



(51) International Patent Classification:

E04B 1/348 (2006.01)

(21) International Application Number:

PCT/IB2023/052177

(22) International Filing Date:

08 March 2023 (08.03.2023)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE,

(54) Title: PRECAST CONCRETE BOX (CELLULAR) SEGMENTS WITH THE POTENTIAL TO CONSTRUCT EARTH-QUAKE-RESISTANT BUILDING STRUCTURES AND OPTIMIZE THEIR ENERGY USAGE EFFICIENCY

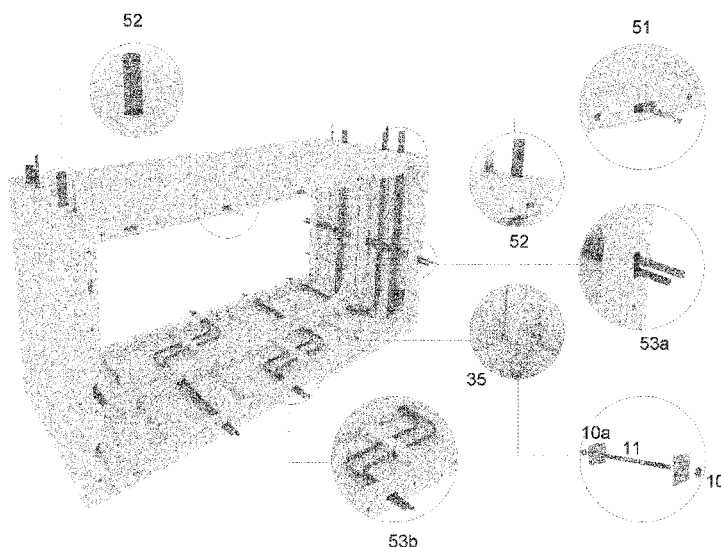


Fig 16

(57) Abstract: This system consists of two elements: the precast concrete foundations and the precast concrete segments connected by bolts and nuts and finally placed on the foundation. Generally, this system is innovative when viewed from three areas. The first area of innovation concerns its design and geometric form, while the second area concerns its impact on construction management procedure. Indeed, besides the ease of storage, transportation, and installation of the elements, their factory-made production can improve both the speed and quality of construction. The third area corresponds to its enhanced safety against seismic loads and more contribution to energy saving during the lifetime, which are the consequences of some features such as box-like structure system, shell-based design, reduced structure weight and dead loads, and built of high performance and durable concrete.



KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
 - *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*
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Description

Title of Invention :

[0001] Precast concrete box (cellular) segments with the potential to construct earthquake-resistant building structures and optimize their energy usage efficiency

Technical Field

[0002] The technical field of this invention relates to construction industry, particularly the precast concrete buildings. In addition to utilizing high performance concrete during the manufacturing process, the design and calculations of this invention have been carried out so that it be a stable structure, capable of optimizing energy usage efficiency. These features altogether can provide comfort, tranquility, safety, and health for the inhabitants, while easing inspection and maintenance of the utilities.

Background Art

[0003] A patent with the number WO/2020/056276 and the title FRAGMENT, OVERPRESSURE, RADIATION, AND TOXIC-RESISTANT EMERGENCY SAFETY SHELTER has been filed in the patent cooperation treaty, which discloses precast concrete segments that have four closed sides and two open ones. In above-mentioned invention, the designed foundation is uniformly placed under the floor of the structure.

[0004] The precast segments lack a place for the passage of utilities and the installation of thermal and sound insulators on all sides of each segment. According to the proposed figures, both walls of the roof and floor in each segment have a flat cross-section. All the above-mentioned features are different from those claimed in this invention.

Technical Problem

[0005] The construction of cast-in-situ concrete structure, in which concrete is produced in the field and formworks are in-situ installed, causes the damage to formworks, the occurrence of human errors, the usage of extensive manpower, and too much waste. In this regard, further issues have been indicated as follows:

[0006] - Regarding construction in urban areas, due to congestion and traffic, it is not easy to transport materials to the construction site.

[0007] - In rural areas, because of the distant location of the construction sites and unsuitability of the rural transportation roads, transportation of materials to the construction site is too expensive.

[0008] - The rate of construction is slow in the conventional methods.

[0009] - In the conventional construction system, owing to the absence of integrated and professional supervision, in addition to being cast-in-situ, hand-made concrete with normal strength (often less than grade C30) is usually used.

[0010] - The energy loss of conventional structures is substantial as a result of not insulating walls and floors.

[0011] - Fast and high-quality construction of this building system in accordance with the relevant standards makes construction cost-effective and leads to a reduction in the materials and manpower wastage compared to conventional construction.

Other aims of this invention are as follows:

[0012] - Increasing the efficiency and rate of construction in comparison to conventional urban and rural construction;

[0013] - Reducing the construction-induced noise pollution or disturbances that cause annoyance of neighborhood;

[0014] - Providing the usage of plant-made concrete, which is quality-controlled in terms of workability, strength, and durability;

[0015] - Optimum utilization of maximum materials bearing capacity and sections geometry;

[0016] - The landscape aesthetic;

[0017] - Flexibility in design and geometric dimensions;

[0018] - Well-organizing the appropriate pass of electrical and mechanical utilities (installations) through the contrived sidewalls;

[0019] - Ensuring structural stability on the basis of sections modification and lightweight construction approaches;

[0020] - Considering the integrated shell of this design, it is not possible for insects and rodents to enter the structure, thus improving health indicators;

[0021] - This system makes it feasible to suitably use of insulators between the outer and inner walls, hence, it also saves energy;

[0022] - This structure is earthquake-resistant;

[0023] - Given the integrated concrete shell of this structure, it has a higher reliability and safety factor.

Solution to Problem

[0024] This invention is a durable concrete building system that was invented to expedite the construction process and improve the quality of precast concrete structures. This system includes precast concrete foundations and segments connected to each other with bolts and nuts connections.

[0025] This system can be regarded as innovative when viewed from the two general scopes as follows: The first scope is related to construction management, in which due to the plant-made production of segments and their connection to each other with bolts and nuts, the rate of installation and construction will be increased to a much greater extent.

[0026] The second scope of this system innovation stems from its production with high-strength and durable concrete, as well as shell-based design, which lead to a lower structure weight and consequently lower absorption of earthquake energy according to the following equation: $V = CW$, where V denotes the seismic base shear force, C is the seismic base shear coefficient and W is the weight of the building.

[0027] On the other side, U-shaped cross-section concrete elements, because of having a higher moment of inertia, bear and distribute all exerted loads, which increases the geometric stability of the system in terms of resistance against gravity and seismic loads. In this design, all the walls of each segment are designed so to have a U-shaped cross-section. On the other hand, the same U-shaped cross-section allows the pass of utility pipes between the two shells and the installation of thermal and sound insulators between the two walls,

consequently leading to less energy consumption and better accessibility to the utilities and installations.

[0028] Constructing this system requires a foundation in separate segments that their location follows the architectural plans. The main segments can be installed in any required plans; subsequently almost all architectural spaces are achievable.

[0029] In other words, in the structure of this building, the roof, the floor, and the walls on both sides are built integrally and simultaneously with high-strength concrete in the shape of a concrete segment (Figure 1a).

[0030] Once produced, these segments are placed next to each other with a crane (Figure 1d) and connected to each other by high-strength bolts and nuts (Figure 2, No. 10) or double-end threaded bolts (Figure 2, No. 11 and 12) in the place of the contrived holes in the ties (beams) around the segment (Figure 2, No. 8). In this way, the segments are placed adjacent to each other and all the holes are connected with screws and metal gaskets, thereby forming architectural spaces (Figure 3, No. 13).

[0031] Accordingly, this system has the potential to longitudinally expand and in particular cases, it is possible to create a wide variety of architectural spaces (Figure 4, No 15).

[0032] A foundation is essential to provide the stability of the structure against gravity and lateral loads (Figure 7, No. 54). The main segments (Figure 5, No. 17) must be placed on isolated foundations (Figure 5, No. 18a). The segment is connected to the foundation by a pair of steel bolts (Figure5, No. 18b), extending from foundation through the segment's floor, plus a plate on each bolt (Figure5, No. 18d). Afterward, in-situ concrete is poured into the contrived sheath, then the screws are tightened to ensure the suitable connection (Figure5, No. 18c).

[0033] The separated foundations built of precast concrete, are placed on lean concrete below the main segments based on a specific pattern derived from architectural and structural drawings. (Figure 6, No. 20 and Figure 7, No. 54).

[0034] It is possible for this system to have more than one story, for which a special roofless segment is manufactured (Figure 8, No. 29). The staircase (Figure 8, No. 30) is also embedded inside this segment (Figure 8, No. 31).

[0035] Subsequently, on the next story, a segment (Figure 9, No. 32) is placed on this staircase and this way the staircase construction procedure is completed (Figure 8, No. 31b). Then, the other segments of the second story are placed on the first story segments (Figure 9, No. 32) and connected to each other by bolt and nut through the relevant holes (Figure 9, No. 33).

[0036] At this stage, the upper story segments (Figure 10, No. 35b) of the structure are placed on the lower ones (Figure 10, No. 35c) (Figure 10, No. 34) and constructed according to the drawing. Next, the upper and lower segments are screwed to each other using bolt and nut (double-end threaded bolt) (Figure 10, No. 35d) passing through the corresponding hole (Figure 1, No. 1b and No. 1c).

[0037] Additionally, this system has the potential to be expanded in the transverse direction (Figure 3, No. 14). The segments can be placed with an end-to-end orientation, so their concrete walls be adjacent to each other (Figure 10, No. 35e), while being connected to each other with bolts and nuts (Figure 10, No. 35a) passing through contrived holes. Additionally, this system has the potential to be expanded in the transverse direction (Figure 3, No. 14). The segments can be placed with an end-to-end orientation, so their concrete walls be adjacent to each other (Figure 10, No. 35e), while being connected with bolts and nuts (Figure 10, No. 35a) passing through contrived holes.

[0038] At this stage, all pipes of electrical and mechanical utilities are passed through the circular or bean-shaped holes in the edge beam of the segment on the floor, ceiling, or wall (Figure 11, No. 36 and 37) and are screwed on concrete with metal fasteners or nails (Figure 11, No. 38). The pipes corresponding to electrical utilities are passed through the upper holes of the segment, on its ceiling (Figure 16, No. 51).

[0039] Next, all the sewage and rainwater pipes are installed in the contrived locations (Figure 12, No. 40 and 41) and (Figure 16, No. 52). Also, hot and cold water pipes in addition to radiator pipes (Figure 16, No. 53a and 53b) are passed through the relevant holes. After Completing all piping procedures beneath the ceiling and walls, the thermal insulations are glued on the wall, floor, and ceiling (Figure 12, No. 42 and Figure 15, No. 49b) and then they are covered with sheet rock (Figure 13, No. 43). After completion of floor piping, the flooring process is

done by means of precast concrete tiles (Figure 13, No. 44), while the cement grout is poured in between them to ensure fixation. Following piping and their covering, other architectural operations are carried out considering the demands and orders of the customers. Eventually, the spaces between all precast concrete segments are filled with special sealant and segments are tuck-pointed (Figure 13, No. 45 and Figure 14, No 47). Subsequently, the building is ready to be painted from the exposed surface (Figure 14, No. 48).

Advantageous Effects of Invention

[0040] The construction of cast-in-situ concrete structure, given the concrete manufacturing in the field and in-situ installing of formworks, causes the damage to formworks, the usage of extensive manpower, and too much waste. However, in this invention, due to the production of formworks for segments and foundations and their availability and reusability, the construction will be cost-effective. Meanwhile, with frequently producing the typical segments and foundations, the workers will be gradually skillful and experienced in manufacturing process. Other advantages of this invention are listed below:

[0041] 1- In urban construction sites, because of congestion and traffic, it is difficult to transport materials to the construction site. However, the construction of this system is element-based, in which immediately after preparing the elements of a structure, all of them are carried to the construction site at once and then installed. This feature can be effective in reduction of the construction-induced traffic and transportation.

[0042] 2- In rural areas, because of the distant location of the construction sites and unsuitability of the rural transportation roads, it is very expensive to transport the materials to the construction site. However, in this method, frequent transportation is avoided as the whole structure elements are transported together at once.

[0043] 3- Considering the minimal need to construction operations with this system, those works having noise pollution are minimized in the field. Actually, with installation of the segments that is usually without noise pollution, the

construction process ends as short as possible, thereby minimizing the annoyance of the construction site neighbors.

[0044] 4- This structure can be erected in a very short time, for example, a two-story building with 120 square meter of area can be erected in less than a day and inhabited in less than two weeks (in particular cases less than 3 days). However, in the traditional cast-in-situ concrete system, completing the just structure of a concrete building takes at least one month or more.

[0045] 5- In the traditional system, due to the lack of integrated and intensive supervision, as well as being cast-in-situ, ready-mixed concrete with normal strengths (usually grade C30 or C35) is used; whereas, in this method, the production of concrete with grades of C40 or C50 is easily achievable.

[0046] 6- With this method, owing to the use of plant-made concrete, the maximal use of the physical features of concrete such as strength and durability is possible. Accordingly, the appropriate sections and geometries can be employed so that the maximum second moment of area (moment of inertia) be obtained. However, in the conventional method, designer should consider the safety factors and uncertainties corresponding to the cast-in-situ construction.

[0047] 7- In this invention, owing to using the precast metal formworks, the concrete surface is very polished, which can even be considered as a finished surface. In some cases, by applying appropriate color additives, almost all demands of designers and customers can be satisfied. However, in cast-in-situ structure, there are some imperfections such as concrete dripping, porous and grubby concrete, and concrete leakage from formworks, making the concrete surface rough, which is impossible or expensive to be modified.

[0048] 8- As this system is designed and manufactured in a modular form based on a certain geometric rationale, it can meet the demands of the designers for a modular design in all three longitudinal, transversal, and altitudinal directions.

[0049] 9- Considering the double-wall shells of this system, the empty space between them can serve as a conduit for passing of utility pipes. This is a great advantage of this system for the sake of inspection and repair of the electrical and mechanical utilities with minimum expense and destruction.

[0050] 10- Because of utilizing excellent structural materials (concrete and steel) with minimal dimensions, the structural dead loads of this system have been reduced as much as possible. Furthermore, considering the technique adopted for passing of utility pipes, it also has the minimum non-structural dead loads. Such properties are almost absent in cast-in-situ structures built with traditional technology and method.

[0051] 11- Due to the integrity of the structural system in this building, the entrance of insects and vermin into this structure will be impossible.

[0052] 12- Since this structure is double-walled, it can easily be insulated to prevent the loss of energy from the building, thus leading to at least 60 to 80 percent saving in energy consumption of this system compared to conventional structures.

[0053] 13- Given that this structure is designed as seismic-resistant, therefore it will be completely safe against the earthquake loads. Whereas, in cast-in-situ structures, due to the presence of non-structural elements that sometimes fall or slip, provided that the main structure be stable during earthquake, some special details must be designed and implemented to inhibit such situation.

[0054] 14- Considering the fact that the outer surface of this structure is built of reinforced concrete, it has a greater security indicator than those conventional buildings constructed with bricks and masonry materials.

Brief Description of Drawings

[0055] Figure 1- Schematic of segments

[0056] 1- Holes for connecting two segments in the transverse and end-to-end direction

[0057] 1a- Representation of the main segment

[0058] 1c- Holes for connecting the upper floor to the lower one

[0059] 1d- Representation of the connection of two main segments next to each other

[0060] 3-Bean-shaped holes for the pass of utility pipes

- [0061] 4- Holes embedded for the pass of mechanical utility pipes, including sewage and rainwater pipes, to the outside of the structure or vice versa
- [0062] 5- The concrete struts to reduce the thickness of the concrete shell around the segment
- [0063] 6 and 1b- Holes for connecting the lower floor to the upper floor
- [0064] 7- Holes for connecting two segments in the longitudinal direction
- [0065] Figure 2 - location and type of connections
- [0066] 8- Holes embedded in beams with diameter ranged from 20 to 24 mm
- [0067] 9- M16 or M18 screw
- [0068] 10-Nut
- [0069] 10a – Metal gasket
- [0070] 11- Double-end threaded bolt
- [0071] 12- The location of double-end threaded bolt
- [0072] Figure 3 - Connected segments
- [0073] 13- Segments connected in the longitude direction
- [0074] 14- Segments connected in the transverse direction
- [0075] Figure 4 - 3-D views of various architectural plans
- [0076] 15- Examples of some particular architectural forms with this system
- [0077] Figure 5 - The details of segment-foundation connection
- [0078] 17- The segment connection to the foundation
- [0079] 18a- The location of segment's connection to the foundation
- [0080] 18b- bolt for connecting the foundation to the segment
- [0081] 18c- The segment-foundation connection by bolts and cast-in-situ concrete
- [0082] 18d – The plate of segment-foundation bolt connection
- [0083] Figure 6 - 3-D view of the isolated foundation
- [0084] 20- Isolated foundation

[0085] Figure 7 - Foundation plan

[0086] 54- Isolated foundation placement plan

[0087] 55- Peripheral ties of segments that act as strip connector of the isolated foundations

[0088] Figure 8 – Roofless segment

[0089] 29- Roofless segment

[0090] 30- Stairs

[0091] 31- The cross-section of the stairs between floors

[0092] 31b – Schematic of placement of the roofless and floorless segments and stairs

[0093] Figure 9 – Floorless segment

[0094] 32- Floorless segment

[0095] 33- Junction of roofless and floorless segments

[0096] Figure 10 – Schematic of segments' connections

[0097] 34- Placement of two floors on top of each other

[0098] 35e- Connection of the upper floor to the lower one

[0099] 35- Installation of segments with an end-to-end orientation to extend the width of the building

[0100] 35b- Upper floor segment

[0101] 35c- Lower floor segments

[0102] 35d- Schematic of the bolts and nuts for connecting the upper floor to the lower one

[0103] 35a – Schematic of the bolts and nuts for connecting two segments in an end-to-end direction

[0104] Figure 11 – Location of the installations

[0105] 36- Built-in holes for water or electrical utility installations

[0106] 37- Built-in holes for water or electrical utility installations

- [0107] 38- Nails or screws and wall anchor for screwing installations on concrete
- [0108] 39- Utilities pipe as an example
- [0109] Figure 12 - Location of contrived holes in segments
- [0110] 40- Built-in holes for rainwater pipes
- [0111] 41- Built-in holes for sewer pipes
- [0112] 42- Placement of thermal insulation
- [0113] Figure 13- Finishing
- [0114] 43- Sheetrock (drywall) to cover the roof and walls
- [0115] 44- Precast concrete tiles for flooring process
- [0116] 45- Sealant paste for sealing segments
- [0117] Figure 14 - Sealing
- [0118] 47- Sealant paste in the spaces between the segments
- [0119] 48- The building is ready to be painted
- [0120] Figure 15- U-shaped cross-section
- [0121] 49- U-shaped cross-section of each segment
- [0122] 56- Sheet rock or cement panel
- [0123] 49b- Thermal insulators
- [0124] Figure 16:
- [0125] 51 - The position of the bean-shaped hole on segment's roof for the conduit of electrical utilities
- [0126] 52- Circular hole for accommodating sewage and rainwater-collecting pipes
- [0127] 53a - The position of the bean-shaped hole on the segment's wall for accommodating heating or cooling pipes
- [0128] 53b- The position of the bean-shaped hole on the segment's floor for passing of hot or cold water supply pipes

Examples

[0129] In this method, because of employing various transportation and installation equipment such as carriers, trailers, and huge cranes, it is necessary to ensure that the neighborhood of the construction site does not make any disturbance to the installation process. Therefore, it is reasonable to use this method of construction in the suburb or garden sites.

[0130] The factory-made precast segments, after gaining the minimum strength for transportation that is generally 60% of characteristic strength (with a 12-hour streaming system), are ready for transportation and installation in the field.

Industrial Applicability

[0131] One of the applications of this invention is the construction of one- and two-story buildings in rural areas or villas in the garden sites. On the other side, this invention can be used in commercial and office buildings, light storage warehouses, medical, sanitary, and military buildings, as well as office buildings on construction and industrial sites. Also, the transportation and quick installation capabilities of this system make it feasible for temporary accommodation or even permanent housing of disaster victims.

Claims

- [Claim 1] Precast concrete segments with four faces in a cube-like shape (figure 1), in which the cross-section of each face is U-shaped (figure 15) comprising:
- Multiple rows of longitudinal reinforcements on the edges of the segment that are tied together (figure 15);
 - Connection of the edge reinforcements of the segment to each other along the segment's length (figure 1, No. 5) and the location of the segments' connections (figure 10, No. 35 and 35e);
 - Connection of the segments to each other through the multi-row reinforcements (figure 10, No. 35 and 35e);
 - Precast foundation segments (figure 6);
- in which the multiple rows of tied reinforcement used at the edges of each segment make the cross-section of segment's faces be U-shaped, the segment's edges are connected with each other through transverse tied reinforcements at regular intervals along the segment's length and the connection of the segments with each other is made by bolts and nuts and contrived holes in the edges.
- [Claim 2] Precast concrete segments which according to claim 1, If it is required to construct a 2-story building, the upper face of the precast concrete segment is removed (figure 8, No. 29), and a floorless segment (figure 8, No. 31b) is installed on top of that using bolt and nut (figure 9, No.33) and the connection holes (figure 1, No. 1c and 1b) and the accessibility to the second story is provided by the staircase (figure 8, No. 31).
- [Claim 3] After placing the precast concrete segments, on the precast concrete foundation, the contrived bolt (figure 5, No.18b) is passed through the relevant connection hole (figure 1, No. 2), which is subsequently filled with cast-in-situ concrete (figure 5, No. 18c) then a metal plate, on which the location of the bolts has been punched, is mounted on the hole and the nuts are screwed.

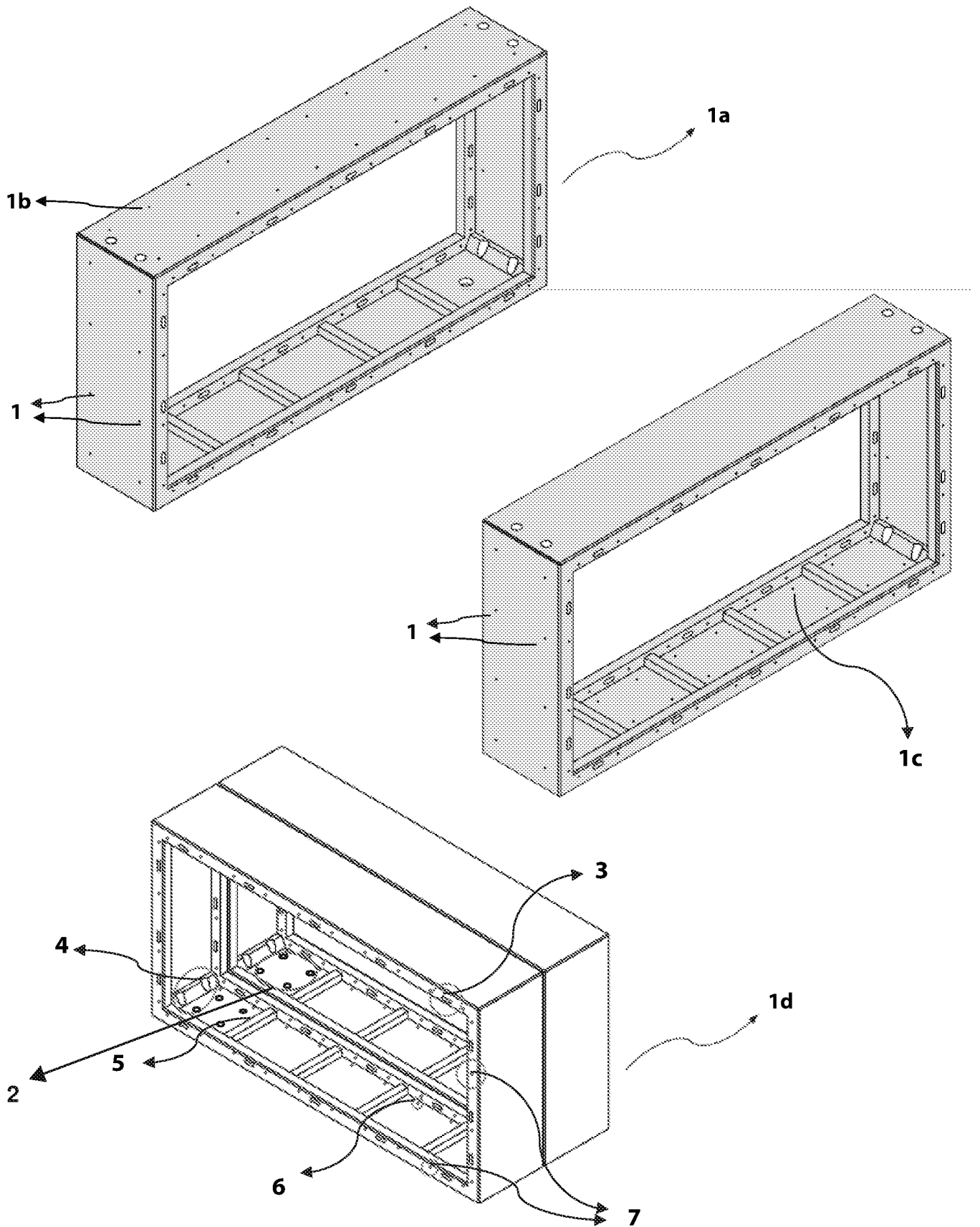


Fig 1

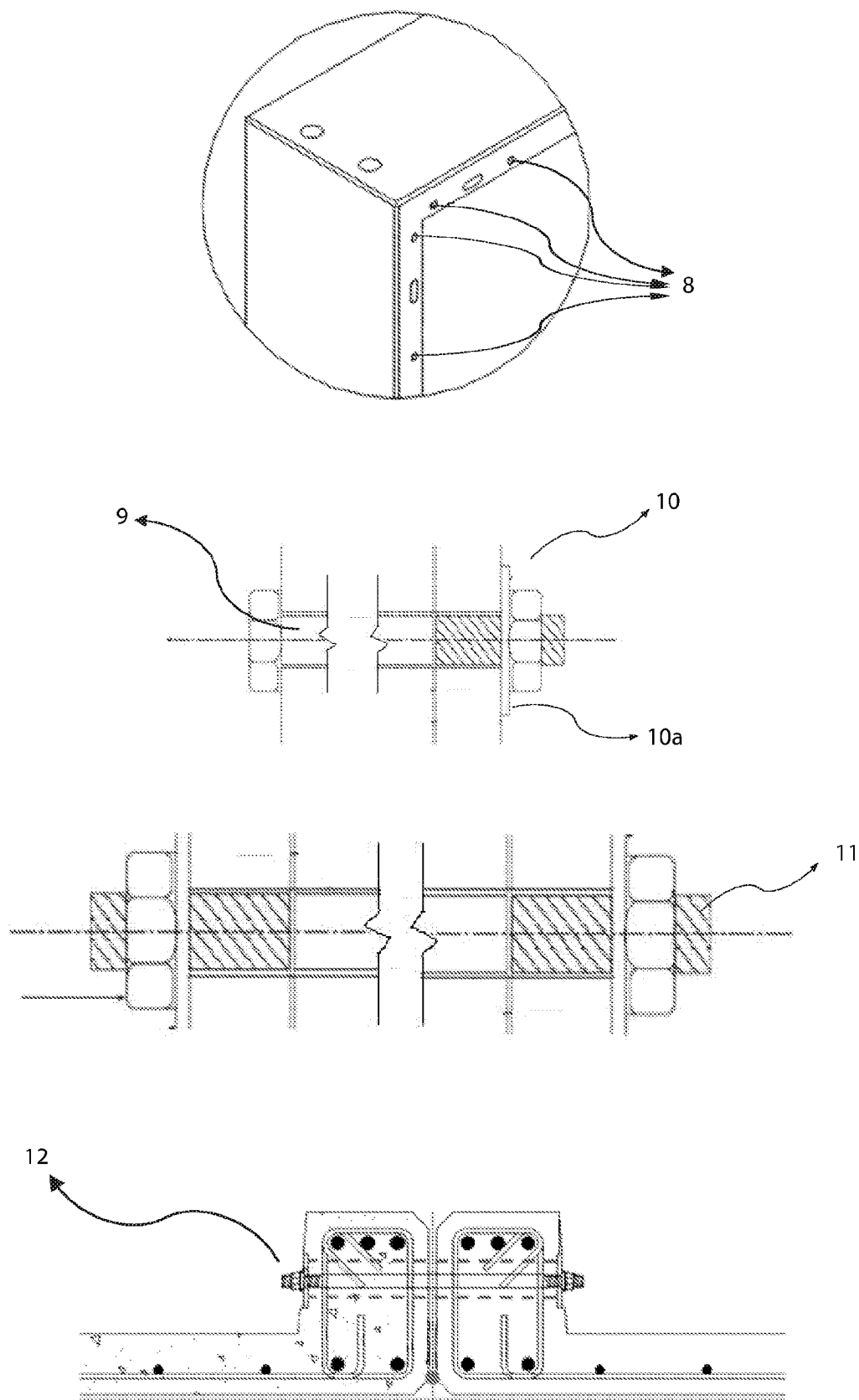


Fig 2

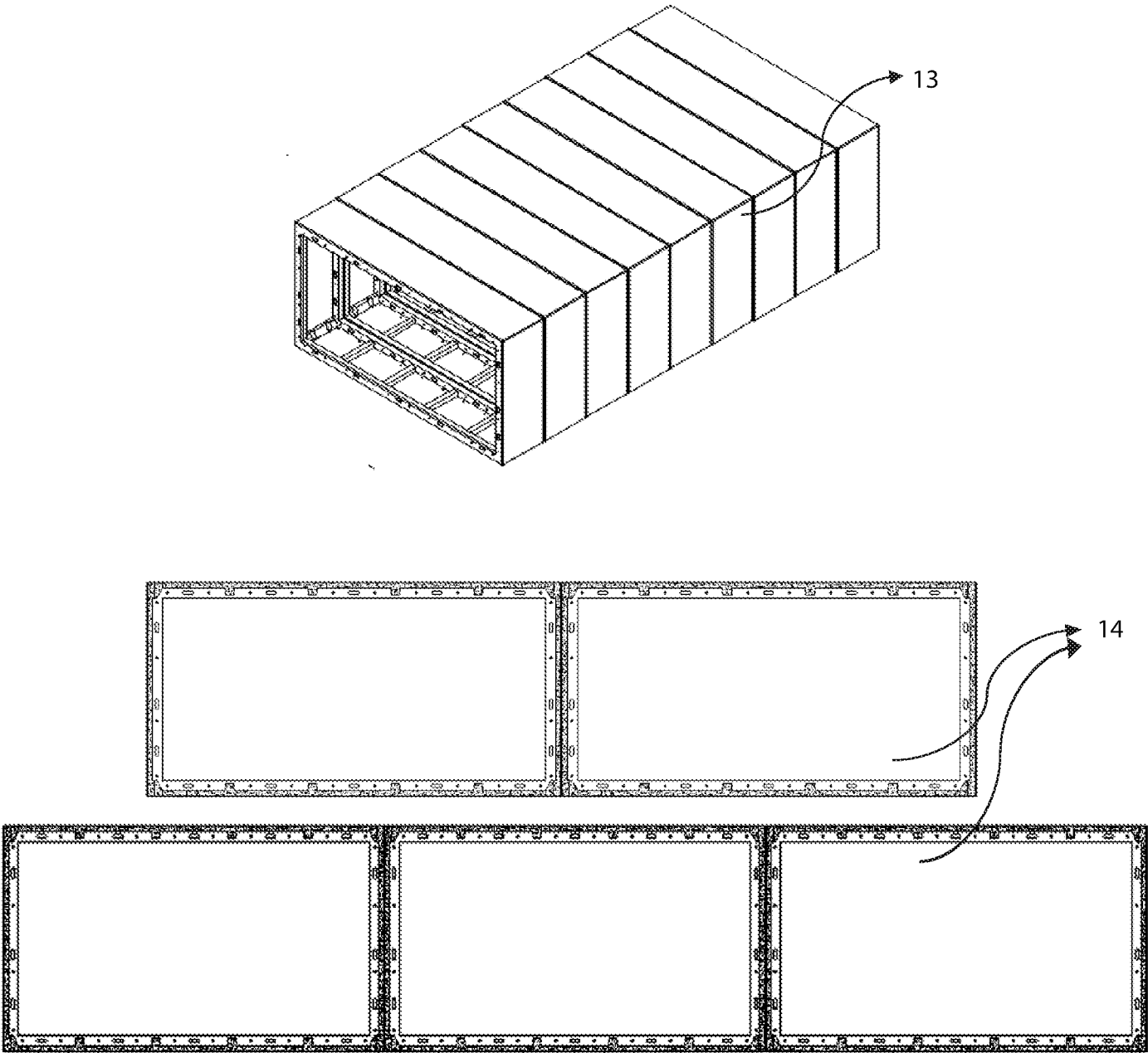


Fig 3

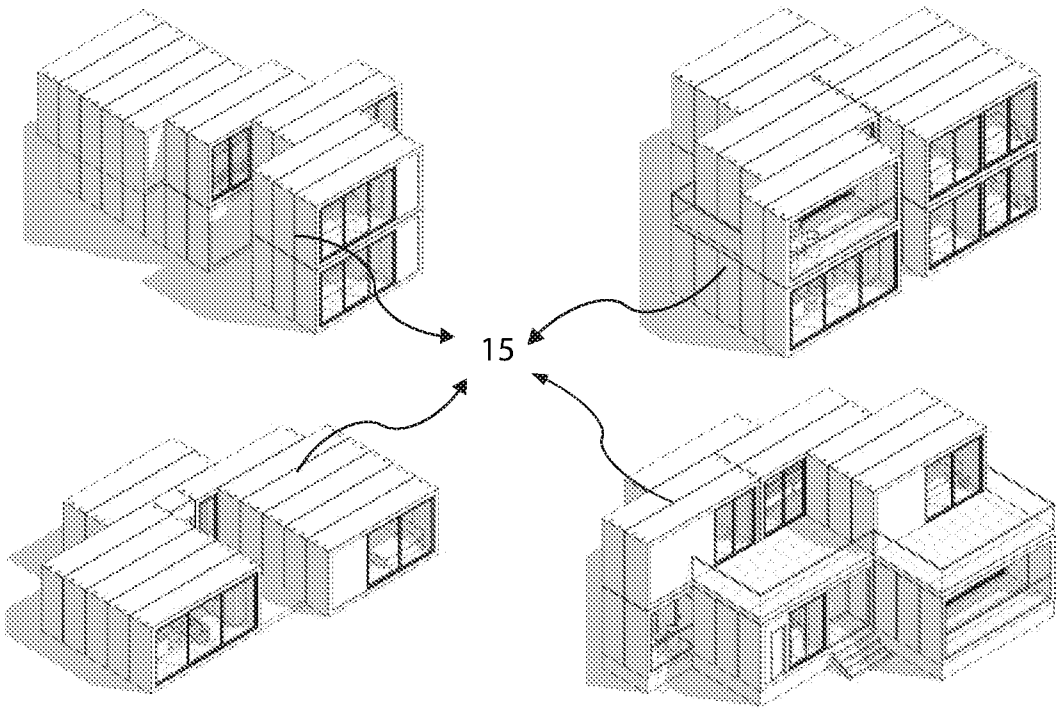


Fig 4
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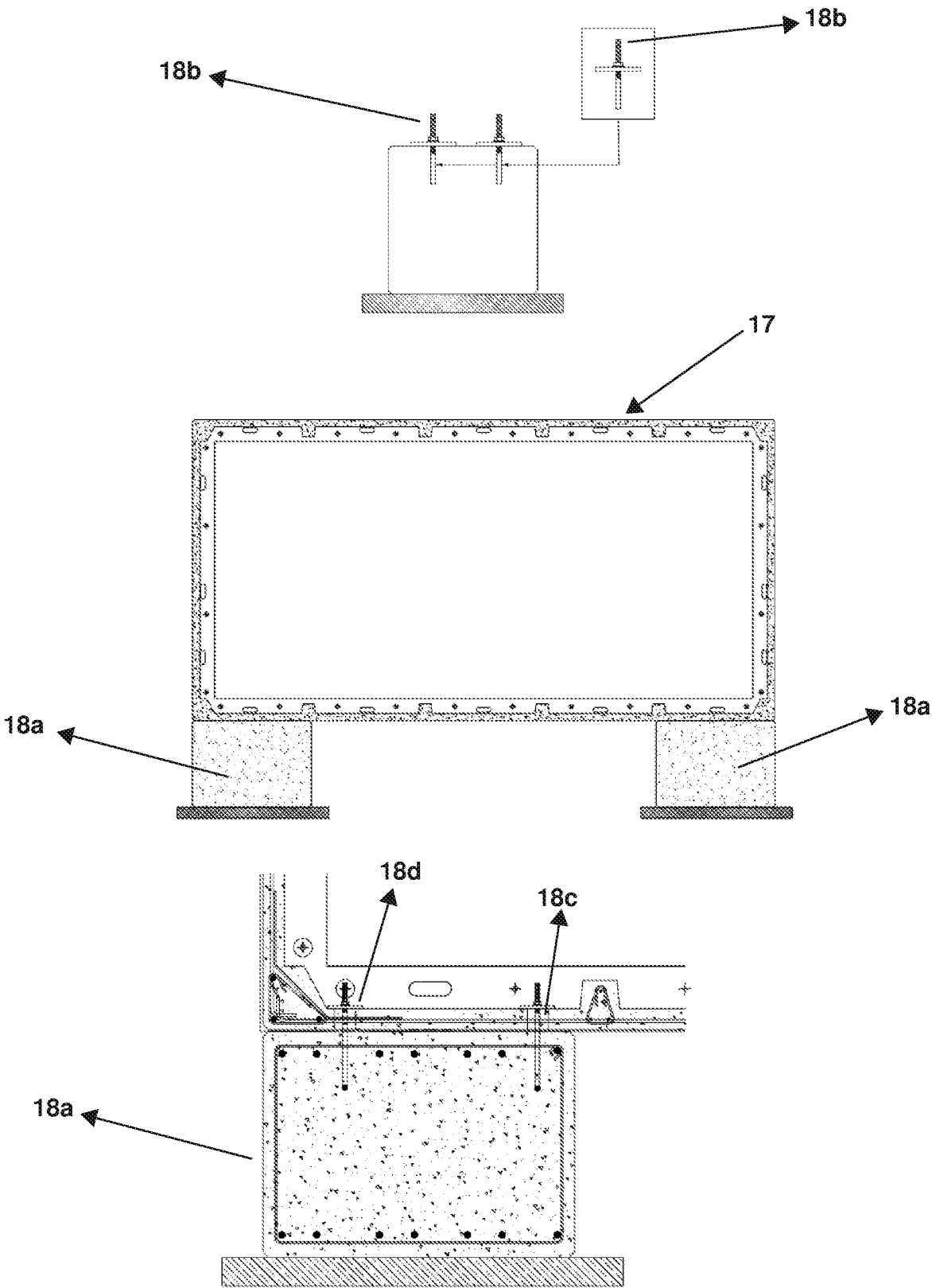


Fig 5

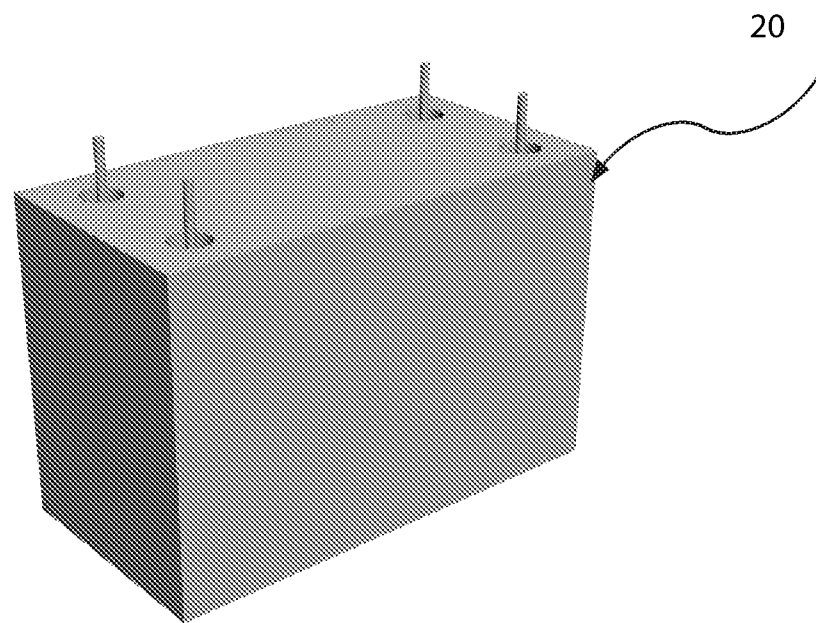


Fig 6

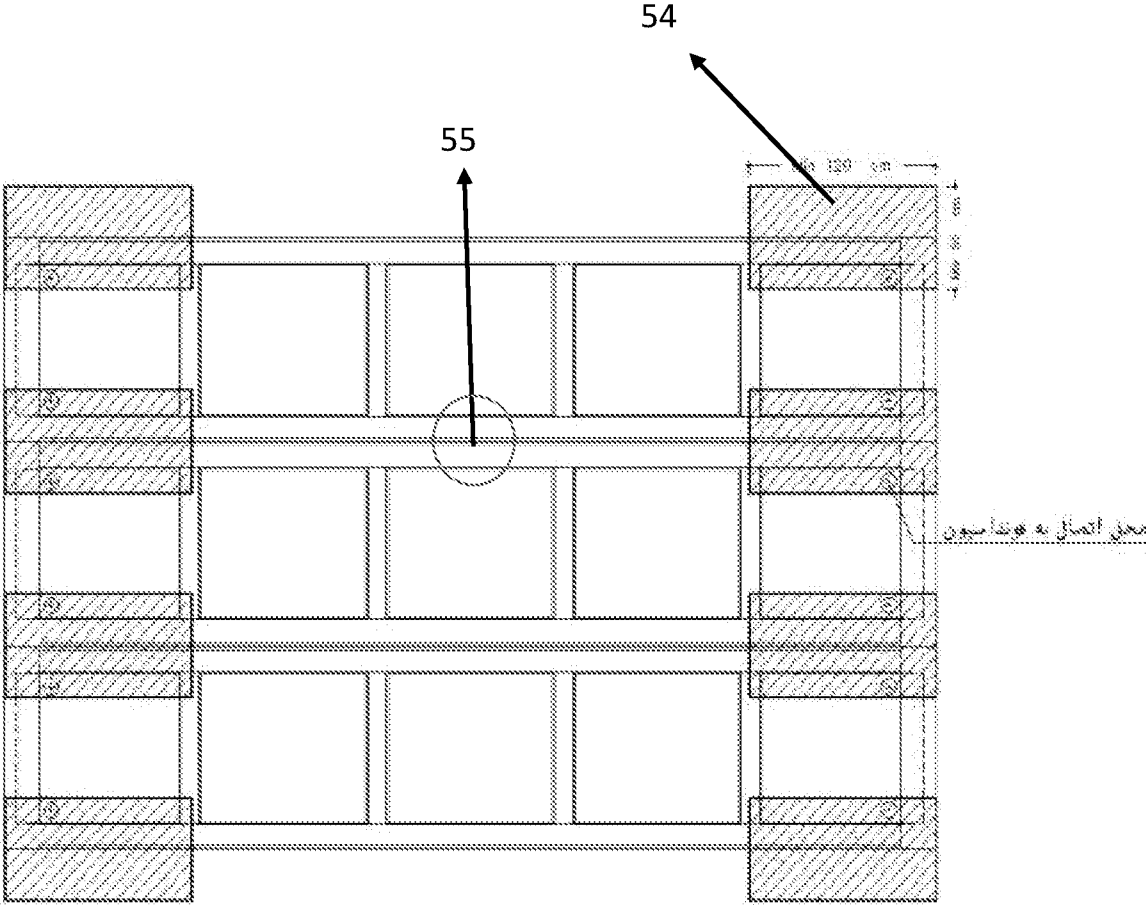


Fig 7

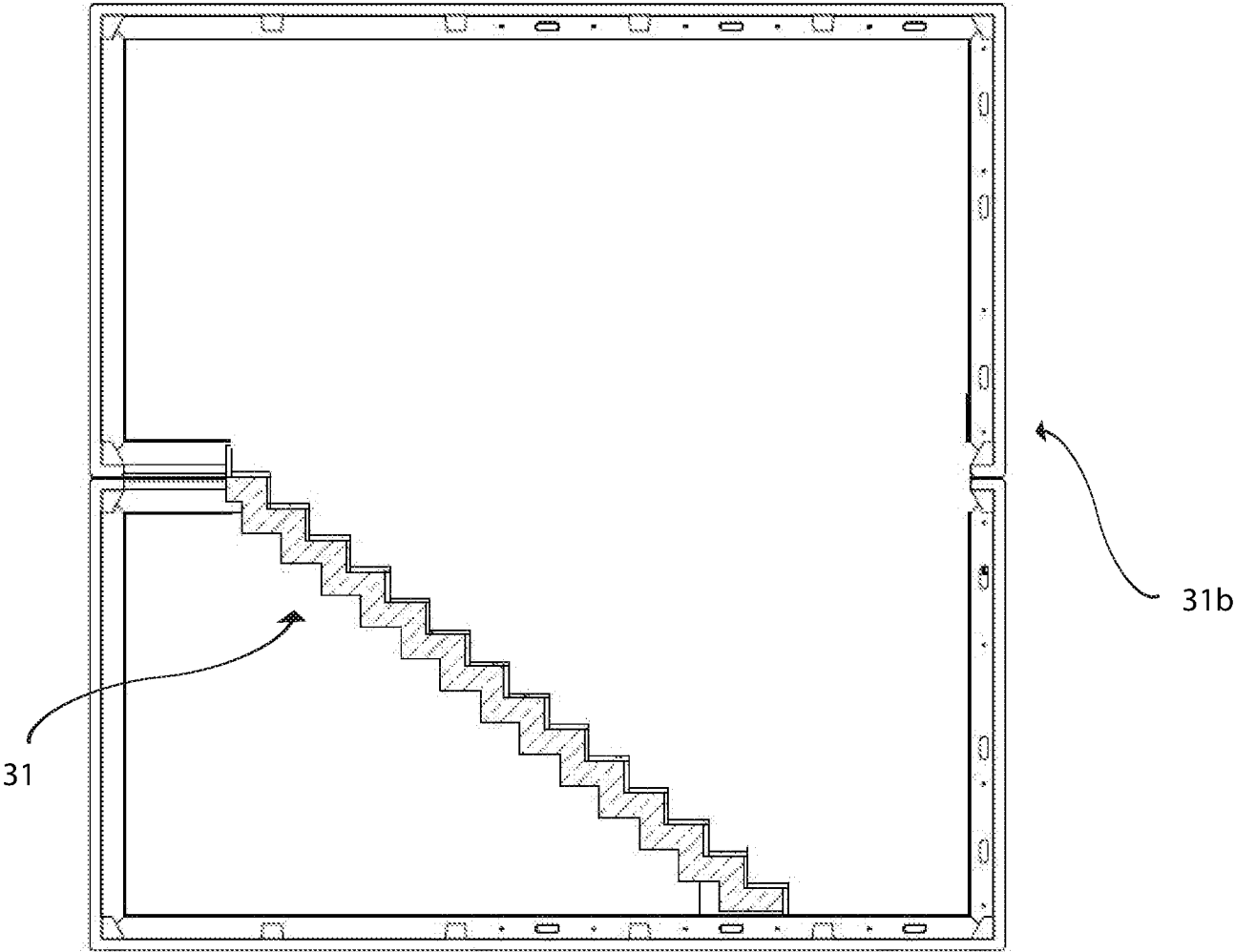
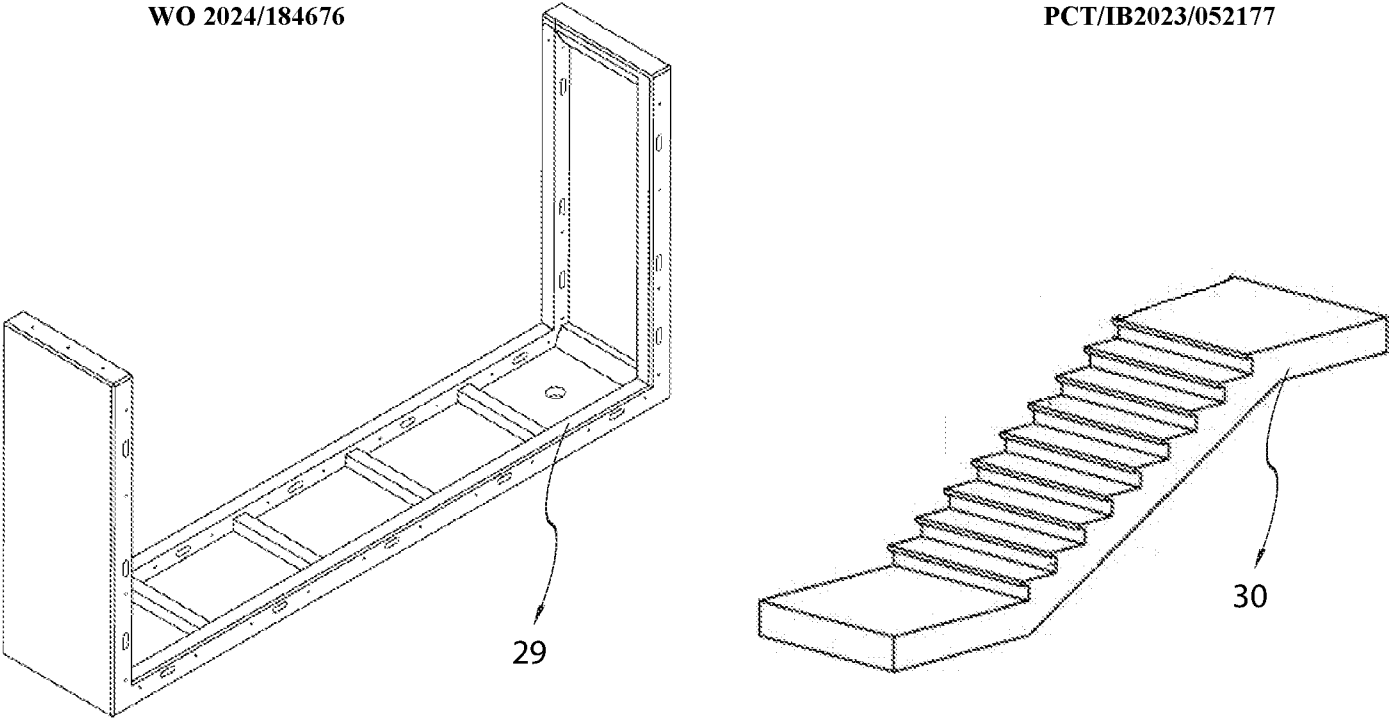
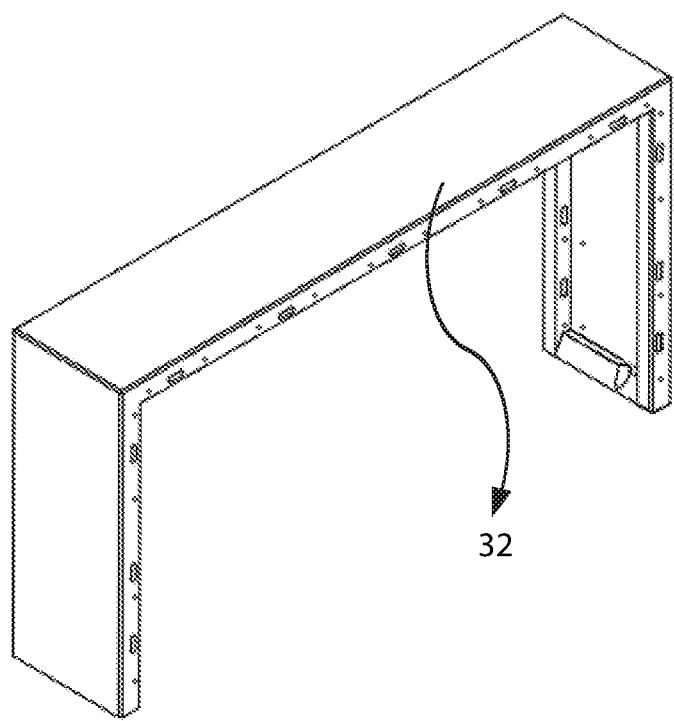
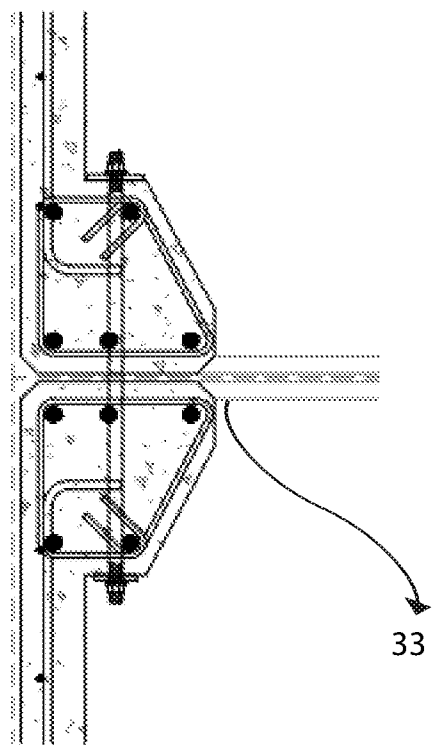


Fig 8



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Fig 9

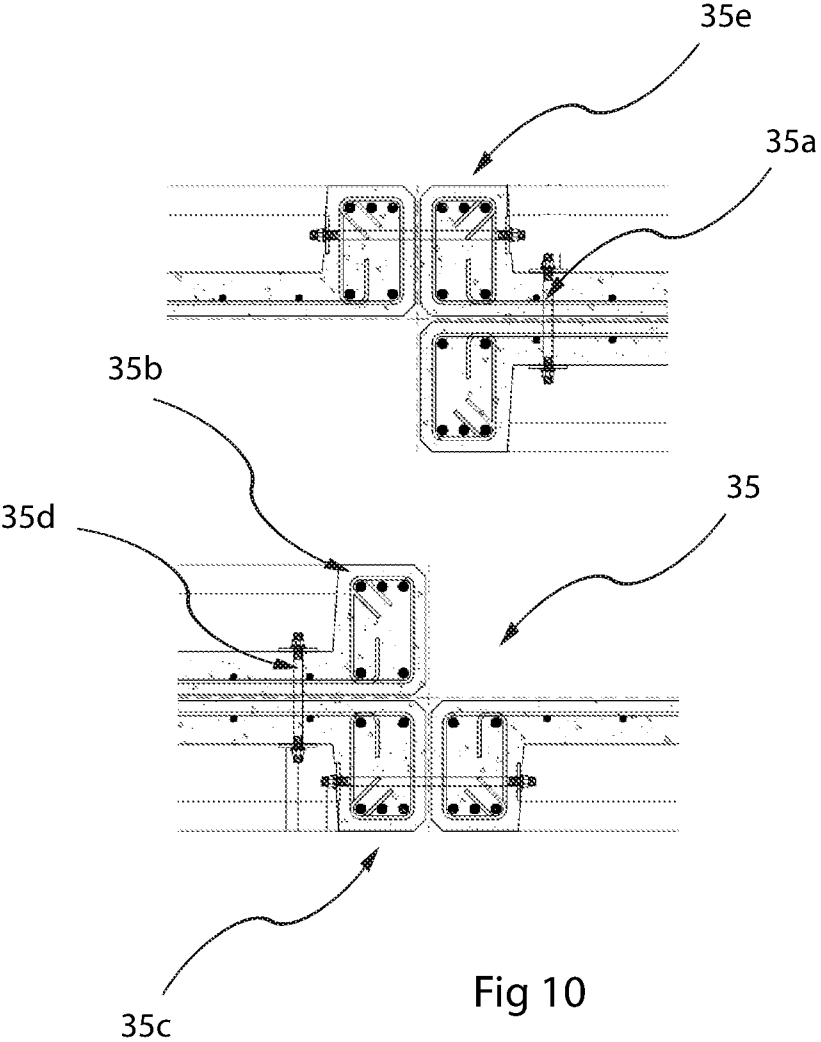
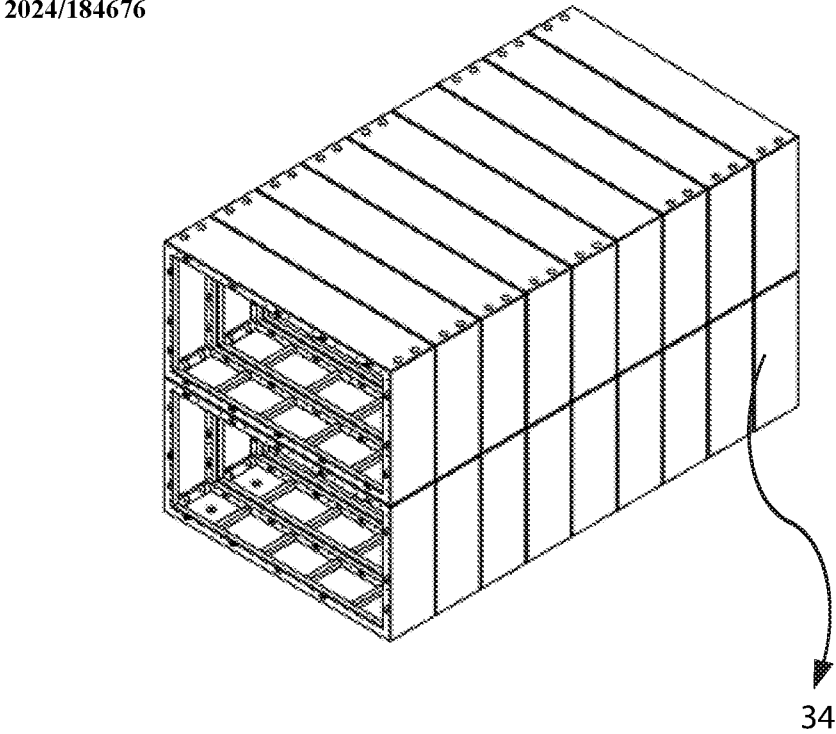


Fig 10

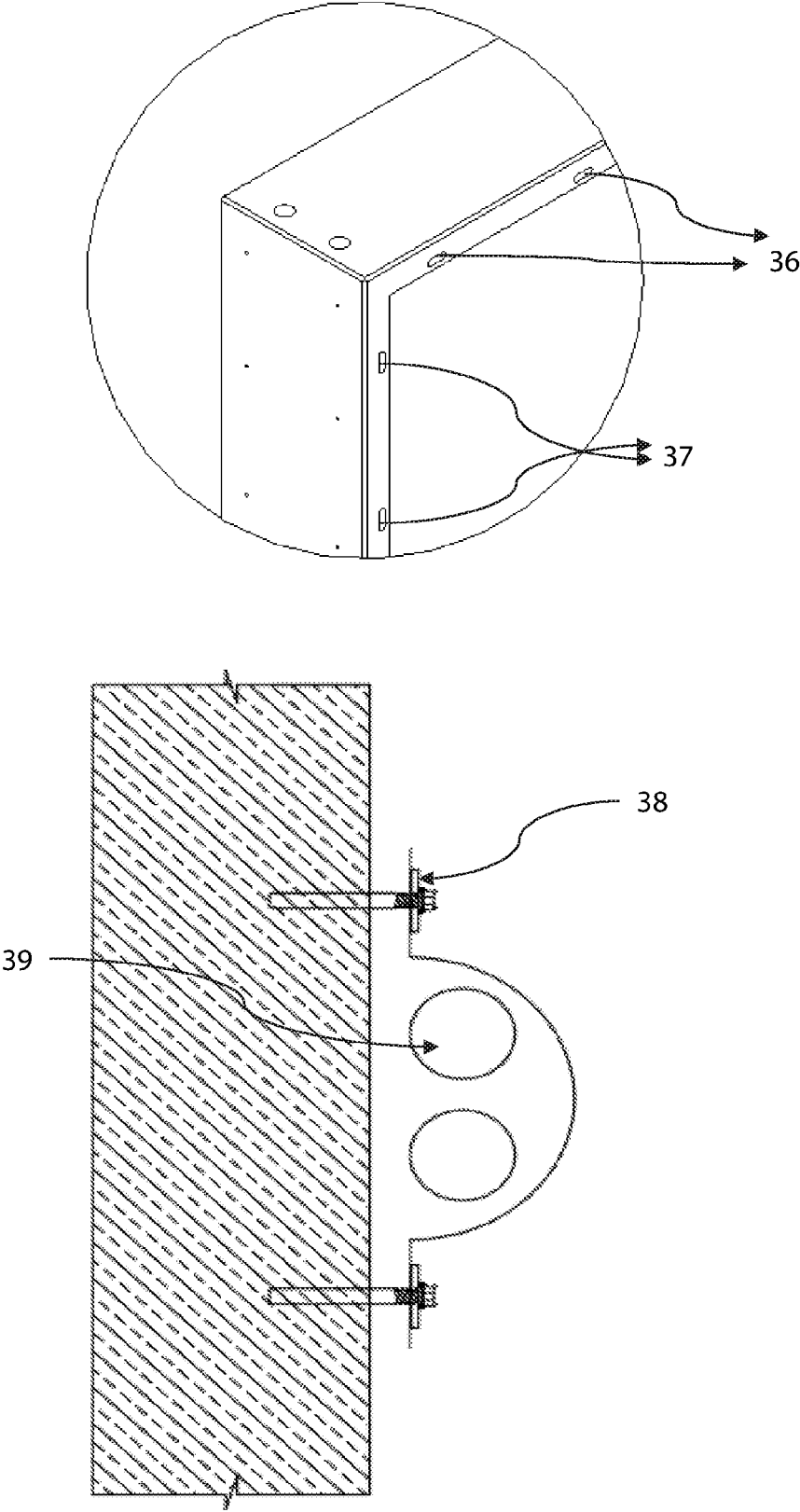


Fig 11

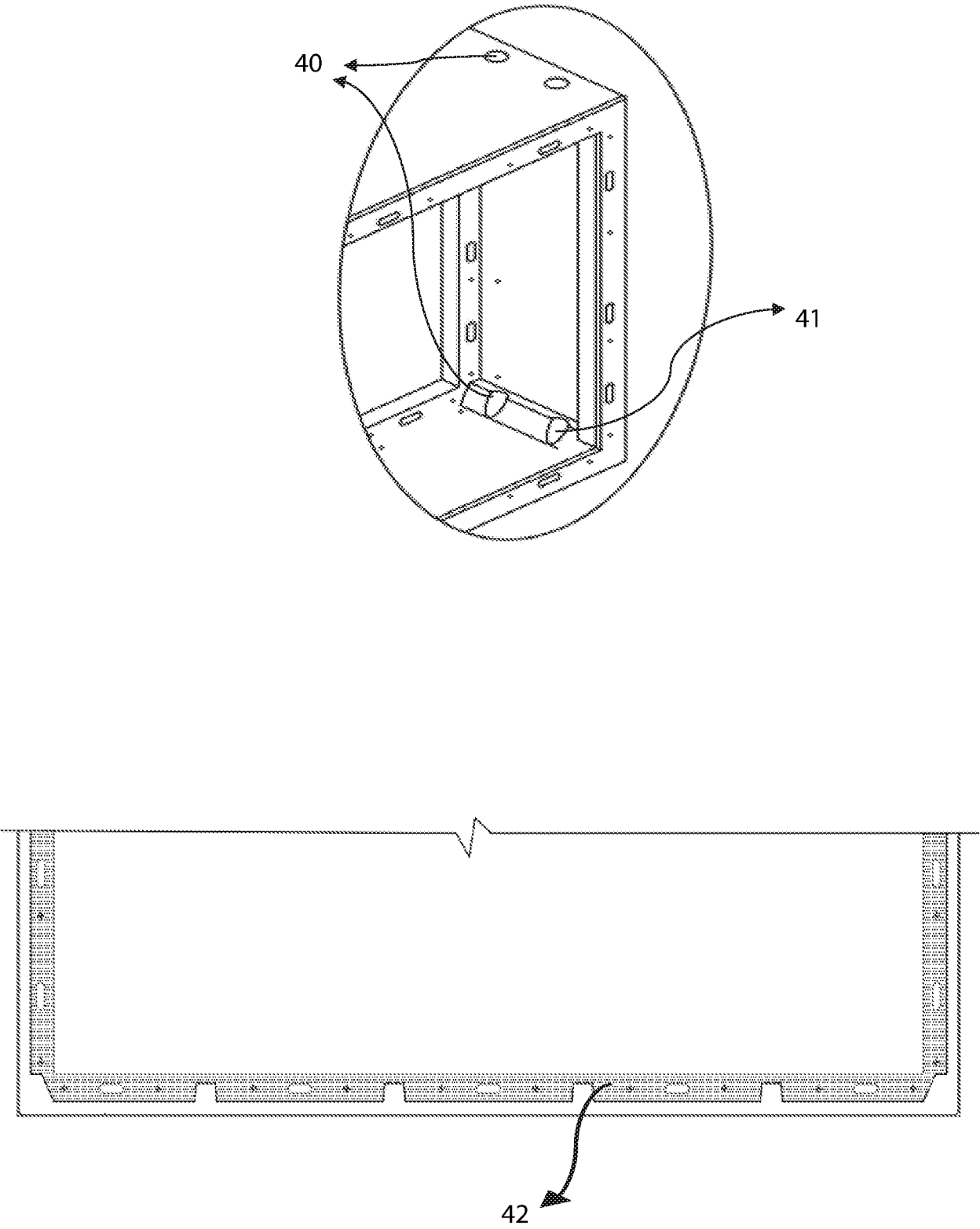


Fig 12

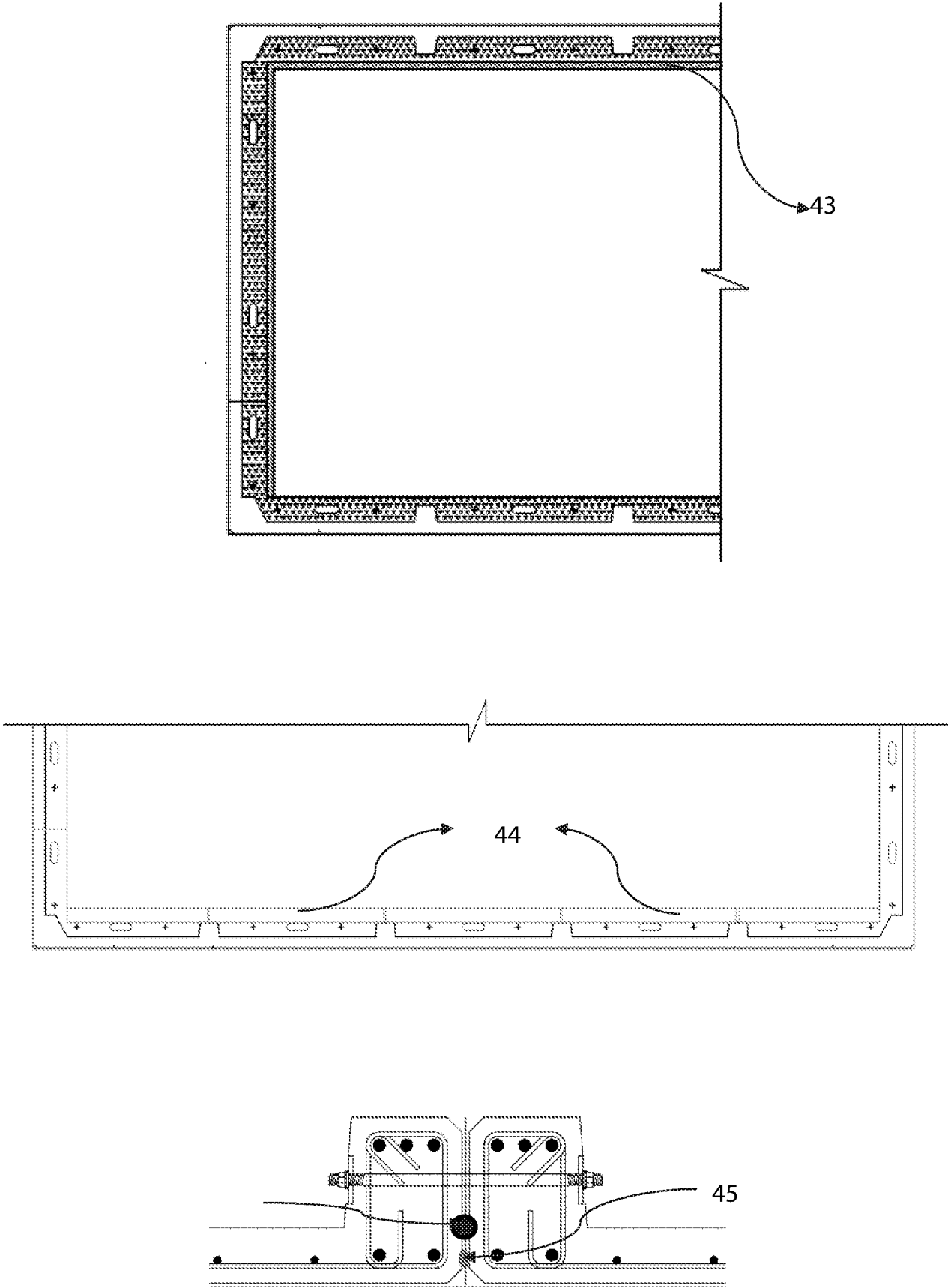


Fig 13

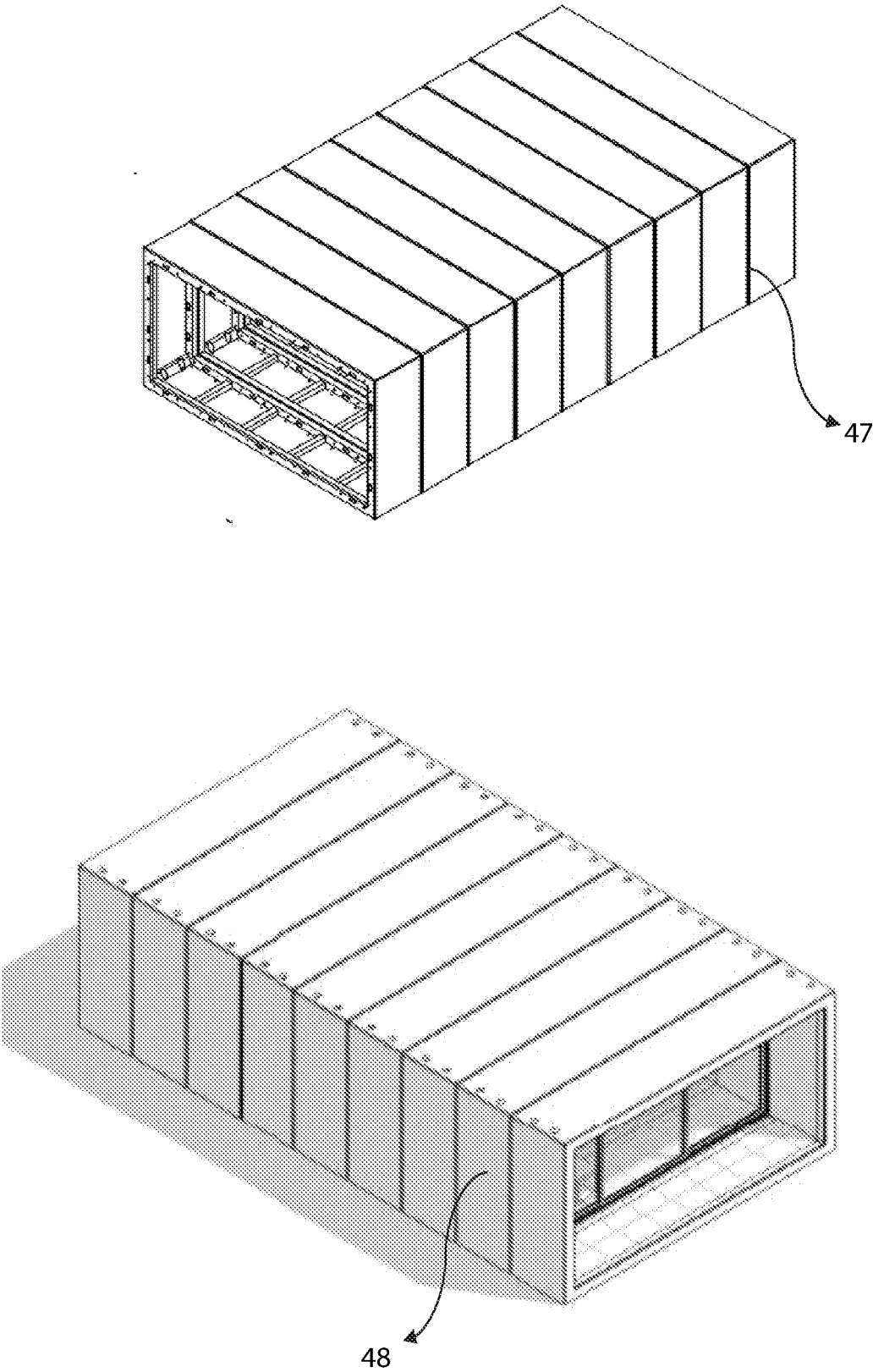


Fig 14

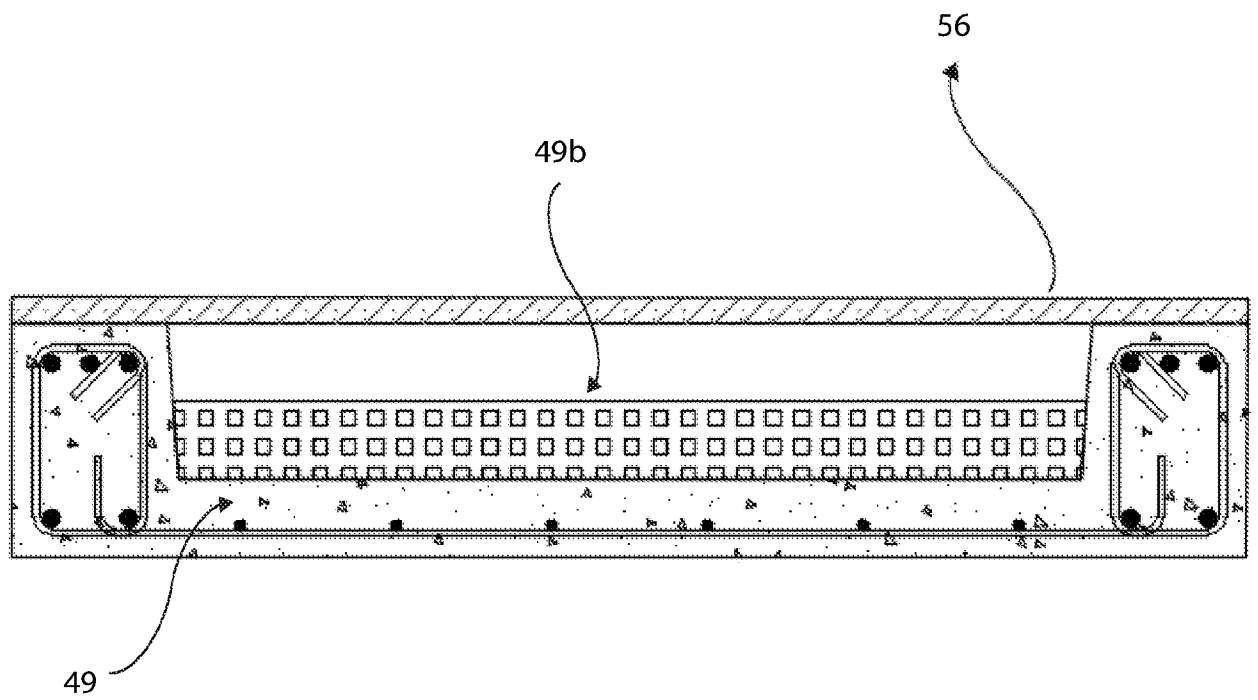


Fig 15

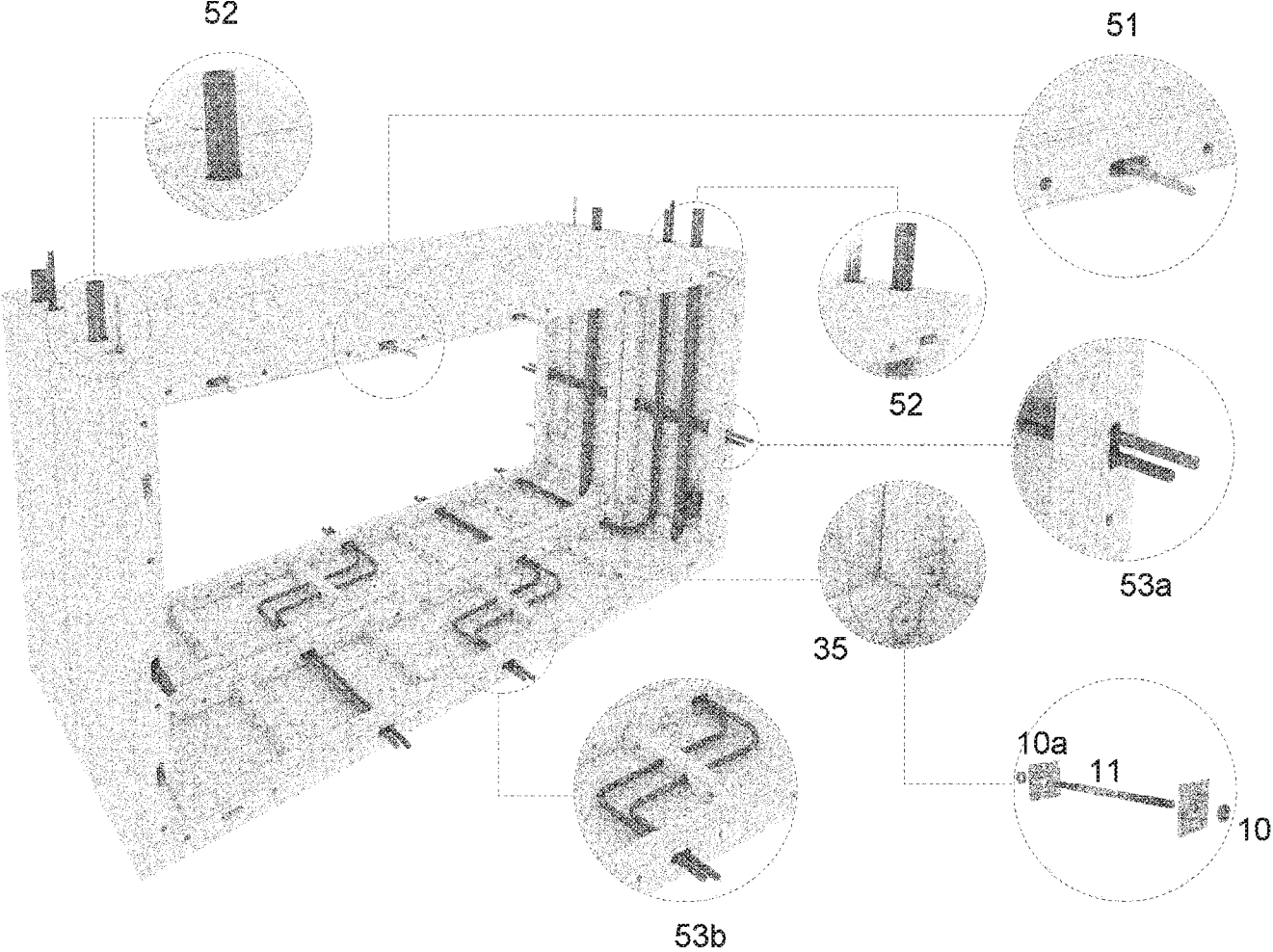


Fig 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2023/052177

A. CLASSIFICATION OF SUBJECT MATTER
E04B1/348 Version=2023.01

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)

E04B

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

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

PatSeer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US20210047824A1 (YAU LEE WAH CONSTRUCTION MAT HUIZHOU COMPANY LIMITED) 18 February 2021 (18/02/2021) Para [0006-0014]	1-3
A	US20150033644A1 (KILONEWTON CONSULTORES DE ENGENHARIA LDA) 05 February 2015 (05.02.2015) Abstract	1-3
A	CN103184807A (TIANJIN ZHONGJIN BOAO HEAVY INDUSTRY MACHINERY CO LTD) 03 July 2013 (03.07.2013) Abstract & NO FAMILY	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19-09-2023

Date of mailing of the international search report

19-09-2023

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2023/052177

Citation	Pub.Date	Family	Pub.Date
US 20210047824 A1	18-02-2021	CN 109057039 A	21-12-2018
		MY 192260 A	12-08-2022
		AU 2018267563 B2	17-11-2022
		EP 3628787 B1	07-06-2023
		SG 10201810614 SA	29-04-2020
		US 10858817 B2	08-12-2020
US 20150033644 A1	05-02-2015	BR 112014020957 A2	01-12-2020
		ES 1120255 Y	24-11-2014
		AP 2014007928 A0	30-09-2014
		WO 2013122494 A1	22-08-2013
		ZA 201406765 B	23-12-2015