C. S. WINSTON.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED APR. 11, 1910.

1,214,982.

Patented Feb. 6, 1917.

3 SHEETS—SHEET 1.

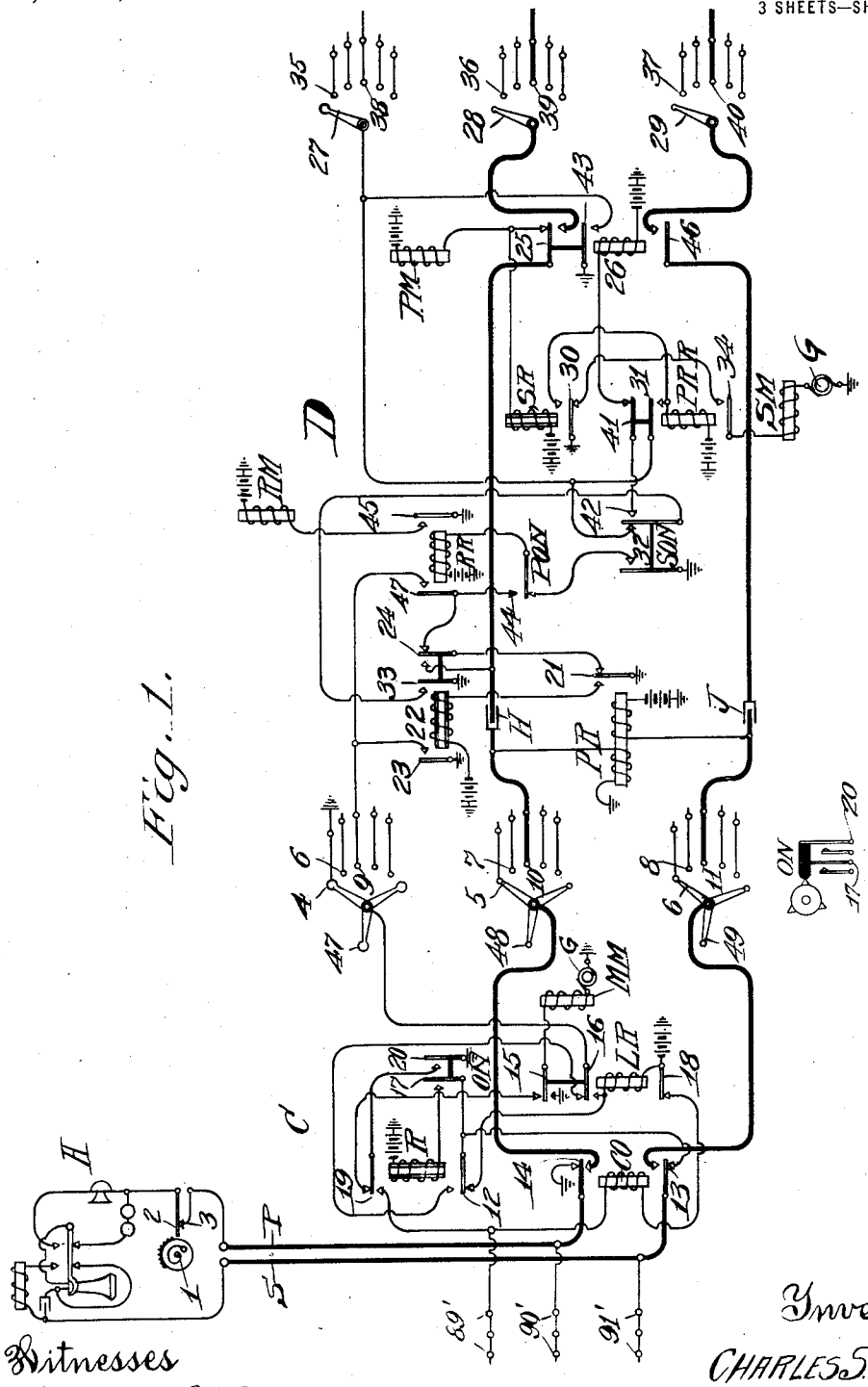

Fig. 1.

Fig. 4.

Witnesses

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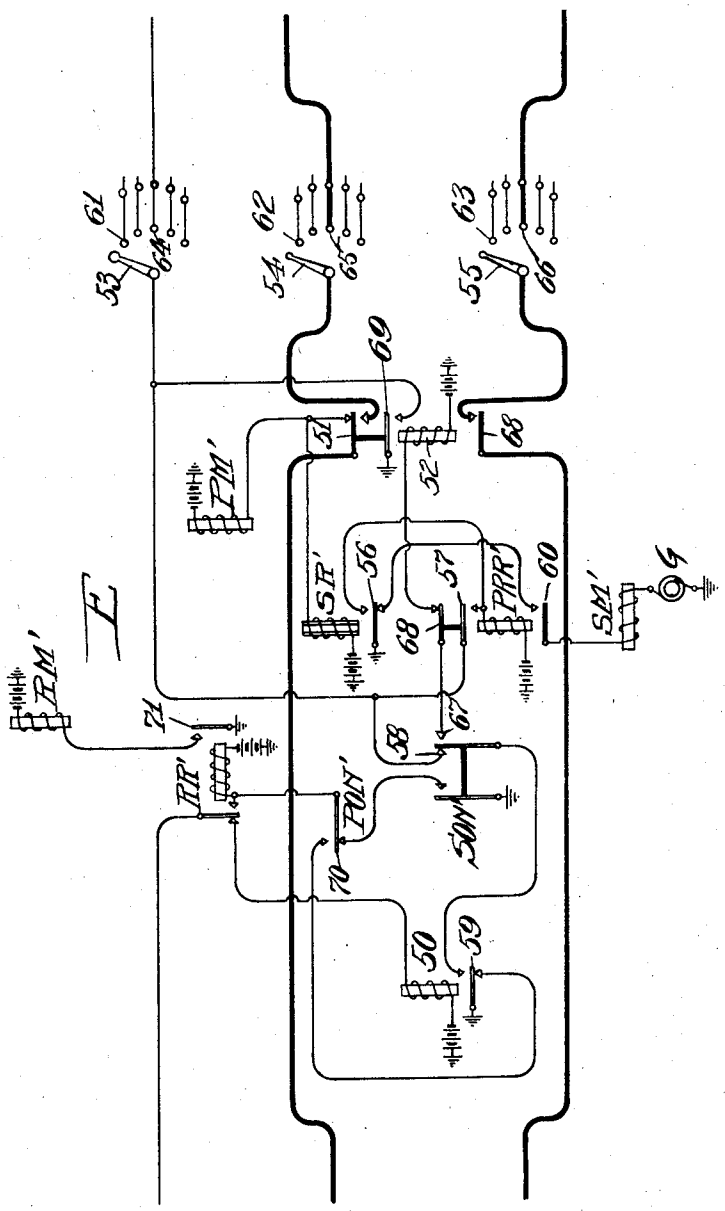
3 SHEETS—SHEET 2.

Fig. 2.



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3 SHEETS—SHEET 3.

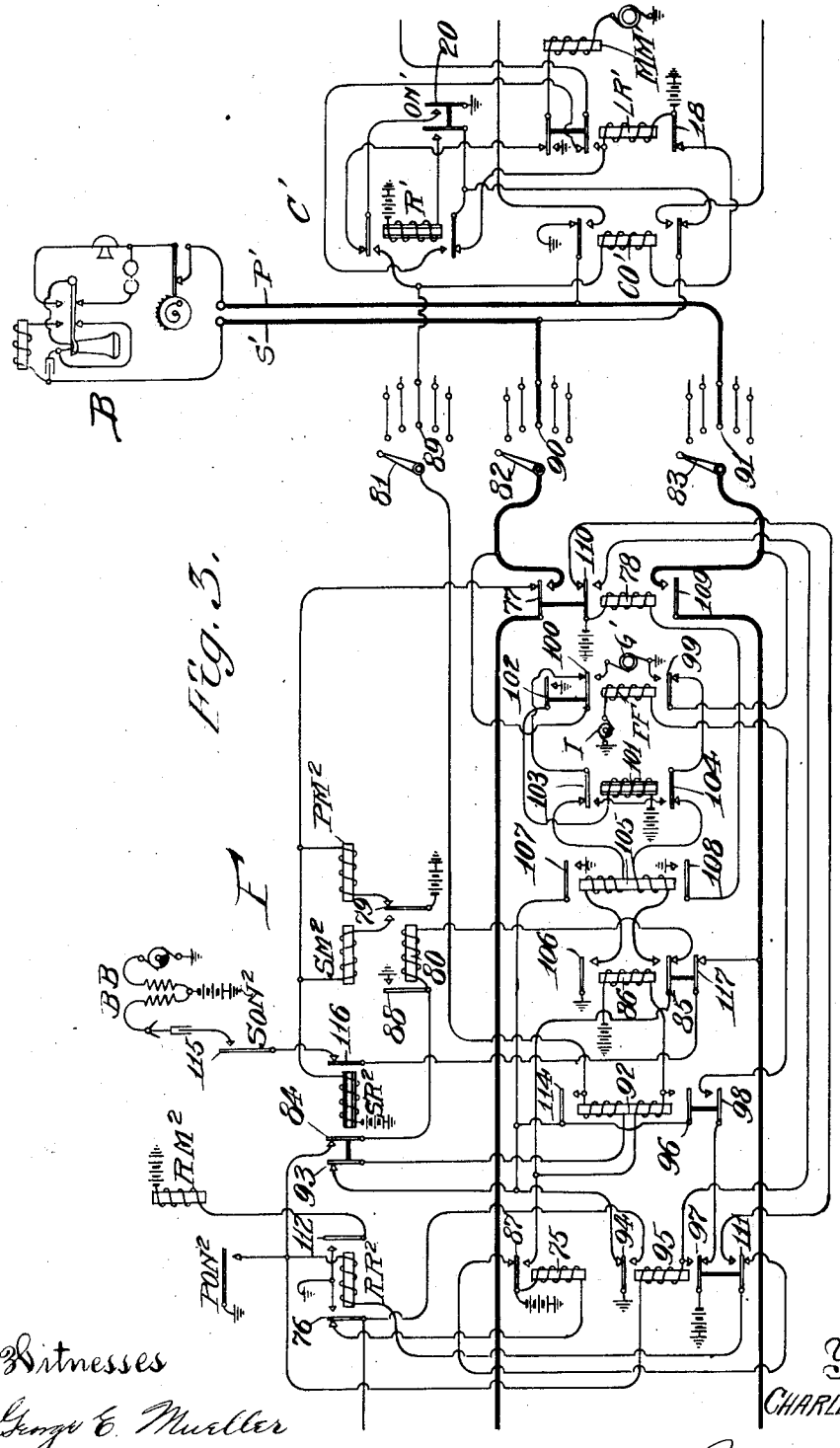

FIG. 3.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,214,982. Specification of Letters Patent. Patented Feb. 6, 1917.

Application filed April 11, 1910. Serial No. 554,595.

To all whom it may concern:

Be it known that I, CHARLES S. WINSTON, 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 that type known as two-wire systems, in which metallic subscribers' lines are provided both for talking and signaling purposes; that is, all ground connections at the subscribers' stations are dispensed with, the object being to provide a system which is free from ground connections at the subscribers' stations and is simple and positive in the operation of its circuits.

The circuits shown in the accompanying drawings are adapted to be used in connection with that type of selector and connector switches in which movable contacts or wipers are adjusted first in a so-called primary movement to bring them to a desired row or bank of contacts, and then adjusted by a so-called secondary movement to cause them to engage the desired contacts in the selected bank or row. While I have shown no drawing of a mechanical switch, the system as shown in the accompanying drawings is adapted to operate in connection with the well-known Strowger switch, although in my system I do not use what is known as the side-switch, but in place thereof, use off-normal springs, those operating on the first primary off-normal step of the switch being known as primary off-normal springs, and those operating on the first secondary off-normal movement of the switch being known as secondary off-normal springs.

In the system of my application I use line switches, one individual to each line, and having access to a group of first selector switches, the said line switches upon the initiation of a call, automatically connecting the calling line with an idle first selector switch.

Referring to the accompanying drawings, Figure 1, Fig. 2 and Fig. 3, by placing the Fig. 1 to the left, Fig. 2 in the middle, and Fig. 3 to the right, the operation of the system may be readily followed. In Fig. 1, the subscriber's telephone at A is shown, with the line switch C individual to the line and the first selector switch D. Fig. 2 is a second selector switch. Fig. 3 is a connector switch, and subscriber's telephone B with its associated line switch C'. Fig. 4 is a detail view of the off-normal contacts of the line switch. Referring now to Fig. 1, the subscriber's station A is connected to the main exchange by the heavily marked conductors terminating at the line switch C which is individual to the subscriber's station A. To obtain a connection between the subscriber's telephone at A and the subscriber's telephone at B shown at the right of the figure, the line switch C is first operated to select an idle first selector D, and then the second selector E and connector F are operated in turn to connect with the subscriber at B.

Assuming now a system of ten thousand lines, there would be ten thousand line switches such as are shown at C, one for each line in the exchange, and assuming that the selector and connector switches each have one hundred contacts, on a basis of ten per cent., trunking, there would be one thousand first selectors D, one thousand second selectors E and one thousand connectors F. The subscribers' lines would be divided into groups of one hundred lines each and there would be ten first selectors D for each one hundred lines. Each subscriber's line would also be multipled to the bank contacts 89, 90 and 91 of the ten connectors which have access to the group of one hundred lines with which it is associated. The movable contacts or wipers of each line switch which comprise the two line and one so-called private wiper, have access to ten first selectors D. The wipers of the second selectors are connected in multiple back before the bank contacts of first selectors, and since there are one thousand of each of these switches and each first selector has one hundred bank contacts, the wipers of each second selector are multiply connected to the corresponding bank contacts of one hundred first selectors. Similarly, the wipers of one thousand connectors are multiply connected to the corresponding bank contacts of one hundred second selectors. The apportionment of values just given may be varied at will to suit the condition of any particular size exchange or to suit any different percentage of trunking.

In establishing connection between the calling station A and the called station B,

the calling subscriber first removes his receiver from its switch hook and thereby causes a line switch C to seek connection with the first idle first selector, with the result that his line is extended to a first selector. The next step in the operation is for the calling subscriber to operate his calling device. Assuming that the number of the called subscriber at B is 6543, the first operation of the calling device causes the wipers of the connected first selector to advance six primary steps and then automatically to select an idle second selector E in the thousand group to which the called line belongs. The second operation of the calling device causes the wipers of this connected second selector E to advance five primary steps and then automatically to select an idle connector F in the group of one hundred lines to which the called line belongs. The third operation of the calling device causes the connector switch F to advance its wipers five steps to that group of ten contacts in the hundred with which the called line is included, and the fourth and final operation of the calling device causes the connector to move the wipers over the contacts in the selected group to the third set of contacts, which are the contacts connected to the called line. Thus, a connection is completed between the subscribers' stations A and B.

The subscriber's station A consists of a well-known form of subscriber's circuit, although any common battery subscriber's substation circuit may be used. As is shown at A, there is a path for ringing current through the bell and the condenser and when the receiver is removed from the switch hook, this circuit is broken and its circuit is closed for direct current through the transmitter and the impedance coil, the voice currents passing in a parallel path through the receiver and condenser. A suitable dial 1 or equivalent calling device is provided at the substation, by means of which the subscriber may interrupt the current flow in the line a given number of times, depending on how far the dial is moved from normal, by means of the normally closed contacts 2 and 3, the said opening or breaking of the circuit at the substation resulting in the operation of the switches at the exchange to effect the connection with a called line. In effecting a connection between the calling subscriber A and the called subscriber B, the subscriber at A removes the receiver from its switch hook, which closes a path for current through the line relay LR which closes a circuit through the motor magnet MM, the said motor magnet then advancing the wipers 4, 5 and 6 to seek connection with an idle first selector D. Assuming the first set of contacts 6, 7 and 8 are connected to a busy first selector D, the line relay LR would remain energized and the motor magnet MM would step the wipers to engage the next set of contacts 9, 10 and 11 which are the contacts connected to the first selector D, which we will assume is idle. The line relay would therefore be deënergized opening the circuit for the motor magnet MM, thus stopping the wipers 4, 5 and 6 in engagement with the idle first selector D. Upon the deënergization of the line relay LR, the cut-off relay CO would energize, cutting off the line relay from further control of the subscriber. The off-normal switch ON which had moved to its alternate position on the first step of the line switch C closed an initial energizing circuit for the release relay R and also placed a ground upon the upper row of multiple private contacts 89′ of the connectors having access to the line of subscriber A, thus making it busy to any incoming calls.

The switch mechanism for the line switch C comprises a shaft having the wipers 4, 5 and 6 mounted thereon, and a bank of ten contact sets 6, 7 and 8 with the normal resting contacts arranged so the wipers may cooperate therewith. The wipers are so arranged that when the wipers 4, 5 and 6 are moving forward out of engagement with the last set in the row, the wipers 47, 48 and 49 are moving into engagement with the first or normal set of contacts. By this arrangement the wipers which were last used in establishing a connection are always advanced when restoring the switch to normal after disconnecting. The off-normal springs ON are so arranged that when any of the wiper sets are engaging contacts of a first selector they are in their alternate position and when any of the wiper sets are restored to normal after a connection is released, the off-normal springs ON move to their normal position. The wipers are advanced by the well-known ratchet and driving pawl arrangement, the pawl being operated by the electromagnet MM.

Each first selector is provided with a primary relay PR which in response to openings of the line circuit due to the operation of the dial 1, will operate the primary magnet PM. The primary magnet PM is effective to step the wipers associated with the first selector to select a certain group or row of contacts, and this results in a circuit being closed through the secondary magnet SM, which moves the wipers to automatically seek connection with a set of bank contacts in the row connected with an idle second selector E. The primary off-normal switch PON moves to its alternate position upon the first primary step of the first selector D and the secondary off-normal switch SON moves to its alternate position upon the first secondary step of the wipers of the first selector D. To release the switch to re-

store it to normal, the release relay RR is energized, which in turn closes an energizing circuit through the release magnet RM which restores the wipers and their associated mechanism to normal.

The second selector E includes a primary magnet PM′, the secondary magnet SM′, release relay RR′, release magnet RM′, the primary and secondary off-normal springs and the wipers 53, 54 and 55 with their coöperating bank contacts 61, 62 and 63. The second selector E is operated in a manner similar to that of the first selector D.

The connector F includes the primary magnet PM^2 for advancing the wipers in a primary direction, and the secondary magnet SM^2 for advancing the wipers in a secondary direction to connect with their cooperating bank contacts. The release relay RR^2 when energized closes an energizing circuit through the release magnet RM^2 to effect the restoration of the switch wipers and their associated parts to normal. The busy back mechanism shown at BB is used to transmit a signal back to the calling subscriber when the line with which he desires to connect is busy. Numerous other relays are used in the operation of the connector switch F, the operation of which will be taken up more in detail further on.

At C′ is shown the line switch which is individual to the subscriber at station B. The operation of this switch is similar to that of the one shown at C in connection with the calling subscriber at substation A. The circuits of the switches are so arranged that in a completed connection, the release of the line switch C, first selector D, and secondary selector E are under the control of the calling subscriber at A, and the release of the connector F is under the control of the called subscriber at B. Should the subscriber at A simply remove his receiver from the switch hook, and before operating the dial 1, replace it on the hook, the line switch C would immediately restore to normal. Should the subscriber at A have operated the dial 1, a single time which would have operated the first selector D and then replaced the receiver on the switch hook, the line switch C and first selector D would be restored. This would also be true if the second selector E were operated or the connector F. In other words, the restoration of all apparatus used in an incomplete connection is under the control of the calling subscriber at A.

Operation.—Having now given a general description of the character of the apparatus diagrammatically illustrated in the three sheets of drawing, it is believed that the invention will be best understood by entering into a complete description of the operation of the system.

Assuming now that the subscriber at A desires to converse with the subscriber at station B, the number of which we will assume to be 6543, he will remove his receiver from its switch hook, energizing the line relay LR over a path traced from the live pole of battery through the winding of line relay LR, normal contact 12 of relay R, normal contact 13 of cut-off relay CO, limb S, impedance coil, switch hook contacts and the transmitter of substation A, limb P and normal contact 14 to ground. The energization of the relay LR closes a circuit through the motor magnet MM from ground at alternate contact 15 and also establishes a locking circuit for the relay LR through the alternate contact 16 to the ground connected to the wiper 4. The motor magnet MM now steps the wipers 4, 5 and 6 to engage the contacts 6, 7 and 8 connected to a first selector, such as is shown at D. Assuming that the first selector D which is connected to the contacts 6, 7 and 8 is busy, the contact 6 will be connected to ground as will be hereinafter described, thus retaining the locking circuit for the relay LR. The wipers 4, 5 and 6 will therefore be advanced another step to engage the contacts 9, 10 and 11 of the first selector D, which being in an idle condition, there would be no ground upon the contact 9, and the relay LR would deënergize, opening the circuit through the motor magnet MM and the wipers 4, 5 and 6 would remain in engagement with the respective contacts 9, 10 and 11. Upon the first step of the line switch C off normal, the off-normal springs ON are moved to their alternate position and an energizing circuit is closed through the relay R from the live pole of battery through the winding of the said relay to contact 17, normal contact 13 of relay CO, limb S, through the substation at A, limb P and to ground at normal contact 14. Upon the deenergization of relay LR an energizing circuit is closed through the cut-off relay CO from the live pole of battery at contact 18 through the winding of the said cut-off relay CO, alternate contact 19 of relay R and off-normal contact 20 to ground, thus energizing the cut-off relay CO and closing a circuit for the primary relay PR of the first selector D from the live pole of battery, through the winding of the said relay PR, bank contact 11, wiper 6, alternate contact 13, limb S, through the substation at A, limb P, alternate contact 14, wiper 5, contact 10 and through the other winding of the relay PR to ground, thus energizing the relay PR and closing the circuit from ground through alternate contact 21, the winding of relay 22 to battery, energizing the relay 22 and attracting its armatures. A locking circuit for the relay R is now established from the ground at contact 23 of relay 22 through contact 9, wiper 4, normal contact 16 of relay LR, al-

ternate contact 12 of relay R, off-normal contact 17 through the winding of relay R to battery. Although the initial energizing circuit through the relay R was broken at the time the cut-off relay CO was energized, the relay R being sluggish in its action, retained its contacts in their alternate positions until the locking circuit was closed from the ground at contact 23 of relay 22.

The substation at A now being connected to the first selector D, the subscriber operates his dial 1 in a clock-wise direction until six teeth on the periphery thereof have passed down below the contact spring 2. The dial is then restored by the spring shown connected therewith and the before-traced circuit through the relay PR of the first selector D is opened and closed six times at the contact springs 2—3, resulting in six deënergizations and six energizations of the said relay PR. For each deënergizations of the said relay PR, a circuit is closed from the ground at normal contact 21 through alternate contact 24 of relay 22, normal contact 25 of relay 26 and the winding of the primary magnet PM to battery, operating the said magnet to step the wipers 27, 28 and 29 to a point opposite the sixth row of contacts, of the bank of contacts associated with the first selector D. The circuit just traced which served to operate the primary magnet PM, divided at a point above the normal contact 25 of relay 26 and then through the secondary relay SR energizing the said relay, and due to its sluggish action, this secondary relay retains its contacts in their alternate position while the impulses are being sent. Upon the energization of relay SR a circuit is closed from ground through alternate contact 30, then through the winding or private relay PRR to battery energizing said relay, which now is locked up through the contact 31, secondary off-normal contact 32 to ground at contact 33 of relay 22, the relay 22 being sluggish and retaining its armatures in an attracted position while the armature of the relay PR is vibrated. After the sixth deenergization and energization of the relay PR, its armature being retained in an attracted position, the before traced circuit through the secondary relay SR remains open long enough for the secondary relay SR to deënergize allowing its armature to retract and close a circuit for the secondary magnet SM, from ground through normal contact 30, alternate contact 34, through the winding of the secondary magnet SM to the ungrounded pole of alternating generator G, the energization and deënergization of the said secondary magnet being effective to advance the wipers 27, 28 and 29 to connect to the first contacts 35, 36 and 37 in the row. Upon the first secondary movement of the wipers 27, 28 and 29, the before-traced locking circuit for the private relay PRR from ground at alternate contact 33 of relay 22 is broken at the contact 32 of the secondary off-normal switch, but a locking circuit is now established through the alternate contact 31 of relay PRR to the wiper 27. The bank contacts 35, 36 and 37 are connected to a second selector similar to that shown at E, Fig. 2, and assuming that the said first selector is busy, there will be a ground upon the contact 35 as will be hereinafter described, and relay PRR remaining locked, the secondary magnet SM advances the wipers 27, 28 and 29 to the second set of contacts, and assuming these to be also busy, advances them to connect with the contacts 38, 39 and 40 which are connected to the idle second selector E. There being no ground upon the bank contact 38 connected to the idle second selector E, the relay PRR is deenergized opening the circuit for the secondary magnet SM at the contact 34 and the wipers 27, 28 and 29 rest in engagement with their respective contacts 38, 39 and 40. Upon the deënergization of the relay PRR the relay 26 is energized over a circuit traced from battery, through the winding of the said relay 26, normal contact 41 of relay PRR, contact 42 of the secondary off-normal switch to ground at alternate contact 33 of relay 22, thus extending the line of the subscriber at A to the second selector E, through the alternate contacts 25 and 46 of relay 26 and also connecting the ground at alternate contact 43 of relay 26 to the wiper 27, thus making the second selector E busy at the contact 38 and all its multiples. This ground connection also serves to energize the relay 50 of the second selector E.

The subscriber at A now operates the calling device 1 to open the before-traced circuit through the primary relay PR at the contacts 2—3 five times. The primary relay PR now transmits five impulses from the ground at normal contact 21, through alternate contact 24 of relay 22, alternate contact 25 of relay 26, wiper 28, bank contact 39, normal contact 51 of relay 52, through the winding of primary magnet PM′ to battery, thus operating the primary magnet PM′ to advance the wipers 53, 54 and 55 to a point opposite the fifth row of contacts in the bank. Upon the first energization of the primary magnet PM′, the secondary relay SR′ is also energized by impulses from the primary relay PR and, due to the sluggish release of the armature of relay SR′, the said armature is retained in its energized or attracted position while the five impulses of current are sent through the winding of the said relay SR′. When the said relay SR′ is first energized the private relay PRR′ is energized over a circuit traced over ground through the alternate contact 56 through the winding of the said relay PRR′

to battery, the said relay now locking up through the alternate contact 57, contact 58 of the secondary off-normal switch to the ground at alternate contact 59 of relay 50, the said relay 50 being held energized from the ground at relay 26 of the first selector D.

After the five impulses have been transmitted, the secondary relay SR′ deënergizes and closes a circuit for the secondary magnet SM′ from ground at normal contact 56, alternate contact 60 of relay PRR′ through the winding of the secondary magnet SM′ to the ungrounded pole of the alternating generator G. The secondary magnet SM′ is now energized and advances the wipers 53, 54 and 55 to engage the first set of bank contacts 61, 62 and 63, and assuming that these contacts are connected to a busy connector similar to that shown at F, there will be a ground upon the said contacts as will be hereinafter described. Upon the first secondary off-normal movement of the switch, the secondary off-normal switch SON′ is moved to its alternate position, opening the locking circuit for the private relay PRR′ at contact 58 of the said secondary off-normal switch, but as the wiper 53 is connected to contact 61 before the secondary off-normal contact 58 is broken, the relay PRR′ remains locked up over the wiper 53 and bank contact 61 to ground. The secondary magnet SM′ now steps the wipers 53—54 and 55 to engage the second set of bank contacts, and assuming that these also lead to a busy connector switch, the private relay PRR′ remains energized and the secondary magnet steps the wipers 53, 54 and 55 to engage the third set of bank contacts 64, 65 and 66 which are the contacts of the idle connector switch F. There being no ground upon the contact 64, the private relay PRR′ is deënergized opening the circuit for the secondary magnet SM′ at contact 60 and the wipers remain in connection with the contacts 64, 65 and 66. Thus, it will be seen that the private relay PRR′ being locked up over the private bank contacts 61 controls the energizing circuit of the secondary magnet SM′ until an idle set of bank contacts are connected with. Upon the deënergization of the relay PRR′ the relay 52 is energized over a circuit traced from the ground at alternate contact 59 of relay 50, contact 67 of the secondary off-normal switch, normal contact 68 of relay PRR′ through the winding of the relay 52 to battery, thus extending the connection from the calling subscriber A through the alternate contacts 51 and 68 of relay 52, through the wipers 54 and 55 and their respective contacts 65 and 66 to the connector switch F. The energization of the relay 52 is effective to place a ground upon the bank contact 64 and all of its multiples from alternate contact 69 making the switch F busy to all other selectors which may seek connection thereto. The ground from alternate contact 69 of relay 52 also serves to energize the relay 75 at connector switch F by a circuit traced from battery through the winding of the relay 75, through normal contact 76 of release relay RR^2, bank contact 64 and private wiper 53 to ground at alternate contact 69 of relay 52.

The subscriber at A now operates the dial 1 to open and close the contacts 2 and 3 four times, which deënergizes and energizes the primary relay PR of the first selector D four times. This deënergization and energization of the relay PR serves to transmit four impulses from the ground at normal contact 21 of the said relay over the before-traced path to wiper 54 of the second selector E, contact 65, normal contact 77 of relay 78 at connector F through the winding of the primary magnet PM^2 to battery at normal contact 79 of relay 80. The primary magnet PM^2 now advances the wipers 81, 82 and 83 four primary steps to a point opposite the fourth row of contacts in the bank. The impulses which serve to operate the primary magnet PM^2 divided at a point above the said contact 77 of the said relay 78 and also energized the secondary relay SR^2, but this relay being sluggish, retains its armatures in their attracted position until after the last impulse has been closed through the winding of the said relay. Upon the deënergization of the secondary relay SR^2, after the cessation of impulses, a circuit is closed from the ground at the primary off-normal switch PON^2, the said switch having closed upon the first primary off-normal movement of the connector F, through the contact 84 of relay SR^2, winding of relay 80, normal contact 85 of relay 86, alternate contact 87 of relay 75 to battery, thus energizing the relay 80 which locks itself from the ground at alternate contact 88 and removes the battery connection at normal contact 79 for the primary magnet PM^2 to the alternate contact 79 leading to the winding of the secondary magnet SM^2.

The subscriber now operates the dial 1 to transmit three impulses from the ground at relay PR of the first selector D over the before-traced path to the normal contact 77 of relay 78 at connector F, but the relay 80 having removed the battery connection from the primary magnet PM^2 to the secondary magnet SM^2, the said secondary magnet is energized and deënergized three times advancing the wipers 81, 82 and 83 in a secondary movement, to engage the third set of contacts 89, 90 and 91 of the row which are the contacts of the line of the subscriber at B, whose line we will assume is idle. The impulses which serve to energize the sec-

ondary magnet SM^2 three times also closed a circuit through the secondary relay SR^2, the said secondary relay remaining energized until after the third impulse has been sent, when its circuit is opened long enough for it to deënergize and return its contacts to their normal position. Upon the deenergization of the secondary relay SR^2 an energizing circuit for the cut-off relay CO' of the line switch C' is closed from battery at normal contact 18 of relay LR' through the winding of the relay CO', private bank contact 89, private wiper 81, the upper winding of relay 92, normal contact 93 of relay SR^2 to ground at normal contact 94 of relay 95, thus energizing the relays 92 and CO'. The energization of the cut-off relay CO' removes the substation control of the line switch C' and the relay 92 is now locked up over a circuit traced from battery at alternate contact 87 of relay 75, the lower winding of relay 92 and alternate contact 96 of relay 92 to ground at normal contact 94 of relay 95. The closing of the contact 96 of relay 92 serves to close a circuit through the relay 86 to battery, energizing the said relay 86 which moves its contacts to their alternate position, opening the circuit for the relay 80 which deënergizes. When the relay 92 is energized, a circuit was closed from the battery at normal contact 97 of relay 95 through alternate contact 98 of relay 92, through the winding of the so-called flip flop relay FF which alternately attracts and detracts its armatures. Upon the energization of the relay FF, ringing current from the generator G' is transmitted over a circuit traced from the ground pole of the generator, alternate contact 99, wiper 83, bank contact 91, limb P' through the ringer and the condenser of the substation at B, limb S', bank contact 90, wiper 82, alternate contact 100 of relay FF to generator G', thus ringing the bell of the subscriber B. The relay FF on its first energization closed a circuit from battery through the winding of relay 101 to ground at alternate contact 102 of relay FF energizing the said relay 101 which closes the alternate contacts 103 and 104, and when the relay FF deënergizes to cut off the generator G', the relay 101 being sluggish in its action, retains its alternate contacts 103 and 104 momentarily closed after the circuit is opened at ground of contact 102, this being effective to short-circuit the line of the subscriber B at the alternate contacts 103 and 104, resulting in the discharge of the condenser of the line of subscriber B to prevent any accidental kick or energization of the relay 105, which might otherwise result from the discharge of the said condenser. The relay FF continues to energize and deënergize and alternately ring the bell of the called subscriber B until the said subscriber B responds by removing his receiver from its switch-hook.

Upon the response of the subscriber at B, a circuit is closed from the alternate contact 106 of relay 86, through the upper winding of relay 105, normal contact 103, normal contact 100, wiper 82, bank contact 90, limb S' through the telephone of the subscriber B, limb P', bank contact 91, wiper 83, contact 99 of relay FF, normal contact 104, the lower winding of relay 105, alternate contact 85 of relay 86, to battery at alternate contact 87 of relay 75, energizing the relay 105 which closes a locking circuit for the relay 92 at grounded contact 107, the said contact also placing a direct ground on the wiper 81 through alternate contact 114 of relay 92, and a circuit is also closed from ground at contact 108 through the winding of relay 78 to battery. The relay 78 now energizes and extends the talking circuit from the subscriber A to the subscriber at B over the heavily marked conductors, closing the said conductors at the alternate contacts 77 and 109. The alternate contact 110 of relay 78 now being closed, a circuit is traced from battery at said contact through the winding of relay 95 to ground at the primary off-normal switch PON^2, energizing the relay 95 which is now locked up over alternate contact 97 to battery, the said relay 95 now remaining energized until the switch F returns to normal, opening the primary off-normal switch contact. The contact 94 of the relay 95 moving to its alternate position, closes a locking circuit for the relay 75 through the contact 76 of release relay RR^2. The alternate contact 111 of relay 95 is also closed but the relay 78 being energized, the release relay RR^2 is not energized at this time.

The subscribers at A and B are now connected for conversation over the heavily marked conductors, the battery for the transmitter at subscriber A being supplied through the winding of the relay PR at first selector D, and the battery for the transmitter of the subscriber at B being supplied from the battery at alternate contact 87 of relay 75 through the before-traced path including the windings of the relay 105 to the ground at alternate contact 106 of relay 86, the condensers H and J at the first selector D separating the two sources of battery supply.

Release.—Assuming that the subscribers have now finished their conversation, the subscriber at B replacing his receiver upon its switch-hook, the before-traced circuit through the relay 105 of the connector F is interrupted at the contacts of the switch-hook, and the said relay 105 is now deënergized opening the circuit through relay 78 at contact 108. The relay 78 now deënergizes

and a circuit through the release relay RR² is closed from battery at normal contact 110 of relay 78, alternate contact 111 of relay 95, through the winding of the release relay RR² to ground at the primary off-normal switch PON². The relay RR² is now energized closing a circuit through the release magnet RM² from the ground at the alternate contact 112 of the relay RR², the energization of the said release magnet being effective to withdraw the retaining pawls for the wipers 81, 82 and 83 and the said wipers are now restored to their normal position. The energization of the release relay RR² opens the circuit for the relay 75 at contact 76, the said relay 75 now deënergizing and opening the circuit for the relays 92 and 86 which are deënergized, restoring their contacts to normal. The primary off-normal switch PON² of the connector F is returned to normal upon the restoration of the wipers of the switch, opening the circuit for the release relay RR² and the relay 95, and the said relays now being deënergized, all the mechanism associated with the connector F is at normal. The cut-off relay CO′ of the line switch C′ deënergized when its circuit was broken at the ground of contact 107 upon the deënergization of relay 105 of the connector switch F, thus placing the line switch C′ again under the control of the subscriber at B.

The calling subscriber at A now replaces his receiver upon its switch-hook, opening the circuit for the primary relay PR of the first selector D, deënergizing the said relay. The relay 22 of the first selector D which has remained energized since the relay PR was first actuated, is now deënergized, due to the opening of its circuit at alternate contact 21 of primary relay PR, and the contacts of the said relay 22 are moved to their normal positions. The release relay PR is now energized over a circuit traced from the ground at normal contact 21 of relay PR, normal contact 24 of relay 22, contact 44 of primary off-normal switch PON, through the winding of the said relay RR to battery, the energization of the said relay RR resulting in the closing of a circuit from ground at alternate contact 45 through the winding of the release magnet RM to battery, energizing said release magnet. The locking circuit for the relay 26 is opened at alternate contact 33 of relay 22, deënergizing the said relay 26 and opening the circuit of the wipers 28 and 29 at the alternate contacts 25 and 46, and also removing the ground from the wiper 27 by the opening of the alternate contact 43 of relay 26. Thus, it will be seen that when the wipers are returning to normal, they are free of any connection while wiping over the bank contacts during the release. Upon the return of the wipers to normal, the primary off-normal switch PON is restored to normal, opening the circuit for the release relay RR at the primary off-normal contact 44 and the said release relay being deënergized, opens the circuit through the release magnet RM at the alternate contact 45. The secondary off-normal springs SON are restored to their normal position when the wipers 27, 28 and 29 reach their secondary normal position. When the relay 22 is deënergized, the circuit from ground at alternate contact 23 through the release relay R of the line switch C is broken at the said contact 23, but due to the sluggish action of the relay R, it did not release or deënergize as the circuit through it was continued through the alternate contact 47 of relay RR, normal contact 24 of relay 22 to ground at normal contact 21 of the relay PR. Upon the return of the switch D to normal, the circuit of the release relay RR being broken at primary off-normal contact 44, the said release relay is deënergized and opens the circuit just traced through the relay R at the contact 47, deënergizing the said relay R of the line switch C, restoring its contacts 12 and 19 to normal. The opening of the alternate contact 19 of the relay R breaks the circuit through the cut-off relay CO which deënergizes. The contact 19 now closes a circuit from the ground at alternate contact 20 of the off-normal switch ON through normal contact 15 of relay LR, winding of the motor magnet MM to the live pole of generator G, which operates the said motor magnet to step the wipers 4, 5 and 6 forward until the wipers 47, 48 and 49 reach the normal resting contacts which were previously normally engaged by the contacts 4, 5 and 6. The off-normal contacts 17 and 20 are now moved to their normal position, the contact 20 opening the circuit through the motor magnet MM, and the said wipers 47, 48 and 49 remain at normal. The line switch C now being at normal, it may be used for making another connection and the ground having been removed from the bank contact 89 of the connectors, due to the opening of the alternate contact 19 of relay R, the subscriber at A may be called or may make connection with another line.

The line switch C and first selector D being restored to normal, the release of the second selector E is brought about as follows: When the relay 26 of the first selector deënergized removing the ground at alternate contact 43 from the wiper 27, the relay 50 of the second selector E deënergized closing a circuit for the release relay RR′ from ground at normal contact 59, alternate contact 70 of the primary off-normal switch through the winding of the said release re-

lay to battery, energizing the said release relay and closing an energizing circuit through the release magnet RM′ from the ground at alternate contact 71, releasing the switch. Upon the deënergization of the relay 50, the energizing circuit for the relay 52 was broken at the alternate contact 59 of relay 50, deënergizing the relay 52 and opening the circuit of the wipers 54 and 55 and also removing the ground from the wiper 53 at the alternate contact 69. The off-normal switches having been moved to their normal position upon the restoration of the wipers 53, 54 and 55, the circuit for the release relay RR′ is broken at alternate contact 70 of PON′, resulting in the deenergization of the said release relay RR′ which opens the circuit for the release magnet RM′. The second selector E with all of its mechanism and relays is now restored to normal and may be used for making another connection.

Called line busy.—Assuming now that the subscriber at A has extended his connection to the called subscriber at B, and assuming that the line of the called subscriber at B is busy, there will be a ground upon the contact 89 traced from the ground at the off-normal contact 20 of the line switch C′ if the subscriber B is making a call or if the subscriber at B is a called line, over the previously described path from the ground at alternate contact 107 of relay 105, alternate contact 114 of relay 92 to the wiper 81 and contact 89 of the connector switch which is connected to the line. Assuming this to be the case, after the secondary relay SR^2 of connector F has deënergized, and after the wipers 81, 82 and 83 have connected to the contacts 89, 90 and 91, the relay 92 would not be energized, due to the direct ground upon the contact 89. Therefore, none of the relays 86, 78, 95, 101 or FF would be energized.

The subscriber at A having completed his call, and the line of the subscriber at B being busy, a characteristic busy signal is transmitted back through the calling subscriber's receiver from the busy back mechanism BB at the switch F through the secondary off-normal contact 115, normal contact 116 of relay SR^2, normal contact 117 of relay 86, along the lower heavily marked conductor, limb S, the receiver of the subscriber at A, limb P, the upper heavily marked conductor and through the winding of the primary relay PR of the first selector D to ground. The subscriber at A receiving this signal, and knowing that the line of the called subscriber B is busy, replaces his receiver upon its switch hook which results in the release of the line switch C, first selector D, and second selector E as previously described, but in this instance the connector switch F is also released. When the second selector E is released, as previously described, and the ground is removed from the bank contact 64 at alternate contact 69 of relay 52, the relay 75 of the connector switch F is deënergized closing a circuit from battery at normal contact 87, normal contact 111 of relay 95, the winding of the release relay RR^2 to ground at the primary off-normal switch, energizing the said release relay, which in turn closes a circuit through the release magnet PM^2 from ground at alternate contact 112, the energization of said release magnet RM^2 being effective to restore the wipers 81, 82, and 83 and all associated switch mechanism to normal.

The circuits and switches are so arranged that should the subscriber at A replace the receiver upon the switch-hook after operating the dial a single time, the first selector D and line switch C would be restored to normal. Should the subscriber at A extend his circuit to the second selector E or to the connector F and then replace his receiver on its switch-hook, all the mechanism used up to that time would be released and restored to normal. It will not be necessary to go into the detail of this release, as it is believed that this will be readily understood from the previous description of the release of the completed connection or a connection to a busy line.

The release magnets of the different switches D, E and F are so constructed that upon their energization, the retaining pawls which hold their respective wipers in engagement with selected contacts are withdrawn from engagement with their respective ratchets and the switches are restored to normal. While I have shown a number of batteries, it is to be understood that they are all one and the same, but have been shown in this manner for convenience in explaining the operation of the system. This is also true of the alternating current generators shown in different parts of the system. While I have preferably described the circuits as working in connection with the well-known Strowger switch, it is to be understood that they will work equally well with any switch in which the wipers or movable contacts partake of a primary movement to select a row of passive contacts and then a secondary movement to select a contact in the row.

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

1. An automatic telephone system comprising a subscriber's telephone line, a plurality of selector switches, a line switch for said telephone line having access to said plurality of selector switches, a driving magnet for said line switch, an energizing circuit for said driving magnet closed upon the initiation of a call from said telephone line

to cause said magnet to operate said switch to connect said telephone line with an idle one of said selectors, means for opening said circuit when said line switch has connected with said idle selector, and means for again closing an energizing circuit for said driving magnet to restore said line switch.

2. An automatic telephone system comprising a subscriber's telephone line, a plurality of selector switches, a line switch for said telephone line having access to said plurality of selector switches, a magnet for said line switch, an energizing circuit for said magnet, closed upon the initiation of a call from said telephone line to cause said magnet to operate said switch off normal to connect said telephone line with an idle one of said selectors, means for opening the said circuit when said line switch has connected with said idle selector, a release relay for said line switch energized upon the first movement of said line switch off normal, and means under the control of the subscriber at said telephone line for deënergizing said relay, whereby the said line switch is restored.

3. An automatic telephone system comprising a subscriber's telephone line, a plurality of selector switches, a line switch for said telephone line having access to said plurality of selector switches, a magnet for said line switch, an energizing circuit for said magnet closed upon the initiation of a call from said telephone line to cause said magnet to operate said switch off normal to connect said telephone line with an idle one of said selectors, means for opening the said circuit when said line switch has connected with said idle selector, a release relay for said line switch energized upon the first movement of said line switch off normal, and means under the control of the subscriber at said telephone for deënergizing said relay, whereby the said magnet is again operated to restore said switch.

4. A telephone system comprising a plurality of subscribers' telephone lines, including a calling line, a plurality of selector switches less in number than the number of telephone lines, a plurality of line switches, one connected to each line, the line switch connected to said calling line upon the initiation of a call over said calling line being adapted to automatically connect said line to one of said idle selector switches, a primary relay for said selector switch for controlling the primary movement thereof, a secondary relay for said selector relatively slow to release its armature, a third relay for said selector relatively slow to release its armature, a release relay for said line switch, a release relay for said selector, and means under the control of said third relay to affect said release relays, whereby their associated switches are restored.

5. An automatic telephone system comprising a telephone line, first selector switches, a line switch individual to said line for automatically connecting said line with an idle one of said first selector switches, a second selector and a connector switch, a quick releasing relay for said first selector for controlling the primary adjustment of said selector and connector switches, and a slow releasing relay for each of said selector and connector switches for controlling the secondary adjustment thereof.

6. A telephone system comprising a plurality of subscribers' telephone lines including a calling line, a plurality of selector switches less in number than the number of telephone lines, a plurality of line switches, one connected to each line, means for operating the line switch connected to said calling line upon the initiation of a call over said line to automatically connect said line to an idle selector switch, a primary relay for said selector switch, means for energizing said primary relay, a secondary relay for said selector relatively slow to release its armature, a third relay for said selector relatively slow to release its armature, an energizing circuit for said third relay closed upon the energization of said primary relay, a release relay for said line switch energized upon the first movement of said switch, a locking circuit for said release relay closed through contacts of the said third relay upon its energization, a release relay for said selector switch, and means under the control of the calling subscriber to deënergize said primary relay, whereby said third relay is deënergized, the deënergization of said third relay being effective to open the said locking circuit of the release relay for said line switch, whereby said line switch is restored, the deënergization of said third relay also closing an energizing circuit through the release relay for the said selector, whereby the said selector is restored.

7. An automatic telephone system comprising a subscriber's calling line, a selector switch, bank contacts for said switch arranged in groups having trunk lines leading therefrom, wipers for said selector for cooperating with said contacts, a primary relay energized over a circuit controlled by said calling subscriber, means under the control of the calling subscriber to rapidly deënergize and energize said primary relay to vibrate its armature, an electromagnet provided with a circuit adapted to be closed responsive to each deënergization of said primary relay to advance said wipers to select a group of contacts, a secondary relay connected in multiple with said electromagnet and relatively slow to release its armature, said secondary relay adapted to hold its armature attracted while the said primary relay armature is vibrating, the

said secondary relay armature retracting when said armature has stopped vibrating, a third relay energized upon the energization of said secondary relay, a secondary magnet for said selector, an energizing circuit for said secondary magnet, said circuit being closed upon the deënergization of said secondary relay to advance the said wipers to engage the contacts in the selected group, and a locking circuit for said third relay closed until said wipers connect to an idle set of contacts in the group.

8. An automatic telephone system comprising a subscriber's calling line, a group of selector switches, a line switch individual to said line and operative upon the initiation of a call over said line for connecting the said line with an idle selector in the group, bank contacts for said switch arranged in groups having trunk lines leading therefrom, wipers for said selector for coöperating with said contacts, a primary relay energized upon said connection of calling line to said selector, means under the control of the calling subscriber to rapidly deënergize and energize said relay to vibrate its armature, an electromagnet energized upon each deënergization of said primary relay to advance said wiper to select a group of contacts, a secondary relay relatively slow to release its armature, means for energizing said secondary relay to hold its armature attracted while the said primary relay armature is vibrating, the said secondary relay armature retracting when said armature has stopped vibrating, a third relay energized upon the energization of said secondary relay, a secondary magnet for said selector, an energizing circuit for said secondary magnet, said circuit being closed upon the deënergization of said secondary relay to advance the said wipers to engage the contacts in the selected group, and a trunk release circuit for said line switch controlled by said primary relay.

9. A telephone system comprising a calling and a called line, means for connecting said lines in a conversational circuit, a quick relay actuated to apply ringing current to the line of the called subscriber, a relatively slow relay energized responsive to said actuation, means for deënergizing said quick relay to disconnect said ringing current from said line, and means controlled by said slow relay for momentarily short circuiting said line.

10. A telephone system comprising a calling and a called line, means for connecting said lines in a conversational circuit, means actuated to apply ringing current to said called line, a slow relay energized responsive to said actuation, means for disconnecting said ringing current from said line and thereafter momentarily short-circuiting said line through contacts of said slow relay.

11. A telephone system comprising a connector switch, bank contacts for said switch, a coöperating wiper and conductor, a motor magnet, means for transmitting impulses to operate said magnet, whereby said wiper is advanced to connect to one of said contacts, a slow relay actuated responsive to said impulses, said relay remaining actuated while said impulses are being transmitted, a busy back signal adapted to be connected to said conductor, and means operated by said slow relay for holding said signal disconnected from said conductor while said impulses are being transmitted.

12. A telephone system comprising a plurality of telephone lines, a switch having a conductor, means for connecting said switch with any one of said lines, a busy-back signal normally disconnected from said conductor, means for connecting said signal to said conductor, a test relay energized responsive to a connection made to an idle one of said lines, and means actuated responsive to said energization to disconnect said signal from said conductor.

13. A telephone system including a calling subscriber's line and a called subscriber's line, connecting means for connecting said lines in a conversational circuit, a quick relay for connecting ringing current to the line of the called subscriber, a relatively slow acting relay, interrupting means for intermittently energizing and deënergizing said relays whereby said ringing current is intermittently connected to said called subscriber's line, and means controlled by said slow relay for momentarily short-circuiting the line of the called subscriber between the ringing periods.

14. A telephone system including a calling telephone line and a called telephone line, automatic trunking means for connecting said lines in a conversational circuit, a quick-acting relay for connecting ringing current to the line of the called subscriber, a slow-acting relay, means for deënergizing said fast relay thereby disconnecting the ringing current from said called line, and means controlled by said slow-acting relay for thereafter momentarily short-circuiting said line.

15. A telephone system including a calling subscriber's line and a called subscriber's line, an automatic selector switch and an automatic connector switch for inclusion in a conversational circuit connecting said lines, ringing apparatus including a quick-acting and a slow-acting relay, an interrupter for intermittently energizing and deenergizing said relays, said quick-acting relay operating to connect ringing current to the line of the called subscriber when energized, and said slow-acting relay operating to momentarily short circuit said subscriber's line when said quick-acting relay

deënergizes and before said slow-acting relay has deënergized.

16. A telephone system including a calling subscriber's line and a called subscriber's line, an automatic selector switch and an automatic connector switch for inclusion in a conversational circuit connecting said lines, an impulse sender for controlling said switches over the two sides of a circuit in series, ringing apparatus including a quick-acting and a slow-acting relay, an interrupter for intermittently energizing and deenergizing said relays, said quick-acting relay operating to connect ringing current to the line of the called subscriber when energized, and said slow-acting relay operating to momentarily short circuit said subscriber's line when said quick-acting relay deënergizes and before said slow-acting relay has deënergized.

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

CHARLES S. WINSTON.

Witnesses:
GEORGE E. MUELLER,
MARJORIE E. GRIER.