Sept. 2, 1924. 1,506,933

L. D. KELLOGG

TELEPHONE SYSTEM

Filed Oct. 24, 1919 4 Sheets-Sheet 1

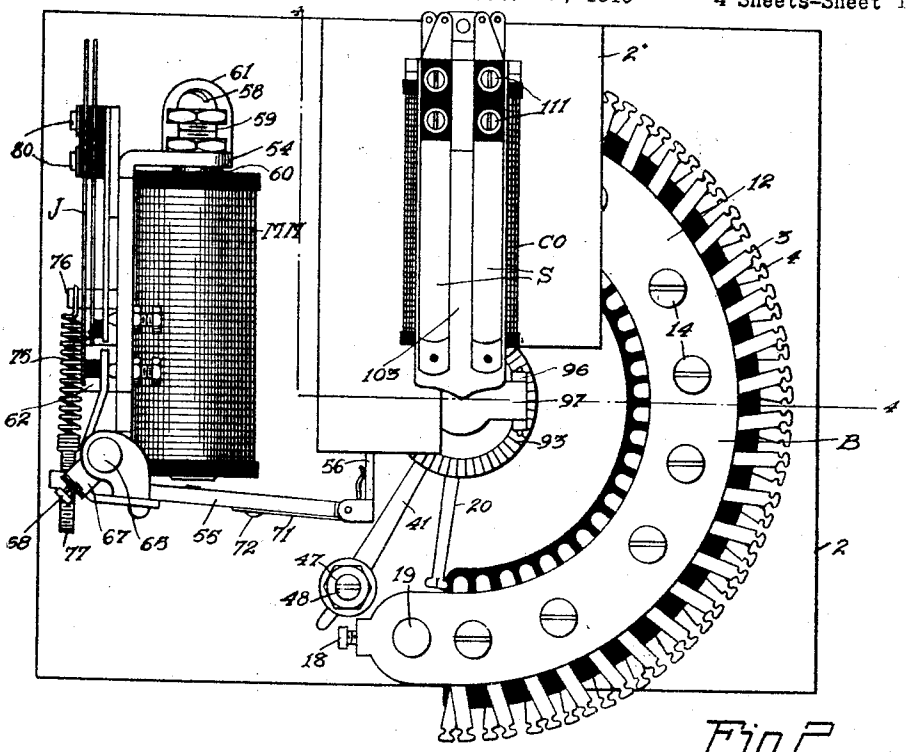

Fig. 2.

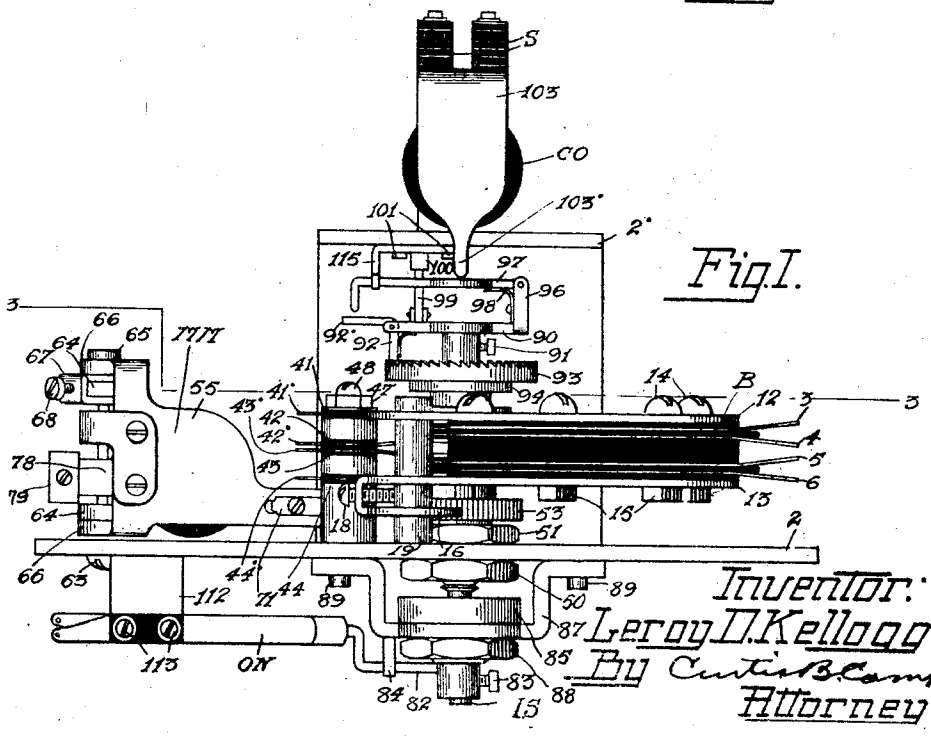

Fig. 1.

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TELEPHONE SYSTEM

Filed Oct. 24, 1919 4 Sheets-Sheet 2

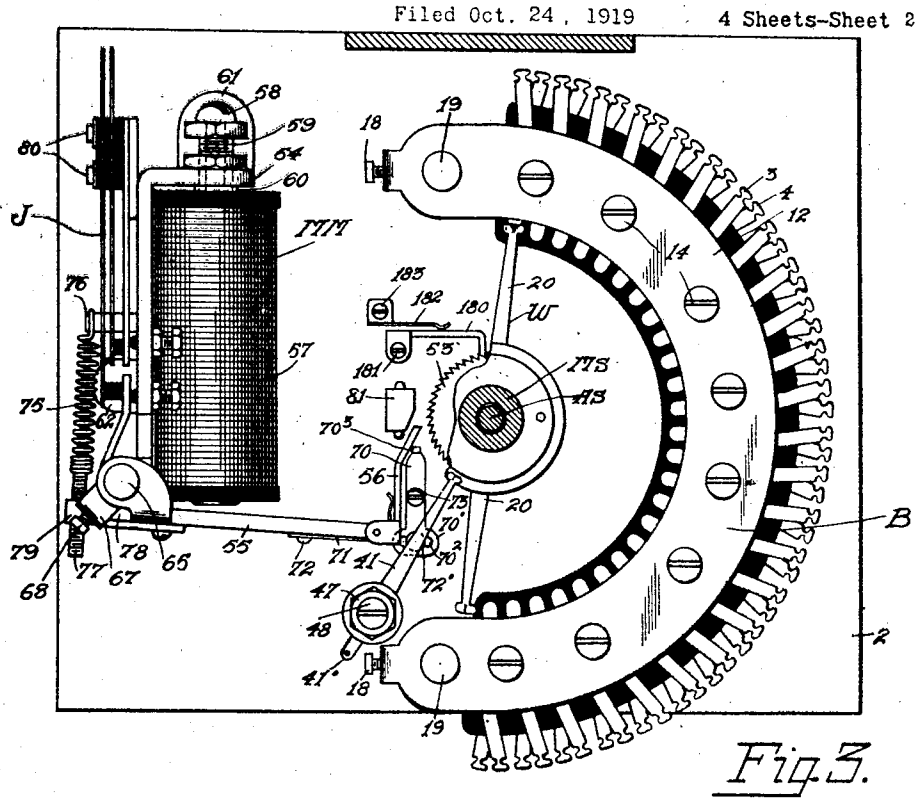

Fig. 3.

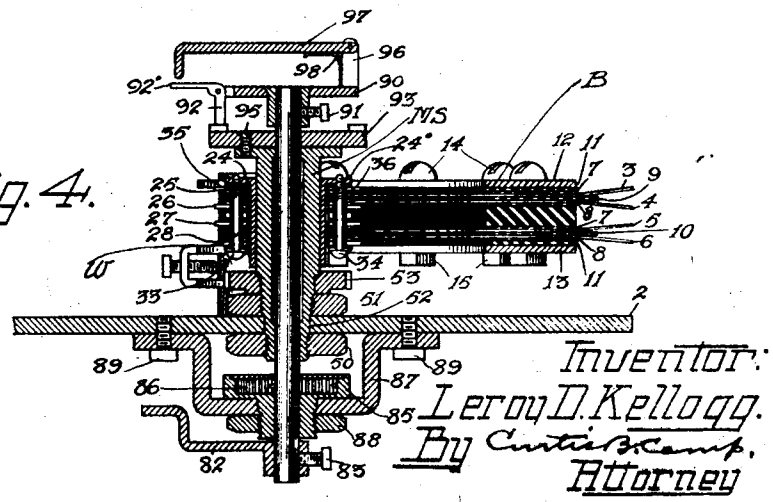

Fig. 4.

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TELEPHONE SYSTEM

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4 Sheets-Sheet 3

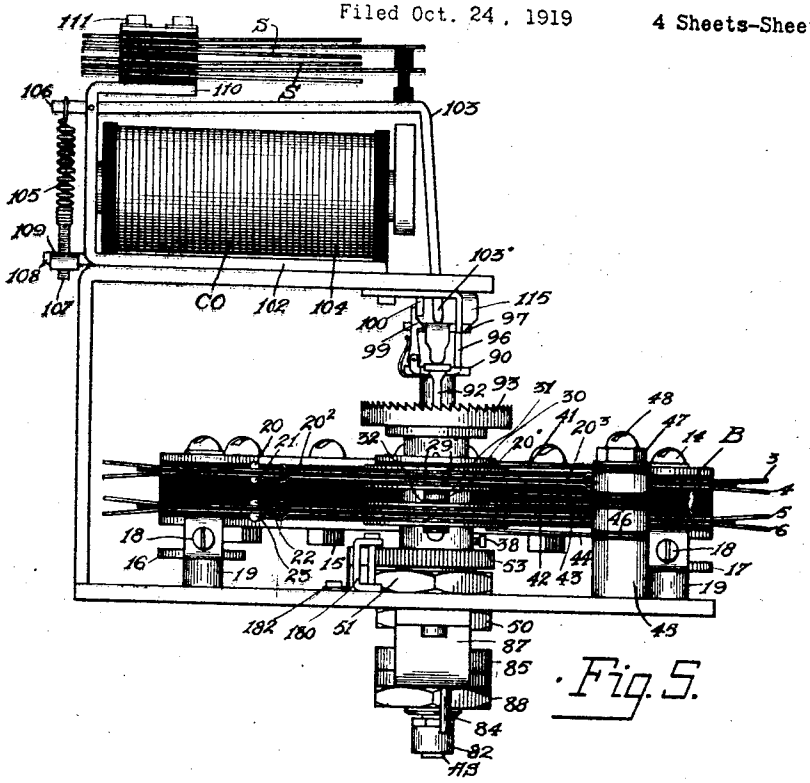

Fig. 5.

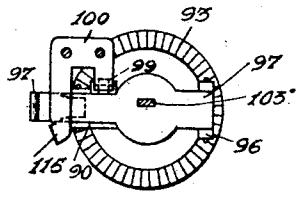

Fig. 6.

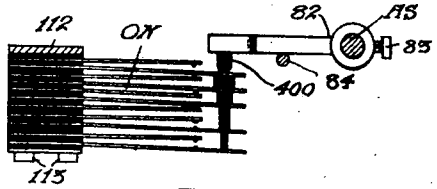

Fig. 7.

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TELEPHONE SYSTEM

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4 Sheets-Sheet 4

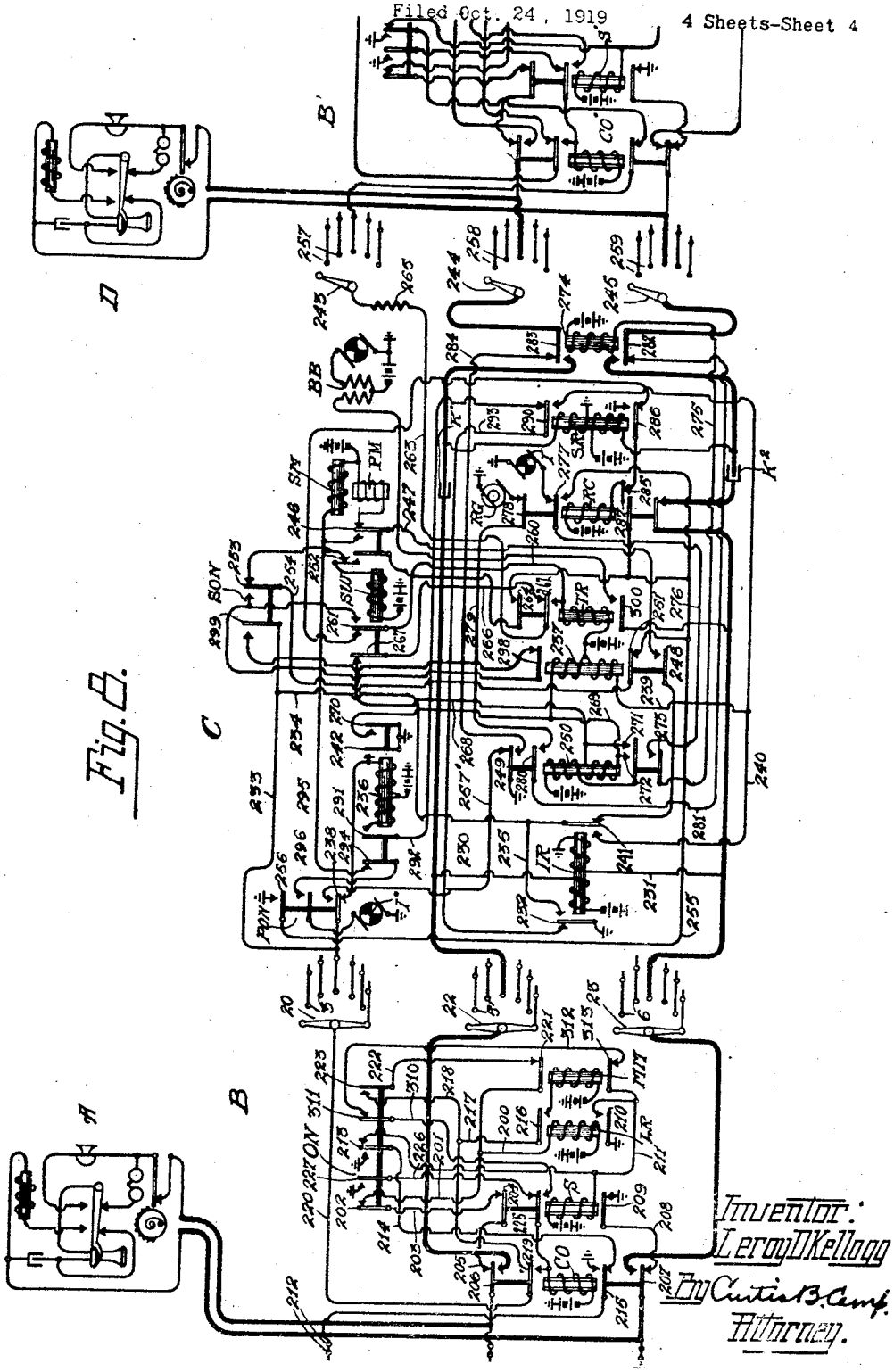

Fig. 8.

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Patented Sept. 2, 1924. 1,506,933

UNITED STATES PATENT OFFICE.

LEROY D. KELLOGG, OF DEERFIELD, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed October 24, 1919. Serial No. 332,866.

To all whom it may concern:

Be it known that I, LEROY D. KELLOGG, a citizen of the United States of America, residing in Deerfield, county of Lake and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems and has to do more particularly with automatic or semi-automatic systems in which switches are used for connecting a calling line to an idle trunk, and an object of my invention is the provision of an improved arrangement which embodies desirable features and advantages all in an efficient, simple and economical manner, and in which the parts are so arranged, constructed and combined as to make them readily accessible for manufacture, assembly, adjustment and repairs.

A feature of my invention is the provision of a switch of the non-restoring type, that is, one which remains in connection with the trunk last used when disconnection is effected, and which will again seize the trunk last used when a call is initiated, provided, of course, that the trunk in the meantime has not been seized by another switch and is in use at the time that the above-mentioned call is made.

Another feature of my invention is a novel latch mechanism for controlling the operation of the apparatus and the functions of certain of the relays associated with the switch of my invention.

Still another feature of my invention is the provision of a switch with a positive drive circuit that does not permit the wipers of the switch to stop on busy contacts nor to pass over idle contacts.

A still further feature of my invention is the provision of a non-restoring type of switch, which always drives against spring tension, thus combining the good features of both the spring restored and the non-restoring types of switches in one structure.

The above features as outlined, as well as others, will be more fully hereinafter described, and for a better understanding of my invention reference is to be had to the accompanying drawings in which like reference characters in the several views denote like parts, and in which:

Fig. 1 is a front elevation of the switch of my invention;

Fig. 2 is a plan view of Fig. 1;

Fig. 3 is a sectional view along the line 3—3 of Fig. 1;

Fig. 4 is a sectional view along the line 4—4 of Fig. 2;

Fig. 5 is a side elevation of the switch of my invention with certain parts omitted to more clearly illustrate the structure;

Fig. 6 is a partial view showing the latch mechanism;

Fig. 7 is a view illustrating the off-normal contacts; and

Fig. 8 illustrates diagrammatically an automatic telephone system including the line switch of my invention.

Referring now more particularly to the structure as illustrated in Figs. 1 to 7, inclusive, the line switch of my invention comprises a mounting plate 2 to which are secured the operating magnets and movable parts of the line switch. The plate 2 also carries a bank of contacts B which co-operate with the wipers W, which are supported upon the main shaft MS.

Contact bank B comprises any suitable number of contact sets, each set including a private contact 3, a common contact 4 and line contacts 5 and 6. Twenty-five sets of contacts per switch is a convenient number. The contacts are radially disposed between strips of insulation cloth 7 and 8 and strips 9 and 10 of micarta or other suitable material are placed between the contacts to properly space and insulate them. Strips of insulation 11 are placed between the clamping plates 12 and 13, and bolts 14 with nuts 15 secure the contact bank, as a whole, between the plates 12 and 13.

To secure the bank of contacts B to the supporting posts 19 (which are fastened to the plate 2), I provide the lower plate 13 with ears 16 and 17 bent over parallel to the plane of said plate 13, the said ears 16 and 17 and plates 12 and 13 being provided

with openings of a size to receive posts 19. Bank contacts B, as a whole, is slipped on the post 19 and screws 18, which have screw-threaded engagement with the bridge portion of the ears 16 and 17, are tightened to maintain the bank B, as a whole, in its adjusted position. Wipers 20, 21, 22 and 23 comprise two oppositely extending arms each, while the contact bank with which the wipers are operatively associated, forms a semi-circle so that when one set of arms leaves the last contact set 3, 4, 5 and 6, the other set of arms engages the first contact set. Wipers 20, 21, 22 and 23 are mounted upon the main shaft MS and are suitably insulated therefrom and are carried by a hub 24 which also supports their associated conducting rings 25, 26, 27 and 28. The wipers 20, 21, 22 and 23 are similarly constructed, for example, wiper 20 has a ring-shaped body portion 20′ and two arms 20^2 and 20^3, which are provided with flared ends for contacting with contacts 3. The pair of conducting rings 25 and 26 are properly spaced from the wipers 20 and 21 by means of metal washers 29. Spacer washer 30 and insulation washers 31 and 32 suitably space the various parts. Screws 33 and 34 clamp the wipers 20, 21, etc., and disks 25, 26, etc., to the hub 24 and pass through insulation bushings 35 and 36 and have screw-threaded engagement with the shouldered portion 24′ of the hub 24.

The hub 24 is provided with a central opening for the purpose of being slipped over the main shaft MS and when the wipers 20, 21, 22 and 23 are adjusted in alignment with their contacts 3, 4, 5 and 6, respectively, the set screw 38 is tightened to hold the wiper unit W in its adjusted position upon the main shaft MS. The conductor rings 25, 26, 27 and 28 form contacting surfaces for wiper brushes 41, 42, 43 and 44, which are suitably mounted upon a stud 45 and insulated therefrom, and from each other by insulation washers 46. The wipers are held upon the stud in any suitable manner, as by means of the nut 47 which has screw-threaded engagement with the stud 45, the said stud 45 being fastened to the plate 2 by means of the screw 48. The wipers 41, 42, 43 and 44 contact respectively and permanently with the conducting rings 25, 26, 27 and 28, which rings are in turn conductively connected to the wipers 20, 21, 22 and 23 by the washers 29, thus the wipers 20, 21, 22 and 23 are always conductively connected to the terminals 41′, 42′, 43′ and 44′. The main shaft MS is rotatably secured to the mounting plate 2 by means of the nuts 50 and 51 and the opening 52 in the mounting plate 2 serves as a bearing for the main shaft MS. A ratchet 53 is suitably secured to the main shaft MS in any suitable manner and through the medium of a motor magnet and pawl steps the wipers 20, 21, 22 and 23 step by step over the contacts 3, 4, 5 and 6. A retaining pawl 180 is pivoted to plate 2 by screw 181 and engages a tooth of ratchet wheel 53 and is thus yieldingly held by leaf spring 182 fastened to plate 2 by means of screw 183. Pawl 180 retains the wipers W in engagement with a set of contacts as selected by the switch.

The motor magnet MM which is adapted to move the wipers over the contacts of bank B, includes a pole piece 54, an armature 55 and a driving pawl 56. The electromagnet 57 is suitably secured to the pole piece 54 by means of a screw 58 which passes through a stud 59, the said screw having screw-threaded engagement with a suitable tapped opening in the core 60 of the magnet 57. The pole piece 54 has integrally formed ears 61 and 62 bent at right angles to the main part of the said pole piece 54, the said ears having suitable tapped openings which receive screws 63 to fasten the magnet 57, pole piece 54 and armature 55 as a unit to the mounting plate 2. The pole piece 54 is provided with projecting ears 64, bent at right angles to the main part of the pole piece, the said ears 64 being provided with suitable openings to receive the pivot pin 65, which pivot pin 65 pivotally supports the armature 55 of the motor magnet MM. The armature 55 is also provided with ears 66, which have suitable openings to receive the pivot pin 65. A U-shaped member 67 is also provided, the arms of which also have suitable openings for receiving the pivot pin 65. To pivotally support the armature 55 upon the pole piece 54, the pivot pin 65 is inserted in the openings in the ears 65 of the pole piece 54 and ears 66 of the armature 55 and through the openings in the arms in the U-shaped member 67. One arm of the member 67 fits between one of the supporting ears 64 of the pole piece 54 and the adjacent ear 66 of the armature 55. A set screw 68 is provided and has screw-threaded engagement with the yoke end of the member 67. The set screw 68 is used to securely hold the pivot pin 65 in place relative to the pole piece 54 and armature 55.

The armature 55 carries a pivoted driving pawl 56 which is normally held against an adjustable stop 70 by means of a leaf spring 71, the said leaf spring 71 being held in place by means of a screw 72. The adjustable stop 70 is pivotally secured to the mounting plate 2 by means of a screw 73. The stop 70 has an enlarged end 70′ provided with a slot 70^2 through which the screw 72′ passes. To adjust the pawl 56 in relation to the ratchet 53 the screws 72′ and 73 are loosened and the stop 70 is then moved about its pivot screw 73, causing the angular portion 70^3 to move to the right or left, as the case may be, and when the

proper adjustments are obtained, the screws 72′ and 73 which have screw-threaded engagement with suitable tapped openings in the plate 2 are tightened to hold it in its adjusted position. The armature 55 is held in its normal position by means of a coil spring 75, the said coil spring having its one end fastened to a pin 76 which is staked to the pole piece 54 and its other end is secured to an adjustable screw 77. The screw 77 passes through a suitable opening in the arm 78, which arm 78 is integrally formed with the armature 55, the said screw 77 being provided with an adjustable nut 79. The tension of the spring 75 is regulated by means of the nut 79. A set of contact springs J is associated with the motor magnet MM and is insulatingly mounted upon the pole piece 54 by means of the screws 80 which are suitably insulated from the springs J.

The pawl 56 is adapted to engage a tooth of the ratchet wheel 53 upon each actuation of the motor magnet MM, and an adjustable post 81 is provided for limiting the stroke of the pawl 53, so that the wipers 20, 21, 22 and 23 are only advanced one step at a time. The post 81 is suitably secured to the mounting plate 2 by means of a nut.

An auxiliary shaft AS is provided and extends through the hollow main shaft MS and has an arm 82 secured to its lower extremity by means of a screw 83. The arm 82 engages a stop 84 which is secured to the mounting plate 2 in any suitable manner and holds the auxiliary shaft AS in its normal position. The auxiliary shaft AS passes through a drum 85 which contains a coil spring 86, one end of the coil spring 86 being secured to the auxiliary shaft AS and the other end of the spring 86 being secured to the drum 85. The drum 85 is secured to a U-shaped bridge plate 87 by means of a nut 88, the bridge plate 87, in turn being secured to the mounting plate 2 by means of screws 89. The upper end of the auxiliary shaft AS protrudes through the main shaft MS and has secured to it a plate 90, which plate 90 is secured to the auxiliary shaft AS by means of the screw 91. The plate 90 pivotally supports a pawl 92 which is operatively associated with a ratchet 93. The main shaft MS is provided with a shouldered portion 94 upon which the ratchet 93 rests and is secured thereto by means of the screws 95. The pawl 92 normally engages a tooth of the ratchet 93 and when the main shaft MS is rotated, due to the actuation of the motor magnet MM, through the medium of the driving pawl 56 and ratchet 53, the ratchet 93 is rotated and as the pawl 92 engages a tooth of the ratchet 93, this motion is also transmitted to the auxiliary shaft AS, rotating the same against the normal tension of the spring 86.

The plate 90 is provided with up-turned ears 96, which ears form supporting means to pivotally support an arm 97, which arm is operatively associated with the pawl 92, the said arm being held in its normal position by means of a leaf spring 98. A retaining pawl or catch 99 is pivotally secured to the plate 90 and is operatively associated with the arm 97 but held away from the said arm 97 when the shaft AS is in its normal position by means of stop 100 which is secured to the angular extending portion 2′ of the mounting plate 2 by means of screws 101.

The cut-off relay CO which is secured to the angular portion of the mounting plate 2 comprises a heel iron 102, armature 103 and an electromagnet 104. The armature 103 is pivotally secured to the heel iron 102 and held in its normal position by means of a spiral spring 105 which has one end fastened to an extension 106 of the armature 103 and its other end secured to an adjustable screw 107. The screw 107 passes through a suitable opening in the angular extension 108 of the heel iron 102 and is provided with an adjustable nut 109 by means of which the tension of spring 105 is regulated. Spring contacts S are secured to the angular extension 110 of the heel iron 102 by means of the screws 111. The armature 103 is provided with an extending portion 103′ which is operatively associated with the arm 97 for purposes as will presently be described.

A set of off-normal contacts ON is secured to a bracket 112 by means of screws 113, the said bracket in turn being secured to the mounting plate 2 in any suitable manner. The off-normal contacts ON are held in their normal position by means of the arm 82 which is provided with a rubber buffer 400 which engages the contacts ON and holds them in their normal position.

Having described in detail the apparatus associated with the switch, I will now describe briefly the operation of the same. The motor magnet MM upon energization and through the medium of the driving pawl 56 and ratchet 53 rotates the main shaft MS, causing the wipers 20, 21, 22 and 23 to move step by step over the sets of contacts 3, 4, 5 and 6. The ratchet 93 which is secured to the main shaft MS is rotated therewith, and as the pawl 92 engages a tooth of the ratchet 93 and as the plate 90 which pivotally supports the pawl 92 is fastened to the auxiliary shaft AS, this motion is transmitted to the said auxiliary shaft AS against the normal tension of the spring 86. Upon the first step of the auxiliary shaft AS off normal, the arm 82 which is secured to the shaft AS disengages the off-normal contacts ON and allows them to assume their alternate position. The

arm 97 and catch 99 also move with the shaft AS as they are supported by the plate 90. When an idle set of contacts is encountered, further rotation of the wipers 20, 21, 22 and 23 is stopped and the cut-off relay CO energizes and the attraction of armature 103 of relay CO causes its extension 103′ of armature 103 of relay CO to engage the arm 97 to force it down against the normal tension of the leaf spring 98. The catch 99 being spring pressed is forced over, holding the arm 97 in its depressed position. The arm 97 engages the extension 92′ of pawl 92 and rotates it about its pivot and causes the pawl to disengage the tooth of the ratchet 93. The auxiliary shaft AS is now released from the main shaft MS and the shaft AS is now free to restore to normal under the tension of the spring 86. When the shaft AS reaches its normal position, the arm 82 again engages the off-normal springs ON and restores them to normal. The catch 99 also engages the stop 100 when the shaft AS reaches its normal position and this engagement of the stop 100 by the catch 99 forces the said catch 99 out of engagement with the said arm 97. Upon the termination of a connection the cut-off relay CO de-energizes and its armature 103 retracts to disengage the arm 97, allowing the arm to restore to normal and the arm 97 restoring disengages the extension 92′ of pawl 92, allowing the said pawl 92 to again engage a tooth of the ratchet 93. The main shaft MS remains in its position of advance, the wipers remaining in engagement with the contacts last used and upon the actuation of the motor magnet MM, the shafts MS and AS are again rotated until an idle contact set is engaged, providing that the contacts engaged by the wipers have been seized by another calling subscriber, and when an idle contact has been seized the shaft AS is again restored, as already described. Should all of the contact sets be busy, a complete revolution of the shafts MS and AS is brought about and upon the last step of the auxiliary shaft, the arm 97 engages a stop 115 which forces the arm 97 down to engage the pawl 92 to bring about the disengagement of the pawl 92 with the tooth of ratchet 93 to allow the shaft AS to restore. This operation of arm 97 causes the same to be latched in its operated position by latch 99, as before described. The latch 99 releases arm 97 when the auxiliary shaft again reaches normal. The stop 115 is integrally formed with the stop 100.

The circuit for Figure 8 shows a calling substation A connected to an individual line switch B, which is the switch of my invention. The said line switch B selects an idle connector C and the connector C connects to the terminals of a called substation D, which has a line switch B′, similar to B. The substation A has the usual talking apparatus and a calling device to send sets of impulses to operate the switch C to select the called substation D. The line switch B of my invention may have twenty-five contact sets and the circuit as shown at B is adapted to work with a switch structure described and illustrated in Figures 1 to 7, inclusive. The switch structure of the connector C may be similar to that illustrated and described in an application for Letters Patent filed by Harry H. Ide, June 18, 1917, and bearing Serial Number 175,364 now Patent No. 1,402,936, granted Jan. 10, 1922.

Assuming now that a call is to be extended from the calling substation A to the called substation D, upon the removal of the receiver by the subscriber at the calling substation A, line relay LR of the switch B energizes by current traced from battery through the line relay LR, conductors 200 and 201, normally closed off-normal contact 202, conductor 203, normal contact 204 of slow-acting relay S, conductor 205, normal contact 206 of the cut-off relay, through the substation back through normal contact 207 of the relay CO and contact 208 to ground at normal contact 209 of the slow-acting relay S. Wipers 20, 22 and 23 always rest upon the set of contacts 3, 5 and 6 last used, and assuming that the contacts upon which the wipers 20, 22 and 23 now rest are busy, due to another subscriber's line switch having selected the connector last used by the subscriber A, the private contact 3 engaged by wiper 20 will be provided with a guarding potential. The relay LR upon energization closes its alternate contact 210, establishing an energizing circuit for the slow-acting relay S traced from battery, through the winding of the relay S and conductor 211, to ground at alternate contact 210 of line relay LR. The private contacts 212 of the calling subscriber's line are also grounded from the ground at alternate contact 210 of line relay LR, over conductor 211, normal contact 213 of off-normal contacts ON, conductor 214, normal contact 215 of relay CO to the private contacts 212, making the private contacts busy against intrusion by any other subscriber who wishes to connect to the now calling subscriber at substation A. The closing of alternate contact 216 of the line relay LR establishes an energizing circuit for the motor magnet MM, traced from battery through the said motor magnet, the alternate contact 216 of line relay LR, conductor 217, normal contact 219 of cut-off relay CO, conductor 220 and wiper 20 to the ground at busy private contact 3. The magnet MM steps the wipers 20, 22 and 23 to engage the next set of contacts. The opening of normal contact 204 of slow-

acting relay S upon its energization opens the initial energizing circuit of the line relay LR and the line relay restores.

Upon the first step of the switch wipers off normal, off-normal contacts ON assume their alternate position and should the contact S now engaged by the wipers 20, 22 and 23 be busy, a substitute energizing circuit for the line relay LR is established, traced from battery through the winding of line relay LR, conductor 200, normal contact 221 of motor magnet MM, the motor magnet MM having restored to normal, conductor 222, alternate contact 223 of off-normal contacts ON, conductor 218, normal contact 219 of cut-off relay CO, conductor 220, wiper 20 to the grounded private contact 3.

The closing of alternate contact 216 of line relay LR again closes an energizing circuit for the motor magnet MM over the previously described path. The line relay LR and the motor magnet MM are thus alternately energized and de-energized, the motor magnet MM stepping the wipers 20, 22 and 23 from one set of contacts to the next as long as busy grounded contacts are encountered. Slow-acting relays S has its circuit opened at alternate contact 210 upon each de-energization of the line relay LR, but due to the slow-to-release construction of the said relay S, the relay remains energized during the rapid interruptions of line relay LR. The closing of alternate contact 213 of the off-normal contacts ON places a substitute ground upon the private contacts 212, over conductor 214, through normal contact 215 to the said contacts 212. When an idle private contact 3 is encountered, relay LR and magnet MM remain unoperated and the opening of alternate contact 210 of line relay LR allows the slow-acting relay S to restore, and the closing of its normal contact 225 establishes an energizing circuit for the cut-off relay CO, traced from battery through the winding of relay CO, normal contact 225 and conductor 226 to ground at alternate contact 227 of off-normal contacts ON.

The cut-off relay CO upon energizing attracts its armature 103, which armature engages arm 97 and moves it in a downward direction to engage pawl 92, forcing the said pawl 92 out of engagement with a tooth of the ratchet 93 secured to the main shaft MS. The catch 99 is moved inward and latches the arm 97 during the restoration of the auxiliary shaft AS. The disengagement of the pawl 92 from ratchet 93 allows the auxiliary shaft AS to restore to normal under the tension of spring 86, and when the said shaft AS has restored the arm 82 secured to the said auxiliary shaft AS engages the off-normal contacts ON, again restoring them to their normal position. The off-normal contact 227 upon restoring opens the initial energizing circuit of the cut-off relay CO, but the said relay being slow to release is held up momentarily until a substitute circuit is established for it, as will presently be described.

Relay CO having been energized, its contacts 206, 207 assume their alternate position and the wipers 20, 22 and 23 of the individual switch B having engaged an idle set of contacts 3, 5, and 6 of the idle connector C, a circuit for the impulse relay IR of the connector C is established over a path traced from battery through the left-hand winding of the interrupter relay IR, conductor 230, contact 5, wiper 22, alternate contact 206 of relay CO, through the substation, alternate contact 207, wiper 23, contact 6 and conductor 231 to ground through the right-hand winding of interrupter relay IR. The closing of alternate contact 232 of interrupter relay IR establishes a substitute energizing circuit for the cut-off relay CO of the individual line switch B, traced from battery, through the winding of the cut-off relay CO, its alternate contact 219, conductor 220, wiper 20, contact 3, conductors 233, 234 and 235 to ground at alternate contact 232 of the interrupter relay IR. The closing of alternate contact 215 of relay CO places a ground or busy potential upon the private contacts 212. The connector switch is now associated with the calling subscriber at the substation A.

If the private contact 3 engaged by the wiper 20 is idle and the subscriber at the calling substation A initiates a call, the line relay LR is energized as before described, as is also the slow-acting relay S, but the closing of alternate contact 216 of line relay LR does not energize motor magnet MM since there is no ground on the contact 3 and the magnet MM remains inert. The contacts 204 and 225 of the slow-acting relay S are so adjusted that upon the energization of relay S the alternate contact 225 is closed before normal contact 204 is opened, permitting the energization of cut-off relay CO, traced from battery through the winding of relay CO, alternate contact 225 of relay S, conductor 310, normal contact 311 of off-normal contacts ON, conductor 312, and normal contact 313 of motor magnet MM to ground at alternate contact 210 of relay LR. The cut-off relay CO upon energization closes its alternate contact 219 establishing a substitute circuit for itself over the circuit from connector D, as previously described. Thus switch B only travels when its wipers are in engagement with a busy trunk when a call is initiated.

The energization of the relay IR brings about the energization of the relays 236 and 237, the circuit of relay 236 extending from battery through the right-hand winding of

said relay, normal contact 238 of the primary off-normal contacts PON, conductor 233 and conductor 234 to ground at alternate contact 232 of relay IR. The circuit for relay 237 extends from battery through the lower winding of the relay 237, conductor 239, conductor 240, and alternate contact 241 of relay IR to ground at alternate contact 232 of impulse relay IR. Upon the energization of relay 236, a locking circuit is closed for the said relay, extending from battery through its alternate contact 242 to ground. Assuming that the called subscriber's number at substation D is 45, the subscriber now operates his calling device CD to send four impulses of current over the line. These four impulses of current bring about four de-energizations and energizations of the relay IR, causing the primary magnet PM to energize and deenergize four times to step the wipers 243, 244 and 245 in a downward primary direction to the fourth group of contacts containing the contacts 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 246 of switching relay SW, conductor 247, alternate contact 248 of relay 237, normal contact 241 of relay IR, conductor 234, conductor 233, and normal contact 238 of the primary off-normal contacts PON to ground at alternate contact 242 of relay 236.

After the primary off-normal contact 238 has moved on the first step of the switch shaft, the ground fed from contact 249 of relay 250 is substituted for the ground fed through contact 242 of relay 236. After the last impulse of the series has been sent, the steady flow of current through both windings of relay 237 causes the said relay 237, due to its differential action, to neutralize and restore its contacts to normal. Relay 237 does not restore during the sending of impulses due to its adjustment, construction, and the rapidity of the interruptions of contact 241. The closing of normal contact 251 of relay 237 brings about the energization of the switching relay SW, traced from battery through the winding of said relay to make-before-break contact 252 of said relay, normal contact 253 of secondary off-normal springs SON, conductor 254, normal contact 251 of relay 237, and conductor 255 to ground at alternate contact 256 of primary off-normal contacts PON, the said primary off-normal contacts PON having been moved to their alternate position on the first step of the wipers 243, 244 and 245 of the connector switch. The closing of alternate contact 246 of the switching relay SW now renders the secondary magnet SM operative so that when the calling subscriber at the substation A actuates his calling device again to send the last set of impulses, which we have assumed are five in number, the said magnet SM will be energized and de-energized by the impulse relay IR five times over a circuit traced from battery through the winding of the said magnet SM, alternate contact 246 of relay SW, conductor 247, alternate contact 248 of relay 237, normal contact 241 of relay IR, conductor 234, conductor 233 and alternate contact 238 of the primary off-normal contacts PON, and conductor 257′ to ground at normal contact 249 of relay 250. The secondary magnet SM now steps the wipers 243, 244 and 245 in a secondary rotary direction to engage contacts 257, 258 and 259 of the called line. Upon the first impulse of the last set, the relay 237 again energizes to permit the secondary magnet SM to be operated, and after the last impulse the relay 237 is again deenergized, as previously described. The restoration of the relay 237 closes a circuit for the test relay TR traced from battery, through the winding of the said relay, conductor 260, the alternate contact 261 of relay SW, alternate contact 253 of the secondary off-normal contacts SON (said contacts having been moved to their alternate position upon the first step of the wipers in their secondary direction), conductor 254, normal contact 251 of relay 237, conductor 255, to ground at alternate contact 256 of the primary off-normal contacts PON. The closing of alternate contact 262 of relay TR connects the said relay over conductor 263 to the test wiper 243, and should the called line be busy the private contact 257 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 257 of the called line will have a battery potential upon it, and the relay TR will not remain energized but will de-energize. The opening of normal contact 264 of relay TR opens the circuit of the switching relay SW. The relay SW de-energizing, opens the circuit for the relay TR at its contact 261, leaving the relay TR dependent upon the potential found upon the private contact 257 of the called line for its holding potential, and, as assumed, this contact is free from ground potential, therefore, the relay TR de-energized and returns to normal. The relay TR de-energizing causes the energization of the relay 250 over a circuit which may be traced from battery through the relay S′, to bank contact 257, through wiper 243, resistance 265, conductor 263, normal contact 262 of relay TR, conductor 266, normal contact 267 of relay SW, conductor 268, through the lower winding of the relay 250, and conductor 269 to ground at alternate contact 270 of relay 236. The energization of relay S′ con-

nects relay CO′ to the private wiper 243, but owing to the resistance 265 placed in circuit with the private wiper, the relay CO′ does not effectively energize when placed in circuit with the private wiper 243. Relay S′ energizing renders switch B′ unresponsive to the removal of the receiver at the called substation. The closing of alternate contact 271 of relay 250 short-circuits the lower winding of the said relay, and the closing of alternate contact 272 of relay 250 closes a circuit through the upper winding of the said relay, through the alternate contact 272 and conductor 269 to ground at alternate contact 270 of relay 236.

The closing of alternate contact 273 of relay 250 connects the interrupter I to the relay 274. The circuit for relay 274 may be traced from battery through the winding of the said relay 274, conductor 275, alternate contact 273 of relay 205, conductor 276, normal contact 277 of relay RC and through the interrupter I to ground. The relay 274 is thus intermittently energized and de-energized, and upon each de-energization of the relay 274 the ringing generator RG is connected to the called line over a circuit extending from the ungrounded pole of the generator RG, through normal contact 278 of ringing control relay RC, conductor 279, alternate contact 280 of relay 250, conductor 281, normal contact 282 of relay 274, wiper 245, bank contact 259, through the condenser and call bell of the called substation, back through bank contact 258, wiper 244, normal contact 283 of relay 274, and conductor 284 to ground at alternate contact 249 of relay 250.

The call bell of the called subscriber at the substation D is thus intermittently rung, due to the energization and de-energization of the relay 274 by the interrupter I. When the called subscriber answers and the relay 274 is in its energized position, a circuit for the relay SR is closed, which may be traced from battery through the lower winding of the relay SR, through alternate contact 282 of relay 274, wiper 245, contact 259, through the now closed contacts of the substation switch hook at the called substation D, back through contact 258, wiper 244, alternate contact 283 of relay 274, 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 and make-before-break contact 285 to ground at alternate contact 286 of relay SR. The closing of alternate contact 287 of relay RC closes a locking circuit for the said relay which may be traced from battery through the winding of the said relay, its alternate contact 287 and conductor 255 to ground at alternate contact 256 of the primary off-normal contacts PON. The opening of normal contacts 277 and 278 disconnects the interrupter I and the ringing generator RG to prevent further application of ringing current. A substitute circuit for the relay 274 is now established which may be traced from battery through the winding of the relay 274, conductor 275, alternate contact 273 of relay 250, conductor 276, alternate contact 277 of relay RC and conductor 255, to ground at alternate contact 256 of primary off-normal contacts PON. 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.

The subscribers having finished conversation, and assuming that the subscriber at the calling substation A is the first to replace his receiver upon the switch hook, the opening of the switch hook contacts brings about the de-energization of the impulse relay IR of the connector C. The restoration of the relay IR brings about the opening of the holding circuit of the relay CO of the individual switch B, which relay CO restores, and the armature of relay CO restoring to normal disengages the arm 97 allowing it to assume its normal position, and the arm 97 when normal disengages pawl 92, allowing the same to again engage a tooth of the ratchet 93, placing the switch B in condition for another call.

The subscriber D restoring his receiver upon its switch hook interrupts the circuit of the relay SR at the switch hook contacts, causing the said relay to de-energize. The closing of normal contact 290 of relay SR closes a circuit through the left-hand winding of the relay 236, which may be traced from battery through the left-hand winding of the said relay 236, alternate contact 291 of relay 236, conductor 292, normal contact 290 of relay SR and conductor 293 to ground at normal contact 232 of relay IR. Due to the differential construction of relay 236, the said relay neutralizes and restores to normal. The closing of normal contact 294 of relay 236 closes an energizing circuit for the secondary magnet SM, which may be traced from battery through the winding of said secondary magnet SM, conductor 295, normal contact 294 of relay 236, alternate contact 296 of the primary off-normal contacts PON, through the interrupter I′ to ground. The secondary magnet SM thus steps the wipers 243, 244 and 245 beyond the last set of contacts in the group. The wipers then restore to normal from this position by spring tension. The restoration of the relay 236 brings about the opening of the circuit of the relay 250 at alternate contact 270, and the relay 250 restoring opens the circuit of relay 274 at

contact 273 of relay 250, and the primary off-normal contacts PON having restored upon the restoration of the switch, the opening of the alternate contact 256 of PON brings about the de-energization of the relay RC. The relay 236 also brings about the de-energization of the cut-off relay S' of the line circuit B', which is associated with the called subscriber D. All the apparatus used in establishing a connection between a calling subscriber at the substation A and the called subscriber at the substation D is now at normal and available for use in establishing other connections.

Assuming now that the subscriber at the called substation D was first to replace his receiver upon the switch hook, the opening of the switch hook contacts at the substation D 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 switch hook contacts. The relay IR de-energizing closes a circuit for the left-hand winding of relay 236, causing the said relay to de-energize, as hereinbefore described. The restoration of the individual switch B and connector C is the same as previously described from this point on. Should the called subscriber D fail to replace his receiver upon the switch hook 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 C, the same as before, and the opening of alternate contact 232 of impulse relay IR opens the circuit of the relay CO of individual switch B as before described, and causes the release of switch B.

The subscriber at the called substation failing to replace his receiver, permits the continued energization of the relay SR, thus holding the contact 290 of said relay in its alternate position, preventing the differential wound relay 236 from restoring to normal and closing the energizing circuit for the secondary magnet SM. The relay 237 energizes when the line or impulse relay IR drops back, but is immediately restored to normal, due to the closure of an energizing circuit through the lower winding of the said relay 237, which may be traced from battery through the said lower winding, conductor 239, alternate contact 290, conductor 293, to ground at normal contact 232 of the now restored impulse relay IR. Relay 237 being differentially wound, restores to normal and the closing of normal contact 298 of the said relay 237 places a ground upon the private contact of the connector C, over a circuit which may be traced from ground at alternate contact 256 of the primary off-normal contact PON, conductor 255, normal contact 251 of relay 237, conductor 254, alternate contact 253, normal contact 298, alternate contact 299 of the secondary off-normal contacts SON, to the private contact 3. The placing of this busy potential upon the private contact prevents any individual switch B from engaging the contacts of this busy connector.

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 257 has a busy potential placed upon it, thus closing a locking circuit for the test relay TR from battery through the winding of the said relay, its alternate contact 262, conductor 263, and the wiper 243 to ground at contact 257. The closing of alternate contact 300 of the test relay TR connects the busy signal BB to the line to transmit a busy signal to said calling subscriber at substation A, thus notifying him of the busy condition of the said called substation D. The relay TR upon locking up to ground at private contact 257, closes a circuit for relay RC, traced from battery, through the winding of said relay RC, make-before-break contact 285, normal contact 286 of relay SR, normal contact 261 of relay SW, conductor 260, alternate contact 262 of relay TR and conductor 263 to the grounded private contact 257. The relay RC thus closes a locking circuit for itself, traced through the winding of said relay RC, alternate contact 287, conductor 255 to ground at alternate contact 256 of the off-normal contacts PON. Now should the line called become idle during the time the busy signal is being transmitted to the calling substation, the falling back of relay TR will not cause the called subscriber to be signaled owing to the fact that relay RC is locked up to ground at contact 256.

The calling subscriber now replaces his receiver, bringing about the de-energization of the impulse relay IR. The relay IR restoring, opens the circuit of the relay CO of the individual switch B to release the switch, as previously described, thus bringing about the release of the individual switch B. The relay IR de-energizing, brings about the restoration of the relay 236, due to the fact that the relay SR has not been energized. The closing of the circuit through the left-hand winding of the circuit 236 brings about the neutralization of said relay 236. The closing of normal contact 294 of the said relay 236 closes a circuit through the secondary magnet SM, which magnet steps the wipers 243, 244 and 245 beyond the last set of contacts. The wipers then restore to normal by spring tension. The primary off-

normal contacts PON and secondary off-normal contacts SON are also restored, and the apparatus used in this busy connection is now at normal and available for use in establishing other connections.

While I have shown a system of 100 capacity, it is to be understood that by inserting first selectors the system may be increased to a 1,000 system, etc.

From the foregoing it is readily seen that I have provided a switch in which the wipers always rotate in one direction, but in which the switch has the advantage of always driving against spring tension.

It is to be understood that I do not wish to be limited to the exact matter shown, as various other arrangements may readily suggest themselves to one skilled in the art. Therefore, I desire to cover all such changes and modifications as come within the spirit and scope of the appended claims.

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

1. A telephone system including an automatic switch, a rotatable shaft for said switch, a spring-restored shaft, wipers for said switch adapted to be advanced by said first switch shaft but to remain in their antecedent progressive position when the said second shaft is released, and a motor magnet for operating said first switch shaft.

2. A telephone system including a non-numerical trunk selecting switch including a selecting shaft, a spring-restored shaft for said switch, movable contact makers for said switch adapted to be advanced by said selecting shaft but to remain in their antecedent progressive position when the said spring-restored shaft is released, and a step-by-step motor magnet for driving said selecting shaft.

3. A telephone system including a non-numerical trunk selecting switch including a movable shaft, a spring-restored shaft for said switch, movable contact makers for said switch adapted to be advanced by said first shaft but to remain in their antecedent progressive position when the said second shaft is released, a step-by-step motor magnet for driving said first switch shaft, a test relay for said switch, a circuit for said test relay including a contact for said motor magnet, and a circuit for said motor magnet including a contact for said test relay.

4. A telephone system including a non-numerical trunk selecting switch including a selecting shaft, a spring-restored shaft for said switch, movable contact makers for said selecting switch adapted to be advanced by said selecting shaft but to remain in their antecedent progressive position when the spring-restored shaft is released, a step-by-step motor magnet for driving said selecting switch shaft, a test relay, and circuits for said motor magnet and said test relay controlled by contacts of each other, whereby when one of said magnets energizes it operates to deenergize the other of said magnets.

5. An automatic telephone system including an individual automatic switch having a non-restoring shaft, a spring-restored shaft for said switch, a movable contact maker for said switch adapted to be moved by said non-restoring switch shaft to a predetermined position and to remain in its advanced position when the spring-restored shaft is released, and a motor magnet for operating said switch shaft.

6. A telephone system including an automatic selector switch having a non-restoring shaft, a spring-restored shaft for said switch, contact wipers movable by said non-restoring shaft, means for moving said first switch shaft and wipers to an idle line, and means for releasing said second switch shaft upon selection made while maintaining said wipers in connection with the selected line.

7. A telephone system including an automatic trunk selecting switch provided with bank contacts, a non-restoring switch shaft and a spring-restored switch shaft, a movable contact maker adapted to be moved by said first switch shaft to an idle one of said bank contacts, a motor magnet for advancing said first switch shaft and contact maker to the idle bank contact, and means for releasing said second switch shaft upon selection made while maintaining said contact maker in its antecedent progressive position.

8. A telephone system including an automatic trunk selecting switch provided with bank contacts, a non-restoring switch shaft and a spring-restored switch shaft, a movable contact maker adapted to be moved by said first switch shaft to an idle one of said bank contacts, a motor magnet for advancing said first switch shaft and contact maker to the idle bank contact, and means for releasing said second switch shaft while permitting the contact maker to remain in connection with the idle selected bank contact.

9. A telephone system including an automatic switch, a spring-restored switch shaft for said switch, a second switch shaft for said switch, contact wipers connected to said second switch shaft, mechanism operatively connecting said first switch shaft to said second switch shaft so that both of said shafts travel together in a progressive direction, means for advancing said second switch shaft whereby said second switch shaft and wipers are advanced, and means for releasing said first switch shaft while maintaining said second switch shaft and wipers in their antecedent progressive position.

10. An automatic selector switch includ-

ing a movable switch shaft, a second movable switch shaft associated therewith and mechanically connected thereto, wipers movable by said first switch shaft, spring-restoring means for said second switch shaft, means for advancing the said first switch shaft whereby it advances against the tension of said spring-restoring means, and means for releasing said second switch shaft whereby said spring-restoring means returns said second switch shaft to normal while said first switch shaft remains in its advanced position.

11. An automatic selector switch provided with a switch shaft having contact makers, a second switch shaft having spring-restoring means for returning the same to normal, mechanism connecting said first switch shaft with said second switch shaft, driving means for advancing said first switch shaft against the spring tension of said second switch shaft, and means for releasing said second switch shaft from said first switch shaft whereby said second switch shaft returns to normal and said first switch shaft remains in its advanced position.

12. An automatic selector switch provided with a switch shaft having contact makers, a second switch shaft having spring-restoring means for returning the same to normal, mechanism connecting said first switch shaft with said second switch shaft, driving means for advancing said first switch shaft against the spring tension of said second switch shaft, and means for operating said connecting mechanism when the second switch shaft reaches a predetermined position, thereby releasing said second switch shaft but permitting said first switch shaft to remain in its advanced position.

13. An automatic selector switch provided with a switch shaft having contact makers, a second switch shaft having spring-restoring means for returning the same to normal, mechanism connecting said first switch shaft with said second switch shaft, driving means for advancing said first switch shaft against the spring tension of said second switch shaft, means for operating said connecting mechanism when the second switch shaft reaches a predetermined position, thereby releasing said second switch shaft but permitting said first switch shaft to remain in its advanced position, and means for maintaining said second switch shaft disconnected from said first switch shaft until the said second switch shaft returns to normal.

14. An automatic selector switch provided with a switch shaft having contact makers, a second switch shaft having spring-restoring means for returning the same to normal, mechanism connecting said first switch shaft with said second switch shaft, driving means for advancing said first switch shaft against the spring tension of said second switch shaft, means for operating said connecting mechanism when the second switch shaft reaches a predetermined position, thereby releasing said second switch shaft but permitting said first switch shaft to remain in its advanced position, means for maintaining said second switch shaft disconnected from said first switch shaft until the said second switch shaft returns to normal, and means for releasing said last means whereby said first switch shaft is again connected to said second switch shaft.

15. An automatic selector switch including a movable switch shaft provided with contact makers, a second switch shaft associated with said first switch shaft, a spring for returning said second switch shaft to its normal position, means for advancing said first switch shaft, a link connecting said second switch shaft to said first switch shaft whereby said first switch shaft is advanced against the tension of the spring associated with said second switch shaft when said first switch shaft is advanced, and means for disconnecting said second switch shaft from said first switch shaft upon selection made, whereby said second switch shaft returns to normal while said first switch shaft remains in its advanced position.

16. An automatic selector switch including a movable switch shaft provided with contact makers, a second switch shaft associated with said first switch shaft, means for advancing said first switch shaft, a spring for returning said second switch shaft to its normal position, a link connecting said second switch shaft to said first switch shaft whereby said first switch shaft is advanced against the tension of the spring associated with said second switch shaft, means for disconnecting said second switch shaft from said first switch shaft upon selection made, whereby said second switch shaft returns to normal while said first switch shaft remains in its advanced position, and mechanism for maintaining said second switch shaft disconnected from said first switch shaft until said second switch reaches its normal position.

17. A telephone system including an automatic trunk selecting switch provided with bank contacts, a non-restoring switch shaft and a spring-restored switch shaft, a movable contact maker adapted to be moved by said first switch shaft to an idle one of said bank contacts, a motor magnet for advancing said first switch shaft and contact maker to the idle bank contact, and means for releasing said second switch shaft while permitting the contact maker to remain in connection with the idle selected bank contact, said second switch shaft being adapted to again advance from its normal position when said first shaft is again operated to

move said contact maker from its antecedent progressive position.

18. An automatic switch provided with a switch shaft adapted to always be advanced in the same direction, and a second switch shaft for moving simultaneously with said first switch shaft and adapted to be released and restored while said first shaft remains in its advanced position.

19. Progressive selecting switch mechanism including a pair of rotatable shafts operatively associated with traveling line contact making means and an off-normal-spring controller traveling with said means but restoring independently.

20. Automatic non-numerical selecting switch means including progressive non-restoring contact makers, an off-normal-spring controller traveling with said makers, and means for restoring said controller at time of selection.

21. Automatic selecting switch means including progressively adjustable wipers secured to a non-restoring rotatable shaft, an off-normal-contact controller, means for causing said wipers and controller to travel together, and means for causing one to restore while the other is at rest.

22. Automatic progressively adjustable contact apparatus actuated against spring tension, automatic means for adjusting the tension at the time the apparatus selects, automatic means for maintaining said apparatus in its selected position, and a cut-off relay for permitting a part of said apparatus to restore to normal.

23. A continuously forward traveling line switch operated against spring tension and having individual driving mechanism normally at rest, and contact wipers for said switch movable in a single plane and always in the same direction.

24. Non-restoring normally at rest progressive selecting mechanism traveling against spring tension, means to prevent excess of said tension, and a set of off-normal contacts controlled by said mechanism.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 17 day of October, 1919.

LEROY D. KELLOGG.