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 [73] Assignee **Foster Wheeler Corporation**  
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[56]

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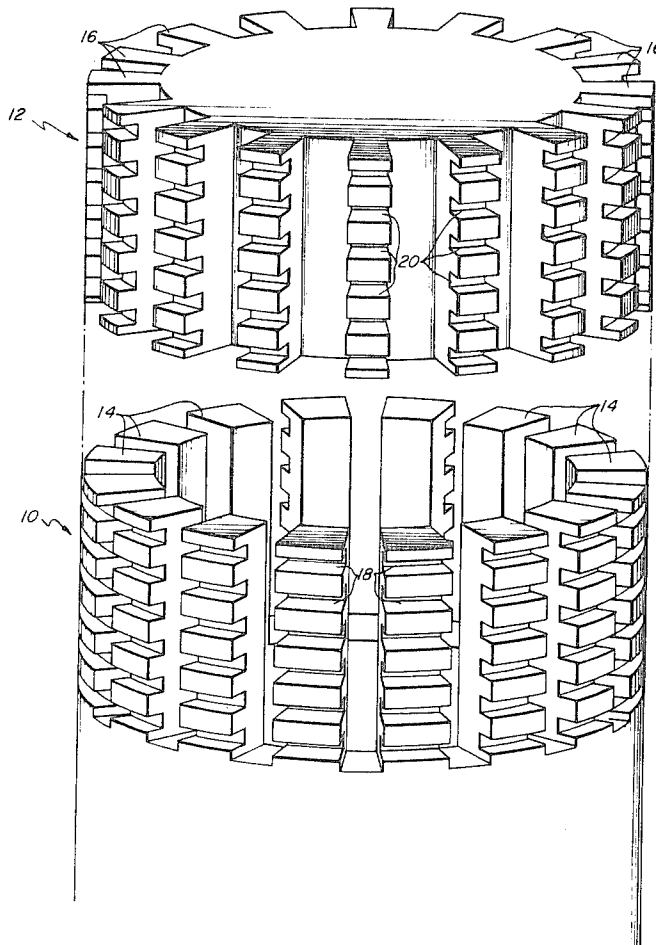
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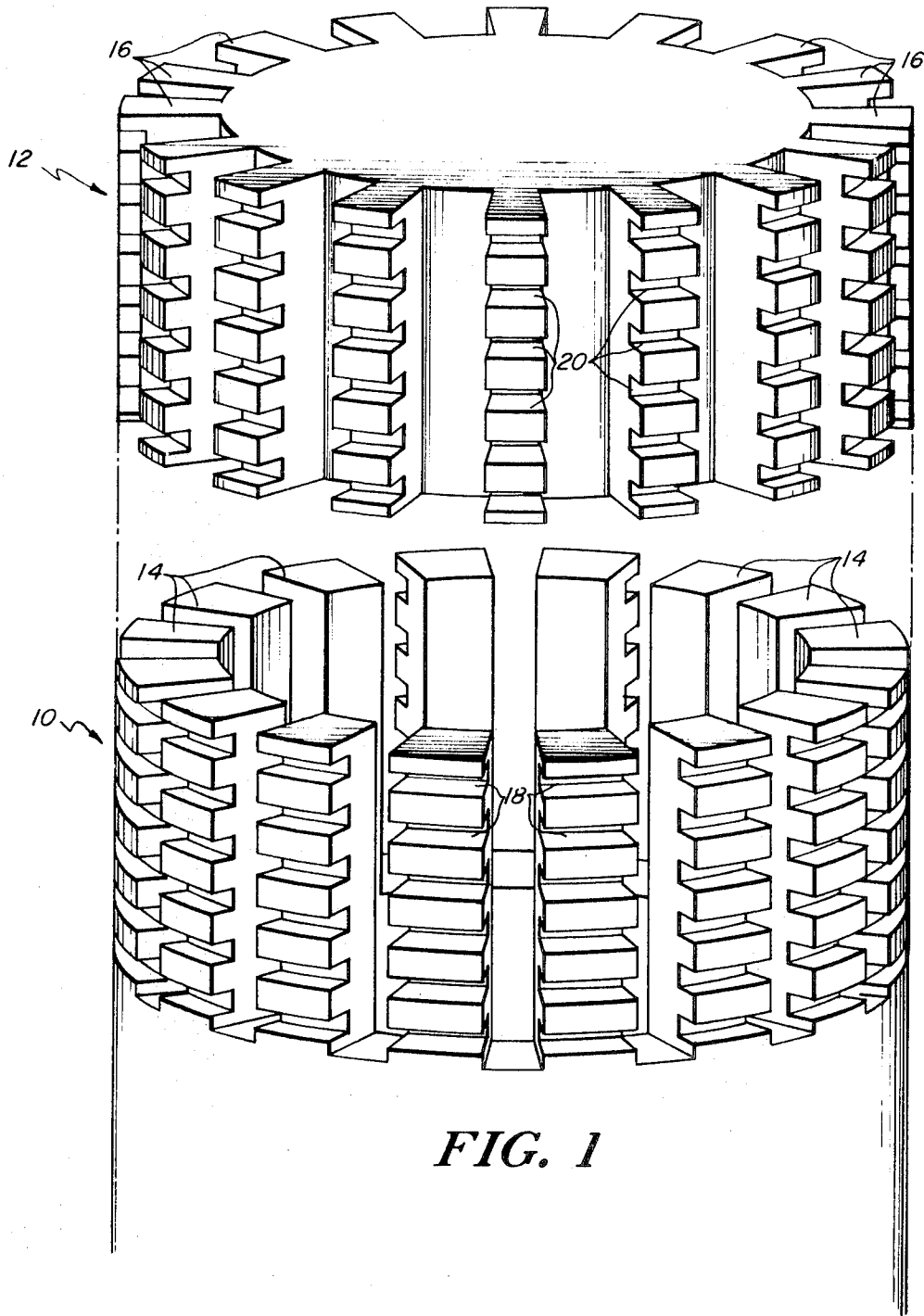
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[54] **PRESSURE VESSEL WITH SHEAR BANDS**  
 4 Claims, 13 Drawing Figs.  
 [52] U.S. Cl..... 220/3,  
 220/55 AN  
 [51] Int. Cl..... B65d 45/32,  
 A47j 36/10  
 [50] Field of Search..... 220/55 O,  
 55 AN, 3, 4, 5, 40, 46; 285/330, DIG. 14, DIG. 15;  
 292/256.5, 256.61, 256.6; 215/95, 98

**ABSTRACT:** A pressure vessel in which a pair of vessel members are attached by means preventing relative rotative movement between the members, and means for preventing relative axial movement between the members.





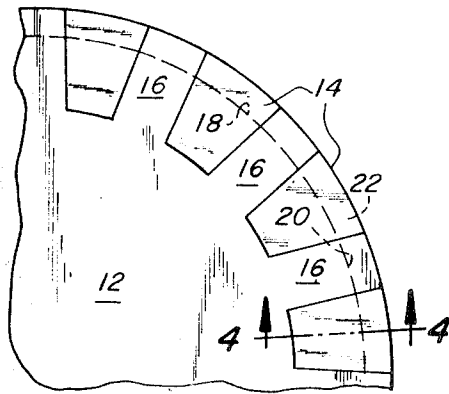
**FIG. 1**

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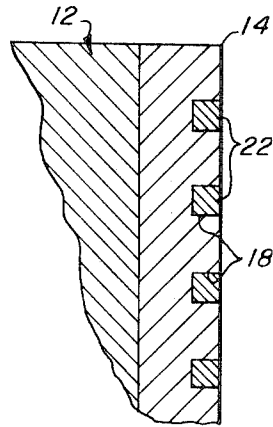
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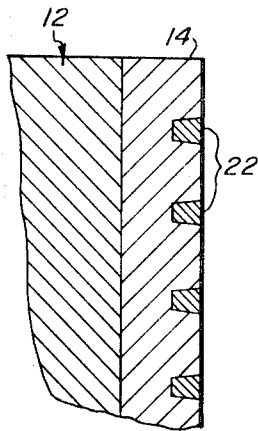
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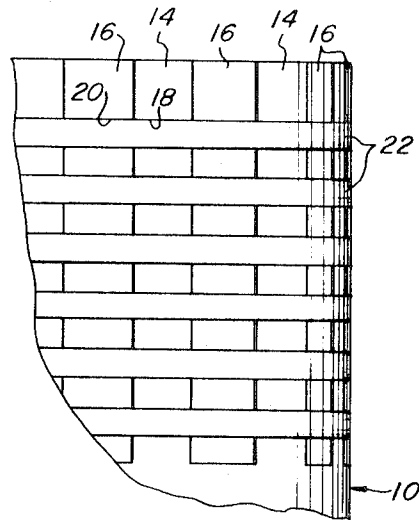
**FIG. 2**



**FIG. 4**



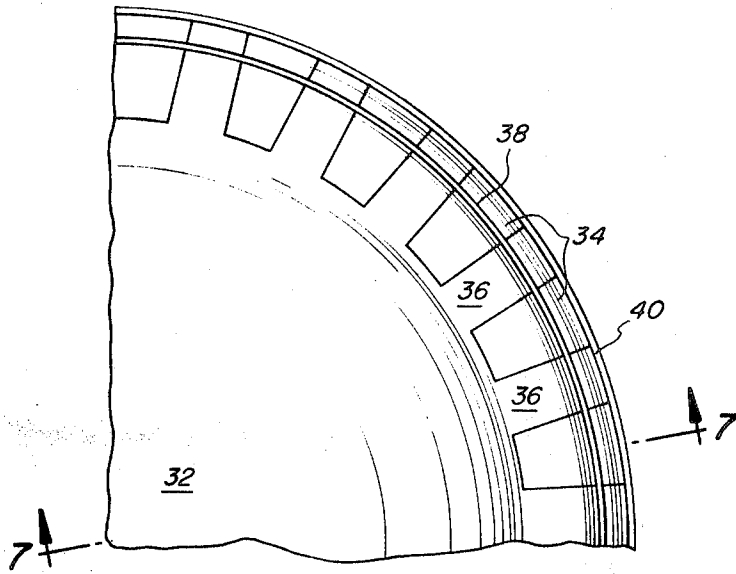
**FIG. 5**



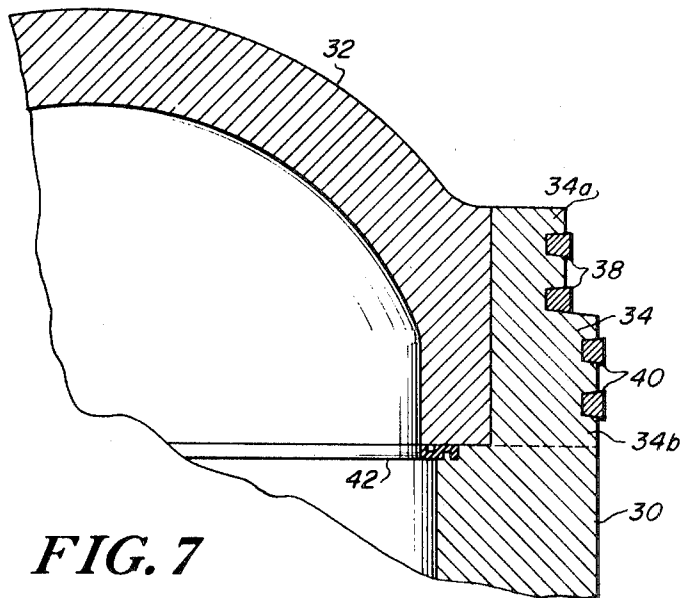
**FIG. 3**

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**FIG. 6**

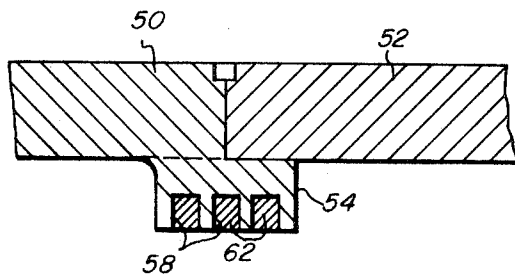
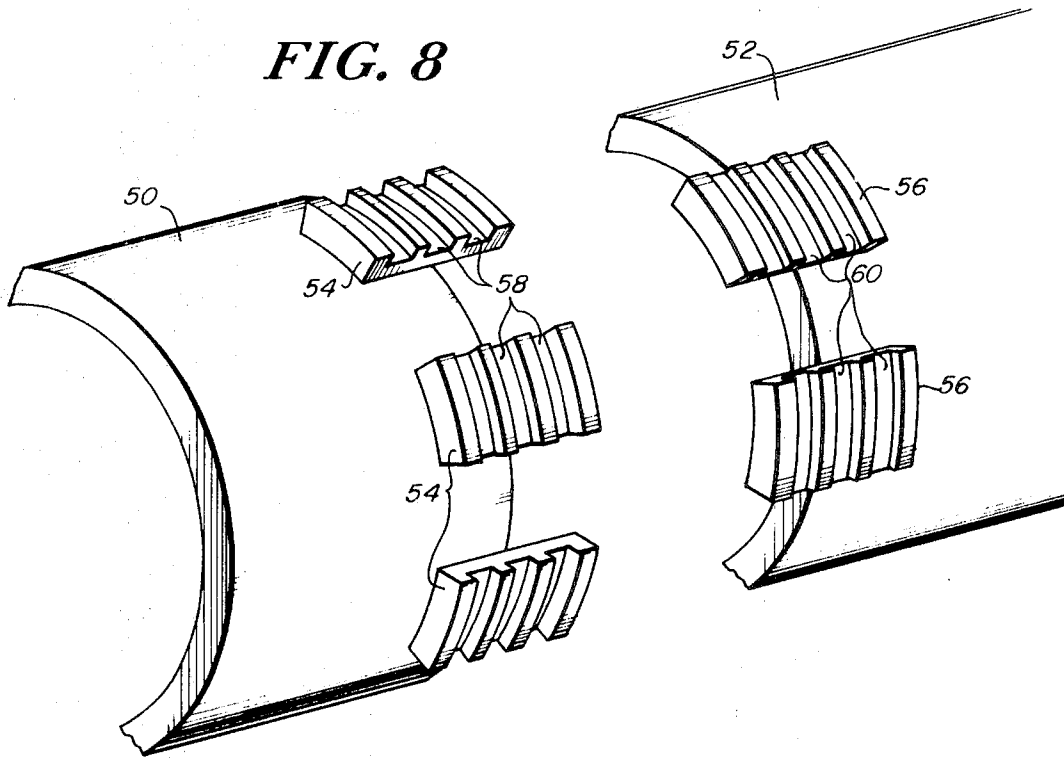


**FIG. 7**

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**FIG. 8**



**FIG. 9**

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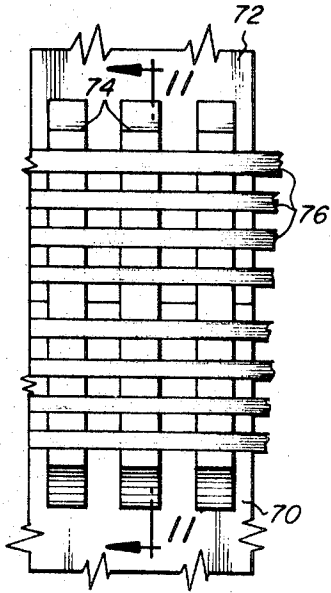


FIG. 10

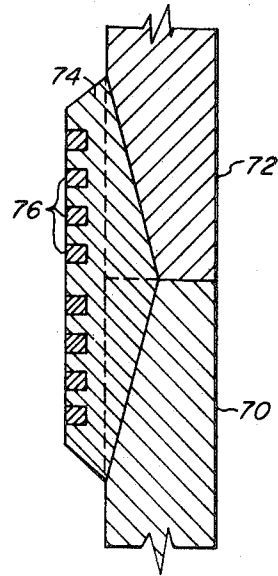


FIG. 11

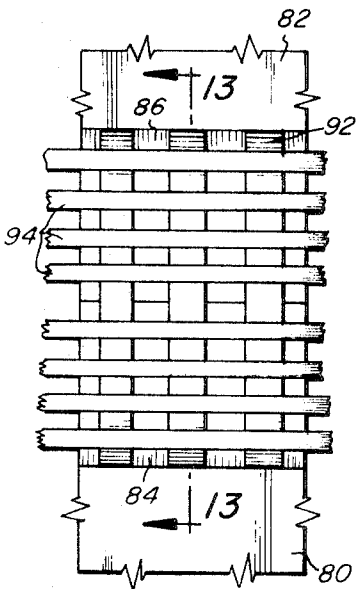


FIG. 12

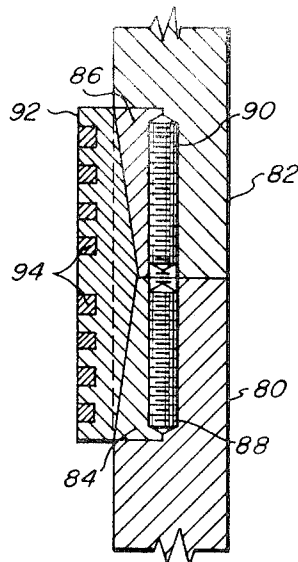


FIG. 13

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## PRESSURE VESSEL WITH SHEAR BANDS

## BACKGROUND OF THE INVENTION

This invention relates to a pressure vessel, and, more particularly, to a pressure vessel in which two adjoining vessel components are fixed together in an improved manner.

In process plants and other environment which require high pressure vessels, many of these vessels, such as reactors, converters, etc., require full size end openings having closures which are removable to permit insertion and withdrawal of external material, equipment, etc. Also, these vessels are often of a size and weight which require them to be constructed of two or more shell members.

Several proposals have been made to connect the closures to the vessels and the shell members to each other. One of the most conventional arrangements utilizes a bolted flange unit with stud bolts attached to a flange at the end of a vessel shell. However, the disadvantages of these type arrangements are numerous. For example, the cost is disproportionately large compared with the total vessel cost, the handling of these units require special equipment, and the size of the complete vessel is unmanageable. Furthermore, the assembling and disassembling of the units is cumbersome and time consuming, as well as being impractical and uneconomical beyond certain limits of size and/or pressure.

Shear block and breech designs have also been suggested, but their use is restricted due to high rotary and bending moments which occur with respect to a groove which is machined in a counterbore formed in one of the units. In order to attempt to overcome these moments, cooperating threads have been provided on the two units. However, in fairly large size vessels, severe machining difficulties are encountered in the threading due to the fact that the male and female threads are threaded from different type machines, and the small differences in thread pitch add up rapidly over a number of threads. This could result in most of the load being carried on a very few threads, thus causing very high stress concentration.

It was also suggested to provide meshing crenulations or splines on each of the units, and utilize a plurality of axially extending threaded shear members located in the interface between the meshing splines. This arrangement resulted in many advantages from a drilling and tapping design standpoint, but was found to be relatively expensive in material and cost, and, just as important, required a relatively long time to assemble and remove the shear members from the cylinder.

## SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a pressure vessel in which two adjoining vessel components may be quickly assembled and disassembled.

It is a further object of the present invention to provide a pressure vessel of the above type which is inexpensive in manufacturing and assembly costs.

Briefly summarized, the pressure vessel of the present invention comprises a first member having at least one open end, a second member engaging said first member at said open end, first means extending from said members for preventing relative rotative movement between said members, and second means extending around and engaging said first means for preventing relating axial movement between said members.

## BRIEF DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying drawings for a better understanding of the nature and objects of the pressure vessel of the present invention, which drawings illustrate the best mode presently contemplated for carrying out the objects of the invention and its principles, and are not to be construed as restrictions or limitations on its scope. In the drawings:

FIG. 1 is a perspective view showing a portion of a disassembled pressure vessel according to the present invention;

FIG. 2 is a partial cross-sectional view of the assembled pressure vessel of FIG. 1;

FIG. 3 is a partial front elevational view of the assembled pressure vessel of FIG. 1;

FIG. 4 is a partial cross-sectional view taken along the line 4-4 of FIG. 2;

FIG. 5 is a view similar to FIG. 4, but depicting another embodiment of the present invention;

FIG. 6 is a partial top plan view of another embodiment of the pressure vessel of the present invention;

FIG. 7 is a cross-sectional view taken along the line 7-7 of FIG. 6;

FIG. 8 is a perspective view of the end portions of a pair of disassembled shell members forming a pressure vessel according to another embodiment of the present invention;

FIG. 9 is a partial cross-sectional view of the assembled pressure vessel of FIG. 8;

FIG. 10 is a partial front elevational view of another embodiment of the present invention;

FIG. 11 is a partial cross-sectional view taken along the line 11-11 of FIG. 10;

FIG. 12 is a view similar to FIG. 10, but showing still another embodiment of the present invention; and

FIG. 13 is a partial cross-sectional view taken along the line 13-13 of FIG. 12.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring specifically to the embodiment of FIG. 1, the reference numeral 10 refers, in general, to the upper portion of a cylindrical vessel which is adapted to receive a closure plug 12 to close the vessel.

The end portion of the vessel 10 is grooved longitudinally as shown to provide a plurality of splines 14 extending around the circumference thereof, each spline having a plurality of circumferentially extending grooves 18 formed therein.

A plurality of corresponding splines 16 are formed in the outer circumference of the closure plug 12 and each has a series of grooves 20 formed therein. These latter grooves are of the same size as, and are spaced apart identically to, the grooves 18.

The machining is such that when closure plug 12 is inserted in the open end of the vessel 10, the splines 16 will extend in the spaces between the splines 14, and vice versa, as shown in FIG. 2. Also, the grooves 18 and 20 will align and thereby extend continuously around the circumference of the vessel.

As shown in FIG. 3, a plurality of circumferential bands 22 are disposed in the aligned grooves 18 and 20 to prevent axial movement between the plug 12 and the vessel 10. These bands 22 may be in the form of solid bars, steel cables, multilayer bands of continuous windings of strip seal, or the like, and may have either a substantially square cross-sectional area as shown in FIG. 4, or a tapered cross-sectional area as shown in the embodiment of FIG. 5. After being fitted into the grooves 18 and 20, the cylindrical bands 22 may be attached at their ends by any means known in the art.

The embodiment of FIGS. 6 and 7 is similar to that of FIGS. 1-5 but depicts a cylindrical vessel 30 having a substantially semispherical closure member 32 extending over an end thereof. A plurality of splines 34 are provided in the cylinder 30 which are adapted to mesh with a plurality of corresponding splines 36 machined in the outer circumferential portion of the closure member 32. The splines 34 and 36 all have a stepped shoulder portion such as shown at 34a in FIG. 7, which extends from a base portion shown at 34b. A pair of grooves are provided in the shoulder portion and in the base portion of all of the splines 34 and 36, and together are adapted to receive circumferential bands 38 and 40, respectively, to fasten the closure member 32 with respect to the cylinder 30. It is noted that in this embodiment the grooves and the corresponding bands 38 and 40 are shown having a tapered cross-sectional area, and that a portion of the bands 38 and 40 extend outwardly from their respective grooves to facilitate removal thereof. A gasket 42 is provided between the vessel 30 and the closure member 32.

The embodiment of FIGS. 8 and 9 show the principles of the previous embodiments when applied to a joint between two shell portions together forming a cylindrical vessel. Specifically, a pair of shell portions 50 and 52 are shown in a disassembled condition in FIG. 8, with the end portions of each having a plurality of spaced projections or fingers 54 and 56, respectively, extending around its circumference and outwardly therefrom. It can be appreciated that the projections 54 and 56 may be machined from a forged vessel and thereby be integral with their respective shell portions, or they may be attached in any known manner, such as by welding. The projections 54 and 56 are adapted to mesh when the shell portions 50 and 52 are brought into abutment, to prevent relative rotative movement between the shell portions.

A plurality of circumferential grooves 58 and 60 are formed in the projections 54 and 56, respectively, and are identically spaced and shaped so that they will align and thereby accommodate a plurality of bands 62, as shown in FIG. 9, to prevent relative axial movement between the shell portions.

In the embodiments of FIGS. 10 and 11, a pair of vessel components such as shell portions 70 and 72 each has a plurality of longitudinal grooves formed therein which are spaced circumferentially around the shell portions. A plate member 74 is disposed in each longitudinal groove and each has a plurality of circumferentially extending grooves formed therein which together receive a set of shear bands 76, as shown.

In the embodiment of FIGS. 12 and 13, a pair of shell members 80 and 82 each has a groove formed therein, and extending continuously around the circumference thereof. A pair of rings 84 and 86 are respectively attached within the grooves by means of a plurality of axially extending, spaced, threaded studs 88 and 90, respectively.

The rings 84 and 86 are each provided with spaced longitudinal slots which are aligned, and which receive plate members 92, as in the embodiment of FIGS. 10 and 11. Each of the plate members 92 has a series of grooves which are aligned circumferentially and which together are adapted to receive a corresponding number of shear bands 94.

It can be appreciated that the pressure vessels of each of the above embodiments are relatively inexpensive to manufacture and yet enable the abutting components of the vessel to be quickly assembled and disassembled.

Several variations of the vessels disclosed above can be made without departing from the scope of the invention. For example, the circumferential bands can be of a tapered or square cross-sectional shape, and can protrude out from, or extend flush with, the splines or plate in any of the embodiments. Also, each of the bands can be formed into two arcuate halves and each half connected to a longitudinal axial member, which members, in turn, can be moved apart in opposite directions, for example, by sliding on rails, etc., to facilitate assembly and disassembly.

Of course, other variations of the specific construction and arrangement of the pressure vessel disclosed above can be made by those skilled in the art without departing from the invention as defined in the appended claims.

I claim:

1. A pressure vessel comprising a hollow cylinder having an open end portion formed by a plurality of longitudinal splines, a cylindrical attachment member for attaching to said open end portion, the outer circumference of said attachment member having a plurality of longitudinal grooves formed therein to receive said splines with the inner surfaces of said splines being supported by the inner walls of said grooves, the length of said longitudinal grooves being equal to the length of said longitudinal splines, the outer surfaces of said attachment member and said splines defining a plurality of axially spaced circumferential grooves, and a plurality of bands extending in said grooves.

2. The vessel of claim 1 wherein said attachment member comprises a closure plug extending within said open end portion.

3. The vessel of claim 1 wherein said attachment member is in the form of another hollow cylinder.

4. The vessel of claim 1 wherein said attachment member is in the form of a semispherical closure member.

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