Nov. 5, 1968 E. B. JUDD ET AL 3,409,749

TOGGLE DRIVE MECHANISM

Filed Aug. 28, 1967

FIG. 1.

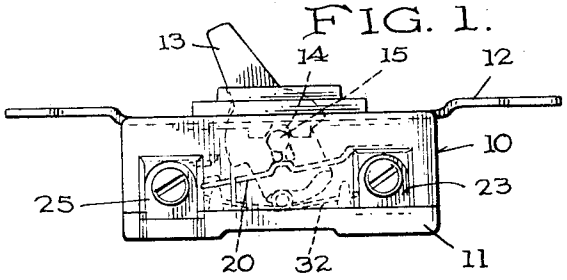


FIG. 2.

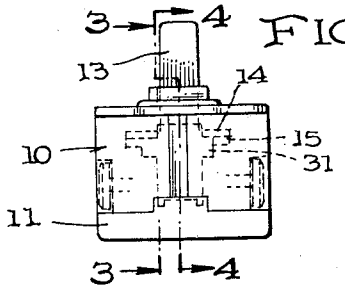


FIG. 3.

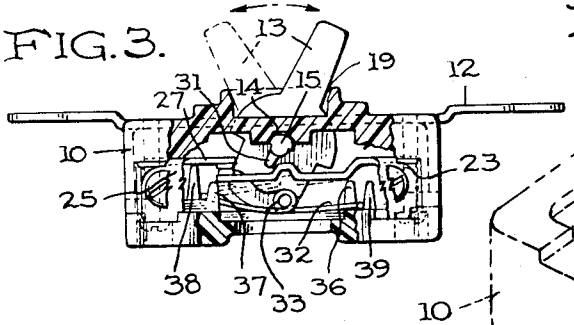


FIG. 4.

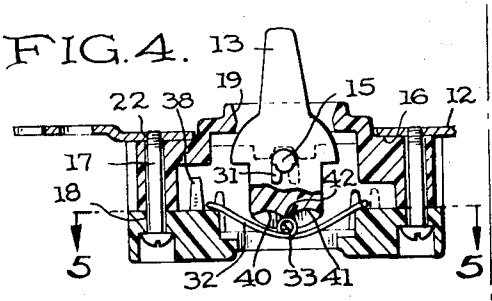


FIG. 5.

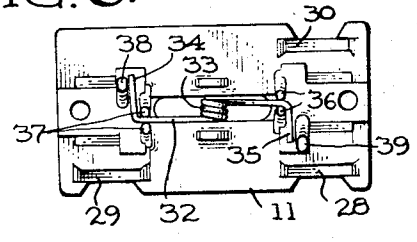


FIG. 8.

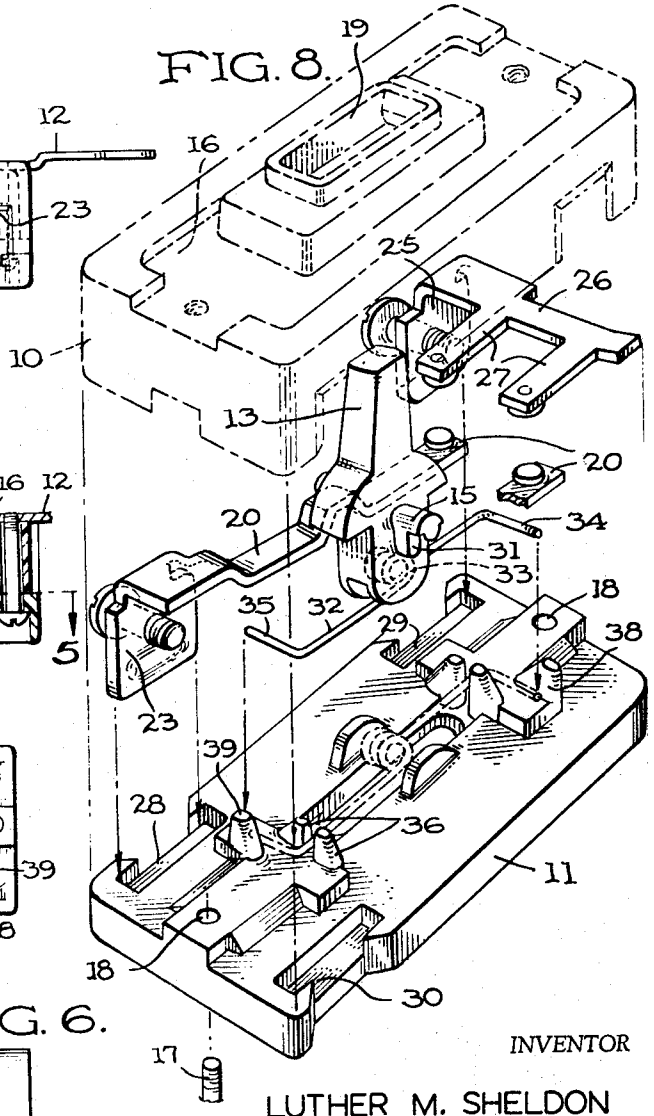


FIG. 7.

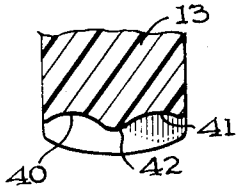
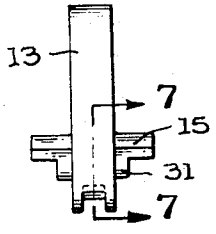


FIG. 6.



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TOGGLE DRIVE MECHANISM

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Continuation-in-part of application Ser. No. 496,044, Oct. 14, 1965. This application Aug. 28, 1967, Ser. No. 667,037

8 Claims. (Cl. 200—67)

ABSTRACT OF THE DISCLOSURE

A toggle mechanism for a switch is provided which employs a spring for the toggle action such that the longest dimension of the spring lies in the plane of movement of the toggle trigger. A novel bumper action is achieved from the spring which is conventionally obtained by use of rubber bumpers.

The present invention relates to trigger mechanisms for switches and the like such as may be employed for use in alternating current circuits, and particularly to a toggle drive mechanism for throwing the switch trigger to a normal rest position when manual pressure on the trigger is released.

This is a continuation-in-part of application Ser. No. 496,044 filed Oct. 14, 1965 and assigned to the same assignee as this application.

In the past most electric switches for use in residential wiring were designed to be operated from both direct and alternating current circuits. However, for many years alternating current has been used almost exclusively in homes so that switches for home use need not be designed for the dual purpose of operating both AC and DC circuits. A switch for alternating current use only can be much simpler in design and quieter in operation. It is this quiet operation which has been found most desirable and which explains in part the extensive use of various silent mercury switches in homes. It is desirable that such switches achieve the large number of switching actions without failure in spite of the lighter construction and lower cost of the structures.

We have illustrated a toggle drive mechanism in the drawings showing a torsion spring which is suspended in the interior of the switch housing such as to allow the lower cam face portion of the trigger to engage the central coil portion of the spring. The cooperation of the cam face portion of the toggle drive and the central coil portion of the spring tends to move the trigger to either one of its extreme rest positions when the trigger is initially not at such a position and is released by the hand. To provide stability of operation around an axis of the long dimension of the switch such that the spring does not become displaced and further for enhancing the resilient, or working, action of the spring there are provided end members, or feet, at the respective ends of the spring. These feet, supported by a specific arrangement of bosses integral with the switch housing, in effect provide resilient supports for the suspended torsion spring, as well as provide vertical (anti-tipping) stability to the spring. In addition, the end members provide a soft end stop for the trigger movement, thus eliminating the need for damping bumpers as are used on conventional switches to quiet the toggle action at the end of the stroke.

Accordingly, it is the principal object of this invention to provide a fast-make, slow-break, electric switch with a novel toggle drive mechanism that includes a torsion spring and serves to reduce the noise present in the operation of the switch trigger.

A further object of this invention is to provide an electric switch with a novel toggle drive mechanism comprising a torsion spring suspended in the interior of the switch housing substantially axially perpendicular to the pivotal axis of the trigger switch for cooperation with the cam surface on the lower end of the trigger switch to hold the trigger normally in one of its two extreme positions.

An additional object is to provide a spring adapted to accommodate a large number of deflections of the indexing cams of a pivotable control member such as a switch trigger.

A further object of this invention is to provide a novel toggle drive mechanism comprising a torsion spring having end members which allow for stable operation around an axis of the long dimension of the switch.

Still a further object of the invention is to provide an electric switch with a novel toggle drive mechanism comprising a torsion spring having end members which act to enhance the resilient or working action of the torsion spring in the direction of the long axis of the switch.

Our invention will be better understood from the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

FIGURE 1 is a front elevational view of a fast-make and slow-break switch embodying our invention;

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

FIGURE 3 is a cross-sectional view taken on line 3—3 of FIGURE 2;

FIGURE 4 is a cross-sectional view taken on line 4—4 of FIGURE 2;

FIGURE 5 is a cross-sectional elevational view taken on line 5—5 of FIGURE 4;

FIGURE 6 is an elevational view of the trigger switch according to our invention;

FIGURE 7 is a transverse elevational view of the trigger switch shown in FIGURE 6, and

FIGURE 8 is an exploded diagram showing the several parts of a fast-make and slow-break switch embodying our invention.

The term torsion spring as used herein is used in the same sense that the term is used in the spring industry and spring art. As found in industrial literature springs exerting pressure along a path which is a circular arc or, in other words, providing a torque are called torsion springs and the term torsion spring as used herein is intended to have this meaning. A coil spring, the coil of which may be stressed or twisted about the axis of the coil and accordingly within which coil a return force is generated tending to reverse the initial twisting, is one type of torsion spring as the term torsion spring is used herein. It is necessary to clarify this point because as pointed out in technical literature the term is somewhat confusing because the individual strands of compression and extension springs are subjected to stresses which are torsional while the strands of the coil of what is designated here as a "torsion" spring is subjected to bending stresses.

Also it is necessary to distinguish between a torsion spring, which is used here to designate the general shape or form of a spring, and a torsional force which designates the nature of the physical action occurring within a member or strand. This distinction is clear from the above where it is pointed out in essence that compression and extension springs in coil form operate principally through torsional forces and the coils of torsion springs operate through bending forces.

The spring illustrated in the figures may be seen to be a torsion spring because it has a central coil portion and the displacement of this central portion by the action of the trigger causes a twisting or tightening of the coil about the axis of the coil. This is evident from an exam-

ination of the orientation of the longitudinally extending portions of the spring **32** relative to the coil portion in FIGURE 3 as compared to these same parts in FIGURE 4. It will be appreciated in the operation of a torsion spring, that is in the development of bending forces in the coils of the torsion spring such as that illustrated, the development of a return force around the axis of the coil is dependent on the change in the relative position of the coil ends and coil axis to develop a twisting of the coil and not on which of the three elements is fixed and which is moved to cause the twisting to occur.

To avoid misunderstanding of the operation of the switch it is also pointed out that a torsional force is developed along the long dimension of the spring. This torsional force along the long dimension of the spring is distinct from the bending forces which are generated in the coil and which give rise to the torque about the axis of the coil when the coil is displaced due to motion of the trigger. The torsional force developed along the long dimension of the spring is referred to above in the paragraph describing the stability of operation around an axis of the long dimension of the switch and in particular is referred to as the vertical or anti-tipping stability of the spring.

Referring now in detail to the drawing and particularly to FIGURES 1 and 2, a hollow switch housing is provided molded of suitable insulating material and comprising a shallow recessed base **11** and a hollow cover **10** is provided with a recess **16** on its upper surface to receive a steel mounting strap **12** which serves as the means for supporting the switch in a switch box in a well-understood manner. A switch handle or trigger **13** is also a molded part which extends through aperture **19** and is pivotally mounted in open bearings **14** in the opposite side walls of the housing **10** by means of trunnions **15** extending transversely of the trigger. As pointed out above the mounting strap **12** fits in a recess **16** in the top side of the housing **10**. Screws **17** extending upwardly through holes **18** in the base **11** engage the mounting strap by suitable threaded apertures therein to hold the mounting strap onto the housing and confine the switch parts in assembled relation.

The particular method of securing the movable and fixed contacts within the housing does not form part of the present invention since it is part of the subject matter of U.S. Patent No. 2,841,673 issued on July 1, 1958. However, for purposes of clarity a brief description of these parts will be given. The fixed contacts **27**, best seen in FIGURE 8, are stamped out of a strip material to have a connecting bar **26** and a terminal end **25** slightly wider than and extending at right angles to the main portion of the contact so that the terminal end may be slid down into groove **29** in the base **11**. The movable contacts **20** (only one of which is shown in FIGURE 8 for the sake of clarity) are similar in over-all shape to the fixed contacts **27** in that they are stamped of resilient strip material and have respectively right angular terminal portions **25** and **23** that are wider than the main portion of the contact so that they may be mounted in the opposed grooves **28** and **30** respectively in the base **11**.

The trigger **13** is designed to pivot on its trunnions **15** between two extreme positions as shown in FIGURE 3. A cam detent **31** extends downwardly below each trunnion **15** for engagement with the spring arm of a related movable contact **20** or with each movable contacts **20** in the case of a three-way switch. In the position of the trigger **13** shown in FIGURE 1, the cam **31** is holding the movable contact **20** away from the corresponding fixed contact **27** so that the circuit is open through the switch. It should be understood that as the trigger **13** moves to the right, the small cam **31** will move clockwise and allow the movable contact **20** to spring into engagement with the fixed contact **27**. It is preferable, however, to provide a toggle drive mechanism in the switch for forcing the trigger **13** to either of two extreme positions when it is released by the hand. By this is meant that it is preferred that an operator should not be able to move the trigger a slight amount into an intermediate position such that the trigger can remain at that position when the operator releases the trigger handle. It is important that this occurrence be eliminated where it is possible that the contacts would be only slightly open because in such case an arc would jump across the short air gap and tend to burn out the contacts until the switch is rendered inoperative. In accordance with this invention a unique toggle drive mechanism is provided for forcing the trigger into one of its two extreme rest positions or for permitting the contacts to be forced apart by a substantial distance before the trigger can be maneuvered into a "rest" position between the two normal and stable "at rest" positions.

As best shown in FIGURES 3–5, the toggle drive mechanism comprises a torsion spring **32** which is substantially unsupported throughout its axial length above the base **11**. The torsion spring **32**, at its respective ends, however, is supported by end members, or feet, **34**, **35** which are arranged at right angles to the axial length of the spring **32**. Each foot extends in an opposite direction with respect to the other from the major axis of the torsion spring **32**. As shown in FIGURES 5 and 8, two pairs of bosses **36**, **37** extend upwardly from the base **11** and the torsion spring fits loosely in the slots defined by the pairs of bosses at those portions of the main body of the spring adjacent the end members **34**, **35**. Additional boss members **38** and **39**, each located to the rear of a respective pair of the bosses **36**, **37**, are off-set from the long axis of the spring in respective opposite directions so that each boss provides a vertically extending surface against which rests a portion of a respective end member **34**, **35**. It is important, however, that the bosses **38**, **39** do not extend along the full length of their respective end members **34**, **35**, but rather remain out of contact with the bent portions in order to allow freedom of motion of the spring along its long axis. With the spring supported in this manner, the central portion including the coils **33** is unsupported and thus is, in effect, suspended between the boss members **36**, **37**.

At the base of the trigger switch **13** there is provided an indexing cam having spaced pockets **40**, **41** divided by a central tip portion **42**, as seen in FIGURES 4 and 7. The coil portion **33** of the torsion spring fits into either one of the spaced pockets **40**, **41**, each of which defines a rest position for the trigger switch when the trigger **13** is in either of its two extreme positions, as seen in FIGURES 1 and 3. When the trigger is moved toward its opposite position, however, the central tip **42** will depress the central portion of the spring **33** such that the spring will tend to be unstable in this position, as best seen in FIGURE 4, and will tend to slip off the central portion into either one of the spaced pockets **40**, **41**. Failure to slip off the central portion produces no adverse effect where the movement of the switch contacts provided for requires, as in the switch illustrated, that the contacts be widely separated when the trigger is in its mid zone. Once the trigger **13** is off-center the inherent resilience in the spring will tend to pivot the trigger into a predetermined position as defined by the curvature of the pockets **40**, **41**.

During the operation of the trigger switch from an "on" position to an "off" position, there is, in effect, no noise because of the rubbing engagement between the cam surface of the trigger switch and the coil spring **33**. The coils in the central portion **33** are contiguous as shown in FIGURES 5 and 8 and, therefore, present an uninterrupted surface to the entire cam surface of the trigger switch **13**, thus distributing the wear of the coil portion **33** of the spring **32** uniformly over the cam surface of the trigger switch **13**. Further, the end members **34**, **35** act as springs themselves in the direction of the long axis of the switch since they are supported at one side or the other

of the long axis by the two rear off-center bosses **38, 39.** This gives the coil part **33** of the torsion spring a freedom of motion with the long axis of the switch as it goes over center of the trigger cam which greatly lessens the "dead zone" when the spring passes the center tip portion **42** of the cam. The freedom of deflection of the torsion spring in various directions is non-symmetrical in that its degree of deflection in the plane of movement of the trigger but in a direction toward and away from the axis of rotation of the trigger is greater than its degree of deflection responsive to the same amount of force applied in a direction parallel to the long axis of the spring. One consequence is that the bumper action is firmer than that observed using a coil spring having a coil axis lying parallel to the axis of rotation of the trigger because such a coil spring when held at both ends is radially deflectable symmetrically at its mid-section, that is, a force applied radially to the mid-section in essentially any direction will result in an essentially equal deflection of the mid-section responsive to the force. The differential deflectability of the torsion spring as taught herein thus gives a firmer damper or bumper action while allowing a relatively highly articulated overcenter action.

The spring action of the end members provides a soft end stop for either of the rest positions of the trigger switch, thus eliminating the need for rubber damping bumpers as are used on conventional switches to quiet the toggle action at the end of the stroke. In this regard the off-set boss members **38, 39** lie adjacent the respective edges of the end members **34, 35,** but out of contact with the bends of the end members so as to allow complete freedom of the long axis of the spring to work in the front-to-back plane of the switch. Thus, when the trigger switch is moved from either one of its extreme rest positions toward its opposite position, it biases the torsion spring **32** downwardly or toward the back plane of the switch during the midportion of its stroke as best seen in FIGURE 4. At this point, when manual pressure is released from the trigger, the spring **32** is working its maximum force in its long direction thus causing the end members **34, 35** to be biased against their respective boss members **38, 39.** This biasing action of the end members **34, 35,** which can be considered stored or potential energy, then becomes dissipated as soon as the central portion **33** of the torsion spring rides over the central tip **42** of the cam surface, thus insuring a positive drive of the central portion **33** of the spring into either one of the spaced pockets **40, 41** of the cam surface. This action results in a fast make with minimum contact bounce and a slow break for minimum destructive arc between the contacts in the switch housing. Further, the resilient action of the end members **34, 35** results in a low spring gradient in the working direction of the spring **32** and a low maximum force on the central tip **42** of the cam, thus allowing for a smooth trigger action.

Having described our invention of a novel toggle drive mechanism using a torsion spring extending in the longitudinal direction of the switch housing, it will be readily apparent to those skilled in the art that it is possible to adapt this mechanism to either a fast-make or slow-break ON-OFF switch or a momentary contact action switch with a minimum number of parts and at an attractive cost as compared with previous designs.

Although only one embodiment of the invention has been depicted and described, it will be apparent that this embodiment is illustrative in nature and that a number of modifications in the apparatus and variations in its end use may be effected without departing from the spirit or scope of the invention as defined in the appended claims.

In a test of the spring of this invention in an actual switch housing the spring was in good operating order after the switch had been subjected to over one million mechanical on-off cycles.

As part of the same test a switch employing a compressing spring supported in a switch housing in the manner illustrated in U.S. Patent 2,841,673 failed at between 150,000 and 175,000 mechanical on-off cycles due to the spring breaking into two parts.

While other compression springs have been shown to have far more extended useful lives it is apparent that the compression type spring, when mounted in housings such as that shown in Patent 2,841,673 is not disposed to function in its intended manner i.e., to undergo axial compression or elongation, and that concentration of forces along the length of the spring due to radial deflection, can shorten the spring life. The useful life of the torsion spring mounted in the housing of this invention operates in a manner consistent with its design and gives very extensive useful life which has been determined to be well over a million mechanical on-off cycles for almost all such switches.

In the mechanical on-off testing the contact arm **20** of most switches broke before one million mechanical on-off cycles were completed so that a better contact arm having a longer useful life had to be developed to take advantage of the extended useful life of the spring.

One factor which, based on mechanical on-off cycle testing, evidently plays an important part in the operation of the device of this invention is the ability of the resiliently suspended coil portion to itself coil up and uncoil sufficiently to add to the deflection action of the overall spring. This is evident for example from tests in other housings of springs having a single coil at the mid portion, or a simple bent wire spring, where the ends of the spring bore against the housing in an alignment which brought the end of the spring (the end formed when the wire was cut) directly into contact with the insulating housing. In such alignment the flexing of the spring caused the end to abrade and dig into the insulating housing to such a degree as to lead to a failure of the spring action. Following more than one million mechanical on-off cycles of the torsion spring as mounted in accordance with this invention, it was observed that there is no appreciable wear or abrading of the bosses or of the housing surfaces but rather a burnishing or polishing of the surface against which the spring bears.

What is claimed is:

1. In an electric switch comprising a hollow housing, movable and fixed contacts, a manually operable trigger movable about a pivotal axis between two rest positions and having an indexing cam surface, elongated wire torsion spring means positioned in said housing, means on opposite ends of said housing to align the long dimension of said spring generally perpendicular to the pivotal axis of said trigger, means connected to said aligning means resiliently suspending a middle coil portion of said spring means for deflection thereof at least partially in a direction normal to both the pivotal axis of the trigger and the long dimension of the spring, said indexing cam surface and the suspended portion of said spring being mechanically engaged to bias said trigger into its rest positions.

2. The switch of claim **1** in which said elongated spring is given anti-tipping stability by torsional force developed along the long dimension of said spring.

3. The switch of claim **2** wherein the torsion spring central coiled portion extends upwardly to engage the indexing cam surface.

4. The switch of claim **1** wherein detent means are provided on said trigger for operative displacement of said movable contacts.

5. The switch of claim **3** wherein the outside surfaces of said pockets conform to the contour of said coil to cushion the end of the trigger stroke.

6. In a switch trigger mechanism a hollow housing, a manually operable trigger movable about a pivotal axis between two rest positions, the base portion of said trigger extending in the interior of said housing and forming an indexing cam surface with two spaced pockets separated by a central tip and a wire torsion spring having a central coil portion, said spring supported on each end by

said housing with the axis of said coil axially parallel to the pivotal axis of said trigger, the central coil portion of said spring engaging said cam surface, whereby said spring coil when in enagement with either of said spaced pockets maintains said trigger in its rest positions.

7. In an electric switch trigger mechanism according to claim 6 wherein said torsion spring includes end members supported by said housing parallel to the pivotal axis of said trigger, whereby said end members provide a resilient and anti-tipping support for the central portion of said torsion spring.

8. The electric switch of claim 7 wherein the support of said end members is by boss means positioned adjacent portions only of said end members whereby said end members are resiliently biased against but not immobilized by said boss means.

References Cited

UNITED STATES PATENTS

2,848,574	8/1958	Hutt et al.	200—68
2,969,442	1/1961	Benander et al.	
2,987,592	1/1961	Johnson.	
3,178,530	4/1965	Lawson.	

FOREIGN PATENTS

637,495	10/1936	Germany.
772,783	4/1957	Great Britain.

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