No. 868,933. PATENTED OCT. 22, 1907.

F. A. LUNDQUIST.

TELEPHONE EXCHANGE..

APPLICATION FILED MAY 20, 1904.

4 SHEETS—SHEET 1.

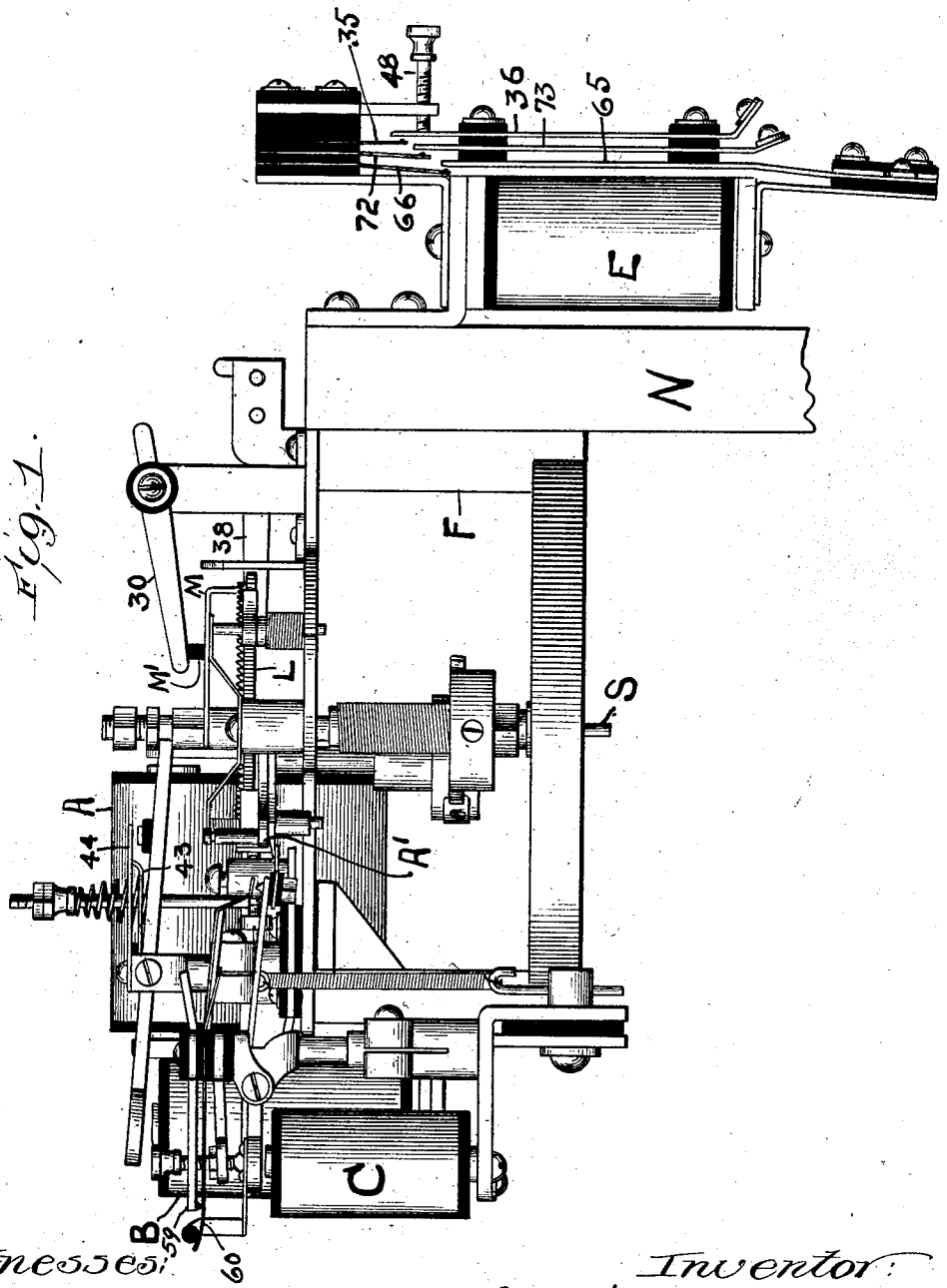

Fig. 1.

Witnesses:
Harry R. Kivlute
Ray White

Inventor:
Frank A. Lundquist
By Casper L. Redfield Atty.

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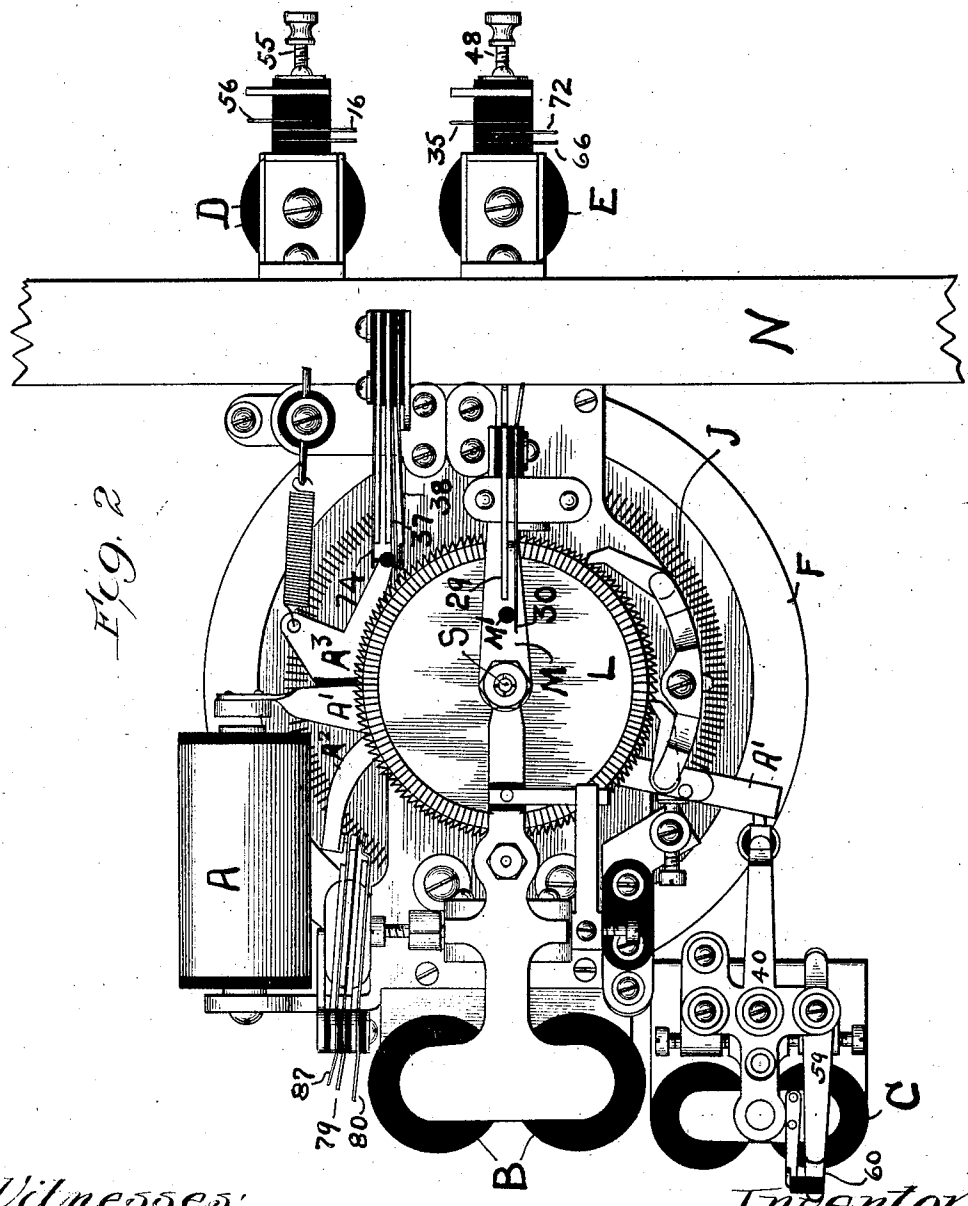

Fig. 2

Witnesses:
Mary E. White
Ray White

Inventor:
Frank A. Lundquist
By Casper L. Redfield Atty.

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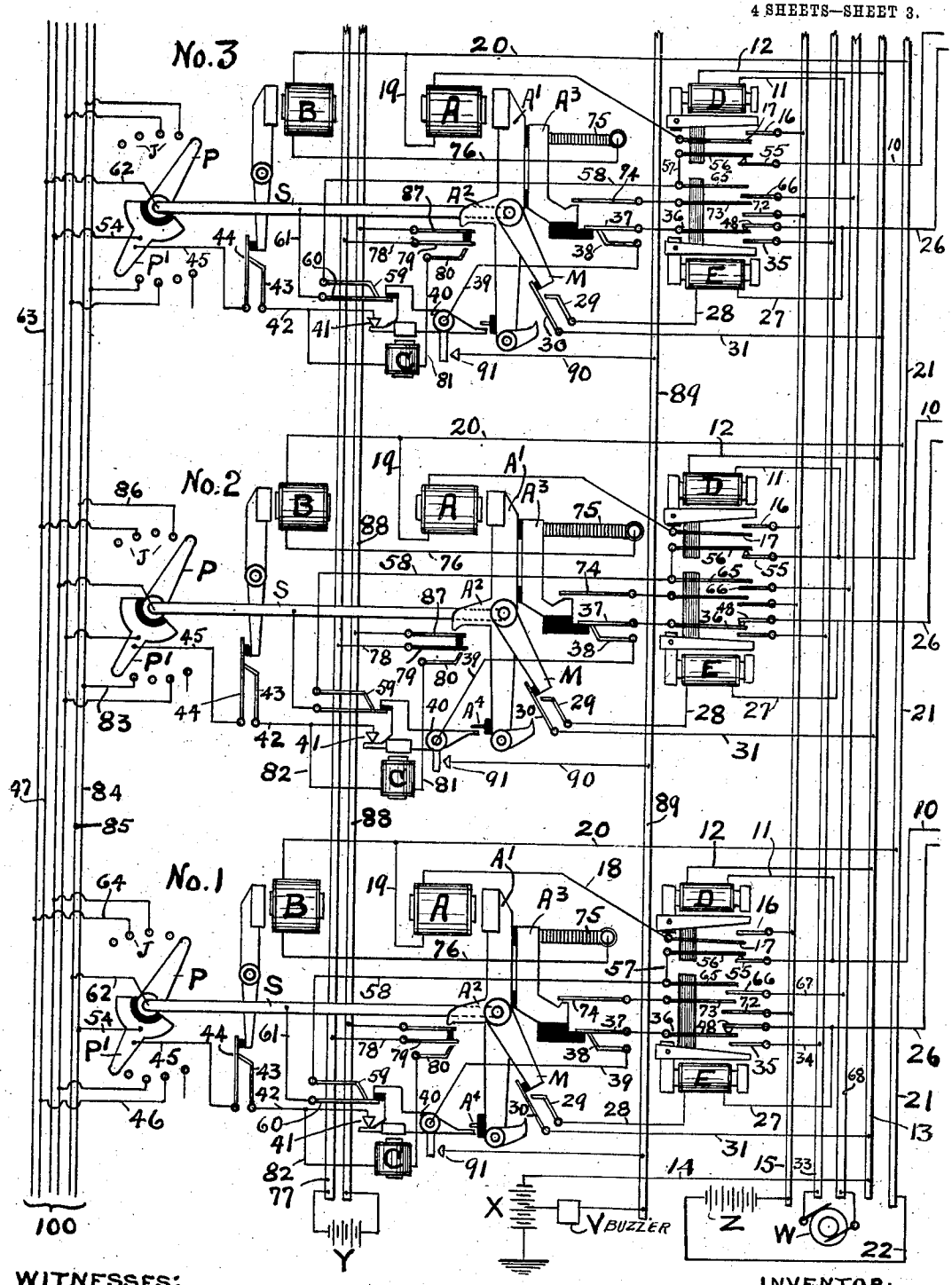

FIG. 3.

WITNESSES:
Carlos Escobar
G. W. Longard

INVENTOR:
Frank A. Lundquist
BY Casper L. Redfield
ATTORNEY.

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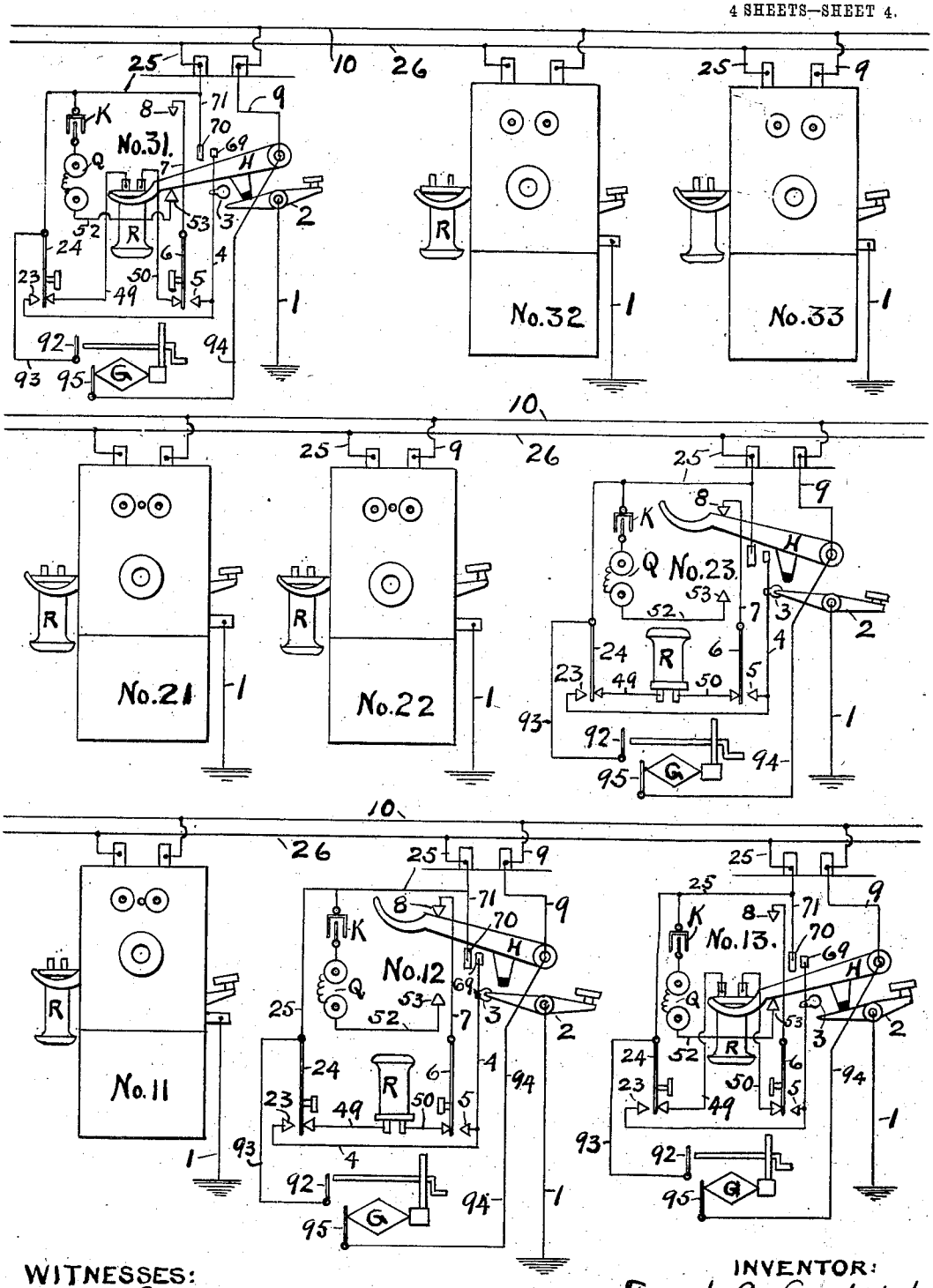

FIG. 4.

WITNESSES:
Carlos Escobar
G. H. Ongard

INVENTOR:
Frank A. Lundquist
BY Casper L. Redfield
ATTORNEY.

UNITED STATES PATENT OFFICE.

FRANK A. LUNDQUIST, OF CHICAGO, ILLINOIS.

TELEPHONE-EXCHANGE.

No. 868,933. Specification of Letters Patent. Patented Oct. 22, 1907.

Application filed May 20, 1904. Serial No. 208,893.

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, and State of Illinois, have invented certain new and useful Improvements in Telephone-Exchanges, of which the following is a specification.

My invention relates to telephone exchanges, and more particularly to automatic exchanges having party lines.

The present invention is not concerned with the particular form of switching mechanism used nor with the particular form of calling device by which the exchange is operated, but with the exchange as an exchange.

The object of the invention is improvement in the arrangement of devices and in an extension of the capabilities of the exchange with a minimum of additional devices.

In the accompanying drawings, Figure 1 is an elevation and Fig. 2 is a plan of the switching mechanism used, said switching mechanism being accompanied by two relays; Fig. 3 represents the central office apparatus for three local telephone stations, connected to a common party line that extends f o witching mechanism; and Fig. 4 represents a series of local stations on each of the lines extending from the central office. Figs. 3 and 4 taken together form a single diagram.

The switching mechanisms for exchanges of the present kind may be of any desired form, the one chosen for illustration being well known in the art and being substantially the same as shown in my Patents No. 606,764 of July 5, 1898; No. 672,327 of April 16, 1901; and No. 747,197 of Dec. 15, 1903. Detailed description is therefore unnecessary but a general description will be given which will be best understood by considering the diagram of Fig. 3 with the views of the switch as shown in Figs. 1 and 2.

In the lower part of a suitable frame F is a block of insulating material which carries a series of contact points J. In the upper part of the frame is a ratchet wheel L which is moved forward step by step by means of a magnet A and a pawl on its armature lever A^1. The spindle S which is secured to the ratchet wheel L has on its lower end two contact makers P and P^1. One of these is in electrical connection with the mechanism of the switch and the other is insulated therefrom as shown in Fig. 3. The operation of magnet A moves these contact makers over the contact points J.

The magnet B serves to release the contact makers from the propelling devices so that said contact makers may be returned to their normal position. The manner of this release and return is well known in the art, and has been described in the patents referred to. There is also on the switch a magnet C whose office is to prevent interfering connections. The operation and effects of the magnet C will be best understood by an examination of Fig. 3 and will hereinafter be described in tracing the electric circuits.

Secured to and moving with the spindle S is an arm M provided with a piece of insulation adapted to come into contact with a spring 30. When the contact makers P and P^1 are at their normal position the insulation M^1 strikes this spring 30 and breaks its electrical connection with spring 29, but as soon as the magnet A has advanced the contact makers one step the arm M leaves this spring and permits it to connect with the spring 29.

Secured to the armature lever A^1 and in electrical connection therewith (see Fig. 3) is an arm A^2 which makes electrical connection with a spring 87 when the armature is attracted, and also closes spring 79 to spring 80. Insulatingly connected to A^1 is an arm A^3 which, when the armature is attracted, makes electrical connection with a spring 74, and also opens the electrical connection between springs 37 and 38.

The switching mechanisms are attached to a board N and each switching mechanism is provided with relay magnets D and E. For convenience and condensation these relays have their armatures parallel with their cores and each carries a series of contact springs. The construction of these relays is best seen in Figs. 1 and 2, and their operation is best understood by the diagram in Fig. 3. They are alike except for the number and arrangement of their contact springs and this difference is readily seen in Fig. 3.

In arranging a telephone exchange according to this system a series of switching mechanisms are arranged in a row or in any convenient manner and these switching mechanisms are interconnected in the usual way as by the bank of wires 100. From each switching mechanism a pair of wires extend out to form a talking circuit and to each pair of wires there are connected as many local stations as may be desired. In Fig. 4 there are shown three stations on each pair of wires, part of which are shown diagrammatically and part of which are shown only by their telephone boxes. For convenience, the switching mechanisms are marked No. 1, No. 2 etc. The stations connected to switch No. 1 are marked No. 11, No. 12 etc. Those connected to switch No. 3 are marked No. 31, No. 32 etc.

At the central office there are batteries X, Y and Z, and a generator W commonly called ringer pole changer. There is also a "buzzer" V which is connected to an intermediate part of battery X so that when said buzzer is operated it receives only part of the energy of the battery. Running through the length of the central office, or so much thereof as is used for switching mechanisms, are a series of metal strips 21, 89 etc. which are connected as shown to the different sources of electricity and also to the different devices to be electrically operated. They are simply convenient conduc-

tors. At each local station there are receiver R, hook H, ringer Q, condenser K, generator G, and keys, contact points and connections as will be described hereinafter.

Assuming that the subscriber at station No. 12 wishes to call the one at station No. 31, he will know by the particular form of numbering here illustrated that he will have to go to switch No. 3 and use whatever ringing that the adopted code calls for to get the first station on party line No. 3. Ordinarily it will be one ring for the first station, two rings for the second station, and so on. Removing his receiver R the subscriber at station No. 12 will first press key 2 so as to move it into connection with contact point 3, at which place it stays until removed by a descent of the hook H, and then press the key on spring 6 so as to make a momentary contact with contact point 5. When this occurs a current flows from battery X at central through ground to 1 at station No. 12, 1—2—3—4—5—6—7—8—H—9—10—11—D—12—13—14—X. This operates relay D breaking connection between springs 55 and 56, and closing connection between springs 17 and 16. When this closure takes place a current flows Z—15—16—17—18—A—19—20—21—22—Z. This moves the contact makers P and P' forward one step and also moves the arm M so as to permit springs 29 and 30 to close connection with each other. As it is the third line that is wanted the operation of closing spring 6 to contact 5 is repeated twice more. When the proper connection is reached the subscriber presses the key that closes spring 24 to contact point 23 when a current flows: X through ground to station No. 12—. 1—2—3—4—23—24—25—26—27—E—28—29—30—31—13—14—X. This operates relay E breaking connection between springs 36 and 48, and making connection between springs 36 and 35 and between springs 73 and 72 and also between 65 and 66. When this occurs a current flows:— W—33—34—35—36—37—38—39—40—41—42—43—44—45—P'—46—47 to switch No. 3,—54—45—44—43—42—41—40—39—38—37—36—48 — 26 to local station No. 31, —25—K—Q—52—53—H—9—10—55—56—57—58—59—60—61—S—P—62—63 back to switch No. 1, —64—P—S—61—60—59—58—65—66—67—68—W. This circuit is traced through No. 32, No. 33 and all other local stations on the same line. As it is the first station on the line that is wanted, only one ring is made, but if some other station is wanted then the ringing is repeated the required number of times by again pressing the key that closes 24 to 23. It will be observed that this ringing goes out only on the called line and not at all on the calling line. This is a very important matter because if the ringing circuit went out on two lines no code of ringing could be established that would not produce confusion.

The called subscriber removes his receiver R when the talking circuit is as follows:—R of station No. 12,—49—24—25—26—48—36—37—38—39—40—41—42—43—44—45—P'—46—47— to switch No. 3,—54—45—44—43—42—41—40—39—38—37—36—48—26—25 of station No. 31,—24—49—R—50—6—7—8—H—9—10—55—56—57—58—59—60—61—S—62—63— back to switch No. 1,—64—P—S—61—60—59—58—57—56—5—10—9 of station No. 12,—H—8—7—6—50—R. When the calling subscriber at station No. 12 hangs up his receiver the hook in descending makes a momentary contact with plates 69 and 70 when a current flows as follows:— X through ground to station No. 12,—1—2—3—69—70—71—25—26—27—E—28 — 29 — 30—31—13—14—X. Also a branch from 69—H—9—10—11—D—12—13—14—X. One of these branches closes the circuit through A as previously described and causes A^3 to engage the spring 74 at the time when the operation of E closes connection between the springs 73 and 72. When this occurs a current flows:— Z—15—72—73—74—A^3—75—76—B—20—21—22—Z. This releases the contact makers P and P' and permits them to return to their normal position.

In case a subscriber on some other line, as the one at station No. 23, should move his switch to connection with the switch of the calling line, then a current would flow as follows:—Y—77—78 of switch No. 2,—79—80—81—C—82—42—43—44—45—P'—83—84—to 54 of switch No. 1. P'—45—43—42—41—40—39—38—37—36—48—26 to station No. 12,—25—24—49—R—50—6—7—8—H—9—10—55—56—57—58—59—60—61—S—62—85—86—P—S—A^2—87—88—Y—. In case the connection was to the called line instead of the calling line then the circuit would be the same except that it would go through the called station instead of the calling station.

By observing the fact that the movement of the contact makers P and P' to any given position occurs when the armature lever A^1 is attracted and that attraction causes A^2 to make electrical connection with 87, it will be seen that this action produces a closed circuit through the magnet C of the moving switch when the contact makers of that switch connect to a line having its receiver removed. The simultaneous operation of magnets A & C of a switch cause the pin A^4 on the lever A^1 to move out of the way of the adjacent end of the armature lever 40, and when A^1 is released 40 is caught behind A^4 and the connections between 40 and 41 and between 59 and 60 are broken at the interfering switch. As all talking circuits for a given switch go through these points, it is evident that a subscriber on one line cannot break into any other line that is busy. This does not prevent him, however, from moving past the busy line to some other line because upon the next movement of A^1 the projection A^4 moves away from 40 and permits connection to be reëstablished between 40 and 41 and between 59 and 60.

When the armature lever 40 is caught behind A^4 it is in contact with point 91 when a current flows:—X—V—89—90 of interfering switch No. 2,—91—40—39—38—37—36—48—26—27—E—28—29—30—31—13—14—X. There is a branch of this from 26 to 25 of station No. 23,—24—49—R—50—6—7—8—H—9—10—11—D—12—13—14—X. These two branches are operated by only a part of the battery X, and the operation of the buzzer V in one branch produces a buzzing sound in the other branch and thus notifies the subscriber that he has moved his switch to connection with a busy line.

Referring back now to the circuit given through the magnet C of switch No. 2 and noticing that point where it reaches line 26 leading to station No. 12, it will be seen on the diagram that there is a branch from 26 to the return line 10 as follows:—26—27—E—28—29—30—31—13—12—D—11—10. This occurs only for the switching mechanism of the calling line because that is the only one that has its relays D and E bridged by

reason of the closure of 29 and 30 caused by moving the arm M away from its normal position. The first object of bridging these relays is to bring E into a circuit including one side of the line and ground, so that it may be operated. The second object, and the one under immediate consideration, is to furnish an extra path at the switch of the calling station for any current flowing through the magnet C of an interfering switch, and thus reduce the resistance in the line beyond such magnet. To this end the magnet C is so adjusted that it will operate if the resistance is sufficiently reduced, but will not operate if it is not reduced. Noticing again this circuit through magnet C of switch No. 2 it will be seen that it reaches the contact maker P^1 of switch No. 1. As this contact maker is on the contact point which is connected through 46 and 47 with the contact maker P^1 of switch No. 3, it will be evident that there is another branch to this circuit that passes through station No. 31 in the same way that it was traced through station No. 12. There is no sub-branch, however, through the relays of switch No. 3 because this switch has not moved from its normal position and the contact springs 29 and 30 are open. From this it will be seen that when a subscriber moves his switch to any part of a talking circuit, either by connecting to a called or calling switch, he places his private magnet C in a circuit having three branches. One of these branches is through the relays of the calling switch, the second is through the receiver of the calling station, and the third is through the receiver of the called station. If the receiver is on its hook then the circuit is to the ringer Q and not to the receiver, but there is a condenser K in the branch to the ringer, and a condenser is an open circuit for a battery current. As a consequence, when a subscriber moves his switch to any part of a talking circuit he places his magnet C in a circuit having its resistance sufficiently reduced to cause that magnet to operate, but when he moves it to any other connection than an established talking circuit the magnet will not operate.

In case the subscriber at station No. 12 wanted to call some one on his own line, as the subscriber at station No. 13, instead of some one on a different line, he would not move his switch by pressing contact spring 6, but would turn his generator G according to the code adopted for that station, which in this case we have assumed to be three rings. The current would flow:—G at station No. 12,—92—93—25—26 to station No. 13,—25—K—Q—52—53—H—9—10—back to station No. 12.—9—H—94—G. This would call the subscriber at station No. 13 who, upon removing his receiver, would be in direct communication with the subscriber at station No. 12.

In the absence of the subscriber having moved his switch, the ringing from generator G is confined entirely to the party line within which it originated. This will be evident from the fact that the line 26 leads directly to the contact maker P^1 which is not on any contact point, and its connection 54 is not connected to any other line unless some other switch has been moved to it. In that case the line on which the calling station was located would be a busy line and a subscriber on it would not break in. To avoid this kind of breaking in each subscriber listens in his receiver to see if the line is busy before he either moves his switch or operates his generator.

For the purpose of making matters somewhat clearer the principal features of the exchange will be briefly reviewed. In the central office are a series of electrically operated switches which are interconnected in the usual way. From each switch there extends a party line to each of which are connected a series of local telephone stations. The subscriber at any station can operate the central office switch connected to his party line so that said switch will make connection to any other switch, and hence to any other party line. By means of the devices provided he can ring or signal the selected party line without ringing or signaling on his own line, and by a suitable code of signals can call any particular station on the party line that he may desire. By the devices provided no subscriber on a third party line can place his line in telephonic connection with either a called or calling line. In addition to the means by which a subscriber on one party line confines to some other line the signals which he causes to be sent, there is means by which he may confine the signals to his own line. In other words, in an automatic exchange having a series of lines running therefrom, each line of which has several local stations connected thereto, there is provided means by which a subscriber at any other station does not cause his signals to travel on any line except the one on which the desired station is located. This result is accomplished by using central energy when a subscriber on one line causes signaling on some other line, and by using local energy when he causes signaling on his own line.

What I claim is:—

1. In an automatic telephone exchange, a plurality of lines leading to a central office, a switching mechanism for each line and operable from a station on the line, a magnet associated with each switching mechanism by the operation of which magnet the associated switching mechanism is prevented from making interfering connections with other lines, a source of electricity, a circuit for each magnet connected to said source and normally having sufficient resistance to prevent the operation of its magnet, and means by which upon moving any switching mechanism to an interfering connection the resistance in the circuit for its associated magnet will be automatically reduced sufficiently to permit the operation of said magnet.

2. The combination with the lines and switching devices of an automatic telephone exchange, of a non-interference magnet associated with each switching mechanism and operable by a reduction of the resistance in its circuit, a source of electricity provided with circuit connections for each magnet, and means controlled by the movement of each switching mechanism through interfering connections made by it for varying the resistance in the circuit of the associated magnet so as to break such interfering connections.

3. The combination with the lines and switching mechanisms of an automatic telephone exchange, of a non-interference magnet associated with each switching mechanism and operable by a reduction of the resistance in its circuit, a source of electricity provided with a circuit for each magnet, means by which upon any switching mechanism being moved to connection with a line other than its own, it will establish an incomplete branch circuit, and means by which upon any other switching mechanism being moved to the connection established by the first moving switching mechanism, the said branch circuit will be connected to the magnet of the second moving switching mechanism so as to reduce the resistance in the circuit of the magnet thereof.

4. The combination with an automatic telephone exchange consisting of a series of electrically operated switches, operating magnets and an operating line for each switching mechanism by means of which it is advanced from and returned to normal position, and two

relays for each switching mechanism for controlling its movements, of a magnet for each switching mechanism for preventing its switching mechanism from making an interfering connection and so arranged that it will be operated when the resistance in the circuit therefor is reduced so as to be less than its normal amount, means by which upon the first forward movement of any switching mechanism its relays will be bridged across the operating line so as to furnish an electrical path which will reduce the resistance in the circuit of the non-interference magnet of any other switching mechanism which moves to an interfering connection with the first moving switching mechanism, and means by which such bridge will be broken upon the return of the switching mechanism to its normal position.

5. The combination with a series of switching mechanisms and a line from each by which it may be operated to select some other, of a non-interference magnet and a circuit therefor for each switching mechanism and so arranged that impulses will operate it if the resistance of its circuit is reduced below its normal but will not operate it if the resistance is not so reduced, relays for each switching mechanism, and means by which upon moving one switching mechanism to select another switching mechanism the relays for the selecting switching mechanism will be bridged on its operating line so as to furnish an electrical path which will reduce the resistance in the circuit for the non-interference magnet of any switching mechanism which moves to interfering connection with the selecting switching mechanism.

Signed at Chicago Ill this 16th day of May 1904.

FRANK A. LUNDQUIST.

Witnesses:
WM. A. ROWLAND,
C. L. REDFIELD.