June 2, 1925. 1,540,062

A. H. DYSON

TELEPHONE SYSTEM

Filed July 20, 1905 7 Sheets-Sheet 1

Fig. 1a

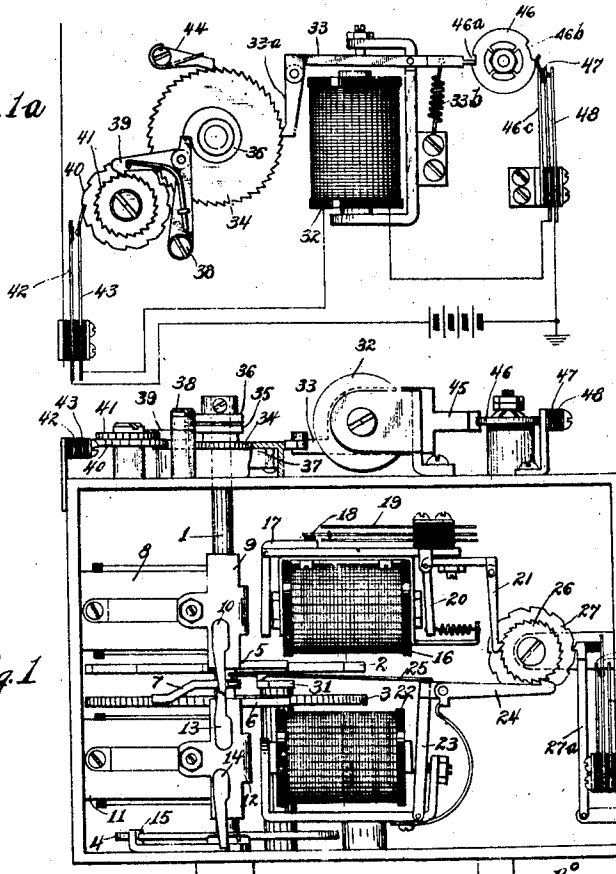
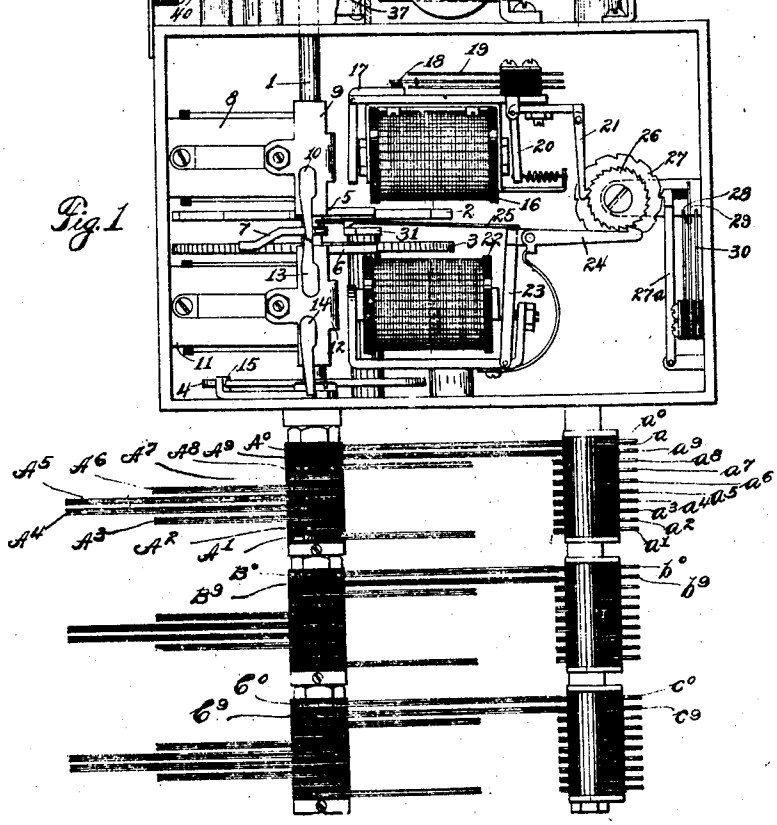


Fig. 1



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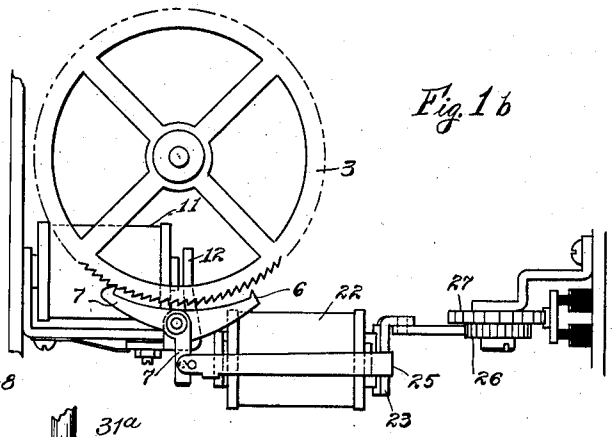

Fig. 1b

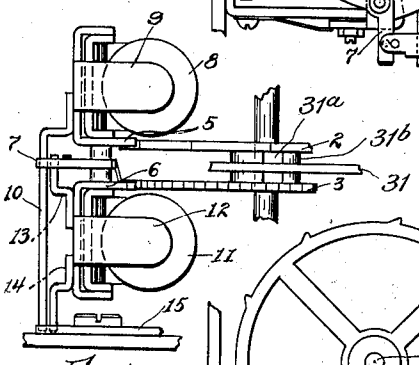

Fig. 1c

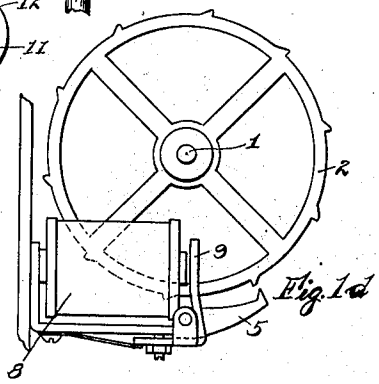

Fig. 1d

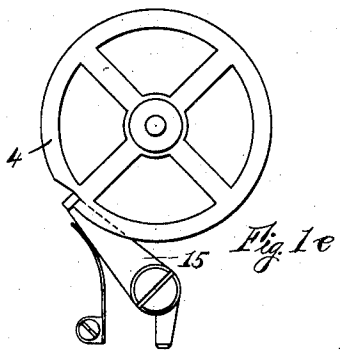

Fig. 1e

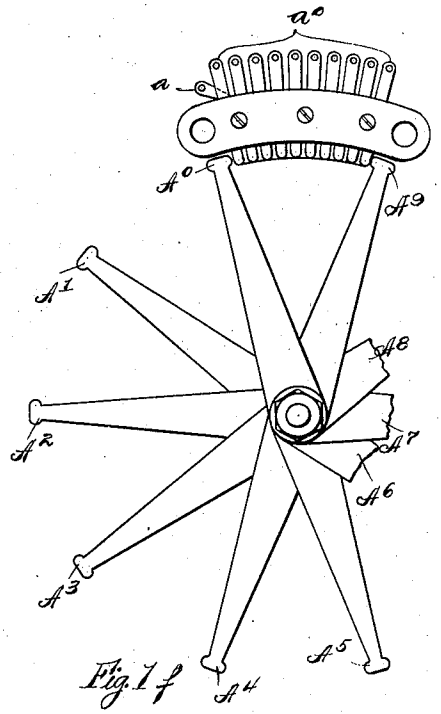

Fig. 1f

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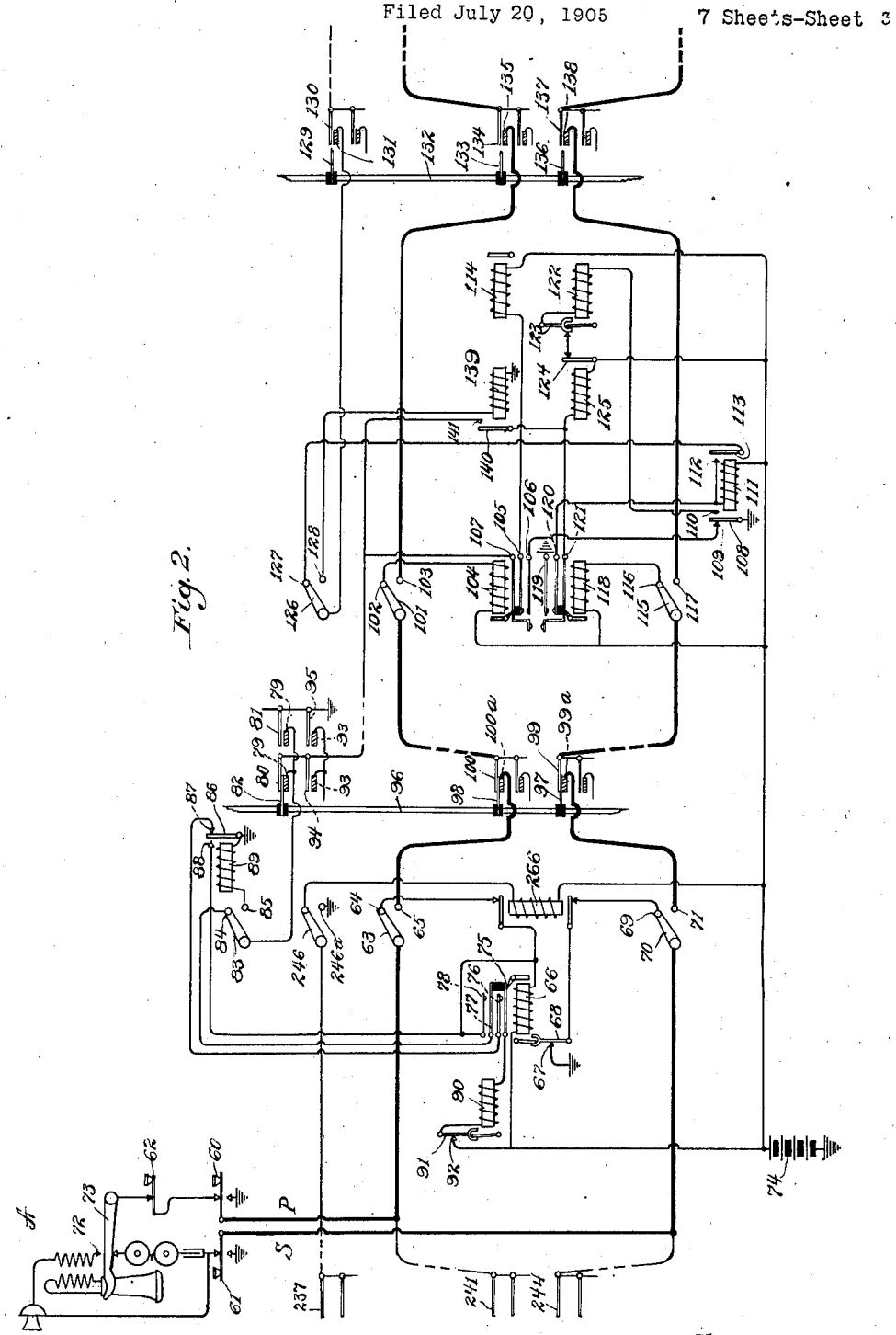

Fig. 2.

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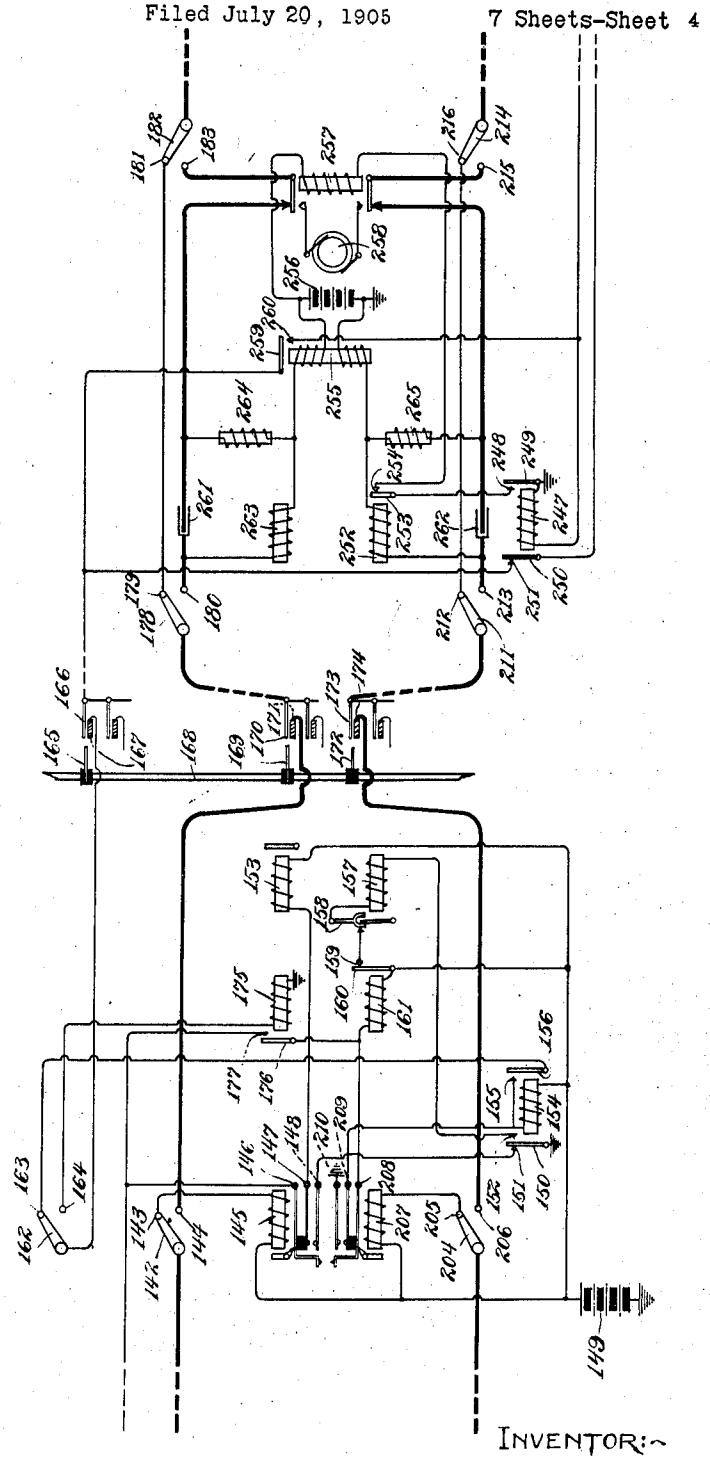

Fig. 3.

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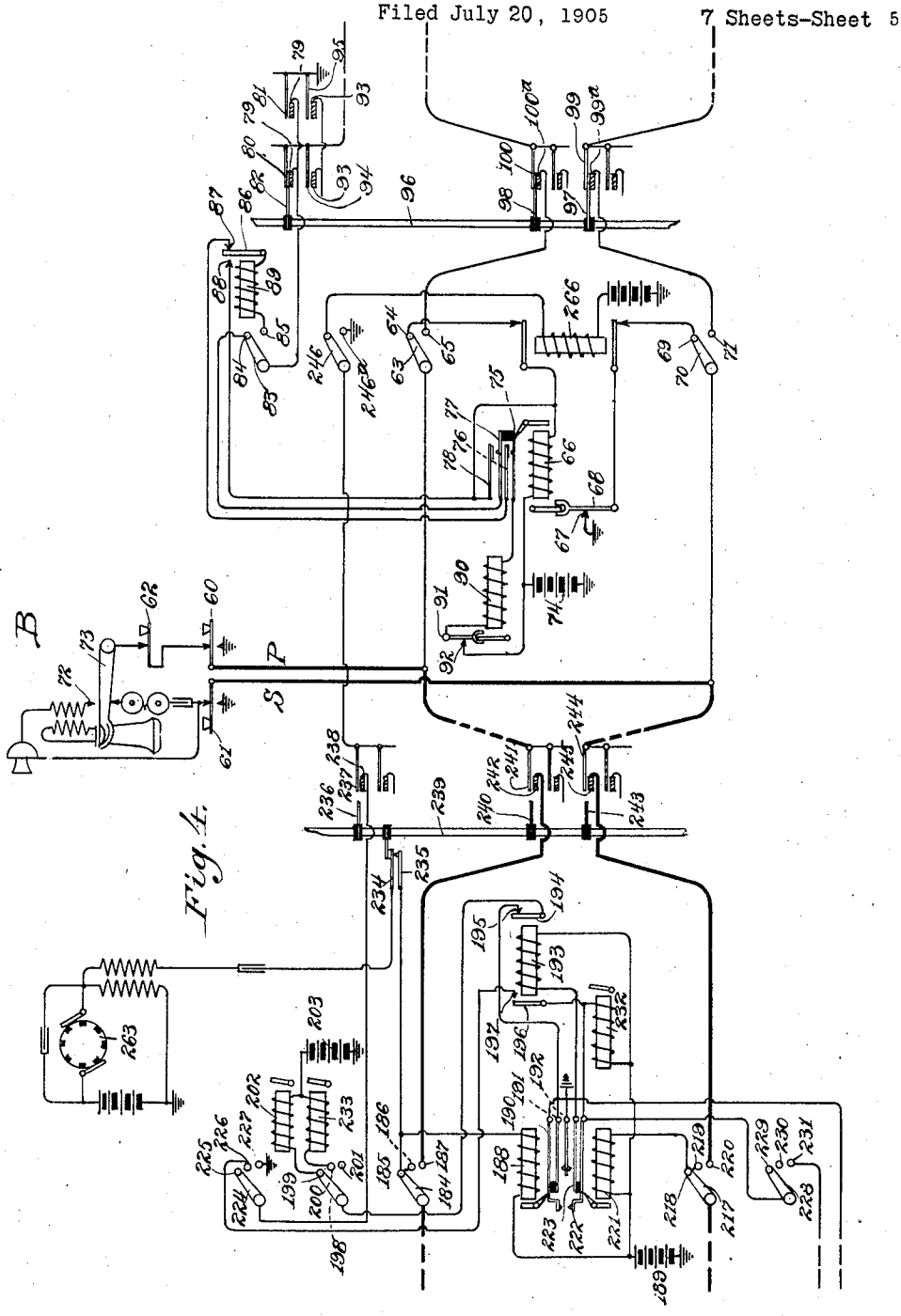

Fig. 4.

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TELEPHONE SYSTEM

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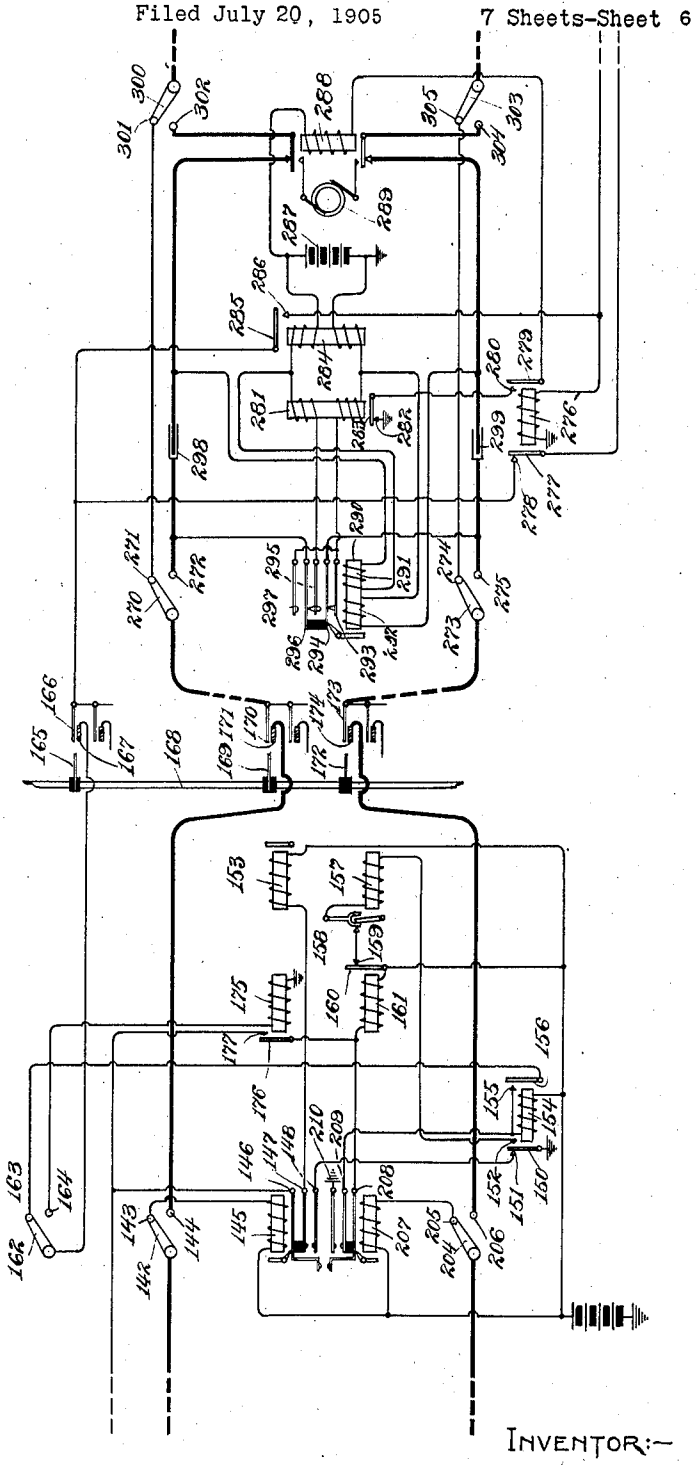

Fig. 5.

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TELEPHONE SYSTEM

Filed July 20, 1905 7 Sheets-Sheet 7

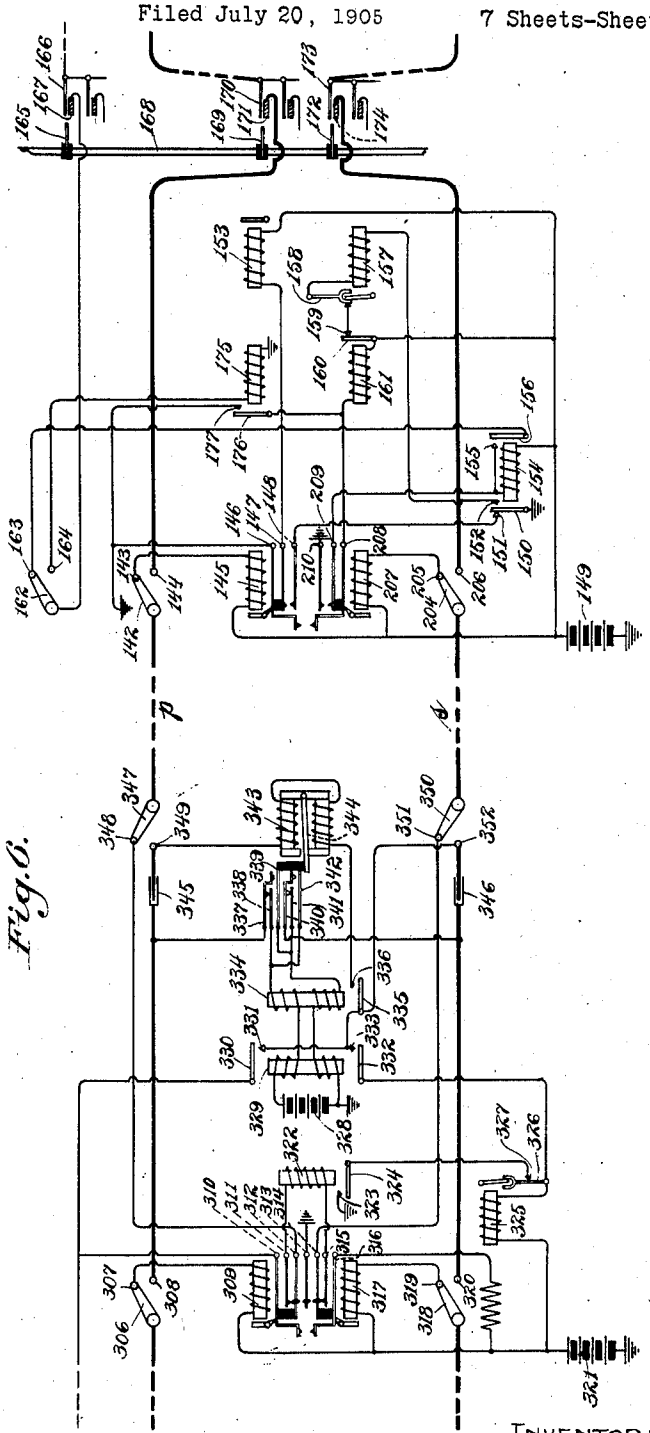

Fig. 6.

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Patented June 2, 1925. 1,540,062

UNITED STATES PATENT OFFICE.

ALFRED H. DYSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed July 20, 1905. Serial No. 270,492.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, a citizen of the United States, resident of Chicago, county of Cook and State of Illinois, have invented new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems in which the interconnection of subscribers' lines is accomplished by means of automatic switches at the exchange, responsive to calling mechanism operated by subscribers. My invention includes novel central office circuit arrangements for connecting for conversation subscribers whose lines terminate in the same exchange. It also includes a circuit arrangement adapted to be used for trunking purposes between exchanges, and provides means whereby subscribers in different exchanges may have their lines interconnected for conversation automatically, each trunk circuit between exchanges consisting of two conductors only.

My invention further includes a machine switch, embodying certain novel arrangements of mechanical parts. Machines of this type may be operated in connection with certain portions of the circuit arrangements, as hereinafter pointed out in the detailed description.

Referring to the drawings, Figure 1 is an illustration of the machine switch of my invention.

Figure 1^a, Figure 1^b, Figure 1^c, Figure 1^d, Figure 1^e and Figure 1^f illustrate details of the switch shown in Figure 1.

Fig. 2 illustrates in diagrammatic form a subscriber's telephone line extending from a substation to the exchange and there connected to an automatic switch with which is shown associated the circuits of a first selector.

Fig. 3 illustrates similarly the circuits of a second selector and a battery control circuit.

Fig. 4 illustrates similarly the circuits of a connector and a second telephone line provided with its automatic switch.

Fig. 5 illustrates circuits of a second selector and a battery control circuit different from that of Fig. 3.

Fig. 6 illustrates a trunk circuit and a battery control circuit adapted to be used in trunking between exchanges.

Referring first to Figure 1, the switch there shown is adapted to be operated by means of escapement movements; shaft 1, when the switch is in its idle or normal position, having a tendency to revolve, due to its being attached to motor-spring 37. Upon the lower portion of shaft 1 are rigidly mounted thirty wipers in sets of three, A^0, A^9, A^8, etc.; B^0, B^9, etc.; C^0, C^9, etc., those having the same coefficient constituting a set. These wipers are insulated from each other and are disposed radially by sets, with respect to the shaft. Adapted to be engaged by these wipers are thirty sets, or curved rows, of immovable contacts, of which a sectional view is shown in Figure 1, each row being provided with a common strip extending beneath and parallel to it. The said contacts are mounted in three banks in vertical and horizontally curved rows.

A top view of the wipers and contact banks is shown in Figure 1^f, a being the common terminal. When shaft 1 is caused to rotate from left to right, wiper A^0 passes over the horizontal curved row of contacts a^0. When the said wiper has revolved a distance such that it assumes the position of wiper A^9, as shown in Figure 1^f, wiper A^1 is in a position, with respect to the vertical edge of the contact bank, similar to that of wiper A^0, shown in the illustration. The shaft continuing to revolve, wiper A^1 passes over the lowest curved row of contact points a^1. When the said wiper has passed over the last of said contact points, the shaft continuing to revolve, wiper A^2 engages the first contact at the left of row a^2; and when the said wiper has left the row, wiper A^3 begins passing over the contacts of its appropriate row. It will be seen that one complete revolution of the shaft 1 will cause each immovable contact of a bank to be wiped by its appropriate wiper. Wipers B^0, B^9, etc., C^0, C^9, etc., operate coincidently with wipers A^0, A^9, etc., with respect to their appropriate contact banks.

In accordance with my invention, in operating the switch, a number of primary rotary movements of the shaft are allowed, depending upon the level of immovable con-

tacts with which it is desired to connect. Each of these first movements is sufficient to move a set of wipers entirely across its respective rows of contacts. When the desired set of wipers is, in this manner, brought, with respect to its contact banks, to a position corresponding to that of wiper A^0, as shown in Figure 1^f, a number of secondary rotary movements of the shaft in the same direction are allowed, to move the said desired set of wipers from contact to contact of its rows, each movement causing the wipers to close contact between successive contacts and their commons, the movement of the wipers being arrested when the proper contacts are engaged by them.

To secure the return of the switch to normal, the shaft is allowed to complete the revolution upon which it has been started, its movement being arrested as soon as the revolution is completed. Upon such completion, apparatus is automatically brought into play to cause spring 37 to be wound up, preparatory for a further use of the switch. It will be noted that each time the switch is operated and returned to normal, each contact in the different banks is wiped by its appropriate wiper, and this is believed to be a new and valuable feature of a switch of this character, inasmuch as the accumulation of dust upon contacts and wipers is prevented and they themselves kept, at all times, bright and clean.

The movements of the shaft are controlled in the following manner, reference being had to Figure 1: one or more impulses of current are first caused to flow through magnet 8, depending upon the contact levels to be selected. Each impulse of current causes the attraction and release of armature 9. Mounted upon shaft 1 is a disk 4, having a single tooth in its periphery which, as shown in the illustration, is engaged by detent 15, preventing movement of the shaft. Arm 10 mounted upon armature 9 (the end of which is illustrated as broken) extends downward so as to overlap arm 14 mounted upon armature 12, its lower end being on a level with the lower end of arm 14, this being shown complete in Figure 1^c. The first attraction of armature 9 causes arm 10 to press against the projection shown upon detent 15, causing the said detent to move out of engagement with the tooth upon disk 4, so that the detent no longer restrains movement of shaft 1. Mounted upon armature 9 is detent 5 which, upon the attraction of the armature, presses against the circumference of circular ratchet wheel 2 rigidly attached to shaft 1, arresting movement of the shaft when it has rotated the distance from one tooth of ratchet wheel 2 to the next by engaging said next tooth. Successive attractions and releases of armature 9 permit movements as described, and the extent of these movements is so guaged as to bring successive sets of wipers to positions in front of, but not engaging, the first contacts of their respective levels.

Figure 1^d is a top view of ratchet wheel 2, detent 5 being shown in the normal position.

3 is a second ratchet wheel rigidly attached to shaft 1, its teeth being so spaced that successive movements, as determined thereby, allow movements of the wipers from contact to contact only. Normally engaging the said ratchet wheel 3, is detent 7, having upon it a projection adapted to be engaged by arm 10 upon armature 9 with each attraction of the said armature, and moved out of engagement with ratchet wheel 3 and so held as long as the armature is attracted. With each release of armature 9, detent 7 engages a tooth of wheel 3 and arrests rotation of the shaft.

The rows having been selected in the manner described, one or more impulses of current are now caused to flow through magnet 11, depending upon the proper contacts in the rows. Each impulse causes the attraction and release of armature 12 which controls detent 6 in a manner generally similar to that in which detent 5 is controlled by magnet 8, the shaft being permitted to rotate one step for each impulse. Detent 7, with each energization of magnet 11, is caused to release ratchet wheel 3 by the operation of arm 13; and upon the de-energization of the magnet, again engages the wheel, preventing movement of shaft 1.

Figure 1^c is another view of the arrangement of these parts. Upon armature 12 of magnet 11, is shown arm 14, adapted to cause the retraction of detent 15, should the detent be in its normal position at the time magnet 11 is energized. This is necessary to enable wipers A^0, B^0 and C^0 to be controlled by magnet 11 in a from-contact-to-contact movement, inasmuch as a complete revolution of the shaft is required to bring the said wipers into positions where they may be controlled by magnet 11. In other words, ten impulses of current are sent through magnet 8 to bring the zero wipers into operative position, thus constituting a complete revolution and causing engagement of disk 4 by detent 15.

Referring now to Figure 1, when magnet 16 is energized, pawl 21, pivotally associated with its armature 20, moves downward, engaging the next tooth of ratchet wheel 26. When the magnet is de-energized, armature 20 is retracted and pawl 21 moves in a vertical direction, causing ratchet wheel 26 to revolve one step from left to right. The said ratchet wheel is rigidly attached to ratchet wheel 27, moving the latter with it, and the end of lever 27^a is moved out of engagement with the tooth of ratchet wheel

27, previously engaged by it, and rests upon the periphery of the wheel. The said lever being mechanically connected to circuit changing spring 29 as shown, this movement causes the said spring to disengage spring 28 and to engage spring 30. Lever 27^a may be mechanically attached to, and cause simultaneous movements of, a plurality of circuit changing springs.

When magnet 22 is energized, its armature 23 is attracted. Pivotally associated with the said armature is pawl 24, engaging a tooth of ratchet wheel 26, the pawl upon the attraction of armature 23 moving toward the left, revolving ratchet wheel 26 one step and thereby moving ratchet wheel 27 into such a position that lever 27^a again engages with its end a tooth of ratchet wheel 27, adjacent to that from engagement with which it was moved by the above described operation of pawl 21. This operates to move the circuit changing spring 29 out of engagement with spring 30 and again into engagement with spring 28, its normal position.

The attraction of armature 23 also moved arm 25 toward the left in such manner that an orifice toward its projecting end is caused to slip over and engage the pin shown in the illustration upon detent 7. In Figure 1^b, a top view of these parts is shown. When magnet 22 is de-energized, arm 25 is moved toward the right by the return of armature 23, and reference to Figure 1^b makes clear the manner in which this movement of arm 25 moves detent 7 out of engagement with ratchet wheel 3.

The disengagement of detent 7 in the manner described operates to restore the wipers to normal by allowing a free rotation of the shaft, until detent 15 engages the single tooth of disk 4.

Referring to Figure 1, 31 illustrates (viewing it from in front) an arm of considerable length, extending from the rear of the switch and engaging, with one edge, a disk fastened to shaft 1 at all times. When the shaft is in its normal position, as shown in Figure 1, the edge of arm 31 engages a depression or flattened portion 31^a in the periphery of disk 31^b, as shown in Figure 1^c and, in this position the arm 31 engaging the projection shown upon arm 25, holds the said arm above the pin on detent 7. With the first rotary movement of the shaft, the edge of arm 31 disengages the depression mentioned, and rests upon the periphery of the shaft; its end, under these circumstances, being moved to the right so that it no longer supports arm 25 in the position shown in Figure 1. It is retained thus retracted until the shaft has completed one revolution. When this occurs, its edge again engages the depression in shaft 1 before mentioned, its end moves forward and lifts arm 25 out of engagement with detent 7 in which it was placed to release the switch, so that the said detent again engages ratchet wheel 3. This, it will be noted, occurs at the termination of the release operation before described and simultaneously with the engagement of detent 15 with disk 4, detent 7 being thereby returned to normal and ready to perform its usual function upon the next operation of the switch.

The means by which spring 37 is wound up after the return of the wipers to normal will now be described. The details of the mechanism used for this purpose are shown in detail in Figure 1^a. Attached to the upper portion of shaft 1, is cam 36 having an off-set, as shown in Figure 1^a, normally engaged by pawl 38. As the shaft is revolved, cam 36 gradually moves pawl 38 to the left; and when the shaft approaches the completion of its revolution, pawl 39, attached to and moving with pawl 38, engages a tooth of ratchet wheel 41 adjacent to that previously engaged by it. As soon as the revolution of the shaft is completed, pawl 38 engages the off-set in cam 36, its free end moving toward the center of the shaft and retracting pawl 39 to move ratchet 41 one step from left to right. Ratchet 40 is rigidly attached to ratchet 41 and moves with the latter, the end of spring 43 (see Figure 1^a) being moved out of its engagement with a tooth of ratchet 40, which is its normal position, in such a manner that it rests upon the periphery of the said ratchet. Spring 43 is thereby caused to engage spring 42, and this closes circuit through winding magnet 32. The said magnet is arranged in a vibratory circuit, a novel form of circuit breaker being provided consisting of disk 46 (see Figure 1^a) and its associated parts. This circuit breaker is designed to secure a full stroke of the armature of magnet 32 before the magnet's circuit is broken, and operates in the following manner: The energizing circuit of magnet 32 passes through contact 47—48. Upon disk 46 is provided a depression 46^a engaged by one end of armature 33, and a second depression 46^b adapted to be engaged by lever 46^c. When armature 33 is attracted, its end, engaging depression 46^a, moves upward, and as the full stroke of the armature is completed, it impacts upon the upper edge of depression 46^a. This causes a slight rotary movement of disk 46 from left to right, and lever 46^c is thereby caused to move out of the position shown in the illustration into depression 46^b, breaking the circuit of magnet 32 by opening contact through springs 47 and 48. Magnet 32 is thereby de-energized, and its armature is retracted by spring 33^b to the position shown, the end of the armature engaging the lower edge of orifice 46^a and moving disk 46 a short distance from right to left so that lever 46^c again rests upon the periphery of

the disk, reestablishing contact between springs 47 and 48, and causing another energization of the magnet.

Each attraction and release of armature 33 of magnet 32 causes ratchet 34 to be revolved a step from left to right by means of pawl 33ª, the said ratchet moving independently of shaft 1, and the shaft remaining motionless under these conditions. One end of spring 37 is attached to ratchet 34 and the movement of freely moving ratchet 34 is in the same direction as the movement of the shaft when the switch is operated. This movement of ratchet 34, therefore, operates to wind up the said spring.

Mounted upon ratchet 34 is cam 35 (Fig. 1), its shape being similar to that of cam 36, being provided with an off-set normally engaged by pawl 38. The described winding movement of ratchet 34 moving cam 35 with it, gradually moves pawl 38 to the left; and when ratchet 34 approaches the completion of its revolution, pawl 38 causes pawl 39 to engage the next tooth of ratchet 41. When armature 33 has been vibrated a sufficient number of times to cause a complete revolution of ratchet 34, cam 35 will also have made a complete revolution and pawl 38 again engages its off-set. Pawl 39 then moves to the right and effects a rotary movement of ratchet 41 one step from left to right. It will be noted that this is the second movement of ratchet 41 accomplished in the winding operation, and this second movement operates to bring ratchet 40 in such a position that spring 43 moves from the periphery of the ratchet into engagement with the tooth next to that engaged by it before the winding operation commenced. This engagement causes spring 43 to disengage spring 42 and opens the circuit of magnet 32, preventing further operation of the said magnet.

All operating parts of the switch have now been returned to normal, and energy has been stored for operating the switch a second time.

While I have especially designed the switch, shown in Figure 1, for use in connection with the circuit arrangements shown at the right of Fig. 2, at the left of Fig. 3, at the left of Fig. 5, at the right of Fig. 6, and with minor changes in connection with the circuit arrangement shown at the left of Figure 4, the invention of the latter figures is not necessarily confined to the operation of such a machine as I show in Figure 1. Figure 1 is generically illustrative of forms of mechanical movements which different parts of the circuit arrangements, comprised in my invention, may assume. For purposes of reference, I shall designate, by descriptive terms, the principal magnets illustrated in Figure 1. When, in the description of the circuit drawings, I come to an electromagnet whose work may assume a form similar to that accomplished by a magnet of Figure 1, I shall designate it by the descriptive title.

A magnet, having functions similar to magnet 8, may be called a "primary magnet."

A magnet, having functions similar to magnet 11, may be referred to as a "secondary magnet."

A magnet, having functions similar to magnet 16, may be referred to as a "circuit-changing switch magnet."

A magnet, having functions similar to magnet 22, may be referred to as a "release magnet."

Referring to the circuit arrangements Figures 2, 3 and 4 placed in the order named with Fig. 2 at the left constitute a first complete diagram illustrative of the circuits of the telephone system of my invention. The apparatus included in this single diagram is that necessary for establishing connection between two subscribers' lines. In Figure 2, I have illustrated a substation A, including a pair of keys 60 and 61 adapted to be used by the subscriber for grounding limbs P and S, respectively, of the telephone line at will. A key 62 is also provided, enabling the subscriber to open the metallic circuit of the substation. Limbs T and S extend to the central office and are there connected with an automatic switch individual to the line, which may be called a private switch.

The system, which I have shown in the diagram referred to, may be used to accommodate several thousand subscribers. Each subscriber's line is provided with an automatic switch, having circuits similar to those illustrated in Figure 2, and these switches may be conveniently divided into groups of one hundred, each switch including movable switch arms or wipers such as are designated 82, 98 and 97 in Figure 2, together with a plurality of contacts constituting the multipled terminals of first selector switches. These contacts may conveniently be disposed in three curved rows, one above the other; those of the upper row, among which contact 80 would be included, being disposed in such manner that successive terminal contacts alternate with permanently grounded contacts, such as contact 81. Each row or level of contacts is provided with a common strip, such as I have shown at 79, 100ª and 99ª in Figure 2. These common strips are the true terminals of the circuits of the private switch, wipers 82, 98 and 97 having themselves no circuit connections, but being arranged so that when the switch is operated, they close circuits between the common strips and the contacts before mentioned.

The number of first selector switches, assigned to a group of one hundred private switches, may vary, depending upon the

number of calls which may be expected to co-exist from the lines of the group. Ten first selector switches for a group of one hundred private switches would be sufficient in an ordinarily busy exchange.

A first selector switch, circuits of which I have illustrated at the right of Figure 2, is common for connection to all subscribers in the exchange.

At the left of Figure 3, I have illustrated the circuits of a second selector switch, such a switch being common for connection to a group of one thousand subscribers' lines.

At the left of Figure 4, I have illustrated the circuits of a connector switch, such a switch being common for connection to a group of one hundred subscribers' lines.

Generally speaking, a calling subscriber first connects his telephone line through to a first selector switch by operating his private switch. He thereupon operates the first selector switch in such manner that it connects his line through to a second selector switch assigned to the one thousand line group of subscribers' lines, among which is included the line of the subscriber whom he is calling. The subscriber then operates the second selector switch in such manner that it connects his line through to a connector switch adapted to be operated to connect his line directly to any line of a one hundred line group of the aforementioned one thousand line group, among which is the line of the desired subscriber. He then operates the connector switch to connect his line through to the desired subscriber's line. The system operates as a multiple trunk system, the principles of which are well known in the art.

Referring to the complete diagram before mentioned, and assuming that subscriber A desires to connect his line with the line of subscriber B, whose number is assumed to be 3456, the operation of the system is as follows: Subscriber A first removes the receiver from the switch hook, closing contact 73—72 and establishing a flow of current as follows: from ground at the central office, through contact 67—68, through contact 69—70, over limb S of the line, returning over limb P, through contact 63—64, through the winding of relay 66 to battery 74, energizing relay 66, which attracts its armatures. This attraction causes a flow of current from ground, through contact 86—87, through contact 76—75, through the winding of magnet 90, contact 91—92, to battery 74. Magnet 90 is placed in a vibratory circuit and will alternately be energized and de-energized as long as relay 66 is maintained energized, due to contact 76—75 being closed. Each energization and de-energization of magnet 90 causes shaft 96 to rotate a step, carrying with it rigidly attached wipers 82, 98 and 97. The first movement of the shaft brings wiper 82 out of engagement with a contact, a multipled terminal of the first selector switch last used by subscriber A in establishing a connection, and into engagement with a permanently grounded contact such as 81. Current thereupon flows from ground, through said contact, through wiper 82, through common strip 79, through contact 83—84, through contact 77—78, through the winding of relay 66 to battery 74, locking the said relay and preventing its de-energization by the opening of contact 67—68 which occurs as the relay becomes energized.

The second energization and de-energization of magnet 90 brings wiper 82 into engagement with a contact, the terminal of a first selector switch. Should this switch be already in use, current continues flowing through relay 66 maintaining it energized, the path being traced as follows: from ground, through relay 89 of the private switch then connected with a multipled terminal of the first selector switch, through contact 85—83 of the said private switch, through the common strip of the said switch, its wiper 82, a contact, a multiple of the one which wiper 82 of the private switch of subscriber A just engaged, through the contact engaged by the said wiper to the common strip of the private switch of subscriber A, through contact 83—84 of the said switch, through contact 77—78, through the winding of relay 66 to battery 74. The windings of relays 66 and 89 are so proportioned that this flow of current is not of sufficient volume to cause relay 89 to attract its armature. A third energization and de-energization of magnet 90 again brings wiper 82 into engagement with a permanently grounded contact, and a fourth energization and de-energization of the said magnet brings wiper 82 again into engagement with a contact, a terminal of a first selector switch. Assuming that the contact thus engaged is contact 80 of the first selector switch illustrated in Figure 2, and that the said switch is idle, circuit through relay 66 is broken, due to the fact that contact 80 is insulated from ground, as appears upon an inspection of Figure 2, in which the first selector switch is shown in its idle position. Relay 66 becomes de-energized, the retraction of its armature opening the circuit of magnet 90 at contact 76—75, thereby arresting wipers 82, 98 and 97 in engagement with contacts 80, 100 and 99, respectively.

When relay 66 was first energized, it prepared for the movement of arms 83, 246, 63 and 70 into engagement, respectively, with contact points 85, 246[a], 65 and 71; and upon its de-energization, caused the engagement of the said arms with the said contact points. A reference to magnet 16, illustrated in Fig-

ure 1, and the method of operation of the said magnet in connection with ratchet 27, discloses a convenient mechanical combination by which the aforesaid movement may be effected.

The engagement of contact point 85 by arm 83 put ground on contact 80 of the first selector switch and its multiples through relay 89, rendering the said switch busy with respect to other private switches having access to it. The engagement of arm 246 with contact point 246ª rendered the private switch of subscriber A busy with respect to other subscribers establishing connection with his line. The engagement of arms 63 and 70 with contact points 65 and 71, respectively, extended the limbs of the line of subscriber A through to the circuits of the first selector switch, thereby rendering the said switch controllable by subscriber A from the substation.

Subscriber A, by means of key 60, now grounds limb P of the line a number of times, corresponding to the thousands digit of the called subscriber's number, or three times, causing three impulses of current to flow from ground at the substation, over limb P of the line, through contact 63—65, through common strip 100ª of his private switch, through wiper 98 to contact 100, through contact 101—102, through the winding of primary relay 104 to battery 74.

Each impulse of current causes an energization and de-energization of primary relay 104, which attracts and releases its armature three times and causes three impulses of current to flow from ground at the first selector switch, through contact 108—109, through contact 106—105, through the winding of primary magnet 114 to battery 74. The resulting energizations of primary magnet 114 cause three primary rotary movements of shaft 132. The third movement brings wipers 129, 133 and 136 to positions adjacent to, but not engaging, the first contacts of three horizontal rows of contacts, multipled terminals of second selector switches assigned to the third one thousand line group of subscribers' lines, or a group including lines of subscribers to whom are assigned numbers from 3000 to 3999.

Subscriber A now sends, by key 61, one impulse of current from ground at the substation, over limb S of the telephone line, through contact 70—71, through contact 99ª—97—99, through contact 115—116, through the winding of secondary relay 118 to battery 74, causing a single attraction and release of the relay's armature and a flow of current from ground, through contact 119—120, through the winding of circuit-changing switch magnet 111 to battery 74. This causes the energization of the said magnet and the attraction of its armatures. The attraction of armature 108 causes a flow of current from ground, through contact 108—110, through the winding of secondary magnet 122 to battery 74. The latter magnet is arranged in a vibratory circuit. Its first energization and de-energization operates to move wipers 129, 133 and 136 into engagement with the first contacts of the rows described. In case these are terminals of a second selector switch already in use, circuit-changing switch magnet 111 is maintained energized by a flow of current from ground at the first selector switch then connected with the said second selector switch, through relay 139 of said first selector switch, through its contact 128—126, through its common 131, its wiper 129, a multiple of the contact engaged, to the said contact, through wiper 129 of first selector switch, Figure 2, to common strip 131, through contact 126—127, through contact 113—112, through the winding of magnet 111 to battery 74. The windings of relays 139 and 111 are so proportioned that this flow of current is not of sufficient volume to cause relay 139 to attract its armature. It is apparent that secondary magnet 122 will continue to vibrate, causing with each energization and de-energization a secondary movement of shaft 132, carrying with its wipers 129, 133 and 136 as long as magnet 111 continues energized. When wipers 129, 133 and 136 engage contacts, terminals of an idle second selector switch, which is assumed to occur when they engage contacts 130, 134 and 137, terminals of second selector switch, Figure 3, contact 130 is insulated from ground and the flow of current through magnet 111 is interrupted. Its armatures thereupon resume their normal positions shown in the illustration, breaking contact 108—110 and preventing further operation of secondary magnet 122. Wipers 129, 133 and 136 are thus brought to rest in engagement with contacts 130, 134 and 137. The de-energization of circuit-changing switch magnet 111 also moved arms 126, 102 and 115, respectively, into engagement with contacts 128, 103 and 117, respectively. The closure of contact 126—128 put ground through relay 139, through contact 128—126, contact 131—129—130, to the multiples of contact 130, rendering the second selector switch busy with respect to other first selector switches having access to it. The closing of contacts 101—103 and 115—117 extended limbs P and S of the telephone line through to the circuits of the second selector switch, Figure 3, and rendered the said switch controllable from substation A.

Subscriber A now grounds limb P of his line a number of times, corresponding to the hundreds digit of the called subscriber's number, or four times, causing four impulses of current to flow from ground at the substation, over limb P, through contact

142—143 of second selector switch, Figure 3, through the winding of primary relay 145 to battery 149. These impulses cause the armature of the said relay to be attracted and released four times and four impulses of current to flow from ground at the second selector switch, through contact 150—151, through contact 148—147. through the winding of primary magnet 153 to battery 149. Each impulse through magnet 153 causes a primary movement of shaft 168, carrying with it wipers 165, 169 and 172. The fourth of these movements brings the wipers to positions adjacent to, but not engaging, rows of contacts, multipled terminals of connector switches assigned to a group of lines including subscribers' lines which are assigned numbers from 400 to 499 of the selected one thousand.

Subscriber A now causes a single impulse of current to flow from ground at the substation, over limb S of the line, through contact 204—205 of the second selector switch, through secondary relay 207 to battery 149, causing a single attraction and release of the relay's armature, and an impulse of current to flow from ground at the second selector switch, through contact 210—209, through the winding of circuit-changing switch magnet 154 to battery 149. The consequent attraction of the magnet's armatures established a flow of current from ground, through contact 150—152, through the winding of secondary magnet 157 to battery 149. Magnet 157 is placed in a vibratory circuit and will alternately be energized and de-energized until contact 150—152 is broken. Each energization and de-energization of magnet 157 causes a secondary rotary movement of shaft 168, moving wipers 165, 169 and 172 to successive sets of contacts, terminals of connector switches of the described group, until terminals of an idle switch are reached. In case contacts of the rows, engaged by wipers 165, 169 and 172, are terminals of a busy connector switch, magnet 154 is maintained energized by a flow of current from ground at the second selector switch then connected with the said connector switch, through relay 175, contact 162—164, contact 167—165 of the second selector switch referred to, to a multiple of the contact engaged by wiper 165 of Figure 3, to said contact, to common strip 167 of the second selector switch now being operated, through its contact 162—163, through contact 156—155, through the winding of magnet 154 to battery 149. Such flow of current is of insufficient volume to cause relay 175 to attract its armature. When a contact, terminal of an idle connector switch, is reached by wiper 165, such contact will be insulated from ground and circuit through magnet 154 will be interrupted, de-energizing it and thereby allowing the return of its armature to normal and preventing further energizations and de-energizations of secondary magnet 157; wipers 165, 169 and 172 resting in engagement, respectively, with contacts 166, 170 and 173, assumed to be terminals of a trunk line extending to the selected connector switch shown in Figure 4. The de-energization of circuit-changing switch magnet 154, above mentioned, also caused arms 162, 142 and 204 to move into engagement with contacts 164, 144 and 206, respectively. The closing of contact 162—164 put ground to contact 166 and its multiples, rendering the said connector switch busy with respect to other second selector switches having access to it. The closing of contact 142—144 and contact 204—206 extended limbs P and S of the telephone line of subscriber A through to the circuits of the connector switch shown in Figure 4, rendering the said switch controllable from substation A.

Subscriber A now causes five impulses to flow from ground at the substation, through contact 171—169—170, contact 178—179, contact 181—182, contact 184—185, and through the winding of primary relay 188 of the connector switch to battery 189. Five attractions and releases of said relay's armature are caused thereby, resulting in five impulses of current flowing over the following path: from ground at the connector switch, through contact 192—191, through contact 195—194, through contact 198—199, through the winding of primary magnet 202 to battery 203. Each energization of primary magnet 202 effects a primary rotary movement of shaft 239, carrying with it wipers 236, 240 and 243. The fifth movement brings the wipers adjacent to rows of contacts, multipled terminals of the lines of subscribers to whom are assigned numbers from 3451 to 3460.

Subscriber A now sends one impulse of current from ground at the substation, through contact 174—172—173, through contact 211—212, contact 216—214, contact 217—218, through the winding of relay 221 to battery 189. The resulting attraction and release of the relay's armature causes an impulse of current from ground, through contact 192—223, through the winding of circuit-changing switch magnet 193 to battery 189. The resulting energization and de-energization of magnet 193 operates to move arms 224, 198, 184, 217 and 228 into engagement with contacts 226, 200, 186, 219 and 230, respectively. The engagement of arm 198 with contact 200 places secondary magnet 233 under control of primary relay 188. Six impulses of current are now caused by subscriber A to flow from ground at the substation, through contact 184—186 and primary relay 188, Figure 4, to battery 189.

Each of the six attractions and releases of the relay's armature causes a flow of current from ground, through contact 192—191, through contact 195—194, through contact 198—200, through the winding of secondary magnet 233 to battery 203. Each energization and de-energization of the said secondary magnet causes wipers 236, 240 and 243 to move to engage successive contacts of the rows above mentioned, the sixth movement bringing the wipers into engagement, respectively, with contacts 237, 241 and 244, multipled terminals connected to the private switch of subscriber B, or subscriber 3456. Subscriber A now causes one impulse of current to flow from ground at the substation, through contact 217—219 of the connector switch, through relay 221 to battery 189, causing circuit-changing switch magnet 193 to be energized by establishing a flow of current over the path previously traced.

Assuming first that the line of the called subscriber is busy, contact 237 in this case is characterized by a ground connection; and upon the attraction of armature 196 of magnet 193, closing contact 196—197, a flow of current results from grounded contact 237, through wiper 236, through common strip 238, through contact 224—226, contact 197—196, through the winding of release magnet 232 to battery 189, energizing magnet 232. When the impulse through relay 221 ceases, causing the de-energization of circuit-changing switch magnet 193, the latter's armature 196 disengages anvil 197, opening circuit through release magnet 232, causing its de-energization and the consequent return of the connector switch to normal; wipers 236, 240 and 243 disengaging contacts 237, 241 and 244, and arms 224, 198, etc. returning to their normal engagement with contacts 225, 199, etc.

When the connector switch returns to normal, contact 235—234 is closed and the calling subscriber receives the busy signal from machine 263 in his receiver, notifying him that the line called is busy. He thereupon simultaneously presses keys 60 and 61 and replaces his receiver. Relays 188 and 221 of the connector switch, Figure 4 are simultaneously energized, closing contact 190—222, establishing a path for the flow of current as follows: from ground at second selector switch, Figure 3, through release relay 175, through contact 164—162, through contact 167—165—166, through contact 251—250 (Figure 3), through contact 190—222 (Figure 4), through the winding of release magnet 232 to the active side of battery 189. This flow of current energizes release relay 175 of Figure 3, and release magnet 232 of Figure 4. The energization of release relay 175 operates to prepare the second selector switch, Figure 3, first selector switch, Figure 2, and private switch, Figure 2, for their returns to normal, which will occur as soon as subscriber A releases keys 60 and 61, thereby removing ground from the limbs of the line, which causes the de-energization of relays 188 and 221 of Figure 4, and the opening of contact 222—190. The opening of this contact causes the de-energization of release relay 175. The detailed description of the manner in which release relay 175 operates in connection with the returns to normal of the various switches will be hereinafter given.

In case the line of subscriber B is idle, contact 237 is connected to battery through relay 266, and release magnet 232 does not become energized upon the closure of contact 196—197. In this case, the energization and de-energization of circuit changing switch-magnet 193 operates to move arms 224, 198, 184, 217 and 228 into engagement, respectively, with contacts 227, 201, 187, 220 and 231. The engagement of arm 224 with contact 227 places ground upon contact 237 and its multiples, rendering the said line of subscriber B busy with respect to other subscribers establishing connection with it. It also energizes relay 266 of the private switch which operates to cut limbs P and S of the line of subscriber B free from the circuits of the private switch. The engagement of arm 228 with contact point 231 establishes a path for the flow of current as follows: from ground at battery control circuit, Figure 3, through the winding of relay 247, through contact 231—228 of the connector switch, through the winding of release magnet 232 to battery 189, causing the energization of relay 247. The windings of magnet 232 and relay 247 are so proportioned that this flow of current does not cause the energization of magnet 232 to a degree to cause it to attract its armature.

It will be observed that the structure of Fig. 1 does not provide for a second forward movement of circuit-changing switch-members as described for arms 224, 198, 184, 217 and 228. For this purpose the well known side switch escapement movement, shown and described in Patent #815,321, dated March 13, 1906, to Keith et al. may be conveniently employed, magnet 193 controlling the forward stepping of the side switch arms, while release magnet 232 when de-energized restores the side switch arms, all as described in the patent cited.

The energization of relay 247 operates to close the following contacts: 178—180, 182—183, 211—213 and 214—215. A flow of current now results over the following path: from the grounded side of battery 256, through the lower winding, as illustrated, of relay 255, through relay 252, energizing the said relay and attracting its

armature, through contact 213—211, through contact 173—172—174, over the talking circuit as shown by the heavy lines, by way of limb S of the line of subscriber A, through the substation, supplying current to the transmitter for talking purposes, returning over limb P, the other side of the talking circuit through the exchange, through contact 171—169—170, contact 178—180, impedance coil 263, through the upper winding of relay 255, to the active side of battery 256. This flow of current does not cause relay 255 to attract its armature, the said relay being differentially wound.

To cause the bell of subscriber B to be rung, subscriber A opens the path of the just-traced flow of current at his substation by means of key 62. This causes the de-energization of relay 252, its armature assumes the position shown in the illustration (Figure 3), closing contact 253—254 and establishing a path for the flow of current from ground (Figure 3), through contact 249—248, contact 253—254, through the winding of ringing relay 257 to battery 256. This energizes the said relay, it attracts its armatures and cuts ringing generator 258, by the said attraction, into circuit with the line of subscriber B, causing his bell to ring. When subscriber A releases key 62, the talking current resumes its flow through the substation, relay 252 is again energized, the attraction of its armature breaking circuit through ringing relay 257, whose armatures resume their normal positions as shown in Figure 3.

When subscriber B answers the call by removing his receiver from the hook, contact 72—73 is closed, and a flow of current results from the grounded side of battery 256 (Figure 3), through impedance 265, over the talking circuit at the exchange, as shown by the heavy lines, to limb S of the line of subscriber B, through the substation, supplying current to the transmitter, returning over limb P of the line, over the talking circuit, through impedance 264 to the active side of battery 256. The two subscribers are now in conversation through condensers 261 and 262, the conversational circuit being traced through the exchange by the heavily lined conductors.

When the subscribers have finished their conversation, each depresses simultaneously keys 60 and 61 and replaces his receiver upon the switch hook. Assuming that subscriber B does this first, the release of the apparatus used in establishing the connection between the two subscribers is secured in the following manner: The grounding of limb S by subscriber B short circuits the lower winding of relay 255 of Figure 3; while the grounding of limb P maintains the flow of current through the upper winding of relay 255 from the active side of battery 256, over limb P to ground at the substation. Relay 255 is differentially wound, and the flow of current through its two windings during conversation and before did not cause the attraction of armature 259. The short circuiting of the lower winding as above described, current continuing to flow in the upper winding, causes the magnetization of the core of relay 255 and the attraction of its armature 259 to engage anvil 260. A flow of current is thereby caused over the following path: from ground, Figure 3, through the winding of release relay 175, through contact 164—162, through contact 167—165—166, through contact 259—260, joining the current flowing from ground through relay 247, through contact 231—228, through the winding of release magnet 232 to battery 189. Relay 175 and magnet 232 are of low resistance and the above described flow of current causes the attraction of the armatures of both. The energization of release magnet 232 prepares for the return of the connector switch, Figure 4, to normal upon the de-energization of the said magnet. The attraction of the armature of the release relay 175 establishes a path for the flow of current as follows: from ground, Figure 2, through the winding of release relay 139, through contact 128—126, through contact 131—129—130, through contact 177—176, through the winding of release magnet 161 to battery 149, causing the attraction of the armatures of relay 139 and magnet 161. The attraction of the armature of magnet 161 prepares for the release of the second selector switch, Figure 4, and its return to normal upon the de-energization of the magnet. The energization of relay 139 establishes a path for the flow of current as follows: from ground at the private switch, Figure 2, through the winding of relay 89, through contact 85—83, through contact 79—82—80, through contact 141—140, through the winding of release magnet 125 to battery 74, the resulting energization of magnet 125 preparing for the release of the first selector switch, Figure 3, and its return to normal upon the de-energization of the said magnet. The energization of relay 89, which results from the above described flow of current, causes a flow of current as follows: from ground at the private switch, through contact 86—88, through the winding of relay 66 to battery 74, and the energization of the said relay.

When subscriber B releases keys 60 and 61, they return to their normal positions as shown; assuming that subscriber A has not yet depressed keys 60 and 61 at his substation, relay 255 no longer attracts armature 259, and the said armature disengages anvil 260. This causes the de-energization of release magnet 232 of the connector switch, Figure 4, and the return of the

switch to normal. The return of arm 228 of this switch opens the circuit of relay 247 of Figure 3. Its consequent de-energization and the release of its armatures causes arms 178, 211, 182 and 214 to return to normal. The release of the connector switch also causes relay 266 of private switch, Figure 4, to become de-energized, restoring the private switch to normal. The de-energization of release relay 175 of the second selector switch, Figure 3, is caused by armature 259 disengaging anvil 260. The resulting opening of contact 176—177 de-energizes release magnet 161, causing the return of the second selector switch to normal. It also causes the de-energization of release relay 139 and the opening of contact 140—141. The opening of this contact causes the de-energization of release magnet 125 and the return of the first selector switch, Figure 2, to normal. It also causes the de-energization of relay 89 and the opening of contact 88—86. The opening of this contact causes the de-energization of relay 66 and the return of arms 83, 246, 63 and 70 to their normal positions as shown in the illustration. It is to be understood that the release of the private switch, or its return to normal, consists in the above described operation only, wipers 82, 98 and 97 remaining in engagement with terminals of the first selector switch used. The return of arm 83 to its normal engagement with its contact 84 removes ground from contact 80 and its multiples, rendering the first selector switch, Figure 2, idle with respect to other private switches having access to it.

Should subscriber A depress keys 60 and 61 at his substation and replace his receiver before subscriber B does so, the grounding of limb S of the line of subscriber A short circuits the lower winding of relay 255, current continuing to flow through the upper winding, over limb P, to ground at the substation. The core of the relay is thereupon magnetized, armature 259 engages anvil 260, and the release operations proceed exactly as described in the case in which subscriber B performs the release operation at his substation first.

It will be noted that during conversation, current flows through differentially wound relay 255 and in parallel paths over the lines of the two connected subscribers; that when one subscriber releases in advance of the other, current through the upper winding of relay 255 is of equal or of greater volume than that during conversation; while current through the lower winding is reduced approximately one-half, the degree depending upon the comparative resistance of the two subscribers' lines.

Should the two subscribers release simultaneously, the flow of current through the upper winding of relay 255 will be substantially the same as that existing during conversation, while the flow of current through the lower winding will be practically nil.

A second complete diagram, illustrative of an alternate form of the circuits of the telephone system of my invention, comprises Fig. 2, Fig. 5 and Fig. 4, placed in the order named. The method of operation of this circuit is largely the same as that of the circuit diagram already described, the difference existing in the battery control circuit, Figure 5. The said Figure 5 provides means whereby, upon the response of the called subscriber, the direction of the flow of current in the line of subscriber A is reversed.

The description already given in connection with the previous circuit diagram applies to this second diagram to the point at which wipers 165, 169 and 172 of the second selector switch come to rest in engagement with contacts 166, 170 and 173. The impulses sent over limb P of the line, corresponding to the tens digit of the called subscriber's number, after passing through contact 171—169—170, in this case pass through contact 270—271, through contact 301—300 and through the winding of primary relay 188, operating the connector switch of Figure 4 in the manner already described. The single impulse sent over limb S of the line after the just mentioned set of primary impulses, after passing through contact 174—172—173, passes through contact 273—274, contact 305—303 and through the winding of relay 221. The impulses corresponding to the units digit sent over limb P, and the single impulse sent over limb S thereafter, traverse the above described paths.

The release of the connector switch, in case the line of the called subscriber is busy, is secured in the same manner as described in connection with the preceding diagram. Should the line of subscriber B be idle, arms 224, 198, 184, 217 and 228 are caused to engage contacts 227, 201, 187, 220 and 231, as in the preceding description. The engagement of arm 228 with contact point 231 establishes a path for the flow of current from ground at battery control circuit, Figure 5, through the winding of relay 276, causing its energization, through contact 231—228, through the winding of release magnet 232, which, due to the resistance of relay 276, does not attract its armature, and to battery 189.

The energization of relay 276 (Figure 5) causes the attraction of armatures 277 and 279, and causes arms 270, 273, 300 and 303 to engage contact points 272, 275, 302 and 304, respectively.

Current thereupon flows as follows: from the grounded side of battery 287, through

the lower winding of differentially-wound relay 284, through the lower winding of relay 281, through contact 293—294, through contact 275—273, over the talking circuit at the exchange, to limb S of the line of subscriber A, through the substation, returning over limb P, over the talking circuit, through contact 270—272, through contact 296—295, through the upper winding of relay 281, through the upper winding of relay 284, to the active side of battery 287. The core of relay 284 is not magnetized by this flow of current, owing to its differential windings. The core of relay 281 is energized, attracting its armature 283 to open contact 282—283. Subscriber A opens the path of the previously traced flow of current by means of key 62, causing the de-energization of relay 281, armature 283 falling back to establish a path for the flow of current as follows: from ground, through contact 282—283, through contact 280—279, through the winding of ringing relay 288 to the active side of battery 287. Relay 288 attracts its armatures, cutting ringing generator 289 into circuit with the called-for subscriber's line and causing his bell to ring. When subscriber A releases ringing key 62, it closes circuit through the substation, relay 281 is again energized, opening contact 282—283, de-energizing relay 288 and allowing the said relay's armatures to resume their normal positions. When subscriber B, in response to the call, removes his receiver from the hook and closes contact 73—72, an additional path for the flow of current, from battery 287, is established as follows: from the grounded side of the said battery, through the lower winding of relay 284, through winding 292 of relay 290, through contact 304—303, over the talking circuit at the exchange, to limb S of the line of subscriber B, through the substation, returning over limb P, over the talking circuit, through contact 300—302, through winding 291 of relay 290, through the upper winding of relay 284 to the active side of battery 287. This flow of current causes the energization of relay 290, attracting its armatures to close contacts 294—295 and 296—297, contacts 293—294 and 295—296 being opened. The original flow of current, from battery 287 over the line of subscriber A, was from the grounded side of the said battery, over limb S, returning by way of limb P to the active side of the said battery. The attraction of the armatures of relay 290 reverses the direction of this flow of current, the path now being traced from the grounded side of battery 287, over limb P of the line, returning over limb S to the active side of the battery.

While the provision of means for reversing the direction of the flow of current in the calling subscriber's line, upon the response of the called-for subscriber, is not essential to the operation of the system as shown, the feature is of value as rendering the system of the whole more flexible, being adapted to be used for various signaling purposes in connection with polarized electromagnets. An example of structures such as may be used in connection with the present system is shown in Fig. 5 of Patent 830,653 to A. H. Dyson issued Sept. 11, 1906.

When, at the conclusion of the conversation, either subscriber depresses keys 60 and 61 to ground the limbs of his line and replaces his receiver, the neutralizing effect of its two windings upon the core of differentially-wound relay 284 is unbalanced; armature 285 is attracted to engage anvil 286, establishing a path for the flow of current from ground at the second selector switch, Figure 5, through the winding of release relay 175, through contact 164—162, through contact 167—165—166, contact 285—286, then joining the flow from ground through relay 276, through contact 231—228, through the winding of release magnet 232 of the connector switch, Figure 4, to battery 189, causing the energization of release magnet 232 and release relay 175 of the second selector switch, Figure 5. Relay 276 of the battery control circuit, Figure 5, continues energized under these conditions. The energizations of the release magnets of the second selector switch, first selector switch and the private switch are accomplished in the same manner as described in connection with the first complete circuit diagram. When the releasing subscriber removes ground from the two limbs of his line at the substation, armature 285 of relay 284 (Figure 5) disengages anvil 286 and opens circuit through release relay 175 of the second selector switch, Figure 5, and release magnet 232 of the connector switch, Figure 4, causing their de-energizations. The de-energization of release magnet 232 causes the return of the connector switch, Figure 4, to normal; the opening of contact 231—228, caused thereby, breaks the circuit through relay 276 of the battery control circuit, Figure 5, de-energizing it, arms 270, 273, 300 and 303 thereupon returning to normal. The return to normal of the second selector switch, first selector switch and the private switch are accomplished as described in connection with the first complete circuit diagram.

A third complete diagram, illustrative of the circuit of my invention for providing means whereby subscribers whose lines terminate in different exchanges may automatically interconnect their lines, two conductors only being required for a trunk circuit between exchanges, comprises Fig. 2, Fig. 6, Fig. 5 and Fig. 4 placed in the order named with Fig. 6 superposed upon Fig. 5 so that the left portion of Fig. 5 including contacts

166, 170 and 173 is covered by Fig. 6. *p* and *s* are the two limbs of a trunk circuit; the apparatus in this diagram to their left being assumed to be in one exchange, and that to their right in the second exchange. The method of operation of this circuit is similar to those already described to the point at which wipers 129, 133 and 136 of the first selector switch, Figure 2, come to rest in engagement with contacts 130, 134 and 137. Impulses corresponding to the hundreds digit of the called subscriber's number, sent by subscriber A from ground at the substation, pass through contact 135—133—134, through contact 306—307, through the winding of primary trunk relay 309, to battery 321. These four impulses of current cause four attractions and releases of the armature of relay 309, each attraction and release causing an impulse of current to flow as follows: from ground at Figure 6, through contact 313—312, through contact 348—347, over limb *p* of the trunk line, through contact 142—143, through the winding of primary relay 145 of the trunking second selector switch, Figure 6. The four attractions and releases of the armature of relay 145, caused by the above mentioned impulses of current, cause four impulses of current to flow from ground at the second selector switch, Figure 6, through contact 150—151, through contact 148—147, through the winding of primary magnet 153 to battery 149, causing four primary movements of shaft 168 and the movement of wipers 165, 169 and 172 to positions adjacent to, but not engaging, levels of contacts, terminals of connector switches assigned to the four hundreds group of the third thousand. The calling subscriber now causes one impulse of current to flow from ground at the substation, over limb S of the line, through contact 138—136—137, through contact 318—319, through the winding of secondary trunk relay 317 to battery 321, causing the attraction and release of the armature of said relay and an impulse of current to flow from ground, through contact 313—314, through contact 351—350, over limb *s* of the trunk line, through contact 204—205, through the winding of secondary relay 207 to battery 149. The resulting attraction and release of the relay's armature causes an impulse of current to flow from ground at Figure 6, through contact 210—209, through the winding of circuit-changing switch magnet 154 to battery 149, causing the energization of the magnet and the attraction of its armatures. The closing of contact 150—152 causes a flow of current from ground, through the said contact, through the winding of secondary magnet 157 to battery 149. Wipers 165, 169 and 172 move over the contacts of the before-mentioned levels, terminals of busy connector switches being grounded, as described in connection with the previous diagrams, and maintaining the circuit-changing switch magnet energized. When the wipers reach contacts, terminals of an idle connector switch, circuit-changing switch magnet 154 is de-energized, opening circuit through secondary magnet 157 and preventing further movement of the wipers under the influence of the said magnet. At the same time, it moves arms 162, 142 and 204 into engagement with contact points 164, 144 and 206, respectively.

The impulses sent from ground by subscriber A, corresponding to the tens digit of the called subscriber's number, cause five energizations and de-energizations of primary trunk relay 309, resulting in five impulses flowing over the following path; from ground, through contact 313—312, contact 348—347, over limb *p* of the trunk line, through contact 142—144, contact 171—169—170, contact 270—271, contact 301—300, contact 184—185, through the winding of primary relay 188 and to battery 189. The resulting energizations and de-energizations of relay 188 cause the operation of the connector switch as described in connection with the preceding complete diagrams. The impulse of current, sent by subscriber A from ground at the substation, over limb S of the line, passes through secondary trunk relay 317, over the previously traced path. The energization and de-energization of this relay causes an impulse of current to flow from ground, through contact 313—314, through contact 351—350, over limb *s* of the trunk line, through contact 204—206, contact 174—172—173, contact 273—274, contact 305—303, contact 217—218, through the winding of relay 221 to battery 189. Relay 221 operates the connector switch, as previously described. The six impulses corresponding to the units digit of the called subscriber's number, sent by subscriber A over limb P of the line, and a single impulse, following the six sent over limb S, are transmitted by relays 309 and 317 of Figure 6 to relays 188 and 221 of the connector switch, Figure 4, over the previously traced paths, causing wipers 236, 240 and 243 to engage terminals of the called subscriber's line.

Should the line be busy, the connector switch is released and subscriber A receives the busy signal from busy-back machine 263, as previously described.

Should the line be idle, the engagement of arm 228 with contact 231 causes a flow of current from ground at battery control circuit, Figure 5, through relay 276, contact 231—228 and release magnet 232 to battery 189, the latter magnet not being operated thereby. The armatures of relay 276 are attracted, and arms 270, 273, 300 and 303

engage, respectively, contacts 273, 275, 302 and 304. Current thereupon flows from the grounded side of battery 287, through a winding of relay 284, a winding of relay 281, through contact 293—294, through contact 275—273, through contact 173—172—174, through contact 206—204, over limb *s* of the trunk circuit, contact 350—351, contact 314—315, through the winding of relay 322, through contact 311—312, through contact 348—347, over limb *p* of the trunk line, through contact 142—144, through contact 171—169—170, contact 270—272, through contact 296—295, the upper winding of relay 281, the upper winding of relay 284, to the active side of battery 287. This flow of current energizes relay 322 of Figure 6, its armature being attracted to close contact 324—323. Current then flows from ground, through the said contact, through contact 327—326, through the winding of magnet 325 to the active side of battery 321. Magnet 325 is energized and its armature is attracted, preparing to move arms 306, 318, 347 and 350 into engagement with contacts 308, 320, 349 and 352 upon its de-energization. As the armature is attracted, it opens the magnet's circuit; the armature thereupon drops back, and arms 306, 318, 347 and 350 are moved, respectively, into engagement with contact points 308, 320, 349 and 352. Pawl 21, associated with magnet 16 in Figure 1, and ratchets 26 and 27 with their circuit-changing arrangement, comprise a mechanical combination that may be employed in connection with magnet 325. The closing of contacts 306—308 and 318—320 establishes a path for the flow of current from the grounded side of battery 328, through the lower windings of relays 329 and 334, through contact 341—340, through contact 320—318, over the talking circuit at the exchange, to limb S of the line of substation A, through the substation, returning over limb P, the talking circuit contact 306—308, through contact 337—338, through the upper windings of relays 334 and 329, to the active side of battery 328. Relay 329 is differentially wound, and the magnetic effects of its two windings upon its core are balanced. Relay 334 is not differentially wound; its core is energized and attracts armature 335 to engage anvil 336. Current thereupon flows from the grounded side of battery 287, through contact 275—273, through contact 173—172—174, through contact 206—204, through contact 350—352, contact 335—336, through the two windings of polarized electromagnet 343 in series, through contact 349—347, through contact 142—144, contact 171—169—170, through contact 270—272, and to the active side of battery 287. This flow of current is in a direction such that polarized electromagnet 343 is not actuated to cause the movement of its armature. It will be noted that the above described flow of current traverses the windings of relays 284 and 281 (Figure 5), relay 281 attracting its armature to open contact 282—283.

When subscriber A opens circuit, by means of key 62, through the substation to ring the called subscriber's bell, circuit is broken through relay 334 of the trunk circuit, Figure 6, and the relay is de-energized, opening contact 336—335, which interrupts the flow of current through relay 281 (Figure 5), de-energizing the said relay and allowing armature 283 to engage anvil 282. The closing of contact 283—282 closes circuit through ringing relay 288, causing it to attract its armatures and include generator 289 in circuit with the called subscriber's line, ringing the substation bell. When subscriber A releases key 62, closing circuit through the substation, relay 334 of Figure 6 is again energized, its armature is attracted, closing contact 335—336, and current again flows through relay 281 (Figure 5), causing it to attract its armature and open the circuit of ringing relay 288, whose armatures return to normal.

When the called subscriber B answers the call by removing his receiver from the hook, contact 73—72 is closed, establishing a path for the flow of current from the grounded side of battery 287, through winding 292 of relay 290, over limb S, through the substation, returning over limb P and through winding 291 of relay 290, to the active side of battery 287, energizing relay 290. The energization of this relay, as described in connection with the second circuit diagram, reverses the connections of battery 287 to the talking circuit on the calling subscriber's side of condensers 298 and 299. In this case, the direction of the flow of current from battery 287, through the windings of polarized relay 343 of Figure 6, is reversed, the said relay is actuated, and its armature 344 attracted, closing contacts 342—340 and 339—337, and opening contacts 341—340 and 337—338. The closing of the contacts mentioned reverses the direction of the flow of current from battery 328, over the line of the calling subscriber A.

The two subscribers are now in conversation through condensers 298 and 299, over limbs *p* and *s* of the trunk circuit, and through condensers 345 and 346.

When the subscribers have finished their conversation, they depress keys 60 and 61 and replace their receivers as before. Assuming that subscriber A does this first, the grounding of limb P of the line at the substation short circuits the lower winding of differentially wound relay 329 (Figure 6); while current continues to flow in equal,

or greater volume, from ground at the substation, over limb S of the line, through the upper winding of the said relay. This destroys the previously balanced effect of the windings upon the core of the relay, which becomes magnetized, attracting armatures 330 and 332. Their attraction establishes a path for the flow of current as follows: from ground at the first selector switch, Figure 2, through relay 139, through contact 128—126, contact 131—129—130, through contact 330—331 (Figure 6), contact 333—332, through the winding of relay 325 to the active side of battery 321, energizing relay 139 and relay 325.

The flow of current from ground at Figure 2, through relay 139, after passing through contact 330—331, divides; a portion flowing through contact 352—350, over limb *s* of the trunk line, through contact 204—206, through contact 174—172—173, through contact 273—275, through contact 294—295, through the upper winding of relay 281, through the upper winding of relay 284, to the active side of battery 287. This flow of current increases the flow through the upper winding of relay 284, while the flow through the lower winding remains as before. The balancing effect of the two windings upon the core of the relay is therefore destroyed; the core is magnetized and attracts armature 285 to engage anvil 286. This establishes a path for the flow of current from ground at the second selector switch, Figure 6, through the winding of its release relay 175, through contact 164—162, contact 167—165—166, through contact 285—286; the current thereupon joining the flow from ground, through relay 276, flowing through contact 231—228, through the winding of release magnet 232 (Figure 4), to battery 189. This causes the energization of magnet 232 and relay 175, which latter attracts armature 176, causing current to flow from ground at the second selector switch, Figure 6, through contact 177—176, through the winding of release magnet 161 to battery 149.

Referring now to the first selector switch, Figure 2, the energization of release relay 139 operated to cause the energization of release magnet 125 of the first selector switch; and by also causing the energization of relay 89 of the private switch of subscriber A, caused the energization of relay 66 of the said switch.

When subscriber A releases keys 60 and 61, removing ground from the line at the substation, the unbalancing effect, caused by the grounding of the limbs of the line upon the core of relay 329 (Figure 6), no longer exists. Current ceases to flow through the windings of the said relay, due to the fact that the receiver of subscriber A has been replaced upon the hook, opening contact 72—73. Armatures 330 and 332 return to normal, opening circuit through relay 325 and causing its de-energization, which effects the return of arms 306, 318, 347 and 350 to normal. The release of the said armatures also opens circuit through release relay 139 (Figure 2), and the first selector switch and the private switch of subscriber A thereupon return to normal, as described in connection with the second complete circuit diagram.

The return of arms 347 and 350 to normal, as above mentioned, opened circuit through polarized relay 343, whose armature returns to normal, as shown in the illustration. The return of arm 350 to normal opened the path for the flow of current, previously described as unbalancing the neutralizing effect of its winding upon the core of relay 284 (Figure 5), whose armature, therefore, returns to normal, opening contact 285—286. This opens circuit through release magnet 232 of the connector switch, Figure 4, whose de-energization causes the return of the switch to normal. The return causes the de-energization of relay 276 (Figure 5), as described in connection with the second complete circuit diagram, and arms 270, 273, 300 and 303 return to normal. The opening of contact 285—286 also effected the de-energization of release relay 175 of the second selector switch, Figure 6, whose armature thereupon disengages anvil 177, opening circuit through release magnet 161 of the said switch, which thereupon returns to normal.

It will be noted that the calling subscriber, by grounding the two limbs of his line at the substation, causes the return of all apparatus, used in establishing the connection, to normal.

Should subscriber B ground the two limbs of the line at his substation in advance of subscriber A, the core of relay 284 (Figure 5) is magnetized, as described in connection with the second complete circuit diagram, which effects the energization of release relay 175 of the second selector switch, Figure 6, and of release magnet 232 of the connector switch, Figure 4. When subscriber B removes ground from the two limbs of his line by releasing keys 60 and 61, the second selector switch, Figure 6, the battery control circuit, Figure 5, and the connector switch, Figure 4, all return to normal.

The opening of contacts 142—144 and 204—206 (Figure 6), upon the release of the second selector switch, destroys the flow of current through polarized relay 343 which is de-energized, the return of its armature reversing the direction of the flow of current from battery 328 in the line of subscriber A.

It will be noted that subscriber B, by performing the release operation, releases only the second selector switch, Figure 6, the battery control circuit, Figure 5, and the connector switch, Figure 4.

The remaining apparatus, used in establishing the connection, remains to be released by subscriber A, who, by grounding the two limbs of his line, short circuits the lower winding of differentially wound relay 329 (Figure 6), this time by the ground applied to limb S at the substation, the direction of current flowing in his line having been reversed by the de-energization of relay 343. The core of relay 329 is magnetized, armatures 330 and 332 are attracted, and the returns to normal of the private switch, Figure 2, the first selector switch, Figure 2, and the battery control circuit, Figure 6, are accomplished in the same manner as that described in the case in which subscriber A performs the release operation first.

While I have shown a plurality of batteries in connection with the various circuit diagrams, it is to be understood that they may be one and the same battery. In connection with the third complete diagram, the various batteries shown may be two batteries, one of which will be located in each exchange.

The circuits, comprised in the three complete diagrams described, provide means whereby the calling subscriber is enabled to release the switches connected with his line at any stage of the operation of connecting his line with that of another subscriber. The description given in connection with the first complete diagram, explaining the manner in which the calling subscriber releases the switches upon receiving the busy signal, is typical of all of these.

The release relays, such as 175 and 139, may be slow-acting relays of which there are various types well known in the art, thus securing a prolonged impulse of current in the releasing operation.

While I have referred to the circuit at the right end of Fig. 3 as "a control circuit," I do not necessarily consider this circuit as a structure independent of the connector switch of Fig. 4 with which it is associated, but for certain purposes and due to the cooperation between them, this right end circuit of Fig. 3 may be considered as a part of the connector switch of Fig. 4.

I claim as my invention:—

1. In a telephone exchange system provided with switches at the exchange adapted to be operated under direction of subscribers to connect their lines for conversation, the combination with calling and called subscribers' lines, of a connector switch for making connection directly with the called subscriber's line, a central source of current, apparatus for establishing a circuit of said source in the line of the calling subscriber to supply talking current thereto, actuated when connection is made with the called subscriber's line and apparatus for reversing the connections of said source to the calling subscriber's line, operated upon the response of the called subscriber.

2. In a telephone exchange system provided with switches at the exchange adapted to be operated under direction of subscribers to connect their lines for conversation, the combination with calling and called subscribers' lines, of terminal contact pieces for the called subscriber's line, a connector switch controllable by the calling subscriber, wipers for said switch adapted to connect with said contact pieces, a central source of current, apparatus for establishing a circuit of said source in the line of the calling subscriber to supply talking current thereto when connection is made with said contact pieces and apparatus for reversing the connections of said source to the calling subscriber's line, operated upon the response of the called subscriber.

3. In a telephone exchange system provided with switches at the exchange adapted to be operated under direction of subscribers to connect their lines for conversation, the combination of a calling subscriber's line extending from the substation to the exchange, a trunk circuit at the exchange adapted to be placed in electrical connection with said line, a selector switch connected by two conductors with said trunk circuits and controllable by means thereof, a connector switch for making connection directly with the called subscriber's line adapted to be controlled by means of said circuit, a central source of current for conversational purposes, apparatus adapted to establish bridges from said source to the calling and called subscribers' lines, actuated when connection is made with the called subscribers' line and apparatus for reversing the connections of said source to the calling subscriber's line, operated upon the response of the called subscriber.

4. In a telephone exchange system provided with switches at the exchange adapted to be operated under direction of subscribers to connect their lines for conversation, the combination with calling and called subscribers' lines, of an automatic switch individual to the calling subscriber's line, a first selector switch common for connection to all subscribers' lines, a second selector switch common for connection to a limited group of subscribers' lines, a central source of current for conversational purposes, apparatus adapted to establish bridges from said source to the calling and called subscribers' lines, actuated when connection is made with the called subscriber's line and apparatus for

reversing the connections of said source to the calling subscriber's line, operated upon the response of the called subscriber.

5. In a telephone exchange system provided with switches at the exchange adapted to be operated under direction of subscribers to connect their lines for conversation, the combination with calling and called subscribers' lines, of an automatic switch individual to the calling subscriber's line, a first selector switch common for connection to all subscribers' lines, a second selector switch common for connection to a limited group of subscribers' lines, a connector switch for making connection directly with the called subscriber's line, a central source of current and apparatus for establishing a circuit of said source in the line of the calling subscriber to supply talking current thereto, actuated when connection is made with the called subscriber's line.

6. An automatic telephone exchange system comprising telephone lines, first selector switches less in number than said lines, means for automatically connecting idle ones of said switches with calling lines, connectors for connecting directly with called lines, a central source of current, and mechanism responsive to the idle conditions of called lines on connections made therewith to automatically establish circuits of said source in calling lines to supply talking current thereto.

7. An automatic telephone exchange system comprising telephone lines, first selector switches less in number than said lines, means for automatically connecting idle ones of said switches with calling lines, connectors for connecting directly with called lines, a central source of current, switches operating in response to the idle conditions of called lines on connections made therewith, and relays actuated responsive to the operations of said switches to establish circuits of said source in calling lines to supply talking current thereto.

8. An automatic telephone exchange system comprising a calling line, relays at the exchange in circuit with said line for operation responsive to currents over said line, a called line, a selector switch and a connector switch adapted to be successively operated responsive to currents transmitted by said relays in connecting said lines, a central source of current and mechanism responsive to the idle condition of said called line to automatically include said source in bridge of the calling line.

9. An automatic telephone exchange system comprising a calling line, relays at the exchange in circuit with said line for operation responsive to currents over said line, a called line, a selector switch and a connector switch adapted to be successively operated responsive to currents transmitted by said relays in connecting said lines, a central source of current, a switch operating in response to the idle condition of said called line, and a relay actuated responsive to the operation of said switch to include said source in bridge of the calling line.

10. An automatic telephone exchange system including a calling line and a called line, a connector switch operatively connected to the calling line and controllable by currents thereover to connect directly with the called line, a central source of current and normally open branches connected thereto, adapted when closed to connect said source in bridge of the calling line, and mechanism automatically responsive to the connection of said switch with the called line in its idle condition to close said branches.

11. An automatic telephone exchange system including a calling line and a called line, a connector switch operatively connected with the calling line for connecting with the called line, a link-circuit having talking conductors disconnected from the calling line, a central source of current in bridge of said conductors, and mechanism operating responsive to the connection of said switch with the called line in its idle condition to connect said conductors with the calling line.

12. In an automatic telephone exchange system the combination with a calling and a called line, of a connector switch controllable from the calling station to connect directly with the called line, a link-circuit associated with said switch having talking conductors disconnected from each of said lines, a central source of current and two branches from each pole of said source extending to conductively disunited portions of said link-circuit, and mechanism actuated responsive to the connection of said switch with the called line in its idle condition to unite the talking conductors of said link-circuit to each line whereby the talking circuit is completed.

13. An automatic telephone system comprising a calling line and a called line, a connector switch operatively connected with the calling line, movable contacts therefor adapted to be adjusted responsive to currents over said line to connect with the called line, a central source of current and branches therefrom open during the process of adjustment and adapted when closed to bridge said source to said movable contacts, other open branches adapted when closed to bridge said source across the calling line, and mechanism automatically operating responsive to connection made with the called line in its idle condition to close the bridges of said source to said contacts and said calling line.

14. An automatic telephone exchange system including a calling line, a connector

switch operatively connected thereto, a called line, multiple terminals therefor at the exchange, means for altering the normal electrical character of said terminals when said line is busy, a movable testing contact for said connector connected with said multiple terminals, an electromagnet in circuit with said contact sensitive to the normal and changed electrical characters of said terminals, a central source of current having open branches adapted when closed to bridge said source across the calling line, and mechanism controlled by said electromagnet adapted when said testing contact is connected with said terminals in their normal condition to automatically close said branches.

15. An automatic telephone exchange system including a calling and a called line, relays at the exchange in circuit with said calling line controllable by currents thereover, a selector switch and a connector switch adapted for successive operation responsive to said relays in connecting said lines, means for switching said relays into and out of operative relation with said switches, a central source of current and mechanism responsive to the idle condition of said called line on connection made therewith to automatically establish a circuit of said source in the calling line to supply talking current thereto.

16. An automatic telephone exchange system including a calling and a called line, relays at the exchange in circuit with said calling line controllable by currents thereover, a selector switch and a connector switch adapted for successive operation responsive to said relays in connecting said lines, means for switching said relays into and out of operative relation with said switches, a central source of current, a switch associated with said connector switch operating in response to the idle condition of said called line on connection made therewith, and a relay controlled by the operation of said switch to establish a circuit of said source in the calling line to supply talking current thereto.

17. An automatic telephone exchange system including a calling and a called line, relays at the exchange in circuit with said calling line controllable by currents thereover, a selector switch and a connector switch adapted for successive operation responsive to said relays in connecting said lines, means for switching said relays into and out of operative relation with said switches, a central source of current and open branches connected thereto adapted when closed to connect said source in bridge of the calling line, and an electromagnet automatically responsive to the connection of said connector switch with the called line in its idle condition to close said branches.

18. An automatic telephone exchange system including a calling and a called line, relays at the exchange in circuit with said calling line controllable by currents thereover, a selector switch and a connector switch adapted for successive operation responsive to said relays in connecting said lines, means for switching said relays into and out of operative relation with said switches, a link-circuit having talking conductors disconnected from the calling line, a central source of current in bridge of said conductors, and mechanism automatically responsive to the connection of said connector switch with the called line in its idle condition to connect said conductors with the calling line.

19. An automatic telephone exchange system including a calling and a called line, relays at the exchange in circuit with said calling line controllable by currents thereover, a selector switch and a connector switch adapted for successive operation responsive to said relays in connecting said lines, means for switching said relays into and out of operative relation with said switches, a link-circuit having an electromagnet operatively related to said connector switch, talking conductors for said link-circuit disconnected from said lines, a central source of current and two branches from each pole of said source extending to conductively disunited portions of said link-circuit, and mechanism operated responsive to the connection of said connector switch with the called line in its idle condition to control said electromagnet to unite the talking conductors of said link-circuit to the calling and called lines.

20. An automatic telephone exchange system including a calling and called line, relays at the exchange in circuit with said calling line controllable by currents thereover, a selector switch and a connector switch adapted for successive operation responsive to said relays in connecting said lines, means for switching said relays into and out of operative relation with said switches, multiple terminals of said called line at the exchange adapted to be engaged by said connector switch, means for altering the normal electrical character of said terminals when said line is in use, a central source of current and mechanism operating automatically, responsive to the connection of said connector switch with said terminals in their normal electrical condition, to bridge said source in metallic circuit of the calling line to supply talking current thereto.

21. An automatic telephone exchange system comprising a calling and a called

line, a plurality of first selector switches adapted for connection with the calling line, means initially actuated from the calling substation for automatically establishing connection between the calling line and an idle first selector, a connector switch for connecting directly with the called line, means for automatically completing a circuit between said lines including switching contacts of an idle first selector and said connector, a central source of current, and mechanism actuated when connection is made with the called line responsive to its idle electrical condition to automatically bridge said source across the calling line to supply talking current thereto.

22. An automatic telephone exchange system comprising a calling and a called line, a plurality of first selector switches adapted for connection with the calling line, means initially actuated from the calling substation for automatically establishing connection between the calling line and an idle first selector, a connector switch for connecting directly with the called line, means for automatically completing a circuit between said lines including switching contacts of an idle first selector and said connector, a central source of current, a switch adapted to operate when connection is made with the called line responsive to its idle electrical condition, and a relay adapted to be controlled by said switch to bridge said source across said calling line to supply talking current thereto.

23. An automatic telephone exchange system comprising a calling and a called line, a plurality of first selector switches adapted for connection with the calling line, means initially actuated from the calling substation for automatically establishing connection between the calling line and an idle first selector, a connector switch for connecting directly with the called line, means for automatically completing a circuit between said lines including switching contacts of an idle first selector and said connector, a link-circuit having talking conductors disconnected from the calling line, a central source of current and branches therefrom to said talking conductors, inductive resistances in said branches, and mechanism operating when connection is made with the called line responsive to its idle electrical condition to automatically connect said conductors with the calling line.

24. An automatic telephone exchange system comprising a calling and a called line, a plurality of first selector switches adapted for connection with the calling line, means initially actuated from the calling substation for automatically establishing connection between the calling line and an idle first selector, a connector switch for connecting directly with the called line, means for automatically completing a circuit between said lines including switching contacts of an idle first selector and said connector, a link-circuit having talking conductors disconnected from the calling and the called line, a central source of current, two branches from each pole of said source extending to conductively disunited portions of said talking conductors, inductive resistances connected in said branches, and mechanism adapted to be automatically operated responsive to the idle electrical condition of the called line on connection made therewith to unite the talking conductors of said link-circuit to the calling and called lines.

25. An automatic telephone exchange system comprising a calling and a called line, a plurality of first selector switches adapted for connection with the calling line, means initially actuated from the calling substation for automatically establishing connection between the calling line and an idle first selector, a connector switch for connecting directly with the called line, means for automatically completing a circuit between said lines including switching contacts of an idle first selector and said connector, multiple terminals for the called line through which said circuit is completed, means for altering the normal electrical character of said terminals when said line is in use, a central source of current having open branches adapted when closed to bridge said source across the calling line, and mechanism automatically responsive to the normal electrical character of said terminals to close said branches.

26. A telephone system including a calling subscriber's line, a central source of current in bridge of said line, an electromagnet for actuation to reverse the connections of said source to the limbs of said line, a called subscriber's line, a selective switch at the exchange operable responsive to directive currents to render said magnet sensitive to current changes in the called line, and a switch for said called line for producing said changes.

27. A telephone system including telephone lines, a link-circuit at the exchange including a pair of conductors, a central source of current normally in bridge thereof, selective switch mechanism for interchangeably connecting said link-circuit with calling lines, selective switches at the exchange responsive to directive currents to connect said link-circuit operatively with a called line, and a switching device at the exchange responsive to current changes controlled at the called substation to reverse the connections of said source to said conductors, whereby the direction of current flow over the calling line is reversed.

28. In an automatic exchange, the combination with a directively controlled selector having a relay for controlling the selection of the first idle contacts, of means for initially energizing said relay responsive to current controlled at a substation, and a local locking circuit for said relay rendered effective by one of its armature contacts, solely controlled by said relay.

29. In a telephone system, the combination with a directively controlled selector, of a relay for said selector, of a locking armature solely controlled by said relay and normally connected with a private terminal or wiper of said selector, and a circuit connection including said relay, said armature and said terminal, determining the selection of idle contacts.

30. In an automatic exchange, the combination with a numerical selector having a relay for determining the selection of the first idle contacts, of a locking armature normally connected to a wiper of said selector, a release relay, and a switch controlled by the de-energization of said first relay to disconnect said armature contact and to complete a circuit for said release relay extending to said wiper contact.

31. In an automatic telephone exchange system, the combination with two connected subscribers' lines of differential relay 255 having its windings conductively connected to the two said lines, means at either substation adapted at the will of the subscriber to unbalance said windings to energize the relay, a selector and a connector included in the connection between said lines, a release relay 175 of said selector, a release magnet 232 of said connector, armature contact 259 operatively responsive to the energization of said differential relay for establishing a series circuit, including said release magnet and said release relay to cause their energizations.

32. In an automatic telephone exchange system, the combination with a selector, of a connector, multiple bank contacts for said connector included in the mechanism of said selector, a control circuit intermediate of said bank contacts and said connector, having talking conductors normally disconnected from said bank contacts and the connector circuits, and means for automatically completing the connection of said talking conductors to said bank contacts, actuated responsive to the connection of said connector with a called line in its idle electrical condition.

33. In an automatic telephone exchange system, the combination with a selector, of a connector, of bank contacts for said connector adapted for engagement by said selector, and a control circuit having talking conductors normally disconnected from said bank contacts and the talking conductors of said connector, a source of current for ringing purposes associated with said control circuit, a relay adapted to connect said source with the talking conductors of said control circuit, and mechanism automatically operated on connection of said connector to a called line in its idle electrical condition to connect the talking conductors of said control circuit to the talking conductors of said connector whereby said ringing mechanism is automatically associated with the called line.

34. An automatic telephone exchange system comprising telephone lines, first selector switches less in number than said lines, means for automatically connecting idle ones of said switches to a calling line, a connector for connecting directly with the called line, a source of current for ringing purposes, means for connecting said source to a portion of the talking circuit normally disconnected from said connector, and mechanism responsive to the idle condition of a called line on connection made therewith to automatically unite said portion to the connector.

35. An automatic telephone system comprising a pair of connected subscribers' lines, a plurality of selective switches included in the connection, a central source of current having its opposite poles connected to the calling line, a relay associated with one of said switches and adapted to be energized responsive to current changes produced in the called line, and armature switches for said relay effective to reverse the connections of said poles to said calling line.

36. An automatic telephone system comprising a pair of connected telephone lines, a selective switch, operated responsive to directive currents transmitted over the calling line, included in the connection, a central source of current having its opposite poles connected to the limbs of the calling line, and means for causing a current flow through said selective switch when the called subscriber answers to reverse the connections of said poles to the calling line.

37. An automatic telephone system including a pair of connected telephone lines, a central source of current having its opposite poles connected to the calling line, a polarized electromagnet at the exchange, a relay connected with the called line, a trunk circuit connecting said relay and said magnet, a switch at the called substation effective on the response of the subscriber to energize said relay to produce a current flow of predetermined polarity over said circuit, and switching mechanism controlled by said magnet responsive to said current flow to reverse the connections of said source to the limbs of the calling line.

38. A telephone system including a selector, a conductor connected therewith, means for transmitting directive currents over said

conductor, terminal contacts for said selector arranged in groups, simultaneously adjustable contacts for said selector, one for each group of stationary contacts, an electromagnet sensitive to transmitted directive currents controlling adjustment of said contacts to bring a desired one in operative relation to its group, and means for moving said desired contact from contact to contact in its group.

39. An automatic telephone system including a calling and a called line, a connector at the exchange for connecting said lines, conductors forming part of said connector having normally open contacts at both ends, a test magnet for said connector, and switches controlled thereby for closing connections to the contacts at the ends of said conductors, whereby a talking circuit is completed between said lines.

40. A connector for automatic telephone exchanges including conductors having normally open contacts at both their ends, said contacts being adapted to be traversed by the voice currents, relay mechanism for ringing and release purposes connected to said conductors, movable switch contacts included in said connector and a magnet for shifting said contacts to complete connections to the ends of said conductors whereby said relay mechanism is rendered operative.

41. An automatic telephone system including a calling and a called line, a connector at the exchange for connecting said lines, conductors forming part of said connector having normally open contacts at both ends, operating relays for said connector, a test magnet for said connector, and switches adapted to be actuated thereby for disconnecting said operating relays and completing talking connections from said lines to the ends of said conductors.

42. An automatic telephone exchange system including a calling line, a connector having wipers for extending connection to a called line, talking conductors between the calling line and said wipers and having normally open contacts at both ends, a source of current in bridge of said conductors between said open ends, switch mechanism included in said connector, and means for shifting said mechanism to extend connections from said line to said conductors and from said wipers to said conductors whereby said source is operatively connected with said line and said wipers.

43. A connector for automatic exchanges including a pair of talking conductors provided with multiple contacts at their ends, wiper contacts at the opposed ends of said conductors, condensers interposed in the middle of said conductors, normally open switch contacts connected in said conductors at both sides of said condensers, and electromagnetic mechanism energized after connection is made with a called line to close said contacts.

44. A common battery connector for automatic exchanges including a pair of talking conductors having multiple contacts at their ends, wiper contacts at the opposed ends, condensers connected in said conductors, a source of current and a pair of connections from said source to each conductor, one on each side of its condenser, connections to said pair of conductors being of opposite polarity, and a pair of switch contacts in each said conductor, one such contact being connected between a connection of said source and said multiple terminals, and the other being connected between the other connection of said source and a wiper contact.

45. A connector for automatic exchanges including a pair of talking conductors, a wiper contact at the end of each conductor, a condenser connected in each conductor, a pair of relay magnets having their windings connected to said conductors respectively, a central source of current connected in series with said windings, switch contacts connected in said conductors, and means for shifting said contacts to close connections from the opposite poles of said source to said wipers, respectively.

46. A telephone system including a calling and a called line, an automatic switch at the exchange for connecting said lines, conductors extending from said switch and having normally open contacts at both ends, a test magnet for said switch, and switch contacts controlled thereby for closing connection to the contacts at the ends of said conductors whereby a talking circuit is completed between said lines.

47. An automatic switch for telephone exchanges having conductors associated therewith having normally open contacts at both their ends, said contacts being adapted to be traversed by the voice currents, relay mechanism for ringing and release purposes connected to said conductors, movable switch contacts included in said automatic switch and a magnet for shifting said contacts to complete connections to the ends of said conductors whereby said relay mechanism is rendered operative.

48. A telephone system including a calling and a called line, a connector at the exchange for connecting said lines, conductors associated with said connector having normally open contacts at both ends, operating relays for said connector, a test magnet for said connector, and switches adapted to be actuated thereby for disconnecting said operating relays and completing talking connections from said lines to the end of said conductors.

49. An automatic telephone exchange system including selector terminals arranged in rows in an arc shaped field, a rotatable shaft,

a series of contact points arranged longitudinally on shaft one for each row of terminals, and electro-magnetic mechanism for rotating said shaft into position in which any desired contact point is in operative relation to its corresponding row of terminals.

50. In a telephone system, a first selector, trunk lines having multiple contacts at said selector arranged in groups, an impulse transmitter adapted to be connected with said selector to transmit directive impulses to said selector to select the group, means for producing long steps of said selector to select the group responsive to said impulses, and automatic circuit selecting means for thereafter producing short steps of said selector in the same direction to select contacts of the group.

51. A telephone system comprising selector and connector switches for interconnecting the lines thereof, talking conductors having multiple contacts at said switches arranged in groups, an impulse transmitter adapted to be connected with said switches to transmit impulses to said switches to select a group, means for producing long steps of said switches to select the group responsive to said impulses, and means for thereafter producing short steps of said switches in the same direction to select contacts in the group.

52. A common battery automatic telephone exchange system comprising a connector provided with a pair of line-relays and a differential-relay, and a trunk-release-circuit for said connector, said release-circuit having normally-open switch-points controlled by said line and differential relays.

53. In a telephone exchange system substantially as disclosed, the combination of a connector provided with a pair of line-relays and a differential-relay, a trunk release circuit for said connector, said release circuit having normally open switch points controlled by said line and differential relays, and subscribers' impulse transmitters or calling devices for transmitting to the exchange or central station the electrical impulses representing the number of any called subscriber.

54. In a telephone system, a plurality of trunks provided with terminals arranged in a row, a metallic wiper adapted to travel along said row of terminals in contact therewith, means including a spring for propelling said wiper in its operative movement, electrically-operated means for winding up said spring, means normally locking the wiper against motion, electrically-operated means for unlocking the wiper, and means for causing the wiper to stop on the terminal of the first idle trunk.

55. In a telephone system, a plurality of trunks provided with terminals arranged in a row, mechanism for selecting idle trunk terminals, means including a spring for operating said mechanism, an electric motor for keeping said motor normally wound up, means for normally locking said mechanism against operation, and an electromagnet for unlocking the mechanism to permit operation thereof by the said spring.

56. In a telephone system, a plurality of trunks provided with terminals arranged in a row, mechanism for automatically selecting idle trunk terminals, means normally exerting power to operate said mechanism, means for normally holding the said mechanism stationary, and means for releasing said mechanism to permit selection of an idle trunk.

57. A telephone system including a calling subscriber's line, a first selector switch provided with a test relay, automatic means for connecting said subscriber's line to said selector switch, a contact normally connected with a private wiper of said selector for controlling a locking circuit for said relay, and a circuit connection including said relay, said contact and said private wiper for determining the selection of an idle contact.

58. A telephone system including a directively controlled selector switch provided with groups of terminal contacts, a test relay for said selector switch, a test wiper for said selector switch, and a circuit connection for said relay including contacts of said terminal contacts, said test wiper, a contact controlled by said relay and a winding of said relay for selecting an idle one of said terminal contacts.

59. A telephone system including a numerical directively controlled automatic selector switch provided with a test wiper and a bank of test contacts, a test magnet for said selector switch, means for energizing said magnet, and a locking circuit for said magnet including said test wiper, a contact of said magnet, and a winding of said magnet for controlling the automatic selection of an idle one of said test contacts.

60. A telephone system including a pair of connected telephone lines, a directively controlled automatic switch responsive to current impulses included in said connection, a central source of current having its opposite poles connected to the calling one of said lines through windings of said automatic switch, and means responsive to a control exercised at the substation of the called one of said lines for reversing the connections of said poles to the calling line.

61. A telephone system including a calling subscriber's line, an automatic switch for extending a connection from said calling line, a central source of current associated with said switch and having its opposite poles connected to the limbs of said calling line, and substation controlled means for re-

versing said connections whereby the flow of current over said calling line is reversed.

62. A telephone system including a calling subscriber's and a called subscriber's line, an automatic switch for use in extending a connection from said calling line to said called line, a central source of current associated with said switch and having its opposite poles connected to the limbs of said calling line, and means controlled by the response of the called subscriber for reversing said connections.

63. A telephone system including a calling and a called subscriber's line, an automatic switch for extending a connection in the direction of said called line, a central source of current having its opposite poles connected through windings of said switch to said calling subscriber's line, and electromagnetic means controlled over the called line for reversing said connections.

64. A telephone system including a calling subscriber's line and a called subscriber's line, an automatic switch provided with resistance windings, subscriber controlled means for including said automatic switch in a connection between said calling and said called subscriber's line, whereby battery current is fed through said windings to the line of the calling subscriber, prior to a response being had from the called subscriber, if the line of the called subscriber tests idle.

65. A telephone system including a calling subscriber's telephone line and a called subscriber's telephone line, an automatic trunking switch individual to the calling subscriber's line, a directively controlled automatic trunking switch accessible to said individual trunking switch, automatic means including both of said automatic switches for connecting said calling subscriber's line and said called subscriber's line in conversational circuit, a central source of battery, and means included in said automatic means for connecting the opposite poles of the said battery to the limbs of the calling subscriber's line prior to the removal of the receiver from the switch hook at the called substation.

66. A telephone system including subscriber's telephone lines, a progressively movable automatic switch for use in extending a connection from a calling one to a called one of said lines, means included in such connection for connecting the opposite poles of a central source of battery to the limbs of the calling subscriber's line prior to a response being had from the called subscriber's line, and means controlled over the called subscriber's line for reversing the connections of said battery to said calling subscriber's line.

67. A telephone system including a calling subscriber's line and a called subscriber's line, directively controlled automatic trunking means having one motion to select groups and a second motion to select a line in a group for connecting said lines, a central source of current supply, and relay windings through which opposite poles of said source are connected to the limbs of the calling line for talking purposes, prior to a response being had from the called subscriber.

68. A telephone system including a calling subscriber's line and a called subscriber's line, a central source of current for supplying said lines with talking current, a directively controlled selector switch, a normally at rest progressively movable non-numerical switch responsive to the removal of the receiver at the calling substation for connecting said directively controlled selector switch to said calling subscriber's line, relays for said selector switch for directively actuating said selector switch to extend the connection in the direction of the called subscriber's line, an automatic switch for completing the connection, and means for supplying current from said source through relay windings to the said calling subscriber's line prior to an application of ringing current to said called subscriber's line.

69. A common battery telephone system comprising connectors having one motion to select groups and a second motion to find the called line in any selected group, each connector having two parallel voice current conductors, a condenser in each conductor, and a battery normally in bridge of said conductors at the calling side of said condensers.

70. In a telephone system, a connector having first one motion to select groups and then a second motion to find the called line in any selected group, a pair of voice current conductors for said connector, a condenser in each conductor, a battery normally in bridge of said conductors on the calling side of said condensers, and an impedance coil in said bridge at each side of said battery.

71. In a telephone system, an automatic connector having a primary motion to select groups and then a secondary motion to find the called line in any selected group, a pair of voice current conductors for said connector, condensers in said conductors, a battery normally in bridge of said conductors on the calling side of said condensers, a relay in said bridge, and releasing means controlled by said relay.

72. In a telephone system, a plurality of trunks divided into groups, a switch operative under substation control for automatically selecting idle trunks having first a primary motion to select the desired group and then a secondary motion to find an idle trunk therein, and suitable common battery means between the selector and a called line

for supplying the calling subscriber with talking current before the called subscriber answers.

73. In an automatic telephone system, a pair of voice-current line conductors, condensers in said conductors, a built-up circuit between two subscribers' lines, selecting switches and trunk lines, including said conductors, involved in building up said circuit, a battery, one of said switches including means individual to the switch normally bridging said battery across said conductors on the calling side of said condensers for supplying talking current to said line, and said switch including also means individual thereto for supplying talking current to the other side of said condensers, controlling magnets connected with said circuit at some of said selecting switches, other controlling magnets disconnected from said circuit at other of said selecting switches, and means at the switches having connected magnets for causing those switches having disconnected magnets to disconnect said built-up circuit, substantially as described.

74. An automatic telephone system, means for establishing a talking circuit comprising a pair of voice-current line conductors, condensers in said conductors, a battery, a selector relay bridge temporarily disconnected or cut off from the said circuit, and a connector relay bridge normally connecting said battery across the conductors on the calling side of said condensers retained across the said circuit for releasing purposes, together with selector and connector releasing means controlled by the said connector relay bridge.

75. In a telephone system, a metallic line circuit, an impulse-transmitting device for transmitting a varying number of impulses over one side of said line, and a single impulse over the opposite side of said line, a plurality of keys, electromagnets controlled thereby for controlling the operation of said impulse device, and means at the central exchange for supplying talking current to the substation on said metallic line circuit.

76. In a telephone system, a metallic line circuit, an impulse device for transmitting a series of impulses over one side of said line, followed by one or more impulses over the opposite side of said line, a movable arm, a plurality of keys, electromagnets controlled thereby for controlling the operation of said impulse device, and means at the central exchange for supplying talking current to a substation on said metallic line circuit.

77. A system including a plurality of electrical transmission lines having different busy and idle conditions and provided with line terminals, a numerical selector switch adapted to connect said lines to a trunk line, means for actuating said switch to move from a normal position successively over the transmission line terminals, and means governed by the condition of any line automatically stopping the movement of said selector switch when an idle line is reached, said means including a self-locking control relay having its locking circuit completed through the transmission line test terminals and dependent upon the condition thereof.

78. A telephone system including a plurality of electrical transmission lines having different busy and idle conditions, a numerical two-motion selector switch adapted to connect said lines to a trunk line, means for actuating said selector switch to move from a position of rest successively over the transmission line terminals, and a testing relay governed by the condition of any line for acting to stop the movement of said selector switch when an idle line is reached, said relay after initial energization locking itself through line test terminals.

79. In combination, a plurality of electrical transmission lines having different busy and idle conditions and provided with line terminals, a numerical selector switch adapted to connect said lines to another circuit, means for actuating said switch to move from a given normal position successively over the transmission line terminals, means governed by the condition of any line automatically stopping the movement of said selector switch when an idle line is reached, said means including a self-locking controlling relay having its locking circuit completed through the transmission line test terminals, and dependent upon the condition thereof, and central office means for supplying talking current over said other circuit.

80. In combination, a plurality of electrical transmission lines having different busy and idle conditions, a numerical selector switch adapted to connect said lines to another circuit, means for actuating said selector switch to move from a given normal position successively over the transmission line terminals, a testing relay governed by the condition of any line for acting to stop the movement of said selector switch when an idle line is reached, said relay after initial energization locking itself through line test terminals, and central office means for supplying talking current to said other circuit.

81. A common battery telephone system comprising connectors having one motion to select groups and rotary motion to find the called line in any selected group, each connector having two parallel voice current conductors, a condenser in each conductor, and a battery normally in bridge of said conductors at the calling side of said condensers.

82. A common battery telephone system

comprising connectors having one motion to select groups and rotary motion to find the called line in any selected group, each connector having two parallel voice current conductors, a condenser in each conductor, and a battery permanently in bridge of said conductors at the calling side of said condenser.

83. In a telephone system, a connector having first one motion to select groups and then rotary motion to find the called line in any selected group, a pair of voice current conductors for said connector, a condenser in each conductor, a battery normally in bridge of said conductors on the calling side of said condensers and an impedance coil in said bridge at each side of said battery.

84. In a telephone system, a connector having first one motion to select groups and then rotary motion to find the called line in any selected group, a pair of voice current conductors for said connector, a condenser in each conductor, a battery permanently in bridge of said conductors on the calling side of said condensers, and an impedance coil in said bridge at each side of said battery.

85. In a telephone system, a pair of subscribers' lines connected by trunk lines at a central office through a metallic circuit, automatic selecting devices for said subscribers' lines, and for each of said trunk lines, a controlling magnet bridged across said metallic circuit line at one of said selecting devices, means under control of said magnet for causing all of said selecting devices to return to their normal position and break the connection between said subscribers' lines and said trunk lines, a battery for talking purposes normally in bridge of said metallic circuit, said automatic selecting devices for said subscribers' lines being non-numerical progressively movable switches individual to said lines.

86. In an automatic telephone system, means for establishing a talking connection compising a pair of voice current line conductors, condensers in said conductors, a battery supplying current for talking purposes normally in bridge of said conductors on the calling side of said condensers, a subscriber's line, a first selector, a progressively movable switch individual to said subscribers' lines for connecting said selector to said line, selecting contacts for said first selector, a trunk line adapted to be connected to said subscriber's line by said first selector, a second selector for said trunk line, controlling magnets at said first and second selectors, means for energizing the magnets of said first selector to move said selecting contacts into engagement with said trunk line, a switch actuated by said magnets during their selecting operation to disconnect said magnets from said line, a release magnet for said first selector, a separate conductor individual to said trunk line, and means controlled by the magnets of said second selector for causing the operation of the release magnet of said first selector over said separate conductor, substantially as described.

87. In a telephone system, subscribers' lines divided into groups, means including automatic progressively movable switches normally disconnected from the subscribers' lines common to said lines and accessible thereto for establishing a talking circuit between a calling and a called subscriber's line, said talking circuit divided into two inductively connected sections, one section on the side of the calling subscriber and another section on the side of the called subscriber, and a battery normally bridged across the calling end of the talking circuit, at a point between one of said automatic switches and the called line.

88. In a telephone system, subscribers' lines divided into groups, means including automatic progressively movable switches normally disconnected from the subscribers' lines common to said lines and accessible thereto for establishing a talking circuit between a calling and a called subscriber's line, said talking circuit divided into two inductively connected sections, one section on the side of the calling subscriber and another section on the side of the called subscriber, a battery normally bridged across the calling end of the talking circuit at a point between one of said switches and the called line, and a transmitter for the calling subscriber connected to receive current from said battery.

89. In a telephone system, an automatic switch having one motion to select groups and then rotary motion to find the called line in any selected group, two parallel voice current conductors for said switch, and a battery having its opposite poles permanently in bridge of said conductors.

90. In a telephone exchange system, the combination of a talking circuit, a plurality of bridges on the conductors of said circuit, automatic means for reducing the number of bridges before talking, releasing means for disconnecting between subscribers, means for retaining one or more of said bridges to control the said releasing means, a common battery for talking purposes, and means whereby said battery is connected through one of said bridges and across the conductors of the talking circuit before the called line answers.

91. In a telephone exchange system, the combination of telephone lines, automatic means for trunking a calling line into connection with a called line to form a talking circuit, a bridge individual to the calling line across the conductors of said circuit at the central station, automatic means for

cutting off or opening up said bridge, a common battery for talking purposes, another bridge across the conductors of said circuit and means whereby said battery is connected through said other bridge and across the conductors of the talking circuit before the called line answers.

92. In a telephone system, a pair of voice current line conductors, condensers in said line conductors, means including a pair of switch wipers having a primary motion and then a secondary motion to include the said conductors in a talking circuit, an actuating magnet for producing the primary motion, another actuating magnet for producing the secondary motion, relays for controlling said magnets, and a battery permanently in bridge of said voice current line conductors on the calling side of said condensers.

93. In a telephone system, an automatic connector having a primary motion to select groups and then a secondary motion to find the called line in any selected group, a pair of voice current conductors for said connector, condensers in said conductors, a battery normally in bridge of said conductors on the calling side of said condensers, a relay in said bridge, and releasing means controlled by said relay.

94. A telephone system including subscribers' lines and trunk lines divided in groups, automatic switches having one movement to select groups, and a second movement to connect with a line in the selected group to connect a calling line to a called line, a plurality of bridges across the talking circuit, the said bridges including operating elements for said switches, means for automatically reducing the number of bridges, and means operative prior to a response from the called subscriber for supplying talking current to both the calling line and to the called line.

95. A telephone system including subscribers' lines and trunk lines, automatic switches for extending a connection from a calling one of said lines to a called one thereof and including trunk lines, control bridges across said trunk lines for controlling said switches, means for disconnecting certain of said bridges, and means controlled solely by the calling subscriber for supplying talking current to the calling line and to the called line.

96. In a telephone system, a plurality of trunks divided into groups, a switch operative under substation control for automatically selecting idle trunks having first a primary motion to select the desired group and then a secondary motion to find an idle trunk therein, and suitable common battery means between the selector and a called line for supplying the calling subscriber with talking current before the called subscriber answers.

97. A telephone system including a calling line and a called line, normally at rest, automatic switches for connecting said lines in conversational circuit, trunk release means for said automatic switches separate from the talking circuit, and means for supplying the calling line and the called line with talking current prior to the time that the called subscriber responds.

98. In a telephone system, subscribers' line, means including a final connector switch controlled over a calling line for extending a connection to a called line, a central source of current, a progressively movable side switch in said connector, and circuit connections controlled solely by said side switch whereby in its final position the said current source is connected to supply talking current to the calling line.

99. In a telephone system, subscribers' lines, means including a final connector switch controllable over a calling line for extending a connection to a called line, a central source of talking current connected in bridge of the calling line upon the completion of the connection and before the called subscriber answers, and a progressively movable side switch in said connector for closing said bridge.

100. A telephone system including a calling subscriber's line and a called subscriber's line, automatic switches for connecting said lines in conversational circuit, a trunk release circuit for said switches independent of the talking circuit, and central office means for supplying said calling line and said called line with talking current prior to a response being had from the called subscriber.

101. A telephone system including a calling line and a called line, a non-numerical switch and a numerical switch for connecting said lines in conversational circuit, a trunk release circuit for said switches independent of the talking conductors included in the conversational circuit, and central office means controlled solely by the calling subscriber for supplying talking current to the calling line and to the called line prior to a response had from the called subscriber.

102. In a telephone system, subscribers' lines and trunk lines divided into groups, automatic switches having one motion to select groups and a second motion to connect with a line in the selected group for extending a connection from a calling line to a called line, a plurality of bridges across the conductors of the talking circuit, said bridges including operating elements for said automatic switches, means for automatically reducing the number of said

bridges, and means controlled only by the calling subscriber for supplying talking current to the calling line and to the called line.

103. In a telephone system, a link circuit for extending connection between calling and called lines, fixed terminals for said link over which said link is seized, movable terminals for said link for extending the connection to a called line, a source of current, means for supplying talking current to said fixed terminals, means for supplying talking current to said movable terminals, and means for reversing the current supply to said movable terminals.

104. In a telephone system, a link circuit for extending connection between calling and called lines, fixed terminals for said link over which said link is seized, movable terminals for said link for extending the connection to a called line, a source of current, means for supplying talking current to said fixed terminals, means for supplying talking current to said movable terminals, and means for reversing the current supply to said fixed and movable terminals.

105. In a telephone system, an automatic progressively movable switch for extending connection between calling and called lines, fixed terminals for said switch over which said switch is seized, movable terminals for said switch for extending the connection to a called line, a source of current, means for supplying current to said fixed terminals, means for supplying talking current from said source to said movable terminals, and means for reversing the current supply to said movable terminals.

106. A telephone system including a calling line, a source of current normally connected in series therewith, automatic means for opening up said series connection and substituting other series connection therefor, and means operating over a called line to reverse said last series connections.

107. A telephone system including a calling line, a source of current normally connected in series therewith, automatic means for opening up said series connections and substituting other series connections therefor, and means operating over a called line to reverse said last series connections, the operation of said means being dependent upon the idle or busy condition of the called line.

108. A telephone system including a calling line, a source of current normally connected in series therewith, automatic means for opening up said series connections and substituting other series connections therefor, and means operating over a called line to reverse said last series connections, said means being operatively connected with the called line and depending upon the electrical condition of an engaged called line contact.

109. A telephone system including a calling subscriber's line and a called subscriber's line, a normally at rest non-numerical switch and a plurality of numerical switches for establishing connections between said lines, said connections including a pair of talking conductors having condensers therein, a central office battery and coils through which talking current is supplied to said lines on opposite sides of said condensers prior to a response from the called subscriber.

110. A telephone system including a calling subscriber's line and a called subscriber's line, non-numerical and numerical automatic switches for extending a connection between said lines, a pair of talking conductors included in said connection, a central office battery, and automatic means for connecting current from said battery to said talking conductors for talking purposes under the control of the calling subscriber.

111. A telephone system including a calling subscriber's line and a called subscriber's line, automatic trunking switch mechanism for establishing a connection between said lines, a pair of talking conductors included in said connection, a central exchange battery, and means for connecting the poles of said battery to said talking conductors to furnish talking current, said means being solely under the control of the calling subscriber.

In witness whereof, I hereunto subscribe my name this 14th day of July, A. D., 1905.

ALFRED H. DYSON.

Witnesses:
L. D. KELLOGG,
G. E. MUELLER.