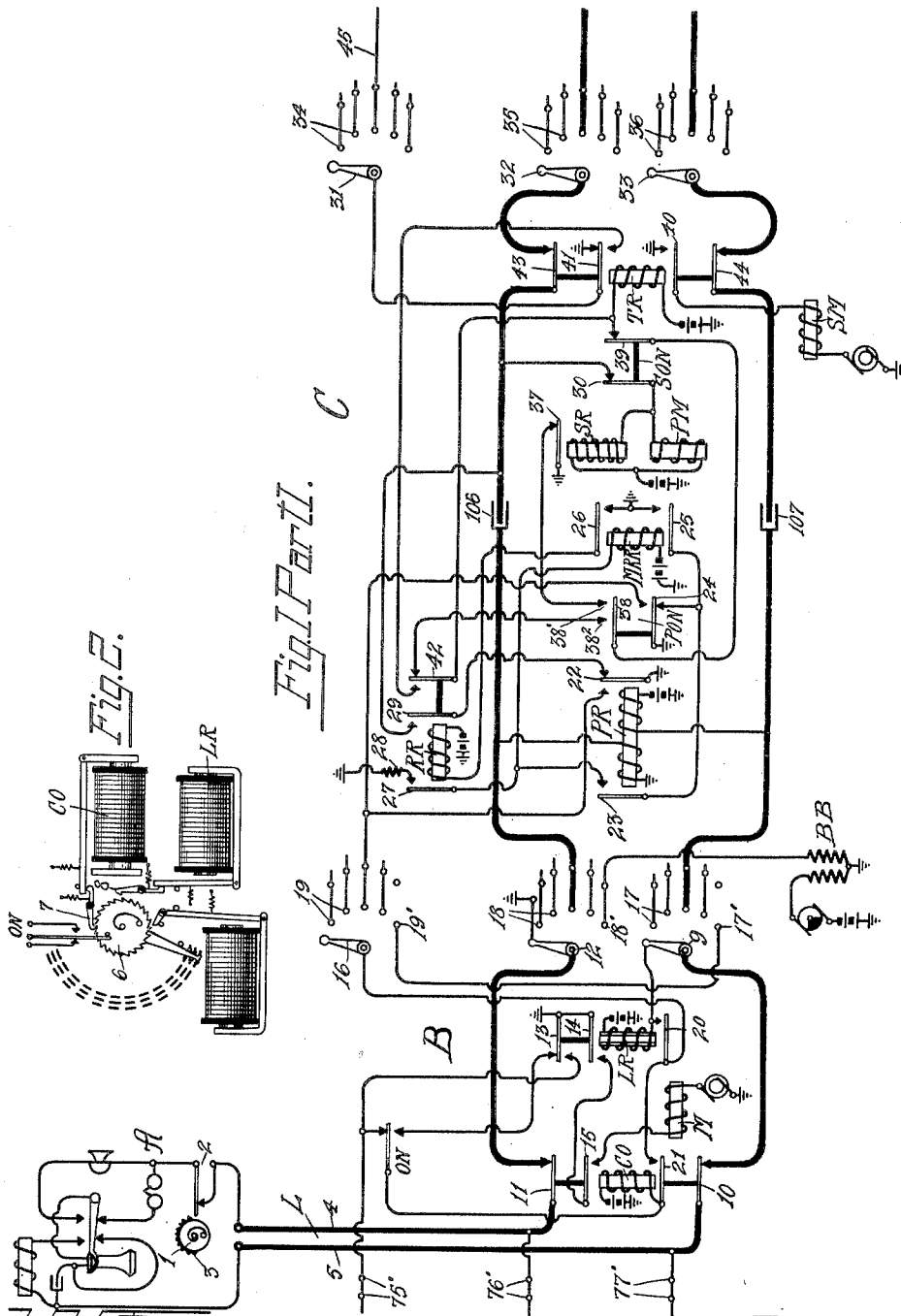


1,108,482.

Patented Aug. 25, 1914.

4 SHEETS—SHEET 1.



Witnesses:

G. E. Mueller
 Wm. Berghahn

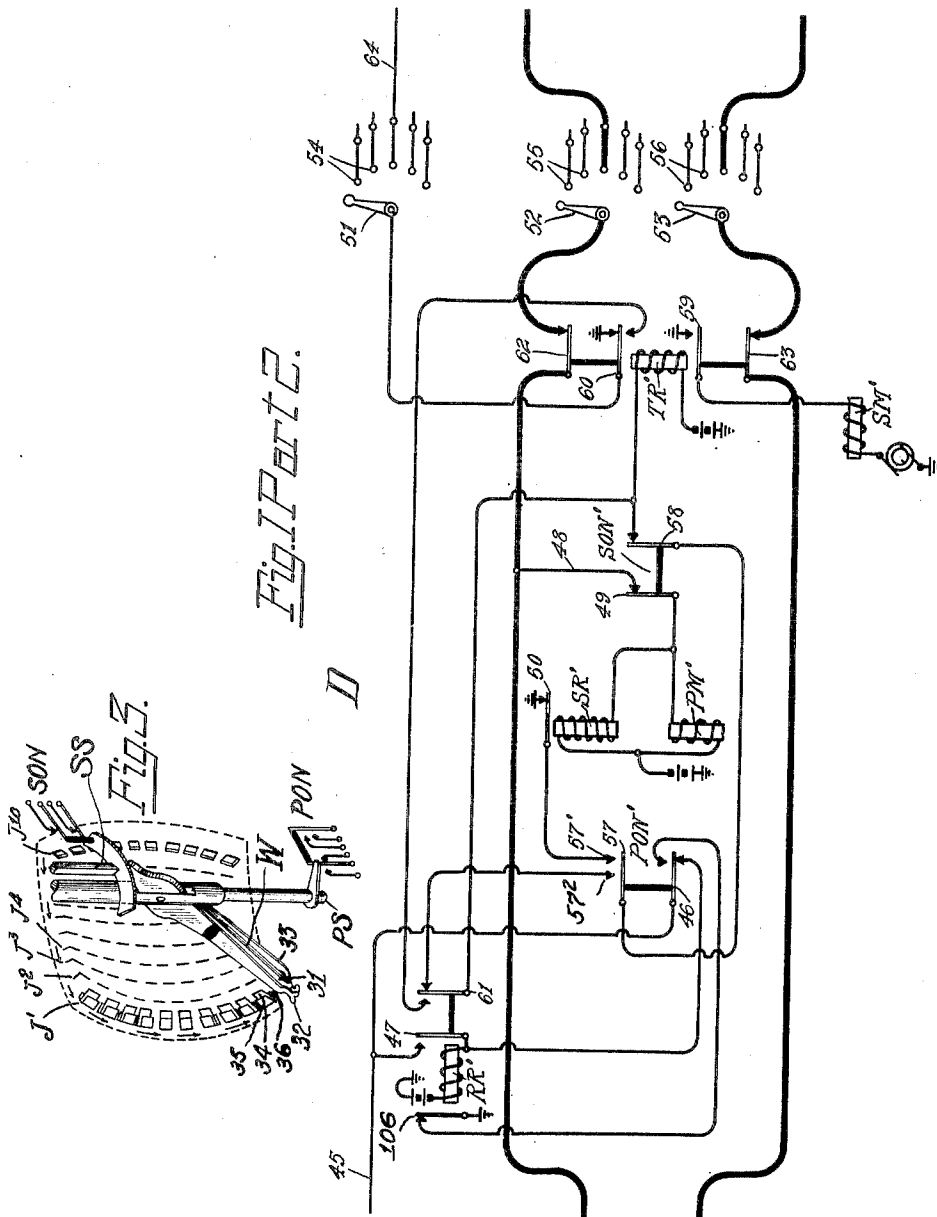
Inventor:
 Charles S. Winston
 By Curtis Blamp.
 Attorney.

1,108,482.

C. S. WINSTON.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 9, 1912.

Patented Aug. 25, 1914.

4 SHEETS—SHEET 2.



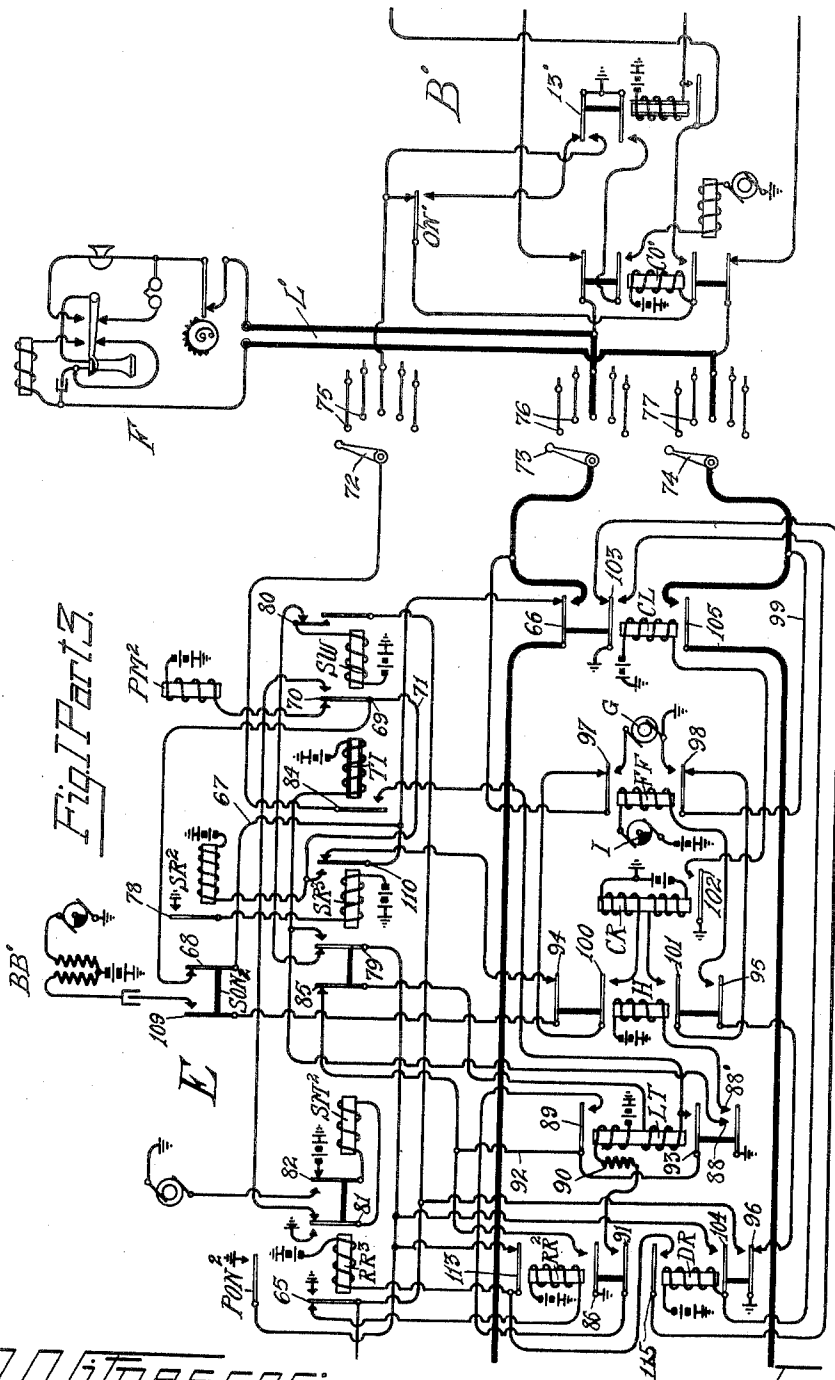
Witnesses:
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1,108,482.

Patented Aug. 25, 1914.

4 SHEETS-SHEET 3.



Witnesses:

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Wm. Berghahn

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1,108,482.

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4 SHEETS-SHEET 4.

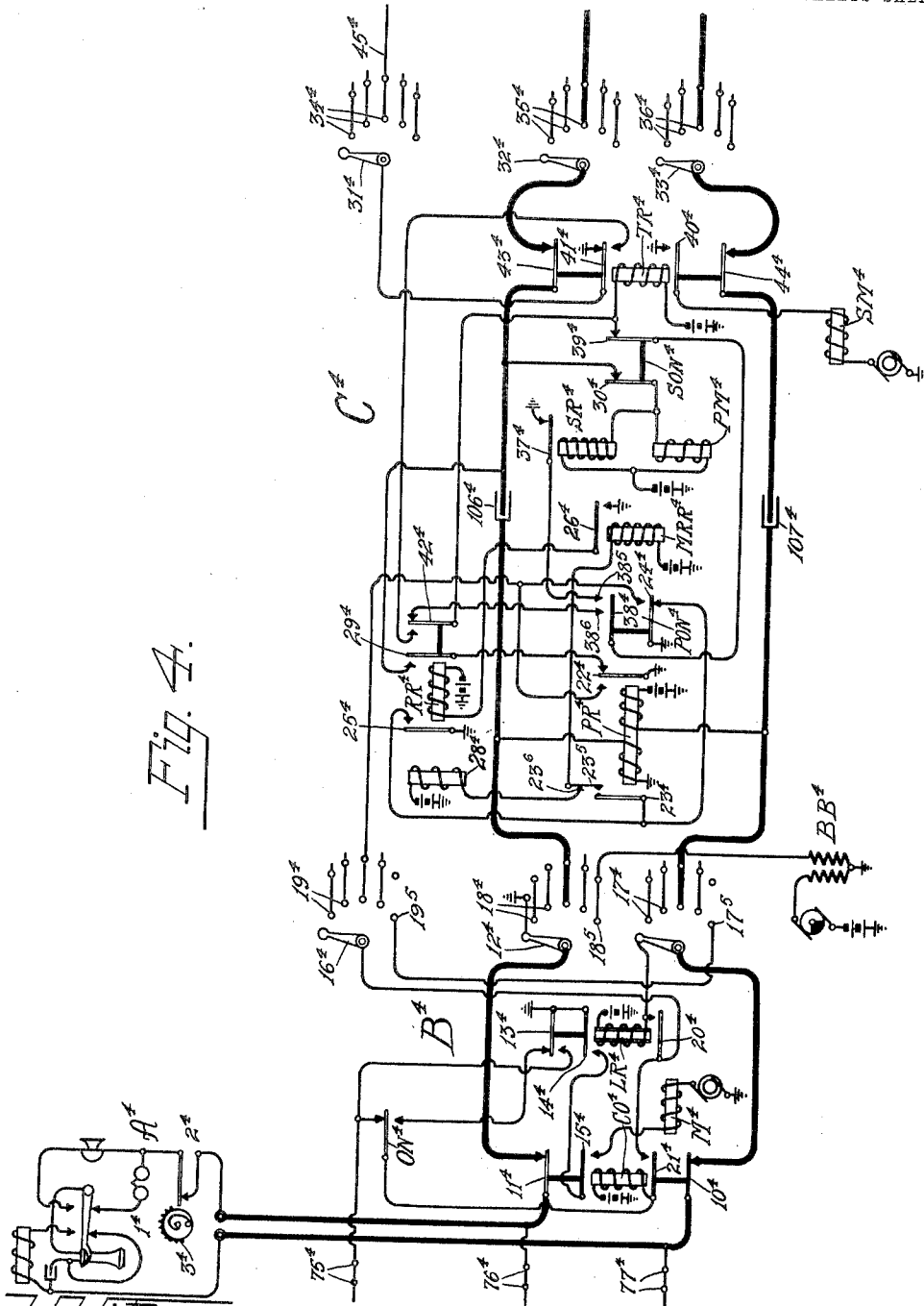


Fig. 4.

Witnesses:

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,108,482.

Specification of Letters Patent.

Patented Aug. 25, 1914.

Application filed September 9, 1912. Serial No. 719,328.

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 certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems in which automatic switches are employed for extending connections, the switches being of what is known as the two dimension type, comprising a bank of contacts divided into groups, and cooperating wipers adapted to be primarily adjusted to select a group, and thereafter secondarily adjusted to select a contact in a group.

My invention has to do more particularly with systems of the above character in which metallic control circuits for the switches are provided, thus eliminating the use of a ground at the control or impulse apparatus.

In previous systems of the above character, slow acting relays have been employed for controlling the secondary and release movements of the switch. That is, slow acting relays have been employed in conjunction with a quick acting primary or impulse relay, and in such systems, due to the fact that the energizing circuit for the release and secondary relays is rapidly interrupted when the primary relay is operated for transmitting primary impulses, these release and secondary relays have been of a special construction in order to maintain their armatures attracted during such primary relay operations, and to this end a copper sleeve about the core or a non-inductive winding connected in multiple circuit with the winding of said relays is usually employed.

In a prior application, I am claiming broadly the invention whereby a second circuit is provided for holding the armatures of the secondary and release relays attracted while the first or initial circuit is interrupted by the primary relay, and my present invention looks more to the specific improvement in this direction as will be more clearly pointed out.

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; and Fig. 4 illustrates a modified circuit arrangement of Fig. 1, part 1.

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 call substation F with its associated switch B¹ 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 would be divided into ten major groups of 1000 each, and each major group would be divided into minor groups of 100 each. On a basis of ten per cent. trunking there would be provided 1000 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 multiply 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 multiplied before the bank contacts of 100 first selectors C, each such one hundred first selectors C com-

prising 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 group and so on. A like arrangement of multiplying would then be given to the ten second hundredths 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 multiplying 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 extends 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 cooperating contacts together with a test wiper 16 and cooperating 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 cooperating 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 deenergization 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 deenergized, 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 affecting 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, 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 34, 35 and 36, (which for clear illustration I have spread apart at the first row in Fig. 3, and which correspond to contacts 34, 35 and 36 in Fig. 1, part 1). A set of wipers W consisting of wipers 31, 32 and 33 are provided to wipe over the corresponding contacts in the vertical groups. (These magnet wipers correspond to wipers 31, 32 and 33 in Fig. 1, part 1). A primary magnet (P. M., 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 im-

pulses sent over the line from the subscriber's station. A secondary magnet (S. M. 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. I preferably arrange magnets SR and PM so that the resistance and self-in-

duction of SR is greater than that of PM so that when current impulses flow through the windings of these magnets in multiple, upon the interruption of such flow, due to the greater self-induction of SR, the self-induced current of SR flows through the closed circuit including magnet PM and therefore maintains the armature of SR attracted between impulses.

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 PM¹, SM¹, a release relay RR¹, and test relay TR¹. Off-normal switches PON¹ and SON¹ are also provided. The relation between magnets PM¹ and SR¹ of this switch is preferably the same as the corresponding magnets of first selector C. Connector switch E is also of the same construction, and comprises besides its wipers and co-operating contacts, off-normal switches PON² and SON², operating magnets PM², SM², secondary relays SR², SR³, release relays RR², RR³, switching relay SW, 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 test conductor interrupter relay TI. In this switch the relay SR² is first connected in multiple with PM² and thereafter with SM² so that magnets PM² and SM² are related to relay SR² like that of the first and second selector switches.

The called line L¹, called sub-station F and associated line switch B¹ 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 en-

ergized, 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 leads to a busy first selector C. This first trunk being busy, it has a ground or busy potential connected to its contacts 19 from the associated first selector in a manner as will be described. A locking circuit for relays LR and CO is therefore established which may be traced from grounded test contact 19, wiper 16 and alternate contacts 20, 21 and the windings of relay LR and CO respectively to battery. 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 the first selector C. This being 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 acting 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-acting 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 deenergized, a circuit for the primary relay PR of the selector C is established over the calling line, which may be traced from ground through the left end 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 end winding of PR to battery, causing its energization. PR is the relay energized over the subscriber's line, which responsive to a single series of directive impulses from the subscriber's station, effects the operation of magnet PM to move the wipers of the first selector to a group of contacts. The wipers are then automatically driven to select an idle contact in the group without the sending of further impulses from the subscriber's station.

Upon the closing of alternate contact 22 of PR, the locking circuit above referred to for the slow-acting line relay LR is estab-

lished, traced over contact 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 23 closes, establishing a circuit or main release relay MRR, traced from ground at normal contact 24 of PON, alternate contact 23, and the winding of MRR to battery, whereby said relay is energized, closing its alternate contact 25, whereby ground from said alternate contact 25 is substituted for holding the circuit through MRR after the interruption of the normal contact 24 upon the first step of the switch. Also responsive to energization of MRR, its alternate contact 26 is closed, establishing an energizing circuit through relay RR, whereby it attracts its armature.

In the present system as well as two wire systems of the past, which relate to two dimension switches, it is essential that the release relay be maintained energized during the operation of the primary relay in sending the directive impulses, although the circuit for the release relay is interrupted each time the primary relay operates. In such control systems, in order to maintain the armature of the release relay attracted during the vibrations of the primary relay, a special construction has been provided in the nature of a copper sleeve about the core of the release relay, or a non-inductive winding in shunt of the magnet winding of the relay, these being well known expedients. In a prior application of mine, I have eliminated the use of such slow acting release relays by providing two paths for current through the release relay, one of which is controlled through contacts of the primary relay, and the other of which was preferably controlled through contacts on the release relay, the second path being of comparatively low current value, but sufficient to maintain the armature of the release relay attracted while its first circuit was being rapidly interrupted by the primary relay. In the present application, I provide such a second path of comparatively low current value for the main release relay, but control it through a second so-called release relay RR, this second path including alternate contact 27 and high resistance winding 28 to ground. This second circuit is so proportioned that the current flowing there-through will be sufficient to maintain the armature of MRR attracted, while the first energizing circuit therefor is being rapidly interrupted at alternate contact 23 of RR. This will be more clearly brought out in the ensuing description of operation. Thus it will be seen how in the preferred embodiment of my invention, the subscriber at a calling substation upon initiation of a call

automatically selects one of the ten first selectors C to which it has access. The subscriber at A now operates his calling device 1 to effect two interruptions of impulse springs 2, this number of impulses corresponding to the first digit of the called substation number. Responsive to the said two interruptions, relay PR retracts its armature two times, causing two interruptions of its alternate contact 23, and thereby two interruptions of the initial or first energizing circuit for MRR. As previously stated these interruptions do not allow the retraction of the armature of MRR, due to the second circuit being maintained closed through alternate contact 27 of RR. Also upon each deenergization of PR, its normal contact 22 is closed, transmitting a primary directive impulse through primary magnet PM. These impulses traverse a path for said normal contact 22, alternate contact 29, normal contact 30, and the winding of PM to battery. These two impulses through magnet PM effect two primary steps of the wipers 31, 32, 33 to select the second group corresponding to J².

In systems of the present character, such as employ two dimension switches, that is, switches in which the wipers are adjusted primarily to select a group of contacts, and thereafter to automatically select an idle set of contacts in the group, a slow acting secondary relay has been provided which is adapted due to its special construction to maintain its armature attracted while the primary relay is operating, and upon cessation of the primary relay operations, such secondary relay retracts its armature to bring about a secondary circuit change to effect the automatic selection of an idle set of contacts in the selected group. Such a slow acting relay necessarily involves a special construction, either by the use of a copper sleeve about its core, or a non-inductive winding in shunt of its magnet winding. In the present invention I eliminate the use of such specially constructed secondary relays, and employ an ordinary quick acting relay SR. To maintain the armature of this quick acting relay energized while the primary relay is operating, (although its circuit is interrupted each time the primary relay operates), I so connect it in circuit with the primary magnet PM that the primary impulses travel through the winding of both the primary magnet and secondary relay, and after each impulse the self-induced current of SR flows through the winding of PM and through the winding of the secondary relay and maintains the armature of SR attracted, during the short period of interruption of its circuit, between the transmission of the impulses. I also preferably wind relay SR to a com-

paratively high resistance with relation to PM, thereby securing a most effective holding operation of SR.

Referring now to the arrangement of the first selector C, upon the first impulse from relay PR flowing through the winding of both the relay SR and magnet PM, normal contact 37 of SR is interrupted, and maintained interrupted during the transmission of the primary impulses. Upon cessation of such impulses, relay SR allows its armature to retract, thereby closing normal contact 37 and establishing a circuit for its relay TR traced from ground at normal contact 37, alternate contact 38', 38, normal contact 39 and the winding of PR to battery. Relay TR therefore closes its alternate contact 40, establishing an operating circuit for magnet SM, whereby wipers 31, 32, 33 are stepped into engagement with the first set of contacts 34, 35, 36 of the selected group. Assuming the first set of contacts leads to a busy second selector D, its test contact 34 will be grounded through one of the multiple contacts, and wiper 31, and normally grounded contact 41 of the switch connected thereto. Therefore, although the initial energizing circuit for relay TR was interrupted by the opening of normal contact 39 of SON, this maintaining circuit from test contact 34, flows over a path including wiper 31, alternate contact 41, alternate contact 42, and the winding of TR to battery whereby said relay maintains its armature attracted and magnet SM continues to advance wipers until an idle set of contacts is reached. Assuming the third set shown is the first idle set reached, its test contact 34 has no busy potential or ground connected thereto so that relay TR deenergizes interrupting its alternate contact 40, whereby the circuit for SM is interrupted, rendering the wipers 31 inert. It will be noted that while the wipers are traveling over the contacts, talking wipers 32, 33 have their circuit interrupted at normal contacts 43, 44, thus preventing interference with the existing connections.

Upon retraction of the armature of TR, its normal contact 41 is closed, placing a ground or busy potential upon the terminals 34 of the selected trunk. This ground connection is also effective to cause energization of relay RR¹ of selected switch D, the circuit being traced over its conductor 45, normal contact 46, and the winding of RR¹ to battery causing the energization thereof, whereby its alternate contact 47 is closed, establishing a locking circuit for itself independent of the normal contact 46. Thus responsive to the first operation of calling device 1, the line of the calling substation has been extended to a second selector D, which has access to the connector switches of the second thousand group which in-

cludes the line of the called substation whose number it will be remembered is 2343. The subscriber at station A now operates calling device 1 to effect three operations of primary relay PR, the number of operations corresponding to the digit value of the second or hundreds digit of the called substation number. Responsive to said three operations of PR, three primary or directive impulses are transmitted through magnet PM¹ and secondary relay SR¹ of switch D, these impulses following a path from normal contact 22 of PR, alternate contact 29, normal contact 43, wiper 32, contact 35, primary conductor of switch D, conductor 48, normal contact 49 and the winding of SR¹ and PM¹ in parallel to battery. The first impulse through SR¹ causes the interruption of its normal contact 50 which is maintained opened as long as the directive impulses are being transmitted through the windings of SR¹ and PM¹.

The maintaining of the armature of SR¹ attracted during the transmission of primary impulses, is brought about by the self-induced current flow through SR¹ and PM¹ in series as in the case of the first selector C as previously described. The said three impulses through the magnet PM¹ are effective to step wipers 51, 52, 53 to the third group of contacts 54, 55, 56, which group corresponds to group J³ of Fig. 3. This third group of contacts leads to connector switches E associated with the third hundreds group of lines in the second thousands group, which includes the line of the called substation. After the transmission of the said three primary impulses, SR¹ retracts its armature closing its normal contact 50 to effect the operation of relay TR¹, the circuit therefor being traced from ground at said normal contact 50, alternate contacts 57', 57, normal contact 58, the winding of TR¹ to battery. Alternate contact 59 of TR¹ is accordingly closed, establishing an energizing circuit for SM¹, whereby wipers 51, 52, 53 are advanced into engagement with the first set of contacts 54, 55, 56 of the selected group. Assuming this first set leads to a busy connector E, its test contact 54 will be at a ground or busy potential through one of its multiple contacts 54, a wiper 51 of a switch D and its normal contact 60 to ground, so that a maintaining circuit for TR¹ is closed. This circuit may be traced from said ground at contact 54, wiper 51, alternate contact 60, alternate contact 61, and the winding of TR¹ to battery, (as it will be noted that the initial circuit for TR¹ is interrupted at normal contact 58 of SON). Magnet SM¹ therefore advances the wipers another step and in fact continues to do so until an idle set of contacts are reached, such set having no ground or busy potential upon its test contact 54. Assuming the third set illustrated is the first

idle set reached, there being no maintaining circuit for TR^1 , it retracts its armature, interrupting the circuit for SR^1 and rendering the wipers inert. Due to the interruption of the circuit for talking wipers 52, 53, at normal contacts 62, 63, while said wipers are in their secondary travel, any existing connections over which these wipers move are not interfered with.

From the foregoing it will be seen that the subscriber in response to the second movement of his dial has selected an idle connector switch having access to the terminals of the wanted line, the connection being traced over the heavily marked conductors.

It will be noted that upon selection of connector E and upon retraction of the armature of TR^1 , a ground or busy potential from normal contact 60 is connected to the selected test contact 54, thus preventing any other switch from connecting to the selected connector E. This ground connection is also effective to energize relay RR^2 of switch E, circuit being traced over test conductor 64, normal contact 65, and the winding of RR^2 to battery, causing its energization, but without any effect at this time. The subscriber at A operates his calling device 1 to effect four interruptions of his line circuit resulting in four operations of the primary relay PR. Four impulses are therefore transmitted from normal contact 22, over the primary conductor to connector E, then over normal contact 66, conductor 67, normal contact 68 to connection 69 at which point the impulses divide and include the windings of PM^2 and SR^2 . From point 69 said impulses are passed through normal contact 70 and the winding of PM^2 to battery, while the other path for said impulse includes conductor 71 and the winding of SR^2 to battery. The said four impulses flowing through the magnet PM^2 , effect four primary steps of wipers 72, 73, 74, to select the fourth group of contacts 75, 76, 77, which group corresponds to group J^4 illustrated in Fig. 3 and which group includes the terminals of the called line.

The first impulse flowing through secondary relay SR^2 causes its energization whereby it closes its alternate contact 78 to cause the energization of secondary relay SR^3 , which by interrupting its normal contact 79 prevents a premature operation of switch relay SW when contact PON closes on the first primary step of the switch. As in the case of the other switches, the self-induced current flow from SR^2 through the winding of PM^2 and of SR^2 , (which it will be noted is connected in parallel with PM^2), causes SR^2 to hold its armature attracted and thereby maintain its contact 78 closed during the transmission of the primary impulses. Upon cessation of said impulses, SR^2 interrupts its contact 78, allowing SR^3 to restore. Upon

restoration of SR^3 , a circuit for SW is closed traced from ground at PON², normal contacts 79, 80, the winding of SW, to battery, whereby its alternate contact 80 is closed, establishing a locking circuit to ground at alternate contact 65. The energization of switching relay SW interrupts normal contact 70 and closes alternate contact 70, whereby primary magnet PM^2 is disconnected and secondary magnet SM^2 is connected with the primary conductor. The subscriber at substation A now operates dial 1 to effect three operations of the primary relay PR, whereby three impulses of current are transmitted from normal contact 22 of PR over the primary conductor and through the winding of SM^2 and SR^2 in parallel to battery. This final set of primary impulses through SM^2 and SR^2 varies, in that the first impulse of the final set flows through normal contact 68 of SON², while any following primary impulses of the final set flow through alternate contact 110 of SR^3 , due to the interruption of normal contact 68 of SON² upon the first secondary step of the switch. Referring now more in detail to the flow of these impulses, the first one flows over the primary conductor, through normal contact 66 of relay CL, conductor 67, normal contact 68 to point 69, part of the current of the first impulse flowing from there over conductor 71 and the winding of SR^2 to battery, while part of the current flows from point 69 over alternate contact 70, normal contact 81, the winding of SM^2 and normal contact 82 to battery. Responsive to the energization of SR^2 by the first said impulse, its alternate contact 78 is closed establishing an energizing circuit for SR^3 so that when normal contact 68 interrupts upon the first secondary step of the switch, the following two impulses of the last primary set flow from normal contact 66 through alternate contact 110 to SR^3 , part of the current flowing through SR^2 and part over conductor 71, alternate contact 70 and SM^2 , as before. These three impulses cause three operations of SM^2 , whereby wipers 72, 73, 74 are advanced three secondary steps to engage the third set of terminals 75, 76, 77, which are the terminals of the line of called substation F. Due to the transmission of these three impulses through SR^2 , and the self-induced current flow through SR^2 and SM^2 which are connected in parallel, said relay holds its armature attracted and its alternate contact 78 closed. SR^3 therefore is energized until after the transmission of the last one of the said three impulses, whereby its armature is retracted, interrupting the circuit for SR^3 , which now restores interrupting its alternate contact 79 and thereby opening the energizing circuit for the slow acting test interrupter relay TI. This relay (TI) being slow acting maintains its armature

attracted momentarily so that if the line connected with is idle, a second energizing circuit is closed through its winding to maintain its armature attracted as will be pointed out. It will be noted that although the test circuit leading to test wiper 72 is closed at alternate contact 84 of relay TI during the secondary travel of the wipers, this test circuit is interrupted at normal contact 85 of SR³, due to the fact that SR³ is energized during the secondary travel of the switch.

In the present embodiment of my invention I have preferably arranged my connector switch so that if connection is made to the terminals of a busy line, a characteristic busy signal is transmitted to the calling substation, while if the line connected with is idle, ringing current is automatically connected to the terminals thereof to operate the call signal at the called substation. Up to the period in the operation of the system as has been described, the operation of the circuit arrangement is the same whether connection has been made to the terminals of an idle or a busy line, but after this last secondary circuit change, that is, upon deenergization of the secondary relay of connector E, the operation differs, depending upon whether the line connected with is idle or busy.

Called line idle.—Assuming that the line connected with is idle, upon restoration of SR³, its normal contact 85 is closed connecting the lower winding of line test relay LT in circuit with the test terminal 75 of the called line before slow acting relay TI has a chance to retract its armature. This circuit may be traced on one hand from wiper 72, through alternate contact 84, the lower winding of LT, normal contact 85, to ground at alternate contact 86 of RR², and on the other hand this test circuit is traced from wiper 72, through terminal 75, contact ON¹ and winding CO¹ to battery. These relays LT and CO¹ are thus connected in series and are both energized over the circuit just traced. The energization of CO¹ removes the substation control of its line switch B¹, while due to the closing of alternate contact 88 of LT, a circuit is closed through the winding of slow acting relay TI, causing it to maintain its armature attracted and its alternate contact 84, which is included in the test circuit, closed. Due to the closing of alternate contact 89 of LT, a locking circuit through its upper winding is established, traced from battery through said upper winding, current reducing resistance 90, alternate contacts 91, 89, conductor 92 to ground at alternate contact 86 of RR². By the closing of alternate contact 93 of LT, its lower winding is short circuited due to the direct ground connection traced from alternate contact 86, conductor 92, to contact 93,

this connection being effective to maintain cut-off relay CO¹ energized, and at the same time place a ground or busy potential upon the test contacts 75. The closing of alternate contact 88' of LT, causes the energization of relay H whereby its normal contact 94 is interrupted, disconnecting busy-back BB¹ from the primary conductor. The closing of alternate contact 95 of H, establishes an energizing circuit for relay FF, whereby it periodically attracts its armature due to the interruptions of its circuit by the rotation of interrupter I. This energizing circuit for FF is traced from ground at normal contact 96 of relay DR, alternate contact 95, winding of FF and interrupter I to battery.

Each time relay FF attracts its armature, its alternate contacts 97, 98 are closed, connecting the ringing generator G in bridge of the terminals of the called line, whereby the call bell at substation F is operated. This circuit may be traced from the upper terminal of generator G, alternate contact 97, wiper 73, terminal 76, over the calling line including the call bell and condenser of substation F, returning over line terminal 77, wiper 74, conductor 99 and alternate contact 98 to the other terminal of generator G.

Upon each retraction of the armature of FF, its normal contacts 97, 98 are closed, whereby control relay CR is connected in bridge of the terminals of the called line, but as long as the receiver remains upon the switch hook at the called substation, due to the interposition of the condenser thereat, no path for the flow of steady current through control relay CR exists, but upon the removal of the receiver at the called substation, a path for steady current is provided to cause the energization thereof. This path may be traced from ground through the upper winding of CR, alternate contact 100, normal contact 97, wiper 73, terminal 76 over the called line and substation F of which the receiver has been removed, returning over the line terminal 77, wiper 74, conductor 99, normal contact 98, alternate contact 101, and the lower winding of CR to battery. Thus with the relay FF deenergized and the receiver removed at substation F, control relay CR energizes to automatically bring about the disconnection of ringing current in the called line as will be described.

Upon energization of CR caused by the response of the called subscriber, its alternate contact 102 being closed, relay CL energizes closing its alternate contact 103, whereby disconnect relay DR is energized interrupting its normal contact 96 and thereby rendering relay FF inert. By the closing of alternate contact 104 of DR, a locking circuit for itself is established to ground at

PON², and by the closing of its alternate contact 96, switching relay SW is maintained energized.

and its pawl 8 out of engagement with ratchet 6, the wipers of switch B restore to normal. Upon restoration of the alternate contact ON, relay CO restores and switch B being at normal, the line at substation A is available for use in establishing other connections.

The release of second selector D is brought about by the energization of TR when its release energization occurs at the release of first selector C. That is, upon the release energization of TR, its normal contact 41 is interrupted, interrupting the circuit for relay RR¹ of second selector D, causing its deenergization. Its normal contact 61 is therefore closed, establishing a release circuit for TR¹ traced from ground at normal contact 50 of SR¹, alternate contacts 57', 57², normal contact 61, and the winding of TR¹ to battery. Alternate contact 59 is therefore closed, establishing a release circuit for SM¹ which advances the wipers of switch D beyond the last contact of the group, whereby they are automatically restored to normal. During the release movement of switch D, the talking wipers 52, 53 have their circuit interrupted at normal contacts 62, 63, while its wiper 51 has its circuit interrupted at alternate contact 61 of RR, thus preventing interference with any existing connection over which the wipers might move during the release movement.

During the release of switch D, ground is maintained upon its test conductor 45 to prevent any first selector C from selecting switch D until it is at normal, this ground connection extending from normal contact 106 of RR, alternate contact 46, test conductor 45 and its contact 34. Upon restoration of PON¹ of switch D, the circuit of TR¹ is interrupted, causing its restoration and the interruption of the release circuit for SM¹. Upon restoration of switch D and the removal of the ground or busy potential from its test conductor 45, said switch is available for use in establishing other connections.

The subscriber at F upon replacing his receiver upon its switch hook, interrupts the circuit for control relay CR whereby it deenergizes interrupting its alternate contact 102 and causing restoration of relay CL. Normal contact 103 of CL is therefore closed establishing an energizing circuit for RR³ traced from ground at normal contact 103, alternate contact 115, and the winding of RR³ to battery. Relay RR³ is therefore energized whereby its normal contact 65 is interrupted allowing restoration of RR² and its alternate contacts 86, 91 being thereby interrupted, relay, LT restores. By the interruption of alternate contacts 88 and 88' of LT, relays H and TI restore and the circuit for cut-off relay CO¹ having been interrupted, said relay also restores to normal.

By the closing of alternate contact 66 and 105, of closing relay CL, the talking circuit between the calling and called substation has been established, said circuit being traced over the heavily marked primary and secondary conductors, condensers 106, 107 being interposed at first selector C. Talking battery for the calling line is provided through primary relay PR, while talking battery for the called line is provided through the control relay CR of connector E.

Release.—After the subscribers have finished conversation they may effect the release of the switches used in establishing the connection by restoring their receivers upon their respective switchhooks. In the present embodiment of my invention I preferably effect the release of the connector E by the called subscriber, while the calling subscriber causes the restoration of switches B, C and D. Assuming the calling subscriber is the first to replace his receiver upon its switch hook, the circuit for relay PR is interrupted causing its restoration. This causes the interruption of contact 23, whereby one of the paths for current for the main release relay MRR is interrupted, and as the current flowing through the second path which includes resistance 28 is not sufficient of itself to maintain the armature of MRR attracted, said relay MRR retracts its armature interrupting its alternate contact 26 allowing relay RR to restore. Upon restoration of RR, normal contact 42 is closed, establishing an energizing or release circuit for relay TR traced from ground at normal contact 37 of SR, alternate contacts 38', 38², normal contact 42 and the winding of TR to battery causing its energization. Alternate contact 40 is therefore closed, whereby magnet SM advances the wipers of the switch in a secondary direction until they have passed beyond the last contact of the group whereby they are automatically restored in a manner as previously described, the contacting ends of the wipers taking the path indicated by the arrows in Fig. 3, as already pointed out. Upon restoration of alternate contact 38 of PON, relay TR deenergizes, interrupting the circuit of SM. Following the restoration of switch C, switch B is restored, this being brought about by the interruption of alternate contact 24 of PON of switch C, thus causing the restoration of relay LR which it will be remembered has been held energized through said alternate contact 24. Upon restoration of LR, its normal contact 13 is closed, establishing an energizing circuit for CO which upon attracting its armature withdraws check pawl 7 from engagement with ratchet 6, and as relay LR is deenergized

Returning now to release relay RR^3 , due to the closure of its alternate contacts 81, 82, a release circuit for SM^2 is established whereby the wipers of connector E are advanced in a secondary direction beyond the last contact in the bank whereby they are automatically restored. Upon restoration of PON^2 , the locking circuit for disconnect relay DR is interrupted causing its restoration whereby its alternate contact 115 being interrupted, relay RR^3 is deenergized. Connector E being at normal is now available for use in establishing other connections.

Called line busy.—In the foregoing connection it is assumed that the called line was found idle upon connection made therewith, and therefore I will now describe the operation upon connection to the terminals of a busy line. Up to the last secondary circuit change at the connector switch, the operation of the system is the same whether the line connected with is idle or busy. It will be remembered that up to this said period, and referring now to connector switch E, relays RR^2 , SW, and TI, have their armatures attracted, relays RR^2 , and SW being energized over locking circuits, while relay TI is momentarily holding its armature attracted after the deenergization of secondary relay SR^3 . The line L' being busy, its test terminals 75 will have a busy or ground potential thereon, either from ground at alternate contact 13¹ of line switch B^1 if the line be calling, or through alternate contact 93 of relay LT of a connector switch E if the line be a called line. Therefore, relay LT of switch E being connected at the upper terminal of its lower winding to ground at alternate contact 86 of RR^2 , and the other terminal of the lower winding being connected through wiper 72 to ground at the engaged test terminal 75, relay LT does not energize, and therefore no substitute energizing circuit for the slow acting relay TI being provided, the armature of TI retracts interrupting its alternate contact 84. Relay LT having failed to come up, relay H does not energize so that busy back BB^1 remains connected to the primary conductor of switch E, traced from BB^1 , alternate contact 109, normal contacts 94, 110 and 66, back over the heavily marked primary conductor through receiver of the calling substation, returning over the heavily marked secondary conductor, the winding of PR to the negative terminal of battery which is of course connected to BB^1 , the path just traced being a closed secondary circuit. By the undulations of current induced in this secondary circuit, a characteristic signal is transmitted to the calling substation and the calling subscriber in response to said busy signal replaces his receiver upon its switch hook, thereby effecting the release of all of the switches used in establishing the

connection. The release of switches B, C and D is as previously described.

The release of connector E is effected responsive to the interruption of the holding circuit of RR^2 when relay TR^1 of secondary selector D energizes and interrupts its normal contact 60. RR^2 therefore restores closing its normal contact 113, whereby a circuit for RR^3 is established from battery through the winding of RR^3 , normal contact 113 and PON^2 to ground. RR^3 therefore closes its alternate contacts 81, 82, effecting a release operation of SM^2 as before described, causing the restoration of switch E. Upon restoration of PON^2 , the holding circuit for RR^3 and SW is interrupted, allowing their restoration and switch E being restored, is available for use in establishing other connections.

Figure 4.—In the above figure, I have illustrated a modified circuit arrangement of that illustrated in Fig. 1, part 1. In the present figure those parts which correspond to parts in Fig. 1, part 1, are indicated by like reference characters but with the suffix ⁴ added, except in a few instances where different suffixes are added as will be apparent from an inspection of the drawing. The arrangement of Fig. 4 differs in one respect from Fig. 1, part 1, in that the main release relay MRR^4 maintains its armature attracted during the vibration of the primary relay PR^4 by impulses through alternate contact 23⁴ of PR^4 and impulses of self-induced current from MRR^4 through its winding and the comparatively low resistance impedance coil 28⁴. In other words, while PR^4 is energized, MRR^4 is maintained energized through the first energizing path which includes alternate contact 23⁴ and alternate contact 25⁴. Upon each deenergization of PR^4 , that is, each momentary deenergization while it is operating to transmit impulses, as armature 23⁴ is restoring, the three contacts 23⁴, 23⁵ and 23⁶ are momentarily in engagement so that there is a flow of current from battery through the windings of MRR^4 and 28⁴ to ground at alternate contact 25⁴. As armature contact 23⁴ disengages from contact 23⁵, the circuit through 28⁴ is interrupted, and due to the fact that the winding of 28⁴ is of low resistance and self-induction compared to the winding of MRR^4 , a discharge of current from MRR^4 due to the declining magnetic field, flows through the closed circuit including the winding of MRR^4 and 28⁴. This impulse of discharge current being at a time when the first energizing circuit for MRR^4 is interrupted, the armature of MRR^4 is maintained attracted momentarily or until the first said circuit through MRR^4 is closed again by the reenergization of PR^4 , and the ensuing closure of its contacts 23⁴, 23⁵. Thus while relay

PR⁴ is vibrating at a predetermined speed, due to the establishment of the first energizing current for MRR⁴, and the closure of its second or discharge circuit, the armature of MRR⁴ is maintained in its attracted position, whereby the contact 26⁴ is maintained closed, and release relay RR⁴ held energized.

As to the operation of Fig. 4, the selection of an idle switch C⁴ is accomplished as in Fig. 1, part 1. Assuming the subscriber at A⁴ has removed his receiver from its hook and switch B⁴ has selected the first selector C⁴, relay PR⁴ is energized to maintain the line relay LR⁴ energized as previously described. The closing of alternate contact 23⁴, 23⁵ of PR⁴ establishes an energizing circuit for MRR⁴ as before whereby its alternate contact 26⁴ is closed causing the energization of RR⁴. The subscriber at A⁴ now operates his dial in the act of calling the wanted line, and therefore interrupts the circuit of PR⁴ a number of times, according to the number of the called line. Upon each deenergization of PR⁴, its normal contact 22⁴ is closed to effect the operation of magnet PM⁴ as previously described. Also upon each deenergization of PR⁴ its armature contact 23⁴ restores to normal and in its restoration the three contacts 23⁴, 23⁵ and 23⁶ are momentarily closed, whereby there is a momentary flow of current through the winding of the low resistance impedance coil 28⁴. Upon the interruption of this said circuit through 28⁴ and MRR⁴, caused by the interruption of contact 23⁶, due to the declining magnetic field of MRR⁴, there is a flow of current through its windings in the same direction as its initial or energizing circuit, the flow discharging through the winding of MRR⁴ and causing relay MRR⁴ to maintain its armature attracted until its first energizing path is again closed through contacts 23⁴, 23⁵. It will be apparent from this that as long as relay PR⁴ is rapidly vibrating its armature, relay MRR⁴ will maintain its armature attracted so that RR⁴ is kept energized to prevent the release of the switch. Upon restoration of the armature of PR⁴ for any extended period, the circuit of MRR⁴ is interrupted long enough to allow the retraction of its armature and thereby cause the release of the switch. The rest of the operation of switch C⁴ is similar to that of switch C and it is believed that from the foregoing description of C⁴ its full operation including its release and the release of B⁴ will be apparent.

Referring again to line switch B, it might be added that this switch is preferably arranged whereby should all of the associated first selectors C be busy, it will automatically step its wipers 9, 12 and 16 to the last contact 17', 18', 19' and there being no ground upon contact 19' the circuits for CO and LR are interrupted causing the imme-

diately deenergization of CO, although the armature of LR is maintained attracted due to the sluggish or slow acting construction of LR. Upon deenergization of CO, its normal contacts 10, 11 are closed, whereby a circuit for LR is established, traced from battery through the winding of LR, its alternate contact 20, wiper 16, contact 19', contact 17', wiper 9, normal contact 10, line L and substation A, normal contact 11, wiper 12, contact 18', and the winding of BB to ground. This circuit is effective to maintain relay LR energized, while a characteristic signal is transmitted over the path described by busy device BB. The subscriber at A knows that all trunks are busy, and thereafter replaces his receiver upon its switch hook interrupting the circuit of LR and causing its restoration. Its normal contact 13 is therefore closed, establishing an energizing circuit for CO whereby CO having energized and LR deenergized, the wipers of switch B restore to normal causing the interruption of alternate contact ON and the restoration of relay CO.

In connection with the multiple circuits of the different switches such as that of the relay SR and magnet PM of first selector C, I have found that by the use of an ordinary standard Kellogg relay of 500 ohms, and an electro-magnet such as is ordinarily employed for driving selector switches with a resistance of 50 ohms, very satisfactory results are secured. With this arrangement the self-induction of the high resistance relay is sufficient to set up a continued flow through the relay and magnet windings in series and thereby maintain the armature of the relay momentarily attracted after its initial energizing circuit has been interrupted. The above figures are given for the purpose of illustration and it is to be understood that the resistances may be varied to the extent that the self-induction of one electromagnet is sufficient to overcome that of the other and cause such a flow through the winding of the relay as to maintain its armature momentarily attracted after its initial energizing circuit is interrupted.

For the purpose of illustrating my invention I have embodied it in a preferred type of automatic telephone system but it is to be understood that my invention is not limited to the exact arrangement shown, and I contemplate applying it in other ways, and therefore I do not desire to be limited to the exact arrangements 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 Letters Patent is:

1. A selector switch comprising an operating magnet, a quick-acting relay, a multiple circuit including said magnet and relay, means adapted for transmitting impulses of

current over said multiple circuit to operate said magnet and relay, the winding of said magnet and relay being so related that a discharge of current from said relay, after each impulse, flows through the windings of said relay and magnet to maintain the armature of the relay attracted between impulses, and a secondary circuit controlled through contacts of said relay.

2. A selector switch comprising a primary magnet, a quick-acting secondary relay, a multiple circuit including said primary magnet and said secondary relay, means adapted for transmitting impulses of current over said multiple circuit whereby said primary magnet is operated and said secondary relay energized to attract its armature, the windings of said primary magnet and secondary relay being so related that a discharge of current from said relay, after each impulse, flows through the windings of said secondary relay and magnet to maintain the armature of the relay attracted between impulses, and a secondary circuit effective upon retraction of said armature upon cessation of the impulses.

3. A selector switch comprising a primary relay, a primary magnet and a quick-acting secondary relay, a multiple circuit including a source of current said primary magnet and said secondary relay, means for transmitting impulses from said primary relay over said multiple circuit whereby said primary magnet is operated to step the switch and said secondary relay energized to attract its armature, the windings of said primary magnet and secondary relay being so related that a discharge of current from said relay after each impulse flows through the winding of said secondary relay and magnet to maintain the armature of the relay attracted between impulses, a secondary magnet and secondary circuit for causing operation thereof effective upon retraction of said armature.

4. A selector switch comprising a primary relay, a primary magnet, an impulse circuit including said magnet and contacts of said primary relay, a quick-acting secondary relay connected in multiple circuit with said primary magnet and adapted to receive said primary impulses whereby its armature is attracted and whereby a discharge of current from its winding through said primary magnet after each impulse causes the armature of the relay to remain attracted, said armature retracting upon cessation of said primary impulses, a secondary magnet for said switch, and a secondary circuit for operating said magnet effective responsive to retraction of said armature.

5. A telephone system comprising a metallic circuit telephone line, selector and connector switches, a primary relay, a primary magnet and quick-acting secondary relay

for each of said selectors and connectors, a multiple circuit for each of said selectors and connectors including a source of current and its said primary magnet and secondary relay, means for transmitting impulses from a primary relay over the multiple circuits of selector and connector switches in extending the circuit of said line, the windings of each primary magnet and secondary relay being so related that impulses through the secondary relay assisted by the discharge from its winding through said winding and the primary magnet after each impulse, maintain the armature of the secondary relay attracted during the transmission of the impulses, and a secondary circuit for each switch effective upon retraction of the armature of the associated secondary relay.

6. A selector switch comprising primary, secondary and release magnets, a primary relay, a quick-acting secondary relay, a multiple circuit including said primary magnet and secondary relay, an impulse circuit controlled by said primary relay for transmitting impulses of current over said multiple circuit to operate the included magnet and relay, the windings of said magnet and relay being so regulated that a discharge of current from said relay, after each impulse, flows through the windings of said relay and magnet to maintain the armature of the relay attracted between impulses, a secondary circuit for said secondary magnet effective upon retraction of said armature upon cessation of the impulses, and means for operating said release magnet also controlled by said primary relay.

7. A telephone system comprising a calling line, a selector switch connected thereto, a primary relay connected in bridge of said line and adapted to be operated over the metallic circuit thereof, a quick-acting release relay, an energizing circuit therefor adapted to be closed when said primary relay is energized and interrupted responsive to impulse operations thereof, a second circuit for said release relay and means for connecting it to maintain the armature of said release relay attracted while its first circuit is being interrupted, a primary magnet and quick-acting secondary relay connected in multiple circuit with an impulse contact of said primary relay, the inductance of said relay being greater than said magnet whereby said secondary relay maintains its armature attracted during the transmission of primary impulses, a secondary magnet, and a secondary circuit for rendering said magnet effective upon cessation of the primary impulses and the ensuing retraction of the secondary relay armature.

8. A connector switch comprising primary and secondary magnets, a quick-acting secondary relay, a multiple circuit including

said primary magnet and secondary relay, the windings of said primary magnet and secondary relay being so related that a discharge of current from said relay, after each directive impulse, flows through the windings of said magnet and relay to maintain the relay armature attracted between impulses, a secondary circuit adapted to be closed responsive to retraction of said armature upon cessation of the impulses whereby said primary magnet is replaced by said secondary magnet in multiple relation to the secondary relay to receive further impulses.

9. A connector switch including primary and secondary magnets, a quick-acting secondary relay, a multiple circuit including said primary magnet and secondary relay, the windings of said multiply connected magnet and relay being so related that a discharge of current from said relay, after each directive impulse, flows through the windings of said magnet and relay to maintain the relay armature attracted between impulses, a secondary circuit adapted to be closed upon retraction of said armature upon cessation of the impulses, a switching relay operated responsive to said secondary circuit closure, whereby said primary magnet is replaced by said secondary magnet in multiple relation to the secondary relay to receive further impulses.

10. The combination with a switch operating magnet, of a relay, means for transmitting impulses of current over a multiple circuit including the windings of said magnet and relay to cause their energizations, one of said windings being so related to the other that upon termination of each impulse a self-induced current flow traverses both of said windings to maintain the armature of the relay attracted between impulses, and a secondary circuit controlled through contacts of said relay.

11. The combination with a switch operating primary magnet, of a secondary relay, means for transmitting impulses of current over a multiple circuit including the windings of said magnet and relay to cause their energizations, one of said windings being so related to the other that upon termination of each impulse a self-induced current flow traverses both of said windings to maintain the armature of the relay attracted between impulses, and a secondary circuit effective upon retraction of said armature upon cessation of the impulses.

12. The combination with a primary relay, of a switch operating primary magnet and secondary relay, means for transmitting impulses of current over a multiple circuit including the windings of the last said magnet and relay to cause their energization whereby said primary magnet is correspondingly operated and said secondary relay attracts its armature, one of said windings be-

ing so related to the other that upon termination of each impulse a self-induced current flow traverses both the said windings to maintain the armature of the relay attracted between impulses, a secondary magnet, and a secondary circuit effective for causing the operation of said secondary magnet upon retraction of the secondary relay armature when said impulses cease.

13. The combination with a metallic circuit telephone line, of selector and connector switches for extending the circuit thereof, a primary relay, a primary magnet and secondary relay for each of said switches, a multiple circuit for each of said switches including the windings of its primary magnet and secondary relay, means for operating said primary relay over said metallic circuit to transmit current impulses through the multiple circuits of the switches to cause their operation in extending the circuit of the line, one of the windings of each said pair being so related to the other that upon termination of each impulse a self-induced current flow traverses both windings to maintain the armature of the relay attracted between impulses, and a secondary circuit for each switch effective upon retraction of the armature of the associated secondary relay.

14. The combination with primary, secondary and release magnets, of a primary relay and a secondary relay, means for operating said primary relay for transmitting current impulses over a multiple circuit including the windings of said primary magnet and secondary relay, one of said windings being so related to the other that upon termination of each impulse a self-induced current flow traverses both the said windings to maintain the relay armature attracted between impulses, a circuit for said secondary magnet effective upon retraction of said armature upon cessation of the impulses, and circuit connections for operating said release magnet, also controlled by said primary relay.

15. A connector switch comprising primary and secondary magnets, and a secondary relay, a multiple circuit including the windings of said primary magnet and secondary relay adapted for receiving directive impulses, the windings of the last said magnet and relay being so related that upon termination of each impulse a self-induced current flow traverses both of said windings to maintain the armature of the relay attracted between impulses, and a secondary circuit adapted to be closed responsive to retraction of said armature upon cessation of the impulses whereby said primary magnet is replaced by said secondary magnet in multiple relation to the secondary relay to receive further impulses.

16. A connector switch including primary

and secondary magnets, and a secondary relay, a multiple circuit including the windings of said primary magnet and said secondary relay adapted for receiving directive impulses, the winding of said relay being so related to the winding of said magnet that upon termination of each impulse a self-induced current flow traverses both of the said windings to maintain the armature of the relay attracted between impulses, a secondary circuit adapted to be closed upon retraction of said armature upon cessation of the impulses, and a switching relay oper-

ated responsive to said secondary circuit closure whereby said primary magnet is replaced by said secondary magnet in multiple relation to the secondary relay to receive further directive impulses. 15

Signed by me at Chicago, county of Cook and State of Illinois, in the presence of two witnesses. 20

CHARLES S. WINSTON.

Witnesses:

G. E. MUELLER,
B. O'BRIEN.