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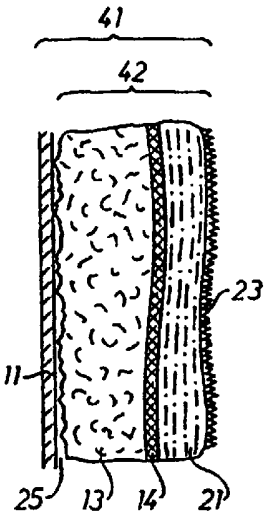
(57) Abstract

This invention concerns a kit (41) for reducing noise in motor vehicles and comprises at least one flat vehicle part (11) with a sound-insulating assembly package (42) consisting of several layers and an at least partly interlaying air layer (25). This assembly package (42) has at least one porous cushioning layer (13), a microporous reinforcing layer (14) which is lightweight, stiff and openly porous, an air flow resistance between R_t = 500Nsm^{-3} and R_t = 2,500Nsm^{-3}, and a surface area of m_F = 0.3kg/m^2 to m_F = 2.0kg/m^2. The reinforcing layer (14) has a stiffness of B = 0.05Nm to B = 10.5Nm. This permits replacing the weight of classic spring-mass-systems for noise reduction in vehicles with a system at least 50 % lighter. In addition to the dampening effect on oscillations, this kit (41) also quite effectively absorbs sound and provides thermal insulation. Preferably, this multifunctional, ultralight kit (41) is used to insulate the floor or fire wall, or as door lining or roof inner lining.



(57) Zusammenfassung

Bausatz (41) dient der Lärmreduktion in Fahrzeugen und umfasst mindestens ein flächiges Fahrzeugteil (11) mit einem schallisolierenden Montagepaket (42) aus mehreren Schichten und mindestens partiell eine dazwischenliegende Luftschicht (25). Dieses Montagepaket (42) weist mindestens eine poröse Federschicht (13) und eine mikroporöse Versteifungsschicht (14) auf, welche Versteifungsschicht (14) leicht und offenporig ist, resp. einen Luftströmungswiderstand von R_t = 500Nsm^{-3} bis R_t = 2500Nsm^{-3}, und eine Flächenmasse von m_F = 0.3kg/m^2 bis m_F = 2.0kg/m^2 aufweist. Insbesondere weist diese Versteifungsschicht (14) eine Biegesteifigkeit von B = 0.005Nm bis B = 10.5Nm auf. Damit können die klassischen Feder-Masse-Systeme zur Lärmreduktion in Fahrzeugen durch ein mindestens 50 % leichteres System ersetzt werden. Dieser Bausatz (41) wirkt nicht nur schwingungsdämpfend und schalldämmend, sondern in hohem Masse auch schallabsorbierend und wärmedämmend. Vorzugsweise wird dieser multifunktionale und ultraleichte Bausatz (41) zur Boden- oder Stirnwandisolation, als Türverkleidung oder Dachinnenverkleidung eingesetzt.

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The present invention relates to a multifunctional kit for the noise reduction and heat insulation in vehicles.

Large areal vehicle parts, such as floor sheeting, roof sheeting, boot lids, end faces or doors and side coverings tend to deform, vibrate and oscillate on travelling on account of their low inherent stability. This behaviour is conventionally counteracted by mounting damping material, in particular of heavy layers of bitumen. In order to reduce the transmission of travelling noises in the inside of the vehicle, in the automobile industry, since a long time, additionally, multi-layered sound insulation assemblies have been applied. In particular by way of these sound insulation assemblies, noises from the vehicle motor, from the gearbox and auxiliary units, from exhaust systems but also wind and tyre noises are effectively insulated. These sound insulating assemblies as a rule are conceived as spring-mass-systems and all comprise an airtight heavy layer coupled to an elastic spring layer in order to damp the vibrations of the large areal car body parts and to insulate the airborne noise.

Such a sound insulating package is for example described in EP-0'334'178 and comprises essentially a soft-elastic foam material layer which faces the car body part capable of oscillation and which acts as the spring of the spring-mass system, an almost compact, air-impermeable and consolidated layer of the same material, which acts as the mass of the spring-mass-system, wherein this for consolidation is incorporated into a frame of fleece or cut foam, as well as a decor covering or carpet layer arranged thereabove. By way of this construction the weight of the heavy layer may be reduced up to 40% and thus also the weight of the whole sound insulation system may be reduced with respect to the known spring-mass-systems, but however at the cost of the acoustic effectiveness.

In EP-0'255'332 a sound insulating package is disclosed which with the help of a semi-flexible carrier layer, in the manner of a snap closure, is tensioned against the vehicle roof. With this carrier layer a classic spring-mass-system of a resilient, sound-absorbing foam layer and of a visco-elastic, closed-pored heavy layer (filled with bitumen) is pressed against the vehicle roof. By way of the non-positive connection of the heavy layer to the vehicle roof the vibrations of this are damped better and the heavy layer no longer needs to cover the whole surface.

Generally spring-mass arrangements however lead to the onset of resonance in the sound insulation, which usually lie in the frequency range of the lower motor arrangements and here are particularly undesirable. This phenomenon as a rule forbids an extremely light construction.

It is the general desire of the automobile industry to reduce the weight of vehicles. This has the result that increasingly also thinner and lighter car body parts are applied, which leads to considerable acoustic disadvantages. The demands on the sound insulation assemblies are significantly increased by the use of lightweight car body parts.

It is desirable to provide an ultra-light kit which also with lightweight car body parts, for example of aluminium or plastic, has no loss of acoustic effectiveness.

It is desirable to provide a sound-insulating kit which is more than 50% lighter than conventional sound-insulating assemblies and furthermore has good heat-insulating properties.

It is the object of the present invention to substantially overcome or at least ameliorate one or more of the above disadvantages or to meet one or more of the above desires.

Accordingly, in a first aspect, the present provides a multi-functional kit adapted for use in noise reduction and heat insulation in vehicles by forming a sound-absorbing, sound-insulating, oscillation-damping and heat-insulation covering, said kit including:

at least one areal vehicle part; and

a noise-reducing multi-layered assembly package arranged on said areal vehicle part such that an air layer is provided between said assembly package and said areal vehicle part, said assembly package being heavy layer free and suitable for combining sound insulation, sound absorption and oscillation damping, said multi-layered assembly package comprising:

at least one porous spring layer; and

a microporous stiffening layer having a total airflow resistance of $R_t = 500 Nsm^{-3}$ to $R_t = 2500 Nsm^{-3}$ and an areal mass of $m_F = 0.3 kg/m^2$ to $m_F = 2.0 kg/m^2$.

In a second aspect, the present invention provides an assembly package adapted for use in a kit according to the first aspect, wherein the package is a heavy-layer-free assembly package and comprises at least one porous spring layer, and a microporous stiffening layer, which has a total airflow resistance of R_t=500Nsm^{-3} to R_t=2500Nsm^{-3}, and an areal-mass of m_F=0.3kg/m^2 to m_F=2.0kg/m^2.

In a preferred embodiment, the air-impermeable heavy layer with conventional spring-mass systems is replaced by a relatively thin, micro-porous and stiff fibre layer, or fibre/foam composite layer. This micro-porous fibre layer is open-pored and has a relatively high airflow resistance. Essential for the solution of the object set is the formation of an air layer in the sound-absorbing kit, the air layer preferably lying between the areal car body part and the other layers. As a result basically the weight of the insulating mechanism with conventional spring-mass-systems is reduced in favour of an improved sound absorption. The effectiveness of preferred embodiments of the kit involves an optimal combination of sound insulation and absorption. The considerable increase of the absorption coefficients achieved in preferred embodiments leads to the fact that they have an extremely light construction and also with lightweight car body parts have no reduction in the acoustic effectiveness. Furthermore, in preferred embodiments it has been found that there is also a considerable improvement of the insulation in the region of the normally occurring onset of resonance.

In a first embodiment form the multi-functional kit according to the invention comprises essentially a soft-elastic, open-pored, spring layer facing the car body part capable of oscillation, this layer consisting of foam or fibre fleece, a microporous and light stiffening layer, in particular a stiffly pressed fibre layer or fibre/foam composite layer, as well as a porous cover layer or carpet or protective layer arranged thereover. All these layers may be connected to one another to a composite part mechanically (stitched), or by partial air-permeable adhesings. In a further formation of this embodiment form the kit according to the invention on the car body side comprises a light damping layer which is applied in a partial or complete-surfaced manner, which preferably has

a surface pattern according to patent EP 0 474 593 and is applied onto the car body sheeting. In flat regions of the car body a light "constrained-layer" damping of ultra-light bitumen and of a tension resistant foil of aluminium or fibre-reinforced plastic paper may be applied. This is conventionally adhesed to the plating.

By way of the acoustic optimisation of the soft-elastic, open-pored layer combined with the likewise open-pored, microporous fibre layer or fibre/foam composite layer arranged thereover, one may obtain a) a sound insulation without the onset of resonance, b) a sound absorption on the decor or carpet side, which is already effective in the low frequency region, c) a heat insulation which is advantageous with vehicles with a very low fuel consumption and d) a considerable reduction in weight of more than 50% in comparison to the classic spring-mass construction with vehicles with a steel car body, and with a simultaneously improved acoustic overall effectiveness.

Preferred forms of the present invention will now be described by way of example only with reference to the accompanying drawings, wherein:

Fig. 1: a classic construction of a floor group;

Fig. 2: the course of the absorption coefficients as a function of the frequency for the floor group according to Fig. 1;

Fig. 3: the course of the insulation as a function of the frequency for the floor group according to Fig. 1;

Fig. 4: the principle construction of the kit according to the invention;

Fig. 5: a kit according to the invention for the floor insulation or inner end wall covering;

Fig. 6: the course of the absorption coefficient as a function of the frequency for the kit according to Figure 5;

Fig. 7: the course of the insulation as a function of the frequency for the kit according to Figure 5;

Fig. 8: a construction through a roof inner covering according to the invention;

Fig. 9: a construction through a dooor covering according to the invention;

Fig. 10: a construction through an adhesed outer end wall according to the invention;

Fig: 11: a construction through an applied outer end wall according to the invention;

The conventional floor group 1 shown in Figure 1 comprises a sound insulating package 2 constructed of several layers, which is fastened on a flat, i.e. areal car body part 3. With conventional vehicles this car body part is manufactured of an approximately 0.8 mm thick steel sheeting, which has an area-weight of approx. 6.32 kg/m^2. On this car body part 3 there is mounted a damping layer 4, as a rule an approx. 2.2 mm thick bitumen-layer, with approx. 3.5 kg/m^2 surface weight. With this damping layer 4 essentially high frequeny oscillations are damped. Onto this damping layer as a rule a spring-mass system is loosely applied so that between the damping layer 4 and the

spring-mass system there arises an approx. 0.2 mm thick air layer 5. The spring-mass system comprises an approx. 15 mm thick fibre layer 6 with a spacial weight of approx. 70 kg/m ^{3} or an area-weight of appprox. 1.05 kg/m^2. Insead of this fibre layer 6 also similarly heavy elastic foam layers are used. Connected to this is an approx. 2 mm thick, air-impermeable heavy layer 7 with an area-weight of approx. 4.0 kg/m^2 on which in turn there is deposited for example an approx. 5.0 mm thick carpet 8 of approx. 0.6 kg/m^2 surface weight. This classic floor group thus comprises a total surface weight of approx. 15.47 kg/m^2 of which the area-weight of the sound insulation package 2 constitutes a part of approx. 9.15 kg/m^2.

The curve 9 represented in Figure 2 shows the behaviour of the absorption coefficients as a function of the frequency of this floor group 1. From this it can be clearly recognised that this sound insulation package in the region of 200 Hz comprises a marked resonance absorption, and in the region above 500 Hz shows a clearly worse absorption which with an increasing frequency improves slightly. This slightly increasing absorption is only caused by the properties of the carpet.

The frequency course 10 of the insulation, which is represented in Figure 3 and belongs to this floor group 1 clearly illustrates the insulation of the high frequency sound, and shows an onset of insulation in the region of 200 Hz which is characteristic for all spring-mass systems.

With the use of approx. 1.1 mm thick aluminium sheeting instead of the approx. 0.8 mm thick steel sheeting as a car body part 3 with these conventional insulation systems the complete insulation is worsened by approx. 6 dB and the onset of resonance of the insulation and the resonance absorption are displaced to somewhat higher frequencies in the region about 250 Hz. This is as a result of the halving

in mass with the use of aluminium instead of steel.

The principle construction of the kit 41 according to the invention shown in Figure 4 comprises essentially an areal vehicle part 11 and an assembly package 42 bearing thereon. This assembly package 42 comprises several layers and by necessity a porous spring layer 13 and a microporous stiffening layer 14. The porous spring layer 13 is preferably formed from an open-pored foam layer. The microporous stiffening layer consists preferably of an open-pored fibre layer or fibre/foam composite layer which has a total airflow resistance of R_t=500Nsm^{-3} to R_t=2500Nsm^{-3}, in particular from R_t=900Nsm^{-3} to R_t=2000Nsm^{-3}, and an areal-mass of m_F=0.3kg/m^2 to m_F=2.0kg/m^2, in particular of m_F=0.5kg/m^3 to m_F=1.6kg/m^2. For helping, further layers 21 and 23 may be deposited. Essential to the acoustic effectiveness of the multifunctional kit 41 is an air layer 25 between the assembly package 42 and the areal vehicle part 11. In order to further improve this acoustic effectiveness the microporous stiffening layer 14 has a bending stiffness of B=0.005Nm to B=10.5Nm, in particular from B=0.025Nm to B=6.0Nm.

The ultralight kit according to the invention, according to Figure 5 is particularly suitable for the construction of a floor insulation or the inner end wall covering. It comprises an approx. 1.1 mm thick aluminium car body part 11, on which there is applied a light damping layer 12, for example an SDL damping layer, whilst forming an air layer 25. Such SDL damping layers are known and as a rule have a surface pattern according to the patent EP 0 474 593 and a special bitumenous material composition. These are applied with the pattern onto the sheeting and are rigidly connected to the soft foam system. The effective density of this damping layer 12 is ρ = 1100 kg/m^3. In the present embodiment example an approx. 2.0 mm thick damping layer with an area-weight of approx. 2.4 kg/m^2 is used. Onto this

there is applied an approx. 25 mm thick layer of moulded foam 13 with a spacial weight of approx. 20 kg/m^3, or with an area-weight of approx. 0.4 kg/m^2 to 1.75 kg/m^2. This moulded foam layer 13 is in particular a thermomoulded foam layer and is open-pored and is connected to an approx. 1.5 mm to 5.0 mm thick microporous, stiff fibre layer 14 of approx. 0.6 kg/m^2 to 1.6 kg/m^2 surface weight. Suitable as a damping layer are also ultra-light, bitumenous damping layers of several layers, which for example comprise an aluminium foil or fibre-reinforced plastic paper or bitumen-free damping materials, for example EPDM or moulded foam with an effective spacial weight of approx. 40 kg/m^3. The microporous fibre layer 14 is of the type such that this has a total airflow resistance of $R_t=500Nsm^{-3}$ to $R_t=2500Nsm^{-3}$, in particular from $R_t=900Nsm^{-3}$ to $R_t=2000Nsm^{-3}$, and an areal-mass of $m_F=0.3kg/m^2$ to $m_F=2.0kg/m^2$, in particular of $m_F=0.5kg/m^2$ to $m_F=1.6kg/m^2$ and a bending stiffness of B=0.005Nm to B=10.5Nm, in particular of B=0.025Nm to B=6.0Nm. This microporosity and stiffness are essential for the absorption capability of the whole assembly package and may be achieved by way of a suitable choice of various materials. With the application as floor insulation a carpet or decor layer 15 is connected to this microporous, stiff fibre layer 15 on the side of the vehicle passenger space and in this embodiment example has a thickness of approx. 5mm or an area-weight of approx. 0.6 kg/m^2. The assembly package 42 according to the invention thus weighs only approx. 4.1 kg/m^2 and permits the weight of the complete floor group to be reduced from approx. 15.47 kg/m^2 to approx. 7.07 kg/m^2. With the application of this kit 41 as an inner end wall, the decor layer or carpet layer may be done away with.

The frequency dependent course 16 of the absorption coefficients shown in Figure 6 clearly illustrates the special frequency course for the kit 41 according to the invention with an approx. 1.1 mm thick aluminium sheeting:

perfect sound absorption in the middle frequency range and constant, not too large an absorption of $\alpha = 0.7$ to $\alpha = 0.8$ in the high frequency range. This is necessary for maintaining the ability to understand conversation in the vehicle.

The course 17 of the frequency dependent insulation of the kit 41 according to the invention, which can be deduced from Figure 7 clearly no longer shows any onset of resonance, as occurs as a matter of course with the conventional spring-mass-systems in the region of 200 Hz.

A further application of the kit 41 according to the invention for the insulation of a roof inner covering (sky roof) is shown in Figure 8. This comprises an approx. 2 mm thick carrier layer 26 of a highly pressed fibre material with an area-weight of approx. 0.5 kg/m^2. As a subsequent layer there is an approx. 15 mm thick foam layer 13 with a spacial weight of approx. 20 kg/m^3. This foam or moulded foam layer according to the invention carries a stiffening layer 14, in particular a microporous fibre layer of approx. 1.5 mm thickness and approx. 0.4 kg/m^3 surface weight. A porous, in particular open-pored, soft decor layer 23 of approx. 2 mm thickness or approx. 0.21 kg/m^2 surface weight closes this sound absorbing and oscillation damping, self supporting sky roof design. This multifunctional kit according to the invention thus comprises a complete thickness of approx. 24.5 mm and a complete surface weight of approx. 1.56 kg/m^2 and acts in the same manner as the previously described embodiment example. Further embodiment forms for the construction of a roof inner covering according to the invention are defined in more detail in the dependent claims 21 to 24.

It is to be understood that this roof inner covering may also be provided with a damping layer, in particular with an approx. 4 mm thick foam damping with a surface pattern

according to EP 0 474 593 and with an area-weight of approx. 0.15 kg/m^2.

In an alternative embodiment form of this roof inner covering the carrier layer 26 may be left out and the assembly package 42, whilst forming an air layer 25, is directly adhesed to the areal vehicle part 11. By way of this, although the oscillation damping of the aluminium roof is reduced and the sound insulation, in particular with rain or tunnel journeys, is somewhat reduced, however with this still a sufficiently effective kit according to the invention with a thickness of approx. 18.5 mm and an area-weight of approx. 0.91 kg/m^2 may be realised.

The kit 41 according to the invention may also be applied to door coverings and comprises in one embodiment form according to Figure 9 an approx. 2.4 mm thick, multi-layered damping layer which consists of an ultra-light bitumenous damping material and at least on approx. 0.1 mm thin aluminium foil. Such multi-layered damping systems directly adhesed to the sheeting are known. They are however as a rule at least 4 kg/m^2 heavy. The applied system according to the invention has an area-weight of still only approx. 2.67 kg/m^2 with a better damping efficiency than conventional systems. Subsequently there follows an air gap 25 of a variable thickness. This may in particular be used in order to accommodate the mechanics of the window. The actual assembly package 42 is protected against damp and contamination by a 25μm thin PU-foil 27 with an area-weight of approx. 0.03 kg/m^2. The porous spring layer 13 and the microporous stiffening layer 14 are formed according to the features of claims 26 to 29. This layer sequence is closed on the passenger space side by an approx. 2 mm thick porous cover layer 23, in particular an open-pored decor layer, with an area-weight of approx. 0.21 kg/m^2. Thus this assembly package comprises an area-weight of approx. 3.51 kg/m^2. It is to be understood that this assembly package 42

may only be mounted partially and preferably only in the areal regions of the door.

It is to be understood that this kit 41 may also be provided with a damping layer 12 between the areal vehicle part 11, this consisting either of multi-layered, approx. 2.3 mm thick ultra-light damping material with an area-weight of approx. 2.67 kg/m^2 and with at least one, approx. 0.1 mm thin aluminium foil, or of a multi-layered, approx. 2.3 mm thick, ultra-light damping material with an area-weight of approx. 2.67 kg/m^2 and with at least one approx. 0.1 mm thin foil of fibre reinforced plastic paper. Thus the area-weight of the multi-layered damping layer is approx. 2.54 kg/m^2.

The kit 41 according to the invention may also be applied as the outer end wall covering, as is shown in Figures 10 and 11. The assembly package used for this comprises on the side of the motor space a dirt-resistant protective layer 28, in particular an oil and water resistant protective fleece. The microporous stiffening layer 14 is arranged between the spring layer 13 and this protective layer, wherein the stiffening layer consists of a highly pressed fibre material with a thickness of approx. 2.5 mm and an area-weight of approx. 1.0 kg/m^2, the open-pored spring layer of the assembly package 42 either consisting of an approx. 15 mm thick thermomoulded foam with an area-weight of approx. 0.3 kg/m^2, or of an approx. 15 mm thick PU moulded foam with an area-weight of approx. 0.6 kg/m^2 to 0.9 kg/m^2, or of an approx. 15 mm thick duroplastic mixed fibre fleece of heat resistant fibres and with an area-weight of approx. 0.7 kg/m^2 to 1.0 kg/m^2. The protective layer on the motor space side comprises a thickness of 0.2 to 0.4 mm and an area-weight of 0.1 to 0.3 kg/m^2. With this embodiment form the assembly package 42 is adhesed in a simple manner to the areal vehicle part 11 whilst forming an air layer 25.

In one further embodiment form of this assembly package 42 used as an outer end wall covering, as is shown in Figure 11, the microporous stiffening layer 14 lies between the porous spring layer 13 and the air layer 25. Again the open-pored spring layer of the assembly package may consist of a thermomoulded foam, of a PU moulded foam or of a duroplastic mixed fibre fleece, and on the motor space side is provided with a protective layer 28. This assembly package 42 may be adhesed to the areal vehicle part 11 or only layed on. In order to lay on the assembly package in a stable manner, this comprises a carrier layer 26. It is to be understood that with these embodiment forms between the assembly package 42 and the air layer 25 there may also be provided a foam damping, which comprises a thickness of 3 mm and an area-weight of approx. 0.12 kg/m^2.

The advantages of the kit according to the invention are particularly evident with the application of thin steel sheeting or light aluminium sheeting or organo-sheeting, as is favourably used today in the automobile industry. A further advantage of the kit according to the invention lies in the extremely low heat conductability of the applied porous spring layer, which leads to the fact that this kit apart from its good acoustic effectiveness also has a good heat insulation.

The claims defining the invention are as follows:

1. A multi-functional kit adapted for use in noise reduction and heat insulation in vehicles by forming a sound-absorbing, sound-insulating, oscillation-damping and heat-insulating covering, said kit including:

at least one areal vehicle part; and

a noise-reducing multi-layered assembly package arranged on said areal vehicle part such that an air layer is provided between said assembly package and said areal vehicle part, said assembly package being heavy layer free and suitable for combining sound insulation, sound absorption and oscillation damping, said multi-layered assembly package comprising:

at least one porous spring layer; and

a microporous stiffening layer having a total airflow resistance of R_t =500Nsm^{-3} to R_t=2500Nsm^{-3} and an areal mass of m_F=0.3kg/m^2 to m_F=2.0kg/m^2.

2. A kit according to claim 1, wherein said porous spring layer comprises an open-pored foam layer.

3. A kit according to claim 1 or 2, wherein said microporous stiffening layer comprises an open-pored fibre layer or fibre/foam composite layer.

4. A kit according to any one of the preceding claims, wherein said total airflow resistance of said microporous stiffening layer is between R_t=900Nsm^{-3} and R_t=2000Nsm^{-3}.

5. A kit according to any one of the preceding claims, wherein said areal-mass of said microporous stiffening layer is between m_F=0.5kg/m^2 and m_F=1.6kg/m^2.

6. A kit according to any one of the preceding claims, wherein the microporous stiffening layer has a bending stiffness of B=0.005Nm to B=10.5Nm.

7. A kit according to claim 6, wherein said bending stiffness is between B=0.025Nm and B=6.0Nm.

8. A kit according to any one of the preceding claims, wherein the assembly package is provided with a porous cover layer.

9. A kit according to claim 8, wherein said porous cover layer comprises a soft decor layer or carpet layer.

10. A kit according to claim 9, wherein said porous cover layer includes a dirt-resistant protective fleece.

11. A kit according to any one of the preceding claims, wherein the porous spring layer is arranged between the air layer and the microporous stiffening layer.

12. A kit according to any one of the preceding claims, wherein the porous spring layer consists of a thermomoulded foam with a density of $\rho \leq 30 kg/m^3$.

13. A kit according to claim 12, wherein said thermomoulded foam has a density of $\rho \leq 15 kg/m^3$.

14. A kit according to any one of claims 1 to 11, wherein the porous spring layer consists of a PU moulded foam of a density of $\rho \leq 70 kg/m^3$.

15. A kit according to claim 14, wherein said PU moulded foam has a density of $\rho \leq 45 kg/m^3$.

16. A kit according to any one of claims 1 to 11, wherein the porous spring layer consists of a thermoplastic mixed fibre fleece of a density of $\rho \leq 70 kg/m^3$.

17. A kit according to claim 16, wherein said thermoplastic mixed fibre has a density of $\rho \leq 35 kg/m^3$.

18. A kit according to any one of claims 1 to 11, wherein the porous spring layer consists of a duroplastic fibre fleece of a density of $\rho \leq 70 kg/m^3$.

19. A kit according to claim 18, wherein said duroplastic fibre fleece has a density of $\rho \leq 50 kg/m^3$.

20. A kit according to any one of claims 12 to 19, wherein a damping layer is arranged at least partially between the assembly package and the areal vehicle part.

21. A kit according to claim 20, wherein an air layer is formed between the assembly package and the damping layer by a relief-like support of the assembly package and has a thickness of approx. 0.2 mm, the porous spring layer having a thickness of approx. 25 mm and areal mass of $0.4 kg/m^2$ to $1.75 kg/m^2$, the microporous stiffening layer having a thickness of 1.5 mm to 5.0 mm and an areal mass of $0.6 kg/m^2$ to $1.6 kg/m^2$.

22. A kit according to claim 21, wherein the damping layer has a thickness of approx. 2.2 mm and consists of an ultra-light damping material with an areal mass of approx. $2.4 kg/m^2$, and wherein said damping layer is adhered onto the areal vehicle part.

23. A kit according to claim 21, wherein the damping layer consists of a multi-layered, ultra-light damping material comprising at least an approx. 0.2 mm thin aluminium foil and having an areal mass of approx. $2.94 kg/m^2$, and wherein this damping layer is adhered onto the areal vehicle part.

24. A kit according to claim 21, wherein the damping layer consists of a multi-layered, ultra-light damping material comprising at least an approx. 0.2 mm thin fibre-reinforced plastic paper and having an areal mass of approx. $2.67 kg/m^2$, and wherein this damping layer is adhered onto the areal vehicle part.

25. A kit according to claim 21, wherein the damping layer has a thickness of approx. 2.0 mm and consists of an ultra-light, damping material with an areal mass of approx. 2.4 kg/m^2 and a relief-like structured surface, wherein this damping layer on the one side lies with this relief-like structured surface on the areal vehicle part.

26. A kit according to claim 25, wherein said damping layer consists of bitumen-free EPDM damping material.

27. A kit according to claim 21, wherein the damping layer consists of an approx. 4 mm thin moulded foam layer with an effective spacial weight of approx 40 kg/m^3 or an areal mass of approx. 0.2 kg/m^2, having a relief-like structured surface, wherein this damping layer on the one side lies with this relief-like structured surface on the areal vehicle part and on the other side is fastened to the open-pored spring layer.

28. A kit according to any one of claims 12 to 19 or 22 to 27, wherein when used for floor insulation, the assembly package comprises a decor layer of approx. 5 mm thickness and an areal mass of 0.4 kg/m^2 to 1.0 kg/m^2.

29. A kit according to any one of claims 12 to 19 or 22 to 27, wherein, when used for inner end wall covering, the assembly package at the most partially comprises a decor layer of about 5 mm thickness and with an areal mass of 0.4 kg/m^2 to 1.0 kg/m^2.

30. A kit according to any one of claims 8 to 11, wherein, when used for roof inner covering, the assembly package comprises a relief-like structured surface, which bears against the areal vehicle part forming an air layer therebetween and wherein the microporous stiffening layer has a thickness of 1.5 mm to 2.0 mm and an areal mass of 0.4 kg/m^2 to 0.6 kg/m^2, and the porous cover layer has a thickness of approx. 2 mm and an areal mass of approx. 0.21 kg/m^2.

31. A kit according to claim 30, wherein the porous spring layer consists of a stiff thermomoulded foam layer with a compression module of more than 120,000 Pa, a thickness of 13 mm to 17 mm and an areal mass of 0.2 kg/m^2 to 0.4 kg/m^2.

32. A kit according to claim 30, wherein the porous spring layer consists of an open-pored soft PU moulded foam layer with a compression module of less than 60 kPa, a thickness of approx. 20 mm and an areal mass of 0.8 kg/m^2.

33 A kit according to claim 30 wherein the porous spring layer consists of a thermoplastic mixed fibre fleece with a density of less than 35 kg/m^3, with a thickness of approx. 20 mm and with an areal mass of 0.7 kg/m^2.

34. A kit according to claim 30, wherein the porous spring layer consists of a duroplastic mixed fibre fleece with a density of less than 50 kg/m^3, with a thickness of approx. 20 mm and with an areal mass of 1.07 kg/m^2.

35. A kit according to any one of claims 31 to 34, wherein the relief-like structured surface is adhered to the areal vehicle part.

36 A kit according to any one of claims 31 to 34, further comprising an open-pored, stiff carrier layer of 3 to 5 mm thickness and an areal mass of 0.4 to 0.6kg/m^2.

37. A kit according to claim 36, wherein said stiff carrier layer consists of a highly pressed, microporous fibre material or a honeycomb-like constructed carrier material.

38. A kit according to claim 36 or 37, wherein, a damping layer is arranged at least partially between the assembly package and the areal vehicle part, which consists of a moulded foam with a thickness of approx. 4 mm and an areal mass of approx. 0.2 kg/m^2.

39. A kit according to any one of claims 8 to 11, wherein, when used for door covering, an approx 25µm thin PU foil with an areal mass of approx. 0.003 kg/m^2 is provided between the air layer and the assembly package, the microporous stiffening layer having a thickness of 1 mm to 1.5 mm and an areal mass of approx. 0.5 kg/m^2, and the porous, cover layer having an areal mass of approx. 0.21 kg/m^2 and a thickness of approx. 2 mm.

40. A kit according to claims 38, wherein the porous spring layer of the assembly package consists of an approx. 15 mm thick thermomoulded foam with an areal mass of approx. 0.3 kg/m^2,

41. A kit according to claim 39, wherein the porous spring layer of the assembly package consists of an approx. 15 mm thick moulded foam layer with an areal mass of 0.6 kg/m^2 to 0.9 kg/m^2.

42. A kit according to claim 39, wherein the porous spring layer of the assembly package consists of an approx. 15 mm thick thermoplastic mixed fibre fleece with a density of less than 35 kg/m^3 and an areal mass of approx. 0.5 kg/m^2.

43. A kit according to claim 39, wherein the porous spring layer of the assembly package consisting of an approx. 15 mm thick duroplastic mixed fibre fleece with a density of less than 50 kg/m^3 and an areal mass of approx 0.75 kg/m^2.

44. A kit according to any one of claims 40 to 43, wherein said porous cover layer is open-pored.

45. A kit according to any one of claims 40 to 44, wherein the areal vehicle part at least partially is provided with a damping layer, which consists of a multi-layered, approx. 2.3 mm thick ultra-light damping material having an areal mass of approx. 2.67 kg/m^2 and with an approx. 0.1 mm thin aluminium foil.

46. A kit according to any one of claims 40 to 44, wherein the areal vehicle part at least partially is provided with a damping layer, which consists of a multi-layered, approx. 2.3 mm thick, ultra-light damping material having an areal mass of approx. 2.67 kg/m^2 and with an approx. 0.1 mm thin foil of fibre-reinforced plastic paper, the areal mass of the multi-layered damping layer being approx. 2.54 kg/m^2.

47. A kit according to claim 8 or 9, wherein, when used for end wall covering on a motor space side, the assembly package on the motor space side is provided with a dirt-resistant protective layer, the microporous stiffening layer being arranged between the spring layer and the protective layer.

48. A kit according to claim 8 or 9, wherein the microporous stiffening layer is arranged between the porous spring layer and the air layer.

49. A kit according to claim 48, wherein, when used for end wall covering on a motor space side, the assembly package on the motor space side is provided with a dirt-resistant protective layer.

50. A kit according to claim 47 or 49, wherein the stiffening layer consists of a highly pressed fibre material with a thickness of approx. 2.5 mm and an areal mass of approx 1.0kg/m^2 and the protective layer on the motor space side has a thickness of 0.2 to 0.4 mm and an areal mass of 0.1 to 0.3 kg/m^2.

51. A kit according to claim 50, wherein the open-pored spring layer of the assembly package consists of an approx. 15 mm thick thermomoulded foam with an areal mass of approx. 0.3 kg/m^2.

52. A kit according to claim 50, wherein, the open-pored spring layer of the assembly package consists of an approx. 15 mm thick PU moulded foam with an areal mass of 0.6 kg/m^2 to 0.9 kg/m^2.

53. A kit according to claim 50, wherein the open-pored spring layer of the assembly package consisting of an approx. 15 mm thick duroplastic mixed fibre fleece of heat-resistant fibres and with an areal mass of 0.7 kg/m^2 to 1.0 kg/m^2.

54. A kit according to any one of claims 51 to 53, wherein said dirt-resistant protective layer consists of an oil and water resistant protective fleece.

55. A kit according to any one of claims 51 to 54, wherein a dirt-resistant protective fleece is provided between the air layer and the assembly package, said protective fleece having an areal mass of 0.05 kg/m^2 to 0.15 kg/m^2.

56. A kit according to any one of claims 51 to 54, wherein a foam damping layer having a thickness of 3.0 mm and an areal mass of approx. 0.12 kg/m^2 is provided between the air layer and the assembly package.

57. A kit according to any one of the preceding claims, wherein the areal vehicle part is an approx. 0. 8 mm thick steel sheeting.

58. A kit according to any one of claims 1 to 56, wherein the areal vehicle part is an approx. 1.1 mm thick aluminium sheeting.

59. A kit according to any one of claims 1 to 56, wherein the areal vehicle part is an approx. 1.5 mm thick, fibre-reinforced plastic part.

60. A kit according to claim 59 wherein said areal vehicle part consists of organo-sheeting.

61. A kit according to any one of the claims 1 to 56, wherein the porous spring layer has a heat conductibility λ of less than 0.05 W/mK.

62. A kit according to claim 60, wherein said heat conductibility λ of said porous spring layer is less than 0.04 W/mK.

63. An assembly package adapted for use in a kit according to any one of the preceding claims, wherein the package is a heavy-layer-free assembly package and comprises at least one porous spring layer, and a microporous stiffening layer, which has a total airflow resistance of R_t=500Nsm^{-3} to R_t=2500Nsm^{-3}, and an areal mass of m_F=0.3kg/m^2 to m_F=2.0kg/m^2.

64. An assembly package according to claim 63 wherein said at least one porous layer is an open-pored foam layer.

65. An assembly package according to claim 63 or 64 wherein said microporous stiffening layer is an open-pored fibre layer or fibre/foam composite layer.

66. An assembly package according to any one of claims 63 to 65 wherein said total airflow resistance is between R_t=900Nsm^{-3} and R_t=2000Nsm^{-3}.

67. An assembly package according to any one of claims 63 to 66 wherein said areal-mass is between m_F=0.5kg/m^2 and m_F=1.6kg/m^2.

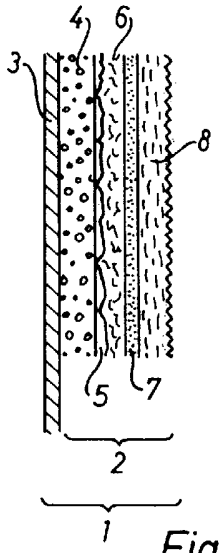
68. An assembly package according to any one of claims 63 to 67, wherein the microporous stiffening layer has a bending stiffness of B=0.005Nm to B=10.5Nm.

69. An assembly package according to claim 68 wherein said bending stiffness is between B=0.025Nm and B=6.0Nm.

70. An assembly package according to any one of claims 63 to 69, further comprising a damping layer and/or adhesive layer.

71. A multi-functional kit for the noise reduction and heat insulation in vehicles, said kit being substantially as described herein with reference to any one of Figs. 4, 5, 8, 9, 10 or 11 of the accompanying drawings.

Dated 16 February, 2001
Rieter Automotive (International) AG
Patent Attorneys for the Applicant/Nominated Person
SPRUSON & FERGUSON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6
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8
5
7
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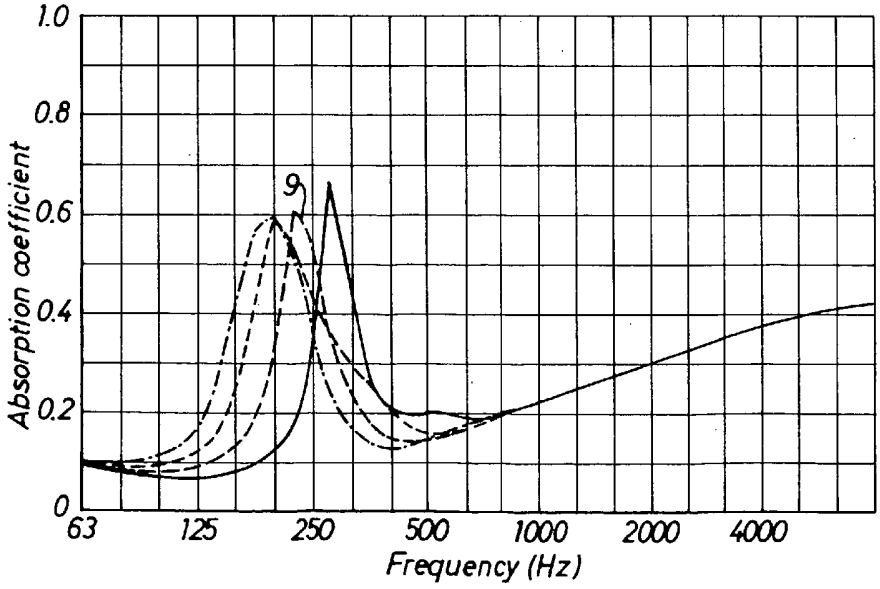
Fig. 1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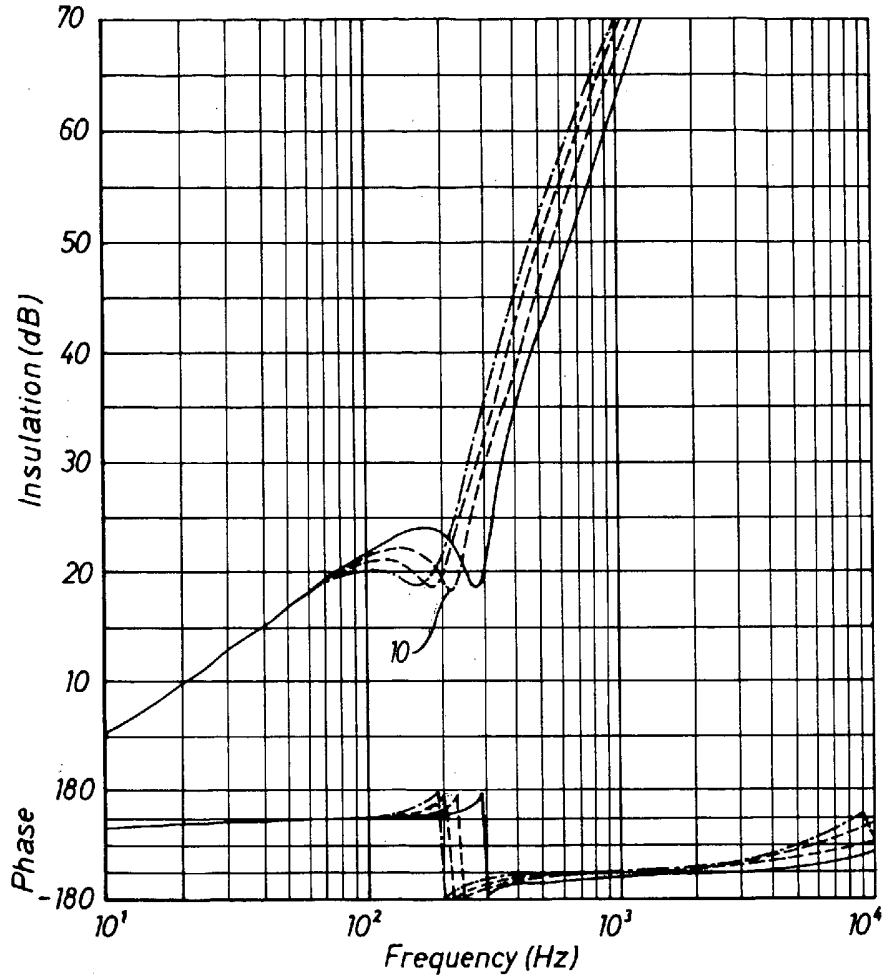
4000
Frequency (Hz)

Fig. 2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Phase
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Frequency (Hz)

Fig. 3

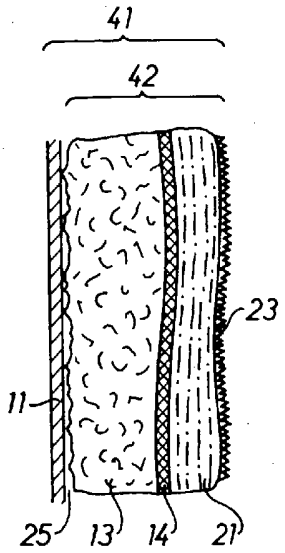


Fig. 4

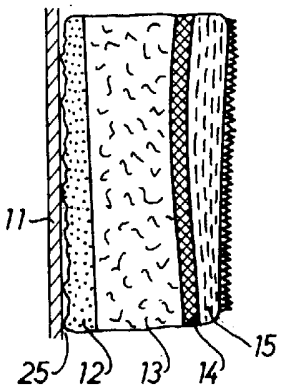
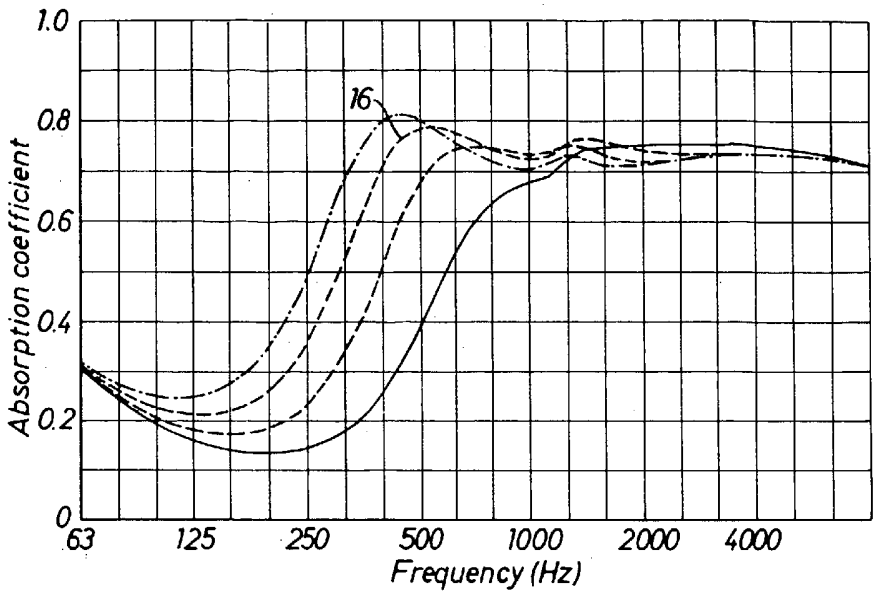


Fig. 5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Absorption coefficient
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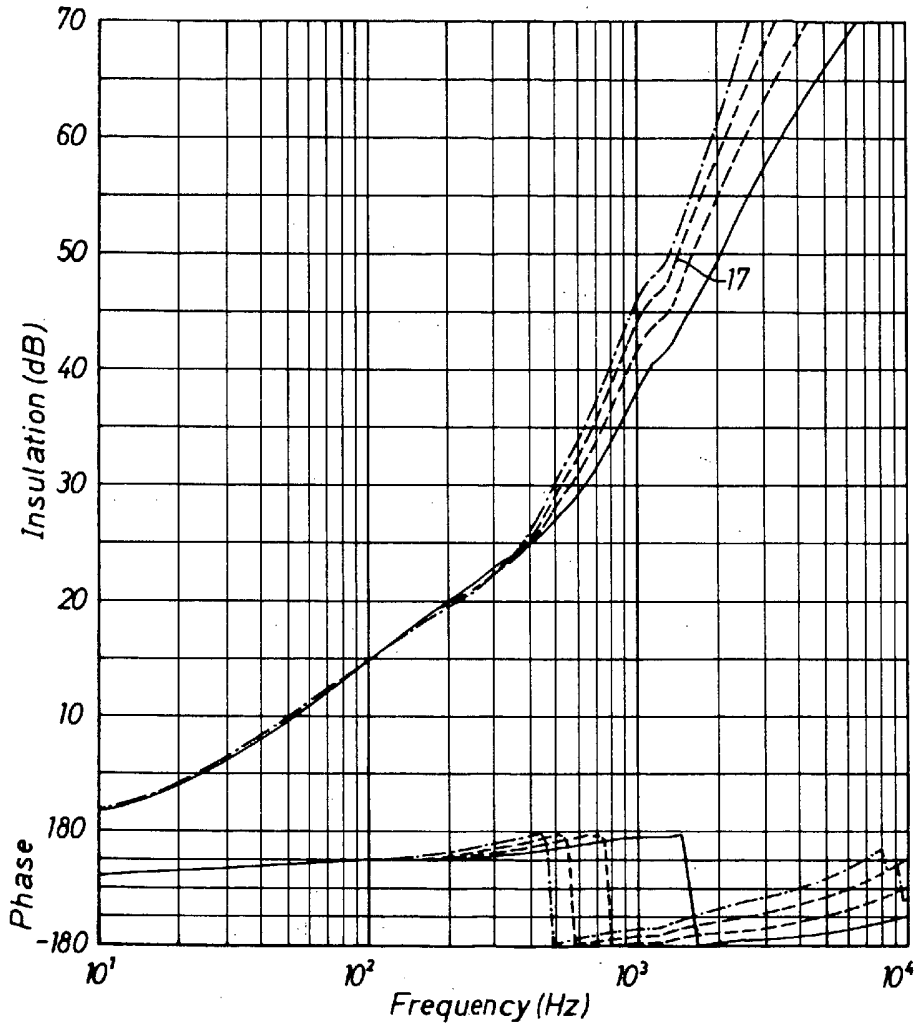
1000
2000
4000
Frequency (Hz)

Fig. 6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50
40
30
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10
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Insulation (dB)
Phase
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10^1
10^2
10^3
10^4
Frequency (Hz)

Fig. 7

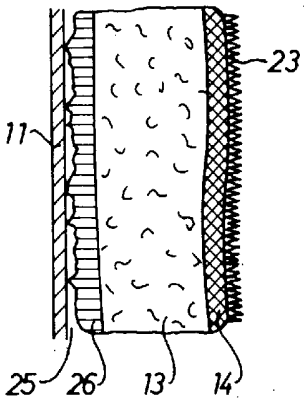

Fig. 8

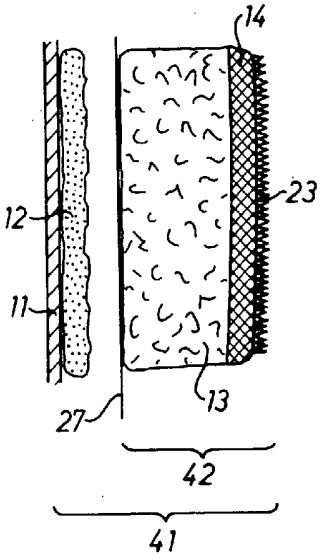

Fig. 9

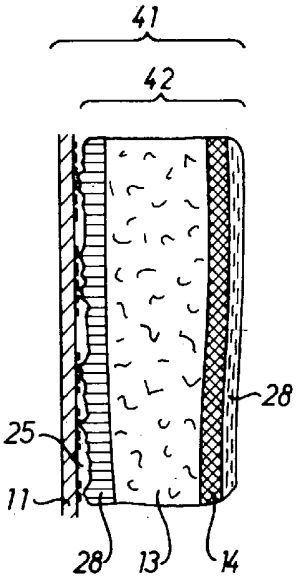

Fig. 10

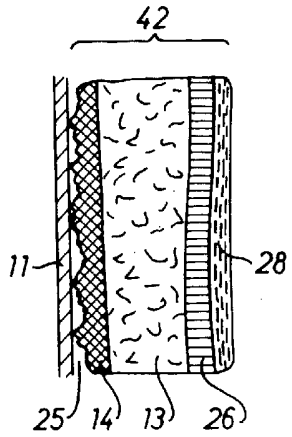

Fig. 11