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PRESSURE VESSEL AND CLOSURE

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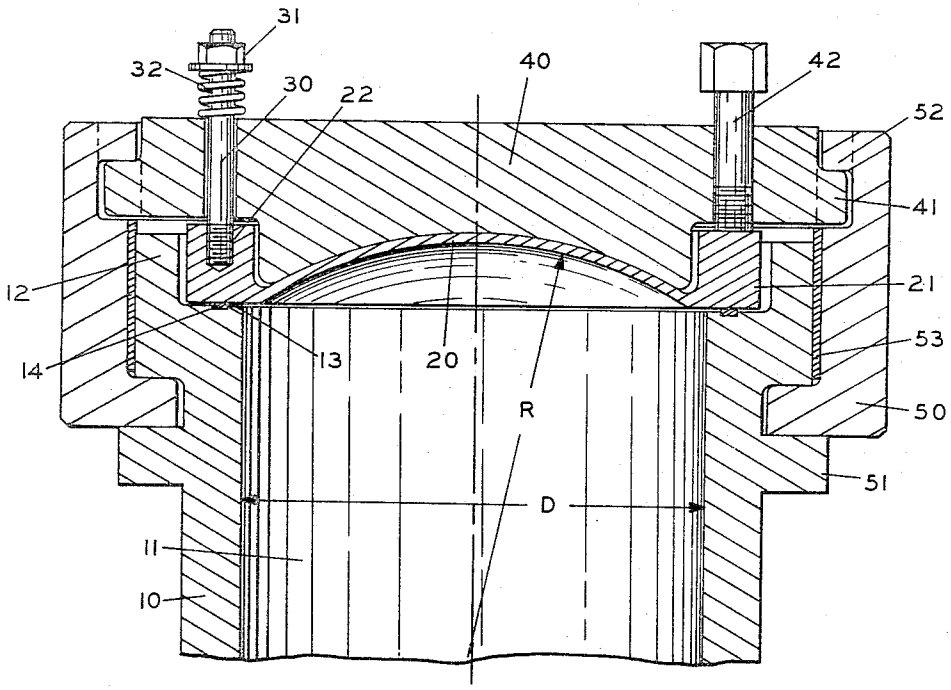


FIG. 1

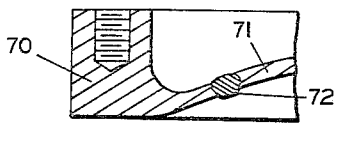


FIG. 2

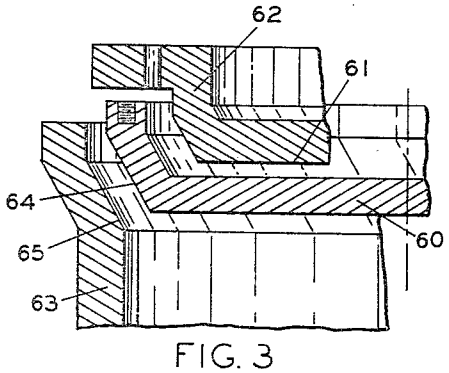


FIG. 3

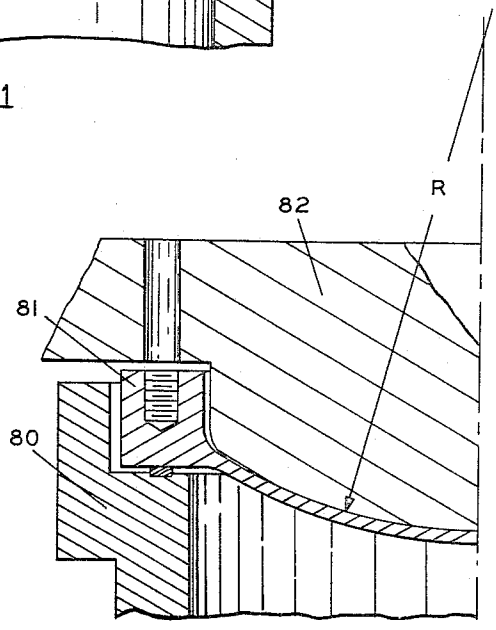


FIG. 4

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PRESSURE VESSEL AND CLOSURE

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This invention relates to pressure vessels and to systems of the quick-opening type for closing and sealing vessels adapted to contain a medium which is subjected to high pressure and/or high temperature. Such pressure vessels are useful as boilers, heat exchangers and autoclaves in which chemical reactions take place under high pressure and temperature conditions.

In the past the closure systems for such vessels have not always been capable of providing satisfactory operation when subjected to the pressure and temperatures which have been desired. With large vessels, there have also been problems in the opening and closing of the vessels, particularly with respect to the sticking or jamming of the threaded elements of the closure. The placement, securement and removal of such closure systems have been complex and have required an undue amount of manipulation which has resulted in protracted delays in changing over from the open and closed positions.

Many operations also require the frequent removal of the closure head, for example to permit charging the vessel with raw material or to remove the products. In order to provide for quick opening and closing with full access of such vessels, particularly in the larger sizes, a continuously threaded closure system is not practical, so that the prior art has employed bayonet and multiple-lug closures. However it has been found that these prior art systems, all of which permit only a small amount of closure movement suffer from jamming because of the so-called "gasket reaction." The mechanism of such action is observed when the securing ring of the bayonet or lug closure is moved from the closed to the open position when the vessel is being opened. It is at this time that the gasket, upon being freed from the imposed pressure, "reacts" or springs back to its normal position. Such springing back has been found to lock the closure head against the securing ring so that the entire assembly becomes jammed. It is therefore necessary to apply considerable force such as by means of levers, air hammers and the like to free the elements of the closure with the obvious danger of warping or bending the individual parts.

Particularly difficult problems have also been encountered in horizontally disposed vessels such as autoclaves and heat exchangers since the presently known gaskets and closure head assemblies have been difficult to align during the assembly of the closure elements.

The principal object of the present invention is to provide a novel sealing closure for a high pressure vessel which includes a deformable floating head used in combination with a restraining head to permit quick and easy opening and closing of the closure assembly without sticking or jamming.

Another object is to provide such a closure in which an internal floating head coacts with an outer restraining head to permit unitary movement and positioning of such heads. Horizontally situated pressure vessels have in the past been difficult to open and close, requiring the use of cranes or hinge systems to permit swinging the closure door into place. The present invention provides a combination system for the placement of the internal floating head together with the outer restraining head. However this unitary system is also useful with vertical vessels when it is desired to handle the dual head system as a single unit.

For a better understanding of the invention, reference is made to the following detailed description of a representative embodiment, and to the variations as shown in the accompanying drawings wherein:

FIGURE 1 is a side elevation in cross-section of one embodiment of the invention; FIGURE 2 is a side elevation in cross-section of a modification of the FIGURE 1 embodiment; FIGURE 3 is a cross-section of a modified dual planar head assembly, while FIGURE 4 shows a convex type of closure assembly.

In FIGURE 1 the reference numeral 10 designates a pressure vessel having an interior chamber 11 which contains a medium (not shown) at high pressure and/or at high temperature. The vessel 10 may be either horizontally or vertically disposed. Communication is afforded from the end of vessel 10 to chamber 11 through an axially extending unthreaded mouth 12 of circular or elliptical shape. The mouth 12 is radially enlarged at its junction at chamber 11 to provide an internal annular shoulder surface 13 which is normal to the axis of the vessel. Seated on this shoulder surface is an annular elastic gasket 14.

The upper end of the chamber 11 is closed off by an unthreaded floating head 20 which is received in the mouth 12 and has a loose fit therein. The head 20 has the approximate rounded shape of the opening, e.g., a circular head for a circular opening, or an elliptical head for an elliptical opening. The head 20 is made of a ductile, high yield-strength metal such as a stainless steel, e.g., an ASTM A240 type 304 or type 316, or a low alloy steel for example the T–1 type. The peripheral portion of the floating head 20 constitutes an axially extending ring or cylinder 21, with the attachment to the disc occurring at the portion of the ring either close to or remote from the autoclave body. Portions 20 and 21 of the floating head may be fabricated as a single unit, or may be made by welding a flat, concave or convex disk to a forged ring, corresponding to the outer portion 21. In such case the outer forging may be made of a suitable forging steel such as ASME–SA182–F1 or a forging stainless steel ASME–SA182–F304. As shown in FIGURE 1 there may be a plurality of studs 30 screwed into openings 22 in the axially extended portion 21 of the floating head for ease of installing and removing the assembly of the two heads.

The rigid portion of the head assembly includes restraining head 40 which cooperates with the floating head 20. The combination of floating head 20 and restraining head 40 are shown in FIGURE 1 as concave relative to the chamber 11. However a planar or convex surface may also be employed. FIGURE 3 shows the seating portion of a planar head with 60 indicating the flat floating head which cooperates with a corresponding planar surface 61 of restraining head 62. In FIGURE 3 the body of the autoclave is shown as element 63.

In FIGURE 3, the sealing surface is shown as being inclined or flared relative to the axial direction of the vessel; this is a variation from the flat or normal surface 13 of FIGURE 1. In FIGURE 3, the closure also illustrates the sealing of the seating surface 64 of the floating head against the inclined surface 65 of the body of the autoclave. The angularity of surfaces 64 and 65 may be the same, or may differ to provide a line contact.

FIGURE 4 illustrates the embodiment of the invention in which the floating and restraining heads of the closure are convex relative to the body of the vessel. In FIGURE 4, element 80 represents the body of the vessel or autoclave, 81 is the floating head and 82 is the restraining head against which the floating head 81 bears upon the application of pressure. The securing means employed in FIGURE 4 are similar to those of FIGURE 1.

The radius of curvature of the concave or convex sur-

face of the floating head and the restraining head has been found to be preferably maintained in the range such that the radius of curvature varies from 0.7 to 1.3 times the diameter of the mouth of the vessel e.g., $R=(0.7 \text{ to } 1.3)D$ in FIGURES 1 and 4. For example with a round mouth opening of 26 inches, the radius of curvature is 19 inches in a specific example. It is in this range of proportions that the optimum flexing of the interal floating head occurs when pressure is applied, and also permitting elastic recovery after the pressure has been released.

The dual head of the present invention solves a difficult problem of unequal temperature distribution with resultant deformations in the metal parts. For example, the use of a 26 inch diameter, and 25 ft. length horizontal body autoclave which is kept hot between runs, and then is charged with a cold feed stock has been found to result in substantial temperature differences in the mouth or hub of the vessel. These temperature differences and the resultant deformation of the metal previously caused pressure leakage. However, the separate movement possible with the present floating head permits accommodation to such thermal deformations since the thinner floating head easily deforms to accommodate the deformations present in the mouth or hub of the vessel. This result cannot be obtained with integrally clad heads based upon a unitary layer of thin metal fastened to a heavier base metal, such as in conventional welded or rolled clad materials.

When the two heads **20** and **40** of FIGURE 1 are to be handled as a unit, a plurality of studs **30** hold such elements together for positioning during removal and securing operations with the stud **30** being held in place by nut **31** and spring **32**.

The head assembly is held in place relative to the body **10** by means of a circular or elliptical ring which may be split for ease of removal. In FIGURE 1, showing a circular head, a rotatable ring **50** engages lugs **41** on the restraining head **40**. While not essential, a collar **51** may also be located on the body **10** in order to hold the movable ring **50** in approximate position during the opening and closing operations. When the vessel is being closed for pressure operations, rotatable ring **50** having interrupted lugs **52** cooperating with lugs **41** of the restraining head permit the approximate positioning of the head assembly consisting of the floating head **20** and restraining head **40**. Closure is then completed by the tightening jack screws **42** which bear against the axial cylindrical portion **21** of the floating head **20** so that a tight seal is made against gasket **14**.

A sleeve bearing **53** of suitable anti-galling properties such as bronze or an impregnated porous bearing material is also desirable to aid in rotating ring **50** during the opening or closing operations.

The present invention provides a quick opening type closure which overcomes the difficulties encountered in prior art devices which were subject to sticking of the closure system as a result of the "gasket reaction" occurring after the release of pressure in the vessel. The present combination head system provides for greater movement of the head assembly, thus preventing the sticking difficulties described above.

The combination head assembly provides for a gap between the restraining head and the floating head before the jack screws are advanced to yield the gasket and provide a tight joint. When pressure is applied to the vessel, the elastic floating head then deforms by changing its radius of curvature to conform to the spherical surface of the restraining head.

Upon the release of pressure in the vessel, the jack screws are retracted, which allows the spring loaded studs to lift the floating head from the gasket.

The dual head system also mades it possible to provide corrosion resistant materials at low cost for the interior of the vessel while providing a high strength rigid head against which the inner, corrosion resistant head

flexes. In general the minimum thickness of the rigid head is at least 5 times that of the floating head, a preferred ratio being from 5 to 100 times as thick. In this way it is also practical to provide an interior material of high elasticity in order to yield with pressure by accommodating itself to the precise shape of the rigid outer head. In this way a gasket may be dispensed with, by basing the yieldable sealing upon the elasticity of the inner head. However the invention also contemplates the use of a gasket made of an elastic material such as copper, soft steel, or stainless steel.

The securing of the dual head combination described herein upon the rounded mouth, e.g., circular or elliptical of the pressure vessel is readily effected with vertical vessels having the opening at the top thereof. In this instance the inner head is placed at the mouth of the vessel after which the outer rigid head is placed thereupon. The securing of the heads is then carried out by the use of a retaining ring, which for ease and speed of application is desirably provided with lugs fitting together with matching lugs on the body of the pressure vessel. Another alternative ring closure is a multi-element bayonet closure particularly for horizontally disposed vessels or for use upon openings at the lower portions of pressure vessels.

In horizontal vessels it is advantageous to mount the dual heads as a single unit. This is readily accomplished by providing a series of threaded bolt holes in the outer rim of the inner head, and also providing cooperating holes of larger diameter in the outer rigid head. Screws or preferably studs are then mounted through the larger holes of the head and threaded into the holes of the floating inner head. The studs may then be secured with nuts, or preferably with springs together with the nuts in order to control the tension. The dual assembly thus screwed together is then readily handled as a unit by means of a crane or hinge to be swung directly in place upon the mouth of the vessel.

In all of the assembly systems described above, the final closure of the head assembly is accomplished by tightening jack screws which are threaded through the outer rigid head, while the rigid head is secured against the vessel by the securing ring or bayonet lug system described above. The jack screws then bear down upon the inner floating head. When the floating head is used without a gasket, this head yields against the shoulder at the mouth of the vessel to achieve a leak proof joint. When a gasket is employed, the tightening of the floating head against the shoulder or chamfer at the mouth of the vessel results in the yielding of the gasket, effecting a leak proof joint.

FIGURE 2 shows a method of fabricating a welded floating head using a ring forging **70** with a dished plate **71** joined together by weld **72**.

What is claimed is:

1. A pressure vessel comprising a pressure chamber having a rounded opening, a radially enlarged shoulder of diameter D at the said opening, an inner seating surface within the said shoulder, a floating head seating against the said seating surface of the shoulder, the said floating head being concave relative to the said pressure chamber, with a radius of curvature R of from 0.7 to 1.3D and in combination therewith a restraining head against which the floating head elastically bears upon the application of pressure.

2. A pressure vessel comprising a pressure chamber having a rounded opening, a radially enlarged shoulder of diameter D at the said opening, an inner seating surface within the said shoulder, a floating head seating against the said seating surface of the shoulder, the said floating head being convex relative to the said pressure chamber, with a radius of curvature R of from 0.7 to 1.3D, and in combination therewith a restraining head against which the floating head elastically bears upon the application of pressure, and a gasket situated between said floating head and the said seating surface.

3. A pressure vessel comprising a pressure chamber having a rounded opening, a radially enlarged shoulder of diameter D at the said opening, an inner seating surface within the said shoulder, a floating head seating against the said seating surface of the shoulder, the said floating head being convex relative to the said pressure chamber, with a radius of curvature R of from 0.7 to 1.3D and in combination therewith a restraining head against which the floating head elastically bears upon the application of pressure.

4. A pressure vessel comprising a pressure chamber having a rounded opening, a radially enlarged shoulder of diameter D at the said opening, an inner seating surface within the said shoulder, a floating head seating against the said seating surface of the shoulder, the said

floating head being convex relative to the said pressure chamber, with a radius of curvature R of from 0.7 to 1.3D, and in combination therewith a restraining head against which the floating head elastically bears upon the application of pressure, and a gasket situated between said floating head and the said seating surface.

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