Aug. 30, 1966 J. D. BUCHANAN 3,270,153

HUMIDITY ACTUATED SWITCH

Filed July 25, 1963 2 Sheets-Sheet 1

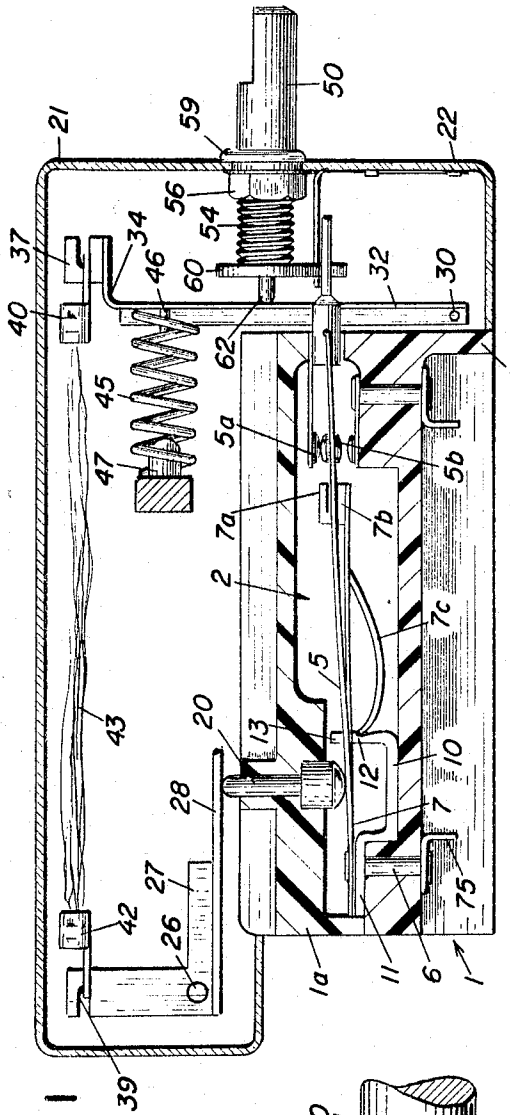


FIG 1

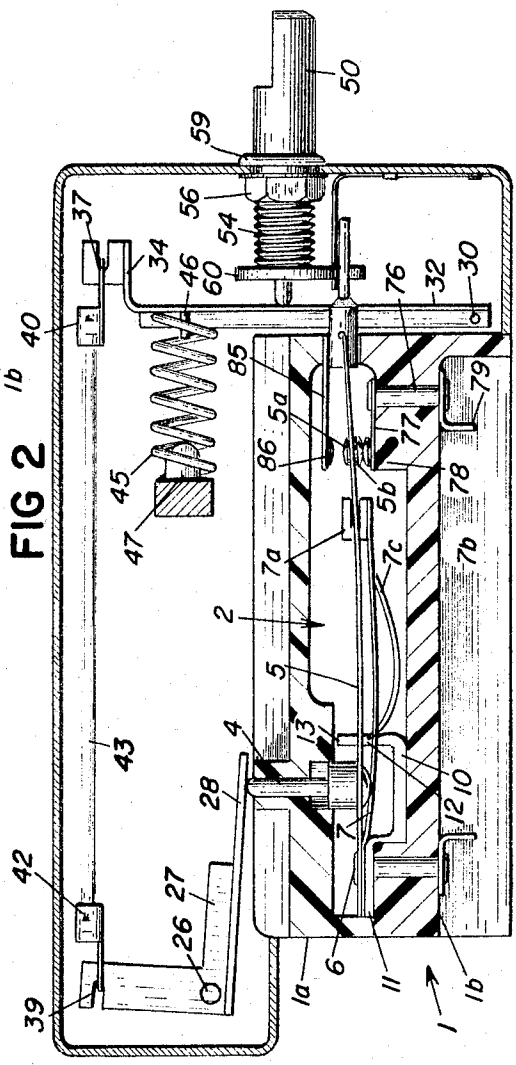


FIG 2

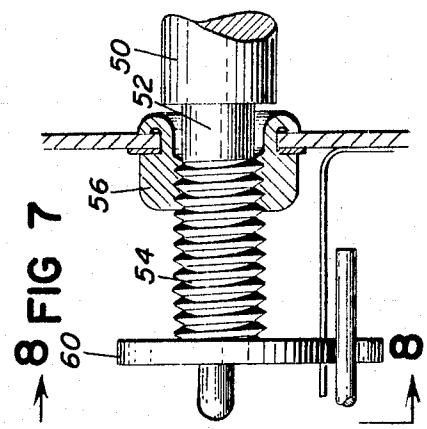


FIG 7

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HUMIDITY ACTUATED SWITCH

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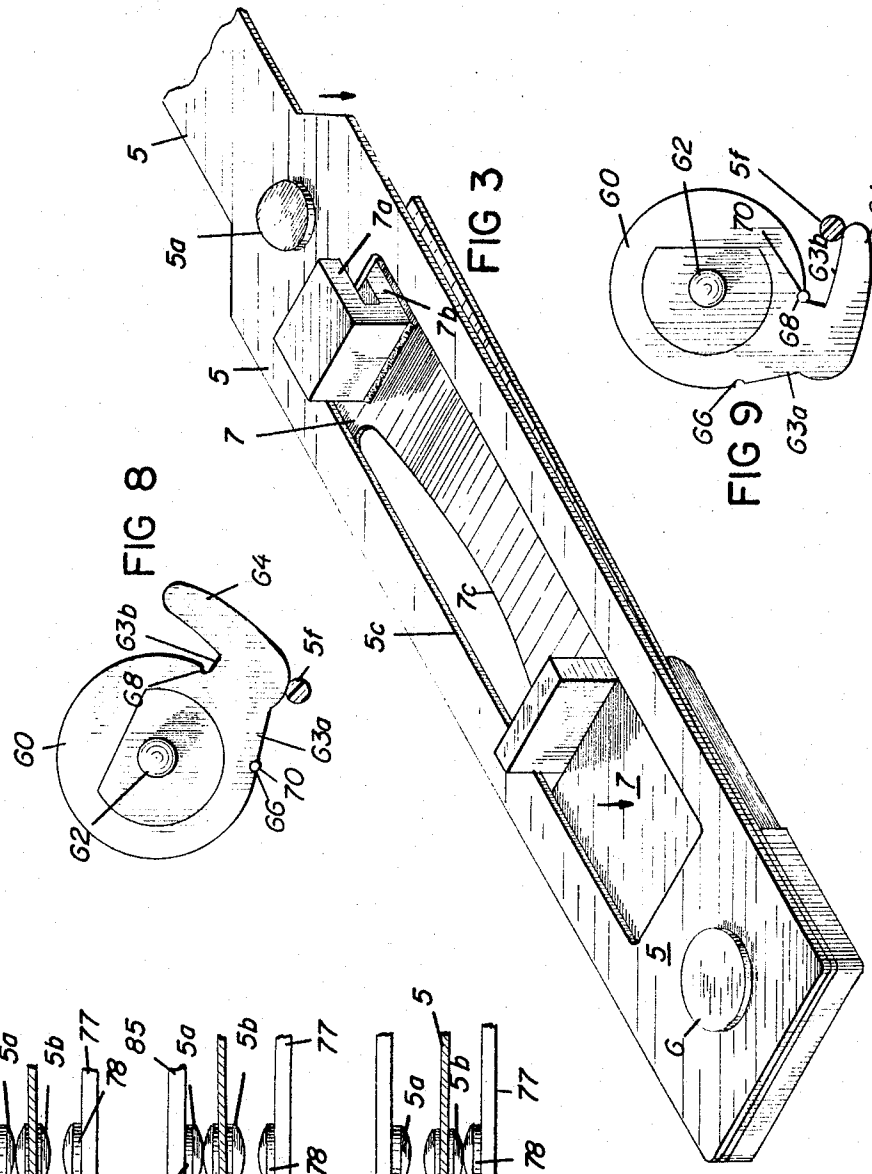


FIG 3

FIG 9

FIG 8

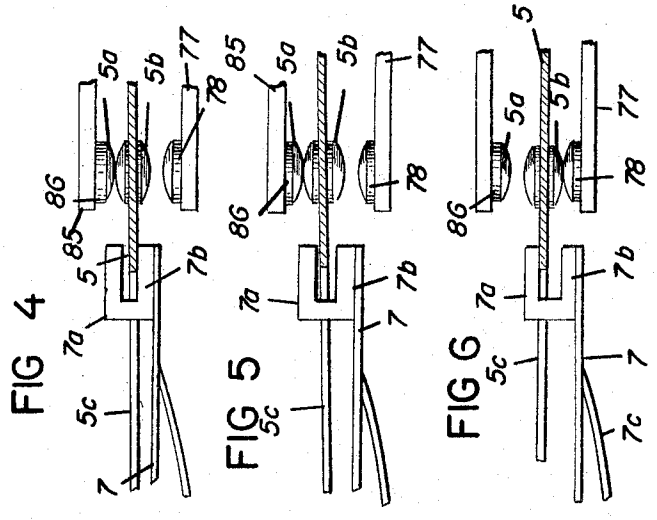


FIG 4

FIG 5

FIG 6

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HUMIDITY ACTUATED SWITCH

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7 Claims. (Cl. 200—61.06)

This invention relates to humidity control apparatus for maintaining an atmosphere of predetermined moisture content within a certain area which, of course, includes both humidifiers and dehumidifiers.

It is, of course, relatively simple to control the overall temperature of the atmosphere in a given area. Distinguish, however, the situation with respect to moisture content.

Heretofore, there have been many developments directed toward the improvement of automatic humidification or dehumidification; but they have usually been characterized by operation with relatively long response times. Other prior art apparatus, while somewhat more accurate in controlling relative humidity, have been expensive to manufacture, install and maintain.

Normally, humidity controls should switch with a change of 5% to 6% in Relative Humidity.

There is a tendency for controls on the market to become stuck (contacts weld together because of extremely slow rate of change in humidity level). This sticking of the control requires 10–20–30% change in humidity level in order for the humidity sensor to generate enough force to break the weld; and the present invention seeks to overcome this problem.

Of the present day commercial humidity controls of which I am aware, none is capable of switching electric motors of over ⅓ horsepower, whereas the apparatus described herein and shown in the appended drawings has been successfully demonstrated to switch ½ horsepower and over; and with an accompanied lesser tendency for the electrical contacts to stick or "weld."

As indicated hereinbefore it is well known that in humidity control apparatus, it is of utmost importance that electrical switching action be initiated with a minimum of motion and force; and with this in mind the present invention provides an improved switching apparatus for achieving these ends. More specifically, this improved switching apparatus or mechanism comprises a switching blade which is anchored adjacent one end and a cooperating spring strip which, under appropriate circumstances, delivers what might be termed a "hammer-blow" to the switching blade thereby causing the electrical contacts to separate with least possible delay (caused by contact sticking).

Another object is the provision, in an apparatus of the class described, of a control mechanism which embodies positive-on and positive-off positions.

Other objects and advantages of the invention will become apparent as the description of same proceeds, and the invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming a part of the specification with the understanding, however, that the invention is not confined to a strict conformity with the showing of the drawings but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In said drawings:

FIGURE 1 is an elevational view, partly in section, illustrating the humidity control apparatus of the present invention;

FIGURE 2 is a view similar to FIGURE 1 but illustrating the operating elements in another stage of operation;

FIGURE 3 is a fragmentary perspective illustrating the elements which effect the "hammer-blow" separation of the electrical contacts of the humidity control apparatus;

FIGURES 4, 5 and 6 are fragmentary elevational views illustrating the application of the aforementioned "hammer-blow" technique to the electrical contacts;

FIGURE 7 is an enlarged fragmentary elevation, partly in section, and illustrating a manual adjustment for the humidity element which will be discussed more specifically hereinafter; and

FIGURES 8 and 9 are end elevational views of the elements of FIGURE 7 in the two extreme stages of manual operation.

Referring more particularly to the drawings, the numeral **1** generally designates the housing for the switching elements of the apparatus of the invention which may acceptably be made of one of the plastics which are currently used for such purposes. This housing **1** is shown as comprising an upper section **1***a* and a matching lower section **1***b*; the same providing an elongate central compartment **2**.

The upper section **1***a* of the housing carries a vertically reciprocable plunger type switch button **4**, the lower end of which extends into the central compartment **2** for a purpose which will appear more fully hereinafter.

Within the compartment **2**, and mounted atop the upper face of the lower 1^b of the housing is a flat switching blade **5** the upper and lower faces of which carry electrical contacts 5^a and 5^b respectively, the same being spaced relatively adjacent to, but spaced from, one of its ends. The other end of the switching blade **5** is anchored to the lower section 1^b of the housing **1**, as by means of a rivet **6**.

Between the rivet **6** and the electrical contacts 5^a and 5^b the switching blade **5** has a rectangular slot 5^c.

Disposed immediately beneath the switching blade **5** is a spring strip **7** one end of which is anchored by the aforementioned rivet **6**. The spring strip **7** extends beneath the rectangular slot 5^c in the switching blade **5** and carries a C-shaped clip providing upper and lower fingers 7^a and 7^b which are in substantially spaced relationship. These upper and lower fingers 7^a and 7^b extend beyond the rectangular slot 5^c and are adapted for alternate engagement with the upper and lower surfaces of the intermediately disposed flat portion of the spring strip **7**.

The spring strip **7** is provided with a longitudinally extending downwardly curved stamped-out tongue 7^c which extends from a position adjacent the C-shaped clip with its free end in contact with a U-shaped member **10**. This U-shaped member **10** is shown as possessing a right-angular outboard flange 10^a extending from one of its legs which underlies the adjacent end of the spring strip **7**, and, together with it and the switching blade **5**, is anchored by the rivet **6**.

This other leg of the U-shaped member **10** is provided with a vertical extension 10^b which extends through, and projects upwardly from, the rectangular slot 5^c in the switching blade **5**.

Immediately below this extension 10^b the innermost leg of the U-shaped member **10** is provided with a slot 10^c which receives the free end of the tongue 7^c when it is stressed. According to the foregoing construction and arrangement, the spring strip **7** provides a toggle action which is such that through the stressed tongue 7^c snap movement is imparted to the C-shaped clip in both directions which is transferred to the switching blade **5**.

Referring particularly to FIGURES 1 and 2, a housing **21** of metal or other suitable material is mounted atop the housing **1** and is provided at one end with a downward extension or leg **22**.

A shaft or stud **26** is disposed interiorly of the (upper) housing **21** adjacent one end thereof and pivotally supports a bellcrank **27**, one arm of which extends vertically with the other overlying the adjacent end of the housing

1. This last-mentioned arm of the bellcrank **27** carries an extension **28**, which, when tilted downwardly, is adapted to contact and depress the upper end of the plunger-type switch button **4**.

A shaft or stud **30** is disposed interiorly of the downward extension or leg **22** of housing **21**; and pivotally supports a vertically extending lever **32**.

The upper end of this vertically extending lever **32** has a right-angular outward extension **34** which carries an outwardly facing C-clip **37**, a similar and corresponding element being provided at the upper end of the vertical arm of the bellcrank **27**.

The C-clips **37** and **39** are detachably engaged by a pair of connectors **40** and **42**, respectively, which are secured to a humidity responsive element which is shown at **43** as being in the form of a multiplicity of strands; for example, of human hair or the like. However, other forms of attenuated humidity responsive material may be utilized such as ribbon, rope, film, etc.

Tension is imparted to the attenuated humidity responsive element **43** by a coil spring **45** which extends between and is supported by spring hangers **46** and **47** carried by the vertical lever **32** and housing **21**, respectively.

An important feature of the present invention is that the attenuated humidity responsive element **43** is emersed in a strong detergent solution prior to installation.

The detergent solution, besides producing a cleaning effect, reduces the surface tension of the moisture entering and leaving the humidity sensing material. That is, the detergent residing in and on the humidity responsive material combines with the moisture particles in the air and allows them to enter and leave the grain structure of the humidity responsive material faster than would otherwise be the case.

Referring to FIGURE 7, a cylindrical shaft **50** is disposed in an aperture in the housing **21** which is positioned somewhat above the mid-section of the vertical lever **32**, the said cylindrical shaft **50** projecting from either side of the housing **21**. That portion of the shaft **50** which extends through the wall of the housing is provided with a cylindrical portion **52** of reduced diameter. Within the housing **21** the cylindrical shaft carries screw-threads **54** for receiving a nut **56**, the latter comprising an integrally formed ferrule **56^a** which extends through the wall of the housing **21** and is bent upon itself to form a bead **56^b** for relatively firm engagement with the outer face of the housing.

A spring washer **57** is disposed between the nut **56** and the inner face of the housing **21** for locking the nut **56** in position; but the nut is capable of being rotated by a wrench in order to calibrate its position with respect to a marked point (flat area, etc.) on the outer end of the cylindrical shaft **50**, thereby establishing the switching point as will be more fully understood hereinafter.

Formed integrally with, or secured to, the inner extremity of the cylindrical shaft **50** is a cam **60** provided with an axially disposed dog **62** for engaging the adjacent side of the vertically extending lever **32**.

The cam **60**, whose peripheral contours will be described later herein, is constructed and arranged to cooperate with the switching blade **5** carrying the electrical contacts **5^a** and **5^b**. For this purpose, the adjacent end of the switching blade **5** is provided with an electrically non-conductive extension which extends through, and projects from, a recess in the adjacent ends of the upper and lower sections **1^a** and **1^b** of the housing **1**.

This electrically non-conductive extension on the free end of the switching blade **5** is illustrated as comprising a clamp **5^e** with an integrally-formed rod **5^f** which extends through and projects from an aperture **32^a** in the vertically extending lever **32** to terminate beyond a vertical plane through the major transverse axis of the cam **60**.

The electrically non-conductive rod **5^f** on the free or unanchored end of the switching blade **5** is adapted to

be raised and lowered by the cam **60** by rotation of the short cylindrical shaft **50**.

In order to achieve the immediately aforementioned objective, the periphery of the cam **60** is contoured in the manner illustrated in FIGURES 8 and 9 of the drawings. That is, the cam **60** is circular throughout approximately 300 degrees with the remainder thereof comprising a portion **63** which extends in a substantially radial direction and merges into a right-angularly extending foot **64**, the latter (as viewed in FIGURES 8 and 9) being shown as extending counter-clockwise.

At each of the terminal points of the circular portion of the cam **60**, there is a semi-circular detent as indicated at **66** and **68**.

That edge of the substantially radially extending portion **63** which is adjacent the semi-circular detent **66** extends therefrom in a substantially straight line **63^a** which in turn connects with an outwardly curved edge **64^a** which forms the heel of the foot **64**.

That edge of the substantially radially extending portion **63** of the cam **60** which is adjacent the semi-circular detent **68** is also substantially straight but as shown at **63^b** is materially shorter than the substantially straight surface **63^a**; and it extends toward the foot **64** at a much greater angle.

The semi-circular detents **66** and **68** are adapted to alternatively receive at either end of the rotational movement of the shaft **50** a spring wire **70** which is mounted on the inside of the downwardly extended portion **22** of the housing **21** (see FIGURES 1 and 2).

On the other hand the foot portion **64** carried by the cam **60** is adapted to contact the electrically non-conductive extension rod **5^f** on the switching blade **5**, the limits of the range or area of said contact being illustrated in FIGURES 8 and 9. As aforementioned this action of the foot **64** of the cam **60** raises and lowers the switching blade **5** to the positions illustrated in FIGURES 4, 5 and 6, respectively. This action is independent of the tendency of the C-clip of the spring strip **7** to position the switching blade **5**, thus providing positive-on/positive-off control.

The switching blade **5** is shown as positioned in—

FIGURE 4 with dehumidifier ON; in

FIGURE 5 with switching elements in INTERMEDIATE position; and in

FIGURE 6 with the dehumidifier OFF.

Referring to FIGURES 1 and 2, the rivet **6**, which anchors the spring strip **7** and superposed switching blade **5**, is connected to a female spade conductor (not shown) through a conventional spade conductor terminal **75**.

A similar rivet **76** is disposed adjacent the other end of the lower section **1^b** of the switch housing **1**, and is connected to a contact strip **77** carrying a contact **78** which is disposed immediately below, and adapted to be engaged by the lower contact **5^b** on the switching blade **5**. This rivet **76** is connected to a spade conductor terminal **79**.

Mounted above the switching blade **5** is a contact strip **85** carrying a contact **86** which is disposed immediately above, and adapted for engagement with the upper contact **5** on the switching blade. When the apparatus is utilized for dehumidifier control, the contact strip **85** is connected to a conductor terminal (not shown), this conductor terminal, together with the spade conductor terminal **75** being wired into a conventional dehumidifier circuit in the manner well known to those skilled in the art.

As indicated earlier herein, when the vertically reciprocable plunger type switch button **4** is depressed, the enlarged head on its lower end enters the central compartment of the switch housing **1**; passes downwardly through the rectangular slot **5^c** in the switching blade **5** and into contact with the spring strip **7**.

The switching blade **5** is performed in such manner that it normally holds its contact **5^a** against the contact

86 on the contact strip 85, as shown in FIGURE 4.

As this downward movement of the plunger type switch button 4 is continued, the adjacent portion of the spring strip 7 is depressed, thereby building up sufficient energy to force the longitudinally extending downwardly curved stamped-out tongue 7^c to snap downwardly that portion of the said spring strip 7 which carries the C-shaped clip.

The intermediate point of this snap action on the part of the spring strip 7 is represented in FIGURE 5.

The continued downward snap action of the C-shaped clip moves the upper finger 7^a thereof downwardly against the adjacent portion of the switching blade 5, which, in turn, moves its contact 5^a downwardly out of engagement with the contact 86 as represented in FIGURE 6.

It will be understood that the switching blade 5 remains stationary until sufficient energy is built up in the spring strip 7 to cause the desired snap-action; at which time the upper finger 7^a of the C-clip delivers a downward "hammer blow" to the switching blade.

As the tongue 7^c of the spring strip 7 approaches the switch-over point, the force between the contacts 5^a and 86 can only be reduced by the force obtained from the spring strip itself. The contact force caused by preforming the switching blade 5 is not reduced until the upper finger 7^a of the C-shaped clip engages the switching blade and drives it downwardly into the "open" position.

The apparatus as described hereinbefore may be employed as either a humidifier control or dehumidifier control by utilizing the upper contact 86 (dehumidifier control) or the lower contact 78 (humidifier control) as part of the electrical circuit.

The switching blade 5 may, of course, be biased in either direction.

It will be observed that the spring 45 normally biases the vertically extending pivoted lever 32 outwardly (or to the right as viewed in FIGURES 1 and 2), the effect of which is to tension the humidity responsive element 43. The degree of tension on the humidity element 43 is regulated in a manner to be described shortly hereinafter; and when it exceeds a predetermined or selected value, the plunger type switch button 4 will exert sufficient force on the spring strip 7 to snap the contact 5^a out of engagement with the upper fixed contact 86. The spring 45 should have sufficient strength to overcome the biasing force of the spring strip 7 when the humidity element contracts beyond the predetermined or selected value; but at the same time it should be weak enough to somewhat elongate before breaking should it contact beyond the anticipated range of movement of the bellcrank 27. The attenuated strands, etc., which make up the humidity element will, of course, contract as the moisture content or the relative humidity of the air decreases and will expand or lengthen when the relative humidity increases. When the apparatus described herein is utilized to control a dehumidifier, it will cause the dehumidifier to run and extract moisture from the air as long as the relative humidity is above that at which the pivoted lever 32 is set.

When the relative humidity drops below the value set by the positioning of the pivoted lever 32, the apparatus will stop and will remain so until the relative humidity again increases above the present value, at which time the lengthening of the humidity sensing element 43 permits the prestressed switching blade 5 to assume its normal position and with the contact 5^a in engagement with the upper fixed contact 86. That is, should the air dry out to a point beyond the setting of the humidistat, the humidity sensing or humidity responsive element 43 will contract, thereby gradually depressing the plunger type switch button 4. When the plunger type switch button has been depressed to a point where it moves the spring strip 7 just past dead center, the upper finger 7^a of the C-shaped clip will strike the adjacent portion of the upper surface of the switching blade 5 and snap the contact 5^a out of engagement with the upper fixed contact 86, whereupon the dehumidifying apparatus will be stopped; and it will not restart until the air has again attained the required degree of relative humidity as determined by the appropriate amount of lengthening of the humidity element.

Some of the humidity control apparatus commercially available at the present time are provided with humidity sensing elements in the form of human hair and others with ribbons of nylon which are about one inch wide and then folded. If there is a sudden 20% change in the Relative Humidity level it takes hair 20 minutes to recover or change to within 80% of the 20% change. It takes nylon ribbon 40 minutes to make the same change and several hours to expand or contract fully equivalent to the new humidity level in fast changing conditions—usually where humidity it being put into the air this rate of response is very important. Using nylon to control a humidifier results in the following:

If a humidifer control is set to add moisture to the air when the relative humidity goes below 40% R.H., the humidifier turns on and runs the relative humidity up to 60 or 70% R.H. before the control can react to the changed humidity level.

From all of the foregoing it will be perceived that the apparatus of the present invention provides

an improved switching mechanism which, due to the hereinbefore described hammer-blow technique, enables the switching of higher electrical current;

an improved means for reducing the responsive time which is required to effect the necessary switching operation, the same including the use of a detergent bath for the humidity element which increases the rapidity with which moisture enters and leaves the humidity element;

an improved positive-on/positive-off means in a humidity control apparatus, the cam 60 overcoming the tendency of the humidity element to start or stop the apparatus.

The detergent bath reduces the time required for the humidity responsive or humidity sensing element 43 to absorb moisture which appears as lessening in the humidity differential; and in this respect strands of nylon produce results which are new and unexpected.

While I have shown and described certain specific embodiments of the present invention, it will be readily understood by those skilled in the art that I do not wish to be limited exactly thereto, since various modifications may be made without departing from the scope of the invention as defined in the appended claims.

I claim:

1. An electrical switch unit including a resilient contact strip provided with an electrical contact on one side thereof; a stationary electrical contact for cooperation with the electrical contact on said resilient contact strip; said resilient contact strip being prestressed sufficiently to cause its electrical contact to normally engage said stationary electrical contact; a prestressed spring strip anchored at one end; said prestressed spring strip being capable of snap action to strike said resilient contact strip and drive it out of its aforementioned normal position; and means for engaging said prestressed spring strip and moving it into snap action; said prestressed spring strip underlying said resilient contact strip and provided with an integrally-formed downwardly-bowed tongue; said tongue being prestressed and with its outer end secured against movement with respect to said prestressed spring strip.

2. An electrical switch unit including a resilient contact strip provided with an electrical contact on one side thereof; a stationary electrical contact for cooperation with the electrical contact on said resilient contact strip;

said resilient contact strip being prestressed sufficiently to cause its electrical contact to normally engage said stationary electrical contact; a prestressed spring strip anchored at one end; said prestressed spring strip being capable of snap action to strike said resilient contact strip and drive it out of its aforementioned normal position; and means for engaging said prestressed spring strip and moving it into snap action, said prestressed spring strip underlying said resilient contact strip and provided with an integrally-formed downwardly-bowed tongue; said tongue being prestressed and with its outer end secured against movement with respect to said prestressed spring strip; said resilient contact strip having an aperture and a push-button type plunger disposed to extend through the aperture in said resilient contact strip and engage said prestressed spring strip and move it into snap action.

3. An electrical switch unit including a resilient contact strip provided with electrical contacts on either side thereof; stationary electrical contacts adapted to be alternatively engaged by the electrical contacts on said resilient contact strip; said resilient contact strip being prestressed sufficiently to cause one of its electrical contacts to normally engage one of said stationary electrical contacts; a prestressed spring strip anchored at one end; said prestressed spring strip being capable of snap action to strike said resilient contact strip and drive it out of its aforementioned normal position; said prestressed spring strip underlying said resilient contact strip and provided with an integrally-formed outwardly-bowed tongue; said tongue being prestressed, and with its outer end secured against movement with respect to said prestressed spring strip.

4. An electrical switch unit including a resilient contact strip provided with electrical contacts on either side thereof; stationary electrical contacts adapted to be alternatively engaged by the electrical contacts on said resilient contact strip; said resilient contact strip being prestressed sufficiently to cause one of its electrical contacts to normally engage one of said stationary electrical contacts; a prestressed spring strip anchored at one end; said prestressed spring strip being capable of snap action to strike said resilient contact strip and drive it out of its aforementioned normal position; said prestressed spring strip underlying said resilient contact strip and provided with an integrally-formed downwardly-bowed tongue; said tongue being prestressed and with its outer end secured against movement with respect to said prestressed spring strip; said resilient contact strip having an aperture; and a push-button type plunger disposed to extend through the aperture in said resilient contact strip and engage said prestressed spring strip and move it into snap action.

5. A humidity control switch comprising, in combination, an electric switch unit including a resilient contact strip provided with an electrical contact on one side thereof; an oppositely positioned stationary electrical contact for cooperation with the electrical contact on said resilient contact strip; said resilient contact strip being prestressed sufficiently to cause its electrical contact to normally engage said stationary electrical contact; a prestressed spring strip anchored at one end; said prestressed spring strip being capable of snap action to strike said resilient contact strip and drive it out of its aforementioned normal position; a push-button type plunger disposed to engage said prestressed spring strip and move it into snap action; a bellcrank switch lever; one of the arms of said bellcrank switch lever being disposed for operative engagement with said push-button type plunger; a pivoted adjusting lever disposed in substantial parallelism with the other arm of said bellcrank switch lever; a plurality of detergent-coated unwoven strands of nylon extending between, and connected to, the last-mentioned arm of said bellcrank switch lever and the free end of said pivoted adjusting lever; a spring biasing said pivoted adjusting lever away from said bellcrank switch lever; and manually operated means for adjusting the position of said prestressed contact strip with respect to said stationary contact.

6. A humidity control switch comprising, in combination, an electric switch unit including a resilient contact strip provided with an electrical contact on one side thereof; an oppositely positioned stationary electrical contact for cooperation with the electrical contact on said resilient contact strip; said resilient contact strip being prestressed sufficiently to cause its electrical contact to normally engage said stationary electrical contact; a prestressed spring strip anchored at one end; said prestressed spring strip being capable of snap action to strike said resilient contact strip and drive it out of its aforementioned normal position; a push-button type plunger disposed to engage said prestressed spring strip and move it into snap action; a bellcrank switch lever; one of the arms of said bellcrank switch lever being disposed for operative engagement with said push-button type plunger; a pivoted adjusting lever disposed in substantial parallelism with the other arm of said bellcrank switch lever; a plurality of detergent-coated unwoven strands of nylon extending between, and connected to, the last-mentioned arm of said bellcrank switch lever and the free end of said pivoted adjusting lever; a spring biasing said pivoted adjusting lever away from said bellcrank switch lever; an adjustable stop member for limiting the effectiveness of said biasing spring; and manually operated means for adjusting the position of said prestressed contact strip with respect to said stationary contact.

7. A humidity control switch comprising, in combination, an electric switch unit including a resilient contact strip provided with electrical contacts on either side thereof; a pair of oppositely positioned stationary electrical contacts for alternate engagement with the electrical contacts on said resilient contact strip; said resilient contact strip being prestressed sufficiently to cause one of its electrical contacts to normally engage one of said stationary electrical contacts; a prestressed spring strip anchored at one end; said prestressed spring strip being capable of snap action to strike said resilient contact strip and drive it out of its aforementioned normal position; a push-button type plunger positioned to engage said prestressed spring strip and move it into snap action; a bellcrank switch lever; one of the arms of said bellcrank switch lever being disposed for operative engagement with said push-button type plunger; a pivoted adjusting lever disposed in substantial parallelism with the other arm of said bellcrank switch lever; a plurality of detergent-coated unwoven strands of nylon, extending between, and connected to, the last-mentioned arm of said bellcrank switch lever and the free end of said pivoted adjusting lever; a spring biasing said pivoted adjusting lever away from said bellcrank switch lever; and manually operated means for adjusting the position of said prestressed contact strip with respect to said stationary contact.

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