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FLUID PRESSURE OPERATED SWITCH

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FIG. 1

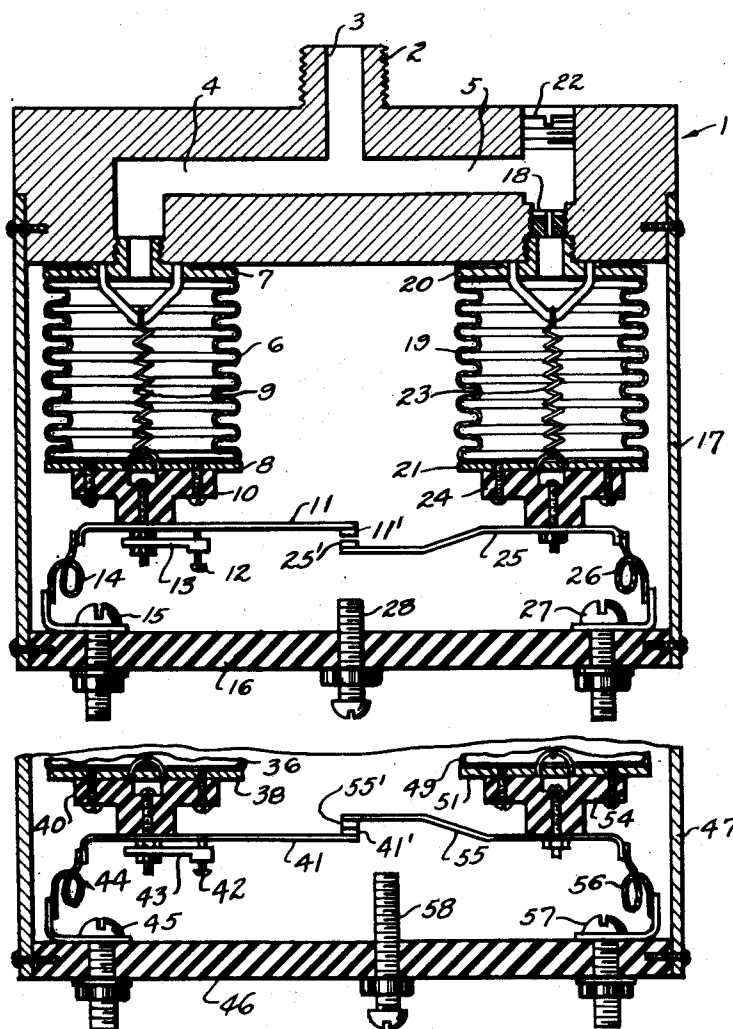


FIG. 2

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FLUID PRESSURE OPERATED SWITCH

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4 Claims. (Cl. 200-81.5)

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

This invention relates to a fluid pressure operated switch that will operate at a lower pressure when the pressure is increasing than when the pressure is decreasing.

The primary object of the invention is to provide an electric switch including two movable contacts each actuated by separate fluid pressure responsive means connected by pressure conduits to a common pressure source and wherein means is provided to retard the action of one fluid pressure responsive means in order to cause switching action in one direction at a low pressure when the pressure is increasing and to cause switching action in the opposite direction at a higher pressure when the pressure is decreasing.

Another object of the invention is to provide an electric switch including two movable contacts each actuated by separate bellows elements connected by conduits to a common pressure source and wherein the pressure conduit leading to one bellows element is provided with a throttling orifice to retard the rate of response of the one bellows as compared with the rate of response of the other bellows in order to cause switching action in one direction at a low pressure when the pressure is increasing and to cause switching action in the opposite direction at a higher pressure when the pressure is decreasing.

A further object of the invention is to generally improve the switching action of fluid pressure operated switches and to provide a switch that will operate at a lower pressure when the pressure is increasing than when the pressure is decreasing.

The above and other objects of the invention will become apparent upon reading the following detailed description in conjunction with the accompanying drawing, in which:

Fig. 1 is a longitudinal cross section taken through the fluid pressure operated switch and showing a switch which will close a circuit as the pressure increases and open the circuit as the pressure decreases.

Fig. 2 is a fragmentary longitudinal cross section taken through the fluid pressure operated switch and showing a switch which will open a circuit as the pressure increases and close the circuit as the pressure decreases.

In certain control circuits it is sometimes advantageous to have a fluid pressure operated switch responsive to a low increasing pressure

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to operate in one direction and also responsive to a high decreasing pressure to operate in the other direction. It is also desirable that after operation in either direction the switch remain in the same relative position until a reversal of pressure conditions arise.

One possible and unique use for a fluid pressure operated switch of the kind described herein is in a fuel control system for a turbojet engine, wherein there is a main fuel system and an emergency or standby fuel system. With the main fuel line connected at one point to the fluid pressure operated switch, the increasing fuel pressure during normal acceleration of the engine will operate and maintain the switch in such a relative position as to hold the emergency fuel system in an "off" or inactive state. However after normal fuel pressure is attained any sudden drop in fuel pressure will operate the switch in such a direction as to bring the emergency fuel system into action and also maintain the emergency system in operation until the normal fuel pressure is again built up and maintained.

The preferred embodiment of the switch device is shown in Fig. 1 wherein the essential parts of the device are mounted on a base or support 1 having a screw threaded projection 2 forming a fluid pressure inlet passage 3 which subdivides at opposite sides to form pressure lead-in branches 4 and 5. Secured on the base 1 in the branch 4 is a pressure-sensitive bellows 6 having opposite end plates 7 and 8 and enclosing a tension spring 9 attached to the end plates at its opposite ends. The spring acts to overcome the stiffness of the metal bellows and thus cause it to contract when the fluid pressure therewithin diminishes. As will be obvious any increase in fluid pressure in the bellows will cause endwise expansion thereof. Relative movement of the end plate 8 will also cause movement of the insulating block 10 and a metal spring arm 11 attached to the insulating block. Precise adjustment of the arm 11 may be accomplished by a set-screw 12 threading through an arm 13 secured centrally of the insulating block 10. A flexible lead 14 connects the switch arm 11 to a terminal screw 15 in the insulating cover member 16. The latter member is secured by screws within the outer end of a casing 17 which is in turn secured to the base or support member 1.

The other lead-in branch 5 has mounted therein a small screw threaded orifice plug 18 and a second pressure-sensitive bellows 19 including end plates 20 and 21. A screw threaded access plug 22 in the base 1 allows for cleaning or re-

placing the orifice plug 18. A tension spring 23 in the bellows is attached at opposite ends to the end plates 20 and 21 as in the first mentioned bellows 8. Attached to the end plate 21 is an insulating block 24 and secured to the block is a metal spring arm 25. The free ends of the spring arms 11 and 25 carry contact points 11' and 25' which in the minimum pressure condition illustrated are slightly spaced apart. A flexible lead 26 connects the arm 25 with a second switch terminal 27. Longitudinally lined up with respect to the contact points 11' and 25' is an abutment screw 28 which is adjustable in the cover member 16 and will cause the switch contacts to close and remain closed at a relatively high and stable fluid pressure condition and at all pressures over and above such stable fluid pressure.

To explain the operation of the switch in its preferred form, it may be assumed that the fitting 2 is connected to the main fuel line leading to an engine from a main fuel pump. Now as the engine is accelerated and the fuel pressure gradually increases, this line pressure affects the bellows 6 without any appreciable time lag and causes the switch arm 11 to move toward the cover member 16. The switch is now closed and closing of the circuit therethrough is adapted to actuate a suitable relay for holding the emergency fuel system in an inactive state. Even though the fuel pressure is transmitted also into the bellows 13, the response thereof is delayed because of the throttling effect of orifice plug 18. Thus the expansion of the bellows 19 takes place at the same time that the bellows 6 is expanding but at a slower rate of change. As the fuel pressure continues to build up to the desired maximum the switch stays closed due to the lag in movement of switch arm 25 but finally the arm 25 contacts the abutment screw 28 and remains relatively stationary. Upon reaching a pressure level at or below the maximum, the arm 11 moves out to such a position as to be bent slightly and thus maintains firm contact of the points 11' and 25'. This continued outward movement of the bellows 6 after the arm 25 has engaged abutment screw 28 may be termed the overtravel of the switch arm 11. Of course the bellows 19 will eventually become extended to the same extent as the bellows 6 under stable maximum fuel pressure conditions but here too the arm 25 may flex slightly as the contact 25' stops and the bellows 19 continues to expand. Now in case the main fuel pump fails or other failure occurs whereby the fuel pressure drops suddenly from the desired maximum operating pressure, the bellows 6 responds immediately by contracting under the influence of spring 9. After any slight overtravel has been canceled, the contact 11' recedes away from contact 25' to thus break the circuit and denegate the relay which was holding the emergency fuel system out of operation. The emergency fuel system now begins operation to rebuild the fuel pressure to the engine. Once the emergency system is in operation it cannot be over-ruled by the pressure responsive switch since its circuit completing relay becomes locked in by a suitable mechanical or electrical interlock.

An alternative form of the invention is shown in Fig. 2 in a fragmentary form. Here the static low pressure condition acts to maintain the switch closed instead of open, as in Fig. 1. The structural arrangement of the parts is the same as in the first or preferred form of the invention, except that the switch arms are arranged in a re-

lation opposite to that of Fig. 1 and the contact points carried thereon are in engagement in the zero pressure condition. The left-hand bellows 35 includes an end plate 38 having an insulating block 40 mounted thereon. The switch arm 41 of springy strip metal is secured to the center of insulating block 40 and may be adjusted precisely by means of a set-screw 42 threaded through an arm 43 also fixed to the block 40. A flexible lead 44 connects the switch arm 41 to the terminal 45 on the insulating cover member 46. A portion of the switch casing is designated at 47.

The right-hand bellows 49 includes an end plate 51 having the insulating block 54 mounted thereon and the latter carries a second spring arm 55. The adjacent ends of the metallic switch arms 41 and 55 carry contact points 41' and 55' which are in engagement when there is no fluid pressure on the pressure responsive bellows 36 and 49. A flexible lead 56 extends from the switch arm 55 to the switch terminal screw 57. An abutment screw 58 is adjustably mounted in the cover member 46 in a position where it will contact the switch arm 55 as the pair of bellows expands to an extent just below the maximum expansion. Thereby the open circuit condition in effect during expansion of the bellows 36 and 49 will be maintained at stable maximum pressure because of the overtravel of contact 41'. As in the first described form of the invention the left-hand bellows 36 will respond immediately to pressure change, whereas the right-hand bellows 49 will respond slowly because of the throttling effect of the orifice leading into the right-hand or slow-acting bellows. Thus as the pressure in the line or container under consideration increases from a minimum the switch arm 41 will move quickly to break the circuit through the switch and as long as the pressure continues to increase up to a maximum the other switch arm 55 will lag behind the switch arm 41. Just before the maximum pressure is reached the arm 55 will contact the abutment screw 58 and therefore even after a stable maximum pressure is reached the switch will remain open due to the overtravel of the switch arm 41 and contact point 41'. If the pressure falls off due to failure of the pressure producing means, the bellows 36 and 49 will start to collapse but the action of the left-hand bellows 36 will be much more rapid than that of the bellows 49. Thus the switch will close very soon after the pressure starts to fall and will stay closed as the pressure continues to fall. Such a switch may be used to directly close a circuit to an electrically driven standby pump, thus acting to restore at least part of the original pressure. Of course it is obvious too that such a switch may operate a relay circuit which may in turn close a circuit to an emergency or standby pumping system.

From the above description taken in conjunction with the drawing it will be clear that I have provided a fluid pressure operated switch operable in one direction at a low pressure when the pressure is increasing and operable in the opposite direction at a high pressure when the pressure is decreasing. While there may be numerous applications or control circuits where the invention in either of its illustrated forms is useful, one particular use has been described in conjunction with an engine fuel system including a main fuel system and an emergency or standby fuel system. Several adjustments for determining the switch operating characteristics have been provided. The difference in rate of response of the pair of

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similar bellows may be varied by change in the orifice plug leading to the slow-acting bellows. The relative spacing of the switch contact points may be adjusted by means of an adjustment screw bearing on one switch arm near its mounting point. The amount of switch contact point over-travel in the stable maximum pressure condition, that is after full expansion of the bellows, may be adjusted by means of the adjustable abutment screws 28 and 58.

The embodiments of the invention herein shown and described are to be regarded as illustrative only and it is to be understood that the invention is susceptible of variations, modifications and changes within the scope of the appended claims.

I claim:

1. In a fluid pressure system including an auxiliary source of fluid pressure, a fluid pressure operated switch comprising a housing having a fluid pressure passage extending into one side thereof and connected to two separate branch passages therein, fluid flow constriction means in one of said branch passages, pressure responsive bellows members, each connected at one end thereof to a respective branch passage and at the other end thereof to a resilient switch arm, contact means on the respective switch arms aligned and normally in spaced relation, a tensioning means operatively associated with one of said switch arms and connected to one of said bellows members for adjusting the normal spacing between said contact means, and an adjustable abutment means in the side of the housing opposed to the fluid pressure passage and in the plane of the contacts whereby on normal fluid pressure the bellows members will expand, the restricting means retarding its associated bellows member expansion and whereby the contact means will immediately close to eliminate the auxiliary source of fluid pressure and on reduction of fluid pressure will immediately separate to provide an activation of the auxiliary source of fluid pressure at a point spaced from the closing point.

2. A fluid pressure operated switch comprising a housing having a fluid pressure passage extending into one end thereof and operatively con-

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nected to two separate branch passages therein, bellows members, each having end plates including an apertured end plate respectively connected with said branch passages, spring members respectively connecting the opposed end plates in the respective bellows members to maintain them in contracted position upon loss of fluid pressure, a throttling means associated with one of said bellows members to retard its expansion and contraction, switch arms each connected to the respective end plates of the bellows members opposed to the apertured end plates and having contact means cooperable upon introduction or loss of fluid pressure in said housing to provide make and break to respectively activate or inactivate an auxiliary source of fluid pressure each at different pressures.

3. The structure as set forth in claim 2 and an adjustable abutment means in the other end of the housing and arranged in the plane of the switch arms to provide a limiting means to maintain said contact means in normal make or break position upon establishing a predetermined pressure condition.

4. A fluid pressure responsive switch comprising a housing, a fluid pressure passage extending into one end thereof and operatively connected to two separate branch passages therein, bellows members respectively connected with such branch passages at one end thereof, resilient means associated with the bellows members to bias them to a contracted position, a throttling means associated with one end of said bellows members to retard its expansion or contraction, switch arms each connected to the other ends of the bellows members respectively and having contact means cooperable upon introduction or loss of fluid pressure in said housing to provide make and break each at different pressures.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,233,746	Bendixen	July 17, 1917
2,239,438	Cockrell	Apr. 22, 1941