A dome spring element including a body having a first and second end and an axis, a bell-shaped wall at the first end defining a chamber with an opening into the chamber, a cylindrical wall attached to the bell-shaped wall at the second end; a rod attached to the body and extending through the chamber and extending axially outwardly from the opening; and the body being moveable from an extended position to a compressed position by application of a force along the axis, and capable of automatically returning to the extended position upon release of the force.
DISPENSING PEN INCORPORATING A DOME SPRING ELEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates to a dome spring for sealing a liquid flow path of a liquid discharging outlet in an uncompressed state and opening a liquid flow path in a compressed state, and more specifically to a rubber or plastic dome spring having a dome-shaped deformable spring section and a cylindrically-shaped upper stem portion for creating and removing a liquid-seal with a cylindrically-shaped outer valve housing, a liquid discharging outlet incorporating such a dome spring, and a dispensing pen incorporating such a dome spring.

2. Description of the Related Art
A portable stain remover for application to fresh stains or prior to laundering has become a common accessory used for preventing the permanent inset of serious stains during, for example, hunches or coffee breaks away from the home. These and other liquid-discharging devices, such as bag-in-box concentrated liquid dispensers and error correction pens, commonly use a spring-loaded valce for tensioning a valve to a closed position to prevent the dispensing of a liquid stored in a liquid storage portion of the device.

The use of a metal valve spring within the liquid dispenser, however, has several disadvantages. First, it is more expensive to manufacture and second, it is difficult to maintain quality control of manufacture. Specifically, a metal spring component and supporting structures are expensive to manufacture and adjoin, and the prevalence of errors in production increases relative to the increase in the number of parts involved in the manufacture of the device. Second, a device containing a metal spring is not capable of being recycled using standard polymeric recycling techniques.

The present invention overcomes the shortcomings and deficiencies of the prior art and is directed to systems and methods which eliminate or at least substantially reduce the impact of these problems associated with existing spring mechanisms and liquid dispensers. A full discussion of the features and advantages of the present invention is deferred to the following detailed description, which proceeds with reference to the accompanying drawings.

SUMMARY OF THE INVENTION
A dome spring element including a body having a first and second end and an axis, a bell-shaped wall at the first end defining a chamber with an opening into the chamber, a cylindrical wall attached to the bell-shaped wall at the second end; a rod attached to the body and extending through the chamber and extending axially outwardly from the opening; and the body being movable from an extended position to a compressed position by application of a force along the axis, and capable of automatically returning to the extended position upon release of the force.

A liquid dispensing container including a housing wall defining a first chamber having an axis, a first end section and an opposed second end section, and a dome spring element positioned within the first chamber. The dome spring element has a body including a first and second end and an axis. A bell-shaped wall at the first end defines a second chamber with an opening into the second chamber. A cylindrical wall is at the second end of the body and is attached to the bell-shaped wall. A rod is attached to the body and extends through the second chamber and axially outwardly from the opening. The body being moveable by an axially inwardly directed force applied to the second end from an extended position wherein the second end forms a fluid tight seal with an inner surface of the housing wall, to a compressed position where fluid can flow through the first chamber, and the body capable of automatically returning to the extended position upon release of the inwardly axially directed force.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of an assembled liquid-discharge valve and applicator tip including a dome spring element in a closed position;
FIG. 2 is a side view in partial cross section of an assembled liquid-discharging pen;
FIG. 3 is a perspective view of a valve seat;
FIG. 4 is a perspective view of a dome spring element;
FIG. 5 is a cross-sectional view of a dome spring element;
FIG. 6 is a side view of a dispensing nib;
FIG. 7 is an end view of a dispensing nib;
FIG. 8 is an exploded-view of a liquid-discharging pen; and
FIG. 9 is an exploded-view of an alternate embodiment of a liquid-discharging pen.

DETAILED DESCRIPTION OF THE INVENTION

While various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides inventive concepts that can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative of specific ways to make and use the invention and do not limit the scope of the invention.

FIG. 1 shows a liquid dispensing member 10 for a liquid container 12 (FIG. 2) having a housing 14, a dome spring element 16, a spring seat 17, a dispensing nib 18 and an O-ring seal 19. FIG. 1 shows the dispensing member 10 in a closed position. The dome spring can be moved from an extended position or closed (FIG. 1) to a compressed or dispensing position by application of a force along an axis of the dome spring, and capable of automatically, without the assistance of another energy source, of returning to the extended position when the compressing force is sufficiently removed or reduced.

The housing 14 has a first end section 20, an opposed second end section 22 and an intermediate portion 24 therebetween. The first end section 20 has a generally cylindrical wall 26 having a first diameter and a radially inwardly tapering, reduced diameter portion 28 at a proximal end. The intermediate portion 24 of the housing has an annular flange 30 having a second diameter greater than the first diameter and defining a shoulder 32 where the flange 30 meets a distal end of the first end section 20. The second end section 22 extends axially away from the flange 30 and is divided into three distinct segments 22a,b,c. Each section has proximal and distal ends wherein the diameter of the proximal end is greater than that of the distal end.

The cylindrical wall 26 and reduced diameter portion 28 are dimensioned to be inserted into a lumen of the container 12 and attached thereto. The flange 30 acts as a stop
that determines the full-insertion position into the container 12. It is also contemplated the housing 14 could be dimensioned to fit over an end portion of the container 12 and form an interference fit therewith or be attached by other means.

The housing 14 defines a chamber 40 that extends the full length dimension of the housing and has opposed first and second openings 42 and 44 into the chamber 40. In the first end section 20 has an inner wall 46 having a first inner diameter and a second inner diameter smaller than the first inner diameter and a shoulder 48 therebetween. In a preferred form of the invention, the inner wall in the first section has a plurality of axially extending, and circumferentially spaced grooves 49 to provide pathways for fluid flow around the dome spring to the discharge opening.

The valve seat 17 is fixedly mounted within the first end section 20 and abuts against a portion of the dome spring 16. The dome spring 16 when in the extended position shown in FIG. 1, extends between the first end section 20 and terminates at segment 22a. The rib 18 is mounted within a portion of the dome spring 16 and extends from segment 22a to a point outside of the housing.

FIG. 3 shows the valve seat 17 having a first outer cylindrical wall 50, a pair of circumferentially spaced docking ears 52, an inner ring 54 connected to the docking ears 52 by a pair of axially extending and circumferentially spaced spokes 56. The docking ears 52 extend axially outwardly from the first outer cylindrical wall 50 and are dimensioned to attach to the inner wall 46 of the housing 14 and to provide space between the inner wall and the first outer cylindrical wall 50 for ease of assembly. The docking ears 52 can be attached to the inner wall by a snap fit connection, friction fit, by adhesives, solvent bonding techniques, welding techniques including conductive and inductive heating and vibration welding or other suitable method well known to one of ordinary skill in the art. The inner ring 54 has a centrally disposed through hole 58 which is dimensioned and positioned to act as a guide for the rod 72 of the dome spring element 16.

FIGS. 4 and 5 show the dome spring element 16 having a first end portion 60 and an opposed second end portion 62 and an intermediate portion 64 therebetween. The first end portion 60 has a generally dome-shaped wall 66 having an opening 68 into a chamber 70. coaxially disposed within the chamber is a segmented rod 72 having a first diameter 74 at a proximal end, a second diameter portion 76 and a shoulder 78 defined therebetween. The rod 72 terminates in a radially inwardly tapering portion 80 at its distal most end. The wall 66 has a gradient of thicknesses from a first end 82 to a second end 84 with the thickness of the wall increasing from the first end 82 to the second end 84. While the rod is shown having two distinct diameters it is contemplated the rod could increase in thickness gradually to achieve the desired spring force constant.

The second end portion 62 is connected to the first end portion by a generally cylindrical wall 88. The second end portion 62 has a generally cylindrical shaped outer wall 100 having a first end 102 and a second end 104. The outer wall 100 defines an inner chamber 106 with an opening 108 to the chamber. The chamber 108 is dimensioned to receive an end portion of the rib 18. The second end 104 of the wall has an enlarged diameter portion having a rounded outer surface 110. The second end 104 forms a fluid tight seal with a surface of the inner wall of the housing when in the closed position as shown in FIG. 1.

In a preferred form of the invention, the dome spring element 16 can be fabricated from a material having elastomeric properties that can be deformed under pressure and resume its undeformed state when the pressure is removed. Suitable materials for forming the spring element 16, for example, can include natural and synthetic rubber materials, and polymeric material such as polyolefins, thermoplastic elastomers, polyamides, polyesters, polyethers, polyetherimides, styrene and hydrocarbon copolymers, styrene and hydrocarbon block copolymers, silicone and other material suitable for its purpose. In a most preferred form of the invention, the dome spring element will be made from thermoplastic elastomers or silicone.

FIGS. 1, 2, 6 and 7 show the dispensing nib 18 is diametrically segmented having a decreased diameter portion 110 that is dimensioned to fit within the chamber 106 and a larger diameter portion 112 extending axially therefrom. The distal most end 114 of the dispensing nib will be shaped to apply a liquid dispensed from the container and can take on many different shapes and sizes for this purpose. In a preferred form of the invention, the distal end of the nib will have a radially inwardly tapering section 116 and will terminate in a generally rectangular shaped outer surface 118. The tapering section 116 is shown having a semicircular shaped surface for spreading the liquid being dispensed onto a surface. However, the semicircular shape is optional and could be replaced with surfaces of differing shapes and surface textures, such as matte or dimpled. The dispensing nib 18 also is shown with an optional axially inwardly tapering surface 120.

The dispensing nib 18 can be formed integrally with the dome spring element 16 as shown in FIG. 8 or separately as shown in FIG. 9.

FIGS. 8 and 9 show the container 12 having a generally cylindrical shaped sidewall 130 with one open end 132 for containing a flowable material and more preferably a liquid material. The liquid material can be applied to any surface in need of treatment and includes fabrics, hard surfaces, soft surfaces, synthetic materials, natural materials, surfaces on animals and plants to name a few exemplary surfaces. In a preferred form of the invention the material will be used to apply to a fabric and more preferably will be a liquid for applying to a fabric and will contain one or more of the following components a cleaning solution, stain removal solution, stain masking solution, anti-static agent, water proofing agent, anti-bacterial agent, paint, stain, topical ointment and anti-viral agent. The cleaning or stain removal solution can contain chemicals including bleach, surfactants, solvents, enzymes, amino acids, emulsifiers, anti-static agents, water, deionized water, demineralized water, hydrogen peroxide, alcohols, ketones, aldehydes, ethers, acrylonitriles, aromatic hydrocarbons, compounds containing aryl, arylhalide and/or aryloxy groups, ethoxylated alcohols, ionic surfactants, non-ionic surfactants, alkyl phenols, alkyl sulfates, amine oxides, and mixtures thereof. Suitable cleaning solutions are disclosed in U.S. Pat. Nos. 6,832,867; 3,748,268; 4,273,661; 5,284,597; 5,324,131; 5,728,609; 5,872,090; and 6,644,879 each of which is incorporated herein in its entirety by reference and made a part hereof.

The dispensing member 10 can be used as shown in FIGS. 1 and 2. In FIG. 1 the second end 104 of the dome spring element 16 is pressed against the inner wall to form a fluid tight seal. To move the dispensing member 10 from the closed to the open position, sufficient axially inwardly directed force must be applied in the direction of arrow 134 to
cause the nib to move axially inwardly and compress the dome spring 16 against the valve seat 17. The bell-shaped wall 66 deforms and the second end 110 pulls away from the inner wall of the housing 14 to allow fluid to flow through the chamber 40 and through a space 136 between the inner wall of the housing and an outer surface of the nib 18. Upon releasing the axially inwardly directed force, the dome spring 16 applies an axially outwardly directed force to the dispensing nib 18 to return the dispensing member 10 to the closed position (FIG. 1).

[0032] The invention has now been explained with regard to specific embodiments. Variations on these embodiments and other embodiments may be apparent to those of skill in the art. It is understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or change in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and the appended claims. Since the present embodiments are in all respects merely illustrative, and not restrictive, the present invention is not to be limited to the details given herein.

We claim:
1. A dome spring element comprising:
a body having a first and second end and an axis, a bell-shaped wall at the first end defining a chamber with an opening into the chamber, a cylindrical wall attached to the bell-shaped wall at the second end;
a rod attached to the body and extending through the chamber and extending axially outwardly from the opening; and
the body being moveable from an extended position to a compressed position by application of a force along the axis, and capable of automatically returning to the extended position upon release of the force.
2. The dome spring element of claim 1, wherein the bell-shaped wall has a varying thickness along its length.
3. The dome spring element of claim 2 wherein a thickness dimension of the bell-shaped wall proximate the opening is greater than a thickness dimension of the wall on an opposite end of the bell shaped wall.
4. The dome spring element of claim 1 wherein the rod is segmented into a first diameter section and a second diameter section wherein the first diameter section has a diameter greater than a diameter of the second diameter section.
5. The dome spring of claim 4 wherein the rod has a radially inwardly directed taper at a distal most end of the rod.
6. The dome spring element of claim 1 wherein the cylindrical wall has an enlarged diameter portion at a distal most end of the cylindrical wall.
7. The dome spring element of claim 6 wherein the enlarged diameter portion has a curved outer profile.
8. The dome spring element of claim 1 wherein the cylindrical wall defines a chamber dimensioned to receive a body.
9. The dome spring element of claim 8 wherein the body is a dispensing nib.
10. The dome spring element of claim 1 further comprising a dispensing nib connected to the body and extending axially outward from the second end in a direction opposite of the rod.
11. A liquid dispensing container comprising:
a housing wall defining a first chamber having an axis, a first end section and an opposed second end section; and a dome spring element in the first chamber having a body having a first and second end and an axis, a bell-shaped wall at the first end defining a second chamber with an opening into the second chamber, a cylindrical wall attached to the bell-shaped wall at the second end, a rod attached to the body and extending through the second chamber and extending axially outwardly from the opening, and the body being moveable by an axially inwardly directed force applied to the second end from an extended position wherein the second end forms a fluid tight seal with an inner surface of the housing wall, to a compressed position where fluid can flow through the first chamber, and the body capable of automatically returning to the extended position upon release of the inwardly axially directed force.
12. The container of claim 11 wherein the bell-shaped wall has a varying thickness along its length.
13. The container of claim 12 wherein a thickness dimension of the bell-shaped wall proximate the opening is greater than a thickness dimension of the wall on an opposite end of the bell shaped wall.
14. The container of claim 11 wherein the rod is segmented into a first diameter section and a second diameter section wherein the first diameter section has a diameter greater than a diameter of the second diameter section.
15. The dome spring of claim 14 wherein the rod has a radially inwardly directed taper at a distal most end of the rod.
16. The container of claim 11 wherein the cylindrical wall has an enlarged diameter portion at a distal most end of the cylindrical wall.
17. The container of claim 16 wherein the enlarged diameter portion has a curved outer profile.
18. The container of claim 11 wherein the cylindrical wall defines a third chamber dimensioned to receive a body.
19. The container of claim 18 further comprising a dispensing nib having a first end and an opposed second end, the first end being positioned within the third chamber.
20. The container of claim 19 wherein the second end of the dispensing nib extends axially outwardly beyond the second end section.

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