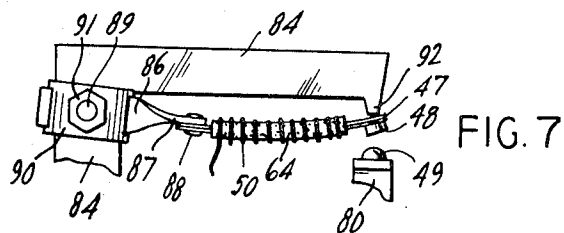
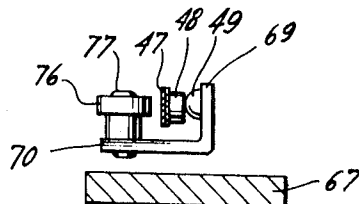
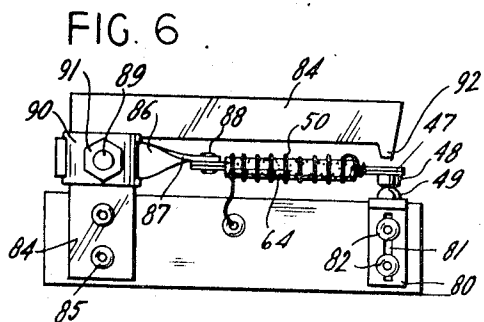
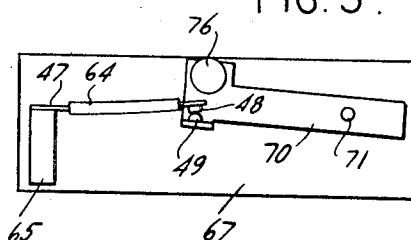
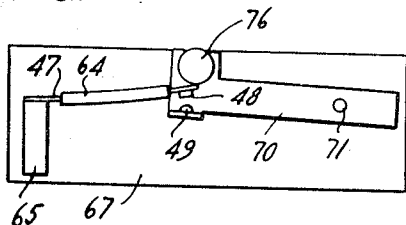
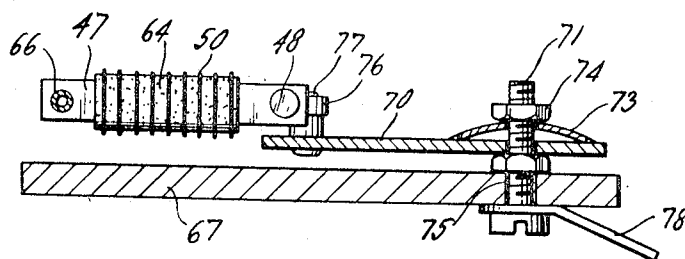
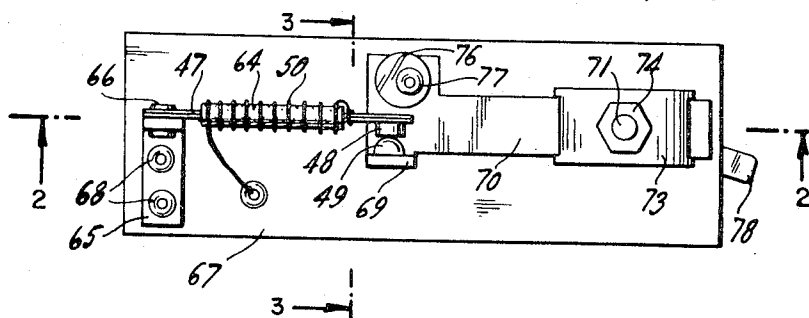


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SELF-ADJUSTING THERMALLY-RESPONSIVE ELECTRIC SWITCH

Original Filed Oct. 9, 1961



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SELF-ADJUSTING THERMALLY-RESPONSIVE ELECTRIC SWITCH

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Original application Oct. 9, 1961, Ser. No. 143,641, now
Patent No. 3,274,441, dated Sept. 20, 1966. Divided and
this application Dec. 23, 1965, Ser. No. 516,046
1 Claim. (Cl. 200—139)

ABSTRACT OF THE DISCLOSURE

An electrical switch in which a stationary contact is mounted on a support and a movable contact is carried by a bimetallic element also mounted on the support and associated with a heater element providing successively a heating period in which the bimetallic element flexes to separate the contacts and a cooling period in which the bimetallic element moves the movable contact into engagement with the fixed contact. One of the contact mounts is a pivotal mount and a stop element is positioned to be engaged by the heat responsive element when the latter is heated, to cause such adjustment of the pivotal mount as to maintain a preselected constant cooling period for the heat responsive element regardless of the degree to which it is heated.

This application is a division of application Serial No. 143,641 entitled "Sequential Electrical Lighting Arrangement," filed Oct. 9, 1961 and issued as United States Patent No. 3,274,441 on Sept. 20, 1966.

In the aforesaid Patent No. 3,274,441 there is shown an electrical circuit arrangement for illuminating a series of lamps in a selected order and in a progressive and repetitive sequence. This circuit includes a series of bimetallic switches consisting of a bimetallic element and a heater element therefor, each switch being so arranged that when the heater element is energized, it heats the bimetallic element, causing the latter to flex in a direction to open the switch contacts, and when the heater element is deenergized, the bimetallic element cools and returns to its unflexed condition to close the switch contacts. The circuit is additionally arranged so that the heater element of each switch is connected across the switch contacts of the preceding switch in the series in such a manner that when one bimetallic switch opens, it energizes the heater of the next switch to cause the bimetallic element of said next switch to flex and open the contacts thereof. Thus, the heating period of each switch is determined by the cooling period of the preceding switch.

It will be appreciated that in the previously described arrangement for the progressive illumination of a series of lamps, the opening and closing periods for the individual bimetal switches can become a critical factor. For example, it is practically impossible to obtain two bimetals with their associated heating elements which react in an identical manner, and if one of the bimetals of the series requires a relatively long cooling period to return to its closed position, this means that the next bimetal is being heated a correspondingly longer period than it was designed for, causing it to flex excessively and thus making the closing time excessive so that the defect is compounded. As a result, the heating and cooling periods are constantly increased to the point where ultimately the heater coils will be burned out, or at least the lighting intervals of the lamps will be too long.

The bimetal switches of the present invention are therefore provided with a novel structure which makes their operation completely controllable and eliminates the aforementioned difficulties. One benefit of this structure is that the lamp-lighting intervals can be selectively made short, so that the lamps can be illuminated in rapid succession.

The present invention contemplates the provision of a

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bimetallic switch having a novel structure which makes its operation completely controllable and eliminates the aforementioned difficulties. One benefit of the structure is that when the improved switches are employed in the circuit arrangement of Patent No. 3,274,441, the lamp-lighting intervals can be selectively made short, so that the lamps can be illuminated in rapid succession.

An object of the invention is the provision of a bimetallic switch of the type in which the bimetallic element is heated to open the switch contacts, wherein the switch structure is so arranged and constructed that the cooling period of the switch may be adjusted to a pre-selected constant interval regardless of the period during which the bimetallic element is heated. As a result, even though the bimetallic element may be heated to a degree far in excess of that required to open the switch contacts, once the bimetallic element begins to cool, it traverses a constant pre-selected distance to close the switch contacts.

In accordance with the invention, there is provided bimetallic switch in which one of the switch contacts is frictionally mounted for limited movement. A stop is provided for limiting the opening movement of the bimetal, and this stop resets the operating position of the frictionally-mounted contact so that the switch is self-adjusting for consistent operation under all conditions. When the bimetal of the switch is heated and the switch contacts are thus separated, the gap between the contacts is a pre-set, constant distance regardless of how much the bimetal has flexed under varying durations of heat application. This structure also provides means for the selective setting of the operating time of each switch, so that the arrangement may be adjusted to illuminate the lamps at uniform intervals in rapid succession, or at a selected slower rate, regardless of the wattage of the lamps employed.

Additional objects and advantages of the invention will become apparent during the course of the following specification when taken in connection with the accompanying drawings, in which:

FIG. 1 is an enlarged top plan view of a preferred form of a bimetallic switch made in accordance with the invention;

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

FIG. 3 is a section taken along line 3—3 of FIG. 1;

FIG. 4 is a diagrammatic plan view of the switch shown in FIG. 1, illustrating the switch in open condition;

FIG. 5 is a diagrammatic plan view similar to FIG. 4, but showing the switch in a reset, closed position after it has cooled from the open position of FIG. 4;

FIG. 6 is a top plan view of a modified form of switch made in accordance with the invention, the switch being shown in closed condition; and

FIG. 7 is a top plan view of the switch shown in FIG. 6, but illustrating the switch in open and reset position.

Referring in detail to the drawings, the switch illustrated in FIGS. 1—5 comprises a bimetallic element or strip 47 carrying at one end a contact 48 which engages and makes contact with a stationary contact 49. The bimetallic strip 47 may be of the conventional brass-steel type, and is so arranged that under heat it will bend in a direction to separate the contacts 48 and 49. The switch formed by the bimetal is therefore normally closed in the sense that the contact 48 is in engagement with the fixed contact 49 when the bimetal is cool, and when the bimetal is heated, the contact 48 is moved away from the fixed contact 49 to open the switch.

The bimetal 47 has a heating element 50 in the form of a coil of resistance wire wrapped around its body and insulated therefrom. One end of the heating coil is connected at 51 to the body of the bimetal 47 while the other end is adapted to be connected to an electrical power

source. A plurality of switches of the type shown herein are particularly intended for use in the sequential lighting arrangement shown and described in my U.S. Patent No. 3,273,441, wherein the heating coil of each switch is energized to open the switch contacts during the time that the preceding switch is cooling and closing. In such a circuit, therefore, the free end of the heating coil 50, and the body of the bimetal 47 would be connected across the contacts of the preceding switch in such a manner the heater coil 50 is energized when the preceding switch contacts are open.

In FIG. 1, the bimetal strip 47 is shown carrying the contact 48, is shown in its normally closed position, with the movable contact 48 in engagement with the fixed contact 49, as previously explained. The intermediate portion of bimetal 47 is covered by a layer of non-flammable insulation 64, preferably a thin sheet of asbestos, in the usual manner. The heater coil 50 is wound about this layer of asbestos 64. The end of the bimetal 47 is mounted on a support bracket 65, as by a rivet 66, and the support bracket is in turn mounted on an insulated base 67 or the like, by rivets 68.

The fixed contact 49, in this instance, is not mounted rigidly on the base 67, but is rather frictionally mounted thereon for a limited degree of movement. For this purpose, the fixed contact 49 is secured to and carried by an upstanding flange 69 of an electrically conductive plate 70 as shown in FIGS. 1 and 3. The plate 70, at its other end, is mounted on a screw bolt 71 which is secured in upstanding position to the base 67 by a nut 72. The plate 70 has an aperture 75 which receives the shank of bolt 71, and overlies the nut 72, being held on the bolt 71 by an arcuate leaf spring 73 engaged and depresses at its center by a nut 74 threaded on bolt 71. The nut 74 holds the leaf spring 73 under selected tension, so that the conductive plate 70 is pivotally mounted on base 67 with a selected amount of friction. Referring to FIG. 1, it may therefore be seen that the fixed contact may be frictionally moved in an arc about the bolt 71. A terminal lug 78 is also connected to bolt 71 for connection of the contact 49 within the circuit.

The conductive plate 70 also carries a cylindrical stop member 76 which is eccentrically mounted on the plate 70 by an off-set eyelet or rivet 77. This stop member 76 is made of electrically insulating material and is located to engage the free end rear face of the bimetal 47 when the latter flexes under heat. The distance between the stop member 76 and the bimetal 47 may be adjusted by turning the stop member about its off-center mount 77, so that a selected heating interval for the bimetal may be obtained before it engages the stop 76.

Where a plurality of the previously described switches are used in the sequential lighting arrangement shown in the aforementioned U.S. Patent No. 3,274,441 the heating and cooling periods of the individual bimetals can all be made uniform, and in addition can be selectively adjusted as to duration. It will be observed that when the bimetal 47 in FIG. 1 is heated, it will flex upwardly so that its contact 48 separates from the fixed contact 49. As the heating continues, the bimetal 47 engages the stop 76 and presses the latter upwardly, causing the plate 70 to turn in a clockwise direction about its pivot 71 against the frictional tension of spring 73. This is shown in FIG. 4. The plate 70 will continue to turn in this manner, carrying with it the fixed contact 49, no matter how long the bimetal 47 is heated and how much it flexes. When the bimetal cools, it will return to pressing engagement with the fixed contact 49, but the distance it travels during the cooling period is always constant and therefore the period in which the switch remains open is always constant. More specifically, it will be observed that no matter how long the bimetal has been heated, when it flexes downwardly in cooling it travels only the pre-selected and constant distance determined by the stop 76 and the fixed contact 49. Thus, the operating time for the individual switch is

always the same despite line voltage fluctuations, changes in ambient temperatures, variations in the wattage of lamps employed, and other variables which would ordinarily influence bimetal operation. In addition, the inherent variations in performance characteristics between the various bimetallic units will not influence the sequential timing uniformity of the assembly. The heating period is made slightly larger than required for opening the contacts and may vary from unit to unit, but the subsequent cooling period is made the controlling factor and this latter is uniform.

In adjusting the series of bimetals for uniform operation, a flat guage may be placed between the contacts 48 and 49 of each bimetal to space the contacts a desired distance. The eccentric stop member 76 is then turned until it engages the rear face of the bimetal 47. The guage is then removed and the plate 90 turned until the contact 49 engages the contact 48. The bimetal 47 is thus adjusted so that its return distance during cooling is equal to the thickness of the guage. Where a plurality of these switches are employed in the aforementioned sequential lighting arrangement, each of the other bimetals can then be similarly adjusted, so that their operations will be identical. If an extremely thin guage is employed, the return distances of the bimetals will be very small so that the lamps will be illuminated in rapid succession.

The contacts 48 and 49 in FIG. 1 are pressed together under a certain amount of tension determined by the amount of friction in the pivotal suspension of arm 70. This tension is adjusted by nut 74 bearing on spring 73 and is made equal in all units. It is advantageous to make it as small as practicable, as will be seen presently.

Starting from position of FIG. 1, the heater 50 is energized, causing bimetal 47 to flex upwardly. At first no physical movement takes place as the pressure existing between the contacts 48 and 49 is reduced to zero. The time required for this is directly proportional to the pressure existing originally, which in turn depends on the amount of friction. This friction has been made small so as to shorten the time period during which the bimetal is motionless while energized.

Once the contact pressure has been overcome, the bimetal proceeds to traverse the gap to the stop 76. Although the heater continues to energize the bimetal, movement of the bimetal stops when it engages the stop 76. The bimetal now builds up energy until its flexing force equals the friction in the pivotal suspension of arm 70. This time, incidentally, is equal to the time required previously to separate the contacts 49, 48.

The bimetal continues flexing, and by bearing against stop 76, it carries arm 70 along in the same direction it is flexing. This continues until the heater is deenergized. FIG. 4 shows the bimetal position at this instant, in which the bimetal as well as arm 70 are displaced from their original positions of FIG. 1.

Different units may have inherently different heating characteristics, so that if energized for the same time period, the displacement of bimetal and arm shown in FIG. 4 may vary from unit to unit. All units, however, will have their bimetals 47 pressing against their respective stops 76 with exactly the same pressure, since the friction pivot in each unit has been adjusted to provide the same tension. Furthermore, all units have exactly the same size of gap between the respective contacts 48, 49.

When the heater coil 50 is deenergized, the bimetal 47 cools and begins to straighten out. It has been pointed out that the position of FIG. 4 for various units may be different; however, the conditions under which the different units will operate in closing the contacts under pressure, are the same. The force residing in the bimetal in straightening out causes the bimetal to retrace its flexing movement in the reverse direction. Initially the pressure against the stop will be reduced to zero, then the gap will be traversed, and then pressure will be built up be-

tween the contacts. Depending upon the temperature, ambient or residual, the unit may come to rest in a reset position such as shown in FIG. 5, which position is slightly different from the original position of FIG. 1. It is important to note that the unit is ready to start on its heating cycle from either position under the same conditions.

FIGS. 6 and 7 illustrate a modified form of bimetal switch construction which will produce the same controlled and uniform bimetal operation, but in which the bimetal is frictionally mounted for a limited degree of lost motion movement, rather than the fixed contact as in the embodiment of FIGS. 1 to 5.

In FIG. 6 it may be seen that the fixed contact 49 is mounted on a conductive bracket 80 which has an elongated slot 81 receiving screws or rivets 82 for adjustable but secure mounting of the bracket 80 on an insulated base 83. A generally L-shaped arm 84 is secured to the base 83, as by rivets or eyelets 85. The arm 84 is electrically conductive and the rivets 85 may therefore serve as terminal soldering posts for the bimetal. The bimetal 47 is carried by a conductive strip 86, the latter having a twisted end portion 87 to which the bimetal 47 is secured, as by a rivet 88.

The strip 86 is frictionally mounted on the L-shaped arm 84 in a manner similar to the mounting of the plate 70 in FIGS. 1 to 5, and previously described. That is to say, the strip 86 is loosely mounted on an upstanding bolt 89 affixed to the arm 84, with an arcuate leaf spring 90 overlying the strip 86 and being depressed at its center by a nut 91. The bimetal 47 and its contact 48 can therefore be turned about the bolt 89, under frictional tension of the spring 90.

The end of the L-shaped arm 84 has a small projection 92 which is located to contact the rear face of the free end of bimetal 47 and act as a stop therefor. When the bimetal 47 is heated through energization of its heater element 50, it will engage the stop 92, so that further flexing movement of the bimetal will reposition its mounting. That is to say, when the bimetal 47, in the closed position of FIG. 6, is heated, it will flex upwardly, the contact 48 moving away from contact 49. The rear face of the bimetal 47 then engages the projection 92 which acts as a fixed stop and prevents the free end of the bimetal 47 from moving further away from the fixed contact 49. As the bimetal continues to heat, it flexes at its center, as shown in FIG. 7, causing the mounted end thereof to turn about the bolt 89. The bimetal thus resets its mounting position, and the spring 90 and nut 91 maintain this reset position. On cooling, the free end of the bimetal 47, carrying contact 48, need only travel the distance between the projection 92 and the fixed contact 49.

The operational timing of the bimetal 47 may be adjusted by loosening the screws 82 and sliding the bracket 80 to vary the gap between the fixed contact 49 and the

projection 92. A gauge may be used for this purpose, as previously explained.

While preferred embodiments of the invention have been shown and described herein, it is obvious that numerous additions, changes and omissions may be made in these embodiments without departing from the spirit and scope of the invention.

What I claim is:

1. A self-adjusting switch comprising a pair of contacts, a support, a bimetallic element mounted on the support and carrying a first of said contacts, an elongated arm element pivotally mounted at one end on the support and carrying the second of said contacts at its free end portion, said elements being positioned on said support such that said contacts are normally in engagement with each other, heating means associated with said bimetallic element and adapted to be alternately energized and deenergized to provide successive operating cycles, each cycle consisting of a heating period in which said bimetallic element flexes in a direction to move said first contact away from said second contact, and a cooling period in which said bimetallic element moves the first contact back into engagement with the second contact, and a stop member mounted on the free end portion of said arm in alignment with said second contact and spaced a fixed distance therefrom, said stop member being positioned in the path of flexing movement of said heat-sensitive element during said heating period and halting movement of said first contact away from said second contact when the contacts are spaced apart a pre-selected distance, whereby said bimetallic element engages said stop member during the heating period and continued flexing of the bimetallic element against said stop member turns said arm about said pivotal mount with the contacts maintained spaced apart by said preselected distance, such that at the end of the heating period of each successful cycle the contacts are spaced apart by said preselected distance and the cooling period for each cycle is maintained constant regardless of the duration of the heating period.

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