

[54] **DIFFERENTIAL BAROSWITCH**

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

[58] Field of Search **200/81, 83; 73/384, 386, 73/387, 389, 406, 409, 178**

[56] **References Cited**

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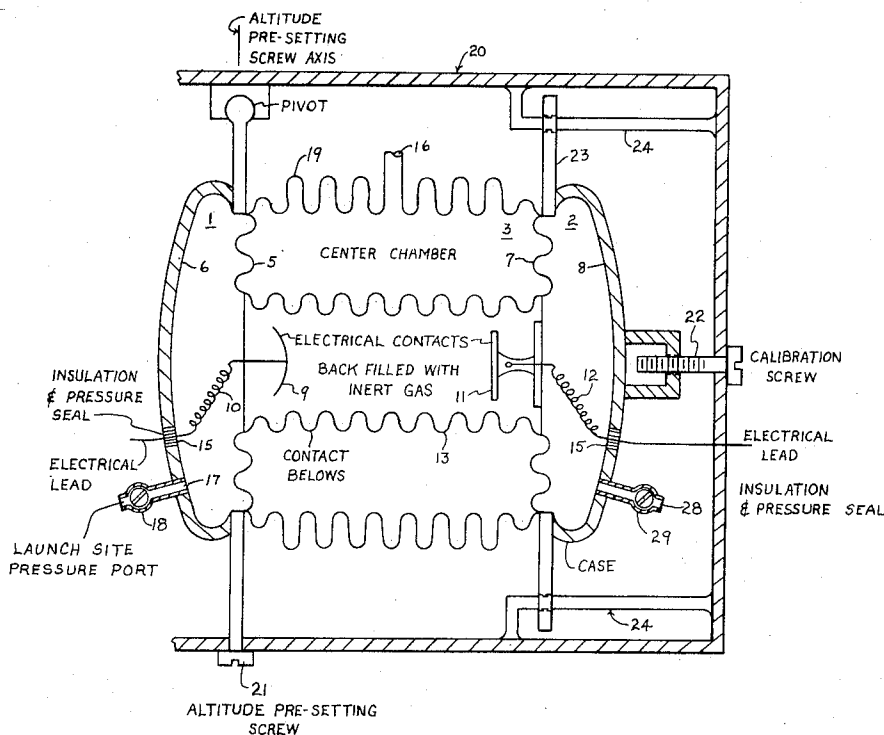
Assistant Examiner—G. E. Montone

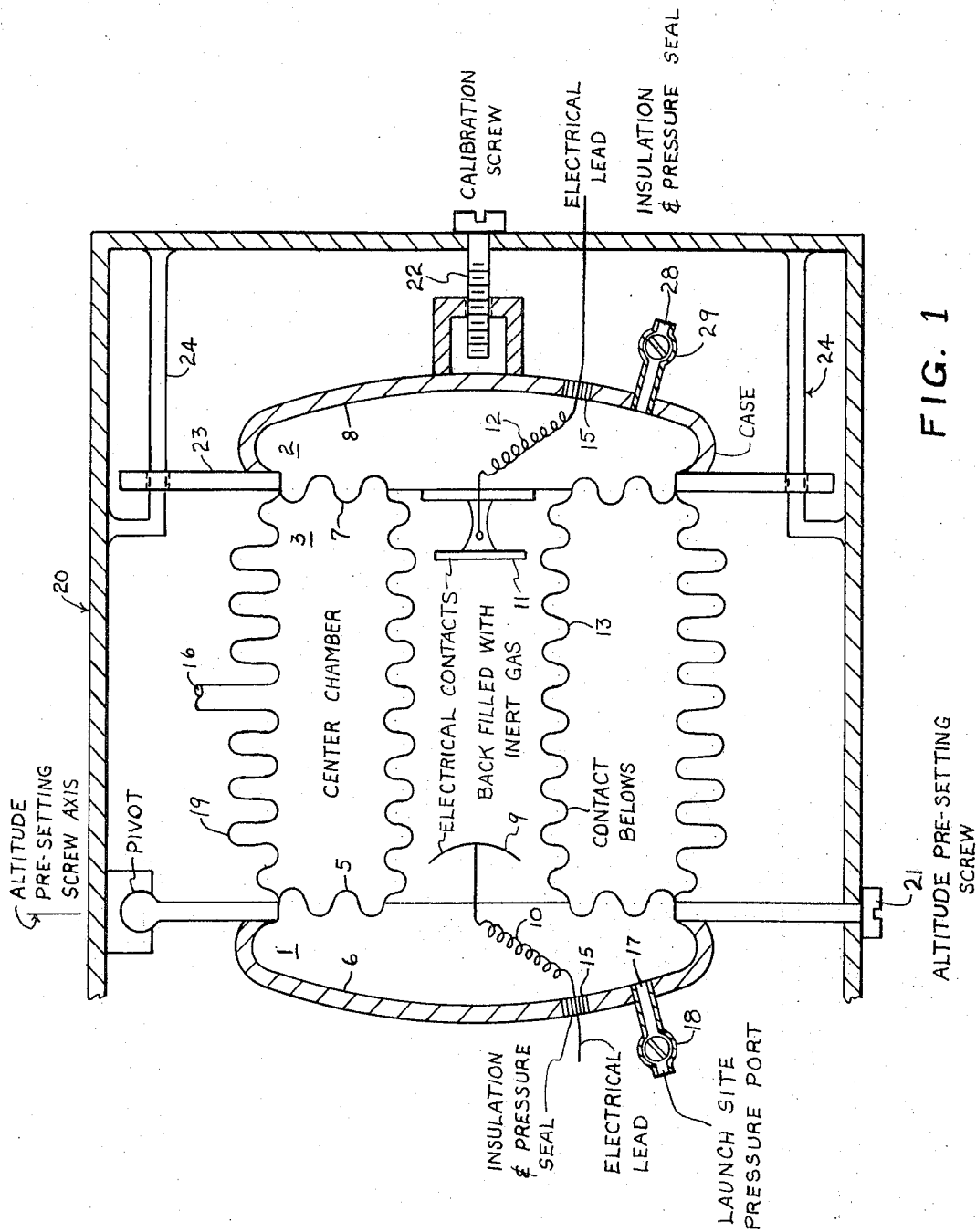
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EXEMPLARY CLAIM

1. A differential baroswitch comprising:
 - a first chamber, a second chamber, and a third chamber between the first and second chambers;
 - a pressure responsive movable element between the first and second chambers;
 - a pressure responsive movable element between the second and third chambers;
 - vent and valve means for opening the first chamber to ambient atmospheric conditions or closing such chamber as desired;
 - means for sealing the second chamber;
 - means for venting the third chamber to ambient atmospheric conditions at all times;
 - sensing means connected to the pressure responsive movable elements to indicate a position of the elements.

7 Claims, 5 Drawing Figures





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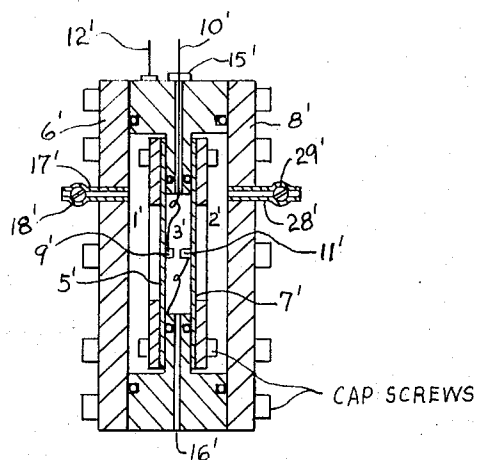


FIG. 2

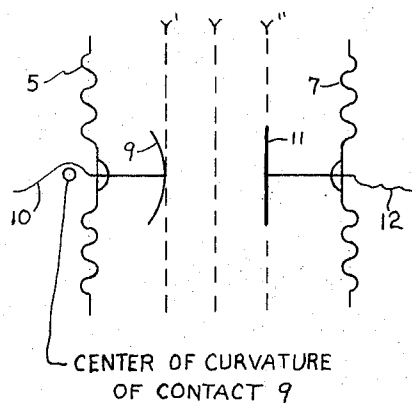


FIG. 3

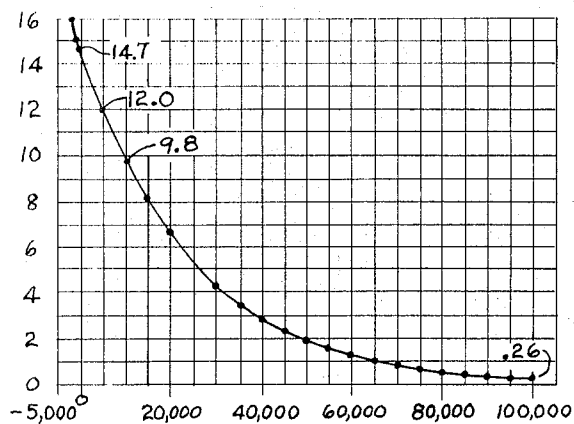


FIG. 5

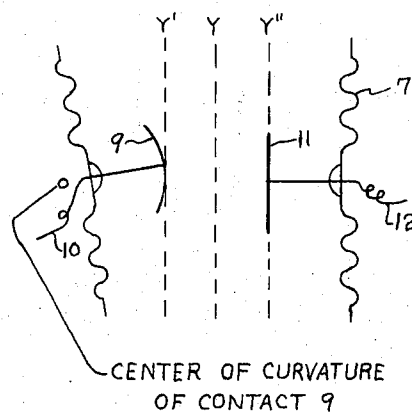


FIG. 4

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DIFFERENTIAL BAROSWITCH

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

An ordinary baroswitch is one which is constructed and pre-set such that its electrical contacts will close at a certain height above sea level as the switch is carried up into the atmosphere. For example, the factory may construct and adjust the switch unit to close at a certain lowered atmospheric pressure representing 5,000 feet above sea level. If such switch is taken aloft from a sea level location, the switch will close at 5,000 feet above the launch location. However, if such switch is taken aloft from a 4,000 foot mountain, then it will close at only 1,000 feet above the launch location.

The present invention is directed toward a baroswitch which will close at a certain predetermined height above the launch location, for example 5,000 feet above the launch location, regardless of whether the launch location is at sea level, 5,000 feet above sea level, or at any other elevation. Further the present baroswitch is adjustable for pre-setting the operating altitude. An additional adjustment is provided for baroswitch calibration.

In the drawing:

FIG. 1 is a diagrammatic representation of the present invention including adjustment means for altitude pre-setting and calibrating the baroswitch;

FIG. 2 is a cross section of an engineering test model of the invention with changeable diaphragms for altitude setting purposes;

FIG. 3 and 4 are diagrammatic representations showing the effect of adjusting the altitude setting screw of FIG. 1; and

FIG. 5 is a graph representing atmospheric pressures at various altitudes.

The present baroswitch has three chambers 1, 2, 3. Chamber 1 has a diaphragm wall 5 and a casing 6. Chamber 2 has a diaphragm 7 and casing 8. Diaphragm 5 carries an electrical contact 9 with an electrical lead 10 attached thereto. Diaphragm 7 carries an electrical contact 11 with an electrical lead 12.

Electrical contacts 9, 11 are preferably protected against corrosion by an inert gas contained within a lightweight bellows 13 which offers substantially zero resistance to movement of diaphragms 5, 7. Insulating pressure seals 15 are used where electrical leads 10, 12 pass through cases 6, 8.

Center chamber 3 has a bellows 19 connecting cases 6, 8 and has a port 16 therein. Chamber 1 has a port 17 which may be closed by valve 18. Chamber 2 is preferably sealed with no port or vent to the outside. However, a closable port may be provided for changing the pressure in chamber 2 if desired. Such port is illustrated at 28 with valve 29 through which pressure in chamber 2 could be lowered or raised. Frame 20 houses the cases 6, 8. Screw 21 provides for adjustment of case 6 with diaphragm wall 5 with respect to diaphragm wall 7. Turning the screw 21 rotates case 6 with diaphragm wall 5 about the axis of screw 21 where this axis passes through the center of curvature of concave contact 9. Screw 21 changes the angle of movement of concave contact 9 relative to flat contact 11.

Screw 22 is the calibration screw. It is used at the factory to adjust the spacing between the contacts to the proper value. Screw 22 passes through frame 20 and

laterally advances or retreats case 8 with diaphragm wall 7 and contact 11. Plate 23 upon which is mounted case 8 and diaphragm wall 7 rides freely along tracks 24 provided on frame 20 as screw 22 is rotated. The tracks are to maintain alignment of the case 8 with diaphragm wall 7 with respect to case 6 and diaphragm wall 5.

FIG. 2 illustrates another form of the baroswitch. It will be noted that the basic elements in FIG. 2 are similar to those in FIG. 1, and are designated with corresponding primed numerals, except that the adjustment apparatus is different. In FIG. 2 diaphragm assemblies 5', 7' may be exchanged for weaker or stronger diaphragms which require lesser or greater pressures to move them and bring contacts 9', 11' together. The pressure in chamber 2' regulated through valve 29' is used to calibrate the baroswitch in this design.

OPERATION

In FIG. 1 pressure chamber 2 is filled at the factory with gas to a predetermined pressure, preferably near zero absolute pressure to minimize temperature change effects on the gas and operation of the baroswitch. Chamber 3 is always filled with air at the ambient atmospheric pressure. Valve 18 remains open until the baroswitch is ready for launching. At the launch site valve 18 is closed so as to trap air in chamber 1 at the ambient air pressure. Thus at launch time, pressure in chambers 1 and 3 is equal and the pressure in chamber 2 is at the predetermined value set at the factory.

With valve 18 closed, the baroswitch unit is carried aloft. As it ascends, pressure in chamber 3 bleeds off through port 16 to lower the pressure and pressure in chambers 1 and 2 remains substantially unchanged except that flexing of the diaphragms may enlarge chambers 1 and 2 slightly and thus lower the pressure slightly. Diaphragms 5, 7 are moved toward one another bringing contacts 9, 11 closer together until they close to thereby close a circuit between electrical leads 10, 12.

If the baroswitch unit is launched from sea level then pressure in chambers 1 and 3 is approximately 14.7 lbs./sq. in. at launch time. Pressure in chamber 2 is sealed at the preselected value, assumed at a very low pressure. As the baroswitch ascends the pressure in chamber 3 bleeds off until, at the preselected altitude, the pressure difference between chambers 1, 3 and 2, 3 forces diaphragms 5, 7 inward and causes contacts 9, 11 to close.

Now assume that the unit is launched from a higher elevation, say 5,000 feet. The present differential baroswitch will not close until an elevation of 5,000 feet above the launch site is reached, i.e., 10,000 feet above sea level. The phenomena causing this action is as follows.

As the baroswitch is moved aloft up from sea level to the preselected altitude, say 5,000 feet above sea level, atmospheric pressure decreases (approximately) 2.7, from 14.7 to 12.0 lbs./sq. in., note FIG. 5. This decrease in pressure would be sufficient to cause diaphragms 5 and 7 to close contacts 9, 11 if launching were from sea level. However, the change in atmospheric pressure from 5,000 to 10,000 feet above sea level decreases only approximately by 2.2, from 12.0 to 9.8 lbs./sq. in. This differential is not as great as in the previous illustration and it would appear that the pressure change would not cause the contacts to close if the

baroswitch were launched from the site elevation of 5,000 feet. However, chamber 2 acts as an automatic compensating chamber. Due to the fixed pressure in this chamber, diaphragm 7 and contact 11 move to the left as the baroswitch unit is moved upwardly and atmospheric pressure in chamber 3 decreases. This movement of contact 11 is substantially equal to the lessening rate of movement of diaphragm 5 as the baroswitch is moved to successively higher launch site elevations. In other words, taking the example of altitudes and pressures given above, as the baroswitch moves aloft to 5,000 feet from sea level with valve 18 closed, a pressure differential of 2.7 lbs./sq. in. forces diaphragm 5 and contact 9 to the right toward contact 11. If the baroswitch were launched from an elevation of 5,000 feet from sea level to a height of 5,000 feet above the launch elevation this altitude change would result in a pressure differential of only 2.2 lbs./sq. in. and therefore, diaphragm 5 and contact 9 would not move as far toward contact 11. Nevertheless, the compensating chamber 2 would have automatically moved diaphragm 7 and contact 11 to the left representing the initial rise of 5,000 feet from sea level to the launch site and would continue to move contact 11 to the left as the baroswitch ascends from the launch site elevation at 5,000 feet up to 10,000 feet. Thus, whether the baroswitch unit is launched from sea level or from 5,000 feet, or from any other level, the contacts will close at the altitude for which the unit is preset.

FIG. 5 illustrates the exponential drop in atmospheric pressure at increasing altitudes. Additional graphs, charts, tables, and formulae could be presented to prove that the compensating chamber 2 automatically compensates for the exponential change in atmospheric pressure and the differential rate of movement of diaphragm 5 and contact 9 as the baroswitch is moved upwardly. However, this data is based on known physical constants and is deemed unnecessary to an understanding of how and why the invention operates. It can be proven that a baroswitch as illustrated, once designed and engineered to close contacts 9, 11 at X feet above the launch site where valve 18 is closed, will always close contacts 9, 11 at X feet above the launch site, regardless of whether the launch site is at sea level, at 10,000 or 20,000 or 30,000 feet, or even if the launch site is in a valley below sea level.

It is possible to change the height at which the contacts will close by any one of several methods. For example, in FIG. 2, parts such as diaphragm 5' or 7' may be interchangeable with other stronger or weaker diaphragms, by removing cover plates 6', 8'. A greater or lesser pressure will then move the contacts together. Thus, with one set of diaphragms the contacts will close at 5,000 feet, with other sets the closing will occur at 10,000 feet, or at 25,000, or 100,000 feet or any other altitude.

Another method of changing the contact-closing height would be to change the pressure in chamber 2. If this pressure were increased, the contact-closing height would be lowered. However, the gas in chamber 2 is subject to pressure changes, such as an increase on a hot summer day when the launch site temperature may be 100° F, or a decrease on a cold day when the temperature is zero F. This could cause error depending on the season or launch site location, and could also cause error as the baroswitch moves to higher and therefore colder altitudes. Therefore, it is deemed pref-

erable to use a very low pressure (near perfect vacuum) in chamber 2 and vary the contact-closing height by other means such as by interchanging parts described above or by the presetting means described hereinafter.

In FIG. 1 altitude presetting screw 21 is used to adjust the angular travel of contact 9 relative to contact 11. Case 6 is pivoted about the axis of the altitude presetting screw 21. As will be noted from FIGS. 3 and 4, the axis of screw 21 passes through the center of curvature of contact 9 and the surfaces of contacts 9 and 11 are spherical and flat respectively. As screw 21 is turned, case 6 with diaphragm wall 5 is rotated about the screw axis 21 to thereby change the angle of the cases 6, 8 and diaphragms 5, 7 relative to one another. If screw 21 is adjusted to set diaphragm wall 5 of case 6 parallel to diaphragm wall 7 of case 8 then contacts 9, 11 will move straight toward one another as in FIG. 3. However, if screw 21 is adjusted to throw the diaphragm walls 5, 7 out of parallelism, then contact 9 will move obliquely toward contact 11. Thus, changing the setting of altitude presetting screw 21 changes the angle of approach of the contacts as illustrated in FIGS. 3 and 4. It will be noted that in FIG. 3, diaphragm 5 need move contact 9 straight from line Y' to line Y and diaphragm 7 need move contact 11, straight from line Y to line Y for a given contact-closing height setting. However, in FIG. 4, contact 9 will be to the left of line Y when contact 11 is at line Y. For the contact to close with diaphragm wall 5 rotated, as shown in FIG. 4, the baroswitch must be carried further aloft. Therefore by rotating diaphragm wall 5 the contact-closing height is changed. Additional graphs, charts, tables, and formulas could be presented to prove that rotating diaphragm wall 5 about the axis of the altitude presetting screw will provide the means for presetting the contact-closing height of the baroswitch. Or, screw 21 may be used to adjust the instrument just prior to launching to compensate for ambient atmospheric pressure changes. Or, screw 21 may be used to adjust the instrument to the desired height setting to compensate for discrepancies among materials and workmanship in the manufacture of the baroswitch components. For example, if one baroswitch has diaphragms slightly stronger than others, offering greater resistance to deflection, then screw 21 could be adjusted to compensate for the off-standard diaphragms.

Other forms of apparatus could be used to achieve the functions described in the specific examples shown in the drawings and described hereinabove, or to perform other similar functions. For example, the geometric shape of the contacts the pivot point of the diaphragm wall, and the means for pivoting the diaphragm walls can be changed to change the altitude setting range of the baroswitch and/or provide a remote set capability.

I claim:

1. A differential baroswitch comprising:

- a first chamber, a second chamber, and a third chamber between the first and second chambers;
- a pressure responsive movable element between the first and second chambers;
- a pressure responsive movable element between the second and third chambers;
- vent and valve means for opening the first chamber to ambient atmospheric conditions or closing such chamber as desired;

means for sealing the second chamber;
means for venting the third chamber to ambient atmospheric conditions at all times;
sensing means connected to the pressure responsive movable elements to indicate a position of the elements.

2. A differential baroswitch as in claim 1 wherein the sensing means comprises electrical contacts adapted to close when the baroswitch reaches a predetermined altitude independent of site elevation with lowered pressure in the third chamber sufficient to move the pressure responsive movable elements inwardly within the third chamber sufficiently to close the electrical contacts.

3. A differential baroswitch as in claim 2 and:
means to protect the electrical contacts against corrosion.

4. A differential baroswitch as in claim 1 and:
means for adjusting the pressure responsive means relative to one another so as to vary the sensing characteristics of the sensing means.

5. A differential baroswitch as in claim 4 wherein one of the pressure responsive means, to which the sensing means is connected, is adjustably mounted to move about a pivot and a second pressure responsive means is mounted on a plate movable along a guide rail and wherein the sensing means for the guide-rail pressure responsive means is an electrical contact with a flat surface and the sensing means for the pivoted pressure responsive means is an electrical contact with a rounded contact area which lies on the radius of a circle with the pivot as the center thereof, such that adjustment of the adjusting means varies the sensing characteristics of the sensing means.

6. A differential baroswitch as in claim 1 wherein the pressure responsive means are interchangeable with pressure responsive means of different characteristics to thereby vary the sensing characteristics of the sensing means.

7. A differential baroswitch as in claim 1 and means to vary the pressure in the second chamber.

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