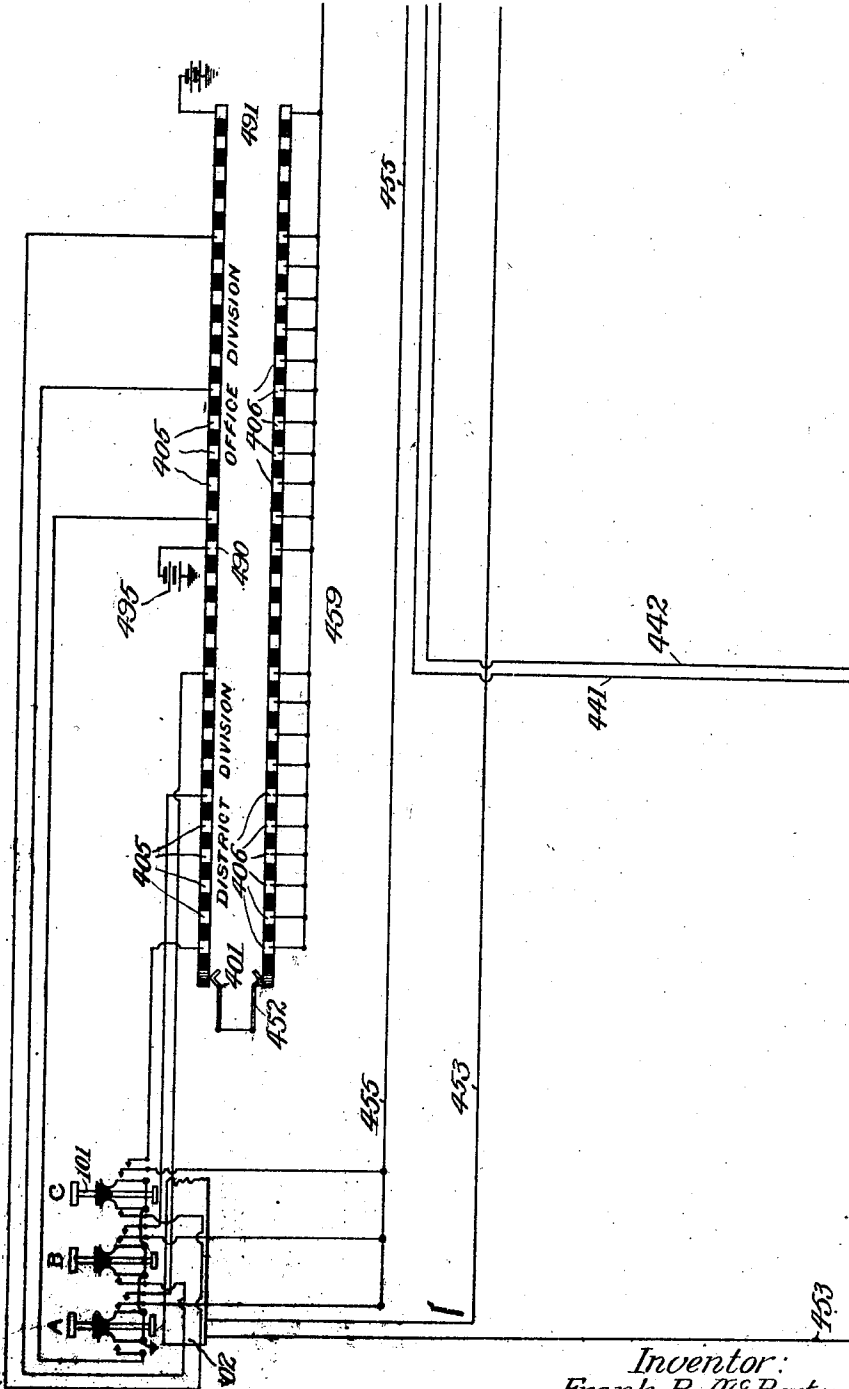


F. R. McBERTY.
 TELEPHONE EXCHANGE SYSTEM.
 APPLICATION FILED AUG. 9, 1909.

1,157,018.

Patented Oct. 19, 1915
 19 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
 F. J. Woodward.
 J. P. M. [illegible]

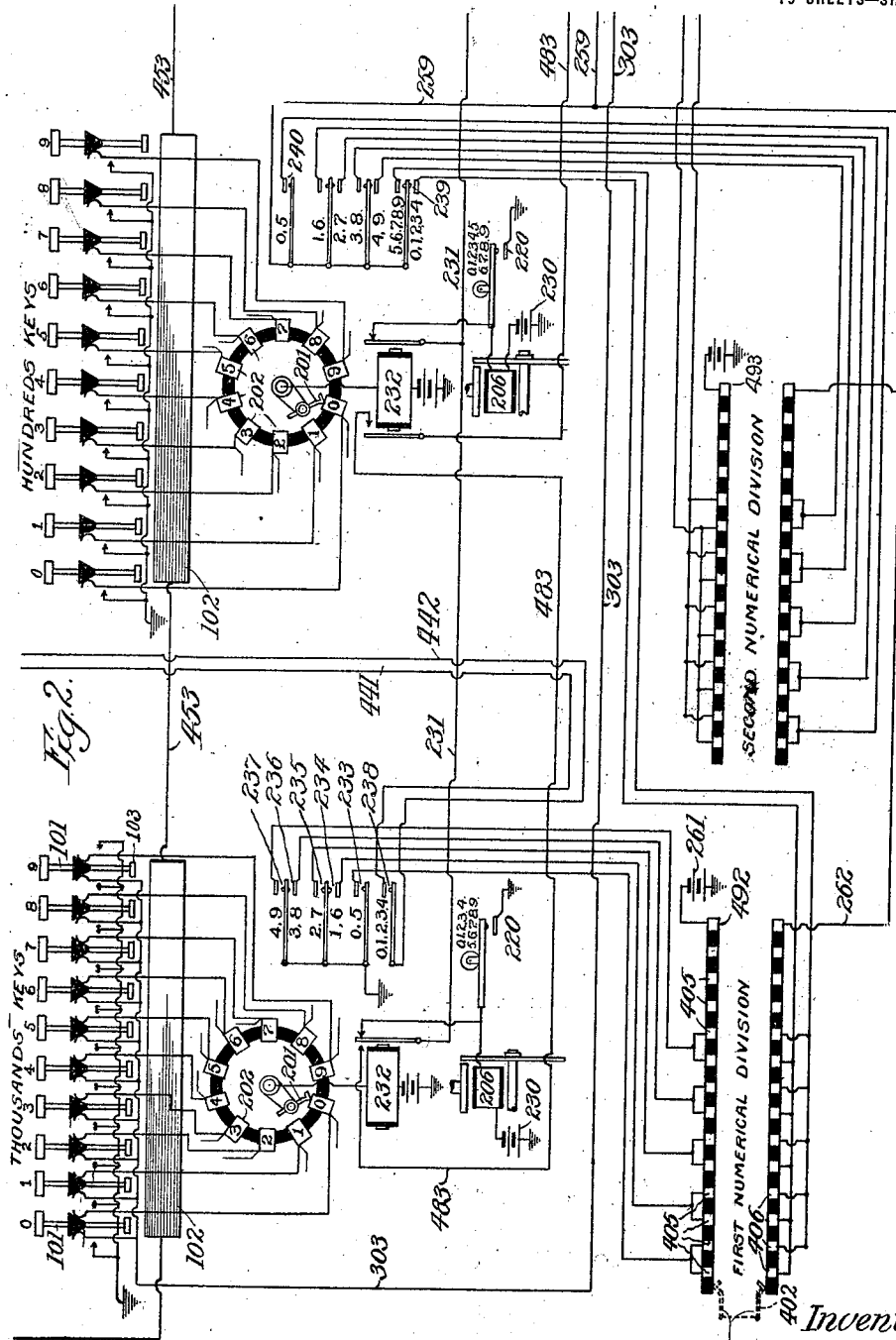
Inventor:
 Frank R. McBerty.
 By J. C. [illegible] Att'y

F. R. McBERTY.
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1,157,018.

Patented Oct. 19, 1915.

19 SHEETS—SHEET 2.

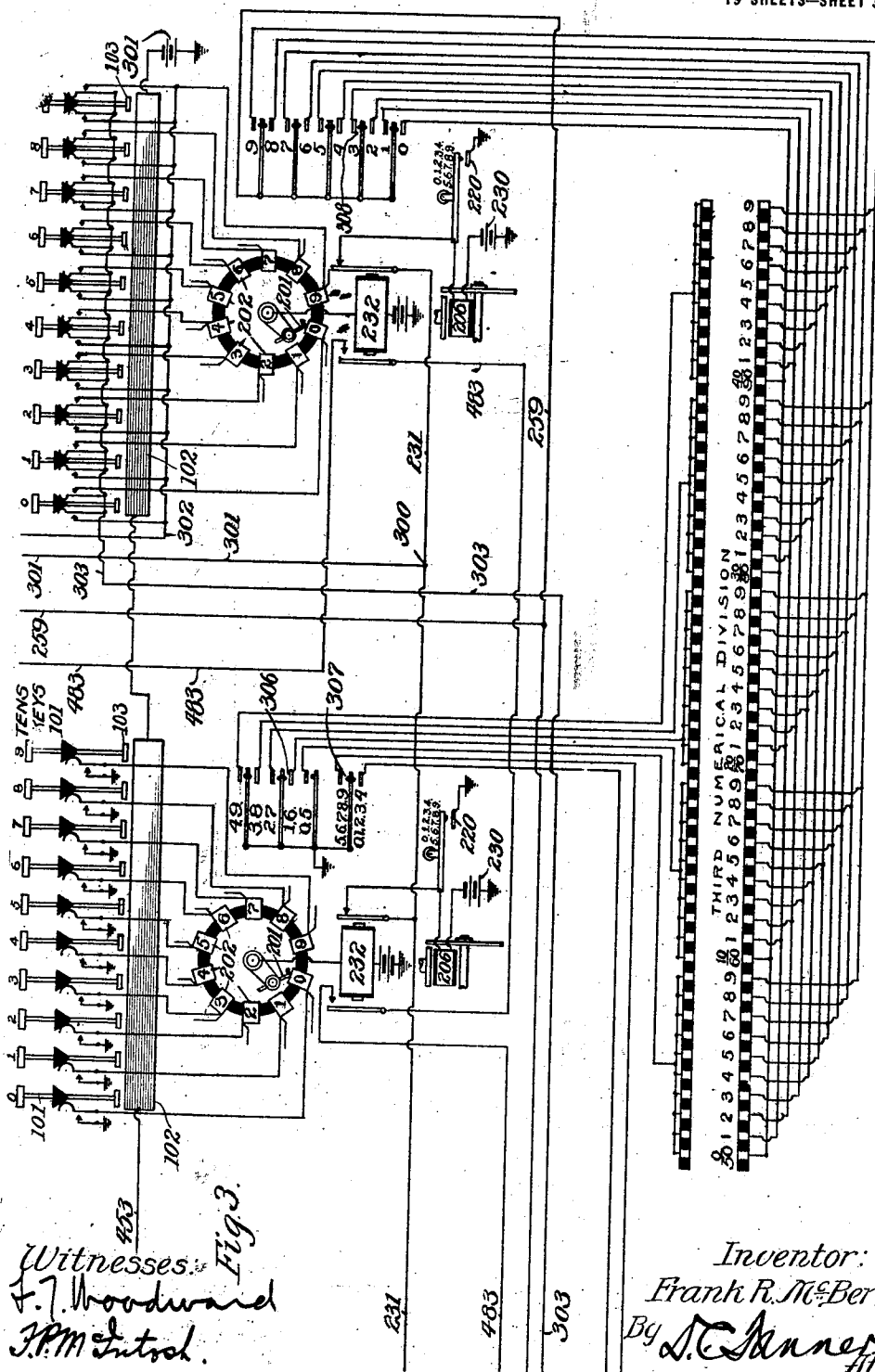


Witnesses:
F. J. Woodward.
J. M. McIntosh.

Inventor:
Frank R. McBerty.
By J. C. Munner
Att'y.

1,157,018.

Patented Oct. 19, 1915.
 19 SHEETS—SHEET 3.

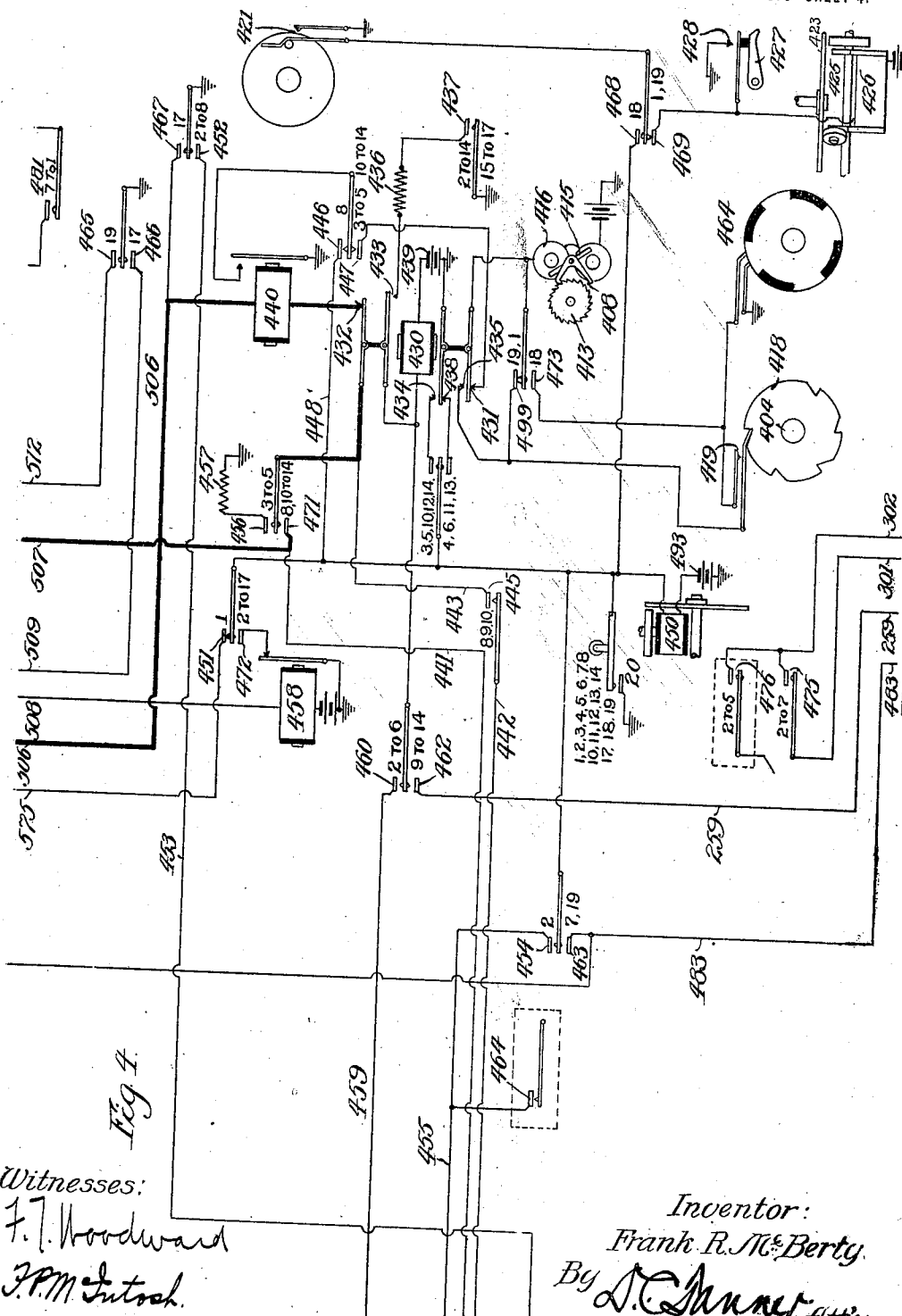


Witnesses:
 F. J. Woodward
 J. P. McIntosh.

Inventor:
 Frank R. McBerty.
 By S. C. Skinner
 Atty

1,157,018.

19 SHEETS—SHEET 4.



Witnesses:

F. J. Woodward

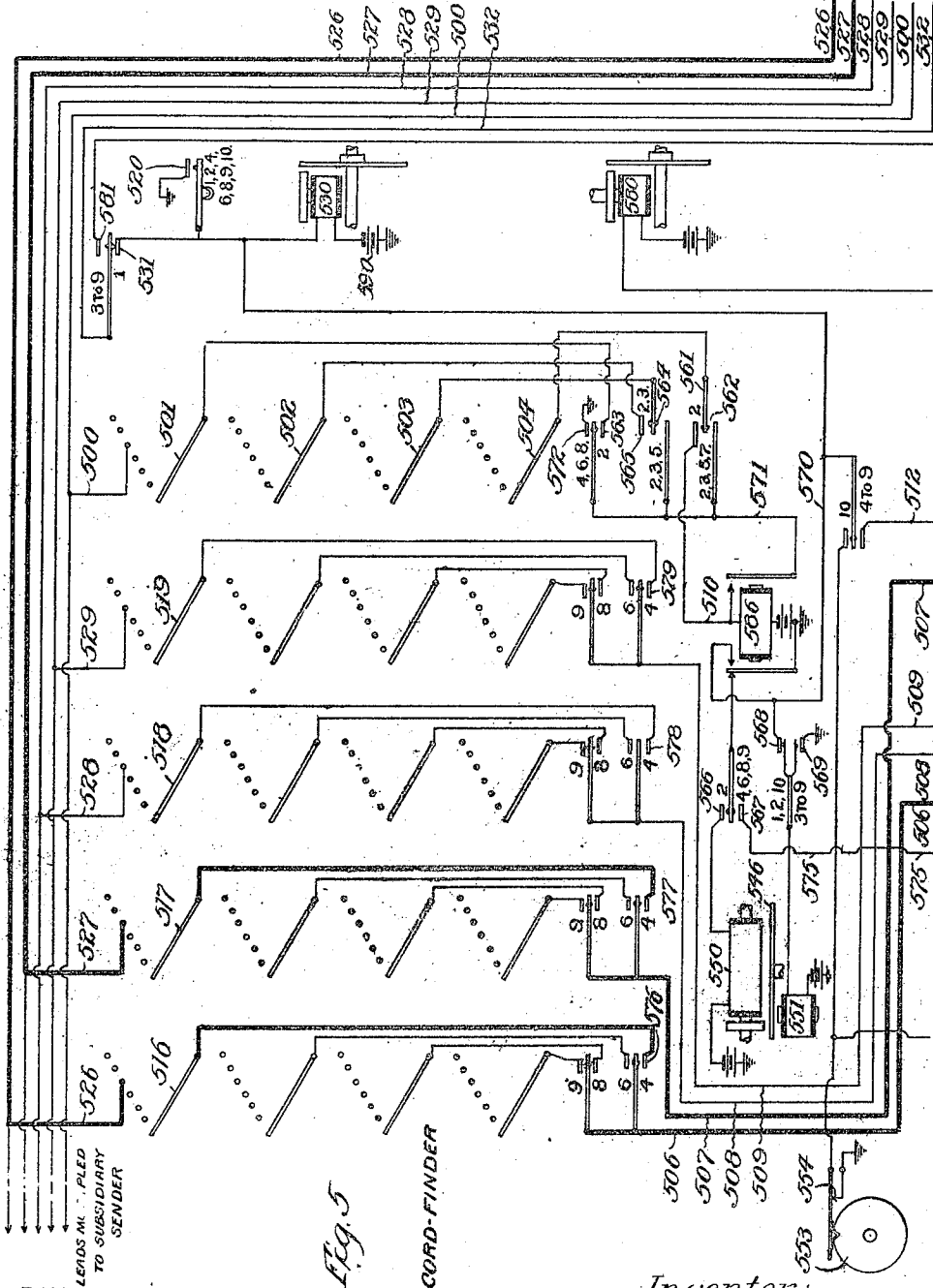
3PM Intoch.

Inventor:
Frank R. McBerty.
By *J. C. Munroe* Atty.

1,157,018.

Patented Oct. 19, 1915.

19 SHEETS—SHEET 5.



Witnesses:
J. T. Woodward
J. M. Entsch

Inventor:
Frank R. McBerty.
By S. C. Manner, Att'y

1,157,018.

F. R. McBERTY.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED AUG. 9, 1909.

Patented Oct. 19, 1915.
19 SHEETS—SHEET 6.

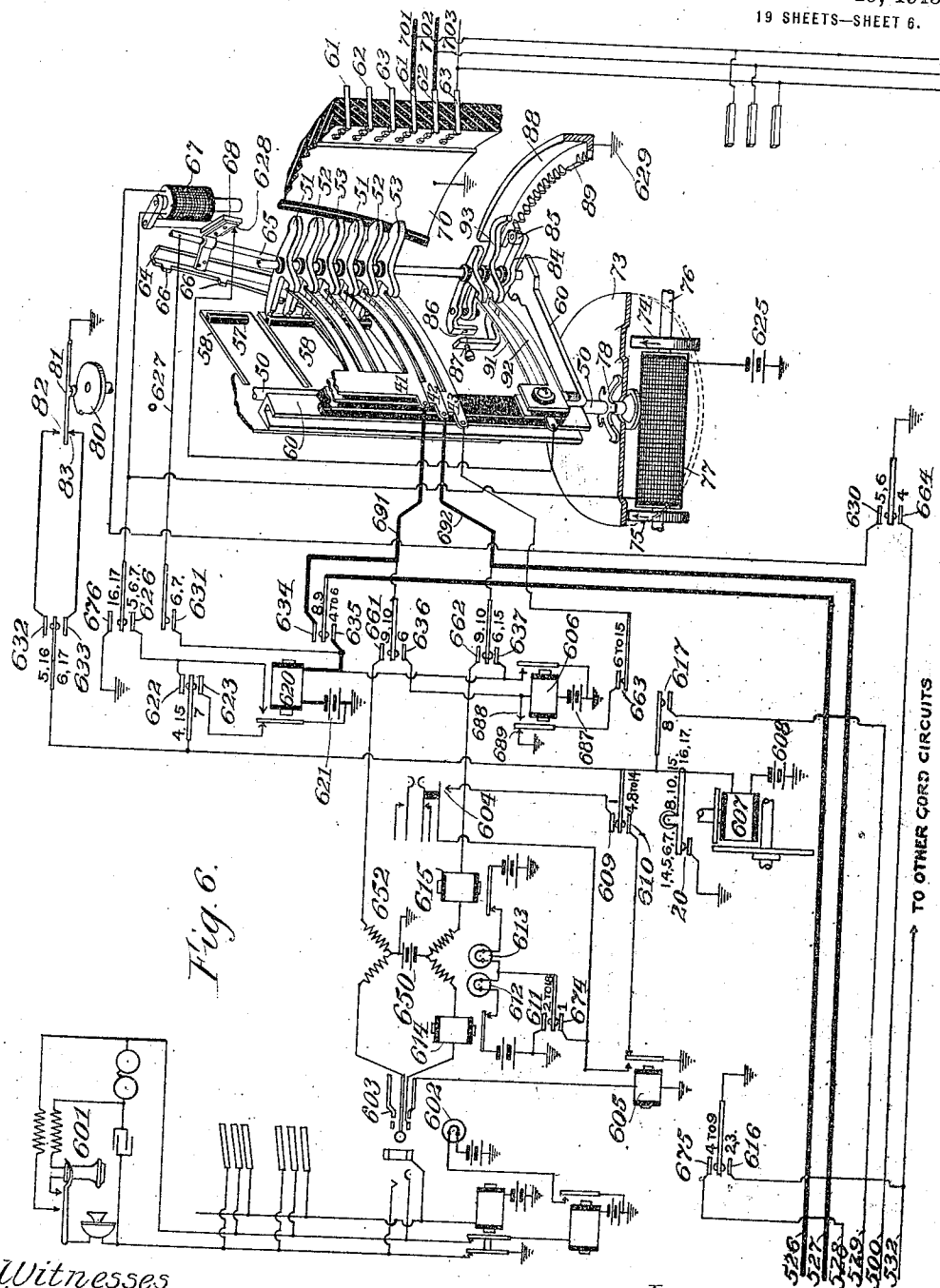


Fig. 6.

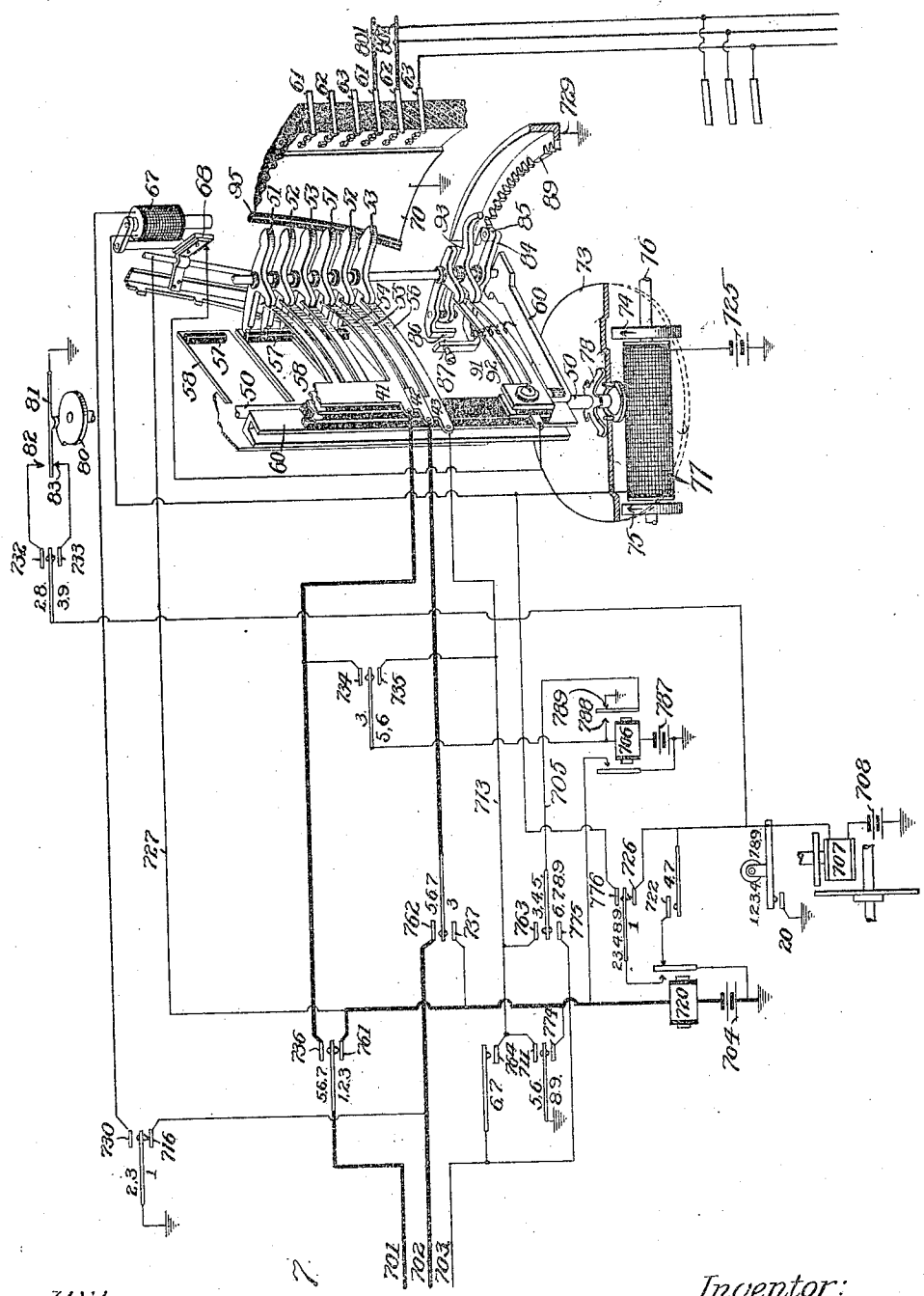
Witnesses
F. J. Woodward.
J. P. McIntosh.

Inventor:
Frank R. McBerty.
By S. C. Skinner, Atty

F. R. McBERTY.
 TELEPHONE EXCHANGE SYSTEM.
 APPLICATION FILED AUG. 9, 1909.

Patented Oct. 19, 1915.
 19 SHEETS—SHEET 7.

1,157,018.



Witnesses:
 J. J. Woodward.
 J. P. McIntosh.

Inventor:
 Frank R. McBerty
 By A. C. Schaner, Att'y.

1,157,018.

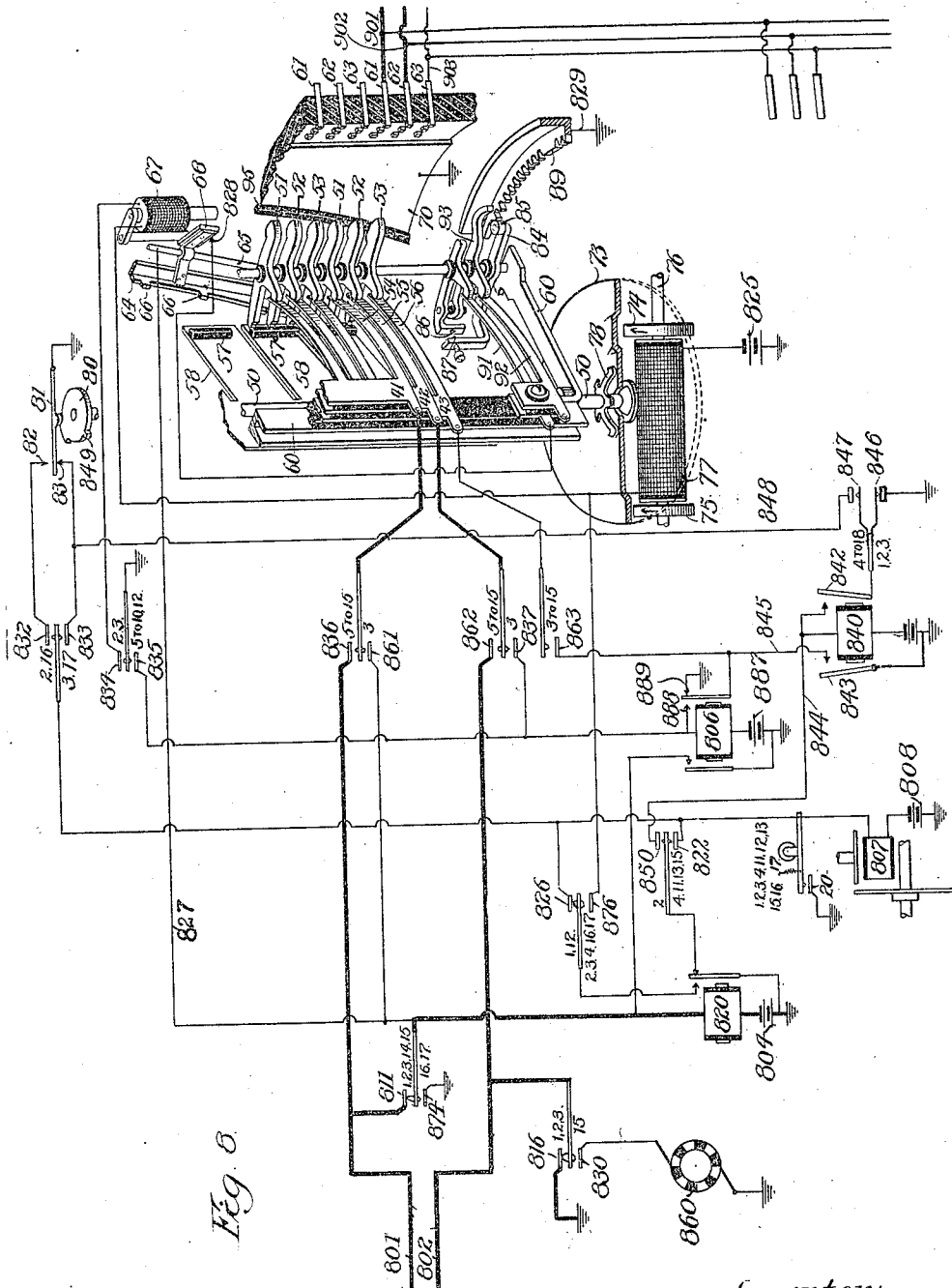


Fig. 8

Witnesses:
F. J. Woodward.
J. R. McIntosh.

Inventor:
Frank R. McBerty.
By *D. C. Minnet* Att'y.

1,157,018

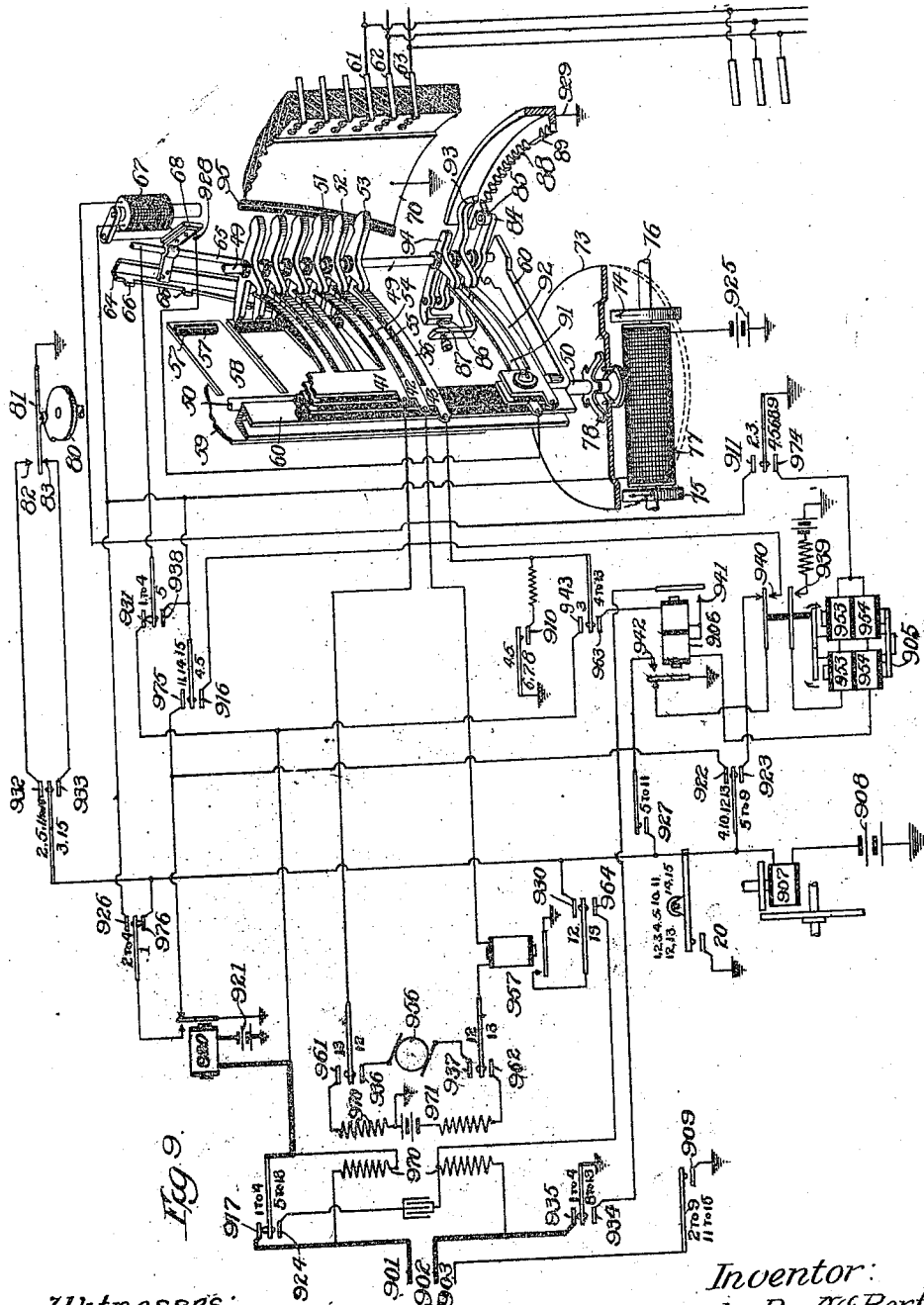


Fig. 9.

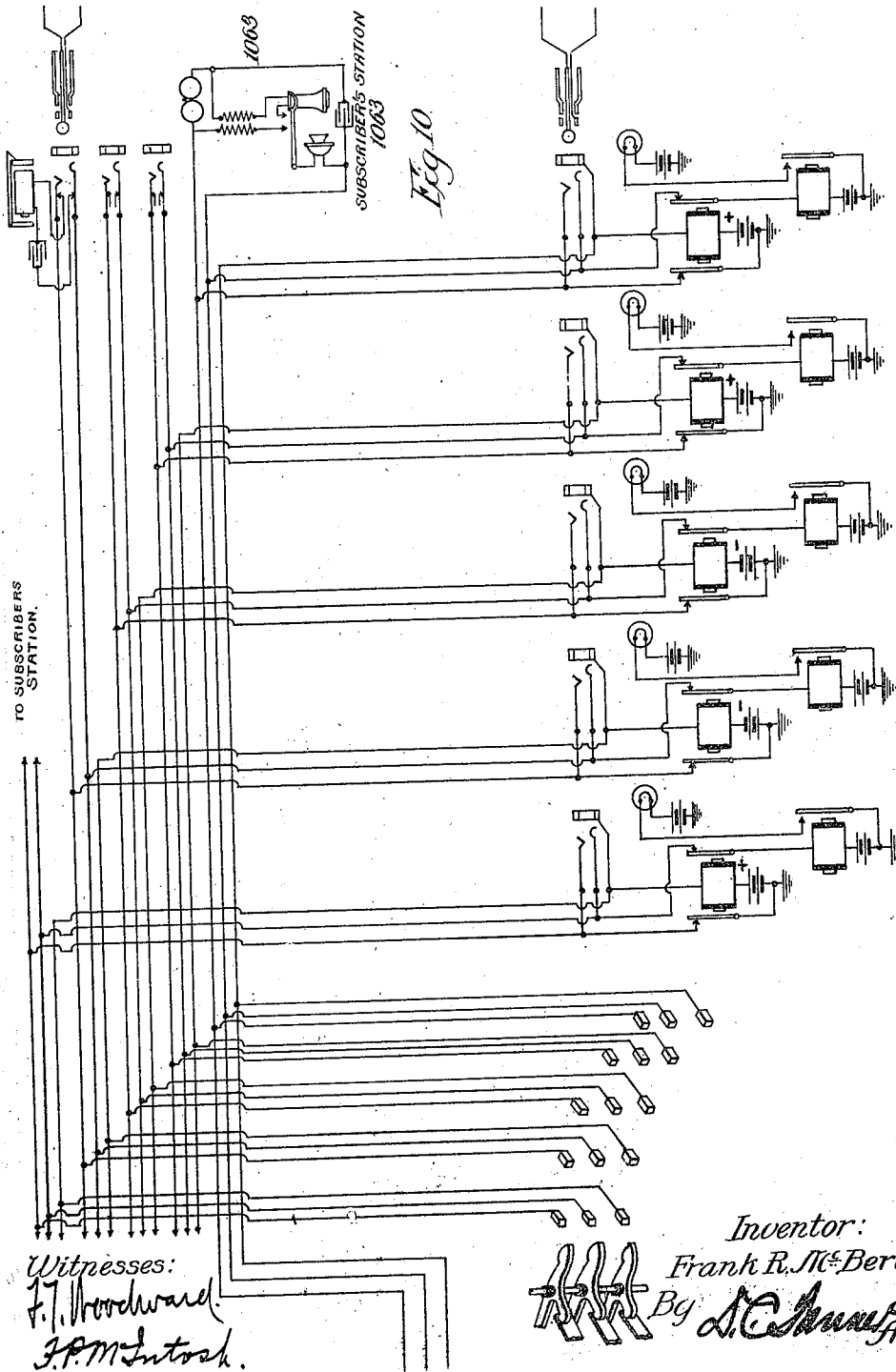
Witnesses:
F. T. Woodward
J. R. McIntosh

Inventor:
Frank R. McBerty.
By J. C. Shannet. Atty.

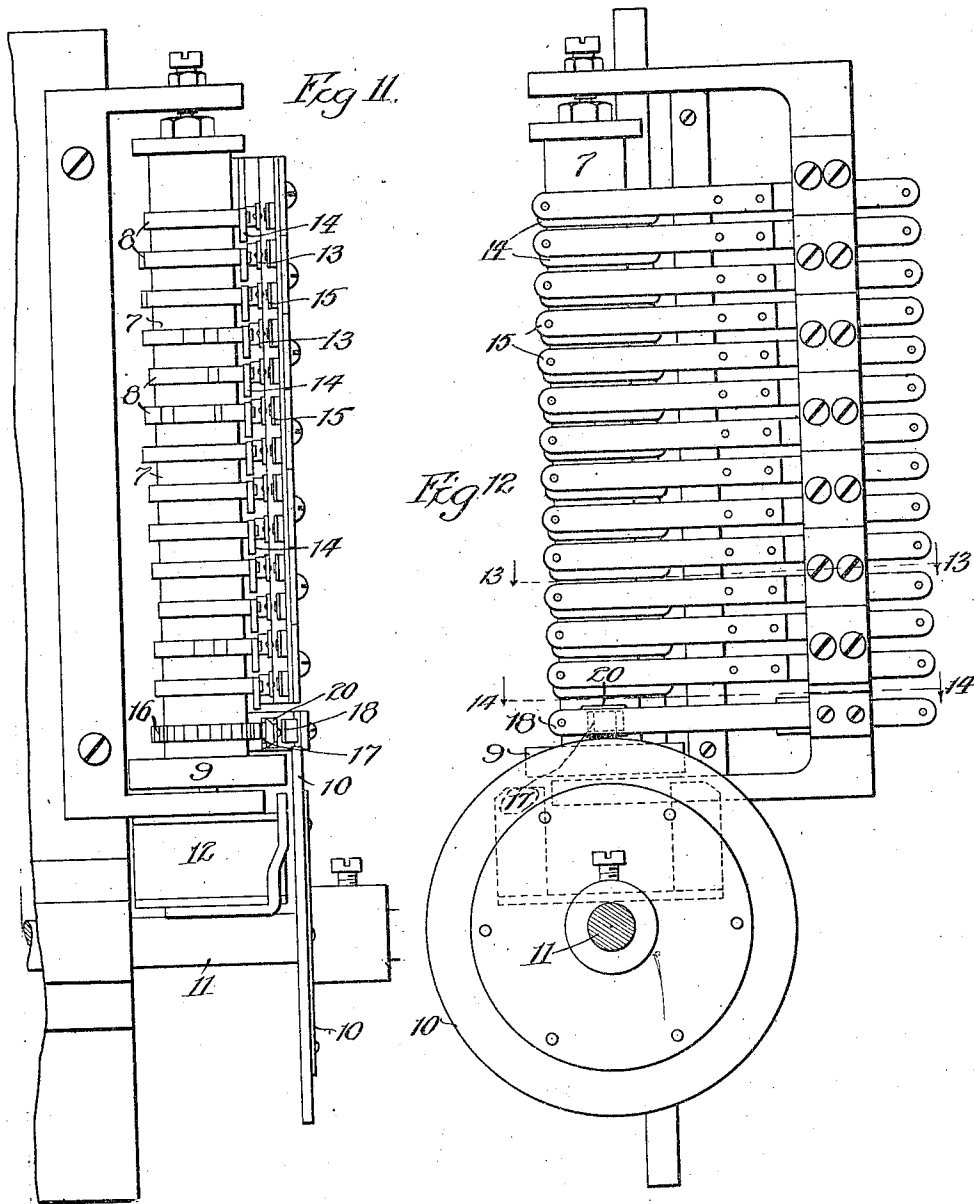
F. R. McBERTY
 TELEPHONE EXCHANGE SYSTEM.
 APPLICATION FILED AUG. 9, 1909.

Patented Oct. 19, 1915
 19 SHEETS—SHEET 10.

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1,157,018.



Witnesses:
J. J. Woodward.
J. P. McIntosh.

Inventor:
Frank R. McBerty.
By S. C. Manner, Att'y

F. R. McBERTY.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED AUG. 9, 1909.

1,157,018.

Patented Oct. 19, 1915.
19 SHEETS—SHEET 12.

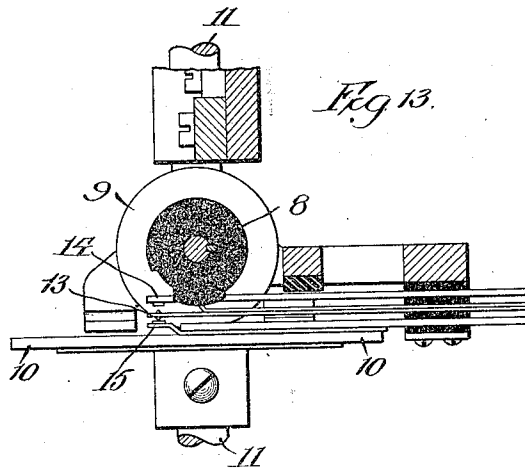


Fig. 13.

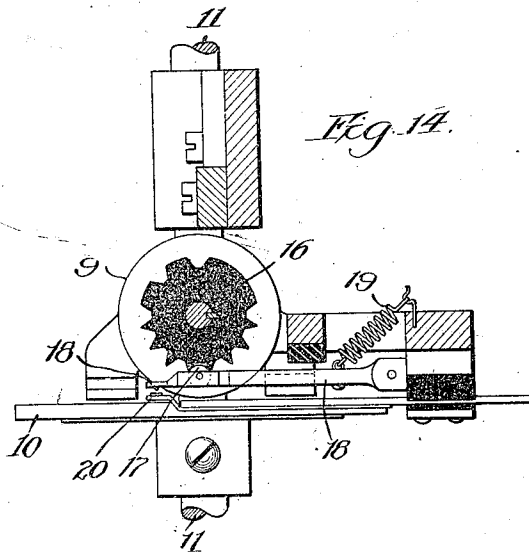


Fig. 14.

Witnesses:
J. J. Woodward.
J. P. M. Lutzsch.

Inventor:
Frank R. McBerty.
By A. C. Manner, Att'y.

1,157,018.

Fig. 10.

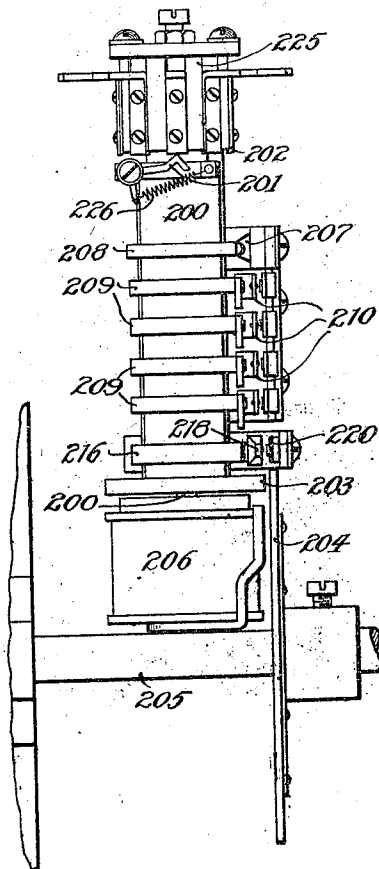
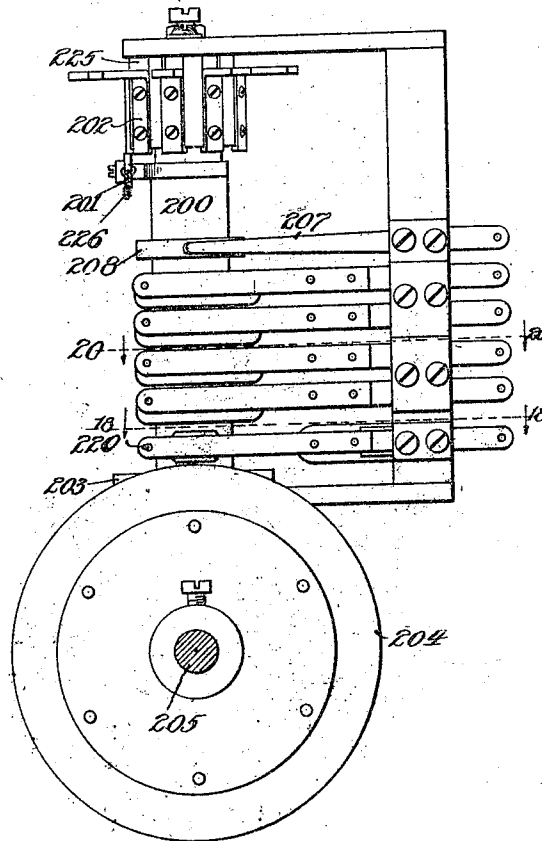


Fig. 16.



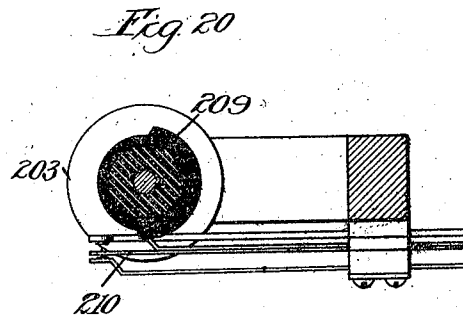
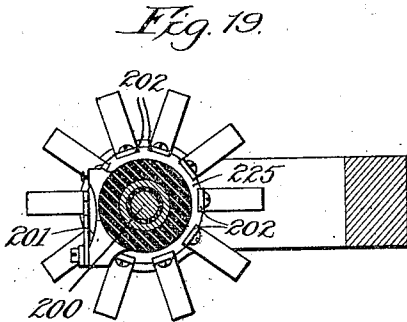
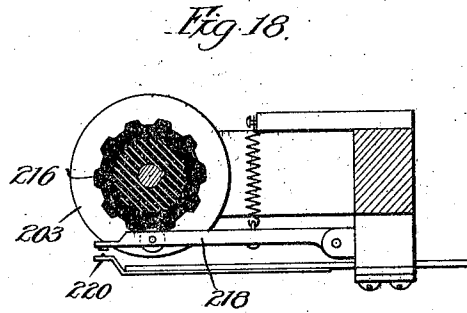
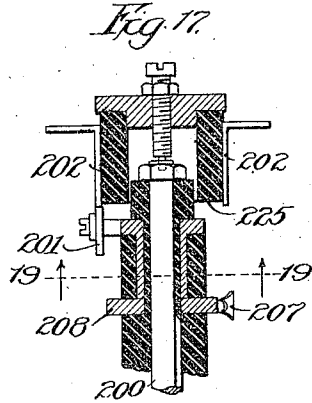
Witnesses:
J. J. Woodward
J. R. McIntosh

Inventor:
Frank R. McBerty
By J. C. Muner. Att'y

F. R. McBERTY.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED AUG. 9, 1909.

1,157,018.

Patented Oct. 19, 1915.
19 SHEETS—SHEET 14.



Witnesses:
J. J. Woodward.
J. P. McIntosh.

Inventor:
Frank R. McBerty.
By J. C. Manner, Atty.

F. R. McBERTY.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED AUG. 9, 1909.

Patented Oct. 19, 1915.
19 SHEETS—SHEET 15.

1,157,018.

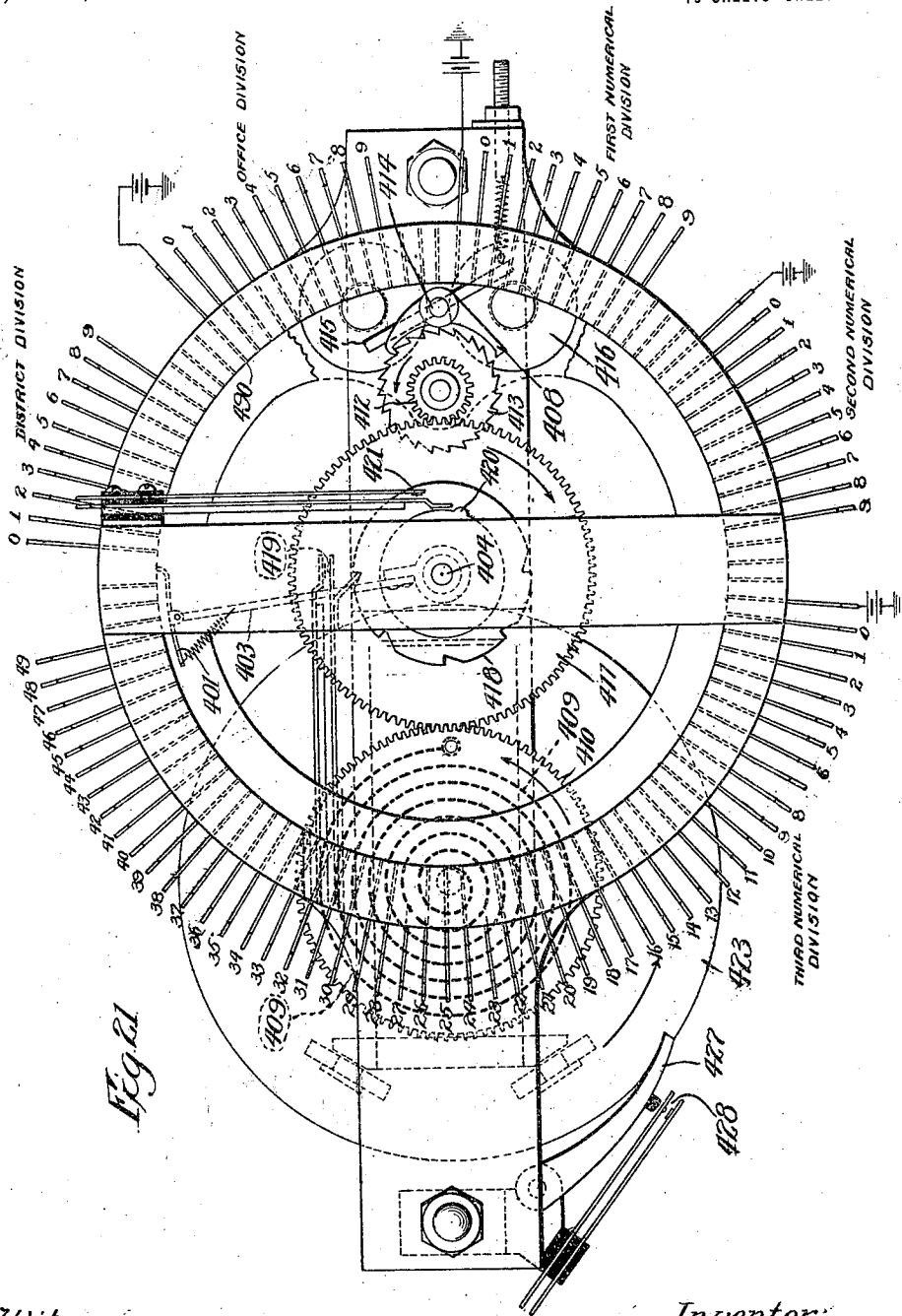


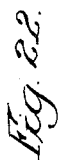
Fig. 1

Witnesses:
J. J. Woodward
J. P. McIntosh.

Inventor:
Frank R. McBerty
By J. C. Shannet, Att'y.

1,157,018.

19 SHEETS—SHEET 16.



Inventor:
Frank R. Mc Bert'y.
By *A. C. Munner*, Att'y.

1,157,018.

Patented Oct. 19, 1915.
 19 SHEETS—SHEET 17.

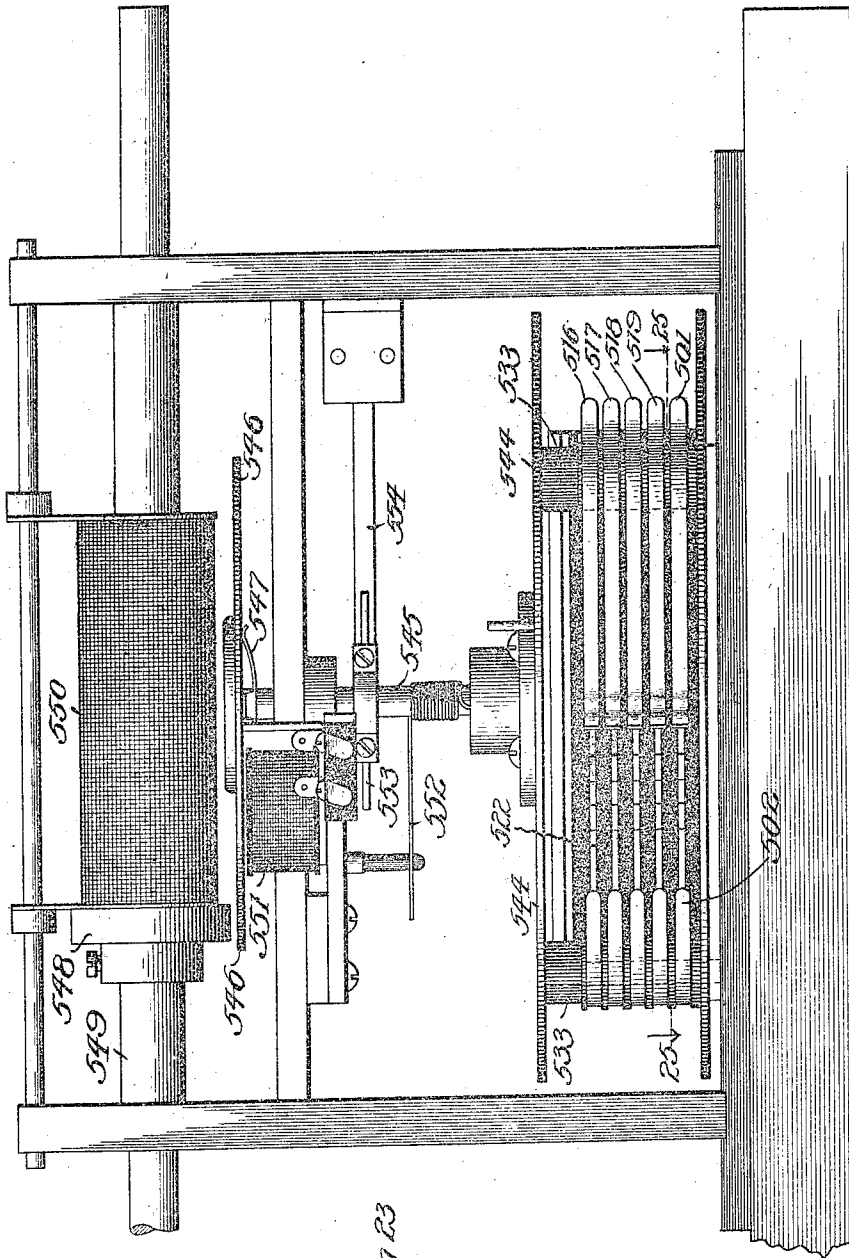
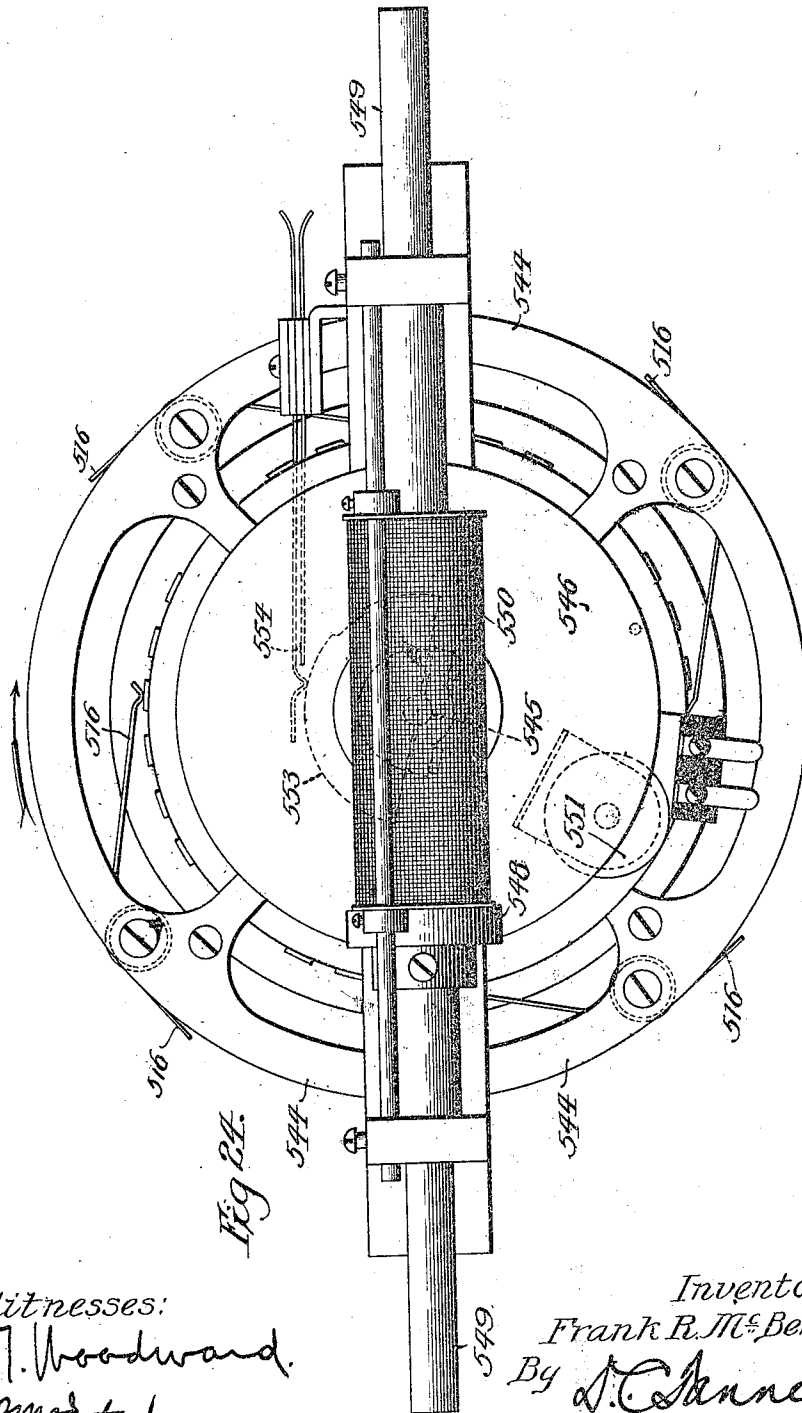


Fig. 23

Witnesses:
 J. J. Woodward
 J. M. McIntosh.

Inventor:
 Frank R. McBerty
 By S. C. Manner, Att'y

1,157,018.



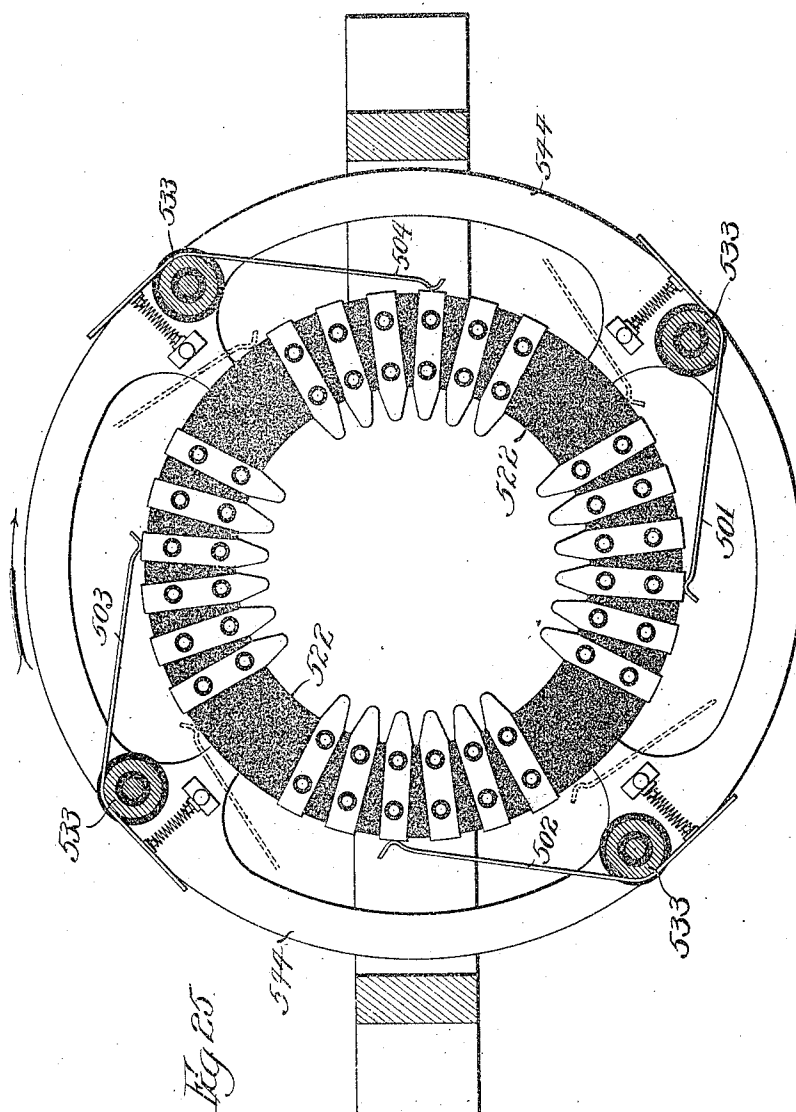
Witnesses:
F. J. Woodward.
J. P. McIntosh.

Inventor:
Frank R. McBerty.
By J. C.anner, Att'y.

F. R. McBERTY.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED AUG. 9, 1909.

1,157,018.

Patented Oct. 19, 1915.
19 SHEETS—SHEET 19.



Witnesses:
J. J. Woodward.
H. M. Entsch.

Inventor:
Frank R. McBerty.
By A. C. Munier Atty.

UNITED STATES PATENT OFFICE.

FRANK R. McBERTY, OF NEW ROCHELLE, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, OF NEW YORK, N. Y., A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

1,157,018.

Specification of Letters Patent.

Patented Oct. 19, 1915.

Application filed August 9, 1909. Serial No. 511,983.

To all whom it may concern:

Be it known that I, FRANK R. McBERTY, citizen of the United States, residing at New Rochelle, in the county of Westchester and State of New York, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is in full, clear, concise, and exact description.

My invention relates to telephone exchange systems and contemplates in general an improved organization and arrangement of circuits and apparatus whereby the interconnection of subscribers' lines in an exchange of the semi-mechanical type may be accomplished with rapidity and precision.

The object of my invention is to provide, in an exchange in which the interconnection of subscribers' lines is accomplished by mechanical switching apparatus under the control of an operator, improved and novel means whereby the automatic line selection may be simply and easily controlled and whereby such controlling means may be automatically associated and dissociated with the mechanical switching apparatus at the proper stages in the operation of the system.

More particularly my invention relates to a switching system involving an improved operator's sending or selector controlling equipment adapted for use with systems of practically any size having any desired grouping of lines or trunks, and adapted to operate with accuracy at high speed to cause the various selecting and trunk-hunting operations throughout a train of selectors to take place in proper sequence and with absolute precision. Furthermore this sending equipment may be, and is preferably, so organized that the connections between subscribers' lines may be established, by the operator, in rapid succession by means of a single set of keys, there being no necessity for the operator to wait until the series of selections required for one call have been completed before beginning the establishment of a second call.

My invention, therefore, involves among other things the provision of a set of keys arranged to be depressed by the operator, registering devices, responsive to said keys, adapted to take up and record the call indicated by any combination of such keys, and automatic selection-controlling apparatus arranged to perform the required series

of operations under control of such registering devices.

My invention further involves means, in an operator's sending equipment, adapted under the control of a key or keys, to perform a series of controlling operations to determine the movement of distant selector mechanisms successively brought under the control of such equipment; this sending equipment being especially adapted for rapid operation by comparatively feeble current impulses transmitted over long lines or cables, and to continue automatically to perform the entire sequence of controlling operations at proper intervals and in definite order without requiring any attention from the operator beyond the initial registration of the call upon the key or keys.

Another feature of my invention involves the arrangement in the operator's sending apparatus of registers or translating devices whereby a number designating a line to be selected, indicated by the operator upon keys arranged according to the decimal system of notation, may be stored up and translated by such registers or translators in such a manner that the selection-controlling device operated under the control of such registers or translators will select the line desired and indicated upon the keys, even though such line or the trunks through which such line must be connected are not, or a part of them are not, arranged upon the decimal system of notation.

Another feature of my invention involves means whereby the operator's sending equipment may be automatically associated with any one of a plurality of connecting circuits which is put into use to answer a call, and involves automatic cord finder apparatus adapted to test said connecting circuits, find the one put into use and unite the sending equipment therewith, maintaining such connection until the sending equipment has completed its operation and then automatically disconnect it from the connecting circuit leaving it free to be associated with another connecting circuit to transmit another call.

Another feature of my invention involves means whereby a plurality of senders may be provided for each operator, means associated with each sender for connecting it with a connecting circuit taken for use, and means for determining which of such send-

ers shall be connected with the connecting circuit so taken.

Another feature of my invention involves means whereby a single set of keys may suffice to control the operation of a plurality of senders, such control being exercised through the interposition of register devices upon which the designation of the line desired is registered or stored up to control the selection controlling means, and means immediately available upon the completion of such registration to permit these keys to be utilized to register upon the registers of another sender device the designation of some other desired line.

Another feature of my invention involves means whereby the various operations of the sender are caused to take place in the proper sequence, and involves the association with the sender of an automatic sequence switching device provided with switch contacts arranged to control circuits to insure the proper operation of the sender and, in turn, of the sequence switching device itself.

My invention also includes certain details of construction and organization of the apparatus and circuits associated with the operator's sending equipment and the automatic switching apparatus by which the foregoing operations and other operations incidental to the proper and expeditious establishment of connections may be best accomplished.

The accompanying drawings which illustrate the preferred form of my invention show in addition various features which form no part of my present invention, and are not claimed in this application. These features are claimed in my applications for Letters Patent as follows: Serial No. 418,123, filed February 27, 1908; Serial No. 418,124, filed February 27, 1908; Serial No. 418,126, filed February 27, 1908; Serial No. 451,867, filed September 3, 1908; Serial No. 451,868, filed September 3, 1908; Serial No. 452,539, filed September 11, 1908; Serial No. 456,418, filed October 6, 1908; Serial No. 456,419, filed October 6, 1908; Serial No. 491,043, filed April 20, 1909.

Another feature of my invention involves means, in an operator's sending apparatus, whereby a mechanical switching device brought under the control of such sending apparatus may be caused to pass its contact brushes entirely over and out of operative relation to one of a plurality of banks or ranges of terminals appearing in such switching device to bring them into coöperative relation with another bank or range of terminals, such means being controlled by the means in the sending apparatus upon which the designation of the desired line is established by the operator.

In the drawings, Figures 1 to 10 inclusive

when placed together form a single diagram illustrating the apparatus and circuits involved in extending connection from a calling line (Fig. 6) to a called line (Fig. 10); the lines which extend to the edge of each sheet being continued on neighboring sheets. In assembling these sheets, Figs. 5, 6, 7, 8, 9, and 10 should be placed side by side in the order named; Fig. 4 should be placed below Fig. 5; Fig. 3 should be placed below Fig. 4; Fig. 1 should be placed on the left hand side of Fig. 4, and Fig. 2 should be placed on the left hand side of Fig. 3. Fig. 11 is a front view of one of the automatic sequence-switches, which are employed at various points in this system to establish in the desired sequence the different local controlling or operating circuits. Fig. 12 is a side view of the sequence-switch. Fig. 13 is a sectional plan view on line 13—13 of Fig. 12. Fig. 14 is a sectional plan view on line 14—14 of Fig. 12. Fig. 15 is a front view of one of the registers which form part of the "sending" equipment. Fig. 16 is a side view of the register shown in Fig. 15. Fig. 17 is a detail sectional view of the upper portion of the register. Fig. 18 is a sectional plan view on line 18—18 of Fig. 16. Fig. 19 is a sectional view on line 19—19 of Fig. 17, looking in the direction of the arrows. Fig. 20 is a sectional plan view on line 20—20 of Fig. 16. Fig. 21 is a plan view of a point-finder apparatus with its electromagnetic escapement operating mechanism which forms part of the sending or controlling equipment, some of the parts being broken away in order to disclose the remainder more clearly. Fig. 22 is a sectional elevation of the apparatus shown in Fig. 21. Fig. 23 is a side elevation of an automatic cord finder mechanism which is employed in association with the sending equipment. Fig. 24 is a plan view of the device shown in Fig. 23. Fig. 25 is a sectional plan view on line 25—25 of Fig. 23. The same reference numerals indicate the same parts wherever they are shown.

Selectors.—The automatic line switching devices or selectors employed in this system may be constructed as follows, although it will be apparent to those skilled in the art that selectors of other types may be employed. A movable switch carriage is provided with a number of multiple sets of contact brushes arranged to traverse corresponding rows of stationary contact pieces forming circuit terminals. Said brushes are normally maintained in such positions that they will not come in contact with the stationary terminals over which they travel, but are adapted to be selectively released and rendered operative to contact with such terminals; and by a movement of the switch carriage any set of brushes thus selected may be brought into engagement with any

particular set of terminals in its corresponding row or level.

Preferably the brushes are arranged to be selectively released during a preliminary movement of the switch carriage before said brushes enter upon the range of stationary line terminals; such release being accomplished by a tripping device which is arranged to be moved into the path of a latch which normally holds the brushes; there being a separate latch for each set of brushes. The mechanism may be so arranged that in the movement of the switch carriage the different sets of brushes will be brought successively into operative relation to the tripping device, and the particular set of brushes to be tripped or brought into service will depend upon the extent to which the switch carriage is moved prior to the actuation of the tripping device. Said tripping device may be actuated by an electromagnet, in response to a selective action of the distant sending apparatus, as will be described.

The switch carriage is preferably arranged to be moved by mechanical power, which is applied by an electromagnetic clutch, said clutch being controlled by a relay which may be responsive to current in the main circuit controlled at the sending apparatus; or in "hunting" over trunk terminals the clutch-controlling relay may be responsive to current received from the test terminals of the lines passed over.

A suitable construction of the selector mechanism is shown diagrammatically in Figs. 6, 7, 8 and 9, and this construction will be explained by reference, for example, to Fig. 9, which illustrates a "final" selector having direct access to the subscribers' lines. The "district" selectors, "office" selectors and "group" selectors may be of practically the same construction as the final selectors.

The same reference numerals are used to designate corresponding parts on all the selectors shown.

The switch carriage or brush-carrier frame 60 is mounted upon a rotatable shaft 50, and at the outer end of said frame 60 the contact brushes 51, 52, 53, are pivoted in a vertical row upon a rod 49 which extends from top to bottom of the frame, each brush being insulated from each other and the rod. Spring tongues 54, 55, 56, extending from insulated metal plates 41, 42, 43, respectively, press against bell-crank lever arms of said brushes, and tend to rock them upon their pivots and throw their forward or contact ends radially outward from the shaft. Said metal tongues also serve to make electrical connection to the brushes from the terminal plates 41, 42, 43; said brushes being in sets of three, the corresponding members of each set being electrically connected to the same terminal plate.

Stationary line-terminal contact-pieces 61, 62, 63, are mounted in parallel horizontal rows corresponding to the brushes, in an insulating frame concentric with the shaft, so that the brushes may traverse the corresponding rows of contacts when the carrier-frame is rotated. Normally, however, the brushes are latched in such positions that their forward ends do not project radially a sufficient distance to contact with the stationary terminals; but any set of brushes may be released and rocked outwardly by their springs 54, 55, 56 into position to contact with the line terminals in the corresponding rows. As shown, the rear ends of the brushes are normally latched or held against the thrust of the springs 54, 55, 56, by insulating latch bars 57, which are mounted upon the free ends or tongues 58 of a spring metal plate 59 fixed to the rotating carrier frame. There is a latch for each set of three brushes. In order to bring any set of brushes into position to engage the stationary contacts of the corresponding rows, the corresponding spring tongue or latch arm 58 must be retracted sufficiently so that the rear ends of the brushes can clear said latch bar and allow the brushes to rock upon their pivotal mounting. This release of the brushes is accomplished by tripping lugs 66 projecting from the edge of a trip bar 64 which is pivotally mounted upon an axis 65; said lugs being interposed in the path of the latch-arms 58 when the trip bar is rocked upon the axis. The trip bar is arranged to be operated by the armature 68 of an electromagnet 67.

It is intended that only one of the several sets of brushes shall be selected and tripped in a given operation of the selector; the other sets of brushes remaining out of service. The trip bar is therefore inclined at an angle so that the tripping lugs 66 will face positions successively reached by the vertical row of latch arms 58 as the brush carrier is rotated. The trip bar will be actuated to thrust forward its tripping lugs only for a moment, just before the latch arm controlling the desired set of brushes reaches the line of the particular lug which is at the proper height to engage that arm.

The range of line terminals 61, 62, 63, begins at the end of the "trip range" or arc of preliminary movement required to bring the whole series of brushes successively into position to be tripped. The terminals may be in sets of three, corresponding to the two main line wires and the test wire of a telephone circuit, the different sets in each horizontal row being arranged in an arc in position to be successively reached by a point-to-point rotary advance of the corresponding set of brushes.

The two line wires and the test wire of the circuit leading to the selector may be

soldered or otherwise permanently connected to the plates 41, 42, and 43 respectively; and by the operation of the selector these three conductors may be put into electrical
 5 connection with any set of stationary terminals 61, 62, 63 in any horizontal level; that is, by first tripping the set of brushes which travels over the required level, and then causing the brush carrier to rotate farther until the selected brushes reach the
 10 particular desired set of terminals in that level.

In the system shown in the drawings, each final selector is intended thus to select any
 15 one of five hundred sets of terminals. Each final selector may therefore have ten sets of brushes (three brushes in each set) and ten corresponding levels of stationary terminals, there being fifty sets (of three each)
 20 in each horizontal level. For simplicity in the diagram, however, there are shown only the lower two sets of brushes, and a few of the stationary contact terminals in the corresponding two lower levels.

The district selectors, office selectors and group selectors may likewise have ten sets of brushes each arranged to travel over stationary trunk line terminals in corresponding levels. The selective action of each of
 30 these machines will consist merely in the tripping of a set of brushes to select a particular one of the ten levels of terminals, after which the selected set of brushes is advanced point-to-point over the sets of stationary terminals in its level, testing said
 35 terminals in succession and coming to rest, as will hereafter be described, upon the first set representing a trunk line which is idle. There may be as many of each of these machines, and as many sets of terminals in each
 40 level, as traffic conditions may require. For the purposes of the present description, the district, office and group selectors may be assumed to be 500-line machines like the
 45 final selectors.

As shown, each selector has a segmental metal plate 70 in position to be engaged by the contact ends of any set of brushes as soon as they are tripped, this plate being
 50 grounded, to complete certain local circuits through said brushes. This plate 70 extends throughout the "trip range"—that is, through the total arc traversed by the brushes as one set after another throughout
 55 the whole series is brought successively into position to be tripped. At the end of the trip range the bank of line terminals begins.

To restore the brushes to their latched positions when the brush carrier returns to normal, an insulating bar 95 is mounted in
 60 position to be passed over by the contact ends of the brushes in the return journey of the carrier; the contact ends of the brushes in riding over this bar being pushed
 65 radially inward against the tension of their

springs until the beveled rear ends of said brushes slip over the catches 57.

The two line brushes 51 and 52 of each set have their contact ends sharpened so that in passing from one set of line terminals to the next they will break contact with the
 70 terminals which they are leaving before making contact with those next to be reached. The same is true of the test brushes 53 of the final selector; but the test
 75 brushes 53 of the district selectors, office selectors and group selectors have longer or more blunt contact ends, so that they will bridge the spaces between materials. Each
 80 of these test brushes therefore will make contact with the terminal in advance before breaking contact with the one which it is leaving; and in leaving the trip range and entering upon the range of contact terminals it will make contact with the first test
 85 terminal before breaking contact with the grounded plate 70.

The motor mechanism for rotating the brush carrier may be as follows: A circular iron plate 73 is mounted upon the shaft 50
 90 in such a manner that it will rotate therewith, but may also be given a downward flatwise or tilting movement toward either side, against the tension of a spring washer 78, into engagement with one or the other
 95 of two iron friction driving rollers 74, 75, which are located underneath it and upon opposite sides of its axis; said rollers being mounted upon a constantly-rotating power-shaft 76. An electromagnet 77, which will
 100 be hereafter referred to as the clutch magnet or power magnet, is arranged to magnetize the driving rollers 74 and 75 to cause them to attract the iron plate 73. Said plate
 105 is formed with cam surfaces as shown, such that in the normal position of the apparatus the under surface of the plate upon one side of the axis is nearer to the driving roller 75
 110 than the under surface upon the other side of said axis is to the roller 74; but when the switch carriage is in an off-normal position, the under surface of said iron plate when
 115 free will be nearer to the roller 74 than to roller 75. When the clutch magnet is initially excited, the rotary element of the selector being in its normal position, the plate
 120 73 will be attracted and tilted into engagement with roller 75, and driven thereby in a direction to advance the brushes over the line terminals. During the first stages of
 125 this movement a set of brushes will be selected and brought into service by the operation of the trip bar actuated by the trip magnet 67 as previously described; after
 130 which, as the brush-carrier continues to rotate, the selected set of brushes will be trailed over the sets of terminals in the corresponding level, until they reach the particular set of terminals desired, whereupon the clutch magnet 77 will be released and the

switch carriage brought to rest. The plate 73 now recovers from its tilted position, by the action of the spring washer 78, and being off-normal, the under surface of said plate lies nearer to roller 74 than to roller 75. A subsequent energization of the clutch magnet 77 will therefore draw said plate into engagement with said roller 74 and the plate will then be rotated in a reverse direction to return the switch carriage to normal position.

A cam 80 is carried by the rotary element of the selector to operate a switch 81. On the first rotary movement, and while the brushes are passing the trip range, the cam forces said switch spring 81 against the anvil 82; and at the end of the trip range the cam allows the spring to break this contact and make an alternate contact 83.

To furnish a means for measuring off at the distant sender the extent of movement of the selector switch carriage, so that such movement can be controlled with precision, the selector is preferably arranged to transmit electrical impulses back to the sender in unison with its point-to-point advance. This may be accomplished by the interrupter mechanism shown. The interrupter arm 84 is pivoted upon the rod 49 of the carrier frame in the same manner as the contact brushes, and carries at its forward end a roller 85 which is adapted, as the frame rotates, to ride over the edge of a stationary toothed segment 88, concentric with the selector shaft; the lever arm being thus caused to vibrate. The rear end of said lever carries a contact point 87, which, as the roller 85 rides up on each tooth of the segment, is closed against a contact anvil 86 carried by another lever 94 which is also pivoted upon the rod 49 of the carrier frame. A spring tongue 91, mounted upon but insulated from the carrier frame, presses against a bell-crank arm of the lever 94 and makes electrical connection therewith. A lever 93 also pivoted to the rod 49 of the carrier frame, has a foot which rides upon the smooth rim of the segment 88, and a hooked rear end which engages an insulating stud on the lever 94 to hold said lever against the tension of the spring tongue 91. A spring tongue 92 bears upon a bell-crank arm of the lever 93 to maintain the curved foot of said arm pressed against the inside of the rim of the toothed segment, which may be electrically connected to earth.

The construction above described, in which the making or breaking of contact 86, 87, is determined by the relative position of levers which ride upon the rim and upon the toothed edge, respectively, of the segment 88, insures an accurate operation of the interrupter, regulated exactly in accordance with the cutting of the teeth upon said segment, which are in fixed positions rela-

tive to the vertical rows of terminals, and independent of slightly variations in the radial distance between said toothed segment and the axis of rotation of the brush carrier.

The operation of the various selectors will hereafter be traced in detail, but in general may be outlined as follows: When a selector is first taken for use, a local circuit is established for its clutch magnet 77, under control of a line relay, which in turn is governed by the distant sending apparatus. The clutch magnet applies power from the constantly rotating shaft 76 to drive the rotary element of the selector, through the agency of the roller 75 engaging the plate 73. After a predetermined movement sufficient to bring the desired set of brushes into position to be tripped, the trip magnet 67 is excited, without releasing the clutch magnet 77. The trip bar 64, being rocked upon its axis 65, thrusts its tripping lugs 66 into the path of the latch arms 58; and one of these arms (the particular one depending upon the extent to which the switch carriage was rotated before the trip magnet was excited) is engaged by the corresponding tripping lug and retained sufficiently to bend it back until the latch bar 57 carried thereby no longer holds the rear ends of the corresponding set of three brushes against the tension of their springs, and said brushes are released and rocked upon their pivotal mounting in a direction to throw their forward or contact ends radially outward. Said brushes in contacting with the metal plate 70 will complete a local circuit for a controlling switch which will cause the trip magnet 67 to be immediately deenergized and the trip bar again retracted by a spring.

One of the sets of brushes having thus been selected and brought into service, the brush-carrier frame continues to rotate until these brushes reach the desired set of line terminals 61, 62, 63, in the corresponding level. In the case of the district selectors, office selectors and group selectors, this movement of the selected set of brushes over the corresponding horizontal level of line terminals will be a "hunting" movement, in which the continued excitation of the clutch magnet will be dependent upon a test relay, which in turn is responsive to the electrical condition of the test terminals 63 of the successive sets which are passed over by the brushes; the test relay being caused to open the circuit of the clutch magnet 77 of the selector as soon as the test brush reaches a terminal having no "busy test guard" or peculiar electrical condition, such as a ground connection, existing thereat. In the case of the final selector, however, the advance of the selected set of brushes will be controlled from the sending apparatus, through the agency of a line relay associated

with the selector, which will break the local circuit including the clutch magnet, after the brush carrier has been rotated a predetermined number of points.

5 In the case of the group selectors, in the particular system being described, the bank of stationary terminals will be divided into two halves or ranges, and the selector will be arranged to "hunt" in either range. That
10 is to say, the clutch magnet of the selector may be put under the control of the test relay immediately after the brushes leave the trip range; or the brush-carrier may, by the action of the sending apparatus, be caused
15 to pass over the first half of the total range of line terminals before beginning the hunting movement under the control of the test brush, such hunting movement taking place only in the second half. This is to enable
20 each selector to choose any one out of twenty groups of trunk lines leading to final selectors, even though the group selector has only ten sets of brushes.

During the rotary movement of the selector, the interrupter contact 86, 87 intermittently establishes a local circuit which short-circuits the line or controlling circuit extending back to the distant sending apparatus, thus causing electrical pulsations in
30 said circuit in unison with the point-to-point advance of the switch carriage. Said local circuit is established by the interrupter while the brushes are in transit from each set of terminals to the next, and the flow of
35 current in this local circuit is caused to maintain, directly or indirectly, the excitation of the clutch magnet 77, so that the clutch magnet cannot be deenergized and the brush-carrier brought to rest in any position except one in which the brushes are
40 accurately in contact with a set of stationary terminals. The selector is thus caused to operate with great precision, since its possible stopping positions are determined positively by the notches in the toothed segment
45 88, and the relations between these notches and the sets of line terminals are definitely and permanently fixed.

When the selector is to be returned to normal position, a local circuit is again established for the clutch magnet 77, which attracts the plate 73 into engagement with the roller 74, and holds it in such engagement until the brush carrier has been rotated back
50 to normal, whereupon, through the action of an automatic switch the circuit for said clutch magnet is broken.

Sequence switches.—The local controlling circuits at each selector and at the sending
60 apparatus, which must be established in definite order at successive stages of the operation, to bring into service the different devices or parts as they are required, in the present system are established by automatic

switching appliances which I term sequence- 65 switches. There is a sequence-switch for each selector, one for each sender and one for each cord-finder. The sequence-switch consists in its elements of a movable switch- 70 operating member, a number of circuit-changers or contact devices actuated in sequence as said member is moved from one position to another, an electromagnet, and motor mechanism operated or controlled by
75 said magnet for advancing said movable member through its successive positions. This sequence-switch may control any desired sequence of operations, whether of the same or of different devices. In each position to which its movable member is ad- 80 vanced, a circuit is established whereby a given operation of the device under control is made possible, and at the same time another circuit is established whereby the motor magnet of the sequence-switch may be 85 actuated automatically when such operation of the device under control has been completed; so that as each operation takes place the sequence-switch will be automatically advanced to the next position, in which a 90 new operation or another stage of the same operation will be brought about, and so on. Finally, the sequence-switch establishes a condition whereby the apparatus under control is returned to its normal condition, and 95 also establishes a circuit whereby the sequence-switch itself will be returned to normal.

Each selector and its sequence-switch may be so related that local reciprocal control- 100 ling circuits will be progressively established by said devices in their operation, in such a manner that when a normal operation of either is started, both devices will be progressively carried through a complete 105 cycle of operations, which may be controlled and checked at different stages through the agency of current flowing in the main circuit controlled at the sending apparatus, but which, unless so checked, will terminate 110 in the automatic return of both the selector and its sequence-switch to normal condition. In case of a failure of current in the main circuit, even immediately after the selector and its sequence-switch have started in oper- 115 ation, said devices cannot become permanently displaced or "stalled" in an off-normal position, but will complete their cycle of operations and be positively returned to normal, under control of circuits which are 120 purely local.

The mechanism of the sequence-switches may be as shown in Figs. 11, 12, 13 and 14. The movable member is a vertical rotary shaft 7 carrying a number of switch-operat- 125 ing cams 8, said shaft being arranged to be driven by power applied through the agency of an electromagnetic clutch. The con-

stantly-driven power-shaft 11 carries a friction driving-disk 10 which is adapted to be drawn into engagement with a friction roller 9, carried upon the shaft 7, by the action of a clutch magnet or "motor" magnet 12. The roller 9 and the disk 10 are of iron, and the clutch magnet 12 is adapted when excited to magnetize said roller 9, which serves as a rotary pole piece for said magnet; whereby the driving disk 10 is attracted into engagement with said roller, the rotation of the shaft 7 thus continuing as long as the motor magnet 12 remains excited.

The cams 8 carried by the rotary shaft 7 are arranged to operate switch springs 13, forcing said springs into engagement with outer contacts 15, or allowing them to engage their alternate inner contacts 14, according to the positions of said cams. As many cams and switches may be provided as the particular apparatus to be controlled may require. Certain of the switch contacts operated in the successive positions of the movable switch element may control circuits for the motor magnet 12. A special switch, such as shown in Fig. 14, is also preferably provided to control a local circuit for said motor magnet, whereby after the initial energizing circuit is broken by one of the other switches, the motor magnet may still be excited by current in the local circuit until the next intended stopping position of the rotary element is fully reached. As shown in Fig. 14, the cam 16 for operating the "local" switch is adapted to be engaged by a cam roller 17 carried by a pivoted switch lever 18. A spring 19 is arranged to act upon said pivoted lever 18 so as to press the cam roller 17 against the edge of the cam 16. When the roller 17 rides upon a tooth or high part of the cam 16, said lever 18 closes a contact 20 which controls the local circuit for the motor magnet. The teeth of the cam 16 have inclined edges, so that the cam roller 17, after riding over the point of a tooth, is forced down the opposite slope by the action of the spring 19, and thus tends to push against the cam to continue the rotation thereof until the roller 17 reaches the bottom of the following notch. The rotary element is thus brought to rest accurately in each of the positions where it is intended to stop. In the operation of the device, the circuit will first be closed for the motor-magnet through one of the springs 13 and one or the other of the contact anvils 14 or 15 of such spring. Then, as the motor-magnet is excited and the shaft of the sequence-switch begins to rotate, the contact through which the motor magnet was initially excited may be broken, but the local circuit will be maintained for the motor-magnet through the contact 20

closed by the cam 16, and the rotary element will thus continue to advance until the cam roller 17 reaches the bottom of the next notch of the cam 16.

In the circuit diagram, Figs. 1 to 9 inclusive, the switch springs of the sequence-switches are not shown in their actual arrangement, but are so located as to give the clearest arrangement of circuits; and the operating cams are not shown. The positions of the rotary element of each sequence-switch in which any of its contacts are closed are indicated by numbers placed adjacent to such contacts; each contact being open in all positions except those indicated by the adjacent numbers. For example, contact 609 of the sequence-switch associated with the district selector (Fig. 6) is closed in the first or normal position of that sequence-switch, as indicated by the number 1 placed adjacent to that contact, and is open in all other positions of the sequence-switch; while the alternate contact 610 is closed in the fourth position and also in positions 8 to 14 inclusive, but open in all other positions.

Each sequence-switch has a special contact governing the local or locking circuit of its motor magnet, such as contact 20 operated by cam 16 in Fig. 14. As these special contacts are closed only while the rotary element of the sequence-switch is in transit from one stopping position to the next, the numbers are placed on the side of the switch lever opposite from the contact, and indicate positions in which said contact is open, said contact being closed while the rotary element is in transit between the positions indicated by the numbers. Thus by reference to the numbers 1, 4, 5, 6, 7, 8, 10, 15, 16, 17, appearing adjacent to the contact 20 of the sequence-switch of the district selector, (Fig. 6) it is seen that this contact is closed between the first position and the fourth, open in the fourth, closed between the 4th and 5th, open in the 5th, closed between the 5th and 6th, and so on; the contact being continuously closed between the 1st and 4th positions, between the 8th and 10th positions, and between the 10th and 15th positions, so that the sequence-switch will not stop in the intermediate positions, but will stop only in those indicated by the numbers.

General organization of sending apparatus and scheme for controlling selections.

The selecting operations, in the system shown, are controlled according to the following plan: When connection is made with a selector, a controlling or stepping circuit is established, including a line relay at the selector and a relay or magnet at the sender which is adapted to operate a step-by-step mechanism. The line relay at the selector closes a local circuit for the clutch magnet thereof which starts the brush carrier in

rotation; and in such rotation an interrupter is operated by the selector to intermittently short-circuit the line, causing pulsations in the controlling circuit in unison with the

5 point-to-point advance of the selector, which pulsations cause the stepping relay or magnet at the sender to operate the step-by-step mechanism thereof, and measure off at the sender the extent of movement of the selector.

10 When the point-finder brush at the sender reaches a predetermined point or terminal in its path, which the operator has selected by depressing a key, it completes thereby a circuit for a "stop relay", which

15 opens the line circuit and so releases the line relay at the selector, thus bringing that particular selecting operation to an end. The line relay at the selector, when released, may cause the trip magnet to be excited and the

20 further advance of the brushes to be a hunting movement controlled by a test circuit from the terminals of the lines successively reached by the brushes; or in case of the final selector, the release of the line relay at

25 the end of the last selection will break the circuit of the clutch magnet and cause the brush carrier to come to rest. The response of the stop relay at the sender also causes an operation of the sequence-switch associated

30 with the sender to prepare the circuits for the next selection; the point finder brush being automatically carried to the beginning of another range of points or terminals which it is to traverse in governing such next selection. The operation thus proceeds until,

35 upon the response of the stop relay in determining the last selection required, the sequence-switch mechanism causes the sending apparatus to be disconnected from the circuit which has been established, leaving

40 the calling line united through the operator's connecting circuit and through the train of selectors to the subscriber's line wanted.

Each selector in the train through which

45 the circuit is successively extended will, as soon as it is reached, be brought under the control of the sending apparatus by the establishment of the stepping circuit, which includes the line relay at the selector and the

50 stepping relay at the sender, this circuit being controlled by the stop relay.

The extent of advance of the sender stepping mechanism prior to the actuation of the stop relay in determining each selection

55 is controlled by a point-finder apparatus, the finder brush of which is caused to traverse a series of points or terminals which may be selected by means of keys actuated by the operator, to complete a circuit for the stop

60 relay when the finder brush reaches the points or terminals so selected.

In the particular system shown, the first two selecting operations required in transmitting a call are, first, the selection of a

65 group of trunk lines leading to office selec-

tors of the required district (an idle office selector of this group being then chosen by an automatic "hunting" operation of the district selector independent of the sending apparatus), and, second, the selection by the

70 chosen office-selector of a group of trunk lines leading to group-selectors in the desired office (an idle one of this group being chosen by another automatic hunting operation). The result of these two selections is

75 to extend the circuit of the calling line through the district selector and office selector to a trunk line which terminates in a group-selector at the distant office. Both of these selections are determined by the

80 "office" key—that is, the key designating the office or exchange in which the wanted subscriber's line is located. In other words, each office key selects a point in each of two

85 divisions of terminals which are successively traversed by the point finder in governing the selecting operations of the district and office selectors, respectively.

To control the selecting operations of the group selector and final selector at the distant exchange, the point-finder apparatus may have other divisions of terminals or contact points to be successively traversed by the point-finder brush in governing these

90 selections.

Keys and registers of the sending apparatus.—The terminals or points which determine the selecting operations of the group selector and final selector are chosen through the agency of keys which may be set in combinations to designate the number of any

100 wanted line. In the system shown, where the lines and trunks are grouped or classified upon a non-decimal basis, "translation" is required in order that the number keys,

105 which are arranged according to the decimal system, may cause operations of the point finder apparatus adapted to the non-decimal grouping of lines and trunks in the exchange. In the system shown, the function of translation is performed by recording

110 devices which are herein called registers. These registers are adapted to take positions in response to the depression of keys representing a number of the decimal system; and in such position to select equivalent

115 points in the divisions successively traversed by the point-finder, to govern the non-decimal selecting operations; the points selected by the registers expressing the

120 equivalent of the number designated by the keys. The registers, which are associated with the point-finder apparatus, also serve to record or "store up" the number registered by any combination of number keys,

125 and thereby to establish permanent conditions for governing the series of point-finding operations required to cause the selection of the desired line, so that when the call is thus registered or stored up upon

130

one sender, the set of keys may be used thereafter to register another call upon another sender, before the first sender has finished transmitting the first call. There may be one key for each office or exchange of the system, and also a bank of number keys which, as shown, comprise four rows of ten keys each, representing the figures 0 to 9 inclusive, of "thousands," "hundreds," "tens" and "units" digits, respectively.

The keys are intended to lock in their depressed positions; and as shown in Figs. 1, 2 and 3, the lower end of the plunger 101 of each key carries an iron plate 103 which is adapted to serve as an armature for an electromagnet 102 common to the whole row of keys; the pole pieces of said magnet extending along under all the keys in the row. The magnet 102 of any row is not strong enough to draw down the plunger of any key from its normal position; but if when the magnet is excited any key is depressed, the plate 103 carried by the plunger of such key will be held in its depressed position until the magnet is deenergized. Springs (not shown) may be provided as usual for restoring the keys to normal position when released. Each key when depressed is adapted to close certain contacts governing circuits which are shown in the diagram and will hereafter be traced in detail. In general, however, it may be said that one contact of each key governs a circuit individual to the key, extending to a corresponding point upon the point-finder (or upon one of the registers, as the case may be) and another contact closed by the key may control a circuit for governing the start of the sender apparatus.

The mechanism of the registers may be as shown in Figs. 15, 16, 17, 18, 19 and 20. In this form of apparatus the rotary element 200 is a vertical shaft carrying at its upper end a contact brush or wiper 201 adapted as the shaft rotates to traverse a series of stationary terminals 202. Each register has ten of these terminals, mounted at equi-distant points around the periphery of a cylindrical insulating support 225. The contact brush 201 is pivoted upon a metal support carried by the shaft 200, and is provided with a spring 226 tending to keep the contact-end of said brush in engagement with the terminals 202 which it traverses. Electrical connection may be made with the moving brush 201 by means of a contact spring 207 bearing upon a contact-ring 208 carried by the rotary shaft of the register, said contact ring being electrically united by a metal bushing with the metallic support of said brush 201.

The rotary shaft of the register may be driven by a constantly rotating power-shaft 205, which is arranged to be mechanically coupled to the shaft of the register by the

action of an electromagnetic clutch. Thus, as shown, the rotary shaft of the register carries an iron disk or roller 203 which serves as a rotary pole-piece, so to speak, for a clutch magnet or motor magnet 206; and an iron friction-driving disk 204 carried by said driving shaft 205 is adapted to be attracted into engagement with the roller 203 to impart motion thereto when the clutch magnet 206 is excited.

The rotary shaft of the register is provided with a series of cams 209 for operating switch springs 210, in the same manner as previously described with respect to the sequence-switches. In fact, the registers are practically the same in mechanical construction and operation as the sequence-switches, except that they are provided with the contact brushes 201 and terminals 202, which the sequence-switches do not require. Each register has a special cam 216 and switch lever 218 shown in detail in Fig. 18, to operate a contact 220 which controls a local circuit for its clutch magnet, as previously described with reference to the sequence-switches. This contact 220 is closed while the rotary element is in transit from each possible stopping position to the next, to insure the accurate stopping of said rotary element in positions which are determined definitely by the notches of said cam 216.

In the circuit diagram, Figs. 2 and 3, the positions of the rotary element of each register in which any of its contacts are closed, are indicated by numbers placed adjacent to such contacts, just as in the case of the sequence-switches; each contact being opened in all positions except those indicated by the adjacent numbers. With respect to the special contact 220 of each register, governing the local or locking circuit for its motor magnet, the numbers are placed on the side of the switch lever opposite from such contact, and indicate positions in which it is open; this contact being closed continuously except when the rotary element of the register is in the positions indicated.

As shown in the circuit diagram, each sender has four registers, corresponding to the "thousands", "hundreds", "tens" and "units" keys, respectively; and the ten stationary terminals traversed by the finder brush 201 of each register correspond to and are electrically connected with the ten-digit keys, 0 to 9 inclusive, of the row with which the register is associated. Thus when the thousands key No. 8 is depressed, for example, it selects the corresponding terminal No. 8 of the thousands register—in the present system by "grounding" such terminal—so that when the finder brush at the register reaches terminal No. 8, a circuit will be completed for a stop relay of the register which will open at its back contact the circuit for

the clutch magnet of said register, thereby bringing the rotary element thereof to rest in its 8th position. So when any other numeral key is depressed, the register corresponding to the order of digits to which the key belongs (thousands, hundreds, tens or units, as the case may be) will be caused to take a position corresponding to the numeral of such key. In each position the cams of the register will close a certain distinctive combination of switch-contacts, to select terminals in the point finder apparatus equivalent to the combination expressed by the actuated keys.

Mechanism of point-finder.—The mechanism of the point-finder selector-controlling apparatus may be as shown in Figs. 21 and 22. A pair of contact brushes 401, 402 are mounted at the extremity of an arm 403 carried by a rotary shaft or spindle 404, said brushes being arranged to wipe over two concentric circular ranges of stationary contact terminals 405, 406, which are mounted one above the other in a suitable insulating support surrounding the shaft 404. The brushes 401, 402, are electrically united, so that they will serve to connect a terminal 405 of the upper range to the corresponding terminal 406 of the lower range, at any point around the circle. In other words, whenever the brush 401 is in contact with a terminal 405 at any point in the upper range of terminals, the corresponding terminal 406 in the lower range will be electrically connected to such upper terminal through the brushes 402, 401. The normal position of the rotary arm 403 may be as shown in Fig. 21, in which the brushes rest in the position indicated diagrammatically in Fig. 1—that is, one step back of the first pair of terminals in the division which is used for controlling selections of the district switch.

The electrical connections of the stationary terminals in the upper and lower ranges 405, 406, are indicated diagrammatically in Figs. 1, 2 and 3. Said terminals are arranged in five divisions which are traversed successively by the finder brushes 401, 402, as the arm 403 makes a complete revolution. That is to say, beginning with the normal position of the brushes, there is first a division which may be called the "district" division, comprising ten pairs of terminals which are used in controlling the brush-choosing action of the district selector; then three pairs of dead terminals, then a pair of terminals representing a secondary starting position for the brushes, preliminary to the "office" division, then the office division comprising ten pairs of terminals used for controlling the brush choosing action of the office selector; then three more pairs of dead terminals; and so on through the three subsequent divisions comprising the terminals

which are used for controlling the first, second, and third numerical selections—namely, the brush-choosing action of the group-selector, the brush-choosing action of the final selector, and the rotary selective action of the final selector. At the end of each division there are three pairs of dead terminals; and at the beginning of each division there is an extra pair of terminals representing a starting position for the brushes, preliminary to their entry upon such division.

The brush-carrier arm 403 is adapted to be rotated step-by-step around the annular bank of stationary terminals, by the action of an escapement which controls a train of gears, the brushes being caused to step from terminal to terminal at each complete vibration of the pallet 408. The motive power for rotating the brush carrier shaft 404 may be furnished by a coiled spring 409 acting upon a gear wheel 410 which meshes with another gear wheel 411 fixed upon said shaft 404. The gear wheel 411 meshes with a pinion 412 mounted upon an arbor which also carries the escape-wheel 413. The pallet 408 of the escapement is mounted upon an arbor 414 which also carries the armature 415 of an electromagnet 416. This "step magnet" 416 is in a local circuit controlled by a "stepping relay" 440 (Fig. 4), which responds to the selecting impulses transmitted over the controlling circuit by the action of the interrupter 86—87 of the distant selector under control.

The rotary brush-carrier shaft 404 of the sender carries a cam 418 which is adapted to close a contact 419 while the brushes 401, 402 are traversing the terminals of each division; said contact being open when the brushes rest in the starting positions preliminary to the respective divisions. The brush-carrier shaft 404 also carries a cam 420 which is arranged to close a contact 421 for a short period of time when the brush-carrier arm 403, having nearly completed a revolution, is approaching its normal position; said contact 421 being open at all other times.

The coiled spring 409 which drives the gear train to rotate the brush carrier under control of the escapement may be automatically wound up after each complete revolution of the brush carrier. The winding mechanism is shown most clearly in Fig. 22. One end of the spring 409 is fixed to a shaft 422 upon which the gear wheel 410 is journaled to rotate; and said shaft 422 carries an iron disk 423 which is adapted to be engaged by an iron friction-driving roller 424 and rotated thereby in a direction to wind up said spring 409. The driving roller 424 is continuously rotated by a power shaft 425; and a clutch magnet 426 is adapted when excited to magnetize said roller 424 to

attract the iron plate 423 into engagement with said roller. A pawl 427 (Fig. 21) is adapted to engage a notch in the edge of the plate 423 to hold the latter against reverse rotation, when the clutch magnet 426 is de-energized. Said pawl 427 is arranged to close a contact 428 whenever the disk 423 has been rotated away from its normal position; said contact 428 being employed to close a local circuit for the clutch magnet 426 to maintain said magnet excited (when it has once been energized) until the disk 423 has made a complete rotation.

The electrical connections of the point finder apparatus may be as shown in Figs. 1, 2, 3 and 4 of the circuit diagram. The stepping magnet 416 is included in a local circuit which is controlled at a back contact 431 of the stop relay 430, and is also controlled at a front contact of the stepping relay 440. Said stepping relay 440 is adapted to be included in a stepping circuit which also includes the line relay of the distant selector to be controlled; and said stepping circuit is controlled by a back contact 432 of the stop relay 430 at the sender. Said stop relay 430 is included in a circuit which is arranged to be completed by the finder brushes 401, 402, when said brushes contact with the pair of terminals 405, 406, which the operator has selected in each division by means of her keys. There is a sequence-switch associated with the sender, by which the stop relay 430 is brought successively under control of the finder brushes and the selected pairs of terminals in the different divisions of the sender; said sequence-switch also performing other necessary circuit changes from time to time, as will hereafter be described in detail.

Automatic finder.—In the system shown each operator may have available for her use two equipments of sending apparatus, either of which may be controlled by a single set of keys. Each sender preferably has an automatic finder associated therewith, to connect the sender to any of the operator's connecting circuits which is put into use to answer a call. Since in the particular system shown the operator's connecting circuits terminate at their answering ends in flexible cords and plugs, they are called "cord circuits" in ordinary engineering parlance; and the automatic finder which connects the sender to any cord circuit taken for use may be termed specifically a "cord finder," although it is obviously adapted for other forms of connecting circuits.

The mechanism of the cord finder is illustrated in Figs. 23, 24, and 25; and the electrical connections thereof, together with the apparatus associated therewith, are shown in Fig. 5. Each cord finder has a sequence-switch associated therewith, the motor mag-

net and switch contacts whereof are shown in Fig. 5. The cord finder consists, in its elements, of a series of contact brushes forming the terminals of circuits individual to the sender, sets of contact terminals arranged to be traversed by said brushes and connected to lead wires which extend to the several cord circuits, and motor mechanism adapted to advance the contact brushes over the terminals, to test the terminals of the different cord circuits in succession and make connection with the set representing the cord circuit which has been taken for use.

In the system shown it is intended that each operator should have twenty-four cord circuits for use in answering calls; and these are divided into four groups of six each. Each lead-wire from the sender is adapted to be connected, through contacts of the sequence-switch associated with the cord finder, with any one of four multiple contact brushes, which are arranged to traverse terminals of the four groups, respectively, of cord circuits.

Each cord circuit is represented by a test terminal in one of four groups of terminals which are traversed respectively by the four test brushes 501, 502, 503 and 504 of the cord finder. When any cord circuit is taken for use, a distinctive electrical condition (such as a "ground") is established at the corresponding test terminal, to cause the response of a test relay which is connected to the four test brushes in multiple. The test relay controls the motor mechanism, which causes the cord finder brushes to traverse the sets of terminals; said motor mechanism being started in operation by the action of the sequence-switch associated therewith when any cord circuit is put into use to answer a call. When the test terminal of the cord circuit which has been put into use is engaged by the test brush which traverses the group in which it is located, the test relay of the cord finder in its response causes the motor mechanism to stop, bringing the cord finder brushes to rest at this point. The sequence-switch is also started in operation by the response of the test relay, and causes the four multiple test brushes to be tested in rotation to determine in which of the four groups the cord circuit which has been put into use is located. The sequence-switch takes one of four positions, according to the particular group in which the cord circuit is located; and in such position the sequence-switch completes electrical connection from the sender leads to the brushes which traverse the terminals representing cord circuits of that group, said brushes having been stopped in position to contact with the terminals of the lead wires extending to the particular cord circuit in question.

In the system shown the sending apparatus has four main leads 506, 507, 508 and 509, and a test lead 510, which are adapted to be connected through contacts of the sequence-switch with the corresponding main brushes 516, 517, 518, 519 and the test brush (501, 502, 503, or 504, as the case may be) of any one of four sets of such brushes which traverse the four groups of cord circuit terminals. Each cord circuit has leads 526, 527, 528, 529 and 500 associated therewith, (the latter being a test wire) which are connected to corresponding terminals traversed by the brushes 516, 517, 518, 519, and the test brush 501, respectively. The motor magnet 530 of the sequence-switch associated with the cord finder is normally connected through a contact 531 of said sequence-switch to a conductor 532 which is multiplied to all the cord circuits, being connected to a contact 616 (Fig. 6) of the sequence-switch associated with each cord circuit. When any cord circuit is taken for use, its sequence-switch in reaching the second position closes a contact 616, and thereby completes a circuit over conductor 532 for the motor magnet of the sequence-switch associated with the cord finder of the primary sender, if that sender is free, in which case the contact 531 of the sequence-switch associated with its cord finder will be closed. The sequence-switch of the cord finder associated with the primary sender is adapted to shift the connection of the conductor 532 from its own motor magnet 530 to contact 581, contact 481 of the sender sequence-switch (Fig. 4) and motor magnet 580 (Fig. 5) of the sequence-switch associated with the subsidiary sender, so that when the primary sender is in use in association with one of the cord circuits the subsidiary sender will be available to serve any of the other cord circuits; the conductor 532 which is multiplied to the sequence-switches of the cord circuit having been transferred to connection with the motor magnet of the sequence-switch associated with the cord finder of the subsidiary sender.

Referring to Figs. 23, 24 and 25, the stationary terminals of the cord circuit leads are mounted in four groups in an annular insulating support 522, as shown most clearly in Fig. 25. The four sets of brushes which are intended to traverse the four groups of stationary terminals are mounted upon the four insulating posts 533 of a frame 544 which is arranged to rotate upon a vertical axis concentric with the axis of the annular terminal-support 522.

Each of the posts 533 of the rotary frame 544 carries five brushes: 516, 517, 518, 519, and the test brush (501, 502, 503 or 504, as the case may be). The group of terminals to be traversed by the brushes of each set are arranged in five levels corresponding to

the respective brushes, each terminal being insulated from all the others.

The rotary brush carrier frame 544 of the cord-finder is carried by the lower end of a vertical shaft 545 which is journaled in suitable bearings in the main frame of the apparatus. The upper end of said shaft 545 carries an iron plate or disk 546 which is arranged to rotate with the shaft but is adapted to be given a slight flatwise or tilting motion against the tension of a spring washer 547.

An iron friction-driving roller 548, which is carried by a constantly-rotating power-shaft 549 is adapted to be magnetized by an electromagnet or helix 550, and when magnetized will attract the iron plate 546 into engagement therewith to communicate rotary motion to said plate, and thereby to rotate the shaft 545. In other words, the magnet 550 and its associated parts constitute an electromagnetic clutch to control the rotation of the brush carrier frame by mechanical power from the driving shaft 549.

A holding magnet 551 is mounted adjacent to the plate 546, in position to attract said plate and maintain the rotary element of the cord finder in a fixed position when the clutch magnet 550 is deenergized. A spring 552 acting upon the shaft 545 is adapted to return the rotary element or brush-carrier of the cord finder to normal position when the holding magnet 551 is deenergized and the disk 546 released. When the rotary element of the cord finder is in normal position the sets of brushes rest in the positions indicated in dotted lines in Fig. 25.

A cam 553 (Fig. 24) may be mounted upon the shaft 545 and arranged to close a contact 554 when the rotary element of the cord finder is in its normal position; said contact being opened when the cord finder is off-normal.

Operation of system.—The apparatus and circuits not already described in detail will sufficiently appear from a consideration of the diagram, Figs. 1 to 10 inclusive, and the description of the mode of operation hereafter to be given. In the diagram, devices of known types are designated by the usual conventional symbols. Certain of the ordinary appliances required in an actual telephone system, such for example as the operator's telephone set, are not shown, because their characteristics, electrical connections and manner of use are well understood by those skilled in the art, and to show them in detail would unnecessarily complicate the diagram. For convenience in tracing the circuits, separate batteries are shown at various points; but it will be understood that where batteries of the same polarity and potential are indicated at the same exchange, these would in practice be replaced by a cen-

tral battery common to the exchange, which would be connected as indicated by the separate symbols shown on the diagram.

The organization and mode of operation of the system can best be understood by tracing the successive steps involved in extending the connection of a calling line through to the line called for, performing the requisite incidental operations, finally disconnecting the lines and restoring the circuits and apparatus to normal condition.

Let it be assumed that the subscriber at station 601 (Fig. 6) wishes to talk to the subscriber No. 1063 (Fig. 10). The calling subscriber signals the central office operator in the usual way by removing his telephone receiver from its hook, thereby causing the line circuit to be closed, exciting the line relay at the central office in the usual way, and causing the signal lamp 602 to be lighted. The operator responds to the call in the usual way by inserting her answering plug 603 into the answering jack of the calling line, and then by depressing her listening key brings her telephone set (not shown) into circuit, and inquires the number of the subscriber wanted.

The insertion of the answering plug 603 in the spring-jack of the calling line completes a circuit for the cord relay 605, which is connected in a ground branch from the third contact or sleeve of the answering plug; the test ring of the jack with which said sleeve engages being connected with the free pole of the grounded central battery, through the usual cut-off relay. The operation of said cut-off relay breaks the circuit of the line relay which, in recovering, causes the line signal lamp 602 to be extinguished.

The cord relay 605, in conjunction with an extra contact on the operator's listening key, controls the start of the sequence-switch associated with the cord circuit and district selector, which in turn starts the sequence-switch of the cord finder associated with the primary sender (or the cord finder associated with the subsidiary sender if the primary sender is busy).

As soon as the operator actuates the listening key of the cord circuit which has been put into use to answer the call, a circuit for the motor magnet of the sequence-switch associated with said cord circuit is completed as follows: from ground, through the front contact of the relay 605, through contact 604 associated with the listening key, normally-closed contact 609 of the sequence switch (said sequence-switch being in the first or normal position as indicated by the numeral 1 appearing near the contact 609) thence through the motor magnet 607 of the sequence-switch to the free pole of the grounded battery 608. The sequence-switch immediately starts to advance, and, as indicated by the numerals appearing opposite

the contact 20 thereof, it will be carried through to the fourth position, by reason of the continuous closure of said contact 20. While this sequence-switch is passing the second and third positions, it closes a contact 616, which applies a ground connection to the lead wire 532, thereby completing a circuit which may be traced back through contact 531 of the sequence-switch associated with the cord finder of the primary sender (assuming this sender to be free) and thence through the motor magnet 530 of said sequence switch to the free pole of grounded battery 590.

If the primary sender were busy, the contact 531 of the sequence-switch associated with the cord finder of said primary sender would be open, and from the third to the ninth positions inclusive of said cord-finder sequence-switch the alternate contact 581 would be closed, connecting the lead-wire 532 to a conductor extending (through a contact 481 of the primary sender sequence switch, (Fig. 4) to the motor magnet 580 (Fig. 5) of the cord finder sequence switch of the subsidiary sender. The equipment of the subsidiary sender with its cord finder is a duplicate of that of the primary sender, and the operations would be the same as those about to be traced for the primary sender.

As soon as the circuit previously traced for the motor magnet 530 (or 580 as the case may be) is completed, the sequence-switch operated by said motor magnet advances to its second position. In this position the test relay 586 of the cord finder is connected to the four test brushes in multiple (by way of the conductor 510, contact 561, and contacts 562, 563, 564 and 565) and a circuit is completed from ground through a back contact of said test relay 586, contact 566 of the cord-finder sequence-switch, clutch magnet 550 of the cord finder to the free pole of a grounded battery. The cord finder, therefore, immediately advances its four sets of brushes over the corresponding four groups of stationary contact terminals until one of the multiple test brushes 501, 502, 503 or 504 reaches a terminal which has been grounded by the closing of contact 664 of the sequence-switch of the cord circuit which has been put into use.

In the diagram, the cord circuit illustrated happens to be one belonging to the group shown nearest the top of Fig. 5, the test terminals whereof are traversed by test brush 501. When said test brush 501 reaches the test terminal to which the test wire 500 of the cord circuit is connected, a circuit is completed for the test relay 586 through contacts 561, 562 and 563 to brush 501, wire 500 (continued on Fig. 6) through contact 664 of the cord circuit sequence switch (said contact being closed in the fourth position of said sequence switch) to earth.

The test relay 586 in opening its back contact breaks the circuit previously traced for the cord-finder clutch magnet 550, and at its front contact closes a circuit from
 5 ground through contact 568 to the holding magnet 551 of the cord finder and free pole of the battery, so that said holding magnet is excited and maintains the rotary brush carrier of the selector in the position
 10 in which it has come to rest. The holding magnet will now remain excited by circuit through contact 568 or an alternate contact 569 as long as the sender is in service, said contacts 568 and 569 being so arranged that
 15 before either is opened its alternate contact will be closed.

The cord finder sequence switch will now proceed automatically to find which of the four test brushes has completed the circuit
 20 of the test relay, and will then close a set of contacts to connect the sender leads 506, 507, 508 and 509 to the other brushes of the set to which such test brush belongs. The sequence switch of the cord finder begins to
 25 advance from its second position as soon as the test relay 586 is excited; a circuit having been completed from ground through a front contact of said test relay and wire 570 to the motor magnet 530 of said sequence switch
 30 and battery 590. As the sequence-switch leaves its second position it opens the contact 561 controlling the initial exciting circuit of the test relay 586, and leaves said test relay dependent for its excitation upon current
 35 flowing in a locking circuit closed through a front contact of said relay to wire 571 and thence to earth by way of that one of the test brushes which has found the grounded terminal. As the sequence switch
 40 leaves the second position, it opens contact 563 and disconnects test brush 501 from the wire 571, leaving the test relay dependent upon the other brushes 502, 503 and 504 to maintain its locking circuit. In the case
 45 assumed, none of these other test brushes would be in contact with a grounded terminal, so that the test relay would be released, removing the ground from wire 570 and causing the sequence switch to come to
 50 rest in the fourth position. If it had been the test brush 502 which found the grounded terminal, the sequence switch would have been carried through to the sixth position before stopping, because its locking circuit
 55 from wire 571 would be maintained through contacts 564 and 565 in the third position, through contact 572 in the fourth position, and on leaving the fourth position the motor magnet 530 of the sequence switch would
 60 remain excited by current in the local circuit controlled by contact 520 which does not open between the fourth and sixth positions. The test relay 586 would in this case be released upon the opening of contact 565
 65 as the sequence switch left the third posi-

tion, and said relay having opened its front contact controlling its connection to wire 571 would not be again excited when sequence switch contact 572 closed in the sixth position.

If it had been brush 503 which found the grounded terminal, the sequence switch of the cord finder would be carried through to the eighth position, the locking circuit for the test relay being maintained through con-
 70 tact 564 in the third position, through contact 572 in the fourth position, through contact 564 again in the fifth position, through contact 572 again in the sixth position; after which said test relay would be released when
 75 the sequence switch left its sixth position, but the sequence switch would be carried through from its sixth to its eighth position by reason of the local circuit of the motor magnet 530 closed by the special contact 520
 80 between these two positions.

If it had been the brush 504 which found the grounded terminal, the sequence switch of the cord finder would in a similar manner be carried through to the ninth position, the
 85 locking circuit of the test relay being maintained through contact 562 in the third, fifth and seventh positions and through contact 572 in the fourth, sixth and eighth positions.

If the cord finder sequence switch comes
 90 to rest in the fourth position, as above described, contacts 576, 577, 578 and 579 will be closed to connect the sender leads 506, 507, 508 and 509, respectively, to the other
 95 brushes 516, 517, 518 and 519, respectively, of the set to which the test brush 501 belongs, said brushes 516, 517, 518 and 519 being now resting upon contacts which are the terminals, respectively, of lead wires 526,
 100 527, 528 and 529 of the cord circuit shown in Fig. 6. Similarly if the cord circuit put into use had been one of the group tested by the test brush 502, the cord finder sequence switch would have come to rest in the sixth
 105 position, in which the sender leads 506, 507, 508 and 509 would have been connected to the other brushes of the set to which brush 502 belonged. And in like manner, whichever of the four test brushes found the terminal of the cord circuit which was put into
 110 use, in its group, the cord finder sequence-switch would come to rest in a distinctive position to connect the sender leads with the other brushes of that set.

The test relay 586, in recovering, closes a
 120 circuit from ground through its back contact 567 of the sequence-switch, wire 575, through contact 451 (Fig. 4) of the sequence-switch associated with the point finder apparatus, and through the motor magnet 450
 125 of said sequence-switch to the free pole of a grounded battery 493. This sequence-switch moves to its second position, and closes contact 452, which completes a circuit for the locking magnets 102 of the operator's keys,
 130

so that when any of these keys is depressed it will be held in the depressed position until released by the opening of said locking circuit, which will not occur until the sequence-switch of the point finder leaves its 8th position. This locking circuit may be traced from ground through contact 452 to wire 453, through the locking magnet of the office key, (Fig. 1) through the locking magnet of the thousands and hundreds keys (Fig. 2) and through the locking magnets of the tens and units keys (Fig. 3) to the free pole of a battery 301 (Fig. 3).

When the sequence-switch of the sender moves to its 2nd position, as before described, it also closes a contact 454 which connects the motor magnet 450 of said sequence-switch to a wire 455 leading to the office keys, where said wire may be grounded by any key which is depressed. When any office key is depressed, therefore, a circuit will be completed for the motor magnet 450 of the point finder sequence-switch, which will thereupon advance to its third position, closing a contact 456 which closes at the sender end the stepping circuit hereafter to be traced over the sender lead 506 and through the stepping relay 440.

Turning now to Fig. 6, it will be remembered that the sequence-switch associated with the cord circuit and district selector was advanced to its fourth position as a result of the insertion of the answering plug in the springjack of the calling line, and the operation of the listening key contact 604. In the fourth position of this sequence-switch a contact 675 is closed and remains closed until the 9th position, which applies ground to the lead wire 528 from which circuit may be traced back through brush 518 (Fig. 5) contact 578, wire 508 to relay 458 (Fig. 4) and the free pole of a grounded battery. This relay 458 controls at its back contact a circuit for the motor magnet 450 of the point finder sequence switch; said sequence-switch will be returned to normal whenever the controlling relay 458 is de-energized; but in the normal operation now to be traced this will not occur until all the sending operations have been completed.

In tracing the circuits between the sending apparatus and the cord circuit and train of selectors the cord finder need not always be mentioned, since it will be understood that it has served merely to extend connection of the sender leads 506, 507, 508 and 509, through its brushes to the lead wires 526, 527, 528 and 529, respectively, of the cord circuit. The stepping circuit between the selector and the sender is established over the lead 506 (or over leads 506 and 507 in the case of the group selector and final selector). The circuit 508, 528, controlled at contact 675 furnishes a means by which the sequence-switch of the point finder appara-

tus can be controlled by the sequence-switch of the cord circuit and district selector; and the circuit 509, 529, furnishes a means whereby the sequence-switch of the sending apparatus may exercise a reciprocal control over the sequence-switch of the district selector.

When the operator has communicated with the calling subscriber and has learned the number of the line wanted, she depresses a key (Fig. 1) representing the office or exchange in which the wanted subscriber's line is terminated, and also depresses numeral keys (Figs. 2 and 3) representing the digits of the number of such wanted line. In the case assumed, where line No. 1063 is called, the operator would depress the thousands key No. 1, the hundreds keys No. 0, the tens key No. 6 and the units key No. 3. The depressed office key (Fig. 1) will ground terminals in the first and second divisions, respectively, of the point-finder apparatus, for governing the district selection and office selection, respectively. The numerical keys will cause the registers to ground terminals in the third, fourth and fifth divisions of the point finder apparatus for governing the selecting operations of the group selector and final selector as will hereafter be described.

Assuming the office key "B" (Fig. 1) to have been depressed by the operator, and that the office or exchange "B" is, say, the fifth office in the sixth district of the system, the depressed key will "ground" the sixth terminal in the first or "district" division of terminals 405 of the point finder apparatus, and also the fifth terminal in the second or "office" division of said terminals 405. Any of the office keys when depressed will also ground the wire 455, whereby a circuit will be completed through contact 454 (Fig. 4) to the motor magnet 450 of the sequence-switch associated with the point finder apparatus, to cause said sequence-switch to move from its second to its third position.

The stepping circuit between the line relay 620 of the district selector and the stepping relay of the sender is closed at the selector end when the sequence-switch associated with the cord circuit and district selector reaches its fourth position, in which contact 635 is first closed. Then as soon as the sequence-switch of the point finder apparatus (Fig. 4) reaches its third position, as the result of the depression of any office key, the selecting or "stepping" circuit will be completed at contact 456, and may be traced from ground through resistance 457 (Fig. 4) through contact 456, back contact 432 of the stop relay 430, through winding of stepping relay 440, lead wire 506, contact 576 of the cord finder (Fig. 5) brush 516, lead wire 526 to the cord circuit (Fig. 6) through contact 635 of the sequence-switch of the dis-

trict selector, through line relay 620 of said district selector to the free pole of grounded battery 621.

As soon as this circuit is established, the line relay 620 of the district selector is excited and closes at its front contact a circuit from ground through contact 622 of the sequence-switch (closed in the 4th position) to the motor magnet 607 of the district selector sequence-switch, and free pole of grounded battery 608. This sequence switch therefore moves from its fourth to its fifth position. In the fifth position the contact 635 remains closed to maintain the circuit for the line relay back to the sending apparatus, and a contact 626 is closed, completing a circuit from ground through the front contact of said line relay, contact 626, through the clutch magnet 77 of the district selector to the free pole of the grounded battery 625.

The power plate or disk 73 of the district selector is now attracted into engagement with the driving roller 75, by the excitation of clutch magnet 77, and the switch carriage begins to rotate. At the beginning of this rotary movement, the cam 80 forces the contact spring 81 into engagement with the anvil 82, and thereby completes a circuit from ground through said contact 81, 82, and through contact 632 of the sequence-switch (closed in the fifth position) to the motor magnet 607 of said sequence-switch, whereby the latter is advanced from its fifth to its sixth position. In this position a contact 631 is closed to provide a local circuit for the line relay 620 through wire 627 and back contact 628 of the trip magnet 67 to the interrupter contact 86, 87, which when closed completes the circuit through interrupter roller 85 to the metal segment 88 which is grounded, as indicated at 629.

As the brush carrier frame of the selector is rotated, the interrupter arm 84 is vibrated by the roller 85 riding over the teeth of the segment 88. As said roller rides up on each tooth the contact 86, 87, is closed, completing the path just traced to earth from the relay 620, short-circuiting the stepping relay 440 of the sender.

When the stepping relay 440 of the sender was initially excited by the establishment of the circuit connecting said relay in series with the line relay 620 at the selector, it closed a local stepping circuit from ground through its front contact, sequence-switch contact 447 and back contact 431 of the stop relay 430 to the stepping magnet 416 of the point finder apparatus, and the free pole of a grounded battery. The armature of the stepping magnet 416 in its attractive movement rocks the pallet 408 (Fig. 21) in a direction to allow the escapement wheel 413 to take a half step, moving the finder brush 401 (Figs. 1 and 21) half the distance between its normal position and the first pair

of terminals 405, 406, in the first division. As the interrupter roller 85 of the district selector rides up on the first tooth of segment 88, closing interrupter contact 86, 87, and short-circuiting the stepping relay 440 at the sender, said stepping relay opens the local circuit of the step magnet 416, whereupon the armature 415 of said step magnet is retracted by a spring, rocking the pallet 408 in a direction to permit the escapement wheel 413 to take another half step, which moves the finder brush 401 the remainder of the distance required to reach the first pair of terminals (No. 0) in its path.

As the selector finishes a complete step, bringing the interrupter roller 85 to the bottom of the next notch in the segment 88, the contact 86, 87, is opened, breaking the short circuit 627 and permitting the flow of current again over wire 526 to the stepping relay 440 of the sending apparatus, unless this stepping circuit has in the meantime been opened at contact 432 of the stop relay (which would have occurred if the first pair of terminals in the district division had been selected by the depressed office key).

As successive impulses are delivered to the stepping relay 440 by the intermittent opening of the short-circuit at interrupter contact 86, 87, of the selector, the point-finder at the sender is thus advanced in unison with the selector, from step to step, until the finder brush 401 finally reaches the terminal 405 which has been grounded by the depressed office key. When such grounded terminal (in this case the sixth, which was grounded by office key "B") is reached, the finder-brush 401 serves to complete a circuit from said grounded terminal to the corresponding terminal 406 in the lower range. All of said lower terminals 406 in the district and office divisions of the point-finder apparatus are connected to a wire 459, through which circuit is now traced through contact 460 of the point-finder sequence-switch (Fig. 4) and through the stop relay 430 to the free pole of a grounded battery 439. As soon as this circuit for the stop relay is completed, which will be at a time when the stepping relay 440 and stepping magnet 416 are deenergized as a result of the roller 85 at the selector riding up on a tooth of the segment 88 and closing contact 86, 87, the stepping circuit will be opened at the back contact 432 of said stop relay. This opening of the stepping circuit at the sender will leave the line relay 620 of the selector dependent for its excitation upon the local circuit 627 closed by the interrupter contact 86, 87. When this circuit is broken, as the roller 85 rides down into the next notch of the segment, the line relay 620 is deprived of current and retracts its armature, which opens the short circuit of the trip magnet 67, previously traced through

sequence-switch contact 626. The current from battery 625 flowing through the clutch magnet 77 of the selector, now, instead of passing to earth through the front contact of the line relay, flows through the trip magnet 67 and sequence-switch contact 630 to earth. The trip magnet is therefore excited, and as the clutch magnet 77 is not released, the brush carrier of the selector continues to rotate.

When the trip magnet 67 is excited, it causes the tripping lugs to be thrust forward into the path of the latch arms 58. The particular one of said latch arms 58 to be engaged by a tripping lug depends upon the number of steps through which the brush carrier of the selector had advanced before the trip magnet was excited. In the case assumed, where the office key "B" was depressed, grounding the sixth terminal in the office division on the point finder, the selector and the point finder will have taken six full steps in unison before the release of the line relay 620 caused the trip magnet 67 to be excited. In those six steps the latch arms of the first five sets of brushes (counting from the bottom up) had successively passed the points at which they might have been tripped, leaving the latch arm of the sixth set of brushes (corresponding to the sixth pair of terminals in the "district" division of the point finder) to pass in its turn the tripping lug at the corresponding level. This tripping lug being now thrust forward, the latch arm of the sixth set of brushes will be engaged thereby and detained sufficiently to release the three brushes of the set, allowing them to be rocked upon their pivots by their springs 54, 55 and 56 until their forward ends contact with the grounded metal plate 70.

As soon as the brush 51 of the set which has been tripped touches the grounded plate 70, a circuit is completed from said grounded plate to said brush 51, metal strip 41, wire 691, contact 636 of the sequence-switch, to the test relay 606 and free pole of grounded battery 687. The test relay 606 in closing its front contact 688, completes a locking circuit through sequence-switch contact 663 to the third or test brush 53 of the set which has been tripped, and by way of the plate 70 to ground. This circuit will be maintained until the selected brushes leave the trip range and enter upon the range of line terminals; after which said circuit may be completed to earth by way of the test terminals 63 of busy lines. The test relay 606 also closes a circuit from ground through its front contact to the line relay 620 and free pole of battery 621, whereby said line relay is again excited and reestablishes at its front contact the short circuit of the trip magnet 67. The trip magnet, therefore, is im-

mediately deenergized, having remained excited only long enough to trip a single set of brushes.

The first or district selection has now been completed, the sixth set of brushes of the district selector having been brought into service as a result of the grounding of the sixth terminal in the first or district division of the point-finder apparatus by the depressed office key; the other brushes of the district selector remaining out of service.

The selected set of brushes may now, by a further rotary movement of the brush carrier, be caused to travel over the line terminals in the corresponding row or level. In the system under consideration each set of line terminals in each level of the district selector represents a trunk line leading to an office selector; all the terminals in a given level representing trunk lines of the same group. Any of the office selectors of this group will serve to complete the connection to a trunk line leading to the desired office; and after a set of brushes of the district selector has been tripped, as before described, the district selector must cause the tripped set of brushes to advance over the corresponding horizontal row of terminals, until a set is reached representing an office selector which is idle. This "hunting" operation will now be described. When the brush carrier of the selector has carried all the brushes beyond the trip range, the cam 80 allows spring 81 to engage the contact anvil 83, completing a circuit from ground through said contact 81, 83, and sequence-switch contact 633 to the motor magnet 607 and battery 608; whereby the sequence-switch is advanced to its seventh position. In this position the contact 630 controlling the branch from the clutch magnet 77 of the selector through the trip magnet 67 thereof is opened, leaving said clutch magnet 77 dependent upon current flowing to earth through contact 626 and the front contact of the line relay 620. Said line relay, under the control of the test relay 606, will now govern the further advance of the selector brushes in "hunting" an idle trunk.

The circuit of the test relay 606 is maintained through its front contact 688 and sequence-switch contact 663 to the test brush 53 of the set which has been tripped and metal plate 70 to ground, while the brushes are passing the remainder of the trip range. The contact between the tripped test brush 53 and the plate 70 is not broken until said test brush is actually in engagement with the test terminal 63 of the first set. As will hereafter appear, the test terminal 63 of a trunk line which is busy will always be connected to earth, and the test relay 606 will therefore remain excited as the test brush 53 is passing over the terminals of busy lines. As soon, however, as the test brush

53 reaches the terminal of a line which is idle, and finds no ground-connection thereon, the test relay 606 will be released. This leaves the line relay 620, which controls the circuit of the clutch magnet 77, dependent for its excitation upon current flowing through the sequence-switch contact 631, wire 627, back contact 628, and interrupter contact 86, 87, to earth. This circuit through the interrupter contact is only maintained while the brushes are in transit from one set of terminals to the next, being opened as the interrupter roller 85 reaches the bottom of each notch corresponding to a position in which the selector brushes are in properly aligned contact with a set of line terminals. When the selector brushes have fully reached and are in good contact with the terminals of an idle line, therefore, the line relay 620 will be released, will open the circuit of the clutch magnet 77 so that the brush carrier will cease to rotate, and the brushes will remain in contact with the terminals of the trunk line so tested and found idle.

The line relay 620 in recovering also closes at its back contact a circuit from ground through sequence-switch contact 623 to the motor magnet 607 and battery 608, whereby the sequence-switch is moved from the seventh to the eighth position. In the eighth position the circuits for the line relay and test relay of the district selector are open, as are the circuits for the power magnet and trip magnet of said selector; and the contact 634 is closed, connecting the lead wire 526 from the sender to wire 691 which leads to the brush 51 of the set which has been tripped, and so to terminal 61 and wire 701 of the trunk line leading to the chosen office selector. This connection through contact 634 is a part of the stepping circuit to be established between the sending apparatus and the line relay of the chosen office selector (Fig. 7).

Let us return now to a consideration of the sending apparatus (Fig. 4). When the stop relay 430 was excited at the time the brush 401 of the point finder reached the terminal in the district division grounded by the depressed office key, said stop relay 430, besides breaking the stepping circuit at contact 432 closed a contact 433 to complete a locking circuit for its own winding; closed a contact 434 to complete a circuit for the motor magnet 450 of the sender sequence-switch; and closed a contact 435 to complete a local circuit for the stepping relay 416 through the cam actuated contact 419 and an interrupter 464. The sequence-switch of the point-finder apparatus therefore advances to its 4th position, and the step magnet 416 is operated by current in the circuit through the interrupter 464 to carry the brush 401 of the point-finder past the re-

mainder of the terminals in the district division, and past the dead terminals at the end of that division, to the secondary starting position 490 (Fig. 1) preliminary to the office division. The time taken by the point-finder brush in traveling from even the last terminal in the district division to the starting position 490 is sufficient to allow for the tripping of a set of brushes at the district selector. This time interval is necessary to prevent the closure of the stepping circuit at the sender end before the line relay at the district selector has been fully released by the opening of interrupter contact 86, 87. It may also be stated at this point that the dead terminals at the end of the office division and the first and second numerical divisions of the point-finder apparatus are for a similar purpose—that is, to allow a time interval after each point-finding operation, in which a set of brushes may be tripped at the selector which is under control.

As soon as the finder brush 401 reaches the starting position 490 preliminary to the office division of terminals in the point-finder apparatus, said brush connects battery 495 to the wire 459 from which current flows through contact 460 (Fig. 4) contact 433, resistance 436, sequence-switch contact 437 to earth. The stop relay 430 will thus be short-circuited by the wire 459. Said stop relay in retracting its armature opens contact 433 controlling its local locking circuit; opens contact 435 controlling the local interrupter circuit for the step magnet 416; closes a contact 438 which completes a circuit for the motor magnet 450 of the sender sequence-switch, moving the latter to its fifth position; and lastly, it again closes contact 432 reestablishing the circuit of the stepping relay 440 from the lead wire 506, through contact 456 and resistance 457 to earth. The circuits at the sender remain in this condition until the district selector has finished its hunting operation and has made connection with a trunk line leading to an idle office selector (Fig. 7). When this connection is made, the stepping circuit is completed from ground at the sender through resistance 457, contact 456, contact 432, stepping relay 440, sender lead 506, brush 516 of the cord finder, wire 526, leading to the district selector (Fig. 6), through contact 634 of the sequence-switch associated with the district selector, to wire 691, plate 41, brush 51 of the set which has been tripped, terminal 61 of the trunk line leading to the seized office selector, wire 701 of said trunk line, contact 761 of the sequence switch associated with the office selector (Fig. 7) through the line relay 720 of said office selector to the free pole of grounded battery 704.

The operation of the office selector is in general the same as that already described

in detail with reference to the district selector. The line relay 720 in attracting its armature completes a circuit from ground through contact 726 of the sequence-switch to the motor magnet 707 of said sequence-switch, and free pole of grounded battery 708. The sequence-switch moves to its second position, closing contact 776 and completing a circuit for the clutch magnet 77 of the office selector, through the front contact of the line relay 720. As the brush carrier begins to rotate, cam 80 closes contact 81, 82, which completes a circuit for the motor magnet 707 to move the sequence-switch to the third position. As the brush carrier continues to rotate, the interrupter contact 86, 87 intermittently short-circuits the line 701. The stepping relay 440 at the sender is thus alternately released and excited, closing and opening the local circuit for the step magnet 416, which operates the escapement and causes brush 401 to advance over the terminals of the office division of the sending apparatus, in unison with the advance of the brushes of the office selector.

When the finder brush 401 reaches the terminal in the office division which has been grounded by the depressed office key, it completes a circuit for the stop relay 430 which opens the stepping circuit at contact 432 and causes the line relay 720 at the office selector to be released. The line relay in opening its front contact breaks the short circuit of the trip magnet 67, which is thereupon excited in series with the clutch magnet 77 of the selector, and a set of brushes is tripped in the manner previously described with reference to the district selector. The particular set of brushes of the office selector to be tripped depends upon the number of steps which the brush carrier has advanced in unison with the point-finder of the sender before the finder brush reached the grounded terminal in the office division. In the present case, where the fifth terminal in the office division was grounded by the depressed office key, the finder brush would have taken five full steps to reach this terminal; and the office selector during this time would have advanced its brush carrier to such a position that the latch arm of the fifth set of brushes (counting from the bottom up) would be in position to be tripped. By the tripping of this set of brushes selection is thus made of the fifth horizontal level of terminals in the office selector, all of which represent trunk lines leading to group selectors at the exchange designated by the depressed office key. The office selector will now proceed to hunt over this level of trunk line terminals to find a line which is idle.

As soon as a set of brushes is tripped at the office selector, the brush 51 of the set, in engaging the grounded metal plate 70 completes a circuit for the test relay 706

through contact 734 of the sequence-switch. Said test relay closes a contact 788 controlling a locking circuit for its own winding through contact 763 of the sequence-switch to the test brush 53 of the set which has been tripped, from which the circuit is completed to ground by way of the metal plate 70, or by way of the test terminals 63 passed over by said test brush. The test relay also closes a front contact which completes a circuit for the line relay 720; and said line relay in attracting its armature again short-circuits the trip magnet 67. When the brush carrier of the office selector has passed the trip range, the cam 80 closes contact 81, 83, and completes a circuit through contact 733 of the sequence-switch for the motor magnet 707 of said sequence-switch which moves to its fourth position. The hunting movement is the same as that previously described with reference to the district selector. The line relay 720 which is maintained excited by the test relay 706 keeps the circuit for the clutch magnet 77 closed while the test brush 53 of the set which has been tripped is passing over the terminals of busy lines. A line which is busy will have a ground connection on its multiple test terminal 63 upon all the office selectors which have access thereto. When the test brush 53 of the hunting office selector reaches the terminal 63 of a line which is idle, and which therefore has no ground connection thereon, no circuit will exist for the test relay 706 of said selector, and said test relay will be released, releasing the line relay 720 which in turn will open the circuit of the clutch magnet 77, thereby causing the brushes of the selector to be brought to rest upon the set of terminals of the trunk line so tested and found idle. The test relay 706 in recovering closes a contact 789 which applies a ground to wire 705, connected through contact 763 of the sequence-switch to the wire 713 leading to the test brush 53, thus immediately establishing the busy test at all the multiple terminals 63 of the seized trunk line.

When the line relay 720 is released by the release of the test relay 706, said line relay closes at its back contact a circuit for the motor magnet 707 of the sequence-switch, whereby said sequence-switch leaves its fourth position; and as the special contact 20 of said sequence-switch is closed between the fourth and seventh positions, said sequence-switch will run through to its seventh position before stopping. In the fifth, sixth and seventh positions, the contacts 736 and 762 are closed, completing the connection of the line wires 701, 702, through to the brushes 51, 52, of the selector, terminals 61, 62, and wires 801, 802, of the seized trunk line. In the sixth and seventh positions of the sequence-switch a contact 764 is closed, completing the connection of the test con-

ductor 703 through to the test brush 53 of the office selector and test terminal 63 of the seized trunk line. In the fifth and sixth positions a contact 711 is closed, maintaining the ground connection on the wire 713 after contact 763 is opened when the sequence-switch leaves the fifth position. In the sixth position a contact 735 is closed, completing a circuit for the test relay 706 to wire 713 and through contact 711 to earth. The wire 713 is also grounded through contact 764, wire 703 leading back to the district selector (Fig. 6) through the test brush 53 at said district selector, contact 663 and back contact 689 of test relay 606 to earth.

The line relay 720 of the office selector (Fig. 7) is thus again excited when the test relay 706 is excited in the sixth position of the sequence-switch; but the line relay cannot now complete the circuit for the clutch magnet, contact 776 having been opened when the sequence-switch left its fourth position. When the test relay 706 is excited in the sixth position, it closes a locking circuit through its front contact 788, contact 775 of the sequence-switch, to wire 703 and back to ground, as previously traced through contact 689 of the district selector (Fig. 6). This circuit is maintained in the seventh or talking position of the sequence-switch of the office selector, so that the test relay 706 remains excited under control of the connection at the district selector. This is for the purpose of maintaining the line relay 720 excited during the connection, to prevent said line relay from closing at its back contact a circuit for the motor magnet of the sequence-switch which would carry said sequence-switch beyond the talking position. The last mentioned circuit is provided for the purpose of causing the sequence-switch and selector to be returned to normal position at the end of the connection, as will hereafter be described.

The result of the second point-finding operation of the sender, governed by the office key, has thus resulted in extending the line circuit 701, 702, from the district selector through the office selector to the conductors 801, 802, of a trunk line leading to a group selector at the exchange designated by the depressed office key. The selecting operations of the group selector and final selector will now take place under control of the sender as the finder brush 401 of said sender is caused to locate in succession the grounded terminals in the first, second and third numerical divisions of the sender; such terminals having been grounded by the registers under control of the depressed thousands, hundreds, tens and units keys.

When the finder brush 401 at the sender reached the grounded terminal in the office division and completed the circuit for stop relay 430 to determine the "office" selection,

said stop relay 430 closed contacts 433, 434 and 435, as before described, with reference to the "district" selection. The sequence-switch of the sender is therefore moved from its fifth to its sixth position when contact 434 is closed; and the finder-brush is caused to advance to the starting position 491 preliminary to the first numerical division, by the action of step magnet 416, which is excited by current in the local interrupter circuit closed at relay contact 435. When said finder-brush 401 reaches the starting position 491 preliminary to the first numerical division, it applies battery to the wire 459, short-circuiting the stop relay 430, as before described with reference to the previous operation. The stop relay 430 in recovering breaks the local interrupter circuit for the stepping magnet 416, closes a contact 438 to cause the sequence-switch to be moved from its sixth to its seventh position, and also closes contact 432. The stepping circuit governed by said contact 432 is now opened, however, at contact 456 of the sequence-switch, and will not be established at contact 471 thereof until the sequence-switch reaches its eighth position.

In the seventh and nineteenth positions of the sequence-switch, a contact 463 is closed, connecting the motor magnet 450 to a wire 483 from which a circuit to ground will be completed when the registers have taken their positions in response to the depression of the numeral keys.

Assuming that the line wanted was No. 1063, the operator would have depressed thousands key No. 1, hundreds key No. 0, tens key No. 6 and units key No. 3 (see Figs. 2 and 3). The motor magnet 206 of each register would then receive current flowing from a battery 230 through the back contact of a stop relay associated with each register, to a wire 231 common to all the registers, from which the circuit would be traced from the point 300 (Fig. 3) to wire 301, contact 475 (Fig. 4) of the sequence-switch of the primary sender (or contact 476 of the subsidiary sender, as the case might be) to wire 302 (Fig. 3) through a contact of the depressed units key (in this case units key No. 3) to wire 303, thence through a contact of the depressed thousands key (in this case key No. 1) Fig. 2, to earth. The contacts of the thousands keys and units keys are included in this circuit in order to prevent the start of the registers until keys representing a complete number have been depressed. Contacts of the hundreds keys and tens keys need not ordinarily be provided to control this circuit, because a number would usually be recorded upon the keys in the order of its digits.

The finder brush 201 of each register will therefore be caused to traverse the stationary terminals 202 thereof as long as the

motor magnet 206 of such register is excited; the circuit for said motor magnet being controlled at the back contact of the stop relay 232 of the corresponding register.

5 The stop relay of each register is connected between the free pole of a grounded battery and the finder brush 201 of such register; and when such finder brush reaches the terminal grounded by the corresponding key of the set with which the register is associated, the stop relay 232 will be excited, opening the circuit of the motor magnet of the register and causing the rotary element of the register to come to rest in a position corresponding to the numeral of the depressed key.

10 In the case assumed, the thousands key No. 1 having been depressed, the thousands register would come to rest in position No. 1. Similarly, hundreds key No. 0 having been depressed, the hundreds register would come to rest in position No. 0. So also the tens register would come to rest in position No. 6, and the units register would take position No. 3; since the tens key No. 6 and units key No. 3 were depressed.

15 The cams carried by the movable element of each register, in each position of the register cause contacts to be closed to ground points or terminals in the sender, to govern the selecting operations of the group selector and final selector, as will hereafter be described.

20 The stop relays 232 of the several registers control a circuit for the motor magnet of the sender sequence-switch, so that when all the registers have taken their positions in response to the depression of the keys, the sender sequence-switch will be enabled to advance and cause the sending operations for the numerical selections to proceed. This circuit may be traced from the free pole of grounded battery 493 (Fig. 4) through motor magnet 450 of the sender sequence-switch, contact 463 (closed in the seventh position), to wire 483, through front contact of the stop relays of the four registers in series to wire 231, which is grounded, as before described. When this circuit is completed, the sender sequence-switch advances to its eighth position. In this position the contact 471 is closed and the metallic circuit is thereby completed, including the main leads 506 and 507, the stepping relay 440 at the sender and the line relay 820 at the group-switch.

25 The sequence-switch having passed to the eighth position does not, however, stop there, as the circuit through the motor magnet 450 is thereupon again closed and the switch continues in motion, coming to rest in the tenth position. The circuit whereby the magnet 450 is energized in the eighth position of the sequence-switch may be traced from ground through the armature and front contact of the stepping magnet

440, which is now energized, contact 446, motor magnet 450 and battery 493 to ground. Since in position nine, the circuit of the motor magnet 450 remains closed at the contact 20, as will be noted, the sequence-switch will not come to rest in position nine, but will pass on to position ten.

Before describing the effects resulting from movement of the sender sequence-switch from the seventh to tenth position, and also before describing the operation at the group selector, attention will be directed to the scheme of translation by which pairs of terminals of the first, second and third numerical divisions of the sender are selected by the registers under the control of the numerical keys.

30 The ten thousand subscribers' lines in each exchange are divided, as before stated, into twenty groups of five hundred lines each; the final selectors being five-hundred-line machines in which the line terminals are arranged in ten levels, with fifty sets of line terminals in each level. Access to a final selector serving any particular group of five hundred lines is had through a group selector which must be capable of picking out any one of twenty groups of trunk lines leading to final selectors, and hunting over the trunk lines of the selected group for one which is idle. In the system shown, where the group selector has only ten sets of brushes, instead of twenty, it is evident that means must be provided for causing the group selector not only to choose a particular set of brushes, but also to choose one of two ranges or divisions of terminals in the horizontal level traversed by the selected set of brushes, in which said brushes may hunt for an idle final selector of the group desired.

35 Each horizontal level of terminals on the group selector therefore represents two distinct groups of trunk lines, five hundred subscribers' lines being represented by each group of trunk lines. The first five thousand lines of the exchange will be represented by the trunk line terminals in the first half or section of the bank on the group selector; and the second five thousand lines will be represented by the trunk line terminals in the second half of the bank. Therefore, the first numerical selection, which is the selection of one of ten sets of brushes of the group selector, must be determined according to whether the line wanted is among the first five thousand or among the second five thousand lines in the exchange, the particular thousand and also whether it is in the first five hundred or the second five hundred of the particular thousand. The selection of a pair of terminals in the first numerical division of the sender to complete the circuit of the stop relay when the finder brush shall reach this pair

of terminals must, therefore, be dependent upon both the thousands and the hundreds keys. The ten pairs of terminals in the first numerical division of the sender, corresponding to the ten sets of brushes of the group selector, may each be considered as representing a group of five hundred lines in either the first five thousand or the second five thousand lines of the exchange.

The ten upper terminals 405 in this division of the sender are connected to five contacts of the thousands register which are adapted, respectively, to ground said terminals in sets of two. If the thousands register stops in position 0 or position 5, in response to the depression of thousands key No. 0 or No. 5, contact 233 of said register will be closed, grounding the first two sets of terminals 405 in the upper row of the first numerical division of the sender. If the thousands register stops in the first or sixth position in response to the depression of thousands key No. 1 or No. 6, contact 234 will be closed, grounding the next two terminals in the upper row; and so on, the thousands keys 0, 1, 2, 3, 4, causing the same set of terminals to be grounded as thousands keys 5, 6, 7, 8, 9, respectively. The thousands register is also provided with a contact 238 which is closed if the register stops in either of positions 0, 1, 2, 3 or 4, this contact not being closed if the register stops in any of positions 5 to 9 inclusive. Said contact 238 determines whether the group selector shall hunt in the first half or division of its bank of terminals representing trunk lines to reach the first five thousand lines of the exchange (thousands 0 to 4 inclusive) or whether it shall hunt in the second half or division of the bank, representing trunk lines to reach the second five thousand lines in the exchange, that is, thousands 5 to 9 inclusive. The other contacts 233, 234, 235, 236 and 237 of the thousands register each select two terminals in the upper row of the first numerical division of the sender. The two connected terminals represent the first five hundred and the second five hundred of the lines of a particular thousand, which may be one of thousands 0 to 4 inclusive, or one of thousands 5 to 9 inclusive, according to whether the thousands key depressed belonged to the group representing the first five thousand lines, or the group representing the second five thousand lines in the exchange.

In the case assumed, where thousands key No. 1 was depressed, the thousands register came to rest in position No. 1, closing contact 234 and grounding the second set of two terminals, that is, the third and fourth terminals in the upper row of the first numerical division of the sender. This determines that either the third or the fourth set of brushes in the group selector will be

tripped to hunt over trunk lines representing, respectively, final selectors for the third group of five hundred or the fourth group of five hundred lines in the exchange. Whether the third set of brushes or the fourth set of brushes in the group selector will be tripped will depend upon which group of five hundred lines contains the line wanted; and the hundreds register is, therefore, arranged to select the first, third, fifth, seventh and ninth, or the second, fourth, sixth, eighth and tenth of the lower terminals 406 in the first numerical division, according as a hundreds key from 0 to 4 or a hundreds key from 5 to 9 has been depressed.

In the case assumed, the hundreds key No. 0 was depressed, causing the hundreds register to come to rest in position No. 0, thereby closing contact 239 and connecting wire 259 (which leads back to the stop relay of the sender) to the first, third, fifth, seventh and ninth terminals in the first numerical division of the sender.

The depressed thousands key No. 1 and hundreds key No. 0 have thus caused the thousands and hundreds registers to cooperate to select the third pair of terminals in the first numerical division of the sender; which will insure that the finder brush 401, when reaching this third pair of terminals will complete a circuit for the stop relay and cause the third set of brushes in the group selector to be tripped, thus selecting a group of trunk lines representing the third group of five hundred lines in either the first five thousand or the second five thousand of the exchange, according as said brushes may be caused to hunt over the first half or the second half of the arc or level which it traverses. The thousands key No. 1, by causing the thousands register to close contact 238, has further determined that the set of brushes to be tripped in the group selector shall be caused to hunt over the first half instead of the second half of the corresponding arc of trunk line terminals, as will hereafter be described.

The scheme of "translation" above set forth, by which the thousands and hundreds key together cooperate to determine which set of brushes shall be tripped in the group selector, is also followed in a general way with respect to the relation between the hundreds, tens and units keys, and the terminals in the second and third numerical divisions of the sender. This scheme of translation will be readily apparent from the diagram and need not be traced out in detail, except with reference to the particular case assumed, where keys were depressed representing the wanted line 1063. The hundreds key No. 0 caused the hundreds register to come to rest in position No. 0, closing contact 240, and connecting wire 259 (which

may be traced back to the stop relay 440) to the first two terminals 406 in the lower row of the second numerical division of the sender. The tens key No. 6 caused the tens register to close contact 306, grounding the second set of ten terminals in the upper row of terminals 405 in the third numerical division of the sender. Said tens key No. 6 also caused the tens register to close contact 307, grounding the second, fourth, sixth, eighth and tenth terminals in the upper row of the second numerical division.

The hundreds key No. 0 and tens key No. 6 have thus cooperated to select the second pair of terminals in the second numerical division to complete the circuit of the stop relay, which will result in causing the second set of brushes in the final selector to be tripped. The line wanted, No. 1063, is thus located as in the second of the ten groups of fifty lines each, in the larger group of five hundred to which the chosen final selector has access.

The tens key No. 6 has also located the line No. 1063 as in the second of the five groups of ten to which the selected set of brushes in the final selector have access in their rotary movement. The units key No. 3, causing the units register to come to rest in position No. 3, closes contact 308 to connect the wire 259 (which may be traced back to the stop relay of the sender) to the fourth terminal (No. 3) in each of the five divisions of ten terminals each in the lower row of the third numerical division. The tens key, No. 6 and the units key No. 3 have, through the agency of their registers, thus located the terminals of the wanted line No. 1063 as the fourteenth set of terminals in the horizontal level of fifty, to be traversed by the selected set of brushes of the chosen final selector.

Having thus assumed that numeral keys representing the wanted line No. 1063 have been depressed, and having shown that the registers associated with these keys have selected the third pair of terminals in the first numerical division of the sender, the second pair of terminals in the second numerical division, and the fourteenth pair of terminals in the third numerical division, we may now follow the operations of the group selector and final selector which take place under control of the sender as the finder brush 401 traverses said divisions in succession.

Taking up again the operation at the point where the stop relay 430 is released at the time the finder-brush reaches the starting position 491 preliminary to the first numerical division, and the office selector has finished its hunting operation and has extended the metallic stepping circuit to the conductors 801, 802, we find that, due to the circuit closed by the registers, the sequence-

switch of the sender has left the seventh position, and further, we find that the contact 471 is closed in the eighth position, open in the ninth position and closed again in the tenth position of the sender sequence-switch. The first closing of this contact 471 completes a metallic circuit including the line relay 820 at the group-selector and the stepping relay 440 at the sender. The energization of the relay 440 completes the circuit heretofore described to energize the motor magnet 450, causing the sequence-switch to continue its movement to the tenth position. In passing the ninth position of the sequence-switch, the contact 471 is again opened, which, unless contact 238 of the thousands register is closed, re-opens the metallic circuit which was closed in the eighth position, causing the deenergization of the relays 820 and 440 with results which will be hereinafter described.

Contact 238 of the thousands register is closed when the register stands at zero, first, second, third, or fourth position, for the purpose of determining whether the line sought shall be selected in the first five thousand lines or in the second five thousand lines of the exchange. The contact 445 of the sender sequence-switch is closed in positions, eight, nine and ten in order that the contact 238 may in these positions be in relation to control the circuit 506 and 507; in all other positions this relation being unnecessary.

Referring now to the group-selector, line relay 820 is normally connected by a contact 811 of the sequence-switch associated with said selector to the trunk line conductor 801; and the trunk line conductor 802 is normally connected to earth through a contact 816 of the sequence-switch. Therefore, as soon as the office selector has made connection with said trunk line 801 and 802, a metallic stepping circuit is established by the contact 471 of the sender including the line relay 820 at the group-selector and the stepping relay 440 at the sender. The line relay 820 in attracting its armature closes a circuit through contact 826 of the sequence-switch for the motor magnet 807 thereof, and the sequence-switch advances to its second position in which a contact 876 is closed, completing a circuit for the clutch magnet 77 of the selector through the front contact of said line relay, provided it is then energized, or closing a circuit through contact 850 of the sequence-switch to the "range relay" 840 through the back contact of said line relay if it is at that time deenergized.

The movement of the sequence-switch of the group-selector from first to second position takes place at the same time as the movement of the sequence-switch of the sender from eighth to ninth position, since it will be noted that both movements take

place immediately upon the closure of the metallic circuit referred to through the energization of the relays 820 and 440.

If at the time the sequence-switch of the group-selector reaches its second position, the contact 238 of the thousands register was closed, there would be no opening of the metallic circuit, the relay 820 would remain excited and the circuit to the clutch magnet 77 of the selector would be immediately closed. If, however, when the sequence-switch passed to the second position, the contact 238 was open, the metallic circuit would at that time be opened and relay 820 deenergized. This as above noted would close a circuit for the range relay 840 including battery 841, and the said range relay would thereupon close contacts 842 and 843, the contact 842 closing a locking circuit for the relay including the contact 846.

The sequence-switch of the sender, having passed on to the tenth position closes the contact 471 and the relay 820 is again energized. This breaks the original circuit to the range relay and closes a circuit through the contact 876 to the clutch magnet 77. The range relay, however, remains energized by the locking circuit referred to. As soon as the brush carrier of the group-selector begins to rotate in response to the excitation of its clutch magnet 77 (which excitation has taken place immediately upon the arrival of the sequence-switch of the group-selector in second position, if the line desired is in the first five thousand, or subsequent to the energization of the range relay 840, if the line desired is in the second five thousand lines of the exchange), the cam 80 of said selector closes the contact 81, 82, completing a circuit for the motor magnet of the sequence-switch through contact 832 of said switch, whereby the latter is moved from second to third position.

As the brush carrier continues to rotate, the interrupter contact 86, 87, intermittently closes a short circuit 827 of the line 801, thus causing the stepping relay 440 at the sender to be alternately released and excited. This operates the step magnet 416, as before described, and causes the finder brush 401 to leave its starting position 491 and begin its traverse of the terminals in the first numerical division of the sender; the brush carrier of the group selector advancing in unison therewith.

When the finder brush 401 reaches the pair of terminals in the first numerical division which have been selected by the thousands and hundreds register (in this case the third pair of terminals); a circuit will be completed from battery 439 (Fig. 4) through the stop relay 430, contact 462, wire 259 (continued on Fig. 3 and Fig. 2) through contact 239 of the hundreds register, to the terminal in the lower row in the first nu-

merical division with which the brush 401 is in contact, through said brush 401 to the terminal 405 in the upper row and through contact 234 of the thousands register to earth. The stop relay 430 being excited by current in this circuit, opens its back contact 432, breaking the stepping circuit and causing the line relay 820 at the group selector to be released. Said stop relay also closes its local locking circuit, closes contact 434 to advance the sequence-switch of the sender from its tenth to its eleventh position, and closes the local interrupter circuit for the step magnet 416 to cause the finder brush to continue its travel to the position 492 (Fig. 2) preliminary to the second numerical division. When the finder brush reaches this position 492, a circuit will be completed from battery 261, through the brush 401 to wire 262, which is connected to wire 259, whereby the stop relay 430 is short-circuited and released. In its recovery said stop relay breaks the local interrupter circuit of the step magnet, closes contact 438 to complete a circuit for the motor magnet of the sender sequence-switch, whereby the latter is moved from its eleventh to its twelfth position; and said stop relay also again closes contact 432 governing the circuit of the stepping relay 440.

When the stop relay 430 opened the stepping circuit as a result of the finder brush 401 reaching the selected pair of terminals in the first numerical division of the sender, the line relay 820 at the group selector (Fig. 8) being released, opens the short-circuit of the trip magnet 67 of said selector and permits said trip magnet to be excited in series with the clutch magnet 67, causing a set of brushes to be tripped, as before described, with reference to the previous selectors. In the case assumed, where the third pair of terminals in the first numerical division of the sender was selected to complete the circuit of the stop relay, the group selector will have advanced its brush carrier to a position in which the third set of brushes will be tripped by the action of the trip magnet 67 when the line relay 820 is released.

Selection has thus been made of the third horizontal level of terminals in the group-selector and the tripped set of brushes will search for an idle set of terminals such as 901, 902, 903, in either the first or second range of terminals, depending on whether the range relay 840 is deenergized or energized at this time; that is to say, depending on whether the line desired is in the first five thousand or the second five thousand lines of the exchange.

As soon as the selected set of brushes are tripped and have made contact with the grounded plate 70, a circuit is completed from brush 51 of such set, through contact 861 of the sequence-switch to the line relay

820 and battery 804, whereby said line relay is again excited to close the short-circuit of the trip magnet through contact 876 and prevent any other brushes from being tripped. Circuit is also completed from the grounded plate 70 through the brush 52 of the selector, and contact 837 of the sequence-switch to test relay 806. The test relay upon being energized and closing the front contact of both of its armatures completes the following circuits: First, a circuit through the line relay 820, which circuit is independent of the contact 861, and will be maintained as long as the test relay is energized. Second, a locking circuit for the test relay itself closed through the contacts 888, sequence-switch contact 863, brush 53 of the set which has been tripped and thence to ground by way of the metal plate 70. Third, a second locking circuit for the test relay itself, contingent upon the energized condition of the range relay 840, this circuit being traced through the contacts 888 of the test relay, conductor 845 and contact 843 of the range relay.

Assuming at first that the line desired is in the first five thousand lines of the exchange, as is the line No. 1063 which we have heretofore considered, the range relay under these conditions will not be energized and the second locking circuit over the test relay 806 will not be closed. As long as the brushes are passing over the metal plate 70, the first locking circuit of the test relay 806 will be closed through said plate to ground, but when the brushes pass beyond the plate 70 this locking circuit will depend upon the grounded condition of the test terminals 63 to keep said test relay energized. Since, as will hereafter be described, the test terminal of each busy trunk line leading to a final selector will be connected to earth, the locking circuit referred to will be maintained as long as the brush 53 is passing over busy terminals, but will be broken immediately upon the arrival of the brushes upon an idle trunk line.

As soon as the brush carrier of the group selector has been carried past the trip range, the cam 80 will cause contact 81, 83, to be closed, completing a circuit for the motor magnet 807 of the sequence-switch, through contact 833 thereof; whereby said sequence-switch will be moved from its third to its fourth position. The clutch magnet 77 will now be maintained excited to continue the rotation of the brush carrier, under control of the line relay 820 which in turn is controlled by the test relay 806; the locking circuit for said test relay being maintained through the test brush 53 of the selector as long as said test brush is passing over test terminals 63 which are grounded. As soon as the brushes reach a set of terminals representing a final selector which is idle, there

will be no ground on test terminal 63 engaged by the test brush 53, and the locking circuit of the test relay 806 will be broken, causing said test relay to release the line relay, which in turn will open the circuit of the clutch magnet 77 and cause the brush carrier of the selector to be brought to rest. The test relay in recovering will immediately apply a ground connection 889 to the test brush 53 and test wire 903 of the seized trunk line 901, 902, 903.

If the desired line had been in the second set of five thousand lines of the exchange, the range relay 840 would have been energized as hereinbefore described, and the second locking circuit of the test relay 806 would have been closed in addition to the first locking circuit thereof. It will, therefore, be apparent that until the deenergization of the range relay 840 the selector will continue to rotate regardless of the idle or busy condition of the trunks over which the brushes are passing. This is for the reason that the clutch magnet 77 is controlled by the line relay 820, which in turn is controlled by the energized test relay 806, which again in turn is controlled by the energized range relay 840. The range relay 840 which was maintained energized over the circuit including the contacts 842 and 846, as long as the sequence-switch of the group-selector was in its first, second and third position, is maintained energized in the fourth position of the sequence-switch over a circuit including the contacts 842, 847, conductor 848, contacts 83 and arm 81 to ground. In order that there may be no deenergization of the range relay 840 when the sequence-switch passes from the third to fourth positions, the contacts 846, 847, of the sequence-switch are as indicated arranged so that the contact 847 is closed before the contact 846 is opened.

The continued energization of the clutch magnet 77 causes the selector brushes to move past the entire first range of terminals, it being of course noted that since the contacts 861, 862, 863, 836 and 837 are all open at this time, none of the busy lines in this range will be interfered with. Just as the brushes of the selector are about to pass on to the terminals of the second range, or more exactly, just after the test brush 53 has come in contact with the first test terminal of the second range, the projection 849 of the cam 80 opens the contact 81, 83, and breaks the second locking circuit of the test relay 806. This leaves the test relay 806 dependent for its excitation entirely upon the locking circuit through the test brush, which will maintain the said test relay energized as long as the test brush 53 is in contact with a busy terminal. When, however, the test brush 53 rests upon an idle or grounded terminal in the second range, the test relay 806 will be

deenergized and upon the falling back of its armatures the line relay 820 will be deenergized, opening the circuit of the clutch magnet 77, and the selector will come to rest as hereinbefore described in connection with the hunting operation in the first range. The projection 849 need only be of sufficient extent to momentarily break the locking circuit of the range relay 840.

The line relay 820 of the group selector, in recovering, closes at its back contact a circuit for the motor magnet 807 of the sequence-switch, through the contact 822 of said switch. The special contact 20 of the sequence-switch of the group selector is closed between the fourth and the eleventh positions, so that after leaving the fourth position, the sequence-switch will run through to the eleventh position without stopping. As it reaches the fifth position, contacts 836 and 862 will be closed, extending the connection of the trunk line conductors 801, 802, through to the brushes 51 and 52, respectively, of the set which has been tripped, which brushes are now in contact with the terminals 61 and 62, respectively, of a trunk line 901, 902, leading to a final selector. In the fifth position of the sequence-switch a contact 835 is closed to complete an energizing circuit for the test relay 806, which thereupon again completes the circuit for the line relay 820. The test relay again closes its front contact 888, completing a locking circuit for its own winding, through sequence-switch contact 863 to test brush 53 of the set which was tripped, terminal 63 of the seized trunk line, through test wire 903 thereof, and through contact 909 (Fig. 9) of the sequence-switch associated with the final selector (which will have been closed by this time) to earth. This locking circuit for the test relay of the group selector will be maintained after sequence-switch contact 835 is opened in the eleventh position. The sequence-switch of the group selector is now maintained in its eleventh position as long as the line relay 820 is excited, which will be as long as the test relay 806 has circuit to earth at contact 909 of the final selector.

When the sequence-switch contacts 836 and 862 of the group selector are closed, completing the line circuit to the conductors 901, 902, leading to the final selector (the bridge containing the stepping relay 440 of the sender having now been closed by contact 432 of the stop relay) the line relay 920 of the final selector (Fig. 9) is excited by current from battery 921 flowing through contact 917 of the sequence-switch, over the metallic circuit including stepping relay 440 at the sender and back to ground through contact 935 of the sequence-switch of the final selector.

The line relay 920 when thus excited closes at its front contact a circuit through contact 976 of the sequence-switch associated with the final selector to the motor magnet 907 of said switch and free pole of grounded battery 908. The sequence-switch moves to its second position, in which contact 926 is closed, completing a circuit for the clutch magnet 77, which starts the brush carrier of the final selector in rotation. At the beginning of the rotary movement the cam 80 closes contact 81, 82, and completes a circuit for the motor magnet 907 of the sequence-switch, advancing the latter to its third position. In this position, as the brush carrier continues to rotate, the interrupter intermittently short-circuits the line, causing the finder brush at the sender to advance step by step in unison with the advance of the final selector.

When the finder brush 401 of the sending apparatus reaches a pair of terminals in the second numerical division, which have been selected by the hundreds and tens registers, under control of the hundreds and tens keys, the stop relay 430 of the sender is excited in a circuit from battery 439 through contact 462, conductor 259, contacts of the hundreds and tens register, brush 401 and the selected terminals in the second numerical division. Relay 430 thereupon opens the stepping circuit and causes the line relay 920 at the final selector to be released, thereby causing a set of brushes to be tripped in the manner heretofore described with respect to the other selectors. In the present case, where the wanted line was No. 1063, the second pair of terminals in the second numerical division of the sender was selected, so that the second set of brushes of the final selector would be tripped.

As soon as the test brush 53 of the set which is tripped touches the grounded plate 70, a circuit is completed for the line relay 920, through contact 943 of the sequence-switch, so that said line relay immediately closes again at its front contact the short circuit of the trip magnet and prevents the tripping of any other set of brushes.

At the end of the trip range, the cam 80 allows contact 81, 83, to close, completing a circuit for the motor magnet of the sequence-switch, causing the latter to move to its fourth position. The line relay at this time is excited by current flowing through sequence-switch contact 931 and the interrupter contact 86, 87, to earth, said interrupter contact being closed by the interrupter roller 85 riding over the long tooth 89 which is provided upon the segment 88.

In the final selector, the segment 88 is provided with an extra notch at the end of the long tooth 89 in advance of the notches corresponding to positions of the brush carrier in which the brushes rest upon line terminals. As the interrupter roller 85 of 130

the final selector passes down from the long tooth into this first notch, in advance of the notches corresponding to line-connecting positions, the short-circuit controlled by the interrupter contact 86, 87, is broken, and as the selector brushes have passed off the plate 70 and have not yet reached the first set of line terminals, the line is no longer short-circuited, and the first of the new series of selecting impulses is applied to the stepping relay 440 at the sender.

When the stop relay 430 at the sender was excited at the time the finder brush 401 reached the selected pair of terminals in the second numerical division, said relay closed its locking circuit at contact 433, closed the local interrupter circuit for the step magnet 416 at contact 435, and closed contact 434 to complete a circuit for the sender sequence-switch, advancing the same from its twelfth to its thirteenth position. The finder brush is then moved by the action of the step magnet 416 operated by the local interrupter, to the position 493 (Fig. 2) preliminary to the third numerical division of terminals (Fig. 3) of the sender. When the finder brush reaches position 493, the stop relay 430 is short-circuited, as before described, and re-establishes the stepping circuit at its back contact 432; also breaking the local interrupter circuit and closing its back contact 438 to complete a circuit for motor magnet 450, whereby the sender sequence-switch is advanced from its thirteenth to its fourteenth position. The metallic stepping circuit having thus been closed at the sender when the finder brush reaches the starting position 493 preliminary to the third numerical division, the sender is ready to respond to the first impulse of the last series to be received from the final selector. The stepping relay 440 in responding to the first impulses transmitted when the interrupter roller 85 of the final selector enters the first notch following the long tooth 89 of the toothed segment 88, causes the stepping relay to complete the local circuit for the step magnet 416, whereby the finder brush is advanced a half step. Now as the interrupter roller at the final selector rides up on the next tooth of the segment and closes contact 86, 87, to short circuit the stepping relay 440 at the sender, the stepping magnet 416 is released by said stepping relay, and in retracting its armature allows the escape-ment to take another half step, advancing the finder brush 401 to the first or zero terminal in the third numerical division.

If this first or zero terminal in the third numerical division had been selected, the stepping circuit would be opened and the line relay 920 at the final selector released as the brushes came to rest upon the first set of line terminals in their level. In the case assumed, however, where the wanted line

was No. 1063 and the fourteenth pair of terminals in the third numerical division of the sender were selected, the stop relay 430 will not be energized to open the stepping circuit until the finder brush reaches said fourteenth pair of terminals; and the brush carrier of the final selector will be advanced in unison with the sender until this point is reached.

When the finder brush 401 reaches the pair of terminals in the third numerical division selected by the tens and units registers under control of the tens and units keys, the stop relay 430 will be excited and will open the stepping circuit, causing the line relay 920 to be released when the interrupter roller 85 next opens the contact 86, 87, thus breaking the circuit of the clutch magnet and allowing the brushes to come to rest upon the set of line terminals which have thus been selected. The line relay in recovering also closes at its back contact a circuit through contact 922 of the sequence-switch to the motor magnet 907 of said switch, and battery 908, whereby the sequence-switch is advanced from its fourth to its fifth position. In this position a test of the called line is made, as will hereafter be described; but it will be convenient to consider the testing and other operations of the final selector hereafter, and before doing so, as the selection of the called line has now been completed, the further operations at the calling exchange, whereby the sending apparatus is disconnected from the circuit, may be traced.

When the finder brush 401 of the sender reaches the pair of terminals selected in the third numerical division, causing stop relay 430 to be excited, said stop relay, in addition to opening the stepping circuit at contact 432, closes the local interrupter circuit for the step magnet 416, closes its locking circuit at contact 433, and also closes contact 434 which completes a circuit for the motor magnet of the sender sequence-switch, whereby the latter is advanced from its fourteenth to its seventeenth position.

Upon leaving the fourteenth position the sender sequence-switch opens contact 437, breaking the locking circuit for the stop relay 430. The stop relay releases its various armatures and at contact 435 breaks the local circuit of the stepping magnet 416 and interrupter 464.

In the seventeenth position of the sequence-switch, contact 467 closes, grounding sender lead 506, 529, completing a circuit for motor magnet 607 (Fig. 6) of the district selector sequence-switch which is thereby advanced from its eighth to its tenth position. In position 10, contacts 661 and 662 are closed and the line from the calling subscriber is extended over the selected trunk line to the final selector, as will be explained later.

Contact 675 is opened, removing the ground connection from sender lead 528, 508, opening the circuit for relay 458 (Fig. 4). Relay 458 releases its armature, completing a circuit through contact 472 for the motor magnet 450 of the sender sequence-switch, which advances to the eighteenth position. In this position contact 473 closes, and the finder brush 401 is then advanced by the action of the step magnet 416 operated by the local interrupter 464.

When the finder brush 401 leaves the last terminal of the third numerical division, contact 421, operated by the rotation of the sender shaft, is closed, and completes a circuit for the motor magnet 450 of the sender sequence-switch, which advances to the nineteenth position, in which a circuit is again established through contacts 499 and 419 and the local interrupter 464. The finder brush 401 is thereupon caused to advance to its normal position, whereupon the local interrupter circuit is broken at contact 419 by the action of the cam 418.

In the nineteenth position of the sender sequence-switch, contact 469 is closed and a circuit completed through contact 421 for the power magnet 426. The said power magnet attracts the plate 423 into engagement with the constantly rotating shaft. The plate 423 is thereby caused to rotate to wind up the spring 409, and as the plate advances the dog 427 rides upon the edge of the said plate, closing the contact 428, whereby a local circuit is maintained for the said power magnet after the contact 421 opens the initial starting circuit. The plate 423 moves through one complete revolution, whereupon the dog 427 is released by the notch in the said plate and the local circuit through contact 428 is broken.

The sender sequence-switch in the nineteenth position closes a contact 465, completing a circuit over sender lead 512 for the motor magnet 530 of the cord finder sequence-switch, which advances to the tenth position. In this position contact 569 (Fig. 5) is opened and the circuit for the holding magnet 551 is broken. Spring 552 of the cord finder thereupon restores the brushes of the cord finder to normal. When the cord finder brushes return to normal, contact 554 is closed through the action of cam 553, and a circuit is completed for the motor magnet 450 of the sender sequence-switch, which immediately advances to its normal position. The sending apparatus, being now disconnected from the cord circuit through which connection has been established, is free to serve other cord circuits in the same manner.

Returning to a consideration of the final selector, the operations of testing the called line, sending a busy signal under proper circumstances, hunting over trunk lines

leading to private branch exchanges, making connection with the line wanted if the same is free, applying ringing current thereto, and finally completing the telephone transmission circuit, may be traced in detail.

In the system shown, the final selector may have direct access not only to ordinary subscribers' lines, but also to groups of trunk lines leading to private branch exchanges. The final selector upon reaching the set of terminals selected under the control of the sending apparatus, establishes a test circuit from its test brush 53, through contact 963 of the sequence-switch, windings of marginal relay 906 and windings 954 of a polarized relay 905, through contact 974 of the sequence-switch to earth.

The test relay 906 is adjusted to respond only to current received from the test terminal of a line which is free, and will not respond when shunted by a similar test circuit at another multiple terminal of the line tested. Said test relay 906 controls at its back and front contacts, respectively, alternative circuits for the motor magnet 907 of the sequence switch. The circuit controlled at the back contact of the test relay will cause the sequence-switch to be carried to the tenth position to control the application of a busy signal to the calling circuit leading back to the calling exchange, while the circuit for the sequence-switch controlled at the front contact of said test relay 906 will cause the sequence-switch to be carried past the tenth position, preventing the transmission of the busy signal and providing instead for the application of ringing current to the selected line.

The polarized relay 905 is required only where the final selector has access to private exchange trunk lines, in addition to ordinary subscribers' lines. The test terminals 63 of all such trunk lines, except the last in each group, are connected to battery of opposite polarity from that to which the test terminals of ordinary subscribers' lines are connected; and the polarized relay 905 of the final selector is adapted to respond only to current of such opposite polarity—that is, in testing the terminal of any trunk line except the last in each group, which is connected like an ordinary subscriber's line. Said polarized relay 905 controls at its back contact the circuit for the motor magnet 907 of the sequence-switch through contact 923 and back contact of the marginal test relay 906. The polarized relay when excited breaks this circuit for advancing the sequence-switch and establishes instead an alternative circuit from ground through the back contact of relay 906, front contact 940 of test relay 905, contact 916 of the sequence-switch, power magnet 77 of the selector and free pole of battery 925. The test relay 905

also controls at contact 939 a local circuit for its own locking winding 953.

If the line tested is an ordinary subscriber's line and is busy at the time the brushes of the final selector reach its terminals, neither of the test relays 905 or 906 will be excited, and a circuit will therefore be completed from ground through the back contact of the polarized test relay and sequence-switch contact 923 to the motor magnet 907; and the sequence-switch will advance from its fifth to its tenth position, contact 923 being closed in positions 5 to 9 inclusive. In this position contact 909 is opened and breaks the locking circuit 903 of the test relay 806 at the group selector (Fig. 8). Said relay 806, in retracting its armature, breaks the circuit for the line relay 820, which, in retracting its armature, completes a circuit through contact 822 for the motor magnet 807 of the sequence-switch associated with the group selector, which advances from its eleventh to its twelfth position. In this position contact 835 of the sequence-switch completes a circuit for the test relay 806 which, in closing its front contact, completes a circuit again for the line relay 820. Said line relay in closing its front contact completes a circuit through contact 826 for the motor magnet 807, whereby the sequence-switch advances from the twelfth to the thirteenth position. When the test relay 806 is excited in the twelfth position of the sequence-switch, it closes at contact 888 a path leading through contact 863 to the test brush of the selector and thence to test terminal 63, wire 903 and contact 909 at the final selector. If the line tested by the final selector is busy, this contact 909 will be open; otherwise it will have been closed by the advance of the final selector sequence-switch beyond the tenth position.

In the case assumed, where the called line is busy and said contact 909 is open, there will be no circuit for the test relay 806 at the group selector, and said test relay will therefore be released when the sequence-switch of the group selector leaves the twelfth position. The line relay 820 will therefore be released by the test relay 806 in the thirteenth position and will close at its back contact a circuit through contact 822 of the sequence-switch to the motor magnet 807, whereby the sequence switch will be advanced to the fifteenth or "busy back" position. In this position contact 830 will be closed, connecting the trunk line conductor 802 to the grounded interrupter 860, which in its operation will intermittently close the circuit from battery 650 (Fig. 6) through the supervisory relay 615 in the cord circuit, causing the operator's supervisory lamp 613 to flash, indicating to her that the line called for is busy. As the sequence-switch of the group selector reaches the fourteenth posi-

tion, contact 811 is closed, connecting the line relay 820 to the line conductor 801, the circuit of which is completed at the ground 652 of the cord circuit, Fig. 6. The line relay 820 is therefore excited, and while it remains so the sequence-switch of the group selector upon reaching the fifteenth position will remain in this position, maintaining the connection of the busy back interrupter 860 to the trunk line conductor 802. The operator at the calling exchange, observing the busy signal, will advise the calling subscriber that the line wanted is busy and will then remove the plug from the spring-jack of such calling line. This act of disconnection will cause the restoration of the train of selectors in a manner hereafter to be described.

If the station called for is a private branch exchange having a number of trunk lines, the selector will first, under control of the sending apparatus, bring its brushes to rest upon the terminals of the first trunk of the group. If this trunk is free, ringing current will be applied as hereafter described. If it is busy, the final selector, instead of immediately causing a busy signal to be sent, will instead be caused to advance its brushes to the next set of terminals representing another trunk line of the same group and so on throughout the group until a free line is found, or until the last trunk of the group is reached, in which case if this also is busy, a busy signal will be sent as heretofore described. In testing each trunk of the group, except the last, the polarized relay 905 will be excited and will prevent the completion of a circuit for the sequence-switch motor magnet, establishing instead a circuit for the clutch magnet 77 of the selector through contacts 916 and 940 and back contact of relay 906, whereby the switch carriage will be caused to continue its rotation. This circuit for the clutch magnet 77 is established in the fourth position of the sequence-switch while the selector brushes are in contact with the selected set of terminals and before the circuit for said clutch magnet through contact 926 and front contact of relay 920 has been broken, so that in case a further or hunting operation of the selector is necessary, to carry the brushes beyond the set of terminals selected under control of the sender, the clutch magnet will not have been deenergized.

The polarized test relay 905 in its response closes a local locking circuit at contact 939, to maintain said test relay excited while the selector brushes are in transit from one set of terminals to the next. The locking winding, however, is so proportioned that when the selector brushes reach the last set of trunk line terminals in a group, said relay will be restored by the current of opposite polarity received from the test terminal of

such last trunk, in spite of the locking winding.

In the ordinary case, where all the private trunk lines are not busy, the marginal test relay 906 will respond when the selector brushes reach the terminals of a trunk which is free. This also will take place if the line selected is an ordinary subscriber's line and is free. In its response, said test relay 906 will break the circuit of the clutch magnet 77 and will complete at its front contact 942 a circuit through contact 927 of the sequence-switch to the motor magnet 907 thereof, whereby said sequence-switch will be advanced from its fifth to its twelfth position, running through the intermediate positions. In the sixth, seventh, and eighth positions the contact 910 will be closed to connect the test brush of the selector to earth to maintain a test guard upon the selected line during this interval. The test relay 906 in its response completes a locking circuit through its own front contact and through sequence switch contact 934 (closed in positions 8 to 13 inclusive of the sequence-switch) to earth. This locking circuit maintains the test relay energized and also provides a low resistance path to ground from the test brush for the purpose of maintaining a test guard upon the multiple test terminals of the selected line. In the tenth position of the sequence switch, the contact 909 controlling the circuit 903 for the test relay 806 of the group selector, will be opened as before described, causing the sequence-switch of the group selector to advance to its thirteenth position as above described, in which a circuit is again established for said test relay 806 to the test wire 903 leading to the final selector; and if the line tested is free, the sequence-switch of the final selector will have passed the tenth position and will have closed the contact 909, causing the test relay 806 of the group selector to remain excited, completing the circuit for the line relay 820 of the group selector, whereby the circuit to carry the sequence-switch of the group selector past the thirteenth position is maintained open at the back contact of said line relay.

When the sequence-switch of the final selector is carried to its twelfth position by the response of the marginal test relay 906 in testing an idle line, contacts 936 and 937 will be closed, connecting the ringing generator 956 across the circuit leading to the called station, thereby ringing the bell or operating the line annunciator at such called station. Upon the response of the called subscriber, the relay 957 will be excited, completing a circuit from ground through contact 930 of the sequence-switch to the motor magnet 907 thereof, whereby the sequence-switch is advanced to the thirteenth position. In this position contacts 961 and 962 are closed, connecting battery 971 in a

bridge of the line leading to the called station, between the windings of a repeated coil. Contact 964 is also closed, completing a path from the trunk line conductor 902 to earth, through the front contact of the relay 957, as long as the called subscriber's telephone switch at the substation is closed, thus maintaining a circuit for the supervisory relay 615 of the operator's cord circuit (Fig. 6). The supervisory relay 615, in its response, breaks the circuit for the supervisory signal lamp 613 which is extinguished, indicating that the called subscriber has answered. In the fifth to the thirteenth positions, inclusive, of the sequence switch of the final selector, a contact 924 is closed, bridging a condenser between the windings of a repeating coil which are connected to trunk line conductors 901, 902, leading back toward the calling exchange.

While the telephonic connection is established between the calling and called lines, the line relay 920 at the final selector remains excited by current from battery 921 flowing through one winding of the repeating coil to trunk line conductor 901, through the group selector to trunk line conductor 801, thence through the office selector to conductor 701 and through the district selector to conductor 691, contact 661 of the district selector sequence-switch and ground at 652. Said relay 920 at the final selector while thus excited does not permit the sequence-switch to be advanced beyond the thirteenth position.

The sequence-switch of the group selector, during the existence of the telephonic connection, is prevented from advancing beyond the thirteenth position by the line relay 820, which is maintained excited by the test relay 806, which in turn is maintained excited by the current in the locking circuit for said test relay through contact 888 thereof, contact 863 of the sequence-switch to test brush 53, test conductor 903 and ground at contact 909 of the final selector.

The sequence-switch of the office selector, during the telephonic connection, is prevented from advancing beyond the seventh position by the test relay 706 which is maintained excited by current from battery 787 flowing in a locking circuit through contact 788 of said relay to conductor 705, contact 775 of the sequence-switch, conductor 703, through the test brush of the district selector, contact 663 of the district selector sequence switch, and back contact 689 of the relay 606 to earth. The test relay 706 of the office selector, while thus excited, maintains a circuit for the line relay 720 of said office selector and prevents said line relay from closing the circuit to advance the sequence-switch beyond the seventh position.

The sequence-switch of the district selector during the telephonic connection is main-

tained in its tenth position by the cord relay 605, which remains excited as long as the plug 603 remains in the springjack of the calling line.

5 *Disconnection.*—During the existence of the connection established as before described between the calling and called lines, the operator exercises supervision in the usual way, and when the subscribers hang
10 up their telephone receivers, the supervisory relays 614 and 615 are released and close the circuits for the supervisory signal lamps 612 and 613, respectively, which are thus lighted to give the disconnect signal. The operator,
15 upon receiving this disconnect signal, or at any time when desired, can cause the restoration of the train of selectors to normal condition by withdrawing the answering plug from the springjack of the calling line,
20 thus breaking the circuit of the cord relay 605. This cord relay, when released, closes at its back contact a circuit for the motor magnet 607 of the sequence-switch associated with the district selector, and said sequence-switch thereupon advances to its fifteenth position. The advance of said sequence-switch beyond the fifteenth position is controlled by a circuit adapted to be completed at the front contact of the line relay
30 620, which line relay is, in the fifteenth position of the sequence-switch, connected through contact 637 to the conductor 692 and through the brush 52 of the district selector to trunk line conductor 702, and
35 through the office selector to conductor 802 at the group selector, which will be connected to earth at contact 816 when the sequence-switch of the group selector is restored to normal condition.

40 As soon as the sequence-switch of the district selector leaves the tenth or talking position, the circuit for the line relay 920 at the final selector is broken. Said line relay, in retracting its armature, closes a circuit for the motor magnet 907, which
45 advances the sequence-switch of the final selector to its fourteenth position. In this position a circuit is closed from battery 925 through the clutch magnet 77 of the selector, contact 975 of the sequence-switch and back contact of the line relay to earth. Since the selector is displaced from its normal position, the surface of the iron disk 73 will be nearer to the return roller 74 than
55 to the forward driving roller 75, and the disk will be engaged by said roller 74 and the rotary element of the selector carried back toward its normal position. When in this return movement, the cam 80 forces the spring 81 into engagement with contact 82,
60 a circuit is completed for the motor magnet 907 of the sequence-switch, through contact 932, and said sequence-switch advances to its fifteenth position. When the rotary element of the selector reaches normal position,

the cam 80 allows the spring 81 to engage contact 83, completing another circuit for the motor magnet 907 to advance the sequence-switch from its fifteenth to its first or normal position. As the sequence-switch
70 leaves the fifteenth position, contact 975 is opened, breaking the circuit for the clutch magnet 77 and so bringing the switch carriage to rest.

As the sequence-switch of the final selector leaves the fifteenth position, it opens contact 909 and thereby breaks the locking circuit for the test relay 806 of the group selector, causing said group selector to return to normal position, as will hereafter be
80 described.

The sequence-switches associated with the selectors have each eighteen positions, and the time required for the sequence-switch of the final selector to run through positions
85 16, 17 and 18 before reaching the first or normal position, is sufficient to enable the sequence-switch of the group selector to interrupt conductor 802 at contact 862 before contact 935 is closed at the final selector
90 when the latter reaches normal. This is to prevent the premature completion of the circuit for line relay 620 of the district selector.

When the test relay 806 of the group selector is released, it releases the line relay 820,
95 which completes a circuit for the motor magnet 807 of the sequence-switch associated with the group selector, which advances from its thirteenth to its sixteenth position. In this position contact 874 is
100 closed, completing a circuit for the line relay 820, which relay at its front contact completes a circuit for the clutch magnet 77, and the switch carriage begins to return toward its normal position.

The projection 849 on the cam 80 is not high enough to force the spring 81 into contact with the contact point 82 and said contact 82 is not closed in the return movement of the switch carriage until said carriage
110 reaches the trip range. At this point the cam causes the contact 81, 82 to be closed, and a circuit is completed for the sequence-switch to advance the latter from its sixteenth to its seventeenth position. Finally,
115 as the switch carriage reaches the normal position, the cam allows contact 81, 83 to close, completing a circuit through contact 833 for the motor magnet of the sequence-switch, whereby the latter is advanced from
120 its seventeenth to its first or normal position, the circuit for the clutch magnet being interrupted when the sequence-switch leaves the seventeenth position, whereby the switch carriage is brought to rest.

When the sequence-switch of the group selector has reached its first or normal position, contact 816 is closed, connecting trunk line conductor 802 to earth, and thereby completing a circuit for the test relay 620 at
125 130

the district selector, which is connected through contact 637 of the sequence-switch (Fig. 6) to wire 692, brush 52, conductor 702, and brush 52 of the office selector to the terminal 62 of said conductor 802.

The line relay 620 of the district selector, in attracting its armature, completes a circuit from ground through a front contact of said line relay and contact 622 of the sequence-switch to the motor magnet 607, whereby the sequence-switch is advanced from its fifteenth to its sixteenth position. In this position contact 676 is closed, completing a circuit for the clutch magnet 77, whereby the switch carriage of the selector is caused to return toward its normal position. In returning, the cam 80 closes contact 81, 82, completing a circuit to advance the sequence-switch from its sixteenth to its seventeenth position; and when the selector switch carriage reaches normal, contact 81, 83 is closed, completing another circuit for the motor magnet 607, to carry the sequence-switch from its seventeenth to its first or normal position. The cord circuit and its associated apparatus are now ready to take up another call.

When the sequence-switch of the district selector leaves its fifteenth position, the locking circuit 703 for the test relay 706 of the office selector is broken, the office selector and its associated sequence-switch being thereupon restored to normal position in the following manner: The test relay 706, when released, breaks the circuit for the line relay 720, which completes at its back contact a circuit for the motor magnet 707 of the sequence-switch, whereby the latter is advanced from its seventh to its eighth position. In the eighth and ninth positions, a contact 774 is closed, completing a circuit for the line relay 720, which in turn closes at its front contact a circuit for the clutch magnet 77, whereby the switch carriage of the selector is caused to return toward its normal position. In returning, the cam 80 closes contact 81, 82, whereby the sequence-switch is advanced from its eighth to its ninth position; and when the switch carriage has reached normal, said cam closes contact 81, 83, completing a final circuit for advancing the sequence-switch from its ninth to its first or normal position. In the eighth and ninth positions, contact 775 remains closed, connecting the test wire 703 through the back contact of the test relay 706 to earth to maintain a test guard upon the multiple terminals of the trunk line 701, 702, 703, at the district selectors which have access thereto.

It will be noted that the order in which the various selectors are restored to normal position is such that a test guard is maintained upon the multiple terminals of the two-wire

trunk line 801, 802, until both ends are free. This is accomplished by maintaining the office selector stationary, with its brushes in contact with the terminals of the trunk line, to apply the test guard to the test terminals of said trunk line, until after the group selector has been completely restored to normal. The test guard is derived, in the circuit shown, from the ground connection at the back contact 689 of the relay 606 at the group selector (Fig. 6), connection being traced through sequence-switch contact 663 to the test brush 53 of the district selector, test wire 703, contact 764 of the sequence-switch associated with the office selector to conductor 713 and brush 53 of the office selector, which is in contact with the test terminal 63 of the trunk line. The test contacts 63 of all the multiple terminals of the trunk line on the different office selectors are wired together. The trunk line 801, 802 is thereby caused to test busy to all hunting office selectors until the apparatus at both ends has been completely restored to normal condition.

I claim:

1. In an automatic sender apparatus, the combination with a plurality of sets of manually operable contact devices, of an automatic register associated with each set of contact devices and operating in accordance with the condition of said contact devices, and a selection controlling mechanism governed by a plurality of said registers.

2. In an automatic sender apparatus, the combination with a plurality of sets of manually operable contact devices, of an automatic register associated with each set of contact devices and operating in accordance with the condition of said contact devices, and a selector controlling mechanism having a plurality of divisions of terminals and a contact member coöperating with said terminals and through which the controlling function is exercised, said terminal divisions being connected with said registers.

3. A sender apparatus comprising a plurality of sets of keys, an electro-mechanical register governed by each set of keys, a switching mechanism associated with each register and having contact devices, and a selection controlling mechanism provided with divisions of terminals connected with the contacts of said switching mechanism and a brush coöperating with the terminals.

4. A sender apparatus for telephone line selecting systems comprising a set of keys, a register electromechanism having terminals connected to said keys and a contact brush movable over said terminals, a switching mechanism having contact springs and spring-actuating members coöperating with said register brush, and a selection controlling electromechanism provided with termi-

nals connected with the springs of the switching mechanism and having a brush cooperating with said last mentioned terminals.

5 In a telephone switching system, an apparatus for controlling a plurality of classes of selection comprising sets of contact devices corresponding to said classes, and a point finder electromechanism having a plurality of divisions of terminals and a selection controlling contact member cooperating therewith, certain of the divisions of said point finder mechanism being in circuit with said contact devices of one class, and register mechanism interposed between 10 said contact devices of another class and other of the point finder divisions.

6. In a telephone switching system, an apparatus for controlling a plurality of classes of selection, comprising sets of contact devices corresponding to each class, point finder mechanism having terminals directly connected to one class of contact devices and a cooperating movable contact member through which the controlling function is exercised, and register mechanism provided with terminals in circuit with other of the classes of contact devices and also having contact members electrically connected with the terminals of said point 15 finder mechanism.

7. A sender apparatus comprising a plurality of sets of keys, register mechanism associated with each set of keys and having decimal terminals, a brush cooperating therewith, a motor magnet for the brush and contact devices operated in the movement of the brush, point finder mechanism having terminals arranged in non-decimal divisions, a brush cooperating with the terminals and a motor magnet for the brush, circuits for governing the motor magnet of each register and including its set of keys together with the terminals and brush of said register, and circuits for governing 20 the motor magnet of the point finder comprising the contact devices of a plurality of the registers, the finder brush and a division of the point finder terminals.

8. In a telephone switching system, a selecting apparatus having a movable contact member and a series of terminals with which it cooperates, said series of terminals consisting of a plurality of groups, and a controlling apparatus for said selecting apparatus having manual means for starting the movement of the contact member over a series of terminals, and automatic means for determining the active cooperation of said contact member with a particular group 25 in the series.

9. In a telephone switching system, a selecting apparatus having contact members each movable over a series of terminals, each of which series consists of a plurality of non-decimal groups, and a controlling appa-

ratus comprising decimal keys whereby the cooperation of a contact member of the selecting apparatus with a series of terminals is governed, and means governed by the position of an actuated key in its set for determining the group in the series with which active cooperation of the contact member shall be had.

10. In a telephone switching system a selecting apparatus having contact members each movable over a series of terminals, each of which series consists of a plurality of groups, a controlling apparatus comprising keys, and a switching mechanism operable under the influence of said keys and provided with a selection controlling contact device corresponding to a similar group in all said series.

11. In a telephone switching system, a selecting apparatus having contact members each movable over a series of terminals, each of which series consists of a plurality of non-decimal groups, a controlling apparatus comprising decimal keys, and a switching mechanism operable under the influence of the keys and provided with selection controlling contact devices each corresponding to a plurality of the series of terminals and a contact device corresponding to a similar group throughout said series.

12. The combination with a selecting apparatus having a brush, a motor magnet therefor and a series of trunk line terminals divided into groups and over which the brush is moved, circuit controlling means associated with said selecting apparatus and being under the influence of an electrical condition of said terminals, and means for rendering said circuit controlling means ineffective while the brush is traversing a group of said series.

13. The combination with a selecting apparatus having a brush, a motor magnet therefor and a series of terminals divided into groups and over which the brush is moved, a controlling apparatus for the selecting apparatus, circuit controlling means associated with the selecting apparatus and operating independently of the controlling apparatus to determine a terminal upon which the brush shall come to rest, and means governed at said controlling apparatus for rendering said circuit controlling means ineffective.

14. The combination with a selecting apparatus having a brush, a motor magnet therefor and a series of trunk line terminals divided into groups and over which the brush is moved, a controlling apparatus for the selecting apparatus, a line relay governed at the controlling apparatus and in turn controlling the circuit of the motor magnet, a test relay under the influence of an electrical condition at said terminals and also governing said line relay, and a range

relay governed at said controlling apparatus and controlling said test relay.

15 The combination with a selecting apparatus having a brush, a motor magnet therefor and a series of trunk lines terminals divided into groups and over which the brush is moved, of a sender apparatus comprising decimal keys, a contact device, and a selection-controlling mechanism provided
10 with non-decimally arranged terminals, the position of both said contact device and said mechanism being determined by the actuation of said keys, a line relay governed at the terminals of said mechanism and controlling the circuit of said motor magnet, and a relay for determining the terminal group with which the brush shall actively cooperate governed at said contact device.

16. In a telephone system, the combination with line selecting apparatus, of a plurality of apparatus any one of which may control selection, a switching mechanism movable in the operation of the system to assume different circuit controlling positions, said switching mechanism in one position rendering one controlling apparatus effective and in a plurality of other positions bringing other controlling apparatus into service.

17. In a telephone system, the combination with line selecting apparatus, of a plurality of apparatus any one of which may control selection, and a sequence switch associated with one controlling apparatus and adapted to render one or another of said controlling apparatus effective.

18. In a telephone system, the combination with line selecting apparatus, of two sender apparatus, a motor magnet included in each sender apparatus, a switching mechanism movable in the operation of a sender apparatus into a number of different positions, and circuits including the motor magnets and contacts of the switching mechanism.

19. In a telephone system, the combination with line selecting apparatus, of two sender apparatus, a motor magnet included in each apparatus, switching mechanism movable in the operation of one sender apparatus into a number of different positions, a circuit including a normal contact of said switching mechanism and one of the motor magnets, and a circuit including a contact of said switching mechanism in a plurality of positions and the other motor magnet.

20. In a telephone line selecting system, a plurality of sender apparatus each provided with a sequence switch, said sequence switches each having a motor magnet and a set of contacts, and controlling circuits including motor magnets at all the sender apparatus and switch contacts at one sender apparatus.

21. In a telephone system, selecting apparatus, two senders for said selecting apparatus each provided with a sequence switch, said sequence switches having contact devices and motor magnets, the sequence switch motor magnet of one sender being normally connected to the selecting apparatus, and a circuit to the selecting apparatus from the other sequence switch motor magnet including a normally open contact of the first-named sequence switch.

22. In a telephone system, selecting apparatus having sequence switches, two senders for said selecting apparatus each provided with a sequence switch, a circuit normally closed between the sequence switch of one sender and those of the selecting apparatus, and a circuit between the other sender sequence switch and the selecting apparatus sequence switches, said circuit being closed upon the actuation of the first-named controller sequence switch.

23. The combination with telephone line selectors, of a plurality of operator's connecting circuits, two operator's sender devices, a connecting circuit finder for each sender device, one of said sender devices being normally associated with said connecting circuits through its finder, and means made effective in the operation of said finder for associating the other sender device with the connecting circuits.

24. The combination with telephone line selectors, of a plurality of operator's connecting circuits, two operator's sender devices, and a connecting circuit finder for each sender device provided with a sequence switch, said sequence switch having circuit controlling contacts and a motor magnet, the motor magnet of one of said finders being normally associated with said connecting circuits through one of its contacts while other of its contacts will join the sequence switch motor magnet of the other finder to the connecting circuits.

25. In a telephone switching system, the combination with selecting apparatus, of controlling apparatus therefor, connecting circuits for the selecting apparatus, and finder mechanism having terminals at which each of said connecting circuits is represented and a movable contact member cooperating with said terminals and which may be joined to said controlling apparatus.

26. In a telephone switching system, the combination with selecting apparatus, of controlling apparatus therefor, connecting circuits for the selecting apparatus, finder mechanism having terminals at which each of the connecting circuits is represented and a movable contact member cooperating with said terminals and which may be joined to said controlling apparatus, means for changing the electrical condition of a ter-

terminal when the corresponding connecting circuit is put into use, and means whereby the said contact member is started in its movement and is stopped upon the electrically changed terminal.

27. In a telephone switching system, the combination with selecting apparatus, of connecting circuits, a sender device for controlling the selecting apparatus at which the connecting circuits appear at terminals arranged in groups, means for determining the position in its group of a terminal, of a connecting circuit which has been put into use, means for determining the group in which said terminal is situated, and means for operatively associating the controlling apparatus and connecting circuit in accordance with such determination.

28. The combination with telephone line selecting apparatus, of operators' controlling apparatus therefor, operators' cord circuits, and cord finder mechanism associated with said controlling apparatus.

29. The combination with telephone line selecting apparatus, of operators' controlling apparatus therefor, operators' cord circuits, and cord finder mechanism associated with said controlling apparatus and at which said cord circuits appear in groups.

30. A finder mechanism comprising circuit terminals arranged in groups, movable contact members one for each group, means actuated when the circuit of one of said terminals is busy for causing said contact member to hunt for and to make connection with such busy terminal, a sequence switch, and means controlled by the connection so made for causing said switch to make connection with said contact member.

31. A finder mechanism for telephone connecting circuits comprising circuit terminals arranged in groups, a movable contact member for coöperation with each group, means for causing all said contact members to move together until one coöperates with a busy terminal in its group, and means for thereafter testing said contact members in succession to select the one coöperating with the busy terminal.

32. The combination with telephone selectors, of a controller and connecting circuits for the selectors, and a finder for operatively associating said controller with a busy connecting circuit and comprising automatic switching mechanism adapted to assume a number of successive positions to govern the finder.

33. The combination with telephone selectors, of a controller and connecting circuits for the selectors, and a finder for operatively associating said controller with a busy connecting circuit, said finder comprising connecting circuit terminals, a coöperating contact member and a motor magnet for

said contact member, local circuits for said finder and circuits joining said finder to said connecting circuits, and a sequence switch for governing said circuits.

34. A finder mechanism for telephone switching systems comprising a plurality of groups of terminals, a set of brushes for coöperation with each group, each set including a test brush, means controlled through a test brush for bringing a set of brushes to rest upon busy terminals of a group, and means for selecting the set contacting with the busy terminals.

35. A finder mechanism for telephone switching systems comprising a plurality of groups of terminals, a set of brushes for coöperation with each group, each set including a test brush, means controlled through a test brush for bringing a set of brushes to rest upon busy terminals of a group, and means also controlled through said test brush for selecting the set contacting with the busy terminals.

36. A finder mechanism for telephone switching systems comprising a plurality of groups of fixed terminals, a movable brush for coöperation with each group, means for causing all of said brushes to come to rest upon corresponding terminals in the groups, and movable switching means having contacts through which its own movement is determined and other contacts for rendering effective the brush coöperating with a busy terminal.

37. A finder mechanism for telephone switching systems comprising a plurality of groups of fixed terminals, a set of brushes for coöperation with each group, each set including a test brush, means controlled through a test brush for bringing a set of brushes to rest upon busy terminals of a group, and switching means having contacts connected to said test brush and other contacts connected to the companion brushes of said sets.

38. A finder mechanism for telephone switching systems comprising a plurality of groups of fixed terminals, a set of brushes for coöperation with each group, each set including a test brush, a test relay, and a sequence switch provided with a motor magnet controlled by said test relay and having contacts controlling the connection of said test relay to said test brushes.

39. In a controlling apparatus for electrical line selecting systems the combination with line designating devices, of a plurality of selection controllers each adapted to be governed thereby, and means for switching said devices into operative relation to any one of said controllers.

40. In a controlling apparatus for electrical line selecting systems the combination with a set of line designating keys, of a plu-

ality of selection controllers each adapted to be governed thereby, and means for switching said keys into operative relation to any one of said controllers.

41. In a controlling apparatus for electrical line selecting systems the combination with line designating devices, of a plurality of selection controllers each adapted to be governed thereby, and automatic means for switching said devices into operative relation to an idle one of said controllers.

42. In a controlling apparatus for electrical line selecting systems the combination with a set of numeral keys, of a plurality of selection controllers each adapted to be governed thereby, one of said controllers being normally in operative relation to said keys and automatic means for switching another of said controllers into operative relation to said keys when the controller first taken is busy.

43. A telephone exchange switching system comprising line switching apparatus, a primary controlling apparatus for determining the selection of a particular line, and a plurality of secondary controlling apparatus any one of which may be governed by the primary controller.

44. A telephone exchange switching system comprising line selecting apparatus, a primary apparatus adapted to be set manually to control selection, and a plurality of automatic secondary controlling apparatus any one of which may be governed by the setting of the primary controller.

45. Controlling means for telephone line selecting apparatus comprising a primary apparatus including manually operable mechanism upon which the designation of a wanted line may be registered, and a plurality of automatic secondary apparatus any one of which may coöperate with the primary apparatus to govern the selection of a wanted line independently of the other secondary apparatus.

46. A telephone exchange switching sys-

tem comprising line selecting apparatus, a primary apparatus for controlling selection, and a plurality of secondary controlling apparatus having movable elements the travel of which may be governed by the primary controller.

47. In a switching system, a single primary apparatus having a plurality of controlling sections, and a plurality of secondary apparatus any one of which may be governed by the primary apparatus and each of which is provided with a plurality of controlling sections operable successively.

48. In a switching system, a single primary apparatus having a plurality of controlling sections, and a plurality of secondary apparatus any one of which may be governed by all the sections of the primary apparatus and each of which is provided with a plurality of controlling sections operable successively.

49. A telephone exchange system comprising switching apparatus, a single primary apparatus for controlling the switching apparatus, a plurality of secondary controlling apparatus, and means for operatively associating the primary controlling apparatus with an idle secondary apparatus.

50. In a controlling apparatus the combination with an automatically movable transmitting mechanism, of a plurality of sets of registers any one of which may control the movement of said mechanism, and means for producing in one of the sets of registers a condition which will determine which of said sets will be operative with said transmitting mechanism in setting up a call.

In witness whereof, I, hereunto subscribe my name this sixth day of August A. D., 1909.

FRANK R. McBERTY.

Witnesses:

F. T. WOODWARD,
EDGAR F. BEAUBIEN.