G. W. LORIMER.

AUTOMATIC TELEPHONE EXCHANGE.

APPLICATION FILED APR. 24, 1907. RENEWED AUG. 7, 1911.

1,020,211.

Patented Mar. 12, 1912.

2 SHEETS—SHEET 1.

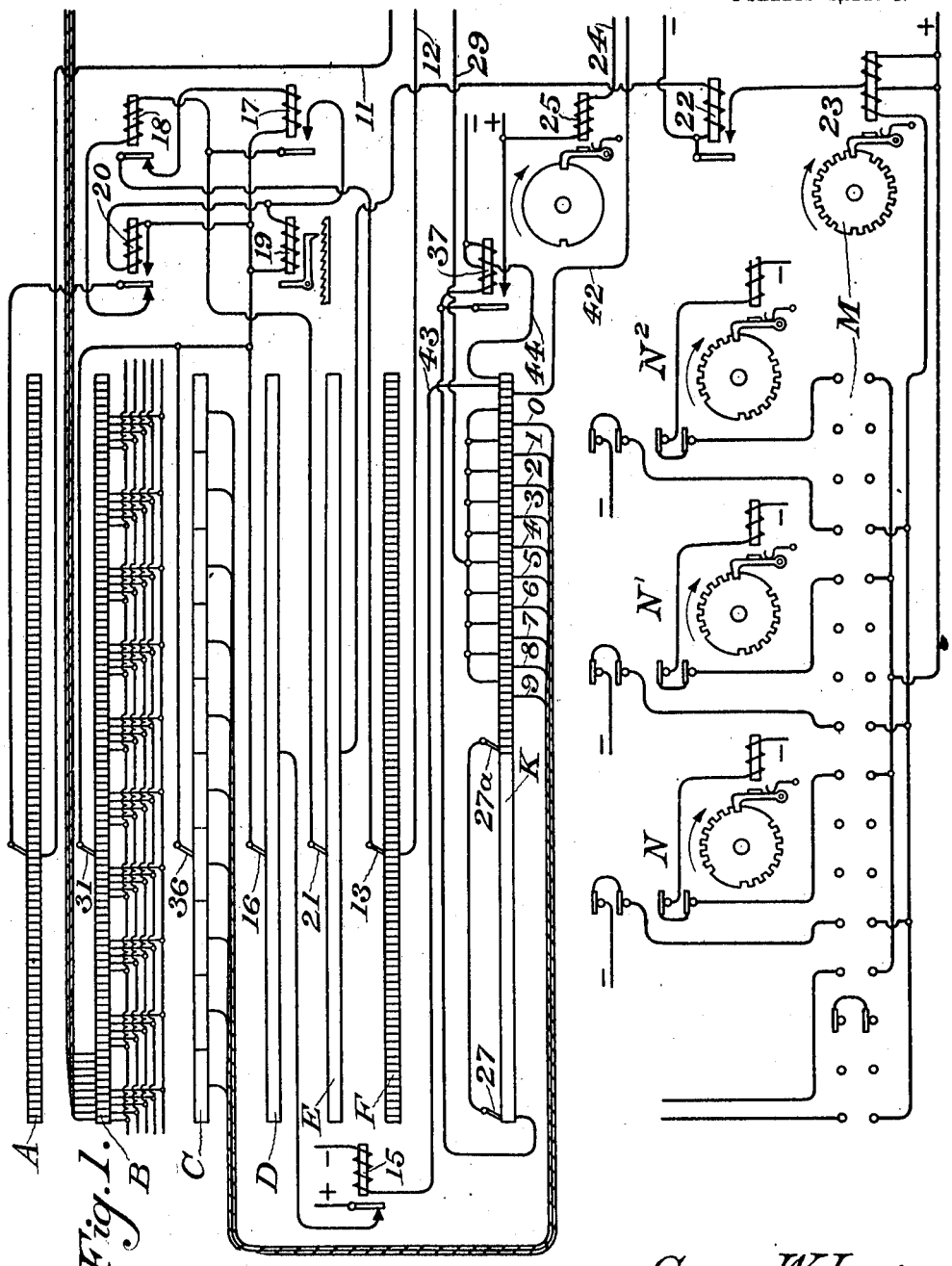

Fig. 1.

Witnesses:
Harael C. Prado.
David S. Kellogg

George W. Lorimer,
Inventor.

by McNeely & Miller
Attorneys

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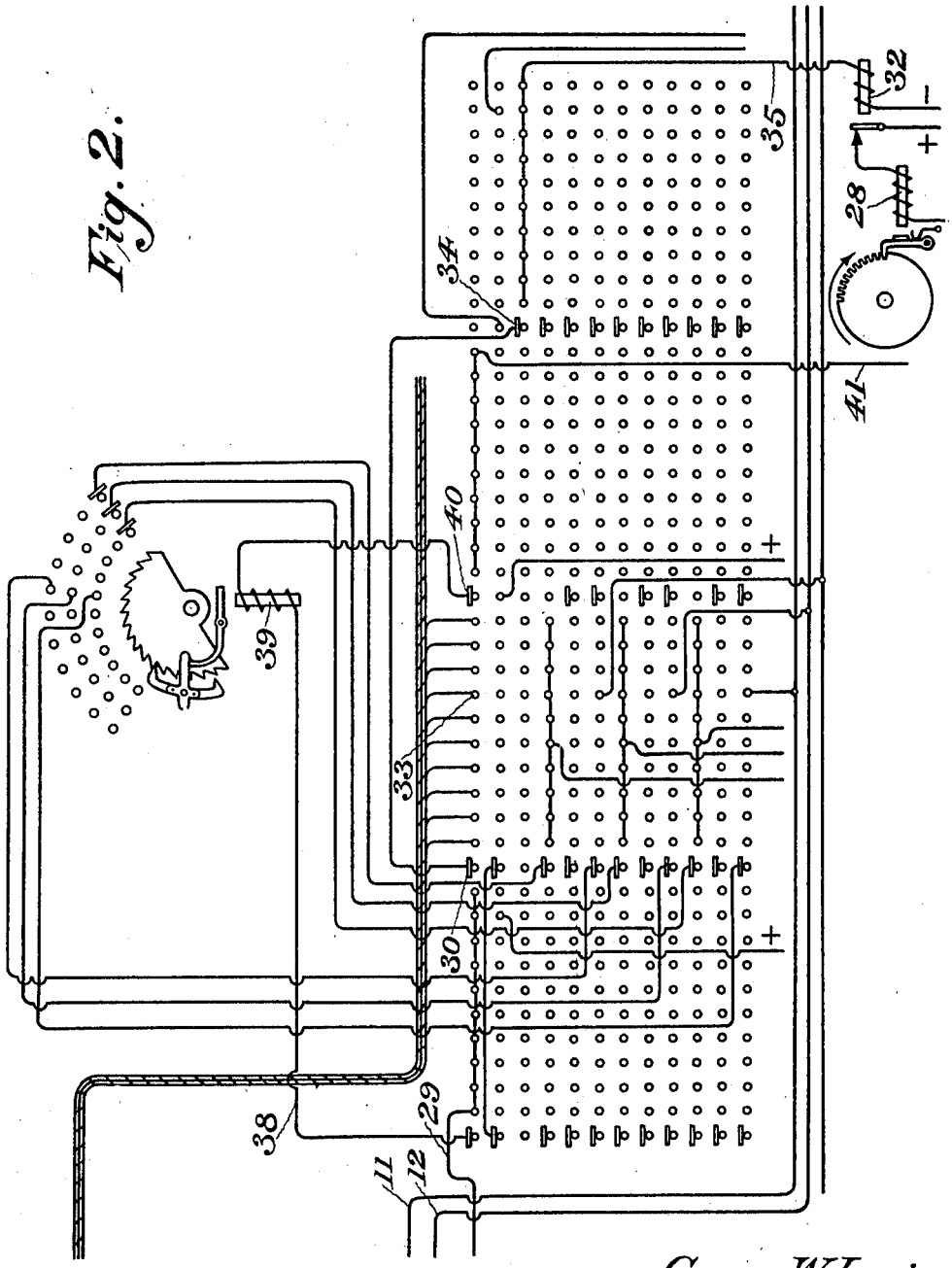
2 SHEETS—SHEET 2.

Fig. 2.



Witnesses:
Harael C. Prado
David S. Kalfish

George W. Lorimer,
Inventor.
by McNeill & Miller.
Attorneys

UNITED STATES PATENT OFFICE.

GEORGE W. LORIMER, OF PIQUA, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTERN ELECTRIC COMPANY, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE-EXCHANGE.

1,020,211. Specification of Letters Patent. Patented Mar. 12, 1912.

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To all whom it may concern:

Be it known that I, GEORGE W. LORIMER, a citizen of the United States of America, and a resident of Piqua, county of Miami, and State of Ohio, have invented a new and useful Improvement in Automatic Telephone-Exchanges, of which the following is a specification.

My invention relates to automatic telephone exchanges, and has for its object the prevention of undesirable acts on the part of the automatic telephone switching machines in the event of derangement of the telephone line by which the automatic mechanism is controlled.

In the system of operating automatic telephone exchanges invented by James Hoyt Lorimer and myself, and described in British Patent No. 8648 of 1901, there are provided a plurality of similar groups of apparatus, each constituting a connecting unit somewhat analogous to a cord circuit in a manual telephone switchboard. Associated with the group of subscribers' lines are several of these connecting devices; each of which is capable of being taken by a calling line for the purpose of setting up a desired connection with another line.

In our system, the act of calling upon the central office apparatus to appropriate one of these units of apparatus,—which we have called divisions,—is instituted by changing the potential of one of the line conductors by making an electrical contact for that purpose at the substation. This may be, for example, the grounding of one of the conductors. Responsive to this change in condition, the device which we have called the "decimal indicator" stops with a brush in contact with a commutator segment connected to the grounded wire of the calling line, and remains so stopped until the calling act has been fully interpreted by the primary connector and other devices, when the decimal indicator is freed from its holding and caused again to start in rotation, capable of use for any other calling line within it.

As the calling act, of any line in a given group embodied in a given decimal indicator, is the grounding or other changing of potential of one wire of the line, for a wire of any line to be changed in that manner by acts other than the act of the subscriber, will stop the decimal indicator; and, in consequence, other acts in the central office could not result in the placing of a call, because the other necessary things at the substation would not have been done. Furthermore, while the decimal indicator will stop when a ground is placed upon a wire of a line in the normal operation of our system as disclosed in the patent referred to, it will proceed in rotation only by the removal of that ground from the line wire, and this takes place when a call actually is instituted and a connection proceeded with; but, as the removal of the ground is requisite to a restarting of the decimal indicator, and as, if it be not removed, the division starter, decimal register controller, and other elements of apparatus, will perform undesirable successions of operation, certain undesirable results ensue. For example, a ground placed upon a wire of the line by accidental means, will cause a division to be appropriated in the normal manner, but instead of doing only this, the continued holding of the decimal indicator will cause other idle divisions to be appropriated, with the result that when all those which are not engaged with other connections have been appropriated, the apparatus will still further harmfully operate by awaiting the release of properly utilized divisions and will appropriate them in turn as fast as this release takes place.

For these reasons, I have devised mechanism and circuits which prevent the successive selection of idle divisions by a line which is not instituting a call, but which is in trouble by having one of its conductors grounded or otherwise put in the same electrical condition as the temporary condition of a truly calling line.

My invention is illustrated in the accompanying drawings, in which similar reference characters refer to similar parts in the two views, and in which—

Figure 1 illustrates the decimal indicator, the decimal register controller, certain parts of rotary switches and of the division starter, and Fig. 2 illustrates a primary connector, with its associated decimal register. When Fig. 1 is placed at the left of Fig. 2, those circuits which pass from one view to the other will be in registry.

Referring now to Fig. 1, the decimal in-

dicator,—of which it will be remembered there is one for each group of, say, one hundred lines and each associated group of connecting divisions,—is shown in the six developed commutator rings lettered A to F. Of these, A is the guard ring commutator, containing one segment for each line of the group, and to each guard ring such a conductor as 11 is led for each line served by this piece of apparatus. B is a commutator ring divided into one hundred segments, divided into ten sets of ten segments each. Corresponding segments of each ten are connected to each other,—segment #1 of one group of ten, for example, being connected to each of the nine other first segments in the remaining nine groups. Conductors run also from each segment of a group of ten, and therefore from each segment of all such groups of the ring B, to a set of ten consecutive contacts in each primary connector, as shown in Fig. 2. The ring C is composed of ten segments connected to ten segments in the decimal register controller K. The rings D and E are solid collecting rings adapted respectively to supply positive and negative potentials, through brushes, to the mechanism of the decimal indicator. The ring F is similar to the ring A, but to its segments are connected conductors of the subscribers' lines, one conductor of each line being led to a segment corresponding in position to the guard segment of that line in the ring A. The conductor 12 is such a conductor of such a line, and all wires leading to the ring F are those referred to herein as the conductors L′ of the lines. The developed commutator ring K, with its associated brushes, conductors, relay and clutch, form the decimal register controller, whose office it is to operate the decimal register of a division to assist in the identification of the calling line. There is one decimal register controller for each decimal indicator, thus serving all of a group of lines, and controlling the decimal registers of all of the corresponding group of divisions. M is the division starter with its clutch, only such contacts being shown as relate to the starting of the rotary switches. The latter are conventionally shown, three in number, as N, N′ and N². Each of these rotary switches is associated with a division, there being a plurality for each group of one hundred lines or fewer, while the division starter M is, like the decimal indicator, singular per group of lines.

The subscriber's telephone instrument is provided with means enabling the subscriber to set levers to positions indicating the numerical designation of the line he wishes to call, and thereafter move a handle or lever so as to wind up a clock train and make a ground or other contact on the wire L′ of his line. Assuming this wire L′ after entering the central office to be conductor 12, and that the brush 13 of the decimal indicator has engaged that segment, it will be seen that positive potential from the central office source may cause current to flow through the armature and back contact of the relay 15, via ring D, the brush 16, winding of relay 17, back contact of relay 18, the brush 13, and the wire 12, to ground or negative potential at the substation. Presuming that the negative terminal of the central office source of current is grounded, it will result that the relay 17 will be operated, and by this local circuit both the magnet 19 and the relay 20 will be operated. The magnet 19 controls the clutch of the decimal indicator, and its operation will stop the latter, holding the brush 13 in connection with the segment of wire 12. But the operation of the clutch 19 was over a circuit as follows: armature of relay 15, ring D, brush 16, clutch 19, contact and armature of relay 17, brush 21, ring E, relay 22, to negative terminal of source. The relay 20 is simply in shunt with the clutch magnet 19; the relations of the windings of 19, 20 and 22 are such that all three magnets will operate at once, and as a consequence of the operation of 22 the clutch 23 of the division starter will be drawn out of the tooth of its ratchet wheel. The division starter now operates, and by passing its brushes over contacts within its selector switch, operates the clutch of the first idle rotary switch whose circuit is so engaged. The rotary switch so started moves its brushes from the normal to the first stop position, and in doing so places negative potential momentarily on the wire 24. This leads through the clutch magnet 25 of the decimal register controller to positive potential, operating 25. When the circuit of 24 is opened in the rotary switch, the clutch tooth is released and the pawl allowed to drop on the periphery of the clutch disk, into the tooth of which it cannot fall again until the disk has made at least one-half revolution, as there are but two teeth in the periphery. As a result of the withdrawal of any pawl from the disk of a clutch, as 23, 25, N, etc., the disk is coupled to a constantly rotating shaft passing through it, as is well known as a prominent feature of our system in general.

The response of the decimal register controller to the withdrawal of the pawl of the clutch 25, is to move its connected brushes 27 and 27ª a half revolution over the ring K, ending with the brush 27 on the first segment of the subdivided portion, and the brush 27ª at the left of the solid portion. The decimal register controller is common to all divisions or connecting switches, being connected with each in turn when the rotary switch of that division stands in its

I position and forming then in conjunction with its thus associated connecting switch a complete call answering device, being guided in its acts of answering by the position of the brushes of the decimal indicator. The decimal indicator thus is a call indicator or call finder, indicating its discovered call decimally to the answering device, the answering device consisting of the primary connector which is aided by its auxiliary device, the decimal register controller. For the purpose of this application, the primary connector may be defined as a call-answering device, the decimal register controller being considered auxiliary thereto, and a subsidiary part thereof, the two jointly being a connecting device when operating together.

During the movement of the brushes 27 and 27ª, caused by an impulse from the rotary switch in stepping from its normal to its first position, a similar rotation has been going on in the brushes of the primary connector of Fig. 2. This was caused by the operation of the clutch 28, which was energized by a negative contact in the rotary switch, simultaneous with that on the wire 24. The primary connector so moving will continue until the brush 30 engages the conductor on which the brush 31 of the decimal indicator is resting. This brush, by its position on a segment of a group of ten in B, indicates the numeral in units place of the number of the calling line. As the brush 31 is stationary on that segment, the engagement of the brush 30 with the contact will energize the relay 32 by current via D, 16, 31, 33, 30, 34 and 35. The armature of relay 32 breaking its circuit, the clutch 28 will reëngage, stopping the primary connector in position to connect with any line within it having a units numeral the same as that of the calling line. The passing of the brush 27ª over the succession of small segments of K, places negative impulses successively on the wires 9, 8, 7, et cetera, to O, interspersed with similar impulses on the wire 29, until in its succession, 9, 8, 7, et cetera, the segment is found on whose conductor the brush 36 is resting in the ring C. When such a contact is made, the relay 37 will be energized by current over D, 16, 36, and its connected segment in K, 27ª, 27, 37 to negative potential. As the relay 37 has two windings, both connected to negative potential, the closing of its armature contact will lock it closed, because of the positive potential on the contact. The potential of the solid half of the commutator K will now be made positive, and successive contacts of 27ª with portions of 29 will give positive instead of negative impulses. As all brushes of the primary connector have been moved from normal position, the wire 29 now is connected over 38, through the escape magnet 39, brush 40, and conductor 41 to negative potential. This connection to the negative terminal is accomplished in the rotary switch, and is true only in the position of the rotary switch which exists during this portion of the cycle.

During the steps of the brushes 27 and 27ª along the commutator ring K prior to the energization of the relay 37, negative potential was connected through the brushes to the wire 29, the wire 29 thus having negative potential connected to both ends with no current resulting; however, subsequent to the energization of the relay 37, each contact of the brush 27ª with the wire 29 results in a flow of current over the path from positive battery terminal, through contact and armature of relay 37, solid half of ring K, brushes 27 and 27ª, conductor 29, conductor 38, escape magnet 39, brush 40 and conductor 41, to the rotary switch and thus to negative battery terminal, resulting at the end of the travel of the brushes 27 and 27ª in the successive energizations of the escape magnet 39 as many times as there are segments connected with wire 29 remaining after the energization of relay 37.

After the brush 27ª has passed the ninth and last contact of the conductor 29, it engages the segment associated with conductor 42 and thus closes a path for current from positive terminal of battery, through contact and armature of relay 37, brushes 27 and 27ª, and conductor 42 to the clutch magnet of the rotary switch pertaining to the active division, thus setting that rotary switch forward to promote the next step in the cycle of acts at the central office required for the ultimate connection of the calling subscriber to the desired line. Upon the next step, the brush 27ª makes connection with conductor 43 and completes path for current as follows: from positive terminal of battery, through contact and armature of relay 37, brushes 27 and 27ª, conductor 43 and winding of relay 15 to negative terminal of battery, energizing relay 15 and breaking its armature contact which thus deënergizes the clutch magnet 19 and permits the group of brushes 31, 36, 16, 21, 13, to step out of registration with the segment of the calling line just served. On its next step, the brush 27ª closes a path through the alternative winding of the relay 37; current flowing through the alternative winding neutralizes the magnetic field produced by the current flowing through the winding formerly identified, and the armature of the relay 37 is released, restoring the initial conditions of the decimal register controller. By the deënergization of the clutch magnet 19, the decimal indicator has been restored to its initial condition, viz., to rotary motion with its brush 13 searching for the calling condition upon a line.

So long as the clutch magnet 19 remained energized it was held by current flowing over the path from positive terminal of battery, through armature and contact of relay 15, collector ring D, brush 16, winding of magnet 19 in shunt with winding of relay 20, contact and armature of relay 17, brush 21, collector ring E, and winding of relay 22 to negative terminal of battery. This holds energized units 19, 20 and 22, with means for breaking the circuit lying in the possible energization of relay 15 or in the possible deënergization of relay 17.

My invention forming the subject matter of this application lies in the provision of the relay 15 as a means for releasing the decimal indicator from the calling line. The need for my invention lay in a possible failure to break the circuit by means of the relay 17, as that relay is held energized over the path from the positive terminal of the battery, through armature and contact of relay 15 which previous to my invention did not exist in the circuit, collector ring D, brush 16, winding of relay 17, contact and armature of relay 18, brush 13 and line conductor 12 to earth or negative battery terminal at or through the telephone substation of the line. The means of deënergization of relay 17 lie (first) in shunting it out, and (second) in opening its circuit at the calling contact of the telephone substation calling; in shunting it out in the system as previously operated, the shunt used contained considerable resistance, but with sufficient resistance in the line circuit between conductor 12 and earth or negative battery terminal the relay 17 could be shunted out unless perchance the conductor 12 or L′ of the line were dead grounded or connected directly to the negative terminal of the battery without resistance, in which case it is obvious that the relay 17 would receive upon its winding the full potential of the battery and could not be shunted out; obviously also such a ground or negative connection would not open its circuit at the calling contact of the substation or elsewhere in response to acts of the central office apparatus. A permanent and low resistance ground upon the line conductor L′ thus would cause the relay 17 to remain energized, which in turn would cause the decimal indicator to remain in registry with the faulty line, and by the continuation of the energization of the relay 22, clutch 23 would permit the division starter to start all divisions, one after another, each of which would connect with the faulty line; thus the entire operating section of the automatic telephone exchange would be tied up by the central office action resulting upon a peculiar fault upon a single line. To obviate this, I introduce into the system the disconnecting or battery controlling relay 15 having its circuit controlled by the decimal register controller, whereby the decimal indicator is released from the line after the closing of the first cycle of operations, and as the primary connector of Fig. 2 places a guard potential upon the guard conductor of the line connected with so that the decimal indicator will not stop upon that line again, only the one division will be tied up by reason of a faulty line.

I do not wish to limit myself to the exact details herein illustrated and described, as I understand that modifications may be made without departing from the spirit or scope of my invention.

Having thus described my invention, what I claim as new and desire to protect by United States Letters Patent is:

1. In an automatic telephone system, a movable conductor terminal, a plurality of fixed terminals, means for stopping said movable conductor terminal in connection with one of said fixed terminals and for holding said movable conductor terminal immovable, an electric circuit controlling said holding means, an automatic call-answering device and a relay in the central office and controlled by said call-answering device and adapted to break said circuit, substantially as described.

2. In an automatic telephone system, a movable conductor terminal, a plurality of fixed terminals, means for stopping said movable conductor terminal in connection with one of said fixed terminals and for holding said movable conductor terminal immovable, an electric circuit controlling said holding means, an auxiliary cycle-controlling commutator and brushes, and a relay having an armature back contact in said circuit and having its winding controlled by said cycle-controlling devices, substantially as described.

3. In an automatic telephone system, lines, a central office, a calling indicator having lines terminating therein and having traveling brushes and adapted to stop its brushes in connection with a calling line and adapted to hold electromagnetically its brushes in connection with the calling line, a source of current supplying energy to said calling indicator, an automatic connecting switch having terminating therein lines terminating also in said calling indicator, and a relay within the central office and controlled by said connecting switch and controlling the connection of said source of current and said calling indicator, substantially as described.

4. In an automatic telephone system, a central office, lines radiating therefrom, line terminals, brushes movable over said line terminals, means for stopping said brushes in register with the terminals of a calling line, an automatic call-answering device, and an electric circuit lying wholly within

said central office and controlling starting means for said brushes and controlled by said automatic call-answering device, substantially as described.

5. In an automatic telephone system, a central office, line terminals, a brush movable over said line terminals, an electromagnetic clutch for stopping said brush, an automatic call-answering device comprising a main connecting switch and subsidiary controlling devices, and a relay within the central office and controlled by said automatic call-answering device to render said electromagnetic clutch inoperative, substantially as described.

6. In an automatic telephone system, line terminals, brushes movable over said line terminals, an electromagnetic clutch for stopping said brushes, an automatic call-answering device, and a relay controlled by said automatic call-answering device over a circuit wholly within the central office and adapted to interrupt the circuit of said electromagnetic clutch, substantially as described.

7. In an automatic telephone system, line terminals, brushes movable over said line terminals, an electromagnetic clutch for stopping said brushes in registry with the terminals of a calling line, a connecting device having as a part thereof a commutator and brushes therefor, a relay within the central office and controlling said electromagnetic clutch, and a circuit including the winding of said relay and a brush and a commutator segment in said connecting device, substantially as described.

8. In an automatic telephone system, a decimal indicator adapted to stop its brushes in registry with a calling line and indicating the directory number of the calling line by the position of the brushes when stopped, the indication being made electrically in part by closing a circuit from one of a series of conductors terminating in the decimal indicator; means for releasing said decimal indicator from the calling line; a connecting device having as a part thereof a brush sweeping over a commutator and testing all of the conductors of the above mentioned series; and a circuit wholly within the central office and controlling said releasing means and controlled by said connecting device after the test for line identification has been made, substantially as described.

9. In an automatic telephone system, a decimal indicator adapted to stop its brushes in registry with a calling line and indicating to some degree the identity of the calling line electrically by closing a path to an identifying conductor terminating in the decimal indicator and in a connecting device; a group of indicating conductors terminating in the decimal indicator and in a connecting device; means for releasing said decimal indicator from the calling line; a connecting device having as part thereof a brush testing all of the conductors of said group; and a circuit controlling said releasing means and controlled by said connecting device after the test of the conductor group has been completed, substantially as described.

10. In an automatic telephone system, a decimal indicator adapted to stop in registry with a calling line and indicating the identity of the calling line electrically by closing paths over identifying conductors terminating in the decimal indicator and in a connecting device; means for releasing said decimal indicator from the calling line; an automatic connecting device adapted to connect with the line indicated by the decimal indicator and comprising a main connecting switch and subsidiary controlling devices; and a circuit wholly within the central office and controlling said releasing means and closed by said automatic connecting device after the connecting device has connected with the indicated line, substantially as described.

11. In an automatic telephone system; a call-indicator; holding means for said call-indicator; an automatic call-answering device; a connection switch forming a part of said complete call-answering device; a decimal-register controller forming a part of said complete call-answering device and operating to control the connection switch of said complete call-answering device; and a circuit controlled by said decimal-register controller and operating said releasing means, substantially as described.

12. In an automatic telephone system, a central office; lines radiating therefrom; a call indicator having lines terminating therein and having brushes normally in motion and adapted to stop its brushes in connection with a calling line and adapted to hold electromagnetically its brushes in connection with the calling line; a source of current supplying energy to said call indicator; an automatic connecting switch having terminating therein lines terminating also in said call indicator; a subsidiary circuit changing device pertaining to said automatic connecting switch; and a relay within the central office and controlled by said subsidiary device and controlling the connection of said source of current and said call indicator; substantially as described.

13. In an automatic telephone system, a central office, lines radiating therefrom; a call indicator having line contact points and normally moving brushes and adapted to stop its brushes in register with a calling line, and identifying the calling line in part by closing a conducting path from one of a series of conductors terminating in the call indicator; means for releasing said call in-

dicator from the calling line; a connecting device adapted to connect with the line identified by the call indicator; a subsidiary device associated with said connecting device and forming a part thereof, and adapted to test all of the conductors of the above mentioned series; and a circuit controlling said releasing means and controlled by said subsidiary device after the test for line identification has been made, substantially as described.

Signed by me at Piqua, county of Miami and State of Ohio in the presence of two witnesses.

GEORGE W. LORIMER.

Witnesses:

GEORGE A. VAUGIER,

LEE R. DRAKE.