Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2399457 C 2009/09/15

(11)(21) 2 399 457

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2001/01/18
(87) Date publication PCT/PCT Publication Date: 2001/08/16
(45) Date de délivrance/Issue Date: 2009/09/15
(85) Entrée phase nationale/National Entry: 2002/08/08
(86) N° demande PCT/PCT Application No.: US 2001/001648
(87) N° publication PCT/PCT Publication No.: 2001/058741
(30) Priorités/Priorities: 2000/02/11 (US09/502,686);
2000/09/06 (US09/655,965)

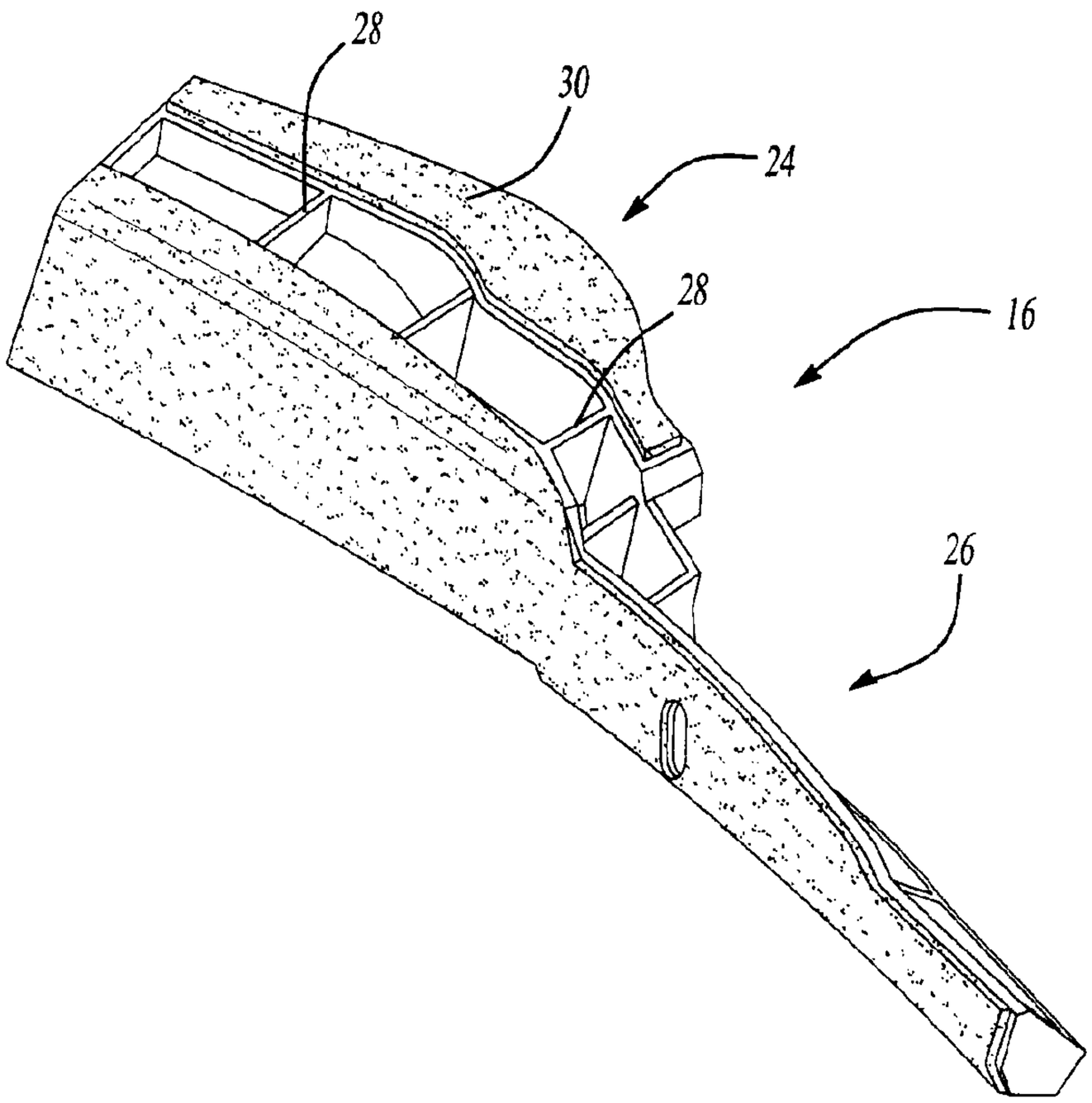
(51) Cl.Int./Int.Cl. *B62D 29/00* (2006.01),
B62D 25/04 (2006.01)

(72) Inventeurs/Inventors:
BARZ, WILLIAM J., US;
COON, THOMAS L., US;
CZAPLICKI, MICHAEL J., US

(73) Propriétaire/Owner:
ZEPHYROS, INC., US

(74) Agent: BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.

(54) Titre : SYSTEME DE RENFORT STRUCTUREL POUR VEHICULES AUTOMOBILES
(54) Title: STRUCTURAL REINFORCEMENT SYSTEM FOR AUTOMOTIVE VEHICLES



(57) Abrégé/Abstract:
An automotive vehicle frame reinforcement system has a skeleton member (16) designed to be placed in a cavity defined in a vehicle frame, such as a roof or pillar section. An expandable material (30), such as an epoxy-based reinforcing foam, is disposed on the skeleton member (16). Once the system is attached to the frame, the foam expands and cures during an automobile assembly operation, bonding the reinforcement system to the frame. As a result, the reinforcement system provides enhanced load distribution over the vehicle frame without adding excessive weight.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 August 2001 (16.08.2001)

PCT

(10) International Publication Number
WO 01/58741 A1

(51) International Patent Classification[7]: B62D 29/00, 25/04

(21) International Application Number: PCT/US01/01648

(22) International Filing Date: 18 January 2001 (18.01.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

09/502,686	11 February 2000 (11.02.2000)	US
09/655,965	6 September 2000 (06.09.2000)	US

(71) Applicant: **L & L PRODUCTS, INC.** [US/US]; 160 McLean Drive, Romeo, MI 48065 (US).

(72) Inventors: **BARZ, William, J.**; 5455 Marsh View Court #46, Shelby, Township, MI 48316 (US). **COON, Thomas, L.**; 3284 Merwin, Lapeer, MI 48446 (US). **CZAPLICKI, Michael, J.**; 1035 Pointe Place, Rochester, MI 48307 (US).

(74) Agent: **DOBRUSIN, Eric, M.**; Dobrusin, Darden, Thennisch & Lorenz PC, Suite 311, 401 South Old Woodward Avenue, Birmingham, MI 48009 (US).

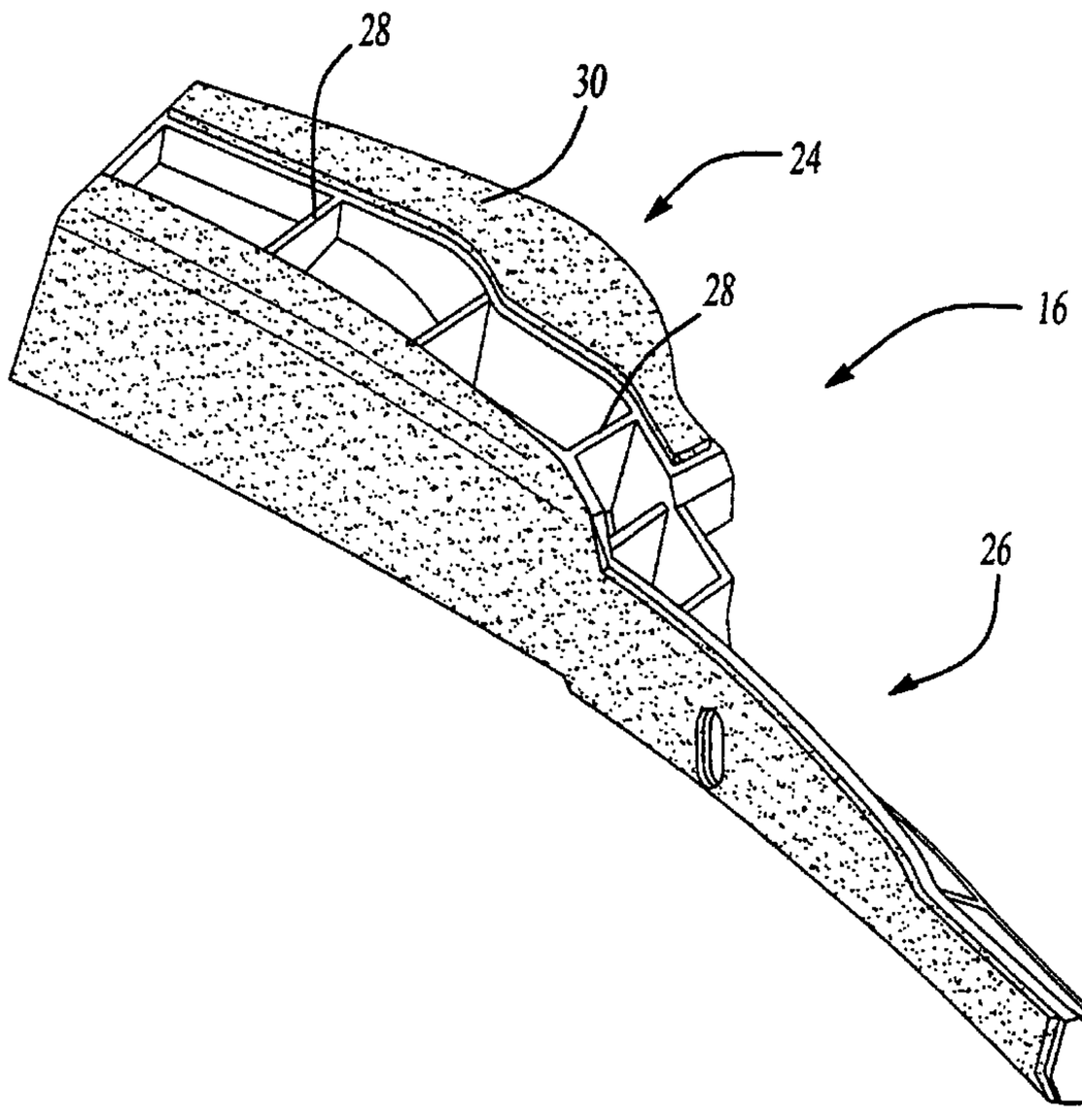
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) Title: STRUCTURAL REINFORCEMENT SYSTEM FOR AUTOMOTIVE VEHICLES



(57) Abstract: An automotive vehicle frame reinforcement system has a skeleton member (16) designed to be placed in a cavity defined in a vehicle frame, such as a roof or pillar section. An expandable material (30), such as an epoxy-based reinforcing foam, is disposed on the skeleton member (16). Once the system is attached to the frame, the foam expands and cures during an automobile assembly operation, bonding the reinforcement system to the frame. As a result, the reinforcement system provides enhanced load distribution over the vehicle frame without adding excessive weight.

WO 01/58741 A1

WO 01/58741 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

STRUCTURAL REINFORCEMENT SYSTEM FOR AUTOMOTIVE VEHICLES

FIELD OF THE INVENTION

The present invention relates generally to a reinforced structural member for use in strengthening the stiffness and strength of a frame assembly. More particularly, the invention relates to a vehicle frame system of an automotive vehicle that is reinforced by a member coated over a portion of its surface with an expandable material, the combination of which increases the structural stiffness and strength of the automotive vehicle.

BACKGROUND OF THE INVENTION

For many years the transportation industry has been concerned with designing reinforced structural members that do not add significantly to the weight of a vehicle. United States Patent Nos. 5,755,486; 4,901,500; and 4,751,249 described prior art reinforcing devices. While these prior art devices may be advantageous in some circumstances, there is needed a simple low cost structure that permits coupling the reinforcement member to a variety of structures of varying geometric configurations. In the automotive industry there is also a need for a relatively low cost system for reinforcing automotive vehicle frame structures.

SUMMARY OF THE INVENTION

The present invention is directed to a structural reinforcement system, and particularly one for reinforcing automotive vehicle frame structures, such as (without limitation) vehicle roof and pillar structures. The system generally employs a skeleton member adapted for stiffening the structure to be reinforced and helping to redirect applied loads. In use, the skeleton member is in contact, over at least a portion of its outer surface, with an energy absorbing medium, and particularly heat activated bonding material. In a particular preferred embodiment, the skeleton member is a molded metal, or composite frame and it is at least partially coated with foamable epoxy-based resin, such as L5206, L5207, L5208 or L5209 structural foam commercially available from L & L Products of Romeo, Michigan.

In one embodiment the skeleton member along with a suitable amount of bonding or load transfer medium is placed in a cavity defined within an automotive vehicle, such as a vehicle roof structure, pillar structure or both. The bonding

medium is activated to accomplish expansion of the resin in the space defined between the skeleton member and the wall structure defining the cavity. The resulting structure includes the wall structure joined to the skeleton member with the aid of the structural foam.

DETAILED DESCRIPTION OF THE DRAWINGS

The features and inventive aspects of the present invention will become more apparent upon reading the following detailed description, claims, and drawings, of which the following is a brief description:

Fig. 1 is a perspective view of aspects of an automotive vehicle roof and pillar structure, illustrating an A-Pillar and B-Pillar.

Fig. 2 is a perspective view of a skeleton member coated with an expandable resin in accordance with the present inventions.

Fig. 3 is another perspective view of the structure shown in Fig. 2.

Fig. 4 is a sectional view showing a coated skeleton member prior to activation of an expandable resin.

Fig. 5 illustrates the structure of Fig. 4 after the expandable resin has been expanded.

Fig. 6 is a perspective view of another illustrative structure in accordance with the present invention.

Fig. 7 is a side elevation view of the structure of Fig. 6.

Fig. 8 illustrates yet another structure in accordance with the present invention.

Fig. 9 illustrates the structure of Fig. 8 employed combination with a vehicle pillar structure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Fig. 1 illustrates an example of an automotive vehicle 10 showing portions of a frame structure. As will be appreciated, it is common for such structures to include a plurality of hollow vehicle frame members that are joined to define the frame. One such structure, for purposes of illustration (without limitation) is a vehicle roof and pillar structure. As will be recognized, included in the roof and pillar structure may also be windows, sunroofs or other removable tops, vehicle doors and door components, headliners (with or without overhead accessories), or the like. As discussed later, other vehicle frame members are also contemplated within the scope of the present invention.

While Fig. 1 illustrates an A-Pillar 12 and B-Pillar 14, other pillars may likewise be employed in accordance with the present invention. In Fig. 1 there is shown also a portion of the roof structure that bridges the A-Pillar 12 and B-Pillar 14.

Depending upon vehicle design, it is possible that the roof structure bridging the A-Pillar and B-Pillar is relatively indistinguishable between the A-Pillar and B-Pillar such that the A-Pillar structure and B-Pillar structure effectively adjoin one another. In such instances the uppermost portion of the pillar structure is deemed the roof structure.

Reinforcement of the roof and pillar sections is accomplished by locating one or more skeleton members in accordance with the present invention in a hollow or cavity portion of the roof or pillar. Fig. 1 illustrates examples of this by showing a first member 16, a second member 18 and a third member 20 in such locations. The members 16, 18 and 20 preferably are sealingly secured to at least one of the roof and pillar sections by a bonding material, which upon heat activation produces adhesion to skeleton members to help secure the members and the walls defining the hollow from movement within the hollow portion.

Though other heat activated materials are possible, a preferred heat activated material is an expandable plastic, and preferably one that is foamable. A particularly preferred material is an epoxy-based structural foam. For example, without limitation, in one embodiment, the structural foam is an epoxy-based material, including an ethylene copolymer or terpolymer that may possess an alpha-olefin. As a copolymer or terpolymer, the polymer is composed of two or three different monomers, i.e., small molecules with high chemical reactivity that are capable of linking up with similar molecules.

A number of epoxy-based structural reinforcing foams are known in the art and may also be used to produce the structural foam. A typical structural foam includes a polymeric base material, such as an epoxy resin or ethylene-based polymer which, when compounded with appropriate ingredients (typically a blowing and curing agent), expands and cures in a reliable and predicable manner upon the application of heat or the occurrence of a particular ambient condition. From a chemical standpoint for a thermally-activated material, the structural foam is usually initially processed as a flowable thermoplastic material before curing. It will cross-link upon curing, which makes the material incapable of further flow.

An example of a preferred structural foam formulation is an epoxy-based material that is commercially available from L&L Products of Romeo, Michigan, under the designations L5206, L5207, L5208 and L5209. One advantage of the preferred structural foam materials 14 over prior art materials is that the preferred materials can be processed in several ways. The preferred materials can be processed by injection molding, extrusion compression molding or with a mini-applicator. This enables the formation and creation of part designs that exceed the capability of most prior art materials. In one preferred embodiment, the structural foam (in its uncured state) generally is dry or relatively free of tack to the touch.

While the preferred materials for fabricating the structural foam have been disclosed, the structural foam can be formed of other materials provided that the material selected is heat-activated or otherwise activated by an ambient condition (e.g. moisture, pressure, time or the like) and cures in a predictable and reliable manner under appropriate conditions for the selected application. One such material is the epoxy based resin disclosed in U.S. Patent No. 6,131,897, filed with the United States Patent and Trademark Office on March 16, 1999 by the assignee of this application. Some other possible materials include, but are not limited to, polyolefin materials, corpolymers and terpolymers with at least one monomer type an alphaolefin, phenol/formaldehyde materials, phenoxy materials, and polyurethane materials with high glass transition temperatures. See also, U.S. Patent Nos. 5,766,719; 5,755,486; 5,575,526; and 5,932,680. In general, the desired characteristics of the structural foam include relatively high stiffness, high strength, high glass transition temperature (typically greater than 70 degrees Celsius), and good corrosion resistance properties. In this manner, the

material does not generally interfere with the materials systems employed by automobile manufacturers.

In applications where a heat activated, thermally expanding material is employed, an important consideration involved with the selection and formulation of the material comprising the structural foam is the temperature at which a material reaction or expansion, and possibly curing, will take place. For instance, in most applications, it is undesirable for the material to be reactive at room temperature or otherwise at the ambient temperature in a production line environment. More typically, the structural foam becomes reactive at higher processing temperatures, such as those encountered in an automobile assembly plant, when the foam is processed along with the automobile components at elevated temperatures or at higher applied energy levels, e.g., during painting preparation steps. While temperatures encountered in an automobile assembly operation may be in the range of about 148.89° C to 204.44°C (about 300°F to 400°F), body and paint shop applications are commonly about 93.33°C (about 200°F) or slightly higher. If needed, blowing agent activators can be incorporated into the composition to cause expansion at different temperatures outside the above ranges.

Generally, suitable expandable foams have a range of expansion ranging from approximately 0 to over 1000 percent. The level of expansion of the structural foam 14 may be increased to as high as 1500 percent or more. Typically, strength is obtained from products that possess low expansion.

Referring now to Fig. 2, there is shown one example of a first reinforcement member 16 in accordance with the present invention. This illustrated embodiment is useful, for instance, for reinforcing the juncture between an automotive vehicle roof 22 and the A-Pillar. The first member 16 has a first portion 24 adapted for placement in a cavity defined in a vehicle roof structure, and a second portion 26 adapted for placement in a cavity defined in a vehicle pillar, such as an A-Pillar as illustrated. Preferably the cross sectional silhouette of both the first portion 24 and the second portion 26 is generally complementary to the walls of the cavity defined in opposing roof or pillar structure. Though the member may also be solid, the member preferably includes a skeleton frame that is prepared to minimize weight while still achieving desired rigidity. Accordingly, the skeleton frame preferably is designed to employ a plurality of ribs that effectively are beamlike (e.g. I-beam) in function, thus helping to selectively strengthen the member. The ribs are illustrated in Fig 2 and 3

generally running orthogonal to one another. However, this is not intended as limiting, as the rib configuration may be varied depending upon the desired outcome.

In general, however, a rib is placed adjacent to, and in generally non-parallel relationship to a surface over which loads will be distributed. In Fig. 2, by way of illustration, a plurality of first ribs 28 are located adjacent to a surface of the member (shown covered with expandable material 30). Fig 3 also shows how the ribs 28 (reference numerals illustrating some of the ribs, but not all) can be configured relative to one another to provide additional stabilization. In general, because of the relatively high bending moment of the ribs, without unduly increasing weight of the member, rigidity can be increased in locations where loads are anticipated by selective design and placement of the ribs. At the same time, enhanced load distribution is possible from the continuous surfaces and foam employed with the ribs to spread energy. Moreover, weight savings can be achieved by such design. For instance, the structure of the member is also such that over at least one quarter, preferably one half and more preferably greater than about three quarter of the length of the member at any given point between the ends of said member, the cross-sectional area of the member is less than 75%, more preferably less than 50% and still more preferably less than 20% of the overall area for a silhouette profile taken such point. In this manner, weight reductions of up to about 50%, more preferably about 70%, and still more preferably about 90%, are possible as compared with a solid structure of the same material.

It should be appreciated that other devices for securing the members 16, 18, and 20 to the vehicle frame may be employed, including suitable fasteners, straps, or other mechanical interlocks. Through-holes 32 may also be defined within the structure to assist in vehicle manufacturing. In a particularly preferred embodiment, the skeleton members of the present invention are injection molded plastics, such as nylons. However, other materials and manufacturing techniques may be employed similarly to achieve like results. For instance, high strength to weight metal components, such as aluminum, titanium, magnesium or the like, may be employed, as well as polymer composites such as a layered polymer with fibers capable of compression molding to generate strength.

Returning to Fig. 1, when employed in an automotive vehicle in accordance with the present invention, the skeleton members, particularly when coated with an expandable material (such as a heat activated epoxy based foam) can reinforce the

region for which it is used by the combination of increased stiffening from the presence of beam-like ribs and load distribution through the combination of relatively high surface area continuous surfaces and an expandable material.

In another preferred embodiment, the expandable material, upon expansion will serve as a sealant for blocking the passage of fluids or other elements through the cavity. Thus, in such embodiment, it is preferred that the expandable material is provided continuously about generally the entirety of the periphery of any portion of the skeleton member that does not sealingly contact the automobile frame structure. Fig. 5 illustrates this by showing how skeleton member 16 coated with an expandable material 30 (shown in Fig. 4) is sealed in place upon activation of the material 30 (shown expanded in Fig. 5).

Figs. 6 through 9 illustrate other embodiments in accordance with the present invention. In Figs. 6 and 7, there is shown a reinforcement member 18 adapted for a pillar of an automotive vehicle. The structure of the skeleton member employs a plurality of ribs 34 adjoining one or more continuous surfaces 36 (shown coated with an expandable material 38).

The expandable material is shown in its expanded state. As the skilled artisan will appreciate, not all ribs are shown, and the specific design of each rib configuration will vary depending upon its intended use, and the geometry of the region being reinforced (e.g. walls 40 and 42 of the vehicle frame structure defining the cavity). Further expandable material may be employed in contact with the ribs.

Figs. 8 and 9 illustrate yet another embodiment according to the present invention. In this embodiment, a skeleton member 20 having a plurality ribs 44 and generally continuous surfaces (shown coated with a layer 46) is fabricated to also include structure for facilitating vehicle manufacture. Specifically, the embodiment shown includes a plurality of through-holes 48, for enabling body shop weld access or the like. As shown in Fig. 9, in this embodiment, the expandable material layer 46, upon expansion, covers the circumference of a cross section of the structure.

The skilled artisan will appreciate that the use of the reinforcements disclosed herein is not intended as being limited only to illustrate the locations shown in Fig 1. They can be used in any location within an automotive vehicle frame. For instance, other reinforced locations are also possible including but not limited to pillar to door regions, roof to pillar, mid-pillar, roof rails, windshield or other window frames, deck lids, hatches, removable top to roof locations, other vehicle beltline locations, motor

rails, lower sills, cross members, lower rails, and the like. Moreover, vehicle roof tops may be reinforced to support additional loads in accordance with the present invention. In the same manner as was described above in the context of a roof and pillar system, a reinforcement frame member having an expandable material thereon is placed in a cavity defined in the vehicle frame structure. The material is expanded to help secure the reinforcement in place.

The preferred embodiment of the present invention has been disclosed. A person of ordinary skill in the art would realize however, that certain notifications would come within the teachings of this invention. Therefore, the following claims should be studied to determine the true scope and content of the invention.

What is claimed is:

1. A reinforced roof and pillar system for an automotive vehicle, comprising:

an automotive vehicle frame for a roof and pillar of the automotive vehicle, the frame having a roof rail with a plurality of wall portions defining a cavity therein, the roof rail extending longitudinally relative to the vehicle;

a skeleton member at least partially disposed within the cavity as defined by the roof rail, the skeleton member having a length and a longitudinal axis extending along the roof rail, the skeleton member comprising a first portion with a plurality of ribs and a second portion extending away from the first portion, the second portion also including a plurality of ribs, the skeleton member including a first outwardly facing surface opposing at least one of the wall portions and a second outwardly facing surface opposite the first outwardly facing surface wherein the first outwardly facing surface substantially extends along the entire length of the skeleton member; and

a structural foam material in sealing contact with the skeleton member and at least one of the plurality of wall portions, wherein;

i) at least two of the plurality of ribs of the first portion are in spaced apart opposing relation to each other; and

ii) the structural foam material sealingly contacts the first outwardly facing surface along substantially the entire length of the skeleton member and the structural foam material sealingly contacts the second outwardly facing surface along a substantial portion of the length of the skeleton member.

2. A reinforced roof and pillar system as in claim 1 wherein the automotive vehicle frame includes a roof rail adjoining an A-pillar and the first portion of the skeleton member is located in the roof rail and the second portion of the skeleton member extends into the A-pillar.

3. A reinforced roof and pillar system as in claim 2 wherein the second portion has a cross-sectional area taken generally perpendicular to the axis that is less than about fifty percent of a cross-sectional of the first portion taken generally perpendicular to the axis.

4. A reinforced roof and pillar system as in claim 1 wherein the first portion has a first cross-sectional area taken generally perpendicular to the axis at one end of the length that is less than about fifty percent of a second cross-sectional area of the second area of the second portion taken generally perpendicular to the axis at an opposite end of the length.

5. A reinforced roof and pillar system as in claim 1 wherein the automotive vehicle frame includes a roof rail and wherein the first and second portions of the skeleton member are located in the roof rail.

6. A reinforced roof and pillar system as in claim 5 wherein the first portion and the second portion are separated by a third portion, the third portion including a through-hole extending through a substantial amount of the third portion, the substantial amount being greater than half of the third portion.

7. A reinforced roof and pillar system as in claim 1 wherein at least two of said plurality of ribs in the first portion intersect with each other and the plurality of ribs in the first portion are substantially devoid of the foam.

8. A reinforced roof and pillar system as in claim 3 wherein the skeleton member and the structural foam material cooperatively seal the cavity to block passage of materials through the cavity.

9. A reinforced roof and pillar system as in claim 5 wherein the skeleton member and the structural foam cooperatively seal the cavity to block passage of materials through the cavity.

10. A reinforced roof and pillar system for an automotive vehicle, comprising:

an automotive vehicle frame for a roof and pillar of the automotive vehicle, the frame having a roof rail with a plurality of wall portions defining a cavity therein;

a skeleton member at least partially disposed within the cavity as defined by the roof rail, the skeleton member having a length and a longitudinal axis extending along the roof rail, the skeleton member comprising a first portion with a plurality of ribs and a second portion extending away from the first portion, the second portion also including a plurality of ribs, the skeleton member including a first outwardly facing surface opposing at least one of the wall portions and a second outwardly facing surface opposite the first outwardly facing surface substantially extends along the entire length of the skeleton member; and

a structural foam material in sealing contact with the skeleton member and at least one of the plurality of wall portions, wherein;

i) at least two of the plurality of ribs of the first portion and at least two of the plurality of ribs of the second portion are in spaced apart opposing relation to each other and the at least two of the plurality of ribs of the first portion both extend between the first outwardly facing surface and the second outwardly facing surface;

ii) the first portion is contiguous with the second portion and the first portion and the second portion are substantially aligned with each other along the longitudinal axis;

iii) the structural foam material sealingly contacts the first outwardly facing surface along substantially the entire length of the skeleton member and the structural foam material sealingly contacts the second outwardly facing surface along a substantial portion of the length of the skeleton member; and

iv) the skeleton member is formed as a singular molded plastic component.

11. A reinforced roof and pillar system as in claim 10 wherein the automotive vehicle frame includes a roof rail adjoining an A-pillar and the first portion of the skeleton member is located in the roof rail and the second portion of the skeleton member extends into the A-pillar.

12. A reinforced roof and pillar system as in claim 10 wherein the second portion has a cross-sectional area taken generally perpendicular to the axis that is less than about fifty percent of a cross-sectional area of the first portion taken generally perpendicular to the axis.

13. A reinforced roof and pillar system as in claim 9 wherein at least two of said plurality of ribs in the first portion intersect with each other and the plurality of ribs in the first portion are substantially devoid of the foam.

14. A reinforced roof and pillar system as in claim 12 wherein the skeleton member and the structural foam materials cooperatively seal the cavity to block passage of materials through the cavity.

15. A reinforced roof and pillar system as in claim 1 wherein the outwardly facing surface of the first portion and the outwardly facing surface of the second portion are coextensive with the longitudinal axis and the structural foam material is coextensive with the outwardly facing surface of the first portion and the outwardly facing surface of the second portion.

16. A reinforced roof and pillar system as in claim 10 wherein the outwardly facing surface of the first portion and the outwardly facing surface of the second portion are coextensive with the longitudinal axis and the structural foam material is coextensive with the outwardly facing surface of the first portion and the outwardly facing surface of the second portion.

17. A reinforced roof and pillar system as in claim 1 wherein the skeleton member is formed as a singular molded plastic component.

18. A reinforced system for an automotive vehicle, comprising:

an automotive vehicle frame, the frame having a plurality of wall portions defining a cavity therein;

a skeleton member disposed within the cavity, the skeleton member having a longitudinal axis, the skeleton member comprising a first portion intermediate a second portion and a third portion; and

a structural foam material in sealing contact with the skeleton member and at least one of the plurality of wall portions, wherein;

i) the first portion, the second portion and the third portion each include a at least one laterally extending rib and at least one longitudinally extending rib;

ii) the skeleton member includes a first longitudinal outwardly facing surface opposite a second outward facing longitudinal surface, both the first surface and the second surface substantially entirely covered by the structural foam material, both the first surface and second surface extending at least along the first portion and second portion of the skeleton member;

iii) the first portion includes an opening suitable for passage of a component therethrough;

iv) the skeleton member includes one or more extensions extending therefrom; and

v) the plurality of walls of the automotive vehicle frame are art of a rail of the automotive vehicle

19. A reinforced system as in claim 18 wherein the first portion has a first cross-sectional area taken generally perpendicular to the axis that is less than about fifty percent of a second cross-sectional area of the second portion taken generally perpendicular to the axis and less than about fifty percent of a

third cross-sectional area of the third portion taken generally perpendicular to the axis.

20. A reinforced system as in claim 19 wherein the longitudinal axis extends horizontally.

21. A reinforced system as in claim 20 wherein the opening extends through a substantial amount of the first portion.

22. A reinforced system as in claim 21 wherein the at least one laterally extending rib of the first portion intersects the at least one longitudinally extending rib of the first portion intersects the at least one longitudinally extending rib of the second portion and the at least one laterally extending rib of the third portion intersects the at least one longitudinally extending rib of the third portion.

23. A reinforced system as in claim 22 wherein the at least one laterally extending rib and the at least one longitudinally extending rib of the first portion, the second portion and the third portion are substantially devoid of the foam.

24. A reinforced system as in claim 23 wherein the skeleton member and the structural foam cooperatively seal the cavity to block passage of materials through the cavity.

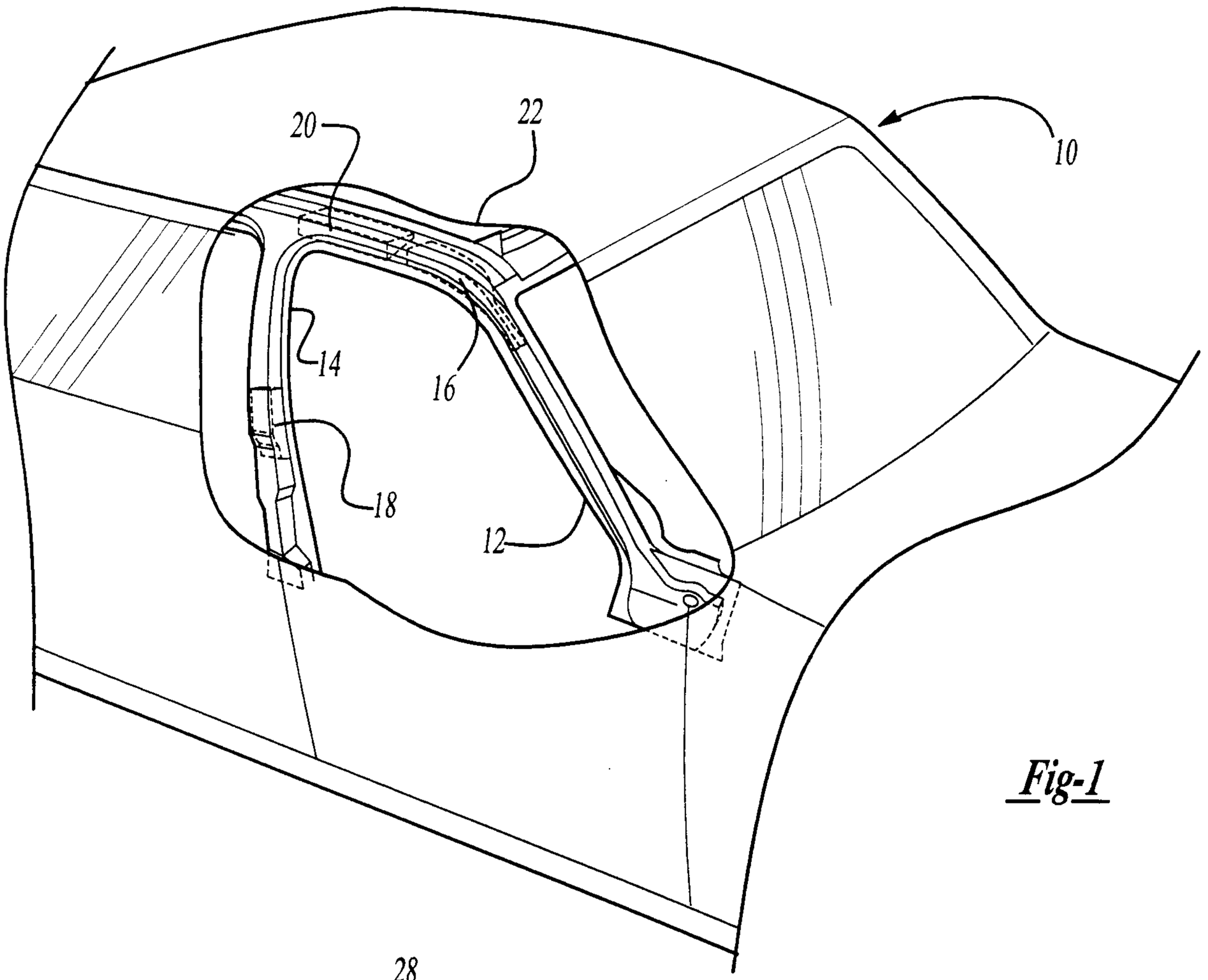


Fig-1

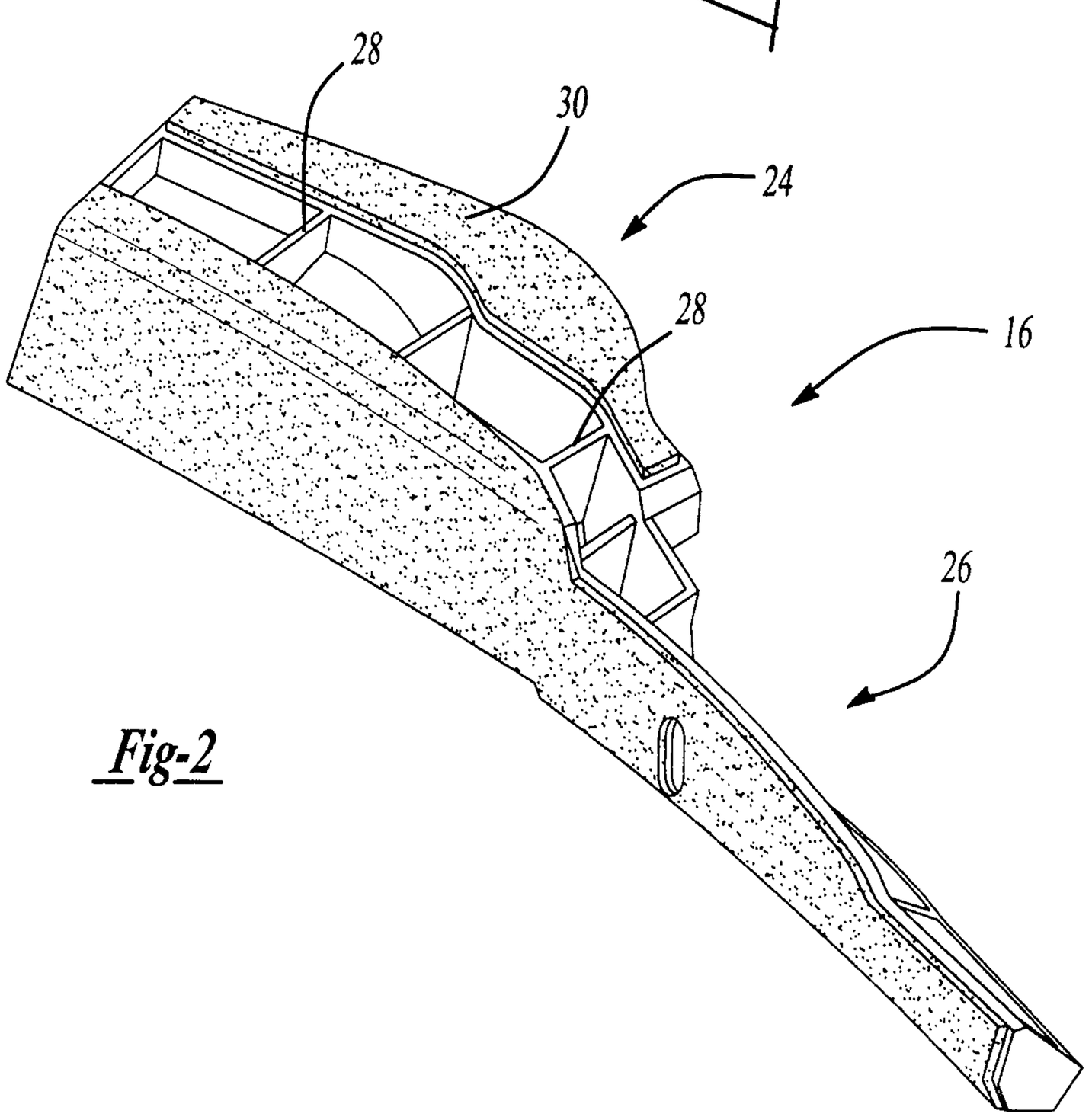


Fig-2

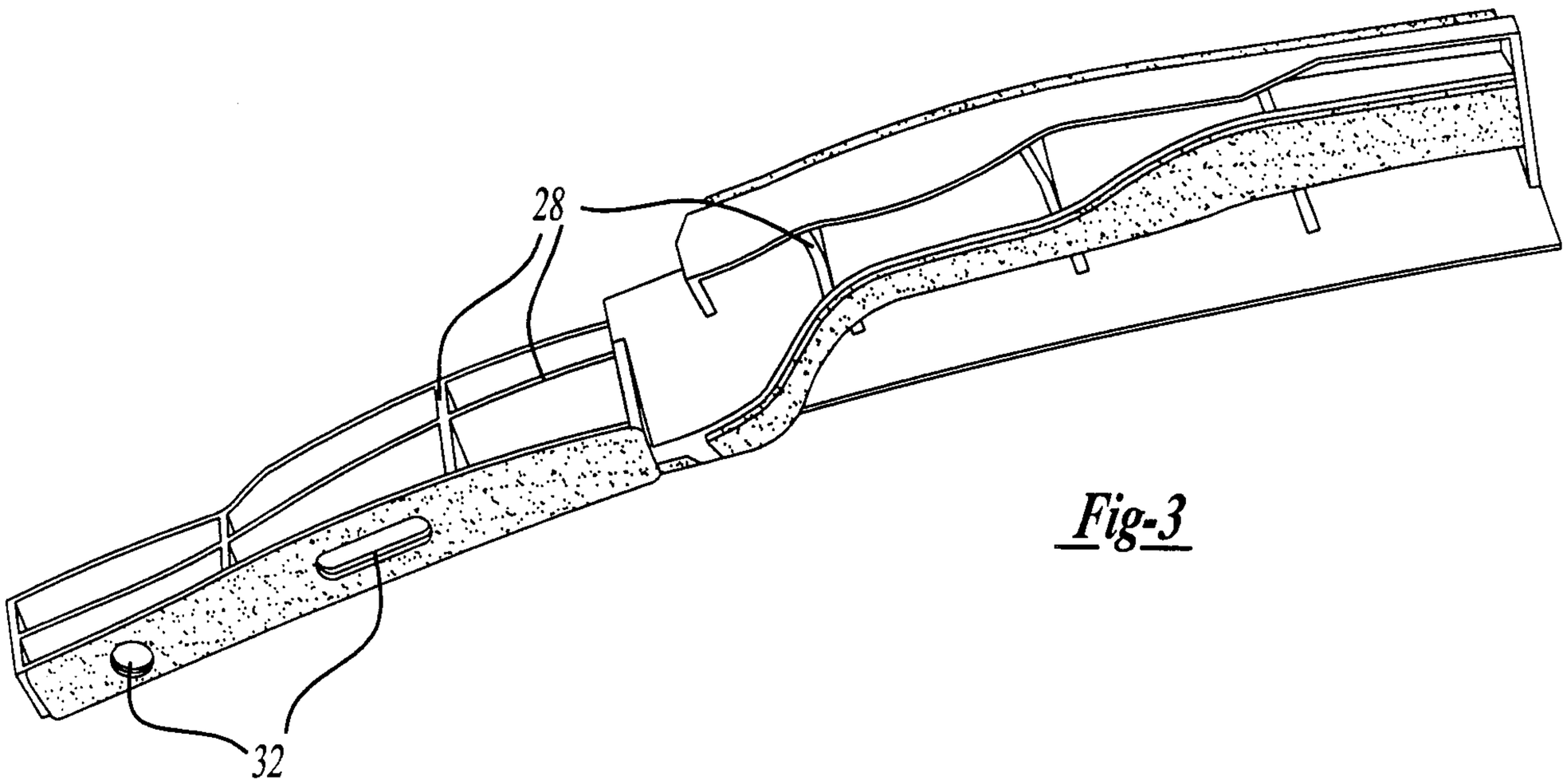


Fig-3

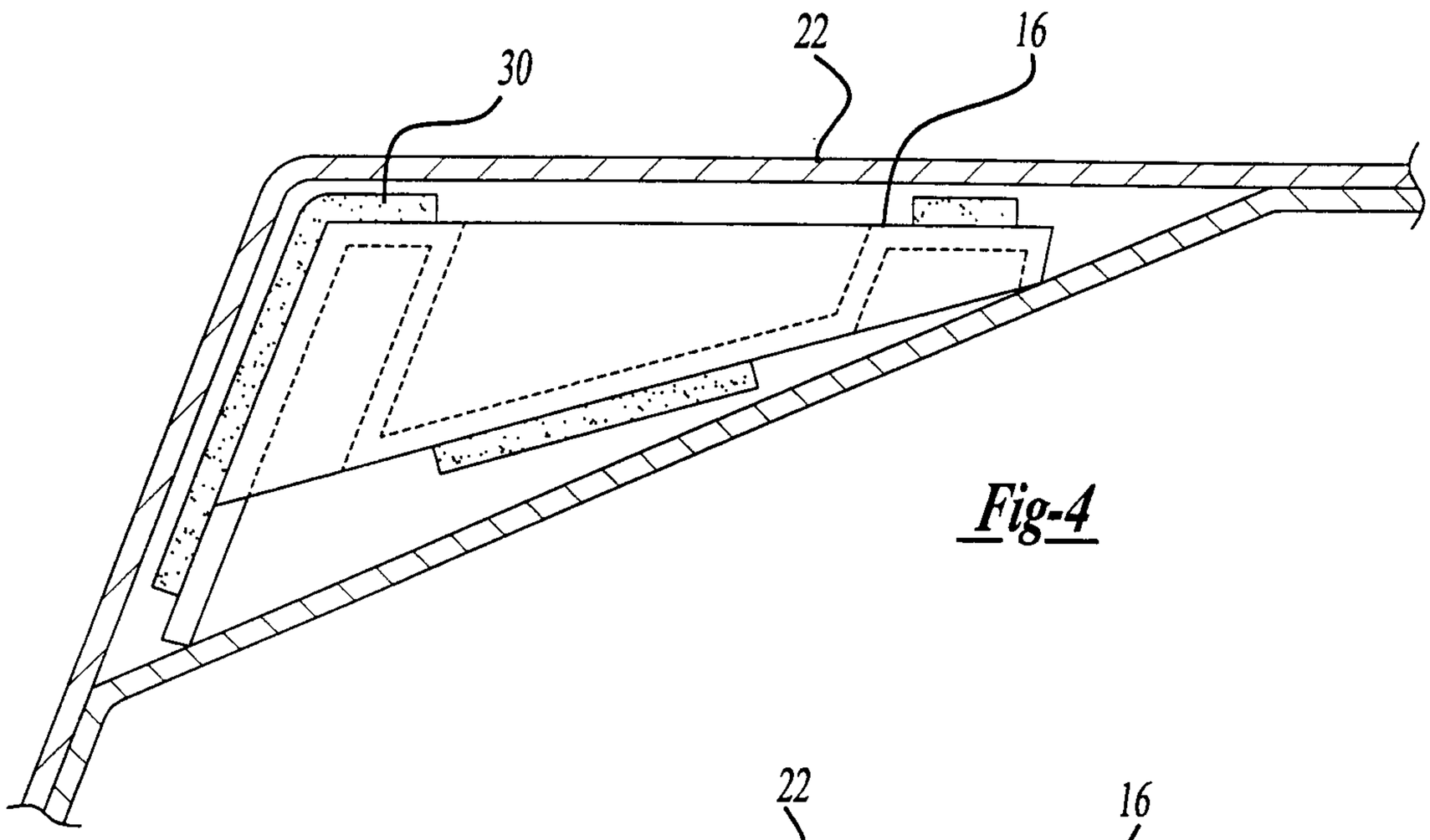


Fig-4

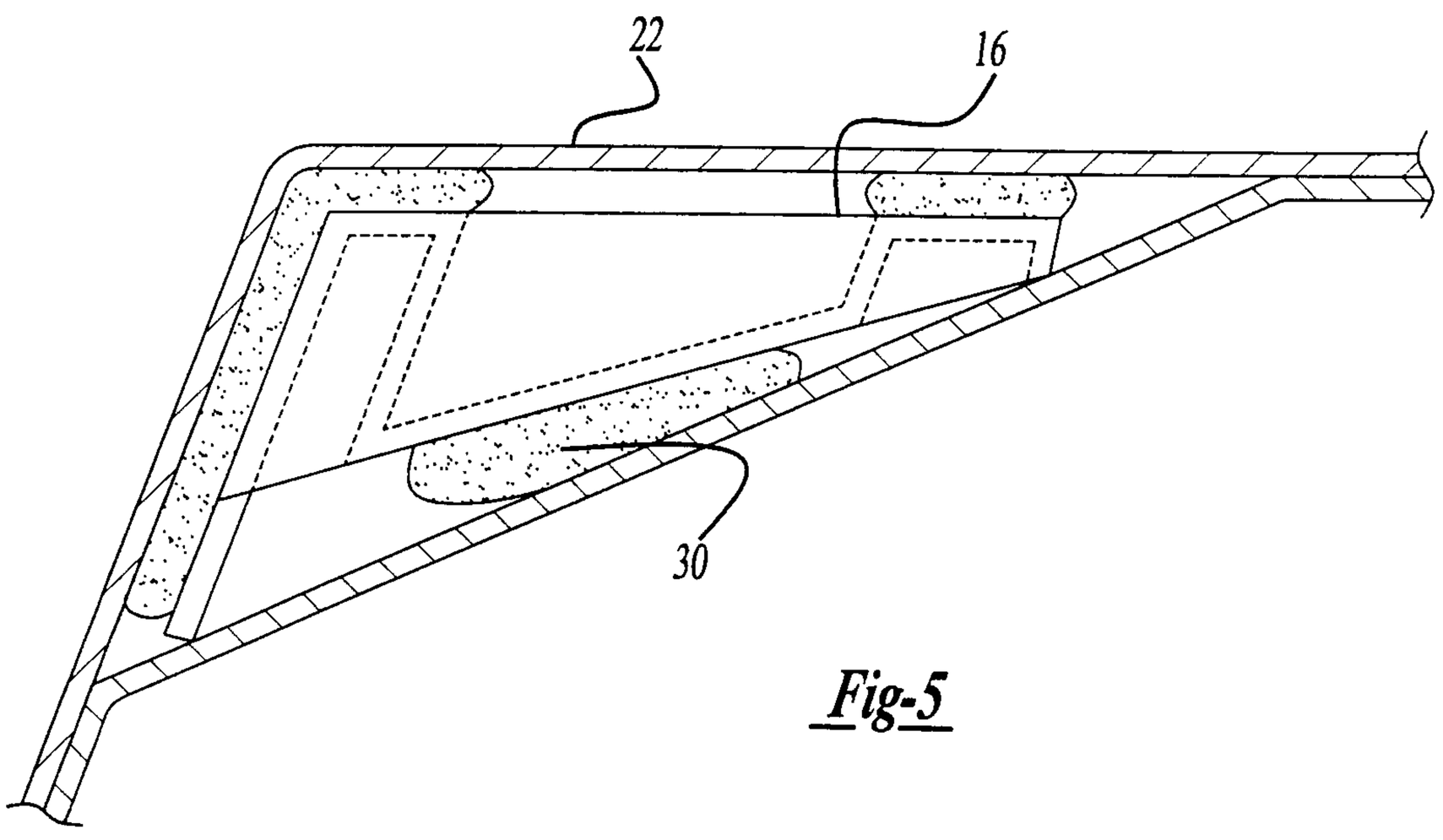


Fig-5

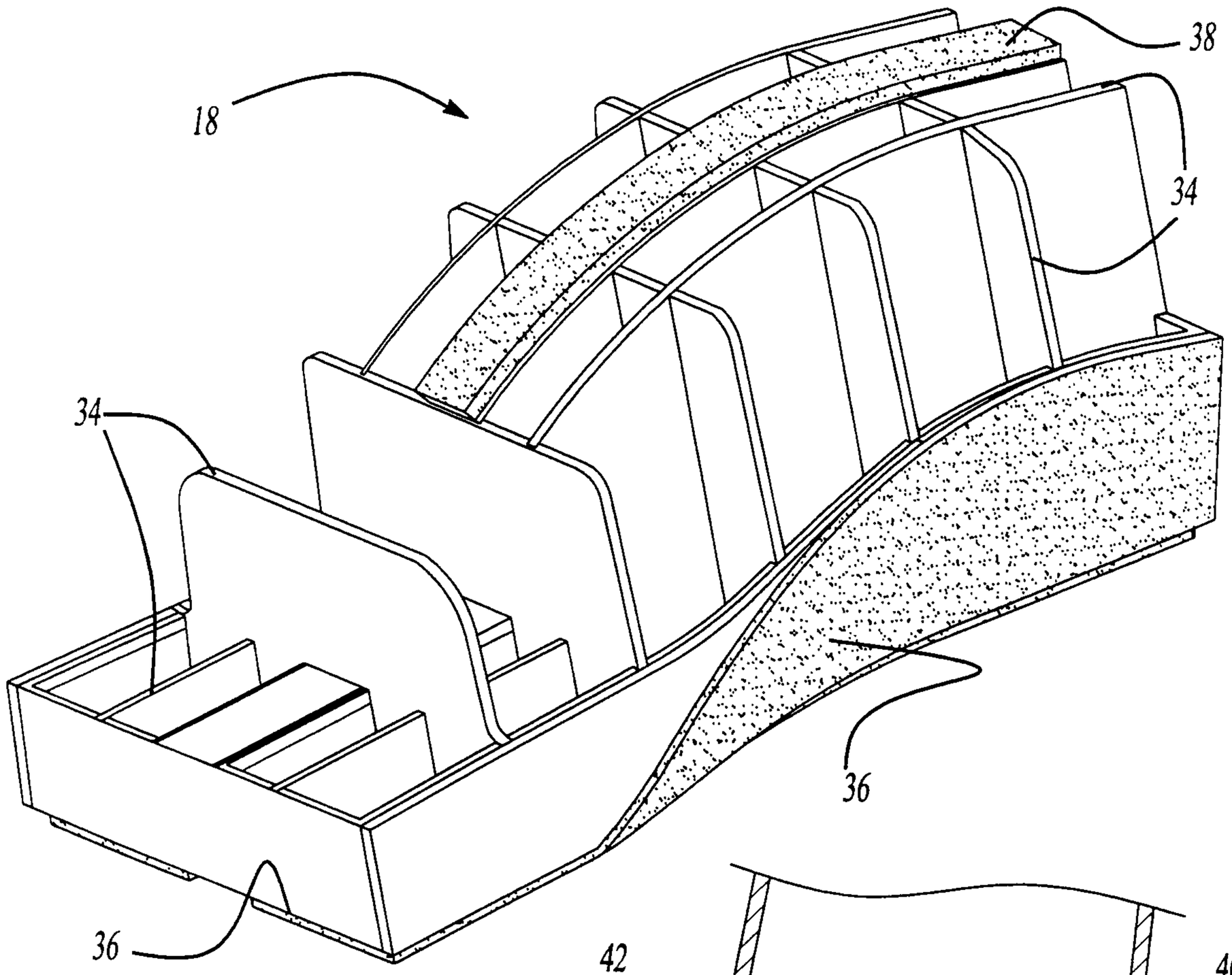


Fig-6

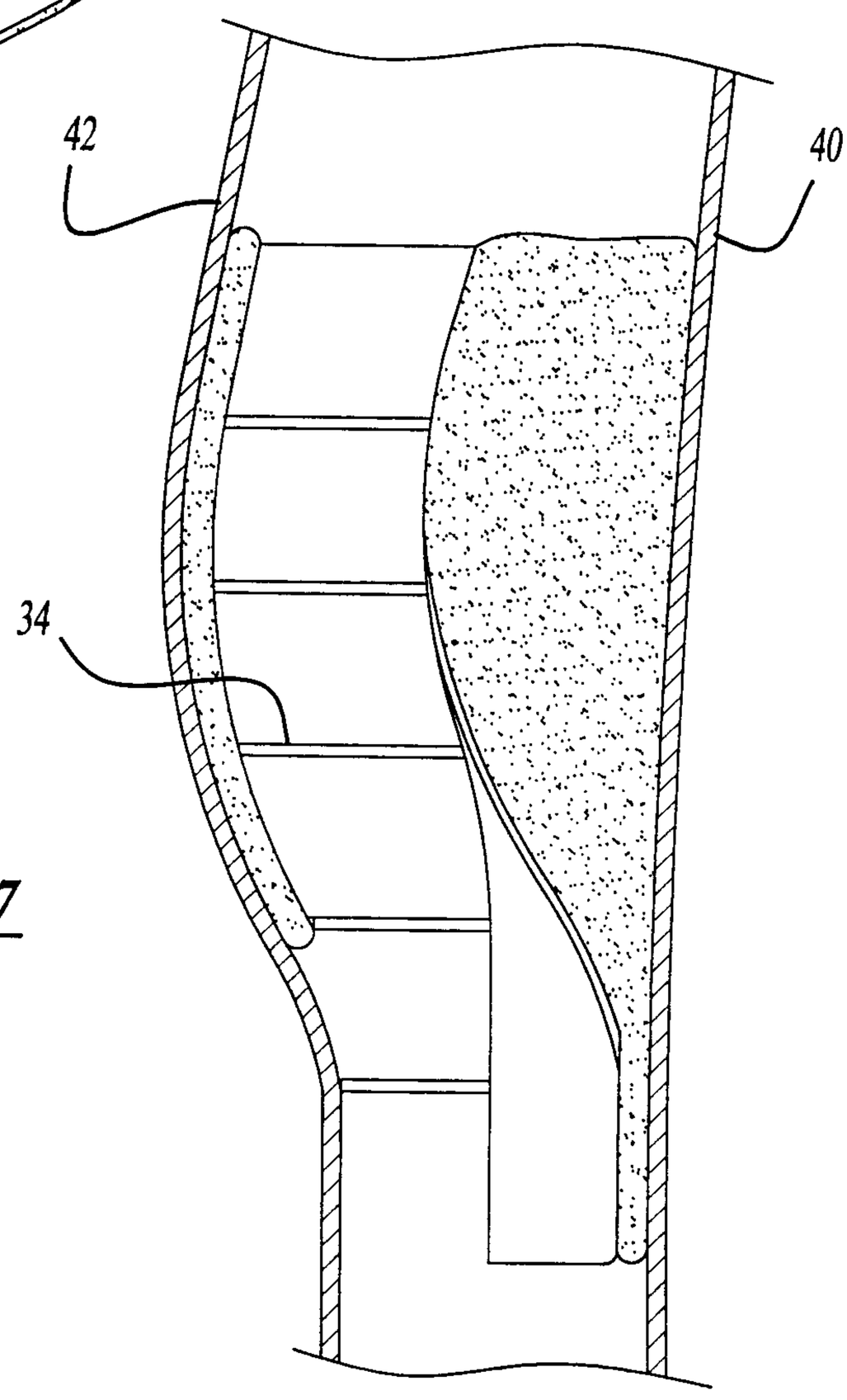


Fig-7

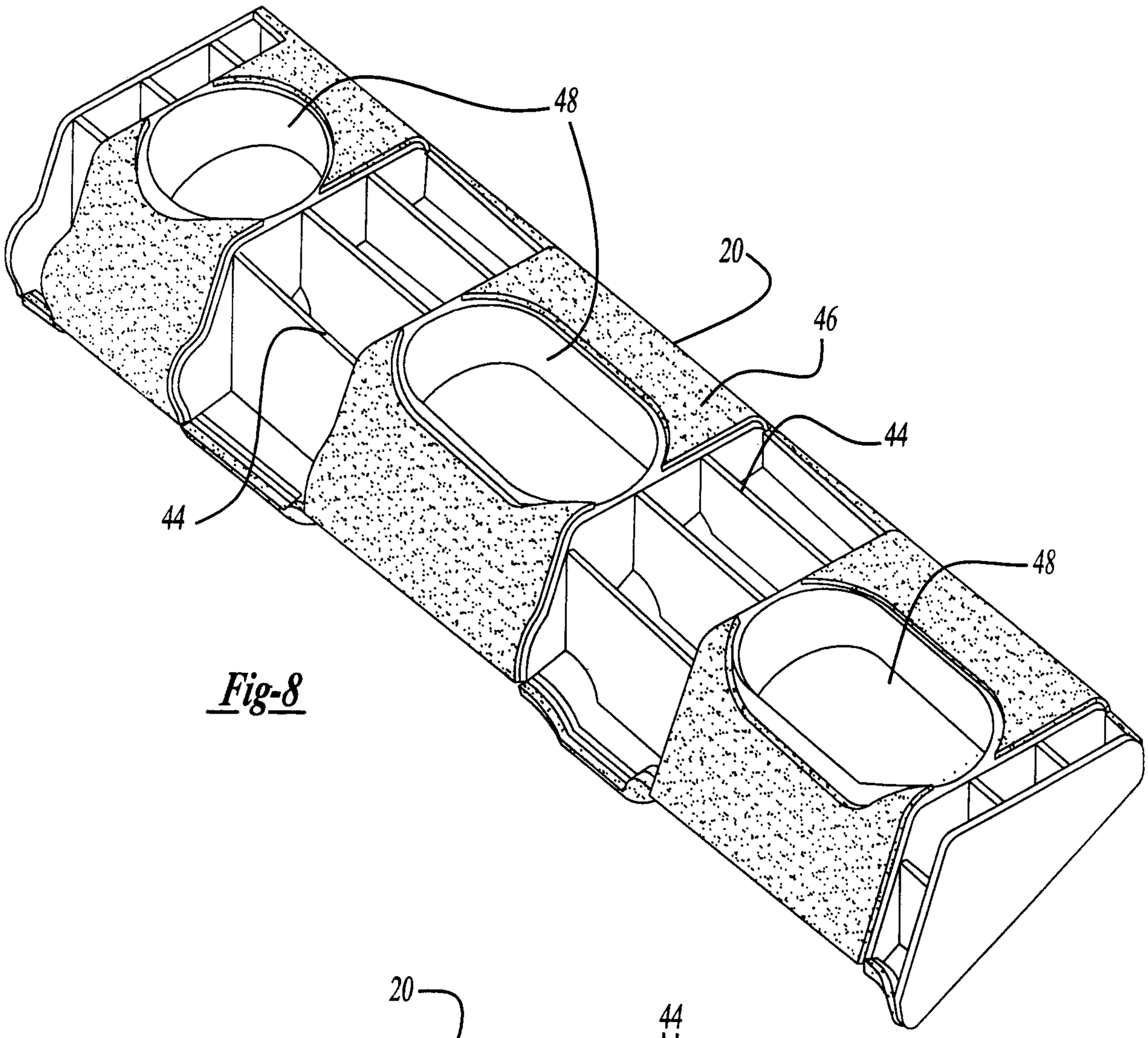


Fig-8

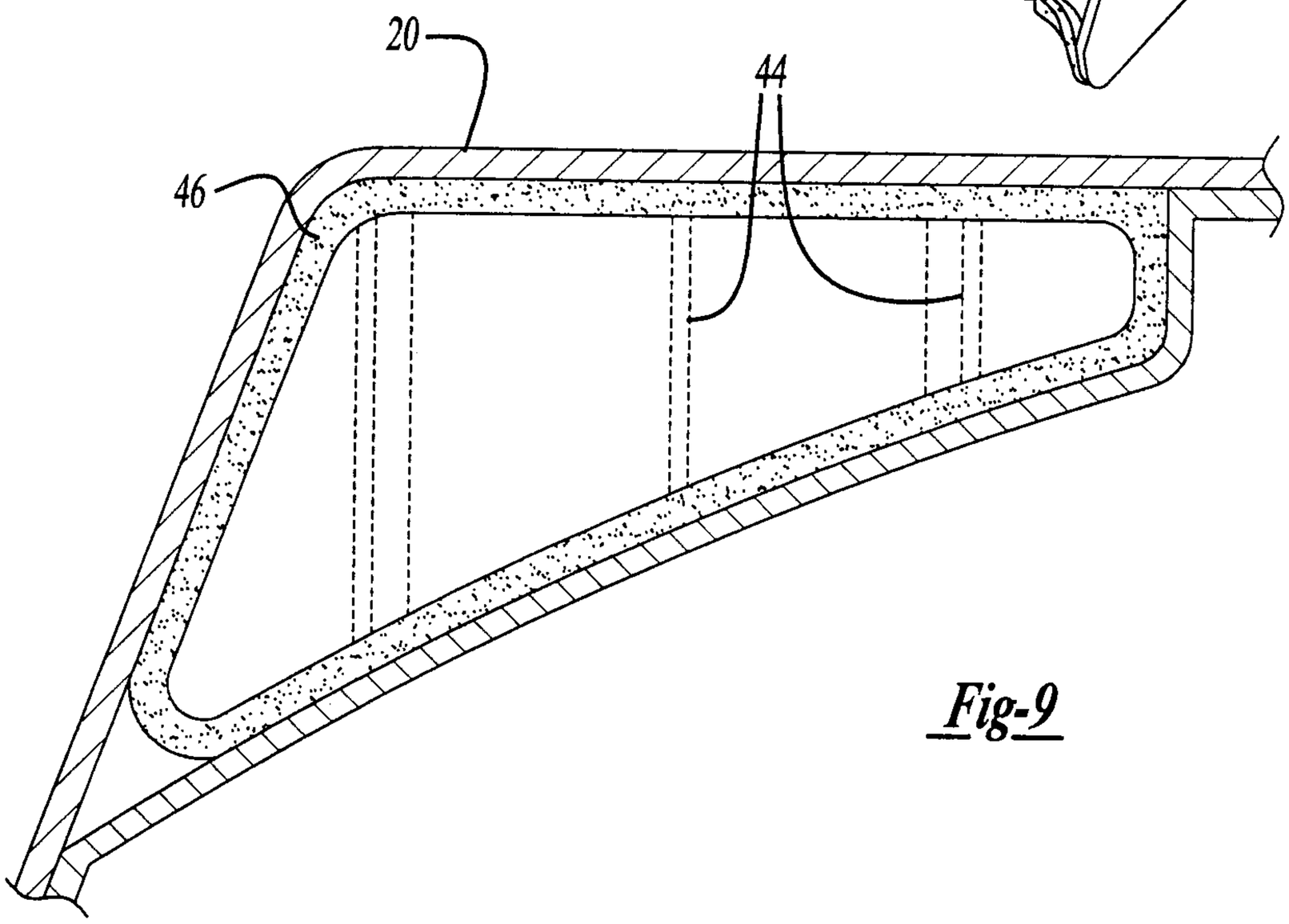
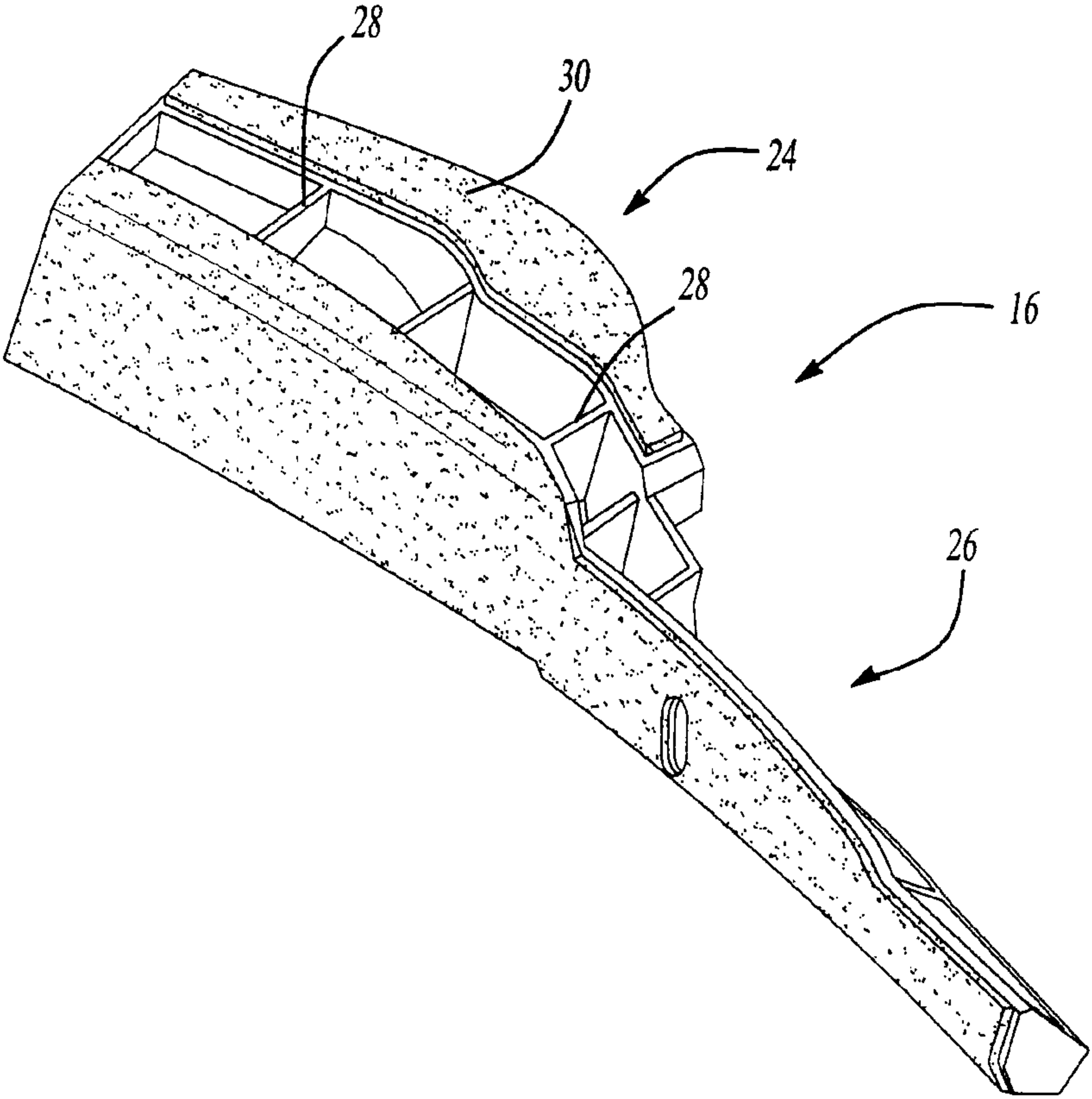


Fig-9


28
30
24
28
16
26
20