Jan. 1, 1946. A. T. NEWELL 2,391,916

PRESSURE ACTUATED SWITCH

Filed May 25, 1943 2 Sheets-Sheet 1

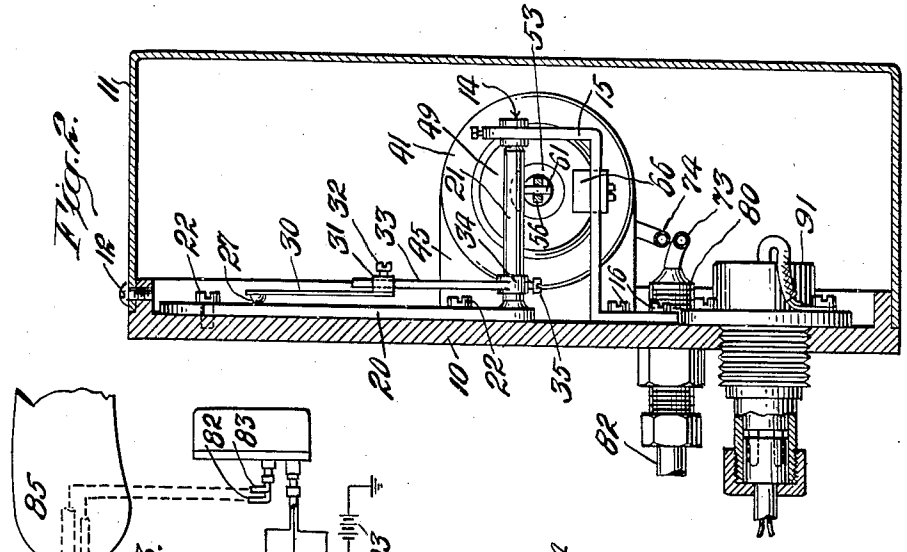

Fig. 2.

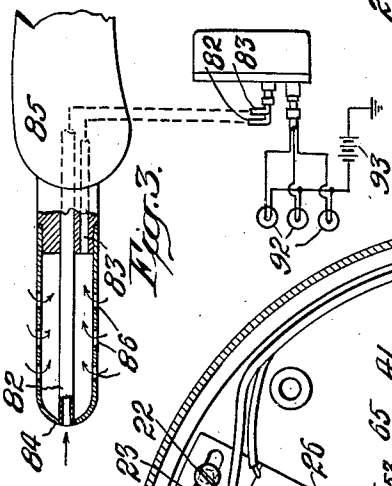

Fig. 3.

Fig. 1.

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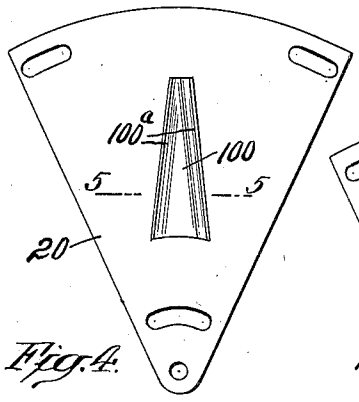

Fig. 4.

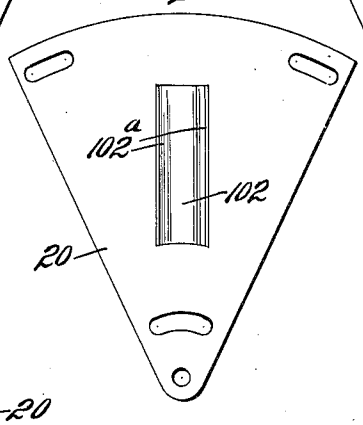

Fig. 6.

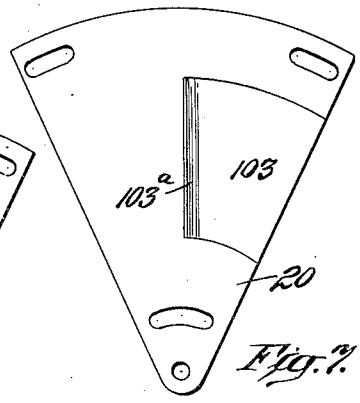

Fig. 7.

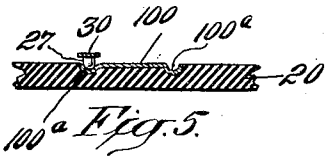

Fig. 5.

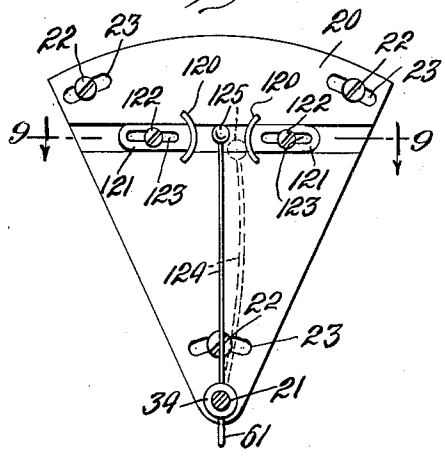

Fig. 8.

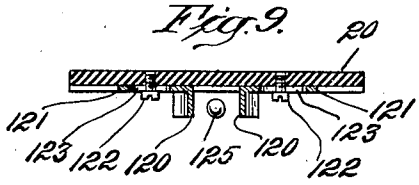

Fig. 9.

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Patented Jan. 1, 1946 2,391,916

UNITED STATES PATENT OFFICE

2,391,916

PRESSURE ACTUATED SWITCH

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Application May 25, 1943, Serial No. 488,360

6 Claims. (Cl. 200—81.5)

This invention relates to pressure actuated switch mechanism and more particularly to an air speed switch for airplanes.

An object of the invention is to provide a switch of the above type having novel and improved details of construction and features of operation.

In accordance with the present invention a balanced bellows mechanism is provided for operating the switch contact arm through a linkage providing a limited amount of lost motion so that the contact, when closed, remains closed over a predetermined range of movement of the bellows, thereby preventing unstable operation.

Another feature of the invention consists in providing internal plug members for reducing the available volume of the bellows so as to increase the sensitivity thereof to changes in air pressure in the supply tubes. The plug members also act as built-in stops to limit the compressional movement of the bellows.

Another feature consists in the provision of capillary metering orifices in the supply tubes which serve to dampen the operation of the device and to eliminate variations in operations which might otherwise occur if the tube area should change, as by the partial closing or the partial plugging of a tube.

The invention also provides novel and improved contact mechanism for successively closing a plurality of different contacts as the air speed changes, with a snap action at each make or break. The contacts are so arranged that the contact periods and the gap periods may be varied over a wide range by a simple adjustment. The contacts are also arranged to be self-cleaning.

Although the novel features which are believed to be characteristic of this invention are pointed out more particularly in the claims appended hereto, the invention itself may be better understood by referring to the following description, taken in connection with the accompanying drawings in which a specific embodiment thereof has been set forth for purposes of illustration.

In the drawings,

Fig. 1 is a vertical section through a switch mechanism embodying the present invention;

Fig. 2 is a transverse vertical section taken on the line 2—2 of Fig. 1;

Fig. 3 is a diagrammatic view of the switch mechanism connected by static and Pitot lines to an airplane wing;

Fig. 4 is a detail view of a switch plate illustrating another embodiment of the invention;

Fig. 5 is a transverse section taken on the line 5—5 of Fig. 4;

Figs. 6 and 7 are detail views of switch plates illustrating further embodiments of the invention;

Fig. 8 is a detail view of a switch plate and contact arm illustrating a still further embodiment of the invention; and

Fig. 9 is a transverse section taken on the line 9—9 of Fig. 8.

In the following description certain specific terms are used for convenience in referring to various details of the invention. It is to be understood, however, that these terms are to be given as broad an interpretation as the state of the art will permit.

Referring first to Figs. 1 and 2, the switch is shown as comprising a base plate 10 having a suitable cover 11 secured thereto by means shown as screws 12. The base plate 10 carries a pin 14, the outer end of which is supported by a stationary bracket 15 attached to the base plate 10 by screws 16.

A segmental contact plate 20 and a sleeve 21 are pivotally mounted about the pin 14. The contact plate 20 is adjustably secured to the base plate 10 by suitable means shown as screws 22, which extend through elongated arcuate slots 23 in the contact plate.

In the embodiment of Figs. 1 and 2 the contact plate carries a plurality of contact segments 24 to 26 which are positioned to be successively engaged by a moving contact 27 as the latter sweeps across the contact plate 20.

The contact 27 is carried by a flat spring member 30 which is biased to hold the contact 27 in firm engagement with the contact segments 24 to 26. The member 30 is attached by a sleeve 31 and a set screw 32 to a spring arm 33 which is attached by a collar 34 and a set screw 35 to the sleeve 21 for turning therewith. The spring arm 33 is adapted to flex in response to the turning movement of the sleeve 21 so as to build up a force for overcoming the resistance of the contact 27.

In the embodiment shown in Figs. 1 and 2 the contact segments 24 and 26 are positioned at opposite sides of the contact plate 20 with the contact segment 25 in an intermediate position. The inside edges of the contact segments 24 and 26 are provided with grooves 24a and 26a and the side edges of the segment 25 are provided with grooves 25a which are similar to the grooves shown in section in Fig. 5 and are adapted to receive and temporarily restrain the contact 27 as

the contact moves thereover, so that an appreciable force is required to move the contact 27 out of said grooves after the contact has once seated therein. This force is built up by flexing of the spring arm 33 which causes the contact 27 to leave the groove with a snap action. The contact 27 likewise enters the grooves with a snap action as it seats therein. Consequently, the various contacts make and break with a snap action as required for electrical purposes.

For operating the contact arm 33 there is provided a pair of bellows 40 and 41 having bases 42 and 43 respectively which are secured to brackets 44 and 45 attached to the base plate 10.

The free ends of the bellows 40 and 41 are formed with diaphragms 48 and 49 having recesses 50 and 51 in which the heads 52 and 53 of screws 54 and 55 are seated. The screws 54 and 55 are carried in the ends of a link 56, which extend between the diaphragms 48 and 49 of the two bellows. The screw heads 52 and 53 may be held in recesses 50 and 51 by the compression of the two bellows, or may be attached to the diaphragms. The link 56 is provided with a central slot 60 into which a pin 61, attached to the sleeve 21, extends. The slot 60 is somewhat wider than the pin 61 to provide a predetermined amount of lost motion between the bellows and the contact arm 33, so that the contact 27, after closing, remains closed during a predetermined return movement of the bellows assembly.

The bases 42 and 43 of the bellows carry plugs 64 and 65 which substantially fill the space within the bellows and extend to a position to engage the diaphragms 48 and 49 for limiting the compressional movement thereof. The plugs 64 and 65 reduce the air volume within the bellows and thereby increase the sensitivity thereof to changes in pressure in the supply lines, in addition to serving as stops for limiting the movement of the bellows and the switch mechanism associated therewith. An additional stop member 66 is shown as adjustably secured to the bracket 15 to provide means for adjusting the range of movement of the contact arm 33.

The plugs 64 and 65 are provided with bores 67 and 68 in which couplings 69 and 70 respectively are secured. The couplings 69 and 70 are drilled to form ducts 71 and 72, which are coupled to flexible tubes 73 and 74 respectively. The bores 67 and 68 terminate in ports 75 and 76 which communicate with the space within the bellows. The ducts 71 and 72 and the tubes 73 and 74 are preferably of capillary size to provide capillary metering orifices for the purpose to be described. These tubes 73 and 74 terminate in coupling members 80 and 81 respectively in the base 10 which are adapted to receive static and Pitot tubes 82 and 83 respectively (Fig. 3).

Referring to Fig. 3, the Pitot tube 83 is connected to the leading edge 84 of an airplane wing 85. The static tube 82 is connected to the space inside of the wing 85, which is provided with openings 86 in the top and bottom surfaces through which air under static pressure, which is unaffected by forward movement, enters. The static tube 82 is thus responsive to static air pressure, whereas the Pitot tube 83 is responsive to pressure built up by forward movement. These two air pressures are supplied to the bellows 40 and 41 respectively and operate the assembly in accordance with their differential effect.

The tubes 82 and 83 may, of course, be connected to be actuated by water pressure for marine work as by a pressure strut of the type set forth in co-pending application of A. T. Newell, Ser. 478,054, filed Mar. 4, 1943, for Marine speedometer.

Contacts 24, 25 and 26 are connected by suitable lines 90 to a connector 91 which, in turn, is connected to suitable control or signalling apparatus, shown in Fig. 3 as a plurality of light sources 92 connected to the individual lines and energized by a battery 93. It is to be understood, of course, that these light sources are illustrative only and that the various lines may be connected to operate suitable relays or other actuating or signalling mechanisms as desired.

In the embodiment shown in Figs. 4 and 5 the plate 20 is provided with a contact segment 100 which tapers in a radial direction away from the axis of the pin 14. The segment 100 is provided with side grooves 100*a* similar to the grooves 25*a* of the contact segment 25.

In the embodiment of Fig. 5 the construction is similar to that of Fig. 4 except that the contact segment 102 of Fig. 5 is rectangular and the side edges are parallel to each other. This contact segment 102 is provided with side edge grooves 102*a* to receive the contact member 27 in the manner above specified.

In the embodiment shown in Fig. 7 the contact plate 20 is provided with a single contact segment 103 having a side groove 103*a*. This type of contact is suitable for a single make and break.

In the operation of the invention thus far described, the differential bellows assembly 40, 41 is responsive to the differential pressure between the Pitot tube 83 and the static tube 82, and accordingly assumes a position which varies in accordance with forward speed and is unaffected by changes in altitude. The total area within the bellows 40 and 41 is reduced to an extremely small value by means of the plugs 64 and 65. Hence, the bellows are responsive to extremely small changes in air pressure in the tubes 82 and 83.

The capillary metering orifices provide a damping effect on the action of the bellows and cause the same to operate in a stable manner. Since the area of the capillary orifice is the limiting area for air flow, the operation of the device is made independent of changes in area of the external tubing provided the effective area of the tubes remains greater than the area of the capillary orifice. Hence the device is unaffected by the partial closing or partial plugging of the external tubing and does not require the use of tubing of any predetermined critical diameter.

In the embodiment illustrated in Fig. 1 the contact 27 is adapted to swing progressively over the contact segments 24, 25 and 26 as the speed of the plane increases. Under minimum speed conditions the contact 24 is closed. As the contact 27 swings to the right in Fig. 1, before leaving the contact 24 it engages the recess 24*a*. Since a substantial force is required for removing the contact out of this recess, the contact remains therein until sufficient force has been built up by flexing of the spring arm 33. The contact 27 then snaps out of the recess 24*a* onto the insulating portion of the plate 20 on which it continues to rest until it has reached the recess 25*a* on the leading edge of the segment 25. When the contact 27 reaches this recess it immediately snaps therein, closing the second circuit. Further turning movement of the sleeve 21 causes the contact 27 to snap out of the leading recess 25*a* and to slide over the surface of the contact segment 25 until it engages the

trailing recess 25a. The snap action above described in connection with the recess 24a is then repeated, the contact 27 finally snapping out of the trailing recess 25a onto the insulating surface of the contact plate 20 between the segments 25 and 26. This action is repeated as the contact reaches the plate 26.

During the above operation the spring member 30 serves to hold the contact 27 in engagement with the various contact segments. The ratio of gap period to contact period may be controlled by adjusting the position of the sleeve 31 on the spring arm 33 so as to thereby vary the radial position of the contact 27. In the embodiment shown in Fig. 1, the contacts 24, 25 and 26 taper toward the axis of the pin 14 but have a greater angular width as the axis is approached. The gaps between the contact segments 24, 25 and 26 have a correspondingly less angular width as the axis is approached. Hence, as the contact 27 is shifted toward the axis, the ratio of the contact area to the gap area is increased. In this way any desired ratio may be obtained by suitable adjustment of the position of the sleeve 31 along the spring arm 33.

The setting of the contacts may be further adjusted by shifting the angular position of the contact plate 20 about the pin 14 within the limits of the elongated slots 23. The plate 20 may be secured in adjusted position by the screws 22.

It is of course to be understood that an additional number of contact segments may be provided if further circuit connections are required. Figs. 4, 6 and 7 illustrate different embodiments of the invention wherein the contact segments are differently arranged. In Fig. 4 the contact plate 100 tapers away from the axis. This permits a greater range in adjustment of the ratio of contact area to gap area. It is to be understood, of course, that a plurality of such contact segments 100 may be provided if desired.

In Fig. 6 the contact segment 102 is provided with parallel side edges. This provides for a range of adjustment which is intermediate between that obtained by the embodiments of Figs. 1 and 4.

Fig. 7 shows the application of the invention to an embodiment wherein only a single make and break contact is required. Such embodiment may be used, for example, when it is desired to close the contact when the plane speed falls to a predetermined minimum value, such, for example, as a value at which it is desired to lower the wing flaps. These flaps may thus be automatically lowered when the plane speed falls to the predetermined value without further attention on the part of the pilot. A single contact, as shown in Figs. 4 and 6, may be used, for example, to indicate normal flying speed and to open the circuits when the flying speed varies either above or below its normal value. The embodiment shown in Fig. 1 may be employed, for example, to lower the wing flaps when the contact 24 is closed, to raise the same when the speed becomes sufficient to open the contact 24, to close the contact 25 for a visual indication of normal flying speed when the latter is reached, and to close the contact 26 for an indication of excessive speed. Various other arrangements will be obvious to a person skilled in the art.

Referring now to Figs. 8 and 9, the pin 14 and the control mechanism is similar to that described above. The contact plate 20 of Fig. 8, however, carries a pair of upstanding contacts 120 which are slidably mounted on brackets 121. The brackets 121 are adjustably secured to the plate 20 by screws 122 which extend through elongated slots 123 in the brackets 121. In this embodiment the sleeve 21 carries a flexible arm 124 having at its end a contact 125. It is to be understood that the bellows arrangement for controlling the sleeve 21 is similar to that above described.

In this embodiment, the contact 125 is caused to selectively close one of the contacts 120 as the air speed varies above or below a predetermined medium value. It is to be noted, however, that after the contact 120 has been closed it remains closed regardless of further movement of the bellows and further turning movement of the sleeve 21, the arm 124 flexing as indicated in dash lines for this purpose. However, as the arm 124 flexes, the contact 125 is caused to wipe across the surface of the contact 120, thereby cleaning the same and insuring a good contact.

Although certain specific embodiments of the invention have been shown for purposes of illustration, it is to be understood that various changes and modifications may be made therein and that the invention may be applied to various uses as will be readily apparent to a person skilled in the art. The invention is only to be limited in accordance with the scope of the following claims.

What is claimed is:

1. A pressure responsive instrument comprising an expansible bellows having rigid end members and collapsible sides forming a closed internal pressure chamber, an external member connected to be actuated by expansion and contraction of said bellows, and an internal plug in said bellows extending substantially the entire axial length thereof to form a stop to limit the compressional movement of said bellows, said plug having a sectional area suited to substantially fill the fluid space in said bellows for thereby reducing the fluid content without reducing the effective length of the bellows.

2. A pressure responsive instrument comprising an expansible bellows having rigid end members and collapsible sides forming a closed internal pressure chamber, an external member connected to be actuated by expansion and contraction of said bellows, and an internal plug in said bellows extending substantially the entire axial length thereof to form a stop to limit the compressional movement of said bellows, said plug having a sectional area suited to substantially fill the fluid space in said bellows for thereby reducing the fluid content without reducing the effective length of the bellows, and a supply duct extending through said plug to communicate with the interior of said bellows, and a coupling member for coupling said duct to an external tube, said coupling member including a capillary tube within said duct forming a metering orifice to dampen the action of said bellows.

3. A pressure responsive instrument comprising a pair of expansible bellows, each having a rigid base, collapsible sides and movable end diaphragms, a support carrying said rigid bases with the respective bellows in axial alignment and with their movable end diaphragms adjacent but spaced apart, aligned recesses in said diaphragms, a link extending between said diaphragms and having members seated in said recesses, said link holding both of said bellows under compression and being removably secured by the compression of said bellows and a member connected to be actuated by said link.

4. In a pressure actuated switch, an expan-

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sible bellows mechanism responsive to pressure changes, a base carrying said bellows, a flat contact member mounted on said base, a spring arm pivoted to said base and adapted to flex laterally, coupling means connecting said arm to be actuated by expansion or contraction of said bellows, a movable contact carried by said arm to sweep across said flat contact member and spring pressed thereagainst, said member having at its leading edge a depression suited to receive said movable contact with a snap action for closing said contacts, said depression having at its trailing edge a slope suited to restrain said movable contact but to release the same with a snap action for opening said contacts in response to increased pressure built up by flexing of said spring arm due to expansion or contraction of said bellows.

5. In a pressure actuated switch, an expansible bellows mechanism responsive to pressure changes, a base carrying said bellows, a fixed contact member mounted on said base, a spring arm pivoted to said base, coupling means connecting said arm to be actuated by expansion or contraction of said bellows, a movable contact carried by said arm to sweep across said contact member, said contact member being segmental in shape and tapering radially in angular width with a depression to receive said movable contact extending along at least one radial edge, said depression having an edge slope suited to restrain said movable contact but to release the same with a snap action in response to increased pressure built up by flexing of said spring arm for opening said contacts, and means adjusting the radial position of said movable contact along said arm to vary the angular arc of contact.

6. In a pressure actuated switch, an expansible bellows mechanism responsive to pressure changes, a base carrying said bellows, a pin carried by said base, a contact plate and a spring contact arm each pivoted for movement about said pin, coupling means connecting said arm to be actuated by expansion or contraction of said bellows, a movable contact carried by said arm, a plurality of segmental contact members carried by said plate to be successively engaged by said movable contact, said members tapering radially in angular width and having depressions extending along their radial edges to receive said movable contact with a snap action for closing said contacts, said depressions having edge slopes suited to restrain said movable contact but to release the same with a snap action for opening said contacts in response to increased pressure built up by flexing of said spring arm, means angularly adjusting said contact plate about said pin, and means adjusting the radial position of said movable contact along said arm to vary the angular arcs of contact.

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