What is claimed is:

1. In a wellhead assembly having a cylindrical bore, a first plug located in and sealingly engaging the cylindrical bore, a second plug located in and sealingly engaging the cylindrical bore, the second plug being spaced axially apart from the first plug, wherein the cylindrical bore, the first plug, and the second plug define a cavity, the cavity being adapted to retain a trapped fluid between the first and second plugs, an apparatus for mitigating pressure in the cavity in response to temperature changes of the trapped fluid, comprising:

   a deformable member and a support member located within the cavity, the deformable member and the support member defining a sealed void between them;

   a compressible fluid located within the void; and

   the deformable member being inwardly deflectable toward the support member in response to a pressure increase in the cavity.

2. The apparatus according to claim 1, wherein the inward deflection of the deformable member is limited by the support member such that the deflection of the deformable member remains elastic.

3. The apparatus according to claim 1, wherein the support member inwardly deflects toward the deformable member in response to the pressure increase in the cavity and the inward deflection of the support member is limited by contact with the deformable member.

4. The apparatus according to claim 1, wherein the deformable member has a bell shape.

5. The apparatus according to claim 1, wherein the deformable member has a concave surface when in a relaxed state.

6. The apparatus according to claim 1, wherein the deformable member is generally flat when in a relaxed state.

7. The apparatus according to claim 1, wherein the deformable member and the support member are each comprised of one of metal, polymer, and elastomer.

8. The apparatus according to claim 1, wherein the compressible fluid comprises a gas.

9. The apparatus according to claim 1, wherein the deformable member and the support member are located within a frame, the frame having a sidewall with at least one sealable aperture in the sidewall.

10. The apparatus according to claim 9, further comprising a second pair of plates located within the frame.

11. The apparatus according to claim 1, wherein the apparatus is connected to the first plug.

12. A method for mitigating pressure in a subsea wellhead member, the method comprising:

(a) connecting a deformable member to a support member to define a sealed void between them;

(b) filling the void with a compressible fluid;

(c) placing the deformable member and the support member in a confined space in the wellhead member;

(d) allowing a second fluid to enter the confined space;

(e) sealing the confined space from seawater on the exterior of the wellhead member with at least one plug;

(f) thermally expanding the second fluid in the confined space; and

(g) elastically displacing the deformable member from a first position to a second position, the second position being nearer the support member than the first position, the second fluid occupying the space previously occupied by the support member.

13. The method according to claim 12, wherein the second fluid is at a first pressure prior to thermal expansion, the first pressure being greater than atmospheric pressure, and the second fluid is at a second pressure after thermal expansion, the second pressure being greater than the first pressure, and wherein the first pressure does not cause displacement of the deformable member and wherein the second pressure does cause displacement of the deformable member.

14. The method according to claim 12, wherein in the second position, the deformable member contacts the support member and the support member limits further displacement of the deformable member.

15. The method according to claim 12, wherein the deformable member has a bell shape defining a first contour on an interior surface and the support member has a second contour on an exterior surface, the second contour being similar to the first contour..

16. The method according to claim 12, further comprising the step of contracting the second fluid, wherein the deformable member returns to the first position.

17. The method according to claim 12, further comprising the step of placing the deformable member and the support member in a frame and step (c) comprises placing the frame in the wellhead member.

18. An apparatus for mitigating pressure changes in a trapped liquid cavity of a subsea wellhead member comprising:

a cylindrical housing;

a first pair of plates and a second pair of plates within the cylindrical housing, each pair of plates comprising a first plate and a second plate, the pair of plates being spaced apart from each other, defining a void between them and being deflectable toward each other;

a compressible fluid located within the void; and

wherein inward deflection of the plates in response to an increase in pressure in the cavity is limited by contact of the plates with each other, such that the deflection remains elastic.

19. The apparatus according to claim 18, wherein the pair of plates comprises a cylindrical ring connecting the first plate and second plate and defining an outer diameter of the void.

20. The apparatus according to claim 18, wherein the first plate has a flat surface in relaxed state.

CLAIMS

What is claimed is:

1. A wellhead assembly comprising:

a cylindrical bore;

a first plug located in and sealingly engaging the cylindrical bore;

a second plug located in and sealingly engaging the cylindrical bore, the second plug being spaced axially apart from the first plug, wherein the cylindrical bore, the first plug, and the second plug define a wellhead cavity, the wellhead cavity being adopted to retain a trapped fluid between the first and second plug; and

an apparatus disposed within the wellhead cavity for mitigating pressure in the wellhead cavity in respond to temperature changes of the trapped fluid, the apparatus comprising;

a deformable member and a support member located within the wellhead cavity, the deformable member and the support member defining a seal void between them;

a compressible fluid located within the sealed void; and

the deformable member being inwardly deflectable toward the support member in response to a pressure increase in the wellhead cavity.

2. The wellhead assembly according to claim 1, wherein the inward deflection of the deformable member is limited by the support member such that the inward deflection of the deformable member remains elastic.

3. The wellhead assembly according to claim 1, wherein the support member inwardly deflects toward the deformable member in response to the pressure increase in the wellhead cavity and the inward deflection of the support member is limited by contact with the deformable member within the sealed void.

4. The wellhead assembly according to claim 1, wherein the deformable member has a bell shape in a relaxed state, the bell shape defined by a first end that is closed and generally rounded, and a second end opposite the first end that is larger in diameter than the first end, and a curved a transition between the first end and the and second end.

5. The wellhead assembly according to claim 1, wherein the deformable member has a concave surface when in a relaxed state.

6. The wellhead assembly according to claim 1, wherein the deformable member is generally flat when in a relaxed state.

7. The wellhead assembly according to claim 1, wherein the deformable member and the support member are each comprised of one of metal, polymer, and elastomer.

8. The wellhead assembly according to claim 1, wherein the compressible fluid comprises a gas.

9. The wellhead assembly according to claim 1, wherein the deformable member and the support member are located within a frame, the frame having a sidewall with at least one sealable aperture in the sidewall.

10. The wellhead assembly according to claim 9, further comprising a compensator including a pair of plates located within the frame.

11. The wellhead assembly according to claim 1, wherein the apparatus is connected to the first plug.

12. A method for mitigating pressure in a subsea wellhead member, the method comprising:

(a) connecting a deformable member to a support member to define a sealed void internally between them;

(b) filling the sealed void with a compressible fluid;

(c) placing the deformable member and the support member in a confined space in the subsea wellhead member;

(d) allowing a second fluid to enter the confined space to externally engage the deformable member;

(e) sealing the confined space from seawater on the exterior of the subsea wellhead member with at least one plug; and

(f) thermally expanding the second fluid in the confined space by flowing a well fluid through the wellhead member

such that the second fluid elastically deforms the deformable member toward the sealed void and thereby displaces the deformable member from a first position to a second position, the second position being nearer the support member than the first position, the second fluid occupying the space previously occupied by the support member.

13. The method according to claim 12, wherein the second fluid is at a first pressure prior to thermal expansion, the first pressure being greater than atmospheric pressure, and the second fluid is at a second pressure after thermal expansion, the second pressure being greater than the first pressure, and wherein the first pressure does not cause displacement of the deformable member and wherein the second pressure does cause displacement of the deformable member.

14. The method according to claim 12, wherein in the second position, the deformable member contacts the support member and the support member limits further displacement of the deformable member.

15. The method according to claim 12, wherein the deformable member has a bell shape in a relaxed state, the bell shape defined by a first end that is closed and generally rounded, and a second end opposite the first end that is larger in diameter than the first end, and a curved transition between the first end and the and second end, the deformable member defining a first contour on an interior surface and the support member has a second contour on an exterior surface, the second contour being similar to the first contour.

16. The method according to claim 12, further comprising the step of contracting the second fluid by flowing the well fluid through the wellhead member, wherein the deformable member returns to the first position.

17. The method according to claim 12, further comprising the step of placing the deformable member and the support member in a frame and step (c) comprises placing the frame in the subsea wellhead member.

18. An apparatus for mitigating pressure changes in a trapped liquid cavity of a subsea wellhead member comprising:

a cylindrical wellhead housing defining the trapped liquid cavity therein;

a first pair of plates and a second pair of plates within the cylindrical wellhead housing, each pair of plates comprising a first plate and a second plate, the the first plate and

the second plate being spaced apart from each other, defining a void between them and being deflectable toward each other;

a compressible fluid located within the void; and

wherein inward deflection of the first plate and second plate of each of the first pair of plates and the second pair of plates in response to an increase in pressure in the trapped liquid cavity is limited by contact of the first plate and second plate of the first pair of plates with each other and by contact of the first plate and the second plate of the second pair of plates with each other, such that the inward deflection remains elastic.

19. The apparatus according to claim 18, wherein the pair of plates comprises a cylindrical ring connecting the first plate and second plate and defining an outer diameter of the void.

20. The apparatus according to claim 18, wherein the first plate has a flat surface in relaxed state.