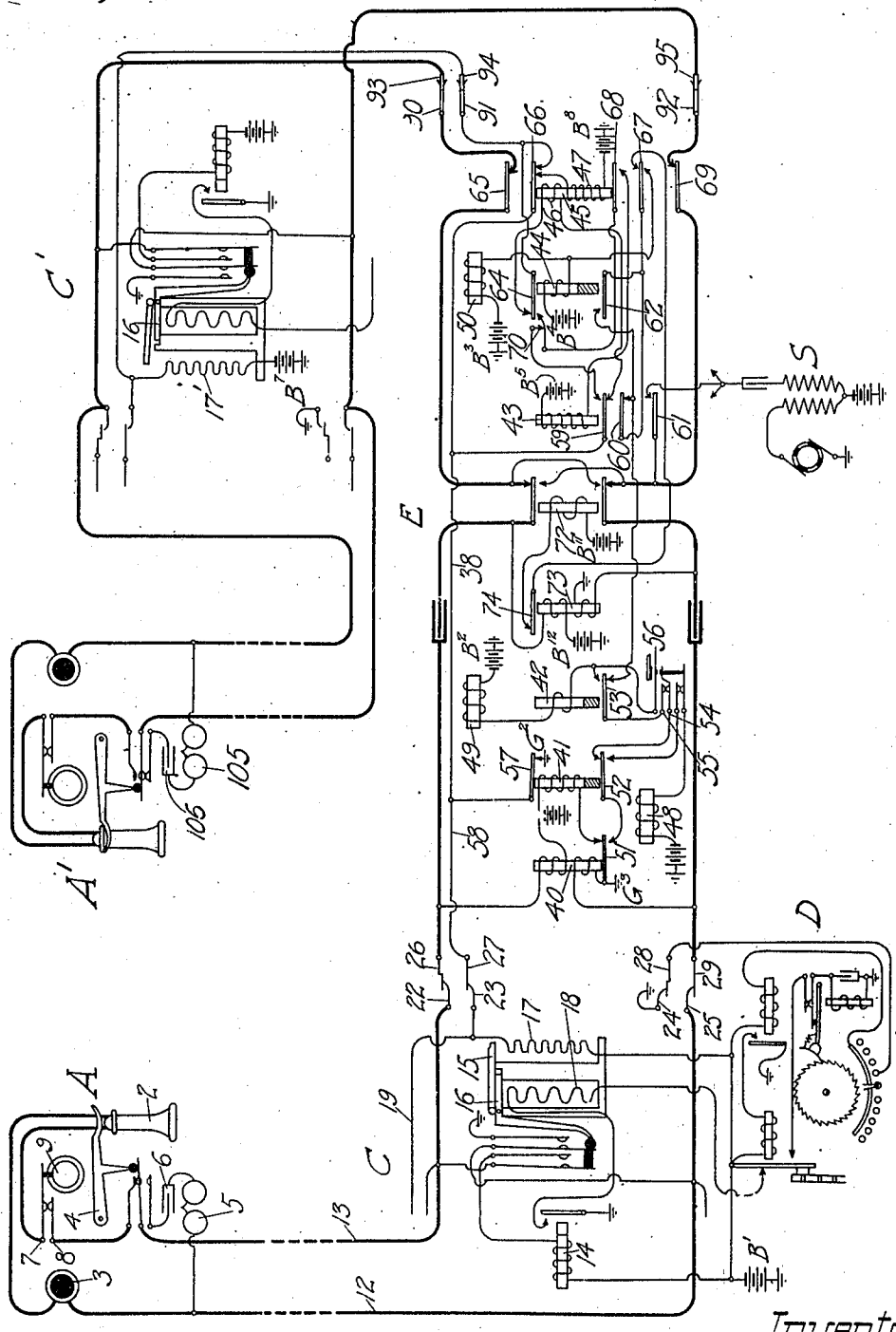
T. G. MARTIN & E. JACOBSEN.

AUTOMATIC TELEPHONE SYSTEM.

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1,292,499. Patented Jan. 28, 1919.



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AUTOMATIC TELEPHONE SYSTEM.

1,292,499. Specification of Letters Patent. Patented Jan. 28, 1919.

Application filed February 12, 1917. Serial No. 147,989.

To all whom it may concern:

Be it known that we, TALBOT G. MARTIN and EMIL JACOBSEN, both citizens of the United States of America, and residents, respectively, of Chicago, Cook county, Illinois, and Evanston, Cook county, Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

Our invention relates in general to automatic telephone systems, but is particularly well adapted for use in small exchanges of this character which are commonly known as private branch exchanges. Where the number of subscribers is small, the expense of providing the usual alternating current ringing apparatus is out of proportion to the cost of the remainder of the exchange equipment, and we have designed, therefore, a ringing system in which each connector is provided with a pole changing or reversing relay in lieu of the usual ringing and ring cut-off relays. When connection is established with a called line, the pole changing relay of the connector in use responds to an extra digit in the called telephone number to rapidly reverse the connections of the called line to the battery supply relay, whereby an alternating current is produced in the called line to actuate the signal in bridge thereof. Additional novelty is believed to exist in certain other features of the connector circuit, including a new method of accomplishing the "change over", from primary to secondary movement, all of which will be described and explained fully hereinafter, reference being had to the accompanying drawing.

In the drawing we have shown diagrammatically private branch exchange equipment embodying our invention, through the medium of which a complete connection has been established between a calling substation A and a called substation A′. The apparatus included in the connection comprises the individual line switch C and the connector switch E. The line switch C′ is associated with the line of the called substation A′, while the master switch D is provided for the purpose of controlling the trunk selecting operations of the line switches C and C′ and other similar line switches.

The substation A may be of any approved automatic type such, for example, as the substation shown in British patent to Martin, No. 1,419 of 1910. As represented herein it comprises essentially the receiver 2, transmitter 3, switch-hook 4, ringer 5, and condenser 6. Being an automatic substation, it is also provided with a pair of impulse springs 7 and 8 controlled by an impulse wheel 9 through the medium of a finger hole dial (not shown).

The line conductors 12 and 13 of the substation A are connected at the exchange to the individual line switch C which is of the general type of line switch disclosed in the British patent to James, No. 26,301 of 1906; being, however, of the particular type shown in U. S. Letters Patent No. 1,078,690, granted Jan. 17, 1912, to Frank Newforth. Through the medium of line switch C the line of substation A when calling is given access to a plurality of trunk lines extending to connector switches.

The line switches shown and a plurality of similar switches are controlled in their trunk selecting operations by means of the master switch D. This latter is of the general type of master switch disclosed in the above mentioned British patent to James, No. 26,301 of 1906; being, however, more nearly of the particular type disclosed in the British patent to Martin, No. 1,419 of 1910, also previously referred to. As is well known, the function of the master switch is to maintain the plungers of all idle line switches which it controls in position before the terminals of an idle trunk line.

One of the trunk lines to which the line switch C has access is shown in the drawing as extending to the connector switch E. The connector E is in general similar in construction to the switch shown in U. S. Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson, and Erickson, except that the side switch and private magnet are omitted, and the circuits are revised in accordance with the two-wire system of control. Further modifications in the circuits, provided in accordance with our invention, will be described in detail hereinafter.

The substation A′ and the line switch C′ may be in all respects similar to the substation A and the line switch C.

There has been shown throughout the drawing a plurality of batteries, B′, B², etc.,

but it is to be understood that there is preferably but one battery having its positive pole grounded. The reference character S indicates a busy signaling machine, which may be of the usual type common in other automatic systems.

The operation of the system is as follows: When the subscriber at substation A removes his receiver to initiate the call an energizing circuit is completed over the line conductors 12 and 13 for the line relay 14 of the line switch C. Upon attracting its armature, the line relay 14 closes a circuit for the pull-in winding 18. Upon energizing, the pull-in winding energizes its core sufficiently to operate both the plunger arm 15 and the cut-off armature 16; the former through the medium of its plunger (not shown) forcing the bank springs 22—25, inclusive, into engagement, respectively, with contacts 26—29, inclusive; and the latter disconnecting the line conductors 12 and 13 from ground and battery, respectively. By the engagement of bank springs 22 and 25 with their associated bank contacts 26 and 29, the line conductors 12 and 13 are extended to the double wound line relay 40 of the connector E.

The line relay 40 is accordingly energized over the calling line circuit and upon attracting its armature 51 closes a circuit for the slow acting release relay 41. Upon energizing in turn, the relay 41 completes a holding circuit for the line switch C which may be traced as follows: Ground at G^2, working contact of armature 57 and the said armature, conductor 58, contact 27, bank spring 23, and the holding winding 17 to battery B'. Since the line relay 14 is slow acting it retains its armature to maintain the pull-in winding energized until after the above holding circuit has been established. A branch of the holding circuit extends by way of conductor 19 to multiple test contacts in the banks of connector switches having access to the line of substation A, where by a ground potential on these test contacts the said line is made busy. By the engagement of bank spring 24 with contact 28 the master switch is operated in well known manner to advance the plungers of all the remaining idle line switches into position before the terminal of the next idle trunk line.

The foregoing operations have occurred in response to the removal of the receiver at substation A. The calling subscriber may now proceed to manipulate his calling device in accordance with the first digit of the desired number, thereby producing in the usual and well known manner a series of interruptions in the line circuit. At each interruption the line relay 40 deënergizes momentarily and sends an impulse of current to the vertical magnet 49 over the following path: Ground at G^3, armature 51 and its resting contact, armature 52 and its working contact, off normal springs 54 and 56, winding of low resistance slow acting relay 42, and winding of vertical magnet 49 to battery B^2. In response to these impulses the vertical magnet operates to raise the switch shaft step by step until the wipers 90, 91, and 92 arrive at the horizontal level of bank contacts in which are located the terminals of the line of substation A'. Relay 42 is energized in series with the vertical magnet and retains its armature during the series of impulses, thereby preventing the opening of the vertical magnet circuit by the shifting of the off normal springs, which operation occurs as soon as the shaft leaves normal position.

The calling subscriber may now call the units or final digit in the desired number, thereby producing as before a series of interruptions in the line circuit. Now, however, the off normal springs being in the position shown in the drawing, and the relay 42 having deënergized, the line relay transmits a series of impulses to the rotary magnet 50 over the following path: Ground at G^3, armature 51 and its resting contact, armature 52 and its working contact, off normal springs 54 and 55, armature 53 and its resting contact, armature 60 and its resting contact, armature 67 and its resting contact, and the winding of rotary magnet 50 to battery B^3. The rotary magnet responds to the impulses of current in the circuit to rotate the wipers 90, 91, and 92 until they arrive at bank contacts 93, 94, and 95, which form the terminal of the line of substation A' in the bank of the connector E. It will be noted that a branch of the rotary magnet circuit extends through the winding of the slow acting relay 44 to battery B^4. It follows that relay 44 will be energized in parallel with the rotary magnet during the rotation of the switch, and since it is slow acting, it retains its armatures attracted continuously. By the attraction of the upper armature 64 the test wiper 91 is connected to the winding of relay 43 as follows: Test wiper 91, armature 64 and its working contact, armature 68 and its resting contact, and the winding of relay 43 to battery B^5. Momentary energizations of relay 43 due to wiper 91 passing over busy contacts (if there be any such in its path) are of no consequence because of the alternative circuit for the rotary magnet by way of armature 62 of relay 44 and its working contact.

The switch wipers having been rotated into connection with the desired line, the line of substation A', the operations now depend on whether or not that line is busy. Assuming the line to be idle, the test contact 94 will be clear of ground, the relay 43 will remain inoperative, and upon the deënergization of relay 44 the following circuit will

be closed: Grounded conductor 58, armature 59 of relay 43 and its resting contact, winding 46 of relay 45, resting contact of armature 64 and the said armature, test wiper 91, test contact 94 and the holding winding 17′ of line switch C′ to battery B^7. Relay 45 and the holding winding 17′ are energized in series, the latter operating the cut-off armature 16′ to clear the line of substation A′ from battery and ground connections in the line switch. Relay 45, upon energizing, closes a locking circuit for itself by way of its armature 66, inner working contact, and winding 47 to battery B^8. At the same time at the outer working contact of armature 66, the conductor 58 is connected direct to the test wiper 91. Further results of the energization of relay 45 are the closure of the line conductors at armatures 65 and 69, the shifting of the control circuit at armature 67 from the rotary magnet to the pole changing relay 72, and the breaking of the previously described test circuit at armature 68.

The required connection has now been established. The signaling of the called subscriber is accomplished in the following manner: Each telephone number may have an extra final digit, preferably the digit 0, in addition to the ones necessary to control the line selection. When the calling subscriber dials this last digit, the line relay 40 transmits a series of ten impulses to the relay 72 over the following path: Ground at G^3, armature 51 and its resting contact, armature 52 and its working contact, off normal springs 54 and 55, armature 53 and its resting contact, resting contact of armature 60 and the said armature, armature 67 and its working contact, armature 74 and its resting contact, and the winding of relay 72 to battery B^{11}. The effect of the rapid energizations and deënergizations of relay 72 responsive to the impulses is obvious. At each energization the called line conductors are reversed as regards their connections to the windings of the bridged battery supply relay 73; and as a result of these reversals the condenser 106 at the called substation is rapidly charged and discharged, first in one direction and then in the other, whereby a flow of alternating current is produced which actuates the ringer 105. Ringer 105 is preferably of rather high resistance and the relay 73 is given a stiff adjustment so that it will not respond to the comparatively small quantities of current intermittently supplied to the called line during the signaling operation.

When the subscriber at substation A′ removes his receiver to answer the call, a direct current circuit is completed over the heavy line conductors for the two windings of relay 73 in series with battery B^{12}, and the said relay is energized. At the rear contact of armature 74 the circuit of relay 72 is broken so that it cannot be energized by another operation of the dial. The two subscribers are now connected for conversation. Talking battery for the transmitter at substation A is supplied from the windings of the line relay 40, while the transmitter at substation A′ is supplied from the windings of relay 73. The path for voice currents is indicated by the heavy conductors, and will be readily understood without further explanation.

When the conversation is finished both subscribers will replace their receivers. By the replacement of the receiver at substation A the circuit of the line relay 40 is broken. Upon deënergizing, line relay 40 breaks the circuit of release relay 41 which upon deenergizing in turn removes ground from the holding circuit extending back to line switch C, and also closes a circuit for the release magnet 48. By the former operation the line switch is allowed to restore to normal by withdrawing its plunger from the bank, while the energization of the release magnet 48 results in the restoration of the connector to normal. These operations are well understood and need no further comment.

It will now be described briefly how the connector E operates when it is attempted to establish connection with a busy line. For this purpose it will be assumed that the line of substation A′ was busy when called, in which case the test contact 94 would have a ground potential upon it. Under these circumstances, when the connector wipers are rotated into engagement with the contacts 93, 94, and 95, the relay 44 being energized during the rotation as previously described, as soon as the test wiper 91 arrives at test contact 94 the relay 43 will be energized over a circuit already traced with results which will now be pointed out. At the resting contact of armature 59 the conductor 58 is disconnected from the winding 46 of relay 45, and at the working contact of the same armature a locking circuit is prepared which, upon the deënergization of relay 44, is completed over the following path: grounded conductor 58, armature 59 and its working contact, contact 70 and the contact spring in engagement therewith, armature 68 and its resting contact, and the winding of relay 43 to battery B^5. Relay 43 is thus locked in energized position until the connector is released, and the relay 45 is prevented from energizing to establish connection with the called line. Further results of the operation of relay 43 at this time are the opening of the rotary magnet circuit at the resting contact of armature 60, and the connection of a lead from the busy signaling machine S to the lower heavy line conductor at armature 61. By the transmission of a distinctive tone to the calling subscriber, he

is informed that the line with which he is attempting to connect is busy, whereupon he will replace his receiver and the line switch and connector will be released as previously explained.

Having described our invention what we consider to be new and desire to have protected by Letters Patent will be pointed out in the appended claims.

What we claim as our invention is:

1. In a telephone system, subscribers' lines, an automatic switch controllable over a calling line to establish connection with a called line, a source of direct current, and a pole changing relay in said connector operable intermittently to set up a flow of alternating current from said source over the called line for signaling purposes, means controlled by the response of the called subscriber for rendering said pole changing relay inoperative.

2. In a telephone system, subscribers' lines, an automatic switch controllable over a calling line to establish connection with a called line, a source of direct current, connections from said source to the opposite sides of a connected called line, including a battery supply relay, another relay for reversing said connections, and means controlled by the subscriber on the calling line for rapidly energizing and deënergizing said other relay.

3. In a telephone system, a calling and a called line, a source of direct current at the exchange, an automatic switch controllable over the calling line to connect with the called line and to bridge said source across the two conductors thereof, a pole changing relay in said connector for reversing the connections of said source to said line, and means controlled over the calling line for rapidly energizing and deënergizing said relay to set up a flow of alternating current over the called line, means controlled by the response of the called subscriber for rendering said pole changing relay inoperative.

4. In a telephone system, a calling and a called line, an automatic connector switch, means comprising a motor magnet responsive to a series of impulses in the calling line for operating said switch to connect with the called line, a pole changer in said switch responsive to a subsequent series of impulses to set up a flow of alternating current in the called line, and means controlled by the response of the called subscriber for rendering said pole changer inoperative.

5. In a telephone system, a calling and a called line, an automatic connector switch, primary and secondary motor magnets responsive to successive series of impulses in the calling line to operate said switch to connect with the called line, a source of direct current, and a pole changer in said switch responsive to a subsequent series of impulses to set up a flow of alternating current in the called line, means controlled by the response of the called subscriber for rendering said pole changer inoperative.

6. In a telephone system, a calling and a called line, an automatic switch comprising talking conductors for connecting said lines, a battery, a relay bridged across said conductors in series with said battery, and means whereby current is supplied from said battery through a winding of said relay to the connected called line both for talking and for signaling the called subscriber.

7. In a telephone system, a calling and a called line, an automatic switch comprising talking conductors for connecting said lines, a battery, a double wound relay bridged across said conductors in series with said battery, and means whereby current is supplied from said source through the windings of said relay to the connected called line both for talking and for signaling the called subscriber.

8. In a telephone system, a calling and a called line, an automatic switch, means controlled by the calling subscriber for operating said switch to connect with the called line, a relay in the switch for supplying talking current to the called line, another relay controlled by the calling subscriber for reversing the connection of said first relay to the called line to operate a signal thereat, said first relay controlled by the subscriber on the called line to render said second relay inoperative.

9. In a telephone system, a calling and a called line, an automatic switch, means controlled by the calling subscriber for operating said switch to connect with the called line, a relay in the switch for supplying talking current to the called line, another relay controlled by the calling subscriber for alternately reversing and restoring the connection of said first relay to the called line to operate a signal thereat, said first relay controlled by the subscriber on the called line to render said second relay inoperative.

10. In a telephone system, a calling and a called line, an automatic switch, a line relay for said switch, said relay controlled by the calling subscriber to operate the switch to connect with the called line, a back bridge relay in the switch for feeding talking current to the called line, a relay controlled by said line relay for reversing the connection of said back bridge relay to the called line to operate a signal thereat, said back bridge relay controlled by the called subscriber to remove said reversing relay from the control of the line relay.

11. In a telephone system, a calling and a called line, an automatic switch, a line relay for said switch, said relay controlled over

two sides of the line in series to operate the switch to connect with the called line, a back bridge relay in the switch for supplying signaling and talking current to the called line, a relay controlled by said line relay for reversing the connections of said back bridge relay to the called line to operate a signal thereat, said back bridge relay controlled by the called subscriber to remove said reversing relay from the control of the line relay.

12. In a telephone system, a calling and a called line, an automatic switch, a relay for said switch in bridge of the calling line, a back bridge relay in the switch for supplying signaling and talking current to the called line, another relay for reversing the connections of said back bridge relay, said first relay controlled over two sides of the line in series in one instance to operate the switch to connect with the called line and in another instance to operate said other relay to supply signaling current to the called line, said back bridge relay controlled over the called line to remove said other relay from the control of said first relay.

Signed by us at Chicago, Cook county, Illinois, this 6th day of Feb., 1917.

TALBOT G. MARTIN.
EMIL JACOBSEN.