

(19)



(11)

EP 4 741 573 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.05.2026 Bulletin 2026/20

(51) International Patent Classification (IPC):
E01C 13/02^(2006.01)

(21) Application number: **24212298.4**

(52) Cooperative Patent Classification (CPC):
E01C 13/02

(22) Date of filing: **12.11.2024**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

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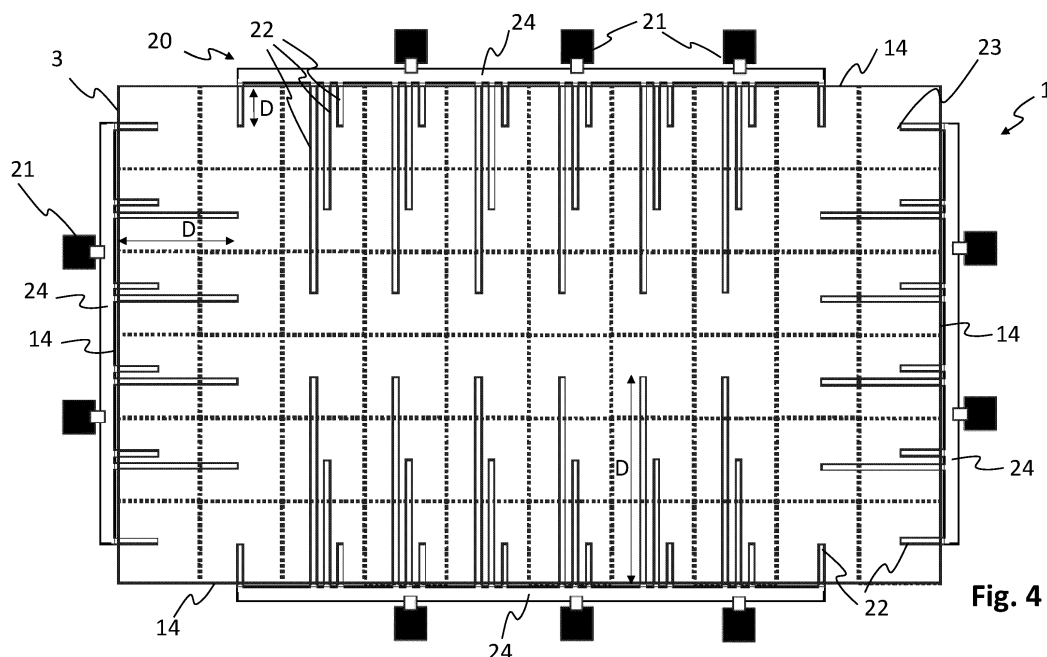
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(54) **FLOOR STRUCTURE AND RELATED METHOD FOR CONTROLLING THE TEMPERATURE OF A FLOOR SURFACE**

(57) A floor structure (1), and a relative method for controlling the temperature, comprising a floor layer (2), a supporting layer (10) realizing a continuous air chamber (11) having an aerial extension comparable to an aerial extension of a floor surface (3), and an air movement system (20) to generate an air flow through the floor layer

(2) from the air chamber (11) to the floor surface (3) and/or viceversa, the air movement system (20) comprising one or more air mouths (23) opening into the air chamber (11) at a distance (D) from a side surface (14) of the air chamber (11).

**Fig. 4****EP 4 741 573 A1**

Description

Technical field of the invention

[0001] The present invention relates to a floor structure with an artificial floor surface, e.g. an artificial turf field, a sport field, a playground, a roof top, a terrace, a garden and the like, and a related method for controlling the temperature of such floor surfaces.

State of the art

[0002] WO2017058018A1 discloses artificial turf systems in which the temperature of the artificial turf within a playing area may be cooled or heated by forced air flow.

Summary of the invention

[0003] With the expression 'air permeable' or 'air permeability' it is meant the ability of a layer or other element to allow air to pass through itself. The expression 'air tight' means the opposite ability.

[0004] The expression "side surface of the air chamber" refers to a lateral surface extending along a perimeter of the air chamber in a plan view.

[0005] The expression "distance between a mouth and a side surface of the air chamber" refers to the shortest horizontal distance between a geometrical centre of the mouth and said side surface of the air chamber.

[0006] Outdoor surfaces are subject to environmental conditions that can significantly affect their usability, safety, and longevity. For example, outdoor surfaces like synthetic turfs can reach temperatures exceeding 80°C under direct sunlight, making them uncomfortable or unsafe for use. Alternatively in colder months all types of surfaces can easily freeze making them unusable or unsafe.

[0007] The Applicant has faced the problem of controlling the temperature of a walkable floor efficiently and/or substantially homogeneously over the entire floor aerial extension, even in case of large or very large floor extension, such as a soccer or football pitch, while at the same time keeping relatively simple and/or compact the overall floor structure.

[0008] One or more of the above problems are solved by a floor structure in accordance with the appended claims and/or having the following characteristics.

[0009] According to an aspect the invention relates to a floor structure comprising:

- a floor layer having a floor surface;
- a supporting layer for supporting the floor layer, wherein the supporting layer realizes a continuous air chamber having an aerial extension comparable to (e.g. same of) an aerial extension of the floor surface, and wherein the floor structure is air permeable from the air chamber to the floor surface and/or viceversa; and

- an air movement system structured to generate an air flow through the floor layer from the air chamber to the floor surface and/or viceversa, the air movement system comprising one or more mouths opening into the air chamber.

[0010] Preferably each air mouth opens into the air chamber at a distance from a side surface of the air chamber.

[0011] According to an aspect, the invention relates to a method for controlling a temperature of the floor surface in the floor structure according to the present invention. Preferably the method comprises generating said air flow through the floor layer by said air movement system to cool or heat said floor surface.

[0012] Said air flow may be directed from the air chamber to said floor surface or from said floor surface to said air chamber.

[0013] The Applicant has found that by placing each mouth (i.e. air inlet and/or outlet according to the various embodiments) to open into the air chamber at a distance from the side surface (i.e. the perimeter edge) of the continuous air chamber favours the distribution of the air flow over the respective portion of floor surface associated to the air mouth and functioned by the air mouth. For example, for a given air permeability of the floor layer and for a given air flow/air flow power at the mouth, each mouth can generate an air flow (passing vertically through the floor layer from the air chamber to the floor surface or viceversa) over a larger portion of the floor surface and/or with a greater air flow uniformity over the portion of floor surface, with respect to a mouth opening up at the perimeter edge of the air chamber, as disclosed for example in WO2017058018A1. In this way it is possible to cool or heat the floor surface efficiently while keeping simple and/or compact and/or energy efficient the overall air movement system.

[0014] The present invention can have one or more of the following preferred features. Preferably the air movement system comprises one or more pipes, each pipe comprising at least one of said one or more air mouths.

[0015] Preferably the air movement system comprises one or more fans in air communication with said one or more mouths, more preferably through said one or more pipes.

[0016] In one embodiment the floor structure comprises one or more manifolds, each manifold putting in air communication at least one of said one or more pipes with the outer environment, possibly through at least one of said one or more fans. Preferably each manifold is placed opposite to said side surface of the air chamber, possibly adjacent to said side surface. Exemplarily each manifold is in air communication with a plurality of said pipes and/or a plurality of said fans. In one embodiment one or more manifolds are placed at each side of the floor surface. One or more of these solutions allow a proper air flow management.

[0017] Preferably said distance between each air

mouth and said side surface of the air chamber is at least 1 m, more preferably at least 2 m, even more preferably at least 3 m. In this way the above air flow distribution is improved.

[0018] Preferably each pipe has an end portion comprising said one or more air mouths and extending within the air chamber (and within the supporting layer). Preferably said end portion is at least 1 m long, more preferably at least 2 m long, even more preferably at least 3 m. In this way the above air flow distribution is improved.

[0019] In one embodiment each pipe has one and only one respective mouth, more preferably at an end of said pipe. In this way the flow management is simple.

[0020] In one embodiment each pipe, and/or said end portion of each pipe, has two or more respective mouths, more preferably distributed along said pipe, and/or along said end portion of said pipe. In this way the piping system is simple.

[0021] Preferably each pipe extends from said side surface of the air chamber up to said respective one or more mouths entirely within the air chamber (and within the supporting layer). Preferably said supporting layer comprises, for each pipe, a respective channel housing said pipe. In this way the air movement system remains compact, since the pipe are contained within the air chamber, and the installation of the pipes is simple.

[0022] Preferably each pipe, or at least the end portion of each pipe, extends within the air chamber at a vertical distance from the bottom surface of said air chamber (in other words a gap exists between the pipe and the bottom). In this way the water possibly entering in the air chamber (due to rain, irrigation or moisture of the floor) through the floor layer does not enter the pipe/s (no need for downstream filters) and/or is not hindered in draining out from the floor structure.

[0023] In an embodiment each pipe extends from said side surface (preferably from said respective manifold) up to, and excluding, said end portion, or up to said respective one or more mouths (in case the mouth/s is/are flush with the bottom surface of the air chamber), entirely below the air chamber (and below the supporting layer), e.g. buried in the substrate below the supporting layer. In one embodiment said end portion has a vertical section proximal to a bottom of the air chamber and, possibly, a horizontal section continuous with said vertical section and comprising said respective one or more mouths.

[0024] Preferably each mouth faces downward, more preferably at an angle of about $45^\circ \pm 25^\circ$ with respect to a horizontal plane. In this way the water possibly dripping from above does not enter the pipe.

[0025] In one embodiment each pipe, and/or said end portion of each pipe, has a cross-sectional area greater than or equal to 200 cm^2 , more preferably greater than or equal to 400 cm^2 , even more preferably greater than or equal to 600 cm^2 , and/or smaller than or equal to 3000 cm^2 , more preferably smaller than or equal to 2000 cm^2 . This facilitates desired air flow rates while keeping en-

ergy consumption of air movement system limited.

[0026] In one embodiment each pipe, and/or said end portion of each pipe, has a non-circular cross-sectional shape wherein a horizontal dimension is larger than a vertical dimension, such as an oval, elliptical, or lenticular shape or a rectangular shape with rounded corners. In this way a higher cross-section is available for a given height (that is the vertical dimension) as compared to a circular pipe.

[0027] Said one or more pipes may be rigid (preferred choice) or flexible. Preferably said one or more pipes have smooth internal surface (to ensure efficient air movement without turbulence or noise).

[0028] Preferably said mouths are distributed all over said aerial extension of said air chamber, more preferably regularly distributed over a pattern, e.g. over a (e.g. rectangular) grid. Preferably a distance of each mouth from each neighbouring mouth is substantially constant (e.g. within $\pm 10\%$ of a constant value). Preferably a distance of each mouth from each neighbouring mouth is greater than or equal to 5 m, more preferably greater than or equal to 8 m, and/or smaller than or equal to 25 m, more preferably smaller than or equal to 20 m. In this way also very large floor, such as those of sport fields for American football, soccer, hockey, etc, can be temperature controlled with an air movement system simple and/or compact.

[0029] Preferably said supporting layer is rigid (i.e. strong and stiff enough to resist the forces that can act on the floor above) and self-supporting (e.g. not inflated).

[0030] Preferably said supporting layer has an (average) volumetric void ratio (i.e. a ratio between the volume of interconnected void and the total volume) greater than or equal to 50%, more preferably greater than or equal to 70%.

[0031] In one embodiment said supporting layer comprises a plurality of supporting elements, more preferably rigid and self-supporting, placed side-by-side (more preferably contactingly) according to a regular pattern (e.g. the supporting layer comprises a single continuous layer of supporting elements). Preferably the supporting elements are all identical. In this way the supporting layer can be assembled in a modular structure. Preferably each supporting element has an open structure (i.e. the element has more interconnected void than material, e.g. more than 70% in volume of interconnected void). Exemplarily an outer shape of each supporting element is a rectangular parallelepiped or a cube. Preferably said supporting elements are in polymeric material, e.g. polypropylene. In this way they are easy to transport and assemble.

[0032] In one embodiment said supporting layer comprises a plurality of columns (e.g. made of bricks or concrete or metal beams) spaced apart one from the other (to create the void) and an upper grid (e.g. made of metal) placed on top of said columns. Preferably the air chamber has a height greater than or equal to 20 cm, more preferably greater than or equal to 30 cm. This

favours the air flow management, e.g. a desired uniformity of the air flow through the floor layer can be obtained with a limited number of mouths.

[0033] Preferably the air chamber has a height less than or equal to 100 cm, more preferably less than or equal to 80 cm. In this way the overall height of the entire floor structure remains limited, with advantages in term of space and complexity of installation. Preferably the floor structure comprises a solid substrate, such as packed soil, concrete, sand, asphalt, stones, the supporting layer being positioned over said substrate. The substrate can be watertight (for horizontal drainage), or water permeable (for vertical or mixed drainage). The substrate can be airtight, or air permeable.

[0034] In one embodiment the floor structure comprises a liner extending continuously over a bottom surface of the air chamber.

[0035] In one embodiment the floor structure comprises a liner extending continuously over said whole side surface of the air chamber. Preferably said liner extends continuously also over a portion of a top surface of the air chamber proximal to said side surface and/or also over a portion of the bottom surface of the air chamber proximal to said side surface. Preferably said liner extends continuously over the whole bottom surface and side surface of the air chamber.

[0036] In one embodiment, the liner is air- and/or water-tight. In one embodiment the liner is water permeable but resists air passage more than the floor layer.

[0037] One or more of the above solutions allow to direct air flow as desired, even in case of an air permeable substrate with vertical drainage.

[0038] Said one or more fans may be centrifugal (providing high pressure prevalence) and/or axial.

[0039] Preferably each axial fan is placed within a respective pipe, more preferably in proximity to said side surface of the air chamber. In this way very small footprint of the air movement system is obtained.

[0040] Preferably the air movement system comprises one or more devices for regulating a power of the fans (to regulate airflow based e.g. on environmental conditions).

[0041] Said floor surface can be a playground floor or a sport floor for padel, pickleball, tennis, American football, soccer, rugby and/or hockey.

[0042] Said floor surface can form part of a garden, a terrace, and/or a rooftop.

[0043] In one embodiment said floor layer is an artificial turf layer. An artificial turf layer comprises a backing support and artificial grass fibers fixed to said backing support to realize said floor surface. The artificial turf layer may comprise a granular infill layer dispersed between the artificial grass fibers on said floor surface (to help supporting the fibers and/or to provide the desired sports performance in terms of force reduction, vertical ball bounce and rotational friction). In an embodiment the artificial turf layer is devoid of any infill.

[0044] In other embodiments the floor surface is realized by polymeric surfaces, paving stones, tiles, and

other outdoor surfaces. These allow easy access for maintenance by allowing the surface to be lifted with minimal disruption.

[0045] According to one embodiment, the floor layer (e.g. the backing support of the artificial turf layer) is provided with through openings having size between 0.5 mm and 7 mm, preferably between 1 mm and 5 mm and more preferably between 1 mm and 2 mm.

[0046] The openings may be of any shape, regular or irregular and including round, triangular, square, rectangular or the like. The size of the openings may be defined as the largest dimension of an individual opening. In one embodiment, the through openings are spaced from each other by less than 50 mm, preferably by less than 30 mm and more preferably by less than 20 mm, and/or more than 10 mm. In this way it is possible to distribute the airflow over the floor layer.

[0047] In an embodiment the floor structure comprises a dampening layer, preferably interposed (preferably contactingly) between the floor layer (e.g. the backing support) and the supporting layer. In this way the artificial turf field may be provided with the desired mechanical performances.

[0048] In one embodiment the dampening layer is formed by woven foam strips forming upstanding loops with spaces therethrough.

[0049] In one embodiment the dampening layer is formed by dampening elements placed horizontally side-by-side and each one comprising a frame comprising a plurality of through openings and, a plurality of support bodies which protrude from said frame, each support body being arranged at a respective through opening and bridging with structural continuity two attachment regions belonging to said frame and mutually opposite with respect to said respective through opening.

[0050] In a first embodiment the method comprises sucking air, by said one or more fans, from said one or more pipes to generate said air flow directed downward through the floor layer. In this way the floor surface is cooled by forced heat exchange between the air, at ambient temperature, and the floor surface (e.g. the artificial grass fibers). Preferably the air flow through the floor layer has an average velocity over the whole floor surface greater than or equal to 0.5 m/min, more preferably greater than or equal to 1.0 m/min, even more preferably greater than or equal to 2.0 m/min, and/or less than or equal to 5.0 m/min, more preferably less than or equal to 4.0 m/min. The Applicant has experimentally verified that the above ranges of flow velocity provide efficient cooling of the floor, while limiting friction and energy consumption.

[0051] In a second embodiment the method comprises blowing air, by said one or more fans, into said one or more pipes to generate said air flow directed upward through the floor layer. In this way the floor surface can be heated or cooled.

[0052] Preferably the air flow through the floor layer has an average velocity over the whole floor surface

greater than or equal to 0.1 m/min, more preferably greater than or equal to 0.2 m/min, even more preferably greater than or equal to 0.3 m/min, and/or less than or equal to 1.0 m/min, more preferably less than or equal to 0.5 m/min. In this way the users of the floor surface do not experience a potentially annoying air flow, which may also raise dust.

[0053] In one embodiment the floor structure comprises an air conditioning system in air communication with said air movement system for heating and/or cooling said air blown into said one or more pipes. The air conditioning system may comprise a heat pump, a geothermal probe, an air conditioner, an evaporative cooler, an air heater, a heat exchanger and/or any other device capable of reducing or increasing the temperature of the air to be blown.

[0054] In the second embodiment the method may comprise cooling said air blown into said one or more pipe below an ambient temperature (i.e. the temperature of air above the floor surface). In this way it is possible to condensate water on the floor surface (e.g. on the artificial grass fibres), which can lead to extra cooling by evaporation.

[0055] In the second embodiment the method may comprise heating said air blown into said one or more pipes above an ambient temperature. In this way it is possible to heat the floor surface from below, e.g. in case of ice or snow.

[0056] In one embodiment the floor structure comprises a heat exchanger in air communication with said air movement system for subtracting heat from said air sucked from said one or more pipes. For example, the heat exchanger may be an air/liquid (water) heat exchanger.

[0057] In one embodiment the method comprises subtracting heat from said air sucked from said one or more pipes.

[0058] In this way heat can be recovered from the floor structure for use in heating facilities or water, or for storing heat, e.g. in water tank or heat batteries or using phase change materials, thus improving overall energy efficiency (the floor surface is used as a solar thermal energy collector).

Brief description of the figures

[0059]

Figure 1 schematically shows a plan view of a floor structure according to an embodiment of the present invention;
figure 2 schematically shows a vertical cross-sectional view of the floor structure of figure 1 or 4;
figure 3 schematically shows a vertical cross-sectional view of the floor structure of figure 1 or 4 in a further embodiment;
figures 4-6 schematically show a plan view of a floor structure according to further embodiments of the

present invention;

figure 7 schematically shows a vertical cross-sectional view of the floor structure of figure 6.

5 Detailed description of some embodiments of the invention

[0060] The features and the advantages of the present invention will be further apparent from the following detailed description of some embodiments, presented by way of nonlimiting example of the present invention, with reference to the attached figures.

[0061] In the figures, the reference number 1 refers to a floor structure in accordance with the present invention.
15 The same reference number will be used for identical or similar elements in the different embodiments.

[0062] The floor structure 1 comprises a floor layer 2 having a floor surface 3.

[0063] In figure 1 the floor surface 3 is a sport floor for padel, pickleball, or tennis, having long side about 20 m long and short side about 10 m long.

[0064] In figure 4 the floor surface 3 is a sport floor for American football, soccer, rugby and/or hockey, having long side about 100 m long and short side about 60 m long. Dashed lines in figures 1 and 4 divide the floor surfaces in virtual (not real) portions of floor surface, exemplarily squares about 10 m side.

[0065] In figure 5 the floor surface 3 forms part of a garden having several different portions 4, 5 and 6 of floor surface 3, and in figures 6 and 7 it forms part of a terrace or a rooftop. Exemplarily the floor layer 2 shown in figures 1-4, 6 and 7, as well the portions 4 in figure 5, is an artificial turf layer (shown only schematically) comprising a backing support, such as a woven fabric (e.g., polyester, PP, or glassfibre), and artificial grass fibers fixed (e.g. by tufting) to said backing support to realizes said floor surface 3. The artificial turf layer may comprise a secondary backing (not shown), such as a latex or polyurethane coating, on a face of the backing opposite to the floor surface 3 to fix the fibers to the backing support to ensure adequate pull-out resistance to the fibers. The artificial turf layer may comprise a granular infill layer (not shown) dispersed between the artificial grass fibers on the floor surface, or it may be devoid of any infill.

[0066] The portions 5 and 6 of floor surface 3 of figure 5 are exemplarily realized respectively in air permeable laminated wood and loose stones. The garden of figure 5 comprises also a pool 15.

[0067] The floor structure 1 comprises a supporting layer 10 for supporting the floor layer 2 and for realizing a continuous (i.e. with fluid communication over the entire air chamber extension) air chamber 11 having an aerial extension comparable to, in case of figure 5, or same of, in case of figures 1, 4 and 6, an aerial extension of the floor surface 3. Exemplarily the supporting layer 10 is formed by a single continuous layer of a plurality of identical rigid and self-supporting polypropylene crates (not shown) having rectangular parallelepiped outer

shape and contactingly placed side-by-side according to a regular pattern. Exemplarily the air chamber has a height equal to about 40 cm (substantially equal to the height of the crate).

[0068] Preferably the floor structure 1 comprises a solid substrate 12, exemplarily crushed stones (as depicted in figure 3), the supporting layer being positioned over the substrate. The substrate 12 is exemplarily water-(and air-)tight in figure 2 and water-(and air-)permeable in figure 3.

[0069] In one embodiment the floor structure comprises a liner 13 (shown schematically in dashed line) extending continuously over a whole side surface 14 of the air chamber, as well as over a portion of a top surface of the air chamber 11 proximal to the side surface 14 and over a portion of the bottom surface of the air chamber 11 proximal to the surface. In other words, as shown in figure 2, in any vertical cross-sectional view of the floor structure 1 the liner 13 is C-shaped on both sides of the air chamber 11. Exemplarily in the embodiment of figure 2 the liner 13 does not cover the bottom surface of the air chamber 11, but the portion proximal to the side surface 14. In this embodiment, the liner may be air- and water-tight, for example a polyethylene (PE) impermeable liner. In this embodiment the water drainage is purely or essentially horizontal.

[0070] Exemplarily in the embodiment of figure 3 the liner 13 extends continuously over the whole bottom surface of the air chamber 11, in continuity with the above C-shaped portion of the liner at the side surface of the air chamber 11. In this embodiment, the liner 13 may be air- and water-tight (for a purely horizontal drainage) or water permeable (or able to begin dripping after reaching a certain thickness of water above it) and at the same time more resistant to air passage than the floor layer 2, for example a woven geotextile (for a mixed horizontal/vertical drainage).

[0071] The water drainage system comprises a drainage outlet 30 at the side surface 14 (where the liner 13 has an opening).

[0072] The floor structure 1 comprises an air movement system 20 structured to generate an air flow (pictorially represented by vertical double arrows in figure 2 and 3) through the floor layer 2 from the air chamber 11 to the floor surface 3 and/or viceversa.

[0073] The floor structure 1 is entirely air permeable from the air chamber 11 to the floor surface 3 and/or viceversa. In case of artificial turf layer, the backing support is advantageously made highly air permeable, to limit the barrier to airflow. Preferred backings are woven materials or highly permeable backings like "One-DNA", made from a calendared polyethylene fleece. Traditional backings coated with latex or polyurethane can also be used, provided a proper number of extra through openings (not shown) is realized, for example having size equal to 1 mm and spaced apart one from the other by about 15 mm. Extra openings can be formed or punched during tufting and/or during coating.

In an embodiment, a non-woven fabric may be placed under the turf layer to prevent the migration of infill granules.

[0074] In an embodiment the floor structure 1 comprises a dampening layer (not shown), contactingly interposed between the floor layer (e.g. the backing support) and the supporting layer. In one embodiment the dampening layer is formed by woven foam strips forming upstanding loops with spaces therethrough, such as the product traded as SINE™, available from TenCate and described in WO2014/092577.

[0075] In one embodiment the dampening layer is formed by dampening elements placed horizontally side-by-side and each one comprising a frame comprising a plurality of through openings and, a plurality of support bodies which protrude from said frame, each support body being arranged at a respective through opening and bridging with structural continuity two attachment regions belonging to said frame and mutually opposite with respect to said respective through opening. A product of this type, traded as WAVE™, is available from Polygreen and described in WO2022/172310.

[0076] In an embodiment the dampening layer is integral with the supporting layer. For example, the crates forming the supporting layer may incorporate elastically deforming elements.

[0077] The air movement system 20 exemplarily comprises one or more fans 21 and one or more pipes 22 in air communication with the one or more fans 21. Exemplarily the air movement system 20 comprises devices (not shown) for regulating the power of the fans, such as dimmers or inverters (able to regulate the fan current frequency).

[0078] Exemplarily each pipe is in polymeric, rigid material and has a circular cross-section with diameter equal to 30 cm. Preferably the pipes have smooth internal surface. Preferably each pipe has one or more air mouths 23, each mouth opening into the air chamber 11 at a distance D, preferably of at least 1 m, from a side surface 14 of the air chamber 11.

[0079] In one embodiment the floor structure 1 comprises one or more manifolds 24, each manifold putting in air communication at least one of the pipes 22 with the outer environment, passing through at least one of the fans 21. Preferably each manifold 24 is placed adjacent, and opposite to, the side surface 14 of the air chamber 11. Exemplarily each manifold is made of concrete.

[0080] In the embodiment of figure 1, the floor structure 1 comprises one and only one manifold 24 placed at only one side of the floor surface. The single manifold 24 is in air communication with two fans 21 and with six pipes 22, each one extending from the side surface 14 of the chamber 11 up to the respective mouth 23. In an alternative embodiment two distinct manifolds 24 may be deployed, one for each fan 21, each manifold being in air communication with three respective pipes 22.

[0081] In the embodiment shown in figure 4 one (or more) manifold 24 is placed at each side of the floor

surface 3.

[0082] In one embodiment, as shown in the figures, each pipe 22 has one and only one respective mouth 23 at an end of the pipe.

[0083] In one embodiment, as shown in figure 2, each pipe 22 extends (preferably horizontally) from the side surface 14 of the air chamber up to the respective mouth 23 entirely within the air chamber, preferably housed within a respective channel realized in the supporting layer (e.g. in the crates).

[0084] Preferably each pipe 22 extends within the air chamber 11 at a vertical distance (figure 2 and 7) from the bottom surface of the air chamber 11. Preferably each mouth 23 faces downward at an angle of about 45° with respect to a horizontal plane (figures 2 and 7). Alternatively, the mouth may face upwards (as shown in figure 3) and the prevention of water infiltration can be avoided by means of a mesh or a cover (not shown) placed at the mouth.

[0085] In an embodiment, as shown in figure 3, each pipe 22 extends from the respective manifold 24 up to, and excluding, an end portion 25 entirely buried in the substrate 12. Exemplarily the end portion 25 extends vertically within the air chamber and ends with the respective mouth 23. In one embodiment not shown the end portion further has a horizontal section continuous with the vertical section and ending up with the respective mouth (possibly facing down).

[0086] In an embodiment, not shown, the mouths are flush with the bottom surface of the air chamber (in other words the pipe is entirely buried up to the respective end mouth). Advantageously each mouth 23 is at a distance D from the side surface 14 of the air chamber 11 (because of an end portion 25 extending from the side surface 14 within the air chamber 11 and/or because of at least a portion of the pipe buried below). Preferably the mouths are distributed all over the aerial extension of the air chamber 11.

[0087] In the embodiment exemplarily shown in figure 1, each of the two squared virtual portions of the floor surface 3 having about 10 m side is served by three pipe 22 and three corresponding mouths 23 which may be distributed over the squared portion in any pattern (two of which are exemplarily shown respectively in the left and right squared portion). In other embodiments for each squared portion a single pipe may extend from the manifold 24 up to a branch where it divides into two or more pipes having a respective mouth 23 and spreading apart one from the other.

[0088] In further embodiments, as shown in figure 4, each squared virtual portion having about 10 m side has a corresponding one pipe and one mouth.

[0089] In one embodiment, as shown in figure 4, the mouths are substantially regularly distributed over a rectangular grid, wherein the distance of each mouth from each neighbouring mouth on its four sides is substantially constant. Exemplarily the distance is equal to about 10 m.

[0090] In one embodiment, not shown, the floor struc-

ture 1 comprises an air conditioning system in air communication with the air movement system 20 for heating and/or cooling the air to be blown into the pipes 22.

[0091] In one embodiment, as shown in figure 5, the floor structure 1 comprises a heat exchanger 26 in air communication with the air movement system 20 for subtracting heat from the air sucked from the pipes.

[0092] In use, the floor structure 1 is suitable for implementing the method for controlling the temperature of the floor surface 3 according to the present invention.

[0093] In a first embodiment the fans 21 suck air from the pipes (through the manifolds) to generate an air flow directed downward through the floor layer with an average velocity over the whole floor surface equal to about 3.5 m/min.

[0094] In a second embodiment the fans blow air into the pipes to generate an airflow directed upward through the floor layer, with an average velocity over the whole floor surface equal to about 0.3 m/s. In this second embodiment the air blown into the pipes may be cooled below the ambient temperature to condensate water on the floor surface. In addition, the air blown may be heated above an ambient temperature to heat the floor surface from below.

[0095] In one embodiment the heat exchanger 26 may subtract heat from the air sucked from the pipes. Exemplarily the heat collected may be used to heat the water of the pool 15 or for any other use.

Claims

1. A floor structure (1) comprising:

- a floor layer (2) having a floor surface (3);
- a supporting layer (10) for supporting the floor layer, wherein the supporting layer realizes a continuous air chamber (11) having an aerial extension comparable to an aerial extension of the floor surface (3), and wherein the floor structure (1) is air permeable from the air chamber (11) to the floor surface (3) and/or viceversa; and
- an air movement system (20) structured to generate an air flow through the floor layer (2) from the air chamber (11) to the floor surface (3) and/or viceversa, the air movement system (20) comprising one or more air mouths (23), each air mouth (23) opening into the air chamber (11) at a distance (D) from a side surface (14) of the air chamber (11).

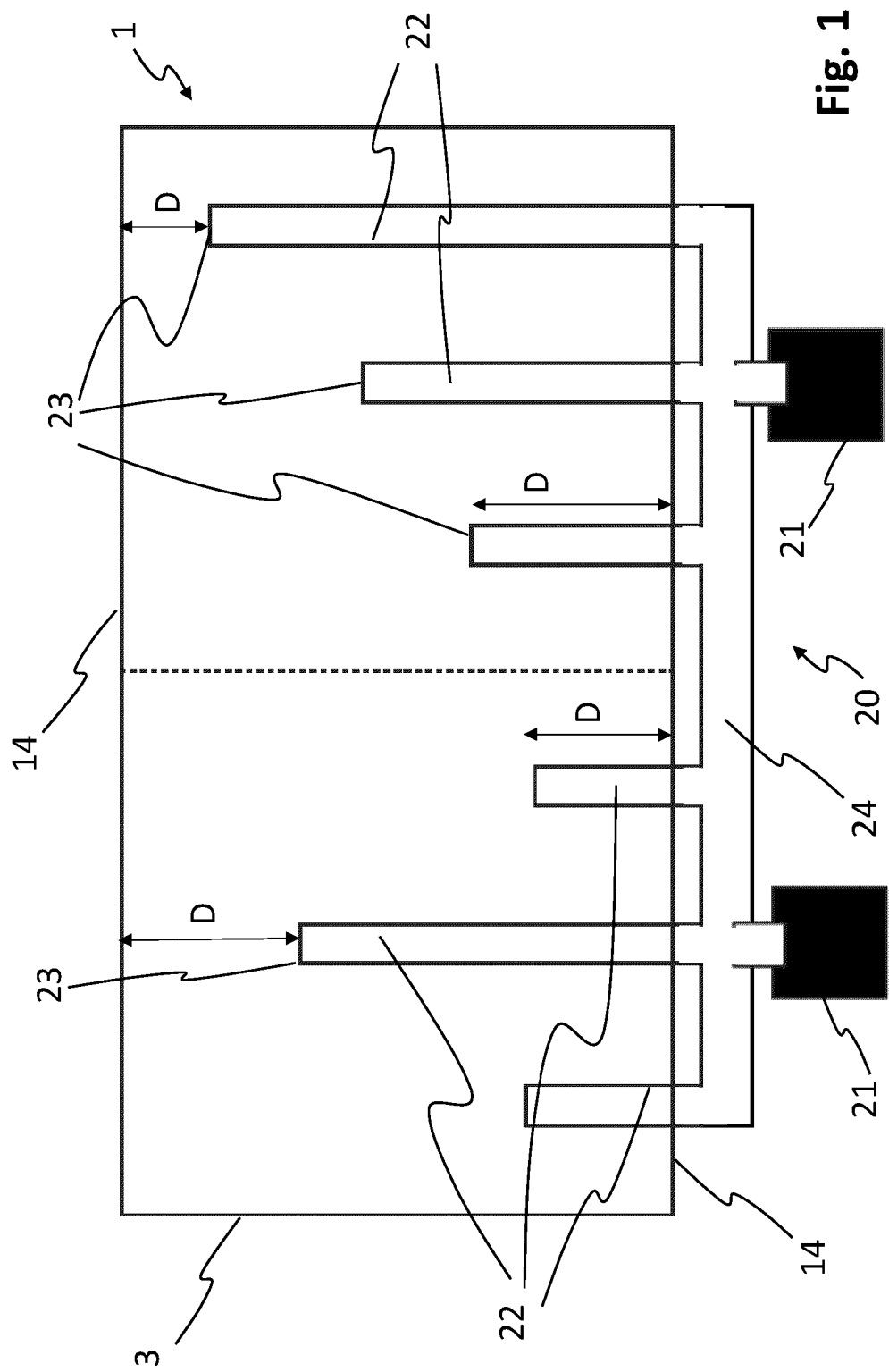
2. The floor structure (1) according to claim 1, wherein the air movement system (20) comprises one or more pipes (22), each pipe comprising at least one of said one or more air mouths (23), wherein the air movement system (20) comprises one or more fans (21) in air communication with said one or more

mouths through said one or more pipes, wherein the floor structure (1) further comprises one or more manifolds (24), each manifold putting in air communication at least one of said one or more pipes (22) with the outer environment through at least one of said one or more fans (21), wherein each manifold is placed opposite, and adjacent, to said side surface (14) of the air chamber.

3. The floor structure (1) according to claim 2, wherein said distance (D) between each air mouth and said side surface of the air chamber is at least 1 m, and wherein each pipe (22) has an end portion (25) comprising said one or more air mouths and extending within the air chamber, wherein said end portion is at least 1 m long. 10
4. The floor structure (1) according to claim 2 or 3, wherein each pipe has one and only one respective air mouth at an end of said pipe. 20
5. The floor structure (1) according to one or more of claims 2 to 4, wherein each pipe extends from said side surface (14) of the air chamber up to said respective one or more mouths entirely within the air chamber. 25
6. The floor structure (1) according to one or more of claims 2 to 5, wherein at least an end portion of each pipe extends within the air chamber at a vertical distance from the bottom surface of said air chamber. 30
7. The floor structure (1) according to one or more of claims 2 to 4, wherein each pipe extends from said side surface up to, and excluding, an end portion (25), or up to said respective one or more mouths, entirely below the air chamber. 35
8. The floor structure (1) according to one or more of the preceding claims, wherein each mouth faces downward. 40
9. The floor structure (1) according to one or more of the preceding claims, wherein said air mouths are distributed all over said aerial extension of said air chamber. 45
10. The floor structure (1) according to claim 9, wherein said air mouths are regularly distributed over a pattern, wherein a distance of each mouth from each neighbouring mouth is substantially constant and greater than or equal to 5 m, and/or smaller than or equal to 25 m. 50
11. The floor structure (1) according to one or more of the preceding claims, wherein the air chamber has a height greater than or equal to 20 cm, and/or less than or equal to 100 cm, more preferably less than or 55

equal to 80 cm.

12. The floor structure (1) according to one or more of the preceding claims, wherein the floor structure comprises a liner extending continuously over a bottom surface of the air chamber and/or over said whole side surface of the air chamber and/or over a portion of a top surface of the air chamber proximal to said side surface and/or over a portion of a bottom surface of the air chamber proximal to said side surface, the liner resisting air passage more than the floor layer.
13. The floor structure (1) according to one or more of the preceding claims, wherein said floor layer is an artificial turf layer comprising a backing support and artificial grass fibers fixed to said backing support to realizes said floor surface, the floor layer being provided with through openings having size between 0.5 mm and 7 mm, and being spaced apart from each other by less than 50 mm and/or more than 10 mm.
14. A method for controlling a temperature of the floor surface (3) in the floor structure (1) according to one or more of the preceding claims, the method comprising generating said air flow through the floor layer by said air movement system to cool or heat said floor surface.
15. The method according to claim 14 further comprising sucking air, by said one or more fans, from said one or more pipes to generate said air flow directed downward through the floor layer, wherein the air flow through the floor layer has an average velocity over the whole floor surface greater than or equal to 0.5 m/min, and/or less than or equal to 5.0 m/min, wherein the floor structure comprises a heat exchanger (26) in air communication with said air movement system (20) and the method comprises subtracting heat from said air sucked from said one or more pipes.



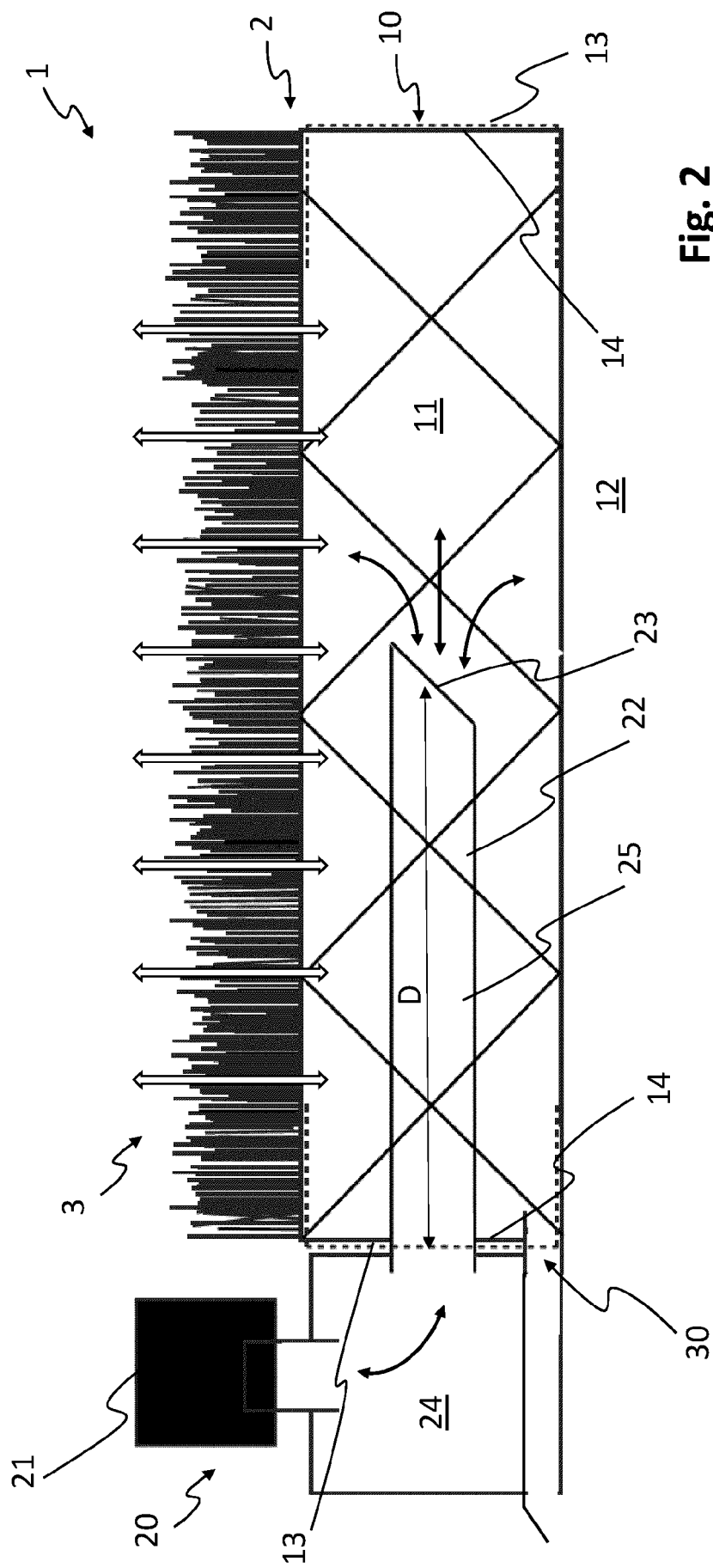
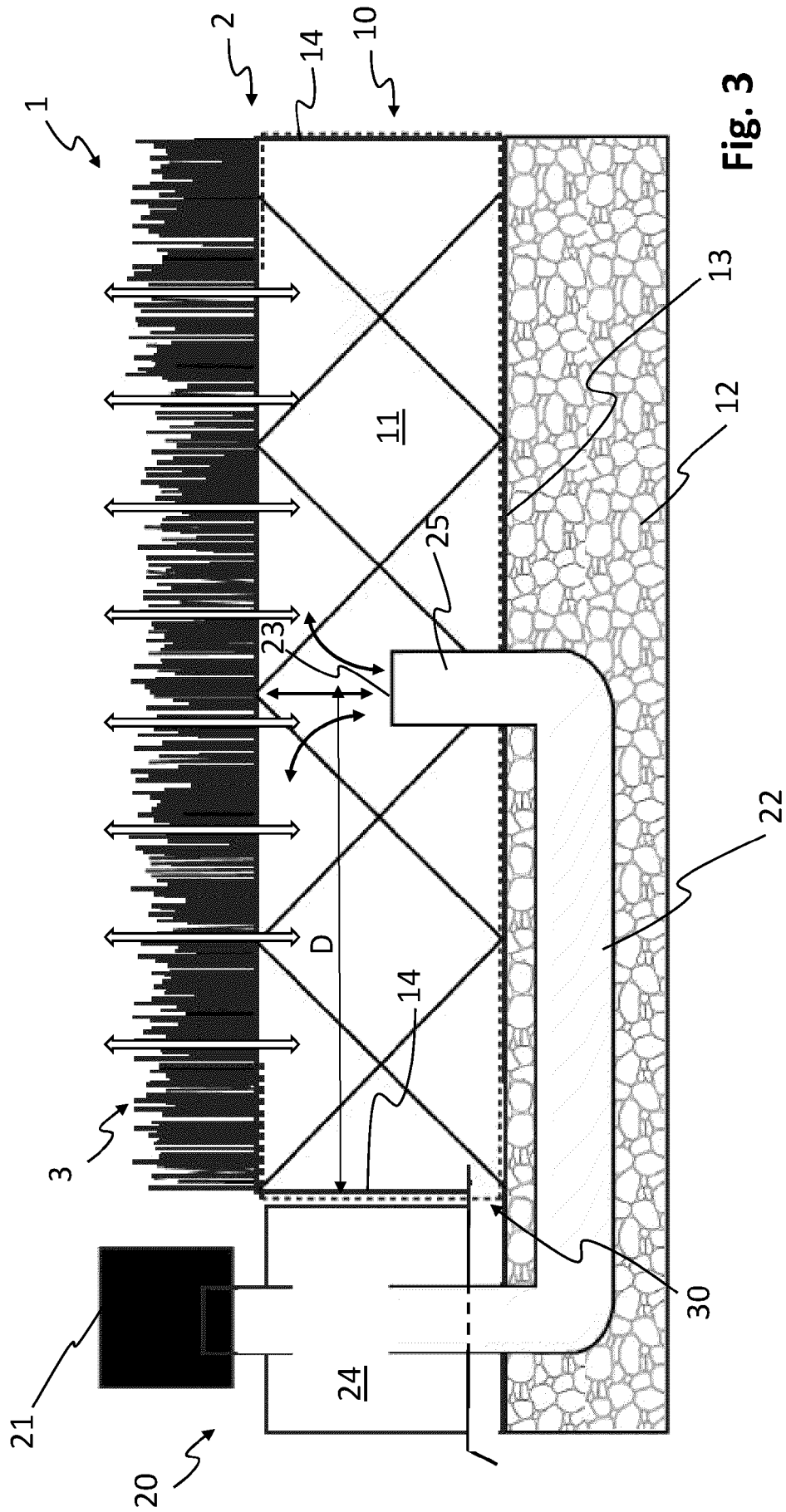


Fig. 2



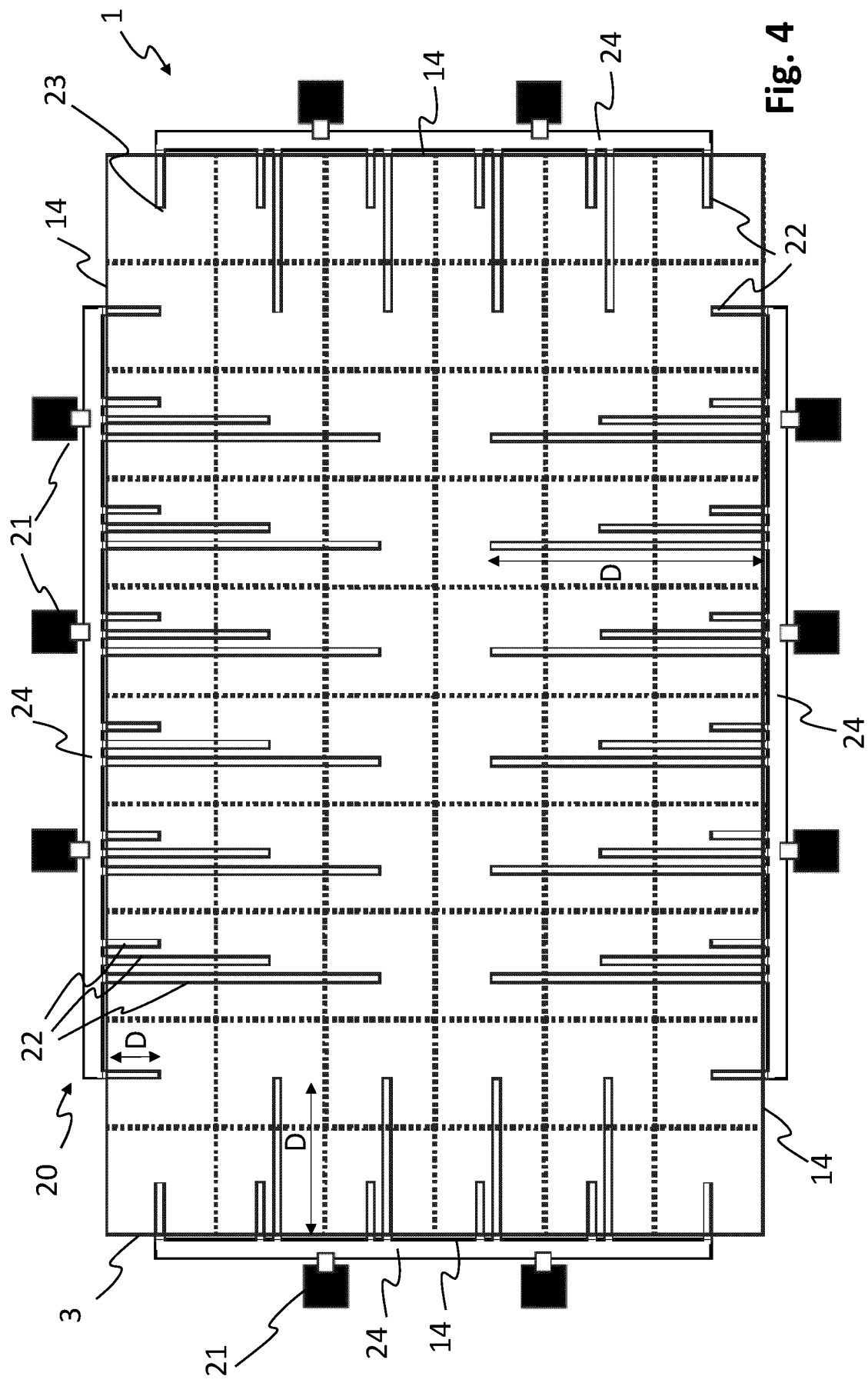


Fig. 4

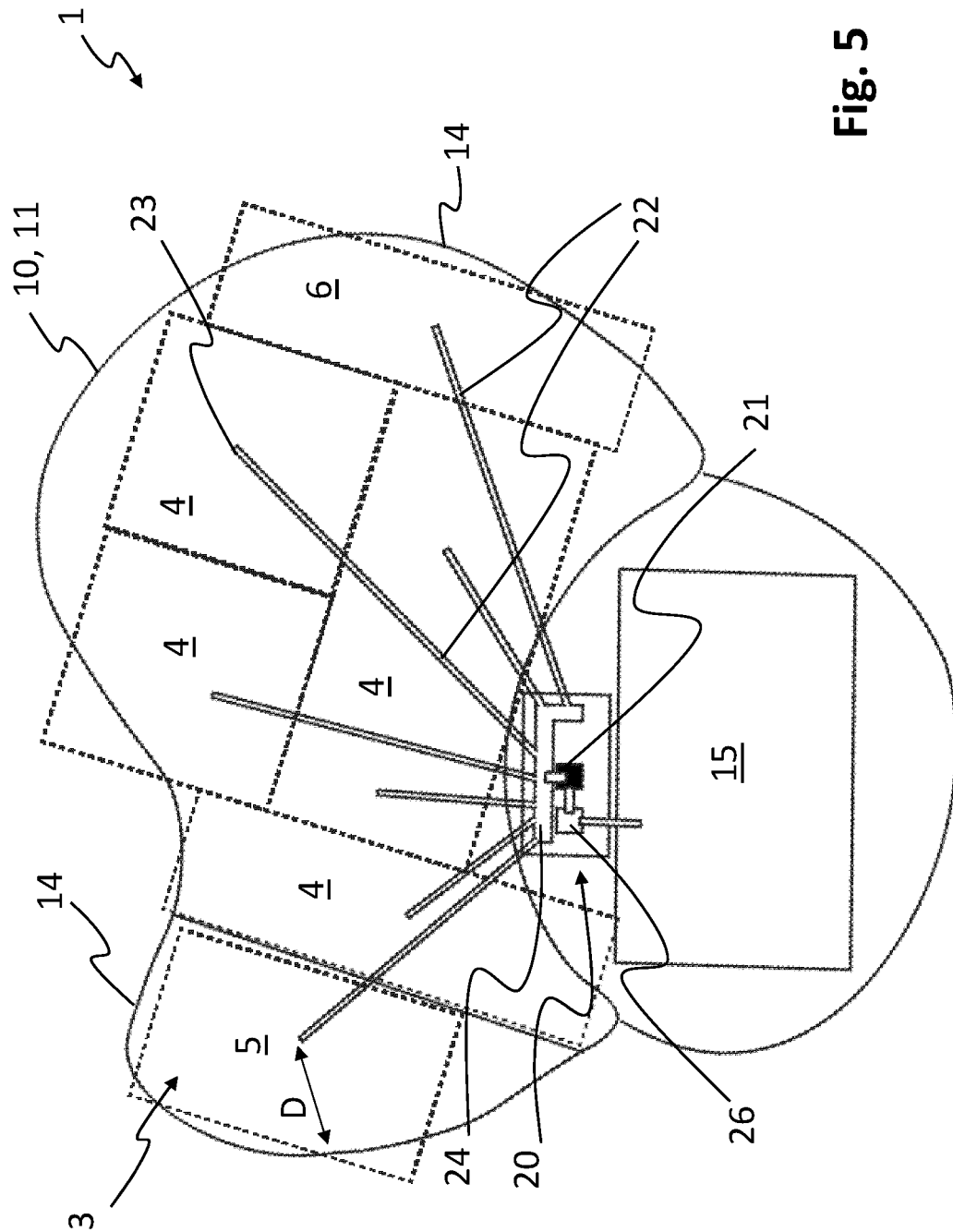


Fig. 5

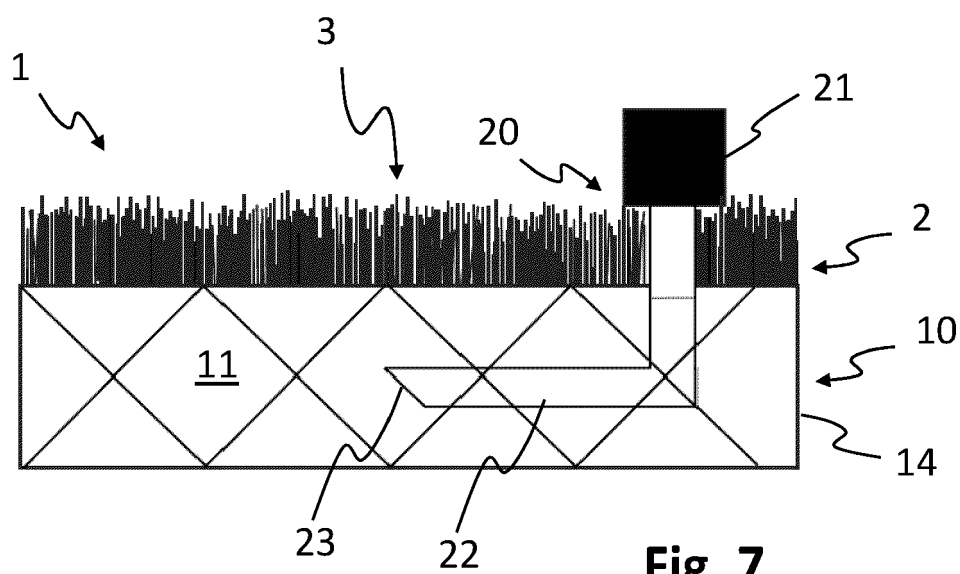


Fig. 7

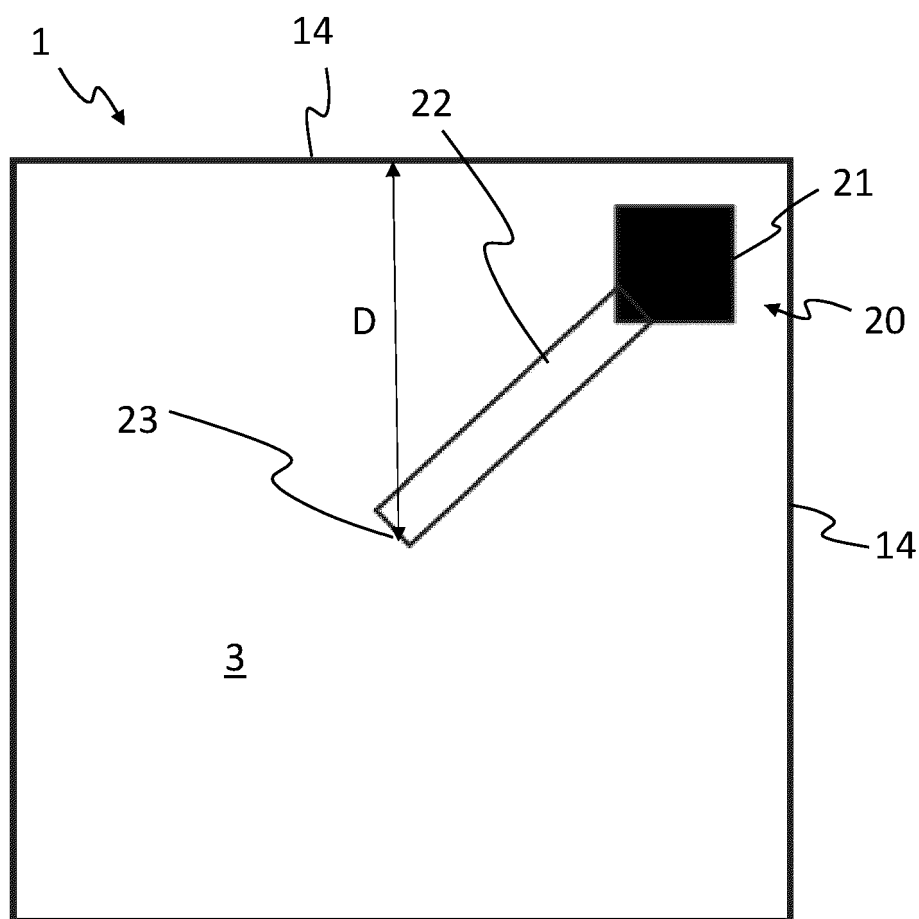


Fig. 6



EUROPEAN SEARCH REPORT

Application Number

EP 24 21 2298

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2017/058018 A1 (TEN CATE THIOLON BV [NL]) 6 April 2017 (2017-04-06)	1-6,8,11-15	INV. E01C13/02
Y	* the whole document *	7,9,10	
Y	US 5 596 836 A (BENSON WILLIAM M [US]) 28 January 1997 (1997-01-28)	7,9,10	
Y	* the whole document *	7,9,10	
Y	KR 2016 0046167 A (JUNG JONG CHEON [KR]) 28 April 2016 (2016-04-28)	7,9,10	
	* the whole document *		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			E01C
Place of search		Date of completion of the search	Examiner
Munich		22 April 2025	Beucher, Stefan
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22-04-2025

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2017058018 A1	06-04-2017	AU 2016330204 A1	26-04-2018
		CA 3000602 A1	06-04-2017
		CN 108368681 A	03-08-2018
		EP 3356602 A1	08-08-2018
		ES 2800303 T3	29-12-2020
		JP 6932692 B2	08-09-2021
		JP 2018531335 A	25-10-2018
		KR 20180082434 A	18-07-2018
		MX 388701 B	20-03-2025
		MY 190058 A	23-03-2022
		US 2018282950 A1	04-10-2018
		WO 2017058018 A1	06-04-2017

US 5596836 A	28-01-1997	US 5433759 A	18-07-1995
		US 5596836 A	28-01-1997

KR 20160046167 A	28-04-2016	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2017058018 A1 [0002] [0013]
- WO 2014092577 A [0074]
- WO 2022172310 A [0075]