

March 20, 1945.

A. E. BAAK

2,371,669

SWITCH

Filed April 6, 1942

2 Sheets-Sheet 1

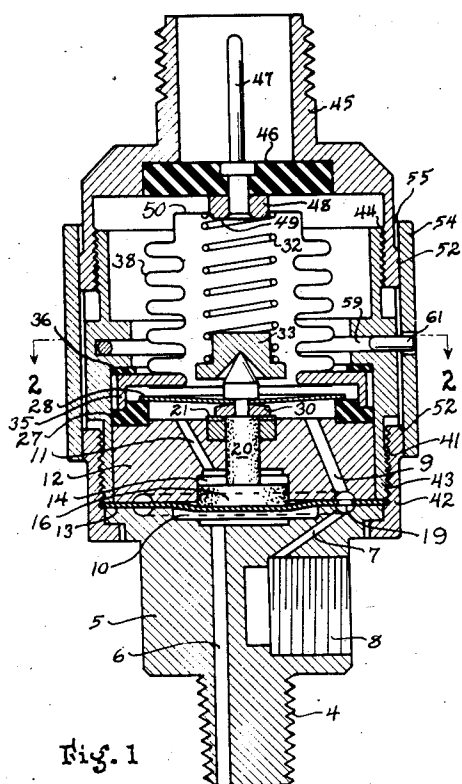


Fig. 1

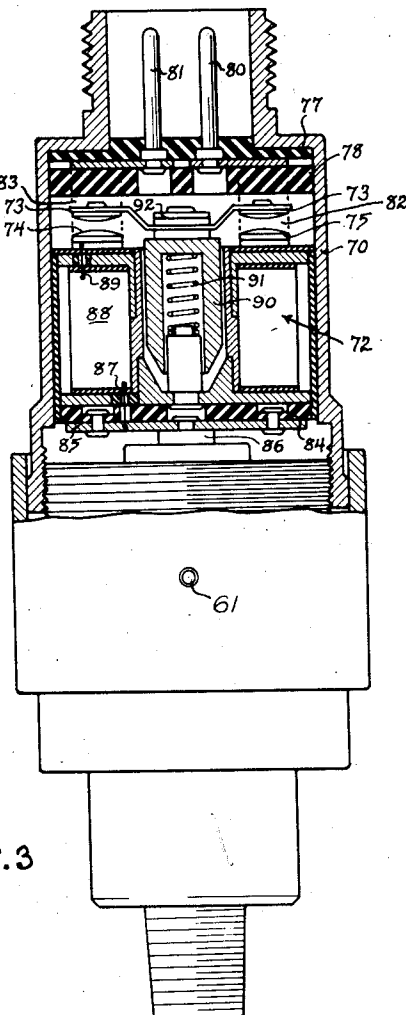


Fig. 3

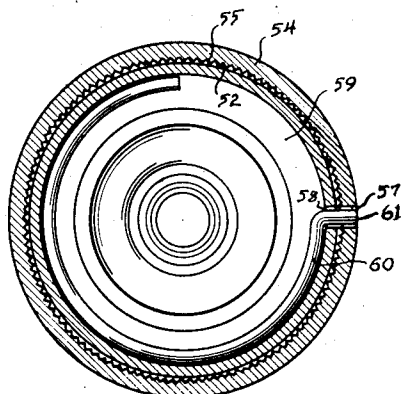


Fig. 2

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2 Sheets-Sheet 2

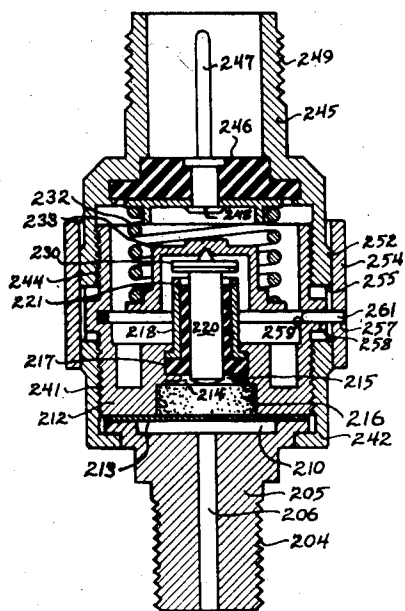


Fig. 5

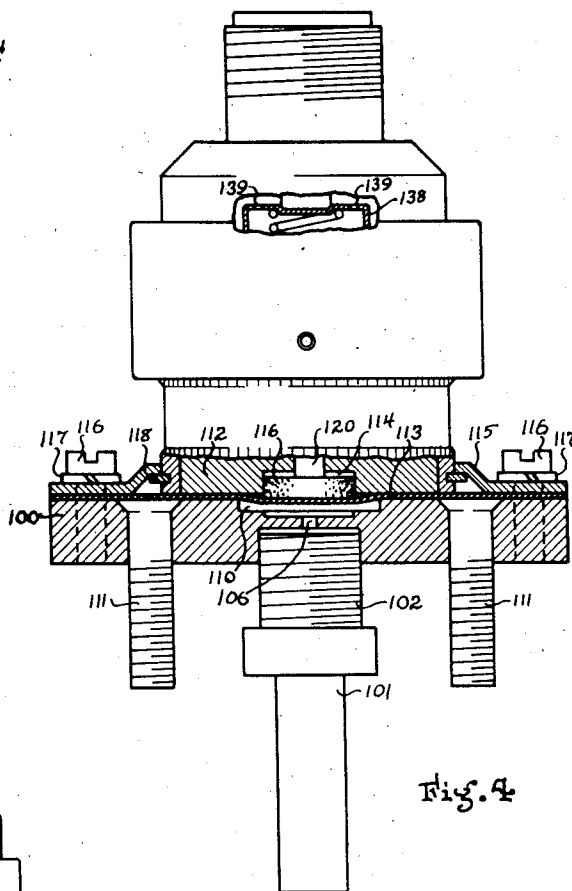


Fig. 4

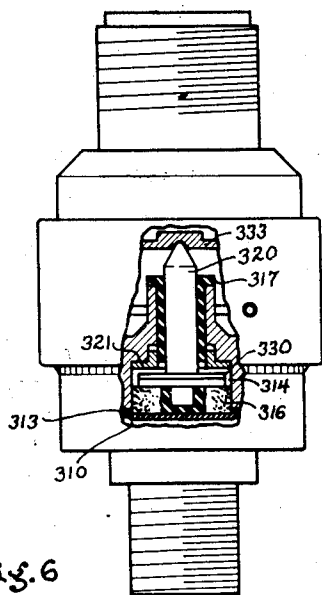


Fig. 6

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UNITED STATES PATENT OFFICE

2,371,669

SWITCH

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Application April 6, 1942, Serial No. 437,863

29 Claims. (Cl. 175—375)

The purpose of this invention is to provide a compact and simple switching device operable by various condition responsive means and readily adjustable for operation over a wide range of conditions for adaptation to a variety of uses. It is a further purpose of the invention to provide a switch unit that may be employed in a variety of types of circuits which may require one or more switch connector elements for connecting the switch in a particular circuit and also to provide means for employing the switch unit with circuits of widely varying operating load and power requirements.

One object of the invention is the provision of a switch device in which a main switch for handling relatively high load and power requirements is actuated by a relay and the relay is controlled by separate switching means located in the device.

A particular object of the invention is the provision of a switch having separate housing sections that are adjustable with respect to each other for the ready and accurate adjustment of the switch for operation at a selected and predetermined condition or upon a predetermined differential in selected conditions. An additional object is the provision of means for maintaining the switch housing sections in the selected position of adjustment and to further provide means for locking the housing sections in the selected position of adjustment to insure the proper functioning of the switch when subjected to considerable vibration.

One purpose of the invention is the provision of a switch for use with aircraft and motor operated devices wherein a main switch housing section for a portion of the switch structure cooperates with a plurality of interchangeable switch housing sections which may be employed to vary the operating characteristics of the switch and adapt the switch to a variety of uses with circuits having widely varying power and load requirements.

In accordance with my invention a switch is provided which, for example, may be employed to operate a signal and the switch contacts of the main housing section of the switch are readily adapted to function directly for this purpose. The switch adapted to be connected in a circuit for this purpose is provided with one of the interchangeable upper housing sections of the type required by the particular circuit and this housing section cooperates with the main housing section with which it is adjustable for controlling the operation of the switch. The switch

may be further employed for a control purpose, or for the same purpose, in a circuit of relatively large power and load requirements by the selection of a housing section that includes therein a relay and the main switching means for operation by the relay under the control of the switch contacts of the main housing section.

Another object of the invention is the provision of condition responsive switching units that may obviously be adapted for operation in response to one or more of a plurality of conditions which, for example, may include pressures and temperatures. Thus, the pressure responsive switches illustrated and described below might obviously be operated directly by temperature responsive means of the hydraulic type employing a volatile fill, and it will be noted that the differential type of switch illustrated may further be actuated in response to a combination of pressure and temperature. It will likewise be obvious that my differential pressure type of switch may be employed for direct response to a condition by the use of a plug for the passage means communicating with one of the two diaphragm separated pressure chambers of the switch.

Other objects and advantages of my invention will become apparent from the detailed description of the illustrated examples disclosed in the drawings and from a consideration of the appended claims.

Figure 1 is a partly diagrammatic longitudinal sectional view of one form of my switch,

Figure 2 is a transverse sectional view of the same device, the section being taken in a plane indicated by the line 2—2 of Figure 1, illustrating the switch housing locking means,

Figure 3 is a vertical view partly schematic and partly in section of a switch employing an upper housing section which includes a relay and the main switching means operated thereby,

Figure 4 is a vertical view partly schematic and partly in section of my switch and of a supporting base therefor, parts also being broken away for purposes of illustration,

Figure 5 is a vertical view partly in section of a modification of my switch embodying a pressure actuated reverse acting switch unit, and

Figure 6 is a vertical view partly in section of a modification of my switch embodying a pressure actuated direct acting switch unit.

In Figure 1 of the drawings, I have illustrated my differential pressure reverse acting type of switch having a base portion 5 with a passage-way 6 extending therethrough for connecting

with a first source of fluid pressure and a second passageway 7 extending into the threaded passageway 8 for connection with a second source of fluid pressure. The base member 5 is provided with an externally threaded position 4 for readily mounting the switch with respect to a fluid pressure line. A threaded plug member, not shown, may be threadedly inserted in the passageway 8 if operation of this switch in direct response to the pressure admitted to the passageway 6 is desired. The base member 5 has formed therein a chamber 10 of relatively large transverse cross-sectional area and shallow longitudinal depth, and the passageway 6 communicates with the lower portion of this chamber 10. A housing member 12 is separated from the housing member 5 by a diaphragm 13. The housing member 12 has formed therein a chamber 14 of relatively smaller transverse cross-section which is separated from the chamber 10 by the diaphragm 13. The passageway 7 in the base member 5 communicates through an opening 19 in the diaphragm 13 with passage means 9 and 11 extending through the housing member 12 for communication with the upper side of the chamber 14. An insulating plunger member 16 of substantially the same size as the chamber 14 is supported upon the diaphragm and mounted within the chamber 14 for slidable axial movement in response to change in the difference between the pressure which is exerted directly on the plunger from the chamber 14 and the pressure transmitted from chamber 10 by operation of the diaphragm 13. It will be noted that the chambers 14 and 10, respectively, limit the movement of both the plunger 16 and the diaphragm 13. Because of the limited movement to which the plunger and diaphragm may be subjected it is impossible to rupture or injure the diaphragm by reason of the occurrence of excessive pressures in either the passageway 6 or the passageways 9 and 11.

Extending through a passage in the housing member 12 is a stem 20 of insulating material which is associated with the plunger member 16 and axially slidable thereby. A stationary switch contact member 21 is also associated with the base member 12 and forms a grounded connection therewith. An insulating member 27 serves to support a snap disk element 28 with which is associated a movable contact member 30. It will be noted that upon one side of the snap disk the movable contact member is actuated by the plunger stem 20. A current carrying spring member 32 and a current carrying spring guide disk 33 cooperate with the movable contact member 30 on the other side of the snap disk and serve to bias the movable contact in opposition to the operation of the movable contact by the plunger operated stem 20. A mounting member 35 is supported by the insulating member 27 and an insulating member 36 for sealingly engaging the open end of a bellows member 38 which houses the movable switch contact biasing spring means.

A lower casing member 42 is threadedly mounted by the cooperating thread members 41 upon an intermediate casing member 43 and serves to support the lower housing member 5 and the diaphragm 13 on the base member 12. An upper casing member 45 is threadedly secured by the cooperating thread members 44 to the intermediate casing member 43. Various types of casing members may be interchangeably employed in accordance with various adap-

tations to which the switching unit may be employed, as is more fully explained below. The upper casing member 45 is at least in part formed by an insulating plate 46 which serves as the support for a connector pin 47. The connector pin 47 extends from a contact carrying base portion 48 through the insulating plate and into an outwardly threaded hub formed by the casing member 45. Base portion 48 is removably received in and makes electrical contact with a depression 49 in the closed end 50 of bellows 38.

The single connector element of the upper casing member illustrated in Figure 1 is incorporated in a circuit which includes the connector element 47, the closed end of bellows 38, the current carrying biasing spring 32, and the spring guide disk to the movable contact 30. When the differential in pressure exerted upon the plunger is such as to permit the stem 20 to recede to a position adjacent the stationary switch contact, the snap disk will operate to rapidly close the movable switch contact upon the stationary contact which is grounded to the housing member 12 for completion of the circuit. Upon an increase in differential pressure in the fluid pressure chambers 10 and 14 a force is exerted by the plunger and stem 20 upon the biased movable switch contact and this force actuates the snap disk to rapidly open the switch contacts.

It will be noted that this switch unit of my invention may be constructed for use with a circuit of a type requiring two separate connector elements 47. Thus the second connector may be supported in the plate 46 and provided with a connection to the stationary switch contact which in this circuit is insulated to avoid forming a ground connection.

In the operation of each of the switch units of my invention accurate and relatively close adjustment of either the differential pressures or the direct pressures to which the switch will respond is provided by the adjustment of the relative position of the intermediate and upper casing members. For this adjustment purpose the members are relatively rotated. Due to the action of threads 44 this rotation produces an axial movement of member 48, accordingly increasing or decreasing the tension in spring member 32. In this manner the differential pressure or the direct pressures required for actuation of the switch contacts may be varied to provide a wide range of operation for the switch.

The lower and upper casing members 42 and 45, respectively, have milled or formed on the outer side surfaces thereof teeth 52 which extend axially of the switch. A sleeve member 54 is provided having teeth members 55 internally formed thereon and extending axially of the sleeve for cooperation with the teeth 52 on the switch housing members. This sleeve member 54 serves to lock and maintain the members in the positions to which they are adjusted to insure proper operation of the switch.

A passageway 57 is drilled, or otherwise formed, as best illustrated in Figure 2, through the sleeve member 54 and a passageway 58 is formed in the housing member 43 to communicate with an annular internal groove 59 formed in the intermediate casing member. A split ring wire member 60 is mounted in the slot 58 and is bent at one end thereof to provide a pin member 61 which is biased by the ring to extend through the passageways 57 and 58 of the housing and sleeve members. When in the position illustrated in Figures 1 and 2 the pin serves to lock the sleeve

and housing members and to prevent the sleeve member 54 from being axially displaced from the switch as a result of vibration. To remove the sleeve it is merely necessary to first move the pin against the force of the ring biasing means until the pin is flush with the inner surface of the sleeve. To properly insert the sleeve on the switch the passageway 57 is first aligned with passageway 58 prior to the engagement of the cooperating teeth 52 and 55 of the housing and sleeve members. The pin is then depressed and the sleeve guided thereover until the pin engages the passageway 57 for locking the housing members in the selected position of adjustment.

Figure 3 discloses the actuating mechanism illustrated in Figure 1 adapted for use in a switch when two connector elements are necessary and where the main switch contacts are required to operate at power and load requirements that would prove prohibitive for the switch unit illustrated in Figure 1. To adapt the mechanism of Figure 1 for this use an upper casing member 70 is provided that houses a relay 72, a set of main switch contacts including movable contacts 73 together with stationary contacts 74 and 75 and two circuit connector elements. Upper casing member 70 is interchangeable with member 45 of Figure 1, and accordingly a description of the member 70 will suffice for an understanding of the construction of the switch.

The upper casing member 70 has molded therein two insulating plate members 77 and 78 through which two connector members 80 and 81 are mounted and supported. The connector members are at one end secured to spaced and insulated conducting plates or strap members 82 and 83, respectively, first ends of which are mounted between the insulating plates 77 and 78, the other ends of the connectors extending into the threaded external receptacle portion of the switch cover. The strap members 82 and 83 are connected at their first ends to the stationary switch contacts 74 and 75 respectively.

The relay unit 72 is mounted upon an insulating plate member 84 and the entire unit is supported in the casing 70 by a press fit. A conducting plate member 85 is riveted to the insulating plate member 84 and secured to this conducting plate is a contact base member 86 which corresponds to the base member 48 of the switch cover unit 45 illustrated in Figure 1. The conducting plate 85 is connected by a lead 87 to a terminal of the relay windings 88. A second terminal of the relay windings is connected by a lead 89 to the strap 83 which is secured to the stationary switch contact 74 and the circuit connector 81. The relay armature member 90 is biased to the position illustrated in Figure 3 by the spring biasing means 91 and rapidly assumes this position when the relay is deenergized. The connected movable contacts 73 of the main switch are secured by a bracket member 92 to the armature 90 for the rapid operation thereof by the relay when the switch contacts 21 and 30 located in the main housing section of the switch unit are closed by operation of the relay in response to the occurrence of a predetermined pressure differential, or of a predetermined pressure, for which the switch has been adjusted.

Upon closure of the switch contacts 21 and 30, located in the main housing section of the switch, a circuit is established from the switch connector element 81 through the strap member 83, lead 89, relay winding 88, lead 87, conducting plate

85, conducting base member 86, the bellows and the current carrying spring biasing means 32, movable switch contact 30 and stationary contact 21 located in the main housing unit to the ground connection established thereby within the switch casing. Upon energization of the relay winding 88 the armature 90 is actuated in a manner to rapidly close the main switch contacts 73. The closure of the main switch contacts 73 establishes a parallel circuit which includes the switch connector element 81, strap member 83, stationary switch contact 74, movable contacts 73 and stationary contact 75 of the main switch, strap member 82, and the associated switch connecting member 80.

Figure 4 relates to a modification of the switch illustrated in Figure 1, and has particular reference to the provision of a switching unit that is directly responsive to pressure and of a modified switch base and unit supporting means. In this embodiment of the invention a base member 100 is substituted for the base member 5 illustrated in Figure 1. A pipe member 101 having the externally threaded end portions 102 is threadedly mounted in the base member 100. This connecting line for the admission of the fluid the pressure of which is employed to actuate the switch communicates with the passage 106 and the fluid pressure chamber 110. The upper base member 112 having the chamber 114 formed therein and the diaphragm member 113 are clamped to the lower base member 100 by an annular disk mounting bracket 115 which is secured to the base member by the screw and lock washer members 116 and 117, respectively. The bracket member 115 engages with a flange or ring member 118 secured in the lower switch housing member for the purpose of mounting the switch in the proper position with respect to the lower base member 100. The entire unit may be secured to a desired mounting bracket member by the screws or through bolt members 111.

The plunger 116 mounted in the chamber 114 is directly actuated by the pressure transmitted thereto from the pressure chamber 110. In this embodiment of the invention the bellows member 138 has openings 139 formed in its end portion to bring about equilibrium between the pressure in the bellows and the varying ambient pressures resulting from changes in altitude to which the unit is subjected. It is apparent that this switch otherwise embodies the feature of construction described in Figure 1 of the drawings and accordingly further description thereof is not necessary.

The switch unit illustrated in Figure 5 is of the direct pressure responsive and reverse acting type and is a modification of the switch unit illustrated in Figure 1. The reference characters applied readily serve to identify the corresponding elements of the unit illustrated in Figure 1 and described above.

The switch employs a base member 205 having the external screw thread 204 by which the unit may be readily associated with a fluid line for operation of the switch by the pressure exerted by the fluid. A passageway 206 extends through the lower base member for communication with a chamber 210 of relatively large transverse cross-section and shallow longitudinal depth which is bored or formed in the upper surface of the base member. A housing member 212 has bored in the lower surface thereof an annular member, or chamber, 214 which is of smaller transverse cross sectional area than the cham-

ber 210. A diaphragm 213 supported between the lower and intermediate base members separates the chambers 210 and 214. A plunger member 216 of substantially the same size as the chamber 214 and of insulating material is supported upon the diaphragm 213 for a slidable axial movement within the chamber 214 as a result of the force transmitted thereto by the diaphragm upon variation of the fluid pressure in the chamber 210.

A passageway 215 extends from the chamber 214 of the base member 212 to the upper surface thereof and secured to the chamber within this passageway as by a roller projection, are a tubular insulating member 217 and a conducting sleeve member 218. A stem 220 associated with plunger 216 for movement thereby is slidably movable within the insulating member 217. A stationary switch contact 221 is mounted on the upper end of the conducting sleeve member 218 and the stem 220 is associated with a switch contact 230 that is movable in alignment for cooperation with the stationary contact. The movable switch contact is associated on the upper side thereof with a current carrying spring guide disk 233 which transmits pressure to the movable contact from a current carrying spring biasing element 232.

A lower casing member 242 cooperates with the housing member 212 by operation of the cooperating thread members 241 for clamping the base member 205 and the diaphragm 213 against the lower surface of the housing member 212. The upper casing member 245 likewise cooperates with the housing member 212 to which it is adjustably secured by the screw threads 244. The upper casing member has formed therein a plate of insulating material 246 through which a circuit connector element is mounted for support. One end of the connector 247 supports a conducting plate and spring guide member 248 against the insulating plate 246. The other end of the connector is centrally disposed within the circuit receptacle formed by the outer portion of the upper casing member 245 and this receptacle has the threads 249 formed on the outer surface thereof.

The conducting plate 248 mounted in the upper casing member serves as a base for supporting the current carrying spring which serves to bias the movable switch contact to the contact closing position. The biasing spring thus opposes the operation of the plunger and stem in the actuation of the movable switch contact in response to the pressure of the fluid in chamber 210. The upper casing member 245 is longitudinally adjustable with respect to the housing member 212 by provision of the cooperating thread members 244. The adjustment of the covering and housing member provides for varying the pressure exerted by the switch contact spring biasing means to selectively vary the actuation of the switch throughout a wide operating range.

The switch is maintained in a selected position of adjustment by cooperation of the sleeve member 254 with the casing members 245 and 242. Thus, the casing members have external teeth 252 formed thereon and these teeth extending longitudinally of the switch for cooperation with similar teeth 255 formed internally on the sleeve member as described with respect to the switch illustrated in Figure 1. Similarly, a split ring wire biasing member and pin 261 is mounted in a slot 259 formed in the base member 212 and

the pin cooperates with the passages 257 and 258 drilled through the sleeve and housing members for locking the sleeve 254 and casing members in any desired position of adjustment.

Upon a decrease in the pressure of the fluid in the chamber 210 the plunger and stem are actuated downwardly under the bias of the current carrying spring and the movable switch contact 230 is seated upon the stationary contact 221. A circuit is then established which includes the connector 247, plate 248, biasing spring 232, movable switch contact 230, stationary switch contact 221 and the sleeve member 218 which is grounded to the switch base member 212. When the fluid pressure in chamber 210 increases sufficiently the plunger and stem actuate the movable switch contact to open the circuit. The diaphragm will withstand the action of very large pressures without rupture as a result of support received from the plunger when the plunger is actuated to the position in which it is seated in and against the chamber 214.

The modification of my switch unit illustrated in Figure 6 of the drawing relates to a unit of the type illustrated in Figure 5 except that the switch is actuated upon a rise in pressure to a predetermined and selected value. Thus the diaphragm 313 is subjected to the pressure exerted by fluid admitted to the chamber 310 for actuating the plunger 316. The plunger 316 of insulating material has mounted therein the stem 320. The stem is formed of conducting material and is slidably movable within the insulating sleeve member 317 for contact with the conducting cup member 333 which guides and is acted upon by the current carrying spring biasing means. A stationary switch contact 321 is supported by and grounded to the base member 212 at the inner surface of the chamber 314 in which the plunger is mounted. A movable switch contact 330 is mounted on the stem 320 and is also movable within the chamber 314. Upon a sufficient increase in pressure in the chamber 310 the diaphragm actuates the plunger and stem member to the elevated position in which the movable contact 330 is closed with the grounded stationary contact 321. A circuit through the switch unit is then completed which includes the unit connector element, current carrying biasing spring, bias spring guide member 333, stem 320, movable contact 330 and the stationary switch contact 321 which is in grounded contact with the switch base.

It will be obvious that the switching units of my invention may be designed for use with base supporting and mounting members of various shapes for cooperation with the variety of members, such as aircraft engines and mounting panels, with which the units may be associated.

From the above description it is apparent that in accordance with my invention both the related and interchangeable members of the switching units involve relatively few parts which are of simple construction and that by reason of the wide and selective range of adjustment provided thereby these switching units may be readily manufactured and assembled for application in a wide range of operating services. The compact switch units are particularly adapted for use with aircraft in the operation of alarm, indicating or control circuits which, for example, may be directly responsive to fuel and oil pressures or may be responsive to a difference between carburetor air pressure, which is maintained constant

by a supercharger regardless of varying altitudes, and the fuel or other fluid pressures.

It is obvious that the related and interchangeable switching units illustrated and described are capable of a wide variety of embodiments within the scope of my invention and accordingly my invention is to be defined by the scope of the appended claims.

I claim as my invention:

1. A switch in combination comprising, a first member having a passageway extending through the member for communication with a first pressure chamber of relatively large cross-section and shallow depth formed in one end thereof, a second member having a second pressure chamber formed in one end thereof and of smaller cross-section than the first chamber, a plunger of substantially the size of said second chamber and having a stem mounted for movement within the second member, passage means through said second member for communication with the second pressure chamber and including an opening adjacent the inner side of said chamber, a diaphragm separating said first and second pressure chambers, the depth of the chambers being such as to limit the movement of the plunger and diaphragm, stationary contact means associated with said second member, movable switch contact means, means including a snap disk, current carrying biasing means and said plunger stem for actuating the movable contact means, a bellows enclosing the said biasing and switch contact means, a switch casing member and an insulating member therein, electrical switch connecting means supported by the insulating member for connection with the current carrying biasing means and the said movable contact, and means including said passage means for connecting each of said chambers with separate sources of fluid pressure for operation of the switch member in response to the difference between the two separate pressures.

2. A switch in combination comprising, a first member having a passageway extending through the member for communication with a first pressure chamber of relatively large cross-section formed in one end thereof, a second member having a second pressure chamber formed in one end thereof and of smaller cross-section than the first chamber, a plunger of substantially the size of said second chamber and having a stem mounted for movement within the second member, passage means through said second member for communication with the second pressure chamber and including an opening adjacent the inner side of said plunger, a diaphragm separating the two said pressure chambers, the depth of the chambers being such as to limit the movement of the plunger and diaphragm, stationary contact means, movable switch contact means and means including a snap disk, current carrying biasing means and said plunger stem for actuating the movable contact means, a bellows enclosing said biasing and switch contact means, a switch casing member and an insulating member therein, electrical switch connecting means supported by the insulating member and connected to the bellows for connection with the current carrying biasing means and the said movable contact, and means for associating the passage means communicating with the first and second pressure chambers to separate sources of fluid the variation in the pressure of which is transferred to the diaphragm for actuation of

the switch contact controlling plunger for actuation of the switch.

3. A switch in combination comprising, a first member having a passageway extending through the member for communication with a first pressure chamber of relatively large cross-section formed in one end thereof, a second member having a chamber formed in one end thereof of smaller cross-section than the said first chamber, a plunger of substantially the size of said second chamber and having a stem mounted for movement within the chamber and second member, a diaphragm separating the two said pressure chambers, the depth of the chambers being such as to limit the movement of the plunger and diaphragm regardless of the pressure applied thereto, stationary contact means, movable switch contact means and snap acting means for the actuation thereof, current carrying biasing means associated with the snap acting means for opposing the operation of the movable switch contact by the said plunger stem, a bellows insulated from and cooperating with said second member for enclosing said biasing and switch contact means, a switch casing member having an insulating member therein, and electrical switch connecting means supported by said housing insulating member for switch actuated connection with the bellows, the current carrying biasing means and the said stationary and movable switch contact means.

4. In combination comprising, a portion having two relatively shallow chambers formed therein and in which one chamber has a larger cross-section than the section chamber, a diaphragm separating the said two chambers, separate passage means communicating with said chambers, a plunger of substantially the same size as the second chamber and mounted for movement guided thereby in response to pressure exerted on one side thereof by the diaphragm and on the other side by pressure from the second chamber, a stationary switch contact associated with said portion, a movable switch contact, a member actuated by the plunger and extending through said portion for operation of the said movable contact, means opposing the operation of the movable switch by the plunger including a snap acting means, and current carrying spring biasing means, a housing means for the spring biasing means, a casing including an insulated portion, switch connector means supported by and extending through the insulated portion of the casing for connection with said current carrying spring biasing means and means for the selective adjustment of the housing means and said casing relative to each other for adjustment of the pressure required for operation of the switch contacts.

5. In combination comprising, a portion having a diaphragm separating two relatively shallow chambers formed therein and in which one chamber has a larger cross-section than the second chamber, separate passage means communicating with said chambers, a plunger of substantially the same size as the second chamber and mounted for movement therein in response to pressure exerted on one side thereof by the diaphragm and on the other side by pressure from the second chamber, a stationary switch contact associated with said portion, a movable switch contact, a member actuated by the plunger and extending through said portion for operation of said movable contact, snap acting movable contact operating means, current carrying spring

biasing means, means for associating the spring biasing means with the snap acting means, the movable contact and the plunger actuated member for biasing the contact in a first manner in opposition to the operation thereof by the said plunger, a casing including an insulated portion, switch connector means supported by and extending through the insulated portion of the casing for connection with said current carrying spring biasing means, an intermediate casing member by which said portion is aligned and supported and upon which the said casing is threadedly secured for adjustment of the pressure required for operation of the switch contacts, said portion and said casing having external teeth extending axially of the switch, a sleeve member having internal teeth extending axially thereof for rigidly securing the sleeve member to said portion and casing to insure operation of the switch in accordance with the selected adjustment thereof.

6. A combination comprising, a switch controlling unit including main switching means, a relay for actuating the main switching means, a second switching means for controlling the operation of the relay, means for actuating the second switching means for the actuation of the relay and main switching means, means for adjusting the second switching means with respect to the actuating means therefor to selectively vary the operation of the relay and main switching means in response to the operation of the said actuating means and terminal connector means for connection with the main switching means.

7. The combination comprising, a switch controlling device including a first switching means, a relay, device main switch controlling means actuated by the said relay, a casing for the said device and connector means extending through the said casing for connection with the said first switching means, the relay and the device main switch controlling means, condition responsive means for operating the said first switching means to actuate the relay for control of the device main switch controlling means, the said casing including at least two sections threadedly secured with respect to each other, and means for adjusting the operation of the first switching means by the selective positioning of the said sections of the casing.

8. The combination comprising, a switch controlling device including stationary and movable switch contact means, a relay, device main switch controlling means actuated by the said relay, a casing for the said device and connector means extending through the said casing for connection with the switch contact means, the relay and the device switch controlling means, condition responsive means for operating the switch contact means to control the operation of the device switch controlling means, the said casing including an intermediate and end portions threadedly secured with respect to each other, means for adjusting the operation of the device by the selective positioning of the said end portions of the casing, the said parts of the casing having teeth on the outside thereof that extend axially of the device, a casing sleeve member having teeth therein and extending axially thereof for cooperation with the said casing teeth to prevent relative movement between parts of the casing and to maintain the selected adjustment of the said device, a passageway extending through the intermediate portion of the casing and the said sleeve, and a locking pin with means for biasing

the pin to extend through the said passageway of the casing and sleeve.

9. In a unitary switch controlling device in combination comprising, housing means for said device including a main portion, switching means and condition responsive means for controlling the switching means in the said main housing portion, a plurality of interchangeable covering units each including connector means insulatively supported therein connected to said main portion of the housing means, the said covering units being adapted to include therein a relay and a main circuit switching means, and the said main housing switching means being operable by the condition responsive means for actuating the relay.

10. A condition responsive switch controlling device in combination comprising, a housing for said device including a main portion, biasing means, snap acting switching means and condition responsive means for actuating a first switching means located in said main housing portion, a plurality of interchangeable covering units, said covering units having at least one switch connecting element supported therein and said covering units being adjustably mounted with respect to the main housing to cooperate with the said biasing means for adjustment of the operation of the device by the condition responsive means, said covering units being adapted to include therein relay means and second switching means, and the first switching means is adapted to control the energization of the relay means whereby the relay means operates the second switching means.

11. In a unitary switch controlling device in combination comprising, a housing for said device including a main portion, biasing means, snap acting switching means and condition responsive means for actuating first switching means located in said main housing portion, a plurality of interchangeable covering units, said covering units having at least one switch connecting element supported therein and said covering units being adjustably mounted with respect to the main housing to cooperate with the said biasing means for adjustment of the operation of the device by the condition responsive means, said covering units including therein motor means and second switch means operated by the said first switching means, the motor means actuating the second switch means, the said main portion of the housing and the said covering units being threaded axially on outer portions thereof, and an internally threaded sleeve member for cooperation with the said threaded housing and covering units for locking them to a selected position of adjustment for control by the said condition responsive means.

12. A pressure actuated switching device in combination comprising, a first portion including a base member having formed in a surface thereof a shallow chamber of relatively large cross-section, a passageway extending through said base member to said chamber, a housing member having formed in a surface thereof a chamber of relatively small cross-section, a diaphragm supported between the members and separating the said chambers, a plunger member of substantially the size of said second chamber and guided for slidable movement therein in response to movement of the said diaphragm, a movable switch contact and stem means slidably actuated by the plunger member for actuation of the movable switch contact, a stationary switch

contact in grounded contact with the said housing, a current carrying spring and movable contact biasing member, a spring guide and current carrying movable contact actuating member, an upper casing member including an insulating portion, and circuit connector means mounted in the insulated portion of the casing member for connection with the said current carrying movable contact switch biasing means.

13. A pressure actuated switching device in combination comprising, a portion including a base member having formed in a surface thereof a shallow chamber of relatively large cross-section, a passageway extending through said base member to said chamber, a housing member having formed in a surface thereof a chamber of relatively small cross-section, a diaphragm supported between the members and separating the said chambers, a plunger member of substantially the size of said second chamber and guided for slidable movement therein in response to movement of the said diaphragm, a movable switch contact, stem means slidably actuated by the plunger member for actuation of the movable switch contact, a stationary switch contact in grounded contact with the said housing, a current carrying spring for biasing the movable contact member, a biasing spring guide and current carrying movable contact actuating member, an upper casing member including an insulating portion, switch connector means mounted in the insulated position of the casing member for connection with said movable contact switch biasing means, a lower casing member associated with said first portion, and an intermediate casing member, said member being threaded for the assembly of at least two of said casing members with respect to each other to provide for adjustment of the operation of the spring biasing means and the actuation of the switch contacts by the diaphragm at a selected pressure.

14. A pressure actuated switching device in combination comprising, a portion including a base member having formed in a surface thereof a shallow chamber of relatively large cross-section, a passageway extending through said base member to said chamber, a housing member having formed in a surface thereof a chamber of relatively small cross-section, a diaphragm supported between the members and separating the said chambers, a plunger member of substantially the size of said second chamber and guided for slidable movement therein in response to movement of the said diaphragm, a movable switch contact, stem means slidably actuated by the plunger member for actuation of the movable switch contact, a stationary switch contact in grounded contact with the said housing, a current carrying spring and movable contact biasing member, a spring guide and current carrying movable contact actuating member, an upper casing member including an insulating portion, switch connector means mounted in the insulated portion of the casing member for connection with said movable contact switch biasing means, a lower casing member associated with said portion, and an intermediate casing member, said member being threaded for the assembly of at least two of said casing members with respect to each other to provide for adjustment of the operation of the spring biasing means and the actuation of the switch contacts by the diaphragm at a selected pressure, at least two of the casing members having axially and outwardly extending teeth, and a sleeve member having internal teeth

extending axially thereof for cooperation with the casing members to maintain the switch in the position of adjustment for operation at a selected pressure.

15. A pressure actuated switching device in combination comprising, a portion including a base member having formed in a surface thereof a shallow chamber of relatively large cross-section, a passageway extending through said base member to said chamber, a housing member having formed in a surface thereof a chamber of relatively small cross-section, a diaphragm supported between the members and separating said chambers, a plunger member of substantially the size of said second chamber and guided for slidable movement therein in response to movement of the said diaphragm, a movable switch contact, stem means slidably actuated by the plunger member for actuation of the movable switch contact, a stationary switch contact in grounded contact with said housing, a current carrying spring and movable contact biasing member, a spring guide and current carrying movable contact actuating member, an upper casing member including an insulating portion, switch connector means mounted in the insulated portion of the upper casing member for connection with said movable contact switch biasing means, a lower casing member associated with said first portion and an intermediate casing member, said member being threaded for the assembly of at least two of said casing members with respect to each other to provide for adjustment of the operation of the spring biasing means and the actuation of the switch contacts by the diaphragm at a selected pressure, at least two of the casing members having axially and outwardly extending teeth, a sleeve member having internal teeth extending axially thereof for cooperation with the casing members to maintain the switch at the position of adjustment for operation at a selected pressure, a passageway extending through the said sleeve member and the said housing, and a pin member biased to extend into the sleeve and housing passageway for locking the switch in the position of adjustment.

16. A switch in combination comprising, casing means including separate casing members, switching means, condition responsive means for actuating the switching means in a first manner, biasing means for opposing the operation of the switching means in the first manner by the said condition responsive means, means for positioning said casing members to adjust the biasing means to control the operation of the switch by the condition responsive means, a locking member, and axially extending means carried by both said casing members and by said locking means for radial cooperation to lock said casing members against relative rotation, whereby to maintain the switch in the selected position of adjustment for control by the condition responsive means.

17. A switch in combination comprising, casing means including intermediate and end members, switch contact means, means for actuating the switching means in a first manner, biasing means for opposing the operation of the switching means in the first manner, means for adjustably mounting an end member on the intermediate member and for adjustment of the biasing means thereby to thus control the operation of the switch, a locking member, and axially extending means carried by both said casing members and by said locking member for radial cooperation to lock said casing members against relative rotation,

whereby to maintain the selected position of adjustment for operation of the switch.

18. A pressure switch in combination comprising, a base including a passage therethrough for the transmission of a fluid pressure to a chamber formed in said member, a diaphragm for transmitting said fluid pressure, a plunger mounted for limited movement by said diaphragm in a chamber formed in a second member, a movable switch contact, a stationary contact, means including said plunger for actuating the movable switch contact, current carrying spring means for biasing the movable switch contact actuating means in a manner to oppose the actuation of the movable switch contact actuating means by the transfer of pressure from said diaphragm, a casing including at least one casing member adjustably secured to a second casing member, the said adjustable casing members providing means for adjusting the said biasing means to operate the said switch at a predetermined pressure and having switch connector means for connection with the said current carrying spring means, a locking member, and axially extending means carried by both said casing members and by said locking member for radial cooperation to lock said casing members against relative rotation, whereby to insure continued operation of the switch at said predetermined pressure.

19. A plurality of axially adjacent relatively rotatable members, said rotatable members being in screw-threaded relation, whereby said rotation causes axial movement between said members, a locking member, axially extending means carried by said members for radial cooperation to lock said members against relative rotation, whereby locking of said members against rotation is effective to fix the axial relationship between said members, condition responsive apparatus associated with said members, the response of said apparatus being adjustable by varying the axial relationship between said members, and releasable means positively maintaining said locking member in a selected axial position.

20. A plurality of axially adjacent relatively rotatable members, said rotatable members being in screw-threaded relation, whereby said rotation causes axial movements between said members, a locking member, external axially extending means carried by said rotatable members, internal axially extending means carried by said locking member for radial cooperation with said first mentioned means to lock said members against relative rotation, and condition responsive apparatus associated with said members, said apparatus including adjustable biasing means for regulation of the response of said apparatus, said biasing means being adjustable by varying said axial relationship between said members, whereby locking of said members against rotation is effective to fix the axial distance between said members and therefore to fix the adjustment of said biasing means, and releasable means positively maintaining said locking member in a selected axial position.

21. A plurality of axially adjacent relatively rotatable members, external axially extending teeth on a first of said members, similar external axially extending teeth on a second of said members, a locking member, internal axially extending teeth in said locking member for cooperation with said teeth in said rotatable members to lock said members against relative rotation, and releasable means positively maintaining said locking member in a selected axial position, said

last mentioned means comprising a groove in one of said members, alignable radial holes in said locking member and one of said rotatable members, and a spring carried in said groove and retractably passing through said holes.

22. In a control instrument, a plurality of axially adjacent relatively rotatable members, said members being in screw-threaded relation, whereby said rotation causes axial movement between said members, axially extending teeth in a first of said members, axially extending teeth in a second of said members, a locking member, axially extending teeth in said locking member for cooperation with said teeth in said first and said second members whereby to lock said members against relative rotation, locking of said members against said rotation being effective to fix the axial relationships between said members, condition responsive apparatus associated with said members, said apparatus including adjustable biasing means for regulation of the response of said apparatus, said biasing means being adjustable by varying the axial relationships between said members, whereby locking of said member against said rotation fixes the adjustment of said biasing means, and releasable means positively maintaining said locking member in a selected axial position, said last mentioned means comprising a groove in one of said members, radial alignable holes in said locking member and one of said rotatable members, and a spring carried in said groove and retractably passing through said holes.

23. In a control apparatus, a plurality of axially adjacent rotatable members, a locking member, axially extending means carried by said members for radial cooperation to lock said members against relative rotation, said rotatable members being in screw-threaded relation, whereby said rotation causes axial movement between said members, and whereby locking of said members against rotation is effective to fix the axial relationships between said members, condition responsive apparatus associated with said members, the response of said apparatus being adjustable by varying the axial relationship between said members, and releasable means positively maintaining said locking member in a selected axial position, said last mentioned means comprising a groove in one of said members, alignable radial holes in said locking member and one of said rotatable members, and a spring carried in said groove and retractably passing through said holes.

24. As an article of manufacture, a sub-assembly for a pressure actuated switch comprising a first member having a passageway communicating with a first pressure chamber of relatively large cross-section formed in one end thereof, a second member having formed in one end thereof a second pressure chamber of smaller cross-section than the first chamber, a plunger of substantially the size of the said second chamber and having a stem mounted for movement within the second member, passage means through said second member for communication with the second pressure chamber and including an opening adjacent the inner side of said plunger, a diaphragm separating the two said pressure chambers, the depths of the chambers being such as to limit the movement of the plunger and diaphragm, stationary contact means, movable switch contact means and means including a snap disk, current carrying biasing means and said plunger stem for actuating the

movable contact means, a bellows enclosing said biasing means, and means for associating the passage means communicating with the first and second pressure chambers to separate sources of fluid variation in the pressure of which is transferred to the diaphragm for actuation of the switch contacts controlling plunger for actuation of the switch.

25. As an article of manufacture, a sub-assembly for a pressure switch comprising a base having a passage for the transmission of a fluid pressure to a chamber formed in said member, the said chamber, a diaphragm for transmitting said fluid pressure, a plunger mounted for limited movement by said diaphragm in a chamber formed in a second member, a movable switch contact, a stationary contact, means including said plunger for actuating the movable switch contact, electrically conducting spring means for biasing the movable switch contact actuating means in a manner to oppose the actuation of the movable switch contact actuating means by the transfer of pressure from said diaphragm, and a casing member adapted to be connected with one of a plurality of interchangeable switch connector means, said casing member comprising a groove, a radial hole opening into said groove, and a spring retractably projecting through said hole, said casing member further comprising axially extending teeth for cooperation with similar teeth in a locking means whereby to prevent relative rotation between said casing and said locking means.

26. A differential pressure responsive switch comprising a housing forming a pressure chamber, a high pressure bore and a low pressure bore communicating with the chamber, a plunger slidably projecting into one of said bores and having a conical end portion located in the chamber, a disk having a central depression rockingly engaging the conical end portion of said plunger, electrical contacts located in the chamber and insulated from the housing, and spring means for biasing the disk towards the conical end of said plunger.

27. Differential pressure responsive switch comprising a housing forming a pressure chamber, a high pressure bore and a low pressure bore communicating with said chamber, a plunger slidably projecting into one of said bores and having a conical end portion located in the chamber, a disk having a central depression rockingly engaging the conical end portion of said plunger, electrical contacts located in the chamber, and

spring means for biasing the disk towards said conical end.

28. A pressure actuated switch device comprising an actuating mechanism including a base having a passage for the transmission of fluid pressure to a chamber formed in said member, the said chamber, a diaphragm for transmitting said fluid pressure, a plunger mounted for limited movement by said diaphragm in a chamber formed in a second member, a movable switch contact, a stationary contact, means including said plunger for actuating the movable switch contact, electrically conducting spring means for biasing the movable switch contact actuating means in a manner to oppose the actuation of the movable switch contact actuating means by the transfer of pressure from said diaphragm, a bellows enclosing and making electrical contact with said biasing spring, a first casing member enclosing and supporting said actuating mechanism, said casing member comprising a groove, a radial hole opening into said groove, and a spring retractably projecting through said hole, said casing member further comprising axially extending teeth for cooperation with similar teeth in a locking means, whereby to prevent relative rotation between said casing member and said locking means, and a second casing member, including an electrical connector element, adapted to cooperate with said first casing member, said second casing member and said bellows including coacting means telescopically making electrical contact therebetween, whereby to complete an electric circuit from said connector element of said second casing member to one of said contacts.

29. A pressure responsive switch comprising a housing having an intermediate and end axial adjustable sections connected together forming a pressure chamber, a pressure bore communicating with the said chamber, pressure responsive means operably mounted in said chamber, a stationary contact electrically connected with said housing, a movable contact actuated by said pressure responsive means, means for biasing the movable contact in opposition to the actuation of the pressure responsive means, bellows means surrounding the biasing means, and at least two of the sections of the housing being axially adjusted to vary the values of the condition actuating the pressure responsive means for operating the switch.

ALBERT E. BAAK

CERTIFICATE OF CORRECTION.

Patent No. 2,371,669.

March 20, 1945.

ALBERT E. BAAK.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 6, first column, line 66, claim 8, for "parts" read --end portions--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of September, A. D. 1945.

Leslie Frazer

(Seal)

First Assistant Commissioner of Patents.

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