

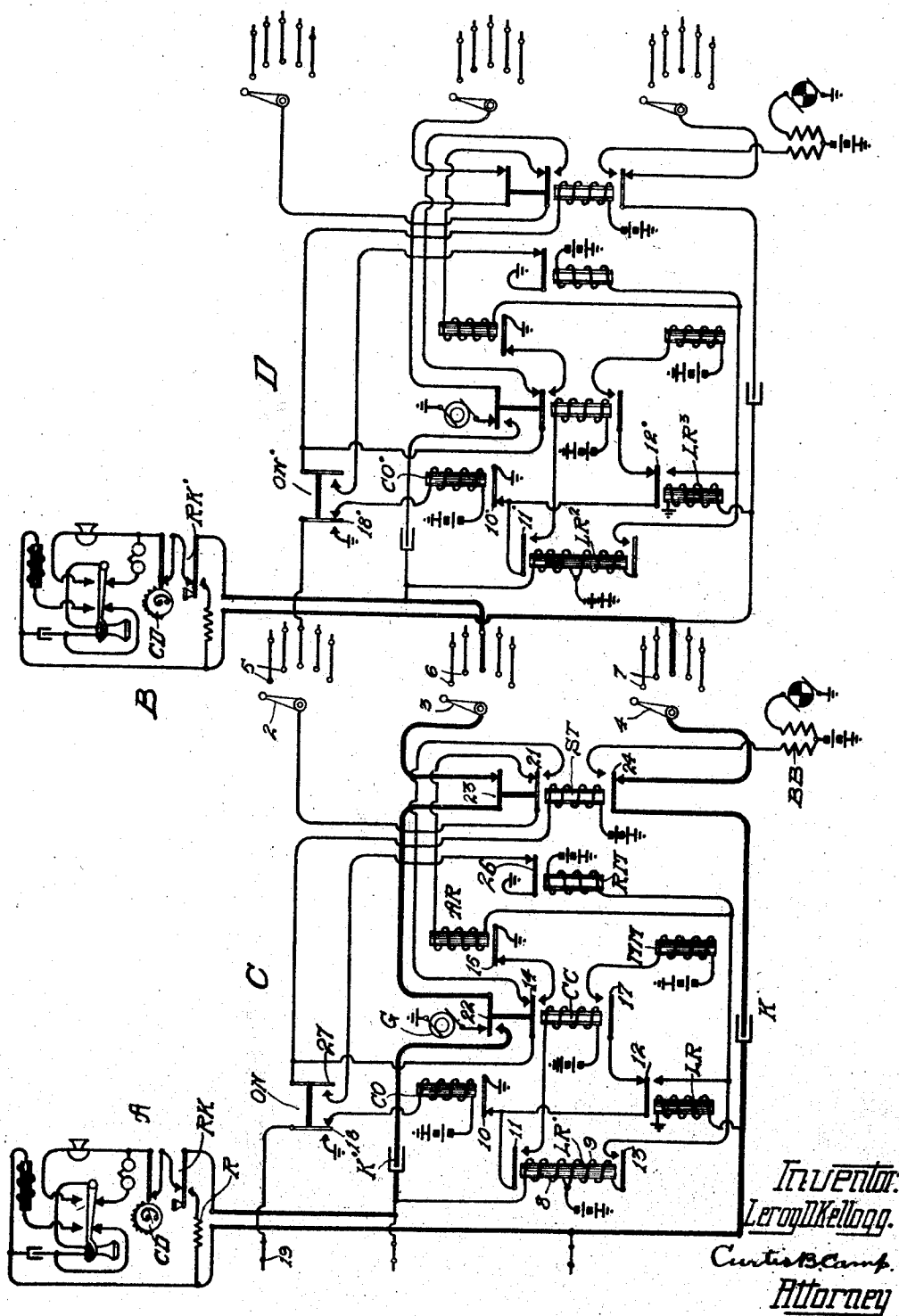
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L. D. KELLOGG

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TELEPHONE SYSTEM

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed August 13, 1919. Serial No. 317,130.

To all whom it may concern:

Be it known that I, LEROY D. KELLOGG, a citizen of the United States of America, and residing at Deerfield, county of Lake, 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 so-called automatic switching type in which impulses transmitted over a calling line by a calling subscriber actuate automatic switching means to connect the calling line to a called line. The system disclosed in this application is of the private automatic exchange type in which each subscriber's line is provided with an individual switch for making connections with any other subscriber's line in the branch exchange. A system of this kind is adapted to serve a plurality of substations, say twenty-five in number, each substation of the system being provided with a single motion adding-type connector. By an adding-type connector, I mean one that operates to add together a plurality of transmitted digits instead of assigning each digit a different decimal position.

An object of my invention is the provision of an improved circuit arrangement which embodies desirable features and advantages all in an efficient, simple and economical manner.

A feature of my invention is the provision of a specially constructed line relay for use in controlling the functions of the adding-type connector.

The novel features of my invention, through the provision of which the above-mentioned and other advantageous results are obtained, will be explained by reference to the accompanying drawing.

Referring now to the drawing, I here show a calling substation A connected to an individual adding-type connector C. The calling substation A comprises the usual substation apparatus and in addition, a calling device CD and a ringing key RK for bridging a resistance R across the limbs of the calling line. The connector switch C is adapted to extend a connection from the calling line A to a called line B. The called substation B is similar to the calling substation A and comprises the usual substation

apparatus along with a calling device CD' and a ringing key RK'. Associated with the called line B is a connector switch D which is similar to the connector switch C associated with the calling line.

The connector switch C comprises line relays LR, LR', a switching and test relay ST, release magnet RM, motor magnet MM, cut-off relay CO and a slow-acting, circuit-changing relay CC. Off-normal contacts ON are provided and assume their alternate position upon the first step of the switch off normal. The switch B, as to switch structure, may be similar to the switch illustrated and described in Ide application, Serial Number 297,244, filed May 15, 1919. The switch structure comprises a rotary shaft (not shown) which carries wipers 2, 3 and 4 adapted to engage bank contacts 5, 6 and 7. The switch shaft and wipers are arranged to be rotated in a single plane by the motor magnet MM, and are restored to normal by spring tension, through the action of the release magnet RM. Each set of bank contacts is connected to the normals of a subscriber's line. At BB, I show a busy back signaling machine for appraising the calling subscriber of the busy condition of a called subscriber's line, and at G, I show a ringing current generator for supplying ringing current to a called subscriber's line.

The line relay LR' is provided with a pair of windings so constructed and connected in circuit that when the receiver is removed at the calling substation, the upper winding 8 is connected in series with the winding of the line relay LR. The relay LR' upon energizing closes a circuit through its lower winding 9 to ground at contact 10 of relay CO. The magnetic lines of force set up by the energization of the lower winding 9 of the relay oppose the lines of force set up by the energization of the upper winding 8 of the relay. However, the magnetic lines of force set up by the current flow in the upper winding 8 of the relay are stronger than the lines of force set up by the current flow through the lower winding 9. Due to the difference in strength of the magnetic lines of force, the relay does not drop back its armature. When the ringing key RK at the calling substation is depressed and the resistance R cut in series with the calling line, the flow

of current in the upper winding 8 of the line relay LR' is decreased to an extent sufficient to permit the magnetic lines of force set up by the current in the lower winding 9 to neutralize or preferably slightly reverse the lines of force set up by the current in winding 8, and the relay LR' permits its armature to drop back. I find by this arrangement that I obtain a very quick and reliable operation of the relay LR'; more so than if I merely depended upon the decrease of flow of current in the winding to cause the same to drop back its armature.

Having described in general the apparatus, I will now describe in detail the circuit connections which may be established between a calling subscriber at substation A and a called subscriber at substation B.

A subscriber at the substation A in initiating a call removes his receiver from the switch hook to close an energizing circuit for the line relays LR and LR' traced from battery, through the upper winding of relay LR', out over one side of the calling line, through the calling substation back over the other side of the calling line and through the winding of relay LR to ground, the two relays operating in series. The closing of alternate contact 11 of relay LR' closes a circuit through the circuit controlling relay CC, extending from battery through the winding of said relay, alternate contact 11 of relay LR' and normal contact 10 of relay CO to ground, thus causing the energization of relay CC. The closing of alternate contact 12 of relay LR closes a circuit through the lower winding of relay LR' and the slow-acting release magnet in series to ground at normal contact 10 of relay CO. The circuit through the lower winding of relay LR' extends from battery through the said lower winding 9, alternate contact 13 of relay LR', alternate contact 12 of relay LR, and normal contact 10 of relay CO to ground. As before mentioned, the winding 9 tends to neutralize the effect of winding 8, but this neutralizing effect is not sufficient to cause the relay LR' to drop back its armature. The circuit for the release magnet extends from battery through the winding of the magnet, alternate contact 12 of relay LR and normal contact 10 of relay CO to ground. The release magnet energizes, but does not release the switch C until it is de-energized, that is, the release mechanism of the switch C is operated upon the de-energization of release magnet, rather than upon the energization of the same. The release magnet remains energized until the subscriber finally replaces his receiver and permanently opens the bridge across the substation line.

Returning now to the energization of relay CC, this relay upon energizing prepares a circuit for the motor magnet MM and

closes a circuit through the switching and test relay ST, extending from battery through the winding of said relay ST, alternate contact 14 of relay CC and through normal contact 15 of auxiliary relay AR to ground. The relay ST upon energizing disconnects the subscriber's line from the line wipers 3 and 4 of the switch and connects the private wiper 2 to a contact of the relay CC. The apparatus is now in condition to be operated by the calling subscriber manipulating his calling device CD.

Assuming that the called number of the called subscriber B is 15, the subscriber at the substation A actuates his calling device CD to send fifteen impulses of current. The subscriber may actuate his dial CD by first pulling the digit naught and then by pulling the digit five, which will cause fifteen impulses of current to be transmitted to the switch C. These impulses of current bring about fifteen de-energizations and energizations of the line relays LR and LR'. The relay LR' de-energizing opens the circuit of relay CC, but relay CC, being slow-acting, does not de-energize between impulses. Relay LR de-energizing opens the circuit of the release magnet RM, but the release magnet RM, being slow acting, does not de-energize between impulses. A further result due to the de-energization of the relay LR is the closing of a circuit for the motor magnet MM extending from battery, through the winding of said magnet MM, alternate contact 17 of relay CC, normal contact 12 of relay LR and normal contact 10 of relay CO to ground. The magnet MM is thus energized and de-energized fifteen times, stepping the wipers 2, 3 and 4 into engagement with contacts 5, 6 and 7, which contacts are connected to the called subscriber at substation B. The de-energization and energization of line relay LR' is only incidental at this time. Upon the first step of the switch wipers off normal, contacts ON assume their alternate position and the closing of alternate contact 18 places a ground upon private normal 19 of the calling substation A, thus preventing any other subscriber from seizing the contacts of the calling line. A further result due to moving the off-normal contacts ON to their alternate position is the opening of the conductor connected to the cut-off relay CO.

The subscriber A having selected the contacts of the wanted line, he depresses the ringing key RK to cause ringing current to be connected to the called subscriber's line, provided the called line is idle. Assuming that the called substation B is idle, the operation of key RK opens the bridge across the calling line including the substation microphone, and connects instead thereof the high resistance R. The bridging of the resistance R across the calling line reduces the amount

of current flowing through the upper winding of relay LR', thereby permitting the lower winding to neutralize the effect of the upper winding and cause the armature of the relay LR' to be retracted. The line relay LR remains in its energized position.

The retraction of the armature 11 of relay LR' opens the circuit of relay CC, thereby permitting relay CC to de-energize. Relay CC de-energizing opens the circuit of relay ST at its alternate contact 14. The armature contacts 14 of the relay CC returning to normal position connects the combined test and switching relay ST to the private wiper 2 over a circuit extending from battery, through the winding of said relay ST, normal contact 14 of relay CC, alternate contact 21 of relay ST to the private wiper 2. The relay ST is now dependent upon the potential found upon the private bank contact of the called subscriber's line. As we have assumed that the called line is idle, its private contact 5 will be free from a ground or busy potential. The relay ST now de-energizes and causes the energization of auxiliary relay AR over a circuit extending from battery, through the winding CO' of the switch D, contact 18' of the off-normal contacts ON', back contact 5, wiper 2, normal contact 21 of relay ST, winding of relay AR, contact 12 of relay LR, and normal contact 10 of relay CO to ground. Relays AR and CO' are energized over this circuit. Relay CO' energizing disconnects ground from contacts 11' and 12' of relays LR², LR³, respectively, of the switch D. Relay AR energizing removes ground from alternate contact 14 of relay CC so that when this relay again energizes, a circuit is not closed for the switching relay ST.

A further result due to the de-energization of relay ST is the connecting of ringing current to the called subscriber's line over a path extending from the ungrounded terminal of generator G, through normal contact 22 of relay CC, normal contact 23 of relay ST, wiper 3, out over the called subscriber's line and through the call bell at the called substation, back through wiper 4, normal contact 24 of relay ST, condenser K, and the winding of relay LR to ground, thus causing the call bell at the called substation to be operated. The private bank contacts 5 of the called substation are rendered busy by the ground connected thereto, through the winding of relay AR. The calling subscriber now permits ring key RK to return to normal, thereby removing the bridge of the resistance R from across the calling line, permitting relay LR' to again energize. Relay LR' energizing again causes the relay CC to energize, but the energization of relay CC does not cause the relay ST to again energize owing to the fact that relay AR has disconnected ground from alternate contact

14 of relay CC. The relay CC energizing removes ringing current from the called subscriber's line. If the calling subscriber again operates the ring key RK, the relay CC is de-energized, connecting ringing current to the called subscriber's line as before described. The subscriber at substation B in response to the signal removes his receiver from the substation switch hook, closing an energizing circuit for relays LR², LR³ of the switch D, traced from battery, through the upper winding of relay LR² out over the called subscriber's line, through the called substation and back through the winding of relay LR³ to ground. The energization of relay LR² and LR³ does not effect switch D. owing to the fact that relay CO' has been energized and removed ground from its normal contact 10'. The subscriber at the called substation A and subscriber at called substation B are now connected in conversational circuit over the heavily marked conductors, said conductors having the condensers K and K' interposed.

Assuming now that the subscribers have finished conversation, they replace their receivers upon their respective switch hooks. The replacing of the receiver at the called substation B opens the series energizing circuit of the line relays LR² and LR³. The de-energization of these line relays does not effect the switch D. The replacing of the receiver at the calling substation permits relays LR and LR' to de-energize. Relay LR de-energizing permits the release magnet RM and relay AR to de-energize. Release magnet RM de-energizing withdraws the retaining pawl from engagement with the switch shaft ratchet and permits the switch shaft and wipers to restore to normal. However, before the switch shaft and wipers start restoring, magnet RM closes its normal contact 26, thereby closing a circuit for relay ST over a path traced from battery, through the winding of relay ST, off-normal contact 27, and normal contact 26 of magnet RM to ground. The relay ST energizing disconnects the line wipers 3 and 4 from the calling subscriber's line. The release magnet RM de-energizes before the slow-acting relay CC de-energizes. The switch shaft upon restoring to normal returns the off-normal contacts to normal, thereby opening the circuit of the relay ST. The relay ST now restores to normal and places the switch C in use for further calls. Should the calling subscriber replace his receiver before the called subscriber replaced his, the calling subscriber releases his switch C from engagement with the bank contacts of the called line. Then when the called subscriber replaces his receiver, the switch D releases and the apparatus is placed in normal condition and available for further calls.

Assuming now that the subscriber at the called substation D is busy, the operation of the circuit is the same up to and including the time that the calling subscriber at substation A depresses the ringing key RK. At the private bank contact 5 of the subscriber B will be found a ground or busy potential, either from the off-normal contacts, if the line B is being used as a calling line, or from ground through relay AR of some other calling line, if the line B is a called line. Upon the depression of the key RK at the calling substation, the relay LR' de-energizes, as before, thereby causing the relay CC to de-energize. The relay CC de-energizing opens the circuit of the relay ST at its alternate contact 14 and connects the relay ST to the private wiper 2. The private bank contact 5 being grounded, maintains the relay in an energized position over a path extending from battery through the winding of relay ST, normal contact 14 of relay CC, alternate contact 21 of relay ST to the private wiper 2 and grounded bank contact 5. The relay ST remaining in an energized condition connects current from the busy back apparatus BB to the calling subscriber's line over a path extending from the busy back apparatus through alternate contact 24 of relay ST and out over the calling subscriber's line to the calling substation and back thru the upper winding of relay LR' to battery. The calling subscriber upon releasing the ring key RK again causes the energization of relay LR' and relay CC. Relay CC energizing again closes a circuit for relay ST and the relay ST remains energized to hold the wipers 3 and 4 disconnected from the calling subscriber's line. The calling subscriber receiving the busy signal, replaces his receiver, thereby de-energizing relay LR' and LR, causing the switch C to be released in the manner hereinbefore described.

In describing my invention I have employed a preferred circuit arrangement, but it is to be understood that various changes and modifications may readily suggest themselves to one skilled in the art, and therefore, I do not desire to be limited to the exact arrangement shown and described, but aim to cover all such modifications and changes 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 subscriber's telephone line, a spring-restored automatic switch individual thereto, a pair of line relays for said switch controlled over said subscriber's line, other subscribers' lines, impulse sending means for operating one of said line relays to cause a connection to be

established between said first subscriber's line and one of said other subscribers' lines, subscriber-controlled means for maintaining said line relay energized and for de-energizing the other of said line relays to signal the called subscriber, and release means for said switch including a release magnet held energized during conversation and adapted to be de-energized upon the de-energization of one of said relays.

2. A telephone system including an automatic switch, a relay for use in controlling said switch, a pair of differential windings for said relay, means for closing circuits through said windings, said windings being so arranged that one winding does not neutralize the effect of the other winding when they are connected in normal circuit, and means for decreasing the flow of current in one of said windings until the other of said windings neutralizes the effect of said first winding to cause the armature of the relay to be retracted.

3. A telephone system including a subscriber's telephone line, a spring-restored adding-type connector therefor, a pair of line relays for said switch, subscribers' lines accessible to said switch, impulsing means for operating one of said relays to establish a connection between said first line and one of said other lines, means for de-energizing the other of said relays to signal the connected calling subscriber, release mechanism controlled by said first line relay for restoring the switch to normal and a cut-off relay for said switch adapted to be energized when the subscriber's line is a called line.

4. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, and means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted.

5. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, and a slow-acting circuit controlling relay for said switch controllable by said double-wound relay.

6. A telephone system including an auto-

matic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, and a release magnet for said switch controllable by said auxiliary relay.

7. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, and a test relay for said switch controllable by said double-wound relay.

8. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, and a slow-acting circuit changing relay controlled by said double-wound relay, and a motor magnet controllable by said slow-acting relay and said auxiliary relay.

9. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, a slow-acting circuit controlling relay for said switch controllable by said double-wound relay, and a cut-off relay for preventing the operation of said slow-acting relay.

10. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of

said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, a release magnet for said switch controllable by said auxiliary relay, and a cut-off relay for preventing the operation of said release magnet.

11. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, a test relay for said switch controllable by said double-wound relay, and a cut-off relay for preventing the operation of said test relay.

12. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, a slow-acting circuit changing relay controlled by said double-wound relay, a motor magnet controllable by said slow-acting relay and said auxiliary relay, and a cut-off relay for preventing the operation of said motor magnet and slow-acting relay.

13. A telephone system including a subscriber's line, an adding-type connector switch individual thereto, movable contacts for said automatic switch, a combination relay for said switch, means controlled over the subscriber's line for energizing said relay to disconnect the subscriber's line from the movable contacts and for then connecting said relay to the movable test contact, said relay then being dependent upon the potential found upon the bank contact which the test contact engages, for either connecting the subscriber's line to the movable contacts, or for maintaining the line disconnected from the movable contacts until the potential is removed from said bank contact.

14. A telephone system including an automatic switch, a relay for controlling a function of said switch, a pair of differential windings for said relay, an auxiliary relay, means including said auxiliary relay for

closing circuits through the windings of said first relay to cause it to attract its armature, means for decreasing the flow of current in one of the windings of the first relay to a point where the windings neutralize the effect of each other thereby causing the armature of said relay to be retracted, a slow-acting circuit controlling relay for said switch controllable by said double-wound relay, and a release magnet for said switch controllable by said auxiliary relay.

15. A telephone system including an adding-type connector switch, a double-wound relay for said switch, means for closing a circuit through one of the windings of said relay, means including an auxiliary relay for closing a circuit through the other winding of said relay, and means for decreasing the current flow in said first winding to a point where the second winding neutralizes the effect of the first winding thereby causing the relay to release its armature.

16. A telephone system including a subscriber's line, an automatic switch therefor, a pair of line relays for said switch, substation-controlled means for closing a circuit through one winding of one of said relays and the winding of said other relay, means controlled by said other relay for closing a circuit through the other winding of said first relay, and subscriber-controlled means for decreasing the current flow in the first-mentioned winding of said double-wound relay to a point where the relay releases its armature.

17. A telephone system including subscriber's substation and a connector switch associated therewith, a circuit for said switch having a double-wound relay, means at the substation for closing a circuit through one of the windings of said relay, means for closing a circuit through the other winding of said relay, and subscriber controlled means including a resistance for changing the amount of current flow through said first one of the windings of

said relay thereby causing the operation of said relay.

18. A telephone system including a circuit having a double-wound relay, means for closing a circuit through the windings of said relay, means for causing a series of impulses to flow through said windings to operate said relay a plurality of times, and means including a resistance for effecting an operation of said relay by affecting the amount of current flow through one of the windings thereof.

19. A telephone system including a subscriber's substation and an automatic switch operable in a single plane and having a double-wound relay, means for closing circuits through the windings of said relay, and substation controlled means including a resistance for effecting an operation of said relay by changing the amount of current flow through one of the windings thereof.

20. A telephone system including a subscriber's substation and an automatic switch operable in a single plane and having a double-wound relay, means for closing circuits through the windings of said relay, and substation controlled means including a resistance for effecting an operation of said relay by changing the amount of current flow through one of the windings thereof, said automatic switch being controlled over the two sides of a subscriber's line for effecting connection between two subscribers' lines.

21. A telephone system having a circuit including a double-wound impulse relay, means for including the windings of said relay in a circuit operation, and means including a resistance for affecting the current flow through one of the windings of said relay to cause an operation thereof.

Signed by me at Chicago in the county of Cook, and State of Illinois, this 11 day of August, 1919.

LEROY D. KELLOGG.