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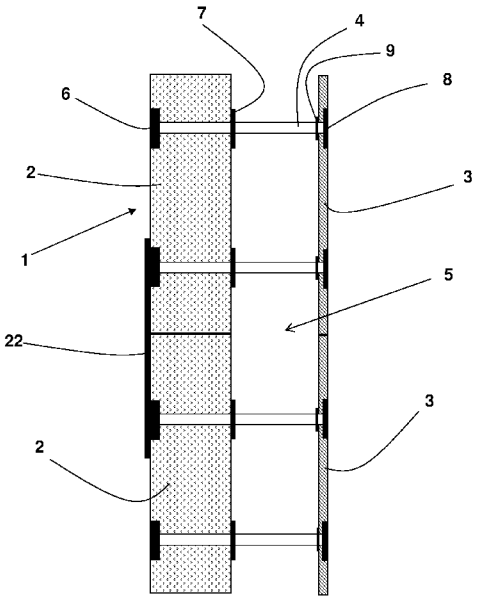

Fig. 1

(57) Abstract: An insulating concrete form for forming a poured concrete wall having a concrete-based heat store sandwiched between an exterior wall surface and an interior wall surface is described. A method for forming a poured concrete wall using insulated concrete formwork is also described. The form comprising of an insulating panel that provides the exterior wall surface and a rigid panel that provides the interior wall surface. The insulating panel and the rigid panel being engaged by one or more connectors so as to define a continuous cavity between the panels into which concrete can be provided.

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INSULATING CONCRETE FORMWORK AND A METHOD OF BUILDING USING SUCH

Field of the Invention

The present invention relates to building systems and in particular insulated concrete formwork (ICF) and the forms and connectors that are used in the construction of poured concrete walls and buildings.

Background of the Invention

Insulated concrete formwork (ICF) is a building system that uses a formwork of insulation blocks or forms, each having an internal cavity. The blocks are used to construct a portion of a building (e.g. a wall) with insulating properties.

The structural strength of the insulation block construction is provided by pouring or pumping concrete into the cavities of the blocks. In this way when the concrete sets the insulation block construction is reinforced.

The use of a large number of insulation blocks to construct a building portion, such as a wall, can be a time consuming process as the blocks need to be individually placed relative to one another.

The construction of insulation block walls, for example, can require a level of skill and errors made during the construction process can be difficult to put right, especially after the concrete has been poured into the wall cavity.

An alternative approach to producing insulated poured concrete walls is disclosed in US 6,314,694, which describes the provision of a formwork consisting of a first insulated panel non-permanently connected to a second removable wall panel to form a concrete receiving panel.

During the construction process concrete is poured into the cavity formed between the two panels. Once the concrete has set the second wall panel, which is located on the exterior of the wall, is removed to reveal the concrete

surface, which then provides the exterior surface of the wall/building. The insulation panel is retained to provide the wall's insulating properties.

Summary of the Invention

The present invention seeks to provide an improved insulating concrete formwork building system that enables the quicker and cheaper construction of poured/pumped concrete walls/buildings.

In accordance with claim 1 a first aspect of the present invention provides an insulating concrete form for forming a poured concrete wall having a concrete-based heat store sandwiched between an exterior wall surface and an interior wall surface.

By locating the insulating panel (or indeed panels), on the exterior surface of the resultant poured concrete wall the heat retaining characteristics of the wall are enhanced.

In use the insulating panel serves as a barrier to prevent heat entering or leaving a building via the wall. Locating the concrete portion of the wall closer to the interior of the building than the insulation layer enables the concrete to act as a heat store for thermal energy trying to escape the interior of the building.

As a result, over the course of a day the excess heat lost though the walls during the day is retained in the concrete portion before being allowed to re-enter the interior of the building at night.

Preferably the insulating panel may have passive insulation properties, in that it allows no heat to be gained or lost through the panel. It is envisaged that insulation having a U-value of 0.11 or better would achieve this.

Preferably the insulating panel may be made from phenolic foam. It is noted that the insulating properties of phenolic foam mean that the desired insulation values can be obtained using a thinner insulating panel. It is appreciated that

alternative insulating materials can be adopted to achieve the desired insulation levels.

Preferably a face of the insulating panel which faces into the cavity may be provided with one or more projections to reduce the amount of concrete required to fill the cavity. It is envisaged that by varying the size and shape of the projections it is possible to reduce the total amount of concrete needed to fill the wall cavity.

Preferably the projections may be formed from additional insulating material. Further preferably the projections may be made from either the same material as the insulating panel itself and/or from a recycled material. In this way the insulating properties of the resultant wall can be varied across the area of the wall.

Preferably the rigid panel that provides the interior wall surface may be a high impact plaster board panel. In this way the interior surface requires very little additional preparatory work before it can be decorated for example. High impact plaster board is considered particularly suitable as it maintains its structural integrity when the wet concrete is poured into the wall cavity.

This greatly speeds up the construction process by avoiding the need to secure plaster board to the interior surface of poured concrete wall once concrete has set.

In addition it is appreciated that by minimising the distance between the interior of the building and the concrete portion of the wall the heat storage capabilities of the wall are increased. The density of high impact plaster board is such that its insulating properties are minimised.

It is also appreciated that the job of fixing shelves and the like to the wall is made easier because the concrete can be easily reached using standard fittings (e.g. screws).

Preferably the rigid panel may be provided with utilities conduits. In this way the process of running cables and pipes through the wall is made much easier and quicker.

In addition, by inlaying the utilities into concrete rather than insulating material (e.g. polystyrene), as is the case in existing insulating concrete formwork, the risk of fires spreading through the wall is greatly reduced.

In accordance with claim 9 a second aspect of the present invention provides an insulating concrete formwork connector for connecting an insulating panel to a rigid panel so as to form a continuous cavity between the panels.

By making the insulating panel engaging means adjustable it is possible to use different thicknesses of insulation in accordance with the materials available or the budget of the construction project. For example it is envisaged that using phenolic foam as the insulating medium it is possible to obtain passive insulation values with a reduced thickness of insulation.

Preferably wherein the insulating panel engaging means may comprise: a fixed retaining surface that projects from the first end portion of the elongate member and, in use, abuts a first face of an insulating panel; and an adjustable retaining surface arrangeable on the elongate member to project therefrom and, in use, abut a second face of an insulating panel thereby engaging the insulating panel with the connector.

Preferably the adjustable retaining surface may comprise a removable clip that is clippable to the elongate member at a range of distances from the fixing retaining surface to accommodate different thicknesses of insulation. Further preferably the elongate member may comprise one or more recesses into which the removable clip is securely received.

In this way the connector can easily and quickly be adjusted to receive different thicknesses of insulating panels.

Preferably the elongate member may comprise one or more cut-outs to reduce the amount of material required to form the connector. It is envisaged that the connectors are moulded from suitable plastics materials such as polypropylene, although alternative materials, such as aluminium, will also be considered by the skilled person upon appreciation of the present invention.

Preferably the elongate member of the connector may comprise one or more rebar receiving slots. The receiving slots can be used to support reinforcing metal work in position within the cavity before encased it in concrete.

Preferably the connector may further comprise link receiving means to enable the connector to be linked to another connector by linking means. In this way neighbouring insulating concrete forms can be attached together to form a large structure before concrete is poured into the cavity.

A further aspect of the present invention makes use of the first and second aspects of the invention to provide an insulating concrete formwork system for use in the construction of poured concrete buildings.

In another aspect of the present invention, and in accordance with claim 19, a method of constructing a building using insulated concrete formwork is provided.

As will be appreciated upon consideration of the general concept of the present invention the claimed construction method facilitates the rapid construction of buildings at a reduced cost, whilst at the same time providing buildings with excellent environmental characteristics in terms of heat management.

Preferably the rigid panels may be high impact plaster board panels.

Preferably the building portion may comprise an entire external wall for a single storey of a building. Alternatively the building portion may comprise a unitary construction with a floor, two opposing side walls and a roof.

Brief Description of the Drawings

The various aspects of the present invention will now be described in more detail with reference to the preferred embodiments shown in the figures, wherein:

Figure 1 shows a top view of two insulated concrete forms of a preferred embodiment of the present invention;

Figure 2 show a side view of the insulated concrete formwork of the present invention;

Figure 3 shows a top view of two insulated concrete forms of an alternative preferred embodiment of the present invention;

Figure 4 shows a top view of multiple building portions formed in accordance with the present invention;

Figure 5 shows a side view of unitary building structure formed in accordance with the present invention;

Figure 6 shows a preferred embodiment of the connector used in the insulated concrete formwork system of the present invention; and

Figure 7 show an alternative view of the connector shown in Figure 6.

Detailed Description of the Preferred Embodiments

The present invention related to an improved insulated concrete formwork building system that can be used to build both single poured/pumped concrete walls and larger poured/pumped concrete structures, which may include a floor, side walls and a roof.

The insulated concrete formwork building system of the present invention makes use of insulated concrete forms 1, which can be connected together to form concrete walls or even larger concrete structures. The insulated concrete form 1 of the present invention will be appreciated from Figure 1, where two neighbouring forms are shown from above.

The insulated concrete form 1 consists of an insulating panel 2 connected in parallel with a rigid panel 3 by one or more connectors 4. The connectors 4 ensure that a gap is maintained between the parallel panels. This gap

provides the cavity 5 into which concrete is poured (or pumped) to give the wall its structural strength and described thermal properties.

For the sake of clarity none of the figures show the presence of concrete within the cavity 5. However it will be appreciated that in order to ensure the structural strength of the walls built using the system of the present invention it is important to put concrete in to the cavity. Various ways of doing this, including pumping and pouring, are known.

In order to minimise the cost of the insulated concrete form it is envisaged that both the insulating panel 2 and the rigid panel 3 would take the form of standard industry panels that could be sourced from a builder's merchant for example.

In order to maximise the environmental qualities of the insulated concrete form of the present invention it is envisaged that the insulating panel 2 preferably has a 'passive' U-value of 0.11 or better.

Although each form 1 is shown as having only one insulating panel 2 it is envisaged that multiple panels may also be used provided the aggregate insulation obtained is suitable.

In order to maximise the speed with which a building can be constructed using the insulated concrete formwork of the present invention the rigid panel 3 preferably takes the form of high impact plaster board. It will be understood that high impact plaster board is more suitable that standard plasterboard because it retains it structural integrity when wet concrete is poured into the wall cavity and does not degrade when it gets damp.

In this way the builder can avoid the step of applying plaster board to the interior surface of the poured concrete wall. Instead the builder just has to tape up the gaps between neighbouring panels and skim plaster over the board to obtain a surface suitable for decoration.

In order to connect the insulating panel 2 in parallel to the rigid panel 3 both panels are provided with holes. Although not shown in detail in the figures the holes on the insulating panel 2 are aligned with the holes on the rigid panel so that the connector 4 can pass through both panels.

In order to retain the insulating panel in position relative to the connector 4 and the rigid panel retaining means 6 and 7 are provided on the elongate body 19 of the connector 4. A preferred embodiment of the connector is shown in Figures 6 and 7 and is described in more detail below.

Retaining means 6, which is located towards the end of the connector 4 that, in use, is positioned at the exterior surface (i.e. the outside of the building) of the poured concrete wall formed according to the present invention. It is envisaged that retaining means 6 is unitarily moulded with the elongate body 19 of the connector 4.

In contrast the retaining means 7 of the preferred embodiment is moulded as a separate component so that it can be removed and repositioned on the elongate body 19. In this way the retaining means 7 are made adjustable so that the connector 4 can engage differing thicknesses of insulating panel 2.

The other end of the connector 4 is provided with retaining means 8, 9 for the rigid panel 3 (e.g. plaster board). The retaining means 8, 9 are securable to clamp the rigid panel 3 and maintain its position relative to the connector 4 and the insulating panel 2, thereby providing cavity 5 to receive concrete.

It is envisaged that retaining means portion 9 is unitarily moulded with the elongate body of the connector 4, whereas retaining means portion 8 a separate moulding.

It is also envisaged that the separate retaining means portion 9 can be secured to the elongate body 19 by a screw thread so that varying thicknesses of rigid panel 3 can be clamped. Alternative ways of fixing the

retaining means portion 9 to the elongate body 19 will be appreciated upon consideration of the invention as whole.

In order to ensure the stability of the insulated concrete form 1 the insulating panel 2 and the rigid panel 3 are preferably connected by way of multiple connectors 4. The connectors 4 may preferably be arranged in a grid formation with an inter connector spacing that alternates between 200 and 400mm (i.e. connector – 200mm gap – connector – 400mm gap – connector, etc..). However the person skilled in that art will appreciate that alternative arrangements are also possible.

As can be seen from Figure 1 neighbouring forms 1 are placed next to one another to produce a larger insulating concrete formwork. The arrangement shown in Figure 1 is a formwork for a simple poured concrete wall.

Neighbouring insulated concrete forms 1 are attached to one another by one or more links 22 that are secured to adjacent connectors 4 locating on neighbouring forms 1. It is appreciated that the linkage arms 22 may sit proud of the insulating layer 2 (as in Figure 1) or they may be countersunk in to the insulating layer (as in Figure 3).

Figure 2 shows a side view of a section of insulated concrete formwork from which it can be appreciated that a single insulating panel 2 can be used for the complete height of the wall. By constructing the formwork from larger panels, rather than moulded insulation blocks, the construction process is made much easier and quicker.

In addition by using a single insulating panel that extends the complete height of the wall it is possible to eliminate horizontal joins in the panelling, which could provide points of weakness when concrete is poured in to the cavity. Thus by reducing or eliminating the number of joins between the panels the likelihood of leakage or even bursting is reduced.

However it is appreciated that system of the present invention may also be adopted using smaller panels for the interior and exterior walls.

As will also be appreciated from Figure 2, the insulating panel 3 is located to the exterior of the wall created using the formwork of the present invention.

By providing the insulating layer on the outside of the building structure rather than the structural concrete layer it is possible to make full use of the heat storage capacity of the concrete (not shown) that fills the cavity 5.

The limited insulating properties of the rigid panel 3, which is preferably plaster board, means that thermal energy can escape the interior of the building. However the insulating properties of the insulating panel 2 prevent the thermal energy completely escaping the building. Instead the thermal energy heats up the concrete and plasterboard layers.

As a result, when the level of thermal energy within the interior of the building falls (e.g. at night) the thermal energy can leave the concrete/plasterboard and re-enter the building giving a heating effect, thus reducing the heating costs of the finished building.

It will be appreciated that heat loss occurs constantly day or night (although the sun does provide heat gain through windows) and that the thermal efficiency is provided by negating the heat loss by the heat gain achieved within the building to maintain a constant temperature.

It is envisaged that, although the present invention requires that the insulating layer is on the outside of the building structure rather than the structural concrete layer, it is possible that the insulating layer may be provided with an additional layer (i.e. cladding, render, etc... for aesthetic purposes) without departing from the present invention.

The structural strength of the formwork, even before the introduction of the concrete, is such that it is envisaged that joists and beams 11 can be supported by the formwork using suitable connection means 10.

It will be appreciated that this ability to hang the joists/beams 11 from the formwork without need for the normally required supporting equipment and scaffolding will also greatly increase the speed with which buildings can be constructed.

Utility conduit means 12 (as illustrated in Figure 2), such as electrical trunking, can be attached to the rigid panel 3 before construction of the formwork or at least before the concrete is introduced in to the formwork cavity 5. In this way, once the concrete walls are formed, the job of fitting utilities is much easier and does not require the wall to be chased out to accommodate electrical trunking for example. Although the conduit means 12 are shown in Figure 2 as being directed towards the floor it will be appreciated that such could also travel up the wall to inter-floor space or along the wall horizontally.

The arrangement of the ICF of the present invention means that the conduit means 12 can be embedded in to concrete rather than in to insulating materials, which provides a reduced risk of fires spreading through the wall.

As is shown in Figure 3, it is envisaged that an alternative embodiment of the insulating concrete form may be provided with additional projections 13 on the cavity facing surfaces of either the insulating panel 2 or the rigid panel 3. By providing the additional projections it is possible to reduce the amount of concrete required to fill the cavity 5.

The projections 13 shown in Figure 3 are preferably formed of additional insulation material such as suitable recycled material. However alternative insulating materials could be used, including the same insulating material as the insulating panel 3.

Alternatively, the additional projections could be formed from a material of high density that is capable of acting as a thermal store.

It will therefore be appreciated that varying the size and shape of the additional projections and also the material use not only reduces the total amount of concrete required, but also allows for a builder to adjust the thermal storage characteristics of the wall of the present invention.

Not only can the system be used on site to construct the components of a building on demand. It is also envisaged that the formwork system of the present invention provides new opportunities for the manufacture of prefabricated concrete walls or even prefabricated building portions.

Figure 4 shows an example of how it would be possible to construct multiple building corner portions 14, 14a, 14b, 14c, 14d by using the neighbouring portions to support one another whilst concrete is conveniently poured into the cavities of the various portions.

It is envisaged that arranging the formwork in the manner described provides for increased factory efficiency as the panels are in close proximity, thus reducing the concrete pouring times.

Although Figure 4 shows multiple building corner portions it is envisaged that other building components could be factory pre-fabricated using this approach.

Figure 5 shows another example of how the formwork system of the present invention can be applied to quickly construct substantial building structures. The formwork 15 shown in Figure 5 is constructed by connecting multiple forms 1 in an arrangement which defines a floor 16, two side walls 17, and a roof 18.

The arrangement, which is viewed from above in Figure 6, then has concrete poured into the continuous cavity 5 provided. Once concrete has set within the

cavity 5 of the formwork has hardened and set the structure can be rotated so that the floor portion 16 is in contact with the ground. The open ends of the structure can then be formed using additional formwork as required.

It will be appreciated that the use of this approach, and those other features described herein, could be adopted to quickly and cheaply construct buildings of various forms.

It will be appreciated, that although the forms and formwork shown in the figures do not have door and window spaces, such openings could be readily provided prior to the introduction of concrete into the formwork cavity. It will also be appreciated that air re-circulation means may be necessarily in buildings constructed in accordance with the present invention because the use of air bricks may not be appropriate.

A preferred embodiment of the connector 4 used in the insulated concrete formwork system of the present invention will now be described in more detail with reference to Figures 6 and 7.

The connector 4 consists of a main elongate body 19 which is shaped to pass through holes in the insulating panel 2 and the rigid panel 3 of the form 1. At one end of the connector 4 is provided the insulating panel retaining means 6, 7.

As already described retaining means 6 is moulded as part of the elongate body 19. The retaining means 6 comprises an annular projection that presents a surface against which the insulating panel 2 can abut.

Retaining means 7 are moulded separately from the elongate body 19 in the form of a clip. The clip does not necessarily need to have the same C-shape of the clip shown in Figure 6 provided it presents some form of surface to abut the other side of the insulating panel.

The clip is moulded so at to securely engageable with the elongate body 19. Although not essential the elongate body 19 is shown as having clip receiving recesses 20 space apart along the length of the elongate body.

The recesses 20 provide distinct distances between the retaining means 6, 7 which are in accordance with the thicknesses of industry standard insulation panels.

The ability to vary the thickness of the insulating panel engaged by the connector is considered an important aspect of achieving the required insulating properties using the different levels of insulation material that might be typically available on a building site.

The connector 4 is preferably moulded from polypropylene, although alternative plastics materials or even aluminium may be suitably applied. Polypropylene is considered particularly suitable because it does not transmit heat and thus will not act as a heat bridge to by-pass the insulation panel 3.

In order to reduce the amount of material required to manufacture the connectors 4 the elongate body is preferably provided with one or more cut outs. Webbing is provided to maintain the structural strength of the elongate body 19.

The elongate body 19 is provided with one or more notches 21 upon which reinforcing metalwork (e.g. rebars) can be supported prior to the introduction of concrete in to the formwork cavity 5.

As will be appreciated from Figure 6 the connector 4 is capable of engaging linking means 22. It is this linking means 22 that enables neighbouring insulating concrete forms 1 to be secured to one another to produce a larger formwork.

Although the linking means 22 is shown as engaging the connector 4 at one of its ends it is appreciated that the linking means may engage the connector

at an alternative location. It is also envisaged that adjacent connectors may be linked by more than one linking means.

Claims

1. An insulating concrete form for forming a poured concrete wall having a concrete-based heat store sandwiched between an exterior wall surface and an interior wall surface, said form comprising:

an insulating panel that provides the exterior wall surface, which minimises the passage of heat through said exterior wall surface;

a rigid panel that provides the interior wall surface, which permits the passage of heat through said interior wall surface; and

one or more connectors that engage with the insulating panel and the rigid panel so as to define a continuous cavity between the panels into which concrete can be provided.

2. The insulating concrete form of claim 1, wherein the insulating panel has passive insulation properties, in that it allows no heat to be gained or lost through the panel.

3. The insulating concrete form of claim 1 or 2, wherein the insulating panel is made from phenolic foam.

4. The insulating concrete form of claim 1, 2 or 3, wherein a face of the insulating panel which faces into the cavity is provided with one or more projections to reduce the amount of concrete required to fill the cavity.

5. The insulating concrete form of claim 4, wherein the projections are formed from additional insulating material.

6. The insulating concrete form of claim 5, wherein the projections are either made from the same material as the insulating panel or from a recycled material.

7. The insulating concrete form of any of the preceding claims, wherein the rigid panel is a high impact plaster board panel.

8. The insulating concrete form of any of the preceding claims, wherein the rigid panel is provided with utilities conduits.

9. An insulating concrete formwork connector for connecting an insulating panel to a rigid panel so as to form a cavity between the panels, said connector comprising:

an elongate member having first and second end portions;

insulating panel engaging means, located on the first end portion, being adjustable to engage different thicknesses of insulation; and

rigid panel engaging means located on the second end portion.

10. The connector of claim 9, wherein the insulating panel engaging means comprises:

a fixed retaining surface that projects from the first end portion of the elongate member and, in use, abuts a first face of an insulating panel; and

an adjustable retaining surface arrangeable on the elongate member to project therefrom and, in use, abut a second face of an insulating panel thereby engaging the insulating panel with the connector.

11. The connector of claim 10, wherein the adjustable retaining surface comprises a removable clip that is clippable to the elongate member at a range of distances from the fixing retaining surface to accommodate different thicknesses of insulation.

12. The connector of claim 11, wherein the elongate member comprises one or more recesses into which the removable clip is securely received.

13. The connector of any of claims 9 to 12, wherein the elongate member comprises one or more cut-outs to reduce the amount of material required to form the connector.

14. The connector of any of claims 9 to 13, wherein the elongate member comprises one or more rebar receiving slots.

15. The connector of any of claims 9 to 14, further comprising link receiving means to enable the connector to be linked to another connector by linking means.

16. An insulating concrete formwork system for use in the construction of poured concrete buildings, said system comprising:

one or more insulated concrete forms according to any of claims 1 to 8; and

linking means which interact with the connectors of adjacent insulated concrete forms to attach the forms together.

17. The formwork system of claim 16, further comprising connectors according to any of claims 9 to 15.

18. A wall constructed using the insulated concrete form of claims 1 to 8 and/or the connectors of claims 9 to 15.

19. A method of constructing a building using insulated concrete formwork with a concrete-based heat store, said method comprising:

providing one or more insulated concrete forms, each having an exterior insulating panel and an interior rigid panel connected together by one or more connectors such that a cavity is formed between the panels;

positioning the forms relative to one another so as to form at least a portion of the building, and wherein the insulating panels are arranged on the exterior of the building and the rigid panels are arranged on the interior of the building such that the cavities of each form are aligned to produce a continuous cavity;

linking the connectors of adjacent forms together to maintain the relative positions of the forms that make up said building or building portion;

providing concrete into the continuous cavity between the exterior insulating panels and the interior plaster board panels and allowing it to set.

20. The method of claim 19, wherein the rigid panels are high impact plaster board panels.

21. The method of claim 19 or 20, wherein the building portion comprises an entire external wall for a single storey of a building.

22. The method of claim 19 or 20, wherein the building portion comprises a unitary construction with a floor, two opposing side walls and a roof.

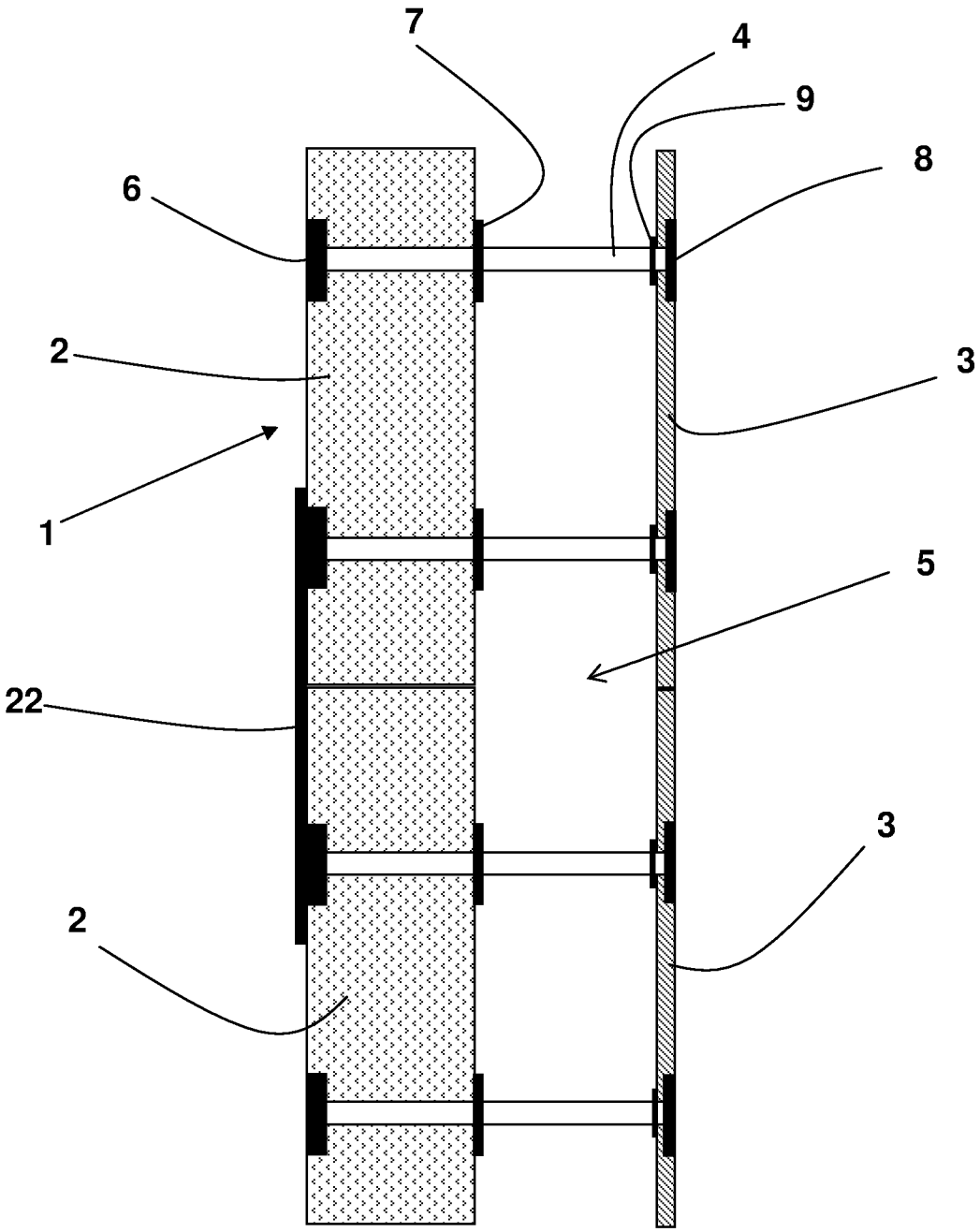

Fig. 1

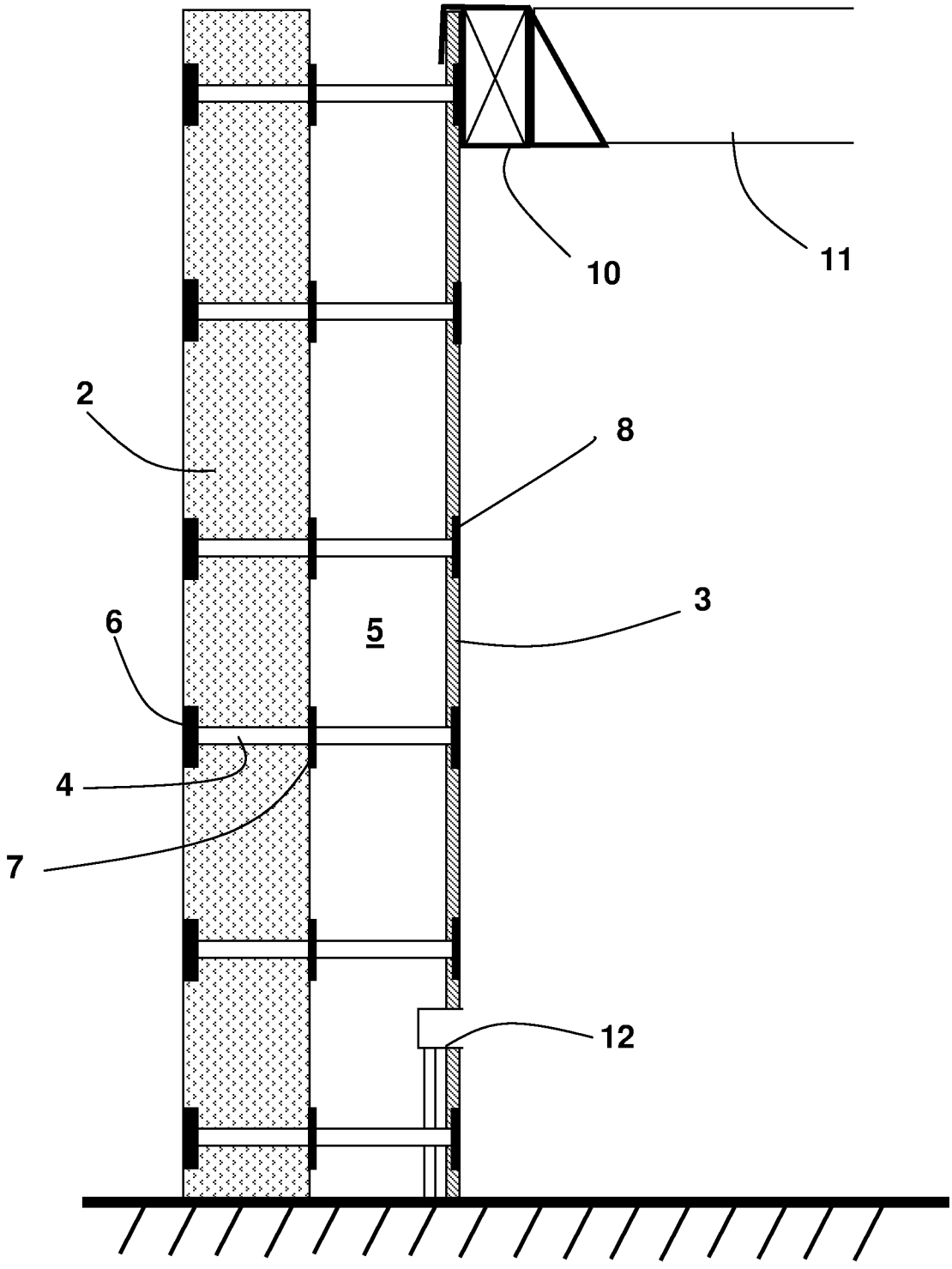

Fig. 2

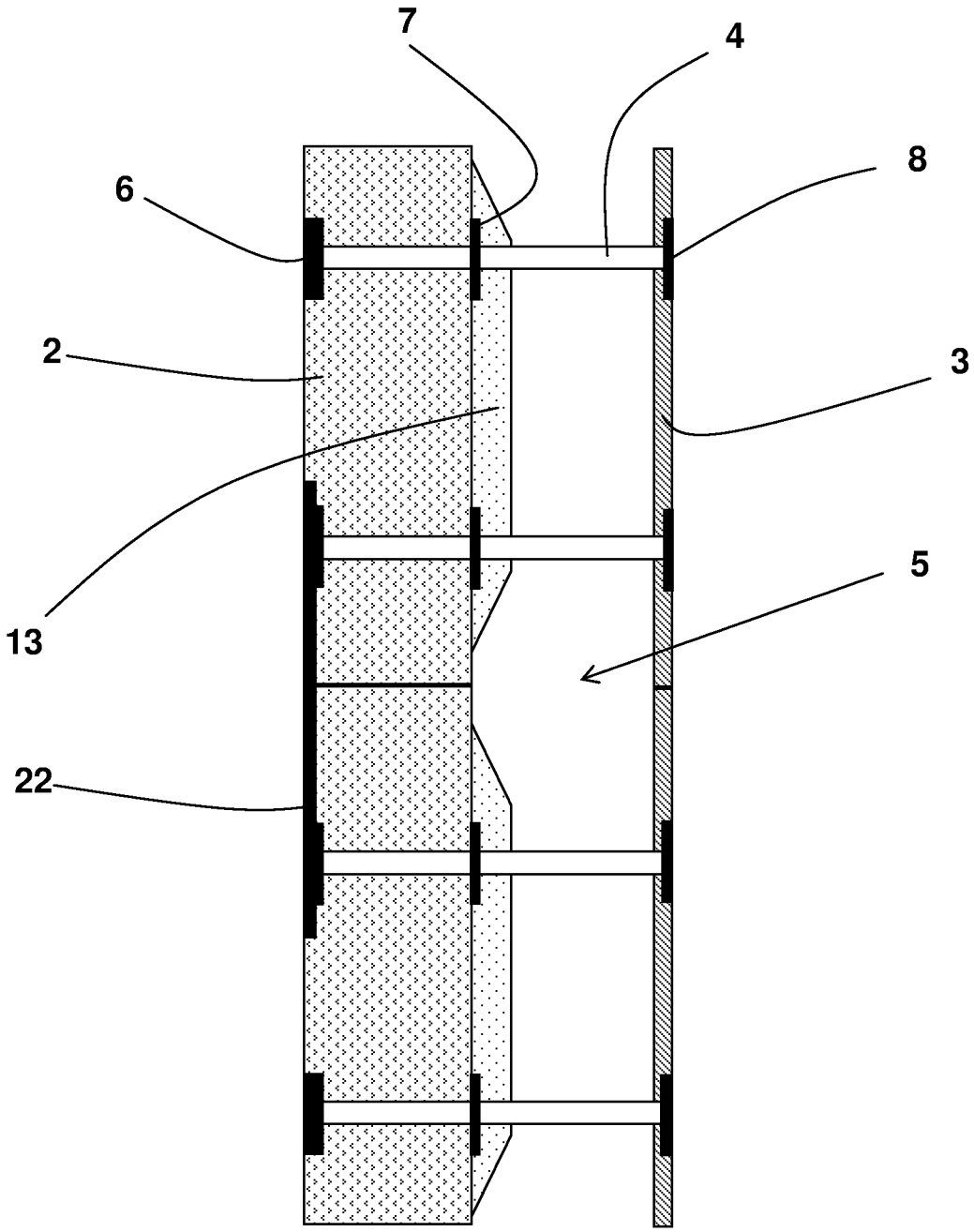

Fig. 3

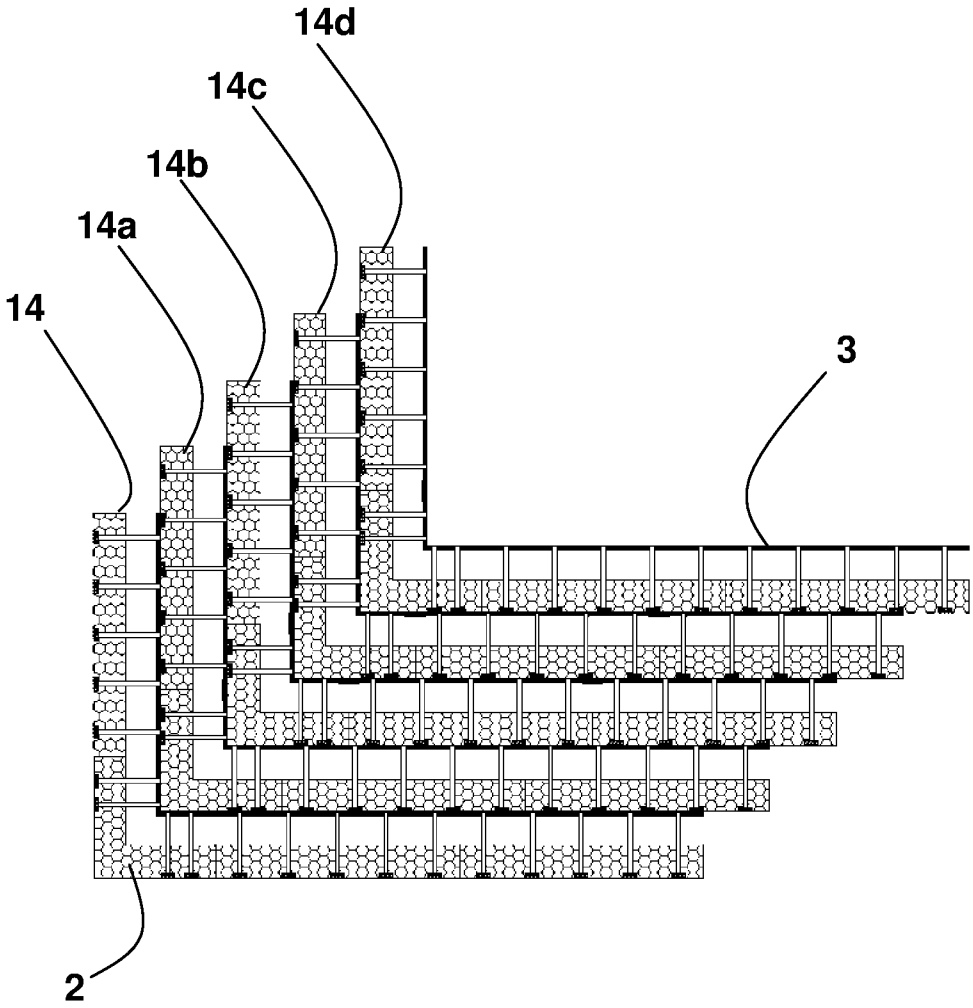

Fig. 4

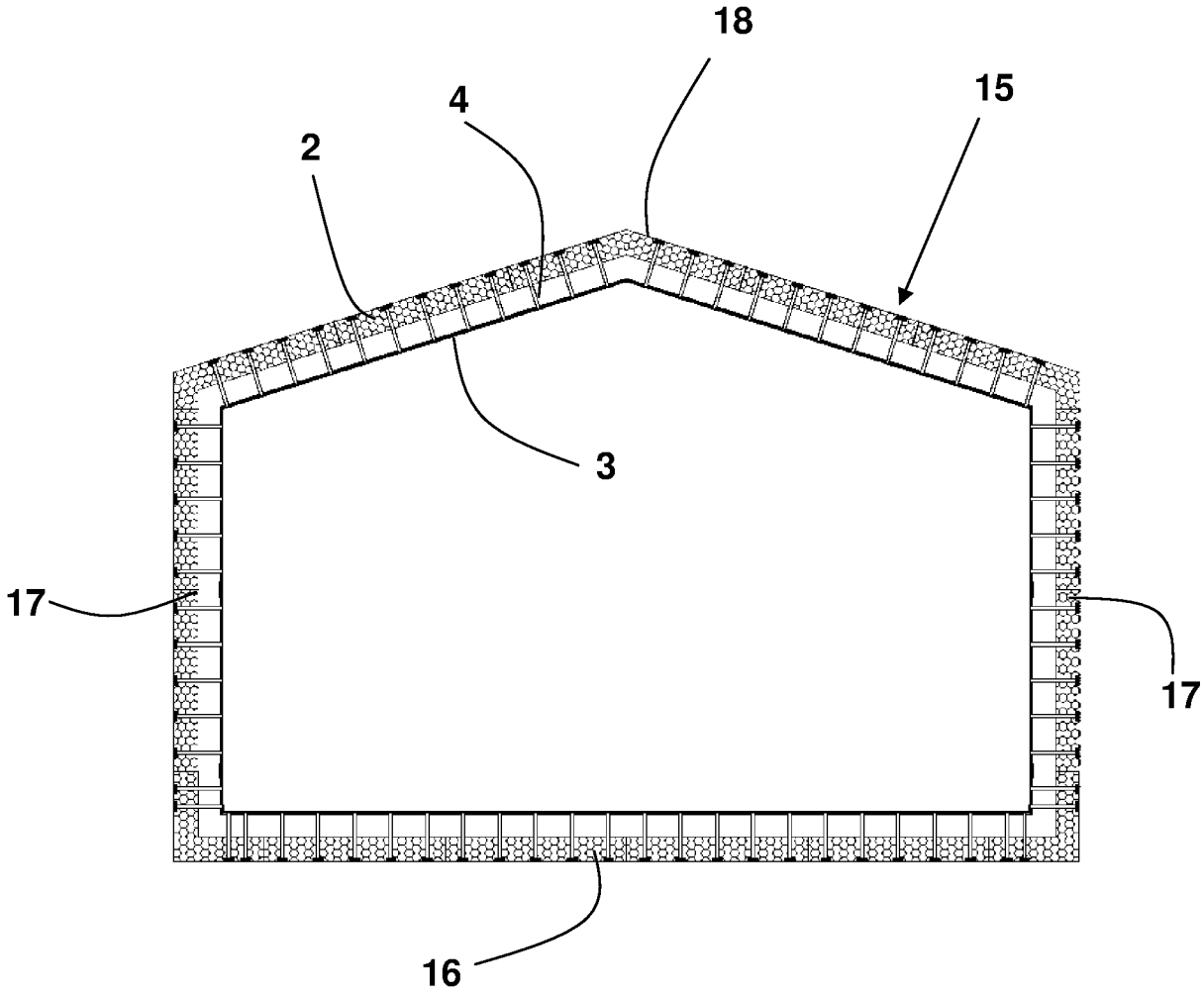

Fig. 5

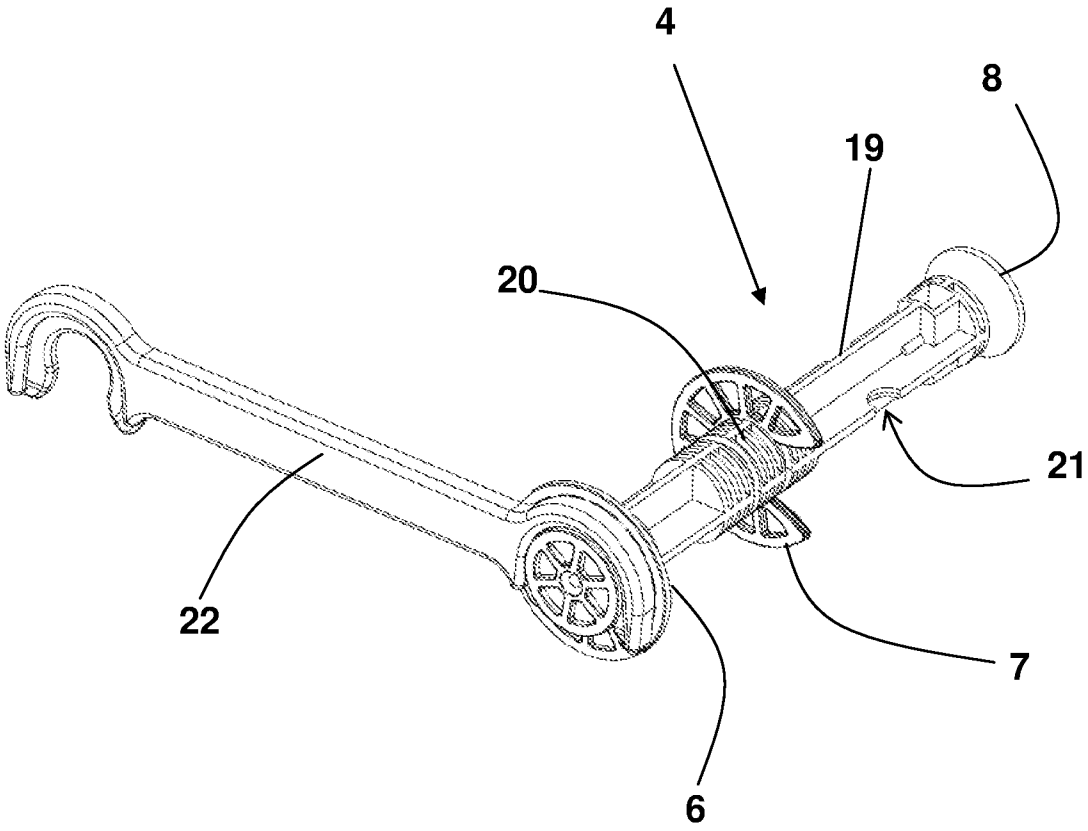

Fig. 6

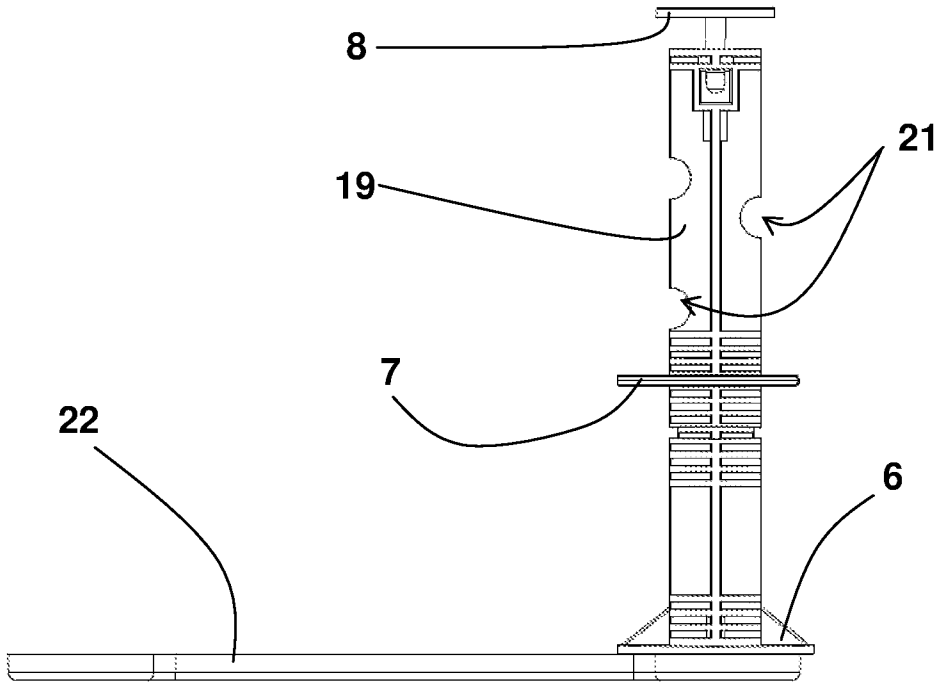

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2014/050832

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04B2/86
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2011/131892 A1 (DEL PINO PEDRO [US]) 9 June 2011 (2011-06-09) figure 6 page 1, left-hand column, line 18 - line 20 page 1, left-hand column, line 29 page 1, left-hand column, line 45 - line 48 page 1, right-hand column, line 27 - line 36 ----- -/--	1,2,7,9, 10,13-21 11,12

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 August 2014	29/08/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Petrinja, Etiel

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2014/050832

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	figures 1,23 column 1, line 56 - line 59 column 2, line 9 - line 14 column 2, line 16 - line 25 column 3, line 1 - line 10	12-15,17
X	US 2006/010831 A1 (SKAKIE EDWARD F [CA]) 19 January 2006 (2006-01-19) figures 1,2 page 2, right-hand column, line 42 - line 44 page 3, left-hand column, line 40 - line 43 page 3, left-hand column, line 53 - line 58	1-6,9, 10,13, 18,19,21
X	US 2011/265413 A1 (DEL PINO GARCIA PEDRO [US] ET AL) 3 November 2011 (2011-11-03) figure 4b page 1, left-hand column, line 10 - line 11 page 2, left-hand column, line 55 - line 56 page 3, left-hand column, line 6 - line 7 page 3, left-hand column, line 29 - line 30 page 4, right-hand column, line 4 - line 6	1-3,7,8, 16,19-22
X	CH 703 446 B1 (PORTMANN JOSEPH [CH]) 31 January 2012 (2012-01-31)	1,2, 7-10,13, 18
A	figures 1,2 page 1, line 6 - line 7 page 1, line 15 - line 16	19-21
A	EP 1 734 199 A1 (SHINNIHON CORP [JP]) 20 December 2006 (2006-12-20) column 3, line 21 - line 27	3
Y	GB 21893 A A.D. 1913 (THACKERAY FREDERICK) 2 July 1914 (1914-07-02)	11,12
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Information on patent family members

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