C. S. WINSTON.

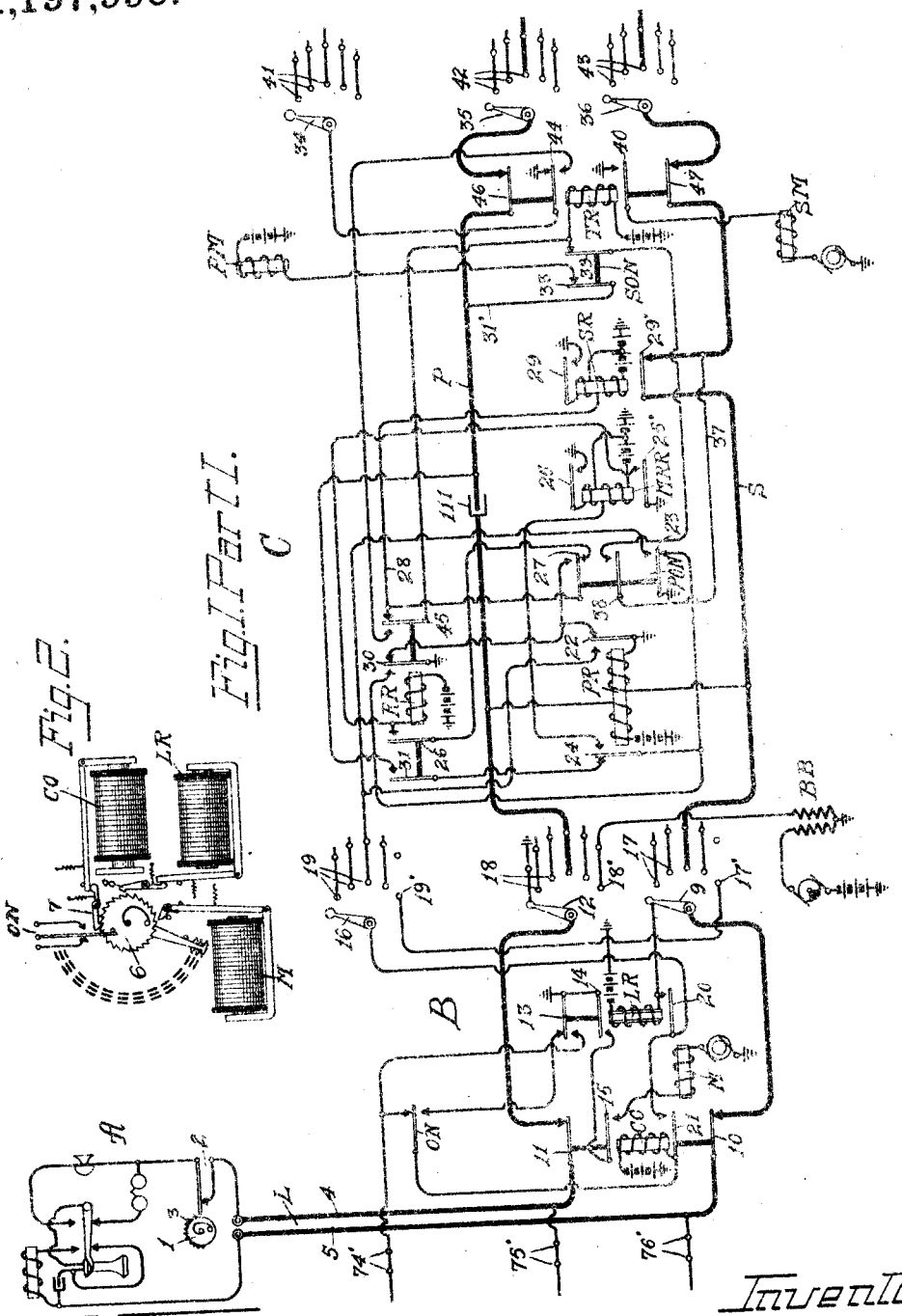
AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED SEPT. 30, 1912.

Patented Sept. 12, 1916.

3 SHEETS—SHEET 1.

1,197,990.



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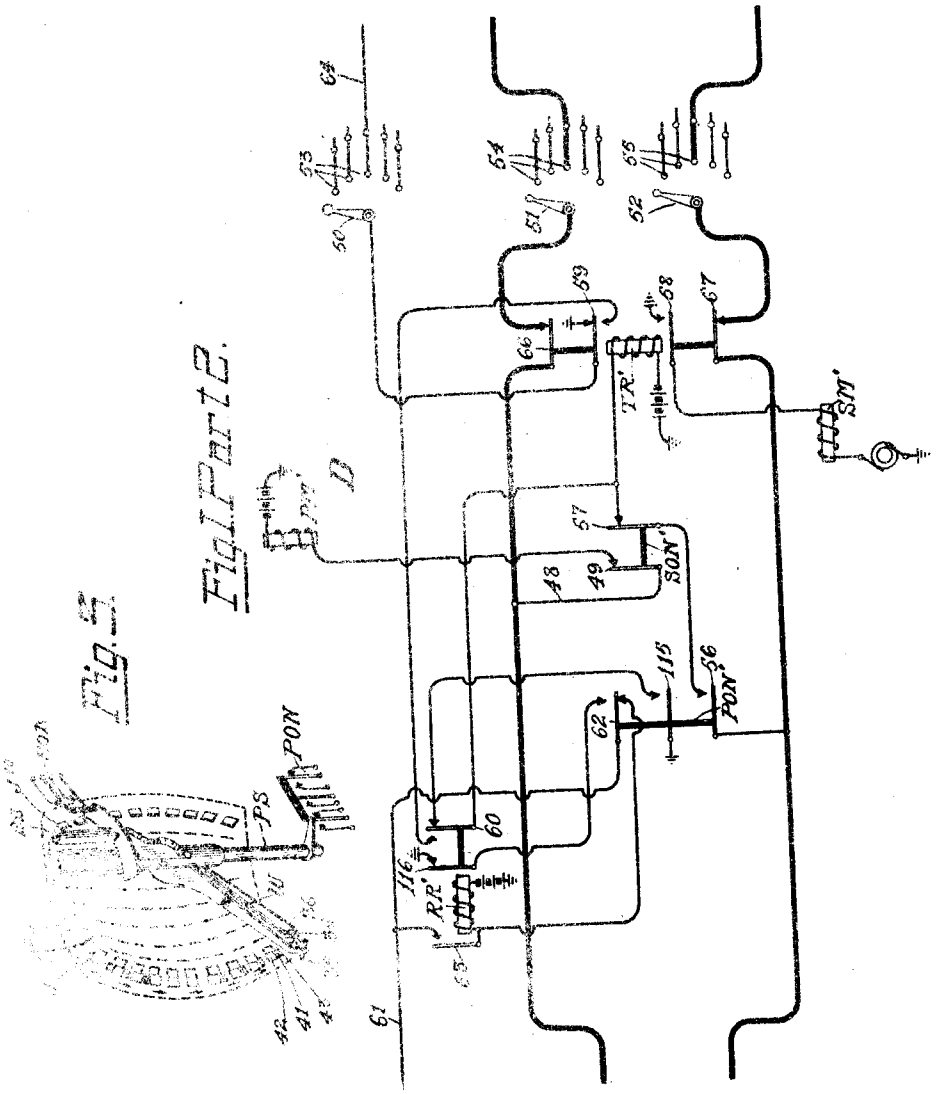

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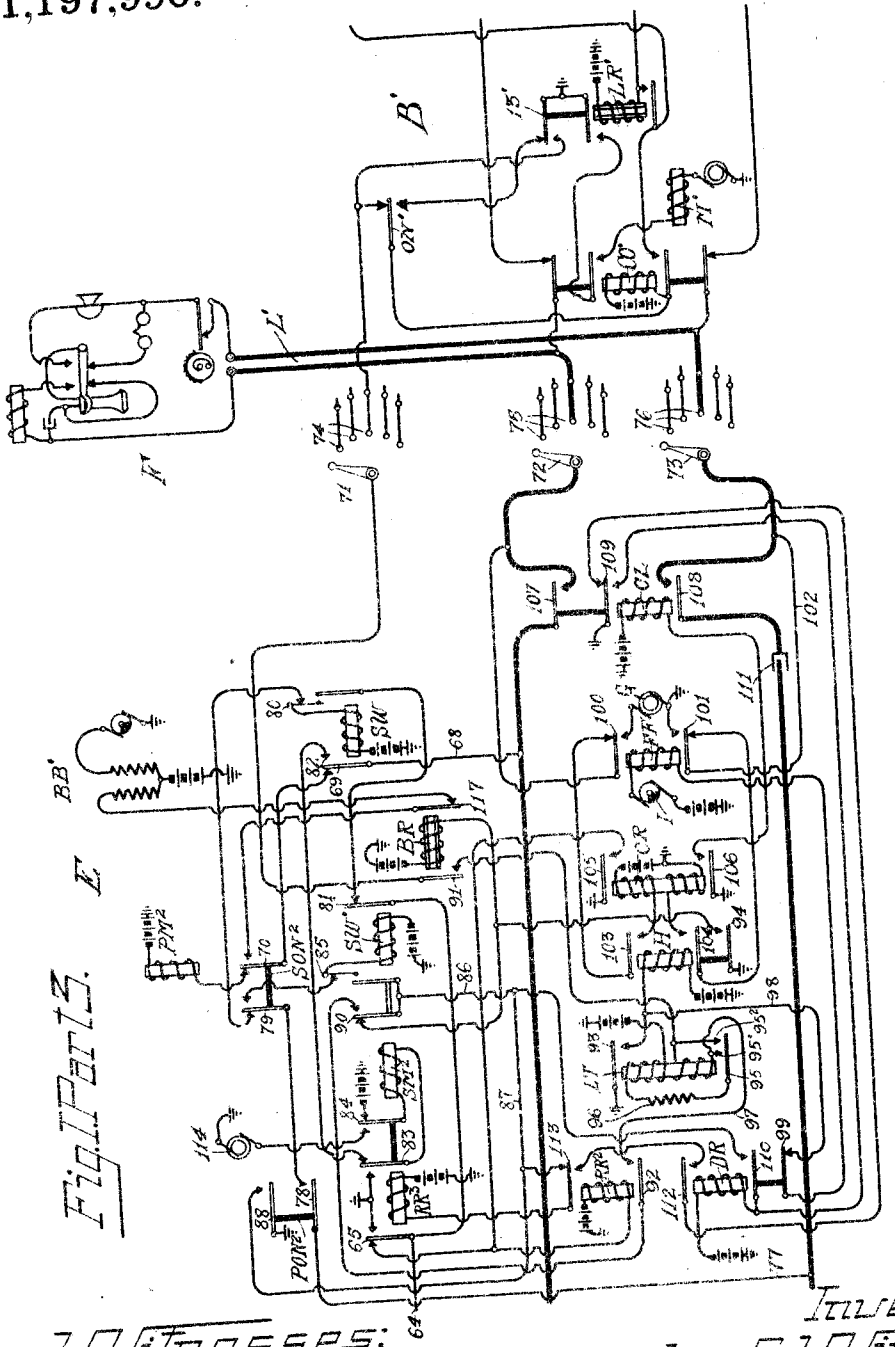

Fig. 1 Parts 3.

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UNITED STATES PATENT OFFICE.

CHARLES S. WINSTON, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,197,990. Specification of Letters Patent. Patented Sept. 12, 1916.

Application filed September 30, 1912. Serial No. 723,013.

To all whom it may concern:

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

My invention relates to two-wire or metallic line automatic telephone systems in which automatic switches known as the two-dimension type are employed, these switches comprising a bank of contacts divided into groups, and coöperating wipers adapted to receive a primary adjustment to select a group of contacts, and thereafter a secondary adjustment to select a contact in the selected group.

My invention has to do more particularly with systems of the above character in which no slow-acting relays are employed in the adjustment and release control circuits of the directively controlled selectors and connectors, an object of my invention being to provide a system of the above character having a more simple circuit arrangement, positive in operation and easily maintained.

In metallic line automatic telephone systems hitherto employed, and in which two-dimension switches are used, slow-acting secondary relays and release relays are employed in connection with a quick-acting primary or impulse relay in such a manner that during the operation of the primary relay, although the circuits for the secondary and release relays are rapidly interrupted, said relays due to their sluggish or slow-acting construction maintain their armature attracted until a prolonged interruption of their holding circuit. This required a specially constructed slow-acting relay and to overcome this I have provided a system as disclosed in a previously filed application of mine, wherein standard quick-acting secondary and release relays are employed, and in which two energizing circuits are provided for said secondary and release relays for maintaining them energized and their armature attracted during the operation of the primary relay. My present application looks to an improvement in the manner in which these two holding circuits for the secondary and release relays are provided.

In my present invention I provide two energizing circuits for the release and secondary relays, the first or primary circuits including a source of current adapted to be closed through contacts on the primary relay and a winding of the release and secondary relays, this primary or first circuit being of sufficient strength to energize the relays and attract their armatures. A second circuit is then provided for each of the relays including a source of current of comparatively low voltage and sufficient to maintain the armatures of these relays attracted while the primary circuit is being rapidly interrupted by the impulse operations of the primary relay. When the primary circuit of either of these relays is interrupted for a prolonged period, the low voltage circuit is not sufficient to maintain the armature in its attracted position whereby it restores to normal to bring about a circuit change.

For a more complete understanding of my invention reference is to be had to the accompanying drawings, in which like reference characters indicate like parts, and in which—

Figure 1, comprising parts 1, 2 and 3, illustrates a so-called complete automatic telephone system; Fig. 2 illustrates diagrammatically a mechanical line switch adapted to operate in connection with line switch circuit B; Fig. 3 illustrates diagrammatically a contact bank and wiper arrangement employed in connection with the selector and connector switch circuits illustrated.

In Fig. 1, I have illustrated a so-called 10,000 line automatic telephone system but have shown only sufficient apparatus for extending a connection from a calling to a called substation. In the preferred embodiment of my invention I employ substations A, line switches B, first selectors C, second selectors D, and connectors E, a called substation F with its associated switch B^1 also being illustrated. In a full installation of a system as referred to, there would be 10,000 substations A each connected by a line L with its associated line switch B of which there would be 10,000. These lines and switches B are divided into ten major groups of 1,000 each, and each major group is divided into minor groups of 100 each. On a basis of ten per cent. trunking there would be provided 1,000 first

selectors C, divided into 100 groups of 10 each, each group of 10 being assigned to a minor group of 100 line switches B. All of the line switches B of each minor group would have access to its associated 10 first selectors C, and to this end each ten selectors C would be multiple connected to the bank contacts of the associated 100 line switches B, although in Fig. 1 but two such multiple connections are shown.

On a basis of ten per cent. trunking as previously referred to, the selector and connector switches employ 100 sets of bank contacts J (Fig. 3) divided into ten groups of ten contact sets each, and the cooperating wiper set W may be primarily adjusted to select one of the groups or rows of contacts, and thereafter secondarily adjusted to select a contact set in a group. Therefore on the basis outlined, one thousand second selectors D would also be provided, being divided into 100 groups of ten second selectors each, and each such group of ten second selectors D would have its wipers multipled before the bank contacts of 100 first selectors C, each such one hundred first selectors C comprising preferably ten groups of ten first selectors each, these ten groups being the corresponding hundred or minor groups of the ten major groups. In other words, take the ten first selectors in the first hundred groups of each of the ten one thousand or major groups. The first rows J^1 (Fig. 3) of these ten minor groups would be multiply connected, the second rows J^2 would be multiply connected, etc., up to and including the tenth group J^{10}. The first groups J^1 of multiply connected contacts would then be connected to the wipers of the ten second selectors D assigned to the first hundred group of the first thousand or major group, the second groups J^2 would be assigned to the second selectors D in the second major gronp and so on. A like arrangement of multipling would then be given to the ten second hundreds groups, etc. Thus assuming a subscriber wished to connect with a line in the third thousand group, the first operation of his calling device would result in three primary steps of wipers W (Fig. 3) of a selected first selector to pick out the third group J^3 which is the group of contacts leading to second selectors D in the third thousand group and thereafter wiper K would automatically select an idle one of these second selectors D.

From the above it will be seen how by the operation of a first selector D, access will be had by a calling subscriber to the thousand or major group including the line of the called substation.

On the same percentage of trunking as outlined above, one thousand connectors E are provided, divided into one hundred groups of ten connectors each, each such group being assigned to a different one hundred group of lines. Each group of ten connectors has its wipers connected to the ten corresponding groups J of the second selector bank contacts in the same one thousand group. In other words, take the group of ten connectors assigned to the first hundred group of lines, in the first thousand group. These connectors would have their wipers multiply connected to the first row J^1 of bank contacts of the one hundred first selectors in the same thousand group. The group of connectors E assigned to the second hundred group of the first thousand group would then be multiply connected to the second rows or groups J^2 of the second selectors in the same thousand groups, and so on to the tenth group of connectors. This same method of multipling the connectors E would also obtain in all of the other major groups. Each such group of ten connectors E would then have its bank contacts multiply connected to the associated one hundred lines.

Thus with the foregoing outline, assume a subscriber desired to connect with telephone number 1234. After picking out an idle first selector C he would effect one primary step of its wipers W to select the first group J^1 of bank contacts, which group would lead to second selectors D in the first thousand or major group of lines, which group includes the line of the called subscriber. Thereafter the first selector would automatically pick out one of the ten second selectors D connected to this first group J^1. The subscriber would then effect two steps of the wipers W of the selected switch D, thereby picking out the second group J^2 which is connected to connectors E in the second hundred group including the line of the called substation. Thereafter switch D would automatically select an idle one of the connectors. The calling subscriber would then effect three primary steps of the wipers W of the selected connector E picking out the third group J^3, which group includes the terminals of the called substation, and thereafter four steps of wipers W would be effected to select the fourth set of contacts in the selected group J^3, which contacts are the terminals of the called line.

While the above trunking and grouping arrangement is well known in the art, it has been herein described that an understanding of a trunking arrangement suitable for the embodiment of my invention herein shown, may be had. It will be understood that the trunking arrangement is not invariable and that other arrangements may be used, according to the exigencies wherein my invention may be employed.

Referring now more in detail to the apparatus and circuit arrangement preferably

employed in this embodiment of my invention, substations A are of the well known Kellogg type having a calling device 1 with its interrupter contacts 2 connected in circuit with the line conductors the impulse wheel 3 being so arranged that when advanced, its teeth will not interrupt the contacts 2 but upon being restored by its spring it will interrupt said contacts 2 according to the number of teeth on its periphery which were initially moved beyond said contacts. The line L comprising line conductors 4 and 5 extend from substation A to its line switch B. Line switch B comprises a line relay LR, cut-off relay CO, motor magnet M, off-normal contacts ON, and a pair of line wipers 9 and 12 and coöperating contacts together with a test wiper 16 and coöperating contacts.

Fig. 2 illustrates diagrammatically a switch mechanism adapted to operate in connection with circuits B, like reference characters indicating corresponding parts. This switch comprises sets of bank contacts 17, 18, 19 and coöperating wipers 9, 12, 16 mounted upon a central shaft carrying a ratchet wheel 6 adapted to be driven by motor magnet M. It will be noted that two check pawls 7 and 8 are employed, pawl 7 being normally in engagement with ratchet 6 while pawl 8 is normally out of engagement with said ratchet. In the preferred operation of Fig. 2, which is in accordance with circuit B, upon initiation of a call by removal of the receiver from the switch hook, line relay LR is energized thus causing the associated pawl 8 to engage ratchet wheel 6 and thereafter cut-off relay CO is energized causing its associated ratchet 7 to disengage from ratchet wheel 6. Thereafter the motor magnet M advances the wipers over the contacts, followed by the deënergization of CO; but LR is maintained energized so that both pawls 7 and 8 are engaging ratchet 6. To release switch B line relay LR is deënergized, thus withdrawing pawl 8 from engagement with ratchet 6 and thereafter cut-off relay CO is again energized moving pawl 7 out of engagement with ratchet 6, allowing the wipers to be restored by a suitable spring. On the first step off-normal, contacts ON assume their alternate position and are maintained thus until the wipers are restored, whereby said contacts ON are again moved to their normal position. Other forms of line switches may be employed without in any way effecting the principle or operation of my invention.

In Fig. 3 I have illustrated diagrammatically the contact bank and wiper arrangement of one form of selector and connector switch that may be used with my invention, and for a more complete understanding of the switch structure reference is to be had to an application of William Kaisling for automatic switch for telephone systems, Serial No. 600,664, Patent No. 1,131,140, filed January 3rd, 1911. Any form of switch adapted to select a group of contacts, and then an idle contact in the group, would be equally within my invention.

My preferred switch, referred to in the previous paragraphs (see Fig. 3) in general comprises a bank of contacts (which I have indicated inclosed in dotted lines), made up of one hundred sets of contacts, arranged in ten vertical groups J^1, J^2, J^3, etc., to J^{10}, ten sets in each group. Each set consists of three contacts 41, 42, 43, (which for clear illustration I have spread apart at the first row in Fig. 3, and which correspond to contacts 41, 42, and 43 in Fig. 1, Part 1). A set of wipers W consisting of wipers 34, 35 and 36 are provided to wipe over the corresponding contacts in the vertical groups. (These wipers correspond to wipers 34, 35 and 36 in Fig. 1 Part 1). A primary magnet (PM, Fig. 1, Part 1) is adapted to rotate the wipers through the medium of a primary shaft PS to bring them opposite one of the vertical groups of contacts. This group selecting movement is in response to directive impulses sent over the line from the subscriber's station. A secondary magnet (SM, Fig. 1, Part 1), is provided to step the wipers in a vertical direction through the medium of a secondary shaft SS to select an idle contact set in the selected group. This secondary movement to select an idle set of contacts in the selected group in the selectors is accomplished automatically, without the aid of directive impulses from the subscriber's station. The switch construction is preferably such that the wipers are advanced against the tension of a pair of so-called watch springs, one spring opposing each movement respectively.

To release the switch wipers, and restore them to normal position after connection with one of the sets of contacts in a group, the secondary magnet is again actuated to step the wipers beyond the last or top contact of that group, whereby they are automatically restored to normal by the springs referred to, the wipers in being restored taking the path indicated by arrows in Fig. 3. Thus, in the operation of the switch the contacting ends of the wipers travel in a primary direction (horizontal rotary) to select a group of contacts, then in a secondary direction (vertical rotary) to select a contact in that group, and in the release of the wipers this secondary travel is continued until the contacting ends have passed beyond the last or top contact in the group, when they are automatically released as shown by the arrows to normal position.

A set of primary off-normal spring contacts PON are moved upon the first primary

step of the switch while a set of secondary off-normal spring contacts SON are moved upon the first secondary step of the switch, being restored upon restoration of the wipers from their respective movements as will be clear from the diagram.

It is to be understood that for a more detailed description of this switch reference is to be had to the above identified application.

First selector C comprises, besides its wipers and bank contacts, a primary magnet PM, a secondary magnet SM, a primary or impulse relay PR adapted to be energized by current over a calling line upon connection made with said switch C, a main release relay MRR which is adapted to be energized responsive to the initial energization of relay PR, a release relay RR adapted to be energized responsive to the initial energization of MRR, and a secondary relay SR adapted to be energized following the energization of RR. A test relay TR is also provided being adapted to be energized to effect a secondary travel of the switch to select an idle set of contacts in the selected group.

Second selector D (Fig. 1, Part 2) is preferably the same construction as the first selector, and comprises wipers and suitable bank contacts, operating magnets PM^1, SM^1, a release relay RR^1, and test relay TR^1. Off-normal switches PON^1 and SON^1 are also provided.

Connector switch E of the same construction, comprises, besides its wipers and cooperating contacts, off-normal switches PON^2 and SON^2, operating magnets PM^2, SM^2, release relays RR^2, RR^3, switching relays SW and SW^1, a line test relay LT, a relay H controlled by relay LT and maintained energized while LT is energized, a flip-flop or interrupter relay FF for intermittently connecting ringing generator G and the bridged control relay CR across the terminals of the called line, a disconnect relay DR for disconnecting the ringing current upon response of the called subscriber, a circuit closing relay CL also energized when a called subscriber responds and a busy and test interrupter relay BR for controlling the application of a busy signal from busy back BB^1, and interrupting the test circuit if the called line is busy.

The called line L^1, called substation F and associated line switch B^1 are similar to the calling line equipment, the similar parts being indicated by like reference characters but with the suffix prime.

Operation of Fig. 1.—Having described in general the apparatus and circuit arrangement in the preferred embodiment of my invention the operation of the system illustrated, in connecting a calling and called line, will now be described.

Assuming a subscriber at station A desires to connect with a subscriber at substation F whose telephone number we will assume is 2343, he will remove his receiver from its switch hook whereby a circuit for line relay LR is established from battery through the winding of LR, wiper 9, normal contact 10, line conductor 5, substation A, line conductor 4, normal contact 11, the wiper 12 to ground. Relay LR is thus energized closing its alternate contact 13 and establishing an energizing circuit for cut-off relay CO through normal contact ON. Relays LR and CO being energized, a circuit for motor magnet M is established through their alternate contacts 14 and 15 respectively, whereby said magnet M advances wipers 9, 12 and 16 into engagement with the first set of contacts 17, 18, 19, which, we will assume lead to a busy first selector C. Therefore, the test contact 19 thereof is grounded through primary off-normal contacts PON, said contacts being in their alternate position when the selector C is busy, and a locking circuit for relays LR and CO is therefore established which may be traced from ground through PON contacts, wiper 16, and alternate contacts 20, 21 and the windings of relays LR and CO respectively. Relay CO thus maintains the circuit of driving magnet M closed notwithstanding the opening of the circuit at off-normal contacts ON at the first step of the switch. Magnet M now advances the wipers another step and in fact continues such advancement until the test wiper 16 reaches an idle test contact 19 which we will assume is the third one leading to first selector C. Assuming this is idle, as stated, it would be ungrounded and therefore the locking circuit for relays LR and CO is interrupted, but relay LR being a slow relay maintains its armature attracted until a locking circuit from switch C is provided, which will be later described, but relay CO being a quick-relay immediately releases its armature opening its contact 15 in the circuit of driving magnet M, thus rendering the switch wipers inert.

As above stated L is one of a group of 100 lines that has access to a group of ten first selectors C, and thus the first idle selector C of the group is automatically selected by the removal of the receiver from the hook of any one of said group of 100 lines.

Due to the closing of normal contacts 10, 11 of relay CO, when it is deënergized, a circuit for the primary relay PR of the selector C is established over the calling line which may be traced from battery through the left hand winding of PR, the upper heavily marked primary conductor, contact 18, wiper 12, normal contact 11, the calling line and substation, normal contact 10, wiper 9, the selected contact 17 and the right

hand winding of PR to ground, causing its energization.

Upon the closing of alternate contact 22 of PR, the locking circuit above referred to for the slow-acting line relay LR is established, traced over contacts 19, wiper 16, alternate contact 20, and the winding of LR to battery thus maintaining said relay energized until a release is desired. Also responsive to energization of PR, its alternate contact 24 is closed connecting ground from normal contact 23 of PON through the lower winding of MRR to battery, causing the energization of MRR. Alternate contact 25 of MRR is therefore closed and a second energizing circuit for MRR is closed through its upper winding, this circuit being of a comparatively low voltage and sufficient only to maintain the armature of MRR attracted while the first circuit of MRR is rapidly interrupted responsive to the impulse operations of primary relay PR. Also upon energization of MRR, its alternate contact 25^1 is closed establishing an energizing circuit for release relay RR whereby said relay is energized and its alternate contact 26 closed. With the closing of this alternate contact 26, ground is connected from alternate contact 25^1 through normal contact 27, conductor 28 and the lower or first circuit winding of secondary relay SR, whereby said relay is energized. Its alternate contact 29 is therefore closed establishing a second circuit for SR through the upper or second winding thereof, this second circuit being of a comparatively low voltage and adapted to maintain the armature of SR attracted while its first circuit is being rapidly interrupted by the impulse operations of PR as will be referred to. Upon the energization of RR, its alternate contact 30 is closed thereby connecting ground to contact spring 24, this ground being substituted for the ground from normal contact 23 which will be interrupted upon the first primary step of the switch, while RR is maintained energized. Thus, it will be seen that upon connection made with first selector C its primary relay PR is operated followed by energization of MRR, RR, and SR in succession.

Assuming the line with which connection is desired is No. 2343, the next step in the operation consists in operating calling device 1 to cause two interruptions of impulse springs 2. These two interruptions cause two interruptions of the metallic energizing circuit of rely PR whereby it retracts and attracts its armature two times. Upon the first retraction of PR and the consequent closing of its normal contact 24, an impulse of current is transmitted from grounded normal contact 24, through alternate contact 31, primary conductor P, branch conductor 31^1, normal contact 33 and the winding of PM to battery. Magnet PM attracts its armature and advances wipers 34, 35 a single primary step whereby primary off normal switch PON is moved to its alternate position. Alternate contact 23 of PON is therefore closed connecting ground to the test contact 19 and rendering switch C busy until it is restored to normal. Also upon the movement of PON, its normal contact 27 is interrupted thereby interrupting momentarily the first energizing circuit of SR, but the second circuit of SR is sufficient to maintain the armature thereof attracted until the first circuit is again closed through alternate contact 27 of PON and normal contact 22 of PR, which occurs upon deënergization of PR. Also upon the first and each succeeding operation of PR, its alternate contact 24 is opened, interrupting the first energizing circuit for MRR, but these rapid interruptions do not allow the retraction of the armature of MRR due to the second energizing circuit which is closed through alternate contact 25 of MRR and the second winding thereof. The said two operations of PR are effective to transmit two primary impulses through the winding of primary magnet PM over the previously described path resulting in two primary steps of wipers 34, 35, 36 to select the second group of bank contacts 41, 42, 43 which are contacts leading to second selectors in the second thousand group of lines.

Following the last or second operation of PR, its normal contact 22, through which the first circuit of SR has been closed since the first primary step of the switch, is interrupted for a prolonged period whereby the second circuit of SR is not sufficient to maintain the armature attracted, so said armature restores closing normal contact 29^1. The closing of normal contact 29^1 is effective to transmit a secondary impulse to cause the operation of test relay TR and start the secondary travel of the switch. This secondary impulse may be traced from ground through the right end winding of PR, secondary conductor S, normal contact 29^1, conductor 37, alternate contact 38, normal contact 39 and the winding of TR to battery. Relay TR therefore energizes interrupting its normal contacts 46, 47 to disconnect the line wipers 35, 36 during the secondary travel of the switch. The closing of alternate contact 40 establishes an energizing circuit for SM, whereby the first impulse from the connected alternating current generator causes SM to advance wipers 34, 35, 36 into engagement with the first set of contacts 41, 42, 43 respectively. Assuming this first set of contacts leads to a busy second selector D, its test contact 41 is at a grounded or busy potential in a manner as will hereinafter be described, and therefore a holding circuit for TR is provided traced

from said grounded contact 41, wiper 34, alternate contacts 44, 45, and the winding of TR to battery. Relay TR being maintained energized, magnet SM advances the wipers another step and continues to advance them until the wiper 34 reaches an ungrounded or idle test contact 41. We will assume that the third contact which is connected to second selector D illustrated is the first idle contact and therefore relay TR having its holding circuit interrupted is deenergized interrupting the circuit for magnet SM.

Upon deënergization of relay TR, normal contact 44 is closed placing ground upon the multiple contacts 41 connected to wiper 34, whereby an energizing circuit for relay RR^1 of secondary selector D is established, traced over test conductor 61, normal contact 62, and the winding of RR^1 to battery, causing its energization, whereby its alternate contact 63 establishes a locking circuit for it. This ground potential at 44, placed upon multiple contacts 41 also renders them unselectable by any other first selector. The subscriber at A now operates calling device 1 to effect three interruptions of the circuit for relay PR and responsive to each ensuing deënergization thereof its normal contact 24 is closed causing the transmission of three primary or directive impulses to the primary magnet PM^1 of the selected switch D. Responsive to the first of said deënergizations of PR, its normal contact 22 is again closed establishing an initial energizing circuit for the secondary relay SR traced through alternate contact 27, conductor 28, and the lower winding of SR to battery. Relay SR again closes its alternate contact 29 whereby a second or alternate circuit for relay SR is closed through the upper winding of SR to the low voltage terminal of battery as previously described. The second circuit for SR is effective to maintain its armature attracted while the primary impulses are coming from normal contact 22, but as previously described, upon the cessation of these primary impulses the flow of current through the second circuit alone is not sufficient to maintain its armature attracted whereby it restores effecting a secondary circuit change for switch D as will be described.

Referring now to the said three operations of relay PR, three impulses of current are transmitted over a path traced from the normal contact 24, alternate contact 31, conductor P, normal contact 46, wiper 35, contact 42, the upper heavily marked primary conductor to conductor 48 of switch D, normal contact 49 and winding of PM^1 to battery resulting in three operations thereof. The wipers 50, 51, 52 therefore receive three primary steps to select the third group of contacts which are the contacts extending to connector switches in the third hundredths group of the selected thousands group, and which includes the line of the called substation F.

Upon the first primary step of switch D, the primary off-normal contact 56 is closed so that upon the said retraction of the armature of secondary relay SR, a secondary circuit is established traced from ground through the right end winding of PR, normal contact 29^1, 47, wiper 36, contact 43, the lower heavily marked secondary conductor, alternate contact 56, normal contact 57 and the winding of test relay TR^1 to battery. Relay TR^1 is thus energized closing its alternate contact 58 whereby a circuit for magnet SM^1 is established causing it to step the wipers into engagement with the first set of contacts in the selected group. Assuming this first set of contacts lead to a busy connector E, its test contact 53 has a busy or ground potential connected thereto (as will be pointed out) so that a maintaining circuit for relay TR^1 is established traced from said grounded contact 53, wiper 50, alternate contact 59, alternate contact 60 and the winding of TR^1 to battery, its initial energizing circuit having been interrupted at normal contact 57 on the first secondary step of the switch. Magnet SM^1 therefore continues to advance the wipers until an idle set of contacts is reached which we will assume are the contacts shown connected to connector E, and there being no busy potential upon these contacts, the circuit for relay TR^1 is interrupted causing its deënergization and the consequent interruption of the circuit for SM^1 whereby the wipers remain in engagement with the contacts leading to selected switch E.

Upon deënergization of TR^1 its normal contact 59 is closed, placing a ground or busy potential upon the selected test contact 53 and its multiples rendering them unselectable. This ground connection also is effective to cause energization of relay RR^2 of switch E, its circuit being traced over test conductor 64, normal contact 65 and the winding of RR^2 to battery, causing its energization. Upon said restoration of TR^1 its normal contacts 66, 67 being again closed, the circuit from the calling line is extended through to the connector, E.

The subscriber at A now operates his calling device to effect four operations of relay PR, this corresponding to the third or tens digit of the called line number, this resulting in the energization of secondary relay SR in a manner as before described and also four impulses of current are transmitted through primary magnet PM^2 of switch E. These impulses are traced from ground over the previously described path to the primary conductor of second selector D, normal contact 66, wiper 51, contact 54, conductor 68,

normal contacts 69, 70 and the winding of PM^2 to battery causing four operations thereof and four primary steps of wipers 71, 72, 73, to select the fourth group of contacts 74, 75, 76, which is the group including the terminals of the wanted line. Following the said primary impulses the secondary relay SR restores its armature in the manner as before described, whereby a secondary circuit is established including switching relay SW of connector E. This circuit is traced from ground through the right end winding of PR along the lower heavily marked secondary conductor through switch D, conductor 77 extending from the secondary conductor of switch E, alternate contact 78 (which is now closed), normal contacts 79, 80 and the winding of switching relay SW to battery. This relay is therefore energized closing its alternate contact 80 and establishing a locking circuit for itself through normal contact 81 to grounded test conductor 64. Alternate contact 82 of relay SW is also closed thereby disconnecting the primary magnet PM^2 and connecting the secondary magnet SM^2 to the primary conductor.

The subscriber at A now operates his dial to cause three operations of primary relay PR, these operations corresponding in number to the last or units digit of the called line number, whereby three impulses are transmitted to switch E followed by the retraction of the armature of SR in a manner as previously described. The said last three impulses of current are traced over the previously described path including the upper or heavily marked primary conductor to conductor 68 of switch E, alternate contact 82, normal contact 83, the winding of SM^2 to battery at normal contact 84. The ensuing three operations of SM^2 are effective to step wipers 71, 72, 73 into engagement with the third set of contacts 74, 75, 76 which are the terminals of the called line.

Following the transmission of the last series of impulses, secondary relay SR retracts its armature in a manner as previously described to effect a secondary circuit change at switch E by the application of ground through right end winding of relay PR to the secondary conductor of switch E. This ground connection then extends over conductor 77, switch E, alternate contacts 78, 79, normal contacts 85 and the winding of switching relay SW^1 to battery causing its energization. Its alternate contact 85 is thereby closed establishing a locking circuit for itself over conductors 86, 87 to ground at alternate contact 88. Its normal contact 81 is also interrupted thereby interrupting the locking circuit for relay SW causing its deënergization. Also responsive to said energization of SW^1 its alternate contact 90 is closed to connect line test relay LT in circuit with the test contact 74 of the seized line. This circuit is traced from wiper 71, alternate contact 91 (relay BR having been energized over a circuit including normal contact 90 and alternate primary off-normal contact 88 upon the first off-normal step of the switch), the lower winding of LT, conductor 97, alternate contacts 92, 90, conductors 86, 87 to ground at alternate contact 88. Although the initial energizing circuit for BR is interrupted at normal contact 90 when SW^1 is energized, BR, being a slow-acting relay, maintains its contact 91 closed until a substitute energizing circuit for BR is established, providing the called-for line is idle, as will be described. Returning now to relay LT, it will be noted that its lower winding has its terminals connected between ground at alternate contact 91 and the wiper 71.

Up to this period the operation of switch E is the same whether connection has been made with an idle or a busy line but after this period the operation differs depending upon whether the called line is idle or busy.

Called line idle.—Assuming that the called line is idle there will be no ground or busy potential upon its test contact 74, as indicated in Fig. 1, Part 3, so that upon wiper 71 making connection therewith and the circuit through the lower winding of relay LT closed by the closing of alternate contact 90 as described, an energizing circuit for LT is established over the said circuit including its lower winding, wiper 71, contact 74, ON^1 and the winding of CO^1 causing the energization of both relays LT and CO^1, the energization of CO^1 removing the substation control of its line switch B^1.

Upon energization of LT, its alternate contact 93 is closed causing the energization of relay H whose alternate contact 94 closes, reëstablishing an energizing circuit for relay BR thus maintaining its armature attracted. The closing of alternate contacts 95^1, 95^2, of relay LT shunts the lower winding thereof, but maintaining circuit therefor is established from battery through its upper winding and the current reducing resistance 96, alternate contacts 95, 95^1, conductor 97, alternate contacts 92, 90, conductors 86, 87, to ground at alternate contact 88. This ground connection is also extended through alternate contacts 95^2, 91 and wiper 71 to the engaged terminal 74 maintaining a direct ground upon this terminal and its multiples and thus rendering the associated line unselectable by any other connector. Also, upon the closure of alternate contact 93 of LT, a path for current through relay FF is established including conductor 98, normal contact 99, the winding of FF and interrupter I to battery. By the operation of interrupter I, relay FF is periodically energized thereby operating its contacts 100,

101 to alternately connect generator G and control relay CR in bridge of the terminals 75, 76 of the called line. Upon each connection of current from ringing generator G the call bell at substation F is operated, the circuit therefor being traced from the upper terminal of generator G, alternate contact 100, wiper 72, terminal 75, over the line and through the condenser and call bell of station F, returning through terminal 76, wiper 73, conductor 102, alternate contact 101, to the lower terminal of generator G.

Upon each retraction of the armature of FF, relay CR is connected in bridge of the called line, this circuit being traced from battery through the upper winding thereof, alternate contact 103, normal contact 100, to the terminal of the called line, while the other winding of CR is connected through alternate contact 104, normal contact 101, terminal 76 of the called line. Due to the condenser included in circuit at the substation F while the receiver is on its switch hook, there is no path for direct current for relay CR so that it does not energize until the called subscriber answers the call and removes his receiver from its switch hook thereby providing a path for direct current over the called line. Thus, when the subscriber at F removes his receiver in response to a call and upon the following de-energization of FF, a path for direct current through control relay CR is provided over the previously described path causing its energization. Therefore its alternate contact 105 is closed maintaining relay RR^2 energized as long as the receiver remains off the switch-hook at substation F. This prevents the release of switch E until the called subscriber replaces the receiver.

Returning now to CR, the closure of its alternate contact 106 is effective to prevent another application of ringing current to the called line, also by the ensuing energization of relay CL causing the establishment of a talking circuit by the closing of alternate contacts 107, 108. Responsive to said energization of CL alternate contact 109 is closed establishing an energizing circuit for disconnect relay DR which closes its alternate contact 110 establishing a locking circuit for itself over conductor 87 to ground at alternate contact 88. Relay DR therefore interrupts its normal contact 99 rendering relay FF inert and preventing any further application of ringing current to the terminals of the called line. The two substations are now connected over a conversational circuit including the heavily marked primary and secondary conductors, a condenser 111 being interposed in the primary conductor at first selector C while a condenser 111^1 is interposed in the secondary conductor at connector E, these condensers being connected in circuit to prevent interference between the control circuits of the respective substations.

The talking battery for the calling substation is provided through the windings of relay PR, while talking battery for the called substation is provided through the winding of relay CR.

Release.—After the subscribers have finished conversation, by replacing their receivers upon their respective switch-hooks they may effect the release of the switches used in establishing the connection. The release of the switches is preferably controlled from both substations, that is, release of switches B, C, and D is effected when the calling subscriber replaces the receiver while the release of the connector E is effected when the called subscriber replaces his receiver. This order of release may, of course, be varied.

Assuming now, that the subscriber at F replaces his receiver, the previously described circuit through relay CR is interrupted at the switch-hook of station F whereby said relay restores. Due to the interruption of alternate contact 106 of CR, relay CL is restored closing its normal contact 109 and thereby establishing an energizing circuit for release relay RR^3 through alternate contacts 112, 113. Relay RR^3 is therefore energized interrupting the circuit for RR^2 causing its restoration, but relay RR^3 is maintained energized through normal contact 113 of RR^2 and normal contact 88 to ground. The restoration of RR^2 and consequent interruption of its alternate contact 92 effects the restoration of relays LT and CO^1, and due to the interruption of alternate contact 93 of LT, relay H restores disconnecting relay CR from the wipers and by the interruption of its alternate contact 94 allows relay BR to de-energize.

Returning now to RR^3, due to the closing of its alternate contacts 83, 84, magnet SM^2 is connected in circuit with the alternating current generator 114 whereby the wipers are advanced in a secondary direction as already described causing their restoration and the restoration of the off-normal contacts. As soon as contact 88 of PON^2 restores to normal, relays SW^1, RR^3, and DR restore, as it will be remembered these relays were held energized over circuits including said grounded contact 88. Upon restoration of RR^3 its normal contact 65 is again closed and as test conductor 64 may still be grounded from second selector D, RR^3 again becomes energized but this is only incidental and has no effect upon the switch at this time.

The cut-off relay CO^1 of switch B^1 having been restored, the line of substation F is

available for use in establishing other connections.

Upon the subscriber at A replacing his receiver, the circuit for relay PR is interrupted causing its restoration and the interruption of its alternate contact 24. Although the interruption of alternate contact 24 opens the high voltage path for current through relay MRR, alternate contact 25 thereof being closed there is still a flow of current through the second or low voltage path but this is not sufficient to maintain the armature of relay MRR attracted. Said armature therefore restores interrupting alternate contacts 25, 25^1 and thus allowing the release relay RR to restore.

Upon the closing of normal contact 45 of RR, a circuit for relay TR is established traced from battery through the winding of said relay, normal contact 45, alternate contact 27, normal contact 22 to ground. Relay TR therefore closes its alternate contact 40 effecting an operating circuit for magnet SM whereby the wipers are advanced to effect their release in a manner as previously described, also causing the off-normal switches to be restored. Upon the interruption of alternate contact 27 of PON, the circuit for relay TR is interrupted causing its deënergization and the interruption of the circuit for SM.

It will be noted that upon the closing of normal contact 22 and the release operation just described, ground is connected through alternate contact 27, conductor 28, and the winding of SR to battery causing the energization of SR but this has no effect upon the release of switch C as relay SR again restores when the alternate contact 27 of PON is interrupted.

Another incidental operation may occur when the calling subscriber replaces his receiver for release purposes, this being an application of ground over the primary conductor. This is brought about in the following manner. Upon restoration of PR its normal contact 24 closes, and as relay RR maintains its armature in an attracted position for an instant after restoration of PR, ground will be connected through alternate contact 30 of RR, normal contact 24, alternate contact 31 causing a short application of ground to the primary conductor. This incidental application of ground to the primary conductor in the present embodiment of my invention, is effective to cause a primary step of connector E (if said connector was released by the called subscriber before the calling subscriber replaces his receiver) but if said connector E is so operated, it is automatically restored. This incidental operation of connector E is brought about as follows: The ground impulse to the primary conductor follows a path over conductor 68 of switch E, normal contacts 69, 70 and PM^2 to battery, causing a primary step of the wipers 71, 72, 73, leaving the switch off-normal until released as will be described.

Returning now to switch C, upon the said releasing energization or operation of relay TR, its normal contact 44 is interrupted disconnecting ground from test wiper 34 whereby the locking circuit for RR^1 of switch D is interrupted causing its restoration. A release circuit is thus closed for relay TR^1 traced from ground at alternate contact 115 of PON^1, normal contact 60 through winding of TR^1 to battery. Its alternate contact 58 is thereby closed establishing an energizing circuit for SM^1 whereby the wipers are advanced and the restoration of switch D effected in a manner as previously described. It will be noted that while switch D is restoring a ground or busy potential is connected to test conductor 61 due to the closing of normal contact 116 of relay RR^1, this being removed when alternate contact 62 of PON^1 is interrupted. Switch D having been restored is available for use in establishing other connections.

Now as to the restoration of switch B, this is effected upon restoration of switch C due to the interruption of alternate contact 23 of PON, this bringing about the restoration of relay LR which has been held energized through this alternate contact 23. Upon restoration of LR its normal contact 13 is closed connecting ground through alternate contact ON and the winding of CO to battery. Thus relay LR being deënergized and relay CO energized, both retaining pawls 7, 8 are disengaged from the ratchet 6 allowing the wipers to be restored. Upon restoration of contact ON the circuit for CO is interrupted causing its deënergization whereby switch B is at normal and available for use in extending other connections.

Connector E it will be remembered was incidentally stepped one point off normal, and relay RR^2 thereof was energized over the circuit including the grounded test conductor 64. But, upon the removal of this ground due to the interruption of normal contact 59 of relay TR^1, switch D, relay RR^2 restores energizing relay RR^3 and causing a restoring operation of switch E from the incidental operation.

In the previous description of the release operation it was assumed that the subscriber at the called substation was the first to replace the receiver upon its switch hook. We will now trace the release operation under the assumption that the subscriber at the calling substation was the first to replace the receiver followed by the replacing of the receiver at the called substation. In such a case relay DR deënergizes upon replacing

the receiver at substation A, causing a restoration of the switches C, B, and D in a manner as previously described. In this instance the connector switch is not affected because its release relay RR^2 is energized over a path including grounded alternate contact 105 of relay CR, said relay CR being maintained energized over the calling line. Therefore, when the subscriber at substation A restores his receiver, relay CR restores to normal followed by the deënergization of RR^2, while due to the interruption of alternate contact 106 of CR, relay CL restores. Responsive to the restoration of RR^2, relay RR^3 energizes closing a circuit through SM^2 whereby the wipers are automatically restored in a manner as previously described. Also, upon restoration of RR^2, due to the interruption of its alternate contact 92, relays LT and CO^1 restore, the restoration of alternate contact 93 of LT causing the restoration of relay H followed by the restoration of BR as before described. Upon restoration of PON^2, relays DR and SW^1 are restored whereby the switch being at normal is available for further use in establishing other connections.

The restoration of CO^1 of line switch B^1 restores the substation control of its line switch whereby the line is free to be used in establishing other connections.

Called line busy.—In the previous description it was assumed that the called line was idle upon connection made therewith. It will now be assumed that said line is a busy line upon connection being made therewith, in which case its test terminal 74 will have a ground or busy potential connected thereto either from alternate contact 13^1 of switch B^1 if the line be calling, or from the grounded test wiper 71 connected to multiple of terminal 74 if the line be a called line.

It will be remembered that following the last secondary circuit change, relays RR^2, SW^1 and BR were in an energized condition and the closing of alternate contact 91 of relay BR had connected the lower winding of line test relay LT in circuit between ground at alternate contact 88 of PON^2 and test wiper 71 and terminal 74. It will be remembered also that upon connection with the idle line, relay LT was energized, but in the present case there being ground or busy potential upon test terminal 74, no energizing circuit for LT of E is provided as both of its terminals are connected to ground, and it remains inert. Therefore, relay H is not energized so that slow-acting relay BR restores closing its normal contact 117 connecting busy back BB^1 through alternate contact 70 and normal contact 82 to the primary conductor. This busy tone follows a path back over the primary conductor and out through the receiver of the calling substation A then back over the lower heavily marked primary conductor through the right end winding of relay PR to ground. The subscriber at A in response to this signal knows that the wanted line is busy and therefore replaces his receiver upon its switch-hook interrupting the circuit for relay PR. Upon restoration of relay PR, switches C, D, and B are restored in a manner as previously described, and in the present instance switch E being off-normal is also restored. This is brought about in the following manner. Upon the interruption of normal contact 59, relay TR^1 of switch D, the energizing circuit for RR^2 is interrupted (relay CR not having been energized) causing restoration of RR^2 whereby its normal contact 113 is closed connecting ground from alternate contact 88 through the winding of RR^3 to battery. Relay RR^3 closes its alternate contacts 83, 84 establishing an operating circuit for SM^2 as before, whereby the wipers are advanced effecting the restoration of switch E in a manner as previously described. Upon interruption of alternate contact 88 relays RR^3 and SW^1 are restored and switch E being at normal is available for use in establishing other connections.

In connection with line switch B, means are provided to indicate to the calling subscriber when such switch has not been able to find an idle trunk. For instance if all of the trunks leading from contacts 17, 18, 19 are busy, their test contacts 19 will be grounded causing the switch to step to the last set of contacts 17^1, 18^1, 19^1. There being no ground connected to terminal 19^1, relay CO immediately deënergizes but relay LR maintains its armature attracted due to its slow acting construction so that upon the closing of normal contacts 10, 11 of CO, a locking circuit for LR is established from ground through busy back BB, terminal 18^1, wiper 12 over the calling line, returning to wiper 9, contact 17^1, contact 19^1, wiper 16, alternate contact 20, and winding of LR to battery. A characteristic signal is thus transmitted from BB over the path just described whereby the subscriber at A receiving such signal knows that all of the trunks are busy and therefore replaces his receiver upon its switch-hook. The circuit for LR being thus interrupted, it restores to normal closing an energizing circuit for CO as before, and relay LR being deënergized and CO energized, both retaining pawls 7, 8, are disengaged from ratchet wheel 6 and the wipers restore to normal. Upon restoration of ON, relay CO is deënergized.

Several alternating current generators are illustrated, these being used for effecting the operation of certain of the motor magnets, but it is to be understood that these generators may be all one and the same but have been shown in this manner to simplify the

drawings. Also a number of batteries are shown in different parts of the drawings but it is to be understood that these may be one and the same batteries, and those terminals which are shown connected to ground, in practice would be connected to the grounded terminal of the battery.

While I have embodied my invention in what is known as a complete automatic telephone system, it is apparent that my invention is by no means limited to such a system and furthermore while I have embodied it in circuits for controlling switches of certain characteristics, my invention is not limited to such particular switches. Also many changes and modifications will be apparent, and therefore I do not desire to be limited to the structure as shown and described but aim to cover all that which comes within the spirit and scope of the appended claims.

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

1. A telephone system comprising a primary relay and metallic control circuit therefor, an automatic switch responsive to said primary relay, a quick-acting release relay and energizing circuit therefor including a source of current a winding of said relay and a normally open contact of the primary relay, and a second circuit for said release relay including a comparatively low voltage source of current a second winding of said release relay and normally open contacts thereof whereby said release relay may maintain its armature attracted when its first circuit is interrupted by the primary relay for short periods only.

2. A telephone system comprising a primary relay and metallic control circuit therefor, an automatic switch responsive to said primary relay, a release relay and energizing circuit therefor including a source of current a winding of said relay and a normally open contact of the primary relay, a second circuit for said release relay including a comparatively low voltage source of continuous current supply a second winding of said release relay and normally open contacts thereof whereby said release relay may maintain its armature attracted due to the continuous flow of current through its windings when its first circuit is interrupted by the primary relay for short periods only, and adapted to restore its armature responsive to a prolonged interruption of its first circuit, and release means for the switch rendered effective upon such restoration of the release armature.

3. A telephone system comprising a primary relay and metallic control circuit therefor, an automatic switch responsive to said primary relay, a quick-acting secondary relay and energizing circuit therefor including a winding thereof a source of current a normally open off-normal contact and a normally closed contact of the primary relay, and a second circuit for said secondary relay including a normally open contact thereof a second winding and a comparatively low voltage source of current whereby said secondary relay may maintain its armature attracted when its first circuit is closed and interrupted by the primary relay for short periods only.

4. A telephone system comprising a primary relay and metallic control circuit therefor, an automatic switch responsive to said primary relay, a quick-acting secondary relay and energizing circuit therefor including a winding thereof a source of current a normally open off-normal contact and a normally closed contact of the primary relay, a second circuit for said secondary relay including a normally open contact thereof a second winding and a comparatively low voltage source of current whereby said secondary relay may maintain its armature attracted when its first circuit is closed and interrupted by the primary relay for short periods only, and adapted to restore its armature responsive to a prolonged interruption of its first circuit, and a secondary circuit change adapted to be effected upon such restoration.

5. A telephone system including an automatic switch, a source of current, a metallic control circuit for said switch including a primary relay energized by current over said metallic circuit and responsive to rapid interruptions thereof, a quick-acting release relay having an energizing circuit closed responsive to the initial energization of the primary relay and interrupted responsive to said primary relay operations, a second energizing circuit for said release relay including a normally open contact thereof a second winding thereof and a comparatively low voltage source of continuous current supply whereby said second circuit is closed and held closed only during said rapid interruptions of the first said circuit of the release relay to maintain the armature of the release relay attracted, and operating and release means for said switch controlled by said primary and release relays.

6. A telephone system including an automatic switch, a source of current a metallic control circuit for said switch including a primary relay energized by current over said metallic circuit and responsive to rapid interruptions thereof, primary driving mechanism for said switch responsive to said primary relay release, a quick-acting secondary relay having a first energizing circuit closed responsive to said primary relay and interrupted responsive to said primary relay operations, a second energizing circuit for said secondary relay including a normally open contact a second winding thereof and a comparatively low voltage source of continuous

current supply whereby said second circuit is closed during said interruptions of its first circuit and its armature maintained attracted only during such rapid interruptions, said armature being retracted upon cessation of said primary relay operations to effect a secondary circuit change for said switch.

7. A telephone system comprising a primary relay and metallic control circuit therefor, an automatic switch, a release relay and secondary relay, an energizing circuit for said release relay including normally open contacts of the primary relay, an energizing circuit for said secondary relay including a normally closed contact of the primary relay, whereby said release and secondary relays have their said circuits interrupted during the operations of the primary relay, and a second circuit for the release relay and the secondary relay including a second winding on each relay and a comparatively low voltage source of current, and means for holding it closed while said primary relay is rapidly operating to maintain the armatures of the release and secondary relays attracted during the interruptions of their first said circuits.

8. An automatic switch comprising a primary relay, a release relay, a quick-acting secondary relay, an energizing circuit for said release relay including a normally open contact of said primary relay and a source of current, an energizing circuit for said secondary relay including a normally closed contact of said primary relay a normally open off-normal contact and said source of current, and a local circuit for each of said release and secondary relays including a comparatively low voltage source of current and normally open contacts of said relays whereby when said relays are energized they maintain their armatures attracted during the rapid operations of the primary relay.

9. In combination with a primary relay and control circuit therefor, of a selector switch responsive to rapid operations thereof, a release relay and energizing circuit therefor including a winding of said relay and a normally open contact of the primary relay, and a second energizing circuit for said release relay including a second winding thereof and a source of direct current and of itself not sufficient to maintain the armature thereof attracted but whereby said release relay maintains its armature attracted when its first circuit is being rapidly interrupted by operations of the primary relay, said release relay being adapted to restore its armature responsive to a prolonged interruption of its first said energizing circuit, and release means for said switch controlled by said release relay.

10. In combination with a primary relay and control circuit therefor, of a selector switch responsive to rapid operations thereof, a secondary relay and energizing circuit therefor including a winding thereof a normally open off-normal contact and a normally closed contact of the primary relay, a second energizing circuit for said secondary relay including a second winding thereof and a source of direct current and of itself not sufficient to maintain the armature thereof attracted but whereby said secondary relay maintains its armature attracted when its first circuit is being rapidly interrupted by operations of the primary relay, said secondary relay being adapted to restore its armature responsive to a prolonged interruption of its first circuit, and a secondary circuit closed responsive to such retraction of the secondary armature.

11. In combination with a primary relay and control circuit therefor, of a selector switch responsive to rapid operations thereof, a release relay and a secondary relay, an energizing circuit for said release relay including normally open contacts of the primary relay, an energizing circuit for the secondary relay including normally closed contacts of the primary relay, whereby said release and secondary relays have their said energizing circuits interrupted during the operations of the primary relay, and a second energizing circuit for each of said release and secondary relays including a second winding of each and a source of direct current of themselves not sufficient to maintain the armatures of the last said relays attracted but whereby said release and secondary relay armatures are maintained attracted when their first energizing circuits are being rapidly interrupted by operations of the primary relay, said secondary relay being adapted to retract its armature responsive to a prolonged energization of the primary relay following the rapid operations thereof to bring about a secondary operation of the switch, and said release relay being adapted to retract its armature following a prolonged deënergization of the primary relay to bring about the release of the switch.

12. A telephone system including an automatic switch, a metallic control circuit for said switch including a primary relay energized over said metallic circuit and responsive to rapid interruptions thereof, a secondary relay provided with a pair of windings, a comparatively low voltage source of current for supplying current to one of said windings and a second source of current for supplying current to the other of said windings, means for closing an energizing circuit through the second of said windings, said circuit being rapidly interrupted responsive to said primary relay operations, means for closing a circuit through

the first of said windings for holding said secondary relay energized during the period of said interruptions of its other circuit so as to maintain the armature of said secondary relay attracted.

13. A telephone system including an automatic switch, a metallic control circuit for said switch including a primary relay energized over said metallic circuit and responsive to rapid interruptions thereof, a secondary relay provided with a pair of windings, a comparatively low voltage source of current for supplying current to one of said windings and a second source of current for supplying current to the other of said windings, means for closing an energizing circuit through the second of said windings, said circuit being rapidly interrupted responsive to said primary relay operations, means for closing a circuit through the first of said windings for holding said secondary relay energized during the period of said interruptions of its other circuit so as to maintain the armature of said second relay attracted, and a secondary circuit closed responsive to the retraction of the secondary armature.

14. A telephone system including an automatic switch, a metallic control circuit for said switch including a primary relay energized over said metallic circuit and responsive to rapid interruptions thereof, a release relay provided with a pair of windings, a comparatively low voltage source of current for supplying current to one of said windings and a second source of current for supplying current to the other of said windings, means for closing an energizing circuit through the second of said windings, said circuit being rapidly interrupted responsive to said primary relay operations, means for closing a circuit through the first of said windings for holding said release relay energized during the period of said interruptions of its other circuit so as to maintain the armature of said release relay attracted, and release means for said switch controlled by said release relay.

15. A telephone system including an automatic switch, a metallic control circuit for said switch including a primary relay energized over said metallic circuit and responsive to rapid interruptions thereof, a release relay and a secondary relay, an energizing circuit for said release relay including normally open contacts of the primary relay, an energizing circuit for the secondary relay including normally closed contacts of the primary relay, a second energizing circuit for each of the release and secondary relays including a second winding of each and a source of comparatively low voltage direct current, the said second windings of the release and secondary relay providing means for holding their respective armatures attracted during the interruptions of their first circuits by the operations of the primary relay, means for deënergizing the said secondary relay to bring about a secondary operation of the switch, and means for deënergizing the said release relay to bring about a release.

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

CHARLES S. WINSTON.

Witnesses:
M. R. ROCHFORD,
GEORGE E. MUELLER.