A. H. DYSON.

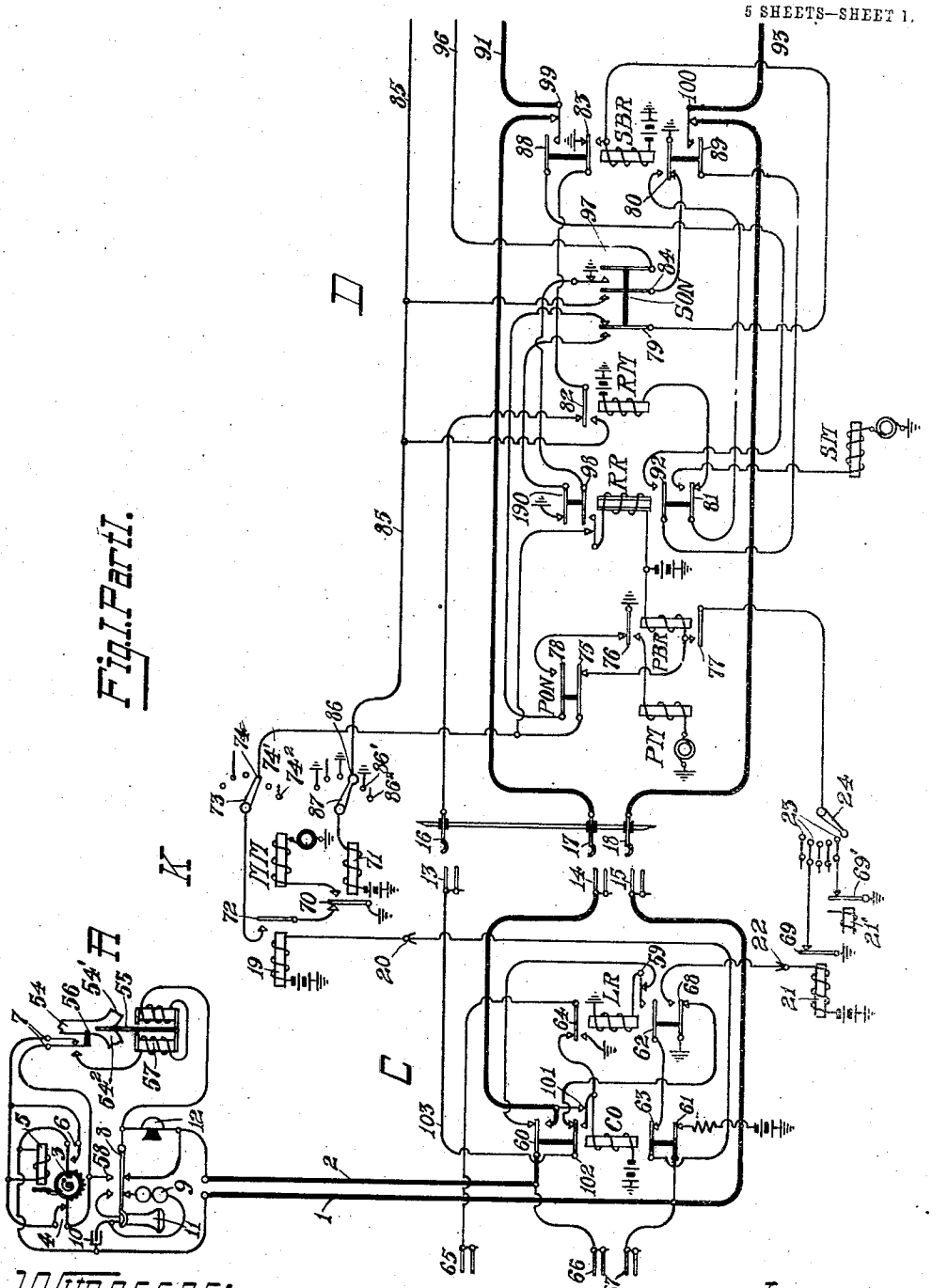
AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED OCT. 13, 1910.

1,118,910.

Patented Nov. 24, 1914.

5 SHEETS—SHEET 1.



Witnesses:

George E. Mueller

Marjorie C. Grier

Inventor:

Alfred H. Dyson.

By Curtis B. Camp

Attorney.

A. H. DYSON.

AUTOMATIC TELEPHONE SYSTEM.

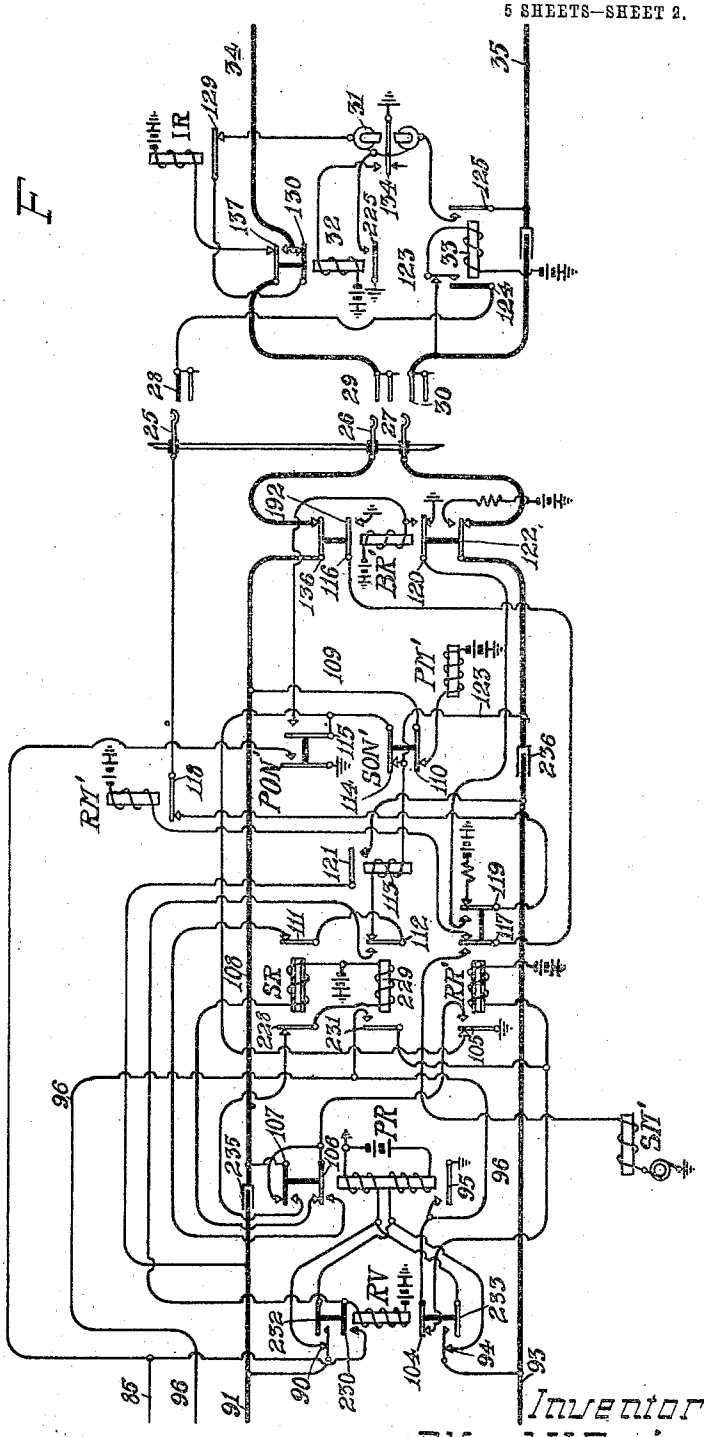
APPLICATION FILED OCT. 13, 1910.

1,118,910.

Patented Nov. 24, 1914.

5 SHEETS—SHEET 2.

Fig. 1 Part 2.



Witnesses:

George E. Mueller

Marjorie C. Grier

Inventor:

Alfred H. Dyson.

By Curtis B. Lamp

Attorney.

A. H. DYSON.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED OCT. 13, 1910.

1,118,910.

Patented Nov. 24, 1914.

5 SHEETS—SHEET 3.

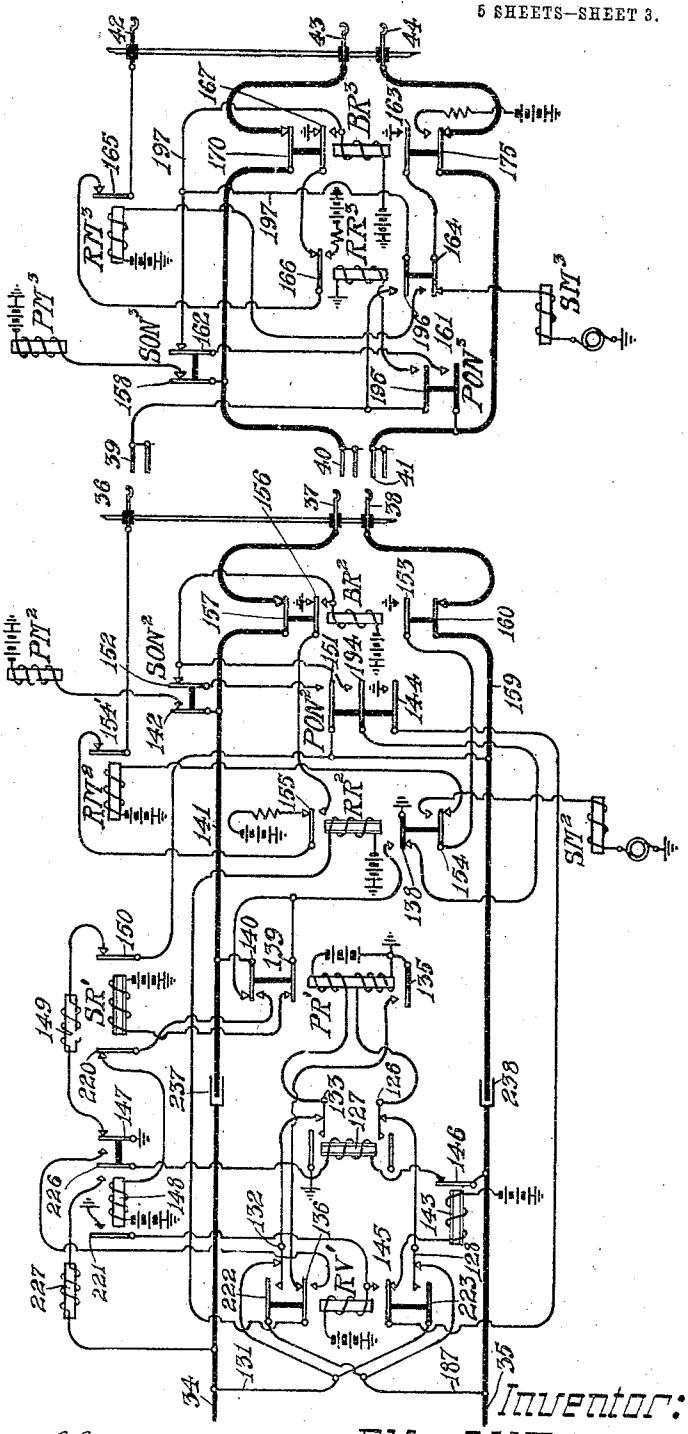


Fig. 1. Part 3.

Witnesses:

George E. Mueller

Marjorie C. Grier

Inventor:

Alfred H. Dyson.

By Curtis B. Cumpt

Attorney.

A. H. DYSON.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED OCT. 13, 1910.

1,118,910.

Patented Nov. 24, 1914.

5 SHEETS—SHEET 4.

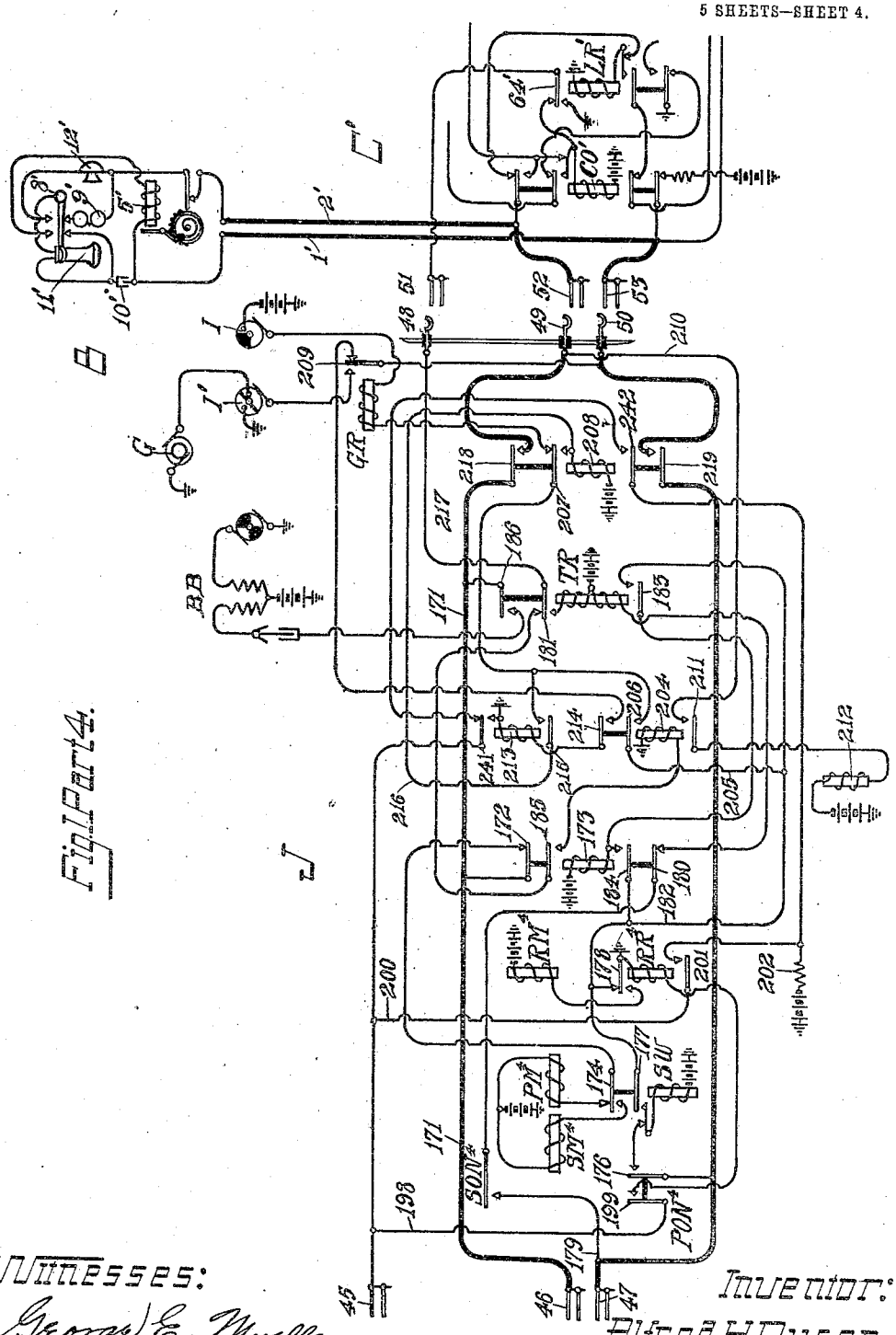


Fig. Part 4.

Witnesses:

George E. Mueller

Marjorie W. Grier

Inventor:

Alfred H. Dyson.

By Curtis B. Esmond

Attorney.

A. H. DYSON.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED OCT. 13, 1910.

1,118,910.

Patented Nov. 24, 1914.

5 SHEETS—SHEET 5.

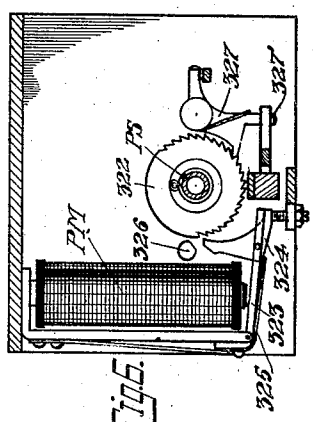


Fig.6.

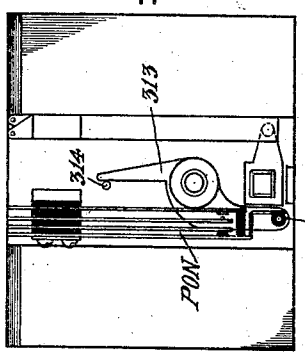
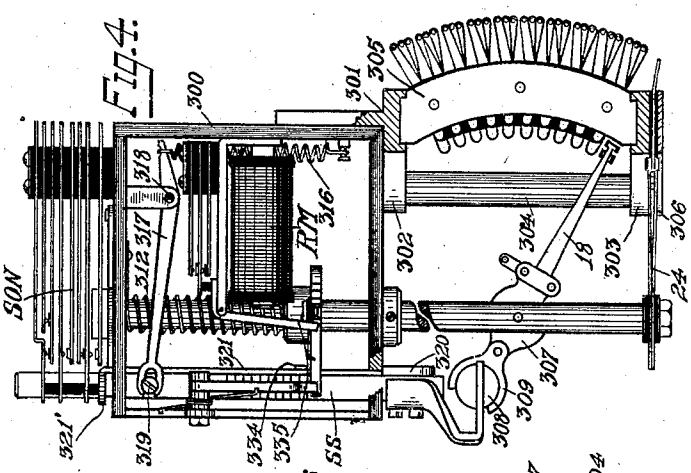
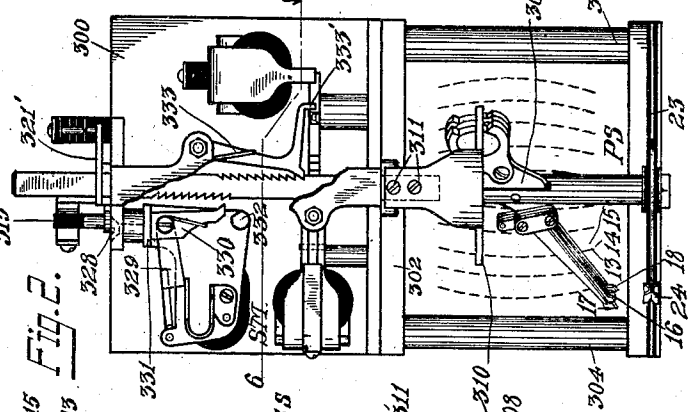
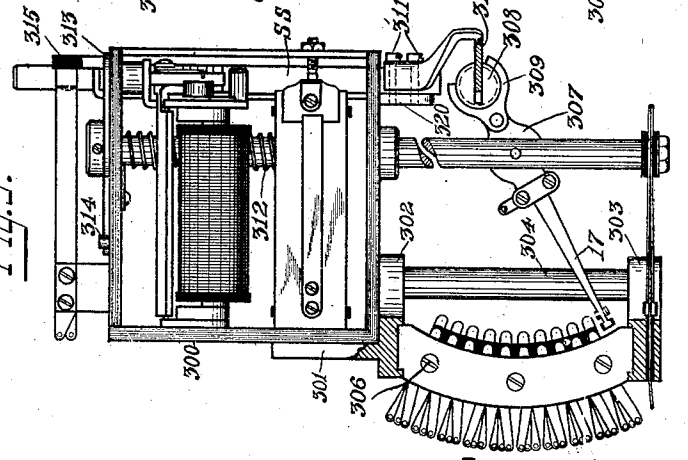


Fig.5.







Witnesses

George E. Mueller

Marjorie E. Grier

Inventor:

Alfred H. Dyson.

By Curtis B. Hunt

Attorney.

UNITED STATES PATENT OFFICE.

ALFRED H. DYSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,118,910. Specification of Letters Patent. Patented Nov. 24, 1914.

Application filed October 13, 1910. Serial No. 586,817.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, a citizen of the United States of America, residing in Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems, and more particularly to systems known as two-wire or metallic line systems in which the switches at the exchange are directively operated responsive to a series of rapid interruptions of the subscribers' line circuits, and without the use of any ground connection at subscribers' stations.

An object of my invention is to provide such a system as above outlined, having improved and simplified circuit arrangements which are more positive in operation and simple of construction.

Another object is to provide an improved metallic trunk circuit for connecting subscribers in different exchanges which is adapted by rapid interruptions of its circuit caused by the originating subscriber to operate switches in the distant exchange to extend the line of the calling to the called subscriber.

Referring to the accompanying drawings, Figure 1, which includes parts 1, 2, 3 and 4 illustrates diagrammatically an automatic telephone system constructed in accordance with my invention. Figs. 2, 3 and 4 are front and side elevations of a selector switch adapted for use with the circuits of my invention. Fig. 5 is a plan view of Fig. 2, showing more particularly the off-normal spring arrangement. Fig. 6 is a cross-section along the line 6—6 of Fig. 2 looking in the direction of the arrow indicated on said Fig. 2.

Referring now more particularly to Fig. 1, A shown at the left of Fig. 1, designates a subscriber's station united to an exchange by line limbs 1 and 2 which terminate in multiple contacts of line selector and connector switches. The substation B shown at the right of Fig. 1, Part 4, is similarly connected to an exchange by line limbs 1′ and 2′, the said line limbs also terminating in multiple contacts of connector switches and line selectors. Connection is established between said subscribers' stations A and B through the line circuit C, line selector D, first selector E, trunk circuit F and its connected second selector G, third selector H, connector J and line circuit C′ associated with the subscriber's line B.

The system illustrated in Fig. 1, is adapted for one hundred thousand lines, and assuming such a system divided into several exchanges, the trunk circuit F is adapted for connecting subscribers in one exchange with subscribers in another exchange. In establishing a connection between calling substation "A" and called substation "B," and assuming the lines of the said substations terminate at different exchanges, upon the removal of the receiver of the subscriber at A from its switch hook upon the initiation of a call, circuit changes are effected at line circuit C. Responsive to said circuit changes, master switch K starts an idle line selector D to seek out and connect with terminals of the calling line. The calling subscriber, after placing a coin in his coin device, actuates his calling device, whereby the first selector E connects with an idle trunk circuit F leading to a second selector G of the distant exchange in which the line of the called for subscriber terminates. The next operation of the calling device is effective to cause the second selector G to connect with an idle third selector, H, having access to the group of one thousand lines with which the called line is associated. Upon the next operation of the calling device, the third selector H extends the connection to an idle connector J of the group of one hundred lines with which the called line is associated. The next two operations of the calling device cause the connector J to step its wipers into connection with the terminals of the called line, which if idle, is automatically rung. If the called line is busy, the calling subscriber receives a characteristic busy signal, and he may then, by replacing his receiver upon its switch-hook, restore the switches which were used in establishing the connection and have his coin returned. If the called line is idle, the called subscribed in response to the calling signal, removes his receiver from its switch-hook, thereby cutting off the ringing current. Upon the termination of conversation, the subscribers, by replacing their receivers upon their switch-hooks, release the apparatus which was used in establish-

ing the connection and it is then available for further use.

The subscriber's station A is a coin-controlled device in which it is necessary for the calling subscriber to deposit a coin or token before being able to establish a connection with a called subscriber. The subscriber's substation includes the dial 3 and the impulse springs 4. The said dial 3 is normally locked against actuation by magnet 5. The off-normal springs 6 are adapted to be closed while the dial 3 is off normal. The impulse springs 4 are normally shunted by the normal contact 7. The substation telephone circuit of A is the well known Kellogg circuit having a switch-hook 8 which normally closes a circuit through the call bell 9 and the condenser 10, while the coil of magnet 5 also serves as an impedance coil. Upon removing the receiver 11 from the said switch hook 8, the call bell 9 is removed from the circuit and the transmitter 12 and receiver are cut in.

The calling device 3 is normally locked against actuation by magnet 5, and is not unlocked until the line has been selected by a line selector, when the magnet 5 is energized, unlocking dial 3. The switches at the exchange are operated responsive to interruptions of the line circuit, this being accomplished by advancing dial 3 until the proper number of insulated projections pass impulse springs 4. The dial being then released, is returned to normal by the spring, thus opening and closing springs 4 according to the number of interruptions or impulses to be transmitted. Although upon removing receiver 8 from its switch-hook, the line will be selected by a line selector D, it is impossible to complete a connection to a called subscriber until the shunt spring 7 is disconnected by dropping a coin or token in slot 54.

The substation A is connected with the exchange by the line limbs 1 and 2, the said limbs terminating at a line circuit C. Each line circuit C comprises a line relay LR which is adapted upon the initiation of a call to start through the medium of a master switch K, an idle line selector D to connect to a calling line. The cut-off relay CO is adapted to be energized when its line is connected to remove the substation control of relay LR.

Each line selector D includes a primary magnet PM which is adapted to move the wipers of the line selector in a primary direction to select the group of ten lines with which a calling line is associated. The said magnet PM is controlled by the primary busy relay PBR while the secondary busy relay SBR controls the actuation of the secondary magnet SM, the said magnet SM being adapted to move the wipers of the line selector D in a secondary direction to connect with a calling line. Each line selector D also includes a release relay RR and a release magnet RM, the said relay and magnet coöperating to release the line selector D when a disconnection is desired. Each line selector D also includes the primary off-normal springs PON which are adapted to be moved to their alternate position upon the first primary movement of the switch, while the secondary off-normal springs SON are adapted to be moved to their alternate position upon the first secondary off-normal movement of the switch.

As previously stated, the lines are divided into groups of one hundred and as there are ten line selectors D assigned to each one hundred lines, each line would be multiply connected to terminals 13, 14 and 15 of the ten line selectors D which have access to the said group. In the illustration only two such terminal sets are shown. The wipers 16, 17 and 18 of the line selector D are adapted to connect to the bank contacts 13, 14 and 15 respectively.

For each group of one hundred lines and associated ten line selectors, a master switch K is provided. Each master switch K is controlled by the hundred lines with which it is associated, it being adapted to start an idle line selector D to seek connection with a line upon the initiation of a call. The switch construction of master switch K includes several banks of contacts disposed in a circle, each bank having a wiper adapted for connection with its contacts. The wipers are mounted on a shaft having a ratchet wheel secured thereto. The motor magnet MM includes an armature with the ordinary pawl to engage the said ratchet wheel to rotate the wipers when the said magnet MM is operated. Thus, the wipers are advanced in one direction only as the contacts are arranged in a complete circle. This construction is well known and a further description thereof is unnecessary. The relay 19 of the master switch K is also common to the hundred lines controlling the said master switch, all of the said lines being connected to the said relay at the common point 20.

The bank contacts 13, 14 and 15 of each line selector D are divided into ten groups of ten each, and the one hundred subscribers' lines which terminate in the said bank contacts are therefore also divided into ten groups of ten each. Each group of ten line circuits C has a common relay 21, each of the ten line circuits being connected to the associated relay 21 at common point 22. Each group of ten bank contacts has a group contact 23 which is adapted to coöperate with the group wiper 24. Each of the group contacts 23 is normally grounded at its associated relay 21, and when any line is calling, its group relay 21 removes the ground from the contact 23 for the purpose of controlling

a selection of that certain group by the wipers 16, 17 and 18.

Each first selector includes a primary relay PR for transmitting the primary operating impulses, a secondary relay SR for transmitting secondary impulses, a primary magnet PM′, a secondary magnet SM′, a release relay RR′ and a release magnet RM′ for releasing the switch. Each first selector E also includes a busy or trunk selecting relay BR′ which is adapted to control the selection of an idle trunk. The reversing relay RV which is operated when a called subscriber responds is adapted to reverse the battery supply over the calling subscriber's line for the purpose of actuating coin controlling or meter mechanism. The primary off-normal switch PON′ and secondary off-normal switch SON′ are adapted to be moved to their alternate position upon the first respective off-normal movements of the switch. The wipers 25, 26 and 27 of each first selector E are adapted to coöperate with the bank contacts 28, 29 and 30.

The trunk circuit F which is multiply connected to the bank contacts 28, 29 and 30 of first selectors E, includes an impulse repeating relay IR and the polarized relay 31 and relays 32 and 33. The said trunk circuit F extends its pair of conductors 34 and 35 to a distant exchange where they terminate in a second selector G.

Each second selector G includes the usual primary relay PR′, secondary relay SR′, primary magnet PM^2 and secondary magnet SM^2, a release relay RR^2 and release magnet RM^2 and a busy or trunk selecting relay BR^2. The battery reversing relay RV′ is adapted to reverse the battery flow over the trunk circuit to operate the polarized magnet 31 of the trunk circuit F upon response of the called-for subscriber. The primary off-normal springs PON^2 and the secondary off-normal springs SON^2 are moved to their alternate position upon the first respective movements of switch G. The wipers 36, 37 and 38 of second selector G are adapted to coöperate with bank contacts 39, 40 and 41. The said bank contacts 39, 40 and 41 lead to third selector switches H, each third selector including a primary magnet PM^3, a secondary magnet SM^3, release relay RR^3 and release magnet RM^3, and a busy or trunk selecting relay BR^3. Each third selector H also includes a primary off-normal switch PON^3 and a secondary off-normal switch SON^3, the said switches being adapted to be moved to their alternate positions upon the first respective movements of switch H. The wipers 42, 43 and 44 of third selector H are adapted to coöperate with their bank contacts 45, 46 and 47, the said bank contacts leading to connector switches J.

Each connector switch J includes the usual primary magnet PM^4 and secondary magnet SM^4, a release relay RR^4 and release magnet RM^4 in addition to several other relays. Each connector J also includes primary off-normal switch PON^4 and a secondary off-normal switch SON^4, each of the said switches being moved to its alternate position on the first respective movement of switch J. The wipers 48, 49 and 50 of each connector J have access to the terminals 51, 52 and 53 of one hundred subscribers' lines. The subscriber's line B terminates at a line circuit C′ which is similar to the line circuit C, although all of the connections are not shown at C′.

The telephone circuit of substation B is similar to that of A except that B has no coin controlling device in connection.

Operation.—Having now given a general description of the character of the apparatus diagrammatically illustrated in Fig. 1, it is believed that the invention will be best understood by describing in detail the operation of the system as illustrated. Assuming now that the subscriber at telephone A desires to converse with the subscriber at telephone B whose number is 23456, the subscriber at *a* will remove the receiver 11 from its switch-hook 8, and thereafter place a coin or token in the slot 54. The switch-hook 8 moving upward, opens the lower contacts removing the shunt from the transmitter 12 and also disconnecting the call bell 9 from the line and connecting the upper contacts with the said switch-hook 8. The coin or token which is placed in the slot 54 moves downward until it rests upon the end of armature 55, and engaging the insulating stud 56, moves the contact spring 7 to its alternate position. The opening of the normal contact 7 removes the shunt from the impulse springs 4, while the closing of the alternate contact 7 connects the winding of the polarized magnet 57 with the telephone line. At this time, however, the switch-hook 8 being in its upward position, the contact 58 is closed, thereby shunting the winding of the polarized magnet 57 rendering it at this time inoperative.

The receiver 11 having been removed from its switch-hook, and said switch hook having moved to its alternate position, as described, a circuit is established through the line relay LR, traced from ground through the winding of the said relay LR, normal contact 59, normal contact 60, line limb 2, switch-hook 8, contact 58, impulse springs 4, the winding of coil 5, line limb 1, normal contact 61 of cut-off relay CO, through protective resistance to battery. Line relay LR is thereupon energized, locking itself through contact 62, contact 63, the winding of the relay 19 to battery, this circuit also energizing the said relay 19. Also,

upon the energization of the relay LR, alternate contact 64 is closed, thereby connecting ground to the multiple private contacts 65 of the connector switches having access to line A, rendering the said contacts 65 and contacts 66 and 67 busy to any incoming call for subscriber's line A.

The contact 68 of the line relay LR having been moved to its alternate position upon the energization of the said relay LR, a circuit is established through the group relay 21 traced from ground at the said alternate contact 68, through the winding of said relay 21 to battery. The said relay 21 is thereupon energized removing the ground at contact 69 from the group contact 23 of the group of ten lines in which the line of subscriber A is included.

Although when the subscriber at A removes receiver 11 from switch-hook 8, a circuit is established through the winding of coil 5, the line relay having been thereupon immediately energized, again opens this circuit and the armature of said electromagnet 5, should it be attracted, immediately falls back, again locking the calling device 3.

Returning now to relay 19, which energized upon the closing of contact 62 of the line relay LR, a circuit is established from ground at normal contact 70 of relay 71, alternate contact 72 of relay 19, wiper 73, contact 74, normal contact 75 of switch PON of line selector D, through the winding of the primary busy relay PBR to battery. The relay PBR is thereupon energized, closing a circuit through the primary PM from ground at alternate contact 76, through the winding of the said magnet PM to the ungrounded pole of alternating current generator. The primary magnet PM is now energized and advances the wiper 24 into engagement with the first group contact 23 and also moves the wipers 16, 17 and 18 opposite the first group of bank contacts.

As illustrated in connection with the line selector D, the line of the calling subscriber at A terminates at contacts in the fourth group of bank contacts of said switch D. The first group having all idle lines connected thereto, there will be a direct ground upon its group contact 23 from normal contact 69′ of relay 21′. The relay PBR is therefore locked over a circuit traced from said ground at contacts 69′ contact 23, wiper 24, alternate contact 77, through the winding of the said primary busy relay PBR to battery. The wipers of the line selector D having taken a single step as described, the primary off-normal switch PON has moved to its alternate position, thereby opening the initial energizing circuit for said relay PBR at the contact 75 of the said switch PON. The relay PBR having been locked in its energized position, to ground at first group contact 23, the circuit for the primary magnet PM is maintained and the said magnet steps the wipers 16, 17, 18 and 24 to the next group. This being also grounded, the relay PBR is maintained energized and continues so until the primary magnet PM has advanced the wiper 24 into connection with the bank contact 23 of the group relay 21. The group relay 21 being energized and the ground being removed from its contact 23 as described, the relay PBR is deënergized, opening the circuit for the primary magnet PM and the wipers 16, 17 and 18 remain in a position opposite the bank or group of contacts which include the contacts 13, 14 and 15 of the calling line A.

At the time the relay 19 was energized, establishing an initial energizing circuit for the relay PBR, a circuit for the release relay RR was also established from the ground at normal contact 70 of relay 71 at master switch K, the said circuit energizing the said relay RR which locked itself to the ground connection at the secondary off-normal switch SON. The wipers 16, 17 and 18 having been moved to the group of contacts which includes the line of subscriber A and the relay PBR having been deënergized, a circuit for the secondary busy relay SBR is established from ground at normal contact 76 to alternate contact 78 of switch PON, which moved to its alternate position upon the first primary step of switch D, normal contact 79 of switch SON, through the winding of said secondary busy relay SBR to battery. The said relay SBR is thereupon energized, closing a circuit through the secondary magnet SM from ground at alternate contact 80, alternate contact 81 of relay RR and through the winding of the said secondary magnet SM to alternating generator. The secondary magnet SM is thereupon energized, advancing the wipers 16, 17 and 18 to connect with the first set of bank contacts in the selected group.

Assuming that the first set of contacts are the terminals of a non-calling line, the private contact 13 is connected with ground at normal contact 68 of line relay LR of the associated line circuit C. Due to said ground upon the first contact 13, a locking circuit is established for the relay SBR traced from the said ground over wiper 16, normal contact 82 of release magnet RM, and alternate contact 83 of relay SBR to battery. The said relay now remains energized and the secondary magnet SM advances the wipers 16, 17 and 18 until they connect with the bank contacts 13, 14 and 15 of the calling line A. The line relay LR of the calling line A being energized, the ground at contact 68 is disconnected from the bank contact 13 and the secondary busy relay SBR finding no locking circuit, de-

energizes, opening the circuit through the secondary magnet SM, preventing any further actuation of the wipers 16, 17 and 18.

The secondary off-normal switch SON having been moved to its alternate position upon the first secondary movement of switch D, upon the deënergization of relay SBR, a circuit is established from ground at normal contact 80, through alternate contact 84 of switch SON, conductor 85, contact 86, wiper 87 and the winding of relay 71 to battery, energizing said relay 71. This energization of relay 71 is for the purpose of advancing the wipers of the master switch K to the next idle line selector D which is accomplished as follows: Upon the said energization of relay 71, a circuit is closed from ground at alternate contact 70, through the winding of motor magnet MM to alternating current generator. The motor magnet MM is energized and advances the wipers 73 and 87 to the next set of contacts 74′ and 86′, and there being a ground upon the contact 86′, relay 70 remains energized and the motor magnet MM advances wipers 73 and 87 another step into engagement with contacts 74^2 and 86^2 which are contacts leading to another line selector D. If this line selector D is idle, there will be no ground upon the contact 86^2 and the relay 71 will deënergize, opening the circuit for the motor magnet MM and preventing any further advance of wipers 73 and 87. If the line selector which is connected to the contact 74^2 and 86^2 is busy, there will be a ground upon contact 86^2 and relay 71 remaining energized, wipers 73 and 87 are advanced until they reach the terminals of an idle line selector switch. Thus, it will be seen that as soon as a line selector contacts with the terminals of a calling line and relay SBR deënergizes, master switch K moves its wipers to connect with the starting terminals of the next idle line selector of the group. When the secondary busy relay SBR became energized, a circuit for the primary relay of the first selector E was closed through the alternate contacts 88 and 89 of relay SBR, the said circuit being traced from ground at primary relay PR of first selector E, through the upper winding of the said relay, contact 90 of relay RV, conductor 91, contact 88, contact 92 of relay RR, contact 89 of relay SBR, conductor 93, contact 94 of relay RV, the lower winding of relay PR to battery, energizing the said relay PR and closing its alternate contacts.

When the line selector switch D starts on its secondary travel to select the calling line A, the secondary off-normal switch is moved to its alternate position, opening the initial locking circuit for relay RR and establishing a new locking circuit from ground at alternate contact 95 of relay PR of first selector E, conductor 96, alternate contact 97 of secondary off-normal switch SON, alternate contact 98 of relay RR, through the winding of the said relay to battery, locking the said relay RR in its energized condition. Upon the deënergization of the secondary busy relay SBR, after the line A has been selected, a circuit for cut-off relay CO is established, being traced from ground at the upper winding of relay PR at the first selector E, contact 90 of relay RV, conductor 91, contact 99, wiper 17, contact 14, contact 101 of cut-off relay CO, through the winding of said relay CO to battery. The said relay CO is thereupon energized and a locking circuit is established from battery through the winding of relay CO, alternate contact 102, conductor 103, bank contact 13, wiper 16, and normal contact 82 to ground at normal contact 83. The series locking circuit for the line relay LR and the master switch relay 19 is opened at contact 63 upon the energization of cut-off relay CO, thereby restoring the said relays LR and 19 to normal. The restoration of contact 68 of relay LR to normal opens the circuit for group relay 21 which is deënergized, again placing ground upon its group contact 23. Should some other line in the group of ten with which the calling line is associated be calling, the group relay 21 remains energized, keeping its contact 23 ungrounded until any other calling lines in the group have been selected. The restoration of the contact 64 of relay LR to normal, removes the initial ground connection from the multiple contacts 65 at the connector switches having access to line A and replaces this initial busy ground by a connection from the ground which locks cut-off relay CO. Upon the said energization of cut-off relay CO, alternate contact 60 is closed, thereby extending the line of subscriber A to the first selector E and also establishing a circuit for the primary relay PR over the line, the said circuit being traced from the ground at the upper winding of said relay PR, contact 90, conductor 91, normal contact 99, wiper 17, bank contact 14, alternate contact 60, line limb 2, switch hook 8 and contact 58, impulse springs 4, electromagnet 5, line limb 1, contact 15, wiper 18, normal contact 100, conductor 93, contact 94, the lower winding of relay PR to battery. The primary relay PR is now energized over the line of the calling subscriber at A, this circuit also energizing the magnet 5, thereby attracting its armature and unlocking the calling device 3.

At the time primary relay PR was energized, as described, a circuit was established through the release relay RR′ of first selector E, traced from ground at alternate contact 95 of relay PR, normal contact 104 of relay RV, through the winding of the said

relay RR′ to battery, energizing the said relay. The subscriber's station at A now having had its line conductors extended to the first selector E, the subscriber now operates the calling device 3 in a clockwise direction until two of the insulated projections have passed the impulse springs 4. The movement of the device 3 off-normal closes the spring 6, shunting the coil 5 while the impulse springs 4 are being operated. The subscriber having advanced the device 3 as described, releases it and it restores to normal by the spring shown thereon, opening and closing the impulse springs 4 two times. This interrupts the previously described circuit through the primary relay PR of the first selector E two times, deënergizing and energizing said relay to transmit two impulses. It will be remembered that the ground at contact 95 of relay PR established a locking circuit for the release relays RR and RR′. These relays being slow acting relays, do not retract their armatures while the primary relay PR is vibrating or transmitting impulses. Upon the first said deënergization of the primary relay PR, a circuit is established through the secondary relay SR from ground at alternate contact 105 of relay RR′, normal contact 106 of relay PR, through the winding of said relay SR to battery, energizing said relay SR. The said relay SR being a slow or sluggish acting relay, remains in its energized condition from the impulses transmitted by primary relay PR and does not retract its armature until said primary relay PR has ceased to vibrate. Upon the said deënergization of relay PR a circuit is also established through primary magnet PM′ traced from the said ground at alternate contact 105 of relay RR′, normal contact 107 of relay PR, conductor 108, conductor 109, normal contact 110 of off-normal switch SON′, through the winding of said primary magnet PM′ to battery, energizing the said magnet. The relay PR is immediately energized, again opening the circuits through the secondary relay SR and the primary magnet PM′, followed by another deënergization of said relay PR to transmit another impulse through the said relay and magnet. The two impulses transmitted through primary magnet PM′ serve to step wipers 25, 26 and 27 to a point adjacent the second group of contacts. The said group of contact is connected with trunk circuits F extending to the exchange in which the line of the called subscriber terminates. After the second operation of primary relay PR, the circuit through the secondary relay SR is opened long enough for said relay SR to deenergize. Upon the said deënergization of relay SR a secondary impulse is transmitted through the busy or trunk selecting relay BR′, the said circuit being traced from ground at alternate contact 105 of relay RR′, alternate contact 106, normal contact 111, normal contact 112, winding of relay 113, normal contact 114 of secondary off-normal switch SON′, alternate contact 115 of primary off-normal switch PON′, through the winding of the said relay BR′ to battery. The relay BR′ is thereupon energized, establishing a circuit through the secondary magnet SM′ from ground at alternate contact 116, alternate contact 117, the winding of said secondary magnet SM′ to alternating generator. The secondary magnet SM′ is thereupon energized and steps wipers 25, 26 and 27 into engagement with the first set of contacts in the selected group. If the first set of contacts leads to a busy trunk circuit F, there will be a ground upon the contacts 28 as will be hereinafter described, and a locking circuit for the relay BR′ is established from the said ground at contact 28, wiper 25, contact 118 of magnet RM′, alternate contact 119 of relay RR′, alternate contact 120 of relay BR′, through the winding of said relay BR′ to battery. The said relay is locked in its energized condition and secondary magnet SM′ steps wipers 25, 26 and 27 to the next set of contacts in the group. Should the second set be busy, relay BR′ will remain energized, and secondary magnet SM′ will step the wipers to the next set of contacts and so on, until relay BR′ finds an ungrounded or idle contact 28. As soon as the wipers 25, 26 and 27 connect with an idle set of contacts, the relay BR′ is deënergized opening the circuit for the secondary magnet SM′ and preventing any further advance of said wipers 25, 26 and 27.

Upon the first secondary off-normal movement of the switch E, the switch SON′ is moved to its alternate position, opening the initial energizing circuit for relay BR′, but the said switch SON′ is so adjusted that the wiper 25 connects with the first contact 28 in the group before the contact 114 of the said switch SON′ is opened. Thus, a locking circuit is established for relay BR′ at contact 28 if the first set of contacts is busy before the initial energizing circuit for the said relay is opened.

To prevent the subscriber from again actuating the calling device 3 before the first selector E has selected an idle trunk and probably sending a false number of impulses, relay 113 is provided to short circuit the line of the calling subscriber until an idle trunk has been selected. Thus, by short circuiting the said line, the battery supply for the magnet 5 is removed allowing the said magnet to deënergize and locking the calling device 3 against actuation. The secondary impulse which initially energized relay BR′ as previously described, flows through the windings of relay 113 as pre-

viously described, energizing said relay 113 and closing contact 121, thereby establishing connection between the conductors 91 and 93, shunting the battery supply from the relay PR to the line of the calling subscriber and deënergizing magnet 5, again locking device 3. This initial energizing circuit for relay 113 which is established by the secondary impulse, is opened at contact 114 when the secondary off-normal switch SON′ is moved to its alternate position, but at this time the relay BR′ being energized, a new circuit for said relay 113 is established from battery at alternate contact 122 of relay BR′, conductor 123, the winding of said relay 113, normal contact 112, normal contact 111, alternate contact 106 to ground at alternate contact 105. The last traced circuit for the relay 113 is maintained until the busy relay BR′ is deënergized, opening the alternating contact 122, and allowing the said relay 113 to deënergize and open the contact 121. The previously traced shunt is thereby opened and the path for battery through the relay PR is again established over the line of the calling subscriber. The magnet 5 is thereupon energized, attracting its armature and again unlocking the calling device 3. Upon deënergization of relay BR′, after selecting an idle trunk circuit F, a busy or grounded condition is established at the multiple contacts 28 traced from ground at normal contact 120 of relay BR′, alternate contact 119 of relay RR′, normal contact 118 of release magnet RM′, wiper 25 and contact 28. Thus, the selected trunk circuit F will be maintained busy against selection by any other first selector. Also, upon the deënergization of relay BR′, an energizing circuit for relay 33 of trunk circuit F is established from ground at alternate contact 105 of relay RR′ of first selector E, alternate contact 106, normal contacts 111 and 112, winding of relay 113, normal contact 122, wiper 27, contact 30, contact 123, the winding of said relay 33 to battery. The said relay 33 is thereupon energized opening its initial energizing circuit and locking itself over contact 124 to ground at bank contact 28. Upon the said energization of relay 33 the contact 125 is closed, establishing a circuit for primary relay PR′ of second selector G traced over the following path: from ground through the lower winding of said relay PR′, contact 126, contact 128, conductor 35, alternate contact 125, the winding of polarized relay 31, normal contact 129 of impulse repeating relay IR, normal contact 130, conductor 34, conductor 131, contact 132, contact 133, the upper winding of relay PR′ to battery. The relay PR′ is thereupon energized, but the flow of battery through the polarized relay 31 is in a direction tending to hold the armature 134 against the lower contact.

Upon the said energization of relay PR′, a circuit is established through release relay RR^2 traced from ground at alternate contact 135, normal contact 136 of relay RV′, through the winding of said relay RR^2 to battery, energizing said relay RR^2.

The line of the subscriber at A has now been extended to the second selector G in the distant exchange, the trunk conductors 34 and 35 connecting the two exchanges. The calling subscriber now operates his calling device 3 to open and close the contacts 4 three times, thereby interrupting the previously described circuit through the relay PR three times. Three primary impulses are thereby transmitted from ground at alternate contact 105 of relay RR′, normal contact 106, the winding of secondary relay SR to battery, energizing the said relay and holding its armature in an attracted position until after the said impulses have been sent through its winding. The said impulses from ground at alternate contact 105 are also conducted through normal contact 107, conductor 108, normal contact 136, wiper 26, contact 29, normal contact 137 of relay 32, through the winding of impulse repeating relay IR to battery. The said three impulses energize and deënergize the said relay IR three times, opening and closing the contact 129 three times. The opening of contact 129 causes three interruptions of the previously described circuit through relay PR′ of second selector G, deënergizing and energizing said relay PR′ three times. Due to this deënergization and energization of the said relay PR′ three impulses are transmitted from ground at alternate contact 138 of relay RR^2 through normal contact 139, and the winding of the secondary relay SR′ to battery, energizing the said relay SR′ which retains its armature in an attracted position due to its sluggish construction, until after the three impulses have been transmitted through its winding. The said three impulses from the ground at alternate contact 138 also energize and deënergize primary magnet PM^2 over a circuit traced from the said ground at alternate contact 138, normal contact 140, conductor 141, normal contact 142 of the secondary off-normal switch SON^2 through the winding of said primary magnet PM^2 to battery. The resultant energizations of the primary magnet PM^2 are effective to step the wipers 36, 37 and 38 to a point adjacent to the third group of contacts in which are included the contacts 39, 40 and 41. The said group of contacts lead to third selector switches in the one thousand group of lines with which the called line B is associated. Upon the first primary off-normal movement of switch G, contacts PON^2 are moved to their alternate position and a circuit for sluggish relay 143 is es-

tablished from ground at alternate contact 144 of primary off-normal switch PON², normal contact 145, the winding of said relay 143 to battery, energizing the said relay and opening contact 146. After the last of said impulses has been transmitted by primary relay PR′ of the second selector G, the secondary relay SR′ is deënergized and a secondary impulse is transmitted from ground at contact 147 of relay 148, impedance coil 149, normal contact 150, alternate contact 151 of switch PON², normal contact 152 of off-normal switch SON², through the winding of the busy relay BR² to battery, energizing the said relay BR². Upon the said energization of relay BR², a circuit through secondary magnet SM² is established from ground at alternate contact 153, through alternate contact 154, the winding of secondary magnet SM² to alternating generator. The said secondary magnet SM² is thereupon energized and advances the wipers 36, 37 and 38 into connection with the first set of contacts in the selected group. If this first set is busy there will be a ground upon the contact 39 as will be hereinafter described and relay BR² will be retained in its energized condition over a circuit traced from the said ground at the first contact 39 in the group, wiper 36, normal contact 154′, alternate contact 155, alternate contact 156, through the winding of said relay BR² to battery. The secondary magnet SM² then steps the wipers 36, 37 and 38 into engagement with the next set of contacts 39, 40 and 41 leading to a third selector similar to H. If this switch is busy, its private contact 39 will be grounded or in a busy condition and relay BR² remaining locked, secondary magnet SM² advances the wipers 36, 37 and 38 to the next set of contacts and so on until the contacts 39, 40 and 41 of an idle third selector switch H are engaged. Assuming the third selector switch H shown is idle, contact 39 is ungrounded and relay BR² deënergizes, opening the circuit for secondary magnet SM² at contact 153, thereby preventing any further advance of wipers 36, 37 and 38.

The secondary off-normal switch SON² is moved to its alternate position on the first secondary movement of switch G, thereby opening the initial energizing circuit for relay BR² and also cutting off primary magnet PM² from connection with the conductor 141. Also, upon the deënergization of relay BR² a ground or busy condition is placed upon the multiple contacts 39 traced from ground at normal contact 156 of relay BR² through alternate contact 155, normal contact 154′, wiper 36 to contact 39 and its multiples. This busy or ground condition of the contacts 39 renders them unselectable by any other switch seeking access to a third selector in the same group with the third selector H.

The line of the subscriber A has now been extended to a third selector H which has access to the group of one thousand lines with which the called subscriber is associated. The subscriber at A now actuates the calling device 3 to interrupt the previously described circuit through the primary relay PR of first selector E four times. Four impulses are thereby transmitted by said primary relay PR over the previously described path including the upper heavily marked conductor 108 and through the winding of impulse repeating relay IR to battery. The said relay IR in response to the said four impulses, is energized four times interrupting the circuit through primary relay PR′ of second selector G four times. The said relay PR′ of second selector G in response to the said four interruptions transmits four impulses of current from ground at alternate contact 138 of relay RR² through contact 139 and the winding of secondary relay SR′ to battery, energizing said relay SR′ which retains its armature in its attracted position until the said impulses have been transmitted through its winding. The said impulses also serve to operate primary magnet PM³ of third selector H over a path traced from ground at said alternate contact 138, normal contact 140, conductor 141, normal contact 157, wiper 37, contact 40, normal contact 158 of the secondary off-normal switch SON³, through the winding of said primary magnet PM³ to battery. The primary magnet PM³ responsive to the said four impulses advances wipers 42, 43 and 44 to a point adjacent the fourth group of bank contacts which lead to connector switches having access to the group of one hundred lines which includes the line of called line B. The next step is to pick out an idle one of these connector switches.

After the last primary impulse has been transmitted from primary relay PR′ of second selector G, secondary relay SR′ is deenergized, transmitting a secondary impulse from ground at contact 147 of relay 148 at second selector G, through impedance coil 149, normal contact 150, conductor 159, normal contact 160, wiper 38, contact 41, alternate contact 161, normal contact 162, and through the winding of busy relay BR³ to battery. The said relay BR³ is thereupon energized closing a circuit through secondary magnet SM³ from ground at alternate contact 163, through normal contact 164 and the winding of said magnet SM³ to alternating generator. The said magnet SM³ responsive to current from said generator, steps the wipers 42, 43 and 44 into engagement with the first set of contacts in the

selected group and in which contacts 45, 46 and 47 are located. If the first set of contacts 45, 46 and 47 lead to a busy connector switch J, contact 45 of the said first set is grounded or in a busy condition, as will be hereinafter described. Assuming the first contact set is busy, a locking circuit for relay BR^3 is established from ground at said first contact 45, through wiper 42, normal contact 165, normal contact 166, alternate contact 167, through the winding of said relay BR^3 to battery. The secondary magnet then steps wipers 42, 43 and 44 into engagement with the next set of bank contacts. If the second set of contacts lead to a selected connector switch, the relay BR^3 remains locked, maintaining the circuit through secondary magnet SM^3 which advances wipers 42, 43 and 44 until a set of contacts 45, 46 and 47, leading to an idle connector switch J are reached.

Assuming switch J is the first idle connector switch in the group, its private contact 45 will be ungrounded and in an idle condition and the locking circuit for relay BR^3 will be interrupted and the said relay BR^3 will deënergize, opening the circuit through the secondary magnet SM^3 at the contact 163. The wipers 42, 43 and 44 will therefore remain in connection with the contacts 45, 46 and 47 which lead to connector switch J. Upon the deënergization of the relay BR^3 a grounded or busy condition is placed upon contact 45 and its multiples, traced from ground at normal contact 167 of said relay BR^3, through normal contact 166, normal contact 165, wiper 42 to the contact 45 and its multiples, rendering the said connector switch unselectable by any other selector having access thereto. The off-normal spring operation of third selector H and the coöperation with the busy relay BR^3 and primary magnet PM^3 is similar to the first and second selector switches.

The subscriber at A has now extended his line to the connector J and the said connector J having access to the one hundred line group with which the line of the called subscriber B is associated, the next step is to operate the said connector switch J to connect with the called line. The calling subscriber now operates the calling device 3 to transmit five impulses. Responsive to the actuation of the said calling device 3, the primary relay PR′ of second selector G is operated five times to transmit five impulses from the ground at alternate contact 138 of relay RR^2 over the previously described path, energizing the secondary relay SR′ in the usual manner and the said impulses flowing over the previously described path to wiper 37, contact 40, normal contact 170, wiper 43, contact 46, conductor 171, normal contact 172, normal contact 174 of switching relay SW through the winding of primary magnet PM^4 to battery, operating the said magnet five times. Responsive to the five operations of said primary magnet PM^4, wipers 48, 49 and 50 are stepped to a point adjacent the fifth group of contact sets, which is the ten group which includes the terminals or bank contacts 51, 52 and 53 of the called subscriber at B. After the last of said primary impulses has been transmitted from primary relay PR′, secondary relay SR′ is deënergized in the usual manner, transmitting an impulse over the lower heavily marked conductor to wiper 38 and contact 41, normal contact 175, wiper 44, contact 47, primary off-normal contact 176, which is now closed and through the winding of switching relay SW to battery, energizing the said relay which locks itself through contact 177 to ground at normal contact 178 of release relay RR^4. Upon the energization of said switching relay SW, the contact 174 is moved to its alternate position, disconnecting primary magnet PM^4 and connecting secondary magnet SM^4 to said contact 174.

The calling subscriber having now picked out the group of ten lines with which the line of the called subscriber is associated, the next step is to actuate calling device 3 to transmit six impulses. Responsive to the actuation of the calling device 3, the primary relay PR′ of the second selector G is operated six times, transmitting six impulses over the previously described path, energizing the secondary relay SR′ as before, the said impulses also flowing along the upper heavily marked conductor to wiper 43, contact 46, normal contact 172, alternate contact 174, and then through the winding of secondary magnet SM^4 to battery, operating the said secondary magnet six times and stepping the wipers 48, 49 and 50 into engagement with contacts 51, 52 and 53 which are the sixth set of contacts in the group and are the terminals of the line of the called subscriber at B which we have assumed is number 23456. The connection from the calling to the called subscriber along the heavily marked conductors is only interrupted at relay 208 of connector J and relay 32 of trunk circuit F.

Called line busy.—The calling subscriber having extended his line to the terminals of the called line, the next step is to test the said line to determine its idle or busy condition. After the last set of six impulses have been transmitted as described, secondary relay SR′ of second selector G deenergizes, and transmits a secondary impulse over the previously described path along the lower heavily marked conductor to wiper 44 and contact 47, then over conductor 179, through the contact of the sec-

ondary off-normal switch SON⁴ which closed upon the first secondary step of connector switch J, normal contact 180 through the lower winding of test relay TR to battery, energizing said relay TR. Assuming that the called line is busy, there will be a ground or busy condition upon multiple contacts 51, either from a connector switch, if the line is a called line, or, as previously described, from ground at contact 83 of a line selector if the called line be calling. Therefore, contact 51 being grounded, relay TR is locked over a circuit from ground at said contact 51 over wiper 48, alternate contact 181, through the upper winding of the said test relay TR to battery. Upon the energization of the said relay TR, a circuit for relay 173 is established from ground at normal contact 178 of release relay RR⁴, along conductor 182, alternate contact 183 of relay TR, then back through the winding of said relay 173 to battery, energizing said relay 173 which is then locked through alternate contact 184 to said ground at normal contact 178. The energization of said relay 173 disconnects test relay TR from the lower heavily marked conductor, and secondary magnet SM⁴ from the upper heavily marked conductor. Although at this time the contact 185 of the relay 173 is closed, the circuit extending through the said contact is opened at contact 181 of the relay TR. Responsive to the energization of the test relay TR, its contact 186 is closed connecting the busy back signal BB with conductor 171 and transmitting said signal to the calling subscriber over a path which includes the upper heavily marked conductor back through third selector H, second selector G, over the trunk circuit F, to normal contacts 130, 129, the winding of relay 31, alternate contact 125, over the lower heavily marked conductor through first selector E, line selector D, line circuit C, the line conductor 1, the receiver of substation A, returning over line conductor 2 along the upper heavily marked conductor of line circuit C, line selector D, conductor 91 of first selector E, normal contact 90 and the upper winding of relay PR to ground. Although the busy signaling current will be shunted by the primary relays, this shunting effect is not sufficient to prevent apprising the calling subscriber of the state of the called line. The said busy back signal which is a well known characteristic signal, being received by the calling subscriber, the said subscriber is notified that the called line is busy and therefore replaces the receiver 11 upon its switch hook 8. The replacing of the receiver 11 upon its switch hook is effective to restore all of the switches used in establishing the connection and is also effective to connect the polarized relay 57 of the coin controlling apparatus to the line to be operated.

As the called subscriber was busy, the coin or token which was placed in the slot 54 is returned to the calling subscriber, this being accomplished in the following manner: When the receiver is placed upon switch-hook 8, the shunt which existed across the terminals of the winding of the polarized magnet 57 is removed by the opening of contact 58 and switch-hook 8. Current from primary relay PR of the first selector E which flowed through the telephone of the calling subscriber at A now flows through the winding of polarized magnet 57, due to the shunt being removed, this flow being in such a direction that the armature 55 is attracted toward the left. This allows the coin or token which has been deposited in the slot 54 to drop out of the slot 54′ which conducts the coin out of the usual coin box to be returned to the calling subscriber. The coin or token having moved out of engagement with insulating stud 56, contact spring 7 is restored to its normal position, disconnecting polarized magnet 57 from circuit with the line, thus interrupting the circuit through the substation A at contact 7. The circuit at the substation A being interrupted, the primary relay PR of first selector E deenergizes, retracting its armature and restoring its contact springs to normal.

The opening of contact 95 of primary relay PR allows release relays RR of line selector D and RR′ of first selector E to deenergize. Upon the deënergization of release relay RR of line selector D, a circuit for relay SBR is established from ground at contact 190, alternate contact 79 of secondary off-normal switch SON, through the winding of relay SBR to battery, energizing said relay SBR. Responsive to energization of said relay SBR, a circuit for release magnet RM is established from ground at alternate contact 80 of said relay SBR, normal contact 81 of release relay RR, through the winding of said release magnet RM to battery, energizing the said magnet which withdraws the retaining pawls of the wiper shafts, and wipers 16, 17 and 18 restore to normal. Upon the energization of release magnet RM, the circuit through cut-off relay CO is interrupted at contact 82 of said magnet RM and said relay CO deënergizes, restoring the line circuit C to normal. The secondary relay SBR has its energizing circuit switches at the time the secondary off-normal switch contact 79 is moved from its alternate to its normal position, to ground at normal contact 76, this circuit being interrupted at contact 78 of switch PON, and said relay SBR retracts its armatures. It will thus be seen that while the wipers 16, 17 and 18 are being restored and moving

over the bank contacts they are disconnected at release magnet RM and at contacts 99 and 100 of relay SBR. Upon the restoration of relay SBR, the energizing circuit through the release magnet RM is interrupted at contact 80 and said magnet RM deënergizes. It will be noted that conductor 85 which is connected to the contact 86 of the master switch K, is connected to ground at line selector D through alternate contact 82 and alternate contact 84, thus maintaining contact 86 of master switch K grounded or busy from line selector D until said switch D has been restored to normal.

Returning now to the release of first selector E, upon the deënergization of its release relay RR′, a circuit for relay BR′ is established from ground at normal contact 105 of said relay RR′, alternate contact 115 of primary off-normal switch PON′, through the winding of said relay BR′ to battery, energizing said relay BR′. Responsive to the energization of said relay BR′, a circuit for release magnet RM′ is established from ground at alternate contact 192, normal contact 117 of the release relay RR′, through the winding of said release magnet RM′ to battery, energizing said magnet RM′ and withdrawing the retaining pawls, allowing wipers 25, 26 and 27 to restore. Also, upon the deënergization of release relay RR′, the locking circuit for relay 33 of trunk circuit F is opened, allowing said relay 33 to deënergize. This is for the purpose of releasing the other switches which will be hereinafter more fully explained. Upon the restoration of first selector E, the primary off-normal switch PON′ moves its contacts to their normal position, thereby opening the previously described circuit through the relay BR′ at the contact 115, allowing said relay BR′ to deënergize and open the circuit for release magnet RM′ which also deënergizes.

As previously stated, the conductor 85 leading to the master switch K is maintained grounded until the line selector D releases. This conductor is also maintained grounded until the first selector switch E restores to normal, by means of the ground at primary off-normal switch PON′. Thus, it will be seen that the contact 86 of the master switch K is maintained grounded or busy until its associated connected pair of switches are restored to normal.

Returning now to relay 33 of trunk circuit F, it will be remembered that the said relay deënergizing upon the energization of the release relay RR′ of the first selector E. The opening of contact 125 of said relay 33 interrupts the circuit through primary relay PR′ of second selector G and the said primary relay deënergizes retracting its armature. The release relay RR^2 of second selector G is thereupon deënergized, due to the opening of its energizing circuit at the contact 135 of relay PR′ and said release relay RR^2 retracts its armatures restoring its contacts to normal. Upon said deënergization of release relay RR^2 a circuit for the relay BR^2 is established from ground at normal contact 138 of relay RR^2, contact 194 of primary off-normal switch PON^2, through the winding of said relay BR^2 to battery, causing its energization. Responsive to the said energization of relay BR^2 a circuit through release magnet RM^2 is established from ground at alternate contact 153 of relay BR^2, normal contact 154 of relay RR^2, through the winding of the release magnet to battery, energizing said magnet RM^2. When release relay RR^2 deënergized, a circuit for release relay RR^3 of third selector H was established from battery, normal contact 155 of said relay RR^2, normal contact 154′ of release magnet RM^2, wiper 36, contact 39, alternate contact 195 of primary off-normal switch PON^3 of third selector switch H, through the winding of said release relay RR^3 to ground, energizing said release relay RR^3.

Returning now to second selector G, release magnet RM^2 having been energized as described, the circuit just traced through release relay RR^3 of third selector H is interrupted at contact 154′ of release magnet RM^2, thus opening the initial energizing circuit for said relay RR^3. Upon the said energization of release magnet RM^2 the retaining pawls for the second selector switch G are withdrawn, allowing wipers 36, 37 and 38 to restore to normal. As relay BR^2 of said switch G remains energized until its circuit is opened at primary off-normal switch PON^2, wipers 37 and 38 remain disconnected at contacts 157 and 160 of said relay BR^2. On the restoration of said switch G to normal, the circuit for relay BR^2 being interrupted by primary off normal switch PON^2, the energizing circuit for release magnet RM^2 is interrupted at contact 153 of relay BR^2, and the said release magnet RM^2 is deënergized. The second selector G and the trunk circuit F are now again in normal condition, and are available for further use.

The release relay RR^3 of third selector H having been energized by the impulse of current from second selector G, a locking circuit for said relay RR^3 is established from ground through the winding of said relay RR^3, alternate contact 195, alternate contact 196, conductor 197, through the winding of relay BR^3 to battery, maintaining said relay RR^3 energized and the said circuit also energizing relay BR^3. Upon the said energization of relay RR^3, a releasing impulse is transmitted to connector J from battery.

at alternate contact 166 of said relay RR^3, normal contact 165, of release magnet RM^3, wiper 42, contact 45, conductor 198, contact 199, through the winding of release relay RR^4 of connector J to ground, energizing said release relay RR^4.

The release relay RR^3 and relay BR^3 of third selector H having been energized and locked up in series, a circuit for the release magnet RM^3 is established from ground at alternate contact 163 of relay BR^3, alternate contact 164 of relay RR^3, through the winding of release magnet RM^3 to battery, energizing said magnet RM^3 which withdraws the retaining pawls of third selector switch H, allowing wipers 42, 43 and 44 to restore to normal. During the restoration of the said wipers, wiper 42 has its circuit opened at contact 165 of said release magnet RM^3, and wipers 43 and 44 have their circuits opened at the contacts 170 and 175 of relay BR^3. On the restoration of said switch H to normal, primary off-normal switch PON^3 is restored to normal, opening the series energizing circuit for relays RR^3 and BR^3 at contact 195. The said relays are thereupon deënergized, opening the circuit for release magnet RM^3. The third selector switch H and its associated mechanism is now at normal and available for further use.

The release relay RR^4 of the connector switch J having been energized from an impulse of current from third selector switch H as described, a locking circuit for said relay RR^4 is established from ground through the winding of said relay RR^4, alternate contact 199 of switch PON^4, conductor 198, conductor 200, alternate contact 201 of relay RR^4, through protective resistance 202 to battery. Upon the said energization of relay RR^4, the locking circuit for relays SW and 173 is opened at contact 178, the said contact then closing a circuit through release magnet RM^4, energizing the said magnet. Upon the said energization of release magnet RM^4, the retaining pawls for the connector switch J are withdrawn, allowing wipers 48, 49 and 50 to restore to normal. The connector switch J and its associated mechanism now having been restored, the said switch is available for further use.

The switches and all their associated mechanism which were used in establishing the connection from the line of the calling subscriber at A to the line of the called subscriber at B have now been restored to normal and are available for use in establishing other connections.

Called line idle.—Assuming now that the calling subscriber has extended his line to terminals 51, 52 and 53 of the line of the called subscriber at B, and that the said line is idle, the last secondary impulse as previously described, energizes test relay TR of connector switch J. Having assumed that the called subscriber is idle, there will be no ground connection to the contact 51 and no locking circuit for the upper winding of the test relay TR will exist. Upon the said energization of relay TR, a circuit for relay 173 is established from ground at normal contact 178 of release relay RR^4, conductor 182, alternate contact 183 of relay TR, through the winding of said relay 173 to battery, energizing said relay 173 and establishing a locking circuit for it through contact 184 to the said ground at normal contact 178. On the energization of the relay 173, the circuit through the lower winding of the test relay TR is interrupted at contact 180, allowing the said relay to deenergize. The opening of contact 172 of relay 173 disconnects secondary magnet SM^4 from the upper talking conductor. Also, upon the energization of relay 173 and deenergization of relay TR, a circuit for relay 204 is established from ground through the winding of said relay 204, alternate contact 185, normal contact 181, wiper 48, contact 51, normal contact 64′ of line relay LR′, the winding of cut-off relay CO′ to battery, energizing both of the relays 204 and CO′.

The energization of cut-off relay CO′ removes the substation control of line relay LR′. Upon the energization of relay 204, a circuit is established from ground at normal contact 178 of relay RR^4, conductor 205, alternate contact 206, normal contact 207 of relay 208, through the winding of the generator or ringing relay GR to battery at the interrupter wheel I.

The interrupter wheels I and I′ are preferably mounted upon the same shaft, being rotated by a motor or in any desirable way. The relay GR energizes responsive to the closing of the circuit just described, thereby connecting ringing generator G with the called line through the lower segment of the interrupter I′ and its brush, alternate contact 209, of relay GR, wiper 50, contact 53, line limb 1′, through the condenser and call bell of the called subscriber's telephone B, line limb 2′, contact 52, wiper 49, conductor 210, alternate contact 211, through the winding of coil 212 and battery to ground, operating the bell of the subscriber's telephone B.

The bell of the called subscriber is intermittently rung due to the interruptions of the circuit through the ringing relay GR at the interrupter I. Due to the construction and relative position of the interrupter wheels I′ and I, the circuit from generator G is interrupted at wheel I′ before the energizing circuit for the relay GR is interrupted at wheel I. The ground connection to the upper segment of interrupter wheel I′ is therefore connected through the brush to

alternate contact 209 before the energizing circuit for the relay GR is interrupted. This direct ground connection to the line of the called subscriber after each ringing period causes the said line conductors and substation condenser to discharge through the said ground should they become charged from the current from ringing generator G. If the line were not discharged to ground as described, there would be a tendency for the line to discharge through relay 213, operating it prematurely. The interrupter wheels I and I′ continue in their rotation until the insulated segment of the wheel I engages its brush and the circuit through the relay GR being interrupted, the said relay deënergizes. Upon the said deënergization of relay GR, relay 213 is connected to the called line through alternate contact 214 of relay 204, normal contact 209 of relay GR to the wiper 50, contact 53, and the limb 1′ of the telephone line. Assuming the subscriber has not responded to the call, the circuit through the telephone B for direct current is interrupted at the condenser 10′ so that the relay 213 is not energized. The interrupter wheels I and I′ continuing in their rotation, generator G and relay 213 are alternately connected through contact 209 of relay GR to the called line.

The called subscriber responding to the call, removes receiver 11′ from its switch hook, thereby disconnecting call bell 9′ and establishing a path for direct current through the upper contacts of the switch hook 8′. A circuit for relay 213 is therefore established when the relay GR is deenergized, from ground, through the winding of said relay 213, alternate contact 214, normal contact 209, wiper 50, contact 53, line limb 1′, the winding of coil 5′, upper contacts of switch hook 8′, transmitter 12′, limb 2′, contact 52, wipers 49, conductor 210, alternate contact 211, impedance coil 212 to battery. The relay 213 is thereupon energized over the path just described, said relay 213 now being under the control of the called subscriber, it being energized over a path including the line of called subscriber B. Upon the said energization of relay 213, a circuit for relay 208 is established from ground at normal contact 178 of relay RR^4, conductor 182, conductor 205, alternate contact 206, alternate contact 215, conductor 216, winding of relay 208 to battery, energizing said relay 208. Upon the said energization of relay 208, the circuit through ringing relay GR is interrupted at contact 207, said relay 208 then locking itself through said contact 207, contact 206, conductor 205, conductor 182, to ground at normal contact 178. The closing of contacts 218 and 219 of relay 208 extend the connection from the connector switch J to the line of the called subscriber at B. Upon the said response of the called subscriber and the energization of the relay 208 of connector J, a circuit for relay 148 of second selector switch G is established from ground at relay 213 of connector J, contact 214, normal contact 209, wiper 50, contact 53, line limbs 1′, and 2′, and the telephone of substation B, contact 52, wiper 49, contact 218, along the upper heavily marked conductor, through the wipers of switches J and H to contact 40 and wiper 37 of switch G, normal contact 157, alternate contact 140 of relay PR′, normal contact 220 of relay SR′, the winding of relay 148 to battery, energizing said relay 148. The said energization of relay 148 is effective to operate reversing relay RV′ which reverses the flow of battery current through the polarized relay 31 of trunk circuit F which, operating in response to the said reversal, is effective to close the circuit of the upper heavily marked conductor of the relay 32 at trunk circuit F, in response to which the reversing relay RV of the first selector switch E is operated.

The operation of the said reversing relays and polarized relay which occurs only when a called subscriber responds, is brought about as follows: Upon the said energization of relay 148 of second selector G, a circuit for reversing relay RV′ is established from ground at alternate contact 221, through the winding of said relay RV′ to battery, energizing said relay RV′, which locks up through alternate contact 145 to ground at alternate contact 144 of switch PON^2. The said energization of relay RV′ reverses the flow of battery at contacts 222 and 223 from primary relay PR′, through polarized relay 31 of trunk circuit F. This said reversal of current through polarized relay 31 is effective to attract its armature 134 upward, closing a circuit through relay 32 from ground at alternate contact 134. The said relay 32 is thereupon energized closing the alternate contact 137 and establishing the continuity of the upper heavily marked conductor. Also, upon said energization of relay RV′, of second selector switch G, the circuit for relay 143 is interrupted at contact 145. The said relay 143 is therefore deënergized, closing contact 146 and establishing a circuit through relay 127 from ground at contact 225 of relay 32, of trunk circuit F, through the winding of the lower coil of polarized relay 31, alternate contact 125, conductor 35, normal contact 146, the winding of said relay 127, alternate contact 226, impedance coil 227, conductor 34, alternate contact 137, contact 29, wiper 26, normal contact 136, conductor 108, normal contact 107, normal contact 228, through the winding of relay 229 to battery. This circuit is effective to retain the armature of the polarized relay 31 in its upward position and to energize relay 127 of second selector

G and relay 229 of first selector E, the three said relays being in series. The said energization of relay 127 opens normal contacts 133 and 126 and establishes a locking circuit for relay PR′ from ground to alternate contact 133.

The release relay RR² of second selector switch G which had its initial energizing circuit opened at normal contact 136 of relay RV′ is maintained energized over a circuit from ground at alternate contact 147 of relay 148, alternate contact 136 of relay RV′, through the winding of the said relay RR² to battery. At second selector switch G, the relays RV′, 127, PR′, RR² and 148 are now all energized, remaining so until the subscribers replace their receivers upon their switch hooks upon the completion of conversation.

At first selector switch E, relay 229 having been energized as described, a circuit for reversing relay RV is established from ground at alternate contact 105 of relay RR′, alternate contact 106, normal contact 111, alternate contact 112, winding of the said relay RV to battery, energizing said relay RV which locks itself through contact 230 to ground at the primary off-normal switch PON′ or ground at line selector D. Upon the said energization of relay RV the initial energizing circuit for release relay RR′ is opened at contact 104 of relay RV, but the relay 229 having been energized, a new path is established through its contact 321. The opening of contact 104 of relay RV places release relay RR′ under control of the calling and called subscribers, as will be more fully described.

The closing of the contacts 232 and 233 of relay RV reversed the flow of battery current from the primary relay PR over the line of the calling subscriber. This reversal of battery flow is effective to operate the polarized magnet 57 to collect the coin or token of the calling subscriber when receiver 11 is replaced upon switch hook 8 at the termination of the conversation. The connection from the calling subscriber to the called subscriber is now completed, the talking circuit being traced over the heavily marked conductors. Talking battery for the calling subscriber is supplied from battery at primary relay PR of the first selector E. Talking battery for the called subscriber is supplied from battery at impedance coil 212 of connector J over the previously described path including the called line and telephone to ground through the winding of relay 213 of connector J.

The condensers 235 and 236 at first selector E and condensers 237 and 238 at second selector G inductively unite the talking conductors between the calling and called subscribers. Battery is bridged across the talking conductors of trunk circuit F during a conversational circuit, the said bridge being traced from battery through the winding of relay 229 of switch E, normal contact 228, alternate contact 107, along the upper heavily marked conductor to switch G, impedance coil 227, alternate contact 226, relay 127, normal contact 146, the lower heavily marked conductor 35 to alternate contact 125 at trunk circuit F, the winding of the lower coil of relay 31 to ground at alternate contact 225.

Release.—On finishing conversation, the subscribers replace their receivers on their respective switch hooks. Should the calling subscriber at A be the first to replace his receiver upon its switch hook, all of the switches used in establishing the connection except the connector switch J will release. Should the called subscriber at B be the first to replace his receiver upon its switch hook, all of the switches except the line selector D will release.

Assuming that the called subscriber at B first restores his receiver to its switch hook, the previously traced energizing circuit for relay 213 of the connector switch J is interrupted at the contacts of the switch hook 8′. The said relay 213, therefore deënergizes, but has no effect upon any of the circuits at this time.

It will be remembered that relay 148 of second selector G has been maintained energized over the previously described circuit from ground through the winding of relay 213 over the limbs of the called telephone line B and back along the upper heavily marked conductor to said relay 148. This energizing circuit for the relay 148 is interrupted when the subscriber at B places his receiver upon its switch hook and said relay 148 deënergizes. Upon the said deënergization of relay 148, the energizing circuit through release relay RR² of switch G is interrupted at ground through alternate contact 147 of relay 148. The said release relay RR² therefore deënergizes and a circuit for relay BR² is established from ground at normal contact 138 of said relay RR², alternate contact 194 of switch PON², through the winding of said relay BR² to battery. The said relay BR² is thereupon energized, closing a circuit through release magnet RM², energizing the said magnet. The release relay RR² having deënergized previous to the energization of the release magnet RM², an impulse of current is transmitted from battery at normal contact 155 of relay RR² to releasing relay RR³ of third selector H. The energization of the release magnet RM² of the second selector G restores the switch as previously described and the energization of the release relay RR³ of third selector H is effective to operate the release magnet of the said switch to restore its wipers as previously described. Upon the said energiza-

tion of release relay RR^3 of switch H, an energizing circuit for the release relay RR^4 of connector switch J is established from battery at alternate contact 166 of said relay RR^3, normal contact 165, wiper 42, contact 45, conductor 198, alternate contact 199, the winding of said relay RR^4 to ground. The relay RR^4 is thereupon energized opening the circuit for switching relay SW and relay 173 as previously described in connection with the release and said relays SW and 173 deënergize. Upon the deënergization of relay 173, the energizing circuit for relay 204 and cut-off relay CO' is interrupted at contact 185 of said relay 173 and said relays 204 and CO' deënergize. The deënergization of the relay 204 opens its contact 206, thereby opening the energizing circuit for relay 208 which now deënergizes, retracting its armature and restoring its contacts. Also, upon the energization of release relay RR^4, a circuit for release magnet RM^4 is established as previously described, resulting in the energization of the said release magnet and the restoration of the connector switch J.

Returning now to switch G, the relay 148 having deënergized upon the restoration of the called subscriber's receiver upon its switch hook as described, the connection from the upper talking conductor 34 to the lower talking conductor 35 is interrupted at contact 226 of said relay 148, interrupting the circuit for polarized relay 31 of trunk circuit F and relays 127 of switch G and 229 of switch E. The said relay 31 is therefore deënergized, opening the circuit for relay 32 at contact 134 and said relay 32 deënergizes, restoring its contact springs to normal. The slow-acting relay 127 of switch G having also been included in circuit with the polarized relay 31, now retracts its armature, opening the circuit for the primary relay PR' at alternate contact 133, allowing the said relay PR' to deënergize. The reversing relay RV' has its energizing circuit opened at contact 144 of the switch PON^2 upon the restoration of the switch G and retracts its armature. The switch G and all of its associated mechanism is now at normal.

Referring now to the first selector E, it will be remembered that the relay 229 thereof was included in the circuit of relay 127 of switch G and relay 31 of trunk circuit F, and the said circuit having been interrupted as previously described at contact 226 of relay 148 of secondary selector G, said relay 229 deënergizes. Upon said deënergization of relay 229 the circuit for release relay RR' of switch E is interrupted at contact 231 of relay 229, and said relay RR' deënergizes, interrupting the circuit for relay 33 of trunk circuit F which restores to normal. Also, upon the deënergization of relay RR'; relay BR' and the release magnet RM' of switch E are energized as previously described, resulting in the release of the said switch E as previously described. The calling subscriber at A now by replacing his receiver upon its switch hook, connects the polarized magnet 57 of the coin controlling device into circuit with the line. The calling subscriber at A having received a response from the called subscriber and the reversing relay RV of switch E having reversed the flow of battery through the primary relay PR and over the line of the calling subscriber as described, the armature of polarized magnet 57 is attracted toward the right, allowing the coin or token which has been deposited in slot 54 to drop through slot 54^2 and be collected in the usual coin collecting box. The coin or token having disengaged itself from insulating stud 56, spring 7 moves to normal, interrupting the circuit for battery flow through substation A as previously described, thereby interrupting the circuit for primary relay PR of switch E, deënergizing said relay PR. Upon the said deënergization of relay PR the energizing circuit for release relay RR of line selector D is interrupted at ground at contact 95 of relay PR, deënergizing said relay RR. The said deënergization of relay RR is effective to energize relay SBR and release magnet RM, resulting in the restoration of line selector D and the line circuit C, as previously described.

The reversing relay RV of switch E is maintained energized through its locking contact 230 to the ground connected to conductor 85 which maintains the contact 86 of the master switch K busy. Therefore, the said relay RV deënergizes upon the restoration of the line selector D when the said ground connections to the conductor 85 are removed. All the switches used in establishing the connection from the calling subscriber at A to the called subscriber at B have now been restored to normal and are available for further use.

Assuming now that the calling subscriber at A is the first to replace his receiver upon its switch hook, line circuit C, line selector D, first selector E, trunk circuit F, second selector D, and third selector H are released. Responsive to the placing of receiver 11 upon its switch hook 8 at the calling substation A, the circuit for primary relay PR of switch E is interrupted, said relay PR deënergizing and interrupting the circuit for release relay RR' by the opening of its contact 95. The opening of said contact 95 also interrupts the energizing circuit for release relay RR of line selector D, said relay RR also deënergizing. Upon the deënergization of said two release relays, their respective switches and line circuit E are released as previously described. Also, upon the deënergization of relay PR, the series circuit, including relays 229,

and 31, is interrupted at contact 107 of relay PR. The relay 127 being a sluggish relay, relays 229 and 31 retract their armatures first. The polarized relay 31 retracting its armature, opens the circuit through relay 32, which deënergizes, restoring its contacts to normal. The relay 127 then retracts its armature, opening the locking circuit for primary relay PR′ at contact 133 and the said relay PR′ deënergizes. Upon the said deënergization of relay PR′, the circuit for relay 148 is interrupted at alternate contact 140 and said relay 148 deënergizes, opening the locking circuit for release relay RR^2 at alternate contact 147. The release relay RR^2 is thereupon deënergized, the said deenergization being effective to energize relay BR^2 and release magnet RM^2 as previously described, resulting in the release of switch G as before. The deënergization of release relay RR^2 of switch G is effective to transmit an impulse to release relay RR^3 of third selector H, resulting in the release of said switch H as previously described. The connector switch J in this instance is not released by the calling subscriber but its release is under the control of the called subscriber at B. At the time release relay RR^3 of the third selector H was energized to release said switch H, an impulse from battery was transmitted to bank contact 45 leading to connector switch J. This impulse of current does not release switch J as said contact 45 is connected directly to ground at alternate contact 241 of relay 213, thereby shunting release relay RR^4 of connector switch J, preventing its energization at this time. The called subscriber at B now replaces his receiver upon its switch hook, interrupting the circuit for relay 213 which has been maintained through substation B as previously described. The relay 213 is thereupon deënergized and a circuit for release relay RR^4 is established from ground through the winding of the said relay RR^4, alternate contact 199 of switch PON^4, conductor 198, normal contact 241 of relay 213, alternate contact 242 of relay 208, through protective resistance 202 to battery, energizing said relay RR^4 which opens the locking circuit for the relays SW and 173, and deenergizes said relays. The deënergization of relay 173 results in the deënergization of relays 204 and CO′ as previously described, due to opening of contact 185. The locking circuit for relay 208 is also opened at contact 178 of relay RR^4 upon its energization. The release magnet RM^4 is energized responsive to the energization of release relay RR^4 resulting in the release of the connector switch J as previously described. All of the switches and their associated mechanism are now at normal and available for further use.

Should the calling subscriber desire at any time not to complete any connection once started, he may by replacing his receiver upon its switch hook, release all of the switches which have been used up to that time. In view of the previous description of the method of releasing the different switches, the method of releasing the switches used in extending an incomplete connection may be readily traced out.

While I have described a connection extending from a subscriber in one exchange to a subscriber in a distant exchange, it is to be understood that the system is adapted for connecting subscribers in the same exchange. In such a case, of course, the trunk circuit F and second selector G may not be included in the connection, but in extending the call, first selector E may connect to a second selector similar to third selector H or it is obvious that switch E may connect directly with a selector H, this, of course, depending on the trunking arrangement.

While I have illustrated a plurality of batteries it is to be understood that the batteries of each exchange are all one and the same, this also being true of the alternating current generator for operating the magnets. Also, where I have shown ground connections, it is to be understood that these connections in practice extend to the grounded pole of battery or generator as the case may be, they being illustrated in this manner as it is more simple and convenient in describing the operation of the system.

Switch construction.—It is obvious that in the telephone system just described, many forms of switching devices may be used to perform the different functions described, but I preferably employ switches of the type illustrated in Figs. 2 to 6. The switch structure shown in said Figs. 2 to 6 is preferably employed as a line selector, but by leaving off the horizontal row of contacts shown at the bottom of Figs. 2, 3 and 4, with their coöperating wiper, and by using the proper off-normal spring arrangement as illustrated in the circuits of the different switches, the said structure may be used as a first, second or third selector, or as a connector switch. The switch illustrated in the said Figs. 2 to 6 comprise a frame 300 having a contact bank frame 301 secured thereto. The said bank frame includes the upper plate 302 and the lower plate 303, the said plates being secured together by means of studs 304. Clamped between plates 302 and 303 are ten contact banks 305, each bank consisting of two plates between which are clamped by means of screws 306, ten sets of contacts 13, 14 and 15 suitably insulated from each other. Thus, it will be seen that each switch includes ten banks 305, although only one such bank is shown,

and there being ten sets of contacts in each bank, there would be one hundred sets of contacts for each switch. In Fig. 2 each contact set is represented by a single line, the bank being illustrated in this manner as it is more simple and easily understood than if a complex perspective view of the bank were shown. For each bank 305 there is a group contact 23, there being ten such contacts 23, the said contacts being insulatingly held between plates 303 and 306.

The wiper 24 which is secured to the lower end of primary shaft PS is adapted to be advanced to any one of the group contacts 23. The wipers 16, 17 and 18 are adapted to cooperate with the bank contacts 13, 14 and 15, the said wipers being adapted to be advanced in a primary direction to a point adjacent to any one of the contact banks 305. The said wipers 16, 17 and 18 are fastened to plate 307, the said plate being pivotally mounted in a slot in primary shaft PS. The said shaft PS is journaled in the upper and lower extensions of frame 300, being adapted to be rotated in its bearings. The roller 308 is adapted to rotate in the fork 309, the said fork being secured to the plate 307. The said roller 308 has a slot cut through its center in which is fitted plate 310, which is fastened to the secondary shaft SS, by means of screws 311. Thus, when the primary shaft PS is rotated to advance the wipers to a group or bank of contacts, roller 308 slides along plate 310.

The primary shaft PS which is under tension of the spring 312 has secured to its upper end, arm 313 normally resting against the stop 314 under tension of said spring 312. The insulating stud 315 which is secured to arm 313 normally rests against primary off-normal springs PON, holding them in their normal position. Upon the first step of primary shaft PS off normal the insulating stud 315 moves toward the left, allowing the springs of primary off-normal switch PON to move to their alternate position.

The secondary shaft SS which is preferably made square is fitted into openings in the upper and lower extensions of frame 300.

The secondary shaft SS which is adapted to receive rectilinear motion only, is adapted to be moved downward, and by means of the connection between the plate 310 and roller 308, the wipers 16, 17 and 18 are advanced along a selected row or bank of contacts. The said shaft SS is held in its normal position by spring 316, the said spring being connected to one end of lever 317. The said lever 317 is pivoted at bracket 318, the other end of lever 317 being connected to secondary shaft SS by means of screw 319. The stop 320 which is fastened to secondary shaft SS rests against the lower extension of frame 300. The sliding bar 321 is arranged alongside of the secondary shaft SS, passing through the upper and lower extensions of frame 300.

The secondary off-normal springs SON rest under tension upon the extension 321′ of bar 321. When the secondary shaft SS is moved downward to advance wipers 13, 14 and 15 into engagement with bank contacts 13, 14 and 15, stop 320 is moved away from frame 300 allowing the secondary off-normal springs to move the bar 321 downward, the said springs thus assuming their alternate position.

The primary ratchet 322 is fastened to primary shaft PS. The primary magnet PM which is fastened to frame 300 has an armature 323 having a pawl 324 pivotally secured thereto. The said pawl 324 is normally out of engagement with ratchet 322 but upon the attraction of armature 323, the said pawl 324 is moved into engagement with a tooth of ratchet 322 by spring 325. The stop 326 is so adjusted that when armature 323 is fully attracted, said stop 326 locks pawl 324 against its engaged tooth, thus preventing any over-run of shaft PS, due to the momentum when it is advanced or rotated. The check pawl 327 which engages teeth of ratchet wheel 322 prevents the return of the said ratchet 322 and primary shaft PS until said pawl 327 is disengaged from said ratchet 322 for the purpose of releasing the switch.

The secondary magnet SM which is fastened to the vertical upright of frame 300 and the upper extension of the same frame by means of screw 328, has an armature 329 pivotally mounted between the two end plates of the said magnet. Pivoted to said armature 329 is pawl 330 normally resting against stop 331, thus holding the pawl 330 out of engagement with the teeth of secondary shaft SS. Upon the attraction of armature 329, pawl 330 is moved away from stop 331 and into engagement with a tooth of secondary shaft SS. The stop 332 is so adjusted that when armature 329 is fully attracted pawl 330 is locked against its engaged tooth of secondary shaft SS, thus preventing any over-run of the said shaft SS, due to its momentum when advancing the wipers 16, 17 and 18 along a selected row of contacts. The retaining pawl 333 prevents the restoration of said secondary shaft SS by spring 316 until said pawl 333 is withdrawn from engagement with a tooth of secondary shaft SS when releasing the switch.

The key 334 which is secured to bar 321 is adapted to engage any tooth of primary ratchet 322 when the secondary shaft SS and bar 321 are moved downward to advance wipers 16, 17 and 18 into engagement with the first set of contacts of a selected group.

The function of this key 334 will be more fully explained when describing the release of the switch. The release magnet RM is fastened to frame 300 and has an armature 335 pivotally secured thereto. The said armature 335 is adapted when the release magnet RM is energized to engage the retaining pawl 327, moving it out of engagement with primary ratchet 322. The extension 327′ of pawl 327 is adapted to engage extension 333′ of pawl 333 to move the said pawl 333 out of engagement with the teeth of secondary shaft SS to release the switch.

Switch operation.—Having described in detail the construction of the switch structure shown in Figs. 2 to 6, the operation of the said switch will now be described. Assuming the wipers are to be connected to a contact set in the fourth bank or group of contacts, primary magnet PM is operated four times, advancing wipers 16, 17 and 18 to a point adjacent the fourth group of contacts. When the first primary off-normal step of the switch is made, off normal springs PON move to their alternate position, remaining there until the switch is restored to normal. Wipers 16, 17 and 18 having been moved to the fourth group of contacts, the secondary magnet SM is operated to step the wipers 16, 17 and 18 to a set of contacts 13, 14 and 15 in the selected group. Upon the first secondary step of the switch, the secondary off-normal springs SON move to their alternate position, remaining so until the secondary shaft SS restores to its normal position. To release the switch, the release magnet RM is energized, withdrawing the retaining pawls 327 and 333 from engagement with their respective coöperating ratchet teeth. When the retaining pawl 327 is withdrawn from the ratchet wheel 322 the spring 335 of the primary shaft PS tends to restore the primary shaft PS to normal. The key 334 of bar 321 at this time is in engagement with a tooth of ratchet wheel 322, thus preventing the spring 335 from forcing wipers 16, 17 and 18 against the sides of contacts 13, 14 and 15 while the said wipers are being restored from their secondary movement. Upon the restoration of secondary shaft SS to normal the stop 320 engages the lower end of bar 321 forcing it upward, thereby restoring the secondary off-normal switch SON and moving key 334 out of engagement with ratchet wheel 322. Ratchet wheel 322 now being free, shaft PS is restored by spring 335, thereby returning the wipers 16, 17 and 18 and restoring the primary off-normal springs PON to normal.

It will be apparent from the above description of the embodiment of my invention that many alterations and modifications may be made in the arrangement of circuits and apparatus, as well as the location of the same, without departing from the spirit or scope of my invention. I therefore do not wish to be limited to the specific matter disclosed, but aim to cover by the terms of the appended claims all such alterations and modifications.

What I claim as new and desire to secure by Letters Patent is:

1. In a telephone system, the combination with a calling subscriber's telephone line connected with an exchange, a called subscriber's telephone line connected with a distant exchange, a two conductor trunk circuit connecting said exchanges, means for connecting the calling line with said trunk circuit, a relay at the distant exchange included in said circuit, a source of current for energizing said relay over the two conductors of said trunk, means for rapidly interrupting said circuit at the first exchange, whereby said relay vibrates its armature, and a plurality of automatic selectors and a connector switch actuated responsive to said vibration for extending said trunk circuit to the called line.

2. In a telephone system, the combination with a calling subscriber's telephone line connected with an exchange, of a called subscriber's telephone line connected with a distant exchange, a two conductor trunk circuit connecting said exchanges, means for connecting the calling line with said trunk circuit, a relay at the distant exchange included in said circuit, a source of current for energizing said relay over the two conductors of said trunk, a calling device at the calling station actuated by the calling subscriber, means at the first exchange operated responsive to said calling device for rapidly interrupting said circuit, whereby said relay vibrates its armature, and one or more automatic selectors and a connector switch successively actuated responsive to said vibrations for extending said trunk circuit to the called line.

3. In a telephone system, the combination with a calling subscriber's telephone line connected with an exchange, of a called subscriber's telephone line connected with a distant exchange, a two conductor trunk circuit connecting said exchanges, means for connecting the calling line with said trunk circuit, a primary relay at the distant exchange included in said circuit, a source of current for energizing said relay over the two conductors of said trunk, a repeating relay at the first exchange having switch contacts included in said circuit, a calling device at the calling station, means for operating said repeating relay responsive to impulses transmitted from said calling device, whereby said contacts interrupt said circuit to thereby operate the primary relay

for transmitting impulses, and automatic switches actuated responsive to the operation of said primary relay for extending said trunk circuit to the called line.

4. In a telephone system, the combination with a calling subscriber's telephone line connected with an exchange, of a called subscriber's telephone line connected with a distant exchange, a normally discontinuous trunk circuit connecting said exchanges, a primary relay at the distant exchange included in said circuit, a source of current included in said circuit, a repeating relay at the first exchange having switch contacts included in said circuit, means for connecting the calling line with said circuit, means actuated responsive to said connection to render said circuit continuous, whereby said primary relay is energized, a calling device at the calling station, means for operating said repeating relay responsive to impulses transmitted from said calling device, whereby said contacts interrupt said circuit to operate the primary relay, and automatic switches actuated responsive to the operation of said primary relay for extending said trunk circuit to the called line.

5. In a telephone system, the combination with a calling subscriber's telephone line connected with an exchange, of a called subscriber's telephone line connected with a distant exchange, a trunk circuit having normally discontinuous talking strands connecting said exchanges, a primary relay at the distant exchange, a source of current, a repeating relay at the first exchange having switch contacts, means for connecting the calling line with said circuit, a normally open series circuit including said source of current, switch contacts and primary relay and part of said strands, means actuated responsive to said connection to close said series circuit, whereby said primary relay is energized, a calling device at the calling station, means for operating said repeating relay responsive to impulses transmitted from said calling device, whereby said contacts interrupt said circuit to operate the primary relay, automatic switches actuated responsive to the operation of said primary relay for extending said trunk circuit to the called line, and means actuated on response of the called subscriber to render said talking strands continuous.

6. In a telephone system, the combination with a calling subscriber's telephone line connected with an exchange, of a called subscriber's telephone line connected with a distant exchange, a trunk circuit having normally discontinuous talking strands connecting the calling line with the distant exchange, a repeating relay at the first exchange having switch contacts, a primary relay at the distant exchange, an energizing circuit for said primary relay including said switch contacts and part of said talking strands, means for rapidly operating the armature of the repeating relay whereby its contacts rapidly interrupt said circuit, and thereby operate said primary relay, automatic switches actuated responsive to said operation of the primary relay for extending said trunk circuit to the called line, and means actuated upon response of the called subscriber to render said talking strands continuous.

7. A telephone system including subscribers' telephone lines, automatic line selectors for connection thereto, means effective upon removal of receiver in initiating a call for causing travel of an idle one of said selectors to connect with a calling line, a release relay for said selector energized upon such removal in the initiation of said call, and means under the control of the calling subscriber to deënergize said relay.

8. A telephone system comprising a calling line, a line selector for connecting to said line, a first selector, a release relay for each switch energized upon initiation of a call, a primary relay for said first selector, energized upon said initiation of a call, a maintaining circuit for said release relays closed upon energization of said primary relay, means for rapidly energizing and deenergizing said primary relay to operate said first selector, thereby rapidly interrupting said maintaining circuit, and means to retain the armatures of said release relays attracted while their circuits are being rapidly interrupted.

9. In a telephone system, the combination with a telephone line, of a calling device therefor, a plurality of trunks, a directively controlled automatic selector switch connected with said line having access to said trunks, means for causing automatic travel of said switch to automatically select and connect with an idle one of said trunks, and means for locking said calling device against actuation until said switch has connected with an idle one of said trunks.

10. In a telephone system, the combination with a subscriber's telephone line, of a calling device therefor, a selector switch connected with said line, a plurality of groups of trunks leading from said switch, step-by-step mechanism for operating said selector switch to select a group of trunks responsive to an actuation of said device, a step-by-step mechanism thereafter automatically operated whereby said switch travels to connect with an idle trunk in the selected group, and means for locking said device against further actuation until said switch has connected with an idle one of said trunks.

11. A telephone system comprising a subscriber's telephone line, a calling device

therefor, an automatic switch, trunk lines leading therefrom, means responsive to said calling device for causing automatic travel of the switch to automatically select and connect with a trunk line, and means for locking said device against actuation during said travel.

12. A telephone system comprising a subscriber's telephone line, a calling device therefor, an automatic selector switch, means for connecting said switch and said line, trunk lines leading from said switch arranged in groups, means for causing travel of said switch to select a group and means for thereafter causing a secondary travel of said switch to connect to a trunk line of the selected group, and means for locking said device against actuation during the secondary travel of said selector switch.

13. A telephone system comprising a calling telephone line connected with an exchange, a called telephone line connected with a distant exchange, a two-wire metallic trunk circuit connecting said exchanges, means for connecting the calling line with said trunk circuit, a relay at the distant exchange and a source of current for energizing said relay included in said metallic circuit, means controlled from the calling substation for rapidly interrupting said metallic circuit at the first exchange whereby said relay is correspondingly operated for transmitting impulses, and selectors and connector switches successively actuated responsive to such impulses from said relay for extending said trunk circuit to the called line.

14. A telephone system comprising a calling telephone line connected with an exchange, a called telephone line connected with a distant exchange, a two-wire metallic trunk circuit connecting said exchanges, means for connecting the calling line with said trunk circuit, a primary relay at the distant exchange and a source of current for energizing said relay included in said metallic circuit, a repeating relay at the first exchange having switch contacts included in said metallic circuit, means controlled from the calling substation for directively operating said relay to periodically interrupt said metallic circuit whereby said primary relay is correspondingly operated, automatic selectors and connector switches, and means whereby one or more selectors and a connector switch are successively actuated responsive to said primary relay for extending said trunk circuit to the called line.

15. A telephone system comprising a telephone line a calling device therefor, a selector switch, at a central office connected with said line, groups of trunk lines leading from said selector switch, means responsive to an actuation of said calling device for causing said switch to select a group of trunks, means for causing an automatic selection of an idle trunk in a selected group, and electromagnetic means at said calling device responsive to control mechanism at the central office for rendering said calling device inoperative while said switch is automatically operating to select an idle trunk.

16. A telephone system comprising a telephone line, a calling device therefor, a selector switch at a central office connected with said line, groups of trunk lines leading from said selector switch, means responsive to an actuation of said calling device for causing said switch to select a group of trunks, means for causing an automatic selection of an idle trunk in a selected group, electromagnetic locking means for said calling device, control mechanism at the central office for short circuiting said telephone line while said switch is automatically operating to select an idle trunk whereby said locking means is rendered effective, and means responsive to selection of an idle trunk for rendering said locking means ineffective.

17. A trunk circuit for automatic telephone exchanges comprising a two conductor metallic circuit, a primary relay and source of current in bridge of said circuit at one end thereof, an impulse relay at the other end having normally closed contacts included in said metallic circuit, and a third relay for said second end having normally open contacts included in said metallic circuit, said last named relay being adapted to be energized upon connection made with its end of the trunk circuit to close said contacts so as to energize said primary relay.

Signed by me at Chicago, county of Cook, and State of Illinois, in the presence of two witnesses.

ALFRED H. DYSON.

Witnesses:
FRANCIS W. DUNBAR,
GEORGE E. MUELLER.