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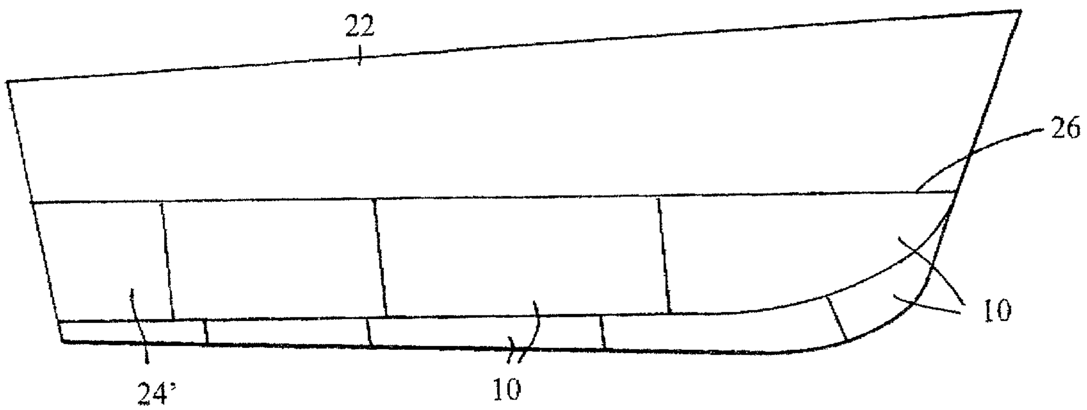
(54) Title: ANTIFOULING SYSTEM FOR THERMOPLASTIC BOATS AND OTHER FLOATING VESSELS AND STRUCTURES



(57) Abstract: A method of antifouling the underwater surface of a boat hull [22] or other vessel composed of polyethylene or other thermoplastic material is disclosed. Expanded metal sheets [10, 12, 14] of copper/nickel or other metallic material having antifouling properties, and comprising a multiplicity of perforations [16, 18, 20], are laid against the underwater surface [24'] of the vessel. The sheets and the underlying surface of the vessel are heated until the thermoplastic material of the surface becomes soft and fluent, allowing the thermoplastic material to penetrate the perforations when the sheets are pressed against to the surface material. The material is allowed to cool and the sheets are mechanically bonded to the surface, principally by the resolidified thermoplastic material in the perforations. The perforations can be formed as slits, diamond-shaped apertures or round holes.

WO 2007/086758 A1

TITLE: ANTIFOULING SYSTEM FOR THERMOPLASTIC BOATS AND OTHER FLOATING VESSELS AND STRUCTURES

FIELD OF INVENTION

This invention relates to an antifouling system for vessels such as boats and other floating structures, whether for use in salt or fresh water.

The invention has application to boat hulls, floating platforms, storage vessels and the like constructed of thermoplastic materials such as polyethylene.

BACKGROUND OF THE INVENTION AND PRIOR ART

Various forms of antifouling have been used over the years. Most are comprised of paint-like preparations. These preparations contain a variety of chemical constituents that very often include toxic ingredients that are not environmentally friendly. Most antifouling materials do not have a long life, typically one or two years with various levels of effectiveness.

Ther antifouling properties of copper are well known. Copper sheet has been applied to wooden boats for many years. This is an effective and longer-term solution. The sheeting is generally applied with nails or screws. Copper sheet is also now available in small panels to one face of which an adhesive is applied. This is being used with some success on surfaces to which the adhesive will adhere. Polyethylene is not one of them.

This invention has been conceived because none of these previous applications for applying antifouling to floating objects are appropriate for polyethylene. The waxy surface on the polyethylene does not readily accept conventional adhesives or paints. Copper sheet could be applied with nails, screws or other fasteners but it would be difficult to shape the sheets when being applied to the multi-curved surfaces of some boat hulls. Further, the action of water that is forced into any space between the interfacing surfaces of a copper sheet and the hull of a high-speed boat might tend to tear the sheet off.

What is commonly called 'expanded metal' is well known. Expanded metal is produced by forming slits in a sheet of metal and stretching the sheet so that the slits are expanded in size.

STATEMENTS OF INVENTION

According to the invention, there is provided a method of antifouling a surface of a vessel that is immersed in water in use and is composed of thermoplastic material, the method comprising the steps of providing a sheet comprised of at least one metallic material having antifouling properties and being formed with a multiplicity of perforations, heating the surface to a temperature at which the thermoplastic material of which the surface is composed becomes fluent, applying the sheet to the surface so that the thermoplastic material flows into the perforations, and allowing the thermoplastic material to cool so that the material in the perforations resolidifies.

In one aspect of the invention the metallic material comprises copper or, perhaps in some cases more advantageously, a material comprising copper and nickel. Any other suitable metallic materials, including pure copper and other copper-based materials, could be used to produce the sheet.

In one aspect of the invention, the method includes the steps of heating the sheet and the surface of the vessel, and applying the sheet to the surface to cause the thermoplastic material to flow into the perforations.

The sheet is advantageously laid against the thermoplastic surface of the vessel, and heat is applied to the sheet and the thermoplastic surface at the same time. The thermoplastic material at the surface becomes soft and fluent and the sheet becomes hot. At this point the sheet is pressed or rolled into the softened material at the surface with an application tool such as a roller or trowel. The heating is advantageously carried out with a blow torch or hot air gun.

The softened fluent material fills perforations in the sheet with the result that the sheet is anchored in place by the material when it resolidifies. After resolidifying, the thermoplastic material that has entered the perforations should advantageously be substantially flush with the outer face of the sheet.

In one aspect of the invention, the method includes the step of cutting slits in the sheet to form the perforations.

In one aspect of the invention, the method includes the step of cutting slits in the sheet and working the sheet so that the slits are expanded to form the perforations.

The sheet may be formed by the same techniques that are used to form expanded metal. The pliant nature of expanded metal allows it to readily take up the shape of a compound-curved surface such as a boat hull.

As there is no reaction between copper/nickel and polyethylene or other inert thermoplastics, the bonded relationship should have a long life. The bond is very strong and the sheets cannot be knocked off easily. Although the finished surface does not totally comprise the copper/nickel material, if the mesh is relatively fine with small perforations, there should be enough copper/ nickel exposed to prevent or at least substantially slow marine growth.

The life expectancy of this antifouling should be similar to that of known copper sheeting provided that the sheeting remains fixed to the surface of the vessel. Furthermore, the applicant believes that copper/nickel in this application releases no toxins and is environmentally friendly.

The applicant is unaware of any antifouling systems that are suitable for polyethylene vessels. This is a significant problem in the aquaculture industry.

It is intended that the invention extends to a vessel having an underwater surface that is antifouled by the methods descrined and claimed herein.

SCHEDULE OF DRAWINGS

Figures 1A – 1C show examples of perforated copper/nickel sheets;
Figure 2 shows a schematic cross section of a hull with antifouling sheets being applied thereto;
Figure 3 is a cross sectional view of an antifouling sheet about to be fixed in place after heat has been applied;
Figure 4 is a similar cross sectional view of the antifouling sheet after it has fixed in place;
Figure 5 is a schematic side view of a boat showing possible positioning of several antifouling sheets on the hull of a boat; and
Figure 6 is a large scale cross sectional schematic view of a detail of a perforation into which thermoplastic material from the surface of the hull has penetrated.

DETAILED DESCRIPTION OF EMBODIMENTS OF INVENTION

Figures 1A – 1C show examples of small areas of three antifouling sheets 10, 12, 14. For ease of illustration Figure 1A is drawn approximately twice full size. Each of the respective sheets is formed with a multiplicity of perforations 16, 18, 20 that are uniformly spaced over substantially the entire surface area of the sheet. The perforations 16 are essentially slits and the perforations 18 are diamond shaped. In both cases the perforations are produced by forming slits in a raw sheet of suitable metallic material. In the case of the sheet 18, the perforations 18 are formed by the further step of stretching or otherwise working the sheet after the slits are formed so that the slits are expanded in size and take up the diamond shape The sheets are produced by the same techniques that are used in the production of expanded metal and need thus not be further described.

The perforations 20 in the sheet 14 are round and could be formed by punching or drilling holes in a sheet of suitable metallic material. It is thought that sheets with perforations so produced would be more expensive than sheets produced as described with reference to Figures 1A and 1B. Owing to the nature and shape of the metal between the perforations, it is also thought that, compared to a sheet such as that shown in Figure 1C, sheets such as those shown in Figures 1A and 1B would more readily take up the shape of a vessel with compound curves. However, the use of sheets such as shown in Figure 1C is not excluded from the scope of the invention.

The sheets are advantageously composed of an alloy, or other known combination, of copper and nickel. The applicant is informed that such materials are known to have superior antifouling properties and are commercially available though not, as far as the applicant is aware, in expanded metal form. A suitable alloy comprises about 90% copper and 10% nickel. Any other suitable metallic materials, including commercially pure copper and other copper based materials, could be used.

In the following description, unless otherwise stated, it is assumed that the sheets 10 with perforations in the form of slits 16 are to be used. This is for convenience of description. Other perforated sheets, including the sheets 12 or 14 could be used. It is also assumed that the boat hull 22 referred to, or at least that part of its surface 24 that is exposed to the water below the waterline 26, is composed of polyethylene or other suitable thermoplastic material.

After the perforations 16 are formed, the sheets 10 are cut to size and fitted to the underwater surface 24' of the hull 22 as shown in Figures 2 and 4. As shown schematically in Figure 3, each sheet 10 is best held loosely against the hull 22 by means of temporary locating screws 28 leaving a small space 30 to allow the heat from a blow torch 32 not only to heat the sheet 10 but also to heat the hull surface 24 until the hull material at the surface 24 softens and becomes plasticised and fluent. For this purpose, the temperature of the sheet and the fluent material would be about 250-300°C.

When the sheet 10 and the hull material are hot enough, the sheet 10 is pressed into the surface of the hull 22. The plasticised material at the hull surface 24' will flow into and through the perforations 16 in the sheet 10 as shown at 34 in Figure 4. The plasticised material is allowed to cool and resolidify. The sheet 10 is mechanically bonded to the hull surface by the now-solid material 34 in the perforations 16.

The perforations 16 also allow any air trapped between the hull surface 24 and the sheet 10 to escape. This improves the contact area between the hull surface and the sheet, thus improving the bond therebetween.

Any excess material 36 that has flowed through the perforations can be cleaned off as shown at 36a to leave a smooth finish on the outer face of the sheet 10.

For the best results the perforations 16 in the sheets should be small to maximise the copper/nickel surface exposed to the water and minimise the ability for weed to attach to exposed material that has flowed through the perforations. The most suitable perforation size can be established by experiment but, in the present example, the slits are 20 mm long and 0.5 mm wide and are spaced about 3 mm apart. The slits are arranged in rows that are about 5 mm apart.

Some vessels on which the sheets can be used may have an underwater profile that is composed of one or more flat surfaces However, many boats have an underwater surface that is compoundly curved. For vessels having such surfaces, including the boat shown by way of example in Figure 5, it is necessary for some of the sheets to be pliant so that they can take up the profile of the surface to which they are applied. Perforated sheets of copper/nickel material such as those described herein with reference to the drawings and that are between 1 mm and 2 mm thick are sufficiently pliant for this purpose.

Round perforations 20 of 4 mm diameter would be suitable and diamond shaped perforations 18 of 6 x 3 mm size would be adequate for most boat hulls.

Expanded metal is often supplied in a condition with the metal ligaments 38 surrounding the perforations raised up from the general plane of the sheet. However, the expanded metal can be supplied with these ligaments flattened and this is the condition in which such sheets should be applied to the vessels in the present application.

A portion of a periphery of at least some of the perforations may advantageously be undercut or sloped as shown at 40 in Figure 6. This is easy to achieve using the techniques for producing expanded metal and has the result that the width of a perforation adjacent the inner face 42 of the sheet is less than the width adjacent the outer face 44. This will tend to lock the thermoplastic material that has penetrated the perforation in place, helping to prevent the material from being pulled out of the perforation.

The perforations 16, 18, 20 illustrated have been used as examples primarily because they are likely to be the most readily available. It is not at present thought that the shape of the perforations is critical to the functionality of the invention and other shapes could be used. For example, perforations of star shape would possibly be advantageous. Such perforations would minimise exposure of plastic surface to the water but could increase the bonded area between the sheets and the hull surface. However, special equipment would be needed to manufacture such sheets.

Copper/nickel sheets of 1- 2 mm thickness would be suitable for most purposes. They can be heated without excessive distortion. Greater thickness is an advantage as the thermoplastic material in the perforations will have more surface area to grip the sheets and hold them in place. Thicker metallic material will also increase the service life of the sheets having regard to wear and tear and corrosion. However, the increased cost of greater thickness would have to be balanced against the other advantages.

The invention can in principle be used for vessels constructed of any type of thermoplastic material suitable for the purpose, including polypropylene and PVC.

It is not intended that recognised mechanical equivalents of and/or modifications of and/or improvements to any matter described and/or illustrated herein should be excluded from the scope of a patent granted in pursuance of any application of which this specification forms a part or which claims the priority thereof or that the scope of any such patent should be limited by such matter further than is necessary to distinguish the invention claimed in such patent from the prior art.

CLAIMS

1.

A method of antifouling a surface of a vessel that is immersed in water in use and is composed of thermoplastic material, the method comprising the steps of providing a sheet comprised of at least one metallic material having antifouling properties and being formed with a multiplicity of perforations, heating the surface to a temperature at which the thermoplastic material of which the surface is composed becomes plastic, applying the sheet to the surface so that the thermoplastic material flows into the perforations, and allowing the thermoplastic material to cool so that the material in the perforations resolidifies.

2.

A method according to claim 1, in which the metallic material comprises copper.

3.

A method according to claim 2, in which the metallic material comprises nickel.

4.

A method according to any one of claims 1 to 3, including the steps of heating the sheet and the surface of the vessel, and applying the sheet to the surface to cause the thermoplastic material to flow into the perforations.

5.

A method according to any one of claims 1 to 4, including the step of cutting slits in the sheet to form the perforations.

6.

A method according to any one of claims 1 to 4, including the step of cutting slits in the sheet and working the sheet so that the slits are expanded to form the perforations.

7.

A vessel having an underwater surface that is antifouled by a method as claimed in any one of claims 1 to 6.

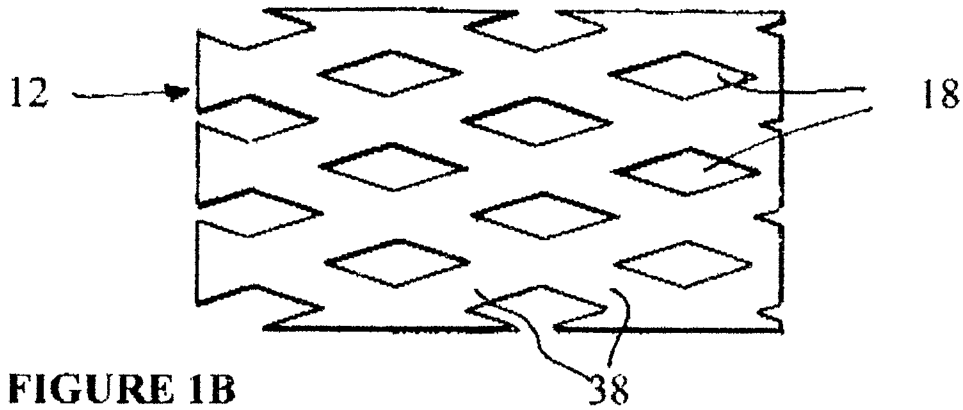


FIGURE 1B

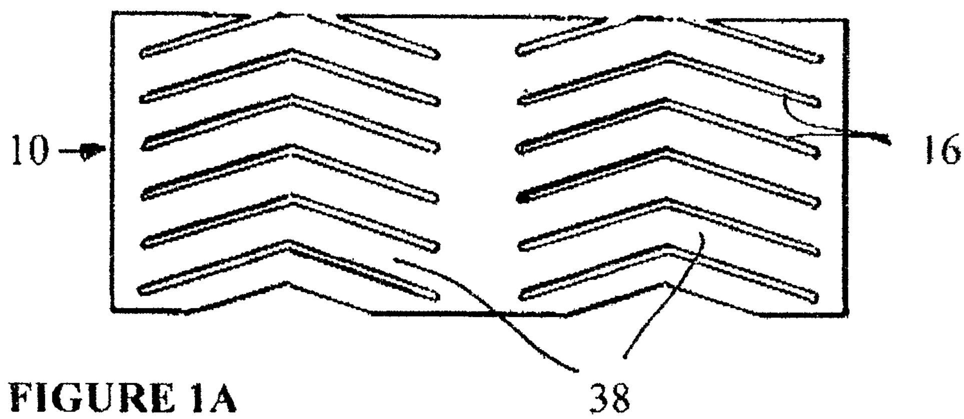


FIGURE 1A

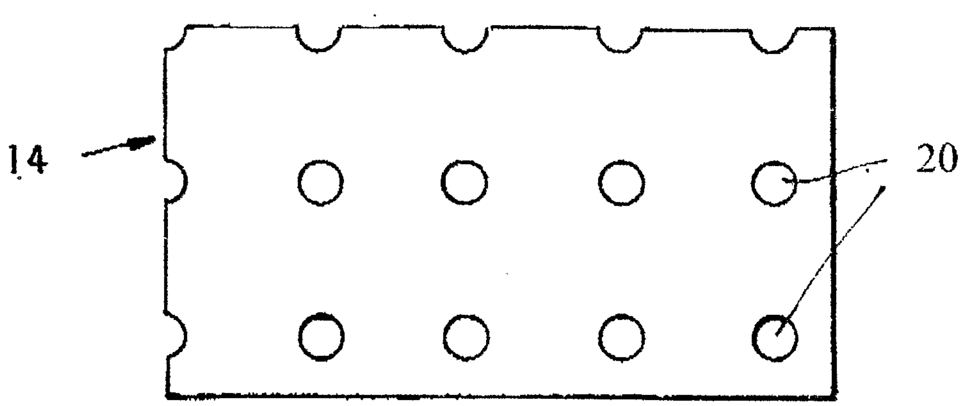


FIGURE 1C

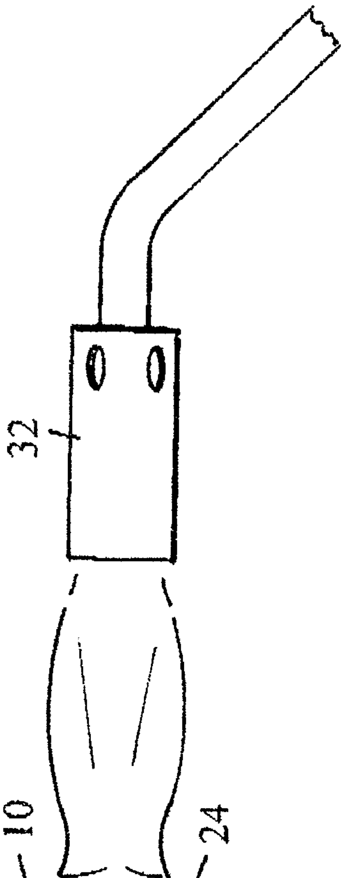
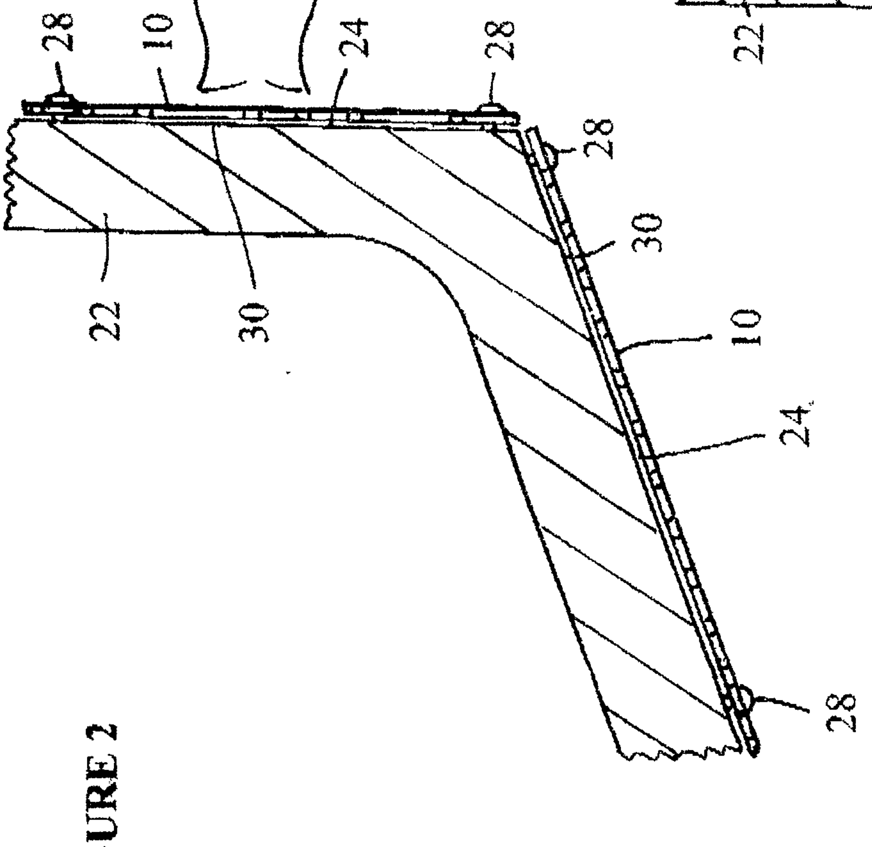



FIGURE 2

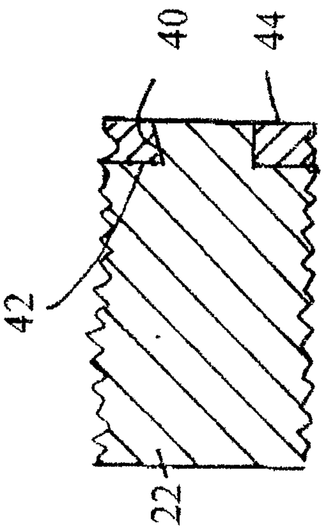


FIGURE 6

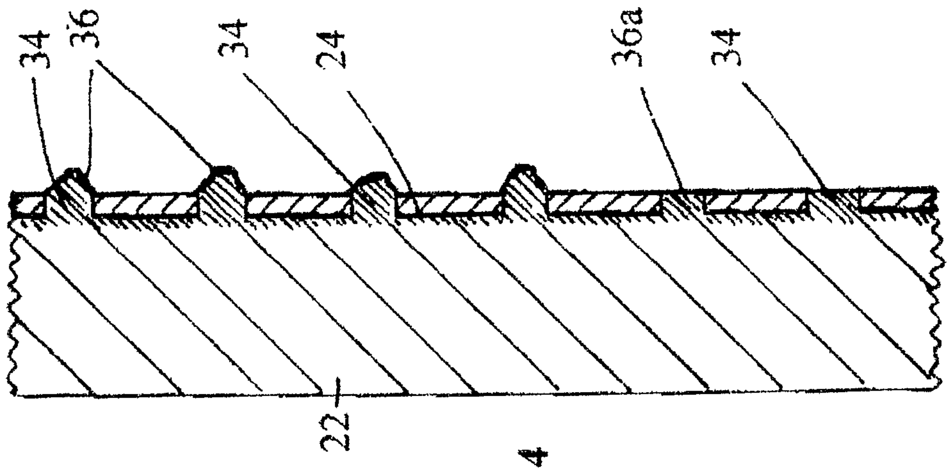


FIGURE 4

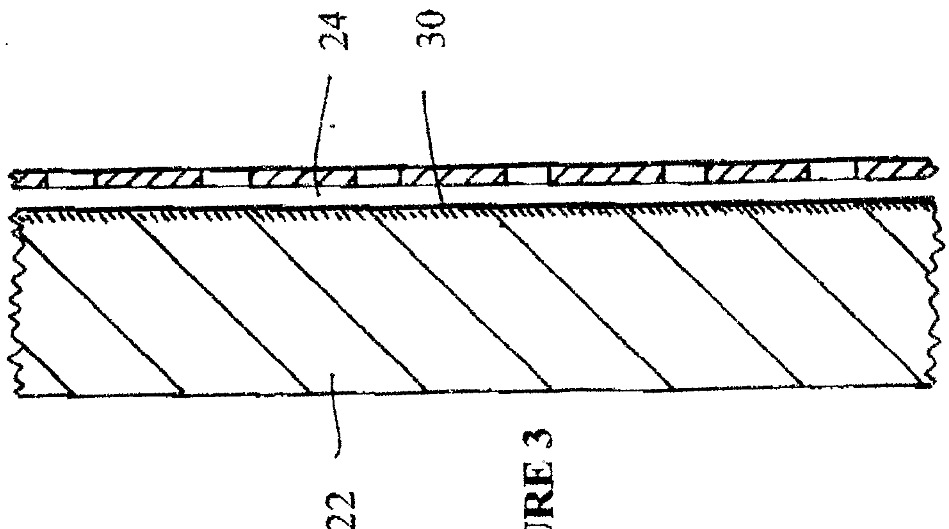


FIGURE 3

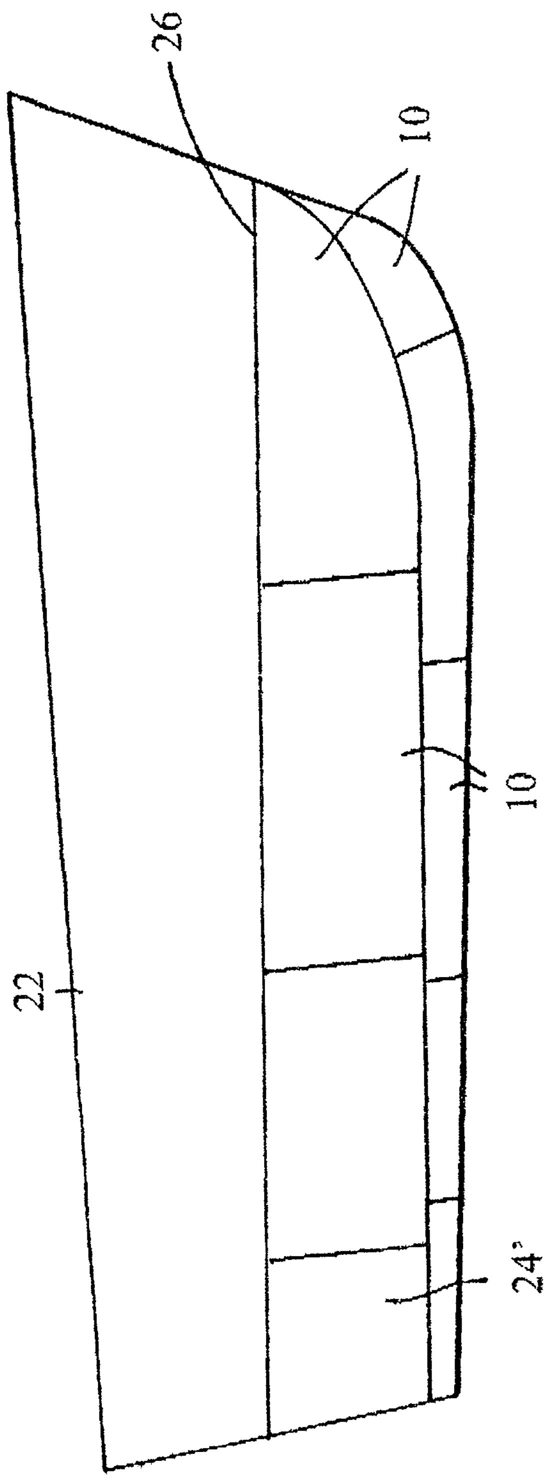


FIGURE 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2007/000009

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl ***B63B 59/04*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI: IPC B63B-059, E02B-017, B32B-015 and keywords FIBRO, PLASTIC, METAL, COPPER, ORIFICE, PERFORATION and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3971084 A (SPIER) 27 July 1976 Whole document	1-7
X	US 4375199 A (GRAEME-BARBER et al.) 1 March 1983 Whole document	1-7
X	GB 2245922 A (COLEBRAND LIMITED) 15 January 1992 Whole document	1-6
A	US 2004/0240944 A1 (KELLY) 2 December 2004 Whole document	1

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 April 2007	20 APR 2007

Name and mailing address of the ISA/AU	Authorized officer
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4987036 A (MILLER) 22 January 1991 Whole document	1
A	US 5044293 A (ANDOE) 3 September 1991 Whole document	1
A	US 4603653 A (BEWS) 5 August 1986 Whole document	1

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4375199	AU	43239/79	BR	7900118	CA	1126095
		DE	2900505	DK	10279	FR	2414404
		GB	1604062	HK	93484	JP	54136094
		MT	840	NL	7900159	NO	790032
		PT	69054	SE	7900231	ZA	7807393
GB	2245922						
US	2004240944	CA	2457031	CN	1571725	EP	1420948
		NZ	531013	WO	03016046	ZA	200401511
US	4603653	CA	1208864	GB	2126959	NO	833290
US	5044293						
US	4987036	AU	36926/89	EP	0371115	NO	900481
		WO	8912144				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX