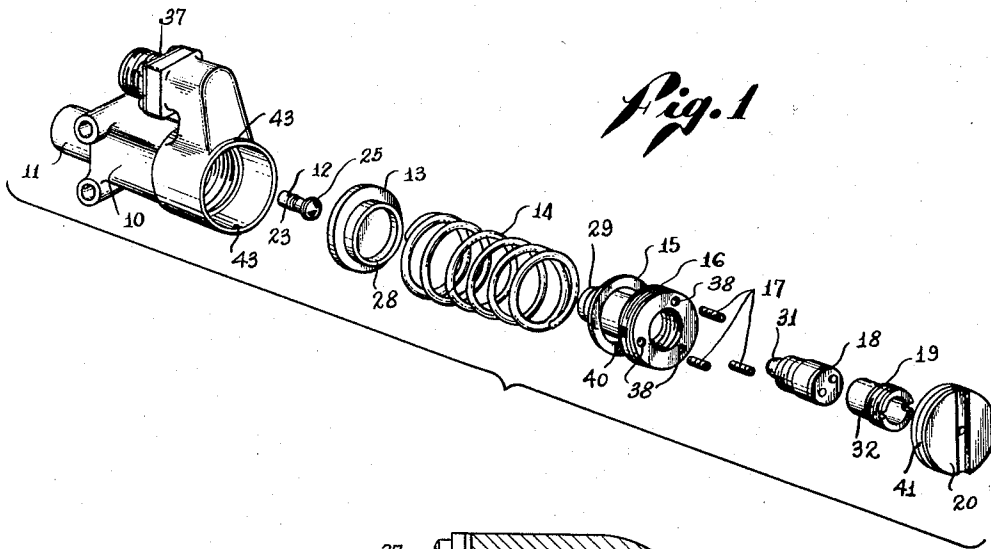
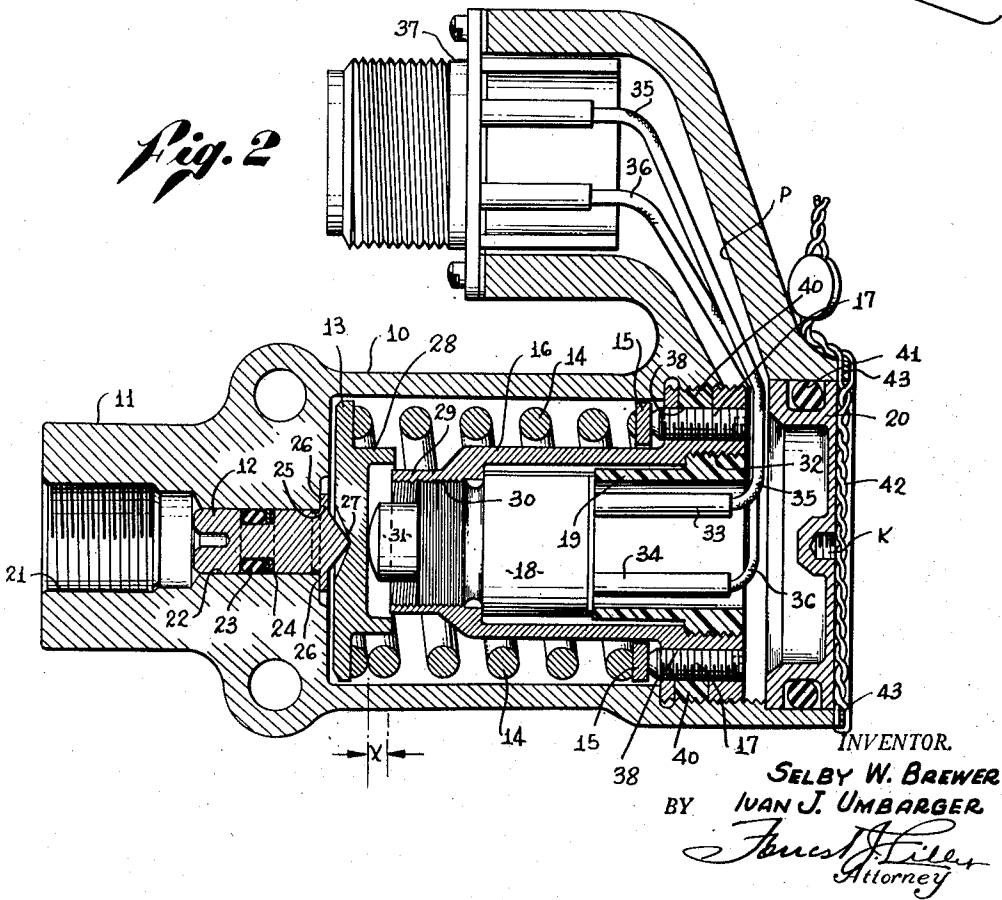


July 22, 1958

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PRESSURE RESPONSIVE SWITCH

2,844,679

Filed March 1, 1954



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2,844,679

PRESSURE RESPONSIVE SWITCH

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Application March 1, 1954, Serial No. 413,009

5 Claims. (Cl. 200—82)

This invention relates to pressure responsive switches and more particularly to a specially designed switch actuating means responsive to relatively high pressures for controlling hydraulic systems in high speed aircraft.

It is extremely important in hydraulic systems employed in aircraft that the pressure of the hydraulic fluid be maintained within certain critical limits. To this end, it is common practice to employ a switch means responsive to a drop in pressure of the hydraulic operating fluid for actuating a pump, for example, to increase the pressure. The pressure responsive device is also designed to turn off such a pump or other pressure control means when the pressure within the system has attained a certain maximum value. The hydraulic pressure is thus maintained within certain limits in a fully automatic manner.

One of the uses for such hydraulic pressure is to operate the control surfaces of an aircraft and it will be readily appreciated that it is extremely important for the safety of the aircraft operation as well as for the pilot, that sufficient pressure be maintained in the hydraulic system to insure proper operation of such control surfaces. Similarly, it is important that the pressure not be increased above a certain critical amount as otherwise certain components of the hydraulic system may blow out or develop leaks. At the same time, however, a certain range through which the pressure may vary is desirable in order that the pressure responsive switch will not commence chattering or hunting in response to every minute variation in the pressure.

A primary object of the present invention accordingly, is to provide an improved pressure responsive switch of the above type for setting minimum and maximum pressure limits in a hydraulic system with an extremely high degree of accuracy.

Another more specific object of the invention is to provide, in such a pressure responsive device, adjusting means for determining the minimum pressure at which the switch will be actuated, such adjusting means being suitably enclosed within the housing for the switch whereby once the adjustment is made, tampering therewith is prevented.

Another important object of the invention is to provide a pressure responsive switch which is compact and whose operating accuracy is not appreciably affected by variations in temperature.

Other important objects are to provide a switch which is light, and may be readily and inexpensively manufactured.

These and further objects and advantages of the present invention are attained by providing a hollow casing having a bore opening at one end to the exterior of the casing, and communicating at its other end with the interior of the casing. Within the interior of the casing, there is provided an electric switch, supported on a switch cage, adapted to be operated by an actuating stem or button, only after it has been moved through a given distance. In other words, the button will,

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in one switch position, be moved inwardly a given distance before the switch is thrown, and similarly, the button must move outwardly over said given distance before the switch is thrown in the other position. A piston is adapted to slide in the bore and through the medium of a plate, engage the switch button. Resilient means, preferably in the form of a coil compression spring, is positioned about the switch cage and exerts a pressure against the plate resulting in an outward pressure against the piston in the cylindrical bore. The arrangement is such that the switch is relatively compact and variations in ambient temperature will not appreciably affect the operating accuracy of the switch.

Pressure on the exterior of the piston of a certain maximum value will force the piston inwardly against the compression spring to throw the switch only after the piston has moved a given distance. Similarly a diminution in the pressure will permit the resilient means to move the plate and piston in an outward direction to gradually release the switch button, but the switch will not be thrown until such outward movement equals the given distance. The difference therefore between the minimum and maximum operating pressures is determined by the spring constant of the coil compression spring and the given distance over which the switch button is designed to move.

A better understanding of the invention and its various objects and advantages will be had by referring to the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a general perspective exploded view of the various components of the pressure responsive switch; and

Fig. 2 is an enlarged cross-section of the switch shown in Fig. 1 in assembled form.

Referring to Fig. 1, the pressure responsive switch is illustrated as comprising an integral casing 10 having a reduced diameter nose portion 11 adapted to be coupled to a conduit or directly exposed to hydraulic pressure in the hydraulic system to be controlled. The various actuating components fitted within the hollow interior of the integral casing 10 are shown in Fig. 1 as comprising a piston 12, a pressure plate 13, arranged to be engaged by the head of the piston 12, a compression coil resilient means in the form of a spring 14, and a spacing element or washer 15, the compression spring 14 being compressed between the pressure plate 13 and washer 15. Arranged to fit coaxially within the spring 14 and spacing element 15 is a switch cage or housing 16 having an enlarged threaded head with suitable bores for receiving adjusting screws 17 all as will become clear as the description proceeds. An electric switch 18 is in turn fitted within the cage 16 and a suitable switch retainer 19 is provided to hold the switch within the cage. Finally, there is provided an end plate 20 for closing off the end of the casing 10.

Referring now to the more detailed view shown in Fig. 2, these components are illustrated in their assembled position. As shown, the nose 11 of the integral casing 10 is provided with internal threads 21 for receiving a suitable conduit exposed to the pressure in the hydraulic system. Also provided in the nose is a reduced diameter cylindrical bore 22 within which the piston 12 is slidably positioned. In order to insure a pressure tight seal between the piston and the walls of the bore 22, there is provided an O ring 23 and "Teflon" backing material 24 about the central portion of the piston. The piston is provided with an enlarged head 25 of the diameter greater than the receiving cylindrical bore 22 whereby outward movement of the piston is stopped by engagement of this enlarged head

with the interior walls of the integral casing 10 as at 26.

The pressure plate 13 is engaged by the head of the piston 12 as at 27. The inner face of the pressure plate 13 is provided with an annular flange 28 the purpose for which will become clear as the description proceeds. The switch cage or housing 16 has an extended annular nose portion 29 of diameter less than the diameter of the flange 28 on the pressure plate whereby the former may telescope within the later. The electric switch 18 is threadedly secured within the cage 16 by threads 30 and is provided with an operating button or stem 31. Switch retainer 19 is shown in Fig. 2 as threaded at 32 to interior threads on the other end of the cage 16. The switch 18 is thus securely mounted within this cage. Within the annular chamber defined by the retainer 19 the switch terminals 33 and 34 are mounted and connect to conductors 35 and 36 leading within a hollow passage P in the casing 10 to a suitable plug receiving socket 37.

The enlarged threaded head portion of the switch cage member 16 is provided with a series of bores 38, there preferably being three such bores as indicated in the exploded view of Fig. 1. These bores are internally threaded to receive the adjustment screws 17 the ends of which bear against the spacer 15 engaging the compression spring 14. This threaded enlarged portion on the switch cage 16 is locked to the casing 10 by means of nylon lock elements 40 into which threads are cut when the switch cage is threaded into the casing 10.

As shown in Fig. 2, the end plate 20 is simply pressed into the end opening of the casing 10 and sealed therein by a sealing gasket or O ring 41. There may also be provided a locking wire 42 passing through a slot in the end plate and suitable bores 43 on the casing to secure the end plate 20 in position.

Operation

The operation of the pressure responsive switch will be clear from the above description. A suitable connection is provided between the nose 11 and the hydraulic pressure system in which it is desired to maintain the pressure within certain limits. Electrical conductors are connected to the plug 37 and may lead to a pressure pump, for example, for increasing the pressure in the chamber, operation of the switch 18 serving to start or stop this pump.

In the illustrative embodiment, the electric switch 18 is normally closed so that the pump or pressure control means (not shown) will be operating when the elements are in the position shown in Fig. 2. As the pressure is increased in the hydraulic system, this pressure is communicated to the nose opening and the piston 12 which will gradually be urged inwardly against the pressure plate 13. Pressure plate 13 will in turn gradually compress the spring 14 and the switch button 31 will be pushed inwardly a corresponding distance. As stated above, the switch is of such a nature that it will not be thrown to open position until the button 31 has been pushed inwardly a given distance. This distance is indicated by the letter X in Fig. 2. The initial bias of the spring is adjusted so that the maximum pressure desirable in the hydraulic system will be sufficient to move the button 31 to its innermost position to throw the switch open thereby turning off the pump. The switch will remain in this open position, and as the pressure in the system gradually decreases over extended use, the compression spring 14 will gradually urge the pressure plate 13, and consequently the piston 12, in an outward direction. Of course as the compression spring 14 expands, the force it exerts against the pressure plate 13 diminishes proportionately. Thus, when the pressure in the system reaches its minimum tolerable value, the spring 14 has been so adjusted that at this minimum value it will have urged the pressure plate 13 to its extreme outward position permitting the button 31 to have traveled outwardly the distance X, at

which time the switch 18 is thrown to closed position to again start the pump.

It will be noted that the travel distance X is carefully maintained by virtue of the enlarged head 25 on the piston engaging the internal end wall of the casing as at 26, which limits the outward distance the piston and thus the pressure plate 13 can move. The extreme inward limit is provided by the nose 29 of the switch cage which nose telescopes within the annular flange 28 of the pressure plate 13 as the pressure plate is moved inwardly, the end of the nose abutting the inside of this pressure plate to limit this movement.

It is also to be noted that the pressure with which the compression spring 14 is urged against the pressure plate 13 may be adjusted by rotating the adjusting screws 17 to move the spacing element 15 against the spring. Such adjustment is initially made during the assembly of the switch after which the end plate 20 is secured in position to prevent tampering of these adjustments. It is also to be noted, however, that the end plate 20 may be easily removed by simply removing the locking wire 42 and inserting a small instrument in the cavity K to pull off the end plate. The small screws 17 are then exposed to permit adjustment. The telescoping nose portion of the switch cage serves in cooperation with the annular flange 28 on the pressure plate 13 as a guide as well as stop means for the pressure plate as it is moved over the given distance X.

The point of contact between pressure plate 13 and piston 12 permits tilting of the plate relative to the piston as might result from unequal adjustment of screws 17. This relative tilting of the plate and piston prevents binding of the piston in bore 22.

Because the adjusting mechanism is secured to the interior of the casing, it will be appreciated that changes in the initial force of the compression spring against the pressure plate in no manner affects the range of compression or expansion of the spring necessary to move the switch button through the given distance X. Therefore, regardless of the initial adjustments, so long as the coil spring is not operated outside its elastic limits, the range of pressures between the set minimum and maximum limits remains substantially constant.

It will be apparent that the positioning of switch cage 16 and switch 18 within spring 14 provides a relatively compact switch construction wherein the relatively short piston 12 is the only movable part which is slidably guided. This compact construction results in reduced total differential expansion and contraction of the parts of the switch during variations in ambient temperature. Thus, a relatively high operating accuracy of the switch may be maintained throughout a wide temperature range. Moreover, since the piston is the only slidably guided element in the switch, the effects of varying friction, arising as a result of expansion and contraction of the parts, on the operating accuracy of the switch will be lessened.

Modifications falling within the scope and spirit of the present invention will occur to those skilled in the art. The switch is therefore not to be thought of as limited to the precise embodiment chosen for illustrative purposes.

We claim:

1. A fluid operated pressure responsive switch for use in high pressure fluid system comprising: a casing having an enlarged chamber therein, a reduced bore opening at its inner end into said chamber and adapted to have its outer end connected to said fluid system, a piston movable in said bore, a radially enlarged pressure plate within and spaced from the walls of said chamber and bearing at its center against the piston, cooperating means on the piston and plate providing substantially point contact therebetween whereby the plate is adapted to tilt relative to the piston, said piston and plate being urged in one direction under the action of the pressure fluid in said system, means including a coil compression spring in said chamber having a diameter substantially larger than that

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of the piston and bearing against said plate for biasing the latter and said piston in the opposite direction, a switch cage fixed to said casing and disposed in said chamber within said spring, and switch means carried by said cage and including operating means engaging said plate.

2. The subject matter of claim 1 wherein said second mentioned means includes adjustable means bearing against the other end of said spring for varying the tension in the latter.

3. The subject matter of claim 2 wherein the last mentioned means comprises an annular member surrounding said cage and abutting said other end of the spring, and a series of adjusting screws threaded in said casing at positions substantially equally spaced about the cage and engaging the member for adjusting the position of the latter along the cage.

4. A fluid pressure switch comprising: a casing having a chamber therein, a bore opening at one end into said chamber and adapted to have its other end connected to a source of pressure fluid, means including a piston axially movable in said bore, a coil compression spring in said chamber engaging said means at one end and a wall of said chamber at the other end for biasing said means in a direction away from said chamber, a switch cage extending from said wall toward said means within said coil compression spring, switch means mounted in the end of said switch cage adjacent said piston and including an axially movable actuating element biased in said direction to a normal position wherein said switch means are in normal condition, said actuating element being movable in the opposite direction to a given limiting position to place said switch means in another condition, said actuating element operatively engaging said first mentioned means for movement of the actuating element with the latter means, said element occupying said normal position when the first mentioned means are in a first position, said element occupying said given position when said first mentioned means are in a second position, said switch cage being positioned to engage said first mentioned

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means upon movement of the latter to said second position for preventing movement of the latter means beyond said second position, and cooperating stop means on the first mentioned means and casing for limiting movement of the latter means in said first mentioned direction to said first position.

5. In a fluid pressure switch of the class described including a casing having a chamber open at one end and a bore opening at one end into the other end of said chamber, means for connecting the other end of said bore to a source of fluid pressure, piston means axially movable in said bore, a peripherally threaded closure threaded in and closing said open end of the chamber, a switch cage fixed to said closure and extending axially through said chamber, switch means on the end of said cage proximate to said piston means and operated by the latter upon given movement of the piston means in the direction of said chamber, a coil spring encircling said cage in said chamber and bearing at one end against said piston means, means bearing against the other end of said spring for adjusting the tension of said spring including a series of axial adjusting screws threaded in axial openings in said closure at positions spaced about said cage, whereby the tension of said spring may be adjusted by adjustment of said screws without movement of said cage relative to said casing.

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