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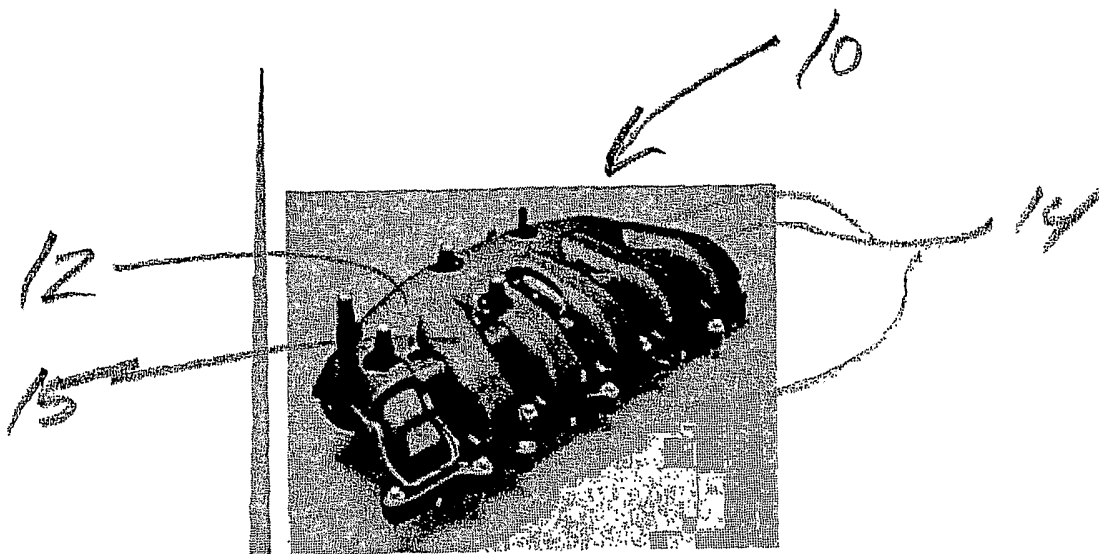
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(54) Title: AIR INTAKE MANIFOLDS AND OTHER STRUCTURES OF RIGID AND FOAMED POLYMERIC MATERIALS HAVING REDUCED NOISE TRANSMISSION AND PROCESSES FOR THEIR PREPARATION



(57) Abstract: Polymeric structures are disclosed, suitable for incorporation into gasoline or diesel internal combustion engines. These structures (and particularly, air intake manifolds) are constructed of an outer rigid polymeric layer and an inner foamed, porous polymeric layer, and offer superior sound dampening properties. Processes for their manufacture are also disclosed.

TITLE

**Air Intake Manifolds and Other Structures of Rigid and Foamed
Polymeric Materials having Reduced Noise Transmission and
Processes for Their Preparation**

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FIELD OF THE INVENTION

The present invention relates to structures (and more specifically to air intake manifolds) including a rigid
polymeric layer and a foamed polymeric layer attached
thereto, and methods of manufacture. More particularly the
present invention relates to such air intake manifolds in
which the rigid and foamed polymeric layers are suitably
joined, and which dampen the transmission of sound
therethrough.

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BACKGROUND OF THE INVENTION

A variety of structures and articles are placed into
working environments in which undesirable sound transmission
develops. Research and development initiatives are
frequently directed to minimizing the propagation of sound
along or across such structures, in an effort to enhance
their attractiveness in the ability to dampen such sound.
One area of particular interest is the manufacture of sound-
dampening air intake manifolds (commonly abbreviated "AIMs").

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Air intake manifolds are vital, major components in
gasoline or diesel powered internal combustion engines.
Typical configurations of AIMs include 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. The flow typically proceeds from the throttle body
into a chamber called the plenum, which in turn feeds

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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.

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Because of the requirements of durability and operability in extreme environments associated with automotive and vehicular under-the-hood applications, a variety of structural components including AIMS have

10 conventionally been made from metal. Metal offers attractive benefits including resistance to cracking, relatively high impermeability to chemical attack, reliable operability in cold and hot temperature zones, and the like. In the past steel has been the material of choice for these applications,

15 although aluminum is often used in the more expensive luxury automobile market. However there are several disadvantages to metal parts, associated with cost and weight on a per part basis. For example, techniques for forming metal parts are highly specialized, including a variety of stamping and

20 machining operations. And in particular, AIMS fashioned from aluminum require substantial, specialized secondary engineering; that is, operations for exacting tolerances and physical constraints required for precise fitting of the AIM within the under-the-hood compartment. Moreover, the weight

25 attributed to metal AIMS is undesirable from the point of view of its contribution to the overall curb weight of the vehicle. More weight in the vehicle is associated with reduced fuel economy and gas mileage.

30 Various alternative approaches have been recently pursued, in an effort to develop structures for these applications that are not entirely metal-based. Plastic shrouds have been incorporated to overlay a smaller metal

manifold design for example, in an attempt to reduce the overall weight of the component. However the plastic shroud results in an increased transmission of sound. Other approaches include various designs of plastic sheathing to
5 insulate the metal manifold assembly. However because these approaches are largely dependent on plastics for some portion of the overall AIM design, they do not produce optimal results in effective sound management.

10 Plastic components have a tendency to vibrate excessively, and therefore non-metal articles when placed into service 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
15 with plastic features, and this condition contributes to the overall noise level in the occupant compartment. While any such noise does not affect the operation of the engine itself, it detracts from the "look and feel" and perceived quality of the automobile from the perspective of the driver
20 and passengers.

It is an object of the present invention to provide polymeric structures and articles which when incorporated into automotive under-the-hood
25 applications results in reduced transmission of engine noise compared to all plastic or hybrid metal and plastic structures. Another object of the invention herein is the considerable savings in both weight and cost, for plastic based parts compared to
30 those that are made from or rely in part on metal. It is a feature of the present invention to provide air intake manifolds having a rigid plastic layer and a foamed plastic layer secured thereto, 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
5 temperature environments and resist degradation from chemical attack, making them ideal candidates for AIMS. An advantage of the present invention is its moldability (for example, polymeric AIMS can be injection molded), thereby avoiding post-formation
10 machining operations. These and other objects, features, and advantages of the present invention will become better understood upon having reference to the description of the invention herein.

15 **SUMMARY OF THE INVENTION**

There is disclosed and claimed herein structures suitable for gasoline and diesel internal combustion engines, comprising a first rigid polymeric layer and a second foamed polymeric layer secured thereto, and wherein said first layer
20 is disposed outside said second layer, and further wherein said second layer comprises air bubbles of a nominal diameter in excess of 0.25 mm.

There is also disclosed and claimed herein processes for
25 the preparation of the aforementioned structures, comprising injection molding a first rigid polymeric layer in the shape of the structure defining an exterior surface and an interior surface, and subsequently securing a second foamed polymeric layer along said interior surface, said second layer further
30 comprising air bubbles of a nominal diameter in excess of 0.25 mm.

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

IN THE DRAWINGS

5 FIGURE 1 is a side view of an air intake manifold in accordance with the invention; and

FIGURE 2 is a side view in partial cross section of an air intake manifold in accordance with the invention,
10 depicting the various polymeric layers described herein.

DETAILED DESCRIPTION OF THE INVENTION

Having reference to FIGURE 1, there is shown generally at 10 a conventional design for an air intake manifold (in
15 this case, for a six-cylinder engine). The body 12 is connected to individual passages 14 that direct air (or a mixture of air and fuel) to the intake ports in the cylinder head (not shown). The first rigid polymeric layer 15 is disposed along the exterior surface of the body 12 and
20 individual passages 14 in this figure.

Having reference to FIGURE 2, there is shown generally at 16 an air intake manifold as in FIGURE 1 however with a cutaway view to provide an interior perspective. The second
25 foamed polymeric layer 18 is secured at 20 to the first polymeric layer 15. The second foamed polymeric layer 18 is foamed, as is evident upon closer inspection.

Specifically, the second foamed polymeric layer 18
30 contains bubbles 22 interspersed therein. These bubbles 22 are void formations developed from application of the foaming agent and are generally spherical unless open to a surface of the foamed polymeric layer 18 in which case they appear as

concavities. They are preferably uniformly dispersed throughout the second foamed polymeric layer 18 and are nominally at least 0.25 mm in diameter. Bubbles less than this diameter do not provide much if any sound dampening effect. Typically these bubbles may be formed of any of a variety of sizes greater than 0.25 mm in diameter, although they do not exceed the width of the foamed polymeric layer 18. Small diameter bubbles can be formed in the second foamed polymeric layer 18 and interspersed with the larger diameter bubbles.

The first rigid polymeric layer 15 and the second foamed polymeric layer 18 are secured to one another by any number of means as will be readily appreciated by those having skill in the art to which the invention pertains. Depending on the material selected for these layers, cohesion alone may be 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 second foamed polymeric layer 18 may be spray coated onto the first polymeric layer 15. Of special interest, it has been found particularly attractive to use coinjection to join the materials together. Other techniques for securing of materials together can also be used, for example including mechanical means to join the layers together. Such means might include fasteners, grommets, screws with nuts and bolts, and the like. Care should be taken in selection of any such mechanical joining means not to incorporate elements which themselves tend to unduly propagate sound. Consideration should also be given to incorporating

overmolding of the first rigid polymeric layer 15 around portions of the second foamed polymeric layer 18, in a way that the layers are disposed in an interlocking pattern.

5 Once secured to each other, the first rigid polymeric layer 15 and the second foamed polymeric layer 18 together form a firm surface that is resistant to movement and vibration, and this assists with dampening of sound transmissions therethrough. This effect is further enhanced
10 by the bubbles 22 within the second foamed polymeric layer 18, inasmuch as the bubbles 22 soften said layer and enhance its ability to absorb sound waves and energy. Altogether the sound from engine components is not readily transmitted across the AIM so formed, because the movement of air mass is
15 dampened and the dynamic energy of sound is absorbed. Engine noise is effectively reduced in the region of the AIM, resulting in a quieter occupant compartment experience.

A wide variety of polymeric materials may be used in
20 formation of the first polymeric layer 15, 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
25 materials is available for the second foamed polymeric layer 18, so long as the material selected is capable of foam formation. Zytel® polyamides are useful for this purpose, although foaming must be controlled and monitored to ensure that the bubbles are of sufficient size. It is recommended
30 although not required that the polymeric layers selected are the same material, because their behavior and performance characteristics in service will largely parallel one another. Another benefit to use of the foamed layer is that less

material is used due to displacement of material by the bubbles themselves, reducing costs accordingly.

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

EXAMPLES

Materials & Methods:

A device was constructed to measure sound transmissions
10 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 external source so that it receives
15 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 suitably fastened in a securing manner. A microphone is
20 placed within the sound proof booth but outside the box, and is connected to equipment capable of measuring the sound so received.

Samples Tested:

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

5			
	Material	Thickness (in mm)	Sound Loss
	Aluminum	3	32.6
10	Zytel® 70G33 nylon	3	32.7
	(Single layer of material)		

These results confirm that the surfaces formed from plastic offer sound dampening qualities that closely
15 approximate those of metal surfaces alone. Therefore adding a foamed polymeric layer to the rigid plastic layer above is expected to further enhance the sound dampening qualities of the resulting combined material. This is because even when
20 the total thickness of the combined material is adjusted to provide a total of 3 mm thickness for comparison purposes, the superior sound dampening quality of the foamed polymeric layer accentuates the overall sound loss across the surface.

It is readily understood and appreciated that those
25 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.

30

IN THE CLAIMS

1. A polymeric structure suitable for gasoline and diesel
5 internal combustion engines, comprising a first rigid
polymeric layer and a second foamed polymeric layer
secured thereto, and wherein said first rigid
polymeric layer is disposed outside said second foamed
polymeric layer, and further wherein said second
10 foamed polymeric layer comprises air bubbles having a
nominal diameter in excess of 0.25 mm dispersed
uniformly therethrough.
2. The structure of Claim 1 wherein said first rigid
15 polymeric layer and said second foamed polymeric layer
are polyamides.
3. The structure of Claim 1 wherein said second foamed
polymeric layer is secured to said first rigid
20 polymeric layer by adhesives.
4. The structure of Claim 1 in the shape of an air intake
manifold.
- 25 5. A process for the preparation of a polymeric structure
suitable for gasoline and diesel internal combustion
engines, comprising injection molding a first rigid
polymeric layer in the shape of the air intake
manifold and thereby defining an exterior surface and
an interior surface, and subsequently securing a
30 second foamed polymeric layer along said interior
surface, said second layer further comprising air
bubbles of a nominal diameter in excess of 0.25 mm.

6. The process of Claim 5 useful to form an air intake manifold.
- 5 7. The process of Claim 6 wherein said first rigid polymeric layer and said second foamed polymeric layer are coinjected together.

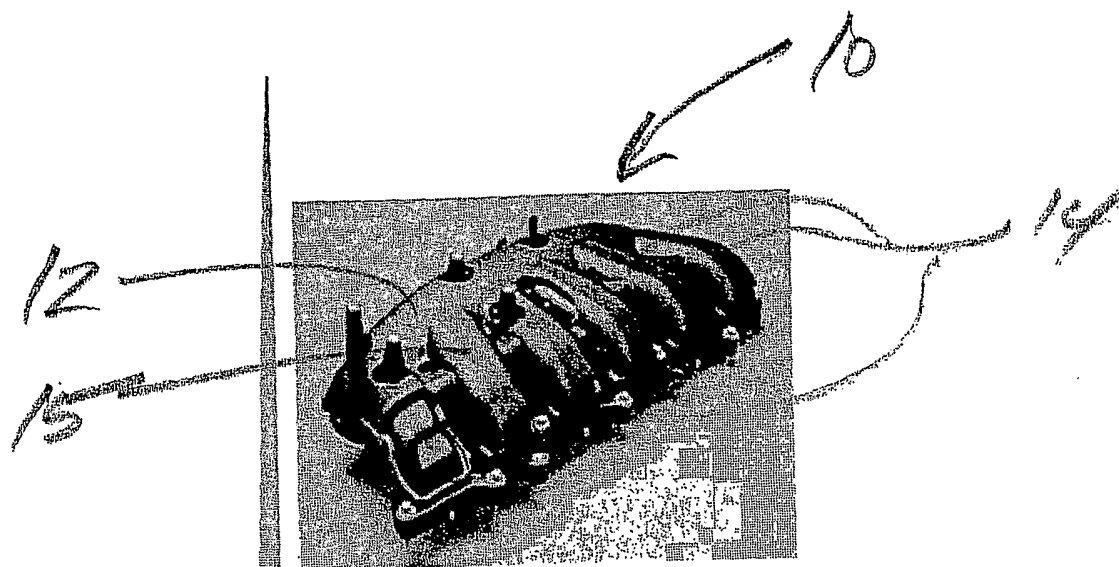


FIGURE 1

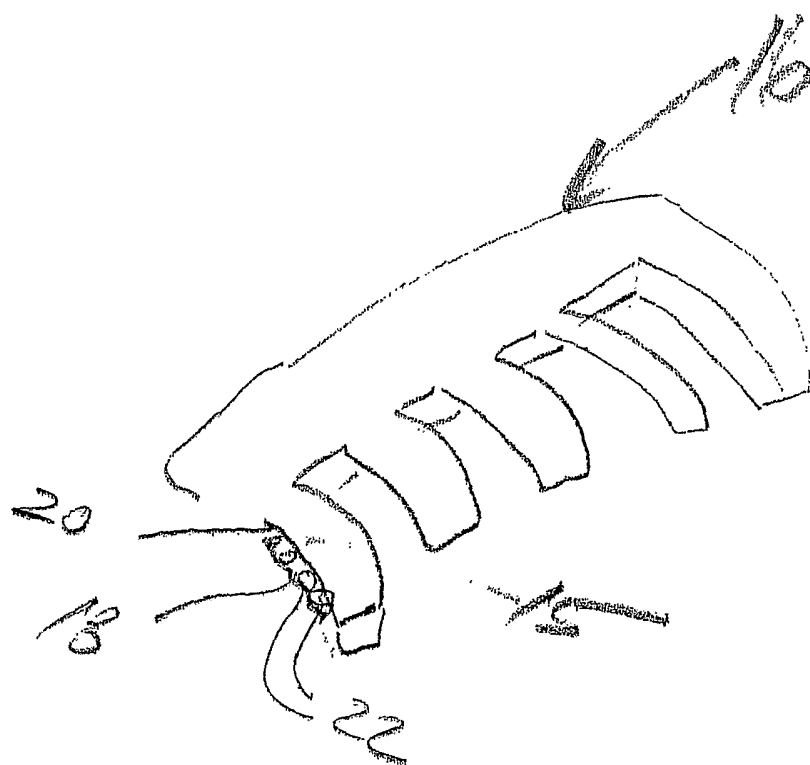


FIGURE 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/016709A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B32B5/18 B32B27/08

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 F02M

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	US 2003/062012 A1 (HAN PETER K ET AL) 3 April 2003 (2003-04-03) Coinjection molded air intake manifold comprising polyamide outer and core layers, the core being foamed in one embodiment. No mention of bubble diameter. paragraph '0009! - paragraph '0010! paragraph '0076! claims 1,2,13,14 figure 2 ----- -/--	1-7

☒ 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
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *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

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *Z* document member of the same patent family

Date of the actual completion of the international search

11 October 2004

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21/10/2004

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/016709

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 494 174 B1 (DALY PAUL D) 17 December 2002 (2002-12-17) Foam assembly for intake manifold with optional plastic layer thereon. column 1, line 29 - line 36 column 1, line 48 - line 52 column 3, line 1 - line 10 column 3, line 46 - line 53 figures 3,4 -----	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2004/016709

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		EP 1430215 A1	23-06-2004
		WO 03027479 A1	03-04-2003
US 6494174 B1	17-12-2002	DE 60003880 D1	21-08-2003
		DE 60003880 T2	03-06-2004
		EP 1096134 A2	02-05-2001