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(54) **Flow control valves**

(57) A flow control valve comprises a valve seat member H and a valve member D movable towards and away from the seat to close and open the valve and a sealing element made from a resilient material and attached to one of the members, the sealing element possessing an initial deformable characteristic whereby initial closure of the valve causes the sealing element to substantially conform to the shape of the other member and retain the so-conformed shape. The sealing element comprises first and second spring components 1, 2, the first component 1 being locked by glue, for example, following assembly of the valve member D against the seat member H.

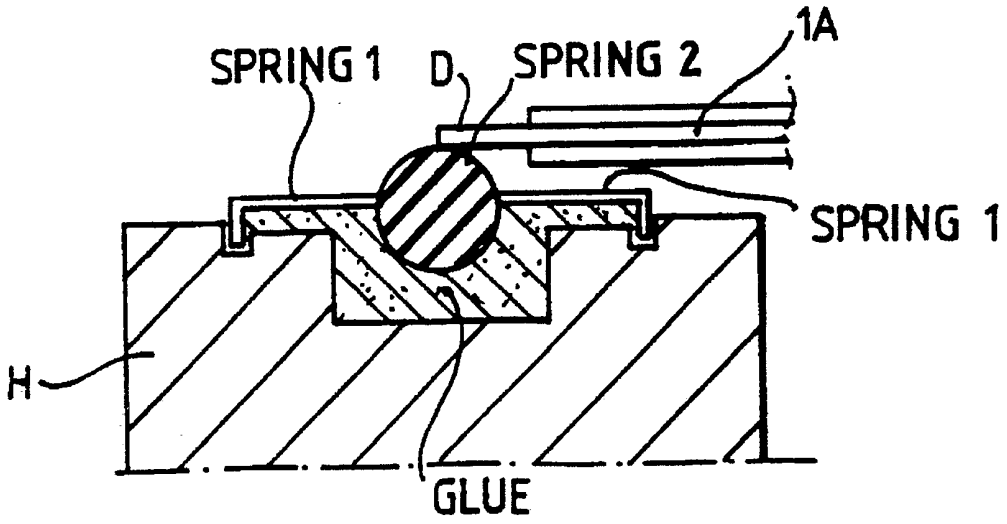

FIG.4.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

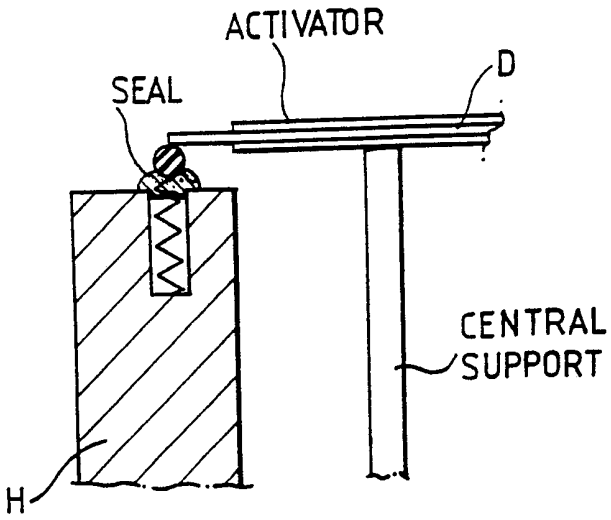


FIG.2.

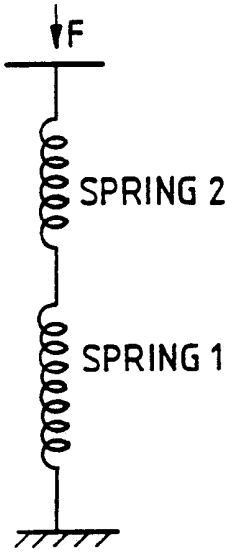
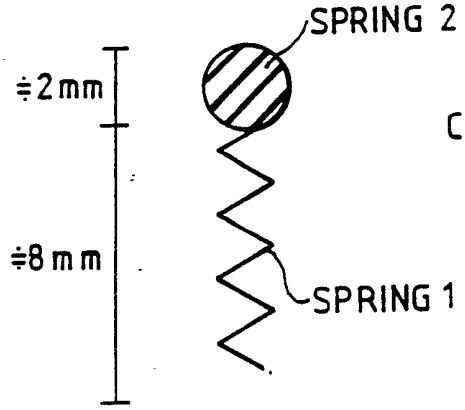


FIG.1.



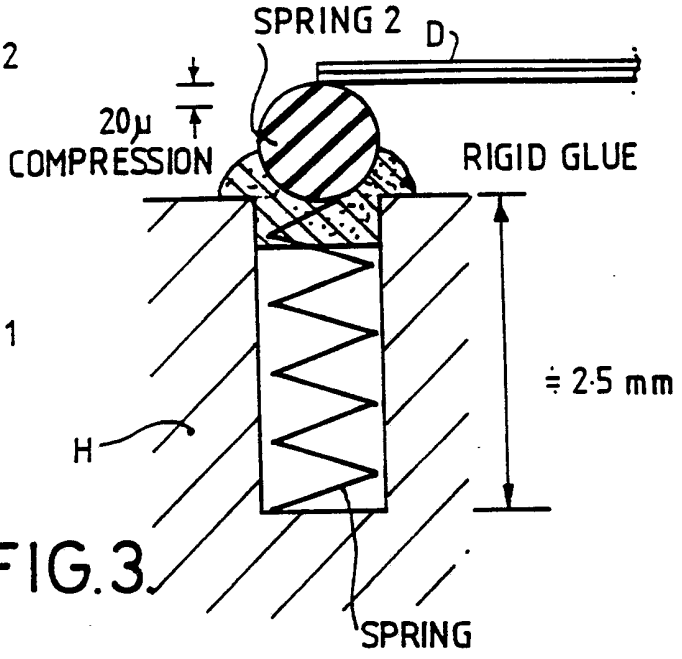


FIG.3.

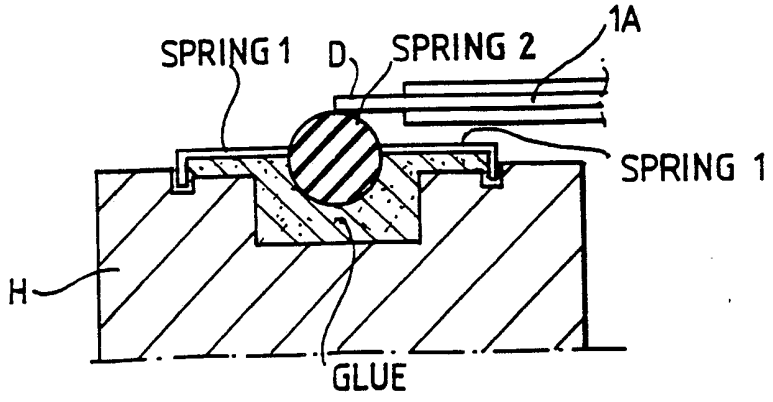


FIG.4.

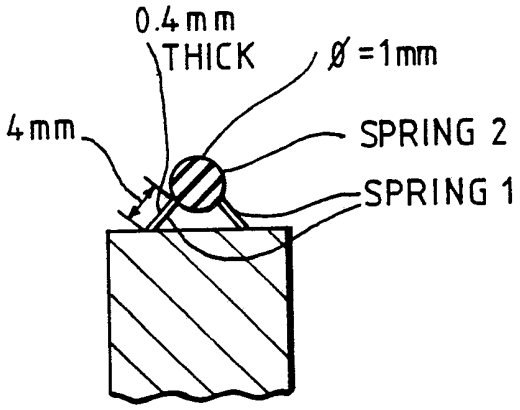


FIG.5.

IMPROVEMENTS IN AND RELATING TO VALVES

This invention relates to valves and, more particularly, to sealing valves during closure.

Valves are used in many fields for controlling the flow of liquid and gaseous media and throughout this specification and claims, such media will be referred to simply as a fluid or fluids as the context requires.

Numerous forms of valve have been proposed having a valve seat member and a valve closure member movable towards and away from the seat member to close and open the valve to control fluid flow through the valve. In order to produce and maintain a satisfactory seal during closure, confronting surfaces of the seat and closure member must be fashioned in strict conformity. Such strict conformity requires, in many instances, accurate machinery of the confronting surfaces of the members.

It is known to control the operation of valves by mechanical, electrical, electronic and pneumatic means.

Piezo electric control valves have also been proposed as substitutes for solenoid controlled valves and are preferable in installations where size and weight are important design considerations. Piezo electric control valves may take the form of discs, usually circular, and beams which may be supported at each end or simply, cantilevered.

Where piezo electric control valves are in the form of circular discs, peripheral flatness not infrequently introduces sealing problems. This is principally due to the fact that it is difficult to produce, on a production basis, relatively thin metal discs possessing a sufficiently high degree of flatness to mate with a corresponding flat surface machined or otherwise formed on a valve seat. Typically, such thin metal discs constitute substrates for supporting piezo electric ceramic materials on one or each face of the disc. Examples of such piezo electric valves are described in US Patent Nos 4,545,567

and 3,360,664.

In prior UK Patent application No. 9122739.7 there is described and claimed a piezo electric valve for controlling fluid flow, the valve comprising a valve housing, a cavity within the housing, inlet and outlet ducts for leading fluid into and out from the cavity, a piezoelectric valve disc element, disposed in the cavity, and means for supporting the valve disc element at a portion inwardly of the disc periphery so that upon actuation of the element by a voltage applied thereto, the periphery of the disc is displaceable and at least a portion of a peripheral region of the disc serves to control fluid flow between the inlet and outlet ducts.

The peripheral flatness of a piezo electric disc forming part of a valve described in copending application No. 9122739.7 is typically of the order of $\pm$ 250 µm whereas the opening per se for fluid flow is of the order of $\leq$ 300 µm. It will, therefore, be appreciated that if closure is achieved using a pliant sealing member to accommodate the tolerance mentioned, the effective valve opening could be reduced to 300 - 250 = 50 µm. Such an opening is generally insufficient to achieve a satisfactory flow of fluid when the valve is open. In addition, the peripheral flatness problem also manifests itself when using a pliant seal in so far that the seal produces an unexpectedly adverse fluid flow against voltage characteristic.

It is an object of the present invention to provide a production system which will provide a relatively low cost valve seal for accommodating normal product ion tolerances without wasting operational movement of the valve.

According to one aspect of the present invention, a valve comprises a valve seat member and a valve member movable towards and away from the seat to close and open the valve and a seating element made from a resilient material and attached to one of the members, the sealing element possessing an initial deformable characteristic whereby initial closure of the valve causes the seating

element to substantially conform to the shape of the other member and retain the so-conformed shape. Preferably, the sealing element is permanently attached to the valve seat member.

The valve member is preferably in the form of a piezo electric disc comprising a substrate having a layer of piezo electric ceramic applied to at least one face thereof.

According to a further aspect of the present invention, a method of forming a valve seat for creating a seal against a valve member having an irregular surface comprises, assembling the valve seat from two compliant elements disposed in juxtaposition, each element initially possessing a different resiliently deformable characteristic and together constituting a seal which conforms to the peripheral shape of the valve member, placing the assembly in a carrier with that element possessing the least resiliently deformable characteristic remotely from the valve member, applying pressure to the sealing assembly via the valve member so that the said least resiliently deformable element absorbs the surface irregularity of the valve member without substantially changing the deformability characteristic of the other element and maintaining the element possessing the least resiliently deferable characteristic in that attitude where the surface irregularity of the valve member is absorbed.

The compliant elements may be made from any suitable synthetic or natural rubber-like material.

Thus, a material may be chosen to achieve the dichotomous properties in a single component which possesses two mechanical states: the first being soft and compliant and the second being semi rigid with the required changes described above being easy to effect yet irreversible.

A valve seal in accordance with the present invention may from a mechanical point of view be compared to a spring system comprising two dissimilar springs connected in

series as shown in Figure 1 of the accompanying drawings. Figures 2 and 3 show in part cross section, a piezo electric valve disc centrally supported and as described in copending application No. 9122739.7. Figure 4 shows in part cross-section an alternative sealing arrangement.

Referring to Figure 1 spring (1) serves to absorb production flatness tolerance of piezo disc (D) without radically changing the compression (and, therefore, the sealing force) in the second spring (2). The first spring (1) is, therefore, compared to the second spring (2) both long and weak. The second spring (2) is the normal sealing element and its stiffness is chosen according to well understood design parameters.

During assembly, both springs (1) and (2) are free to move and accommodate the tolerances in all dependent components such as; disc (D), second spring member and housing (H). The second spring (2) has a constant compression (since there is a spatially constant force applied) and, therefore, matches exactly the profile irregularity of the disc (D). However, after initial assembly, the first spring (1) is locked to prevent further movement by for example, an adhesive and, therefore only the second spring (2) participates in the subsequent sealing operations (see Figure 3).

Referring to Figure 4, the helical spring (1) of Figure 3 has been replaced by a plurality of leaf springs (1A) which support spring (2) which is the form of a ring of circular cross-section. Upon assembly, and after an initially applied force via the valve member, springs (1A) are locked or otherwise secured to housing (H).

A further form of an equivalent spring arrangement is shown in Figure 5.

CLAIMS

1. A valve comprising a valve seat member and a valve member movable towards and away from the seat to close and open the valve and a seating element made from a resilient material and attached to one of the members, the sealing element possessing an initial deformable characteristic whereby initial closure of the valve causes the seating element to substantially conform to the shape of the other member and retain the so-conformed shape.

2. A valve according to claim 1, wherein the sealing element is permanently attached to the valve seat member.

3. A valve according to claim 1 or claim 2, wherein the valve member is preferably in the form of a piezo electric disc comprising a substrate having a layer of piezo electric ceramic applied to at least one face thereof.

4. A method of forming a valve seat for creating a seal against a valve member having an irregular surface, the method comprising assembling the valve seat from two compliant elements disposed in juxtaposition, each element initially possessing a different resiliently deformable characteristic and together constituting a seal which conforms to the peripheral shape of the valve member, placing the assembly in a carrier with that element possessing the least resiliently deformable characteristic remotely from the valve member, applying pressure to the sealing assembly via the valve member so that the said least resiliently deformable element absorbs the surface irregularity of the valve member without substantially changing the deformability characteristic of the other element and maintaining the element possessing the least resiliently deferable characteristic in that attitude where the surface irregularity of the valve member is absorbed.

. atents Act 1977

Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition K) F2V (VP40,VP42,VP46, VW55,VW58)

(ii) Int Cl (Edition 5) F16K

Search Examiner

PAM HYETT

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

2 NOVEMBER 1992

Documents considered relevant following a search in respect of claims 1-3

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1471211 (KLINGER) see particularly page 2, lines 63-91	1-3

		to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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