United States Patent [19]

Bowditch

[11] **3,758,093**

[45] **Sept. 11, 1973**

[54] **PNEUMATIC RELAY**

[75] Inventor: **Hoel L. Bowditch,** Foxboro, Mass.

[73] Assignee: **The Foxboro Company,** Foxboro, Mass.

[22] Filed: **July 15, 1970**

[21] Appl. No.: **62,748**

Related U.S. Application Data

[62] Division of Ser. No. 789,453, Jan. 7, 1969, Pat. No. 3,566,899.

[52] **U.S. Cl.** **267/159**

[51] **Int. Cl.** **F16f 1/22**

[58] **Field of Search** 267/159, 158

[56] **References Cited**

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Primary Examiner—James B. Marbert

Attorney—Lawrence H. Poeton

[57] **ABSTRACT**

A pneumatic relay wherein a diaphragm is used as a valve actuator, with the diaphragm formed as a sandwich of a flexible metal sheet with relieving slots therethrough and a rubber sheet as a covering seal for the slots, and in which a leaf spring structure is provided as an adjustable zero bias device for the relay valve, the spring being an H form with the H leg ends grounded and tongues between the H legs, one tongue having grounded adjustment means and another tongue as the spring force applicator to the relay valve as a bias therefor, this device, further, having an adjustable valve seat in the relay valve.

7 Claims, 10 Drawing Figures

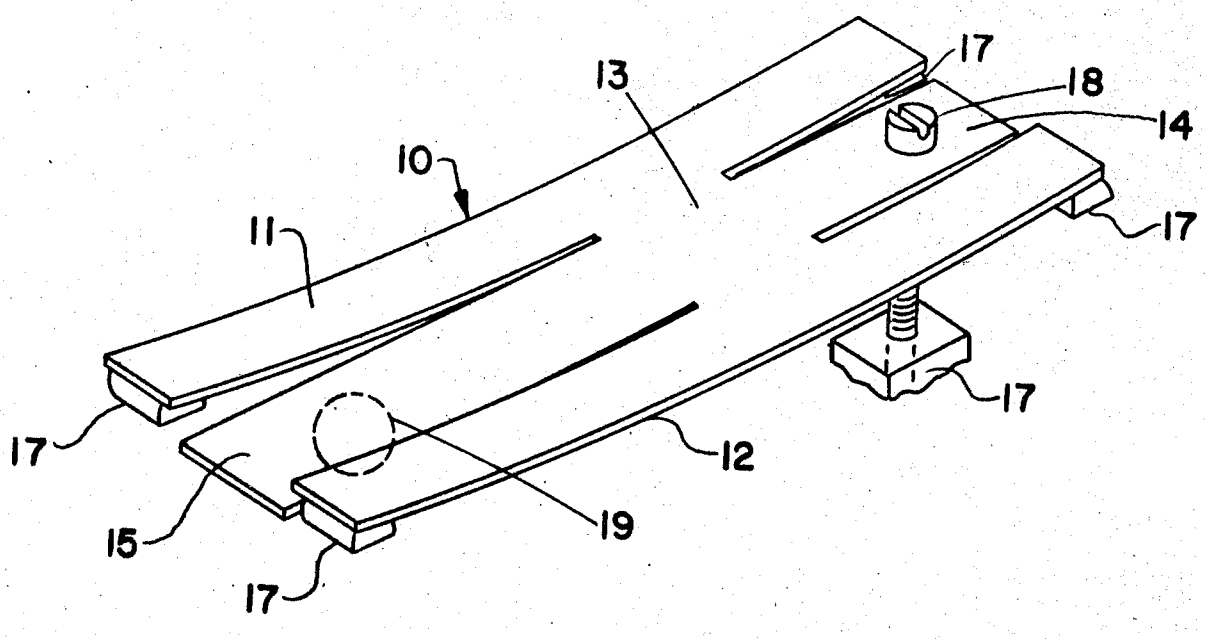


FIG. 1

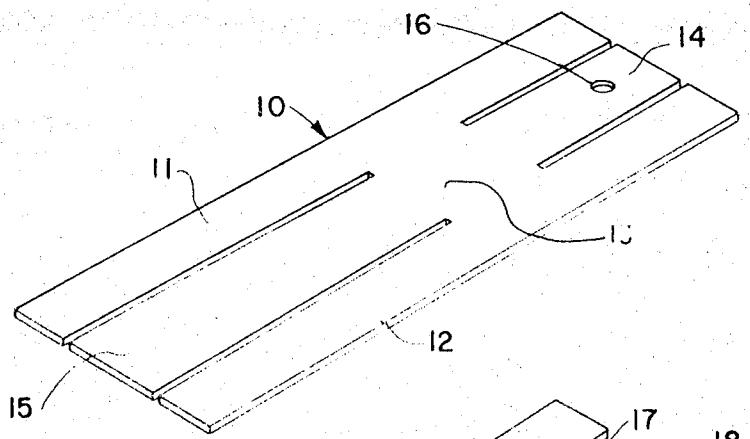
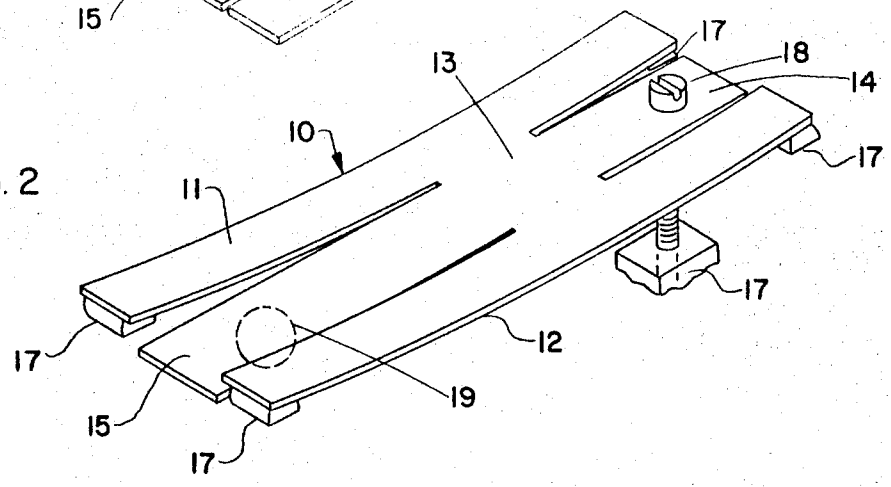


FIG. 2



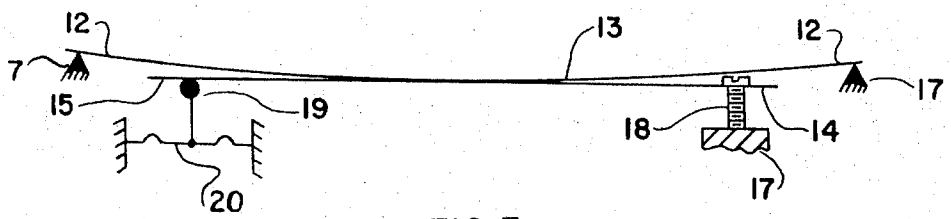


FIG. 3

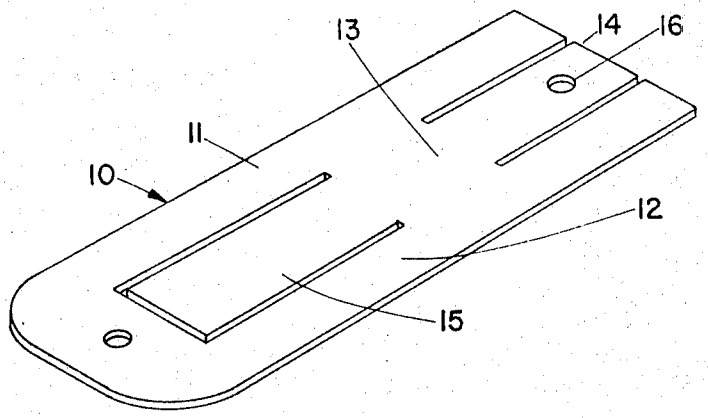


FIG. 4

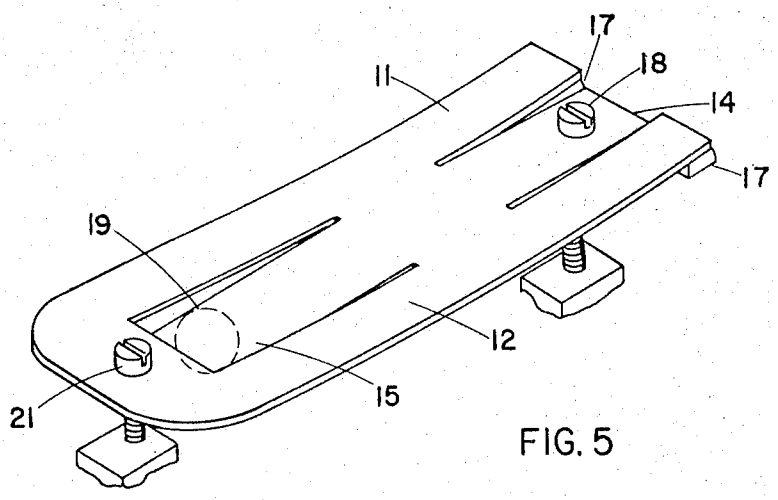


FIG. 5

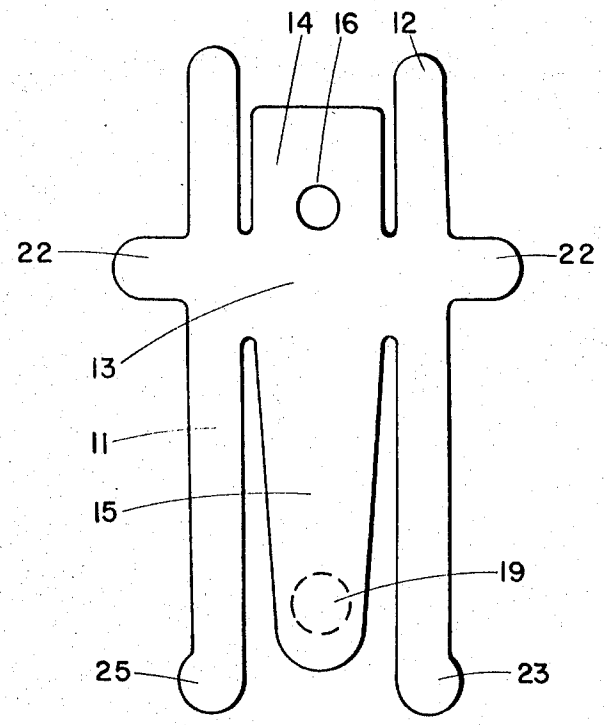

14
16
12
22
22
13
11
15
19
25
23

FIG. 6

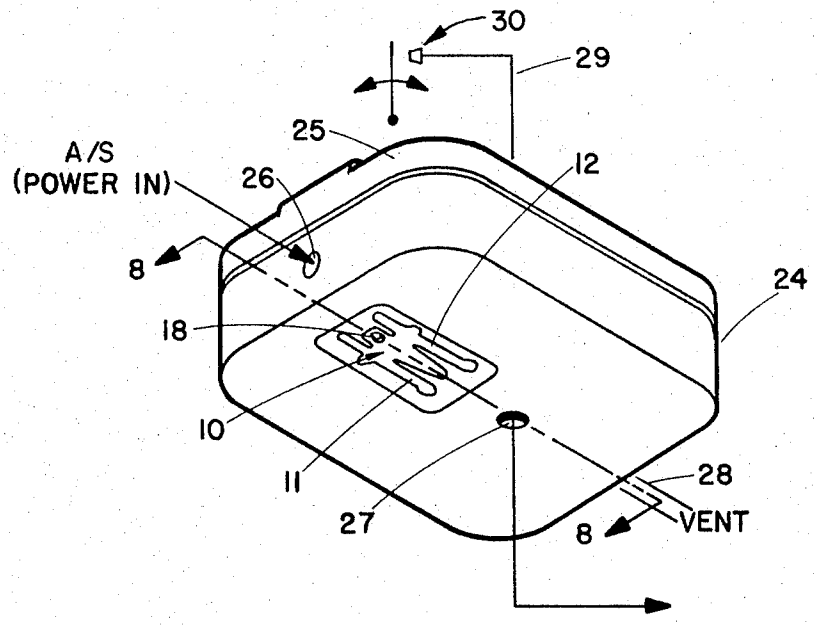

30
29
25
A/S
(POWER IN)
26
12
8
24
18
10
11
27
28
8
VENT

FIG. 7

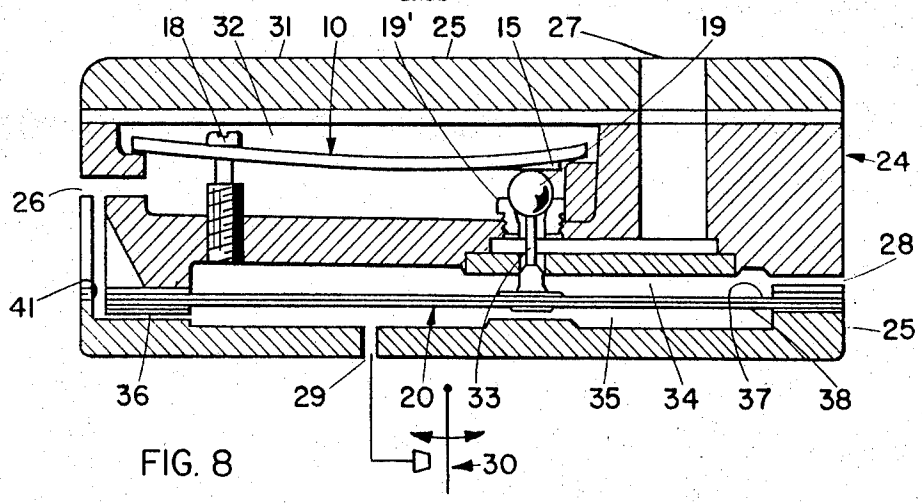


FIG. 8

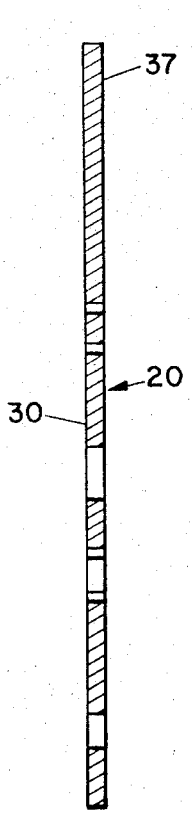


FIG. 10

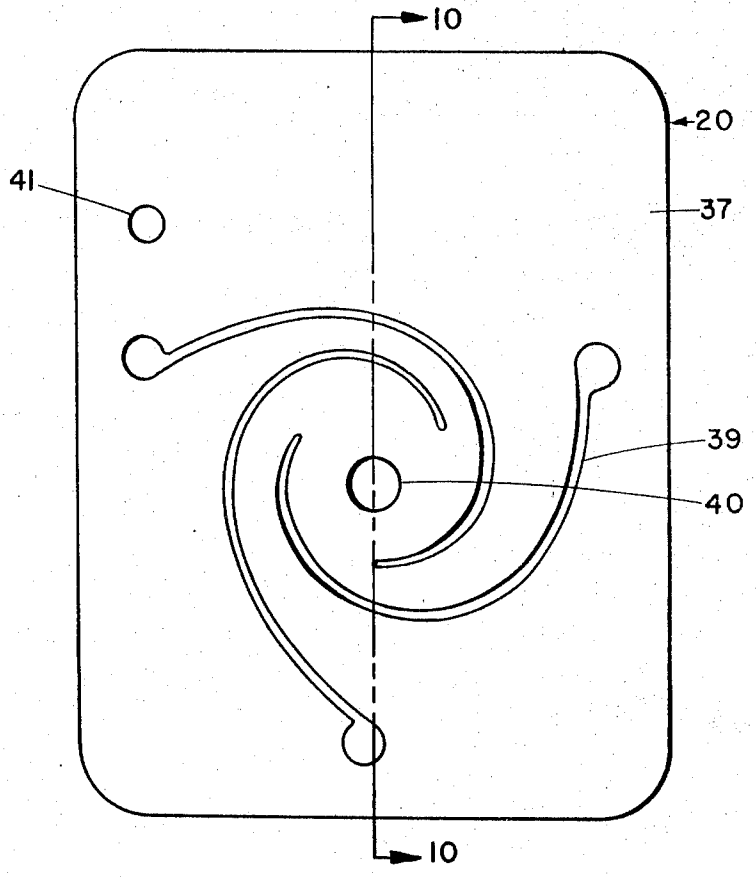


FIG. 9

PNEUMATIC RELAY

This application is a division of Ser. No. 789,453 filed Jan. 7, 1969, now U.S. Pat. No. 3,566,899.

This invention relates to instrumentation for process and energy control, and has particular reference to pneumatic systems in such instrumentation, and to pneumatic relay devices in such systems, such as shown in U. S. Patent No. 3,105,508 to Bowditch.

Relays are key elements in such pneumatic systems, as devices for providing operating forces in response to small pilot pressures. For example, a fluid pressure may be used to control a fluid power stream. A useful relay form is one which uses a diaphragm, to operate a valve, in response to the pilot pressure on the diaphragm. Sensitivity and accuracy of response and operation is necessary in the handling of relatively large forces by small signal forces in such devices, the signal forces often being provided by back pressures from a highly sensitive pneumatic nozzle-baffle device. In the past such devices have been expensive to manufacture and assemble to the necessary precision requirements of control instrumentation.

The device of this invention provides simple and inexpensive means of such manufacture, assembly, and adjustment, while maintaining the necessary sensitivity, accuracy of response, and operational integrity.

This invention provides, for this purpose, a special combination of a sandwich form of diaphragm and a leaf spring grounded adjustment zero bias device. These devices are in themselves, each a subcombination of this invention. These devices, further, are simple stamping formations, with location and adjustment problems minimized.

The zero bias device provides grounded adjustment means. This means that the forces of adjustment do not disturb the adjustment except as directly applied to adjustment. For example, this device uses a grounded screw for zero bias adjustment. No amount of pressure down on the screw head has any effect on the adjustment. Only rotation of the screw accomplishes adjustment. Thus this device lends itself to automatic machine manufacture, assembly, and calibration or adjustment. The adjustment spring of this device thus lends itself to devices other than relays, and to calibrating as well as direct zero bias adjustment in a concept applicable to fully automatic manufacture.

The relay of this invention is provided with an adjustable valve seat, and is a low bleed device, saving in air waste.

Other objects and advantages of this invention will be in part apparent and in part pointed out hereinafter and in the accompanying drawings wherein:

FIG. 1 is an at rest perspective of a zero bias spring structure according to this invention;

FIG. 2 is a further view of the structure of FIG. 1, with the spring variously bent, in an operating condition;

FIG. 3 is a schematic of the spring of FIGS. 1 and 2, in the condition of FIG. 2;

FIGS. 4 and 5 are showings of an alternative spring structure according to the views of FIGS. 1, 2 and 3;

FIG. 6 is a plan view of a further variant of the zero bias spring structure according to this invention;

FIG. 7 is a perspective of an overall relay structure according to this invention;

FIG. 8 is a central section of the relay, taken on line 8—8 of FIG. 7;

FIG. 9 is a plan view of a slotted diaphragm metal plate sandwich assembly according to this invention; and

FIG. 10 is a section of the diaphragm assembly, taken on line 10—10 of Figure 9.

In FIG. 1, the leaf-spring 10 is a one piece sheet of matal, formed by stamping or cutting for example, into an H form flexure with side leg strips 11 and 12, with a bridge 13 therebetween, and tongues 14 and 15 extending between the legs 11 and 12, from the bridge 13. The whole device is flexible, and an adjustment screw hole 16 is provided in the tongue 14. The FIG. 1 showing is in 'at rest' flat condition.

The operational form of the leaf-spring 10 is illustrated in FIG. 2. Each of the H leg ends is rested on a fixed ground as at 17. These are ground supports, as provided by the body of a relay, for example. The H leg ends are free to bend and possibly slightly slide on their ground supports as the overall flexure is bent. An adjustment screw 18 is also grounded, that is, it is threaded into the fixed ground 17. The tongue 14 is biased upward by its own resilience against the underside of the head of the screw 18. A dotted circle 19 on the tongue 15 indicates the location of, for example, a relay valve ball as the device to which the variable pressure of the spring is applied, in this case as a zero bias for the relay.

As illustrated in both FIG. 2 and FIG. 3, as the screw 18 is rotated so as to progress downward into the ground support 17, the tongue 14 is depressed. This results in downward bowing in the side strips 11 and 12, and downward bending of the tongue 15, to a greater extent than the side strips because the outer end of the tongue 15 is not grounded and the side strip end are grounded.

Variation of movement of the tongue 15 per unit of adjustment of the screw 18 may be accomplished by locating the screw closer to or further away from the flexure bridge 13.

It is notable that downward pressure on the head of the screw 18 has no effect on the flexure force or adjustment. it is only when the screw is rotated that spring bias change occurs. This device therefore usefully lends itslef to simple and precise adjustment, and to automatic machine assembly and calibration or adjustment of a pneumatic relay or other instrument device. Thus, this flexure is applicable to a wide variety of instruments.

FIG. 3 indicates the location of a diaphragm 20 and the valve ball 19 movable therby as related to this flexure device in an application such as a pneumatic relay.

The leaf-spring structure of FIGS. 4 and 5, and that of Figure 6, as alternatives to the structure of FIGS. 1, 2 and 3, are given like reference numbers for like elements. The structure of FIGS. 4 and 5 differs in that the side strips 11 and 12 are joined at the output end, that is the end adjacent the tongue 15, to provide a screw 21 as a grounded adjustment for course adjustment, instead of the two fixed grounds 17 for the like ends of FIG. 2 side strips 11 and 12.

The FIG. 6 structure is a desirable form for the pneumatic relay of this invention. The tongues 14 and 15 are of different lengths for more effective operation for this application, and side knobs 22 and 23 are used as locaters in suitable recesses (not shown) in the relay body to prevent undue planar movement of the overall flexure device.

In FIG. 7, the externals of a pneumatic relay according to this invention include a main body 24 and a cover plate 25. A zero bias spring structure 10 is shown in a recess in the body 24, this structure being of the nature of those illustrated in FIGS. 1 through 6. This relay has an A/S (air supply) power in opening at 26, a power exit at 27, a vent at 28, and a pilot signal input through the cover as indicated at 29, for example, from the back pressure of a nozzle-baffle device 30.

FIG. 8 details the interior of the relay of FIG. 7. A suitable cover of panel 31 is used to close off the zero spring recess (not shown in FIG. 7). The power fluid system starts at the input 26, into a chamber 32, containing the zero spring 10, past the valve ball 19 when it is lifted from its seat by the diaphragm 20 through a valve stem 33 attached to the diaphragm but unattached to the ball 19, and then to the power outlet 27. The valve comprises the ball 19, an adjustable conical seat 19' for receiving the ball, and the valve stem 33.

The diaphragm assembly 20 divides a housing chamber into an inner sub-chamber 34 and an outer sub-chamber 35. The inner sub-chamber 34 is open to the power stream when the valve is open (when the ball 19 is lifted from its seat), and the vent to atmosphere is provided from the inner sub-chamber 34, at 28.

The outer sub-chamber 35 is part of a pneumatic system leading from the air supply 26, through a restrictor 36 into sub-chamber 35 and out to the nozzle-baffle device 39, as a nozzle bleed supply therefor by way of the housing opening 29. Back (pilot) pressure from the nozzle, when restricted by the baffle, builds up in the outer sub-chamber 35, to move the diaphragm and lift the valve ball 19 to allow passage of power flow. Thus, the pressure point of valve opening depends on the adjustment of the spring plate 10 as it applies a resislient bias against the valve ball 19 to hold it in its valve seat.

The diaphragm assembly 20, FIGS. 8, 9 and 10, comprises a flexible, thin metal plate 37 sandwiched with a rubber or rubberlike backing sheet 38. This rubber backing allows for assembly of the valve stem 33 without the necessity of highly precise and expensive locating and sealing of the stem in the diaphragm assembly, and provides for self-aligning seat action in the associated valve.

In FIG. 9, the metal diaphragm plate 37 is shown with relieving radially a arcuate slots 39 therethrough which provide an inexpensive structure providing the necessary response and sensitivity in a simple manner by allowing greater and freer movement of the center of the diaphragm. The rubber sealing sheet 38 covers and seals the slots 39. A center hole 40 is used to mount the valve stem 33, and an opening 41 through the assembly is part of the pneumatic passage from the air supply into the outer sub-chamber 35, FIG. 8.

With the simplicity and inexpensiveness of this overall structure, the relay according to this invention lends itself to miniaturization and low pressure pneumatic uses and systems.

This invention therefore provides a new and useful pneumatic relay in a combination of sandwiched diaphragm and grounded leaf-spring zero bias means, lending itself to simple and inexpensive manufacture assembly and adjustment while maintaining the sensitivity and operational integrity necessary to control devices of modern instrumentation.

As many embodiments may be made of the above invention, and as changes may be made in the embodiment set forth above without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth and in the accompanying drawings is to be interpreted as illustrative only and not in a limiting sense.

I claim:

1. A one-piece H-form leaf spring structure comprising:
- a pair of side strips;
- a bridge strip between said side strips and joining said side strips at points intermediate the ends thereof;
- a first tongue strip extending from said bridge strip, between and toward one end of said side strips and terminating in a free end;
- a second tongue strip extending from said bridge strip, between and toward the other end of said side strips and terminating in a free end;
- wherein said leaf spring structure is provided for mounting on ground support means at the ends of said side strips, and the free end of said first tongue strip is provided for application to an operator; and
- grounded adjustment means applied to said second tongue strip;
- whereby said adjustment means is at least a factor in holding said side strips on the ground support means therefor, and adjustment of said adjustment means results in variance of the force of said application of said first tongue strip to said operator.

2. A leaf spring structure according to claim 1 wherein the said side strips are joined at one end and provided at said end with adjustable ground support means as a coarse adjustment of said spring structure, with said grounded adjustment means applied to said second tongue strip as a fine adjustment of said spring structure.

3. A spring structure according to claim 1 wherein: said operator is a valve closure element.

4. A spring structure according to claim 1 wherein: said operator is a valve closure element in a pneumatic system.

5. A spring structure according to claim 1 wherein: said operator is a valve in a pneumatic relay.

6. A spring structure according to claim 1 wherein: said operator is an element responsive to a differential pressure.

7. A spring structure according to claim 2 wherein: said operator is a valve in a pneumatic relay.

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