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Phillips et al.

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[45] **Jan. 21, 1975**

[54] **MINIATURIZED DIFFERENTIAL PRESSURE SWITCH WITH INTEGRAL CONTACT AND SPRING MOUNTED ON DIAPHRAGM**

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[21] Appl. No.: **425,267**

[52] **U.S. Cl.** ..... **200/83 N**, 200/83 S, 200/83 N

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

[58] **Field of Search** .... 200/83 R, 83 A, 83 N, 83 P, 200/83 S, 83 T, 83 V, 83 W

[56] **References Cited**

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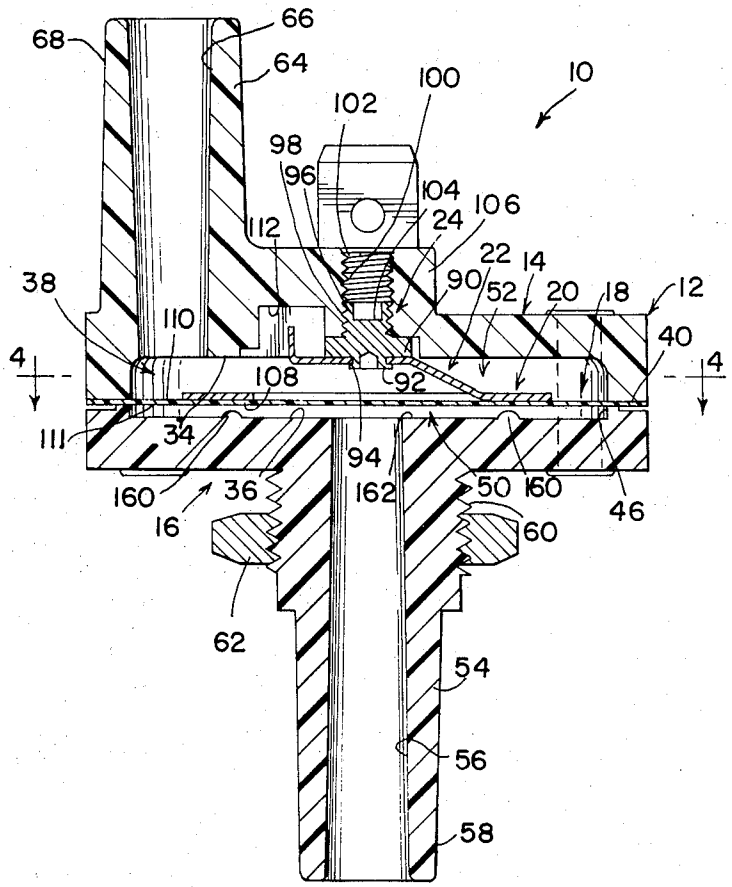
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Primary Examiner—Robert K. Schaefer
Assistant Examiner—Gerald P. Tolin
Attorney, Agent, or Firm—Mann, Brown, McWilliams & Bradway

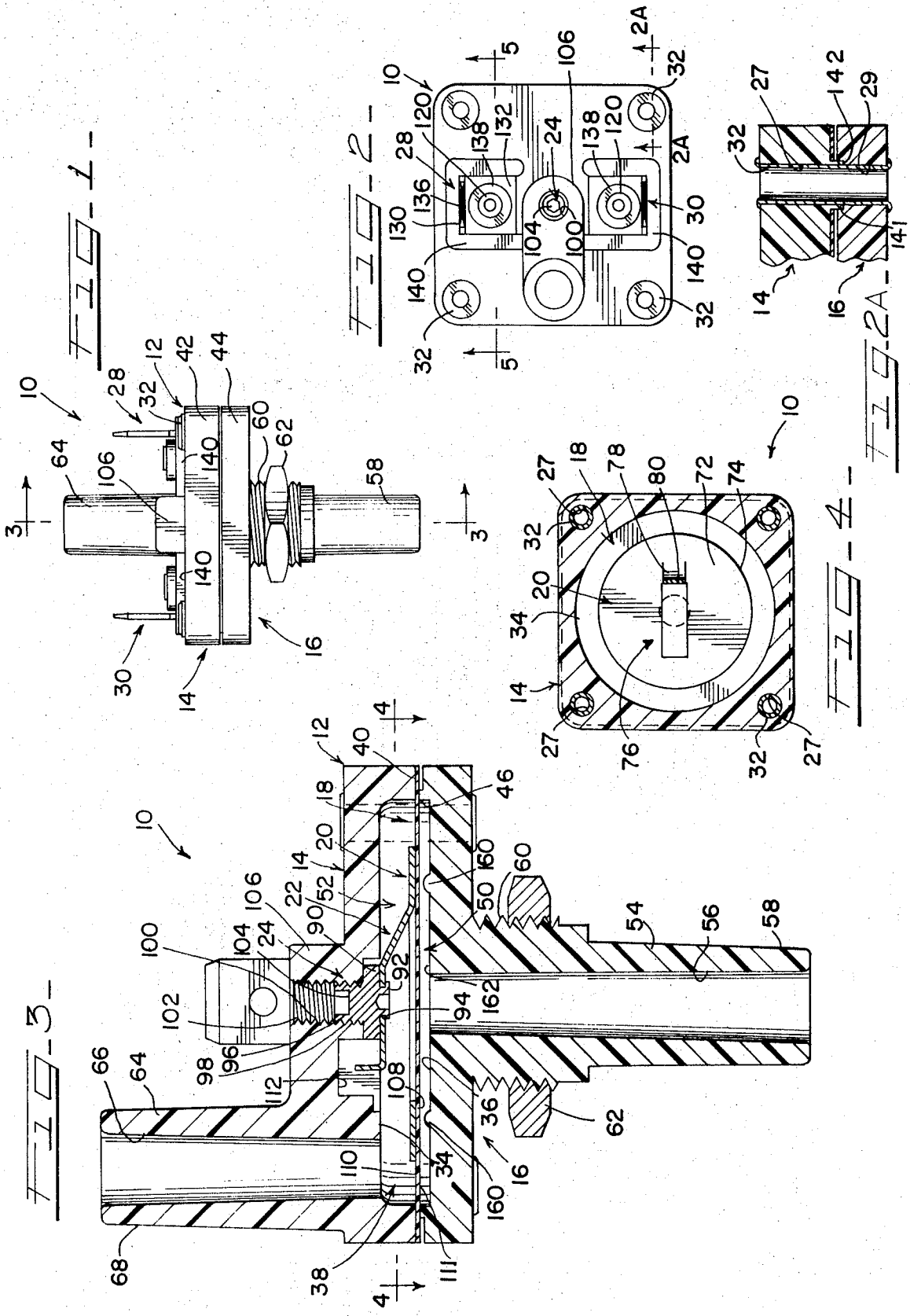
[57] **ABSTRACT**

A miniaturized differential pressure switch comprising a pair of matched housing sections and a low spring rate diaphragm of quadrilateral shape in the plane of the housing sections secured together by rivets at their corners, with the housings being recessed about on either side of the diaphragm to define high and low fluid pressure chambers of restricted depth that are adapted to be connected to differential gas pressure sources, in which the housing section that defines the low pressure chamber is equipped with electrical contacts disposed in the low pressure chamber, and the low pressure chamber has mounted in same a diaphragm plate that serves to close the switch contacts at the desired pressure differential, which diaphragm plate is equipped with a tongue acting as a range spring that is adjustable exteriorly of the housing by way of an adjusting screw that is threadedly mounted in the housing and that has its inner end journaled in an end portion of the tongue. The switch is adapted for use in connection with gas pressures of under 5 psig.

10 Claims, 9 Drawing Figures



2 Sheets-Sheet 1



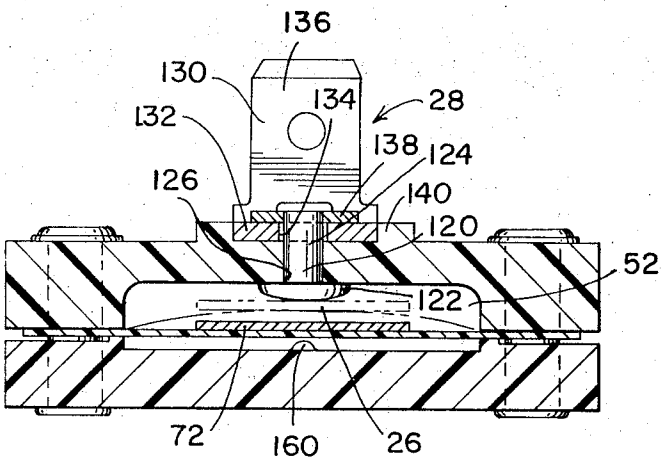


FIG. 5

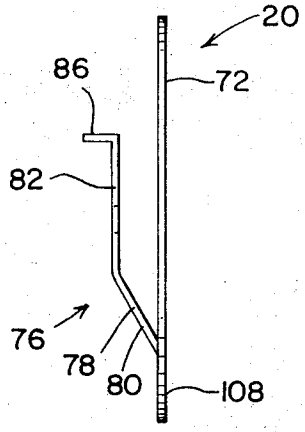


FIG. 8

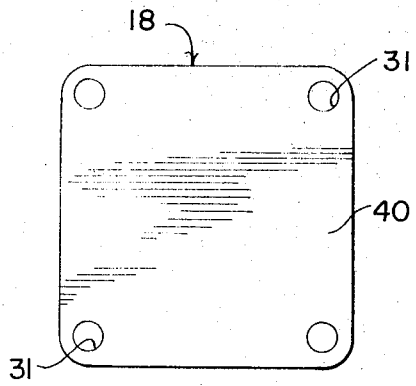


FIG. 6

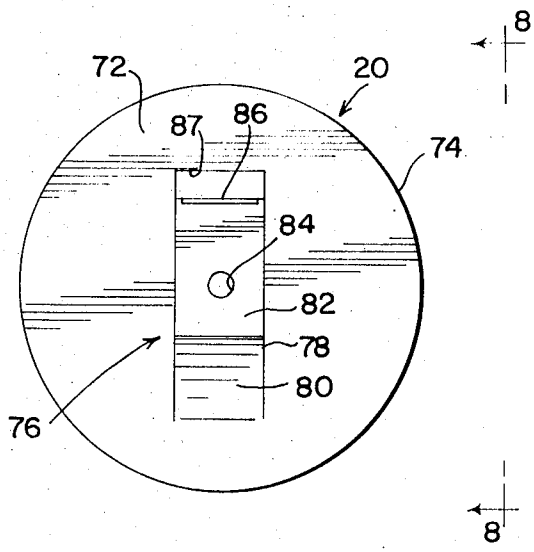


FIG. 7

MINIATURIZED DIFFERENTIAL PRESSURE SWITCH WITH INTEGRAL CONTACT AND SPRING MOUNTED ON DIAPHRAGM

This invention relates to a miniaturized differential pressure switch, and more particularly, to a differential pressure switch of small proportions that is adapted for use in connection with pressures below 5 psig.

Miniaturizing differential pressure switches for low pressure applications requires that the basic switching components and sensitivity be retained while providing an arrangement that can be readily mass produced to supply the demand and yet has the requisite sensitivity and long lived operation that are essential for devices of this type. This means that components suitable for larger switches operating at higher pressure levels are frequently too cumbersome, introduce too much friction and lost motion into the switching action, and unduly complicate the manufacturing procedures to be readily adaptable for miniaturized low pressure differential switch applications.

A principal object of the invention is to provide a miniaturized differential pressure switch that is especially adapted to be of the miniature switch type.

Another principal object of the invention is to provide miniaturized differential pressure switch that is reduced to a minimum of separate parts, and in which the diaphragm plate and range spring therefor are of special one-piece construction.

Other objects of the invention are to provide a miniaturized differential pressure switch of simplified construction that is economical of manufacture, convenient to use, and long-lived in operation.

In accordance with this invention, a miniaturized differential pressure switch is provided comprising a pair of matched housing sections formed from a suitable plastic material, and a low spring rate type diaphragm, in which the housing sections and diaphragm are of quadrilateral shape in the plane of the housing sections and are secured together by rivets at their corners. The housing sections are recessed a restricted amount on either side of the diaphragm to define high and low pressure chambers of restricted depth, with the housing sections being formed to connect the respective chambers to differential gas pressure sources. The housing section that defines the low pressure chamber is equipped with a pair of spaced apart electrical contacts disposed in the low pressure chamber, and the low pressure chamber has mounted in same a special diaphragm plate that seats against the diaphragm and is equipped with a tongue that acts as a range spring which is adjustable through an adjusting screw that is threadedly mounted in the housing to extend into the low pressure chamber, with the inner end of the adjustment screw being journaled in an end portion of the tongue.

The high and low pressure chambers are round in outline, as is the diaphragm plate, and the diaphragm plate tongue includes a tab that is placed in keying relation with the housing to hold the diaphragm against rotational shifting movement within the low pressure chamber.

The range spring adjustment screw is socketed for application thereto of a suitable turning tool from the exterior of the housing whereby the adjustment screw may be adjusted to set the diaphragm plate against the diaphragm as required so that a predetermined pressure differential will cause the diaphragm to seat the diaphragm plate against the switch contacts to close the switch.

Other objects, uses, and advantages will be obvious or become apparent from a consideration of the following detailed description and the application drawings.

In the drawings:

FIG. 1 is an elevational view of one embodiment of the invention;

FIG. 2 is a plan view of the low pressure end of the housing, the view of FIG. 2 being taken from the top of FIG. 1 and rotated counterclockwise 90 degrees;

FIG. 2A is a fragmental sectional view taken substantially along line 2A—2A of FIG. 2;

FIG. 3 is a sectional view taken substantially along line 3—3 of FIG. 1, but on an enlarged scale;

FIG. 4 is a sectional view taken substantially along line 4—4 of FIG. 3;

FIG. 5 is a sectional view taken substantially along line 5—5 of FIG. 2;

FIG. 6 is a plan view of the switch diaphragm;

FIG. 7 is a plan view of the switch diaphragm plate; and

FIG. 8 is an edge view of the diaphragm plate taken substantially along line 8—8 of FIG. 7.

However, it is to be distinctly understood that the specific drawing illustrations provided are supplied primarily to comply with the requirements of the Patent Laws, and that the invention may have other embodiments that will be obvious to those skilled in the art, and which are intended to be covered by the appended claims.

Reference numeral **10** of FIGS. **1 – 4** generally indicates a preferred embodiment of the invention which comprises a housing **12** comprising a low pressure housing section **14** and a high pressure housing section **16**, a low spring rate diaphragm **18** (see FIG. 3), a diaphragm plate **20** equipped with a range spring defining tongue **22**, an adjustment screw **24** threadedly mounted in the housing **12** in operative association with the diaphragm plate tongue **22**, and a pair of electricaal contacts **26** adapted to be closed by the diaphragm plate **20** at the desired pressure differential, which contacts **26** are respectively operatively connected to the respective electrical connectors **28** and **30.**

The housing sections **14** and **16** are in face to face relation, and the sections **14** and **16** and the diaphragm **18** are of matching quadrilateral configuration so that these parts may be assembled together by aligning their respective corner openings **27, 29** and **31** to receive suitable tubular rivets **32** (see FIG. 2A).

The housing sections **14** and **16** are formed with the respective circular recesses **34** and **36** (of substantially equal diameters), that are of limited depth, so that they define a diaphragm chamber **38** across which is applied the diaphragm **20** that has its margin **40** disposed between the rim portions **42** and **44** of the respective housing sections **14** and **16.** The housing section **16** is formed with an upstanding sealing ridge **46** (see FIG. 3) that is in unbroken circumambient relation about the recess **36** to effect a good fluid tight seal about the diaphragm when the housing sections are clamped together under the action of applying the rivets **32.**

The diaphragm **18** defines the diaphragm chamber **38** into a high pressure chamber **50** and a low pressure chamber **52.** Housing section **16** is shaped to define tubular portion **54** providing a bore **56** communicating

with the high pressure chamber **50**, through which the high pressure chamber **50** is placed in communication with the higher pressure source by applying a suitable flexible tube over the projecting end portion **58** of the tubular portion **54**. Tubular portion **54** is suitably threaded as at **60** for application thereto of suitable nut **62** for applying the device **10** to a suitable mounting board or the like.

The housing section **14** is formed with tubular portion **64** defining bore **66** that communicates with chamber **52**. The tubular portion **64** is either left open to the atmosphere or connected to a source of low pressure by applying a suitable flexible tubular member to the projecting end **68** thereof.

Received within the low pressure chamber **52** is diaphragm plate **20** (see FIGS. 7 and 8) that has special significance. Plate **20** generally comprises a disc **72** formed from electrically conducting material, such as copper, and formed to define a round margin **74**, and a tongue portion **76** that is defined from the mid portion of same, and which projects outwardly of same. The tongue **76** thus comprises a struck out section **78** of the disc **72** that comprises angled or diagonal portion **80**, and end portion **82** that is disposed generally parallel to the plane of the disc **72** that is formed with aperture **84** and an upstanding tab **86**. Struck out section **78** leaves opening **87** in plate **72**.

In accordance with this invention, the diaphragm plate **72** has operably associated therewith the adjusting screw **24** (see FIG. 3), which defines a head end **90** (see FIG. 3) formed with a stud **92** that is received in the tongue opening **84** for purposes of journaling the screw **24** of the diaphragm plate. The screw stud **92** is suitably pressed formed as at **94** to rotatably mount the stud **92** within the opening **84** for journaling purposes. Screw **24** also comprises shank **96** that is threaded as at **98** for cooperation with threading **100** of opening **102** formed in the housing section **14** for this purpose. The shank **96** of screw **24** is socketed as at **104** in a hex shape or the like to receive the shank of a suitable turning tool to move the screw **24** relative to the housing section **14** for adjustment purposes. Housing section **14** is bossed as at **106** so that the shank end of the screw **24** is recessed within the housing section **14**.

As indicated in FIG. 3, the diaphragm plate **20** is applied to chamber **52** so that the side **108** of the disc **72** bears against the side **110** of the diaphragm **18**, with the shank of the adjustment screw **24** being placed in threaded relation with the threading **100** of housing opening **102**. The housing section **14** is recessed as at **112** to receive the tab **86** of the diaphragm plate tongue **76** to key the diaphragm plate against rotational movement relative to the housing **12** (which movement would tend to change the adjustment of the screw **24**).

The housing section **14** on either side of the boss **106** has mounted in same the contacts **26** that are operably associated with the respective connectors **28** and **30**. The contacts **26** extend into the low pressure chamber **52** (see FIG. 5, which is illustrative of both contacts **26**, even though only one is shown) for contact by the diaphragm plate **20** at points on either side of the diaphragm plate tongue **76**. In the form shown, the contacts **26** are in the form of rivets **120** having their heads **122** disposed within the chamber **52** and their shanks **124** extending through housing openings **126** for application to the respective connectors **28** and **30**. The connectors **28** and **30** each comprise an angle shaped terminal member **130** having a base arm **132** apertured as at **134** to receive the respective rivet shanks **124**, and an upright arm **136** shaped and apertured as may be necessary or desirable for connection thereto of suitable leads. The members **130** are held in place by the rivet shanks **134** being riveted over against washers **138**.

The connector members **130** are seated within a low three sided centering wall **140** that holds the respective members **130** from rotation.

The housing sections **14** and **16** may be formed from a suitable plastic compound by employing suitable molding procedures. Examples are fiberglass filled polycarbonate, acetals, and acrylonitrile butadiene styrene.

The diaphragm **18** comprises a sheet of suitable wear resisting elastomeric material (such as polyurethane) given the generally quadrilateral shape that is shown in FIG. 6.

The housing section **14** at each of its rivet receiving openings **27** is formed with a short annular extension **141** (see FIG. 2A) that is received in counterbore **142** of the housing section **16**, which counterbores **142** are formed about the respective rivet receiving openings **29** of the housing section **16**. The diaphragm **18** has its corner openings **31** proportioned to closely receive the projections **141** to facilitate assembly of the device, whereby the diaphragm **18** is readily correctly aligned relative to both of the housing sections.

Assuming that the switch **10** is wired into the desired circuit, and the tubular portions **54** and **64** of the respective housings have been connected to the sources of gas under pressure as required, the range spring formed by diaphragm plate tongue **76** maintains the diaphragm plate **20** spaced from the contacts **26** until the pressure in the high pressure chamber **50** exceeds a predetermined desired amount, whereupon the pressure differential acting on the diaphragm **18** brings the diaphragm plate **20**, against the bias exerted by tongue **76**, into contact with the contacts **26** to close the circuit that is involved, through the switch **10**. Of course, switch **10** can be used to open the circuit as well as close it, by appropriate control of the gas pressures available to the respective chambers **50** and **52**.

In conformity with the miniaturizing approach that the invention takes, the housing recesses **34** and **36** are of restricted depth for minimizing the volume of the high and low pressure chambers of the device. The housing section **16** is formed with protuberances **160** at spaced points thereabout to hold the diaphragm **18** spaced from the floor surface **162** of recess **36** to insure that all of the area of the diaphragm on its side **111** that is disposed within the chamber **50** is exposed to the high pressure source.

The differential pressures sensed may be between two positive pressures, two negative pressures, a positive pressure and atmospheric pressure, and atmospheric pressure and a negative pressure, depending on the application. The pressure source connected to chamber **52** should be the lower pressure of the differential to be sensed. Also, the high pressure chamber **50** is adapted to accommodate liquids and thus may be connected to liquid pressure sources.

The invention as disclosed is particularly suited for use in connection with low current electronic circuitry such as might be found in connection with computer equipment or the like for control purposes. However,

the general arrangement involved may be readily adapted for other applications, and specifics such as the quadrilateral configuration of the housing sections **14** and **16** and diaphragm **18**, the use of rivets to hold the assembly together, and the operating pressure levels of the switch may be varied to suit conditions.

The foregoing description and the drawings are given merely to explain and illustrate the invention and the invention is not to be limited thereto, except insofar as the appended claims are so limited, since those skilled in the art who have the disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

We claim:

1. In a differential pressure switch of the type including a housing having a diaphragm therein defining with said housing fluid pressure chambers on either side of said diaphragm of restricted depth, with said housing defining bores in communication to separate sources of fluid pressure, and an electrically conductive diaphragm plate received in one of said chambers and seated on one side thereof against said diaphragm, with the housing portion that defines said one chamber being equipped with a pair of spaced apart electrical contacts mounted to project into said one chamber for engagement by said plate to close said contacts, the improvement wherein:

said diaphragm plate comprises a disc element defining a resiliently flexible tongue projecting laterally thereof and away from the diaphragm, and defining a projecting end portion,

and means cooperating between said tongue end portion and said housing to cause said tongue to act as a range spring while resiliently spacing said disc element from said contacts whereby said disc element closes said contacts under predetermined pressure differentials in said chambers.

2. The improvement set forth in claim **1** wherein said means cooperating between said tongue end portion and said housing comprises:

an adjustment screw threadedly mounted in said housing and being in operative engagement with said tongue end portion.

3. A differential pressure switch, said switch comprising:

a pair of matched housing sections secured together in face to face relation to form a housing,

a diaphragm interposed and clamped between said sections,

said sections each being recessed on either side of said diaphragm to define fluid pressure chambers on either side of said diaphragm of restricted depth,

said sections each defining a bore in communication with said chambers thereof that is adapted for communication to a source of fluid pressure,

a diaphragm plate received in one of said chambers and seated on one side thereof against said diaphragm,

said diaphragm plate comprising a disc element of electrically conductive material defining a tongue projecting laterally thereof and defining a projecting end portion,

with the housing section that defines said one chamber being equipped with a pair of spaced apart electrical contacts projecting into said one chamber for engagement by said disc element to close said contacts,

said contact equipped housing section having a range spring adjustment screw threadedly mounted in same that extends crosswise of said diaphragm plate and is journalled at one end of same in said tongue projecting end portion,

whereby said adjustment screw may adjust said tongue to act as a range spring for said diaphragm plate to set said plate against said diaphragm whereby said disc element closes said contacts under predetermined pressure differentials in said chambers.

4. The pressure switch set forth in claim **3** wherein:

said chambers are round in outline in the plane of said diaphragm,

said disc element being round in circumferential configuration,

said tongue includng a tab off set from the axial center of said disc and in keying relation to said housing.

5. The pressure switch set forth in claim **4** wherein:

said tongue tab is received in an indentation formed in said contact equipped section.

6. The pressure switch set forth in claim **3** wherein:

said contact equipped housing section chamber is the low pressure chamber of said switch and the chamber of the other housing section is the high pressure chamber of the switch,

said recess of said other housing section defining a generally planar end wall surface of said high pressure chamber that is spaced laterally of said diaphragm to make said high pressure chamber of shallow proportions transversely of said diaphragm,

said other housing section including spaced bosses on said recess wall thereof of restricted dimension laterally of said diaphragm to maintain said diaphragm spaced from said recess wall for application to pressures in said high pressure chamber to the full area of said diaphragm that is exposed to said high pressure chamber.

7. The pressure switch set forth in claim **3** wherein:

said housing is quadrilateral in configuration in the plane of said sections,

said sections each defining matching openings at the corners thereof,

with at least some of said openings of the respective housing sections including interengaging means,

and means for riveting said housing sections together thorugh said openings.

8. The pressure switch set forth in claim **3** wherein:

the other end of said screw is exposed exteriorly of said housing,

said screw other end being recessed within said housing and hex socketed for application thereto of a turning means.

9. The pressure switch set forth in claim **3** including:

a pair of electrical connectors applied to said contact equipped housing section and each including a planar end seated against said contact equipped housing section,

said contacts each comprising rivet means anchoring the respective connectors to said housing in electrical conducting relation thereto,

and means for keying said connectors relative to said housing against rotational movement with respect thereto.

10. A differential pressure switch of miniaturized proportions, said switch comprising:

a pair of matched housing sections of relatively small proportions secured together in face to face relation to form a housing,

a diaphragm interposed and clamped between said sections and substantially coextensive therewith,

said sections each being recessed on either side of said diaphragm to define fluid pressure chambers of circular shape and of restricted depth on either side of said diaphragm,

said sections each defining a bore in communication with said chambers thereof that is adapted for communication to a source of fluid pressure,

a round diaphragm plate received in one of said chambers and seated on one side thereof against said diaphragm,

said diaphragm plate comprising a disc element of electrically conductive material defining a tongue projecting laterally thereof and defining a projecting end portion,

with the housing section that defines said one chamber being equipped with a pair of spaced apart electrical contacts projecting into said one chamber for engagement by said disc element to close said contacts,

said contact equipped housing section having a range spring adjustment screw threadedly mounted in same that extends crosswise of said diaphragm plate and is journalled at one end of same in said tongue projecting end portion,

said tongue including a tab offset from the axial center of said disc and connected in keying relation to said housing,

said housing sections and said diaphragm defining matching openings about the margin of said housing,

with at least some of said openings of the respective housing sections including interengaging means including means for locating said diaphragm relative to said sections on assembly thereof,

whereby said adjustment screw may adjust said tongue to act as a range spring for said diaphragm plate to set said plate against said diaphragm whereby said disc element closes said contacts under predetermined pressure differentials in said chambers.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,862,387 Dated January 21, 1975

Inventor(s) James Phillips and Richard S. Zoludow

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 42, "to" should be -- of --.

Signed and Sealed this

seventh Day of October 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

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U.S. GOVERNMENT PRINTING OFFICE : 869-930

UNITED STATES PATENT OFFICE
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