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(71) Applicant (for all designated States except US): **E.I. DU PONT DE NEMOURS AND COMPANY** [US/US]; 1007 Market Street, Wilmington, DE 19898 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **YU, Yong** [CN/US]; 1366 Welland Drive, Rochester, MI 48306 (US).

(74) Agent: **HAMBY, William, H.**; E.I. du Pont de Nemours and Company, Legal Patent Records Center, 4417 Lancaster Pike, Wilmington, DE 19805 (US).

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(54) Title: HOUSINGS OF LAYERED AND BONDED POLYMERIC MATERIALS SUITABLE FOR SOUND DAMPENING AND THEIR MANUFACTURE

(57) Abstract: Housings and other containment devices are disclosed, suitable for enclosing a variety of components (for example, mechanical or electrical components). The housings are constructed of a substantially rigid polymeric layer or blendable material and a substantially flexible polymeric layer or blendable material, and such that the housing provides a reduction in sound transmitted therethrough in comparison to a single layer of polymeric material identical to the rigid layer herein. Processes for their manufacture are also disclosed.



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TITLE**Housings of Layered and Bonded Polymeric Materials
Suitable for Sound Dampening and Their Manufacture**

5

FIELD OF THE INVENTION

The present invention relates to housings and covers made from a plurality of layers of relatively stiff engineering plastic material bonded with relatively flexible polymeric material, and together with methods of their manufacture. More particularly the present invention relates to such articles formed from laminates of nylons or polyesters joined with elastomeric materials, and which function to reduce the attenuation of sound and noise.

15

BACKGROUND OF THE INVENTION

Durable housings, covers, containers and the like are often essential to protecting the integrity of mechanical or electrical components placed within them. Such articles are widely used throughout the automotive and electronics industries, for example. Depending on the specific nature of the application, housings and other containment devices must meet exacting standards with respect to rigidity, impermeability to the elements, structural integrity, soundproofing characteristics and cost, among others.

Many illustrations of containment devices are found in the automotive field for example, including uses for housings and covers within both the engine compartment (often referred to as "under-the hood" applications) and the occupant compartment (under the dashboard, for example) of a motor vehicle. Materials and constructions

of housings are selected for their ability to withstand or even dampen vibration during operation of the vehicle, or for their suitability for multiple motions such as repetitive opening and closing. Such housings must additionally withstand extremes of temperature and attack from the elements, particularly those in under-the-hood applications. Another consideration is the visual appearance of the housing to the consumer of the product in which it is incorporated. In still other situations housings function to attenuate the propagation of sound generated by or associated with the components contained within them. While it is generally acknowledged that metal and metal alloy housings perform well in these conditions, they are costly and their manufacture is highly specialized, and further their weight must be factored into the design of any vehicle.

Likewise in the electronics field, fragile or delicate components rely on several varieties of housings to protect their integrity or to segregate them from other components. Electronic components associated with solenoids or motors are typically concentrated within a housing, and are prone to failure if the housing does not adequately protect this equipment from the elements. The coordinated mechanical movements of electronic components must be properly protected. One such example is in chain drivers, where housings must be designed to afford this protection. As is seen in the automotive field, electronic components in operation sometimes also generate undesirable noise and effective housings are installed in an effort to reduce such transmissions.

As noted above, metal is the traditional material of choice in automotive, electronic and myriad other applications because of its durability and operability in the extreme environments encountered. Metal (in particular, steel) offers attractive benefits including resistance to cracking, relatively high impermeability to chemical attack, reliable operability in cold and hot temperature conditions, and the like. However there are several disadvantages to metal housings associated with cost and weight on a per part basis. For example, techniques for forming metal parts are highly specialized and of necessity include a variety of metal stamping and machining operations.

Various alternative approaches have been recently pursued, in an effort to develop housings that are not entirely metal-based. In particular, plastic shrouds or hybrid plastic/metal structures have been designed with various degrees of success, and with the replacement of metal with plastic there is an associated savings in cost and increase in design freedom (particularly if the plastic features are capable of being injection molded). However, plastic structures or hybrid structures result in an increased transmission of sound in comparison to all-metal systems, making them difficult to accept as alternative design solutions.

Moreover, plastic housings also have a tendency to vibrate excessively, effectively making them media for the propagation of sound transmissions. For example when plastic housings are placed into service in under-the-hood applications they do little to reduce the overall engine noise. Metals and metal alloys alone are not

prone to the transmission of noise and component vibrations unless coupled with plastic features, and this condition contributes to the overall noise level in and around the vicinity of the component. While any such noise usually does not affect the operation of the components themselves, it detracts from the "look and feel" and the perceived quality of the system encased in the material.

10 It is an object of the present invention to provide a polymeric housing material which when incorporated into encapsulation applications results in reduced transmission of noise compared to hybrid metal/plastic counterpart housings. Another object of the invention
15 herein is the considerable savings in both weight and cost, for plastic based housings compared to those that are made from or rely in part on metal. It is a feature of the present invention to provide housings or covers suited to a variety of applications, and having stiff
20 plastic layers bonded by a flexible layer of polymeric material, in a way that the sound transmissions are effectively dampened across these materials. Another feature of the present invention is to provide polymeric materials that offer resilience in extreme temperature
25 environments and resist degradation from chemical attack. An advantage of the present invention is its moldability, thereby avoiding post-formation machining operations. These and other objects, features, and advantages of the present invention will become better understood upon
30 having reference to the description of the invention herein.

SUMMARY OF THE INVENTION

There is disclosed and claimed herein a housing suitable for the attenuation of sound therethrough. This housing comprises a plurality of substantially rigid polymeric layers each separated by and bonded to a substantially rigid polymeric layer adjacent thereto by a substantially flexible polymeric layer. The substantially rigid polymeric layers are independently selected from polyethylenes, polyamides, and thermoplastic elastomers having a crystalline polybutylene terephthalate hard segment and an amorphous glycol soft segment. Moreover each substantially flexible polymeric layer is independently selected from an elastomeric material suitable for adhering to said substantially rigid polymeric layers which it contacts. The housing provides for a reduction in sound transmitted therethrough in comparison to a single rigid layer of the same material as the substantially rigid polymeric layer herein.

There is also disclosed and claimed herein processes for the preparation of the aforementioned housings, comprising injection molding a plurality of substantially rigid polymeric layers independently selected from polyethylenes, polyamides, and thermoplastic elastomers having a crystalline polybutylene terephthalate hard segment and an amorphous glycol soft segment and one or more substantially flexible polymeric layers independently selected from an elastomeric material suitable for adhering to said substantially rigid polymeric layers which it contacts into desired shapes. The substantially rigid polymeric layers are then oriented to alternate with the substantially flexible

polymeric layers, and such that adjacent substantially rigid polymeric layers are bonded together by the substantially flexible polymeric layer positioned therebetween. Altogether the housing provides a
5 reduction in sound transmitted therethrough in comparison to a single rigid layer of the same material as the substantially rigid polymeric layer herein.

Another process disclosed and claimed herein for the
10 preparation of the housing of the invention comprises first blending together (i) the substantially rigid polymeric materials as above and (ii) the substantially flexible polymeric materials as above suitable for
adhering to said substantially rigid polymeric material
15 which it contacts; followed by injection molding the blend of the substantially rigid polymeric material and the substantially flexible polymeric material into a desired shape. Housings so formed also provide a
reduction in sound transmitted therethrough in comparison
20 to a single rigid layer of the same material as the substantially rigid polymeric layer herein.

The invention will become better understood upon having
reference to the drawing herein.

25

IN THE DRAWING

FIGURE 1 is a cross sectional view of a housing of the invention.

5

DETAILED DESCRIPTION OF THE INVENTION

The housings as disclosed herein are useful in a wide range of applications, and in general are applicable as sound-reducing structures wherever they may be desirably used. Without intending to limit the generality of the foregoing, applications of special interest include applications for the reduction of noise, vibration and harshness, for example air intake manifolds. Regarding the latter, air intake manifolds (commonly abbreviated "AIM's") consist of an array of passages and channels that direct air (or a mixture of air and fuel) from the throttle body to the intake ports in the cylinder head of internal combustion engines. The flow typically proceeds from the throttle body into a chamber called the plenum, which in turn feeds individual tubes, called runners, leading to each intake port. Engine breathing is enhanced if the intake manifold is configured to optimize the pressure pulses in the intake system.

As used herein, the term "substantially" (as in, substantially rigid or flexible polymeric material is a qualitative term intended to convey a broad range of materials that have the desired property as a characteristic. "Substantially rigid" materials therefore are directed to those materials that one having skill in the art of materials science will appreciate is basically solid and inflexible. Likewise a "substantially flexible" material will be appreciate by

those having skill in this field as having some degree of bendability or cushioning effect associated with it.

Continuous bonding of the polymeric layered materials is essential to achieving good performance herein. Having reference to FIGURE 1, there is shown generally at 10 a representative housing of the invention, and in which an enclosure 16 is defined. The substantially rigid polymeric layers 12 are secured to one another by the substantially flexible polymeric layer 14. That is, cohesive forces alone are typically sufficient to secure the layers together. Adhesives may also be applied to the interface of the layers; suitable adhesives are selected based on their compatibility with the material of each of the layers and their adhesive properties, again as is commonly appreciated by those having skill in this field. The layers may also be hot pasted together or the substantially flexible polymeric layer(s) may be spray coated onto the substantially rigid polymeric layers. Of special interest, it has been found particularly attractive to use coinjection to join the materials together. Consideration should also be given to incorporating overmolding of the substantially rigid polymeric layer around portions of the substantially flexible polymeric layer, in a way that the layers are disposed in an interlocking pattern. The combination of layers is sometimes considered a "laminated" structure. Mechanical techniques for securing layers of materials together are generally not suited to the instant invention.

Alternatively, and instead of using a layered approach to form the housings of this invention, the various

materials (both rigid and flexible) may be first blended together and then injection molded as the housing.

Blending is a popular technique that is well understood in the field, and care should be taken during blending operations to ensure that there is a uniform distribution of the substantially rigid and flexible polymeric materials. The materials may be blended together in the hopper for example. In such case, the resulting blend is at once injection moldable and when formed into an article of desired shape suggests overall is uniformly pliable.

Once secured to each other, the substantially rigid polymeric layer or material and the substantially flexible polymeric layer or material together form a firm surface that is resistant to movement and vibration and readily absorbs sound waves and energy, and this assists with dampening of sound transmissions therethrough. Altogether the sound from components within the formed enclosure is not readily transmitted across the formed polymeric surface, because the movement of air mass is dampened and the dynamic energy of sound is absorbed.

A wide variety of polymeric materials may be used in formation of the substantially flexible polymeric layer or blendable material, and those materials that are readily injection moldable are preferable. For example, Zytel® polyamides offered by E.I. DuPont de Nemours & Company offer superior benefits in moldability and longevity of performance. Likewise a broad selection of materials is available for the substantially flexible polymeric layer or blendable material. Hytrel® polyester-based materials also offered through E.I.

DuPont de Nemours & Company are suitable for this purpose.

5 The invention will become better understood upon having reference to the following examples.

EXAMPLES

Materials & Methods:

10 A device was constructed to measure sound transmissions across different materials. A square box was placed within a sound proof booth. The box is also suitably insulated on all six sides to be considered sound proof. A speaker was placed inside the box (as through a hinged door on one side of the box), and connected to an
15 external source so that it receives radio signals and transmits sound (either a constant monotone signal or a pulsed signal) inside the box. A circular opening was cut into the top panel of the box, and samples of materials for evaluation are placed into this opening and
20 suitably fastened in a securing manner. A microphone is placed within the sound proof booth but outside the box, and is connected to equipment capable of measuring the sound so received.

25

Samples Tested:

Samples of materials tested (and their sound loss measured in decibels (dB)) are as follows:

5	Material	Thickness (in mm)	Sound Loss
	Crastin® SK605 polyester and Hytrel® 5526 polyester (Crastin® exterior layers and Hytrel® interior layer each 10 roughly the same thickness, with the total thickness of sample measured at 5 mm)		42
	Crastin® SK605	5	37
15	Zytel® 70G33 nylon	5	38
	Hytrel® 5526	5	40

20 These results confirm that the surfaces formed in
accordance with the invention offer sound dampening
qualities that are superior to surfaces of the various
incumbent plastic materials. Moreover the multilayered
25 construction above offered better sound dampening than
either of the materials when tested alone.

30 It is readily understood and appreciated that those
having skill in the art to which this invention pertains
can make any number of variations and modifications to
the invention as set forth and described herein. Such
enhancements are contemplated as within the spirit and
scope of the invention.

IN THE CLAIMS

- 5 1. A housing suitable for the attenuation of sound
therethrough, comprising a plurality of substantially
rigid polymeric layers each separated by and bonded to a
substantially rigid polymeric layer adjacent thereto by a
substantially flexible polymeric layer, and wherein said
10 substantially rigid polymeric layers are independently
selected from polyethylenes, polyamides, and
thermoplastic elastomers having a crystalline
polybutylene terephthalate hard segment and an amorphous
glycol soft segment, and further wherein each
15 substantially flexible polymeric layer is independently
selected from an elastomeric material suitable for
adhering to said substantially rigid polymeric layers
which it contacts, and further wherein said housing
provides for a reduction in sound transmitted
20 therethrough in comparison to a single rigid layer of the
same material as said substantially rigid polymeric
layer.
- 25 2. The housing of Claim 1 consisting of two
substantially rigid polymeric layers and one
substantially flexible polymeric layer.
- 30 3. The housing of Claim 2 wherein said substantially
rigid polymeric layer is polyamide and said substantially
flexible polymeric layer is a thermoplastic elastomer
having a crystalline polybutylene terephthalate hard
segment and an amorphous glycol soft segment.

4. The housing of Claim 1 in the shape of an air intake manifold.

5. A process for the preparation of a housing suitable for the attenuation of sound therethrough, comprising:
injection molding a plurality of substantially rigid polymeric layers independently selected from polyethylenes, polyamides, and thermoplastic elastomers having a crystalline polybutylene terephthalate hard segment and an amorphous glycol soft segment and one or more substantially flexible polymeric layers independently selected from an elastomeric material suitable for adhering to said substantially rigid polymeric layers which it contacts into desired shapes; orienting said substantially rigid polymeric layers to alternate with said substantially flexible polymeric layers, and such that adjacent substantially rigid polymeric layers are bonded together by said substantially flexible polymeric layer positioned therebetween,
and further such that said housing provides a reduction in sound transmitted therethrough in comparison to a single rigid layer of the same material as said substantially rigid polymeric layer.

6. A process for the preparation of a housing suitable for the attenuation of sound therethrough, comprising:
blending together (i) substantially rigid polymeric material independently selected from polyethylenes, polyamides, and thermoplastic elastomers having a crystalline polybutylene terephthalate hard segment and an amorphous glycol soft segment and (ii) substantially

flexible polymeric material independently selected from an elastomeric material suitable for adhering to said substantially rigid polymeric material which it contacts; and

5 injection molding said substantially rigid polymeric material and said substantially flexible polymeric material into a desired shape;

wherein said housing provides a reduction in sound transmitted therethrough in comparison to a single rigid
10 layer of the same material as said substantially rigid polymeric layer.

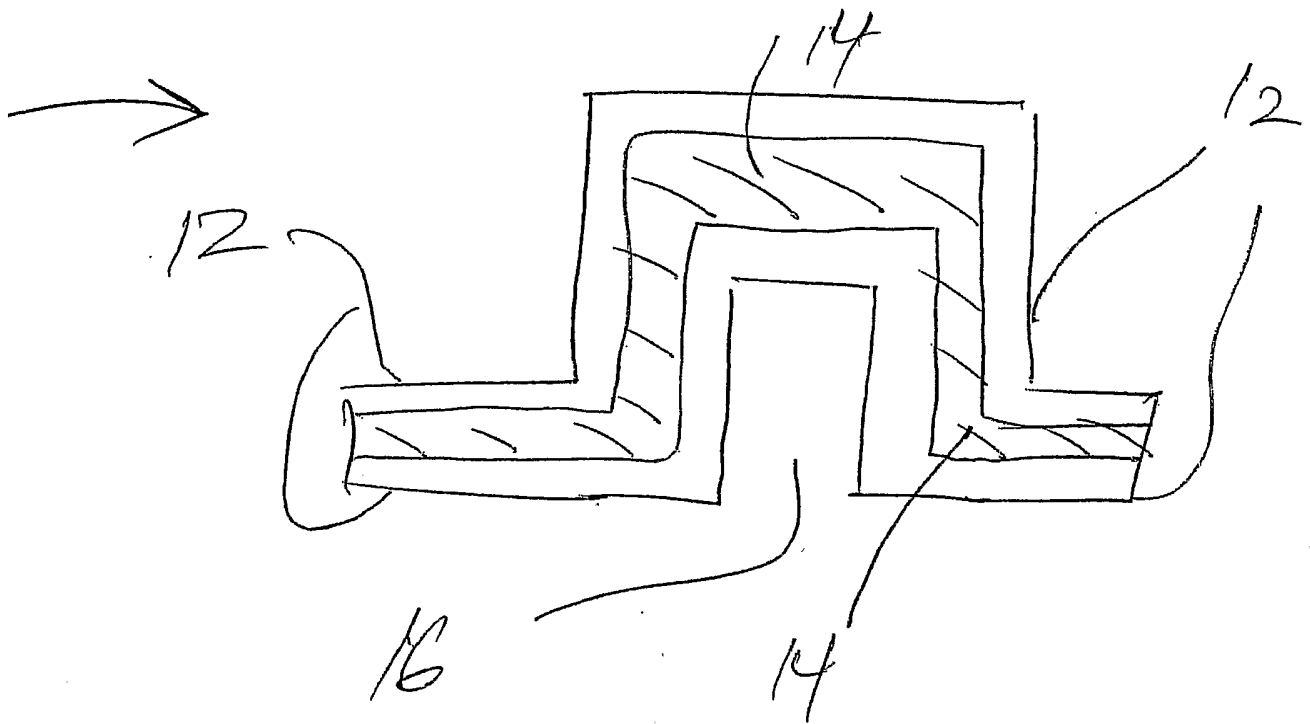


FIGURE 1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/JP2004/016708

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B32B3/00

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 C08L

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, PAJ, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	claims 1,7,8	1-3
X	WO 96/21560 A (MINNESOTA MINING & MFG) 18 July 1996 (1996-07-18) claim 1 page 18, line 9 - line 14 page 27, line 1 - line 9 figure 3a	1,2
X	US 3 855 376 A (ONO K ET AL) 17 December 1974 (1974-12-17) claim 1 column 9, line 42 - line 47	1,2
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Hillebrand, G

INTERNATIONAL SEARCH REPORT

International Application No
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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.
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