

R. S. WILBUR.
 AUTOMATIC TELEPHONE SYSTEM.
 APPLICATION FILED JULY 11, 1910.

1,157,745.

Patented Oct. 26, 1915.
 10 SHEETS—SHEET 1.

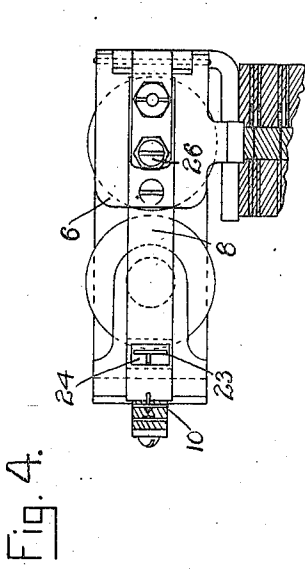


Fig. 4.

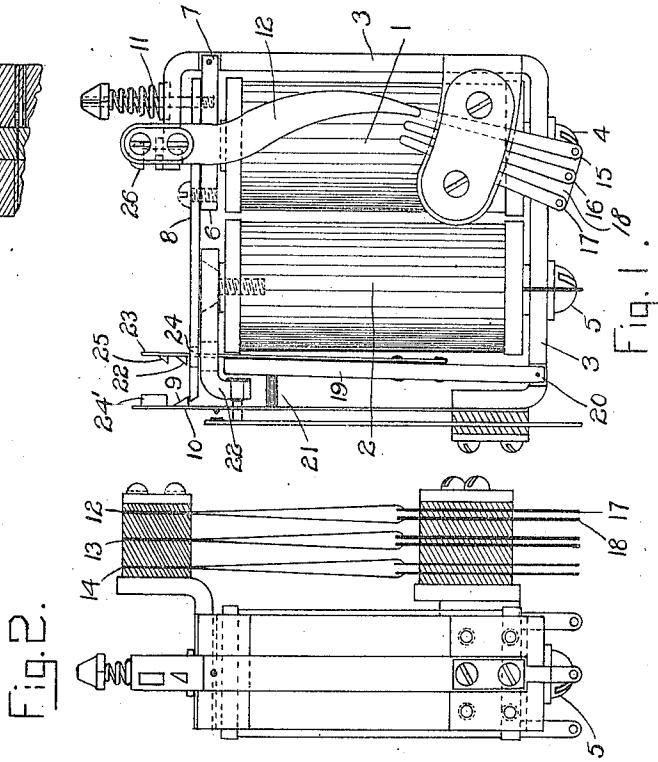


Fig. 1.

Fig. 2.

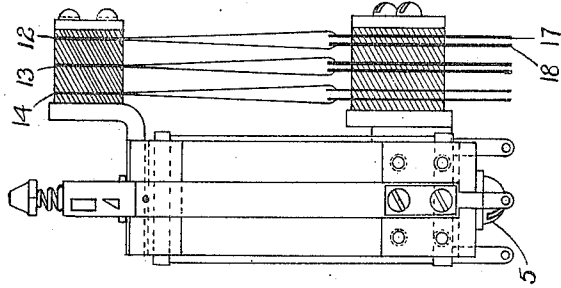


Fig. 3.

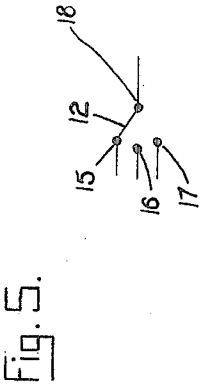
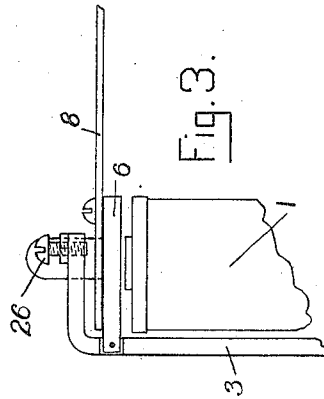


Fig. 5.

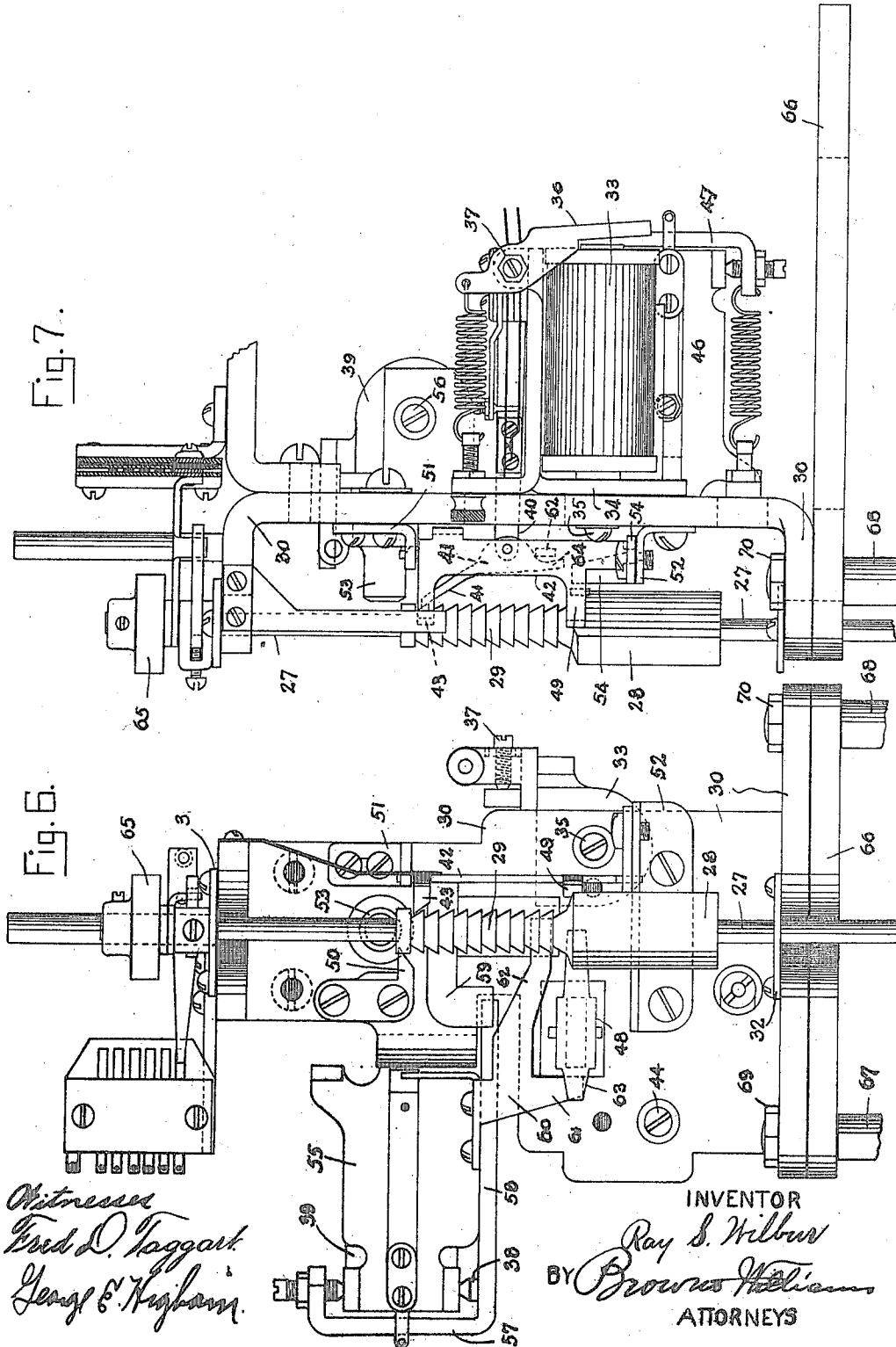
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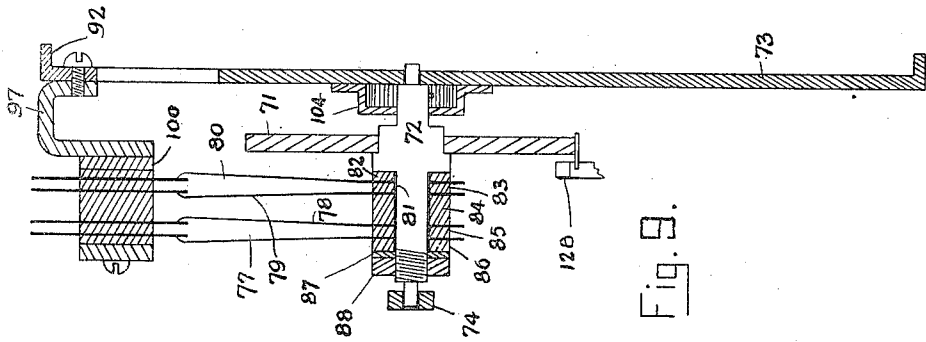


Fig. 9.

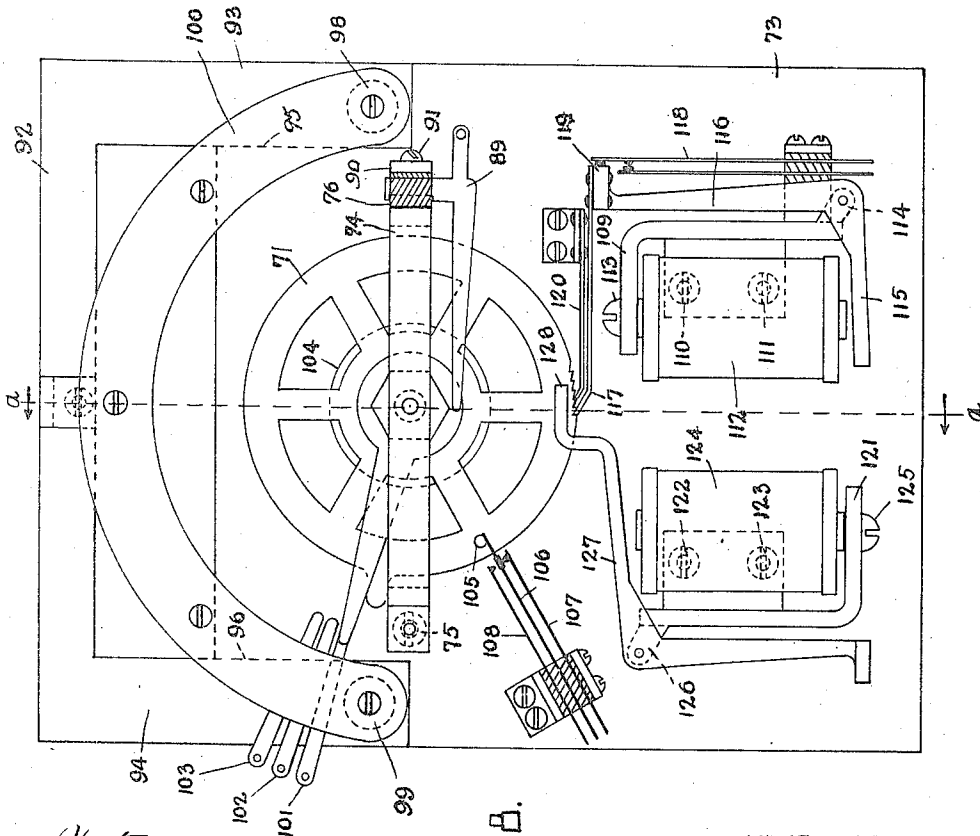


Fig. 8.

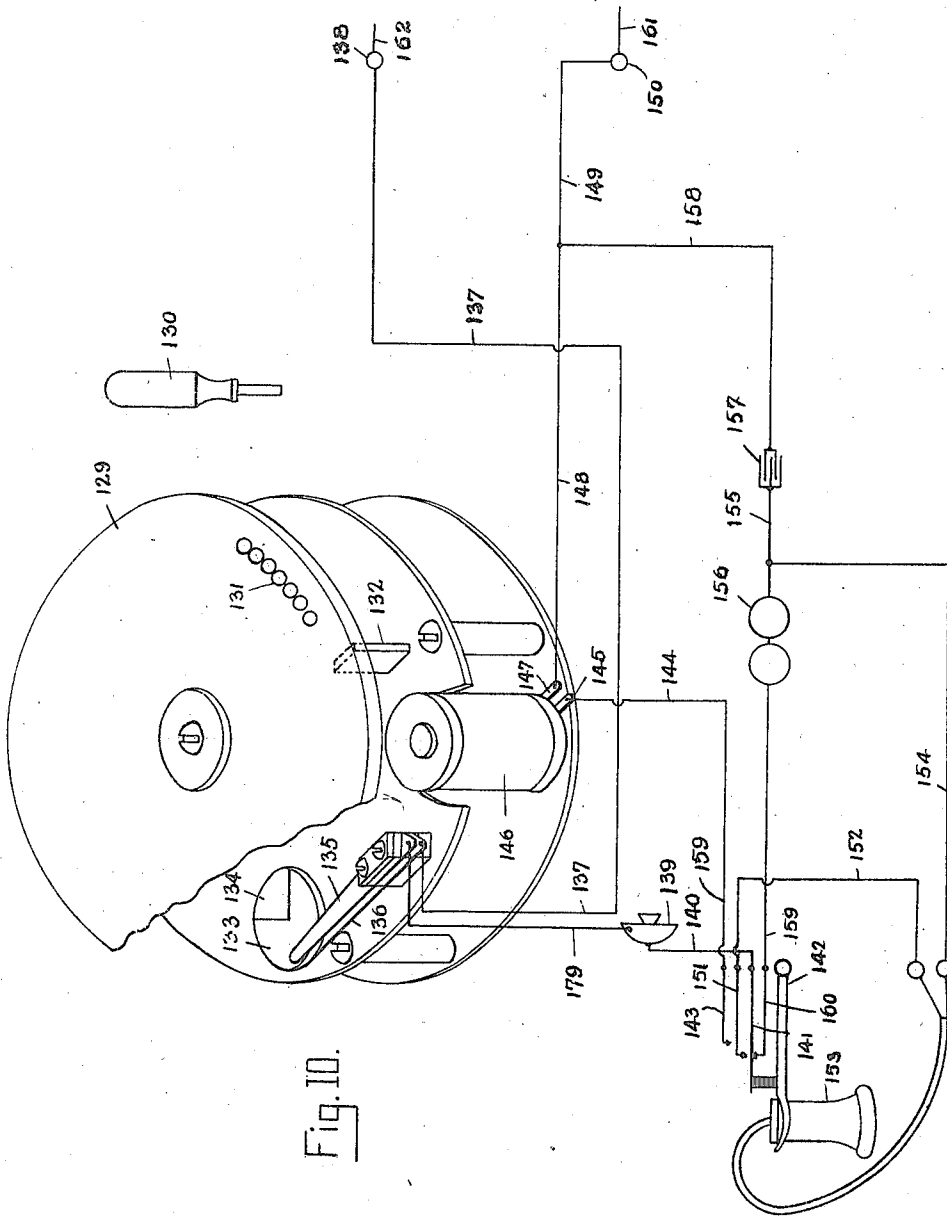
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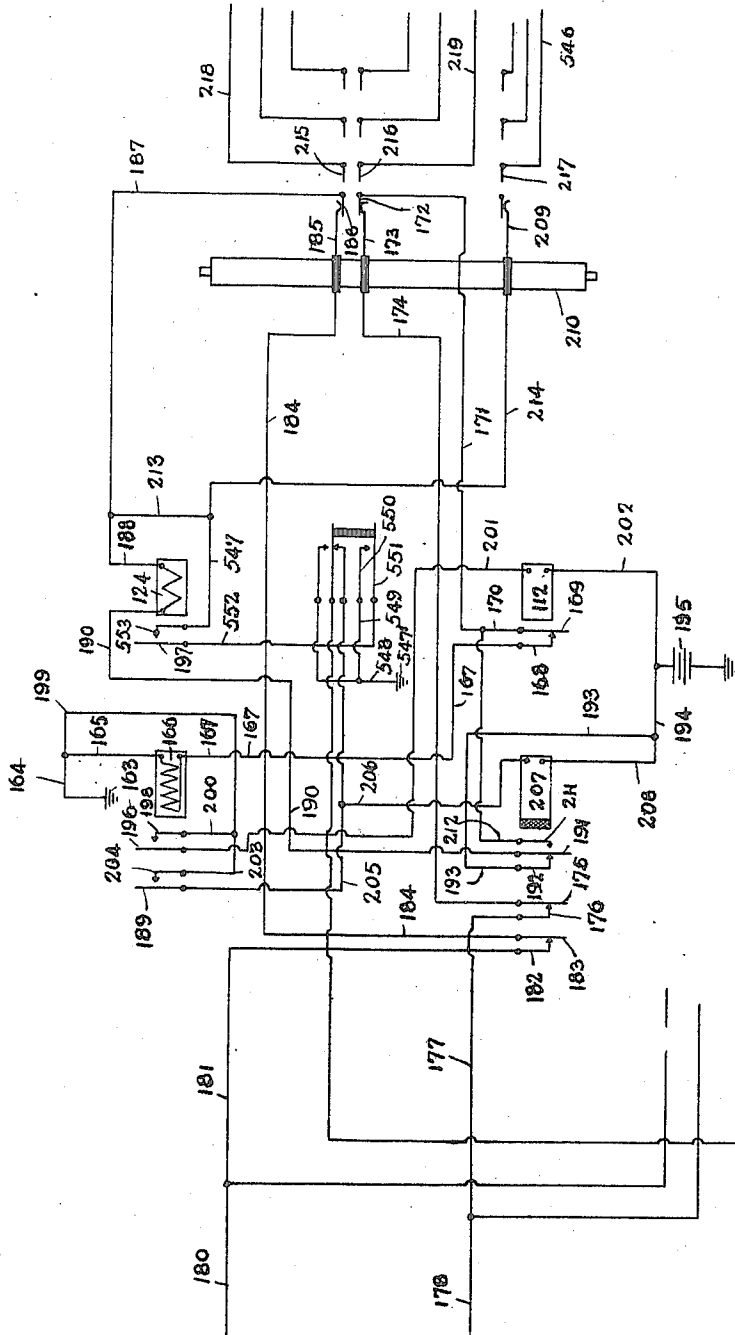
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Fig. 11.



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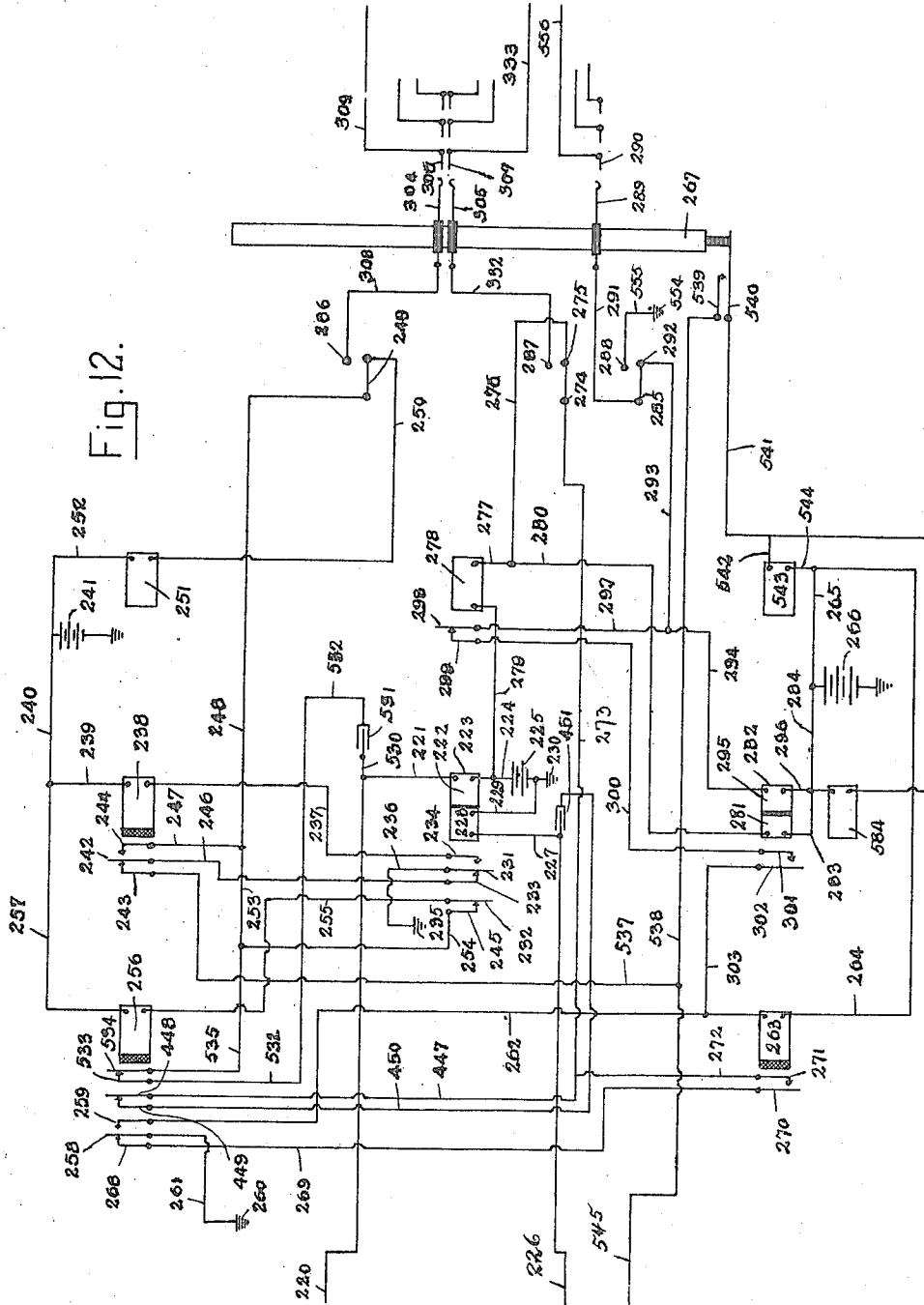


Fig. 12.

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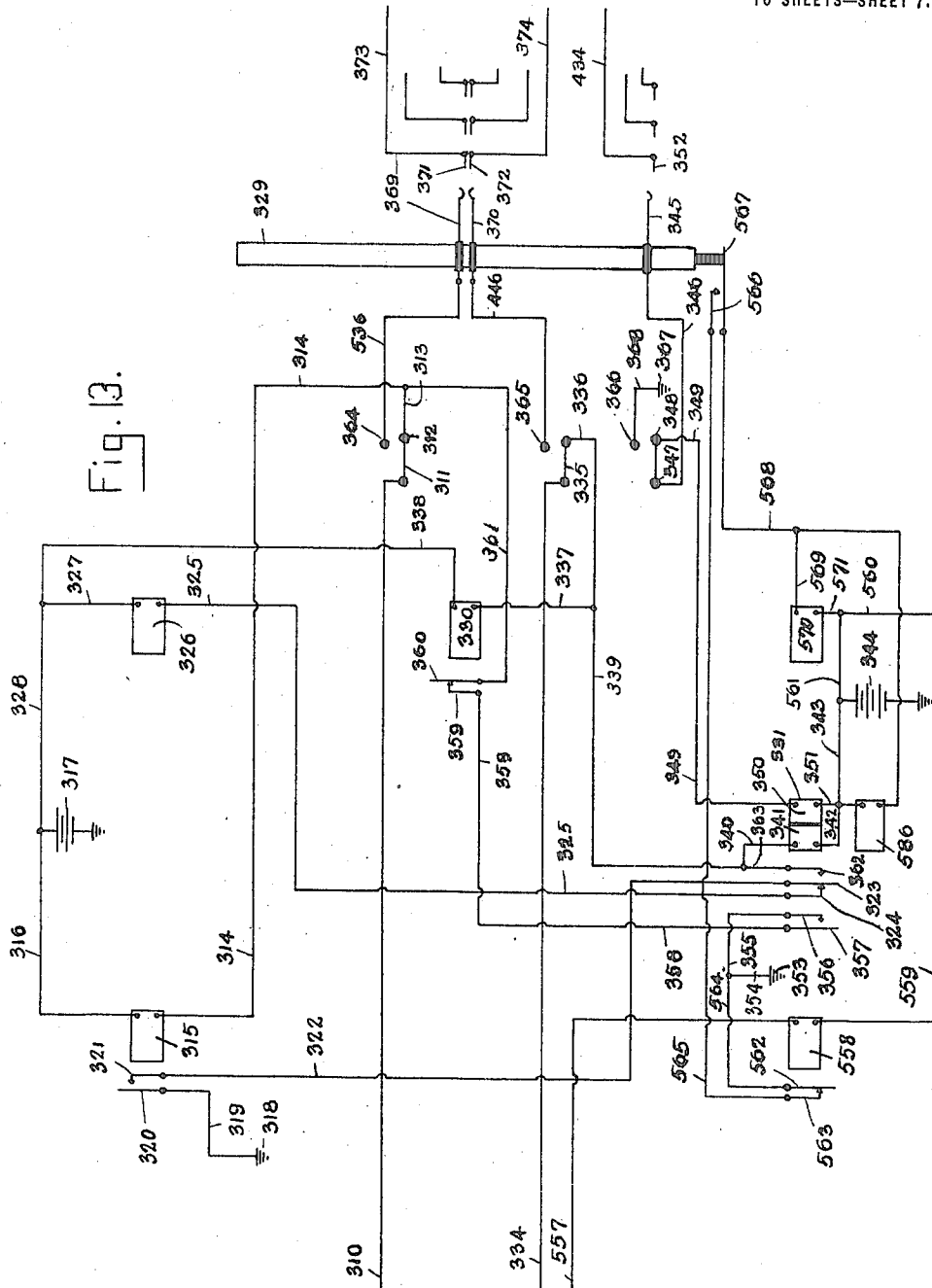
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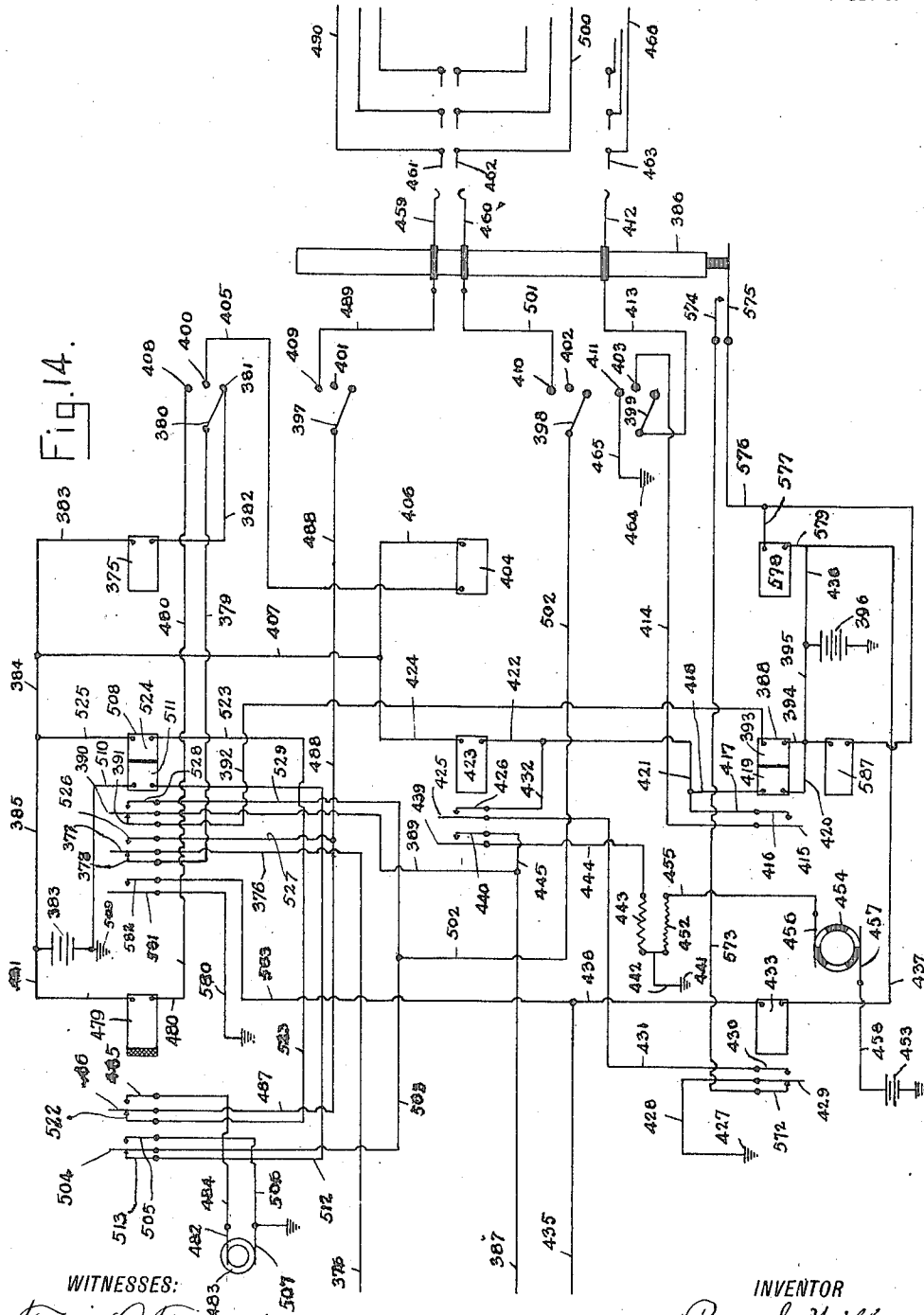
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10 SHEETS—SHEET 8.



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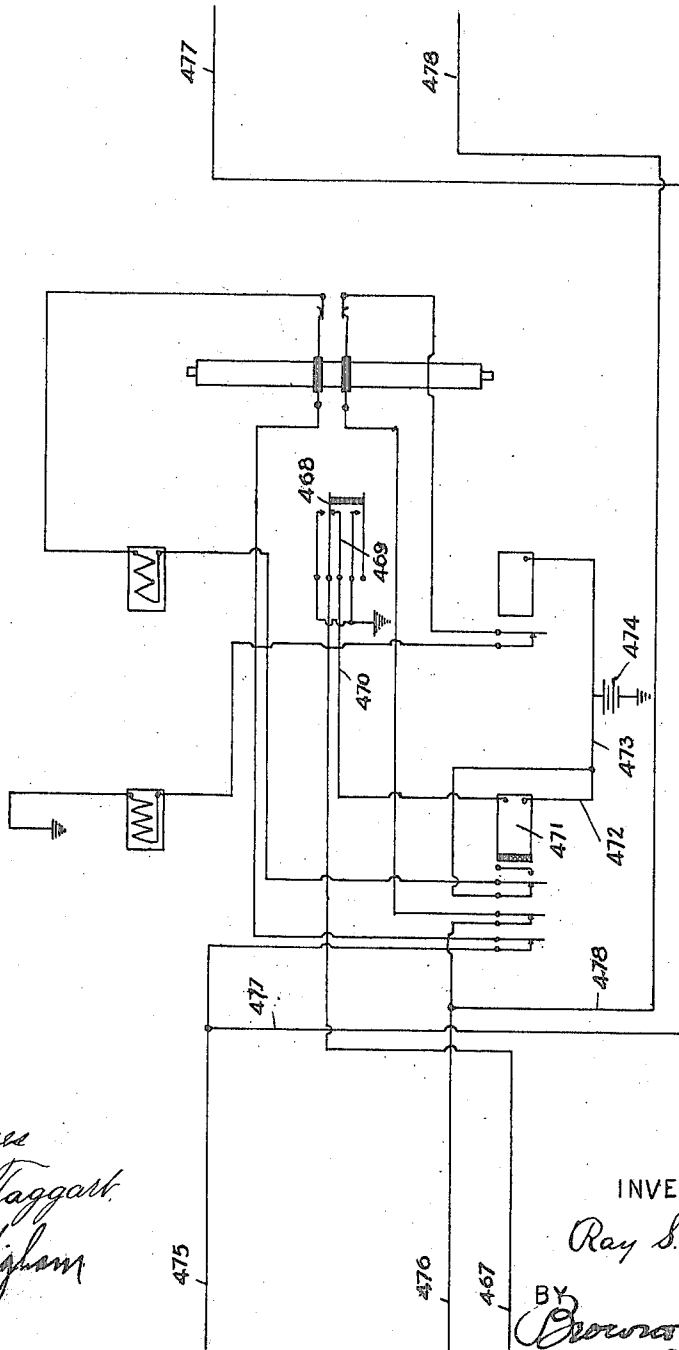
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Fig. 15.



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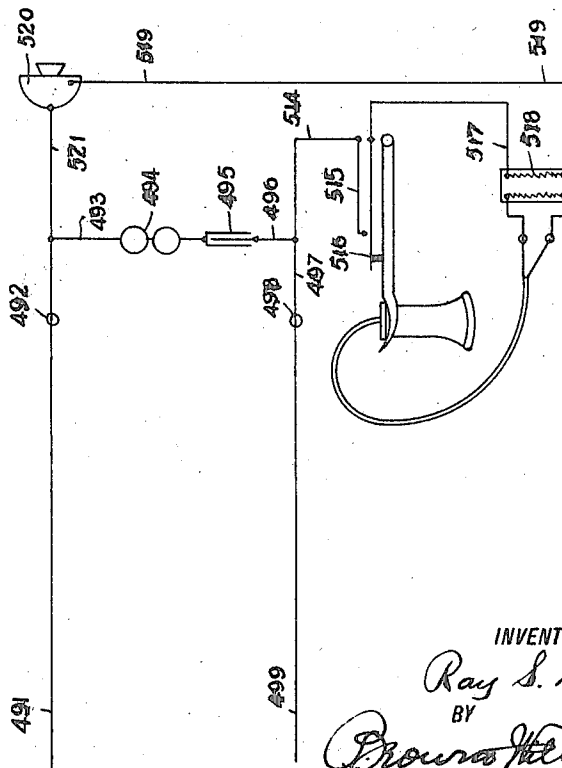
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Fig. 16.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, RAY S. WILBUR, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented a certain new and Improved Automatic Telephone System, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention has for its object to accomplish the connection of subscribers to a telephone exchange system by means of automatic apparatus at the exchange adapted to be actuated by the subscriber initiating the call, without the intervention of an operator at the exchange.

My invention is an improvement over automatic telephone systems heretofore employed in that the first selector switch usually associated with each telephone line is replaced by a comparatively simple "trunk finder" which is automatically operated upon the removal of the receiver at the calling station without a further act on the part of the calling subscriber to select an idle trunk circuit extending from the calling line to the first selector switches employed in setting up the connection to the called subscriber. By my invention the number of first selector switches required is the same as the number of second selector switches and third selector switches and is preferably such that each digit of a number corresponding to a called subscriber is provided with ten of these switches or in other words that one hundred of each of the selector switches mentioned are required. This provides that each digit may be selected over any one of ten paths or trunks until the connector switch is reached, the latter serving to establish connection between the last selector switch employed and the called subscriber.

By my invention the apparatus employed in connection with each selector switch is automatically cut off from the built up connecting circuit as the connection proceeds toward the called subscriber, and when the connection is effected the only paths connected across such connection are those required to furnish battery to the connected subscribers for talking purposes. In other words, the resulting connection is the equivalent of the most efficient form of connecting

circuits known in connection with the operation of manual exchanges which is characterized by conductors at the exchange separated either by condensers or the windings of a repeating coil in such a manner that each section of the circuit may be separately supplied with battery from the exchange for talking purposes and furthermore that no other windings than those employed in the supply circuits are connected during conversation across the conductors establishing such talking connection.

By my invention the number of actuating magnets and relays required for the actuation of the automatic switching mechanism is materially reduced thus reducing the cost of installation of such a system.

An advantage secured by my present system is that the calling subscriber is supplied with battery current from the first selector switch, also the called subscriber is supplied from the connector switch thus avoiding the necessity for the flow of current through the contacts of the intermediate connecting mechanisms. The automatic switching device may be of any desired type, those shown in the accompanying drawings being of the well known form in which wipers are adapted to be moved vertically by succeeding current impulses, opposite rows of contacts corresponding to the digits of the number wanted, and in which when the wipers come opposite the proper rows or banks of contacts such wipers may be moved angularly in engagement with the contacts until an idle trunk is found which is in connection with the contacts selected by the wipers.

My invention further consists in a means for restoring the selecting apparatus to its normal condition at the termination of a conversation which apparatus operates over a third wire of each trunk involved in the connection beginning at the first selector switch and disconnecting each of the succeeding switches one after the other in a forward direction through the connection.

The several drawings illustrating the invention are as follows:

Figure 1 is a side view of an auxiliary switch or mechanism used in connection with the main connecting switch; Fig. 2 is a top view of the switching mechanism shown in Fig. 1; Fig. 3 is a view of the auxiliary

switching mechanism taken from the opposite side from that shown in Fig. 1 and shows the armature operated by the lower magnet; Fig. 4 is a view taken from the lower end of the parts of the auxiliary switching mechanism shown in Fig. 1; Fig. 5 is a diagrammatic view of the results accomplished by the auxiliary switching mechanism shown in Figs. 1 to 4 inclusive, the convention employed in Fig. 5 being similar to that employed throughout the description of the apparatus below; Fig. 6 is a front view of one of the main switches; Fig. 7 is a side view of the mechanism shown in Fig. 6; Fig. 8 is a top view of the trunk finder; Fig. 9 is a sectional view taken along the line *a-a* of Fig. 8, and shows the method of carrying the wipers on the rotary shaft of the trunk finder and the manner in which the wipers engage the contacts of the switching mechanism; Fig. 10 is a diagrammatic drawing of a substation circuit and shows in diagrammatic perspective view a calling mechanism used to control the circuits of the automatic connecting switches at the exchange; Fig. 11 is a diagrammatic circuit drawing of the connections employed in the trunk finder switch shown in Figs. 8 and 9; Fig. 12 is a diagrammatic circuit drawing of a first selector switch; Fig. 13 is a diagrammatic circuit drawing of a second selector switch; Fig. 14 is a diagrammatic circuit drawing of a connector switch; Fig. 15 is a diagrammatic circuit drawing similar to Fig. 11 of a trunk finder switch connected with the called subscriber; and Fig. 16 is a diagrammatic circuit drawing of the apparatus located at a called substation which is involved in establishing a talking connection.

Referring to Figs. 1, 2, 3 and 4, the construction of the auxiliary switch is as follows; Coil 1 is the release magnet and coil 2 is the escapement magnet, both being fastened to a heel piece 3 by screws 4 and 5 screwed into the cores of the coils. Coil 1 has an armature 6 pivoted on the heel piece 3 at 7. To the armature 6 there is fastened an arm 8 which engages a hook 9 on a spring 10. A spring 11 is provided to cause the armature 6 to move away from the core of the coil 1 when such armature is released from the hook 9 on the spring 10. The armature 6 carries a set of wipers 12, 13 and 14, as shown in Fig. 2. The wiper 12 engages the contacts 15, 16 and 17 when in its different positions and the wipers 13 and 14 engage similar contacts disposed below the contacts 15, 16, and 17. The wiper 12 is divided into two parts one of which engages the contacts 15, 16 and 17, while the other engages the segment 18, as shown in Fig. 2. As a result, segment 18 is placed in electrical connection with either the contact 15, 16 or 17 depending upon the position of the arma-

ture 6. The wipers 13 and 14 are constructed in a manner similar to that described for the wiper 12. An armature 19 is provided for the escapement magnet 2 pivoted to the heel piece 3 at the point 20. The armature 19 is connected by an insulating stud 21 with the spring 10 and when the magnet 2 is energized, the armature 19 is attracted to the pole piece 22, thus moving the spring 10 to release the arm 8 from the hook 9 carried by such spring. When thus released, the spring 11 moves the armature 6 outwardly away from the magnet 1 and causes the wiper 12 to move toward the contact 16. Before the wiper 12 leaves the contact 15 it is stopped by the engagement of the hook 22' on a spring 23 carried by the armature 19 and extending through an opening in the arm 8, as shown at 24 in Fig. 4. When the magnet 2 is deenergized the armature 19 drops back to normal position and allows the arm 8 to move into engagement with the stop 24' carried by the spring 10 and at the same time allowing the wiper 12 to leave the contact 15 and rest upon the contact 16. Another upward and downward motion of the armature 19 causes a similar operation between the stop 24' on the spring 10 and the hook 25 on the spring 23, thus permitting the wiper 12 to leave the contact 16 and to rest upon the contact 17 under the action of the spring 11. When the magnet 1 is energized, it attracts the armature 6 and moves the arm 8 to again engage the hook 9 and the wipers 12, 13 and 14 are returned to their normal contacts where they remain until the armature 19 is again operated as described above. An adjusting screw 26 is provided in the heel piece 3 to limit the outward motion of the armature 6 so as to prevent motion of the wipers 12, 13 and 14 beyond the contact 17.

In Fig. 5 the pivotal point 18 represents the segment 18 above referred to, while the switch 12 and the contacts 15, 16 and 17 represent diagrammatically the wiper 12 and the contacts 15, 16 and 17 above referred to. Figs. 6 and 7 show one of the main automatic switches employed in effecting the connection between a called and the calling subscriber. As shown in these figures, a shaft 27 carries two ratchets 28 and 29 adapted to move the shaft in a rotary and a vertical direction respectively. The shaft 27 is carried from the bracket 30 by two bearings 31 and 32. A magnet 33 is provided with a heel piece 34 and both are fastened to the bracket 30 by a screw 35. The heel piece 34 has an armature 36 pivoted to it at 37, which pivot is similar to a pivot 38 shown in connection with the magnet 39. The armature 36 has an arm 40 extending toward the shaft 27 to which arm is pivoted the pawl 41 which engages the ratchet 29. When the magnet 33 is ener-

gized, it attracts the armature 36, which in turn lifts the pawl 41 and thereby the shaft 27 by means of the ratchet 29. After the shaft has been lifted one step, it is held in this position by a pawl 42 which is provided with an extending arm 43 engaging the ratchet 29. As a result, when the magnet 33 is deenergized, the shaft 27 does not drop back, but is held in the position to which it has been actuated and the pawl 41 moves downwardly and into engagement with another tooth of the ratchet 29 ready to lift the shaft 27 another step when the magnet 33 is again energized. The bracket 30 has also secured to it by a screw 44 a rotary magnet, the part 46 shown in Fig. 7 being the heel piece thereof. The rotary magnet is provided with an armature 47 pivoted to the heel piece 46 and to the armature 47 there is secured an arm similar to the arm 40 above described in connection with the armature 36. The arm secured to the armature of the rotary magnet has pivoted thereto a pawl 48 which engages the ratchet 28. The operation of the armature 47 of the rotary magnet moves the pawl 48 to rotate the shaft 27 which is held in the position to which it is advanced by means of an arm 49 extending from the pawl 42 into engagement with the ratchet 28. A support 50 is provided in connection with the ratchet 29, which support normally lies in a vertical groove in such ratchet and necessitates motion of the shaft 27 first in a vertical direction, after which motion the support 50 may enter one of the grooves of the ratchet to permit rotary motion of such shaft, thus serving to support the shaft in the vertical position to which it has been moved while the pawl 42 is passing over the teeth of the ratchet 28 during rotary motion of the shaft. The pawl 42 is supported in suitable bearings in the brackets 51 and 52. A stop 53 is carried by the bracket 30 to limit the motion of the pawl 41 so that the shaft 27 may be raised one step at a time. A similar stop 54 is provided to so limit the motion of the pawl 48 that the shaft 27 may be rotated but one step at a time by means of the ratchet 28.

Assuming now that the shaft 27 has been displaced several steps in a vertical direction and several steps in a rotary direction, the next operation is that of releasing or returning the shaft to its normal position. This is accomplished by means of the magnet 39 which is secured to a heel piece 55 and to the bracket 30 by means of a screw 56. The magnet 39 is provided with an armature 57 pivoted to the heel piece 55 as indicated and provided with an arm 58 extending toward the shaft 27. This arm rests back of the arm 59 extending from the pawl 42, as a result of which an outward movement of the arm 58 moves the pawl 42 upon its pivotal supports and moves the arms 43

and 49 from engagement with the ratchets 29 and 28 respectively. The arm 58 has secured to it a member 60 consisting of two portions, one of which 61 rests normally back of the tail 63 on the pawl 48, while the other portion 62 rests normally back of the tail 64 of the pawl 41. When the armature 58 is moved outwardly therefore, it serves not only to disengage the arms 43 and 49 of the pawl 42 from the ratchets 29 and 28 respectively, but also to disengage the pawls 41 and 48 from such ratchets and to leave the shaft free to be returned to normal position which is accomplished by means of a spring located in the cup 65 and by the action of gravity. The spring rotates the shaft backwardly to its normal position at which time the support 50 is in line with the groove in the ratchet 29 and gravity causes the shaft to then drop to its normal position.

The complete switch is supported on the back frame or support 66 which holds the switches that make up a complete switchboard. The two posts 67 and 68 are screwed into the frame 66 while the bracket 30 is provided with clearance holes for the posts so that the switch can be removed from the bank support by taking off the nuts 69 and 70 from the ends of the posts 67 and 68. The posts 67 and 68 support the banks of contacts adapted to be engaged by suitable wipers carried by the shaft 27, which contacts and wipers are not here shown since they may be constructed in a manner well known in the art and do not constitute an essential part of this invention.

The trunk finder switch is constructed as indicated in Figs. 8 and 9 in which a ratchet wheel 71 is supported by a shaft 72 suitably mounted in bearings in the switch base 73 and in a bridge 74 secured to the base by screws 75. Wipers 77, 78, 79 and 80 are carried but insulated from the shaft 72 by an insulating bushing 81, such wipers being separated from each other by insulating washers 82, 83, 84, 85 and 86. These washers and wipers are all clamped securely in position by the washer and nut 87 and 88. Each of the wipers 77, 78, 79 and 80 is provided with a feeder spring, the feeder for the wiper 77 being shown in Fig. 8 at 89. These feeders make contact with circular portions of the corresponding wipers disposed around the shaft 72 and are supported by a block of insulating material 76 secured to the bridge 74 by the clamping plate 90 by means of screws 91. The base 92 used to support the bank of contacts adapted to be engaged by the wipers has two arms 93 and 94 grooved on their edges at 95 and 96 so as to slide on the base 73 and thus line up the base 92 with the switch base 73 to properly center the contacts. The bank base 92 has secured thereto by means of the three sup-

ports 97, 98 and 99, the bank 100. Contacts 101, 102 and 103 illustrate the method of arranging the contacts of the bank 100 with which the wipers 77, 78, 79 and 80 make contact. For the particular system described in the present specification, it is to be understood that there are to be eleven contacts in each row and three different rows. The shaft 72 is held in its normal position by a spring in the cup 104 which also serves to return it to normal position after it has been rotated and released. The ratchet wheel 71 carries an insulated post 105 which engages the spring 106 and normally causes such spring to make contact with a spring 107. One rotary step of the ratchet wheel 71 is sufficient to cause the spring 106 to break contact with the spring 107 and to make contact with the spring 108. These springs are called off normal springs. To the base 73 there is secured the heel piece 109 by means of the screws 110 and 111. This heel piece has secured thereto a coil 112 by means of a screw 113 and is provided with two ears 114 which pivotally support the armature 115. The armature 115 has secured thereto an arm 116 extending toward the ratchet wheel 71, which arm carries at its upper end a spring 117 which acts as a pawl for operating the ratchet wheel 71. When the coil 112 is energized, the armature 115 is attracted and thus the arm 116 is moved outwardly, bringing the pawl 117 into engagement with another tooth of the ratchet wheel 71. When the coil 112 is deenergized, the spring 118 engaging the arm 116 at the point 119 advances the ratchet wheel 71 one step. A retaining pawl 120 is provided to engage the teeth of the ratchet wheel 71 to hold it in the position to which the pawl 117 has moved it. A heel piece 121 is secured to the base 73 by screws 122 and 123. This heel piece has secured thereto a coil 124 by means of a screw 125. This heel piece has formed thereon two ears which pivotally support the armature 127 of the coil 124. The armature 127 has extending therefrom back of the two pawls 117 and 120 an arm 128, so disposed that when the coil 124 is energized, the attraction of the armature 127 moves the arm 128 to lift the pawls 117 and 120 away from the ratchet wheel 71, thus leaving it free to be rotated to normal position by the operation of the spring in the cup 104.

As shown in Fig. 10, the mechanism used at a calling station is indicated diagrammatically by a disk 129 adapted to be operated by a removable handle 130 which may be inserted in any one of a plurality of holes 131 to rotate the disk varying amounts, at the end of which rotation the lower end of the handle projecting below the disk 129 engages a fixed stop 132. After any such rotation when the handle 130 is released, suit-

able spring mechanism not shown serves to rotate the disk 129 to its normal position, at the same time rotating the make and break mechanism consisting of a metal plate 133 provided with an insulating sector 134 upon opposite sides of which are disposed the contact springs 135 and 136 supported by and insulated from the frame of the sending mechanism. As a result, when the springs 135 and 136 rest upon the metal disk, the conductors connected with such springs are electrically connected together and when the insulating sector 134 rests between the springs 135 and 136, the circuit through the wires connected with such springs is interrupted. The spring 136 is connected by the wire 137 with one terminal 138 of the substation apparatus, the other spring 135 being connected with one terminal of the transmitter 139, the other terminal of which is connected by wire 140 with a spring 141 of the switch 142. The spring 143 of the hook switch is connected by wire 144 with one terminal 145 of the magnet 146, the purpose of which magnet is to be explained. The other terminal of this magnet 147 is connected by wires 148 and 149 with the terminal 150 of the substation apparatus. The spring 151 of the hook switch is connected by wire 152 with one terminal of the receiver 153, the other terminal of which is connected by wire 154 with wire 155 connecting one terminal of the ringer 156 with one terminal of the condenser 157. The other terminal of the condenser is connected by wire 158 with wire 149. The other terminal of the ringer is connected by wire 159 with the spring 160 of the hook switch. The terminals 150 and 138 are connected respectively with the line conductors 161 and 162. It is thought that in view of the description of the apparatus already given and the diagrammatic nature of the remaining drawings, that the construction and operation of the apparatus may be readily understood by following through the operation of the apparatus in setting up a connection without describing in detail the circuit connections employed.

Assuming that the substation shown in Fig. 10 desires to effect a connection with the substation shown in Fig. 16, and that the trunk finder shown in Fig. 11, the selector switches shown in Figs. 12 and 13, the connector switch shown in Fig. 14, and the trunk finder switch shown in Fig. 15 are involved in making the connection, the operation is as follows: The subscriber at the substation shown in Fig. 10 removes receiver 153 from the hook switch 142, thus closing the following circuit: ground 163, wire 164, wire 165, coil 166, wire 167, spring 168, spring 169, wire 170, wire 171, contact 172, wiper 173, wire 174, spring 175, spring 176, wire 177, wire 178, conductor 161, ter-

minal 150, wire 149, wire 148, coil 146, wire 144, spring 143, spring 151, spring 141, wire 140, transmitter 139, wire 179, spring 135, metal plate 133, spring 136, wire 137, terminal 138, wire 162, wire 180, wire 181, spring 182, spring 183, wire 184, wiper 185, contact 186, wire 187, wire 188, coil 124, wire 190, spring 191, spring 192, wire 193, wire 194 to battery 195, thus closing a circuit from ground 163 through coils 124 and 166 to battery 195. This flow of current will energize coil 166 and cause its armature to operate spring 189 and the spring 196. Coil 124 is low wound and has a heavy spring tension on its armature, therefore it will not operate spring 197. When spring 196 is brought into contact with spring 198 by the movement of the armature for coil 166, the following circuit will be closed: ground 163, wire 164, wire 199, wire 200, spring 198, spring 196, wire 201, coil 112, wire 202 to battery 195. When the motor magnet 112 is energized, the following circuit is closed: ground 163, wire 164, wire 199 and wire 203, spring 204, spring 189, wire 205, wire 206, coil of the cut-off relay 207, wire 208, wire 194 to battery 195, thus energizing cut-off relay 207 which is a slow acting relay having a copper shield over its core. Therefore, while the motor magnet 112 is moving wipers 185, 173 and 209 over the bank contacts, relay 207 will cause its armature to operate springs 183, 175 and 191, thus opening the two lines 180 and 178, at the same time keeping the wipers 185 and 173 free from any connections while they are passing over busy contacts or trunks.

Through the medium of mechanism not shown in the drawing, the magnet coil 146 controls the movement of the impulse-sending device so that its dial 129 and its contact making segments 133 and 134 cannot be rotated for the purpose of sending impulses except during the period when battery from the central office is applied to the limbs 161 and 162 of the telephone line. This renders it impossible for a subscriber to use his interrupting device during the period of energization of the relay 207, which relay is energized as above described during the selective movement of the wipers carried by the shaft 210. If all the trunks with which the wipers of the shaft 210 may connect are busy, the relay 207 will remain actuated and the calling subscriber will be unable to send any impulses over the line.

Spring 191 being operated will be in contact with spring 211, thus completing the following circuit: ground 163, wire 164, wire 165, coil 166, wire 167, spring 168, spring 169, wire 170, wire 212, spring 211, spring 191, wire 190, coil 124, wire 188, wire 213, wire 214 to wiper 209. Therefore, if wiper 209 finds battery on the contacts over which it is passing, the relay 166 will be energized

and as the circuit for relay 166 passes through the contacts 168 and 169 which are controlled by the motor magnet 112, it is apparent that each time the motor magnet is energized, it will deenergize relay 166 which will in its turn deenergize motor magnet 112. This alternate action will be continued as long as wiper 209 finds battery on the contacts over which it passes, thus stepping the wipers 185, 173 and 209 over busy contacts. By busy contacts is meant contacts that are in use at some other switch connected in multiple with the switch shown in Fig. 11.

To show how one of the switches shown in Fig. 11 may make another of such switches with which it is multiplied busy by being in use, assume that wiper 209 has stopped on a certain contact, the corresponding contacts of the other switches will be made busy by the following circuit: wiper 209, wire 214, wire 213, wire 188, coil 124, wire 190, spring 191, spring 192, wire 193, wire 194 to battery 195. The springs 191 and 192 are in engagement at this time since the magnet 112 has ceased to advance the wipers 185, 173 and 209. This provides that one subscriber cannot break in upon the conversation of another subscriber who has established a connection making busy certain of the contacts of the trunk finder switch.

Assume now that wipers 185, 173 and 209 have been moved to contacts 215, 216 and 217, thus extending the lines 180 and 178 through to trunks 218 and 219. Trunk 218 is connected through wires 220 and 221, coil 222 of relay 223 and wire 224 to battery 225. Trunk 219 is connected through wires 226 and 227, coil 228, and wire 229 to ground 230, thus closing the circuit through the telephone Fig. 10 to energize operating relay 223. When relay 223 is energized, it will cause springs 231 and 232 to move. Spring 231 will break contact with spring 233 and make contact with spring 234, thus closing a circuit from ground 235 through wire 236, springs 231 and 234, wire 237, relay 238, wires 239 and 240 to battery 241. This will energize slow relay 238 and cause spring 242 to break contact with spring 243 and make contact with spring 244.

Assume now that the line at the telephone is opened for an instant as occurs in sending selecting impulses from the calling substation, allowing relay 223 to be deenergized, thus causing spring 231 to make contact with spring 233 and spring 232 to make contact with spring 245. Relay 238 being slow will remain in operated condition for the instant that relay 223 is deenergized, thus causing a current flow from ground 235, through wire 236, spring 231, spring 233, wire 246, spring 242, spring 244, wire 247, wire 248, wiper 249, wire 250, vertical magnet 251, wire 252 to battery 241. At the same time a second circuit is closed from

wire 247 to wires 253, 254, spring 245, spring 232, wire 255, relay 256, wire 257, wire 240 to battery 241. Thus, during the instant that the telephone circuit is opened, vertical magnet 251 and relay 256 will receive a momentary flow of current.

Relay 256 being a slow relay will remain in operated condition during the continuance of a series of recurring impulses coming one after the other in rapid succession. While relay 256 is in operated condition, spring 258 is in contact with spring 259, thus causing a current flow from ground 260 through wire 261, spring 258, spring 259, wire 262, relay 263, wire 264, wire 265 to battery 266, thus energizing relay 263. Assume now that five impulses were sent over the line and vertical magnet 251 has lifted the shaft 267 five steps. At the cessation of these impulses relay 256 allows spring 258 to break contact with spring 259 and make contact with spring 268, thus de-energizing relay 263, which, being a slow relay, will stay in operated position for an instant allowing a flow of current from ground 260, through wire 261, spring 258, spring 268, wire 269, spring 270, spring 271, wire 272, wire 273, wiper 274, contact 275, wire 276, wire 277, rotary magnet 278, wire 279, wire 224 to battery 225. At the same time a branch circuit is closed from wire 276 as follows: wire 280, coil 281 of escapement magnet 282, wire 283, wire 284, battery 266, thus causing the switch to rotate shaft 267 one step and to prepare the escapement of the auxiliary switch to take place, or in other words to allow wipers 249, 274 and 285 to move to contacts 286, 287, and 288. Assuming, however, that wiper 289 finds ground on contact 290, the following circuit is established: grounded contact 290, wiper 289, wire 291, wiper 285, contact 292, wire 293, wire 294, coil 295 of escapement magnet 282, wire 296, wire 284 to battery 266, thus keeping escapement magnet 282 energized as long as wiper 289 finds ground on the bank contacts. The following circuit is closed in parallel with the circuit last traced: wire 293, wire 297, spring 298, spring 299, wire 300, spring 301, spring 302, wire 303, relay 263, wire 264, wire 265 to battery 266, which will energize relay 263 and close the contact between springs 270 and 271, thus energizing rotary magnet 278, as above described, which will open the circuit to relay 263 because it breaks the contact between springs 298 and 299. This alternate action of the relays 278 and 263 continues as long as there is ground on wiper 289. Or in other words, the shaft will be rotated until wiper 289 ceases to find ground on the contacts with which it engages.

Assume now that the shaft 267 makes one rotary step and places the wipers 304, 305 and 289 upon contacts 306, 307 and 290 and

that at the same time wipers 249, 274 and 285 are moved into engagement with contacts 286, 287 and 288. Now when relay 223 is operated, instead of operating vertical magnet 251, the following circuit is closed: ground 235, wire 236, spring 231, spring 233, wire 246, spring 242, spring 244, wire 247, wire 248, spring 249, contact 286, wire 308, wiper 304, contact 306, wire 309, wire 310, wiper 311, contact 312, wire 313, wire 314, relay 315, wire 316, to battery 317, thus energizing relay 315 which will close the following circuit: ground 318, wire 319, spring 320, spring 321, wire 322, spring 323, spring 324, wire 325, vertical magnet 326, wire 327, wire 328 to battery 317. Thus shaft 329 can be stepped up as desired. When these vertical impulses cease, there will be a rotary impulse as described for Fig. 12 which will operate rotary magnet 330 and escapement magnet 331 as follows: ground 260, wire 261, spring 258, spring 268, wire 269, spring 270, spring 271, wire 272, wire 273, spring 274, contact 287, wire 332, wiper 305, contact 307, wire 333, wire 334, wiper 335, wire 336 and wire 337, rotary magnet 330, wire 338, wire 328 to battery 317. There is also closed at the same time a circuit in parallel with the circuit last traced as follows: wire 336, wire 339, wire 340, coil 341 of escapement magnet 331, wire 342, wire 343 to battery 344. This gives the wipers on shaft 329 one rotary step and in case wiper 345 finds ground it will take another rotary step as follows: ground on wiper 345 will keep escapement magnet 331 energized by the following circuit: ground on wiper 345, wire 346, wiper 347, contact 348, wire 349, coil 350, wire 351, wire 343 to battery 344. This circuit is closed as long as the wiper 345 finds ground upon the contacts 352 and the following circuit is closed through relay 315, ground 353, wire 354, wire 355, spring 356, spring 357, wire 358, spring 359, spring 360, wire 361, wire 314, relay 315, wire 316, to battery 317.

Relay 315 being energized will energize rotary magnet 330 as follows: ground 318, wire 319, spring 320, spring 321, wire 322, spring 323, spring 362, wire 363, wire 339, wire 337, rotary magnet 330, wire 338, wire 328 to battery 317. The energization of rotary magnet 330 will open the energizing circuit of relay 315, therefore this alternate action of the relays 330 and 315 will take place until wiper 345 ceases to find ground on the contacts over which it is rotating. As soon as wiper 345 rests on a contact that is not grounded, the escapement magnet 331 will be deenergized and wipers 311, 335 and 347 will pass to contacts 364, 365 and 366. It will now be seen that wiper 347 passing to contact 366 grounds wiper 345 as follows: ground 367, wire 368, contact 366, wiper 347, wire 346 to wiper 345, thus grounding

the contact on which it rests, making that trunk busy through the multiple to other second selector switches.

Assume now that wipers 369, 370 and 345 have been moved into engagement with contacts 371, 372 and 352, thus extending lines 310 and 334 to trunks 373 and 374. The impulses sent out from relay 223 will operate vertical magnet 375 as follows: wire 376, spring 377, spring 378, wire 379, wiper 380, contact 381, wire 382, vertical magnet 375, wire 383, wire 384, wire 385 to battery 383. Thus shaft 386 can be stepped up as desired and an impulse sent over line 387 will energize escapement magnet 388 as follows: ground on line 387, wire 389, spring 390, spring 391, wire 392, coil 393 of escapement magnet 388, wire 394, wire 395, to battery 396. This impulse energizing and deenergizing the escapement magnet will allow wipers 380, 397, 398 and 399 to pass to contacts 400, 401, 402 and 403. The next set of impulses sent over line 376 will operate the rotary magnet 404 as follows: from the ground on the wire 248 as caused by the action of the relay 223, through the trunk conductors connected therewith, to wire 376, springs 377 and 378, wire 379, wiper 380, contact 400, wire 405, rotary magnet 404, wire 406, wire 407, wire 384, wire 385 to battery 383. Thus as many rotary steps as desired can be taken and another impulse over line 387 will again energize escapement magnet 388 and allow wipers 380, 397, 398 and 399 to escape to contacts 408, 409, 410 and 411. If, however, the subscriber called is busy, or in other words wiper 412 is resting on a grounded contact at the time this impulse is made, the following circuit is closed which will prevent the wipers 380, 397, 398 and 399 from advancing: ground on wiper 412, wire 413, wiper 399, contact 403, wire 414, spring 415, spring 416, wire 417, wire 418, coil 419, wire 420, wire 395 to battery 396. At the same time a circuit is closed in parallel with the circuit last traced as follows: the junction of wires 417 and 418, wire 421, wire 422, relay 423, wire 424, wire 407, wire 384, wire 385 to battery 383, thus closing contact between springs 425 and 426. This will lock up relay 423 and escapement magnet 388 regardless of the ground on wiper 412 as follows: ground 427, wire 428, spring 429, spring 430, wire 431, spring 425, spring 426, wire 432 to wires 422 and 421, which will keep relay 423 and escapement magnet 388 energized as long as relay 433 is energized. Relay 433 is energized as long as the switch (Fig. 13) is connected with this trunk as follows: ground 367, wire 368, contact 366, wiper 347, wire 346, wiper 345, contact 352, wire 434, wire 435, wire 436, relay 433, wire 437, wire 438, to battery 396. The energization of the relay 423 as a result of the ground upon the wiper 412 caused by

its resting upon a contact associated with a busy line, closes the contacts 439 and 440, thus closing the following circuit through the calling substation: ground 441, wire 442, secondary winding 443, wire 444, spring 439, spring 440, wire 445, wire 387, wire 374, contact 372, wiper 370, wire 446, contact 365, wiper 335, wire 334, wire 333, contact 307, wiper 305, wire 332, contact 287, wiper 274, wire 273, wire 447, spring 448, spring 449, wire 450, condenser 451, wire 226, wire 219, contact 216, wiper 173, wire 174, contact 175, contact 176, wire 177, wire 178, wire 161, terminal 150, wire 149, wire 148, coil 146, wire 144, contact spring 143, contact spring 151, contact spring 141, wire 140, transmitter 139, wire 179, spring 135, metal segment 133, spring 136, wire 137, terminal 138, wire 162, wire 180, wire 181, spring 182, spring 183, wire 184, wiper 185, contact 215, wire 218, wire 220, wire 221, winding 222, of relay 223, battery 225, ground 230. Induced impulses are sent through the circuit just traced by means of the primary winding 452 inductively related to the secondary winding 443, the circuit being closed periodically through such primary winding from battery 453 by means of a revolving commutator 454 as follows: ground 441, wire 442, primary winding 452, wire 455, brush 456, commutator 454, brush 457, wire 458, battery 453 to ground. The impulses thus transmitted through the apparatus at the calling substation indicate to the calling subscriber that the connection desired has been effected but that the called subscriber's line is busy.

Assume now that wipers 459, 460 and 412 have been moved to contacts 461, 462 and 463 of an idle subscriber's line. This closes a circuit from ground 464, wire 465, contact 411, wiper 399, wire 413, wiper 412, contact 463, wire 466, wire 467, spring 468, spring 469, wire 470, cut-off relay 471, wire 472, wire 473 to battery 474. The energization of this relay opens the lines 475 and 476 from any connection with the apparatus in Fig. 15 except the two normal wires 477 and 478. The called subscriber is now ready to be signaled. Impulses sent out on line 376 will now operate relay 479 as follows: ground on wire 376, spring 377, spring 378, wire 379, wiper 380, contact 408, wire 480, relay 479, wire 481 to battery 383. Relay 479 being a slow relay will remain operated during the impulses and connect the generator to the called line as follows: brush 482 of generator 483, wire 484, spring 485, spring 486, wire 487, wire 488, wiper 397, contact 409, wire 489, wiper 459, contact 461, wire 490, wire 475, wire 477, wire 491, post 492, wire 493, ringer 494, condenser 495, wires 496 and 497, post 498, wire 499, wire 478, wire 476, wire 500, contact 462, wiper 460, wire 501, contact 410, wiper 398, wire 502, wire 503, spring 504, spring

505, wire 506, brush 507 of generator 483, thus ringing the called subscriber. When the called subscriber answers, he cuts his telephone across the two lines 490 and 500 which will energize relay 508 as follows: ground 509, wire 510, coil 511 of relay 508, wire 512, spring 513, spring 504, wire 503, wire 502, wiper 398, contact 410, wire 501, wiper 460, contact 462, wire 500, wire 476, wire 478, wire 499, post 498, wire 497, wire 514, spring 515, spring 516, wire 517, coil 518, wire 519, transmitter 520, wire 521, post 492, wire 491, wire 477, wire 475, wire 490, contact 461, wiper 459, wire 489, contact 409, wiper 397, wire 488, wire 487, spring 486, spring 522, wire 523, coil 524 of relay 508, wire 525, wire 385 to battery 383. The energization of this relay opens the energizing circuit of the relay 479 by breaking contact between springs 377 and 378 and connects line 376 through to the called line by closing the contact between springs 377 and 526, wire 527 and wire 488 which, as has been shown, is connected to the called line. Also the escapement magnet 388 is disconnected from line 387 by breaking contact between springs 390 and 391 and connects line 387 to the called line by closing contact between springs 390 and 528, wires 529 and 502 which, as has been shown, are connected to the called line.

The talking circuit as now set up is as follows: relay 223 is supplying battery to the calling subscriber and relay 508 is supplying battery to the called subscriber. Commencing with line 180 one side of the talking circuit from the calling to the called subscriber is as follows: line 180, wire 181, spring 182, spring 183, wire 184, wiper 185, contact 215, wire 218, wire 220, wire 530, condenser 531, wire 532, spring 533, spring 534, wire 535, wire 253, wire 248, wiper 249, contact 286, wire 308, wiper 304, contact 306, wire 309, wire 310, wiper 311, contact 364, wire 536, wiper 369, contact 371, wire 373, wire 376, spring 377, spring 526, wire 527, wire 488, wiper 397, contact 409, wire 489, wiper 459, contact 461, wire 490, wire 475, wire 477, which is connected to the called line. The other side of the talking circuit is as follows: wire 178, wire 177, spring 176, spring 175, wire 174, wiper 173, contact 216, wire 219, wire 226, condenser 451, wire 450, spring 449, spring 448, wire 447, wire 273, wiper 274, contact 287, wire 332, wiper 305, contact 307, wire 333, wire 334, wiper 335, contact 365, wire 446, wiper 370, contact 372, wire 374, wire 387, wire 389, spring 390, spring 528, wire 529, wire 502, wiper 398, contact 410, wire 501, wiper 460, contact 462, wire 500, wire 476, wire 478 to the called subscriber's line. The only operation now is the release which on all the switches except the trunk selector is accomplished over local circuits. When the

calling subscriber hangs up his receiver, the trunk selector and the first selector are the first switches to release and the releasing circuits of these two switches are as follows: The hanging up of the calling subscriber's receiver deenergizes relays 223 and 238 and allows their armatures to return to normal position, thus closing the following circuits: ground 235, wire 236, spring 231, spring 233, wire 246, spring 242, spring 243, wire 537, wire 538, off normal spring 539, off normal spring 540, wire 541, wire 542, release magnet 543, wire 544, wire 265 to battery 266. This will energize release magnet 543 which will remain energized until shaft 267 reaches its normal position and opens the contact between springs 539 and 540. At the same time a circuit is closed in parallel to the last circuit as follows: wire 537, wire 538, wire 545, wire 546, contact 217, wiper 209, wire 214, wire 213, wire 188, release magnet 124, wire 190, spring 191, spring 192, wire 193, wire 194, to battery 195, thus energizing release magnet 124 which will remain energized as follows until wipers 185, 173 and 209 return to their normal position: ground 547', wire 548, wire 549, off normal spring 550, off normal spring 551, wire 552, spring 197, spring 553, which are thrown into contact by the armature of release magnet 124, wire 547, wire 213, wire 188, release magnet 124, wire 190, spring 191, spring 192, wire 193, wire 194 to battery 195, thus locking up the relay until the switch has resumed its normal position and opened the contact between springs 551 and 550.

When the first selector is operated and wiper 289 is placed upon contact 290, the following circuit is closed: ground 554, wire 555, contact 288, wiper 285, wire 291, wiper 289, contact 290, wire 556, wire 557, relay 558, wire 559, wire 560, wire 561 to battery 344, thus holding the springs 562 and 563 on relay 558 out of contact until the first selector is released and relay 558 deenergized. With relay 558 deenergized, the following release circuit for the second selector is closed: ground 353, wire 354, wire 564, spring 562, spring 563, wire 565, off normal spring 566, off normal spring 567, wire 568, wire 569, release magnet 570, wire 571, wire 561 to battery 344, thus energizing release magnet 570 until the shaft 329 returns to normal position and opens contact between springs 566 and 567.

Relay 433 is energized during the operation of the connector as follows: ground 367, wire 368, contact 366, wiper 347, wire 346, wiper 345, contact 352, wire 434, wire 435, wire 436, relay 433, wire 437, wire 438 to battery 396. When the second selector is released, relay 433 will allow spring 429 to make contact with spring 572 thus closing the following release circuit: ground 427, wire 428, spring 429, spring 572, wire 573, 130

spring 574, spring 575, wire 576, wire 577, release magnet 578, wire 579, wire 438 to battery 396, thus energizing release magnet 578 until shaft 386 reaches its normal position and opens the contact between springs 574 and 575.

The connector will not be released in case the called subscriber has not hung up his receiver. In this instance the circuit for the release relay will remain energized. This circuit may be traced from ground, lead 580, springs 581 and 582, lead 583, lead 436, relay 433, lead 437, lead 438 to battery 396. This circuit will remain closed as long as the bridged relay 508 remains actuated. When the called subscriber replaces his receiver on the hook, the subscriber's loop will be opened and the bridged relay 508 will be deenergized. The consequent retraction of its armatures will open the circuit at the contacts 581 and 582 and thereupon the release relay 433 will be deenergized, which in turn will deenergize the release magnet 578 and thus restore the connector switch to normal. In the first selector, second selector and connector, the auxiliary release magnets 584, 586 and 587 are in multiple with the switch release magnets 543, 570 and 578 so that the auxiliary switch wipers are also returned to normal position.

While I have shown my invention in the particular embodiment hereindescribed, I do not, however, desire to limit myself to this exact construction, but desire to claim broadly any equivalent that may suggest itself to those skilled in the art.

What I claim is:

1. In an automatic telephone system, the combination of automatic switching mechanisms, trunk voice current conductors, a side switch for controlling the connection of the actuating devices of the switching mechanism to such conductors, releasing devices for said switching mechanisms, independent releasing devices for said side switches, and a trunk conductor independent of the voice current conductors over which the releasing device of one side switch is controlled from the preceding side switch.

2. In an automatic telephone system, the combination with a plurality of switches in a built up circuit, of bridging magnets at two of said switches, of release relays at each of said switches, the release of the second switch depending upon the deenergiza-

tion of its release relay, said relay being under the control of the bridging magnet at the first switch unless the bridging magnet at the second switch is actuated and the release of the first switch being independent of the bridging magnet of the second switch.

3. In an automatic telephone system, the combination with a pair of telephone lines connected for conversation, of a plurality of switches associated with said connected circuit, release relays at each of said switches, means to energize said release relays when the switches are taken for use, a pair of bridges across said circuit located at different switches, one or more intervening switches free from bridged electromagnets, the release of the switches depending upon the deenergization of their release relays, means whereby the bridge nearest the calling subscriber's station controls the release of all switches intervening between said switch and the switch containing the other bridge.

4. In an automatic telephone system, the combination with a built-up circuit, of a plurality of switches through the contacts of which said circuit is maintained, a releasing relay for each of said switches, means to energize said release relays when the switches are taken for use, the release of each switch depending upon the deenergization of its release relay, controlling magnets located at two of said switches, the controlling magnets of the switch nearest the calling subscriber's station controlling the release relays of succeeding switches with the exception of the other switch having controlling magnets.

5. In an automatic telephone system, a selector switch and a connector switch in a built up circuit, a release relay for the connector switch having its circuit closed in two branches, one branch controlled by the calling subscriber through said selector switch and the other branch controlled by the called subscriber through said connector switch, the release of said connector switch being effected by the deenergization of said release relay.

In witness whereof, I hereunto subscribe my name this 30 day of June, A. D. 1910.

RAY S. WILBUR.

Witnesses:

G. B. KEISER,
ALFRED A. FRANCK.