592154

COMMONWEALTH of AUSTRALIA

PATENTS ACT 1952

APPLICATION FOR A STANDARD PATENT

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 24-10-89

I/We THE BUDD COMPANY
of 3155 West Big Beaver Road,
Troy, Michigan 48084,
UNITED STATES OF AMERICA.

hereby apply for the grant of a Standard Patent for an invention entitled:

"PERIMETER RESIN FEEDING OF COMPOSITE STRUCTURES"

which is described in the accompanying ~~provisional~~ complete specification.

Details of basic application(s):—

Number	Convention Country	Date
833,304	UNITED STATES OF AMERICA	26th February 1986

The address for service is care of DAVIES & COLLISON, Patent Attorneys, of 1 Little Collins Street, Melbourne, in the State of Victoria, Commonwealth of Australia.

Dated this 19th day of February 1987

To: THE COMMISSIONER OF PATENTS

H. M. Rimington
.....
(a member of the firm of DAVIES & COLLISON for and on behalf of the Applicant).

Davies & Collison, Melbourne and Canberra.

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952–1973

DECLARATION IN SUPPORT OF CONVENTION OR NON-CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

Insert title of invention.

In support of the Application made for a ~~patent~~ patent of addition for an invention entitled: "PERIMETER RESIN FEEDING OF COMPOSITE STRUCTURES"

Insert full name(s) and address(es) of declarant(s) being the applicant(s) or person(s) authorized to sign on behalf of an applicant company.

I / ~~We~~ Thomas I. Davenport
The Budd Company
3155 West Big Beaver
Troy, Michigan 48084 United States of America

Cross out whichever of paragraphs 1(a) or 1(b) does not apply

1(a) relates to application made by individual(s)

1(b) relates to application made by company; insert name of applicant company.

do solemnly and sincerely declare as follows :–

1. (a) ~~I am / We are the applicant..... for the patent / patent of addition~~

or (b) I am authorized by

THE BUDD COMPANY

the applicant..... for the ~~patent / patent of addition~~ to make this declaration on ~~its~~ / their behalf.

Cross out whichever of paragraphs 2(a) or 2(b) does not apply

2(a) relates to application made by inventor(s)

2(b) relates to application made by company(s) or person(s) who are not inventor(s); insert full name(s) and address(es) of inventors.

2. (a) ~~I am / We are the actual inventor..... of the invention~~

, or (b) Richard Benjamin Freeman
405 Riblett Lane
Wilmington, Delaware 19809
United States of America

~~is~~ / ~~are~~ the actual inventor..... of the invention and the facts upon which the applicant..... ~~is~~ / ~~are~~ entitled to make the application are as follows :–

State manner in which applicant(s) derive title from inventor(s)

The Applicant is the Assignee of the Actual Inventor in respect of the Invention

Cross out paragraphs 3 and 4 for non-convention applications. For convention applications, insert basic country(s) followed by date(s) and basic applicant(s).

3. The basic application..... as defined by Section 141 of the Act ~~was~~ / ~~were~~ made

in United States of America on the 26 February 1986
by Richard Benjamin Freeman

in ..... on the .....
by.....

in ..... on the .....
by.....

4. The basic application..... referred to in paragraph 3 of this Declaration ~~was~~ / ~~were~~ the first application..... made in a Convention country in respect of the invention the subject of the application.

Insert place and date of signature.

Declared at Troy, Michigan this 11th day of March, 1987

Signature of declarant(s) (no attestation required)

THE BUDD COMPANY

.....

Thomas I. Davenport

Note: Initial all alterations.

DAVIES & COLLISON, MELBOURNE and CANBERRA.

(12) PATENT ABRIDGMENT (11) Document No. AU-B-69060/87
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 592154

(54) Title
PERIMETER RESIN FEEDING OF COMPOSITE STRUCTURES

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DAVIES & COLLISON, MELBOURNE

(56) Prior Art Documents
AU 579020 60273/86 B29C
US 4570523
US 4521354

(57) Claim

1. A method of forming a fiber reinforced hollow structure comprising the steps of:

providing a mold having upper and lower pieces, with at least one of said pieces including a plurality of resin channels for receiving resin, the mold further having a plurality of input ports connected to the channels;

placing fibrous material along the inner walls of said upper and lower pieces adjacent the resin channels;

inserting an inflatable member into the mold;

introducing compressed air into said inflatable member;

injecting resin through said channels into said fibrous material;

venting air from the mold through at least one air vent; and

curing said fibrous material to form said solid fiber reinforced hollow structure.

COMMONWEALTH OF AUSTRALIA

PATENT ACT 1952

COMPLETE SPECIFICATION

592154

(Original)

FOR OFFICE USE

Class Int. Class

Application Number: 69060/87
Lodged:

Complete Specification Lodged:
Accepted:
Published:

Priority:

Related Art:

Name of Applicant: THE BUDD COMPANY

Address of Applicant: 3155 West Big Beaver Road,
Troy, Michigan 48084,
UNITED STATES OF AMERICA.

Actual Inventor(s): Richard Benjamin FREEMAN

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1 Little Collins Street, Melbourne, 3000.

Complete Specification for the invention entitled:

"PERIMETER RESIN FEEDING OF COMPOSITE STRUCTURES"

The following statement is a full description of this invention, including the best method of performing it known to us :-

PERIMETER RESIN FEEDING OF COMPOSITE STRUCTURES

In a copending patent application, Serial No. 768,259 filed August 22, 1985, assigned to the same assignee as the present application, there is described a method of forming a hollow fiber reinforced structure of varying cross sections. The method includes impregnating fiber material while utilizing an inflatible bladder. This present application utilizes some of the steps described in the copending application.

The aforementioned application involves resin transfer molding (RTM). In this copending application resin is applied to fiber material disposed between an upper and lower mold piece, with an inflatible bladder occupying the hollow area of the structure being formed.

Many composite structures formed by resin transfer molding (RTM), as illustrated in the copending application, utilizing an injection port for injecting the resin and a vent port for venting air during the resin injection. While the system described in the copending application is generally satisfactory, it provides some inconvenience when large structures are to be formed.

For large structures, such as sandwich panels, automotive floor pans or hoods, decks, fenders as well as other parts, the feeding of the part from a single central port results in some disadvantages. For example, the further the resin flows from a single central fill port, the greater area of reinforcement which must be impregnated. This requires higher inlet resin pressures and results in slower port fillout.

In accordance with the present invention there is provided a method of forming a fiber reinforced hollow structure comprising the steps of:

providing a mold having upper and lower pieces, with at least one of said pieces including a plurality of resin channels for receiving resin, the mold further having a plurality of input ports connected to the channels;

placing fibrous material along the inner walls of said upper and lower pieces adjacent the resin channels;

inserting an inflatable member into the mold;

introducing compressed air into said inflatable member;

injecting resin through said channels into said fibrous material;

venting air from the mold through at least one air vent; and

curing said fibrous material to form said solid fiber reinforced hollow structure.

The invention further provides a solid fiber reinforced structure produced by the method in the immediately preceding paragraph.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view, partly broken away, of an automotive side frame structure, of the type which may be formed using the present invention;

Fig. 2 is a cross sectional view, taken along lines 2-2 of Fig. 1, including upper and lower molds not illustrated in Fig. 1;

Fig. 3 is a cross sectional view of the part formed, as illustrated in Fig. 2;

Fig. 4 is a front view of a panel structure which may be formed utilizing the present invention;

Fig. 5 is a cross sectional view taken along lines 5-5 of Fig. 4, and

Fig. 6 is a cross sectional view illustrating the formation of another irregular shaped member, in accordance with the present invention.

DESCRIPTION OF THE INVENTION

The present invention will be described by way of example only in connection with the embodiments illustrated in Figs. 1, 4 and 6. The invention is directed toward increasing the speed at which the structures may be impregnated with resin. Also, the amount of pressure required to inject the resin may be minimized when the present invention is employed, thereby reducing the possibility of high pressures "washing" or displacing the reinforcement material.

Referring to Fig. 1, an automotive frame 10 is illustrated. The frame may include front post 12, center post 14 and rear post 16.

The frame is designed to provide door openings 18 and 20 and a window opening 22.

Reference is made to the previously mentioned copending application, Serial No. 768,259, filed August 22, 1985. In this application a portion of an automobile structure is illustrated which forms part of a door frame for an automobile. The frame may include various joints, curved surfaces and areas of irregular cross sections. A singular integral cured structure was formed from several prelocated, but unimpregnated, fiber pieces which were subsequently injected with resin and suitably molded and cured. The structure included a hollow area extending thereto. The present invention includes many of the steps illustrated in the copending patent. In the present invention, however, the structure 10 is much larger than the structure illustrated in the copending application.

Because of the relatively large structure involved in the present application, if a single source of resin was used to impregnate the structure 10, a relatively long time would be involved to complete the impregnation of a single structure. Also, a relatively high amount of pressure would be required to inject the resin. High input pressures may collapse the inflatible bag used or may displace the fabric material.

Referring again to Fig. 1, along with Figs. 2 and 3, a source of resin is connected to a plurality of inlet ports 24 to impregnate the fiber material 26 which ultimately forms the solid structures. Between the resin inlet ports 24 and the fibrous

material 26, there are provided a plurality of channels or reservoirs 28, 30, 32, 34 and 36. The grooves or reservoirs are disposed adjacent the fibrous material 26. Channels or reservoirs receive the resin from the ports 24. When the resin is applied under pressure, the fibrous material 26 is impregnated with the resin. A plurality of air vents 38 is provided to vent the air as the resin is injected into the fibrous material. Vent groove 48 is disposed about ther periphery of the frame, vent groove 50 is dispcsed at the center post 14, and vent groove 54 is disposed at the end post 16 to facilitate the venting of the air to the vent ports 38.

In Fig. 1, for purposes of explanation, the pieces are not illustrated. However, the various channels for reservoirs for receiving the resin are actually part of the mold involved, and may be in the upper or lower mold piece. Likewise, the air vent grooves also form part of the mold involved.

Referring to Figs. 2 and 3, a single integrally cured structure then is developed from several prelocated fibrous pieces, such as pieces 54 and 56. The piece 54 is placed within the inner wall of the piece 58 of a mold 60 and is lapped over the piece 56. The piece 56 is disposed on the inner wall of the lower piece 62 of the mold 60. A hollow area 64 extends through the structure, as in the aforementioned copending patent application.

Prior to closing the mold 60, an inflatible bladder 66, is inserted between pieces 54 and 56. The bladder may comprise a

plurality of pieces cut to suitable shapes and sizes, corresponding to the shape and size of the structure to be formed.

Air, or other suitable gas from a pressurized source, is applied through a conduit 68 into the inflatible bladder 66 causing it to inflate to force it against the fibrous pieces 54 and 56.

With the mold 60 closed, resin under pressure is forced through the inlet ports 24 into the various reservoirs or channels into the fibrous material. Air is vented from the fibrous material from ports 38 as the resin is being injected to insure that there are no voids in the fibrous material.

Following are steps for impregnating the fibrous material with resin, a curing operation is performed. Depending upon the chosen resin, the curing could be done either at room temperature or an elevated temperature, which involves heating the fibrous material with the resin while under pressure. The curing completes the formation of the structure 10, which is the side frame illustrated in Fig. 1.

Referring to Figs. 4 and 5, a sandwich panel structure 70 is formed between a mold 72, which includes upper and lower pieces 74 and 76. The sandwich panel structure 70 includes a foam such as urethane material 48 at a core surrounded by fiberglass or other fibrous material skins 80. A channel or reservoir 82 is disposed about the periphery of the main panel structure 70. Resin is injected to the skin 80 from resin inlet ports 83 to the reservoir 82 to the skin 80.

It is noted that resin is injected completely around the panel or structure edge to allow molding of the complete structural edging as well as the sandwich skin. In one embodiment of the invention, the skins were .035 inches thick fiberglass, which is relatively thin with respect to RTM. The perimeter resin feeding permitted such a thin skin to be completely impregnated.

An air vent 84 disposed toward the center of the panel is centrally disposed. The single air vent 84 is relatively close to all the inlet resin ports 83. This permits relatively fast injection of the resin under relatively low pressure. The vent port 84 extends completely through the foam core as illustrated by the dotted lines.

Referring to Fig. 6, a fiber structure 86 is formed between a mold 88 which includes upper and lower pieces 90 and 92. Resin is injected through a conduit 94 into a channel or groove 96, which is disposed about the periphery of the fibrous piece 86. An air vent 96 is centrally disposed to vent the air as the resin is injected into the piece 86. As in previous embodiment, a plurality of conduit 94 may be provided to assure fast resin injection at relatively low pressure.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A method of forming a fiber reinforced hollow structure comprising the steps of:

providing a mold having upper and lower pieces, with at least one of said pieces including a plurality of resin channels for receiving resin, the mold further having a plurality of input ports connected to the channels;

placing fibrous material along the inner walls of said upper and lower pieces adjacent the resin channels;

inserting an inflatable member into the mold;

introducing compressed air into said inflatable member;

injecting resin through said channels into said fibrous material;

venting air from the mold through at least one air vent; and

curing said fibrous material to form said solid fiber reinforced hollow structure.

2. A method as set forth in claim 1 wherein the hollow structure formed is asymmetrical.

3. The method of claim 1 or claim 2 wherein at least one air vent is centrally disposed between said inlet ports.

4. The method of claim 1 or claim 2 wherein a plurality of air vents are provided, at least one air vent being associated with each of the inlet ports.

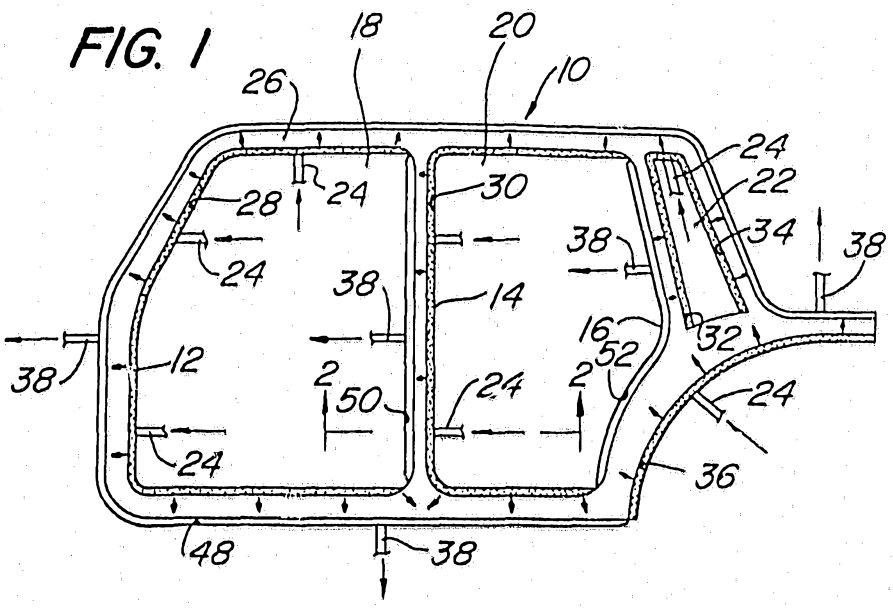
5. A method of forming a fiber reinforced asymmetrical hollow structure substantially as hereinbefore described with reference to the drawings.

6. A fiber reinforced structure produced by the method of any preceding claim.

DATED this 17th day of October 1989.

THE BUDD COMPANY
By Its Patent Attorneys
DAVIES & COLLISON

FIG. 1



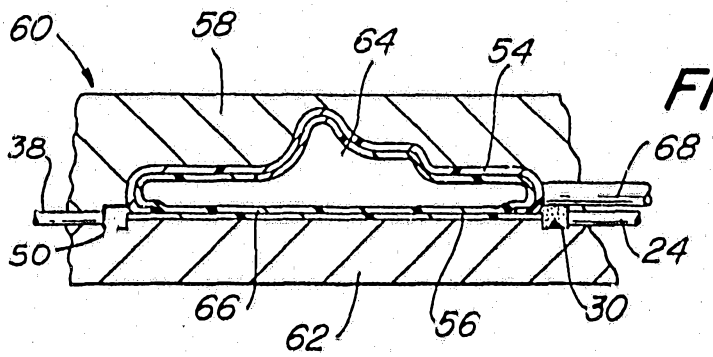


FIG. 2

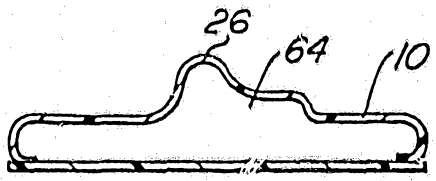


FIG. 3

69060/87

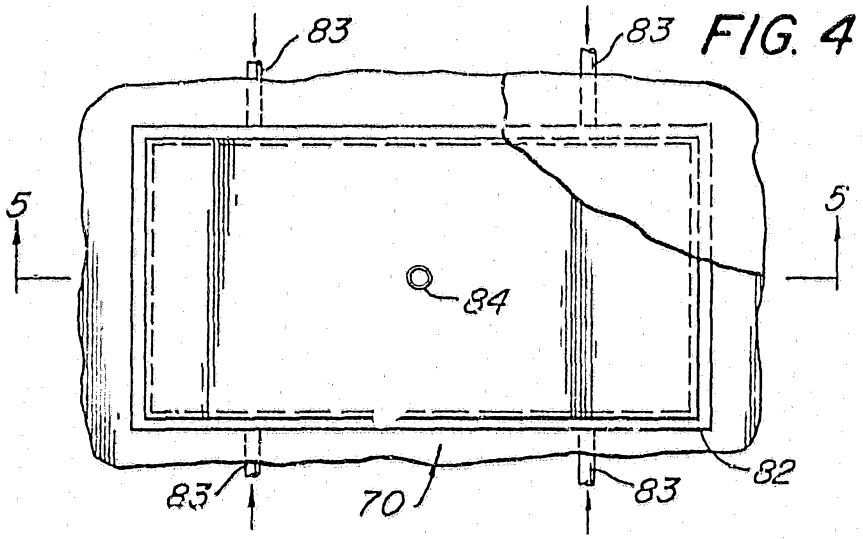


FIG. 4

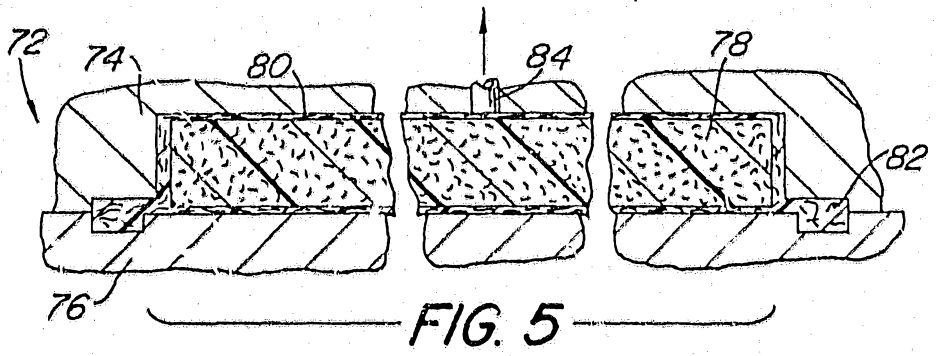


FIG. 5

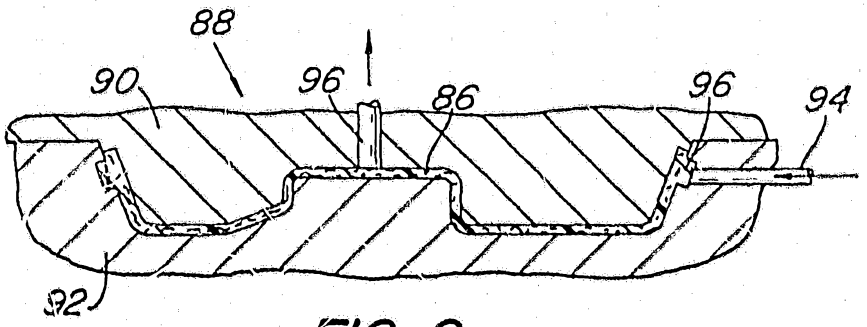


FIG. 6