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(54) **Soundproofing and thermal insulating fibrous material**

(57) A soundproofing and thermal insulating fibrous material is disclosed which comprises a spring yarn. The spring yarn is composed of a core yarn (1) and a second yarn (2), wherein the second yarn (2) extends from the

core yarn (1) in radial directions and is fixed to the core yarn (1) in irregular intervals.

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Description

FIELD OF THE INVENTION

[0001] The present invention refers to a soundproofing and thermal insulating fibrous material (sometimes merely referred to as "soundproofing fibrous material" hereinafter) as well as to different applications and uses of such a fibrous material.

TECHNICAL BACKGROUND

[0002] Sound absorbing soundproofing and thermal insulating fibrous material materials are widespread and are used in many different applications for which building materials for houses, etc., sound insulating walls, noise protections as well as aeronautic applications are examples.

[0003] Further, such materials are also widely used in automotive and motorcycling (hereinafter jointly referred to as "automotive") applications, in an external air-intake and an exhaust for a gas turbine as well as a propeller for power generation (pumps), compressors and so on.

[0004] A particular application is the use thereof in a silencer for an internal combustion engine. During the production of such a silencer the interspace between the exhaust pipe and the external covering is filled with a fibrous material which exhibits a soundproofing property.

[0005] Different solutions for a respective fibrous material which suitably fills the interspace have for example been proposed in U.S.-A-6,155,379, WO-A-99/23367 and WO-A-02/066800.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide an improved fibrous material as well as products comprising the fibrous material and uses thereof.

[0007] In order to achieve this object, the present invention provides a soundproofing fibrous material which comprises a spring yarn which is composed of a core yarn (1) and a second yarn (2) extending from the core yarn (1) in radial directions and being fixed to the core yarn (1) in irregular intervals.

[0008] The spring yarn is preferably such that it is obtainable by opening and blowing up a smooth yarn using compressed air jets, thus providing a fluffy yarn full of fibre loops.

[0009] It is further preferred that the second yarn (2) has an average wave height (A) which is larger than the nominal diameter of the core yarn (1). It is further preferred that the second yarn (2) has an average wave height (A) of about 3 mm or more.

[0010] Additionally, it is preferable that the fibers which form the second yarn (2) have a yarn count of about 100 tex or more. Further, the fibers which form the second yarn (2) preferably have a nominal diameter in the range of about 6 μm to about 24 μm .

[0011] The above soundproofing fibrous material can preferably be formed as a mat having at least two layers, wherein the spring yarns of a first layer are oriented in a direction intersecting the direction in which the spring yarns of a second layer are oriented. This preferred soundproofing fibrous material which is formed as a mat may preferably comprise a third layer, wherein the spring yarns of said third layer are oriented in a direction intersecting the directions in which the spring yarns of said first and said second layer are oriented.

[0012] In the aforementioned soundproofing fibrous material which is foamed by a foam yarn mat, it is also preferable that the layers are held together by a sewing yarn. Further, it is preferred that the layers are present in foam forms. A preferred minimum nominal thickness of all layers in total, e.g. of the aforementioned two or three layers, is 12 mm. A preferred nominal weight of the respective layers is 600 g/m².

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Figure 1 is a schematic illustration of a yarn of the fibrous material according to the invention;

Figure 2 is another schematic illustration of a yarn of the fibrous material according to the invention;

Figure 3 is a cross-sectional view of the yarn which is depicted in Figure 2; and

Figure 4 schematically shows different possibilities for aligning a yarn to form a mat-type fibrous material by stacking layers made of the differently aligned yarns.

PREFERRED EMBODIMENTS OF THE INVENTION

[0014] The soundproofing fibrous material according to the present invention comprises a spring yarn as it is shown in Figures 1 to 3. This spring yarn is composed of a core yarn (1) and a second yarn (2) extending from the core yarn (1) in radial directions and being fixed to the core yarn (1) in irregular intervals. Figure 1 shows schematically in one dimension how the second yarn (2) is fixed to the core yarn (1) in irregular intervals. Figure 2 shows that the second yarn (2) does not only extend from the core yarn (1) in one direction (or within a single plane only), but that the second yarn (2) can extend from the core yarn (1) in several different radial directions so that it extends into the entire radial space surrounding the core yarn (1). This particular geometry of the spring yarn becomes further clear from Figure 3 which is a cross-sectional view of the yarn depicted in Figure 3. It can be seen that the second yarn (2) forms a looped periphery around the core yarn (1), thus forming the spring yarn.

[0015] The spring yarn can also be described as a tex-

turized yarn which is obtainable by a texturizing process. Any texturizing process can be employed, as long as the characteristic geometry of the spring yarn of the present invention as described above and as shown in Figure 1 to 3 is obtainable. Preferably, in the texturizing process, a smooth gam is opened and blown up using e.g. compressed air jets, thus creating a fluffy yarn full of fibre loops.

[0016] The soundproofing fibrous material according to the present invention preferably has the form of a mat. A mat as understood herein can be described as a layer or a stacking of layers which are formed of spring yarns as described above. Within such a layer, the spring yarns can be aligned basically in parallel to each other. It is to be understood that it is mainly the direction in which the core yarn (1) runs, which determines the direction of the orientation of the yarns in such a layer.

[0017] The present invention further provides a silencer for an internal combustion engine. In this silencer, the fibrous material according to the present invention, preferably in the form of a mat, fills most of or even the entire interspace between an exhaust pipe, which is covered by the silencer, and an external covering of the silencer. The fibrous material is preferably inserted during the production of the silencer into the interspace between the exhaust pipe and the external covering. The external covering can for example be made of aluminium, carbon, titanium, steel or any other suitable material.

[0018] The present invention also provides the use of the inventive soundproofing fibrous material as a filling material in a silencer of an internal combustion engine.

[0019] Further preferred embodiments and advantages of the present invention are set out below.

[0020] As aforesaid, the soundproofing fibrous material according to the present invention comprises a spring yarn which is composed of a core yarn (1) and a second yarn (2) extending from the core yarn (1) in radial directions and being fixed to the core yarn (1) in irregular intervals. This arrangement of the spring yarn advantageously improves the soundproofing performance of the fibrous material compared to a material made from smooth yarns alone.

[0021] The soundproofing fibrous material according to the present invention preferably comprises the core yarn (2) and a second yarn which is fixed to the core yarn (1) in such a manner that a second or multi-waved yarn (2) is formed which has an average wave height (A) which is larger than the nominal diameter of the core yarn (1). The average wave height can for example be controlled by putting the yarn on a graph paper and using a transparent glass to press the yarn onto it.

[0022] It is more preferred that the average wave height (A) is about 3 mm or more. By this particular setting of the wave height (A), waves are fixed on the core yarn (1) in the length direction of the latter so that they actually support the core yarn (1) which improves the latter's stability. Additionally, the average wave height (A) of about 3 mm or more further improves the sound absorbance

of the fibrous material compared to the case that the average wave height (A) is below about 3 mm.

[0023] It is more preferred that the undulated or multi-waved structure of the multi-waved yarn (2) is such that the average wave height (A) is about 3 mm or more and that the average wave width (B), that is the average width between two points at which the multi-waved yarn is fixed to the core yarn, is about 3 mm or more. In this way, the soundproofing ability of the fibrous material is further stabilized. The respective arrangement can be further understood from Figure 1 in which reference numeral (1) denotes the core yarn and reference numeral (2) denotes the multi-waved yarn. Further, in Figure 1 (A) denotes the wave height and (B) denotes the wave width. While the above average values can be given, it is to be noted that the individual values of (A) and (B), respectively, can be highly irregular and can be distributed over a wide range.

[0024] Figure 2 also shows an embodiment of the yarn which is encompassed by the fibrous material of the invention. As can be seen from Figure 2, the multi-waved yarn (2) forms waves (or loops) not only in one direction, but the waves are formed in numerous different radial directions starting out from the core yarn (1).

[0025] Figure 3 represents a cross-section of the yarn depicted in Figure 2. This cross-section shows that waves are formed by the multi-waved yarn (2) in a multi-axial manner around the entire core yarn (1). It is currently assumed that this particular arrangement is one of the main reasons for the advantageously improved soundproofing property of the fibrous material of the present invention.

[0026] The core yarn (1) can either be formed by a single or a double yarn. The fibers which form the core yarn (1) preferably have a yarn count of about 100 tex or more in order to achieve a sufficiently robust fibrous material. Further, these fibers preferably have a nominal diameter in the range of about 6 μm or more to about 24 μm or less. It has been found that the nominal fiber diameter has a significant influence on the soundproofing property, which is optimized when the nominal diameter falls within the aforementioned range.

[0027] For the same reasons as above, the second yarn or multi-waved yarn (2) is preferably made from fibers which have a yarn count of about 100 tex or more. It is also preferred that these fibers have a nominal diameter in the range of about 6 μm or more to about 24 μm or less.

[0028] Preferably, at least one of the core yarn (1) and the multi-waved yarn (2) is made of glass fibers, aramid fibers, ceramic fibers, silica fibers, basalt fibers or carbon fibers, but is most preferably made of glass fibers because of their superior soundproofing properties. It is more preferred that both, the core yarn (1) and the multi-waved yarn (2), are made of the aforementioned specific kinds of fibers, wherein the best results are achieved when the core yarn (1) and the multi-waved yarn (2) are both made of glass fibers.

[0029] The glass material for the glass fibers is not specifically limited and one or more of the following can be used:

E-glass, which has been found to be very suitable in many applications including sound absorbing applications, S-Glass, which has an improved chemical resistance, R-glass, which has a higher strength and durability, C-glass, which exhibits an especially high corrosion resistance, ECR-glass, which is an E-glass of further improved corrosion resistance, especially acid resistance, D-glass, which shows an advantageously low dielectric loss, and AR-glass, which is typically zirconium-enriched and can be suitably used in a basic environment.

[0030] Among the forgoing glasses, E-glass is most preferred because the sound absorbing properties of the inventive fibrous material are further improved when this kind of glass is employed. Typical constituents of E-glass as used in the present invention include SiO_2 , Na_2O , K_2O , CaO , MgO , B_2O_3 , Al_2O_3 , F_2 , Fe_2O_3 and others.

[0031] A specifically preferred composition of the E-glass is the following:

53 - 57 wt.% SiO_2 ,
 ≤ 1 wt.% $\text{Na}_2\text{O} + \text{K}_2\text{O}$,
 22 - 26 wt.% $\text{CaO} + \text{MgO}$,
 5 - 8 wt.% B_2O_3 ,
 12-15 wt.% Al_2O_3 ,
 0- 0.6 wt.% F_2 ,
 about 0.5 wt.% Fe_2O_3 ,
 and a remainder of other constituents,

wherein the total content of all constituents is 100 wt.%. Such a glass can be preferably used in applications in which the operating temperature might raise up to 500°C . For such cases, it is preferred that the glass has a melting point the range of 800 to 850°C , for example of about 835°C .

[0032] Also, it is possible to raise the SiO_2 content in an employed glass beyond 57 wt.% SiO_2 , for example up to 94 wt.%, which allows for environmental temperatures of up to 900°C . In this regard, such a glass having an increased SiO_2 -content preferably exhibits a melting point of up to about 1600°C .

[0033] In other applications it can be suitable to employ a ceramic fiber, preferably one made of a continuous filament. Such a ceramic fiber preferably has a melting of up to about 1700°C . respective fibers can also be used in high-temperature applications in which temperatures of up to about 1700°C can occur.

[0034] An E-glass of the above composition allows for a well-controlled processing of the glass so that the specific structure of the yarn used in the present invention is easily achievable and the parameters thereof, like the above mentioned average values of (A) and (B), can be readily controlled.

[0035] Additionally, it is preferred that the fibrous material according to the present invention is heat-resistant in a range of 60°C up to a temperature of about 200°C , i.e. no melting or cracking occurs up to about 200°C .

However, as aforesaid, a heat-resistance at a temperature higher than 200°C , e.g. of up to 1200°C , which is for example achieved by the use of quartz fibers, is also beneficial in some instances. Such a heat resistance is favourable when the inventive soundproofing material is employed in environments of elevated temperature, specifically in automotive applications like e.g. as a filling material which is positioned in a silencer of an internal combustion engine.

[0036] As aforementioned, a suitable production process for the inventive yarn is a production process in which a smooth yarn is treated with an air jet, preferably of compressed air, by which an undulated structure is achievable. That is, a fluffy yarn full of fibre loops with best insulation values is obtainable by this process. Also, according to such a process, it is possible to easily control the shape of the finally obtained yarn, e.g. the aforementioned average wave height (A) and average wave width (B).

[0037] Further, the mat according to the present invention can be described as a bulky or foamed yarn mat and exhibits superior soundproofing properties compared to mats which are produced from smooth yarns. The mat can either be constituted by the inventive fibrous material alone, or can be mixed with other materials which are formed e.g. of synthetic or natural fibers.

[0038] In a preferred application of this mat, the mat is compacted by and when it is wound around e.g. a perforated pipe or is for example held between 2 metal sheets so as to remain there.

[0039] It is also preferably that the soundproofing fibrous material has been pre-pressed before assembly because in an actual application in which the material is used, empty spaces might be generated due to the temperature effects, and then these spaces are filled by the material as a result of the employed spring yarn.

[0040] As to a mat made of stacked layers, different stacking possibilities are contemplated. In this case, the mat is constituted by at least two (or more) layers. In Figure 4, a layer (3) formed of horizontally oriented yarns, a layer (4) formed of vertically oriented yarns (thus including an angle of about 90° with those of layer (1)), a layer (5) formed of transversely oriented yarns, which include an angle of about $+45^\circ$ with those of layer (1), a layer (6) formed of transversely oriented yarns, which include an angle of about -45° with those of layer (1), and a sewed layer (7) respectively, are depicted.

[0041] Suitable sound proofing and thermal insulation properties are especially achieved with a preferred minimum nominal thickness of all layers of 12 mm in total. Similar results are achievable when the nominal weight of the respective layers is 600 g/m^2 , which is therefore also preferred.

[0042] Preferable mats according to the invention in-

clude or are exclusively formed by the following combinations of layers:

- a layer (3) and a layer (4) stacked in this order;
- a layer (3), a layer (4) and a layer (3) stacked in this order;
- n-times alternating layers (3) and (4), wherein n is an integer in the range of 2 to 10;
- a layer (3) and either a layer (5) or a layer (6) stacked in this order;
- a layer (3), a layer (4) and either a layer (5) or a layer (6) stacked in this order;
- a layer (3), a layer (4), a layer (5) and a layer (6) stacked in this order; and
- any combination of the above listed combinations.

[0043] The mat is preferably a med-glass yarn mat which can be pressed. During its application, it can for example be pressed by the worker and filled in the parts where it shall be applied.

[0044] The foamed yarn mat according to the present invention is formed of one or more of the above described layers. Preferably, the spring yarn is held together by a sewing yarn which allows the operator to fill the mat into a desired equipment, for example into an exhaust gas pipe, exhaust gas silencers, air-intake silencer filters, sound absorbing pillows for gas turbine exhaust system, fire wall flexible blankets, sound absorbing quilted blankets and all the other application where sound and heat has to be reduced. When it is filled into a respective equipment, the mat comprising the spring yarn tries to release is foamed form, thus filling the empty space to be occupied by the mat.

[0045] Also, the fibrous material may simply be wound up around the exhaust pipe, which allows for a simple and economic production of the silencer. The fibrous material may be supplied pre-cut and/or pre-formed so that it can be quickly applied even by unskilled personnel.

[0046] Of course, the fibrous material of the present invention may be blended with other materials in order to satisfy the specific requirements of the purchaser. For example, it may be blended with needled felt of low, medium or high density, so that it can be advantageously used at various temperatures of up to 1200°C.

[0047] In a further preferred embodiment, the mat according to the invention is constituted by at least 2 layers, one of which is made of the fibrous material of the present invention and which must not be different in the direction of the orientation of the yarns forming the layers. The different layers can for example also be differentiable by their composition and/or by their microscopic or macroscopic structure. As the second layer, a fibrous material of the present invention having different physical or chemical characteristics such as fiber diameter, yarn count, etc. and other fibrous materials as well as solid materials like metals, wood, plastics, etc. can be used. If the second layer is made from a fibrous material, the at least two different layers can be joined by needling,

thermal bonding, adhesives or the like.

[0048] In view of the foregoing, it is understood that the fibrous material of the present invention is especially suitable for use in soundproofing applications, i.e. as a soundproofing building material, a sound insulating wall, a noise protection or a soundproofing material which is used in aeronautic and space applications. A most preferred embodiment of the use of the inventive fibrous material is the use as a filling material in a silencer of an internal combustion engine. Here, the fibrous material preferably fills most of or even the entire interspace between an exhaust pipe, which is covered by the silencer, and an external covering of the silencer.

Claims

1. A soundproofing and thermal insulating fibrous material comprising a spring yarn which is composed of a core yarn (1) and a second yarn (2) extending from the core yarn (1) in radial directions and being fixed to the core yarn (1) in irregular intervals.
2. The fibrous material according to claim 1, wherein the spring yarn is obtainable by opening and blowing up a smooth yarn using compressed air jets, thus providing a fluffy yarn full of fibre loops.
3. The fibrous material according to claim 1 or 2, wherein the second yarn (2) has an average wave height (A) which is larger than the nominal diameter of the core yarn (1).
4. The fibrous material according to any one of claims 1 to 3, wherein the second yarn (2) has an average wave height (A) of about 3 mm or more.
5. The fibrous material according to any one of claims 1 to 4, wherein the fibers which form the second yarn (2) have a yarn count of about 100 tex or more.
6. The fibrous material according to any one of claims 1 to 5, wherein the fibers which form the second yarn (2) have a nominal diameter in the range of about 6 μm to about 24 μm .
7. The fibrous material according to any one of claims 1 to 6, which is formed as a mat having at least two layers, wherein the spring yarns of a first layer are oriented in a direction intersecting the direction in which the spring yarns of a second layer are oriented.
8. The fibrous material according to claim 7, further comprising a third layer, wherein the spring yarns of said third layer are oriented in a direction intersecting the directions in which the spring yarns of said first and said second layer are oriented.

9. The fibrous material according to claim 7 or 8, wherein the layers are held together by a sewing yarn and are in foam forms, and the minimum nominal thickness of all layers in total is 12 mm and the nominal weight is 600 g/m².

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Amended claims in accordance with Rule 86(2) EPC.

9. The fibrous material according to claim 7 or 8, wherein the layers are held together by a sewing yarn, and the minimum nominal thickness of all layers in total is 12 mm and the nominal weight is 600 g/m².

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10. A silencer for an internal combustion engine, wherein the fibrous material according to any one of claims 1 to 9 is filled into an interspace between an exhaust pipe, which is covered by the silencer, and an external covering of the silencer.

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FIG.1

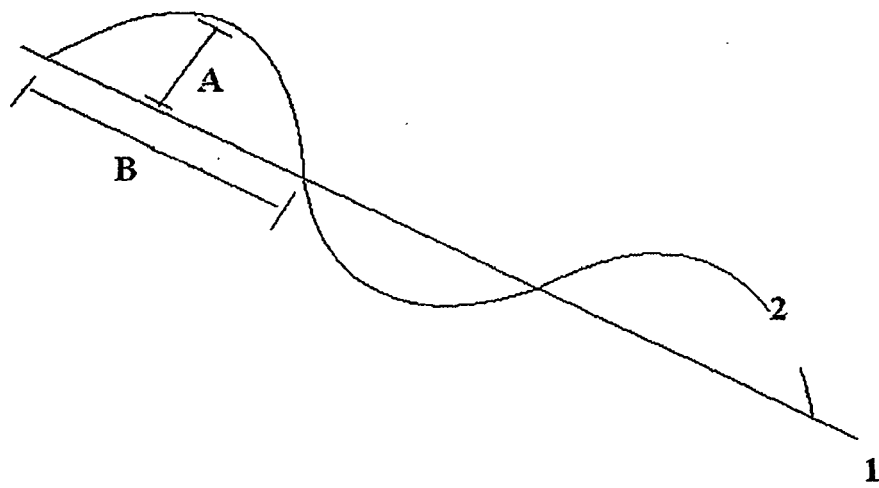


FIG.2

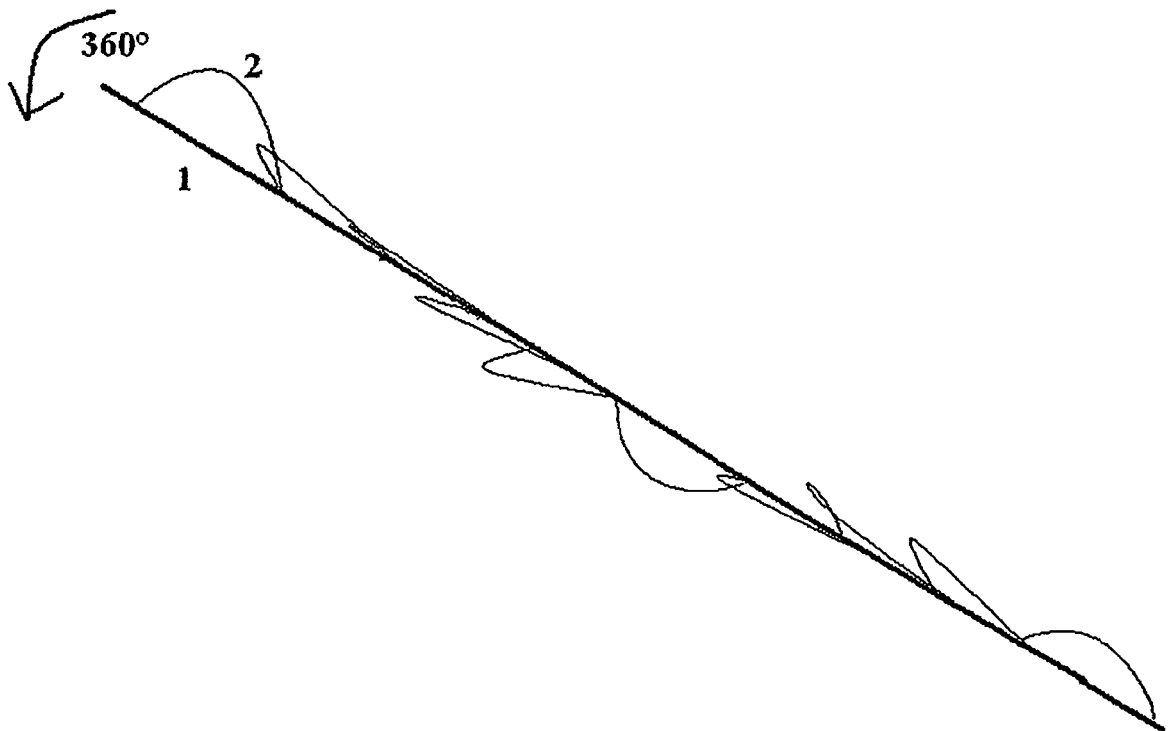


FIG.3

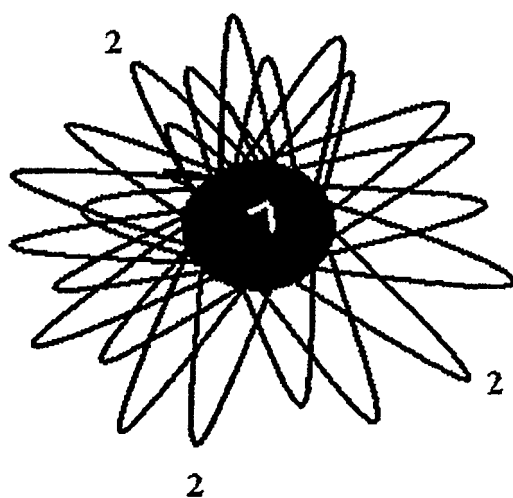
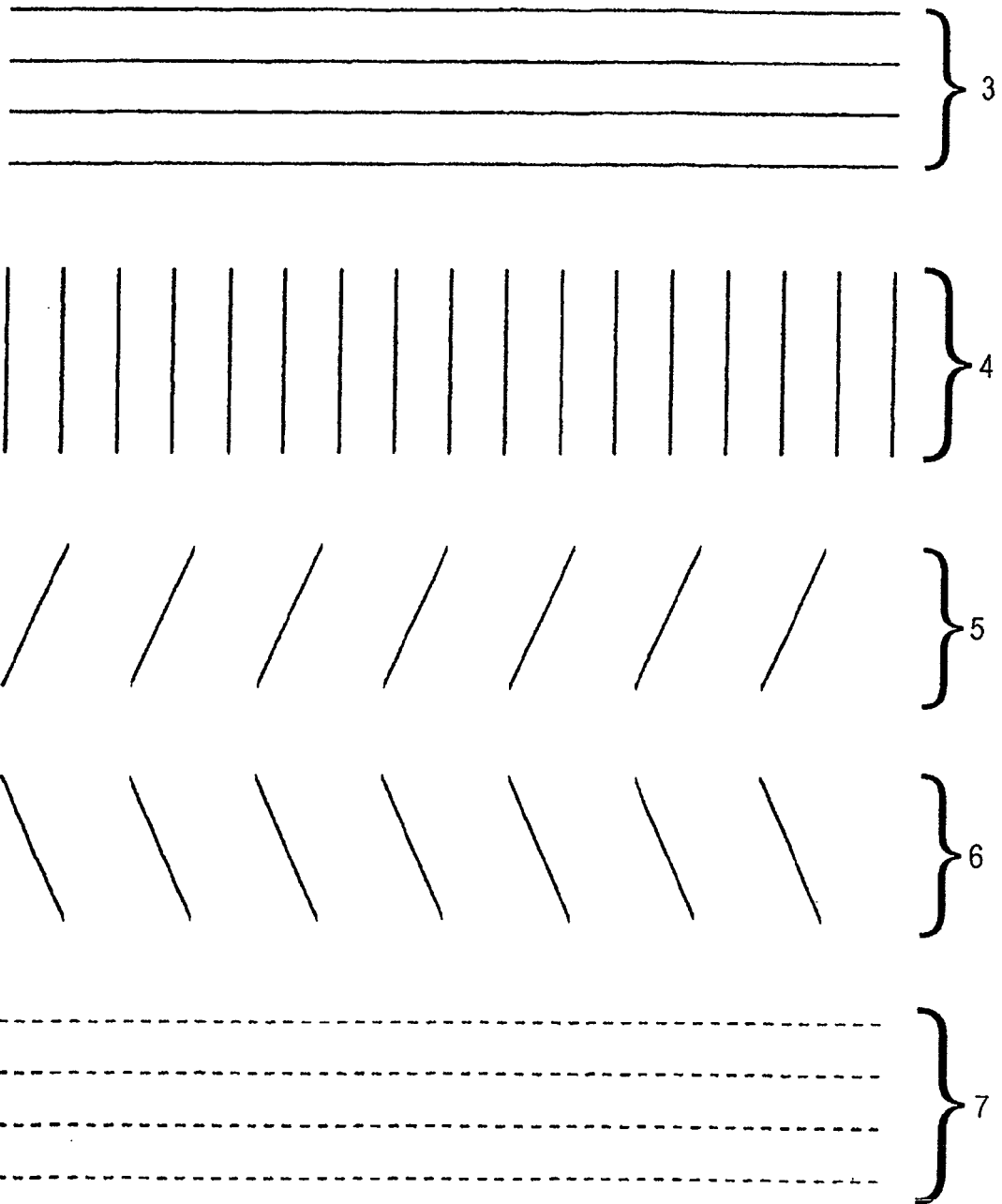


FIG.4





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 42 5754

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	* claim 8; figures 2,3; example 1 * -----	4,5	
D,Y	WO 02/066800 A (KLEVERS ITALIANA S.R.L; ESPOSITO, GERARDO, CIRO) 29 August 2002 (2002-08-29) * claim 1; figure 1 * -----	1-3,6-9	
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			D02G F01N C03C
Place of search		Date of completion of the search	Examiner
The Hague		26 April 2006	D'Souza, J
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			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 42 5754

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26-04-2006

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REFERENCES CITED IN THE DESCRIPTION

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