

Sept. 29, 1970

S. J. DONAHUE ET AL

3,531,607

SWITCH ASSEMBLY

Filed April 5, 1968

2 Sheets-Sheet 1

FIG. 1-A

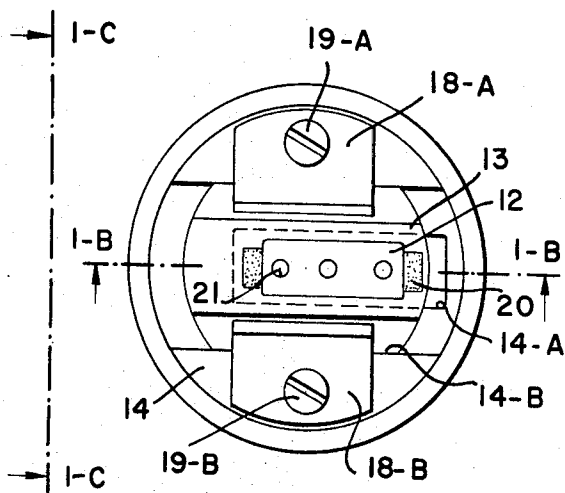


FIG. 4-C

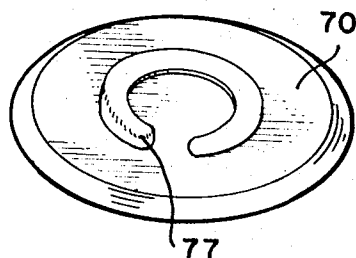


FIG. 1-C

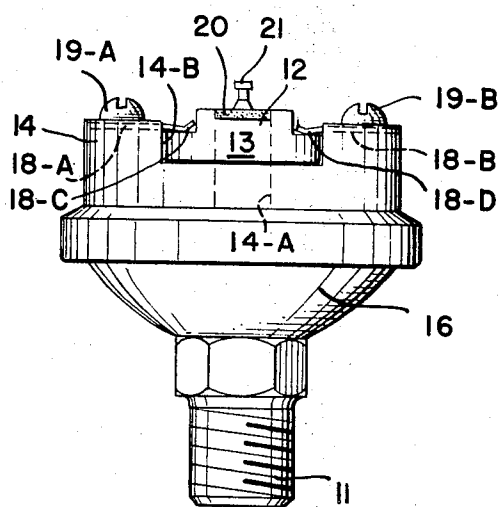


FIG. 1-B

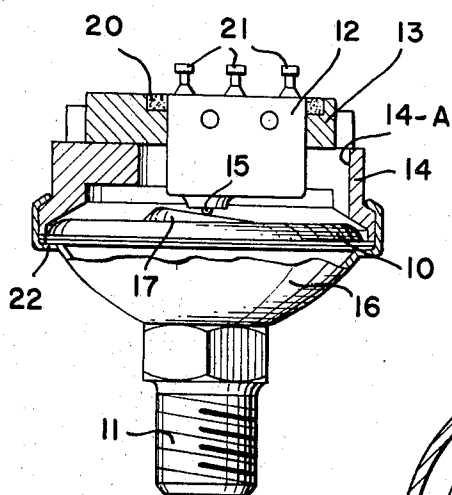
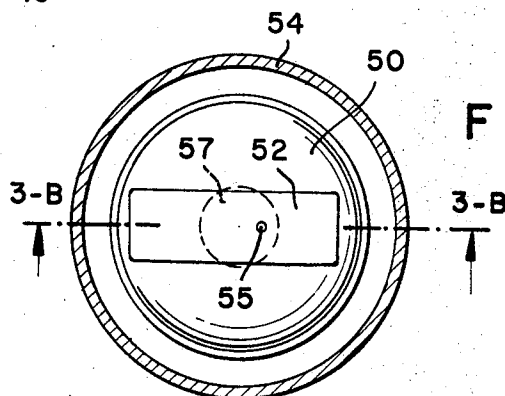


FIG. 3-A



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FIG. 4-A

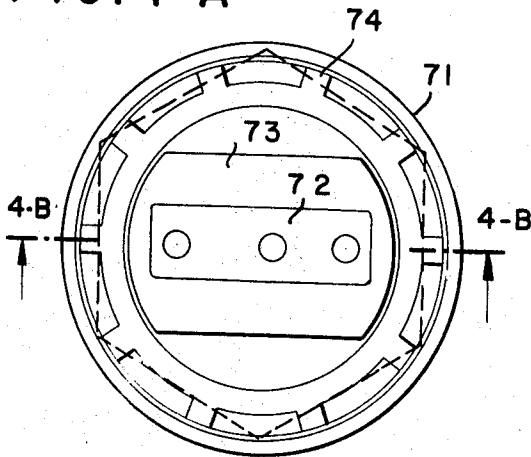


FIG. 4-B

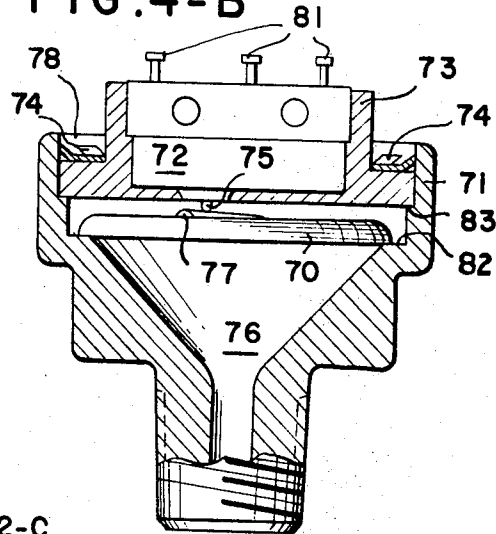


FIG. 2-A

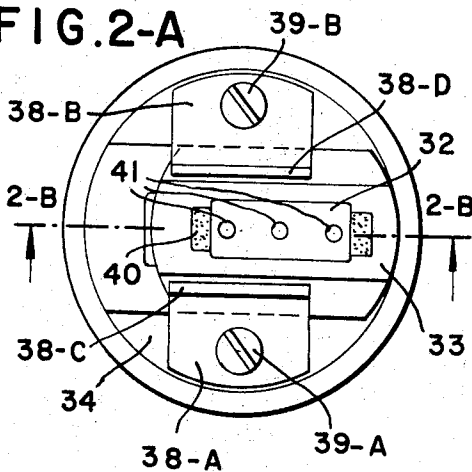
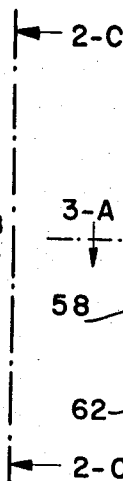


FIG. 3-B

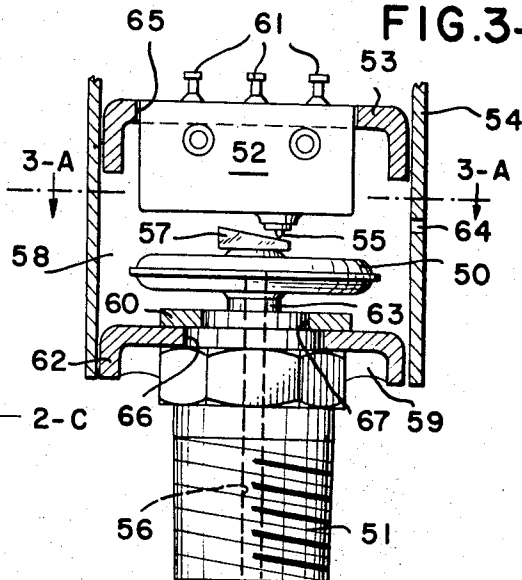


FIG. 2-B

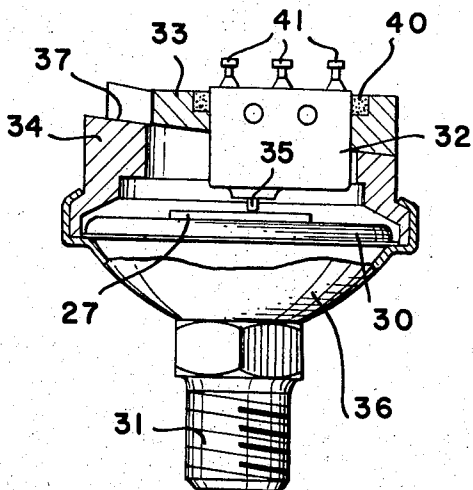
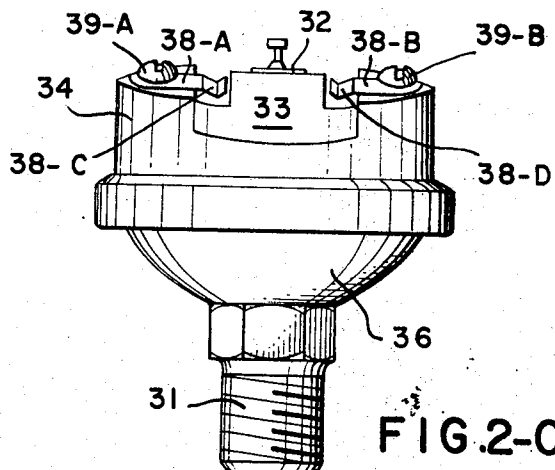


FIG. 2-C

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SWITCH ASSEMBLY

Simeon J. Donahue, Cheshire, Conn., and Edward J. Kosowicz, deceased, late of Trumbull, Conn., by John P. Evans, executor, Easton, Conn.; said Donahue assignor to American Chain & Cable Company, Bridgeport, Conn., a corporation of New York
Filed Apr. 5, 1968, Ser. No. 719,273
Int. Cl. H01h 35/40

U.S. Cl. 200—83

14 Claims

ABSTRACT OF THE DISCLOSURE

A pressure sensitive switch assembly in which a diaphragm, bellows or other pressure responsive element is effective to operate the actuating member of an electric switch at a preset operating point. Either the pressure responsive element or the switch supporting structure is provided with an inclined ramp which is arranged such that the operating point of the assembly may be readily adjusted by moving the pressure responsive element relative to the switch.

BACKGROUND OF THE INVENTION

Switch assemblies of the type having a pressure responsive element for controlling the actuating member of an electric switch are used for a wide variety of industrial applications. Heretofore, however, difficulties have been encountered in the rapid and straightforward adjustment of the particular pressure setting at which the actuating member of the switch is effective to control its electrical circuit. In the manufacture of the assemblies, for example, it often is desirable to test and adjust each individual assembly to ensure operation of the actuating member at the desired pressure, and in many prior assemblies the making of the necessary adjustments has proved both time consuming and unwieldy.

Similarly, during the use of the assemblies in the field, it frequently is advantageous to be able to adjust the set point to a different or more accurate setting. In several types of assemblies previously employed, the set point is permanently built into the unit, with the result that any adjustment is precluded and a change in set point necessitates the purchase of a completely new assembly. Other types of prior assemblies have been designed so that they may be taken apart by the user, thus enabling the relocation of the switching element, the adjustment of biasing springs, etc., to vary the set point. Such disassembly often has been a time consuming procedure and renders the reassembled parts subject to misalignment or other deficiencies.

SUMMARY OF THE INVENTION

One general object of this invention, therefore, is to provide a new and improved pressure sensitive switch assembly for actuating an electric switch in response to a predetermined input pressure.

More specifically, it is an object of this invention to provide a pressure switch assembly of the character indicated which may be readily adjusted during the manufacturing process to ensure actuation at the preselected pressure.

Another object of the invention is to provide such switch assembly in which the set point of the assembly may be varied over a wide range.

Still another object of this invention is to provide a pressure operated switch assembly utilizing comparatively simple mechanical and electrical components which is economical to manufacture and thoroughly reliable in operation.

In one illustrative embodiment of this invention, the

assembly comprises a casing member having a diaphragm or other pressure responsive element sealably mounted therein. The element includes a portion which is linearly movable in response to variations in the applied pressure and is positioned in predetermined relationship with the actuating member of an electric switch to operate the switch in response to a preselected pressure. In order to adjust the pressure setting at which the actuating member is effective to operate the switch, the predetermined relationship between the linearly movable portion of the pressure responsive element and the actuating member may be varied in a rapid and straightforward manner without the need for taking the assembly apart.

In accordance with one feature of the invention, the adjustment means defines an inclined ramp or plane which extends at an acute angle with respect to the direction of movement of the linearly movable portion of the pressure responsive element. In certain advantageous embodiments, the ramp is mounted on the pressure responsive element, and the switch unit is readily rotatable or otherwise movable relative thereto to carry the actuating member in a direction transverse to the direction of movement of the linearly movable portion. Because of the inclined ramp, the movement of the switch unit is effective to vary the spacing between the actuating member and the pressure responsive element and thus change the preselected operating point of the assembly.

In other good embodiments in accordance with the invention, the inclined ramp is mounted on the switch unit. In these latter arrangements, movement of the switch unit in a direction transverse to the direction of movement of the pressure responsive element similarly produces a change in the spacing between the element and the switch actuating member. This variation in spacing enables a corresponding change in the preselected point at which the switch is actuated.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention as well as further objects and features thereof will be understood more clearly and fully from the following description of certain preferred embodiments, when read in conjunction with the accompanying drawings, in which:

FIG. 1A is a top plan view of a pressure actuated switch assembly in accordance with one illustrative embodiment of the invention;

FIG. 1B is a sectional view taken along the line 1B—1B in FIG. 1A, with certain portions shown in elevation;

FIG. 1C is a side view of the assembly as seen from the line 1C—1C in FIG. 1A;

FIG. 2A is a top view similar to FIG. 1A but showing a switch assembly in accordance with another illustrative embodiment of the invention;

FIG. 2B is a sectional view taken along the line 2B—2B in FIG. 2A, with certain portions shown in elevation;

FIG. 2C is a side view of the assembly as seen from the line 2C—2C in FIG. 2A;

FIG. 3A is a sectional view of a switch assembly in accordance with a further illustrative embodiment of the invention, taken along the line 3A—3A in FIG. 3B, with certain portions shown in elevation;

FIG. 3B is a sectional view taken along the line 3B—3B in FIG. 3A, with certain portions shown in elevation;

FIG. 4A is a top plan view of a switching assembly in accordance with still another illustrative embodiment of the invention;

FIG. 4B is a sectional view taken along the line 4B—4B in FIG. 4A, with certain portions shown in elevation; and

FIG. 4C is a perspective view showing the pressure responsive element utilized in the assembly of FIGS. 4A and 4B.

DESCRIPTION OF CERTAIN PREFERRED EMBODIMENTS

Referring to FIG. 1B of the drawings, the switch assembly includes a pressure responsive diaphragm 10 of circular, substantially planar configuration. The diaphragm 10 is supplied with a variable input pressure from a fitting 11 which is affixed to a generally cup-shaped casing member 16. The periphery of the diaphragm is sealed to the casing member, as at 22, by brazing, soldering or a suitable adhesive such as that available under the designation "Stycast 2651" from Emerson & Cuming, Inc., Canton, Mass.

The pressure responsive diaphragm 10 is supported in predetermined cooperating relationship with a switch unit 12 of conventional construction. The unit 12 advantageously is of the snap-action type and may be obtained from various sources including the Microswitch Division of Honeywell, Inc. under designation "1SX12-T." The unit 12 includes output terminals 21 which are connected in an electrical circuit (not shown) to provide make, break and transfer functions depending upon the circuit requirements. A housing 13 of phenolic plastic material serves to support the unit 12 and is affixed thereto by an epoxy adhesive 20.

A circular support plate 14 is mounted on the side of the diaphragm 10 opposite that adjacent the casing 16. The rim of the casing 16 is rolled over the periphery of the support plate 14 to firmly clamp the diaphragm therebetween. The plate 14 includes an elongated rectangular aperture 14A therein which is of a size sufficient to accommodate the switch unit 12 but is somewhat shorter than the housing 13. This aperture communicates with a recess 14B (FIG. 1C) in the upper portion of the plate 14. The housing 13 is slidably positioned in the recess 14B to enable movement of the switch 12 in a direction transverse to the direction of movement of the diaphragm for purposes that will become more fully apparent hereinafter.

The switch unit 12 includes an actuating pin 15 in predetermined cooperating relationship with the central portion of the diaphragm 10. Rigidly mounted on this portion of the diaphragm is a ramp 17 having a surface adjacent the pin 15 which is disposed in an inclined flat plane. The plane intercepts the direction of movement of the diaphragm portion at an acute angle and meets the plane of the diaphragm at an angle which illustratively is of the order of about 6°. The ramp 17 may be embossed directly on the upper surface of the diaphragm, or it may form a separate part which is welded or otherwise affixed thereto.

The housing 13 and its attached switch unit 12 are held in position relative to the support plate 14 and the diaphragm 10 by two leaf springs 18A and 18B (FIGS. 1A and 1C). These springs are removably affixed to the upper surface of the housing 13 by screws 19A and 19B. The springs 18A and 18B are provided with bends 18C and 18D, respectively, along their edges contiguous to the housing 13 which serve to hold the housing in rigid but adjustable relationship with the plate 14.

Upon the application of a preselected input pressure to the fitting 11, the central portion of the diaphragm 10 moves upwardly, as viewed in FIG. 1B, to similarly move the ramp 17 thereon. The inclined surface of the ramp exerts a force against the actuating pin 15 to operate the snap-action switch 12.

In order to adjust the particular pressure for which the apparatus is effective to operate the switch 12, the switch and its housing 13 are manually moved in a lateral direction relative to the diaphragm 10. During this movement, the distance between the actuating pin 15 and the inclined surface of the ramp 17 changes to either increase or decrease the preselected operating pressure. When the desired relative relationship between the actu-

ating pin and the ramp is reached, the screws 19A and 19B are tightened to hold the switch in its new position. The arrangement is such that the assembly may be quickly and easily adjusted to produce operation of the switch over a wide range of input pressures without the need for disassembling the apparatus or for making structural changes in the various parts. This adjustment may be accomplished with substantially equal facility either during the manufacturing process or in the field. The leaf springs 18A and 18B serve not only to affirmatively hold the switch in the adjusted position but to guide the switch during its lateral movement.

In the embodiment of the invention illustrated in FIGS. 1A, 1B and 1C, the assembly is adjusted in accordance with the desired set point by moving the switch unit 12 in a lateral direction relative to an inclined ramp on the pressure responsive diaphragm 10. In other advantageous arrangements, the ramp may be formed on the support for the switch unit. In the embodiment shown in FIG. 2B, for example, there is provided a switch unit 32 having a circular support plate 34 which includes a sloping upper surface 37. This surface serves as an inclined ramp which extends at an acute angle with respect to the direction of movement of a plate 27 on the upper surface of the diaphragm 30. The ramp 37 supports a switch housing 33 having a lower surface which is similarly inclined so that it may slide smoothly along the ramp. The switch 32 is of the snap-action type and includes an actuating pin 35 and three terminals 41. The switch is carried in a suitable aperture in the housing 33 and is affixed thereto by an epoxy adhesive 40. A pair of leaf springs 38A and 38B (FIGS. 2A and 2C) are mounted on the upper surface of the support plate 34 on opposite sides of the housing 33. These springs are provided with bends 38C and 38D and are held in place by screws 39A and 39B, respectively, in a manner similar to that described heretofore.

The assembly is designed to operate the actuating pin 35 of the switch unit 32 in response to a preselected pressure supplied to an input fitting 31. The pressure is applied to one side of the diaphragm 30 from a pressure casing 36 and is effective to move the plate 27 on the opposite side of the diaphragm against the pin 35 to operate the switch. In order to change the set point of the assembly, the housing 33 and the switch 32 are slidably adjusted up and down the ramp 37, thereby raising or lowering the position of the pin 35 relative to the plate 27.

In some embodiments of the invention, the leaf springs 38A and 38B may be eliminated, and the switch housing may be provided with elongated laterally extending slots (not shown). These slots accommodate suitable locking screws which serve to guide the housing during its movement along the inclined ramp and to hold the housing in position upon the completion of the adjustment.

Referring now to FIGS. 3A and 3B, there is shown a pressure sensitive switch assembly in accordance with a further embodiment of the invention which is particularly suitable for the accurate and precise adjustment of the set point during manufacture. The assembly includes a pressure sensitive capsule or bellows 50 which is supplied with air under pressure from an input fitting 51. The fitting 51 includes an inlet opening 56 and is provided at its inner end with a reduced portion 63 affixed to one side of the bellows 50.

The side of the bellows 50 opposite that adjacent the fitting portion 63 is provided with a ramp member 57. The member 57 is movable in a linear direction (a vertical direction, as viewed in FIG. 3B) in response to changes in pressure within the bellows, and the upper surface of the member lies in a flat inclined plane extending at an acute angle with respect to the direction of movement. This surface cooperates with the actuating pin 55 of a snap-action switch 52 to control the electrical circuit connected to the switch terminals 61.

The snap-action switch 52 is permanently affixed, as at 65, within a rectangular opening in a cup-shaped housing

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plate 53. The periphery of the plate 53 similarly is affixed to the inner wall of a generally tubular casing 54 which encloses the switch 52 and the bellows 50. The casing 54 defines an interior chamber 58 which is vented at 64 to maintain the chamber at atmospheric pressure. The lower portion of the chamber is substantially closed by a plate 62. The input fitting 51 extends into the chamber 58 through a suitable aperture 66 in the plate 62. The diameter of this aperture is sufficient to permit unobstructed rotary movement of the fitting 51 with respect to the switch casing 54. A collar 60 surrounds the inwardly extending portion of the fitting 51 and is staked at 67 thereto.

To adjust the set point of the assembly, the fitting 51 is rotated relative to the casing 54 and the switch unit 52 to similarly rotate the bellows 50 and the ramp 57. The actuating pin 55 of the switch is located at a point which is spaced from the axis of rotation of the ramp. As the ramp rotates, the distance between the ramp and the pin is varied to change the point at which a given input pressure to the bellows 50 will cause operation of the switch. By rotating the bellows 50 and the ramp 57 through an angle of one hundred and eighty degrees, the set point is varied over the entire range of adjustment.

When the distance between the ramp 57 and the actuating pin 55 has been adjusted by rotation of the fitting 51 in accordance with the selected actuating point, the fitting is permanently attached to the bottom plate 62 of the switch casing 54 to prevent any further rotation or change of position. This attachment may be accomplished through the use of "Stycast" adhesive 59 which is applied around the joint between the fitting and the plate. When the adhesive hardens, it is effective to prevent further adjustment of the actuating point and also to provide an airtight seal.

In some embodiments of the invention, the switch assembly may be adjusted by rotating the pressure input fitting relative to the switch unit both during the manufacturing process and in the field. Referring to FIGS. 4A, 4B and 4C, for example, there is shown a pressure responsive diaphragm 70 which is brazed, soldered or otherwise permanently affixed to an internal step or ledge 82 within an input fitting 71. The diaphragm 70 cooperates with a switch unit 72 having an actuating pin 75 and three output terminals 81. The unit 72 is mounted in a rectangular opening in a switch housing 73 which is rotatably carried on a second ledge 83 within the open upper portion of the fitting 71. A retaining ring 74 is positioned around the upstanding portion of the housing 73 and is arranged to exert a comparatively strong pressure against the interior wall of the fitting 71 to resiliently hold the housing and the fitting in fixed but adjustable relationship with each other.

One side of the diaphragm 70 communicates with an input chamber 76 within the fitting 71. As best shown in FIG. 4C, the opposite side of the diaphragm 70 is provided with a generally helical ramp 77 having an inclined upper surface which extends at an acute angle with respect to the direction of movement of the diaphragm. The ramp 77 is annular in plan view, and the actuating pin 75 of the switch 72 is offset such that the pin is in a position to contact the ramp at all times.

To vary the preselected operating point of the assembly, the upstanding portion of the switch housing 73 is rotated relative to the fitting 71 to produce a corresponding change in the distance between the actuating pin 75 and the inclined surface of the ramp 77. Depending upon the spring tension in the retaining ring 74, the rotational movement of the housing 73 may be accomplished by hand or with a wrench or other suitable tool. After the housing has been rotated in accordance with the desired operating point, the spring tension is sufficient to maintain the various parts in their new positions.

In cases in which it is desirable to adjust the assembly to a particular operating point and to then prevent further

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adjustment, when the housing 73 has been moved to the desired position a suitable bonding or sealing material is placed in the well 78 between the housing and the adjacent lip of the fitting 71. One advantage of the helically rising ramp 77 is that the inclined upper surface of the ramp provides a longer slope and thus enables the realization of an extremely sensitive adjustment. The annular path of this surface extends through an angle of slightly less than 360° to enable the accurate variation of the set point pressure over a wide range.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions, of excluding any equivalents of the features shown and described, or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A pressure sensitive switch assembly comprising, in combination, a pressure responsive element movable in response to variations in pressure applied thereto, an electric switch element having actuating means in predetermined cooperating relationship with said pressure responsive element, the movement of said pressure responsive element controlling said actuating means to operate said switch element in response to a preselected applied pressure, means for maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means in said predetermined cooperating relationship, and means including an inclined ramp connected to one of said elements, said ramp having a bearing surface extending in a single flat plane which intersects the direction of movement of said pressure responsive element at an acute angle, and switch element being movable relative to said pressure responsive element to vary the predetermined relationship between said actuating means and said pressure responsive element, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

2. A pressure sensitive switch assembly comprising, in combination, a pressure responsive element including a portion linearly movable in response to variations in pressure applied thereto, an electric switch element having actuating means in predetermined cooperating relationship with the linearly movable portion of said pressure responsive element, the movement of said linearly movable portion controlling said actuating means to operate said switch element in response to a preselected applied pressure, means for maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means and said linearly movable portion in said predetermined cooperating relationship, and means on one of said elements and defining a single inclined plane extending at an acute angle with respect to the direction of movement of said linearly movable portion for enabling the variation of the predetermined relationship between said actuating means and said linearly movable portion, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

3. A pressure sensitive switch assembly comprising, in combination, a casing member, a pressure responsive element mounted in said casing member, said pressure responsive element having a generally planar portion movable in response to variations in pressure applied thereto, an electric switch element having actuating means in predetermined cooperating relationship with said pressure responsive element, the movement of said pressure responsive element controlling said actuating means to operate said switch element in response to a preselected applied pressure, means for maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means in said predetermined cooperating relationship, and means per-

manently affixed to the planar portion of said pressure responsive element and having a bearing surface extending in a single flat plane inclined at an angle with respect thereto for enabling the variation of the predetermined relationship between said actuating means and said pressure responsive element, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

4. A pressure sensitive switch assembly comprising, in combination, a casing member, a pressure responsive element mounted in said casing member, said pressure responsive element including a portion linearly movable in response to variations in pressure applied thereto, an electric switch element having actuating means in predetermined cooperating relationship with the linearly movable portion of said pressure responsive element, the movement of said linearly movable portion controlling said actuating means to operate said switch element in response to a preselected applied pressure, adjustment means for maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means and said linearly movable portion in said predetermined cooperating relationship, and ramp means on said linearly movable portion and defining a single inclined plane extending at an acute angle with respect to the direction of movement thereof for enabling the variation of the predetermined relationship between said actuating means and said linearly movable portion, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

5. A pressure sensitive switch assembly of the character set forth in claim 4, in which said electric switch element is linearly movable with respect to said pressure responsive element in a direction transverse to the direction of movement of said linearly movable portion, to vary the position of said actuating means relative to said linearly movable portion.

6. A pressure sensitive switch assembly of the character set forth in claim 4, in which said electric switch element is rotatably movable with respect to said pressure responsive element, to vary the position of said actuating means relative to said linearly movable portion.

7. A pressure sensitive switch assembly of the character set forth in claim 6, in which said ramp means is of helical configuration.

8. A pressure sensitive switch assembly comprising, in combination, a casing member, a pressure responsive element mounted in said casing member, said pressure responsive element including a portion linearly movable in response to variations in pressure applied thereto, an electric switch element having actuating means in predetermined cooperating relationship with the linearly movable portion of said pressure responsive element, the movement of said linearly movable portion controlling said actuating means to operate said switch element in response to a preselected applied pressure, adjustment means for maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means and said linearly movable portion in said predetermined cooperating relationship, and ramp means on said electric switch element and defining a single inclined plane extending at an acute angle with respect to the direction of movement of said linearly movable portion for enabling the variation of the predetermined relationship between said actuating means and said linearly movable portion, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

9. A pressure sensitive switch assembly of the character set forth in claim 8, in which said ramp means comprises a housing member affixed to said electric switch element, and support means connected to the casing member for said pressure responsive element and having a single inclined surface disposed in said inclined plane, said housing member being linearly movable along the inclined sur-

face of said support means to vary the position of said actuating means relative to the linearly movable portion of said pressure responsive element.

10. A pressure sensitive switch assembly comprising, in combination, a casing member, a pressure responsive element sealably mounted in said casing member, said pressure responsive element being of generally planar configuration and including a portion linearly movable in response to variations in pressure applied thereto, an electric switch element having actuating means in predetermined cooperating relationship with the linearly movable portion of said pressure responsive element, the movement of said linearly movable portion controlling said actuating means to operate said switch element in response to a preselected applied pressure, means for maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means and said linearly movable portion in said predetermined cooperating relationship, and means connected to one of said elements and defining a single inclined plane extending at an acute angle with respect to the direction of movement of said linearly movable portion for enabling the variation of the predetermined relationship between said actuating means and said linearly movable portion, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

11. A pressure sensitive switch assembly comprising, in combination, a casing member, a pressure responsive element sealably mounted in said casing member, said pressure responsive element being of generally planar configuration and including a central portion linearly movable in response to variations in pressure applied thereto, an electric snap-action switch element having actuating means in predetermined cooperating relationship with the linearly movable portion of said pressure responsive element, the movement of said linearly movable portion controlling said actuating means to operate said switch element in response to a preselected applied pressure, spring means for maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means and said linearly movable portion in said predetermined cooperating relationship, and means connected to one of said elements and having a bearing surface extending in a single flat plane inclined at an acute angle with respect to the plane of said pressure responsive element for enabling the variation of the predetermined relationship between said actuating means and said linearly movable portion, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

12. A pressure sensitive switch assembly of the character set forth in claim 11, in which said spring means comprises a pair of leaf springs cooperating with opposite sides of said switch element, said leaf springs guiding said switch element during the adjustment thereof relative to said pressure responsive element.

13. A pressure sensitive switch assembly of the character set forth in claim 11, in which said casing member includes a circular lip surrounding said switch element in spaced relationship therewith, and said spring means comprises an annular spring in resilient engagement with said lip.

14. A pressure sensitive switch assembly comprising, in combination, a casing member, a pressure responsive element sealably mounted in said casing member, said pressure responsive element being of generally planar configuration and including a portion linearly movable in response to variations in pressure applied thereto, an electric switch element having actuating means in predetermined cooperating relationship with the linearly movable portion of said pressure responsive element, the movement of said linearly movable portion controlling said actuating means to operate said switch element in response to a preselected applied pressure, means for

maintaining said switch element in fixed but adjustable juxtaposition with said pressure responsive element, to hold said actuating means and said linearly movable portion in said predetermined cooperating relationship, said switch element being rotatably movable with respect to said pressure responsive element, and means including a helical ramp connected to said pressure responsive element and defining a single inclined plane extending at an acute angle with respect to the direction of movement of said linearly movable portion for enabling the variation of the predetermined relationship between said actuating means and said linearly movable portion in response to rotary movement of said switch element with respect to said pressure responsive element, to thereby adjust the preselected pressure at which said actuating means is effective to operate said switch element.

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ROBERT S. MACON, Primary Examiner

J. R. SCOTT, Assistant Examiner

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