This invention relates to electrically conductive leaf springs and more particularly to bridges for reducing or controlling the differential movement of such springs.

Many electrical devices use leaf springs for carrying electrical current. An actuated point on this type of leaf spring moves over a discrete distance (sometimes called the "differential movement") and causes the contacts to open or close an electrical circuit responsive to an excursion of a moving part on an associated control device, sometimes called an "actuator."

The elasticity of the leaf spring causes a second excursion of the moving part returned to normal. This, in turn, returns the electrical circuit to normal. The invention does not require any particular type of leaf spring; however, a monostable snap acting spring will be described, to provide a concrete illustration.

Generally, the actuator for moving the spring has a somewhat critical design characteristic. For example, the actuator could be a relay which must operate only when an applied voltage or current exceeds a given value for a specific length of time. Or, the actuator could be a sensor controlled device which must operate only when the ambient temperature, for example, reaches a certain degree. Those skilled in the art will readily perceive other uses for a leaf spring contact and other reasons why the actuator may tend to have critical characteristics.

In the past, these leaf springs have sometimes tended to require too much mechanical movement. A desirable leaf spring would have a short travel and yet maintain great resilience. This way, the electrical contacts on the leaf spring could be operated responsive to the lightest touch and small motion of an extremely sensitive actuator. However, when efforts are made to decrease the length of actuator travel, the resilience of the spring blade increases and becomes the critical and limiting factor. Hence, there is generally a trade-off wherein some excessive spring travel is tolerated in order to hold the spring resilience within reasonable limits. Or, some increase in resilience is tolerated in order to hold spring travel within reasonable limits. Either way, the leaf spring is less than ideal, requires actuator design compromises, and tends to reduce actuator reliability. Conversely, to carry an increased current, it is sometimes desirable to increase the gap across open contacts without changing the movement differential required to close the contacts.

Accordingly, an object of this invention is to provide new and improved leaf springs for use as part of current carrying electrical contacts. In this connection, an object is to reduce the motion required to cause a contact travel without increasing the leaf spring resilience. Hence, an object is to provide a leaf spring construction where the travel and resilience may be varied independently of each other. More specifically, an object is to either reduce the differential without affecting the open contact gap or to increase the gap without affecting the differential.

Another object of the invention is to increase the sensitivity and reliability of electrical devices using leaf springs. In particular, an object is to provide new and improved snap action switches for use with automatic sensors.

Yet another object of the invention is to accomplish these and other objects without materially increasing the costs of either the leaf springs or the associated actuators. Quite the contrary, an object is to reduce the cost of both the leaf springs and the associated actuators. In this connection, an object is to reduce such costs by making the leaf spring members on conventional machine tools.

These and other objects are accomplished by means of a bridge on a multi-time, leaf spring assembly. In the exemplary construction described herein, the assembly is supported at one end of a line held in tension and biased to a non-normal condition by at least one other line held in compression. When a force is applied to the tension line, the spring snaps to an off-normal position from which it returns—owing to its self-bias—after the force is removed. According to the invention, a bridge member loosely rides upon and at least partly surrounds the line held in tension to preclude the application of a force on a single point to cause a flexing of the tension member. This way, the tension line is flexed by forces which can only occur near the ends of the bridge member. This has the effect of restricting the actuator travel without changing the contact travel.

The above mentioned and other objects and features of this invention and the manner of obtaining them will become more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a bottom plan view which shows an exemplary usage of the leaf spring as part of a snap action switch;

FIG. 2 is a cross sectional view of the switch taken along the line 2—2 of FIG. 1;

FIG. 3 is a top plan view of the leaf spring assembly, per se;

FIG. 4 is a side elevation view of the leaf spring taken along line 4—4 of FIG. 3;

FIG. 4A shows how the tension-line bends without the bridge member;

FIG. 4B shows how the tension-line bends with the bridge member;

FIG. 5 is a cross sectional view of a first embodiment of the invention taken along line 5—5 of FIG. 3;

FIG. 6 is a cross sectional view of a second embodiment of the invention also taken along the line 5—5 of FIG. 3;

FIG. 7 is a top plan view showing of a continuous strip of leaf spring bridge elements produced by an automatic punch press;

FIG. 8 is a top plan view of a single bridge element after it has been cut from the strip of FIG. 7;

FIG. 9 is a cross sectional view of the bridge element taken along line 9—9 of FIG. 8; and

FIG. 10 is a side elevation view of the bridge element taken along line 10—10 of FIG. 8.

The snap action switch of FIGS. 1 and 2 includes a plastic base 20 having a leaf spring assembly 21 mounted thereon. One end of the spring assembly 21 is supported on the base 20 at point 22. The other end 23 of the spring assembly 21 is free to move between the upper and lower positions. In the upper or normal position, the end 23 makes electrical contact with a stationary contact 24. In the lower or off-normal position, the end 23 makes electrical contact with another stationary contact...
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25. Electrical wires (not shown) are attached to these contacts via terminal lugs such as 26.

The leaf spring assembly 21 is here shown as a flat blade of spring material having three tines 27, 28, 29 (FIG. 3). This spring can be made from a cleaned and hardened piece of beryllium copper. The center tine 28 is supported at the end 22 to provide for a mechanical motion in a fixed-free mode. The two outer tines 27, 29 bear against a fulcrum plate 30 (FIG. 1) at points 31, 32, respectively. This plate could be made of brass which is thick enough to preclude any significant motion at the fulcrum points 31, 32.

The proportions of the parts are such that the center tine 28 is held in tension and the outer two tines 27, 29 are held in compression. This compression-tension arrangement provides for a snap action in a well known manner.

The snap action switch of FIGS. 1, 2 includes an actuator (not shown) arranged to exert a downward (as viewed in FIG. 2) force upon the tension leaf spring tine 28. This force is represented by the arrow A1. When this force bears down on the tension tine member 28, the contact end 23 moves over center, and the leaf spring assembly 21 sags to its off-normal position which closes contacts 25, 23 and opens contacts 23, 24. The spring is inherently monostable so that it returns to normal when the force A1 is removed. In the normal position contacts 23, 24 close and contacts 23, 25 open.

In keeping with the invention, bridge means 40 is added to the tension tine member 28 between the point 22 of support and the contact end of the spring. The force A1 is applied to the bridge means. The location and operation of the bridge is shown best in FIGS. 3–6. The design of the bridge itself may be understood best from a study of FIGS. 7–10. The purpose of the bridge is to span any sag in tine 28 (FIG. 4B) and thereby tend to reduce the differential.

In greater detail, the bridge members may be made on a punch press as a continuous strip of material which looks somewhat as shown in FIG. 7. Each section of this strip, such as 40, constitutes a single bridge element. After the punch press has completed the strip, it is sheared, sawed or otherwise cut at the end of each bridge section. For example, the strip of FIG. 7 may be cut at 41, 42 to make the single bridge element which is shown in FIGS. 8–10.

Conveniently, one end of the bridge is shaped to form a tab as shown 43 and two depending lugs 44, 45. This tab 43 is bent downwardly and fitted into a hole 46 formed near the support end 22 of the tension tine member 28. However, this particular arrangement is exemplary only. Neither the tab, lugs, nor hole are required as long as the general purpose of anchoring the bridge is accomplished. The orientation and dimensions of bridge element 40 is such that it fits loosely over the spring tine 28 and extends from near the support 26 toward the contact end.

The bridge lugs 44, 45 fit over either side of the spring 28 to hold the bridge against both sidewise and rotational motion. Then, the lugs are rolled (as shown at 47, 48) to secure the bridge 40 to the spring. As shown at 40 (FIG. 5), the ends of the roll may come close to but avoid actual contact with the spring 28. This provides a freedom, within restricted limits, of flexing motion between the bridge and spring. Or, as shown at 51 (FIG. 6), the roll may be rolled far enough to come into actual contact with the spring 28 to hold the bridge firmly against the spring member. However, in the embodiment of FIG. 6, care must be taken to avoid distortion of the spring 28. This is important because internal stresses would otherwise form in the spring and cause a premature failure due to metal fatigue.

Stated otherwise, a primary advantage of the invention is the freedom which it provides from internal stresses within the spring 28 which could result in an early metal fatigue. These internal stresses could result from stress starters forming at the ends of any areas in the spring which might be stiffened by embossments or rails on or attached to the spring. The embossment or rails is what must be avoided in the embodiment of FIG. 6.

The function of the bridge is to reduce the differential or mechanical motion required to snap the switch. This function may be understood best from a study of FIGS. 4A and 4B. In these figures, dashed lines are used to show the normal position of the tensioned tine 28. A somewhat accurate shaped solid line is used to show symbolically the off-normal position of the 28. The arcuate shape, shown here, is idealized to illustrate the operation; it does not necessarily represent any actual shape of the flexed spring. The supported end of the tensioned tine is indicated by short, slanting ground lines.

If no bridge member is present the spring flexes about a point P where the bending force A1 is applied. This means that the structure applying the force must move over the distance D1, FIG. 4A. This is the movement distance called the differential.

If the bridge 40 is present (FIG. 4B), the spring (solid line) ideally flexes in exactly the same way that it flexes when the bridge is absent (FIG. 4A). However, the bending force is transmitted through the bridge to two points on the spring. The bridge extends over the point where the spring sags the most. This reduces the movement of the structure applying the force to the distance D2. Or stated another way, the bridge reduces the differential from the distance D1 to the distance D2.

An alternative to the embodiment shown herein is to support the bridge on the end of the actuator structure for applying the force A1. In this alternative embodiment, the bridge should be loosely supported (on the end of a pin plunger, for example) so that it may adopt any attitude which allows the spring to follow its normal mode of bending.

An advantage of the invention is that the spring may carry greater current for any given differential. If the current remains the same before and after the bridge is used, the differential is reduced. If the differential remains the same, the current carrying capacity is increased because the contact gap is increased.

While the principles of the invention have been described above in connection with specific apparatus and applications, it is to be understood that this description is made only by way of example and not as a limitation on the scope of the invention. I claim:

1. A multi-tine, leaf spring assembly having at least one tine member held in tension and one other tine member held in compression, said assembly being supported at one end of said tension tine member, said compression tine member biasing said assembly for monostable snap action responsive to an application of force upon said tension member, and generally inflexible bridge member mounted on said tension member between the ends thereof and extending along a substantial length of said tension member for receiving the applied force for reducing the differential required to move said tension member without affecting the resilience of said spring.

2. The assembly of claim 1 wherein said bridge member is made with two depending lugs which fit over either side of the tension member and are formed to secure the bridge to the tension member without distorting said spring.

3. The assembly of claim 1 wherein the formed ends of said lugs do not touch said spring.

4. The assembly of claim 1 wherein the formed ends of said lugs come into contact with said spring.

5. An electrical current carrying leaf spring assembly having at least one blade member mounted adjacent one end and contact means attached to the other end, said means for applying an actuator force upon said spring blade intermediate its two ends to flex said blade and cause it
to move from a normal to an off-normal position, and a generally inflexible bridge member loosely mounted on said tension member between the ends thereof and oriented to extend along the length of said blade member for applying said actuator force at two points on said blade to reduce the differential required to move said member.

6. The assembly of claim 5 and means for precluding a distortion of said spring by said bridge member.

7. The assembly of claim 2 wherein said tension member is formed with a hole near one end and said bridge member has a tab depending through said hole to restrict movement of said bridge along said tension member.

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