

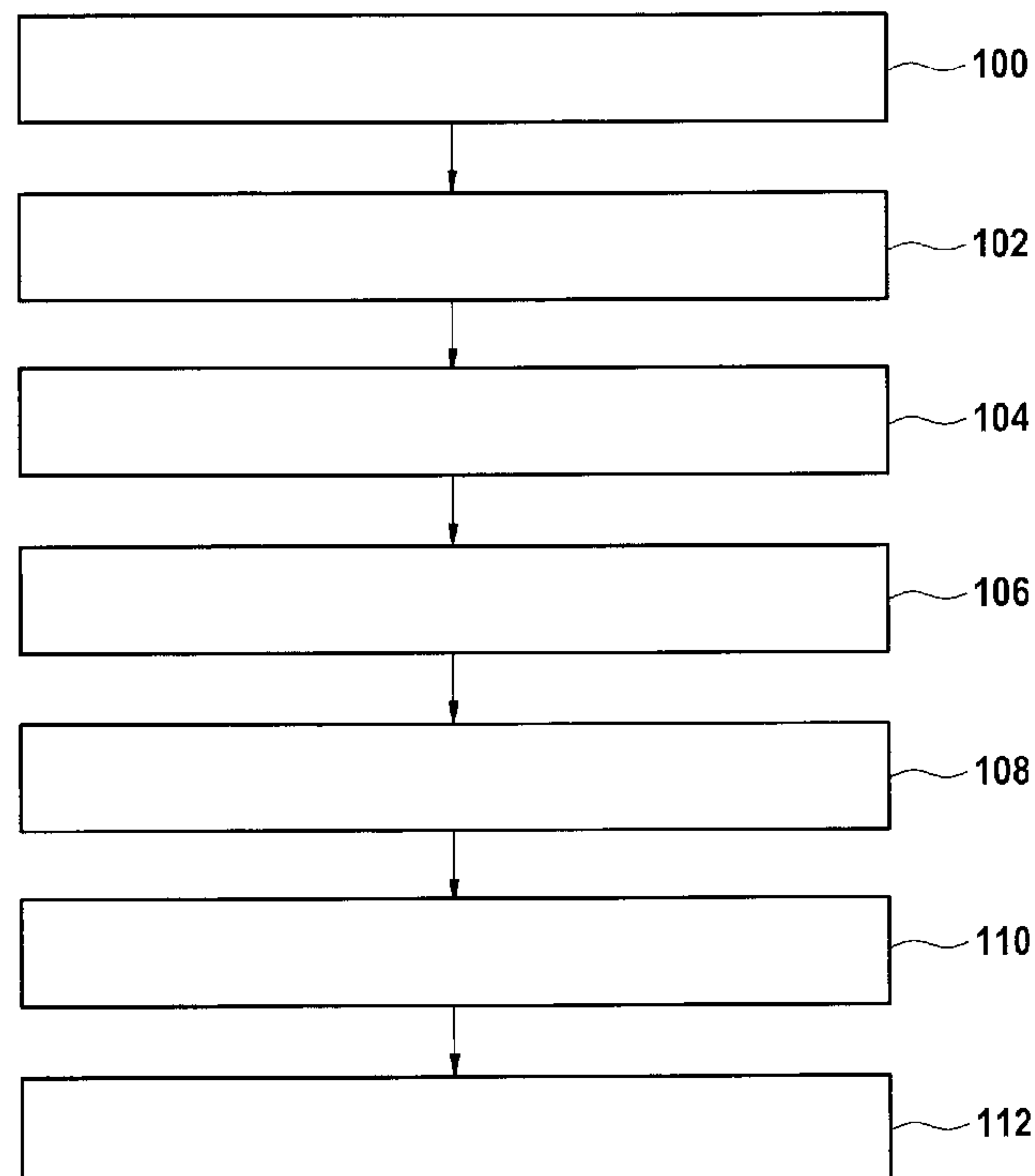


(86) **Date de dépôt PCT/PCT Filing Date:** 2014/03/27
(87) **Date publication PCT/PCT Publication Date:** 2015/10/01
(85) **Entrée phase nationale/National Entry:** 2016/09/21
(86) **N° demande PCT/PCT Application No.:** EP 2014/056149
(87) **N° publication PCT/PCT Publication No.:** 2015/144223

(51) **Cl.Int./Int.Cl. E01C 13/08** (2006.01),
D01F 1/10 (2006.01), **D01F 6/46** (2006.01),
D01F 6/90 (2006.01), **D01F 6/92** (2006.01)
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(54) **Titre : GAZON ARTIFICIEL ET SON PROCEDE DE PRODUCTION**
(54) **Title: ARTIFICIAL TURF AND PRODUCTION METHOD**

Fig. 1



(57) **Abrégé/Abstract:**

The invention provides for a method of manufacturing artificial turf (1000). The method comprising the steps of: creating (100) a polymer mixture (100, 400, 500), wherein the polymer mixture is at least a three-phase system, wherein the polymer mixture

(57) Abrégé(suite)/Abstract(continued):

comprises a first polymer (402), a second polymer (404), and a compatibilizer (406), wherein the first polymer and the second polymer are immiscible, wherein the first polymer forms polymer beads (408) surrounded by the compatibilizer within the second polymer; extruding (102) the polymer mixture into a monofilament (606); quenching (104) the monofilament; reheating (106) the monofilament; stretching (108) the reheated monofilament to deform the polymer beads into threadlike regions (800) and to form the monofilament into an artificial turf fiber (1004); incorporating (110) the artificial turf fiber into an artificial turf carpet (1002).

- (51) International Patent Classification:
E01C 13/08 (2006.01) *D01F 6/92* (2006.01)
D01F 6/46 (2006.01) *D01F 1/10* (2006.01)
D01F 6/90 (2006.01)

(21) International Application Number:
PCT/EP2014/056149

(22) International Filing Date:
27 March 2014 (27.03.2014)

(25) Filing Language: English

(26) Publication Language: English

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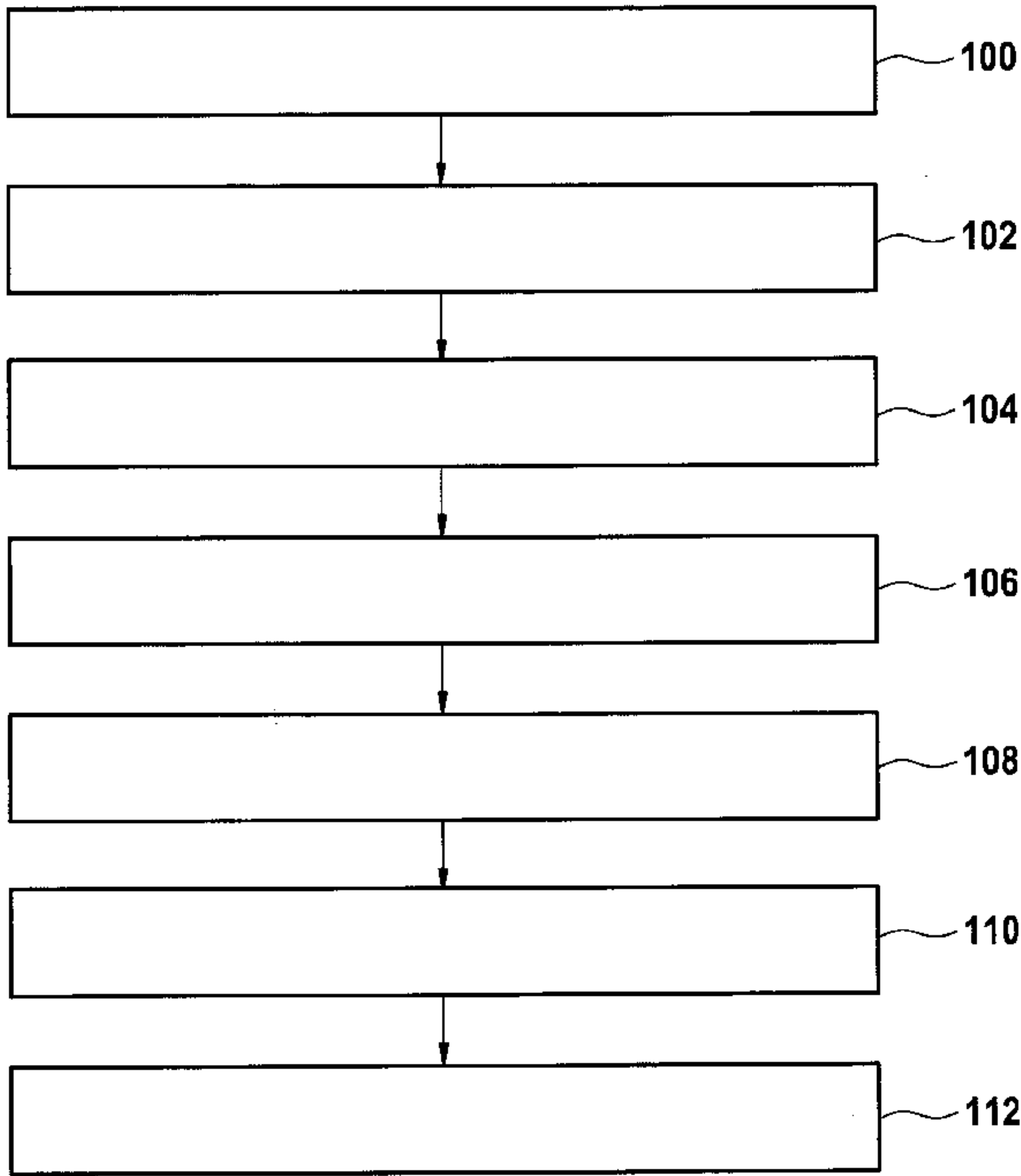
(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

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(54) Title: ARTIFICIAL TURF AND PRODUCTION METHOD

Fig. 1



(57) Abstract: The invention provides for a method of manufacturing artificial turf (1000). The method comprising the steps of: creating (100) a polymer mixture (100, 400, 500), wherein the polymer mixture is at least a three-phase system, wherein the polymer mixture comprises a first polymer (402), a second polymer (404), and a compatibilizer (406), wherein the first polymer and the second polymer are immiscible, wherein the first polymer forms polymer beads (408) surrounded by the compatibilizer within the second polymer; extruding (102) the polymer mixture into a monofilament (606); quenching (104) the monofilament; reheating (106) the monofilament; stretching (108) the reheated monofilament to deform the polymer beads into threadlike regions (800) and to form the monofilament into an artificial turf fiber (1004); incorporating (110) the artificial turf fiber into an artificial turf carpet (1002).

WO 2015/144223 A1



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, **Published:**
KM, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

Artificial Turf and production method

Description

Field of the invention

- 5 The invention relates to artificial turf and the production of artificial turf which is also referred to as synthetic turf. The invention further relates to the production of fibers that imitate grass, and in particular a product and a production method for artificial turf fibers based on polymer blends and of the artificial turf carpets made from these artificial turf fibers.

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.

An advantage of using artificial turf is that it eliminates the need to care for a grass playing or landscaping surface, like regular mowing, scarifying, fertilizing and watering. Watering can be e.g. difficult due to regional restrictions for water usage. In other climatic zones the re-growing of grass and re-formation of a closed grass cover is slow compared to the damaging of the natural grass surface by playing and/or exercising on the field. Artificial turf fields though they do not require a similar attention and effort to be maintained, may require some maintenance such as having to be cleaned from dirt and debris and having to be brushed regularly. This may be done to help fibers stand-up after being stepped down during the play or exercise. Throughout the typical usage time of 5-15 years it may be beneficial if an artificial turf sports field can withstand high mechanical wear, can resist UV, can withstand thermal cycling or thermal ageing, can resist inter-actions with chemicals and various environmental conditions. It is therefore beneficial if the artificial turf has a long usable life, is durable, and keeps its playing and surface characteristics as well as appearance throughout its usage time.

United States Patent application US 2010/0173102 A1 discloses an artificial grass that is characterized in that the material for the cladding has a hyprophilicity which is different from the hyprophilicity of the material which is used for the core.

Summary

The invention provides for a method of manufacturing artificial turf in the independent claims. Embodiments are given in the dependent claims.

In one aspect the invention provides for a method of manufacturing artificial turf carpet. The method comprises the step of creating a polymer mixture. The polymer mixture as used herein encompasses a mixture of different types of polymers and also possibly with various additives added to the polymer mixture. The term 'polymer mixture' may also be replaced with the term 'master batch' or 'compound batch'. The polymer mixture is at least a three-phase system. A three-phase system as used herein encompasses a mixture that separates out into at least three distinct phases. The polymer mixture comprises a first polymer, a second polymer, and a compatibilizer. These three items form the phases of the three-phase system. If there are additional polymers or compatibilizers added to the system then the three-phase system may be increased to a four, five, or more phase system. The first polymer and the second polymer are immiscible. The first polymer forms polymer beads surrounded by the compatibilizer within the second polymer.

The method further comprises the step of extruding the polymer mixture into a monofilament. To perform this extrusion the polymer mixture may for instance be heated. The method further comprises the step of quenching the monofilament. In this step the monofilament is cooled. The method further comprises the step of reheating the monofilament. The method further comprises the step of stretching the reheated filament to deform the polymer beads into thread-like regions and to form the monofilament into an artificial turf fiber. In this step the monofilament is stretched. This causes the monofilament to become longer and in the process the polymer beads are stretched and elongated. Depending upon the amount of stretching the polymer beads are elongated more.

The method further comprises the step of incorporating the artificial turf fiber into an artificial turf backing. In some examples the artificial turf backing is a textile or a textile matt.

The incorporation of the artificial turf fiber into the artificial turf backing could for example be performed by tufting the artificial turf fiber into an artificial turf backing and binding the tufted artificial turf fibers to the artificial turf backing. For instance the artificial turf fiber may be inserted with a needle into the backing and tufted the

way a carpet may be. If loops of the artificial turf fiber are formed then may be cut during the same step. The method further comprises the step of binding the artificial turf fibers to the artificial turf backing. In this step the artificial turf fiber is bound or attached to the artificial turf backing. This may be performed in a variety of ways
5 such as gluing or coating the surface of the artificial turf backing to hold the artificial turf fiber in position. This for instance may be done by coating a surface or a portion of the artificial turf backing with a material such as latex or polyurethane.

The incorporation of the artificial turf fiber into the artificial turf backing could for
10 example be performed alternatively by weaving the artificial turf fiber into artificial turf backing (or fiber mat) during manufacture of the artificial turf carpet. This technique of manufacturing artificial turf is known from United States patent application US 20120125474 A1.

15 The term 'polymer bead' or 'beads' may refer to a localized region, such as a droplet, of a polymer that is immiscible in the second polymer. The polymer beads may in some instances be round or spherical or oval-shaped, but they may also be irregularly-shaped. In some instances the polymer bead will typically have a size of approximately 0.1 to 3 micrometer, preferably 1 to 2 micrometer in diameter. In other
20 examples the polymer beads will be larger. They may for instance have a size with a diameter of a maximum of 50 micrometer.

In some examples the stretched monofilament may be used directly as the artificial turf fiber. For example the monofilament could be extruded as a tape or other
25 shape.

In other examples the artificial turf fiber may be a bundle or group of several stretched monofilament fibers is in general cabled, twisted, or bundled together. In some cases the bundle is rewound with a so called rewinding yarn, which keeps the
30 yarn bundle together and makes it ready for the later tufting or weaving process.

The monofilaments may for instance have a diameter of 50-600 micrometer in size. The yarn weight may typically reach 50- 3000 dtex.

Embodiments may have the advantage that the second polymer and any immiscible polymers may not delaminate from each other. The thread-like regions are embedded within the second polymer. It is therefore impossible for them to delaminate. The use of the first polymer and the second polymer enables the properties of the artificial turf fiber to be tailored. For instance a softer plastic may be used for the second polymer to give the artificial turf a more natural grass-like and softer feel. A more rigid plastic may be used for the first polymer or other immiscible polymers to give the artificial turf more resilience and stability and the ability to spring back after being stepped or pressed down.

A further advantage may possibly be that the thread-like regions are concentrated in a central region of the monofilament during the extrusion process. This leads to a concentration of the more rigid material in the center of the monofilament and a larger amount of softer plastic on the exterior or outer region of the monofilament.

This may further lead to an artificial turf fiber with more grass-like properties.

A further advantage may be that the artificial turf fibers have improved long term elasticity. This may require reduced maintenance of the artificial turf and require less brushing of the fibers because they more naturally regain their shape and stand up after use or being trampled.

In another embodiment the polymer bead comprises crystalline portions and amorphous portions. The polymer mixture was likely heated during the extrusion process and portions of the first polymer and also the second polymer may have a

more amorphous structure or a more crystalline structure in various regions.

Stretching the polymer beads into the thread-like regions may cause an increase in the size of the crystalline portions relative to the amorphous portions in the first polymer. This may lead for instance to the first polymer to become more rigid than when it has an amorphous structure. This may lead to an artificial turf with more rigidity and ability to spring back when pressed down. The stretching of the monofilament may also cause in some cases the second polymer or other additional polymers also to have a larger portion of their structure become more crystalline.

In a specific example of this the first polymer could be polyamide and the second polymer could be polyethylene. Stretching the polyamide will cause an increase in the crystalline regions making the polyamide stiffer. This is also true for other plastic polymers.

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In another embodiment the creating of the polymer mixture comprises the step of forming a first mixture by mixing the first polymer with the compatibilizer. The creation of the polymer mixture further comprises the step of heating the first mixture. The step of creating the polymer mixture further comprises the step of extruding the first mixture. The creating of the polymer mixture further comprises the step of extruding the first mixture. The creation of the polymer mixture further comprises the steps of granulating the extruded first mixture. The creating of the polymer mixture further comprises the step of mixing the granulated first mixture with the second polymer. The creation of the polymer mixture further comprises the step of heating the granulated first mixture with the second polymer to form the polymer mixture. This particular method of creating the polymer mixture may be advantageous because it enables very precise control over how the first polymer and compatibilizer are distributed within the second polymer. For instance the size or shape of the extruded first mixture may determine the size of the polymer beads in the polymer mixture.

20

In the aforementioned method of creating the polymer mixture for instance a so called one-screw extrusion method may be used. As an alternative to this the polymer mixture may also be created by putting all of the components that make it up together at once. For instance the first polymer, the second polymer and the compatibilizer could be all added together at the same time. Other ingredients such as additional polymers or other additives could also be put together at the same time. The amount of mixing of the polymer mixture could then be increased for instance by using a two-screw feed for the extrusion. In this case the desired distribution of the polymer beads can be achieved by using the proper rate or amount of mixing.

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In another embodiment the polymer mixture is at least a four-phase system. The polymer mixture comprises at least a third polymer. The third polymer is immiscible

with the second polymer. The third polymer further forms the polymer beads surrounded by the compatibilizer within the second polymer.

In another embodiment the creating of the polymer mixture comprises the step of forming a first mixture by mixing the first polymer and the third polymer with the compatibilizer. The creating of the polymer mixture further comprises the step of heating the first mixture. The creating of the polymer mixture first comprises the step of extruding the first mixture. The creating of the polymer mixture further comprises the step of granulating the extruded first mixture. The creating of the polymer mixture further comprises mixing the first mixture with the second polymer. The creating of the polymer mixture further comprises the step of heating the first mixture with the second polymer to form the polymer mixture. This method may provide for a precise means of making the polymer mixture and controlling the size and distribution of the polymer beads using two different polymers. As an alternative the first polymer could be used to make a granulate with the compatibilizer separately from making the third polymer with the same or a different compatibilizer. The granulates could then be mixed with the second polymer to make the polymer mixture.

As an alternative to this the polymer mixture could be made by adding the first polymer, a second polymer, the third polymer and the compatibilizer all together at the same time and then mixing them more vigorously. For instance a two-screw feed could be used for the extruder.

In another embodiment the third polymer is a polar polymer.

In another embodiment the third polymer is polyamide.

In another embodiment the third polymer is polyethylene terephthalate, which is also commonly abbreviated as PET.

In another embodiment the third polymer is polybutylene terephthalate, which is also commonly abbreviated as PBT.

In another embodiment the polymer mixture comprises between 1% and 30% by weight the first polymer and the third polymer combined. In this example the balance of the weight may be made up by such components as the second polymer, the compatibilizer, and any other additional additives put into the polymer mixture.

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In another embodiment the polymer mixture comprises between 1 and 20% by weight of the first polymer and the third polymer combined. Again, in this example the balance of the weight of the polymer mixture may be made up by the second polymer, the compatibilizer, and any other additional additives.

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In another embodiment the polymer mixture comprises between 5% and 10% by weight of the first polymer and the third polymer combined. Again in this example the balance of the weight of the polymer mixture may be made up by the second polymer, the compatibilizer, and any other additional additives.

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In another embodiment the polymer mixture comprises between 1% and 30% by weight the first polymer. In this example the balance of the weight may be made up for example by the second polymer, the compatibilizer, and any other additional additives.

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In another embodiment the polymer mixture comprises between 1% and 20% by weight of the first polymer. In this example the balance of the weight may be made up by the second polymer, the compatibilizer, and any other additional additives mixed into the polymer mixture.

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In another embodiment the polymer mixture comprises between 5% and 10% by weight of the first polymer. This example may have the balance of the weight made up by the second polymer, the compatibilizer, and any other additional additives mixed into the polymer mixture.

30

In another embodiment the first polymer is a polar polymer.

In another embodiment the first polymer is polyamide.

In another embodiment the first polymer is polyethylene terephthalate which is commonly known by the abbreviation PET.

5 In another embodiment the first polymer is polybutylene terephthalate which is also known by the common abbreviation PBT.

In another embodiment the second polymer is a non-polar polymer.

10 In another embodiment the second polymer is polyethylene.

In another embodiment the second polymer is polypropylene.

15 In another embodiment the second polymer is a mixture of the aforementioned polymers which may be used for the second polymer.

In another embodiment the compatibilizer is any one of the following: a maleic acid grafted on polyethylene or polyamide; a maleic anhydride grafted on free radical initiated graft copolymer of polyethylene, SEBS, EVA, EPD, or polypropylene with an unsaturated acid or its anhydride such as maleic acid, glycidyl methacrylate, ricinoloxazoline maleinate; a graft copolymer of SEBS with glycidyl methacrylate, a graft copolymer of EVA with mercaptoacetic acid and maleic anhydride; a graft copolymer of EPDM with maleic anhydride; a graft copolymer of polypropylene with maleic anhydride; a polyolefin-graft-polyamidepolyethylene or polyamide; and a polyacrylic acid type compatibilizer.

25 In another embodiment the polymer mixture comprises between 80-90% by weight of the second polymer. In this example the balance of the weight may be made up by the first polymer, possibly the second polymer if it is present in the polymer mixture, the compatibilizer, and any other chemicals or additives added to the
30 polymer mixture.

In another embodiment the polymer mixture further comprises any one of the following: a wax, a dulling agent, a ultraviolet stabilizer, a flame retardant, an anti-oxidant, a pigment, and combinations thereof. These listed additional components

may be added to the polymer mixture to give the artificial turf fibers other desired properties such as being flame retardant, having a green color so that the artificial turf more closely resembles grass and greater stability in sunlight.

5 In another embodiment creating the artificial turf fiber comprises weaving the monofilament into the artificial turf fiber. That is to say in some examples the artificial turf fiber is not a single monofilament but a combination of a number of fibers.

10 In another embodiment the artificial turf fiber is a yarn.

In another embodiment the method further comprises bundling stretched monofilaments together to create the artificial turf fiber.

15 In another embodiment the method further comprises weaving, bundling, or spinning multiple monofilaments together to create the artificial turf fiber. Multiple, for example 4 to 8 monofilaments, could be formed or finished into a yarn.

In another aspect the invention provides for an artificial turf manufacture according
20 to any one of the aforementioned methods.

In another aspect the invention provides for an artificial turf comprising an artificial turf backing and artificial turf fiber tufted into the artificial turf backing. The artificial turf backing may for instance be a textile or other flat structure which is able to have
25 fibers tufted into it. The artificial turf fiber comprises at least one monofilament. Each of the at least one monofilament comprises a first polymer in the form of thread-like regions. Each of the at least one monofilament comprises a second polymer, wherein the thread-like regions are embedded in the second polymer. Each of the at least one monofilaments comprises a compatibilizer surrounding each of the thread-
30 like regions and separating the at least one first polymer from the second polymer. This artificial turf may have the advantage of being extremely durable because the thread-like regions are embedded within the second polymer via a compatibilizer. They therefore do not have the ability to delaminate. Having the second polymer surrounding the first polymer may provide for a stiff artificial turf that is soft and feels

similar to real turf. The artificial turf as described herein is distinct from artificial turf which is coextruded. In coextrusion a core of typically 50 to 60 micrometer may be surrounded by an outer cover or sheathing material which has a diameter of approximately 200 to 300 micrometer in diameter. In this artificial turf there is a large number of thread-like regions of the first polymer. The thread-like regions may not continue along the entire length of the monofilament. The artificial turf may also have properties or features which are provided for by any of the aforementioned method steps.

10 In another embodiment the thread-like regions have a diameter of less than 20 micrometer.

In another embodiment the thread-like regions have a diameter of less than 10 micrometer.

15 In another embodiment the thread-like regions have a diameter of between 1 and 3 micrometer.

In another embodiment the artificial turf fiber extends a predetermined length beyond the artificial turf backing. The thread-like regions have a length less than one half of the predetermined length.

In another embodiment the thread-like regions have a length of less than 2 mm.

25 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.

Brief description of the drawings

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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 shows a flowchart which illustrates an example of a method of manufacturing artificial turf;

Fig. 2 shows a flowchart which illustrates one method of creating the polymer mixture;

Fig. 3 shows a flowchart which illustrates a further example of how to create a polymer mixture;

5 Fig. 4 shows a diagram which illustrates a cross-section of a polymer mixture;

Fig. 5 shows a further example of a polymer mixture;

Fig. 6 illustrates the extrusion of the polymer mixture into a monofilament;

Fig. 7 shows a cross-section of a small segment of the monofilament;

Fig. 8 illustrates the effect of stretching the monofilament;

10 Fig. 9 shows an electron microscope picture of a cross-section of a stretched monofilament; and

Fig. 10 shows an example of a cross-section of an example of artificial turf.

Detailed Description

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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.

20 Fig. 1 shows a flowchart which illustrates an example of a method of manufacturing artificial turf. First in step 100 a polymer mixture is created. The polymer mixture is at least a three-phase system. The polymer mixture comprises a first polymer. The polymer mixture further comprises a second polymer and a compatibilizer. The first polymer and the second polymer are immiscible. In other examples there may be
25 additional polymers such as a third, fourth, or even fifth polymer that are also immiscible with the second polymer. There also may be additional compatibilizers which are used either in combination with the first polymer or the additional third, fourth, or fifth polymer. The first polymer forms polymer beads surrounded by the compatibilizer. The polymer beads may also be formed by additional polymers
30 which are not miscible in the second polymer.

The polymer beads are surrounded by the compatibilizer and are within the second polymer or mixed into the second polymer. In the next step 102 the polymer mixture is extruded into a monofilament. Next in step 104 the monofilament is quenched or

rapidly cooled down. Next in step 106 the monofilament is reheated. In step 108 the reheated monofilament is stretched to deform the polymer beads into thread-like regions and to form the monofilament into the artificial turf fiber. Additional steps may also be performed on the monofilament to form the artificial turf fiber. For instance the monofilament may be spun or woven into a yarn with desired properties. Next in step 110 the artificial turf fiber is incorporated into an artificial turf backing. Step 110 could for example be, but is not limited to, tufting or weaving the artificial turf fiber into the artificial turf backing. Then in step 112 the artificial turf fibers are bound to the artificial turf backing. For instance the artificial turf fibers may be glued or held in place by a coating or other material. Step 112 is an optional step. For example if the artificial turf fibers are woven into the artificial turf backing step 112 may not need to be performed.

Fig. 2 shows a flowchart which illustrates one method of creating the polymer mixture. In this example the polymer mixture is a three-phase system and comprises the first polymer, a second polymer and the compatibilizer. The polymer mixture may also comprise other things such as additives to color or provide flame or UV-resistance or improve the flowing properties of the polymer mixture. First in step 200 a first mixture is formed by mixing the first polymer with the compatibilizer. Additional additives may also be added during this step. Next in step 202 the first mixture is heated. Next in step 204 the first mixture is extruded. Then in step 206 the extruded first mixture is then granulated or chopped into small pieces. Next in step 208 the granulated first mixture is mixed with the second polymer. Additional additives may also be added to the polymer mixture at this time. Finally in step 210 the granulated first mixture is heated with the second polymer to form the polymer mixture. The heating and mixing may occur at the same time.

Fig. 3 shows a flowchart which illustrates a further example of how to create a polymer mixture 100. In this example the polymer mixture additionally comprises at least a third polymer. The third polymer is immiscible with the second polymer and the polymer mixture is at least a four-phase system. The third polymer further forms the polymer beads surrounded by the compatibilizer with the second polymer. First in step 300 a first mixture is formed by mixing the first polymer and the third polymer with the compatibilizer. Additional additives may be added to the first mixture at this

point. Next in step 302 the first mixture is heated. The heating and the mixing of the first mixture may be done at the same time. Next in step 304 the first mixture is extruded. Next in step 306 the extruded first mixture is granulated or chopped into tiny pieces. Next in step 308 the first mixture is mixed with the second polymer.

- 5 Additional additives may be added to the polymer mixture at this time. Then finally in step 310 the heated first mixture and the second polymer are heated to form the polymer mixture. The heating and the mixing may be done simultaneously.

Fig. 4 shows a diagram which illustrates a cross-section of a polymer mixture 400.

- 10 The polymer mixture 400 comprises a first polymer 402, a second polymer 404, and a compatibilizer 406. The first polymer 402 and the second polymer 404 are immiscible. The first polymer 402 is less abundant than the second polymer 404. The first polymer 402 is shown as being surrounded by compatibilizer 406 and being dispersed within the second polymer 404. The first polymer 402 surrounded by the compatibilizer 406 forms a number of polymer beads 408. The polymer beads 408
15 may be spherical or oval in shape or they may also be irregularly-shaped depending up on how well the polymer mixture is mixed and the temperature. The polymer mixture 400 is an example of a three-phase system. The three phases are the regions of the first polymer 402. The second phase region is the compatibilizer 406 and the third phase region is the second polymer 404. The compatibilizer 406
20 separates the first polymer 402 from the second polymer 406.

Fig. 5 shows a further example of a polymer mixture 500. The example shown in Fig. 5 is similar to that shown in Fig. 4 however, the polymer mixture 500

- 25 additionally comprises a third polymer 502. Some of the polymer beads 408 are now comprised of the third polymer 502. The polymer mixture 500 shown in Fig. 5 is a four-phase system. The four phases are made up of the first polymer 402, the second polymer 404, the third polymer 502, and the compatibilizer 406. The first polymer 402 and the third polymer 502 are not miscible with the second polymer
30 404. The compatibilizer 406 separates the first polymer 402 from the second polymer 404 and the third polymer 502 from the second polymer 404.

In this example the same compatibilizer 406 is used for both the first polymer 402 and the third polymer 502. In other examples a different compatibilizer 406 could be used for the first polymer 402 and the third polymer 502.

- 5 Fig. 6 illustrates the extrusion of the polymer mixture into a monofilament. Shown is an amount of polymer mixture 600. Within the polymer mixture 600 there is a large number of polymer beads 408. The polymer beads 408 may be made of one or more polymers that is not miscible with the second polymer 404 and is also separated from the second polymer 404 by a compatibilizer. A screw, piston or other
10 device is used to force the polymer mixture 600 through a hole 604 in a plate 602. This causes the polymer mixture 600 to be extruded into a monofilament 606. The monofilament 606 is shown as containing polymer beads 408 also. The second polymer 404 and the polymer beads 408 are extruded together. In some examples the second polymer 404 will be less viscous than the polymer beads 408 and the
15 polymer beads 408 will tend to concentrate in the center of the monofilament 606. This may lead to desirable properties for the final artificial turf fiber as this may lead to a concentration of the thread-like regions in the core region of the monofilament 606.
- 20 Fig. 7 shows a cross-section of a small segment of the monofilament 606. The monofilament is again shown as comprising the second polymer 404 with the polymer beads 408 mixed in. The polymer beads 408 are separated from the second polymer 404 by compatibilizer 406 which is not shown. To form the thread-like structures a section of the monofilament 606 is heated and then stretched along
25 the length of the monofilament 606. This is illustrated by the arrows 700 which show the direction of the stretching.

Fig. 8 illustrates the effect of stretching the monofilament 606. In Fig. 8 an example of a cross-section of a stretched monofilament 606 is shown. The polymer beads
30 408 in Fig. 7 have been stretched into thread-like structures 800. The amount of deformation of the polymer beads 408 would be dependent upon how much the monofilament 606' has been stretched.

Examples may relate to the production of artificial turf which is also referred to as synthetic turf. In particular, the invention relates to the production of fibers that imitate grass. The fibers are composed of first and second polymers that are not miscible and differ in material characteristics as e.g. stiffness, density, polarity and a compatibilizer.

In a first step, a first polymer is mixed with the a compatibilizer. Color pigments, UV and thermal stabilizers, process aids and other substances that are as such known from the art can be added to the mixture. This may result in granular material which consist of a two phase system in which the first polymer is surrounded by the compatibilizer.

In a second step, a three-phase system is formed by adding the second polymer to the mixture whereby in this example the quantity of the second polymer is about 80-90 mass percent of the three-phase system, the quantities of the first polymer being 5% to 10% by mass and of the compatibilizer being 5% to 10% by mass. Using extrusion technology results in a mixture of droplets or of beads of the first polymer surrounded by the compatibilizer that is dispersed in the polymer matrix of the second polymer. In a practical implementation a so called master batch including granulate of the first polymer and the compatibilizer is formed. The master batch may also be referred to as a "polymer mixture" herein. The granulate mix is melted and a mixture of the first polymer and the compatibilizer is formed by extrusion. The resulting strands are crushed into granulate. The resultant granulate and granulate of the second polymer are then used in a second extrusion to produce the thick fiber which is then stretched into the final fiber.

The melt temperature used during extrusions is dependent upon the type of polymers and compatibilizer that is used. However the melt temperature is typically between 230°C and 280°C.

A monofilament, which can also be referred to as a filament or fibrillated tape, is produced by feeding the mixture into an fiber producing extrusion line. The melt mixture is passing the extrusion tool, i.e., a spinneret plate or a wide slot nozzle, forming the melt flow into a filament or tape form, is quenched or cooled in a water

spin bath, dried and stretched by passing rotating heated godets with different rotational speed and/or a heating oven.

5 The monofilament or type is then annealed online in a second step passing a further heating oven and/or set of heated godets.

By this procedure the beads or droplets of polymer 1, surrounded by the compatibilizer are stretched into longitudinal direction and form small fiber like, linear structures which stay however completely embedded into the polymer matrix
10 of the second polymer.

Fig. 9 shows a microscopic picture of a cross-section of a stretched monofilament manufactured using an example of a method described above. The horizontal white streaks within the stretched monofilament 606 are the thread-like structures 800.
15 Several of these thread-like structures are labeled 800. The thread-like structures 800 can be shown as forming small linear structures of the first polymer within the second polymer.

The resultant fiber may have multiple advantages, namely softness combined with
20 durability and long term elasticity. In case of different stiffness and bending properties of the polymers the fiber can show a better resilience (this means that once a fiber is stepped down it will spring back) In case of a stiff first polymer, the small linear fiber structures built in the polymer matrix are providing a polymer reinforcement of the fiber.

25 Delimitation due to the composite formed by the first and second polymers is prevented due to the fact that the short fibers of the second polymer are embedded in the matrix given by the first polymer. Moreover, complicated coextrusion, requiring several extrusion heads to feed one complex spinneret tool is not needed.

30 The first polymer can be a polar substance, such as polyamide, whereas the second polymer can be a non-polar polymer, such as polyethylene. Alternatives for the first polymer are polyethylene terephthalate (PET) or polybutylene terephthalate (PBT) for the second polymer polypropylene. Finally a material consisting of 3 polymers is

possible (e.g. PET, PA and PP, with PP creating the matrix and the other creating independent from each other fibrous linear structures. The compatibilizer can be a maleic anhydride grafted on polyethylene or polyamide.

- 5 Fig. 10 shows an example of a cross-section of an example of artificial turf 1000. The artificial turf 1000 comprises an artificial turf backing 1002. Artificial turf fiber 1004 has been tufted into the artificial turf backing 1002. On the bottom of the artificial turf backing 1002 is shown a coating 1006. The coating may serve to bind or secure the artificial turf fiber 1004 to the artificial turf backing 1002. The coating
- 10 1006 may be optional. For example the artificial turf fibers 1004 may be alternatively woven into the artificial turf backing 1002. Various types of glues, coatings or adhesives could be used for the coating 1006. The artificial turf fibers 1004 are shown as extending a distance 1008 above the artificial turf backing 1002. The distance 1008 is essentially the height of the pile of the artificial turf fibers 1004. The
- 15 length of the thread-like regions within the artificial turf fibers 1004 is half of the distance 1008 or less.

List of reference numerals

	100	create a polymer mixture
5	102	extrude the polymer mixture into a monofilament
	104	quench the monofilament
	106	reheat the monofilament
10	108	stretch the reheated monofilament to deform the polymer beads into threadlike regions and to form the monofilament into an artificial turf fiber
	110	incorporate the artificial turf fiber into an artificial turf carpet
	112	optionally bind the artificial turf fibers to the artificial turf carpet
15	200	form a first mixture by mixing the first polymer with the compatibilizer
	202	heat the first mixture
	204	extrude the first mixture
	206	granulate the extruded first mixture
20	208	mix the granulated first mixture with the second polymer
	210	heat the granulated first mixture with the second polymer to form the polymer mixture
	300	form a first mixture by mixing the first polymer and the third polymer with the compatibilizer
25	302	heat the first mixture
	304	extrude the first mixture
	306	granulate the extruded first mixture
	308	mix the first mixture with the second polymer
30	310	heat the mixed first mixture with the second polymer to form the polymer mixture
	400	polymer mixture
	402	first polymer
	404	second polymer
	406	compatibilizer

	408	polymer bead
	500	polymer mixture
	502	third polymer
	600	polymer mixture
5	602	plate
	604	hole
	606	monofilament
	606'	stretched monofilament
	700	direction of stretching
10	800	threadlike structures
	1000	artificial turf
	1002	artificial turf carpet
	1004	artificial turf fiber (pile)
	1006	coating
15	1008	height of pile

New Claims

-
1. A method of manufacturing artificial turf (1000), the method comprising the steps of:
 - 5 - creating (100) a polymer mixture (100, 400, 500), wherein the polymer mixture is at least a three-phase system, wherein the polymer mixture comprises a first polymer (402), a second polymer (404), and a compatibilizer (406), wherein the first polymer and the second polymer are immiscible, wherein the first polymer forms polymer beads (408) surrounded
 - 10 by the compatibilizer within the second polymer;
 - extruding (102) the polymer mixture into a monofilament (606);
 - quenching (104) the monofilament;
 - reheating (106) the monofilament;
 - stretching (108) the reheated monofilament to deform the polymer beads
 - 15 into threadlike regions (800) and to form the monofilament into an artificial turf fiber (1004), wherein forming the artificial turf fiber comprises forming the stretched monofilament into a yarn; and
 - incorporating (110) the artificial turf fiber into an artificial turf backing (1002).
 - 20 2. The method of claim 1, wherein the polymer bead comprises crystalline portions and amorphous portions, wherein stretching the polymer beads into threadlike regions causes an increase in the size of the crystalline portions relative to the amorphous portions.
 - 25 3. The method of claim 1 or 2, wherein the creating of the polymer mixture comprises the steps of:
 - forming (200) a first mixture by mixing the first polymer with the compatibilizer;
 - heating (202) the first mixture;
 - 30 - extruding (204) the first mixture;
 - granulating (206) the extruded first mixture;
 - mixing (208) the granulated first mixture with the second polymer; and
 - heating (210) the granulated first mixture with the second polymer to form the polymer mixture.

4. The method of claim 1 or 2, wherein the polymer mixture is at least a four phase system, wherein the polymer mixture comprises at least a third polymer (502), wherein the third polymer is immiscible with the second polymer, wherein the third polymer further forms the polymer beads surrounded by the compatibilizer within the second polymer.
5. The method of claim 4, wherein the creating of the polymer mixture comprises the steps of:
- forming (300) a first mixture by mixing the first polymer and the third polymer with the compatibilizer;
 - heating (302) the first mixture;
 - extruding (304) the first mixture;
 - granulating (306) the extruded first mixture;
 - mixing (308) the first mixture with the second polymer; and
 - heating (310) the mixed first mixture with the second polymer to form the polymer mixture.
6. The method of claim 4 or 5, wherein the third polymer is a polar polymer.
7. The method of any one of claims 4 to 6, wherein the third polymer is any one of the following: polyamide, polyethylene terephthalate (PET), and polybutylene terephthalate (PBT).
8. The method of any one of claims 4 to 7, wherein the polymer mixture comprises 1 to 30 percent by weight the first polymer and the third polymer combined.
9. The method of any one of claims 4 to 7, wherein the polymer mixture comprises 1 to 20 percent by weight the first polymer and the third polymer combined.
10. The method of any one of claim 4 to 7, wherein the polymer mixture comprises 5 to 10 percent by weight the first polymer and the third polymer combined.

11. The method of claim 1, 2, or 3, wherein the polymer mixture comprises 1 to 30 percent by weight the first polymer.
- 5 12. The method of claim 1, 2, or 3, wherein the polymer mixture comprises 1 to 20 percent by weight the first polymer.
13. The method of claim 1, 2, or 3, wherein the polymer mixture comprises 5 to 10 percent by weight the first polymer.
- 10 14. The method of any one of the preceding claims, wherein the first polymer is a polar polymer.
- 15 15. The method of any one of the preceding claims, wherein the first polymer is any one of the following: polyamide, polyethylene terephthalate (PET), and polybutylene terephthalate (PBT).
16. The method of any one of the preceding claims, wherein the second polymer is a non-polar polymer.
- 20 17. The method of any one of the preceding claims, wherein the second polymer is any one of the following: polyethylene, polypropylene, and a mixture thereof.
- 25 18. The method of any one of the preceding claims, wherein the compatibilizer is any one of the following: a maleic acid grafted on polyethylene or polyamide; a maleic anhydride grafted on free radical initiated graft copolymer of polyethylene, SEBS, EVA, EPD, or polypropylene with an unsaturated acid or its anhydride such as maleic acid, glycidyl methacrylate, ricinoloazoline maleinate; a graft copolymer of SEBS with glycidyl methacrylate, a graft copolymer of EVA with mercaptoacetic acid and maleic anhydride; a graft copolymer of EPDM with maleic anhydride; a graft copolymer of polypropylene with maleic anhydride; a polyolefin-graft-polyamidepolyethylene or polyamide; and a polyacrylic acid type compatibilizer.
- 30

19. The method of any one of the preceding claims, wherein the polymer mixture comprises 80 to 90 percent by weight the second polymer.
20. The method of any one of the preceding claims, wherein the polymer mixture further comprises any one of the following: a wax, a dulling agent, a UV stabilizer, a flame retardant, an anti-oxidant, a pigment, and combinations thereof.
21. The method of any one of the preceding claims, wherein creating the artificial turf fiber comprises weaving, spinning, twisting, rewinding, and/or bundling the stretched monofilament into the artificial turf fiber.
22. The method of any one of the preceding claims, wherein incorporating the artificial turf fiber into the artificial turf backing comprises: tufting the artificial turf fiber into the artificial turf backing and binding the artificial turf fibers to the artificial turf backing.
23. The method of any one of claims 1 through 21, wherein incorporating the artificial turf fiber into the artificial turf backing comprises weaving the artificial turf fiber into the artificial turf backing.
24. A artificial turf manufactured according to the method of any one of the preceding claims.
25. The artificial turf of claim 24, wherein the threadlike regions have a diameter less than 50 micrometers.
26. The artificial turf of claim 24, wherein the threadlike regions have a diameter less than 10 micrometers.
27. The artificial turf of claim 24, wherein the threadlike regions have a diameter of between 1 and 3 micrometers.
28. The artificial turf of any one of claims 25 to 27, wherein the artificial turf fiber extends a predetermined length (1008) beyond the artificial turf backing, and

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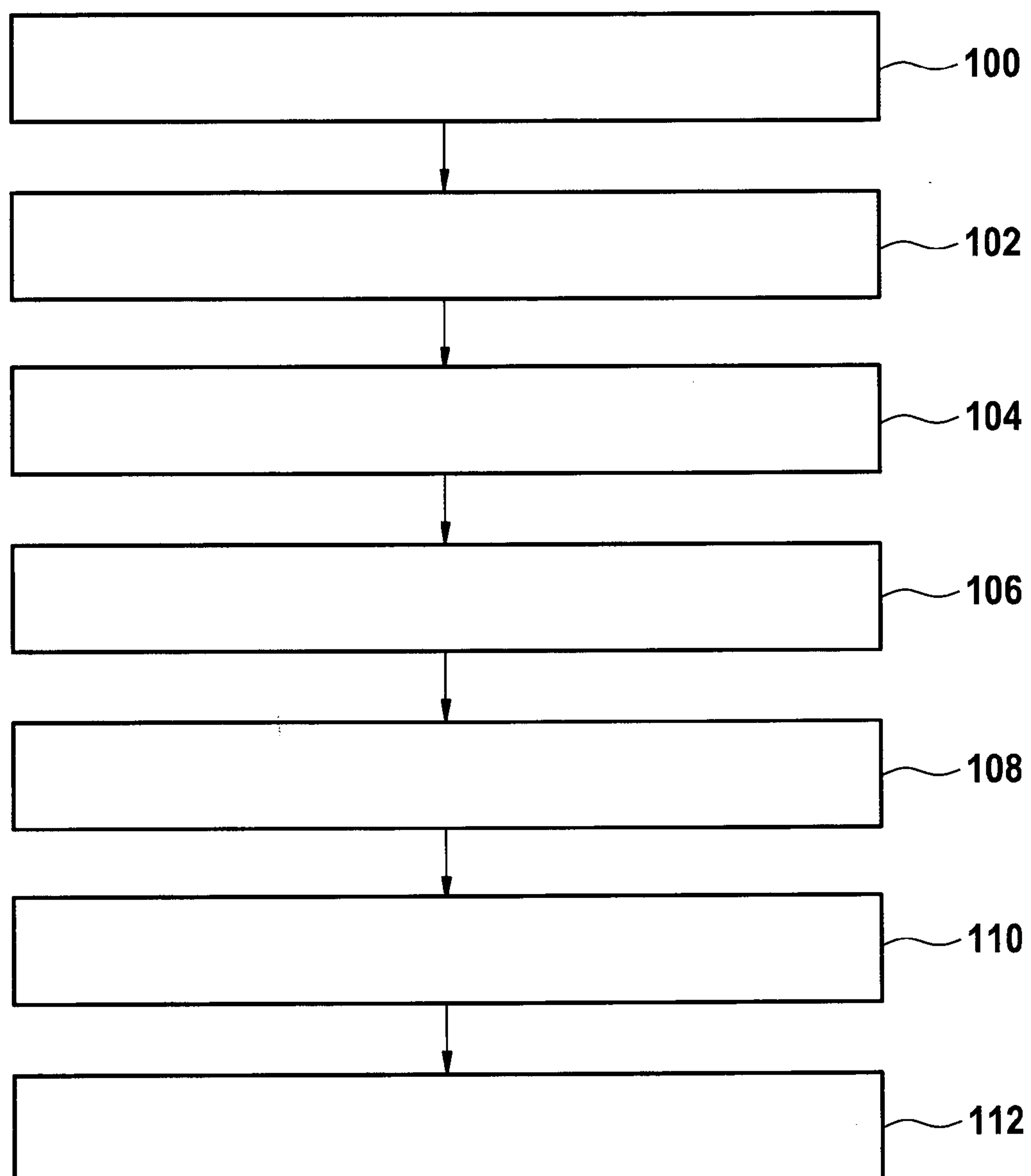
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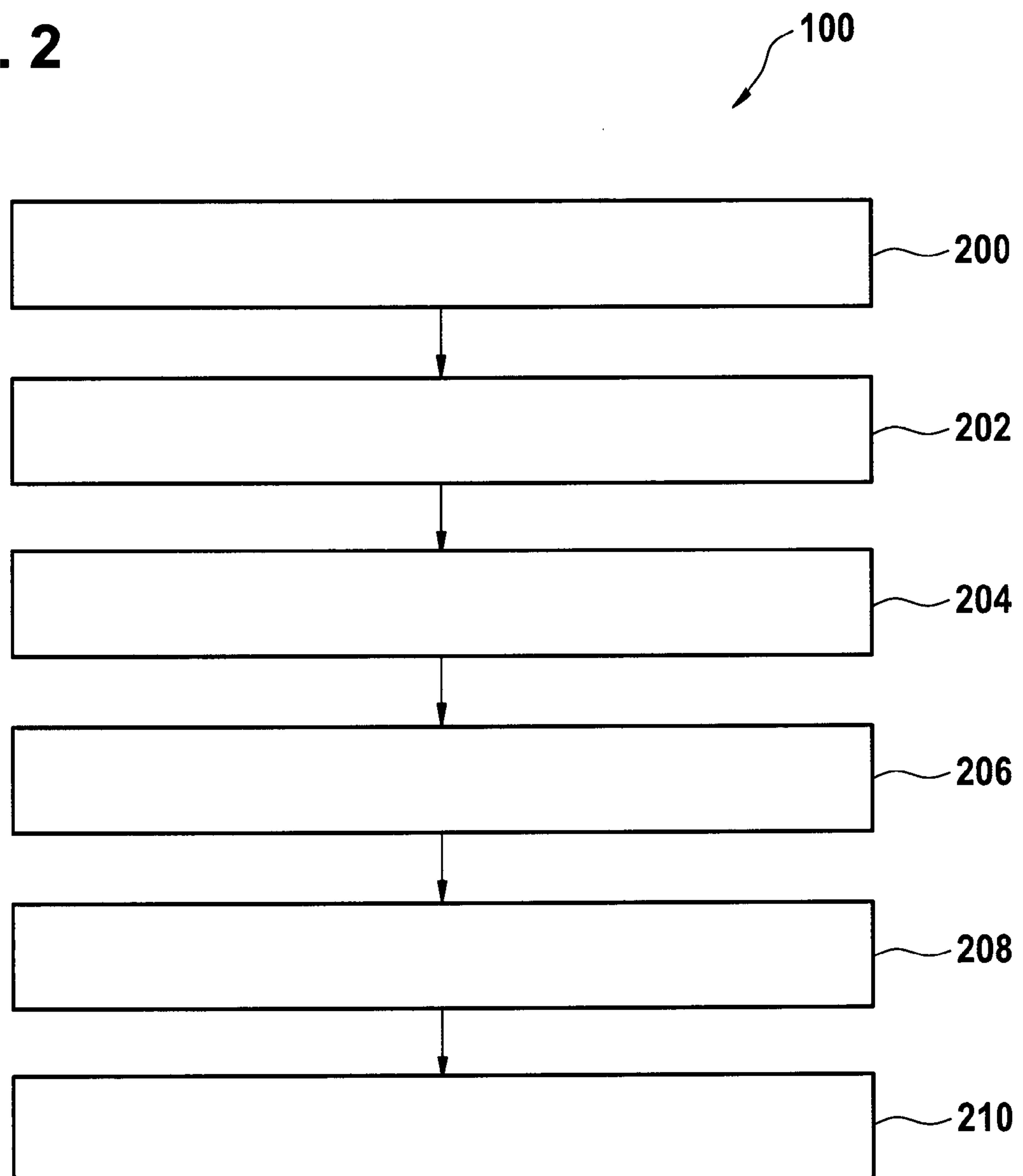
wherein threadlike regions have a length less than one half of the predetermined length.

29. The artificial turf of any one of claims 25 to 27, wherein the threadlike regions
5 have a length less than 2 mm.

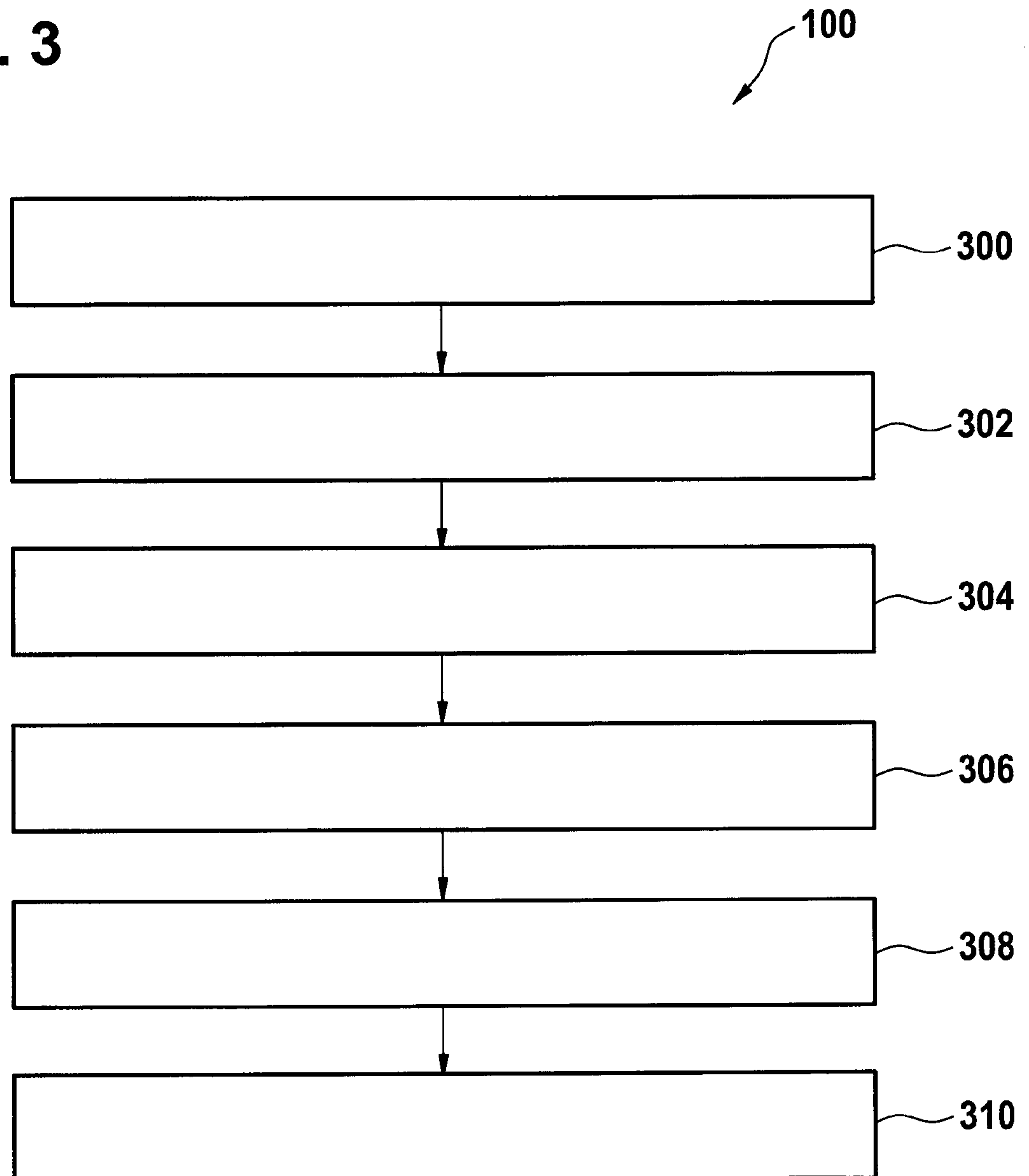
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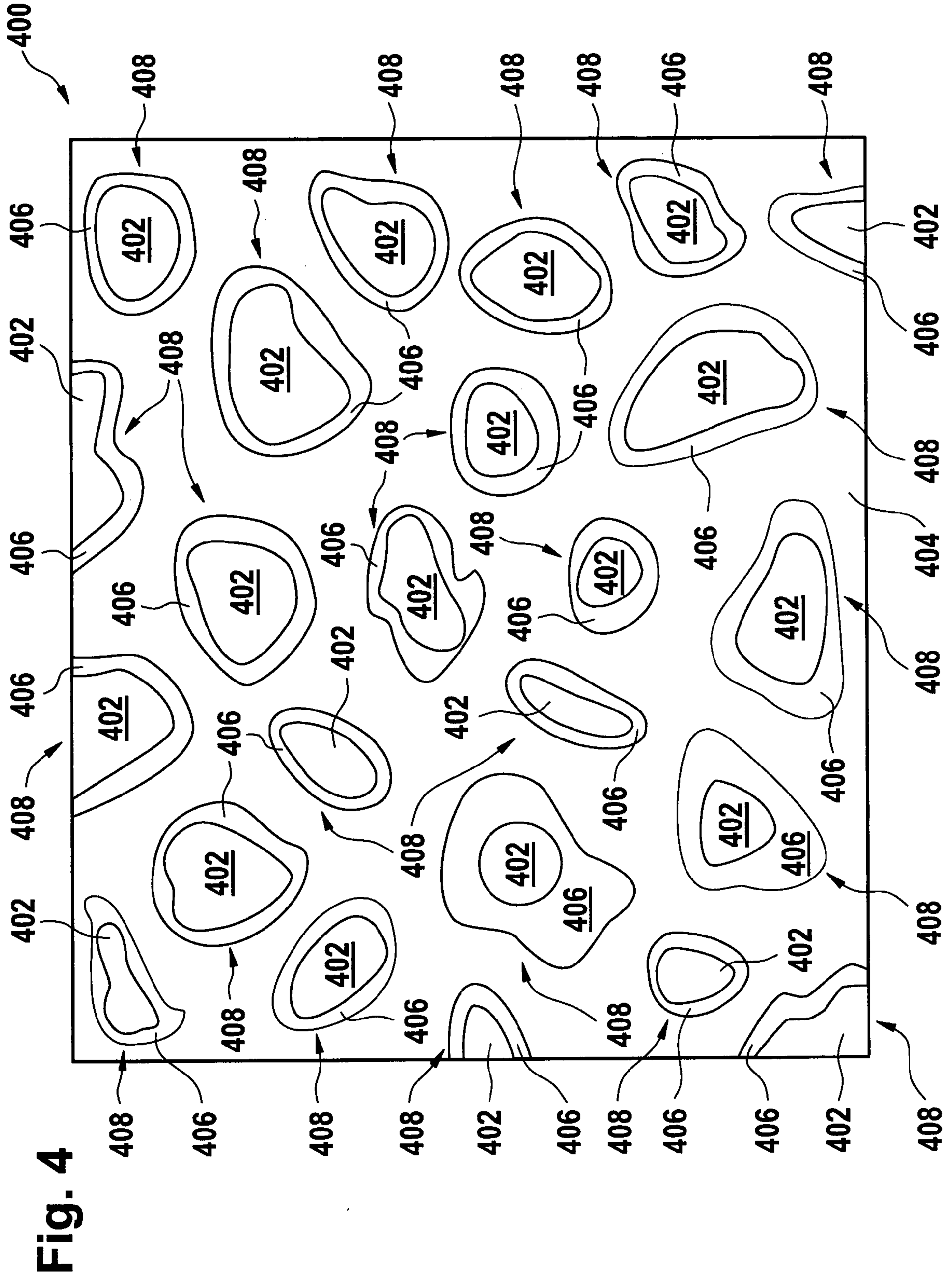
Fig. 1

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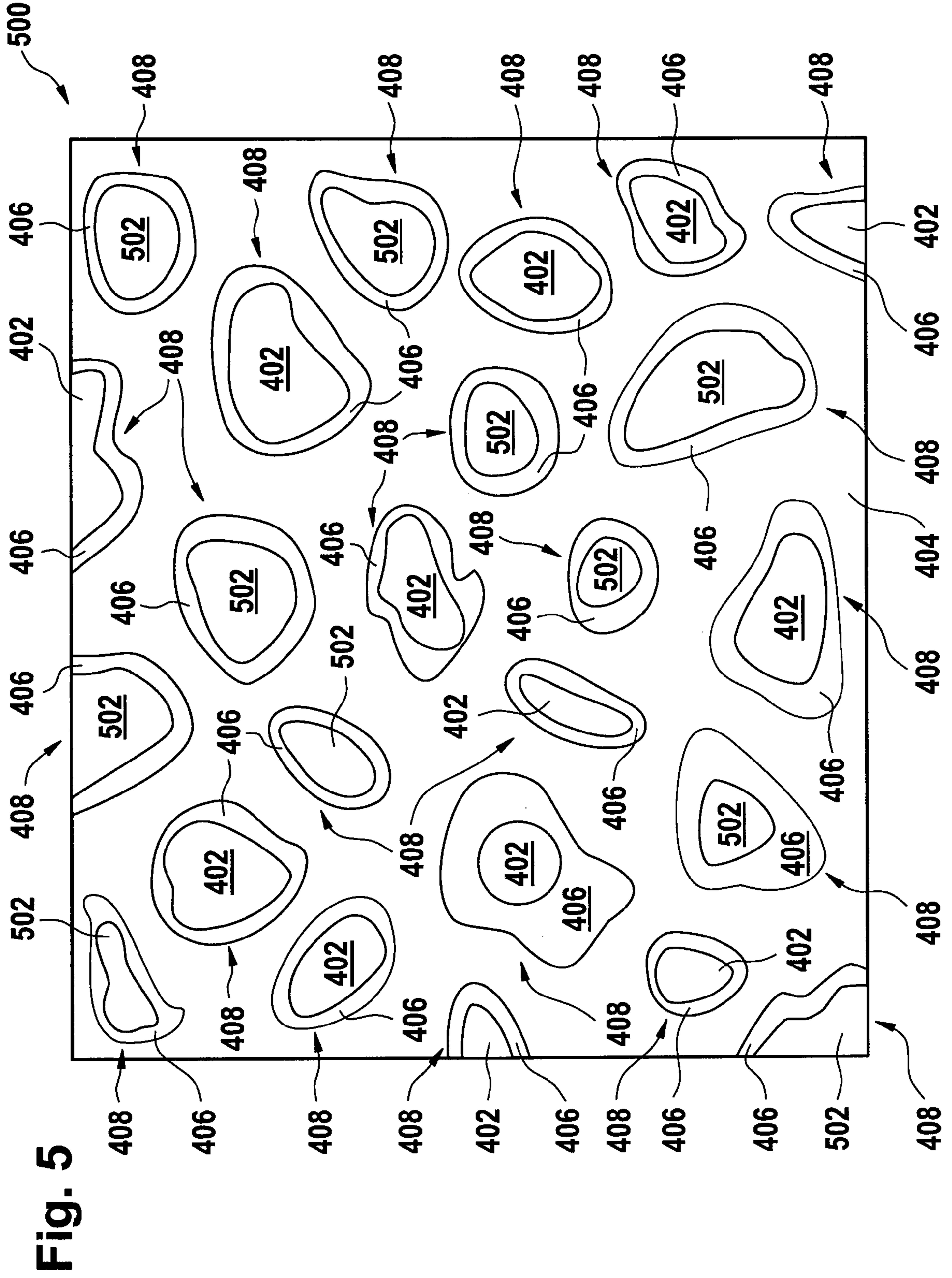
Fig. 2

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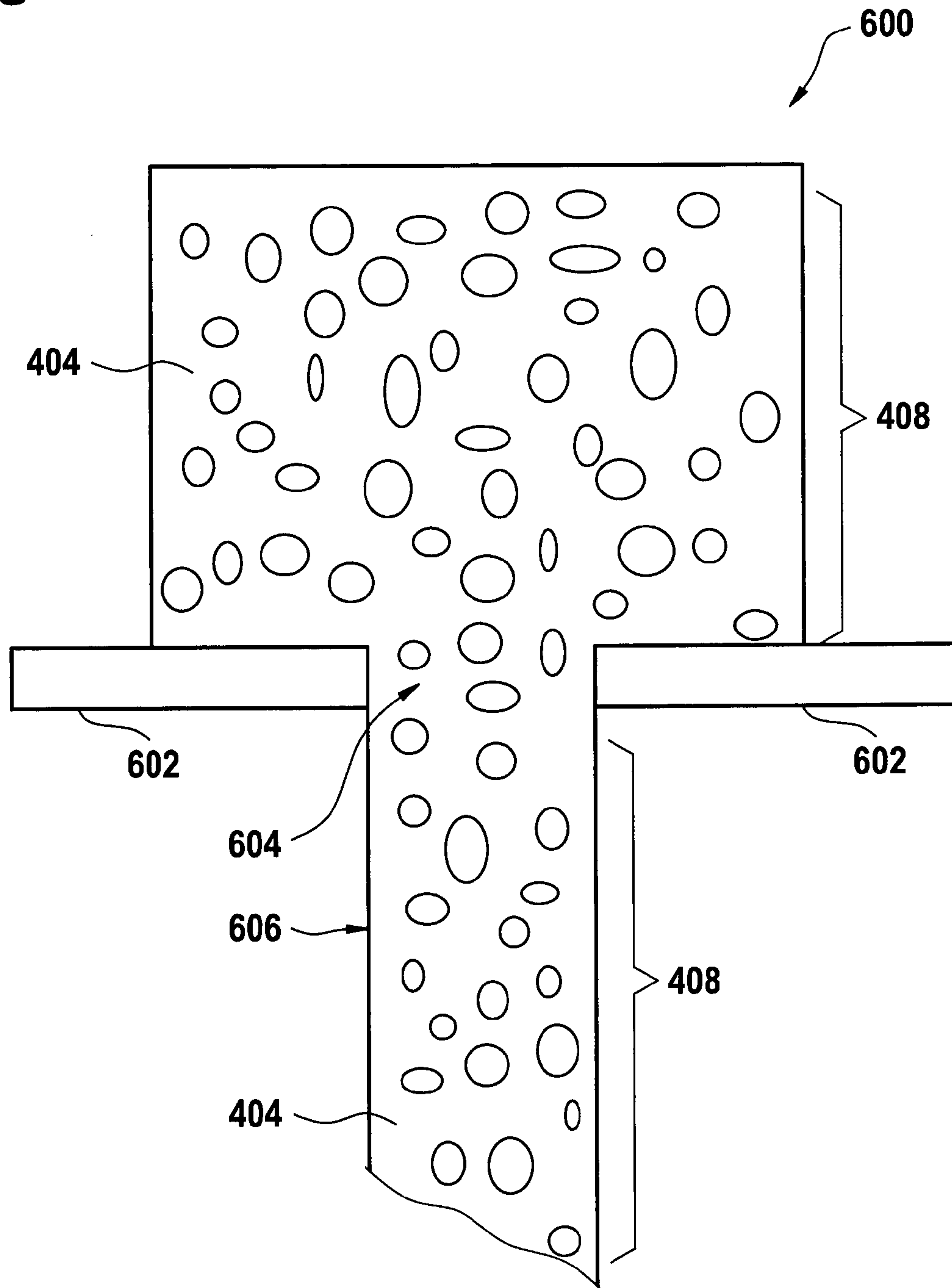
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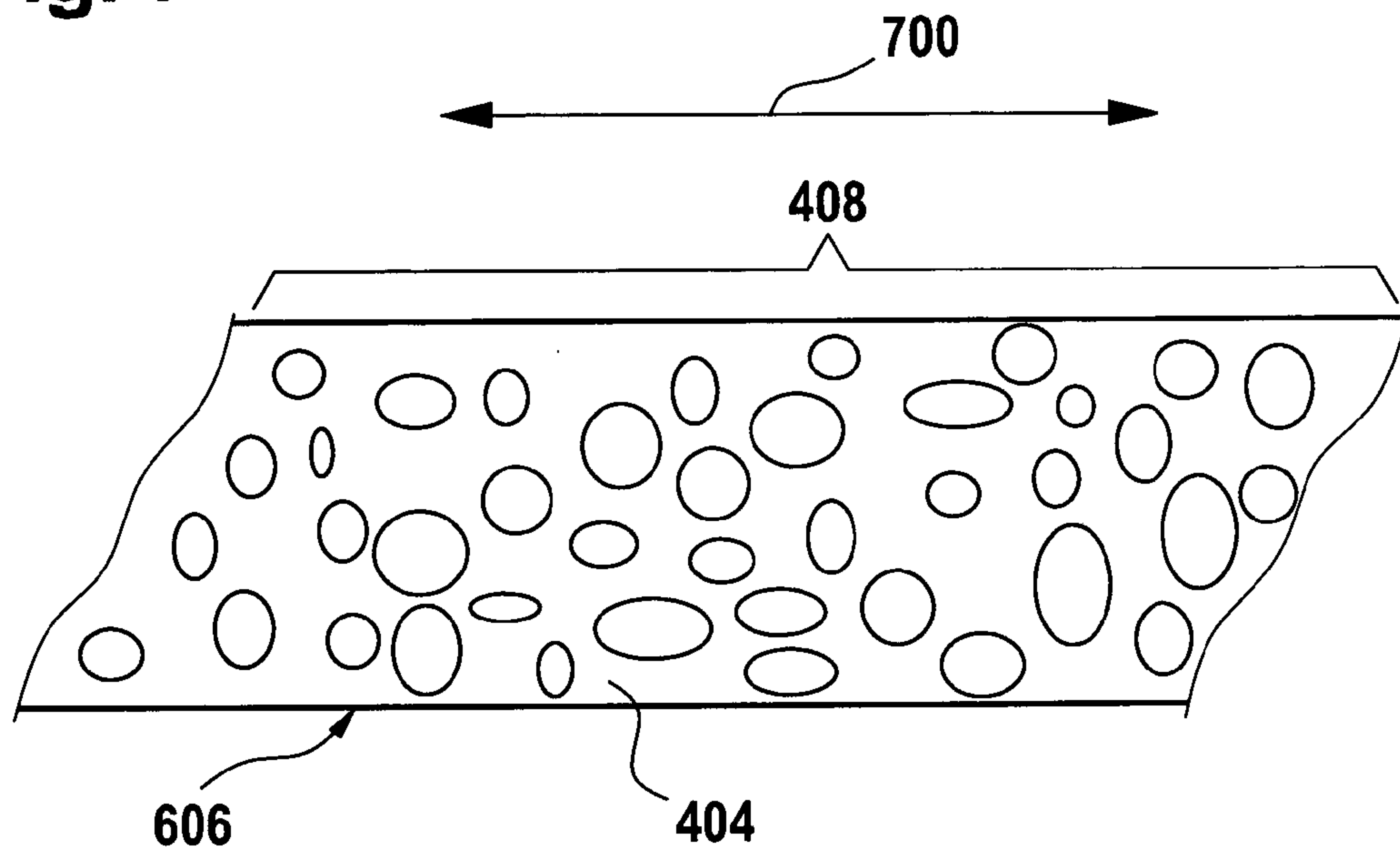
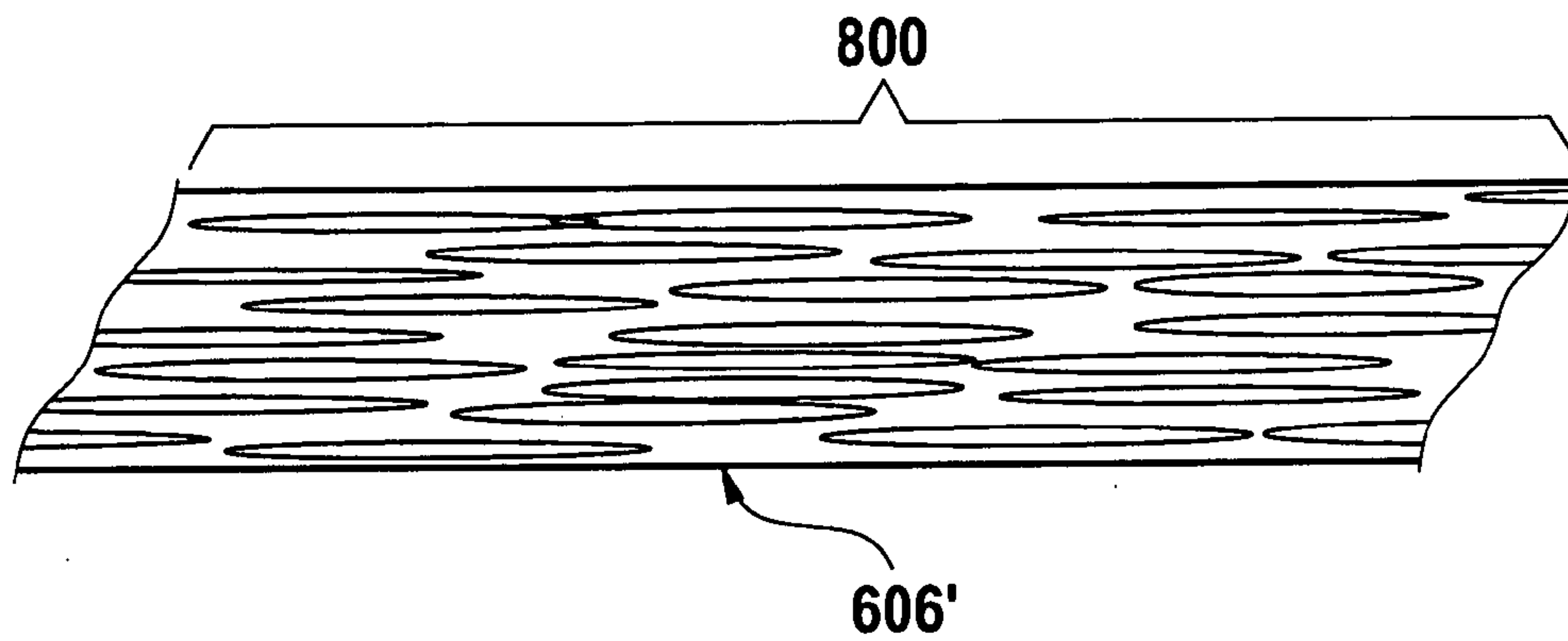
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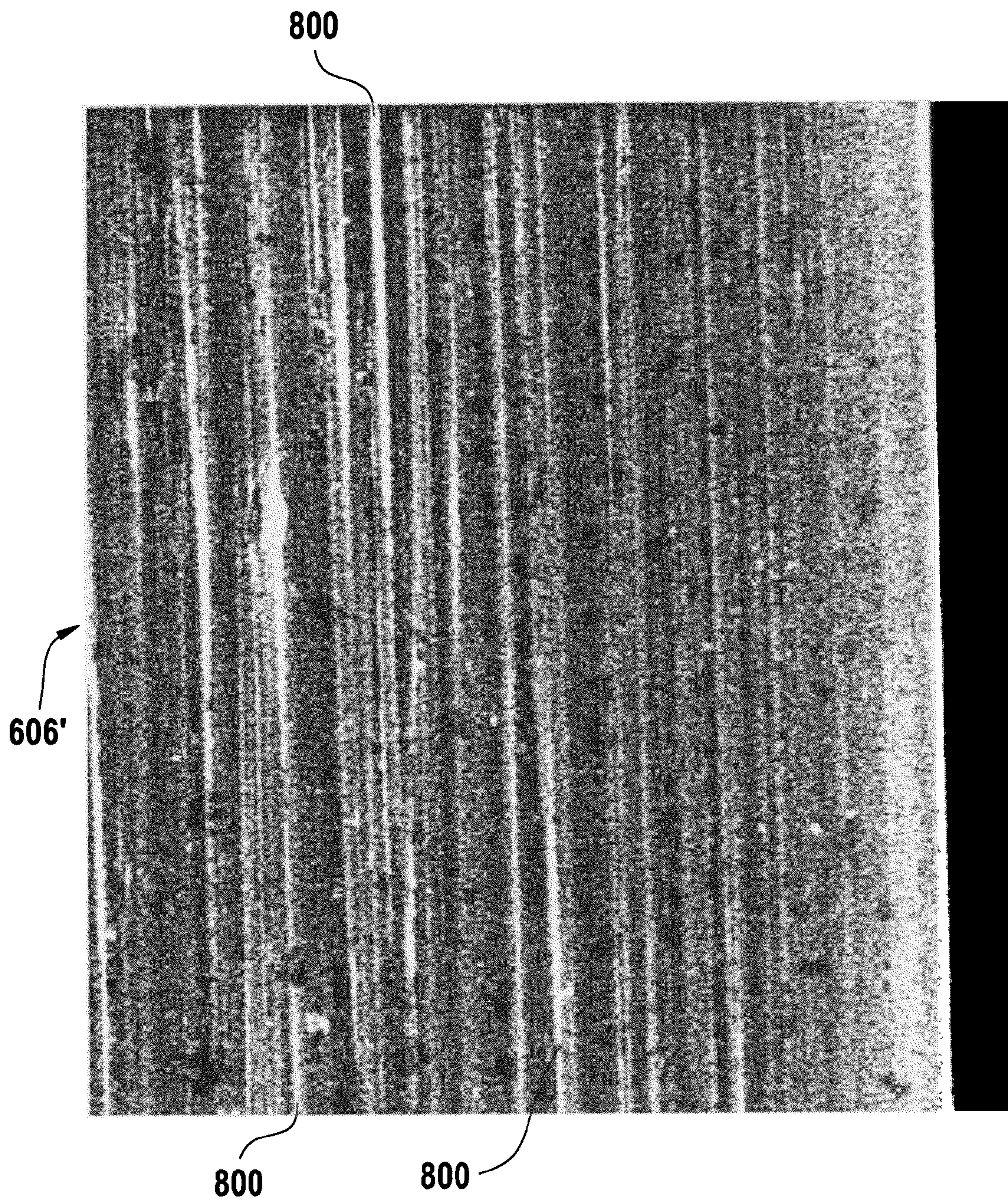
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Fig. 6

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Fig. 7**Fig. 8**

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Fig. 9

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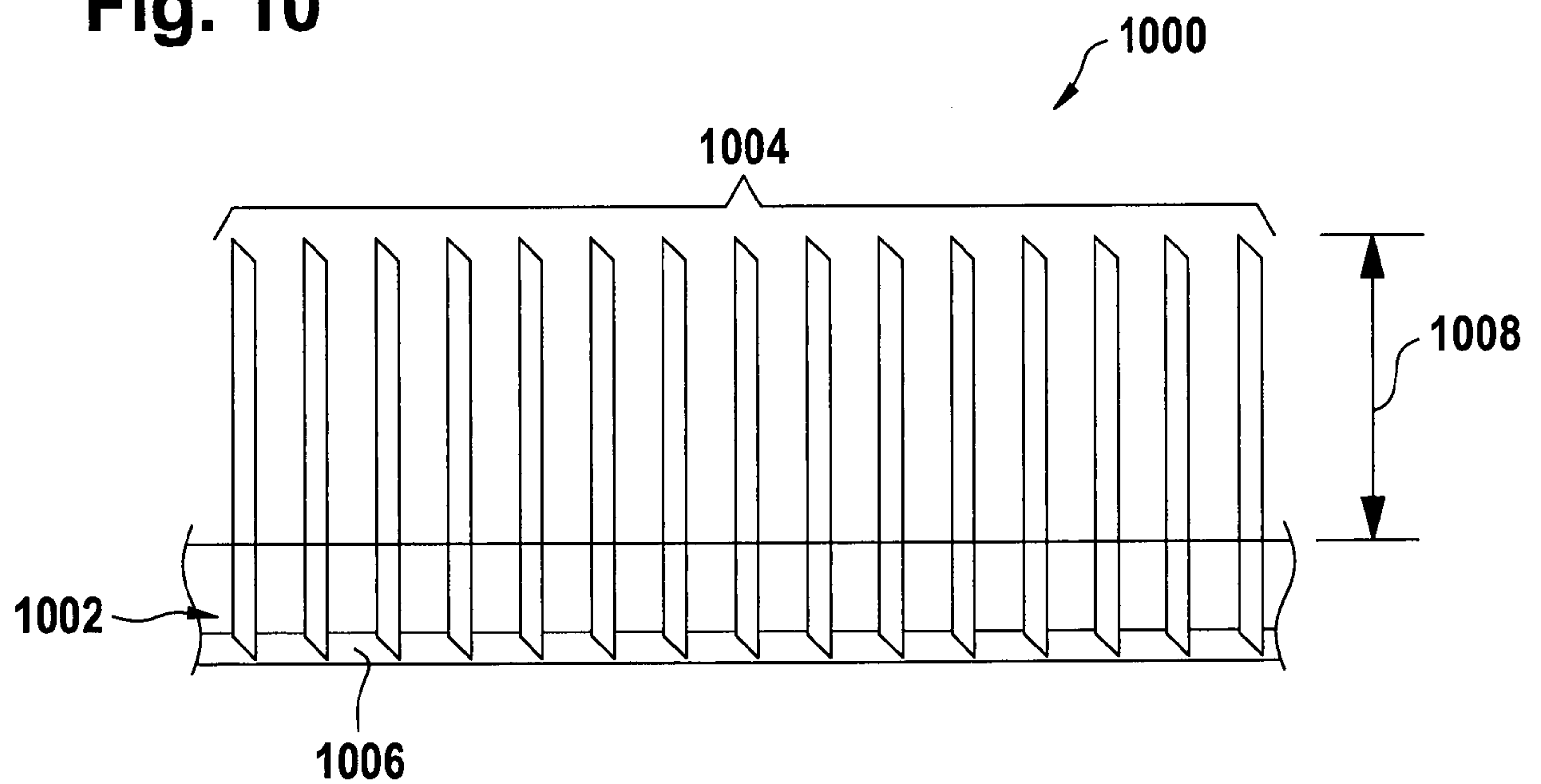
Fig. 10

Fig. 1

