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(54) Title: SEMI-PREFABRICATED TIMBER-CONCRETE COMPOSITE SLAB

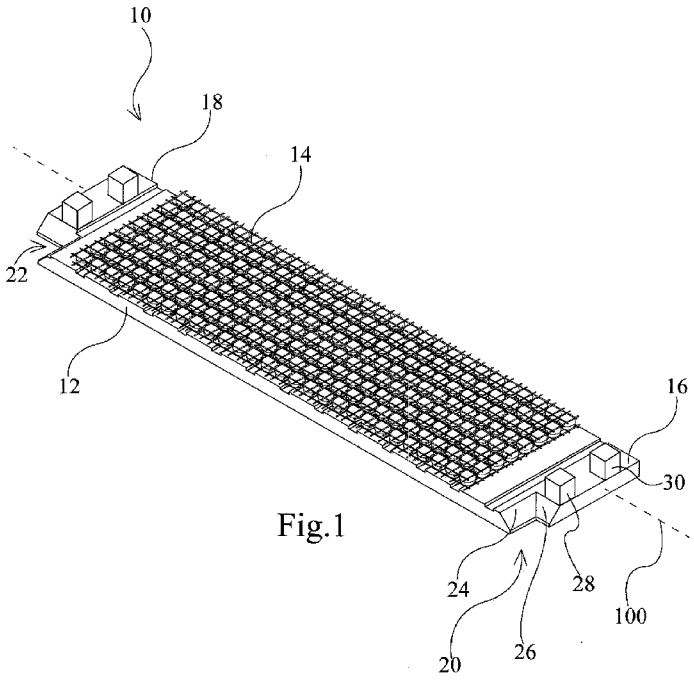


Fig.1

(57) Abstract: A semi-prefabricated timber-concrete composite floor slab comprises a mass timber base panel and a concrete reinforcement assembly mounted on the timber base panel. The concrete reinforcement assembly includes a plurality of hollow bodies disposed between a first reinforcement mesh and a second reinforcement mesh. Concrete is poured onto the timber base panel and the concrete encases the concrete reinforcement assembly.

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[Continued on next page]

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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— *as to the identity of the inventor (Rule 4.17(i))*
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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— *with international search report (Art. 21(3))*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

# SEMI-PREFABRICATED TIMBER-CONCRETE COMPOSITE SLAB

## TECHNICAL FIELD

**[0001]** The present disclosure relates to a laminate concrete slab and, in particular, to a semi-prefabricated laminate concrete slab having a plurality of hollow bodies in a concrete portion thereof.

## BACKGROUND

**[0002]** United States Patent No. 5,396,747, which issued on March 14, 1995 to Breuning, discloses plane, hollow, reinforced concrete floor slabs with a two-dimensional structure and a method for their production. The technique makes it possible to choose higher strength and stiffness, less volume of materials, greater flexibility, better economy or an arbitrary combination of these gains. The technique makes it possible to create a total balance between bending forces, shear forces and stiffness (deformations) so that all design conditions can be fully optimized at the same time. The technique presents a distinct minimized construction characterized by the ability that concrete can be placed exactly where it yields maximum capacity. The technique offers material and cost savings compared with the conventional compact two-way reinforced slab structure. The technique is suitable for both *in situ* works and for prefabrication.

**[0003]** United States Patent No. 9,879,423, which issued on January 30, 2018 to Breuning, relates to the existing problem of obtaining a self-carrying biaxial homogeneous lightweight concrete slab, and discloses a system and method comprising semi-prefabricated elements and special stringer structures, designed in such a way, that the finished flat slab structure appears homogeneous and can be achieved without temporary supports during the execution.

## SUMMARY OF THE DISCLOSURE

**[0004]** There is provided a semi-prefabricated timber-concrete composite slab comprising a mass timber base panel and a concrete reinforcement assembly mounted on the timber base panel. The concrete reinforcement assembly includes a plurality of hollow bodies disposed between a first reinforcement mesh and a second reinforcement mesh. Concrete is poured onto the timber base panel and the concrete encases the concrete reinforcement assembly. The ends of the timber base panel may extend beyond the concrete reinforcement assembly. There may be one or more timber blocks extending orthogonally from each of the ends of the timber base panel. There may be a recess in each of the ends of the timber base panel. The recess may be defined by chamfered walls. There may be a plurality of transverse grooves on a surface of the timber base panel on which the concrete reinforcement assembly is mounted. There may be means to achieve shear force transfer between the timber base panel and the poured concrete, such as embedded steel plates or wires, or crossing screws. The hollow bodies may be part of a lattice of hollow bodies.

**[0005]** There is also provided a floor constructed using a semi-prefabricated timber-concrete composite slab comprising a mass timber base panel and a concrete reinforcement assembly mounted on the timber base panel. The concrete reinforcement assembly includes a plurality of hollow bodies disposed between a first reinforcement mesh and a second reinforcement mesh. Concrete is poured onto the timber base panel and the concrete encases the concrete reinforcement assembly. The ends of the timber base panel may extend beyond the concrete reinforcement assembly. There may be one or more timber blocks extending orthogonally from each of the ends of the timber base panel. There may be a recess in each of the ends of the timber base panel. The recess may be defined by chamfered walls. There may be a plurality of transverse grooves on a surface of the timber base panel on which the concrete reinforcement assembly is mounted. There may be means to achieve shear force transfer between the timber base panel and the poured concrete, such as embedded steel plates or wires, or crossing screws. The hollow bodies may be part of a lattice of hollow bodies.

**[0006]** There is further provided a building constructed using a semi-prefabricated timber-concrete composite slab comprising a mass timber base panel and a concrete reinforcement assembly mounted on the timber base panel. The concrete reinforcement assembly includes a plurality of hollow bodies disposed between a first reinforcement mesh and a second reinforcement mesh. Concrete is poured onto the timber base panel and the concrete encases the concrete reinforcement assembly. The ends of the timber base panel may extend beyond the concrete reinforcement assembly. There may be one or more timber blocks extending orthogonally from each of the ends of the timber base panel. There may be a recess in each of the ends of the timber base panel. The recess may be defined by chamfered walls. There may be a plurality of transverse grooves on a surface of the timber base panel on which the concrete reinforcement assembly is mounted. There may be means to achieve shear force transfer between the timber base panel and the poured concrete, such as embedded steel plates or wires, or crossing screws. The hollow bodies may be part of a lattice of hollow bodies.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** Figure 1 is an axonometric view of a semi-prefabricated timber-concrete composite floor slab;

**[0008]** Figure 2 is an exploded view of the semi-prefabricated timber-concrete composite floor slab of Figure 1;

**[0009]** Figure 3 is a perspective view of an array of load bearing columns and post shores to be used in the construction of a building frame;

**[0010]** Figure 4 is a perspective view showing the semi-prefabricated timber-concrete composite floor slab of Figures 1 and 2 being positioned on the array of load bearing columns and post shores of Figure 3 during the construction of the building frame;

**[0011]** Figure 5 is a perspective view showing a plurality of semi-prefabricated timber-concrete composite floor slabs similar to the semi-prefabricated timber-concrete composite floor slab of Figures 1 and 2 being positioned on the array of load bearing columns and post shores of Figure 3 during the construction of the building frame;

**[0012]** Figure 6 is a perspective view similar to Figure 5 further showing a plurality of column assemblies coupled to the load bearing columns during the construction of the building frame;

**[0013]** Figure 7 is a perspective view of a concrete reinforcement assembly used in the construction of the building frame;

**[0014]** Figure 8 is a perspective view showing the concrete reinforcement assembly of Figure 7 being positioned on the semi-prefabricated timber-concrete composite floor slabs during the construction of the building frame;

**[0015]** Figure 9 is a perspective view showing a plurality of concrete reinforcement assemblies similar to the concrete reinforcement assembly of Figure 7 being positioned on the semi-prefabricated timber-concrete composite floor slabs during the construction of the building frame;

**[0016]** Figure 10 is a perspective view showing concrete poured on the semi-prefabricated timber-concrete composite floor slabs during the construction of the building frame;

**[0017]** Figure 11 is a perspective view showing load bearing columns coupled to the column assemblies on a first floor during the construction of the building frame;

**[0018]** Figure 12 is a perspective view showing a second floor during the construction of the building frame; and

**[0019]** Figure 13 is a perspective view showing a second floor during the construction of the building frame with the post shores removed.

## DESCRIPTION OF SPECIFIC EMBODIMENTS

**[0020]** Figure 1 shows a semi-prefabricated timber-concrete composite slab which, in this example, is a floor slab 10 generally comprising a mass timber base panel 12 and a concrete reinforcement assembly 14 mounted on the timber base panel 12. The concrete reinforcement assembly 14 is mounted on the timber base panel 12 with ASSY® screws in this example. However, it will be understood by a person skilled in the art that other means may be employed to mount the concrete reinforcement assembly 14 on the timber base panel 12 in other examples.

**[0021]** The semi-prefabricated timber-concrete composite floor slab 10 is generally rectangular in this example and has a longitudinal axis 100. The timber base panel 12 has opposite end portions 16 and 18 which each extend axially beyond respective opposite ends of the concrete reinforcement assembly 14. There is a recess 20 in the end portion 16 and a recess 22 in the end portion 18. Each of the recesses is defined by chamfered walls as shown by chamfered walls 24 and 26 for the recess 20 in the end portion 16. Each of the end portions 16 and 18 is provided with a plurality of timber blocks, for example, timber blocks 28 and 30 which extend orthogonally from the end portion 16. The end portions 16 and 18 are each provided with two timber blocks in this example. However, the end portions 16 and 18 may be provided with any suitable number of timber blocks, and timber blocks may extend from wherever required on the timber base panel 12. Referring now to Figure 2, the timber base panel 12 is further provided with a plurality of transverse grooves, for example, transverse grooves 32 and 34, on a surface 36 of the timber base panel 12 upon which the concrete reinforcement assembly 14 is mounted. Alternatively, there may be embedded steel plates or wires, crossing screws or other means to achieve shear force transfer between the timber base panel and the poured concrete.

**[0022]** The concrete reinforcement assembly 14 includes a plurality of hollow bodies, for example, hollow bodies 38 and 40, retained between a first reinforcement mesh 42 and a second reinforcement mesh 44. In this example, the hollow bodies 38 and 40 are thermoplastic hollow bodies which are part of a lattice 46 of hollow bodies in which each of the hollow bodies is connected to an adjacent one of the hollow bodies by an integral connector, for example, integral connector 48 which connects hollow bodies 38 and 40. In this example, the first reinforcement mesh 42 is a plurality of criss-crossing steel reinforcement bars, for example, steel reinforcement bar 50 and steel reinforcement bar 52. It will be understood by a person skilled in the art that the second reinforcement mesh 44 is substantially identical to the first reinforcement mesh 42. The second reinforcement mesh 44 is accordingly not described in detail herein.

**[0023]** The semi-prefabricated timber-concrete composite floor slab 10 may be used in the construction of a building as shown in Figures 3 to 12. An array 51 of load bearing columns, for example, load bearing columns 54 and 56, and post shores, for example, post shores 58 and 60, is arranged in a desired formation as shown in Figure 3. The semi-prefabricated timber-concrete composite floor slab 10 is positioned on the array 51 of load bearing columns and post shores as shown in Figure 4. The load bearing columns 54 and 56 are each received in a respective one of the recesses 20 and 22 of the semi-prefabricated timber-concrete composite floor slab 10 while the post shores 58 and 60, together with other post shores, support the semi-prefabricated timber-concrete composite floor slab 10. Figure 5 shows a plurality of semi-prefabricated timber-concrete composite floor slabs, similar to the semi-prefabricated timber-concrete composite floor slab 10, being positioned on the array 51 of load bearing columns and post shores in the construction of a building frame 64. A plurality of column assemblies, for example, column assemblies 66 and 68 shown in Figure 6, are then coupled to respective ones of the load bearing columns, for example, load bearing columns 54 and 56, to allow for the construction of another level of the building frame 64 as will be discussed below.

**[0024]** Figure 7 shows a concrete reinforcement assembly 70 which is also used in the construction of the building frame 64, shown in Figures 5 and 6. Referring back to Figure

7, the concrete reinforcement assembly 70 includes a plurality of hollow bodies, for example, hollow bodies 72 and 74, retained between a first reinforcement mesh 76 and a second reinforcement mesh 78. The concrete reinforcement assembly 70 has a portion 80 without hollow bodies and an opening 82 in the portion 80. The concrete reinforcement assembly 70 is positioned on the axially outwardly extending end portions of adjacent ones of the semi-prefabricated timber-concrete composite floor slabs as shown in Figure 8. The opening 82 in the concrete reinforcement assembly 70 receives a column assembly 86. The portion 80 of the concrete reinforcement assembly 70 without hollow bodies is accordingly in a region of high shear forces.

**[0025]** Figure 9 shows a plurality of concrete reinforcement assemblies, similar to the concrete reinforcement assembly 70, shown in Figures 7 and 8, being positioned on the end portions of adjacent ones of the semi-prefabricated timber-concrete composite floor slabs. Concrete 88 is then poured onto the concrete reinforcement assemblies, as shown in Figure 10, to construct a first floor 90 of the building frame 64. The recesses in the timber base panels of the semi-prefabricated timber-concrete composite floor slabs, for example, recesses 20 and 22 in the timber base panel 12 shown in Figure 1, may allow a thicker section of concrete to be formed in that region.

**[0026]** Referring back to Figure 10, the column assemblies, for example, column assemblies 66 and 68, extend from the first floor 90 and the timber blocks of the semi-prefabricated timber-concrete composite floor slab, for example, timber blocks 28 and 30, are generally flush with the first floor 90. This allows for load bearing columns, for example, load bearing column 92, to be positioned on the first floor 90, as shown in Figure 11, to allow for additional semi-prefabricated timber-concrete composite floor slabs, for example, semi-prefabricated timber-concrete composite floor slab 94, to be supported during the construction of a second floor 96 of the building frame 64 as shown in Figure 12. The post shores are removed once the concrete is poured as shown in Figure 13. It will be understood by a person skilled in the art that this process may be repeated to construct additional floors.

**[0027]** It will also be understood by a person skilled in the art that the slab is described herein as being a floor slab but that the slab may be any slab.

**[0028]** It will further be understood by a person skilled in the art that many of the details provided above are by way of example only, and are not intended to limit the scope of the invention which is to be determined with reference to the following claims.

What is claimed is:

1. A semi-prefabricated timber-concrete composite slab comprising:

a mass timber base panel; and

a concrete reinforcement assembly mounted on the timber base panel, the concrete reinforcement assembly including a plurality of hollow bodies disposed between a first reinforcement mesh and a second reinforcement mesh, wherein when concrete is poured onto the timber base panel, the concrete encases the concrete reinforcement assembly.

2. The semi-prefabricated timber-concrete composite slab of claim 1, wherein ends of the timber base panel extend beyond the concrete reinforcement assembly.

3. The semi-prefabricated timber-concrete composite slab of claim 2, further including one or more timber blocks extending orthogonally from each of the ends of the timber base panel.

4. The semi-prefabricated timber-concrete composite slab of claim 2, further including a recess in each of the ends of the timber base panel.

5. The semi-prefabricated timber-concrete composite slab of claim 4, wherein the recess is defined by chamfered walls.

6. The semi-prefabricated timber-concrete composite slab of claim 1, further including a plurality of transverse grooves on a surface of the timber base panel on which the concrete reinforcement assembly is mounted.

7. The semi-prefabricated timber-concrete composite slab as claimed in claim 1 wherein the hollow bodies are part of a lattice of hollow bodies.

8. A floor constructed using the semi-prefabricated timber-concrete composite slab of claims 1 to 7.

9. A building constructed using the semi-prefabricated timber-concrete composite slab of claims 1 to 7.

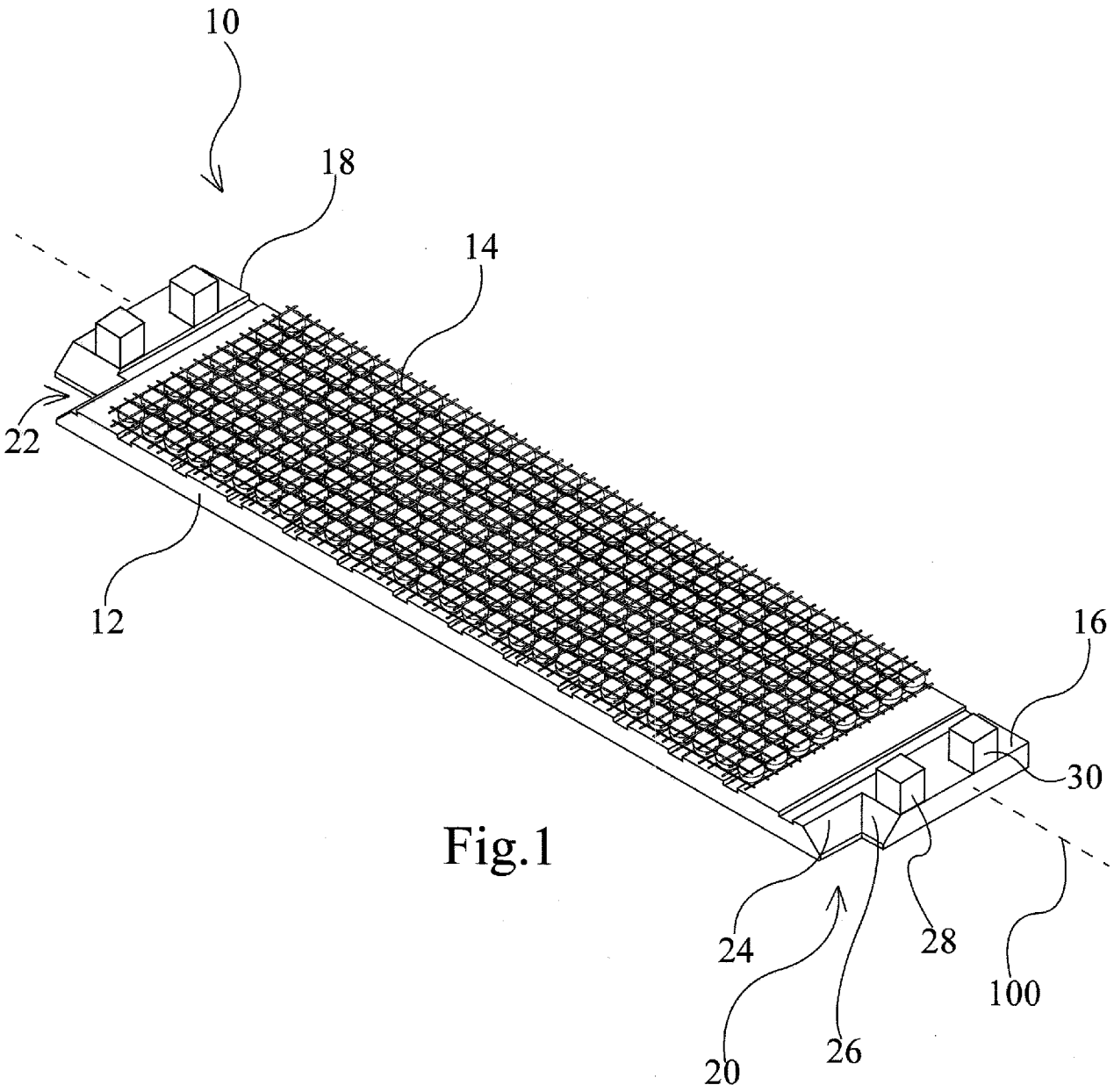


Fig.1

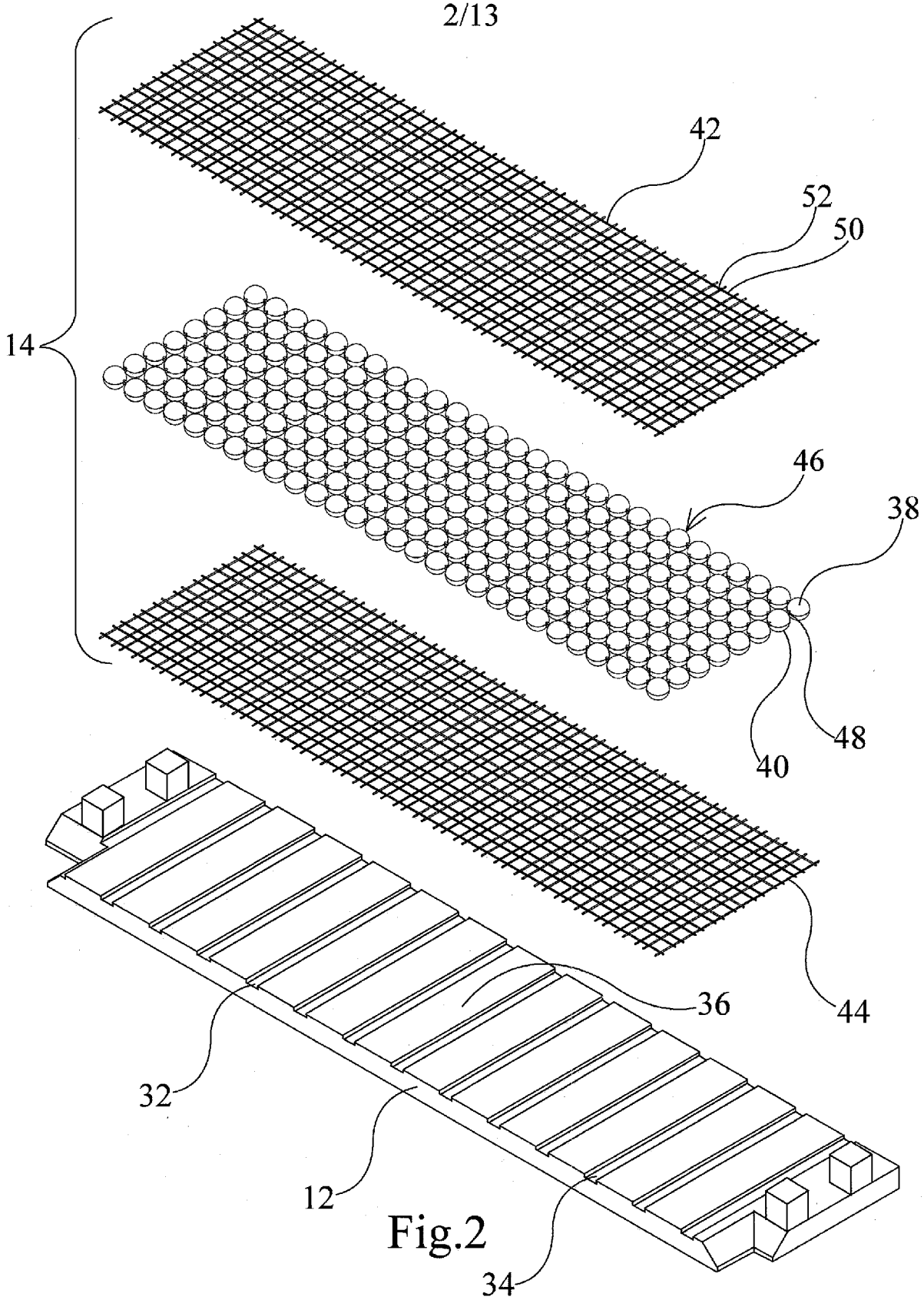


Fig.2

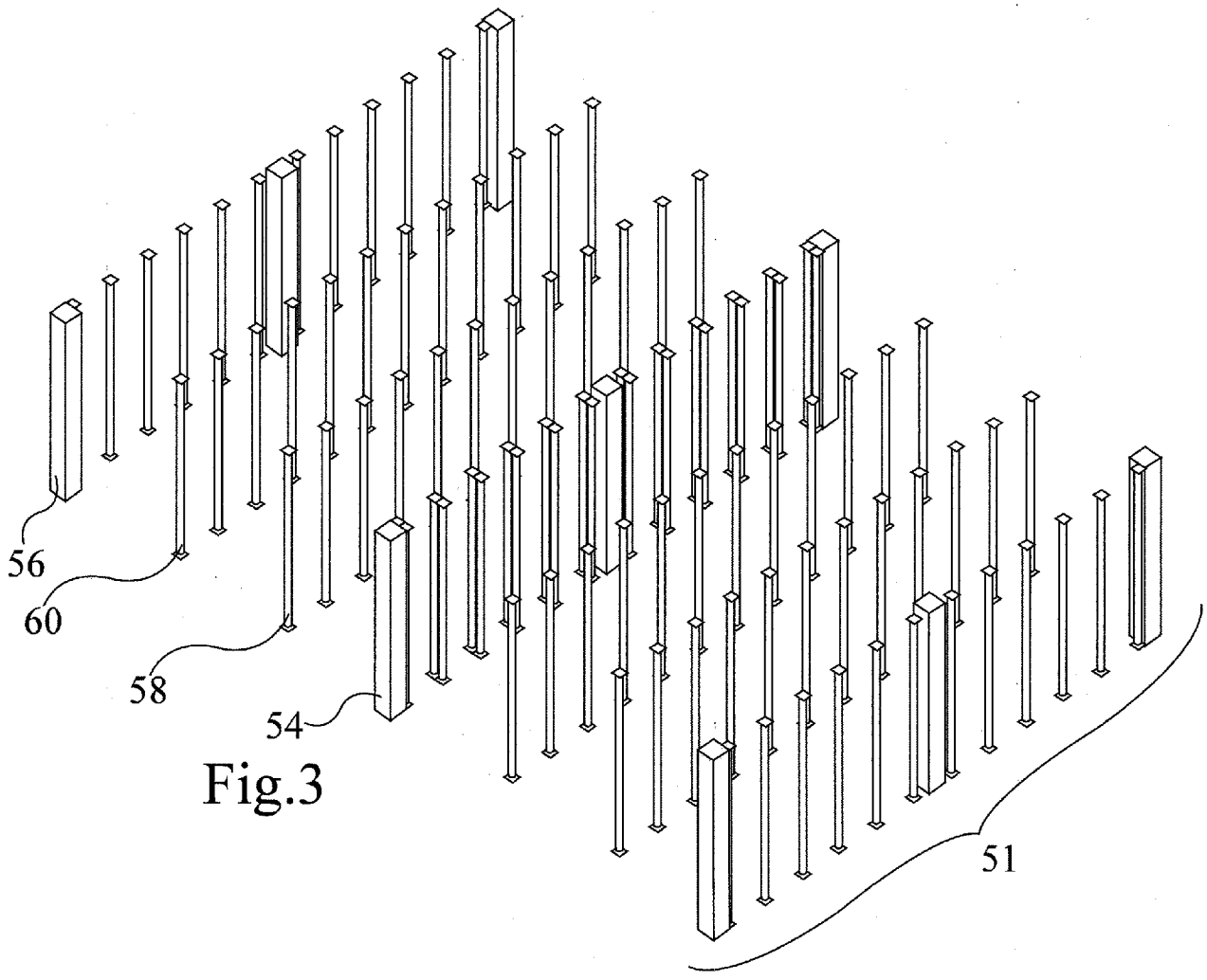


Fig.3

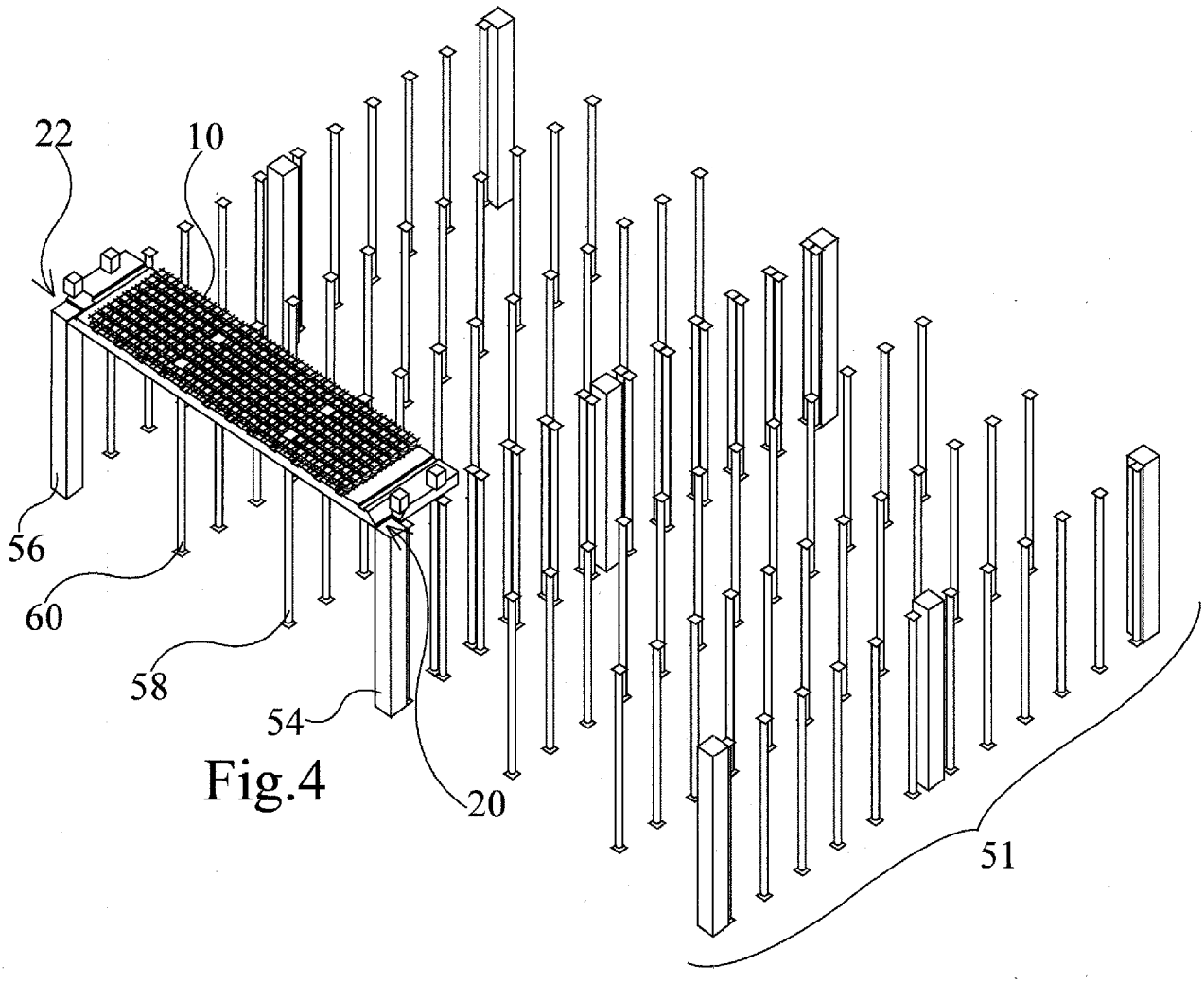


Fig.4

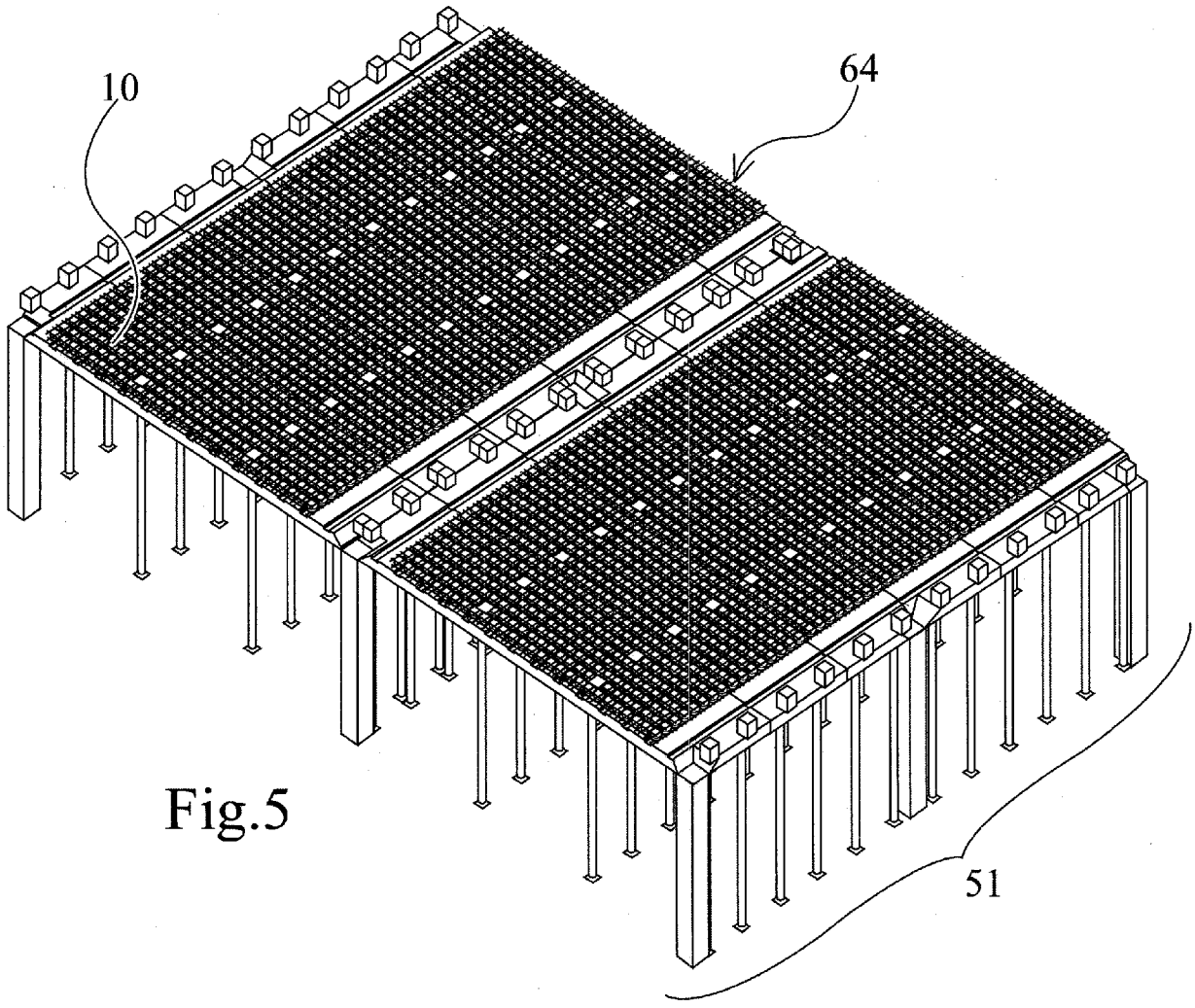


Fig.5

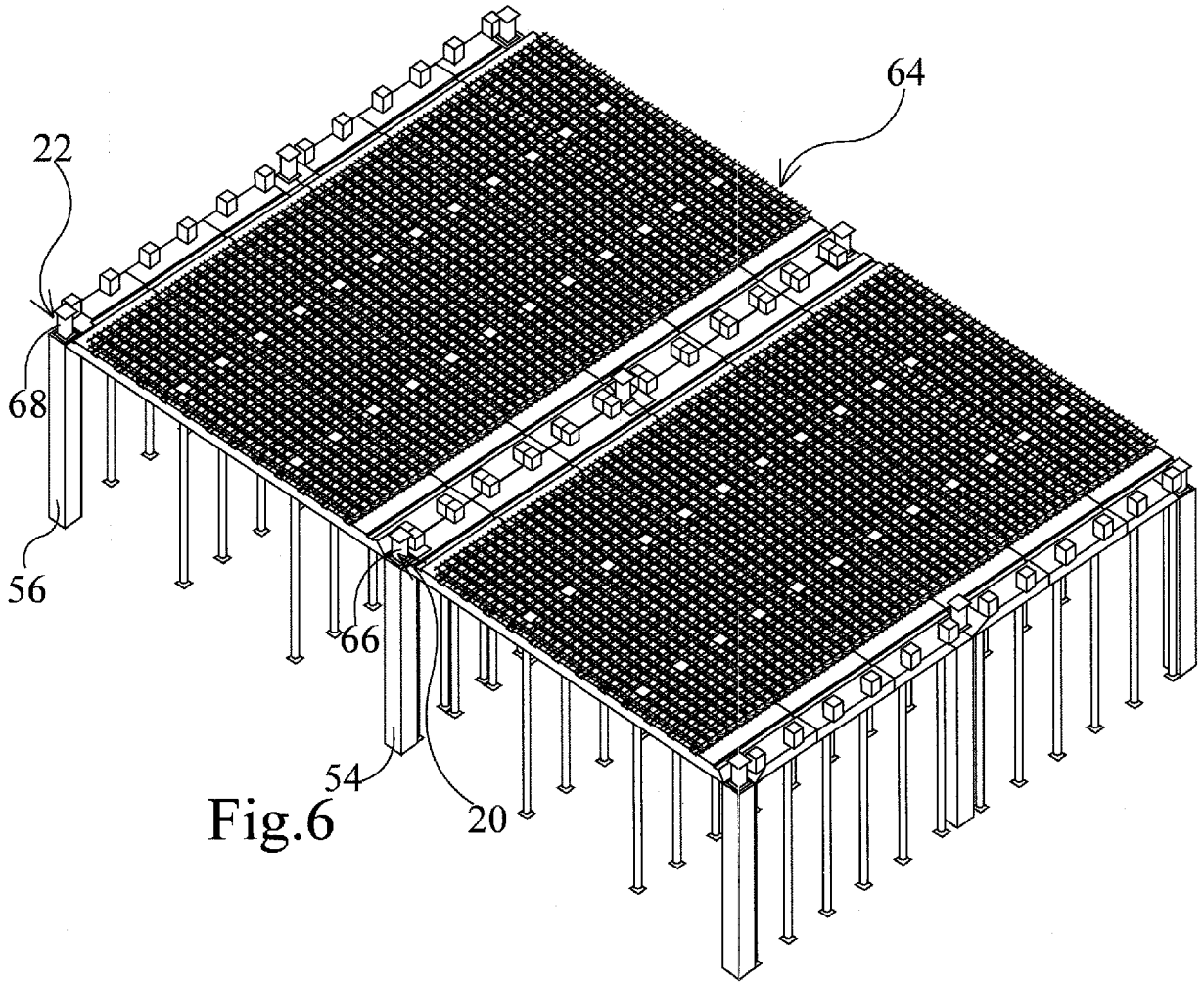


Fig.6

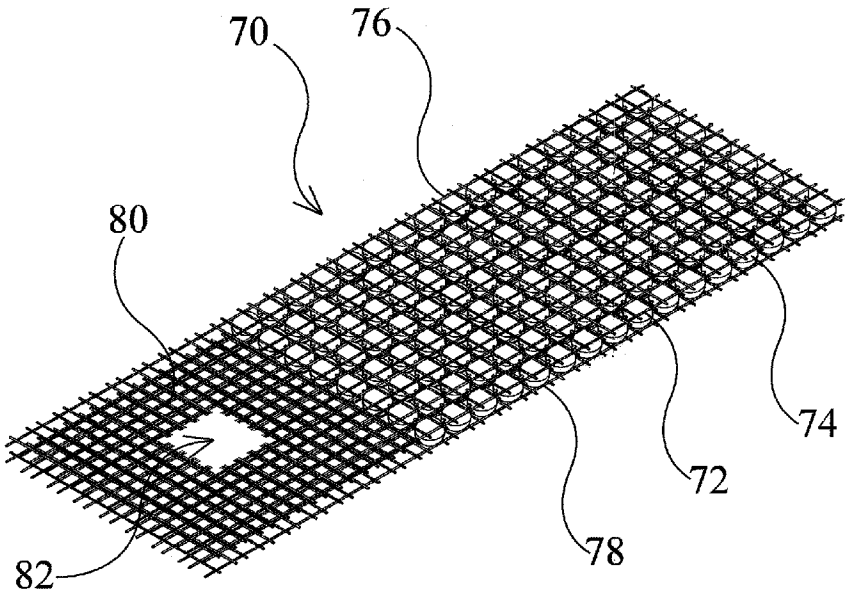


Fig.7

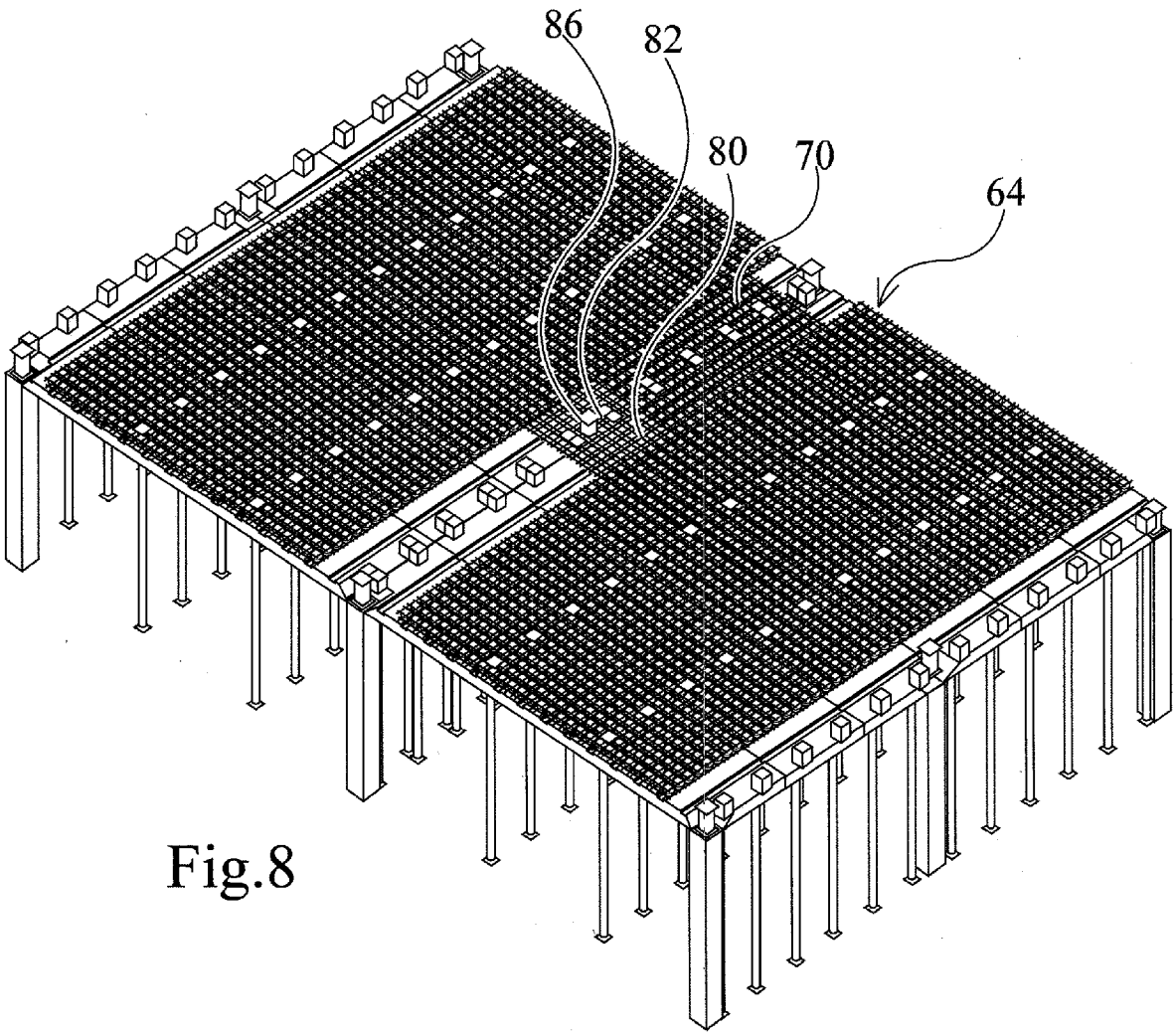


Fig.8

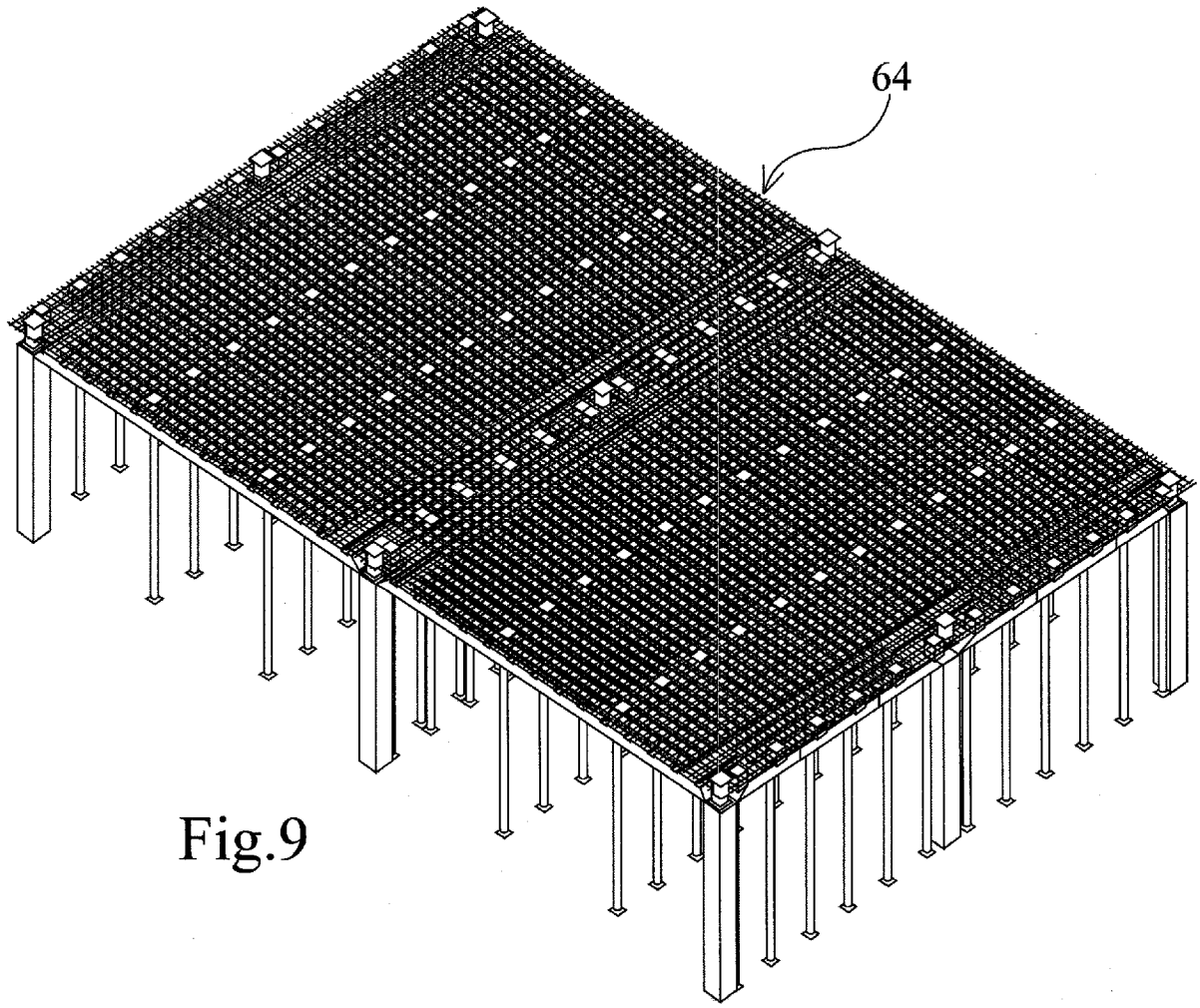


Fig.9

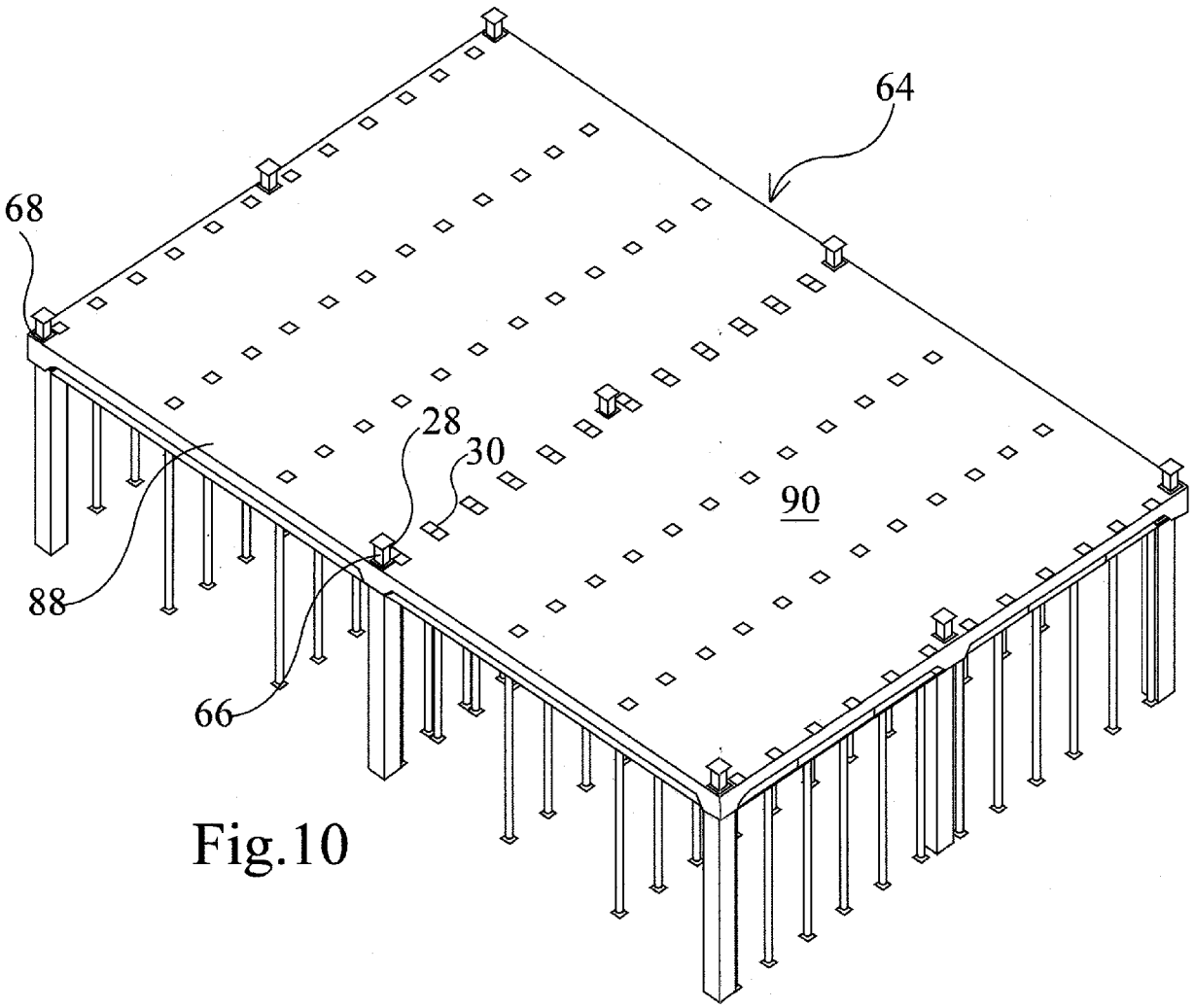


Fig.10

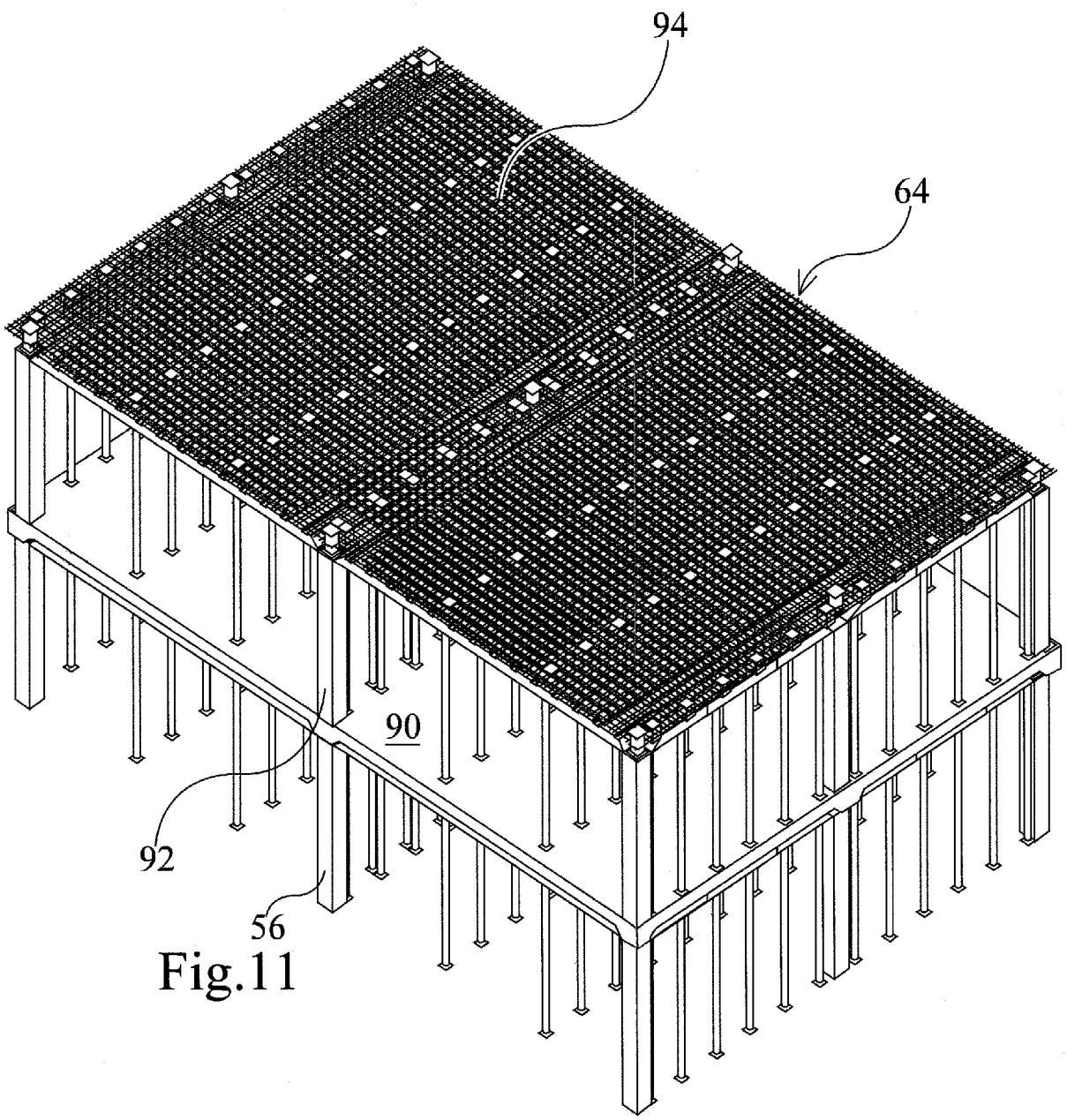


Fig.11

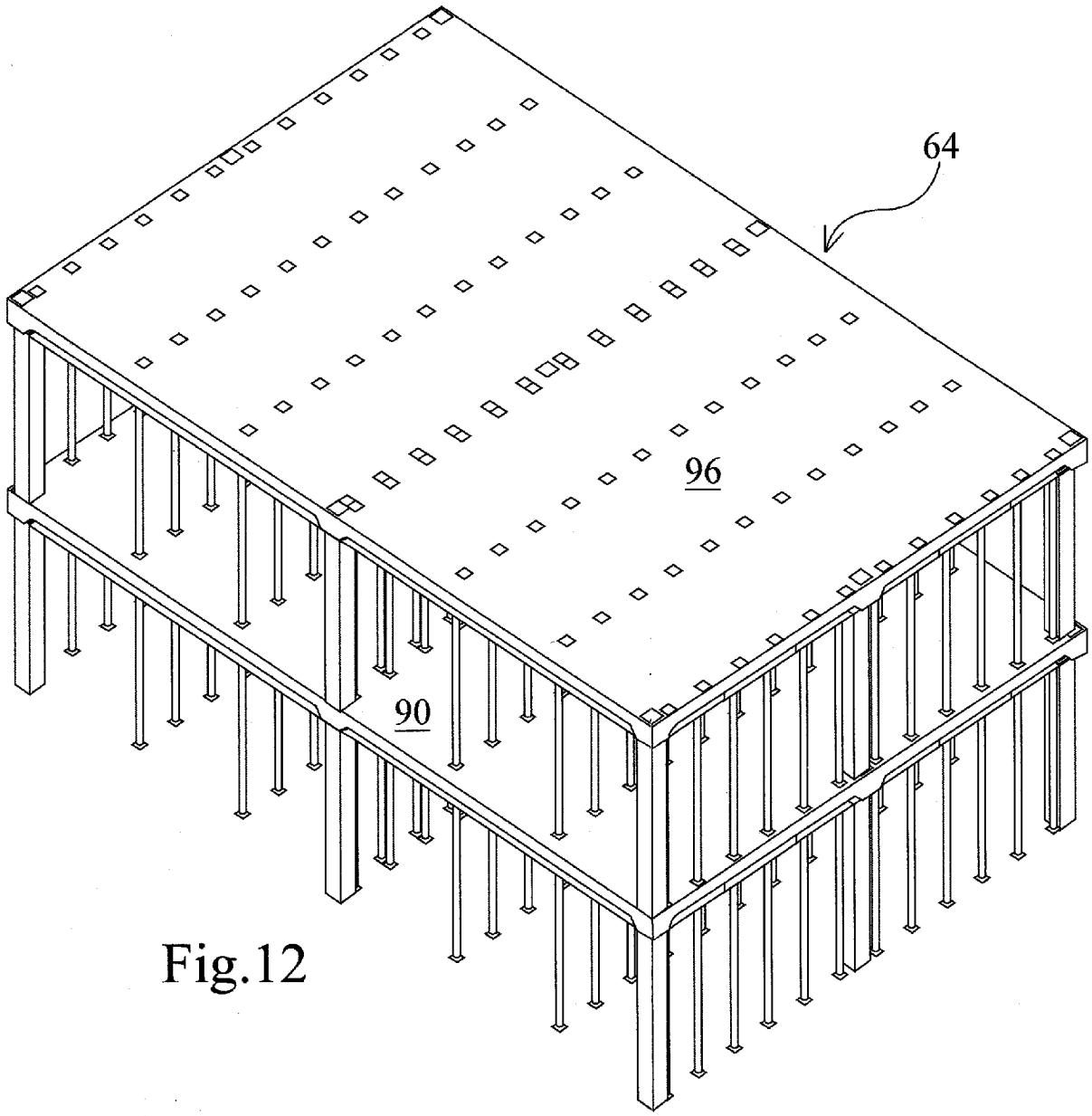


Fig.12

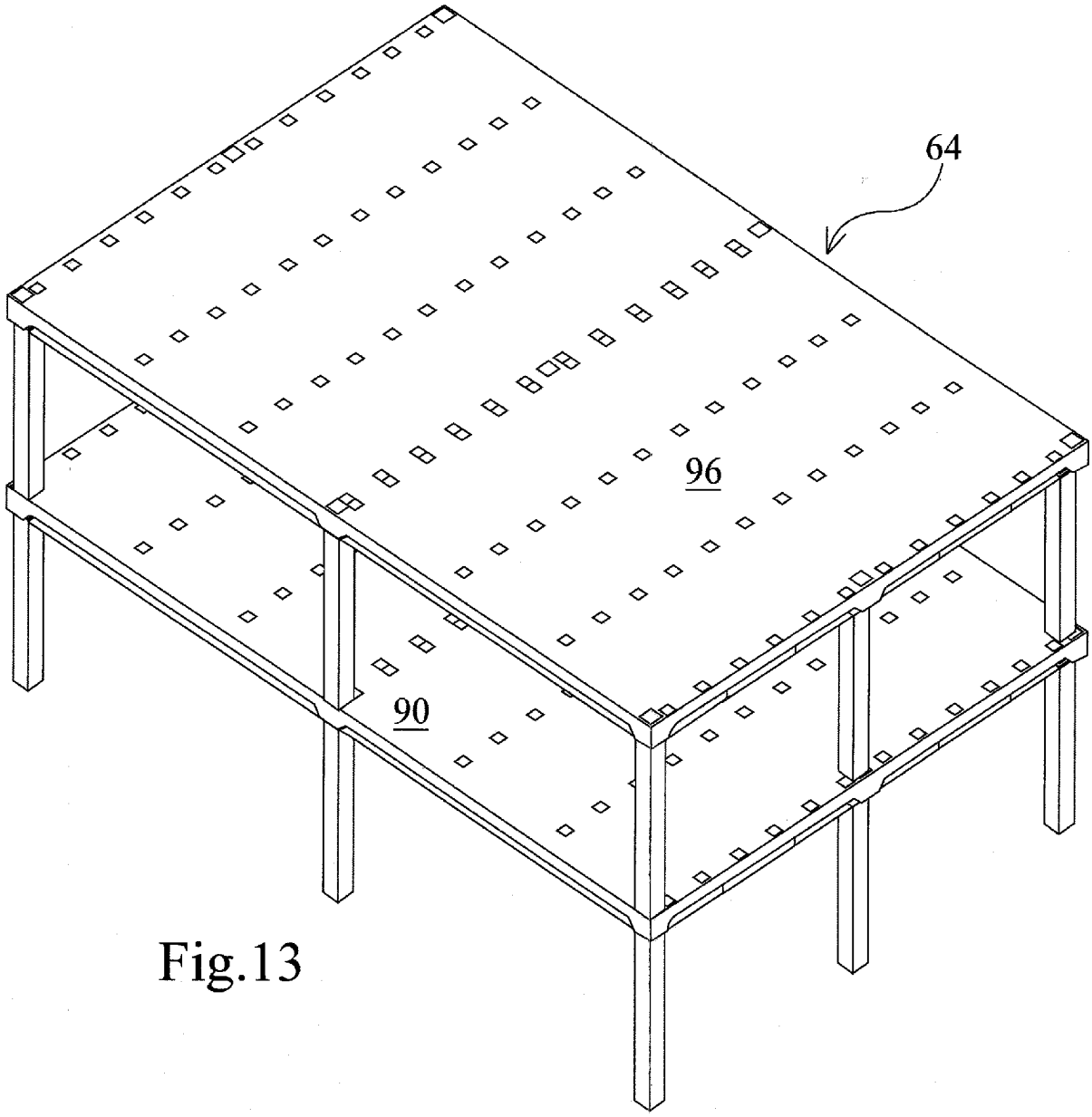


Fig.13

**INTERNATIONAL SEARCH REPORT**

International application No.
**PCT/CA2019/051730**

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***E04C 2/26*** (2006.01) , ***E04B 5/04*** (2006.01) , ***E04B 5/32*** (2006.01) , ***E04C 2/04*** (2006.01) , ***E04C 2/06*** (2006.01)

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)
IPC (2006.01): E04C 2/26, E04B 5/04, E04B 5/32, E04C 2/04, E04C 2/06

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Questel
Keywords: slab, panel, wood, timber, concrete, cross, laminated, floor, semi-prefabricated

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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☐ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

| | |
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Date of the actual completion of the international search
20 March 2020 (20-03-2020)

Date of mailing of the international search report
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**INTERNATIONAL SEARCH REPORT**
Information on patent family members

International application No.
**PCT/CA2019/051730**

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