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(54) **UTILIZATION OF POROUS BUILDING MATERIALS IN SOUND ABSORPTION**

(57) According to an example aspect of the present invention, there is provided an acoustic structure comprising a natural fibrous acoustic coating on a surface of a porous background structure.

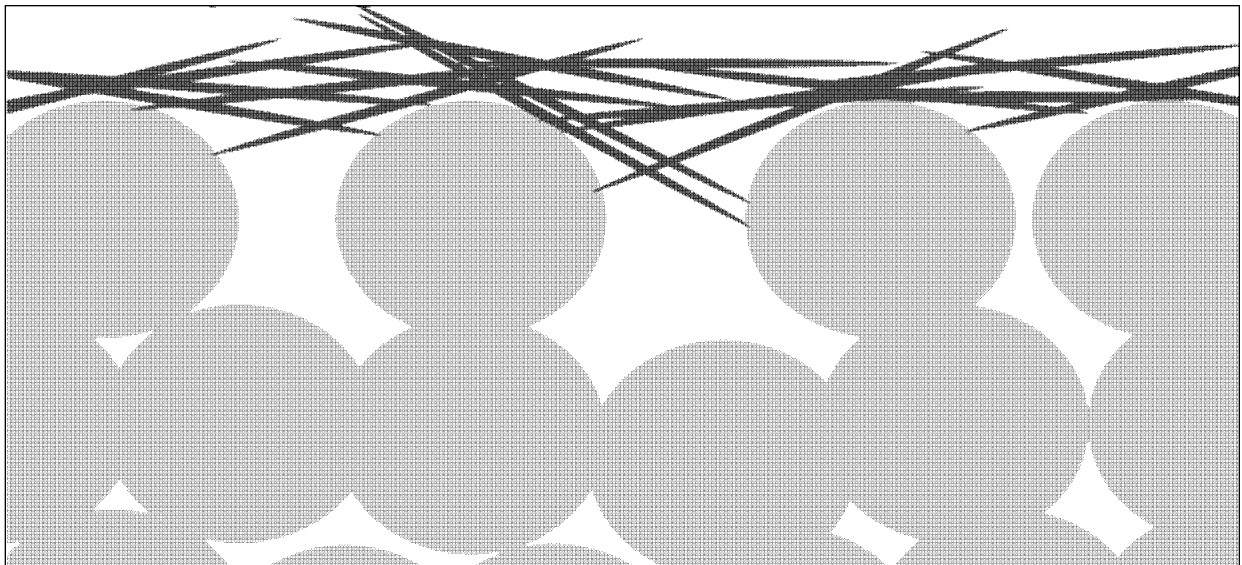


FIG. 2

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Description

FIELD

[0001] The present invention relates to improved acoustic structures and natural fibrous acoustic coatings on porous building materials.

BACKGROUND

[0002] When planning and implementing structures, more and more attention is paid to the acoustics of rooms, offices and other spaces. Naturally, functioning acoustics are a prerequisite, for example, in concert halls, but, the acoustics also have significant impacts on the levels of satisfaction, work efficiency, and even human health, for example, in homes, schools, and workplaces. Since structural solutions cannot be selected on the terms of acoustics alone, different acoustic elements or acoustic surfaces, which are installed in the spaces and on their surfaces after the actual construction stage, are needed.

[0003] A primary requirement for the functioning of the acoustic surface or element, naturally, is that it has suitable acoustic properties. Generally, this signifies a sound absorption that is sufficiently strong or has a frequency response of a suitable form. On one hand, since the acoustic elements and surfaces are structures that remain in sight, their architectural image should also be suitable for their environment and the other surfaces of the space. The thickness of the panel or surface should remain within reasonable limits, which, on the other hand, is inconsistent with the high requirement of sound absorption. Naturally, the acoustic elements or surfaces should also fulfil the criteria of purity which is set for the surface materials of interiors, and they should also have mechanical and physical properties that are suitable for their environment of use. Similarly to other structural elements, the requirement of considering environmental aspects, to an increasing extent, also applies to the acoustic surfaces and elements with respect to the manufacture and recyclability of the materials, for example.

[0004] The most common commercially available, ready-made acoustic elements include mineral wool-based (fibreglass or rock wool-based) acoustic panels. On the sides of these which remain in sight, the surface of the mineral wool is coated, for example, with paper, plastic, fabric or glass fleece. Being relatively light components, these acoustic elements, which are based on insulating wool panels, are simple to install, for example, on the ceiling or walls of the space that is to be provided with sound absorption, either as separate elements or as an unbroken surface. They can also be formed into acoustic planes that are lowered down from the ceiling, for example.

[0005] For the coating of walls, ceilings or the like in different interiors, various fibre-based coating compounds are also known, which are sprayed or applied in another way and which provide a mechanical surface

structure that is more elastic and durable than glass and rock-based coatings, and which can also contribute to the acoustics of the premises.

[0006] For example, the specifications FI 95041 and WO 2007/063178 disclose natural fibre-based coatings that are sprayed when mixed with water, or applied in a similar manner and hardened through drying. The fibre of the coating compound of the specification FI 95041 comprises fine cellulose fibre. In the solution of the specification WO 2007/063178, in addition to the fibre material and the binder, the compound includes particle-like, typically mineral-based fillers, by means of which the surface of the coating becomes smooth and which can adjust the acoustic properties of the coating.

[0007] Typically, the fibre-based coatings are attached to the desired acoustic properties requiring surface by binders.

[0008] US 3,044,919 relates to a surfacing or facing construction particularly adaptable for application on wall and ceiling areas or surfaces and to a method or system of applying the surface of facing to an area, the surfacing or facing construction embodying a thin mat, layer or sheet of mineral material adapted to be adhesively joined to the surface or area to be finished. However, it does not disclose natural fibrous acoustic coatings on cinder block, nor especially fixing the coating to a desired surface without binders.

[0009] GB 358,995 relates to improvements in sound-absorbing materials adapted to be used in buildings, enclosures and the like. It discloses an acoustic composition having desirable sound-absorbing properties of various fibrous materials combined with the advantages with respect to durability and appearance of plastic or stone-like materials. The composition comprises a layer of a resilient sound-absorbing material or fibre-board having a hard facing or protective layer of granular particles which has pores or openings leading into the sound-absorbing material. The publication is however silent on natural fibrous acoustic coatings on cinder block, nor especially fixing the coating to a desired surface without binders.

[0010] Thus, there is a need for improved acoustic structures and reverberation reducing surfaces utilizing natural fibrous acoustic mass.

SUMMARY OF THE INVENTION

[0011] The invention is defined by the features of the independent claims. Some specific embodiments are defined in the dependent claims.

[0012] According to an aspect of the present invention, there is provided an acoustic structure, such as a wall, made of a porous background material and coated with a natural fibrous acoustic material.

[0013] According to another aspect of the present invention, there is provided an acoustic structure, such as a wall, made of porous incompressible or load-bearing background structures and coated with a natural fibrous

acoustic material, wherein the acoustic coating is attached to the surface of the background structure without using any binders. The background structure neither needs to be felted before applying the acoustic coating.

[0014] This and other aspects, together with the advantages thereof over known solutions are achieved by the present invention, as hereinafter described and claimed.

[0015] The acoustic structure of the present invention is mainly characterized by what is stated in the characterizing part of claim 1.

[0016] Considerable advantages are obtained by means of the invention. For example, the natural acoustic coating can be applied, for example by spraying, straight on to a surface of a wall made of e.g. cinder blocks without any ground work, yet providing a plain surface. In addition, the natural fibrous acoustic coating according to the present invention is applicable to the surface of the wall material the without using any binders. Furthermore, natural fibrous coatings are not harmful for consumers and they enable moisture vaporization from the below structures.

[0017] Next, the present technology will be described more closely with reference to certain embodiments.

EMBODIMENTS

[0018] The present technology provides coatings on porous background structures that improves the acoustic properties of premises and reduces the drawbacks of the known solutions. The present technology is particularly suitable for reducing reverberation in inner acoustics of premises.

[0019] One purpose of the invention, in particular, is to provide an acoustic structure, which is formed by utilising a natural fibrous coating composition, which is particularly suitable for the purpose and which provides effective sound absorption, and from which no significant amounts of dust or other particles come off, even after drying.

FIGURE 1 is a photo of a cinder block coated with the natural fibrous acoustic coating according to the present invention.

FIGURES 2 and 3 are schematic drawings of a porous coating consisting of natural fibres on top of a porous (Fig.2) and perforated or micro-perforated (Fig. 3) background structure.

FIGURE 4 is a diagram showing acoustic properties of another possible acoustic structure, wherein porous cinder blocks (thicknesses 90 mm and 125 mm) were coated with approximately 6 to 8 mm fibrous coating according to the present invention.

FIGURE 5 is a diagram showing improvement of the acoustic properties of perforated metal when coated with the fibrous 8 mm thick coating according to the

present invention. Diameter of the perforation holes is approximately 5 mm.

[0020] The present invention is based on a combination of a porous background material and/or structure and a natural fibrous coating on at least one surface of the porous background material and/or structure.

[0021] One aspect of the present invention is a combination of a porous background structure and an acoustic coating, wherein the acoustic coating is made of natural fibrous matter and is applied on at least one surface of the porous background structure, and wherein the natural fibrous matter forms a plain network on top of the holes in the surface of the porous background.

[0022] Herein the term "porous background structure" is intended to comprise all materials, where to holes have been made or formed during the production of such structure. Porous background structure may therefore be for example a building material such as cinder block, or a perforated or micro-perforated structure consisting of for example wood or metal.

[0023] The acoustic structure can be for example an acoustic element, or a wall structure, or any other structure, which requires sound-proofing and is preferably made of a porous building material, such as a cinder block.

[0024] According to one embodiment of the present invention, the natural fibrous matter is plant or plant-based fibre, such as cellulose, flax, cotton or hemp fibre, or animal-based fibre, such as silk or wool-based fibre, or a mixture of such fibres. The acoustic coating comprises the natural fibrous matter 20-100% of the dry-matter mass of the acoustic coating.

[0025] In one embodiment of the present invention the coating has a thickness between 1 to 30 mm, preferably between 3 to 10 mm.

[0026] In one embodiment of the present invention, the acoustic coating further comprises 0-80% of mineral filler from its dry matter mass, preferably mineral silicate, mineral sulphate or mineral carbonate, most preferably kaolin.

[0027] In a further embodiment of the present invention, the coating comprises a fire retardant and an anti-rot agent, selected from a group of boron-based substances, such as boric acid or borax or a mixture thereof, hydroxides, such as aluminium or magnesium hydroxide or a mixture thereof, or absorbing agents, such as talc or calcium carbonate or a mixture thereof, most preferably boric acid or borax, particularly a mixture thereof, in an amount of 8-25% by weight of the dry matter at the most.

[0028] In one embodiment of the present invention, the structure below the acoustic coating, such as a cinder block, has a density of 300 to 2200 kg/m³ and a pore size preferably of 1 to 16 mm. The thickness of the structure varies based on the used building material, but should be at least 2 mm, more preferably at least 5 mm.

[0029] In a further embodiment of the present inven-

tion, the porous background structure underneath the natural fibrous acoustic coating is incompressible. In another embodiment of the present invention, the porous background structure is a load-bearing structure.

[0030] In one embodiment of the present invention, the background structure underneath the natural fibrous acoustic coating is a perforated or micro-perforated structure, which alone without the coating provides very poor acoustic properties. Similarly, the background structure may be any other kind of porous or perforated structure having holes, on top of which the natural fibrous coating matter forms a plain network.

[0031] In one particular embodiment of the present invention, the acoustic coating does not contain any binders for binding into the surface of the porous background. This embodiment is achieved by the network of the natural fibrous matter formed on top of the holes in the porous background. Porous acoustic coating can thus be prepared without binders by utilizing particles of different size scales, for example by combining cellulosic fibres with micro-fibrillated or nano-fibrillated cellulose.

[0032] One aspect of the present invention is that because of the fibre network on top of the holes in the surface of the porous background, the surface can be made plain.

[0033] Another aspect of the present invention is that the porous background structure does not need to be felted before applying the acoustic coating, which reduces the process steps and costs as well as provides easier yet effective acoustic solutions. The present invention also provides material savings for example in binder and seaming materials.

[0034] Reference throughout this specification to one embodiment or an embodiment means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Where reference is made to a numerical value using a term such as, for example, about or substantially, the exact numerical value is also disclosed.

[0035] As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. While the foregoing examples are illustrative of the principles of the present invention in one or more particular applications, it will be apparent to those of ordinary skill in the art that numerous modifications in form, usage and details of implementation can be made without the exercise of inventive faculty, and without departing from the principles and concepts of the invention. Accordingly, it is not intended that the invention be limited, except as by the claims set forth below.

[0036] The verbs "to comprise" and "to include" are

used in this document as open limitations that neither exclude nor require the existence of also un-recited features. The features recited in depending claims are mutually freely combinable unless otherwise explicitly stated. Furthermore, it is to be understood that the use of "a" or "an", that is, a singular form, throughout this document does not exclude a plurality.

INDUSTRIAL APPLICABILITY

[0037] The present invention is applicable to for example walls and other kinds of structures comprising porous or perforated background structures in for example buildings, providing acoustic solutions mainly to the inner acoustic needs of the space formed by such structures.

EXAMPLE

[0038] Preparation and characterization of the natural fibre coated cinder block structure as illustrated in Figure 1 is herein described. Coating was prepared by dissolving or dispersing additives, such as binders, thickeners and fire retardants, into a solvent and dispersing the fibres by mechanical mixing to form a suspension. The coating was applied onto the surface of the cinder block by spraying an approximately 6 mm thick layer using specially designed pumping and spraying equipment. The coating was then dried in ambient conditions. Absorption coefficient of the coating, cinder block and coated cinder block (Figure 3) were measured by using a reverberation chamber built in a shipping container (6 m x 2.4 m x 2.4 m) using ISO 354:2003 "Acoustics. Measurement of sound absorption in a reverberation room" as a guideline. Measurements were done with 8 "Superlux ECM 999" microphones using ARTA software (www.artalabs.hr/) for measurement and calculation of the results. Results illustrate clearly the advantage of using porous background material underneath the coating.

CITATION LIST

Patent literature

[0039]

1. FI 95041
2. WO 2007/063178
3. US 3,044,919
4. GB 358,995

Claims

1. An acoustic structure comprising a combination of a porous background structure and an acoustic coating, **characterized in that** the acoustic coating is made of natural fibrous matter and applied on at least one surface of the porous background structure,

wherein the natural fibrous matter forms a plain network on top of the holes in the surface of the porous background structure.

ing of for example wood or metal.

2. The acoustic structure according to claim 1, **characterized in that** the natural fibrous matter is plant or plant-based fibre, such as cellulose, flax, cotton or hemp fibre, or animal-based fibre, such as silk or wool-based fibre, or a mixture of such fibres. 5
3. The acoustic structure according to any of the preceding claims, **characterized in that** the acoustic coating has a thickness between 1 to 30 mm, preferably between 3 to 10 mm. 10
4. The acoustic structure according to any of the preceding claims, **characterized in** further comprising 0-80% of mineral filler from its dry matter mass, preferably mineral silicate, mineral sulphate or mineral carbonate, most preferably kaolin. 15 20
5. The acoustic structure according to any of the preceding claims, **characterized in that** the acoustic coating further comprises a fire retardant and an anti-rot agent, selected from a group of boron-based substances, such as boric acid or borax or a mixture thereof, hydroxides, such as aluminium or magnesium hydroxide or a mixture thereof, or absorbing agents, such as talc or calcium carbonate or a mixture thereof, most preferably boric acid or borax, particularly a mixture thereof, in an amount of 8-25% by weight of the dry matter at the most. 25 30
6. The acoustic structure according to any of the preceding claims, **characterized in that** the acoustic coating does not contain any binders. 35
7. The acoustic structure according to any of the preceding claims, **characterized in that** the acoustic coating comprises particles of different size scales, such as a combination of cellulosic fibres with micro-fibrillated or nano-fibrillated cellulose. 40
8. The acoustic structure according to any of the preceding claims, **characterized in that** the porous background structure has density of 300 to 2200 kg/m³ and thickness of at least 2 mm, preferably at least 5 mm. 45
9. The acoustic structure according to any of the preceding claims, **characterized in that** the porous background structure preferably has a pore size of 1 to 16 mm. 50
10. The acoustic structure according to any of the preceding claims, **characterized in that** the porous background structure is for example a cinder block, or a perforated or micro-perforated structure consist- 55

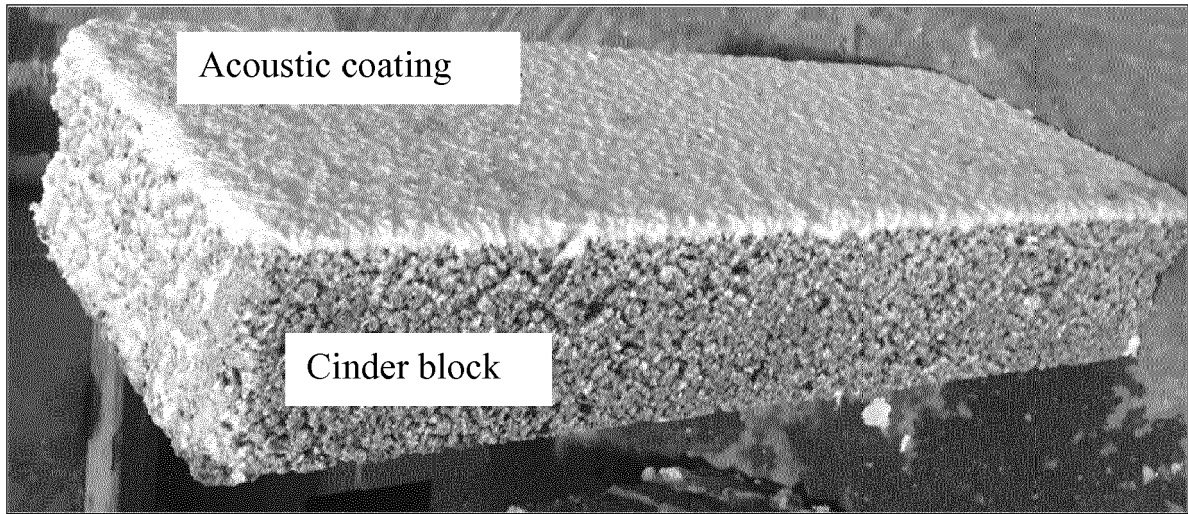


FIG. 1

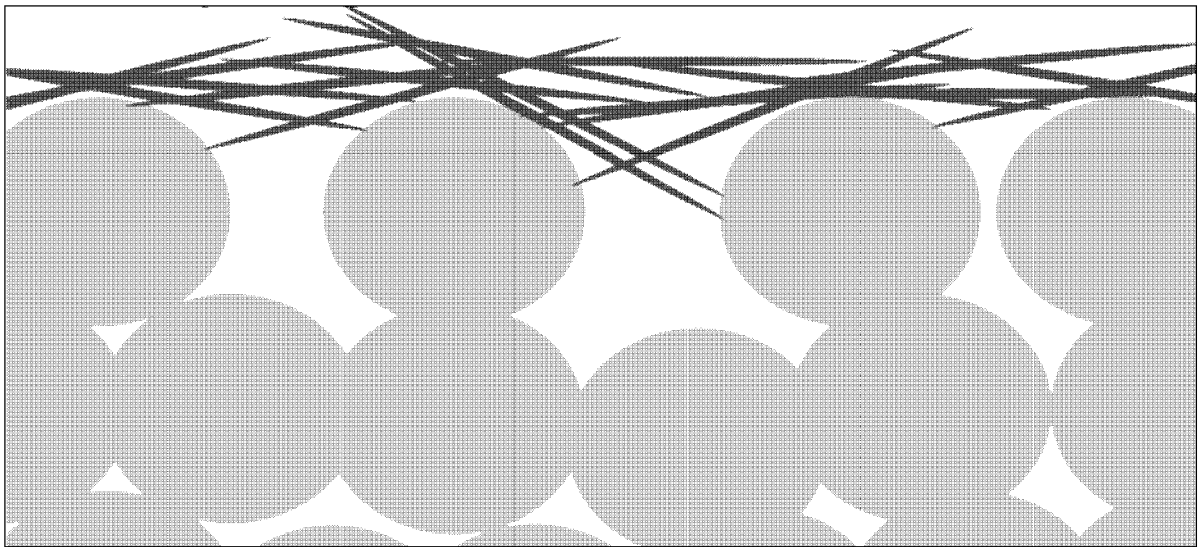


FIG. 2

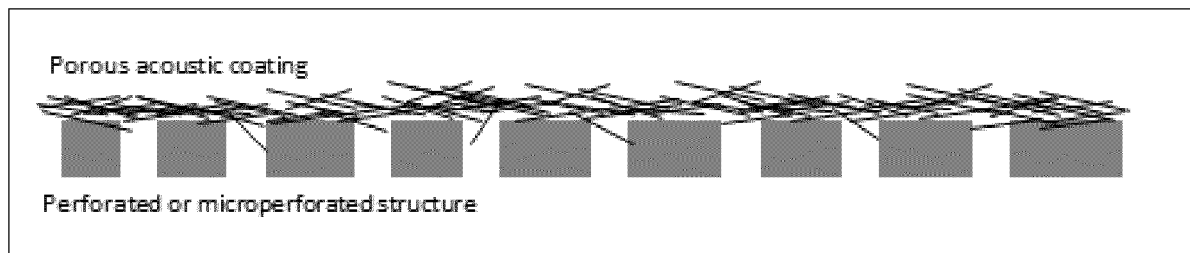


FIG. 3

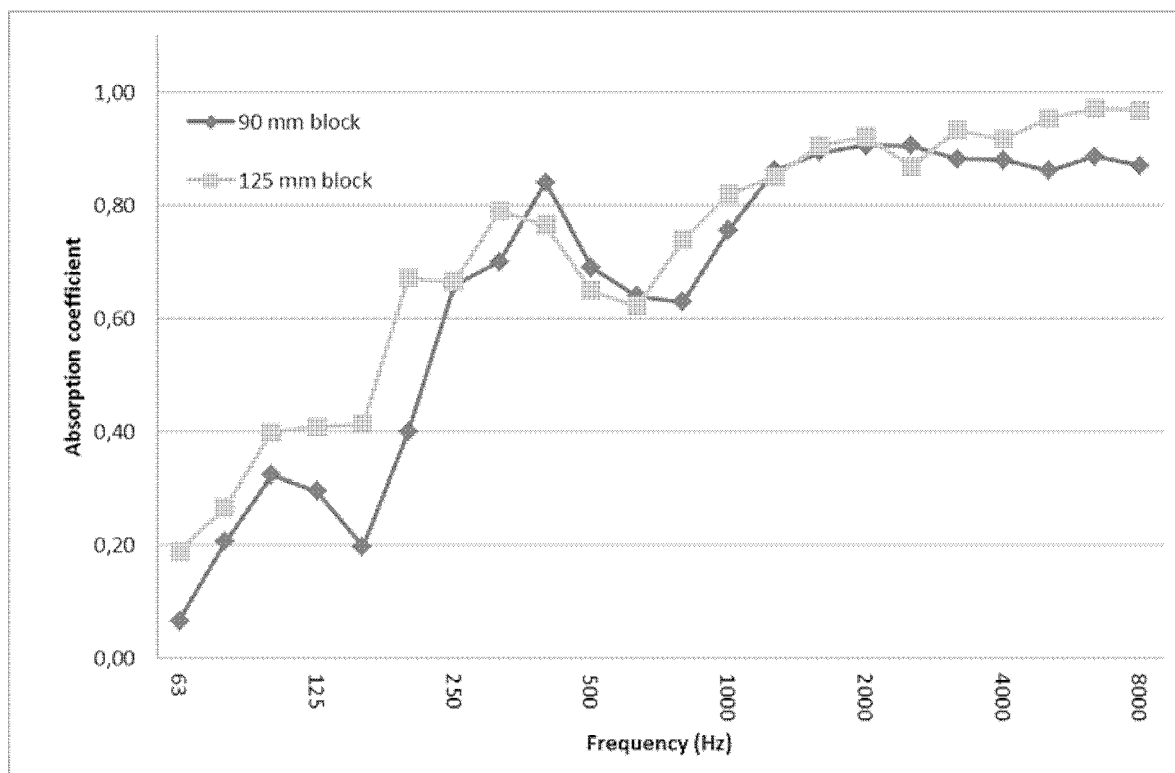


FIG. 4

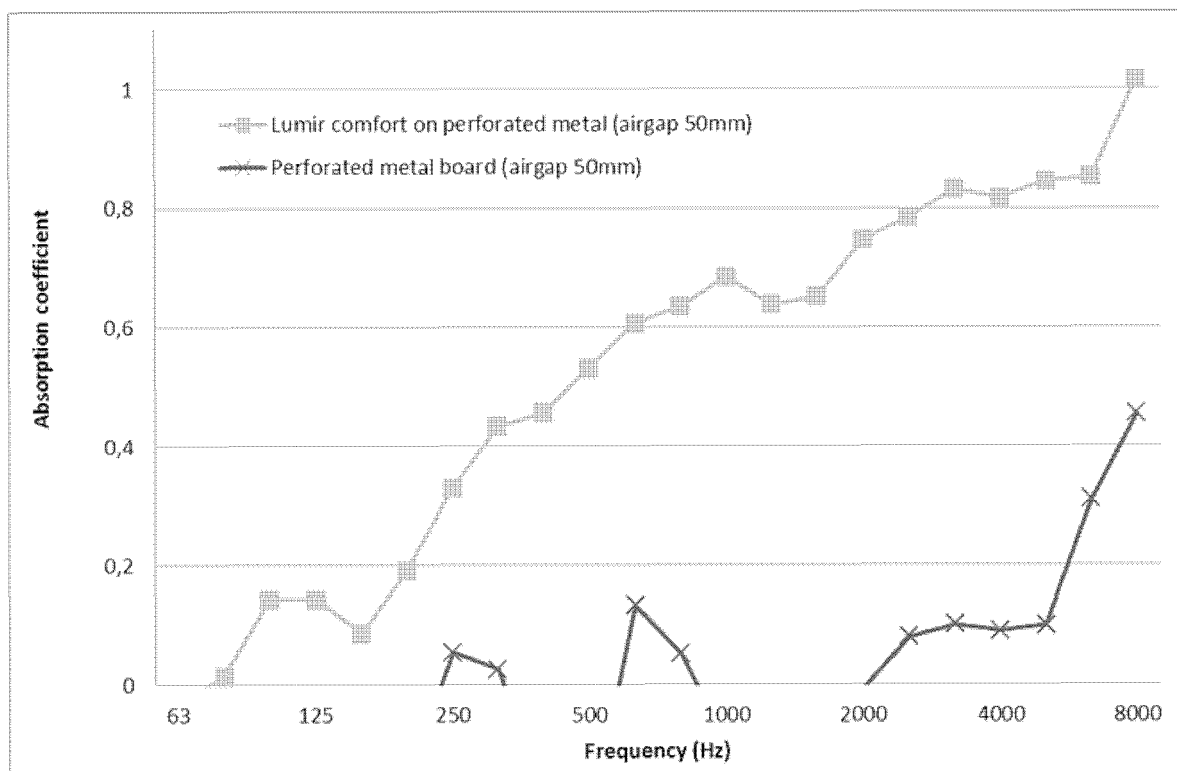


FIG. 5



EUROPEAN SEARCH REPORT

Application Number
EP 19 15 2584

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	RU 2 369 495 C2 (NPP TEHNIKAL KONSALTING AOZT [RU]) 10 October 2009 (2009-10-10) * paragraphs [0003], [0055], [0096] - [0119]; figures 15,16 *	1-10	INV. E04B1/86 B32B3/26
X	RU 2 490 150 C1 (FEDERAL NOE G BJUDZHETNOE OBRAZOVATEL NOE UCHREZHDIENIE VYSSHEGO PROFES) 20 August 2013 (2013-08-20) * paragraphs [0088], [0090], [0103], [0108], [0109], [0134] - [0150]; figures 4,9,10 *	1-10	ADD. E04B1/84
			TECHNICAL FIELDS SEARCHED (IPC)
			E04B B32B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 June 2019	Examiner Zuurveld, Gerben
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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RU 2369495	C2	10-10-2009	NONE

RU 2490150	C1	20-08-2013	NONE

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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