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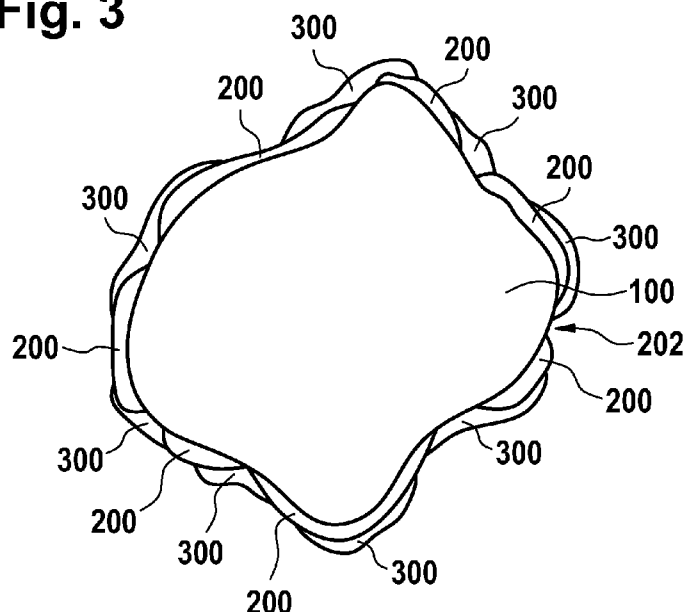
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(54) Title: ARTIFICIAL TURF INFILL AND METHOD FOR MAKING IT

Fig. 3

(57) Abstract: The invention provides for a method manufacturing artificial turf infill (602), wherein the method comprises providing (700) an initial composition (1120) comprising a granulate (1006), at least one type of pigment, and a fluid binding agent. The fluid binding agent comprises at least one type of polymer component. The method further comprises mixing (702) the initial composition; adding (704) water and a catalyst to the initial composition during the mixing of the initial composition to cure the fluid binding agent and the at least one type of pigment into an initial coating (200) of the granulate. The method further comprises providing (706) a subsequent composition (1122) comprising the granulate with the initial coating, the at least one type of pigment, and the fluid binding agent. The method further comprises mixing (708) the subsequent composition. The method further comprises adding (710) water and the catalyst to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one type of pigment into a subsequent coating (300) of the granulate. The method further comprises providing (712) the granulate with the subsequent coating as artificial turf infill.

ARTIFICIAL TURF INFILL AND METHOD FOR MAKING IT

Description

Field of the invention

The invention relates to artificial turf and methods for the manufacture of artificial turf infill.

Background and related art

Artificial turf or artificial grass is surface that is made up of fibers which is used to replace grass. The structure of the artificial turf is designed such that the artificial turf has an appearance which resembles grass. Typically artificial turf is used as a surface for sports such as soccer, American football, rugby, tennis, golf, for playing fields, or exercise fields. Furthermore artificial turf is frequently used for landscaping applications.

- Artificial turf may be manufactured using techniques for manufacturing carpets. For example artificial turf fibers which have the appearance of grass blades may be tufted or attached to a backing. Often times artificial turf infill is placed between the artificial turf fibers. Artificial turf infill is a granular material that covers the bottom portion of the artificial turf fibers. The use of artificial turf infill may have a number of advantages. For example, artificial turf infill may help the artificial turf fibers stand up straight. Artificial turf infill may also absorb impact from walking or running and provide an experience similar to being on real turf. The artificial turf infill may also help to keep the artificial turf carpet flat and in place by weighting it down.
- European patent application EP 1 416 009 B1 describes a loose, free flowing rubber particles as litter material for artificial turf. The particles have an average size between 0.4 mm and 4.0 mm and their complete surface is covered with a permanently elastic and pigmenting coating.
- European patent application EP1201388 B1 discloses a method of manufacturing colored rubber chips: To 100 parts by weight of crushed rubber chips having a particle size of from 1 to 10 mm or fibrous rubber chips having a fibrous length of 30 mm or below are added a film forming material, which contains a pigment and 10 to 100 parts by weight of a one-pack type or two-pack type polyurethane resin which gels at least from a liquid state in 60 seconds or more and cures through the gelling process, and they are stirred for mixing. When the polyurethane resin starts to gel and the rubber chips start to aggregate, stirring is further continued for mixing in spite of heavy load on the mixer so to loosen the aggregation of the rubber chips. By configuring as described above, A manufacturing method which can form a thick

colored film without requiring a complex procedure and can inexpensively obtain colored rubber chips which have a remarkable color keeping property and a pyramid shape with edges similar to those formed when crushed is provided. The particle size is desired to have almost the same size as the thickness of the film. And if it is
5 excessively larger or smaller than that size it does not meet the objective of completely covering the rubber chips. The film thickness in the present invention is about 0.8 mm maximum and the particle sizes is also about the same accordingly.

International patent application WO 2010/081632 A1 discloses a method for
10 producing coated particles made of rubber granulate, the coating, the particles coated with said coating, and the uses of the coated particles. The coating contains no solvents.

Summary

15 The invention provides for a method of manufacturing artificial turf infill, a method of manufacturing artificial turf, artificial turf infill, and artificial turf. Embodiments are given in the dependent claims.

In one aspect the invention provides for a method of manufacturing artificial turf infill.
20 Artificial turf infill as used herein, encompasses a granular material that is spread out on an artificial turf carpet in between the fibers. Artificial turf infill may be used to modify an artificial turf carpet to have more earth like properties. For example the artificial turf infill may provide a surface which is able to absorb impacts in a manner similar to real turf.

25 The method comprises providing an initial composition comprising a granulate, at least one first type of pigment, and a fluid binding agent. The fluid binding agent comprises at least one type of polymer component. The method further comprises mixing the initial composition. The method further comprises adding water and a
30 catalyst to the initial composition during the mixing of the initial composition to cure the fluid binding agent and the at least one type of pigment into an initial coating of the granulate.

The method further comprises providing a subsequent composition comprising the granulate with the initial coating, the at least one second type of pigment and the fluid binding agent. The method further comprises mixing the subsequent composition. The method further comprises adding water and the catalyst to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one type of pigment into a subsequent coating of the granulate.

The at least one second type of pigment and the at least one first type of pigment may be identical or they may be different. If they are the same then the coating of the granulate will be of a uniform color. If the at least one second type of pigment and the at least one first type of pigments are different colors then the two colors can be chosen so that the resulting artificial turf infill has a more natural and earth like appearance.

The method further comprises providing the granulate with the subsequent coating as artificial turf infill.

The coating of the granulate in at least two steps as described above, may be beneficial because it may provide for better coating of the granulate. For example, during the mixing of the initial composition individual grains of the granulate will touch and interact with each other as the initial coating on each of the grains forms. The physical contact between different grains will however cause defects. By coating the granulate particles a second time with the subsequent coating, much higher coverage of the granulate can be achieved.

As a hypothetical example, during the formation of the initial coating or the subsequent coating the coverage is each only 90% of the surface of the granulate. After the initial coating has been deposited, roughly 10% of each granule of the granulate would be uncoated. There would be small surface defects. Deposition of the subsequent coating would then also cover 90% of the surface. As the interaction between the grains or particles of the granulate is essentially a random process, one can expect that 90% of the defects that were exposed after the deposition of the initial coating are coated in this case. The result of doing two coatings is then an

artificial turf infill that is 99% coated with only minor amounts of defects, where the granulate is not coated with either the initial coating or the subsequent coating.

Improving the coverage of the granulate may be beneficial in several different situations. For example, it may be desirable to color the artificial turf infill the same or a similar color as fibers or tufts, which are used to manufacture an artificial turf carpet. This may provide a more realistic-looking play surface or playfield. Another advantage is that the elastomeric granulate may be better coated and may therefore have superior wear qualities or may even be better isolated from the environment.

In an embodiment, the granulate comprises an elastomeric or elastic granulate.

In different embodiments the granulate is an elastomeric material based on elastomers like synthetic rubbers as e.g. styrene butadiene rubber, polybutadiene rubber, styrene- ethylene-butadiene-styrene copolymer (SEBS), ethylene-propylene-diene monomer rubber (EPDM), acryl nitrile butadiene rubber. In other embodiments a cis- 1,4 –polyisoprene, as natural rubber and trans 1,4 – polyisoprene as gutta-percha based granulate can be used.

In another embodiment the granulate comprises a compression resistant granulate or a rigid granulate.

In another embodiment the granulate comprises any one of the following: natural latex, cork, linoleum, composites made from solidified vegetable oils and wood flour or a hydrogel of methyl-cellulose.

In another embodiment the curing of the initial coating and the curing of the subsequent coating is a polymerization process. Within the claims, the term 'cure' or 'curing' may be replaced with polymerization.

In another embodiment the subsequent coating at least partially covers the initial coating.

In another embodiment the initial coating only partially covers the granulate.

In another embodiment the subsequent coating only partially covers the initial coating.

- 5 In another embodiment, the initial coating and the subsequent coating each have a thickness of less than any one of the following: 0.1 mm, 0.075 mm, 0.05 mm, and 0.01 mm. This embodiment may be beneficial because it may provide a means of reducing the amount of fluid binding agent necessary to coating the granulate.
- 10 In another embodiment the initial coating comprises gaps. The subsequent coating also comprises gaps. The gaps in the initial and subsequent coatings may be distributed randomly on the surface of the granulate. As the gaps in both coatings are distributed randomly, it is unlikely that the gaps will line up. The result will be that there will be few if any portions of the underlying granulate exposed.
- 15 It is possible that some of the gaps in the initial and subsequent coatings may line up. However, all or the vast majority of the surface of the granulate will be coated. Using the double coating may greatly reduce the amount of fluid binding agent necessary to coat the granulate.
- 20 In another embodiment, the granulate with the initial coating and the subsequent coating is re-coated at least one time by performing the following sequence. The first step in the sequence is provide a subsequent composition by adding at least one additive and the fluid binding agent to the granulate that has already been coated with the initial coating and the subsequent coating. The next step in the
- 25 sequence is to mix the subsequent composition. The next step in the sequence is to add water and the catalyst to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one additive into a further coating. The granulate with the further coating is provided then as the artificial turf infill. This embodiment may be beneficial because an additional coating
- 30 or layer may be put on the granulate. If the at least one first and/or second type of pigment is used again then the granulate may be coated a third or more times to improve the coverage and the coating of the granulate. This embodiment may also be beneficial because it may enable the deposition of so-called functional layers or additives, which may add to the utility or wear or usefulness of the artificial turf infill.

In another embodiment, the further coating has a thickness of less than any one of the following: 0.1 mm, 0.075 mm, 0.05 mm, and 0.01 mm. This embodiment may be beneficial because it may provide a means of reducing the amount of fluid binding agent necessary for coating the granulate.

In another embodiment the PU catalyst is partially or completely water soluble and is of the group: secondary amine, tertiary amine, a metal organo catalyst.

10 In another embodiment the liquid PU component is based on an NCO terminal polymer which might be a pre-polymer, a polymeric isocyanate, an oligomeric isocyanate, a monomer and a mixture hereof.

15 In another embodiment the liquid PU component is based on an aromatic diisocyanate of the group toluene diisocyanate or methylene- 2,2 -diisocyanate,

In another embodiment the liquid PU component is based on an aliphatic diisocyanate of the group hexamethylene diisocyanate, isophorone diisocyanate and 1,4-cyclohexyldiisocyanate.

20 In preferred embodiment the liquid PU component is based on methylenediphenyl-isocyanate isomer mixture.

25 In another embodiment the hydroxyl component for the production of the PU is out of the group polyether polyol or polyester polyol.

In another embodiment the hydroxyl component is based on a polyetherpolyol of the molecular weight 500 to 10000. In a preferred embodiment the polyetherpolyol has a molecular weight of 1500- 6000. In a very preferred embodiment the molecular weight is in the range of 2000- 4000.

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In another embodiment the at least one additive comprises the at least one first and/or second type of pigment.

In another embodiment the at least one additive further comprises a flame retardant like aluminum trihydrate, magnesium hydroxide turning a by itself burnable or flammable elastomeric material into a flame retardant infill material.

- 5 In another embodiment this flame retardant additives creates an intumescent coating and is based on intumescent component comprising ammonium polyphosphate or exfoliated graphite or a mixture hereof .

- 10 In another embodiment the at least one additive further comprises zeolite. The addition of zeolite may be beneficial because then the surface of the artificial turf infill may be able to absorb or de-absorb water. For example before a football game, which is scheduled to be held in the sun or in hot conditions, water may be sprayed onto the artificial turf and the zeolite may absorb an amount of water. As the sun or hot air heats the artificial turf infill during the game, the evaporation of water may
15 cool the playing surface for the players and make the use of the artificial turf more pleasant.

- In another embodiment the at least one additive further comprises methylcellulose, which may be beneficial in a similar way like zeolite for absorbing and desorbing of
20 water, rendering a cooling effect at hot climatic conditions.

In another embodiment the at least one additive further comprises an antibacterial agent.

- 25 In another embodiment the at least one additive further comprises silver. Silver may be beneficial as an antibacterial agent.

In another embodiment the at least one additive further comprises chitosan, showing natural antibacterial properties.

30

In another embodiment the at least one additive further comprises an IR reflective pigment. The use of the IR reflective pigments as mixed metal oxides may be beneficial because it may reflect infrared light. This may reduce the heating of the

artificial turf infill. A specific advantage may be that in this case the comparably expensive and precious pigments are merely on the surface of the infill granulates, where they are fully effective and not in the complete core of the elastic material. In another embodiment the elastomeric granulate is a rubber granulate.

5

In another embodiment the elastomeric granulate comprises any one of the following: rubber, an elastomeric polymer, Metallocene Butadiene Rubber, nitrile rubber granulate, natural rubber granulate, styrene-butadiene rubber granulate, ethylene propylene diene monomer rubber granulate, black crumb rubber granulate, acrylonitrile butadiene rubber, a thermoplastic polymer, Styrene Ethylene Butylene Styrene, Styrene Block Copolymers, and combinations thereof.

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In a further embodiment the granulate is an elastic foam.

15

In a further embodiment the granulate is an elastic PU foam

In another embodiment the granulate has an average diameter between 0.1 mm and 3.0 mm.

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In another embodiment the granulate has a maximum diameter of less than 5.0 mm.

In another embodiment the at least one first and/or second type of pigment comprises an inorganic pigment, an organic pigment or mixtures hereof..

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In another embodiment the at least one first and/or second type of pigment comprises any one of the following: iron oxide, iron oxide hydroxide, chromium(III) oxide, a copper phthalocyanine pigment, a nickel azopigment, titanium oxide and combinations thereof.

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In another embodiment the at least one type of additive is hindered amine light stabilizer (HALS) which is able to protect the PU coating as well as the elastic and/or compression resilient granulate against UV degradation.

In another embodiment the at least one type of additive is a thermostabilizing agent, protecting the elastic and/ or compression resilient granulate against thermal degradation.

- 5 In another embodiment the at least one type of additive is an anti-freeze/ deicing additive of the group: sodium chloride, potassium chloride, calcium chloride, sodium formiate, potassium formiate or a mixture hereof. The additive is migrating into the neighborhood of the granulate and by this inhibits the formation of ice by freezing humidity between the infill granulate particles.

10

In another embodiment the fluid binding agent further comprises any one of the following: a surfactant, a polyurethane aliphatic isocyanate, a polyurethane aromatic isocyanate, zeolite, an antibacterial agent, silver, IR reflective pigment, and combinations thereof.

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In another embodiment the polymer component comprises any one of the following: at least one type of monomer, at least one type of partially polymerized polymer, and combinations thereof.

- 20 In another embodiment the polymer component is cured into at least one type of polyurethane by the water and the catalyst.

For example the polymer component could be methylene diphenyl diisocyanate. The polymer component could also comprise polyols.

25

In another embodiment the catalyst comprises any one of the following: an amine catalyst and a metal organic catalyst.

- 30 In another embodiment the method further comprises drying the subsequent composition before providing the granulate as the artificial turf infill.

It may also be possible to dry the initial composition after coating the granulate with the initial coating; however, it is not necessary. The water, which is leftover from the

formation of the initial coating on the elastic and /or compression resilient granulate may be used in the reaction of the subsequent composition.

In another embodiment the method is at least partially performed in a flow reactor.

- 5 In the flow reactor the granulate is slowly moved along a linear sequential path, where the granulates are generally mixed and moved along. The benefit of using a flow reactor is that the artificial turf infill may be produced on a continuous basis.

- 10 In another embodiment the method is at least partially performed as a batch process. The initial coating is formed on the granulate during an initial batch and the subsequent coating is formed on the granulate during a subsequent batch. Forming the initial coating and the subsequent coating in separate batches may be beneficial because it may enable precise control over the formation of the initial and subsequent coatings.

15

- In another aspect the invention provides for a method of manufacturing artificial turf. The method comprises installing an artificial turf carpet. The artificial turf carpet comprises multiple artificial turf fiber tufts. For example, the artificial turf carpet may be a tufted artificial turf carpet. There may be a backing which has tufts of artificial grass fibers tufted into it. The method further comprises providing the artificial turf by spreading a layer of artificial turf infill between the multiple artificial turf fiber tufts. The artificial turf infill comprises a granulate. The granulate comprises at least two outer coatings. Each of the two outer coatings comprises at least one first and/or second type of pigment and a binding agent. The binding agent comprises at least one type of polyurethane polymer. This method may be beneficial because the artificial turf infill may be more completely covered with the two outer coatings. This may for instance provide superior optical appearance of the artificial turf infill. It may also provide better wear and longevity of the artificial turf infill.

- 20 25 30 In another embodiment, the two outer coatings each have a thickness of less than any one of the following: 0.1 mm, 0.075 mm, 0.05 mm, and 0.01 mm. This embodiment may be beneficial because it may provide a means of reducing the amount of fluid binding agent necessary for coating the granulate.

In another embodiment, the at least two outer coatings each comprise gaps. In other words the at least two outer coatings each incompletely covers the granulate and each of the two outer coatings has gaps.

- 5 The gaps in the at least two outer coatings may be distributed randomly on the surface of the granulate. Some of the gaps in the at least two outer coatings may line up. However, many of the gaps in the at least two outer coatings will be at different locations on the surface of the granulate. The result is that there will likely be a few places where the underlying granulate is exposed. However the majority of
10 the surface of the granulate will be coated. Using the double coating may greatly reduce the amount of fluid binding agent necessary to coat the granulate.

In another embodiment the method further comprises manufacturing the artificial turf infill according to an embodiment.

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- In another embodiment the granulate comprises at least two outer coatings. Each of the two outer coatings comprises at least one first and/or second type of pigment and a binding agent. The binding agent comprises at least one type of polyurethane polymer. This artificial turf infill may have the benefit that the use of the two outer
20 coatings enables more complete coverage of the grains or particles of the artificial turf infill.

- In another aspect, the invention provides for an artificial turf. The artificial turf comprises an artificial turf carpet. The artificial turf carpet comprises multiple
25 artificial turf fiber tufts. The artificial turf further comprises artificial turf infills spread between the multiple artificial fiber tufts. The artificial turf infill comprises a granulate. The granulate comprises at least two outer coatings. Each of the two outer coatings comprises at least one first and/or second type of pigment and a binding agent. The binding agent comprises at least one type of polyurethane polymer.

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The use of the artificial turf infill with the two outer coatings may provide superior wear or longevity of the artificial turf. It may also provide superior optical appearance as the artificial turf infill may be more uniformly pigmented if the pigments in the two layers are identical. The pigments can also be selected so that the artificial turf infill

has a patch work of different colors. This may make the artificial turf infill look more natural and earth-like.

5 In another embodiment, the two outer coatings each have a thickness of less than any one of the following: 0.1 mm, 0.075 mm, 0.05 mm, and 0.01 mm. This embodiment may be beneficial because it may provide a means of reducing the amount of fluid binding agent necessary to coating the granulate.

10 In another embodiment, the at least two outer coatings each comprise gaps. In other words the at least two outer coatings each incompletely covers the granulate and each of the two outer coatings has gaps.

The gaps in the at least two outer coatings may be distributed randomly on the surface of the granulate. Some of the gaps in the at least two outer coatings may
15 line up. However, many of the gaps in the at least two outer coatings will be at different locations on the surface of the granulate. The result is that there will likely be a few places where the underlying granulate is exposed. However the majority of the surface of the granulate will be coated. Using the double coating may greatly reduce the amount of fluid binding agent necessary to coat the granulate.

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In another embodiment the granulate has an average diameter between 0.45 mm and 2.0 mm.

25 In another embodiment the granulate has a maximum diameter of less than 4 mm.

In another embodiment, the artificial turf fiber tufts are arranged in rows. The artificial turf fibers have a row of space in between 0.5 cm and 1.95 cm. This corresponds approximately to 3/8" to 3/4".

30 In another embodiment the artificial turf covering has a pile height between 2.5 cm and 7.5 cm. The pile height is the length of the artificial turf fibers above the backing or base of the artificial turf carpet.

It is understood that one or more of the aforementioned embodiments of the invention may be combined as long as the combined embodiments are not mutually exclusive.

5 Brief description of the drawings

In the following embodiments of the invention are explained in greater detail, by way of example only, making reference to the drawings in which:

Fig. 1 illustrates a cross sectional coating of a grain of a granulate;

Fig. 2 illustrates the granule of Fig. 1 after being partially coated with an initial coating;

Fig. 3 illustrates the granule of Fig. 2 after being partially coated with a subsequent coating;

Fig. 4 illustrates the granule of Fig. 3 after being partially coated with a subsequent coating;

Fig. 5 illustrates an example of an artificial turf carpet;

Fig. 6 illustrates an example of artificial turf;

Fig. 7 shows a flow chart which illustrates a method of manufacturing artificial turf infill;

Fig. 8 shows a flow chart which illustrates a further method of manufacturing artificial turf infill;

Fig. 9 shows a flow chart which illustrates a method of manufacturing artificial turf;

Fig. 10 illustrates an example of a batch reactor; and

Fig. 11 illustrates an example of a flow reactor.

Detailed Description

Like numbered elements in these figures are either equivalent elements or perform the same function. Elements which have been discussed previously will not necessarily be discussed in later figures if the function is equivalent.

Figs. 1-4 illustrate the manufacture of artificial turf infill by examining a single grain or granule 100. The granule 100 could for example be made from an elastomeric compound, a rigid compound, a semi-rigid compound, and/or a compression resilient compound. Fig. 1 shows a grain or granule. For example the grain 100

could be a grain or granule of rubber or a compression, a rigid compound, a semi-rigid compound, or resilient compound. The view shown in Figs. 1-4 is a cross-sectional view.

5 Fig. 2 shows the same grain 100 or granule after it has been coated with an initial coating 200. The initial coating 200 was formed by providing an initial composition of a granulate, which is made up of a large number of grains or granules 100. The initial composition comprised at least one first type of pigment and a fluid binding agent also. The fluid binding agent comprises at least one type of polymer
10 component. The initial composition was then mixed. Next, water and a catalyst were added to the initial composition during the mixing process to cure the fluid binding agent and the at least one first type of pigment into the initial coating 200. As a large number of these granules 100 or grains are mixed they interact with each other and bump into each other occasionally during the process. For this reason there may be
15 holes or defects in the initial coating 200. In Fig. 2 it can be seen that there are a number of gaps 202 in the initial coating 200. These are regions where the grain 100 or granule is coated or is insufficiently coated by the initial coating 200.

Fig. 3 shows the same grain 100 or granule after it has been coated with a
20 subsequent coating 300. As with the initial coating 200 the subsequent coating 300 does not completely cover all portions of the grain 100 or granule. However, due to the two-step process almost the entire grain 100 or granule 100 is coated. In this example there can only be seen one gap 202. The subsequent coating 300 was formed by providing a subsequent composition comprising the granulate with the initial coating as is shown in Fig. 2 and then combining it with the at least one first
25 type of pigment or at least one second type of pigment and the fluid binding agent. This subsequent composition was then mixed. During the mixing process additional water and a catalyst were added to the subsequent composition to cure the fluid binding agent and the at least one type of pigment into the subsequent coating 300.
30 Fig. 3 illustrates how a two-step coating process may be used to improve the coverage or quality of the coating on a granule that makes up a larger granulate. Granules manufactured, such as is shown in Fig. 3, may be provided as a group to form an artificial turf infill.

It is also possible to perform further coatings on the grain 100 or granule 100. Fig. 4 shows the grain 100 after a further coating 400 has been applied. This further coating 400 may for example be formed by recoating the granulate, which comprises the grain 100, by adding at least one additive and the fluid binding agent to the granulate. Next, a combination of the granulate and the at least one additive in the fluid binding agent form a subsequent composition. This subsequent composition is then mixed and again, water and a catalyst can be added to cure the fluid binding agent and at least one additive into the further coating 400. It can be seen now that the coverage of the grain 100 or granule is sufficient that there are no longer any gaps visible in this cross-section. The at least one additive could take different forms.

If it were desired to ensure that there are no gaps in the coatings the at least one pigment could be used again. In other cases additional additives may be added to form a functional further coating 400. For example a flame retardant such as polyurethane oligophatic isocyanates could be added. To provide for the absorption and de-absorption of water, to cool the carpet a zeolite could be added. Also various antibacterial or antifungal agents could be added too. In other examples an infrared reflection agent such as EPDM may be used to reduce the amount of heat absorbed by the artificial turf infill and/or also to help protect it from sunlight.

Figs. 5 and 6 illustrate the manufacture of an artificial turf using an artificial turf carpet and artificial turf infill. In Fig. 5 an artificial turf carpet 500 can be seen. The artificial turf carpet 500 comprises a backing 502. The artificial turf carpet 500 shown in Fig. 5 is a tufted artificial turf carpet in this example. The artificial turf carpet is formed by artificial turf fiber tufts 504 that are tufted into the backing 502. The artificial turf fiber tufts 504 are tufted in rows. There is row spacing 506 between adjacent rows of tufts. The artificial turf fiber tufts 504 also extend a distance above the backing 502. The distance that the fibers 504 extend above the backing 502 is the pile height 508. In Fig. 5 it can be seen that the artificial turf carpet 500 has been installed by placing or attaching it to the ground 510 or a floor. To manufacture the artificial turf the artificial turf infill made up of grains or granules such as is shown in Figs. 3 or 4 are spread out on the surface and distributed between the artificial turf fiber tufts 504. Fig. 6 shows the artificial turf carpet 500 after the artificial turf infill

602 has been spread out and distributed between the artificial turf fiber tufts 504. It can be seen that the artificial turf infill 602 is a granulate made up of individual grains 100 or granules such as is depicted in Figs. 3 or 4.

5 Fig. 7 shows a flowchart which illustrates a method of manufacturing artificial turf infill 602 such as is depicted in Figs. 1-3 in the coating of the single grain 100 or granule. First in step 700 an initial composition is provided. The initial composition comprises a granulate, at least one first type of pigment, and a fluid binding agent. The fluid binding agent comprises at least one type of polymer component. Next in
10 step 702 the initial composition is mixed. Next in step 704 during the mixing water and catalyst are added to the initial composition to cure the fluid binding agent and the at least one type of pigment into an initial coating 200 of the granulate. In step 706 a subsequent composition is provided. The subsequent composition comprises the granulate with the initial coating 200, the at least one second type of pigment,
15 and the fluid binding agent. Next in step 708 the subsequent composition is mixed. Next in step 710 water and the catalyst are added to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one second type of pigment into a subsequent coating 300 of the granulate. Finally in step 712 the granulate with the subsequent coating 300 is
20 provided as the artificial turf infill 602.

Fig. 8 shows a flowchart, which illustrates an alternate method of manufacturing artificial turf infill. The method depicted in Fig. 8 is similar to the method depicted in Fig. 7 with several additional steps. The method in Fig. 8 is identical to Fig. 7 in
25 steps 700-710. After step 710 has been performed, step 800 is performed. Steps 802 and then 804 are performed before step 712 is performed. Steps 800, 802 and 804 are the steps of recoating the granulate after it has been coated with the subsequent coating. First in step 800 a subsequent composition is provided by adding at least one additive and a fluid binding agent to the granulate. Next in step
30 802, the subsequent composition is mixed. Finally, in step 804, during the mixing in step 802, water and catalyst are added to the subsequent composition during mixing of the subsequent composition to cure the fluid binding agent and at least one additive into the further coating 400. Finally, in step 712, the granulate that has been

coated with the initial coating, the subsequent coating, and the further coating 400, is provided as the artificial turf infill 602.

Fig. 9 shows a flowchart, which illustrates a method of manufacturing artificial turf 600 such as depicted in Fig. 6. First in step 900 an artificial turf carpet 500 is installed. The artificial turf carpet comprises multiple artificial turf fiber tufts 504. Next in step 902, the artificial turf 600 is provided by spreading a layer of artificial turf infill 602 between the multiple artificial turf fiber tufts 504. The artificial turf infill comprises the granulate. The granulate comprises at least two outer coatings 200, 300, 400. Each of the at least two outer coatings 200, 300, 400 comprises at least one type of pigment and a binding agent. The pigments in each of the coatings may be identical or different. The binding agent comprises at least one type of polyurethane polymer.

Fig. 10 illustrates some equipment which may be used for manufacturing the artificial turf infill 602 and for coating grain or granules 100, such as is illustrated in Figs. 1-4. Fig. 10 depicts a mixing vat 1000. The mixing vat has a rotatable shaft 1002 that is connected to a number of mixing paddles 1004. The mixing vat 1000 is filled with the granulate 1006. The elastomeric granulate can then be manufactured into artificial turf infill by following the methods illustrated in Figs. 7 or 8. Since water is added with the catalyst for forming each of the initial coating 200, the subsequent coating 300 or the further coating 400 it is not necessary to dry the granulate 1006 between the coating of each of the coatings. The granulate 1006 can be added to the mixing vat 1000 and then at different times the different materials can be added while the rotatable shaft 1002 is turned.

The apparatus depicted in Fig. 10 may be used for manufacturing the artificial turf infill as batches. It is also possible to manufacture the artificial turf infill as a continuous process using a flow reactor.

Fig. 11 illustrates an example of a flow reactor 1100. The example shown in Fig. 11 is illustrative and is not drawn to scale. The flow reactor 1100 comprises a rotatable shaft 1102 that is connected to a screw conveyor 1104. The screw conveyor 1104 is similar to an Archimedes screw, which is mounted horizontally. The flow reactor

1100 can be shown as being filled with granulate 1006. The granulate 1006 comprises grains or particles 100 such as is shown in Figs. 1-4. As the rotatable shaft 1102 is turned, it causes the granulate 1006 to move through the flow reactor 1100. It also causes the granulate 1006 to be mixed. At an entrance there is an inlet 1108 for adding granulate 1006. This may be done on a continual basis as the shaft 1102 is rotated. This causes the granulate to go to a first inlet for at least one pigment and fluid binding agent. At this first inlet 1110 the at least one pigment and the fluid binding agent are added to the granulate 1006 and become mixed with it as the shaft 1102 is rotated. When they are thoroughly mixed, the granulate 1006 and the at least one pigment and the fluid binding agent form an initial composition 1120. This initial composition 1120 is then transported beneath a first inlet for water and catalyst 1112. The water and catalyst may be added on a continual or intermittent basis at this inlet 1112.

As the initial composition 1120 is transported further along the flow reactor 1100 fluid binding agent and at least one pigment cure into the initial coating 200 such as depicted in Fig. 2. After the initial coating 200 is formed, the initial composition 1120 is transported underneath the second inlet for at least one pigment and fluid binding agent. At this point more of the pigment and fluid binding agent are added and the initial composition 1120 becomes the subsequent composition 1122. The pigments used for the initial composition and the subsequent composition may be identical or they may be different.

The subsequent composition 1122 is mixed and transported underneath the second inlet for water and catalyst 1116. The water and catalyst are then mixed with the subsequent composition 1122 and over time are further transported to the end of the flow reactor 1100. By the time the subsequent composition 1122 has reached the end of the flow reactor 1100 the subsequent coating 300 has formed on the grains or particles of the granulate 1006 such as depicted in Fig. 3. At the very end, then the granulate 1006 exits the flow reactor 1100 at an outlet 1117. The granulate 1006 at this point is then artificial turf infill 602. The artificial turf infill 602 is then shown as entering into an optional dryer 1118.

It is clear from Fig. 11 that the flow reactor may also be extended. For example if it is desired to put a third or fourth or even more coatings, the number of inlets in the flow reactor 1100 can simply be increased. This may involve moving the granulate at a different rotational rate or possibly even making the flow reactor 1100 longer.

List of reference numerals

	100	grain or granule
5	200	initial coating
	202	gap
	300	subsequent coating
	400	further coating
	500	artificial turf carpet
10	502	backing
	504	artificial turf fiber tufts
	506	row spacing
	508	pile height
	510	ground or floor
15	600	artificial turf
	602	artificial turf infill
	700	providing an initial composition comprising a granulate
	702	mixing the initial composition
	704	adding water and a catalyst to the initial composition
20		during the mixing of the initial composition to cure the fluid binding agent and the at least one first type of pigment into an initial coating of the granulate
	706	providing a subsequent composition comprising the granulate with the initial coating
25	708	mixing the subsequent composition
	710	adding water and the catalyst to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one second type of pigment into a subsequent coating of the granulate
30	712	providing the granulate with the subsequent coating as artificial turf infill
	800	providing a subsequent composition by adding at least one additive and the fluid binding agent to the granulate

- 5 802 mixing the subsequent composition
804 adding water and the catalyst to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one additive into a further coating
- 900 installing an artificial turf carpet with multiple artificial turf fiber tufts
- 902 providing the artificial turf by spreading a layer of artificial turf infill between the multiple artificial turf fiber tufts
- 10 1000 mixing vat
1002 rotatable shaft
1004 mixing paddles
1006 granulate
1100 flow reactor
- 15 1102 rotatable shaft
1104 screw conveyor
1108 inlet for granulate
1110 first inlet for at least one pigment and fluid binding agent
1112 first inlet for water and catalyst
- 20 1114 second inlet for at least one pigment and fluid binding agent
1116 first inlet for water and catalyst
1117 outlet
1118 dryer
- 25 1120 initial composition
1122 subsequent composition

C l a i m s

-
1. A method manufacturing artificial turf infill (602), wherein the method
5 comprises:
- providing (700) an initial composition (1120) comprising a granulate (1006), at least one first type of pigment, and a fluid binding agent, wherein the fluid binding agent comprises at least one type of polymer component;
 - mixing (702) the initial composition;
 - 10 - adding (704) water and a catalyst to the initial composition during the mixing of the initial composition to cure the fluid binding agent and the at least one type of pigment into an initial coating (200) of the granulate;
 - providing (706) a subsequent composition (1122) comprising the granulate with the initial coating, at least one second type of pigment, and the fluid binding
15 agent;
 - mixing (708) the subsequent composition;
 - adding (710) water and the catalyst to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one type of pigment into a subsequent coating (300) of the granulate; an
20 - providing (712) the granulate with the subsequent coating as artificial turf infill.
2. The method of claim 1, wherein the initial coating comprises gaps (202), wherein the subsequent coating comprises the gaps.
- 25 3. The method of claim 1 or 2, wherein the granulate with the initial coating and the subsequent coating is re-coated at least one time by performing the following sequence:
- providing (800) a subsequent composition by adding at least one additive and the fluid binding agent to the granulate;
 - 30 - mixing (802) the subsequent composition; and
 - adding (804) water and the catalyst to the subsequent composition during the mixing of the subsequent composition to cure the fluid binding agent and the at least one additive into a further coating (400), wherein the granulate with the further coating is provided as the artificial turf infill.

4. The method of claim 3, wherein the at least one additive further comprises any one of the following: the at least one first type of pigment, the at least one second type of pigment, a flame retardant, aluminum trihydrate, magnesium hydroxide, an intumescent component, ammonium polyphosphate, exfoliated graphite, methylcellulose, zeolite, an antibacterial agent, silver, chitosan, an IR reflective pigment, a hindered amine light stabilizer, an anti-freeze additive, a de-icing additive, sodium chloride, potassium chloride, sodium formate, potassium formate, and combinations thereof.
5. The method of any one of the preceding claims, wherein the granulate comprises an elastomeric granulate.
6. The method of any one of the preceding claims, wherein the granulate comprises any one of the following: rubber, an elastomeric polymer, Metallocene Butadiene Rubber, nitrile rubber granulate, natural rubber granulate, styrene-butadiene rubber granulate, ethylene propylene diene monomer rubber granulate, black crumb rubber granulate, acrylonitrile butadiene rubber, a thermoplastic polymer, Styrene Ethylene Butylene Styrene, Styrene Block Copolymers, an elastic foam, elastic polyurethane foam, and combinations thereof.
7. The method of any one of claims 1 through 4, wherein the granulate comprises a compression resilient granulate.
8. The method of any one of claims, 1, 2, 3, 4, or 7, wherein the granulate is any one of the following: natural latex, cork, linoleum, a composite formed from one or more type of solidified vegetable oil and wood flour, a hydrogel of methyl-cellulose, and combinations thereof.
9. The method of any one of the preceding claims, wherein the granulate has an average diameter between 0.1mm and 3.0 mm and/or wherein the granulate has a maximum diameter less than 5.0 mm.

10. The method of any one of the preceding claims, wherein the at least one first type of pigment and/or the at least one second type of pigment comprises any one of the following: an inorganic pigment, an organic pigment, iron oxide, thalo green, Chromium(III) oxide, a Copper phythalocyanie pigment, a nickel azopigment,
5 titanium oxide, and combinations thereof.

11. The method of any one of the preceding claims, wherein the polymer component comprises any one of the following: at least one type of monomer, at least one type of partially polymerized polymer, and combinations thereof.

12. The method of any one of the preceding claims, wherein the polymer component is cured into at least one type of polyurethane by the water and catalyst.

13. The method of any one of the preceding claims, wherein the fluid binding agent comprises a liquid polyurethane component.

14. The method of claim 13, wherein the liquid polyurethane component comprises an NCO terminal polymer, which may comprise a pre-polymer, a polymeric isocyanate, an oligomeric isocyanate, a monomer, and a mixture thereof.

15. The method of claim 13 or 14, wherein the liquid polyurethane component comprises an aromatic diisocyanate of the group of toluene diisocyanate and/or methylene- 2,2 -diisocyanate.

16. The method of claim 13, 14, or 15, wherein the liquid polyurethane component comprises an aliphatic diisocyanate of the group hexamethylene diisocyanate, isophorone diisocyanate, and/or 1,4-cyclohexyldiisocyanate.

17. The method of any one of claims 13 through 16, wherein the liquid polyurethane component comprises an methylenediphenyl-isocyanate isomer mixture.

18. The method of any one of claims 13 through 17, wherein the liquid polyurethane component comprises a hydroxyl component, wherein the hydroxyl component is selected from the group of polyether polyol or polyester polyol.

5 19. The method of claim 18, wherein the hydroxyl component is based on a polyetherpolyol with a molecular weight between 500 and 10000, preferably the molecular weight is between 1500 and 6000, and more preferably the molecular weight is between 2000 and 4000.

10 20. The method of any one of the preceding claims, wherein the catalyst belongs to any one of the following groups: a secondary amine catalyst, a tertiary amine catalyst, and a metal organic catalyst.

15 21. The method of any one of the preceding claims, wherein the method further comprises drying the subsequent composition before providing the granulate as the artificial turf infill.

22. The method of any one of the preceding claims, wherein the method is at least partially performed in a flow reactor (1100).

20

23. The method of any one of claims 1 through 10, wherein the method is at least partially performed as a batch process (1000), wherein the initial coating is formed on the granulate during an initial batch, and wherein the subsequent coating is formed on the granulate during a subsequent batch.

25

24. The method of any one of the preceding claims, wherein any one of the following:

- the at least one first type of pigment is identical with the at least one second type of pigment, and

30 - the at least one first type of pigment is a different color from the at least one second type of pigment.

25. The method of any one of the preceding claims, wherein the initial coating and the subsequent coating each have a thickness of less than any one of the following: 0.1 mm, 0.075 mm, 0.05 mm, and 0.01 mm.

5 26. A method of manufacturing artificial turf (600), wherein the method further comprises:

- installing (900) an artificial turf carpet (500), wherein the artificial turf carpet comprises multiple artificial turf fiber tufts (504); and
- providing (902) the artificial turf by spreading a layer of artificial turf infill (602) between the multiple artificial turf fiber tufts, wherein the artificial turf infill comprises granulate, wherein the granulate comprises at least two outer coatings (200, 300, 400), wherein one of the at least two outer coatings comprises at least one first type of pigment and a binding agent, wherein the other of the at least two outer coatings comprises at least one second type of pigment and the binding agent, wherein the binding agent comprises at least one type of polyurethane polymer.

27. The method of claim 26, wherein the at least two outer coatings each comprise gaps (202).

28. Artificial turf infill (602), wherein the artificial turf infill comprises granulate, wherein the granulate comprises at least two outer coatings (200, 300, 400), wherein one of the at least two outer coatings comprises at least one first type of pigment and a binding agent, wherein the other of the at least two outer coatings comprises at least one second type of pigment and the binding agent, wherein the binding agent comprises at least one type of polyurethane polymer.

29. The artificial turf infill of claim 28, wherein the at least two outer coatings each comprise gaps (202).

30. An artificial turf (600), wherein the artificial turf comprises:

- an artificial turf carpet (500), wherein the artificial turf carpet comprises multiple artificial turf fiber tufts (504); and

- artificial turf infill (602) spread between the multiple artificial fiber tufts, wherein the artificial turf infill comprises a granulate (602), wherein the granulate comprises at least two outer coatings (200, 300, 400), wherein one of the at least two outer coatings comprises at least one first type of pigment and a binding agent, wherein the other of the at least two outer coatings comprises at least one second type of pigment and the binding agent, wherein the binding agent comprises at least one type of polyurethane polymer.

31. The artificial turf infill of claim 30, wherein the at least two outer coatings each
10 comprise gaps (202).

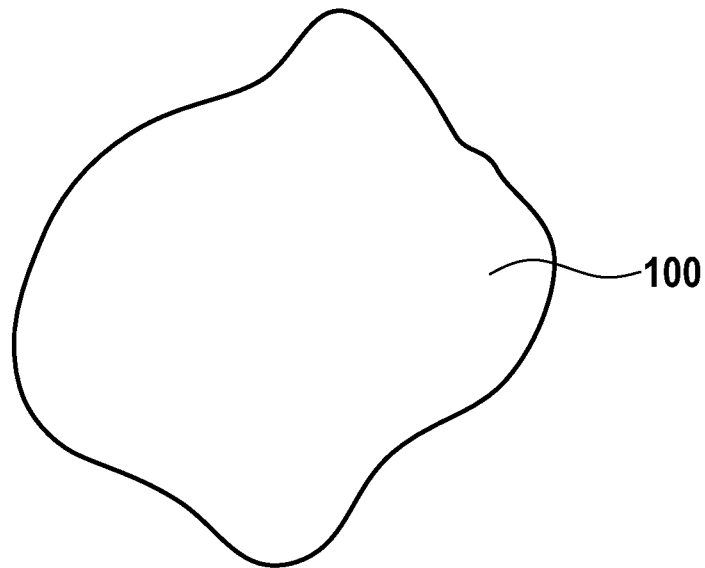
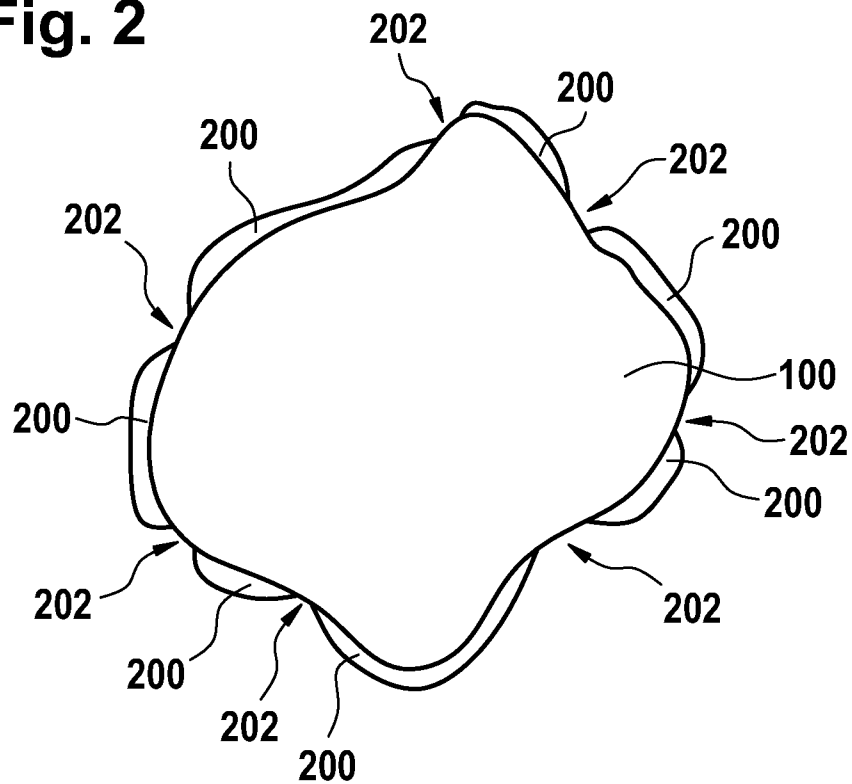
Fig. 1**Fig. 2**

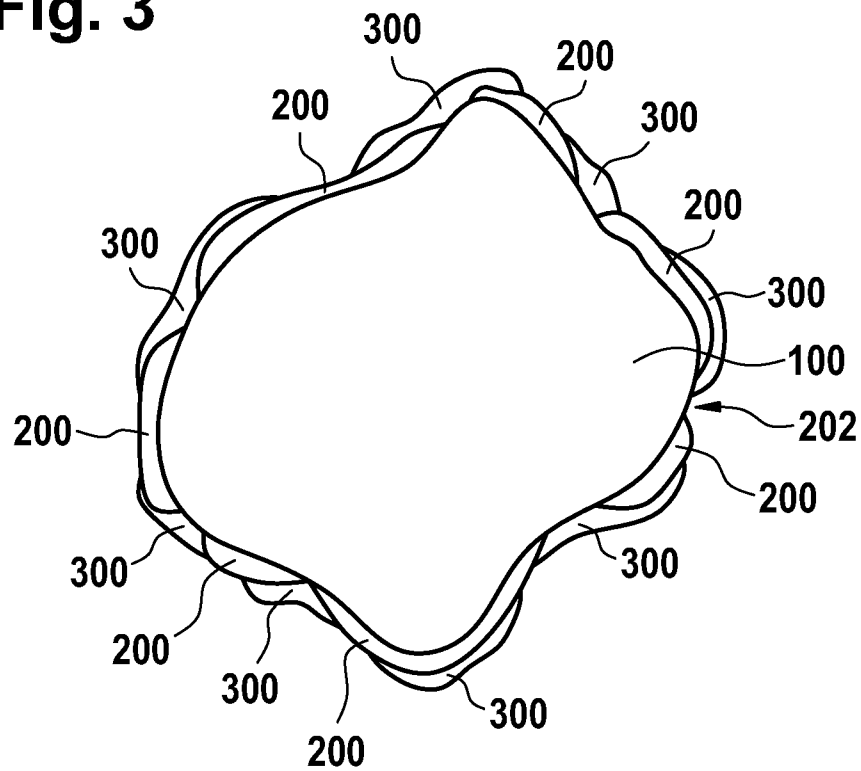
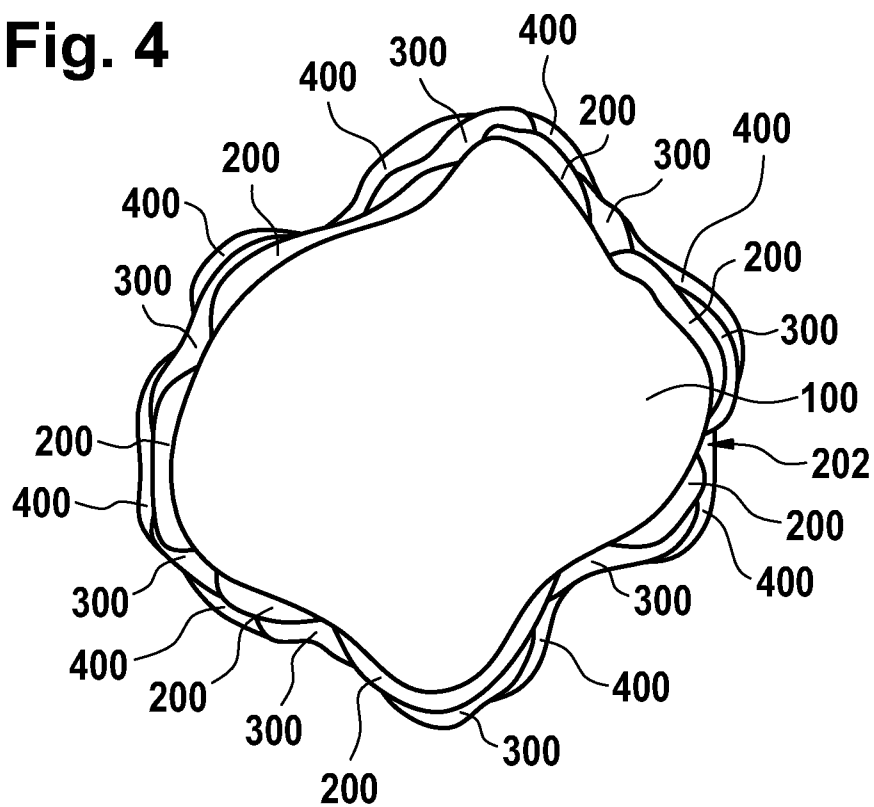
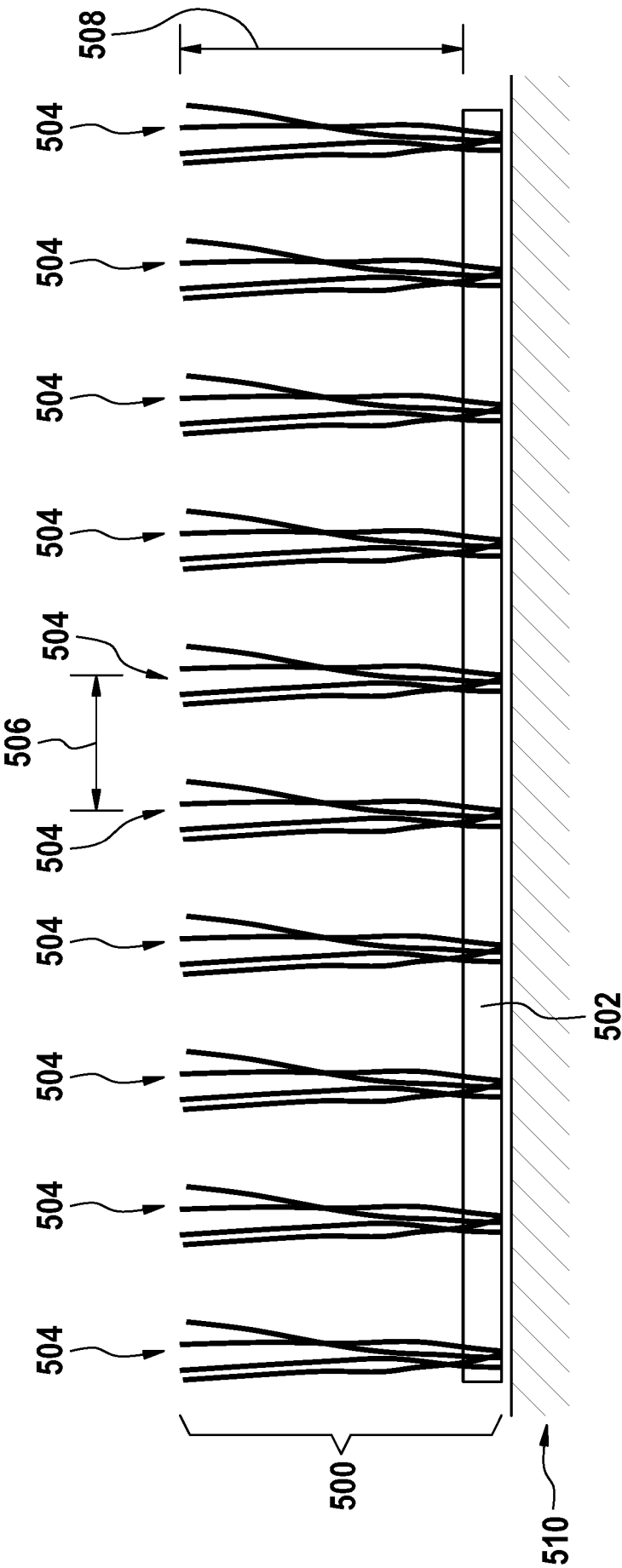
Fig. 3**Fig. 4**

Fig. 5



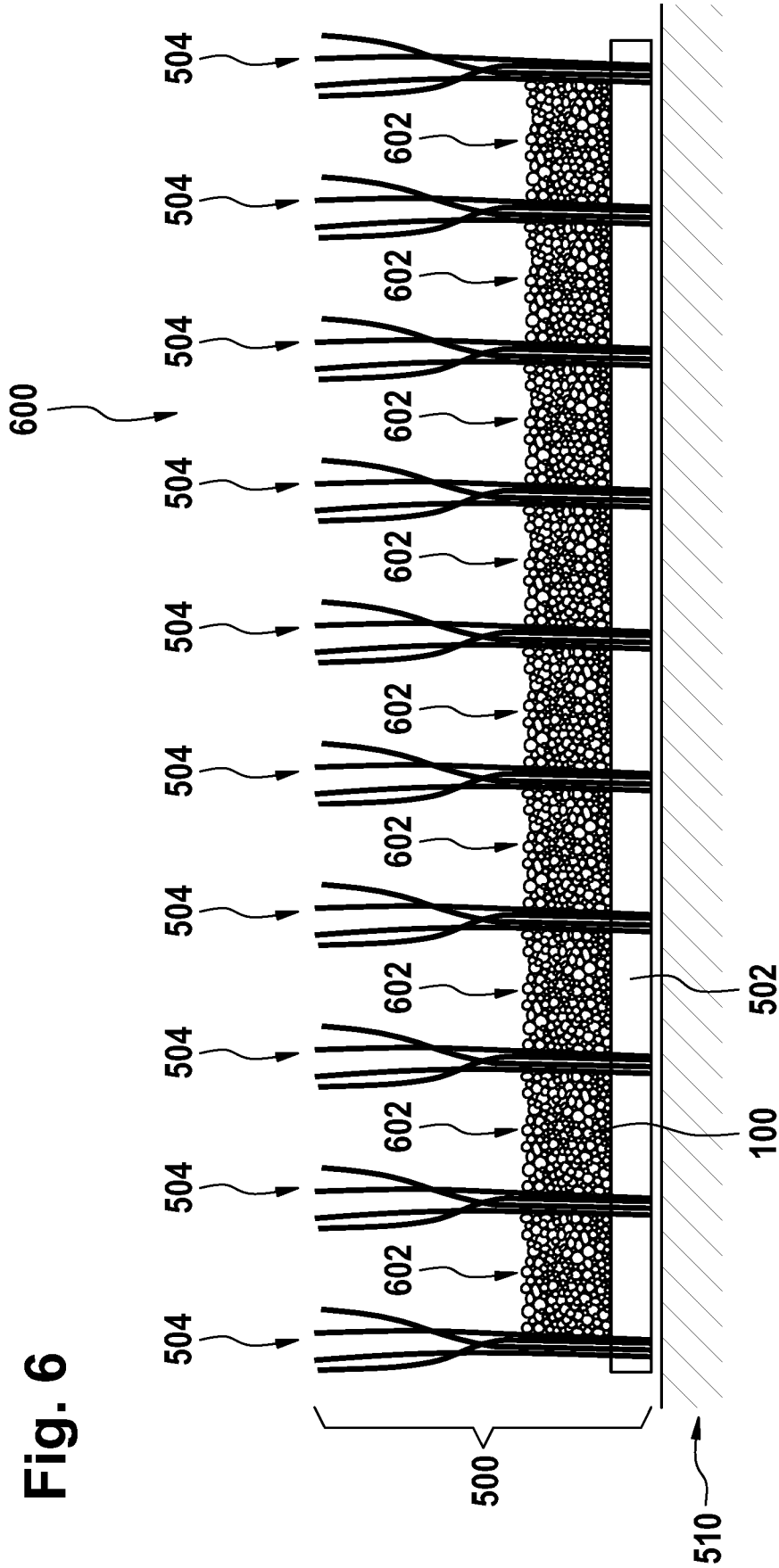


Fig. 6

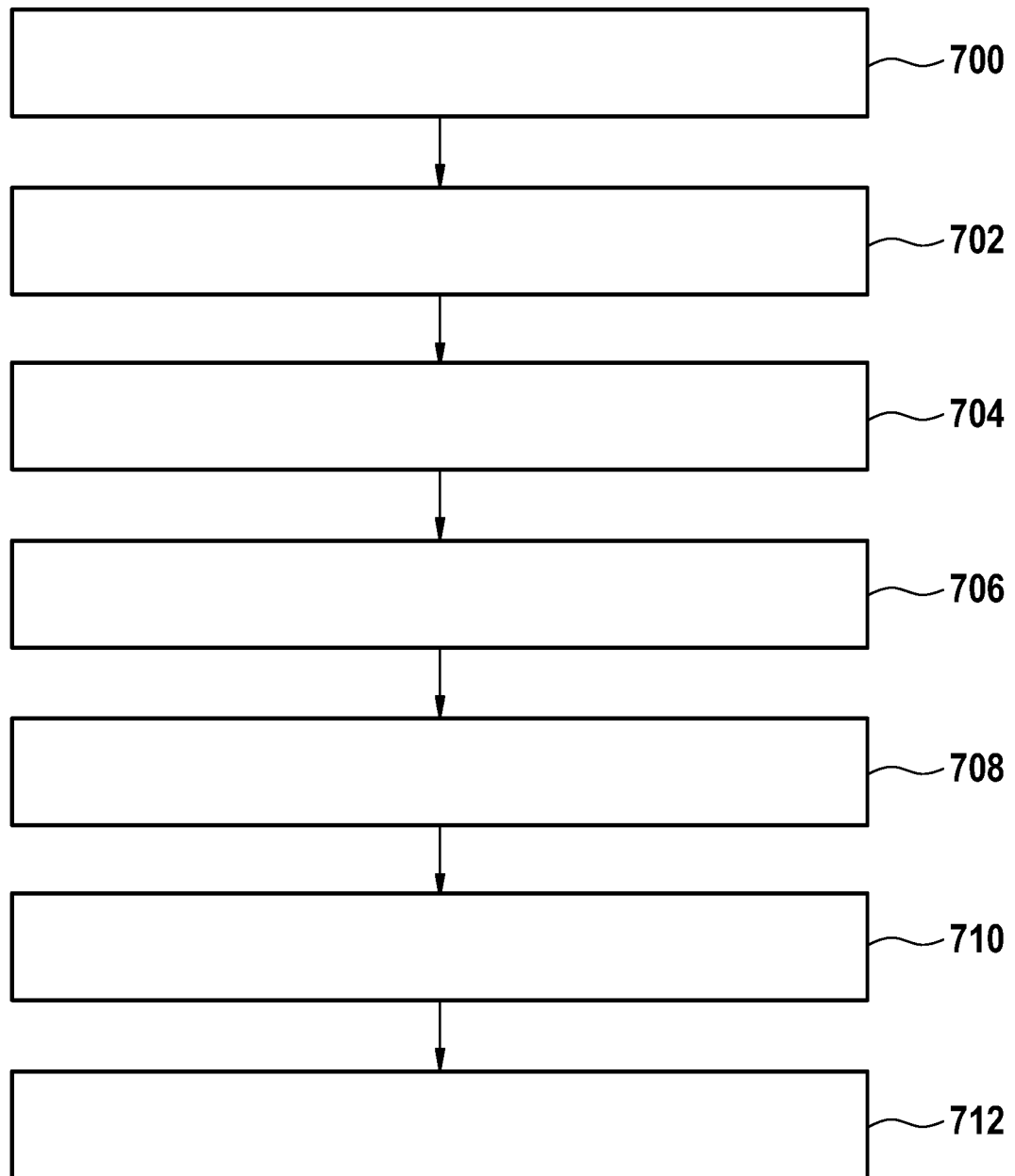
Fig. 7

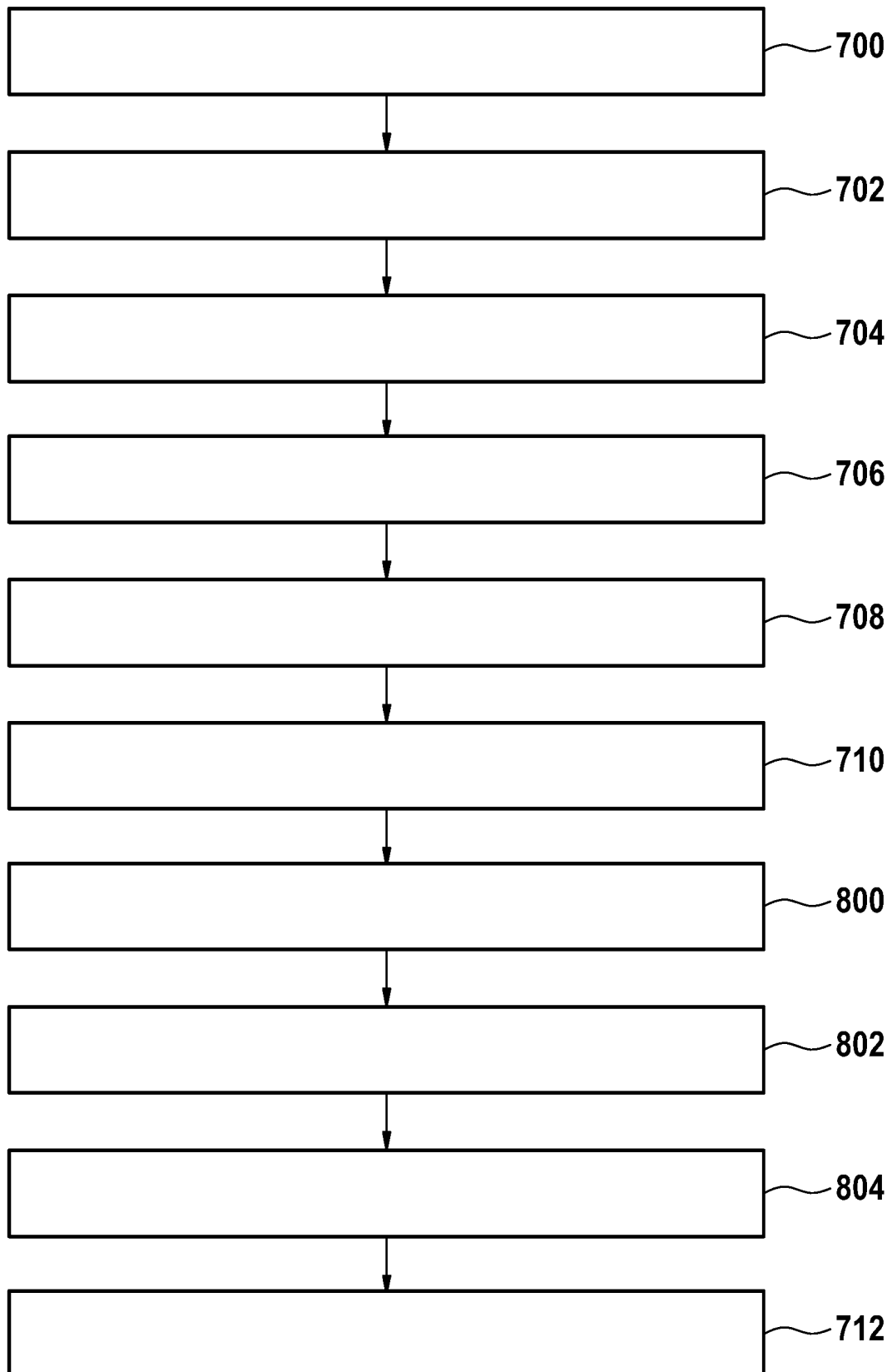
Fig. 8

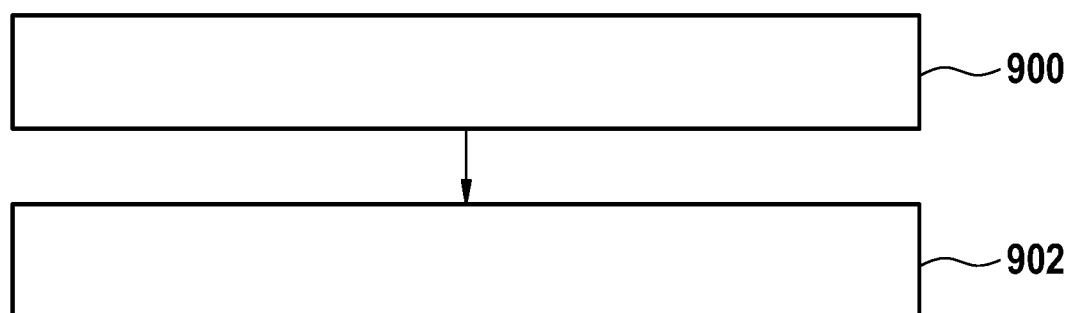
Fig. 9

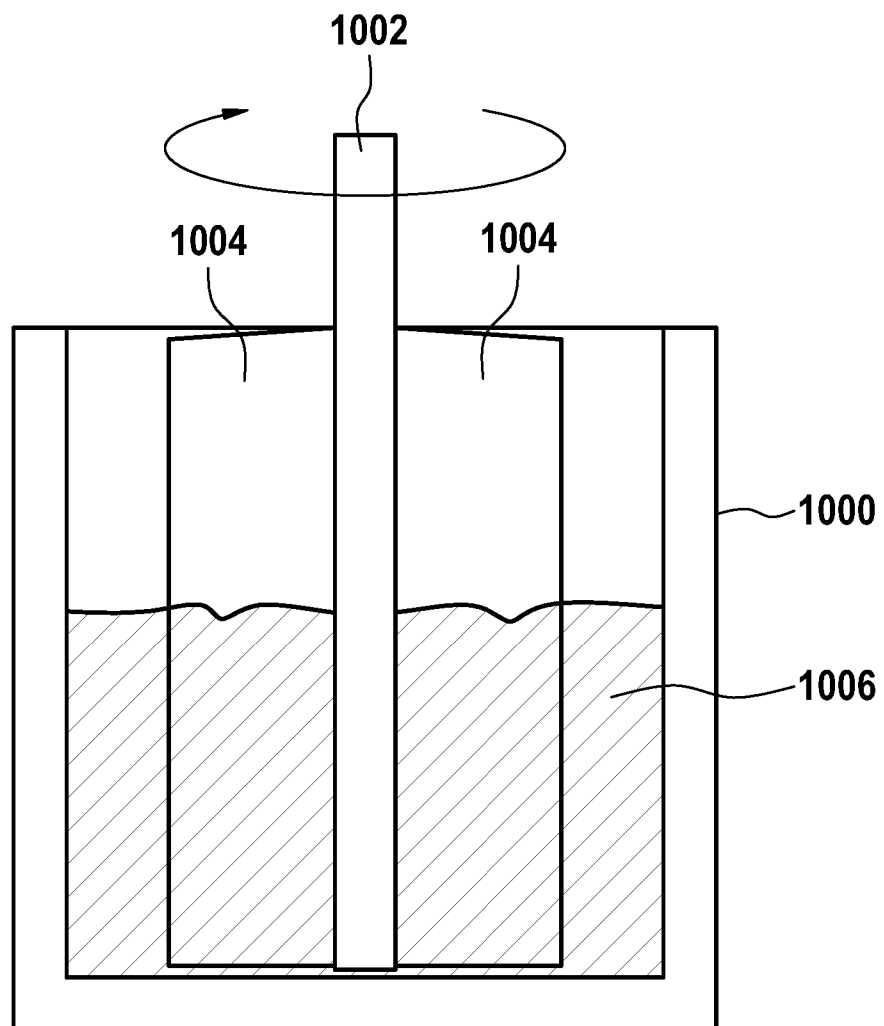
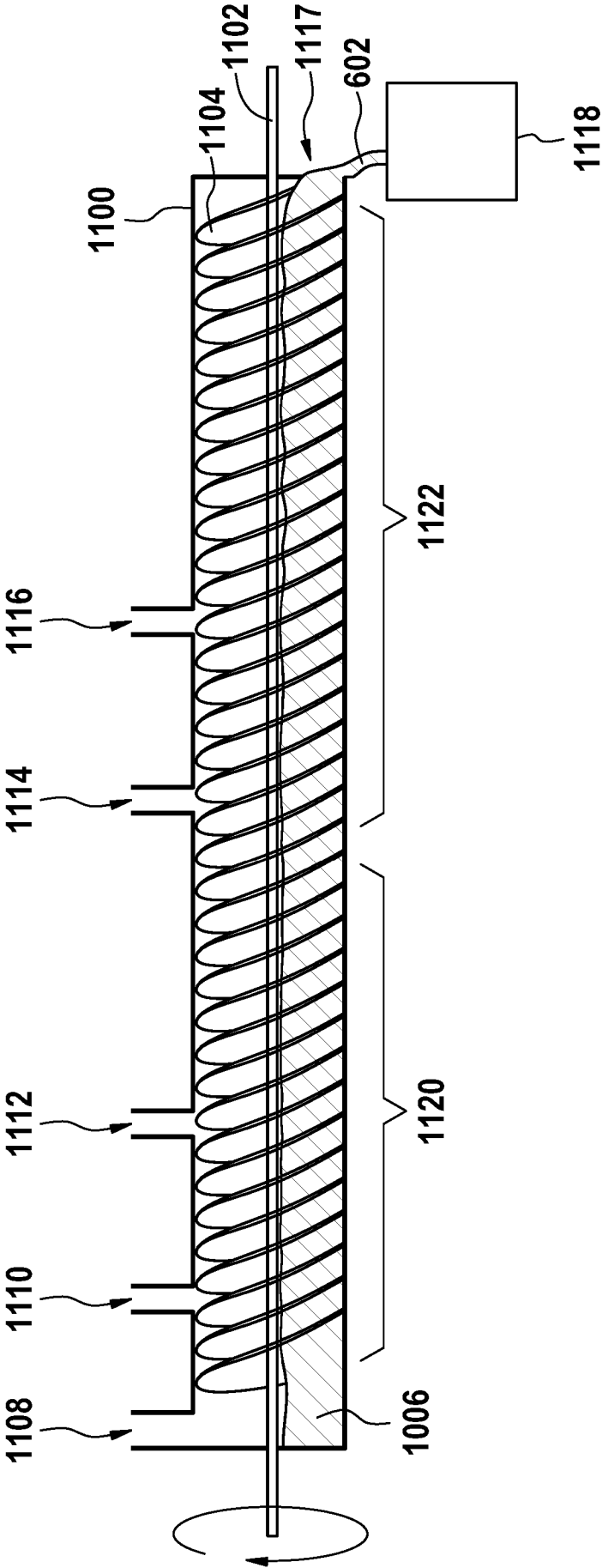
Fig. 10

Fig. 11



301J2/00	International application No PCT/EP2017/054964	
A. CLASSIFICATION OF SUBJECT MATTER INV. C08J3/12 E01C13/08 E ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) C08J E01C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EP0-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 201 388 A2 (MURAYAMA TOSHIYA [JP]) 2 May 2002 (2002-05-02) paragraphs [0001], [0021], [0024] - [0027], [0030] - [0033], [0035], [0040], [0043]; claims 1,2,5 -----	1-27
Y	WO 2010/081632 A1 (EVONIK DEGUSSA GMBH [DE]; BERLINEANU ANDREAS [DE]; LUCE KIRSTEN [DE];) 22 July 2010 (2010-07-22) page 1, lines 8-11; claims 1,9,11,12,17 page 6, lines 24-29 page 7, lines 10-27 page 8, line 23 - page 9, line 9 pages 25-42 ----- -/--	1-31
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 27 April 2017		Date of mailing of the international search report 10/05/2017
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Pamies Olle, Silvia

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/054964

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 2004/080709 A2 (GROUNDSCAPE TECHNOLOGIES LLC [US]; COFFEY GERALD P [US]) 23 September 2004 (2004-09-23) page 3, lines 3-5; claims 1,2,4,8,9,11,18,32 -----	1-31

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Information on patent family members

International application No

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