

Nov. 14, 1944.

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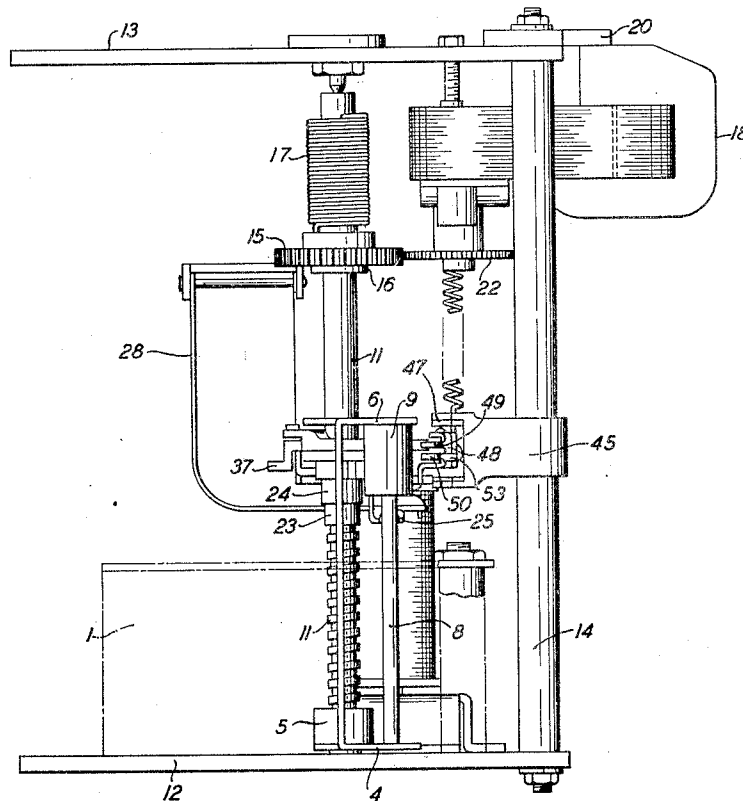
2,362,632

SELECTOR SWITCH

Filed Feb. 10, 1943

5 Sheets-Sheet 2

FIG. 3



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SELECTOR SWITCH

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FIG. 4

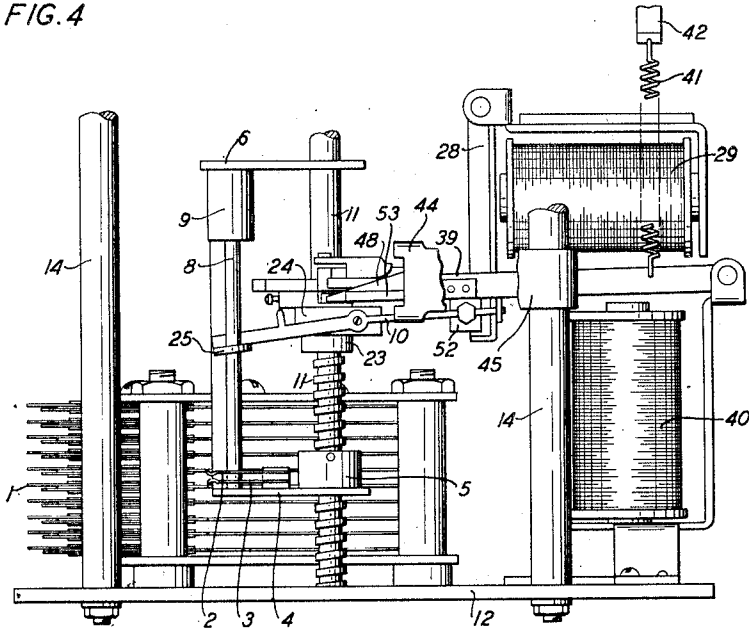
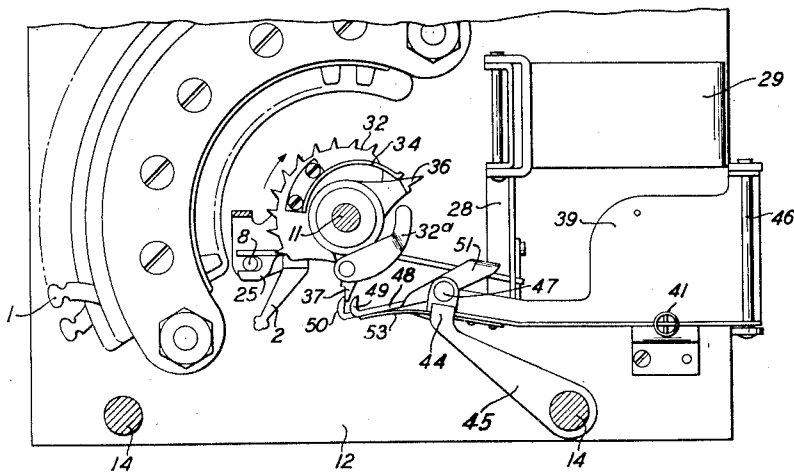


FIG. 5



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FIG. 6

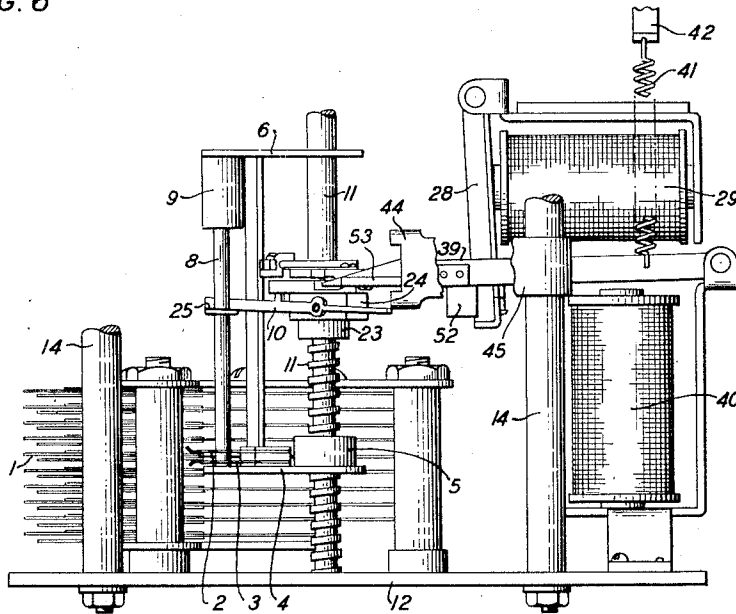
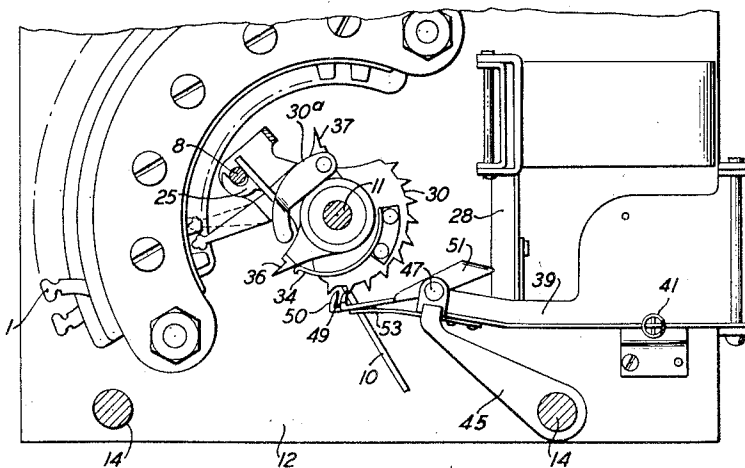


FIG. 7



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FIG. 10

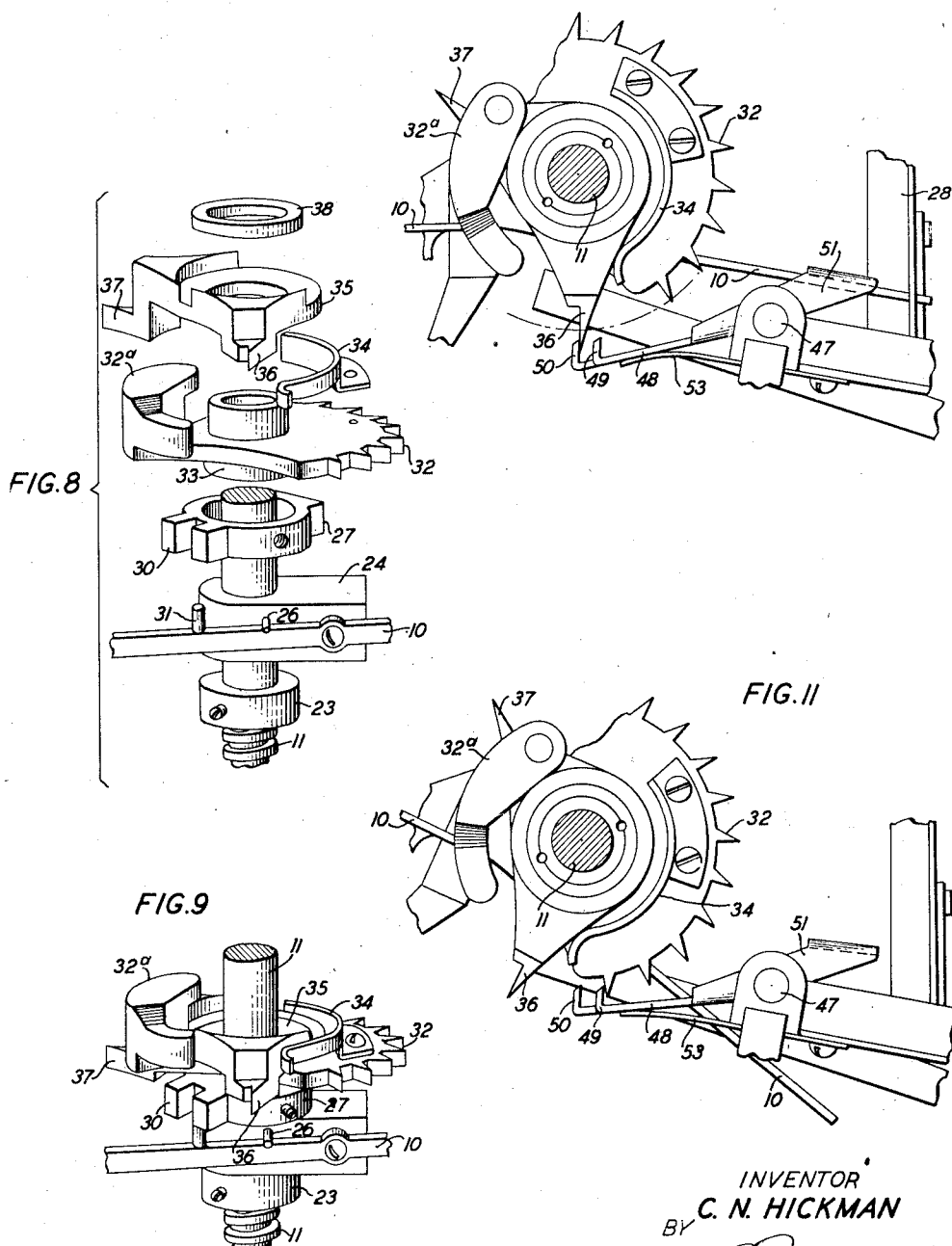


FIG. 11

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UNITED STATES PATENT OFFICE

2,362,632

SELECTOR SWITCH

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Application February 10, 1943, Serial No. 475,380

6 Claims. (Cl. 179—27.52)

This invention relates to telephone systems and more particularly to an improved and simplified form of automatic switching apparatus for use in automatic or semi-automatic telephone systems.

In step-by-step telephone systems employing a two-movement automatic switching apparatus, it is customary to employ two slow acting relays and two stepping magnets to control the setting and releasing of the switching apparatus.

The main feature of this invention is a switch in which a single magnet responsive to line impulses controls its movement in both the translatory and rotary directions either for controlled selective positioning or for "hunting" operations.

Another feature of the invention relates to a novel motion-controlling device in the switch by means of which the rotary motion of the switch shaft is converted into a translatory movement of the brush carriage and by which, at the appropriate time, the carriage is locked to the shaft in order to partake of the latter's rotary motion in the terminal row to which the carriage has been moved.

These and other features of the invention will be more readily understood by reference to the following detailed description in connection with the attached drawings and appended claims.

In the drawings,

Fig. 1 shows a front elevation of one embodiment of the switch of the present invention with the brush carriage in the normal position, said embodiment being a structure particularly adapted for step-by-step vertical and rotary movements of the brush carriage;

Fig. 2 shows a plan view of the switch with the brush carriage in the normal position, taken along the section line 2—2 of Fig. 1;

Fig. 3 shows a side view of the switch with the terminal bank indicated only in outline;

Fig. 4 is identical in view to the lower part of the switch structure which is shown in Fig. 1 except that the brush carriage is shown elevated to a vertical level;

Fig. 5 shows a plan view of the portion of the switch shown in Fig. 4, to more especially illustrate the position of the motion-controlling device during vertical operations;

Fig. 6 is a front elevation of the lower part of the switch shown in Fig. 4, with the brush carriage rotated within a terminal level;

Fig. 7 shows a plan view of the portion of the switch shown in Fig. 4, to more especially illus-

trate the position of the motion-controlling device during rotary operations;

Fig. 8 shows an "exploded" view of the various parts of the motion-controlling device;

Fig. 9 shows the motion-controlling device in assembled form;

Fig. 10 shows a plan view of the motion-controlling device as set to control the elevation of the brush carriage, while

Fig. 11 shows a plan view of the motion-controlling device as set to control the rotary stepping of the brush carriage.

Referring now to the drawings in which identical designations in the different figures refer to identical parts, the numeral 1 designates a terminal bank representing, say, the terminals of a plurality of lines, it being understood that while only one such bank is shown, the switch may be easily adapted for operation with as many terminal banks as desired. These terminal banks may be of any suitable and well-known construction and may comprise (as they do in the present embodiment of the invention) ten arcuate horizontal rows and ten vertical rectilinear rows of terminals. These terminals are arranged to be wiped over by brushes 2 and 3 which are mounted upon the lower plate 4 of the brush carriage, said brush carriage comprising said lower plate 4, the upper plate 6, the coupling rod 8 formed with the stop 9, said rod being rigidly secured between the two plates 4 and 6, and the internally threaded cylindrical member 5 which is supported at the right extremity of the plate 4 and fitted upon the threaded portion of shaft 11. The lower portion of the rod 8 serves as a guide for the key lever 10 while the under-surface of the enlarged portion 9 of the rod serves as a stop for said lever as described hereinafter.

The brush carriage is rotatably supported upon the shaft 11. This shaft has a lower portion which, extending for some distance above the terminal bank, is spirally slotted to permit the cylindrical member 5 to ride upon the thread thereof. The upper portion of the shaft is unthreaded and freely supports the upper plate 6 of the brush carriage through an opening in said plate.

The shaft 11 is rotatably mounted, by suitable bearings, between the lower plate 12 and the upper plate 13 of the switch frame, said plates being securely held together by the four pillars 14. Adjustably keyed to the upper part of the unthreaded portion of shaft 11 is the collar 16 (see Fig. 3) upon which is freely supported the gear

wheel 15 to the hub of which and to the upper end of shaft 11 is anchored the coil spring 17 which can be wound to store energy therein if the shaft 11 is held in a stationary position and the gear wheel 15 rotated with respect thereto. It is obvious that when the spring 17 is tensioned and the shaft 11 is released, the shaft will be rotated by the power stored in the spring 17 until the energy therein is exhausted; and it is further obvious that, as the shaft rotates and the spring unwinds, the shaft may be kept in a state of instant rotation only if the spring is constantly rewound by some source of power connected to the shaft. Since the selection operations of the switch take place through the rotation of the shaft with the energy supplied by the spring 17 as subsequently set forth, means are provided to keep said spring under constant tension. This means is the induction motor unit 18 which is supported on the upper plate 13 of the switch through the medium of the plate 20 secured to said upper plate by the bolts extending through the pillars 14 and the screws 19, the latter being turned into the two internally threaded studs 21 embedded in the field laminations of the motor. Upon the armature shaft of the motor is rigidly mounted the gear wheel 22, and the collar 16 supported upon the shaft 11 is raised or lowered therealong until the teeth of the gear wheel 15 mesh with those of gear wheel 22.

It is now evident that with gear wheels 22 and 15 meshed and shaft 11 held stationary by means shortly to be described, the application of alternating current to the motor 18 will cause the rotation of gear wheel 22 which, in turn, will impart rotation to gear wheel 15. Since this last-mentioned gear wheel revolves freely upon the shaft 11 and since the shaft is assumed to be stationary, the rotation of the motor shaft will cause spring 17 to be wound up in readiness to rotate the shaft 11 when the latter is released. With the shaft 11 in the stationary position, the increments of energy stored in spring 17 exert, of course, an increasing back pressure upon the armature of the motor, and the armature will stop rotating when its turning moment exactly balances the tension in the spring. At this time, although current will still be flowing through the field coil of the motor, its armature will remain stationary and the coil spring 17, of course, will receive no more energy. When the shaft 11 is released and is thereby made free to rotate under the tension stored in the spring, the energy therein is reduced and the turning moment of the motor armature will then exceed the back force of the spring tension. As a consequence the armature again rotates to apply tension to the spring. Thus, by means of motor unit 18, coil spring 17 is kept under constant tension to supply shaft 11 at all times with power for selection operational purposes as set forth below.

The mechanism by which the brush shaft 11 is stepped up to and around the various terminal levels, is a motion-controlling device comprising a ratchet assembly disposed upon the shaft 11 immediately above the unthreaded portion thereof, and a double pawl for operating the same. Referring to Figs. 8 to 11, inclusive, and particularly to Fig. 8 which shows the various parts of the mechanism separated from one another along the shaft 11 upon which they are mounted as an assembly indicated in Fig. 9, the collar 23 is locked to the lowermost section of the unthreaded portion of shaft 11. Above this collar is mounted the clutch member 24, which is free upon the shaft

11. To the front side of the member 24 is loosely pivoted the key lever 10 which, at its extreme left end, terminates in a fork 25 (see Figs. 1, 4 and 6) that straddles the coupling rod 8 and, at its extreme right, ends in a finger which, in the normal position of armature 28 of magnet 29 engages a horizontal V-notch that latches the lever. The key lever is rotatable about its pivot by a spring (not shown) and is held against the tension of the spring when the lever is latched in the notch of armature 28. When, however, magnet 29 is operated and its armature 28 is attracted to the right, the lever is unlatched and the spring frees the lever which now turns clockwise until it strikes the stop 26, at which time, as will be subsequently shown, the pin 31 carried thereby intermediate the fork 25 and the point of suspension will enter the aperture 30 of the member 27 which is so keyed to the shaft 11 directly above the clutch member 24 that, when the key lever 10 is latched, the aperture 30 is slightly to the left of the pin 31.

The ratchet sector 32 is mounted upon a collar 33 which is force-fitted upon the shaft 11, the external diameter of this collar being such as to fit freely within the member 27 and then adjustably keyed thereto in the position above indicated; that is, so that the aperture 30 is normally a little to the left of the pin 31 when the key lever 10 is latched in the armature 28.

The ratchet sector 32 is formed with ten teeth on the arcuate right periphery thereof and a counter-balance weight 32a at the left, said counterweight being formed with a forward and rear stop for the two teeth 36 and 37 of member 35 which is mounted loosely upon that portion of the collar 33 which extends above the ratchet sector 32. The stop member 34 is secured to the rim of the ratchet sector 32 to allow tooth 36 only a limited amount of rotational movement between the forward stop of the counterweight 32a and the stop 34.

The member 35 is so formed that when fitted over the collar 33 as above mentioned, the tooth 36 is in alignment with the ten teeth of the gear sector 32 while the tooth 37, which is formed to project outwardly beyond the rear stop of counterweight 32a, comes below the plane of the teeth of the gear sector and, therefore, below that of tooth 36.

The bushing 38 is fitted into the aperture of member 35 after all of the above elements are put together as described to form the ratchet assembly shown in Fig. 9. From this figure, it will be noted that all members are fixed to the shaft 11 except the clutch member 24 which may be held stationary with respect to any rotation of the shaft during the time that the key lever 10 is latched to the armature 28 and free to turn with the shaft when said lever is unlatched by the operation of this armature.

The vertical and rotary stepping of the brush carriage is obtained by operating ratchet sector 32 by means of the double pawl 48 which is mounted upon the armature 39 of the pulsing magnet 40.

The armature 39 is formed with a forward flange portion to which is hooked one end of the spring 41, the other end of said spring being hooked to the adjustable post 42 suspended underneath the plate 13 through an aperture therein and secured in the suspended position by the bolt 43. The post 42 may be so adjusted as to provide the spring 41 with sufficient tension to cause the armature, when the coil 40 is unenergized, to rest against the back stop 44 which is

formed at the left end of member 45 supported upon the front right pillar 14. The end of the armature remote from the hinged support 46 is formed into a clevis 47 between the arms of which is rotatably supported the double pawl member 48. This member, which is shown in detail in Figs. 10 and 11 in the normal and operated positions, respectively, has an upper short pawl 49 with respect to the pivot 47 and a lower long pawl 50 with respect to said pivot, the teeth of the pawls being otherwise identical. The pawls are disposed one on top of the other and are so positioned that when the armature 39 is normal, the lower pawl 50 is in alignment with tooth 36 and the teeth of the gear sector 32 while, when the armature is in an operated position, the lower pawl 50 is in alignment to engage tooth 37 and the upper pawl is in alignment with but not engaging the teeth of the gear sector. Beyond the hinged support on the clevis 47, the pawl member 48 is formed into an oblique flat portion 51 and a portion 52 extending downwardly therefrom slightly beyond an extension member on armature 28, said portion 52 extending downward therebeyond a distance sufficient to restrict the key lever 10 to a vertical movement when unlatched from armature 28. The armature 39 also has mounted at the left of its front flange the long flat spring 53 which presses the double pawl inwardly against the ratchet sector 32 as described hereinafter.

The pulse magnet 40 is mounted at such a height above the lower plate 12 that when the armature 39 is in the released position against the stop 44, the lower pawl 50 is in alignment with and engaging the recessed left side of tooth 36, said pawl being pressed against the recessed portion of the tooth by the spring 53. Now when current is applied to the motor unit 18 in a direction to rotate its armature in the clockwise direction, the spring 17 is wound up to put the shaft 11 in a position also to move in a clockwise direction if unrestrained. The shaft, however, is restrained by the pawl 50 which, being positioned to the left of tooth 36, will permit the shaft to move only until this tooth abuts against the right surface of the pawl, after which the shaft will be held until, upon the energization of the pulse magnet 40, the armature 39 is pulled downward to disengage the pawl 50 from the tooth 36, whereupon the shaft and ratchet assembly will then be free to rotate in a clockwise direction and elevate the brush carriage a vertical step as described hereinafter.

For horizontal stepping, the upper pawl 49 is adapted to engage the teeth of the gear sector 32 and, in cooperation with the lower pawl 50, to operate as an escapement whereby the entire ratchet assembly except the clutch member 24 is rotated one step for each operation and release of the pulse magnet, as described hereinafter.

Having particularly pointed out the physical elements of the switch, I will now describe those electromechanical movements by which the brush carriage is stepped first vertically and then horizontally over the various levels of the terminal bank.

It will be assumed that alternating current is constantly applied to the motor unit 18 and that, to operate the switch, the current is in a direction to rotate the gear wheel 22 in a clockwise direction. The gear wheel 15 then rotates in the counter-clockwise direction and the spring 17 is wound up until, with the shaft 11 locked against movement by tooth 36 being lodged to the left

of the lower pawl 50, the tension in the spring balances the torque of the motor armature and the two wheels 22 and 15 are restrained from further rotation. Now let it be assumed that the pulse magnet 40 is made to respond to a train of pulses not greater than ten. When the magnet operates on the first pulse, its armature 39 is pulled down and the lower pawl 50 is released from engagement with tooth 36. Since the spring 17 is under constant tension, the shaft 11 will immediately start rotating in a clockwise direction. With the armature 39 in the operated position, the shaft will continue to rotate until the tooth 37 has been carried around into engagement with the lower pawl 50, the brush carriage in the meanwhile having been carried vertically upward by the rotation of the threaded portion of the shaft to cause the cylindrical member 5 to rise therealong and elevate the brush carriage. When the tooth 37 comes into engagement with the right side of the lower pawl 50, the rotation of the shaft is stopped and this condition prevails until the open interval of the pulse deenergizes magnet 40 and restores the armature 39 to its normal position, at which time the lower pawl 50 is cleared of the path of tooth 37 and the shaft 11 will again be rotated to elevate the brush carriage along the threaded portion of the shaft until the lower pawl 50, which is now in alignment with tooth 36 and the teeth of the gear sector 32, encounters tooth 36. Inasmuch as the right face of the tooth is curved up to the apex thereof and formed into a rectangular crevice to the left of its apex, and since the pawl is pressed against the surface of the tooth by spring 53, the shaft 11 will continue to rotate, though at a somewhat slower rate, until the pawl drops into the crevice of the tooth, at which time the shaft will be prevented from further rotation until the next pulse again energizes magnet 40 to pull armature 39 down to disengage the pawl 50 from tooth 36. In the time that shaft 11 turns one complete revolution, the brush carriage will have been lifted one terminal level. With each succeeding pulse in the pulse train, the above operations are repeated, the shaft being caused to take one complete turn and the brush carriage being caused thereby to be elevated one terminal level in the terminal bank, the last pulse in the train representing the terminal level in the bank to which the brush carriage is to be raised. In the meanwhile as the spring 17 is unwound by the rotation of the shaft, the motor 18 rewinds it to maximum tension so that there will always be the required amount of power in the spring to actuate the shaft upon being released by the action of the pawl member 48.

Here it may be mentioned that while "off-normal" springs of any kind are not shown in any of the figures of the switch structure, it is obvious that springs which are to be closed as soon as the brush carriage leaves its normal position, for example, may be mounted on the lower plate 12 and controlled by a lever or equivalent device that will operate upon the elevation of the brush carriage to close said springs.

The rotary stepping of the brush carriage in the terminal level to which said carriage has been elevated occurs upon the reception of the second train of pulses by the magnet 40. Prior to the reception of this train of pulses, however, magnet 29 is operated by any suitable circuit means whereupon its armature 28 is drawn to the right. It has been mentioned that the key lever 10 is held latched in a V-notch at the bottom of armature 28. This latch holds the clutch member 24

to which the key lever is pinned from moving in unison with the shaft when the latter rotates to vertically elevate the brush carriage as above described. Now when, upon the operation of magnet 29 armature 28 is moved to the right, the key lever 10 becomes unlatched, moves to the right out of engagement with armature 28, causes the pin 31 to become inserted into the aperture 30 of the member 27, frees the pawl member 48 the extension portion 52 of which is lodged beyond the key lever, and causes the pawl member 48 to turn clockwise about its pivot 47 under the influence of spring 53, thereby pressing both pawls 50 and 49 sufficiently inward to bring them into position to engage the teeth of the ratchet sector 32 although, during the time that the pawl member 48 is held behind the key lever 10 by its extension member 52, sufficient clearance is maintained between the pawls and the teeth of the ratchet sector. The result is that, during the rotation of the ratchet sector 32 on vertical elevation of the brush carriage, the lower pawl 50 will engage the two teeth 36 and 37 of the member 35 as above set forth but the upper pawl 49 which, while the armature 39 of the pulse magnet 40 is in an operated position, lies in the same horizontal plane with the teeth of the ratchet sector, yet is clear of these teeth. But when the key lever 10 is unlatched, the portion 52 of the double pawl member 48 lying in back thereof is freed, and spring 53 can then exert its full pressure against the pawls so that the upper pawl 49 is then brought into operative engagement with the teeth of the ratchet sector.

After the pin 31 of key lever 10 becomes inserted in aperture 30 of the member 27, any rotation of the shaft 11 will obviously involve the rotation of the clutch member 24 and also the rotation of the brush carriage itself since the latter is coupled to the key lever 10 by means of the fork 25 hooked around the coupling rod 8 of said carriage. Hence on the first pulse of the second train of pulses (assumed to be transmitted after magnet 29 has been operated) magnet 40 operates, as described, to move armature 39 downward, whereupon the lower pawl 50 frees tooth 36 to cause the shaft 11 to rotate. However, since the pin 31 of key lever 10 is now in the aperture 30 of the member 27 and clutch member 24 will now rotate with the shaft, the lever will also partake of the rotation of the shaft, and since the lever is also connected to the brush carriage by the fork 25 hooked around the rod 8, it follows that the brush carriage also partakes of the rotation of the shaft. Moreover, since the pawls have been moved inwardly by the action of spring 53 so that the upper pawl 49 engages the teeth of the ratchet sector 32, the shaft 11 will not now be free to keep on rotating until the tooth 37 engages the lower pawl 50 as was the case on the vertical elevation of the brush carriage. In this case the shaft 11 will be stopped as soon as the upper pawl 49 comes into engagement with the first tooth on the ratchet sector, at which time the brush carriage will have been rotated into near engagement with the first group of terminals on the terminal level to which the brush wipers 2 and 3 mounted upon said carriage have been raised. On the release of magnet 40 at the termination of the pulse, the release of armature 39 causes the upper pawl 49 to be raised out of engagement with the first tooth of the ratchet sector 32, and the lower pawl 51 to be raised up to the plane of said ratchet sector. Since the shaft 11 is constantly urged to rotate

by virtue of the force stored in spring 17, said shaft rotates until the second tooth of the ratchet sector is caught by the upper pawl 50. The amount of rotation of the shaft 11 between the first and second tooth in the ratchet sector centers the brush wipers 2 and 3 of the brush carriage upon the first group of terminals in the selected terminal level. Succeeding pulses will reoperate the pulse magnet 40 to cause its armature 39 to lower and raise in succession the two pawls between the succeeding teeth on the ratchet sector, thereby moving the brush carriage over succeeding terminal groups in the selected terminal level, the last pulse of the series positioning the brush carriage on the selected terminal group in the level.

In order to restore the brush carriage to normal, the current in the motor unit 18 is reversed by any suitable means. The tension in spring 17 is now built up to produce a turning force that will urge the shaft to move in the counter-clockwise direction. When the brush has rotated to the left, back to its original position at the raised terminal level, the key lever 10 is again latched in the V-notch of armature 28, the pin 31 of the lever is withdrawn from the opening 30 of member 27, pressure is again exerted against the downwardly projecting portion 52 of the pawl 48 and the pawls are pressed back free of the teeth ratchet assembly. The brush carriage now moves vertically downward until it reaches its normal position.

While the switch of the present invention has been described in connection with its operation as a connector switch responsive to two series of impulses, it will be apparent that it could as well be operated as a selector switch the vertical motion thereof being controlled in response to a single series of impulses and the horizontal movement thereof be controlled automatically in the usual hunting motion.

What is claimed is:

1. A selector switch comprising a threaded shaft, a brush carriage mounted upon said shaft, means for imparting rotary motion to said shaft whereby said brush carriage is moved along the shaft, and means for locking said carriage to said shaft whereby said carriage moves rotatively with said shaft.

2. A selector switch comprising in combination a plurality of terminal rows, a threaded shaft, means for imparting rotary motion to said shaft, a brush carriage mounted upon said shaft, an escapement device secured to said shaft having a pawl cooperating therewith to latch said shaft against rotation, means for operating said escapement device to unlatch said shaft for one revolution thereof whereby said brush carriage is moved along said shaft to a terminal row, restraining means secured upon said shaft and to said brush carriage for maintaining the displaced position of said brush carriage during its movement along said shaft, and means for freeing said restraining means whereby the rotation of said shaft is imparted to said brush carriage.

3. A step-by-step selector switch comprising in combination a plurality of terminal rows, rotatable shaft having a threaded section, a power source connected to said shaft for rotating the same, a brush carriage mounted on the threaded portion of said shaft, a ratchet device, a clutch member and a collar having an opening therein mounted on the unthreaded portion of said shaft, said ratchet device having a pawl member cooperating therewith to secure said shaft against

rotation and said clutch member having a lever pivoted thereon and attached to said carriage, a latching means for securing said lever to prevent said clutch member from rotating with the shaft, means for operating said ratchet device to release said shaft for rotation whereby said brush carriage is moved along said shaft to a terminal row, and means for unlatching said lever to cause said clutch member to partake of the motion of the shaft whereby said lever engages the opening in said collar for communicating the shaft's rotary motion to said brush carriage.

4. A selector switch comprising a bank of terminals arranged in a plurality of parallel rows, a threaded shaft, a brush carriage mounted on said shaft having wiper brushes mounted thereon for selectively engaging said terminals upon the operation of said shaft, means for imparting intermittent rotary motion to said shaft whereby said carriage is moved along said shaft to successive terminal rows, and means for locking said carriage to said shaft whereby the rotary motion of the shaft is imparted to said carriage for causing the brushes mounted thereon to selectively engage cooperating terminals in a selected terminal row.

5. In an automatic switch, a constantly powered threaded shaft, a brush carriage mounted on said shaft, means for locking said brush carriage to said shaft, and an escapement device for controlling the translatory and rotary movement of said shaft comprising a gear sector mounted on said shaft having a first plurality of teeth and a second plurality of teeth and a pawl normally engaged with one of said first plurality of teeth to restrain said shaft from rotation, and means for operating said pawl intermittently first in cooperation with said first plurality of teeth to rotate said shaft whereby said brush carriage is moved along said shaft, and secondly in cooperation with said second plurality of teeth to cause the rotation of said brush carriage in its displaced position after said brush carriage is locked to said shaft.

6. In an automatic step-by-step switch, a

threaded shaft, a brush carriage mounted on said shaft, the pitch of the thread on said shaft being the distance of the one vertical step of said brush carriage, a power source applied to said shaft for applying power constantly thereto, a ratchet device mounted on said shaft for controlling the vertical and rotary stepping of said brush carriage, said ratchet device comprising a teeth sector having thereon as many teeth as there are rotary steps to be taken by said brush carriage, a separate first tooth in the same plane as said teeth sector, a separate second tooth formed on a lower plane than the plane of said teeth sector, and a pulse magnet for operating said ratchet device comprising a double pawl mounted one on top of the other and both mounted on the armature of said magnet, the lower of said pawls being disposed to engage said separate first tooth in the normal position of the armature to prevent the rotation of said shaft, the upper of said two pawls being disposed for alignment with the plane of said teeth sector but normally out of engagement therewith when said armature is operated on a pulse, and said upper pawl being disposed for engagement with said separate second tooth in the operated position of said armature, said shaft rotating between said separate first tooth and said separate second tooth in the operated position of said armature and back to said separate first tooth into engagement with said lower pawl on the release of said armature of the termination of the pulse, said brush carriage being elevated the pitch of one thread on said shaft during the rotation of said shaft during the revolution thereof, and means for locking said brush carriage to said shaft and for pressing said double pawl inwardly whereby upon the subsequent operation of said magnet in response to one or more pulses said upper pawl is brought into engagement with the teeth of said gear sector to operate as an escapement in conjunction with said lower pawl for stepping said brush carriage in a horizontal plane one step for each pulse.

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