

[72] Inventor **Richard V. Wiese**
Minneapolis, Minn.
[21] Appl. No. **24,283**
[22] Filed **Mar. 31, 1970**
[45] Patented **Oct. 19, 1971**
[73] Assignee **Graco Inc.**
Minneapolis, Minn.

FOREIGN PATENTS

471,458 5/1969 Switzerland..... 200/83 PA

Primary Examiner—Robert K. Schaefer
Assistant Examiner—Robert A. Vanderhye
Attorneys—Frederick E. Lange and William C. Babcock

[54] **PRESSURE CONTROL ASSEMBLY WITH TWO SWITCH HOUSINGS AND AN OPEN SPACE BETWEEN THE PRESSURE SOURCE AND CONTACTS**
12 Claims, 3 Drawing Figs.

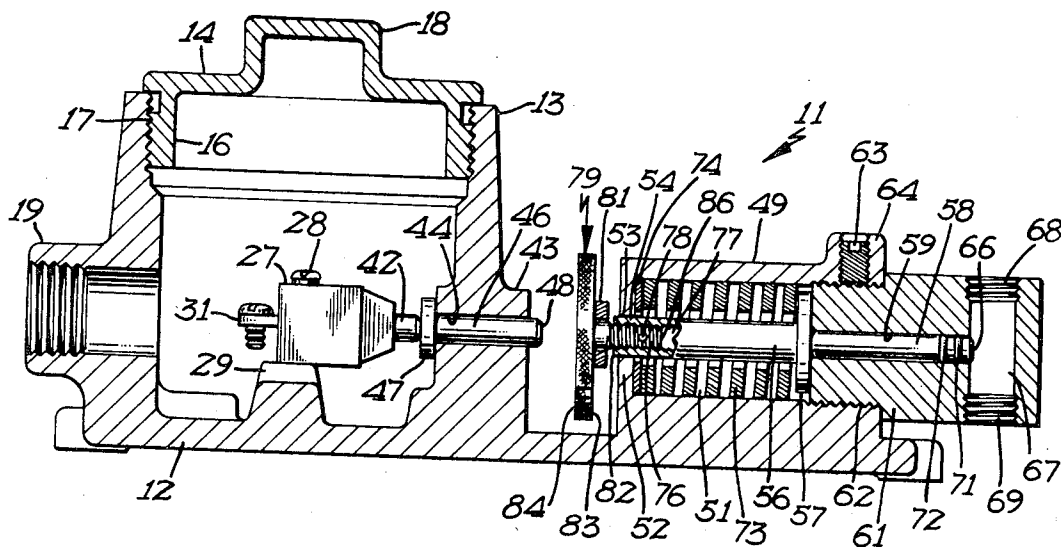
[52] U.S. Cl..... 200/82 C,
200/82 R, 200/172 A
[51] Int. Cl..... H01h 35/38
[50] Field of Search..... 200/82 R,
82 A, 83 J, 83 G, 83 PA, 172 A, 82 C

References Cited

UNITED STATES PATENTS

3,326,089	6/1967	Machado.....	200/83 J UX
2,759,061	8/1956	Edelman	200/82 C
3,232,182	2/1966	Gilbert	92/13
3,422,845	8/1966	Behne et al.	200/82 R X
2,292,546	8/1942	Rockwell.....	200/82 C
2,432,312	12/1947	Hasselhorn.....	200/83 G UX
3,211,878	10/1965	Holden.....	200/172 A
3,306,999	2/1967	Goodwin.....	200/82 R

ABSTRACT: A pressure control unit includes a housing having spaced wall portions defining a switch chamber and a separate pressure responsive actuator chamber. Cooperating switch actuating and pressure responsive actuator plungers in the walls of the respective chambers are aligned with each other for operation of the switch in response to pressure responsive movement of the actuator plunger. An adjusting knob is carried by one of the plungers in the space between the chambers where such knob is accessible for manual adjustment of the switch operating pressure. The pressure chamber includes a special construction involving a spring housing portion and a cooperating plunger guide, in which the plunger guide provides a variety of functions including means for connection to a source of control pressure, a pressure chamber in which the actuator plunger may be exposed to such pressure, a guide for the actuator plunger, and a means for retaining the plunger and a suitable compression spring within the spring housing portion. The construction provides an explosion proof chamber for the switch which is separated and isolated from the pressure chamber in which the fluid whose pressure is to be controlled, or used for control, might have flammability characteristics which would represent a hazard in the presence of the electric switch contacts.



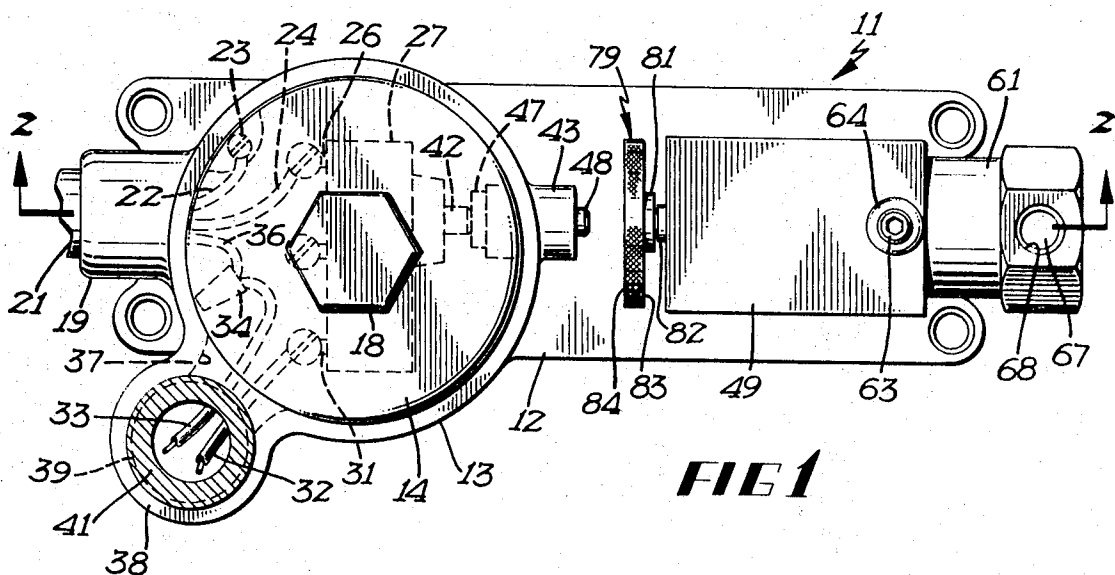


FIG 1

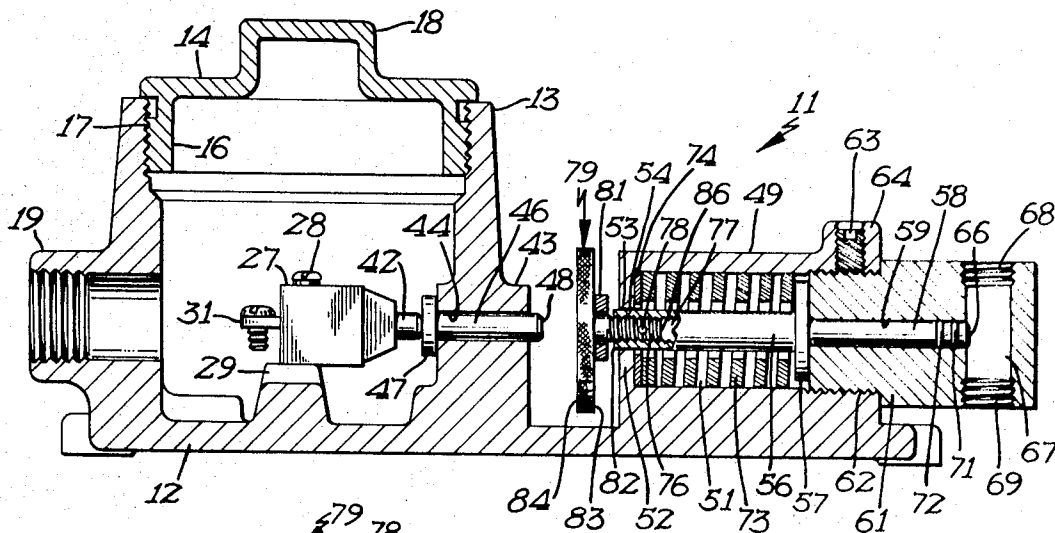


FIG 2

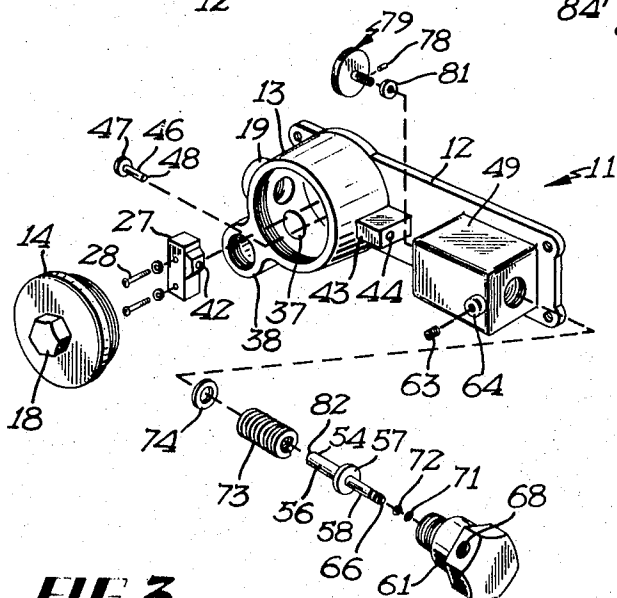


FIG 3

INVENTOR
RICHARD V. WIESE

BY *William C. Burdick*
ATTORNEY

PRESSURE CONTROL ASSEMBLY WITH TWO SWITCH HOUSINGS AND AN OPEN SPACE BETWEEN THE PRESSURE SOURCE AND CONTACTS

BACKGROUND OF THE INVENTION

Pressure control units are known in which an electric switch is actuated in response to movement of a member which is urged in one direction by the pressure to be controlled, or used for control, and in the other direction by a suitable resilient spring member. Various adjustments have also been provided for such switches to at least preset the operating range of pressures at which the switch will be actuated. If the material whose pressure is to be controlled, or used for control, is such that an explosion might conceivably result from sparking at the switch contacts, there is a definite explosion hazard if the switch construction permits any leakage of such fluid into the vicinity of the switch contacts.

SUMMARY OF THE INVENTION

The pressure control assembly of the present invention has a main body or housing member which includes walls defining a switch chamber in which an electric switch may be supported and enclosed in an explosion-proof manner. The switch chamber has a first wall portion in which a switch actuating plunger is mounted so that the plunger substantially closes the opening but may be actuated by forces applied externally of the switch chamber to the outer end of such plunger. The assembly also includes a pressure actuator housing, one wall of which is spaced from the wall portion of the switch housing by a predetermined distance. The second wall portion includes an opening aligned substantially with the plunger opening in the switch chamber wall. A pressure responsive actuator plunger is slidable within this second opening and is designed for movement back and forth along the common axis of the two openings in response to pressures to which the other end of such plunger is exposed. A spring within the housing for the pressure actuator normally urges the actuator plunger away from the switch housing and the end of such actuator plunger farthest from the switch housing is carried in a plunger guide member which has a pressure chamber in its outer end to which the plunger end is exposed.

An adjusting knob is carried in the space between the respective wall portions of the switch chamber and the pressure actuator housing and is mounted on one of the plungers in such a way that the effective axial length of such plunger may be adjusted by movement of such knob. The knob engages or is engaged by the other plunger to provide an effective operating connection between the two plungers. Thus, there is no single member penetrating both the switch housing and the pressure actuator housing, the operative connection between the plungers and the respective housings is provided by an adjusting member in the open space between the housings, and the possibilities of leakage of the fluid whose pressure is to be controlled, or used for control, from the pressure actuator housing to the switch chamber is minimized or eliminated. The provision of the respective first and second wall portions which are fixed in position a predetermined distance apart facilitates the adjustment of the operating pressures of the switch by a member which is conveniently accessible without opening either the switch chamber or the pressure actuator housing, and these fixed wall portions also provide useful limiting stops for the movement of the pressure responsive actuator plunger regardless of the maximum and minimum pressures to which the plunger may be exposed.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings which form a part of this application, and in which like reference characters indicate like parts,

FIG. 1 is a plan view of a pressure control assembly according to the present invention;

FIG. 2 is a sectional view on the line 2—2 of FIG. 1, with the wiring omitted for clarity and certain elements shown in side elevation rather than in section, and

FIG. 3 is an exploded view to facilitate understanding of the manner in which the parts may be assembled and disassembled.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown particularly in FIGS. 1 and 2, the pressure control assembly according to the present invention includes a main housing member indicated generally at 11. This housing includes a flat base portion 12 provided with openings at its four corners through which mounting bolts may pass to connect the housing to a suitable support.

At one end of the base portion there is a switch housing or chamber which is formed in this embodiment by a cylindrical wall portion 13 integrally formed with the base 12 as parts of a common casting. Thus, an open topped cylindrical switch chamber is provided which is closed at its upper end by a cover member 14. The cover has a peripheral depending flange 16 provided with external threads which engage mating internal threads at the top of the cylindrical wall 13 to provide an interengaging screw-threaded connection 17 between these parts. A hexagonal-shaped projection 18 on the top of cover 14 may be engaged by a suitable wrench to remove or assemble the cover.

A tubular extension 19 projecting at one end of the unit from the cylindrical wall 13 provides an opening communicating with the switch chamber for entrance of an electric supply cord 21. The supply cord is preferably of the three-wire grounded type in which one wire 22 is grounded at 23 to the housing wall 13. One supply wire 24 is then connected to the terminal 26 of a suitable electric switch member 27. Switch 27 is mounted within the switch chamber by means of bolts 28 threaded into a supporting boss 29 projecting upwardly from the base portion 12 of the housing. The other terminal 31 of the switch 27 is connected to one of the wires 32 which leads to the electric motor to be controlled. The other motor supply wire 33 is connected at 34 to the remaining electric input wire 36 of the supply cord 21. Wires 32 and 33 extend outwardly through an opening 37 in the cylindrical switch chamber wall 13 and into an elbow connection or projection 38 which is internally threaded at 39 for interconnection with the fitting 41 of a suitable enclosed conduit through which the wires pass to the electric motor (not shown).

Switch 27 may be of known construction with an appropriate rating for the voltage and amperage of the motor to be controlled. The switch means includes the usual contacts supported within the second or inner housing which is fully enclosed within the switch housing 13 as shown in FIGS. 1 and 2. Switch 27 also includes an actuator member in the form of a linearly movable operating button 42 and as shown in FIGS. 1 and 2, the switch is so oriented within the switch chamber that button 42 is movable back and forth along an axis which is parallel to the bottom of housing base 12 and which is generally in the plane of the vertical section line 2—2 of FIG. 1.

The switch construction internally is such that an appropriate differential is provided between the linear position at which button 42, when moved toward the left in FIGS. 1 and 2, will open the switch contacts to deenergize the motor, and its other operating position when button 42 moves to the right in these figures a predetermined distance away from the switch opening position to a point where the contacts within switch 27 will again be closed to energize the motor wires 32 and 33. In such constructions button 42 is normally urged by internal resilient means to its right-hand position as shown in FIGS. 1 and 2.

According to the invention, the switch chamber wall 13 has an enlarged or thickened portion 43, sometimes referred to herein as a first wall portion, through which an opening 44 is provided to support a movable switch actuating plunger member 46 for reciprocal movement along the same axis as that of the switch operating button 42, between two switch-controlling positions. At its inner end plunger 46 has an enlarged flange 47 which engages the inner surface of the

thickened first wall portion when the switch button 42 is in its normal closed position. In this position the outer end 48 of plunger 46 extends beyond the outer surface of the thickened first wall portion. Thus, it is in position for engagement by a suitable operating knob or member to move the plunger and switch button 42 far enough to the left to operate the switch. Preferably, the end 48 projects beyond the outer wall surface just far enough so that when end 48 is pushed to the left in FIG. 2 far enough to make the outer end flush with the outer wall surface, the inner flange 47 will have pushed button 42 just far enough to the left to insure operation of the switch contacts from closed to open position. As described below, in the preferred form of the invention this plunger end 48 is engaged by a surface at one end of a pressure responsive plunger member, and this surface has an area greater than the diameter of opening 44 in the first wall portion 43. Thus, the outer surface of this wall portion provides a positive stop to limit the maximum movement of the pressure responsive plunger to the left in the drawings and thus prevent undesired overtravel of plunger 46 which might otherwise damage or deform the switch button 42 or other switch elements.

According to a further feature of the invention, a pressure responsive actuator plunger, separate from the switch actuating plunger 46, is mounted within a second and separate housing portion 49. Housing 49 is also formed as an integral part of the main housing 11, e.g., as parts of a single casting, and includes a cylindrical inner bore 51, the longitudinal axis of which is in essential alignment with the axis of movement of switch button 42 and plunger 46. The end of cylindrical bore 51 closest to the switch housing 13 is closed by an end wall 52, sometimes referred to herein as a second wall portion. This second wall portion 52 is thus separated from the first wall portion 43 by a predetermined fixed distance, is generally parallel to the first wall portion, and is provided with an opening 53 which is also coaxial with the cylindrical bore 51, plunger 46 and opening 44.

Within opening 53, one end 54 of the pressure responsive actuator plunger 56 is supported for sliding movement along the axis thus described. Actuator plunger 56 has a laterally extending flange 57 at an intermediate point along the plunger and the opposite end of the plunger, at 58, provides a pressure responsive piston portion which closely fits and slides within a cylindrical bore 59 in a plunger guide member 61.

This plunger guide member 61 is externally threaded at one end to provide an interengaging threaded connection at 62 with the outer end (right end in the figures) of the bore 51. A set screw 63 in a threaded bore of an upwardly projecting enlargement 64 of the housing 49 may be tightened to lock the plunger guide 61 in its desired position along the axis of movement of the plungers. The outer end 66 of piston portion 58 of actuator plunger 56, i.e., the end farthest away from switch 27, is supported for exposure to the fluid, the pressure of which is to be used to control the switch. For this purpose the bore 59 in the plunger guide 61 intersects a cross passage 67 which serves as a pressure chamber. This cross passage 67 in the plunger guide 61 extends all the way through such member and is provided with internally threaded ends 68 and 69 for connection of suitable fittings of a pressure line or hose. Thus, the pressure within passage or chamber 67 acts on the outer end 66 of the piston portion 58 to urge the plunger to the left in FIGS. 1 and 2 with a force proportional to the pressure involved. The outer end of piston 58 is provided with circumferential grooves in which suitable sealing members are mounted. Within the groove nearest the end 66, a suitable packing 71, in the form of an O-ring is supported to seal the parts against leakage of pressure fluid from chamber 67 through the bore 59 along the outer surface of plunger end 58. A suitable backup ring of "teflon" or other suitable material is supported in the circumferential recess on the side of packing 71 away from the end face 66. Thus, the end face 66 of the pressure responsive actuator plunger 56 is exposed to the pressure in chamber 67, but the fluid which is under pressure within that chamber during operation of the device is not per-

mitted to leak along the plunger toward the left in the drawings to cause problems in other portions of the assembly. The pressure chamber 67 is at the farthest point from switch 27, i.e., at the opposite end of the assembly.

5 Movement of the plunger 56 toward the switch opening position, in response to pressure within chamber 67, is resisted by an appropriate compression spring 73 within the cylindrical bore 51. The outer end of the spring, i.e., the end farthest from switch 27, engages flange 57 of the actuator plunger. The inner end of the spring 73 may directly engage the second wall portion 52, but preferably one or more spacing or adjusting washers 74 may be positioned within bore 51 between the wall portion 52 and the inner end of spring 73. The use or omission of one or more of such washers 74, together with the extent to which plunger guide 61 is threaded into the outer end of spring housing 49 will predetermine the initial compression of spring 73, which depends on the relative axial distance between flange 57, when it abuts the plunger guide 61, and either end wall 52 or a washer 74. Thus, the insertion of one or more washers 74 will precompress spring 73 to a greater degree and require even higher pressures within chamber 67 before the actuator plunger 56 can be moved far enough to the left to operate the switch 27.

25 The plunger guide member 61, as described herein, combines a number of features in a single element, which can be precisely machined to closer tolerances than may be necessary for other parts of the assembly. Thus, it provides a close-fitting guide for the pressure responsive piston portion 58 of actuator plunger 56. It also provides a pressure chamber 67 to which plunger end face 66 is exposed. It further provides connections for pressure line fittings at 68, 69. Finally, it provides an adjustable stop for outward plunger movement and/or spring compression, and serves as a removable end closure member for the housing 49.

35 According to a further feature of the invention, an adjusting member is axially adjustably mounted on the end of one of the switch actuating and pressure responsive actuator plungers. In this preferred embodiment, the adjusting member is connected to the inner end of the actuator plunger 56 and is shown as a cylindrical member 76 threaded into the hollow interiorly threaded end 77 of actuator plunger 56. A cross bore in member 76 contains a nylon pellet 78 of known construction, which is adapted to be compressed within the threaded portion 77 to prevent undesired relative rotation of member 76, but to permit intentional manual adjustment. Thus, the length of this nylon pellet is substantially equal to the outside diameter of the internal threads at 77.

45 In order to provide convenient manual adjustment of the pressure setting at which switch 27 will be actuated from one position to another, the adjusting member 76 is provided with a laterally projecting flange 79 which is located within the space between the first and second wall portions 43 and 52. Flange 79 thus serves as a manually accessible adjusting knob which provides for rotation of the adjusting member 76 to vary its relative axial position within the threaded bore 77 of plunger 56. Rotation of knob 79 thus changes the relative effective length of the plunger 56 and the pressure at which the switch actuating plunger 46 will be engaged and moved to the left to open the switch, or will be permitted to move to the right to close the switch contacts.

50 One or more shims or adjusting washers 81 may be mounted on member 76 between the outer face 83 of the adjusting knob 79 and the inner end 82 of plunger 56. The use of such a washer 81 establishes a minimum total length for the plunger member 56 and thus, for any given effective length of the compression spring 73, a maximum pressure at which the switch 27 can be operated. Since such a washer 81 merely limits the extent to which member 76 can be adjusted axially to the right within plunger 56, it does not limit the adjustment of knob 79 to move member 76 relatively to the left and thus effectively lengthen the plunger 56. Such lengthening insures operation of the switch 27 earlier, i.e., at lower pressure, than when the knob 79 and member 76 are threaded all the way to the right within plunger 56.

As previously described, the inner surface 84, i.e., the surface toward switch 27, of adjusting knob 79 provides the operating engagement of the pressure responsive actuator plunger with the switch plunger end 48 to operate switch 27. This surface 84 is substantially larger than the area of the plunger end 48 or its guide opening 44. Surface 84 will accordingly engage the outer surface of the thickened wall portion 43 after the plunger end 48 has been moved inwardly far enough to operate switch 27. Even if there is a further increase of pressure within chamber 67 after such switch operation, the engagement of surface 84 against the thickened wall portion 43 provides a stop or limit so the plunger 56 cannot move any closer to switch 27 and cannot drive plunger 46 or button 42 far enough to deform or damage the switch parts. To insure such protection, the wall portion 43 is made substantially thicker than the remaining cylindrical wall portion 13, and its thickness is great enough to resist deformation of wall 43 itself under any operating pressures anticipated.

In order to facilitate assembly and disassembly of the parts, the predetermined spacing between the first and second wall portions 43 and 52 is preferably greater than the total axial length of the adjusting member 76, i.e., the axial distance from surface 84 of knob 79 to the end 86 of the member 76. Thus, to disassemble the unit, the set screw 63 would be released, the plunger guide 61 threaded outwardly at least far enough so that the inner end 82 of plunger guide 56 is substantially flush with the surface of wall portion 52, and the adjusting member 76 would then be rotated to move it toward the switch far enough so that this member would be disengaged from the threaded bore 77 of plunger 56 and could be removed laterally through the space between wall portions 43 and 52. If further disassembly is desired, the guide 61 can be threaded all the way out from spring housing 49, the switch chamber cover 14 can be removed, and the switch 27 itself can be removed or replaced.

FIG. 3 illustrates and clarifies the relative locations of the parts and the manner in which they fit together during assembly or disassembly of the unit.

The provision of the spaced first and second wall portions as integral parts of one casting, with aligned openings therein, and the relative location of the other elements of the assembly, avoid difficult machining or finishing of the casting between such walls, and facilitate the boring, threading and finishing of the casting, as well as the convenient assembly and disassembly of the unit.

Pressure control assemblies according to the present invention may be constructed with relative dimensions, spring constants and other operating features which will insure starting and stopping of an electric motor or other device at predetermined pressures and pressure differentials of any desired magnitude. By suitable selection of a relatively stiff spring, for example, the pressure at which switch 27 is opened may be as high as 3,000 p.s.i.g., and, depending on the characteristics provided by the switch construction itself, the control assembly may permit reclosing of the switch and reenergizing of the motor or other device when the pressure drops to a predetermined level below the maximum pressure, e.g., to a lower pressure of 2,600 p.s.i.g.

The foregoing specification accordingly describes the background and nature of the present invention and suggests some of the ways of practicing it, including the embodiment presently contemplated as the best mode of carrying out the invention.

Now, therefore, what is claimed is:

1. A pressure control assembly comprising a body member having a switch housing and a separate pressure actuator housing thereon, the switch housing providing a closed switch chamber separated from the pressure actuator housing, the switch housing having a first wall portion with a first opening therethrough and a switch actuating plunger member aligned with said first opening and reciprocally movable along the axis of said opening between first and second switch controlling positions, a second housing enclosed within said switch housing, switch means having an actuator member, said switch

means being supported and enclosed in said second housing and operated by movement of said actuator member in response to movement of said plunger member from one of said controlling positions to another, said pressure actuator housing having a second wall portion spaced a predetermined fixed distance from said first wall portion of the switch housing and having a second opening therethrough generally coaxial with the axis of the first opening, said first and second wall portions being separated by an open space between said housings, said pressure actuator housing having means for connection to a source of control pressure, and a pressure responsive actuator plunger member having one end aligned with said second opening and reciprocally movable along the axis of said second opening in response to changes in said control pressure, and an adjusting member axially adjustably mounted on the end of one of said switch actuating and pressure responsive actuator plunger members and having a portion adapted to engage the end of the other of said plunger members for moving said switch plunger in response to movement of the pressure responsive actuator plunger.

2. A pressure control assembly according to claim 1 in which the body member and first and second wall portions are parts of a single casting.

3. A pressure control assembly according to claim 1 in which the adjusting member is threaded on the end of said one plunger member and has an adjusting knob portion manually accessible in the open space between said first and second wall portions for convenient manual engagement by an operator.

4. A pressure control assembly according to claim 3 in which the total length of said adjusting member along said axis is less than the corresponding axial distance between said first and second wall portions.

5. A pressure control assembly according to claim 1 in which said adjusting member is axially threaded to one end of the pressure responsive actuator plunger and has a diameter greater than said first opening, and in which said switch actuating plunger, in one of its switch controlling positions, has an end projecting through said first opening a predetermined distance beyond said first wall portion toward said second wall portion, said pressure responsive plunger and adjusting member being movable axially toward said first wall portion in response to a predetermined pressure increase, until said adjusting member has moved said switch actuating plunger end from said one of its switch controlling positions to another of its switch controlling positions, said adjusting member then engaging said first wall portion and thereby preventing further axial movement of the pressure responsive actuator plunger toward said switch regardless of further pressure increase.

6. A pressure control assembly according to claim 5 in which said first wall portion has reinforcing means adjacent said first opening in the area of engagement by said adjustable member.

7. A pressure control assembly according to claim 6 in which said reinforcing means includes a part of said first wall portion of greater axial thickness adjacent said first opening than the thickness of other parts of said first wall portion spaced from said first opening.

8. A pressure control assembly according to claim 1 in which said pressure actuator housing includes a cylindrical spring-enclosing bore with its central longitudinal axis extending coaxially with the axis of said second opening in a direction away from said first and second wall portions, said means for connection to a source of control pressure includes a removable end closure member for said bore, said closure member having a cylindrical plunger guide portion therein extending toward and coaxially with said spring-enclosing bore and said second opening, and in which said pressure responsive actuator plunger reciprocates axially within the cylindrical plunger guide portion in response to changes in pressure, the end closure member having coupling means for attachment to a source of control pressure and also providing a connecting passage therein between said coupling means and said cylindrical plunger guide portion at a location exposing

the remaining end of said actuator plunger to pressure in said passage.

9. A pressure control assembly according to claim 8 in which said connecting passage extends laterally all the way through said end closure member generally perpendicular to the axis of said plunger guide portion and in which said coupling means includes threaded portions in the surfaces of the end closure member at each end of said connecting passage.

10. A pressure control assembly according to claim 8 having an axially compressible resilient spring member supported in said spring-enclosing bore between said second wall portion and said end closure member, said actuator plunger having a portion engaged by said spring between the spring and end closure member, said spring member normally urging said pressure responsive plunger axially away from said first wall

portion until the pressure in said passage acting on the actuator plunger reaches a predetermined level at which it overcomes the urging of said spring member and forces the actuator plunger toward said first wall portion, thereby engaging said switch actuating plunger and moving the latter from one switch controlling position to another.

11. A pressure control assembly according to claim 10 having means for calibrating the initial compression of said spring member, said calibrating means including at least one removable shim of predetermined axial thickness supported in said cylindrical bore axially adjacent said resilient spring member.

12. A pressure control assembly according to claim 1 in which the opening in the first wall portion is substantially closed by one of said movable plunger and adjusting members.

20

25

30

35

40

45

50

55

60

65

70

75