

Oct. 20, 1953

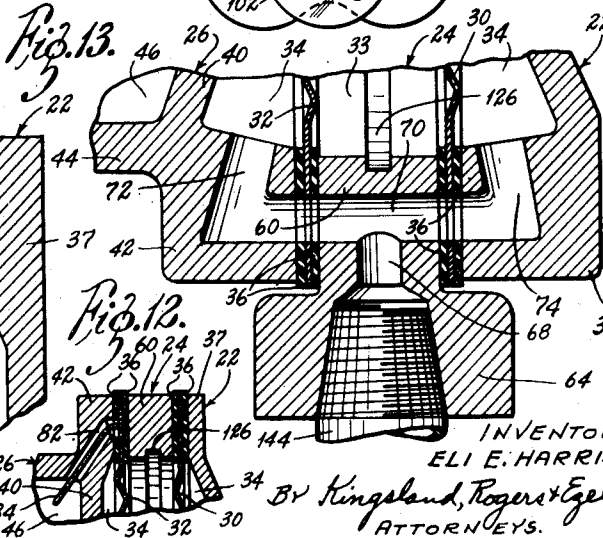
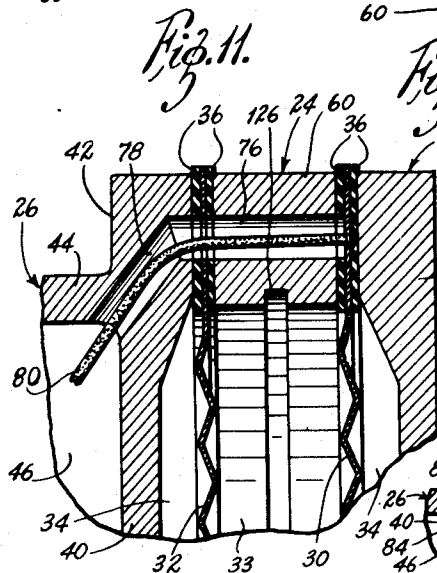
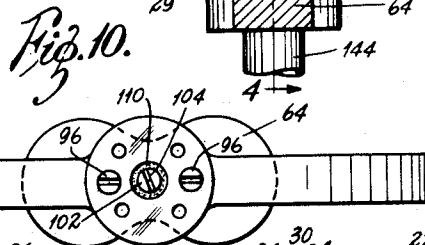
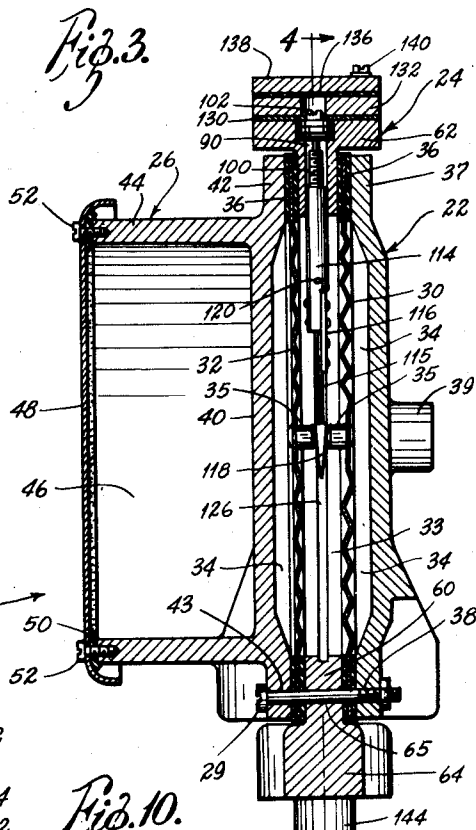
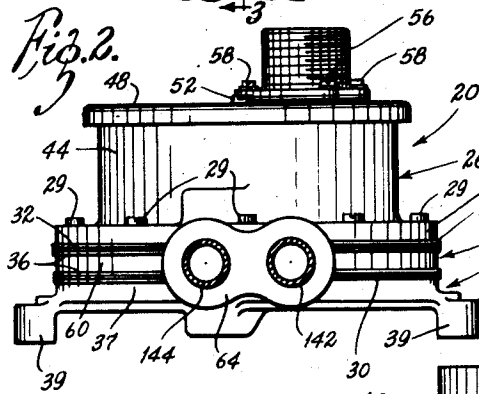
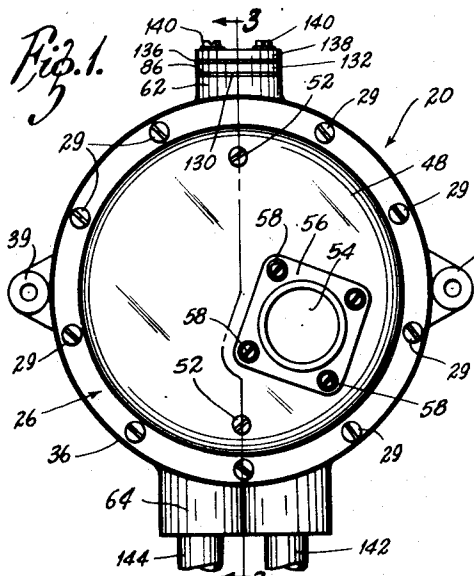
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2,656,428

DIFFERENTIAL PRESSURE SWITCH

Filed June 30, 1950

2 Sheets-Sheet 1



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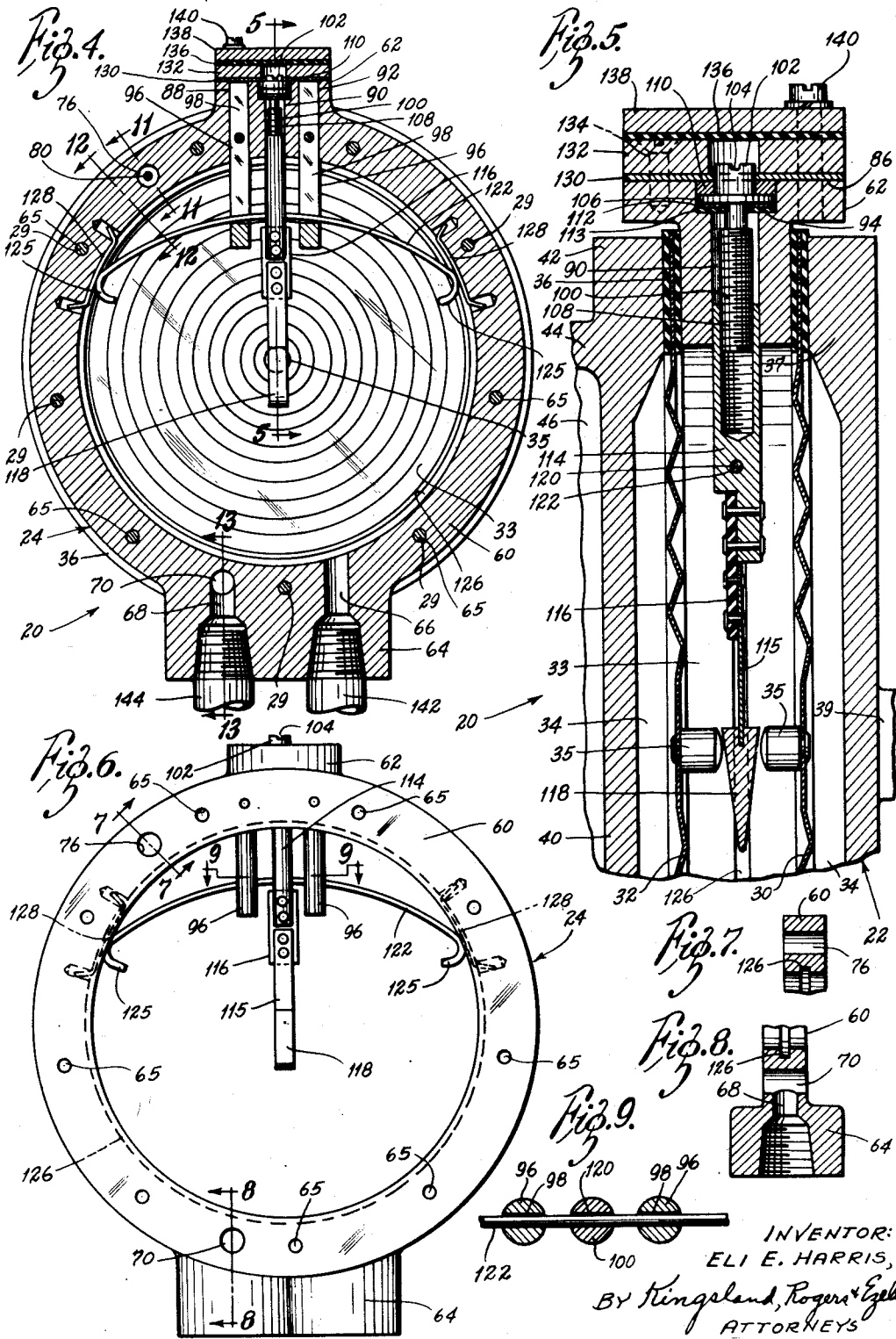
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,656,428

DIFFERENTIAL PRESSURE SWITCH

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12 Claims. (Cl. 200—81.5)

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The present invention relates generally to the switch art and more particularly to a novel differential pressure switch employing a double diaphragm and which is especially advantageous for use on aircraft and in other installations where a switch is subjected to extreme temperature changes, impact and vibration, and where extreme sensitivity is desired.

In its preferred form, the switch comprises a housing having a pair of spaced diaphragms disposed within the interior of the housing so as to divide it into an inner chamber and a pair of outer chambers, the outer chambers being in communication. The diaphragms are preferably of the same shape and size and have substantially the same mass, the same coefficient of expansion, and the same vibration characteristics. There is one passageway into the inner chamber and another passageway into the outer chambers. A contact is fastened to each diaphragm adjacent its center on the inner chamber side. An adjustable supporting member, which can be adjusted from outside the housing, extends into the inner chamber, and a wedge-shaped member of electricity conducting material is fastened to the inner end of the supporting member, but electrically insulated therefrom so as to be movable between the contacts on the diaphragms. When the diaphragms are made of electricity conducting material which is the preferred construction, a wire is fastened to each diaphragm adjacent its edge; whereas, if the diaphragms are made of non-conducting material, the wires are connected directly to the contacts. Thus, when the pressure in the outer chambers exceeds that in the inner chamber by a predetermined amount, the diaphragms and the contacts thereon are forced inwardly against the wedge-shaped member so as to complete the electrical circuit between the wires.

As is well known to those familiar with the art, switches which are used on aircraft and the like are subjected to relatively sudden temperature changes of as much as several hundred degrees F., impact and vibration. In addition, in switches of this type, high sensitivity is required.

It is an object of the present invention, therefore, to provide a novel differential pressure switch which is not adversely affected by temperature change, sudden impact or vibration, and which is very sensitive. More particularly, it is an object to provide a switch of this type which includes a pair of spaced diaphragms which support the contacts and which have substantially the same mass, the same coefficient of expansion,

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the same vibration characteristics, etc., so that they will move together in the same direction when the temperature changes or when the switch is vibrated.

Another object is to provide a differential pressure switch which can be adjusted while it is under pressure. With the switches in use at the present time it is necessary to remove the pressure and disconnect the terminals before the switch can be adjusted.

Another object is to provide a differential pressure switch which can be used with combustible gas in one set of chambers without risking an explosion.

Another object is to provide a differential pressure switch which is more sensitive than the single diaphragm type differential pressure switch.

Another object is to provide a differential pressure switch in which the diaphragms themselves act as electrical conductors.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is shown, in which:

Fig. 1 is a front elevational view of a switch constructed in accordance with the teachings of the present invention;

Fig. 2 is a bottom plan view of the switch;

Fig. 3 is an enlarged vertical sectional view of the switch taken on the line 3—3 in Fig. 1;

Fig. 4 is a vertical sectional view taken on the line 4—4 in Fig. 3;

Fig. 5 is an enlarged fragmentary vertical sectional view taken on the line 5—5 in Fig. 4;

Fig. 6 is a front elevational view of the center ring assembly with the cover plate removed from the upper projection;

Fig. 7 is a radial transverse sectional view taken on the line 7—7 of Fig. 6;

Fig. 8 is a fragmentary vertical sectional view taken on the line 8—8 in Fig. 6;

Fig. 9 is an enlarged fragmentary horizontal sectional view taken on the line 9—9 in Fig. 6;

Fig. 10 is a top plan view of the center ring assembly shown in Fig. 6;

Fig. 11 is an enlarged fragmentary transverse sectional view taken on the line 11—11 in Fig. 4;

Fig. 12 is a fragmentary sectional view taken on the line 12—12 in Fig. 4; and

Fig. 13 is an enlarged fragmentary vertical sectional view taken on the line 13—13 in Fig. 4.

Referring to the drawings more particularly by

reference numerals, 20 indicates generally a differential pressure switch embodying the teachings of the present invention.

The switch 20 includes a housing having a dish-like base member 22, a center ring assembly 24, and a cup-like cover member 26, in juxtaposition as shown in Fig. 3; the three members being fastened together by machine screws 29.

Disposed between the base member 22 and the center ring assembly 24 in a diaphragm 30, and disposed between the center ring assembly 24 and the cover member 26 is another diaphragm 32, the two diaphragms and the three members defining an inner chamber 33 and a pair of outer chambers 34.

The diaphragms 30 and 32 are made in the shape shown in Figs. 4 and 5 of preferably a resilient electricity conducting material, preferably beryllium copper, and are of substantially the same thickness and size and have substantially the same mass, the same coefficient of expansion, and the same vibration characteristics. Preferably, both diaphragms should face the same way, as shown in Figs. 3 and 5. Each diaphragm has a cylindrical contact 35 with a rounded inner end fastened adjacent the center thereof, the contacts 35 being in alignment and extending into the inner chamber for a purpose to appear.

Flat annular gaskets 36 of rubber or like material are disposed between the diaphragms and the members adjacent thereto at their marginal portions so as to seal the chambers against the escape of air or gas.

The base member 22 (Fig. 3) is perfectly circular in shape and includes a peripheral flange portion 37 which contains a plurality of spaced openings 38 formed therein to receive the free ends of the fastening screws 29.

Mounting lugs 39 (Figs. 1 and 2) extend from the periphery of the base member 22 for fastening the switch 20 to a fixed support.

The cover member 26 (Figs. 1, 2 and 3) is also preferably cylindrical in shape and includes a base portion 40 and a peripheral flange portion 42. The flange portion 42 contains a plurality of spaced openings 43 which are in alignment with the openings 38 in the base member, and which receive the head ends of the screws 29. Openings are also contained in the diaphragms 30 and 32 in alignment with the openings 38 and 43, so that the screws 29 can pass through. The openings in the diaphragms are made larger than the others, however, so the screws 29 won't "short" the diaphragms.

Extending normal to the base portion 40 is a cylindrical wall 44 which forms a chamber 45 to receive switches, relays, wiring, etc., which form no part of the present invention.

A flat cover 46 and an annular gasket 50 are removably fastened to the outer edge of the wall 44 by screws 52 (Fig. 3).

An opening 54 (Fig. 1) is contained in the cover 46, and an externally threaded cylindrical electrical disconnect receptacle 56 is fastened to the cover 46 in alignment with the openings 54 by means of screws 58.

The center ring assembly 24 (Figs. 6 and 10) includes a flat annular body portion 60 and a pair of diametrically opposed upper and lower projections 62 and 64, respectively, which are formed integral with the body portion 60 and extend outwardly therefrom.

The body portion 60 contains spaced openings

65 in alignment with openings 38 and 43 to receive the machine screws 29.

The lower projection 64 contains two inwardly extending passageways 66 and 68 (Fig. 4), the outer portions of the passageways containing internal threads to receive the ends of tubes or pipes which are in communication with the pressure sources, as will appear.

The passageway 66 extends through the annular body portion 60 so as to be in communication with the inner pressure chamber 33.

The passageway 68 extends partially through the body portion 60 and intersects another passageway 70 which extends transversely through the body portion 60 (Fig. 8). Openings are contained in the diaphragms 30 and 32 and the gaskets 36 in alignment with the ends of the passageway 70. As shown in Fig. 13, angular passageways 72 and 74 are contained in the flange portions 42 and 37, respectively, and connect the ends of the transverse passageway 70 with the outer chambers 34. Thus, the pipe or tube connected to the outer end of the passageway 68 is in communication with both outer chambers 34, and they are in communication with each other.

As shown in Figs. 7 and 11, a passageway 76 extends transversely through the annular body portion 60 and is in alignment with the inner end of a passageway 78 which extends from the chamber 45 through a flange portion 42 of the cover member 26. Openings are contained in the diaphragm 32 and the gaskets 36 in alignment with these passageways.

An insulated wire 80 extends through the passageways 78—76 and is connected to the diaphragm 30 adjacent its edge.

Another passageway 82 (Fig. 12) extends from the chamber 45 through the flange portion 42 of the cover member 26, adjacent the passageway 78. The gasket 36 adjacent one side of the diaphragm 32 contains an opening in alignment with the end of the passageway 82.

A second insulated wire 84 extends through the passageway 82 and is connected to the diaphragm 32.

Thus, there is one electrical circuit from the wire 80, through the diaphragm 30 to the contact 35 adjacent the center thereof, and a second circuit from the wire 84 through the diaphragm 32 to the contact 35 adjacent its center.

As shown in Figs. 4 and 5, the upper projection 62 which extends from the body portion 60 has a flat upper surface 86, and contains three parallel openings 88, 90 and 92 which are of circular cross section and which extend inwardly from the surface 86 to the inner chamber 33. The outer portion of the opening 90 is slightly enlarged so as to provide a shoulder 94 inwardly of the upper surface 86.

Rigidly fastened in the openings 88 and 92 are a pair of cylindrical elongated stop members 96 which extend into the inner chamber 33 and which contain vertically extending slots 98.

Disposed in the center opening 90 is an adjustable supporting assembly which includes a screw member 100 comprising a head portion 102 which contains a slot 104, a flange portion 106 (disposed above the shoulder 94) and a threaded body portion 108.

An annular metal washer 110 is disposed in the opening 90 around the head portion 102 and another annular metal washer 112 and a rubber gasket 113 are disposed between the flange portion 106 and the shoulder 94.

Threadedly mounted on the inner end of the body portion 108 so as to extend well into the inner chamber 33, is an elongated supporting member 114 of circular cross section.

A resilient strip 115 is fastened to the inner end of the supporting member 114 by means of an insulator member 116, in the manner shown in Fig. 5. The strip 115 has a wedge shaped member 118 fastened to its end which is made of electricity conducting material and is disposed between the contacts 35 so that when they are forced against it by the difference in pressure between the inner chamber 33 and the outer chambers 34, as will appear, an electrical circuit is completed between the two diaphragms and the wires fastened thereto.

Formed in the supporting member 114 is a transversely extending opening 120 (Fig. 5), and disposed in the opening is a bowed, wire-like, tensioning member 122 (Fig. 4) which extends through the slots 98 in the stop members 96. The tensioning member 122 contains inwardly curving ends 125 which bear against the inner face of the body portion 60.

As shown in Figs. 3, 4 and 6, the annular body portion 60 of the center ring assembly 24 contains a groove 126 of rectangular cross section formed in its inner face.

Bearing strips 128 are disposed in the groove 126 adjacent the curved ends 125 of the tensioning member 124 so as to be in sliding contact with them.

Thus, when the screw member 100 is rotated by means of a screw driver inserted in the slot 104, the supporting member 114 is moved outwardly or inwardly a predetermined distance, depending upon the direction of rotation, and the wedge-shaped member 118 is moved relative to the contacts 35 so as to position a portion thereof of different thickness between them. Because the supporting member is insulated from the wedge-shaped member 118 by the insulator member 116, the operator adjusting the switch will not receive a shock even if the contacts 35 are touching the wedge shaped member 114.

The supporting member 114 is prevented from turning when the screw 100 is actuated because the ends of the tensioning member are disposed in the groove 126 and also because the member 122 is confined within the slots 98 in the stop members 96.

The tensioning member 122 exerts a force on the supporting member 114 tending to move it inwardly, and this movement is resisted by the flange portion 106 of the screw member 100 bearing against the washer 112 and gasket 113 on the shoulder 94. Thus, the adjustable supporting assembly is always under tension so that there is no "play" between the parts.

The outward movement of the wedge-shaped member 118 is limited by the outer end of the supporting member 114 abutting the inner face of the gasket 113, and the inward movement is limited by the tensioning member 122 abutting the lower ends of the slots 98 in the stop members 96. Consequently, there is no chance of the wedge-shaped member 118 being driven inwardly beyond the contacts 35.

As shown in Fig. 5, an annular metal washer 130 is disposed on top of the upper projection 62 of the body portion 60. Disposed on top of the washer 130 is a flat, ring-like member 132 which contains an opening at its center to receive the head portion 102 of the screw member 100. The washer 130 and the ring-like member 132

are maintained in position by flat headed screws 134.

Disposed on top of the ring-like member 132 is a gasket 136 and a cover plate 138 which are held in place by two machine screws and lock washers 140. Thus, when it is desirable to adjust the setting of the switch 20, the cover plate 138 and gasket 136 can be easily and quickly removed, or merely swung to one side and out of the way, by unloosening one screw 140 and removing the other so as to expose the head portion 102 in the opening contained in the ring-like member 132.

The primary seal is achieved by means of the gasket 136 and the cover plate 138, but the gasket 113 also aids in preventing the escape of air or gas from the inner chamber 33 through the opening 90.

When the pressure within the inner chamber 33 is only atmospheric pressure, the gasket 113 can be omitted and a thicker metal washer 112 used in place of the washer and gasket. However, when the pressure within the inner chamber 33 is greater than atmospheric it is advantageous to use the gasket 113 to aid in sealing the opening 90.

Operation

The switch 20 has proven very successful in aircraft to control the circuit which lowers and raises the flaps. In such an installation, one end of a tube 142 is connected to the passageway 66 and the other end thereof is connected to a static pressure area within the aircraft. Also, one end of a tube 144 is connected to the passageway 68 and the other end is connected to a Pitot tube or the like, outside the aircraft. Thus, the pressure in the inner chamber 33 is substantially the same as the pressure within the static area of the aircraft, and the pressure in the outer chambers 34 is substantially the same as the ram air pressure, the difference between the two indicating the air speed of the aircraft.

As the pressure in the outer chambers 34 increases above the pressure in the inner chamber, the diaphragms 30 and 32 flex slightly toward each other, and when the difference between the two pressures reaches the amount for which the switch 20 has been set, the contacts 35 touch the wedge-shaped member 118. This will complete the circuit through the diaphragms 30 and 32, and the wires 80 and 84, so as to energize the relay or the like (not shown), contained in the chamber 46.

If the contacts 35 are not touching the wedge-shaped member 118 and there is a sudden unidirectional impact against the aircraft, both diaphragms will flex in the same direction so that even if one diaphragm moves a certain distance towards the wedge-shaped member 118, and touches it, the other diaphragm will move away from the wedge-shaped member 118 a like distance so that the distance between the inner ends of the contacts 35 will remain substantially the same. This is because the mass, size, shape, etc., of the diaphragms are substantially the same and they face in the same direction. Also, if the impact is oscillatory, both diaphragms will vibrate in the same manner because they have the same vibration characteristics and the distance between the inner ends of the contacts 35 will likewise always remain substantially the same. The same thing is true if both contacts 35 are against the wedge-shaped member 118 when the movement occurs. In the latter case, the contacts 35 and the member 118 will all move together with the latter held between the contacts 35. Fur-

thermore, the same thing is true when a change in temperature occurs. Inasmuch as both diaphragms are the same size, have the same coefficient of expansion, face the same direction, and are subjected to the same temperatures, any change in temperature in the outer chambers 34 due, for example, to a change in altitude in the aircraft, will affect them equally and cause like movement of the diaphragms.

Because there are two diaphragms in the switch 20 and because they both move inwardly the same distance, each has to move only half the distance required of a single diaphragm type switch, so that the switch 20 is twice as sensitive as the switches employing a single diaphragm.

Another advantage of this switch is that there is no arcing of any kind in the outer chambers so that it can be used in installations where it is desirable or necessary to use combustible gases in the outer chambers.

Thus, it is apparent that there has been provided a novel differential pressure switch which fulfills all of the objects and advantages sought therefor.

It is to be understood that the foregoing description and the accompanying drawings have been given only by way of illustration and example, and that changes and alterations in the present disclosure, which will be readily apparent to one skilled in the art, are contemplated as within the scope of the present invention, which is limited only by the claims which follow.

What is claimed is:

1. A pressure switch, comprising a housing; a pair of spaced diaphragms within the housing dividing it into an inner chamber and two outer chambers, the two outer chambers being in communication; a contact fastened to each diaphragm adjacent its center and extending inwardly into the inner chamber; adjustable means in the inner chamber for electrically connecting together said contacts at predetermined positions of the diaphragms; passage means into the inner chamber; and passage means into the outer chambers.

2. A pressure switch, comprising a housing; a pair of spaced diaphragms within the housing dividing it into an inner chamber and two outer chambers, the two outer chambers being in communication; a contact fastened to each diaphragm adjacent its center and extending inwardly into the inner chamber; adjustable contact means of varying thickness movable between said contacts so as to provide a bridging contact between the contacts on the diaphragms when the latter are in predetermined flexed positions; passage means into the inner chamber; and passage means into the outer chambers.

3. A pressure switch, comprising a housing; a pair of parallel spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers, the outer chambers being in communication; a contact fastened to each diaphragm adjacent its center and extending inwardly into the inner chamber; an adjustable supporting member in the inner chamber which contains a wedge-shaped element of electricity conducting material adjacent its inner end, the wedge-shaped element being movable between and relative to the contacts on the diaphragms so as to provide a bridging contact between them; passage means into the inner chamber; and passage means into the outer chambers.

4. A pressure switch, comprising a housing; a pair of parallel spaced diaphragms of electricity

conducting material within the housing dividing it into an inner chamber and a pair of outer chambers, the outer chambers being in communication; a conductor connected to each of the diaphragms; a contact fastened to each diaphragm adjacent its center and extending inwardly into the inner chamber; and an elongated adjustable supporting member extending into the inner chamber and having a wedge-shaped element of electricity conducting material adjacent the inner end thereof, the wedge-shaped element being movable between and relative to the contacts on the diaphragms so as to provide a bridging contact between them and complete the circuit between the conductors when the diaphragms are in predetermined flexed positions.

5. A pressure switch, comprising a housing; a pair of spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; a contact fastened to each diaphragm and extending inwardly into the inner chamber; an adjustable elongated supporting member extending into the inner chamber and having a wedge-shaped element of electricity conducting material adjacent the inner end thereof but insulated therefrom; and means for adjusting the length of the supporting member from outside the housing so as to vary the positions of the wedge-shaped element relative to the contacts on the diaphragms.

6. A pressure switch, comprising a housing; a pair of spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; a contact fastened to each diaphragm and extending inwardly into the inner chamber; an adjustable elongated supporting member extending into the inner chamber and having a wedge-shaped element of electricity conducting material adjacent the inner end thereof; and yieldable means urging the supporting member inwardly.

7. A pressure switch, comprising a housing; a pair of spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; a contact fastened to each diaphragm and extending inwardly into the inner chamber; an adjustable elongated supporting member extending into the inner chamber and having a wedge-shaped element of electricity conducting material adjacent the inner end thereof; means for adjusting the length of the supporting member from outside the housing; and means limiting the inward movement of the wedge-shaped element.

8. A pressure switch, comprising a housing having a side wall; a pair of spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; a contact fastened to each diaphragm and extending into the inner chamber; an opening in the side wall; an elongated adjustable supporting member disposed in the opening and extending into the inner chamber, the supporting member having a contact bridging element of varying width adjacent its inner end; and an elongated resilient wire-like member extending transversely through the supporting member and having its ends against the inner surface of the side wall.

9. A pressure switch, comprising a housing having a side wall; a pair of spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; a contact fastened to each diaphragm and extending into the inner chamber; an opening in the side wall; an elongated adjustable supporting

member disposed in the opening and extending into the inner chamber, the supporting member having a contact bridging element of varying width adjacent its inner end; an elongated stop member containing a slot therein extending inwardly from the side wall on each side of the supporting member; and an elongated resilient wire-like member extending transversely through the supporting member and the slots in the stop members and having its ends against the inner surface of the side wall.

10. A pressure switch, comprising a housing having a side wall; a pair of spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; a contact fastened to each diaphragm and extending into the inner chamber; an opening in the side wall leading into the inner chamber; a screw-like member extending into said opening from outside the wall; an elongated supporting member having its outer end threadedly disposed on the end of the screw-like member within the opening; means preventing rotation of the elongated member in the opening; a resilient strip fastened to the inner end of the elongated member; and a wedge-shaped member of electricity conducting material fastened to the end of the resilient strip.

11. A pressure switch, comprising a housing having a side wall; a pair of spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; an opening in the side wall leading into the inner chamber; a screw-like member extending into

said opening from outside the wall; an elongated supporting member having its outer end threadedly disposed on the end of the screw-like member; means preventing rotation of the elongated member when the screw-like member is rotated; a resilient strip fastened to the inner end of the elongated member; a wedge-shaped member fastened to the end of the resilient strip; and an elongated resilient member extending transversely through the elongated member and having its inner ends against the inner surface of the side wall so as to urge the elongated member inwardly away from the screw-like member.

12. A switch, comprising a housing; a pair of opposed spaced diaphragms within the housing dividing it into an inner chamber and a pair of outer chambers; a contact carried by each diaphragm and extending into the inner chamber; a member extending into the inner chamber and supporting an element of varying thickness for movement between the contacts and relative thereto.

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