

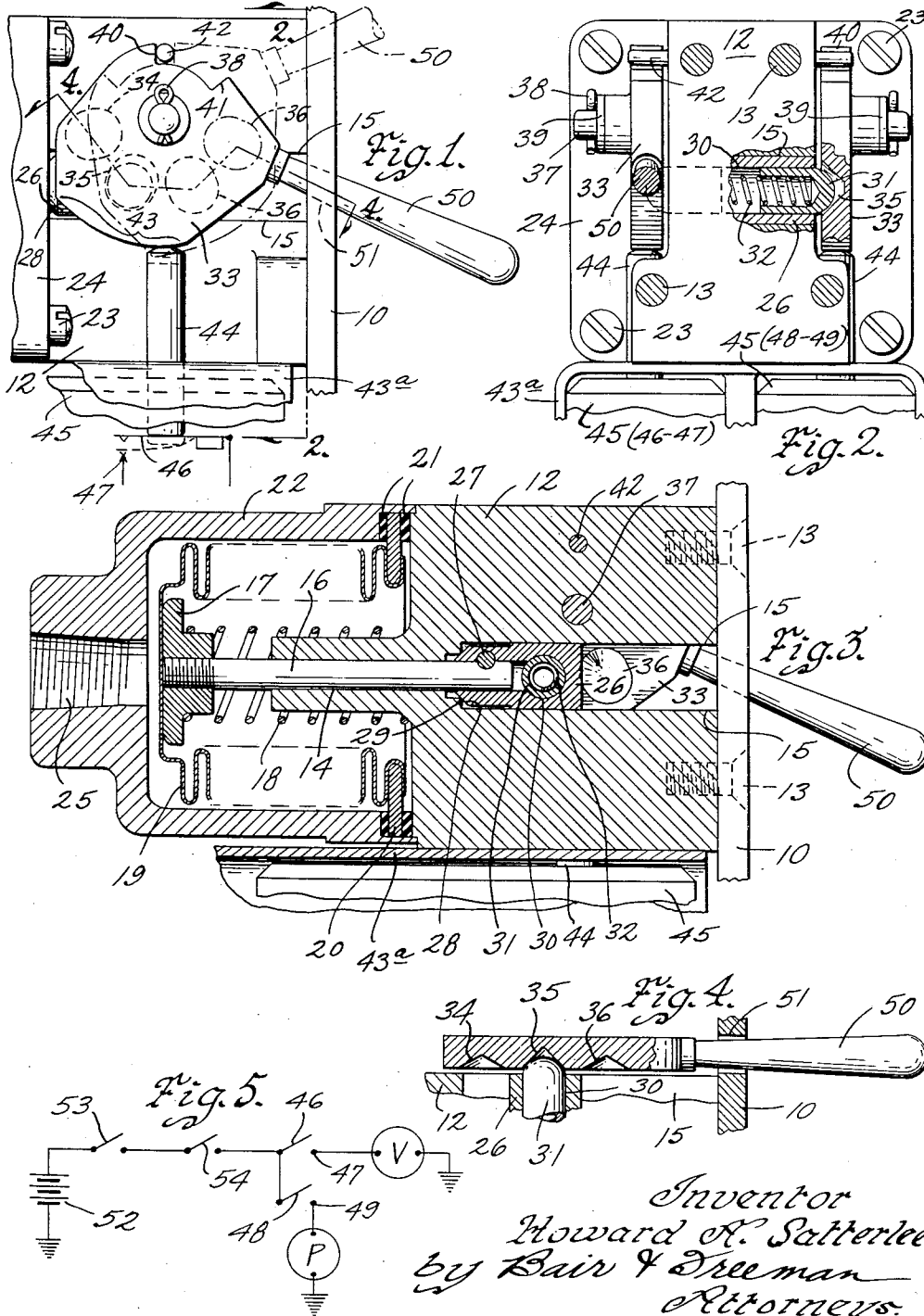
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PRESSURE SWITCH STRUCTURE

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## PRESSURE SWITCH STRUCTURE

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18 Claims. (Cl. 200—83)

My present invention relates to a pressure switch structure particularly designed for use in an automatic fuel system of the kind shown in my copending application, Serial No. 408,233, filed August 25, 1941.

One object of the invention is to provide a switch which is normally automatically operated response to pressure changes, such as the lubricating oil pressure of an airplane engine, and which may be additionally operated manually to turn it either on or off, regardless of the position it has assumed as a result of being pressure operated, the switch, however, after a manual operation, being again under automatic control of the pressure operated means when it subsequently changes position.

Another object is to provide a switch structure wherein a specific design of detent means is provided for the purpose of securing the type of operation just outlined, the detent means providing coaction between a pressure operated element and a switch actuating element.

Still another object is to provide a pressure switch structure wherein a valve plug and seat arrangement provides for cutting off the flow of oil to atmosphere in case the pressure operated member develops a leak in operation.

With these and other objects in view, my invention consists in the construction, arrangement and combination of the various parts of my device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in the claims and illustrated in the accompanying drawing in which:

Figure 1 is a side elevation of a portion of my pressure switch structure showing a switch actuating element in "off" position by solid lines, and in "on" position by dot-and-dash lines;

Figure 2 is an end view, partly in section, of the switch structure, as taken on the line 2—2 of Figure 1;

Figure 3 is a vertical sectional view through the switch structure;

Figure 4 is a sectional view on the line 4—4 of Figure 1; and

Figure 5 is an electro-diagrammatic view showing a representative installation wherein my pressure switch structure is used.

On the accompanying drawing I have used the reference numeral 10 to indicate a panel, on the back of which my pressure switch structure may be mounted. The switch structure includes a body casting 12, secured, as by screws 13, to the panel 10, and having therein a bore 14 and a slideway 15. The bore 14 is adapted to slidably receive a stem 16 terminating in a head 17, with which a spring 18 coacts to bias the stem 16 toward the left in Figure 3. The head 17 coacts with the closed end of a bellows 19, the open end of which has a flange 20 confined between a pair

of gaskets 21. A housing 22 is provided for the bellows 19, and the body 12 is secured to the housing 22 as by screws 23, passing through a flange 24 of the body and entering screw-threaded openings of the housing 22. The housing 22 is tapped, as at 25, for connection to a source of pressure, such as the lubricating oil system of an airplane engine.

In the slideway 15 a cross-head 26 is slidably mounted. The cross-head 26 is secured to the stem 16 as by a cross-pin 27, and is provided with a valve plug portion 28. The valve plug portion 28 is adapted, normally, to seat against a valve seat 29 of the body 12 under bias of the spring 18, the valve seat being in communication along the bore 14 with the interior of the bellows 19.

The cross-head 26 has a bore 30 in which is slidably mounted a pair of spring-pressed pins 31. The pins 31 are preferably hardened and provided with sockets into which a spring 32 extends for the purpose of biasing the pins away from each other.

The pins 31 are adapted to coact with depressions of switch actuating cams 33, the depressions being indicated at 34, 35 and 36. Each of the two cams 33 is provided with the three depressions noted, and the depressions, as shown in Figure 4, wherein the far side cam of Figure 1 is illustrated, are of different depths. The depression 35 is relatively deep, whereas the depressions 34 and 36 are relatively shallow, the purpose of which will hereinafter appear. The depressions and the spring-pressed pins form a detent means of coaction between the pressure operated bellows 19 and the switch actuating cams 33.

The cams 33 are pivoted on a pin 37 extending through the body 12, and are retained thereon by cotter pins 38 and washers 39. The cams 33 are limited in movement by shoulders 40 and 41 thereof, and a stop pin 42 extending through the body 12.

The cams 33 have cam surfaces 43, the right hand end of the one shown in Figure 1 being lower than the left hand end thereof. These cam surfaces are adapted to coact with switch actuating pins 44 extending into switch housings 45. The switches 45 are supported on a channel-shaped plate 43<sup>a</sup> secured to the bottom of the body 12. The near side switch housing in Figure 1 has a switch therein comprising a switch blade 46 and a contact 47, shown diagrammatically in this figure, whereas the far side switch 45 has a similar switch blade 48 and a contact 49, shown in Figure 5. It is obvious that the switch 46—47, in Figure 1, is in open position when the parts are in full-line position, and in closed position when the cam 33 assumes the dot-and-dash line position, at which time the pin 44

and the switch blade 46 assume the dotted positions illustrated.

The cams 33 are provided with actuating handles 50 which extend through slots 51 in the panel 10. These are adapted for manual actuation of the switches, as later described.

#### Practical operation

My pressure switch structure may be installed in a circuit of the kind shown in Figure 5, wherein a source of current supply, such as a battery, is indicated at 52. An ignition switch 53 and a fuel pressure switch 54 are in series with the switches 46-47 and 48-49, as described in my copending application. The switches 46-47 and 48-49 are identical, as far as operation is concerned, and one of them may be for controlling a motorized selector valve V, whereas the other may be provided for controlling an auxiliary fuel pump P, suitable for starting operations where a main fuel pump is used after the engine is started and is running properly. Instead of P being an auxiliary fuel pump, it might be a booster pump for boosting the supply of fuel from the tank to the main fuel pump, in which case it would be desirable to run it whenever the ignition switch 53 is on.

The desired type of automatic operation is that a rise in lubricating oil pressure will close both switches, and will open them when the oil pressure falls. When there is manual operation, however, it is desirable that either switch may be permitted to move to its opposite position, regardless of the position of the bellows 19, the switch always reverting to automatic control of the bellows whenever there is a subsequent rise or fall of oil pressure. For instance, when the airplane engine is started up, it is desirable to operate the auxiliary fuel pump P, but it is undesirable to operate the selector valve V until fuel pressure has been built up to properly control the fuel pressure switch 54. Therefore, the switch 46-47 is left open, and the switch 48-49 is manually closed at the time the ignition switch 53 is closed, so that the pump P will supply fuel to the engine until the main fuel pump does so. As the engine comes up to speed, the pressure oiling system, being in operation, raises the pressure of the oil which acts upon the bellows 19, tending to collapse it and to move the cross-head 26 toward the right.

Since the near side handle 50 is down, or in "off" position, its deep depression 35 is coacting with the spring-pressed pin 31, and the cam will therefore be carried along with the cross-head to effect raising of the handle and closure of the switch 46-47. Thus the selector valve V is automatically energized for operation in selecting the fuel tank from which fuel is to be taken, whereas the switch 48-49, already being on, its cam 33 cannot be moved further, as its stop shoulder 41 would be against the stop pin 42. In this position the spring-pressed pin 31 is in the shallow depression 34, and, therefore, readily rides out of it as the cross-head 26 advances. At the fully advanced position of the cross-head the pin 31 snaps into the relatively deep depression 35 of the far side cam 33 in Figure 1, and the parts are now in position for a subsequent opening of the switch 48-49, as well as the switch 46-47, when the oil pressure recedes. Such recession takes place when the engine stops due to cutting off the ignition at switch 53.

As to the switch 48-49, it will be opened by the pilot after the main fuel pump begins to sup-

ply fuel to the engine, as the auxiliary fuel pump P is then no longer needed. Where the pump P is a booster pump, however, it is desirable that it operate as long as the engine operates, and the switch 48-49 therefore requires no attention, since it is automatically closed when it goes down. If booster pump operation is desired before the oil pressure comes up, the switch 48-49 can be manually closed, and will subsequently be opened by a fall in oil pressure.

When the switch 46-47 is closed, due to rise in oil pressure, it may subsequently be opened manually if desired by the pilot, if he does not want the selector valve V to operate automatically, as when he wants to operate this valve manually. The pin 31 in that case, would be advanced to a position coincident with the dash-line illustrated depression 36 in Figure 1, and this depression would be advanced to the dot-and-dash illustrated position. The pin would still be in the deep depression 35, but the handle 50 could be forced downwardly by hand, and would disengage the pin from the deep depression and permit it to snap into the shallow depression 35 after the handle is all the way down. Thus the switch may be turned off when the oil pressure is up, or may be turned on when the oil pressure is down; yet any subsequent fall or rise of oil pressure will move the switch cam one way or the other, or if it has already been manually moved, the cross-head will move relative to the cam and permit snap-in of the pin 31 with relation to the deep depression 35 for a subsequent automatic operation of the switch actuating cam when the oil pressure changes in the opposite direction.

I have shown two of the switch actuating cams merely by way of illustration, and it will be obvious that they, together with the detent means of coaction between them and the pressure operated element, form a simple means of actuating the switches manually, in addition to automatic operation, and cause reversion of the switches to automatic operation upon a subsequent pressure change.

The valve 28-29 performs the important function of guarding against oil leakage in the event of failure such as puncture of the bellows. In that event, the spring 13 automatically closes the valve, thus eliminating the possibility of oil leakage from the interior of the bellows and along the stem 16 to atmosphere in the slideway 15.

Some changes may be made in the construction and arrangement of the parts of my device without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope without sacrificing any of the advantages thereof.

I claim as my invention:

1. In a pressure switch structure, a pressure-operated element, a pair of stops, a switch operating element movable between said stops, and detent means of coaction between said pressure-operated element and said switch operating element comprising a spring-pressed pin carried by one of said elements, and the other element having a series of three depressions to receive said pin, the center one of said depressions being sufficiently deep to cause said pressure-operated element to carry said switch operating element with it as the pressure-operated element moves, and the other two of said depressions being sufficiently shallow to permit said spring-pressed pin

to ride out of them upon the pressure-operated element moving when the switch operating element is stopped by one of said stops.

2. In a pressure switch structure, a pressure-operated element, a switch operating element movable between open and closed circuit positions, and detent means of coaction between said pressure-operated element and said switch operating element comprising a spring-pressed element carried by one of said elements, and the other element having a series of three depressions to receive said spring-pressed element, the center one of said depressions being sufficiently deep to cause said pressure-operated element to carry said switch operating element with it as the pressure-operated element moves, and the other two of said depressions being sufficiently shallow to permit said spring-pressed element to ride out of them upon the pressure-operated element moving when the switch operating element is at its relatively opposite circuit controlling position.

3. In a pressure switch structure, a pressure-operated element, a switch operating element movable between open and closed circuit positions, and detent means of coaction between said pressure-operated element and said switch operating element comprising a spring-pressed element carried by one of said elements, and the other element having a series of three depressions to receive said spring-pressed element, the center one of said depressions being sufficiently deep to cause said pressure-operated element to carry said switch operating element with it as the pressure-operated element moves, and the other two of said depressions being sufficiently shallow to permit said spring-pressed element to ride out of them upon the pressure-operated element moving when the switch operating element is at its relatively opposite circuit controlling position, said switch operating element being manually movable when said spring-pressed element is in any of said three depressions.

4. In a pressure switch structure, a pressure responsive element movable between predetermined limits, a control element movable between predetermined positions, and detent means of coaction between said pressure-operated element and said switch operating element including a series of depressions, certain of which are sufficiently deep to cause the detent means to carry said control element with it as the pressure responsive element moves between its limits of movement, and certain of which depressions are sufficiently shallow to permit said detent means to ride out of them upon the pressure responsive element moving to one of its limits of movement when the control element is at its relatively opposite limit of movement.

5. In a pressure switch structure, a pressure responsive element movable between predetermined limits, a control element movable between predetermined positions and detent means of coaction between said pressure-operated element and said switch operating element including a series of depressions, certain of which are sufficiently deep to cause the detent means to carry said control element with it as the pressure-responsive element moves between its limits of movement, and certain of which depressions are sufficiently shallow to permit said detent means to ride out of them upon the pressure-responsive element moving to one of its limits of movement when the control element is at its relatively opposite limit of movement, said detent means permitting manual movement of said control ele-

ment independent of said pressure-responsive element.

6. A switch structure comprising a cross-head element, a slideway therefor, operating means for moving said cross-head element relative to said slideway, a switch actuating element, one of said elements having three depressions therein, a spring-pressed pin carried by the other of said elements to coact with said depressions, the center depression being relatively deeper than the other two depressions to permit said spring-pressed pin to ride out of the shallow ones upon movement of the cross-head element, and causing the switch actuating element to be carried with the cross-head element when said spring-pressed pin coacts with the deep depression.

7. A control structure of the kind described comprising a movable cross-head, pressure-responsive means for moving said cross-head, a control element, said control element having a plurality of depressions therein, and a spring-pressed element carried by said cross-head to coact with said depressions, certain of said depressions being relatively deeper than certain others thereof to permit said spring-pressed element to ride out of a shallow depression upon movement of the cross-head, and causing said control element to be carried with the cross-head when said spring-pressed element coacts with a deep depression.

8. A control structure of the kind described comprising a movable cross-head, pressure-responsive means for moving said cross-head, a control element, said control element having a plurality of depressions therein, and a spring-pressed element carried by said cross-head to coact with said depressions, certain of said depressions being relatively deeper than certain others thereof to permit said spring-pressed element to ride out of a shallow depression upon movement of the cross-head, and causing said control element to be carried with the cross-head when said spring-pressed element coacts with a deep depression, said control element being manually movable relative to said cross-head in any position thereof.

9. A switch structure comprising a cross-head, a slideway therefor, pressure-operated means for moving said cross-head relative to said slideway, a switch actuating cam, said cam having three depressions therein, a spring-pressed pin carried by said cross-head to coact with said depressions, the center depression being relatively deeper than the other two depressions to permit said spring-pressed pin to ride out of the shallow ones upon movement of the cross-head, and causing the switch actuating cam to be carried with the cross-head when said spring-pressed pin coacts with the deep depression.

10. In a switch structure of the character described, a switch actuating element having an "on" position and an "off" position, a pressure operated element having a low pressure position and a high pressure position, means of operative coaction between said switch actuating element and said pressure operated element comprising a spring-pressed pin carried by one of the elements and the other element having a plurality of depressions for coaction therewith, certain of said depressions being relatively deep and certain thereof being relatively shallow to permit said switch actuating element to be manually moved to either "on" or "off" position when the pressure is either down or up, and causing the switch actuating element to be moved to one of

its positions when the pressure falls, and to the other of its positions when the pressure rises, regardless of the position of the switch actuating element before the fall or rise of pressure.

11. In a structure of the character described, an actuated element having two opposite positions, an actuating element having two opposite positions, means of operative coaction between said elements and comprising a spring-pressed pin carried by one of the elements and the other element having a plurality of three depressions for coaction therewith, the center depression being relatively deep and the other two relatively shallow to permit said actuated element to be manually moved to either of its opposite positions when the other element is in either of its positions and to the other position of the actuated element when the actuating element changes its direction of movement.

12. In a switch structure of the character described, a switch actuating element having an "on" position and an "off" position, a pressure-operated element having a low pressure position and a high pressure position, means of operative coaction between said switch actuating element and said pressure-operated element comprising a spring-pressed pin carried by one of the elements and the other element having three depressions for coaction therewith, the center depression being relatively deep and the other two relatively shallow to cause the switch actuating element to be moved to one of its positions when the pressure falls, and to the other of its positions when the pressure rises, regardless of the position of the switch actuating element before the fall or rise of pressure.

13. A pressure switch structure comprising a bellows responsive to pressure, a spring urging said bellows in one direction in opposition to pressure rise, a stem extending from said bellows and actuated thereby, a cross-head element carried by said stem and having a valve plug, a valve seat communicating with the side of said bellows open to atmosphere, said valve plug being coactible with said valve seat when the pressure is down or when the bellows fails to seal off the pressure side of the bellows from atmosphere, and a switch actuating element operated by said cross-head element through detent means of coaction, said detent means comprising a spring-pressed pin carried by one of said elements and the other element having three depressions to coact therewith, the center depression being deeper than the other two to effect simultaneous movement of the switch actuating element with the cross-head element when the spring-pressed pin coacts with the deep depression and to permit the pin to ride out of either of the shallow depressions when coacting therewith.

14. A pressure switch structure comprising a bellows responsive to pressure, a spring urging said bellows in one direction in opposition to pressure rise, a stem extending from said bellows and actuated thereby, a cross-head carried by said stem and having a valve plug, a valve seat communicating with the side of said bellows open to atmosphere, a valve plug carried by said stem and coactible therewith when the pressure is down or when the bellows fails to seal off the pressure side of the bellows from atmosphere, and a switch actuating element operated by said cross-head through detent means of coaction said

detent means including three depressions, the center depression being deeper than the other two to effect simultaneous movement of the switch actuating element with the cross-head element when the detent coacts with said center depression and to permit the detent to ride out of either of the other depressions when coacting therewith.

15. A pressure switch structure comprising a bellows responsive to pressure, a spring urging said bellows in one direction in opposition to pressure rise, a stem extending from said bellows and actuated thereby, a cross-head carried by said stem, a valve seat communicating with the side of said bellows open to atmosphere, a valve plug carried by said stem and coactible with said valve seat when the pressure is down or when the bellows fails to seal off the pressure side of the bellows from atmosphere, and a switch actuating element operated by said cross-head through detent means of coaction.

16. A pressure switch structure comprising a bellows responsive to pressure, a stem extending from said bellows and actuated thereby, a cross-head element carried by said stem, a valve seat communicating with the side of said bellows open to atmosphere, a valve plug carried by said stem and coactible therewith when the pressure is down or when the bellows fails to seal off the pressure side of the bellows from atmosphere, and a switch actuating element operated by said cross-head through detent means of coaction comprising a spring-pressed pin carried by one of said elements and the other element having a plurality of three depressions to coact therewith, the center depression being deeper than the other two to effect simultaneous movement of the switch actuating element by the cross-head element when the spring-pressed pin coacts with the deep depression and to permit the pin to ride out of either of the shallow depressions when coacting therewith, said switch actuating element being manually operable and such operation being permitted by said detent means of coaction.

17. A pressure switch structure comprising a bellows responsive on one side to pressure and having its other side open to atmosphere, a stem extending from said bellows and actuated thereby, a cross-head carried by said stem and having a valve plug, a valve seat communicating said other side of said bellows to atmosphere, a valve plug carried by said stem and coactible therewith when the pressure is down or when the bellows fails to seal off its pressure side from atmosphere, and a switch actuating element operated by said cross-head through detent means of coaction.

18. A pressure switch structure comprising a bellows responsive on one side to pressure and having its other side open to atmosphere, a stem extending from said bellows and actuated thereby, a cross-head carried by said stem and having a valve plug, a valve seat communicating said other side of said bellows to atmosphere, a valve plug carried by said stem and coactible therewith when the pressure is down or when the bellows fails to seal off said one side of the bellows from atmosphere, and a switch actuating element operated by said cross-head through detent means of coaction, said switch actuating element being manually operable and such operation being permitted by said detent means of coaction.

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