Feb. 28, 1967 J. E. GOODWIN 3,306,999

PRESSURE-RESPONSIVE SWITCH

Filed Oct. 5, 1964 2 Sheets-Sheet 1

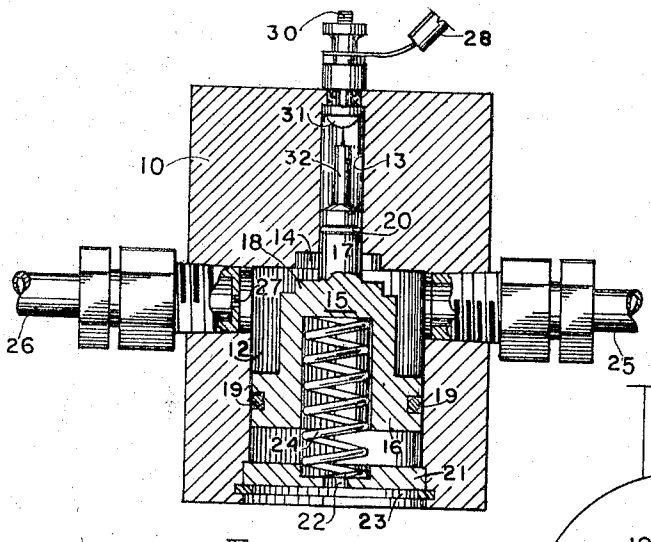

Fig. 1

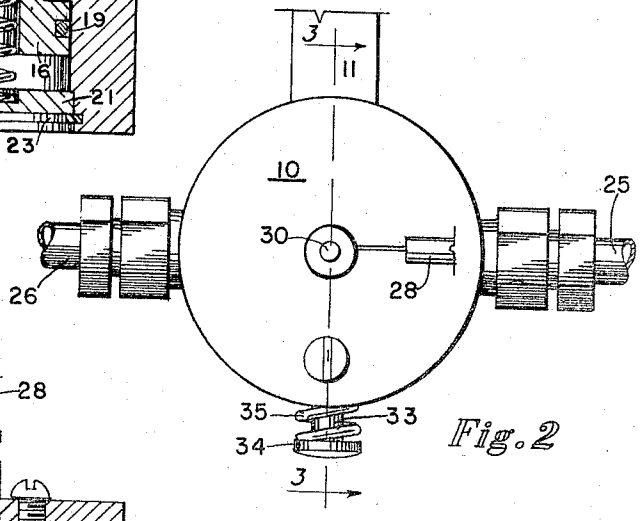

Fig. 2

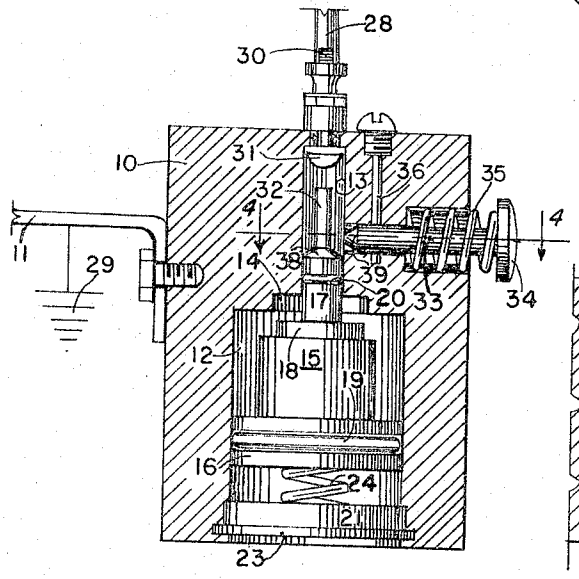

Fig. 3

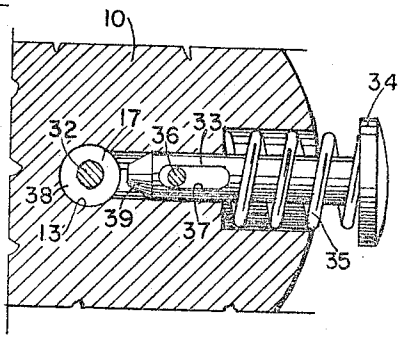

Fig. 4

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PRESSURE-RESPONSIVE SWITCH

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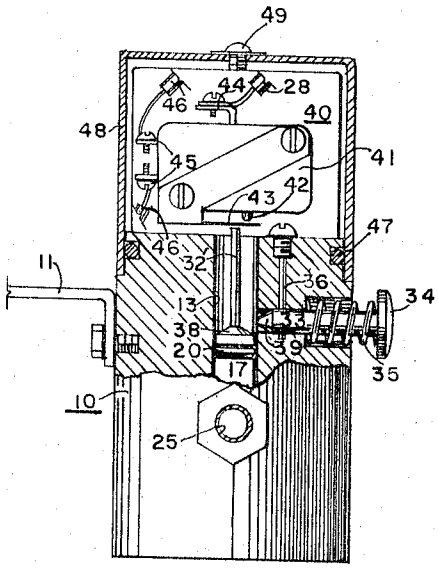

Fig. 5

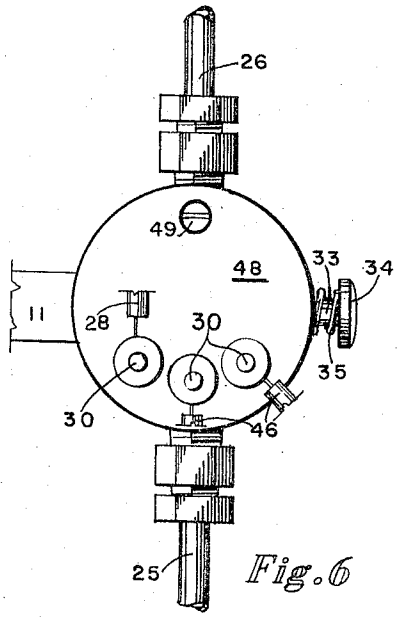

Fig. 6

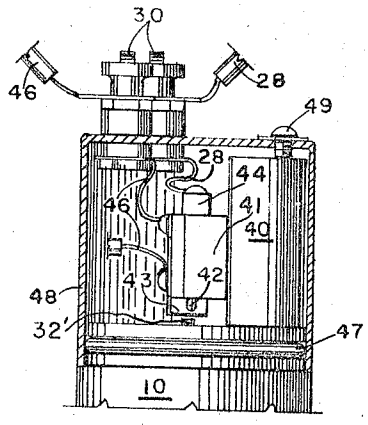

Fig. 7

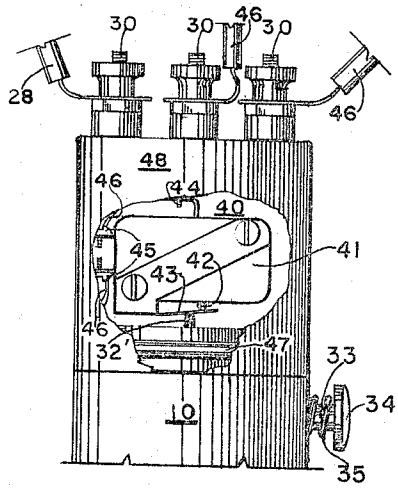

Fig. 8

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PRESSURE-RESPONSIVE SWITCH

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Filed Oct. 5, 1964, Ser. No. 401,429
5 Claims. (Cl. 200—82)

The instant invention relates to a pressure-responsive switch employable automatically to sense and protectively apply deficiences of pressure manifest in fluid circulation systems significant to the normal operation of mechanical equipment, and has as its principal object the provision of a novel and improved such unit of diverse applicability and operatve reliability.

A further object of the invention is to provide a novel and improved pressure-responsive switch that is dependably effective to interrupt operation of associated equipment in immediate reaction to loss of requisite pressure in a fluid circulating system consequential to proper functioning of the equipment.

A further object of the invention is to provide a novel and improved pressure-responsive switch that is efficiently applicable to immediately and automatically reflect loss of requisite pressure in a fluid circulating system primary to proper functioning of mechanical equipment through either alternative or simultaneous interruption of equipment operation, actuation of alarms and signals, and activation of adjunctive protective and corrective facilities.

A further object of the invention is to provide a novel and improved pressure-responsive switch incoroprating means readily facilitating correction of conditions signaled by automatic reaction of the switch.

A further object of the invention is to provide a novel and improved pressure-responsive switch adapted automatically to close for completion of an electrical circuit in reaction to loss of requisite pressure in an associated fluid circulating system and automatically to open to a reset condition of potential use upon re-establishment of requisite pressure in the system.

A further object of the invention is to provide a novel and improved pressure-responsive switch adapted automatically to close for completion of single or multiple electrical circuits in reaction to loss of requisite pressure in an associated fluid circulating system, automatically to a reset condition of potential use upon re-establishment of requisite pressure in the system, and to accommodate manual interruption of the circuit or circuits thereby closed incident to correction of the conditions signaled by closing of the switch.

A further object of the invention is to provide a novel and improved pressure-responsive switch that is particularly adapted for intended use with isolated unattended equipment installations exposed to weather and therewith rugged and dependable in attainment of its functions.

A further object of the invention is to provide a novel and improved construction and operative interrelation of features and elements in and as a pressure-responsive switch applicable to inhibit damage to electrically governed, mechanical equipment consequential to loss of requisite pressure in an associated fluid circulating system.

A further object of the invention is to provide a novel and improved pressure-responsive switch that is expedient and economical of production, simple and convenient of operative installation, feasible of adaptation for operative reaction to pressure values selected from an extensive available range, reliably indicative of pressure deficiencies requiring attention, suited for repetitious functioning

under corrected conditions without occasion for replacement, servicing, or maintenance, substantially immune to adverse effect by climatic environment or the extremes of weather variations, and positive and efficient in attainment of the ends for which designed.

In broad functioned analogy, the present invention is employable in combination with, as a supplement to or as a substitute for a switch device disclosed in United States Patent No. 3,082,306 dated March 19, 1963.

With the foregoing and other objects in view, my invention consists in the construction, arrangement, and operative combination of elements and features as hereinafter set forth, pointed out in the appended claims, and illustrated by the accompanying drawings, in which:

FIGURE 1 is a vertical section taken substantially axially through a typical, simple embodiment of the invention as associated with a fluid pressure line and an electrical conductor in condition of potential use, the position of the illustrated elements reflecting a state of requisite pressure obtaining within the system represented by the pressure line.

FIGURE 2 is a top view of the arrangement according to FIGURE 1 with certain exterior attachment broken away to conserve space.

FIGURE 3 is a vertical, substantially-axial section through the arrangement according to the preceding views taken at a right angle to the showing of FIGURE 1 approximately on the indicated line 3—3 of FIGURE 2.

FIGURE 4 is a fragmentary, detail, transverse section, on a relatively-enlarged scale, taken approximately on the indicated line 4—4 of FIGURE 3.

FIGURE 5 is a side elevational view, partly in vertical, axial section, of a multi-circuit elaboration of the organization according to the preceding views within the contemplation and effective to apply the principles of the invention.

FIGURE 6 is a top plan view of the arrangement according to FIGURE 5 with certain of the exterior attachments broken away to conserve space.

FIGURE 7 is a partial side elevation showing the upper portion of the arrangement according to FIGURE 5 as viewed from the indicated line 7—7 of FIGURE 6 with a housing component in diametric section to expose otherwise concealed associations.

FIGURE 8 is a side elevation of the upper portion of the arrangement according to FIGURE 5 showing through an opened area of the housing component the element relationships obtaining upon actuation of the switch occasioned by loss of requisite pressure in the associated pressure line.

It is common experience in the operation of internal combustion engines, powered pumps, compressors and analogous mechanical apparatus, however cooled and lubricated, that decline of normal operating pressure in an associated fluid circulating system, such as the lubricating oil circuit, may develop to induce overheating of the operating mechanisms which, if not observed and promptly countered, promotes damage to and possible destruction of the equipment with concomitant interruption of the ofttimes critical functions thereof. Technical advances in many fields and services have aggravated the problems and consequences of equipment failure due to inadequate fluid circulating pressures because of the expanding practice of locating powered equipment installations remote from observation and prompt access to operate, either continuously or intermittently, without attention for long periods of time subject to malfunction promotive of or consequent upon inadequate pressure of fluid circulation. Previous recognition of the unpredictable possibility of such malfunctions has hitherto occasioned the provision of means effective in exposure

and reaction to the variable operating conditions of a given equipment installation to halt the action thereof in automatic response to loss of requisite fluid circulating pressure before serious damage ensues. Commonly applied to control the efficacy of an electrical circuit governing operation of the associated equipment, the pressure-responsive means hitherto available for the purpose discussed have been less than satisfactory by reason of structural complexity, indurability, especially when exposed to weather, over-sensitivity, expense, vulnerability as attractive targets for gunners, lack of resetting facility, and inadequate practical reliability, in correction of all of which the instant invention is directed to the provision of a novel and improved pressure-responsive switch diversely applicable in appropriate association with fluid circulating systems to positively and dependably close an electrical circuit controlling operaton of the associated equipment and, if desired, to energize other electrical circuits whereby to signal or extend the effect of such action, at a predetermined reduction of requisite pressure in the fluid circulating system whereto applied.

Manifestly adapted to function as intended in practical association with equipment of many different types, constructions, and capabilities utilizing fluid circulating systems subject to loss of pressure requisite to sustain efficient operation thereof, the improved switch of the invention is constituted as a rugged, unitary assembly integrated with an upon a preferably-cylindrical body **10** of appropriate size and suitable rigid material furnished with an exterior bracket attachment **11** of optional particularity employable to securely mount said body **10** with its axis upright in any selected use location. A through bore longitudinally traverses the body **10** to define therein a cylindrical chamber **12** adjacent and accessible through the lower end of the body and a tubular cavity **13** coaxially communicating in a lesser diameter with and as an uprise from said chamber. The lesser diameter of the cavity **13** may open directly to the chamber or may, as illustarted, communicate with the chamber through a counterbore **14** formed to a diameter between those of the chamber and cavity.

The body **10** reciprocably houses an actuator **15** having a piston component **16** receivable in sliding coaction within the chamber **12** and a coaxial stem component **17** receivable in sliding coaction within the cavity **13**, the conjunction of said piston and stem components being marked, if desired, by a stepped boss **18** suited for sliding reception within the counterbore **14**. In appropriate relative axial lengths qualifying the actuator with an adequate range of play within and relative to its housing, the piston component **16** is slidably sealed to its chamber by an O-ring **19**, or the equivalent, and the stem component **17** is correspondingly slidably sealed to its cavity by an O-ring **20**, or the equivalent, whereby to establish between said seals **19** and **20** an upper compartment of the chamber **12** conditioned to effectively confine fluid under pressure for reaction directly upon the contiguous area of the piston component **16**. Where it opens through the lower end of the body **10** the chamber **12** is stepped to receive and seat a flat, annular end closure **21** formed with a vent aperture **22** and detachably retained in operative disposition by means of a snap ring **23** conventionally groove-seated in the body exteriorly there against. Fixed relative to the body **10**, the end closure **21** serves as an abutment for one end of an expansive spring **24** bearing within the lower portion of the chamber **12** against the actuator **15** and hence effective to urge the latter to the upper limit of its reciprocable range within the body, it being expedient, as illustrated, to accommodate the upper end of the spring within a socket formed to open through the lower face of the piston **16**, whereby to facilitate interchange of the spring element and use therewith of adapters applicable to vary and determine the expansive force acting upon the actuator.

The actuator-biasing influence of the spring **24** is directly opposed to the pressure of fluid circulation whereto the switch of the present invention is designed to react, for which purpose the fluid circulation to be pressure-sensed is directed through the upper compartment of the chamber **12** operatively defined between the seals **19** and **20** by means of a flow input line **25** opening in communication with the fluid circulation system of the equipment to be protected through the body **10** to said chamber above the upper limiting position of the piston **16** and a complementary flow output line **26** similarly communicating as a return to said system from said chamber compartment, the full pressure of fluid circulation in the associated system being reflected and maintained in said chamber to oppose through the actuator the proportioned influence of the spring **24** in consequence of a flow capacity for the output line **26** reduced, as at **27**, relative to that of the input line **25**. As so organized and connected in position of intended use with a biasing value for the spring **24** less than the force of requisite fluid pressure acting on the upper area of the piston **16**, appropriate pressure of fluid circulation depresses and holds the actuator **15** against the influence of the spring which, in reaction to decrease in the pressure of the circulating fluid, immediately and automatically acts to elevate the actuator relative to and within the body **10**.

Reciprocatory displacement of the actuator **15** responsive to the biasing and pressure influences as above described is availed of to operate controls of preferred particularity and equipment-protecting significance. Designed and effective to halt the functioning of electrically-governed equipment in reaction to inadequate pressure of fluid circulation sensed thereby, the embodiment of the invention represented by FIGURES 1–4, inclusive, of the drawings is arranged to close a single-lead circuit thereby qualified, in any desired conformity with known practice, to interrupt operation of the associated equipment. Given, as is quite customary, a single-lead control circuit typified by the fragmentary showing of a conductor **28** amenable to completion at ground **29** on the associated equipment with concomitant interruption of equipment operation, it is feasible and expedient to form the elements **10**, **11**, **15**, **21** and **24** of conductive material suited in their structural interrelation as set forth to pass current to the ground **29**. In such an arrangement, the conductor **28** closes from the instrumentalities to be actuated by the closed circuit to a connection **30** exteriorly of the upper end of the body **10** which serves in closing, insulated relation with the upper end of the body cavity **13** a contact **31** thereby fixed within said cavity in spaced opposition to the upper end of the actuator stem **17**, and a coaxial pin extension **32** of conductive material is provided at said upper end of the stem **17** in a length adapted to engage said contact **31** with circuit-closing effect when the influence of the spring **24** prevails to elevate the actuator **15** against the pressure of fluid circulation manifest in the upper compartment of the chamber **12** and to separate from said contact and open the circuit when the fluid pressure is dominant to depress the actuator against the force of the spring. Thus, as should be readily apparent, the switch organization according to FIGURES 1–4, inclusive, reliably functions without impairment of normal equipment operation to automatically arrest such operation when the pressure of fluid circulation requisite thereto is incapable of dominating through the piston **16** the pre-proportioned influence of the spring **24**.

Intentional resumption of equipment operation at adequate pressure of fluid circulation, once appropriately initiated, will quite naturally reset the switch of the invention for repetitious intended functioning as the adequate fluid pressure dominates the influence of the spring **24**, and interruption of the circuit typified by the

conductor 28 to condition the equipment for resumed operation may be variously accomplished, as is obvious. However, considerations of convenience and practicality recommend the provision of a manually-actuable reset device capable as a component of the switch assembly unit of separating the pin 32 from the contact 31 preliminary to resumption of the equipment operation interrupted by circuit completion therethrough, and such a reset device is represented in the views of the drawings as an optional supplement to the functional switch organization hereinbefore described. As best shown in FIGURES 3, 4 and 5, the reset device is constituted as a bolt 33 axially reciprocable through a wall of the body 10 radially of the actuator 15 to intrusion within the body cavity 13. In a length exceeding the thickness of the body wall thereby traversed the bolt 33 terminates in an enlarged head 34 exteriorly of the body against which an expensive spring 35 socketed in the body wall acts to yieldably urge the bolt outwardly of the body to a limiting position determined by a stop 36 fixed in the body 10 perpendicular to the bolt and through a slot 37 longitudinally thereof, whereby to normally retain the bolt under outward bias with its inner end substantially tangent to the wall of the body cavity 13 and amenable to intrusion therewithin. The conjunction of the actuator stem 17 and its pin 32 is formed as an annular, preferably frusto-conical, shoulder 38 and the inner end of the bolt 33 is complementarily chamfered, as at 39, so that, the said bolt being located axially of the actuator 15 and cavity 13 to effect sliding coaction of its chamfered end 39 with the shoulder 38 when the actuator is elevated to engagement of the pin 32 with the contact 31, inward displacement of the bolt occasions interengagement of the shoulder 38 and chamfered bolt nose 39 with consequent depression of the actuator 15 against the influence of the spring 24 sufficient to retract the pin 32 from the contact 31 for interruption of the circuit completed therethrough. With a fluid pressure in the chamber 12 inadequate to dominate the influence of the spring 24 the friction attending interengagement of the shoulder 38 and bolt nose 39 suffices to retain the bolt in its circuit-interrupting inward displacement against the bias of its spring 35 until corrective measures justify resumption of equipment operation and further retraction of the actuator in reaction to requisite fluid pressure manifest in the chamber 12, whereupon the spring 35 automatically retracts the bolt 33 from intrusion within the body cavity 13 to reassociate the elements of the switch assembly for intended use.

The elaboration of the invention represented by FIGURES 5–8, inclusive, of the drawings differs from the foregoing but in the means responsive with circuit-closing effect to elevation of the actuator 15 incident to drop of fluid pressure manifest in the chamber 12 and includes in equivalent structure, correlation, and mode of operation the elements and features heretofore described with the exception of the ground 29 and contact 31. In an arrangement operable automatically to energize and complete warning, signaling and analogous circuits, when desired, in addition to a circuit controlling equipment operation, the body 10 of the previous disclosure is formed with a prolongation 40 fixedly outstanding axially therefrom at one side of the open upper end of the body cavity 13 and a conventional, multi-circuit, microswitch unit 41 housing, as is customary, a detent yieldably biased to open-circuit condition and rockable by an exposed projection 42 to closed-circuit condition is secured to said prolongation 40 spacedly above and in overhanging relation with the open upper end of the body cavity 13 in such disposition as to direct the projection 42 as biased to open-circuit condition toward the body 10 at one side of said cavity. A flexible finger 43 extends from end-attachment to the unit 41 over and across the open end of the cavity 13 to underlie at its free end the microswitch projection 42, whereby upward flexing of said finger 43 applies through said projection to rock the unit detent to circuit-closing condition, and an elongation of the actuator pin 32, designated 32', is provided in a length suited to engage said finger between its end attachment and the projection 42 and flex the finger for closing of the detent circuits when the actuator 15 is elevated in reaction to dominance of its spring bias and to retract from said finger with concomitant return of the detent to open-circuit condition with the actuator is depressed by dominance of fluid pressure.

The microswitch unit 41 is conventionally furnished with a plurality of exteriorly-available circuit connections, one of which, designated 44, provides attachment for a powered lead, such as 28 of the earlier disclosure, and the others of which, 45, serve to complete circuits through leads 46 to the instrumentalities desired to be energized when the pressure of fluid circulation is inadequate and receive current from the lead 28 upon rocking of the detent to its circuit-closing condition, all of which is well within known skill and practice. The upper end of the body 10 is worked about the base of the prolongation 40 to receive and coact by means of a sealing ring 47 with the open end of a cap closure 48 invertible over and to protectively house said prolongation and the microswitch unit 41 in a separable association secured by a screw 49 engaged through the closed end of the cap closure with the end of the prolongation 40 thereunder. The leads 46 and 28 obviously must intersect and be insulated from the cap closure 48 in some expedient manner, and such is readily, conveniently, and conventionally accomplished by the provision of a binding post 30 for each of the several circuits secured in insulated relation to and to continue the respective circuit through the closed end of the cap closure.

Utility, function, and mode of operation of the organization represented by FIGURES 5–8, inclusive, should be fully apparent from the description of the embodiment first discussed as hereinabove amplified.

Since changes, variations, and modifications in the form, construction, and arrangement of the elements shown and described may be had without departing from the spirit of my invention, I wish to be understood as being limited solely by the scope of the appended claims, rather than by any details of the illustrative showing and foregoing description.

I claim as my invention:

1. A pressure-responsive switch comprising a rigid body formed with a through bore defining a cylindrical chamber coaxially communicating with a tubular cavity of lesser diameter, an actuator having coaxial piston and stem components respectively slidably sealed in said chamber and cavity, a chamber end closure at the side of the piston remote from the stem, a spring expansively reactive between said end closure and the proximate side of the piston yieldably biasing the actuator in the direction of its stem, a fluid flow input line and a relatively restricted fluid flow output line serving said chamber between the piston and stem seals, whereby fluid pressure in said chamber opposes the influence of said spring and said actuator is moved axially in response to a differential in the opposed spring and fluid pressure factors, an electrical circuit operatively associated with said body, a closable break in said circuit normally open between said body and the end of the actuator stem component remote from the piston, and a pin extending from said end of the stem component adapted to engage said housing to close said break and complete the circuit upon shift of the actuator under dominance of spring pressure and to open said circuit upon shift of the actuator under dominance of fluid pressure.

2. A pressure-responsive switch comprising an actuator reciprocably housed within a rigid housing, said actuator having coaxial piston and stem components, said piston component being slideably housed within a chamber in said housing and said stem component being slideably

housed within a tubular cavity in said housing opening in a lesser diameter to said chamber, a piston component seal slideably sealing said piston component in coaction with said chamber, a stem component seal slideably sealing said stem component within said tubular cavity, means yieldably biasing said actuator in the direction of its stem component, means for the pressure-circulation of fluid through said housing between the piston and stem component seals in opposition to the yieldable biasing means influencing the actuator, said pressure-circulation means including flow input and flow output lines separately serving the housing chamber at the stem side of the piston component therein, said flow output line having flow communication with the chamber restricted relative to that of the flow input line thereby positively to reflect within the chamber the pressure of the flow circulated therethrough, a normally-open electrical circuit operatively associated with said housing, and means for closing said circuit in response to a shift of said actuator occasioned by the dominant influence of said yieldable biasing means.

3. A pressure-responsive switch according to claim 2 wherein the means yieldably biasing the actuator in the direction of its stem component comprises a chamber end closure at the side of the piston component remote from the stem and an expansive spring reactive between said end closure and the proximate side of the piston component.

4. A pressure-responsive switch according to claim 2 wherein the housing actuator and associated elements are of conductive material suited to function in an electrical circuit, the normally-open circuit associated with the housing includes a contact insulated from the housing in spaced opposition to the end of the actuator stem component remote from the piston, and the means for closing such circuit consists of a conductive pin extension of said end of the stem component adapted to engage said contact when the bias influencing the actuator overcomes the pressure of fluid circulation and to separate from the contact in a reversed correlation of the pressure and bias factors.

5. A pressure-responsive switch comprising an actuator reciprocably housed within a rigid housing, said actuator having coaxial piston and stem components respectively slideably sealed within said housing, means yieldably biasing said actuator in the direction of its stem component, means for the pressure-circulation of fluid through said housing between the piston and stem component seals in opposition to the yieldable biasing means influencing the actuator, the housing actuator and associated elements being of conductive material suited to function in an electrical circuit, a normally-open electrical circuit operatively associated with said housing and including a contact insulated from the housing in spaced opposition to the end of the actuator stem component remote from the piston, and means for closing said circuit in response to a shift of said actuator occasioned by the dominant influence of said yieldable biasing means, said means for closing said circuit comprising a conductive pin extension of said end of the stem component adapted to engage said contact when the bias influencing the actuator overcomes the pressure of fluid circulation and to separate from the contact in a reversed correlation of the pressure and bias factors.

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