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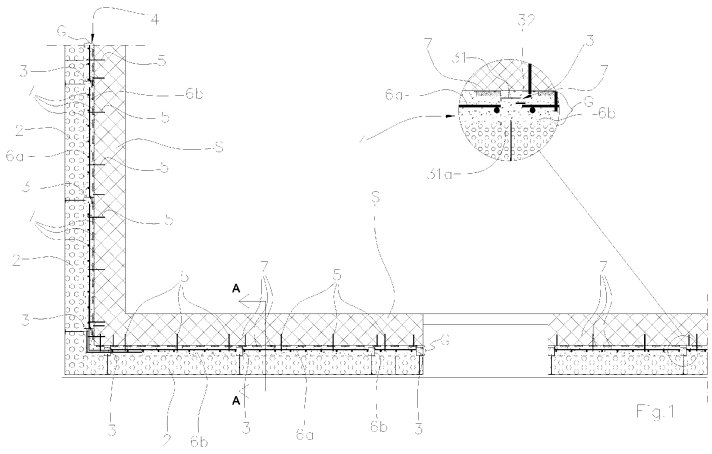
(54) **SYSTEM AND METHOD FOR THE SEISMIC CONSOLIDATION,THERMAL INSULATION AND AIR CONDITIONING OF A STRUCTURE**

(57) System for the seismic consolidation, thermal insulation and air conditioning of buildings, comprising:
one or more panels (2);
one or more fixing elements (3), structured to allow the fixing of the panels (2) to an existing structure (S), maintaining a gap (G);
an exoskeleton (4), consisting of a metal structure (6a) and a cast in cementbased conglomerate or similar (6b).
The exoskeleton (4) is located inside the gap (G) and provided with anchoring means (5) to allow the fixing to the structure on which it intervenes (S).
an air conditioning system (7) positioned at the interface between the exoskeleton (4) and the existing structure (S), and/or inside the exoskeleton (4) or the existing structure (S).



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Description

[0001] The present invention relates to a system and a method for the seismic consolidation, air conditioning and thermal insulation of buildings.

[0002] In particular, the system and the method according to the present invention allow to obtain: (a) an anti-seismic consolidation of a building through the systematic reinforcement of the building envelope adapted to impart an overall seismic-resistant box-like behaviour thereto, (b) a thermal insulation and, (c) a particularly efficient air conditioning of the building.

[0003] Currently, interventions for the anti-seismic consolidation of a building have considerable complexity and a rather high cost and in most cases no type of integration with the energy efficiency and air conditioning of the construction.

[0004] Regarding the seismic reinforcement of the existing structure, the methodological approach is to make an outer structural envelope of reinforced concrete (or similar), which is much more rigid compared to the horizontal actions of the existing structures, and therefore capable of absorbing most of the seismic actions instead of the latter. Regarding the thermal insulation, the methodological approach is to make an insulating element (for energy efficiency) on the outer portion of the newly built structural envelope. Regarding the air conditioning, the methodological approach is to make the new air conditioning system (typically of the radiant wall type) by means of a special heating/cooling system placed inside the reinforced concrete (or similar) envelope and/or at the interface between such an envelope and the existing structure.

[0005] It should be noted that the current seismic strengthening techniques do not address the problem of obtaining thermal insulation of the building and implementing an effective air conditioning system in an integrated manner. In addition, the traditional seismic consolidation systems and the creation of new air conditioning systems require invasive operations within existing buildings. The proposed system, on the other hand, is simple to implement and does not require invasive interventions therein. In fact, an advantage of the present invention is constituted by the fact that the execution of the works (seismic reinforcement and thermal insulation and new air conditioning and/or heating) occurs starting from the outer portion of the building without the need to clear it during the operations.

[0006] Another advantage of the present invention is that it can be applied to a variety of cases: masonry and/or stone buildings, buildings with a framereinforced cement-based conglomerate structure with different types of infills.

[0007] Additional features and advantages of the present invention will become more apparent from the following detailed description of an embodiment of the invention in question, illustrated by way of non-limiting example in the appended figures, in which:

- figure 1 shows a sectional view, executed on a horizontal plane, of a first embodiment of the system for the seismic consolidation, the thermal insulation and the air conditioning of buildings according to the present invention;
- figure 2 shows a sectional view on plane A-A of figure 1;
- figure 3 shows a second embodiment of the system according to the present invention;
- figure 4 shows a third embodiment of the system according to the present invention;
- figure 5 shows a sectional view on plane B-B of figure 4.

[0008] With reference to the appended figures, 1 denotes overall an anti-seismic system.

[0009] In particular, the system (1) according to the present invention is applied to a structure (S).

[0010] The term "structure" is meant to indicate buildings and/or parts of buildings (e.g., the walls), on which to carry out a specific anti-seismic consolidation, thermal insulation and new air conditioning. For example, the term "structure" can mean a masonry wall, both load-bearing and infill.

[0011] The system according to the present invention comprises one or more panels (2), arranged to be fixed to the structure (S).

[0012] In an advantageous use of the system according to the present invention, the structure (S) extends vertically and could be, for example, the outer wall of a building. The panels (2) can be, merely by way of example, insulating panels, of the type used to make the outer covers with a thermal insulation function. Such panels comprise a layer of thermal insulating material, for example polystyrene, and can be provided with an outer surface arranged, for example with a metal mesh, to allow the laying of a layer of plaster. Preferably, but not necessarily, the system according to the present invention comprises a plurality of panels (2), mutually juxtaposed to form a surface substantially parallel to the structure (S). Preferably, the panels (2) form a vertical surface.

[0013] Each panel (2) can be fixed to the structure (S) by means of one or more fixing elements (3). Such fixing elements (3) are structured to allow an effective connection, i.e., the fixing of the panels (2) to the structure (S), maintaining a gap (G) between the latter and the panels (2).

[0014] For example, each fixing element (3) comprises a box-like portion (31) with a "C" profile, open on at least one side. The box-like portion (31) can possibly be provided with holes or slots arranged at a predefined spacing. In the embodiment depicted, the box-like portion (31) has a "C" section, but other shapes would be possible, for example a tubular shape or the like. Each fixing means (3) further comprises one or more brackets (32) configured to allow the fixing of the box-like portion (31) to the structure (S). Advantageously, the brackets (32) also allow to adjust the inclination of the box-like portion (31)

so that it is substantially vertical. The brackets (32) can be fixed to the structure (S) by means of dowels or other equivalent means. A panel (2) can be fixed to a head surface (31a) of the box-like portion (31), placed at a certain distance (d) from the structure (S). Such a distance (d) substantially defines the thickness of the gap (G), i.e., the distance between an inner surface of the panel (2) and the structure (S).

[0015] The system according to the present invention further comprises an exoskeleton (4), located inside the gap (G) and provided with anchoring means (5) to allow the fixing to the structure (S). In a preferred but not exclusive embodiment, the exoskeleton (4) comprises a reinforcement (6a) resistant to traction, i.e., resistant to tensile stresses. For example, the reinforcement (6a) is made of metal mesh or other material. The exoskeleton (4) further comprises a cast (6b) of a suitable structural material, such as a cement-based conglomerate or similar. Preferably, the reinforcement (6a) is incorporated in the cast (6b).

[0016] Another possible, but not exclusive embodiment, envisages that the exoskeleton (4) arranged inside the gap (G) and the fixing elements (3) are effectively connected to each other by means of horizontal reinforcement irons of appropriate diameter and spacing, to be positioned through holes or slots already arranged in the box-like portions (31).

[0017] The anchoring means (5) comprises for example mechanical and/or chemical dowels, which can be partially inserted in the structure (S). The anchoring means (5) can be distributed variously with respect to the structure (S). In the event of a structure (S) comprising curbs, slabs and/or load-bearing beams, the anchoring means (5) will be distributed mainly along such load-bearing elements, but also at the infills and/or pillars. In the event of a masonry structure (S), the anchoring means (5) can be distributed in a widespread manner, with greater density at the slabs.

[0018] The exoskeleton (4), constrained to the structure (S) by the anchoring means (5), considerably reinforces and consolidates the structure (S). The exoskeleton (4) is fixed outside the structure (S), so that the building supported by the structure (S) can be used without particular drawbacks during all the installation operations of the anti-seismic system. Furthermore, the panels (2), which enclose the exoskeleton (4) on the outer side, allow to achieve a thermal insulation of the structure (S).

[0019] The cast (6b) is arranged inside the gap (G). The cast (6b) adheres to the structure (S) and the panels (2) and incorporates therein the first structure (6a) previously positioned inside the gap (G), creating an extremely solid reinforcement of the building envelope in reinforced concrete. The preferred mesh configuration of the reinforcement (6a), and the hollow shape of the fixing elements (3), in particular of the box-like portions (31), allows the cast (6b) to substantially completely incorporate all the structural components of the system. The cast (6b) also allows the use of a reinforcement (6a) comprising several mutually separate structural elements, for example in the form of metal mesh panels or similar substantially flat panels, which are constrained to each other by the concrete casting itself, and possibly also by the horizontal reinforcement irons of appropriate diameter and spacing, to be positioned through the holes or slots already arranged in the box-like portions (31).

[0020] The system according to the present invention is also provided with an air conditioning device (7) positioned inside the gap, or interposed between said one or more panels (2) and the structure (S) so as to make wall air conditioning. In particular, the air conditioning device (7) is integrated in the cast (6b).

[0021] In a possible embodiment, the air conditioning device (7) is placed in contact with the outer surface of the structure (S) at the interface between the existing structure and the exoskeleton (4).

[0022] In another possible embodiment, the air conditioning device (7) may not be directly in contact with the outer surface of the structure (S) but included inside the cast (6b) of the exoskeleton (4).

[0023] In both embodiments, the air conditioning device (7) is regardless isolated from the external environment by means of the panels (2) and the cast (6b). The thermal input of the air conditioning device (7) is thus substantially directed towards the structure (S), allowing an effective and efficient thermal regulation also by means of the special design of the panels (2) and the cast (6b).

[0024] The air conditioning device (7) is substantially a heating, and/or cooling device positioned within the proposed system, so as to optimise the energy efficiency of the structure.

[0025] In a possible embodiment, the air conditioning device (7) comprises electric heating elements. For example, the electric heating elements comprise electrical tapes and/or cables of known type, typically powered at low voltage. In this embodiment, the heating elements are preferably applied to the outer surface of the structure (S), by means of mechanical and/or chemical anchors known in the art. The use of electric heating elements is particularly suitable for use in combination with photovoltaic and highefficiency electricity generation systems.

[0026] In another possible embodiment, the air conditioning device (7) comprises fluid thermal elements. For example, the thermal elements comprise serpentine ducts and/or fluid circulation panels, connected to a thermal regulation circuit of an operating fluid. The serpentine ducts, the fluid circulation panels and the thermal regulation circuit are known in the art, and comprise, for example, a boiler and/or a heat pump for heating and cooling the operating fluid. In this embodiment, the thermal elements are preferably connected to the structure (S) by means of mechanical connectors known in the art, which are then included in the cast (6b). Preferably, but not necessarily, the system according to the present invention comprises a thermally conductive layer (8), interposed between the structure (S) and the air condition-

ing device (7). The thermally conductive layer (8) is preferably applied to the outer surface of the structure (S), and constrained to the latter by fixing means of known type. The thermally conductive layer (8) allows to evenly distribute the thermal input of the air conditioning device (7), so that the entire structure (S) receives the effect thereof substantially uniformly. Various examples of materials suitable for making the thermally conductive layer (8) are known in the art, and will thus not be described in greater detail.

[0027] The consolidation and air conditioning of a building can be achieved with the method comprising the following steps.

[0028] The method provides as a first activity that of fixing the air conditioning device (7) to the structure (S) and/or inside the gap (G) according to the usual techniques in the art for the type of air conditioning adopted. If present, the thermally conductive layer (8) is fixed to the structure (S) before the installation of the air conditioning device (7).

[0029] Subsequently, the method envisages positioning the reinforcement (6a) with respect to the structure (S). Such a step initially envisages positioning the fixing elements (3), for all or part of the height of the structure (S). Preferably, the fixing elements (3) are positioned, by means of the brackets (32), so that the box-like portions (31) are oriented vertically. Subsequently, the method envisages fixing the reinforcement (6a) associated to the structure (S) by the anchoring means (5). The anchoring means (5) can be configured to connect the reinforcement (6a) directly to the structure (S) and/or to the fixing elements (3).

[0030] As already underlined, the reinforcement (6a) could be a single body or, preferably, comprise distinct structural elements, possibly connected by means of reinforcement irons or similar elements of appropriate diameter and spacing, to be positioned through the holes or slots already arranged in the box-like portions (31). Each structural element is connected to the structure (S) by the anchoring means (5).

[0031] Subsequently, the method envisages associating one or more panels (2) to the structure (S), so as to make said gap (G). This occurs by fixing each panel (2) to one or more fixing elements (3), so that the reinforcement (6a) is located inside the gap (G) defined between the panels (2) and the structure (S). In the embodiment depicted, each panel (2) is fixed to the head surface (31a) of one or more box-like portions (31).

[0032] In a subsequent step, the cast (6b) of structural material, such as a cement-based conglomerate or similar, is introduced into the gap (G), comprised between the structure (S) and the panels (2), in which the reinforcement (6a) and the air conditioning device (7) are arranged.

[0033] Preferably, but not necessarily, the installation of the panels (2) and the cast (6b) are carried out in layers. In particular, the panels (2) can be installed by successive layers or levels, in which each level is formed by mutually juxtaposing the necessary panels, and in which the next level is formed above the previous one, proceeding from the bottom upwards. In such a case, the fixing elements (3) can also be connected to the structure (S) following the sequence of the layers of panels (2). Upon completion of a first layer or level of panels (2), which is located at the lower level with respect to all the subsequent layers or levels, it is possible to introduce a cast (6b) which, having to fill a gap (G) of relatively limited height (equal to the height of the first layer or level of panels (2)), is more easily arranged within all the free spaces of the gap (G) and without giving rise to excessive thrusting and spreading of the panels (2). Once the first cast (6b) has been completed, a second layer or level of panels (2) can be installed, upon completion of which a second cast (6b) is introduced, above the previous one, and so on until the envisaged layers or levels are completed.

[0034] The system according to the present invention achieves important advantages. In fact, the system according to the present invention makes it possible to obtain seismically safe and thermally insulated structures, which are also provided with effective air conditioning systems. The system is also relatively simple and fast to implement. As is evident from the description above, the installation of the system occurs outside the structure or building on which the intervention is performed. This allows to continue with the normal planned activities inside the building.

Claims

1. A system for the static and seismic consolidation, thermal insulation and air conditioning of a structure (S), comprising:

   one or more panels (2);
   one or more fixing elements (3), structured to allow the fixing of the panels (2) to the structure (S), maintaining a gap (G);
   characterised in that it comprises:

   an exoskeleton (4), comprising a reinforcement (6a) and a cast (6b), located inside the gap (G);
   anchoring means (5), arranged to allow the fixing to the structure (S);
   an air conditioning device (7), placed inside the gap (G) between said one or more panels (2) and the structure (S).

2. The system according to claim 1, wherein the air conditioning device (7) is placed in contact with an outer surface of the structure (S).

3. The anti-seismic system according to claim 1, wherein the air conditioning device (7) is included in the cast (6b).

4. The anti-seismic system according to one of the preceding claims, wherein the air conditioning device (7) comprises electric heating elements.

5. The anti-seismic system according to one of the preceding claims, wherein the air conditioning device (7) comprises fluid thermal elements.

6. The system according to one of the preceding claims, wherein the panels (2) comprise a thermal insulator.

7. The system according to one of the preceding claims, wherein said reinforcement (6a) comprises a mesh made of metal or other material.

8. The system according to one of the preceding claims, comprising a thermally conductive layer (8) interposed between the structure (S) and the air conditioning device (7).

9. The system according to one of the preceding claims, wherein each fixing element (3) comprises a box-like portion (31), open on at least one side so as to allow the inflow and filling of the cast (6b), and a bracket (32), arranged to fix the box-like portion (31) to the structure (S), allowing to adjust an inclination of the box-like portion (31).

10. The system according to one of the preceding claims, wherein the exoskeleton (4) comprises two or more structural elements, connected to each other by means of horizontal reinforcements.

11. A method for the consolidation, thermal insulation and air conditioning of buildings comprising a structure (S), comprising the following steps:

    associating an air conditioning device (7) to the structure (S);
    connecting one or more fixing elements (3) to the structure (S);
    connecting an exoskeleton (4) to the structure (S);
    connecting one or more panels (2) to the structure (S), fixing said one or
    more panels (2) to said one or more fixing elements (3), so as to form a gap (G) between the panels (2) and the structure (S) which contains the exoskeleton (4) and the air conditioning device (7);
    introducing the cast (6b) into the gap (G).

12. The method according to claim 11, wherein the step of connecting one or more panels (2) to the structure (S) includes arranging the panels (2) by successive layers or levels, proceeding from the bottom upwards, and wherein, upon completion of the connection of each layer or level of panels (2), a cast (6b) is introduced inside the gap (G).

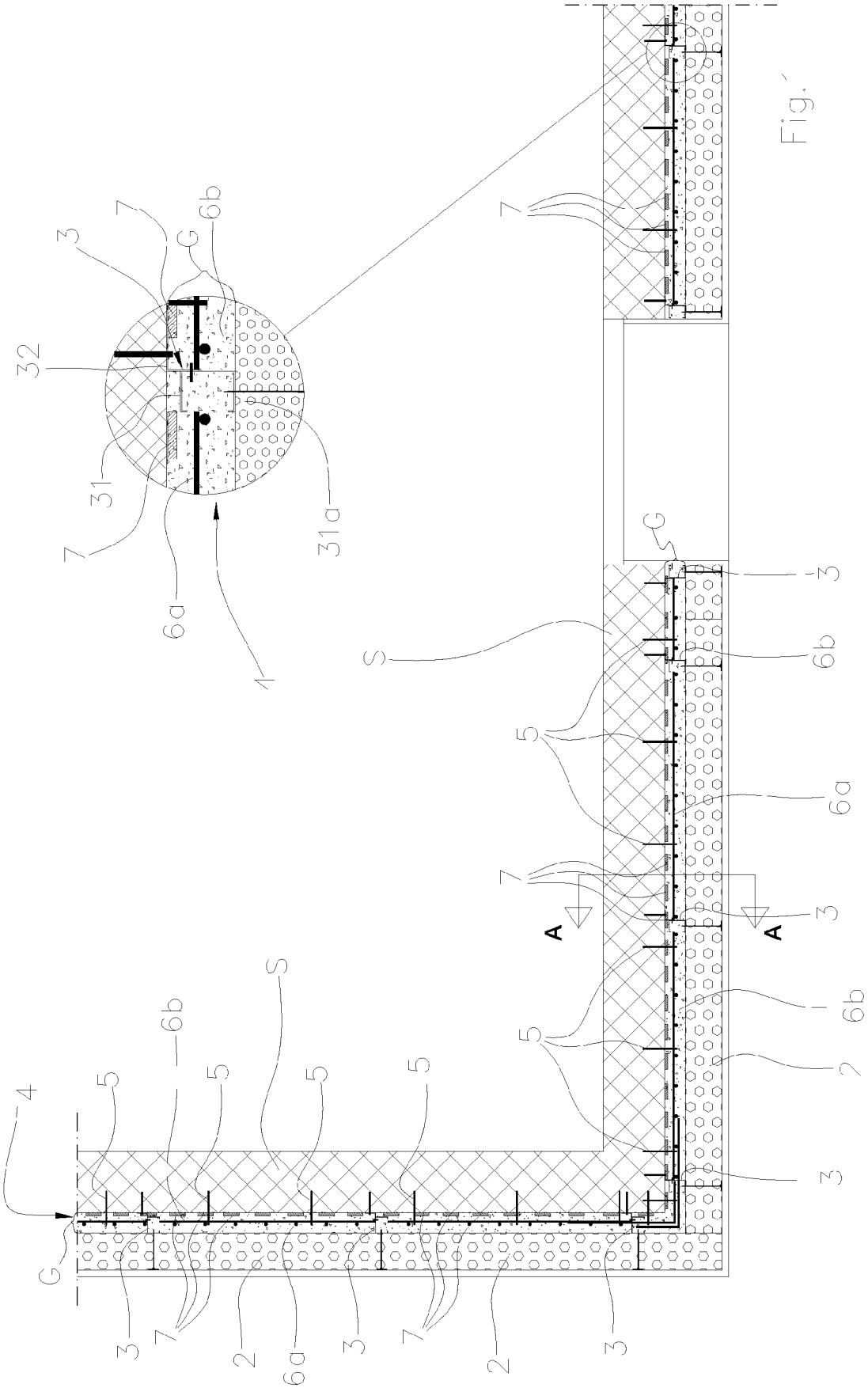
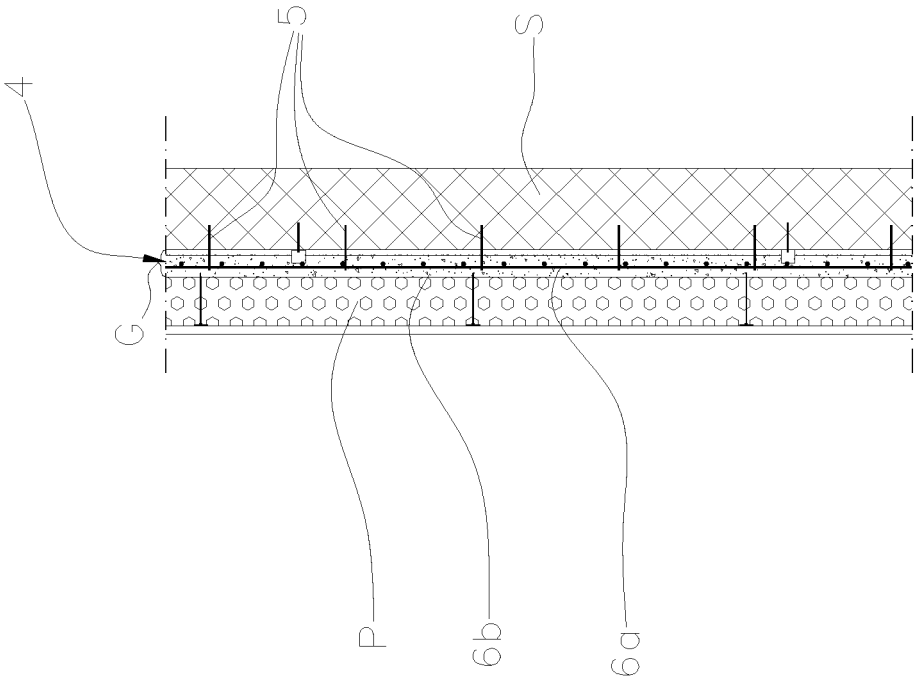


Fig. 1
A
A
G
S
1
2
3
4
5
6a
6b
7
31
31a
32

Fig. 2



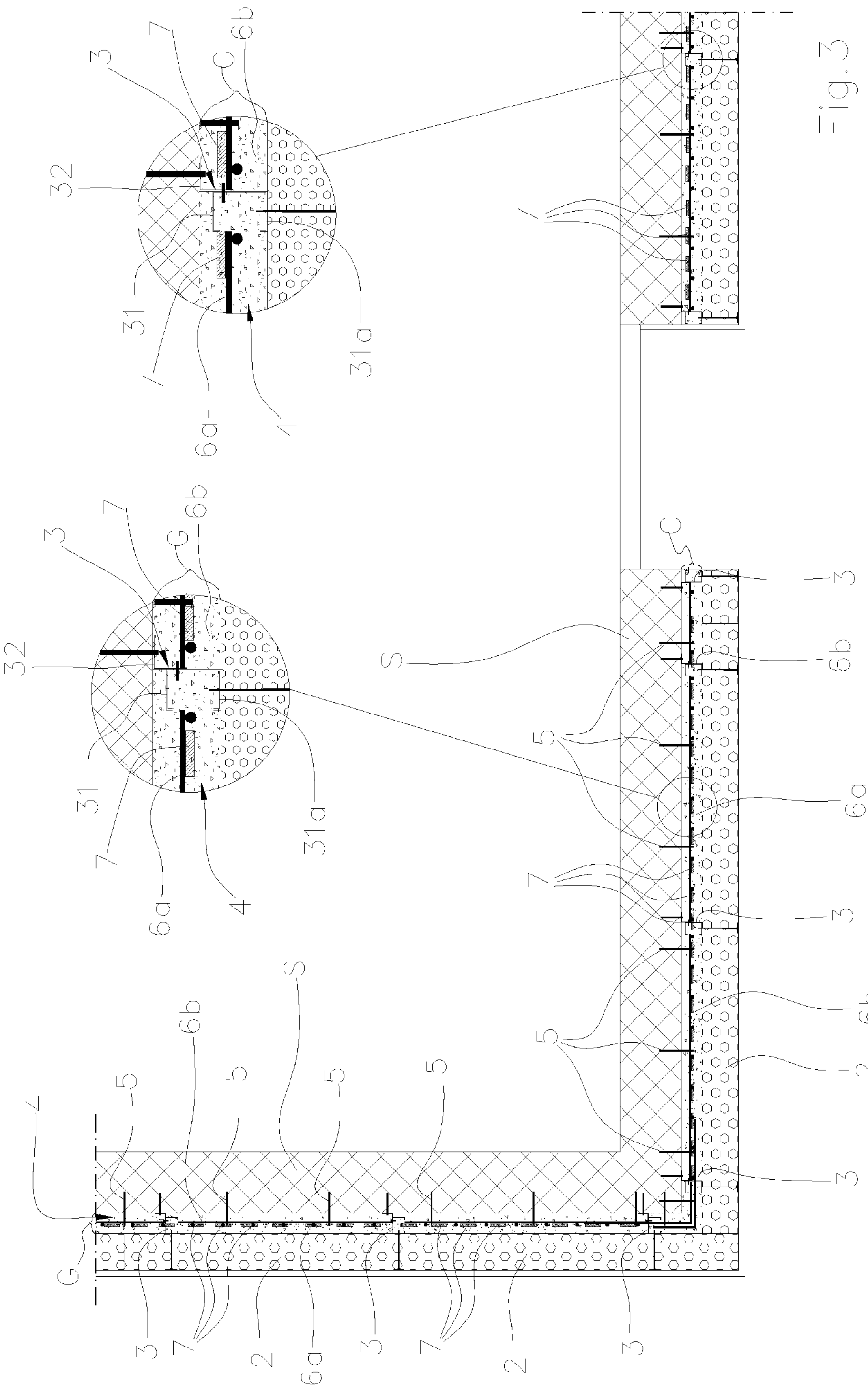


Fig. 3

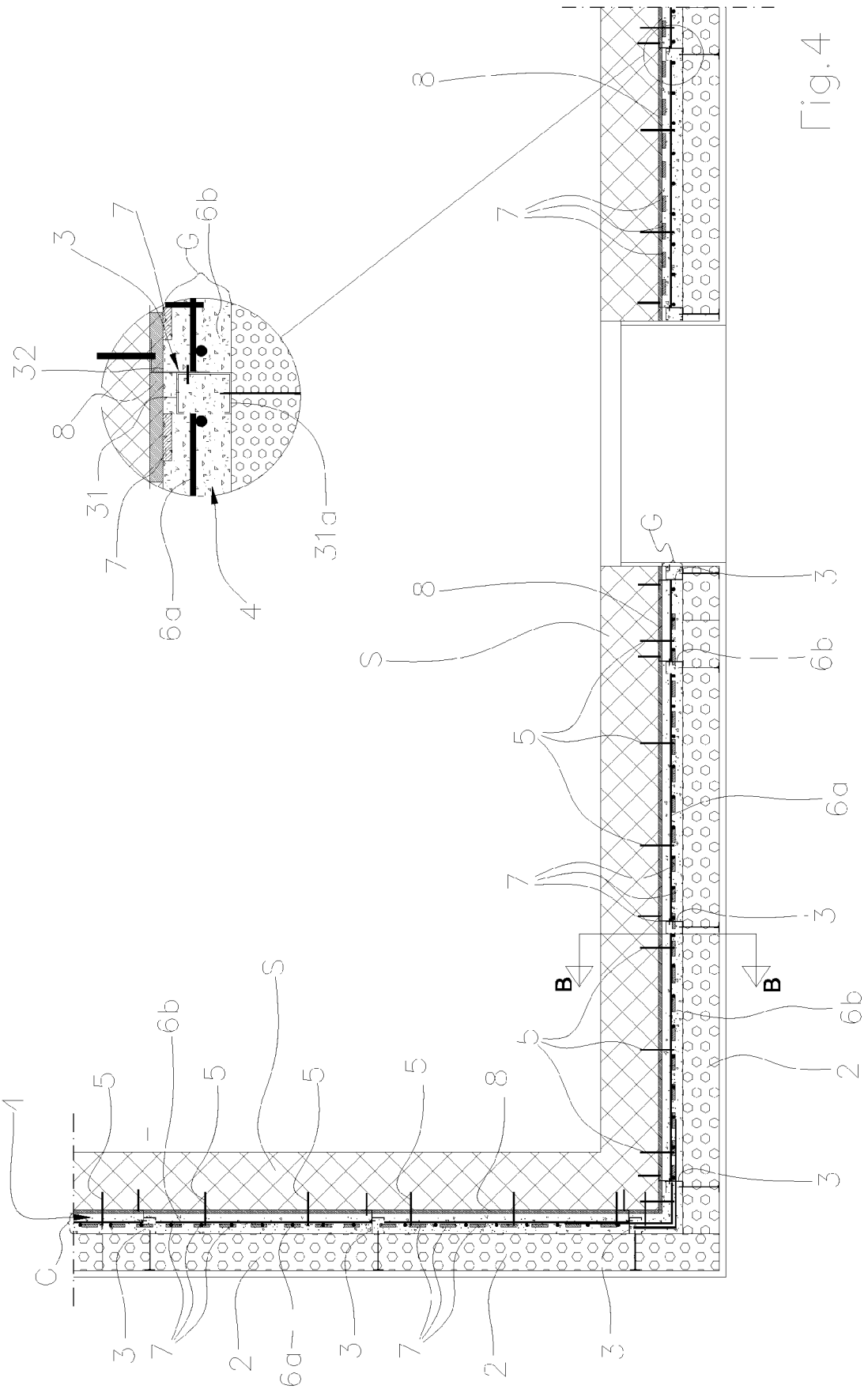

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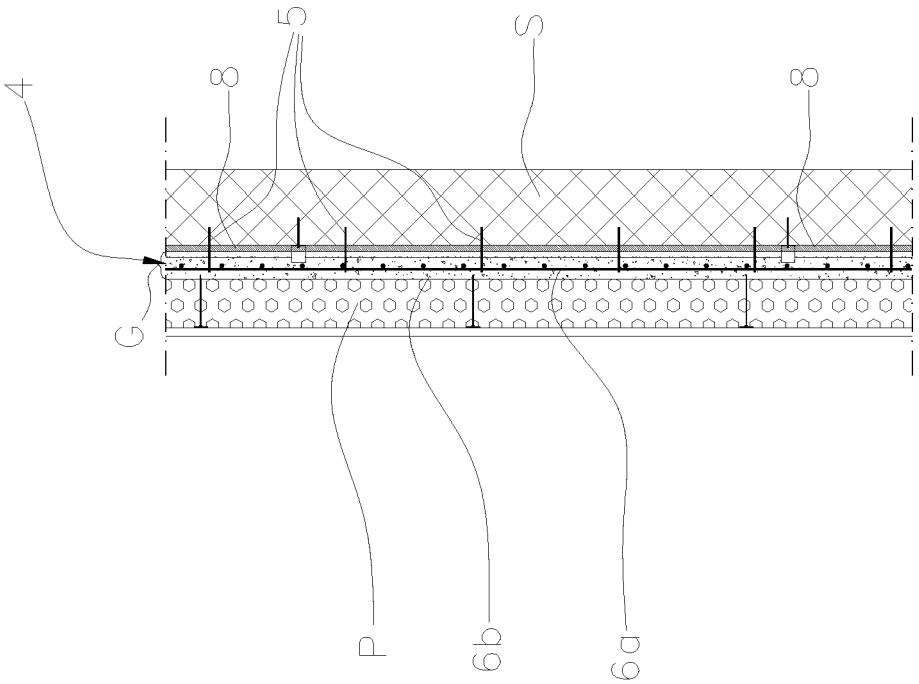
Fig. 4

Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 4461

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E04G
E04B
F24F
E04F
E04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	3 November 2023	Tryfonas, N

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