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(54) **Self latching relay for ADSL application**

(57) The invention relates to a bi-stable mechanical device including at least a relatively fixed section and a relatively movable section. The movable section therein is connected to the fixed section by a resilient collapse mechanism, wherein said collapse mechanism maintains the movable section in either a first or a second position, there being a toggle point between the first and second positions.

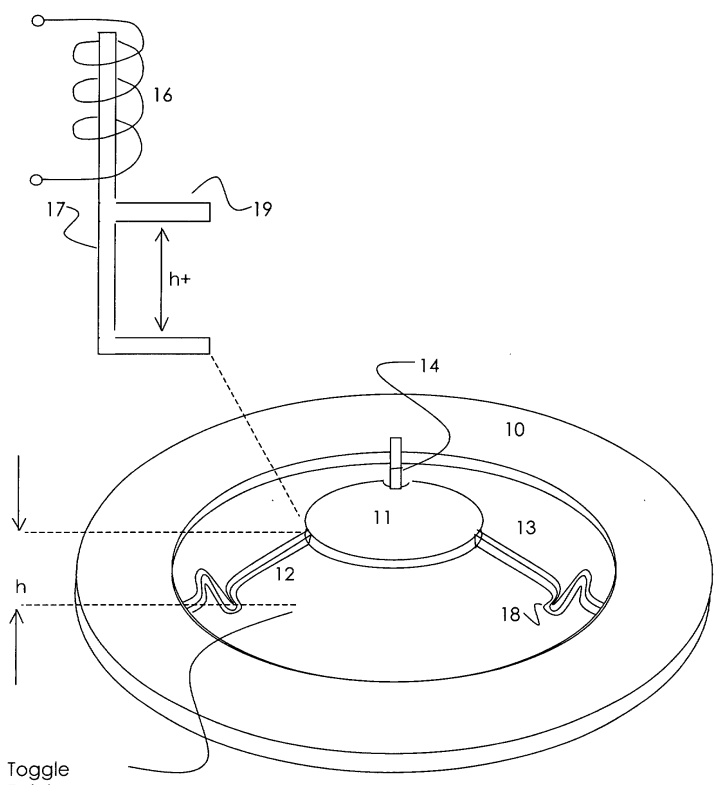

FIGURE 1

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Description

[0001] This invention relates to a bi-stable mechanical device like a self latching relay element for service agile ADSL application. Bi-stable mechanical devices have a number of uses. The invention will be described with reference to a bi-stable mechanical device suitable for use as the moving contact of an electrical toggle switch.

[0002] Normally, bi-stable mechanical devices utilize an "over-the-centre" spring mechanism composed of a base, a lever pivoted to the base, and a spring. In operation, the attachment point of the spring to the base and the lever align with the pivot point and the attachment of the spring to the lever at the point of maximum stretch of the spring. In other words, the connection points of the spring to the lever and the base, and the pivot point form a triangle except at the maximum stretch. Such an arrangement is used to provide positive action in moving the lever between first and second end positions. As the spring/lever connection moves beyond the aligned position, the spring action will tend to snap the lever to the end position on that side of the alignment positions.

[0003] An object of the invention is to improve the structure of existing bi-stable mechanical devices.

[0004] More precisely, the invention provides a bi-stable mechanical device including at least a relatively fixed section and a relatively movable section, the movable section being connected to the fixed section by a resilient collapse mechanism, the collapse mechanism maintaining the movable section in either a first or a second position, there being a toggle point between the first and second positions.

[0005] Advantageously, the collapse mechanism includes a collapse zone including one or more bends to provide a region partly or wholly transverse to the line of transmission of the deforming force.

[0006] In one embodiment, the mechanical device is formed of a single piece of material.

[0007] Furthermore, the movable section can include a permanent magnet on the movable section.

[0008] Advantageously, the movable section is associated with a solenoid showing one prong above the movable section and the other prong below the movable portion, with means to push the movable section down from a first position to a second position below a toggle point or to pull the movable section up from below the toggle point to a first position above the toggle point.

[0009] Advantageously, an upper and a lower electrical contact point are provided for electrical contact with the movable section, the upper and lower contact points located within the first and second position to provide contact pressure between the movable portion and the upper or lower contact point.

[0010] The invention will be described with reference to the accompanying drawings.

Figure 1 shows a first embodiment of the invention,
Figure 2 shows a second embodiment of the invention using an annular collapse zone,
Figure 3 illustrates a section through the embodiment of Figure 3 in first and second positions,
Figure 4 illustrates the collapse action.

[0011] Figure 1 shows a first embodiment of the invention in the form of an electrical contact including an annular first portion 10 connected to a second portion 11 via three resilient armatures 12, 13, 14. The arms include collapse zones, such as 18, intended to store elastic energy as the second portion is pushed towards the toggle point 17, and to release the elastic energy once the second portion is pushed past the toggle point. In this embodiment, the arms include a straight section which is inclined to the plane of the movable part to assist in transmitting the force applied to the contact to the collapse zones. The first portion 10 is intended to be held fixed while the second portion 11 is designed to be moved between a first stable position and a second stable or quasi-stable position. An operating mechanism such as a solenoid 15, 16 is associated with the movable portion 11 of the electrical contact. The solenoid is shown in an exploded position with reference to the electrical contact. In operation the solenoid arm 16 would be located with one prong, 19, above the movable portion 11 and the other prong below the movable portion 11 so the solenoid can push the second portion down from a first position to past the toggle point 17 or pull the movable portion 11 up from below the toggle point to above the toggle point 17. When the movable portion is pushed below the toggle point by the first prong, it will toggle mechanically so the stored elastic energy, mainly in the collapse zones of the arms 12, 13, 14, will force the movable portion further below the toggle point towards a second stable position. Similarly, when the movable portion is pulled above the toggle point by the second prong, the stored elastic energy pushes it back towards the first stable position. The prongs on the solenoid arm are spaced apart to permit the movable portion to travel between first and second positions. One or both of these positions may be contact points where the movable portion makes contact with upper and/ or lower contacts. The upper and lower contacts are within the first and second stable positions to provide contact pressure between the movable portion and the first or second contact point.

[0012] The invention is suitable for implementation as a single piece article, manufactured from a single piece of material. For example, the device may be stamped from a sheet of nickel, which has good ferromagnetic, electrical conductivity and resilience characteristics.

[0013] Figure 2 is a view of a second embodiment of the invention. In figure 2, there is a circular fixed portion 20, a circular or dome shaped movable portion 21, and the collapse zone 22 in the form of a circular corrugation. This arrangement is similar to the embodiment of figure 1 with the collapse region formed by the rotation of the arms about the vertical axis, and the arms being wholly used as collapse zones.

[0014] Figure 3 shows a section through the middle of the embodiment of Figure 2. The solid lines show the contact in a first stable position 25, and the dotted lines show the contact in a second stable position 26. The toggle position is shown at 27. As the section 21 is pushed from position 25 towards toggle point 27, elastic energy is stored in the collapse zone 22 which deforms elastically to store the energy.

[0015] When the section 21 is pushed below the toggle point 27, the stored elastic energy is released and the section 21 snaps towards position 26.

[0016] The device may be used as part of a snap-action electrical switch provided with one or two contact positions. If electrical contacts were to be provided, the upper contact would be slightly below position 25 and above the section 21, and the lower contact would be slightly above position 26 and below section 21.

[0017] While the embodiments of Figures 1 & 2 show circular configurations with three collapse arms or a continuous circular collapse zone, other configurations are within the scope of the invention. For example, the movable contact may be square or rectangular and connected to first and second fixed portions by first and second resilient arms in a linear arrangement.

[0018] In addition, the movable contact 11, 21 may be moved by other means than a solenoid. For example the movable contact may be incorporate some permanent magnetic material and be located between a pair of poles of a bi-directional electro-magnet with which upper and/or lower fixed contacts may be associated.

[0019] Figure 4 illustrates an example of the snap action utilized in the invention. In this embodiment the whole of the arm forms the collapse zone.

[0020] Figure 4 may be assumed to be a side view of a linear arrangement including a movable contact 41 connected to a first fixed zone 40 by a first resilient collapse arm 42, and to a second fixed zone 44 by a second resilient collapse arm 43 as illustrated in Stage 1 of the figure. For simplicity, movable contact 41 is shown in a first rest position on the same plane as the fixed zones 40 & 44. However it is not necessary for the working of the invention that the first rest position be in this plane. Stage 2 shows the initial stages of the collapse action as contact 41 is pushed down a first distance h_1. The collapse regions 42 & 43 begin to distort elastically. Stage 3 shows the contact as it reaches the toggle point at distance h_2 .Stage 4 shows the second stable position at a distance h_3. If a fixed contact were located at a distance h_4, where h_4, h_3, there would be contact pressure exerted between the movable contact 41 and the fixed contact due to the unreleased elastic energy in the arms 42 & 43.

[0021] As shown in Figure 4, the collapse mechanism includes one or more bends in the arm. The force applied to the movable contact is transferred to the collapse zone along the arm. Because the collapse zone includes a bend out of the line of the arm, some of the force is converted to elastic energy as the material i the collapse zone is deformed. The geometry of the arm is such that the collapse zone will continue to store energy until the contact passes through the toggle point. Once the contact portion is pushed through the toggle point from the first stable position, it will snap across towards the second stable position. Similarly, in the reverse direction, pushing the contact from the second position through the toggle point will result in the contact snapping across towards the first stable position.

[0022] The collapse zone can be thought of as a portion of material being angled out of the line joining the edge of the contact to the fixed portion. Assuming a constant cross-section in the collapse zone, the greater the angle (up to 90°) through which the collapse zone is bent in the unloaded stable condition, the "softer" the collapse zone, ie, as the angle between the line of transmission of the force and the collapse zone material increases, the less the force required to deform it.

Claims

1. A bi-stable mechanical device including at least a relatively fixed section and a relatively movable section, the movable section being connected to the fixed section by a resilient collapse mechanism, the collapse mechanism maintaining the movable section in either a first or a second position, there being a toggle point between the first and second positions.

2. A bi-stable mechanical device according to claim 1, wherein the collapse mechanism includes a collapse zone including one or more bends to provide a region partly or wholly transverse to the line of transmission of the deforming force.

3. A bi-stable mechanical device according to any one of claims 1 or 2, formed of a single piece of material.

4. A bi-stable mechanical device according to any one of the preceding claims, the movable section including a permanent magnet on the movable section.

5. A bi-stable mechanical device according to any one of the preceding claims, with the movable section associated with a solenoid showing one prong above the movable section and the other prong below the movable portion, with means to push the movable section down from a first position to a second position below a toggle point or to pull the movable section up from below the toggle point to a first position above the toggle point.

6. A bi-stable mechanical device according to any one of the preceding claims, wherein an upper and a

lower electrical contact point is provided for electrical contact with the movable section, the upper and lower contact points located within the first and second position to provide contact pressure between the movable portion and the upper or lower contact point.

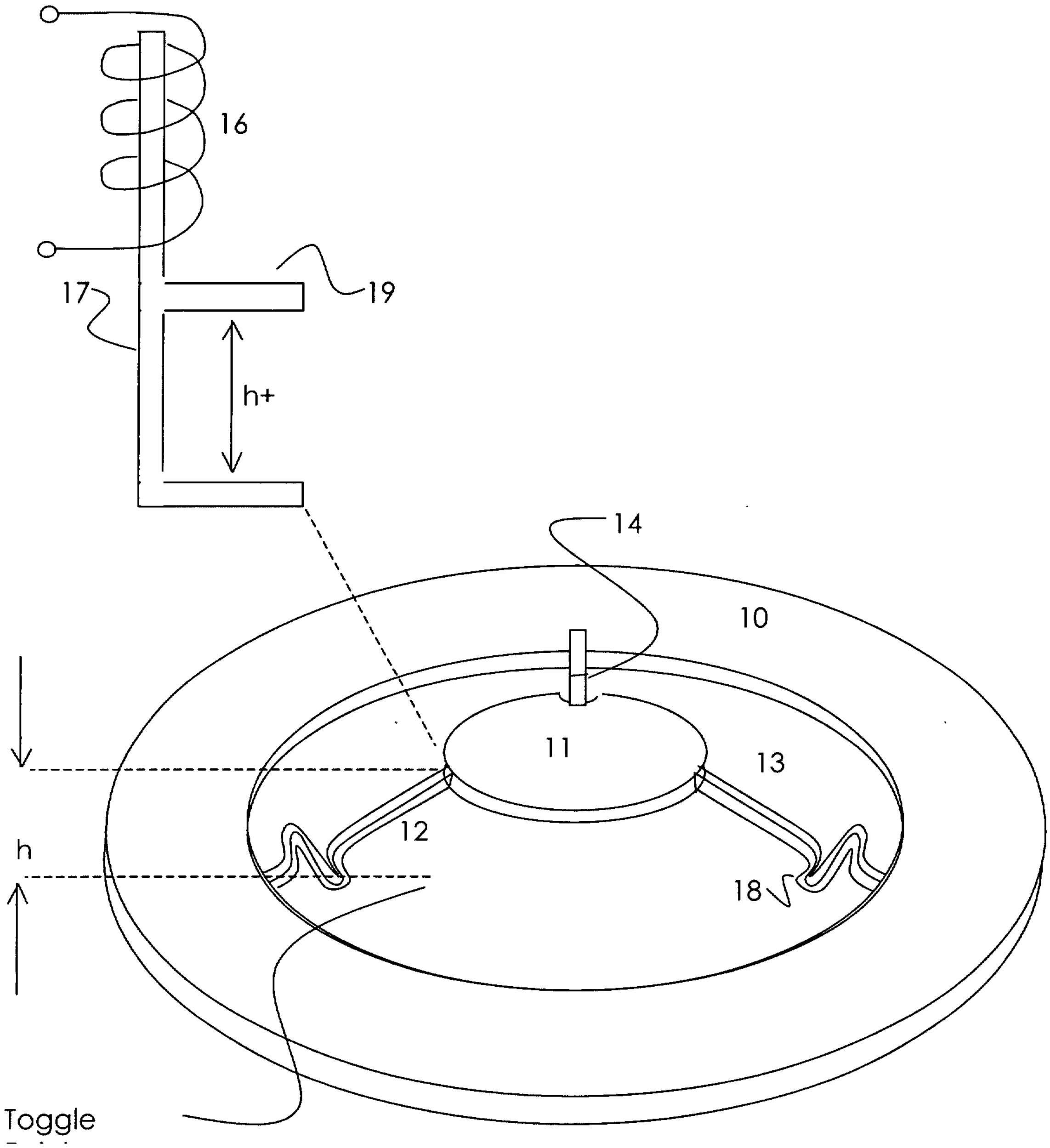

FIGURE 1

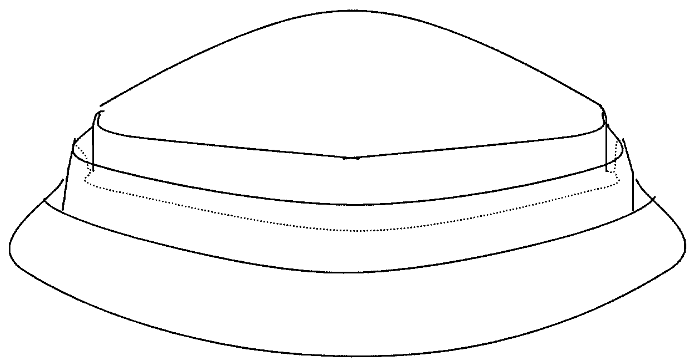

FIGURE 2

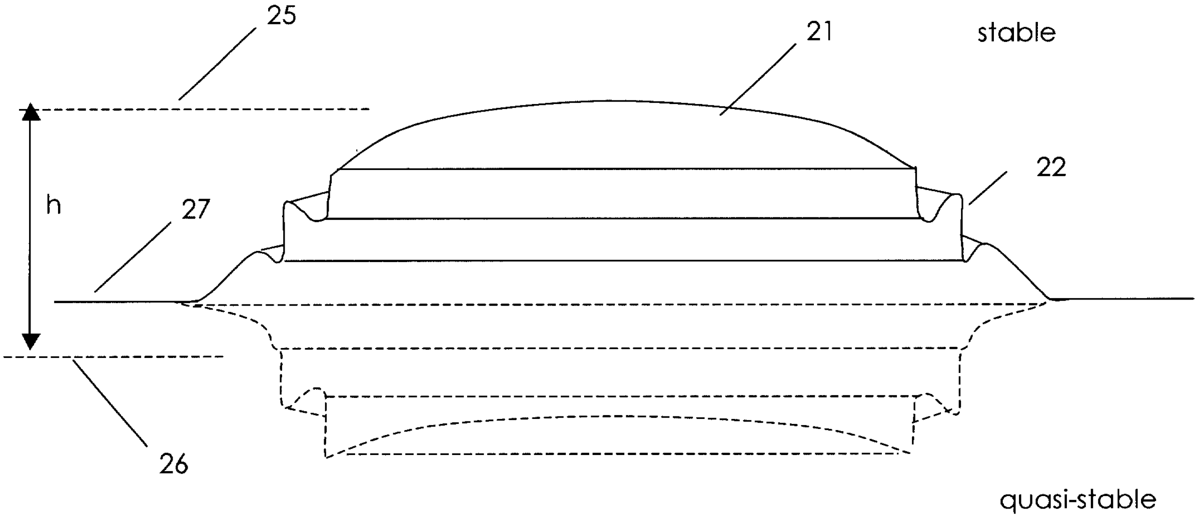

FIGURE 3

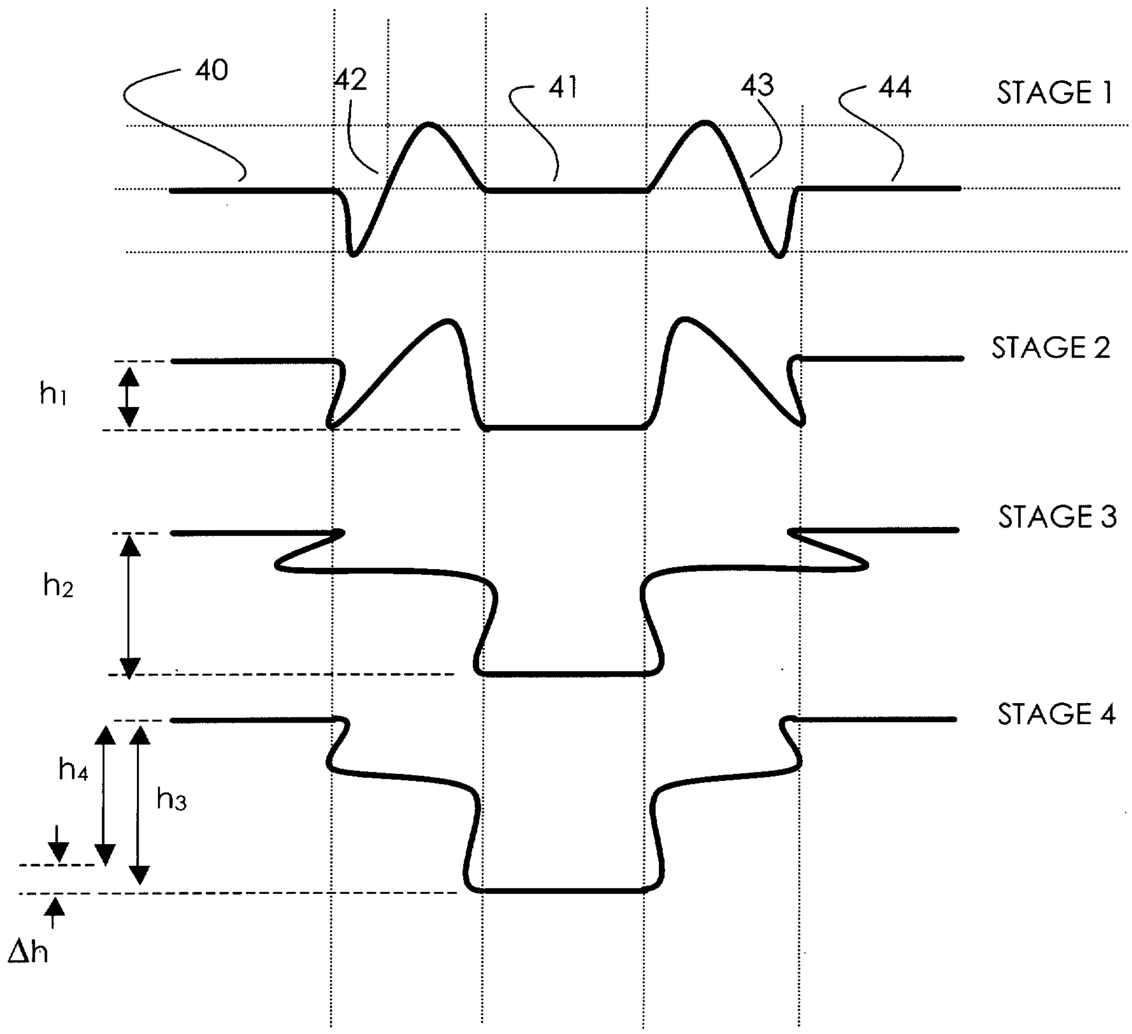

FIGURE 4