

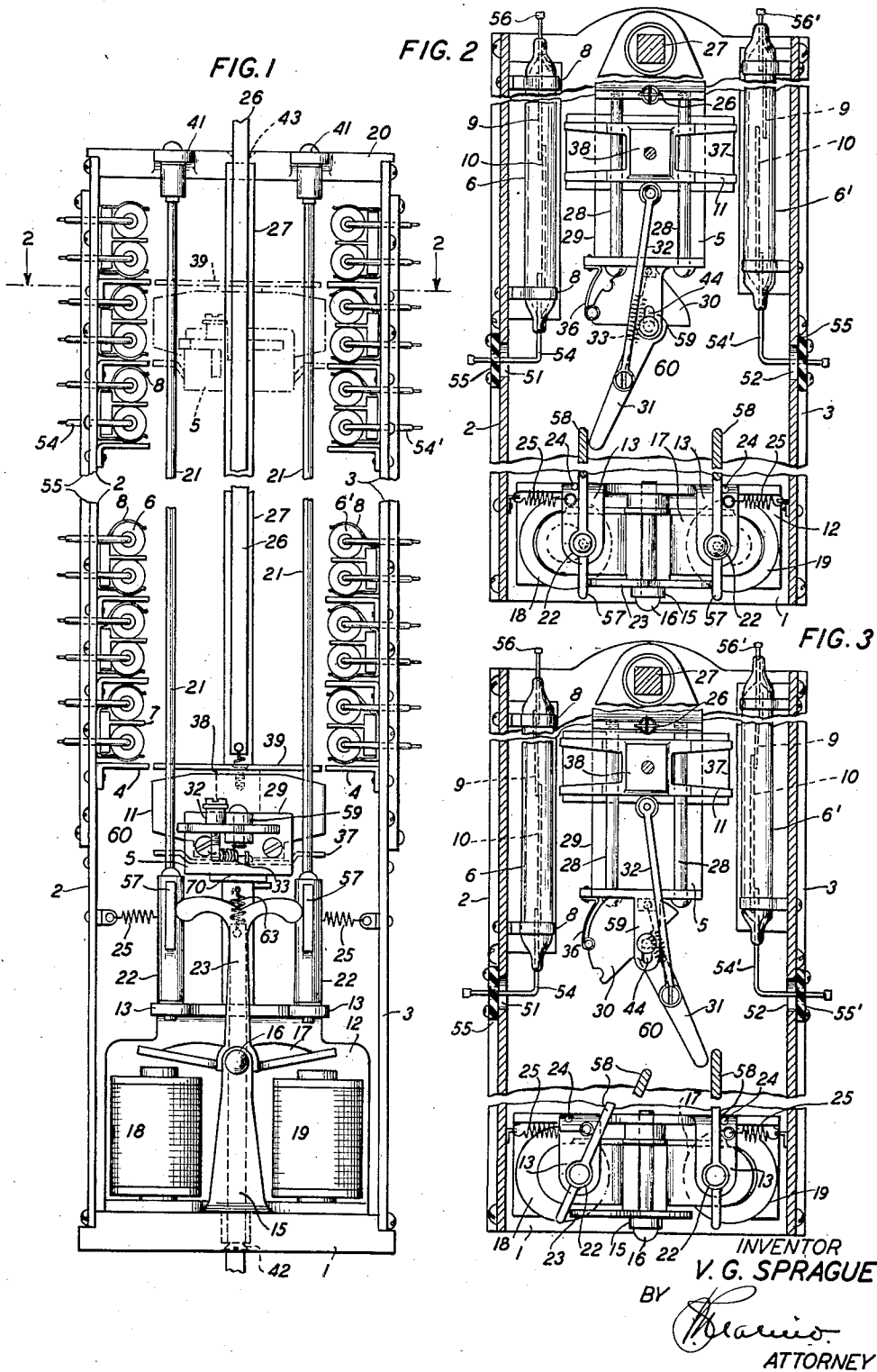
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SELECTOR SWITCH

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SELECTOR SWITCH

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This invention relates to selector switches and more particularly to switches of the terminal hunting type wherein the terminals are made up of contact springs which may be operated like relay contacts.

A feature of this invention is the utilization of the two springs in the relay tube disclosed in Patent 2,289,830, granted to W. B. Ellwood on July 14, 1942, as a pair of terminals of the switch, such tubes being arranged in appropriate groups to designate complete terminal sets and further arranged to be operated by the magnetic field of a moving magnetic element which may be driven into proximity of such groups by driving means such as is shown in the tape-driven switch of Patent 2,123,229, granted on July 12, 1933, to W. W. Carpenter and R. F. Mallina.

Heretofore switching arrangements have been used in which the principle of relay contact operation has been utilized, that is, switching arrangements in which the terminal sets consist of fixed terminals and flexible members moved into engagement with said fixed terminals by a moving mechanical or magnet element.

In my invention, relay tubes of the type above mentioned are utilized as contact terminals. Each of these tubes is an evacuated or gas-filled vessel that contains a pair of flexible contact springs of magnetic material which, being fixed within the tube end-to-end but slightly displaced from one another, are caused to come into engagement by a magnetic field applied to the springs from outside of the tube. By dividing the tube groups which make up the "terminal" sets of the proposed switch into two vertical arrays of subgroups of tubes on either side of a movable magnet element, and by displacing the two arrays of tubes relative to each other and to the magnet element so that the magnetic field may be made to traverse first the tube subgroups of one array and then those of the two arrays, a selector switch is obtained in which the tubes in one array may be used for testing the selectivity of the different tube groups and the tubes in the other array may be used, for example, to complete a talking circuit through the tube subgroup in said other array belonging to the tube group selected.

The invention has been illustrated in the accompanying drawing, in which:

Fig. 1 is a front elevation of so much of the switch structure as is necessary to a complete understanding of the invention;

Fig. 2 is a top elevation of the switch taken along section line 2—2 of Fig. 1 to show the nor-

mal position of the moving magnetic element; while

Fig. 3, which is the same as Fig. 2, shows the displaced position of said magnetic element.

Referring now to the above figures, the switch comprises a base support 1 to the sides of which are secured the rectangular uprights 2 and 3 topped by the cross-member 20 having the two spaced sleeves 41 formed on the front edge thereof. The length of the uprights 2 and 3 is determined by the terminal capacity of the switch and their widths by the length of the base 1 with which said uprights are coextensive. Aligned apertures 42 and 43 are provided in the base 1 and cross-member 20, respectively, for the passage therethrough of the drive belt 26 as more particularly pointed out hereinafter. The uprights 2 and 3 are provided with oppositely disposed rectangular slots 51 and 52, respectively, which are for a purpose described below.

To the inner face of the upright 2 beyond the slot 51 at a distance from the base determined by the "normal" position of the magnet carriage 5 as more particularly pointed out hereinafter, there is secured in vertical alignment a number of supporting units each comprising the magnetic angle members 4, the off-center T-shaped separator 7 and a pair of spring clips 8, the latter being held in position at the two ends of the separator 7 which, preferably, is secured to the upright 2 by screws that pass through aligned apertures in both clips and separator. The supporting units are equally spaced in vertically aligned relation along the inner face of the upright 2, the width of the separator 7 and the space between the clips 8 being such that a tube relay 6 may be slipped between the respective collars of a pair of clips and the included protruding portion of the separator 7 and held securely gripped between said collars and said separator.

Each of the relay tubes 6 supported on the upright 2 as above described is formed with a forward L-shaped connection post 54 which extends through an aperture in the rectangular insulating block 55 that is suitably secured to both sides of the aperture 51 on the outer face of upright 2. This block 55 is provided with as many apertures as there are tubes 6 affixed to the left upright 2, and since the end of the connection post 54 of each tube extends through and beyond the aperture in the block, an array of connection posts is provided for extending one end of each of the tubes 6 to the connecting circuits, the other end of said circuits being connected to the back connection post 56 of each of the tubes.

In the same manner, an equal number of identical supporting units for the tubes 6' is secured in vertical alignment along the inner side of upright 3 behind the slot 52, each of said supporting units on said upright 3 being further positioned for horizontal alignment with corresponding supporting units on the inner face of upright 2. In the case of the supporting units on upright 3, however, the same are displaced as a group behind the group in upright 2 so that the engaging portions of the contact springs 9 and 10 of the tubes 6' mounted on upright 3 are all located behind the engaging portions of the contact springs 9 and 10 of the tubes 6 mounted on the inner side of upright 2. As pointed out below, the amount of displacement between the two groups of tubes is determined by the position of magnet 11 and the amount of allowable horizontal movement for this magnet once it has been selectively positioned between a pair of aligned tubes 6 and 6' on each of the uprights.

The tubes 6' affixed to upright 3 are the same as the tubes 6 affixed to upright 2 except that the forward connection post 54' of each of the former may be slightly longer than the connection posts 54 of each of the latter, to compensate for the horizontal displacement between the two arrays of tubes. The slot 52 in upright 3 is covered by the apertured block 55' which is identical with block 55, and through the apertures of said block 55' are extended the ends of the connection posts 54' to which are soldered the wires of the circuits which are to extend to the springs 10 of the various tubes 6', the wires for the other ends of said circuits which are to be extended to the springs 9 being soldered to the rear connection posts 56' of said tubes.

Secured to the top of the base member 1 at the forward end thereof is the L-shaped frame 12 which is formed with the two apertured tongues 13 outwardly projecting from each end of the top of the flange portion and the single armature post 15 upwardly extending from the middle of the forward end of the base portion of said frame. To the end of this post is pivotally secured, through the pin 16 passing through aligned apertures in the support and the flange of the frame, the butterfly armature 17 for the two magnets 18 and 19 which are mounted upon and secured to the base of said frame. Mounted between the tongues 13 and the sleeves 41 in the cross-member 20, which sleeves are aligned with the apertures in said tongues, are the two rods 21 each of which is formed at its lower end into a vane 22 having a short outer strip 57 and a long inner strip 58 (foreshortened in Figs. 2 and 3). The rods 21 are free to rotate about their supports but are normally held by the springs 25 against the associated stop pins 24 carried by the tongues 13, the pin 24 on the left tongue 13 stopping the left vane 58 from any counter-clockwise motion and the pin on the right tongue stopping the right vane from any clockwise motion. The spring 25, holding its associated vane from the indicated rotation, is secured between each upright and a ring on the long strip of each vane so that any motion of a vane is possible only against the tension of the spring 25.

Between the two front strips 57 of the vanes 22 is disposed the T-shaped vertical portion 23 of the armature 17. It is now obvious that if magnet 18 is energized, the vertical portion 23 of the armature will be tilted to the left, causing said vertical portion to strike the strip 57 and exert a force thereon which will cause the left vane to

turn clockwise against the tension of its spring 25. The release of the magnet 18 will then cause the spring 25 to pull the vane back to its original position of rest against the left pin 24 by causing the rod 21 to turn counter-clockwise under the force of the spring until the long strip 58 of the vane engages the pin 24. In the same manner, if magnet 19 is energized, member 23 will be tilted to the right causing it to strike strip 57 of the right vane and thereby impart a counter-clockwise motion to said vane against the tension of the right spring 25. The release of magnet 19 will then cause said spring to pull the vane back to its original position of rest against the right pin 24.

The "selecting" magnet carriage 5 is attached to the two ends of a tape 26 which passes through the aligned slots 42 and 43 in the base 1 and cross-member 20, respectively, and is controllably driven by a motor (not shown) in the manner disclosed in the above-mentioned patent to Carpenter and Mallina for selectively driving said carriage 5 up and down between the two arrays of tubes. This carriage which is slidably mounted upon the guide rod 27 centrally secured between the base 1 and the cross-member 20, comprises a U-shaped cradle 29 between the flanges of which are secured the threaded parallel rods 28 which act as a track for the H-shaped magnet 11 slidably mounted thereon. The rear flange of the cradle is integral with a solid triangular portion apertured for the passage therethrough of the guide rod 27, said aperture being sufficiently wide to house a suitable bushing that rides over the surface of the rod 27. The front flange is formed with a forwardly extending slotted finger 59 upon which is mounted the off-center cam member 30 of a toggle switch 60. The cam is formed with a flat portion to the right of its high point, an arcuate portion with two positioning notches to the left of said high point and an off-center lever 31 the end of which, when the high point of the cam is in contact with the flange, engages the long strip 58 of left vane 22. A tie rod 32 connected to an eyelet on the front of the magnet 11 and to a screw on the lever converts the circular motion of the cam into a reciprocal motion for the magnet. A spring 33 connects the front end of the tie rod 32 with the front flange of the cradle, which spring builds up tension when the cam swings to the right as pointed out hereinafter, to restore the magnet to its normal position. The spring 36 secured to the left end of the left flange of the cradle has a roller mounted at the end thereof which falls into either of the two notches in the cam 30 to hold the latter in each of the two positions to which it may be displaced.

Secured between the base of the cradle 29 and the rods 28 is a lower magnetic shield 37 and secured to the top of the magnet 11 is the member 38 upon which is secured the upper magnetic shield 39. Both of these shields act to prevent the magnetic lines of force emanating from the magnet 11 from traversing the contact elements of the relay tube groups above and below the magnet when the latter moves between the tube arrays to select a particular group of tubes constituting a terminal set. It is to be observed at this juncture that the height of the cradle 29 is such that when the magnet carriage is positioned between a pair of tubes on the right and a pair of tubes on the left, the upper shield 39 is in substantial alignment with the upper angle members 4 immediately above the pairs of tubes and that the lower

shield 37 is in substantial alignment with the lower angle members 4 immediately below said pairs of tubes. Furthermore, the breadth of the magnet 11 is such that the poles thereof span the tubes adjacent thereto. The fields of the magnet 11 are thus concentrated upon the pairs of tubes between the shields while the latter act to prevent the fields from penetrating therethrough to the tubes above and below said shields.

Having described the mechanical structure of one embodiment of my proposed switch, I will now describe its manner of operation:

At the outset, it may be mentioned that the principle of operation depends upon the fact that the magnetic springs 9 and 10 in the tubes 6 and 6' comprising the terminal elements of the switch can be energized into engagement with each other by a magnetic field of one strength and thereafter retained in engagement by a magnetic field of lesser strength, but springs in the weak field not previously exposed to the action of the strong field will continue to remain separated from each other. That is, the magnetic contact elements 9 and 10, for example, are normally separated from each other. Yet when subjected to a strong magnetic field applied outside of their enclosing vessel, they are brought together and will thereafter be held together by a field of less intensity than the one which caused their engagement. Thus considering Fig. 2 in which the left poles of the magnet 11 are shown to be on either side of the springs 9 and 10 of the left tube array, it being assumed that the magnet carriage 5 is raised to the dotted indication thereof as shown in Fig. 1 so that the magnet is between and in alignment with a pair of tubes 6 on its left and a pair of tubes 6' on its right, the magnetic field emanating from the left poles embraces said springs 9 and 10 of tubes 6, and since these springs are made of magnetic material they will be attracted into engagement as shown. It will be noted, however, that, with the position of the magnet 11 as indicated in Fig. 2, the springs 9 and 10 of each of the two right tubes 6' are not within the magnetic field produced by the right poles of the magnet. This is due to the fact that, as previously described, the right array of tubes 6' is located behind the left array of tubes 6 by a distance that will ensure that the springs 9 and 10 of the tubes 6' will not be positioned between the two right poles of the magnet 11 but substantially in line with the back pole of the magnet when the latter is in the position to include between its two left poles the springs 9 and 10 of the tubes 6 in the left array which are included between the magnetic shields 37 and 39 mounted on either side of the magnet carriage. Under these circumstances, the field of force emanating from the right pole nearest the springs 9 and 10 of the two right tubes 6' will be insufficient to cause these springs to be attracted into engagement.

Now assume that, in the manner to be described below, magnet 11 is shifted rearwardly as shown in Fig. 3 to the position where the springs 9 and 10 of the two tubes 6' come between the right poles of the magnet while the springs 9 and 10 of the two tubes 6 are brought substantially into alignment with the front left pole of said magnet. Since the springs 9 and 10 of the tubes 6' are now encompassed within the two right poles, said springs are attracted into engagement while the springs 9 and 10 of the tubes 6, having been previously energized when between the two left poles of said magnet, now remain in the energized position in consequence of

the weak magnetic field available through the left front pole shifted into alignment therewith. Hence it is obvious that, with the tubes arranged in groups of four as "terminal sets," with two tubes of the group disposed on the left of the magnet 11 so that the springs of said tubes lie between the left poles of said magnet, and the other two tubes disposed on the right of the magnet so that the springs of said last-mentioned tubes are preferably in alignment with one of the right poles of the magnet, then if the magnet can be shifted in position so as to bring the springs of the left tubes into alignment with a left pole and the springs of the right tubes between the two right poles, a two-stage operation may be obtained, the first stage being the one in which the springs in the two tubes 6 are first energized by the magnet and the second stage being the one in which said springs remain energized, the springs of the two tubes 6' are subsequently energized if the position of the magnet is shifted rearwardly to bring said last-mentioned springs between the two right poles and bring the first-mentioned springs into alignment with the front left pole. When the two subgroups of springs are thus sequentially energized, the subgroup of tubes first energized may be used for "hunt" and "control" functions during operations to select the group of four tubes that designate a desired line or "terminal set" and the subgroup of tubes later energized (in the group of four tubes selected) being used as the line terminals over which a talking circuit, for example, may be closed.

This two-stage operation, exemplified herein by a mechanical shift of the magnet 11 to change the position of its magnetic field, may be accomplished, of course, purely by electrical means without any mechanical shifting and the same is intended to be covered by the present invention. For example, the magnet structure 11 may be made up of two oppositely disposed magnetically insulated U-shaped electromagnets, one having its two pole-pieces on either side of the engaging portions of the springs 9 and 10 of tubes 6 and the other having its two pole-pieces on either side of the engaging portions of the springs 9 and 10 of tubes 6'. Upon the core of each of these two electromagnets may be mounted two magnetizing coils connected in series, with one pole of a battery connected to one terminal of the coil wound upon the magnet whose poles face tube 6' and the other pole of the battery selectively connectable either to the unwired terminal of the second coil or to the joining terminal of both coils. Now when the battery circuit is completed only to the coil of the magnet whose poles face the array of tubes 6, said magnet is energized and the springs of the tubes are brought into engagement in the manner above described. Since no circuit is completed at this time to the coil of the magnet whose poles face the array of tubes 6', and since the two magnets are insulated from each other, there will be no field emanating from the first-mentioned magnet and the springs 9 and 10 of the tubes 6' will not be brought into engagement. Now when it is desired to energize the springs 9 and 10 of tubes 6' in a selected subgroup of tubes (the springs 9 and 10 of tubes 6 in such a subgroup having been previously brought into engagement by the energization of the one magnet) the electric circuit is changed so as to complete a series circuit through both coils. There will now be a magnetic field produced by each magnet. The strength of the field produced in the magnet

whose poles face the tube array 6' will be such as to energize the springs 9 and 10 of the subgroup of tubes 6' which will be traversed by this field, while the strength of the field now produced in the magnet whose poles face the tube array 6, although diminished in intensity, will still be sufficient to hold energized the springs 9 and 10 of the subgroup of tubes 6 which were previously energized.

The above, of course, is merely given as an example of the many ways in which the two-stage operation of the tubes may be accomplished by controlling the magnetic field of the selecting magnet. Others will readily occur to those skilled in the art.

In Fig. 1 of the drawing, the magnet carriage 5 is shown in its normal position of rest on the stop collar 70 which is tightly fitted on the guide rod 27 at a height from the base to cause the upper magnetic shield 39 to be level with the lowest pair of angle members 4, thereby insuring that the magnetic field produced by the magnet 11, when the carriage is normal, will not act upon the springs of the lowest tubes 6 and 6'. When the switch is to be operated for the selection of a group of four tubes which constitute a terminal set, power is applied to the tape 26 by means not shown, whereupon the carriage 5 is raised vertically as indicated by its dotted position in Fig. 1, to bring it successively into horizontal alignment with the tubes on either side thereof, it being borne in mind that the magnet 11 on the carriage is in the position indicated in Fig. 2 both when the carriage is normal and when it is being moved vertically. When the magnet is in alignment with the first group of tubes, the springs 9 and 10 of the two tubes 6 to the left of the magnet 11 are caused to be energized for the reasons already given. It is assumed that the lower one of these two tubes 6 is preferably suitably connected by means of its two connection posts 54 and 56, to a circuit in the sector terminating in the group of tubes which controls the rotation of the drive motor, and that the rotation of said motor will remain undisturbed if the circuit indicates that the selector is unavailable. It may be further assumed that the upper of these tubes 6 is (preferably) suitably connected by means of its own two connection posts, to a circuit in the selector by means of which, when the circuit is completely closed by the engagement of the springs 9 and 10 of said tube, the selector will be held. If the circuit completed through the springs of the lower tube indicates that the first selector is "busy," the motor will continue operating to lift the magnet carriage 5 into alignment with the second group of tubes where a similar test for the availability of the second selector is made with the circuit in the selector completed through the springs 9 and 10 of the lower of the two tubes 6 in the second group. In this hunting operation and since the magnet 11 is in the position indicated in Fig. 2, the springs 9 and 10 of the two tubes 6 in each group of tubes will remain energized until the lower shield 37 comes into alignment with the pair of angle members 4 located on each upright 2 and 3 directly above the two tubes 6 and 6' of the group constituting a terminal set.

When the circuit (or the absence of a circuit) through the closed springs in a lower tube 6 in the left set of tubes of a group indicates that said group is available, the motor drive is stopped and a circuit is then momentarily completed for

magnet 18 in any suitable manner. This magnet, in operating, causes the lever 23 to be turned to the left against the tension of spring 25 and strike the short strip 57 of the left vane which is thereby turned clockwise against the tension of spring 25 to tilt the toggle lever 31 to the right against the tension of spring 33. After the short energizing impulse, the magnet is deenergized and the spring 63 restores the armature 17 to its normal position. Since the cam 30 normally engages the outer flange of the carriage cradle at its high point and since, to the right of said high point, said cam is flat by a depth from its arcuate surface equal to the distance required to shift magnet 11 to the position in which contacts 9 and 10 of the right tubes 6' are between the two right poles of said magnet and contacts 9 and 10 of the left tubes 6 are in substantial alignment with the lower left pole of said magnet, the tension built up in spring 33 pulls the toggle lever 31 inwardly until the flat surface of the cam 30 engages the flange of the cradle. The rotary motion of the toggle lever is communicated to the magnet 11 by the tie rod 32, said magnet being driven rearwardly until the cam comes to rest with its flat surface on the forward flange of the cradle, at which time the magnet is in the position indicated in Fig. 3 and the roller 35 is in the second notch on the cam 30. That is, the contacts 9 and 10 of the two right tubes 6' of the selected group of tubes are now between the two right poles of the magnet 11 and become energized by virtue of the strong magnetic field between the two poles, while the contacts 9 and 10 of the two left tubes 6 of the selected group are in alignment with the forward left pole of said magnet and remain energized on the portion of the field which leaves (or enters) this pole. The closure of the contacts 9 and 10 of the two right tubes 6' of the selected group may now be utilized to complete a talking circuit therethrough by means of wires connected to the connection posts 54' and 56' of said tubes. Since the utilization of these contacts for such or other types of circuits which may be closed through the selector is not a part of this invention, the same are not illustrated.

When it is desired to restore the switch to normal, the selector completes a reverse circuit in any suitable manner for the drive motor, which applies a downward pull to the tape 26 to carry the magnet carriage 5 down until the bottom thereof strikes the stop collar 60. Contacts (not shown) controlled by the magnet carriage when the latter thus comes to rest may be used to open the circuit of the motor. Prior to the reverse operation of the motor, however, magnet 19 is momentarily energized in any suitable manner. This causes member 23 to strike the short strip 57 of the right vane and impart to the latter a counter-clockwise rotation against the tension of right spring 25 and causing the long strip 58 to push the toggle lever 31 to the left. The cam 30 is thereby pulled down the distance of the slot 44, whereupon the cam is caused to turn on the supporting pin until the high point of the cam again engages the outer flange of the magnet cradle. The turning motion of the cam is communicated as forward motion to the magnet 11 which, by time the cam has again reached its high point, the roller at the end of spring 35 will have engaged the first notch on the cam and the magnet 11 will have been driven to its forward position as indicated in Fig. 2.

In the downward movement of the magnet

carriage 5, the contacts 9 and 10 of the sets of tubes 6 are progressively energized and deenergized, respectively, while the contacts 9 and 10 of the tubes 6' remain unaffected since the position of the magnet is the one shown in Fig. 2. The fact that the springs in the tubes 6 are energized on both movements of the magnet carrier makes it possible to use the switch in both directions of travel.

While I have described my invention in connection with its specific embodiments in one particular structure of a selector switch, it is to be understood that various other modifications and embodiments thereof may be made by those skilled in the art without departing from the spirit of the invention as defined within the scope of the appended claims.

What is claimed is:

1. A selector switch comprising two arrays of paired magnetic contacts, each array being disposed in staggered relation with respect to the other, a magnetic element disposed to move between said arrays for energizing those pairs of contacts in the one of said arrays which are traversed by the field of said magnetic element, and means for changing the position of said magnetic element to cause the field thereof to traverse a number of pairs of magnetic contacts in the other of said arrays whereby said contacts are energized.

2. A selector switch comprising two arrays of paired magnetic contacts, each array being disposed in staggered relation with respect to the other, a magnetic element disposed to move between said arrays for progressively energizing the pairs of contacts in one of said arrays which are traversed by the field of said magnetic element, and means for shifting the position of said magnetic element with respect to certain pairs of magnetic contacts in the other of said arrays whereby said contacts are traversed by the field of said magnetic element and energized thereby and whereby certain pairs of magnetic contacts in the other of said arrays remain traversed by the field of said magnetic element in its new position and are maintained energized thereby.

3. A selector switch comprising two staggered arrays of oppositely disposed tubes, each of said tubes enclosing a pair of normally separated resilient contacts of magnetic material, a magnet disposed to move between said two arrays of tubes to cause the operation of contacts within the tubes in the one array which are traversed by the field of said magnet, and means for shifting the position of said magnet in relation to the other array of tubes whereby the field of said magnet additionally traverses some of the tubes

in said other array to cause the operation of their contacts and to retain operated the contacts in the tubes of the first-mentioned array which are still traversed by the field of said magnet.

4. A selector switch comprising two vertically supporting members, an equal number of clamping means affixed in vertical alignment to each of said supporting members, the clamping means on one supporting member being staggered with respect to the clamping means on the other of said supporting members, a tube mounted on each of said clamping means, each of said tubes enclosing a pair of normally separated resilient contacts of magnetic material, an H-shaped magnet adapted for vertical movement between the tubes, mounted on said supporting members, said magnet being normally positioned in its line of movement with two of its poles on either side of the engaging portion of the contact pairs in the tubes on one supporting member, whereby, as the magnet is moved into horizontal alignment with one or more tubes affixed to one member, the contacts in said tubes are flexed to establish electrical circuit making connections therethrough, and means operative when said magnet is selectively positioned between a group of tubes affixed to one supporting member for shifting the position of said magnet to cause its two other poles to be on either side of the engaging portions of the contact pairs in a similar group of tubes affixed to the other supporting member whereby contacts in said similar group of tubes are flexed to establish electrical circuit-making connections therethrough and whereby the contacts in the group of tubes first mentioned remain flexed.

5. A selector switch comprising two parallel staggered arrays of an equal number of gas-tight vessels, resilient circuit-making contacts of magnetic material in each vessel, an H-shaped magnet adapted for movement along one of said arrays with two of its poles disposed on either side of the contacts of the vessels in said one array whereby the contacts in the vessels in said one array which are traversed by the field of said magnet are flexed to establish electrical circuit-making connections therethrough, and means for moving the position of said magnet so that its two other poles are on either side of the contacts of the vessels in the other of said arrays, whereby said contacts are energized when the field of said magnet traverses said contacts and whereby the contacts in the first array previously energized remain energized.

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