(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 215 381 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.06.2002 Bulletin 2002/25

(51) Int Cl.[7]: **F02B 77/13**

(21) Application number: **01129540.9**

(22) Date of filing: **11.12.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **12.12.2000 JP 2000377615**

(71) Applicant: **NICHIAS CORPORATION**
Tokyo (JP)

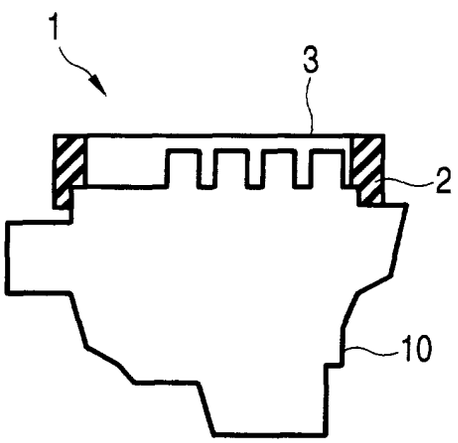
(72) Inventors:
- **Murakami, Atsushi**
  Hamamatsu-shi, Shizuoka (JP)
- **Arisawa, Atsushi**
  Hamamatsu-shi, Shizuoka (JP)
- **Nishimoto, Kazuo**
  Hamamatsu-shi, Shizuoka (JP)
- **Niwa, Takahiro**
  Tokyo (JP)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) Soundproof cover for automobile

(57) A soundproof cover to be mounted on the engine of an automobile is provided. The soundproof cover includes a foam material having a mixed cell structure of open cells and closed cells and a water absorption coefficient of 0.01 g/cm^3 or more and less than 0.5 g/cm^3. The foam material is provided along the circumferential rim of a cover main body surface facing an engine, and projects to the engine side by a predetermined height such that the foam material closes the gap with respect to the engine at the time it is mounted on the engine.

FIG. 1



EP 1 215 381 A2

Description

Background of the Invention

Field of the Invention

[0001] The present invention relates to a soundproof cover to be mounted on the engine of an automobile (hereinafter simply referred to as a "soundproof cover").

Description of the Related Art

[0002] Soundproof covers made of a foam material have been used as a noise insulation material for preventing the noise emitted from an engine of an automobile. As this kind of a soundproof cover, for example, a soundproof cover as shown in FIG. 9 are commonly used. The soundproof cover has a configuration for filling the gap between a cover main body 3 and an engine 10 by mounting a soundproof cover 1 on the engine 10 with a foam material 2 in a compressed state so as to recover the thickness by the elastic force of the foam material itself. In such a soundproof cover 1, a soft urethane foam with an open-cell structure is used frequently as a soft and low cost material. However, in the case the gap is filled using the urethane foam, the noise insulation effect is improved merely slightly.

[0003] By using a foam material with a closed-cell structure instead of the urethane foam, the noise insulation performance can be improved. However, since the foam material 2 is hard and has a high recovery force, the work of compressing the foam material 2 for mounting the soundproof cover 1 is difficult so that the soundproof cover mounting operativity is deteriorated. In the case the foam material 2 of the closed cells is thinned for improving the mounting property as shown in FIG. 10, a gap is generated with respect to the engine 10 so that the noise insulation effect is extremely deteriorated.

[0004] Moreover, although is it not shown, a foam material of the closed cells may be molded into a shape so as to fill the gap along the outer shape of the engine and sometimes used for a soundproof cover. In this case, the foam material should be molded into a specific shape. This increases the production cost, and thus it is problematic.

Summary of the Invention

[0005] In view of the circumferences, the invention has been achieved, and an object thereof is to provide a soundproof cover for an automobile engine, satisfying the two contrary characteristics of the noise insulation performance and the mounting property.

[0006] As a result of the elaborate discussion of the inventors, it was found out that the operativity at the time of mounting a soundproof cover onto an engine can be improved remarkably as well as the noise insulation performance can be substantially equal to the case a foam material is disposed on the entirety of the soundproof cover by providing a specific foam material on a side wall part of the soundproof cover, and sealing the gap with respect to an engine by the foam material. The invention is based on the knowledge.

[0007] In order to achieve the object, the invention provides a soundproof cover to be mounted on the engine of an automobile, including a foam material having a mixed-cell structure of open cells and closed cells wherein the water absorption coefficient is 0.01 g/cm^3 or more and less than 0.5 g/cm^3, provided along the circumferential rim of a cover main body surface facing an engine and projecting to the engine side by a predetermined height such that the foam material closes the gap with respect to the engine at the time it is mounted on the engine.

[0008] In the conventional soundproof covers, a foam material is disposed on the entirety of the engine side of a cover main body, but the sound insulation performance is not high despite the use of a large amount of the foam material. In contrast, according to a soundproof cover of the invention, by using a foam material with a specific property, the noise insulation effect can be improved only by providing the foam material only on the side wall part, compared with the structure conventionally used widely, which disposes a urethane form on the entirety of the cover. That is, despite use of a small amount of the foam material, the excellent noise insulation effect can be provided. Moreover, since the foam material need not be compressed, the mounting operation onto the engine can be carried out extremely easily.

Brief Description of the Drawings

[0009]

FIG. 1 is a sectional view showing an embodiment of a soundproof cover of the invention.
FIG. 2(a) is a top view of the soundproof cover shown in FIG. 1, and FIG. 2(b) is a sectional view taken along a

line I-I, showing the structure of the soundproof covers used in the embodiments 1, 2, and the comparative examples 1, 2.

FIG. 3(a) is a top view of a soundproof cover of another embodiment of the invention, and FIG. 3(b) is a sectional view taken along a line I-I, showing the structure of the soundproof covers used in the embodiments 3, 4, 5, and the comparative example 4.

FIG. 4(a) is a top view showing the structure of the soundproof cover used in the comparative example 4, and FIG. 4(b) is a sectional view taken along a line I-I.

FIG. 5 is a schematic diagram of a testing device used in the embodiments.

FIG. 6 is a graph showing the noise level measurement results of the embodiments 1, 2, and the comparative examples 1, 2.

FIG. 7 is a graph showing the noise level measurement results of the embodiment 1, and the comparative examples 3, 4.

FIG. 8 is a graph showing the noise level measurement results of the embodiments 1, 3, 4, 5.

FIG. 9 is a sectional view showing a conventional embodiment of a soundproof cover.

FIG. 10 is a sectional view showing another conventional embodiment of a soundproof cover.

Detailed Description of the Preferred Embodiments

[0010] Hereinafter, the invention will be explained in detail.

[0011] FIG. 1 is a sectional view showing a soundproof cover 1 of the invention. Similar to FIGS. 9 and 10, it is shown in the state mounted on an engine 10. FIG. 2(a) is a top view, and FIG. 2 (b) is a sectional view taken along a line I-I. As shown in the figures, the soundproof cover 1 includes a foam material 2 projecting from the circumferential rim of the surface facing the engine 10 of a cover main body 3 to the engine side by a predetermined height.

[0012] In general, in the case where a soundproof cover is mounted on an engine, the noise generated in the engine and reaching the outside can be classified roughly into the transmission noise transmitted through the soundproof cover and the leakage noise leaking from the gap between the soundproof cover and the engine. Here, the conventional soundproof cover (see FIG. 9) has the foam material 2 disposed on the entirety of the engine side opening part of the cover main body 3, aiming at reduction of the transmission noise and the leakage noise simultaneously. However, depending on the kind of the foam material, the effect is not sufficient. For example, a sufficient noise insulation performance cannot be obtained by a urethane foam, which has the excellent mounting property. In contrast, the soundproof cover 1 according to the invention reduces the noise effectively by disposing the foam material 2 on the circumferential rim of the cover main body 3 so as to close the gap with respect to the engine 10. That is, the noise insulation effect is improved, with the leakage noise as the target because it was found out that the leakage noise is dominant among the transmission noise and the leakage noise from the entire noise reaching the outside of the soundproof cover 1 so that the entire noise can be reduced by reducing the leakage noise.

[0013] Therefore, as the foam material 2 for closing the gap with respect to the engine 10, one having a specific property for effectively preventing leakage of the noise should be used. In the invention, a foam material having a mixed cell structure of open cells and closed cells, wherein a water absorption coefficient is 0.01 g/cm^3 or more and less than 0.5 g/cm^3, is used in order to meet the demand.

[0014] Since a foam material with the open cells have the cells communicating with each other, a sound wave transmits easily in the inside of the foam material. Since a foam material with the closed cells have the cells not communicating with each other, a sound wave cannot transmit easily in the inside of the foam material. Therefore, from the viewpoint of the noise insulation performance, a foam material with a large ratio of the closed cells is preferable as the soundproof foam material from the viewpoint of the noise insulation performance. In contrast, the recovery force of a compressed foam material is classified roughly into the recovery force of the cell wall and the recovery force of the inside air. Since a foam material with the open cells have the air inside the foam material easily discharged to the outside through the communicating cells being compressed, only the recovery force of the cell wall functions so that the recovery force when it is compressed is small in most cases. Since a foam material with the closed cells have the air inside the form material not easily discharged to the outside in the case it is compressed, both the recovery force of the cell wall and the recovery force of the air inside the foam material function so that the recovery force of the foam material being compressed is large in most cases. Since the soundproof cover mounting property is deteriorated in the case where the recovery force of the compressed foam material is large, it is preferable to use a foam material with the open cells as the soundproof foam material from the viewpoint of the soundproof cover mounting property. Therefore, in order to satisfy both the noise insulation performance and the mounting property, it is preferable to use a foam material having a mixed cell structure of open cells and closed cells, with a specific ratio of the open cells and the closed cells.

[0015] Moreover, in general, a foam material with an open cell structure has a large water absorption coefficient, and a foam material with a closed cell structure has a small water absorption coefficient. A mixed cell structure of open

cells and closed cells has an intermediate value therebetween. Therefore, by specifying the water absorption coefficient, the ratio of the open cells and the closed cells can be identified. The water absorption coefficient is measured by the B method of the JIS K6767.

[0016] The water absorption coefficient of the foam material 2 used in the invention is 0.01 g/cm^3 or more and less than 0.5 g/cm^3, preferably 0.02 g/cm^3 or more and less than 0.2 g/cm^3, more preferably 0.04 g/cm^3 or more and less than 0.1 g/cm^3. By the use of the foam material 2 with such a water absorption coefficient, the soundproof cover 1 having the excellent noise insulation performance and mounting property can be obtained. In the case where the water absorption coefficient is larger than the range, since a sound wave easily transmits the inside of the form material 2, the leakage noise cannot be insulated so that a sufficient noise insulation effect cannot be realized. Moreover, in the case where the water absorption coefficient is smaller than the range, the mounting operativity is deteriorated due to the recovery force of the foam material 2 at the time of mounting the soundproof cover 1 on the engine.

[0017] Furthermore, it is known that the noise insulation performance of the foam material 2 is proportional to the weight measurement so that a substance with a higher bulk density provides a higher noise insulation performance in the case where the thickness of the substances is same. However, since a material with a high bulk density is hard, in most cases the recovery force when it is compressed is large. Since the soundproof cover mounting property is deteriorated in the case where the recovery force of the compressed foam material is large, it is preferable to use a foam material with a low bulk density as the foam material. Therefore, in order to satisfy both the noise insulation performance and the mounting property, it is preferable to use a foam material with a bulk density in a specific range.

[0018] In the foam material 2 used in the invention, the bulk density is preferably 20 kg/m^3 or more and less than 400 kg/m^3, more preferably 30 kg/m^3 or more and less than 300 kg/m^3, and further preferably 50 kg/m^3 or more and less than 200 kg/m^3. By the use of a foam material 2 with a bulk density in the range, a soundproof cover having the excellent noise insulation performance and mounting property can be obtained. In the case where the bulk density is smaller than the range, since a sound wave transmits easily in the inside of the foam material 2, the leakage noise cannot be insulated so that a sufficient noise insulation effect cannot be realized. Moreover, in the case where the bulk density is larger than the range, the mounting operativity is deteriorated due to the recovery force of the foam material 2 at the time of mounting the soundproof cover 1 on the engine.

[0019] Furthermore, as a prerequisite for the foam material, a highly close contact with the engine can be presented. A soft foam material can sufficiently follow a complicated shape so as to provide a good initial close contact, and thus it is preferable. In contrast, a hard foam material has a low shape followability at the time it is compressed, and thus in the case where the engine outer shape is complicated, a gap may be generated. Moreover, a hard material also involves a problem in that the operativity at the time of mounting the soundproof cover is deteriorated due to the recovery force of the foam material. Therefore, in order to satisfy both the noise insulation performance and the mounting property, it is preferable to use a foam material with a hardness in a specific range. The foam material hardness is measured as the 25% compression hardness by the JIS K6767.

[0020] In the foam material 2 used in the invention, the 25% compression hardness is preferably less than 0.5 N/cm^2, more preferably 0.02 N/cm^2 or more and less than 0.1 N/cm^2. By the use of a foam material with a compression hardness in the range, a soundproof cover having the excellent noise insulation performance and mounting property can be obtained. In the case where the 25% compression hardness is larger than the range, a gap may be generated due to inability of following the outer shape of the engine 10, and further, the mounting operativity is deteriorated due to the recovery force of the foam material 2 at the time of mounting the soundproof cover 1 on the engine 10.

[0021] The main component of a foam material used in the invention is not particularly limited as long as the characteristics are satisfied. Various kinds of polymer materials, such as rubber, elastomer, a thermoplastic resin, a thermosetting resin, or the like can be used. Examples of the polymer materials include rubbers such as natural rubber, CR (chloroprene rubber), SBR (styrene butadiene rubber), NBR (nitrile-butadiene rubber), EPDM (ethylene-propylene-diene terpolymer copolymer), silicone rubber, fluoride rubber, and acrylic rubber; elastomers such as a thermoplastic elastomer and a soft urethane; thermoplastic resins such as polyethylene, polypropylene, polyamide, and a polyester; and thermosetting resins such as a urethane and an epoxy resin, but it is not limited thereto. By the use of a foam material 2 containing a rubber or an elastomer as the main component, a soundproof cover 1 having the excellent noise insulation performance and mounting property can be obtained. In particular, since a foam material 1 containing EPDM as the main component is used widely so that it can be obtained easily, and has the heat resistance, the ozone resistance, and the price is well balanced, it is preferable as the foam material 2 in the invention.

[0022] Moreover, as the foam material 2, a foam material sheet of EPDM or NBR commercially available as a waterproof sealant for the construction or the weak charge may be used.

[0023] In order to fix the foam material 2 on the cover main body 3, various means such as an adhesive, a bond, a bonding tape, and a hot melt adhesive can be adopted. Moreover, a pin or a clip may be used for the fixation, but the method for fixing the foam material 2 and the cover main body 3 is not limited thereto.

[0024] As the material of the cover main body 3 used in the invention, various metals such as iron, aluminum, and stainless steel, and various resins such as nylon, polypropylene, and an unsaturated polyester can be used. It is also

possible to add a filler and/or a fiber to the various resins. In particular, a material produced by adding a filler and/or a fiber to nylon or polypropylene has a light weight, and the excellent heat resistance and strength characteristic. Thus, it is preferable.

[0025] As heretofore mentioned, according to the invention, a soundproof cover 1 having the excellent mounting property and noise insulation performance can be obtained. Besides, the foam material 2 need only to be provided on the circumferential rim of the cover main body 3 so that the amount of the foam material 2 can be cut back, and thus it is advantageous in terms of the cost. Moreover compared with the case of disposing the foam material 2 on the entirety of the cover main body 3, the recovery force of the foam material is made lower so that the mounting property of the soundproof cover 1 can be improved as well.

[0026] In the invention, as shown in FIGS. 3(a) and 3(b) (Fig. 3(a) is a top view, and Fig. 3(b) is a sectional view taken along a line I-I), the same foam material 2a can be provided on the facing surface 3a, in addition to the circumferential rim of the cover main body 3. Thereby, the noise insulation performance can further be improved. In this case, the foam material 2a to be provided on the facing surface 3a need to have a thin thickness so as not to influence the mounting property. Furthermore, in some cases, the foam material 2a provided on the facing surface 3a and the foam material 2 provided on the circumferential rim may have different configurations.

[0027] As to the portion of using the soundproof cover 1 of the invention, in addition to the upper part of the engine 10 as shown in the figures, for example, it can be used on the lower part of the engine for reduction of the noise from the lower part of the engine, or on the front surface or the side surface of the engine. Moreover, the entirety of the engine may be covered, or a part thereof may be covered. Furthermore, it may be used partially on the appliances to be the source of a noise, such as a fuel injection pump, and an intake manifold, and thus the portion of use is not limited thereto.

Embodiments

[0028] Hereinafter, the invention will be explained in further detail with reference to the embodiment, but the invention is not limited to the following embodiments.

[0029] In the embodiments 1, 2 and the comparative examples 1, 2, the soundproof cover has a structure shown in FIG. 2, and in the embodiment 3 and the comparative example 3, the soundproof cover has a structure shown in FIG. 3. Moreover, in the comparative example 4, the soundproof cover has a configuration of the sound proof cover having the foam material 2 on the facing surface 3a of the cover main body 3 as shown in FIG. 4. Furthermore, the cover main body is made of a stainless steel.

(Embodiment 1)

[0030] A band-like EPDM foam material, which is 15 mm in thickness, 30 mm in width, 100 kg/m^3 in bulk density, 0.071 g/cm^3 in water absorption coefficient, and 0.040 N/cm^2 in 25% compression hardness, was bonded only on the entire circumferential rim of the inside of the cover main body so as to provide a soundproof cover.

(Embodiment 2)

[0031] A band-like NBR foam material, which is 15 mm in thickness, 30 mm in width, 120 kg/m^3 in bulk density, 0.058 g/cm^3 in water absorption coefficient, and 0.070 N/cm^2 in 25% compression hardness was bonded only on the entire circumferential rim of the inside of the cover main body so as to provide a soundproof cover.

(Embodiment 3)

[0032] An EPDM foam material having 100 kg/m^3 in bulk density, 0.071 g/cm^3 in water absorption coefficient, and 0.040 N/cm^2 in 25% compression hardness was bonded on the entire circumferential rim of the inside of the cover main body and the facing surface so as to provide a soundproof cover. The foam material on the circumferential rim had a band-like shape, which is 15 mm in thickness and 30 mm in width, and the foam material on the facing surface had a flat plate-like shape, which is a size of 350 mm $\times$ 330 mm $\times$ a thickness of 15 mm.

(Embodiment 4)

[0033] A band-like EPDM foam material, which is 15 mm in thickness, 30 mm in width, 100 kg/m^3 in bulk density, 0.071 g/cm^3 in water absorption coefficient, and 0.040 N/cm^2 in 25% compression hardness was bonded on the entire circumferential rim of the inside of the cover main body, and a soft urethane foam material, which is a size of 350 mm $\times$ 330 mm $\times$ a thickness of 15 mm, 25 kg/m^3 in bulk density, 0.076 g/cm^3 in water absorption coefficient, and 0.065

N/cm^2 in 25% compression hardness was bonded on the facing surface, respectively so as to provide a soundproof cover.

(Embodiment 5)

[0034] A band-like EPDM foam material, which is 15 mm in thickness, 30 mm in width, 100 kg/m^3 in bulk density, 0.071 g/cm^3 in water absorption coefficient, and 0.040 N/cm^2 in 25% compression hardness was bonded on the entire circumferential rim of the inside of the cover main body, and an EPDM foam material, which is a size of 350 mm × 330 mm × a thickness of 15 mm, 460 kg/m^3 in bulk density, 0.028 g/cm^3 in water absorption coefficient, and 0.105 N/cm^2 in 25% compression hardness was bonded on the facing surface, respectively so as to provide a soundproof cover.

(Comparative Example 1)

[0035] A band-like soft urethane foam material, which is 15 mm in thickness, 30 mm in width, 25 kg/m^3 in bulk density, 0.076 g/cm^3 in water absorption coefficient, and 0.065 N/cm^2 in 25% compression hardness was bonded only on the entire circumferential rim of the inside of the cover main body so as to provide a soundproof cover.

(Comparative Example 2)

[0036] A band-like EPDM foam material, which is 15 mm in thickness, 30 mm in width, 460 kg/m^3 in bulk density, 0.028 g/cm^3 in water absorption coefficient, and 1.05 N/cm^2 in 25% compression hardness was bonded only on the entire circumferential rim of the inside of the cover main body so as to provide a soundproof cover.

(Comparative Example 3)

[0037] An foam material, which is 25 kg/m^3 in bulk density, 0.076 g/cm^3 in water absorption coefficient, and 0.065 N/cm^2 in 25% compression hardness was bonded on the entire circumferential rim of the inside of the cover main body and the facing surface so as to provide a soundproof cover. The foam material on the circumferential rim had a band-like shape, which is 15 mm in thickness and 30 mm in width, and the foam material on the facing surface had a flat plate-like shape, which is a size of 350 mm × 330 mm × a thickness of 15 mm thickness size.

(Comparative Example 4)

[0038] An EPDM foam material, which is a size of 350 mm × 330 mm × a thickness of 15 mm, 100 kg/m^3 in bulk density, 0.071 g/cm^3 in water absorption coefficient, and 0.040 N/cm^2 in 25% compression hardness was bonded only on the facing surface of the cover main body so as to provide a soundproof cover.

[0039] The noise insulation performance was evaluated for the soundproof covers of the embodiments and the comparative embodiments using a measurement device shown in FIG. 5. That is, the soundproof cover 20 was fixed on an aluminum plate with the foam material disposed on the lower side by M6 bolts 23 via pedestals 21 having a round sectional shape, a diameter of 20 mm, and a height of 40 mm. Each pedestal 21 was provided with a bolt hole on the soundproof cover side so as to provide the bolt fastening part of the soundproof cover at 4 portions. A speaker 24 was placed on the aluminum plate 22, and further, it was covered with a box 25, which has a size of 425 mm × 320 mm x a height of 20 mm. The box 25 includes a metal side plate 25a and a mesh-like upper plate 25b. A white noise was radiated from the speaker 24 and the noise level was measured with a noise meter by picking up the noise by a microphone 26 installed immediately above the soundproof cover 20 by 50 mm for evaluation of the noise insulation performance. The noise level was measured for the 250 to 5,000 Hz frequency range by a 1/3 octave band resolution. A lower value represents a low noise level and a high noise insulation performance.

[0040] Moreover, a cover mounting property was evaluated by the maximum torque at the time of fastening the bolts in mounting the soundproof cover 20 on the plate 22. A lower maximum torque at the time of fastening the bolts represents a better cover mounting property. In the case where the bolts are fastened by a ratchet type torque wrench, the ratchet functions when the torque exceeds a preset torque. The ratchet does not function when it is not more than the preset torque. The ratchet setting was at 120 kg·cm so that in the case where the maximum torque of any of the four bolts 23 was 120 kg·cm or more, the mounting property was judged to be not passed "×", and in the case the maximum torque of all of the four bolts 23 was less than 120 kg·cm, the mounting property was judged to be passed "o".

[0041] The noise level of the embodiments 1, 2, and the comparative examples 1, 2 are shown in FIG. 6. The noise level of the embodiment 1, and the comparative examples 3, 4 are shown in FIG. 7. The noise level of the embodiments 1, 3, 4, 5 are shown in FIG. 8. Moreover, the cover mounting property evaluation results are shown in Table 2. Furthermore, the kinds and the bonding portion of the foam materials of the embodiments and the comparative examples are

shown in FIG. 1.

Table 1

		Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Comp. 1	Comp. 2	Comp. 3	Comp. 4
Circumferential Rim	Existence of Foam Material	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Material	EPDM	NBR	EPDM	EPDM	EPDM	Urethane	EPDM	Urethane	
	Water Absorption Coefficient	0.071	0.058	0.071	0.071	0.071	0.76	0.0028	0.76	
	Bulk Density	100	120	100	100	100	25	460	25	
	25% Compression Hardness	0.040	0.070	0.040	0.040	0.040	0.065	1.05	0.065	
	Thickness	15	15	15	15	15	15	15	15	
Facing Surface	Existence of Foam Material	No	No	Yes	Yes	Yes	No	No	Yes	Yes
	Material			EPDM	Urethane	EPDM			Urethane	EPDM
	Water Absorption Coefficient			0.071	0.76	0.0028			0.76	0.071
	Bulk Density			100	25	460			25	100
	25% Compression Hardness			0.040	0.65	1.05			0.065	0.040
	Thickness			15	15	15			15	15

(Notes) Emb. : Embodiment; Comp. : Comparative Example

Table 2

	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Comp. 1	Comp. 2	Comp. 3	Comp. 4
Cover Mounting Property	○	○	○	○	○	○	×	○	○
(Notes) Emb. : Embodiment; Comp. : Comparative Example									

[0042] From the results of the tests, it was found out that the embodiments provide good noise insulation performance and cover mounting property. Although the comparative examples 1 and 3 provide a small maximum torque and a good cover mounting property as in the embodiments, since a foam material with the open cells was used, the noise level was high due to the sound wave transmission inside the foam material and the noise insulation performance was low. The comparative example 3 having a structure widely used as a soundproof cover provides an insufficient noise insulation effect. Although the comparative example 2 provides a good noise insulation performance similar to the embodiments, since a foam material with the closed cells was used, it is problematic in terms of the cover mounting property. The comparative example 4 having a foam material disposed only on the facing surface part of the cover main body provides a low noise insulation performance due to the noise leakage from the circumferential rim gap.

[0043] As heretofore explained, according to the invention, by providing a foam material with a specific property on the circumferential rim of a cover main body, a soundproof cover having the excellent noise insulation performance and a good mounting property can be obtained despite use of the foam material in a small amount.

Claims

1. A soundproof cover to be mounted on an engine of an automobile, comprising:

a cover main body including a surface facing the engine; and
a foam material including a mixed cell structure of open cells and closed cells and having a water absorption coefficient of 0.01 g/cm^3 or more and less than 0.5 g/cm^3,

wherein said foam material is provided along a circumferential rim of said surface of said cover main body, and projects to an engine side by a predetermined height such that said foam material fills a gap with respect to the engine at the time it is mounted on the engine.

2. The soundproof cover according to claim 1, wherein a bulk density of said foam material is 20 g/m^3 or more and less than 400 kg/m^3.

3. The soundproof cover according to claim 1, wherein a 25% compression hardness thereof is less than 0.5 N/cm^2.

4. The soundproof cover according to claim 1, wherein a bulk density of said foam material is 20 g/m^3 or more and less than 400 kg/m^3, and a 25% compression hardness thereof is less than 0.5 N/cm^2.

FIG. 1

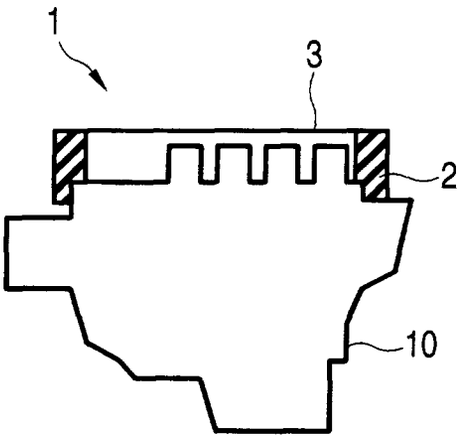


FIG. 2 (a)

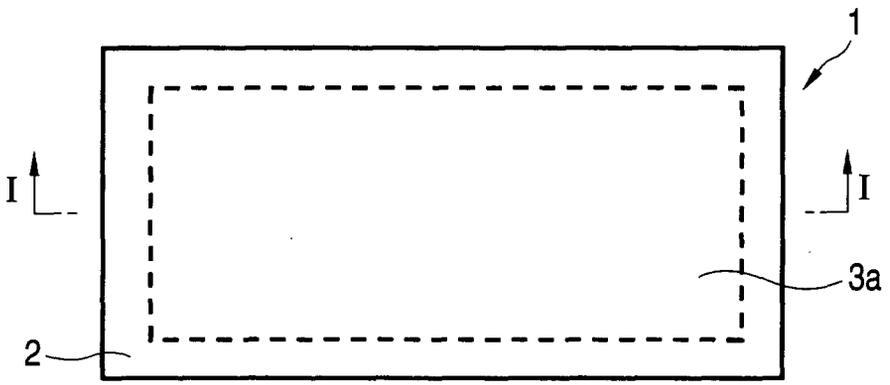


FIG. 2 (b)

FIG. 3 (a)

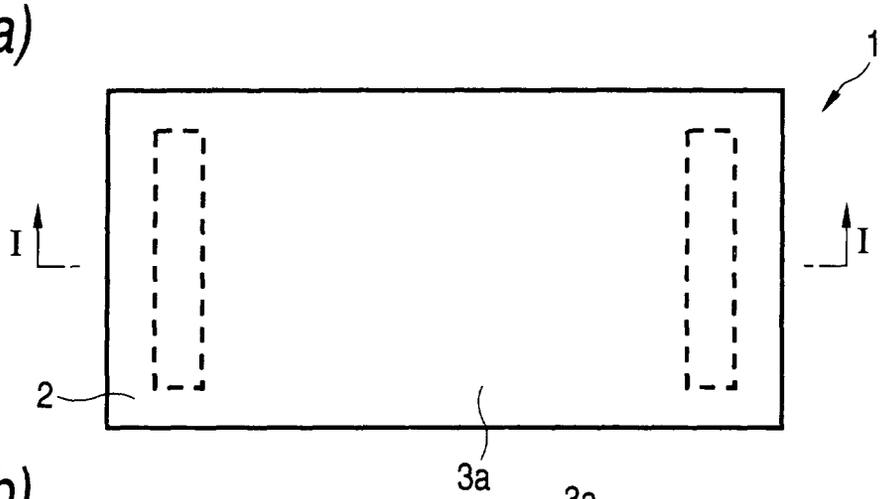


FIG. 3 (b)

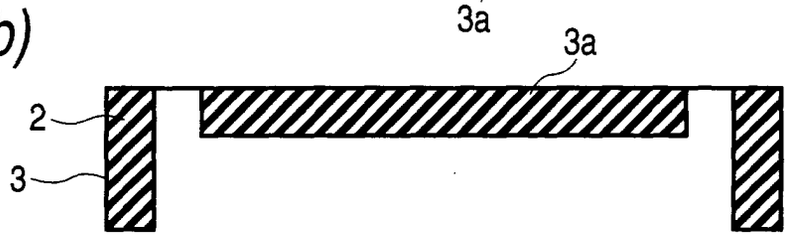


FIG. 4 (a)

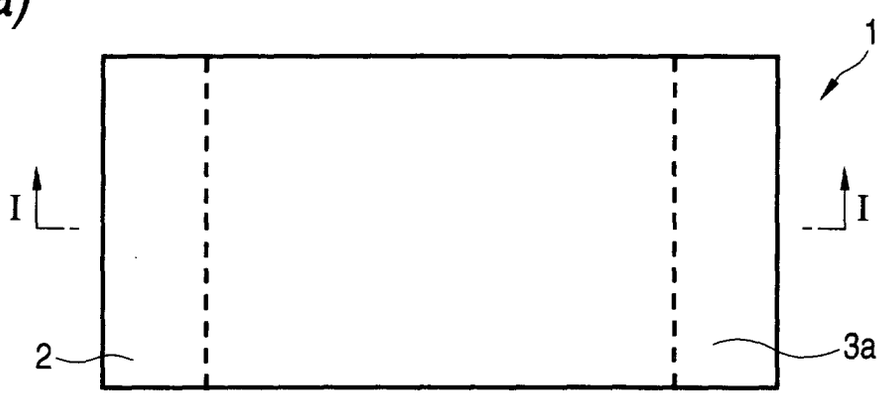


FIG. 4 (b)

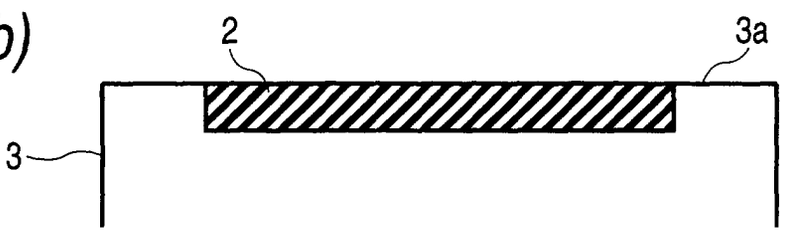


FIG. 5

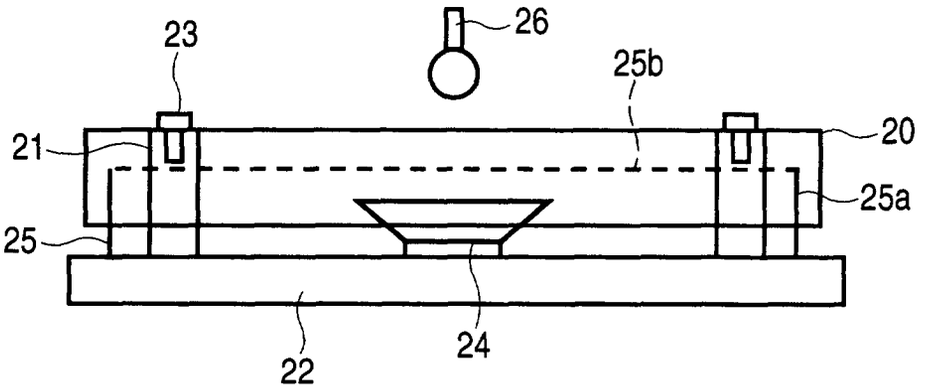

23
26
25b
21
20
25a
25
24
22

FIG. 6

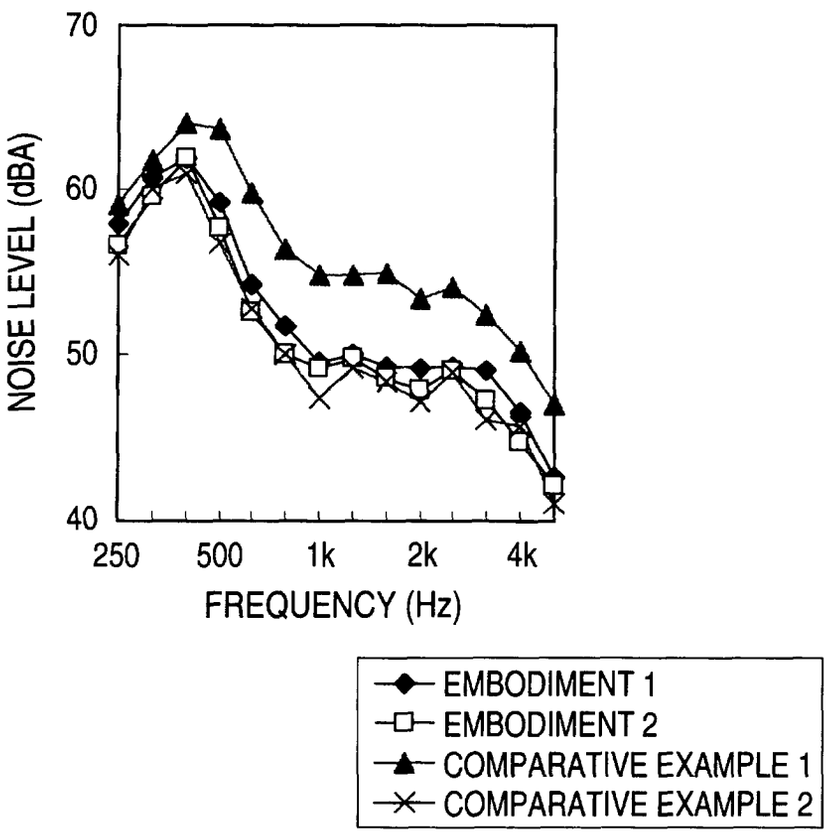

70
60
50
40
NOISE LEVEL (dBA)
250
500
1k
2k
4k
FREQUENCY (Hz)
EMBODIMENT 1
EMBODIMENT 2
COMPARATIVE EXAMPLE 1
COMPARATIVE EXAMPLE 2

FIG. 7

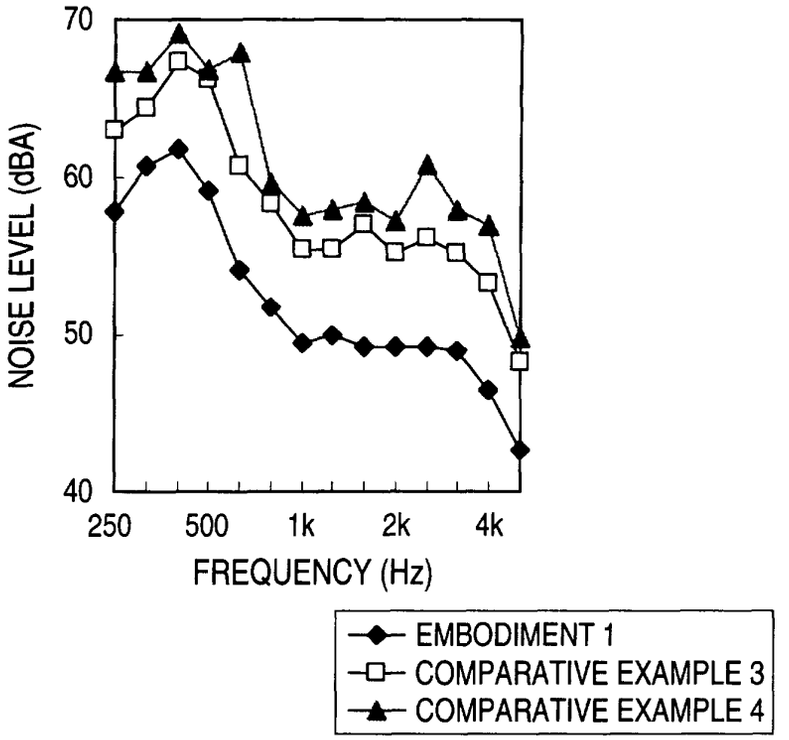

70
60
50
40
NOISE LEVEL (dBA)
250
500
1k
2k
4k
FREQUENCY (Hz)
EMBODIMENT 1
COMPARATIVE EXAMPLE 3
COMPARATIVE EXAMPLE 4

FIG. 8

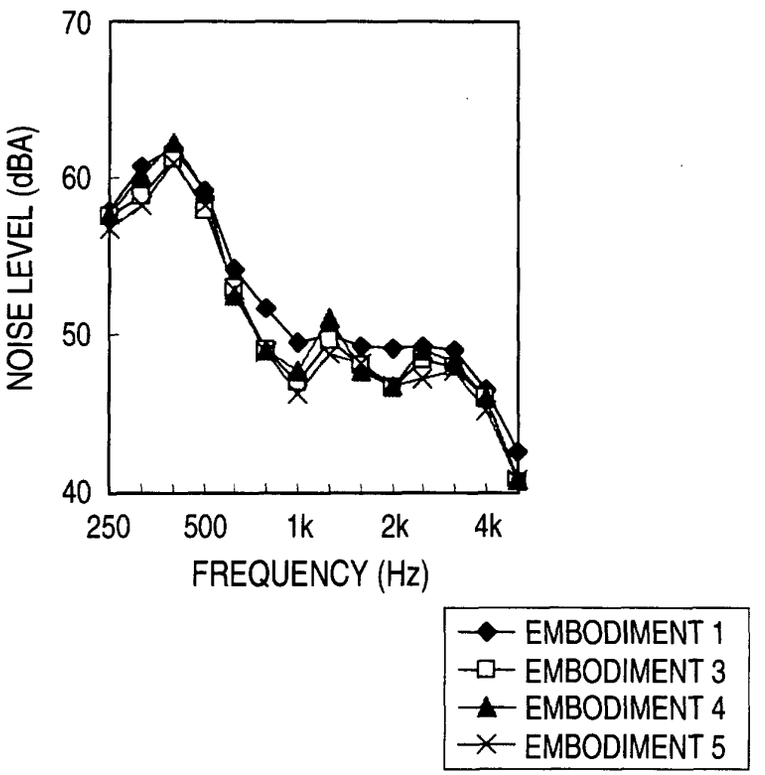

70
60
50
40
NOISE LEVEL (dBA)
250
500
1k
2k
4k
FREQUENCY (Hz)
EMBODIMENT 1
EMBODIMENT 3
EMBODIMENT 4
EMBODIMENT 5

FIG. 9

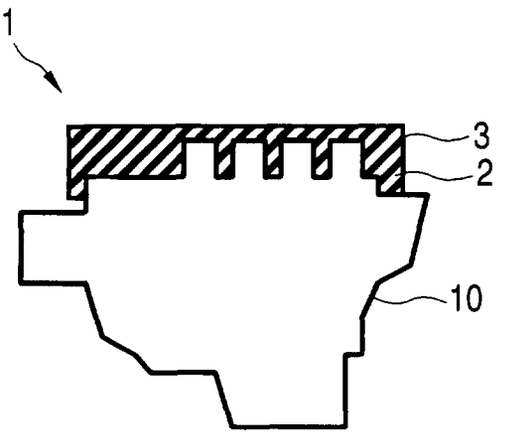


FIG. 10