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(71) Applicant: **URSA Insulation, S.A.**
28004 Madrid (ES)

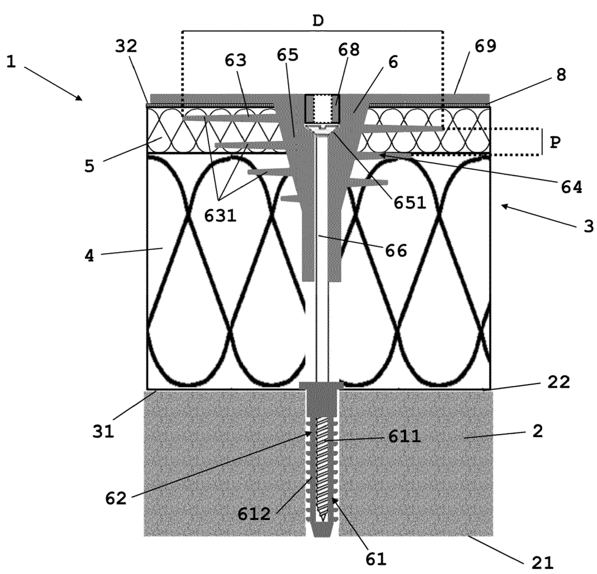
(72) Inventors:
- **Molinero Arenas, Alejandro**
  28050 Madrid (ES)
- **Casado Domínguez, Arturo Luís**
  28860 Paracuellos de Jarama (ES)

(74) Representative: **Zimmermann & Partner Patentanwälte mbB**
Postfach 330 920
80069 München (DE)

(54) IMPROVED BUILDING WALL OR ROOF SYSTEM COMPRISING FIBROUS INSULATION

(57) A wall or roof system (1) comprising a structural element (2) having a first (21) and a second side (22); an insulation element (3) having first (31) and second (32) major surfaces, the insulation element (3) arranged with its first major surface (31) proximal to the second side (22) of the structural element (2), the insulation element (3) comprising an internal layer (4) proximal to the structural element (2), and an external layer (5) distal from the structural element (2), both layers being distinct and both layers extending in the length and width direction of the insulation element (3); a spacer fastening device (6) for fixation of the insulation element (3) to the structural element (2), spacer fastening device (6) adapted to hold the second major surface (32) of the insulation element (3) spaced at a defined distance from the second side (22) of the structural element (22), this distance being adjustable by acting on the spacer fastening device (6); wherein the external layer (5) comprises fibrous insulating material with a density lower than 140 kg/m^3; and the fibrous insulating material in the external layer (5) has a laminar configuration of the fibers.

FIGURE 1



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Description

Filed of the Invention

[0001] The invention relates to a wall or roof system of a building or the like, preferably a building insulated façade, comprising fibrous insulating material.

Background

[0002] The façades of buildings are recurrently thermally and acoustically insulated by applying insulating materials externally to its structural elements. For this purpose, the use of generically called "External Thermal Insulation Composite Systems" (abbreviated as ETICS) is nowadays well established. The ETICS commonly comprise a layer of insulation elements (e.g. panels) arranged externally on the surface of a structural element, fastening devices erecting through the thickness of the insulation elements and fixing those to the structural element, a rendering coating (e.g. mesh reinforced mortar) applied to the external surface of the insulation elements, and optionally a finishing layer (e.g. dyed mortar), acting as an aesthetic and/or protective layer for the outer surface of the system. Frequently, a bonding agent is also applied to the insulation elements for adhering them to the surface of the structural element during installation.

[0003] The insulation elements in these insulation systems are usually formed by panels made of polymer foam (expanded polystyrene EPS, extruded polystyrene XPS, polyurethane), of fibrous insulating materials (glass wool, stone wool, wood or lignocellulose wool), or other more complex composite materials. As a result of the mechanical stresses to which the insulation elements are subjected to in this type of application, like the compression forces applied during application of the rendering, impacts, or the pulling force caused by the wind suction or the own weight of the system, the insulation elements are required to have high mechanical robustness and resistance against compression and tearing forces, particularly in the direction of the thickness of the insulation elements.

[0004] In the case of fibrous insulating materials, these high mechanical requirements have led to efforts directed to products with increased density and/or binder content. This approach has found some success, mostly for stone wool or wood wool products. These efforts face however obvious drawbacks, such as the increased weight and costs of the panels, but also less obvious ones, such as reduced manufacturing productivity due to the lower machine speeds necessary. Further, the maximum level of density and binder content is often limited by the fibrous material manufacturing methods.

[0005] In an alternative approach to increase the mechanical rigidity of fibrous insulating materials in the direction of its thickness, it has been described to enhance the orientation of the fibers inside the insulating material in this thickness direction, this is, perpendicular to the larger surfaces of the insulating material. Two such techniques have been used with relative success, commonly referred to as the lamella formation and the crimping process. In the first one, described e.g. in the patent application WO2005068574A1, the cured or uncured mat as produced is cut into strips (lamellae), which are then rotated 90° and joined together again to form a lamella panel. By this rotation of the strips, the fibers, originally in a parallel orientation to the larger upper and lower surfaces of the mat, are re-oriented parallel to the thickness of the new panel formed. In the crimping process, described e.g. in patent application US 2004051205 A1, the uncured mineral wool mat is subjected to successive longitudinal compression by pairs of conveyors sequentially running at lower speeds. The longitudinal compression crimps the fibers and re-orients them before the binder is cured and the new orientation is set. Although these techniques have proven efficient for increasing mechanical resistance of the panels obtained, in the direction of their thickness, they also cause an important decrease in their thermal insulation capacity in this same direction. Furthermore, the lamella or crimping formation adds significant complexity to the manufacturing processes, and reduces production efficiencies.

[0006] In order to overcome some of the limitations of the systems described above, ETICS comprising insulation elements with layers of different properties has been described. Some examples are disclosed in the patent publications EP 2 666 919 A2, EP 2 216 454 A2, and WO 2014/090707 A1. In these systems, a softer, more flexible layer arranged closer to the structural element of the building is laminated to a harder, more rigid, tougher layer located more distal from the structural element. Fastening devices extend through the layers in the insulation element and fix them to the structural element. Frequently, the fastening devices are adapted to hold the harder layer at a certain distance from the wall. Among other advantages, in these configurations, the harder layer serves as base for the rendering coating and it is able to withstand mechanical stresses applied to the insulation element. The softer layer reduces the weight of the insulation element, and is capable of adapting itself to irregular contours which might be present in the structural element.

[0007] The multilayer systems above, however, still suffer from limitations and drawbacks when fibrous insulating materials are used. Thus, for instance, the harder layer still requires fibrous insulating material of very high density and high binder content, or materials which fibers have undergone a process for orientation in the thickness direction of the layer. In fact, the fibrous insulating materials described as suitable for the hard layer are in most cases high density stone wool or wood wool, or lamella/crimped mineral fiber materials.

[0008] The invention disclosed herein is based on the surprising finding by the inventors that in ETICS systems, multilayer insulation elements can very suitably be used, where the layer of the insulation element intended to be located distal from the structural element comprises a fibrous insulating material, particularly a glass wool material, with a reduced density when compared to the systems known in the art, and wherein the fibers of the fibrous insulating material in this layer have not been subjected to re-orientation in the thickness direction of the insulation element. This provides significant advantages, such as improved thermal insulation capacity, lower weight and more straightforward and economical manufacture, among others.

Brief description of the invention

[0009] The invention relates to an improved wall or roof system for a building or the like, comprising a structural element, an insulation element and a spacer fastening device, which overcomes the problems and limitations of similar systems known in the art. In particular, the wall or roof system described in embodiments of the invention offers better thermal insulation capacity, lighter and quicker installation, as well as economic and manufacturing advantages.

[0010] The invention is particularly useful as externally insulated walls or roofs of buildings, such as façades, flat or pitched roofs. Because of this fact, through this description and for clarity purposes sometimes relative wording is used, such as exterior, external, outer, inner, interior or internal. It should be understood that this wording relates to the general intended location relative to the structural element of the building. The invention is not limited to these applications, and, although less preferred, the inventive wall or roof system might be also useful in other cases, such as e.g. internal walls, floors or ceilings of buildings.

[0011] In an aspect of the invention, the wall or roof system comprises:

a) a structural element having a first and a second side;

b) an insulation element having first and second major surfaces, the insulation element arranged with its first major surface proximal to the second side of the structural element, the insulation element comprising an internal layer proximal to the structural element, and an external layer distal from the structural element, both layers being distinct from each other and both layers extending along the length and width of the insulation element, i.e. in the length and width direction of the insulation element;

c) a spacer fastening device for fixation of the insulation element to the structural element, adapted to hold the external layer and therefore also the second major surface of the insulation element spaced at a defined distance from the second side of the structural element, this distance being adjustable by acting on the spacer fastening device (6);

wherein the external layer comprises fibrous insulating material with a density lower than 140 kg/m^3; and the fibrous insulating material in the external layer has a laminar configuration of the fibers , i.e. with the fibers predominantly oriented perpendicular to the thickness of the external layer.

[0012] In other words, with the laminar configuration of the fibers of the fibrous insulation material in the external layer it is meant that the fibers have not been subjected to any process to enhance their orientation in the direction of the thickness of the external layer.

[0013] The internal layer and the external layers are distinct. In other words, both layers have different compositions and/or properties, and a boundary exists between them. The external and internal layers are preferably manufactured separately from each other. In embodiments, the external layer of the insulation element has higher rigidity than the internal layer. The higher rigidity of the external layer turns into a better ability of this layer to resist deformation without fracture in response to applied forces in its thickness direction.

[0014] Preferably, the external layer has a compressive stress at 10% deformation, measured according UNE EN 826:2013, of at least 3 times, preferably at least 4 times, higher than the compressive stress at 10% deformation of the internal layer. Also preferably, the external layer has a compressive stress at 10% deformation lower than 15 kPa or lower than 10 kPa, more preferably of 5 - 1 kPa.

[0015] Preferably, the density of the fibrous insulating material of the external layer ranges from 120 - 60 kg/m^3, more preferably 100 - 70 kg/m^3. The thickness of the external layer is preferably at least 15 mm, more preferably at least 25 mm.

[0016] In preferred embodiments, the fibrous insulating material of the external layer is mineral wool, more preferably glass wool.

[0017] The fibrous insulating material of the external layer, particularly mineral wool or glass wool, is preferably bonded with a cured organic binder. The binder content is suitably higher than 5 wt.%, and preferably it ranges from 6 - 15 wt.-%.

[0018] The external layer of the insulation element preferably comprises a reinforcing web either on or at its larger surface (inner side of the external layer) more proximal to the structural element, or on or at its larger surface (outer side of the external layer) more distal to the structural element. More preferably, the reinforcing web is present in or on or at both larger surfaces.

[0019] In embodiments, the internal layer comprises fibrous insulating material. According to these embodiments of the wall or roof system, the fibrous insulating material of the internal layer has a density lower than 60 kg/m^3, preferably lower than 45 kg/m^3 and more preferably lower than 35 kg/m^3. Also preferably, the fibrous insulating material of the internal layer is mineral wool, particularly glass wool. The orientation of the fibers in the fibrous insulating material of the internal layer might be laminar, not having been subjected to any process to enhance their orientation in the direction of the thickness of the internal layer.

[0020] In embodiments where both external layer and internal layer comprise fibrous insulating material, it is preferred that the external layer has a higher density than the internal layer, more preferably the density of the external layer is at least 1.5 times higher than the density of the internal layer.

[0021] In preferred embodiments, the insulation element does not comprise fibrous insulating material with a density equal or higher than 140 kg/m^3.

[0022] In preferred embodiments of the invention, the insulating element consists of an internal layer and an external layer. Preferably both internal and external layers comprise glass wool material. Also preferably, the density of the external layer is higher than the density of the internal layer. The glass wool comprised in both internal and external layer might have a laminar configuration of the glass fibers. More preferably, the external layer comprises glass wool material with a density in the range 100 - 70 kg/m^3 and a laminar orientation of the glass fibers. The external layer preferably further comprises a reinforcing web applied on or at its major surface intended to be located more distal from the structural element. The internal layer comprises glass wool material with a density in the range 20 - 45 kg/m^3 and a laminar orientation of the glass fibers.

[0023] In an aspect of the invention, the spacer fastening device may be adapted to hold the external layer and the second major surface of the insulation element spaced at a defined distance from the structural element, by having means for fixation to the structural element on a first end portion, and means for engaging into the external layer on a second end portion further away from the first end portion.

[0024] In embodiments of the spacer fastening device, it comprises a hollow shank and a fastening screw received into the inner cavity of the hollow shank. The fastening screw is furthermore restrained from movement relative to the hollow shank along the axial direction of the fastening screw in suitable examples. Preferably, the hollow shank is provided with a thread running as a helical band along its length, preferably in a conical shape. The maximum major diameter of the helical thread is preferably at least 50 mm, and it might range from 50 - 100 mm, more preferably from 60 - 80 mm. The pitch of the helical thread is preferably constant along the thread and at least 3 mm, more preferably at least 4 mm. The thread pitch preferably does not exceed 30 mm, and more preferably it does not exceed 20 mm, most preferably it does not exceed 10 mm.

[0025] The wall or roof system might preferably comprise a plurality of insulation elements arranged side-by-side with abutting lateral edges. Each of the insulation elements might itself be fastened to the structural element by a plurality of spacer fastening devices. Adhesive tapes might be applied to the abutting edges of at least some neighboring insulation elements.

[0026] In another aspect of the invention, it is provided a method for the manufacture of a wall or roof system according to the embodiments, the method comprising:

a) providing an insulation element having first and second major surfaces, the insulation element comprising an internal layer and an external layer, both layers being distinct and both layers extending in the length and width direction of the insulation element; the external layer comprising fibrous insulating material with a density lower than 140 kg/m^3 and a laminar configuration of the fibers;

b) providing a spacer fastening device;

c) fixing the insulation element to a structural element of a building with the spacer fastening device; wherein the spacer fastening device is adapted to hold the external layer and therefore also the second major surface of the insulation element spaced at a defined distance from the second side of the structural element, this distance being adjustable by acting on the spacer fastening device.

Definitions

[0027] Fibrous insulating material is understood as a thermally and acoustically insulating material formed by an entangled three dimensional mesh of fibers of different lengths and diameters. The spaces between the fibers are filled with a gas, usually air, and the fibers are commonly bonded by a cured binder. It should be understood that the main component of the material are the fibers, being the binder in a much lower amount, usually in a content of less than 30 wt.-% relative to weight of the fibers. Examples of fibrous insulating materials are mineral wools, such as stone wool and glass wool, and wood wools.

[0028] Mineral wool is a material formed by an intricate network of fibers which might be bonded in their crossover points by different means, e.g. by using a cured binder. Three types of mineral materials are most commonly employed, glass, stone or slag. Processes for the production of mineral wool products are well known in the art, and usually comprise the steps of melting the mineral material to an adequate temperature, fiberizing the molten mixture into fine fibers, application (e.g. spraying) of a binder composition to the individual fibers, collection of the fibers and formation of a primary fleece on a foraminous conveyor, densifying the fleece, and curing the binder at elevated temperatures. The cured mat is then cut to the desired size with transverse and edge trimmers and optionally rolled up, before it is packaged for transport.

[0029] The artisan readily identifies the characteristics making a mineral fiber composition a glass fiber composition, and differentiates glass from other minerals. As a simple distinguishing feature, the term glass fibers means that the mineral composition of the fibers is characterized by having a weight ratio of compounds having alkali metals (i.e. K_2O, Na_2O) relative to compounds having alkaline earth metals (i.e. MgO, CaO) higher than 1. In comparison, stone wool or slag wool fibers have a weight ratio of compounds having alkali metals to compounds having alkaline earth metals of less than 1. Glass wool is a mineral wool material where the fibers have a glass composition.

[0030] By laminar configuration of the fibers in the fibrous insulating material it is meant that the fibers forming the material are predominantly oriented parallel to the major surfaces of the mat as produced in the manufacturing line. These major surfaces normally correspond to the major surfaces of the elements, such as panels, cut from the mat. From a different perspective, the fibers are predominantly oriented perpendicular to the thickness of the mat or the panels formed therefrom. The laminar configuration of the fibers results from the deposition of the fibers freshly formed by a series of fiberizers and attenuated by air from burners vertically onto a receiving foraminous conveyor, under air suction from beyond the conveyor. Optionally, the laminar configuration of the fibers, this is, the predominant orientation parallel to the major surfaces, can be further improved by compressing the mat in the thickness direction and/or by stretching the uncured mat, and then curing the binder. The stretching of the mat can be achieved for example by running the conveyors at sequentially increased speeds downstream the manufacturing line. In the laminar configuration of the fibrous insulating material, the fibers shall have not been subjected to any process to increase their orientation in the direction perpendicular to the major surfaces of the mat, such as lamella formation or crimping processes.

[0031] The fibers of the fibrous insulation material are preferably bonded with a cured binder based on a thermoset resin. The term thermoset resin refers to the mixture of thermosetting components which will form a crosslinked polymeric network after curing. The term binder refers to the mixture of components which is applied to the fibers in the manufacture of fibrous insulating material products and subsequently cured to produce the bonding of the fibers at their cross-over points.

[0032] The binder content of the fibrous insulating materials is defined as the "Loss on Ignition" (LOI), measured according ISO 29771:2008.

[0033] The major diameter of the helical thread of the hollow shank in the spacer fastening screw should be understood as the cylinder distance between two diametrically opposed thread crests, this is the distance between two diametrically opposed crests measured in projection onto a plane perpendicular to the central axis of the thread. For a helical thread in the shape of a cone, the maximum major diameter corresponds to the larger of such distances. By the pitch of the helical thread it is meant the distance between two consecutive thread crests measured along the direction of the central axis of the thread.

Detailed disclosure of the invention

[0034] The invention relates to a wall or roof system, particularly related to façades of buildings, comprising a structural element having a first side and a second side.

Structural element

[0035] In embodiments, the structural element comprises a wooden, masonry or concrete structure of the type used in the construction of walls, façades, floors, ceilings, roofs and the like of buildings. Generally, the first side of the structural element corresponds to the side that faces the interior of the building, while the second side, usually essentially parallel to the first side, corresponds to the side of the structural element facing away from the interior of the building.

[0036] The wall or roof system comprises an insulation element having two major surfaces, referred here as a first major surface and a second major surface. The first major surface is preferably substantially parallel to the second major surface of the insulation element, and distanced from it by the thickness of the insulation element. The insulation element is preferably in the shape of a panel or slab, with two larger parallel surfaces forming the first and second major surfaces mentioned above, and four smaller lateral surfaces parallel two-by-two and perpendicular to the two larger surfaces, forming the edges of such panel or slab.

[0037] In the wall or roof system, the insulation element is arranged with its first major surface proximal to the second side of the structural element, while the second major surface is arranged distal from this second side of the structural element, and therefore outwardly from it. In preferred embodiments of the wall or roof system, the insulation element is arranged proximal to the second side of the structural element without intermediation of any binding agent such as mortar, cement and the like. In other words, the insulation element is preferably arranged directly against the second side of the structural element and contacting it at least partially.

[0038] The insulation element further comprises two distinct layers extending, preferably homogeneously, planar and in parallel, through the whole length and width of the insulation element, being the thickness of the insulation element the sum of the thicknesses of both layers. In other words, preferably the two layers are different from each other and arranged in a two-ply configuration.

External layer

[0039] The layer of the insulation element distal from the structural element, referred to here as the external layer due to its position relative to structural element of the building, comprises a fibrous insulating material with a density lower than 140 kg/m^3, and preferably lower than 120 kg/m^3. The density of the external layer is preferably also at least 60 kg/m^3, and more preferably at least 70 kg/m^3.

[0040] In embodiments, the external layer comprising fibrous insulating material with a density lower than 140 kg/m^3 is the layer of the insulation element intended to be located most distal from the structural element. In other words, the external layer comprising insulating material with a density lower than 140 kg/m^3 is the most external layer of the insulation material.

[0041] In preferred embodiments, the external layer of the insulation element comprises at least 90 wt.-%, more preferably at least 95 wt.-% in relation to the total weight of the external layer, of fibrous insulating material with a density lower than 140 kg/m^3.

[0042] The fibrous insulating material in the external layer has preferably a homogeneous composition and/or uniform properties.

[0043] The density of the fibrous insulating material refers to the material as such, including the fiber network and any binder, additive, etc. it might have. The density is meant in the uncompressed and unpacked state. The artisan knows how to determine the density of fibrous insulating materials such as wood wool or mineral wool. Reference is made to the standard method UNE EN 823:2013 for measuring the thickness of thermal insulating products, from which density can be calculated from the length and width dimensions, and the weight of a fibrous material sample.

[0044] The external layer of the insulation elements according to the invention comprises fibrous insulating material with a laminar configuration of the fibers. In other words, the fibers forming the fibrous insulating material of the external layer are predominantly oriented parallel to the larger surfaces of the fibrous insulating material external layer, since they have not been subjected to any process to enhance their orientation in the direction of the thickness of the external layer. This preferred orientation of the fibers requires less manufacturing efforts and complexity, and contributes to an enhanced thermal insulation capacity of the internal layer, when compared with fibrous insulating materials where the fibers have been oriented in the direction of the heat transfer. The fibrous insulating material layer in preferred embodiments comprises mineral wool, formed by entangled glass, stone or slab fibers. More preferably, the fibrous insulating material layer comprises glass wool insulation.

[0045] In preferred embodiments, the fibrous insulating material of the external layer is bonded by a cured organic binder, suitably comprising a thermoset resin. The content of the organic binder in the fibrous insulating material of the external layer, measured as "Loss On Ignition" (LOI) is preferably higher than 5 wt.-% related to the total weight of the fibers, preferably between 6 - 15 wt.-% and more preferably between 8 - 13 wt.%. This levels of binder content contribute to further enhance the mechanical properties, particularly the rigidity and compression resistance, of the external layer.

[0046] The mean fiber diameter of the fibrous insulating material of the external layer may be suitably at least 4 micrometers and lower than 15 micrometers, preferably from 5 - 10 micrometers, as calculated from microscopy analysis. Fibrous insulating material with this fiber diameter range provides an enhanced rigidity to the external layer.

[0047] The compressive stress at 10% deformation of the external layer, measured according to UNE EN 826:2013, is preferably lower than 15 kPa, preferably lower than 10 kPa and more preferably in the range 5 - 1 kPa. The compressive stress, although it represents only the resistance to compression forces, is an indication of the robustness, hardness and rigidity in the thickness direction of the material. The thermal conductivity of the internal layer, measured as lambda at 10°C according to UNE EN 12667:2002 is preferably lower than 0.040 W (K m)$^{-1}$, preferably lower than 0.036 W (K m)$^{-1}$, and more preferably in the range 0.036 - 0.030 W(K m)$^{-1}$.

[0048] In embodiments, the external layer does not comprise fibrous insulating material with a density equal or higher than 140 kg/m^3.

Internal layer

[0049] The layer of the insulation element proximal to the structural element, referred to here as the internal layer due to its position relative to the structural element of the building, is characterized by being distinct, less rigid and more flexible than the external layer. This internal layer has thus a lower resistance to compressive stress in its thickness direction than the external layer. This internal layer might be formed by a single layer of homogeneous composition, or it might also comprise several layers of different composition or properties.

[0050] In preferred embodiments, the internal layer comprises fibrous insulating material with a density lower than the density of the external layer. The density of the internal layer preferably ranges from 10 - 60 kg/m^3, suitably from 20 - 45 kg/m^3 and more preferably from 25 - 35 kg/m^3.

[0051] The fibrous insulating material in the internal layer has preferably a homogeneous composition and/or uniform properties.

[0052] The internal layer of the insulation elements according to embodiments comprises fibrous insulating material with a laminar configuration of the fibers. In other words, the fibers forming the fibrous insulating material of the internal layer are predominantly oriented parallel to the larger surfaces of the fibrous insulating material layer, and they have not been subjected to any process to enhance their orientation in the direction of the thickness of the internal layer. This preferred orientation of the fibers contributes to an enhanced thermal insulation capacity of the internal layer. The fibrous insulating material layer in preferred embodiments comprises mineral wool, formed by entangled glass, stone or slab fibers. More preferably, the fibrous insulating material layer comprises glass wool insulation.

[0053] In the embodiments where the internal layer comprises fibrous insulating material, this material is preferably bonded by a cured organic binder. The organic binder content "LOI" of the fibrous insulating material of the internal layer in these embodiments is preferably lower than 12 wt.-% related to the total weight of the fibers, more preferably between 2 - 8 wt.-%, and even more preferably between 3 - 6 wt.-%. This level of binder content results in improved flexibility, softness and adaptability of the internal layer.

[0054] The compressive stress at 10% deformation of the internal layer, measured according to UNE EN 826:2013, is preferably lower than 5 kPa, preferably lower than 3 kPa and more preferably lower than 2 kPa. The thermal conductivity of the internal layer, measured as lambda at 10°C according to UNE EN 12667:2002 is preferably lower than 0.045 $W(K\ m)^{-1}$, preferably lower than 0.040 $W(K\ m)^{-1}$, and more preferably in the range 0 . 038 - 0.030 $W(K\ m)^{-1}$.

[0055] In embodiments, the internal layer does not comprise fibrous insulating material with a density equal or higher than 60 kg/m^3.

Insulation element

[0056] In embodiments, the external layer thickness is lower than 50% of the thickness of the insulation element, and preferably lower than 40%. It is preferred that the thickness of the external layer is enough to avoid excessive bending when pulling or compression loads are applied to the insulation element during installation or use of the wall or roof system. The thickness of the external layer is at least 15 mm, more preferably at least 20 mm and even more preferred at least 25 mm. The thickness of the external layer might range from 10 to 60 mm, preferably from 20 - 40 mm and more preferably it ranges from 25 - 35 mm.

[0057] The thickness of the internal layer might be in the range 10 to 200 mm, preferably from 30 - 150 mm and more preferably from 40 - 100 mm, depending on the application.

[0058] The insulation elements, comprising the external and internal layers, have preferably a total thickness of 60 - 220 mm, more preferably of 80 - 160 mm. The length of the insulation elements preferably ranges from 60 - 150 cm and the width from 30 - 120 cm.

[0059] In a preferred configuration of the insulation elements, they are shaped as rectangular prism panels having two major substantially parallel surfaces and four lateral smaller surfaces substantially parallel two-by-two, parallel also to the thickness direction of the panel, and perpendicular to the two larger surfaces.

[0060] Preferably, the internal and external layers are shaped as panels (or slabs), each with two larger surfaces and four smaller lateral surfaces, and with a thickness smaller than the thickness of the insulation element.

[0061] In embodiments, the thickness of the insulation element is the sum of the thicknesses of the internal layer and the external layer. In other words, in embodiments, the insulation element does not comprise other layers apart from the internal layer and the external layer.

[0062] In preferred embodiments, the internal and external layers comprised in the insulation element are laminated to each other. The internal and external layers might have similar dimensions and might be arranged in alignment of their lateral surfaces. In alternative embodiments, the internal and external layers are arranged in a shifted position from each other, forming an insulation element with stepped or shiplap edges.

[0063] The average density of the insulation element preferably ranges from 30 - 100 kg/m^3. The external layer of insulation element preferably has higher rigidity than the internal layer. Preferably, the external layer has a compressive stress at 10% deformation, measured according UNE EN 826:2013, of at least 3 times higher than the internal layer.

[0064] In the embodiments where both internal and external layers comprise fibrous insulating material bonded by a cured organic binder, the average binder content in the insulation element is 6 - 15 wt.-%, measured as LOI.

[0065] Preferably, the internal and external layers are laminated by being bonded to each other by an adhesive applied to their facing surfaces. The adhesives used might be reactive (one or two component) polyurethane, polyolefin hotmelt or other adhesives, applied by any suitable method known in the art. Alternatively, the internal and external layers might be joined by application of a layer of thermoplastic film or non-woven (e.g. non-woven polyamide) between them, which is molten before the layers are contacted and cooled down after the joining to achieve their bonding.

[0066] In order to improve the rigidity of the external layer, it is preferably that the external layer comprises a reinforcing web on at least one of its two larger surfaces. More preferably, the reinforcing web is provided on both larger surfaces of the external layer. The reinforcing web acts as a distribution layer for loads applied to the insulation element during use of the wall or roof system, such as those caused by wind suction or compression. Those loads are concentrated in the areas of the insulation element close to the fastening devices. The reinforcing web distributes this load through a larger area, thus, increasing the resistance of the insulation element against mechanical tensioning.

[0067] In preferred embodiments, the reinforcing web is arranged on the larger surface of the external layer more proximal to the structural element. The presence of the reinforcing web on or at this surface facilitates the bonding of the internal and external layers, by providing a more homogeneous and smoother bonding surface, which results in increased bonding strength and reduced adhesive or thermoplastic consumption.

[0068] In equally preferred embodiments, the reinforcing web is arranged on the larger surface of the external layer more distal from the structural element. An advantage of having a reinforcing web on this surface of the external layer is that rendering mortar can be coated onto the external layer easier and more homogeneously than when it is coated directly to the more porous and irregular fibrous insulating material.

[0069] The reinforcing web can be any web of sufficient mechanical resistance to dimensional change. It is preferred that it has a porous open structure, more preferably a fabric or nonwoven structure of fibers. The reinforcing web is preferably a glass fiber textile or non-woven. Glass fiber veils made out of glass fibers laid down randomly and bonded with a binder have shown to be suitable. Reinforcing filaments might be incorporated into the web structure to increase dimensional stability. The thickness of the reinforcing web ranges preferably from 100 to 1000 micrometers, more preferably from 200 - 700 micrometers, and the weight per surface area from 20 - 150 g/m^2, more preferably from 30 - 100 g/m^2.

[0070] This reinforcing web is preferably directly laminated to the fibrous insulating material by any conventional method. It is however preferred that the reinforcing web is bonded to the fibers by the same cured binder used for bonding the fibers of the fibrous insulating material. Particularly advantageous is the application of the reinforcing web to the fibrous material while it is in uncured state, during manufacturing, and the subsequent introduction of contacted fibrous insulating material and reinforcing web into a curing oven to produce their bonding by the cured binder.

[0071] In alternative preferred embodiments, the internal layer of the insulation element comprises a reinforcing web on one or both of its two larger surfaces.

[0072] Additional reinforcing layers might be included in the insulation element according to the embodiments. For instance, reinforcing mesh of high stability resistance against mechanical stress can be located between the internal and external layers of the insulation element. Advantageously, the mesh is formed by strands of fibers of a thermoplastic or mineral material, such as nylon or glass. The additional reinforcing layers further support the distribution along a larger surface of the loads suffered by the insulation element during use, such as suction or compression.

[0073] In preferred embodiments, the insulation element does not comprise fibrous insulating material with a density equal or higher than 140 kg/m^3.

Spacer fastening device

[0074] The wall or roof system according to the invention further comprises a spacer fastening device for fixation of the insulation element to the structural element. The spacer fastening device is adapted to hold the second major surface of the insulation element at a defined distance from the second side of the structural element. This is achieved by the fastening device by engaging simultaneously with its first end portion into the structural element and with its second end portion into the external layer of the insulation element. In this manner, the space between the external layer of the insulation element and the structural element is adjusted by the length of the fastening device.

[0075] Any spacer fastening device of this type might be used for the invention, as long as the chosen fastening device is capable of sufficiently engaging into the external layer of the insulation element, by means of anchors, threads, and the like, located at the second end portion of the spacer fastening device, and which by penetrating into the fibrous insulating material structure reliably anchor it against movement along the axis of the spacer fastening device. The spacer fastening device shall have means for fixation to the structural element such as a fastening screw and a plastic dowel at the first end portion, this is, at the end further away from the means for engaging into the external layer. The spacer fastening device has preferably an elongated shape delimited by the first and second end portions, and extends through the thickness of the insulation element.

[0076] In the wall or roof system according to embodiments, preferably, the spacer fastening device comprises a hollow shank with a inner cavity. This hollow shank is preferably made of plastic. As means for engaging with the external layer of the insulation element, the hollow shank is provided with a helical thread, i.e. a thread running as a helical band, arranged on the outside of the hollow shank along its length. The hollow shank might further comprise a retainer disk for the insulation element, arranged at one of its ends, preferably at its end most distal to the first end portion, and with a diameter at least the size of the maximum major diameter of the helical thread. The retainer disk might furthermore comprise small indentations on its surface more proximal to the insulation element, so that during installation the retainer disk might cut into the insulation element and slightly penetrate into it. A fastening screw, preferably made of metal, is received into the cavity of the hollow shank and restrained from axial movement relative to the hollow shank by locking means comprised in the hollow shank. The fastening screw extends away from the cavity through an aperture in the hollow shank available in its end more proximal to the structural element, and penetrates into the structural element. The fastening screw is provided with means for fixation to the structural element. In this particular embodiment, since the helical thread engages firmly with the external layer of the insulation element and with the structural element, and the relative position, along the axis of the fastening screw, of the hollow shank and the fastening screw is blocked against displacement, the external layer, and thus also the second major surface of the insulation element, are hold at a defined distance from the second side of the structural element, distance determined by the length of the spacer fastening device.

[0077] The helical thread comprised in the hollow shank is adapted to penetrate into the external layer of the insulation element by rotational screwing movement. The diameter of the thread band is large enough to provide sufficient anchoring strength of the fibrous insulating material to the shank. In embodiments, the maximal diameter of the thread band is preferably at least 50 mm, and it might range from 50 - 100 mm, more preferably from 60 - 80 mm. Preferably, the helical thread has a conical shape, with increasing diameter going away from the structural element. The conical shape facilitates the penetration of the thread in the fibrous insulating material. The helical thread might be formed as a continuous band or it might be formed by different separated thread sections. The parameters of the helical thread such as the pitch and the thread angle are adapted to facilitate the penetration by screwing movement into the external layer, and to allow sufficient fibrous insulating material getting inserted between thread crests to enhance the anchoring effect. The pitch of the helical thread, this is, the distance between two consecutive thread crests, is preferably constant and at least 3 mm, more preferably at least 4 mm. The thread pitch preferably does not exceed 30 mm, and more preferably it does not exceed 20 mm, and even more preferred it does not exceed 10 mm.

[0078] In embodiments, the helical thread preferably extends through the whole thickness of the external layer and partially into the internal layer of the insulation element, with a length larger than the thickness of the external layer. In alternative embodiments, the length of the thread is selected to be essentially the same as the thickness of the external layer, or slightly smaller.

[0079] The wall or roof system might comprise further elements. In embodiments, a mortar coating is applied to the second major surface of the insulation element, also covering with mortar the spacer fastening device and its optional retainer disk. A reinforcing grid might be incorporated embedded into the mortar layer, to enhance its resistance to mechanical stresses. Optionally, the mortar coating layer is covered by additional layers to improve the weathering resistance and/or the appearance of the wall or roof system, such as finishing colored mortar, paints, and the like.

[0080] The wall or roof system according to the embodiments comprises at least one insulation element and one spacer fastening device. In preferred embodiments, a plurality of insulation elements are arranged side-by-side with abutting lateral sides covering at least partially the second side of the structural element. More preferably, the whole second side of the structural element is covered by one or more insulation elements according to embodiments. Each of the insulation elements is itself fastened to the structural element preferably by a plurality of spacer fastening devices according to embodiments, preferably by at least 3 spacer fastening devices, more preferably by at least 5 spacer fastening devices. The number of spacer fastening devices might range from 1 to 12 spacer fastening devices per square meter of the layer of insulation elements, preferably from 1 to 8. Suitably, the fastening devices are located one approximately at the center of the second major surface of the insulation element, and additional ones in the proximity of the corners or the insulation elements, although other arrangements are possible.

[0081] Adhesive tapes might be applied to the abutting edges of at least some neighboring insulation elements, bridging the space left between the juxtaposed lateral sides of those elements. Preferably, adhesives tapes are applied bridging all the abutting edges of all neighboring insulation elements. The adhesive tapes are adhered to the surfaces of the insulation elements most distal from the structural element, this is, to their second major surfaces, to the edge areas of those neighboring insulation elements. The tapes are selected to provide sufficient adhesion to the surface of the insulation element, and having a carrier for the adhesive compatible with the mortar coating. Preferably, the adhesive carrier of the tapes is selected to have an open structure to improve the bonding strength of the mortar layer to it. In preferred embodiments, the adhesive carrier is an open mesh or veil of glass fibers. The adhesive tapes are useful to avoid penetration of mortar in the space between neighboring insulation elements during application of the mortar coating, what could create thermal bridges detrimental to insulation. In addition, the adhesive tapes facilitate application of the mortar coating, by avoiding unevenness between insulation elements which could be visible later on through the mortar coating.

Description of the drawings

[0082]

Figure 1 represents a schematic lateral cut-through view of a wall system according to an embodiment of the invention.

Figure 2 represents a schematic perspective view of a wall system according to an embodiment of the invention.

Figure 3 depicts a schematic lateral cut through view of wall or roof system according to an embodiment of the invention, showing three stages of an exemplary installation method.

[0083] Figure 1 depicts a wall system 1 comprising a structural element 2 having first 21 and second 22 sides. In this scheme, the first side 21 is the side facing the interior of the building, while the second side 22 faces the exterior.

[0084] The wall system further comprises an insulation element 3 having a first major surface 31 and a second major surface 32. The insulation element 3 is arranged with its first major surface 31 proximal to the structural element 2. The insulation element 3 comprises two distinct layers 4, 5 of smaller thickness than the insulation element 3. The external layer 5 is located further away from the structural element 2, while the internal layer 4 is arranged closer to it. The external layer 5 comprises a reinforcing web 8 of glass fiber veil laminated to the external surface of the external layer 5.

[0085] The insulation element 3 is fixed to the structural element 2 by an elongated spacer fastening device 6 having a first end portion 62 and a second end portion 64. The spacer fastening device 6 extends through the thickness of both internal and external layers 4, 5. The spacer fastening device 6 comprises a hollow shank 65 located in the second end portion 65 and a fastening screw 66 received in the inner cavity of the hollow shank 65. The hollow shank 65 has a stepped inner cavity, this is, the cavity has portions with different inner diameter, and the head of the fastening screw 66 rests on the neck 651 formed between the two portions of different diameter. The fastening screw 66 and the hollow shank 65 are restrained from axial movement relative to each other by locking the fastening screw 66 head between the cavity neck 651 and the stopper 68. This stopper 68 is firmly fixed to the hollow shank 65 by gluing, clamping, or by being molded together with the hollow shank, and is exemplarily shaped with an aperture extending through its thickness to permit access from the exterior to the fastening screw head with a screwing tool (not drawn). In this configuration, the fastening screw 66 can be rotated by application of a rotational torque with a screwing tool through the stopper 68, without the hollow shank 65 being necessarily simultaneously rotated.

[0086] In the first end portion 62 of the spacer fastening device 6, means for fixation 61 to the structural element 2 are arranged. The means for fixation 61 comprise a threaded tip 611 of the fastening screw 66 and an expanded plastic dowel 612 inserted in a hole drilled in the structural element 2.

[0087] As means for engagement into the external layer 5, the hollow shank 65 comprises a helical thread 63, i.e. a thread running as a helical band on its outside. This helical thread 63 engages into the external layer 5 and partially also into the internal layer 4 of the insulation element 3. The helical thread 63 has a maximum major diameter D, which decreases going towards the structural element 2, creating a conical thread shape. The pitch or distance between consecutive thread crests P is preferably constant and adequate to produce sufficient axial anchoring of the external layer 5 to the hollow shank 63.

[0088] The hollow shank 65 further comprises a retainer disk 69 located flush with the second surface 32 of the insulation element 3. The retainer disk 69 is preferably provided with a pattern of openings (not shown in this Figure 1) along the disk.

[0089] In the wall or roof system depicted in Figure 1, since the hollow shank 65 and the fastening screw 66 are locked against relative axial movement, the external layer 5 and the second surface 32 of the insulation element 3 are hold spaced at a defined distance from the structural element 2. This distance is determined by the length of the spacer fastening device 6, and can be further adjusted by screwing or unscrewing the fastening screw 66 inside or outside the hole in the structural element 2. This screwing/unscrewing can be done with a screwing tool passing through the aperture of the stopper 68 without rotating the hollow shaft 65.

[0090] Figure 2 shows a wall system according to the embodiments, with a structural element 2 covered by a plurality (in this case 6) of insulation elements 3 in form of rectangular panels arranged side-by-side. Each insulation element 3 is fixed to the structural element 2 by a plurality of spacer fastening devices 6 (in this case by 5). Each insulation element 3 comprises internal and external layers 4, 5.

[0091] The wall system according to the embodiment in Figure 2 further comprises adhesive tapes 7 applied bridging the abutting edges of the neighboring insulation elements 3. The adhesive tapes 7 are adhered to the surfaces of the insulation elements most distal from the structural element 2, to the edge areas of the neighboring insulation elements 3.

[0092] Figure 3 depicts schematically three stages of an exemplary method for the installation of the wall or roof system according to embodiments. The stages occur sequentially from left to right, this is, from A to C. For clarity purposes, the number references for elements which are the same as in Figure 1 are not included in this drawing, and only the new elements are referenced.

[0093] In an initial stage, marked in Figure 3 as (A), the insulation element 3 is positioned with its first major surface 31 proximal to the second side 22 of the structural element 2, without intermediation of any binding agent, such as bonding mortar or the like. Then, a hole is drilled from the second major surface 32 of the insulation element 3, through its full thickness and essentially perpendicular to the structural element 2. The drilling is continued until a hole of a desired depth is also created in the structural element 2. As a consequence, both holes in the insulation element 3 and in the structural element 2 match each other and are in direct communication.

[0094] The spacer fastening device 6 comprising the hollow shank 65 and the fastening screw 66, having the dowel 612 premounted in unexpanded form in the threaded tip 611, is then inserted, with the threaded tip 611 first, into the hole of the insulation element 3, until the dowel 612 has entered substantially into the hole in the structural element 2.

[0095] A screwing tool 10, manually or automatically operated, having a cross head 102 and protrusions 101 is placed over the retainer disk 69 of the spacer fastening device 6. The cross head 102 is adapted for engaging through the aperture in the stopper 68 with the head of the fastening screw 66, and the protrusions 101 are adapted for engaging with the retainer disk 69. The engagement between the protrusions 101 and the retainer disk 69 is achieved for instance by designing the protrusions 101 with a shape so that they can enter into the openings (not shown) present in the retainer disk 69.

[0096] In this position, when the screwing tool 10 is operated with a rotation in the screwing direction, shown as R in the Figure 3 (B), this causes the simultaneous rotation of the fastening screw 66 and the hollow shank 65. The rotation of the fastening screw 66 results in the advance of the threaded tip 611 into the dowel 612. The rotation of the hollow shank 65 produces the advancement and insertion of the helical thread 631 into the insulation element 3. This screwing step is continued until the retainer disk 69 of the hollow shank 65 rests in abutment with the second major surface 32 of the insulation element 3, as shown in Figure 2. The threaded tip 611 has also entered the dowel 612, expanding it, and achieving firm fixation to the structural element 2. The spacer fastening device 6 holds the external layer 5 and therefore also the second major surface 32 at a defined distance S1 from the second side 22 of the structural element 2.

[0097] In a next step, the screwing tool 10 is modified so that the protrusions 101 do not engage anymore with the retainer disk 69, for instance, by shifting the plate 104 to a further position up along the shaft 103. Alternatively, a different screwing tool can be used, which only engages with the head of the fastening screw 66. The fastening screw 66 is then rotated, this time without simultaneous rotation of the hollow shank 65, to adjust the space between the second major surface 32 and the second side 22 of the structural element 2 to a desired defined distance S2. This second screwing step can be used to decrease the distance between the external layer 5 and the structural element 2 (S2<S1) to increase the compression of the internal layer 4, so that it better adapts to the contours of second side 22 of the structural element 2. Alternatively, as shown in Figure 3 (C), an unscrewing rotation (shown as R' in Figure 3) results in the partial withdrawal of the threaded tip 611 from the dowel 612, and the increment in the separation of the second major surface 32 of the insulation element 3 from the second side 22 of the structural element 2 (S2>S1). This unscrewing can be useful for instance to adjust the planarity of the second major surfaces 66 of a plurality of insulation elements 3 positioned over the same structural element 2.

Claims

1. A wall or roof system (1) comprising:

    a) a structural element (2) having a first (21) and a second side (22);
    b) an insulation element (3) having first (31) and second (32) major surfaces, the insulation element (3) arranged with its first major surface (31) proximal to the second side (22) of the structural element (2),
    the insulation element (3) comprising an internal layer (4) proximal to the structural element (2), and an external layer (5) distal from the structural element (2), both layers being distinct from each other and both layers extending in the length and width direction of the insulation element (3);
    c) a spacer fastening device (6) for fixation of the insulation element (3) to the structural element (2), spacer fastening device (6) adapted to hold the external layer and therefore also the second major surface (32) of the insulation element (3) spaced at a defined distance from the second side (22) of the structural element (2), this distance being adjustable by acting on the spacer fastening device (6);

    wherein

    the external layer (5) comprises fibrous insulating material with a density lower than 140 kg/m^3; and
    the fibrous insulating material in the external layer (5) has a laminar configuration of the fibers.

2. A wall or roof system (1) according to claim 1, wherein the fibrous insulating material of the external layer (5) is mineral wool.

3. A wall or roof system (1) according to any previous claim, wherein the fibrous insulating material of the external layer (5) is glass wool.

4. A wall or roof system (1) according to any previous claim, wherein the density of the fibrous insulating material of the external layer (5) ranges from 120 - 60 kg/m^3.

5. A wall or roof system (1) according to any previous claim, wherein the density of the fibrous insulating material of the external layer (5) ranges from 100 - 70 kg/m^3.

6. A wall or roof system (1) according to any previous claim, wherein the external layer (5) has a compressive stress at 10% deformation, measured according UNE EN 826:2013, of at least 3 times higher than the internal layer (4).

7. A wall or roof system (1) according to any previous claim, wherein the external layer (5) has a compressive stress at 10% deformation, measured according UNE EN 826:2013, lower than 15 kPa.

8. A wall or roof system (1) according to any previous claim, wherein the fibrous insulating material of the internal layer (4) has a density lower than 60 kg/m^3, preferably lower than 45 kg/m^3 and more preferably lower than 35 kg/m^3.

9. A wall or roof system (1) according to any previous claim, wherein the fibrous insulating material of the internal layer (4) is mineral wool, particularly glass wool, with a laminar configuration of the fibers.

10. A wall or roof system (1) according to any previous claim, wherein the external layer (5) of the insulation element (3) comprises a reinforcing web (8) on one of its larger surfaces.

11. A wall or roof system (1) according to any previous claim, wherein the spacer fastening device (6) has means for fixation (61) to the structural element on a first end portion (62), and means for engaging (63) into the external layer (5) on a second end portion (64) further away from the first portion (62).

12. A wall or roof system (1) according to any previous claim, wherein the spacer fastening device (6) comprises a hollow shank (65) and a fastening screw (66) received into the inner cavity of the hollow shank (65), the hollow shank (65) being restrained from axial movement relative to the fastening screw (66) .

13. A wall or roof system according to claim 12, wherein as means for engaging (63) into the external layer, the hollow shank is provided with a thread (631) running as a helical band along its length, preferably in a conical shape.

14. A method for the manufacture of a wall or roof system according to the claims 1-13, the method comprising:

a) providing an insulation element (3) having first (31) and second (32) major surfaces, the insulation element (3) comprising an internal layer (4) and an external layer (5), both layers being distinct and both layers extending in the length and width direction of the insulation element (3); the external layer (5) comprising fibrous insulating material with a density lower than 140 kg/m^3 and a laminar configuration of the fibers;
b) providing a spacer fastening device (6);
c) fixing the insulation element (3) to a structural element (2) of a building with the spacer fastening device (6); wherein the spacer fastening device (6) is adapted to hold the external layer and therefore also the second major surface (32) of the insulation element (3) spaced at a defined distance from the second side (22) of the structural element (2), this distance being adjustable by acting on the spacer fastening device (6).

FIGURE 1

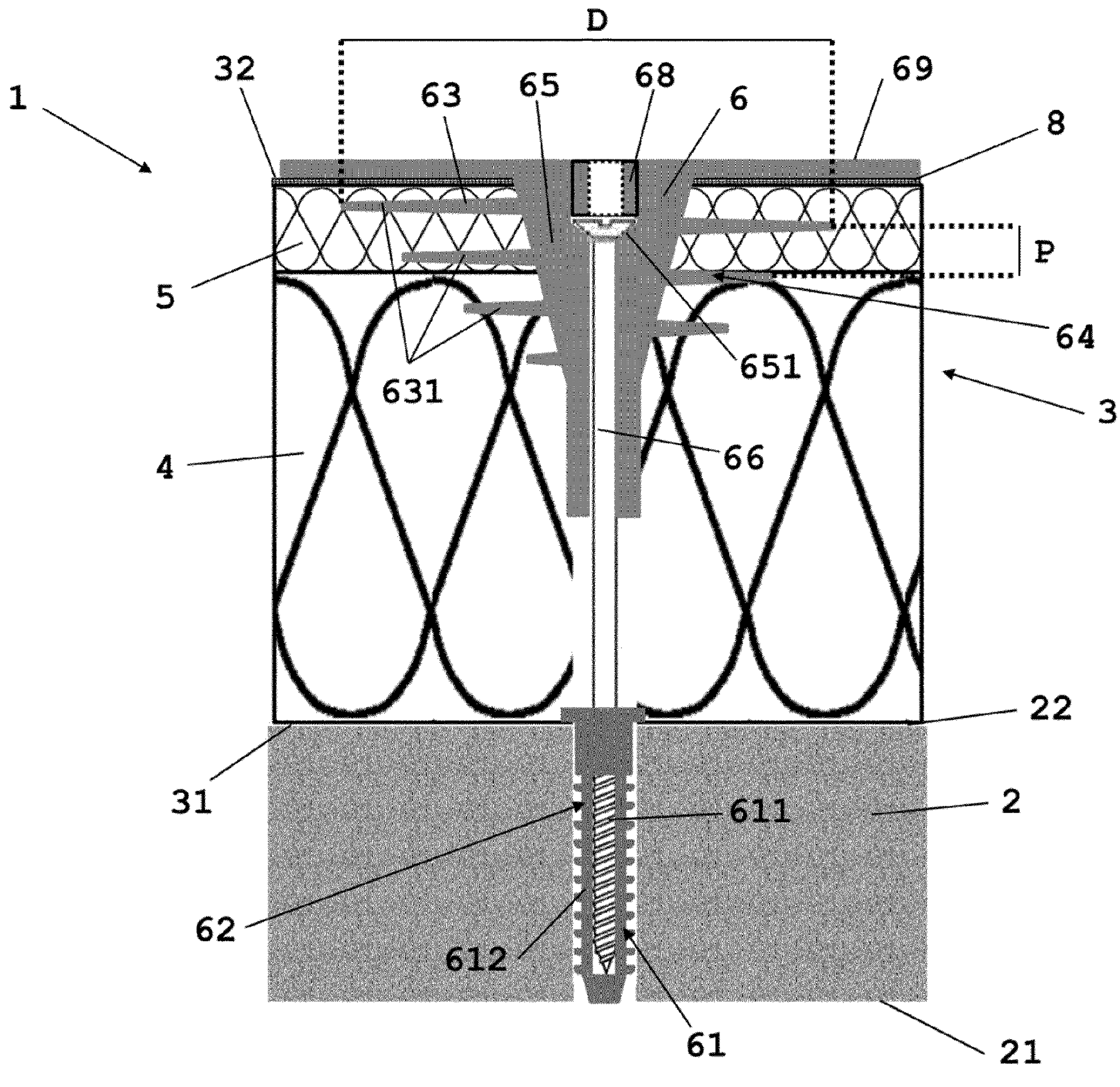


FIGURE 2

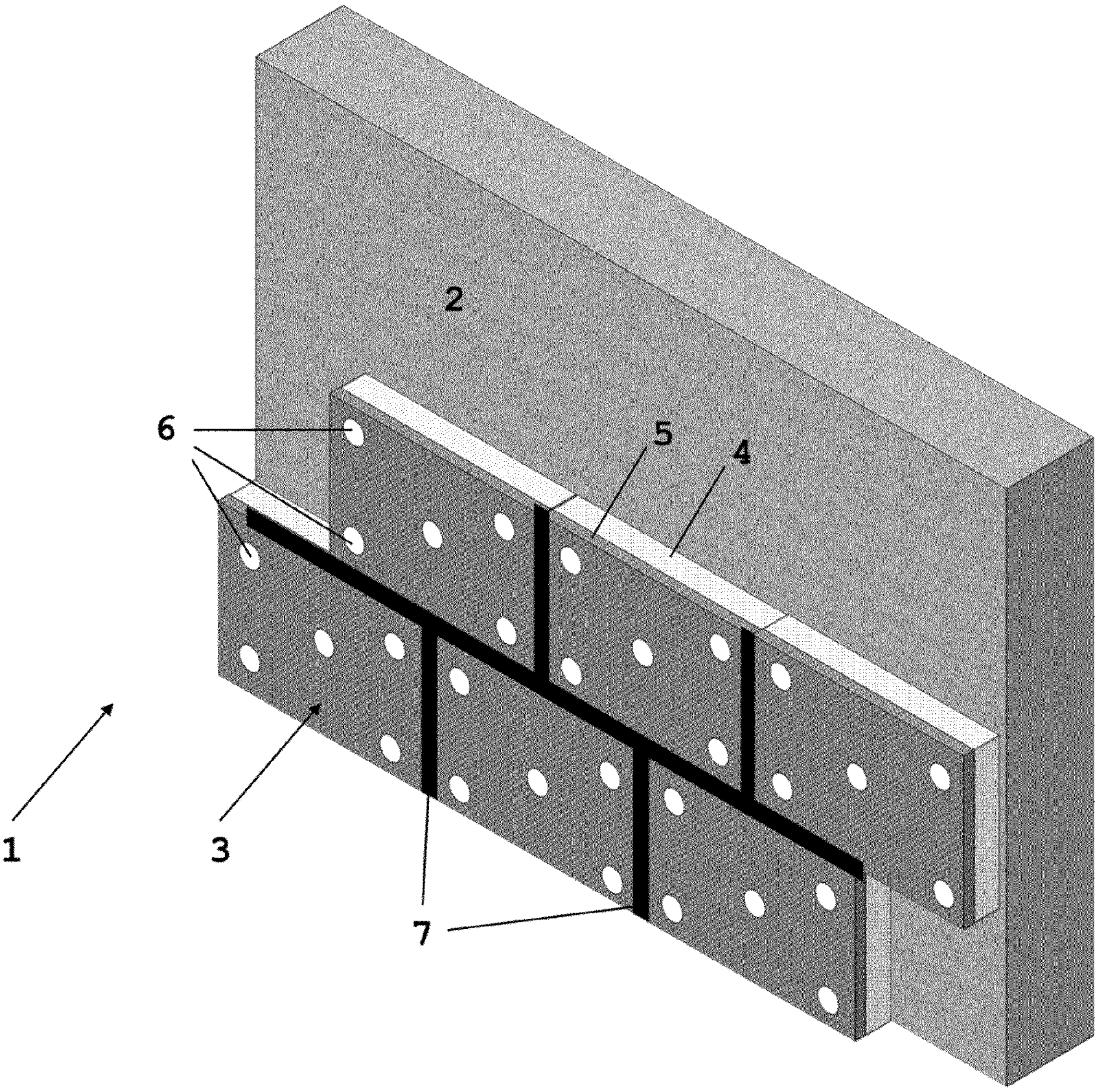
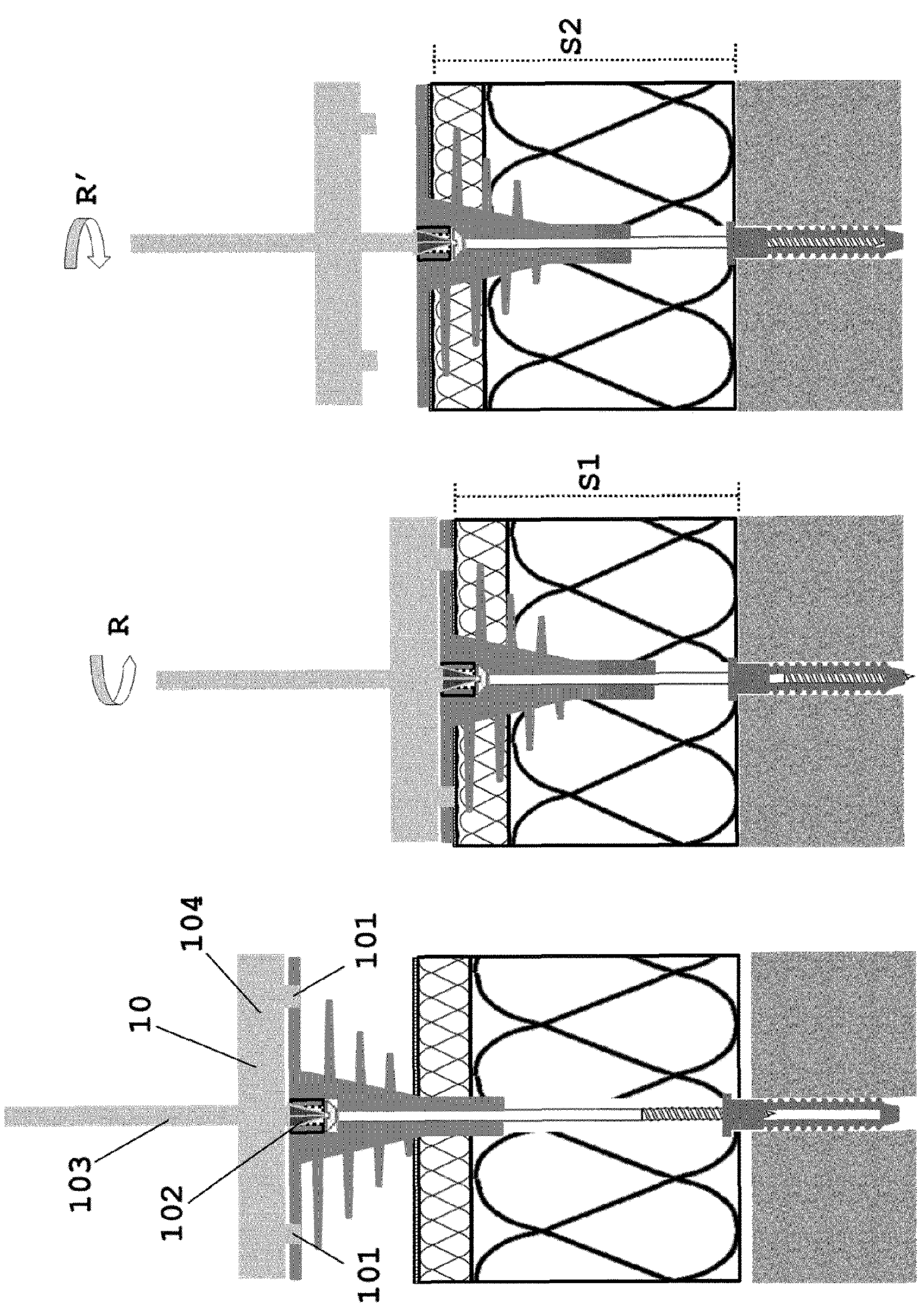


FIGURE 3



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EUROPEAN SEARCH REPORT

Application Number
EP 15 18 8164

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,D	WO 2014/090707 A1 (KNAUF INSULATION [BE]) 19 June 2014 (2014-06-19) * page 1, line 1 - page 11, line 29; figures 1-5b * -----	1-14	INV. E04B1/76
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TECHNICAL FIELDS SEARCHED (IPC)
E04B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	11 March 2016	Dieterle, Sibille

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 18 8164

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11-03-2016

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

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