Nov. 23, 1943. E. MARTIN ET AL 2,335,073

PRESSURE ACTUATED SWITCH

Filed Dec. 27, 1940

Fig. 1

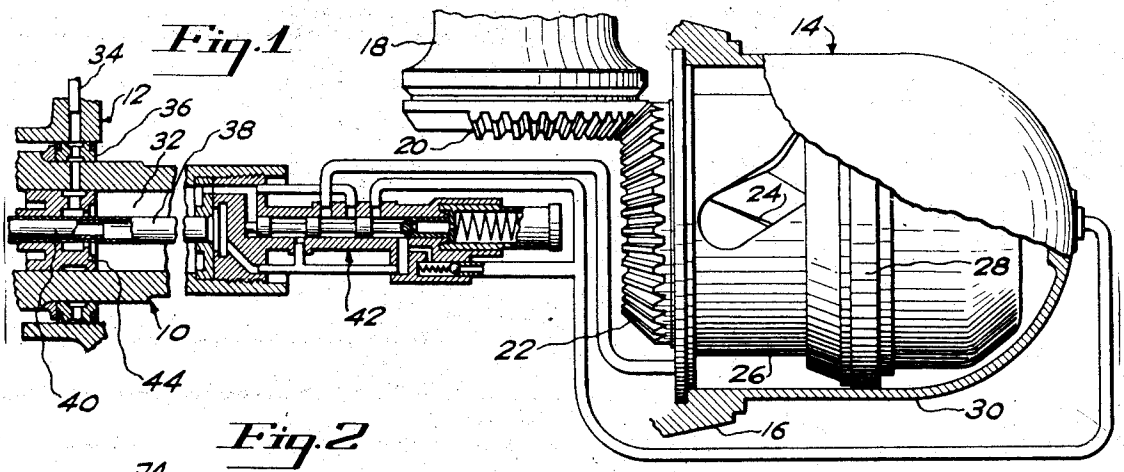


Fig. 2

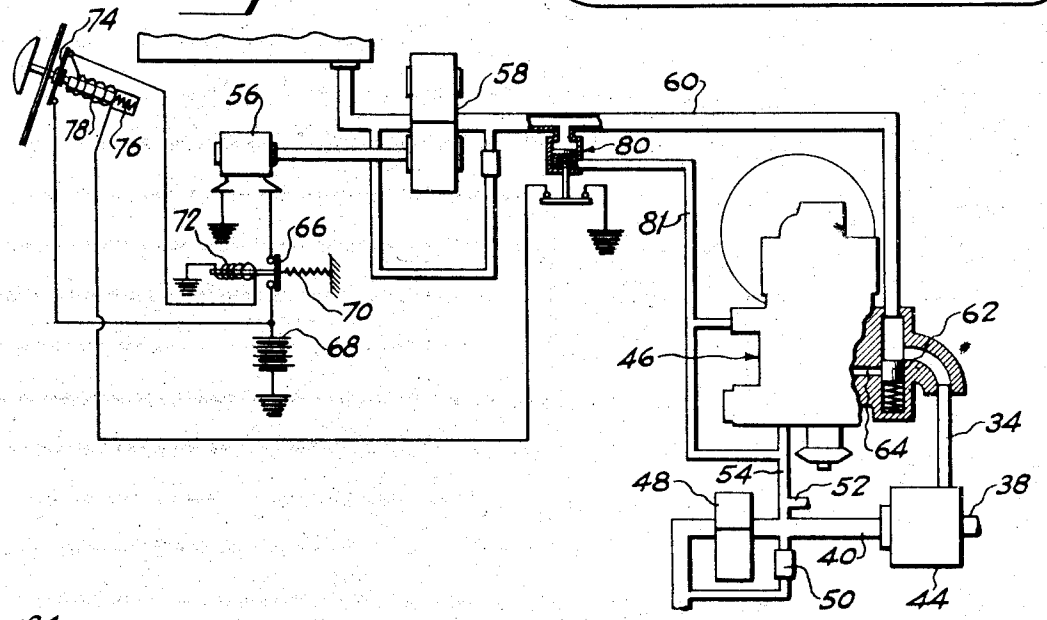


Fig. 3

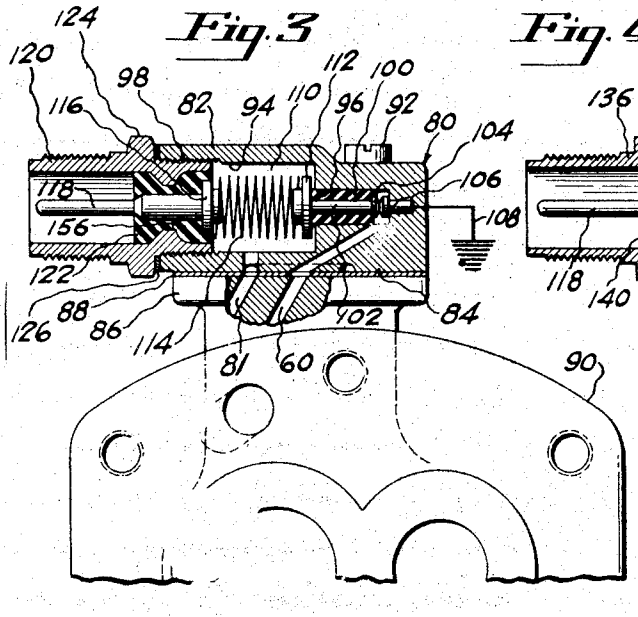
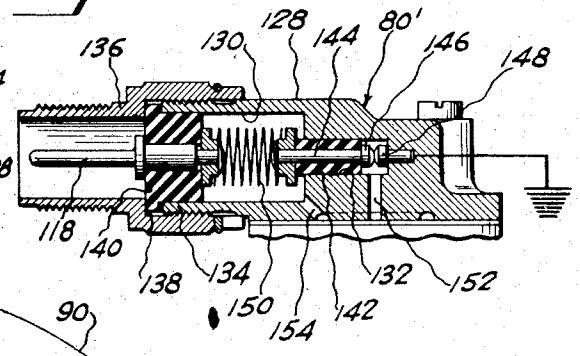


Fig. 4



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PRESSURE ACTUATED SWITCH

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13 Claims. (Cl. 200—82)

This invention relates to improvements in hydraulic control devices and has particular reference to an improved control unit for a hydro-controllable feathering-type propeller.

An object of the invention resides in the combination of an improved pressure actuated electric switch for discontinuing the application of pressure to a hydraulic mechanism when the pressure has reached a predetermined value.

A further object resides in the provision of an improved pressure actuated switch of the character indicated which is responsive to a difference in the inlet and exhaust pressures of a hydraulic mechanism such as a propeller pitch changing mechanism.

A still further object resides in the provision of an improved pressure actuated switch of the character indicated which may be connected into a hydraulic circuit without danger of leakage of hydraulic fluid through or from the switch mechanism and in which the switch contact points are immersed in hydraulic fluid which tends to damp any tendency of the electric current to arc at the contact points.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawing in which like reference numerals are used to designate similar parts throughout, there is illustrated in two somewhat different forms a suitable mechanical arrangement for the purpose of disclosing the invention. The drawing, however, is for the purpose of illustration only and is not to be taken as limiting or restricting the invention since it will be apparent to those skilled in the art that various changes in the illustrated construction may be resorted to without in any way exceeding the scope of the invention.

In the drawing,

Fig. 1 is a schematic partly sectional view of a hydro-controllable feathering-type propeller.

Fig. 2 is a schematic view of the control apparatus for such a propeller schematically illustrating the manner in which a pressure actuated switch such as that constituting the invention is incorporated therein.

Fig. 3 is a detailed sectional view on an enlarged scale of a pressure actuated switch constructed according to the invention, the switch being shown in operative position with respect to a member of the control apparatus through which fluid conduits extend, and

Fig. 4 is a detailed sectional view on an enlarged scale of a slightly modified form of pressure actuated switch constructed according to the invention.

Referring to the drawing in detail, the numeral 10 generally indicates a propeller driving shaft projecting from an engine generally indicated at 12 and carrying a hydro-controllable feathering-type propeller generally indicated at 14. This propeller may be of the type particularly illustrated and described in my co-pending United States application Serial No. 184,792, filed January 13, 1938, for Feathering propeller control, and may have a hub 16 carrying a plurality of blades, one of which is indicated at 18, rotatably mounted therein for pitch changing movements. Each blade may be provided with a gear member 20 all of which mesh with a gear 22 carried by a rotatable cam member 24 which is in turn supported in a fixed cam member 26 for changing the pitch of the propeller blades. The cam 24 may be rotated by means of a piston 28 reciprocable in a relatively fixed cylinder 30 and carrying cam followers as particularly illustrated and described in United States application Serial No. 184,792, referred to above. Hydraulic fluid is led to a passage 32 in the shaft 10 from a suitable conduit 34 and oil transfer bearing 36 and hydraulic fluid from a different source is also led to a conduit 38 within the propeller shaft through a tubular connection 40. Both of the passages 32 and 40 lead to a valve generally indicated at 42 which, when subjected to pressures below a predetermined limit, connects the passage 32 with the interior of the cylinder 30 at the pitch increasing side of the piston 28 and connects the passage 38 with the interior of the cylinder 30 at the pitch decreasing side of the piston. This position of the valve 42 is shown in Fig. 1. When subjected to pressures above the above mentioned predetermined limits the connection of these passages to the respective ends of the cylinders is reversed. The passage 32 is then connected to the interior of the cylinder at the pitch reducing side of the piston 28 while the passage 38 is connected to the interior of the cylinder at the pitch increasing side of the piston. Within the shaft 10 the passages 32 and 38 are separated and the end of the passage 32 is closed by a suitable plug 44 disposed in the bore of the shaft. Referring now to Fig. 2 it will be observed that the conduit 34 leads to the outlet side of a governor, generally indicated at 46 and the passage 38 is connected by the conduit 40 with a pump 48 which may be the engine oil supply pump the outlet pressure of which is controlled by the pressure relief valve 50. From the pump outlet conduit 40 a passage 52 leads to the

engine lubricating system and a passage **54** leads to the governor **46**. This governor may include a booster pump and a governor actuated valve disposed between the outlet of the booster pump and the passage **34** which construction is particularly illustrated and described in United States Patent No. 2,204,640, issued June 18, 1940, to Elmer E. Woodward for Governor mechanism.

With the arrangement so far described it is apparent that oil at engine lubricating oil pressure will be continuously supplied to the interior of the cylinder **30** at the pitch decreasing side of the piston **28** while oil from the governor, at a pressure controlled by the governor booster pump, will be supplied to the cylinder **30** at the pitch increasing side of the piston **28** under the control of the governor actuated valve which acts to connect the space at the pitch increasing side of the piston with the outlet of the booster pump or with a drain, presently to be described, as the governor demand for a change of speed may require. As is clearly set forth in my co-pending United States application Serial No. 184,792, referred to above, the pitch changing mechanism is provided with some form of intermediate pitch limit stop which will prevent the mechanism from turning the blades beyond a predetermined high pitch position when actuated by hydraulic fluid at the pressure supplied by said governor booster pump to keep the pitch within the range of constant speed control.

When it is desired to bring the propeller to a feathered position high pressure fluid from any suitable source is supplied to channel **60** and preferably electrically controlled. In the structure chosen for disclosing the invention a motor **56** is energized to drive a high pressure pump **58** the outlet of which is connected through a channel **60** with a valve **62** which acts, when subjected to high pressure fluid from the pump **58** to block off the governor outlet channel **64** and connect the channel **34** directly with the outlet of the pump **58** to supply hydraulic fluid at the increased pressure, sufficient to override the intermediate pitch limit stop mentioned above, to the space within the cylinder **30** at the pitch increasing side of the piston **28** to rotate the propeller blades to their limiting high pitch or feathered position.

Energization of the motor **56** is controlled by a relay switch **66** interposed in the circuit between the motor and the source of power such as the battery **68**. This relay switch is urged toward its open position by a spring **70** and is closed by a solenoid **72** the energization of which is controlled by a manually operable switch **74**. Switch **74** is urged toward its open position by a spring **76** and retained in closed position by a solenoid **78** the energizing circuit of which includes the pressure operated switch **80** hydraulically connected with the channel **60** in such a manner that fluid pressure in the channel **60** at a predetermined value will open this switch. Opening of switch **80** de-energizes the solenoid **78** and permits switch **74** to open under the influence of the spring **76** thus de-energizing the solenoid **72** and permitting the relay switch **66** to open under the influence of the spring **70**. Opening of switch **66** de-energizes the motor **56** and stops the pump **58**. The predetermined pressure value selected is a value slightly above the maximum required to turn the propeller blades in a pitch increasing direction between intermediate high pitch position and feathering position indicating that the propeller has reached its full feathered condition.

Since the pressure necessary to feather the propeller is not always the same, varying somewhat with the viscosity of the hydraulic fluid and the resistance met by the fluid exhausted from the space at the pitch decreasing side of the piston it has been found desirable to connect the space at the side of the switch actuating member opposite the space at the side connected with the channel **60** to the channel **40** through which the fluid vents from the pitch decreasing end of the cylinder **30**. Such a fluid connection is indicated at **81**. This arrangement causes the pressure actuated cut-out switch to operate on the difference between the pressure of the fluid supplied to the pitch increasing side of the pitch changing mechanism and the pressure of the fluid vented from the pitch decreasing side of the mechanism when the propeller is brought to its feathered position which arrangement gives a more sensitive action of the switch and insures that the propeller will have reached a fully feathered condition before the feathering circuit is broken by the switch **80**.

It has been assumed that the switch **80** shown in Fig. 2 is of the same form as the switch shown in Fig. 3 which has been generally designated by the numeral **80** while the somewhat modified form of switch shown in Fig. 4 is generally designated by the numeral **80'**.

The switch **80** comprises a casing **82** which may be conveniently formed as a metal casting or forging. This casing has a flat plate **84** for cooperation with the flat face of a pad **86** to which the switch is attached, a gasket **88** being preferably included between the switch and the pad to prevent leakage of fluid through this joint. The pad **86** is formed integrally with some portion of the control apparatus, for example with the base or pad **90** of the governor **46** and the switch is secured to the pad by suitable means such as the screws **92**. Within the casing **82** there is a cylindrical bore **94** having a reduced cylindrical extension **96** at one end thereof the end of which is closed by the wall of the casing and having an internally screw threaded portion **98** at the opposite open end thereof. An insulating bushing **100** is molded onto a plunger **102** and positioned in the reduced extension **96** of the cylindrical bore. The plunger **102** carries a contact portion **104** and extends through this bushing to a position near the closed end of the extension **96**. A second contact member **106** is secured in the closed end of the extension **94** in position to cooperate with the contact member **104** and is connected with a return to the battery **68** which may be through the ground indicated at **108**. At its end opposite the contact member **104** the plunger **102** projects into the chamber **110** formed by the inner portion of the bore **94** and carries an abutment **112** for one end of a compression spring **114** the opposite end of which bears against an abutment **116** formed on the inner end of a connector **118** fixed in a terminal member **120** by a bushing **122** of insulating material. The terminal member **120** is provided with an externally threaded portion which cooperates with the threaded portion **98** of the bore **94** and with a shoulder **124** which provides a nut for turning the member **120** and also cooperates with the gasket **126** to provide a seal between the member **120** and the casing **82**. It is to be understood, however, that the terminal member may be secured to the casing by other suitable

means such, for example, as flange bolts or a gland nut. The channel 81 leads into the chamber 110 and the channel 60 is led to the space at the closed end of the cylindrical extension 96 of the bore 94 which space contains the contact members 104 and 106. The bushing 100 is preferably formed of insulating material such as a thermo-setting phenolic condensate and is dimensioned to provide a positive clearance between itself and the wall of the bore 96 so that a small quantity of the fluid forced under pressure into the space between the inner end of this bushing and the closed end of the bore will pass into the chamber 110 defined by the larger bore 94, and into the drain channel 81 to prevent accumulation of sludge and congealing of oil in the contact chamber. The spring 114 is sufficiently resilient to permit separation of the contact members 104 and 106 when the pressure of the fluid in the space at the closed end of the bore reaches the selected value at which the circuit through the pressure switch is to be broken. When the pressure of the fluid in the space containing the contact members 104 and 106 reaches the value indicated these embers will be separated breaking the circuit and de-energizing the feathering pump motor.

While the electrical contact between the members 102 and 118 is shown to comprise the spring 114 it is to be understood that an additional flexible electrical conduit can be secured between these two members if desired.

In the slightly modified form of the invention shown in Fig. 4, the casing 128 is substantially the same as the casing 82 of the switch shown in Fig. 3 and has an internal bore 130 with a cylindrical extension 132 at one end thereof the end of the extension being closed by the end wall of the casing. At the open end of the bore 130 casing is provided with a cylindrical extension 134 having external screw threads for the reception of the internal screw threads in the end of a terminal member 136. This terminal member is provided with an internal shoulder 138 which engages the edge of a circumferential flange provided on a sealing member 140 which carries the connecting plug 118. The body portion of the sealing member 140 is disposed within the cylindrical portion 134 of the casing 128 to provide a firm support for the member in the casing. With this arrangement seal member 140 can be independently removed from the casing when the terminal member 136 has been removed. The extension 132 contains a resilient bushing 142 of some suitable material such as rubber or synthetic rubber and through this bushing extends a stem 144 similar to the stem 102 and carrying a contact member 146 which cooperates with a contact member 148 secured in the end wall of the casing. A spring 150 extends between suitable abutments carried respectively by the members 118 and 144 and, if desired, a flexible electrical conduit may be connected between these members. A channel 152 leads to the space containing the contact members 146 and 148 and a channel 154 leads into the chamber containing the spring 150, the channel 152 being arranged for connection with the high pressure channel 60 in the governor base and the channel 154 being arranged for connection with the low pressure channel 81 in the governor base in the manner described above.

The switches shown in Figs. 3 and 4 both operate in the same manner, the structural differences shown in these two embodiments of the invention being mainly important from a manufacturing standpoint. In the switch mechanism shown in Fig. 3 the sealing member 122 is molded into the terminal member 120 around the internal shoulder 156 and the connecting plug 118 which means that the terminal member and the connecting plug both have to be at hand when the molding or vulcanizing process is performed and that the three members namely the terminal 120, the bushing 122 and the connecting plug 118 constitute a single unit when the bushing has been formed in place. In the form shown in Fig. 4 the seal member or bushing 140 can be made separately and thereafter the connecting plug 118 can be inserted through an aperture in the bushing and riveted in place and the unit comprising the bushing 140 and connecting plug 118 can be assembled with the switch when the terminal 136 is screwed into place on the cylindrical extension of the casing. In this case the terminal 136 and connecting plug 118 do not have to be incorporated in the structure during the molding or vulcanizing process and these various units can be brought together and assembled by the manufacturer or user of the switch.

While two slightly different mechanical arrangements have been hereinabove described and illustrated in the accompanying drawing it is to be understood that various other structural modifications may be resorted to without in any way changing the method of operation of the switch or exceeding the scope of the invention so long as the structure provides that the make and break contact members are immersed in hydraulic fluid at the time they become operative to interrupt the circuit including this switch. While it is desirable that the switch operate on the difference between the high pressure and the low pressure sides of the hydraulic mechanism, it is within the scope of the invention that the switch should operate only on the pressure of the high pressure side.

While a suitable mechanical embodiment in two somewhat different forms has been hereinabove described and illustrated in the accompanying drawing for the purpose of disclosing the invention, it is to be understood that the invention is not limited to the particular embodiment so described and illustrated, but that such changes in the size, shape and arrangement of the various parts and of the materials of which they are formed may be resorted to as come within the scope of the sub-joined claims.

Having now described the invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows:

1. A switch comprising a casing, a contact member fixed therein, a sleeve of insulating material within said casing, and a movable contact member supported thereby for movement toward and from said fixed contact member, means resiliently urging said movable contact member into contact with said fixed contact member, said casing having two pressure chambers therein separated by said sleeve and passages for introducing fluid under pressure simultaneously into said chambers, whereby variations of fluid pressure within said chambers will open said switch and permit said switch to close.

2. A switch comprising a casing having a chamber therein and a counterbore of smaller diameter than said chamber extending from said chamber to adjacent one end of said casing, a fixed contact member extending through said casing into

the closed end of said counterbore, a bushing of insulating material separating the closed end of said counterbore from said chamber, a movable contact member mounted in said bushing and extending into said counterbore, resilient electrical conducting means urging said movable contact member into contact with said fixed contact member and forming a part of the circuit controlled by said switch, and a passage in said casing opening into said counterbore at the closed end thereof to admit fluid under pressure to said counterbore at the side of said bushing opposite said resilient means to open said contact.

3. In a fluid pressure actuated cut-out switch, a hollow casing, movable means comprising an electrical contact member and an insulating bushing therefor dividing the interior of said casing into two separate chambers, respective fluid channels leading to said chambers, and a fixed contact member in one of said chambers in electrical contact with said casing and cooperating with said movable contact member to make and break an electrical circuit including said switch, an electrical connector insulatedly carried at one end of said chamber, and a spring urging said contact members together and constituting the sole electrical connection between said connector and said movable contact.

4. The arrangement as set forth in claim 3 in which said bushing is dimensioned to provide clearance between itself and said casing to provide a restricted passage for the flow of fluid from one of said chambers to the other chamber.

5. A fluid pressure actuated electric switch comprising, a unitary casing adapted to be mounted on a machine surface and having at one side thereof a flat external surface and interiorally thereof a bore open at one end and closed at the opposite end and providing tandem pressure chambers, and fluid passages extending one from each pressure chamber and opening to said flat surface, a fixed contact member mounted in said casing at the closed end of said bore, an insulating bushing slidable in said bore between said fluid passages, and a movable contact member carried by and extending through said bushing.

6. A fluid pressure actuated electric switch comprising, a unitary casing adapted to be mounted on a machine surface and having at one side thereof a flat external surface and interiorly thereof a bore open at one end and closed at the opposite end and providing tandem pressure chambers, and fluid passages extending one from each pressure chamber and opening to said flat surface, a fixed contact member mounted in said casing at the closed end of said bore, an insulating bushing slidable in said bore between said fluid passages, and a movable contact member carried by and extending through said bushing, said contact members constituting a stop for said busihng to restrain said bushing from covering the end of one of said fluid passages.

7. In a fluid pressure actuated switch, a unitary casing comprising a flat plate base portion having a flat surface, and a cylindrical portion extending across said base portion and provided with an internal bore the axis of which is substantially parallel to said flat surface and which is closed at one end by the casing wall, a fixed contact member secured in said casing, a plunger in said bore separating said bore into two fluid chambers each connected through a respective fluid channel with the face surface of said base portion, and a movable contact member carried by said plunger.

8. In a fluid pressure actuated switch, a unitary casing comprising a base portion having a flat face surface, and a chamber portion having a bore the axis of which is substantially parallel to said face surface and which is closed at one end by a wall of said casing, a fixed contact member carried by said casing at one end of said bore, means including a movable contact member dividing said bore into separate pressure chambers each connected through a respective fluid channel with said flat face surface, and a current conducting spring in said bore resiliently urging said movable contact member toward said fixed contact member.

9. In an oil pressure actuated switch, a casing having a high pressure chamber and a low pressure chamber and an intercommunicating cylinder wall therebetween, a fixed contact in said high pressure chamber, an insulated piston slidable in said cylinder wall and carrying a movable contact, and a spring in said low pressure chamber electrically connected to said movable contact and urging the same into engagement with said fixed contact, said piston being smaller than said cylinder wall and having a clearance to permit passage of oil from said high pressure chamber around and past said piston to said low pressure chamber.

10. In an oil pressure actuated switch, a casing having a high pressure chamber and a low pressure chamber and an intercommunicating cylinder wall therebetween, a fixed contact in said high pressure chamber, an insulated piston slidable in said cylinder wall and carrying a movable contact, and a spring in said low pressure chamber urging said piston toward said fixed contact to maintain said movable contact in engagement therewith, said casing having a passage connected with an actuating system and said high pressure chamber for admitting high pressure oil from the actuating system to said high pressure chamber and another passage connected with said actuating system and said low pressure chamber for returning oil from said low pressure chamber to the actuating system, and said piston being smaller than said cylinder wall and having a clearance for the passage of oil from said high pressure chamber to said low pressure chamber.

11. In an oil pressure actuated switch, a casing having a high pressure chamber and a low pressure chamber, a fixed contact in said high pressure chamber, an insulated piston subject to said high pressure and carrying a movable contact, a spring in said low pressure chamber electrically connected to said movable contact and urging the same into engagement with said fixed contact, said low pressure chamber having an insulated wall, and a terminal carried by said wall forming a seat and a guide for said spring and forming a stop for said movable contact.

12. In an oil pressure actuated switch, a metal casing having a first bore and a smaller bore extending therebeyond, a fixed contact grounded in said smaller bore, an insulated piston slidable in said smaller bore and carrying a movable contact having a head extending into said first bore, an insulated plug closing said first bore and supporting a terminal stem having a head extending into said first bore, and a coiled compression metal spring surrounding said terminal head and seated thereon and bearing against the head of said movable contact.

13. A switch forming a portion of a liquid system and comprising a casing having a pressure chamber therein, a fixed contact member extend-

ing into said chamber, a second chamber in said casing, a slidable bushing of insulating material separating said chambers and having a contact member mounted therein and extending into the chamber containing said fixed contact, said bushing having clearance in said casing to provide a restricted connection between said chambers, means to admit liquid under pressure from said liquid system to said chamber containing said fixed contact to open said contacts, and means for conducting liquid from said second chamber to said liquid system, some of said liquid under pressure moving through said restricted connection from the contact chamber to said second chamber to prevent an accumulation of sludge and congealing of liquid in said contact chamber.

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