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Byam

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[54] **SEQUENTIALLY ACTUATED PRESSURE SWITCHES HAVING SEPARATE RESISTOR ELEMENTS ASSOCIATED WITH EACH**

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[52] **U.S. Cl.** ..... **200/81.4,** 73/407 R, 200/83 J, 337/311, 338/42, 338/215

[51] **Int. Cl.** **H01h 35/34,** H01c 13/00, G01l 7/08

[58] **Field of Search** ..... 200/81.4, 81.5, 83 J, 200/83 V, 5 C, 83 R; 337/311, 309, 310; 73/407 R; 338/42, 48, 215, 307; 318/422

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Assistant Examiner—Robert A. Vanderhye
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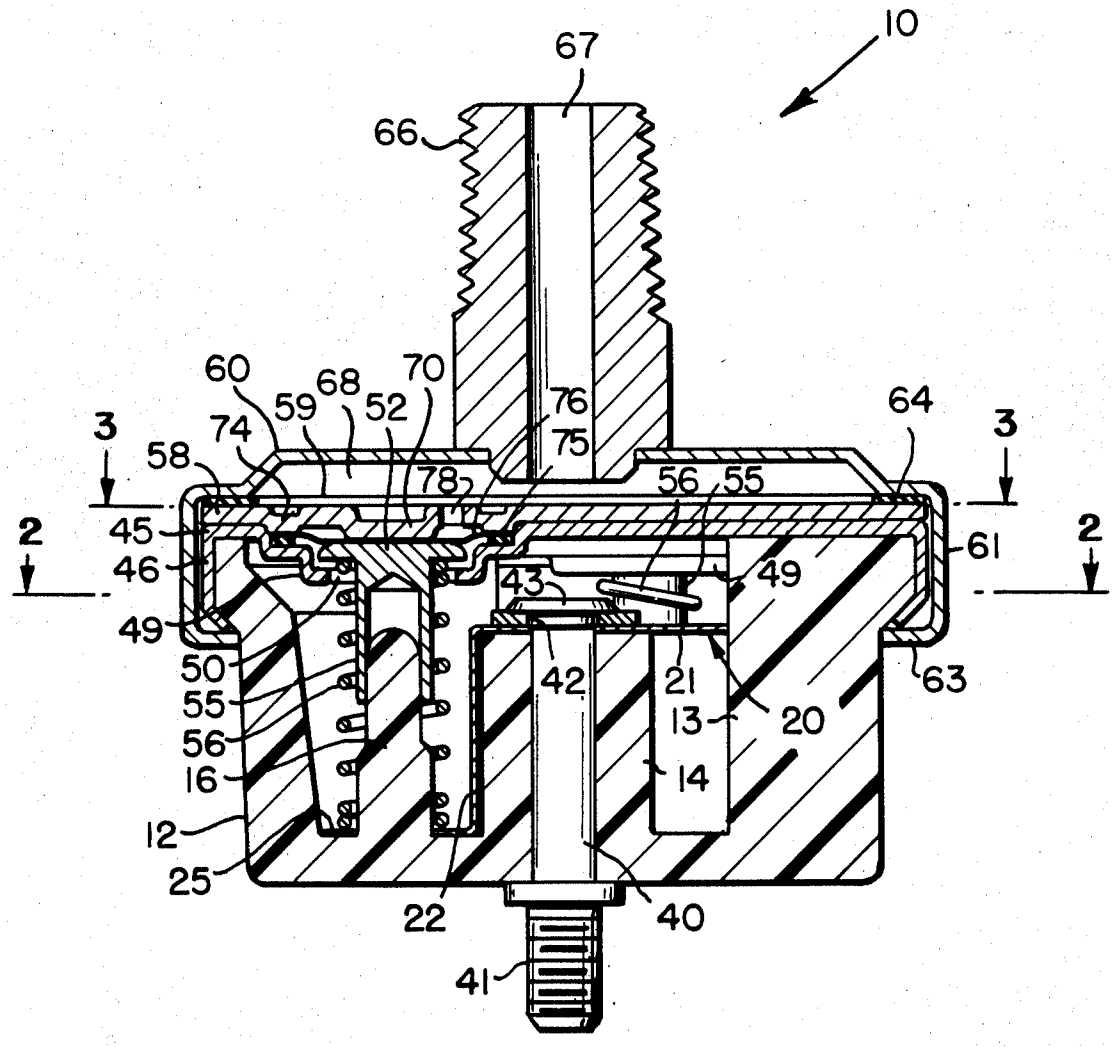
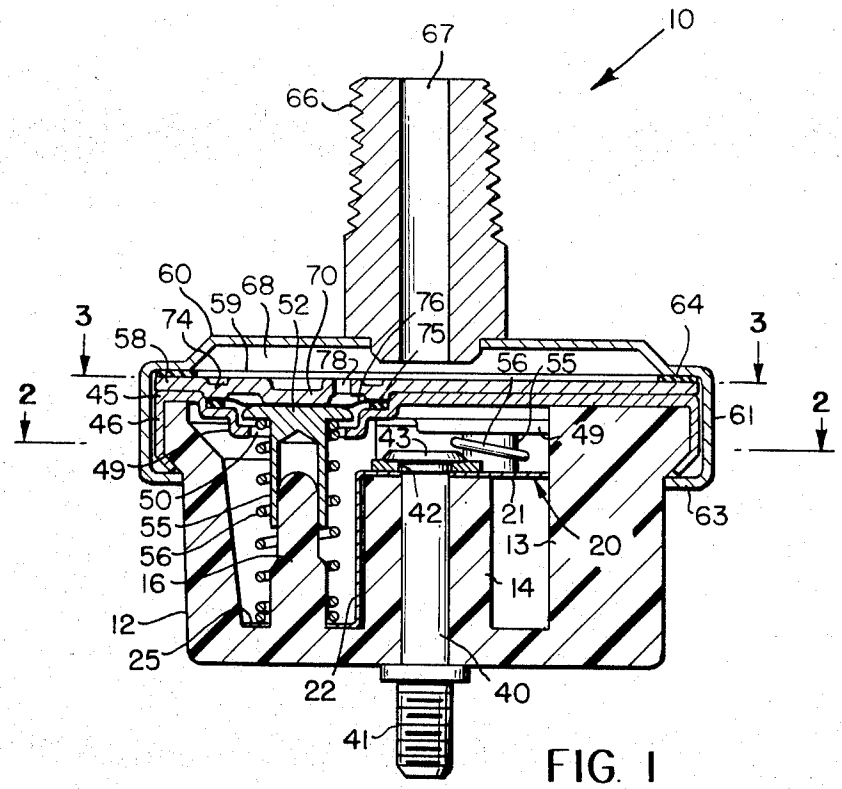
[57] **ABSTRACT**

Three different pressure-operated switches are mounted in a housing to be connected to a fluid pressure system for operation thereby at three different values of the system pressure -e.g. low, medium and high. Each switch comprises a movable contact; and these contacts are connected through three different resistors with a common terminal in the housing. These contacts are urged by separate springs against one of three separate flexible diaphragms. As the fluid pressure rises, one diaphragm after the other urges its associated contact against a grounded portion of the housing successively to connect the resistors in parallel circuit between the terminal and ground.

7 Claims, 4 Drawing Figures

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46
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43
49
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12
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FIG. 1

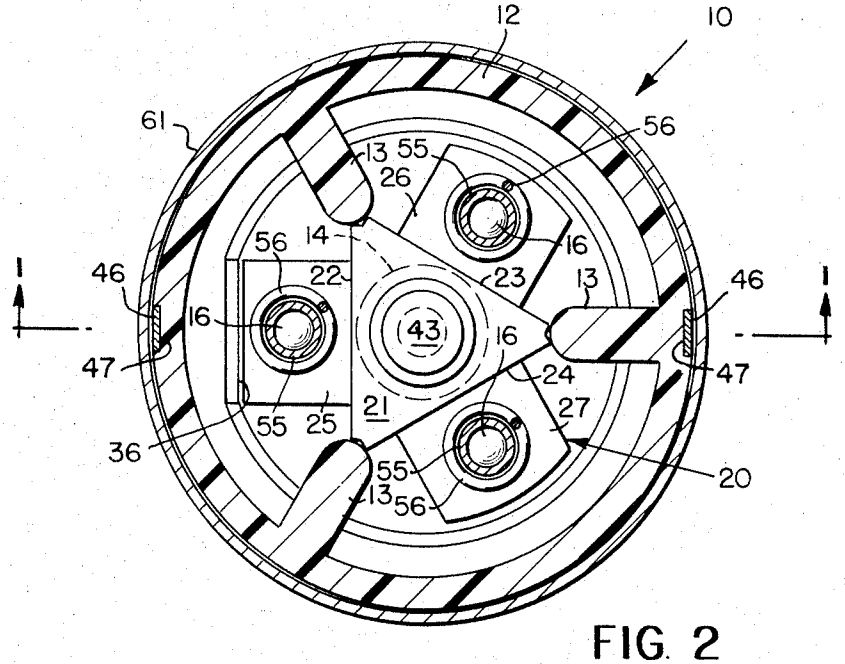
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FIG. 2

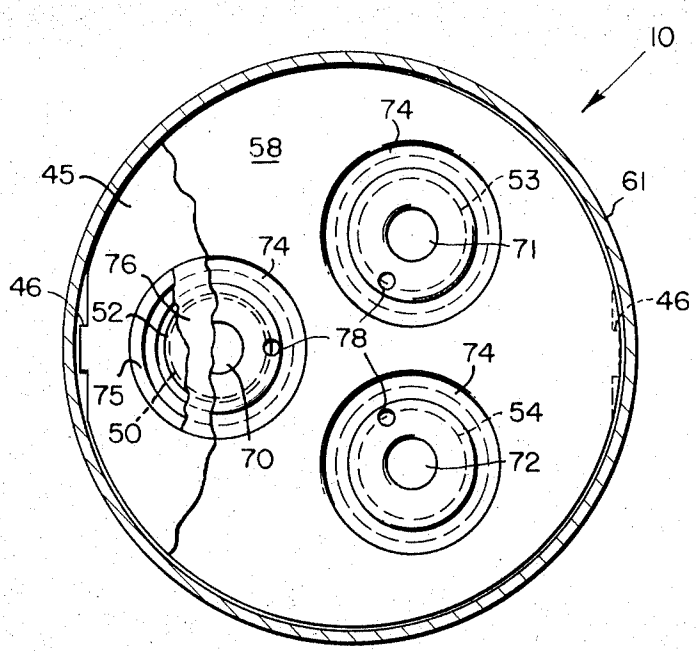
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FIG. 3

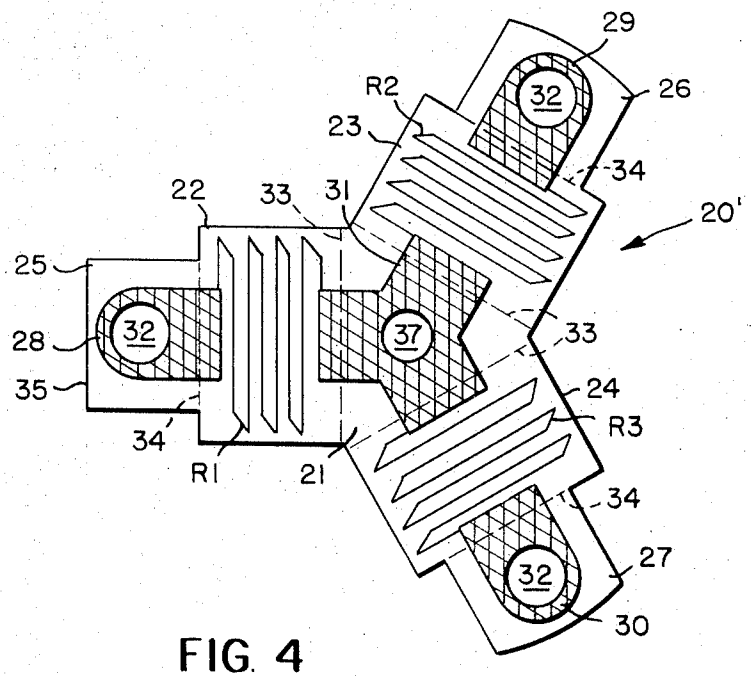
29
R2
32
26
23
34
22
33
31
20'
25
32
37
33
28
24
35
R3
34
R1
21
34
27
32
30

FIG. 4

SEQUENTIALLY ACTUATED PRESSURE SWITCHES HAVING SEPARATE RESISTOR ELEMENTS ASSOCIATED WITH EACH

This invention relates to pressure-operated electrical switches, and more particularly to hydraulically operated pressure-sender switches for monitoring the oil pressure in internal combustion engines.

The so-called oil pressure sender switch for automotive use is a device mounted in the oil supply system of an internal combustion engine to monitor the oil pressure in the engine and transmit this pressure as an electrical signal to a pressure gauge or so-called receiver. The electrical signals are normally produced by a change in resistance in a sender unit, which in turn varies the heating effect on a bimetallic element that operates the pointer of the gauge (receiver). Conventionally the sender includes a single flexible diaphragm which is exposed at one side to the hydraulic pressure developed in the oil supply system, and uses the motion of the diaphragm to operate a relatively intricate lever assembly, which in turn, moves the wiper arm of a variable non-linear resistor to alter the signal output. This structure is complicated, and tends to make known sender switches expensive and failure prone.

A principal object of this invention is to provide a more compact, simple and reliable pressure sender switch.

A further object of this invention is to provide an improved pressure sender switch that is designed to produce an electrical signal, in response to predetermined pressure changes in an oil pressure system.

Still another object of this invention is to provide an improved pressure sender switch which will have substantially less moving parts than prior such switches, thereby increasing its operating life and dependability.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims, particularly when read in conjunction with the accompanying drawings:

In the drawings:

FIG. 1 is a sectional view taken along the line 1—1 of FIG. 2 looking in the direction of the arrows, and illustrating an oil pressure sender switch made in accordance with one embodiment of this invention;

FIG. 2 is a sectional view of this switch taken along the line 2—2 in FIG. 1 looking in the direction of the arrows;

FIG. 3 is a sectional view taken along the line 3—3 in FIG. 1 looking in the direction of the arrows, and with portions of the switch broken away for purposes of illustration; and

FIG. 4 is a plan view of a printed resistor blank which is used to produce the parallel resistance circuits that are employed in this switch.

Referring now to the drawings by numerals of reference, 10 (FIGS. 1 to 3) denotes generally a sender switch comprising a plastic dielectric casing 12 having on its inner surface three, integral, axially extending ribs 13, which project radially inwardly toward the axis of housing 12 and are equi-angularly spaced thereabout. The inner ends of these ribs are disposed in radially-spaced relation to an integral, cylindrical center post 14, which extends axially into the housing from its closed end. Also projecting axially into housing 12 from its closed end are three, integral pins 16, which

are equiangularly spaced around post 14 alternating with the ribs 13.

Mounted on the post 14 is a printed circuit substrate 20 (FIGS. 1, 2 and 4). This substrate has a central, triangularly-shaped hub section 21, which is seated on post 14; three leg sections 22, 23 and 24, which extend axially (FIG. 1) along the outside of the center post 14; and three laterally projecting tabs 25, 26 and 27, which are seated in housing 12 between ribs 13. Substrate 20 is prepared from a printed circuit blank 20' (FIG. 4) by folding the blank along lines 33 and 34.

The legs 22, 23 and 24 of blank 20' have printed thereon resistors R1, R2 and R3, respectively. At their inner ends the resistors R1, R2 and R3 are connected to a common wire mesh terminal 31, which is formed on the blank 20' around a central opening 37 in hub section 21. At their outer ends resistors R1, R2 and R3 are connected to similar mesh-type contacts or terminals 28, 29 and 30, respectively, which are formed on the foot sections 25, 26 and 27, respectively, to surround openings 32 therein.

Before insertion into the switch 10, the legs 22, 23 and 24 of the blank 20' are bent at right angles to the web section 21 along the score lines 33; and the tabs 25, 26 and 27 are bent laterally outwardly, and at right angles to the leg sections along the score lines 34. The now-folded substrate 20 is inserted in casing 12 with the openings 32 in the tabs slid over the three pins 16. To assure proper orientation of the substrate in casing 12, the outer edge 35 of the tab 25 is flatted off to register with a corresponding flat 36 (FIG. 2), formed on the inside of the casing.

After it has been inserted into the casing 12, the substrate 20 is fastened to post 14 by a terminal 40 (FIG. 1) that is secured in an axial bore in the post. Terminal 40 is threaded at one end 41 exteriorly of the casing 12, and at its inner end projects through the substrate opening 37 and a metal washer 42, which overlies the web section 21 of the substrate. The inner end of terminal 40 is riveted or peened over to provide thereon an enlarged head 43, which overlies the washer 42 so that the common mesh terminal 31 for the resistors R1, R2 and R3 is electrically connected with the terminal.

Secured over the open end of casing 12 (FIG. 1) is a contact plate 45, which has at diametrally opposite sides thereof integral tangs 46 that are crimped into notches 47 in the casing 12 to secure the plate thereon. Plate 45 has three equi-angularly spaced depressions 49 (FIG. 1), therein, each of which has a central opening 50 that registers with one of the pins 16.

Mounted on the pins 16 to reciprocate thereon and in the three recesses 49 are three metal contacts 52, 53, and 54, each of which has a head whose diameter is slightly larger than the diameter of the opening 50 in the registering recess 49. The stems 55 of the contacts 52, 53 and 54 and the lower ends of the guide pins 16 are surrounded by coiled compression springs 56. Each spring is seated at one end on one of the resistor contacts 28, 29 or 30, and presses at its other end against the inner side of the associated contact 52, 53 or 54 normally to maintain this contact spaced from plate 45.

Mounted against plate 45 is a support plate 58 (FIGS. 1 and 3). Mounted on casing 12 against a gasket 59 is generally cup-shaped housing 60. Housing 60 has an annular wall portion 61, which surrounds the open end of casing 12, and a flange or lip 63 bent inwardly to fas-

ten it on the casing. Housing **60** has an internal, circumferential shoulder **64**, which engages the gasket **59**. A threaded base or nipple **66** is brazed or otherwise sealingly secured at one end thereof in a central opening in the housing. Oil under pressure is admitted to the housing through the bore **67** in the base or fitting **66**.

As shown more clearly in FIGS. **1** and **3**, plate **58** has therein three, equi-angularly-spaced dimples **70, 71** and **72**, and three annular bosses **74**, each of which surrounds one of the dimples **70, 71** and **72**. Each of three flexible diaphragms **76** is secured around its marginal edge between each boss **74** and an annular gasket **75**, which is seated in each plate recess **49**. In the radial space between each dimple **70, 71, 72** and its surrounding boss **74** the plate **58** has therethrough a port **78**, which connects the space **68** in housing **60** with one side of the associated diaphragm **76**.

In use the externally threaded fitting **66** is mounted for example, in the crank of an internal combustion engine, so that the oil in the crank case will transmit its pressure through the bore **67** in fitting **66**, space **68**, and the ports **78** in the plate **58** to all these diaphragms **76**. Also, the terminal **41** is connected to a conventional, electrically operated pressure gauge. The housing **60** is, of course, grounded through the crank case.

The diaphragms **76** are made of dielectric material, so that under normal circumstances, when the springs **56** hold the contacts **52, 53** and **54** against the diaphragms, the contacts will not be connected electrically to either of the plates **45** or **58**, and consequently will be disposed in their open positions. Whenever the oil pressure exerted through the ports **78**, however, causes one of the diaphragms **76** to urge the associated contact **52, 53** or **54** far enough to cause the marginal edge thereof to engage the plate **45** around one of its openings **50**, then this contact will be closed, and will connect its associated resistance **R1, R2** or **R3** in circuit with the terminal **40**.

For example, assuming that the oil pressure exerted through the bore **67** and ports **78** is sufficient to cause the diaphragm **76** to move contact **52** into its closed position, a circuit will be completed from the terminal **40**, through washer **42**, the common terminal **31** of the printed circuit on substrate **20**, resistance **R1**, the terminal **28** thereof on the tab **25**, spring **56** (FIG. **1**), and the now-closed contact **52** to plate **45** which is grounded on housing **60**. Similarly, whenever one of the other contacts **53** or **54** is closed, its associated resistance R2 or R3, respectively, will be connected between terminal **40** and ground. The three circuits are in parallel with one another.

To register, for example, no oil pressure, undesirably low oil pressure, normal oil pressure, and excessively high oil pressure in the system that is being monitored, the several resistances **R1, R2** and **R3** are selected to have, for example, a resistance of 58 ohms, 44 ohms, and 17 ohms, respectively. The three springs **56** are selected to hold the associated contacts **52, 53, 54** in their open positions against an oil pressure of, for example, 2 pounds per square inch, 30 lbs. per square inch and 80 pounds per square inch respectively.

When the engine is not running, the oil pressure is at zero, and all three switches are open, and the oil pressure gauge (not shown), which is activated by the sender, will register zero. After the engine is started, when the oil pressure reaches approximately 6 pounds per square inch, the first contact **52** will close to connect the 58 ohms resistance **R1** in the circuit between the grounded plate **45** and the terminal **40**, thereby causing the gauge to register low oil pressure. At this time the contacts **54** and **53** remain open.

When the engine oil pressure increases to approximately 30 pounds per square inch, the contact **53** will be urged by its associated diaphragm **76** to closed position, thereby connecting the 44 ohm resistance **R2** in parallel with the resistance **R1**, thus changing the total sender resistance to approximately 25 ohms, which causes the gauge to register normal oil pressure.

Whenever the engine oil pressure reaches approximately eighty pounds per square inch, the third contact **54** will be closed by its diaphragm **76**, thus introducing the seventeen ohm resistance R3 in parallel with the resistances **R1** and **R2**, thereby reducing the overall switch resistance to about ten ohms, so that the associated gauge will indicate high pressure.

Conversely, it will be apparent that when the oil pressure in the system decreases, the contacts **54, 53** and **52** will be returned successively stepwise to their open positions by their associated springs **56**.

With a pressure sender switch such as disclosed the dial of the gauge does not have to be graduated; it needs only to indicate "Low", "Normal", and "High". The gauge will, of course, be connected in any suitable manner in electric circuit with the terminal **40**.

From the foregoing it will be apparent that the instant invention provides an oil pressure sender switch which has three independent pressure sender switches, all built within a common housing and connected to a common fitting. Each switch contact **52, 53** and **54** is operated separately by its associated diaphragm **76** and spring **56** selectively to introduce one of three known resistances into the associated gauge circuit, thus enabling the gauge to register the four critical points of the system pressure — i.e., zero, low, normal and high, thereby accurately indicating the four critical points of the engine oil pressure while disregarding all other nonfunctional pressure values. Moreover, by employing the printed circuit on substrate **20**, the actual moving parts in the electrical portion of the circuit are held to an absolute minimum. This produces a substantially more rugged, inexpensive, and dependable sender switch than was heretofore available, since the resistor values transmitted to the gauge are known fixed values and the diaphragm assemblies are the only moving parts required within the switch.

While selected critical pressure ranges and resistance values for the resistors **R1, R2** and **R3** have been suggested herein, it will be apparent to one skilled in the art that these parameters may be varied as desired to suit different operations, and this application is intended to cover any such modifications or variations of the invention which fall within the disclosure or the scope of the appended claims.

I claim:

1. A pressure switch unit, comprising

a housing having a chamber therein,

a plurality of pressure responsive switches mounted in said chamber for movement between open and closed positions,

means connecting said chamber to a supply of pressure fluid thereby to apply the pressure of said fluid to all said switches simultaneously to urge said switches to closed positions,

separate resilient means connected to each switch normally to hold the respective switches open,

said resilient means for the individual switches being operative to require, respectively, different amounts of pressure to close the separate switches, against the resistances of the resilient means associated with the respective switches,

an electrical terminal fastened to said housing to connect to an electrically-operated pressure gauge, and

a separate resistor connecting each of the separate switches, respectively, with said terminal, the separate resistors having, respectively, different resistances.

2. A pressure switch unit as defined in claim **1**, including

a printed circuit substrate in said housing,

each of said resistors being printed on said substrate with one end thereof operatively connected directly to said terminal, and with the opposite end thereof connected to one of said switches.

3. A pressure switch unit as defined in claim **1**, wherein

said switches comprise a plurality of movable contacts electrically connected by said resilient means to different of said resistors, respectively, and

said means for applying said pressure fluid to said switches comprises a plurality of flexible diaphragms mounted in said housing and responsive to predetermined variations in fluid pressure to urge said different switches, respectively, to closed positions, thereby to introduce said resistors separately into circuit with the gauge.

4. A pressure switch unit for monitoring the fluid of a system comprising

a housing having thereon a terminal,

a plurality of normally-open switches mounted in said housing and angularly spaced from one another around said terminal,

a plurality of resistors in said housing and each connected at one end to said terminal, and connected at their opposite ends through said switches to another terminal, whereby said resistors may be connected selectively between said terminals by the selective closing of said switches,

means for connecting said housing to a supply of fluid under pressure, and

pressure responsive means interposed between said connecting means and said switches, and operative, when the pressure of said fluid increases from a predetermined low range to a predetermined high range, successively to close said switches and connect said resistors between said terminals.

5. A pressure switch unit as defined in claim **4**, wherein

said pressure responsive means comprises a plurality of flexible diaphragms secured in said housing with one side thereof in communication with said connecting means,

each of said switches comprises a metal contact mounted to reciprocate in said housing at the opposite side of one of said diaphragms,

a plurality of electrically conductive springs are interposed between said contacts and said opposite ends of said resistors electrically to connect each contact to one of said resistors, and normally to hold said contacts in open positions against said diaphragms, and

said diaphragms are operative for different values of pressure of said fluid to urge said contacts to closed positions against said other terminal electrically to connect the respective associated resistors in said circuit through one of said springs.

6. A pressure switch unit as defined in claim **4**, including

a printed circuit substrate secured in said housing to said terminal and having said resistors printed thereon,

each of said resistors having a different ohmic value, and

means operative to resist movement of said switches to their closed positions until said pressure has reached predetermined values which differ for each switch.

7. A pressure sender switch unit, comprising

a housing having an electrical terminal secured thereto,

a printed circuit substrate in said housing having a plurality of separate resistances of respectively different values printed thereon, each of said resistances being electrically connected at one end to said terminal,

a plurality of separate switches mounted in said housing, equal in number to said resistances,

different spring means electrically connecting the opposite ends of said resistances to separate ones of said switches, and acting on one side of each switch normally to hold the associated switch open,

the different spring means yielding, respectively, to different pressures to permit the separate switches to close,

a flexible diaphragm associated with each switch at the opposite side thereof from the associated spring means, and

means for admitting fluid under pressure into said housing against the separate diaphragms simultaneously, whereby the different switches are closed successively at the different pressures required to overcome their respective associated spring means,

each switch, when closed, contacting an electrically conductive portion of said housing to close a circuit from the associated resistance to ground.

* * * * *