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Tanks with internal jacket made out of polymer material.

The invention concerns the construction of tanks with inner lining horn appropriate polymer material, which (i.e the lining) has the form of a jacket and a shape similar to the corresponding tank, for the purpose of corrosion or other kind of protection of the inner side of the tanks from liquids which are stored or circulated through the tanks.

which is resistant to corrosion, while the need for strength to hydraulic pressure is satisfied by the tank itself (usually made out of steel) and this combination has important economical and technical advantages.

The use of internal jacket from polymer material, in direct contact with the walls of the tanks, creates a new product which can have many applications and as an example only reference is made to the storage water heaters (solar, electric, etc.) where the need of the corrosion protection of the tanks is satisfied by the use of the internal jacket from polymer material

The basic method for the production of the new product, in accordance with the invention, includes either the production of a tank from a pre-constructed jacket from polymer material (i.e. polyethylene, polypropylene, etc.), which (jacket) is enclosed by the various parts of the tank, whose parts are assembled by welding, screws, etc., or the production of the tank by forming the jacket from polymer material directly inside the tank.

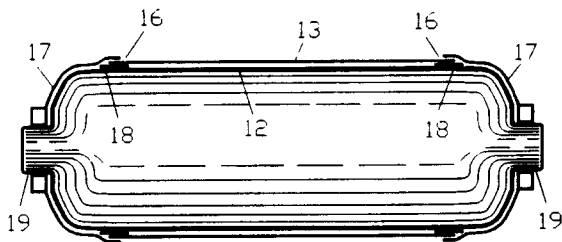


FIGURE 6

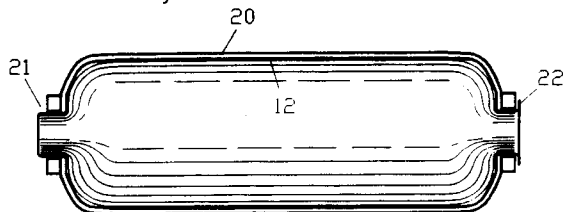


FIGURE 7

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The invention has as a basic idea the construction of tanks with inner lining from appropriate polymer material, in the form of a jacket, which has a shape similar to that of the corresponding tank, for the purpose of corrosion or other kind of protection of the inner side of the tanks.

The tanks are used for storage or heating or other treatment (relevant uses) of liquids of any nature, with applications in e.g. storage water heaters, solar domestic hot water systems, etc.

The use of internal jacket from polymer material in direct contact with the walls of the tank creates a new product in the field of tanks with important economical and technical advantages.

A production method of the previously mentioned product is described next, where the pre-constructed internal jacket from the polymer material is enclosed by the metallic parts of the tank, where these parts are either welded together or assembled with screws or by any other method. In addition, a description of a production method is included where the internal jacket from polymer material is shaped directly inside the tank.

The invention concerns tanks with internal jacket (lining) made out of polymer material. The invention also concerns relevant production methods for the parts of the final product as well as the product itself.

Raw materials utilized for the construction of the internal jackets, which are used as inner lining of tanks, are various polymer materials, with low, medium or high density and with low, medium or high molecular weight. The selection of the raw material depends on the desirable properties or characteristics of the lining (anticorrosion or antitoxic, etc.) as well as on the cost. As examples only the materials polyethylene, polypropylene, etc. are mentioned.

In order to emphasize the advantages of the products and the production methods of this invention, the description of the invention will be based on storage water heaters (i.e. stationary appliance for heating water in a tank intended for long term or temporary storage of the heated water and provided with a device or devices to control and/or limit the water temperature), with internal jacket (lining) made out of high density, high molecular weight polyethylene. Similar procedures, with no important variations, are applied to all types of tanks as well as to various raw materials used to construct the internal jackets.

In the case of storage water heaters, the invention covers the need for their corrosion protection, which is the most important item of concern for the design of the tank. The storage water heaters include electric water heaters, solar water heaters, and tanks with heat exchangers which operate in cooperation with the heating system of a house,

etc.

The corrosion protection of storage water heaters is achieved today by applying one of the following methods:

- 5 - galvanizing or electroplating
- glass enamelling
- 10 - thermosetting resins or thermoplastic materials or other polymer materials either in liquid phase or in the form of powder (the process of coating takes place in the ambient temperature or in ovens) where the protective polymers adhere on the inner side of the tank.
- 15 - metal lining made out of thin sheets of copper or stainless steel or other material.
- copper or stainless steel or other materials which can resist the corrosive action of domestic water.

20 These methods have been proved to be in some cases expensive, and so they increase the cost of the products, and in some other cases they do not offer complete protection either because of their nature or due to lack of the required technical experience for the specific application (incomplete knowlegde, cost, etc.) In cases of coating with thermoplastic or other materials, the problem of formation of blisters on the surface is well known and it is caused by the infiltration of liquid between the surface and the walls of the tank.

25 The existence of so many methods of corrosion protection of storage water heaters, reflects upon the continuous efforts in searching for new solutions for the corrosion problem which is at the same time technical and economic.

- 30 - Technical, as far as it concerns the design and the construction of a reliable product, with low cost which covers the needs of the consumers for a long time period.
- 35 - Economic, because the usage of storage water heaters is rising continuously (new users, replacements) in all forms of applications (electric, solar, use in combination with heating systems, etc.) with direct effect on the economy of any country.

40 The corrosion protection of storage water heaters mainly concerns the protection of the internal surface of the corresponding tanks which is exposed to the corrosive action and/or electrolytic phenomena, due to the liquids contained in the tanks, leading to tank failure.

45 A new type of product is been created in accordance with this invention, which satisfies the needs for corrosion protection, as a combination of an internal jacket (lining) made of polymer material which is resistant to corrosion and a metallic tank (usually made out of steel or other material) in direct contact with the internal jacket and which can sustain the hydraulic pressure inside the tank.

Water or other corrosive liquid, which is stored or circulates inside the storage water heater and which is manufactured in accordance with this invention, does not come in contact with the internal metallic surfaces of the heater because of the existence of the walls of the internal jacket made of polymer material which is resistant to the corrosion. This way, any corrosion problems or electrolytical phenomena on the inner surface of the metallic tank are eliminated and perfect corrosion protection is achieved.

The internal jacket from polymer material which is used for the lining of the tank, is constructed in such shape so that complete contact is achieved with the inner surface of the tank and in this way the walls of the jacket are fully supported and no stresses are developed on them other than a compression due to hydraulic pressure. The tank (usually made of steel or other material) being in direct contact with the internal jacket provides the necessary strength and rigidity to sustain the hydraulic pressure inside the tank, without being under the influence of the corrosive action of the liquid inside, which can destroy it.

The internal jacket made of polymer material and used for the lining of storage water heaters can be constructed at any desirable thickness and in this way corrosion protection is achieved for long time period.

The internal jacket from polymer material which is used for the inner lining of tanks can be constructed by various methods such as:

- Blow moulding, where a tube is formed from polymer material with proper diameter and temperature and which is inflated by compressed air either inside a mould or directly inside the tank in order to take the desirable shape.
- Rotational moulding, where the polymer material (as a powder or liquid) is placed in a mould which is heated while being rotated about two perpendicular axes simultaneously and then cooled taking the shape of the cavity of the mould.

The previously described methods are associated with production processes of the internal jackets that have cost advantages.

The cost and the technical characteristics of the material for the internal jacket are such that they allow any desirable thickness of the lining (indicative thickness of 2-3mm is mentioned), providing this way reliability and durability to the jacket at the required level and so reducing the danger caused by marginal designs which are obligatory when more expensive materials and methods are utilized for the purpose of corrosion protection.

The rather thick walls of the internal jacket of this invention, which are used for satisfactory corro-

sion protection of the storage water heaters, are not only technologically and economically feasible, but at the same time they provide thermal insulation to the tank and so they reduce the energy losses to the environment a fact that constitutes another advantage of this invention.

It must be pointed out that the storage water heater with the inner lining from polymer material is a new product which requires new tools, new production methods and the relevant equipment and most importantly special measurements and quality control procedures of all the new factors that are related to the invention.

The stages of production of the internal jacket, made of polymer material, are described next, together with examples of how the jackets can be used for manufacturing the storage water heaters. Reference to drawings illustrates all important points.

Figure 1, shows in general terms a storage water heater (solar, electric, etc. or a tank for storage of hot water or other liquids) which will be protected against corrosion by the use of an internal jacket from polymer material in accordance with the invention. It is easy to see the cylindrical part (1) of the tank, the two ends or heads (2) and the two openings (3).

Figures 2 and 3, present schematically and in general terms the basic principle of forming the jackets from polymer material by blow moulding. Specifically in Figure 2, the tube (4) from polymer material with the proper diameter, temperature and thickness (known as parison), is shown in front of the two halves of the mould (5), which are apart (mould is open).

Figure 3, shows the two parts of the mould in the closed position where they have entrapped the tube where compressed air is blown inside the tube from the upper opening of the mould (8). The tube is shown just as it starts to be inflated by the compressed air. The tube is expanded against the cavity of the mould, it takes the shape of the mould and it becomes firm due to the fact that the walls of the mould are cooled. The cooling water enters the mould from points (7) and leaves it from points (6). The cooling system is shown only schematically while in reality there are more inlet and exit points of the cooling water.

Figure 4 illustrates schematically the production of an internal jacket by the method of rotational moulding. In this case the mould is rotated by a proper device about two perpendicular axes simultaneously and has the desirable shape and the appropriate temperature (it is heated). The raw material is inserted into the mould from the opening (11) through the nozzle (10).

Figure 5 shows an internal jacket from polymer material (12), which is inside the cylindrical part

(13) of the metallic tank to which it will be the inner lining. Shown also in place is the right head (14) of the metallic tank which however is not welded to the cylindrical part. The left head (15) is ready to be placed in its position. With a proper device, the three parts of the metallic tank and the jacket are held together so that circular welding can take place at points (16). There is always the possibility of adding a specific material between the jacket and the walls of the tank, in solid or liquid form for the purpose of improving the mechanical or thermal characteristics of the storage water heaters.

Figure 6 shows the way that the ends of the head (17) and the cylindrical part (13) are shaped at the points of the circular welding (16). This shape provides the capability for a complete fit along the axis of the tank, between the two heads and the jacket, while at the same time the effect of the generated heat, due to circular welding at points (16), on the internal jacket from polymer material, is considerably reduced. Additional thermal protection of the internal jacket, is achieved by the use of thermal shields, made from strips which are either metallic (copper, aluminium, steel, etc) or insulating or other materials, which are inserted between the jacket and the metallic tank at the points of circular welding. Alternatively, it's possible that the ends of the heads (17) and those of the cylindrical part (13) are placed opposite one another at points (16) where the circular welding is conducted. In this case however there is a need for a stronger shield system. The parts (19) of the internal jacket from polymer material which are projected beyond the openings of the metallic tank, are processed in the way that is described next.

Figure 7, shows the metallic tank (20) after the circular weldings have been completed, and with the jacket (12) from polymer material inside it. One end of the jacket (21) has been cut in the necessary length and with proper thermal and mechanical processes this end is bent to a right angle as it is seen on the opposite side of the jacket (22). This bending is conducted in both ends of the jacket.

Figure 8 shows in a schematic way the method used for the bending of the end (25) of the jacket (12) from polymer material. At the left side of the figure are the sources of heat (24) which heat the end of the jacket (25) until its temperature reaches a desirable level (similar heating takes place simultaneously at the other end of the jacket). Next, a special tool, which consists of parts (26) and (27), is moved towards the tank (similar tool exists at the opposite side of the jacket where this tool also moves towards the tank) and as soon as the part (26) is inside the tank through the opening (23), it extends by a special mechanism, it takes the shape (28), which is shown clearly at the right side of this figure, and it supports the jacket on the tank,

at the location of the opening (23). While the part (28) remains in this position, the part (27) starts moving towards the tank (this action takes place simultaneously at both sides of the tank), where initially the end of the jacket (already heated), is bent into a right angle [the jacket is being supported at the same time at the other side of the opening (23) by the extended part (28)] and next, the ends of the jacket and of the tank are compressed between parts (27) and (28) with simultaneous cooling of the end of the jacket through part (27) [the entrance of the cooling water is shown schematically at point (29) and the exit at point (30)] in order that the end of the jacket becomes firm in the new position. In the final step, the part (28) returns to its initial shape and the whole system of the specially designed moving tool [i.e. parts (26) and (27)] retreats from the tank.

Figures 9, 10 and 11, generally explain the basic principle of forming the jacket by blow moulding of a tube from polymer material (4) directly into the tank (20), where the jacket will remain as an internal lining (of the tank).

Specifically, in figure 9, the two halves of the mould which consist of parts (31) and (32) are shown schematically in the open position, and the tank (20) has been placed into the mould.

In figure 10, the parts of the mould (31), have been moved towards the tank (20), are in contact with it and they support it. The same figure shows the tube from polymer material (4), with proper diameter, temperature and thickness, inside the tank (20).

In figure 11, the parts of the mould (32) have also been moved towards the tank and compressed air is fed into the tube through the opening (8). The tube (4) is shown just as it starts to be inflated by the compressed air. Finally the tube is expanded against the internal walls of tank and partially of the mould [part (32)], it takes the corresponding shape and it becomes firm due to the fact that the walls of the tank are cooled at their external side. The cooling water enters the mould from points (7) and comes out from points (6). It is to be noted that the cooling system is shown only in a schematic form. After the jacket is formed, the mould opens, first parts (32) and then parts (31), and the tank with the jacket inside is removed from the mould. The ends of the jacket are formed next by applying the process which is shown in figure 8.

Claims

1. A new kind of product, which is a tank characterized in that it includes a jacket from polymer material, which (jacket) is enclosed and in direct contact with the walls of the tank, wherein the jacket and the various parts of the

tank are assembled in such a way so that liquids of any nature in the tank are in contact only with the jacket and not with the walls of the tank, for the purpose of corrosion, or other protection of the walls of the tank.

2. A production method of tanks with an internal jacket from polymer material, characterized in that the jacket is formed by blowing compressed air inside a tube from polymer material having the appropriate temperature and thickness (blow moulding) either:
 - a. in a cooled mould specifically designed so that the jacket produced has the desirable thickness distribution at its various locations, without mechanical stresses, without bubbles, with the desirable molecular structure, etc., which next is enclosed by the various parts of the tank which are assembled by welding or screws etc., and in this final product the liquids inside the tank are in contact only with the walls of the jacket from polymer material, this way protecting the walls of the tank from corrosive or other action due to the presence of the liquids, or
 - b. directly inside the tank in which it will remain as its inner lining.

3. A production method of tanks with an internal jacket from polymer material, as claimed in Claim 2, characterized in that the tank is metallic and that it consists of a cylindrical part and two heads, where the ends of the heads of the tank are properly shaped so that they have a larger diameter than the one of the cylindrical part, so that the following are achieved :
 - a. complete fit along the axis of the tank between the two heads and the jacket, because there is capability of relative movement between the heads and the cylindrical part, and which is due to the difference of their diameters and
 - b. reduction of the effects on the jacket from polymer material of the heat generated during the circular weldings, due to the presence of the wall of the cylindrical part of the tank between the jacket and the points of weldings.

4. A production method of tanks with an internal jacket from polymer material as claimed in Claim 2, characterized in that thermal shields made from strips either of metallic or insulating or other material, are inserted between the metallic tank and the jacket, at the points of circular weldings with the purpose of protecting the jacket from the heat generated during the

circular weldings.

5. A production method of tanks with an internal jacket from polymer material, as claimed in Claim 2, characterized in that the ends of the jacket from polymer material are bent to a right angle to fit the ends (openings) of the tank, with the purpose of achieving proper sealing at the opening of the tank when used, where in the bending is made, by initially heating the ends of the jacket and next by applying mechanical pressure between the ends of the jacket and the tank, with the use of a special tool, part of which is inserted into the end of the jacket (which is enclosed by the head), where it is expanded, while the ends of the jacket become firm after the heating and bending by proper cooling.

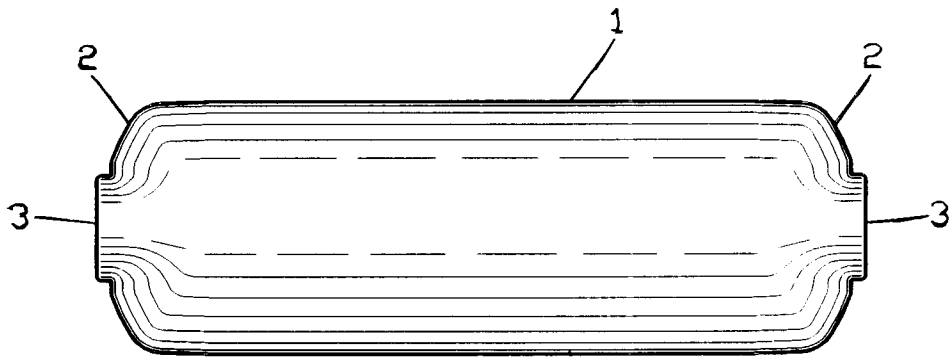


FIGURE 1

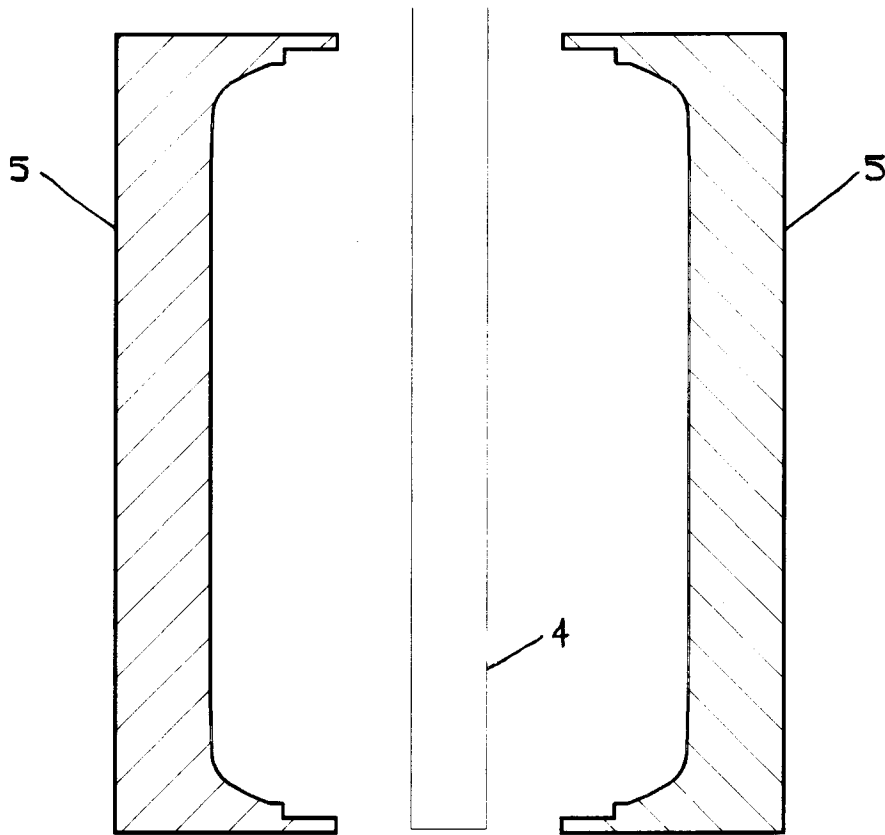


FIGURE 2

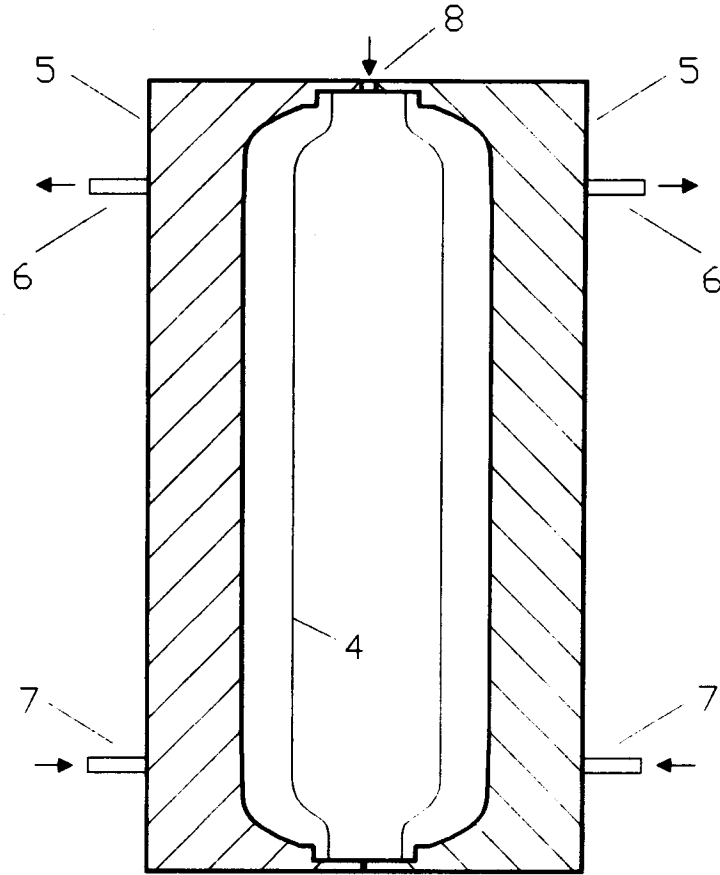


FIGURE 3

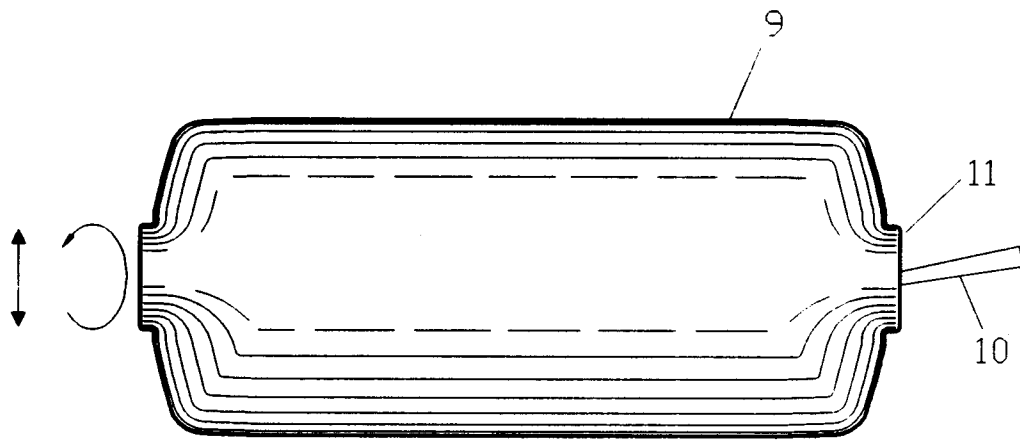


FIGURE 4

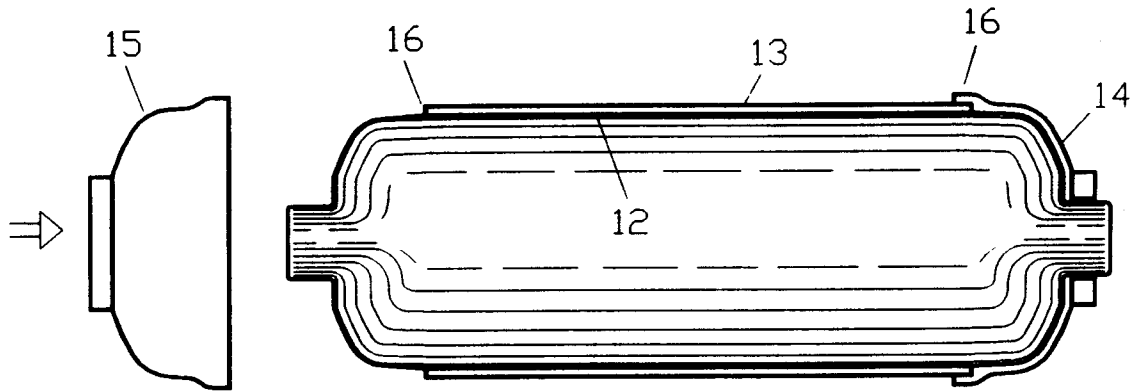


FIGURE 5

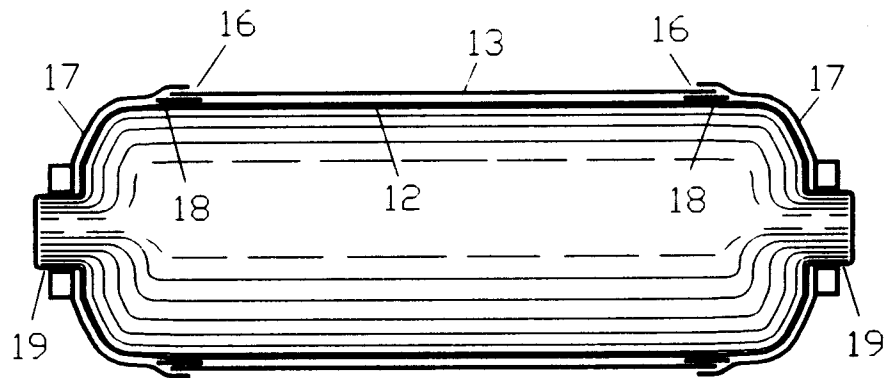


FIGURE 6

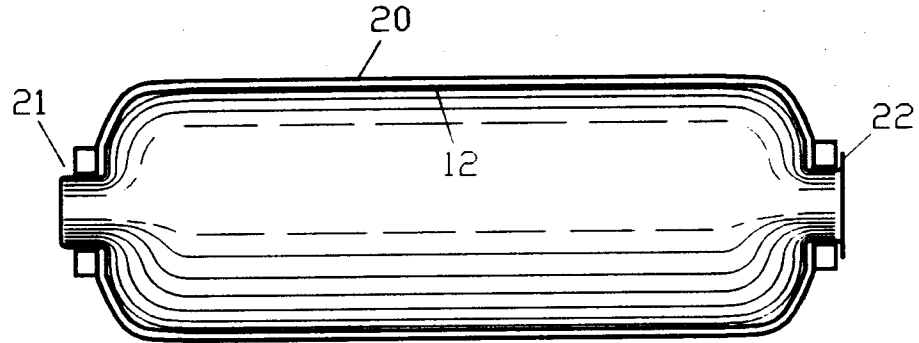


FIGURE 7

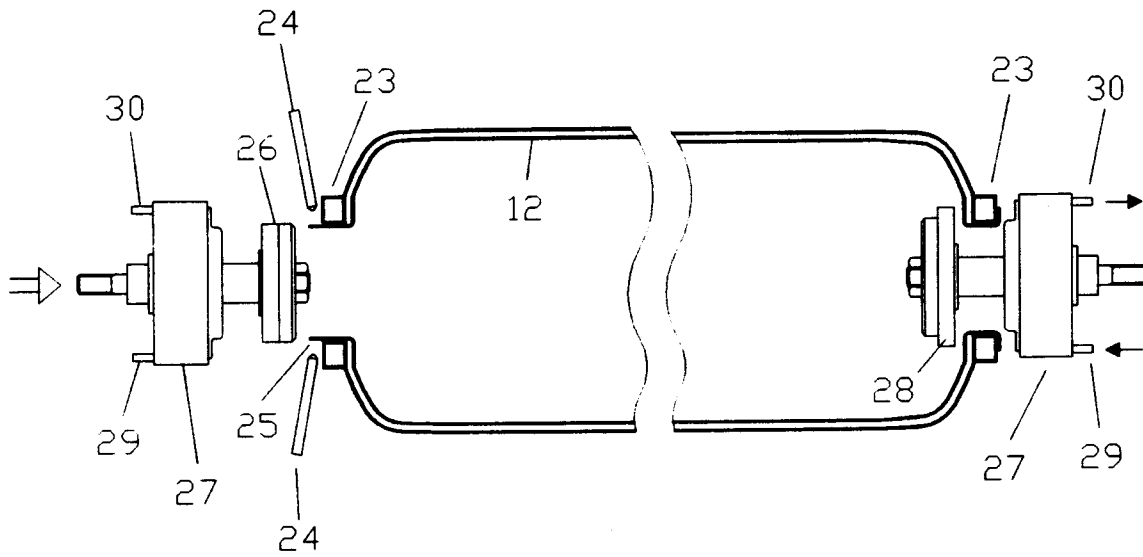


FIGURE 8

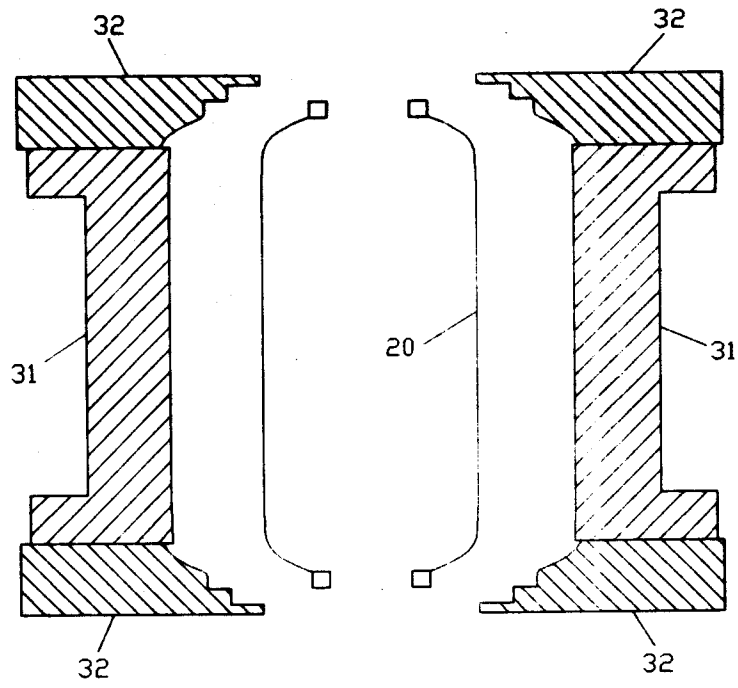


FIGURE 9

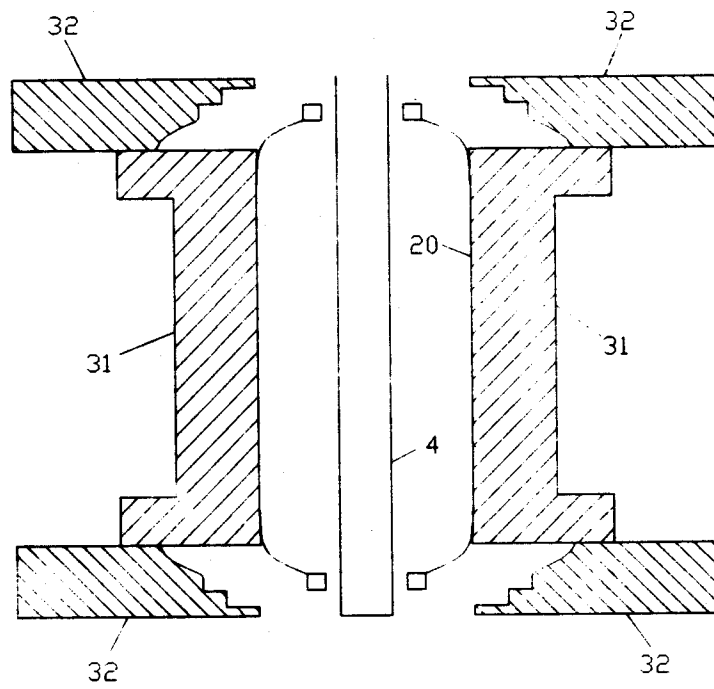


FIGURE 10

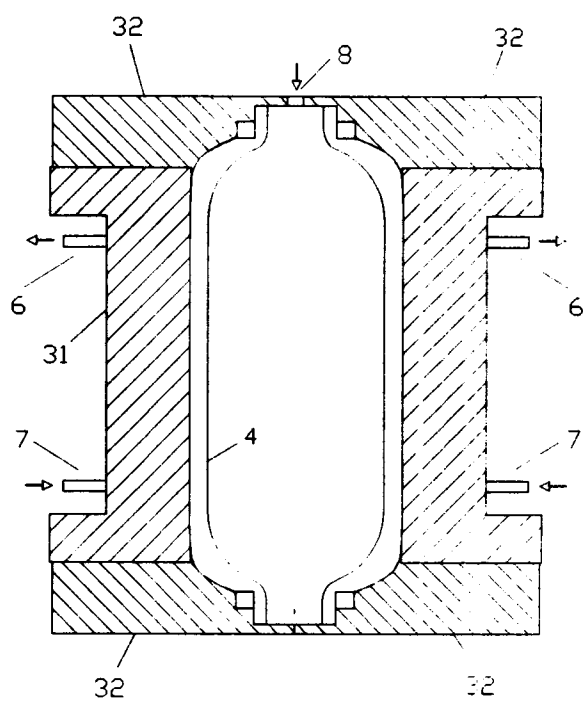


FIGURE 11