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(54) Title: REMOVABLE ARTIFICIAL TURF PANEL SYSTEM AND METHOD OF INSTALLING SAME

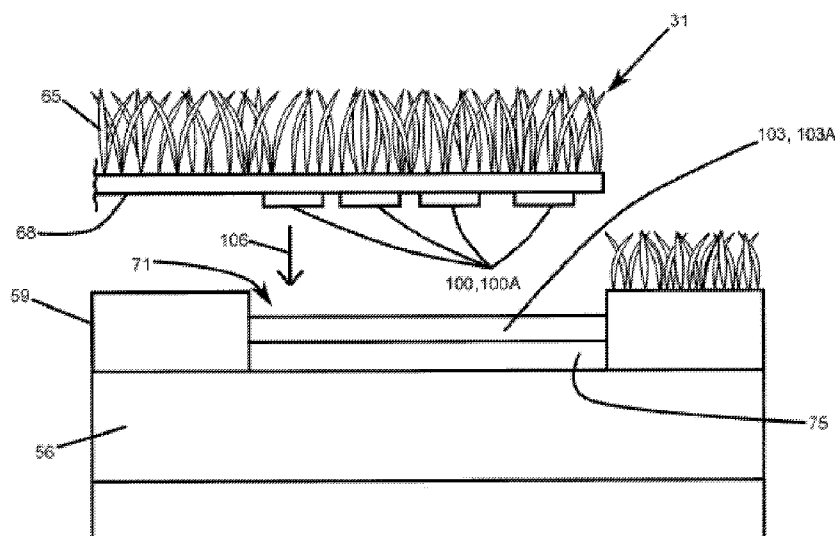


FIG. 7

(57) Abstract: A removable artificial turf panel system (10) with an artificial turf panel (13,31) that has a plurality of upstanding ribbons (65) extending from a backing layer (68). An infill layer (69) is interspersed between the upstanding ribbons on the backing layer. The outside of the backing layer may be provided with one of a magnet (103) and a ferromagnetic (103A) material. The magnet/ferromagnetic material cooperates with a corresponding magnet/ferromagnetic material disposed in a channel (71) on a layer of elastomeric (59) material that supports the artificial turf panel. Accordingly, an artificial turf panel can be removably attached to a section of elastomeric material on an artificial turf playing surface. A method of installing a removable artificial turf panel is also disclosed.

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REMOVABLE ARTIFICIAL TURF PANEL SYSTEM AND METHOD OF INSTALLING SAME

TECHNICAL FIELD

[0001] The present subject matter relates generally to the field of synthetic turf, and more particularly to a removable active panel system for use in connection with playing surfaces where sections of turf for athletic events may be exchanged or removed between events.

BACKGROUND ART

[0002] Artificial turf fields, pitches, and courts may be utilized in place of natural grass surfaces. An artificial turf field may comprise rows of synthetic ribbons that extend generally vertically from a backing layer. The synthetic ribbons may be designed to resemble grass. An infill layer of particulate material may be interspersed between the ribbons on the backing layer. In this arrangement, the synthetic ribbons are designed to extend a distance above the infill layer of particulate material. The infill may comprise, for example and without limitation, sand, rubber, a mixture of sand and rubber, or other granulated particles such as thermoplastic elastomers or rubbers, EPDM rubber, or cork. The infill of particulate material provides resiliency to the surface and helps keep the ribbons in an upright position.

[0003] Generally, the ribbons and backing of artificial turf known in the prior art is formed by tufting the ribbons through one or more layers of backing. The backing may comprise a single layer of material or multiple layers of material, and the individual layers may be woven and/or nonwoven material.

[0004] The tufting is generally performed using a conventional tufting machine analogous to a giant sewing machine with hundreds of needles. Multiple ends of yarn are fed to a bank of heavy needles with a typical span of twelve to fifteen feet. The tufting process involves passing a previously constructed primary backing under the needles and anchoring each stitch. The ribbons are thereby stitched into the backing fabric, leaving loops which form the turf pile. The pile may be loop pile, cut pile, or a combination of cut and loop introduced simultaneously in the turf by pushing off certain loops from the hook before they are cut.

[0005] Once the ribbons are tufted in place through the primary backing, a secondary backing may be applied to the primary backing.

BRIEF SUMMARY

[0006] With parenthetical reference to the corresponding parts, portions or surfaces of the disclosed embodiment, merely for the purposes of illustration and not by way of limitation, a removable active panel system is provided for installing removable artificial turf panels in a playing surface, the system comprising an artificial turf panel having a plurality of upstanding ribbons extending from a backing layer, at least a portion of the backing layer comprising at least one of a magnet and a ferromagnetic material, a support layer supporting the artificial turf panel and having a channel formed therein, the channel comprising at least one of a magnet and a ferromagnetic material, wherein the artificial turf panel is removably attached to the support layer by magnetic engagement of at least one of the magnet and ferromagnetic material of the artificial turf panel with the other of the at least one of the magnet and the ferromagnetic material of the support layer.

[0007] The panel may have an infill layer interspersed between the upstanding ribbons extending from the backing layer. The magnet may comprise a permanent magnet. The ferromagnetic material may comprise a permanent magnet. The magnet may comprise an electromagnet. The backing layer may comprise a primary backing layer and a secondary backing layer. The at least one of a magnet and a ferromagnetic material of the backing layer may comprise a magnetic additive in at least a portion of the secondary backing layer. The secondary backing layer may comprise urethane. The at least one of a magnet and a ferromagnetic material of the backing layer may comprise a permanent magnet fixed to at least a portion of the secondary backing layer. The support layer may comprise an elastomeric material. The support layer may comprise a layer of stone, concrete or asphalt disposed below the layer of elastomeric material. The support layer may comprise stone, concrete and/or asphalt.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The accompanying drawings are incorporated herein as part of the specification. The drawings described herein illustrate embodiments of the presently disclosed subject matter and are illustrative of selected principles and teaching of the present disclosure and do not illustrate all possible implementations thereof. The drawings are not intended to limit the scope of the present disclosure in any way.

[0009] FIG. 1 is a plan view of a turf system having removable panels according to an embodiment of the present disclosure.

[0010] FIG. 2 is a plan view of an end zone schematic layout according to an embodiment of the present disclosure.

[0011] FIG. 3 is a cross-sectional view taken along lines 3-3 of FIG. 2.

[0012] FIG. 4 is a schematic diagram depicting the installation of removable panels according to an embodiment of the present disclosure.

[0013] FIG. 5 is a top view of a schematic diagram depicting steps for forming a channel in an elastomeric layer according to an embodiment of the present disclosure.

[0014] FIG. 6 is a schematic diagram depicting the formation of an internal seam according to an embodiment of the present disclosure.

[0015] FIG. 7 is a schematic diagram depicting the installation of removable panels according to another embodiment of the present disclosure.

[0016] FIG. 8 is a schematic diagram depicting the installation of removable panels according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0017] It is to be understood that like reference numerals are intended to identify the same structural elements, portions or surfaces consistently throughout the several drawing figures, as such elements, portions or surfaces may be further described or explained by the entire written specification, of which this detailed description is an integral part. Unless otherwise indicated, the drawings are intended to be read (*e.g.*, cross-hatching, arrangement of parts, proportion, debris, etc.) together with the specification, and are to be considered a portion of the entire written description of the invention. As used in the following description, the terms “horizontal”, “vertical”, “left”, “right”, “up” and “down”, as well as adjectival and adverbial derivatives thereof, (*e.g.*, “horizontally”, “rightwardly”, “upwardly”, etc.), simply refer to the orientation of the illustrated structure as the particular drawing figure faces the reader. Similarly, the terms “inwardly” and “outwardly” generally refer to the orientation of a surface relative to its axis of elongation, or of rotation, as appropriate.

[0018] Additionally, it is to be understood that the invention may assume various alternative orientations and step sequences, except where expressly specified to the contrary. Hence, specific dimensions, directions or other physical characteristics relating to the embodiments disclosed are not to be considered as limiting, unless expressly stated otherwise.

[0019] Referring now to FIG. 1, in an embodiment, a multipurpose artificial turf system 10 includes removable panels 13. The turf system 10 may include some areas of the turf that are permanently installed and some areas that comprise the removable panels 13. As illustrated in FIG. 1, in an embodiment, the turf system 10 may be installed to create an American football field. In an embodiment, removable panels 13 may be used to decorate special events or may be used for providing individual team logos where more than one team may share the venue for home games. Removable panels 13a, 13b, and 13c are located at midfield and may be used to depict logos related to the team, league, or to special events such as championships or all-star games. Removable panels 13d-k and removable panels 13l-s are located at opposite end zones. The surrounding turf 16 and the remainder of the field 19 are permanently installed. At the top of the figure, additional removable panels 22a-o are provided to convert the turf system 10 to a baseball field configuration. Other configurations for additional or alternative playing surfaces such as, without limitation, for a soccer field/football pitch or rugby field, will be evident to those of ordinary skill in the art based on this disclosure.

[0020] As illustrated in FIG. 2, in an embodiment, an American football field end zone portion 25 may be divided into six subsections 28a-f. In other embodiments, the end zone portion 25 may be divided into any number of sections as will be evident to persons of ordinary skill in the art based on this disclosure. In an embodiment, the end zone portion subsections 28a-f provide for attachment of removable panels 31 along their outside edges 34a-d. The end zone portion 25 has a border area 37 that extends around the periphery of the end zone portion 25. In an embodiment, the border area 37 may have a width between 2 inches and 6 inches. Interior seam areas 40, 43, and 46 extend between the sides of the border area 37. In an embodiment, the interior seam areas 40, 43, 46 may have a width of approximately twice the width of the border area 37.

[0021] As illustrated in FIG. 3, in an embodiment, the turf system 10 includes several supportive layers. In this embodiment, a first supportive layer 50 may comprise a concrete slab. The first supportive layer 50 may also be referred to as the base layer. A second supportive layer 53 may be provided on top of the concrete slab 50. In an embodiment, the second supportive layer 53 may comprise stone. The supportive layer 53 may be referred to as an intermediate layer. A third supportive layer 56 may be disposed on top of the second supportive layer 53. In an embodiment, the third supportive layer 56 may comprise a porous asphalt. A fourth supportive layer 59 of an elastomeric material may be provided on top of the stone and asphalt layers 53, 56, respectively. The additional supportive layers 53, 56, 59 above the concrete slab 50 provide for drainage and cushioning beneath the artificial turf system playing surface. While a multi-layer support system 50, 53, 56, 59 is shown and described, different numbers and/or types of layers may be used as alternatives without deviating from the present disclosure. For example, and without limitation, the base layer may comprise either porous or non-porous asphalt with a top cushioning elastomeric layer, or the base layer may comprise the only supportive layer beneath the artificial turf system playing surface.

[0022] A top layer 62 of the artificial turf system 10 is comprised of the artificial or synthetic turf. The top layer 62 includes turf fibers 65 on one side and a backing 68 on the opposite side. The backing 68 may be disposed directly onto the elastomeric layer 59. In an embodiment, the backing 68 may be permanently attached to the elastomeric layer 59 in certain areas of the field and may be removably coupled with the elastomeric layer 59 in other areas, such as at midfield and the end zones, as removable panels 13, 31.

[0023] As illustrated in FIG. 2, in an embodiment, rails 120 may be disposed in the seam areas 40, 43, 46 and border areas 37 for supporting one or more trays of natural grass turf. The rails 120 may be disposed generally parallel to the seam areas 40, 43, 46 and border areas 37 in which they are located, respectively. In an embodiment, the rails 120 may comprise, but are not limited to, steel, aluminum, and/or alloy. One or more removable panels 31 may be removed and one or more trays of natural grass turf may be inserted/supported on the rails 120.

[0024] The turf top layer 62 includes a primary backing layer 68 and a plurality of upstanding synthetic ribbons 65 representing blades of grass, extending upwardly from the upper surface of backing layer 68. In this embodiment, ribbons 65 are fibrillated slit-film and/or extruded polyethylene ribbons. Fibrillation means that the yarn is of a flat, tape-like character and includes longitudinally extending slits across its width. With light brushing, these slits tend to split along the slits into several individual free standing strands of a width that is thinner than the full width of the yarn and thereby more closely resembles blades of grass.

[0025] In an embodiment, an infill layer 69 may be provided above the top layer 62. The infill layer 69 may be interspersed between the upstanding ribbons 65 on the backing layer 68. In this arrangement, the synthetic ribbons 65 are designed to extend a distance above the infill layer 69. The infill layer 69 may comprise, without limitation, sand, rubber, a mixture of sand and rubber, and/or other granulated particles such as thermoplastic elastomers, rubbers, EPDM rubber, cork and/or organics. The infill layer 69 of particulate material provides resiliency to the top layer 62 and helps keep the ribbons 65 in an upright position.

[0026] Generally, the ribbons 65 and backing layer 68 are formed by tufting the ribbons 65 through one or more layers of backing 68. The backing 68 may comprise a single layer of material or multiple layers of material, and the individual layers may be woven and/or nonwoven material.

[0027] The tufting is generally performed using a conventional tufting machine, which is analogous to a giant sewing machine with hundreds of needles. Multiple ends of yarn are fed to a bank of heavy needles with a typical span of twelve to fifteen feet. The tufting process involves a previously constructed primary backing passing under the needles and anchoring each stitch. The ribbons 65 are thereby stitched into the backing fabric, leaving loops which form the turf pile. The pile may be loop pile, cut pile, or a combination of cut and loop introduced simultaneously in the backing 68 by pushing off certain loops from the hook before they are cut.

[0028] Once the ribbons 65 are tufted in place through the primary backing, the backing 68 is further coated on its back side with a urethane or latex coating, which may be referred to as a secondary backing, to help adhere the stitched ribbons 65 to the backing member 68 and to provide dimensional stability. In an embodiment, the secondary backing may include fiberglass disposed in the urethane or latex coating. The fiberglass in the secondary backing increases the stiffness of the backing layer 68.

[0029] Turning now to FIG. 3, in an embodiment, an infill layer 69 may be provided in the top layer 62. The infill layer 69 may be a mixture of rubber and sand particles interspersed between the upstanding ribbons 65 on the backing layer 68. In an embodiment, the synthetic ribbons 65 extend a length of about one (1) inch or greater from the upper surface of backing layer 68. The height of infill layer 69 may extend from about 50% to 80% the height of the ribbons 65, which means that ribbons 65 extend a distance of about 50% to 20% of their height above the top surface of the infill layer 69. In other embodiments, other ratios may be used as alternatives.

[0030] With continued reference to FIG. 3, in an embodiment, the end zone area may include three longitudinal channels 71a-c disposed in the elastomeric layer 59. Materials for engaging with the removable active panels 31 may be disposed in the three longitudinal channels 71a-c, as described in greater detail below. In other embodiments, the number and shape of the channels 71 may be varied as desired.

[0031] As illustrated in FIG. 5, in an embodiment, the elastomeric layer 59 may be disposed on top of the porous asphalt layer 56. In production of the artificial turf system 10, the elastomeric layer 59 may be applied to the porous asphalt layer 56 via a paving process as will be evident to those of ordinary skill in the art based on this disclosure. During the paving process, one or more channel forms 93 are positioned where longitudinal channels 71 are desired. In an embodiment, the forms 93 may be constructed of a sturdy lightweight material such as, but not limited to, aluminum. The forms 93 fill the space for the channels 71 to prevent elastomeric material 59 from entering the channel space during paving. After the elastomeric layer 59 dries and sets/cures, the forms 93 are removed. Alternatively, and without limitation, the layer 59 may be applied as a continuous flat surface and channels 71 may thereafter be cut, ground, or otherwise formed via a subtractive process into layer 59. At this stage of production, the channels 71 are longitudinal empty spaces located in the portion of the elastomeric material 59 defining the seam areas 40, 43, 46 and border areas 37 (see FIG. 2). The attachment of the removable turf panels 31 is described in greater detail below.

[0032] As illustrated in FIG. 7, in an embodiment, the removable turf panels 31 may include a plurality of bars 100 containing a ferromagnetic material such as iron or the like. The ferromagnetic bars 100 may be disposed in the backing layer 68 of the removable panel top layer 62. Alternatively, the ferromagnetic material may be formed as a unitary structure (not depicted). In an embodiment, the longitudinal channel 71 may be provided with a pad 75 for permanent attachment to the third supportive layer 56. In an embodiment, a permanent magnet 103 may be disposed on the pad 75 in the channel 71. As an alternative, the permanent magnet 103 may be disposed on the backing layer 68 of removable panel 31 and the ferromagnetic material may be disposed on the pad 75.

[0033] As another alternative, the backing layer 68 may be provided with a number of magnetic strips 100A and corresponding magnetic strips 103A may be provided on the pad 75 in the channels 71, or in the channels 71 without a pad 75. In an embodiment, the magnetic strips 100A, 103A may comprise flexible magnet sheets. The magnet sheets may include a ferromagnetic material integrated with a polymeric material or other flexible binder. In an embodiment, the magnetic strips 100A, 103A may be separated with a relatively small pull force normal to the field surface to facilitate efficient removal of the removable panels 31. However, to ensure that shear forces applied to the removable panels 31 during an athletic event do not cause shifting of the removable panels 31, the magnetic attraction between the magnetic strips 100A, 103A is greater in a plane parallel to the playing surface than in a plane normal to the playing surface. Thus, magnetic strips 100A, 103A have a magnetic attraction that provides improved dimensional stability parallel to the playing surface to prevent shear slip of the removable panel 31 relative to the multi-layer support system 50, 53, 56, 59.

[0034] In an embodiment, the inside surface of one or more of the magnetic strips 100A, 103A may have a high coefficient of friction material applied thereto. The high coefficient of friction material may include, but is not limited to, a polymeric material. In an embodiment, to prevent shear slip of the removable panels 31, a rough coating may be applied between the magnetic strips 100A, 103A.

[0035] When the panel 31 is aligned with the channel 71 and pushed down in the direction of arrow 106, the ferromagnetic material 100 and the permanent magnet 103 attract and provide a magnetic force to hold the panel 31 in position in the turf system 10. The magnetic bond is strong enough to hold the turf panel 31 securely in position, but may be manually separated during removal of the turf panel 31. As an alternative, the permanent magnet 103 may be

replaced by an electromagnet which becomes magnetic when energized by an electrical current and/or the ferromagnetic material 100 may comprise permanent magnets.

[0036] Turning to FIG. 8, an alternate embodiment is shown. In this embodiment the backing 68 of the turf panel is provided with an additional secondary layer 107 formed from a plastic or elastomeric resin or urethane containing a magnetic additive or a magnetic powder. In addition, or as an alternative, the primary backing 68 may be provided with a magnetic additive or magnetic powder. As illustrated in FIG. 8, the magnet for engaging with the ferromagnetic material in the backing 68 may be an electromagnet 109 provided with a current through an electrical circuit 110 connected thereto.

[0037] Turning now to FIG. 4, in an alternative embodiment, the attachment of the removable turf panels 31 may include a hook and loop system 78, 81. As illustrated in FIG. 4, a removable turf panel 31 is attached along edge 34c to the border area 37. The longitudinal channel 71c is provided with a pad 75 for permanent attachment to the sublayer. As shown, pad 75 is supported by the porous asphalt layer 56. Alternatively, the pad 75 may be supported by a different sublayer or a partial layer 59 of elastomeric material. The pad 75 may have a top surface 79 that is provided with a hook and loop fastening material 78. The pad 75 is constructed of any material suitable for attachment to a sublayer on one side and for attachment of the hook and loop fastening material 78 on the opposite side. The removable panel 31 may also be provided with hook and loop fastening material 81 disposed on the backing layer 68. The hook and loop fastening material 81 attaches to the corresponding hook and loop fastening material 78 when the panel 31 is positioned and a force is applied in the direction of arrow 90.

[0038] Turning to FIG. 6, an internal seam such as located along interior seam area 40 (FIG. 2) is shown. The edges of two adjacent panels 31 are disposed adjacent to each other and removably attached by means of cooperating hook and loop fastening materials 78, 81.

[0039] One or more features of the embodiments described supra may be combined to create additional embodiments which are not depicted. The present invention contemplates that many changes and modifications may be made. Therefore, while the presently-preferred form of the removable active panel system has been shown and described, and several modifications and alternatives discussed, persons skilled in this art will readily appreciate that various additional changes and modifications may be made without departing from the scope of the invention.

CLAIMS

What is claimed is:

1. A removable artificial turf panel system, comprising:

an artificial turf panel having a plurality of upstanding ribbons extending from a backing layer and having an infill layer interspersed between the upstanding ribbons extending from the backing layer;

at least a portion of the backing layer comprising at least one of a first magnet and a first ferromagnetic material;

a support layer supporting the artificial turf panel and having a channel formed therein, the channel comprising at least one of a second magnet and a second ferromagnetic material;

wherein the artificial turf panel is removably attached to the support layer by engagement of at least one of the first magnet and the first ferromagnetic material with at least one of the second magnet and the second ferromagnetic material of the support layer.

2. The artificial turf panel system of claim 1, wherein the artificial turf panel comprises an infill layer interspersed between the upstanding ribbons extending from the backing layer.

3. The artificial turf panel system of claim 1, wherein at least one of the first and second magnets comprises a permanent magnet.

4. The artificial turf panel system of claim 3, wherein at least one of the first and second ferromagnetic materials comprises a permanent magnet.

5. The artificial turf panel system of claim 1, wherein at least one of the first and second magnets comprises an electromagnet.

6. The artificial turf panel system of claim 1, wherein the backing layer comprises the first magnet and the channel comprises the second magnet, the first and second magnets comprising sheet magnets.

7. The artificial turf panel system of claim 6, wherein a force required to disengage the first and second magnets is less than a force required to move the first and second magnets relative to one another in a plane parallel to the backing layer.
8. The artificial turf panel system of claim 1, wherein the backing layer comprises a primary backing layer and a secondary backing layer.
9. The artificial turf panel system of claim 1, wherein the at least one of a magnet and a ferromagnetic material of the backing layer comprises a magnetic additive in at least a portion of the secondary backing layer.
10. The artificial turf panel system of claim 9, wherein the secondary backing layer comprises urethane.
11. The artificial turf panel system of claim 8, wherein the at least one of a magnet and a ferromagnetic material of the backing layer comprises a permanent magnet fixed to at least a portion of the secondary backing layer.
12. The artificial turf panel system of claim 1, wherein the support layer comprises an elastomeric material.
13. The artificial turf panel system of claim 12, wherein the support layer comprises one of a layer of stone, concrete and asphalt disposed below the layer of elastomeric material.
14. The artificial turf panel system of claim 1, wherein the support layer comprises stone, concrete and asphalt.
15. A method of installing a removable artificial turf panel on a base layer, the method comprising:
 - a) providing a layer of stone;
 - b) providing a layer of porous asphalt on top of the layer of stone;

c) providing a layer of elastomeric material on top of the layer of porous asphalt, the layer of elastomeric material having at least one channel formed therein, the channel comprising at least one of a magnet and a ferromagnetic material;

d) providing an artificial turf panel having a plurality of upstanding ribbons extending from a backing layer, wherein the backing layer of the artificial turf panel comprises at least one of a magnet and a ferromagnetic material and wherein the artificial turf panel has an infill layer interspersed between the upstanding ribbons extending from the backing layer;

e) placing the artificial turf panel on the layer of elastomeric material and magnetically engaging the at least one of the magnet and ferromagnetic material in the artificial turf panel with the other of the at least one of the magnet and the ferromagnetic material in the channel of the elastomeric layer.

16. The method of claim 15, wherein the system further comprises a pad attached to the elastomeric layer inside the channel.

17. The method of claim 16, wherein the channel is created by a form that is inserted onto the porous asphalt layer during application of the elastomeric layer by means of a paving process.

18. A removable artificial turf panel system, comprising:

an artificial turf panel having a plurality of upstanding ribbons extending from a backing layer and having an infill layer interspersed between the upstanding ribbons extending from the backing layer;

one of a male and female hook and loop fastening material disposed on at least a portion of the outside of the backing layer;

a layer of elastomeric material supporting the artificial turf panel and having a channel formed therein, the channel having the other of the male and female hook and loop fastening material;

wherein the artificial turf panel is removably attached to the layer of elastomeric material by engagement of the hook and loop fastening material on the artificial turf panel with the hook and loop fastening material on the elastomeric layer.

19. The artificial turf panel system of claim 18, wherein the system further comprises a layer of stone disposed below the layer of elastomeric material.
20. The artificial turf panel system of claim 18, wherein the system further comprises a layer of porous asphalt disposed below the layer of elastomeric material.
21. The artificial turf panel system of claim 18, wherein the system further comprises a concrete slab disposed below the layer of elastomeric material.
22. The artificial turf panel system of claim 18, wherein the system further comprises a pad attached to the layer of elastomeric material inside the channel.
23. The artificial turf panel system of claim 18, wherein the channel is created by a form that is inserted onto the porous asphalt layer during application of the layer of elastomeric material by means of a paving process.
24. A method of installing a removable artificial turf panel on a concrete slab, the method comprising:
- a) providing a layer of stone;
 - b) providing a layer of porous asphalt on top of the layer of stone;
 - c) providing a layer of elastomeric material on top of the layer of porous asphalt, the layer of elastomeric material having at least one channel formed therein, the channel having one of a male and female hook and loop fastening material;
 - d) providing an artificial turf panel having a plurality of upstanding ribbons extending from a backing layer and having an infill layer interspersed between the upstanding ribbons extending from the backing layer;
 - e) placing the artificial turf panel on the layer of elastomeric material by engaging the hook and loop fastening material on the backing layer with the hook and loop fastening material on the layer of elastomeric material; and
 - f) applying pressure to the artificial turf panel to attach it to the layer of elastomeric material.

25. The method of claim 24, wherein the system further comprises a pad attached to the elastomeric layer inside the channel.

26. The method of claim 24, wherein the channel is created by a form that is inserted onto the porous asphalt layer during application of the elastomeric layer by means of a paving process.

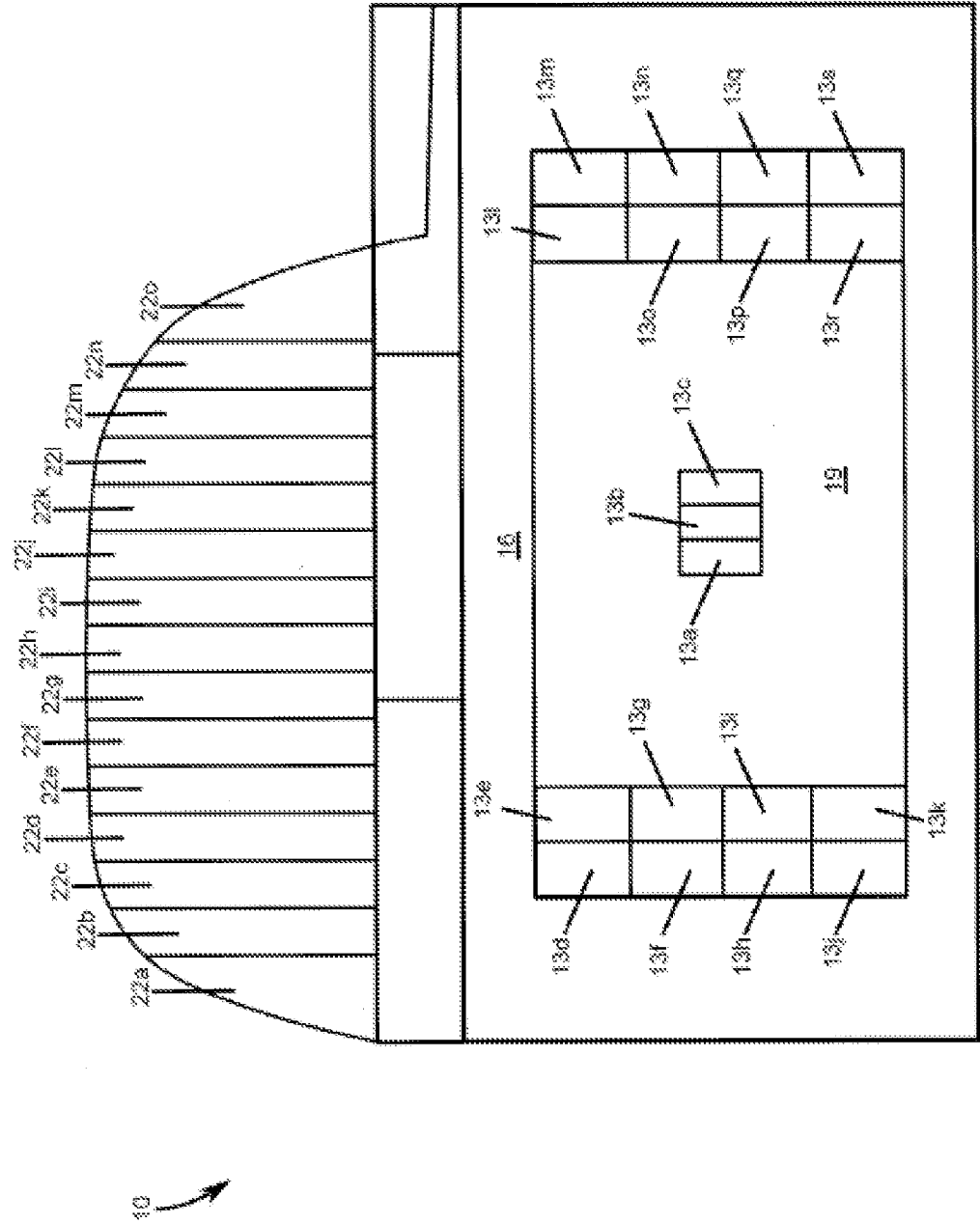
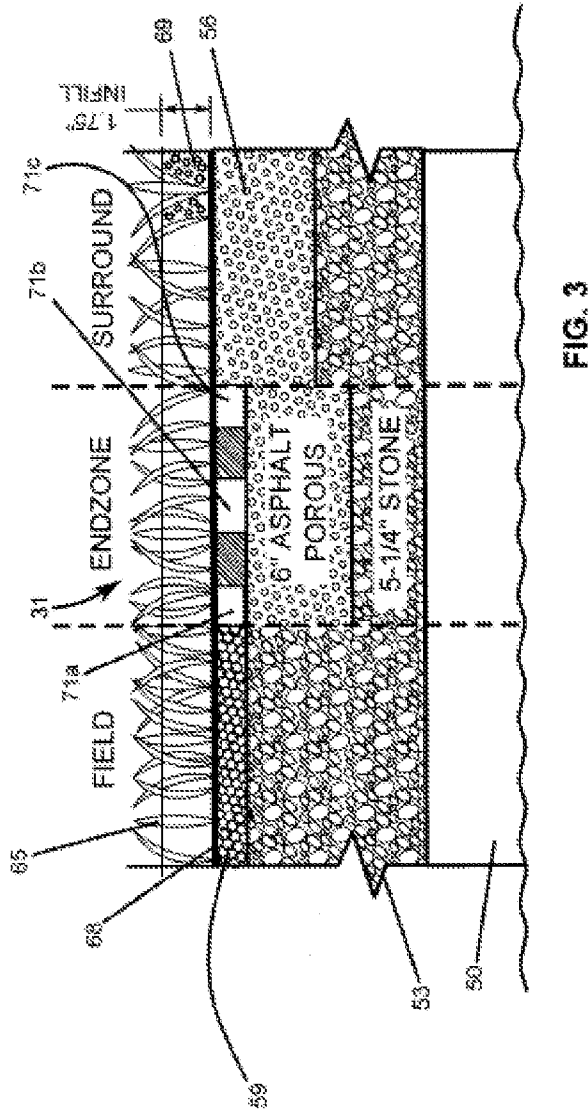
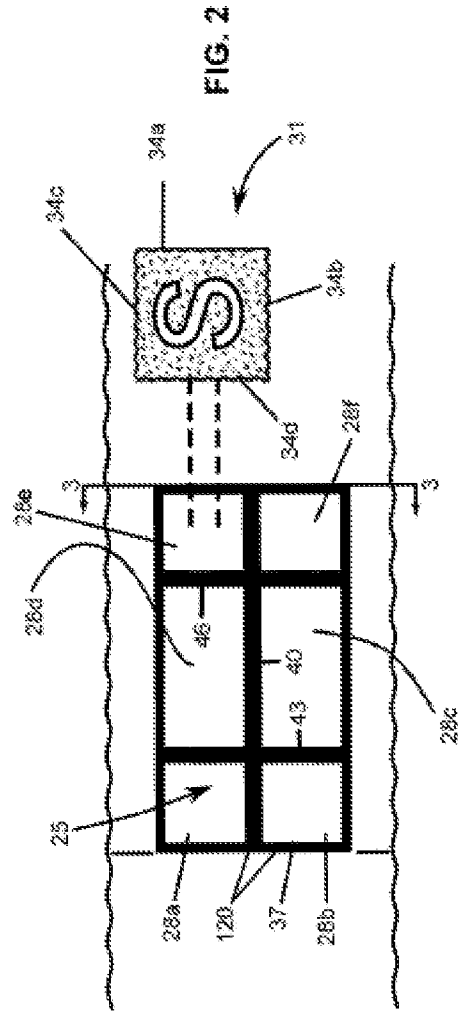
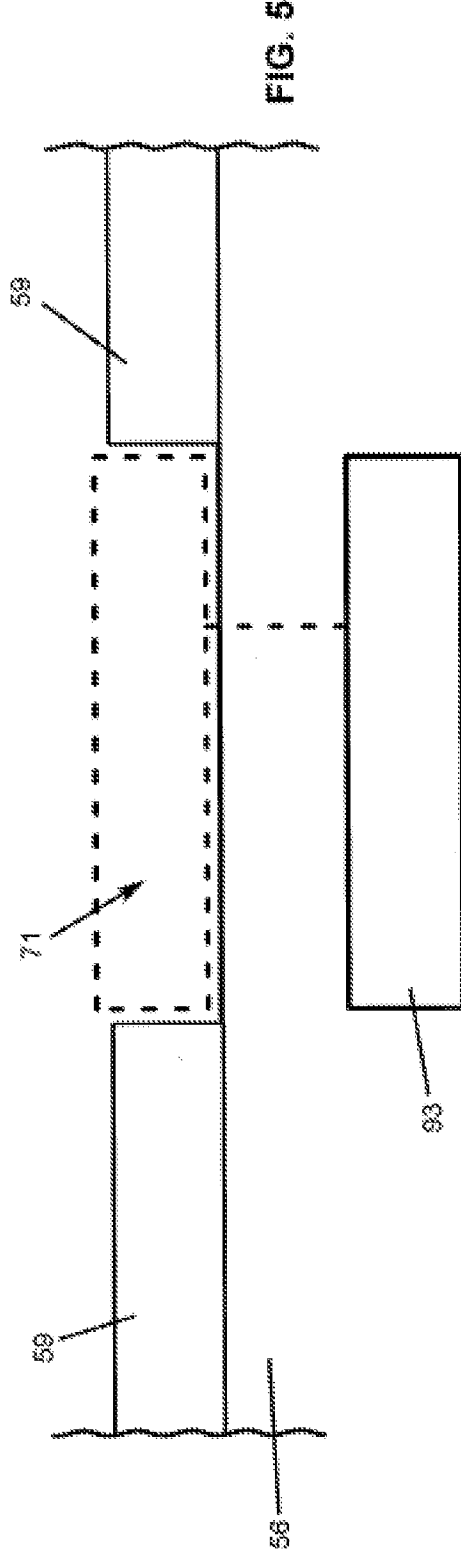
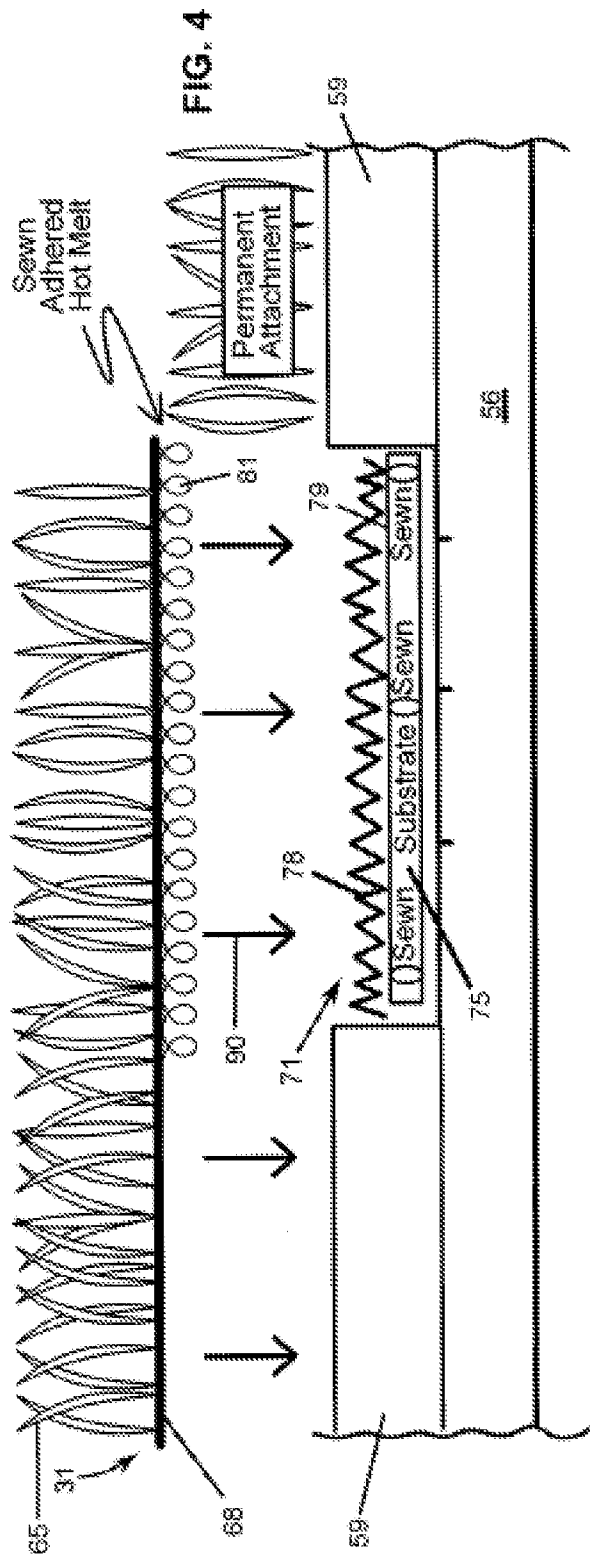


FIG. 1





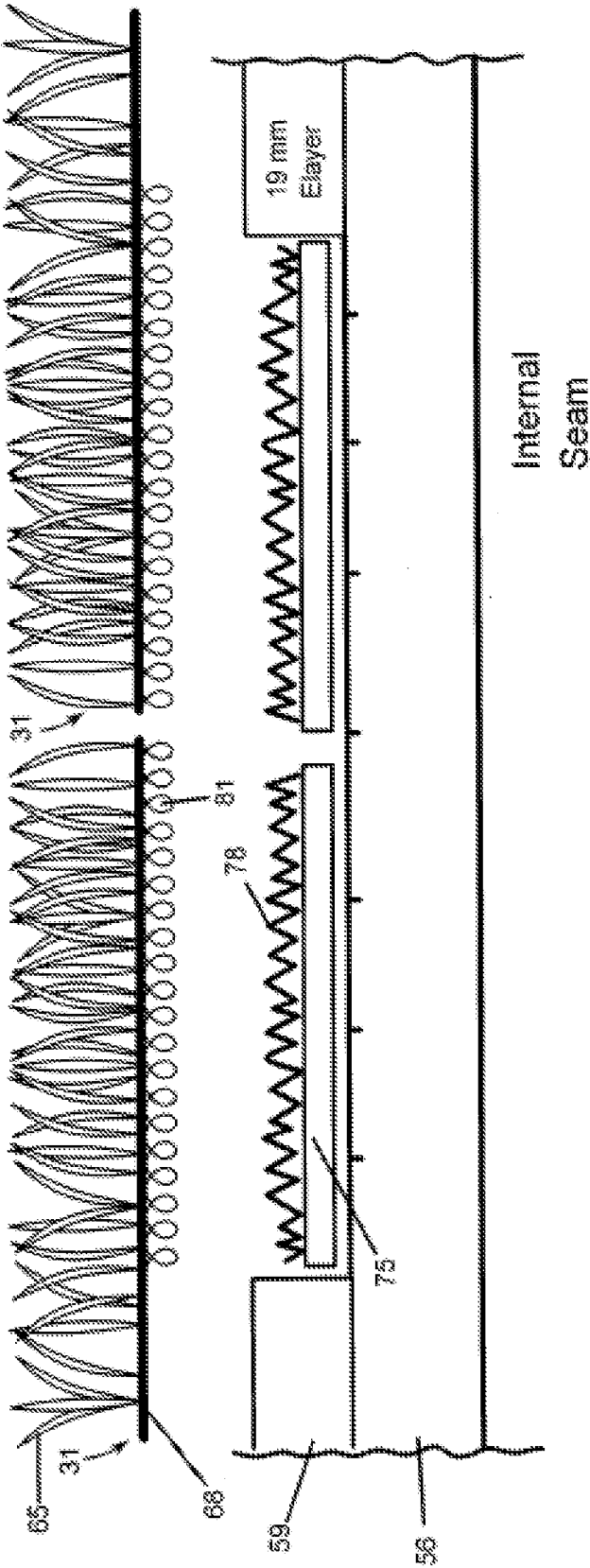


FIG. 6

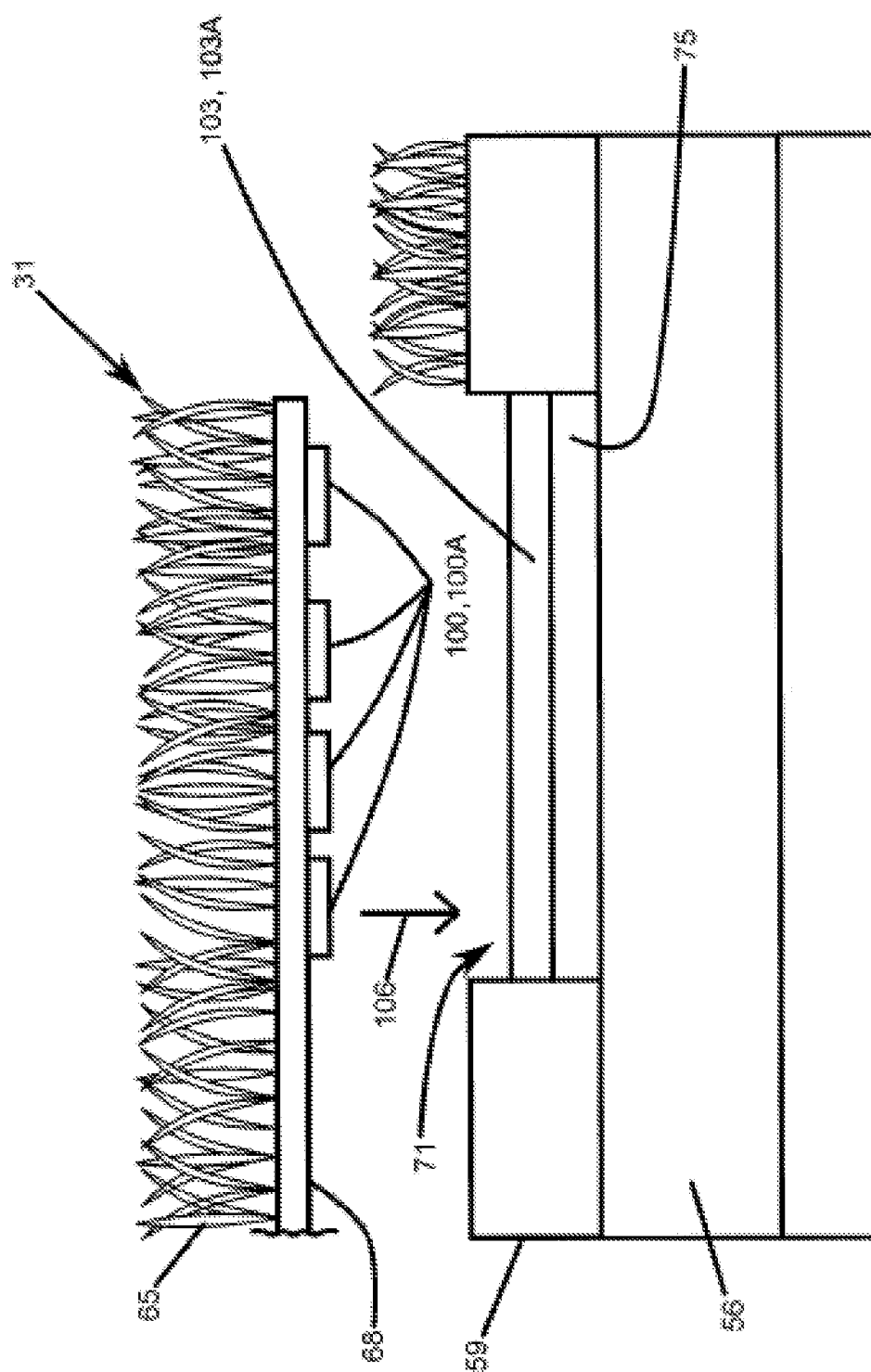


FIG. 2

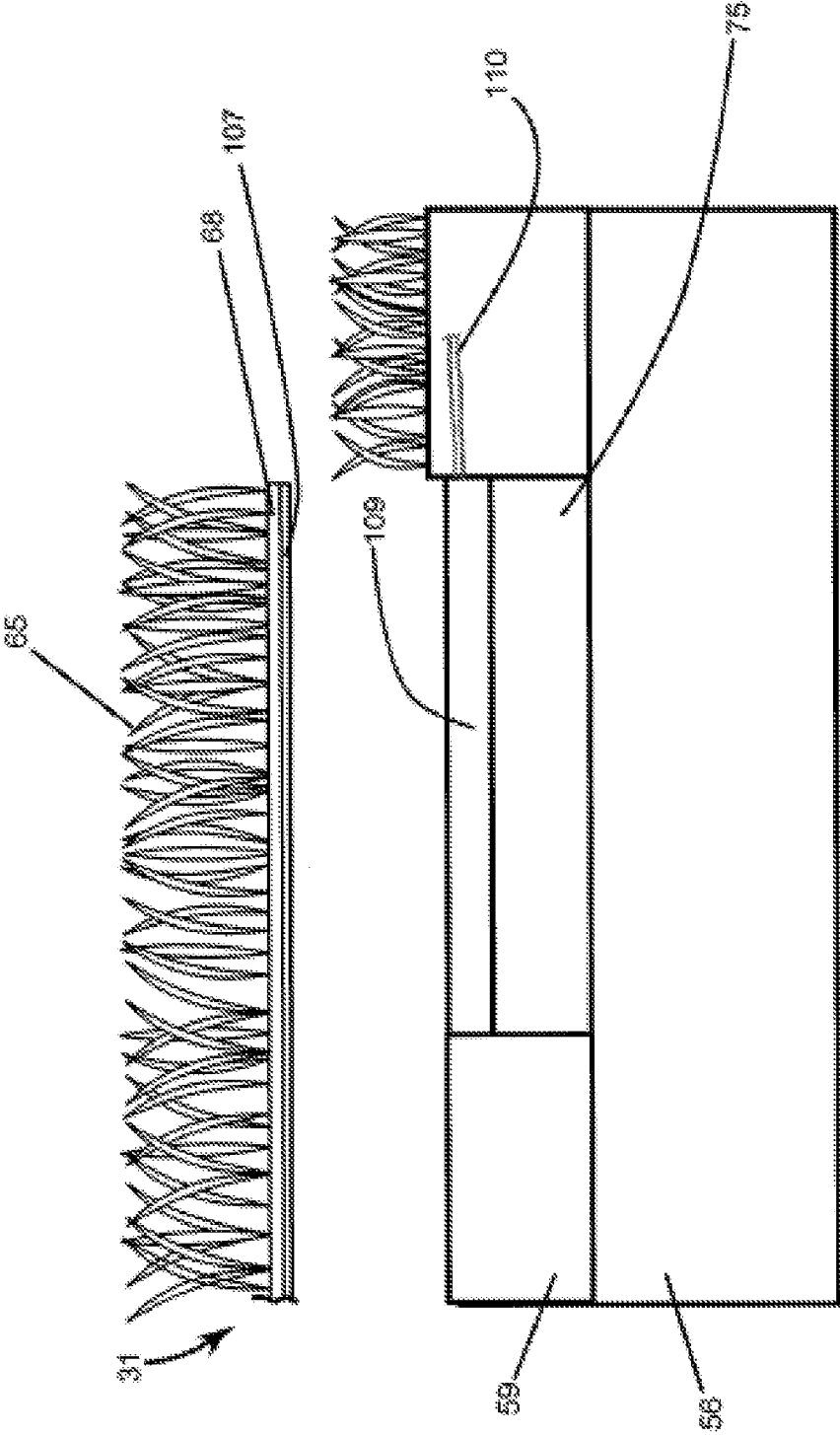


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/064631

A. CLASSIFICATION OF SUBJECT MATTER
INV. E01C13/04 E01C13/08 E01C9/08 E01C13/00
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)
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)

EPO-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 Y	EP 1 705 292 A1 (HEEK SCHOLCO ENTPR B V VAN [NL]) 27 September 2006 (2006-09-27) figure 1 paragraphs [0018], [0021], [0022], [0024] the whole document -----	1,2,5-8, 15-17 3,4,9-14
Y	EP 0 159 865 A2 (MENHENNET JOHN ALBERT FREDERIC) 30 October 1985 (1985-10-30) figure 1 page 3, line 6 - page 5, line 24 the whole document -----	3,4,9-14
A	US 2004/058096 A1 (PREVOST JEAN [CA]) 25 March 2004 (2004-03-25) figures 1,14,21 paragraphs [0049], [0065], [0078] the whole document ----- -/-	1-4,8, 11,14,15



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

15 February 2019

Date of mailing of the international search report

26/02/2019

Name and mailing address of the ISA/

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Authorized officer

Klein, A

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2018/064631

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016/312414 A1 (FOWLER GREGORY D [US] ET AL) 27 October 2016 (2016-10-27) figures 1-5 paragraph [0042] the whole document -----	1-17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/064631

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 18-26
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 18-26

On 12-02-2019, pursuant to Article 17(2)(a)(ii) PCT, the applicant was invited to indicate the claims complying with the Article 6 PCT on the basis of which the search was to be carried out.

On 12-02-2019, the applicant requested "that the International Searching Authority search claims 1 and 15 and the claims depending directly or indirectly therefrom", which is understood as an appropriate answer to the invitation pursuant to Article 17(2)(a)(ii) PCT.

The search is therefore done, in accordance with Article 17(2)(a)(ii) PCT, on independent claim 1 and its dependent claims 2-14, and on independent claim 15 and its dependent claims 16,17.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2018/064631

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