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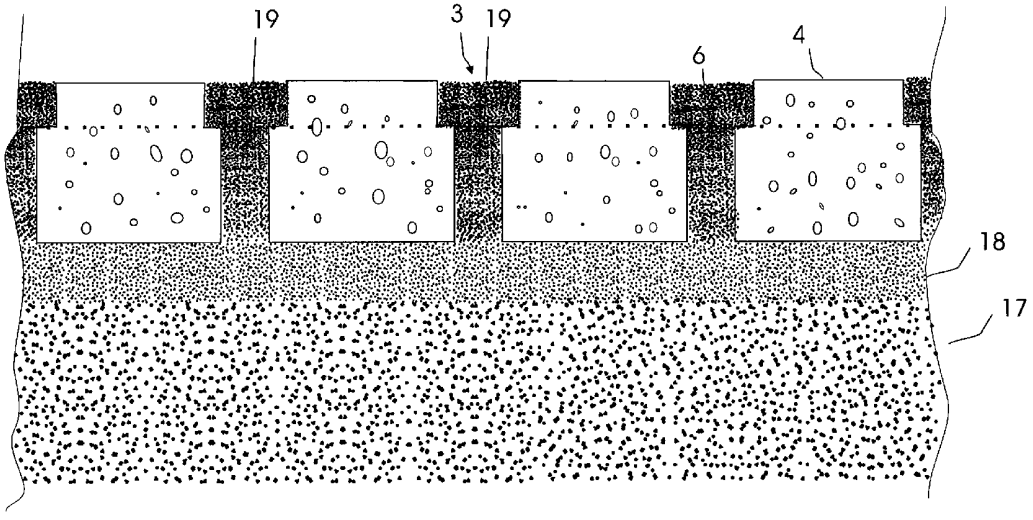
(54) Title: A PAVING OF ELEMENTS WITH CAST PAVING STONES AND MOULD AND METHOD FOR MANUFACTURING SUCH AN ELEMENT



(57) Abstract: A paving (1) comprising at least one element (2) with a number of cast paving stones (4) is laid with intermediate joints (3) and vibrated on a foundation of a particulate material (18) completely or partly filling the joints (3) as well. At least one mesh (5) embedded in the stones (4) and joining the stones (4) of the element (2) is serving for securing a particulate filler material (19) in a joint during even heavy showers and cleaning with sweeping and sucking machines as at least a part of the mesh (5) which is in the joints (3) has a small-meshed structure (6) and is embedded in the upper part of the stones.

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A paving of elements with cast paving stones and mould and method for manufacturing such an element

The invention relates to partly a paving comprising at least one element with a number of cast paving stones laid and vibrated with intermediate joints on a foundation of a particulate material which also completely or partly fills the joints and at least one mesh embedded in the stones and joining the stones of the element, partly a mould and a method for manufacturing such an element.

Paving stones for e.g. pavements, parking areas, and parks are normally laid on a foundation one after the other at a joint distance from each other. The joints are subsequently filled with a mineral, particulate joint filling material, such as sand, which is spread and swept down into the joints. Then, the paving is vibrated so that the foundation is compacted to become compact and solid and the filler material is compacted in the joints.

However, a joint of this kind is vulnerable to softening and washing-out of the joint filler during e.g. heavy showers when the rain water can penetrate down into the joint filler and further down into the foundation which thereby is softened. When the softened paving is loaded by the traffic of e.g. cars and lorries, the paving will sink. The joint filler is softened gradually in order to be washed away in the end so that the paving stones will be loose.

Corresponding problems will arise when a stone paving is to be cleaned by means of e.g. machines which often both wash, sweep and/or suck the joint completely or partly empty of joint filler.

The thus loaded paving is extremely uneven and therefore difficult to drive or walk on. In order to avoid accidents and

damages to e.g. vehicles, it is therefore necessary to repair the damaged and uneven pavings. The costs of maintaining stone pavings of this kind are therefore very high and the re-laying is hard and time-consuming as the stones are to be laid again stone by stone with a uniform joint distance across the entire damaged area.

An element consisting of paving stones is known from US 5,615,971. The stones in this element are kept together by a single, elastic connecting links or an elastic mesh making it possible to vary the distance between the individual stone during the laying according to needs and wishes. By elastically deforming the connecting link or mesh, the shape of the element can be changed so that it can be made to follow curved edges. However, this elastic mesh has a varying mesh size which leaves large joint openings between the individual stones. A mesh or single connecting link designed in this way cannot keep the joint filler in the joint after laying of the stone element.

The object of the invention is to provide a paving of the kind mentioned in the opening paragraph, in which the joint filler is kept stably and firmly embedded in the joint between the stones even during heavy showers and cleaning with sweeping and sucking machines.

Another object of the invention is to provide a paving having a pre-determined joint spacing which can be laid more quickly than hitherto known without employment of great manpower and which is quickly, simple and inexpensive to manufacture.

A third object of the invention is to provide a mould for manufacturing an element for such a paving.

A fourth object of the invention is to provide a method for manufacturing the paving.

The novel and unique features according to the invention, whereby this is achieved, is the fact that at least the part of the mesh which is in the joints has a small-meshed structure and that the mesh is embedded in the upper part of the stones.

The elements forming the stone paving can preferably be laid on top of a graded levelling course of e.g. sand, rubble, or bitusand known from the Japanese patent application no. 9-316808 and the German Auslegeschrift DE 1093396, by gripping the corner stone of each element, tightening its mesh and laying it in its place in the paving. The distance of the mesh between the joint will in this way correspond to the joint spacing which advantageously will have a pre-determined size across the entire paving.

Particulate joint filler such as e.g. sand, bitusand, rubble and the like or pulverised cinder material which complies with possible legal requirements to depositing, will in the following generally be referred to as joint filler sand and the individual particles as grain of sand.

When the elements have been laid, filler sand having a grain size corresponding to or smaller than the size of a mesh in the small-meshed structure of the mesh is swept across the paving.

As the meshes in the part of the mesh that is in the joints have a size that allows loose filler sand to pass, grains of sand can easily pass through the mesh openings, and the joint filling can therefore take place quickly and easily.

In a preferred embodiment, the meshes in the small-meshed structure of the mesh can be rectangular and of a size that allows the largest grains of sand to pass.

By means of a vibrator such as a pan vibrator, the stone paving is vibrated against the levelling course whereby sand from this layer will penetrate into the joint at the same time as particulate joint filler, such as sand, is vibrated down into the joint until the entire joint is full of sand. The vibrated grains of sand turn over and over during the vibration and form a compact mass in which the orientation of the grains of sand is changed in relation to the orientation they had when they were filled into the joint. In this way, the individual grains of sand will secure each other mutually in a larger, compacted plate structure which is secured under the small-meshed structure of the mesh. Thereby, the individual grains of sand are prevented from leaving the joint in a simple manner. The plate structure which is also known as base gravel has a very small pore volume and can therefore not absorb large amounts of rain water.

During the placing of the elements of the above kind, it will be expedient if the meshes in the part of the mesh that is embedded in the stoned are sufficiently large to allow casting material to pass during the casting process. Casting material such as concrete often has a content of pebbles and slightly larger particles, and these can easily pass through the large meshes and be distributed in a mould. The casting process thus takes place easily and quickly.

The embedded mesh advantageously serves for holding a number of paving stones together in an element so that several stones can be laid quickly and easily in one work operation.

In a preferred embodiment, the size of a mesh in the part of the mesh that is embedded in the stones constitutes about 50%, preferably 75% and especially 95% of the surface area of one stone.

When the mesh is made of a material which is not or only very slowly is degraded upon action of the surrounding environment, the paving can easily be re-laid or repaired according to wishes and needs as one single element can be moved as a coherent unit.

When the mesh is projecting along the sides of the element, it is advantageously obtained that joints made when the elements are laid side by side also are covered by small-meshed mesh. As the compacted filler sand in this way also can be kept in the joint between the elements, the finished paving has no weak or especially vulnerable areas.

Such an element with a number of cast paving stones with intermediate joints and embedded mesh can, in particularly expedient manner, be cast in a moult comprising partly a lower mould having a casting chamber for each stone, said chamber having a height corresponding to the distance of the mesh from the top of the stones, partly an upper form having casting chambers corresponding to the casting chambers of the lower form.

The form can be designed with any desired size with regard to e.g. thickness, extent, or shape of a stone, as one or more meshes intended therefore belong to each individual mould.

The element can be cast in such a mould by means of a method comprising an initial step in which a lower form having a chamber for each stone, that has a height corresponding to the distance of the mesh from the top of the stones is placed on a foundation with a casting opening in the casting chambers facing upwards. In the further manufacturing steps, the mesh is first placed on the top of the lower form so that the casting openings are covered by the large meshes in the mesh and the small-meshed structure covers the area between the casting openings. On top of the lower form, an upper form is

then placed having casting chambers corresponding to the casting chambers of the lower form. The upper and lower forms together form a casting mould with casting chambers in which the casting material is cast to stones that are mutually joined by means of the mesh.

The casting material is allowed to harden before the mould is separated and the elements removed. The same mould can be used for several castings.

Alternatively, the lower form can be filled with one or several natural stones, coloured stones or embossing pieces in the initial step in order to thereby be able to easily manufacture paving elements having different patterns and appearances. As an example, texts and directions for parking areas can advantageously already be present in the paving element before it is laid.

In case natural stones are used, the mesh can optionally be adhered to said at least one natural stone. Alternatively, the casting material will in itself adhere to both the mesh and the natural stone during the actual casting.

The invention will be explained in greater detail below, describing only exemplary embodiments with reference to the drawing, in which

Fig. 1 is a diagrammatic plan view of a paving according to the invention with six paving elements,

Fig. 2 is a plan view of a mesh in a paving element according to the invention,

Fig. 3 is a plan view of a paving element according to the invention,

Fig. 4 is on a larger scale a fractional sectional view through a casting mould for cast paving stones, and

Fig. 5 is a side elevational view of a section of a completely laid paving with filled joints.

In the following, it is assumed that the paving is made of cast concrete stones and that the particulate material used as foundation and for filling the joints is sand.

Fig. 1 shows a complete paving 1 consisting in this case of six elements 2. One of these elements is indicated by the shown broken line. Each element 2 consists of sixteen stones 4 separated by sand-filled joints 3.

Fig. 2 shows a mesh 5 embedded in the stones 4 at a distance from the top of the stones. In fig. 1, the mesh is concealed by the sand in the joints.

The mesh 5 is formed by a large number of wires preferably placed mainly perpendicular to each other to form partly a small-meshed structure 6 for covering the joints 3 between the cast stones 4 of the element, partly a large-meshed structure 7 for at least partly embedment in the stones 4. The mesh size varies according to needs and in dependence of the nature and quality of the concrete and filler sand. The meshes in the small-meshed structure 6 in figs. 2 and 3 have both square and rectangular openings. However, the openings can advantageously also be either only square or only rectangular as different combinations of number of openings having different sizes and shapes can be expedient for different purposes. The openings in the large-meshed structure 7 is chosen so large that the concrete is freely allowed to pass during the casting process.

Fig. 3 is a plan view of a finished cast element 2 with embedded mesh 5 and sixteen stones 4. As can be seen, the

small-meshed structure 6 of the mesh 5 is in the joints 3 between the stones 4 whereas the large-meshed structure 7 is embedded in the stones 4 and consequently is not visible in the figure. The mesh 5 joins the stones 4 together to a manageable unit.

The size of at least one mesh in the part of the mesh which is in the joints is for example smaller than 100 mm^2, preferably smaller than 50 mm^2 and especially smaller than 35 mm^2, in order to allow grains of sand having typical diameters of between 0 and 6 mm to pass, and the size of a mesh in the part of the mesh embedded in the stones is preferred about 50%, preferably 75% and especially 95% of the surface area of one stone.

In a preferred embodiment, the size of at least one mesh in the large-meshed structure 7 embedded in the stones 4 is larger than about 1 cm^2 and smaller than the surface area of one stone 4.

Fig. 4 is a fractional view of a mould 8 for manufacturing an element 2 of the kind shown in fig. 3 with a mesh 5 of the kind shown in fig. 2.

The mould 8 is serving for casting an element 2 with a number of stones 4 with intermediate joints 3 and embedded mesh 5 by means of a lower form 9 and an upper form 10. The lower form 9 has casting chambers 11 each having a height "a" corresponding to the distance of the mesh 5 from the top 12 of the stones 4. The upper form 10 has casting chambers 13 corresponding to the casting chambers 11 of the lower form 9 and having a height "b".

Each of the casting chambers 11,13 corresponding in pairs together form a casting chamber 11,13 of a height a+b.

When an element is to be cast, the lower form 9 is placed on a foundation with the casting opening of the casting chambers 11 facing upwards. The mesh 5 is placed on the top of the lower form 9 so that its large-meshed structure 7 will cover the casting opening and the small-meshed structure 6 the partition between the casting chambers 11. Then, the upper form 10 is placed on top of the lower form 9 so that each casting chamber 13 of the upper form 10 will correspond to a casting chamber 11 in the lower form 9.

Finally, the mould is filled with concrete 14 possibly having a content of larger particles 15, and when the concrete has hardened, the form is separated and the finished element removed. The mesh 5 is now binding the stones 4 to a coherent element 2 which, with fixed joints "c", is ready to be used for a concrete stone paving.

The moulds can preferably be made of a synthetic polymer, such as polypropylene or polyethylene, which is partly elastic so that the stones easily can be removed from the moulds.

Fig. 5 is a fractional sectional view of a paving with four stones 4. On an about 15 cm thick levelled foundation 17 of e.g. base gravel, a layer of levelled sand 18 is placed in a thickness of about 3 cm. On top of the sand layer 18, a number of elements 2 are laid with a joint spacing "c" and forming the paving 1. The joints 3 are filled with filler sand 19 which has passed the meshes in the small-meshed structure 6 in loose condition.

Preferably the mesh 5 is embedded very near the top 12 of the stones 4 and as an example, the mesh is embedded between 5 and 15 mm from the top of the stones, embedment of the mesh about 15 mm from the top of the stones being especially preferred.

The invention is not limited to the above-mentioned dimensions of joint spacing, stone thickness, stone sizes and mesh sizes, as any advantageous combination of the size of e.g. particles in commercially available filler sand sets limits to e.g. mesh sizes in the small-meshed structure, and the content of the casting material of larger particles sets limits to the mesh size of the large-meshed structure.

Furthermore, strips of mesh with a small-meshed structure can be used instead of a coherent mesh within the scope of the invention. These mesh strips are laid during the casting process on the partitions of the lower form 9 and are extending into the mould chambers with a part that is sufficiently large for the stones to cohere securely in a whole element 2.

Areas which are to be paved but where a whole element is too large can be covered with a section of an element as the desired section is made merely by cutting the mesh between the stones.

As mentioned above, the small-meshed structure 6 of the mesh allows the sand in loose condition to pass the meshes and fill the joints with filler sand. When the paving is vibrated, sand from the levelled layer 18 will rise into the joints 3 at the same time as filler sand 19 is vibrated down into the joints. Thereby, the sand is compacted in the filled joint and the sand is packed to a compacted mass which, due to the plate effect, now no longer can pass the mesh even if the joints are subjected to heavy showers or to sweeping/suction machines. Filling and vibration can possibly be repeated in the cases where joint refilling is required.

The moisture degree in the layer 18 can be adjusted as desired and as may be required. The moisture degree can advantageously be utilised in case of joint filling from the bottom as it has

proven that the higher a moisture content in the layer, the more sand will penetrate up into the joint from the bottom.

Due to the above considerable advantages, the joints in the paving do not have to be refilled and maintained as often as hitherto known. The costs of maintaining the paving will therefore be low.

As the small-meshed mesh advantageously is keeping the filler sand in the joint, elements can be manufactured with a hitherto novel and unknown large joint spacing between the cast paving stones.

The elements are easy and quick to lay and it is furthermore easy to stack and transport a large amount of elements as the embedded mesh will eliminate the risk of the stones falling apart and that stacks of stones is overturning.

Claims

1. A paving (1) comprising
   - at least one element (2) with a number of cast paving stones (4) laid with intermediate joints (3) and vibrated on a foundation of a particulate material (18) completely or partly filling the joints (3) as well,
   - at least one mesh (5) embedded in the stones (4) and joining the stones (4) of the element (2)

   characterised in
   - that at least a part of the mesh (5) which is in the joints (3) has a small-meshed structure (6), and
   - that the mesh (5) is embedded in the upper part of the stones (4).

2. A paving (1) according to claim 1, **characterised** in that the meshes in the part of the mesh (5) that is embedded in the stones (4) are larger than the meshes in the part of the mesh (5) that is in the joints (3).

3. A paving (1) according to claim 1 or 2, **characterised** in that the meshes in the part of the mesh (5) that is in the joints (3) have such a size that loose particulate material (19) is able to pass but not compacted particulate material (19).

4. A paving (1) according to claim 1, 2 or 3, **characterised** in that the size of the meshes in the part of the mesh (5) that is in the joints (3) is preferred smaller than 100 mm^2, preferably smaller than 50 mm^2 and especially smaller than 35 mm^2.

5. A paving (1) according to any of the claims 1 - 4, **characterised** in that the meshes in the part of the mesh (5) that is embedded in the stones (4) are sufficiently

large to allow casting material (14) to pass during the casting process.

6. A paving (1) according to any of the claims 1 - 5, **characterised** in that the size of a mesh in the part of the mesh (5) that is embedded in the stones (4) is preferred 50%, preferably 75% and especially 95% of the surface area of one stone (4).

7. A paving (1) according to any of the claims 1 - 6, **characterised** in that the size of at least one mesh in the part of the mesh (5) that is embedded in the stones (4) is larger than about 1 cm^2 and smaller than the surface area of one stone (4).

8. A paving (1) according to any of the claims 1 - 7, **characterised** in that the mesh (5) is made of a material which is not or only slowly is degraded upon action of the surrounding environment.

9. A paving (1) according to any of the claims 1 - 8, **characterised** in that the mesh (5) is projecting along the sides of the element (2) with a small-meshed structure (6).

10. A mould (8) for casting a paving according to claim 1, **characterised** in that the mould (8) comprises

- a lower form (9) having a casting chamber (11) for each stone (4), said chamber having a height corresponding to the distance of the mesh (5) from the top of the stones (4), and
- an upper form (10) having casting chambers (13) corresponding to the casting chambers (11) of the lower form (9).

11. A method of manufacturing a paving according to claim 1, **characterised** in that the method comprises
an initial step in which
- a lower form (9) having a casting chamber (11) for each stone (4), said chamber having a height a corresponding to the distance of the mesh (5) from the top (12) of the stones, is placed on a foundation with a casting opening in the casting chambers (11) facing upwards, and

the further manufacturing steps comprising
- that the mesh (5) is placed on the top of the lower form (9),
- that an upper form (10) having casting chambers (13) corresponding to the casting chambers (11) of the lower form (9) is placed on top of the lower form,
- that the casting material (14) is cast in the assembled form (8),
- that the casting material (14) is hardened
- that the mould (8) is separated, and
- that the element is removed from the mould (8).

12. A method according to claim 11, **characterised** in that the initial step furthermore comprises that at least one casting chamber (11) in the lower form (9) is filled with one or more natural stones, and that the mesh (5) optionally is adhered to said at least one natural stone.

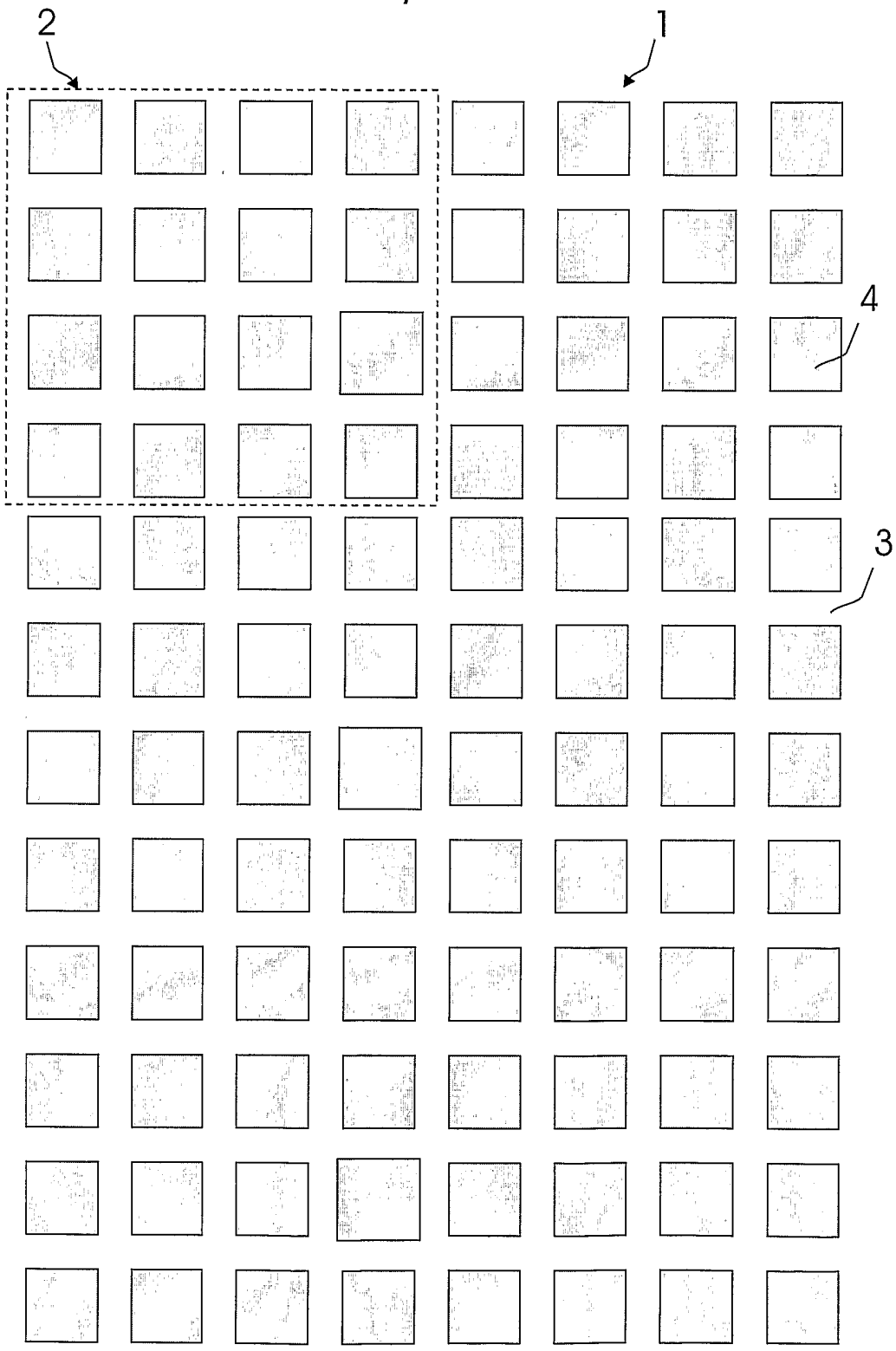

Fig. 1

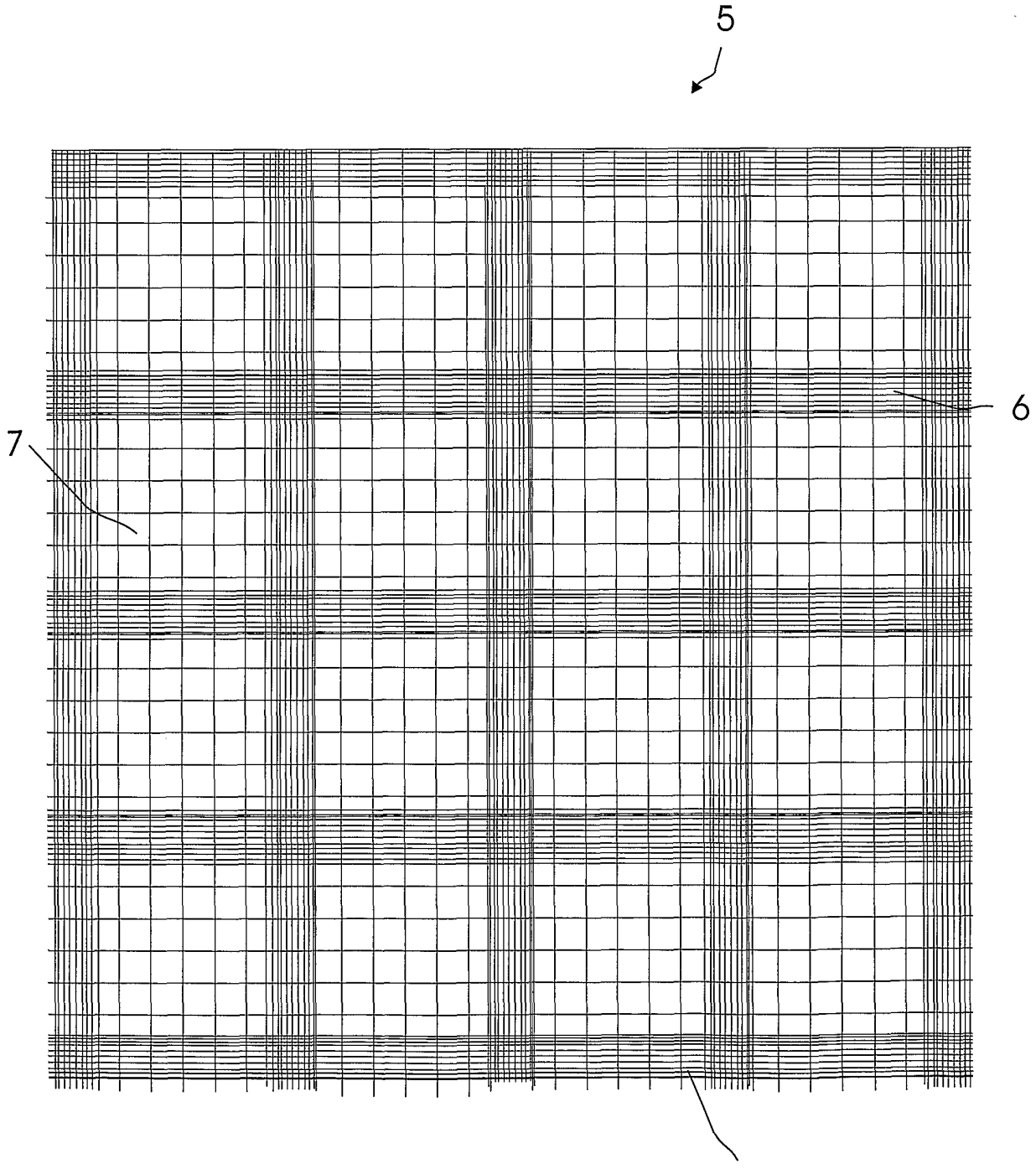

Fig. 2

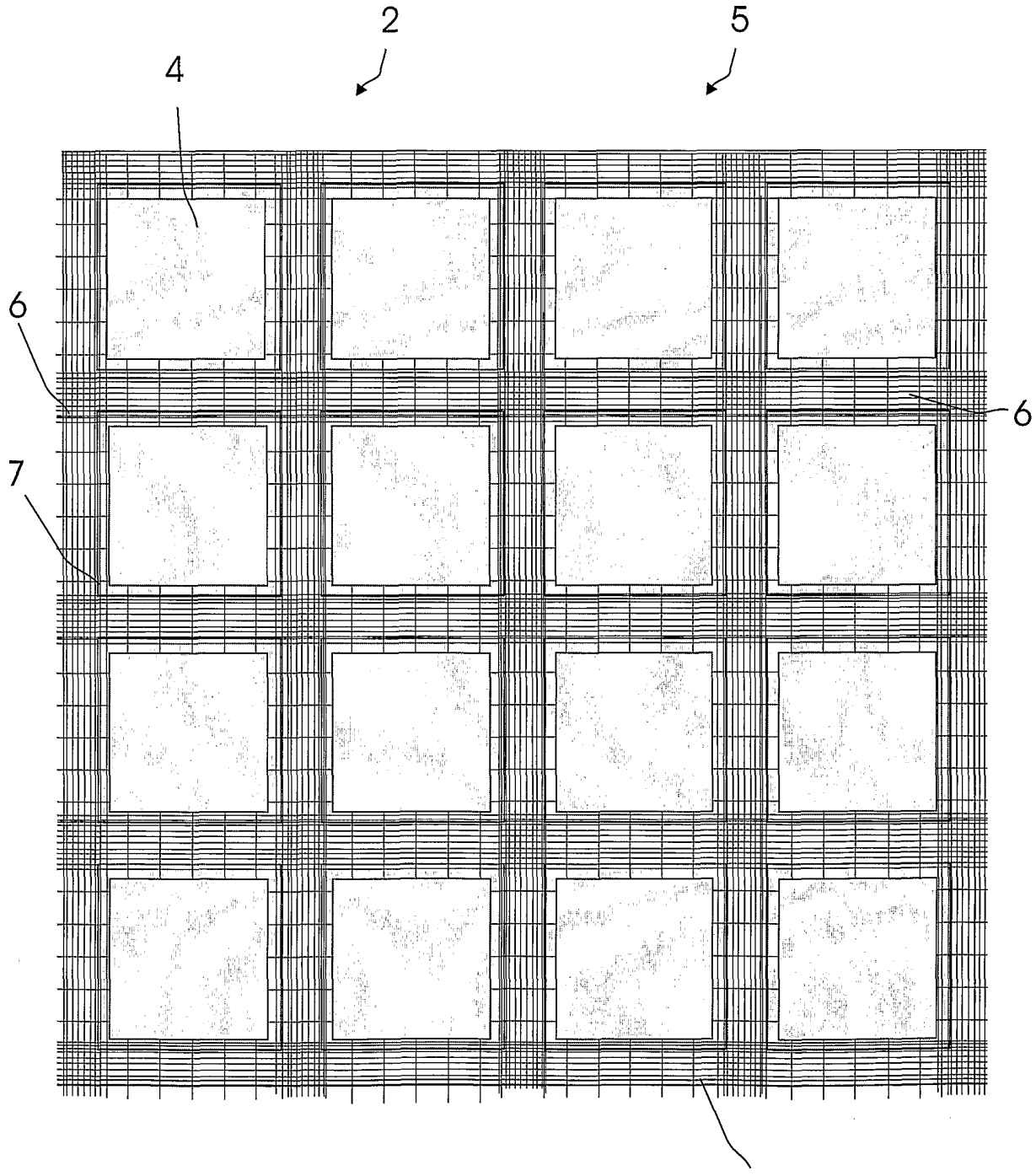

Fig. 3

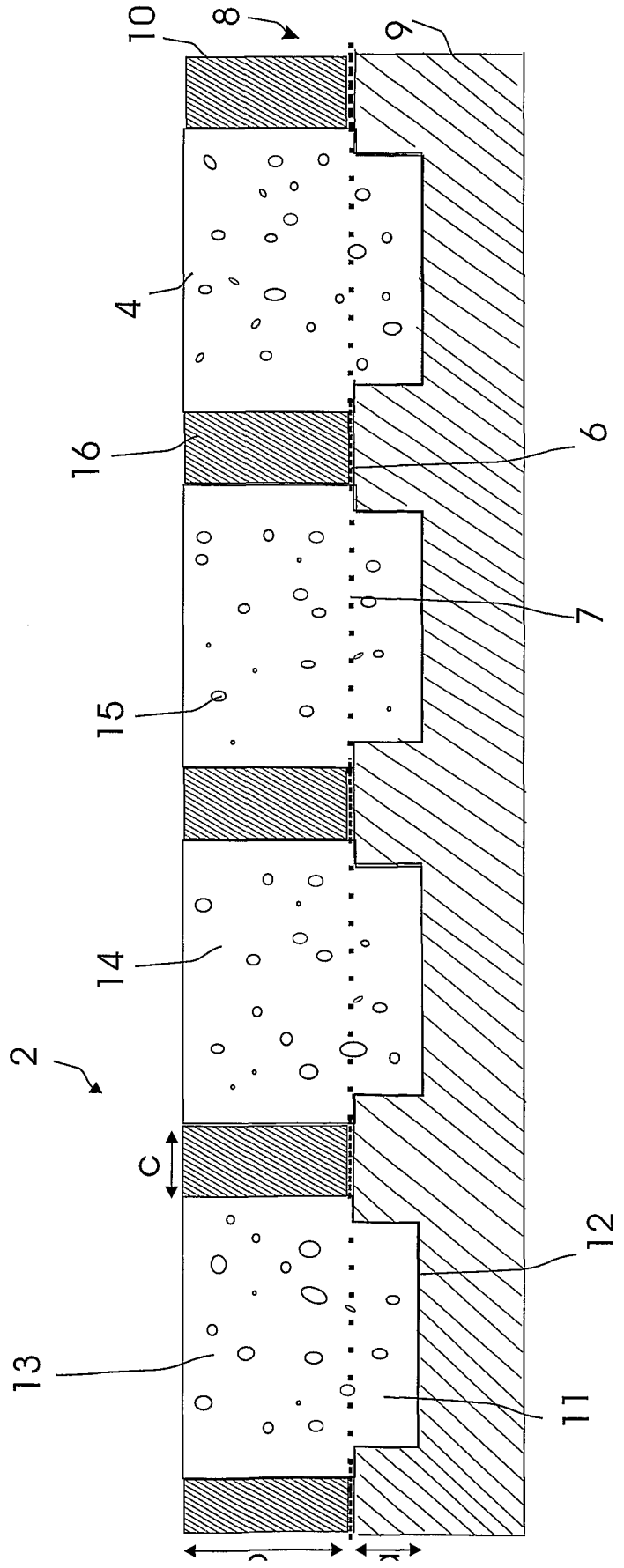

Fig. 4

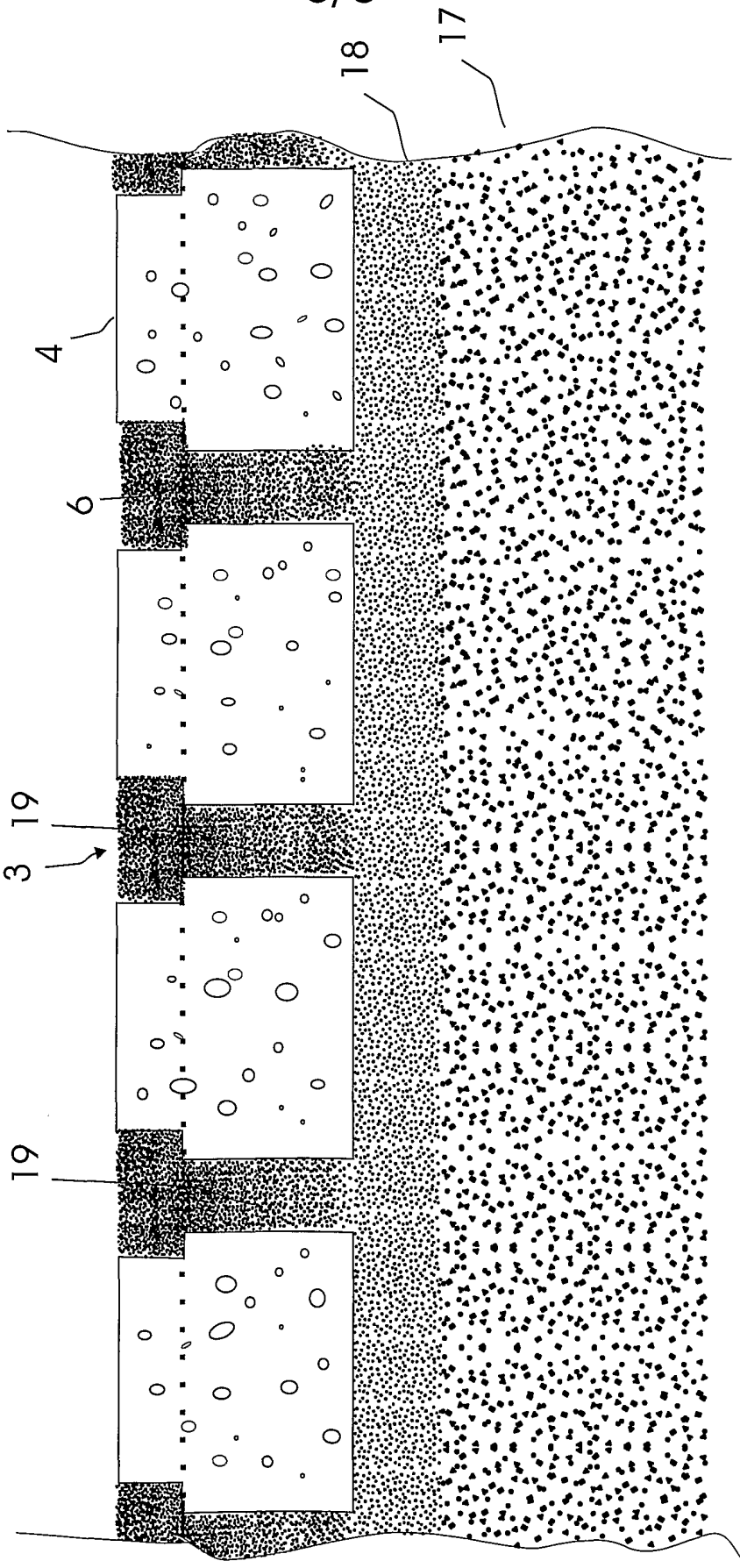

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 01/00781

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E01C 5/06
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)

IPC7: E01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 0005453 A1 (DALLAPICCOLA, R. ET AL), 2 March 2000 (02.03.00), figure 1, abstract, detail 1	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2002	15 -03- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Örjan Nylund / MRo Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

Information on patent family members

28/01/02

International application No.
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