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Structural panel

The invention relates to a structural panel comprising a flat clay-based matrix containing binders, which is provided with a reinforcement, having a first main face and a second main face and a surface heating system with the structural panel.

A layer-type structure for exterior walls is known from DE 20 2010 010 199 U1. The layer-type structure comprises a supporting layer, which can be formed from clay.

A structural panel with a flat clay-based matrix is known from DE 10 2008 058 359 A1, which is suitable for accommodating heating components. The structural panel is produced in an extrusion process.

EP 1 564 341 A2 shows a structural panel with a flat clay-based matrix, which is provided with a reinforcement. The two main faces of the structural panel are formed smooth, and a heating element is embedded in the structural panel.

US 2010/0146884 A1 shows a structural panel with a grid-shaped profiling.

Ecological building materials, such as clay or clay-based building materials, have the advantage that fewer chemicals are introduced into the building. Such building materials have no harmful effect on the health of the occupants. Furthermore, materials obtained from ecological building materials can easily be sent for recycling.

Apart from avoiding the emission of chemicals, clay furthermore has outstanding physical and performance properties, which improve the interior climate and thus enhance the well-being and physical comfort of the occupants. For example, clay has a high thermal storage capacity and is able, by storing and releasing water, to regulate the atmospheric humidity of the room. In addition clay has screening properties as regards electromagnetic radiation.

Clay-based building products are however difficult to process. Thus, the successful application of a clay-based wall plaster depends, inter alia, on the surface structure of the substrate, the absorbing capacity of the substrate, the surface temperature of the substrate, the surface moisture content

of the substrate, the temperature of the room air, the moisture content of the room air during and after the application of the plaster, and the composition of the plaster itself and its shrinkage behaviour when drying. Changes in these conditions during the drying process of the clay also affect the successful application.

Furthermore, for the processing it is essential whether additional components are to be incorporated into the clay, such as reinforcement fabrics or pipes, tubes, cables, for example of water-conducted or electric surface heating systems. Overall therefore the application of a clay plaster is difficult, even for experienced workmen, without suitable training.

A further problem is that clay hardens exclusively by drying, wherein a drying time of 24 hours can be reckoned per millimetre of clay. This means that for a ceiling or wall structure with a layer thickness of 21 mm, a drying time of 3 weeks is required. In addition there is the fact that the moisture is released to the room air during the drying.

For the insulation in new-build energy-plus houses, passive houses and low-energy houses, at the present time insulating layers that are generally 30 to 40 cm thick are applied to the exteriors of the buildings. These normally consist of polystyrene or other petroleum-based building materials, which have the disadvantage that these cannot be sent for material recycling.

For the internal finish of new buildings, for cost reasons walls are generally plastered with gypsum or, in dry construction methods, are prepared using plasterboards. Wallpaper or wall coverings are then mostly applied to these walls and are painted with emulsion paint. In terms of building physics these building materials can absorb and release only an insignificant amount of moisture, which is why in summer the room air is generally too humid and in winter is too dry. The result is an unhealthy room climate, which can be harmful to the occupants' health.

Buildings that are built or converted according to the general recognised building and engineering rules should be free from thermal bridges. In the case of restructuring, external insulations are often unacceptable for aesthetic or economic reasons. In this case it is possible to use interior insulations. These are however problematic from the building physics aspect, since on account of the displacement of the dew point and the resultant condensation of water, these have to be provided with a tight water vapour diffusion barrier. This can be achieved only with difficulty in practice

however. The moisture stored in the heated and therefore warmer internal air condenses on the layers that become externally colder. The building components become wet, leading to the formation of mould and loss of sustainability of the building components. For this reason old buildings were often not insulated and energy losses are accepted.

A majority of the existing heating units are oil-fired or fired by natural gas. In this connection there is the problem that these fossil fuels are not unlimitedly available.

In order to heat the room air radiators or convector plate heaters are generally used. These heat almost exclusively the air that flows upwardly from the heaters, while cold air flows in from underneath. The disadvantage in this case is that the occupant senses the heat only when the air surrounding the occupant is sufficiently warm and also the walls have sufficiently warmed up until their radiation is no longer felt to be uncomfortable. This process continues therefore until the temperature is felt to be comfortable. Furthermore, due to the constant movement of the air an unpleasant draft can be created. In transition periods the heaters are set at low temperatures, as a result of which the heaters become less warm and the convection of the air becomes slower. The heating system is sluggish and the efficiency of the introduced energy is adversely affected. Also, dust from the floor is entrained in the rising air. This is a problem in particular for allergy sufferers.

Floor heating systems are also problematic, since they are effective only up to about 50% as radiant heating and up to about 50% as convection heating. Due to the large amount of convection heating dust is circulated. In addition floor heating systems are very slow, since they are embedded deeply in the screed and their large mass first of all has to be heated before the occupant is conscious of the heat from a floor heating system. Conversely, a floor heating system also cools only slowly.

Water-conducted wall and ceiling heating systems, designed as wet variants and dry variants, are also known.

The wet variant also has the problem of a high moisture uptake, like the application of a clay-based plaster. In addition the thickness of the heating tube/pipe has to be taken into account in the layer thickness of the construction. A covering with plaster has to be applied as a second layer, as a result of which the drying time is correspondingly prolonged.

The dry building variant in the form of a prefabricated structural panel with heating pipes firmly integrated at the factory is not practicable for processing, since an exact measurement of the walls first of all has to be made and the plates cannot be cut flexibly to size at the installation site. A further problem are the connections between the heating lines at the transition from one panel to the next. Each connecting site conceals the danger of a leak, alters the flow behaviour of the heating medium, and leads to an increase in costs.

In addition, in the case of structural panels with pipes firmly integrated at the factory a homogenous distribution of the heat output over the whole surface is not possible, since the panels cannot be cut on account of the firmly integrated heating pipes and unheated edge regions are formed. Even if the surface is fully covered, areas of higher temperature can occur due to the firmly integrated heating pipes, in particular where heating pipes cannot be arranged closely next to one another on account of the system.

In the case of an electrical resistance heating the laying of the cables on a surface that then has to be plastered is a lengthy and complicated process. In order to achieve a complete embedding, it is necessary to skim the surface first of all and then allow it to dry out. The cable then has to be mechanically fastened or bonded. On account of the difficulty of aligning the cable, for this purpose two persons are required for the unrolling and fixing of the cable. Power cables of an electrical resistance heating system normally cannot be shortened and have to be applied over the whole surface. If the cable is not processed completely on the intended surface, or the surface is occupied so tightly that not the whole surface is covered, the cable has to be removed and the complicated laying procedure has to be repeated. Only when the cables are correctly laid on the wall can the application of the plaster begin.

Starting from the problems described above, the object of the invention is to provide a structural panel that can be combined in a particularly simple and space-saving manner with a heating system.

This object is achieved with the features of claims 1 and 7. Sub-claims refer to advantageous embodiments.

The structural panel according to the invention for achieving this object comprises a flat clay-based matrix containing binders, which is provided with a reinforcement, and has a first main face and a

second main face, wherein at least one main face is provided with a profile for accommodating elongated air conditioning elements.

Due to the profiling a versatile clay-based structural panel is formed. The structural panel combines the structural physiological advantages of the building material clay with the possibility of accommodating elongated air conditioning elements. Air conditioning elements according to the invention are for example heating pipes for the passage of water and cables of an electrical resistance heating system. As regards the heating pipes, it is furthermore conceivable that these can also be charged with cold water for cooling.

In addition clay has a good absorption behaviour, so that the clay-based structural panel is able to absorb moisture from the room or from layers arranged underneath the structural panel and also to release moisture. Clay thus exhibits regulating properties as regards the atmospheric moisture.

Furthermore, clay is a capillary-active substance. This means that clay can conduct moisture through the capillaries of more moist layers to dry layers and to the room air.

According to the invention the profiling is formed in the matrix. In order to achieve this the surface profiling is impressed directly into the support construction. The structural panel is advantageously produced by means of pressing. To generate the profiling, a corresponding pattern is provided in the mould. In this way it is possible to incorporate the profiling into the structural panel already during the original forming. In this connection it is in particular advantageous that subsequent fabrication steps such as milling can be dispensed with. Furthermore it has been found that the stability of the structural panel is only insignificantly damaged due to the directly introduced profiling.

The profiling according to the invention exhibits elevations and indentations, wherein the indentations are formed to accommodate the air conditioning elements. In this connection the elevations are arranged in the form of a pattern on the first main side of the structural panel.

Due to the profiling according to the invention the application of a cover layer, for example of a clay-based plaster, it is also greatly simplified. First of all the structural panel according to the invention, which is supplied prefabricated and dried to the installation site, is fixed to the wall or

ceiling. A cover layer is then applied. If clay-based plaster is used, this adheres on account of the surface profiling particularly well to the structural panel, so that the processability is significantly simplified.

The drying times are significantly shorter, since the structural panel is processed dry and only the cover layer applied to the structural panel has to dry out. On account of the small layer thickness the drying time is reduced and less moisture is released to the room air.

The structural panel according to the invention can be fastened to a wall or ceiling and thus simplifies the application of a clay-based plaster to a wall, ceiling or sloping surface of a room, and thereby also enables air conditioning elements, such as for example heating pipes, to be accommodated. In the case of a clay plaster excellent physical and room air conditioning properties are obtained.

The fastening of the structural panel to the wall or ceiling can be carried out using bolts, screws or other fastening means. Alternatively the structural panel can also be fastened cohesively by means an adhesive bonding.

The previously described profiling preferably extends in a joint-bridging manner from panel to panel. A continuous insulation plane is thus created by a full area occupancy of the wall by panels. No measurements are necessary and the panels can be adapted in situ to the required geometry. A production of special sizes can be dispensed with.

In an advantageous embodiment the structural panel is provided with a rabbet or chamfer at the edges. In this connection the rabbet is designed so that two panels adjoining one another can be arranged so as to overlap. For this purpose the edges of two adjacent edges can be designed so that the front region projects, whereas the edges of the two other edges are designed so that in each case the rear region projects. Due to the rabbet the installation and the stability of the wall or ceiling construction is again improved.

Due to the additionally created installation layer in the form of the profiling close to the surface, the invention enables a simplified and significantly quicker installation for air conditioning elements and also for all other cables that have to be laid in the wall or ceiling.

Preferably the air conditioning elements are held by frictional connection in the surface structure of the structural panel. This can be effected by wedging in the air conditioning elements. In addition the cables, pipes or tubes can also be fixed cohesively by wedging them in or using fixing elements such as clamps. Overall the fixing of the tubular, pipe or cable media can be accomplished quickly and by a single person, and if necessary can be corrected quickly and easily.

An advantage is that, due to the permeability of the installation layer in situ, the routing of the surface heating media can be freely selected having regard to the technical circumstances and standards.

The length of the air conditioning elements can be freely chosen having regard to the hydraulic circumstances. Couplings lying underneath the plaster can be dispensed with.

The matrix preferably includes a reinforcement with a fibre material of natural fibres. Clay and natural fibre reinforcements can in the case of recycling be passed free of residues to the natural cycle. Natural fibres include for example wood shavings, hemp fibres, jute fibres, flax fibres and the like.

In an advantageous embodiment the reinforcement contains plant fibres. Plant fibres improve the stability, whereby a particularly good binding of the plant fibres to the clay-based matrix is achieved.

Further conceivable fibre materials for the reinforcement include basalt fibres, glass fibres, carbon fibres, textile fibres, cellulose, straw, coconut fibres or miscanthus.

A further improvement of the stability of the structural panel is achieved if the reinforcement furthermore includes at least one fibre-containing flat structure. In this connection preferably a reinforcement in the form of a fibre reinforcement and a further reinforcement in the form of a flat structure are embedded in the matrix. The flat structure can be formed as a mesh. The mesh can be formed from glass fibres, natural fibres, jute fibres, basalt fibres, flax fibres or carbon fibres.

Advantageously the embedding of the flat structure is near the surface in the region of one of the two main faces. Preferably one flat structure is provided per main face. In this embodiment, with two flat structures spaced from one another and arranged in each case close to the surface in the region of the main faces, a particularly high bending strength of the structural panel is obtained.

The matrix can contain one or more additives. An additive can consist for example of fired and ground clay. The additive improves the construction physical properties of the binder and its processability. Alternatively the additive can contain sand, expanded glass, expanded clay, foam glass, cork, wax, calcium silicate, plastic, expanded or extruded plastic.

Apart from clay, or the clay components in the clay, the binder can also contain gypsum, limestone, cement or bitumen.

The matrix can furthermore contain one or more organic additives. In particular a starch-containing additive is conceivable in this connection.

The profiling can be in the form of a grid. With a gird-shaped arrangement of the elevations and indentations an ordered pattern of the elevations arranged on the first main face is obtained. If elevations are arranged uniformly above and adjacent to one another, an arrangement is obtained in which the indentations run linearly in different directions and at the same time intersect one another, so as to produce lines that cross vertically or at an angle. Depending on the shape of the indentations the lines can also be wave-shaped or the like. The indentations can thus also have a meandering course.

The depth of the indentations accommodating the air conditioning elements is in this connection preferably chosen so that the air conditioning elements laid in the indentations do not project above the indentations. This allows a small layer thickness of a plaster to be applied to the main face and/or the application of a further structural panel.

The grid pattern of the indentations can for example be formed rectilinear, honeycomb-shaped or oblique angle shaped. Other geometrical shapes, in particular in connection with curved lines, are in principle also possible.

Preferably the indentations forming the profiling have the same interspacing in both the longitudinal and transverse directions. In this connection the interspacing can be adapted to the predetermined dimensions for the air conditioning elements. If the grid patterns are the same in the longitudinal and transverse directions, the structural panel can be installed independently of the direction and independently of the laying direction of a wall heating system.

The profiling can enclose protruding fields. In this case the corners of the fields can in particular be provided with radii, which simplify the installation.

The indentations can have a V-shaped, U-shaped or a swallow tail-shaped cross section. Furthermore, the grooves can also be formed having a semi-circular or rectangular shape with a semi-circular shape base. Between the depressions indentations are formed, which depending on the shape of the indentations can be rectangular, oval, round or the like.

The indentations form a receptacle for the air conditioning elements. In the case of the U-shaped indentations the air conditioning elements can first of all be fixed in a frictional manner by wedging them in, which simplifies the installation.

A U-shaped cross-section of the indentations provides for a good embedding of the media in the cover layer, which has a positive effect on the heat output. The air conditioning elements can for example be laid in the form of a meander in the groove structure.

The indentations can be rectangular, circular, oval or droplet-shaped. In principle the geometrical shape of the indentations is not restricted and depends on the intended use. Thus, for example, hexagonal or octagonal shaped indentations are also conceivable. In particular, indentations with a rounded contour enable a kink-free installation of elongated media.

The surface heating system according to the invention includes a structural panel according to the invention, in which elongated air conditioning elements are laid in the profiling of the structural panel and in which the main face comprising the profiling is provided with a covering.

If the structural panel is part of a surface heating system, in particular a wall heating or a ceiling heating, a surface heating of large surface area is obtained after installation. In this connection it is

advantageous if surface heating systems are operated at low temperatures on account of their size, and at the same time the room is heated by a large proportion of radiant heat. Due to the radiant heat not only is the air heated, but also the surfaces and objects in the room are in radiation exchange with the surface heating and are thereby heated. From the construction physics aspect heat bridges are less important, since only heated air, but not the radiant heat, escapes via heat bridges.

The proportion of the heat of an installed surface heating system that is not released as radiant heat heats the interior of the panel and thus in addition counteracts a possible loss of moisture.

Also, in the embodiment as ceiling heating a large area surface heating is also achieved.

In this connection the heat carrier can be designed as an electrical resistance heating. In particular by using renewable forms of energy a constant heating can be achieved with this embodiment. In the case of a water-based heat carrier a cooling in summer is also possible, depending on the design of the heating installation.

Due to the high proportion of radiant heat, wall and ceiling heating systems provide for a comfortable room climate despite relatively low air temperatures. Accordingly, also less insulation is therefore required. Due to the low convection effect virtually no dust convection takes place. In lower air layers the air remains cooler and the blood circulation is not adversely affected owing to too high temperatures in the region of the feet, which would be the case with a floor heating.

According to a first embodiment the covering is formed as a plaster. In this connection the plaster, or the plaster layer, is preferably formed as a clay-based plaster. This, like the structural panel, has advantageous building physiological properties. The plaster when applied penetrates into the indentations, fills these, and forms a direct contact with the air conditioning elements. A good heat transfer at the free surface and thus a high efficiency is thereby achieved.

According to a second embodiment the covering is formed as a further structural panel. The further structural panel is preferably also clay-based and can, apart from the profiling, be designed similarly to the structural panel. In this embodiment there is the advantage that a particularly rapid installation of the surface heating system is possible and no drying processes are necessary.

Alternatively it is also conceivable, after laying the air conditioning elements, to fill the indentations firstly with a putty and then install a further structural panel. In this embodiment the moisture penetration is slight, and at the same time a contact is produced between the air conditioning elements and further structural panel, so that here a heat transfer by thermal conduction is possible. Preferably the putty for filling the indentations is also clay-based.

In the case of an electrical surface heating the lines can be laid in the profiling so as to produce the effect of a Faraday cage. Such a Faraday cage acts inter alia to screen undesirable electromagnetic radiation, for example from mobile phones.

Some embodiments of the structural panel according to the invention are now described in more detail with the aid of the drawings. These show schematically in each case:

Fig. 1 a structural panel in a perspective view;

Fig. 2 a structural panel according to Fig. 1 with alternatively shaped indentations;

Fig. 3 a surface heating with a plaster covering in a perspective view and sectional view;

Fig. 4 a surface heating according to Fig. 1 with alternative profiling in a perspective illustration and sectional view;

Fig. 5 a surface heating with a covering in the form of a further structural panel in a perspective illustration and sectional view;

Fig. 6 a surface heating according to Fig. 3 with alternative profiling in a perspective illustration and sectional view.

Figs. 1 and 2 show a structural panel 1, in particular for the installation of a ceiling layer, for example of a clay-based final plaster coat.

The structural panel 1 comprises a flat clay-based matrix 2, which is provided with a reinforcement 3. In this connections the structural panel 1 has a first main side 4 and a second main side 5. The reinforcement 3 consists of natural fibres, in this embodiment of plant fibres. In addition a further reinforcement 3 in the form of a fibre-containing flat structure 8 is provided. In this embodiment

the flat structure is formed as a fabric mesh and is embedded in two layers spaced from one another and from the two main faces 4, 5 and parallel to one another in the clay-based matrix 2.

Fired and ground clay is provided as additive for the matrix 2. Clay also has capillary-active properties and assists the drying process.

At least the main face 4 of the structural panel 2 is provided with a profiling 7 for accommodating elongated air conditioning elements 6.

The profiling 7 includes elevations 9 and indentations 10. The indentations 10 are U-shaped in this embodiment. The profiling 7 serves first of all on the one hand to receive elongated air conditioning elements 6, for example cables of an electrical resistance heating or heating pipes. On the other hand the profiling 7 improves the adhesion of a plaster layer that is to be applied.

The profiling 7 can be impressed into the main face 4 of the structural panel 1 so as to produce a regular grid from the indentations 7 with elevations 9 arranged there between. Here the indentations 10 run in the form of intersecting lines.

In the embodiment according to Fig. 1 the elevations 9 are circular, wherein further elevations 9' are arranged between the elevations 9. The further elevations 9' are rectangular with a side contour bent concavely inwards.

The embodiment according to Fig. 2 has exclusively circular elevations 9.

In other embodiments the profiling 7 can be designed so that rectangular, oval, ellipsoidal or droplet-shaped elevations are formed.

In order to facilitate the installation the structural panel 1 can be provided with a surrounding rabbet. After installation of the structural panel 1 elongated air conditioning elements 6 can be incorporated into the profiling 7. Finally, a covering layer of clay can be applied to the side facing the room, which on account of the profiling 7 adheres particularly well to the structural panel 1 and covers the air conditioning elements 6.

Fig. 3 shows a surface heating system 11, which is based on a structural panel 1 according to Fig. 1. Elongated air conditioning elements 6, in this embodiment heating pipes, are laid in the profiling 7 of the structural panel 1. The main face 4 of the structural panel 1 comprising the profiling 7 is provided with a covering 12.

The air conditioning elements 6 can be a conduction system of an electrical or a water-conducting heating. In the figures it can be seen that the air conditioning element 6 is arranged in the profiling 7 of the structural panel 1. In this case the air conditioning element 6 is arranged in the profiling 7 so as to produce a meandering course of the air conditioning element 6. The air conditioning element 6 can be an electrical conductor of an electrical resistance heating. Alternatively the air conditioning element 6 can include tubes or pipes of a fluid-conducting heating. The indentations 7 are in this case U-shaped.

The structural panel 7 is provided with a covering 12 in the form of a plaster layer. The plaster layer is clay-based, wherein the plaster layer fills the indentations 10.

Fig. 4 shows the previously described surface heating 11 in combination with a structural panel 1 according to Fig. 2.

Figs. 5 and 6 show an alternative embodiment of the surface heating 11. In the embodiment according to Fig. 5 a covering 12 in the form of a further structural panel is provided on the structural panel 1 according to Fig. 1. In the embodiment according to Fig. 6 a covering 12 in the form of a further structural panel is likewise provided on the structural panel 1 according to Fig. 2. In both embodiments the cavity in the indentation 10 between the air conditioning element 6 and covering 12 can additionally be filled with a clay-based putty.

Patentkrav

1. Byggeplade (1) omfattende en flad ler-baseret matrix (2) indeholdende bindemidler, hvilken byggeplade er forsynet med en armering (3) og har en første hovedflade (4) og en anden hovedflade (5), hvor mindst en hovedflade er forsynet med en profil (7) til at rumme aflange klimaanlægskomponenter (6), hvor profilen (7) har forhøjninger (9) og fordybninger (10), hvor fordybningerne (10) er udformet til at rumme klimaanlægskomponenterne (6), hvor forhøjningerne (9) og fordybningerne (10) er indrettet således, at der i fordybningerne (10) er indrettet krydsende linjer, hvor profilen (7) er indstøbt i matricen (2).

2. Byggeplade ifølge krav 1, **kendetegnet ved, at** armeringen (3) omfatter naturlige fibre.

3. Byggeplade ifølge krav 2, **kendetegnet ved, at** armeringen (3) omfatter en fiberholdig flad struktur (8).

4. Byggeplade ifølge et hvilket som helst af kravene 1 til 3, **kendetegnet ved, at** profilen (7) er gitterformet.

5. Byggeplade ifølge et hvilket som helst af kravene 1 til 4, **kendetegnet ved, at** fordybningerne (10) i tværsnit er U-formet eller V-formet.

6. Byggeplade ifølge et hvilket som helst af kravene 1 til 5, **kendetegnet ved, at** forhøjningerne (9) er rektangulære, cirkulære, ovale eller dråbeformede.

7. Overfladevarmesystem (11), omfattende en byggeplade (1) ifølge et hvilket som helst af de foregående krav, hvor aflange klimaanlægskomponenter (6) er indlagt i byggepladens (1) profil (7), og hvor profilens (7) fremviste hovedflade (4) er forsynet med en afdækning (12).

8. Overfladevarmesystem ifølge krav 7, **kendetegnet ved, at** afdækningen (12) er dannet af puds.

9. Overfladevarmesystem ifølge krav 7, **kendetegnet ved, at** afdækningen (12) er tilvejebragt som en yderligere byggeplade.

10. Overfladevarmesystem ifølge krav 9, **kendetegnet ved, at** profilen (7) er fyldt med spartelmasse.

11. Overfladevarmesystem ifølge et hvilket som helst af kravene 7 til 10, **kendetegnet ved, at** afdækningen (12) omfatter ler og/eller kalk.

12. Overfladevarmesystem ifølge et hvilket som helst af kravene 7 til 11, **kendetegnet ved, at** overfladevarmen (11) er tilvejebragt som væg- eller loftsopvarmning.

Fig. 1

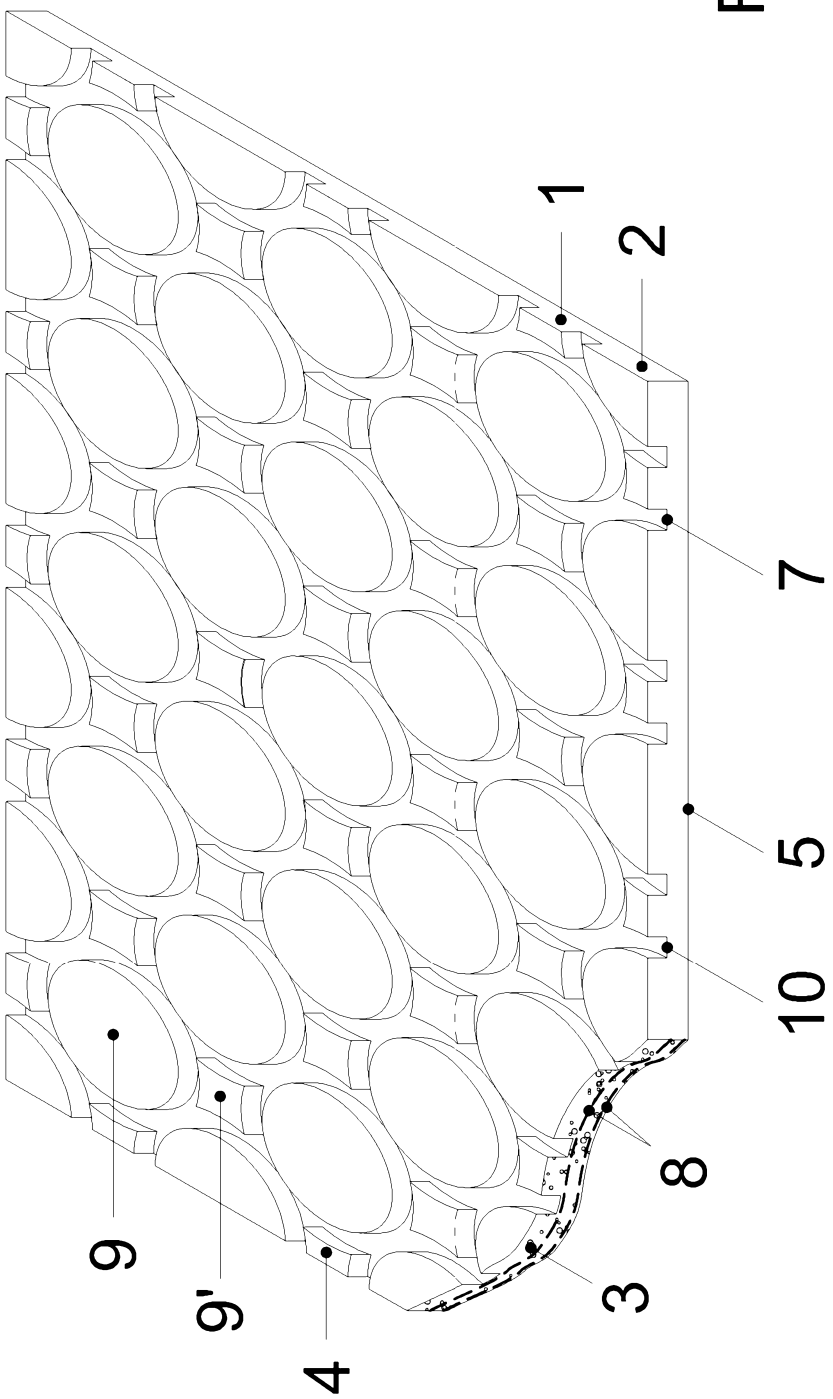
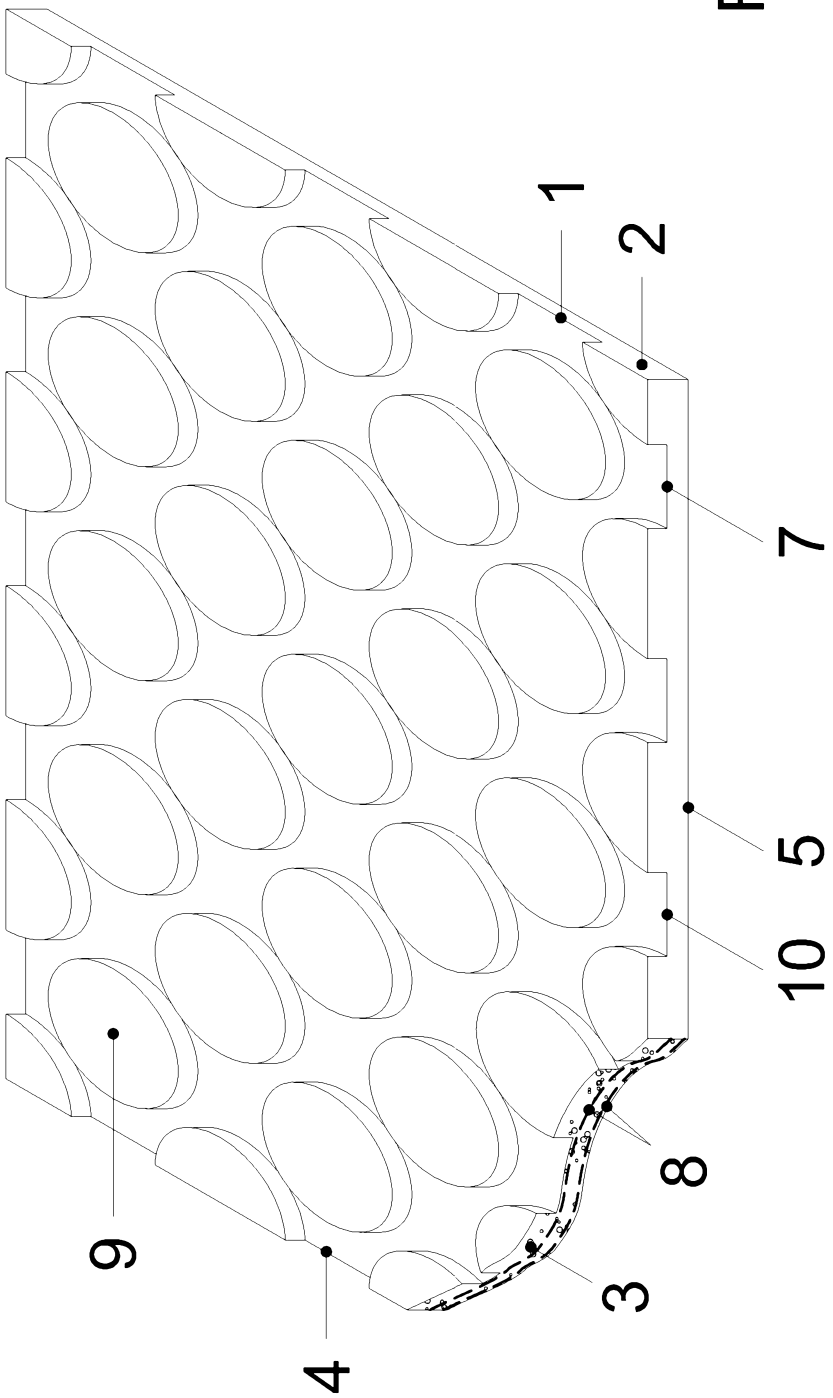


Fig. 2



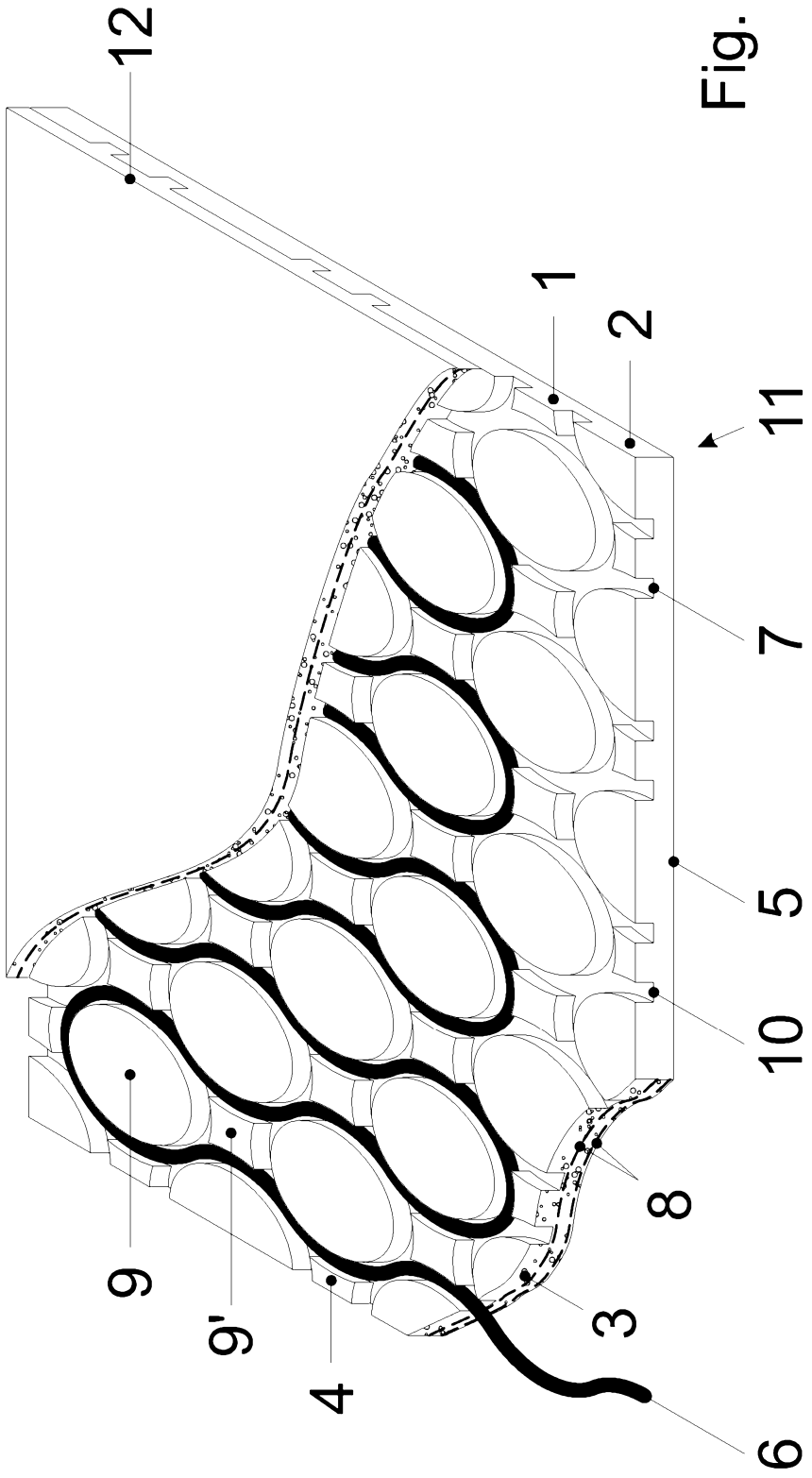


Fig. 3

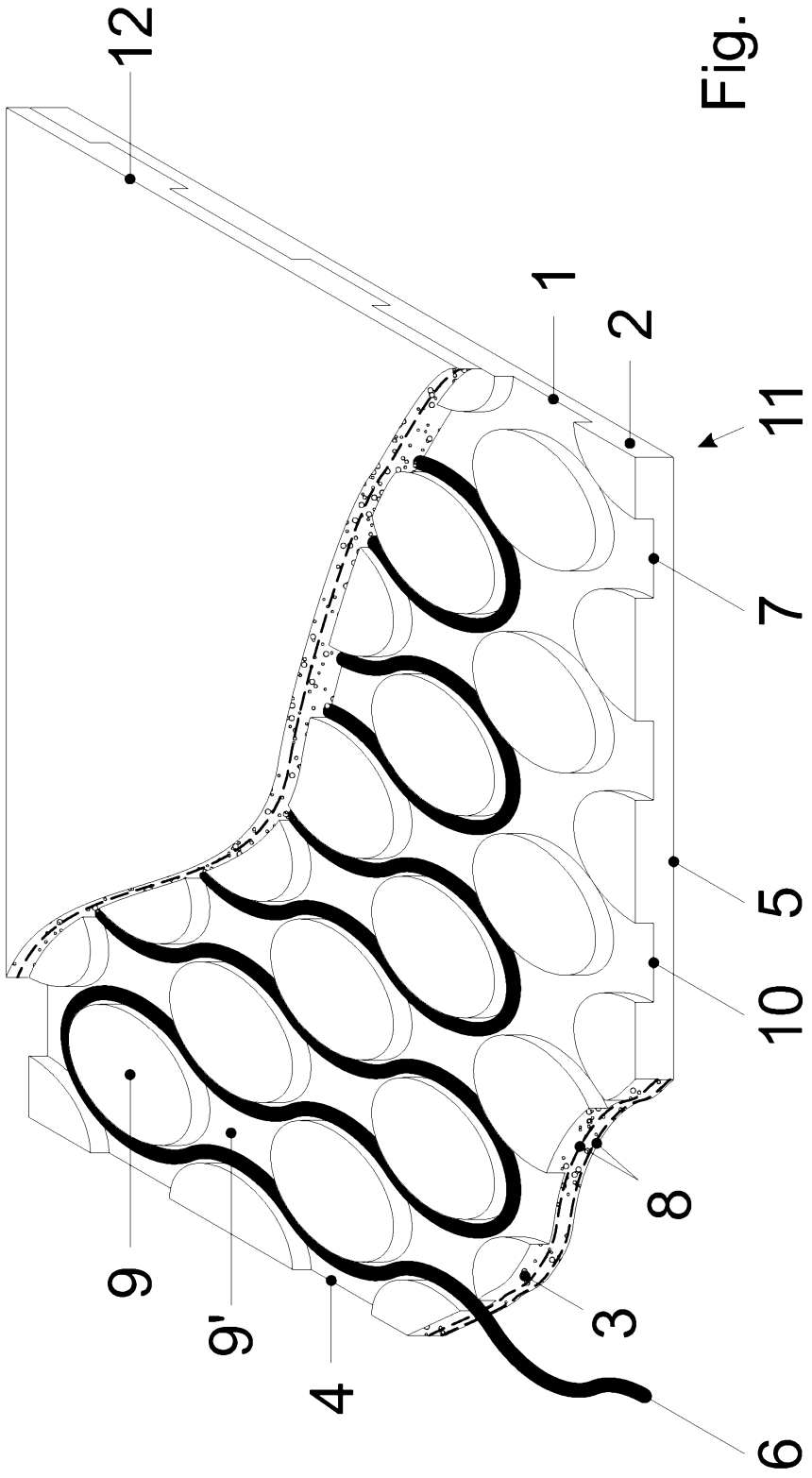


Fig. 4

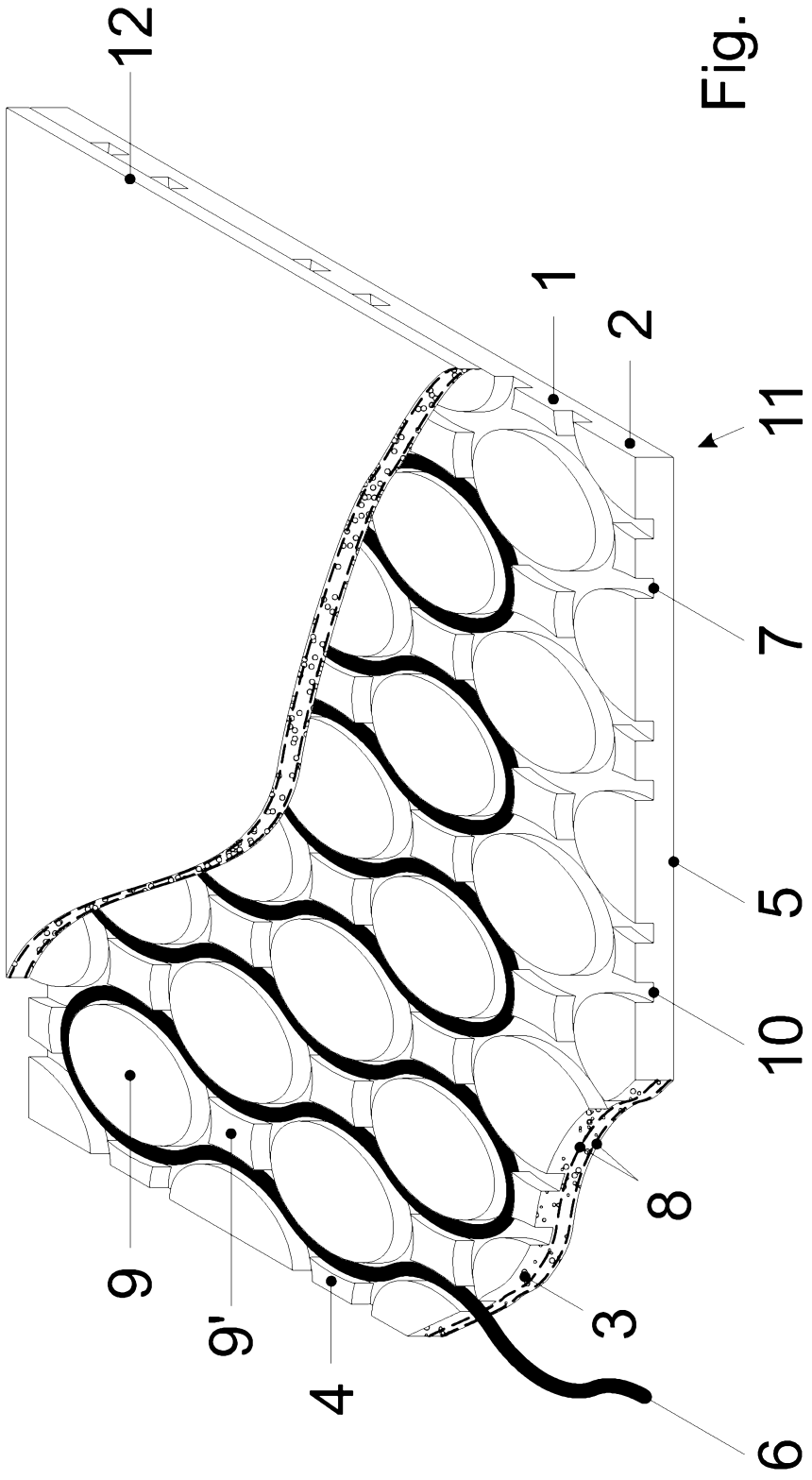


Fig. 5

Fig. 6