Oct. 16, 1956 A. W. GAUBATZ 2,767,275

DIFFERENTIAL PRESSURE SWITCH

Filed Sept. 5, 1951

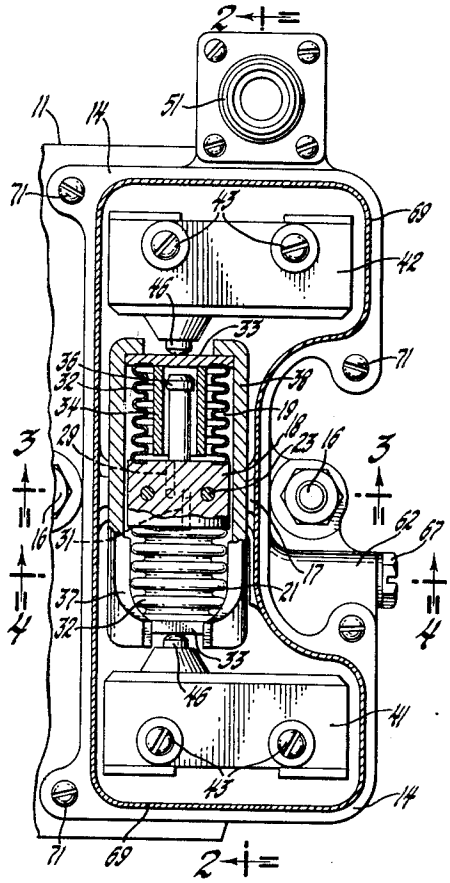


Fig. 1

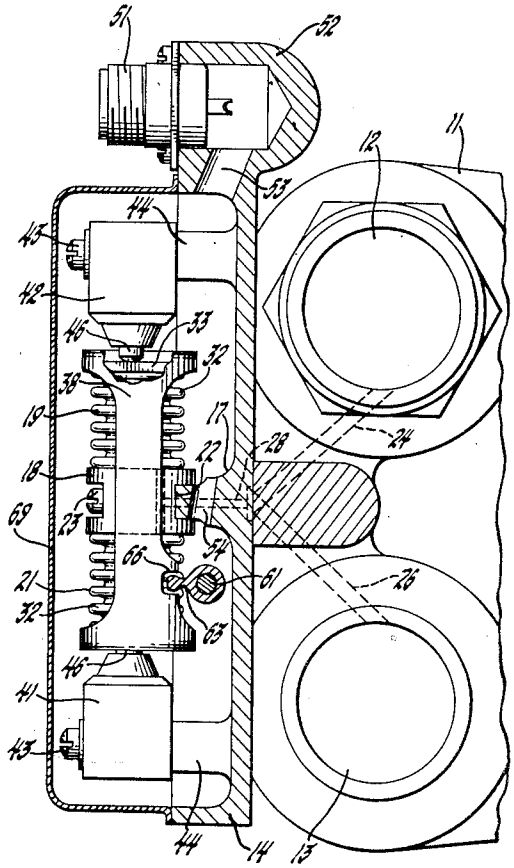


Fig. 2

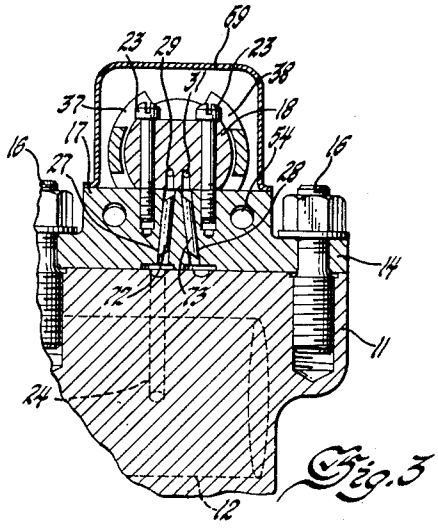


Fig. 3

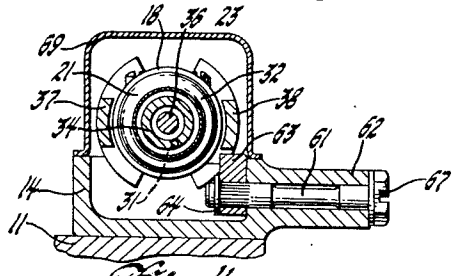


Fig. 4

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United States Patent Office 2,767,275 Patented Oct. 16, 1956

2,767,275

DIFFERENTIAL PRESSURE SWITCH

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Application September 5, 1951, Serial No. 245,162

2 Claims. (Cl. 200—81.4)

My invention relates principally to pressure actuated devices and, more particularly, to a switch or other device actuated by the differential between two pressures. A feature of the switch lies in the provision of means for actuating the switch manually to test the operation of the electrical portion thereof. A further feature of the invention lies in means for damping the operation of the device and for preventing response to transient pressure surges. While the invention may be employed in various connections, in its presently preferred embodiment the invention is incorporated in an aircraft engine fuel system to provide means by which a change in the relation of two pressures, which indicates a condition in the fuel system, may be signaled to an engineer or pilot of the aircraft in which the engine is installed.

The principal objects of the invention are to provide an improved device for signaling pressure conditions, to provide an improved differential pressure responsive switch, and to provide means for checking the operation of an electric switch.

The nature of the invention and the manner in which the stated objects, as well as other more or less ancillary objects are realized, will be apparent to those skilled in the art from the succeeding detailed description of the preferred embodiment of the invention and the accompanying drawings, in which Figure 1 is a longitudinal sectional view of a differential pressure switch in accordance with the invention, Figure 2 is a longitudinal section, and Figures 3 and 4 are transverse sections, the planes of Figures 2 to 4 being indicated in Figure 1.

Since the invention may be employed with various fluid pressure systems, and the details of the fluid system are immaterial to the invention or to the understanding thereof, the fluid system will not be described in detail. Referring to Figure 2, the fluid system may include, for example, a pump body, filter casing, fuel regulator or the like comprising a casing **11** in which are two fluid chambers **12** and **13**. The switch of the invention responds to the difference in pressures between the chambers **12** and **13**. The switch assembly comprises a base **14** which may be secured to the casing **11** by studs **16**. A rectangular post **17** extending from the base **14** mounts a support **18** on which are fixed two expansible bellows assemblies **19** and **21**. As will be apparent, the support **18** is generally drum-shaped but is slotted on opposite sides thereof. The slot **22** in the support receives the end of the post or web **17**. Machine screws **23** extending through the block **18** are received in tapped holes in the base portion **17**.

Passages **24** and **26** in the casing **11** extend from the chambers **12** and **13** respectively to the surface on which the base **14** is mounted where they connect with drilled passages **27** and **28** through the base. These passages communicate with drilled passages **29** and **31** in the block **18** which extend to the opposite faces thereof.

The bellows assemblies **19** and **21** may be identical, each comprising a corrugated metal bellows **32**, one end of which is brazed or otherwise fixed in a fluid-tight manner to the block **18** and the free end of which is

sealed to a metal disk or head **33**. The bellows is guided by an internal sleeve **34** fixed to the head **33** which slides on a pin **36** extending from the block **18**. The heads **33** are joined by a yoke comprising two strips **37** and **38**, the ends of which are bent over the face of the disk **33** and brazed or soldered thereto.

As will be apparent, a fluid pressure introduced into either of the bellows through the passages described will tend to extend the bellows. Since the two are yoked together and are of the same dimensions, the movement of the yoke **37**, **38** will be proportional to the difference between the two pressures, the restraining force being developed by the inherent elasticity of the bellows.

Two snap switches **41** and **42** of known commercial type are mounted in the usual manner by screws **43** extending through the bodies of the switches on posts **44** extending outwardly from the base **14**. The switches are of the type which are actuated in response to a small extent of reciprocation of an actuating plunger **46** extending from the body of the switch. The plungers **46** are in contact with or adjacent the heads **33** so that upon movement of the bellows indicating the pressure differential for which the apparatus is set one or the other of the switches **41** and **42** is actuated. Thus, for example, if the pressure in the chamber **12** is normally greater than that in the chamber **13**, the bellows is normally moved upward as viewed in Figure 1 to depress the plunger **46**. If the pressure differential decreases or reverses, the switch plunger of the switch **42** may return and that of the switch **41** may be actuated. Obviously, the switches may be single or double throw, normally open or normally closed, and one only switch may be employed if desired. The switches **41** and **42** are connected by wiring (not shown) to a standard cable connector **51** mounted on an extension **52** of the body from which the wires may be led through an opening **53** in the end of the body and holes **54** in the web **17**.

Since the pressure switch may be provided only for the purpose of indicating malfunctioning of the fluid system, the switches may not be caused to operate over a long period of time. It is highly desirable, therefore, to provide some means for determining whether the switches and the circuits actuated thereby are operative. To this end, a mechanism, which may be termed a check key, is provided by which the bellows assemblies may be moved manually to check the operation of the electric system. This key comprises a shaft **61** (Fig. 4) which is journaled in a portion **62** of the base **14**. An arm **63** is splined to the inner end of the shaft and is retained by snap ring **64**. The end of the arm **63** is disposed in a slot **66** in the yoke **38**, preferably with sufficient clearance to permit normal movement of the yoke without striking the arm **63**. The outer end of the shaft **61** is provided with a head **67** which may be adapted for engagement by a wrench or screw driver so that the shaft may be oscillated to force the bellows assembly through its range of travel and actuate the switches.

Another valuable feature of the device is the provision for hydraulic damping of the movement of the bellows assemblies to prevent undesirable response to short-period transient pressure fluctuations and stabilize the action of the pressure-responsive device and switches. The sleeves **34** are brazed or otherwise fixed in a fluid-tight manner to the heads **33**, and the heads of the pins **36** fit in the sleeve with a small clearance to define an annular orifice between the sleeve and pin.

For the bellows assembly to move in either direction, fluid must be forced from within the sleeve **34** past the head of the pin **36**. The clearance may be fixed to provide a suitable degree of damping for the particular requirements. This hydraulic frictional damping strongly resists vibration or oscillation of the bellows assembly and

delays the response to pressure differential slightly to prevent response to transient pressure or shock wave conditions.

Because of the annular form of the orifice and the relative movement of the sleeve and pin, the orifice is not subject to clogging.

Further damping, and protection of the bellows assemblies against pressure surges, is provided by restrictions in the pressure line leading from the chambers **12** and **13** to the bellows. In the preferred form, this is accomplished by pins **72** and **73** in the passages **27** and **28**. These pins are of such diameter as to slide freely in the passages and provide a restricted orifice for fluid flow between the outer surface of each pin and the wall of the passage. Because of the annular form of the orifice and the reciprocation of the pins in the passages with changes in pressure, these orifices are self-cleaning.

The ends of the pins **72** and **73** are cut off at an acute angle to the axis of the pins so that the pins cannot seat at the end of the passages and block fluid flow. The pins cannot enter the passages **29** and **31** because of the small diameter of these passages, and may be prevented from dropping out of the lower end of passages **27** and **28** by peening the ends of these passages to create a shoulder.

The pins **72** and **73** are slightly shorter than the passages **27** and **28** so that limited reciprocation is possible to dislodge foreign matter which might collect in the passages.

The mechanism may be enclosed by a sheet metal cover **69** retained by machine screws **71** threaded into the base **14**.

It will be apparent that the bellows **19** and **21** may be of different diameters so that the response to the two pressures is unequal. The term "differential" is used to refer to a differential between functions of pressure such as will be arrived at in case the bellows are of different area. It will also be apparent that the location of the switches may be such that the neutral position of the bellows is that due to a value of pressure differential other than zero.

The detailed description of the preferred embodiment of the invention for purposes of disclosing the principles thereof is not to be considered as limiting the invention, since many modifications thereof may be made within the scope of the invention by the exercise of skill in the art.

I claim:

1. A differential pressure responsive device comprising in combination, a support, two extensible bellows mounted on opposite faces of the support, a yoke coupling the free ends of the bellows for joint movement, the support defining a fluid pressure connection leading to each bellows, and a switch adjacent the free end of one bellows, so constructed and arranged that the switch responds to a differential of pressure in the two bellows, and manually operable means for reciprocating the yoke to actuate the switch independently of pressure to check the operation of said switch comprising a manually rotatable shaft, an arm thereon, and a lost motion connection between the arm and the yoke.

2. A differential pressure responsive device comprising in combination, a support, two extensible bellows mounted on opposite faces of the support, a yoke coupling the free ends of the bellows for joint movement, the support defining a fluid pressure connection leading to each bellows, and an operable device adjacent the free end of one bellows, so constructed and arranged that the operable device responds to a differential of pressure in the two bellows, and manually operable means for reciprocating the yoke to actuate the operable device independently of pressure to check the operation of said operable device comprising a manually rotatable shaft, an arm thereon, and a lost motion connection between the arm and the yoke.

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