

[54] **MULTI-LEVEL STEP-BY-STEP SWITCH**

[76] Inventor: **A. Lee Reaves, Jr.**, 355 Ruby St.,
Clarendon Hills, Ill. 60514

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[58] Field of Search..... **335/118, 117, 122,
335/108, 109, 110, 111, 136, 123; 200/176**

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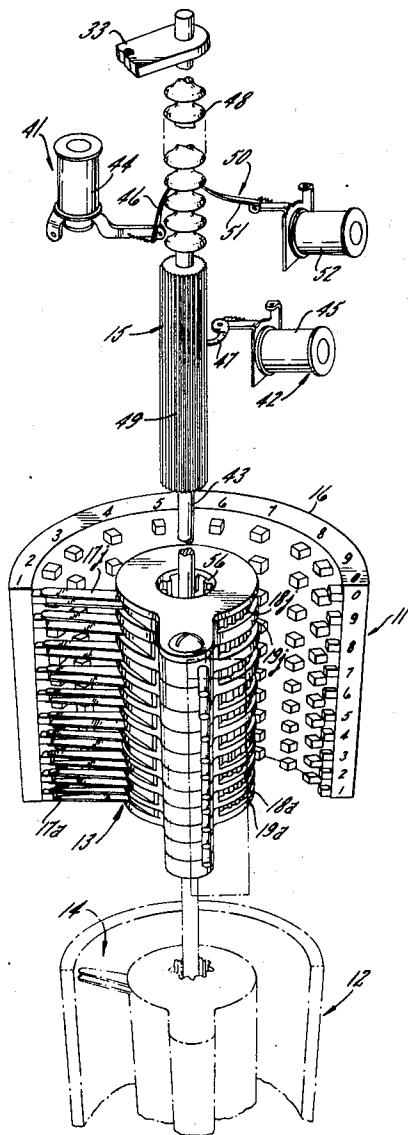
Primary Examiner—Harold Broome

Attorney—C. Frederick Leydig, Franklin M. Crouch
et al.

[57] **ABSTRACT**

A multi-level Step-by-step switch capable of simultaneously serving a plurality of electrical circuits comprises at least one terminal bank with an associated set of brushes. The bank includes several vertically separated rows of contact terminals, and each of the brushes is permanently dedicated to a respective one of the rows. A two motion stepping mechanism provides sequenced vertical and rotary motion for independently positioning the brushes in engagement with selected ones of the contact terminals in their respective associated rows of terminals. One brush is positioned per brush positioning operation, and after each such operation, the stepping mechanism is reset merely by gravity. For additional capacity, as well as for certain specialized applications, a plurality of terminal banks, with respective sets of brushes, may be vertically stacked to be served by a single stepping mechanism. The switch with stacked terminal banks may be configured to operate as a simple step-by-step switch, separate step-by-step switches, or a compound step-by-step switch.

17 Claims, 6 Drawing Figures



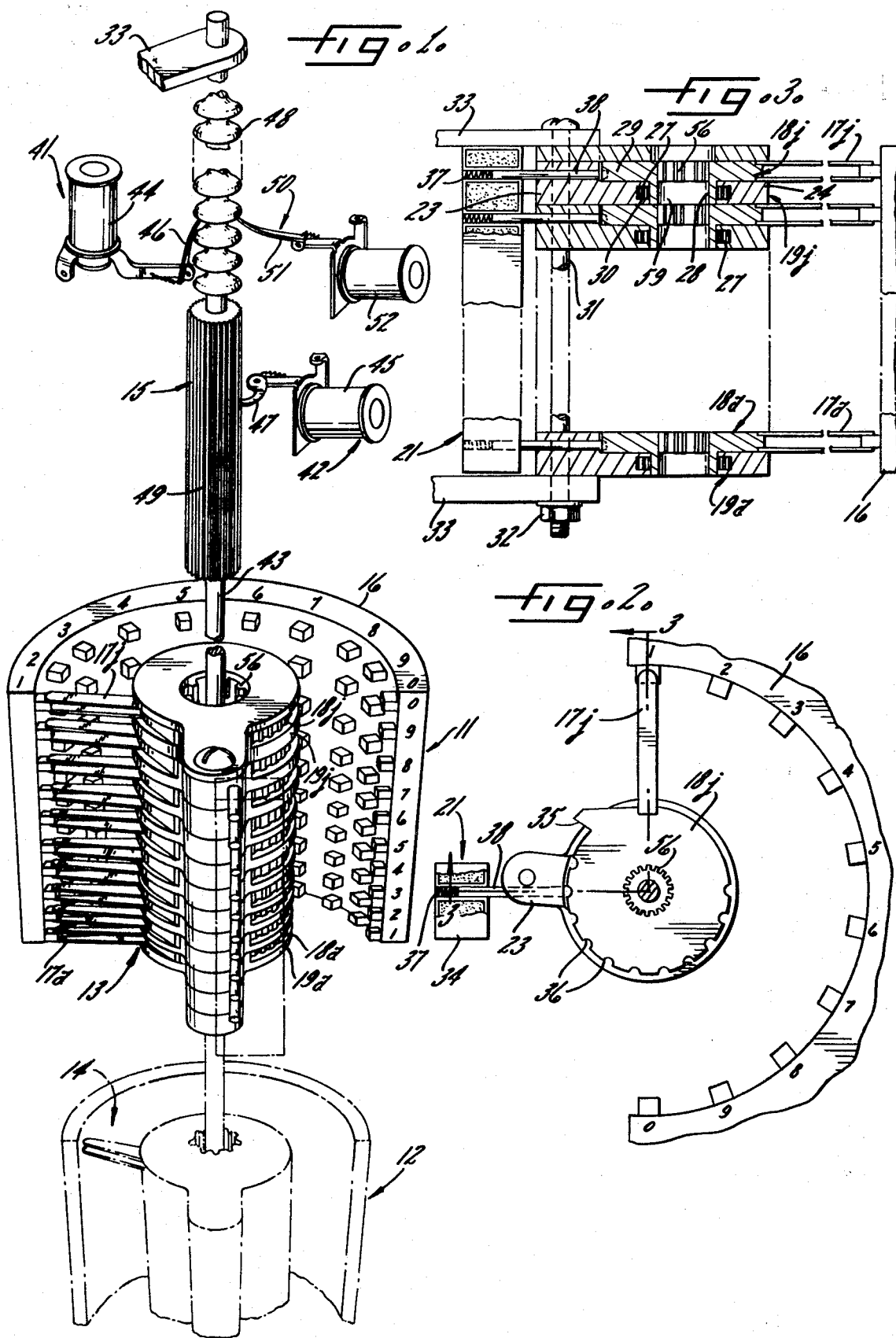


FIG. 4.

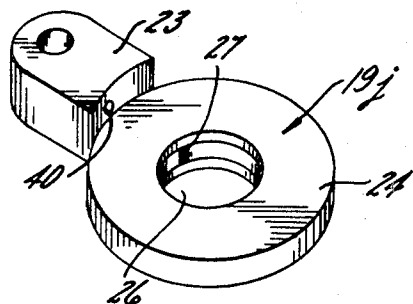


FIG. 5.

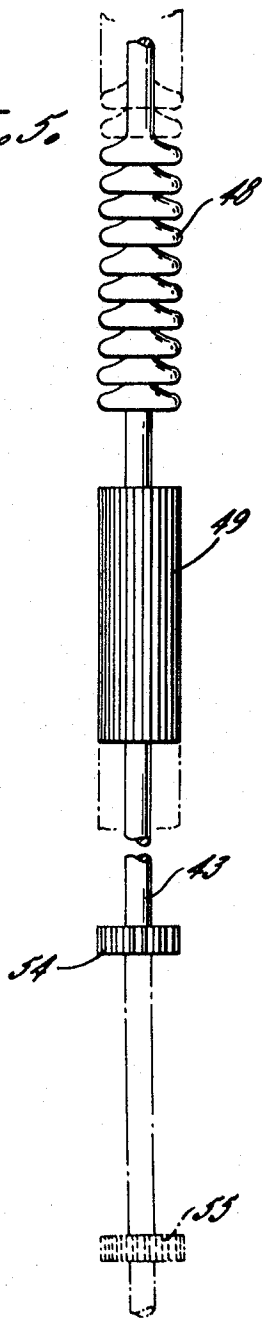
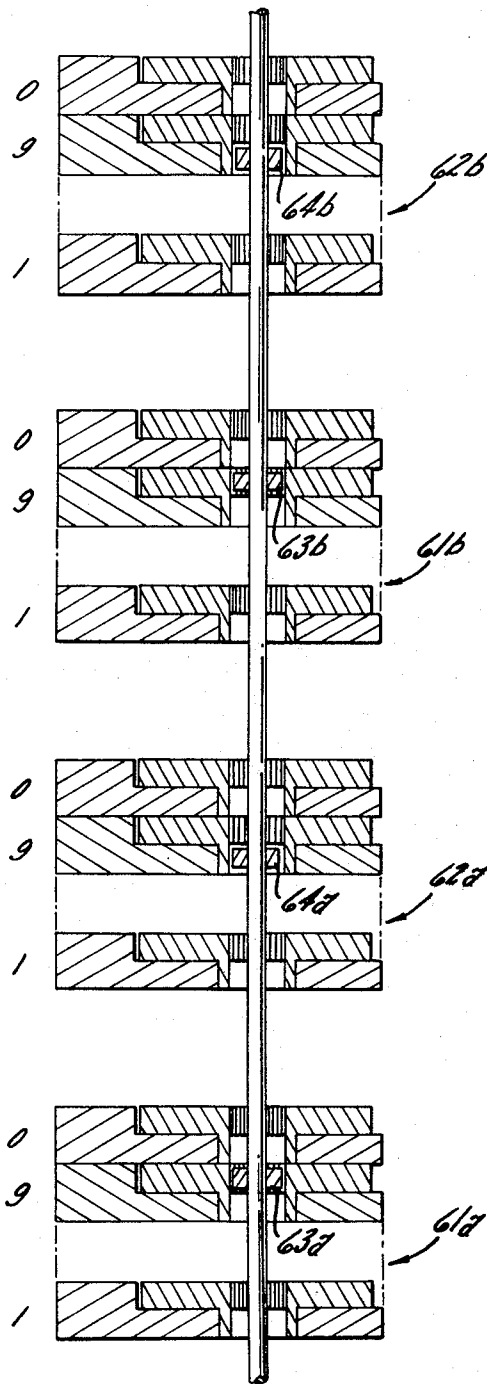


FIG. 6.



MULTI-LEVEL STEP-BY-STEP SWITCH

BACKGROUND OF THE INVENTION

This invention relates, generally, to step-by-step switches and, more particularly, to multi-level step-by-step switches capable of simultaneously serving a plurality of electrical circuits.

There are a wide variety of step-by-step switches, as well as a number of applications for such switches, in the prior art. The principal function of such a switch is to provide an electrical terminal or set of terminals with selective access to any one of a plurality of further terminals or further sets of terminals. To that end, the known step-by-step switches (sometimes also referred to as "stepping switches") typically comprise one or more terminal banks, a respective brush or wiper associated with each such terminal bank, and a stepping mechanism for selectively positioning the brush or brushes. The terminal banks generally comprise several vertically separated rows of contact terminals so that there are multiple levels to the switch, and two motion stepping mechanisms have been developed for so-called multi-level step-by-step switches. Specifically, such stepping mechanisms supply a vertical component of motion followed by a horizontal or rotary component of motion so that a brush may be first moved to any level or row of its associated terminal bank and then moved into engagement with any one of the contact terminals at the selected level of the terminal bank.

Step-by-step switches may comprise only a single terminal bank. It is, however, at least as common for the terminal banks to be grouped or stacked. For example, stacked switches are used in step-by-step telephone switching systems to form the so-called switch train by which the connections for processing and completing a call are established. Specifically, the first stepping switch of such a switch train is a linefinder, the last is a connector, and all intermediate stepping switches are selectors. There are, of course, important distinctions between the functions of such switches and the circuits (sometimes referred to as the "guiding circuits") which are provided to enable the switches to carry out their different functions. Structurally, however, the various types of step-by-step switches of such a switch train are very much the same. That is, the connector and selector switches each usually comprise a pair of terminal banks, one for the tip and ring leads and the other for the sleeve leads, and each of the terminal banks has ten levels or rows of contact terminals with ten terminals per row, so that each switch has a one hundred line capacity. The linefinder switches, on the other hand, each usually have two pairs of terminal banks, with each pair having one bank for the tip and ring leads and another bank for the associated sleeve banks. Again, each terminal bank conventionally includes ten levels or rows of contact terminals with ten terminals per row. However, because there are two pairs of terminal banks, a linefinder switch typically has a two hundred line capacity. As will be appreciated, tip, ring and sleeve lead connections must all be completed to establish a telephone circuit. Thus, step-by-step telephone switching systems may be viewed as a specialized application for step-by-step switches requiring stacking of a plurality of terminal banks.

It is believed that the available step-by-step switches all suffer from the limitation of being able to serve no more than one circuit at a time. That is a very serious

disadvantage, especially for applications in telephone switching systems and the like which call for the ability to simultaneously serve several circuits. The extent of the problem is, perhaps, best illustrated by the tremendous number of switches and related equipment required in a typical step-by-step telephone switching system merely to provide a reasonable probability that any subscriber will be able to obtain service on demand.

SUMMARY OF THE INVENTION

Thus, the primary aim of the present invention is to provide a relatively efficient step-by-step switch for reducing the space and equipment requirements of step-by-step switching systems. More particularly, it is an object to provide a multi-level step-by-step switch which is capable of simultaneously serving a plurality of electrical circuits, but which only requires a single stepping mechanism.

Another object of this invention is to provide a relatively simple and reliable two motion stepping mechanism for a step-by-step switch of the foregoing type. A more detailed object is to provide a two motion stepping mechanism which is automatically reset after each brush positioning operation merely by gravity and without having to be restored to an initial or normal rotary position, so as to be immediately available for a further brush positioning operation.

A further object of the instant invention is to provide a multi-level step-by-step switch having a plurality of vertically stacked terminal banks with respective brush sets which are served by a single stepping mechanism. Specifically, it is an object to provide a step-by-step switch which may alternatively be configured to operate as a simple step-by-step switch such that each brush positioning operation of the stepping mechanism results in the simultaneous and corresponding positioning of a selected brush of each of the brush sets, or as a compound step-by-step switch such that each brush positioning operation results in the simultaneous and corresponding positioning of a selected brush of several, but not all, of the brush sets, or as effectively separate step-by-step switches such that each brush positioning operation results in the independent positioning of a selected brush of a selected brush set.

As will be appreciated, the so-called simple step-by-step switch with a pair of vertically stacked terminal banks is suitable for use as a connector or selector switch in a step-by-step telephone system. The so-called compound step-by-step switch with two pairs of vertically stacked terminal banks is, on the other hand, suitable for use as a linefinder switch. These are, however, merely examples of useful applications for step-by-step switches embodying the present invention and are, therefore, not intended to indicate any limitation on either the configuration or utility of such switches.

BRIEF DESCRIPTION OF THE DRAWINGS

Indeed, other objects and advantages of the invention will become apparent when the following detailed description is read in conjunction with the attached drawings, in which:

FIG. 1 is a simplified perspective view, partly in phantom, of a multi-level step-by-step switch embodying the present invention;

FIG. 2 is a fragmentary plan view of the switch shown in FIG. 1, with the stepping mechanism omitted and the

brushes identically rotated clockwise from their normal off-contact positions for increased clarity;

FIG. 3 is a fragmentary offset vertical section taken axially of the switch along the line 3-3 in FIG. 2 to illustrate the upper terminal bank and its associated set of brushes in more detail;

FIG. 4 is a perspective view of a suitable brush carrier to illustrate the provision made to bias the brushes to normal, disengaged or off contact position;

FIG. 5 is a side elevation of the driven portion of the stepping mechanism for the switch shown in FIG. 1;

FIG. 6 is a fragmentary axial vertical section illustrating the relationship of the terminal banks, brush carriers and drive heads in a compound step-by-step switch constructed in accordance with one of the more detailed aspects of this invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

While the invention is hereinafter described in some detail with reference to certain illustrated embodiments, it is to be understood that the intent is not to limit it to those embodiments. On the contrary, the intent is to cover all modifications, alternatives and equivalents falling within the spirit and scope of the invention as defined by the appended claims.

Turning to the drawings, and particularly to FIGS. 1-5, it will be seen that the invention is principally disclosed for exemplary purposes in connection with a multi-level step-by-step switch configured for applications in step-by-step telephone switching systems. More particularly, as illustrated, the switch comprises two vertically stacked terminal banks 11 and 12, one for the tip and ring leads and the other for the sleeve leads of such a switching system. There are respective sets of brushes 13 and 14 for the terminal banks and a common or shared stepping mechanism 15. Each of the brush sets 13 and 14 includes a plurality of brushes, and each of the brushes is permanently dedicated to a respective level of the switch, as described more fully hereinbelow. Of course, it will be understood that there are other applications for switches embodying the present invention, including some requiring only a single terminal bank.

The terminal banks 11 and 12 are generally conventional and essentially identical, with the possible exception that different types of contact terminals may be used (e.g., split contacts for, say, the tip and ring leads as opposed to simple contacts for, say, the sleeve leads). Hence, although only the upper bank 11 is illustrated in detail, it will be understood that each of the terminal banks comprises several vertically separated, arcuate rows of contact terminals which extend substantially horizontally from the inner face of a generally semi-cylindrical shell 16. The axis of the shell 16 is coincident with the axis of the switch and, consequently, the terminals are all at substantially the same radial distance from the switch axis. Further, the terminals are circumferentially distributed at fixed angular intervals, in vertically aligned columns. There may, of course, be any number of rows and columns of contact terminals per terminal bank, without departing from the invention. In step-by-step telephone switching systems, however, tradition and convenience have dictated the use of a decade based numbering system. Thus, as indicated by the coordinate reference numerals appearing on the upper and right-hand edges of the shell 16 in

certain of the views to permit ready identification of the individual contact terminals (e.g., the terminal 9-2 is the second terminal from the left-hand end of the ninth row), the switch shown has ten rows of terminals per terminal bank with ten terminals in each row. In keeping with accepted practices, the terminal banks 12 and 13 are mounted (by means not shown) on a rigid frame, indicated in fragmentary form at 33. Hence, the terminal banks are held in vertical alignment and there is a predetermined vertical displacement separating their corresponding rows or levels of contact terminals.

In accordance with the present invention, provision is made to permit the switch to simultaneously serve several circuits. To that end, the brush sets 13 and 14 are held in fixed vertical relationship relative to the terminal banks 11 and 12 and comprise respective pluralities of brushes or wipers. The brushes of the brush set 13 are permanently dedicated to respective rows or levels of the terminal bank 11, and the brushes of the brush set 14 are permanently dedicated to respective rows or levels of the terminal bank 12. The maximum capacity of the switch is realized only if all rows or levels of all terminal banks are in use, but there may be occasions in which one or more rows of contacts are free of connections to external circuitry. Nevertheless, it is preferable to have a separate brush for each row of contact terminals of each terminal bank so that the switch may readily be extended to its full capacity. Of course, in the interim, the brush (or, more precisely, the carrier and mount for the brush) for a non-used row of contacts is a suitable alternative to the spacer which would otherwise be required.

The brush sets 13 and 14 are also substantially identical, with the possible exception that different types of brushes may be employed (e.g., one set may have double arm brushes to accommodate split contacts and the other set may have single arm brushes to accommodate simple contacts). Thus, taking the upper brush set 13 by way of example, it will be seen that its brushes 17a, 17j are fixed to and extend generally horizontally or radially from respective carriers 18a, 18j which are, in turn, seated on respective mounts 19a, 19j. The brush carriers 18a, 18j are biased so that the brushes 17a, 17j are all urged toward normal, off-contact, rest positions. Specifically, the rest positions for the brushes 17a, 17j are vertically aligned at the left-hand side of the terminal bank 11 as viewed in FIG. 1 and are displaced one rotary step from the first column of contact terminals.

The brush carriers 18a, 18j are independently rotatable about the axis of the switch and are provided with respective detent mechanisms, such as indicated generally at 21. Hence, the brushes 17a, 17j may be independently positioned to simultaneously serve different circuits. For example, the carrier 18j may be rotated to position the brush 17j in engagement with any of the contact terminals in its associated row of terminals, and the brush 17j will then be held in engagement with that terminal until the detent mechanism 21 for the carrier 18j is released. When the detent mechanism is released, the bias on the carrier 18j will automatically reset the brush 17j by causing the carrier to rotate so as to restore the brush 17j to its normal off-contact position.

More particularly, as best shown in FIGS. 2-4, a suitable brush mount has a generally L-shaped vertical section defined by a mounting ear 23 and a ring-like support plate 24, which has a centrally located circular aperture as at 26. A suitable brush carrier, on the other

hand, comprises a cylindrical sleeve 28 depending from an arcuate flange 29. The brush (say, the brush 17j) is secured to the flange 29 of its carrier 18j, and the flange 29 rides on the support plate 24 of the associated brush mount 19j. The sleeve 28 of the carrier 18j extends into the aperture 26 of the support plate 24 and has a slight clearance from the aperture sidewalls. That arrangement prevents horizontal or radial translation of the carrier 18j relative to its mount 19j, but still permits rotation of the carrier 18j relative to the mount 19j.

The carriers 18a, 18j and the brush mounts 19a, 19j alternate in a sandwich-like assembly which is supported by means of a bolt 31 and a cooperating nut 32 on the same frame 33 as the terminal bank 11. The details of the frame 33 and of the mounting of the terminal bank 11 thereon are not shown because they may be entirely conventional. It is, however, worthy of note that each of the mounting ears 23 has a height selected to substantially equal the vertical distance separating adjacent rows or levels of contact terminals on the terminal bank 11. The support plate 24 of each brush mount and the flange 29 of each brush carrier are, in turn, selected to have a combined thickness or height also substantially equal to the vertical distance separating adjacent levels of the terminal bank. Moreover, as shown, the bolt 31 extends through aligned vertical bores formed in the mounting ears 23, and the axes of the sleeves 28 of the brush carriers 18a, 18j are coincident with the axis of the switch. Hence, as previously mentioned, the brushes 17a, 17j are permanently dedicated to respective levels of the terminal bank 11 and the brush carriers 18a, 18j are independently rotatable about the axis of the switch.

To bias the brush carriers 18a, 18j there are respective bias springs 27, and to define the normal off-contact rest positions for the brushes 17a, 17j there are respective stops 35. More particularly, referring again to the brush carrier 18j for exemplary purposes, it will be seen that there is a step-like stop 35 on the outer periphery of its flange 29 and that a clock-wound spring 27 is seated in a circumferential groove 30 in the sidewalls of the aperture 26 of the support plate 24 of its associated brush mount 19j. The spring 27 is anchored at one end to the bottom of the groove 30 and at its opposite end to the carrier sleeve 28, and is wound so that the carrier 18j is biased, in this instance, to rotate in a counterclockwise direction. The stop 35, on the other hand, is angularly displaced from the brush 17j so that the stop engages the mounting ear 23 of the associated mount 19j to prevent further counterclockwise rotation of the carrier 18j when the brush 17j is in its normal rest position.

As previously mentioned, there are respective detent mechanisms 21 provided for the brushes 17a, 17j to releasably lock the brushes against return or reset movement toward their normal rest positions. The detent mechanisms are selectively actuatable to permit the brushes 17a, 17j to be independently reset. Thus, any one of the brushes may be positioned in engagement with a selected one of the contact terminals of its associated row of terminals and then locked in that position as other brushes are positioned and reset. More specifically, as shown in connection with the brush 17j, a suitable detent mechanism 21 includes a shot pin 38, together with cooperating notches 36 formed in the outer circumferential edge of the associated carrier flange

29. The shot pin 33 is controlled by a solenoid 34 and biased toward the flange 29 by a spring 37. Furthermore, the shot pin extends generally horizontally and is guided through a bore 40 (FIG. 4) provided in the mounting ear 23 of the associated mount 19j, so that the shot pin is held in horizontal alignment with the edge of the flange 29. The notches 36, on the other hand, are spaced about the circumference of the flange 29 at fixed angular intervals corresponding to the intervals separating the contact terminals of the row to which the brush 17j is dedicated. Moreover, the notches 36 are oriented relative to the brush 17j so that successive ones of the notches 36 are brought into alignment with the shot pin 38 as the brush 17j is rotated from its rest position into engagement with the successive contact terminals of its associated row of terminals. Thus, the shot pin 38 seats in one or another of the notches 36 whenever the brush 17j is positioned in engagement with any of the contact terminals of its associated row of terminals. Then, when the solenoid 34 is energized (by means not shown), the shot pin 38 is retracted, thereby permitting the brush 17j to reset to its normal rest position under the influence of the bias applied to its associated brush carrier 18j by the spring 27. Preferably, to avoid having to energize the solenoid 34 when the brush 17j is to be positioned, the shot pin 38 and the cooperating notches 36 cause the detent mechanism 21 to ratchet as the brush 17j is driven away from its rest position. Also, to avoid having the bias spring 37 under extreme compression for excessive periods of time, an additional notch 36 may be provided to seat the shot pin 38 when the brush 17j is in its rest position.

In keeping with one of the more detailed aspects of this invention, the stepping mechanism 15 is capable of independently and selectively positioning the brushes of each of the brush sets 13 and 14, but is nevertheless relatively simple and reliable. Indeed, one of the advantageous features contributing to the simplicity of the stepping mechanism is that it is reset after each brush positioning operation merely by gravity, without having to be returned to a normal or initial angular position, and is then immediately available for another brush positioning operation.

As will be seen, the illustrated stepping mechanism 15 comprises generally conventional ratchet and pawl-type vertical and rotary drives 41 and 42, respectively, for driving a shaft 43, together with a reset mechanism 50 for selectively permitting the driven shaft to drop or reset to a normal rest position. The vertical drive 41 includes a solenoid 44 for stroking a pawl 46 which cooperates with a vertical ratchet gear 48. Similarly, the rotary drive 42 includes another solenoid 45 for stroking a pawl 47 which cooperates with a horizontal ratchet gear 49. The gears 48 and 49 are integral with the shaft 43, which extends axially of the switch and passes through the sleeves 29 of the carriers for the brushes of the upper and lower brush sets 13 and 14. Suitably, the shaft 43 is supported by the switch frame 33. For example, there may be a stop (not shown) on the lower portion of the shaft 43 to bottom against the lower inner face of the frame 33 to thereby arrest the downward or reset motion of the shaft in a predetermined normal rest position, and the shaft 43 may be contained by upper and lower journals (also not shown) on the frame 33 and be elongated so that its upper and lower ends extend beyond the frame 33 at all vertical positions of

the shaft. As shown, the reset mechanism 50 comprises a pawl 51 which is normally engaged with the vertical ratchet gear 48, and a control solenoid 52 for selectively disengaging the pawl 51.

To carry out this aspect of the invention, the driven shaft 43 carries respective drive gears 54 and 55 (FIG. 5) for the brush sets 13 and 14, and the sleeves 28 of the brush carriers are all internally splined as at 56. The pitch of the drive gears 54 and 55 matches the pitch of the splines 56, so that gears may be brought into meshing engagement with the internal splines of any selected ones of the brush carriers of the respective brush sets. Further, the angular intervals between successive teeth of the ratchet gear 49, successive teeth of the drive gears 54 and 55, and successive teeth of the splines 56 are all selected to equal the angular interval between the successive columns of contact terminals as best shown in FIG. 2. Thus, each time the rotary stepping solenoid 45 is energized or pulsed (by means not shown), the pawl 47 is stroked to rotate the shaft 43 through a fixed angular increment precisely equal to the angle separating successive contact terminals. The movement is, of course, transmitted via the drive gears 54 and 55 and the splines 56 of the brush carriers meshingly engaged therewith to selected ones of the brushes, so that the brushes are advanced a step at a time into engagement with successive ones of the contact terminals of their associated rows of contacts. Moreover, since the shaft 43 is rotated in fixed angular increments equal to the angular interval between successive teeth of the splines 56, the teeth of all of the splines 56 are aligned regardless of the angular position in which the shaft 43 may come to rest. Accordingly, it will be understood that when the solenoids 44 and 52 are simultaneously actuated to disengage the pawls 46 and 51 from the vertical ratchet 48, the shaft 43 is pulled or reset to its normal rest position merely by gravity.

The drive gears 54 and 55 may be separately or simultaneously brought into meshing engagement with selected brush carriers of the brush sets 13 and 14, respectively. In the former case the switch functions as a simple step-by-step switch, whereas in the latter case the switch effectively functions as separate step-by-step switches. The configuration employed if the switch is to be used as separate step-by-step switches will become apparent when a compound switch is discussed hereinafter. Concentrating for now, therefore, on the so-called simple step-by-step switch, it will be seen that for that application the pitch of the vertical ratchet gear 48 is selected to match the vertical displacement between successive rows of contact terminals, the drive gears 54 and 55 are vertically separated from one another by a distance equal to the distance between corresponding rows or levels of the terminal banks 11 and 12, and the normal rest position for the driven shaft 43 is selected so that the gears 54 and 55 are displaced below the lowermost brush carriers of the brush sets 13 and 14, respectively, by a distance equal to the vertical displacement between the successive rows of contacts. Under those conditions, each time the solenoid 41 is energized or pulsed (by means not shown) to stroke the vertical ratchet 48, the shaft 43 is stepped upwardly through a fixed vertical distance to advance the drive gears 54 and 55 into meshing engagement with the brush carrier for the brushes at corresponding levels of the terminals banks 11 and 12, respectively. As previously mentioned, if the solenoids 41 and 52 are simultaneously

actuated, the shaft 43 will reset rather than advance the drive gears.

In passing it is, perhaps, worth noting that to position the selected brush or brushes, without changing the positions of the other brushes, the vertical and rotary stepping solenoids 44 and 45 are energized in order. Thus, during each brush positioning operation, the driven shaft 43 has a vertical component of motion followed by a rotary component of motion. The stepping mechanisms of prior art step-by-step switches are similarly sequenced, although for different reasons. Hence, a detailed discussion of a typical provision made to carry out the sequencing is not necessary.

As described above, the step-by-step switch is, for example, suitable for use as a connector or selector switch of a step-by-step telephone switching system. Thus, attention may be turned to FIG. 6 and an alternative configuration permitting the switch to be employed, for example, as a linefinder switch. In the alternative configuration illustrated by FIG. 6, the switch has a lower pair of terminal banks (not shown) and an upper pair of terminal banks (also not shown), with respective brush sets 61a, 61b and 62a, 62b. Further, the driven shaft 43 carries respective drive gears 63a, 63b, 64a and 64b for the brush sets. The terminal banks are generally similar to the terminal banks 13 and 14 (FIG. 1). However, the pitch of the vertical ratchet gear 48, the vertical displacement between the terminal banks, and the vertical displacement between the drive gears 63a, 63b, 64a and 64b are selected to cause the switch to function as a compound step-by-step switch.

More particularly, the switch is configured so that each time the vertical stepping solenoid 44 is pulsed to stroke the pawl 46, the driven shaft 43 is shifted upwardly by a distance equal to one half the vertical displacement between the successive rows of contact terminals on any of said terminal banks. The drive gears 63a and 63b are vertically displaced from one another on the driven shaft 43 by a distance equal to the vertical displacement between corresponding levels of the lower terminal banks. Likewise, the drive gears 64a and 64b are vertically displaced from one another on the shaft 43 by a distance equal to the vertical displacement between corresponding levels of the lower terminal banks. There is, however, an additional offset between the drive gears 63a and 63b for the lower terminal banks, on the one hand, and the drive gears 64a and 64b for the upper terminal banks, on the other hand. Specifically, the offset is selected so that when the drive gears for one, say, the lower group of terminal banks are at corresponding levels of those terminal banks, the drive gears for the other or upper terminal banks are displaced from the corresponding levels of such terminal banks by one-half of the separation distance between successive rows of contact terminals. Moreover, as best shown in FIG. 3, the splines 56 are confined to the upper halves of the brush carrier sleeves 28 or, in other words, have an axial length equal to one half of the separation distance between successive rows of contact terminals. Hence, it will be understood that as the driven shaft 43 is stepped upwardly, the drive gears 63a, 63b and 64a, 64b for the lower and upper terminal banks are alternately brought into meshing engagement with the splines 56 of the brush carriers for the brushes at corresponding levels of the two terminal banks. Of course, the normal rest position for the driven shaft 43 may be selected so that, when the stepping mechanism

15 is reset, the drive gears for, say, the upper terminal bank are displaced beneath the lowermost levels of their respective terminal banks by a distance equal to the aforementioned separation distance of successive rows of contact terminals, while the drive gears for the other or lower group of terminal banks are vertically displaced beneath the lowermost levels of their respective terminal banks by one-half the separation distance.

CONCLUSION

It will now be appreciated that the present invention provides a multi-level step-by-step switch capable of simultaneously serving a plurality of circuits, but still having a relatively simple stepping mechanism. The switch may comprise stacked terminal banks and, moreover, it may then be alternatively configured to operate as a simple step-by-step switch, a compound step-by-step switch, or even effectively separate step-by-step switches.

I claim as my invention:

1. A step-by-step switch capable of simultaneously serving a plurality of electrical circuits, said switch comprising the combination of:

a terminal bank having several columns and rows of contact terminals extending toward and disposed at a constant radial distance from a predetermined axis, with successive ones of said columns being angularly displaced about said axis by a predetermined angular interval and with successive ones of said rows being vertically displaced by a predetermined separation distance;

a plurality of brushes extending radially from said axis, with each of said brushes being mounted for rotation about said axis and being horizontally aligned with and permanently dedicated to a respective one of said rows, the brushes being mounted on respective carriers having internally splined sleeves of predetermined pitch coaxial with said axis; and

drive means for selectively and independently rotating said brushes about said axis, whereby the brushes may be separately positioned to serve different circuits, said drive means including a shaft extending along said axis, a drive gear fixed to said shaft and having a pitch substantially equal to said predetermined pitch, and vertical and rotary drives for vertically and angularly advancing said shaft a step at a time and in sequence to first bring said drive gear into meshing engagement with the splined sleeve of the carrier for a selected one of said brushes and for then rotating the selected brush about said axis.

2. The switch of claim 1 wherein said shaft is vertically displaced on each vertical step by a distance equal to said separation distance and angularly displaced on each rotary step by an angle equal to said angular interval; and further including respective means for selectively resetting said brushes to normal rest positions angularly displaced about said axis from the first of said columns by said angular interval, and means for selectively resetting said drive means to a normal rest position with said gear vertically displaced beneath the lowermost of said rows by a distance equal to said predetermined separation distance, whereby said gear is advanced on successive ones of said vertical steps into meshing engagement with the splined sleeves of the carriers for successive ones of said brushes and the se-

lected brush is angularly advanced on successive ones of said rotary steps into engagement with successive contact terminals of its respective row.

3. The switch of claim 2 wherein said means for selectively resetting said brushes include respective means for biasing said carriers to rotate said brushes toward said normal rest positions, and respective means for releasably locking said carriers to prevent rotation of said brushes toward said positions, and wherein said means for selectively resetting said drive means includes means for releasably locking said shaft against downward movement.

4. The switch of claim 1 wherein said vertical drive includes a first ratchet gear on said shaft, a first pawl cooperating with said first gear and a first control solenoid coupled to stroke said first pawl to vertically step said shaft upwardly a step at a time, with said first gear having a pitch selected so that the shaft is advanced on each of said vertical steps through a distance equal to said separation distance; said rotary drive includes a second ratchet gear on said shaft, a second pawl cooperating with said second gear, and a second control solenoid coupled to stroke said second pawl to angularly step said shaft about said axis a step at a time, with said second gear having a pitch selected so that shaft is advanced on each of said angular steps through an angle equal to said angular interval.

5. The switch of claim 4 wherein the pitch of said splines is selected to match the angular interval between successive columns of contact terminals so that the splines of the respective sleeves vertically align with one another after any one of said brushes has been positioned, whereby the drive means may then be reset merely by gravity and is then immediately available to position any other of said brushes that is still in its normal rest position.

6. A step-by-step switch capable of simultaneously serving a plurality of electrical circuits, said switch comprising the combination of:

a pair of vertically aligned terminal banks including respective columns and rows of contact terminals disposed at a constant radial distance from a predetermined axis, with successive ones of the columns of each of said terminal banks being angularly displaced from one another about said axis by a predetermined angular interval, successive ones of the rows of each of said terminal banks being vertically displaced from one another by a first predetermined separation distance, and corresponding rows of the respective terminal banks being vertically displaced from one another by a second predetermined separation distance;

respective brush sets associated with said terminal banks, with each of said sets including a plurality of brushes mounted for rotation about said axis in horizontal alignment with respective ones of the rows of the associated terminal bank, said brushes being mounted on respective carriers having internally splined sleeves of predetermined pitch coaxial with said axis; and,

drive means for selectively and independently rotating the brushes of each of said sets, whereby the brushes of each set may be separately positioned to serve different circuits, said drive means including a shaft extending along said axis and through the sleeves of said carrier, respectively, drive gears for said brushes sets fixed to said shaft, with each of

said gears having a pitch substantially equal to said predetermined pitch, and vertical and rotary drives for vertically and angularly advancing said shaft a step at a time and in sequence to first bring the drive gear for at least one of said brush sets into meshing engagement with the splined sleeve of said carrier for a selected one of the brushes of said one set and for then rotating the selected brush about said axis.

7. The switch of claim 6 wherein said second separation distance and said drive means are selected so that the brushes for corresponding rows of said terminal banks are simultaneously and identically positioned by said drive means.

8. The switch of claim 6 wherein said second separation distance and said drive means are selected so that the brushes for corresponding rows of said terminal banks are separately and independently positioned by said drive means.

9. The switch of claim 6 wherein the sleeves of said carriers have corresponding portions which are splined, with each of said splined portions having an axial length approximately equal to one half of said first separation distance; and said drive gears are vertically displaced on said shaft a distance approximately equal to said second separation distance, whereby said drive means simultaneously and identically positions brushes for corresponding rows of said terminal banks.

10. The switch of claim 9 further including respective means for biasing said brushes to normal rest positions angularly displaced from the first columns of contact terminals on said terminal bank by said angular interval, and respective means for releasably and selectively locking said brushes against movement toward said rest positions.

11. The switch of claim 10 wherein each of said splined portions is selected to have a pitch substantially matching said predetermined angular interval so that said shaft may be reset to a normal lower rest position merely by gravity, and further including means for releasably locking said shaft against downward movement to prevent said shaft from being prematurely reset.

12. The switch of claim 6 wherein the sleeves of said carriers have corresponding portions which are splined, with each of said splined portions having an axial length approximately equal to one half of said first separation distance; said drive gears are vertically displaced on said shaft a distance offset from said second separation distance by approximately one half of said first separation distance; and said shaft is vertically displaced on each vertical step a distance approximately equal to one half of said first separation distance to thereby permit a selected brush of a selected brush set to be positioned independently of the brushes of the other brush set.

13. The switch of claim 12 further including respective means for biasing said brushes to normal rest positions angularly displaced from the first columns of contact terminals on said terminal bank by said angular interval, and respective means for releasably and selectively locking said brushes against movement toward said rest positions.

14. The switch of claim 13 wherein each of said splined portions is selected to have a pitch substantially matching said predetermined angular interval so that said shaft may be reset to a normal lower rest position

merely by gravity, and further including means for releasably locking said shaft against downward movement to thereby prevent said shaft from being prematurely reset.

15. A step-by-step switch capable of simultaneously serving a plurality of electrical circuits, said switch comprising the combination of

first and second groups of vertically aligned terminal banks, with each of said groups including a pair of terminal banks and each of said banks having respective rows and columns of contact terminals disposed at a constant radial distance from a predetermined axis with successive ones of said rows vertically displaced from one another by a first separation distance, successive ones of said columns being angularly displaced from one another about said axis by a predetermined angular interval, and corresponding rows of the terminal banks of each of said groups being vertically displaced from one another by a second separation distance;

respective brush sets associated with said terminal banks, with each of said brush sets including a plurality of brushes extending radially from respective carriers, said carriers being mounted for rotation about said axis and having respective sleeves coaxial with said axis, said sleeves each having corresponding internally splined portions, with each of said splined portions having an axial length approximately equal to one-half of said first separation distance; and

a drive means including a shaft extending axially of said switch and through the sleeves of said carriers, respective drive gears for said brush sets fixed to said shaft, with the gears for the brush sets for each group of terminal banks being vertically displaced from one another by said second separation distance and from the gears for the brush sets of the other group of terminal banks by a third separation distance offset from said second separation distance by approximately one-half said first separation distance; and vertical and rotary drives for vertically advancing said shaft a step at a time and in sequence, with said shaft being vertically displaced on each vertical step a distance substantially equal to one-half said first separation distance on each angular step through an angle substantially equal to said angular interval, whereby brushes at corresponding levels of any selected group of said terminal banks may be simultaneously and identically positioned independently of the brushes for the other group of terminal banks.

16. The switch of claim 15 further including respective means for biasing said brushes to normal rest positions angularly displaced from the first columns of contact terminals on said terminal bank by said angular interval, and respective means for releasably and selectively locking said brushes against movement toward said rest positions.

17. The switch of claim 16 wherein each of said splined portions is selected to have a pitch substantially matching said predetermined angular interval so that said shaft may be reset to a normal lower rest position merely by gravity, and further including means for releasably locking said shaft against downward movement to thereby prevent said shaft from being prematurely reset.