Dec. 17, 1935. E. A. HOOPES 2,024,362

SPRING SWITCH

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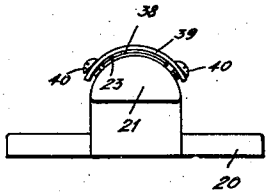
Fig. 6



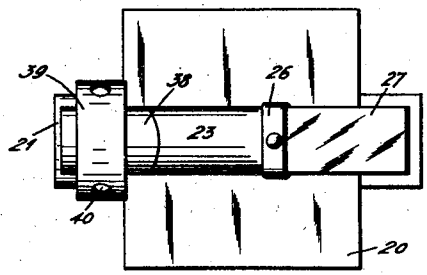
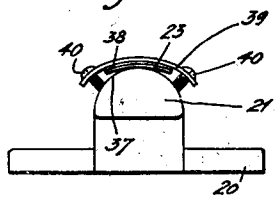


Fig. 4

Fig. 7



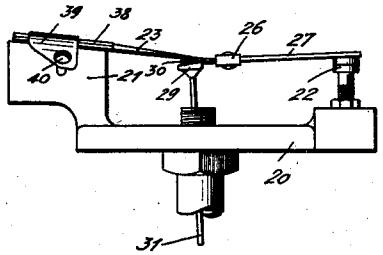
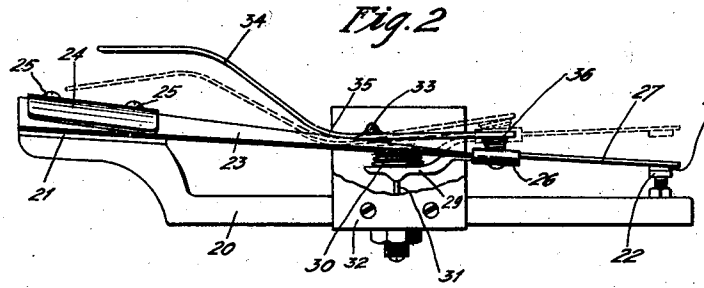


Fig. 5

Fig. 2



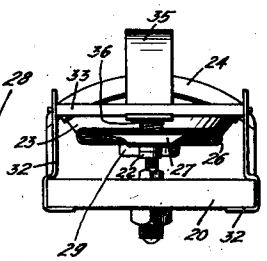


Fig. 3

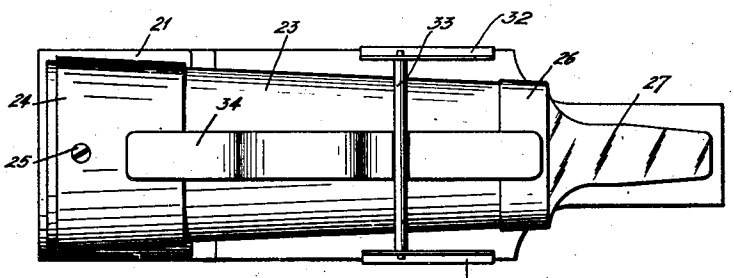


Fig. 1

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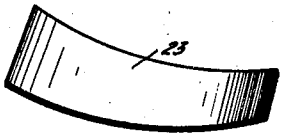


Fig. 8

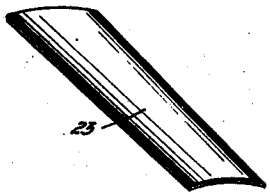
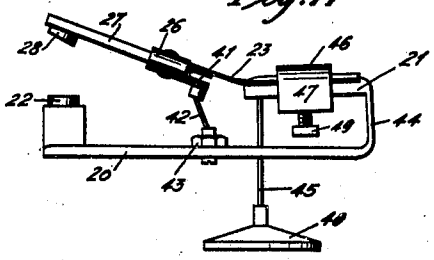


Fig. 9

Fig. 11



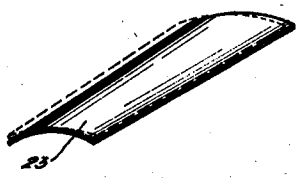


Fig. 10

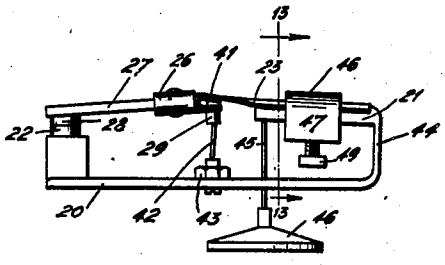


Fig. 12

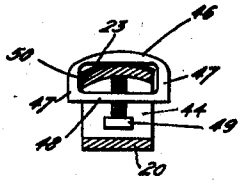


Fig. 13

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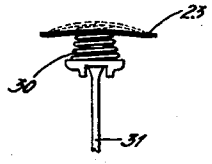


Fig. 14

Fig. 15

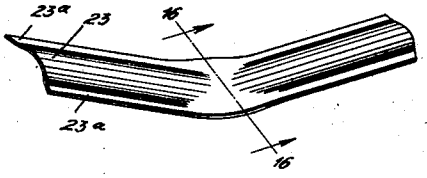
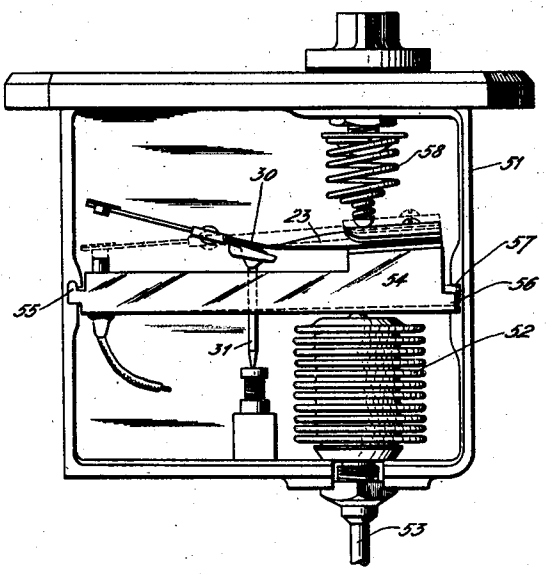


Fig. 16

Fig. 17



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Patented Dec. 17, 1935 2,024,362

UNITED STATES PATENT OFFICE

2,024,362

SPRING SWITCH

Ernest A. Hoopes, Des Moines, Iowa, assignor to Guy H. Hall, Milwaukee, Wis.

Application January 30, 1933, Serial No. 654,129

12 Claims. (Cl. 74—100)

This invention relates to and consists in certain improvements on and additions to the general form of switch devices disclosed in my application for United States Letters Patent filed August 17, 1931, Serial Number 557,557.

In my said application I disclosed means for opening the switch by applying pressure against the under or concave side of the main spring and the main spring automatically returns the switch to closed position when this pressure is released.

One of the objects of my present invention is to provide an improved spring switch in which compression required for springing the switch to open position may be applied to the upper or convex side of the spring, and further in this connection to provide such means whereby pressure upon the convex side of the main spring may be limited to the longitudinal central portion thereof to aid in straightening transversely the portion thus engaged to aid in moving the switch to open position.

A further object is to provide improved and simplified means for mechanically applying pressure alternately to the main spring in such positions as to in one movement cause it to snap to open position, and in another movement cause it to snap to closed position.

A further object is to provide means of simple, durable and inexpensive construction for varying the transverse curvature of the main spring, whereby it may be strengthened or weakened to suit the requirements against bending in a direction toward its upper or convex side.

A further object is to provide an improved method of forming a spring of the character employed in this device substantially straight longitudinally and substantially concavo-convex transversely, and which is intended to be operated by being bent transversely, and whereby the life of the said spring is naturally increased, and whereby the said spring may be bent upwardly or toward its convex side when a transverse portion thereof is straightened out with a minimum amount of crystallization and without weakening the spring at the bent portion.

My invention consists in the construction, arrangement and combination of the various parts of the device, and in the method of preparing the main spring, whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims, and illustrated in the accompanying drawings, in which:

Figure 1 shows a top or plan view of a switch embodying my invention.

Figure 2 shows a side elevation of same with a portion broken away. In this figure the dotted lines show the position of the parts when the switch is opened.

Figure 3 shows an end elevation of same.

Figure 4 shows a top or plan view of a modified form of my improved switch illustrating the means for adjusting the curvature of the main spring.

Figure 5 is a side elevation of same.

Figure 6 is an end elevation of same with the main spring shown at its maximum degree of curvature; and

Figure 7 shows a similar view showing the main spring at a less degree of curvature.

Figure 8 shows a perspective view of the main spring flat in cross section and curved longitudinally illustrating the shape of the spring in a preliminary stage of my improved method of forming same.

Figure 9 shows a similar view illustrating the main spring in its completed form.

Figure 10 shows a similar view illustrating the normal curvature transversely of the main spring, and by dotted lines the curvature transversely when mounted in a switch device ready for use.

Figure 11 shows a side elevation of another modification of my improved switch.

Figure 12 shows a similar view with the switch in a closed position; and

Figure 13 shows a sectional view on the line 13—13 of Figure 12.

Figure 14 shows a transverse sectional view through the concavo-convex spring and the conical spring, as shown in Figure 2, and illustrating by dotted lines the curvature given to the concavo-convex spring by the pressure of the conical spring.

Figure 15 shows an isometric view of the concavo-convex spring in the position which it assumes when the switch is open, and illustrating a modified form of this spring in which the longitudinal edges are relatively straight as compared with the transverse curvature of the body portion thereof.

Figure 16 shows a sectional view of same on the line 16—16 of Figure 15; and

Figure 17 shows a side view of a pressure operated switch embodying my invention, and illustrating a modified form thereof in which the base which supports the concavo-convex spring is tilted at one end by pressure operated mechanism to effect opening and closing of the switch. The dotted lines show the switch in closed position.

Referring to the accompanying drawings, and particularly to Figures 1 and 2 thereof, it will

be seen that my improved switch comprises a base 20. On one end of this base there is a raised spring seat member 21 arched upwardly at its longitudinal central portion as shown in Figure 3. On the opposite end of the base there is an upstanding electrical contact member 22.

Mounted upon the seat 21 is the main spring 23 of my improved switch which is normally substantially straight longitudinally and substantially concavo-convex transversely. It is also tapered longitudinally from the end supported on the seat 21 to its free end. This main spring is secured to the seat by a plate 24 held in place by screws 25 inserted into the seat portion 21.

At the free end of the spring 23 I have applied a cross piece 26 straight transversely, and which holds the adjacent portion of the main spring 23 in a straight transverse position at the edge of the cross piece 26 adjacent to the central portion of the main spring 23.

Extended through this cross piece 26 is a lever 27, with one end projecting straight outwardly from the spring 23 and provided with a contact device 28. The other end of the lever 27 projects under the main spring 23 where it is formed with a cup shaped member 29, and in this cup shaped member is an extensible coil spring of conical shape indicated by the reference numeral 30. Its upper end bears against the under or concave side of the spring 23.

The movable pin 31 is applied to the under surface of the lever 27 below the spring 30. This prevents downward movement of the lever 27 at the point where it is applied.

For causing this switch to snap from its closed to its open position, and for causing it to return to its closed position, I have provided the following mechanism:

On opposite sides of the base 20 are two upright supports 32 between which there is pivoted a rod 33. Fixed to this rod is a lever 34 having a curved portion 35 arranged adjacent to but slightly spaced apart from the rod 33 in a direction toward the fixed end of the main spring 23. The other end of the lever 34 projects forwardly over the lever 27 and a cushioning spring 36 is fixed to its under surface to engage the cross piece 26.

In practical operation with this form of the invention and assuming that the parts are in the position shown by solid lines in Figure 2, then the main spring 23 on account of its transverse concavo-convex curvature tends to yieldingly remain in a straight line, whereas the pressure of the spring 30 against the under or concave side of the main spring tends to move its free end upwardly, but the pressure of the spring 30 is so proportioned that it of itself will not bring a portion of the spring 23 to a substantially straight line position transversely, and hence normally the parts will remain in the position shown in Figure 2.

When, however, it is desired to snap the switch open pressure may be applied to the lever 34 in a direction tending to press the curved portion 35 thereof downwardly against the longitudinal central portion of the main spring 23. This pressure tends to straighten out transversely that portion of the main spring 23, and when this has been wholly or partially straightened out at that point, then the pressure of the spring 23 is sufficient to cause the free end of the main spring and the lever 27 carried thereby to spring rapidly to the position shown by dotted lines in said figure, and separating the contacts 22 and 28, and the parts will remain in that position until the lever 34 is again operated to cause the cushioning spring 36 carried thereby to press downwardly upon the outer end of the main spring 23, whereupon the switch is moved to closed position.

In the modification illustrated in Figures 4 to 7 inclusive, I have shown a means whereby a main spring may be employed of a maximum degree of curvature transversely to thereby be relatively easily flexed in the direction of its upper or convex side, and which may be readily, quickly and easily adjusted by an operator to decrease its curvature transversely to thereby make it relatively harder to flex upwardly in the direction of its convex side.

This mechanism comprises a curved support 21 having its upper or bearing face at 37 made on a substantially less curvature than the normal curvature of the main spring 23.

Mounted on top of the main spring above the seat portion 21 is a small spring leaf 38 of substantially the same material and having substantially the same normal curvature as that of the main spring 23. Above the leaf 38 is a saddle member 39 of bendable material and normally having a considerably greater curvature transversely than that of the seat portion 37. At the opposite sides of this saddle member 39 are two screws 40 extended through the saddle member and screwed into the seat member 21, and whereby the saddle member, the main spring and the spring leaf 38 may all be bent to any degree of transverse curvature less than normal up to the position shown in Figure 6, which is substantially concentric with the curvature 37 of the seat 21.

Obviously by this arrangement the amount of resistance applied to the main spring opposing the opening movement of the switch may be varied to suit the requirements from a minimum amount of pressure applied to the rod 31 for opening the switch when the transverse curvature of the main spring is relatively flat, to a maximum amount of pressure required to open the switch when the curvature of the main spring is at its minimum amount, as shown in Figure 6.

In the modification shown in Figures 10 to 13 inclusive I have shown a substantially U-shaped leaf spring 41 in place of the conical coil spring 30 before described, and for the same purpose, and I have also disclosed a supporting rod 42 engaging the socket 29 on the lever 27 mounted at its lower end in a stationary support 43.

I have also shown a portion of the main frame at 44 made of spring material to normally incline the spring seat 21 downwardly at its forward end, as shown in Figure 10, to thereby apply a yielding downward pressure to the top or convex side of the main spring, tending to flatten the main spring out transversely, and to co-operate with the spring 41 and its support 42 in moving the switch to open position.

In this form of the invention I have shown as a means for moving the switch to a closed position a rod 45 connected with a movable member 46 and engaging the front end of the seat 21, so that an upward pressure upon said rod will tilt the seat 21 to the position shown in Figure 12, and during this tilting movement, the main spring, on account of its resiliency, will snap the switch to closed position.

In Figure 13 I have illustrated a modified form of means for clamping the main spring to the spring seat, comprising a saddle device 46 to pass

over the top of the main spring with a substantially flat surface in engagement with the main spring, and having extensions 47 at its sides extending downwardly beyond the main spring, and a cross piece 48 connecting said extensions. Seated in the cross piece 48 is a set screw 49 engaging a block 50, the curvature of the upper surface of which is substantially the same as that of the adjacent portion of the main spring.

By this means the main spring is firmly clamped on the support at least at its longitudinal central portion, and at the same time the side edges adjacent to the clamped portion are free to move upwardly. This construction operates to relieve the main spring of unnecessary strains and stresses such as might occur if it were clamped on all sides.

In Figure 14 I have illustrated a feature of my invention which is of importance in increasing the life of the main concavo-convex spring and increasing the efficiency of the switch device.

The conical shaped coil spring 30 is of such size and shape that it will engage only the longitudinal central portion of the concavo-convex spring 23. When pressure is applied to the spring 30 in an upward direction by pressure upon the rod 31, then the first effect of this pressure is to cause the spring 23 to be arched upwardly at its central portion, as shown by dotted lines in Figure 14. This causes the spring 23 to be curved along an arch of less diameter, thereby the spring 23 is stiffened against the force of pressure tending to move the spring 23 to a straight line transversely at the point where the spring 30 engages it. Then when pressure is applied to the spring 23 sufficiently to move it to a straight line transversely at one point, the switch will snap open more rapidly than though its central portion had not previously been arched upwardly, as shown by dotted lines in said figure.

One of the advantages of this construction is that the spring 23 need not be given as great a degree of initial curvature before being assembled in the switch as would be necessary but for this action of the spring 30 in arching the spring 23 upwardly, and this tends to prolong the life of the spring 23 in actual use.

In Figures 15 and 16 I have illustrated another feature of my invention which consists in giving the same concavo-convex curvature to the central portion of the spring by leaving the edge portions at 23a substantially straight transversely, as shown in Figure 15. This relative degree of curvature and straightness is somewhat exaggerated for clearness and illustration, but I have found in practice that by leaving the edge portions 23a relatively straight transversely and arching only the central portion between said edges, the tendency for the edge portions to crystallize and break after long use is greatly minimized.

In Figure 17 of the drawings, I have shown a modified form of my improved switch especially adapted for use with pressure operated mechanisms, and which consists of a frame or casing indicated generally by the numeral 51. Mounted in this frame is an expansible corrugated cylinder 52 of ordinary construction to which fluid under pressure is delivered by a pipe 53. The switch mechanism consisting of the concavo-convex spring 23 and associated parts is the same as that illustrated in Figures 4 and 5.

However, the base 54 upon which the spring 23 is mounted is provided at one end with a rounded hinge member 55 seated in a rounded groove in the frame 51 so that the opposite end of the base 54 may have a limited up and down movement. On its opposite end there is a projecting shoulder 56 inserted in a notch 57 in the frame 51 to permit a limited up and down movement of this end of the base 54. A coil spring 58 bears upon the top of the spring 23 directly in line with the expansible cylinder 52.

In operation with this form of the invention, the spring 58 normally holds the switch device in position shown by solid lines in Figure 17. Then when pressure is applied to the expansible cylinder 52, it elevates the adjacent end of the base 52 as shown by dotted lines, which overcomes the pressure of the spring 58 and permits the base 54 to move upwardly. When this base moves upwardly, then the relative pressure of the spring 30 is overcome by the tendency of the spring 23 to assume its straight line position, and the switch moves to a closed position as shown by dotted lines.

My improved method of forming the main spring is as follows:

I first take a piece of flat spring metal, slightly tapered toward one end. I then bend it longitudinally in the manner illustrated in Figure 8, and cause it to become set in that position, preferably by the usual heat treatment for such purposes. I then bend it to the position shown in Figure 9, giving it substantially concavo-convex shape transversely, and when this is done its body will naturally assume a substantially straight line position longitudinally, and I then cause the spring to be set in this position preferably by the customary heat treatment. I then clamp the relative sides of the main spring to a seat or support which has a less curvature than that of the curvature to which the spring was originally set, as illustrated in Figure 9. I then apply pressure to the side edges of the spring to give it a less degree of curvature transversely, as shown by solid lines in Figure 10. The curvature of the main spring longitudinally, as shown in Figure 8, is midway between the positions of the spring when the switch is open and when the switch is closed, so that during this opening and closing movement of the switch a minimum amount of strains and stresses will be set up in the main spring.

In actual tests I have found that where springs are employed like the main spring herein illustrated, but which are not set to the normal curvature illustrated in Figure 8, then in endurance tests the springs not set to the curvature illustrated in Figure 8 before being set to the curvature illustrated in Figure 9 will, during the snapping movement of the switch, crystallize and break much earlier or with a much less number of snapping movements than will occur when the spring is normally set to the position shown in Figure 8 before being normally set to the position shown in Figure 9.

Furthermore, I have found by actual tests that when the spring is normally set to a position shown in Figure 9, on a normal relatively large arc, and later clamped to position with a relatively less arc transversely, then the life of the spring in its snapping switch action is greatly increased over springs which are normally set to the transverse curvature desired for use in the switch.

In repeated tests with main springs of this character I have caused the switch to be snapped from closed to open position and back more than

one million times, without showing any appreciable deterioration in the main spring or any appreciable difference in the amount of pressure which the main spring applies to the contacts when in closed position.

In practical use and with the form of the invention illustrated in Figures 1 and 2, the resiliency of the main spring **23** tends to hold the contact **28** firmly against the contact **22**.

The spring **30**, however, in co-operation with the lever **27**, tends to oppose the resiliency of the spring **23** and tends to move the contact **28** to open position. However, the spring **23** in this respect is stronger than the spring **30**, and when both of these spring pressures are applied, the switch will remain in its closed position, as shown in Figure 2. This switch could be moved to open position by pressure upon the rod **31** in an amount sufficient to bring a portion of the spring **23** to a straight line position transversely, whereupon the spring **23** would become so weakened that the spring **30** would rapidly snap the switch to its open position.

Instead, however, of applying upward pressure to the rod **31**, I have provided a means for snapping the switch to both open and closed positions with a relatively small amount of power by providing the lever **34**. When the handle end of this lever **34** is moved downwardly, then the curved portion **35** thereof presses against the central portion of the main spring against its top or convex side, and this tends to straighten out the main spring transversely at the point where this pressure is applied, and with a very slight amount of applied pressure at this point. The constant pressure of the spring **30** causes the switch to snap to open position where it will remain until an opposite movement of the lever **34** causes the cushion **36** on the opposite end of the lever to engage the outer end of the main spring, or the cross piece **26** thereof, and thus forces this free end of the spring downwardly against the action of the spring **30**, and in the direction of the normal tendency of the spring **23** to move to a straight line position. Hence, a very slight amount of pressure applied to the cushion **36** will snap the switch back to closed position.

In the modified form illustrated in Figures 11 and 12 the main frame of the switch device is formed with a spring element **44** which normally tends to assume the position shown in Figure 11, and throws the switch to and holds it in open position through the co-operation of the fulcrum pin **43**. Then a means for applying pressure through the rod **45** is provided, which, when the pressure is applied, opposes the action of the spring **44**, and permits the switch to snap to closed position, as illustrated in Figure 12.

In the accompanying claims I have used the expression, or its equivalent "means for applying yielding pressure to the main spring in the direction of its convex side", and this is intended to cover any yielding pressure device applied to the spring in such a manner as to cause it to straighten out transversely at one portion, thereby greatly reducing its resiliency and permitting its easy snap to an open position.

I claim as my invention:

1. In a device of the class described, the combination of a spring substantially concavo-convex in cross section, means for supporting it, means for applying a yielding pressure to an unsupported portion of said spring in a manner tending to bend said portion in the direction of its convex side, but in an amount less than that required to bring said spring to a substantially straight line position transversely, and means for applying pressure to the convex side of said spring in an amount sufficient to bring said spring to a substantially straight line position transversely, and whereby the said means for applying a yielding pressure to said spring will cause the unsupported portion of said spring to move rapidly in the direction in which it is forced by said yielding pressure means.

2. In a device of the class described, the combination of a spring substantially concavo-convex in cross section, means for supporting it, means for applying a yielding pressure to an unsupported portion of said spring in a manner tending to bend said portion in the direction of its convex side but in an amount less than that required to bring said spring to a substantially straight line position transversely, and means for applying pressure to the convex side of said spring between the supported portion and the portion where the said yielding pressure is applied in an amount sufficent to bring said spring to a substantially straight line position transversely, and whereby said means for applying a yielding pressure to said spring will cause the unsupported portion of said spring to move rapidly in the direction in which it is forced by said yielding pressure means.

3. In a device of the class described, the combination of a spring substantially straight longitudinally and substantially concavo-convex transversely and having a normal set which tends to return the spring from any position to a straight line position longitudinally, means for supporting it at one end, means for applying a yielding pressure to the concave side of its opposite end, and means for applying a pressure to the convex side of said spring, for the purposes stated.

4. In a device of the class described, the combination of a spring substantially straight longitudinally and substantially concavo-convex transversely and having a normal set which tends to return the spring from any position to a straight line position longitudinally, a lever fulcrumed to one end of said spring having a portion thereof projected adjacent the concave side of said spring, a yielding pressure device interposed between said lever and the concave side of said spring and said lever, and means for applying pressure to said spring in a direction tending to straighten it transversely at one point, for the purposes stated.

5. In a device of the class described, the combination of a spring substantially straight longitudinally and substantially concavo-convex transversely, means for applying pressure to a portion of the spring tending to move it in the direction of its convex side, and means for varying the curvature of said spring transversely to make it more or less rigid in opposing said pressure applying means.

6. In a device of the class described, the combination of a spring substantially concavo-convex in cross section, means for applying a yielding pressure to said spring tending to move it in the direction of its convex side, and means for applying pressure to the convex side of the spring tending to bring it to a straight line position transversely.

7. In a switch of the class described, the combination of a spring substantially straight longitudinally and substantially concavo-convex transversely, a second spring engaging the central longitudinal portion only of the concave side of

the concavo-convex spring, and means for applying pressure to said second spring in a direction tending to increase the curvature of the concavo-convex spring.

8. An improved switch comprising a base, means for pivotally supporting the base at one end, a spring substantially straight longitudinally and substantially concavo-convex transversely fixed at one end to said base, a contact carrier on the free end of said spring, a support engaging the concave side of said spring near its free end, and means for moving the free end of the base to open the switch when moved in one direction and to close it when moved in the opposite direction.

9. In a device of the class described, the combination of a spring substantially straight longitudinally and substantially concavo-convex transversely, a support for said spring having a spring engaging portion shaped to normally engage only the longitudinally central portion of said spring, and a spring adjusting device for adjusting the edge portions of said spring toward said support to increase its curvature transversely.

10. In a device of the class described, the combination of a spring substantially straight longitudinally and substantially concavo-convex transversely, a support for said spring having a spring engaging portion shaped to normally engage only the longitudinally central portion of said spring, a flexible saddle engaging the convex side of said spring, and screws passed through the saddle and seated in the support for adjusting the side portions of said spring toward the support to increase its curvature transversely.

11. In a device of the class described, the combination of a spring of a length materially greater than its width and substantially concavo-convex transversely, a yielding pressure device applied to said spring in a manner tending to bend it in the direction of its convex side, and means for applying pressure to said spring in a direction for opposing the action of said yielding pressure device.

12. In a switch of the class described, a spring substantially straight longitudinally, the central portion of the spring being substantially concavo-convex in transverse section, and the side edge portions being approximately straight in transverse section for the purposes stated.

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