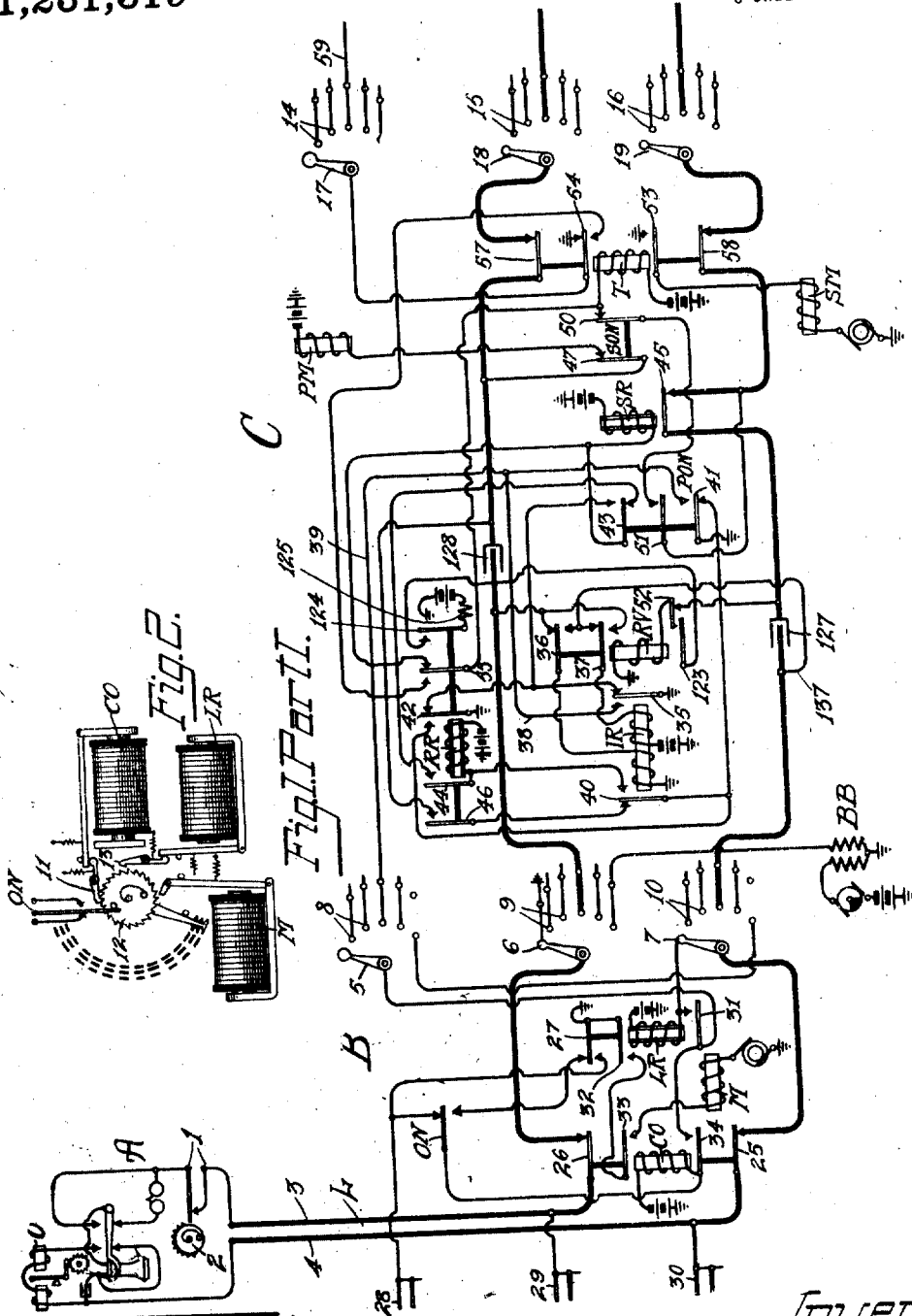


C. S. WINSTON.
AUTOMATIC TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 17, 1913.

Patented June 26, 1917.
3 SHEETS—SHEET 1.

1,231,319

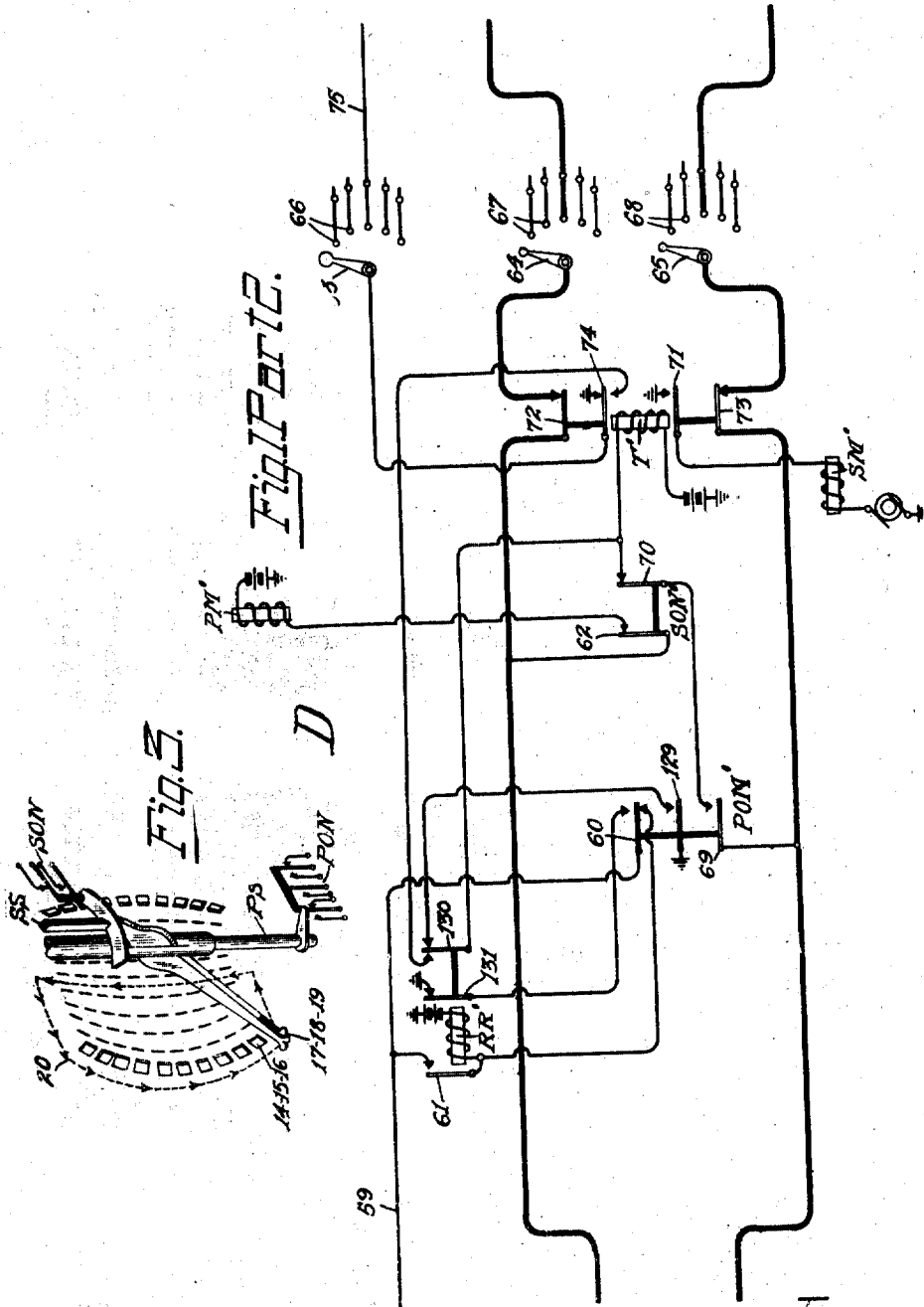


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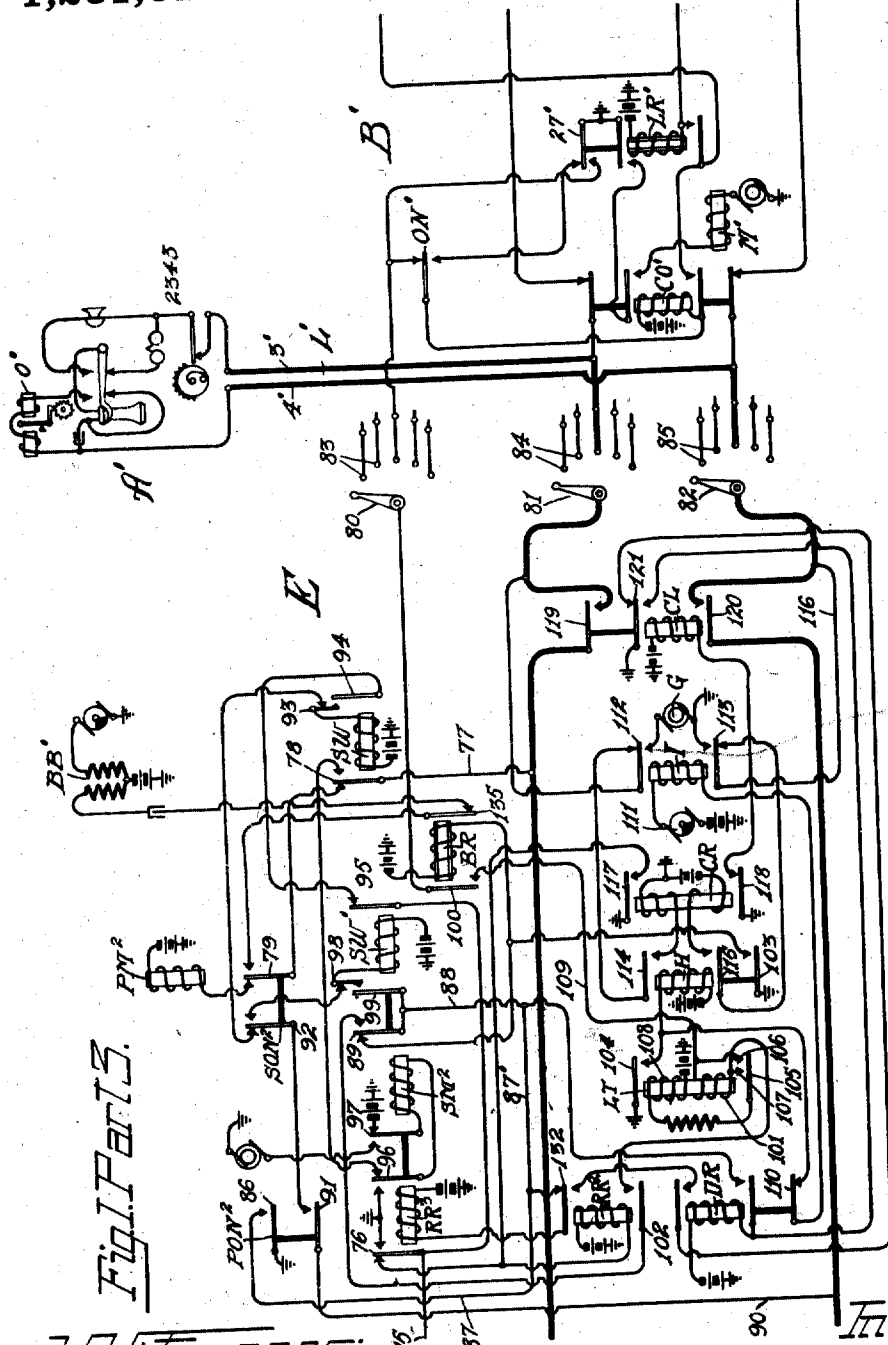


Fig. 1. PARTS.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,231,319.

Specification of Letters Patent. Patented June 26, 1917.

Application filed September 17, 1913. Serial No. 790,303.

To all whom it may concern:

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

My invention has to do with telephone systems employing automatic switches in interconnecting telephone substations, and relates more particularly to improved means for reversing the battery flow over a calling telephone line upon response being received from a called substation, my invention being more particularly applicable to so-called two-wire or metallic line systems.

One of the features of my invention is the provision of a battery reversing relay through which the so-called secondary impulses are transmitted, but which relay is preferably a marginal relay, and although such secondary impulses flow through this winding, this relay does not energize until a low resistance path is provided upon a response from the called substation, whereby the said relay operates to cause the reversal of the current flow over the calling telephone line.

For a better 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 an automatic telephone system embodying my invention;

Fig. 2 illustrates diagrammatically a mechanical structure for the individual line switch employed in the embodiment illustrated; and

Fig. 3 illustrates diagrammatically and in perspective the preferred contact bank and wiper arrangement of the directly operable selector and connector switches.

Referring now more in general to the circuit arrangement illustrated, calling and called substations A and A', respectively, are shown connected to individual or line switches B and B', by means of lines L and L'. Each line switch B is preferably arranged to have access to a plurality of first selector switches C, and I also provide second selectors D and connectors E.

The system illustrated is what is known as a 10,000 line system, and I preferably

provide each line with an individual switch, arranging the lines in groups of 100, and providing 10 first selectors C for each such group, thus making a total of 1000 first selectors for the system. The selectors are preferably of the 100 point type, having contact banks arranged in ten groups of 10 contact sets each, and multiplied to second selectors D, the trunking to the second selectors being on a basis of 10 per cent. which is the ordinary percentage employed so that 1000 second selectors D are provided. Continuing this basis of ten per cent. trunking, I provide 1000 connectors E which are multiply connected in a well-known manner to the bank contacts of second selectors D. This multipleing arrangement is so well known it is thought no further reference thereto need be made.

Referring now more particularly to the preferred embodiment of my invention as herein illustrated, the substations A may be of any common battery type and I have shown a well-known form of common battery substation having a calling device with interrupter contacts 1 connected in series with the line circuit and adapted to be operated by means of a dial 2 which is advanced by the operator until the proper number of teeth have passed the contact springs so that when the dial is released it is restored to normal interrupting the contacts 1 the desired number of times.

As already pointed out, my invention looks to means for reversing the battery flow over the calling line, and in order to illustrate the adaptability of my invention more clearly I have shown a polarized magnet O at the substation, which is adapted to be operated when the current flow is in the right direction, which occurs when the flow is reversed upon response from the called substation.

The substations are connected by means of line conductors 3 and 4 to a line switch B at the central office, the switch employed comprising a line relay LR, which is of a slow-acting type, a cut-off relay CO, motor magnet M, off-normal contacts ON, test wiper 5, line wipers 6 and 7, and cooperating contacts 8, 9, 10 respectively. As already referred to, I preferably provide ten per cent. trunking which in practice has been found to be sufficient for ordinary commercial use, and therefore the line switch

is provided with ten sets of bank contacts 8, 9, 10.

In Fig. 2, I have illustrated the preferred mechanical arrangement of the line switch B, like parts being indicated by like reference characters. With the switch in its normal position, the cut-off relay retaining pawl 11 engages the driving ratchet 12, while the line relay retaining pawl 13 is disengaged from said ratchet. When a call is initiated, the line relay LR is energized followed by the energization of the cut-off relay CO, these relays remaining energized during the selecting operation of switch B whereby pawl 11 is disengaged from ratchet 12, while pawl 13 is in engagement with said ratchet. Upon the selection of an idle trunk, cut-off relay CO restores but the line relay remains energized until a disconnection is desired, at which time the line relay is de-energized and the cut-off relay energized so that both retaining pawls are disengaged from the ratchet 12 whereby the wipers are permitted to restore to normal by spring tension.

Before proceeding with the description of the circuit arrangements of the selector and connector switches, I will describe briefly the preferred switch arrangement employed for these switches, this being illustrated in Fig. 3. As already outlined, the directive switches which include the selectors and connector, are preferably of a two-dimension 100 point type, there being 100 sets of contacts arranged in groups of ten contact sets 14, 15, 16 each, these contact sets being represented by a single element in the illustration as it is thought in this manner it will be as easily understood and without complicating the illustration. A set of wipers 17, 18, 19 are also provided for cooperating with said bank contacts, said wipers being supported by a primary shaft PS which is adapted to be rotated in a primary direction by means of a primary magnet PM and associated driving mechanism of a well-known type, to select a row or group of contacts. Thereafter a secondary shaft SS is adapted to be moved downwardly by means of a secondary magnet SM and a well-known form of ratchet and pawl mechanism, thereby rotating the wipers in their secondary adjustment to select a contact set of the selected group. The bank contacts 14, 15, 16 are arranged in arcuate radially disposed rows so that the wiper ends are rotated to select a row, and thereafter rotated to select a contact set in a row. Upon the first primary step of the switch, a primary off-normal switch PON which is provided, moves into its alternate position, while upon the first secondary step of the switch, a secondary off-normal switch SON which is provided, is moved to its alternate position.

Now as to the restoring operation, this

is what is known as a step-ahead release. That is, assuming the wipers have been advanced to select a set of contacts, to effect their restoration they are again advanced until they have reached a point beyond the last contact of the selected row at which time they are automatically restored in a horizontal rotary counter-clockwise direction until they have reached point 20 above their normal resting position, at which time they are restored downwardly to their normal resting position. The complete cycle or travel of the wipers is illustrated by the dotted line in Fig. 3, the arrows thereon indicating the direction of travel of the wipers but the degree of primary travel of course depends upon the row selected. Now as to the restoration of the off-normal switches, upon the restoration of the wipers to the point 20 on the dotted lines, the switch PON is restored and thereafter upon the wipers reaching their normal resting position the switch SON is restored.

It is thought that the above description of the switch mechanism is sufficient to give an understanding of the preferred mechanism employed but for a more complete understanding of this switch mechanism, reference may be had to an application of Wm. Kaisling for automatic switches Serial No. 600,664, Patent No. 1,131,140.

Referring now to the circuit arrangement of first selector C, a primary magnet PM is provided as is also a secondary magnet SM. An impulse relay IR which is adapted to be controlled over the metallic circuit of the line for transmitting primary impulses, is also provided together with a slow acting secondary relay SR which is adapted to bring about a secondary circuit change to set the secondary magnet SM in operation. The secondary selection of the switch is controlled by a test relay T and the release of the switch is controlled by a slow acting relay RR which is adapted to be energized when the impulse relay is initially energized, said release relay remaining energized as long as the impulse relay is vibrated at a predetermined rate. But upon a prolonged interruption of the circuit of RR it is adapted to retract its armature and thereby bring about the release of the switch. A reversing relay RV is also provided which relay has its winding included in circuit with relay T or other relays after each series of primary impulses are transmitted. This relay RV is of a comparatively low resistance while the relay T is of a comparatively high resistance so that the relay T will attract its armature when included in circuit with RV, but the relay RV will not. I have found that a resistance of 100 ohms for the reversing relay and a resistance of 1000 ohms for the test relay operate very well.

When a switch C is initially selected, the impulse relay IR is immediately energized over the calling line whereby both the slow acting relays RR and SR are also energized, both of said relays remaining energized during the rapid operations of IR in transmitting primary impulses. Upon cessation of such primary operations of IR, RR remains energized while IR is energized, but the secondary relay SR, due to a prolonged interruption of its energizing circuit retracts its armature and therefore establishes an energizing circuit for the test relay T through the winding of the reversing relay RV. Although the test relay T attracts its armature, relay RV does not receive sufficient current to attract its armature and therefore upon energization of T the secondary magnet SM advances the wipers until an idle trunk is engaged.

Now, as to the second selectors D, these are also provided with primary magnet PM¹, a secondary magnet SM¹, test relay T¹ and release relay RR¹, the primary impulses for this switch being transmitted from the impulse relay IR of the first selector, which relay IR serves as a repeating relay also. After the primary operation of switch D, its test relay T¹ is connected in circuit with the reversing relay RV of first selector C to bring about the secondary operation of switch D, but the relay T¹ being of a high resistance like the relay T, relay RV does not attract its armature although the test relay T¹ does and brings about the secondary operation of switch D.

Referring now to the connector switch E, a release relay RR² is provided which is adapted to be energized upon selection of its switch, a second release relay RR³ also being provided for the purpose of connecting the secondary magnet SM² in a release circuit when a release of switch E is desired. Primary and secondary magnets PM², SM², respectively are also provided as is also switching relay SW which is adapted to be connected in circuit with the reversing relay RV responsive to the secondary circuit change following the primary operation of the connector. The said relay SW is also of a high resistance so that although it will attract its armature, it will not permit sufficient current to flow through the reversing relay to bring about the operation thereof. Relay SW is adapted when energized, to disconnect the primary magnet PM² and connect the secondary magnet SM² in circuit with the primary conductor so as to be operated by the last set of primary impulses. Following the transmission of the last series of primary impulses, the reversing relay RV is connected in circuit with the second switching relay SW¹ which is also of a high resistance so that it will operate without permitting the operation of RV, this operation

of SW¹ being effective to connect the line test relay LT in circuit with the called line. A supplementary relay H is also provided which is energized or deenergized according to the condition of LT. If the line tested is idle the interrupter relay I is energized to alternately connect ringing current or the control relay CR in bridge of the called line. When a response is secured from the called substation, control relay CR, circuit closing relay CL and disconnect relay DR are energized. This connects the lower winding of the control relay CR in circuit with the reversing relay RV, but in this instance due to the low resistance of this lower winding of CR, the reversing relay is energized sufficiently to attract its armature and reverse the current over the calling line to operate the electromagnetic device O.

Should the called line tested be busy, then the slow acting busy relay BR which had been energized upon the initial step of switch E, retracts its armature and thus connects the busy back BB¹ in circuit with the calling line to notify the calling substation that the desired line is busy.

The called line L¹ and its switch B¹ are of course similar to the calling line, the like parts being indicated by like reference characters except for the addition of the suffix prime.

Operation.

Having described in general the characteristics of the preferred circuit and mechanical embodiment of my invention, its operation in establishing connection between a calling and a called line will now be described more in detail. Assuming that substation A desires to establish connection with substation A¹ whose number is 2343, the receiver at substation A is removed, thereby establishing an energizing circuit for the line relay LR traced from battery through the winding thereof, wiper 7, secondary conductor and normal contact 25, line conductor 4, through the substation A including the winding of polarized magnet O, conductor 3, normal contact 26, primary conductor and wiper 6 to ground. Relay LR therefore energizes causing check pawl 13 to engage the driving ratchet 12 while the closing of its alternate contact 27 places ground upon the test terminal 28 which appears at certain connectors together with the associated terminals 29, 30. Also upon the closing of alternate contact 27 a circuit is established through normal contact ON for cut-off relay CO causing its operation, whereby the circuit for motor magnet M is established from ground through alternate contacts 32, 33, and the winding of M to the alternate current generator. Responsive to the first current impulse through M, wipers 5, 6, 7, are

advanced into engagement with the first set of contacts 8, 9, 10 which, assuming they are busy, have a ground or busy potential upon their test contact 8. Therefore a holding circuit for relays LR and CO is established from ground at the engaged test terminal 8, wiper 5, alternate contact 31 and winding of LR to battery, and also through contact 34 and winding of CO to battery maintaining these two relays energized. Therefore the motor magnet M advances the wipers another step and in fact continues such advancement until the test wiper 5 reaches an idle set of contacts which we will assume is the third contact set leading to switch C. The test contact 8 of the idle set having no ground or busy potential connected thereto, the circuit for CO and LR is interrupted and CO being a quick acting relay immediately retracts its armature interrupting the circuit of M and rendering the wipers inert. Relay LR is a sluggish acting relay and therefore maintains its armature attracted until a locking circuit is provided from alternate contact 35 of IR which is brought about as follows:

Upon the said deenergization of CO following the selection of idle first selector C, the impulse relay IR is connected in bridge of the calling line establishing an energizing circuit therefor which may be traced from ground through the left winding thereof, normal contact 36, back over the primary conductor, contact 9 and wiper 6, normal contact 26, through substation A and its polarized magnet O, conductor 4, normal contact 25, wiper 7 and contact 10, normal contact 37 and the right end winding of IR to battery. Relay IR therefore attracts its armature closing alternate contact 35 and connecting ground over conductors 38, 39, to test contact 8 and wiper 5, alternate contact 31 and the winding of LR to battery maintaining LR energized. This ground connection to contact 8 also serves as a busy potential and thus prevents other line switches from selecting the trunk leading from the multiply connected contacts 8. Also responsive to the operation of IR, a circuit for release relay RR is established traced from battery through the winding of RR, alternate contact 40 to ground at normal contact 41, thus energizing RR whereby its alternate contact 42 is closed to serve as a holding circuit for RR and maintain alternate contact 40 grounded after switch C has stepped off-normal and normal contact 41 is interrupted.

Upon energization of RR, a circuit for the secondary relay SR is also established traced from battery through the winding of SR, normal contact 43, alternate contact 44 to ground at alternate contact 40 thus energizing SR to interrupt its normal con-

tact 45 and to prevent a premature operation of the test relay T.

Although current flows through magnet O first from battery then LR and then through IR, this flow is not in a direction to effectively operate magnet O.

The switch C is now in condition to receive the first set of primary impulses this being brought about by the operation of calling device 2 to interrupt contacts 1 two times, corresponding to the first digit of the called substation. Contacts 1 being included in the energizing circuit of IR, the two interruptions thereof are effective to cause two operations of the primary or impulse relay IR whereby two primary impulses are transmitted through primary magnet PM traced from ground at normal contact 40 upon each operation of IR, alternate contact 46, normal contact 47 of SON, and the winding of PM to battery. The ensuing two operations of PM are effective to advance wipers 17, 18, 19 two primary steps to select the second row of contact sets 14, 15, 16, which row leads to second selectors in the 2000 group. It will be noted that upon the first primary step of switch C, the initial energizing circuit of SR is interrupted at normal contact 43 of PON, but each time relay IR is deenergized, a holding circuit for SR is established from normal contact 35, alternate contact 43 and the winding of SR so that relay SR which is a sluggish acting relay maintains its armature attracted during the primary operations of IR.

Upon cessation of the first series of primary operations of IR, said relay is maintained energized through the calling line until the next operation of the calling device 2, this period of energization being sufficient to permit of the restoration of SR when its circuit is interrupted at normal contact 35. Relay SR therefore closes its normal contact 45 to bring about the secondary operation of the switch due to the establishment of an energizing circuit for test relay T traced from battery through the winding thereof, normal contact 50, alternate contact 51, normal contact 45, normal contact 52 and the winding of RV to ground. Due to the marginal difference between the operations of RV and T, sufficient current flows to operate relay T but not relay RV and therefore upon the closing of alternate contact 53, a circuit for secondary magnet SM is established whereby wipers 17, 18, 19 are advanced in their secondary adjustment to engage the first set of contacts 14, 15, 16 of the selected row.

Upon the first secondary step of the switch, the initial energizing circuit for T is interrupted at normal contact 50, but assuming the first contact set engaged leads

to a busy second selector D, a maintaining circuit for relay T is established from a ground or busy potential at the test contact 14 engaged, wiper 17, alternate contact 54, alternate contact 55, and the winding of T to battery maintaining said relay T energized so that the wipers 17, 18, 19 are stepped ahead until an idle set of contacts is reached. There being no busy potential upon the test contact of such an idle set, the maintaining circuit for T is interrupted causing it to retract its armature and thus interrupt the circuit from magnet SM. During the secondary travel of switch C, the talking wipers 18, 19 have their circuit interrupted at normal contacts 57, 58, of T, and upon the said deenergization of T normal contact 54 is again closed connecting a ground or busy potential through the wiper 17 to the connected test contacts 14 and thereby preventing any other switch from seizing the selected trunk. This ground connection to the seized test contact 14 is also effective to cause the energization of the release relay RR¹ of the second selector D, the circuit therefor being traced from said grounded contact 14, test conductor 59, normal contact 60, the winding of RR¹ to battery whereby said relay energizes and closes its alternate contact 61 to establish a locking circuit for itself independent of the off-normal switch contact 60.

The calling line has now had its circuit extended to the selected second selector D and the subscriber at A again operates the calling device 2, this time to effect the transmission of three impulses corresponding to the second digit of the number of the called substation. Responsive to the three primary operations of relay IR, relay SR is energized and maintained energized while three primary impulses are transmitted from the grounded normal contact 40, alternate contact 44, normal contact 57, wiper 18 and contact 15, primary conductor to switch D, normal contact 62 and the winding of PM¹ to battery causing three operations of said magnet PM¹ and effecting three primary steps of the associated wipers 63, 64, 65. The third row of contacts 66, 67, 68 is thus selected, which is the row having terminals of connector switches in the third hundred of the second thousand. Upon cessation of the three primary operations of IR, the circuit for SR being interrupted at normal contact 35 of IR, said relay SR deenergizes effecting the transmission of a secondary impulse through the test relay T¹ of switch D over a path traced from ground through the winding of RV, normal contact 52, normal contacts 45, 58, wiper 19 and contact 16, secondary conductor of switch D, alternate contact 69, normal contact 70 and the winding of T¹ to battery.

Relay T¹ therefore energizes and closes its alternate contact 71 whereby magnet SM¹ advances the wipers 63, 64, 65 into engagement with the first set of contacts 66, 67, 68 of the selected row. Assuming these contacts lead to a busy connector E, their test contact 66 has a ground or busy potential connected thereto thereby providing a maintaining circuit for the test relay T¹ because said relay T¹ had its initial energizing circuit interrupted at normal contact 70 of SON¹ on the first secondary step of the switch. Therefore, relay T¹ remaining energized, the wipers are advanced until an idle set of contacts is reached. There being no ground or busy potential upon the test contact 66 of the idle set, the maintaining circuit for T¹ is interrupted causing its deenergization and rendering the wipers inert.

During the secondary travel of switch D, its talking wipers 64, 65 have their circuit interrupted at normal contacts 72, 73 which circuit is again closed upon deenergization of T¹. Also, upon deenergization of T¹ its normal contact 74 is closed connecting a ground or busy potential to the multiply connected test contacts 66 of the selected contact set, this ground also being effective to cause the energization of release relay RR² of the selected connector E, the energizing circuit being traced from said grounded test contact 66 over test conductor 75, normal contact 76 and the winding of RR² to battery. Relay RR² is therefore energized but without any immediate effect upon the circuits.

The calling line having had its circuit extended, to an idle connector E, the next step in extending the connection is effected by the third operation of calling device 2 to cause the transmission of four primary impulses corresponding in number to the third digit of the number of the called substation. Responsive to the four primary operations of IR, which are effected by the said third operation of calling device 2, secondary relay SR is energized and maintained energized in a manner as before described while four primary impulses are transmitted from grounded normal contact 40 over primary conductor to connector switch E then following a path over branch conductor 77, normal contacts 78, 79 and the winding of PM² to battery causing four operations of said primary magnet whereby the associated wipers 80, 81, 82, are advanced four steps to select the fourth row of contacts 83, 84, 85, which row includes the terminals of the wanted line.

Upon the first primary step of connector E, alternate contact 86 of PON² is closed establishing an energizing circuit for the busy relay BR traced from said grounded contact 86, conductors 87, 87¹, conductor 88,

normal contact 89, and the winding of BR to battery, said relay BR thereby energizing but without any immediate effect upon the circuit.

- 5 Following the said four primary operations of IR, the associated secondary relay SR deenergizes as before whereby a secondary circuit change is brought about to effect the energization of switching relay
- 10 SW of connector E the energizing circuit for SW being established over a path traced from ground through the winding of RV, normal contacts 52, 45, over the secondary conductor to the secondary conductor of
- 15 connector E, branch conductor 90, alternate contact 91, normal contacts 92, 93, and the winding of SW to battery whereby relay SW energizes and establishes a locking circuit for itself through alternate contact 94, normal contacts 95, 76, to grounded test conductor 75. The operation of SW is effective to disconnect PM² and connect SM² to the primary conductor of switch E due to the operation of alternate contact 78.
- 25 The subscriber at substation A now operates the calling device 2 to effect three operations of the impulse relay IR, corresponding to the last digit of the number of the called substation. Responsive to the
- 30 three operations of IR, the associated secondary relay SR is energized and maintained energized as before and three primary impulses are transmitted from the grounded normal contact 40 and over the primary conductor to connector E, branch
- 35 conductor 77, alternate contact 78, normal contact 96, winding of SM² to battery at normal contact 97. These three primary impulses cause three operations of the secondary magnet SM² whereby the wipers 80,
- 40 81, 82, are advanced three secondary steps to engage the third set of contacts 83, 84, 85, which contacts are the terminals of the wanted line.
- 45 Following the last three operations of IR, relay SR deenergizes as before whereby a secondary impulse is transmitted from ground through RV and over the secondary conductor to connector E, branch conductor
- 50 90, alternate contacts 91, 92, normal contact 98 and the winding of SW¹ to battery. This circuit permits the operation of relay SW¹ but sufficient current does not flow to operate RV, therefore SW¹ operates to attract its armature and interrupts its normal contact 95,
- 55 restoring the other switching relay SW. At the same time alternate contact 99 of SW¹ is closed whereby a locking circuit for SW¹ is established over conductors 88, 87¹, 87
- 60 to ground at normal contact 86. Also, responsive to the operation of SW¹ its normal contact 89 is interrupted to open the energizing circuit for relay BR but said relay, being a slow acting relay is able to
- 65 maintain its armature momentarily attract-

ed, or with the called line idle, until a substitute holding circuit therefore is provided as will be described. Responsive to the closing of alternate contact 89 of SW¹, line test relay LT is connected in circuit with the test contact 83 of the called line. From this point on the operation of connector E differs depending upon whether the line connected with is in an idle or busy condition.

Called line idle.

Assuming that the called line is idle, its associated test contacts 83 have no busy potential connected thereto and are connected through cut-off relay CO¹ to battery. Therefore following the energization of relay SW¹, the relay LT is energized over a path from battery including the winding of CO¹, normal contact ON¹, contact 83, and wiper 80, alternate contact 100 of BR, winding 101 of LT, alternate contacts 102, 89, conductors 88, 87¹ and 87 to ground at 86. Relay LT therefore energizes causing the immediate energization of its supplementary relay H whereby alternate contact 103 of H is closed to establish a holding circuit for relay BR before it has had time to retract its armature and thereby preventing the relay BR from connecting busy back BB¹ with the calling line. Also responsive to the operation of LT, its alternate contacts 105, 106, 107, are closed short-circuiting the winding 101 but connecting the holding winding 108 through alternate contacts 105 and 107, to alternate contacts 102, 89, conductors 88, 87¹, 87 to ground at 86, this ground connection also extending through alternate contact 106 and conductor 109 through the winding of the cut-off relay CO¹ to battery, also maintaining this relay energized.

The closing of alternate contact 104 of LT also establishes a circuit for interrupter relay I through normal contact 110 and the interrupter 111, so that relay I is alternately energized and deenergized operating its contacts 112, 113. The closure of alternate contacts 112, 113 connects the ringing generator G in bridge of the called line so as to ring the call bell at substation A¹, while upon each closure of normal contacts 112, 113, the control relay CR is connected in bridge of the called line through alternate contacts 114, 115, of relay H. As long as the receiver is upon the switch-hook at the called substation, no direct current is permitted to flow through said substation on account of the interposed condenser and therefore the energization of CR is prevented until a path for direct current is provided when the receiver at substation A¹ is removed.

The subscriber at substation A¹ now removes his receiver from its switch-hook in response to the signal, thus providing an

energizing path for control relay CR from ground through the upper winding thereof, alternate contact 114, normal contact 112, wiper 81 and contact 84, conductor 3¹, substation A¹ including polarized magnet O¹ returning over conductor 4¹, contact 85 of wiper 82, conductor 116, normal contact 113, alternate contact 115 and the lower winding of CR to battery energizing CR by current over the called line. Alternate contact 117 of CR is thereby closed establishing a holding circuit for RR² and thus placing the control of this relay RR² under the called substation. Upon the closing of alternate contact 118 of CR, a circuit for closing relay CL is established whereby said relay energizes closing its alternate contacts 119, 120 and thereby establishing a continuity of the talking conductors between the two substations.

Upon energization of CL its alternate contact 121 is closed establishing an energizing circuit for disconnect relay DR whereby normal contact 110 of DR is interrupted rendering interrupter relay I inert.

The direction of current flow over the called line and through the polarized magnet O¹ of its substation, is such that the armature of O¹ is attracted toward the left so that no effective operation of the register occurs.

As already referred to, upon a response being secured from the called substation, the direction of current flow over the calling line is reversed, this being brought about by the inclusion of the reversing relay RV in circuit with the lower winding of CR at the time relay CL energizes. This circuit may be traced from ground through the winding of RV, normal contact 52, over the secondary conductor to connector E, alternate contact 120 of CL, conductor 116, normal contact 113, alternate contact 115, and the lower winding of CR to battery. This lower winding of CR is of a low enough resistance to permit sufficient current to flow through RV to cause the attraction of its armature so that relay RV operates establishing a locking circuit for itself through contacts 52, 123, alternate contact 124, resistance 125 to battery. Also responsive to the operation of RV, its alternate contacts 36, 37 are closed whereby the connection from battery through IR to the calling line is reversed, thus causing the operation of the polarized magnet O at the calling substation. It will be noted that relay RV is now locked up through RR, and due to the fact that RR is maintained energized by a control over the calling line, it will be apparent that this reverse flow is maintained until a release of the connection is brought about, so that it is impossible to effect more than one operation of the magnet O for each connection.

The connection between calling and called

substations has thus been established, the talking circuit being traced over the heavily marked conductors, talking battery being supplied to the calling substation through the windings of relay IR while talking current is supplied to the called substation through the windings of control relay CR. Interference between these battery supplies is prevented by the interposed condensers 127, 128, at first selector C, thus also permitting of separate control of the relays in the two ends of the talking circuit. It is of course to be understood that the plurality of batteries shown may be one and the same.

Release.

Now as to the release of the apparatus employed in a connection, I have preferably arranged the present embodiment of my invention so that the control of the release of switches B, C and D, of an established connection is with the calling substation, while the release of the connector E is under the control of the called substation.

Assuming now that the subscriber at the calling substation is the first to replace his receiver upon its switch-hook, the circuit for relay IR is interrupted causing its restoration and thereby interrupting the holding circuit for relay RR at alternate contact 40. Relay RR therefore restores, interrupting its alternate contact 124 and thus interrupting the holding circuit for RV, while the closing of normal contact 55 on RR establishes an energizing circuit for relay T which may be traced from battery through the winding of T, normal contact 55, alternate contact 43 and normal contact 35 to ground. This ground connection from 35 through alternate contact 43 incidentally causes the energization of SR. Relay T thus is energized to interrupt its contacts 57, 58 before the reversing relay can again be energized over the secondary conductor, while the closing of alternate contact 53 of T establishes an energizing circuit for SM whereby wipers 17, 18, 19 are advanced beyond the last contact of the selected row from which point they are automatically restored to normal over the path indicated by the dotted line in Fig. 3, as already described. Upon interruption of alternate contact 43 of PON, upon the restoration of switch C, the circuit for relays T, and SR is interrupted allowing the restoration of these relays and thus switch C is at normal.

Upon interruption of alternate contact 41 of PON in the restoration of switch C, the holding circuit for line relay LR of B is interrupted, permitting the restoration of LR whereby the closing of its normal contact 27 establishes an operating circuit for CO through alternate contact ON. Thus relay LR being deenergized and relay CO energized, both the check pawls 11, 13 are out

of engagement with the ratchet 12 and therefore the wipers are permitted to restore to normal interrupting alternate contact ON whereby relay CO is again at normal and switch B is now available for use in extending other calls.

Now as to the restoration of second selector D, it will be remembered that its release relay RR¹ was maintained energized through its alternate contact 61, test conductor 59 and back to ground at normal contact 54 of relay T, switch C. Therefore when relay T energizes in the restoration of switch C, this holding circuit for RR¹ is interrupted at normal contact 54 allowing the restoration of RR¹. A release circuit for switch D is thereby established traced from ground at alternate contact 129 of PON¹, switch D, normal contact 130, and the winding of T¹ to battery. Relay T¹ is thus energized closing its alternate contact 71 and thereby establishing an operating circuit for SM¹ whereby wipers 63, 64, 65 are advanced to bring about their restoration to normal in a manner as previously described. It will be noted that during the restoration of switch D, a ground or busy potential is maintained upon the test conductor 59, its multiply connected test contacts 14, from ground at normal contact 131 of RR¹ through alternate contact 60. Upon restoration of switch D, and the interrupting of alternate contact 129 on PON¹, the circuit for T¹ is interrupted causing its restoration and thereby rendering SM¹ inert. Switch D is now available for use in establishing other connections.

Referring now to the release of connector E, when the receiver is replaced upon its switch-hook at substation A¹, the circuit for relay CR is of course interrupted causing the restoration of CR and the interruption of its alternate contact 118 which causes the deenergization of relay CL. At the same time alternate contact 117 of CR is interrupted thus interrupting the holding circuit of relay RR² whereby it restores to normal closing its normal contact 132 and establishing an energizing circuit for RR³, from ground at alternate contact 86 of PON². The energization of RR³ is effective to bring about the release of switch E through the operation of SM² by the closing of alternate contacts 96, 97.

Also responsive to the restoration of RR², and due to the interruption of its alternate contact 103, the holding circuit for relays LT and CO¹ is interrupted, as it will be remembered that these two relays were maintained energized over a holding circuit including this alternate contact 102, over a previously described path to ground at alternate contact 86 of PON². Relays LT and CO¹ therefore restore to normal, the

restoration of CO¹ placing the called line in condition for further use.

Due to the interruption of alternate contact 104 of LT, relay H of course also restores whereby its alternate contact 103 is interrupted permitting the restoration of BR. During the restoration of switch E, relays RR³ and DR are maintained energized from ground at alternate contact 86 of PON², so that upon interruption of this contact 86, said relays RR³ and DR are restored. Switch D being at normal is again available for use in establishing other connections.

Called line busy.

Having described the operation of the system when connection is established to an idle called line, the operation thereof will now be described when connection is made with a busy called line. As already pointed out the operation of the apparatus in the course of establishing a connection is the same up to the transmission of the final secondary impulse and the consequent energization of SW¹, whether connection is made to an idle or a busy line.

It will be remembered that up to and including the transmission of this last secondary impulse, relays RR² SW¹ and BR are energized, relay SW¹ having been energized by the last secondary circuit change and by the closing of its alternate contact 89 has connected the lower winding of LT in circuit with the test contact 83 of the called line. Assuming that the called line is busy, its test terminal 83 will have a ground or busy potential connected thereto either through alternate contact 27¹, if the line be calling or from a connector switch if the line be a called line. Therefore no energizing circuit is established for the line test relay LT because both terminals of its winding 101 are connected to ground potential. Therefore its supplementary relay H does not energize and of course no holding circuit for busy relay BR is established. Therefore said relay BR restores interrupting its alternate contact 100 to open the circuit of the test wiper 80, while the closing of its normal contact 135 connects busy back BB¹ in circuit with the calling line thereby transmitting a characteristic busy signal to the calling substation. This busy signal flows over a path traced from BB¹, normal contact 135, alternate contact 79, normal contact 78, back over the primary conductor and out over the calling line and through the receiver of its substation, returning over the secondary conductor to switch C and over conductor 137, normal contact 37, and the winding of IR to battery and ground.

The calling subscriber in response to this signal will of course replace his receiver

upon its switch-hook thereby causing the restoration of IR and bringing about the restoration of all the apparatus employed in the connection.

5 Upon restoration of IR, switches C, B, and D, are restored to normal in a manner as previously described, but in this instance the connector switch E is also restored.

10 It will be remembered that due to the connection having been established with a busy line, relay CR did not energize to close its alternate contact 117 and therefore no additional holding circuit for RR² was provided whereby said relay RR² was maintained energized back through the grounded test conductor 75. Therefore when ground was removed from this conductor 75, due to the interruption of normal contact 74 of relay T¹ at second selector D, release relay RR² restores to normal closing its normal contact 132 whereby an energizing circuit for RR² is established in a manner as before described and thus bringing about the operation of SM² and the restoration of connector E.

25 It will be noted that when connection is made with a busy called line, the reversing relay RV does not operate and therefore no reversal of current flow over the calling line is effected, in which case the magnet O at the calling substation does not effectively operate.

30 In illustrating my invention I have shown a plurality of batteries, this method being followed for the sake of simplification but I contemplate using one common source of current. Also it is to be understood that a single alternating current generator for driving the operating magnets is the preferred arrangement. Although I have embodied my invention in a straight automatic telephone system, I contemplate applying it in other ways and therefore I do not desire to be limited to the exact structure as shown and described.

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

1. A telephone system comprising a calling telephone line, a source of current connected to said line, automatic switches for extending the circuit of said line, a called line, means for producing impulses for controlling the operation of said switches for extending the circuit of the calling to the called line, a marginal reversing relay included in direct circuit of certain of said impulses, means to prevent effective operation of said relay when so included, an electromagnet, and means effective upon response of the substation of the called line for operating said reversing relay to reverse the current connections to the calling line to operate said electromagnet.

2. A telephone system comprising a calling telephone line, a source of current connected to said line, automatic switches for extending the circuit of said line, a called line, means for producing impulses for controlling the operation of said switches in extending the circuit of the calling to the called line, a reversing relay included in circuit of certain of said impulses, said circuit including sufficient resistance to prevent operation of said relay, mechanism, and means controlled over the called line for causing the operation of said reversing relay to reverse the current connection to the calling line to operate said mechanism.

3. A telephone system comprising a calling telephone line, a source of current connected to said line and flowing thereover, automatic switches for extending the circuit of said line, a called line, means for producing impulses for controlling the operation of said switches for extending the circuit of the calling to the called line, a reversing relay included in the direct circuit of certain of said impulses, means to prevent effective operation of said relay when so included, electromagnetic means, and means controlled over the called line for causing the operation of said reversing relay to reverse the current flow over the calling line to operate said electromagnetic means.

4. A telephone system comprising a calling telephone line, a source of current connected to said line, automatic switches for extending the circuit of said line, a called line, means for producing primary and secondary impulses for controlling the operation of said switches for extending the circuit of the calling to the called line, a reversing relay included in circuit of each secondary impulse, said circuit including sufficient resistance to prevent effective operation of the said reversing relay, an electromagnet, and means effective upon response from the substation of the called line for operating said reversing relay to reverse the current connection to the calling line to effectively operate said electromagnet.

5. A telephone system comprising a calling telephone line, a source of current connected to said line and flowing thereover, automatic switches for extending the circuit of said line, a called line, means for producing primary and secondary impulses for controlling the operation of said switches in extending the circuit of the calling to the called line, a single wound reversing relay included in circuit of each secondary impulse, means to prevent effective operation of said relay when so included, electromagnetic means and means for causing the operation of said reversing relay to reverse the current flow over the calling line upon re-

sponse from the substation of the called line to operate said electromagnetic means.

6. A telephone system comprising a calling telephone line, a source of current connected to said line, an impulse relay included in said connection, a called line, automatic switches adapted for interconnecting said lines, a calling device at the substation of the calling line for operating said impulse relay, means for producing primary and secondary impulses responsive to the said operation of the impulse relay for controlling the operation of said switches for interconnecting said lines, a marginal reversing relay included in direct circuit of each secondary impulse, means to prevent effective operation of said reversing relay when so included, electromagnetic mechanism, and means controlled over the called line for causing the operation of said reversing relay to reverse the current connections to the calling line to operate said electromagnetic mechanism.

7. A telephone system comprising a calling telephone line, a source of current connected to said line and flowing thereover, an impulse relay included in said connection, a called line, automatic switches adapted for interconnecting said lines, a calling device at the substation of the calling line for operating said impulse relay, means for producing primary and secondary impulses responsive to said operation of the impulse relay for controlling the operation of said switches for interconnecting said lines, said primary impulses being equal in number to the number of impulses transmitted by said calling device, a reversing relay included in circuit of each secondary impulse, means to prevent effective operation of said reversing relay when so included, an electromagnet, and means effective upon response of the substation of the called line for operating said reversing relay to reverse the current flow over the calling line to operate said electromagnet.

8. A telephone system comprising a calling telephone line, a source of current connected to said line, a called line, automatic switches adapted for interconnecting said lines, means for producing primary and secondary impulses for controlling the operation of said switches for interconnecting said lines, secondary-impulse-operated control relays for said switches, a reversing relay, means for including said reversing relay and one of said control relays in circuit of each of said secondary impulses, means to prevent effective operation of said reversing relay when so included, mechanism, and means controlled over the called line for operating said reversing relay to reverse the current connections to the calling line to effect said mechanism.

9. A telephone system comprising tele-

phone lines, selector and connector switches for interconnecting said lines, reversing relays for the selectors, control relays for the connectors for furnishing transmitter currents to the called lines, electromagnetic means, and circuit connections effective upon a response from a called substation for including the windings of the reversing and control relays in circuit whereby said reversing relay is operated to reverse the battery connection to the calling line to operate said last means.

10. A telephone system comprising telephone lines, selector and connector switches for interconnecting said lines, reversing relays for the selectors, control relays for the connectors for furnishing transmitter currents to the called lines, circuit connections effective upon a response from a called substation for including the windings of the reversing and control relays in circuit whereby said reversing relay is operated to reverse the battery connection to the calling line to operate an electromagnet, and means for disconnecting the reversing relay from the control relay upon its operation and placing said reversing relay under control of the calling substation.

11. A telephone system comprising telephone lines, automatic switches for interconnecting a calling and called line, means for producing impulses for operating said switches to effect such connection, a single wound reversing relay included in circuit of certain of said impulses, means to prevent effective operation of said relay when so included, electromagnetically controlled mechanism, means active upon response from the called substation for operating said reversing relay to reverse the battery connections to the calling line to operate said mechanism, and circuit connections for placing said reversing relay when so operated under control of the calling line.

12. A telephone system comprising telephone lines, automatic switches for interconnecting a calling and called line, means for producing primary and secondary impulses for operating said switches to effect such connection, a reversing relay included in circuit of each secondary impulse, an electromagnet, means to prevent effective operation of said relay when so included, means active upon response from the called substation for operating said reversing relay to reverse the battery connections to the calling line to operate said electromagnet, and circuit connections for placing said reversing relay when so operated under the exclusive control of the calling line.

13. A telephone system comprising telephone lines, automatic switches for interconnecting a calling and called line, means for producing primary and secondary impulses for operating said switches to effect

such connection, secondary-impulse-operated control relays for said switches, a reversing relay, means for including said reversing relay and a control relay in circuit of said secondary impulses, the resistance of the control relay being sufficient to prevent an effective operation of the reversing relay, mechanism means controlled over the called line for operating said reversing relay to reverse the battery connections to the calling line to cause an operation of said mechanism, and circuit connections for placing said reversing relay when so operated under control of the calling line.

14. A telephone system comprising a calling and a called telephone line, automatic means for connecting said lines, means located at the calling substation for producing impulses for operating said automatic means to effect such connection, a reversing relay included in the direct circuit of certain of said impulses, means to prevent the operation of the said relay when so included, electromagnetically controlled means, and means operated upon response from the said

called line for operating said reversing relay to reverse the battery connections to the calling line to operate said electromagnetically controlled means.

15. A telephone system comprising a calling and a called subscriber's line, automatic switches for connecting said calling and said called line, means for interrupting the calling subscriber's line circuit for operating said switches to effect such connection, a reversing relay provided with a winding included in the direct path of certain of said impulses, an electromagnet, and means effective upon response from the said called line for effectively energizing said reversing relay to reverse the battery connection to the said calling line to operate said electromagnet.

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

CHARLES S. WINSTON.

Witnesses:

GEORGE E. MUELLER,
M. R. ROCHFORD.