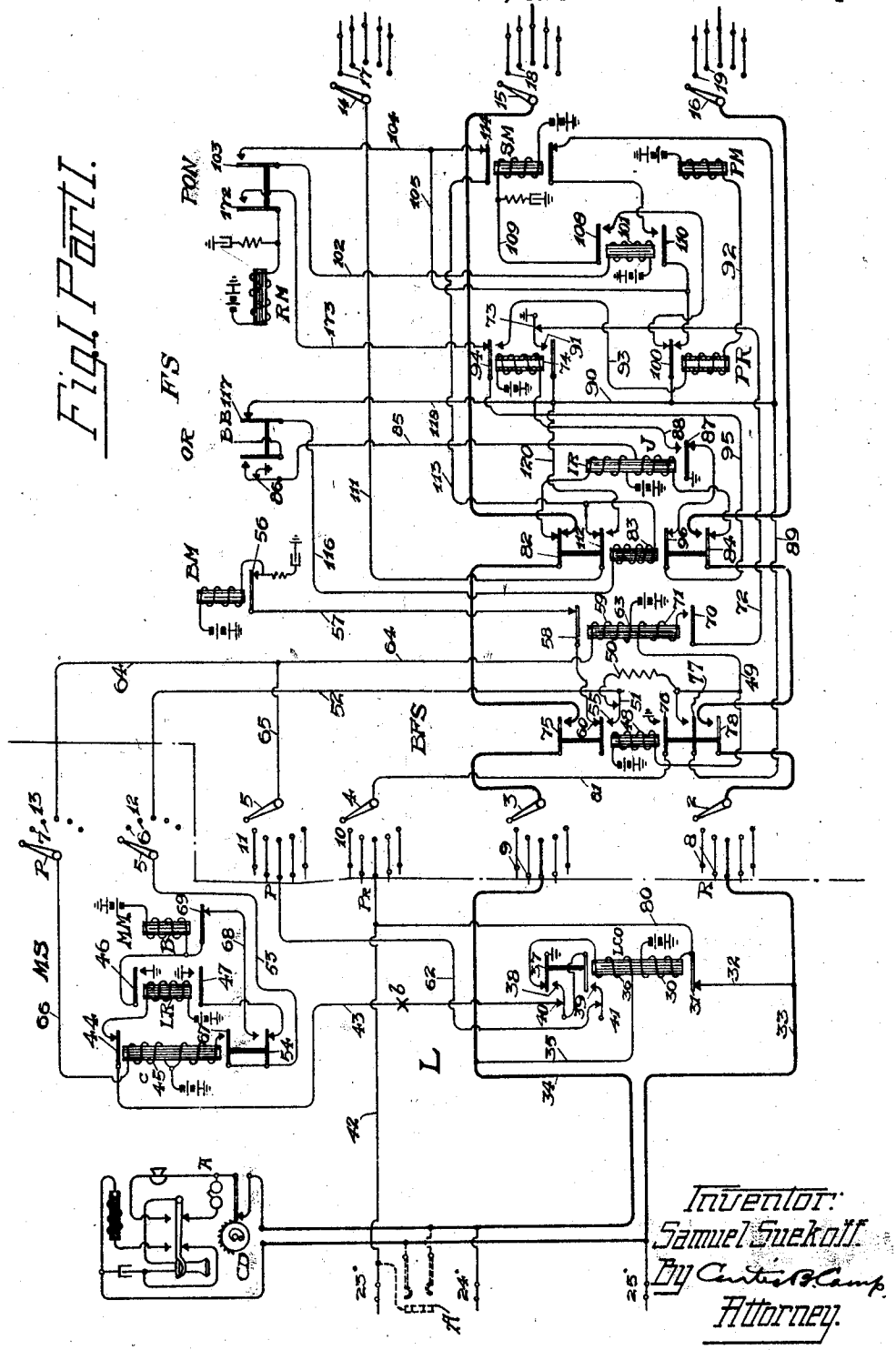
Feb. 24, 1925. 1,527,612

S. SUEKOFF

TELEPHONE SYSTEM

Filed Jan. 6, 1921 3 Sheets-Sheet 1



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TELEPHONE SYSTEM

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3 Sheets-Sheet 2

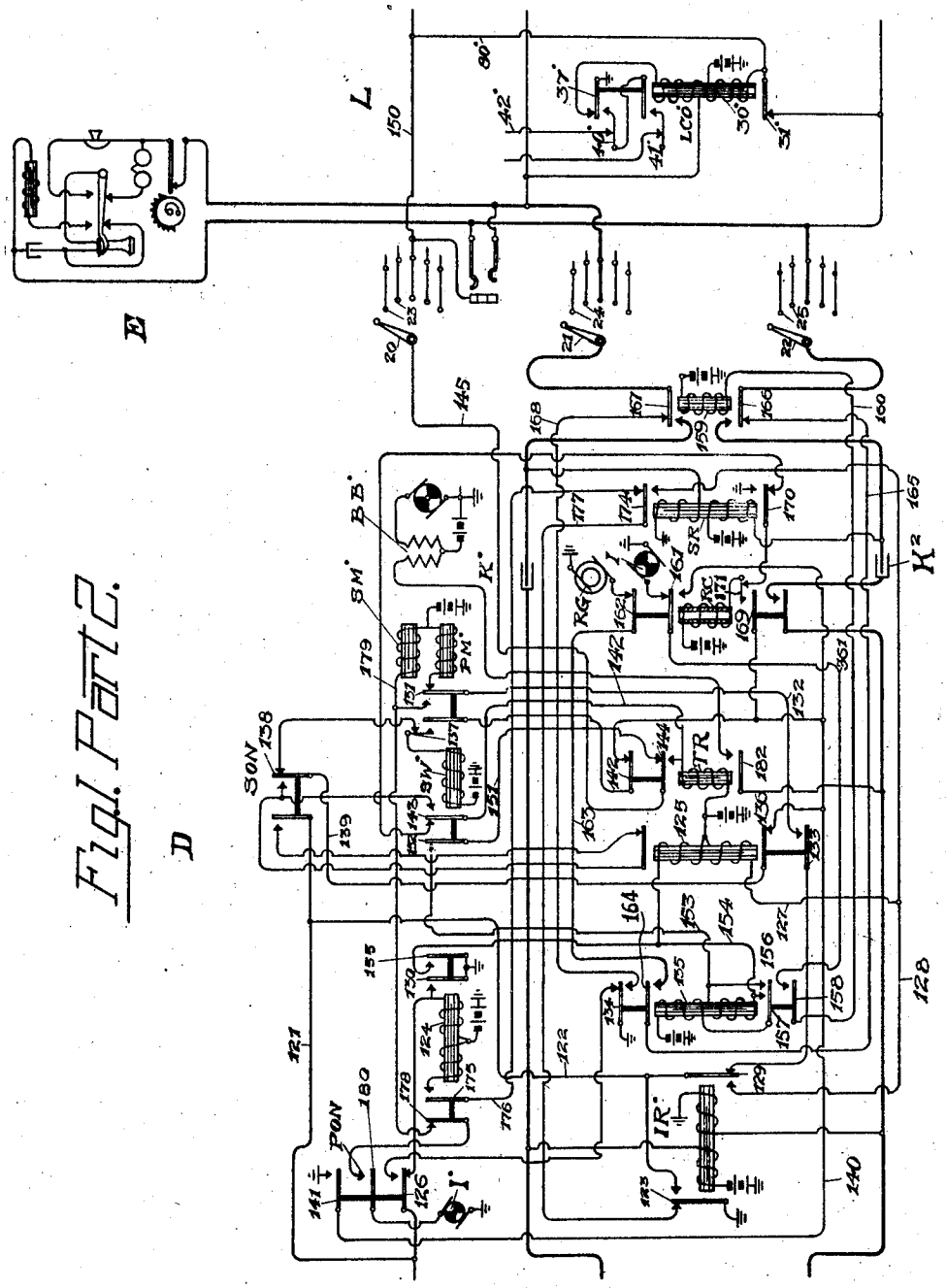

Fig. Part 2.

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TELEPHONE SYSTEM

Filed Jan. 6, 1921 3 Sheets-Sheet 3

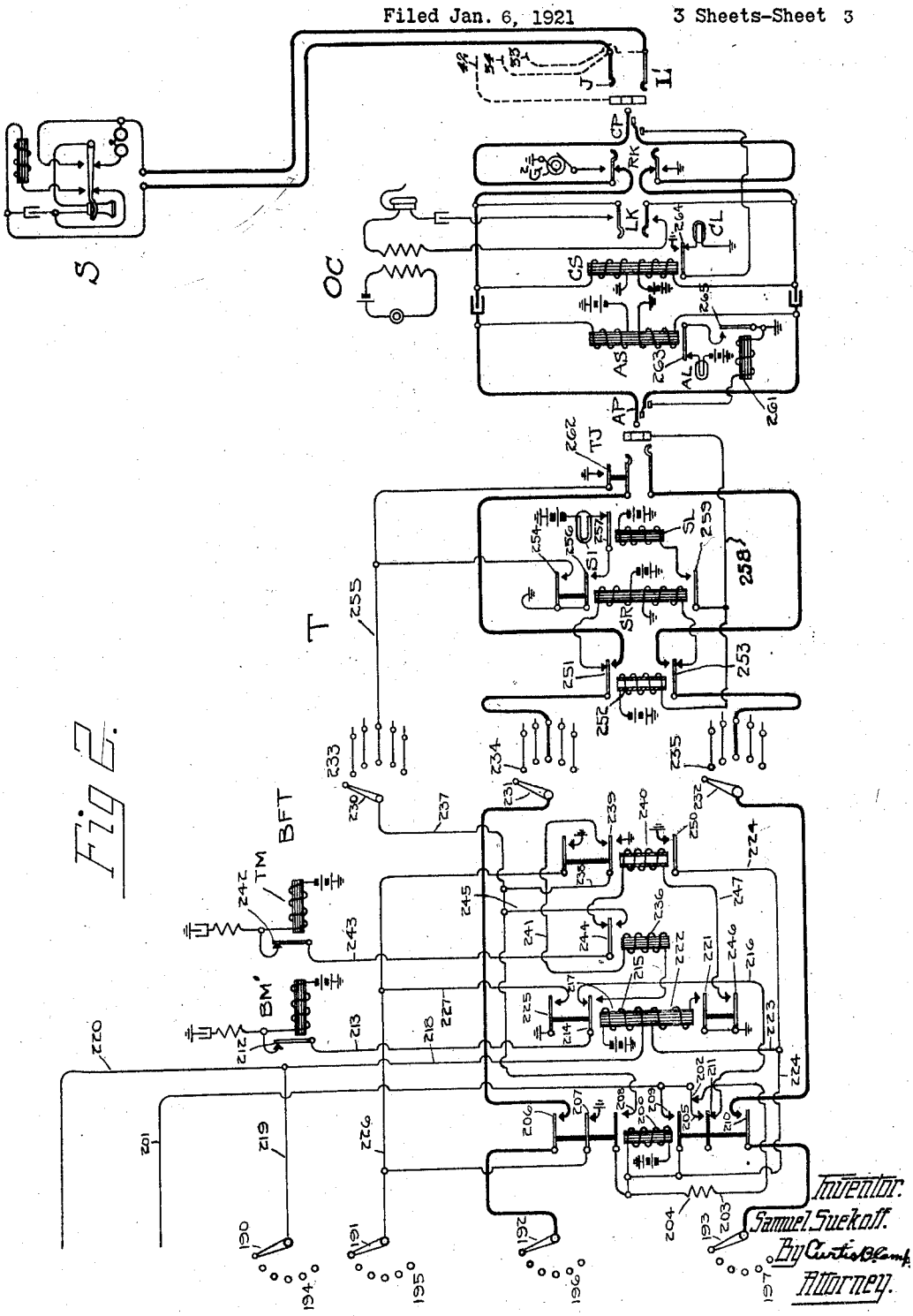

Fig 2.

Patented Feb. 24, 1925. 1,527,612

UNITED STATES PATENT OFFICE.

SAMUEL SUEKOFF, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed January 6, 1921. Serial No. 435,306.

To all whom it may concern:

Be it known that I, SAMUEL SUEKOFF, a citizen of the United States of America, residing at Chicago, in the 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 automatic selecting telephone systems, including one in which switches at the exchange are directively operated responsive to a series of rapid interruptions of the subscribers' line circuits.

One object of my invention is to provide such a system as above outlined, having improved and simplified circuit arrangements which are most positive in operation and simple in construction.

A feature of my invention is the provision of an improved and simple line circuit of the one relay type. At one time the relay is only partially energized to close a part only of the contacts associated with the relay, and at another time it is fully energized to actuate all of the contacts to bring about circuit changes to allow the further functioning of the apparatus.

Another feature of my invention is the provision of an improved back selector and an improved first selector in association with an improved master switch, which back selectors when a call is initiated selects the terminals of the calling line and the first selector is thereafter actuated by directive impulses from the calling line to select a group and then an idle set of contacts leading to an idle first selector or an idle connector, as the case may be, depending upon the size of the exchange.

Still another feature of my invention is the provision of an improved back selector and trunk selector which may be used in association with a semi-automatic system, in which case the back selector and trunk selector, when a call is initiated, operate respectively to select the terminals of the calling line and an idle trunk terminating before an operator's position at an exchange switchboard.

The novel features above outlined and the further features not specifically referred to above will appear from the detailed description in connection with the accompanying drawings, in which a preferred embodiment of the invention is shown, and in which—

Fig. 1, which comprises parts 1 and 2, illustrates diagrammatically an automatic telephone system constructed in accordance with my invention; and

Fig. 2 illustrates my improved back selector and trunk selector, and may be placed on Fig. 1, part 1, at the dotted line to illustrate a complete system.

Referring now to Fig. 1, part 1, to the left I illustrate a calling substation A with the usual apparatus, and in addition I provide it with a calling device CD. The substation A connects at the exchange with a line circuit L, comprising a combined line and cut-off relay LCO, which is of the unbalanced differential type, that is, the differential windings 30 and 36 are of different energizing values so that when the subscriber in initiating a call closes a circuit through the two windings in series, only a partial actuation of the relay LCO is brought about due to the difference in the values of the two windings 30 and 36, which are then opposed, and only certain of the contact springs of the relay LCO are moved to bring about circuit changes. Thereafter, and by different means, the relay is fully actuated to operate all of its spring contacts to bring about further circuit changes, all of which will be more fully hereinafter described.

The back selector comprises the magnet BM, which when energized is adapted to step the line wipers 2 and 3, private wiper 4 and pick up wiper 5 in a rotary direction over line contacts 8 and 9, private contacts 10 and pick up contacts 11, respectively, to select the contacts of the calling line and its circuit is then interrupted to prevent further actuations. The first selector comprises an impulse relay IR which is energized when the wipers 2, 3, 4 and 5 have selected the calling line terminals 8, 9, 10 and 11 and is adapted to receive impulses from the calling substation A to operate the selector by means of a primary magnet PM, adapted to be operated by impulses from the said relay IR to step the wipers 14, 15 and 16 of the selector in a primary direction to select a group of contacts containing contacts leading to the connector D. A

secondary magnet SM is provided which, when energized and de-energized, steps the wipers 14, 15 and 16 in a secondary direction to seek an idle set of contacts 17, 18 and 19 leading to an idle connector as D. The selector is also provided with a release magnet RM, which magnet brings about the release when disconnection is desired. Primary off-normal contacts PON are provided which assume their alternate position upon the first step of the wipers 14, 15 and 16 off normal, and a set of overrun contacts are also provided which assume their alternate position upon the eleventh step of the said wipers and serve to connect the busy-back apparatus BB and bring about the release of the selector if all contacts of the selected group are busy.

For each group of one hundred lines ten pairs of back selectors and first selectors FS are provided and a master switch MS. Each master switch MS is controlled by any of the hundred lines with which it is associated, it being adapted to start an idle selector BFS to seek a calling line upon initiation of a call. The master switch MS may be a simple non-restoring type rotary selector of a type well known in the art. The motor magnet MM, upon operation through the agency of a ratchet and pawl mechanism, steps the wipers 6 and 7 over contacts 12 and 13. The relay 45 of the master switch is common to a group of one hundred lines, all of said lines being connected to the said relay 45 at the point *b*.

The connector D, illustrated in Fig. 1, part 2, comprises an impulse relay IR′, which, through the agency of a first set of impulses from the calling substation, is energized and de-energized to actuate the primary magnet PM′ to step the wipers 20, 21 and 22 in a primary direction to a group of contacts which contain the contacts of the called line. A switching relay SW′ is actuated, after the first set of impulses, to associate the secondary magnet SM′ with the impulse relay IR′ and the latter is acted upon by the last set of impulses to operate magnet SM to step the wipers 20, 21 and 22 into engagement with contacts 23, 24 and 25 of the wanted line. A test relay is also provided for testing the idle or busy condition of the called line and a busy-back apparatus BB′ is connected, in case the calling line is busy, to transmit a busy signal to the calling subscriber. A ringing generator RG and interrupter I, in association with a ringing control relay RC and interrupter relay 159 connect ringing current to the called line. Primary off-normal and secondary off-normal contacts PON′ and SON′ move, respectively, to their alternate positions upon the first step of the connector in a primary direction and in a secondary direction. To the right of the drawing, I show a called substation E similar to the calling substation A and connecting at the exchange with a line circuit L′ similar to L.

Referring now to Fig. 2, I illustrate a BFT back selector and trunk selector circuits. The back selector portion comprises wipers 190, 191, 192 and 193, which wipers are stepped over successive groups of contacts 194, 195, 196 and 197 by means of the magnet BM′ to select contacts of a calling line. The trunk selector portion comprises wipers 230, 231 and 232, which wipers are stepped over successive sets of contacts 233, 234 and 235, by means of magnet TM, to seek a set of contacts leading to an idle trunk as T. The switches at BFT may be the well known rotary non-restoring type, in which when release occurs, the wipers 190, 191, 192 and 193 and wipers 230, 231 and 232 remain in engagement with the last set of contacts used. The trunk circuit T terminates into a trunk jack TJ and comprises the supervisory relay SR, which is energized when the said trunk is seized by a switch BFT, to light a signal lamp SI to attract the operator's attention and notify her that a call is to be answered. A sleeve relay SL is also provided, which is energized when the plug is inserted into the trunk jack TJ to efface the signal S. The operator's cord circuit OC, which is used for extending connection from the seized trunk to the called line, comprises an answering plug AP and a calling plug CP, the two plugs being connected by the heavily marked talking conductors. The cord circuit OC also comprises an answering supervisory relay AS and a calling supervisory relay CS, the two relays controlling, respectively, the answering supervisory lamp AL and the calling supervisory lamp CL. A listening key LK is provided, which when actuated connects the operator's set OC to the cord conductors, and a ringing key RK, when actuated, connects ringing generator G^2 to the called line to actuate the call bell thereat. To the right of the drawing I show a called substation S of the well-known common battery type, the said substation S connecting at the exchange with a line circuit L′.

Having described in general the apparatus comprising the preferred form of my invention, I will now describe more in detail the operation of the system as illustrated in Fig. 1, parts 1 and 2.

Assuming now that the subscriber at the substation A initiates a call, the removal of the receiver closes an energizing circuit for the combined line and cut off relay LCO, traced from battery, through the lower winding 30 of the relay, normal contact 31, conductors 32 and 33, through the closed contacts of the substation switchhook, back over conductors 34 and 35, through the up-

per winding 36 of the relay LCO, to ground at the normal contact 37. The relay LCO is of the unbalanced differential type in which the winding 36 may have a resistance value of 400 ohms and the winding 30 may have a resistance value of 500 ohms, and this unbalanced condition of the two differential windings 30 and 36 permits the relay to be only partially energized and the movement of its armature is only sufficient to close the alternate contacts 38 and 39, but not sufficient to open normal contacts 31 and 37, 40 and 41. The ground at contact 37 also extends through the upper winding of relay LCO, through substation A, normal contact 31 of relay LCO and over conductors 80 and 42 to the private terminal 23′ of the contacts 23′, 24′ and 25′ of the connector with which the calling line is associated to prevent any connector seeking the calling line as a called line from making connection with the said now calling line. The closing of contact 38 of relay LCO establishes an energizing circuit for the line relay LR of the master switch MS, traced from ground at alternate contact 38 of the relay LCO, normal contact 40 of the said relay, conductor 43, normal contact 44 of the relay 45 of the master switch MS, to battery through the winding of the relay LR. The relay LR upon energization closes its alternate contact 46, establishing an energizing circuit for the motor magnet MM of the master switch MS, but the master switch wipers do not move, said magnet driving on the back stroke only, the master switch resting on contacts of an idle line selector. The closing of alternate contact 47 of the relay LR establishes an energizing circuit for the relay 48 of the back selector BFS, traced from battery through the winding of the relay 48, conductor 49, through the high resistance 50, normal contact 51 of relay 48, conductor 52, contact 12 and wiper 6 of the master switch MS, conductor 53, normal contact 54 of the relay 45, to ground at alternate contact 47 of the relay LR. It is to be remembered that the wipers of the master switch normally rest upon contacts of an idle line selector. The circuit of relay 48 is in series relation with the high resistance 50 at this time, and the high resistance permits only a partial energization of the said relay and there is only sufficient actuation of the said relay 48 to close its contact 55 leaving contacts 75, 76, 77 and 78 and contacts 60 and 51 in their normal positions. The closing of contact 55 establishes an energizing circuit for the motor magnet BM, traced from battery through the winding of the magnet BM, its normal contact 56, conductor 57, normal contact 58 of the relay 59, normal contact 60 of relay 48, closed contact 55 of relay 48, conductor 52, contact 12 and wiper 6 of the master switch MS, conductor 53, normal contact 54 of the relay 45, to ground at alternate contact 47 of the relay LR. The relay LCO of the line circuit L upon its partial energization places a ground upon the pick-up contact 11 associated with the calling line, the said ground extending from normal contact 37 of relay LCO, closed contact 38, normal contact 40, closed contact 39, normal contact 41 and conductor 62 to the pick-up contact 11 associated with the calling line. The finder magnet BM is now alternately energized and de-energized due to the opening and closing of its contact 56 to step the wipers 2, 3, 4 and 5 of the back selector BFS over successive contacts 8, 9, 10 and 11, to seek the contacts of the calling line, the retaining pawl of the back selector having been caused to engage on the initial energization of relay 48 which also serves as a release magnet for the switch which may be of the rotary spring restored type. When the pick-up wiper 5 engages the now grounded contact 11, an energizing circuit is established for the relay 59, traced from battery through the upper winding 63, conductors 64 and 65, pick-up wiper 5, pick-up contact 11, to ground at the normal contact 37 of the relay LCO, over the previously described path. The relay 59 upon energization opens its normal contact 58, opening the energizing circuit of the finder magnet BM, thus preventing further stepping of the finder wipers 2, 3, 4 and 5, and the wipers 2, 3, 4 and 5 now engage contacts 8, 9, 10 and 11 which contacts lead to the calling line. The ground encountered by the pick-up wiper 5 of the switch also closes an energizing circuit for the relay 45 of the master switch MS, which ground extends over conductors 65 and 64, the contact 13 and wiper 7 of the master switch MS, conductor 66 to battery through the upper winding of the relay 45. The relay 45 upon energization opens its normal contact 44, opening the energizing circuit of the relay LR, which in turn opens its alternate contact 46, opening the energizing circuit of the motor magnet MM of the master switch MS. The said magnet upon de-energization steps the wipers 6 and 7 of the master switch into engagement with the next set of contacts 12 and 13, and should this set lead to an idle back selector, the magnet 45 de-energizes, preventing further stepping of the wipers 6 and 7. Should the contacts encountered by the wipers 6 and 7 lead to a busy-back selector, the contact 12 would have a busy or grounded potential upon it and the grounded contact 12 now engaged by the wiper 6 will connect over the conductor 53 through alternate contact 67 of the relay 45, to battery through the lower winding of said relay 45, maintaining relay 45 energized. The ground also extends through alternate contact 54 of relay 45,

over conductor 68, through normal contact 69 of the motor magnet MM of the master switch MS to battery through the winding of the said magnet. The magnet MM is thus energized, and upon energization opens its normal contact 69, and the resulting de-energization of the said magnet MM steps the wipers 6 and 7 of the master switch MS into engagement with the next set of contacts 12 and 13, and the wipers 6 and 7 are thus stepped over succeeding sets of contacts until an idle set is encountered which leads to an idle back selector BFS. The wipers 6 and 7 of the master switch MS are thus normally resting upon an idle set of contacts 12 and 13 leading to an idle switch BFS so that as soon as a call is initiated the idle switch BFS will be started into operation to seek the calling line terminals.

Assuming now that the wipers 6 and 7 of the master switch have engaged an idle set of contacts 12 and 13 leading to an idle switch BFS, the contact 12 will be free from ground and the relay 45 will now restore, and the opening of alternate contact 54 will prevent further actuations of the motor magnet MM.

The relay 59 of the switch BFS upon energization as before described, closes an alternate contact 70, establishing an energizing circuit from battery through the winding of the relay 48, conductor 49, through the low resistance winding 71 of relay 59, alternate contact 70, conductor 72, to ground at normal contact 73 of the relay 74. The relay 48 is now in series with the low resistance winding 71 of the relay 59 in shunt of the high resistance 50 and thus permits the full energization of the relay 48, to thus bring about the closure of its normally open contacts 75, 76, 77 and 78 of the relay 48 and bring about the opening of its normally closed contacts 51 and 60. The closing of alternate contact 76 of the relay 48 establishes a circuit traced from battery through the winding 30 of the relay LCO of the line circuit L, conductor 80, the contact 10 and wiper 4 of the switch BFS, conductor 81 to ground at alternate contact 76 of the relay 48. The circuit just traced through the lower winding 30 of the relay LCO causes the full energization of the said relay, thus opening normal contacts 31, 37 and 40 and 41. The closure of alternate contact 76 of relay 48 places a ground or busy potential upon the connector contacts 23′ as upon the full energization of relay LCO, the initial busying ground is interrupted. The closing of alternate contacts 75 and 78, when the relay 48 is fully energized, energizes impulse relay IR of the first selector by current from battery through the upper winding of IR, normal contact 82, contact 75, wiper 3, contact 9, conductor 34, through the closed contacts of the substation switchhook, back over conductor 33, contact 8, wiper 2, contact 78, normal contact 84, through the lower winding of the relay IR, conductor 85, to ground at normal contact 86 of the overrun contacts OR. The relay IR upon energization closes its alternate contact 87, establishing an energizing circuit for the relay 74. The relay 74 upon energization opens its normal contact 73 and opens the circuit through the relay 59 and relay 48, but a substitute circuit is established for the relay 48, which may be traced from battery through the winding of said relay 48, conductor 49, its alternate contact 77, conductors 89 and 90 to ground at alternate contact 91 of the relay 74. This circuit just traced excludes the energizing winding 71 of relay 59 and the relay 59 thus restores. The ground at alternate contact 91 of relay 74 also extends from alternate contact 77 of relay 48 over conductor 52 to contact 12 of the master switch MS, thus busying the said contact.

The subscriber at A now actuates his calling device, (assuming that the called subscriber's number is 234) to cause two interruptions of the line, and thus brings about two de-energizations and energizations of the impulse relay IR. Upon the deenergization of IR, an energizing circuit is established for the relay PR and the primary magnet PM, traced from battery through the winding of the primary magnet PM, conductor 92, through the winding of the relay PR, conductor 93, alternate contact 94, conductor 95, normal contact 96, to ground at normal contact 87 of the relay IR. Due to the two de-energizations and energizations of the impulse relay IR, the primary magnet PM thus receives two impulses of current to step the wipers 14, 15 and 16 in a primary direction to the second group of contacts 17, 18 and 19. The relay PR is energized upon the first de-energization of the impulse relay IR and remains energized during the rapid actuations of the contacts 87, due to its slow-to-release construction as does relay 74 which also is slow-to-release. After the two impulses have been transmitted by the subscriber at the substation A, the impulse relay IR remains energized, and the open normal contact 87 of the relay IR holds open the circuit of the relay PR and primary magnet PM. On the first step the relay 101 was initially energized over a circuit traced from battery through the winding of relay 101, conductor 102, alternate contact 103 of the primary off-normal contact PON, which contacts assume their alternate position upon the first step of the wipers 14, 15 and 16, through conductors 104 and 105, alternate contact 100 of relay PR, conductor 90 of alternate contact 91 of relay 74. The relay 101 upon energization closes contact 108 and also its contact 110 to lock

itself in shunt of contact 100. The slow relay PR now drops back its armature, energizing magnet SM, from battery through the winding of the said magnet SM, conductor 109, alternate contact 108 of the locked relay 101, conductor 110, normal contact 100, conductor 90 to ground at alternate contact 91. The secondary magnet SM upon energization steps the wipers 14, 15 and 16 into engagement with the first set of contacts 17, 18 and 19 in search of an idle set of contacts in the selected group, and said magnet SM opening its lower contact de-energizes relay 101 whose opening contact 108 in turn de-energizes magnet SM.

Assuming that the first private contact 17 engaged by the private wiper 14 leads to a busy connector, the said contact will have a busy or grounded potential upon it, now extended from said contact 17 through the wiper 14, over conductor 111, normal contact 112 of the relay 83, conductor 113, normal contact 114 of the secondary magnet SM, conductor 104, alternate contact 103 of the primary off-normal contacts PON, conductor 102, to battery through the winding of the relay 101. The relay 101 upon energization again closes its alternate contact 108 to establish an energizing circuit for the secondary magnet SM, over the previously described circuit, and the said secondary magnet SM upon energization steps the wipers 14, 15 and 16 into engagement with the next set of contacts 17, 18 and 19. The magnet SM upon energization opens its contact 114, and its lower contact opening the energizing circuit of the relay 101, causing its de-energization, and the opening of alternate contact 108 of relay 101 opens the energizing circuit of the secondary magnet SM, and by this see-saw action of the relay 101 and of the secondary magnet SM, a positive operation of the secondary magnet is obtained and wipers 14, 15 and 16 will not stop on a busy contact or go past an idle contact because unless relay 101 is energized magnet SM cannot be energized, and relay 101 can only be energized when magnet SM is at normal and wiper 14 is engaging a busy contact. When an idle connector as D is found, the private contact 17 engaged by the wiper 14 is free from ground and further energizations of the relay 101 and secondary magnet SM are prevented. A set of contacts 17, 18 and 19 leading to an idle connector D having been seized by the wipers 14, 15 and 16, an energizing circuit is now established for the relay 83, which may be traced from battery through the winding of the relay 101, conductor 102, alternate contact 103 of off-normal contact PON, conductor 104, normal contact 114 of magnet SM, conductor 113, through the winding of the relay 83, conductor 116, normal contact 117 of the overrun contacts OR, conductor 118 to ground at alternate contact 73 of the relay 74. During selection the relay 83 did not energize because it was short-circuited to ground at the busy contacts engaged by wiper 14, but now the relay 83 is energized over the path just described, and due to the high resistance of the relay 83, the relay 101 fails to energize. Relay 83 energizing opens its normal contacts 82 and 84; thus opening the energizing circuit of the impulse circuit IR, and the impulse relay IR upon restoration opens its alternate contact 87 to interrupt the energizing circuit of the relay 74. The relay 74 upon de-energization opens its alternate contact 91, which opens the energizing circuit of the relay 48, but relay 74 being slow to release its alternate contact 91 held closed momentarily until a substitute circuit is established for the relay 48, as will presently be described. The closing of alternate contacts 82 and 84 of the relay 83 now extends circuit from the substation A to the selected idle connector D which is engaged by wipers 14, 15 and 16 bringing about the energization of the impulse relay IR′ of said connector D over a circuit traced from ground through one winding of the relay IR′, contact 19, wiper 16, alternate contact 84, alternate contact 78, wiper 2, contact 8, conductor 33, through the substation A, conductor 34, contact 9, wiper 3, alternate contact 75, alternate contact 82, wiper 15, contact 18, and through the left hand winding of the relay IR′ to battery and ground. The restoration of the relay 74 of the selector BFS will open the initial energizing circuit of relay 48 at contact 91, but the relay 74 being slow to release the circuit of relay 48 is held momentarily closed until a substitute circuit is established for it traced from battery through the winding of said relay, conductor 49, its alternate contact 77, conductors 89, 90 and 120, alternate contact 112 of relay 83, conductor 111, wiper 14, contact 17, conductor 121 and conductor 122 to ground at alternate contact 123 of the impulse relay IR′. The said relay 48 remains energized until the termination of the conversation.

The energization of the relay IR′ energizes relays 124 and 125, the circuit of relay 124 extending from battery through the right hand winding of said relay, normal contact 126 of the primary off-normal contacts PON′, conductor 121, and conductor 122 to ground at alternate contact 123 of relay IR′. The circuit for relay 125 extends from battery through the lower winding of the relay 125, conductors 127, 128 and alternate contact 129 to ground at alternate contact 123 of relay IR′, but relay 125 neutralizes and falls back as soon as contact 155 closes. Relay 124 locks itself to ground at 130. Three impulses now transmitted from

A de-energize and energize relay IR′ three times causing the primary magnet PM′ to energize and de-energize three times to step the wipers 20, 21 and 22 in a primary direction to the third group of contacts containing those of the called line. The circuit of the primary magnet PM′ may be traced from battery through the winding of the said magnet, normal contact 131 of switching relay SW′, conductor 132, alternate contact 133 of relay 125, said relay 125 becoming unbalanced and energizing as soon as contact 129 opens, normal contact 129 of relay IR′, conductor 122, conductor 121, through normal contact 126 of the primary off-normal contacts PON′, to ground at alternate contact 130 of relay 124. After the primary off-normal contact 126 assumes its alternate position, which occurs upon the first step of the switch shaft, the ground fed from contact 134 of relay 135 is substituted for the ground fed through contact 130 of relay 124. After the last impulse of the series has been sent the steady flow of current through both windings of relay 125 causes the said relay 125, due to its differential action, to neutralize and restore its contacts to normal, but it does not restore during the sending of impulses due to its adjustment, construction and the rapidity of the interruptions of contact 129 of relay IR′. The closing of normal contact 136 of relay 125 energizes switching relay SW′ by current from battery through the winding of said relay SW, its make-before-break contact 137, normal contact 138 of secondary off-normal springs SON′, conductor 139, normal contact 136 of relay 125, and conductor 140 to ground at alternate contact 141 of primary off-normal contacts PON′, and relay SW locks itself to ground at alternate contact 141 of PON through normal contact 142 of relay TR. The closing of alternate contact 131 of the switching relay SW now substitutes secondary magnet SM′ for magnet PM′, so that when the calling subscriber at the substation A sends the last set of impulses, which we assumed are four in number, relay IR′ energizes magnet SM′ four times, (relay 125 energizing as before on the first opening of contact 129) and secondary magnet SM′ steps the wipers 20, 21 and 22 in a secondary rotary direction to engage contacts 23, 24 and 25 of the called line. After the last impulse the relay 125 is again de-energized, as previously described, and closes a circuit for the test relay TR traced from battery, through the winding of the said relay, conductor 142, the alternate contact 143, alternate contact 138 of the secondary off-normal contacts SON′ (said contacts having been moved at their alternate position upon the first step of the wipers in their secondary direction), conductor 139, normal contact 136, conductor 140 to ground at 141. The closing of alternate contact 144 of relay TR connects the said relay over conductor 145 to the test or private wiper 20, and should the called line be busy the private contact 23 of the called line would be grounded, thus closing a locking circuit for the said relay TR through the private wiper.

Called line idle.

Assuming that the called line is idle, private contact 23 of the called line will be free of ground, and the relay TR will not remain energized but will de-energize, because the opening of normal contact 142 of relay TR upon its energization opens the circuit of the switching relay SW, and the relay SW de-energizing opens the initial energizing circuit for relay TR at its contact 143, leaving the relay TR dependent upon the potential found upon the private contact 23 of the called line. Since, as assumed, this contact is idle and thus free from ground, the relay TR de-energizes and thereby causes the energization of relay 135 by current from battery, through the lower winding 30′ of the cut-off relay LCO of the line circuit L′, associated with the called line, conductors 80′ and 150, private contact 23, through wiper 20, conductor 145, normal contact 144, conductor 151, normal contact 152, of relay SW, conductor 153, through the lower winding of relay 135, and conductor 154 to ground at 155. The closing of alternate contact 156 of relay 135 short circuits the lower winding of the said relay, and the closing of its alternate contact 157 closes a circuit through the upper winding of the said relay through the alternate contact 157 and conductor 154 to ground at 155. The relay LCO′ of the line circuit L′ associated with the called line E attracts its armature as the relay LCO′ is fully energized to open normally closed contacts 31′, 37′, 40′ and 41′ and this opening of normal contact 40′ removes ground from the conductor 42′, thus preventing master switch from operating to select the called line. This movement of contacts 31′, 37′, 40′ and 41′ removes the substation control of the line circuit L′ of the called line E.

The closing of alternate contact 158 of relay 135 connects the interrupter I with the relay 159, circuit being traced from battery through relay 159, conductor 160, alternate contact 158, conductor 361′, normal contact 161, and through I to ground. The relay 159 is thus intermittently energized and de-energized, and upon each de-energization ringing generator RG is connected to the called line over a circuit extending from the ungrounded pole of the generator RG, through normal contact 162 of ringing control relay RC, conductor 163, alternate contact 164, conductor 165, normal contact 106,

wiper 22, bank contact 25, through the condenser and call bell of the called substation back through bank contact 24, wiper 21, normal contact 167, and conductor 168 to ground at alternate contact 134 of relay 135.

The call bell of the called subscriber at the substation E is thus intermittently rung, and when the called subscriber answers and the relay 159 is energized, a circuit for the relay SR is closed, from battery through the lower winding of the relay SR, through alternate contact 166 of relay 159, wiper 22, contact 25, through the now closed upper contacts of the substation switch hook at the called substation E, back through contact 24, wiper 21, alternate contact 167 of relay 159, and through the upper winding of the relay SR to ground. The relay SR, upon energizing, closes an energizing circuit for the ringing control relay RC, which may be traced from battery through the winding of the said relay RC, its make-before-break contact 169, to ground at 170. Contact 171 locks relay RC from battery, through the winding of the said relay RC, its alternate contact 171 and conductor 140, to ground at alternate contact 141 of the primary off-normal contacts PON'. The opening of normal contacts 161 and 162 disconnects the interrupter I and the ringing generator RG to prevent further application of ringing current. A substitute circuit for the relay 159 is now established which may be traced from battery, through the winding of the relay 159, conductor 160, alternate contact 158, conductor 361 alternate contact 161 and conductor 140 to ground at 141. The subscribers are now in conversational circuit, and the talking circuit may be traced over the heavily marked conductors, said conductors having the condensers K' and K² interposed.

Assuming that the subscriber at the substation A is the first to replace his receiver, the resulting de-energization of the impulse relay IR' of the connecter D opens the holding circuit of the relays 48 and 83 of the back selector and first selector at BFS, and the closing of normal contact 96 of the relay 83 establishes an energizing circuit for the release magnet RM, traced from battery through the winding of magnet RM, alternate contact 172 of the primary off-normal contacts PON', conductor 173, normal contact 94 of relay 74, conductor 95, normal contact 96, to ground at normal contact 87 of relay IR. The release magnet RM upon energization withdraws the retaining pawls and allows wipers 14, 15 and 16 of the first selector to restore to normal by spring tension. The relay 48 upon de-energization withdraws the retaining pawl of the back selector and opens its alternate contact 76, removing ground from circuit of the lower holding winding 30 of the combined line and cut-off relay LCO of the line circuit L, thus allowing the relay LCO to restore to normal. The primary off-normal contacts PON restore to normal when the wipers 14, 15 and 16 reach normal, and the opening of alternate contact 172 opens the energizing circuit of the release magnet RM.

The subscriber E restoring his receiver upon its switch hook interrupts the circuit of the relay SR at the switchhook contacts, causing the said relay to de-energize. The closing of normal contact 174 of relay SR closes a circuit through the left-hand winding of the relay 124, which may be traced from battery, through the left-hand winding of the said relay 124, alternate contact 175, conductor 176, normal contact 174 and conductor 177, to ground at normal contact 123. Due to the differential construction of relay 124, the said relay neutralizes and restores to normal. The closing of normal contact 178 of relay 124 closes an energizing circuit for the secondary magnet SM', from battery through said magnet, conductor 179, normal contact 178, contact 180, through the interrupter I' to ground. The secondary magnet SM' thus steps the wipers 20, 21 and 22 beyond the last set of contacts in the group, the wipers then restoring to normal from this position by spring tension. The restoration of the relay 124 opens the circuit of relay 135 at contact 155, and the relay 135 restoring opens the circuit of relay 159 at contact 158. The primary off-normal contacts PON' having restored upon the restoration of the switch, the opening of the contact 141 de-energizes relay RC. The relay 124 also brings about the de-energization of the relay LCO' of the line circuit L', which is associated with the called subscriber E.

All the apparatus used in establishing a connection between a calling subscriber at the substation A and the called subscriber at the substation F is now at normal and available for use in establishing other connections.

Assuming now that the subscriber at the called substation E was first to replace his receiver upon the switchhook, the opening of the switchhook contacts at the substation E brings about the de-energization of the relay SR. Nothing else happens at this time as the relay IR' is still maintained energized over the line of the calling substation A. The calling subscriber at the substation A replacing his receiver interrupts the circuit of the impulse relay IR' at the switchhook contacts. The relay IR' de-energizing closes a circuit for the left-hand winding of relay 124, causing the said relay to de-energize, as hereinbefore described. The restoration of the line circuit L and connector D is the same as previously described from this point on. Should the called sub-

scriber E fail to replace his receiver upon the switchhook after the conversation is terminated, the replacing of the receiver at the substation A brings about the de-energization of the impulse relay IR′ of connector D, the same as before, and the opening of alternate contact 123 of impulse relay IR′ opens the circuit of the relays 48 and 83 of the switch BFS, as before described, and causes the release of switch BFS and line circuit L.

Called line busy.

Assuming now that the called line is busy, the operation of the circuit is the same up to and including the time that the relay TR momentarily energizes. The line being busy, the private contact 23 has a ground connected to it, and it thus closes a locking circuit for the test relay TR from battery, through the winding of the said relay, its alternate contact 144, conductor 145, and the wiper 20 to the grounded contact 23. Alternate contact 182 of the test relay TR remains closed and connects the busy signal apparatus BB to the calling line to transmit a signal to A, thus notifying the subscriber of the busy condition of the called substation E. Relay RC is also energized when connection is made to a busy line to prevent an application of ringing current from being applied to the called line if the called line should become idle before the connector D is disconnected from the bank contacts of a called subscriber's line. The relay RC upon energizing locks up through its own make-before-break contacts 169 and 171 to ground at alternate contact 141. The calling subscriber now replaces his receiver, bringing about the de-energization of the impulse relay IR′, and the relay IR′ restoring, opens the circuit of the relays 48 and 83 of the switch BFS, which, as previously described, brings about the release of the switch BFS and line circuit L. The relay IR′ de-energizing, restores relay 124 (since the relay SR has not been energized) and by the closing of circuit through the left-hand winding of said relay 124 the closing of contact 178 now connects secondary magnet SM′ and interrupter I′, and the connector restores to normal by spring tension. The primary off-normal contacts PON′ and secondary off-normal contacts SON′ are also restored, and all the apparatus used is now at normal and available for use in establishing other connections.

Referring now to Figure 2 I have illustrated a back selector and trunk selector at BFT, a trunk circuit T, an operator's cord circuit OC, and a called substation S terminating at the exchange in a line circuit L′, and in which the back finder and trunk selector BFT selects the calling line and a trunk leading to an idle trunk circuit T whereby a local operator may now extend the calling line to the called substation S through the medium of the cord circuit OC.

I will now describe the detailed operation of Figure 2 in connection with the master switch MS and line circuit L of Figure 1, part 1, and by placing Figure 2 on top of Figure 1, part 1, at the dotted line, a complete system is illustrated.

Generally expressed, the system of Figure 2 operates as follows, it being understood that the substation to be used will be of the ordinary common battery type. The call dial at A would be omitted and the terminals 23′, 24′, 25′ would be omitted and replaced by multiple jacks connected as indicated at A.

The calling subscriber removing his receiver has his line selected by the line selector apparatus, circuits of which are shown at the left of BFT in Figure 2, and after this selection is completed, the trunk selector whose circuits are illustrated at the right of BFT will operate and automatically select an idle trunk T whose line signal SI will be displayed. The operator will connect answering plug AP and after learning the number of the subscriber wanted, will test the latter's multiple jack, as L, in the usual way and complete the connection with calling plug CP, in the usual manner.

Assuming now that the subscriber at the substation A initiates a call, the removal of the receiver at the substation thereat closes an energizing circuit for the combined line and cut off relay LCO of the line circuit L, traced through the lower winding of the relay 30 of the relay LCO, normal contact 31 of the relay LCO, conductors 32 and 33, through the closed contacts of the substation switch hook, back over the conductors 34 and 35 through the upper winding 36 of the relay LCO to ground at normal contact 37 of the relay LCO. The relay LCO is only partially energized, due to its construction, as previously described, and the movement of the armature of the relay LCO is only sufficient to close the alternate contacts 38 and 39, but not sufficient to open normal contacts 31 to 37 and 40 and 41.

The closing of contacts 38 of relay LCO establishes an energizing circuit for the line relay LR of the master switch MS as before. Relay LR upon energizing closes a circuit for motor manget MM of the master switch MS. The closing of alternate contact 47 of the relay LR establishes an energizing circuit for the marginal relay 200 of the back selector traced from ground at alternate contact 47 of the line relay LR of the master switch MS, normal contact 54 of relay 45, conductor 53, wiper 6 and contact 12 of the master switch MS, conductor 201, normal contact 202 of relay 200, conductor 203, 5000 ohm resistance 204, and

through the winding or marginal relay 200 to battery. The relay 200 upon initial energization allows the retaining pawl to fall in, said relay 200 serving as release magnet just as did relay 48 in Fig. 1. The circuit of relay 200 is in series relation with the high resistance 204 at this time, and this permits only a partial energization of the said relay 200 and there is only sufficient movement of its armature to close contact 205, leaving contacts 206, 207, 208, 209 and 210 to remain in their normally open positions, and the armature movement is not sufficient to open normally closed contacts 202 and 211.

The closing of contact 205 of the relay 200 of the switch BFT establishes an energizing circuit for the back selector motor magnet BM′, traced from battery through the winding of the said magnet BM′, its normal contact 212, conductor 213, normal contact 214, of the relay 215, conductor 216, contacts 211, 205 and 202 of the relay 200, conductor 201, contact 12 and wiper 6 of the master switch MS, conductor 53, normal contact 54, relay 45 to ground at alternate contact 47 of the line relay LR of the master switch MS. The relay LCO of the line circuit L upon its partial energization places a ground upon the pick-up contact 194 associated with the calling line, the said ground extending from normal contact 37 of relay LCO, closed contact 38, normal contact 40, closed contact 39, normal contact 41 and conductor 62 to the pick-up contact 194 associated with the calling line. The back finder magnet BM′ is now alternately energized and de-energized due to the opening and closing of its normal contact 212 to step the wipers 190, 191, 192 and 193 of the combined back selector and trunk selector BFT, over successive sets of contacts 194, 195, 196 and 197, to seek the contacts of the calling line.

When the pick-up wiper 190 engages the grounded contact 194, an energizing circuit is established for the relay 215 of the switch BFT, traced from battery through the upper winding 217 of the relay 215, conductors 218 and 219, the pick-up wiper 190, pick-up contact 194, to ground at normal contact 37 of the relay LCO. The relay 215 upon energization opens its normal contact 214, opening the energizing circuit of the back finder magnet BM′, thus preventing further stepping of the finder wipers 190, 191, 192 and 193, the said wipers now engaging contacts 194, 195, 196 and 197, which lead to the calling line. The ground encountered by the pick-up wiper 190 also closes an energizing circuit for the relay 45 of the master switch MS, which ground extends over conductors 219 and 220, contact 13 and wipers 7 of the master switch MS, conductor 66 to battery through the upper winding of the relay 45. The relay 45 upon energization opens its normal contact 44, opening the energizing circuit of the relay LR and the relay LR upon de-energization in turn opens its contact 46, opening the energizing circuit of the motor magnet MM of the master switch MS. The motor magnet MM upon de-energization steps the wipers 6 and 7 of the master switch into engagement with the next set of contacts 12 and 13 and the magnet MM is then alternately energized and de-energized as previously described in connection with Figure 1, part 1, until an idle set of contacts 12 and 13 is encountered which lead to an idle back selector and trunk selector BFT. The relay 215 of the back selector-trunk selector BFT upon energization closes its alternate contact 221, closing an energizing circuit through its high resistance lower winding 222 traced from ground through alternate contact 221, of the relay 215, through the winding 222 of the relay 215, conductors 223 and 224 to battery through the winding of the relay 200. This series circuit through winding 222 of relay 215 and the winding of relay 200 just traced continues to hold the marginal relay 200 in its partially energized condition and locks the relay 215 at this time in its energized position.

The closing of alternate contact 225 of the relay 215 places ground upon the private conductor 226 establishing an energizing circuit through the lower winding 30 of the relay LCO of the line circuit L, traced from battery through the winding 30 of the relay LCO, conductor 80, contact 195 and wiper 191 of the switch BFT, conductor 226, conductor 227 to ground at alternate contact 225 of the relay 215. The circuit as just traced permits the full energization of the said relay LCO, thus opening normal contacts 31, 37, 40 and 41. The ground from alternate contact 225 of the relay 215 extends over conductors 226 and 227 and also places a ground or busy potential upon the multiple sleeve contact of jacks A′ as upon the full energization of relay LCO, the initial busying ground is interrupted and this busy potential remains upon the contacts until conversation is terminated, the connections of calling plug CP being such that the operator receives the busy test from grounded sleeve contacts. The trunk selector may be of the rotary non-restoring type and the wipers, 230, 231, 232 of the trunk selector remain in engagement with the contacts last engaged when the switch was last used in establishing a connection. The calling line having been seized and the relay 215 operated, the next operation of the switch is the selection of an idle trunk T, and assuming that the private wiper 230 of the trunk selector of BFT is engaging a contact leading to a busy trunk circuit T, an energizing

circuit is established for the relay 236, traced from the busy grounded contact 233 engaged by the wiper 230, conductors 237 and 238, normal contact 239 of the relay 240, conductor 241 through the winding of the relay 236 through alternate contact 214 of the relay 215, conductor 213, normal contact 212, through the winding of the back finder magnet BM' to battery. The high resistance relay 236 energizes over this circuit, but the low resistance back finder magnet BM' is not energized. The relay 236 upon energization closes a circuit through the trunk finder magnet TM, traced from battery through the winding of the said magnet TM, normal contact 242 of the relay TM, conductor 243, alternate contact 244 of relay 236, conductors 245 and 237, through the wiper 230 of the grounded busy contact 233. The magnet TM, upon energization, steps the wipers into engagement with the next set of contacts 233, 234 and 235 and should the next set of contacts be busy, the magnet TM is again energized to bring about the stepping of the wipers to the next set of contacts, and this operation is continued until the wipers engage a set of contacts which lead to an idle trunk circuit T. When such idle trunk contact 233 is encountered by the wiper 230, this contact will be free from ground, and therefore, the energizing circuit of the relay 236 is interrupted, and the relay opens its alternate contact 244, preventing further energization of the magnet TM. The closing of normal contact 244 of the relay 236 now establishes an energizing circuit for the relay 240 traced from ground at alternate contact 246 of the relay 215, conductor 247, through the winding of the relay 240, normal contact 244 of relay 236, conductor 243, normal contact 242 of the magnet TM, through the winding of the said magnet to battery. The high resistance relay 240 is energized over this circuit, but the low resistance magnet TM is not energized. The closing of alternate contact 250 of the relay 240 shunts out the high resistance winding 222 of relay 215, and permits relay 215 to de-energize and open its alternate contact 221. This shunt about winding 222 establishes an energizing circuit for the relay 200 traced from battery through the winding of the relay 200, conductor 224 to ground at alternate contact 250, and this circuit permits the relay to fully energize to close alternate contacts 206, 207, 208, 209 and 210 to open normal contacts 202 and 211.

The relay 215 upon de-energization opening its alternate contact 235, removed the initial busy ground from the private conductor 226, but the closing of alternate contact 207 of relay 200 now establishes a busy potential for the private conductor 226. The relay 215 upon de-energization also opens the energizing circuit of the relay 240 at its alternate contact 246, but the relay 240 being slow to release is held momentarily energized holding the circuit of the relay 200 closed until a substitute circuit is established from the seized trunk T.

The closing of alternate contacts 206 and 210 of the relay 200 upon its full energization, extends the connection of the calling subscriber at the substation A to the seized trunk T, this establishing an energizing circuit for the supervisory relay SR of the trunk T, traced from battery through the upper winding of the relay SR, normal contact 251 of the relay 252 of the trunk T, contact 234 and wiper 231, alternate contact 206 of relay 200, wiper 192, contact 196, through the calling substation A, back through the contact 197 and wiper 193, alternate contact 210 of the relay 200, wiper 232, contact 235, normal contact 253 of the relay 252 to ground through the lower winding of the supervisory relay SR. The supervisory relay SR of the trunk circuit T, upon energization, closes its alternate contact 254, closing a substitute energizing circuit for the relay 200 of the switch BFT, traced from battery through the winding of the relay 200, its alternate contact 208, conductor 237, wiper 230, contact 233, conductor 255, to ground at alternate contact 254 of the relay SR.

It will be observed that if the wipers 230, 231, 232 were already engaging contacts of an idle trunk, relay 236 and magnet TM would not have energized at all but relay 240 would have done so and the already engaged trunk would have been seized and rendered busy. To prevent interference the relay 240 may be made slightly slower to pull up than 236, or the contact 214 arranged to close a trifle ahead of 246.

The closing of alternate contact 256 of the relay SR establishes an energizing circuit for the signal lamp SI, traced from battery through the lamp SI, normal contact 257 of the sleeve relay SL, to ground at alternate contact 256. The signal lamp SI is lighted to notify the operator at the manual exchange that a call is awaiting her attention, and she now inserts answering plug AP of the cord circuit OC into the trunk jack TJ of the seized trunk T, establishing an energizing circuit for the relay 252 of the trunk circuit T and the sleeve relay SL, the circuit of relay 252 being traced from battery through the winding of the said relay, conductor 258, sleeve contacts of the connected trunk jack TJ, and plug AP to ground through the winding of the relay 261 of the operator's cord circuit OC; and the circuit of the sleeve relay SL being traced from battery through the winding of the said relay, alternate con-

tact 259 of the relay SR to ground through the winding of relay 261 of the operator's cord circuit OC.

The relay LS upon energization opens its normal contact 257 effacing the signal lamp SI. The relay 252 upon energization closes its alternate contacts 251 and 253, thus extending the connection from the calling substation A to the operator at the manual exchange. The opening of alternate contact 254 of the relay SR, when the said relay restores upon the operation of relay 252 will remove ground from the private conductor 255, thus tending to de-energize the relay 200 of the combined back finder and trunk selector BFT, but ground is connected to the conductor 255 upon the insertion of the plug AP into the trunk jack TJ at alternate contact 262 of the trunk jack TJ, and this maintains relay 200 energized after relay SR restores. The insertion of the answering plug AP into the jack TJ establishes an energizing circuit for the answering supervisory relay AS of the cord OC over the calling line, and the opening of normal contact 263 of said relay AS prevents the lighting of the answering supervisory lamp AL of the cord OC at this time. The operator now actuates her listening key LK to connect her operator's set O to the cord conductors, and inquires the wants of the calling subscriber at the substation A, and assuming that it is the subscriber at the substation S that is wanted, the operator after testing in the usual way inserts the calling plug CP into the multiple jack J of the wanted line, and this insertion closes its circuit through the calling supervisory lamp CL, traced from ground through the lamp CL, normal contact 264 of the calling supervisory relay CS to battery through the sleeve of the jack J, over wire 42 and the lower winding of relay LCO of the called line, and said relay fully actuates all its contacts operatively dissociating itself from the called substation and preventing any operation of an associated line selector to select it. The operator of the cord OC now actuates the ringing key RK to connect ringing current from the generator G^2 to actuate the call bell of the called substation S, and the subscriber at the called substation in response to his signal removes his receiver from the switch hook closing an energizing circuit for the calling supervisory relay CS over the called line, and the relay CS opens its normal contact 264 to thus efface the supervisory signal CL to notify the operator that the called substation S has answered. The calling subscriber at the substation A and the called subscriber at the substation S are now in conversational circuit, the talking circuit being traced over the heavily marked conductors.

Assuming now that the subscribers at the substations A and S have finished conversation, they replace their receivers upon the respective switch hooks, and the replacing of the receiver at the calling substation A opens the energizing circuit of the answering supervisory relay AS of the cord circuit OC. The relay AS upon restoration closes its normal contact 263, establishing a circuit for the answering supervisory lamp AL, traced from battery through the lamp AL, normal contact 263 of the relay AS, alternate contact 265 of the relay 261 to ground. The calling subscriber at the substation S replacing his receiver upon the switch hook opens the energizing circuit of the calling supervisory relay CS; the said relay upon restoration closes its normal contact 264 to again light the supervisory signal CL. The operator of the cord circuit OC noting the two lighted signals AL and CL knows that conversation has terminated and withdraws the answering plug AP from the trunk jack TJ, and the calling plug CP from the jack J. The withdrawal of the plug AP from the jack TJ opens the energizing circuit for the relay 252 of the trunk circuit T and relay 261 of the cord circuit OC, and the relay 261 upon de-energization effaces the supervisory signal AL. The withdrawal of the plug CP brings about the effacement of the signal CL. The withdrawal of the plug AP from the jack TJ also removes ground from the private conductor 255, which ground extended through the winding of the relay 200 to battery. This circuit being now interrupted at the contact 262 allows the relay 200 to restore and upon de-energization, it opens its alternate contact 207, removing ground from the winding 30 of the combined line and cut off relay LCO of the line circuit L associated with the calling substation A, the said relay LCO now restoring to normal. The relay 200 in de-energizing withdraws the retaining pawl of the line selector which is spring restored to zero. The apparatus used in establishing the connection between the calling subscriber at the substation A and the called subscriber at the substation S is now at normal and available for use in establishing other connections.

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

1. A telephone system including a station connected by a telephone line with a relay in the exchange having a pair of windings magnetically opposed to one another when their circuit is closed at the station, one of said windings of greater power than the other to effect a partial actuation of said relay, and means to further energize said relay to effect a further actuation thereof.

2. A telephone system including a station connected by a telephone line with a relay in the exchange having a pair of windings of dissimilar energizing capacities opposed to one another when the circuit is closed at the station and serving to permit a partial actuation of said relay, and automatic selecting mechanism sensitive to said partial actuation to effect a further actuation thereof to disconnect said relay from the line.

3. A station connected with a differential relay having its windings inductively opposed when its circuit is closed at the station, said windings then effective to partially actuate the relay, and a selecting switch set in travel by such partial actuation and serving at a predetermined point in its travel to further actuate said relay.

4. A station connected with a differential relay having its windings inductively opposed when its circuit is closed at the station, said windings then effective to partially actuate the relay, a link circuit and a traveling switch adapted to interconnect said link circuit and said relay, and a second energizing circuit for said relay to further actuate it effective when said relay in its partially actuated condition is in connection with said link circuit.

5. A station connected with a differential relay having its windings inductively opposed when its circuit is closed at the station, said windings then effective to partially actuate the relay, an idle link circuit and automatic selecting and connecting mechanism for connecting said relay and circuit, and means sensitive to the partially actuated condition of said relay when so connected to further actuate it.

6. A station connected with a differential relay having its windings inductively opposed when its circuit is closed at the station, said windings then effective to partially actuate the relay, a back selector and selective starting means therefor operated by said partial actuation to connect a link circuit to said relay, and a circuit including said relay and a portion of said link circuit when so connected to further actuate said relay.

7. A telephone line connected with a line relay having a pair of windings opposed to one another when the line circuit is closed, one winding of greater power to partially actuate said relay, a back selector to select the line, a master switch to start said selector having a relay winding energized at a point in the operation of said selector, said relay then actuating further, and means thereon effective to disconnect said relay from the line.

8. A telephone line connected with a line relay having a pair of windings opposed to one another when the line circuit is closed, one winding of greater power to partially actuate said line relay, a back selector to select the line and automatic starting means therefor including a relay serving when energized to change the connections of said means, a selector relay magnet connected in multiple circuit with the said relay included in said automatic starting means at the time of selection and energized therewith over a connection including a contact of said second relay, and apparatus thereon effective to further energize said line relay.

9. A telephone line having a line relay whose two windings are energized in opposition when the line circuit is closed, said windings then effective to partially actuate said relay, an idle link circuit and a selector adapted to interconnect said circuit and line, and a link circuit relay magnet sensitive on such interconnection to the partial actuation of said relay to establish connections to further actuate it.

10. A telephone line having a line relay whose two windings are energized in opposition when the line circuit is closed, said windings then effective to partially actuate said relay, an idle link circuit and a selector adapted to interconnect said circuit and line, a link circuit relay magnet sensitive on such interconnection to the partial actuation of said relay to establish connections to further actuate it, and switching means effective by such further actuation to disconnect said relay from the line.

11. A telephone line having a line relay partially actuated when the line circuit is closed to start a back selector and render said line selectable thereby, and a selector relay magnet sensitive on selection of said line to the partial actuation of said relay to establish connections and further actuate the same.

12. In a telephone system a line and a back selector to select it, a non-restoring preselecting master switch including a relay to start the selector, a driving magnet for said selector controlled by said relay for operating said selector, and an energizing circuit for said driving magnet including a bank contact wiper of said master switch and a contact of said relay.

13. In a telephone system, a line and a plurality of back selectors to select it, a non-restoring device including a relay for selectively starting said selectors, a stepping magnet for each of said selectors controlled by said relay and adapted to be energized over a circuit including a contact of said relay, and a combined line and cut off relay for controlling said relay.

14. A telephone system including telephone lines, back selectors to select them, means including a starting relay for selectively starting said selectors, a relay magnet

included in said means adapted to shift said starting relay from one selector to another so that said means is normally engaging an idle selector, and adapted to be initially energized by said relay.

15. A telephone system including lines, selectors to select them, non-restoring means including a relay for selectively starting the selectors, a stepping magnet to shift said relay from selector to selector driving on its back armature stroke, means for energizing said magnet when a selector starts, and for de-energizing it when the selector stops.

16. A telephone system including a line, selectors to select it, means including a relay for selectively starting the selectors, a stepping magnet in said means driving on the back stroke of its armature to determine the succession in which said selectors shall start, a line relay for said line effective when energized to cause said stepping magnet to energize, a second relay included in said means and sensitive to the condition of said line relay to de-energize said magnet.

17. An automatic telephone exchange system including a calling substation connected with a differential line relay at the exchange having its windings opposed when its circuit is closed at the substation to partially actuate said relay, a plurality of selectors and automatic selecting and connecting mechanism responsive to said partial actuation to interconnect said substation with an idle selector, automatic means including said selector operable by directive impulses from said station to extend connection to the called line, a differential relay for the called line like that of the calling line, and circuits effective by connection made to the called line to fully actuate the relay thereof.

18. A telephone line extending from a substation to the exchange, a selector to select said line, a stepping magnet for said selector, a relay for said selector partially actuated to close a contact in the circuit of said magnet, means for more fully actuating said relay, and a switch contact shifted on such last actuation.

19. A telephone line extending from a substation to the exchange, a link circuit, traveling switch mechanism serving to interconnect said circuit and said line, a relay normally disconnected from said line, means for partially actuating said relay, a contact of said relay controlling said traveling switch shifted on such actuation, other contacts of said relay, and means to further actuate said relay to shift said contacts.

20. A telephone line extending from a substation to the exchange, a link circuit, traveling switch mechanism serving to interconnect said circuit and said line, a relay normally disconnected from said line, means for partially actuating said relay, a contact of said relay controlling said traveling switch shifted on such actuation, talking circuit contacts of said relay open when it is partially actuated, and means effective after connection of said link circuit and said line to close said talking circuit contacts.

21. A telephone system including a calling line and a called line, a link circuit having a selective switch on either end, one to select the calling line, the other to select another link circuit for use in extending connection to the called line, a relay and means to partially actuate it to initiate travel of a switch, means for holding said relay partially actuated till both said switches have completed their travel, circuit connections automatically changed thereon to further energize said relay, and contacts shifted by such energization.

22. A telephone system including a calling line and a called line, a link circuit having a selective switch on either end, one to select the calling line, the other to select another link circuit for use in extending connection to the called line, a relay and a circuit to hold it partially actuated while the one selective switch is traveling, another circuit to hold it partially actuated while the other switch is traveling, and apparatus effective to fully actuate said relay.

23. A telephone system including a calling line and a called line, a link circuit having a selective switch on either end, one to select the calling line, the other to select another link circuit for use in extending connection to the called line, a relay and means to partially actuate it, a contact of said relay shifted by the partial actuation and serving to render said switches active, circuit connections maintaining said relay partially actuated till both switches have completed their operation, a connection thereon effective to further actuate said relay, and contacts closed by such actuation.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 3rd day of January, 1921.

SAMUEL SUEKOFF.