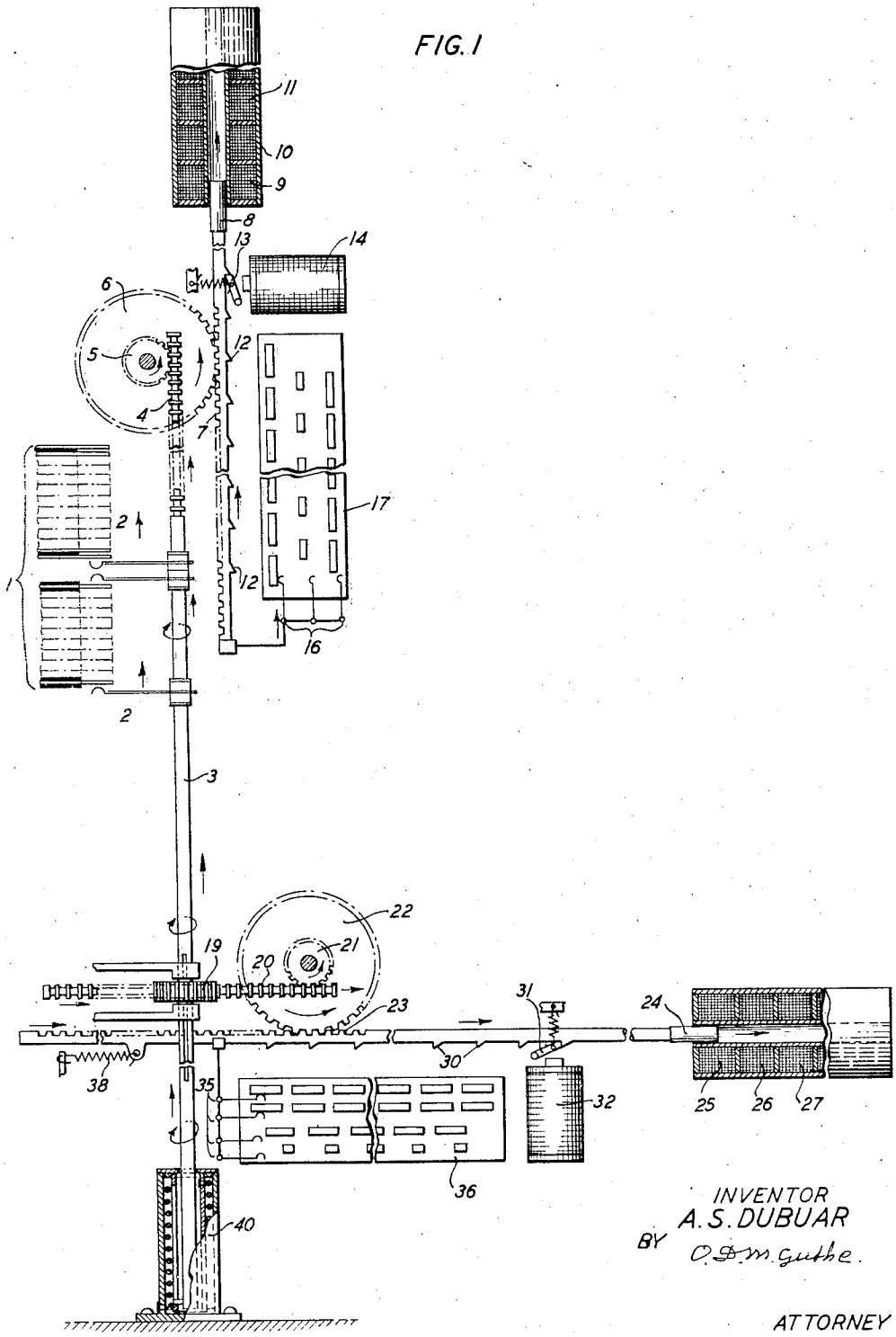
Jan. 4, 1949. A. S. DUBUAR 2,457,878

SOLENOID OPERATED SWITCH

Filed Dec. 2, 1944 4 Sheets-Sheet 1

FIG. 1



INVENTOR
A. S. DUBUAR
BY O. B. M. Guthe.

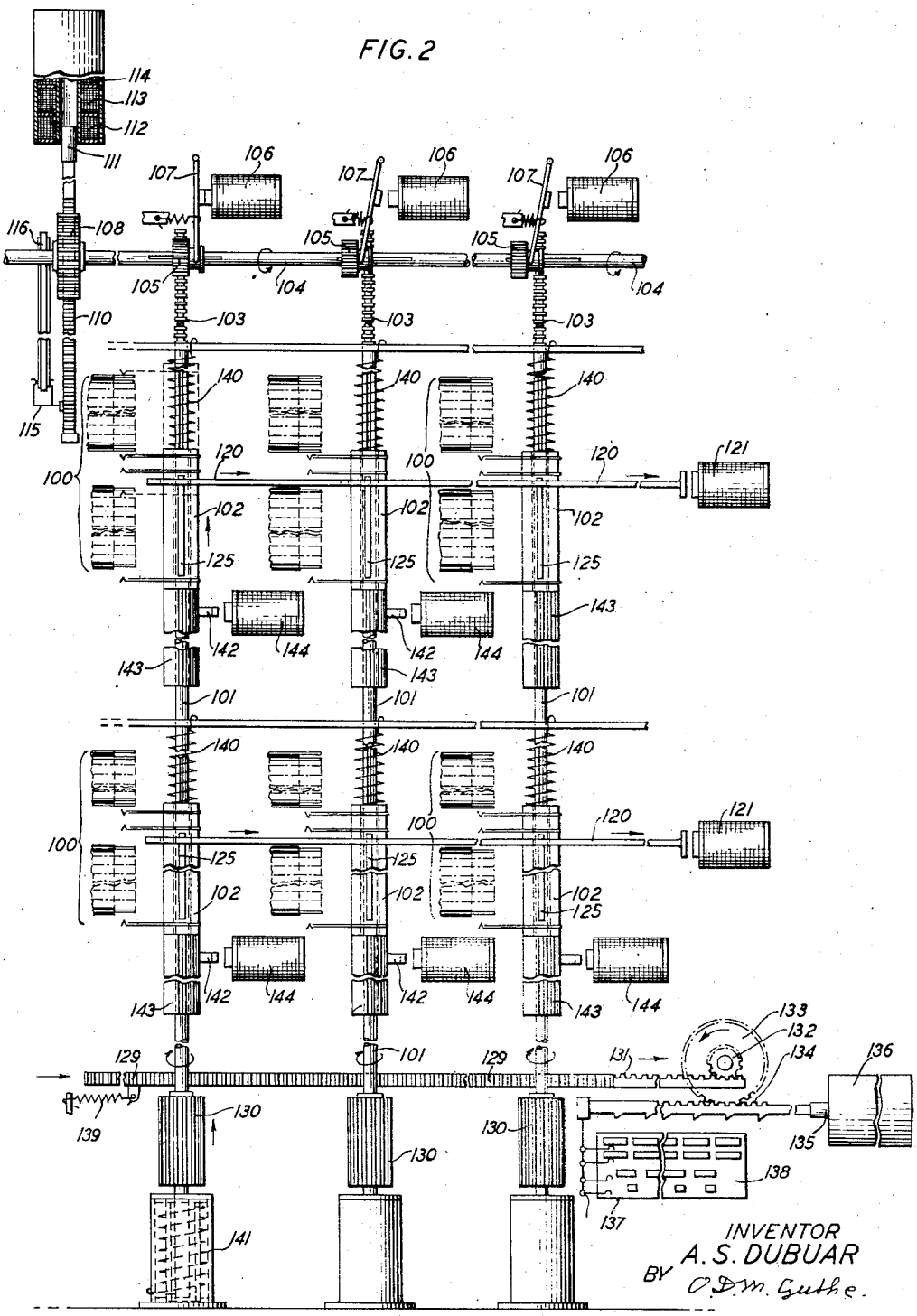
ATTORNEY

Jan. 4, 1949. A. S. DUBUAR 2,457,878

SOLENOID OPERATED SWITCH

Filed Dec. 2, 1944 4 Sheets-Sheet 2

FIG. 2



INVENTOR
A. S. DUBUAR
BY O. Dm. Guthe.

ATTORNEY

Jan. 4, 1949. A. S. DUBUAR 2,457,878

SOLENOID OPERATED SWITCH

Filed Dec. 2, 1944 4 Sheets-Sheet 3

FIG. 3

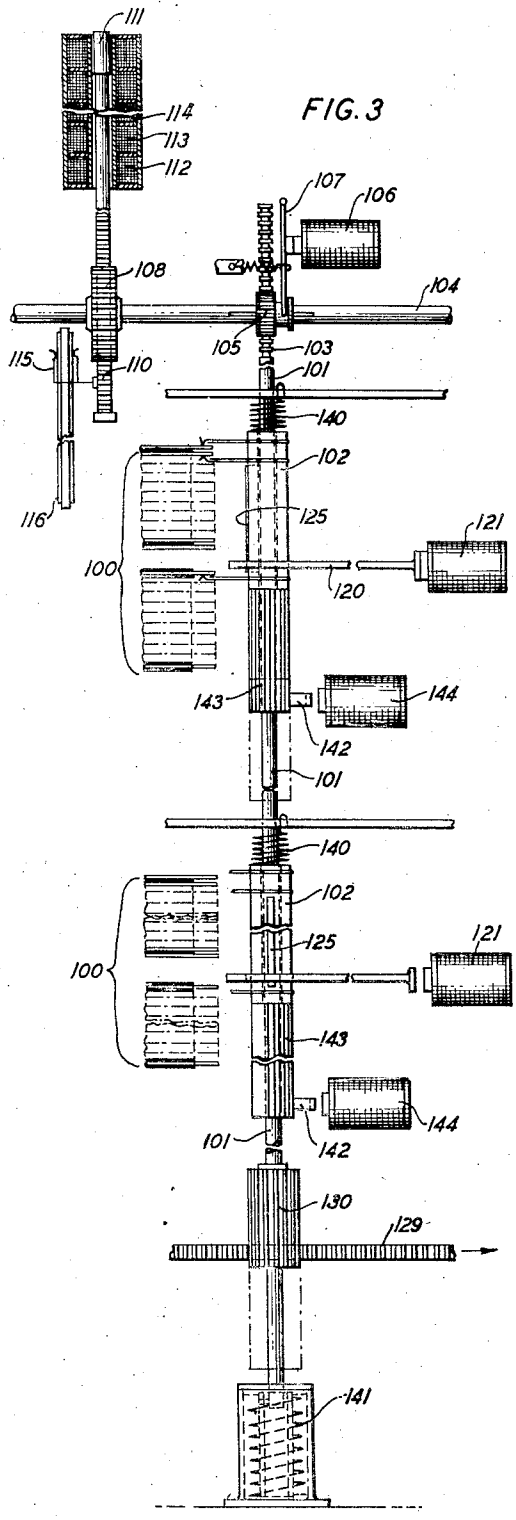


FIG. 4

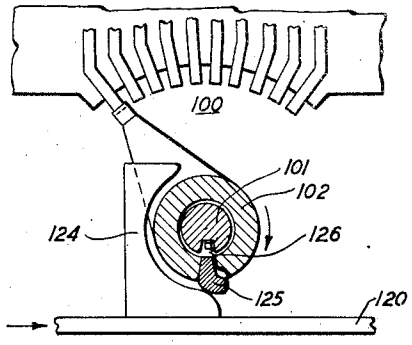


FIG. 5

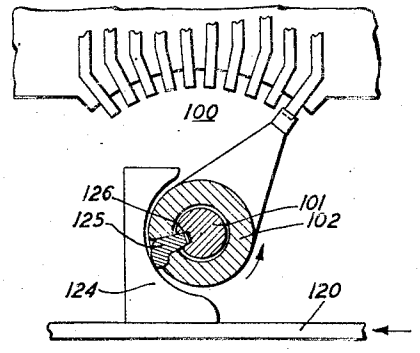
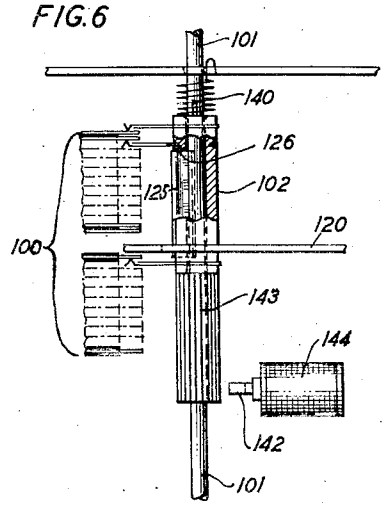


FIG. 6



INVENTOR
A. S. DUBUAR
BY
O. Sm. Guthe
ATTORNEY

Jan. 4, 1949. A. S. DUBUAR 2,457,878

SOLENOID OPERATED SWITCH

Filed Dec. 2, 1944 4 Sheets-Sheet 4

FIG. 8.

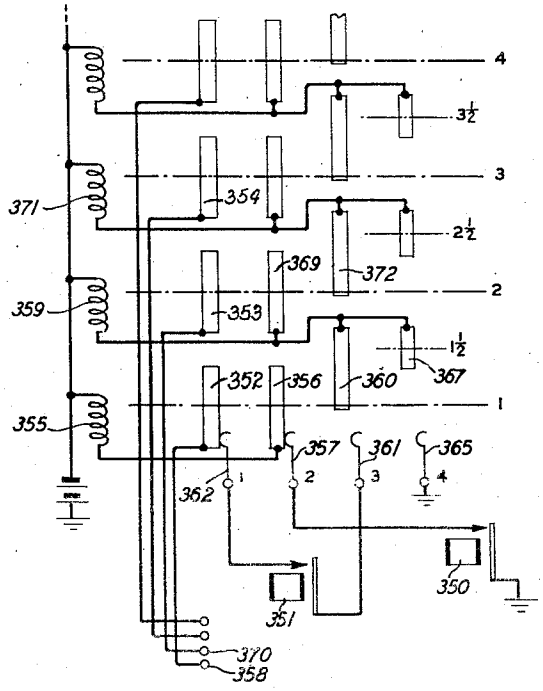
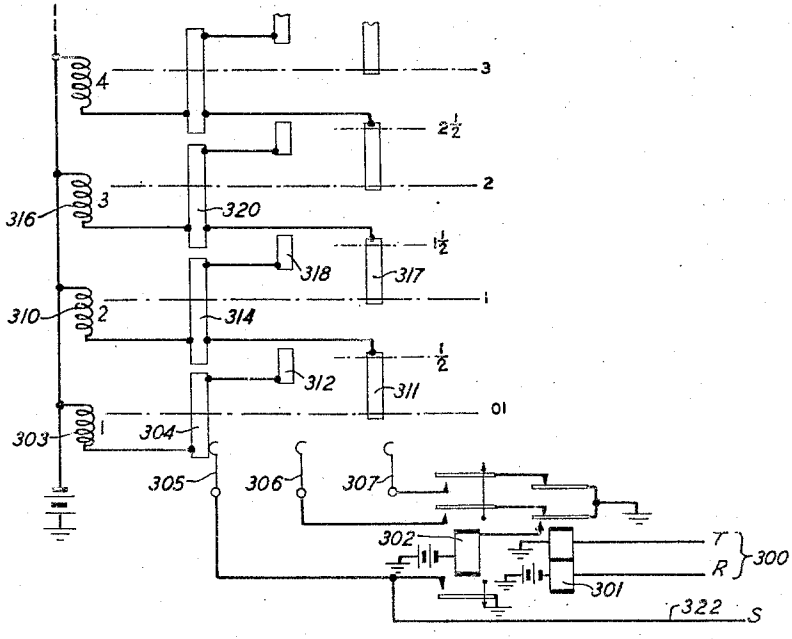


FIG. 7.



INVENTOR
A. S. DUBUAR
BY O. Sam Guthe.

ATTORNEY

Patented Jan. 4, 1949 2,457,878

UNITED STATES PATENT OFFICE

2,457,878

SOLENOID OPERATED SWITCH

Arthur S. Dubuar, East Orange, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 2, 1944, Serial No. 566,276

11 Claims. (Cl. 179—27.52)

1

This invention relates to switching mechanisms and particularly to such mechanisms employed in telephone systems to automatically establish electrical connections.

An object is to simplify and improve the mechanical details of such switching mechanisms and to improve the operating characteristics thereof.

Heretofore various types of switching mechanisms have been employed in automatic telephone systems and elsewhere for establishing electrical connections by advancing brushes in steps to contact with succeeding terminals. In some types a single solenoid coil energized at intervals has been used to act on a single plunger to advance a shaft connected thereto in steps. This shaft may carry brushes for connection to succeeding terminals or levels of terminals. In other cases a series of three such coils has been used to act on a succession of plungers to advance the shaft.

The present invention relates to solenoid controlled switching devices of these types, and a feature thereof is an arrangement of a plurality of solenoid coils and a single magnetic plunger, connected to the brush carrying shaft. This plunger is in position to be acted upon by said coils in response to the energization of a first coil to advance the plunger a first step, then to the energization of the second coil followed by the deenergization of the first coil to advance said plunger a second step and to then repeat said operations of energizing a succeeding coil and deenergizing a preceding coil to advance the plunger one step for each such set of repeated operations. This system of control may be applied to an arrangement where the shaft with its brushes is advanced in steps to succeeding levels in a terminal bank by one set of coils and then rotated to connect the brushes with a certain set of terminals in the selected level by another set of coils.

Another feature is a switching arrangement employing this type of coil and plunger system for selecting from coordinately arranged terminal banks, a particular terminal bank, then selecting a level of terminals in this bank and then a set of terminals in the selected level for establishing of a connection between said terminals and a set of brushes.

Circuit arrangements may be provided whereby all the selecting movements may be made in individual selectively controlled steps except in cases where the selection may be done by automatically hunting for an idle set of terminals in the selected level. These circuits may be applied

2

to a single two-motion selective switch or to a switching system in which the terminal banks are coordinately arranged.

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

Fig. 1 shows a selector switch in which the applicant's invention has been applied for the advancement of brushes to a particular level and rotated to select and connect with a particular set of terminals in the selected level;

Fig. 2 shows the applicant's invention applied in a switching system in which the terminal banks are coordinately arranged;

Fig. 3 shows a portion of the switching arrangement shown in Fig. 2 with the brushes advanced to a certain level at a certain terminal bank;

Figs. 4, 5 and 6 show various details of the switching arrangements shown in Fig. 2;

Fig. 7 shows circuits and commutator arrangements for controlling the coils to advance the brushes in selectively controlled steps; and

Fig. 8 shows circuits and commutator arrangements for controlling the coils to advance the brushes for hunting for an idle set of terminals.

Referring now to the switch shown in Fig. 1, where the applicant's invention has been applied to mechanisms for advancing a set of brushes or wipers to any one of a set of terminals in a particular level in a switch bank. This mechanism consists of a standard bank of terminals 1 in which the terminals are arranged in levels, the brushes 2 are mounted on a shaft 3, the upper end of this shaft being provided with a rack 4 meshing with a pinion 5 to which is attached a gear wheel 6 meshing in turn with a rack 7, to the upper end of which is attached a magnetic plunger 8 located inside a solenoid coil 9. Above this coil 9 are located other coils, such as 10 and 11. This group of coils may consist of ten coils for the passage of the plunger 8 therethrough to lift it and the rod 7 from one to ten steps. As these coils of necessity must be larger than the distance between the levels of terminals of bank 1, this rack 7, gear 6, pinion 5 and rack 4 may be so proportioned that when the plunger 8 is advanced one step the brushes 2 advance only the distance from one level of terminals to another. To hold the brushes in advanced position the rack 7 is provided with teeth such as 12 engaged by pawl 13 controlled by a holding and release magnet 14. Attached to the rack 7 is a series of brushes 16 which engage, as the rack 7 advances, contact segments on the commutator 17. These brushes 16 and commutator 17 are used for the

control of the advancement of the rack 7 as will be hereinafter described.

To rotate the shaft 3 for causing the brushes to engage terminals in the selected level of bank 1, an arrangement is provided similar to that for lifting the rod 3 to advance it to a particular level. It will be noted that the lower part of shaft 3 is provided for that purpose with a pinion 19 which is rotatable with the shaft but is prevented from moving with the shaft when raised vertically. This pinion meshes with the rack 20 which in turn meshes with the pinion 21 connected to a gear wheel 22. This gear wheel 22 meshes with a rack 23 at one end of which is connected a plunger 24. This plunger is normally located inside the coil 25 and may be moved horizontally through succeeding coils such as 26, 27. In this arrangement ten coils may be provided to rotate the shaft 3 from one to ten steps. The rack 23 is also provided with a means for holding the brushes at a particular rotary position by having the teeth 30 provided thereon engaged by a pawl 31 controlled by a holding and release magnet 32. To control the rotary movement of the shaft 3, the rack 23 is also provided with a series of brushes 35 engaging segments of a commutator 36. The operation of this control will be described hereinafter. The brushes may be rotated back to normal position by energizing the holding and release magnet 32 permitting rack 23 to return to normal position under the tension of a spring 38. Similarly, the shaft may be returned from its vertical position to its normal position by a restoring spring arrangement shown at 40 on the operation of release magnet 14.

Referring now to Figs. 2 to 6, a description will be made of the applicant's invention as applied to a switching system in which the terminal banks are coordinately arranged. In these figures a series of terminal banks, the same as shown in Fig. 1, are arranged in vertical and horizontal rows. These banks are marked 100. Associated with each vertical row of banks is a shaft such as 101 on which is provided a series of sleeves or carriages 102, each carrying a set of brushes for connecting with the associated bank. This arrangement is such that any brush carriage may be selected to be advanced vertically and then rotated horizontally to connect its brushes with a particular set of terminals. On each shaft 101 at the upper end thereof is provided a rack 103 and on a shaft 104 running horizontally across all of the shafts 101 are mounted pinions such as 105 keyed to the shaft to be moved horizontally each by a magnet 106 and its armature 107. The shaft 104 is connected to a gear 108, meshing with a rack 110 connected to a plunger 111 normally located inside a first coil 112. This coil is the bottom coil of a series of ten coils, such as 113, 114, etc., for the movement of the plunger 111 through these coils as in the structure shown in Fig. 1. Brushes 115 are attached to the rack 110 to engage the segment of commutator 116 for the control of the movement of the rack and the plunger through the coils. Across each series of horizontally located carriages is a rod 120, controlled to be moved longitudinally by a magnet 121. This rod 120 is provided at each carriage with a cam member 124 which when the bar 120 is moved longitudinally, as shown in Fig. 5, engages an associated key 125 to move it into a hole 126 in the shaft 101. Thus, when the associated shaft is lifted from a normal position, the carriage locked by this means will be lifted by the shaft and later be rotated as well, as the key will remain locked during rotation by this cam 124. To rotate a shaft 101 a rack 129 is provided at the bottom running horizontally across all the shafts 101. For that purpose each shaft is provided with a pinion 130 which when a particular shaft is lifted will engage the rack 129 for rotation of the associated shaft when the rack 129 is moved horizontally. The rack 129 is connected at the right-hand end to another rack 131 which meshes with the pinion 132 attached to gear wheel 133 meshing with a rack 134 at one end of which is connected a plunger 135 inside a first coil 136 of a series of ten coils similar to those shown for raising the shaft. Brushes 137 on rack 134 engage segments on commutator 138 for controlling the movements of plunger 135 in the coils. Each carriage may be rotated back to normal by an associated spring such as 139 and may be restored in the vertical direction by a spring such as 140 while the shaft 101 may be restored to normal by a spring 141. To maintain a carriage in rotated position a holding pawl 142 is provided for each carriage to engage a ratchet 143 connected to the carriage and may be released by release magnet 144 actuating the pawl 142. The whole structure may be mounted in any suitable frame structure.

To select a particular bank and actuate its associated carriage to cause the brushes thereon to connect with a particular set of terminals of this bank, the operation of this mechanism is as follows: The first operation that takes place is the actuation of a particular rod 120 by its magnet 121. This locks all of the carriages in the corresponding horizontal row to their respective shafts 101 by cams 124 and keys 125. The next operation is the actuation of a particular magnet 106 to shift the associated pinion 105 in mesh with the corresponding rack 103 of a shaft 101 to be selected. Then the magnets, such as 112, 113, 114, etc., are operated in accordance with the applicant's invention as will be described hereinafter. This will rotate the shaft 104 to raise the shaft 101 to the desired level. The racks 110 and 103, pinion 105 and gear wheel 108 are so proportioned in relation to the movement of the plunger 111 that the shaft 101 will advance for each step the distance between two succeeding layers of the terminals in the switch banks. As this shaft 101 is raised, the carriage in the corresponding horizontal row locked thereto will be raised the desired distance to the desired level. The next operation will be the actuation of the coils 136, etc. to shift the rack 131 towards the right as indicated by the arrow in Fig. 2, but as only the ratchet 130 associated with the raised shaft 101 is in mesh with rack 131 at this time, this particular shaft 101 will, therefore, be the only one that will be rotated. As this shaft 101 is rotated it will only cause the rotation of the particular carriage 102 that has its key 125 engaging the hole 126 in the shaft due to the operation of the particular magnet 121. The rotation of shaft 101 with its particular carriage will thus cause the associated brushes on this carriage to engage a particular set of terminals in the particular level to which this carriage has been raised. The magnet 106 which was actuated and the coils 112, etc. that may have been operated will now be deenergized and the plunger 111, rack 110, shafts 104 and 101 will return to normal position. The magnet 121 which was operated will now also be deenergized to release the associated rod 120, to release the key 125. The ele-

vated and rotated carriage 102 will now remain in connection with the selected set of terminals under control of pawl 142. When it is desired to release this connection the associated release magnet 144 operates to remove the pawl 142 from the ratchet 143 and thereby permits this carriage to rotate back to normal under tension of spring 140 and then drop back into its normal position in the vertical direction under tension of spring 141.

It should now be observed that as all the mechanisms for selecting lifting and rotating the carriage are returned to normal position, other selections of other carriages may be made. This common mechanism may be employed for selecting any and all of the terminal banks in this switching arrangement without interfering with each other as long as selections of two carriages are not carried on at the same time. Fig. 3 shows one of the carriages in a raised position and Fig. 6 shows partly in cross-section the inside mechanism of this carriage.

With regard to the control circuits that may be used for advancing the shaft in these two forms of switches by means of the coil and plunger system disclosed, the following general arrangement may be employed. If the shaft is to be advanced in a vertical direction in response to incoming impulses, the commutator 17 and brushes 16 shown in Fig. 1 or the commutator 116 and brushes 115 shown in Fig. 2 may be used and if idle line hunting is desired, the commutator 36 and brushes 35, Fig. 1, or the commutator 138 and brushes 137 in Fig. 2 may be used. Of course, if the switch, such as the one shown in Fig. 1, for example, is to be used for advancing the shaft in a rotary direction by impulses, the commutator arrangement 36 would be changed to correspond with the commutator 17. If it is, considering that the switch, shown in Fig. 1, is to be controlled by the coils and plungers to advance the brushes 2, for example, in the first or vertical moment under influence of impulses, and in the second or rotary moment under influence of impulses or current for an idle line, the arrangement would be as follows: The calling circuits shown in Fig. 7 has been drawn to illustrate how the plunger may be advanced to advance the associated brushes in steps in response to impulses. In this case a circuit is completed over the tip and ring conductors 300 for the operation of relay 301 on the seizure of the switch. Relay 301 closes an obvious circuit for the operation of relay 302. Relay 302 in operating closes a circuit for the energizing of the first coil 303 from battery through the winding of this coil, the commutator segment 304, brush 305, to ground at contacts of relay 302. This advances the brush 305 and its companion brushes 306 and 307 to a position marked in the drawing 01 which causes the plunger to occupy this position in the magnetic center of coil 303 and the mechanism is now ready for reception of impulses by dialing. The first impulse will advance the brushes 305, 306 and 307 to position marked 1, that is, so that the brushes 2 of the shaft 3 will land opposite the first level of terminals in the bank 1. To this end relay 301 is first deenergized. Relay 302 being slow to release remains operated during the deenergization of relay 301. In deenergizing it closes a circuit for the energization of coil 310 from battery through the winding of this second coil, commutator segment 311, brush 307, contacts of relays 302 and 301 to ground. This advances the brushes 305 to 307 to the position marked ½, that is, to the magnetic center of coils 303 and 310. It should be noted that just before this position is reached the brush 305 rides off commutator segment 304, but before this takes place, a circuit is completed for coil 303 from battery through the winding of this coil, commutator segments 304 and 312, brush 306, contacts of relays 302 and 301 to ground so that coil 303 is maintained energized to permit the coil 303 to remain energized with coil 310 when position ½ is reached for the plunger to stop at said magnetic center of these two coils. The plunger will remain in this position ½ until the pulsing relay 301 is again energized when the circuit through brushes 306 and 307 is opened at the contacts of relay 301 so that at this time the circuit for coil 303 is broken at the back contacts of relay 301. However, by that time the brush 305 has come in contact with commutator segment 314 so that the coil 310 is maintained operated from battery through the winding of this coil, commutator segment 314, brush 305 to ground at relay 302. Coil 310 advances the plunger to the magnetic center of this coil to position marked 1 and the plunger will now remain in this position until the second impulse is received. Should a second impulse be received, these operations are repeated as follows: When the relay 301 releases on the second impulse a circuit is completed for coil 316 from battery through the winding of this coil, commutator segment 317, brush 307, contacts of relay 302 and 301 to ground. This advances the brushes 305 to 307 to position marked 1½ and the circuit completed over brush 306 and segment 318 maintains coil 310 operated. When relay 301 then reoperates this circuit for coil 310 is broken and as at that time the brush 305 will engage commutator segment 320 coil 316 is maintained energized from ground at contacts of relay 302, and thus advancing the brushes to position marked 2. If no other impulses are received, the plunger will remain in this position the wipers 2 will rest at the second level of terminals in bank 1. A ground may at this time be connected at the sleeve 322 for maintaining coil 316 operated to maintain the plunger in this position or if this ground connection is not maintained, the arrangement may be made as shown in Fig. 1 to have the release magnet pawl 13 maintain the shaft 3 in this position.

The commutator coil arrangement shown in Fig. 8 may now be used for hunting for an idle line in the selected level. For example, if the switch shown in Fig. 1 is used, as soon as the brushes have been advanced to the desired level, circuits may be prepared for the operation of relays 350 and 351. In this arrangement the commutator segments such as 352, 353 and 354, etc. are connected with the succeeding sleeve terminals of succeeding outgoing lines. In this case, therefore, when relays 350 and 351 are operated, relay 350 closes a circuit for the first coil 355 from battery through the winding of this coil, commutator segment 356, brush 357, to ground at the contacts of relay 350. This advances the plunger to the magnetic center of coil 355 marked 1 and the plunger will remain in this position if the first line is idle as the brushes of the switch will now land on the first set of terminals including the sleeve terminal which has been shown in this figure and marked 358. However, if this first line is busy, the circuits closed by relay 351 cause the energization of coil 359 from battery, winding of this coil, commutator segment 360, brush 361, contacts of relay 351, brush 362, commutator segment 352, sleeve terminals

358 to ground. This will advance the plunger to the magnetic center between the two coils 355 and 359. This position is marked 1½. Just before the brushes arrive at this position, it will be noted that the circuit for coil 355 is broken at segment 356 but the brush 365 is now engaged at the segments 367 so that coil 359 is maintained energized to ground on brush 365. Thus, the brushes are advanced through the position 1½ to position 2 as the original circuit established by relay 351 is now closed for coil 359 from battery through this coil, commutator segments 369, brush 357 to ground at relay 350. The plunger will now be maintained at the magnetic center of coil 359 if the second trunk of the line is idle as there will be no ground on the corresponding sleeve terminal 370. Thus, the plunger may be advanced to connect the brushes 2 to the terminals of an idle line.

What is claimed is:

1. In a multiposition switching device, a series of electromagnetic coils, there being one coil for each position of said switch, an electromagnetic plunger in position to be acted upon by said coils when energized, means for energizing a first coil to advance the plunger a first step, for then energizing the second coil followed by the deenergization of the first coil, and for repeating the operation of energizing a succeeding coil and deenergizing a preceding coil to advance said plunger one step for each such repeated operation, and means associated with said plunger for establishing succeeding electrical connections.

2. In a multiposition switching device, a series of solenoids arranged on a common axis, there being one coil for each position of said switch, an electromagnetic plunger in position to be acted upon by said solenoids to travel through the same in succession, means for energizing a first solenoid to advance the plunger to the magnetic center of said first solenoid, for then energizing a second solenoid to advance the plunger to the magnetic center of both said solenoids, followed by the deenergization of the first solenoid to advance the plunger to the magnetic center of the second solenoid and then repeating the operations of energizing a succeeding solenoid and deenergizing a preceding solenoid to advance the plunger accordingly through said magnetic centers, and means associated with said plunger for establishing separate electrical connections at each instant the plunger is suspended at the magnetic center of each solenoid during its travels therethrough.

3. In a multiposition switching device, a series of coils arranged one on top of the other on a common axis, there being one coil for each position of said switch, an electromagnetic plunger inside the lower coil, means for energizing said lower coil and then the next coil and then deenergizing the first coil and for continuing such energization and deenergization of succeeding coils to move said plunger from coil to coil, a shaft on said plunger, brushes on said shaft, and a row of terminals over which said brushes may travel when the plunger is advanced through said coils.

4. In a multiposition switching device, a series of solenoids arranged on a common axis, there being one coil for each position of said switch, a plunger in position to be acted upon by said solenoids when energized in succession to travel through said solenoids in succession, a series of commutator plates, a series of brushes associated with said plunger to engage said plates in succession as the plunger is traveling through said solenoids, impulse responsive means and circuit means connecting said impulse responsive means, said solenoids, said plates and said brushes effective to cause said solenoids to be energized through said brushes and said plates to advance the plunger through one solenoid into a succeeding one for each impulse received.

5. In a multiposition switching device, a series of solenoids arranged on a common axis, there being one coil for each position of said switch, a plunger in position to be acted upon by said solenoids when energized in succession to travel through said solenoids in succession, a series of commutator plates, a series of brushes associated with said plunger to engage said plates in succession as the plunger is traveling through said solenoids, impulse responsive means, circuit means connecting said impulse responsive means, said solenoids, said plates and said brushes effective to cause said solenoids to be energized through said brushes and said plates to advance the plunger through one solenoid into a succeeding one for each impulse received, and means controlled by said plunger as it passes through the magnetic center of each solenoid for establishing separate electrical connections.

6. In a multiposition switching device, a series of coils arranged on a common axis, there being one coil for each position of said switch, a plunger in position to be acted upon when said coils are energized to travel through said coils in succession, a relay, means for energizing and deenergizing said relay at intervals, means operating on a first energization of said relay for energizing a first coil and operative on the succeeding deenergization of said relay for energizing a second coil and maintaining said first coil energized and then on the next energization of said relay for deenergizing said first coil and for repeating the energization of a succeeding coil and the deenergization of a preceding coil to advance said plunger through succeeding coils for each such cycle of energization, and deenergization of said relay, and terminals and brushes controlled by the plunger to close connections with succeeding sets of terminals each time a succeeding coil is energized alone.

7. In a switch, a series of vertical shafts, a series of horizontal bars intersecting said vertical shafts, a carriage loosely mounted on said shafts at each intersecting point of said shafts and bars, brushes on each carriage, a terminal bank at each said intersecting point comprising horizontally located semicircular levels of terminals, a magnet for moving each of said bars longitudinally, means responsive to the longitudinal movement of a bar for locking the carriages crossed by said bar to their respective shafts, a horizontally located shaft, pinions on said horizontal shaft, a rack associated with each said vertical shaft, a magnet for each pinion, said pinions, racks and magnets being so located in relation to each other that on the energization of any one of said magnets the associated pinion will be shifted in mesh with the associated rack, a series of coils, means responsive to the energization of said coils in succession for rotating said horizontal shaft to lift the particular vertical shaft whose rack is in mesh with the associated pinion on said horizontal shaft to raise the particular carriage locked to said vertical shaft so that its brushes are placed opposite a corresponding level of terminals of the associated bank, a pinion attached to each vertical shaft,

a horizontal rack, a series of coils associated with said rack, means responsive to the energization of said coils in succession for moving said rack longitudinally, said rack and said pinions on said vertical shafts being so located in relation to each other that when a particular vertical shaft has been lifted and said coils shift said rack longitudinally, said particular lifted vertical shaft is rotated through the pinion by said rack to cause the brushes on the carriage locked to said shaft to rotate over the terminals in the selected level of the associated terminal bank to engage said terminals in succession, and remain engaged with a certain set of said terminals depending on the extent of the rotary movement of said vertical shaft.

8. In a switch, a series of shafts, a series of bars intersecting said shafts, a brush carriage loosely mounted on said shafts at each intersecting point of said shafts and bars, a terminal bank associated with each brush carriage, means for actuating any one of said bars to lock the carriages at the intersecting points of said bar to said shafts, means for lifting any one of said shafts and means for rotating a lifted shaft, said lifted and rotated shaft causing the brushes of its locked carriage to engage a certain set of terminals in the associated bank depending on the extent of the lifting and rotating movements thereof.

9. In a switch, a series of shafts, a series of bars intersecting said shafts, a brush carriage loosely mounted on said shafts at each intersecting point of said shafts and bars, a terminal bank associated with each brush carriage, means for actuating any one of said bars to lock the carriages at the intersecting point of said bar to said shafts, means for lifting any one of said shafts, means for rotating the lifted shaft, said lifted and rotated shaft causing the brushes of its locked carriage to engage a certain set of terminals in the associated bank depending on the extent of the lifting and rotating movements thereof, and means for holding said carriage in engagement with said set of terminals after the said lifted and rotated shaft and actuated bar are returned to normal.

10. In a switch, a series of shafts, a series of bars intersecting said shafts, a brush carriage loosely mounted on said shafts at each intersecting point of said shafts and bars, a terminal bank associated with each brush carriage, means for actuating any one of said bars to lock the carriages at the intersecting points of said bar

to said shafts, a series of solenoid coils, a plunger therein, means for moving said plunger in step through said coils when said coils are energized in succession, means for selectively associating any one of said shafts with said plunger and lifting said shaft when said coils are energized in succession, a second series of solenoid coils and a plunger therein for moving said plunger in steps through said solenoid coils when said coils are energized in succession, means associated with said shafts and said last-mentioned plunger for rotating in steps any one of said shafts after it has been lifted, said lifted and rotated shaft causing the brushes of its locked carriage to engage a certain set of terminals in the associated bank depending on the extent of said lifting and rotating movements.

11. In a multiposition switching device, a series of coils having one coil for each position of said device, said coils arranged on a common axis, a plunger in position to be acted upon when said coils are energized to travel through said coils in succession, a first relay, means to energize and deenergize said relay at intervals, a second relay, said second relay responsive to the first energization of said first relay to energize the first of said series of coils to advance said plunger, distributing means under the control of said plunger, circuits controlled by said second relay and said distributing means, effective in response to each deenergization of said first relay to maintain the energization of the previously energized coil and to energize the succeeding coil to advance said plunger a half step and effective responsive to each subsequent energization of said first relay to maintain the energization of the succeeding coil and to deenergize the previously energized coil to advance said plunger a second half step, and brushes controlled by said plunger to close connections with succeeding sets of terminals at each complete step.

ARTHUR S. DUBUAR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,247,399	Hendrickson	Nov. 20, 1917
1,284,672	Hendrickson	Nov. 12, 1918
1,284,732	Magrath	Nov. 12, 1918
1,296,680	McQuarrie	Mar. 11, 1919