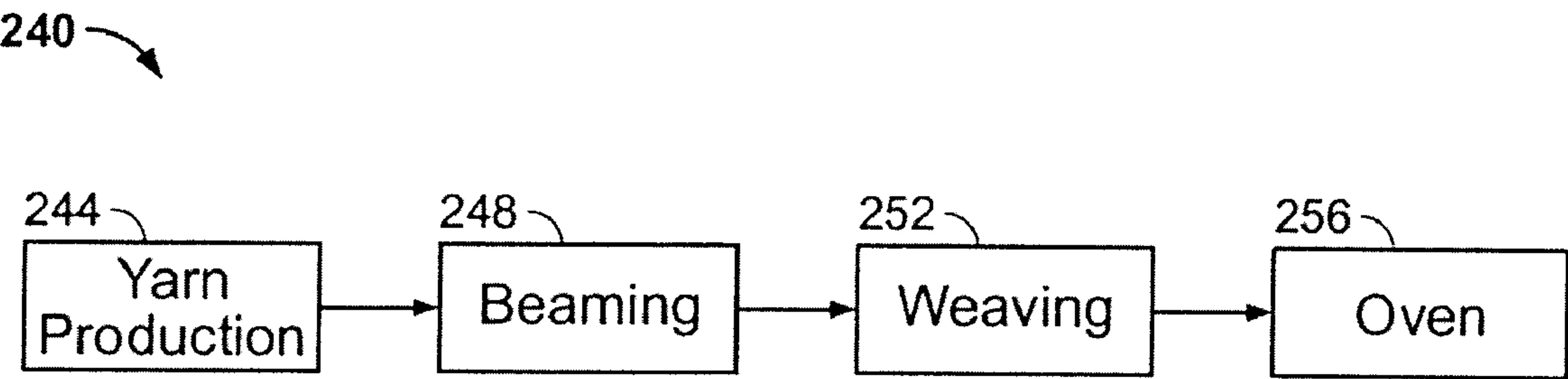




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(54) **Titre :** TAPIS DE RENFORT DE GAZON SUBMERSIBLES
(54) **Title:** SUBMERSIBLE TURF REINFORCEMENT MATS



(57) **Abrégé/Abstract:**
Disclosed are exemplary embodiments of submersible turf reinforcement mats that may include polymer and one or more additives. For example, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives may be mixed or blended with the polymer such that the overall density is high enough to cause the submersible turf reinforcement mat to sink in water.

ABSTRACT

Disclosed are exemplary embodiments of submersible turf reinforcement mats that may include polymer and one or more additives. For example, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives may be mixed or blended with the polymer such that the overall density is high enough to cause the submersible turf reinforcement mat to sink in water.

SUBMERSIBLE TURF REINFORCEMENT MATS

FIELD

[0004] The present disclosure relates to submersible turf reinforcement mats.

BACKGROUND

[0005] This section provides background information related to the present disclosure which is not necessarily prior art.

[0006] Turf reinforcement mats may be used for soil reinforcement, retention, stabilization, erosion control, support for vegetation and/or mulch, *etc.* In some applications, it is necessary for a turf reinforcement mat to be submerged in water.

[0007] A turf reinforcement mat may include warp and weft yarns interwoven together with the warp yarns inserted over-and-under the weft yarns (or vice versa) to thereby secure the yarns together. For example, FIG. 1 shows a portion of a conventional turf reinforcement mat 10 having monofilament yarns 14 in the warp direction (from top to bottom in FIG. 1) and monofilament yarns 18 in the weft or fill direction (from left to right in FIG. 1).

DRAWINGS

[0008] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0009] FIG. 1 shows a portion of a conventional turf reinforcement mat; and

[0010] FIG. 2 is a process flow diagram representing an exemplary manufacturing process or method of making a submersible turf reinforcement mat according to exemplary embodiments.

DETAILED DESCRIPTION

[0011] Example embodiments will now be described more fully with reference to the accompanying drawings.

[0012] Turf reinforcement mats may be used for soil reinforcement, retention, stabilization, erosion control, support for vegetation and/or mulch, *etc.* In some applications, it is necessary for a turf reinforcement mat to be submerged in water. But conventional turf reinforcement mats float in water because they are made of materials with a density less than water such that the mat is manufactured using a material with a density less than the water in which they will be submerged. When a turf reinforcement mat floats, the usefulness of the product can be nullified. Mechanical anchors are oftentimes used to hold a turf reinforcement mat in place so that any type of force does not disturb the relationship of the mat to the vegetation and the soil underneath. These forces can be massive rain fall, wind, turbulent water, foot traffic, *etc.* When exposed to submersion, the movement or tendency of the turf reinforcement mat to float can actually dislodge the anchors over time. Furthermore, a turf reinforcement mat that floats when exposed to water can disturb the soil it is protecting as well as the vegetation that it is supporting.

[0013] Accordingly, disclosed herein are exemplary embodiments of submersible turf reinforcement mats that may include polymer and one or more additives. The one or more additives have a specific gravity greater than 1 and greater than a specific gravity of the base polymer. For example, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives may be mixed or blended with polymer (*e.g.*, polypropylene, polyethylene, other polymers having a specific gravity less than 1, *etc.*) such that the submersible turf reinforcement mat has an overall density greater than the density of water. Thus, the submersible turf reinforcement mat may sink and not float in water. Mechanical anchors may be used with the submersible turf reinforcement mat, which does not float and thus advantageously will not

cause the anchors to dislodge or disturb the soil and vegetation around the mat. In exemplary embodiments, one or more additives may be mixed or blended with polymer such the weight percentage of the one or more additives compared to the total weight of the polymer/additive mixture is within a range from about 0.1 % to about 99%.

[0014] In some exemplary embodiments, the submersible turf reinforcement mats are made of polymer and calcium carbonate. In these exemplary embodiments, calcium carbonate may be mixed or blended with polymer such that the weight percentage of the calcium carbonate is within a range from about 17% to about 40% compared to the total weight of the polymer/calcium carbonate mixture or blend. The specific gravity of the polymer/calcium carbonate mixture or blend will vary depending on the weight percentage of the calcium carbonate. That is, the specific gravity of the polymer/calcium carbonate mixture or blend will be higher when the weight percentage of the calcium carbonate is higher. For the 17% to 40% range noted above, the specific gravity of the polymer/calcium carbonate mixture or blend may fall within a range from 1.015 to 1.228, where the specific gravity is determined by the ratio of the density of the polymer/calcium carbonate mixture or blend to the density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

[0015] By way of example, the weight percentage of the calcium carbonate may be about 20% compared to the total weight of the polymer/calcium carbonate mixture or blend. In this example, the specific gravity of the polymer/calcium carbonate mixture or blend would be 1.039 as determined by the ratio of the 1.039 g/cm³ density of the polymer/calcium carbonate mixture or blend with 20% percentage of calcium carbonate to the 1.0 g/cm³ density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

[0016] In other exemplary embodiments, the submersible turf reinforcement mats are made of polymer and zinc sulfide. In these other exemplary embodiments, zinc sulfide may be mixed or blended with polymer such that the weight percentage of the zinc sulfide is within a range from about 14% to about 30% compared to the total weight of the polymer/zinc sulfide mixture or blend. The specific gravity of the polymer/zinc sulfide mixture or blend will vary depending on the weight percentage of the zinc sulfide. That is, the specific gravity of the polymer/zinc sulfide mixture or blend will be higher when the weight percentage of the zinc sulfide is higher, and vice versa. For the 14% to 30% range noted

above, the specific gravity of the polymer/zinc sulfide mixture or blend may fall within a range from 1.01 to 1.175, where the specific gravity is determined by the ratio of the density of the polymer/zinc sulfide mixture or blend to the density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

[0017] By way of example, the weight percentage of the zinc sulfide may be about 15% compared to the total weight of the polymer/zinc sulfide mixture or blend. In this example, the specific gravity of the polymer/zinc sulfide mixture or blend would be 1.019 as determined by the ratio of the 1.019 g/cm³ density of the polymer/zinc sulfide mixture or blend with 15% percentage of zinc sulfide to the 1.0 g/cm³ density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

[0018] In further exemplary embodiments, the submersible turf reinforcement mats are made of polymer and barium sulfate. In these further exemplary embodiments, barium sulfate may be mixed or blended with polymer such that the weight percentage of the barium sulfate is within a range from about 14% to about 25% compared to the total weight of the polymer/barium sulfate mixture or blend. The specific gravity of the polymer/barium sulfate mixture or blend will vary depending on the weight percentage of the barium sulfate. That is, the specific gravity of the polymer/barium sulfate mixture or blend will be higher when the weight percentage of the barium sulfate is higher, and vice versa. For the 14% to 25% range noted above, the specific gravity of the polymer/barium sulfate mixture or blend may fall within a range from 1.014 to 1.125, where the specific gravity is determined by the ratio of the density of the polymer/barium sulfate mixture or blend to the density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

[0019] By way of example, the weight percentage of the barium sulfate may be about 14% compared to the total weight of the polymer/barium sulfate mixture or blend. In this example, the specific gravity of the polymer/barium sulfate mixture or blend would be 1.014 as determined by the ratio of the 1.014 g/cm³ density of the polymer/barium sulfate mixture or blend with 14% percentage of barium sulfate to the 1.0 g/cm³ density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

[0020] In exemplary embodiments, a submersible turf reinforcement mat may comprise a woven fabric made from warp and weft yarns. The warp and weft yarns may be

interwoven together with the warp yarns inserted over-and-under the weft yarns (or vice versa) to thereby secure the yarns together. In these exemplary embodiments, the warp and/or weft yarns may be made from one or more of the polymer/additive mixtures or blends disclosed herein. For example, the warp yarns and/or weft yarns may be made from blend or mixture of polymer (*e.g.*, polypropylene, polyethylene, other polymers having a specific gravity less than 1, *etc.*) and one or more additives (*e.g.*, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives having a specific gravity greater than 1, *etc.*) such that the resulting woven fabric/submersible turf reinforcement mat has an overall density greater than the density of water.

[0021] The warp yarns and weft yarns may be made from the same polymer/additive blend or mixture. Or, the warp yarns may be made from a polymer/additive blend or mixture that is different than the polymer/additive blend or mixture used to make the weft yarns. Moreover, each warp yarn and each weft yarn does not necessarily need to be made from a polymer/additive blend or mixture so long as enough of the polymer/additive blend or mixture is preferably used such that the resulting woven fabric/submersible turf reinforcement mat has an overall density greater than the density of water and high enough to sink when exposed to water. By way of example, either the warp yarns or the weft yarns (but not both) may be made from a polymer/additive blend or mixture while the other of the warp or weft yarns are made from polymer without the additive in an exemplary embodiment. By way of further example, only some of the warp and/or weft yarns may be made from a polymer/additive blend or mixture while the remaining warp and/or weft yarns are made from polymer without the additive in another exemplary embodiment.

[0022] The polymer/additive blends or mixtures disclosed herein may be used to make various different types of yarns, such as monofilament yarns, multifilament yarns, and spun yarns (*e.g.*, core-sheath spun yarn, ring-spun yarn, rotor-spun yarn, open-end spun yarn, *etc.*), tape yarns, fibrillated yarns, *etc.* for either or both the weft and warp directions. A submersible turf reinforcement mat may be formed by layers of warp and weft yarns made from a polymer/additive blend or mixture disclosed herein, where the warp and weft yarns are secured or interwoven together in a weave, construction, or pattern, which helps to enhance water flow and strength characteristics. The warp and weft yarns may be configured such that

the submersible turf reinforcement mat has a three-dimensional shape. For example, the submersible turf reinforcement mat may have a plurality of portions or cells having a pyramidal, honeycomb, or dome shapes. By way of example, the submersible turf reinforcement mat may have a plain weave, a twill weave (*e.g.*, 2x2, 3x3, 2x1, 4x4, *etc.*), satin weave, pyramidal weave, *etc.* For example, warp yarns may be interwoven with the weft yarns such that the warp yarns cross over and then under more than one weft yarn (*e.g.*, three weft yarns, two weft yarns, *etc.*). The warp and weft yarn systems may comprise one, two, three or more different types of yarns, *e.g.*, multifilament yarns and/or spun yarns with different cross-sectional shapes or geometries, monofilaments, tape yarns, fibrillated yarns, *etc.*

[0023] In other exemplary embodiments, a submersible turf reinforcement mat may comprise other three dimensional structures manufactured from monofilament strands that create an open mat. In these other exemplary embodiments, the monofilament strands may be made from one or more of the polymer/additive mixtures or blends disclosed herein. The monofilament strands may be made from a blend or mixture of polymer (*e.g.*, polypropylene, polyethylene, other polymers having a specific gravity less than 1, *etc.*) and one or more additives (*e.g.*, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives having a specific gravity greater than 1, *etc.*) such that the overall density is greater than the density of water. Thus, the submersible turf reinforcement mat will sink and not float in water.

[0024] In further exemplary embodiments, a submersible turf reinforcement mat may include netting/grid products that are layered or attached together with fibrous layers to form three dimensional structures. In these further exemplary embodiments, the netting/grid may be made from one or more of the polymer/additive mixtures or blends disclosed herein. The netting/grid may be made from a blend or mixture of polymer (*e.g.*, polypropylene, polyethylene, other polymers having a specific gravity less than 1, *etc.*) and one or more additives (*e.g.*, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives having a specific gravity greater than 1, *etc.*) such that the overall density is greater than the density of water. Thus, the submersible turf reinforcement mat will sink when exposed to water.

[0025] The polymer/additive blends or mixtures disclosed herein should not be limited to any particular type of yarn, any particular manufacturing process, any particular yarn cross-sectional profile, any particular three-dimensional shape, any particular base polymer, any particular heat treatment to form a three dimensional structure, any particular type of turf reinforcement mat, *etc.* The polymer/additive blends or mixtures disclosed herein may be used with any of the typical processes for manufacturing turf reinforcement mats. Moreover, the polymer/additive blends or mixtures disclosed herein may also be used with various types of turf reinforcement mats, such as the woven submersible turf reinforcement mats disclosed herein, the submersible turf reinforcement mats made from monofilament strands that create an open mat, the submersible turf reinforcement mats that include netting/grid products layered or attached together with fibrous layers to form three dimensional structures, *etc.*

[0026] As shown by rows 1, 2, and 3 in the table below, exemplary embodiments of a submersible turf reinforcement mat may include spun yarn (*e.g.*, core-sheath spun yarn, *etc.*) in the warp direction and monofilament yarn, multifilament yarn, or spun yarn in the weft direction. As shown by rows 4 and 5 in the table below, exemplary embodiments of a submersible turf reinforcement mat may include monofilament yarn in the warp direction and spun yarn or multifilament yarn in the weft direction. As shown by rows 6, 7, and 8 in the table below, exemplary embodiments of a submersible turf reinforcement mat may include multifilament yarn in the warp direction and spun yarn, monofilament yarn, or multifilament yarn in the weft direction. The spun, monofilament, and multifilament yarns in the table below may be made from one or more of the polymer/additive mixtures or blends disclosed herein.

Row	Warp Yarn	Weft Yarn
1	Spun	Monofilament
2	Spun	Multifilament
3	Spun	Spun
4	Monofilament	Spun
5	Monofilament	Multifilament
6	Multifilament	Spun

7	Multifilament	Monofilament
8	Multifilament	Multifilament

[0027] In exemplary embodiments that include spun yarn in either or both of the warp and weft directions, the spun yarn may include relatively short filaments or staple fibers, *e.g.*, from 1 denier per filament (dpf) to 60 dpf, *etc.* The short filaments or staple fibers may be spun, entangled, twisted, *etc.*, together to form a larger yarn. The short filaments or staple fibers may also be utilized in a core-sheath spun yarn where single or multiple yarns for a core structure are encapsulated in a single or multiple (*e.g.*, 1 to 1 to 6, *etc.*) blend of fibers around the core.

[0028] By way of example only, core-sheath spun yarns may be made by Dref spinning, ring spinning, rotor spinning, open-end spinning, *etc.* But aspects of the present disclosure should not be limited to any single type of manufacturing process for making spun yarns and/or multifilament yarns as spun yarns and/or multifilament yarns may be made by different manufacturing processes.

[0029] In exemplary embodiments, yarn may be formed from at least one of the polymer/additive mixtures or blends disclosed herein such that the yarn has a round (*e.g.*, circular or substantially circular, *etc.*) cross section. In exemplary embodiments, a submersible turf reinforcement mat may include warp yarns and weft yarns having the same cross-sectional shape (*e.g.*, round, substantially circular cross-sectional shape, *etc.*). Alternatively, other embodiments may include warp and weft yarns that have cross-sectional shapes or geometries different than the cross-sectional shapes or geometries of the weft yarns. For example, the warp or weft yarns may have a round, substantially circular cross-sectional shape, while the other one of the warp or weft yarns has an oval cross-sectional shape with a width greater than its thickness or height. Alternative embodiments may include a submersible turf reinforcement mat having warp and/or weft yarns with other or additional cross-sectional shapes, geometries, and/or sizes. For example, the warp and weft yarns may both have an oval cross-sectional shape.

[0030] In exemplary embodiments, the submersible turf reinforcement mat may consist of a single warp set/system and a single weft set/system. In this example, either or

both of the first/warp system and the second/weft system may include multifilament yarns and/or spun yarns formed from one or more of the polymer/additive mixtures or blends disclosed herein. The first and second (or warp and weft) sets of yarns may be interwoven together to form a dimensionally stable network, which allows the yarns to maintain their relative position.

[0031] FIG. 2 is a process flow diagram representing an exemplary manufacturing process or method 240 of making a submersible turf reinforcement mat comprising a polymer/additive mixture or blend according to exemplary embodiments. Generally, the method 240 includes four operations or steps labeled as yarn production 244, beaming 248, weaving 252, and oven 256 in FIG. 2.

[0032] By way of background, single strand yarns may be produced from plastic resin pellets. The pellets are introduced to a plastic extrusion machine, which heats the pellets to a high enough temperature to transform the pellets into a molten state. At this point, additives (*e.g.*, color or other substances, *etc.*) may be introduced along with the plastic pellets to achieve desired characteristics of the yarn. The molten plastic is then forced through a hole in a die to create a continuous strand. The shape of the hole governs the shape of the strand. The molten strand is then quenched to become solid again. The solid state strand is then stretched, *e.g.*, from 5 times to 12 times, to achieve appropriate physical properties. After it is stretched, the yarn strand is then wound onto a tube for later use.

[0033] In the first operation or step 244 of method 240, multifilament yarns may be extruded in a similar manner as described above for single strand yarns. In this example, the multifilament yarns are made from a blend or mixture of polymer (*e.g.*, polypropylene, polyethylene, other polymers having a specific gravity less than 1, *etc.*) and one or more additives (*e.g.*, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives having a specific gravity greater than 1, *etc.*). With multifilament yarns, the individual holes in the die are typically smaller. The individual continuous strands of filaments are bundled, twisted, textured, bulked, *etc.* together to form a heavier weight yarn. The yarn bundle may then be exposed to a number of other processes (*e.g.*, twisting, *etc.*) to enhance the yarn properties.

[0034] Alternatively, the first operation or step 244 may include manufacturing spun yarns from cut lengths of plastic fibers or relatively short staple fibers, where the fibers

are made from a blend or mixture of polymer (*e.g.*, polypropylene, polyethylene, other polymers having a specific gravity less than 1, *etc.*) and one or more additives (*e.g.*, calcium carbonate, zinc sulfide, barium sulfate, and/or other additives having a specific gravity greater than 1, *etc.*). The short staple fibers are entangled among themselves or around a core yarn(s) to form a single strand of yarn.

[0035] After the yarns are manufactured at the first operation or step 244, the yarns may then proceed to the second operation or step 248 where the yarns are processed into either warp yarns or weft yarns for a submersible turf reinforcement mat. First, individual packages of yarn may be loaded onto a creel and then transferred to a single loom beam. These yarns are generally referred to as warp yarns. A loom beam may contain thousands of individual warp yarns. The loom beam becomes the source in the loom for the machine direction yarns. Other yarns may then be inserted on the loom in the cross machine direction. These other yarns are generally known as weft or fill yarns. In an alternative process, the beaming process may be bypassed and looms can be fed directly from a creel.

[0036] At the third operation or step 252, a weaving machine, commonly called a loom, is loaded with the loom beam and the weft yarns mentioned above. The weaving machine may then interlace the yarns in a woven method.

[0037] After the yarns are woven, the woven fabric may then be processed through a finishing oven at the fourth operation of process 256. The heat in the oven may heat shrink and cause shrinkage of the warp and weft yarns within the submersible turf reinforcement mat to achieve the desired characteristics (*e.g.*, three dimensional, pyramidal, honey comb, or cusped profile shape, *etc.*) of the finished turf reinforcement mat. For example, the warp and weft yarns may have heat shrinkage characteristics such that when heated, the warp and weft yarns form a three-dimensional, pyramidal, honey comb, or cusped shape.

[0038] The method 240 shown in FIG. 2 and described above is provided for purpose of illustration only as a submersible turf reinforcement mat comprising a polymer/additive blend or mixture may be made by other processes. For example, another exemplary embodiment may include a submersible turf reinforcement mat including spun yarn and/or multifilament yarn comprising a polymer/additive blend or mixture in either or

both of the warp and weft directions where the submersible turf reinforcement mat is made by a different process.

[0039] A common issue in the industry for turf reinforcement mats is that the materials are typically manufactured from polymers with specific gravity characteristics that cause them to float in water. In exemplary embodiments disclosed herein, a submersible turf reinforcement mat is made out of materials that can allow either or both of the yarns (warp and/or weft) to be manufactured from polymers and additives (*e.g.*, additives with a specific gravity greater than one, *etc.*) so that the submersible turf reinforcement mat sinks and does not float when exposed to water.

[0040] Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms, and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail. In addition, advantages and improvements that may be achieved with one or more exemplary embodiments of the present disclosure are provided for purpose of illustration only and do not limit the scope of the present disclosure, as exemplary embodiments disclosed herein may provide all or none of the above mentioned advantages and improvements and still fall within the scope of the present disclosure.

[0041] Specific dimensions, specific materials, and/or specific shapes disclosed herein are example in nature and do not limit the scope of the present disclosure. The disclosure herein of particular values and particular ranges of values for given parameters are not exclusive of other values and ranges of values that may be useful in one or more of the examples disclosed herein. Moreover, it is envisioned that any two particular values for a specific parameter stated herein may define the endpoints of a range of values that may be suitable for the given parameter (*i.e.*, the disclosure of a first value and a second value for a given parameter can be interpreted as disclosing that any value between the first and second

values could also be employed for the given parameter). For example, if Parameter X is exemplified herein to have value A and also exemplified to have value Z, it is envisioned that parameter X may have a range of values from about A to about Z. Similarly, it is envisioned that disclosure of two or more ranges of values for a parameter (whether such ranges are nested, overlapping or distinct) subsume all possible combination of ranges for the value that might be claimed using endpoints of the disclosed ranges. For example, if parameter X is exemplified herein to have values in the range of 1 – 10, or 2 – 9, or 3 – 8, it is also envisioned that Parameter X may have other ranges of values including 1 – 9, 1 – 8, 1 – 3, 1 – 2, 2 – 10, 2 – 8, 2 – 3, 3 – 10, and 3 – 9.

[0042] The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms “a”, “an” and “the” may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms “comprises,” “comprising,” “including,” and “having,” are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

[0043] When an element or layer is referred to as being “on”, “engaged to”, “connected to” or “coupled to” another element or layer, it may be directly on, engaged, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being “directly on,” “directly engaged to”, “directly connected to” or “directly coupled to” another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (*e.g.*, “between” versus “directly between,” “adjacent” versus “directly adjacent,” *etc.*). As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0044] The term “about” when applied to values indicates that the calculation or the measurement allows some slight imprecision in the value (with some approach to exactness in the value; approximately or reasonably close to the value; nearly). If, for some reason, the imprecision provided by “about” is not otherwise understood in the art with this ordinary meaning, then “about” as used herein indicates at least variations that may arise from ordinary methods of measuring or using such parameters. For example, the terms “generally”, “about”, and “substantially” may be used herein to mean within manufacturing tolerances.

[0045] Although the terms first, second, third, *etc.* may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as “first,” “second,” and other numerical terms when used herein do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example embodiments.

[0046] Spatially relative terms, such as “inner,” “outer,” “beneath”, “below”, “lower”, “above”, “upper” and the like, may be used herein for ease of description to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the figures. Spatially relative terms may be intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” other elements or features would then be oriented “above” the other elements or features. Thus, the example term “below” can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0047] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements, intended or stated uses, or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable,

are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

CLAIMS:

1. A submersible turf reinforcement mat comprising one or more yarns made from a polymer/additive blend or a mixture of polymer and one or more additives, the one or more yarns create an open mat configured so as to allow water flow and vegetation growth through the open mat, the one or more additives having a specific gravity greater than one and greater than the polymer, whereby an overall density of the submersible turf reinforcement mat is greater than water such that the submersible turf reinforcement mat sinks in water.
2. The submersible turf reinforcement mat of claim 1, wherein the polymer comprises at least one or more of polypropylene, polyethylene, and polymer having a specific gravity less than 1.
3. The submersible turf reinforcement mat of claim 1 or 2, wherein the one or more additives comprise at least one or more of calcium carbonate, zinc sulfide, and barium sulfate.
4. The submersible turf reinforcement mat of any one of claims 1 to 3, wherein a weight percentage of the one or more additives compared to a total weight of the mixture of the polymer and the one or more additives is within a range from about 0.1 % to about 99%.
5. The submersible turf reinforcement mat of claim 1 or 2, wherein the one or more additives comprise calcium carbonate in an amount such that a weight percentage of the calcium carbonate is within a range from about 17% to about 40% compared to a total weight of the mixture of the polymer and the calcium carbonate.
6. The submersible turf reinforcement mat of claim 5, wherein a specific gravity of the mixture of the polymer and the calcium carbonate falls within a range from about 1.015 to about 1.228 where the specific gravity is determined by a ratio of the density of the mixture of the polymer and the calcium carbonate to the density of water at 4 degrees Celsius or 39 degrees Fahrenheit.
7. The submersible turf reinforcement mat of claim 1 or 2, wherein:
the one or more additives comprise calcium carbonate in an amount such that a weight percentage of the calcium carbonate is about 20% compared to a total weight of the mixture of the polymer and the calcium carbonate; and

the specific gravity of the mixture of the polymer and the calcium carbonate is about 1.039 as determined by the ratio of the 1.039 g/cm³ density of the mixture of the polymer and the calcium carbonate to the 1.0 g/cm³ density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

8. The submersible turf reinforcement mat of claim 1 or 2, wherein the one or more additives comprise zinc sulfide in an amount such that a weight percentage of the zinc sulfide is within a range from about 14% to about 30% compared to a total weight of the mixture of the polymer and the zinc sulfide.

9. The submersible turf reinforcement mat of claim 8, wherein a specific gravity of the mixture of the polymer and the zinc sulfide falls within a range from about 1.01 to about 1.175 where the specific gravity is determined by the ratio of the density of the mixture of the polymer and the zinc sulfide to the density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

10. The submersible turf reinforcement mat of claim 1 or 2, wherein:

the one or more additives comprise zinc sulfide in an amount such that a weight percentage of the zinc sulfide is about 15% compared to a total weight of the mixture of the polymer and the zinc sulfide; and

a specific gravity of the mixture of the polymer and the zinc sulfide is about 1.019 as determined by the ratio of the 1.039 g/cm³ density of the mixture of the polymer and the zinc sulfide to the 1.0 g/cm³ density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

11. The submersible turf reinforcement mat of claim 1 or 2, wherein the one or more additives comprise barium sulfate in an amount such that a weight percentage of the barium sulfate is within a range from about 14% to about 25% compared to a total weight of the mixture of the polymer and the barium sulfate.

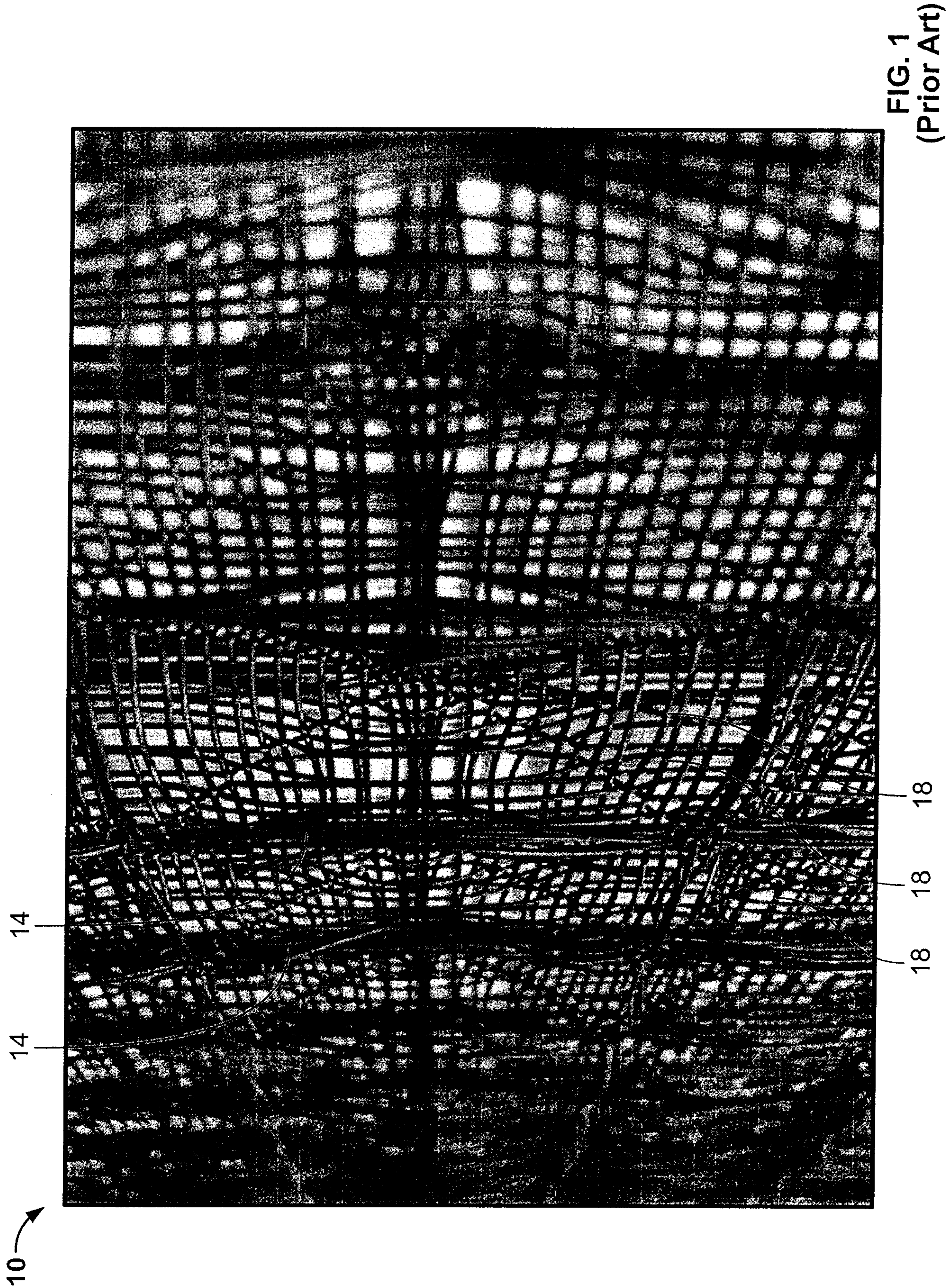
12. The submersible turf reinforcement mat of claim 11, wherein a specific gravity of the mixture of the polymer and the barium sulfate falls within a range from about 1.014 to about 1.125 where the specific gravity is determined by the ratio of the density of the mixture of the polymer and the barium sulfate to the density of water at 4 degrees Celsius or 39 degrees Fahrenheit.

13. The submersible turf reinforcement mat of claim 1 or 2, wherein:
- the one or more additives comprise barium sulfate in an amount such that a weight percentage of the barium sulfate is about 14% compared to a total weight of the mixture of the polymer and the barium sulfate; and
- the specific gravity of the mixture of the polymer and the barium sulfate is about 1.014 as determined by the ratio of the 1.014 g/cm³ density of the mixture of the polymer and the barium sulfate to the 1.0 g/cm³ density of water at 4 degrees Celsius or 39 degrees Fahrenheit.
14. The submersible turf reinforcement mat of any one of claims 1 to 13, wherein the one or more yarns of the submersible turf reinforcement mat comprise one or more spun, monofilament, and/or multifilament yarns made from the polymer/additive blend or the mixture of the polymer and one or more additives.
15. The submersible turf reinforcement mat of any one of claims 1 to 14, wherein the one or more yarns of the submersible turf reinforcement mat comprise one or more warp and/or weft yarns made from the polymer/additive blend or the mixture of the polymer and one or more additives.
16. The submersible turf reinforcement mat of any one of claims 1 to 15, wherein the submersible turf reinforcement mat comprises weft yarns and warp yarns interwoven with the weft yarns so as to allow water flow and vegetation growth through the submersible turf reinforcement mat, wherein either or both of the warp yarns and weft yarns are made from the polymer/additive blend or the mixture of the polymer and one or more additives.
17. The submersible turf reinforcement mat of any one of claims 1 to 13, wherein the submersible turf reinforcement mat comprises monofilament strands that are made from the mixture of the polymer and one or additives, the monofilament strands create an open mat through which water is flowable and that is configured to allow vegetation to grow through the open mat when placed on soil for erosion control.
18. The submersible turf reinforcement mat of any one of claims 1 to 13, wherein the submersible turf reinforcement mat comprises a netting or grid that is made from the mixture of the polymer and one or additives, the submersible turf reinforcement mat is layered or attached together with fibrous layers to form an open three dimensional structure through which water is flowable, the open three dimensional

structure configured to allow vegetation to grow through the netting or grid when placed on soil for erosion control.

19. The submersible turf reinforcement mat of any one of claims 1 to 18, wherein the submersible turf reinforcement mat has an open three-dimensional, pyramidal, honeycomb, or cusped profile shape through which water is flowable and through which vegetation can grow.

20. The submersible turf reinforcement mat of any one of claims 1 to 19, wherein the submersible turf reinforcement mat includes warp and weft yarns having heat shrinkage characteristics such that when heated, the submersible turf reinforcement mat has an open three-dimensional, pyramidal, honeycomb, or cusped profile shape through which water is flowable and through which vegetation can grow.



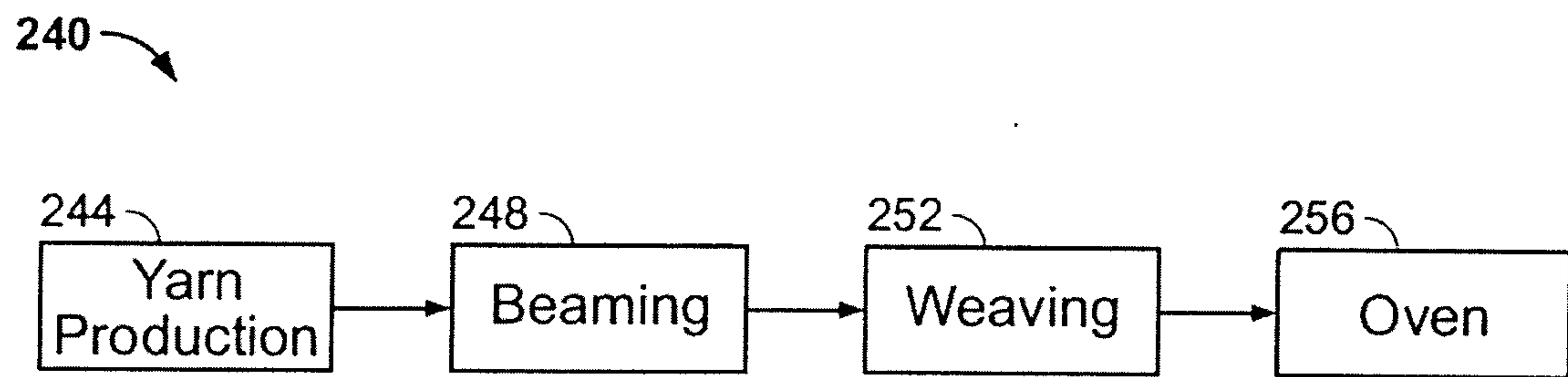


FIG. 2

240



244



Yarn
Production

248



Beaming

252



Weaving

256



Oven