

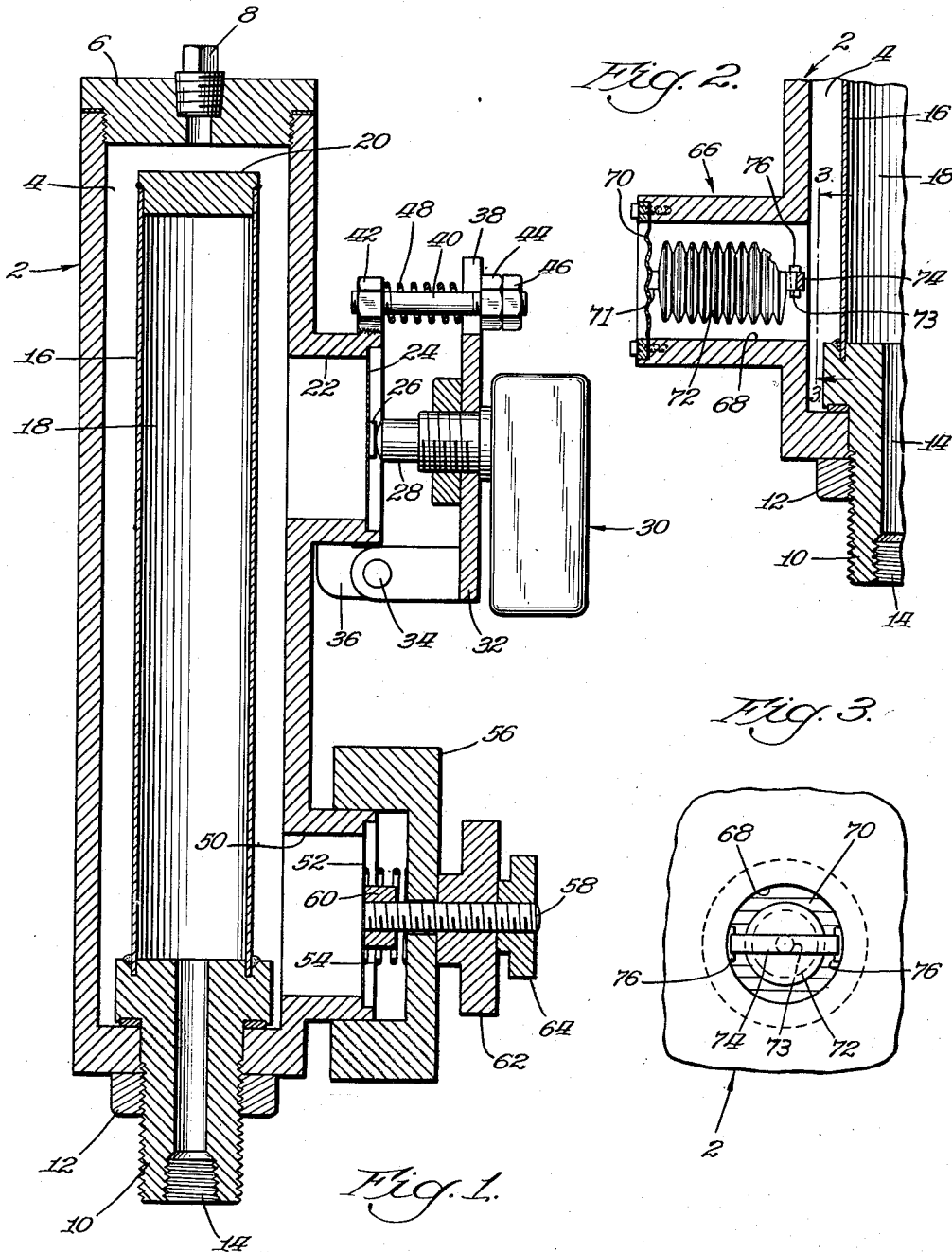
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PRESSURE SWITCH

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PRESSURE SWITCH

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This invention relates to pressure switches and more particularly to a novel pressure responsive switch actuator adapted for use in connection with hydraulic devices, such as hydraulic presses, to open and close electrical circuits operable in well known manner to control the operation of such devices by controlling the hydraulic circuits associated therewith.

The hydraulic press industry has for many years needed a pressure switch which would operate at pressures up to three thousand pounds per square inch, would have a long life in service, and would operate consistently with respect to the cut-in and cut-out pressure values. Resilient materials heretofore utilized for switch actuating diaphragms have not been satisfactory inasmuch as relatively sensitive materials, such as rubber, have proved unsuitable for the lack of sufficient strength to resist high pressures; and relatively stiff materials, such as steel and beryllium copper, have proved too rigid to afford sufficient sensitivity and operating range when made sufficiently strong. Various switch actuators have been used with diaphragms having borderline strength so that after relatively few operations the diaphragms have failed. Furthermore, many switches have been designed utilizing spring loaded plungers; however, such plungers must be lapped to substantially eliminate friction thereby involving prohibitive costs.

A general object of the invention is to provide a novel pressure responsive switch actuator which is strong enough to have a substantial safety factor and fatigue resistance yet flexible enough to have a substantial deflection under load thereby affording sensitivity and accommodating close adjustment.

The above object is accomplished, according to the present invention, by utilizing two resilient members in series, one of said members being subjected to the pressure to which the switch is responsive. This member is relatively strong and is adapted to displace a fluid medium partly confined by the other resilient member which is very sensitive and thus relatively weak. The latter member is adapted to actuate an associated make and break element of the switch. The strong member may be constructed to any desired size to afford any desired volumetric displacement of the fluid for any given stress, and the sensitive member may be constructed to any desired dimension to convert this volumetric displacement to any desired linear displacement.

Another object of the invention is to provide novel means for adjusting a switch actuator, such

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as above described, by acting upon the fluid medium at a point remote from the resilient elements.

Still another object of the invention is to design a switch, such as above described, wherein the fluid medium has a coefficient of thermal expansion approximately equal to that of the metal parts so as to reduce the effect of varying temperatures to a minimum.

A further object of the invention is to provide in a switch, such as above described, novel means for automatically compensating variations in temperature to which the device is subjected.

The foregoing and other objects and advantages of the invention will become apparent from a consideration of the following specification and the accompanying drawings wherein:

Figure 1 is a central vertical cross sectional view through a preferred embodiment of the invention, portions of the structure being shown in elevation for clarity;

Figure 2 is a fragmentary view corresponding to Figure 1 and illustrating a novel temperature compensation device which may be utilized with the embodiment illustrated in Figure 1; and

Figure 3 is a view taken on the line 3—3 of Figure 2.

Describing the invention in detail and referring first to Figure 1, the preferred embodiment of the invention illustrated therein comprises a metal body or housing 2 with an internal chamber 4 closed at one end by a cap 6 with a filler plug 8 to accommodate filling and draining of the chamber 4, as hereinafter discussed. The opposite end of the body 2 is provided with a separable shank 10 secured by a nut 12 threaded thereon. The shank 10 is provided with an axial passage 14 adapted for connection to an associated source of pressure to which the device is responsive.

Mounted on the shank 10 is a metallic tube or bulb 16 with an internal chamber 18 closed by a cap 20. The tube 16 is formed of any suitable resilient material, such as steel or beryllium copper, having relatively great strength and preferably capable of resisting hydraulic pressures within the chamber 18 on the order of three thousand pounds per square inch without overstressing the tube. The tube 16 thus forms a very strong flexible partition or wall separating the chambers 4 and 18 and adapted to be distorted by the pressure within the chamber 18 so as to displace variable volumetric quantities of an associated fluid within the chamber 4.

The chamber 4 is preferably filled with a fluid medium by removal of the plug 8 and the pre-

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ferred fluid is one, such as glycerine, having, as nearly as practicable, the same coefficient of thermal expansion as the metals utilized in the device. However, it will be understood that the broad aspect of the invention is afforded by any hydraulic fluid.

The body 2 is provided with a port or opening 22 closed by a diaphragm 24 carrying a button 26 adapted to actuate a make and break element 28 of an associated precision snap-action switch 30 of conventional design. The switch 30 is mounted on a support plate 32 for movement therewith to and from the button 26 to adjust the spacing between the button and the element 28. The plate 32 is pivoted at 34 to a fulcrum bracket 36 on the body 2 and the upper end of the plate 32 is provided with a slot 38 receiving a bolt or pin 40 secured to a member 42 mounted in any convenient manner, as by welding, on the body 2. The bolt is provided with an adjusting nut 44 and a lock nut 46, and a compression spring 48 is disposed between the member 42 and the plate 32 to yieldingly resist movement of the plate 32 toward the body 2. Thus, by means of the bolt and nut assembly 40, 44, the distance between the button 26 and the element 28 may be readily adjusted to accommodate calibration of the device.

The body 2 is also provided with another opening or port 50 closed by a diaphragm 52 urged inwardly toward the chamber 4 by a compression spring 54 seated against a cap or closure plate 56 secured in any convenient manner to the body 2. The diaphragm 52 is adjusted by a threaded pin or stem 58 secured to a boss 60 carried by the diaphragm and actuated by a nut 62 and a lock nut 64. The diaphragm 52 is a setting diaphragm which is effective to introduce an initial bias into the system so that with the tube 16 in normal unstressed condition, the switching diaphragm 24 is at a predetermined distance from the element 28. If it is desired to adjust the device to actuate the element 28 at a lower pressure, the nut 62 is turned counterclockwise, so that the spring 54 urges the setting diaphragm 52 inwardly thereby bulging the switching diaphragm 24 outwardly so that less displacement of the fluid in the chamber 4 by distortion of the tube 16 is required to actuate the element 28. To adjust the device so that the element 28 is actuated at a higher pressure value than the initial setting, the nut 62 is turned clockwise pulling the diaphragm 52 outwardly against the resistance of the spring 54 and thereby bulging the switching diaphragm 24 inwardly.

It will be understood that in operation of the device, the chamber 18, which is subjected through the passage 14 to the pressure under which the device is responsive, is filled with high pressure fluid subject to pressure variations, such as are common in the hydraulic circuit of an hydraulic press. The tube 16 under load assumes a barrel-like shape and expands and contracts with increase and decrease, respectively, of the pressure in the chamber 18. The desired displacement of the fluid within the chamber 4 may be regulated by varying the size of the tube 16. Inasmuch as the sensitivity of the device is dependent upon the displacement of the fluid within the chamber and not upon the percentage distortion of the tube 16, a device, such as above described, may be readily constructed with any desired degree of sensitivity combined with any desired degree of ruggedness. Thus, if one device, constructed according to the invention,

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should fail under any given set of service conditions, a more rugged switch may be constructed on the same principle with the same degree of sensitivity.

Referring now to Figures 2 and 3 illustrating a device identical to that shown in Figure 1 except as hereinafter discussed, the parts of the device shown in Figure 2 corresponding with those of Figure 1 are identified by corresponding numerals.

A temperature compensation device is generally designated at 66, said device comprising a port or outlet 68 communicating with the chamber 4 and closed by a flexible, preferably corrugated, diaphragm 70 which is secured to a connecting lug 71 on one end of a Sylphon bellows 72, the opposite end of which is provided with a connecting lug 73 secured to a bar or bridge 74, which is interlocked with the body 2 in any convenient manner, as, for example, by lugs 76 extending into the passage 78. The bellows 72 is operable to resist in tension outward bulging of the diaphragm 70 due to displacement of the hydraulic medium within the chamber 4. However, any changes in the temperature of this medium are transmitted to the bellows 72 which thus expands and contracts to automatically adjust the position of the diaphragm 70 thereby compensating for expansion and contraction of the various elements of the device due to temperature changes therein. It may be noted in this connection that the various components of the device, including the hydraulic medium, are preferably formed of materials having approximately the same coefficient of thermal expansion.

If desired, the diaphragms 24 and 52 may be corrugated in the same manner as the diaphragm 70.

It is to be understood that I do not wish to be limited by the exact embodiment of the device shown which is merely by way of illustration and not limitation as various and other forms of the device will, of course, be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

I claim:

1. A pressure responsive switch actuator comprising an outer hydraulic chamber, an inner chamber disposed within the outer chamber, means for connecting one of said chambers to an associated source of pressure to which said actuator is responsive, a relatively strong flexible partition separating said chambers, an hydraulic medium in the other chamber adapted to be displaced by distortion of said partition, a port communicating with said other chamber, a relatively weak and sensitive partition across said port adapted to be distorted by displacement of said medium, a switch make and break element associated with said sensitive partition for actuation thereby, and temperature compensating means comprising a diaphragm confining a portion of said medium spaced from said partitions and thermally expandable and contractable resilient means contacting said medium and connected to said diaphragm for yieldingly resisting movement thereof in response to displacement of said medium.

2. An actuator, according to claim 1, wherein means are provided for adjusting the distance between said element and said sensitive partition, comprising means independent of said partitions for displacing said medium.

3. A pressure responsive switch actuator comprising a chamber containing hydraulic fluid, a

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cylindrical steel bulb within said chamber, means for connecting the interior of said bulb to an associated pressure to which said actuator is responsive, a port in said chamber, a diaphragm closing said port and formed of material substantially more yielding than said bulb, and a switch make and break element supported adjacent said diaphragm for actuation thereby during flexure thereof due to variation in the amount of hydraulic fluid displaced by said bulb.

4. A hydraulic device for actuating a switch element comprising a body and a flexible cylindrical tube therein defining a chamber in the tube and a chamber externally thereof, said tube being capable of withstanding pressure in excess of 2000 pounds per square inch without permanent deformation and without breaking, means for connecting one of the chambers to an associated source of pressure to which the device is responsive, the other member being entirely filled with liquid and having a port, a diaphragm closing said port and formed of material more sensitive to pressure than said tube, and a switch make and break element disposed externally of said port and associated with said diaphragm for actuation thereby.

5. A pressure responsive switch actuator comprising a bulb having an internal chamber adapted for connection to an associated source of pressure to which said actuator is responsive, a body of hydraulic fluid confined against the outside of said bulb, a flexible wall confining a portion of said body, a switch make and break element associated with said wall for actuation thereby upon distortion thereof by displacement of said fluid, and temperature compensating means characterized by a diaphragm confining a portion of said body spaced from said walls, and a thermally expandable and contractable

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resilient member contacting said fluid and connected to said diaphragm for yieldingly resisting movement thereof in response to displacement of said fluid.

6. An actuator, according to claim 5, wherein means are provided for adjusting the actuator, comprising means confining a portion of said fluid spaced from said walls, and adjustable means for moving said confining means to displace variable amounts of said fluid.

7. An hydraulic device for actuating an associated switch element, comprising an outer chamber containing hydraulic liquid, an inner chamber within said outer chamber and defined by a cylindrical flexible steel wall having its exterior surface contacting said liquid, said inner chamber being defined by an interior surface of said wall, a passage for connecting the inner chamber to an associated source of pressure to which the device is responsive to actuate said element, and a flexible diaphragm more sensitive to pressure than said wall, said diaphragm being in contact with said liquid whereby expansion of said wall due to increase of pressure against said inner surface flexes said diaphragm.

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