United States Patent [19]

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[54] **DIFFERENTIAL PRESSURE SWITCH**

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[73] Assignee: **Westport Development & Manufacturing Company, Inc.,** Milford, Conn.

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[52] **U.S. Cl.**..... **200/83 Y,** 200/83 S, 200/83 A, 200/83 W, 200/168 G

[51] **Int. Cl.**..... **H01h 35/32,** H01h 9/04

[58] **Field of Search**..... 200/83 A, 83 C, 83 D, 200/83 Y, 83 S, 83 W, 168 G, 83 R

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[57] **ABSTRACT**

A differential pressure switch having a bellows mounted in a housing to which pressures are applied to cause the bellows end to be moved by the pressure difference toward and from an open end of the housing. A cap closes the open end and carries a snap action electrical switch that is sealed from the pressures by another bellows mounted transversely to the first, so that movement of the end of the first bellows caused by pressure differences is transmitted to the switch by radial distorting the another bellows.

5 Claims, 4 Drawing Figures

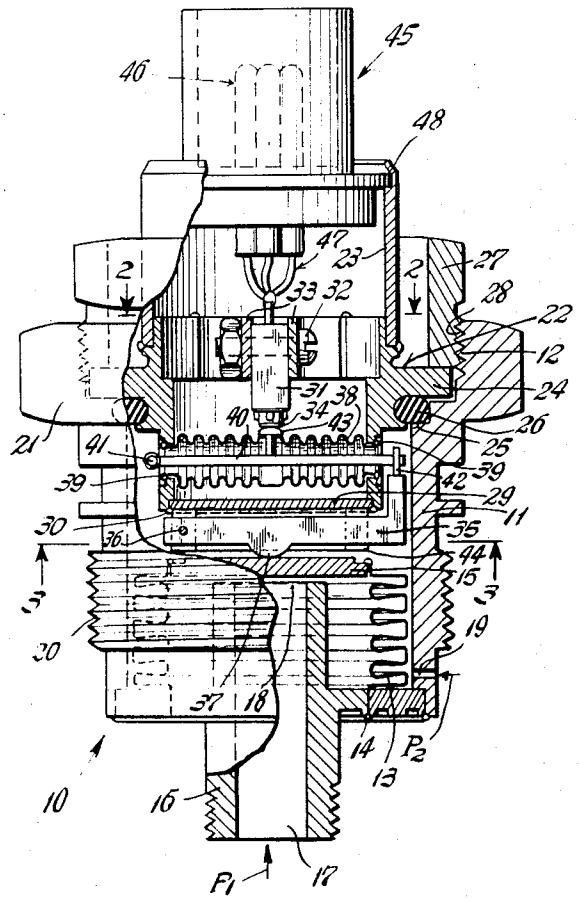

Fig. 1

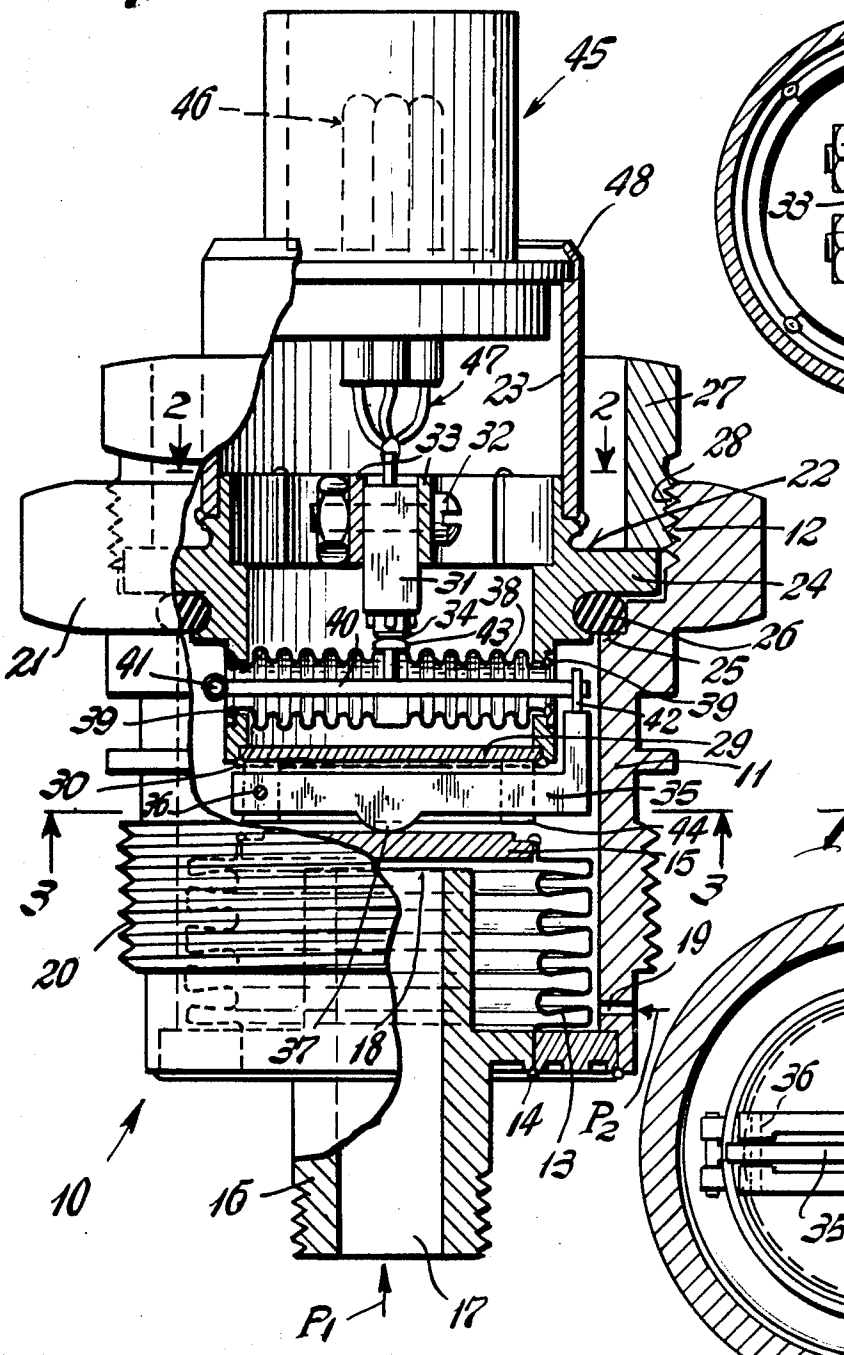

Fig. 2

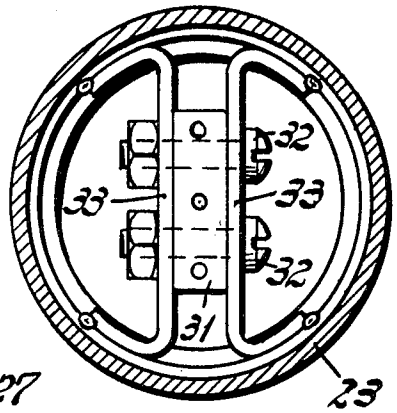

Fig. 3

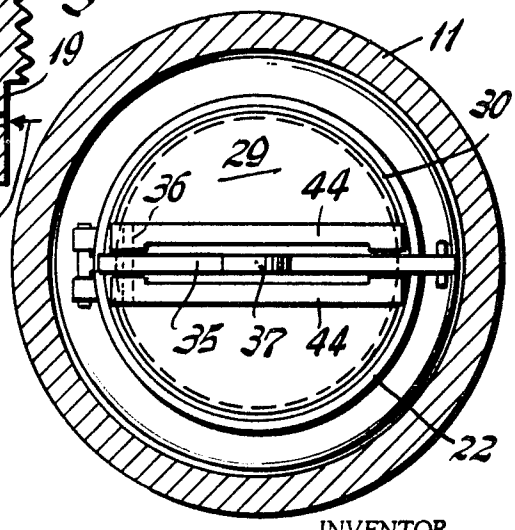

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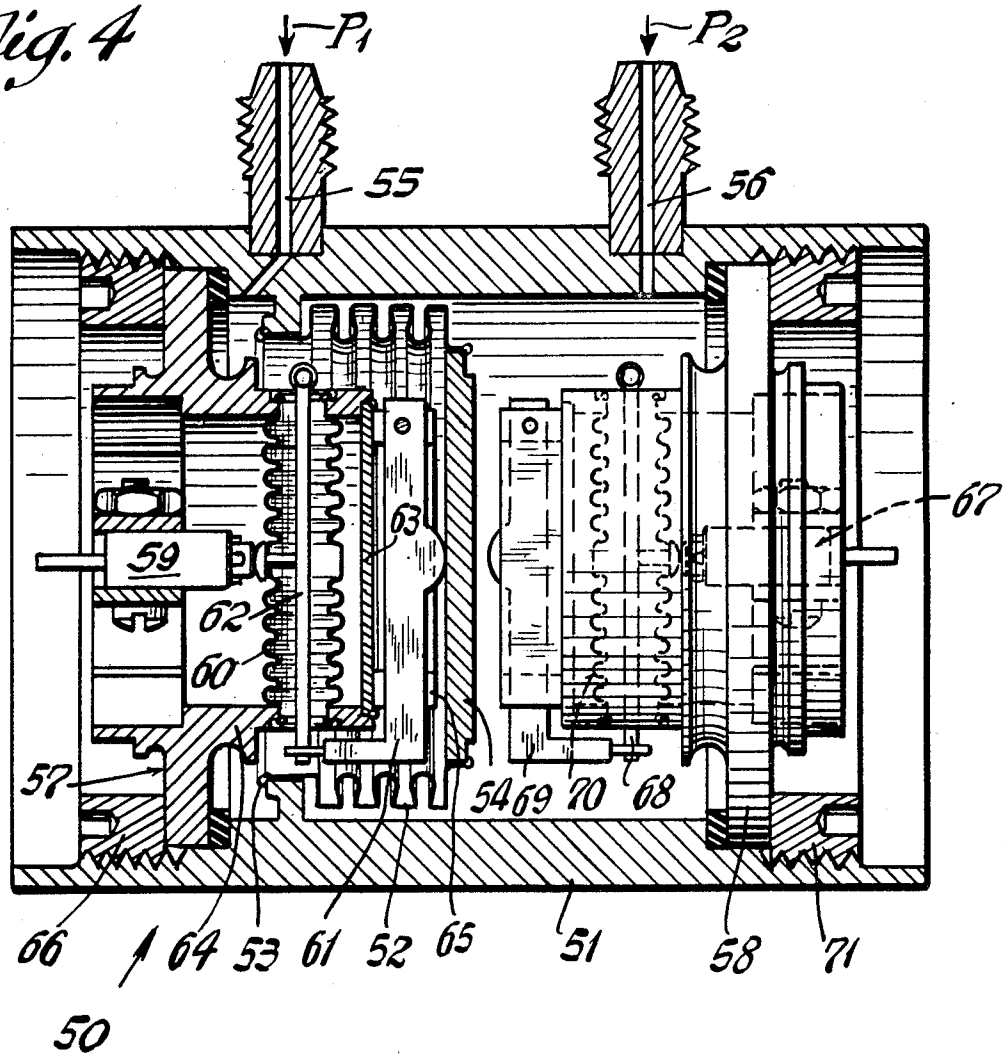
Fig. 4



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DIFFERENTIAL PRESSURE SWITCH

In heretofore suggested differential pressure switches, a pressure responsive mechanical device, such as a bellows, has one fluid applied to one side thereof and the other fluid applied to the other side, so that the bellows changes its length in direct relation to the difference in value between the pressures of the two fluids. The bellow's length for a preselected value of differential pressure is used to actuate an electrical switch which provides an electrical signal that indicates that the preselected differential pressure exists. In many instances, it is also required that the switch be contained so that it be separate from the fluids causing the pressures, and sometimes even that it be in its own environment in an hermetically sealed container.

Pressure switches that have heretofore been proposed to meet these requirements generally have not been found to be completely satisfactory. Some of the objections thereto have been based on the fact that these tend to be quite expensive, are somewhat complex, may be difficult to adjust and repair, are unreliable in maintaining their settings, are physically large and are not susceptible to being altered for use in a plurality of installations having wide pressure ranges.

It is accordingly an object of the present invention to provide a differential pressure switch which obviates most if not all of the heretofore noted deficiencies in differential pressure switches.

Another object of the present invention is to provide a differential pressure switch which has a bellows contained within a hollow body, and in which the switch actuating means and switch are contained within the cap that closes the end of the body with the switch actuating means including another bellows that is mounted transverse to the first bellows.

A further object of the present invention is to achieve the above objects with a differential pressure switch that is extremely simple in construction, relatively economical to manufacture, easy to assemble and adjust and which is reliable over a wide range of pressures and environmental conditions.

In the differential pressure switch of the present invention, there is provided a hollow body having an open end and a tubular bellows having a closed end. The bellows is connected in the body to have fluids separately applied to its interior and exterior, with the closed end of the bellows moving towards and away from the open end of the body in response to differences in the fluid pressures. The open end of the body is closed by the head of a cap.

A mechanically responsive electrical device, specifically a snap action electrical switch, is positioned on the side of the cap head remote from the bellows and the head contains actuating means for translating movement of the closed end of the bellows into actuation of the switch. In particular, the head of the cap includes another bellows that extends transversely to the movement of the closed end of the first-mentioned bellows, together with actuating arms. One actuating arm is directly engageable by the closed end of the bellows, while the other actuating arm is moved by the first arm and transmits movement of the first arm through the side of the transverse bellows by radially distorting it, and with the radial distortion being used as the mechanical movement for effecting actuation of the snap action switch.

Though the cap closes the end of the body, it is also mounted for relative axial movement therein, such that it may be located with respect to the closed end to be actuated at any desired position of the closed end, with the latter being determined by the difference between the two pressures applied to the bellows. Moreover, to protect the bellows and switch from over-pressures, the cap further includes stop means which limits the extent of movement towards the switch of the closed end, thereby assuring that over-pressures will not deform either the bellows or the switch means.

Other features will hereinafter appear.

In the drawing:

FIG. 1 is a plan, partly in section, of a differential pressure switch made according to the present invention, shown enlarged about four times.

FIG. 2 is a section taken on line 2—2 of FIG. 1.

FIG. 3 is a section taken on the line 3—3 of FIG. 1.

FIG. 4 is an axial section of another embodiment of a differential pressure switch in which the switch is capable of producing electrical signals for two differential pressures, and is also shown enlarged.

Referring to the drawing, the differential pressure switch shown in FIGS. 1–3 is generally indicated by the reference numeral **10** and includes a tubular hollow body **11** having an open end formed with internal threads **12.** Positioned at the other end is a tubular bellows **13** having an open end secured as by welding **14** to the body and having a plug **15** secured to close its other end. A tubular connector **16** is secured to the body **11** and includes a passageway **17** through which a first fluid P1 may be introduced in the direction of the arrow into the interior of the bellows **13.** It will be understood that the connector **16** extends to have its end **18** be closely adjacent the plug **15** to limit the movement of the plug **15** theretowards.

An opening **19** extends through the wall of the body, such that a fluid P2 may be introduced into the body to be on the exterior of the bellows. As it is desired that this specific embodiment of a pressure switch be used by securing it into a tapped opening, the exterior of the body is formed to have exterior threads **20** and a hexagonical periphery **21.**

The open end of the body **11** is closed by a cap generally indicated by the reference numeral **22.** The cap includes a tubular portion **23** formed with a flange **24** which cooperates with a ledge **25** on the body **11** for effecting sealing therebetween through the use of a sealing member such as an O-ring **26.** For securing the cap **22** against the body **11** to both effect the seal and also enable axial movement therebetween, an annular retain-ing nut **27** is provided having threads **28** that cooperate with the threads **12.** It will thus be appreciated that, by rotating the nut **27,** it cap may be separated from the body or else it may be secured to the body at a selectable location.

The interior end of the tubular portion **23** is closed by a round disk **29** secured thereto as by welding **30.** Supported within the cap on the side of the disk **29,** remote from the bellows **13,** is a snap action switch **31** that is held in position by screws **32** passing through apertures in brackets **33** secured to the interior of the tubular portion. The switch **31** is specifically shown as a snap action switch having an operating lever **34** which, when actuated, causes the switch to shift its movable contact, as is well known in the art, though it will be un-

derstood that different positioning sensing devices may be used if desired.

The switch **31** is actuated at a predetermined position of the plug **15** which is attained when the first fluid P1 has a selected value of pressure higher than the pressure of fluid P2. The translation of the position of the plug **15** to the operating arm **34** of the switch includes actuating means consisting of an L shaped arm **35** that is pivoted on the disk as at **36** and has a hump **37** that is engageable by the end surface of the plug **15**. Extending diametrically across the tubular portion **23** transversely to the movement of the plug **15** and above the disk **29** is another bellows **38** having its ends connected to form a seal with the sides of the tubular portion, it being understood that the ends of the bellows are open and fit within apertures formed in the tubular portion **23** with welding, such as welding **39**, about the junction affecting the seal and securement.

A second arm **40** is pivoted, as at **41**, on the exterior of the tubular portion and extends through the bellows **38** to be engaged by an end portion **42** of the L shaped arm **35**. Intermediate the arm **40** there is a headed rivet **43** that passes through the wall of the bellows **38** and is sealingly secured thereto. The head of the rivet engages the operating arm **34**, while the shank of the rivet is engageable by the intermediate portion of the arm **40**.

With the above construction of the actuating means, it will be understood that, as the pressure of fluid P1 increases relative to the pressure of fluid P2, at a predetermined differential value, the plug **15** will have moved to engage the hump **37** and pivot the arm **35**, which in turn will effect pivoting of the arm **40**. The latter pivoting will force the rivet **43** upwardly, radially distorting the bellows **38** and causing actuation of the switch **31**. For a more complete description of the manner in which the bellows **38** functions, reference is made to my U.S. Pat. No. 3,431,378.

It will be understood that, by selection of the position of the nut **27** with respect to the body, the differential pressure at which switch **31** is actuated may be easily selected within the limits of the bellows **13** and that the selection automatically compensates for tolerances that may occur during the manufacture of the various parts. Thus the ability to move the cap **22** with respect to the bellows **13** enables the present switch to have a relatively wide range of differential pressures at which it may be adjusted to be actuated and, also, the setting of the part for actuation at the selected differential pressure may be easily achieved and/or modified.

In order to prevent abnormal differential pressures from causing the bellows **13** to be elongated beyond its elastic limits, the disk **29** further includes a pair of outwardly extending plates **44** which serve as stops to limit outward movement of the plug **15**. Further, the plates **44** also limit the extent of movement of the arm **35** to prevent excessive overtravel movement on the switch. As shown in FIG. **3**, the arm **35** extends between the plates **44**, while the pivot **36** thereof includes apertures formed in the plates.

It will accordingly be appreciated that the cap **22** closes off the open end **12** of the body **11** while permitting actuating movement of the plug **15** to be transferred to the operating arm **34** of the switch **31**. If desired, the other end of the tubular member **23** may be closed by electrical connector **45** which has electrical pins **46** that extend through the terminal and are sealed thereto by a fluid proof seal. Wires extend from the switch **31** terminals, such as wire **47**, to the appropriate end of pins **46** to provide electrical connection between the pins and the switch. Accordingly, by use of the electrical connector **45** and an hermetic seal at the junction **48** between the connector **45** and the tubular portion, the switch **31** becomes contained within an hermetically sealed enclosure.

Referring to FIG. **4**, there is shown another embodiment of the present invention generally indicated by the reference numeral **50**. This embodiment includes a tubular body **51** open at both ends, together with a bellows **52** having one end connected as at **53** to the interior of the body and having a plug **54** closing the other end of the bellows. A first passageway **55** directs a fluid P1 to the interior of the bellows, while a second passageway **56** directs another fluid P2 to the exterior of the bellows.

The present embodiment of the differential switch is designed to provide electrical signals for two different differential pressures and, accordingly, there is provided a first cap **57** and a second cap **58** for closing off the open ends of the body **51**. The caps are identical and essentially similar in shape to the cap **22** of the embodiment of a differential switch shown in FIGS. **1–3**. Accordingly, referring to the cap **57**, it includes a snap action switch **59** together with a transverse bellows **60**, operating arms **61** and **62** together with a round disk **63** that closes off the end of a tubular member **64**. In addition the disk **63** includes stop plates **65** for limiting leftward movement of the plug **54**. A retaining nut **66** serves to adjust and secure the position of the cap with respect to the body **51**.

With respect to the cap **58**, it similarly has a switch **67** operated by arms **68** and **69** together with a transverse bellows **70** and a nut **71** for securing it to the body **51**. It will be appreciated that with this embodiment, at one value of differential pressure wherein P2 may be greater than P1, the switch **59** is actuated at a value selected by the position of the cap in the body, as set by the nut **66**, while at a different value of differential pressure where P1 may be greater than P2, the switch **67** is operated by the plug **54** moving rightward and pivoting the arms **68** and **69**. Again the value of differential pressure at which the switch **67** is operated is set by movement of the nut **71**.

It will accordingly be understood that there has been disclosed a differential pressure switch which is composed essentially of two parts, one of the parts including a body that has a pressure responsive member such as a bellows, while the other part includes a cap that carries an electrical switch and actuating means therefor. The two parts are releasably secured together in a manner which enables the position of the cap to be altered with respect to the housing to thereby enable, not only adjustment of the differential pressure at which the switch will be operated, but also to enable setting of the switch to be actuated at that selected pressure. The cap also serves to seal the end of the tubular member, while the construction of the actuating means prevents either of the fluids that are exerted on the bellows from contacting the switch, thereby hermetically sealing the switch from the two pressures.

Variations and modifications may be made within the scope of the invention and portions of the improvements may be used without others.

I claim:

1. A differential pressure switch comprising a hollow body having an open end, a tubular bellows having a closed end and an open end, means securing the open end of the bellows to the interior of the body with the closed end being directed towards the open end of the body, means in said body for directing a first fluid to the interior of the bellows and a second fluid to the exterior thereof to have the differential pressure therebetween move the closed end of the bellows toward and away from the open end of the body, a cap secured to the body to close the open end thereof and having a head portion positioned within the body, electrical translating means secured on the cap on the opposite side of the head portion from the bellows, a second bellows mounted on the head portion to extend transversely to the movement of the first-mentioned bellows and actuating means engageable with the closed end and the second bellows for transmitting preselected movement of the closed end through the second bellows to the electrical translating means by radial distortion of the second bellows to thereby effect operation of the electrical translating means, in which the cap is secured to the body by a releasable connecting means, in which the connecting means includes means for relatively moving the cap with respect to the closed end of the bellows along the line of movement of the closed end to thereby enable adjustment of the position of the closed end of the bellows that operates the electrical translating means and in which the releasable connection includes a nut, cooperating threaded connectors on said nut and body and a flange formed on the cap and engageable by the nut.

2. A differential pressure switch comprising a hollow body having an open end, a tubular bellows having a closed end and an open end, means securing the open end of the bellows to the interior of the body with the closed end being directed towards the open end of the body, means in said body for directing a first fluid to the interior of the bellows and a second fluid to the exterior thereof to have the differential pressure therebetween move the closed end of the bellows toward and away from the open end of the body, a cap secured to the body to close the open end thereof and having a head portion positioned within the body, electrical translating means secured on the cap on the opposite side of the head portion from the bellows, a second bellows mounted on the head portion to extend transversely to the movement of the first-mentioned bellows and actuating means engageable with the closed end and the second bellows for transmitting preselected movement of the closed end through the second bellows to the electrical translating means by radial distortion of the second bellows to thereby effect operation of the electrical translating means, in which the cap is secured to the body by a releasable connecting means, in which the connecting means includes means for relatively moving the cap with respect to the closed end of the bellows along the line of movement of the closed end to thereby enable adjustment of the position of the closed end of the bellows that operates the electrical translating means, in which there is compressible sealing means between the cap and the body and in which the releasable connection causes compression to be exerted on the sealing means to effect a seal.

3. A differential pressure switch comprising a hollow body having an open end, a tubular bellows having a closed end and an open end, means securing the open end of the bellows to the interior of the body with the closed end being directed towards the open end of the body, means in said body for directing a first fluid to the interior of the bellows and a second fluid to the exterior thereof to have the differential pressure therebetween move the closed end of the bellows toward and away from the open end of the body, a cap secured to the body to close the open end thereof and having a head portion positioned within the body, electrical translating means secured on the cap on the opposite side of the head portion from the bellows, a second bellows mounted on the head portion to extend transversely to the movement of the first-mentioned bellows and activating means engageable with the closed end and the second bellows for transmitting preselected movement of the closed end through the second bellows to the electrical translating means by radial distortion of the second bellows to thereby effect operation of the electrical translating means, in which the cap is secured to the body by a releasable connecting means, in which the connecting means includes means for relatively moving the cap with respect to the closed end of the bellows along the line of movement of the closed end to thereby enable adjustment of the position of the closed end of the bellows that operates the electrical translating means, in which the head portion includes stop means positioned to be engaged by the closed end to limit movement thereof after the translating means operating position and in which the stop means is positioned to limit the movement of the actuating means by the closed end after operation by the closed end.

4. The invention as defined in claim 3 in which there is a second cap secured to close the other end of the body and having a head portion, second electrical translating means secured on the second cap on the opposite side of the second head portion from the bellows, a third bellows mounted on the second head portion to extend transversely to the movement of the first-mentioned bellows and second actuating means engageable with the closed end and the third bellows for translating preselected movement of the closed end through the third bellows to the second electrical translating means by radial distortion of the third bellows to thereby effect operation of the second electrical translating means and in which the head portion of the second cap carries stop means for limiting movement of the closed end and actuating means after operation of the second electrical translating means.

5. The invention as defined in claim 4 in which the second cap is secured to the body by independently operable releasable connecting means.

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