No. 747,197. PATENTED DEC. 15, 1903.

F. A. LUNDQUIST.

TELEPHONE EXCHANGE.

APPLICATION FILED SEPT. 23, 1898.

NO MODEL. 7 SHEETS—SHEET 1.

FIG. 1.

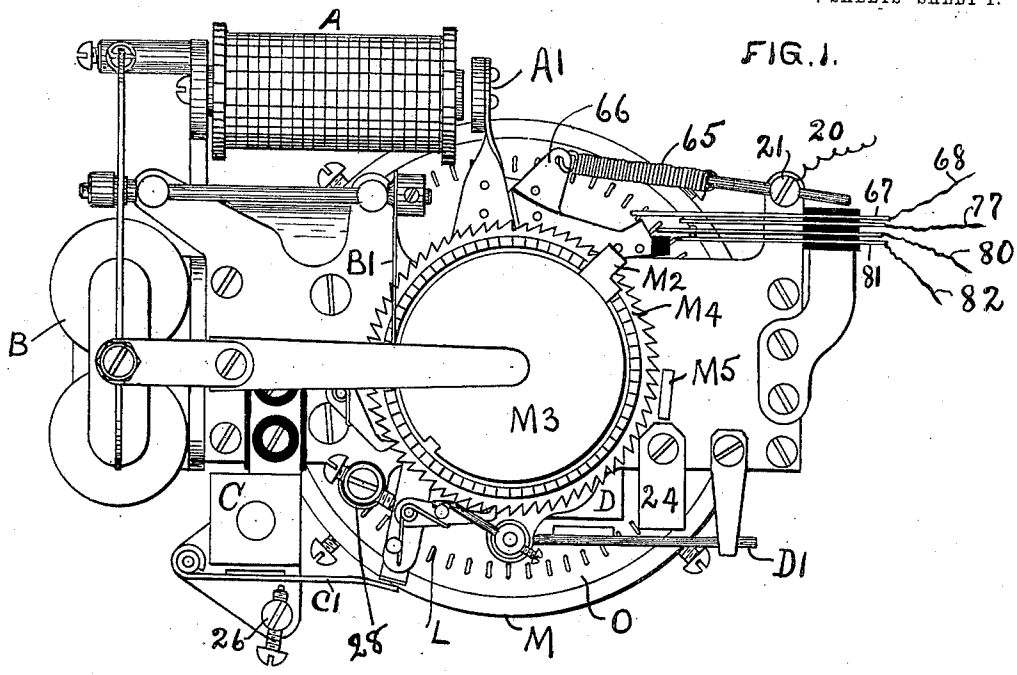
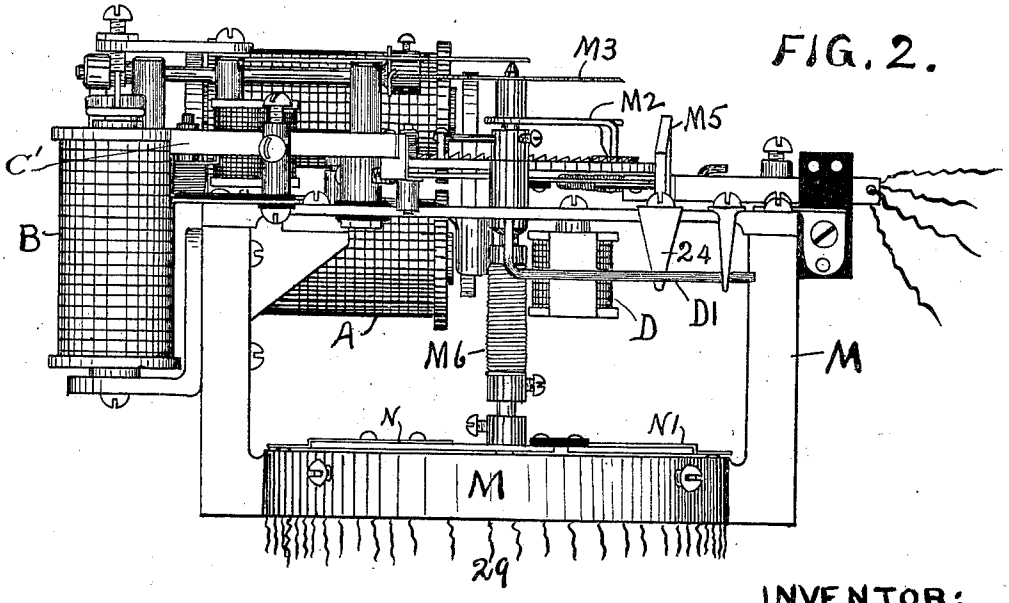


FIG. 2.



WITNESSES

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NO MODEL. 7 SHEETS—SHEET 2.

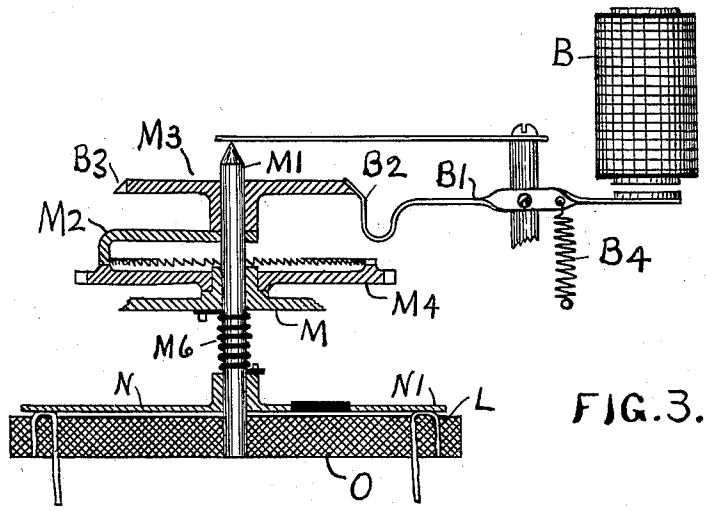

FIG. 3.

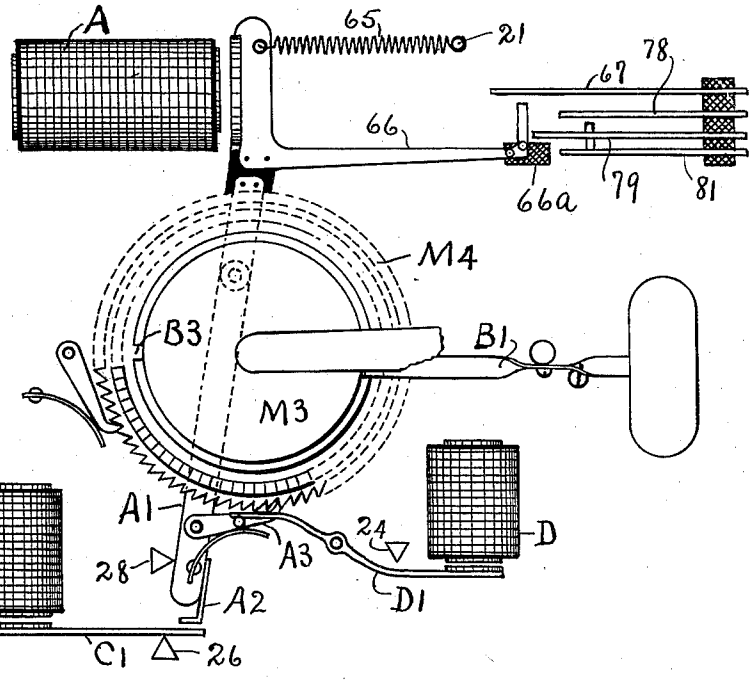

FIG. 4.

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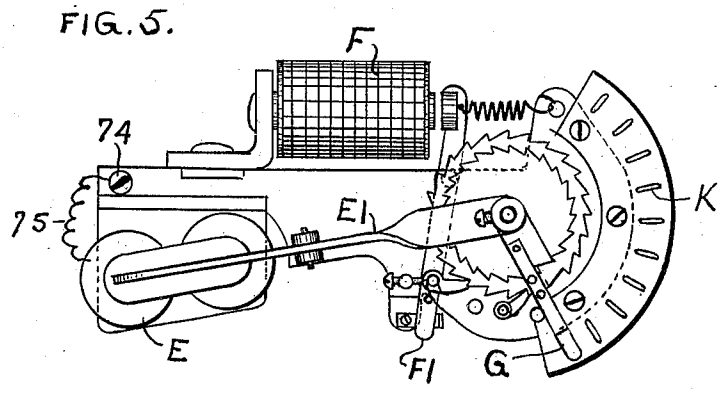
NO MODEL. 7 SHEETS—SHEET 3.

FIG. 5.



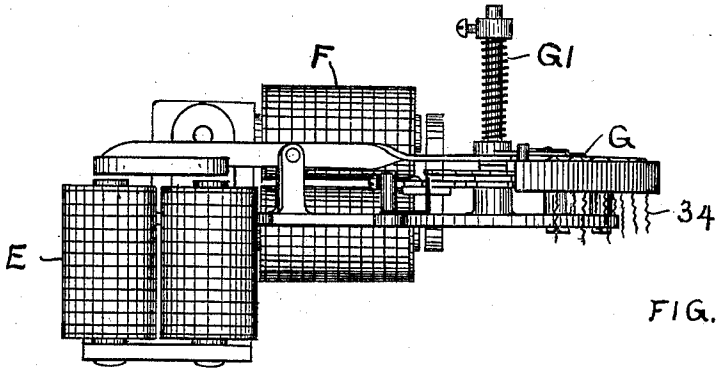


FIG. 6.

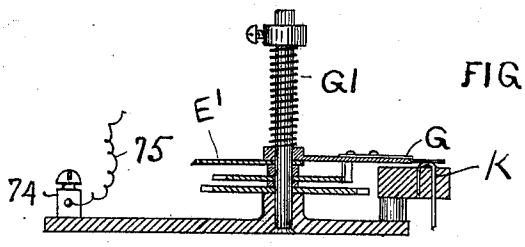


FIG. 7.

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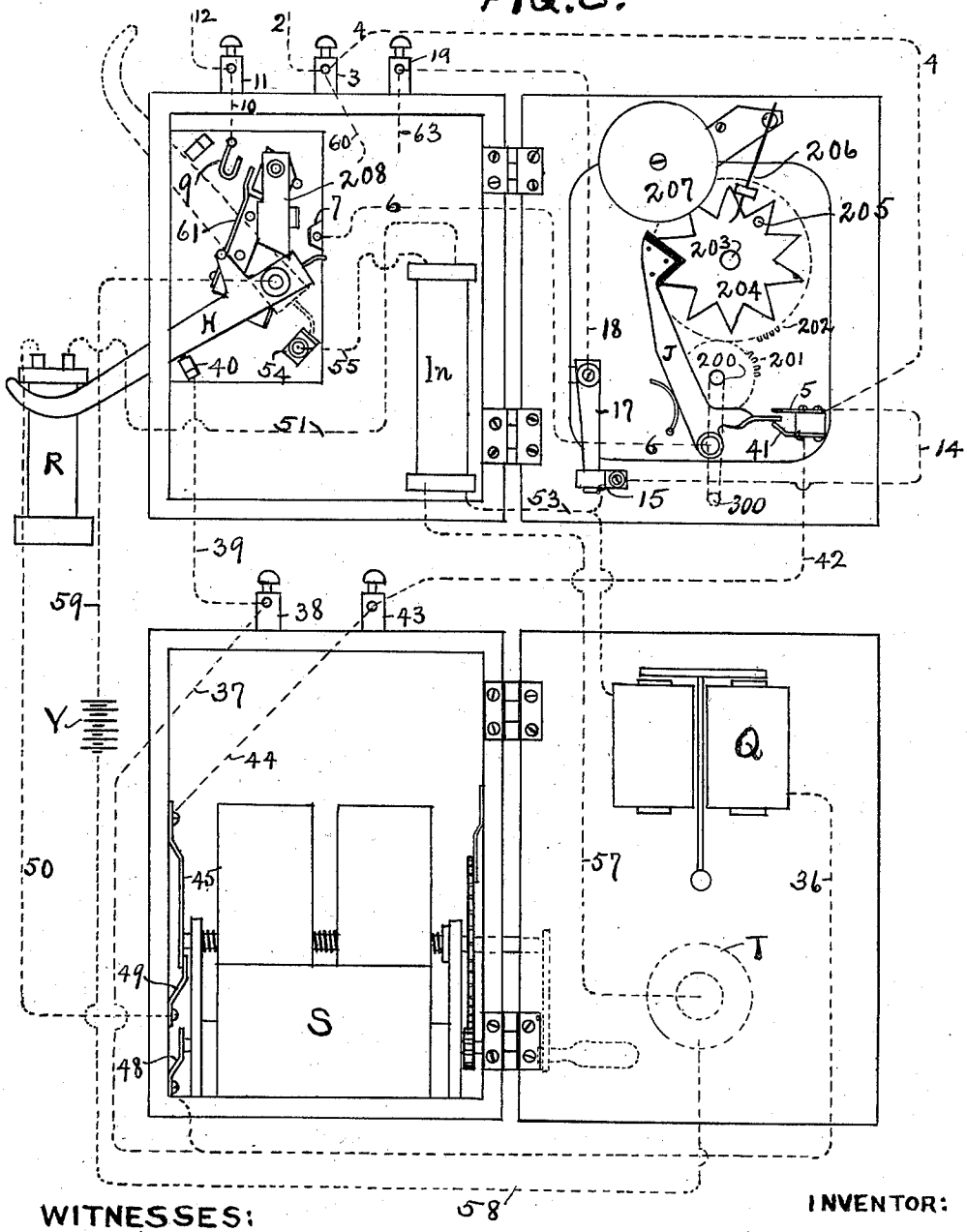
APPLICATION FILED SEPT. 23, 1898.

NO MODEL. 7 SHEETS—SHEET 4.

FIG. 8.



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NO MODEL. 7 SHEETS—SHEET 5.

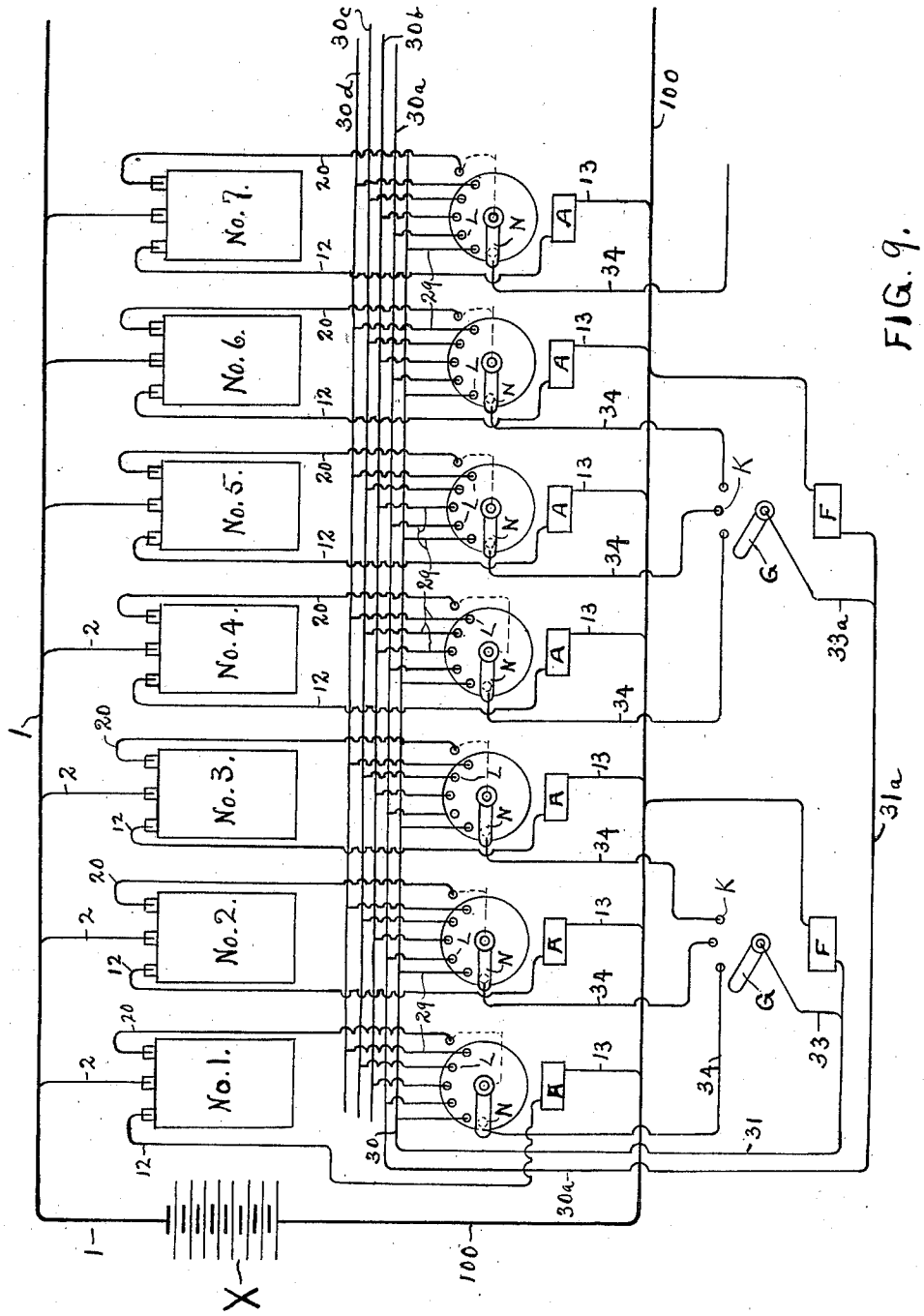

FIG. 9.

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APPLICATION FILED SEPT. 23, 1898.

NO MODEL. 7 SHEETS—SHEET 6.

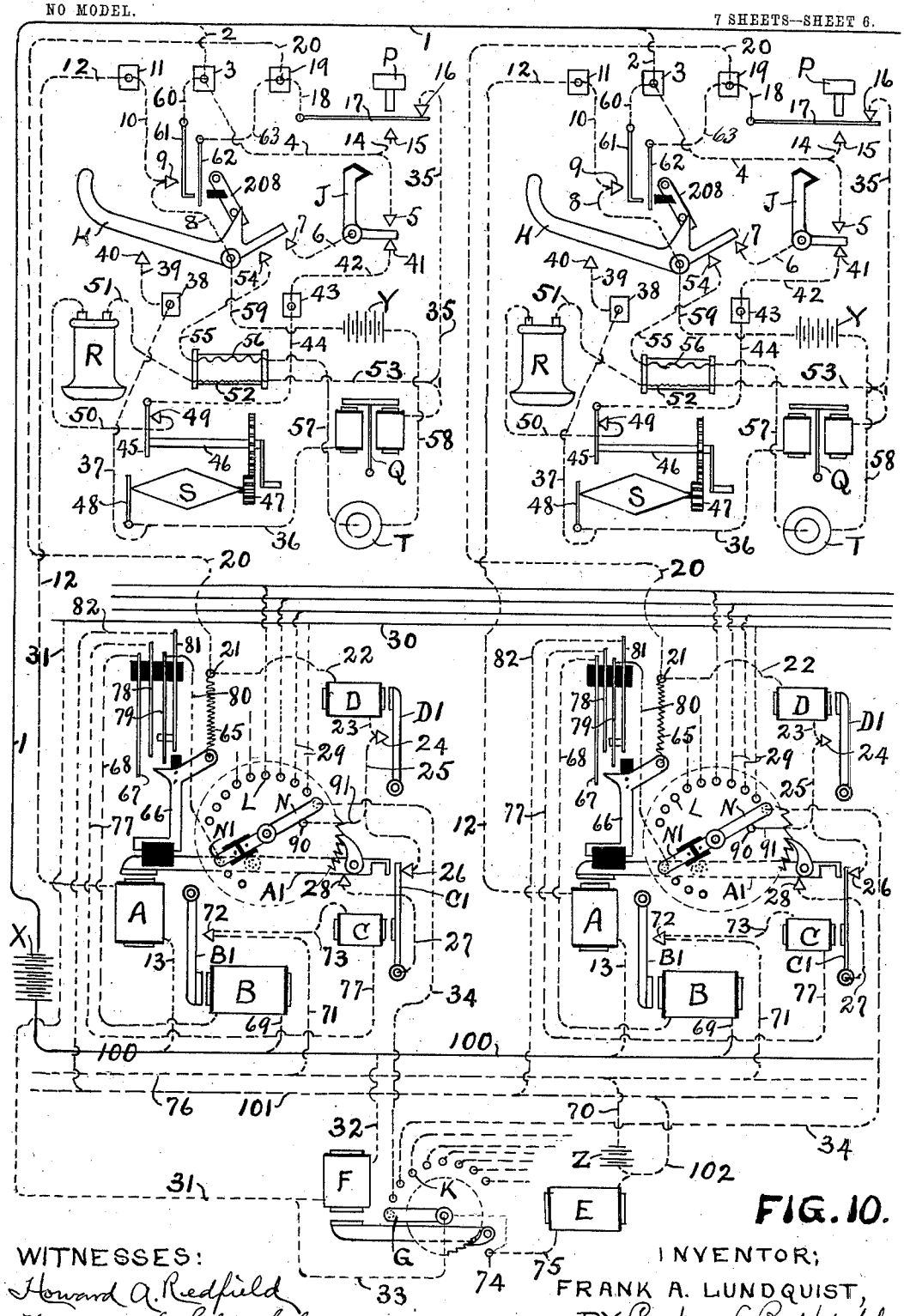

FIG. 10.

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APPLICATION FILED SEPT. 23, 1898.

NO MODEL. 7 SHEETS—SHEET 7.

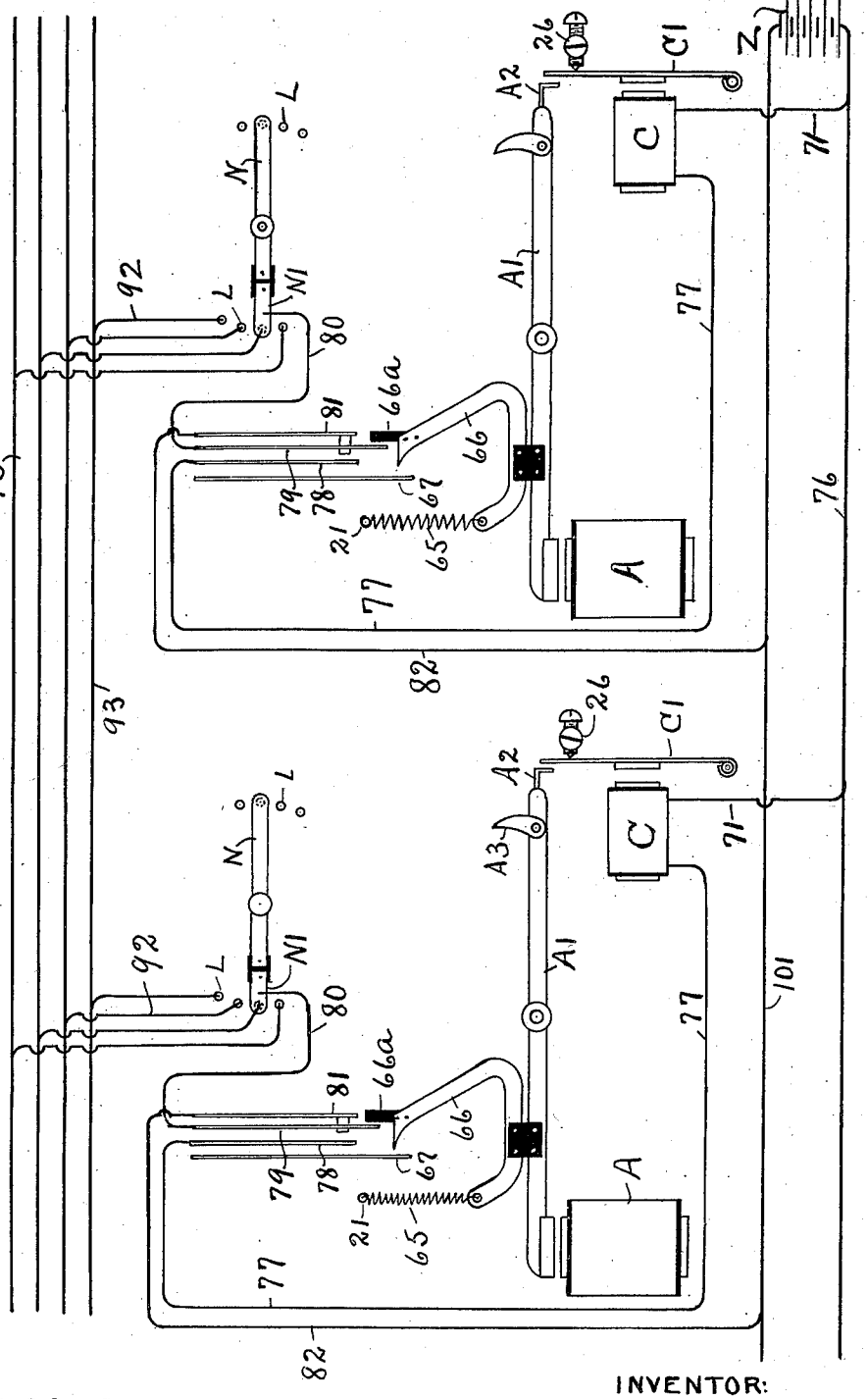

FIG. 11.

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 747,197, dated December 15, 1903.

Application filed September 23, 1898. Serial No. 691,705. (No model.)

To all whom it may concern:

Be it known that I, FRANK A. LUNDQUIST, a citizen of the United States of America, and a resident of Chicago, county of Cook, State of Illinois, have invented certain new and useful Improvements in Telephone-Exchanges, of which the following is a specification.

My invention relates to automatic exchanges in which the calling subscriber himself selects the telephone called, and has for its object improvements in my previous construction and arrangement as shown in my Patent No. 606,764, of July 5, 1898. The main parts of the switches and telephone-boxes in the present application are very similar to those described in the said patent, the differences lying principally in certain additions to or modifications of those parts, the addition of auxiliary switches, and a new arrangement of circuits.

In the accompanying drawings, Figure 1 is a plan of one of the main switches. Fig. 2 is an elevation of the same. Fig. 3 is a partial vertical section, and Fig. 4 is a partial diagrammatic plan, of said switch, illustrating the differences between it and my previous switch. Fig. 5 is a plan of the auxiliary switch. Fig. 6 is an elevation of the same. Fig. 7 is a partial vertical section of the same, showing the details of construction. Fig. 8 is an interior view of the telephone-boxes, showing part of the electric circuits. Fig. 9 is a general diagram. Fig. 10 is a more complete diagram, and Fig. 11 is a detail diagram showing means for maintaining privacy of circuits.

In the said drawings, M is a switch-carrying frame or base in which is mounted an insulating-disk O, provided with a series of contact-points L. Supported in the frame M is a vertical spindle M′, upon the upper end of which are an arm M^2 and a disk M^3, while upon the lower end of said spindle is a secured arm having the end N in electrical contact therewith and the end N′ insulated therefrom. The ends N and N′ come into contact with the contact-points L. Loosely mounted about the spindle M′ and supported on the frame M is a ratchet-wheel M^4, provided with both spur and crown teeth. A magnet A, with its armature-lever A′ and pawl A^3, serves to turn the wheel M^4 by engagement with the spur-teeth thereof. The arm M^2 is normally in engagement with the crown-teeth, so that the turning of the wheel M^4 serves to also turn the spindle M′, and consequently the arms N and N′. Supported at a suitable place on the frame or base M is a magnet B, whose armature-lever B′ has a flexible end B^2, that normally rests next to the beveled edge of disk M^3, as shown in Fig. 3. At one place in the periphery of the disk M^3 is cut a notch B^3. The spindle M′ and the parts connected thereto have a normal position which is determined by contact between the arm M^2 and a stop M^5 on the base M. When in normal position, the notch B^3 comes in line with the lever B′. After the spindle M′ and its connected parts have been moved by the action of magnet A they may be returned to normal position by sending a current through magnet B, which action moves B′ and causes the flexible end B^2 to slide over the beveled edge and under disk M^3. Then as soon as the current is broken through B the spring B^4 tilts the lever B′ to raise the disk M^3, and consequently the arm M^2, free from the teeth of the wheel M^4. The spring M^6 then returns the spindle M′ to normal position, when the notch B^3 being in line with B^2 the parts settle down with M^2 again in contact with the teeth of the wheel M^4. The action of the magnet A is therefore to move the arms N and N′ by successive steps into contact with the points L, and the action of B is to release these arms and permit them to be returned to normal position.

The end of the lever A′ terminates in a hook A^2, that is arranged to engage and hold the armature-lever C′ of the magnet C. When the magnets A and C both operate at the same time, the release of the magnet A permits the hook A^2 to catch the lever C′ and hold it from engagement with the contact-point 26. The parts C, C′, and 26 are mounted upon but insulated from the base and from each other. A magnet D has its armature-lever D′ so arranged that when

the said magnet is energized the pawl A^3 is moved away from the teeth of wheel M^4, so that the operation of the magnet A will not turn said wheel and the levers or pointers N and N'. Secured to the lever A', but insulated therefrom, is a bent lever 66, to one arm of which is connected the spring 65 that retracts the armature from magnet A, and to the other end of which is fastened a piece of insulating material 66^a. Adjacent to 66^a are four insulated strips 67, 78, 79, and 81. The strips 79 and 81 are normally in contact with each other; but the tilting of the lever 66 breaks this contact, closes the contact between 78 and 79, and also between 66 and 67.

The auxiliary switch (shown in Figs. 5, 6, and 7) is very similar in its principles and construction to those of the main switch just described. The magnet F turns the pointer G step by step over the contact-points K, and the magnet E releases the connection between the said pointer and its propelling mechanism, so that the spring G' can return it to normal position. From the contact-points K and L, electrical connections are made in the manner hereinafter to be described. On the main switch are insulated binding-posts and contact-points 21, 24, 26, 28, and 72. The binding-post 74 on the auxiliary switch is in electrical connection with the base of that switch, so that a current passing through that post will go direct to the particular point K on which the pointer G happens to be. The levers A' and B' are also in electrical contact with the base of the main switch, so that the current is free to pass from either to N. The end N' being insulated is reached only by a wire 80. (Shown in the diagram.)

The telephone-boxes (shown open in Fig. 8) are similar in their general arrangement to those shown in my previously-mentioned patent, but differ somewhat in the details and in the arrangement of the circuits. On the front cover of the upper box is a crank 300 for turning the spindle 200 and gear 201, which meshes into a larger gear 202 on the spindle 203. Connected to and turning with the gear 202 is a ten-pointed star-wheel 204, which engages an insulated piece on the lever J. Normally the lever J is in the position shown in the drawings, with its shorter end in contact with the contact-point 41; but the rotation of the star-wheel 204 vibrates the lever J, so that the said shorter end makes alternate contacts between 5 and 41. A pin 205 on the wheel 204 comes into contact with the striker 206 of the bell 207 once during each revolution of said wheel. Consequently the bell 207 rings once for every ten times that the lever J connects to the contact 5. From the contact 5 a wire 14 runs to another contact 15, against which a spring 17 may be pushed by a push-button located on the front cover of the box and illustrated by P in Fig. 10. The receiver R is supported on the ordinary hook H, which in its lower position is in contact with the point 40 and in its upper position in contact with the points 7 and 54. The hook or lever H is so arranged that during ts descending motion it will move a secondary lever 208, so as to cause electrical contacts between the three pieces 61, 62, and 9, and will release these contacts before it reaches its lowest position. During the rising motion the lever H catches or hooks on to the lever 208, so that when it again descends it will again make contacts between the pieces 61, 62, and 9. From these points electrical connections run to the binding-posts 11, 3, and 19 and from these to other points hereinafter described. Also in the upper box is the ordinary induction-coil I*n*, and in the lower box are the generator S, the ringer Q, and the transmitter T. There are also certain binding-posts and contact-points, the purposes of which are evident from the drawings. The various parts mentioned are connected together by electrical connections in the manner illustrated in the drawings and which will be readily understood by following through the electric circuits hereinafter described. In Fig. 8 part only of these electric circuits are illustrated, the complete diagram appearing in Fig. 10.

In carrying my system of automatic telephone-exchange into operation I place a large number of main switches (one for each telephone) in a central exchange, and then to each group of nine or ten main switches I connect one auxiliary switch. From each one of the contact-points on an auxiliary switch a wire runs to the normal contact of a different main switch. Thus if the auxiliary switch has ten contact-points wires will run from these to ten main switches, while the eleventh main switch will be connected to the first point on the second auxiliary, the twenty-first main switch to the first point on the third auxiliary, and so on. The first contact-point of each one of the whole series of main switches is connected to a cable or main wire which runs to (or is connected to) the operating-magnet F of the first auxiliary and also has a branch 33 to the base or to the pointer G. In a like manner the second contact-point of each main switch is connected to the second auxiliary, and so on. The general plan of this arrangement is illustrated in Fig. 9, in which the several telephones are marked "No. 1," "No. 2," "No. 3," &c. Each main switch is placed directly under the telephone to which it belongs, and the main switches are shown arranged in groups of three. If subscriber at telephone "No. 2" wishes to talk to the one at telephone "No. 6," he would know by a suitable index or by an established system of numbering that it was on the second auxiliary and third point. He would therefore move his pointer N two steps, which would connect through 30^a and

31[a] to magnet F of the second auxiliary. He would then move the pointer G to the third point, which connects direct to the normal of switch No. 6. To talk, telephone No. 2 will be connected to the base of his own switch through line 20. Then the current would be N, 29, 30[a], 31[a], 33[a], G, 3rd K, 34, normal, (of No. 6,) N, base, 20, telephone No. 6, 12, A, 13, 100, 13, (of No. 2,) A, 12, telephone No. 2. If the same person had wished to call telephone No. 1, he would have moved pointer N (of his own switch) and G (of the first auxiliary) each one step, when he would have been in direct connection with telephone No. 1.

Referring now to Figs. 8 and 10, to move his pointer N on his own switch, so as to connect to the proper auxiliary switch, the subscriber first removes his receiver R from its hook H, which rises in the ordinary manner into contact with point 7. Then by means of the crank 300 on the front of the telephone-box he turns the star-wheel 204, so as to cause vibrations of the lever J and make electrical connections with the contact 5. At each contact between J and 5 the current flows as follows: from battery X, 1, 2, 3, 4, 5, J, 6, 7, H, 8, 9, 10, 11, 12, A, 13, 100, X. As each time a current from the battery X passes through the magnet A it moves the pointer N one step. It therefore follows that for each point on the star-wheel 204 that is moved past the lever J the connection is made to an auxiliary switch correspondingly distant from the first of the series. For example, if he wishes to reach auxiliary number forty-seven he would move forty-seven points on the wheel 204 past the lever J and cause the pointer N to reach the forty-seventh contact L. The ringing of the bell 207 facilitates the counting by tens, while a dial similar to that shown in my previous patent indicates the units. Having reached the required auxiliary, then to move the pointer G of that auxiliary he pushes the button P to make connection between 17 and 15, when the current flows as follows: battery X, 1, 2, 3, 4, 14, 15, 17, 18, 19, 20, 21, 22, D, 23, 24, 25, 26, C', 27, 28, A', base, N, (to the particular contact to which N has been moved,) 29, 30, 31, F, 32, 100, X. Each push on the button P moves the auxiliary pointer G one step, and consequently if the sixth contact of the forty-seventh switch is the one wanted he pushes the button P six times.

As thus far explained the subscriber who wishes to talk to another has removed his receiver, has moved the pointer of his switch to the forty-seventh contact-point, so as to reach the forty-seventh auxiliary switch, and has moved the auxiliary pointer to the sixth contact-point, which is in turn connected to the normal of a definite switch. We may assume that this switch is the one that belongs to telephone No. 47-6, in which event the number will tell how to make the proper connection. If the subscriber at telephone No. 47-6 is not then talking, his receiver is on its hook and his pointer N in its normal position. To call, the first subscriber turns his generator-crank, (at the same time pushing inward to make connection between 45 and 46,) when the current is as follows: S, 48, 36, Q, 35, 16, 17, 18, 19, 20, 21, 22, D, 23, 24, 25, 26, C', 27, 28, A', base, N, 47th L, 29, 30, 31, 33, G, 6th K, 34, normal of switch called, N, base, A', 28, 27, C', 26, 25, 24, 23, D, 22, 21, 20, 19, 18, 17, 16, 35, Q, 36, 37, 38, 39, 40, H, (hook being down,) 8, 9, 10, 11, 12, A, 13, 100, 13, (on switch of calling-telephone,) A, 12, 11, 10, 9, 8, H, 7, 6, J, 41, 42, 43, 44, 45, 46, 47, S. This calls the subscriber, who takes down his receiver, when with both hooks up the primary circuit at each telephone is closed as follows: from battery Y, 59, H, 54, 55, 56, 57, T, 58, Y. The talking-circuit is complete as follows: 12, 11, 10, 9, 8, H, 7, 6, J, 41, 42, 43, 44, 45, 49, 50, R, 51, 52, 53, 35, 16, 17, 18, 19, 20, 21, 22, D, 23, 24, 25, 26, C', 27, 28, A', base, N, 47th L, 29, 30, 31, 33, G, 6th K, 34, normal of switch called, N, base, A', 28, 27, C', 26, 25, 24, 23, D, 22, 21, 20, 19, 18, 17, 16, 35, 53, 52, 51, R, 50, 49, 45, 44, 43, 42, 41, J, 6, 7, H, 8, 9, 10, 11, 12, A, 13, 100, 13, (on calling-switch,) A, 12. The calling subscriber breaks all connections and returns his own switch and the auxiliary to their normal position by simply hanging up his receiver on its hook H. The descent of the receiver-hook tilts the lever 208 and makes an electrical contact between 61, 62, and 9. This completes a series of circuits, as follows: one circuit from battery X, 1, 2, 3, 60, 61, 62, 63, 19, 20, 21, 22, D, 23, 24, 25, 26, C', 27, 28, A', base, N, 47th L, 29, 30, 31, F, 32, 100, X; A second circuit from X, 1, 2, 3, 60, 61, 9, 10, 11, 12, A, 13, 100, X. The closing of the second circuit from the battery X through the magnet A makes electric connection between 66 and 67, and as this is done while 61 and 62 are in contact then a third circuit will flow from battery X, 1, 2, 3, 60, 61, 62, 19, 20, 21, 65, 66, 67, 68, B, 69, 100, X. The breaking of this third circuit releases the pointer N from its propelling mechanism and permits it to return to its normal position. The closing of the third circuit (through B) completes connection from 72 to base by way of B', when there is a fourth circuit from battery Z, 70, 76, 71, 72, B', base, N, 29, 30, 31, 33, auxiliary base, 74, 75, E, Z. This releases the pointer G and permits it also to return to its normal position.

It will be observed that as 61 comes into contact with 62 before it does with 9 the current through magnet D precedes that through magnet A. Consequently when A' is attracted it does not turn the pointer N from the contact belonging to the selected auxiliary, because the armature-lever D' has already moved the pawl A[3] out of contact with the wheel M[4], Fig. 4. Also breaking the connection between 28 and A' does not break the

circuit to base, because it was previously closed from 24 to base by way of D'. Consequently the second circuit does not break the first, but simply changes its course to D, 23, 24, D', base, &c. Representing these four circuits by the magnets through which they pass, the order in which they occur is D, A, B, E.

The method of preventing a subscriber who is using a particular auxiliary switch from having some one else come upon it and move its pointer G to some other point is shown in the supplementary diagram, Fig. 11. The pointer N moves over only one half of the circle of contacts L, while the other end N' goes over the other half. The manner of connecting the points over which N moves has been described, and shown in Fig. 10. A similar but separate series of connections is made for the points over which N' moves. These consist of a connection 80 from N' to 79 and connections 92 from each point L to corresponding cables 93. Referring to Fig. 11, if we assume that the subscriber at the left-hand switch has his pointer on the second contact L, and is consequently in possession of the second auxiliary switch, then if the subscriber at the right-hand switch (or any switch) should move his pointer to the second contact-point the following conditions would occur: The movement of A' while moving the pointer N' to the second contact and at the instant of connection between N' and the said second contact will break the connection between 79 and 81 and complete it between 79 and 78. The current will then flow from Z, 71, (of right-hand switch,) C, 77, 78, 79, 80, N', 92, 93, (to the left,) 92, N', 80, 79, 81, 82, 101, Z. This current through C draws C' in at the same time that A draws A' inward, and as both are released at the same time the hook A^2 catches and holds C', so as to break the circuit between 26 and C'. As the circuit through A for moving the pointer N does not pass through 26, this action does not prevent the second subscriber from moving his pointer along to some other auxiliary, and as another movement of A' without a corresponding movement of C' will release C' it is evident that the circuit will be broken at 26 only when the pointer N is in connection with an auxiliary already in use. As the circuits for moving the auxiliary pointer G for calling and for talking all pass through 26, it is evident that a subscriber who moves his pointer N into connection with an auxiliary already in use has his circuits left open and can do nothing but hang up his receiver and wait till that particular line (auxiliary) is at liberty. As hanging up his receiver under these conditions sends currents through both A and B, but not through 26, it follows that he releases C' and returns his pointer to normal position without having disturbed any one.

On the insulating-base O is a contact 90, which bears against N when in its normal position. From 90 a shunt 91 runs to 25, so that a circuit may be completed to N without having to pass through 26 or 28. This is a precaution for preventing the circuit through N being broken in case the contacts at 26 or 28 are open for any cause. As the movement of N from its normal position to any one of the contacts L breaks the connection to 90, this does not in any way interfere with the results of a circuit through C, as described.

What I claim is—

1. A spindle provided with two arms insulated from each other, means for rotating said spindle so as to move said arms, a series of contact-points in the path of each arm, electrical connections to one arm for establishing a talking-circuit therethrough, and other electrical connections to the other arm for preventing a second talking-circuit being established through the same connections.

2. In a main switch, a frame or base, a pair of pointers, supported on said frame and insulated from each other, a magnet for moving said pointers, a series of contact-points in the path of each pointer, electrical connections from the contact-points for one pointer to different telephones for establishing talking-circuits, and other electrical connections from the contact-points for the other pointer to wires for preventing a second talking-circuit being made through connections in use.

3. In combination with the base of an electric switch, a series of insulated contact-points, a pointer in electrical connection with the base, a ratchet-wheel and pawl for turning said pointer, a magnet and lever for operating said pawl, a second magnet and lever for disengaging said pawl from said wheel, an electric circuit having insulated contact-points at 24 and 28, electrical connection between 28 and base when the first lever is in normal position and from 24 to base when the second lever is attracted by its magnet, means for causing separate electric currents to be passing through both magnets simultaneously, and means whereby in the making of such simultaneous circuits the beginning of the circuit through the second magnet will precede that through the first magnet.

4. A series of main switches and a series of auxiliary switches, a magnet on each main switch for moving it into electrical connection with any auxiliary switch, a circuit-breaking device and a magnet therefor located at each main switch, electrical connections between the several circuit-breaking magnets, means for holding the circuit-breaking device open when simultaneous electrical currents pass through the propelling and circuit-breaking magnets of a main switch, and means for causing such simultaneous currents to flow when a main switch is moved to

electrical connection with an auxiliary switch to which there is an existing connection from another main switch.

5. A series of contact-points and a pointer therefor, a second series of contact-points and an insulated pointer therefor, connections from the first series of points to a corresponding series of auxiliary switches and from the second series of points to corresponding cables, a series of other pointers having corresponding contact-points similarly connected to the same auxiliary switches and cables, a separate propelling device for each pair of pointers for moving them synchronously into contact with any required auxiliary switch and the corresponding cable, and means whereby the placing of any other pair of pointers in contact with the same switch and cable will cause an electric current to pass through the selected cable and break the connection between the second pointer and the selected auxiliary switch.

6. In a telephone-exchange having a main switch for each telephone, an electrical division of such switches into groups, an auxiliary switch for each group, on each auxiliary switch a separate contact-point for each member of the group to which it belongs, connections between the contact-points and the corresponding members, a pointer adapted to be moved into successive contact with the several contact-points, a magnet and devices for so moving it, means for operating said magnet from any switch of the exchange so as to complete connections from the operating-point to a selected member of the group to which said auxiliary belongs, and means for preventing a similar operation from a second switch while the said auxiliary is in possession of the first.

7. A series of main switches, a series of insulated contact-points on each switch, a series of auxiliary switches less in number than the main switches, a series of insulated contact-points on each auxiliary switch, a wire extending from the first auxiliary switch and having branches to the first contact-point of each one of the main switches, similar connections from each of the other auxiliary switches to corresponding points on the main switches, and separate connections from each one of the contact-points of the auxiliary switches to the normal contact of a different main switch whereby said main switches are divided into groups, there being as many in each group as there are contact-points on each auxiliary switch.

8. In a telephone-exchange, a series of main switches divided into groups, an auxiliary switch for each group consisting of a pointer and devices for moving it into successive contact with a series of contact-points, a connection from each main switch of a group to a different contact-point on the auxiliary switch for that group, and a connecting-line from the pointer of each auxiliary switch to a position adjacent to the whole series of main switches, said connecting-lines each being provided with branches connecting to corresponding points on the main switches.

9. In a telephone-exchange, a group of main switches each of which is provided with a series of contact-points one of which points is called the normal contact-point, an auxiliary switch provided with as many contact-points as there are main switches in the group, connections from each contact-point of the auxiliary switch to the normal contact-point of a different main switch, a series of such groups of main switches each of which is provided with similar connections to a different auxiliary switch, and a separate connection from each auxiliary switch, each of which connections is provided with branches connecting to corresponding contact-points on all of the main switches in the exchange.

10. In a telephone-exchange having a main switch for each telephone, an auxiliary switch for a group of such switches, a separate insulated contact-point on the auxiliary switch for each main switch of such group, connections from each contact-point to the several members of the group, a pointer adapted to be moved into successive contact with the several points, a magnet and devices for so moving it, a second magnet for releasing it from its propelling mechanism, means for returning said pointer to its normal position when so released, and means for operating said magnets from or through any main switch of the exchange.

11. A spindle and devices for turning it, a disk on said spindle provided with a notch on its edge, a magnet provided with an armature-lever adapted to engage the under side of said disk and to pass through said notch when said disk is in normal position, means whereby engagement between said armature-lever and said disk will release said spindle from its propelling devices, and means for returning said spindle to normal position when so released.

12. A pointer and a propelling mechanism therefor, a circuit-breaking device operated by a magnet, a catch on the propelling mechanism adjacent to the circuit-breaking devices, and means whereby the simultaneous operation of said propelling mechanism and said circuit-breaking device will cause said catch to hold the circuit-breaking device open.

13. A ratchet-wheel and a pawl, a magnet and a lever for operating said pawl, a second magnet as C, an armature-lever therefor, an electric contact closed by said armature when free from said second magnet, a hook on the first-mentioned lever and adjacent to the second, and means whereby the making and breaking of simultaneous circuits through the two magnets will cause said hook to catch said armature-lever and break the circuit at said contact-point.

14. The combination with a switch and electrical mechanism for moving it, for releasing it and for preventing other switch connections from interfering with electrical connections made by said switch, of four insulated metallic strips, electrical connections to said strips, and an arm carried by the propelling mechanism for said switch and adapted to come into contact with said strips for making and breaking electrical circuits substantially as set forth.

Signed by me at Chicago, Illinois, this 19th day of September, 1898.

FRANK A. LUNDQUIST.

Witnesses:
H. L. KNIGHT,
FRANK O. SWANSON.