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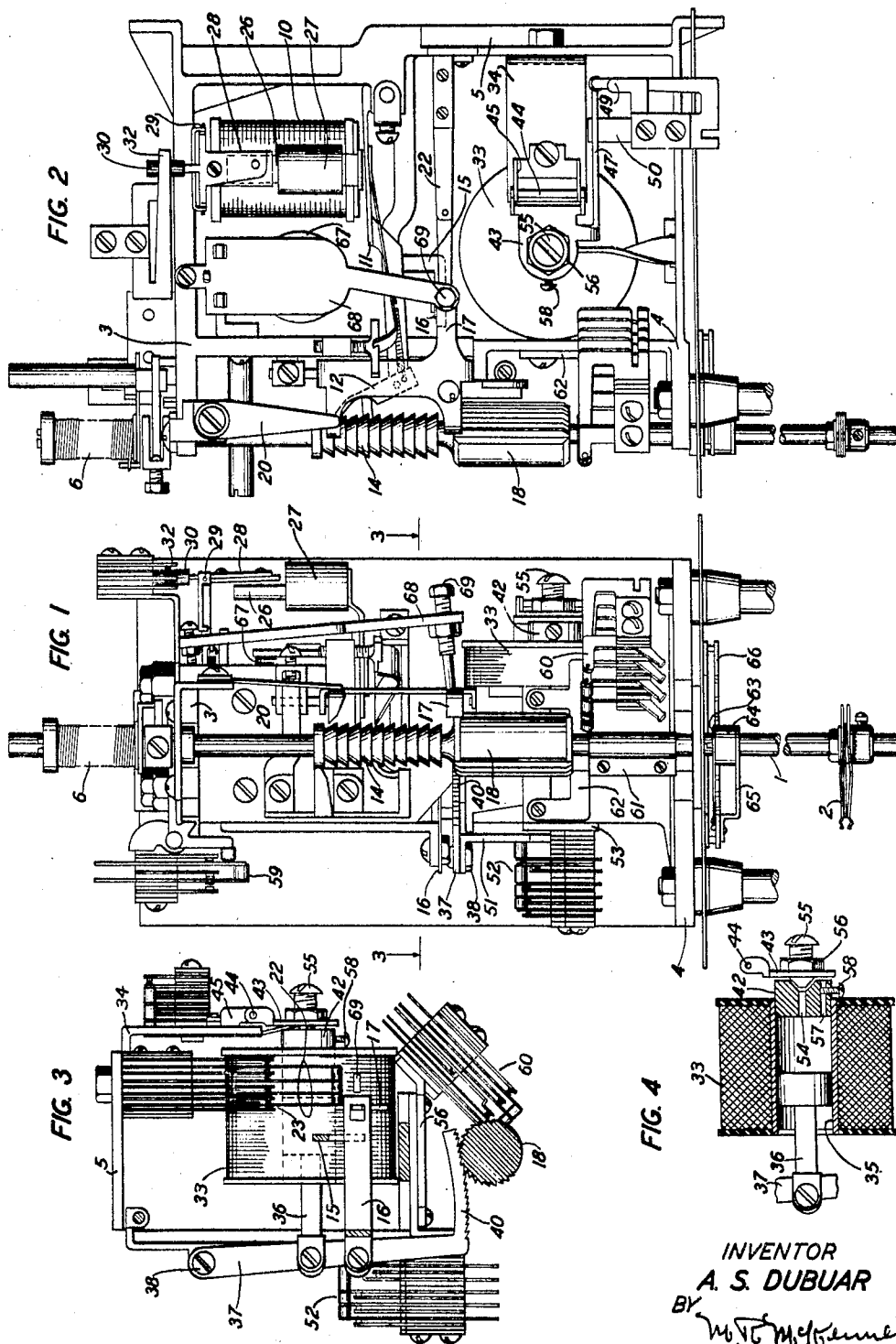
A. S. DUBUAR

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SWITCHING DEVICE

Filed March 17, 1943

2 Sheets-Sheet 1



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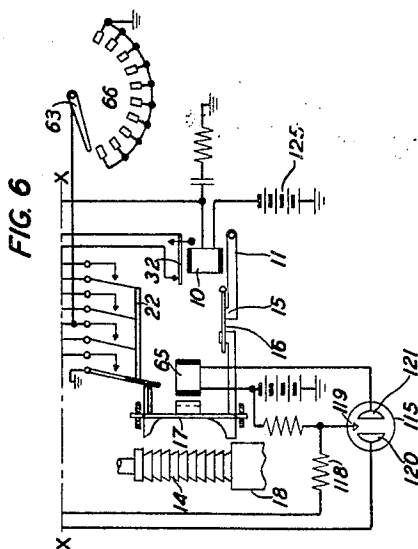
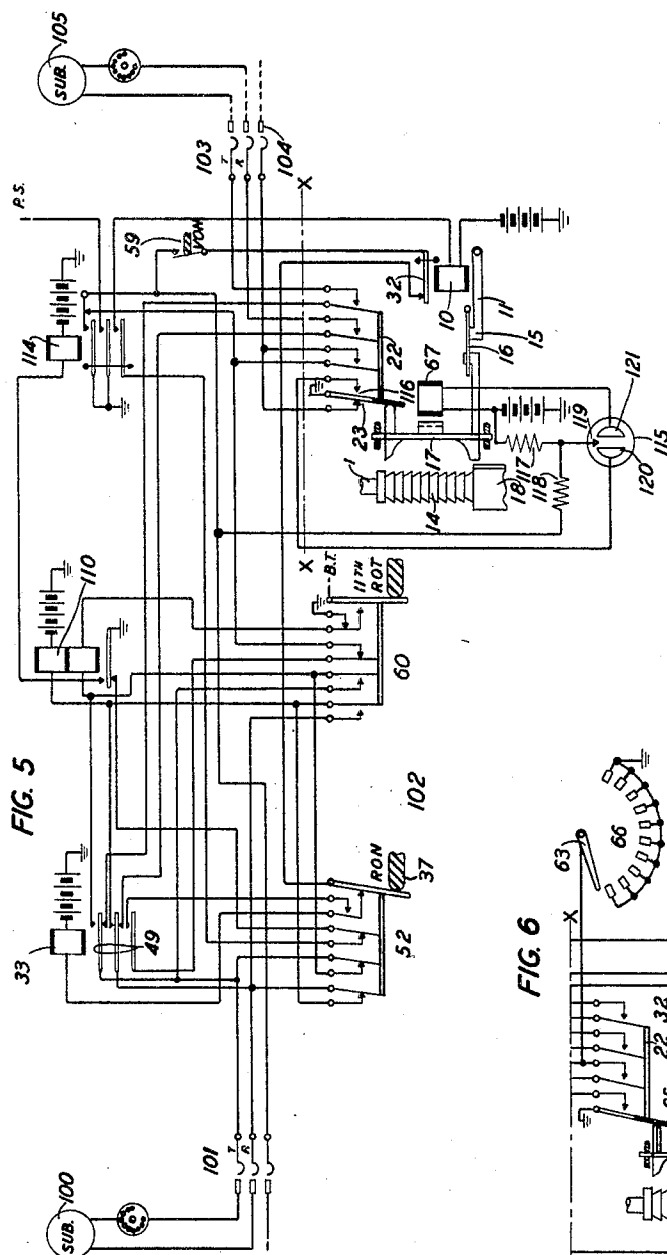
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UNITED STATES PATENT OFFICE

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SWITCHING DEVICE

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7 Claims. (Cl. 179—27.52)

This invention relates to telephone systems and more particularly to improvements in switching devices and circuits for automatically establishing electrical connections in such systems.

An object is to simplify the switching devices and simplify the operating control circuits for such devices to reduce the relay switching means required to establish electrical connections over such switching devices.

Heretofore so-called step-by-step mechanisms have been used in which a shaft having wipers thereon is advanced in a vertical direction by a stepping magnet to select levels of terminals in a terminal bank and then advanced in a rotary direction by a stepping magnet to select a particular idle set of terminals in the chosen level to establish a telephone connection through the wipers and said selected terminals. The control circuits for operating switches of this kind to perform the functions of advancing telephone connections have heretofore required certain special relays, generally designated as the C, D and E relays, to perform some of these functions. It is a feature of the present invention to eliminate these relays and to provide mechanism in the switch itself for performing the functions usually assigned to these relays.

To this end the applicant has provided in place of the usual C relay, a slow-to-release armature arrangement on the vertical stepping magnet which arrangement controls the circuit for the rotary magnet when the vertical magnet finally releases after its pulsing operations.

Applicant also provides in place of the usual E relay and the usual rotary magnet which normally advance the wipers in steps under the control of a hunting circuit, a rotary magnet arrangement including a solenoid coil and a plunger with the plunger operating a rack and pinion gear arrangement for the shaft so that the rotary magnet may be maintained operated continuously until an idle set of terminals is found. The original energizing circuit for the rotary magnet is as stated closed on the release of the vertical magnet. To maintain the rotary magnet operated after the rotary off-normal contacts open this original energizing circuit, a ground connection is established by the usual double-dog arrangement. This ground is maintained while the shaft rotates from one set of busy terminals to another to insure that the wipers will be advanced to and properly center on the terminals of succeeding sets. The rotary magnet is therefore continuously operated by this ground and the ground on the busy sleeves

of succeeding set of terminals until an idle set is found when the magnet is released.

To eliminate the usual D relay arrangement advantage is taken of the fact that the rotary magnet is continuously operated to maintain the tip and ring connections to the wipers by armatures and contacts of this magnet. Normally these circuits are closed through the armatures and contacts of the rotary magnet but are opened at contacts controlled by the double-dog which is released as soon as the vertical magnet is operated. Normally the D relay functions to release the connection when the ground on the sleeve is removed and to perform this function applicant has provided a special arrangement including a cold-cathode tube which operates when the ground on the sleeve is removed and closes a circuit for the operation of the release magnet.

An arrangement has also been provided to permit the rotary magnet solenoid arrangement to rotate the shaft at the most suitable speed during the hunting operation and to release it to normal as quickly as possible during the restoring of the switch to normal. To this end apertures are provided in the plunger cylinder inside the magnet coil, one of which may be adjusted to regulate the escape of air from the cylinder during the energization of the coil to attract the plunger at the desired speed, while the other is closed by the auxiliary armature mentioned above during this operation. On the other hand during the release of the plunger, this second aperture is opened by the release of the auxiliary armature to permit the plunger to return to normal quickly without hindrance by air pressure in the cylinder.

The invention has been illustrated in the accompanying drawings in which:

Fig. 1 shows a typical step-by-step switch mechanism in which the applicant's invention has been incorporated.

Fig. 2 shows a right-hand side view of the switch disclosed in Fig. 1.

Fig. 3 is a cross-section taken on line 3—3 of Fig. 1 to illustrate the improvements in accordance with the applicant's invention adapted to this switch.

Fig. 4 shows an arrangement for controlling the movement of the rotary magnet plunger.

Fig. 5 shows a circuit diagram of a telephone system in which the applicant's invention has been applied to a selector circuit arrangement.

Fig. 6 shows a partial circuit diagram that may be employed in connection with the circuit as

shown in Fig. 5 to perform the functions thereof in a somewhat modified manner.

Referring now to the drawings and particularly to Figs. 1, 2 and 3, it will be noted that the switching mechanism shown in these figures is essentially the well-known step-by-step switch of the Strowger type in which shaft 1 is moved vertically to advance wipers such as 2 to a particular level in a switching bank and then rotated to advance them to a desired set of terminals in the chosen level. In general the shaft 1 is journaled between the upper and lower frame members 3 and 4 of a frame 5 and provided at its upper end with the usual rotary return spring assembly 6. The vertical magnet 10 for raising the shaft 1 in a vertical direction is mounted on the upper frame member 3 and provided with an armature 11 and a pawl 12 which engages the vertical ratchet 14 on shaft 1 when the armature is attracted by the magnet. It should be observed that when this armature 11 is attracted by the magnet a hook-like extension 15 thereof operates on a spring 16 which releases the double-dog 17 to permit it to engage the ratchet 14 and the rotary ratchet 18 to maintain the shaft in its raised and rotated position as is well known. It shall be observed that this double-dog 17 is controlled by the usual spring 20 to cause it to engage the ratchet. In addition this double-dog also controls in this mechanism a set of contact springs 22 which is so arranged that all of the contacts normally open are closed as soon as the dog is released and maintained closed while the dog is slightly raised as it is when it passes from one tooth to the other on either one of the ratchets 14 or 18, while the connection at contacts 23 opens when the dog is released to engage between two teeth in either rack but which closes as the pawl rides over a tooth from one tooth to another. These contacts 23 are provided as pulse-aid contacts as will be described hereinafter. The vertical magnet 10 is also provided with a special extension core 26 having a heavy copper sleeve 27 surrounding it and a special armature 28 pivoted at 29. This armature has an insulated extension 30 which controls a set of contact springs 32. This special arrangement is to permit the armature 28 to be attracted by the core 26 and be maintained attracted during the pulsing of the vertical magnet and be released when the vertical magnet is finally released after the pulsing ceases. The purpose of this arrangement in the circuit control of the mechanism will be described hereinafter. In place of the usual rotary magnet having an armature and pawl to engage ratchet 18 to rotate the shaft 1, a solenoid coil 33 has been provided and connected to a bracket 34 mounted on the frame member 5. Inside the coil 34 is a plunger sleeve 35 in which a plunger 36 is inserted with a sliding fit. This plunger 36 is attached to an arm 37 which is pivoted at 38 at one end and is formed into a rack 40 at the other end. This rack 40 engages the teeth on the ratchet or pinion 18 as shown particularly in Fig. 3, the arrangement being such that when the coil 33 is energized, the plunger 36 will be attracted inside the sleeve 35 and move arm 37 so that rack 40 will rotate the shaft 1 through the medium of the rack teeth and the teeth on the ratchet 18. Sleeve 35 has a special extension core 42 on the opposite side from the plunger and a special armature 43 pivoted at 44 on a bracket 45 secured to the bracket 34 on frame member 5. When the coil 33 is energized core 42 attracts armature 43 and the extension arm

47 thereon engages and controls a set of contact springs 49 mounted on a bracket 50 secured to the bottom member 4 of the frame. The arm 37 while in normal position controls by means of an extension 51 thereon the rotary off-normal contact set 52 and when the arm is moved from the normal position these contacts are operated to make and break the desired connections as will be described hereinafter. The contact sets 52 are mounted on a bracket 53 secured to the front of the frame.

Referring now particularly to Fig. 4, to secure an operation of the plunger to rotate the shaft during the hunting operations as quickly as possible but at the same time to control the wipers so as not to pass by but stop accurately on the first idle set of terminals and to control the release movement of the wipers to normal on the release of the switch, to take place as quickly as possible, a special plunger control arrangement has been provided as follows: Extension core 42 is provided with a comparatively large aperture 54 and a screw or stopper 55 is secured by nut 56 to auxiliary armature 43 so that when the armature is actuated the stopper will close the aperture 54 during the operating movement of the plunger 36 in the plunger sleeve 35 to control the speed of the plunger during this movement, the smaller aperture 57 is provided in the core 42. An adjustment of this aperture to regulate the escape of air may be accomplished by the screw 58 extending into the aperture 57 so that the plunger 36 will advance in the plunger sleeve at the desired speed during the hunting operation. On the other hand when the coil de-energizes to release the plunger, the auxiliary armature 43 is also released and opens the opening 54 so that the plunger may be released as quickly as possible and not be hampered by the intake of air through the smaller aperture 57 during the return movement.

Vertical off-normal contacts shown at 59 are provided to be closed on the vertical movements of the shaft and eleventh step rotary off-normal contacts are shown at 60 and may be engaged by the bracket 61 on the shaft 1 when rotated to the eleventh position. These contacts are mounted on a bar 62 secured to the front of the frame. Mounted on the shaft 1 to rotate therewith but not partake of the vertical movement in the shaft is a brush 63 mounted on sleeve 64 which is held in place by a bracket 65 connected to the lower frame member 4 and this brush 63 engages while rotating with the shaft a series of contacts indicated at 66, one contact for each rotary position of the shaft. This mechanism and special brush arrangement may be employed in a modification of the applicant's invention as will be described hereinafter.

The usual release magnet 67 is provided having an armature 68 which engages with its extension 69 the double-dog 17 to return it to normal position where it is latched by the member 16 controlled by the vertical armature 11. When this magnet 67 operates the double-dog releases the shaft for return to normal position under tension of the return spring 6 and by gravity in the usual manner.

The applicant's invention has been incorporated in a telephone system as shown in diagrammatic form in Fig. 5 and in modified form in Fig. 6 and applied specifically to a selector in which the vertical magnet is operated by impulses and the rotary magnet operated continuously un-

til an idle line outgoing from this selector is found.

Referring to Fig. 5 a calling subscriber's station has been shown at 100 terminating in a line finder 101 which is shown merely in diagrammatic form and terminating in a selector 102 embodying the applicant's invention. This selector terminates with its brushes 103 in terminals such as 104 which may lead through a connector to a subscriber's line 105. A description will now be made of the operation of this selector. If the subscriber at 100 calls and causes the connection to be established through the line finder 101, a circuit is completed for the relay 110 from battery through the upper winding of this relay, rotary off-normal contacts 52 over the tip and ring conductors through the subscriber's set 100 and the line finder, off-normal contacts 52, lower winding of relay 110, eleventh step contacts 60 to ground. Relay 110, in operating, closes an obvious circuit for the operation of relay 114. The impulses for the first digit may now be sent by the subscriber at 100. As the impulses are received, the relay 110 alternately releases and operates. On each release of the relay 110 a circuit is completed for the vertical magnet 10 from battery through the winding of this magnet, contacts of relays 114, rotary off-normal contacts 52 to ground at the contacts of relay 110. On the first operation of the vertical magnet 10, the contacts 32 are opened and remain open during the subsequent pulsing of the vertical magnet due to the arrangements for these contacts as described in connection with Figs. 1 and 3, including the armature 28, core 26 and copper sleeve 27. The first operation of the vertical magnet 10 also raises the spring 16 to release the double-dog 17 to engage the ratchets 14 and 18 on the shaft 1. The operation of the double-dog 17 on the release causes the set of contacts 22 to be operated, the contacts that are normally opened will be closed and the contacts at 23 will be opened. The contacts that are closed remain closed as long as the double-dog is engaged between two teeth, while the connection through the pulse-aid contacts 23 is closed for each step taken by the shaft 1, that is, while the pawl disengages the top of a tooth. When the vertical magnet 10 has advanced the shaft 1 to the desired level the pulsing ceases. The contacts 32 will then close and provide a circuit for the operation of the rotary magnet 33 from battery through the winding of this magnet, rotary off-normal contacts 52, contacts 32, vertical off-normal contacts 59 to ground at the contacts of relay 114. The operation of this magnet causes the contacts 49 to be actuated and to open the tip and ring connections for the brushes 103, closed at the double-dog contacts 22 and connecting the tip and ring conductors from the line finders through the windings of the pulsing relay 110 in shunt of the rotary off-normal contacts 52. It should be noted now that this operation of the rotary magnet 33 causes the rotary off-normal contacts 52 to operate by the movement of arm 37 and open the tip and ring connections formerly extending through these contacts through the winding of the pulsing relay 110. The rotary magnet in operating therefore maintains the connections for the pulsing relay 110. The rotary off-normal contacts 52 also open the original energizing circuit for the rotary magnet and close a circuit for this magnet from battery through the winding of this magnet, rotary off-normal contacts 52, contacts 49, eleventh step rotary

contacts 60, contacts 22 to ground at the contacts 23, which as stated, are closed when the double-dog 17 rides over the top of a tooth. Thus the contacts 23 serve as a pulse-aid connection so as to make sure that the rotary magnet actually advances until the shaft takes one step when the double-dog 17 comes to rest in the next tooth on the ratchet 18. At this time the connection at 23 opens and the circuit for the rotary magnet is opened to stop the shaft in this position. However, it should be noted that if the brushes 103 land on the terminals of a busy outgoing connection, there will be a ground on the sleeve brush from the terminal of this busy connection and 15 this ground will now maintain the rotary magnet operated from battery through the winding of this magnet, rotary off-normal contacts 52, contacts 49, eleventh step rotary contacts 60, contacts 22, sleeve of the brushes 103 and this busy sleeve terminal to ground. Thus, the rotary magnet will advance the shaft another step in the rotary direction, and as the contacts 23 are now closed to maintain the magnet operated until the step is completed, the rotary magnet will 25 now therefore be continuously operated until an idle outgoing line is encountered as signified by the absence of ground on the sleeve terminal 104. When an idle outgoing line is found, the rotary magnet will be released and the brushes 103 30 maintained on the terminals of this line.

On the release of the rotary magnet 33, the connection established from the calling line and line finder 101 through the pulsing relay 110 is opened at the contacts 49 and closed through 35 these contacts and contacts 22 to the tip and ring conception over the brushes 103 to the idle engaged line. The connection may now be extended through the connector to the called subscriber's station 105 in the usual manner in automatic telephone systems, with a ground supplied in the connector for sleeve terminal 104 to make this line busy.

To release the selector after the conversation is ended and the subscribers hang up their receivers, the removal of the ground on the sleeve from the connector initiates this release. The particular arrangement shown operates as follows: It should be noted that on the operation of the contacts 22 a path was established from battery 40 through the winding of the release magnet 67 and the three-element cold-cathode discharge tube 115 to ground at contacts 116. However, the tube does not break down at this time as a connection was previously established from this battery through resistances 117, 118 to the ground 45 on the sleeve from the line finder. When, however, the ground on the sleeve is removed, the battery through resistances 117, main anode 119 and control electrode 120 through the tube to 50 ground at contacts 116 will cause the tube to ionize and the path to be completed from battery through the winding of release magnet 67, the control electrodes 121 and 120 to the ground at 116. Release magnet 67 is now, therefore, energized and operates on the double-dog 17 to 55 release the switch shaft 1 to normal position. The dog 17 is then latched by the spring 16 controlled by the armature of the vertical magnet. When the double-dog 17 is operated, the ground at contacts 116 is removed and the tube returned to normal and the release magnet is deenergized. By 60 this arrangement there is very little drain on the battery 125 while the switch is being held in an operated position which is a considerable advantage over the system in which the D control relay 75

has to be held energized while the switch is in use.

If Fig. 6 is inserted in place of the portions below the line X—X of Fig. 5, a modification of the arrangement for maintaining the rotary magnet constantly operated until an idle line is found may be produced. The principal difference is the arrangement of the brush 63 and the contacts 66 in place of the contact to ground at 23. The brush 63 as discussed in connection with Figs. 1 to 3 rotates with the shaft 1. The purpose of this brush 63 and contact 66 is to maintain the rotary magnet energized as it moves the shaft from one set of terminals to another, the terminals 66 being located in positions to close the circuit for this magnet as the regular brushes travel from one set of terminals to the other. This circuit may be traced from ground through any one of terminals 66, brush 63, contacts 22, eleventh step rotary contacts 60, contacts 49 of the rotary magnet, rotary off-normal contacts 52, winding of rotary magnet 33 to battery. When the brushes of the switch land on the next set of terminals, the connection between the brush 63 and one of the preceding terminals in group 66 is opened so that in the case there is no ground on the sleeve of this succeeding switch, the rotary magnet will be stopped.

What is claimed is:

1. In a switching system, a switch including a vertical magnet, a rotary magnet, a release magnet, a shaft having tip, ring and sleeve brushes, a terminal bank, a holding pawl and ratchet teeth for said shaft for holding the shaft in any desired advanced position, a talking circuit for the tip and ring brushes normally opened, means for actuating the vertical magnet in a step-by-step manner to advance said shaft and brushes to any desired level of bank terminals and to release said holding pawl into engagement with the ratchet teeth, means for continuously energizing the rotary magnet to advance the shaft and brushes in an uninterrupted movement until the brushes connect with a first idle set of terminals in the chosen level, said energization being initiated on the last release of the vertical magnet and then controlled jointly by a ground applied by the movement of the holding pawl over the ratchet teeth and by ground on the sleeve terminals of succeeding busy lines, means including contacts controlled by the rotary magnet when it releases for closing said talking circuit, a discharge tube, means operative when the rotary magnet releases and controlled by said holding pawl and a ground applied to the sleeve terminal of the chosen idle line for preventing the tube from ionizing until said ground is removed, and means controlled by said tube when it ionizes for actuating said release magnet to release the switch.

2. In a switching system, a switch having a shaft, brushes on said shaft, a terminal bank, a magnet responsive to current impulses for alternately operating and releasing said magnet to impart to said shaft a movement of one step in one direction for each impulse to select a group of terminals by said brushes, a second magnet for imparting to said shaft a movement in another direction from a normal position, a circuit for actuating said second magnet to start said second movement, said circuit being controlled by the first magnet to be maintained open during the operation and release of said first magnet and to be closed when said magnet finally releases, a second circuit, means for opening said

first circuit after the shaft has started its second movement and for closing said second circuit to continue the movement of the shaft in the second direction until the terminals of an idle line in the selected group are encountered.

3. In a switching system, a step-by-step switch having a shaft, tip, ring and sleeve brushes on said shaft, sets of tip, ring and sleeve terminals in a terminal bank, a vertical magnet and ratchet mechanism for raising said shaft in steps to select a horizontal row of sets of terminals, a rotary magnet and a gear mechanism for rotating said shaft to select with said brushes a particular set of terminals in the selected row, a double-dog pawl for holding the shaft in the raised horizontal position and in any rotary position, contacts normally closed on said vertical magnet and a slow-to-release armature for maintaining said contacts open during the stepping of said vertical magnet, a latch controlled by the vertical magnet for releasing said double-dog pawl on the first energization of said vertical magnet, contacts controlled by said double-dog pawl when released to close during the rotation of the shaft while the double-dog pawl passes from one gear tooth to another and to open while the double-dog pawl is engaged between two gear teeth, contacts controlled by said rotary magnet to close when the rotary magnet is energized, vertical off-normal contacts, rotary off-normal contacts, a release magnet, a cold-cathode tube, a source of current, circuit means responsive to impulses for alternately operating and releasing the vertical magnet to select a horizontal row of sets of terminals, circuit means including the vertical off-normal contacts, the contacts controlled by the vertical magnet and rotary off-normal contacts for starting the energization of said rotary magnet when the vertical magnet releases at the end of the last energizing impulse, circuit means including the rotary off-normal contacts, the contacts of the rotary magnet, the contacts controlled by the double-dog pawl when released and other contacts on the double-dog pawl operative when it is engaged between two gear teeth for continuing the energization of the rotary magnet until it has rotated the shaft for a distance equal to one step to connect the brushes with the first set of terminals in the selected horizontal row, circuit means closed over the sleeve brush and the sleeve terminal of the first line to ground on said sleeve terminal if said line is busy to continue the energization of the rotary magnet, and said circuit controlled by the double-dog pawl being then closed to continue the energization of the rotary magnet while the brushes pass between succeeding sets of terminals, circuit means including the contacts controlled by the double-dog pawl when released and the contacts controlled by the rotary magnet for connecting the tip and ring conductors through to the brushes operative when the rotary magnet finally releases, a circuit means including contacts connected to ground and controlled by the double-dog pawl and including a shunt circuit for said source of current to the ground on the sleeve of the seized line for preventing said cold-cathode tube from ionizing as long as said last-mentioned ground remains and to permit it to ionize when said last-mentioned ground is removed, and circuit means including said source of current, said release magnet, said contacts to ground controlled by the double-dog pawl and said tube when ionized for energizing said release magnet to release the switch.

4. In a switching system, a calling line, called lines, a step-by-step switch including a vertical magnet, a rotary magnet, a release magnet, a shaft, brushes on said shaft, a terminal bank, a holding pawl for holding the shaft in any desired position, contacts controlled by said pawl, circuit means controlled by impulses incoming over the calling line for advancing the shaft in a vertical direction by operation and release of the vertical magnet at intervals to select a horizontal row of terminals, contacts controlled by said vertical magnet, contacts controlled by the rotary magnet, circuit means for advancing the shaft in a rotary direction to the set of terminals of an idle called line in the selected horizontal row by continuous operation of the rotary magnet, said last-mentioned circuit means being started in operation by the closing of said contacts controlled by the vertical magnet on its last release and continued closed by said contacts controlled by the holding pawl, and by a ground on terminals of busy called lines, circuit means for connecting the calling line over contacts controlled by said rotary magnet and contacts controlled by said holding pawl through the brushes and the terminals of an idle called line when found, means including a cold-cathode tube and the release magnet for ionizing said tube when a ground on a terminal of the called engaged line is removed over contacts controlled by the holding pawl for actuating said release magnet to release the switch.

5. In a switching system, a step-by-step switch including a vertical, a rotary and a release magnet, a shaft, tip, ring and sleeve brushes on said shaft, a terminal bank, a holding pawl to maintain the shaft in any desired advance position, a talking circuit comprising tip and ring conductors and normally opened and connected to said tip and ring brushes, means for advancing the shaft in a vertical direction followed by advancement in a rotary direction to select an idle set of terminals in a desired level of terminals in said bank including said holding pawl and means whereby the rotary movement is continuous to actuate the brushes to travel over said terminals and controlled partly by ground on succeeding busy terminals and ground applied by movements of the holding pawl to maintain the rotary magnet continuously energized until the idle line terminals are encountered, means operative when the rotary magnet is deenergized for connecting the tip and ring conductors to complete the talking circuit, a cold-cathode tube, means controlled by said holding pawl and a ground on the engaged line for preventing said tube from ionizing until the ground on said line is removed and means controlled by the holding

pawl when said tube is ionized for actuating the release magnet to release the switch.

6. In a switching system, a switch including a shaft having brushes, a terminal bank, a vertical magnet and associated means for advancing the shaft and brushes to any desired level of terminals on the energization and release of said magnet, a rack and a pinion gear for rotating the shaft, a rotary magnet having a plunger sleeve inside the magnet coil, a plunger in said sleeve attached at one end to said rack so that on the energization of the magnet coil said plunger is attracted inside said sleeve to cause the rotation of the shaft by said rack and pinion gear to advance the brushes to a desired set of terminals, a core closing the end of said sleeve opposite to the end through which the plunger enters said sleeve said core having two air escape apertures one being large as compared with the other, an armature for said rotary magnet having a stopper for closing said larger aperture when the armature is attracted by the rotary magnet so that the speed of the plunger into the sleeve will be regulated by the volume of air escaping through the smaller aperture and the return speed of the plunger when the rotary magnet is deenergized and the armature is released and is regulated by the air influx through both apertures and a regulating valve for said smaller aperture to control the volume of air passing through said aperture.

7. In a switching system, a switch including a shaft having brushes, a terminal bank, a vertical magnet and associated means for advancing the shaft and brushes to any desired level of the bank terminals on the energization and release of said magnet, a rack and a pinion gear for rotating the shaft, a rotary magnet having a plunger sleeve inside the magnet coil, a plunger in said sleeve attached at one end to said rack so that on the energization of the magnet coil, said plunger is attracted inside of said sleeve to cause the rotation of the shaft by said rack and pinion to advance the brushes to a desired set of terminals and means operative during the energization of said rotary magnet for regulating the speed of the plunger into said sleeve and for regulating the speed of the plunger during its return to normal after the deenergization of the rotary magnet including a small valve and a large valve in the sleeve, the small valve being always opened to serve as an air escape and air influx means while the large valve is maintained closed during the energizing period of the rotary magnet to serve as an air escape prevention valve during the energization period and as an air influx valve during the deenergization period of the magnet.

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