(No Model.) 4 Sheets—Sheet 1.

A. B. STROWGER.

AUTOMATIC TELEPHONE OR OTHER ELECTRICAL EXCHANGE.

No. 486,909. Patented Nov. 29, 1892.

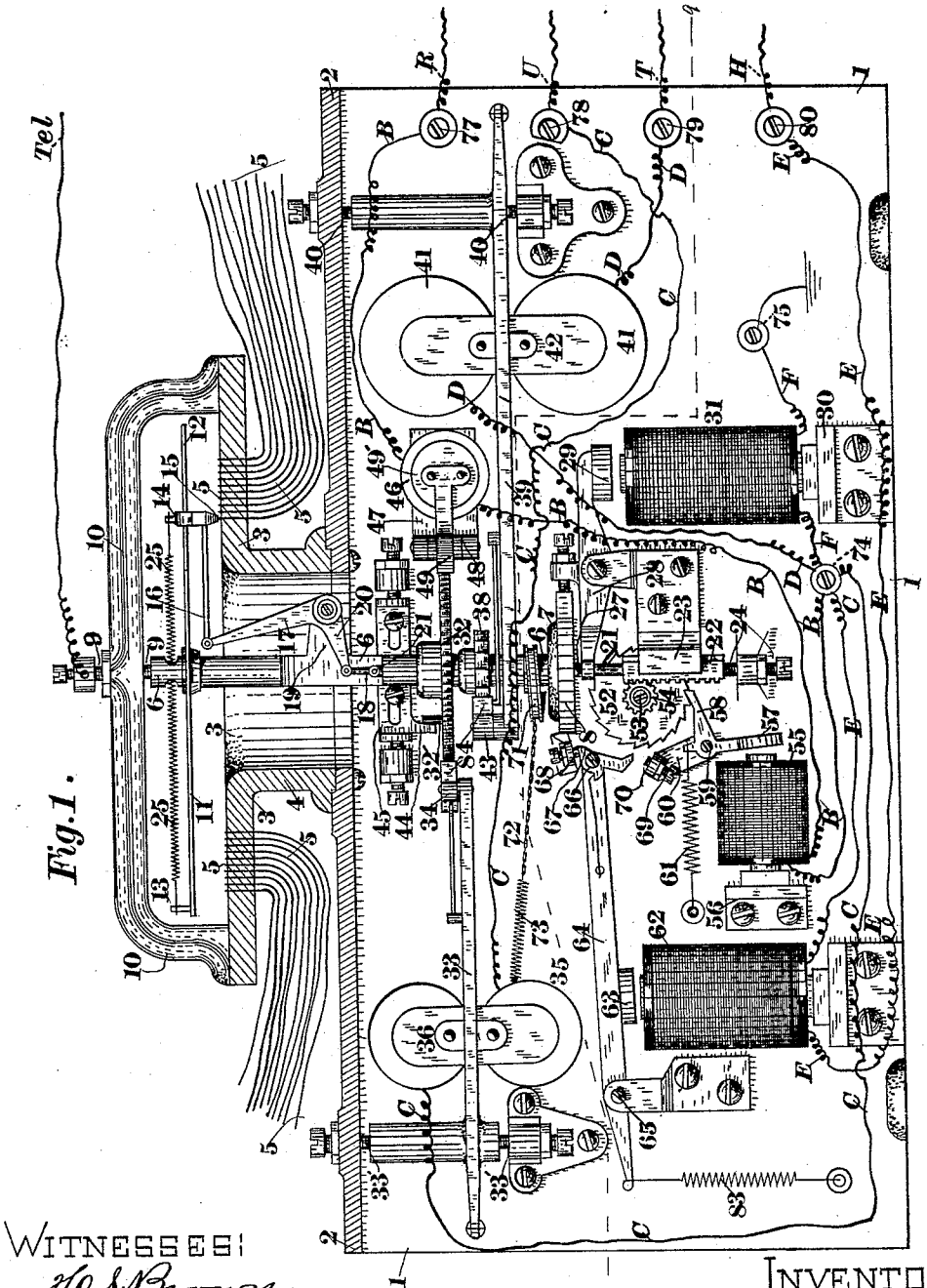


Fig. 1.

WITNESSES:
H. S. Brown.
Wm. Upton

INVENTOR:
Almon B. Strowger.
by his atty. Oscar Snell.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 4 Sheets—Sheet 2.

A. B. STROWGER.

AUTOMATIC TELEPHONE OR OTHER ELECTRICAL EXCHANGE.

No. 486,909. Patented Nov. 29, 1892.

Fig. 2.

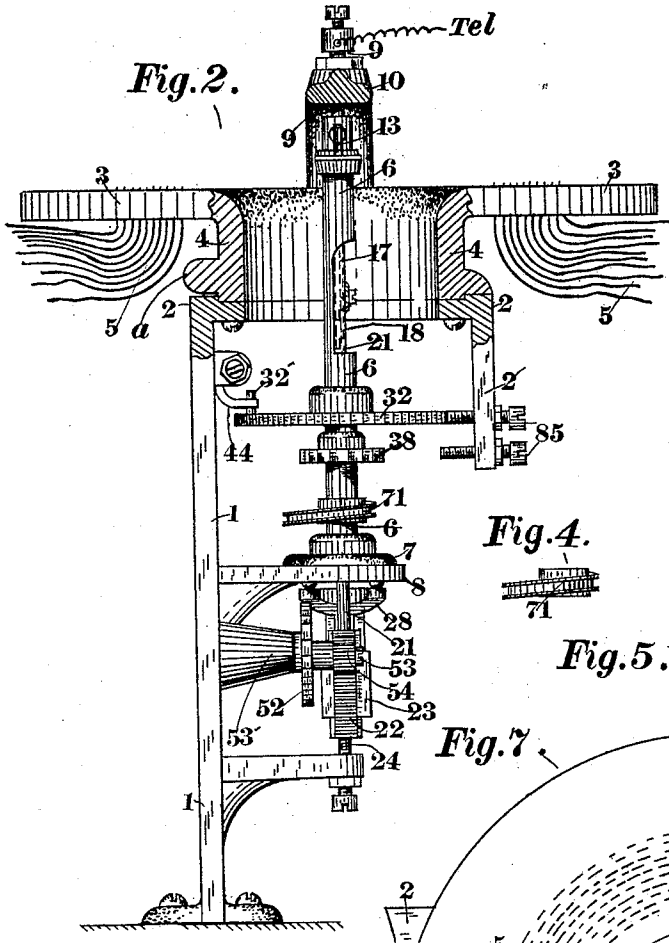


Fig. 3.

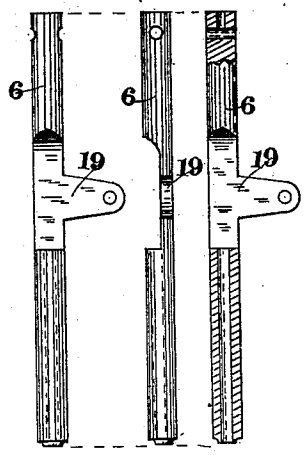


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

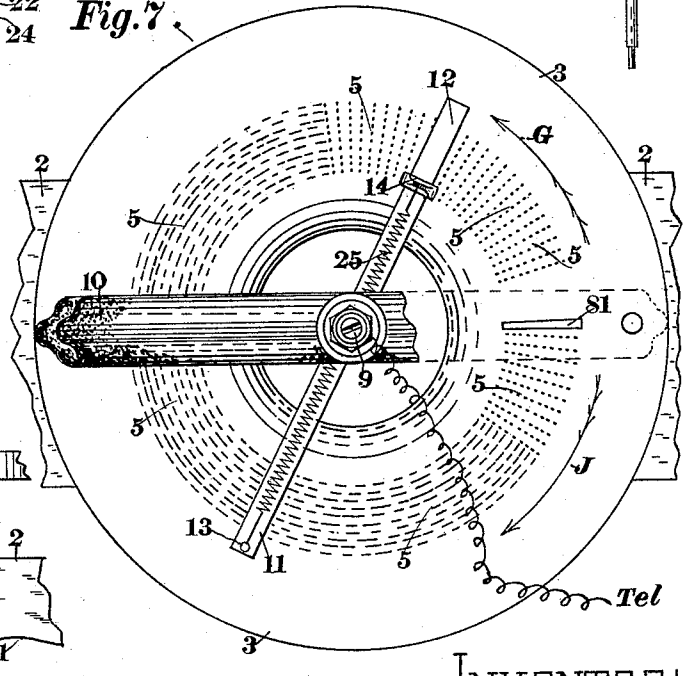
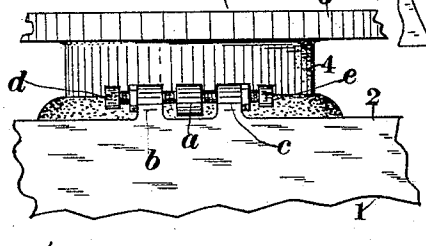


Fig. 8.



WITNESSES:

H. C. Brown.
Wm. Upton

INVENTOR:

Almon B. Strowger
by his atty Oscar Trees

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 4 Sheets—Sheet 3.

A. B. STROWGER.

AUTOMATIC TELEPHONE OR OTHER ELECTRICAL EXCHANGE.

No. 486,909. Patented Nov. 29, 1892.

Fig. 9

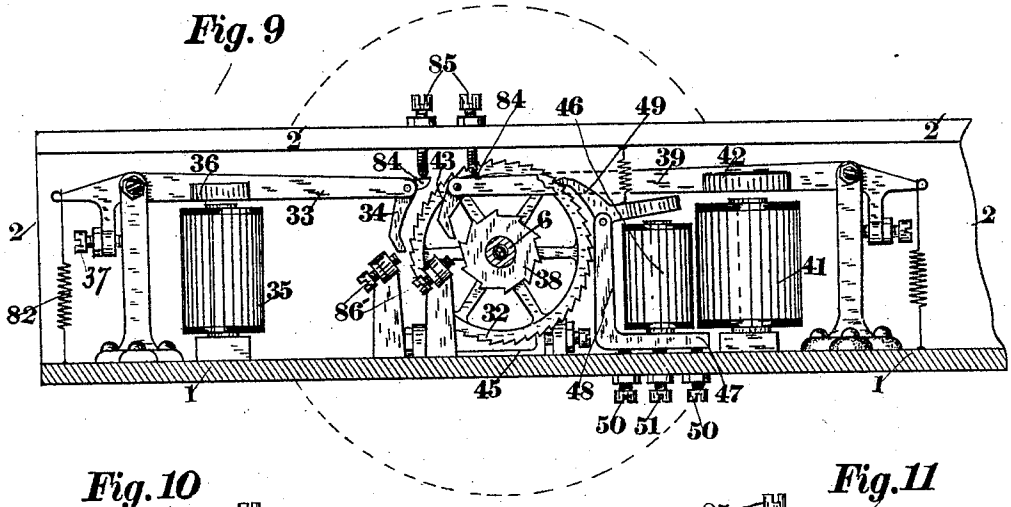


Fig. 10

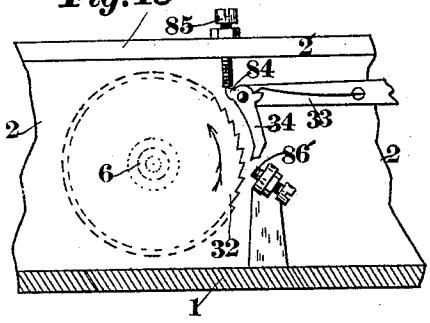


Fig. 11

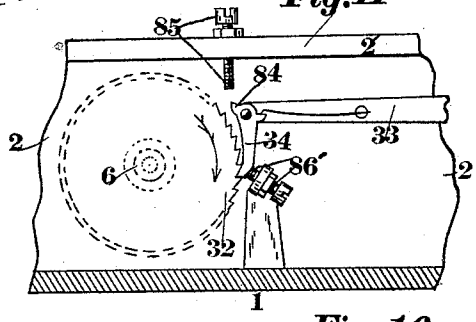


Fig. 12

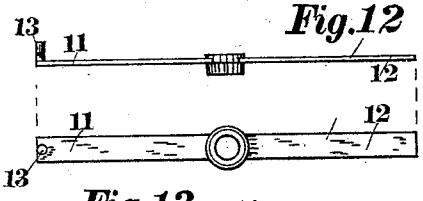


Fig. 13

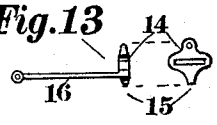


Fig. 14

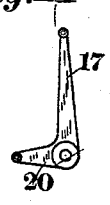


Fig. 15

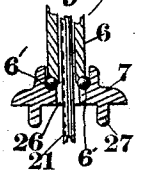


Fig. 16

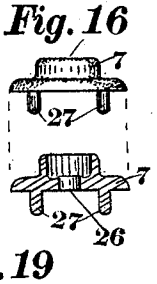


Fig. 17

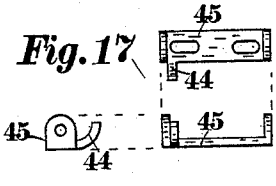


Fig. 18

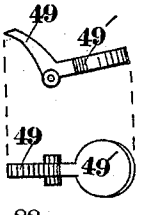


Fig. 19

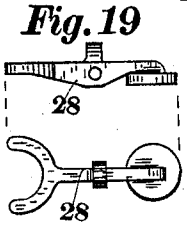
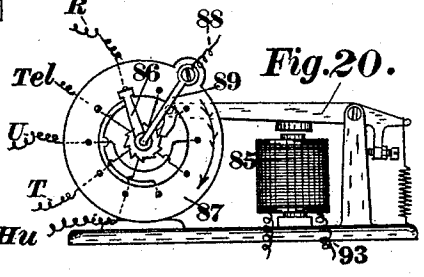


Fig. 20.



WITNESSES:
H. S. Brown.
Wm. Upton

INVENTOR:
Alison B. Strowger,
per his atty.
Oscar Snell.

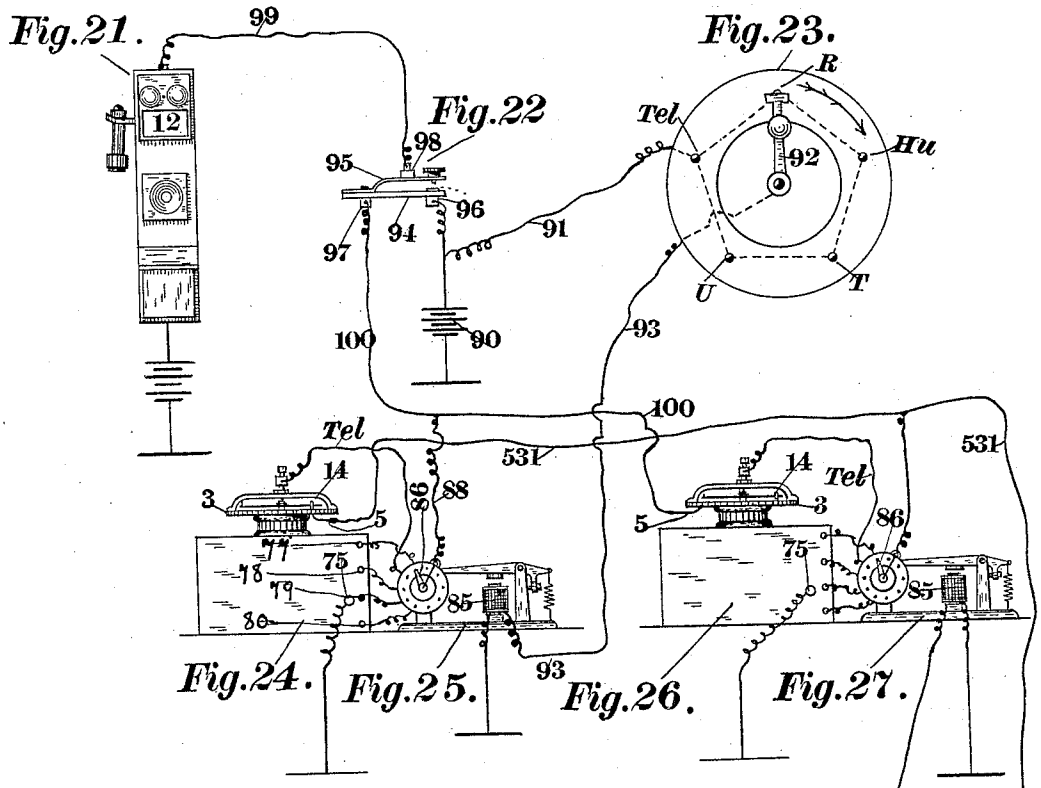
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

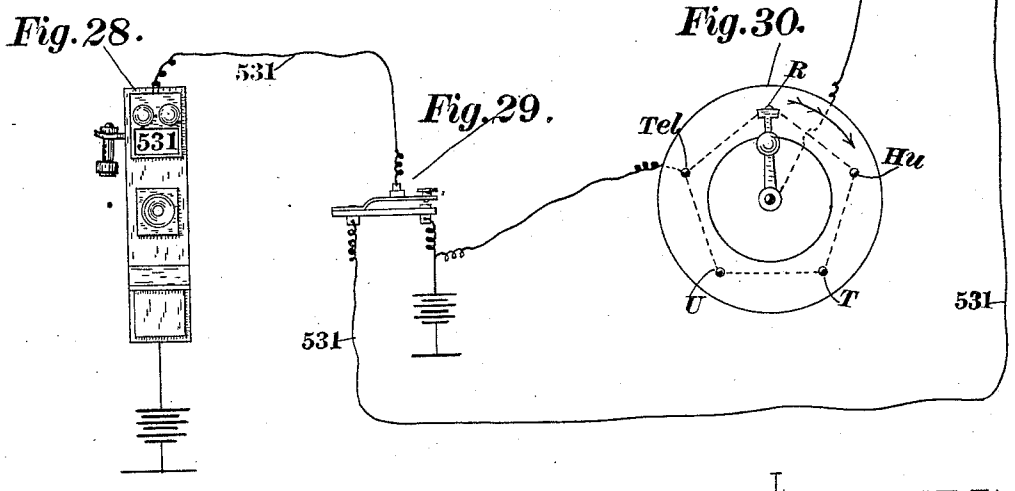
(No Model.) 4 Sheets—Sheet 4.

A. B. STROWGER.

AUTOMATIC TELEPHONE OR OTHER ELECTRICAL EXCHANGE.

No. 486,909. Patented Nov. 29, 1892.





WITNESSES:
H. S. Brown
Wm. Upton

INVENTOR:
Almon B. Strowger
by his atty. Oscar Snell.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

ALMON B. STROWGER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE STROWGER AUTOMATIC TELEPHONE EXCHANGE, OF SAME PLACE.

AUTOMATIC TELEPHONE OR OTHER ELECTRICAL EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 486,909, dated November 29, 1892.

Application filed February 19, 1892. Serial No. 422,162. (No model.)

To all whom it may concern:

Be it known that I, ALMON B. STROWGER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Automatic Telephone or other Electrical Exchange, of which the following is a specification.

My invention relates to means for switching a telephone, telegraph, or any other electrical instrument into electrical connection with any other electrical instrument of a given system, as will be hereinafter explained.

The particular object is to provide means whereby a person at one station may make connection with any other station in the system by the aid of electrical appliances without the assistance of an operator at the central station, and a further object is to provide means for the purpose of a very reliable nature, so as to adapt this system of exchange to general use.

In describing my new system of exchange I will confine myself to its application for telephonic purposes; but it can be applied equally as well to changing the electrical connections for telegraph and other similar instruments, dynamos, or any kind of electrical appliances where changes in connections are made from a distant station. For the purpose of illustration I will term the place where each telephone is located a "sub-station" and the exchange mechanism, located at some distance from the telephones, the "central station." The sub-stations are each connected with the central station by means of two wires in the herein-described system of mechanism, one of the wires serving for telephonic and the other for switching purposes. At the sub-station in addition to the telephone there are keys serving to control currents of electricity, which operate the mechanism at the central station. For the sake of brevity I will term the system of mechanism at the central station, which can be operated by a person at a sub-station, an "exchange." At the central station there are as many exchanges as there are telephones or sub-stations, so that each telephone is intimately connected to a particular exchange by means of the two wires above mentioned, which exchange cannot be operated from any other telephone, but each exchange is connected electrically with every other exchange at the central station for telephonic purposes.

My new system of electrical exchange is illustrated in the accompanying drawings, in which—

Figure 1 is a front elevation of the operative mechanism with the switch-table and part of the top of the base, shown in vertical section. Fig. 2 is a side elevation at a right angle to Fig. 1, of the mechanism directly connected to the main spindle, the switch-table being in vertical section. Fig. 3 shows three views of the main spindle, the last view at the right having a portion of the top and bottom ends broken away to show longitudinal and transverse holes. Fig. 4 is a side elevation of a fusee which is secured to the main spindle. Fig. 5 is a plan view of Fig. 4. Fig. 6 shows a thrust-rod, which operates within the main spindle, as will be described. Fig. 7 is a plan view of the switch-table, together with several other parts, the top of the base broken away. Fig. 8 is a portion of switch-table and base of the instrument, showing a means for adjusting the position of the switch-table. Fig. 9 is a view looking upward on line 9 9 of Fig. 1, showing mechanism for rotating the main spindle in one direction and which will be fully explained; Fig. 10, a partial view of central portion of Fig. 9, showing method of withholding pawls from ratchet-wheels; Fig. 11, a view similar to Fig. 10, but showing combined ratchet-wheel, pawl, and stop in action. Fig. 12 shows respectively side and top views of spring-arms for main spindle, one of which arms supports contact-head shown in Fig. 13 respectively in side and end views; Fig. 14, an elbow-lever for actuating contact-head; Fig. 15, a section of step and lower end of hollow portion of main spindle, showing ball-bearing; Fig. 16, respectively elevation and vertical section of step-bearing for lower end of main spindle; Fig. 17, respectively top, side, and end views of adjustable stop for main spindle; Fig. 18, side and plan views of combined pawl and armature, the pawl engaging with the teeth of the main ratchet-wheel and serving as a back-stop for main spindle; Fig. 19, respectively side and plan views of bifurcated lever and armature for imparting a longitudi-

nal motion to the main spindle; Fig. 20, a front elevation of the Strowger central station line-wire switch, whose mechanism is subdivided in an application for a patent of the United States filed December 24, 1891, Serial No. 416,023. Figs. 21, 22, and 23 and Figs. 28, 29, and 30 are telephones and switches for two separate sub-stations. Figs. 24 and 25 and 26 and 27, respectively, show two exchanges at the central station, there being one exchange at the central station for each of the sub-stations, if desired.

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

1 is the base upon which most of the operative parts composing the central exchange are mounted.

2 is the top of the base, which has a position at a right angle to 1. Figs. 2, 9, 10, and 11 show a portion 2′ of top 2, which hangs down from the front edge of the top, but is broken away in Fig. 1 in order to show the operative mechanism attached to the upper portion of base 1.

One of the most important parts of the central exchange is the switch-table 3, which in this instance consists of an annular-shaped piece of insulating material, having a neck 4, which elevates the table above top 2 of base 1. The switch-table is adjustably attached to top 2. Around the switch-table, Fig. 2, are annular rows of wires 5, whose heads project through table 3, as shown, a portion of each row indicated by dotted line, the lower ends of the wires projecting outward from under the projecting outer portions of table 3 to a sufficient distance to permit an easy attachment to them of certain wires, which will be described. Centrally located at the center of the diameter of the circular rows of wire heads 5 is the main spindle 6, whose lower end has a pivotal ball-bearing in a step 7, which step is supported by means of a projecting lug 8 from base 1. The upper end of spindle 6 is pivoted upon the lower end of a screw 9, which screw is held in central position by means of the cross-brace 10, the feet of the brace being secured to the switch-table 3 near the outer edge thereof. Main spindle 6 is pivoted so as to be capable of a small amount of longitudinal motion, which will again be referred to. Near the top of the main spindle 6 are secured to a central base spring-arms 11 and 12. Constructed to slide upon arm 12 is a contact-head 14, which is provided with a contact-point 15 and an arm 16 to connect the head with the long arm 17 of an elbow-lever, which lever is pivoted to a projecting lug 19 of main spindle 6. The short arm 20 of the elbow-lever projects inward, and its end is pivotally connected with the top of a short pitman 18, the lower end of the pitman being pivotally connected to the top of thrust-rod 21, which rod passes down through the center and out at the lower end of main spindle 6, where the lower end of rod 21 is pivoted in the top of a short piece of cog-rack 22 to permit rod 21 to rotate. This rack 22 is fitted to slide vertically in side and rear guide 23. There is a screw 24 under the end of rack 22, as shown, by means of which the distance of the downward movement of the rack 22 can be adjusted, the rack being always urged downward by the action of spring 25 at arms 11 and 12, pulling radially inward upon contact-head 14, which by the connection of elbow-lever 17 to 20 the short arm 20 of this lever presses downward against thrust-rod 21. It will be noticed that spring 25 passes directly through spindle 6.

The construction of the step 7 is shown in section, Figs. 15 and 16. The center of the step is perforated at 26 to permit the passage of thrust-rod 21 downward from spindle 6. At 6′ are balls fitted under the lower end of spindle 6 to diminish friction. Projections 27 at the bottom of step 7 are loosely fitted to holes in the projecting lug 8, so as to prevent the step from rotation with spindle 6, but permit the step and spindle to be moved vertically a short distance. The lugs 27 project below the lower side of lug 8, and bearing against their lower end are the ends of the bifurcated lever 28, Figs. 1 and 2, which lever is pivoted at the center of its length to a lug firmly secured to base 1, forming a part of the guide 23 of rack 22. There is an armature 29 attached to the outer end of lever 28, and below and attached to an outwardly-projecting bracket 30 from base 1 is an electro-magnet 31, by which armature 29 and lever 28 are operated.

At 32, Figs. 1, 2, 9, 10, and 11, is a ratchet-wheel having over one hundred teeth, and at 33 is a lever, which is pivoted at 33′, the lever having a pawl 34 at the outer end of its long arm to engage the teeth of wheel 32.

An electro-magnet 35 is secured to the base 1, and the armature 36 of this magnet is secured to magnet 35. Lever 33, Fig. 9, has a top screw 37 to limit its motion.

At 38 is a ratchet-wheel having one tooth to every ten teeth on ratchet-wheel 32, and a lever pivoted at 40, which lever has a pawl 43 at the end of its long arm contacting with the teeth of and for operating ratchet-wheel 38, and there is an electro-magnet 41, having an armature 42, which is attached to lever 39. Secured to ratchet-wheel 32 is a pin 32′, which operates as a stop by contacting an arm 44 of an adjustable slide 45, this slide being movably attached to the front of base 1.

Figs. 1 and 9 show a magnet 46, which is attached to a base 47, the base having an arm 48, to whose top end is pivotally secured the combined pawl 49 and armature 49′, Fig. 18, this armature being operated by magnet 46, and the pawl engages with the teeth of ratchet-wheel 32, serving as a stop, which stop is released from contact with the teeth of wheel 32 by the attraction of magnet 46 for armature 49′, as will be further explained. The base 47, together with all the attached parts, is adjustable, in order that the contact end of

pawl 49 can be moved to stop ratchet-whee 32 and all the parts attached to spindle 6 in the exact position necessary. Screws 50 and 51 are operated to adjust pawl 49 to the proper position.

In Figs. 1 and 2 is seen a ratchet-wheel 52, which is pivoted to revolve on a stationary pin 53, the pin having one end firmly secured in the end of lug 53′ of base 1, Fig. 2. Firmly secured to the front side of ratchet-wheel 52 and revolving therewith is a small pinion 54, which engages with the cogs of rack 22. There is an electro-magnet 55 secured to a bracket 56 of base 1. The armature 57 of magnet 55 forms one piece with pawl 58, and is pivoted at 59 to a projecting lug 60 of base 1. Pawl 58 is held in contact with ratchet-wheel 52 by spring 61, and the pawl is released from contact with the ratchet-wheel by the attraction of magnet 55 for armature 57.

Ratchet-wheel 52 is revolved by the action of magnet 62 attracting armature 63 of lever 64, which lever is pivoted at 65. At the end of 64 there is pivoted a pawl 66, which engages the teeth of ratchet-wheel 52, and the length of the lever is such that one downward stroke causes pawl 66 to revolve wheel 52 a distance equal to the pitch of one tooth thereof. Pawl 66 is always out of engagement with ratchet-wheel 52 when lever 64 is at the upward limit of its stroke by a small forward projection 67 of the pawl striking against adjusting-screw 68, for the purpose as will appear hereinafter. There is a screw 69, which passes through a stationary lug 70, and this screw holds pawl 66 in close engagement with the teeth of ratchet-wheel 52 when the pawl is at the termination of its downward stroke, which combination of parts serves as a stop mechanism to limit ratchet-wheel 52 from turning more than one notch for every downward stroke of lever 64.

71, Figs. 1, 2, 4, and 5, is a fusee, which is firmly secured to main spindle 6. To the fusee 71 is attached one end of a chain 72, the other end of the chain being attached to a spring 73. This fusee, chain, and spring mechanism is for revolving shaft 6 against the action of pawls 34 and 43, the fusee equalizing the pull of spring 73.

At 77, 78, 79, and 80 are binders, to which are attached wires which electrically connect them with the several magnets, as follows: Wire B connects binder 77 with release electro-magnets 46 and 55, the same current of electricity passing through both magnets and operating them simultaneously and the same current passing out of magnet 55 through wire B into binder 74, thence by wire F through electro-magnet 31, thence through wire F to binder 75, which is connected with the ground. Wire C conducts current from binder 78 with electro-magnet 35, thence by wire C to binder 74, thence by wire F through electro-magnet 31, thence by wire F to ground-binder 75. Wire D conducts current from binder 79 with electro-magnet 41, thence by wire D to binder 74, thence by wire F through electro-magnet 31 and to the ground-binder 75. Wire E conducts current from binder 80 with electro-magnet 62, thence by wire E to binder 74, thence by wire F through electro-magnet 31, thence by wire F to ground-binder 75. By this arrangement the out-current wires from magnets 35, 41, 46, 55, and 62 all connect with binder 74, thence by wire F through magnet 31, which magnet is thus always energized by every current of electricity which passes through the other magnets shown in Fig. 1 for the purpose as will be described hereinafter.

The construction and relation of the switch-table is shown in Figs. 1, 2, 7, and 8. In this instance it is intended to perforate the table with ten concentric rows of holes, as shown by the dots 5 and dotted lines in Fig. 7, each row to have one hundred holes, making a total of one thousand for the entire table, and each of these holes is to form the place of attachment of a wire, the ends of the wires preferably projecting slightly above the top of the table, the other end of the wires projecting radially outward all around under the table to a distance sufficient to be easily connected to other wires of the exchange system. For convenience the wires of the first row next the center of the table will be numbered from "1" up to "100," and the next row outward be numbered from "100" to "200," and so on, the last row being "900" to "1,000," and any convenient number of rows can be added, if necessary, or a greater number than one hundred wires can be placed in each of the rows to suit the requirements of practice.

When spindle 6 is in the position shown in Fig. 1, with pin 32′ in contact with adjustable stop-arm 44, the contact-point 15 of head 14 will rest on the metal plate 81, which is sunk with its upper face flush with the top surface of switch-table 3, Fig. 7. In this position contact-head 14 will have no electrical connection with wires 5. For convenience of description I will term plate 81 the "zero-plate," since it forms the starting-place from which to find any numbered wire on switch-table 3. Spindle 6, with its several attached parts, is held at the start or zero position with pin 32′ against stop-arm 44 by the tension of spring 73, whose attached chain 72 is secured to fusee 71 at its largest diameter, so that when the spring is contracted it will have the advantage of greater leverage to turn spindle 6; but when the spring is pulled out to its greatest length and its tension greatest, chain 72 exerts a pull at the smallest diameter of the fusee, the action of spring 73 turning arm 12 with head 14 in the direction of arrow G, Fig. 7.

When an electric current is sent through magnet 35 by way of wire C, binder 78, pawl 34 engages ratchet-wheel 32, which is turned the distance of the pitch of one tooth, which revolves spindle 6 and arm 12 with contact-head from the zero-plate 81 in the direction of arrow H, Fig. 7, so that point 15 of head

14 will contact the first wire 5 in first row next the center of switch-table, when, if the current is broken in magnet 35, spring 82, Fig. 9, will lift lever 33 and pawl 34, the end of the pawl falling into the next higher notch in wheel 32, when, if another current of electricity is sent through magnet 35, contact-head 14 will simultaneously be moved forward, with its contact-point 15 resting upon wire No. 2 in the first row, and so on, until by the successive impulses by currents sent through magnet 35, the contact-head 14 will be carried around and successively contact the end of every wire in the first row until the pin 32′ will contact the opposite side of stop-arm 44, when, if required, the spindle 6, together with contact-head 14, can be quickly revolved backward to the starting-place or zero-plate 81 by sending a current of electricity into release-magnet 46 by wire B, when armature 49′ will be operated and disengage its pawl 49 from wheel 32, when spindle 6, being free to revolve, will quickly return because of the pull of spring 73 on fusee 71 until pin 32′ contacts with adjustable stop-arm 44, when contact-point 15 will again lie at the zero-plate 81.

In order to facilitate the operation of this exchange, we have introduced a ratchet-wheel 38, having ten teeth, which wheel is also firmly secured to spindle 6 and is operated by an electro-magnet 41, having an armature 42, attached to a lever 39, which lever has a pawl 43 to engage the teeth of the ratchet-wheel. Now it is obvious that by sending a current through wire D into magnet 41 spindle 6 would be turned over as much space by one downward thrust of pawl 43, turning wheel 38 the distance of the pitch of one of its teeth as would be done by ten separate thrusts of pawl 34 on wheel 32, so that should it be necessary to have contact-point 15 connect with wire 42 of the switch-table 3 four separate and distinct currents of electricity being sent through magnet 35, when ratchet-wheel 32 will be turned through the distance of the pitch of two teeth, when contact-point 15 will rest upon the end of wire No. 42.

I have now explained the means for causing contact-head 14 to move to and contact its point 15 with the end of every wire in the first row of switch-table 3, and will now explain the means by which contact-head 14 is carried to the second, third, or other rows of wires exterior to row No. 1. When a current of electricity is sent through magnet 62, armature 63, together with lever 64 and pawl 66, is operated. Pawl 66, by the downward motion of lever 64, moves out of contact with screw 67, and the lever end of the pawl contacts with the teeth of ratchet-wheel 52, and the continued downward motion of the pawl turns wheel 52 the distance of the pitch of one tooth thereof. When in the meantime stop-pawl 58 has engaged a tooth of wheel 52, so that when the current of electricity ceases in magnet 62 spring 83 raises the long arm of lever 64, together with pawl 66, to the position shown in the drawings, the projection 67 contacting screw-stop 68 and turning the pawl on its pivot and force it out clear of ratchet-wheel 52, the ratchet-wheel being held in the changed position by pawl 58. By the partial revolution of wheel 52 rack 22 is caused to ascend by the action of pinion 54, which is attached to wheel 52. The upward movement of rack 22 causes the attached thrust-rod 21 also to rise, and the upper end of the thrust-rod being connected to the short arm of elbow-lever 20 17, causes the long arm 20 of this lever, together with the attached contact-head 14, to move outward from the center of spindle 6 the distance for the point 15 of head 14 to contact the second row of wire ends of switch-table 3. It is understood that this action takes place while the contact-head 14 is at the zero-plate 81 and before shaft 6 is revolved to carry pin 32′ from stop-arm 44. It is obvious that every time a current is passed through magnet 62 contact-head 14 will be moved outward from the center of shaft 6 the distance of one row of wires 5 from the next inner row, and so on, to any row in table 3, when any certain wire in the particular row desired can be contacted by point 15 of head 14 by the means described for the first row. When it is desired to return contact-head 14 to the zero-plate in the first row of wires on switch-table 3, a current of electricity is sent into magnet 46 through wire B, which releases pawl 49, and the same current after passing through magnet 46 is led into magnet 55 by wire B, when armature 57 is operated, causing the release of pawl 58 from ratchet-wheel 52, when by the gravity of rack 22 and thrust-rod 21 and the tension of spring 25, operating to pull contact-head 14 and arm 17 of elbow-lever 17 20 inward and short arm 20 downward with thrust-rod 21, rack 22 falls, so that its lower end rests upon the top of adjusting-screw 24, and in the meantime, pawl 49 being released, shaft 6 is carried around by the pull of spring 73 on fusee 71 until pin 32′ contacts with adjustable stop-arm 44, when the point 15 of contact-head 14 will rest on zero-plate 81, near the end of the first row of wire heads 5.

In the operation of the several parts herein described, if shaft 6 should have no vertical longitudinal motion, the point 15 of contact-head 14 would cause considerable friction by its contacting the top of switch-table 3 while arm 12 is being carried around to some designated wire end 5, or when the pawls 49 and 58 are released and spindle 6 is revolving backward by the action of spring 73, there would necessarily be required a much stronger spring 73 to give the necessary power for this duty. Therefore to obviate this objection I provide means to lift head 14 clear of switch-table 3 by connecting the out-current wires from magnets 35, 41, 46, 55, and 62 to binder 74, and then connect binder 74 by wire F to magnet 31, thence by wire F to ground binder 75, as hereinbefore stated, so that, simultane-

ously with every horizontal movement of contact-head 14, magnet 31, through the medium of bifurcated lever 28, lifts step 7 from bracket 8, together with spindle 6, spring-arm 12, and the attached head 14, the distance lifted being small and simultaneous with the action of any of the other magnets. Head 14 is moved to any position when spindle 6 is moving forward or backward without point 15 contacting with any part of table 3 or with wires 5 until spindle 6 has ceased revolving, thus making it possible to construct a switch-table 3 with many thousands of wires 5, any one of which is within easy reach of contact-head 14 without requiring more power to carry contact-head around outer than the inner rows of wires of switch-table 3.

In Figs. 9 and 10 it will be noticed that pawls 34 and 43 are always lifted from engagement with the ratchet-wheels when the pawls are not in action, the ratchet-wheels and shaft 6 being held from turning backward through the action of spring 73 on fusee 71 by pawl 49, which is one of the release-pawls. There is a projection 84 near the pivotal center of both pawls 34 and 43, which projection contacts with screws 85, passing through a portion 2′ of the top 2. Stop-screws 86 are also provided, which contact the ends of these pawls to serve as stops for the ratchet-wheels in the same manner as has been described for pawl 66, which is operated by magnet 62. In order to insure perfect central contact of contact-point 15 with the ends of wire 5 on switch-table 3, this switch-table is secured to the top 2 of base 1, so that it can be moved slightly concentric with shaft 6. Figs. 1 and 8 show a lug *a*, which projects from the neck 4 of the switch-table, and at either side are lugs *b* and *c*, which are part of the top 2. Adjusting-screws *d* and *e* of lugs *b* and *c* contact at each side of lug *a* and serve as means for quickly and accurately adjusting the switch-table and of retaining it securely in the position desired.

Sheet 4 of the drawings shows the wire connections from two sub-stations to a central station, and the application of the Strowger indicating-switch. Figs. 21, 22, and 23 I will assume is sub-station No. 12, and Figs. 28, 29, and 30 sub-stations No. 531, the number of the station being shown on the telephone-box, as usual. Figs. 24 and 25 is the exchange belonging to telephone 12, and Figs. 26 and 27 the exchange for telephone No. 531.

It will be noticed that Fig. 20, Sheet 3, shows an enlarged view of Figs. 25 and 27, Sheet 4, this being the central-station portion of the Strowger automatic switch, which, in short, consists of an electro-magnet 85, which through a lever, pawl, and ratchet moves a hand 86 around a dial 87 in direction of arrow and connects, successively, one at a time, ten insulated-metal heads with a wire 86, which has a spring connection 89 with the center of motion of hand 86. The heads diametrically opposite on dial 87 are connected together. The wires marked "R.," "Tel.," "U.," "T.," and "Hu.," which project from the dial, connect with a pair of the metal heads. Figs. 23 and 30 show a dial with five insulated-metal heads all connected together by wire, (shown in dotted lines,) and these heads are also connected to a battery 90 by a wire 91. The metal heads are marked "R.," "Tel.," "U.," "T.," and "Hu." Key 92 can be revolved entirely around the dial and successively contact each of the metal heads. The hand marked "92" is connected by wire 93 to magnet 85 at the central station.

Figs. 22 and 29 show keys which have an insulated base 94. A metal spring 95 contacts 96, which is connected with battery 90. Binder 97 is connected with spring 95. Metal stop and binder 98 connects with spring 95 when spring is in position shown in drawings. Wire 99 from telephone connects with binder 98, and wire 100 connects binder 97 to one of the wires 5 of the switch-table of exchange, Fig. 26, there being also a wire 88 connecting wire 100 with the switch-hand 86 of Fig. 25, as plainly shown in Fig. 20. The connection of sub-station 531, Sheet 4, with the central station is similar to that above described for sub-station 12.

It will be noted that a current of electricity can pass from telephone 12 through wire 99 to binder 98, thence through spring-key 95 to binder 97, thence by wire 100 to switch-table 3 of Fig. 26, where it can be secured to one of the wires 5, where it will be known as "wire 12." The same connections are made from telephone 531, Fig. 28, so that its wire is connected to table 3 of exchange, Fig. 24. Wires 88 having electrical connection with wire 100 a current can pass from battery 90 to binder 96, thence by way of key 95, when the key contacts 96, to binder 97, thence by wire 100 and then wire 88 to connection 89 and out hand 86 to any of the wires "R.," "Tel.," "U." "T.," or "Hu.," according to the contact-head of dial 87, which hand 86 may rest upon. Wires "R.," "Tel.," "U." "T.," and "Hu.," Fig. 20, are connected, respectively, with wires shown at right-hand end of Fig. 1, which are designated by similar letters, and communicate with the magnets, respectively, for "release," "telephone," "units," "tens," and "hundreds." These wire connections are plainly shown by Figs. 24 and 25.

The drawings on Sheet 4 plainly show that since there is an unbroken connection between No. 531 and the switch-table 3, Fig. 24, of telephone 12, a person turning the contact-head 14 of exchange, Fig. 24, around to No. 531 could ring up telephone 531 from telephone 12; but, to particularly explain, should a person at telephone 12, Fig. 21, desire to communicate with a person at telephone 531, Fig. 28, key 92, Fig. 23, would be turned in the direction of the arrow from contact-head "R.," or "release," to contact-head "Hu.," or "hundreds," where an electric current will pass from battery 90 through wire 91, thence through contact-head "Hu." key 92, wire 93,

and into magnet 85 of the auxiliary switch, Fig. 25, which will cause hand 86 of the switch to move to the right of "R.," which head connects with "Hu." on the opposite side of the switch-dial. If now spring-key 95 be pressed down to contact 96 an electric current from battery 90 will pass through the key, thence through wire 100, then wire 88 to and through connection 89, thence through hand 86, thence through wire "Hu." into the exchange, Fig. 24, to energize the magnet which operates the hundreds mechanism. Spring-key 95 is pressed down four times, which sets the contact-head 14 in the exchange out to the beginning of the fifth row of wires of the switch-table 3. The next number required is three tens, so that key 92 is moved in the direction of the arrow to contact with the "T." or "tens" contact-head, when simultaneously hand 86 at the exchange auxiliary switch will move one more space on dial 87 and make connection with "T." or the "tens" wire of the exchange, after which key 95 is pressed down three times, causing the main spindle 6 to carry contact-head 14 around the switch-table to wire 30 in the fifth row. The next number wanted is one or one unit, so the key 92 is turned to contact the units-head, when hand 86, Fig. 20, makes connection with the units-magnet in the exchange, when by pressing down upon key 95 one time the required wire, No. 531 is contacted by head 14 when key 92 is turned to contact-head "Tel." or "telephone," when hand 86 connects wires 100 and 88 with wire "Tel.," which connects at the extreme top of the exchange to binder on main-spindle pivot-screw 9, thence an electric current can pass into the main spindle 6, spring-arm 12, contact-head 14, thence through wire No. 531 to and through spring-key, Fig. 29, thence to telephone 531, when the signal-bells can be made to ring and the telephones operated as ordinarily. If, however, only units are wanted, as No. 9 of the first row of wires, the switch 95 is not operated as the key 92 passes the "H." or "hundreds" contact-head nor as it passes the "T." or "tens" head, and consequently the contact-head 14 is not moved outward on the arm 12. Hence when the key 92 reaches "U." or the "units" contact-head each downward pressure of the switch 95 will only cause the head 14 to move one step or wire around the first row of wires, and when it has been pressed down nine times the head 14 will be in contact with the end of line 9, which establishes communication with the desired telephone at the other sub-station.

It is obvious that an additional number of telephone-exchanges can be connected in the same manner, as is shown by Sheet 4 of the drawings.

Having thus described my invention, I claim—

1. In an automatic electrical exchange, the combination, with a series of wires the ends of which are arranged in a horizontal plane, of a switch movably secured relatively thereto, said switch having its contact-head movable vertically, radially, and laterally, whereby it occupies a plane above the ends of the wires when moving and occupies the plane of the ends of the wires when at rest and may be moved from the end of one wire to any other wire without coming in contact with the intermediate wires, substantially as set forth.

2. In an automatic electrical exchange, the combination, with wires the ends of which are arranged in concentric rows in a horizontal plane, of a switch movably secured at the axis of said rows, the contact-point of which switch is movable radially and annularly relatively to the axis of the rows of wires and occupies a plane above the ends of the wires when moving and occupies the plane of the ends of the wires when at rest, substantially as set forth.

3. In an automatic electrical exchange, the combination, with a series of wires, of a switch adapted to be placed in electrical connection with any one of said wires and a pin connected therewith and an adjustable slide provided with an arm for engaging said pin and for limiting the return movement of said switch after said connection has been made and broken, substantially as set forth.

4. In an automatic electrical exchange, the combination, with a series of wires, the ends of which are arranged in concentric rows or circles, of a shaft journaled at the axis of the rows of wires, a switch secured thereto, the contact-point of which is movable radially and annularly relatively to said shaft, a rod movable longitudinally to the axis of the shaft, connected with the contact-point of said switch, and an adjustable stop at one end of the rod for limiting the return movement of the contact-point, substantially as set forth.

5. In an automatic electrical exchange, the combination, with a series of wires, of a switch adapted to be placed in electrical connection with any one of said wires, the contact-point of which switch occupies a different plane when moving from what it does when at rest, and a series of magnets, one of which operates mechanism for moving the contact-point from one plane to the other and the remaining magnets operate mechanism for moving the point in the different planes, all of said magnets having a common ground-wire, the first-mentioned magnet being electrically connected with each of the other magnets and with the ground-wire, whereby the contact-point is always moved from one plane to the other whenever the switch is operated, substantially as set forth.

6. In an automatic electrical exchange, the combination, with a series of wires, the ends of which are arranged in concentric rows or circles, of a switch movably secured at the center of said rows, the contact-point of which switch is movable radially and annularly relatively to the axis of said rows, ratchet-wheels for placing said switch in contact with any one of the ends of said wires, an electrically-operated lever for each wheel, one end of

which lever is provided with a pawl, and means for positively disconnecting said pawl from its ratchet-wheel when at rest, substantially as set forth.

7. In an automatic electrical exchange, the combination, with a series of wires, the ends of which are arranged in concentric rows or circles, of a switch movably secured at the center of said rows, the contact-point of which switch is movable radially and annularly relatively to the axis of said rows, ratchet-wheels for placing said switch in contact with any one of the ends of said wires, an electrically-operated lever for each wheel, one end of which lever is provided with a pawl, and adjustable mechanism for releasing said pawl from its ratchet-wheel when at rest, substantially as set forth.

8. In an automatic electrical exchange, the combination, with a series of wires, the ends of which are arranged in concentric rows or circles, of a switch movably secured at the center of said rows, the contact-point of which switch is movable radially and annularly relatively to the axis of said rows, ratchet-wheels for placing said switch in contact with the ends of any one of said wires, an electrically-operated lever for each wheel, one end of which lever is provided with a pawl, and means for limiting the forward movement of said pawl and for forcing it toward the ratchet-wheel, whereby it acts as a stop for the ratchet-wheel at the end of the thrust or forward movement of the pawl, substantially as set forth.

9. In an automatic electrical exchange, the combination, with a series of wires, the ends of which are arranged in concentric rows or circles, of a switch movably secured at the center of said rows, the contact-point of which switch is movable radially and annularly relatively to the axis of said rows, ratchet-wheels for placing said switch in contact with the ends of any one of said wires, an electrically-operated lever for each wheel, one end of which lever is provided with a pawl, and adjustable mechanism for limiting the forward movement of said pawl, substantially as set forth.

10. In an automatic electrical exchange, the combination, with a table having a series of wires radially secured thereto, of a zero-plate insulatingly secured to said table, said plate being substantially as long as the distance between the outer and inner rows of wire-heads and having its upper surface flush with the top of the table, and a switch the contact-point of which rests upon and is movable toward and from said plate, substantially as set forth.

11. In an automatic electrical exchange, the combination, with a table having a series of wires secured thereto, of a switch the contact-point of which is adapted to be placed in electrical connection with any one of said wires, said table being concentrically adjustable relatively to the switch, substantially as set forth.

12. In an automatic electrical exchange, the combination of a series of wires the ends of which are arranged in concentric rows or circles, a shaft journaled at the center of said rows, a switch secured to said shaft, means for rotating the shaft in one direction, a fusee on the said shaft for rotating the shaft in the opposite direction, and a spring-actuated chain secured to and adapted to run on and off of said fusee substantially in a line with the angle of the pitch of the spiral of said fusee, substantially as set forth.

13. In an automatic electrical exchange, the combination of a series of wires arranged in a horizontal plane and a contact-head movable relatively thereto, a longitudinally-movable spindle or shaft for operating said head, a step for the reception of the lower end of the spindle, provided with projections upon the bottom, a bracket or lug provided with perforations for the reception of the step, an armature-lever, one end of which is bifurcated and engages with the ends of the projections upon the step below the bracket, and an electro-magnet for operating the lever, substantially as set forth.

14. In an automatic electrical exchange, the combination of a series of wire ends arranged concentrically in a horizontal plane, a vertically-movable shaft or spindle at the center of said ends, spring-arms secured to the upper end of the spindle, a contact-head movably secured to one of said arms, a spring secured to the head at one end and to the outer end of the other arm at the opposite end, and means for rotating said spindle upon its axis and moving the head upon said arm, substantially as set forth.

In testimony that I claim the foregoing I have hereunto set my hand, this 5th day of February, 1892, in the presence of witnesses.

ALMON B. STROWGER.

Witnesses:
WATTS S. STROWGER,
OSCAR SNELL.