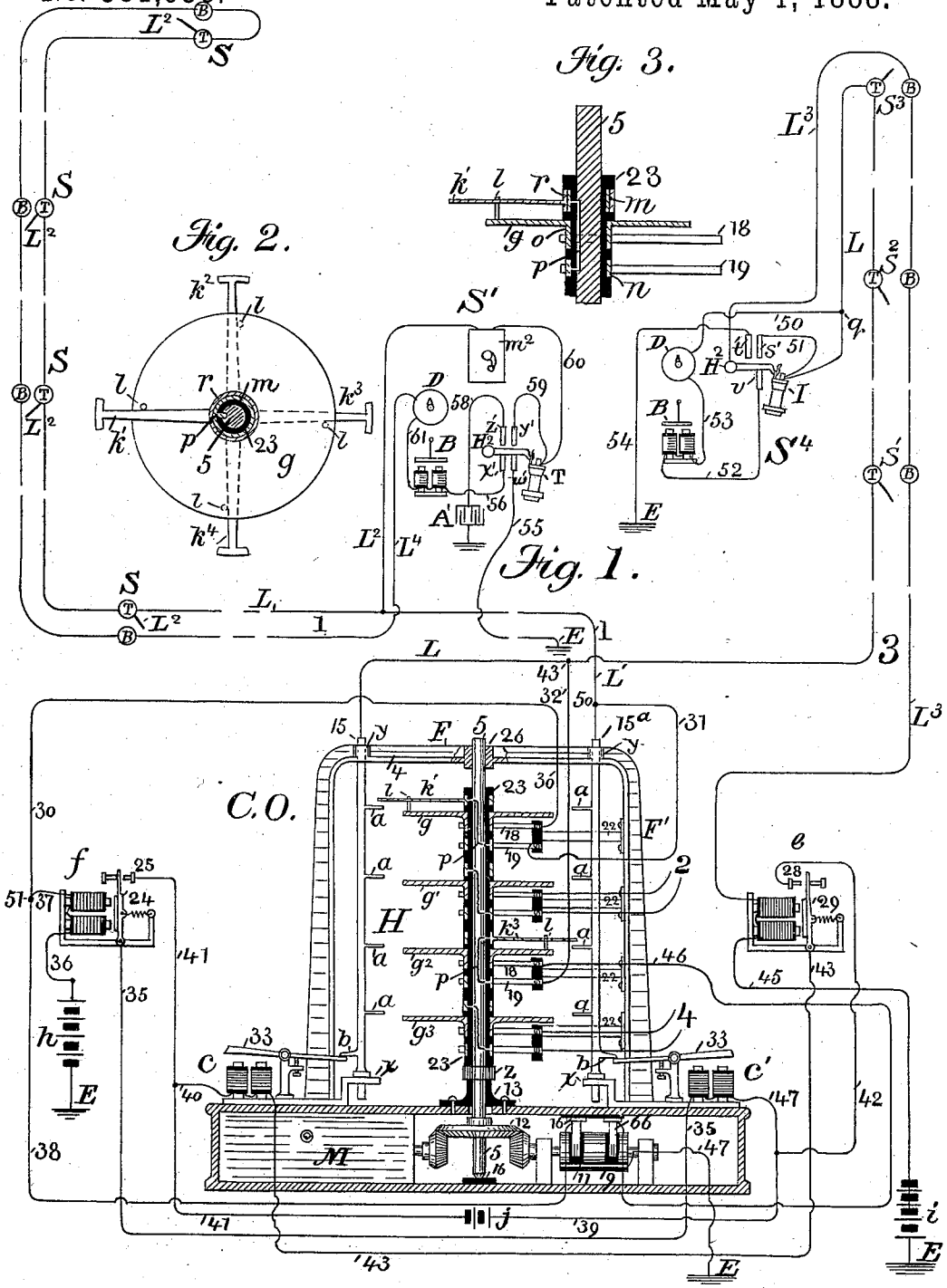
(No Model.)

J. A. McCOY.

SYSTEM OF TELEPHONIC INTERCOMMUNICATION.

No. 381,938. Patented May 1, 1888.



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SYSTEM OF TELEPHONIC INTERCOMMUNICATION.

SPECIFICATION forming part of Letters Patent No. 381,938, dated May 1, 1888.

Application filed July 6, 1887. Serial No. 243,505. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. McCOY, of Medford, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Systems of Telephonic Intercommunication, of which the following is a specification.

The present invention relates to the automatic interconnection of telephone-lines at a common point of convergence or central exchange by means actuated from any sub-station of either line concerned, and without requiring care in manipulation.

In a prior application for Letters Patent filed by me January 29, 1887, Serial No. 225,862, and allowed May 25, 1887, I have described such a system of intercommunication. The invention therein described involves at each subscriber's station, as usual, a call-bell and telephones, and also a dial indicating the number of the several lines composing the system upon which a pointer rotates, denoting, as it passes any number, that the apparatus at the central station is at that moment in such a position that the sub-station observing may, by taking proper action, connect its own line with the line indicated by the pointer. The dial mechanisms are kept in unison with the central-station connecting mechanism by proper appliances located at the central station and operated by the said connecting mechanism to make or break the circuit, or to admit the battery to or shut it off from the line once in each revolution of the pointer. At the central station there are a number of dials or disks—one for each line—revolving in unison, upon each of which is an arm or pointer hung independently of the said disk, but normally participating in its motion. This arm is connected directly with the main line, constituting, for the purpose of connecting the said line with any other line, the practical terminal thereof. Means are provided for raising the arms from their disks, and when so detached the motion of the arm ceases and the line it represents is disconnected from the ground terminal and electrically transferred to the lifting instrumentality. To effect this change, a number of electro-magnets—one for each line in the system—are arranged around each disk, and their armature-levers are adapted, when actuated, to engage the rotating arms and to lift them out of engagement with their respective disks. By means of an electrical connection between the armature-lever of each of these electro-magnets and the main line which it represents the contact between the said levers and the rotating arm at any time lifted thereby effects the union of the two lines concerned, and the connections and special instrumentalities are so arranged that this union is effected without including in the compound line thus provided for the telephonic communication any electro-magnets. The several electro-magnets are controlled through the instrumentality of a relay and battery included in the main circuits, and these are made operative from any sub-station by there effecting a certain change in the condition of the circuit, which change is in practice made by the act of raising the telephone from its support after observing that the dial-pointer indicates the desired line. The relays so operated close a local circuit, including the connecting-magnets, representing at each disk the initiating line. The sub-station dials are marked with figures representing the line in the system, and the figure at any moment indicated by the pointer at any sub-station represents the line which at that moment the connecting apparatus of such sub-station is in position to connect with. Thus when the pointers of the sub-stations on line No. 1 point to No. 2 it is at once understood that the central-station disk of line No. 2 has its revolving arm in position approaching the electro magnet armature-lever controlled by line No. 1, and that a connection between these lines may now be effected by either one; also, when the pointers of line No. 1 at the sub-stations indicate No. 2 the pointers of No. 2 in like manner indicate No. 1, and so on through the entire system.

My present invention, while utilizing the general arrangement of circuits and many of the instrumentalities described in my former application, to which reference may be made, is an improvement thereupon and modification thereof, whereby the connecting apparatus is materially simplified without militating against the efficiency of the system.

In the former invention, which I have hereinbefore briefly described, it will be seen that

it is essential to provide for each line of the system at the central exchange a series of connecting electro-magnets (all to be actuated by the changes occurring in the circuit of such line) equal in number to the number of lines in the system—that is, in other words, each entering line is provided with a connecting electro-magnet located within range of the connecting-arm of each disk—so that, assuming there are four lines in the system, sixteen electro-magnets are required.

My present invention consists, chiefly, in providing such a modification in the connecting apparatus proper that a single electro-magnet only for each line is necessary.

In the drawings which illustrate and form a part of this specification, Figure 1 is a general view in diagram of the system embodying my present improvement. Fig. 2 is a plan view of the connecting disks and arms, looking down on the top disk, showing that the arms are, when in motion, each at any one time in different positions in the common orbit of rotation with respect to one another; and Fig. 3 is an enlarged sectional view of a portion of the vertical shaft, showing the electrical connections of the disk and arms.

The drawings show a connecting apparatus, H, adapted for a system of four line-circuits; but two only are carried out in detail, it being of course understood that no specific number is essential, and that, given the means for the automatic connection of two circuits, the rest is but a question of multiplication.

The letters C O indicate the central station, to which converge the line-circuits 1, 2, 3, and 4. Each of these passes through a series of stations, S′ S^2 S^3, &c.

The circuits, indicated in full and shown as being in position to connect with one another, are Nos. 1 and 3. In circuit No. 1 the line L, leading out, passes each sub-station S, leading into each by a normally-open telephone branch, L^2, to be used only during conversation, and after reaching the most distant station is retraced on its own path, looping into and passing through the bell-magnets B and dial-magnets D of each station, reaching, finally, its earth terminal, which may be located at or near the first sub-station, S′. In circuit No. 3 the line L, leading out, passes in like manner the several stations S′, S^2, S^3, and S^4, connecting at each station *en route* by normally-open telephone branch circuits. Arriving at the last station on the line, the circuit, as in the former case, is retraced through the bell-magnets B and indicating-dials D to the central station. This circuit, however, instead of terminating at earth at the first station out, S, is brought absolutely back to the central station; and I have in the drawings and description shown both classes of circuit to indicate that my apparatus is equally well adapted for one class of circuit as for the other. For the same reason also I have shown, as will hereinafter appear, No. 1 as being a normally-closed battery-circuit, No. 3, *per contra*, being a normally-open circuit, being closed on its battery at regular periods only, for the purpose of regulating the sub-station dials.

I will now describe the actual central station-connecting apparatus H, which constitutes the distinctive feature of my invention. The said connecting apparatus comprises a shaft, 5—in this instance vertically mounted in a suitable frame, F. The foot of the shaft rests in a step, 16, and it is supported at its upper end in a vertical bearing, 26, set in one of the upper cross-bars, 4, of the frame. The shaft 5 is driven through suitable bevel-gear, 12, by a motor of any desired character inclosed in the case M. The said shaft passes through a non-conducting guide-sleeve, 13, and above the collar *z* is surmounted by a non-conducting sleeve, 23, upon which, as more clearly indicated in Fig. 3, are rigidly mounted a series of conducting disks or plates, $g\ g'\ g^2\ g^3$, one after another, and equal in number to the number of circuits in the system, (in the present case four,) the series of disks of course participating at all times in the motion of the shaft, which is to be continuous. A series of spring-arms, k', k^2, k^3, and k^4, normally rotate each with its own disk, as shown, but are by means of the non-conducting sleeve 23 insulated therefrom, the disks being, moreover, insulated from one another and from the shaft 5 by the same means. Furthermore, though controlled by the disks *g*, they are to a certain extent mechanically independent of them—that is, they are adapted to work loosely upon the shaft and caused to participate in the motion of the disks only by the engagement of their free ends with the disk-pins *l*. By such engagement the disks *g* not only are enabled to carry the arms around, but also maintain an electrical connection with them. The arms are at their shaft end terminated in a ring-piece, *r*, which rotates on the rings *m*, permanently fixed to the shaft and let into the insulated sleeve 23.

It is necessary to provide for both disk and arm an independent electrical connection, and I accomplish this by providing the disk *g* with a flange-piece, *o*, which extends for a short distance along the sleeve 23. There is also an additional ring, *n*, let into the sleeve and insulated thereby from the flange, although closely adjacent thereto. This ring is united by a wire, *p*, passing through the substance of the non-conductor with the bearing-plate *m* of the arm. Now, by affixing brush-springs 18 and 19 to suitable supports and allowing their free ends to bear respectively upon the disk-flange *o* and the extra arm-ring *n* in the manner of the brushes of a dynamo, I am, by attaching suitable wires to the said springs, enabled to properly connect the said disks and arms with their respective lines.

The engaging pins *l* are not in each disk at the same point. In the present illustration of the invention they are properly represented as being located at points upon the circle distant ninety degrees from one another, there be-

ing four line-wires in the system, and in every case the several pins and the several arms when engaged thereby would be arranged at regular distances from one another around the periphery of the circle, the distance in every case being regulated by the number of lines. This is illustrated by Fig. 2, where the upper disk, *g*, is shown in plan supporting and engaging the rotating arm *k'* by means of the pin *l*, the shaft 5, insulated sleeve 23, permanent bearing *m*, and the ring-plate of the arm *r* being also shown in horizontal cross-section. The position of the other arms, k^2, k^3, and k^4, is indicated in the figure, the concealed portions of said arms being in dotted lines. It is evident, therefore, that when none of the lines are connected together the four arms are disposed with reference to one another as indicated in Fig. 2. This may be arranged by rigidly fixing the disks in their proper positions on the shaft; or it may more readily and conveniently be attained by placing the engaging-pins *l* differently for each disk.

Referring again to the principal apparatus, H, it will be seen that two uprights, constituting a part of the frame work, are shown supporting the cross-bar 4, and that a short distance to the inside of these uprights two vertical rods, 15, are placed, supported by and capable of sliding vertically within brackets *x* at their lower end and in bearings *y* at their upper end. Although not shown, it will readily be understood that inasmuch as there are four lines in the system there must be four of such vertical rods, each fitted with the short projecting arms *a*, adapted to engage the disk-arms *k*, provided the said rods are elevated when any one of the said disk-arms is in its rotation passing the said rods. The vertical rod 15, belonging to line 3, is shown at the left-hand side of the drawings and that belonging to line 1 is shown at the right-hand side of the drawings. The rods belonging to lines 2 and 4 may be assumed to be immediately at the rear and front of the central shaft, 5, the former being concealed by the said shaft and the latter being cut away. The rotatable arms k^2 and k^4 are likewise at right angles with the other two arms, and are for that reason not seen except in Fig. 2. If the form of frame shown here be adopted, it is obvious that when complete two other uprights, 2 and 3, would be required. Nothing in the character of the invention, however, necessitates such a construction, it being evident that, if desired, two uprights may be caused to sustain a supporting-plate at the top of the apparatus, instead of the cross-bars 4, in which the several vertical rods and central shaft may find bearing. As many vertical rods 15 are introduced as there are lines in the system, and these, like the disk-pins, are regularly disposed at points around the circle at equal distances apart. Each of these rods, as already stated, has a series of projecting arms, *a*, one opposite each of the revolving disks in the series, and each on a plane immediately below that of the arm of such disk, as shown. When any one of these vertical rods is elevated in the manner to be hereinafter described, that one of the rotating spring-arms which happens to be opposite the said vertical rod is engaged by the short arm *a* opposite its own disk, and is thereby disengaged from its clutch-pin *l*. The rotation of such arm thereupon ceases until it is permitted again to be depressed, and not only so, but the circuit represented by said arm is by the act of contact united electrically with the circuit represented by the vertical rod. No other arm can be at the same time raised, because no other arm is opposite, nor can any other arm be engaged during the elevation of the rod, because during such elevation the short arms are raised to a point above the plane of the other rotating arms, which consequently pass under them.

Each vertical rod 15 is provided near its lower end with a spur, *b*, resting just above the free end of an armature-lever, 33, of an electro-magnet, *c*, so that when the said electro-magnet becomes vitalized the rod controlled thereby can be raised to perform its function.

There is, of course, a separate electro-magnet, *c*, for each rod, each magnet representing one of the lines of the system; and this feature exemplifies the value and novelty of my improvement, since by the employment of a single vertical rod provided with individual engaging arms, each adapted to engage one of the rotating arms of another line, and by use of a single electro-magnet controlling the said vertical rod, I am enabled to dispense with the use of the series of electro-magnets required by my former invention, to which reference has been made.

Each of the electro-magnets *c* is operated by a local circuit and battery controlled by a relay. The electro-magnet *c'* is actuated by the relay *f*, and since the main circuit which includes the said relay is a closed battery-circuit, its local circuit is made operative by the back-stroke of the relay.

The electro-magnet *c* is governed by relay *e* in main circuit 3. This being a normally-open circuit, its relay is caused to close its local by a forward stroke. The local circuits will be hereinafter traced. The general course of the main circuits having been already traced, it only remains to trace their course within the central station and to indicate their arrangement at the sub-stations.

Line No. 1, entering by L', arrives at a point, 50, where it bifurcates. One branch leads by wire 31 to contact-spring 19, through the shaft by wire *p* to arm *k'*, through the rotating disk *g* to spring 18, wire 30, branch 37 to relay *f*, thence by wire 36 to main battery *h* and earth. At the point 51, external to the said relay, a branch wire, 38, leads to contact-spring, 16, pressing upon the surface of a rotating-cylinder, 9, revolving in bearings 10, and actuated synchronously with the disks *g*, preferably by the same motor. This cylinder-surface is non-

conducting with the exception of a conducting-strip, 11, which is connected with the earth by wire 47. In association with this character of line the branch serves to short-circuit the battery *h* through the relay once in each revolution of the cylinder, for the purpose of governing the indicating-dials at the sub-station. Going back to the point 50, the other branch of the circuit simply leads to a connection with the vertical rod 15^a, where it is normally open. The battery-circuit being at all times (when the system is at rest) closed through the relay *f*, the armature of said relay is normally attracted.

Line 3 has both of its ends at the central station. End L, entering, passes to point 43, where it divides. One branch, normally open, leads simply to vertical rod 15. The other branch, 32, leads to spring 19 of the third disk, thence through the shaft by wire *p* to arm k^3, engaging pin *l*, disk g^2, contact-spring 18, wire 46, and contact-spring 66, which rests upon the rotating cylinder 9, as in the former case. Here the line is grounded and thereby closed once in each revolution of the cylinder, being at other times open. The end L^3 of the same line leads to relay *e*, thence by wire 45 to battery *i* and to earth.

The other lines, Nos. 2 and 4, may be of either class; but in any practical installation it is obvious that it would be economical to have all of the lines of the same class. As herein shown, the disk and arm contact-springs 18 and 19 may be mounted on a block of non-conducting material and supported by a bracket, 22, bolted to the standard F′ of the frame F. The local circuit of relay *e* may be traced from relay-armature 29, *via* wire 43, to one side of magnet *c*, through said magnet, wire 40, wire 41, to one pole of local battery *j*, then by wire 39 and wire 42 to front stop, 28, of said relay. This is normally open between the front stop and armature-contact. The local circuit of relay *f* extends from relay-armature lever 24, *via* wire 35, to one side of magnet *c′*, then by wires 47 and 39 to battery *j*, and by means of wires 41 to back stop, 25, where it is normally open.

The sub-stations upon line No. 1 are arranged as shown at S′. The branch L^2 from the telephone side of the line passes into the sub-station and through the generator m^2, which, when at rest, is of course shunted in a manner well understood, and by wire 60 to telephone T, and by wire 59 to contact-spring *y′*, where, when the telephone is at rest, the branch is normally open. The main line L^4, entering, passes through and onward *via* L^4, dial D, wire 61, bell B, wire 56, contact-spring *x′*, substance of switch hook H^2, contact-spring *w′*, wire 55, and outward to end of line. The telephone is shown in place and serves to depress the hook-switch and keep the line closed through the bell and dial. When the telephone is removed, the line is opened and the telephone-line closed through the switch H^2, the contact-springs *z′* and *y′*, the wire 58, condenser A′, and earth.

The sub-stations on such lines as No. 3 are arranged as follows: in, *via* L^3, switch-hook H^2, then, when the telephone is on the hook, to contact-spring *v*, wire 52, bell B, wire 53, dial D, wire 50, to a point, *q*, on the line L leading out. From the same point the normally-open telephone branch leads, *via* telephone I, wire 51, contact-springs *s′* and *t′*, and wire 54, to earth.

The operation of the system in either case may be now described. S^4 desires to connect with S′ on another line. He knows that when his dial-pointer indicates S′ the central-station apparatus is in position to bring about such connection. He also knows that at the same moment the dial at S′ indicates S^4, the two apparatuses registering with one another. It is only required at such a moment for either station-operator to remove his telephone from its support. Suppose S^4 to have so removed his telephone from its support. The circuit which was formerly open is now closed through the switch metal H^2, the spring *t′*, and the line L^3 and relay *e*. The relay-armature 29 is attracted, the local circuit thereof closed, and the magnet *c* energized. This attracts its armature and raises the vertical rod 15. The rod so elevated engages by its short arm *a* the arm *k′* of the upper disk, representing and terminating the telephone side of line No. 1. The arm *k′* is thus lifted from its disk, and the two lines are thereby connected for conversation, the telephone side of No. 1 being represented by the rotating arm *k′*, while the telephone side of No. 3 connects by its branch wire from 43 with the upright rod 15, which has been raised. Inasmuch, moreover, as the rotating arm of the second circuit has been raised from its disk, it is evident that the circuit of the second line is thereby broken between the disk and arm. The circuit of battery *h* being thus broken, the armature of the relay *f* falls back and closes its local circuit, energizing in turn the magnet *c′*, which raises the vertical rod 15^a. The arm *a* on the side of this rod immediately engages the arm k^3 of circuit No. 3. Two talking-routes are thus constituted through the central-office apparatus between the junction-points 43 and 50. As soon as the two lines are thus connected, the subscriber initiating the call may ring up the other, who will then remove his telephone and the conversation may be carried on. When the telephones are replaced, the original conditions are at once automatically restored, as the rotating arms fall back upon their disks and resume their motion. Should the stations on line 1 initiate a communication, the operation would be similar, although the action of removing the telephone would in that case first open the circuit instead of closing it. The hook may therefore be entitled a "circuit-changer."

In case all of the circuits are of the same character the same main battery may be used for all.

Much of this specification is necessarily descriptive, and the arrangement of the several central and sub-station main and local circuits, as also that of the dial-indicators and regulating-cylinder, therefore, is not claimed herein, the same having been heretofore described in my previous application, hereinbefore referred to. I do not restrict myself, moreover, to any special position of the apparatus or to a vertical supporting shaft, since it is obvious that the shaft may be supported horizontally or even be absolutely inverted without departing from the spirit of the invention; and

I claim—

1. The hereinbefore-described improvement in connecting apparatus for automatic telephone-exchanges, comprising a series of disks, one for each line, carried upon a single rotating shaft, a series of rotating arms normally engaged by the said disks and rotating therewith, each of the said arms constituting the terminal of a telephone-line, a series of lifting-rods, one for each line and connected by branch circuit with said line, disposed around the central shaft and provided with projecting arms equal in number to the number of disks, and a single electro-magnet controlling each of the said lifting-rods and adapted, when energized, to move the said rod longitudinally, whereby the rotating line terminal at the time opposite any one of the projecting arms of the said rod may be engaged, lifted from its disk-engagement, and electrically connected with the line represented by said lifting-rod, substantially as and for the purpose described.

2. The combination, in an automatic telephone-exchange system, with a series of telephone-lines centering at a common station, a relay included in the circuit of each line, and a single electro-magnet for each line in a local circuit controlled by said relay, of an automatic connecting apparatus comprising the following instrumentalities: a shaft constantly revolved by a suitable motor, a series of disks mounted thereon rigidly, but insulated therefrom, a series of rotating conducting-arms, each constituting a line terminal mounted loosely upon the said shaft at different points of the periphery thereof and normally participating in the movement thereof by engagement with the said disks, each line being provided normally with a continuation through one of the said disks, and a series of lifting-rods arranged parallel to the said shaft, (one for each line and each connected by a branch circuit with its own line,) provided with projecting arms, one opposite each revolving disk and capable of longitudinal motion, the said rods being each controlled by the local magnet of its own line and adapted, when actuated thereby, to move longitudinally in its bearings and to engage by means of its projecting arms any predetermined terminal arm, thus disconnecting the main line, represented by said arm, from it normal continuation and connecting it through the said lifting-rod to the circuit represented by said rod, substantially as specified.

3. The combination, in an automatic telephone-exchange system, of a series of telephone lines centering at a common station and radiating therefrom each to one or more sub-stations, and an indicating-dial and circuit-changer at each sub-station, as described herein, with an automatic connecting apparatus at the central station comprising the following instrumentalities: a relay in the main circuit of each line adapted to respond to the operation of the sub-station circuit-changer, a single electro-magnet in a local circuit for each of the said relays and controlled thereby, the longitudinally-movable lifting-rods 15, each connected by a branch with one of the lines actuated by said magnets and each having a series of projecting arms equal in number to the lines of the system, the vertical shaft 5, carrying the disks *g*, and the rotating arms *k*, each constituting the terminal of a line and normally rotating with the said disks and shaft, but mounted at different points of the periphery of the latter and adapted to be engaged by one of the projecting arms of the said lifting-rods when actuated by the electro-magnet, whereby the line terminated by said rotating arm may be disconnected from its normal continuation through the disk and connected with the line represented by the lifting-rod, as described.

4. The hereinbefore-described appliance for the automatic interconnection of electric lines at a central exchange, consisting of the vertical shaft 5, covered with the insulating-sleeve 23, and maintained in motion by the motor M, the disks *g*, rigidly mounted thereon but insulated therefrom, and each forming the terminal of a normal continuation of one of the main circuits, the rotating arms *k*, loosely mounted on the said shaft on different horizontal planes and at different points of the periphery of said shaft and insulated therefrom, each arm forming the terminal of one of the main lines, the said arms being each normally engaged by one of the said disks, maintained in motion thereby and connected therethrough with the said circuit combination, the vertical lifting-rods 15, one for each line, and each electrically connected with its own line, provided with the arms *a*, one opposite each disk of the series, the said lifting-rods being capable of longitudinal movement, and the said arms *a* being adapted to engage any predetermined rotating arm *k* and to raise the same from its normal connection with the disk *g*, the electro-magnets actuating the said lifting-rods, and relays, one in each line-circuit, controlling the said magnets, all combined as described, and for the purposes specified.

5. The combination, with a relay in a main circuit, an electro-magnet in a local circuit controlled thereby, and an armature and

armature-lever therefor, of a vertical rod capable of longitudinal movement in its bearings and forming a normally-disconnected branch terminal of the said main circuit, and a series of terminal springs representing, respectively, and connected with other main circuits, the said rod being adapted to be lifted by the armature-lever of said electro-magnet when energized, and thereby to be brought into electrical connection with a predetermined one of the said terminal springs for the purpose of establishing through communication, as described.

6. The combination, in an automatic telephone-exchange, of a series of spring-arms forming telephone main-line terminals, all maintained in rotary motion, so as to pass a given point successively, and being maintained normally in connection with a series of circuit continuations by engagement with an equal number of revolving disks, combined with a series of relays, one for each line, included in the circuit of said main lines, a series of electro-magnets in local circuits, one for each line, controlled by the said relays, and armatures and armature levers therefor, and a series of vertical rods, one for each line, capable of longitudinal movement in their bearings, and each forming a normally-disconnected branch terminal of one of the said main lines, the said rods being each actuated and adapted to be lifted by the armature-lever of the electro-magnets of its own line when energized, and being provided with a series of projecting arms extending, when the rod is lifted, into the path of the rotating spring-arms, whereby the said rods may be caused to connect with any of the said spring-terminals (each in its own time) and to disconnect the same from its normal continuation for the purpose of establishing through connection, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 5th day of July, 1887.

JOHN A. McCOY.

Witnesses:
GEO. WILLIS PIERCE,
V. M. BERTHOLDE.