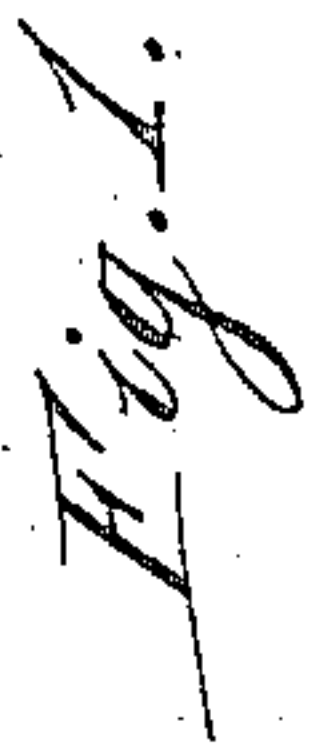


APPLICATION FILED DEC. 16, 1905. RENEWED JULY 31, 1916.

Patented Apr. 22, 1919.

4 SHEETS—SHEET 1.



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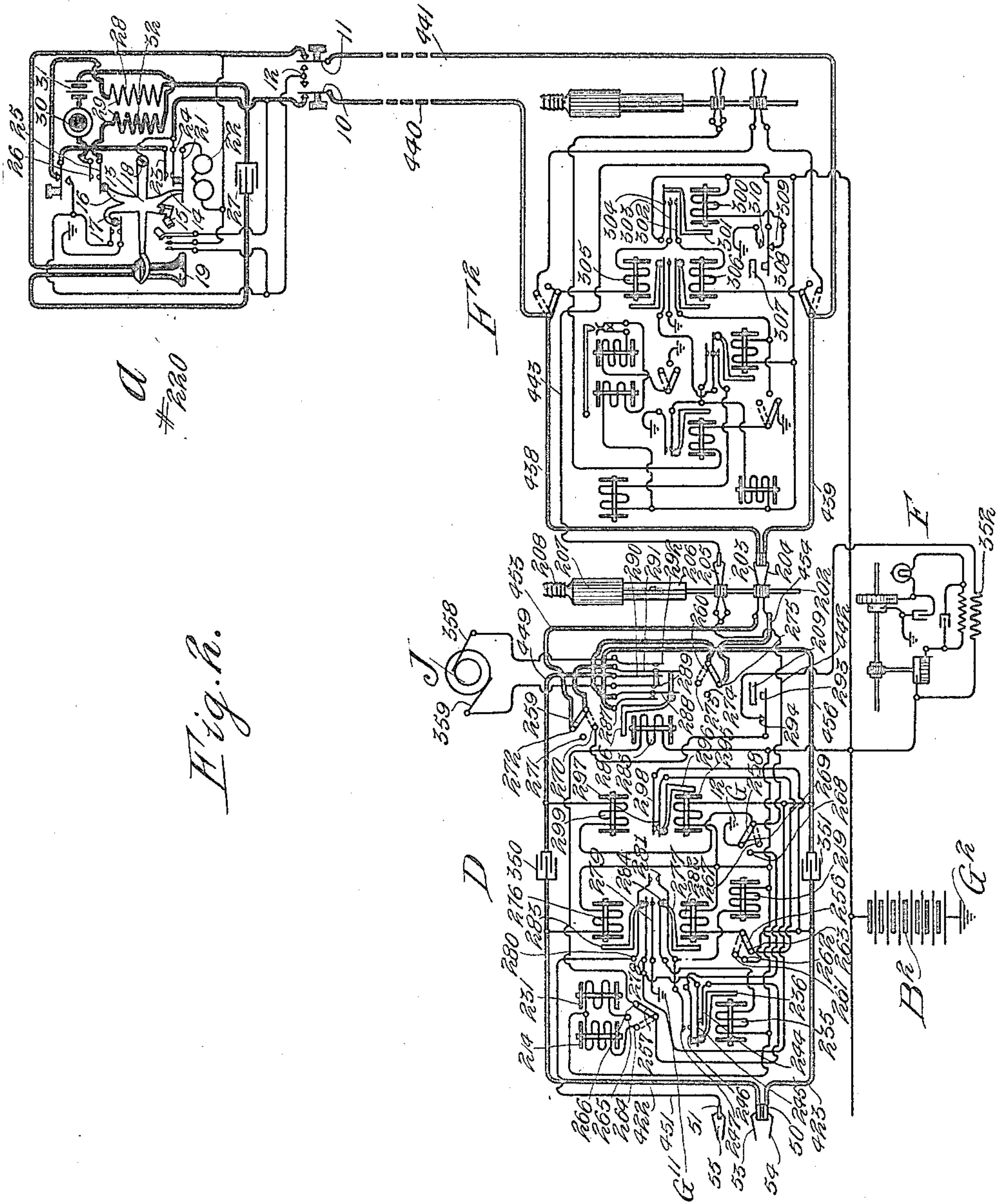
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4 SHEETS—SHEET 2.



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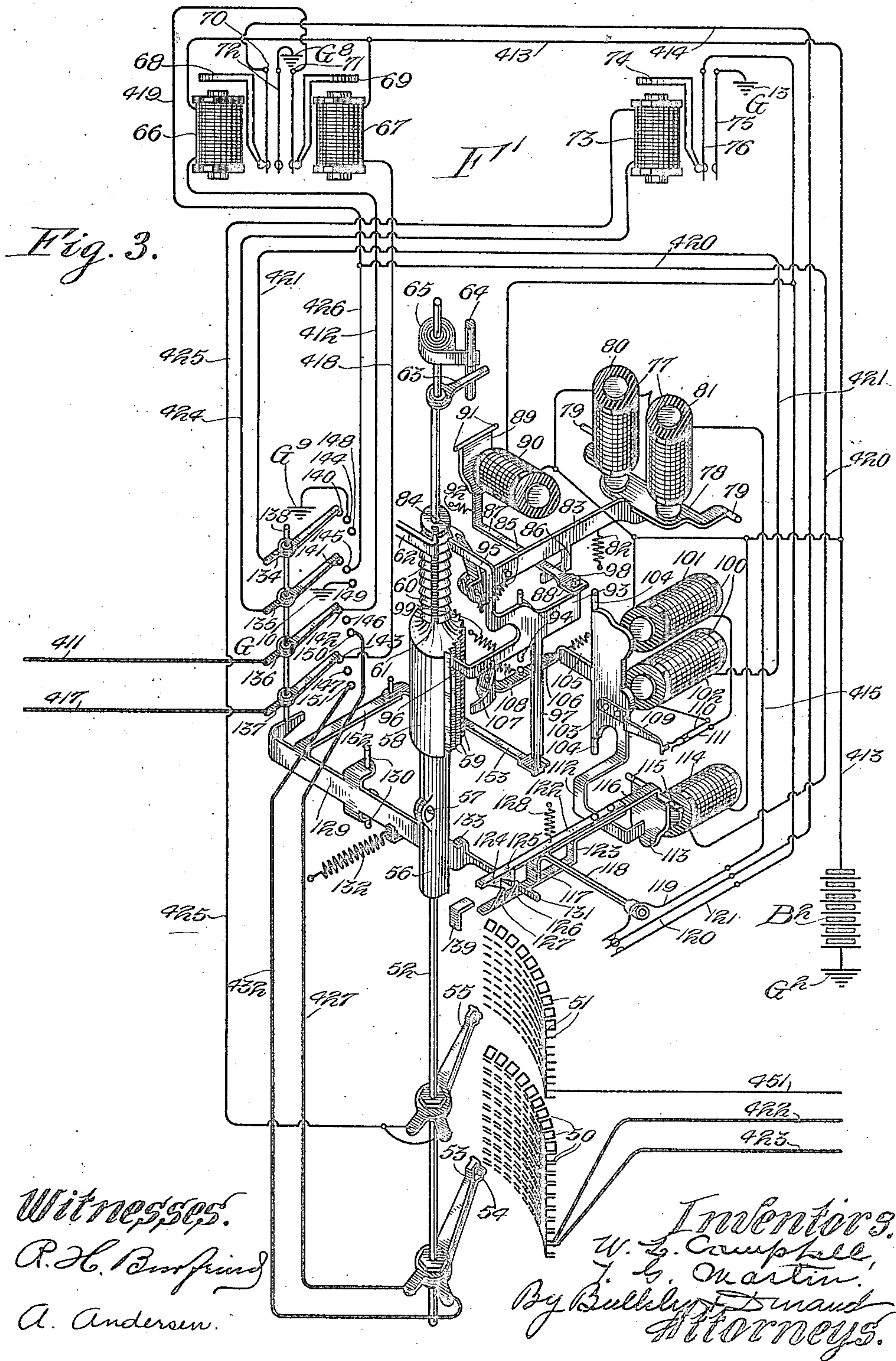
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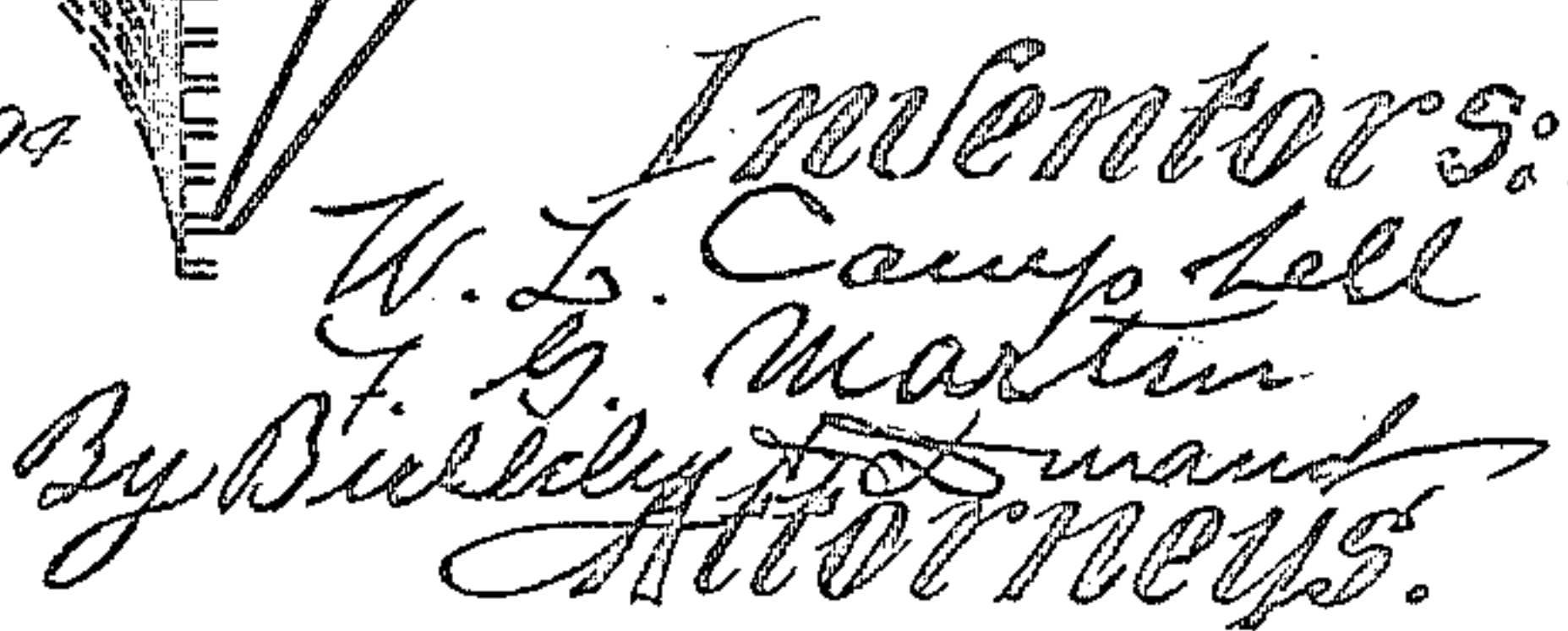
4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,301,647.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that we, WILSON L. CAMPBELL and TALBOT G. MARTIN, both citizens of the United States of America, and residents of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Telephone Systems, of which the following is a specification.

Our invention relates to telephone systems in general, but more particularly to automatic exchange systems having provisions for both talking and signaling, and especially to telephone exchange systems involving both automatic and manual board exchange apparatus—that is to say, telephone systems in which subscribers whose lines terminate at manually-operated switchboards will have occasion to call up and obtain connection with subscribers whose lines terminate in automatic or semi-automatic exchange or central station apparatus.

Generally stated, the object of our invention is the provision of an improved and highly efficient telephone exchange system.

Special objects of our invention are the provision of improved means for giving service between the subscribers of a manual board exchange and the subscribers of an automatic or semi-automatic exchange system; the provision of an improved construction and arrangement whereby a manual board subscriber may call up an automatic exchange subscriber and obtain connection with the latter's line through the medium of one or more manual board operators, and also through the medium of the automatic or semi-automatic apparatus of the other exchange; the provision of an improved construction and arrangement whereby any manual board operator who may be in charge of an established connection between a manual board subscriber and an automatic subscriber may have satisfactory supervision over such connection—that is to say, may know when the automatic exchange subscriber answers, and may also be properly signaled and advised when the automatic exchange subscriber is through talking and hangs up his receiver; the provision of an improved automatic or semi-automatic telephone exchange connector of such character that it will operate in conjunction with the manual board apparatus of another ex-

change, and so constructed that it will give the manual board exchange operator satisfactory supervision over any connection between manual and automatic subscribers established through the medium of said connector; the provision of an improved construction and arrangement whereby the subscriber of a common battery manual board telephone exchange system may call up and obtain connection with the line of an automatic telephone exchange subscriber, through the medium of one or more manual board operators, and through the medium of suitable trunk-selecting and line-connecting or other suitable automatic switching machinery, and whereby the manual board operator in charge of the cord-circuit through the medium of which such connection is established may have satisfactory supervision of the established connection; and the provision of certain details and combinations and features of improvement tending to increase the general efficiency of a telephone system of this particular character, and tending to render more satisfactory the giving of service between the subscribers of manual and automatic telephone exchanges or central stations.

One of the principal and most important objects of our invention consists in the provision of satisfactory supervision of an established connection between a manual board subscriber and an automatic subscriber—that is to say, the provision of a supervision which will coöperate and work satisfactorily in conjunction with an operative release for whatever automatic switching machinery is brought into use in establishing connection between the two lines.

To the foregoing and other useful ends, our invention consists in the matters herein described, illustrated and claimed.

In the accompanying drawings Figures 1 and 2 show a telephone system embodying the principles of our invention, and illustrate diagrammatically the circuits involved when a subscriber M of a manual exchange is connected with a station A of the automatic exchange, the line-conductors of which automatic subscriber's station terminate in a first-selector F². The connection is established by means of a cord-circuit C, a modified first-selector F¹ located at the manual

exchange, and a connector D at the automatic exchange and through the first-selector F.

5 Figs. 3 and 4 are diagrammatic perspective drawings of the first-selector F¹ and of the connector D, respectively, showing the character of the switches. Beneath said switches are shown the terminals of trunk-
10 lines with which the said switches operate, which terminals are assembled in banks. The cord-circuit apparatus is controlled and operated by the central battery B¹; but the automatic apparatus employs a battery B²
15 which appears in various places, but which is designated always by the same reference character.

The manual sub-station M may be of any ordinary or suitable common battery type, comprising a receiver 2, switch-hook 3 and
20 transmitter 4, an impedance coil 5, a ringer 6 and condenser 7. The transmitter 4, which is included in a normally-open circuit, is bridged across the main line in series with the impedance-coil 5 at the instant that the
25 switch-hook rises and closes the contact-points 8 and 9. The automatic sub-stations, like sub-station #220, are of a well-known type, and comprise a calling device composed of two push-buttons that control a
30 couple of springs 10 and 11 with respect to a so-called ground-post 12; there is also a switch-hook 13 with a number of cam-arms 14, 15, 16 and 17, said hook being suitably pivoted to hinge about an axis extending
35 through the point 18. The receiver 19, when on the hook, maintains the cam-arm 14 against a ringer circuit-spring 21 through which the ringer circuit comprising the ringer 22 is normally closed across the main
40 line. Whenever the hook rises the said ringer circuit is destroyed at the instant that the cam-arm 14 leaves the ringer-spring 21, and the secondary talking circuit is closed as the secondary circuit-springs 23 and 24
45 engage; and at the same time the primary talking circuit is closed when the cam-arm 16 forces the primary circuit-springs 25 and 26 together. The secondary circuit contains in series the receiver 19, condenser 27 and
50 the secondary winding 28 of the induction-coil 29; and the primary circuit contains as usual a transmitter 30, a battery 31 and the primary winding 32 of the said induction-coil. The cord-circuit C is an ordinary
55 common battery cord-circuit with a set of supervisory lamps 33 and 34. The calling side, however, is especially adapted to be used in connection with automatic switches, by the provision of a calling device similar
60 to that shown at sub-station #220 and by means of which the manual operator may call any of the automatic lines through the medium of the automatic switching apparatus. The said operator's calling device is
65 represented as having two push-buttons 35

and 36 by which are controlled the two springs 37 and 38 with respect to a ground-spring 39. This calling device, however, may be of any suitable design common to automatic systems of the type in connection
70 with which I have elected to demonstrate my invention. It will be understood, of course, that any suitable means can be employed for regulating the transmission of
75 impulses over the line circuits, so as to obtain the desired results and the described mode of operation. For example, suitable and well-known means can be provided for insuring a proper transmission of current
80 when the receiver 19 is placed on its switch-hook.

In Fig. 3 the first-selector F' is shown with the bank 50 of trunk-line-terminals beneath it, while the private-bank 51 is located just above the latter. The switch-shaft 52
85 is vertically disposed on the front of the switch-frame and is retained connected therewith by bearings which are not shown. The shaft may be moved longitudinally in said bearings and then rotated by ratchet
90 and pawl electro-magnetically-operated devices, the vertical or longitudinal movements occurring first. Among the functions of the shaft an important one is that of holding the line-wipers 53 and 54 and the
95 private-wiper 55. The first two comprise a set distinct from the latter, but both are located within range of the contacts of their respective banks 50 and 51. Said wipers are not only insulated from the shaft, but from
100 each other as well. Among the details that are associated with the shaft is a cam-piece 56 which is of a split sleeve design and secured to the shaft by a screw 57. The general shape of said cam in section at a right
105 angle to the shaft is that of an oval with the smaller end thereof on the side farthest away from the said screw. Said cam abuts on a hub 58 which is shrunk to the shaft near the middle of the latter. This hub carries a set
110 of longitudinal teeth 59 that serve, as will be disclosed, as means for rotating the shaft, and as a locking means against backward rotation of the same. On the neck portion of said hub there is formed a set of circular
115 ratchet-teeth 60 that serve in turn as a means by which the raising of the shaft is accomplished, and for locking it when raised. These circular teeth are traversed by a
120 groove 61 into which the end of a so-called shaft-rest 62 normally projects; but when the shaft is rotated, any one of the said circular teeth which may be at the proper height then slides onto the end of said rest. The end of said rest is, of course, adapted to
125 fit the circular grooves between said circular teeth. The upper surface of the engaging end of the rest is level, but the under side is chamfered to form a bevel that corresponds to the upper slope of the circular
130

teeth. Above the hub 58 the shaft carries an arm 63, known as the normal-post-arm, which, while the switch-shaft is at rest and while the shaft-rest occupies the slot 61, is retained against the normal-post 64 by the coil-spring 65. Among the magnets allotted to the first-selector some are used as relays and others as actuating magnets. The magnets 66 and 67 are among the former kind and are known as the vertical and rotary line-relays. By means of their respective armatures 68 and 69, the springs 70 and 71 are controlled with respect to the ground-spring 72. Said springs are comprised in energizing circuits of actuating magnets that raise and rotate the shaft. The magnet 73 with its armature 74 and springs 75 and 76 constitute the back-release-relay, as it is called, which is used for restoring the switch after the latter has seized a trunk-line and when such release is desired. Of the actuating magnets the magnet 77 is known as the vertical-magnet and has allotted to it a so-called vertical-armature 78 supported by pivots 79 beneath said vertical-magnet. Whenever the coils 80 and 81 of said magnet become energized, the armature 78 is attracted; and when the magnetism ceases, the retracting-spring 82 then restores said armature to its normal position. The upward movement of the armature is limited by the pole-pieces of the magnet-coils 80 and 81, and the lower limit is marked by a section of the switch-frame that passes under the arm 83. Said arm is known as the vertical-arm and extends forwardly from the vertical-armature 78, of which latter it is a part. The vertical-arm carries on its end a so-called vertical-pawl 84 which, when the vertical-armature is attracted, engages with some one of the circular teeth 60 to raise the shaft. Normally, the under surface of the upper section of said pawl rests against a piece that is secured to the switch-frame and that retains the pawl away from the circular teeth. When the vertical-armature is attracted, as the pawl rises, a retracting-spring 85 thrusts the forward side of the pawl toward the circular teeth 60. As soon as said pawl clears the rest, and by the time that the vertical-armature strikes the pole-pieces, the vertical-pawl strikes, with the rear surface of its upper section, a bumper piece, which latter constitutes a part of the switch-frame. Therefore, the shaft is prevented from being raised more than one notch at a time by its own momentum. It is clear, then, that the pawl 84 not only raises the shaft, but it also acts as a lock at the end of each stroke. The vertical-arm has also a depending L-shaped piece 86 that engages a so-called release-link 87 of flexible spring material. Said link has an aperture 88 on its front end, and is secured to the armature 89 of one of the actuating magnets

90, known as the release-magnet. Said armature is suspended from the frame by the supports 91, and is normally retained by the spring 92 away from the pole-piece of the release-magnet. A stop is suitably provided behind said armature to limit its movement when retracted. The first-selector is provided with a peculiarly shaped element 93, known as the double-dog. It is pivoted so that it may swivel about a vertical axis that passes through the pivots 94. On its front side said double-dog divides into two dogs 95 and 96 which are so situated and constructed that the dog 95 may operate in conjunction with the circular teeth 60, while the switch-shaft is raised and in normal rotary position, and that the dog 96 may engage the longitudinal teeth 59 when the shaft is rotated. To the right of the pivots 94 the body of the double-dog extends rearwardly, and projecting down therefrom is an arm 97 that comes into play very prominently during the releasing of the switch. Near the extremity of and on the upper side of said body a pin or lug 98 projects upwardly. Said lug is normally caught in the aperture 88 of the release-link 87, and because of the tension in the spring 92 the dogs 95 and 96 are retained away from the shaft. At the first stroke of the vertical-armature the link 87 is drawn away from the lug 98 by the piece 86, and then the double-dog is so rotated by the retracting-spring 99 that the dog 95 falls under the first circular tooth, and so that when the vertical-armature returns to its normal position the said shaft is retained by said dog in its new position. The release-link 87, while the double-dog is free, rests with its end upon the lug 98, but out of locking engagement therewith. When the vertical-armature is attracted a second time, the shaft is raised a second step, and the dog 95 at the second stroke passes from under the first tooth to a position under the second tooth, holding the shaft again as explained. The release-magnet 90 is composed of two coils like the vertical-magnet 77 but, for convenience of illustration, only one coil is shown. If, while the shaft is raised, the said release-magnet should be energized, the release-armature 89 is attracted, and the release-link 87 is thrust forward to catch the lug 98 in the aperture 88. Upon the deenergization of the release-magnet the retracting-spring 92 then withdraws the dogs 95 and 96 from the shaft, which latter, being deprived of its temporary support, then falls to normal position by its own weight. After the shaft is once raised it may be rotated by a second operative magnet 100, known as the rotary magnet. Said magnet has two coils 101 and 102, and, unlike the vertical-magnet, has its armature 103 pivoted in a vertical plane. Said armature may be moved about a vertical

axis that passes through the pivots 104. The limit of the movement of said armature toward the rotary magnet is determined by the pole-pieces of said magnet, which movement is produced by the rotary-magnet itself. The motion of the armature in the opposite direction is produced by the retracting-spring 105, and is limited by a switch-stop behind the so-called rotary-arm 106. This arm, like the vertical-arm, carries a so-called rotary-pawl 107. Similar to the vertical-pawl, said rotary-pawl normally rests against a stop that retains it away from the longitudinal teeth, and when the rotary-armature is attracted it is drawn into engagement with the longitudinal teeth by a spring 108 that is attached between the rotary-arm and the rear of said pawl. By the time that the rotary-armature strikes the pole-pieces of the rotary-magnet, the rotary-pawl also strikes a bumping post, as does the vertical-pawl, and locks the shaft against further advance by the force of its own momentum. At the end of the first rotary step the dog 96 falls behind the first longitudinal tooth, so that when the rotary-pawl falls back the shaft is retained. It should be evident that as the shaft is rotated the vertical-dog 95 is extricated from the groove of the circular tooth below which it has been resting, by the passage of the rotary-dog 96 over the longitudinal tooth over which it has to slide at the time; but at the beginning of the rotation the tooth which has been caught by the vertical-dog slides onto the shaft-rest 62, and in this way the shaft is still held raised after the rotation begins. The rotary-armature is provided with a so-called interrupter-finger 109 that separates the interrupter-springs 110 and 111 whenever the rotary-armature is attracted, and also with a rotary-armature-finger 112 that exercises certain controlling influences over the armature 113 of one of the operative or actuating magnets, namely the private-magnet 114. The said private-armature 113 works in a vibratory manner about a horizontal axis that passes through the supporting points 115. This armature is provided with a forwardly-projecting arm 116, the latter having two flat surfaces in an approximately horizontal plane. Furthermore, the end 117 of the arm is bent downwardly and said arm 116 carries certain mechanical details, namely a lateral arm 118 which is designed to control circuits comprising the private-springs 119, 120 and 121, and a tooth-escapement which includes two flexible springs 122 and 123, each of which is riveted by one end to the arm 116, one on the upper side and the other on the lower. The upper spring is straight and has formed on its end two tooth projections 124 and 125 which extend downwardly, while the lower spring is bent down and at a right

angle again to the front. This double angle on the lower spring is so designed that the latter may clear the bent portion 117 of the private-arm, against which portion the said spring rests with a requisite degree of tension, and so that space is afforded in front of said bent portion to receive two other tooth-shaped upwardly-projecting pieces 126 and 127 that are formed on the forward end of the escapement-spring 123 and which are sustained in juxtaposition to the upper teeth but slightly to the rearward of them. A retracting-spring 128, suitably located, holds said armature normally away from the private-magnet pole-piece. A well-known auxiliary switching mechanism common to such switches is the so-called side-switch. It is shown in connection with the first-selector F' and comprises an arm 129 which is secured to the switch-frame in such a manner that it may be made to swivel in a vertical plane about the pivots 130. The right extremity of said arm is drawn out into a finger 131 that works in conjunction with the escapement-teeth previously described. Said teeth, in a manner to be explained, reduce the outward movement of the side-switch to a step-by-step motion, which movement is produced by a retracting-spring 132. At the base of the finger 131 a lug 133, which is bent to the front, is adapted to strike the cam 56 at a suitable time. Whenever the shaft is rotated, however, said cam is carried beyond the reach of the said lug, and after that the finger 131 simply falls against the tooth 127. Near its left extremity the arm 129 carries a number of wipers 134, 135, 136 and 137 suitably mounted upon a pin 138 and insulated therefrom and from each other. Said wipers are known as the side-switch-wipers, and are adapted to be operated by the private-magnet and escapement device previously explained. If the private-magnet is energized once, the private-armature is drawn down once and then restored to its normal position. The escapement-finger 131 then passes from behind the tooth 126 onto the rear of the tooth 125, upon the downward stroke of the private-armature 113, and from behind the latter tooth upon the return stroke. As soon as the escapement-finger clears the latter tooth, the retracting-spring 132 draws the side-switch to the second position, where it is stopped by the lug 133 when it strikes the cam 56. Immediately, then, as it will be shown, the rotary-magnet becomes energized, the shaft is rotated, and the cam passes away from reach of the lug 133; then the finger 131 of necessity falls against the tooth 127, because of the tension in the spring 132. The rotation of the shaft results when the rotary-armature 103 is attracted by the rotary-magnet; and, at the same time, the rotary-armature-finger 112 depresses the private-armature

113 and causes the finger 131 to disengage from the tooth 127 and to advance against the tooth 124; then, as the rotary-armature returns to normal position, when the rotary-magnet deenergizes, the private-armature, upon following the finger 112, permits the escapement-finger 131 to escape from the last tooth 124, at which instant the side-switch passes to third position with the said finger 131 resting against the side-switch-stop 139. In their normal positions, the side-switch-wipers 134, 135, 136 and 137 engage, respectively, with the contact-points 140, 141, 142 and 143. This position is known as the first position of the side-switch, at which time it will be clear that the finger 131 is held behind the escapement-tooth 126. In the second position, while the said finger is between the teeth 126 and 127, the said side-switch-wipers engage, instead, with the contact-points 144, 145, 146 and 147, respectively; and when the said finger 131 falls against the stop 139, the wipers change their positions into contact with the contact-points 148, 149, 150 and 151, respectively. Between the pivots 130 and the wiper-supporting pin 138, a rearwardly-extending arm 152 on the side-switch-arm 129 supports on its end, pivotally, one end of a link 153, the other end of which latter, being bifurcated, engages with the lower end of the double-dog arm 97, which lower end is constructed somewhat in the shape of an inverted T. Should the release-magnet be energized while the side-switch is in third position, and, of course, while the shaft is rotated, the release-link 87, being attached to the release-armature 89, is thrust forward when the release-armature is attracted and catches the lug 98 in the aperture 88. Then, when said release-armature is restored, the spring 92, as before described, withdraws the dog 95 from the circular teeth 60. At the same time, the arm 97 drives back the link 153, which latter then rotates the side-switch-arm 129 about the pivots 130, against the tension of the side-switch retracting-spring 132, and thus drives the finger 131 between the springs 122 and 123 to a position behind the tooth 126, locking the side-switch in the first or normal position. The switch-shaft being unlocked by the removal of the dog-support 96, and being thus left free, is rotated by the coil-spring 65 until the end of the shaft-rest enters the slot 61, at which time the shaft drops to its normal position. Therefore, after the switch has been operated, the energization and deenergization of the release-magnet is sufficient to restore the switch completely to its normal position. Since the line and private banks are each provided with ten rows of contact-terminals, each row consisting of ten sets of contacts, the shaft is, therefore, so constructed that it may be raised to any one of ten levels, and so that it

may be rotated ten successive steps at each level in order that the wipers which it carries may be placed in connection with any one of the ten sets of contact-terminals in each level.

Fig. 4 shows the connector D which has many parts and circuits very similar to those of the first-selector. The line and private banks 200 and 201 will be recognized. The switch-shaft 202 is identical with the first-selector switch-shaft and is, therefore, provided with the line-wipers 203 and 204, and the private-wiper 205, the cam 206, the longitudinal and circular teeth 207 and 208, respectively, the normal-post-arm 209, and the coiled spring 210. As usual, the circular teeth 208 are traversed by a slot 211 in which the end portion of the shaft-rest 212 is retained as long as the normal-post-arm 209 is in contact with the normal-post 213. The vertical movement of the shaft is, of course, produced through the medium of the vertical-magnet 214, the vertical-armature 215, the vertical-arm 216, and the vertical-pawl 217; the said vertical-arm 216 being supplied with the usual L-shaped piece 218. The release-magnet 219, however, has its armature 220 on the right side instead of on the left side, which armature is constructed with an elongated portion or finger 221 that reaches as far as the middle portion of the body of the double-dog 222. The release-link 223 is under the control of the L-shaped piece 218 and is permanently secured to the switch-frame at the pin 224. The double-dog has the usual vertical and rotary dogs 225 and 226, respectively, and the side-switch releasing-arm 227; while on the upper side of the body of the double-dog a lug 228 that is caught by the release-link 223 is in its usual position. When the release-magnet of the connector is energized, the release-link 223, instead of being thrust forward to catch the said lug 228, remains where it is, and the double-dog 222 is struck by the armature 220 at a point to the right of the bearings 229, by the end 221 of the said armature 220, so that the lug 228 is driven under the aperture 230, in which latter the lug is then caught by release-link 223. The double-dog 222 is thus prevented from returning to its operative position when the release-magnet becomes deenergized. The rotary-magnet 231 has a rotary-armature 232 that is quite simple. This latter is provided with only a rotary-arm 233 upon the extremity of which the rotary-pawl 234 is located. The rotation of the shaft is produced in a step-by-step manner similar to that described in connection with the first-selector, each time that the rotary-magnet is energized. The private-magnet 235, the private-armature 236, springs 237 and 238, escapement-teeth 239, 240, 241 and 242, and the arm 243 are substantially identical with the similar parts



of the first-selector. The said arm 243, however, controls the private-springs 244, 245, 246 and 247, so that when the private-armature 236 is down the first two of said springs are separated and the last two brought into contact; but when the said armature is up the reverse takes place—that is, the springs 244 and 245 close, and the springs 246 and 247 separate. In the side-switch of the connector the side-switch-arm 248, escapement-finger 249, cam-lug 250, side-switch-stop 251 and retracting-spring 252, at one side of the pivots 253, and the member 254, link 255, side-switch-wipers 256, 257, 258, 259 and 260, together with their corresponding contact-points 261, 262 and 263; 264, 265 and 266; 267, 268 and 269; 270, 271 and 272; and 273, 274 and 275, at the other side, are similar to like parts of the first-selector side-switch. It will be seen that the connector side switch has one more wiper than the selector side switch. Among the relays of the connector the vertical-line-relay 276 can, by its armature 277, flex the spring 278 against the ground-spring 279 and the spring 280 toward the spring 281, when said relay is energized. The rotary-line-relay 282, in the same manner, by its armature 283, when the former is magnetized, forces the spring 284 against the same ground-spring 279 and permits the spring 281 in turn to bend toward the spring 280. Said two springs 280 and 281 are so adjusted that they come into contact with each other when the two armatures 277 and 283 are attracted at the same time. The ringer-relay 285 is a feature common to all connectors of the type under consideration and has the ability, when magnetized, to disconnect the terminals of the called line from those of the calling line and place across the former the terminals of the ringer-generator J. This operation is accomplished by means of the armature 286 and the ringer-relay-springs 287, 288, 289, 290, 291 and 292. It will be noticed that the connector-shaft 202, by means of the normal-post-arm 209, controls the shaft-spring 293 with respect to the contact-point 294 so that when the shaft is up the said contact and spring come into engagement. The object of said spring and contact, as will be made clear, is to control a busy signaling current that comes into use when a busy line is called. The release of the first-selector, it has been pointed out, does not occur until the deenergization of the release-magnet, but the release of the connector occurs immediately upon the energization of the release-magnet of the latter. Should the connector-shaft 202 be found raised at a time when the release-magnet is energized, the release-armature 220, as above stated, moves the double-dog 222 under the release-link, which latter then catches the lug 228 and holds the said

double-dog out of engagement with the shaft. The shaft being free, in the same manner described in connection with the first-selector, returns to its normal or released position. The connector, in addition, is provided with a so-called back-bridge-relay 295, the object of which relay will be fully described hereinafter. It is also provided with an armature 296, as relays usually are, through which latter the back-bridge-relay-springs 297 and 298 are controlled. There is a resistance-coil 299, known as the back-bridge resistance-coil, that serves as a retardation-coil, and as a current regulator, as will be clearly pointed out. It shall be shown fully how the line-relays 276 and 282, the ringer-relay 285, back-bridge-relay 295, and the back-bridge resistance-coil 299 take part in the balancing of circuits and in the controlling of currents through circuits that comprise said coils.

In Fig. 2 the first-selector F^2 , besides having all the parts described in connection with the first-selector F^1 , is provided also with a so-called bridge-cut-off-relay 300 which controls, by means of its armature 301, three springs 302, 303 and 304 connected with the line-relays 305 and 306 and the non-grounded terminal of battery B^2 , which latter terminates in spring 304. In addition, said first-selector has under the control of the normal-post-arm 307 a spring 308, with respect to the contact-points 309 and 310. When reference is made to all other parts of this switch F^2 it will be understood that their functions and constructions are in general the same as those of the selector F^1 . In the selector F^2 of the called line no bank contacts are shown, but it will be understood that they have been omitted for convenience of illustration; for it is obvious that said switch will have bank contacts like the selector F^1 . Furthermore, the selectors are divided into groups and in each group like bank contacts are connected in multiple. For example, all first contacts of the first level on the vertical side are connected together, and all first contacts of the first level on the rotary side are connected together; and likewise all corresponding private bank contacts are connected together. This method, of course, is followed throughout. In the system under consideration, it is clear, of course, that there may be a multiplicity of sub-stations common to each central station, each of which stations is connected with its central station by a line of two conductors. In the particular illustration of our invention, each of the lines of the automatic subscriber has permanently allotted to it a first-selector F^2 , which is used exclusively by said line. Such first-selectors may be sub-divided into groups of one hundred each with all corresponding bank-terminals (not shown) of the same

group connected in multiple. For each level of first-selector line-bank-terminals one set of ten trunk-lines is provided which connects with suitable groups of switches.

5 Therefore, for each level to which a first-selector-shaft may be raised, there are trunk-lines leading to different sets of switches any one of which may be selected for the purpose of reaching through connectors to

10 subscribers in a given numerical group. Each of the said first-selectors and the line leading to it is connected with a given set of bank-contact-points in the banks of the connectors of the hundred to which said first-

15 selector and line belong; and whenever the first-selector is used a guarding potential appears at the connector-private-bank-contacts corresponding to the calling line, to prevent any other calling subscriber from

20 calling in on said line over the so-called normal-conductors that connect the connector-banks and the first-selector and line. To more fully understand the operations and circuits in connection with our improved

25 system, a description will be given of the apparatus and circuits brought into use continually in the system whenever a manual subscriber calls an automatic subscriber. Such a connection is illustrated in Figs. 1

30 and 2 taken together. For instance, if the subscriber at sub-station M wishes to call the subscriber at sub-station #220, he—the calling subscriber—removes his receiver from the switch-hook and thereby connects the

35 two contact-points 8 and 9 through said hook when it rises. At once the signal-lamp 311 becomes illuminated as the direct result of the magnetizing of the line-relay 312 by a current that then flows from ground-terminal G³, through the contact-point 313,

40 line-conductor 400, the retardation-coil 5 to the switch-hook 3, thence through the transmitter 4, line-conductor 401, contact-point 314, conductor 402, line-relay 312 and con-

45 ductor 403 to the non-grounded terminal of the battery B¹ and to ground G¹. When the armature 315 of said line-relay is attracted, a circuit is closed through the said signal-lamp 311, by which a current flows from the

50 ground-terminal G⁴, through said lamp and by way of a contact-point 316 and the armature 315 to the non-grounded terminal of battery B¹ and to ground G¹. The manual operator, seeing the light, recognizes the call

55 and inserts the answering-plug 317 into the answering-jack, thereby closing another energizing circuit through the cut-off-relay 318. The current here flows from the ground-terminal G⁵, through the cut-off-re-

60 lay 318 to the conductor 404, jack-sleeve 319, and to the conductor 405, thence through the supervisory-relay 320 to the non-grounded terminal of battery B¹ and to grounded terminal G¹. Then when the cut-off-relay at-

65 tracts its armatures the circuit through the

line-coil 312 is opened at the point 314, and when the armature 315 falls away from the contact-point 316 the energizing circuit through the lamp 311 is also broken and the current ceases to flow and the light is ex-

70 tinguished. At the same time that the cut-off-relay is energized the sleeve supervisory-relay 320, being in series with the former, is energized also. As soon as the cut-off-re-

75 lay-armatures 321 and 322 close in connection with the contact-points 323 and 324, respectively, the tip supervisory-relay 325 is energized by a current passing from the grounded terminal G¹ of battery B¹ to the

80 supervisory-relay 325 thence through the conductor 406, tip spring 326, conductor 407, contact-point 324, armature 322, conductor 400, retardation-coil 5, switch-hook 3, the transmitter 4, conductor 401, armature 321,

85 contact-point 323, conductors 404 and 405, and supervisory-relay 320 to the non-grounded terminal of battery B¹ and to ground G¹. The two supervisory-relays thus energized will remain so as long as the sub-

90 station M is in connection with the cord-circuit C. The central operator having inserted the plug as stated then throws the springs 327 and 328 away from the contact-points 329 and 330 and onto the contact-

95 points 331 and 332, respectively, thereby placing her receiver 333 across the calling subscriber's line, through the condenser 334 on one side, and the condenser 335 on the other. The operator will then speak in the

100 transmitter 336 and inquire of the calling subscriber the number desired. It will be understood that the current that has been described as passing through the transmit-

105 ter 4 is the current that charges or energizes said transmitter for talking purposes. Furthermore, the current for the transmitter 336 of the operator passes from ground G⁶ to the said transmitter, thence through the pri-

110 mary winding 337 of the induction-coil 338 to the resistance-coil 339, and to the non-grounded terminal of battery B¹ and to ground G¹. The secondary winding 340, of course, is in series with the receiver 333, both of which are placed across the main

115 talking line, as it has been stated. The path taken by the voice-currents between the sub-station M and the operator's talking set may be traced through the receiver 333, sec-

120 ondary winding 340 of the induction-coil 338, contact-point 331, spring 327, conductor 408, condenser 334, conductor 406, tip spring 326, contact-point 324, armature 322, conductor 400, condenser 7, receiver 2,

125 switch-hook 3, contact-point 8, transmitter 4, conductor 401, armature 321, contact-point 323, jack-sleeve 319, conductor 405, condenser 335, conductor 409, spring 328, and contact-point 332 to the receiver 333 again. Upon connecting with the sub-

130 scriber the operator inquires the number;

the calling subscriber wishing the automatic number 220 so informs the operator, who will then insert her calling plug 341 into the calling jack, and press her calling key so that the springs 342 and 343 are forced away from the contact-points 344 and 345 and into engagement with the contact-points 346 and 347. The said calling jack it will be understood is connected with a trunk-line that extends to the first-selector F^1 . Being thus connected the operator proceeds by pressing the so-called vertical-button 35 twice, and the rotary-button 36 once. This will cause the first-selector F^1 to operate in such manner as to raise its wipers to the second level, causing it to select from said level one of the trunk-lines leading to a connector in the automatic exchange. Then the vertical-button 35 is again operated twice, and the rotary-button 36 once, and in this way the connector is now raised to the second level also; then when the vertical-button 35 is pressed ten times for the last time, and the rotary-button 36 once, the connector-wipers are brought into engagement with the terminal of the line of the desired subscriber. The first time the vertical-push-button 35 is pressed twice the vertical-line-relay 66 of the first-selector F^1 is energized by a current flowing from ground G^7 through the springs 39 and 37, contact-point 346, spring 342, conductor 410, tip spring 348, vertical-line-conductor 411, side-switch-wiper 136, contact-point 142, conductor 412, and vertical-line-relay 66 to the battery lead 413 and to the non-grounded terminal of battery B^2 and to ground G^2 . As a result, the line-relay-spring 70 is forced onto the ground-spring 72 twice, which operation closes a second magnetizing circuit through the vertical-magnet 77. The current in this second circuit enters the line at the ground-terminal G^8 and then passes through the springs 72 and 70 to conductor 414, and through the private-springs 120 and 119 and conductor 415 to the vertical-magnet 77, passing thence to the battery lead 413, and to the non-grounded terminal of battery B^2 and to ground G^2 . The vertical-magnet 77 then attracts the vertical-armature 78 twice and drives the vertical-pawl into engagement with the circular teeth, raising the switch-shaft two steps. At the first step of the vertical-armature the release-link 87 is withdrawn from the double-dog 93, at which time the dog 95 engages with one of the circular teeth 60 and prevents the shaft from falling to its original position. At the second step the vertical-armature raises the shaft to the second level, when it is again caught by the vertical-dog. After the first-selector-shaft 52 is thus raised two steps, by pressing the vertical-button 35 twice, the rotary-line-relay 67 is energized once when the rotary-button is pressed once. The energizing current passes then from ground G^7 through the springs 39 and 38, contact-point 347, spring 343, conductor 416, jack-sleeve 349, rotary-line-conductor 417, side-switch-wiper 137, contact-point 143, conductor 418, rotary-line-relay 67 to the battery lead 413 and to the non-grounded terminal of battery B^2 and to ground G^2 . The rotary-line-relay being energized once the springs 71 and 72 close together, and as a result a second magnetizing circuit is completed through the private-magnet 114. The electric current in this latter case flows from the grounded terminal G^8 to the line-relay-springs 72 and 71, thence through the conductors 419 and 420 to the private-magnet 114, after leaving which it passes to the battery lead 413 and to the non-grounded terminal of battery B^2 and to ground G^2 . The private-armature 113 being attracted once and restored immediately, the escapement-tooth 126 first clears the escapement-finger 131, which latter then falls against the second tooth 125, and when the armature returns to its normal position this latter tooth then clears in turn the said escapement-finger. At that instant the side-switch is drawn into the second position by the retracting-spring 132, and the cam-lug 133 then rests against the cam 56. It will be understood that the prongs of the bifurcated end of the link 153, that rest upon the T-shaped extremity of the side-switch releasing arm 97, are of sufficient length to permit the said releasing-arm 97 to move from the position that it holds when the double-dog is held normally locked by the release-link 87, to the position it assumes when the double-dog is released, without disengaging said prongs. At the moment that the side-switch passes from first to second position a circuit is completed through the rotary-magnet 100, as will be shown, when the side-switch-wiper 134 closes with the contact-point 144. The current through said rotary-magnet then flows from the ground-terminal G^9 to the contact-point 144, and through the side-switch-wiper 134 and conductor 421 to the rotary-magnet-coil 102, thence through the interrupter-springs 110 and 111, and through the second rotary-magnet-coil 101, to the battery lead 413 and to the non-grounded terminal of battery B^2 and to ground G^2 . The rotary-magnet 100 then attracts the rotary-armature 103 and thereby forces the rotary-pawl 107 into engagement with one of the longitudinal teeth 59, causing the shaft to rotate one step. Just at the time, or the instant before the rotary-armature strikes the rotary-magnet pole-pieces, the rotary-dog 96 falls behind the first of the longitudinal teeth, in the manner already described, to prevent the shaft from returning to its normal position when the rotary-magnet becomes deenergized at the instant that the interrupter-

finger forces the interrupter-springs apart and destroys the energizing circuit through the said magnet. This interruption occurs just at the time when the rotary-armature strikes the pole-pieces. When the rotary-pawl 107 advances to engage the longitudinal teeth, as described, the rotary-armature-finger 112 comes into contact with the private-armature 113, producing a depression of the latter at the same time that the rotary-pawl produces a rotation of the shaft. As the shaft begins to rotate the cam 56 very soon passes out of reach of the cam-lug 133 and permits the escapement-finger 131 to fall against the tooth 127 before the rotary-armature-finger 112 has depressed the private-armature 113 too far. Very soon, however, the said tooth 127 is carried below the finger 131, which latter then falls against the upper tooth 124 at about the time that the shaft-wipers are rotated onto the first contacts of the second level of their respective banks. As soon as the energizing circuit through the rotary-magnet is interrupted the rotary-armature then begins to return to its normal position, and the private-armature 113 as well, following up the receding movement of the rotary-armature-finger 112. Very soon the tooth 124 clears the escapement-finger 131 also, and the side-switch springs into third position, with the escapement-finger 131 against the side-switch-stop 139. The shifting of the side-switch takes place just before the interrupter-finger permits the interrupter-springs 110 and 111 to reengage, so that by the time they do reengage the energizing circuit that has been described through the rotary-magnet has been opened at a point between the side-switch-wiper 134 and the contact-point 144. When the motion of the rotary-armature ceases altogether, the operation of the first-selector then comes to an end, the line-wipers 53 and 54 having seized upon an idle trunk-line similar to the trunk-line whose conductors 422 and 423 terminate at the tenth set of contacts of the second level of the same line-bank. The seized line is protected from further seizure by a guarding potential at the private-wiper 55 and, therefore, at the first contact of the second level of the private-bank 51, and at all other private-contacts in multiple. Said guarding potential is established by means of the connection between the grounded terminal of battery B^2 and said private-contacts, through the grounded terminal G^{10} , side-switch-wiper 135, conductor 424, back-release-relay 73, conductor 425 and the private-wiper 55. Similarly, should any first-selector appropriate to its use the second trunk-line of the same level, a guarding potential will appear at the second private-contact of the second level of the private-bank 51, as well as at all other private-bank-contacts in multiple; and should a third first-selector seize the third trunk on the same level a guarding potential will appear also at the third private-contact of the second level; and should the fourth, fifth, etc., and ninth trunks be occupied guarding potentials will be found at the fourth, fifth, etc., as well as at the ninth private-contact-terminals of the second level of the private-bank. Therefore, if the first nine trunk-lines of the second level are busy, a guarding potential is necessarily found at each one of the first nine private-contacts of the second level of the private-bank 51. If this condition exists at the time that the calling operator grounds her rotary-line-conductor by pressing button 36, the rotation of the shaft will not terminate as soon as the wipers have engaged the first terminal of the level to which they have been raised. The first nine private-contacts being grounded, then when the calling subscriber grounds the rotary side of the line the side-switch trips into second position in the manner described; but then the rotation of the shaft begins not to cease until the wipers have been carried beyond the last of the busy trunk-lines, in this case onto the tenth terminal of the second level of the banks in question. The operation takes place in the following manner: The energizing circuit through the rotary-magnet being closed, as was pointed out, at the time when the side-switch-wiper 134 engaged with the contact-point 144, the rotary-armature is attracted by the rotary-magnet 100 and the shaft is rotated one step in the manner described, so that the line and private wipers are rotated into engagement with the first terminals of the second level of their respective banks. At the same time, the private-armature is depressed by the rotary-armature-finger, and the interrupter-springs 110 and 111 are, at the end of the stroke, separated by the interrupter-finger 109. There being a guarding potential at the first contact which the private-wiper meets, a circuit is thereby completed through the private-magnet 114, which extends from the grounded terminal G^2 of the battery B^2 through the private-wiper of whatever first-selector is occupying the first trunk of the second level in question, and through the bank-multiplying conductors to the contact-point with which the private-wiper 55 has engaged; thence through said private-wiper 55, conductor 425, winding of the back-release-relay 73, conductor 424, side-switch-wiper 135, contact-point 145, conductors 426 and 420 and private-magnet 114, to the non-grounded terminal of battery B^2 and to ground G^2 . The private-armature is thereby retained in its attracted position, even after the energizing circuit is broken at the interrupter-springs, and while the rotary-armature

ture-finger 112 is returning to its normal position, in response to the retracting tension of the rotary-armature retracting-spring 105. Since the escapement-finger 131 is held prisoner by the upper foremost escapement-tooth 124, and the side-switch-wiper 134 being, therefore, retained in engagement with the grounded contact-point 144, it follows that as soon as the interrupter-springs reengage the energizing circuit through the rotary-magnet 100 is completed once more. As a result, the rotary-armature is attracted again, the shaft is rotated one more step, and the private-wiper 55 is moved onto the second terminal of the second level of the private-bank 51, said second contact also being grounded, the energizing circuit through the private-magnet is still maintained; so that the side-switch is not liberated when the rotary-armature again returns to its normal position. Clearly, then, the shaft will be rotated in a step-by-step manner as long as the private-wiper continues to encounter grounded private-contacts. After being rotated onto the ninth contact, the private-wiper is rotated one more step and brought into engagement with the tenth contact of the second level of the private-bank; but this last contact being devoid of guarding potential, it follows that as soon as the said wiper leaves the ninth contact the magnetizing circuit through the private-magnet, that has up to this time maintained the private-magnet energized, is broken. This occurs at just about the time when the rotary-armature is at the end of its attractive stroke, so that the private-armature that has up to this time held the side-switch in its second position, by the magnetizing force that has now disappeared from the private-magnet, falls back upon the rotary-armature-finger and follows the latter as the rotary-armature returns to its normal position. Between the time that the private-armature is released by the private-magnet and the time that the rotary-armature fully regains its normal position, the escapement-finger 131, which, during the rotation of the shaft, has been resting against the foremost tooth of the upper escapement-spring, disengages from said tooth and permits the side-switch to pass into the third position. It is then that the side-switch-wipers leave the contact-points 144, 145, 146 and 147 and pass onto the contact-points 148, 149, 150 and 151. When the wipers 136 and 137 arrive on the contact-points 150 and 151, the line-conductors 411 and 417 are then extended to the connector D by the conductors 422 and 423. The disengagement of the wiper 134 from the contact-point 144 occurs just before the interrupter-springs 110 and 111 reengage, so that the circuit through the rotary-magnet is permanently broken in order

that no further rotation of the shaft may take place during its operation, and the engagement of the wiper 135 with contact-point 149 provides the private-wiper 55 with guarding potential. After the operator's line-conductors are extended to the connector the operation of the calling device, for calling the second digit, will cause the vertical-line-conductor 411 to be grounded twice when the vertical-button 35 is pressed twice, and this will cause the vertical-line-relay 276 of the connector to be energized twice. A current then flows from ground G^7 at the calling apparatus to the vertical-line-conductor 411, thence through the side-switch-wiper 136, contact-point 150, conductor 427, vertical-line-wiper 53, vertical-trunk-conductor 422, and vertical-line-relay 276 of the connector to the battery lead 428 and to the non-grounded terminal of battery B^2 and to ground G^2 . The vertical-line-relay then attracts its armature 277 and closes the springs 278 and 279 together, establishing an energizing circuit through the vertical-magnet 214. The energizing current passes from ground G^{11} through the springs 279 and 278, conductor 429, private-springs 245 and 244, conductor 430, side-switch-wiper 257, contact-point 264, conductor 431, vertical-magnet 214 to the battery lead 428 and to the non-grounded terminal of battery B^2 and to ground G^2 . The vertical-magnet, on attracting its armature twice, raises the shaft 202 two steps, and places the connector-wipers 203, 204 and 205 opposite the first contact of the second level of their corresponding banks. The operator then presses the rotary-button 36 once and grounds the rotary-line-conductor 417 once. The said conductor extending to the connector causes the rotary-line-relay 282 to become energized, and the current in this last circuit flows from ground G^7 to the rotary-line-conductor 417, through the first-selector side-switch-wiper 137, contact-point 151, conductor 432, rotary-line-wiper 54, trunk-conductor 423 and conductors 433 and 434, side-switch-wiper 256, conductor 435, rotary-line-relay 282, to the battery lead 428, to the non-grounded terminal of battery B^2 and to ground G^2 . The connector line-relay-springs 284 and 279 being brought together, the private-magnet 235 is then energized by a current flowing from ground G^{11} through said springs 279 and 284, conductor 436, private-magnet 235 to the battery lead 428, and to the non-grounded terminal of battery B^2 and to ground G^2 . The connector-private-magnet, being energized once attracts its armature once, which latter then permits the connector-side-switch to pass to second position; the side-switch-wiper 257 passing from the contact-point 264 onto the contact-point 265, and the side-switch-wiper 258 from the contact-point 267 onto the con-

tact-point 268. The shifting of the side-switch-wiper 257 produces a change in circuits in the connector by which, when the vertical-button 35 again is pressed ten times
 5 for the last digit, the rotary-magnet 231, instead of the vertical-magnet 214, is operated when the line-relay-springs 278 and 279 are brought into contact. Each time the said springs close a current is sent from ground
 10 G^{11} through the springs 279 and 278 and through the private-springs 245 and 244 to the side-switch-wiper 257, passing through which latter it extends to the contact-point 265 and conductor 437, thence through the
 15 rotary-magnet 231 to the battery lead 428 and to the non-grounded terminal of battery B^2 and to ground G^2 . At each pulsation the rotary-magnet attracts its armature 232, rotating the shaft 202 one step at a time,
 20 and sliding the wipers 203, 204 and 205 along the second level of the banks which they engage. At the end of the tenth pulsation the wipers are on the tenth terminals of the second level of their banks; then for
 25 the last time the rotary-button 36 is pressed once. As a result, the rotary-line-conductor 417 is grounded by the means described; again the rotary-line-relay 282 of the connector is energized once, and the said relay
 30 in turn produces an energization of the private-magnet 235 that permits the side-switch to pass to third position with the side-switch-wipers 256, 257, 258, 259 and 260 in connection with the contact-points 263,
 35 266, 269, 272 and 275, respectively. The engagement of the side-switch-wiper 258 with the contact-point 269 places a guarding potential at the private-wiper 205, and at the tenth private-contact of the second level of
 40 the private-bank 201, to preclude any other connector from entering into connection with the called line 220. It will be understood, of course, that the same guarding potential exists at all other private-bank-con-
 45 tacts connected in multiple with the private-bank-contact mentioned. The closure of contact between the side-switch-wipers 259 and 260 and contact-points 272 and 275, respectively, connects the operator's extended
 50 line-conductors 422 and 423 through the condensers 350 and 351 to the vertical and rotary line-wipers 203 and 204, respectively, and, therefore, with the normal-conductors 438 and 439 that constitute the terminals of
 55 the called sub-station. At the instant that the connector seizes on the called subscriber's normal-conductors 438 and 439, it places a guarding potential over the called line because the side-switch-wiper 258 engages with
 60 the grounded contact-point 269. The establishment of this guarding potential over the called line not only protects it from further seizure, but also forces a current through the bridge-cut-off-relay 300 of the called first-
 65 selector F^2 , in order that the latter may

separate the bridge-cut-off-relay-springs 302, 303 and 304. The separation of the said springs from each other opens a bridged circuit through the vertical and rotary line-
 relays 305 and 306, that normally extends 70 across the line-conductors 440 and 441, and at the same time interrupts a connection between said relays 305 and 306 and the non-grounded terminal of the battery B^2 , which
 75 terminal is directly connected with the spring 304. Since the conductors 440 and 441 are included, one on each side of the main talking circuit, as will hereafter be disclosed, it is desirable to remove all un-
 80 necessary bridges from across said conductors, for obvious reasons, and at the same time to remove all possibility of the vertical and rotary line-relays being energized when a ringing current is projected to the called
 85 sub-station, so that no undesirable interruptions may take place. The energizing circuit through the bridge-cut-off-relay 300 extends from ground G^{12} over the connector-side-switch-contact-point 269, side-switch-
 90 wiper 258, conductor 442, private-wiper 205, private-normal-conductor 443, spring 308, contact-point 309 and bridge-cut-off-relay 300 to the non-grounded terminal of battery B^2 and to ground G^2 . The connection
 95 between the calling and called line having been established, the calling operator is in a position to signal the called line by pressing his button 35. But before going any further it will be explained that if for any
 100 reason the called line is busy at the time that the calling operator grounds the rotary-line-conductor 417 for the last time, to transfer the connector-side-switch from second to third position, the connector is necessarily
 105 released. For instance, if the line #220 has been called by another connector, there will then be a guarding potential at the tenth private-contact of the second level of the private-bank 201, corresponding to the line
 110 of the sub-station #220. Or, on the other hand, if the first-selector F^2 of the called line is being used, and the shaft of said first-selector is off-normal as a result, the same private-bank-contact will then be connected
 115 to ground from the instant that the normal-post-arm 307 permits the shaft-spring 308 to engage with the grounded contact-point 310. Said guarding potential will reach the private-bank of the connector by way of the
 120 private-normal-conductor 443. At any rate, if the private-wiper 205 finds a guarding potential at the tenth contact of the second level of the private-bank 201 at the instant that the calling operator grounds her rotary
 125 line-conductor 417 for the last time, then instead of the side-switch being tripped to third position the connector will be released, because the energization of the private-magnet 235, as a result of grounding the rotary-
 130 line-conductor 417, sets up an energizing cir-

cuit through the release-magnet of the connector when the armature of the said private-magnet forces the springs 247 and 246 into contact. The energizing circuit through
 5 the release-magnet allows the current to flow from the grounded terminal of the battery B² to the tenth contact of the second level of the connector-private-bank 201, through the private-wiper 205, conductor 442, side-switch-
 10 wiper 258, contact-point 268, conductor 444, private-springs 246 and 247, conductors 445 and 446, and release-magnet 219 to the battery lead 428 and to the non-grounded terminal of battery B² and to ground G². The connector-release-magnet being energized, the release-armature 220 so moves the double-dog
 15 222 that the lug 228 is caught and held in the aperture 230 on the end of the release-link. Of course, when the double-dog is thus rotated, the locking-arm 226 is withdrawn from the longitudinal teeth 207. Then the shaft is free to rotate back to its normal rotary position, owing to the tension of the coiled spring 210, until the normal-post-arm
 20 209 strikes the normal-post 213. At that instant the shaft-support 212 enters the slot 211, and the said shaft of necessity then falls to its normal position. The release-armature, when it rotates the double-dog 222,
 25 at the same time swings the side-switch to its first position, about the pivots of the latter, by means of the side-switch-link 255 and the release-arm 227. The latter, by pressing the former back, forces the escapement-finger 249 between the escapement-springs
 30 237 and 238, which finger is then caught behind the rearmost lower tooth 241, where it remains until the connector comes into use again. The restoration of the connector-shaft begins while the release-magnet 219 is in an energized state; but, since the energizing circuit through said magnet comprises the private-wiper 205 and the side-switch-wiper 258, it will be evident that as
 35 soon as the shaft begins to rotate to its normal position the energizing circuit through the release-magnet 219 will be broken as soon as the said private-wiper 205 leaves the private-contact-point with which it has been engaged; and the same energizing circuit is also interrupted at the side-switch-wiper 258 when the latter is forced into its first position. The operator then thinking she has established connection, presses the
 40 button 35 to signal, with the result that the vertical side of the line is grounded. The grounding of the vertical line causes the energizing of the connector vertical-line-relay 276, in the usual manner, and, since the connector-side-switch is in first position, the connector vertical-magnet 214 is energized, when the line-relay-springs 278 and 279 are pressed into contact, through a circuit that is already familiar. As a result, and for
 45 60 65 reasons previously explained, the shaft of the connector is raised, and the springs 293 and 294 which it controls are brought into contact. The engagement of these two parts completes a busy circuit through which a busy signaling current is transmitted to the
 70 calling line, which current may originate in any suitable apparatus F (Fig. 2) comprising a coil 352 in which the busy signal current is induced. The operator, when she has thus far completed the operations de-
 75 scribed, will restore the cam-springs 342 and 343 to the contact-points 344 and 345, connecting the sub-station M through to the automatic apparatus by way of the line-condensers 334 and 335. At that instant
 80 the busy signaling current is conducted to the said sub-station M through the receiver 2, which current will notify the subscriber at the manual sub-station that the desired number is busy. This busy current passes
 85 from the coil 352 to the conductor 447, thence through the springs 294 and 293 to the conductor 448, contact-point 270, side-switch-wiper 259, ringer-relay-springs 291 and 290, conductor 449, condenser 350, conductor 422,
 90 wiper 53, conductor 427, side-switch-wiper 136, vertical-line-conductor 411, jack tip spring 348, spring 342, conductor 408, condenser 334, conductor 406, jack tip spring 326, conductor 407, contact-point 324, armature
 95 322, conductor 400, condenser 7, receiver 2, switch-hook 3, transmitter 4, line-conductor 401, armature 321, contact-point 323, conductor 404, jack sleeve 319, conductor 405, condenser 335, conductor 409, spring
 100 343, jack sleeve 349, rotary-line-conductor 417, wiper 137, conductor 432, wiper 54, trunk-conductor 423, conductors 433 and 434, side-switch-wiper 256 to the conductor 435, rotary-line-relay 282 and back to the coil
 105 352. The calling subscriber will then restore his receiver to its switch-hook, thereby destroying the energizing circuit through the tip supervisory-relay 325, at which instant the armature 353 of said relay falls
 110 back again to the contact-point 354. This last operation completes a circuit through the front supervisory-lamp 33 from the non-grounded terminal of battery B¹ through the armature 356, contact-point 357, conductor
 115 450, armature 353 and contact-point 354 to the grounded terminal G¹ of battery B¹. The operator, as soon as the lamp 33 flashes up, will understand that the subscriber at the sub-station M has restored his
 120 receiver and will withdraw the answering plug from the answering jack, producing as a result, of course, the restoration of the cut-off-relay 318 and the supervisory-relay 320. She will then proceed to release the
 125 automatic apparatus by operating the springs 342 and 343 so as to force said springs back onto the contact-points 346 and 347, respectively, after doing which the vertical and rotary buttons 35 and 36 are
 130

pressed simultaneously, so that the vertical and rotary line-conductors 411 and 417 are grounded at the same time. The grounding of these two conductors causes a simultaneous energizing of the vertical and rotary line-relays 276 and 282, and as previously explained the springs 280 and 281 are brought into contact. An energizing circuit is then completed that includes the release-magnet 219 of the connector D and the back-release-relay 73 of the first-selector F¹. The magnetizing current for the latter circuit passes from the ground point G¹⁰ to the contact-point 149 of the side-switch of the first-selector, then through the side-switch-wiper 135 to the back-release-relay 73, after passing through which the current flows to the private-wiper 55 and to the private-trunk conductor 451, through the release-springs 280 and 281 to the conductors 452 and 446, through the release-magnet 219, and to the non-grounded terminal of battery B² and to ground G². At the instant that the release-armature 220 of the connector is attracted by said release-magnet, the double-dog is restored to its normal position, driving the side-switch to its first position and depriving the shaft of the locking means provided by the locking-dog 226. In a manner already recited, the shaft 202 of the connector falls to its normal position, thus rendering the connector restored in all parts save the release-magnet-armature and line-relays. The energizing of the back-release-relay of the first-selector closes the back-release-relay-springs 75 and 76, thus completing a magnetizing circuit through the release-magnet 90 of the first-selector. This current flows from the ground point G¹³ and through the springs 75 and 76 to the release-magnet 90 and the non-grounded terminal of the battery B² and to ground G². At once the release-armature 89 is attracted, at which instant the release-link 87 is thrust forward sufficiently to catch the lug 98 of the double-dog. The release-magnet of the first-selector remains energized without restoring the said switch until after the energizing current is broken; but as soon as the ground impulse over the line-conductors is interrupted, the rotary and vertical line-relays of the connector then become deenergized and permit their armatures to be restored, at which instant the springs 280 and 281 are forced apart, destroying the continuity of the circuit that includes the back-release-relay 73 and the release-magnet 219 of the connector. Evidently, at this time, the release-armature 220 of the connector is restored, leaving said switch in readiness for further operation. When the back-release-relay 73 of the first-selector allows the springs 75 and 76 to separate, the release-magnet 90 becomes deenergized, and the re-

tracting-spring 92 of the release-armature 89 draws the said armature back to its normal position, causing the double-dog 93 to be rotated about the pivots 94, thrusting the side-switch to its normal position, moving the escapement-finger 131 behind the escapement-tooth 126, and depriving the shaft 52 of the locking means furnished by the rotary-locking-dog 96. The first-selector-shaft then falls to its normal position, producing a full restoration of said switch. The energizing circuit through the bridge-cut-off-relay 300 of the called first-selector F², it will be remembered, comprises the side-switch-wiper 258 of the connector D, the private-wiper 205 and private-normal 443. Evidently, therefore, as soon as the connector is restored this energizing circuit is interrupted and the bridge-cut-off-relay of the first-selector F² resumes its normal position, restoring the bridge-cut-off-relay-springs 302, 303 and 304 into contact. But it has been described that the called line is not busy, and that the connection with said line is completed. Then when the button 35 is pressed for signaling, in a manner already stated, the operator thereby grounds the vertical-line-conductor 411, and the vertical-line-relay 276, by means of circuits already familiar, is energized. Since the side-switch of the connector is then in third position, and since the connector-side-switch-wiper 257 is, therefore, in engagement with the contact-point 266, it follows that the engagement of the line-relay-springs 278 and 279 causes the energization of the connector-ringer-relay 285. The energizing current passes from ground G¹¹ through the springs 279 and 278, private-springs 245 and 244, side-switch-wiper 257, contact-point 266 and ringer-relay 285, to the non-grounded terminal of battery B² and to ground G². The ringer-relay-armature 286 then forces the ringer-relay springs 288 and 291 onto the ringer-generator-springs 289 and 292. A signaling current then passes out to the subscriber's line from the ringer-generator J to the brush 358, springs 292 and 291, side-switch-wiper 259, contact-point 272, conductor 453, vertical-wiper 203, vertical-normal-conductor 438, vertical-line-conductor 440, spring 10, switch-hook 13, spring 21, ringer 22, spring 11, rotary-line-conductor 441, rotary-normal-conductor 439, rotary-wiper 204, conductor 454, contact-point 275, wiper 260, ringer-relay-springs 288 and 289 and brush 359 to the ringer-generator J. The bell at the substation will be rung as long as the operator presses her button 35, but as soon as she releases said button the ringer-relay 285 is deenergized, and the ringer-relay-springs return to their normal positions. Having made the call and signaled the subscriber, the manual operator then restores the key-

springs 342 and 343 to normal position, thereby connecting the calling subscriber's line with the called subscriber's line. At that instant the back supervisory-lamp-light
 5 34 flashes up as current passes from battery B¹ through the said lamp and through the back supervisory-relay-armature 361 to ground G¹⁴. The completion of this circuit comes about in the following manner: At
 10 the instant that the connector-side-switch-wiper 258 passes into third position, after the connector has connected with the called line, the back-bridge-relay 295 of said connector becomes magnetized by a current that
 15 flows from ground G¹² to the contact-point 269 and through the side-switch-wiper 258 to the conductor 455, through the back-bridge-retardation-coil 299, conductor 449, ringer-relay-springs 290 and 291, side-
 20 switch-wiper 259, contact-point 272, conductor 453, line-wiper 203, normal-conductor 438, line-conductor 440, spring 10, switch-hook 13, ringer-circuit-spring 21, ringer 22, spring 11, rotary-line-conductor 441,
 25 rotary-normal-conductor 439, rotary-line-wiper 204, conductor 454, contact-point 275, side-switch-wiper 260, ringer-relay-springs 288 and 287, conductor 456, through the back-bridge-relay 295 to the non-grounded
 30 terminal of battery B² and to ground G². As soon the back-bridge-relay 295 attracts its armature 296 the back-bridge-relay-springs 297 and 298 are pressed into contact and a second circuit is established through
 35 the cord-circuit supervisory-relay 362, contact-point 330, spring 328, contact-point 345, spring 343, jack sleeve 349, rotary-line-conductor 417, side-switch-wiper 137, contact-point 151, conductor 432, rotary-line-wiper
 40 54, rotary-trunk-conductor 423, conductors 433 and 457, back-bridge-relay-springs 298 and 297, conductor 458, contact-point 263, side-switch-wiper 256, conductor 435 and rotary-line-relay 282, to the non-grounded terminal
 45 of battery B² and to ground G². In this circuit the rotary-line-relay 282 of the connector is included in series with the back-bridge-supervisory-relay 362 of the cord-circuit, which latter relay attracts its armature
 50 361 against the contact-point 363, and completes the illuminating circuit through the back supervisory-lamp 34, as described. However, the current that passes through the rotary-line-relay 282, at this stage, is not
 55 strong enough to attract the armature 283 against the retracting tension of the spring 284, since the back-bridge-supervisory-relay 362 is wound to a resistance of about 3000 ohms, while the said rotary-line-relay is only
 60 about 500 ohms. Now, when the signaled subscriber removes his receiver 19 from the switch-hook 13, the established energizing circuit through the ringer 22 and the back-bridge-relay 295 is interrupted as soon as
 65 the arm 14 leaves the ringer-circuit-spring

21. As a result, the connector-back-bridge-relay-armature 296 is restored to normal position, and the back-bridge-relay-springs 297 and 298 are permitted to separate. As a further result, the energizing circuit through
 70 the cord-circuit back supervisory-relay 362 is opened, which latter releases its armature 361, at which instant the back supervisory-lamp 34 is extinguished, and the operator will then understand that the called sub-
 75 scriber has answered. The two subscribers—the calling and called—will find themselves connected, and, since the transmitters are energized, the transmitter 4 by current from the battery B¹ in series with the super-
 80 visory-relays 325 and 320, and the transmitter 30 with current from the local battery 31, the two subscribers may speak with each other in the usual and well-known manner. The talking circuit comprises in series the
 85 receiver 2 at the sub-station M, the condenser 7, conductor 400, tip spring 326, conductor 406, condenser 334, conductor 408, tip spring 348, vertical-line-conductor 411, side-switch-wiper 136, conductor 427, vertical-
 90 line-wiper 53, vertical-trunk-conductor 422, condenser 350, conductor 449, ringer-relay-springs 290 and 291, side-switch-wiper 259, conductor 453, vertical-line-wiper 203, vertical-normal-conductor 438, vertical-line-
 95 conductor 440, spring 10, secondary circuit-springs 24 and 23, secondary winding 28, condenser 27, receiver 19, spring 11, rotary-line-conductor 441, rotary-normal-conductor 439, rotary-line-wiper 204, conductor 454,
 100 side-switch-wiper 260, ringer-relay-springs 288 and 287, conductor 456, condenser 351, conductor 423, rotary-line-wiper 54, conductor 432, side-switch-wiper 137, rotary-line-conductor 417, jack sleeve 349, conduc-
 105 tor 409, condenser 335, conductor 405, jack sleeve 319, conductor 401, transmitter 4, and switch-hook 3, which latter is connected to the receiver 2. When the subscribers are through communicating they restore their
 110 receivers to their switch-hooks, and at once the supervisory-lamps 33 and 34 become illuminated for reasons and by means already pointed out. Clearly when the subscriber at station A restores his receiver the
 115 energizing circuit through the back-bridge-relay 295 is reestablished through the ringer 22 as soon as the switch-hook-cam 14 engages the ringer-circuit-spring 21, and when the back-bridge-relay springs 297 and 298 are
 120 closed into contact the energizing circuit through the back supervisory-relay 362 is reinstated, which relay, becoming magnetized, completes the energizing circuit through the lamp 34. The operator, under-
 125 standing that the subscribers are through talking, withdraws the answering plug from the answering jack, thereby restoring the armatures 321 and 322 of the cut-off-relay to their normal positions, as well as the arma-
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tures 353 and 356 of the supervisory-relays 325 and 320, respectively; and she will then proceed to separate the springs 342 and 343 from the contact-points 344 and 345, forcing them onto contact-points 346 and 347, respectively. As soon as the spring 343 leaves the contact-point 345 the energizing circuit through the back supervisory-relay 362 is destroyed and the latter then permits the lamp 34 to go out. The operator will then restore the automatic switches by pressing the buttons 35 and 36 simultaneously, as before, thus grounding the vertical and rotary line-conductors 411 and 417 at the same time. The release-circuit in this case, however, while the connector-side-switch is in third position, is different from the release-circuit while the connector-side-switch is in the first or second position, since the back-bridge-relay-springs 297 and 298 are now inserted between the main talking line-conductor 423 and the rotary-line-relay 282. The vertical-line-relay becomes energized through the usual circuit, but the rotary-line-relay receives current from the ground G^7 through the rotary-line-conductor 417 and the rotary-trunk-conductor 423, after which it passes to the conductors 433 and 457 through the back-bridge-relay-springs 298 and 297, conductor 458, side-switch-wiper 256, after leaving which said current enters the rotary-line-relay 282 and passes to the non-grounded terminal of battery B^2 and to ground G^2 . As a result, the connector release-springs 280 and 281 are brought together, and the connector release-magnet, together with the first-selector back-release-relay, are energized in series, in a well-known manner, at which instant the connector-shaft and side-switch are restored to their normal positions. As soon as the connector-line-wipers 203 and 204 leave their bank-contacts the energizing circuit through the back-bridge-relay 295 would be destroyed were it not for the fact that the main talking circuit rotary-conductor 456 is connected to ground as soon as the vertical-line-relay 276 becomes energized. This circuit is completed from ground G^{11} through the connector line-relay-springs 279 and 278, conductor 459 to the said rotary-conductor 456. The current after leaving the said conductor 456 passes to the back-bridge-relay 295 and to the non-grounded terminal of battery B^2 . However, as soon as the side-switch-wiper 256 is restored to the normal position the energizing current through the rotary-line-relay 282 changes in its course and, instead of passing from the rotary-trunk-conductor 423 to the back-bridge-relay-springs, passes directly to the conductors 433 and 434 and side-switch-wiper 256, thence through the conductor 435 and rotary-line-relay 282 to the non-grounded terminal of battery B^2 and to ground G^2 . There is one circuit that is destroyed when

the private-wiper 205 leaves the private-bank 201, and that is the circuit through the bridge-cut-off-relay 300 of the first-selector F^2 , at which time the bridge-cut-off-relay-springs are then restored to their normal positions. As soon as the operator releases the buttons 35 and 36 the energizing circuits through the connector line-relays are destroyed, and the connector as well as the first-selector F^1 are fully restored in a well-known manner. If the subscriber at sub-station A should neglect to restore his receiver, the back-bridge-relay 295 will be retained deenergized, and the connection between the rotary-normal-conductor 423 and the rotary-line-relay 282 is not closed at the back-bridge-relay-springs 297 and 298, but in spite of this fact should the operator insist upon releasing before the subscriber at said station restores his receiver, she may do so successfully, because as soon as the vertical-line-relay becomes energized the back-bridge-relay 295 becomes energized over the circuit that has already been pointed out from ground G^{11} through the connector line-relay-springs 279 and 278, conductor 459 to the said back-bridge-relay, to the non-grounded terminal of battery B^2 to ground G^2 , after which step the release will proceed in a manner that has already been made clear.

It will be understood that we do not restrict ourselves to having all of the lines with their cut-off relays, such as the relay 318 (Fig. 1) connected to ground. Some of the lines may be arranged with cut-off relays connected to the negative side of battery, in which case contacts, such as the contact 313 associated with the cut-off relay, would be connected to the negative side of battery, and the relay 312 would consequently be connected to ground.

Our invention, therefore, comprises an improved telephone system having manual apparatus and automatic apparatus, the former comprising an improved cord-circuit the answering side of which is adapted to operate in connection with the manual line in a well-known manner, while the calling side is improved and modified to be used in connection with automatic switches and trunk-lines for the purpose of establishing connection through the automatic switching apparatus among which is comprised an improved connector that may be termed a supervisory-connector. Said connector, in connection with an improved circuit in an automatic sub-station of the usual local battery type, and with the improved answering section of a common battery manual cord-circuit, provides the means by which a supervisory light at the manual central office is controlled to notify the manual operator when the automatic subscriber has answered, or when he has restored his receiver to

the hook. It will be noticed that although the rotary-line-relay 282 is removed from the rotary side of the talking line the balance to the talking circuit during talking is restored by the connection of the ringer-relay 285 with the said rotary side to make up for the loss of the said rotary-line-relay. The said ringer-relay, it will be clear, is connected through the conductor 460 to the side-switch contact-point 266, side-switch-wiper 257, conductor 430, private-springs 244 and 245, conductors 429 and 459 to the rotary side of the line at a point in common with the conductor that leads to the back-bridge-relay 295.

From the foregoing it will be seen that we provide an improved connector switching machine having means for cooperating with the supervisory-relay 362 of the operator's cord-circuit C in giving the operator in charge of this cord-circuit satisfactory supervision over the connection established between the two lines. As explained, the said connector back-bridge-relay 295 is, as far as function is concerned, a supervisory-relay allotted to the called subscriber, inasmuch as this relay of the connector is only used by the called subscriber and is only useful in cooperating with the other necessary elements in notifying the operator at the manual board that the called subscriber has answered, or that the called subscriber has hung up his receiver after having terminated the conversation. Furthermore, the said back-bridge or supervisory relay 295 controls the circuit of the line-relay 276—that is to say, the circuit which is necessarily closed through this relay when the manual board operator, having received either one or both of the supervisory signals, performs the grounding or switching operation necessary for releasing the connector and selector switches, and for restoring the automatic switching machinery to its normal condition. Again, it will be seen that the manual board operator gets a signal just as soon as the called subscriber answers, inasmuch as the lamp 34 ceases to glow. Also, the manual board operator gets a positive supervisory signal as soon as the called subscriber hangs up his receiver, inasmuch as the lamp 34 is then illuminated. All this supervision afforded the operator of the established connection is totally independent of the dial or calling device at the called subscriber's station. In other words, the manual board operator's supervisory apparatus is operated in a natural and satisfactory manner, and by the ordinary act of hanging up the receiver at either the calling or called subscriber's station. Obviously, then, we combine an operative automatic release with an operative supervision which is totally independent of the subscriber's or operator's calling devices.

It will be understood that the selectors herein described and illustrated can be of the general type disclosed in Patent No. 815,321, granted March 13, 1906, to Keith, Erickson & Erickson. It will also be understood that the connectors herein referred to can be of the general type disclosed in Patent No. 815,176, granted March 13, 1906, to Keith, Erickson & Erickson.

What we claim as our invention is:—

1. In a telephone system, calling and called subscribers' lines temporarily connected together through the medium of an operator's cord-circuit and automatic trunk-selecting and line-connecting switching machinery, supervisory apparatus for the operator's cord-circuit, means at the calling and called subscribers' stations for controlling said supervisory apparatus, and a calling device at the called subscriber's station for automatically calling other subscribers in the same exchange.

2. In a telephone system, a calling manual board exchange subscriber's line, a called automatic exchange subscriber's line, means including an operator's cord-circuit and a forward and back operating connector for temporarily connecting the two lines together, supervisory signal apparatus for the operator's cord-circuit, and telephone switch-hooks allotted to the two subscribers and adapted for automatically controlling the supervisory apparatus through the removal and replacement of the subscribers' receivers.

3. In a telephone system, a subscriber's line, a forward and back operating connector temporarily set on the said line, an operator's cord-circuit having suitable connection with said connector, a supervisory-relay for the said cord-circuit, a supervisory-lamp controlled by the said relay, and a subscriber's telephone switch-hook allotted to the said line, together with means including suitable connections whereby the upward movement of the switch-hook automatically deenergizes said relay and retires the lamp signal to indicate that the subscriber has answered, and whereby the downward movement of the switch-hook automatically energizes said relay and illuminates the lamp signal to indicate that the subscriber is through talking and has hung up his receiver.

4. In a telephone system, a calling manual board exchange subscriber's line, a called automatic exchange subscriber's line, means including an operator's cord-circuit and a forward and back operating connector for temporarily connecting the two lines together, receivers for the two subscribers' stations, a supervisory signal controlled by the removing and the hanging up of the receiver at the calling subscriber's station, and another supervisory signal controlled by the

removing and the hanging up of the receiver at the called subscriber's station, whereby the operator may know when the called subscriber answers, and whereby the operator may also know when either subscriber has hung up his receiver.

5. In a telephone system, a manual board exchange subscriber's line, an automatic exchange subscriber's line, means including an operator's cord-circuit and a forward and back operating connector for temporarily connecting the two lines together, a receiver for each subscriber's station, and a couple of supervisory signals coöperating with the cord-circuit, one supervisory signal being controlled by the hanging up of the receiver at one subscriber's station, and the other supervisory signal being controlled by the hanging up of the receiver at the other subscriber's station, whereby the operator may know when the called subscriber answers, and whereby the operator may also know when either subscriber hangs up his receiver.

6. In a telephone system, a subscriber's switch-hook, an automatic connector-switch provided with a supervisory-relay, a circuit for said supervisory-relay controlled by said switch-hook, an operator's cord-circuit, a supervisory-relay associated with said cord-circuit, a circuit for said last-mentioned supervisory-relay controlled by said first-mentioned supervisory relay, and a supervisory-lamp-signal, together with a circuit for said lamp-signal controlled by said last-mentioned supervisory-relay.

7. In a telephone system, an operator's cord-circuit, a supervisory device for said cord-circuit, a connector provided with a supervisory-relay, a circuit for said supervisory device controlled by said supervisory-relay, and a release-circuit for the connector controlled by said supervisory-relay.

8. In a telephone system, a connector provided with line-relays and a supervisory-relay, a supervisory signal controlled through the medium of said supervisory-relay, and a plurality of energizing circuits for one of said line-relays, one of said energizing circuits being controlled by said supervisory-relay.

9. In a telephone exchange system, the combination of a cord circuit, a telephone line, automatic means controlled by the operator for connecting the cord circuit with the telephone line, means by which the subscriber on said telephone line may give the operator at said cord circuit a disconnect signal over the said connection, means by which the operator may release said automatic means to cause it to return to normal through a backward movement, and a central source of current for operating said disconnect signaling means.

10. In a telephone exchange system, the

combination of a telephone line, a cord circuit, automatic means for connecting the cord circuit with the said telephone line, adapted to be restored to normal position through a backward movement, means by which the called subscriber can give the operator at said cord circuit a disconnect signal over said connection, and a central source of current for operating said disconnect signaling means.

11. In a telephone exchange system, the combination of telephone lines, connector switches having motion in two intersecting planes, less in number than said lines, adapted for seizing called lines, means for trunking to an idle connector switch, and cord circuits for connecting calling lines with said trunking means.

12. In a telephone exchange system, the combination of a cord circuit, automatic switches having motion in two intersecting planes, subscribers' lines, means by which the operator at the cord circuit controls said switches to connect with one of said lines, and to release the same, and means by which the called subscriber signals the operator at the cord circuit.

13. In a telephone system, calling and called subscribers' lines temporarily connected together through the medium of an operator's cord circuit and automatic trunk-selecting and line-connecting switching machinery, devices whereby the operator may disconnect from both lines, supervisory apparatus for the operator's cord circuit, means at the calling and called subscribers' stations for controlling said supervisory apparatus, a calling device at the called subscriber's station, and means at the central station responsive thereto for automatically calling other subscribers in the same exchange.

14. In a telephone system, calling and called subscribers' lines temporarily connected together through the medium of an operator's cord circuit and automatic trunk-selecting and line-connecting switching machinery, devices whereby the operator may disconnect from both lines, supervisory apparatus for the operator's cord circuit, and telephone switch-hooks at the calling and called subscribers' stations, together with suitable circuit connections whereby the removal and replacement of the subscribers' receivers controls the said supervisory apparatus through the operation of the said switch-hooks.

15. In a telephone system, calling and called subscribers' lines temporarily connected together through the medium of an operator's cord circuit and automatic switching machinery having motion in two intersecting planes, devices whereby the operator may disconnect from both lines, supervisory apparatus for the said cord circuit, and telephone switch-hooks for the calling and

called subscribers' stations, together with suitable circuit connections whereby the operation of the said switch-hooks controls the supervisory apparatus.

5 16. In a telephone system, a calling manual board exchange subscriber's line, a called automatic exchange subscriber's line, means including an operator's cord circuit and a forward and back operating connector for
10 temporarily connecting the two lines together, said connection having condensers in the talking circuit, supervisory signal apparatus for the operator's cord circuit, and telephone switch-hooks allotted to the two
15 subscribers and adapted for automatically controlling the supervisory apparatus through the removal and replacement of the subscribers' receivers.

17. In a telephone system, a subscriber's
20 line, a connector temporarily seizing the said line, an operator's cord circuit having suitable connection with said connector, a supervisory relay for the said cord circuit, a supervisory lamp controlled by the said relay,
25 and a subscriber's telephone switch-hook allotted to the said line, together with means including suitable connections and a relay in the connector whereby the upward movement of the switch-hook automatically de-
30 energizes said relay and retires the lamp signal to indicate that the subscriber has answered, and whereby the downward movement of the switch-hook automatically en-
35 ergizes said relay and illuminates the lamp signal to indicate that the subscriber is through talking and has hung up his receiver.

18. In a telephone system, a calling manual board exchange subscriber's line, a called
40 automatic exchange subscriber's line, means including an operator's cord circuit and a connector having one or more relays for temporarily connecting the two lines together, receivers for the two subscribers'
45 stations, a supervisory signal controlled by the removing and the hanging up of the receiver at the calling subscriber's station, and another supervisory signal controlled by the removing and the hanging up of the receiver
50 at the called subscriber's station, through the medium of a relay in the connector, whereby the operator may know when the called subscriber answers, and whereby the operator may also know when either sub-
55 scriber has hung up his receiver.

19. In a telephone system, a manual board exchange subscriber's line, an automatic exchange subscriber's line, means including an operator's cord circuit and a connector hav-
60 ing one or more relays for temporarily connecting the two lines together, a receiver for each subscriber's station, and a couple of supervisory signals coöperating with the cord circuit, one supervisory signal being
65 controlled by the hanging up of the receiver

at one subscriber's station, and the other supervisory signal being controlled by the hanging up of the receiver at the other subscriber's station, through the medium of a relay in the connector, whereby the operator
70 may know when the called subscriber answers, and whereby the operator may also know when either subscriber hangs up his receiver.

20. In a telephone system, a subscriber's
75 switch-hook, an automatic connector switch provided with a supervisory relay, a circuit for said supervisory relay controlled by said switch-hook, an operator's cord circuit, a supervisory relay associated with said
80 cord circuit, a circuit for said last-mentioned supervisory relay, controlled by the first-mentioned relay, and a supervisory lamp signal, together with a circuit for said lamp
85 signal controlled by said last-mentioned supervisory relay.

21. In a telephone system including manual and automatic exchange apparatus, means for connecting a manual board ex-
90 change subscriber's line with an automatic exchange subscriber's line, which exchanges have relays, means for giving the manual board operator full supervision of the connection temporarily established between the
95 two lines, by relays at both exchanges, and means under the control of said switchboard operator for restoring to normal condition all connecting means brought into use between
the two lines.

22. In a telephone system including man-
100 ual and automatic exchange apparatus, the combination of a supervisory apparatus, relays at both exchanges for enabling a switchboard operator to fully supervise the connections established between a manual
105 switchboard subscriber's line and an automatic exchange subscriber's line, and an automatic release for enabling the switchboard operator to automatically restore to normal condition all means temporarily brought
110 into use between the two lines.

23. In a telephone exchange system, the combination of a cord circuit, a called tele-
115 phone line, automatic means controlled by the operator for connecting said cord circuit with said telephone line, means by which the called subscriber may signal the operator at said cord circuit, including a relay out-
side of the cord circuit, a calling telephone line, a plug and jack connection intermediate
120 said calling line and the cord circuit, and a central source of talking current for said calling telephone line.

24. In a telephone exchange system in-
125 cluding a manual board, the combination of automatic switches, means by which a manual exchange operator may release said switches and disconnect the called line, a plug and jack connection intermediate the
calling line and switches, a central source
130

of talking current for said calling line, and means by which the called subscriber can signal the said operator, including a relay outside of the cord circuit.

5 25. In a common battery telephone exchange system, the combination of a telephone line, a manual operator's cord circuit, automatic means for connecting the cord circuit with the said telephone line, and means
10 by which the called subscriber can signal the operator at said cord circuit, including a relay outside of the cord circuit.

26. In a common battery telephone exchange system, the combination of automatic switches, subscribers' lines, a manual
15 operator's cord circuit, means by which the operator at a cord circuit controls said switches to connect with one of said lines, and means by which the called subscriber
20 signals the operator at the cord circuit, including a relay outside of the cord circuit.

27. A telephone system comprising subscribers' telephone lines extending from substations to an exchange, call signals controlled from the substations of said lines,
25 operators' answering means adapted for connection with said lines, other telephone lines, multiple terminals for said other lines, switches having motion in two planes adapted
30 to be employed for making connection therewith, operators' switching means to enable the operators to transmit directive currents to said switches to cause them to connect said answering means with terminals of
35 particular ones of said other telephone lines, whereby connections between subscribers are completed, and a central source of current and branches to supply current therefrom to calling substations for conversation.

40 28. In a telephone system, a plurality of subscribers' lines, a connector switch for connecting with said lines, a rotary line relay for said connector, a second relay in
45 said connector, a switch for controlling the connection of said rotary relay to the rotary side of the line, and means whereby in one position of said switch said rotary relay connection is controlled by said second relay.

50 29. In a telephone system, a plurality of subscribers' lines, a connector switch for connecting with said lines, a rotary line relay for said connector, a side switch having a plurality of positions, means whereby
55 said relay is connected directly to the rotary line through said side switch in the first two positions thereof, and a second relay controlling said connection when said side switch is in third position.

60 30. In a telephone system, a plurality of subscribers' lines, a connector switch for connecting with said lines, a rotary line relay for said connector, a second relay in
65 said connector, a switch for controlling the connection of said rotary relay to the ro-

tary side of the line, and means whereby in one position of said switch said rotary relay connection is controlled by said second relay, said second relay being under the control of the called subscriber.

70 31. In a telephone system, a plurality of subscribers' lines, a connector switch for connecting with said lines, a rotary line relay for said connector, a side switch having a plurality of positions, means whereby said
75 relay is connected directly to the rotary line through said side switch in the first two positions thereof, and a second relay controlling said connection when said side switch is in third position, said second relay
80 being under the control of the called subscriber.

32. In a telephone system, a plurality of subscribers' lines, a connector switch for connecting with any one of said lines, a line
85 relay for said connector, a second relay in said connector controlling the circuit of said line relay, means for energizing said second relay when connection is made with a called line, and means for deenergizing
90 said relay when the called subscriber answers.

33. In a telephone system, a plurality of subscribers' lines, a connector switch for connecting with any one of said lines, a line
95 relay for said connector controlling the operation thereof, a back-bridge relay under the control of the called subscriber, means whereby said back-bridge relay controls the energizing circuit of said line relay, means
100 for energizing said back-bridge relay when connection is made with a called line, and means for deenergizing said relay when the called subscriber answers.

34. In a telephone system, a plurality of
105 subscribers' lines, a connector switch for connecting with said lines, a rotary line relay for said connector, a second relay in said connector, a switch for controlling the connection of said rotary relay to the ro-
110 tary side of the line, means whereby in one position of said switch said rotary relay connection is controlled by said second relay, said second relay being under the control of the called subscriber, means for energizing
115 said second relay when connection is made with a called line, and means for deenergizing said relay when the called subscriber answers.

35. In a telephone system, a plurality of
120 subscribers' lines, a connector switch for connecting with said lines, a rotary line relay for said connector, a side switch having a plurality of positions, means whereby said relay is connected directly to the rotary
125 line through said side switch in the first two positions thereof, a second relay controlling said connection when said side switch is in third position, said second relay being under the control of the called sub-
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scriber, means for energizing said second relay when connection is made with a called line, and means for deenergizing said relay when the called subscriber answers.

5 36. In a telephone system, an operator's cord circuit, a supervisory device for said cord circuit, a connector switch for connecting with any one of said lines, a line relay therefor for controlling the operation
10 thereof, and a second relay controlling the circuit of said line relay and said supervisory device, said second relay controlled by the called subscriber.

37. In a telephone system, an operator's
15 cord circuit, a supervisory device for said cord circuit, a connector switch, a line relay therefor, a second relay controlling the circuit of said line relay and said supervisory device, and means for energizing said relay
20 when connection is made with a called line and deenergizing the same when the called subscriber answers.

38. In a telephone system, a plurality of subscribers' lines, an operator's cord circuit,
25 a supervisory device for said cord circuit, a connector switch for connecting with a subscriber's line, a rotary line relay for said connector, a switch for controlling the connection of said relay to the rotary side of
30 said line, a second relay in said connector, means whereby in one position of said side switch said relay connection is controlled by said second relay, and a circuit controlling said supervisory device including said rotary
35 line relay.

39. In a telephone system, a plurality of subscribers' lines, an operator's cord circuit, a supervisory device for said cord circuit, a connector switch for connecting with a sub-
40 scriber's line, a rotary line relay for said connector, a switch for controlling the connection of said relay to the rotary side of said line, a second relay in said connector, means whereby in one position of said side
45 switch said relay connection is controlled by said second relay, a circuit controlling said supervisory device including said rotary line relay, and means for energizing said line relay when connection is made with a called
50 line and deenergizing the same when the called subscriber answers.

40. In a telephone system, a plurality of subscribers' lines, an operator's cord circuit, a supervisory device for said cord circuit, a
55 connector switch for connecting with a subscriber's line, a circuit for controlling said supervisory device including a rotary line relay in said connector, a side switch having a plurality of positions, means whereby said
60 line relay is connected directly to the rotary line through said side switch in the first two positions thereof, a second relay controlling said connection when said side switch is in third position, and means for energizing
65 said second relay when connection is made

with a called line and for deenergizing the same when the called subscriber answers.

41. In a telephone system, a subscriber's line, an automatic switch for establishing a connection with said line, said switch having
70 one magnet for moving it to the group of said line and another magnet for finding the said line, a signal, and means controlled by the subscriber's switch hook for operating said signal.
75

42. In a telephone system, a subscriber's line, an automatic switch for establishing a connection with said line, said switch having one magnet for moving it to the group of said line and another magnet for finding the
80 said line, a signal at the central office, and means for operating said signal when the subscriber replaces his receiver upon the switch hook after said connection has been established.
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43. In a telephone system, a subscriber's line, an automatic switch for establishing connection with said line, trunk conductors extending to said switch, means for releasing
90 said switch over said trunk conductors, a signal, and means whereby a subscriber on said line may operate said signal when he replaces his receiver upon the switch hook before the switch is released.

44. In a telephone system, a cord circuit, a
95 pair of relays bridged across the operator's cord circuit, with condensers between them, and a battery included in each relay bridge adapted to supply talking current to the calling and called subscribers, together with
100 means for calling automatically in the same system, said means comprising an automatic progressively movable trunking switch controlled over said cord circuit.

45. In a telephone system, a cord circuit, a
105 pair of supervisory relays connected in the two sides of the operator's cord circuit, a battery in circuit with each relay, one relay circuit for supplying talking current to the calling subscriber, and the other relay circuit
110 for supplying talking current to the called subscriber, together with means for calling automatically in the same system, said means comprising an automatic progressively movable trunking switch controlled over said
115 cord circuit.

46. In an automatic and manual telephone exchange system, a connector provided with a rotary line relay and a side switch having
120 a plurality of positions, and a rotary trunk conductor normally connected to non-grounded battery, said rotary line relay adapted to be disconnected from said rotary trunk conductor when said side switch wiper passes to third position for the purpose of
125 disconnecting said battery potential from said conductor.

47. In an automatic and manual telephone exchange system, a subscriber's substation including a bell, a connector, a rotary back-
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bridge relay and a vertical back-bridge coil therefor, said rotary back-bridge relay adapted to be energized by a circuit including said subscriber's bell and the back-bridge coil in series until the called subscriber answers.

48. In an automatic and manual telephone exchange system, a subscriber's line, a connector, a rotary back-bridge relay, a rotary line relay, a rotary line conductor for said connector, a suitable source of current, and means for energizing the rotary back-bridge relay whereby the rotary line relay is connected with the rotary line conductor for supplying non-grounded battery potential thereto until the called subscriber answers.

49. In an automatic and manual telephone exchange system, a trunking operator's cord circuit, a supervisory relay for said cord circuit, a connector, a bridge relay for said connector, and means for operatively energizing said supervisory relay via a circuit including said bridge relay.

50. In an automatic and manual telephone exchange system, subscribers' lines divided into groups, a connector operative by vertical motion from one level to another to select groups and by rotary motion in any selected level to connect with a line therein, a rotary line relay, a side switch wiper having a plurality of positions for said connector, a rotary trunk line conductor, a suitable source of current, and means whereby said rotary line relay is disconnected from the rotary trunk conductor when the side switch wiper passes to third position, thereby disconnecting non-grounded battery potential from said rotary trunk conductor.

51. In an automatic and manual telephone exchange system, subscribers' lines divided into groups, a trunking operator's cord circuit, a supervisory relay for said cord circuit, a connector, a bridge relay for said connector, and means for energizing said

supervisory relay and bridge relay in series, said connector operative by vertical motion from one level to another to select groups and by rotary motion in any selected level to connect with a line therein, substantially as described.

52. In a telephone exchange system, the combination with a plurality of subscribers' lines terminating in different central offices, trunk lines of the two and three conductor type, automatic selector switches, sending mechanism at one of said offices adapted to direct said switches to interconnect said subscribers' lines by means of said trunk lines, an established connection including both two-conductor and three-conductor trunk lines, and signals before the operator at said controlling office for supervising connection so established.

53. In a telephone system, a subscriber's line provided with manual equipment, a second subscriber's line provided with automatic equipment, a third subscriber's line, an operator's cord circuit, selectors and connectors responsive to the second subscriber's equipment for extending a connection to said third subscriber's line, other selectors and connectors for extending a call from said first subscriber's line to said second subscriber's line, and means associated with said cord circuit for connecting one of said other selectors with said first subscriber's line before said call can be extended to said second subscriber's line, one of said other connectors controlled from said cord circuit for completing said call.

Signed by us at Chicago, Cook county, Illinois, this 14th day of Dec., 1905.

WILSON L. CAMPBELL.
TALBOT G. MARTIN.

Witnesses:

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."