Jan. 31, 1967 R. F. OXLEY 3,301,976

CAM ACTUATED SNAP ACTING MULTIPLE POSITION SWITCHES

Filed Oct. 15, 1964 3 Sheets-Sheet 1

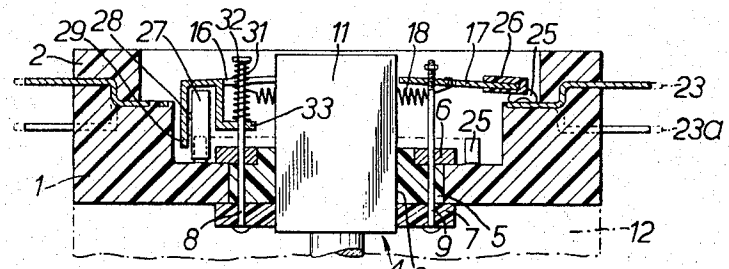


FIG. 1.

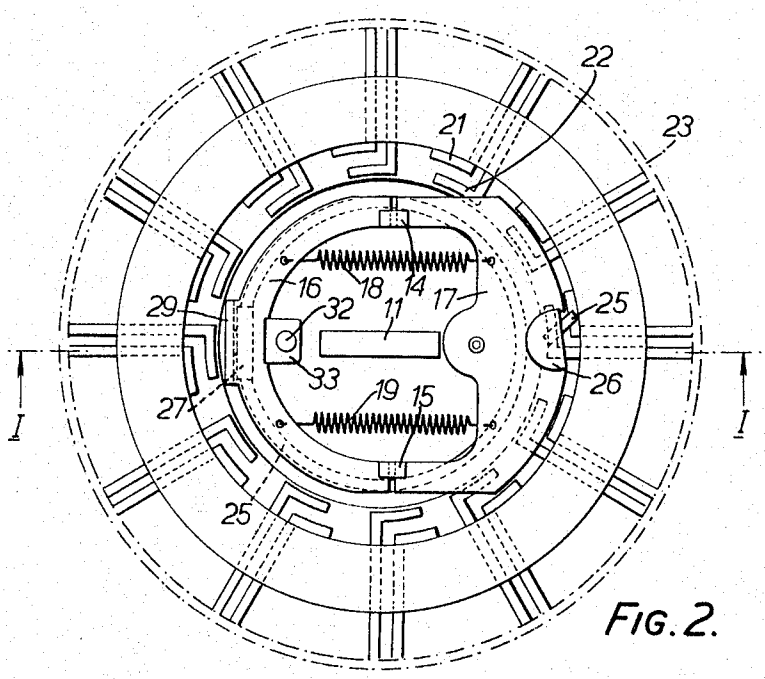


FIG. 2.

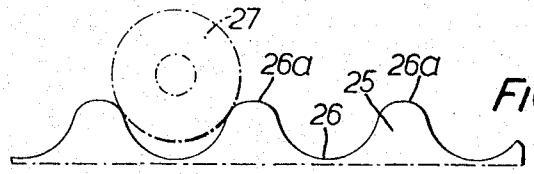


FIG. 3.

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CAM ACTUATED SNAP ACTING MULTIPLE POSITION SWITCHES

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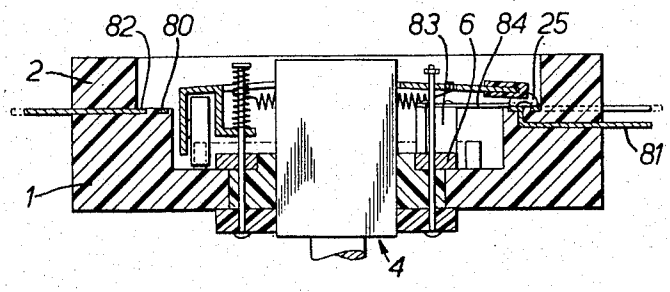


FIG. 4.

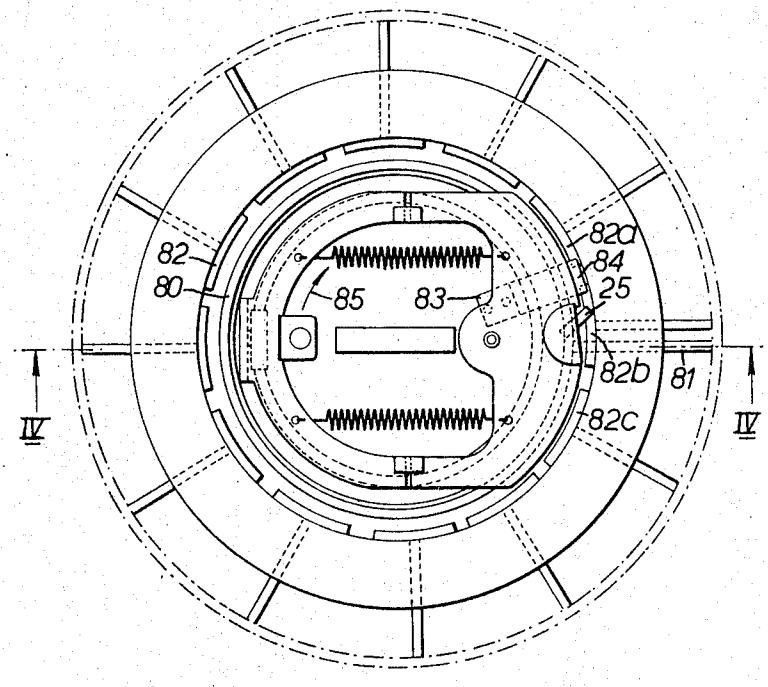


FIG. 5.

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CAM ACTUATED SNAP ACTING MULTIPLE POSITION SWITCHES

Filed Oct. 15, 1964 3 Sheets-Sheet 3

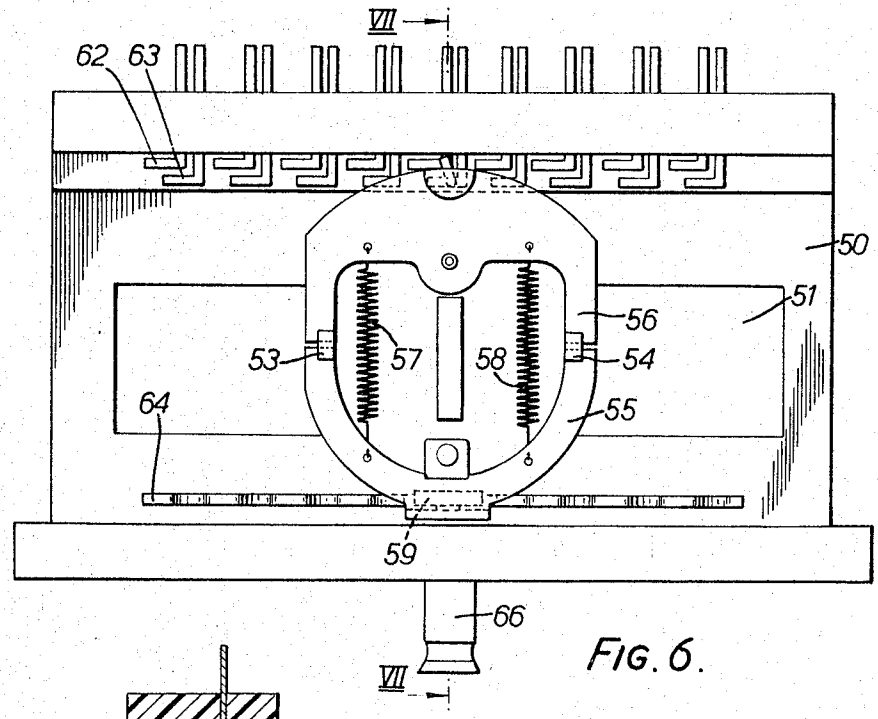


FIG. 6.

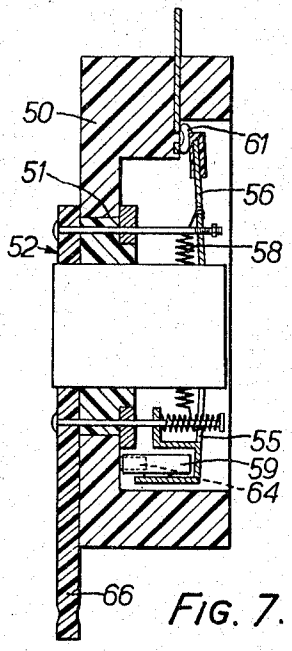


FIG. 7.

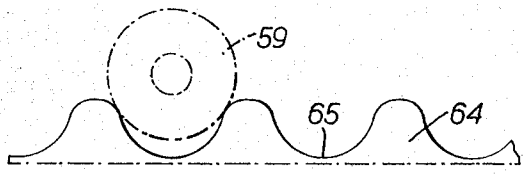


FIG. 8.

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United States Patent Office

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CAM ACTUATED SNAP ACTING MULTIPLE POSITION SWITCHES

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15 Claims. (Cl. 200—63)

This invention relates to snap acting multi-contact electric switches and has for its object the provision of such switches with a snap action either at the make or at the break or at both make and break. The invention is particularly applicable to rotary switches but may also be applied to linear multi-contact switches.

The majority of rotary multi-contact switches at present available are not snap action, the movable contact or contacts merely sliding onto and off the fixed contacts. Certain rotary switches have been proposed having a motion which approximates to a snap action but in general these do not provide a true snap action or are very clumsy and unsuitable for small switches.

According to the present invention, a multi-contact snap acting electric switch comprises a first member carrying a row of fixed contacts, a second member movable with respect to the first member and carrying a movable contact positioned to move along the row on such relative movement, spring means on said second member arranged to bias the movable contact alternatively into a fixed contact-engaging position and into a fixed contact non-engaging position and to produce a snap-action motion from a position of unstable equilibrium between the two positions to either of the two positions, and cam and cam follower means arranged to trigger such motions in synchronism with and as a result of relative movement between the first and second members.

The term "fixed" contact is used only in contradistinction to the movable contact and it will be understood that the first member may be movable and the second member may be stationary or both may move although the preferred arrangement is for the first member to be stationary and for the second member to move relatively to it and for convenience such an arrangement will be referred to hereafter.

In a switch constructed in accordance with the invention the actual movement of the movable contact is compounded of the movement imparted to it by movement of the second member by which it is carried and the movement produced by the snap action produced by the bias of the spring means and controlled by the cam and cam follower means. Preferably, these two components are at right angles to each other.

Preferably, the switch includes a rigid element pivoted to the second member and carrying the movable contact at a point spaced from the pivot axis, and a tension or compression spring one end of which is secured to the rigid element at a point spaced from the pivot axis and anchored at a point at the other end, the cam and cam follower means being arranged to move the anchor point and the pivot point relative to one another through a position in which the said securing point, the said anchoring point and the pivot axis lie in a common plane. In a preferred construction the spring is a tension spring and the switch includes a second rigid element pivoted to the second member about an axis parallel to that of the first rigid element, the tension spring being anchored to the second rigid element. The second rigid element may carry the cam follower and the cam may be fixed with respect to the first member and may have an undulating surface.

The invention is particularly applicable to rotary switches and a preferred form of such a switch comprises a first member carrying a ring of spaced fixed contacts, a second member mounted for rotation relative to the first, two rigid elements mounted on the second member on pivots the axes of which are parallel and perpendicular to the axis of rotation of the second member relative to the first, the two rigid elements projecting generally away from each other, at least one tension spring connecting the rigid elements so as to tend to draw the radial outer ends of the elements towards one another, an annular generally undulating cam surface afforded by the first member and facing axially with respect to the axis of rotation of the first member relative to the first, a cam follower carried by one rigid element and adapted to engage the cam surface, and a movable contact carried by the other rigid element in a position to engage the fixed contacts.

The invention may be carried into practice in various ways and three embodiments will now be described by way of example with reference to the accompanying drawings, in which:

FIGURE 1 is an axial section through a rotary switch taken on the line 1—1 of FIGURE 2;

FIGURE 2 is a plan view of the switch shown in FIGURE 1;

FIGURE 3 is a development of the cam surface of the switch shown in FIGURES 1 and 2 to a larger scale;

FIGURE 4 is an axial section through a rotary switch like that shown in FIGURE 1 but with an additional moving contact;

FIGURE 5 is a plan view of the switch shown in FIGURE 4;

FIGURE 6 is a plan view of a linear switch;

FIGURE 7 is a cross section of the switch shown in FIGURE 6 on the line VI—VI; and

FIGURE 8 is a detailed elevational view of the linear cam surface of the linear switch.

Referring now to FIGURES 1 to 3 of the drawings, the rotary switch comprises an insulating disc **1** having a stepped circumferential flange **2**. The disc **1**, which forms the stationary member of the switch, is of moulded plastics material. For convenience of description it will be assumed that the axis of the disc is vertical and the flange **2** projects upwardly. There is a central aperture **3** through the disc **1** in which is mounted the rotor member **4** of the switch. This comprises a journal portion **5** which revolves in the aperture **3** in the disc and an upper disc **6** and a lower disc **7** which engage the upper and lower surfaces of the disc **1** respectively. The discs **6** and **7** and the journal portion are held together by bolts **8** and **9**. Passing through the discs **6** and **7** and the journal portion **5** is a shaft **11** which is of rectangular cross section in its upper portion as seen in FIGURE 2 but which is of circular cross section in its lower portion which may receive an operating knob. The shaft may be common to a number of identical switches mounted one on top of the other and another such switch **12** is indicated in chain dotted lines in FIGURE 1.

Projecting upwardly from the upper disc **6** of the movable member are a pair of diametrically opposed rectangular section pillars **14** and **15**. Opposite faces of the pillars have 60° included angle notches to receive corresponding edges of a pair of toggle plates **16** and **17** which extend outwardly from the pillars and away from one another. The notches form pivot means about which the toggle plates can swing through small arcs. The toggle plate **16** is approximately C-shaped and the toggle plate **17** is approximately E-shaped. The two toggle plates are connected by a pair of parallel tension springs **18** and **19**, one spring lying on each side of the shaft **11**. The toggle mechanism formed by the toggle plates **16** and **17**

and the springs 18 and 19 tends to adopt either a position in which both plates incline upwardly from the pillars or a position in which both plates incline downwardly from the pillars. Projecting upwardly from and integral with the disc 1 is a cylindrical flange 25 which is located between the step in the outer flange 2 and the upper disc 6 of the rotary member. The upper surface of this flange has an undulating profile having twelve indentations 26 alternating with high points 26*a* as can be seen in the development shown in FIGURE 3. The upper surface of the flange is engaged by a roller 27 carried on a radially extending spindle 28 mounted on a downwardly projecting lug 29 on the outer edge of the central portion of the C-shaped toggle member 16. The roller is held in engagement with the upper surface of the flange 25 by a compression spring 31 which surrounds the bolt 8 and which extends between a cap 32 on the top of the bolt and a bracket 33 on the C-shaped toggle plate 17 through which the bolt passes.

Evenly spaced around the switch are twelve pairs of stationary contacts. Each pair consists of two conductive members 21 and 22 which are L-shaped in plan and are cranked in elevation and are moulded into the disc 1 in such a way that their upper surface are flush with the upper surface of the shelf 23 formed by the step on the flange 2. During manufacture the individual stationary contacts 21 are integral with a ring 23 to form a stationary contact components which may be produced by stamping or by for example electro etching or other printed circuit techniques. The contacts 22 are similarly integral with a ring 23*a*. After the disc 1 has been moulded part or all of the rings 23 and 23*a* are cut away depending upon the particular arrangement of stationary contacts which is required. Thus it may be possible to interconnect some of the stationary contacts by cutting away portions of the radial legs of the stationary contacts 21 and 22 while leaving other contacts connected to the ring 23.

The stationary contacts 21 and 22 can be engaged by the lobes of a kidney-shaped contact shoe 24 fastened in a vertical slot in a polytetrafluoroethylene bushing 26 which is carried by the toggle plate 17. The shoe 24 extends between the stationary contacts 21 and 22 of each pair and electrically interconnects them.

The operation of the switch is as follows. It will be assumed that the switch begins in a condition in which the roller 27 is seated in the middle of an indentation 26 in the annular flange 25 as indicated in FIGURE 3. Accordingly as indicated in FIGURES 1 and 2 the two toggle plates 16 and 17 extend generally downwardly from their pivot points on the pillars 14 and 15 as shown in FIGURE 3 so that the movable contact 25 is in engagement with and interconnects the pair of stationary contacts 21 and 22 diametrically opposite the indentation in which the roller 29 is engaged. If the shaft 11 is now rotated the roller 27 will tend to rise from the indentation 26 in which it is seated towards an adjacent high point 26*a* raising the toggle plate 16 with it. A point will eventually be reached where the roller is moved so high that the toggle plates 16 and 17 will pass through an over-center position whereupon the E-shaped toggle plate 17 carrying the movable contact 25 will snap upwardly into a position in which it is extending obliquely upwards from the pivot points on the pillars 14 and 15. This movement is substantially instantaneous and effects a very rapid break between the movable contact 25 and the stationary contacts 21 and 22. Continued rotation of the knob 13 will cause the roller to pass over the high point 26*a* towards the next indentation 26 and eventually a state will be reached where the plate 17 carrying the movable contact will snap downwardly and the movable contact will move rapidly into engagement with the next pair of stationary contacts 21 and 22.

The rotary switch shown in FIGURES 4 and 5 is identical with that shown in FIGURES 1 to 3 except for the addition of an extra moving contact and modifications to the stationary contacts. These parts which are identical and to which reference need be made have been given the same reference numerals.

The shelf on the flange 2 of the body 1 carries an inner continuous contact ring 80 which may be connected to an external lead by a tag 81 mouded into the body. The shelf also carries an outer ring of fixed contacts 82 which are similar to the contacts 21 of the previously described construction but each has a greater circumferential length. A block 83 is fixed to the upper surface of the upper disc 6 of the rotor 4 and carries a resilient slider 84 whose outer end makes electrical contact with both the inner continuous contact ring 80 and the individual contacts 82 of the outer ring. The width of the slider 84 is such that it can span the gaps between adjacent contacts 82 as can be seen from FIGURE 5.

During rotation of the rotor the movable contact 25 successively interconnects the contact ring 80 with the individual contacts 82 of the outer ring and the interconnections will be made and broken with snap actions, all as previously described. However, in addition the slider 84 also successively interconnects the contact ring with the individual contacts 82, although not with a snap action. The sequence of operation is as follows starting from the position shown in FIGURE 5 and the rotor being rotated in the direction shown by the arrows 85. Contacts 82*a* and 82*b* are connected to the contact ring 80 both by the slider 84 and by the moving contact 25. After a small rotation the slider will leave the contact 82*a* which will be isolated from the ring 80. Shortly thereafter the movable contact 25 will snap away from the fixed contacts but the contact 82*b* will still be connected to the contact ring 80 by the slider 84. After further rotation, the movable contact 25 will snap on to contact 82*c* connecting this contact to the contact ring 80. However, this will occur before the slider 84 leaves the contact 82*b* so that contact is made with contact 82*c* before it is broken with contact 82*b*. Such a make-before-break characteristic is necessary for certain applications.

The switch shown in FIGURES 6, 7 and 8 is similar in its method of operation and construction to that shown in FIGURES 1 to 3 but the stationary contacts are arranged in a straight row and the switch operates linearly. The switch comprises a base 50 having a slot 51 in which slides a movable member 52 having a pair of upwardly extending pillars 53 and 54 carrying a pair of toggle plates 55 and 56 interconnected by a pair of tension springs 57 and 58. The toggle plate 55 carries a roller 59 and the toggle plate 56 carries a movable contact 61. The movable member 52 and the toggle plates are of similar construction to that of the switch of FIGURES 1 to 3. Arranged in a row on the base member 50 are a number of pairs of stationary contacts 62 and 63 which can be interconnected by the movable contact 61. Extending parallel with the row of stationary contacts is a rib 64 whose upper surface has a number of indentations 65 separated by high points, 65*a*, this rib corresponding to the cylindrical flange 25 of the switch shown in FIGURES 1 to 3 and being engaged by the roller 59 of the movable member of the switch. The movable member 52 can be slid along the base 50 by a handle 66 and when this occurs the roller 59 will move into and out of the indentations 65, 65 on the rib 64 to cause the toggle mechanism to snap between its two positions of stability and thus the pairs of stationary contacts 62, 63 are interconnected in turn.

The switches described are of a simple nature and it will be apparent that they may be modified in many ways. For example the contours of the flange 25 and the rib 64 need not be as shown but may be truly sinusoidal or the indentations may be separated by flat portions, for example. Instead of a flange, the cam surface could take the form of a groove engaged by a roller. The movable member could carry more than one movable contact and there could be a second set of stationary

contacts above and facing the first set and staggered with respect to those of the first set so that when the movable contact is in its lowermost position it will engage a pair of stationary contacts of the lower set and when it is in its upper position it will engage a pair of stationary contacts of the upper set.

What I claim as my invention and desire to secure by Letters Patent is:

1. A multi-contact snap acting electric switch comprising a first member carrying a row of fixed contacts, a second member movable with respect to the first member and carrying a movable contact positioned to move along the row to engage sequentially different ones of said fixed contacts, spring means on said second member arranged to bias the movable contact alternatively into a fixed contact-engaging position to electrically contact one of said fixed contacts with said movable contact and into a fixed contact non-engaging position to electrically open said movable contact from all of said fixed contacts and to produce in movement of the movable contact from one fixed contact to the next a snap-action motion away from a position of contact through a position of unstable equilibrium between the two into the fixed contact non-engaging position and therefrom producing a snap-action motion back into a further position of contact, and cam and cam follower means coupled with said spring members and arranged to trigger said snap action motions in synchronism with and as a result of relative movement between the first and second members to cause said movable contact to move between each fixed contact on the row to the next.

2. A switch as claimed in claim 1 in which the snap-action motions are in directions approximately at right angles to the direction of motion of the movable contact and means moving said second member coupled with the cam means to produce said snap-action motions solely by relative movement of the first and second members.

3. A switch as claimed in claim 2 in which the movable contact is carried by a contact carrier mounted on the second member and comprising at least two approximately parallel components connected together adjacent the movable contact and projecting from the second member in a direction generally perpendicular to the direction of the row adjacent the movable contact, one of the components being in tension and the other in compression, the cam and cam follower means being arranged to move parts of the two components relative to one another.

4. A switch as claimed in claim 2 which includes a rigid element pivoted to the second member and carrying the movable contact at a point spaced from the pivot axis, and a tension or compression spring one end of which is secured to the rigid element at a point spaced from the pivot axis and anchored at a point at the other end, the cam and cam follower means being arranged to move the anchor point and the pivot point relative to one another through a position in which the said securing point, the said anchoring point and the pivot axis lie in a common plane.

5. A switch as claimed in claim 4 in which the spring is a tension spring and which includes a second rigid element pivoted to the second member about an axis parallel to that of the first rigid element, the tension spring being anchored to the second rigid element.

6. A switch as claimed in claim 5 in which the second rigid element carries the cam follower and in which the cam is fixed with respect to the first member.

7. A switch as claimed in claim 6 in which the cam surface has an undulating profile.

8. A switch as claimed in claim 7 in which the cam follower is a roller.

9. A switch as claimed in claim 6 which includes a spring adapted to hold the cam follower in contact with the cam surface.

10. A switch as claimed in claim 1 which includes a second row of fixed contacts parallel with the first, the movable contact being arranged to interconnect contacts from the two rows.

11. A switch as claimed in claim 1 in which the second member is arranged to rotate with respect to the first and the row of fixed contacts extends along a circular arc about the axis of rotation.

12. A switch as claimed in claim 1 in which the second member is arranged to move in a straight line with respect to the first member and the row of fixed contacts extends along a straight line.

13. A switch as claimed in claim 1 in which the second member carries a further movable contact arranged to remain in contact with a fixed contact until the first movable contact has engaged the next fixed contact in the row.

14. A rotary electric switch comprising a first member carrying a ring of spaced fixed contacts, a second member mounted for rotation relative to the first, two rigid elements mounted on the second member on pivots the axes of which are parallel and perpendicular to the axis of rotation of the second member relative to the first, the two rigid elements projecting generally away from each other, at least one tension spring connecting the rigid elements so as to tend to draw the radially outer ends of the elements towards one another, an annular generally undulating cam surface coupled with the first member and facing axially with respect to the axis of rotation of the first member relative to the first to produce a series of sequential stable positions interspersed between intermediate unstable positions, a cam follower carried by one rigid element and adapted to engage the cam surface to snap the rigid elements about their pivots against the tension spring whenever the unstable positions of the cam surface are encountered and a movable contact carried by the other rigid element in a position to engage the fixed contacts only when the cam follower engages the stable positions of the cam surface.

15. A rotary electric switch as claimed in claim 14 in which there is a second ring of spaced contacts and the movable contact is arranged to interconnect contacts from the two rings.

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