July 3, 1923. 1,460,913

D. L. LIENZÉN ET AL

SWITCHING APPARATUS FOR TELEPHONE SYSTEMS

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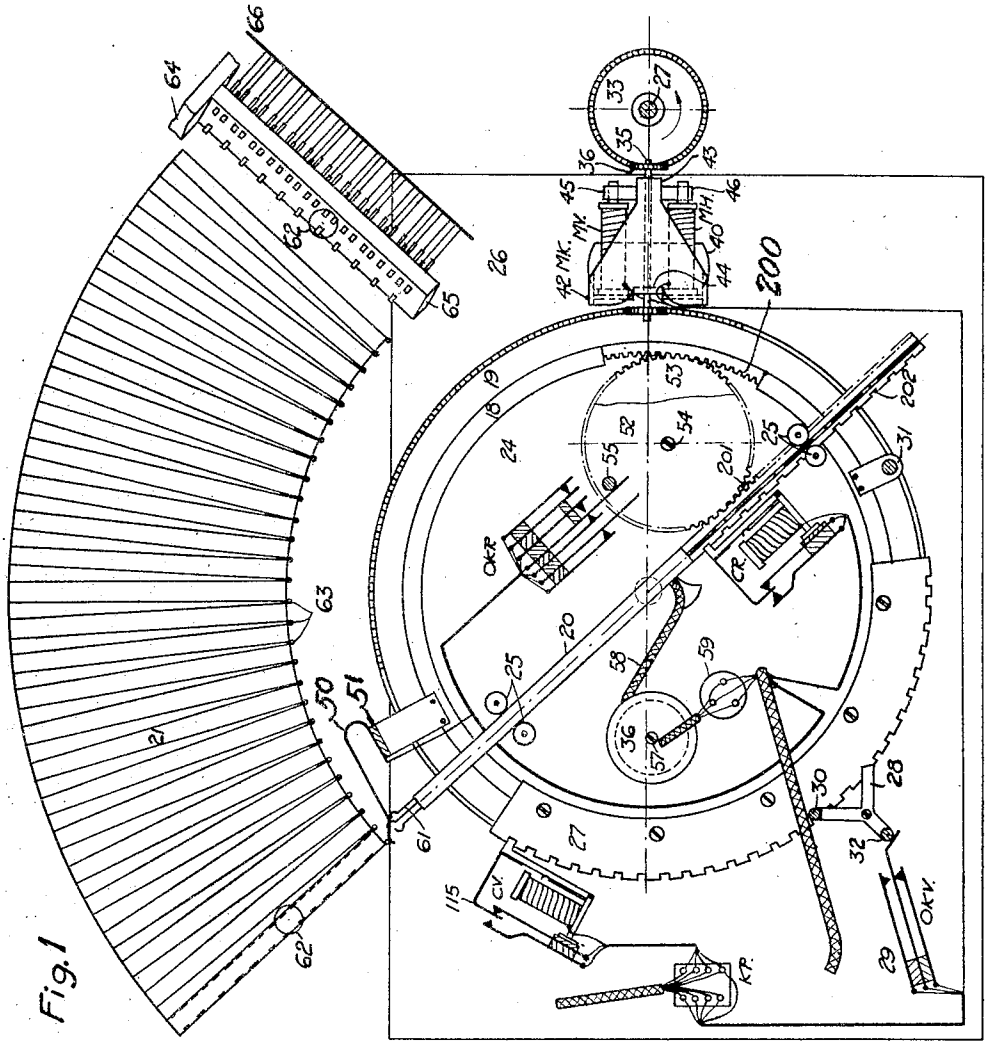


Fig. 1

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Fig. 2.

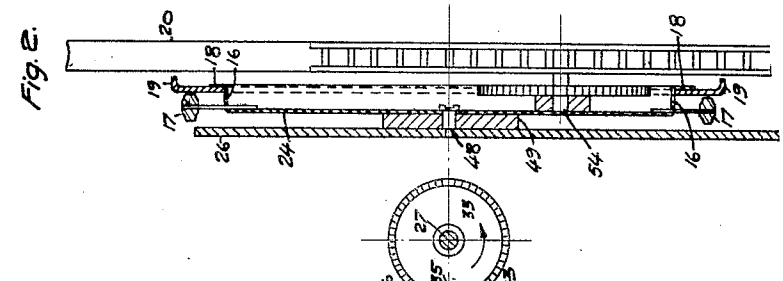
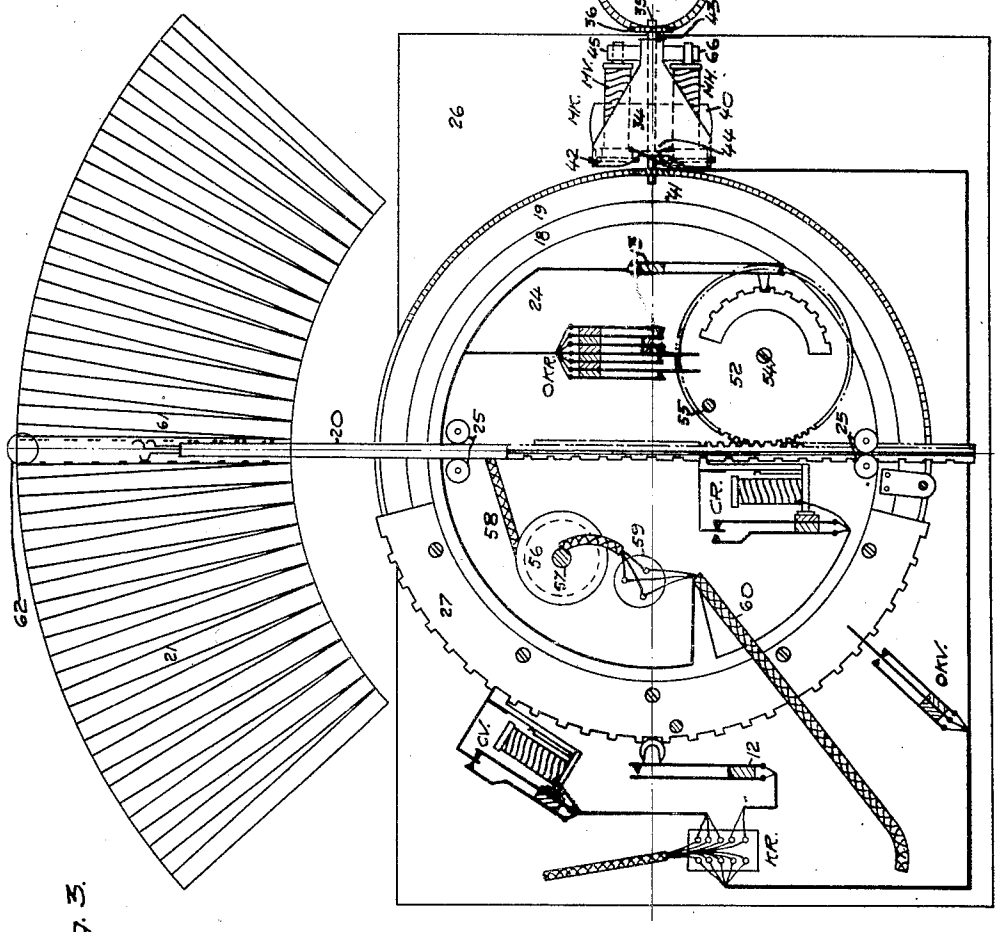


Fig. 3.



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SWITCHING APPARATUS FOR TELEPHONE SYSTEMS

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Fig. 5.

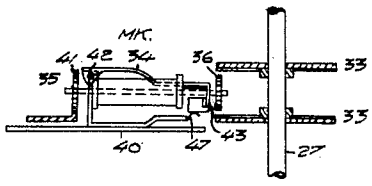
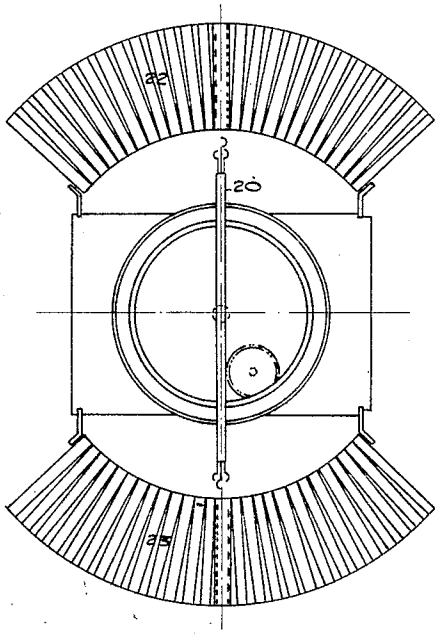


Fig. 4.



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SWITCHING APPARATUS FOR TELEPHONE SYSTEMS

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Fig. 6

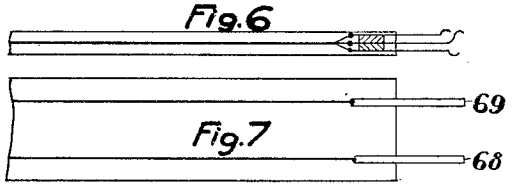


Fig. 7

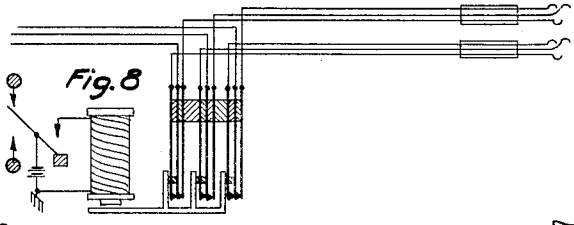


Fig. 8

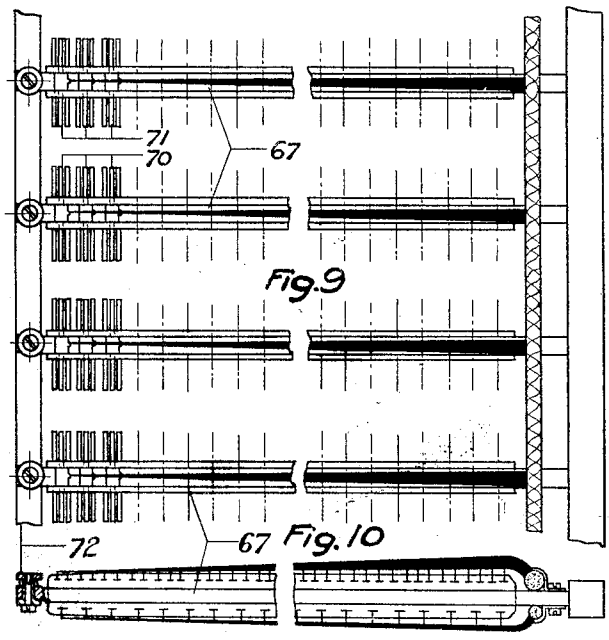


Fig. 9

Fig. 10

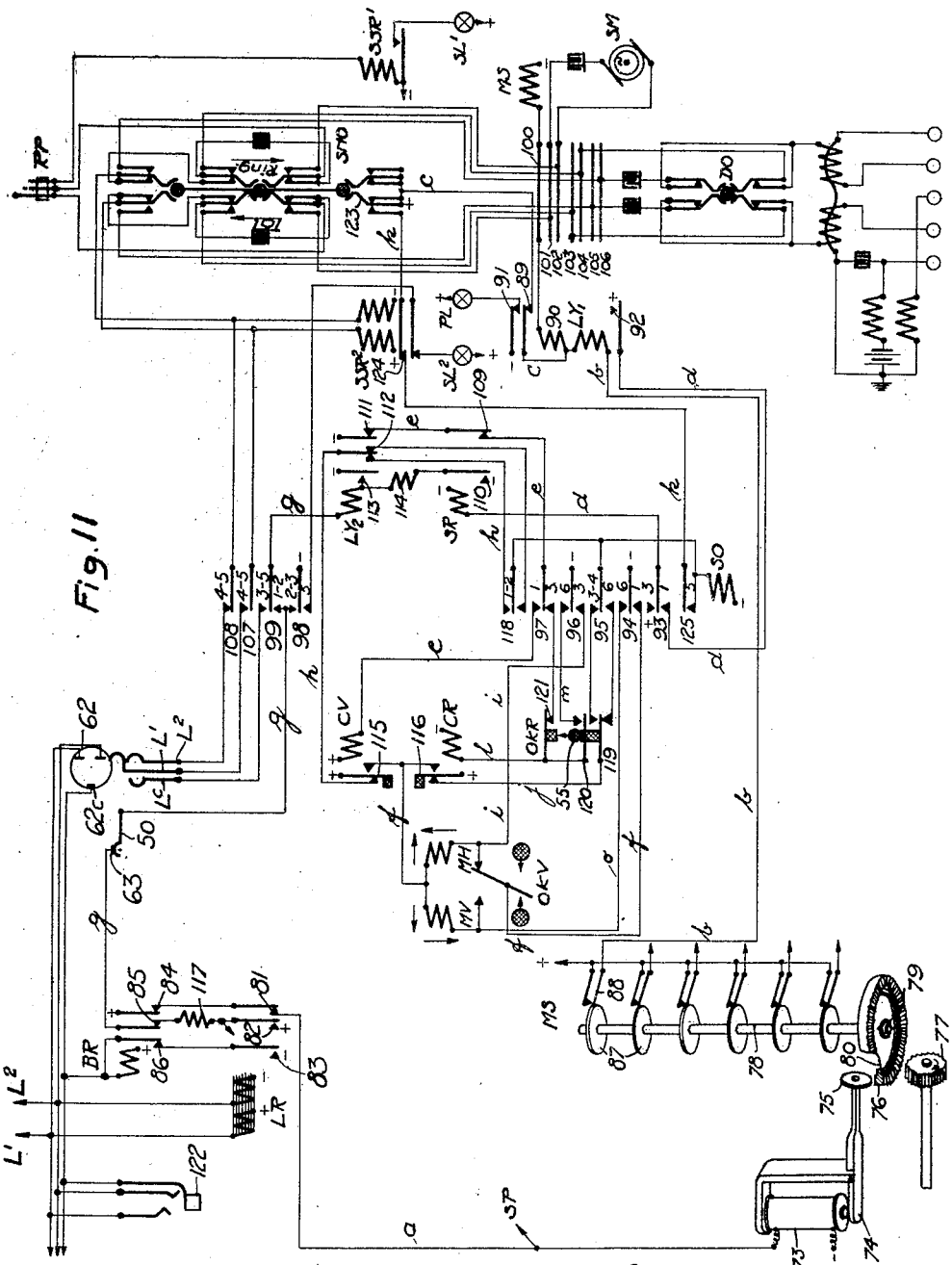
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SWITCHING APPARATUS FOR TELEPHONE SYSTEMS

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UNITED STATES PATENT OFFICE.

DAVID LAURENTIUS LIENZÉN AND KNUT LARSSON, OF STOCKHOLM, SWEDEN.

SWITCHING APPARATUS FOR TELEPHONE SYSTEMS.

Application filed October 21, 1920. Serial No. 418,503.

To all whom it may concern:

Be it known that we, DAVID LAURENTIUS LIENZÉN and KNUT LARSSON, subjects of the King of Sweden (whose post-office address is Brannkyrkagatan 14, Stockholm, Sweden), have invented new and useful Improved Switching Apparatus for Telephone Systems, of which the following is a specification.

This invention relates to improvements in automatic or semi-automatic telephone exchange systems, and more particularly to switching apparatus for such systems.

In such systems as well as in manual telephone exchange systems having automatic distribution of incoming calls it is desirable to obtain a switching apparatus which while attending to a large number of lines will not become too complicated or expensive. Such a switching apparatus is of great importance, as it would enable a very considerable reduction of the number of mechanisms necessary at an exchange for the establishment of a connection between a calling subscriber and a called subscriber. Moreover, a more plain circuit arrangement, a decreased number of movable parts and reduced costs of building and maintaining the system would be obtained by using such a switching apparatus as compared with systems using switching apparatus of existing types.

This invention has for its object to provide such an improved switching apparatus. The invention is characterized, chiefly, in this that the apparatus is constructed and arranged to perform both a rotation and a radial movement with respect to the centre of rotation.

The apparatus according to this invention is especially adapted for automatic or semi-automatic telephone exchange systems having power driven mechanisms for operating the switching means, but it should be understood, that said apparatus may equally well be used in exchange systems in which the automatic switching apparatus are controlled by step-by-step movements.

In the drawings Figure 1 is a plan view, partly in section, of a line finder switch constructed according to this invention. Fig. 2 is a cross section and Fig. 3 is a plan view, respectively, of a selector switch constructed according to this invention. Fig. 4 is a plan view of a modified form of the switching apparatus. Fig. 5 is a vertical section of the driving mechanism of the switching apparatus. Figs. 6 and 7 are longitudinal section and plan view, respectively, of part of a switching apparatus having double sets of terminals. Fig. 8 shows the circuit arrangement for such a switching apparatus. Figs. 9 and 10 are plan view and cross section, respectively, of part of a bank of multiple terminals to be used in connection with the switching apparatus shown in Figs. 6 and 7. Fig. 11 shows a circuit arrangement to illustrate the use of the switching apparatus as a line finder switch.

The apparatus illustrated in Fig. 1 involves a movable contact member 20 comprising a rod mounted on a rotatable disk 24 in the direction of a diameter. The rod 20 is movable longitudinally and guided by rollers 25. The rod 20 carries at its one end a set of contact springs 61 to engage the fixed multiple terminals 21. The multiple terminals are placed in an arc around the disk 24 and involve a number of groups extending radially with respect to the disk and forming between themselves radial spaces or slots to be engaged by the rod 20 in its radial movement for searching the fixed terminals which are situated in the side of said spaces. The portion of the rod adapted to engage in said spaces consists of insulating material or is covered by a layer of such material. The apparatus being arranged as a line finder switch, the bank of multiple terminals also contains a test wire or bar 63 for each group of terminals, the rotatable disk 24 carrying a group testing spring 50 to cooperate with said bar 63. The said spring 50 is carried by a bracket 51.

In operation, in the rotation of the disk 24 the group testing spring 50 determines the group, to which the called line belongs, whereupon the rod 20 with its contacts 61 engages the respective space in hunting for the calling line terminals.

The construction of the apparatus will now be described in detail with reference to Figs. 1, 2 and 5 of the drawing. The disk 24 above referred to may either be rotatably mounted on a support or, as shown

in the drawing, on a plate 26. Said plate is adapted to be inserted in slots formed in supports in the same way in which jack panels are inserted in a usual multiple switchboard. This method of mounting the plate is very suitable, as the switching apparatus will have a very small vertical length, as will appear from Fig. 2. The disk 24 is mounted on the plate 26 by means of a pivot 48 (Fig. 2), and to avoid undue friction a washer 49 is inserted between the plate 26 and the disk 24.

The plate 26 carries in addition to the rotatable disk 24 a driving mechanism to rotate the disk 24 and move the rod 20 radially, a so called centering magnet CV to arrest the disk 24 in proper angular position, a shifting device OKV, and a switchboard KP.

The driving mechanism comprises a continuously rotating shaft 27 and an electromagnetic clutch MK between the driving shaft 27 and the disk 24. Said clutch MK consists of electromagnet coils MV and MH mounted on an angular bracket 40 (Fig. 5) and an armature 34 rotatably mounted on pivots 42 attached to the bracket 40. The armature is provided with downwardly bent lugs 43, 44, and in said lugs there is mounted a shaft 35. Furthermore, said armature is formed with two laterally extending projections 45, 46 in its free end, one of said projections being situated above the core of one of the magnet coils, while the other projection is situated below the other magnet coil, as shown in Fig. 1. The shaft 35 carries two pinions 36 and 41. The pinion 36 engages between two disks 33 carried by the shaft 27 and having teeth formed on their surfaces facing each other, said teeth engaging with the pinions 36. The axial distance between said toothed portions of the disks is sufficiently greater than the diameter of the pinion 36 to prevent the pinion from engaging more than one of such disks at a time and to permit the pinion to be set in an intermediate position in which it is out of engagement with the teeth of both of said disks. The pinion 36 is usually held in such intermediate position by a spring 47 (Fig. 5) acting on the armature 34, and may be brought into engagement with the teeth of either of said disks as the result of the energization of one of the magnet coils or the other. According as the pinion 36 is caused to engage one disk or the other the shaft 35 is rotated in one direction or the other. The pinion 41 of the shaft 35 engages a toothed rim 19 rotatably mounted on the disk 24 and guided, in part, by a flange 18 of the disk 24 and, in part, by rollers 17, as shown in Fig. 2.

The centering magnet CV serves to maintain the rotatable disk 24 in the angular position desired. To this end the armature of said magnet is provided with a tooth, cooperating with a toothed segment 27 of the disk 24. The pitch of said toothed segment corresponds to the distance between the radial spaces formed in the bank of multiple terminals 21 to be engaged by the contact rod 20, so that the contact rod 20 will be in alinement with such a space as the disk 24 is locked by the magnet CV.

The shifting device OKV serves to change the direction of rotation of the disk 24. The shifting device comprises a rotatably mounted system of arms 28 operated by studs or rollers 30, 31 on the disk 24, and adapted to operate the central spring of a contact system 29 comprising three springs.

The switchboard KP serves to receive incoming connecting lines extending from the mechanisms mounted on the plate 26 and outgoing lines leading to their respective connecting points.

The rotating disk 24 carries besides the switch rod 20 and the guiding rollers 25, means for imparting a longitudinal movement to the switch rod 20 and means for arresting the switch rod when the terminals of the calling line are found.

The means for moving the switch rod 20 longitudinally comprises a set of teeth 200 on the inner edge of the said toothed rim 19, a toothed wheel 53 meshing with the teeth 200 and mounted on the stud pin 54 carried by the disk 24, and a toothed wheel 52 rigidly attached to the toothed wheel 53 and meshing with teeth 201 of the rod 20. Formed in the rod 20 at the side diametrically opposite to the teeth 201, are recesses 202 situated at a distance between themselves corresponding to the distance between the sets of terminals of a group. Cooperating with said recesses 202 is the pawl-shaped armature of an electromagnet CR adapted to arrest and lock the rod 20 in proper position after longitudinal displacement thereof.

The disk 24 also carries a group of contact springs OKR electrically insulated from the disk 24 and operated by a pin 55 carried by the toothed wheel 52 and insulated therefrom, said group of contact springs serving to control the end positions of the switching rod 20 and to close and break circuits as will be hereinafter more clearly described.

A stud pin 57 attached to the disk 24 carries a freely rotatable wire pulley 56 to guide a cable 58 formed by the conductors connected to the switching rod 20. The input conductors 60 of the disk 24 are brought together on a switchboard 59.

The bank of multiple terminals briefly described above may be constructed in many different ways; for instance, the terminals may be clamped or cast into blocks or disks or may be combined to form frames, as in the present case. Such frames are laid or

suspended in a circle around the switching apparatus in such a way that the spaces or slots for receiving the switching member 20 extend radially around the switching apparatus. The frames are formed by panels 65 attached to a strong bar 64 and carrying the terminals which are insulated from each other. The terminals of each panel have their connections to subscribers' lines or trunk lines assembled in a cable 66. While for each line three terminals are shown, it is evident, that the number of terminals may be greater or less than three according to the requirements of the system in question.

To control the circuits and the switching apparatus we may use relays alone or relays with other circuit controlling means, such as the sequence switches MS and SO diagrammatically shown in Fig. 11. The principle of such sequence switches is well known in the art. The sequence switch MS comprises in well known manner a shaft 78 carrying a plurality of cam discs 87 which on the rotation of shaft 78 successively operate contacts 88 included in circuits leading to different operators' positions. The shaft 78 carries at one end a toothed rim 76, connected to a hub 79 on the shaft 78 by means of a thin disk 80 permitting an axial movement of the toothed rim 76. The toothed rim 76 is adapted to be driven from the continuously rotating pinion 77. The toothed rim 76 is normally held out of engagement with said pinion 77 and is brought into engagement therewith by the operation of an electromagnet 73. The armature 74 of said magnet carries a roller 75 pressing when the armature is attracted, the toothed rim 76 against the pinion 77. Upon the deenergization of the electromagnet 73 the armature 74 and the toothed rim 76 are restored to their normal position, shown in Fig. 11, in which the toothed rim 76 is out of engagement with the pinion 77.

The operation of the apparatus above described as an automatic line finder switch will now be described briefly with reference also to Fig. 11. The sequence switch MS is common to all of the lines belonging to a complete bank of multiple terminals, as for instance 500 lines, which is indicated by the connecting point SP, while the sequence switch SO is individual for the line finder switch shown.

The circuit arrangement further contains a usual listening key SNO for each cord circuit with its calling plug RP for connection to the called line and an allotting key DO common to an operator's position. Connected to the allotting key are the means necessary for the operator's equipment, and connected to the bus-bars 101, 102 is a ringing machine SM.

When a subscriber calls by removing his receiver from the switch-hook, the armature of his coils supplying current to the transmitter is attracted and establishes a circuit *a*, as follows: positive battery, contact 84 of cut off relay BR, contact 81 of line relay LR, connecting point SP, winding of magnet 73, to negative battery. The magnet 73 is energized and attracts its armature 74, the roller 75 of which brings the toothed rim 76 into engagement with the pinion 77 so that the shaft 78 with its cams 87 starts to rotate. As soon as a contact 88 belonging to an idle operator's position is closed a circuit *b* is established as follows: positive battery, contact 88, winding of test relay LY_1, bus-bar 100, common to an operator's position, resistance RS, to negative battery. The test relay LY_1 is energized and attracts its armature. This establishes a circuit *c* as follows: positive battery of listening key SNO, contact 89, winding 90, resistance RS, to negative battery. The attraction of the armature of the relay LY_1, lights the calling lamp PL due to the closing of the contact 91, and establishes a circuit *d* as follows: contact 92, lower contact of spring 93 of switch SO, starting relay SR, to negative battery. The armature of relay SR is attracted and establishes a circuit *e* as follows: negative battery, contacts 111, 109, upper contact of spring 97 of switch SO, centering magnet CV, to positive battery. The armature of the magnet CV is attracted and is thereby brought out of engagement with the slot of the centering segment 27 (Fig. 1) in which it was engaged at this time, and at the same time a circuit *f* is established as follows: positive battery, front contact of armature 115, winding MH of the driving device, shifter OKV, lower contact of spring 94 of switch SO, to negative battery. This circuit starts the switching apparatus to rotate to the right, until the test spring 50 finds the group or frame 63, to which the calling line belongs, and this results in the establishment of a circuit *g* as follows: negative battery, contact 110 of relay SR, resistance 114, test relay LY_2, lower contact of spring 99, test spring 50, test bar 63, contact 85, resistance 117, contact 82, to positive battery. This circuit *g* operates the test relay LY_2, which by attracting its armature breaks the circuit *e* at contact 111 thereby deenergizing the electromagnet CV the armature of which when restored to normal locks the disk 24 with the contact rod 20 in alinement with the slot corresponding to the group in which the call is initiated.

At the same time the test relay LY_2 receives negative potential from contact 113 through its own low resistance holding winding thus preventing all of the other operating apparatus from coming to rest on this test bar, until the calling subscriber's *c* line is extended and the armature of the test relay LY_2 is attracted a second time to

release the relay BR, which removes at contact 85 the negative battery used as busy test guard.

The restoration of the armature of CV to normal broke the connection of the positive battery with the driving device, thereby arresting the rotation of the switching apparatus and establishing a circuit *h* which may be traced from back contact or armature 115, through attracted contact 112 of relay LY_2, upper contact of spring 118 of switch SO, power magnet of switch SO, to negative battery. This circuit moves the sequence switch SO into position 3 in which its circuit is broken at contact 118 closed in positions 1 and 2. The rotation of the switching apparatus ceases when the test relay LY_2 is energized, and the radial movement begins, when the switch SO reaches position 3, in which a circuit is established from positive battery, upper contact of spring 93, winding of starting relay SR, to negative battery. This circuit energizes the relay SR which by closing the contacts 109, 110 a second time establishes a circuit *e*, which extends through contacts 111, 109, lower contact of spring 97, shifter OKR, winding CR of centering electromagnet, to positive battery. The armature of coil CR is now attracted and moves out of the centering slot of the switching member 20. At the same time circuits *f* and *i* are established containing front contact of armature 116, winding MH of the driving device of switch SO, lower contact of spring 96, to negative battery. The driving device cannot rotate the switching apparatus at this time, as the hook of the armature of CV now engages the slot of the segment 27 corresponding to the group in which the call was initiated, thus preventing the rotation, while permitting the radial movement, as the armature of the magnet CR has released the switching member 20. Said movement ceases as the spring L^c of the connecting group establishes the circuit *c*—*g*, which may be traced from negative battery, through contact 110, resistance 114, relay LY_2, upper contact of spring 99 of switch SO, spring L^c, contact 62^c, contact 83 of relay LR, cut off relay BR, to positive battery. This breaks the circuit *e* at contact 111, thereby restoring the armature of magnet CR to normal, at the same time breaking the circuit *f*—*i* so as to arrest the driving device. The contact 116 of said armature now establishes a circuit *j*, which may be traced from upper contact of spring 119 of shifter OKR, switch SO, upper contact of spring 95, winding of driving device, to negative battery. The sequence switch SO now rotates into position 5 in which the circuit *j* of the switch is opened at upper contact of spring 95. The switch is thus arrested in position 5 in which it remains until after the releasing the connection. The attraction of the armature of the cut off relay BR removed the busy test guard at contact 85 from the group bar 63 thereby opening the circuit *g* and permitting other subscribers of the same group to call. Moreover, the circuit *a* was opened at contact 84 to arrest the quick-break switch MS, provided no other subscriber of the common field calls, and further BR receives its holding and test potential from contact 83 of the line relay LR, to sleeve of jack 122, which is found in the usual bank of multiple terminals.

The calling subscriber's line is now extended to an operator's position over its line conductors L^1, L^2, springs L_1, L_2 of the switching member, contacts 107, 108 of SO, to the listening key. The operator, depressing the listening key SNO into talking position and after having been informed by the calling subscriber of the designation of the called line, extends the connection by means of the plug RP and signals the called subscriber by shifting the listening key SNO into ringing position.

Upon the completion of the conversation after lighting of the supervisory lamps SL_1 and SL_2 of both subscribers by circuits over their contacts at the relays SSR_1 and SSR_2, the operator removes the plug RP and depresses the listening key SNO into ringing position. This establishes a circuit *k* from positive battery, through contact 123 of listening key SNO, contact 124 of relay SSR_2, contact 125 of switch SO, winding of the driving device, to negative battery. The sequence switch SO now rotates into position 6 and establishes a circuit *l*—*m* which may be traced from positive battery, through magnet CR, contact 120 of contact group OKR (closed during the radial movement), upper contact of spring 96 of switch SO, to negative battery. The armature of the magnet CR is now attracted and its pawl is lifted out of the centering slot of the switching member 20 and closes a circuit *f*—*o* which may be traced from positive battery, through contact 116, winding MV of the driving device, upper contact of spring 94 of switch SO, to negative battery. This circuit causes the switching member 20 to perform its radial restoring movement to the initial position. In this movement the pin 55 operates the contacts OKR so as to break the circuit *l*—*m* at contact 120. The magnet CR now deenergizes and restores its armature. At the same time the circuit *f*—*o* is opened at contact 116 and arrests the driving device. The switching apparatus is now ready to be taken in use for another call the direction of rotation being determined by the position of the shifter OKV and is only shifted, as the switching apparatus passes the last contact group during its rotation to the right or to the left.

The selector switch shown in Fig. 3 differs from the line finder switch above described only in this that the group testing spring is removed, as unnecessary, while a group of contact springs 12 is added to control the rotary movement, and another group of contact springs 13 is added to control the radial movement. These two contact groups operate registers in well known manner.

In the switching apparatus shown in Figs. 1 and 3 the rod 20 carries contact springs 61 at its one end only. In Fig. 4 a contact rod 20 is shown having a set of contact springs at each of its ends. Said two sets of contact springs are each adapted to cooperate with one multiple field 22 and 23, respectively. With this embodiment a duplication of the number of lines which may be controlled by means of one switching apparatus is obtained.

In Figs. 6, 7 and 8 switching members are shown having two sets of contact springs at one end.

In combination with such switching members the arrangement of multiple terminals shown in Figs. 9 and 10 is preferred. In this arrangement the contact supporting panels 67 are provided with contact members permitting connection with two switching members mounted side by side in such a way that upon the insertion of the switching member, Figs. 6 and 7, between the terminals of the panels 67 contact may take place between the set of contact springs 68 and the contact pieces 70 on the one hand, and the set of contact springs 69 and the contact pieces 71 on the other hand.

Fig. 8 shows a circuit arrangement to be used for the double sets of contact springs, which enables that both of said sets need not be in the circuit at a time but may operate alternately, as, for instance, in such way that upon the switching member (Figs. 6, 7) entering between the contact pieces, the set of springs 68 will operate, while in the return movement of the switching member, contact will take place between the sets of springs 69 and the contacts 71.

The bar shown in Figs. 9 and 10 is made of metal but insulated electrically from the other part of the frame, and has the same purpose as the test bar 63 above described.

Having thus described our invention, we claim:

1. A switching apparatus for telephone exchange systems, comprising stationary contacts arranged in radial groups with respect to a centre, a movable contact member, a single driving device adapted to rotate said movable contact member and to impart a radial movement thereto for engagement with any of the stationary contacts, and means for reversing the operative engagement between the driving device and said movable contact member for returning it to an idle position in relation to said stationary contacts.

2. A switching apparatus for telephone exchange systems, comprising stationary contact members arranged in radial groups with respect to a centre, a movable contact member capable of performing rotary as well as radial movements, a single driving device adapted to rotate said movable contact member, means for stopping the rotary movement of the movable contact member while the driving device remains operative; means for imparting to the movable contact member radial movements from said driving device, and a reversing clutch between the driving device and said movable contact member for reversing its rotary as well as its radial movements.

3. In a switching apparatus for telephone exchange systems, the combination with a movable contact member, of a mechanical source of power to both rotate said member and move same radially, a relay to control said source in its operation to rotate the movable contact member, and another relay to control said source in its operation to move said member radially.

4. In a switching apparatus for telephone exchange systems, the combination with a movable contact member, of a mechanical source of power to both rotate said member and move same radially, a relay to control said source in its operation to rotate the said member, another relay to control said source in its operation to move the said member radially, and means for causing said relays to arrest the switching member until one of said relays operates to control the movement desired.

5. In a switching apparatus for telephone exchange systems, the combination with a rotatable disk, of a contact rod mounted to slide radially thereon, contact springs on said rod, a bank of rigid contacts, arranged in groups having a radial extension with respect to the center of said disk and forming between themselves radial spaces adapted to be engaged by said rod in its radial movement and at the sides of which said rigid contacts end, and a single mechanical source of power to both rotate said disk and move the rod radially in selecting a contact in any of said spaces and move said rod radially and rotate the disk in restoring the switch to normal.

6. In a switching apparatus for telephone exchange systems, the combination with a rotatable disk, of a ring rotatably mounted on said disk and having two annular sets of teeth, a mechanical source of power, connected with one of said sets to rotate the ring in one direction or the other, an idle gear on said disk meshing with said other teeth, and a contact rod mounted to slide

radially on said disk and having teeth meshing with said idle gear.

7. In a switching apparatus for telephone exchange systems, the combination with a rotatable disk, of a contact rod, mounted to slide radially thereon, a relay to normally lock the rotatable disk, another relay to normally lock the contact rod, and means for causing said relays to operate alternately.

In testimony whereof we have signed our names.

DAVID LAURENTIUS LIENZÉN.
KNUT LARSSON.