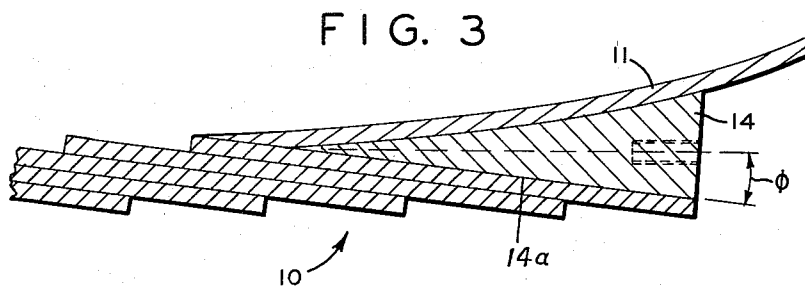
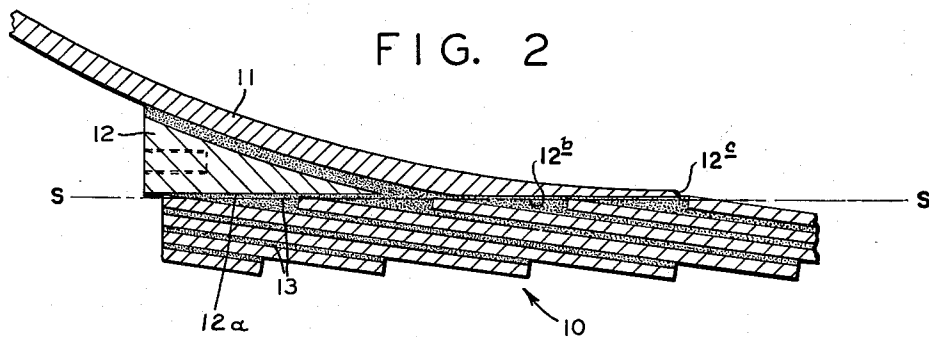
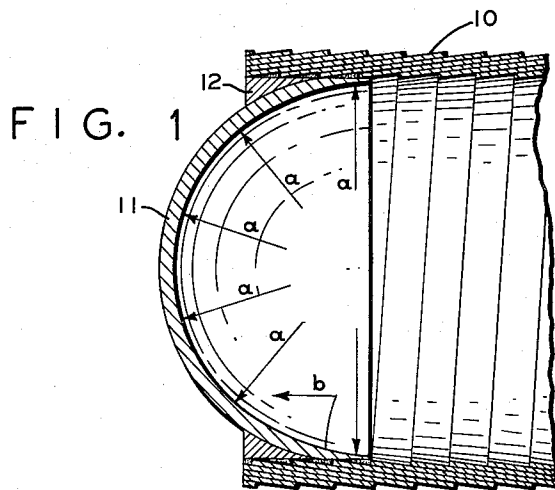


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PRESSURE VESSEL JOINT
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PRESSURE VESSEL JOINT

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This invention relates to pressure containing vessels. More particularly, this invention relates to the joint between an end piece and the tubular body portion of such pressure vessels.

To aid in understanding this invention, it must be borne in mind that the strength of a bonded joint when subjected to shearing forces is proportional to the area of the bonded joint. As related to bonded joints of tubular pressure containing vessels, such as form the subject of the present invention, the strength of such joint is proportional to the length of the joint; the longitudinal dimension of the joint being fixed as the circumference of the pressure containing vessel at the joint.

As related to the problem of constructing a tubular pressure containing vessel having domed end closures, the above considerations require that the joint between the body portion and the domed end closure extend over a substantial longitudinal distance. In order to provide such a substantial longitudinal distance on the domed end closure, the domed end closure may be provided with a tubular skirt of the appropriate length integral therewith. However, several problems in manufacture immediately arise by use of this expedient. First, as the depth of the domed end closure increases, the more severe problems of deep drawing of such a domed end closure from sheet material arise. This problem is minimized where the domed end closure is relatively shallow as in a hemispherical piece, for example. Also, where the domed end closure is of relatively thin construction, it is difficult to accurately machine the joint surface on the lengthy longitudinal skirt or flange portion thereof. According to this invention, the domed end closure for a pressure containing vessel does not require deep drawing since it does not require such a flange or skirt portion.

It is an object of this invention to provide a joint between an end closure and a tubular body portion of a pressure containing vessel which will provide sufficient area of joint to enable the joint to resist any shear stresses which may be encountered in service.

It is a further object of this invention to provide such a joint which may be economically constructed and which will have a maximum of strength for the particular materials used.

The foregoing objects and additional objects and advantages as will become apparent from the following description are achieved through the use of a domed end closure positioned within an end of a tubular portion of the pressure containing vessel and having a chock means interposed between the external surface of the domed end closure and the internal surface of the end of the tubular body portion.

Illustrative of specific embodiments of this invention are the accompanying drawings in which:

FIG. 1 is a sectional view of one end of a pressure containing vessel utilizing the joint in accordance with this invention;

FIG. 2 is an enlarged sectional view of one joint according to this invention; and

FIG. 3 is an enlarged sectional view of another embodiment of a joint according to this invention.

Referring next to the drawings, and more particularly to FIG. 1, the joint of this invention is illustrated as embodied in a pressure containing vessel having a tubular body portion 10 and a domed end closure 11 positioned

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within the tubular body portion 10 and positioned near an end thereof. Chock means 12 is interposed between the inside surface of tubular body portion 10 and the external surface of domed end closure 11 in the region of overlap between tubular body portion 10 and domed end closure 11.

Tubular body portion 10 may be of any construction and of any cross-sectional configuration, but as illustrated in FIG. 1, is preferably constructed according to the teachings of the co-pending application Ser. No. 41,931, filed July 11, 1960, by Dobell and Roberts wherein strip material is wound so as to overlap itself by at least 50% to produce a tubular configuration substantially as illustrated in FIG. 1 herein. However, it is to be understood that tubular body portion 10 may also be made by producing tubular sections by other known techniques, such as by extrusion, rolling a sheet to the appropriate configuration and butt or lap welding the edges thereof, etc. and may be in any cross-sectional configuration, whether circular, elliptical, square, etc.

While as illustrated in FIG. 1, domed end closure means 11 is hemi-spherical in shape, it is readily apparent that the domed end closure may assume a variety of shapes partially depending upon the cross-sectional shape of tubular body portion 10 and partially depending upon the uses to which the pressure containing vessel is to be put. For example, if tubular body portion 10 is square in cross-section, domed end portion 11 will have a square rim and may be appropriately domed in a pyramidal fashion. Likewise domed end closure means 11 may be a section of an ellipsoid, a paraboloid, or other curved configurations. Also, domed end closure means 11 may be provided with openings therethrough to permit communication between the inside of the pressure containing vessel and the outside surroundings, as for example, through the use of flange or screw fittings to which conduits may be attached.

As illustrated, chock means 12 is of toroidal configuration having the outside face cylindrical and the inside face a zone of a sphere. This particular configuration was selected for the illustrated example to conform with the illustrated configurations of tubular portion 10 and domed end closure means 11 illustrated herein. It is readily apparent, however, that should any of the other configurations hereinbefore mentioned for tubular body portion 10 and domed end closure means 11 be selected, chock means 12 would preferably be given an appropriate configuration and an appropriate cross-sectional shape. However, it will be noted that the cross-sectional shape of chock means 12 will in all cases be substantially triangular. As illustrated, chock means 12 is a single ring-shaped piece of toroidal configuration, but it is readily apparent that chock means 12 may be made of a plurality of pieces which, when positioned between domed end closure 11 and tubular body portion 10 will assume a substantially toroidal shape in the aggregate.

Referring next to FIG. 2, there is shown an enlarged view of the joint between tubular body portion 10 as prepared according to the technique of the aforesaid Dobell and Roberts application and the hemispherical domed end closure means 11. Interposed in the overlapping region between tubular body portion 10 and domed end closure means 11 is positioned chock means 12, having a face 12a of substantially cylindrical configuration. The various laps of strip material comprising the tubular body portion 10, the domed end closure means 11 which has a terminal edge 12c, and the chock means 12 are all firmly bonded together by the use of braze 13.

It will be noted that cylindrical surface 12a of chock means 12 provides an extension of surface 12b of the

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closure means 11 along the line $s-s$ to which the tubular body portion 10 may be bonded, thus increasing the area of the bonded joint to an amount sufficient to withstand any shearing stresses to which the joint may be subjected during the use of the pressure containing vessel.

It should further be noted that chock means 12 (see FIG. 1) serves to prevent domed end closure means 11 from being moved axially outward from within tubular body portion 10 under the influence of internal pressure within the pressure containing vessel. The internal pressure indicated by force vectors a , a acts uniformly within the end closure means 11 to produce a resultant longitudinal force vector acting in the direction of vector b . Since the chock means 12 is secured to tubular body portion 10 to prevent sliding longitudinal motion thereof, the only way end closure means 11 could move under the influence of the internal pressure would require end closure means 11 to buckle sufficiently to allow its rim to pass through the constricted opening of chock means 12. This buckling may be opposed by the internal strength of end closure means 11 or, preferably, end closure means 11 may also be bonded to chock means 12.

Referring next to FIG. 3, there is illustrated a joint according to this invention which is particularly useful in conjunction with the technique for producing pressure containing vessels described in the aforesaid Dobell and Roberts application. In this joint, chock means 14, interposed between domed end closure means 11 and tubular body portion 10 is provided with a frusto-conical outer surface 14a having a cone angle ϕ which is substantially equal to the cone angle of the strip material comprising the tubular body portion 10 in accordance with the teachings of my co-pending application Ser. No. 41,933, filed July 11, 1960.

The chock means 12 and 14 previously described may have any appropriate configuration on the exposed face thereof. For example, the exposed face may be stream-lined to merge with the domed end closure means 11 to distribute stresses over an extended area and thus further strengthen the pressure containing vessel. Also, chock means 12 and 14 may be provided in the exposed face thereof with means for securing attachments thereto such as drilled and tapped holes to which such attachments may be screwed.

While the bonding of the various portions to each other have been described and illustrated in terms of using braze, it is readily apparent that the principles of this invention likewise apply when other bonding techniques are used, such as welding, use of epoxy resins, etc.

In order to prepare a pressure containing vessel in accordance with the teachings of this invention, two alternative techniques readily come to mind. First, the tubular body portion may be prepared in any known fashion and a prepared domed end closure inserted therein. Chock means 12 is then interposed within tubular body portion 10 external to domed end closure 11 and appropriately bonded in place. Alternatively, chock means 12 may be placed around domed end closure 11 and then tubular body portion 10 formed around chock means 12 and bonded thereto.

To prepare the pressure containing vessel in accordance with the teachings of the aforesaid Dobell and Roberts application making use of the beginning end joint in accordance with my aforesaid co-pending application, it is preferred that annular chock means 14 be placed around the rim of a hemi-spherical domed end closure means 11 and brazed in place. To another hemi-spherical domed end closure means 11, annular chock means 12 is brazed in place. The two domed end closure means with attached chock means are then placed on a rotatable mandrel. One end of a length of strip material is brazed to surface 14a of chock 14 of the beginning end piece. The strip is then helically wound so as to overlap itself by at least 50% over the length of the intermediate mandrel on which the two domed end portions were placed until the strip material reaches

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the other domed end portion and is wrapped securely around the other chock means 12. All contacting metal to metal surfaces between the domed end closures, the chocks, and the various laps of the strip material are brazed together, and the mandrel used in the construction is removed.

It is thus seen that herein has been provided a joint between a tubular body portion and a domed end closure means of a pressure containing vessel which will have a maximum strength, will be light in weight, and which can be readily fabricated economically by known techniques without weakening either the tubular body portion or the domed end closure of the pressure containing vessel.

While this invention has been described and illustrated in certain embodiments, it is readily apparent that obvious equivalents exist for specific details contained in the illustrative embodiments. It is intended that all such equivalents as may be embraced within the scope of the subjoined claims are to be considered as part of this invention.

I claim:

1. A cylindrical pressure vessel, comprising a domed round end member having an outer cylindrical surface at the wide end thereof; a ring member coaxially surrounding said end member and having an outer substantially cylindrical face providing together with said cylindrical face of the domed member a combined cylindrical attachment area, and having an inner substantially conical face substantially conforming to an adjacent annular portion of the surface of the domed member and adapted to restrain the same against internal pressure in the vessel; a tubular construction consisting of helically wound strip material of substantial tensile strength with a large ratio of width to thickness, said strip material having an end portion wound around said combined attachment area with the windings of the strip material tightly wound helically one upon the other in overlapping relationship and the overlap large enough to constitute a wall thickness comprising a plurality of thicknesses of said strip material, and with the outer edge portion of the strip material stretched relative to the inner edge thereof to accommodate said overlap; first bonding means provided at the interface between said tubular construction and said combined attachment area, second bonding means effective at the interface between the overlapping portions of said windings, each of said bonding means providing sufficient shear resistance to absorb the longitudinally directed forces present in said wall thickness due to said internal pressure in the vessel.

2. The arrangement according to claim 1, wherein bonding means are provided at the interface between said domed member and said ring member.

3. The arrangement according to claim 1, wherein at least the cylindrical surfaces of said domed member and of said ring member as well as said strip material consist of metal, and said bonding means are in the nature of a braze.

4. The arrangement according to claim 1, wherein both said domed member and said strip consist of steel, and said bonding means are in the nature of a braze.

5. The arrangement according to claim 1, wherein said ring member has an outer end face extending substantially normal to said cylindrical face of the ring member with threaded holes provided in said end face substantially co-extensive with the axis of the vessel.

6. The arrangement according to claim 1, wherein said end portion of the domed member is of a thickness diminishing towards the terminal edge of said domed member.

7. The arrangement according to claim 1, wherein said end portion of the domed member is of diminishing thickness and shaped to present a relatively sharp terminal edge providing a smooth transition between the inner face of the domed member and the inner face of the tubular construction.

8. A pressure vessel, comprising a domed round end

member having an outer cylindrical surface at the wide end thereof, a ring member coaxially surrounding said end member and having an outer substantially cylindrical face providing together with said cylindrical face of the domed member a combined cylindrical attachment area, and having an inner substantially conical face substantially conforming to an adjacent annular portion of the surface of the domed member and adapted to restrain the same against internal pressure in the vessel; a tubular construction consisting of helically wound strip material having end portions wound around said combined attachment area and arranged to constitute a wall comprising a plurality of strip thicknesses; first bonding means at the interface between the strip thicknesses connecting the strip windings to one another, and second bonding means effective at the interface between said ring member and said tubular construction, each of said bonding means providing sufficient shear resistance to absorb the longitudinally directed forces present in said wall due to said internal pressure in the vessel.

9. The arrangement according to claim 8, wherein bonding means are provided at the interface between said domed member and said ring member.

10. The arrangement according to claim 8, wherein said cylindrical face of the domed member constitutes with the inner face thereof an edge portion diminishing in thickness towards the terminal edge of said domed member.

11. The arrangement according to claim 8, wherein said cylindrical face of the domed member constitutes with the inner face thereof an edge portion of diminishing thickness and shaped to provide a relatively sharp terminal edge presenting a smooth transition between the inner face of the domed member and the inner face of said tubular construction.

12. A pressure vessel, comprising a domed round end member, a ring member coaxially surrounding said end member and having an outer substantially cylindrical face substantially registering with the outer periphery of said domed member and having an inner substantially conical face substantially conforming to an adjacent annular portion of the surface of the domed member and adapted to restrain the same against internal pressure in the vessel, a tubular construction consisting of helically wound strip material having an end portion wound around said cylindrical face of the ring member and arranged to constitute a wall comprising a plurality of strip thicknesses, first bonding means provided at the interface between the strip thicknesses connecting the windings to one another, and second bonding means effective at the interface between said ring member and said tubular construction, each of said bonding means providing sufficient shear resistance to absorb the longitudinally directed forces present in said wall due to said internal pressure in the vessel.

13. The arrangement according to claim 12, wherein bonding means are provided at the interface between said domed member and said ring member.

14. The arrangement according to claim 12, wherein said tubular construction consists of helically wound strip material of substantial tensile strength and of great width relative to its thickness, said strip material being wound around said cylindrical surface of the ring member with the windings tightly wound helically one upon the other

in overlapping relationship and the extent of the overlap such that the wall thickness of the tubular construction comprises a plurality of thicknesses of said strip material, with the outer edge portion of said strip material stretched relative to the inner edge thereof; and wherein other bonding means are provided effective in the helical area of the interface between the overlapping portions of said windings.

15. A pressure vessel, comprising a domed round end member, a ring member coaxially surrounding said end member and having an outer substantially cylindrical face substantially registering with the outer periphery of the domed member, and having an inner substantially conical face substantially conforming to an adjacent annular portion of the surface of the domed member and adapted to restrain the same against internal pressure in the vessel, a tubular construction having an end portion surrounding said cylindrical face of the ring member, and means connecting said tubular construction to said ring member, effective to absorb the longitudinally directed forces present in the wall of said tubular construction due to said internal pressure in the vessel.

16. The arrangement according to claim 15, wherein bonding means are provided at the interface between said domed member and said ring member.

17. A pressure vessel, comprising a domed round end member having an outer cylindrical surface at the wide end thereof, a ring member coaxially surrounding said end member and having an outer substantially cylindrical face providing together with said cylindrical face of the domed member a combined cylindrical attachment area, and having a substantially conical inner face substantially conforming to an adjacent annular portion of the surface of the domed member and adapted to restrain the same against internal pressure in the vessel, a tubular construction having an end portion surrounding said combined area, and means connecting said tubular construction to said ring member effective to absorb the longitudinally directed forces present in the wall of said tubular construction due to said internal pressure in the vessel.

18. The arrangement according to claim 17, wherein a bonding connection is provided at the interface between said domed member and said ring member.

19. The arrangement according to claim 17, wherein said cylindrical face of the domed member constitutes with the inner face thereof an edge portion diminishing in thickness towards the terminal edge of said domed member.

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