Aug. 16, 1966 C. RAGETTLI 3,266,660

FILAMENT WOUND VESSEL

Filed May 22, 1964 2 Sheets-Sheet 1

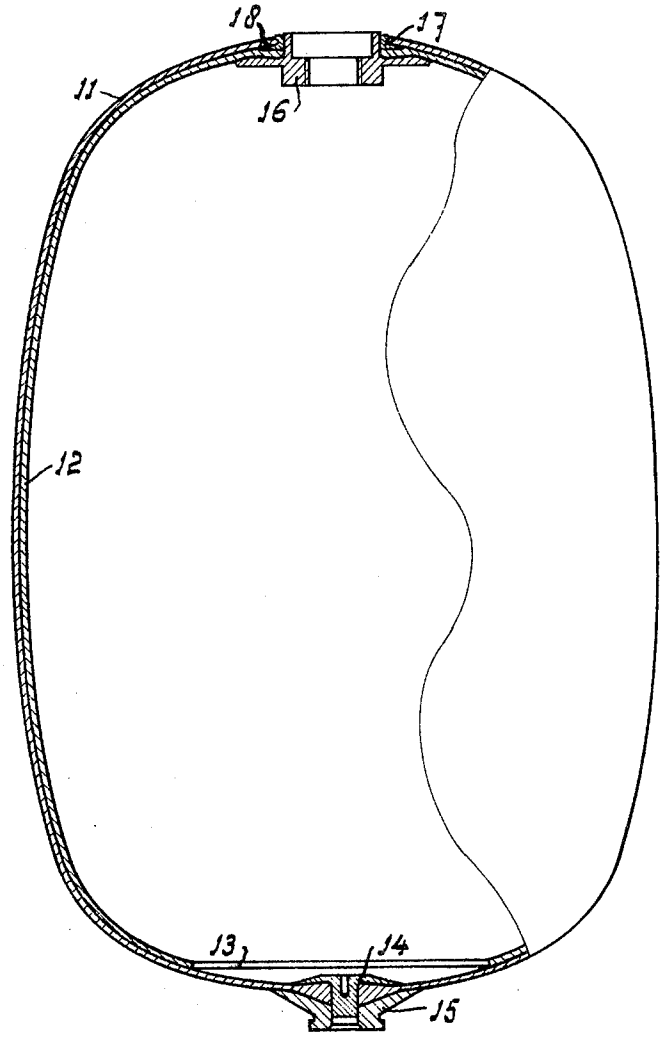


FIG. 1

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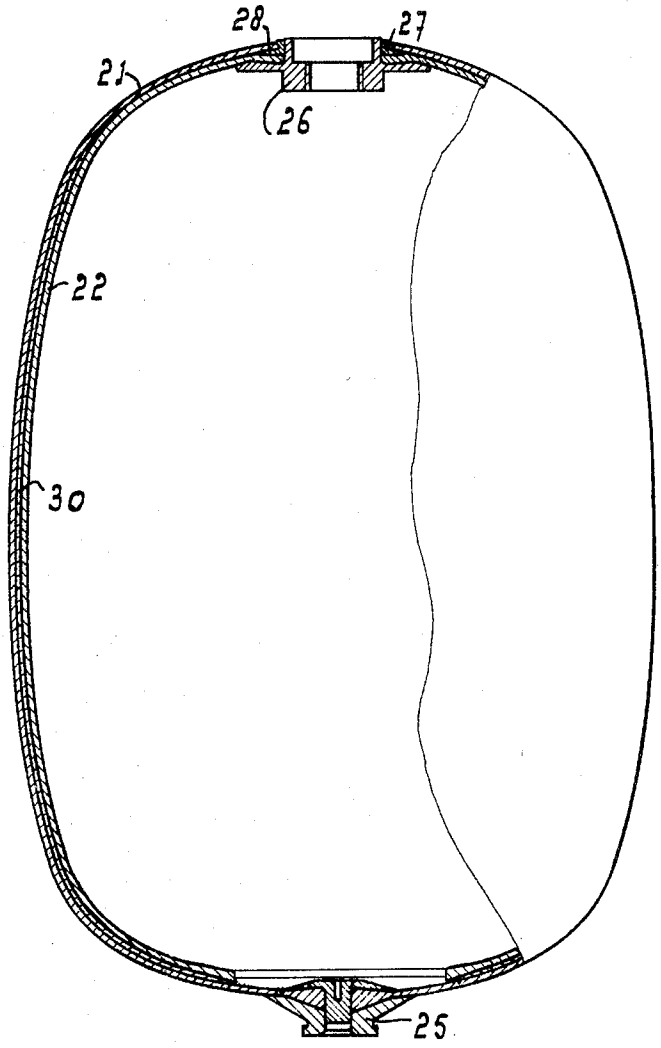


FIG. 2

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United States Patent Office 3,266,660 Patented August 16, 1966

3,266,660

FILAMENT WOUND VESSEL

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Filed May 22, 1964, Ser. No. 369,541
Claims priority, application Great Britain, May 24, 1963, 20,814/63
13 Claims. (Cl. 220—63)

The present invention relates to a filament wound vessel, i.e. a vessel produced by winding filaments such as glass filaments on a mandrel, the filaments being impregnated or moistened with a synthetic resin before, during or after the winding operation and the thus produced shell being ultimately cured, for instance by means of a heat treatment.

It is an object of the present invention to provide a vessel of the type described which has an improved or increased impact strength, that is which has a greater resistance to the deleterious effects of heavy shocks or blows as might, for instance, be caused by a drop of the wholly or partly filled vessel onto a hard floor, such as a concrete floor.

With this and other objects in view the present invention provides a filament wound vessel comprising two or more shells consisting of similarly shaped hollow bodies of revolution each including two poles, said shells fitting into one another and being distinct from one another, and said shells supporting one another over substantially their entire surface area and being secured to one another only at or adjacent to one of said poles. As is apparent from the figures, adjacent shells either engage or contact one another directly over substantially their entire surface area (FIG. 1) or indirectly engage one another over substantially their entire surface area, i.e., they are separated from one another by an intermediate layer (FIG. 2).

I have found that a vessel according to the invention and comprising two distinct shells nested into one another has a greater impact strength than a single walled vessel having a wall thickness which is equal to the total of the wall thicknesses of the two distinct shells constituting the vessel of the invention, all other conditions and materials being the same. In many cases the impact strength of a double walled vessel according to the invention proved to be greater than that of a single walled vessel even if the overall wall thickness of the double walled vessel was smaller than that of the single walled vessel.

In a preferred embodiment of the invention an intermediate layer is provided between two adjacent ones of said shells. However, the shells should not be bonded together by such intermediate layer; on the contrary, it should allow a relative movement in its plane of adjacent shells with respect to one another.

It is to be understood that the invention is not restricted to a vessel comprising two shells, the one enveloping the other, only; the vessel may have three or more shells without departing from the scope of the invention.

If the vessel comprises more than two shells they may all be separated from one another by intermediate layers, or some or all of them may be in direct engagement with the adjacent shell or shells.

The intermediate layer may include a release agent or an anti-adhesive agent and it may consist of a thin, molecular film having a wall thickness of some microns only.

The intermediate layer may have crack arresting and/or energy absorbing properties, and it may consist of or include an elastomer.

Advantageous results have been obtained with intermediate layers consisting of or including a polymer such as polyglycol, polyvinylalcohol, polyethylene or polypropylene.

As will appear from the following description other materials come into consideration for the intermediate layer or layers and many of them have also given highly satisfactory results.

I have found that preferably, the wall thickness of the outer one of two of said shells should not be less than one half of the wall thickness of the adjacent inner one of said two shells, otherwise fatigue fractures or cracks may occur in the outer shell.

The invention will now further be explained and more fully be described in detail, reference being made to the accompanying drawings, in which:

FIGURE 1 is partly a vertical cross-sectional view and partly a side elevation of one embodiment of the invention and

FIGURE 2 is a similar view of another embodiment of the invention.

The vessel shown in FIGURE 1 of the drawings comprises an outer shell **11** enveloping an inner shell **12**. Both shells consist of similarly shaped hollow bodies of revolution each including two poles and produced by winding filaments such as glass filaments on a mandrel, the filaments being impregnated or moistened with a synthetic resin before, during or after the winding operation and the thus produced shell being ultimately cured, for instance by means of a heat treatment. It will be appreciated that such curing will, of course, cause the vessel to become rigid in nature.

As described in my co-pending patent application Serial No. 418,235, filed December 14, 1964 and assigned to the assignee of the present invention when winding the inner shell **12** an area adjacent and around one pole has been left uncovered thus forming an opening **13** through which the mandrel used for winding the inner shell has been removed after the inner shell has been cured. The outer shell **11** has been wound while using the inner shell **12** as a mandrel, the opening **13** being substantially closed by winding through open space and around the bottom fitting **14**. A retaining ring **15** is secured to the bottom fitting **14** and the edge of the outer shell surrounding a hole at the pole thereof is clasped between these two parts.

As shown in FIGURE 1 of the drawing the shells **11**, **12** fit into one another and they are distinct from one another, they engage one another directly over substantially their entire surface area and at the lower pole they are not secured to one another. They are only secured to one another at the top pole, by means of a top fitting **16** adapted to receive a screw threaded discharge valve (not shown) and co-operating with a retaining ring **17** which may be held in place by part of the windings of the outer shell being wound over a flange **18** thereof; additionally, or alternatively, it may be secured to the top fitting.

To ensure that the two shells **11**, **12** will permanently form distinct parts a release agent or anti-adhesive agent may be applied to the outer surface of the inner shell **12** before winding the outer shell thereon. Thereby, it will under certain conditions also be possible to start winding the outer shell before the inner shell has completely cooled down after curing. For instance, polyethylene or polypropylene in powder form together with a binding agent such as, for instance, nitrocellulose lacquer, can be applied to the outer surface of the inner shell by means of paint spraying; the mixture may, for instance, contain four parts in weight of binding agent and one part of powder. The powder may also be applied by means of a sintering process. In the event of the resin for impregnating the glass filaments being an epoxy resin or a similar synthetic resin it appears that the polyethylene or polypropylene powder forms an external coating on the

inner shell and an internal lining in the outer shell and that the adhesion between the lining-and-coating material and that of the shells is greater than the cohesion of the lining-and-coating material; thus the outer and inner shells remain wholly separate as could be ascertained by sawing vessels according to the invention into parts.

The embodiment of the invention shown in FIGURE 2 of the drawings is substantially identical to that shown in FIGURE 1: here too the vessel comprises two filament wound shells **21** and **22** respectively consisting of similarly shaped hollow bodies of revolution each including two poles. The shells fit into one another and are distinct from one another.

As shown in the drawings, the wall thickness of the outer shell **11** or **21** respectively may be substantially equal to the wall thickness of the inner shell **12** or **22** respectively. The outer shell may be formed with a smaller wall thickness than that of the inner shell; however, preferably, the wall thickness of the outer shell is equal to or greater than one half of the wall thickness of the inner shell. It has been found that if the wall thickness of the outer shell is less than approximately one half of the wall thickness of the inner shell fatigue fractures, ruptures or cracks may occur in the outer shell and evidently, such a failure is not acceptable.

At the top pole the inner and outer shells are secured to one another by means of the top fitting **26** adapted to receive a discharge valve and co-operating with a retaining ring **27** which, like the embodiment of FIGURE 1, has a flange **28** which is covered by part of the filament windings forming the outer shell.

Moreover, in this embodiment the inner and outer shells are not in direct engagement, but on the contrary, in indirect engagement with one another over substantially their entire surface area; they are separated from one another by means of an intermediate layer **30** which, for the sake of clearness, has been shown in FIGURE 2 with an exaggerated wall thickness.

The intermediate layer **30** may have crack arresting and/or energy absorbing properties, and it may, for instance, consist of or include an elastomer.

The intermediate layer **30** may have a molecular thickness of some microns only; it may consist of or include a release agent or an anti-adhesive agent. For instance, as described with reference to FIGURE 1, it may be formed by applying polyethylene or polypropylene in powder form to the outer surface of the inner shell before starting winding the outer shell.

Alternatively, the intermediate layer may be formed by winding a layer of polyethylene or polypropylene strap around the inner shell before forming the outer shell.

Other polymers have been found to yield good results as a material for the intermediate layer **30**; for instance, polyvinylalcohol and polyglycol have been found satisfactory. Also synthetic resins containing alkyds such as a mixture of alkyd formaldehyde and other resins have been found suitable.

The intermediate layer **30** may also consist of or include a wax.

Furthermore, advantageous results have been obtained by using a powder of a brittle material, for instance a crystalline powder such as quartz powder or an amorphous material such as glass powder as the material for the intermediate layer. Alternatively, sand and particularly fine sand may be used as a material for the intermediate layer.

The intermediate layer, or the inner shell, or both, may be used as a carrier for a colour paint, or a trade mark, or another indication if the outer shell is wholly or partly transparent.

I claim as my invention:

1. A rigid vessel comprising at least two shells each of which comprises a filament wound similarly shaped hollow body, corresponding to a surface of revolution and including two poles, said shells being distinct from one another, fitting into one another and supporting one another over substantially their entire surface area, said shells being secured to one another only adjacent to one of said poles, said shells being free of attachment to one another over the remainder of their surface area and the unsecured pole of said inner shell having a relatively large polar opening formed therein.

2. A rigid vessel as claimed in claim **1**, in which an intermediate layer is provided between two adjacent ones of said shells.

3. A rigid vessel as claimed in claim **2**, in which said intermediate layer includes a release agent.

4. A rigid vessel as claimed in claim **2**, in which said intermediate layer has crack arresting properties.

5. A rigid vessel as claimed in claim **2**, in which said intermediate layer includes an elastomer.

6. A rigid vessel as claimed in claim **2**, in which said intermediate layer consists of a thin, molecular film.

7. A rigid vessel as claimed in claim **2**, in which said intermediate layer includes a polymer selected from the group consisting of polyglycol, polyvinylalcohol, polyethylene and polypropylene.

8. A rigid vessel as claimed in claim **2**, in which said intermediate layer includes an alkyd containing synthetic resin.

9. A rigid vessel as claimed in claim **2**, in which said intermediate layer includes a wax.

10. A rigid vessel as claimed in claim **2**, in which said intermediate layer includes a powder of a brittle material.

11. A rigid vessel as claimed in claim **1**, in which the outer one of two of said shells is provided with an internal lining and the adjacent inner one of said two shells is provided with an external coating of a similar material as that of said internal lining, the adhesion between said lining and coating material and the material of said shells being greater than the cohesion of said lining and coating material.

12. A rigid vessel as claimed in claim **1**, in which the wall thickness of the outer one of two of said shells is at least equal to one half of the wall thickness of the adjacent inner one of said two shells.

13. A rigid vessel as claimed in claim **2**, in which the intermediate layer has energy absorbing properties.

References Cited by the Examiner

UNITED STATES PATENTS

2,809,762	10/1957	Cardona	220—3
2,995,011	8/1961	Kimmel.	
3,031,099	4/1962	Wiltshire	220—3
3,047,191	7/1962	Young	220—83
3,057,509	10/1962	Bernd	220—3
3,073,575	1/1963	Fingerhut	220—3
3,132,761	5/1964	Sylvester	220—63
3,137,405	6/1964	Gorcey	220—63
3,172,252	3/1965	Boek	220—3

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