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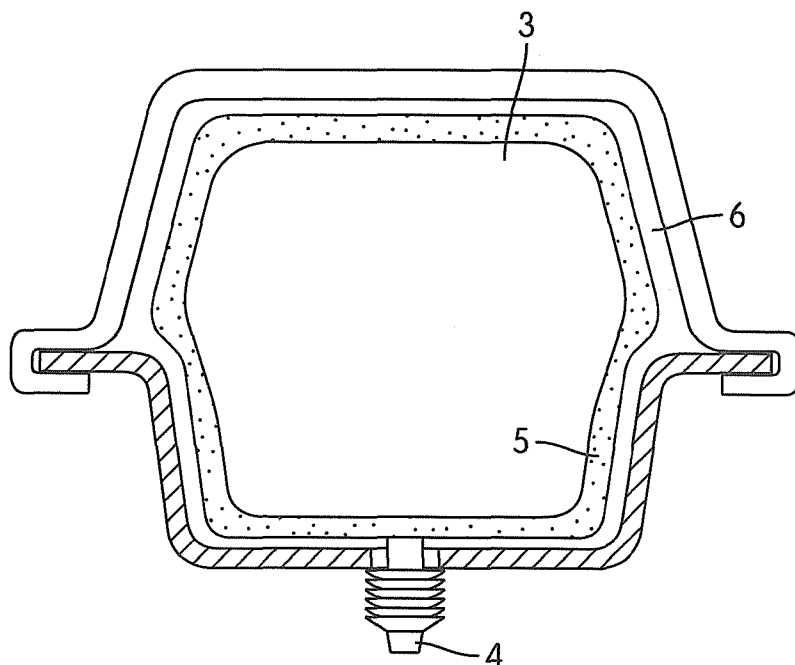
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(54) Title: CAVITY FILLER INSERT



(57) Abstract: A cavity filler insert for use in a cavity of a structural member is disclosed. According to one embodiment of the invention, the cavity filler insert is substantially planar in shape and includes a carrier, a thermally expandable material operably coupled with and supported by at least a portion of the carrier and extending at least around substantially the entire periphery of said cavity filler insert, and an attachment member for securing the cavity filler insert to the structural member. Once activated by heating so as to cause the expandable material to foam, the cavity filler insert effectively reduces both air-borne and structure-borne noise by dampening sound and vibration within hollow portions of vehicles and the like.

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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.

CAVITY FILLER INSERT

FIELD OF THE INVENTION

The present invention relates to a cavity filler insert that can be used for sealing and/or baffling purposes in a vehicle body. More particularly, the present invention relates to a cavity filler insert that preferably is substantially planar and that includes a high damping expandable material around substantially the entire periphery of the insert. The insert is mounted in a cavity of a vehicle body utilizing an attachment member. Upon activation, the expandable material foams to form a seal around the interior cavity wall. The activated cavity filler insert is particularly effective in reducing both the vibrations transmitted through the walls of the cavity as well as the air-borne noise within the cavity.

BACKGROUND OF THE INVENTION

As shown in Fig. 1, a vehicle body typically includes a plurality of hollow structural members (such as pillars **A**, **B**, and **C** in Fig. 1) that form the passenger compartment, engine compartment, trunk, doorways, windows, and wheel wells thereof. Each hollow structural member typically includes one or more interconnected cavities, and these cavities can transmit undesirable noises and vibrations to the passenger compartment of the vehicle that are caused by the power train and road upon which the vehicle travels. One conventional way of reducing these undesirable noises and vibrations is to block the cavities of the vehicle with one or more cavity filler inserts **90**. Such cavity filler inserts may also assist in reinforcing or stiffening the hollow structural member of the vehicle.

A typical cavity filler insert **90** employed for this purpose includes a carrier, an attachment member integrally formed with the carrier, and a thermally expandable expandable material formed on the carrier. The cavity filler insert **90** is typically configured so as to be similar in shape to, but somewhat smaller than, the cross-section of the cavity in which it is to be placed. The attachment member is usually configured so as to be inserted into an opening formed in one of the walls that define the cavity in order to fix the cavity filler insert **90** to the wall. The cavity filler insert is typically positioned so that the plane of the

carrier is substantially perpendicular to the longitudinal direction of the cavity. The expandable material will undergo heat-induced expansion when the vehicle body is conveyed through a baking oven that forms a part of the primer or paint curing step of the vehicle manufacturing process. This heat-induced expansion of the expandable material will fill any peripheral space between the expandable material and the walls of the cavity, with the intent that the levels of undesirable noise produced by the vehicle being transmitted to the passenger compartment thereof are reduced.

Although considerable effort has been expended to date in the development of such cavity filler inserts (often referred to as "acoustic baffles"), most such cavity filler inserts are only effective in lowering the amount of air-borne noise that is transmitted through the structural member cavity. However, it has proven to be more difficult to significantly lessen or stop so-called structure-borne noise. "Structure-borne noise" is the noise generated by an emitting surface (typically, a panel) that is largely transmitted through the structure supporting the panels (typically, a frame or other hollow structural member) and that has been generated by a dynamic force generator (such as an engine, motor, pump or gear box). Although a conventional acoustic baffle can muffle the air-borne noise within the structural member cavity, the structure-borne noise that is not stopped by the baffle continues through the cavity walls and regenerates air-borne noise within the cavity downstream of the baffle. The overall effectiveness of the acoustic baffle in eliminating noise from entering the passenger compartment by means of the frame of the vehicle is thereby compromised.

In view of the above, there exists a need for a cavity filler insert that overcomes the above-mentioned problems in the prior art. This invention addresses this need in the prior art as well as other needs, which will become apparent to those skilled in the art from this disclosure.

BRIEF SUMMARY OF THE INVENTION

A cavity filler insert for use in a cavity of a structural member is disclosed. According to one embodiment of the invention, the cavity filler insert includes a carrier, an expandable material operably coupled with and supported by at least a portion of the carrier and

extends at least around substantially the entire periphery of said cavity filler insert, and an attachment member for holding the cavity filler insert in the desired position within the cavity. The cavity filler insert is substantially planar in shape. The expandable material, once expanded, has a Young's storage modulus E' between 0.1 MPa and 1000 MPa, a loss factor of at least 0.3 (preferably, at least 1) and a shear storage modulus G' between 0.1 MPa and 500 MPa at a temperature between -10 and $+40$ degrees C in the frequency range 0 to 500 Hz.

These and other objects, features, aspects and advantages of the present invention will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

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Referring now to the attached drawings which form a part of this original disclosure:

Fig. 1 is a perspective view of an automobile body having a plurality of cavity filler inserts disposed therein;

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Fig. 2 is a perspective view of a cavity filler insert according to an embodiment of the present invention;

Fig. 3 is a cross-sectional view of a cavity of a hollow structural member having an unactivated cavity filler insert in accordance with an embodiment of the present invention positioned therein;

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Fig. 4 is a partial sectional view of an unactivated cavity filler insert according to an embodiment of the invention within a hollow structural member;

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Fig. 5 is a cross-sectional view of a cavity of a hollow structural member having an activated cavity filler insert obtained by heating the cavity filler insert shown in Fig. 3;

Fig. 6 is a partial sectional view of the cavity filler insert of Fig. 4 after activation of the expandable material around the periphery of the insert;

Fig. 7 is a graph of mean quadratic velocity versus frequency for different test samples, as explained in more detail in the Examples section hereof; and

Fig. 8 is a graph of nSTL versus frequency for different materials, explained in more detail in the Examples section hereof.

10 DETAILED DESCRIPTION OF CERTAIN EMBODIMENTS OF THE INVENTION

We have discovered that expandable materials that when expanded meet certain requirements with respect to Young's storage modulus (E'), loss factor and shear storage modulus (G') at a temperature between -10 and $+40$ degrees C in the frequency range 0 to 500 Hz are remarkably and unexpectedly efficient in controlling both air-borne and structure-borne noise transmission within the cavity of a structural member when formed into a substantially planar cavity filler insert (having the thermally expandable material extending at least around substantially the entire periphery of the insert) which is placed into position within the structural member cavity using one or more attachment members and then activated by heating. The expandable material increases in volume so as to come into contact with the interior surface of said hollow structure, thereby sealing off said hollow structure.

The activated cavity filler insert not only provides a significant increase in the efficiency with which air-borne noise transmission is suppressed, but also effectively reduces the structure-borne noise transmission by dampening the vibrations propagated through the cavity.

Young's storage modulus (E') is defined as the ratio of tensile stress to tensile strain below the proportional limit of a material. Shear storage modulus G' is defined as the ratio of shearing stress to shearing strain within the proportional limit and is considered a measure of the equivalent energy stored elastically in a material. The loss factor (also sometimes referred to as the structural intrinsic damping or tan delta) is the ratio of the Young's loss

modulus E'' over Young's storage modulus E' for the damping in tension compression. For the damping in shear, the loss factor is the ratio of the shear loss modulus G'' over the shear storage modulus G' . These values may be readily determined by Dynamic Mechanical Analysis (DMA) of a material, which in the context of this invention is the thermally expandable material after expansion. As is well known in the art, Dynamic Mechanical Analysis can be performed either by an indirect method where the material is characterized on a carrier (Oberst's beam test) or by a direct method where the tested sample is made only from the material to be characterized (viscoanalyzer).

10 "Substantially planar" in the context of the present invention means that the cavity filler insert is relatively flat and thin and has a maximum thickness that is significantly less than the maximum width of the insert. For example, the maximum thickness of the insert is typically less than 20% of the insert's maximum width. Typically, the thickness of the thermally expandable material that is present at the periphery of the cavity filler insert is from about 4 to about 10 mm. In this context, "thickness" means the dimension of the cavity filler insert that is perpendicular to the plane of the insert and parallel to the longitudinal axis of the hollow structural member in which the insert is to be positioned.

The thermally expandable material is a material that will foam and expand upon heating but that is typically solid (dimensionally stable) at room temperature (e.g., 15-30 degrees C). In some embodiments, the expandable material will be dry and non-tacky, but in other embodiments will be tacky. Upon activation, i.e., upon being subjected to a temperature of between about 130°C and 240°C (depending on the exact formulation of expandable material that is used), the expandable material will typically expand to at least about 100% or at least about 150% or alternatively at least about 200% of its original volume. Even higher expansion rates (e.g., at least about 1000%) may be selected where substantial gaps exist between the cavity filler insert and the inner walls of the cavity and it is desired to assure that the cavity is completely sealed upon activation of the cavity filler insert. When used in an automobile body, for example, the expandable material typically has an activation temperature lower than the temperature at which primer or paint is baked on the vehicle body during manufacture. The expandable material will expand at least radially during activation in order to seal against the internal surfaces of the structural member to

which the cavity filler insert is attached, and thus prevent undesirable noises and vibrations produced by the vehicle from being transmitted to the passenger compartment. The expandable material may be formulated such that it comes into contact with, but does not adhere or bond to, the interior walls of the cavity when activated and expanded.

- 5 Alternatively and preferably, the expandable material components may be selected such that in its expanded state the expandable material does securely adhere or bond to the interior cavity wall surfaces (i.e., cannot be separated from the wall surfaces without application of significant force). In highly preferred embodiments of the invention, the expanded material is adhered sufficiently strongly to the cavity wall surfaces such that
- 10 cohesive failure is observed (i.e., structural failure of the adhesive occurs such that adhesive remains on the surface of both the carrier and the cavity wall when the two items are separated). Preferably, the expanded material is a closed cell foam. It is also preferred that the expanded material be relatively low in density (e.g., less than 1200 kg/m^3) so that the resulting dampened hollow structural member remains relatively low in weight,
- 15 thereby providing vehicles with improved fuel economy.

In an especially advantageous embodiment, the thermally expandable material comprises:

- from 25 to 70% by weight, preferably from 35 to 55% by weight, of at least one thermoplastic elastomer (preferably a styrene/butadiene or styrene/isoprene block
- 20 copolymer or at least partially hydrogenated derivative thereof);
- from 15 to 40% by weight, preferably from 20 to 35% by weight, of at least one non-elastomeric thermoplastic (preferably an ethylene/vinyl acetate or ethylene/methyl acrylate copolymer);
- from 0.01 to 2% by weight, preferably from 0.05 to 1% by weight of at least one
- 25 stabilizer or antioxidant;
- from 2 to 15% by weight of at least one blowing agent, preferably an amount effective to cause the expandable material to expand at least 100% in volume when heated at a temperature of 150 degrees C;
- from 0.5 to 4% by weight of a curing agent, optionally including from 0.5 to 2% by
- 30 weight of at least one olefinically unsaturated monomer or oligomer, and optionally
- up to 10% by weight of at least one tackifying resin;

- up to 5% by weight of a plasticizer;
 - up to 10% by weight of at least one wax;
 - up to 3% by weight of an activator for the blowing agent,
- as well as optionally at least one filler (although the amount of filler is preferably less than 10% by weight, more preferably less than 5% by weight), the percentages being expressed as weight percentages of the total weight of the thermally expandable material.

Generally speaking, it will be desirable to use a thermoplastic elastomer that has a softening point no higher than the temperature at which the blowing agent begins to be activated, preferably at least about 30 degrees C lower than the temperature that the cavity filler insert will be exposed to when the expandable material is to be expanded. The thermoplastic elastomer is preferably selected within the group consisting of thermoplastic polyurethanes (TPU) and block copolymers (including linear as well as radial block copolymers) of the A-B, A-B-A, A-(B-A)_{n-2}-B, A-(B-A)_{n-1} and (A-B)_n-Y types, wherein A is an aromatic polyvinyl ("hard") block and the B block represents a rubber-like ("soft") block of polybutadiene, polyisoprene or the like, which may be partly or completely hydrogenated, Y is a polyfunctional compound and n is an integer of at least 3. The blocks may be tapered or gradient in character or consist entirely of one type of polymerized monomer.

Hydrogenation of the B block removes originally present double bonds and increases thermal stability of the block copolymer. Such copolymers may be preferred in certain embodiments of the present invention.

Suitable block copolymers include, but are not limited to, SBS (styrene/butadiene/styrene) copolymers, SIS (styrene/isoprene/styrene) copolymers, SEPS (styrene/ethylene/propylene/styrene) copolymers, SEEPS (styrene/ethylene/ethylene/propylene/styrene) or SEBS (styrene/ethylene/butadiene/styrene) copolymers.

Especially suitable block copolymers include styrene/isoprene/styrene triblock polymers, as well as fully or partially hydrogenated derivatives thereof, in which the polyisoprene block contains a relatively high proportion of monomer moieties derived from isoprene having a 1,2 and/or 3,4 configuration. Preferably, at least about 50% of the polymerized

isoprene monomer moieties have 1,2 and/or 3,4 configurations, with the remainder of the isoprene moieties having a 1,4 configuration. Such block copolymers are available from Kuraray Co., Ltd. under the trademark HYBRAR and may also be prepared using the methods described in U.S. Pat. No. 4,987,194, incorporated herein by reference in its entirety.

In certain preferred embodiments of the invention the "hard" blocks represent from about 15 to about 30 percent by weight of the block copolymer and the "soft" blocks represent from about 70 to about 85 percent by weight of the block copolymer. The glass transition temperature of the "soft" blocks is preferably from about -35 degrees C to about 10 degrees C while the glass transition temperature of the "hard" blocks is preferably from about 90 degrees C to about 110 degrees C. The melt flow index of the block copolymer preferably is from about 0.5 to about 6 (as measured by ASTM D1238, 190 degrees C, 2.16 Kg). Typically, the block copolymer will have a number average molecular weight of from about 30,000 to about 300,000.

Examples of suitable thermoplastic polyurethanes (TPU) are those made according to conventional processes by reacting diisocyanates with compositions having at least two isocyanate reactive groups per molecule, preferably difunctional alcohols. Suitable organic diisocyanates to be used include, for example, aliphatic, cycloaliphatic, araliphatic, heterocyclic and aromatic diisocyanates.

Specific examples of diisocyanates include aliphatic diisocyanates such as, for example, hexamethylene-diisocyanate; cycloaliphatic diisocyanates such as, for example, isophorone-diisocyanate, 1,4-cyclohexane-diisocyanate, 1-methyl-2,4- and -2,6-cyclohexane-diisocyanate and the corresponding isomer mixtures, 4, 4', 2, 4' and 2,2'-dicyclohexylmethane-diisocyanate and the corresponding isomer mixtures; and aromatic diisocyanates such as, for example, 2,4- toluylene-diisocyanate, mixtures of 2,4- and 2,6-toluylene-diisocyanate, 4,4'-diphenylmethane-diisocyanate, 2,4'-diphenylmethane-diisocyanate and 2,2'-diphenylmethane-diisocyanate, mixtures of 2,4'-diphenylmethane-diisocyanate and 4,4'-diphenylmethane-diisocyanate, urethane-modified liquid 4,4'-diphenylmethane-diisocyanates and/or 2,4'-diphenylmethane-diisocyanates, 4,4'-diisocyanato-1,2-diphenyl-ethane and 1,5-naphthylene-diisocyanate. Diphenylmethane-diisocyanate isomer mixtures with a 4,4'-diphenylmethane-diisocyanate content of greater

than 96 wt. % are preferably used, and 4,4'-diphenylmethane-diisocyanate and 1,5-naphthylene-diisocyanate are used in particular. The diisocyanates mentioned above can be used individually or in the form of mixtures with one another.

The compounds reactive with the isocyanate groups include, polyhydroxy compounds
5 such as, polyester polyols, polyether polyols or polycarbonate-polyols or polyols which may contain nitrogen, phosphorus, sulfur and/or silicon atoms, or mixtures of these. Linear hydroxyl-terminated polyols having on average from about 1.8 to about 3.0 Zerewitinoff-active hydrogen atoms per molecule, preferably from about 1.8 to about 2.2 Zerewitinoff-active hydrogen atoms per molecule, and having a molecular weight of 400 to 20, 000
10 g/mol are preferably employed as polyol. These linear polyols often contain small amounts of non-linear compounds as a result of their production. Thus, these are also often referred to as "substantially linear polyols".

The polyhydroxy compounds with two or three hydroxyl groups per molecule in the molecular weight range of 400 to 20000, preferably in the range of 1000 to 6000, which
15 are liquid at room temperature, glassy solid/amorphous or crystalline, are preferably suitable as polyols. Examples are di- and/or trifunctional polypropylene glycols; random and/or block copolymers of ethylene oxide and propylene oxide can also be used. Another group of polyethers that can preferably be used are the polytetramethylene glycols (poly(oxytetramethylene) glycol, poly-THF), which are produced e.g. by the acid
20 polymerisation of tetrahydrofuran, the molecular weight range of these polytetramethylene glycols lying between 600 and 6000, preferably in the range of 800 to 5000.

The liquid, glassy amorphous or crystalline polyesters that can be produced by condensation of di- or tricarboxylic acids, such as e.g. adipic acid, sebacic acid, glutaric acid, azelaic acid, suberic acid, undecanedioic acid, dodecanedioic acid, 3,3-dimethyl-
25 glutaric acid, terephthalic acid, isophthalic acid, hexahydrophthalic acid, dimerised fatty acid or mixtures thereof with low molecular-weight diols or triols, such as e.g. ethylene glycol, propylene glycol, diethylene glycol, triethylene glycol, dipropylene glycol, 1,4-butanediol, 1,6-hexanediol, 1,8-octanediol, 1,10-decanediol, 1,12-dodecanediol, dimerised fatty alcohol, glycerin, trimethylolpropane or mixtures thereof, are also suitable as polyols.

Another group of polyols to be used for making the TPU's are polyesters based on ϵ -caprolactone, also known as "polycaprolactones".

However, polyester polyols of oleochemical origin can also be used. These polyester polyols can be produced, for example, by the complete ring opening of epoxidized
5 triglycerides of an at least partially olefinically unsaturated, fatty acid-containing fat mixture with one or more alcohols with 1 to 12 C atoms and subsequent partial transesterification of the triglyceride derivatives to alkyl ester polyols with 1 to 12 C atoms in the alkyl radical. Other suitable polyols are polycarbonate polyols and dimerized diols (Henkel), as well as castor oil and its derivatives. The hydroxyfunctional
10 polybutadienes, as obtainable, for example, with the trade name "Poly-bd", can be used as polyols for making the TPU's to be used according to the invention.

Preferably a combinations of polyether polyols and glassy amorphous or crystalline polyester polyols are used for making the TPU's.

Preferably, the polyols have an average functionality towards isocyanate from about 1.8 to
15 2.3, preferably 1.9 to 2.2, particularly about 2.0.

The thermoplastic polyurethanes may also be made by additionally using chain extending compounds like low molecular weight polyols such as ethylene glycol, propylene glycol or butadiene glycol or low molecular weight diamines such as 1,2-diaminoethylene, 1,3-diaminopropylene or 1,4-diaminobutane or 1,6-diaminohexane.

20 In preferred embodiments, the soft domains of the thermoplastic polyurethane are selected from the group consisting of poly(ethylene adipate), poly(1,4-butene adipate), poly(ethylene 1,4-butene adipate), poly(hexamethylene 2,2-dimethylpropylene adipate), polycaprolactone, poly(diethylene glycol adipate), poly(1,6-hexanediol carbonate) and poly(oxytetramethylene).

25 Other thermoplastic elastomers suitable for use in the present invention include other types of block copolymers containing both hard segments and soft segments such as, for example, polystyrene/polydimethylsiloxane block copolymers, polysulfone/polydimethylsiloxane block copolymers, polyester/polyether block copolymers (e.g., copolyesters such as those synthesized from dimethyl terephthalate,

poly(tetramethylene ether) glycol, and tetramethylene glycol), polycarbonate/polydimethylsiloxane block copolymers, polycarbonate/polyether block copolymers, copolyetheramides, copolyetheresteramides and the like. Thermoplastic elastomers which are not block copolymers but which generally are finely interdispersed multiphase systems or alloys may also be used, including blends of polypropylene with ethylene-propylene rubbers (EPR) or ethylene-propylene-diene monomer (EPDM) rubbers (such blends often being grafted or cross-linked).

In addition to one or more thermoplastic elastomers, it is also preferred for the expandable material to contain one or more non-elastomeric thermoplastics. Preferably, the non-elastomeric thermoplastic is selected so as to improve the adhesion properties and processability of the expandable material. Generally speaking, it will be desirable to use a non-elastomeric thermoplastic that has a softening point no higher than the temperature at which the blowing agent begins to be activated, preferably at least about 30 degrees C lower than the temperature that the cavity filler insert will be exposed to when the expandable material is to be expanded. Particularly preferred non-elastomeric thermoplastics include olefin polymers, especially copolymers of olefins (e.g., ethylene) with non-olefinic monomers (e.g., vinyl esters, (meth)acrylate esters). Exemplary non-elastomeric thermoplastics especially suitable for use in the present invention include ethylene/vinyl acetate copolymers (particularly copolymers containing from about 20 to about 35 weight % vinyl acetate) and ethylene/methyl acrylate copolymers (particularly copolymers containing from about 15 to about 35 weight % methyl acrylate and/or having Vicat softening points less than 50 degrees C and/or melting points within the range of 60 to 80 degrees C and/or melt flow indices of from 3 to 25 g/10 minutes, as measured by ASTM D1238, 190 degrees C, 2.16 Kg).

In certain embodiments of the invention, the weight ratio of thermoplastic elastomer: non-elastomeric thermoplastic is at least 0.5:1 or at least 1:1 and/or not greater than 5:1 or 2.5:1.

The tackifying resin may be selected within the group consisting of rosin resins, terpene resins, terpene phenolic resins, hydrocarbon resins derived from cracked petroleum distillates, aromatic tackifying resins, tall oil resins, ketone resins and aldehyde resins.

Suitable rosin resins are abietic acid, levopimaric acid, neoabietic acid, dextropimaric acid, palustric acid, alkyl esters of the aforementioned rosin acids, and hydrogenation products of rosin acid derivatives.

5 Examples of suitable plasticizers include C₁₋₁₀ alkyl esters of dibasic acids (e.g., phthalate esters), diaryl ethers, benzoates of polyalkylene glycols, organic phosphates, and alkylsulfonic acid esters of phenol or cresol.

10 Suitable waxes include paraffinic waxes having melting ranges from 45 to 70°C, microcrystalline waxes with melting ranges from 60 to 95°C, synthetic Fischer-Tropsch waxes with melting points between 100 and 115°C as well as polyethylene waxes with melting points between 85 and 140°C.

Suitable antioxidants and stabilizers include sterically hindered phenols and/or thioethers, sterically hindered aromatic amines and the like.

15 All known blowing agents, such as "chemical blowing agents" which liberate gases by decomposition or "physical blowing agents", i.e., expanding hollow beads (also sometimes referred to as expandable microspheres), are suitable as blowing agent in the present invention. Mixtures of different blowing agents may be used to advantage; for example, a blowing agent having a relatively low activation temperature may be used in combination with a blowing agent having a relatively high activation temperature.

20 Examples of "chemical blowing agents" include azo, hydrazide and carbazide compounds such as azobisisobutyronitrile, azodicarbonamide, di-nitroso-pentamethylenetetramine, 4,4'-oxybis(benzenesulfonic acid hydrazide), diphenyl-sulfone-3,3'-disulfohydrazide, benzene-1,3-disulfohydrazide and p-toluenesulfonyl semicarbazide.

"Chemical blowing agents" may require additional activators such as zinc oxide, (modified) ureas and the like.

25 However, "physical blowing agents" and particularly expandable hollow microbeads are also useable. Advantageously, the hollow microbeads are based on polyvinylidene chloride copolymers or acrylonitrile/ (meth)acrylate copolymers and contain encapsulated volatile substances such as light hydrocarbons or halogenated hydrocarbons.

Suitable expandable hollow microbeads are commercially available, e.g., under the trademarks "Dualite" and "Expancel" respectively, from Pierce & Stevens (now part of Henkel Corporation) or Akzo Nobel, respectively.

Suitable curing agents include substances capable of inducing free radical reactions, in particular organic peroxides including ketone peroxides, diacyl peroxides, peresters, 5 perketals, hydroperoxides and others such as cumene hydroperoxide, bis(tert.-butylperoxy) diisopropylbenzene, di(-2-tert-butyl peroxyisopropyl benzene), 1,1-di-tert-butylperoxy-3,3,5-trimethylcyclohexane, dicumyl peroxide, t-butylperoxybenzoate, di-alkyl peroxydicarbonates, di-peroxyketals (such as 1,1-di-tert-butylperoxy-3,3,5-10 trimethylcyclohexane), ketone peroxides (e.g., methylethylketone peroxide), and 4,4-di-tert.-butylperoxy n-butyl valerate. The curing agent is preferably a latent curing agent, that is, a curing agent that is essentially inert or non-reactive at room temperature but is activated by heating to an elevated temperature (for example, a temperature within the range of from about 130 degrees C to about 240 degrees C).

15 In a particularly desirable embodiment, the thermally expandable composition contains a small amount (e.g., 0.1 to 5 weight percent or 0.5 to 2 weight percent) of one or more olefinically unsaturated monomers and/or oligomers such as C₁ to C₆ alkyl (meth)acrylates (e.g., methyl acrylate), unsaturated carboxylic acids such as (meth)acrylic acid, unsaturated anhydrides such as maleic anhydride, (meth)acrylates of polyols and 20 alkoxyated polyols such as glycerol triacrylate, ethylene glycol diacrylate, triethylene glycol diacrylate, trimethylolpropane triacrylate (TMPTA) and the like, triallyl trimesate, triallyl trimellitate (TATM), tetrallyl pyromellitate, the diallyl ester of 1,1,3-trimethyl-5-carboxy-3-(4-carboxyphenyl)indene, dihydrodicyclo pentadienyl acrylate, trimethylolpropane trimellitate (TMPTM), pentaerythritol trimethacrylate, phenylene-25 dimaleimide, tri(2-acryloxyethyl)isocyanurate, triallyl isocyanurate (TAIC), triallyl cyanurate (TAC), tri(2-methacryloxyethyl)trimellitate, unsaturated nitriles such as (meth)acrylonitrile, vinyl compounds (including vinyl aromatic compounds such as styrene), allyl compounds and the like and combinations thereof. In one embodiment, the olefinically unsaturated monomer(s) and/or oligomer(s) used contain only one carbon-30 carbon double bond per molecule (i.e., the monomer or oligomer is monofunctional with respect to olefinically unsaturated functional groups). Preferably, the monomer(s) and/or

oligomer(s) are selected to be capable of undergoing free radical reaction (e.g., oligomerization or polymerization) initiated by the curing agent(s) present in the expandable material when the expandable material is heated to a temperature effective to activate the curing agent (for example, by thermal decomposition of a peroxide).

- 5 Examples of suitable fillers include ground and precipitated chalks, carbon black, calcium-magnesium carbonates, barite and silicate fillers of the aluminium-magnesium-calcium type, such as wollastonite and chlorite. Preferably, however, the total amount of filler is limited to less than 10% by weight, more preferably less than 5% by weight. In one embodiment, the expandable material contains no filler (defined herein as substantially
10 inorganic particles, such as particles of the materials mentioned above).

In certain embodiments of the invention, the components of the thermally expandable material are selected such that the expandable material is free or substantially free of any thermosettable resin such as an epoxy resin.

- The present invention also relates to a method for reducing the transfer of vibrations from
15 a vibration generator to a location to which the vibration generator is connected via a structural element, comprising equipping said structural element with means for dissipating vibrational energy generated by the vibration generator, characterized in that the means for dissipating vibrational energy comprises an activated cavity filler insert according to the present invention as described here above.

- 20 Examples of vibration generators include motors, engines, pumps, gear boxes, suspension dampers and springs.

- The method according to the present invention is particularly adapted for reducing structure-borne noise in an automobile vehicle. In this case the vibration generator is connected to at least one of the constitutive parts of the passenger compartment of said
25 vehicle via a structural element. The shape of the structural member typically is that of a tubular rail with a polygonal (e.g., square or rectangular) cross-section, although the cross-section may also be irregular in shape.

A method according to the present invention may comprise the follow successive steps:

- selecting a cavity filler insert according to the present invention having dimensions such that it can be inserted into the cavity of the structural member,
- inserting the cavity filler insert into the cavity, preferably in a location close to the vibration generator, using the attachment member to fix the insert in the desired position (usually, such that the plane of the insert is substantially perpendicular to the longitudinal direction of the cavity); and
- expanding the thermally expandable material.

The cavity filler insert is preferably inserted into the cavity of the structural member between the vibration generator and the receiving vibrating structure from which the sound is generated.

If the desired location within the structural member cavity is difficult to access, the cavity filler insert may alternatively be affixed to one part of the structural member before the structural member is completely assembled to form the cavity. For example, a hollow structural member such as a rail or pillar is often manufactured from two or more separate formed metal pieces that are then welded or otherwise attached together. In such cases, it may be more convenient to attach the cavity filler insert to one of these pieces using the attachment member(s) prior to fabrication of the hollow structural member incorporating such formed metal piece.

Expansion of the thermally expandable material is achieved by a heating step, wherein the thermally expandable material is heated for a time and at a temperature effective to activate the blowing agent and also any curing agent that may be present.

Depending on the nature of the thermally expandable material and the line conditions at the assembly line, the heating step is typically carried out at a temperature from 130°C to 240°C, preferably from 150°C to 200°C, with a residence time in the oven from about 10 min. to about 30 min.

It is advantageous to take benefit of the heating step that follows the passage of the vehicle parts in the generally used electro coating bath (E-coat bath) to cause expansion of the thermo-expandable material as the temperature during this heating step is generally sufficient to cause the expected expansion.

The amount of thermally expandable material that is present in the cavity filler insert is selected such that, after expansion, its volume occupies the clearance between the insert and the inner surface of the structural element and it is effective in suppressing both air-borne and structure-borne noise transmission within the hollow structural member to the
5 desired degree.

In one embodiment of the invention, the substantially planar cavity filler insert is formed entirely from the thermally expandable material. For example, the thermally expandable material may be molded (e.g., by injection molding using a mold having the desired shape of the finished cavity filler insert) or otherwise shaped (e.g., by forming a flat sheet of the
10 thermally expandable material and then cutting that sheet by die stamping or other suitable means) to provide the insert. In such embodiments, the attachment member(s) are an integral part of the insert (i.e., are comprised of the thermally expandable material) and may take the form of legs or the like that help to hold the insert in position within the structural member cavity by friction or pressure (e.g., where the legs are sufficiently
15 resilient to permit them to be displaced slightly while inserting the insert and then spring back into position against the cavity walls upon release). Alternatively, the attachment member(s) may be in the form of engaging projections or the like that are capable of being inserted through openings in the cavity walls but are designed to resist being withdrawn through such openings (for example, by engagement of hooks or ridges on the projections
20 with the exterior surface of the structural member wall in the vicinity of the opening), thereby securing the cavity filler insert in place. In one advantageous embodiment, the attachment members are comprised of thermally expandable material so that upon activation by heating the attachment member expands and helps to fill and seal off the opening in the cavity wall into which it has been inserted.

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In another embodiment of the invention, the main body of the cavity filler insert is fabricated from the thermally expandable material but the attachment member(s) are comprised of a different material such as metal or non-expandable heat-resistant plastic or rubber. For example, the attachment member may include a pin that extends into the edge
30 of the thermally expandable material body as well as a plastic compressible plug or the like that can be inserted through a cavity wall opening but that resists being withdrawn from the opening.

In preferred embodiments of the invention, however, the cavity filler insert comprises a carrier upon which the thermally expandable material is mounted, as such a design helps to make the most effective and efficient use of the thermally expandable material. For example, the amount of thermally expandable material needed to seal and dampen the hollow structural member may be minimized. Additionally, as will be described in more detail subsequently, the carrier may be configured so as to direct the expanding foam produced from the expandable material towards the cavity walls and to prevent the expanding foam from sagging or distorting in a manner that interferes with complete sealing of the cavity.

Preferred embodiments of the present invention will now be explained with reference to the drawings. It will be apparent to those skilled in the art from this disclosure that the following description of this embodiment of the present invention is provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

Referring initially to Fig. 2, a cavity filler insert **1** includes a carrier **3**, an expandable material **5** supported on the carrier **3**, and an attachment member **7** (comprised, in this particular embodiment, of a flange **2** and a fastener **4**) which may be integrally molded with the carrier **3**. The carrier **3** includes a substantially flat and relatively rigid support plate **9** that in this embodiment is not covered by the expandable material **5**. The carrier may include a structure (such as a groove or channel, not shown in Fig. 2) that substantially surrounds the perimeter of the support plate **9**, that is integrally molded therewith and that is configured to receive the expandable material **5** prior to thermal expansion.

The overall shape of the cavity filler insert **1** is not particularly limited, but is typically configured so as to be similar in shape to, but somewhat smaller than, the vertical cross-section of the structural member cavity in which it is to be placed, as shown in Fig. 3. Generally, it will be desirable for the outer edge of the cavity filler insert to substantially parallel the inner wall of the cavity so as to create a gap **6** that is substantially uniform in

width between the insert and the cavity wall (typically, this gap will be from about 1 to about 10 mm). This gap permits a liquid coating material such as a metal pretreatment solution (e.g., a phosphate bath), primer, or paint to substantially coat the entire interior surface of the hollow structural member before the expandable material is activated (i.e., foamed). Furthermore, the structure on the carrier **3** that receives the thermally expandable material **5** is not particularly limited and may, for example, be in the form of an “L” shaped shelf or flange, a “V”, “U”, or “C” shaped groove or channel, brackets, tabs, clips or the like. Figure 4 illustrates one embodiment of the invention wherein the expandable material **5** is positioned in a channel around the periphery of the carrier **3** and the cavity filler insert is fixed within a hollow structural member so as to create a gap between the expandable material **5** and the cavity walls **10** and **11**. The channel includes a mounting surface **13** that is substantially perpendicular to the plane of the carrier **3** as well as side walls **14** and **15** that are substantially parallel to the plane of the carrier **3**. The thermally expandable material may also be secured to the carrier by means of holes, channels or notches around the perimeter of the carrier, wherein the expandable material extends into or through such holes, channels or notches (thereby creating mechanical interlocking between the carrier and the thermally expandable material), or by means of a rim around the perimeter of the carrier and generally perpendicular to the plane of the carrier, wherein the expandable material surrounds such rim. The carrier may contain multiple types of structures that secure the thermally expandable material to the carrier. It will generally be preferred to employ a supporting structure that helps to direct the expandable material as it is expanding towards the interior surface of the cavity that is being sealed, such as the side walls **14** and **15** illustrated in Figure 4. The thermally expandable material may be disposed as discrete and separate portions around the periphery of the carrier or may be in the form of a circumscribing and continuous band. The outer edge of the band of thermally expandable material may be slightly recessed from the outer edge of the carrier, or may be substantially flush with the outer edge of the support plate, or may extend out beyond the outer edge of the carrier (as is shown in Figures 2, 3 and 4).

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Figure 5 illustrates the cavity filler insert of Figure 3 after heating the expandable material **5** to a temperature effective to cause the latent blowing agent to be activated. The expandable material is converted to an expanded material **12** which fills the gap **6** which

originally existed between the cavity filler insert and cavity walls 10 and 11, thereby providing effective reduction of both the vibrations transmitted through the walls of the cavity as well as the air-borne noise within the cavity. Figure 6 similarly shows the cavity filler insert of Figure 4 after thermal activation of the expandable material 5.

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Although the carrier in one embodiment of the present invention is in the form of a single plate, in other also suitable embodiments the carrier comprises a plurality of plates that are assembled such that at least a portion of the thermally expandable material is positioned between two of the plates. The plates thus may be substantially parallel to each other with a layer of thermally expandable material sandwiched in between the plates. The outer edge of the thermally expandable material layer may be slightly recessed from the outer edges of the plates, or may be substantially flush with the outer edges of the plates, or may extend out beyond the outer edges of the plates. In one embodiment, the thermally expandable material layer extends over essentially the entire surface of each of the plates.

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However, in another embodiment the thermally expandable material layer is present only around the outer edge of the cavity filler insert, with the interior of the cavity filler insert being free of thermally expandable material. In yet another embodiment, the cavity filler insert may comprise a first plate that is substantially flat and a second plate that has a raised substantially flat interior portion. The plates are fastened together such that the raised substantially flat interior portion of the second plate is brought into contact with the first plate to create a channel around the periphery of the two plates that is capable of receiving and supporting the thermally expandable material.

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One or both of the plates may contain a plurality of openings into which and/or through which the expandable material may extend (either before and after activation and expansion or only after activation and expansion). The cavity filler insert may thus, for example, be in the form of a lattice. In preferred embodiments, any through holes which are initially present in the cavity filler insert are filled or closed after activation of the thermally expandable material.

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Any of the devices known in the art to be capable of securing a carrier bearing an expandable material to the interior wall of a structural member cavity may also be utilized as an attachment member in the cavity filler inserts of the present invention and the

selection of a particular design is not believed to be particularly critical. For example, the attachment member may include two or more resiliently deflectable barbs configured for secured receipt in an opening in the structural member. Each barb may comprise a shank bearing a retaining piece that protrudes at an angle to the shank so as to form a hook.

5 Such an attachment member is inserted into the wall opening with application of minor force, causing the barbs reversibly bend together and towards each other. After the barbs have passed through the opening, they return to their normal position apart from each other. This allows the retaining pieces to engage with the outer surface of the structural member wall around the periphery of the opening, thereby preventing the attachment
10 member from being readily withdrawn through the opening and securing the cavity filler insert within the cavity. Affixing the insert in this manner so as to prevent it from being easily displaced is highly desirable, since otherwise the handling that the structural member will normally encountered during assembly of the vehicle prior to heating and activating the expandable material is likely to cause the cavity filler insert to no longer be
15 properly positioned in the desired location within the cavity. Other types of attachment members may also be used for this purpose, including for example a "Christmas tree"-type fastener (typically fabricated of a resilient plastic) having an elongated portion with multiple angled flanges. The cavity filler insert may have one attachment member or a plurality of attachment members, of the same type or different types.

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Typically, the attachment member projects radially from the cavity insert filler and may be generally parallel to the plane of the cavity insert filler or in the plane of the cavity insert filler.

25 The carrier is preferably comprised of a moldable material which is sufficiently resistant to cracking and breakage during normal usage, and has a melting or softening point that is higher than both the activation temperature of the expandable material 5 and the bake temperature that the structural members containing the cavity filler insert will be exposed to. Preferably, the moldable material is sufficiently resilient (non-brittle) and strong at
30 ambient temperatures to withstand cracking or breaking while also being sufficiently heat resistant at elevated temperatures (e.g., the temperatures employed to foam the expandable material) to hold the expandable material in the desired position within the cavity of the structural member without significant warping, sagging or distortion. For example, the

carrier may be formed of a moldable material that is somewhat pliable and resistant to breaking so that the assembled cavity filler insert can be subjected to bending forces at room temperature without being cracked or permanently deformed. The material that comprises the carrier is not particularly limited, and for example, may be any number of

5 polymeric compositions that possess these qualities (e.g., polyesters such as polyethylene terephthalate, polybutylene terephthalate or polycyclohexylene-dimethylene terephthalate, aromatic polyethers such as polyphenylene oxide, polycarbonates, polyimides, polysulphones, polyether ketones, polyether ether ketones, acetal resins and especially polyamides such as nylon 66). Polymeric compositions that are suitable for use as the

10 carrier would be well known to those of ordinary skill in the art and include both thermoplastic and thermoset materials, and thus will not be described in detail herein. Unfoamed (solid) as well as foamed polymeric compositions may be utilized to fabricate the carrier. The moldable materials can, in addition to the polymeric compositions, also

15 comprise various additives and fillers, such as colorants and/or reinforcing materials such as polymeric or inorganic fibers (e.g., glass fibers), depending on the desired physical characteristics. Preferably, the moldable material has a melting or softening point (ASTM D789) of at least 200 degrees C, more preferably at least 225 degrees C, or most preferably at least 250 degrees C and/or has a heat deflection temperature at 18.6 kg

20 (ASTM D648) of at least 180 degrees C, more preferably at least 200 degrees C, or most preferably at least 220 degrees C and/or a tensile strength (ASTM D638; 50% R.H.) of at least 1000 kg/cm², more preferably at least 1200 kg/cm², most preferably at least 1400 kg/cm² and/or a flexural modulus (ASTM D790; 50% R.H.) of at least 50,000 kg/cm², more preferably at least 60,000 kg/cm², most preferably at least 70,000 kg/cm².

Alternatively, the carrier or one or more portions of the carrier may be fabricated from a

25 metal such as steel or aluminum.

The expandable material may be assembled with the carrier by any of the known methods for manufacturing cavity filler inserts, including co-injection molding, side-by-side injection molding, overmolding and insert molding.

30

When the cavity filler insert is to be attached to a wall of a structural member, a portion of the attachment member may be inserted into an opening of the wall that is sized to substantially match the attachment member portion that is being inserted. The shape of the

opening is not particularly critical and may, for example, be square, circular, rectangular, polygonal, oval, or irregular, provided it is capable of receiving the attachment member and interacting with the attachment member so as to hold the cavity filler insert in the desired position.

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In preferred embodiments of the invention, a portion of expandable material is positioned near the opening in the structural member wall so that upon activation of the expandable material the expandable material expands to completely block the opening. For example, the attachment member may extend out from the cavity filler insert through a portion of
10 the thermally expandable material. Upon activation, the expanded material may extend through the opening and at least partially encase the attachment member, thereby helping to provide a secure, permanent fixing of the cavity filler insert within the cavity.

Other carrier and attachment member designs known in the art can be readily adapted for
15 use in the present invention, including the designs described in the following patents and applications, each of which is incorporated herein by reference in its entirety: U.S. Pat. Nos. 6,146,565; 5,631,027; 5,642,914; 6,413,611; 6,988,585; 6,347,799; 4,810,548; 5,089,311; 5,506,025; 5,806,915; 5,931,474; 5,979,902; 6,062,624; 6,114,004; 6,382,635; and 6,491,336; U.S. Published Application Nos. 2005-0082111; 2006-0041227; 2005-
20 0279567; 2004-0201258; 2004-0239148; and 2005-072116.

The cavity filler insert can be used in products having hollow structural members other than vehicles, including, without limitation, aircraft, domestic appliances, furniture, buildings, walls and partitions, and marine applications (boats).

25

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. Furthermore, the foregoing description of the
30 embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

EXAMPLES

A cavity filler insert in accordance with the present invention is preparing by placing a thermally expandable material prepared using the following formulation within a
5 peripheral channel of a molded polyamide carrier:

46.7 parts by weight SIS block copolymer, styrene content 20%

5.2 parts by weight aromatic hydrocarbon resin tackifier;

2.6 parts by weight diisononylphthalate;

4.7 parts by weight microcrystalline wax;

10 28.5 parts by weight thermoplastic ethylene/vinyl acetate copolymer (28% vinyl acetate);

0.1 parts by weight phenolic antioxidant

9.1 parts by weight blowing agent (azodicarbonamide)

1.0 part by weight 1,1-di-tert-butylperoxy-3,3,5-trimethylcyclohexane

0.5 parts by weight methyl acrylate

15 1.6 parts by weight zinc oxide treated urea.

The cavity filler insert is placed in an elongated hollow structural member fabricated of sheet metal and having a substantially square cross-section ca. 100 mm in diameter and then activated by heating to a temperature effective to expand the thermally expandable material. The plane of the insert is oriented so as to be substantially perpendicular to the
20 longitudinal axis of the hollow structural member. The insert is positioned at about the middle point of the elongated hollow structural member. Upon activation, the expandable material expands sufficiently to seal off the elongated hollow structural member. A similar hollow structural member is prepared in the same manner, except that the expandable material having characteristics when expanded in accordance with the present
25 invention is replaced with a conventional expandable "pillar filler".

One end of the elongated hollow structural member is excited by a white noise, with the other end of the elongated hollow structural member being clamped in place. Velocities are computed in all the points of the structural member having the activated cavity filler insert placed inside. Figure 7 compares the vibratory levels observed for an undampened hollow structural member (“Without Treatment”) to those obtained for members containing an activated cavity filler insert in accordance with the present invention (“Invention”) or an activated cavity filler insert containing a conventional “pillar filler” (“Comparative”). The activated cavity filler insert of the present invention reduces significantly the medium frequency vibrations of the hollow structural member, whereas the insert prepared using conventional “pillar filler” provides lower reductions in such vibrations. Further, the area of the hot spots is strongly reduced with the activated cavity filler insert of the present invention.

The efficiency of an activated cavity filler insert can be measured using the normal Sound Transmission Loss (nSTL), which corresponds to the ratio of the incident acoustic power “P_{inc}” inside the cavity up-stream of the insert divided by the radiated (transmitted) power “P_{rad}” downstream of the insert. The Sound Transmission Loss is expressed in dB:

$$nSTL = 10 \log \{ P_{inc} / P_{rad} \}$$

Inserts which have a higher nSTL value are more efficient in dampening sound. In Figure 8, the results obtained for two activated expandable materials, including one in accordance with the present invention (“Invention”) and one obtained from a conventional “pillar filler” (“Comparative”), are shown. The main advantage is observed at the first nSTL minimum (around 700 Hz), where the sound dampening effectiveness of the activated expandable material is enhanced by more than 7 dB by utilizing an expandable material meeting the requirements of the present invention.

Further testing was carried out to better measure the effectiveness of the activated cavity filler insert of the present invention in suppressing the transmission of structure-borne noise. In this testing, the vibration and noise propagated into a hollow body having the activated cavity filler insert placed therein in response to a mechanical excitation generated by a shaker were measured and compared to the vibration and noise obtained

where the hollow body contained an activated cavity filler insert having a conventional thermally expanded material (prepared from TEROPHON 6059, available from Henkel KGaA) around its periphery. The activated cavity filler insert in accordance with the present invention that was evaluated contained a thermally expanded material produced
5 from a thermally expandable material in accordance with the previously stated formulation.

The cavity filler insert was placed 135 mm from one end of a hollow metal body having a total length of 800 mm. This location within the hollow metal body was determined by
10 simulation to be a hot spot of vibration between 100 Hz and 1250 Hz. Two cavities are thereby created inside the hollow metal body, one cavity being 135 mm in length and the other cavity being 665 mm in length. The hollow metal body was suspended by two springs at the opposite end. Each of the two cavities was equipped with a microphone,
15 with the microphone in the shorter cavity being capable of being placed in two positions and the microphone in the longer cavity being capable of being placed in five positions. These different positions allow computation of a mean sound pressure level within each cavity. In addition, four accelerometers were placed on the external surface of the hollow metal body to measure its vibratory levels (Accelerometer #1 was placed near the end of the hollow metal body where the shorter cavity was located, Accelerometer #4 was placed
20 near the opposite end of the hollow metal body). Comparisons between the vibratory levels and between the sound pressure levels permit measurement of the global efficiency of the activated cavity filler insert. The levels were normalized by the energy of the mechanical excitation, to ensure that the levels measured within the two systems (System 1 used a cavity filler insert in accordance with the present invention and System 2 used a
25 cavity filler insert bearing a conventional expandable material (TEROPHON 6059)) are comparable.

The third octave frequency bands of the normalized mean quadratic velocities measured by Accelerometer #1 and Accelerometer #4 were compared for System 1 and System 2.
30 Significant reductions in vibratory levels for System 1 (in accordance with the present invention) were observed above 200 Hz, with the mean reduction being 5 dB. The third octave frequency bands of the normalized sound pressure levels measured within the short cavity and the long cavity were compared for System 1 and System 2. A strong reduction

in the sound pressure level in both cavities in the frequency range of interest was observed for System 1 (in accordance with the present invention). The reduction was up to 10 dB (mean reduction = 8 dB) in the short cavity and up to 13 dB (mean reduction = 6.5 dB) in the long cavity. In the long cavity, a small amplification of the sound pressure level was
5 observed in the long cavity at 400 Hz. However, this is not a significant problem because the sound pressure levels are generally low within the third octave frequency range.

What is claimed is:

1. A cavity filler insert useful for acoustic insulation and damping vibration in a hollow structure, said cavity filler insert being substantially planar and comprising a thermally expandable material and at least one attachment member capable of holding said cavity filler insert in a predetermined position within said hollow structure, wherein a) said thermally expandable material extends at least around substantially the entire periphery of said cavity filler insert and b) said thermally expandable material when expanded has a Young's storage modulus E' between 0.1 MPa and 1000 MPa, a loss factor higher than 0.3 and a shear storage modulus G' between 0.1 MPa and 500 MPa at a temperature between -10 and $+40$ degrees C in the frequency range 0 to 500 Hz.
2. A cavity filler insert in accordance with Claim 1, wherein said cavity filler insert is essentially free of any through holes after said thermally expandable material is expanded.
3. A cavity filler insert in accordance with Claim 1, wherein said cavity filler insert is additionally comprised of a carrier.
4. A cavity filler insert in accordance with Claim 3, wherein said carrier is in the form of a plate and said thermally expandable material is attached to the periphery of said carrier.
5. A cavity filler insert in accordance with Claim 3, wherein said carrier comprises two parallel plates with a layer of said thermally expandable material positioned at least partly in between said two parallel plates.
6. A cavity filler insert in accordance with Claim 3, wherein said carrier is in the form of a plate, said thermally expandable material is attached to a supporting structure

around the periphery of said carrier, and said mounting structure includes a mounting surface that is substantially perpendicular to the plane of said plate.

7. A cavity filler insert in accordance with Claim 3, wherein at least a portion of said thermally expandable material is positioned in a channel that extends at least partially around the periphery of said carrier.
8. A cavity filler insert in accordance with Claim 1, wherein said thermally expandable material comprises:
 - a). from 25 to 70% by weight of at least one thermoplastic elastomer;
 - b). from 15 to 40% by weight of at least one non-elastomeric thermoplastic;
 - c). from 0.01 to 2% by weight of at least one stabilizer or antioxidant;
 - d). from 2 to 15% by weight of at least one blowing agent; and
 - e). from 0.5 to 4% by weight of at least one curing agent.
9. A cavity filler insert in accordance with Claim 1, wherein said thermally expandable material comprises:
 - a). from 35 to 55% by weight of at least one thermoplastic elastomer selected from the group consisting of thermoplastic polyurethanes, styrene/butadiene block copolymers, hydrogenated styrene/butadiene block copolymers, styrene/isoprene block copolymers, and hydrogenated styrene/isoprene block copolymers;
 - b). from 20 to 35% by weight of at least one non-elastomeric thermoplastic selected from the group consisting of ethylene/vinyl acetate copolymers and ethylene/methyl acrylate copolymers;
 - c). from 0.05 to 1% by weight of at least one stabilizer or antioxidant;
 - d). at least one latent chemical blowing agent in an amount effective to cause the expandable material to expand at least 100% in volume when heated at a temperature of 150 degrees C for at least 20 minutes;
 - e). from 0.5 to 4% by weight of a peroxide; and
 - f). from 0.5 to 2% by weight of at least one olefinically unsaturated monomer or oligomer;wherein said thermally expandable material contains less than 10% by weight filler.

10. A noise- and vibration-dampened article comprising a hollow structure having an interior surface and a cavity filler insert within said hollow structure, wherein said cavity filler insert is substantially planar in shape and comprised of an expanded material which a) extends at least around substantially the entire periphery of said cavity filler insert, b) is in contact with said interior surface so as to seal off said hollow structure, and c) has a Young's storage modulus E' between 0.1 MPa and 1000 MPa, a loss factor of at least 0.3 and a shear modulus G' between 0.1 MPa and 500 MPa at a temperature between -10 and $+40$ degrees C in the frequency range 0 to 500 Hz.
11. A noise-dampened article in accordance with Claim 10, wherein said cavity filler insert is additionally comprised of a carrier.
12. A noise- and vibration-dampened article in accordance with Claim 11, wherein said carrier is in the form of a plate and said thermally expanded material is attached to the periphery of said carrier.
13. A noise- and vibration-dampened article in accordance with Claim 11, wherein said carrier comprises two parallel plates with a layer of said thermally expanded material positioned at least partly in between said two parallel plates and occupying at least a portion of the space between the two parallel plates.
14. A noise- and vibration-dampened article in accordance with Claim 10, wherein said thermally expanded material is obtained by heating a thermally expandable material comprising:
 - a). from 25 to 70% by weight of at least one thermoplastic elastomer;
 - b). from 15 to 40% by weight of at least one non-elastomeric thermoplastic;
 - c). from 0.01 to 2% by weight of at least one stabilizer or antioxidant;
 - d). from 2 to 15% by weight of at least one blowing agent; and
 - e). from 0.5 to 4% by weight of at least one curing agent.

15. A noise- and vibration-dampened article in accordance with Claim 10, wherein said thermally expanded material is obtained by heating a thermally expandable material comprising:
- a). from 35 to 55% by weight of at least one thermoplastic elastomer selected from the group consisting of thermoplastic polyurethanes, styrene/butadiene block copolymers, hydrogenated styrene/butadiene block copolymers, styrene/isoprene block copolymers, and hydrogenated styrene/isoprene block copolymers;
 - b). from 20 to 35% by weight of at least one non-elastomeric thermoplastic selected from the group consisting of ethylene/vinyl acetate copolymers and ethylene/methyl acrylate copolymers;
 - c). from 0.05 to 1% by weight of at least one stabilizer or antioxidant;
 - d). at least one latent chemical blowing agent in an amount effective to cause the expandable material to expand at least 100% in volume when heated at a temperature of 150 degrees C for at least 20 minutes;
 - e). from 0.5 to 4% by weight of a peroxide; and
 - f). from 0.5 to 2% by weight of at least one olefinically unsaturated monomer or oligomer;
- wherein said thermally expandable material contains less than 10% by weight filler.
16. A noise- and vibration-dampened article in accordance with Claim 10, wherein said noise- and vibration-dampened article comprises a component of a vehicle.
17. A noise- and vibration-dampened article in accordance with Claim 10, wherein said noise-dampened article comprises a pillar of a vehicle.
18. A method of damping air- and structure-borne vibration in a hollow structure, said method comprising a) placing within said hollow structure a cavity filler insert which is substantially planar in shape and which comprises a thermally expandable material and at least one mounting device capable of holding said cavity filler insert in a predetermined position within said hollow structure and b) heating said thermally expandable material to a temperature effective to cause said thermally expandable material to expand and come into contact with the interior surface of

said hollow structure, thereby sealing off said hollow structure, wherein said thermally expandable material when expanded has a Young's storage modulus E' between 0.1 MPa and 1000 MPa, a loss factor of at least 0.3 and a shear storage modulus G' between 0.1 MPa and 500 MPa at a temperature between -10 and $+40$ degrees C in the frequency range 0 to 500 Hz.

19. A method in accordance with Claim 18, wherein said cavity filler insert is additionally comprised of a carrier.
20. A method in accordance with Claim 19, wherein said carrier is in the form of a plate and said thermally expandable material is attached to the periphery of said carrier.
21. A method in accordance with Claim 19, wherein said carrier comprises two parallel plates with a layer of said thermally expandable material positioned in between said two parallel plates.
22. A method in accordance with Claim 18, wherein said thermally expandable material comprises:
 - a). from 25 to 70% by weight of at least one thermoplastic elastomer;
 - b). from 15 to 40% by weight of at least one non-elastomeric thermoplastic;
 - c). from 0.01 to 2% by weight of at least one stabilizer or antioxidant;
 - d). from 2 to 15% by weight of at least one blowing agent; and
 - e). from 0.5 to 4% by weight of at least one curing agent.
23. A method in accordance with Claim 18, wherein said thermally expandable material comprises:
 - a). from 35 to 55% by weight of at least one thermoplastic elastomer selected from the group consisting of thermoplastic polyurethanes, styrene/butadiene block copolymers, hydrogenated styrene/butadiene block copolymers, styrene/isoprene block copolymers, and hydrogenated styrene/isoprene block copolymers;

- b). from 20 to 35% by weight of at least one non-elastomeric thermoplastic selected from the group consisting of ethylene/vinyl acetate copolymers and ethylene/methyl acrylate copolymers;
 - c). from 0.05 to 1% by weight of at least one stabilizer or antioxidant;
 - d). at least one latent chemical blowing agent in an amount effective to cause the expandable material to expand at least 100% in volume when heated at a temperature of 150 degrees C;
 - e). from 0.5 to 4% by weight of at least one peroxide; and
 - f). from 0.5 to 2% by weight of at least one olefinically unsaturated monomer or oligomer;
- wherein said thermally expandable material contains less than 10% by weight filler.

- 24. A method in accordance with Claim 18, wherein said hollow structure comprises a component of a vehicle.
- 25. A method in accordance with Claim 18, wherein said hollow structure comprises a pillar of a vehicle.

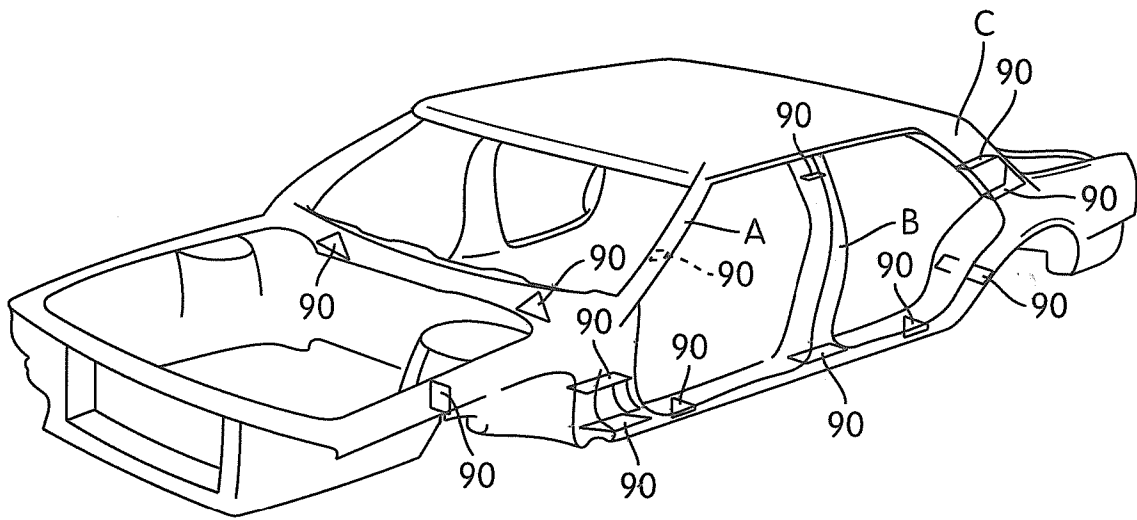


FIG. 1

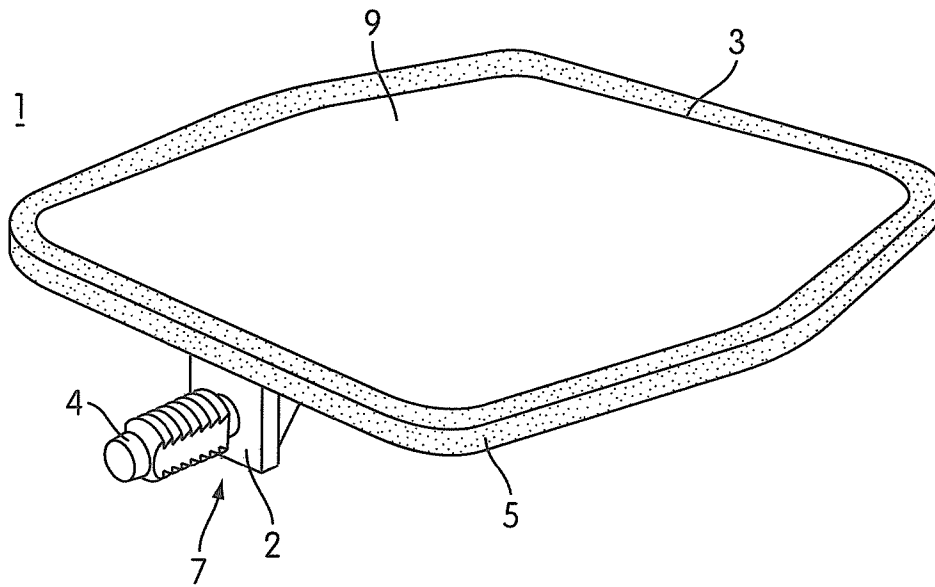


FIG. 2

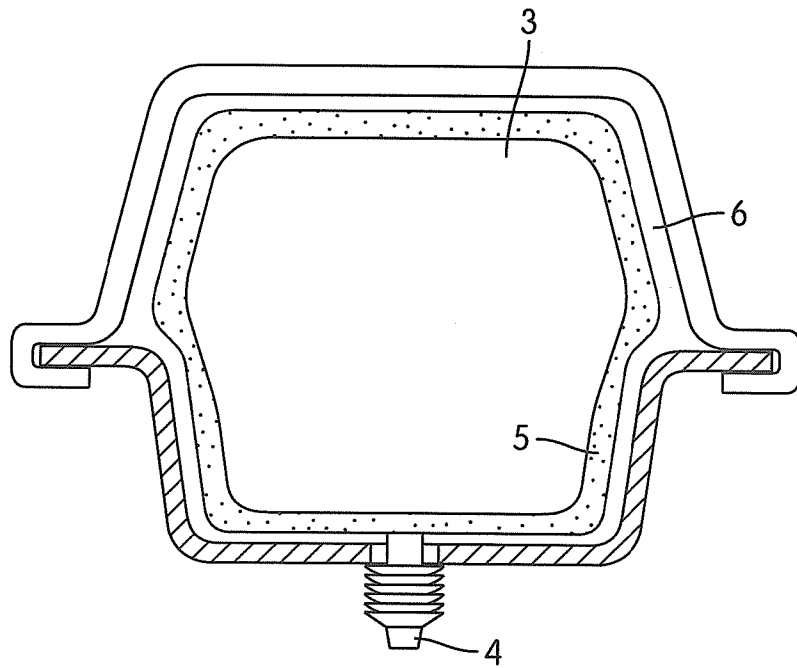


FIG. 3

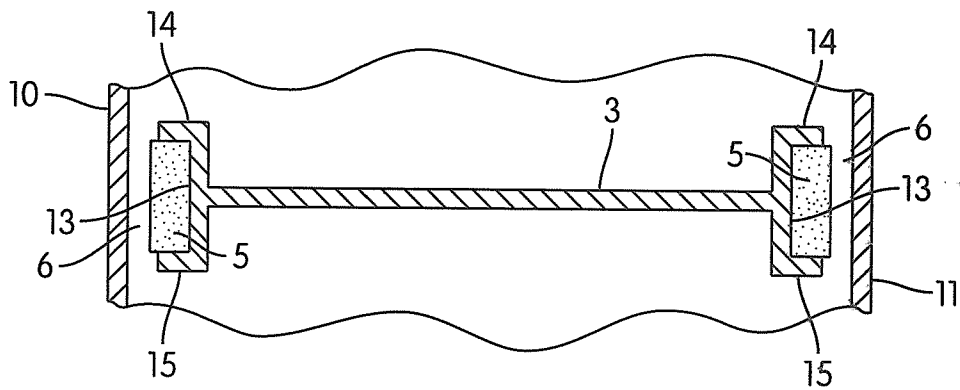


FIG. 4

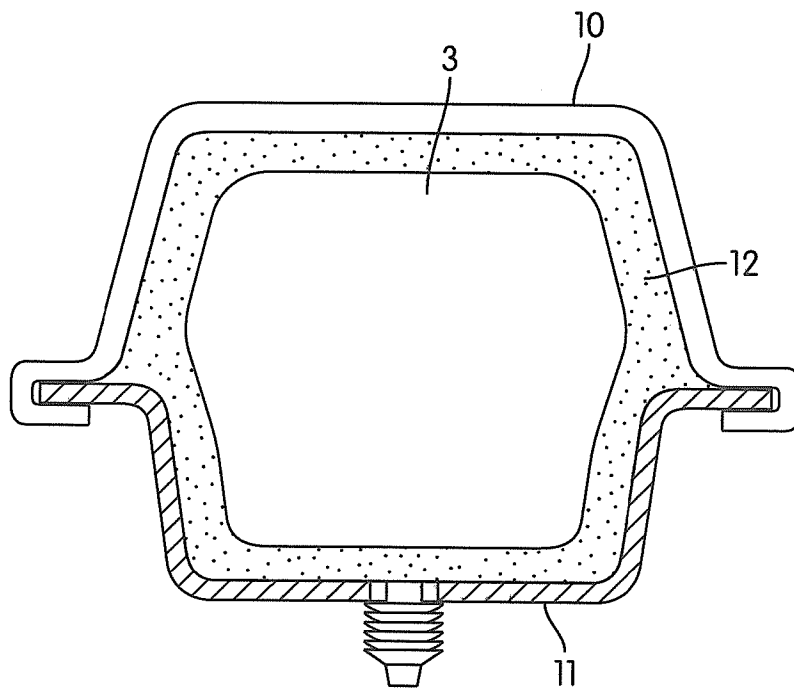


FIG. 5

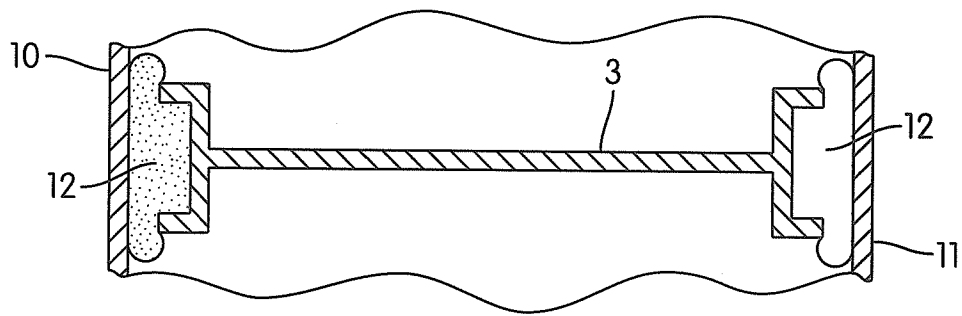


FIG. 6

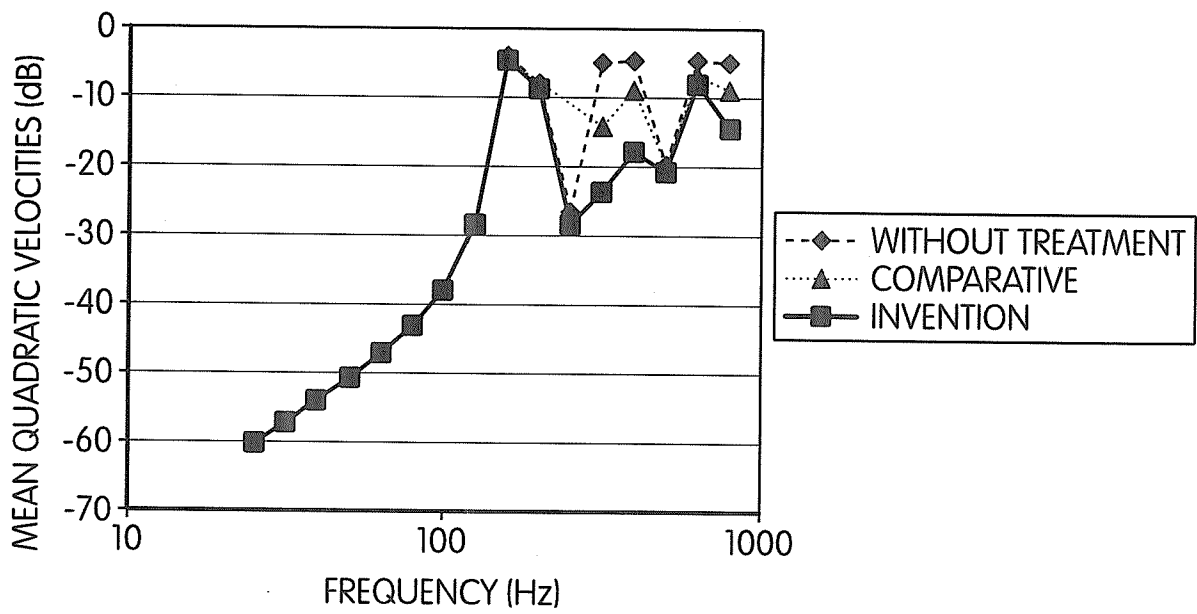


FIG. 7

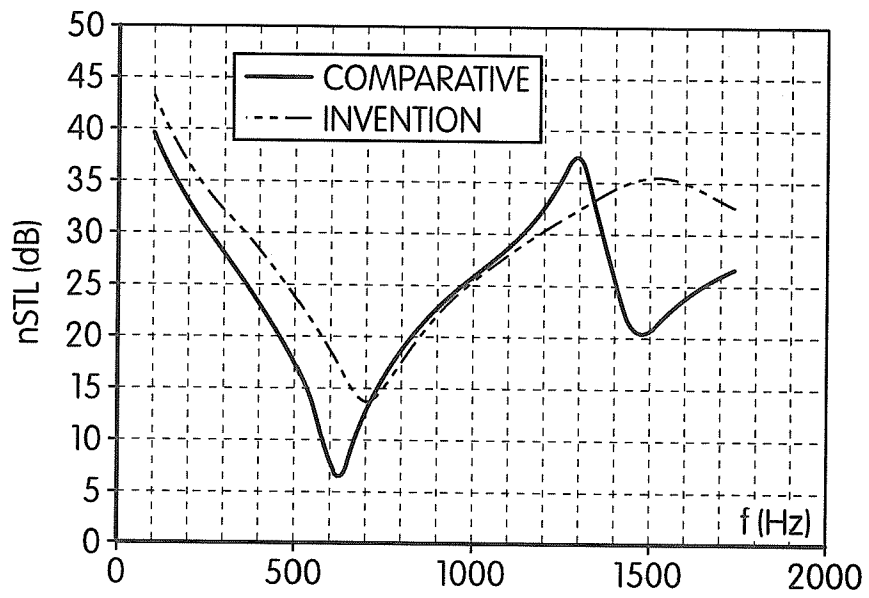


FIG. 8