

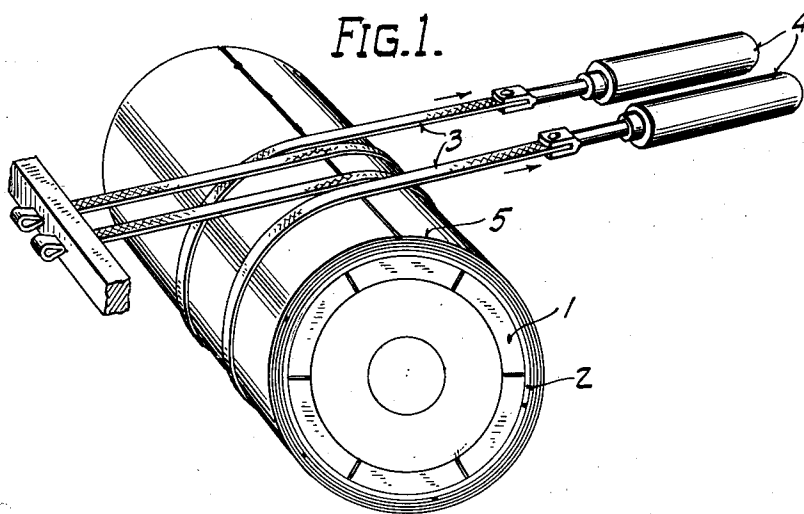
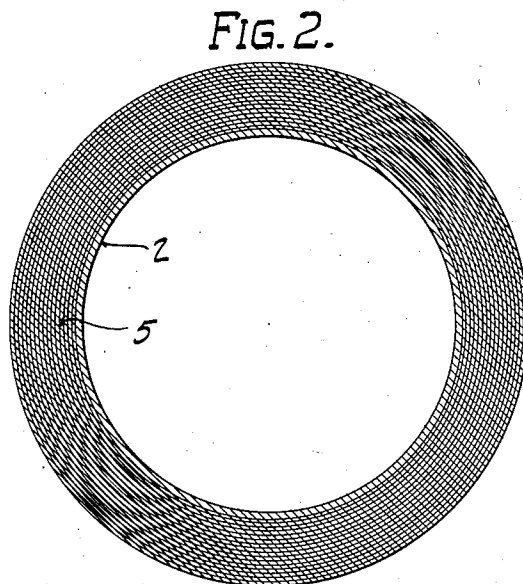
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METHOD OF CONSTRUCTING MULTI-LAYER PRESSURE VESSELS

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METHOD OF CONSTRUCTING MULTILAYER
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This invention relates to a method of constructing multi-layer pressure vessels and more particularly to the pre-stressing of the cylindrical walls of a vessel during fabrication.

It has been known that in the construction of multi-layer pressure vessels in accordance with the Stresau Patent No. 1,925,118, and with certain improvements thereon, it is possible to pre-stress the cylindrical wall of the vessel to compensate for the different rates of stress increase in the metal of the inner and outer section of the vessel under working load. This pre-stressing is accomplished by squeezing the structure during the welding of each layer to an extent producing elastic flow of the metal of the layers, resulting in initial residual compression stresses in the inner section of the cylindrical wall of the vessel and initial residual tension stresses in the outer section of the wall. In carrying out this process it has been found that there is a tendency for the innermost layer or layers to be excessively compressed so that the over-all efficiency of the vessel may be less than desired. In other words, the stress has a tendency to accumulate or concentrate in the innermost layers as subsequent layers are successively applied to the structure.

Various methods have been proposed for removing the concentration of stress or evening out the stress distribution in the structure. Most of these methods require additional and expensive steps.

The principal object of the present invention is to provide a process for preventing the excessive concentration of compressive stress in the innermost layers of the structure when fabricated in the manner described.

The accompanying drawing illustrates a method of carrying out the invention and the views therein are as follows:

Figure 1 is a perspective view showing diagrammatically the application of the fifth layer of the cylinder; and

Fig. 2 is a transverse section through a completed cylinder with the inner supporting structure removed.

In carrying out the invention the compressive stress is concentrated in a removable elastically yieldable structure inside the innermost layer of the vessel wall, and which structure supports the layer against compression. This removable structure preferably comprises a removable inner layer or cylinder upon which the innermost layer 2 of the vessel is wrapped. It may have consid-

erable thickness or it may be relatively thin and be backed up by internal fluid pressure to support the innermost layers of the vessel wall during fabrication. It preferably comprises a form of collapsible mandrel and has an outer circumference which is capable of absorbing considerable compression stress in a circumferential direction as well as radially.

The inner structure 1 constitutes a foundation upon which the innermost layer 2 of the vessel is wrapped and tensioned. This tensioning is accomplished by applying tightening bands 3 encircling the layer and pulled tightly thereon by hydraulic cylinders 4 which exert forces sufficient to cause the bands to actually squeeze the structure beneath to a smaller diameter, within the limit for elastic return of the metal.

The layer 2 is then welded along its longitudinal seam while the bands are tensioned. Upon release of the bands the inner structure 1 which has been compressed will tend to expand outwardly and place the inner layer 2 under tension.

As subsequent layers are applied in the same manner the neutral axis between the compressive stresses and tensile stresses moves outwardly, and the inner layer 2 should have its stress changed from tensile stress to compressive stress. This may occur when the fifth layer 5 is applied depending upon the amount of compression and elastic return in the inner supporting structure 1.

The inner structure 1 is removed after the cylinder is completely fabricated, although it may be removed before all of the layers are applied, where a very thick wall is being built up. This takes away the support for the inner layer 2 and the latter is immediately compressed an amount depending upon the tension of the outer layers. The final cylinder will have the inner layers under residual compressive stress and the outer layers under residual tension stress. The neutral axis of pre-stress will be nearer the center of the wall than would be the case if the inner structure were not used.

The invention is based on the discovery that in constructing cylinders by the pre-stressing process there was a greater stress differential between the first few layers than between the outer layers, and that this stress differential was retained in the final structure. The difference in stress between each layer and the next previous layer is dependent upon the relative thickness of the given layer and of the previous layers.

The tensile stress in the outermost layer re-

sults from a tendency to compress the entire previous structure, and the compressive stress corresponding to it may be assumed to be distributed evenly throughout the previous layers. It is thus divided between about fourteen layers.

On the other hand, the tensile stress in say the fifth layer being applied corresponds to a compressive stress divided between four layers. Each time a layer is applied the innermost layer 2 receives some additional compressive stress.

The present invention utilizes these facts and provides an inner supporting structure capable of constituting the inner layer during fabrication, and which is subsequently removed to effect a redistribution of stresses in the multi-layer cylinder.

The innermost layer of the vessel has the position, during fabrication, that the third or fourth layer would have in a cylinder fabricated without an inner supporting member. The amount of pre-stressing of the innermost layer will be determined by its position. The innermost layer, therefore, will not receive the amount of compression stress which is ordinarily accumulated near the inner surface of a layer structure which does not have an inner support.

After the cylindrical wall of the vessel has been fabricated in the manner described and the inner supporting structure removed, the remaining vessel wall will have a more evenly distributed initial stress tending to compensate for the differences in rate of stressing of the wall under working load.

Where the inner supporting structure is a heavy cylinder it may be cut out after fabrication of the vessel wall by any suitable method to remove the same.

The invention is claimed as follows:

1. The method of pre-stressing a multi-layer high pressure cylinder during fabrication to improve the stress distribution therein in service, comprising providing a removable elastically yieldable cylindrical internal supporting structure capable of resisting compression stresses in a circumferential direction, applying a layer of sheet metal thereon, tensioning said layer circumferentially upon the structure and welding said layer to provide the innermost load carrying layer of the pressure cylinder, similarly applying tensioning and welding subsequent layers under conditions of elastic compression of

said inner structure and adjacent layer to build up a cylinder of considerable thickness and effect a pre-stressing of the metal of the several layers tending to compensate for the different rates of stress increase therein under working load, and subsequently removing said internal supporting structure to redistribute the pre-stress in the cylinder wall.

2. The method of pre-stressing a multi-layer high pressure cylinder during fabrication to improve the stress distribution therein in service, comprising providing a removable elastically yieldable cylindrical internal supporting structure capable of resisting compression stresses in a circumferential direction, applying a layer of sheet metal thereon, squeezing the structure and welding said layer to provide the innermost load carrying layer of the pressure cylinder, similarly applying and welding subsequent layers under conditions of elastic compression of said inner structure and adjacent layer to build up a cylinder of considerable thickness and effect a pre-stressing of the metal of the several layers tending to compensate for the different rates of stress increase therein under working load, subsequently removing said internal supporting structure to redistribute the pre-stress in the cylinder wall, and thereafter completing the cylinder by adding subsequent layers and welding the same thereon.

3. The method of pre-stressing a multi-layer high pressure cylinder during fabrication to improve the stress distribution therein in service, comprising providing a removable elastically yieldable cylindrical internal supporting structure capable of resisting compression stresses in a circumferential direction, applying a layer of sheet metal thereon, squeezing the structure and welding said layer to provide the innermost load carrying layer of the pressure cylinder, similarly applying and welding subsequent layers under conditions of elastic compression of said inner structure and adjacent layer to build up a cylinder of considerable thickness and effect a pre-stressing of the metal of the several layers tending to compensate for the different rates of stress increase therein under working load, and after completion of the cylinder removing said internal supporting structure to redistribute the pre-stress in the cylinder wall.

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