(No Model.) 3 Sheets—Sheet 1.

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ELECTRICAL EXCHANGE.

No. 540,168. Patented May 28, 1895.

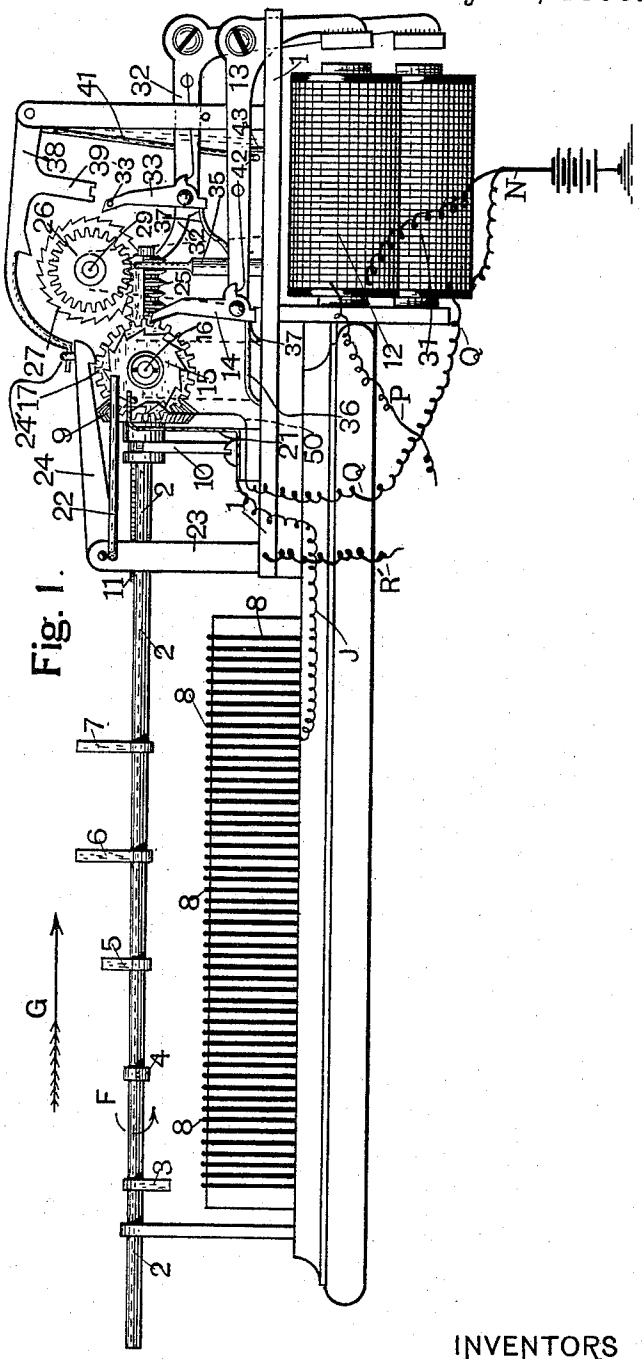

Fig. 1.

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Fig. 2.

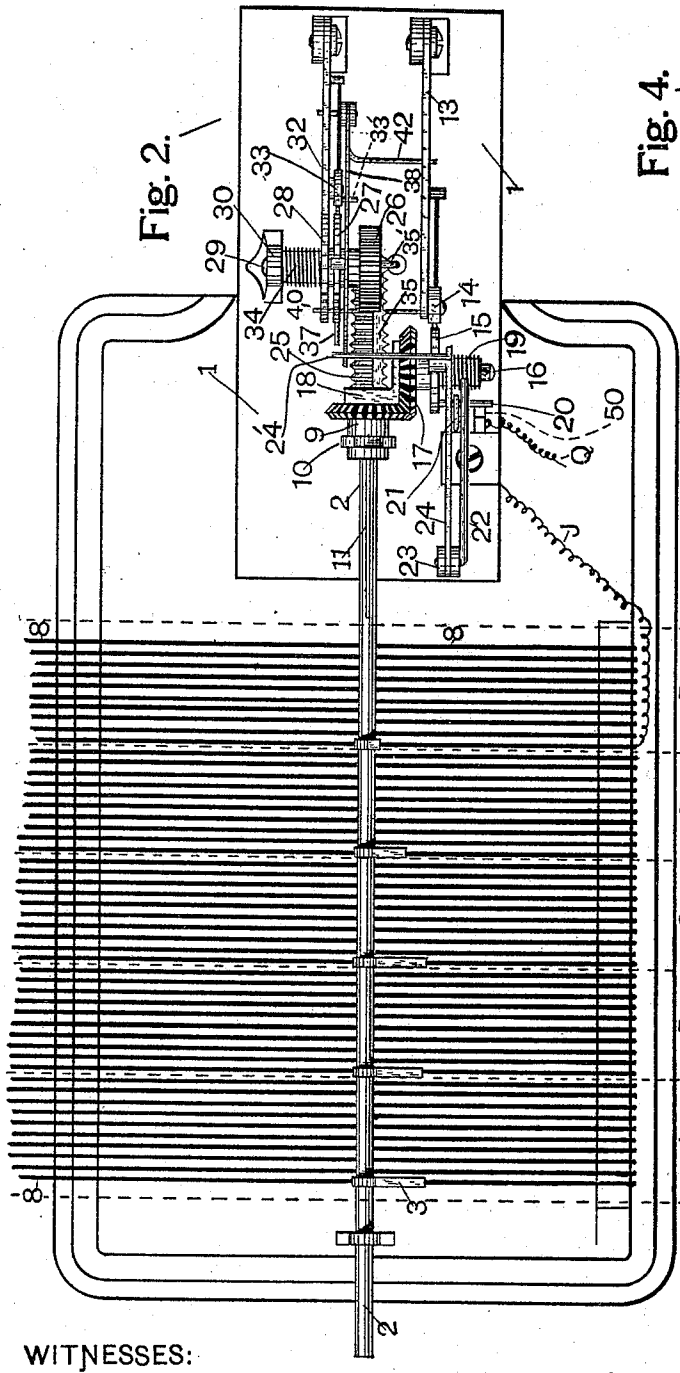


Fig. 4.

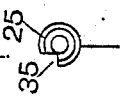
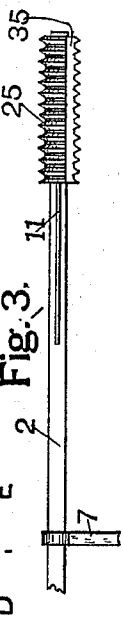


Fig. 3.



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ELECTRICAL EXCHANGE.

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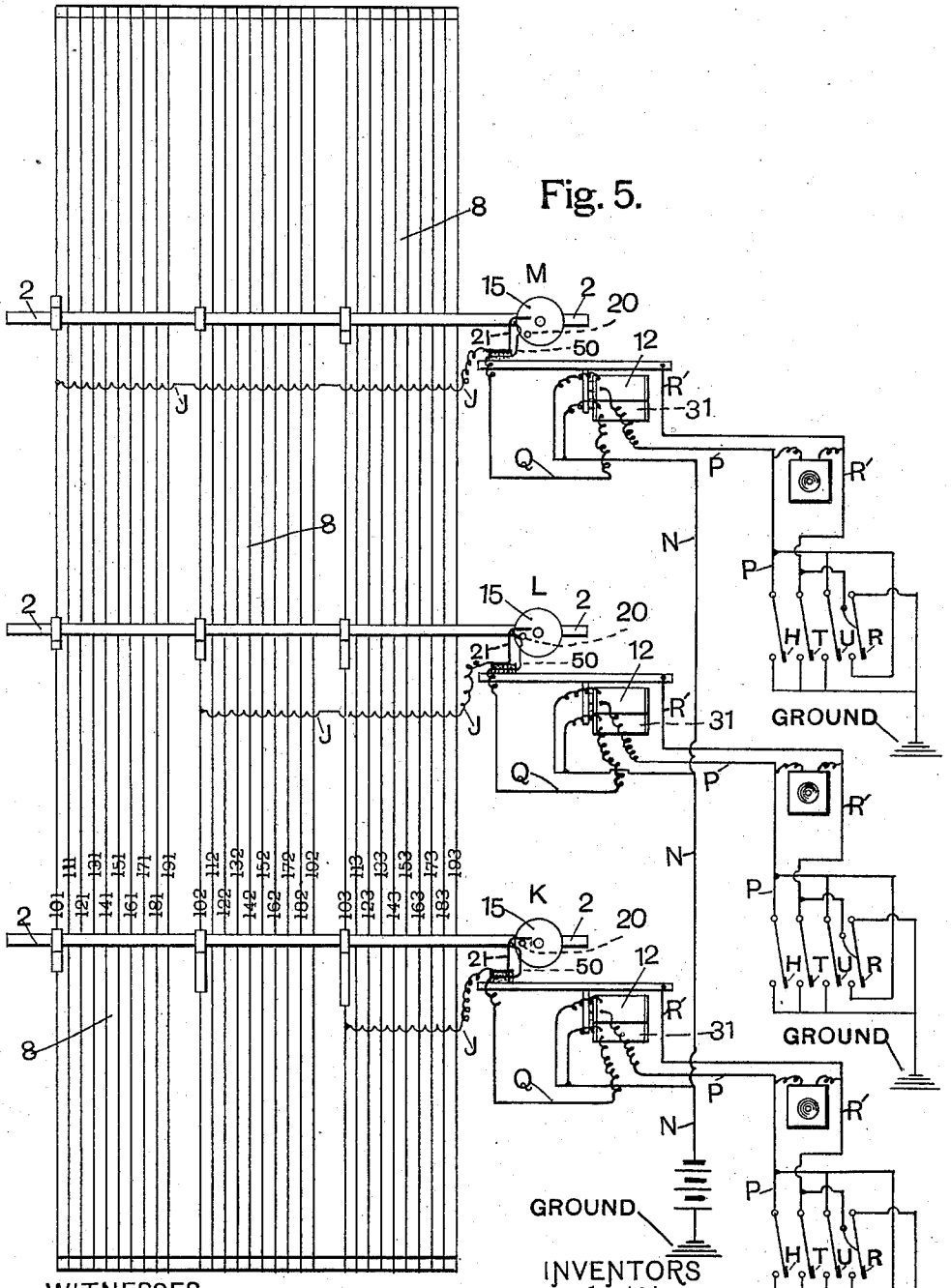
Fig. 5.



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UNITED STATES PATENT OFFICE.

ALEXANDER E. KEITH, FRANK A. LUNDQUIST, JOHN ERICKSON, AND CHARLES J. ERICKSON, OF CHICAGO, ILLINOIS, ASSIGNORS TO THE STROWGER AUTOMATIC TELEPHONE EXCHANGE, OF SAME PLACE.

ELECTRICAL EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 540,168, dated May 28, 1895.

Application filed November 7, 1894. Serial No. 528,165. (No model.)

To all whom it may concern:

Be it known that we, ALEXANDER E. KEITH, FRANK A. LUNDQUIST, JOHN ERICKSON, and CHARLES J. ERICKSON, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Electrical Exchange, of which the following is a specification.

This invention relates to electrical exchanges and the objects are to provide a special system of mechanism therefor, which is adapted to accomplish the purpose intended, with a much less number of parts than has usually been employed in apparatus of this class, there being a plurality of electrically interconnected switch arms in each exchange, which are operated simultaneously, and the several exchanges of any given system are electrically interconnected by a new system of wiring whereby the connecting wires serve as contacts with which the switch arm in each exchange may be placed in direct electrical communication without the necessity of the usual contacts and the leg wires for establishing communication between such contacts and the exchange interconnecting wires; and still another object is to provide a special arrangement of the exchange interconnecting wires in groups of ten, there being one switch-arm for each group and mechanism whereby each switch-arm may contact any one wire of its particular group, and by which but one of the several switch arms in each exchange is placed in electrical communication with but one wire at a time of the several groups, substantially as hereinafter described and illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation. Fig. 2 is a plan view. Figs. 3 and 4 are side and end elevations of a portion of one end of the principal operative parts. Fig. 5 is a diagram showing a system of interconnecting exchange-wires with three exchanges connected therewith.

Similar numerals and letters refer to like parts throughout the several views.

The exchange comprises a switchboard having a series of rows of contact points mounted thereon, the contact points of each row being electrically connected, in combination with a series of connectors arranged for co-operation with the switch-board, and means for operating the connectors to interconnect the wires of the system.

A very desirable form of switch-board is made by arranging a series of wires parallel with each other in such a position that each connector is capable of making and breaking electrical connection with each and every one of them. One form of connector is shown in the drawings and consists of a revoluble shaft 2, capable of a rotary and a longitudinal movement, in two directions, the shaft having secured thereto, and in electrical communication therewith, a plurality of electrically interconnected switch-arms, as 3, 4, 5, 6, and 7 whose outer free ends, by the movements of the shafts 2, are capable of contacting the series of interconnecting contact points or wires 8 or any other means of conducting electricity. Shaft 2 is mounted in a bearing at one end, and at the other end passes through a miter wheel 9 which is mounted in the top of a bearing 10 to permit rotation only, the shaft being capable of rotation with the miter wheel and also of a longitudinal movement therethrough, being held to revolve with the wheel by the long spline 11. The shaft is caused to rotate, step by step, by virtue of electro magnet 12, or any other means, operating bell crank lever 13, whose pawl 14 engages the teeth of ratchet wheel 15, which ratchet wheel is mounted to rotate on a stud pin 16 with miter wheel 17, this pin being secured at one end to a standard 18 from base plate 1, the two miter wheels being in engagement as shown so that, any rotary movement given to ratchet wheel 15 is transmitted to the shaft. There is a helical spring 19, Fig. 2, which revolves the ratchet wheel and the bevel wheels in an opposite direction to that imparted by the action of pawl 14. There is a stop pin 20 projecting outwardly from ratchet wheel 15 which strikes against a bent wire 21, and limits the motion imparted to it by a spring 19, and there is a projection 22 from standard 23 against which the stop pin strikes to limit the motion imparted by the action of pawl 14, the ratchet wheel never completing a whole revolution. Detent 24 when in engagement with the teeth

of the ratchet wheel serves to hold it after the thrusts of pawl 14.

At the inside end of shaft 2 is an enlargement 25 which is fitted with a series of circumferential grooves which are engaged by a cog wheel 26 which is mounted, together with ratchet wheels 27 and 28, upon a stud pin 29, which is secured at one end to a stout standard 30 projecting upward from base plate 1; both standards 18 and 30 being shown in plan view in Fig. 2, but in broken lines in Fig. 1.

Cog wheel 26 is made to rotate step by step in one direction by virtue of electro magnet 31, or any other means, operating bell crank lever 32 when pawl 33 is in engagement with ratchet wheel 27, ratchet wheel 28 serving as a stop wheel when engaged by the outer end 32′ of bell crank lever 32.

Helical spring 34 serves to operate cog wheel 26 in the opposite direction to that just described.

Figs. 3 and 4 plainly show a longitudinal groove 35 cut in the enlargement 25 of shaft 2 which is for the purpose of receiving the end of a stop 35′ which, when shaft 2 is revolved, may pass into any of the circumferential grooves and hold the shaft in position longitudinally until it has revolved backwardly to the position shown in Figs. 1 and 2, with all the switch arms 3, 4, 5, 6, and 7 lifted from the wires 8.

The relative arrangement of the mechanism for rotating shaft 2 and for imparting a longitudinal motion thereto is such that, the shaft must always be in position shown in Figs. 1 and 2 before it can be moved longitudinally.

In Fig. 1 are shown bent arms 36 and 37 which have one end attached to the actuating pawls, while the other end contacts with the base plate to throw the pawls out of engagement with the ratchet wheels, when the levers are in the initial position shown. Detent 38 engages with ratchet wheel 28 and is also hooked to detent 24 by means of a cross rod 24′, Fig. 2, so that by lifting detent 38, detent 24 is also lifted.

In Fig. 2 is shown a cross rod 40 which is attached at one end to the end of a bell crank lever 13, near pawl 14, and the outer end of this cross rod passes in under lifter 37 of pawl 33 so that, whenever pawl 13 is raised, pawl 33 is thrown back until pin 33′, at the top end thereof, is in line with downward projection 39 of detent 38, when if lever 32 is lifted pin 33′ will strike the projection and lift detent 38 together with detent 24 clear of the ratchets. Pendent from and firmly secured to detent 38 is an arm 41 which has the lower end 42 bent at a right angle to project laterally sufficiently to pass under bell crank lever 13, Fig. 2, and when the several parts are at the initial position, as shown in the drawings, with all the pawls and detents raised, the end 42 has a position at the left hand side of a pin 43, as shown in the solid lines, which projects downwardly from lever 13, this pin serving to hold detents 38 and 24 in the raised position, shown in the act of release, which permits all of the operative parts to be returned to the initial position by the action of helical springs 19 and 34.

In Fig. 2 is shown five groups of exchange inter-connecting wires, indicated by A, B, C, D, and E between the dotted lines, each group comprising ten wires, and in order to illustrate one manner of operating this exchange, we will say that the wires 8 in each group are numbered and connected with an exchange 8 having a corresponding number, as for instance by a wire or connector J, leading from one of the wires, and that it is desired to connect shaft 2 with the first wire, at the left hand side of Figs. 1 and 2, then, the first act is to operate lever 13, which will cause pawl 14 to turn ratchet wheel 15 and shaft 2 the amount of one ratchet notch, lever 13 lifting high enough to permit the weight of detents 24 and 38 to carry the end 42 of arm 41 to the rear of pin 43, to position shown in broken lines in Fig. 1, when detent 38 will engage ratchet wheel 27, and detent 24 engage ratchet wheel 15, after which, if another movement is given to pawl 14, switch-arm 3 will be turned with shaft 2 around in the direction indicated by arrow F, and the free end of the switch-arm be placed in contact with the first wire 8 in the first group A, with detent 24 holding the switch-arm in that position against the tension of spring 19, when it is obvious that a current of electricity may be sent from shaft 2 into and through said first wire. To return the operative parts to the initial again, lever 13 is first operated, and held in the operated position, which causes pawl 33 to be forced back, as hereinbefore described, under projections 39, when lever 32 is operated, causing detents 38 and the attached detent 24 to be lifted from their ratchets. The levers 13 and 32 are successively released and the springs 19 and 34 cause a backward movement of the operative parts to the initial position.

It is obvious that by the step by step movement shaft 2 may be rotated in the direction of arrow F so that each of the switch arms 3, 4, 5, 6, and 7 will successively contact the first wire of each group, beginning with series A at the left hand side of Fig. 2.

From the initial position, to cause the switch arms to contact the other wires of the groups, the longitudinal movement of shaft 2 is necessary, which is attained by one upward movement of pawl 14 to permit the detents 38 and 24 to fall into engagement with the ratchet wheel, after which lever 32 is operated causing pawl 33 to actuate ratchet wheel 27 and move shaft 2 longitudinally in the direction of arrow G, step by step, pawl 33 being actuated as many times as is necessary to find the wire in each group desired, after which contact may be had with said wire, by actuating pawl 14 to cause some designated switch arm 3, 4, 5, 6, or 7 to contact the de-

sired wire, as before described, each step or longitudinal movement of the shaft being equal to the distance from center to center of the wires 8 in each group.

Whether shaft 2 is rotated to cause the switch arms to contact the first wire of each group, or whether a longitudinal and a rotary movement, successively, are given the shaft by which the switch arms may contact some other wire of each group, the release by which the several parts return to the initial position is accomplished first by spring 19, and then by spring 34 after lifting detents 24 and 38 as described, but the backward rotary movement of the shaft 2 first takes place first on account of the engagement of stop 35′ in one of the grooves of the enlargement 25, which throws all the switch arms clear of the wires, but as soon as the stop is in longitudinal groove 35, spring 34 is free to slide shaft 2 longitudinally to the initial position shown in the drawings.

It will be understood that after shaft 2 has been turned forwardly sufficiently to cause any one of the switch arms to contact a wire, any longitudinal movement of the shaft in either direction cannot take place, on account of the enlargement of stop 35′, as before indicated.

It is obvious that it is not always necessary for the interconnecting wires 8 to be directly contacted by the switch arms, for any form of contact in electrical connection with these wires may be used.

In Fig. 5, three groups of ten wires each, and three exchanges, K, L, and M are shown in diagram, each exchange being directly connected by some one of the wires J to but one of the wires 8 which are disposed usually parallel and in horizontal plane at the rear of all the exchanges in a given system so that, although each exchange has but one of the wires 8, such as wires 101, 102, 103 respectively, directly connected thereto, each of the exchanges may be placed in electrical communication with any other wire of the several groups by means of the plurality of switch arms and shaft described, each of which switch arms contact only the ten wires which comprise its particular group. The switch arms are disposed on the shaft radially, each at a different angle to the other so that, but one switch arm of the same exchange is in contact with a wire at one time. In exchanges of this class it is usual to insulate each of the exchanges from ground and from each other.

Shaft 2 is usually of metal and is electrically connected with the switch arms and with the metal frame of the exchange so that, as a telephone exchange the line wire is usually in electrical communication with the switch arms through the frame and shaft 2, although the switch arms may each be insulated from the shaft and be in electrical communication with the line wire in various ways, as is obvious to those skilled in the art to which this invention belongs, as above described.

As above described, the exchange can be operated manually and can be substituted for the mechanism used at present in the various kinds of exchanges, or it may be operated electrically and thereby be used for any of the automatic exchanges in use, although we wish it to be distinctly understood that we do not limit ourselves to any particular method of using it, our invention residing broadly, in the plurality of wires or contact points and the plurality of shafts and switch arms or connectors, each of which is adapted to be moved into or out of engagement with each of the contact points.

For the purpose of explaining how our invention may be used electrically, or with an automatic system, we will now explain one way, although it is evident that other ways may be employed.

Referring more particularly to Figs. 1 and 5, 12 and 31 indicate two magnets, the armature of one of which, 12, is connected with the lever 13, and is adapted to rotate the shaft, and the armature of the other one, 31, is connected with the lever 32, and is adapted to move the shaft longitudinally. Each of the magnets is connected with a battery or other source of electrical energy at one terminal through the wire N, and one of them, 12, is permanently connected with a suitable telephone and key board by a wire P, and the other one, 31, is detachably connected with the shaft 2 through the wire Q which connects with the spring 50. The telephone and key board is also connected with the shaft through the wire R′ through the frame of the machine. The spring 50 is insulated from the base at one end and is adapted to be engaged by the pin 20 when the wheel 15 has been rotated one step and to be disengaged when the wheel has been rotated any farther. The bent wire 21 is permanently connected with any one of the wires 8 through its respective connecting wire J, and is normally in electrical connection with the shaft 2, through the pin 20, but as soon as the wheel 15 has been rotated one step, the connection between the shaft and the wire J is broken. It will thus be seen that the first step made by the wheel 15 breaks the circuit between the shaft and the wire J, thereby preventing outside interference and at the same time establishing a circuit through the magnet 31 whereby the shaft may be moved longitudinally if desired.

Referring to Fig. 5 in which the wires or contact points 8 are arranged in three groups, numbered from 101 to 191; 102 to 192, and 103 to 193 respectively, each exchange is provided with a shaft having three switch arms, each one of which is adapted to be moved into and out of contact with any one of the wires of its respective series. Two of the exchanges K and L, are shown in their normal position, while the exchange M is shown as being in communication with exchange L. In the exchanges K and L all the switch arms on the

shaft 2 are out of contact with the wires 8, while in the other exchange M, the end switch arms are out of contact, but one of the middle ones, T, is shown in contact with wire 102, thereby establishing communication through the wire J with exchange L. If communication had been desired by M with exchange K it would only have been necessary to have rotated the shaft 2 another step, which would have thrown the middle switch arm out of contact and the end one next the exchange into contact with the wire 103.

In order to operate the magnet and other mechanism as above described, resort may be had to any suitable means, as for instance a key board having four keys, H, T, U, and R, in which each operation of the keys H or U will close the circuit through wire P, magnet 12, and wire N and will rotate the shaft one step, and cause pin 20 on ratchet wheel 15 to contact spring 50 when each operation of the key T will close the circuit through the wire R′, and the frame and mechanism to pin 20, spring 50, magnet 31 and wire N, and will move the shaft longitudinally one step. The key H might be dispensed with by operating the key U once before trying to place the switch in connection with any of the wires, as one operation of it will operate the shaft one step which will break the connection with the outside wires and will also place the shaft in position to be moved longitudinally, if desired, after which the key U can be operated as many times as is necessary to cause the proper switch arm to engage with the desired wire; but we prefer to use the key H for rotating the shaft the first step, and then not numbering any of the wires less than 100 as this prevents any confusion of operating any of the keys the second time, after any of the other keys have been operated. For instance, if a subscriber wants to call 143, he first presses the key H which indicates the hundreds and also rotates the shaft one step. He then operates the key T four times which carries the shaft four steps, after which he operates the U key three times which makes the third switch arm contact with its wire. To release the mechanism, the key R is pressed down which will close the circuits through both wires and magnets and the wire N and will permit all the parts to assume their normal positions, as heretofore explained for the manual operation of the levers 13 and 32.

Having thus described our invention, we claim—

1. An automatic electrical exchange comprising the combination of a switch-board having mounted thereon a series of rows of contact points, the contact points of a row being in electrical connection, a series of connectors arranged for co-operation with the switch-board, a series of subscribers' lines connected with the respective connectors and through them, and through them only, to the contacts of the switch-board, and means for operating the connectors to interconnect said lines, substantially as set forth.

2. An automatic electrical exchange comprising the combination with a switch-board provided with a series of rows of electrically interconnected contact points, a series of connectors arranged to co-operate therewith, each connector being normally connected with but one of the rows of contact points, and means for breaking the normal connection as soon as the connector is operated for making connection with any of the rows whereby communication between any two of the subscribers is entirely secret from the others, substantially as described.

3. An automatic electrical exchange comprising the combination of a flat, continuous, non-sectional switch-board having mounted thereon a series of rows of electrically interconnected contact points, a series of connectors arranged parallel with the switchboard, and means for operating the connectors to interconnect the wires of the system, substantially as set forth.

4. An automatic electrical exchange comprising the combination of a flat, continuous, non-sectional switch-board having parallel wires mounted thereon, a series of rotatable conductors arranged transversely with the wires, each conductor being provided with means for making and breaking electrical contact with each and every one of the wires, and means for operating the connectors, substantially as set forth.

5. An automatic electrical exchange comprising the combination with a flat switchboard having parallel wires mounted thereon, a series of longitudinally movable, rotatable conductors arranged transversely with the wires, said conductors being each provided with a series of spirally arranged arms, the free ends of the arms being adapted to be moved into and out of electrical contact with the wires, and means for operating the conductors, substantially as set forth.

6. An automatic electrical exchange comprising the combination of a flat switch-board having parallel wires mounted thereon, a series of longitudinally movable, rotatable conductors arranged transversely with the wires, each conductor being provided with laterally projecting arms, the free end of said arms being adapted to be moved into and out of contact with the wires, and means for preventing the longitudinal movement of the conductor when any arm is in contact with its respective wire, and means for operating the conductors, substantially as set forth.

7. An automatic electrical exchange comprising the combination of a switch-board provided with parallel wires mounted thereon, said wires being arranged in groups, a series of longitudinally movable, rotatable connectors arranged transversely with the wires, each connector being provided with a series of radially projecting arms, one for each group, and means for moving each arm of the

connector into and out of electrical engagement with each wire of its respective group, substantially as set forth.

8. An automatic electrical exchange comprising the combination of a switch-board provided with parallel wires mounted thereon, a series of longitudinally movable, rotatable connectors arranged transversely with the wires, each connector being rotatable at all times and normally in electrical connection with but one of the wires, and means for moving each connector step by step, the electrical connection being broken at the first rotary step and the longitudinal movement being possible only after the first rotary step, substantially as set forth.

9. An automatic electrical exchange comprising the combination with a switch-board provided with parallel wires, a series of connectors arranged transversely with the wires, each connector being provided with means for making electrical connection with the wires by a rotary and a longitudinal movement, two levers for operating the connectors, one of which controls the rotary movement, and the other the longitudinal movement, substantially as set forth.

10. An automatic electrical exchange comprising the combination with a switch-board provided with parallel wires, a series of connectors arranged transversely with the wires, each connector being provided with means for making electrical connections with the wires by a rotary and a longitudinal movement, of two levers for operating each conductor, one of which controls the rotary movement and the other the longitudinal movement, a magnet for each lever, and means under the control of the subscriber for placing the rotary magnet in the circuit at any time and the longitudinal magnet only after the rotary magnet has been operated one time, substantially as set forth.

In testimony that we claim the foregoing we have hereunto set our hands this 30th day of October, 1894, in the presence of witnesses.

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CHARLES J. ERICKSON.

Witnesses:
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