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Weber

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[45] **Aug. 5, 1975**

[54] **DIAPHRAGM PRESSURE SWITCH WITH BALANCE PLATE AND ADJUSTABLE SPRINGS**

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[21] Appl. No.: **488,207**

Related U.S. Application Data

[60] Continuation-in-part of Ser. No. 432,460, Jan. 11, 1974, which is a division of Ser. No. 236,732, March 21, 1972, Pat. No. 3,786,212, which is a continuation-in-part of Ser. No. 154,536, June 18, 1971, abandoned.

[52] **U.S. Cl.** ..... **200/83 J;** 200/83 S; 73/406; 92/130; 337/323; 200/16 C

[51] **Int. Cl.** **H01h 35/34**

[58] **Field of Search** ..... 73/406; 92/95, 96, 101, 92/130; 200/18, 5 C, 153 T, 153 W, 83 J, 83 R, 83 P, 83 S, 83 T, 286, 16 B, 16 C, 16 D, 81 R; 337/320, 323, 332; 340/229, 240

[56] **References Cited**

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3,210,486	10/1965	Holzer	200/81 R
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Primary Examiner—Gerald P. Tolin
Attorney, Agent, or Firm—Arthur Schwartz

[57] **ABSTRACT**

A device for producing control signals in response to changes in a given condition, such as pressure. Variations in the condition causes a balance plate to pivot about two different axes which are defined by the points of contact between certain protrusions on the balance plate and stop plates disposed above and below the balance plate. Pivotal movement of the balance plate about one axis triggers one signal producing device, such as a microswitch, and pivotal movement about the other axis triggers another, similar signal producing device. The balance plate is coupled with both signal producing devices by an improved linkage system including a pair of actuating rods extending through the interiors of a pair of coil springs which act on the balance plate. The protrusions on the balance plate are of a construction which facilitates manufacturing. Specifically, the protrusions are formed from the plate itself, and yet one protrusion extends upwardly and another extends downwardly from the same immediate region of the plate.

20 Claims, 11 Drawing Figures

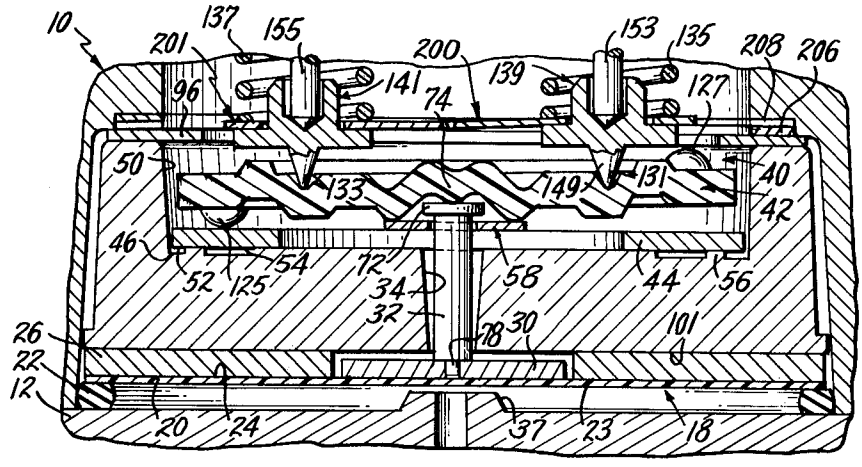
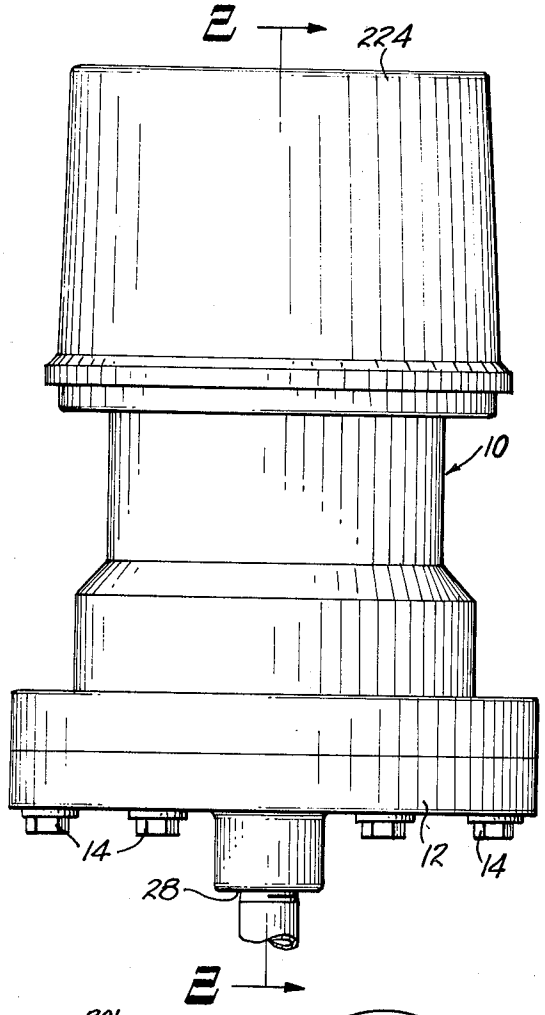


Fig. 1.



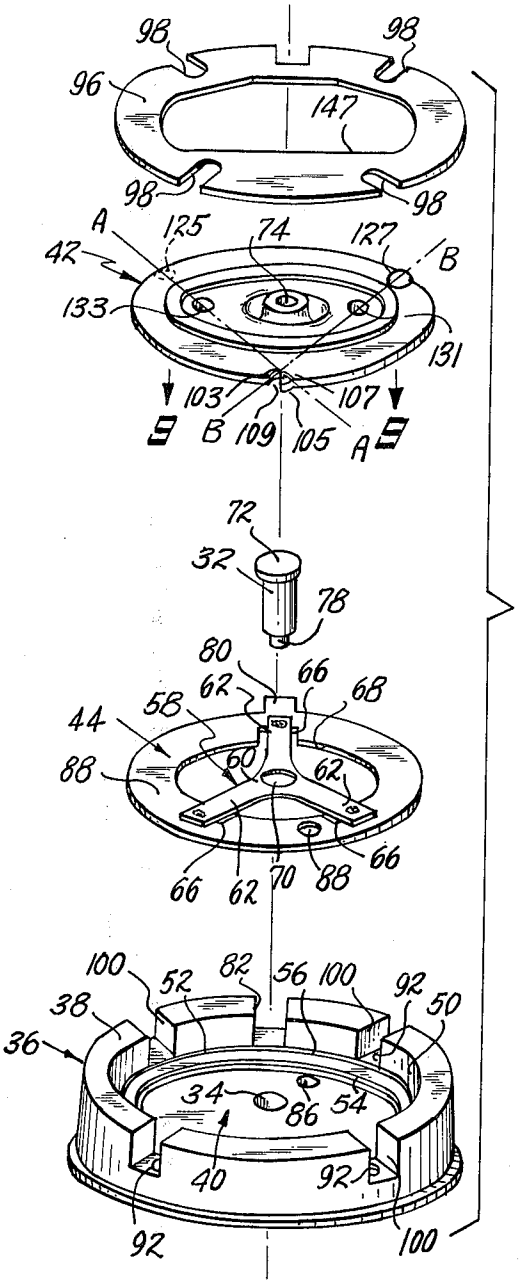


Fig. 8.

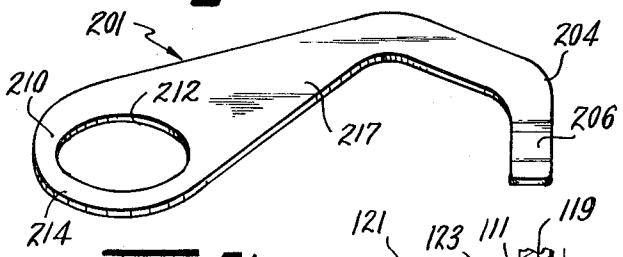


Fig. 5A.

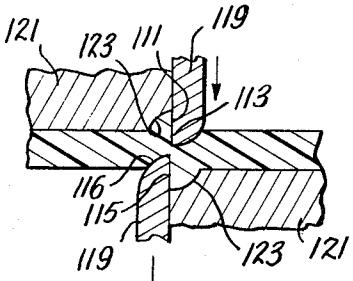


Fig. 9.

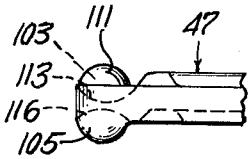


Fig. 9A.

Fig. 2.

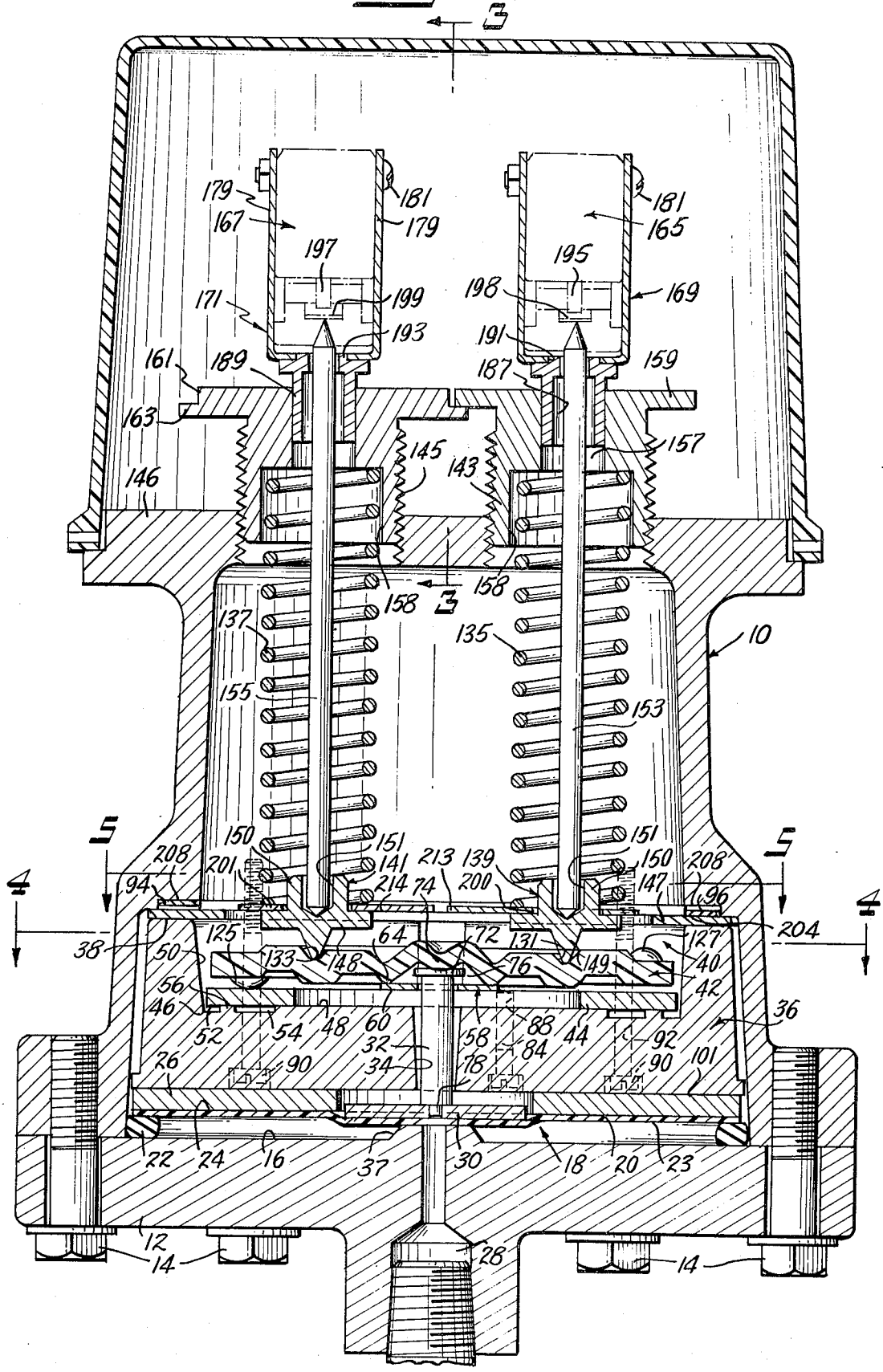

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Fig. 3.

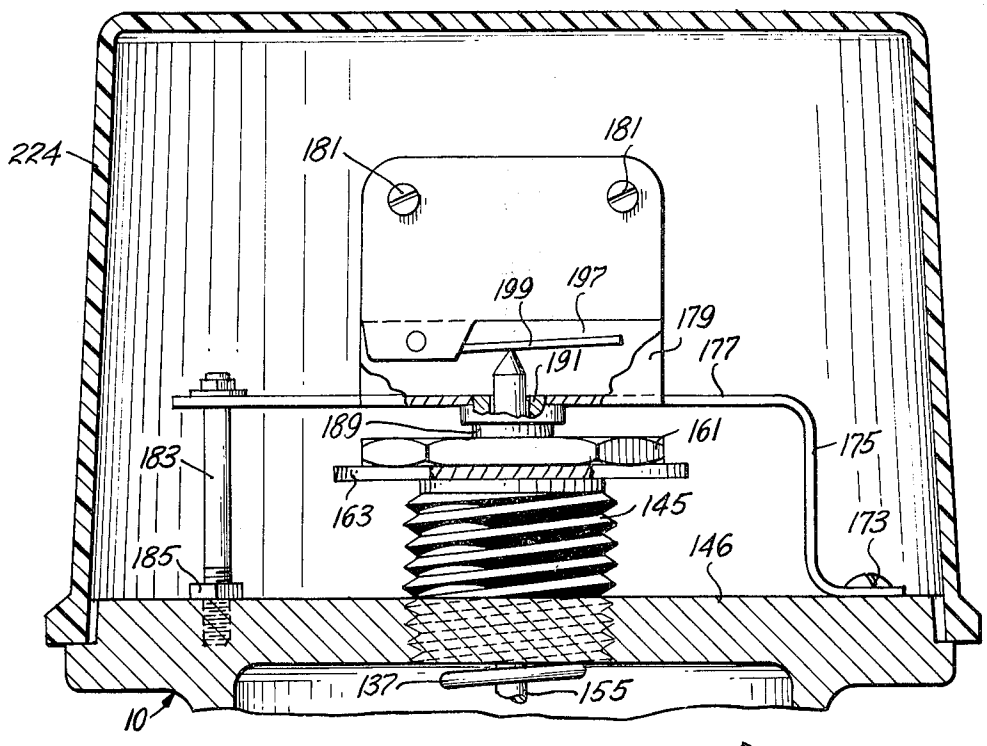

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Fig. 4.

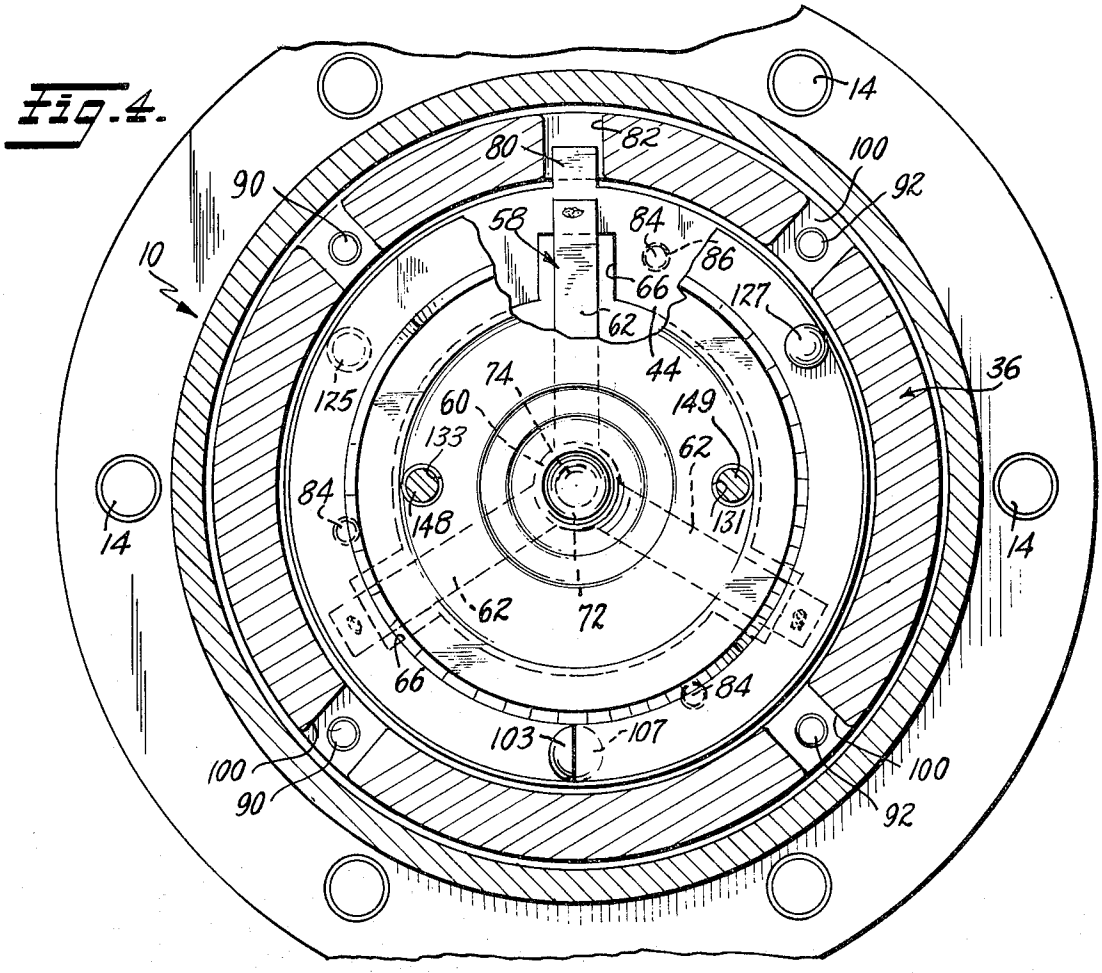

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Fig. 5.

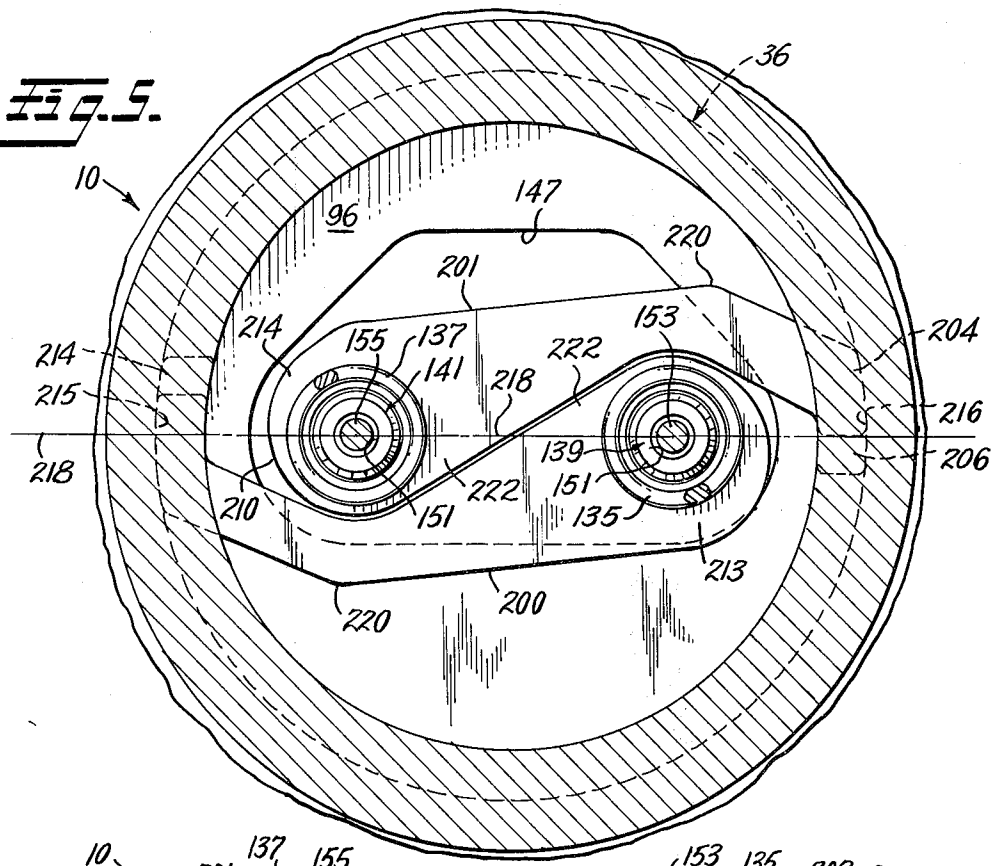


Fig. 6.

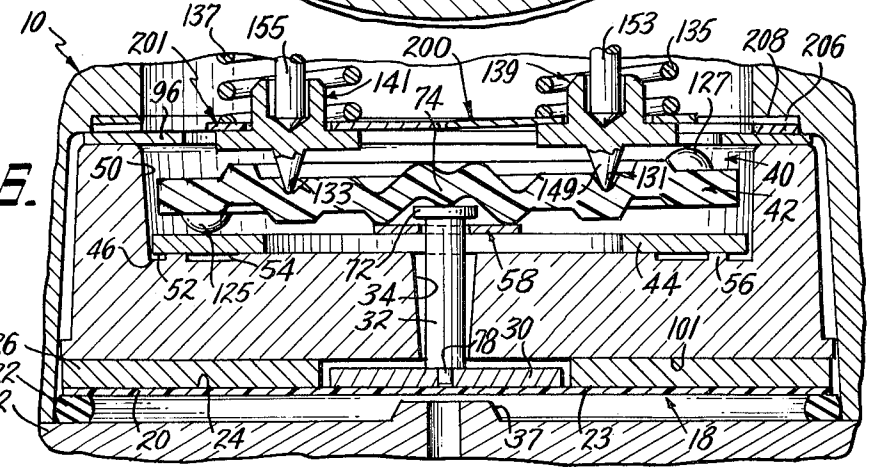
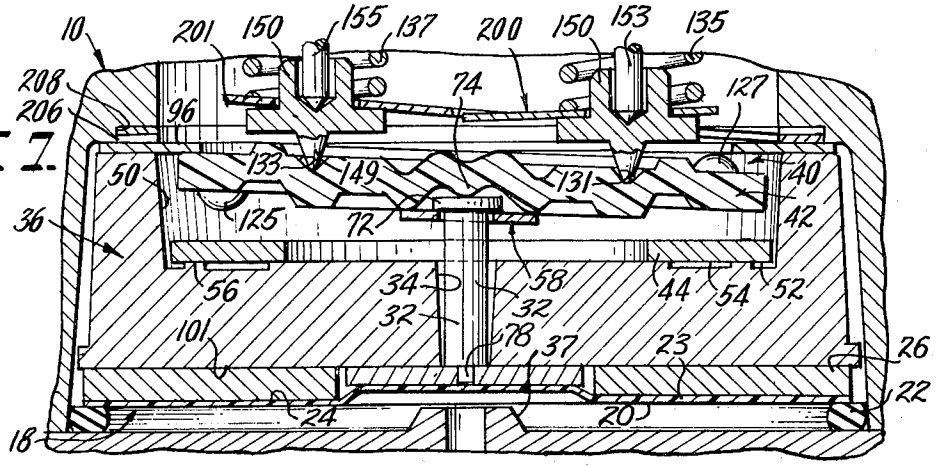


Fig. 7.



DIAPHRAGM PRESSURE SWITCH WITH BALANCE PLATE AND ADJUSTABLE SPRINGS

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of co-pending U.S. patent application Ser. No. 432,460, filed Jan. 11, 1974 which, in turn, is a divisional of U.S. patent application Ser. No. 236,732, filed Mar. 21, 1972 now U.S. Pat. No. 3,786,212, which was a continuation-in-part of U.S. patent application Ser. No. 154,536, filed June 18, 1971 and now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a device for producing control signals in response to condition changes. The prefered embodiment of the invention is a pressure switch, i.e., a device which produces electrical signals in response to pressure variations, but the invention may also be embodied by devices which measure conditions other than pressure and which produce signals other than electrical. For instance, the invention could be embodied by a device which produces control signals in fluid or fluidic circuits and/or by a device which produces control signals in response to temperature variations.

The device of the present invention, in certain of its aspects, falls within a class of condition responsive devices which can be described as alternating fulcrum or alternating axis devices. In this type of device, a pressure sensing element is coupled to a balance plate or balance beam which pivots, alternately, about a pair of fulcrums or axes. Pivotal movements about the different axes effect actuation of the device into different control modes. Examples of alternating fulcum and alternating axis control devices are found in U.S. Pat. Nos. 2,284,940, 2,266,144, and 2,274,119 all to A. E. Baak, U.S. Pat. No. 2,766,349 to H. F. Hamburg, U.S. Pat. No. 3,210,486 to W. Holzer, and U.S. Pat. No. 3,786,212 to the present inventor.

The present invention relates specifically to improvements in the construction of control devices of the foregoing type. For instance, the balance plate of the present invention has a special construction which greatly simplifies manufacturing without sacrificing reliablity or performance. Also, the device of the invention includes an improved and simplified construction and arrangement of actuating components for a plurality of microswitches or other signal producing devices. The springs which control the movement of the balance plate have improved guides to prevent buckling, and the balance plate itself, is coupled to an improved guiding device therefor.

2. Description of the Prior Art

In the devices disclosed by U.S. Pat. Nos. 2,284,940, 2,266,144 and 2,279,119 all to A. E. Baak; U.S. Pat. No. 2,766,349 to H. F. Hamburg and U.S. Pat. No. 3,210,486 to W. Holzer, the electrical signal producing components either are integral parts of the switch mechansim, or are disposed within the housing for the mechanical switching elements, or both. As a result, access to these electrical components is limited and convience of replacement and/or repair is curtailed.

This is not a problem in the device disclosed by U.S. Pat. No. 3,786,212 to the present inventor, but this latter patent discloses an arrangement wherein only a single switch, preferably a conventional microswitch, is actuated. An alternating fulcrum or alternating axis arrangement, wherein two or more switching components which are readily accessible, replaceable and/or interchangeable and which are actuated by a simple linkage system, has not heretofore been known.

Also, in the field, it is often necessary that the electrical switching components be separately enclosed with respect to the remaining elements of the condition responsive device and with respect to the surroundings. Those known alternating fulcrum or alternating axis devices which include pluralities of separate, electrical signal producing elements do not lend themselves well to such field applications.

It is noted that, in the device disclosed by U.S. Pat. No. 3,786,212, to the present inventor the balance plate includes a plurality of protrusions which engage stationary surfaces to define points about which the balance plate pivots during operation. The protrusions are preferably formed by staking spherical balls within appropriately sized holes in the balance plate. This requires several assembly and several metal working operations. The present invention seeks to achieve cost savings over this construction by providing a balance plate which has equivalent performance characteristics, but which can be formed from a single piece of stock material in very few metal working operations.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a control device of the alternating fulcrum or alternating axis type wherein the overall device, and particularly the balance device therefore, are of improved and simplified construction, embodying few parts, which can be constructed with simplified metal working and assembly operations, and which can be produced at a low cost.

It is a more particular object of the invention to provide a balance plate for alternating axis control device wherein the plate itself and the protrusions thereon may be formed from a single piece of flat, stock material in a few, simple, working operations.

It is another more particular object of the invention to provide an alternating fulcrum or alternating axis control device with a very simple, economical and reliable actuation linkage system for transferring movements of the balance plate to a pair of separate switching devices, such as conventional microswitches, mounted outside the housing of the condition responsive device.

It is also an object of the invention to provide simple and reliable guides for the main springs which impose a bias on the balance plate.

It is a further object to provide an improved guide device for the balance plate.

Other objects and advantages will be apparent from or pointed out in the following description and accompanying drawings.

SUMMARY OF THE INVENTION

The present invention overcomes the shortcomings of the prior art and fulfills the foregoing objects by providing a device wherein a pair of microswitches are mounted outside the main housing of the device at an end of the housing opposite to the pressure inlet. The actuation linkage between the balance plate and microswitches is greatly simplified and is made very compact

by use of a piar of retainer members which serve the dual purpose of: (1) coupling the main biasing springs to the balance plate; and (2) coupling a pair of actuating rods to the balance plate. The construction is further simplified and made compact by utilizing the elongated hollow space within each of the foregoing springs as a passageway for receiving the actuating rods. Each rod extends from one spring retainer through the interior of one spring to be coupled with one microswitch.

The point at which actuation of each microswitch takes place is determined by the biasing forces of the springs acting on the balance plate. These forces may, in turn, be adjusted by a pair of adjusting members disposed at the upper end of the housing. The pressure at which the balance plate pivots about one axis is determined entirely by adjustment of the spring which acts through the other axis, and vice versa. Thus, adjustment of each spring determines the point at which its one associated microswitch is actuated, independently of the adjustment of the other spring.

The adjusting members include concentric bores therethrough to provide passageways through which the actuating rods extend. Thus, each actuating rod passes through the bore in one adjusting member to be coupled with one microswitch. A pair of sleeves, which are fixedly attached to a pair of mounting brackets for the microswitches, extend downwardly from the brackets into the bores of the adjusting members. As the adjusting members are advanced and retracted, they slide telescopically with respect to the stationary sleeves. Thus, the sleeves protect against: (a) tampering with the portions of the actuating rods which extend outside the housing; and (b) entry of foreign matter into the housing through the bores in the adjusting members.

The balance plate of the device of the invention has a unique structure which greatly simplies manufacturing and affords considerable cost savings. In particular, the balance plate includes a pair of pivotal protrusions both of which are disposed in the same immediate region of the balance plate but which extend outwardly therefrom in opposite directions; i.e., one protrusion extends upwardly from the top surface of the balance plate, while the other extends downwardly from the bottom surface thereof. Each pivotal protrusion preferably takes substantially the form of a quarter sphere, thereby making it possible to: (a) produce both protrusions with a simple stamping or pressing operation, and (b) closely space the protrusions so that they both extend from the same immediate region of the balance plate.

Because the pivotal protrusions are produced by stamping or pressing, depressions wil be formed in the balance plate on the opposite side of each protrusion. In view of the close proximity of the two pivotal protrusions, a depression produced during the formation of one pivotal protrusion will be disposed contiguously with respect to the other pivotal protrusion and vice versa.

At points on the balance plate spaced from the pivotal protrusions, there are disposed two additional protrusions. One extends downwardly, and this protrusion, together with the downwardly extending protrusion of the pivotal set of protrusions, selectively engages a lower, annular stop plate to define one axis about which the balance plate pivots during operation. Another protrusion extends upwardly, and this latter protrusion, together with the upwardly extending protrusion of the pivotal set of protrusions, selectively engages an upper, annular stop plate to define another axis about which the balance pivots during operation.

A guiding device, having a center hub and a plurality of radially outwardly extending arms, is used both to guide the balance plate in its pivotal movements and to retain the balance plate in the proper position in the housing. The center hub of the guiding device is fixedly attached to a central annular protrusion of the balance plate. The outer ends of the radially extending arms are attached to the lower stop plate at points disposed radially outwardly of an inside diameter of this plate. Recesses are provided in the stop plate immediately below the radially extending arms to allow the arms to flex downwardly below the surface of the plate during operation.

To prevent buckling of the main biasing springs, a resilient spring guide is coupled to the lower end of each spring at the point where the spring is coupled to its retainer member. Each guide is given a special configuration so that it may be anchored within the housing at a region in the housing which is most remote from the spring to be guided. Thus, the length of each guide is maximized, thereby minimizing the extent of arcuate movement of each guide as it bends during operation.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a side elevation of the preferred embodiment of the present invention.

FIG. **2** is an enlarged, vertical, sectional view, taken substantially on the line **2—2** of FIG. **1.**

FIG. **3** is a transverse, vertical, sectional view taken substantially on the line **3—3** of FIG. **2.**

FIG. **4** is a horizontal, sectional view taken substantially on the line **4—4** of FIG. **2.**

FIG. **5** is a horizontal, sectional view taken substantially on the line **5—5** of FIG. **2.**

FIG. **5A** is a perspective view of one of the spring guides illustrated in FIG. **5.**

FIGS. **6** and **7** are fragmentary, sectional view which are substantially the same as a portion of the view of FIG. **2,** but FIGS. **6** and **7** show various displaceable elements in different positions.

FIG. **8** is an exploded perspective view of certain of the elements shown in FIG. **2.**

FIG. **9** is an enlarged, fragmentary, sectional view taken on the line **9—9** of FIG. **8.**

FIG. **9A** is an enlarged, fragmentary, side elevation of the pivotal protrusions of the balance plate as illustrated in the foreground of the perspective view of the balance plate as per FIG. **8.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following description, and in the drawing, like reference characters, when used in connection with different figures of the drawing, refer to like elements and/or features.

Referring now to FIGS. **1** and **2,** there is shown a control device having a main housing **10** and a lower end closure member **12** secured to the main housing by a plurality of threaded fasteners **14.** An inside surface **16** (FIG. **2**) of closure member **12** partially defines one wall of a sensing chamber **18** in the housing. The sensing chamber is further defined by a sensing element in the form of a diaphragm **20** and by an O-ring **22** compressibly held between surface **16** and diaphragm **20.**

O-ring 22 resiliently engages the lower side 23 of diphragm 20 and urges a radially outward portion of upper side 24 of the diaphragm into tight, face-to-face engagement with a cylinder member 26 disposed in the housing directly thereabove. O-ring 22 also seals chamber 18 with respect to both the housing 10 and the closure member 12. When the device of the invention is to be used as a pressure switch, fluid under pressure is admitted into chamber 18 via connecting port 28 in closure member 12.

Although the sensing means preferrably takes the form of a diaphragm, other suitable sensing means may be used instead.

A central portion of the upper side 24 of the diaphragm 20 engages a piston 30 in face-to-face relationship therewith. Displacements of the diaphragm, effected, for example, by variations of pressure in chamber 18, are transferred directly to the piston 30, which is displaceable within cylinder member 26. The pistion, in turn, engages a pin 32 which extends through an upwardly diverging, central opening 34 in a support member 36. The tapering walls of opening 34 permit slight pivotal movements of the piston and pin during operation. An abutment member 37 within chamber 18 facilitates retention of piston 30 within cylinder member 26 and functions as a lower stop to limit downward movement of the diaphragm and piston.

An upwardly facing annular surface 38 of support member 36 includes a large recessed area 40 within which a balance plate 42 is displaceably disposed. Pin 32 engages the balance plate to transfer thereto the displacements of piston 30.

Also disposed within recessed area 40 of support member 36, but in fixed relationship therewith, is an annular plate 44 referred to hereafter as the lower stop plate. Lower stop plate 44 fits within and is retained by a circular corner 46 defined by the walls which form the recessed area 40. In particular, corner 46 is defined by a bottom wall 48 and an upwardly extending side wall 50 of the support member. In the bottom wall 48, at positions immediately adjacent corner 46, are two, side-by-side, shallow, annular grooves 52, 54 which define an annular ridge 56 therebetween. The outer annular groove 52 has a smaller radial dimension than the inner annular groove 54, but both grooves have larger radial dimensions than does annular ridge 56. Stop plate 44 overlies annular grooves 54, 56 and is engaged from below both by annular ridge 56 and by a small portion of the bottom wall 48 located immediately radially inwardly of inner annular groove 54.

The displaceable balance plate 42 is disposed above the lower stop plate 44 and will rest on this plate in certain positions of displacement. Extending between lower stop plate 44 and balance plate 42 is a guiding device 58, the construction of which may best be seen by reference to FIG. 8. Guiding device 58 includes a central hub 60 with a plurality of resilient, radially extending members 62 projecting outwardly therefrom. At points near their outermost ends, the radially extending members are fixedly attached to the lower stop plate 44 at points between the inner and outer circumferences thereof. Preferably the radially extending members are attached by spot welding. At points near the innermost ends of the radially extending members 62, namely, in the region of central hub 60, the guiding device is attached to a downwardly extending, annular projection 64 (FIG. 2) in the central region of balance plate 42. Preferably, attachment of guide member 58 to the balance plate is again effected by spot welding.

Guide member 58 retains the balance plate 42 concentrically within the recessed area 40, but, by virtue of the resiliency of radially extending members 62, the balance plate is permitted to move generally vertically in an alternate pivoting fashion (to be described hereafter). Flexing of the radially extending members during movement of the balance plate 42 is facilitated by a plurality of recesses 66 in the inner circumference 68 of the lower stop plate 44 (see FIG. 8). Each recess 6 is located immediately below one radially extending member and is positioned radially inwardly of the point at which the radially extending member 62 is attached to stop plate 44. Accordingly, each radially extending member may flex downwardly below the upper surface of stop plate 44 during pivotal movement of the balance plate.

The guiding device 58 includes an opening 70 in its hub 60. Pin 32 extends through opening 70, so that a head 72, at the upper end of the pin, engages a downward projection 74 on the balance plate 42. The downward projection 74 is disposed on the center of annular projection 64 and is positioned such that its bearing surface is at a substantially different level than than of annular projection 64. This creates a space 76 between the hub 60 of guiding device 58 and the central projection 74. The head 72 of pin 32 is disposed within this space. Pin 32 fits loosely within the central opening 70 which guides the head 72 into proper engagement with projection 74 of the balance plate 42. AT the lower end of the pin 32 is a projection 78 which fits within a corresponding opening in the center of piston 30 to secure the pin 32 to the piston.

A tab 80, which extends outwardly from the outer edge of stop plate 44, fits within a slot 82 in support member 36 to position and secure stop plate 44 and guiding device 58 with respect to support member 36. Stop plate 44 is further secured to support member 36 by a plurality of screw fasteners 84 which extend through holes 88 in stop plate 44, and also through tapped holes 86 in support member 36. Support member 36, in turn, is secured to the housing by a plurality of elongated screw members 90 which extend, through holes 92 in the support member, into a portion of housing 10 immediately above an annular shoulder 94 therein. An upper annular stop plate 96, disposed above the balance plate 42, is clampled between surface 38 of support member 36 and annular shoulder 94 of housing 10. Slots 98 in the upper stop plate 96 provide openings through which elongated screw members 90 pass. Corresponding slots 100 in support member 36 make it possible to provide shorter holes 92 through the side wall of the support member 36.

When support member 36 is fastened in position, its lower surface 101 porivdes an abutment against which cylinder member 24 bears. Thus, cylinder member 24, diaphragm 20 and O-ring 22 are all clamped between closure member 12 and lower surface 101 of support member 36.

As best seen in FIG. 8, the balance plate 42 has a disc-like configuration. In the forwardmost area of the balance plate, as viewed in FIG. 8, an upper pivotal protrusion 103 extends upwardly from the top of the plate and a lower pivotal protrusion 105 extends downwardly from the bottom thereof.

Preferably, each pivotal protrusion has substantially the shape of a quarter sphere. It is possible, however, that spherical segments of less than a quarter sphere may be provided. For instance, the imaginary planes which define the boundaries of each semi-spherical segment, namely, a plane coinciding with the surface of the balance plate and a plane normal thereto, may cut through imaginary spheres so as to define less than quarter spheres. Also, the partial spheres may be further truncated if the radially outermost boundary of the balance plate, in effect, cuts through them.

Immediately adjacent upper pivotal protrusion **103** is a depression **107** which, in positioning and configuration, is a mirror image of the upper pivotal protrusion except that the depression extends downwardly into the balance plate from the top surface thereof. The upper depression **107** is disposed exactly opposite lower pivotal protrusion **105** so that, taken together, the depression and protrusion form a downward bend in the surface of the balance plate.

Similarly, a lower depression **108** is disposed immediately adjacent lower pivotal protrusion **105.** In positioning and configuration, lower depression **109** is a mirror image of the lower pivotal protrusion except that the depression extends upwardly into the balance plate from the bottom surface thereof. The lower depression **109** is disposed directly opposite upper pivotal protrusion **105,** and, taken together, this depression and this protrusion from an upward bend in the balance plate.

Upper pivotal protrusion **103** is partially defined by a semi-circular flat side **111** (FIG. **9**) which coincides with a corresponding semi-circular flat side **113** which partially defines depression **107.** Together, semi-circular sides **111, 113** from a single circular surface. Likewise, lower pivotal protrusion **105** and lower depression **109** have semi-circular sides **115, 116** which form a single circular surface. Preferably, the two circular surfaces formed by sides **111, 113, 115** and **116** fall in substantially the same vertical plane.

The significance of the foregoing structural characteristics of the upper and lower pivotal protrusions stems from the ease and economy with which such protrusion may be formed in a generally flat, metal plate. As will be apparent from FIG. **9,** it is only necessary that a circular plate be properly positioned between a set of male and female die members **119, 121.** Male die members **119,** have ends which are shaped to form upper and lower depressions **107, 109,** and female die members **121,** have cavities **123** which are shaped to form upper and/or lower pivotal protrusions. Each female die member is disposed directly opposite a male die member. Thus, when a male die member is brought into engagement with one side of the plate, it forms a depression on that one side and forces material into cavity **123** of the oppositely disposed female die member **121.** The material which has been forced into cavity **123,** of course, forms a protrusion on the balance plate. Each protrusion is always accompanined by an oppositely disposed depression, but the formation of a depression in one side does not prevent the formation of a protrusion on that same side in the same immediate region. The pairs of pivotal protrusions **103, 105** may be formed either simultaneously or in separate operations.

The quarter spherical configuration of pivotal protrusions, **103 105** greatly facilitates positioning of the protrusions in such close relative proximity that they will have the same operative effect as hemispherical or convex protrusions aligned on vertical axis (as disclosed in U.S. Pat. No. 3,786,212). Of course, the quarter spherical protrusions have the advantage that they can be formed in a generally flat plate by a simple stamping or pressing operation whereas convex or hemispherical protrusions aligned on single vertical axis cannot be.

Balance plate **42** includes an additional protrusion **125** extending downwardly from the bottom side thereof. In this instance, there is no need to provide a complementary protrusion extending from the upper side in the same immediate region as in the case of pivotal protrusions **103, 105.** Accordingly, protrusion **125** is given a fully convex shape rather than a truncated convex shape. For reasons which shall become apparent, protrusion **125,** is referred to hereafter as the low pressure protrusion.

Another protrusion, namely, protrusion **127,** extends downwardly from the bottom surface of the balance plate at a location thereon remote from the locations of any of the above-described protrsions. Again, there is no need to provide a complementary protrusion extending from the opposite side in the same immediate region, and, accordingly, protrusion **127** has a fully convex shape. Protrusion **127** shall be referred to hereafter as the high pressure protrusion.

Protrusions **125, 127** are both formed, preferably, by a stamping or pressing operation so that concave depressions will also be formed in the blance plate on the side directly opposite each protrusion. Preferably, the pivotal set of protrusions, the low pressure protrusion and the high pressure protrusion are spaced so as to be located at the points of an imaginary equilateral triangle.

Lower pivotal protrusion **105** and low pressure protrusion **125** cooperate with lower stop plate **44** to define an axis, namely, axis A, (see FIG. **8**) about which the balance plate pivots during operation. Likewise, upper pivotal protrusion **103** and high pressure protrusion **127** cooperate with upper stop plate **96** to define another axis, namely, axis B, about which the balance plate also pivots during operation. As will be evident from FIG. **8,** axes A and B nearly intersect each other in the immediate region of the upper and lower pivotal stops. Thus, regardless of whether the balance plate pivots about axis A or B, there will always be a pivotal movement in the region of pivotal protrusions **103, 105** when the balance plate is in motion.

Pivotal protrusions **103, 105** may simultaneously engage the lower and upper stops plates **44, 96** to suspend the balance plate therebetween. Nevertheless, it is possible that, in actual practice, a slight clearance may exist between upper and lower pivotal protrusions **103,** 105, on the one hand, and lower and upper stop plates **44, 96,** on the other hand.

The alternating pivotal movement of the balance plate in a control device of the present type has been described in U.S. Pat. No. 3,786,212 and will be described in detail hereinafter. However, for purposes of understanding the structural arrangement of elements, it is helpful to now refer briefly to the balance plate movement. In this regard, the alternating pivotal movement is best understood by reference to FIGS. **2, 6** and **7.**

In FIG. **2** the balance plate and other moveable elements are shown in their extreme low pressure posi-

tions. When the balance is in this position, the protrusions on the lower side thereof, namely, protrusions **105, 125,** engage the lower stop plate **44.** When the balance plate moves from the lower pressure position of FIG. **2** to the middle position of FIG. **6,** it pivots about axis A which is defined by the bearing points of protrusions **105** and **125** on the upper surface of lower stop plate **44.**

In the middle position of FIG. **6,** high pressure protrusion **127** of the balance plate engages upper stop plate **96.** From here, the balance plate will move toward the high pressure position of FIG. **7** by pivoting about axis B which is defined by the bearing points of protrusions **103, 127** on the lower surface of the upper stop plate **96.**

The top surface of balance plate **42** includes a pair of spaced indentations **131, 133** therein. These serve to couple a pair of compression coil springs **135, 137** to the balance plate.

Preferably, the balance plate **42,** as well as its annular projection **64,** its central projection **74,** its upper and lower pivotal protrusions **103, 105,** its upper and lower depressions **107, 109,** its low and high pressure protrusions **125, 127,** and its indentations **131, 133** are all formed from a single, one-piece metal plate by a stamping operation, a pressing operation, or the like. Thus, each substantial protrusion or projection on one side of the balance plate will have a corresponding depression, recess or indentation on the other side, and vice versa.

Compression coil springs **135, 137** act on the balance plate through a pair of spring retainers **139, 141.** The upper ends of the springs are coupled to a pair of adjusting members **143, 145** which are threadably disposed in a top wall **146** of housing **10.** Each adjusting member may be threadably advanced or retracted relative to the housing **10** to selectively vary the biasing force of its one associated spring. A laterally elongated opening **147** in upper stop plate **96** permits springs **135,** 137 to extend through the plate. Although the springs **135, 137** are preferably identical in construction, one spring, namely, spring **135,** is generally adjusted to exert a lesser biasing force than the other spring, namely, spring **137.** Hence, spring **135** shall be referred to as the low pressure spring and spring **137** shall be referred to as the high pressure spring.

Each spring retainer is preferably of a one-piece construction and each includes a disc shaped base **148** and an elongated projection **149** which extends downwardly from the base. Each elongated projection mates with an indentation (either **131** or **133**) in the balance plate to couple each retainer, and thus each spring, to the balance plate. Extending upwardly from the base **148** of each spring retainer is a cylindrical projection **150** having a bore **151** therethrough.

Each bore **151** extends only partially through one spring retainer and preferably only through cylindrical projection **150** to each retainer without entering base **148.** The openings provided by bores **151** receive the lower ends of a pair of actuating rods **153, 155** to couple the rods to the balance plate.

Each of the above-described adjusting members **143,** 145 has an axial bore **157** extending entirely therethrough. At the lower end of each bore **157** is a concentric counterbore **158** which extends a substantial distance into each adjusting member. Each counterbore receives the upper end of one coil spring (either **135** to **137**) so that both springs are held in compression between adjusting members **143, 145** and balance plate **42.**

The upper ends of the adjusting members are disposed externally of the housing **10** and include driving heads **159, 161** thereon. The driving heads are configured for driving engagement by a wrench or other tool whereby the adjusting members may be threadably advanced and/or retracted to, in turn, adjust the bias of springs **135, 137.** Specifically, threadable advancement of adjusting member **143** in a downward direction into the housing effects further compression of coil spring **135** thereby increasing its biasing force. Likewise, threadable retraction of the same adjusting member in an upward direction effects a relaxation of the spring thereby decreasing its biasing force. Of course, threadable advancement and retraction of adjusting member **145** effects adjustment of biasing force of spring **127** in the same fashion.

As will be apparent from FIG. **2,** the upper ends of adjusting members **143, 145** are not identical. Adjusting member **145** includes a rim member **163** which is disposed immediately below driving head **159** and which extends radially outwardly therefrom. The spacing of adjusting members **143, 145** and the relative sizes of the driving heads **159, 161** and rim member **163** are such that part of rim member **163** will be disposed directly beneath the driving head of the adjacent adjusting member, i.e., beneath driving head **159** of adjusting member **143.**

The above-described construction provides an interlock between the two adjusting members. Adjusting member **145** cannot be adjusted to a position above that of adjusting member **143** because the rim member of the former would interfere with the driving head of the latter. Likewise, adjusting member **143** cannot be adjusted to a position below that of adjusting member **145** because the same type of interference would occur.

The foregoing interlock assures that adjusting member **143** can only be adjusted so that the spring associated therewith, namely, spring **135,** will always exert a bias as low or lower than that of spring **137.** It follows, of course, that adjusting member **145** can only be adjusted so that its associated spring, namely, spring **137,** will always exert a bias as high or higher than that of spring **135.** As will be described in more detail hereinafter, low pressure spring **135** controls movement of balance plate **42** about one axis and high pressure spring **137** controls movement of the balance plate about the other axis. The interlock mechanism prevents accidental adjustment of the adjusting members to effect reversal in the functioning of the springs and in the pivoting of the balance plate. This not only prevents malfunctioning of the control device but also prevents possible damage to the balance plate.

A pair of microswitches **165, 167** are positioned directly above adjusting members **143, 145** by means of mounting brackets **169, 171.** As can best be seen in FIG. **3,** one end of bracket **171** is fixedly secured directly to top wall **146** by a screw fastener **173.** The bracket includes an upright leg **175** extending upwardly from top wall **146** and a horizontal arm **177** extending across the top of adjusting member **145.** At about midway along the length of horizontal arm **177** and extending upwardly therefrom, are a pair of mounting plates **179.** The mounting plates enclose the sides of micro-

switch **167** and, along with fasteners **181**, mount microswitch **167** directly above adjusting member **145**.

A post **183** extends between top wall **146** and that end of horizontal arm **177** opposite upright leg **175**. The lower end of post **183** is threadably disposed in top wall **146** such that the height of the post may be varied by threadably advancing or retracting the same. A lock nut **185** is disposed on the lower end of the post to secure the post at selected positions of height adjustment. Varying the height of post **183**, of course, effects variation of the bracket height, which, in turn, effects adjustment of the height of the microswitch.

The details of contruction and mounting of bracket **169** are identical to those of bracket **171**, but, of course, bracket **169** is disposed directly over adjusting member **143** (rather that over adjusting member **145**), and bracket **169** is used to mount a different microswitch, namely, switch **165**.

Actuating rods **153, 155** extend upwardly from the bores **151** of spring retainers **139, 141** and through the internal area defined by the coils of springs **135, 137**. Preferably, the axis of each actuating rod coincides with the axis of the coil spring through which it extends. This construction greatly simplifies the coupling of the two actuating rods to the balance device and provides considerable space savings. In the device of the present invention, the internal areas of both coil springs, which areas would ordinarily constitute wasted space, are used to provide clear passageways, free from obstructions, through which a pair of actuating rods may transfer the motion of the balance plate to a pair of microswitches disposed outside the housing.

In order to: (a) prevent the entry of foreign substances into the housing through bores **157** in adjusting members **143, 145**; (b) prevent tampering with exposed sections of the actuating rods; and (c) guide the actuating rods in their vertical movement, a pair of sleeves **187, 189** are provided around the upper ends of actuating rods **153, 155**. Each sleeve extends between one of the brackets (either **169** or **171**) and its associated adjusting member (either **143** or **145**). The upper end of each sleeve is fixedly secured within an opening **191** in one of the brackets and is solidly stabilized with respect to the bracket by an integral shoulder **193** extending radially outwardly from the main shank of the sleeve. Each sleeve extends downwardly from its bracket into the bore **157** of whichever adjusting member is located immediately therebelow. Although sleeves **187, 189** fit tightly within the bores **157**, the fit is, nevertheless, loose enough to permit an easy sliding relationship between each sleeve and bore. Thus, when it is desired to adjust the biasing forces exerted by springs **135, 137**, driving heads **159, 161** may be engaged by a driving tool and rotated to threadably advance or retract the adjusting members without interference from stationary sleeves **187, 189**.

Both microswitches **165, 167** are preferably single pole, double throw, low differential, low force, spring return switches. However, any suitable electric switches, fluid valves or fluidic valves of the spring return or toggle type could be used in their place. Regardless of which type of switching apparatus is used, each switch should have two, distinct, mutually cancelling control modes. By way of example only, and for the sake of convenience, these two modes are referred to hereafter as the "actuation" or "on" mode and the "deactuation" or "off" mode.

Each of the microswitches includes a spring-loaded actuating button extending downwardly from the underside thereof. The actuating button for switch **165** is identified as button **195** and the actuating button for switch **167** is identified as button **197**. A lever **198** is disposed below microswitch **165**, and similarly, a lever **199** is disposed below microswitch **167**. Each lever is hinged near one end of its respective microswitch and each engages the actuating button near the other end of that switch. At about its midpoint, the lower side of each lever is engaged by one of the actuating rods **153**, 155. Motion of the balance plate is transmitted through actuating rods **153, 155** to levers **198, 199** which, in turn, transfer the motion to actuating buttons **195, 197** to actuate or deactuate microswitches **165, 167**.

In order to avoid possible buckling of springs **137**, 135 and a consequent cocking or rotation of spring retainers **139, 141**, a pair or elongated spring guides **200**, 201 (FIG. 5) are connected between the housing **10**, on the one hand, and spring retainers **141, 143** and springs **135, 137**, on the other hand. Each spring guide includes a base portion **204** (FIG. 5*a*) extending laterally to only one side of the guide. The base portion, in turn, includes a stepped section **206** which provides resiliency in the base member, so that it may be compressed in a direction normal to its major surface area. A pair of oppositely disposed recesses **208** in shoulder **94** define, in conjunction with upper stop plate **96**, two enclosed spaces within which base portions **204** of guides **200, 201** are compressibly clamped. The compressibility of the base portions effects a secure, yet non-rigid connection so that the base portion may, to a limited extent, rotate within the recesses when the springs and spring retainers move vertically during operation.

Each base **204** is disposed at one end of one of the guides. At the other end of each guide is an enlarged portion **210** having a circular opening **212** therein, serves to couple one guide with one spring and one retainer. Thus, each enlarged portion and circular opening therein shall be referred to collectively as the coupling portion of each guide. In particular, guide **200** has a coupling portion **213** which is coupled to spring **135** and retainer **139**. Likewise, guide **201** has a coupling portion **214** which is coupled to spring **137** and retainer **141**.

Opening **212** of enlarged portion **210** of each spring guide has a larger diameter than does cylindrical projection **150** of either of the spring retainers **141, 143**. The disc-like bases **148** of retainers **141, 143** however, have larger diameters than do openings **212** in the guides. Hence, the cylindrical projection **150** of each retainer will pass through the circular opening **212** of one spring guide, yet the disc-like base **148** of each retainer will abut the underside of the enlarged portion **210**, of the guide thereby coupling the guide to the retainer. One of the openings **135, 137** in turn, fits over the cylindrical projection of the retainer and abuts the upper surface of the enlarged portion of the guide, so that the spring, the retainer, and the guide are all coupled together.

The regions where base portions **204** are connected to housing **10** (i.e., the areas in which the base portions are clamped between plate **96** and recesses **208**) shall be referred to as the connecting regions and shall be designated by reference numerals **215 216**. To maximize the length of each guide, its associated connecting region is located as remotely as possibly from the spring

to be guided. Thus, although spring **135** and its retainer **139** (to which spring guide **200** is coupled) are disposed adjacent to connecting region **216**, the base portion of the associated spring guide, namely guide **200**, is connected to the housing at connecting region **215** which is disposed diametrically opposite to connecting region **216**. Likewise, spring **137** and its retainer **141** (to which spring guide **201** is coupled) are disposed adjacent to connecting region **215**. Nonetheless, the base portion of the associated spring guide, namely guide **201** is connected to the housing at connecting region **216** which is disposed diametrically opposite to connecting region **215**. Pivotal displacements of balance plate **42** causes the spring retainers to move generally vertically. The coupling portions **213, 214** of guide members **200, 201** will move upwardly or downwardly along with the spring retainers but the base portions will remain fixed in the housing. The generally vertical movement of the coupling portions **213, 214** is permitted by slight flexing of the spring guides along their lengths and slight twisting of the resilient base portions **204** within recesses **208**.

Because spring guides **200, 201** are anchored at their base portions, the movements of their coupling portions are, strictly speaking, slightly arcuate. The extent to which the coupling portions (and thus the spring retainers) move arcuately however, is minimized by the fact that guides are greatly elongated. Elongation of each guide, in turn, is facilitated by locating the connecting region for its base portion remotely from its associated spring and spring retainer. In fact, in the illustrated embodiment, the connecting region for each guide is disposed in that region — within housing **10** and also within the plane of the spring guides — which is most remote from the spring and spring retainer to which the guide is coupled.

As mentioned above, guide **200** is coupled to spring **135** and retainer **139**, but the connecting region for guide **200** is adjacent to spring **137** and retainer **141**. To prevent the interference of guide **200** with spring **137** and retainer **141**, the guide is provided with a special configuration. Also, guide **201** is provided with a special configuration so that its length can be maximized without interference with spring **135** and retainer **139**. These configurations will now be described, reference being had to FIGS. **5** and **5***a*.

Guides **200, 201** each have a leg portion **217** extending between base portion **204** and the coupling portion (either **213** or **214**). Each leg portion **217** is offset with respect to a line **218** passing through the centers of the coupling portion and base portion of each guide. Indeed, each leg portion is disposed entirely to one side of line **218** and is spaced a substantial distance therefrom. Hence, the coupling portion of each guide may be considered to be offset with respect to the leg portion or vice versa. When both guides are positioned in the housing, the leg portion of one guide will be located immediately adjacent to the enlarged portion of the other guide but entirely to one side thereof.

In the illustrated embodiment, the foregoing offset configuration and the avoidance of interference between the springs, retainers and guides is achieved: (a) by providing a guide construction wherein each leg portion joins the base portion at one extreme end: (b) by providing in the leg portion of each guide an outward bend **220** away from line **218**; and (c) by providing in each coupling portion, an inward extension **222** toward line **218**.

A transparent plastic cover **224** fits over top wall **146** to completely enclose microswitches **167, 169** and adjusting members **143, 145**, thereby protecting them from dust, dirt and other harmful substances in the surrounding environment.

The operation of the device of the present invention will be described below, reference being had to FIGS. **2, 6** and **7** showing various displaceable elements in different positions.

In FIG. **2**, diaphragm **20** is displaced upwardly, and this displacement is transmitted to piston **30**, through pin **32**, and thence to balance plate **42**. The balance plate will first begin to move against the bias of the weaker of the two coil springs, namely, low pressure spring **135**, whereupon high pressure protrusion **127** moves upwardly toward upper stop plate **96**. Meanwhile, high pressure spring **137** continues to bias lower pivotal protrusion **105** and low pressure protrusion **125** against lower stop plate **44**. Thus, the upward movement of the right hand side of the balance plate is a counterclockwise pivotal movement about that axis (i.e., axis A) defined by the points of engagement of protrusions **105, 125** with lower stop plate **44**.

Pivotal movement of the balance plate about axis A ends when high pressure protrusion **127** comes into contact with upper stop plate **96** thereby restraining further upward movement of the right hand side of the balance plate. At this stage the balance plate is disposed in its middle position as illustrated in FIG. **6**. The balance plate remains in the middle position until the pressure in chamber **18** increases to such an extent that the bias of high pressure spring **137** is overcome. Then, low pressure protrusion **125** disengages from lower stop plate **44** and moves upwardly. Such movement is effected by a clockwise pivoting (as viewed in the drawing) of the balance plate about axis B (defined by the points of contact of uppper pivotal protrusion **103** and high pressure protrusion **127** with upper stop plate **96**).

Pivotal movement of the balance plate about axis B continues until the extreme high pressure porition of FIG. **7** is reached, at which stage the diaphragm **20**, piston **30** and balance plate **42** are all at their upper limits of travel. Preferably, the upward movement is delimited by engagement of the piston with lower surface **101** of support member **36**.

Upon decrease in pressure, the sequence of operations is precisely the reverse of that described above. With reference to FIGS. **6** and **7**, the return pivoting about axis B from the high pressure position of FIG. **7** to the middle position of FIG. **6** is in a counterclockwise direction. Then, after the pressure decreases to a value at which low pressure spring **135** overcomes the upward force on the diaphragm, the balance plate returns from the middle position of FIG. **6** to the low pressure position of FIG. **2**, pivoting in a clockwise direction about axis A.

It will be understood that, at all times where the balance plate pivots about axis A, the force of high pressure spring **137** acts directly through axis A. Therefore, the high pressure spring is at this time, rendered ineffective, exerting no influence on the pivotal movement. Likewise, when the balance plate pivots about axis B, low pressure spring **135** acts directly through that axis and is rendered ineffective, exerting no influence on

the pivotal movement about axis B. Accordingly, movement about each axis is governed by the bias adjustment of only one spring, independently of the bias adjustment of the other spring. Of course, the bias adjustment of each spring determines the actuation point (in terms of pressure) of one of the microswitches. Due to the independent action of the springs, the actuation setting for one microswitch is determined entirely independently of the other and vice versa.

The above-described alternate pivotal movements of the balance plate effect generally rectilinear displacements of actuating rods **153, 155.** Specifically, pivotal movement of balance plate **42** about axis A is translated, via spring retainer **139,** into a linear movement of actuating rod **153** generally along a path coincident with the longitudinal axis thereof. Movement of rod **153,** in turn, is transmitted to lever **198** which displaces actuating button **195** to actuate or deactuate microswitch **165.** Likewise, pivotal movement of balance plate **42** about axis B is translated, via spring retainer **141,** into linear movement of actuating rod **155** generally along a line coincident with its longitudional axis. This movement is transmitted to lever **199** which displaces actuating button **197** to actuate or deactuate microswitch **167.**

Assuming that the balance plate is in its extreme low pressure position and that microswitchs **165, 167** are both in their deactuated or off condition, an increase in pressure within chamber **18** eventually causes low pressure spring **135** to yield, whereupon balance plate **42** pivots about axis A, as described above. At this time actuating rod **153** is moved upwardly to trigger microswitch **165** thereby shifting it, in this particular example, into the on condition. Thus, microswitch **165** will be in the "on" condition when the balance plate reaches the middle position illustrated in FIG. **6.** When, as described above the pressure then increases sufficiently to overcome the bias of high pressure spring **137,** causing the balance plate to pivot about axis B, acutating rod **155** is moved upwardly to trigger microswitch **167,** thereby shifting it, in this example, also into the on condition. Thus, microswitch **165, 167** will both be in the on condition when the balance plate reaches the high pressure position illustrated in FIG. **7.**

Of course, a pressure decrease causes the balance plate to move back to the middle position by pivoting about axis B. During this return movement, actuating rod **155** moves downwardly causing microswitch **167** to shift back into the deactuated or off condition. When the pressure further decreases to an extent where the balance plate then pivots about axis A and moves toward the low pressure position, actuating rod **153** moves downwardly along with the right hand side of the balance plate causing microswitch **165** to also shift back into the deactuated or off condition. Thus, when the balance plate has returned to the extreme low pressure position of FIG. **2,** both switches will again be in the off condition.

It will be understood that the foregoing sequence of switching operations is merely exemplary and that many others are possible. That is, pressures may fluctuate other than from an extreme low value to an extreme high value. Then, of course, the sequence of switching will be different. Also, the control functions of one or both microswitches may be reversed so that a given increase in pressure would effect deactuation and a given decrease in pressure will effect actuation.

While throughout the above description words such as "vertical", "upper", "lower", "upwardly", "downwardly", "right", and "left" have been used, it will be understood that these terms are used only to describe relative relationships and are not intended to be limiting. It will also be understood that those skilled in the art may make many changes and modifications to the above-described embodiments of the present invention without departing from the spirit and scope of the invention.

What is claimed is:

1. A condition responsive device comprising:

a. a housing;

b. a chamber in said housing;

c. a sensing means partially defining said chamber, said sensing means being displaceable through a stroke;

d. a balance plate having first and second sides, said sensing means being operatively coupled to said balance plate;

e. stop means associated with both said first and second sides of said balance plate defining first and second axes about which said balance plate pivots, said stop means associated with said first side of said balance plate including a first pivotal protrusion disposed on said first side of said balance plate immediately adjacent to a depression in said first side, said stop means associated with said second side of said balance plate including a second pivotal protrusion disposed on said second side of said balance plate immediately adjacent to a depression in said second side, said first pivotal protrusion being disposed directly opposite said depression in said second side, and said second pivotal protrusion being disposed directly opposite said depression in said first side;

f. a pair of biasing means, at least one of which being adjustable and each having a line of force acting on said balance plate;

g. signal producing means operatively coupled to said balance plate;

h. whereby displacement of said sensing means through one part of its stroke effects pivoting of said balance plate about said first axis and displacement of said sensing means through another part of its stroke effects pivoting of said balance plate about said second axis.

2. A condition responsive device as defined in claim **1** wherein both biasing means of said pair are adjustable.

3. A condition responsive device as defined in claim **1** wherein said signal producing means is at least one microswitch.

4. A condition responsive device as defined in claim **1** wherein:

a. said stop means include a first set of protrusions extending from said first side of said balance plate, said first set including said first pivotal protrusion and a low pressure protrusion, the protrusions of said first set being spaced from each other;

b. said stop means include a second set of protrusions extending from said second side of said balance plate, said second set including said second pivotal protrusion and a high pressure protrusion, the protrusions of said second set being spaced from each other; and

c. said stop means include stationary means disposed above and below said balance plate, said protrusions of said first set being engageable with said stationary means below said balance plate to define said first axis, said protrusions of said second set being engageable with said stationary means above said balance plate to define said second axis.

5. A condition responsive device as defined in claim **1**, wherein said first and second pivotal protrusions have substantially the configuration of spherical segments, each spherical segment being one quarter or less of a complete sphere.

6. A condition responsive device as defined in claim **5**, wherein said first and second pivotal protrusions include flat sides having substantially semi-circular configurations, each of said flat sides being disposed perpendicular to the plane of the balance plate.

7. A condition responsive device as defined in claim **6**, wherein said flat sides are disposed substantially in the same vertical plane.

8. A condition responsive device comprising:

a. a housing;

b. a chamber in said housing;

c. sensing means partially defining said chamber, said sensing means being displaceable through a stroke;

d. a balance means in said housing operatively connected to said sensing means;

e. a plurality of stop means co-operating with said balance means defining a pair of axes about which said balance means pivots;

f. a pair of elongated, hollow biasing means coupled with said balance means, at least one of said biasing means being adjustable and being adjusted to exert a different biasing force than the other biasing means, whereby movement of said sensing means through one part of its stroke effects pivoting of said balance means about one axis, and movement of said sensing means through another part of its stroke effects pivoting of said balance means about the other axis;

g. a pair of switching devices, each device being coupled to said balance means by an actuating rod, each actuating rod extending through the hollow interior of one of said biasing means.

9. A control device as defined in claim **8**, wherein:

a. both of said biasing means are coil springs held in compression, and

b. each of said actuating rods are concentrically disposed with respect to one of said springs.

10. A control device as defined in claim **9**, including a pair of spring retainers for coupling said springs and said actuating rods to said balance means, one end of each spring being connected with one of said retainers, one end of each retainer being connected with said balance means, the other end of each retainer being connected with one of said actuating rods, whereby said actuating rods are operatively coupled with said balance plate.

11. A control device as defined in claim **10**:

a. wherein both of said springs are adjustable;

b. including: a pair of adjusting members, said springs being connected with said adjusting members;

c. wherein: each adjusting member has a bore therethrough, one of said actuating rods extending through each bore to be coupled with one of said switching devices.

12. A control device as defined in claim **8**, including an adjusting member coupled to the adjustable biasing means, said adjusting member including a bore therethrough, said actuating post passing through said bore in said adjusting member.

13. A control device as defined in claim **8**, wherein:

a. both of said biasing means are adjustable;

b. each biasing means has an adjusting member connected therewith;

c. each adjusting member has a bore therethrough; and

d. one of said actuating rods extends through each bore to be coupled with one of said switching devices.

14. A control device as defined in claim **13**, including:

a. a pair of brackets, each bracket mounting one of said switching devices with respect to said housing;

b. a pair of sleeves, each sleeve extending from one bracket into the bore of one adjusting member, said adjusting members being telescopically moveable relative to said sleeves.

15. A control device as defined in claim **8**, wherein said switching devices are mounted externally of said housing.

16. A condition responsive device comprising:

a. a housing;

b. a chamber in said housing;

c. a sensing means partially defining said chamber, said sensing means being displaceable through a stroke;

d. a balance plate having first and second sides, said sensing means being operatively coupled to said balance plate;

e. stop means associated with said balance plate defining first and second axes about which said balance plate pivots, said stop means including a plurality of protrusions on both sides of said balance plate, said stop means further including an upper annular stop plate above said balance plate and a lower annular stop plate below said balance plate, said protrusions on said balance plate being engageable with said stop plates;

f. a pair of biasing means, at least one of which being adjustable and each having a line of force acting on said balance plate;

g. a guiding device for said balance plate, said guiding device including a plurality of resislient, radially extending members, one end of each radially extending member being connected with a central region of said balance plate, the other end of each radially extending member being fixedly attached to said lower annular stop plate, said lower stop plate including a plurality of recesses therein, one recess being disposed immediately adjacent to each point on said lower stop plate where said radially extending members are attached, said recesses facilitating flexing of said radially extending members;

h. a signal producing means operatively coupled to said balance plate;

i. whereby displacement of said sensing means through one part of its stroke effects pivoting of said balance plate about said first axis and displacement of said sensing means through another part of its stroke effects pivoting of said balance plate about said second axis.

17. A condition responsive device as defined in claim 16, wherein both biasing means of said pair are adjustable.

18. A condition responsive device as defined in claim 17, wherein said signal producing means is at least one microswitch.

19. A control device comprising:

a. a housing;

b. a chamber in said housing;

c. a displaceable sensing means partially defining said chamber;

d. first and second compressible coil springs disposed in said housing and operatively connected to said sensing means;

e. first and second resilient guide members connected with said springs, said members also being connected to said housing at first and second connecting regions;

f. said first and second connecting regions of said housing being disposed substantially diametrically opposite to one another;

g. said first connecting region being disposed adjacent said first spring, said second connecting region being disposed adjacent said second spring;

h. said first guide member extending from said second connecting region to said first spring;

i. said second guide member extending from said first connecting region to said second spring; wherein each guide member includes:

j. a base portion by which said guide member is attached to said housing at one of said connecting regions;

k. a coupling portion by which said guide member is coupled to one of said springs;

l. a leg portion extending between said base and said coupling portion; wherein said coupling portion extends laterally to only one side of said leg portion to facilitate avoidance of interference between said guide member and the spring other than that to which said guide member is connected.

20. A control device as defined in claim 19, wherein said leg portion includes a bend therein, said bend facilitating avoidance of interference between said guide member and the spring other than that to which said guide member is connected.

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