Oct. 25, 1966 R. N. NANNINGA 3,281,553

SNAP SWITCH WITH DUAL BLADES URGED TOWARD EACH OTHER

Filed Nov. 4, 1963 2 Sheets-Sheet 1

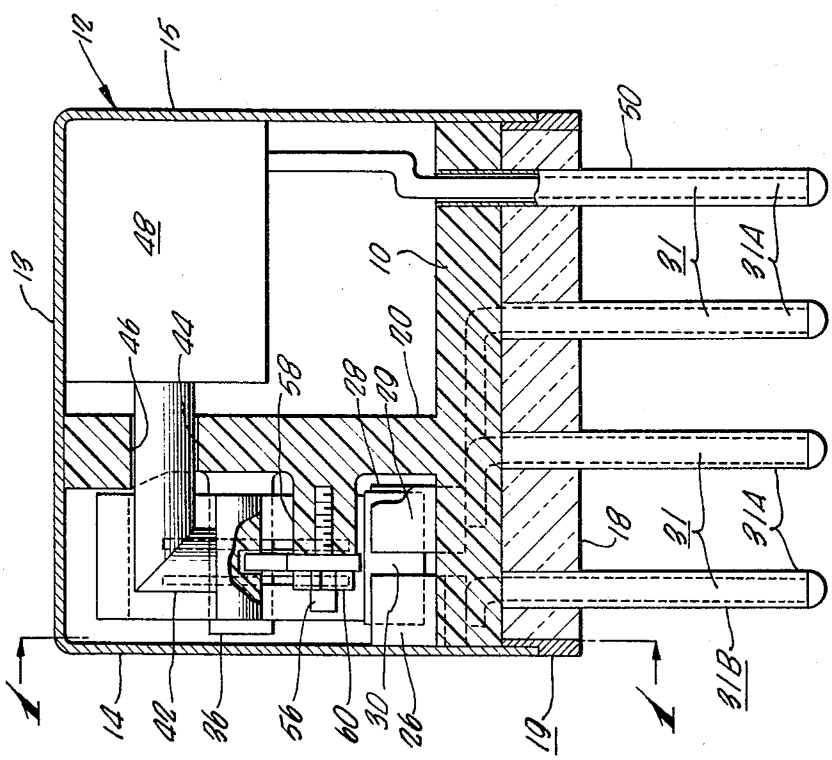

FIG. 2

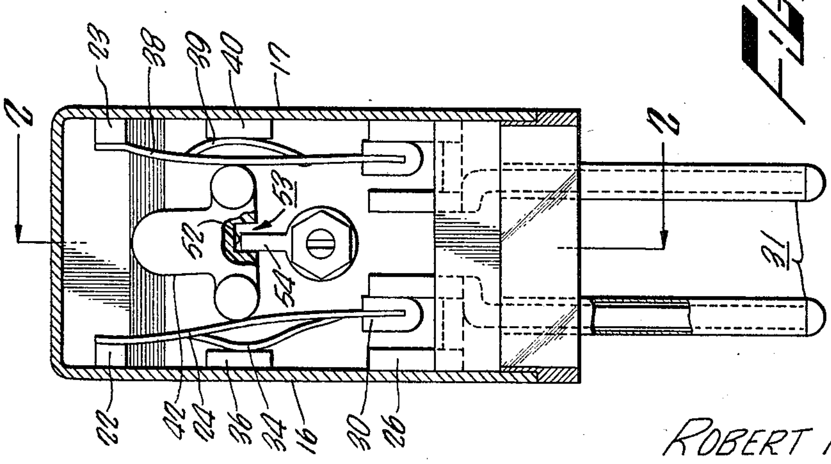

FIG. 1

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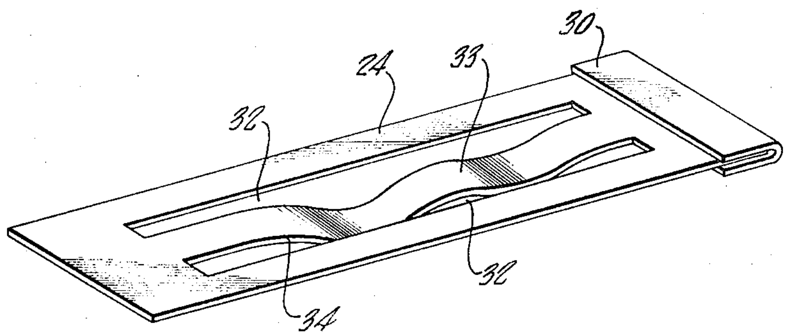


FIG_3_

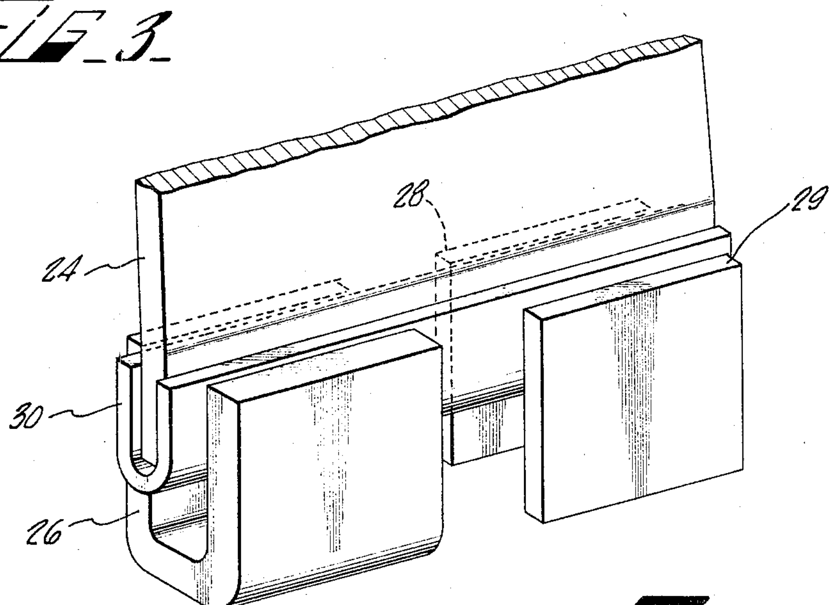
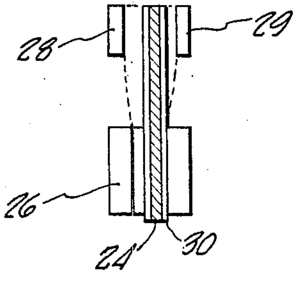


FIG_4_

FIG_5_



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SNAP SWITCH WITH DUAL BLADES URGED TOWARD EACH OTHER

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This invention relates to switches, and more particularly to snap switches having rapidly operating blades for closing and opening contact elements.

My U.S. Patent 3,013,131 describes a snap switch in which a snap action blade has a sensitive area that causes the blade to snap from one position to another when the sensitive area is moved relative to an adjacent portion of the blade from an unstressed to a stressed condition.

One of the advantages of the prior art snap action blades is that they exert a high contact pressure when actuated. Unfortunately, the blades also require a relatively high force for actuation. This is a disadvantage when the snap switch is to be actuated remotely, say, with a solenoid, because a relatively large solenoid must be used and, therefore, limits the minimum size of the switch, which often must be fitted into cramped and sometimes almost inaccessible spaces.

This invention provides an improved snap action switch which greatly reduces the force required to actuate such a switch without sacrificing any of the inherent advantages in snap switches using snap action blades. Moreover, the snap action switch reduces the amount of movement required to change the condition of the switch, thereby further minimizing the size of the solenoid.

In the snap action blade switch of this invention, a biasing force or spring means urges the blade from its normal or unstressed condition to an actuated or stressed condition. The biasing force or spring is not strong enough to shift the blade from the unstressed to the stressed condition, but it substantially reduces the force required to actuate the blade, and thus permits a snap action relay switch of subminiature size to be designed.

Briefly, the snap switch of this invention includes a support on which is mounted a snap action blade that has a sensitive area which causes the blade to snap from one position to another when the sensitive area is moved relative to an adjacent portion of the blade between an unstressed and a stressed condition. An electrical contact is disposed adjacent the blade, and means are provided for moving the sensitive area of the blade relative to an adjacent portion to cause the blade to snap against and away from the contact. Spring biasing means are arranged to urge the blade toward its stressed position. However, the spring means is insufficient by itself to force the blade from the unstressed to the stressed condition required to cause the blade to snap from one position to another. The additional force, which is substantially reduced by the spring biasing means, is supplied by the means for moving the sensitive area relative to the rest of the blade.

In the preferred form of the invention, the moving means is solenoid-actuated.

Preferably, a shorting bar of higher electrical conductivity than the remainder of the blade is attached to one end of the blade to engage two electrical contacts when the blade is in one position or the other. Thus, when the shorting bar is forced against the two electrical contacts, an electrical circuit, which forms no part of this invention, may be closed without causing current to flow through the main body of the spring. This reduces heating of the spring and increases spring life. Moreover, since the shorting bar is of higher electrical conductivity than the body of the spring, the resistance of the circuit is reduced.

In another preferred form of the invention, two snap action blades are mounted in opposing relationship, and a common actuator is used for moving the separate respective sensitive areas of the blades relative to their respective adjacent portions to cause the blades to snap against and away from respective electrical contacts. With this arrangement, one of the blades is in the stressed condition, while the other is in the unstressed condition. The stressed blade acts as the biasing means to urge the actuator to move the sensitive area of the other blade toward its respective stressed position. Preferably, the actuator includes a control gap, and an adjustable balance and stop pin is disposed in the gap for setting the actuator to provide a proper stressing of the respective blades, and to prevent over-traveling.

These and other aspects of the invention will be more fully understood from the following detailed description and the accompanying drawings, in which:

FIG. 1 is an end sectional elevation of the presently preferred embodiment of the invention;

FIG. 2 is a view taken on line 2—2 of FIG. 1;

FIG. 3 is a perspective view of one of the snap action blades used in the switch shown in FIGS. 1 and 2;

FIG. 4 is a fragmentary perspective view of one end of one of the snap action blades and adjacent electrical contacts; and

FIG. 5 is a plan view of the contacts shown in FIG. 4.

Referring to FIGS. 1 and 2, a horizontal rectangularly shaped base **10** which is made of any suitable electrical insulating material, such as plastic, is sealed within a case **12** having a top wall **13**, front and rear walls **14**, **15**, respectively, left and right side walls **16**, **17**, respectively, and a bottom or header **18**, which is made of an electrical insulating material, such as glass or plastic. A metal band **19** encircles the header and is bonded to it. The band is hermetically sealed, say, by welding, to the lower edges of the case walls. An upwardly extending transverse support wall **20** is formed integrally with an intermediate portion of the base to be parallel with the front and end walls and to extend from one side wall to the other of the case. The upper end of the support terminates just short of the top of the case.

Left and right mounting blocks **22**, **23**, respectively, are formed integrally with the forward face of the support and extend toward the forward wall **14** adjacent the upper sides of the left and right walls, respectively, of the case. The upper end of a left snap blade **24** of generally elongated rectangular shape is secured rigidly at one end to the left mounting block. The blade extends downwardly to terminate just short of the base. The lower end of the left snap blade fits within an upwardly opening U-shaped common electrical contact **26** (FIG. 4), between a normally open electrical contact **28** and a normally closed electrical contact **29**. A U-shaped shorting bar **30** is bonded over the lower end of the snap blade. The shorting bar is preferably a metal of relatively high conductivity, say, a silver alloy. The snap blade is made of a high quality spring metal, such as berryllium-copper alloy, Phosphor bronze alloy, or spring steel.

As shown best in FIG. 5, the spacing between the upper portions of the U-shaped contact is slightly less than the spacing between the normally open and normally closed contacts. This arrangement produces a damping effect on the snap blade when it is snapped from contacting one side of the U-shaped common contact and, say, the normally closed contact to engage the opposite side of the U-shaped common contact and the normally open contact. As shown in slightly exaggerated form, the blade is sufficiently flexible to permit the lower end of the bar to twist or warp slightly so that either the normally open or normally closed contact is engaged by the shorting bar when it engages one side or the other of the U-shaped common contact.

Alternatively, the opposing contacts can be made of a tempered spring metal, say, an alloy of 85% silver, 14% copper, and 1% beryllium, and spaced equally apart. The common contacts are wider than the other contacts (as shown in FIG. 5), and thus present more inertia to the impact of the shorting bar, thereby damping out bounce and vibration, which otherwise might be excessive since the switch is sometimes operated at 2,000 to 20,000 cycles per second. This arrangement avoids twisting of the blade, which might cause premature fatigue. The larger mass of the common contacts also provide better heat dissipation, since these contacts are usually conducting current. The slight resiliency of the spring contacts also produces a wiping action between them and the shorting bar, thereby reducing contact resistance.

Each of the electrical contacts is connected to a respective terminal **31** which extends down through a respective tube **31A** sealed through the header. The tubes are metal, as are each of the terminals, and the terminals are slightly smaller in diameter than the tubes so that there is a small annular space **31B** between each tube and its respective terminal to permit an inert gas to be flushed through the case prior to sealing by welding or soldering the terminals to their respective tubes.

As shown best in FIG. 3, the snap blade is an elongated thin rectangular sheet with a pair of laterally spaced longitudinal slots **32** intermediate the ends of the blade and parallel and co-terminal with each other, so that a flexure strip **33** is formed between the slots and integrally at its opposite ends with the main body of the blade. The blade is conveniently formed by stamping it from a rectangular sheet of spring material so the center flexure strip **33** is curved convexly outwardly at a point **34** out of the major plane of the blade to form a sensitive or actuating portion for the blade. As shown best in FIG. 1, the convex curved sensitive portion of the left snap blade rests normally in an unstressed position in contact with a horizontal pedestal **36** formed integrally with the forward face of the support and extending adjacent the left wall of the case.

A right snap blade **38**, identical with the left snap blade (except that it has a weaker spring action for a purpose described below), is secured at its upper end to the right mounting block **23**. The right blade has an outwardly extending convex flexure strip **39** which bears against a right pedestal **40** formed integrally with the forward face of the support. The lower end of the right blade extends down between electrical contacts arranged identically with those described for the left switch blade, and therefore their description is not repeated for brevity.

As shown best in FIGS. 1 and 2, a downwardly extending actuator **42** is formed integrally on the forward end of a horizontal actuator axle **44** which is journalled through a horizontal opening **46** in the upper portion of the support and extends into a conventional rotary solenoid **48** mounted by any suitable means within the case. The solenoid is actuated through electrical leads **50**, one of which is shown in FIG. 2, to rotate the actuator axle in either a clockwise or counterclockwise direction, as viewed in FIG. 1.

Referring to FIG. 1, the lower portion of the actuator includes a downwardly opening notch or recess **52** which forms a control gap **53** that fits over the upper end of an upwardly extending balance and stop pin **54** rigidly attached to a horizontal screw **56** threaded into a forwardly extending boss **58** on the forward face of the support. A lock nut **60** around the screw locks the balance and stop pin in the desired position, and permits the pin to be adjusted as required for proper operation as described below.

As indicated previously, the left snap blade is selected to have a slightly stronger spring action than the right

blade, so that when the solenoid is not actuated, the left snap blade forces the actuator over against the stop pin and against the right blade so that the flexure strip **39** of the right blade is deflected sufficiently to cause the lower end of the blade to snap from the contacts on its left against the contacts on its right (FIG. 1). In a typical switch, each snap blade may be about .003 inch thick, and ¼ to ½ inch long. The force differential of the left snap blade, i.e., the difference between the operation force and the return force, can be selected to be of the order of ¾ ounce, or about 21 grams. The right snap blade is selected to have a force differential of about ½ ounce, or about 14 grams. Thus, the left snap blade has a sufficient springing action to actuate the right snap blade. However, the right snap blade exerts a 14-gram force against the actuator, so that instead of requiring 21 grams to actuate the left snap blade, a force of only about 7 grams is required to be applied by the actuator to actuate the left snap blade. This force is supplied by energizing the rotary solenoid so that the actuator tends to rotate in a clockwise direction, as viewed in FIG. 1. As the actuator starts to move to the left, the flexure strip **34** is forced against its pedestal, resulting in greater contact of the shorting bar across the contacts on its right face. As additional movement of the actuator takes place, the stress imposed on the flexure strip causes the snap blade to snap suddenly from its position against the contacts on the right to a position against the contacts on its left, so that the shorting bar quickly breaks contact with one set of contacts and rapidly makes it with the opposite set. The stop pin in the control gap of the actuator prevents overtravel and avoids possible damage to the left blade.

While the left snap blade changes from an unstressed to a stressed condition, the actuator permits the right snap blade to move outwardly, due to the springing force of its flexure strip in the stressed condition, and as the actuator approaches the limit of its travel to the left, the flexure strip on the right switch blade is permitted to curve outwardly enough to cause the lower end of the right snap blade to snap from right to left and change the contact position of its shorting bar.

Since all snap action blades have a dead center, another advantage of having one with a stronger spring action than the other is that their dead centers cannot occur at the same position or time, so that even a very slow change in solenoid voltage will not result in a "dead break."

The adjustable feature of the stop pin permits it to be moved as required to attain the minimum differential force necessary to provide positive actuation of the snap blades from one set of conditions to the opposite set.

In a typical subminiature relay of the type just described, a contact pressure of 35 to 70 grams is easily achieved between the shorting bar and the contacts. Yet the force required to actuate the relay is on the order of only 7 grams. This permits the actuated solenoid to be small, with attendant reduction in overall size of the switch. Moreover, by using snap blades, relatively large movement of the free end of the blades is available with small actuating travel. The actuator travels only slightly past the movement differential of either blade alone while the other follows. In a typical relay made in accordance with this invention, each shorting bar moves as much as .035 inch, with total actuator movement of only .003 inch. Because of this, the armature stroke can be greatly reduced, thereby allowing instantaneous use of maximum working flux and a minimum of flux leakage. Consequently, the reduced actuating travel further greatly reduces the size of the solenoid required.

I claim:

1. A snap switch comprising a support, a first snap action spring blade, means for securing the first blade to the support, a second snap action spring blade, means for securing the second blade to the support to be spaced

from the first blade, each blade having a respective slot, a raised strip on the blade adjacent the slot forming a sensitive portion that causes the blade to snap from an unstressed position to a stressed position when the sensitive portion is moved relative to an adjacent part of the blade between an unstressed and a stressed condition, an actuator having opposite sides and disposed between the two blades to engage each blade in the vicinity of its respective sensitive portion, means urging the two blades toward each other and against the opposite sides of the actuator, the actuator being movable between first and second positions so that when in its first position the sensitive portion of the first blade is forced to its stressed condition and when in its second position the sensitive portion of the second blade is forced to its stressed condition, an electrical contact disposed adjacent at least one of the blades, means for moving the actuator between its first and second positions to cause at least one of the blades to snap against and away from an electrical contact, the actuator having a control gap in it, a stop pin disposed in the gap to limit the travel of the actuator toward the blades, and means for adjusting the position of the stop pin within the gap.

2. A snap switch comprising a support, a first snap action spring blade having a slot, means for securing the first blade to the support, a second snap action spring blade, means for securing the second blade to the support to be spaced from the first blade, each blade having a respective raised strip on the blade adjacent the slot to form a sensitive portion that causes the blade to snap from one position to another when the sensitive portion is moved relative to an adjacent part of the blade between an unstressed and a stressed condition, an actuator having opposite sides and disposed between the two blades to engage each blade in the vicinity of its respective sensitive portion, means urging the two blades toward each other and against the opposite sides of the actuator, one of the blades having a stronger spring action than the other so the one with the stronger spring action exerts a larger force on the actuator than the other, the actuator being movable between first and second positions so that when in its first position the sensitive area of the first blade is forced to its stressed condition and when in its second position the sensitive area of the second blade is forced to its stressed condition, an electrical contact disposed adjacent at least one of the blades, and means for moving the actuator between its first and second positions to cause at least one of the blades to snap against and away from an electrical contact.

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