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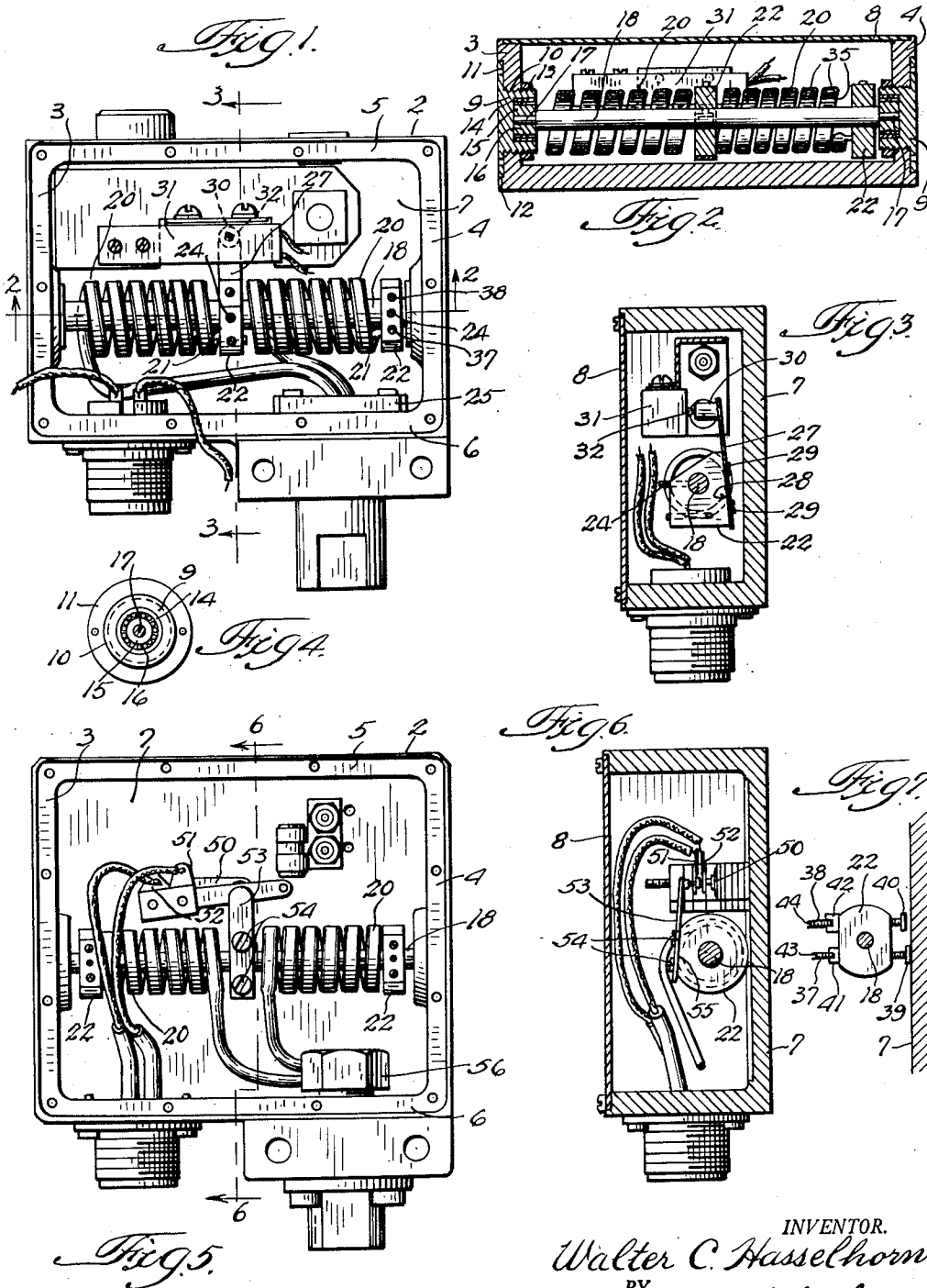
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2,810,800

PRESSURE SWITCH

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2 Sheets-Sheet 1



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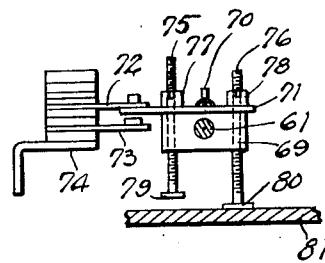
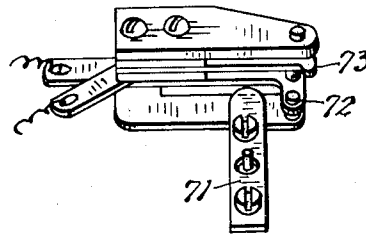
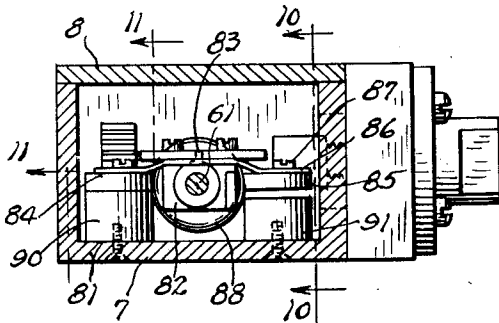
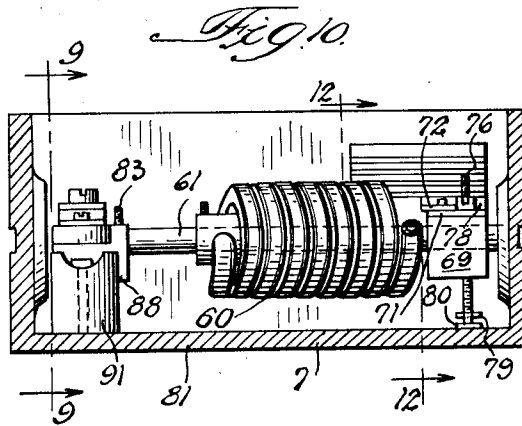
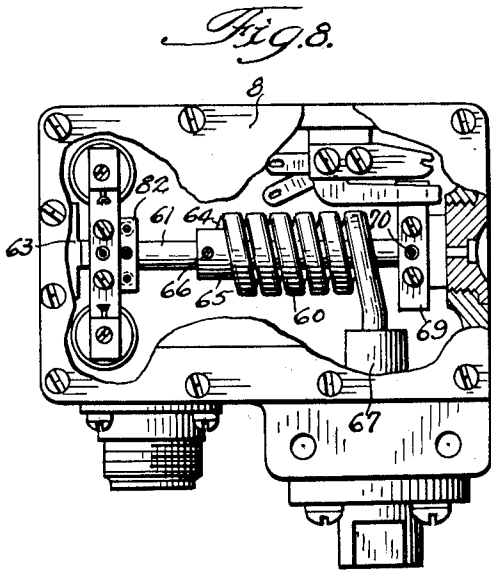
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PRESSURE SWITCH

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2 Sheets-Sheet 2



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2,810,800

PRESSURE SWITCH

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7 Claims. (Cl. 200—81)

This invention relates to high pressure operated electric switches and, more particularly, to devices of this type designed primarily to eliminate the inherent difficulties encountered in constructing pressure switches adapted to operate in high pressure ranges.

It has heretofore been the practice in the construction of high pressure operated switches to employ such pressure-sensing elements as pistons, Bourdon tubes, diaphragms, bellows, etc., which invariably distort when subjected to abnormal high pressures. A disadvantage of the diaphragm operated switch is the relatively large pressure area it has and the substantial forces developed when exposed to high pressures. These forces must be restrained by heavy members, which add to the bulk and weight, and are therefore highly undesirable in aircraft work. Accuracy for given operating ranges is difficult to maintain and temperature variations seriously affecting their operating adjustments and requiring compensating mechanisms have also been experienced in these prior structures. Excessive vibrations, high impact shocks, water hammer, etc., also affect the accuracy of operation and impair the reliability of the device for general application.

An object of the invention is to employ a new principle of operation in pressure switches operating in high ranges. To this end the invention is directed to the use of a tube of relatively small inside diameter to drive a shaft mounted in suitable bearings. The tube is wound in helical turns about the shaft and has one of its ends closed and connected to the shaft. The opposite end of the tube is connected to a pressure line so that pressure variations will cause a controlled rotational movement around a fixed center point. The sides of the tube are preferably flattened so that increased pressure will expand the same and cause thereby a rotational movement of each coil or winding due to this fixed center point of the shaft with the coils wound thereabout. The structure distinguishes from Bourdon tubes heretofore employed having one or more turns with a free tiltable end carrying switch contacts or other similar actuating parts.

A further object of the invention resides in providing, in a device of the above type, an unique form of calibrating mechanism for accurately determining the pressure at which the rotation of the shaft will operate an electric switch or other desirable form of actuator.

A still further object of the invention resides in providing a device of the above type that remains stable when subjected to extreme vibration, physical shock, thermal cycling and long use. An improved type of snap-acting switch employing a magnetic lock may be used so that perfect stability may be had substantially at all times.

Other objects and advantages of the invention will be apparent from the following detail description when accompanied with the drawings in which:

Figure 1 is a top view of one form of the invention with the top cover removed;

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Fig. 2 is a transverse section taken along line 2—2 of Fig. 1;

Fig. 3 is a similar sectional view but taken along line 3—3 of Fig. 1;

Fig. 4 is a face view of one of the end bearings removed from the housing and employed for the actuating shaft;

Fig. 5 is a view similar to Fig. 1 but showing a different arrangement of parts;

Fig. 6 is a transverse sectional view taken along line 6—6 of Fig. 5;

Fig. 7 is a detail view illustrating the pressure calibrating mechanism that may be used in either form of the invention;

Fig. 8 is a view with the cover broken away showing a still further form of the invention;

Fig. 9 is a sectional view taken along line 9—9 of Fig. 10;

Fig. 10 is a sectional view taken along line 10—10 of Fig. 9;

Fig. 11 is a detail view of the switch employed in the form of the invention shown in Fig. 9 and taken along line 11—11 of Fig. 9; and

Fig. 12 is a detail view of the pressure calibrating mechanism and taken along line 12—12 of Fig. 10.

In the drawings, the device shown is preferably in the form of a housing 2 with side walls 3, 4, 5 and 6, a base 7 and a cover 8. Side walls 3 and 4 are provided with bearing bushings 9 threaded exteriorly at 10 and provided each with a head disk 11 adapted to seat in a recess 12 in walls 3 and 4 when the bushings 9 are threaded seated in their openings in the side walls. A lock nut 13 may be employed to hold each bushing 9 in position. Bushings 9 carry inner and outer races 14 and 15, respectively, for ball bearings 16. Each inner race 15 receives a reduced end 17 of shaft 18. These reduced ends 17 are preferably tightly fitted in the inner races 15 to permit shaft 18 to rotate freely.

Pressure-sensing elements 20 and 20, shown in Fig. 1, are provided in the form of two tubes wound helically about shaft 18. Each tubing has one end sealed at 21 and mechanically connected to rotatable shaft 18 by a collar 22 fixedly attached to shaft 18 by a set screw 24. Opposite ends of the tubings lead from the last turn of the helix to a pressure port fitting designated broadly as 25. Fitting 25 may assume different forms depending upon the installation and the pressure line. It will be observed that bearing supported shaft 18 passes through the center of coils 20 and is mechanically connected at one point to the closed end 21 of each coil, the opposite end of each coil being free of the shaft and in pressure communication with the pressure line through fitting 25.

Attached to collar 22, disposed preferably between the coils 20, is an arm 27 shown more clearly in Fig. 3. Collar 22 may have a flat face 28 to which arm 27 may be attached by screws 29. A button 30 is carried upon the free end of arm 27.

The device operated or actuator may, in the embodiment of the invention shown in Fig. 1, be a snap-action switch 31 with the usual contact finger 32 operating in a well-known manner to open and close contacts in an electric circuit disposed in the housing of switch 31. This form of switch operation is well understood in the art. Thus any rotational movement of shaft 18 produced by a variation of pressure in the line will open and close an electric circuit controlled by this switch 31.

Coils 20 are preferably provided with opposed flattened sides 35 whereby increased pressure in the coils 20 will cause the flattened sides to expand and produce a rotational movement of each coil due to the fixed center point of both coils being about shaft 18. Not only are the opposite sides of coils 20 flattened at 35, but the coils

themselves may be of small inside diameter, this being in some instances as small as one-thirtieth of an inch. Also, the walls may be relatively heavy or of substantial wall thickness. With increased pressures that may reach as high as 10,000 p. s. i. and even greater, the coils are caused to rotate and produce an angular motion which accumulatively is adequate to rotate shaft 18 to actuate switch 31. The design uniquely permits the number of turns in coils 20 to be changed if it is desired to accommodate higher or lower pressures. In order to regulate or calibrate the pressure range which will function to actuate switch 31 as desired, outer collar 22 may be provided with a pair of adjustable stop members 37 and 38 (Fig. 7). Stop members 37 and 38 are preferably threaded their entire length or substantially so and have feet 39 and 40 at the bottom. The screws 37 and 38 may thread through the entire distance of collar 22 and be provided with locking collars 41 and 42 which will hold screws 37 and 38 in a position of minute adjustment made through the use of a sharp pointed instrument engaging in slots 43 and 44 cut in the upper end of screws 37 and 38. The arrangement is such that a micrometer adjustment can be made in securing a desired pressure range for the device. For example, if it is desired to operate the switch 31 at 10,000 pounds, screws 37 and 38 may be adjusted to effect a predetermined spacing of either or both feet 39 and 40 so that when a 10,000 p. s. i. is reached in coils 20, the expansion of the flattened sides of the tubing will produce that rotational movement that will bring button 30 on contact arm 27 against switch member 32 to move the same sufficiently to actuate switch 31. At this pressure of 10,000 p. s. i., one of the feet 39 or 40 will firmly engage against back wall or floor 7 of housing 2 to prevent any further rotation of shaft 18. The small inside diameter of the tube entirely eliminates the effect of excessive pressure and makes it possible to select high pressure zones in which to actuate the switch so that its repeatability and response will be uniform and constant for any given calibrated pressure range.

Figs. 5 and 6 illustrate substantially the same structure shown in Figs. 1 to 4, inclusive. Instead of using a switch of a snap-acting type illustrated in Figs. 1 to 3, inclusive, Figs. 5 and 6 show a common form of contact pile 50 wherein contacts 51 and 52 are connected in the electric circuit to be controlled, these contacts being actuated by a contact arm 53 secured to center collar 22 in substantially the same manner as above described. The contact arm 53 is, however, attached at 54 to a flat 55 on the upper face of collar 22 instead of at the bottom. A slightly different form of pressure fixture 56 is also illustrated, but, as previously stated, this fixture may vary in form according to the installation and pressure line involved.

Figs. 8 to 12, inclusive, disclose a form of invention employing a single coil 60 helically wound around a center shaft 61 also carried in antifriction bearing units 63 of substantially the same construction as the bearing units 9 heretofore described. Coil 60 is likewise sealed at its free end 64 and attached to a collar 65 which is fixed at 66 to shaft 61. The opposite end of coil 60 is connected to pressure fitting 67 which may vary, as stated, according to the installation and pressure line. A collar 69 is secured by a screw 70 to shaft 61. Contact arm 71 is also secured to collar 69. Contact arm 71 controls the contacts 72 and 73 of the electric circuit to be controlled. These contacts 72 and 73 may be arranged in pile form carried by a bracket 74 suitably attached to the housing of the unit.

Similar pressure calibrating means may be employed in the form of threaded screws 75 and 76 carried by collar 69 and having adjusting nuts 77 and 78 so that the feet 79 and 80 may be varied in distance from the back wall 81 of the housing in order to predetermine the pressure range in which the device will actuate switch

contacts 72 and 73. This construction is similar to that described in connection with Fig. 7.

A collar 82 is attached to the opposite end of shaft 61 by a set screw 83. Collar 82 functions to carry a pair of armature heads 84 and 85 secured to a plate 86 by means of screws 87, the plate being secured to an enlargement 88 carried adjacent collar 82 and attached thereto. Permanent magnets 90 and 91 cooperate with armatures 84 and 85, respectively, these magnets being secured to the base 81 of the housing.

It will be observed that permanent magnets 90 and 91 serve to provide a snap action for switch arm 71 when it moves to actuate contacts 72 and 73, whether it is to open or close said contacts. As the pressure increases and approaches the point where the expansion of the flat walls of the coil windings causes rotation of shaft 61, armature 84 will, as it approaches magnet 90, be suddenly attracted to magnet 90 and effect a quick completion of the turning action of shaft 61 so that switch arm 71 will effect a snap action at contacts 72 and 73. It will be observed that these contacts are thus held in this actuated position under the magnetic holding influence of the magnet 90 and armature 84 so that extreme vibration, physical shock, thermal force and constant operation will not disturb the contacts in their actuated position. Thus, the device becomes vibration and physical shock proof as well as eliminates any need for temperature compensating devices heretofore used in pressure-actuated switches in order to prevent temperature changes from affecting the predetermined setting at which the switch should operate.

The same action occurs when the pressure recedes and the windings of coil 60 unwind to return switch arm 71 to original position and thus again actuate switch contacts 72 and 73. In this position the switch arm 71 is protected against the effects of extreme vibration, physical shock, etc., because the armature 85 is attracted to and held against permanent magnet 91. The rotational action of the windings of coil 60 is sufficient to overcome the magnetic attraction by the armatures 84 and 85 and their respective magnets 90 and 91. However, the magnetic holding action between these parts when in either position is sufficient to prevent extreme vibration, physical shock, long use and thermal force from disturbing the position of contact arm 71, whether in an actuated position to close the contacts or a position to keep the contacts open.

Without further elaboration, the foregoing will so fully explain the character of my invention that others may, by applying current knowledge, readily adapt the same for use under varying conditions of service, without eliminating certain features, which may properly be said to constitute the essential items of novelty involved, which items are intended to be defined and secured to me by the following claims.

I claim:

1. A pressure switch comprising a pressure-sensing element having one end closed, a rotatable shaft to which said closed end is connected, said pressure-sensing element being in the form of a tubing having a series of coils wound in helical form about said shaft, a source of pressure, means for connecting the opposite end of said tubing with said source of pressure, means for mounting said shaft for rotatable movement by the angular motion produced by the winding and unwinding of said tubing upon variations of pressure in said source and said tubing, a switch, switch actuating means operated by the rotation of said shaft, and means for predetermining the pressure variations effecting the operation of said switch actuating means.

2. A pressure switch comprising a pressure-sensing element having one end closed, a rotatable shaft to which said closed end is connected, said pressure-sensing element being in the form of a tubing having a series of coils wound in helical form about said shaft, a source of

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pressure, means for connecting the opposite end of said tubing with said source of pressure, means for mounting said shaft for rotatable movement by the angular motion produced by the winding and the unwinding of said tubing upon variations of pressure in said source and said tubing, a switch, switch actuating means operated by the rotation of said shaft, and means limiting the rotation of said shaft to predetermine the pressure actuating said switch.

3. A pressure switch comprising a pressure-sensing element having one end closed, a rotatable shaft to which said closed end is connected, said pressure-sensing element being in the form of a tubing having a series of coils wound in helical form about said shaft, a source of pressure, means for connecting the opposite end of said tubing with said source of pressure, means for mounting said shaft for rotatable movement by the angular motion produced by the winding and unwinding of said tubing upon variations of pressure in said source and said tubing, a switch, switch actuating means operated by the rotation of said shaft, and a pair of opposite stop members limiting the rotation of said shaft.

4. A pressure switch comprising a pressure-sensing element having one end closed, a rotatable shaft to which said closed end is connected, said pressure-sensing element being in the form of a tubing having a series of coils wound in helical form about said shaft, a source of pressure, means for connecting the opposite end of said tubing with said source of pressure, means for mounting said shaft for rotatable movement by the angular motion produced by the winding and unwinding of said tubing upon variations of pressure in said source and said tubing, a switch, switch actuating means operated by the rotation of said shaft, a pair of opposite stop members on said shaft, and means against which said stop members alternately strike to limit the pressure range rotating said shaft.

5. A pressure switch comprising a pressure-sensing element having one end closed, a rotatable shaft to which said closed end is connected, said pressure-sensing element being in the form of a tubing having a series of coils wound in helical form about said shaft, a source of pressure, means for connecting the opposite end of said tubing with said source of pressure, a housing, bearings in opposite walls of said housing for rotatably carrying said shaft, pressure variations in said source and said tubing causing said tubing to wind and unwind and to produce angular motion for rotating said shaft, a device adapted to be operated by the rotation of said shaft, means actuated by the rotation of said shaft for actuating said device, and adjustable stop means for predetermining the

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limit of the rotation of said shaft and therefore the range of pressure in which said device is actuated.

6. A pressure switch comprising a pressure-sensing element having one end closed, a rotatable shaft to which said closed end is connected, said pressure-sensing element being in the form of a tubing having a series of coils wound in helical form about said shaft, a source of pressure, means for connecting the opposite end of said tubing with said source of pressure, a housing, bearings in opposite walls of said housing for rotatably carrying said shaft, pressure variations in said source and said tubing causing said tubing to wind and unwind and to produce angular motion for rotating said shaft, a device adapted to be operated by the rotation of said shaft, means actuated by the rotation of said shaft for actuating said device, a collar on said shaft, and a pair of adjustable pins projecting from said collar on opposite sides of said shaft, said pins being arranged for alternate engagement with a part of said housing to determine the pressure range in which said device is actuated.

7. A pressure switch comprising a pressure-sensing element having one end closed, a rotatable shaft to which said closed end is connected, said pressure-sensing element being in the form of a tubing having a series of coils wound in helical form about said shaft, a source of pressure, means for connecting the opposite end of said shaft with said source of pressure to place the interior of said tubing in communication with said source of pressure, means for mounting said shaft for rotatable movement by the angular motion produced by the winding and unwinding of said tubing upon variations of pressure in said source and said tubing, a device adapted to be actuated by the rotation of said shaft, means operated by the rotation of said shaft for actuating said device, and magnetic locking means producing a snap-acting operation for said device when actuated through the rotation of said shaft and to prevent jarring or vibration from actuating said device.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 10,193	D'Infreville	Sept. 5, 1882
1,852,982	Schlaich	Apr. 5, 1932
1,865,082	Chrisman	June 28, 1932
1,970,819	Reynolds et al.	Aug. 21, 1934
1,976,954	Mantz	Oct. 16, 1934
2,038,768	Spilzglass	Apr. 28, 1936
2,088,569	Beecher	Aug. 3, 1937
2,244,373	Powers	June 3, 1941
2,690,768	Sedgwick	Oct. 5, 1954