July 27, 1948. F. R. BEAN 2,445,756

FLUID OPERATED SWITCH ASSEMBLY

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Fig. 1

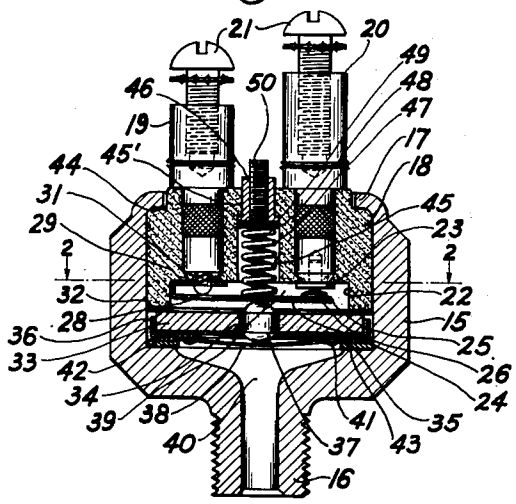


Fig. 2

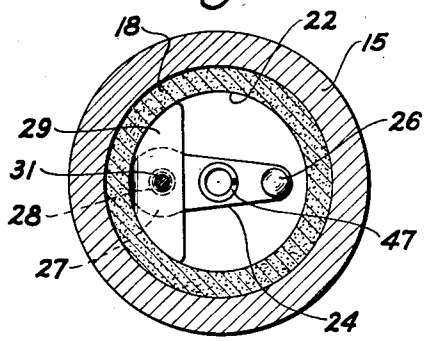


Fig. 3

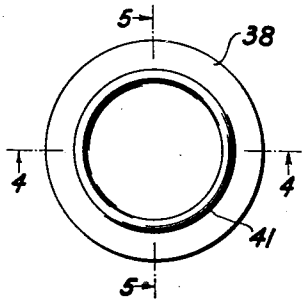


Fig. 4



Fig. 6

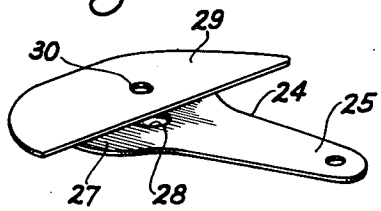
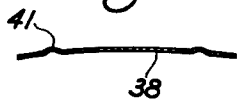


Fig. 5



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Fig. 7

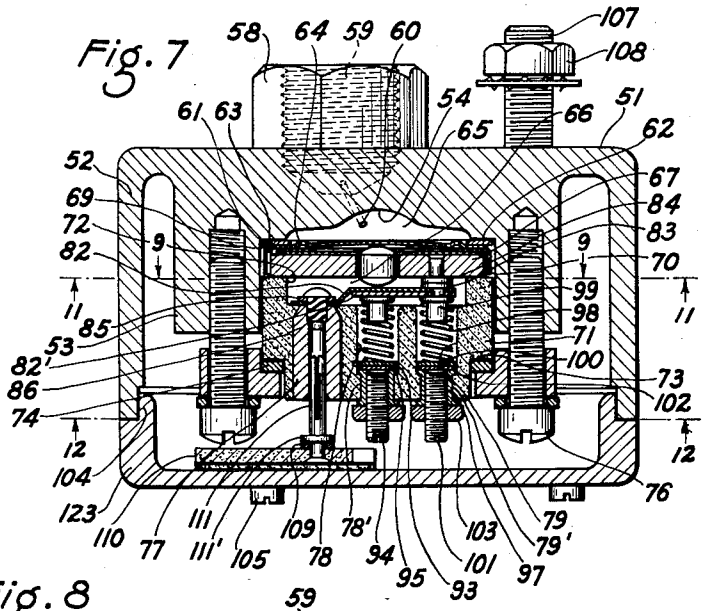


Fig. 8

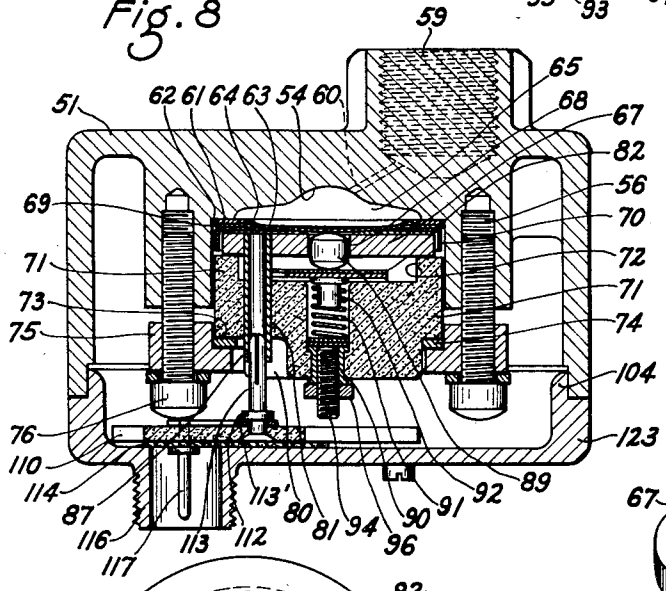


Fig. 10

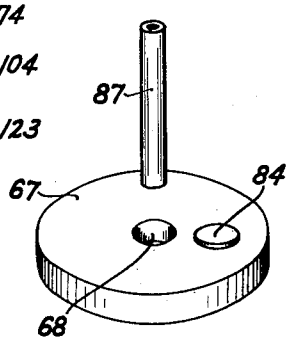
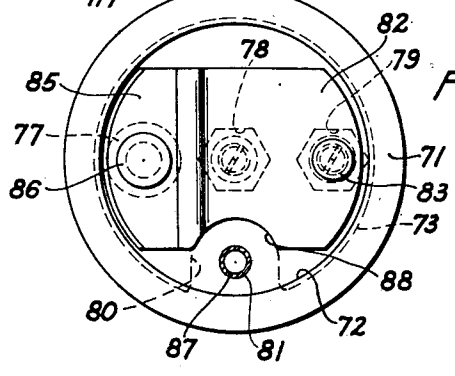


Fig. 9



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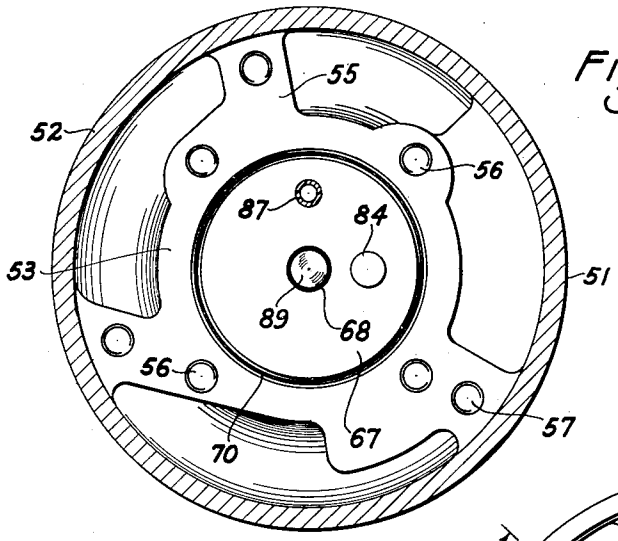


Fig. 11

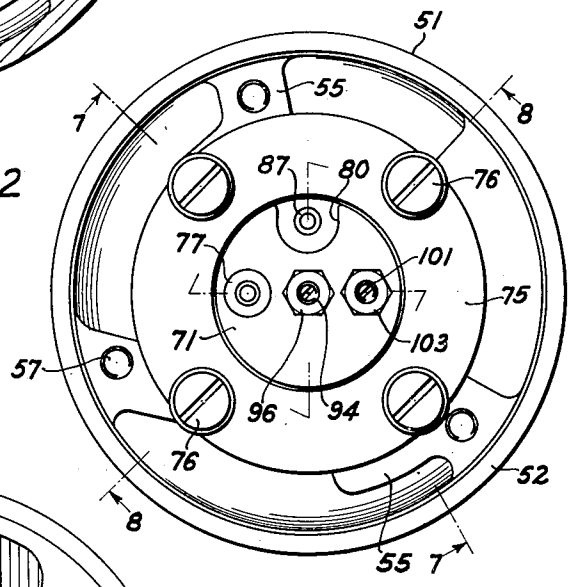


Fig. 12

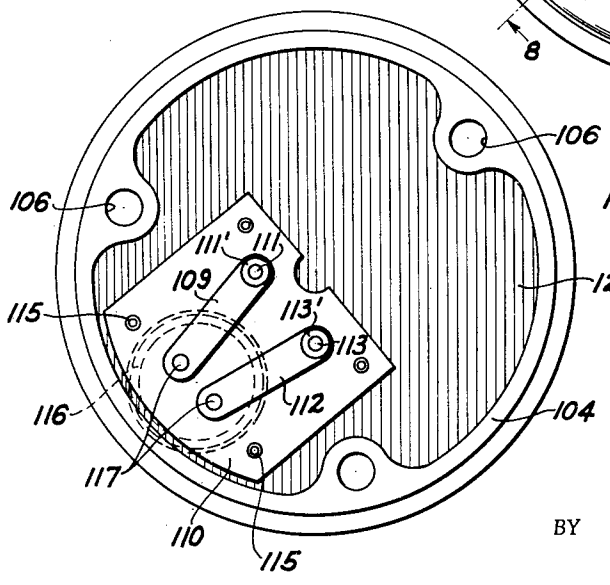


Fig. 13

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UNITED STATES PATENT OFFICE

2,445,756

FLUID OPERATED SWITCH ASSEMBLY

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Application June 21, 1944, Serial No. 541,349

17 Claims. (Cl. 200—83)

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The present invention relates to a fluid operated switch assembly and more particularly to a fluid operated switch assembly having one or more adjustments to control switch operating pressures.

Most fluid operated devices are responsive either to an increase or a decrease of fluid pressure or to a fluid pressure of predetermined value. However, there is a difference between the pressure at which a device is operated in one direction during an increasing fluid pressure and the pressure at which the same device is operated in an opposite direction during a decreasing fluid pressure. Such pressure differential is quite considerable in fluid operated switch assemblies wherein the pressure responsive member is arranged for substantial movement at a predetermined fluid pressure and so as to produce critical operation and/or rapid opening or closing of the switch assembly.

In many circumstances it is quite desirable and necessary that a snap acting switch assembly shall be opened and closed at substantially the same fluid pressure or that the pressure differential be made as small as possible. A typical example is an oxygen pressure signal switch for use in an airplane and which is opened to interrupt a warning signal when the oxygen has increased to a predetermined value and which must be closed to establish such warning signal when said oxygen pressure has decreased to said predetermined value. Obviously any lag or pressure differential in the closing or re-closing of such an oxygen pressure operated switch could have dire consequences.

The primary object of the present invention is the provision of a quick acting fluid operated switch assembly which is operated in opposite directions with a minimum differential between operating pressures.

Another object of this invention is a fluid operated switch assembly having a mechanically stressed diaphragm responsive to an increasing and predetermined pressure to operate said switch assembly in one direction and including means for causing operation of the switch assembly in the opposite direction when the fluid pressure decreases to substantially the same pressure as said predetermined pressure.

A further object of the invention is a fluid operated switch assembly including a snap acting member and one or more means reacting thereagainst so that said switch assembly is operated in opposite directions at substantially the same fluid pressure.

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Still another object is the provision of a fluid operated switch assembly of simple construction, easily assembled and thoroughly reliable in operation.

A still further object is the provision of a fluid operated switch assembly including a switch arm actuated by a fluid pressure responsive diaphragm and a pair of loading assemblies, one of which is adjusted to determine the pressure at which said switch assembly is opened and the other of which is adjusted to cause said switch assembly to close at substantially the same pressure.

Other and further objects of the invention will be evident to those skilled in the art by the disclosure which follows. Reference is hereby made to the accompanying drawings wherein similar reference characters designate similar elements and wherein:

Fig. 1 is a longitudinal section through one form of fluid operated switch assembly according to the invention.

Fig. 2 is a transverse cross-section taken on the line 2—2 of Fig. 1.

Fig. 3 is a plan view of the flexible diaphragm.

Figs. 4 and 5 are cross-sections respectively on the lines 4—4 and 5—5 of Fig. 3 and showing the curvatures of the mechanically stressed diaphragm prior to mounting in the switch assembly.

Fig. 6 is a perspective detail of the switch arm for the switch assembly of Figs. 1 and 2.

Figs. 7 and 8 are longitudinal cross-sections of the preferred form of the fluid operated switch assembly taken respectively on the lines 7—7 and 8—8 of Fig. 12.

Fig. 9 is a cross-section taken on the line 9—9 of Fig. 7.

Fig. 10 is a perspective detail of the supporting plate for the preferred form of my fluid operated switch assembly.

Figs. 11 and 12 are cross-sections taken respectively on the lines 11—11 and 12—12 of Fig. 7.

Fig. 13 is plan view of the inside of the cover member.

Although the illustrated embodiments of my invention are described as responsive to oxygen or gas pressure it shall be understood that the invention is also useful for switch assemblies that are responsive to liquid pressure. Hence, the term "fluid" as used in the specification and claims means and includes gas and/or liquid. In addition the invention in its broadest aspects is not limited to the specific form of switch assem-

bly, loading assembly, and/or flexible mechanically stressed diaphragm shown.

In general both embodiments of the invention comprise a casing providing a chamber for connection to a fluid pressure or fluid supply, a head member closing said chamber, a flexible diaphragm dividing said chamber into a pressure compartment and a switch compartment, a switch assembly in said switch compartment, and means for mechanically loading said diaphragm either in the form of a deformed portion in said diaphragm and/or one or two loading assemblies exerting pressure upon said diaphragm and particularly upon the deformed portion thereof. In the preferred embodiment of the invention one of said loading assemblies directly engages the free end of the switch arm to flex the same.

The simpler embodiment of the invention shown in Figs. 1–6 inclusive is housed in a hollow casing 15, having at one end a threaded nipple 16 for connection to a source of fluid and/or fluid pressure, and having at its other end a flange 17. A head member 18 is preferably composed of an insulating material such as Bakelite and has a pair of terminal studs 19 and 20 molded therein. Terminal studs 19 and 20 are internally threaded to receive screws 21 by which electrical connectors may be attached to said studs 19 and 20. The inner end of said head member 18 is provided with a circular recess 22 within which is mounted a switch assembly. Such switch assembly comprises a contact 23 driven into a hole in the end of terminal stud 20 and a switch arm 24. Said switch arm 24 has a free end 25 carrying a contact 26, has an intermediate enlarged portion 27 provided with an opening 28, and has a semi-circular end portion 29 in parallel spaced relation to said portion 27 and provided with a hole 30 in alignment with opening 28 but eccentric to said semi-circular portion 29. A headed screw 31 extends through hole 30 into the end of the other terminal stud 19. Said switch arm 24 is arranged for convenient and accurate mounting because the head of screw 31 is available for driving through opening 28. Also the engagement of the periphery of semi-circular portion 29 with the wall of circular recess 22 and the eccentric position of screw 31 accurately maintains said switch arm 24 in position with its contact 26 directly opposite contact 23.

A circular washer 32 of dielectric or insulating material such as paper covers the unrecessed inner end of head member 18. A rigid supporting plate 33 of a metal such as steel is provided with a central hole 34 and has its edge abutting against said washer 32. A disc 35 is apertured opposite hole 34 and an insulating cup 36 covers disc 35 and overhangs the periphery of plate 33, both disc 35 and cup 36 are preferably made of paper. An actuating pin 37 has rounded ends and is movably mounted within the hole 34 in plate 33.

A flexible diaphragm 38 is mounted adjacent plate 33 and divides the interior of casing 15 into a switch compartment 39 and a pressure compartment 40. Said flexible diaphragm 38 is composed of a resilient sheet material such as Phosphor-bronze or copper and according to the invention is mechanically stressed in such a manner that an area thereof snaps or moves abruptly from one position to another. The preferred manner of mechanically stressing said diaphragm 38, particularly when provided as a circular disc as shown, is to emboss a circular groove 41 having a semi-circular cross-section concentrically into said diaphragm 38. Such embossing of the groove 41 causes diaphragm 38 to assume an over-all concavo-convex form as illustrated by Figs. 4 and 5, that is concave in the same direction as said groove 41.

The flexible diaphragm 41 is mounted within casing 15 with its peripheral faces clamped between cup 36 and a gasket 42 which is preferably in the form of a ring and composed of a resilient insulating material such as rubber. Said gasket 42, the diaphragm 38, insulating cup 36, disc 35, supporting plate 33 and washer 32 are held under pressure or are clamped between a shoulder 43 on the interior of casing 15 and the unrecessed rim of head member 18 by turning or peening over the flange 17 into the position shown in Fig. 1 and overlying a shoulder 44 of head member 18. Such clamping of the peripheral portions of flexible diaphragm 38 into a plane causes the central portion thereof to be normally displaced from such plane in the direction away from said plate 33. The rounded ends of actuating pin 37 respectively centrally engage the displaced portion of diaphragm 38 and switch arm 24.

An adjustable loading assembly is mounted on head member 18 which is preferably provided centrally with a bore 45 having a restricted portion 45'. A flanged bushing 46 is internally threaded and is pressed into the head member 18 with the flange of said bushing in bore 45 and the remainder of said bushing 46 engaging and extending through the restricted portion 45' of bore 45. A coil spring 47 is placed within bore 45, has one end bearing upon the switch arm 24, and has its other end bearing against a fiber disc 48. A small metal disc 49 is adjacent fiber disc 48 and is engaged by the end of a threaded stem 50 extending through bushing 46.

For operation the pressure compartment 40 is connected to a source of pressure, as by connection of threaded nipple 16 to a pressure container, and the terminal studs 19 and 20 are electrically connected to a signal circuit of any known form. Normally the parts are in the position shown in Fig. 1 and the signal circuit is interrupted. An increase in fluid pressure tends to reverse the flexible diaphragm 38 but such tendency is opposed or resisted by the mechanical stress in diaphragm 38 and by the action of the adjustable loading assembly. However, at a predetermined fluid pressure both those said resistances are overcome and the diaphragm 38 is abruptly reversed causing rapid movement of pin 37 and rapid closing of the switch assembly to complete the signal circuit. Since the flexible diaphragm 38 when reversed abuts against the supporting plate 33 any further increase in pressure can not reverse said diaphragm 38 any farther to increase the pressure required to return it to original position or to cause damage to said flexible diaphragm 38 if subjected to an excessive pressure. Consequently, when the fluid pressure decreases to approximately said predetermined pressure, said diaphragm 38 returns to its original position and the switch assembly opens normally to again interrupt the signal circuit.

By virtue of the mechanical stresses in flexible diaphragm 38 caused by deformation and/or the co-operative action or reaction of the adjustable loading assembly and/or supporting plate 33, the fluid operated switch assembly just described and shown in Figs. 1 and 2 has a small differential between the fluid pressures at which the switch assembly is closed and opened. Adjust-

ment of said loading assembly as by turning of stem 50 either increases or decreases the predetermined fluid pressure at which the switch assembly is operated. For a given design, it has been found that such adjustment to obtain a predetermined operating pressure has little effect upon the differential between the switch closing pressure and the switch opening pressure.

The preferred embodiment of the invention is illustrated in Figs. 7–13, inclusive, and in general has parts corresponding to those of the embodiment shown in Figs. 1–6. The housing 51 for said preferred embodiment comprises an outer cylindrical wall 52 and an inner casing 53 provided with a chamber 54. A plurality of irregular ribs 55, see Figs. 11 and 12, extend between wall 52 and inner casing 53 and are provided with a set of four threaded holes 56 located in quadrature and with a set of three threaded holes 57 for purposes to be later explained. A hollow hexagonal projection 58 on the bottom of housing 51 is provided with a threaded bore 59 for connection to a source of fluid pressure or fluid and a hole 60 extends from the bottom of bore 59 into chamber 54, see Fig. 8.

A ring gasket 61 of a flexible resilient material such as rubber abuts a shoulder 62 within the chamber 54 in casing 53. A flexible diaphragm 63 is provided with a circular concave groove 64 in the same manner as the flexible diaphragm 38 shown in Figs. 3–5 and is placed adjacent gasket 61. Said diaphragm 63 divides the chamber 54 into a pressure compartment 65 and a switch compartment 66.

A supporting plate 67, preferably made of steel, is provided with a central hole 68 and an apertured insulating disc 69 and cup 70 are interposed between supporting plate 67 and said diaphragm 63. A head member 71 of insulating material is provided at one end with a circular recess 72 and has an external intermediate shoulder 73. A soft metal ring 74 encircles head member 71 adjacent shoulder 73. A clamping ring 75 is recessed to fit over ring 74 and head member 71 and a plurality of machine screws 76 extend through clamping ring 75 into threaded holes 56. Upon tightening of said screws 76 the unrecessed end of head member 71 is pressed toward shoulder 62 and ring gasket 61 to clamp the edges of supporting plate 67, cup 70, disc 69 and flexible diaphragm 63 therebetween. As before, such clamping of the peripheral portion of the flexible diaphragm 63 into a plane causes the central portion thereof to be normally displaced from such plane in the direction away from said plate 67, see Fig. 7. As a result the mechanical stresses in said diaphragm 63 resist movement by fluid or fluid pressure until a predetermined pressure is exerted whereupon the diaphragm 63 and particularly the central portion thereof within groove 64 are abruptly reversed, see Fig. 8. The supporting plate 67 and/or the disc 69 limit such reversing movement of said diaphragm 63 to contribute to the minimizing of the differential pressure between diaphragm operation.

The head member 71 has a hollow connector stud 77 embedded or moulded therein and is provided with a pair of polygonal holes 78 and 79 each respectively having restricted circular portions 78' and 79' adjacent the outer face of head member 71. Said head member 71 is also provided with a lateral recess 80 and a hole 81 extending from said recess 80 into the circular recess 72. Preferably the polygonal or hexagonal hole 78 extends through the center of head member 71 and the stud 77 and holes 79 and 81 are arranged at angular spacings of 90°, see Fig. 9, although other arrangements of the stud and holes may be employed.

The switch elements include a switch arm 82 having a free end carrying a contact 83 for engaging a contact 84 riveted to the supporting plate 67. Said switch arm 82 has a re-enforcing strip 82' and has its fixed end curved to correspond to the curvature of the adjacent wall of the circular recess 72. A cross strip 85 overlays the curved end of switch arm 82 and a self-threading screw 86 extends therethrough and into one end of the hollow connector stud 77. The screw 86 is off-center with respect to the curved fixed end of said switch arm 82 which is consequently readily and securely mounted with contacts 83 and 84 in juxtaposition. A hollow connector post 87 is fastened to supporting plate 67 and is located to extend through the hole 81 and into the lateral recess 80 in head member 71. The switch arm 82 is provided with a lateral notch 88 for clearance of said post 87, see Fig. 9. The supporting plate 67 is preferably of iron or steel to provide the necessary rigidity and would ordinarily offer considerable resistance to electrical currents flowing from contact 84 to post 87. Consequently, the supporting plate 67, contact 84 and post 87 are coated with a metal of high electrical conductivity and are preferably electrolytically silver plated.

An actuating pin 89 is movably mounted within the hole 68 in plate 67, is preferably composed of an insulating material and has rounded ends respectively engaging the central portion of flexible diaphragm 63 and switch arm 82. Since the switch assembly is intended to complete a signal circuit for all fluid pressures below a predetermined pressure, the switch arm 82 is normally closed when diaphragm 63 is in the position shown in Fig. 7. Reversal of diaphragm 63 through the medium of actuating pin 89 moves said switch arm 82 to open contacts 83 and 84. However, there may be some difference between the switch opening pressure and switch closing pressure which creates a dangerous condition when the fluid operated switch assembly is employed as a signal switch for low pressure in the oxygen supply of an airplane. Therefore, an important feature of the invention is the provision of a pair of adjustable loading assemblies whereby the predetermined pressure for switch operation may be varied and the switch initiating and return pressures are substantially equal.

Such adjustable loading assemblies may be similar in construction, one being located for a point of application on said switch arm 82 directly opposite actuating pin 89 and the other being located to act upon the free end of said switch arm 82 and preferably opposite a fixed abutment which may be in the form of a contact 84 on supporting plate 67. Said one loading assembly includes an internally threaded bushing 90 having at one end a hexagonal head within polygonal hole 78 and engaging the walls thereof and spun over at the other end to engage the outer face of head member 71. A coil spring 91 within hole 78 has one end encircling the stem of a pin 92 in contact with switch arm 82 opposite actuating pin 89 and has its other end bearing against an insulating disc 93. An adjusting screw 94 is threaded into bushing 90, has its inner end abutting a metal disc 95 adjacent insulating disc 93, and is secured in adjusted position by a lock nut 96.

The other loading assembly includes an internally threaded bushing 97 having at one end a hexagonal head within polygonal hole 79 to engage the walls thereof and spun over at the other end to engage the outer face of head member 71. A coil spring 98 within hole 79 has one end encircling the stem of a pin 99 in contact with the free end of switch arm 82 opposite contacts 83 and 84 and has its other end bearing against an insulating disc 100. An adjusting screw 101 is threaded into bushing 97, has its inner end abutting a metal disc 102 and is secured in adjusted position by a lock nut 103.

The fluid operated switch assembly is preferably sealed to prevent infiltration of dust and dirt and/or accidental or other movement of the adjusting screws 94 and 101. For this purpose a cover 123 has a rabbeted rim 104 fitting into cylindrical wall 52 of housing 51 and machine screws 105 extend through holes 106 in said cover 123 and into engagement with the threaded holes 57 in ribs 55. A pair of bolts 107 extend from the bottom of housing 51 and receive nuts 108 whereby the switch assembly may be mounted on a panel or in any other desired position.

The electrical connections may conveniently be made through cover 123 and so as to be interrupted upon removal thereof. To this end a conductor strip 109 has one end fastened to an insulating plate 110 by the riveted end of a split plug 111 having a collar 111' and a conductor strip 112 has one end fastened to said insulating plate 110 by the riveted end of a split plug 113 having a collar 113'. Said insulating plate 110 and an interposed insulating layer 114 are fastened, as by rivets 115, to the inside of cover 123 and in such position that plug 111 enters and engages the interior of hollow connector stud 77 and plug 113 enters and engages the interior of hollow connector post 87 when cover 123 is placed upon the housing 51. A hollow socket 116 extends from cover 123 and a pair of connector prongs 117 are within said socket 116, extend through insulating layer 114, insulating plate 110 and are respectively riveted to the other end of conductor strips 109 and 112. A plug of conventional design can be fitted into said socket 116 for connection to the terminals of said switch assembly and need not be disconnected when the cover 123 is removed for access to the interior of housing 51 and/or adjustment of screws 94 or 101.

It is obvious from the foregoing description that an increase of the fluid pressure connected to the hexagonal projection 58 and hole 60 of housing 51 will, when a predetermined pressure is reached, cause flexible diaphragm 63 abruptly to reverse and move activating pin 89 and switch arm 82 so that contacts 83 and 84 are opened. Also when said fluid pressure is decreased the diaphragm 63 abruptly returns to its original position and contacts 83 and 84 are closed. Hence a signal circuit containing the switch assembly is effected only when the fluid pressure is above said predetermined pressure.

It has been found that adjustment of the two loading assemblies can be accomplished so that there is very little, if any, difference between the switch initiating pressure and the switch return pressure. For instance adjustment of screw 94 to increase the pressure exerted by spring 91 and pin 92 against the switch arm 82 also increases the loading on flexible diaphragm 63 through actuating pin 89 so that a higher fluid pressure is required to operate said diaphragm and open contacts 83 and 84. Conversely adjustment of screw 94 in the opposite direction will decrease the fluid pressure necessary to operate diaphragm 63 and open contacts 83 and 84. However, the mechanical stresses set up in flexible diaphragm 63 upon reversal thereof and which must be overcome for return to original position oppose such return and ordinarily make it necessary for the fluid pressure to decrease somewhat below that at which the assembly first operated and before the same returns to its original position.

Adjustment of screw 101 to increase the pressure exerted by spring 98 and pin 99 against the free end of switch arm 82 will increase the fluid pressure at which said diaphragm 63 returns to its original position and such return pressure can be adjusted to approach and substantially equal the switch initiating pressure. Inasmuch as the point of application for the loading assembly controlling the switch return pressure is opposite the fixed contact 84 on the rigid supporting plate 67, the action of such loading assembly generally has no appreciable effect upon the switch initiating pressure because most of loading is applied to the fixed contact 84 and little, if any, is transmitted through the switch arm 82 and actuating pin 89 to the flexible diaphragm 63. However, upon the opening of switch arm 82 and contacts 83 and 84, the loading of such assembly is no longer received by fixed contact 84 but is transmitted to said actuating pin 89 and the thin reversed flexible diaphragm 63 immediately to oppose, together with loading assembly controlling the switch initiating pressure, the mechanical stresses in the reversed flexible diaphragm 63 and to approach very nearly the equilibrium condition for return of the flexible diaphragm 63 to its original position. As a result, when the fluid pressure decreases to or only slightly beyond the switch initiating pressure, the mechanical stresses in the reversed flexible diaphragm 63 are overcome and the switch assembly returns to its original or closed position.

Although not necessary, it is preferable first to adjust the switch initiating pressure and then to adjust the switch return pressure. Also during calibration it is advisable to check and adjust the switch initiating pressure and switch return pressure more than once. Within the limits of any particular design it is possible by employment of the present invention to minimize the differential between switch initiating and return pressures over a considerable range of pressures.

Those skilled in the art will recognize that the opened and closed positions of the switch assemblies shown may be reversed as required and that reversal of switch operation in the preferred embodiment merely requires the substitution of a non-conducting abutment in place of contact 84 and opposite the point of application of the loading assembly for controlling the switch return pressure. The present disclosure is merely illustrative and other variations of the fluid operated switch assembly are within the scope of the invention as defined in the claims which follow.

Having now particularly described my invention, what I desire to secure by Letters Patent of the United States and what I claim is:

1. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of variable fluid pressure, a head member closing said chamber, a flexible diaphragm dividing said chamber into a pressure compartment and a switch compartment, said diaphragm being

mechanically stressed toward said pressure compartment, a switch assembly within said switch compartment and having a switch arm movable to closed and open positions and operatively connected to said diaphragm for movement to open position upon reversal of said diaphragm, and a loading assembly engaging and urging said switch arm to closed position and exerting a loading pressure on said diaphragm when the same is reversed to minimize the differential between the fluid pressures for reversal and return of said diaphragm and for opening and closing of said switch assembly.

2. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of variable fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, an annular corrugation in said diaphragm mechanically stressing the central portion of the same away from said switch compartment and adapted to be abruptly reversed by a predetermined fluid pressure, a switch assembly within said switch compartment having a switch arm adapted to be opened and closed by reversal of said central portion of the diaphragm, and a loading assembly engaging and urging said switch arm to closed position and exerting a pressure on the central portion of said diaphragm when the same is reversed to minimize the differential between the fluid pressures for reversal and return of said diaphragm and for opening and closing of said switch assembly.

3. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of variable fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, a supporting plate in said switch compartment adjacent said flexible diaphragm, a deformed portion in said diaphragm, mechanically stressing the same away from said plate, and adapted to be abruptly reversed and pressed against said plate by a predetermined fluid pressure, a switch assembly within said switch compartment and including a switch arm adapted to be opened by reversal of said diaphragm, and a loading assembly urging said switch arm to closed position and exerting a force on said flexible diaphragm primarily when said diaphragm is reversed and for returning said diaphragm to normal position at substantially said predetermined fluid pressure.

4. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of variable fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, a supporting plate in said switch compartment adjacent said flexible diaphragm which is deformed and normally stressed toward said pressure compartment and away from said supporting plate, a switch assembly within said switch compartment and including a switch arm adapted to be opened by reversal of said diaphragm and including an abutment on said supporting plate and engaging said switch arm when said diaphragm is in normal position and said switch arm is closed, and a loading assembly engaging said switch arm opposite said abutment and for exerting a restoring force on said diaphragm when it has moved said switch arm away from said abutment.

5. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, said diaphragm having a deformed portion mechanically stressing the same toward said pressure compartment and adapted to be reversed abruptly by a predetermined fluid pressure, a supporting plate in said switch compartment adjacent said flexible diaphragm to limit reversal thereof, a switch assembly within said switch compartment and including a switch arm adapted to be opened and closed by reversal of said diaphragm and including a contact on said plate and engaged by said switch arm in its closed position, and a loading assembly mounted in said head member and engaging said switch arm at a point opposite said contact and for exerting a restoring force on said diaphragm when said switch arm is in open position.

6. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber and provided with a circular recess, a switch assembly including a switch arm having an elongated contact arm at one end, a semi-circular portion at the other end, and an enlarged intermediate portion provided with an opening, and bent to bring said semi-circular end portion and enlarged intermediate portion into spaced relation, and a fastening means attaching said switch arm to said head member with the periphery of said semi-circular end portion engaging the wall of said circular recess and having a head opposite to and accessible through the opening in said enlarged intermediate portion.

7. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment and mechanically stressed in one direction and adapted to be abruptly reversed by a predetermined fluid pressure, a switch assembly within said switch compartment and having a switch arm moved by reversal of said diaphragm from one position to another position, and a pair of loading assemblies arranged to exert their loads upon said flexible diaphragm in opposition to said fluid pressure, one of said assemblies exerting its load upon said diaphragm at all times to determine a diaphragm initiating fluid pressure and the other of said assemblies exerting its load upon said diaphragm only when the same is reversed and for rendering the diaphragm return pressure substantially equal to said diaphragm initiating pressure.

8. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment and mechanically stressed in one direction and adapted to be abruptly reversed by a predetermined fluid pressure, a switch assembly within said switch compartment and including a switch arm adapted to be opened and closed by reversal of said diaphragm, and a pair of loading assemblies each having a member engaging said switch arm at displaced points of application, one of said assemblies exerting a load to determine the switch initiating pressure and the other of said as-

semblies exerting a load upon said switch arm such that the switch return fluid pressure is substantially the same as said switch initiating fluid pressure.

9. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment and mechanically stressed in one direction and adapted to be abruptly reversed by a predetermined fluid pressure, a switch assembly within said switch compartment and having a switch arm moved by reversal of said diaphragm from one position to another position, an abutment in said switch compartment and located to engage said switch arm in said one position thereof, and a pair of loading assemblies each having a member engaging said switch arm at displaced points of application one of which is opposite said abutment whereby the load of such assembly is transmitted to said abutment when said switch arm is in said one position and is applied to said switch arm and flexible diaphragm when said switch arm is in said other position and said diaphragm is reversed.

10. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment and mechanically stressed in one direction and adapted to be abruptly reversed by a predetermined fluid pressure, a supporting plate in said switch compartment adjacent said flexible diaphragm to limit reversal thereof, a switch assembly within said switch compartment, including a contact on said plate and a switch arm having a free end movable into and out of engagement with said contact, an actuating member movably mounted between said diaphragm and said switch arm and for transmitting the movement of said flexible diaphragm to said switch arm, and a pair of loading assemblies mounted in said head member and each having a member engaging said switch at displaced points of application, one of said members engaging said switch arm opposite the contact on said plate and the other of said members engaging said switch arm opposite said actuating member.

11. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, a stationary supporting plate in said switch compartment adjacent said flexible diaphragm to limit movement thereof by fluid pressure, and a switch assembly within said switch compartment and including a contact on said supporting plate, said contact and said supporting plate constituting an electrical path to said switch assembly.

12. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, a stationary supporting plate in said switch compartment adjacent said flexible diaphragm to limit movement thereof by fluid pressure, a switch assembly within said switch compartment and including a contact on said supporting plate, and a connector mounted on said plate and extending through said head member.

13. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, a stationary supporting plate in said switch compartment adjacent said flexible diaphragm to limit movement thereof by fluid pressure, a switch assembly within said switch compartment and including a contact on said supporting plate, a connector stem mounted on said plate and extending through said head member, and a coating of high electrical conductivity covering said plate, contact and stem.

14. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, a stationary supporting plate in said switch compartment adjacent said flexible diaphragm to limit movement thereof by fluid pressure, a switch assembly within said switch compartment and including a contact on said supporting plate and a switch arm provided with an opening, and a connector stem mounted on said plate and extending through said opening in said switch arm and through said head member.

15. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, an insulating head member for closing said chamber, provided with three holes in diametrically spaced relation, and having a connector sleeve in one of said holes, a switch arm having one end fastened to said sleeve and extending over said other two holes, and a pair of adjustable loading assemblies each mounted in one of said other two holes and each comprising an internally threaded sleeve attached to said head member, a spring member within said hole and having one end exerting a pressure upon said switch arm, and a threaded stem extending through said sleeve and engaging the other end of said spring member.

16. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, an insulating head member for closing said chamber, and provided with a polygonal hole having a restricted portion at the outer end thereof, and a bushing having at its inner end a polygonal head complementary to said hole, having a central portion in the restricted portion of said hole, and having at its outer end a deformed flange engaging said head member.

17. A fluid operated switch assembly comprising a casing providing a chamber for connection to a source of fluid pressure, a head member for closing said chamber and provided with a central hole and three holes spaced in quadrature therearound, a hollow connector sleeve in one of said three holes, a flexible diaphragm dividing said chamber into a switch compartment and a pressure compartment, having a deformed portion mechanically stressed toward said pressure compartment and adapted to be reversed abruptly by fluid pressure, a supporting plate in said switch compartment adjacent said flexible diaphragm to limit its movement by said fluid pressure and provided centrally with an opening, a switch assembly within said switch compartment and in-

cluding a contact on said supporting plate and a switch arm fastened to said connector sleeve, overlying said central hole and the diametrically opposite hole, and provided with a lateral notch, a hollow connector stem mounted on said plate and extending through said notch and said head member, an actuating member movably mounted within the opening in said plate and engaging said switch arm and the deformed portion of said flexible diaphragm, a pair of adjustable loading assemblies in said head member, one in the central hole opposite said actuating member and the other in the hole opposite the contact on said plate, and a cover member for said casing and carrying a pair of spaced connector terminals adapted detachably to engage respectively said hollow connector sleeve and said hollow connector stem when said cover member is fitted onto said casing.

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