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[54] **FLUID PRESSURE OPERATED DIAPHRAGM SWITCH WITH IMPROVED MEANS AND METHOD FOR CALIBRATION**
6 Claims, 1 Drawing Fig.

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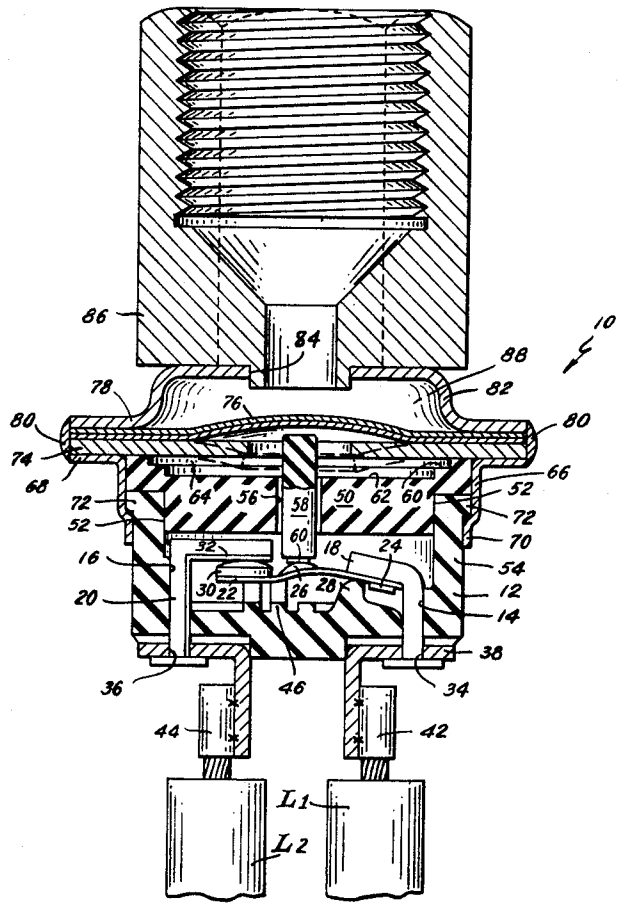
[56] **References Cited**

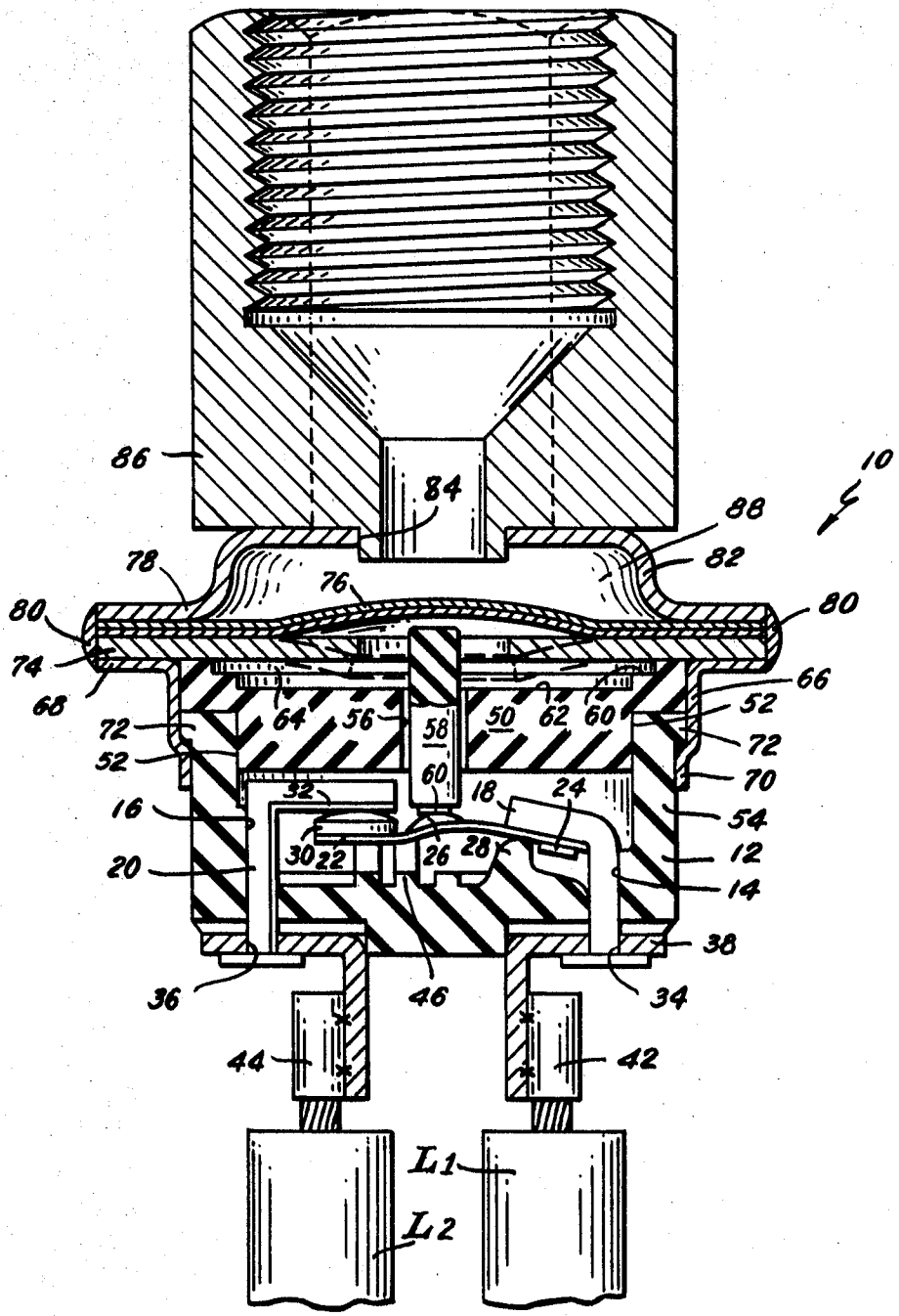
UNITED STATES PATENTS

1,183,486	5/1916	Pardue	200/83X
1,684,530	9/1928	Bast	200/83(.2)X
2,381,835	8/1945	Moorhead	200/83(.2)
3,302,269	2/1967	Cooper et al.	29/622
3,365,557	1/1968	Cooper et al.	200/83
3,367,244	2/1968	Charter	92/13

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ABSTRACT: A pressure responsive device including a primary subassembly of a casing member having a cavity sealed by a snap-acting diaphragm member of either mono or bimetal. An annular calibration-stop member is located adjacent to the diaphragm and is deformed in either of two directions to change the calibration of the diaphragm member. The device is shown operatively connected to an electric switch.





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FLUID PRESSURE OPERATED DIAPHRAGM SWITCH WITH IMPROVED MEANS AND METHOD FOR CALIBRATION

This invention relates generally to condition responsive devices, and the methods of making them, and in particular with regard to certain more specific features to pressure responsive devices particularly adapted for actuation of electrical switches.

Among the several objects of the invention may be noted the provision of pressure responsive devices which are particularly adapted for miniaturization and light weight hermetically sealed constructions, and methods of making the same; the provision of such devices which include improved calibration means while enabling the pressure sensing means to withstand relatively large overpressures without incurring deleterious changes in calibration; the provision of such pressure responsive devices, and methods of making the same, which can be more easily and inexpensively calibrated than prior art devices; the provision of new and improved pressure responsive devices, and methods of making the same, which employ a diaphragm member which seals a compartment or cavity in the device; and a provision of new and improved devices which are responsive to a combination of predetermined pressure and temperature conditions. Other objects will be in part apparent and in part pointed hereinafter.

The invention accordingly comprises the elements and combinations of elements, steps and sequence of steps, features and structures of manipulation, and arrangements of parts, all of which will be exemplified in the structures and methods hereinafter described, and the scope of the application of which will be indicated in the appended claims.

In the accompanying drawings, in which a preferred embodiment of the invention is illustrated, the sole figure is an axial cross section of a pressure responsive device according to the present invention.

Dimensions of certain of the parts as shown in the drawings, and relative movements between parts, have been modified and/or exaggerated for the purposes of clarity of illustration.

The pressure responsive devices embodying the invention have many useful applications wherein it is desirable to provide a sudden or rapid actuation force whenever the pressure from an independent source reaches either one of two selected limit values. For example, a pressure responsive or combined temperature pressure device according to this invention, may be used in connection with an electrical switch or with a valve or other mechanism or device for which actuation is desired in response to predetermined changes in pressure.

The relative simplicity and relatively small number of parts comprising the pressure responsive device according to the present invention, advantageously permits miniaturization and light weight construction. Devices of this general type are known in the art and are disclosed and claimed in coassigned U. S. Pats.: Nos. 3,302,269 and 3,365,557 which issued Feb. 7, 1967 and Jan. 23,1968 respectively. As disclosed in these patents, calibration is effected by employing precisioned formed parts, as by machining. The invention disclosed and claimed herein permits the use of inexpensive stamped parts to effect calibration as will be explained below.

Referring now more particularly to the drawings, switch **10** comprises a cylindrical cup-shaped member **12** formed of a conventional molded phenolic material, electrically insulating, and is formed with apertures **14, 16** for reception therein of support member **18** and stationary contact **20** respectively. Movable contact arm **22** of electrically conductive material having good spring characteristics, such as beryllium nickel, is cantilever mounted to support member **18** as by riveting at **24**. Arm **22** is formed with a dimple **26**, for a purpose to be described below, and mounts on its free end movable contact **30**. A boss **28** is formed in the bottom wall of base **12** so that when support member **12** and movable contact arm **22** are inserted through aperture **14**, they are biased against the boss to effect a given angle so that a predetermined contact force will exist between contacts **20** and **30**. To improve electrical conductivity while minimizing additional expense, stationary contact **20**, which also serves as part of the terminal structure, is preferably provided with a layer **32** of highly conductive material, such as silver alloy. The outer ends of support **18** and stationary contact **20** pass through apertures **34, 36** of terminal members **38, 40** respectively, and are headed over to firmly lock the contact assembly in the housing and to provide electrical connection to the switch via leads L1, L2. Leads L1, L2 are clinched in tabs **42, 44** respectively, which are in turn welded to terminal members **38, 40** respectively. To mitigate the deleterious effects of arcing, ribs **46** are formed in base member **12** to prevent tracking of vaporized contact material by providing an arc shadow, a common expedient employed in the art.

A disc **50**, generally plate-shaped of electrically insulating material, is formed with a seating groove **52** about its periphery and is received in the distal portion of wall **54** of base **12**. Disc **50** slidably mounts in a centrally located bore **56** provided with a motion transfer pin **58** of electrically insulating material, such as a ceramic or glass material, and isolates the electrical switch from diaphragm area. Pin **58** may be formed with projection **60** on one end which contacts dimple **26** in movable arm **22** to enhance smooth transfer of motion from pin **58** to movable arm **22**.

A cavity **64** is formed by recessing disc **50** at **60** and **62** to provide clearance for diaphragm **76** to snap from the position shown to the opposite configuration, and for calibration-stop element **74**.

Tubular member **66** which may be formed of a conventional metallic material, is formed with a radially outwardly extending flange **68** and is placed over the distal wall **54** of base **12** and attached thereto, as by crimping, at **70**. It will be noted that a small flange **72** is provided on distal wall **54** to permit locking of the tubular member **66** to base **12**. Mounted on flange **68** are calibration-stop member **74**, imperforate circular diaphragm member **76** and cover **78**, all hermetically secured at their periphery as by welding at **80**. Cover **78** is dished out at **82** to provide a cavity **88** sealed by diaphragm **76** and provided with bore **84** for reception therein of a port fitting **86** which is hermetically attached thereto. Port fitting **86** permits attachment to a pressure source which it is desired to monitor.

Although it is preferred that cover **78**, diaphragm **76**, calibration-stop member **74** and tubular member **66** be welded together at their marginal periphery, it will be understood that other means may be employed to clamp and seal the diaphragm member between the upper and lower casing members.

Diaphragm **76** is shown as a bimetallic member but can also be formed of a monometallic member such as stainless steel. This diaphragm is formed into a snap-acting disc by means known in the art; basically, it involves forming a nondevelopable surface by permanently deforming the disc.

During operation of the device when a monometallic diaphragm **76** is employed, it snaps from the position shown in the figure to the opposite curvature when a predetermined amount of pressure is introduced into chamber **88** through port fitting **86**.

The diaphragm will snap back to its original position when the pressure decreases a predetermined amount. This differential, i.e., the difference in pressure between that amount at which the diaphragm snaps in a first direction and that amount at which the diaphragm will return to its original position, is controlled by calibrating in the following manner.

First, the device is partly assembled by hermetically attaching cover **78**, diaphragm **76**, calibration-stop member **74** and tubular member **66** together as by welding about their periphery as described above, with port fitting **86** mounted on cover **78** as by brazing or resistance welding. If it is desirable to increase the differential, that is, to lower the pressure at which the diaphragm will snap back to its original position,

sufficient pressure is introduced through port fitting **86** to snap the diaphragm and deform the calibration-stop member **74**. On the other hand, if it is desired to narrow the differential, i.e., increase the amount of pressure at which the diaphragm will snap back to its original position, a force is exerted against the side of member **74** remote from the diaphragm (as by a tool) and it is deformed toward the diaphragm.

It will be understood that the pressure exerted on the diaphragm to effect calibration is far greater than the pressures which the diaphragm will be subjected to during operation of the device, so that member **74** during operation also effectively acts as a stop member preventing a change in the calibration of the diaphragm. Considerable care must be taken to select the proper material for calibration-stop member **74**. It has been found that heat treating permits the use of member **74** effectively as a calibration member (so that it can be deformed beyond its elastic limit) as well as a stop member (so that it will retain its configuration during operation). One example which has worked well as A.I.S.I. type 304 stainless steel, hydrogen annealed after being formed to achieve a depth hardness of 110—150 DPH (Diamond Pyramid Hardness) with a 500 gram load. It has also been found preferable to initially form the annular member **74** in a slightly concave configuration (somewhere between the solid and dotted lines shown in the drawings) in applications where a wide differential is desired.

After calibration, the switch mechanism contained in member **12** is fixedly attached to tubular member **66** at **70** by crimping to complete the assembly.

One use of a pressure switch built in accordance with the invention is to deactivate an electrical circuit over a particular pressure range. Port fitting **86** is attached to the pressure source to be mounted and when the pressure rises to a predetermined level, P_1, diaphragm **76** snaps from the convex curvature shown in the FIG. through center to a concave curvature thereby transmitting motion through pin **58** to dimple **26** on movable arm **22**, causing movable contact **30** to disengage from stationary contact **20**. Calibration-stop member **74** is sufficiently rigid that operating pressures above P_1 will not affect the calibration of the diaphragm. When the pressure drops to a second level P_2, determined by the amount member **74** was deformed during calibration, the diaphragm will snap back to its convex position shown in the drawing and the spring bias of movable arm **22** will cause contacts **30**, **20** to reengage.

It is within the purview of the invention to locate stationary contact **20** on the opposite side of movable arm **22** if it is desired to cause circuit closing rather than circuit opening when the diaphragm snaps to the concave configuration, or, if desired, an additional circuit can be controlled (double throw) by placing a stationary contact in base **12** for engagement by movable contact arm **22** when diaphragm **76** snaps to the concave configuration while still maintaining the location of stationary contact **20** as shown.

If a bimetallic diaphragm (as shown) is employed in the device, the device will respond to temperature as well as pressure. That is, the diaphragm will snap through center when specific combinations of pressure and temperature conditions exist.

While it is preferred that the cavities **88**, **64** be hermetically sealed from each other, which sealing is advantageously accomplished by the sealing action of the diaphragm member according to the present invention, it should be understood that there may be some cases in which these two cavities need only be adequately sealed against entry of the pressure creating medium during the calibration operation. In such cases, the parts may be sealed and clamped against the marginal periphery of the diaphragm member by means other than welding, e.g., flange **68** could be extended and clamped over the aligned portion of cover **78**.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained. The cost of making devices employing marginally held diaphragms is materially reduced and assembly greatly facilitated since the calibration-stop member **74** is merely a stamped part compared to the precision machined elements used for calibration in prior art devices.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense, and it is also intended that the appended claims shall cover all such equivalent variations as come within the true spirit and scope of the invention.

We claim:

1. A condition responsive device comprising a generally circular cover member, the cover member having an aperture therein for ingress and egress of fluid pressure and formed with a medial annular flange; a snap-acting diaphragm movable to and from first and second positions and having a generally circular periphery attached about and adjacent its periphery to the radial annular flange of the cover member; and an annular calibration-stop member deformable by fluid pressure within a calibration range but nondeformable within a lower operating range, the calibration-stop member having a generally circular inner and outer periphery attached about and adjacent its outer periphery to the diaphragm adjacent and about its periphery, that portion adjacent the inner periphery shaped in a generally concave configuration with respect to the diaphragm and contacting the diaphragm throughout 360°when the diaphragm is in one of its two positions.

2. A condition responsive device comprising a generally circular cover motion the cover member having an aperture therein for ingress and egress of fluid pressure and formed with a radial annular flange; a snap-acting diaphragm having a generally circular periphery attached about and adjacent its periphery to the radial annular flange of the cover member; an annular calibration-stop member having a generally circular inner and outer periphery attached about and adjacent its outer periphery to the diaphragm adjacent and about its periphery, that portion adjacent the inner periphery shaped in a generally concave configuration with respect to the diaphragm; an electric switch including a cup-shaped base having an upstanding wall; a stationary contact and a movable contact arm, the movable contact arm adapt to engage and disengage the stationary contact; a platelike member of electrical insulation enclosing the base, the platelike member having an aperture therein; and a motion transfer pin slidably mounted in the aperture and adapted to transfer MOTION from the diaphragm to the movable contact arm.

3. A device according to claim **2** in which the platelike member is recessed on the side thereof remote from the base to provide clearance for the calibration-stop member.

4. A device according to claim **2** including a tubular member having two ends, one end formed with a radial flange connected to the outer peripheral portion of the calibration-stop member; the distal end portion of the upstanding base wall formed with a radial flange extending outwardly, the flange of the base wall receiving the other end of the tubular member which is crimped around the flange to lock the electric switch to the device.

5. A condition responsive device comprising a first member having a recessed portion, a snap-acting diaphragm having a nondevelopable surface responsible for its snapping to and from a first and second position sealingly covering the recessed portion, a calibration-stop member deformable by fluid pressure within a calibration range but nondeformable

within a lower operating range, the calibration-stop member located adjacent the diaphragm and configured to contact the nondevelopable surface of the diaphragm adjacent its outer periphery throughout 360°thereof, and means for admitting fluid pressure to the recessed portion whereby fluid pressure will be transmitted through the diaphragm member to the calibration-stop member.

6. A condition responsive device comprising a cover member, the cover member having an aperture therein for ingress and egress of fluid pressure and formed with a flange, a snap-acting diaphragm movable to and from generally convex and concave positions, and having a periphery attached about and adjacent its periphery to the cover flange; and a stop member deformable by fluid pressure within a calibration range but nondeformable within a lower operating range, the calibration-stop member having an inner and outer periphery attached about and adjacent its outer periphery to the diaphragm adjacent and about its periphery, the surface of the stop member adjacent the inner periphery thereof shaped in a generally concave configuration with respect to the diaphragm and contacting the diaphragm when the diaphragm is in one of its two positions.