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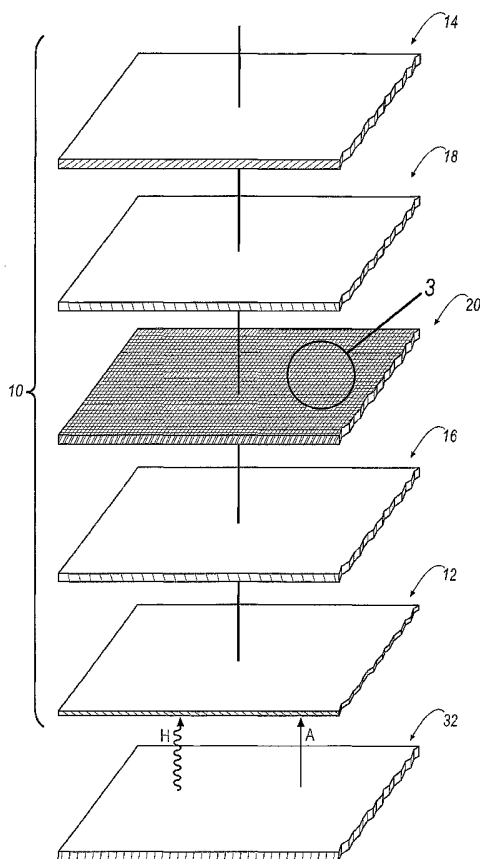
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[Continued on next page]

(54) Title: ACOUSTICAL HEAT SHIELD



(57) Abstract: A heat shield includes an inner portion, an outer portion, first and second insulating portions, and a deflecting portion. The inner portion includes a reflective material to reflect thermal energy that radiates from a heat/acoustic source. The outer portion includes a rigid material to provide structural support for the heat shield. The first and second insulating portions are intermediately positioned between the inner and outer portions. The deflecting portion is intermediately positioned between the first and second insulating portions to deflect acoustics from the heat/acoustic source. A method for manufacturing the heat shield is also disclosed.



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ACOUSTICAL HEAT SHIELD

BACKGROUND OF THE INVENTION

Field of Invention

[0001] The present invention relates to improvements in heat shields for internal combustion engines, and more particularly to heat shields having improved acoustic and heat dampening features.

Description of the Prior Art

[0002] Those skilled in the art will appreciate the issues involved in the dampening of undesirable acoustics and heat generated by automotive components, such as, for example, exhaust manifolds, turbochargers, exhaust gas recirculators and catalysts. Known heat shields that provide acoustic dampening may include multiple aluminum foil layers with embossments. Typically, the embossments are positioned in a staggered relationship to contact and space opposing foil layers. However, because the embossments directly contact the opposing foil layers, undesirable noise issues, such as rattle, may occur as a result of the vibrations of the embossments against the foil layers.

[0003] Other known heat shields comprise a three-layer structure including inner and outer metal layers with an intermediately disposed sound and heat shielding layer. Such three-layer heat shields have design restrictions that require the inner and outer layers to include different thicknesses so as to provide resonant frequencies that dampen undesirable acoustics. Even further, such three-layer heat shields undesirably require that the intermediately disposed sound and heat shielding layer includes a relatively large thickness in comparison to the inner and outer layers to fully damp the sound and heat to operable levels.

[0004] Thus, there is a need for an alternative heat shield that may overcome the undesirable fallbacks of traditional heat shields.

SUMMARY OF THE INVENTION

[0005] The disclosed invention provides a heat shield including an inner portion, an outer portion, first and second insulating portions, and a deflecting portion. The inner portion includes a reflective material to reflect thermal energy that radiates from a heat/acoustic

source. The outer portion includes a rigid material to provide structural support for the heat shield. The first and second insulating portions are intermediately positioned between the inner and outer portions. The deflecting portion is intermediately positioned between the first and second insulating portions to deflect acoustics from the heat/acoustic source.

[0006] The disclosed invention also provides a method for manufacturing the heat shield. The method includes the steps of blanking the outer portion to form a hemmed portion, positioning the first insulating portion over the outer portion, positioning the deflecting portion over the first insulating portion, positioning the second insulating portion over the deflecting portion, positioning the inner portion over the second insulating portion, and hemming the hemmed portion of the outer portion about a periphery of the heat shield defined by the first insulating portion, the deflecting portion, the second insulating portion, and the inner portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is an exploded perspective view of a heat shield according to one embodiment of the invention.

[0008] Figure 2 is an assembled side view of a portion of the heat shield of Figure 1.

[0009] Figure 3A is a magnified view of a surface of the heat shield portion that opposes an insulation portion of the heat shield, which is referenced from line 3 of Figure 1.

[0010] Figures 3B-3D are magnified views of alternative embodiments of the heat shield surface illustrated in Figure 3A.

[0011] Figure 4A is a cross-sectional view of the heat shield portion of Figure 3A, taken along lines 4-4 of Figure 2.

[0012] Figures 4B-4D are cross-sectional views of alternate embodiments of the heat shield surface illustrated in Figure 4A, which corresponds to the magnified views illustrated in Figures 3B-3D.

[0013] Figure 5 is a perspective view of an isolator adapted for coupling to the heat shield illustrated in Figure 1.

[0014] Figure 5A is a cross-sectional view of the isolator of Figure 5.

[0015] Figures 6A-6H illustrates an assembly process for forming the heat shield of Figure 1.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0016] Referring initially to Figure 1, components comprising a heat shield 10 in accordance with the present invention are shown in exploded form. As illustrated, the heat shield 10 includes an inner portion 12 and outer portion 14 that are spaced by insulating portions 16, 18 with an intermediately positioned deflecting portion 20. The outer portion 14 is constructed from a rigid material to provide structural support for the heat shield 10, and, as seen more clearly in Figure 2, the inner portion 12 comprises a reflective material to reflect undesirably produced thermal energy, or heat, which is generally shown at H, that radiates from a heat/acoustic source 32. The deflecting portion 20 includes a material that is defined by a plurality of dimples 22 and dual air pockets 24 (Figures 3A-4D) that deflect undesirably produced acoustics, A, from the heat/acoustic source 32.

[0017] According to the illustrated embodiment, the inner portion 12, the outer portion 14, and the insulating portions 16, 18 preferably each includes aluminized clad, aluminized steel, and mineral fibers, respectively, to provide adequate heat absorption, structural support, and insulation. The inner portion 12 and outer portion may be perforated and/or dimpled, as well. As seen in Figure 2, the inner and outer portions 12, 14 include first and second thickness, T1 and T2, and the insulating portions 16, 18 include third and fourth thicknesses, T3 and T4. The thicknesses T1, T2, T3 and T4 may include any desirable thickness. For example, thickness, T1, may preferably range between approximately 0.15mm-0.40mm, thickness, T2, may preferably range between approximately 0.30mm-0.60mm, and thicknesses, T3, T4, may preferably range between approximately 0.50mm-3.00mm. Although any desirable thickness not included in any of the ranges listed may be incorporated in the design of the heat shield 10, the above described thickness ranges provide optimal weight and performance characteristics of the heat shield 10.

[0018] In conjunction with the illustrated embodiment of the heat shield 10, the thickness, T1, may be approximately equal to 0.15mm, the thickness, T2, may be approximately equal to 0.40mm, the thickness, T3, may be approximately equal to 0.92mm, and the thickness, T4, may be approximately equal to 0.92mm. The thickness, T1, of the inner portion 12 is thinner in comparison to the thickness, T2, of the outer portion 14 to decrease the overall weight of the heat shield 10. Aside from weight considerations, the primary function of the inner portion 12 is to provide a reflective surface as opposed to a

relatively thicker, rigid surface that the outer portion 12 defines at T2. Although the insulation portions 16, 18 in the described example have the same thicknesses, T3, T4, it is important to consider that the insulation portions 16, 18 may have any desirable thickness. Also, other thickness values for T1, T2, T3, and T4 that do not fall within the preferable ranges listed above may be implemented in other embodiments; however, greater thicknesses of T1, T2, T3, and T4 may undesirably introduce clearance issues and increase the cost and weight of the heat shield 10.

[0019] Other embodiments of the heat shield 10 may comprise inner and outer portions 12, 14 that include any other desirable materials such as stainless steel, nickel, or the like. Even further, the insulating portions 16, 18 may include any other desirable fiber, such as graphite fiber, ceramic fiber, or the like. Insulating portions 16, 18 may also include (but do not require) any desirable type of organic or inorganic binder. Although alternate materials such as ceramic fiber, graphite fiber, and nickel perform adequately when implemented in the design of the above-described heat shield 10, ceramic fiber, graphite fiber, and nickel tend to also increase the overall cost and weight of the heat shield 10. Yet even further, mineral fibers are preferable for implementation in the design of the heat shield 10 in favor of ceramic and graphite fibers because mineral fibers are nearly 100% recyclable.

[0020] Referring now to Figure 2, the deflecting portion 20 includes any desirable rigid material, such as steel, having any desirable thickness, T5, which is measured from the dimple peak 26 on an upper surface 28 to the dimple valley 29 on a lower surface 30. Alternatively, the deflecting portion 20 may be constructed of woven or knitted steel. As illustrated, the dimples 22 and air pockets 24 are formed on an upper surface 28 and lower surface 30 of the deflecting portion 20. The thickness, T5, may range from approximately 0.90mm - 1.50mm. According to the illustrated embodiment, the thickness, T5, is approximately equal to 0.91mm.

[0021] Functionally, the dimples 22 and air gaps 24 function in the dissipation of undesirable noise energy, or acoustics, A, that radiate from the heat/acoustic source 32, which may be an automotive component, such as an exhaust manifold. If the heat/acoustic source 32 is an exhaust manifold, it is preferable to space the exhaust manifold and heat shield 10 by a distance, D, such that an air gap, G, (Figure 2) is formed between the exhaust manifold and the heat shield 10. The distance, D, may be any desirable length. One possible

implementation of the heat shield 10 may include a distance, D, from the acoustic/heat source 32 that falls between the range of approximately 8.0mm-15.0mm.

[0022] The dissipation of the acoustics, A, is illustrated in Figure 2 such that the acoustics, A, travel in a path from the heat/acoustics source 32 and are deflected or broken-up upon encountering the deflecting portion 20. The insulating portions 16, 18 complement the function of the deflecting portion 20 by providing pre- and post-damping of the acoustics, A, while also functioning in isolating the inner, outer, and deflecting portions 12, 14, 20. If the insulating portions 16, 18 were not included in the design of the heat shield 10, the inner, outer and deflecting portions 12, 14, 20, may otherwise produce inherently undesirable acoustics, such as rattle, that would typically occur as a result of the vibrations emitted from the inner, outer, and deflecting portions 12, 14, 20. Even further, the insulating portions 16, 18 provide a secondary barrier to absorb the undesirable acoustics, A, that may not be entirely damped by the deflecting portion 20 in the event that the noise energy of the acoustics, A, increase past the design threshold of the deflecting portion 20.

[0023] Referring to Figures 3A-3D, the dimples 22 may have any desirable shape that functions in the dissipation of acoustics, A, and heat, H. For example, the dimples 22 may have a generally spherical (Figure 3A), pyramid (Figure 3B), conical (Figure 3C), or trapezoidal shapes (Figure 3D). As illustrated, the dimples 22 are distributed in an offset row and column pattern; however, the dimples 22 may alternatively comprise a uniform row and column distribution or a randomized non-uniform distribution.

[0024] As seen in the illustrated embodiment, the deflecting portion 20 generally includes an even distribution of dimples 22 and air gaps 24. In this example, because there is an even distribution of dimples 22 and air gaps 24, acoustic and heat dissipation performance is matched (i.e. there is an approximate one-to-one ratio of dimples 22 and air gaps 24). However, if the amount of dimples 22 is decreased (i.e. a larger air gap field is created), acoustic dissipation may be compromised in favor of providing improved heat absorption characteristics as a result of the heat, H, being forced to travel through more air. Conversely, the dimples 22 may be formed to a shape that minimizes the air gaps 24, and the acoustic dissipation characteristics may improved as the heat absorption characteristics may be compromised.

[0025] As seen more clearly in Figures 4A and 4B, the dimples 22 and air gaps 24 may be symmetrically disposed about a plane, P. Alternatively, as seen in Figures 4C and 4D, the dimples 22 and air gaps 24 may be disposed in a non-symmetric pattern. Referring to each of the illustrated embodiments in Figures 4A-4D, the deflecting portion 20 may also include perforations 34 that are generally disposed about the dimple peaks 26 and valleys 29 on the upper and lower surfaces 28, 30 of the deflecting portion 20. Functionally, the perforations 34 may increase the size of the air gap 24 by permitting each air gap 24 to be bounded by each insulating portion 16, 18 about the deflecting portion 20. Also, the perforations 34 may permit compression of the dimples 22 about opposing perforation surfaces 31 if an undesirable load is applied to the heat shield 10.

[0026] Although generally symmetric or non-symmetric geometric shapes are suggested for the dimples 22, it is contemplated that the dimples 22 may include other shapes or designs including perforations 34 or openings that do not necessarily face the insulating portions 16, 18 in a perpendicular relationship. For example, the deflecting portion 20 may comprise a texture or grain that creates dimple-like features including minimized air gaps 24. One possible deflecting portion 20 may include a high-density wire mesh. In this instance, the deflecting portion 20 does not necessarily include symmetric or geometrically controlled dimples 22 and air passages or gaps 24, but rather, a textured surface to dissipate acoustics, A, as well as minimized air passages or gaps 24 that assists in the absorption of heat, H. Another embodiment of the absorption portion 20 may include a generally honeycomb-shaped surface. While a honeycomb-shaped surface may increase heat absorption performance and structural rigidity of the heat shield 10 by providing air gaps 24, the honeycomb design may compromise the overall performance of the acoustic dampening by providing relatively flat upper and lower surfaces 28, 30 that do not include dimples 22.

[0027] If desired, the heat shield 10 may also include an isolator assembly 36 that assists in damping vibrations applied to the heat shield 10 from the heat/acoustic source 32. As illustrated in Figures 5 and 5A, the isolator assembly 36 includes top and bottom cold rolled steel washers 38, 40 and upper and lower isolators 39, 41 (Figure 5A). A low bearing tube 44 is positioned through washers 38, 40 and upper and lower isolators 39, 41. The upper and lower isolators 39, 41 each include stepped portions 43, 45 that mate together when upper and lower isolators 39, 41 are assembled together so as to form a groove 47. The steel washers 38, 40 are crimped about a stainless steel mesh 42 that is positioned about an outer

periphery of upper and lower isolators 39, 41. The groove 47 serves to hold the heat shield 10 such that the heat shield 10 interlocks with the steel mesh 42. Once interlocked on the heat shield 10, the isolator assembly 36 penetrates the heat shield 10, perpendicular to the layers of the heat shield 10. According to one embodiment of the invention, the isolator 36 may include an external diameter of approximately equal to 20.0mm, and internal diameter of approximately equal to 8.0mm and a height approximately equal to 10.0mm.

[0028] Referring now to Figures 6A-6H, a process for assembling the heat shield 10 is illustrated. First, as seen in Figure 6A, the outer portion 14 is blanked to form a hemmed portion 46 for subsequent closing to form a hemmed edge 48 (Figure 6D). Then, as seen in Figures 6B and 6C, a blank of steel or other suitable rigid material 20a is inserted into a press or die 50 having a textured surfaces 52 corresponding to the desired shape of the dimples 22. After inserting the steel blank 20a, the press or die 50 is closed to form the deflecting portion 20 including the dimples 22. Prior to forming the dimples 22, the steel blank 20a may include any desirable thickness, T6, that ranges between approximately 0.15mm - 0.40mm. As stated above, after the press or die 50 is closed, the dimples 22 define the thickness, T5, that may range between 0.90mm - 1.50mm.

[0029] Next, as seen in Figure 6D, the insulating portion 18 is positioned over the outer portion 14; the deflecting portion 20 is positioned over the insulating portion 18; the insulating portion 16 is positioned over the deflecting portion 20; and the inner portion 12 is positioned over the insulating portion 16. After the portions 12, 14, 16, 18, 20 are properly positioned, the hemmed portion 46 is pre-closed, as seen in Figure 6D, so that the outer portion 14 may be subsequently closed in a beading step to form the hemmed edge 48, as seen in Figures 6E and 6F. Although shown in a partial side view, it is important to note that the hemming process illustrated in Figures 6A-6F includes the hemmed structural edge 48 about the entire periphery of the heat shield 10 to fully secure each portion 12, 16, 18, 20 stacked therein.

[0030] Then, if desired, heat shield 10 may be formed to a desired contour, such as, for example, the contour of an exhaust manifold (Figure 6G), and subsequently stamped or punch to include passages 54 for fasteners, such as bolts (Figure 6H). Although steps illustrated in Figures 6B and 6C are directed to the formation of the dimples 22, it is contemplated that the deflecting portion 20 may be a preformed component, that is, if a wire

mesh is implemented, and the dimple formation steps illustrated in Figures 6B and 6C may be eliminated. The heat shield 10 may include additional bracket attachments (not shown) that comprise the same components of the heat shield 10. Essentially, the bracket may be riveted to the heat shield 10 to provide a heat shield extension, for other components close to the acoustic/heat source 32. As stated above, if the acoustic/heat source 32 is an exhaust manifold, the bracket may shield other automotive components from the manifold, such as a spark plug. In an automotive application as explained above, the heat shield 10, may withstand thermal temperatures of approximately 650⁰C (1202⁰F) for exhaust manifolds that have operating temperatures as high as 900⁰C (1652⁰F). If the inner portion 12, which provides the primary heat reflecting barrier, includes nickel rather than aluminum, the heat shield 10 may withstand temperatures higher than 650⁰C (1202⁰F). The heat shield 10 includes a material formation and composition that includes strength characteristics, corrosion resistance, and other user parameters. For example, the materials described above provide resistance to corrosion as a result of constituents including: the elements, salt, engine fluids, and high temperatures of the manifold.

[0031] It is to be understood that the above description is intended to be illustrative and not limiting. Many embodiments will be apparent to those skilled in the art upon reading the above description. The scope of the invention should be determined, however, not with reference to the above description, but with reference to the appended claims with full scope of equivalents to which such claims are entitled.

WHAT IS CLAIMED IS:

1. A heat shield comprising:

an inner portion and outer portion, wherein the inner portion includes a reflective material to reflect thermal energy that radiates from a heat/acoustic source, wherein the outer portion includes a rigid material to provide structural support for the heat shield;

first and second insulating portions intermediately positioned between the inner and outer portions; and

a deflecting portion intermediately positioned between the first and second insulating portions that deflects acoustics from the heat/acoustic source.

2. The heat shield according to Claim 1, wherein the deflecting portion material is constructed of steel.

3. The heat shield according to Claim 1, wherein dimples and air pockets are formed on an upper surface and lower surface of the deflecting portion.

4. The heat shield according to Claim 3, wherein the dimples may be formed to a geometric shape, wherein the geometric shape is selected from the group consisting of a spherical shape, a pyramid shape, a conical shape, and a trapezoidal shape.

5. The heat shield according to Claim 3, wherein the dimples are distributed in offset rows and columns.

6. The heat shield according to Claim 3, wherein the dimples are distributed in a uniform row and column pattern.

7. The heat shield according to Claim 3, wherein the dimples are distributed in a randomized non-uniform pattern.

8. The heat shield according to Claim 3, wherein the dimples and air gaps are symmetrically disposed about a plane.

9. The heat shield according to Claim 3, wherein the dimples and air gaps are non-symmetrically disposed about a plane.

10. The heat shield according to Claim 3, wherein the dimples include perforations disposed about dimple peaks located on the upper surface of the deflecting portion, and about dimple valleys located on the lower surface of the deflecting portion.

11. The heat shield according to Claim 10, wherein the deflecting portion includes a thickness defined by the dimple peaks on an upper surface to the dimple valleys on a lower surface.

12. The heat shield according to Claim 1, wherein the deflecting portion may comprise a high-density wire mesh or honeycomb-shaped surface.

13. The heat shield according to Claim 1, wherein the inner portion material includes aluminized clad, the outer portion material includes aluminized steel, and the insulating portions includes a mineral fiber material.

14. The heat shield according to Claim 1, wherein the inner portion includes a first thickness approximately equal to 0.15mm, the outer portion includes a first thickness approximately equal to 0.40mm, the first insulating portion includes a first thickness approximately equal to 0.92mm, the second insulating portion includes a first thickness approximately equal to 0.92mm, and the deflecting portion includes a first thickness approximately equal to 0.91mm.

15. The heat shield according to Claim 1, wherein the heat/acoustic source is at least one of an exhaust manifold, a turbo charger, an exhaust gas recirculator or a catalyst.

16. The heat shield according to Claim 15, wherein the heat shield is spaced from the exhaust manifold by a predetermined distance so as to form an air gap between the exhaust manifold and the heat shield.

17. The heat shield according to Claim 1 further comprising at least one isolator that damps vibrations applied to the heat shield from the heat/acoustic source.

18. The heat shield according to Claim 17, wherein the isolator includes top and bottom cold rolled steel washers crimped about a stainless steel mesh that are positioned about an outer periphery of a low bearing tube.

19. The heat shield according to Claim 1, wherein at least one of said inner and outer portions are perforated and/or dimpled.

20. The heat shield according to Claim 1, wherein said deflecting portion is constructed of woven or kitted steel.

21. A method for manufacturing a heat shield comprising the steps of:

blanking an outer portion to form a hemmed portion;

positioning a first insulating portion over the outer portion;

positioning an acoustic and heat deflecting portion over the first insulating portion;

positioning a second insulating portion over the deflecting portion;

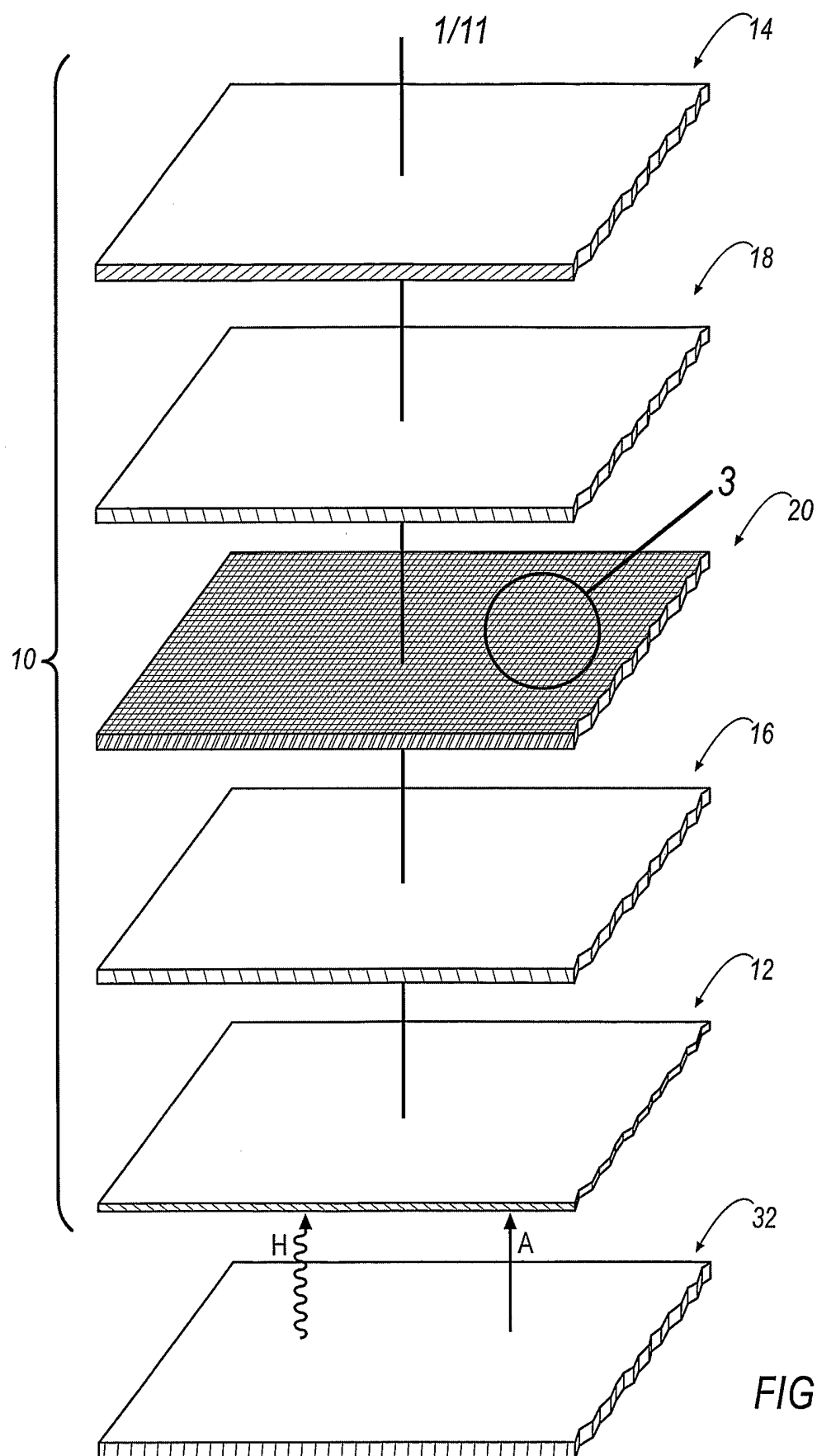
positioning an inner portion over the second insulating portion; and

hemming the hemmed portion of the outer portion about a periphery of the heat shield defined by the first insulating portion, the deflecting portion, the second insulating portion, and the inner portion.

22. The method according to Claim 21 further comprising the step of forming said deflecting portion by blanking a rigid material in a press or die having a textured surface so as to produce dimples and air gaps on the deflecting portion.

23. The method according to Claim 21 further comprising the step of forming the heat shield to a contour of a component that shields acoustics and heat.

24. The method according to Claim 21 further comprising the step of forming passages in the heat shield.



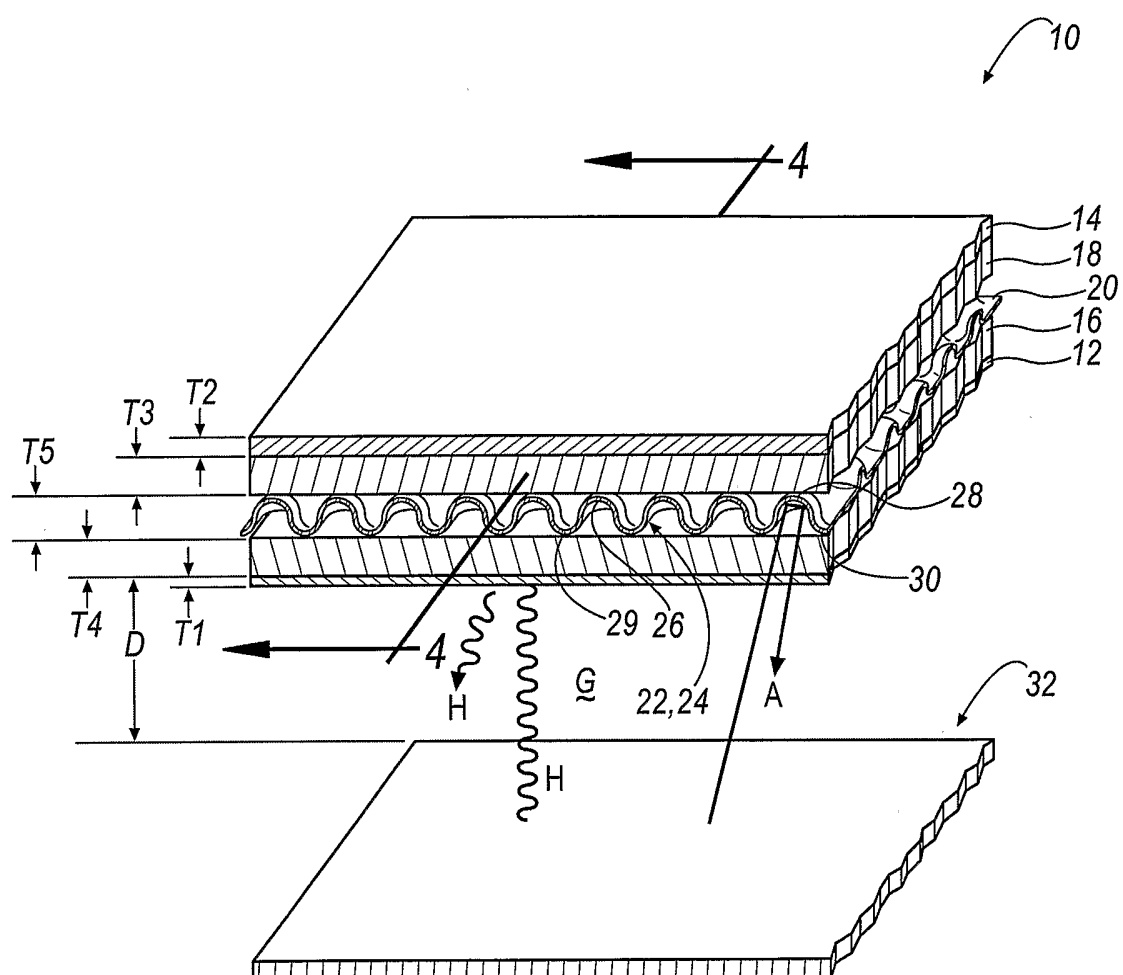


FIG. 2

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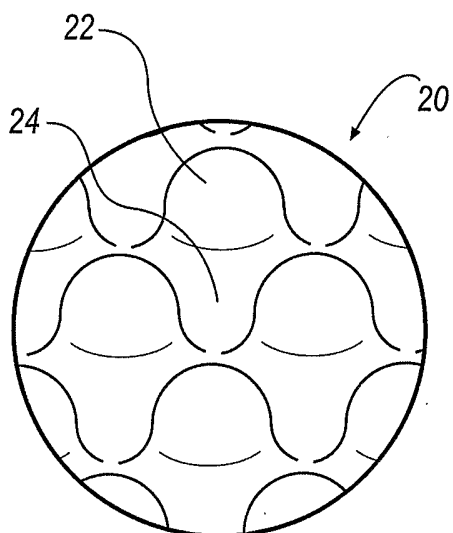


FIG. 3A

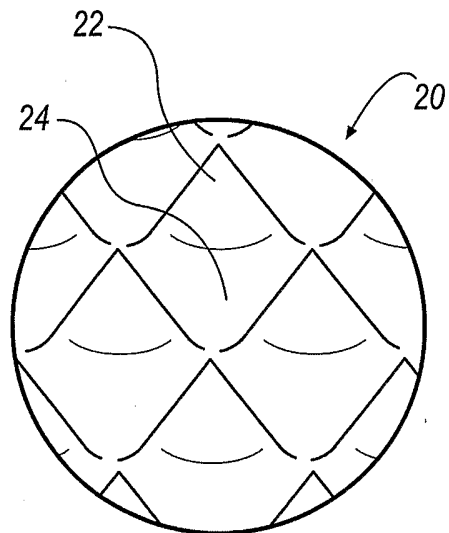


FIG. 3B

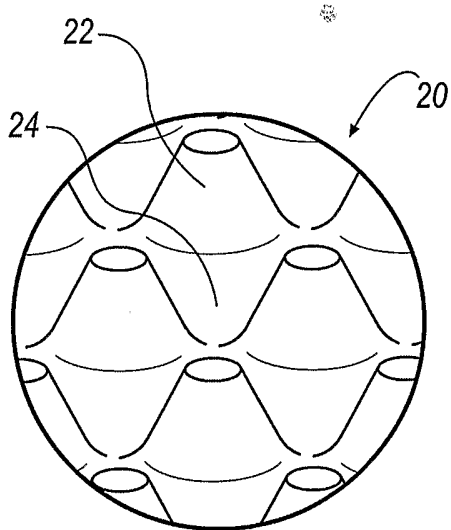


FIG. 3C

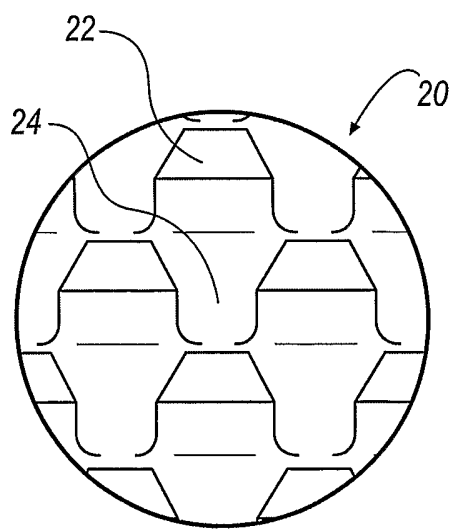


FIG. 3D

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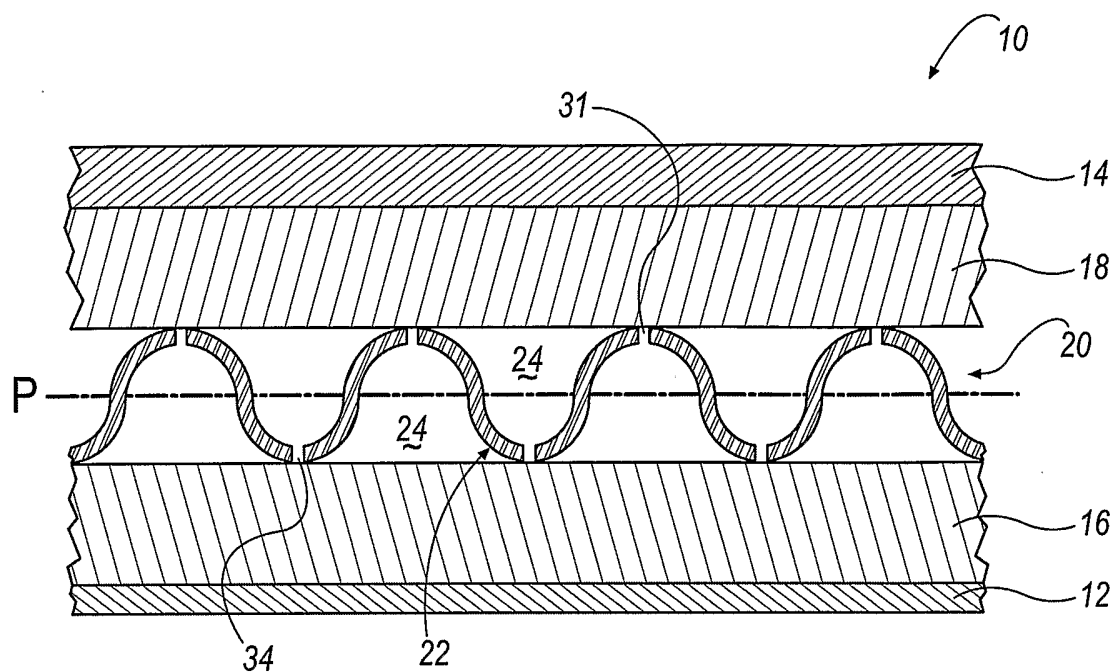


FIG. 4A

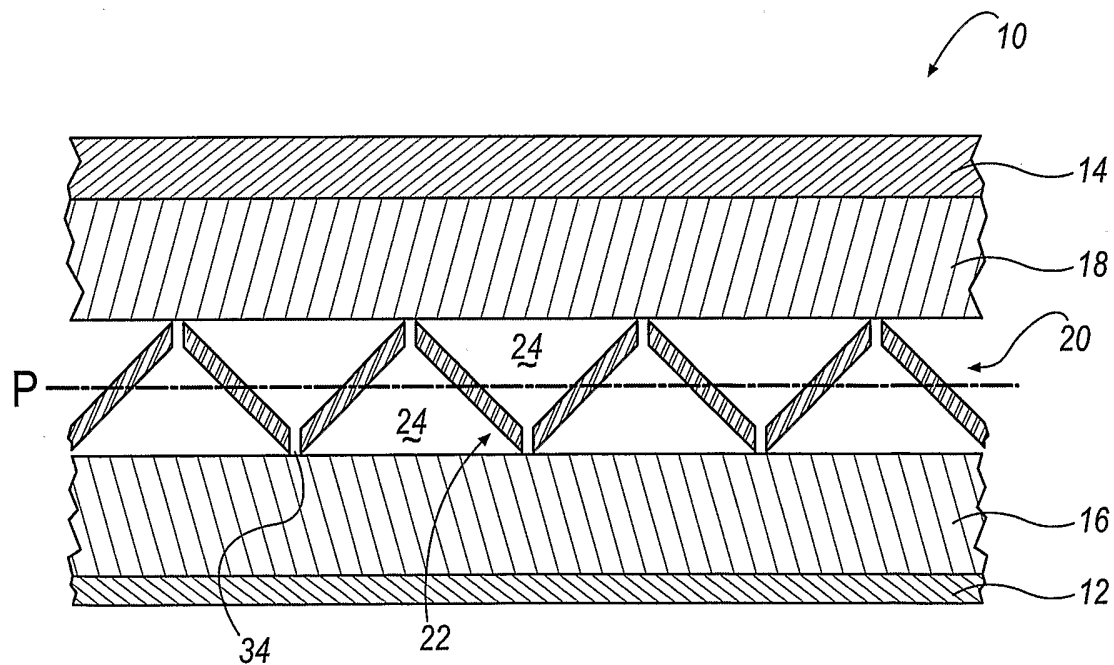


FIG. 4B

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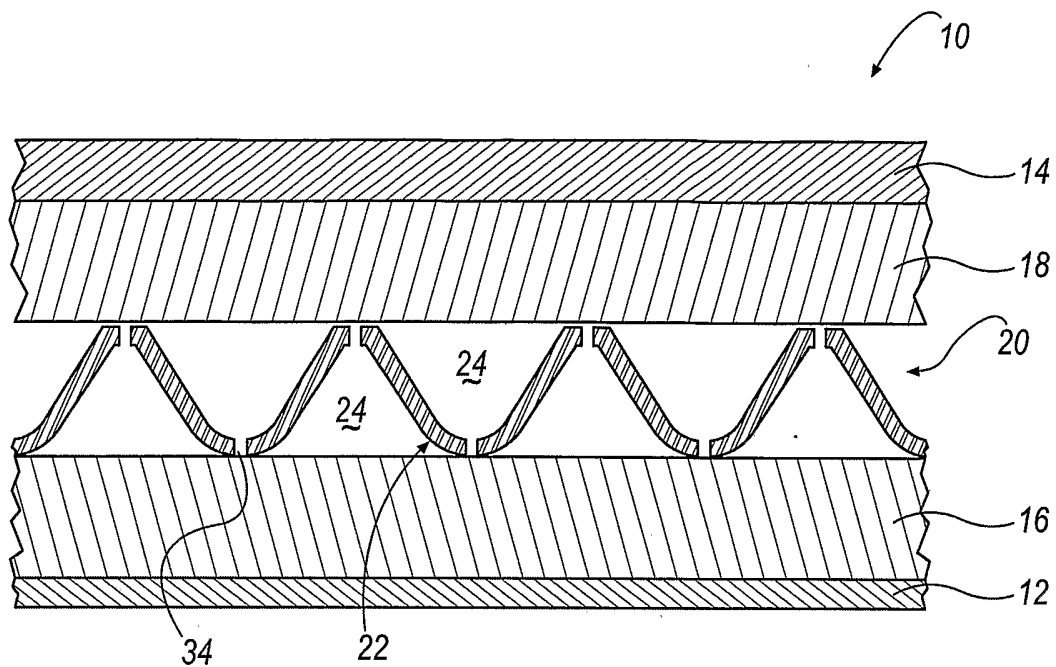


FIG. 4C

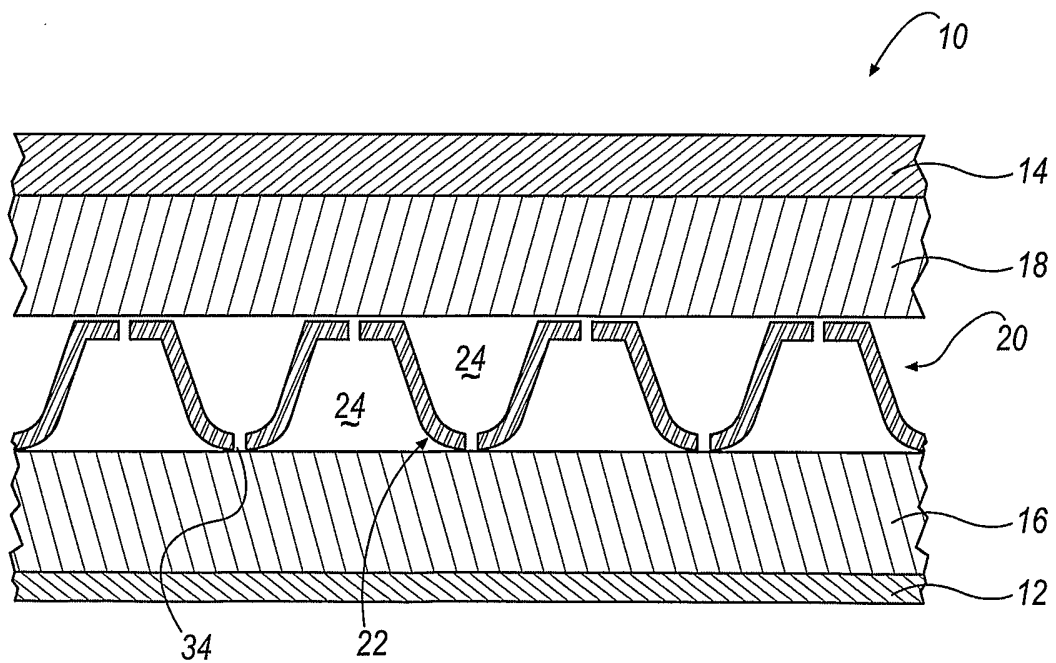


FIG. 4D

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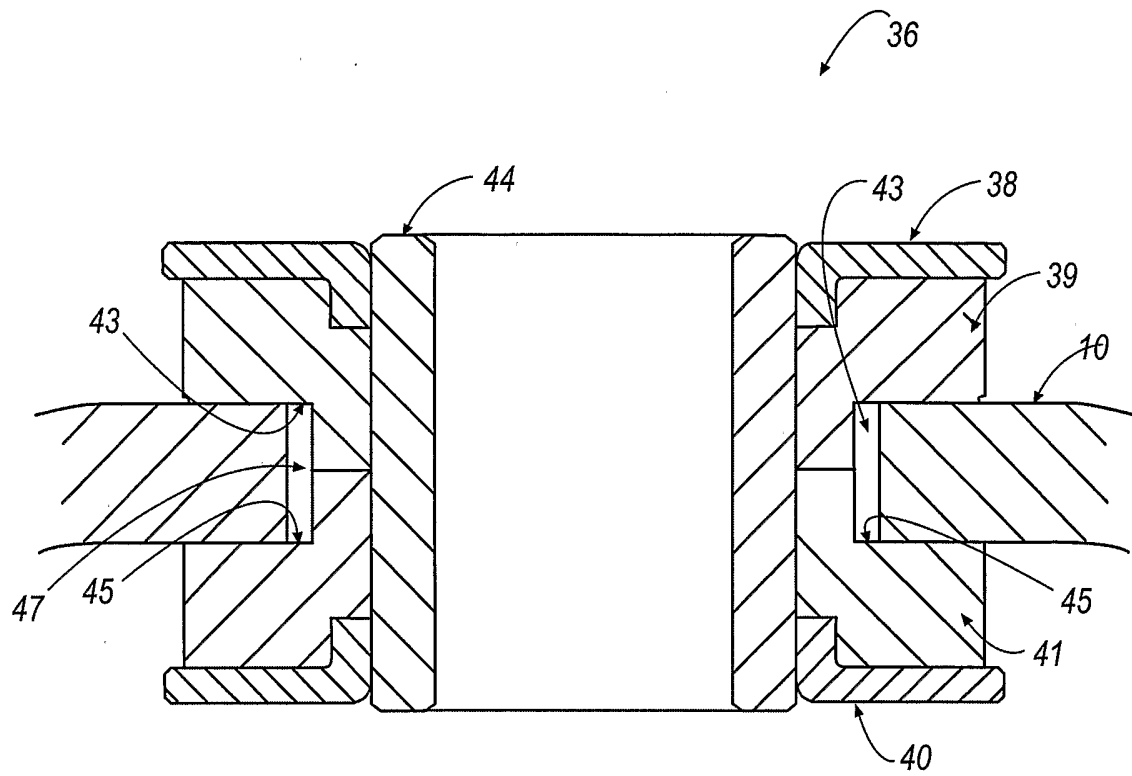


FIG. 5A

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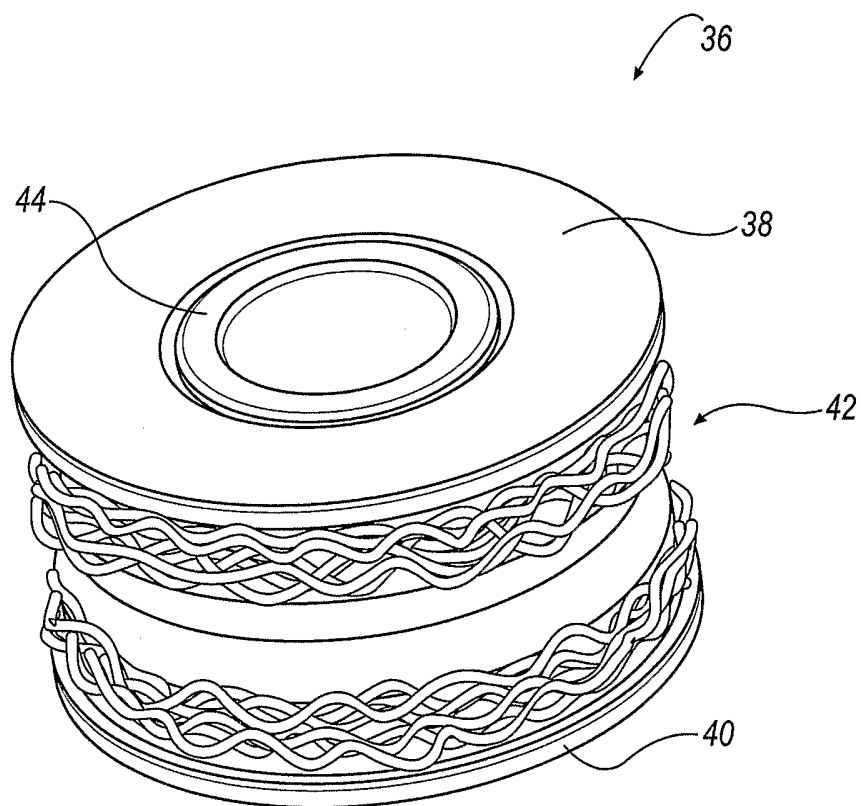


FIG. 5B

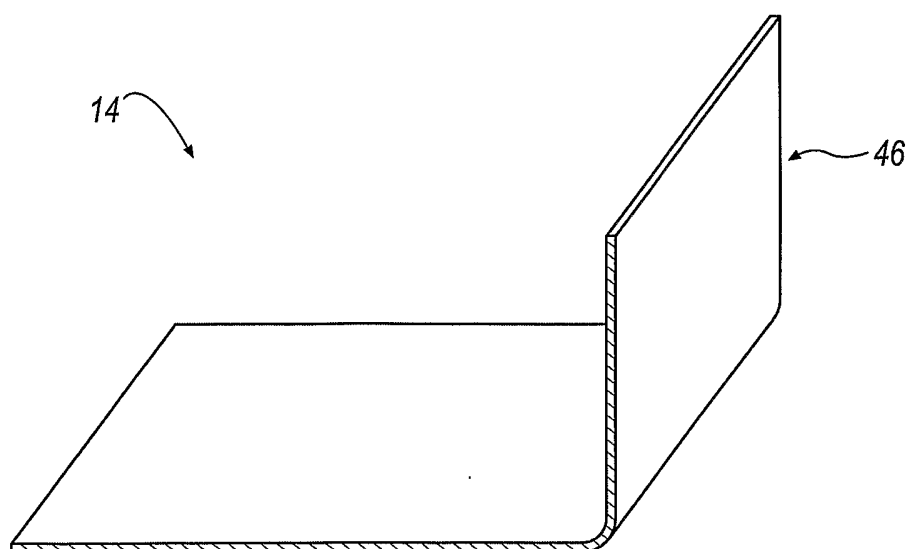


FIG. 6A

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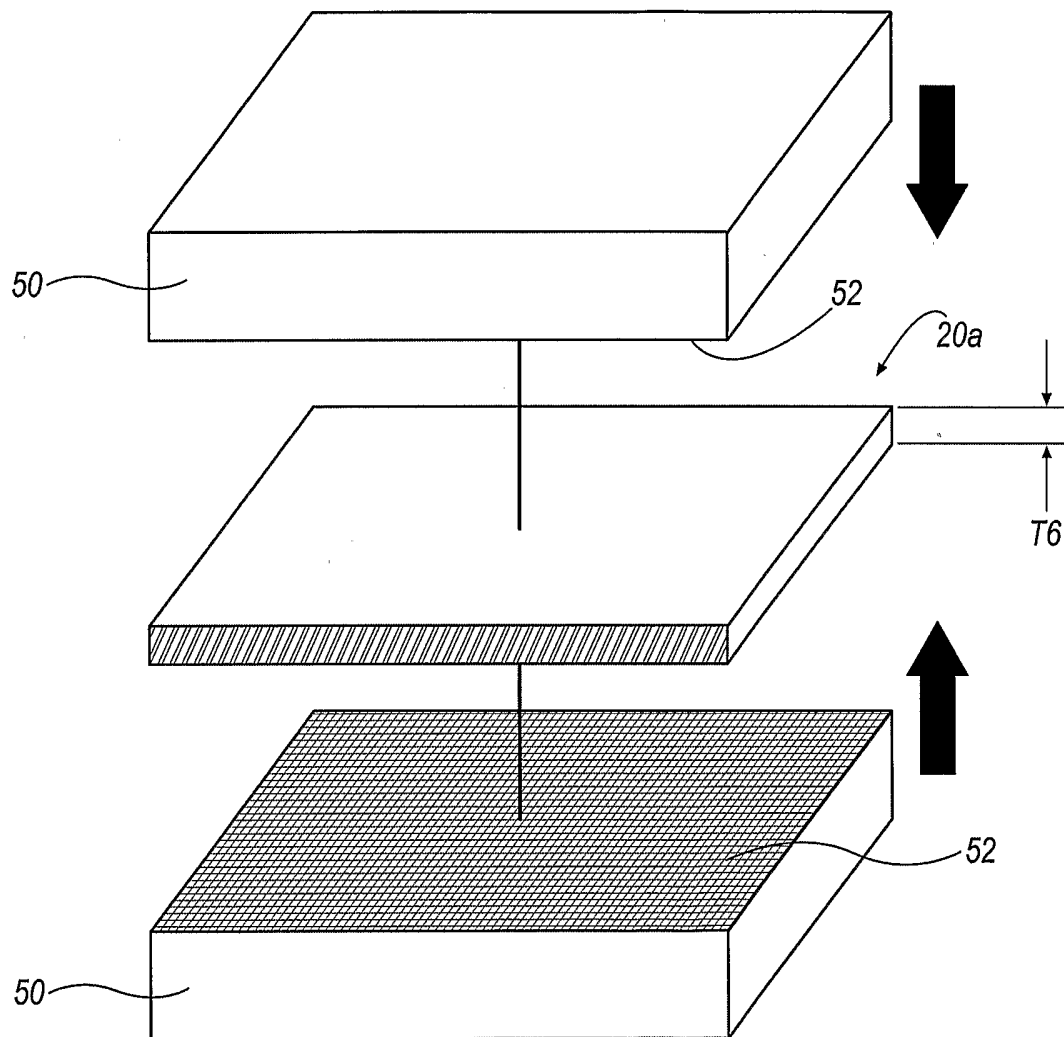


FIG. 6B

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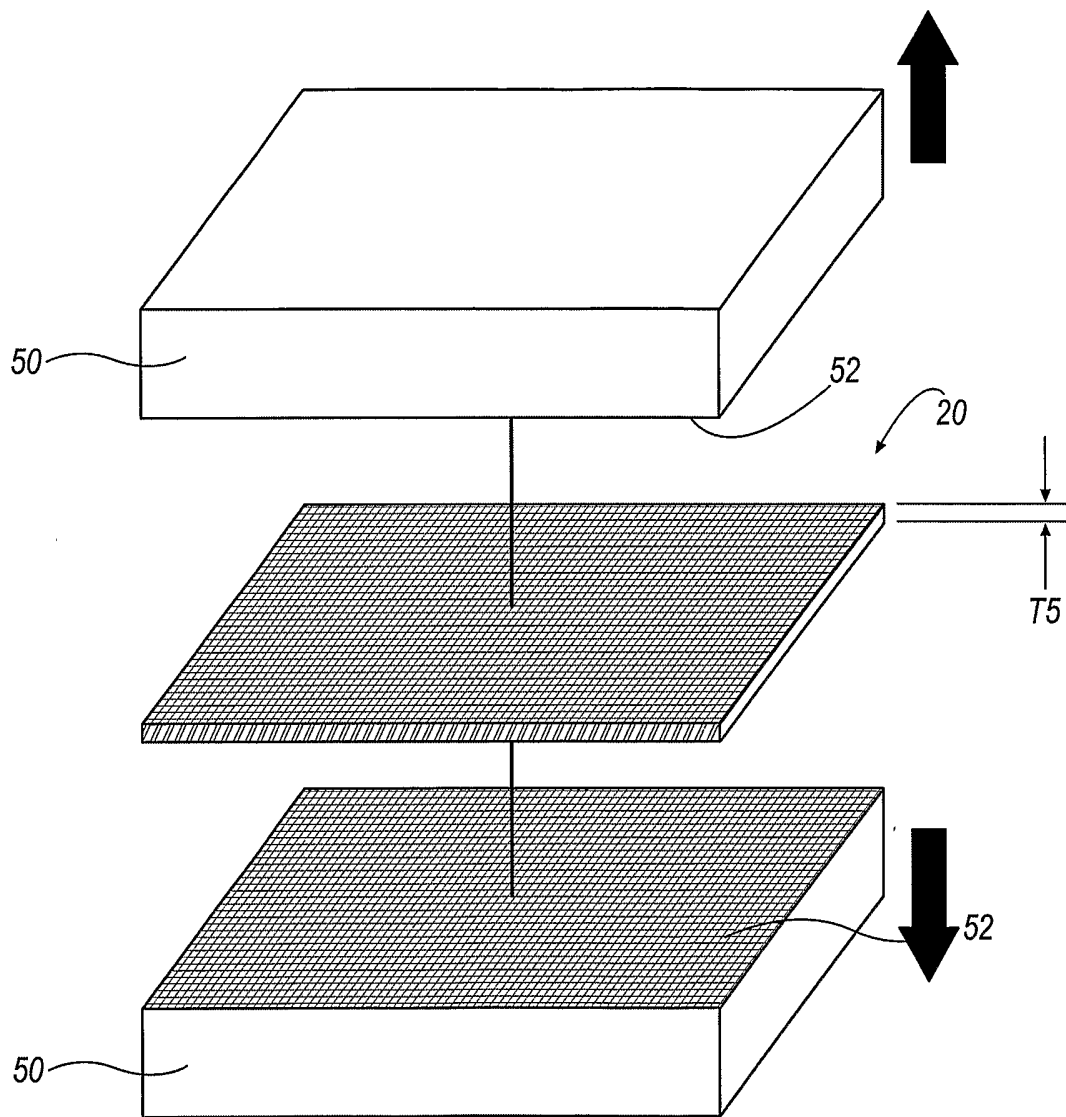
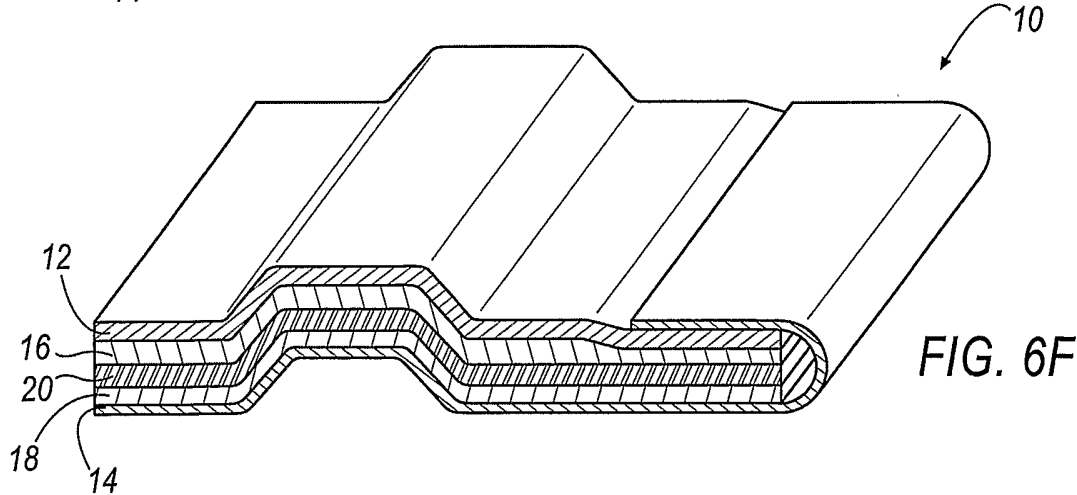
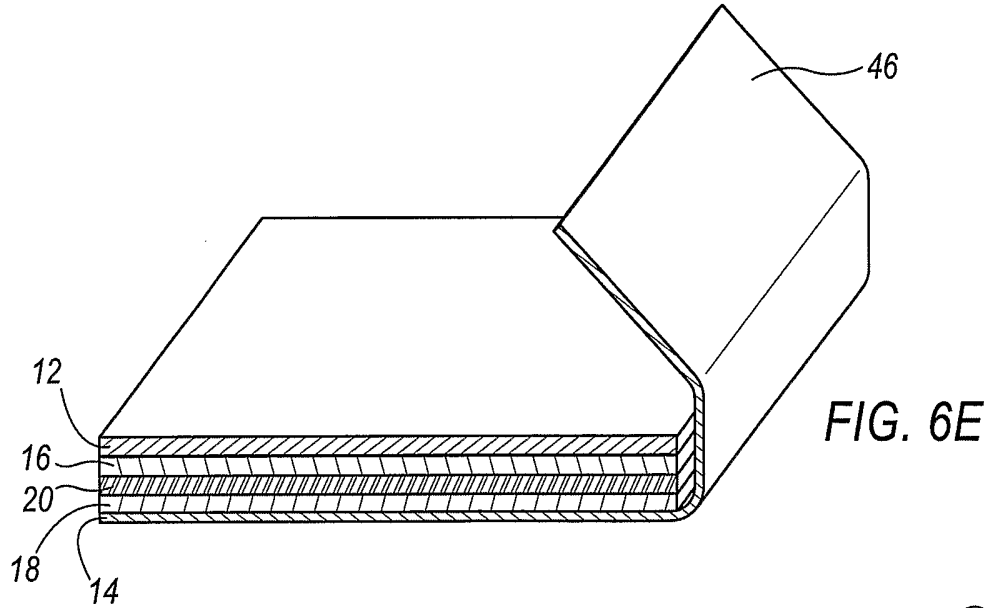
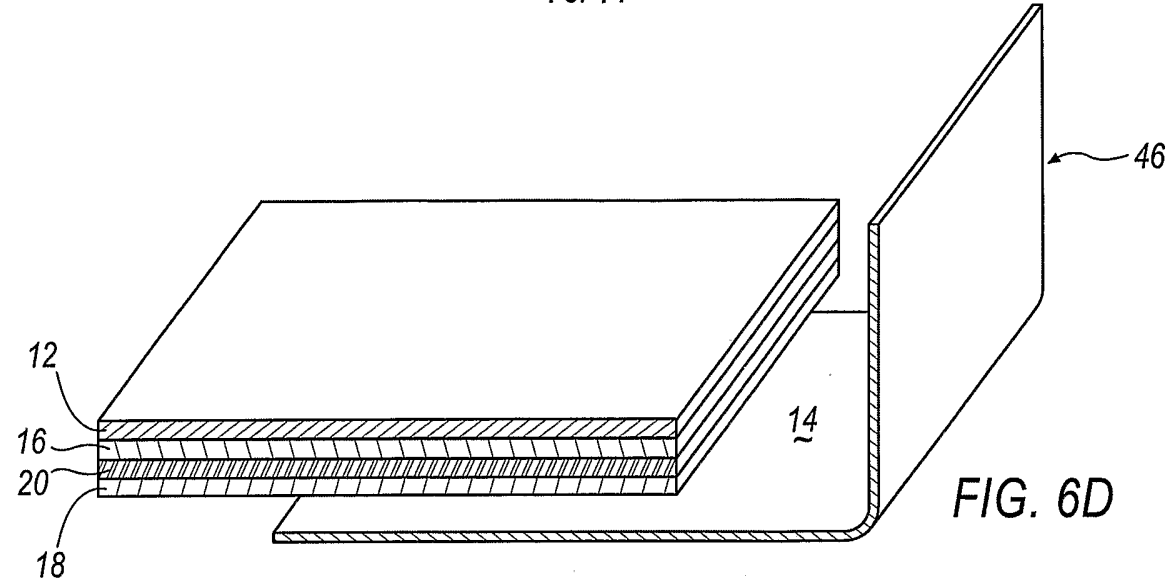


FIG. 6C

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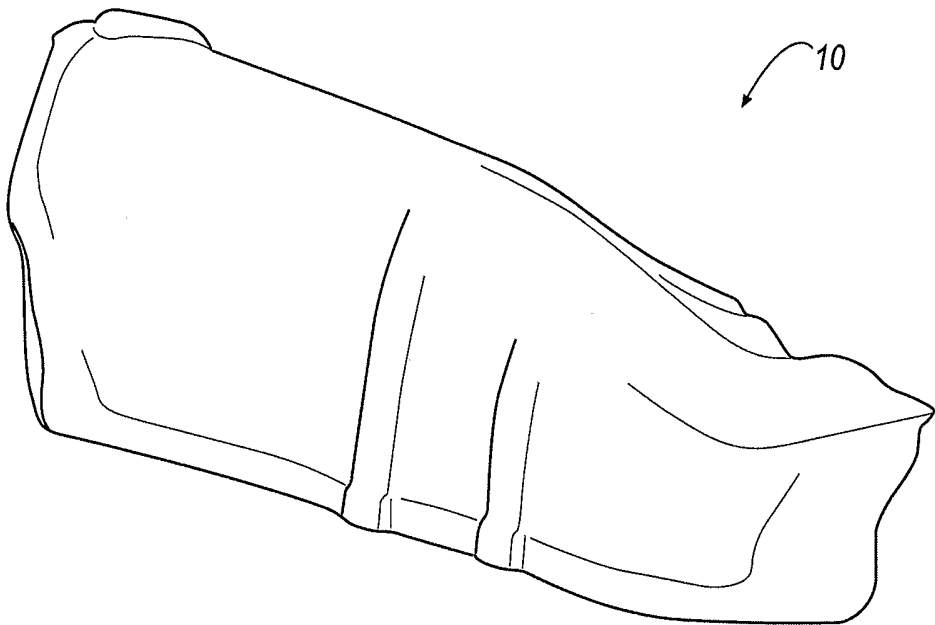


FIG. 6G

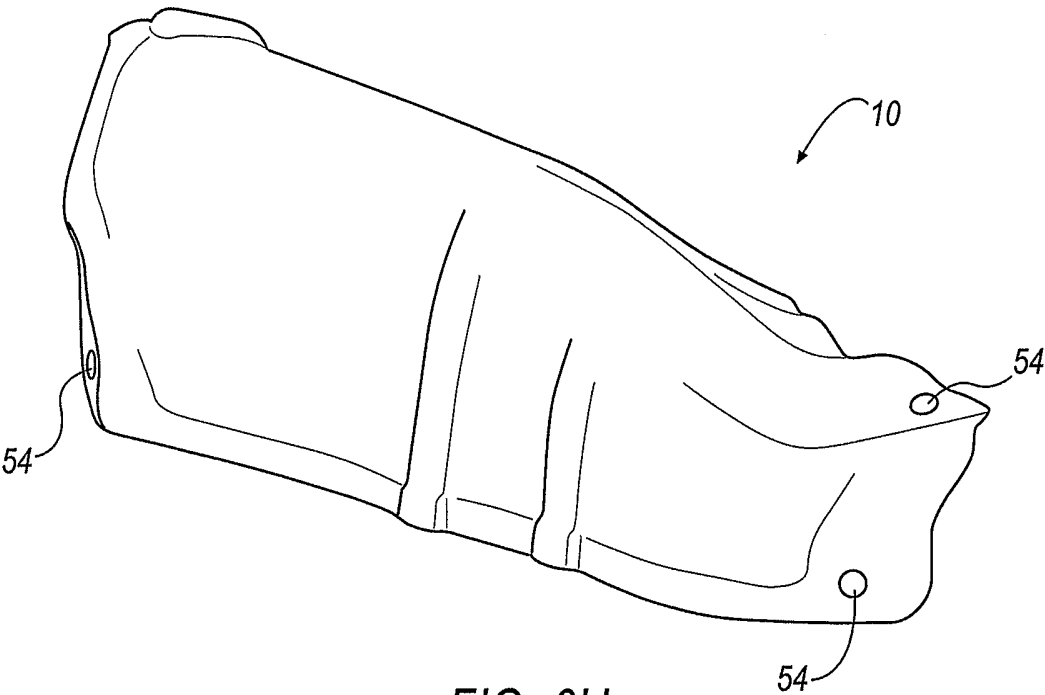


FIG. 6H

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/017106

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B32B7/02 B32B3/10 F16L59/02 F02C7/24

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)

IPC 7 B32B F16L F02C

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 practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97/36743 A (ATD CORP INC) 9 October 1997 (1997-10-09) page 3, lines 11-30; figure 3 -----	1
A	GB 2 152 431 A (CAPE BOARDS & PANELS LTD) 7 August 1985 (1985-08-07) figure 1 -----	1-20
A	WO 90/12168 A (SNYDER STEPHEN J) 18 October 1990 (1990-10-18) claim 1 -----	1-24



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

17 September 2004

Date of mailing of the international search report

05/10/2004

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Schweissguth, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2004/017106

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