

G. A. YANOCHOWSKI.
TELEPHONE SYSTEM.

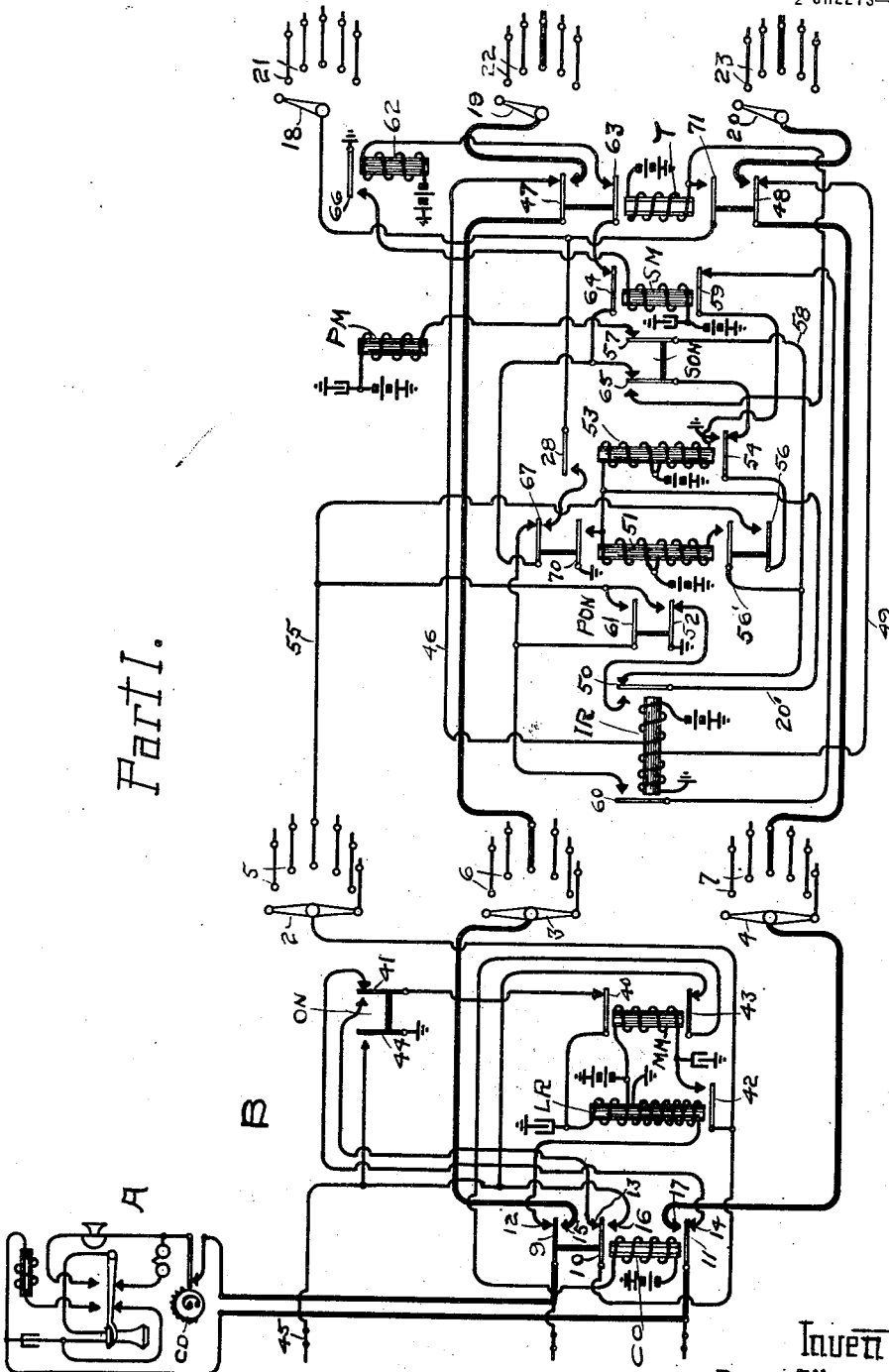
APPLICATION FILED AUG. 22, 1919.

1,405,175.

Patented Jan. 31, 1922.

2 SHEETS—SHEET 1.

Part I.



Inventor:
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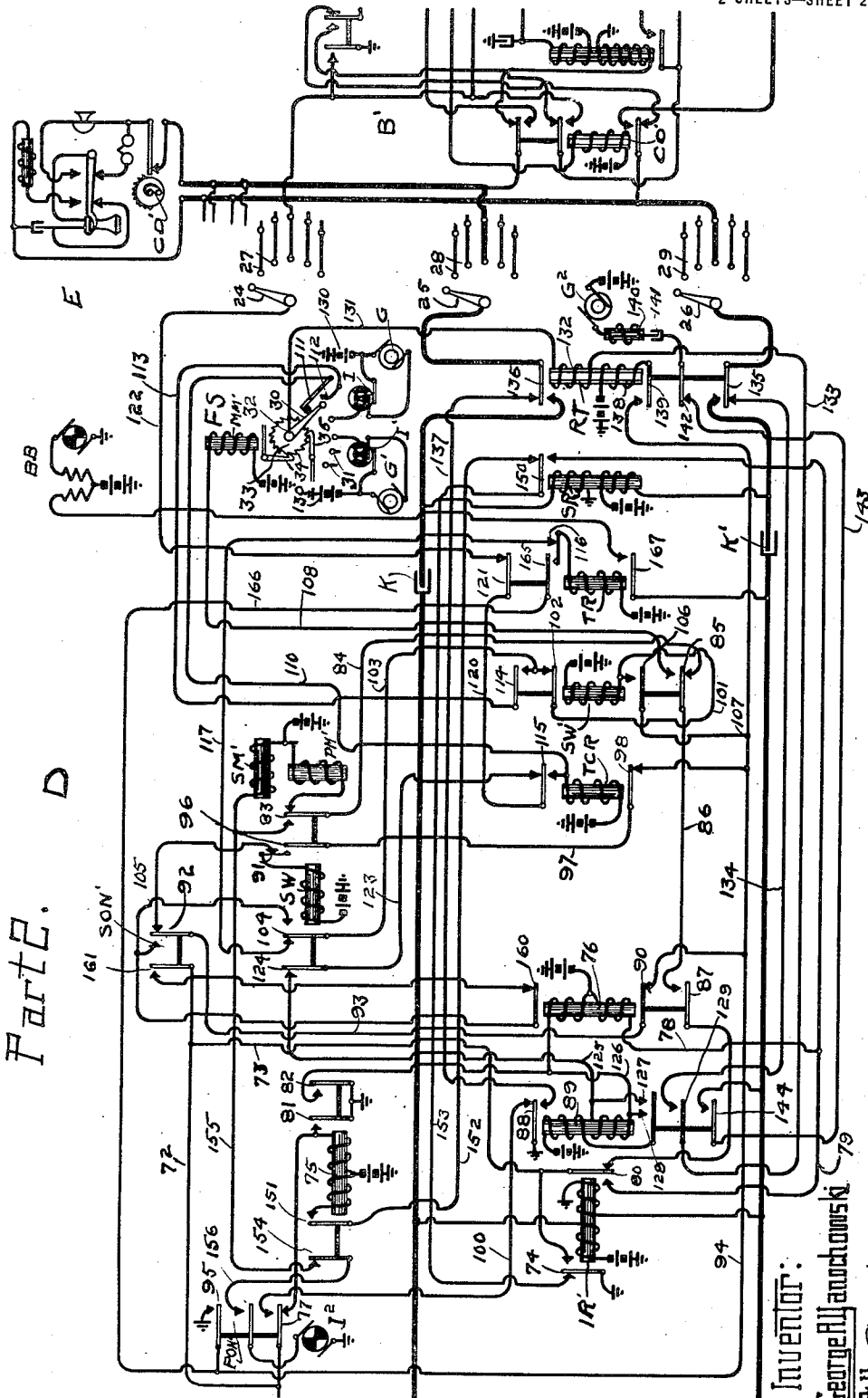
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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,405,175.

Specification of Letters Patent. Patented Jan. 31, 1922.

Application filed August 22, 1919. Serial No. 319,050.

To all whom it may concern:

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

My invention relates to telephone systems and has to do more particularly with systems of the type in which automatic switches are employed at the exchange or central office for establishing connections between subscribers' lines.

A general object of my invention is the provision of improved circuit arrangements for the automatic switches.

One of the features of my invention is the provision of a frequency selector associated with a connector switch, provided with differential switching relays, which is actuated by series of impulses to select the proper ringing current generator to actuate the call bell of the desired substation.

A further feature of my invention is the provision of a frequency selector of the type above described, which is provided with holding means that is released by the connector switch when it is released.

A still further feature of my invention is the provision of a system of the character above described in which, when the called subscriber responds, the ringing current is instantly disconnected, no matter whether the called subscriber responds during a ringing interval or a silent interval.

A still further feature of my invention is the provision of a system of the above character for operation with connectors of the side switchless type and of the step-ahead release type.

The above and other features of my invention will be hereinafter more fully described in the ensuing specification and more particularly pointed out in the appended claims.

For a better understanding of my invention reference may be had to the accompanying drawings which comprise Parts 1 and 2. In order to more fully understand the circuits as pointed out, Part 2 is placed to the right of Part 1 to form a continuation thereof and to form a complete circuit arrangement between a calling and a called substation.

Referring now more particularly to the system as shown in Part 1, the substation A comprises the usual switch-hook and substation equipment, and includes a calling device CD. The said substation A is connected, by means of the two line limbs as shown, to a line switch B at the exchange. The said line switch B is adapted, upon the initiation of a call from substation A, to automatically connect with an idle first selector C. The subscriber at A, by the use of the calling device CD in connection with his substation equipment, operates the first selector C to extend the connection from the substation A to an idle connector switch D. The subscriber at A then, by further actuations of his calling device CD, operates the connector switch D to extend the connection to the terminals of the called-for line E. To the right of the drawing in Part 2, I illustrate a frequency selector FS and by the use of the calling device CD the subscriber at substation A may actuate the frequency selector FS to select the proper generator frequency to ring the call bell of a called-for substation. If the called line is idle, ringing current is automatically applied to the terminals thereof to signal the called-for subscriber. Should the line of the called-for subscriber be busy, a characteristic busy signal will be automatically transmitted back to the calling subscriber who may, by replacing his receiver upon the switch-hook, release the switches which were used in extending the connection to the called-for subscriber. The line switch B may structurally be of the type shown in co-pending application, Serial Number 271,960, filed by H. H. Ide, January 20, 1919.

The switch B, as diagrammatically illustrated, comprises a double-wound line and test relay LR, a single-wound cut-off relay CO, and a motor magnet MM. The line relay LR is adapted to be energized over the two sides of the subscriber's line in series; the cut-off relay CO is adapted when energized to disconnect the subscriber's line circuit from the line relay LR, and to connect the switch wipers to the subscriber's line when the line switch B is used for calling purposes. A motor magnet MM is provided for stepping the switch shaft and wipers 2, 3 and 4 step by step over the bank contacts 5, 6 and 7. The switch wipers 2, 3 and 4 are

adapted to be rotated always in the same direction and do not restore to normal, that is, the switch wipers do not have a normal position, but remain in their antecedent progressive position when a connection is released. The wipers 2, 3 and 4 are double-ended wipers and as one contacting end of these wipers moves off the last contacts of their respective switch banks, the other contacting ends thereof move onto the first contacts of the switch banks. The off-normal contacts ON are so arranged that when the line relay LR is energized, they are moved to their off-normal position and are returned to their normal position by the energization of the cut-off relay CO, that is, these off-normal springs are so arranged that when the line relay LR is energized a catch mechanism is operated to release the off-normal springs to their operated position, and upon the energization of the cut-off relay CO the springs are returned to their normal position, in which position the catch mechanism again is brought into operation to hold the off-normal springs in their normal position. Reference may be had to said Ide application S. N. 271,960 for a more complete understanding of the mechanical construction of the line switches B and B'.

The switch shaft which carries wipers 2, 3 and 4 is provided with a ratchet mechanism which is adapted to co-operate with the driving pawl controlled by the motor magnet MM to rotate the switch shaft and wipers in a clockwise direction.

A further mechanical arrangement is provided for the line switch and connects the line relay LR and the cut-off relay CO in such a manner that the armature of the cut-off relay CO can not be fully attracted unless the line relay LR has been energized first, that is, if the line relay LR has been energized, the armature of the cut-off relay CO may then be energized to move its switch contacts to their alternate positions, while if the cut-off relay CO is energized before the line relay LR is operated, the armature of the cut-off relay CO is permitted to move only far enough so that its contacts 9, 10 and 11 move from engagement with their back contacts 12, 13 and 14, respectively, but not into engagement with their front contacts 15, 16 and 17. This feature is provided so that when the substation A is called from a connector switch and the cut-off relay CO energized, the subscriber's line can be disconnected from the line relay LR of the switch B, but cannot be connected with the switch wipers of the switch.

The circuits shown for the selector switch C and connector switch D are adapted to work with a switch structure similar to that shown in co-pending application, Serial Number 175,364, filed by H. H. Ide, June 18, 1917. It is to be understood, however, that

the circuits may be used in connection with various other switch structures. For a more complete understanding of the switch structures C and D, reference may be had to said Ide application S. N. 175,364.

The first selector C comprises an impulse relay IR, which relay is energized and de-energized by impulses from the calling device CD at the calling substation A, and the energization and de-energization of the relay IR brings about the actuation of the primary magnet PM to step the first selector switch wipers 18, 19 and 20 in a primary direction to a certain group of contacts. A secondary magnet SM is provided for said selector which automatically steps the wipers 18, 19 and 20 in a secondary direction over the contacts 21, 22 and 23 in the selected group in search of a set of contacts leading to an idle connector D. A switching relay T is also provided, which when energized extends the connection of the calling substation A to the idle connector D. Primary and secondary off-normal contacts PON and SON, respectively, are provided. The said primary off-normal contacts PON assume their alternate position on the first step of the wipers 18, 19 and 20 in a primary direction, and the secondary off-normal contacts SON assume their alternate position upon the first step of the wipers 18, 19 and 20 in a secondary direction over contacts 21, 22 and 25.

The connector switch D is provided with an impulse relay IR', responsive to the impulses of the calling device CD at the calling substation A, which relay IR' brings about the actuation of the primary magnet PM' to step the connector switch wipers 24, 25 and 26 in a primary direction to a certain group of contacts containing contacts of the called line E. A switching relay SW is provided which is energized upon the termination of the first set of impulses to connect the secondary magnet SM' in circuit with the impulse relay IR', to be actuated by the energization and the de-energization thereof to step the connector switch wipers 24, 25 and 26 over the contacts 27, 28 and 29 in the selected group to the contacts of the called line. A switching relay SW' is also provided which is energized after the termination of the last set of impulses which step the wipers 24, 25 and 26 into engagement with the contacts 27, 28 and 29 of the called substation E. The relay SW' upon energization places the motor magnet MM' of the frequency switch FS in association with the impulse relay IR' so that the impulses transmitted from the calling device CD at calling substation A actuate the frequency selector switch to select the proper frequency of ringing current to actuate the call bell at the called substation E. A shaft 32 is provided for the switch FS, which carries the wiper

30 and ratchet 33. A driving pawl 34 is provided for the motor magnet MM', and operates to step the wiper 30 from one contact to the next to select the proper frequency generator G, G', etc., to signal the called substation E. A retaining pawl 35 is provided which engages the ratchet 33 and holds the wiper 30 in its advanced position, to which position it has been stepped. The retaining pawl 35 is operatively associated with the shaft of the connector switch D and after the termination of conversation the connector restores to normal and its shaft engages the retaining pawl 35, withdrawing it from engagement with ratchet 33, allowing the wiper 30 to restore to its normal position under spring tension. In the drawing I show, for the sake of clearness, only generators G and G' connected through interrupters I and I' to supply interrupter generator ringing current. However, there will be as many generators and interrupters as there are substations on the called line to signal. Of course, other than the harmonic system of signaling may be used, for example, pulsating current may be used and the substations connected from each side of the line to ground, etc.

A test control relay TCR is provided which is used to test the called line as to its idle or busy condition, and a test relay TR is provided which is actuated upon connection with a busy called line through the agency of the relay TCR. The relay TR operates when engaging a busy line to connect busy-back apparatus BB to the calling substation to notify the calling subscriber of the busy condition of the called line and disconnects the relay TCR from the test wiper 24. A ringing trip relay RT is also shown which is operated when a called subscriber removes his receiver in response to a call, the said relay RT opening the ringing circuit to disconnect the ringing current from the called line. Should a called subscriber remove his receiver during either a ringing or a silent period, the ringing current is immediately disconnected, as will be more fully hereinafter described. The relay RT is provided with a locking winding to prevent a reapplication of ringing current to the called subscriber's line prior to a disconnection of the connector D from the line of the called subscriber. With this ringing arrangement, it is only necessary to provide one control relay for the ringing current. A back bridge or supervisory relay SR is also provided, which operates upon the actuation of the ringing trip relay RT. Primary and secondary off-normal contacts PON' and SON' are provided and assume their alternate positions, respectively, upon the primary and secondary movements of the wipers 24, 25 and 26.

To the right of the drawing in Part 2, I

show a called substation E, similar to that of A, the said subscriber being provided with a line switch B', similar to line switch B.

Having described in general the structure of the switches and apparatus, I will now explain more in detail the operation of the same.

Assuming that a call is to be traced from the calling substation A to the called substation E, upon the removal of the receiver by the subscriber at the calling substation A, line relay LR of switch B is energized by current traced from battery, through the upper winding of relay LR, contact 40 of motor magnet MM, normal contact 41 of off-normal springs ON, contacts 14 and 11 of relay CO, through the calling substation back through contacts 9 and 12 of relay CO and through the lower winding of relay LR to ground. Line relay LR upon energizing trips the off-normal contacts ON to their operated position. As before mentioned, wipers 2, 3 and 4 always rest upon the set of contacts 5, 6 and 7 last used, and assuming the contacts upon which the wipers now rest are busy, due to another subscriber's line switch having selected the first selector last used by the subscriber A, the engaged private contact 5 will be found to contain a busy potential. The tripping of off-normal contacts ON connects the upper winding of line relay LR to the private bank contact 5, which we have assumed contains a busy potential, over a circuit extending from battery, through the upper winding of relay LR, normal contact 40 of motor magnet MM, alternate contact 41 of off-normal springs ON, contacts 13 and 10 of relay CO, to private wiper 2 and the grounded bank contact 5. The line relay will thus remain energized until its circuit is opened at contact 40 of the motor magnet MM. The closure of contact 42 of relay LR closes a circuit for motor magnet MM, extending from battery, through the winding of said motor magnet MM, contact 42 of relay LR, to the private wiper 2 and grounded busy bank contact 5.

The motor magnet MM upon energizing opens the circuit of test relay LR at its contact 40, thereby permitting the same to de-energize. The motor magnet at the same time, of course, steps the wipers 2, 3 and 4 to the next set of bank contacts. The line and test relay LR restoring opens its contact 42, thereby opening the circuit of motor magnet MM and permitting the said motor magnet MM to restore. Should the contacts now engaged by the wipers be busy, relay LR again energizes by current through normal contact 40 of motor magnet MM and again closes contact 42, energizing motor magnet MM, as before described. The line and test relay LR and magnet MM are thus alternately energized and de-energized, magnet MM stepping wipers 2, 3 and 4 from one

set of contacts to the next as long as busy, that is, as long as grounded contacts 5 are encountered, and relay LR energizing each time a grounded bank contact is encountered. Magnet MM alternately opens and closes its contact 43, and thus a vibratory circuit is closed through the winding of cut-off relay CO to ground, through contacts 44 of off-normal contacts ON. The winding of relay CO is of high resistance and as motor magnet MM is energized and de-energized with great rapidity, the said winding of relay CO does not effectively energize and attract its armature while the motor magnet MM is operating. The relay CO may also contain a copper sleeve to make it slightly slow to energize. Closure of contacts 44 of off-normal contacts ON places a ground upon private normal contacts 45 at the connectors having access to the calling subscriber's line A to render such contacts busy to incoming calls. When an idle private contact 5 is encountered, test relay LR and magnet MM remain unoperated and the prolonged closure of contact 43 of magnet MM now effectively energizes the relay CO by current over a path traced from battery, through the winding of relay CO, contact 43 of motor magnet MM, and contact 44 of off-normal contacts ON to ground. Relay CO upon energizing restores the off-normal contacts ON to their normal positions, connects the subscriber's line to line wipers 3 and 4 and connects the said winding of relay CO to private wiper 2. The relay CO being slow to release is held up momentarily until a substitute circuit is established for the relay CO, as will be presently described.

The connection of the subscriber's line to line wipers 3 and 4 of the switch B closes an energizing circuit for impulse relay IR of the idle first selector C over a circuit traced from battery through the right-hand winding of relay IR, conductor 46, contact 47 of relay T, contact 6, wiper 3, alternate contacts 15 and 9 of relay CO, through substation A, back through alternate contacts 11 and 17 of relay CO, wiper 4, contact 7, normal contact 48 of relay T, conductor 49 and through the left-hand winding of relay IR to ground. The closing of alternate contact 50 of relay IR energizes relay 51 by current from battery, through the upper winding of relay 51, contact 50, to ground at normal contact 52 of the primary off-normal contacts PON. Relay 53 is also energized, due to the closure of alternate contact 50 over a circuit traced from battery, through the upper winding of said relay 53, and alternate contact 50, to ground at normal contact 52 of primary off-normal contacts PON. The closing of alternate contact 54 of relay 53 establishes a substitute energizing circuit for relay CO of the line switch C before it has had time to de-energize, said circuit being traced from battery, through relay CO, normal contact 43, contacts 16 and 10 of relay CO, wiper 2, contact 5, conductor 55 and alternate contact 56, to ground at alternate contact 54. Relay CO remains energized until time of release. The connector contacts 45 of substation A are also made busy by the ground just traced.

If the private contact 5 engaged by the wiper 2 is idle when the subscriber A initiates a call, the line relay LR is energized as before described, and contacts ON assume their alternate position, but the closing of contact 42 of relay LR does not energize magnet MM since there is no ground on contact 5 and the magnet MM remains inert. The cut-off relay CO is immediately energized to ground at contact 44, restores contact ON as before described, and the relay CO is held energized over a circuit to ground at first selector C, as already described. Thus switch B only travels when its wipers are in engagement with a busy trunk when a call is initiated.

An idle first selector C having been seized as just described, and assuming that the number of the called substation E is 345, the subscriber A actuates the calling device CD to send three impulses of current over the line, which impulses bring about three rapid de-energizations and energizations of the impulse relay IR. The primary magnet PM is energized and de-energized three times, due to the closing and opening of normal contact 50 of relay IR, the circuit being traced from battery, through magnet PM, normal contact 57 of secondary off-normal contact SON, conductor 58, normal contact 50 of relay IR, conductor 20' to ground at alternate contact 70 of relay 51, which magnet operates to step the wipers 18, 19 and 20 of the first selector C in a downward primary direction to the third group of contacts, thus selecting the three-hundreds group of connectors. After the last impulse, the relay 53 de-energizes, due to a circuit being closed through the lower winding of the said relay 53, normal contact 59 of magnet SM, alternate contact 60 of relay IR, and alternate contact 61 of primary off-normal contacts PON to ground at alternate contact 52 of primary off-normal contacts PON. The primary off-normal contacts PON move to their alternate positions upon the first step of the wipers 18, 19 and 20 of the first selector D off-normal, and the energizing circuit for the lower winding of relay 53, just mentioned, is closed upon the first step of the wipers off normal, but the relay 53 does not de-energize during the sending of impulses, it being differentially wound and only receiving short impulses of current through its neutralizing winding during the impulse operation of relay IR. As soon as the

above-mentioned circuit through the lower winding of relay 53 is steadily closed, the lower or neutralizing winding builds up and the said relay permits its armature to retract. The opening of contact 54 disconnects ground from conductor 55 at this point, but a substitute ground from alternate contact 52 of the primary off-normal contact PON is substituted before said relay 53 de-energizes, to keep contact 5 busy and for other apparent purposes. Differential relay 51 is not de-energized during the rapid operation of relay IR, although rapid impulses are transmitted through its lower or neutralizing winding, due to the construction and adjustment of the said relay 51. Upon the de-energization of the relay 53, an energizing circuit for the relay 62 is established, traced from battery, through the winding of said relay, normal contact 63 of relay T, normal contact 64, normal contact 65 of the secondary off-normal contact SON, normal contact 54 of relay 53 and alternate contact 56 to ground at alternate contact 52 of primary off-normal contacts PON. Relay 62 causes secondary magnet SM to be energized over a circuit traced from battery through said magnet SM to ground at alternate contact 66 of relay 62, and secondary magnet SM steps the wipers 18, 19 and 20 one step in a rotary or secondary direction into engagement with the first set of contacts 21, 22 and 23, and the opening of normal contact 64 at magnet SM de-energizes relay 62. The opening of normal contact 59 of magnet SM opens the circuit through the lower winding of relay 53, which relay energizes again. Relay 62 upon de-energization opens its contact 66, permitting secondary magnet SM to de-energize. Upon the first step of the wipers 18, 19 and 20, the secondary off-normal contacts SON assume their alternate position, opening the initial energizing circuit of the relay 62, and should the private wiper 18 of the first selector D engage a contact leading to a busy connector, a substitute circuit is established for relay 62 traced from battery, through the winding of the relay 62, normal contact 63 of relay T, normal contact 64 of magnet SM, alternate contact 67 of relay 51, alternate contact 28 and wiper 18 to the grounded busy contact 21. The resulting closing of contact 66 of relay 62 again energizes secondary magnet SM. The relay 62 and magnet SM are thus alternately energized and de-energized to step the wipers 18, 19 and 20 in a secondary rotary direction to seek the contacts of an idle connector switch as D. When a contact 21 leading to an idle connector is encountered by the wiper 18, the energizing circuit for relay 62 remains open and no further energizations of the secondary magnet SM occur. By this see-saw action of

relay 62 and magnet SM a positive driving operation of the secondary magnet SM is secured and the selector C will not stop on a busy contact or go past an idle contact, because unless relay 62 is energized, magnet SM can not be energized, and relay 62 can only be energized when magnet SM is at normal and private wiper 18 is resting on a busy contact.

The relay 53 does not de-energize during the secondary movement of the wipers, due to its adjustment and the rapidity of the interruptions of contact 59 of secondary magnet SM. The steady closure of contact 59 of magnet SM after its last de-energization closes a circuit for the lower winding of the relay 53, as previously described, and due to its differential construction, it de-energizes, whereon an energizing circuit for the relay T is established traced from battery, through the winding of the said relay T, alternate contact 65 of the secondary off-normal contacts SON, normal contact 54 of relay 53, alternate contact 56 of relay 51 to ground at alternate contact 52 of primary off-normal contacts PON. The opening of normal contacts 47 and 48 of relay T opens the energizing circuit of the impulse relay IR, and the closing of normal contact 50 of said relay IR closes a circuit through the lower winding of the relay 51, traced from battery, through the said lower winding, contact 56', and normal contact 50 of relay IR to ground at contact 70 of relay 51, which relay 51, due to its differential winding neutralizes and restores to normal, and opens the circuit of relay 53 permitting the latter to restore. The closing of alternate contacts 47 and 48 of relay T extends the connection of the calling subscriber A to the idle connector D, engaged by wipers 18, 19 and 20 of the first selector, bringing about the energization of the impulse relay IR' of connector D over a circuit traced from ground through the right-hand winding of the relay IR', contact 23, wiper 20, alternate contact 48 of relay T, contact 7, wiper 4, alternate contacts 17-11 of relay CO, through the substation A, alternate contacts 12-15 of relay CO, wiper 3, contact 6, alternate contact 47 of relay T, wiper 19, contact 22, and through the left-hand winding of the relay IR' to battery and ground. The restoration of the relay 51 opens the initial energizing circuit of relay T at contact 56 of relay 51, but the relay T being slow to release has a substitute circuit established for it, traced from battery through the winding of said relay, its alternate contact 71, wiper 18, bank contact 21, conductor 72, and conductor 73 to ground at alternate contact 74 of the impulse relay IR'. The said relay T remains energized until the termination of the conversation.

The energization of the relay IR' brings

about the energization of the relays 75 and 76, the circuit of relay 75 extending from battery through the right-hand winding of said relay, normal contact 77 of the primary off-normal contacts PON', conductor 72 and conductor 73 to ground at alternate contact 74 of relay IR'. The circuit for relay 76 extends from battery through the lower winding of the relay 76, conductor 78, conductor 79 and alternate contact 80 of relay IR' to ground at alternate contact 74 of impulse relay IR'. Upon the energization of relay 75, a locking circuit is closed for the said relay 75 extending from battery through its alternate contact 81 to ground. A circuit is closed through the upper winding of relay 76 at contact 82 of relay 75 when it energizes. The closing of this circuit causes the relay 76 to be de-energized, due to its differential construction. However, the de-energization of relay 76 is without effect at this time because the instant the impulse relay IR' is de-energized when the subscriber starts to send impulses, the circuit through the lower winding of relay 76 is opened and the said relay instantly energizes and remains in its energized condition during the period that the impulse relay IR' is operating.

The subscriber now operates his calling device CD to send the second series of impulses, which are four in number, over the line. These four impulses bring about four de-energizations and energizations of the relay IR', causing the primary magnet PM' to energize and de-energize four times to step the wipers 24, 25 and 26 in a primary direction to the fourth group of contacts containing the contacts of the called line.

The circuit of the primary magnet PM' may be traced from battery through the winding of the said magnet PM', normal contact 83 of switching relay SW, conductor 84, normal contact 85 of switching relay SW', conductor 86, alternate contact 87 of relay 76, normal contact 80 of relay IR', conductor 73, conductor 72, normal contact 77 of the primary off-normal contacts PON' to ground at alternate contact 81 of relay 75. The primary off-normal contacts PON' assume their alternate positions upon the first step of the wipers off normal. The opening of the primary off-normal contact 77 substitutes a ground from contact 88 of relay 89 for the ground fed through contact 81 of relay 75. After the last impulse of the series has been sent, the steady flow of current through both windings of relay 76 causes the said relay 76, due to its differential action, to neutralize and restore its contacts to normal. Relay 76 does not restore during the sending of impulses, due to its adjustment, construction and the rapidity of the interruptions of contact 80.

The closing of normal contact 90 of relay 76 brings about the energization of the switching relay SW, traced from battery through the winding of said relay SW, its make-before-break contact 91, normal contact 92 of secondary off-normal contacts SON', conductor 93, normal contact 90 of relay 76, and conductor 94 to ground at alternate contact 95 of primary off-normal contacts PON', the said primary off-normal contacts PON' having been moved to their alternate position on the first step of the wipers 24, 25 and 26 of the connector switch D. The closing of alternate contact 96 of relay SW closes a locking circuit for itself traced from battery, through the winding of relay SW, alternate contact 96, conductor 97, normal contact 98 of relay TCR, conductor 94 to ground at alternate contact 95 of primary off-normal contacts PON'. The said relay SW remains energized until the relay TCR is actuated, as will be presently described. The closing of alternate contact 83 of switching relay SW now renders the secondary magnet SM' operative so that when the calling subscriber at the substation A actuates his calling device again to send the next set of impulses, which we have assumed are five in number, the said magnet SM' will be energized and de-energized by the impulse relay IR' five times over a circuit traced from battery through the winding of the said magnet SM', alternate contact 83 of relay SW, conductor 84, normal contact 85 of relay SW, conductor 86, alternate contact 87 of relay 76, normal contact 80 of relay IR', conductor 73, conductor 72, alternate contact 77 of the primary off-normal contacts PON', and conductor 100 to ground at normal contact 88 of relay 89. The secondary magnet SM' now steps the wipers 24, 25 and 26 in a secondary direction to engage contacts 27, 28 and 29 of the called line. Upon the first impulse of this set, that is, upon the opening of contact 80 of relay IR' the relay 76 again energizes to permit the secondary magnet SM' to be operated, and after the last impulse the relay 76 is again de-energized by having a circuit closed through its lower winding, as previously described. The restoration of the relay 76 closes a circuit for the switching relay SW', traced from battery through the winding of the said relay SW', conductor 101, its normal contact 102, conductor 103, alternate contact 104 of relay SW, conductor 105, alternate contact 92 of secondary off-normal contacts SON', conductor 93, normal contact 90 of relay 76, conductor 94 to ground at alternate contact 95 of primary off-normal contacts PON'. The closing of alternate contact 106 of relay SW' establishes a locking circuit for the said relay SW', traced from battery through the winding of relay SW', alternate contact 106, conductors 107 and 94 to ground at alternate

contact 95 of primary off-normal contacts PON', the said relay SW' remaining energized until the restoration of the switch D.

The subscriber at the calling substation
 5 A now actuates his calling device CD to send impulses of current to bring about the movement of the frequency switch wiper 30 over contacts 31 to select the proper generator frequency to actuate the call bell at
 10 the called substation E. Assuming that the desired party is the first party or subscriber E on the party line, the subscriber at the calling substation A now actuates the calling device CD thereat to transmit one impulse
 15 of current, which brings about one de-energization and energization of impulse relay IR'. The de-energization of relay IR', due to the impulse of current, allows relay 76 to again energize, as previously described, and closes a circuit for the motor magnet
 20 MM' of the frequency switch FS over a circuit traced from battery, through the winding of the magnet MM', conductor 108, alternate contact 85 of switching relay SW', conductor 86, alternate contact 87 of relay 76,
 25 normal contact 80, conductors 73 and 72, alternate contact 77 of primary off-normal contacts PON', conductor 100 to ground at normal contact 88 of relay 89. The magnet MM' upon energization causes pawl 33
 30 to engage a tooth of ratchet 34, rotating the wiper 30 one step into engagement with the first contact 31, which contact is connected through interrupter I to generator G, which
 35 we assumed is the proper generator frequency for actuating the call signal at the called substation E. The retaining pawl 35 engages a tooth of the ratchet 34 and holds the wiper 30 in engagement with the contact
 40 31 until restored, as will presently be described. The impulse relay IR' again energizes after the impulse has been transmitted and again closes a circuit through the lower winding of relay 76 as previously described,
 45 allowing the relay 76 to restore, due to its differential construction, and also preventing further actuation of magnet MM'. The restoration of relay 76 closes a circuit for the test control relay TCR, traced from battery,
 50 through the winding of relay TCR, conductor 110, closed contacts 111 and 112, which contacts are controlled by the shaft 32 of the frequency switch FS and assume their alternate position on the first step of
 55 the wiper 30 off normal, conductor 113, alternate contact 114, conductor 103, alternate contact 104 of relay SW, conductor 105, alternate contact 92 of secondary off-normal contacts SON', conductor 93, normal contact
 60 90 of relay 76, conductor 94 to ground at alternate contact 95 of primary off-normal contacts PON'.

The relay TCR upon energization opens the locking circuit of switching relay SW at
 65 its contact 98, permitting the said relay SW

to de-energize. The relay SW de-energizing opens the circuit of relay TCR, at its contact 104, leaving the relay TCR dependent upon the potential found on the private contact 27 of the called line. The closing
 70 of alternate contact 115 of relay TCR connects the test relay TR in multiple circuit with relay TCR to the test wiper 24, the circuit of the test relay TR being traced from battery through the winding of the said relay
 75 TR, its make-before-break contacts 116, conductor 117, normal contact 104, conductor 103, alternate contact 114 of relay SW', conductor 113, closed contacts 111 and 112, conductor 110, alternate contact 115, conductor
 80 120, normal contact 121 of relay TR, conductor 122 to wiper 24. The circuit of relay TCR may be traced from battery, through the winding of relay TCR, its alternate contact 115, conductor 120, normal
 85 contact 121 of relay TR and conductor 122 to the test wiper 24.

Called line idle.

Assuming that the called line is idle, private contact 27 of the called line will have a battery potential upon it and the relay TR will not be energized, but will remain at normal and the relay TCR failing to find a ground upon wiper 24 returns to normal,
 90 having its initial energizing circuit opened at alternate contact 104 of relay SW, as before described.

The relay TCR de-energizing brings about the energization of the relay 89 over a circuit traced from battery through the cut-off relay CO' of the individual line switch B', bank contact 27, through wiper 24, conductor 122, normal contact 121 of relay TR,
 100 conductor 120, normal contact 115 of relay TCR, conductor 123, normal contact 124 of relay SW, conductor 125, through the lower winding of the relay 89, conductor 126, to ground at alternate contact 82 of the relay
 105 75. Relays 89 and CO' energize over this circuit. Relay CO' upon energizing, removes the called subscriber's control of the line switch B'.

The closing of alternate contact 127 of relay 89 short-circuits the lower winding of the said relay and feeds ground to the cut-off relay CO' of the line switch B', and at the same time supplies the busy potential to the multiple private contacts 27 of the called line. The closing of alternate contact 128 of
 110 relay 89 closes a circuit through the upper winding of said relay 89, traced from battery through its winding, the alternate contact 128 of said relay 89, and conductor 126 to ground at alternate contact 82 of relay
 115 75. The closing of alternate contact 129 of the relay 89 closes a circuit for ringing current from generator G to signal the called subscriber's substation, the path of said ringing current being traced from battery 130,
 120 130

through the ringing generator G, through the live segment of the interrupter I, contact 31 and wiper 30 of the frequency switch FS, through the winding 132 of ringing trip relay TR, conductor 133, alternate contact 129 of relay 89, conductor 134, normal contact 135 of relay RT, wiper 26, contact 29, through the call bell and condenser of the called substation E, back through contact 28, wiper 25, normal contact 136 of relay RT and conductor 137 to ground at alternate contact 88 of relay 89. The ringing current is intermittently connected to the called line, due to the constantly rotating interrupter I, thus bringing about an intermittent actuation of the call signal at the called subscriber's substation E. The interrupter I is so arranged that ringing current from the generator G and battery 130 are alternately connected to the called line, so that should the subscriber answer in either a silent or a ringing period, ringing current is instantly disconnected, thus eliminating the undesirable feature of ringing the answering subscriber at the called substation in the ear should the subscriber remove his receiver during a ringing period. During the ringing and silent periods, and before the subscriber at the called substation E answers, the condenser at the said substation prevents a flow of battery through the winding 132 of the relay RT. The calling subscriber at substation A also receives an audible signal notifying him that the called subscriber is being signaled; the audible signal circuit being traced from the ungrounded pole of the generator G², through resistance 140, condenser 141, normal contact 142, conductor 143, alternate contact 144 of relay 89, contact 23, wiper 20, alternate contact 48 of relay T, contact 7, wiper 4, closed contacts 17 and 11 of relay CO, through the receiver of the calling substation A, back through closed contacts 9 and 15 of relay CO, wiper 3, contact 6, alternate contact 47 of relay T, wiper 19, contact 22, to ground through the upper winding of supervisory relay SR.

The subscriber in response to the call signal, removes his receiver, and should he remove it during a live period the combined generator and battery current of the generator G and battery 130 brings about the energization of the relay RT over a circuit traced from battery 130, through the said generator G, through the interrupter I, the upper winding 132 of relay RT, conductor 133, alternate contact 129, conductor 134, normal contact 135, wiper 26 and contact 29, through the now closed contacts at the substation switch hook, back through contact 28, wiper 25, normal contact 136, conductor 137, to ground at alternate contact 88. The relay RT energizes over the circuit traced and closes a locking circuit for itself, traced from battery through the lower winding 138 of relay RT, its alternate contact 139, and conductor 94 to ground at alternate contact 95 of the primary off-normal contacts PON'. Should the subscriber remove his receiver from the switch hook during a silent period, the relay RT will energize over a circuit from battery 130, through the live battery segments of the interrupter I, the upper winding 132 of relay RT, and over the previously described path to ground at alternate contact 88, which causes the relay RT to energize and close the locking circuit for itself through its winding 138, as before described. Thus it will be seen that ringing current is instantly disconnected from the called line either during live or silent periods by the opening of contacts 135 and 136 of relay RT. Upon the energization of the relay RT, an energizing circuit for the supervisory relay SR is established traced from battery through the lower winding of said relay SR, alternate contact 135 of relay RT, wiper 26, contact 29, through the substation back to the contact 28, wiper 25, alternate contact 136 of relay RT and through the upper winding of the relay SR to ground. The subscribers are now in conversational circuit and the talking circuit may be traced over the heavily marked conductors, the said conductors having the condensers K and K' interposed.

The subscribers having finished conversation, and assuming that the subscriber at the substation A is the first to replace his receiver upon its switch hook, the opening of the switch hook contacts thereat brings about the de-energization of the impulse relay IR' of the connector D. The restoration of the relay IR' brings about the opening of the holding circuit of the relay T of the first selector C, and the closing of normal contact 63 of the restored relay T of the first selector C closes an energizing circuit for the relay 62, which may be traced from battery through the winding of the relay 62, normal contact 63, normal contact 64 of magnet SM, normal contact 67 of relay 51, and alternate contacts 61 and 52 of primary off-normal contacts PON to ground. The closing of alternate contact 66 of the relay 62 brings about the energization of the secondary magnet SM. The relay 62 and the secondary magnet SM are alternately energized and de-energized, as previously described the secondary magnet SM thus stepping the wipers 18, 19 and 20 beyond the last contacts of the row of bank contacts, from which point the wipers are restored to normal. The secondary off-normal contacts SON and primary off-normal contacts PON restore to normal, and the opening of alternate contact 52 of the primary off-normal contacts PON opens the energizing circuit of the cut-off relay CO of the individual line switch B. The restoration of the cut-off relay CO restores the individual switch B to normal.

The subscriber E placing his receiver upon the switch hook interrupts the circuit of the relay SR of the connector D at the switch hook contacts, causing the said relay to de-energize. The closing of normal contact 150 of relay SR closes a circuit through the left-hand winding of the relay 75, which may be traced from battery through the said left-hand winding of relay 75, through its alternate contact 151, conductor 152, normal contact 150, and conductor 153 to ground at normal contact 74 of the relay IR'. Due to the differential construction of relay 75, the said relay neutralizes and restores to normal. The closing of normal contact 154 of relay 75 closes the circuit of secondary magnet SM', which may be traced from battery through the winding of said secondary magnet SM', conductor 155, normal contact 154 of relay 75, alternate contact 156 of primary off-normal contacts PON', through the interrupter I² to ground. The secondary magnet SM' thus steps the wipers 24, 25 and 26 beyond the last set of contacts in the group, and the wipers then restore to normal from this position. The restoration of the relay 75 also brings about the opening of the circuit of the relay 89 at alternate contact 82, bringing about the restoration of the said relay 89. The primary off-normal contacts PON' having restored upon the restoration of the switch, the opening of alternate contact 95 of the contacts PON' brings about the restoration of the relay RT and relay SW'. The relay 75 also causes the de-energization of cut-off relay CO' of the line circuit B', which is associated with the called subscriber's substation E. The switch shaft of the connector D upon restoring to normal engages the retaining pawl 35 of the frequency switch FS and withdraws it from engagement with the ratchet 34, thus allowing the wiper 30 to restore to normal again, opening contacts 111 and 112. All of the apparatus used in establishing the connection between the calling subscriber at the substation A and the called subscriber at the called substation E is now at normal and available for use in establishing other connections.

Assuming now that the subscriber at the called substation E is the first to replace his receiver upon the switch hook, the opening of the switch hook contacts at the substation E brings about the de-energization of the relay SR. Nothing else happens at this time as the relay IR' is still maintained energized over the line of the calling substation A. The calling subscriber at the substation A replacing his receiver interrupts the circuit of the impulse relay IR' at the switch hook contacts. The relay IR' de-energizing, closes a circuit through the left-hand winding of relay 75, causing the said relay to de-energize, as hereinbefore described. The restoration of the individual

switch B, first selector C and connector D is the same as previously described from this point on.

Should the called subscriber E fail to replace his receiver upon the switch hook after the conversation is terminated, the replacing of the receiver at the substation A brings about the de-energization of the impulse relay IR' of connector D, the same as before, and the opening of alternate contact 74 of the impulse relay IR' opens the circuit of the relay T of the first selector C, as before described, and causes the release of the selector C and individual switch B. The subscriber at the called substation failing to replace his receiver upon the switch hook permits the continued energization of the relay SR, thus holding contact 150 of said relay in its alternate position, preventing the differentially wound relay 75 from restoring to normal and closing the energizing circuit for the secondary magnet SM'. The relay 76 energizes when the impulse relay IR' drops back but is immediately restored to normal, due to the closure of an energizing circuit through the lower winding of the said relay 76, which may be traced from battery through the lower winding of the relay 76, conductor 78, conductor 79, alternate contact 150, conductor 153, to ground at normal contact 74 of the now restored impulse relay IR'. The relay 76 being differentially wound restores to normal, and the closing of normal contact 160 of said relay 76 places a ground upon the private contact of the connector D over a circuit which may be traced from ground to alternate contact 95 of primary off-normal contacts PON', over conductor 94, through normal contact 90 of relay 76, conductor 93, alternate contact 92, normal contact 160 of relay 76, alternate contact 161 of secondary off-normal contacts SON' and conductor 72 to the private contact 21. The placing of the busy potential upon the private contact prevents any first selector switch C from engaging the contacts of this busy connector.

Called line busy.

Assuming now that the called line is busy, the operation of the circuit is the same up to and including the time when the relay TCR energizes, as previously described. The line being busy, private contact 27 has a busy potential placed upon it, thus closing the multiple circuit for the relay TCR and the test relay TR, the circuit of the relay TCR being traced from battery through the winding of the said relay TCR, its alternate contact 115, conductor 120, normal contact 121 of relay TR, conductor 122, to the busy grounded private contact 27. The circuit of the test relay TR is traced from battery through the winding of the said relay TR, the make-before-break contact 116 of said

relay, conductor 117, normal contact 104 of relay SW, conductor 103, alternate contact 114 of relay SW, conductor 113, closed contacts 111 and 112, conductor 110, alternate contact 115 of relay TCR, conductor 120, normal contact 121 of relay TR, conductor 122 and wiper 24 to ground at busy private contact 27. The contacts 116 and 121 of the relay TR are so adjusted that the alternate contact 165 makes before the contact 121 breaks, thus closing a locking circuit for relay TR through its alternate contact 165 before the normal contact 121 of the said relay breaks. The locking circuit of the said relay TR extends from battery through the said relay, its alternate contact 165, conductor 166, to ground at alternate contact 95 of primary off-normal contacts PON'. The locking circuit for the said test relay TR is independent of the grounded private contact and the opening of the normal contact 121 of the relay TR opens the circuit for the relay TCR which restores to normal. The falling back of relay TCR does not affect relay 89, due to the fact that the test conductor 122 is held open at contact 121 of relay TR. The locking circuit for the test relay TR is thus independent of the busy grounded contact 27. This arrangement does away with the method usually employed of locking the busy relay up to the busy private contact of the called busy line. The closing of alternate contact 167 of relay TR connects the busy-back signal BB to the calling line to transmit a busy signal to the said calling subscriber at the substation A, thus notifying him of the busy condition of the said called substation E.

The calling subscriber now replaces his receiver upon the switch hook, bringing about the de-energization of IR'. The relay IR' restoring opens the circuit for the relay T of the first selector C, which closes the circuit of the secondary magnet SM as previously described, thus bringing about the release of the first selector C and individual switch B. The relay IR' de-energizing brings about the restoration of relay 75, due to the fact that the relay SR is not energized. The closing of normal contact 154 of the said relay 75 closes the circuit for the secondary magnet SM', which magnet steps the wipers 24, 25 and 26 beyond the last set of contacts. The wipers then restore to normal. Primary off-normal contacts PON' and secondary off-normal contacts SON' are also restored. The apparatus used in this busy connection is now at normal and available for use in establishing other connections. Should the called line become idle during the time of the transmission of the busy signal and before the calling subscriber replaces his receiver, nothing happens as the contact 121 of relay TR is in its alternate position, preventing the

energization of relay 89, and thus preventing ringing current from being sent out to the now idle called line.

While I have shown a system of 1,000-line capacity, it is to be understood that by inserting second selectors this system may be increased to 10,000 lines, etc.

While I have described my invention operating in connection with a well-known system, I do not wish to be limited to this exact disclosure, as my invention may be applied to other systems without departing from the spirit of the invention, and I, therefore, do not wish to be limited to this exact disclosure, but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

Having described my invention, what I claim as new and desire to secure by United States Letters Patent, is:

1. A telephone system including a called and a calling subscriber's line, a side-switchless connector switch, means for connecting said connector switch to said called subscriber's line, ringing current generators, a frequency selector for said connector switch, subscriber-controlled means for operating said frequency selector to select one of said ringing current generators, automatic means for intermittently applying ringing current from said selected generator to the called subscriber's line, and subscriber-controlled means for disconnecting the selected generator from the called line during a ringing period if the called subscriber answers during a ringing interval.

2. A telephone system including a called and a calling subscriber's line, a side-switchless connector switch, means for connecting said connector switch to said called subscriber's line, ringing current generators, a frequency selector for said connector switch, a differential relay for placing the control of said frequency selector under the calling subscriber, subscriber-controlled means for operating said frequency selector to select one of said ringing current generators, automatic means for intermittently applying ringing current from said selected generator to the called subscriber's line, and subscriber-controlled means for disconnecting the selected generator from the called line if the called subscriber answers during a ringing interval.

3. A telephone system including a called and a calling subscriber's line, a connector switch, means for connecting said connector switch to said called subscriber's line, ringing current generators, a frequency selector for said connector switch, subscriber-controlled means for operating said frequency selector to select one of said ringing current generators, automatic means for intermittently applying ringing current from said selected generator to the called sub-

scriber's line, subscriber-controlled means for disconnecting the selected generator from the called line if the called subscriber answers during a ringing interval, holding means for maintaining said frequency selector in advanced position, and means controlled by the restoration of the connector for actuating said holding means to release the frequency selector.

4. A telephone system including a called and a calling subscriber's line, a connector switch, means for connecting said connector switch to said called subscriber's line, ringing current generators, a frequency selector for said connector switch, subscriber-controlled means for operating said frequency selector to select one of said ringing current generators, automatic means for intermittently applying ringing current from said selected generator to the called subscriber's line, subscriber-controlled means for disconnecting the selected generator from the called line if the called subscriber answers during a ringing interval, and a holding pawl for maintaining said frequency selector in advanced position, said holding pawl being actuated by said connector when said connector is advanced and restored to its normal position.

5. A telephone system including a calling and a called subscriber's line, a side-switchless connector switch adapted to be connected to the calling subscriber's line, ringing current generators, a frequency selector for said connector switch, subscriber-controlled means for actuating said connector switch and said frequency generator over the two sides of the calling subscriber's line in series for extending the connection to the calling subscriber's line and for selecting one of said ringing current generators, automatic means for intermittently applying ringing current from the selected generator to the called subscriber's line, and means responsive to the removal of the receiver at the called substation for instantly disconnecting or for preventing a reapplication of ringing current to the called subscriber's line depending upon whether the called subscriber responds during a ringing interval or a silent interval.

6. A telephone system including a called and a calling subscriber's line, a connector switch, means for connecting said connector switch to said called subscriber's line, ringing current generators, a frequency selector for said connector switch, subscriber-controlled means for operating said frequency selector to select one of said ringing current generators, automatic means for intermittently applying ringing current from said selected generator to the called subscriber's line, subscriber-controlled means for disconnecting the selected generator from the called line if the called sub-

scriber answers during a ringing interval, a holding pawl for maintaining said frequency selector in advanced position, means controlled by the restoration of the connector for actuating said holding pawl to release the frequency selector, and differential switching and release relays for said connector switch for controlling circuits thereof.

7. A telephone system including a called and a calling subscriber's line, a connector switch, means for connecting said connector switch to said called subscriber's line, ringing current generators, a frequency selector for said connector switch, subscriber-controlled means for operating said frequency selector to select one of said ringing current generators, automatic means for intermittently applying ringing current from said selector generator to the called subscriber's line, subscriber-controlled means for disconnecting the selected generator from the called line if the called subscriber answers during a ringing interval, holding means for maintaining said frequency selector in advanced position, said holding means being actuated by said connector when it is advanced and restored to its normal position, and differential switching and release relays for said connector switch for controlling circuits thereof.

8. A telephone system including a calling and a called subscriber's line, a side-switchless connector switch adapted to be connected to the calling subscriber's line, ringing current generators, a frequency selector for said connector switch, subscriber-controlled means for actuating said connector switch and said frequency generator over the two sides of the calling subscriber's line in series for extending the connection to the calling subscriber's line and for selecting one of said ringing current generators, automatic means for intermittently applying ringing current from the selected generator to the called subscriber's line, means responsive to the removal of the receiver at the called substation for instantly disconnecting or for preventing a reapplication of ringing current to the called subscriber's line depending upon whether the called subscriber responds during a ringing interval or a silent interval, and differential switching and release relays for said connector switch controlling circuits thereof.

9. A telephone system including a connector switch provided with driving magnets, a frequency selector for said connector switch provided with a driving magnet, a control relay for controlling said magnets, and a differential relay for switching the control of said relay from a driving magnet of the connector to a driving magnet of the frequency selector.

10. A telephone system including a connector switch provided with driving mag-

nets, a frequency selector for said connector switch provided with a driving magnet, a control relay for controlling said magnets, a circuit, and a differential relay adapted to switch said circuit controlled by said control relay from a driving magnet of the connector to the driving magnet of the frequency selector.

11. A telephone system including a connector switch provided with driving magnets, a frequency selector for said connector switch provided with a driving magnet, a control relay for controlling said magnets, an electrical conductor, a differential relay adapted to switch said conductor controlled by said control relay from a driving magnet of the connector to the driving magnet of the frequency selector, holding means for maintaining the frequency selector in an advanced position, and means controlled by the release of the connector for releasing said holding means.

12. A telephone system including a connector switch provided with driving magnets, a frequency selector for said connector switch provided with a driving magnet, a control relay for controlling said magnets, a circuit controlled by said control relay, a differential relay adapted to switch said circuit from a driving magnet of the connector to the driving magnet of the frequency selector, holding means for maintaining the frequency selector in an advanced position, and means actuated when the connector is advanced and restored to release said holding means.

13. A telephone system including a side-switchless connector switch provided with a driving magnet, a frequency selector for said connector switch provided with a driving magnet, a control relay adapted to supply impulses of current over a circuit to said driving magnets, and a differential relay for switching the impulse circuit controlled by said control relay from the driving magnet of the connector to the driving magnet of the frequency selector.

14. A telephone system including a side-switchless two-wire connector switch, a switch shaft for said connector, a driving magnet for advancing said shaft in one di-

rection, a second driving magnet for advancing said shaft in another direction, a frequency selector provided with a driving magnet, an impulse relay, an impulse circuit controlled by said relay, and a differential relay for switching said impulse circuit from one driving magnet of the connector to the other and from said other driving magnet of the connector to the driving magnet of the frequency selector.

15. A telephone system including a side-switchless two-wire connector switch, a switch shaft for said connector, a driving magnet for advancing said shaft in one direction, a second driving magnet for advancing said shaft in another direction, a frequency selector provided with a driving magnet, an impulse relay, an impulse circuit controlled by said relay, a differential relay for switching said impulse circuit from one driving magnet of the connector to the other and from said other driving magnet of the connector to the driving magnet of the frequency selector, and a differential release control relay for controlling the release of said connector and frequency selector.

16. A telephone system including a side-switchless two-wire connector switch, a switch shaft for said connector, a driving magnet for advancing said shaft in one direction, a second driving magnet for advancing said shaft in another direction, a frequency selector provided with a driving magnet, an impulse relay, an impulse circuit controlled by said relay, a differential relay for switching said impulse circuit from one driving magnet of the connector to the other and from said other driving magnet of the connector to the driving magnet of the frequency selector, a differential release control relay for controlling the release of said connector and frequency selector, means for advancing said switch shaft to restore the same to normal, and means effective upon the restoration of the switch shaft to normal to release said frequency selector.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 20th day of August, 1919.

GEORGE A. YANOCHOWSKI.