(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
07 July 2022 (07.07.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/147233 A1

(51) International Patent Classification:
E04B 1/348 (2006.01) *E04B 1/19* (2006.01)

(21) International Application Number:
PCT/US2021/065663

(22) International Filing Date:
30 December 2021 (30.12.2021)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/132,865 31 December 2020 (31.12.2020) US

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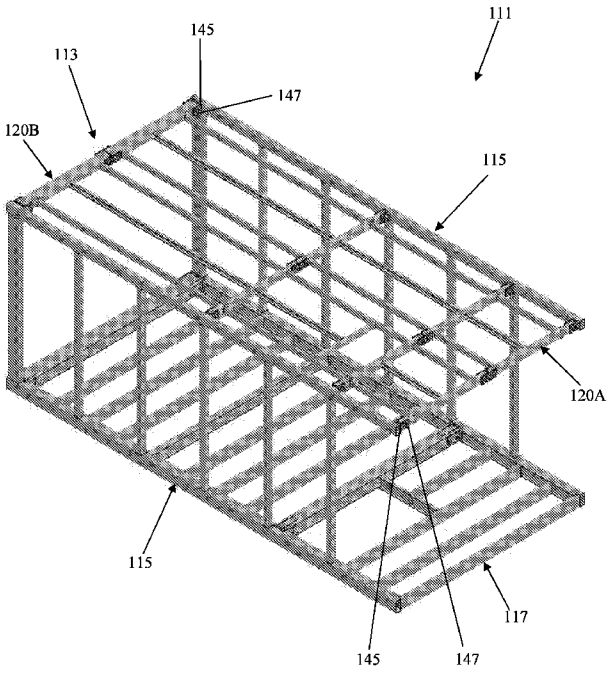
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, 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, GH, GM, KE, LR, LS, MW, MZ, NA, RW, 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, 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))*
— *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))*

(54) Title: RAPID ASSEMBLY CONSTRUCTION MODULES AND METHODS FOR USE

FIG. 29



(57) Abstract: A module for use in constructing a building includes a ceiling assembly. Wall assemblies are configured for attachment to opposite sides of the ceiling assembly generally at tops of the wall assemblies. A floor assembly is configured for attachment generally to bottoms of the wall assemblies. Connector plates are attached to the wall assemblies. The connector plates are configured to receive fasteners for attaching the ceiling assembly and floor assembly to the wall assemblies. A method of construction using the modules is also disclosed.

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RAPID ASSEMBLY CONSTRUCTION MODULES AND METHODS FOR USE

CROSS-REFERENCE TO RELATED APPLICATION

[001] This application claims priority to U.S. Provisional Patent Application Serial No. 63/132,865, filed December 31, 2020, and which is hereby incorporated by reference in its entirety.

BACKGROUND

[002] The present disclosure is directed to construction modules that can be rapidly assembled for use in the construction of a building framework. The module provides a system configured for rapidly erecting a building framework at a construction site or work site. Additionally, in some embodiments, the disassembled module can be stacked together with other modules for transporting multiple modules within a single transportation vehicle of standard over-the-road configuration.

SUMMARY

[003] In one aspect, a module for use in constructing a building, the module generally comprising a ceiling assembly. The module also includes wall assemblies configured for attachment to opposite sides of the ceiling assembly generally at tops of the wall assemblies. The module also includes a floor assembly configured for attachment generally to bottoms of the wall assemblies. The module also includes a plurality of connector plates attached to the wall assemblies and configured to receive fasteners for attaching the ceiling assembly and floor assembly to the wall assemblies to form a module. The module so formed is configured to be placed with other modules to form at least a portion of the building.

[004] In another aspect, a module for use in constructing a building generally comprises a ceiling assembly including a plurality of ceiling units each including a plurality of ceiling members fixedly attached together such that each ceiling unit is a self-contained unit formed separately from any other ceiling unit. The ceiling units are operatively coupled to each other. The module also includes wall assemblies configured for attachment to opposite sides of the ceiling assembly generally at tops of the wall assemblies. The module also includes a floor

assembly configured for attachment generally to bottoms of the wall assemblies. The ceiling assembly, wall assemblies, and floor assembly form a module configured to be placed with other modules to form at least a portion of the building.

[005] In yet another aspect, a method of assembling a module for a building generally comprises attaching a first wall assembly to a first longitudinal side of a floor assembly generally at a bottom of the first wall assembly. A second wall assembly is attached to a second longitudinal side of the floor assembly generally at a bottom of the second wall assembly. A first ceiling unit is coupled to a second ceiling unit to at least in part form a ceiling assembly, where each of the ceiling units includes a plurality of ceiling members fixedly attached together. Each ceiling unit is a self-contained unit formed separately from any other ceiling unit. The ceiling assembly is attached generally to tops of the first and second wall assemblies.

[006] In still another aspect, a method of building a modular building generally comprises fabricating modules at a manufacturing facility such that each module is made up of separate component parts. Loading the component parts onto a semi-trailer with the component parts separated from each other and arranged so that a width of the loaded components does not exceed a predetermined dimension. Transporting the component parts of the frame on the semi-trailer to a desired location. Assembling the component parts from the load on the semi-trailer to form at least part of one module. Transporting an assembled module to the construction site.

[007] Other features of the present invention will be apparent from the following description.

DESCRIPTION OF THE DRAWINGS

[008] FIG. 1 is a perspective of a modular steel cage or "skeleton frame" as assembled;

[009] FIG. 2 is a perspective showing ceiling and wall components of the skeleton frame being lifted from a collapsed configuration;

[010] FIG. 2A is a perspective showing multiple collapsed skeleton frames stacked on top of each other;

[011] FIG. 2B is a side view of Fig. 2A;

[012] FIG. 3 is a perspective of a wall assembly of the skeleton frame;

[013] FIG. 4 is an elevation view of the wall assembly;

[014] FIG. 5 is an elevation of a wall assembly having an alternative construction;

[015] FIG. 6 is an enlarged fragmentary perspective of the frame of Fig. 1 showing connecting elements of a ceiling to a wall joint;

[016] FIG. 7 is a perspective of a ceiling assembly;

[017] FIG. 8 is a plan view of the ceiling assembly;

[018] FIG. 9 is a plan view of a ceiling assembly without certain rafter components;

[019] FIG. 10 is a plan view of the ceiling assembly without certain perimeter components;

[020] FIG. 11 is a perspective of a floor assembly;

[021] FIG. 12 is a plan view of the floor assembly;

[022] FIG. 13 is a plan view of the floor assembly without certain joist components;

[023] FIG. 14 is a plan view of a floor assembly without certain perimeter components;

[024] FIG. 15 is an enlarged fragmentary perspective of the frame of Fig. 1 showing the connecting elements of a ceiling to a wall joint;

[025] FIG. 16 is an end view showing the ceiling and wall assemblies in a collapsed configuration;

[026] FIG. 17 is the end view of Fig. 16, but further including the floor assembly;

[027] FIG. 18 is a schematic illustration of erecting the skeleton frame;

[028] FIG. 19 is an end view of the erected skeleton frame;

[029] FIG. 20 is a cross section of the erected skeleton frame;

[030] FIG. 21 is a schematic illustration showing how the frame might be collapsed;

[031] FIG. 22 is a schematic showing a sequence of erecting a skeleton frame of another embodiment in which the wall assemblies are pivotally connected to the floor assembly during transport;

[032] FIG. 23 is a perspective of a modular steel cage or “skeleton frame” of another embodiment as erected;

[033] FIG. 24 is a perspective of a portion of a modular steel cage or skeleton frame of another embodiment;

[034] FIG. 25 is a fragmentary portion of the connection elements in Fig. 24;

[035] FIG. 26 is a perspective of a modular steel cage or skeleton frame of another embodiment as erected;

[036] FIG. 27 is an enlarged fragmentary view of Fig. 26 showing connection elements;

[037] FIG. 28 is a perspective of a bracket in Fig. 26;

[038] FIG. 29 is a perspective of a modular steel cage or skeleton frame of another embodiment as erected;

[039] FIG. 30 is a perspective of a ceiling assembly in Fig. 29;

[040] FIG. 31 is a perspective of a first ceiling unit of the ceiling assembly in Fig. 30;

[041] FIG. 32 is a perspective of a second ceiling unit of the ceiling assembly in Fig. 30;

[042] FIG. 33 is an enlarged fragmentary perspective of the second ceiling unit;

[043] FIG. 34 is an enlarged fragmentary perspective of the frame of Fig. 29 showing connected ceiling units;

[044] FIG. 35 is a perspective of the floor and wall assemblies in Fig. 29 with the ceiling assembly removed;

[045] FIG. 36 is an enlarged fragmentary perspective of the frame of Fig. 35 showing a bracket;

[046] FIG. 37 is a perspective of a floor assembly in Fig. 29 also showing bottom members of wall assemblies of the frame;

[047] FIG. 38 is a perspective of the bottom members of the wall assemblies of the frame in Fig. 29 showing connector brackets/plates attached thereto;

[048] FIG. 39 is a perspective of the bottom members in Fig. 38 showing second floor members of the floor assembly attached thereto;

[049] FIG. 40 is a perspective of the floor assembly in Fig. 37 with the second floor members removed;

[050] FIG. 41 is a perspective of a modular steel cage or “skeleton frame” of another embodiment as erected;

[051] FIG. 42 is a perspective of a modular steel cage or “skeleton frame” of another embodiment as erected;

[052] FIG. 43 is a perspective of a ceiling assembly in Fig. 42;

[053] FIG. 44 is a perspective of a first ceiling unit of the ceiling assembly in Fig. 43;

[054] FIG. 45 is a perspective of a second and third ceiling unit of the ceiling assembly in Fig. 43;

[055] FIG. 46 is a perspective of a fourth ceiling unit of the ceiling assembly in Fig. 43;

[056] FIG. 47 is an enlarged fragmentary view of the frame of Fig. 42 showing connecting elements;

[057] FIG. 48 is a perspective of the skeleton frame in Fig. 42 with the ceiling assembly removed;

[058] FIG. 49 is an enlarged fragmentary perspective of the frame of Fig. 48 showing a bracket;

[059] FIG. 50 is a perspective of a bracket in Fig. 42;

[060] FIG. 51 is a perspective of a floor assembly of the skeleton frame in Fig. 42;

[061] FIG. 52 is a perspective of a first floor unit of the floor assembly in Fig. 51;

[062] FIG. 53 is a perspective of a second and third floor unit of the floor assembly in Fig. 51;

[063] FIG. 54 is a perspective of a fourth floor unit of the floor assembly in Fig. 51;

[064] FIG. 55 is a perspective of a modular steel cage or "skeleton frame" of another embodiment as erected;

[065] FIG. 56 is an enlarged fragmentary perspective of the frame of Fig. 55 showing connecting elements;

[066] FIG. 57 is a perspective of the skeleton frame in Fig. 55 with a ceiling assembly removed;

[067] FIG. 58 is an enlarged fragmentary view of the frame of Fig. 57 showing connecting elements;

[068] FIG. 59 is a partially exploded perspective of the ceiling assembly in Fig. 55;

[069] FIG. 60 is a perspective of a first ceiling unit of the ceiling assembly in Fig. 59;

[070] FIG. 61 is a perspective of a second ceiling unit of the ceiling assembly in Fig. 59;

[071] FIG. 62 is a perspective of a third ceiling unit of the ceiling assembly in Fig. 59; and

[072] FIG. 63 is a perspective of a modular steel cage or "skeleton frame" of another embodiment as erected.

[073] Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION

[074] Referring to Figs. 1-2B, an expandable and collapsible steel module or “skeleton frame” of the present disclosure is generally indicated at 11. The skeleton frame 11 may be used in the construction of a building framework and may also be referred to as a “skeleton”, “frame”, “steel cage”, or "cage". For example, multiple assembled steel modular skeleton frames 11 may be stacked on top of each other and disposed side-by-side to form the framework of a building. In the illustrated embodiment, the frame 11 comprises a ceiling assembly 13, a pair of wall assemblies 15 attachable to opposite sides of the ceiling assembly, and a floor assembly 17 attachable to bottoms of the wall assemblies. The wall assemblies 15 may be movably (e.g., pivotably) attached to the ceiling assembly 13 so that initially, the frame 11 may be formed in a collapsed or flattened state (Figs. 2 and 17). The collapsed state allows multiple collapsed frames 11 to be stacked on top of each other for transporting the frames to a construction site or work site (e.g., an assembly plant) by a single trailer (Figs. 2A and 2B). In one embodiment, the frame is erected and other components are attached to the frame to create a completed volumetric module for installation at the construction site. For example, a substantially completed room, including drywall, paint/wall finishing, plumbing, electrical and even furniture could be installed and shipped to a construction site. As used herein, "module" or “collapsible steel module” may refer to the skeleton frame 11 or to a more fully or completely finished construction unit that includes additional components added to the module cage to partially or fully finish the interior.

[075] The moveable connection between the wall assemblies 15 and the ceiling assembly 13 allows the wall assemblies to be quickly and easily unfolded from the collapsed state to the expanded (erected) state. As will be explained in greater detail below, once the ceiling assembly 13 is lifted, gravity helps the wall assemblies 15 to be rotated around a key bolt to configure the frame 11 from the collapsed state to the expanded state. Alternatively, the wall assemblies 15 may be movably attached to the floor assembly 17 (Fig. 22) such that the wall assemblies are unfolded upward to configure the frame 11 from the collapsed state to the expanded state.

[076] Additionally, the ceiling assembly 13 and floor assembly 17 may have bracing straps 19 (Fig. 23) for reinforcing the frame 11. However, the frame 11 can be

configured to withstand the structural requirements to function as the building framework without additional straps. The assemblies 13, 15, 17 may also be transported in a separate/non-staked configuration and suitably attached together at the construction site. Moreover, the movable connection between the wall assemblies 15 and the ceiling assembly 13 and/or floor assembly 17 is not required. Thus, the frame 11 can be suitably erected by separately attaching the wall assemblies 15 to the floor assembly 17 and then attaching the ceiling assembly to the wall assemblies. Other orders of attachment of the assemblies 13, 15, 17 are also envisioned without departing from the scope of the disclosure.

[077] Referring to Figs. 3-6, each wall assembly 15 comprises a top member or beam 21, a bottom member or beam 23, and a plurality of first vertical members or studs 25 extending between the top and bottom members. The top and bottom members 21, 23 extend parallel to each other, and the first studs 25 extend parallel to each other. The first studs 25 are spaced inward from longitudinal ends of the top and bottom members 21, 23 such that the first studs extend from a top surface of the bottom member to a bottom surface of the top member. A second vertical member 27 is disposed on one of the longitudinal ends of the top and bottom members 21, 23 and extends generally from a bottom surface of the top member to a bottom surface of the top member such that the top and bottom of the second vertical member is flush with the top and bottom members, respectively. The second vertical members 27 extend parallel to the studs 25. In the illustrated embodiment, a single second vertical member 27 is shown. However, additional (e.g., two or four) second vertical members may be provided. For example, a second vertical member 27 may be disposed between two or more pairs of connection plates 45. Additionally, the single second vertical member 27 can be omitted.

[078] In one embodiment, the top and bottom members 21, 23 may have a length L of between about 5 and about 60 feet. The length L of the top and bottom members 21, 23 may also define a length of the frame 11. In one embodiment, the first studs 25 may have a length or height of between about 6 and about 12 feet. A horizontal spacing between the first studs 25 may vary. In one embodiment, adjacent first studs are spaced between about 1 and about 72 inches apart. In one embodiment, the adjacent first studs are spaced between about 1 and about 11 inches apart. It will be understood that these dimensions

are exemplary only, and that the components of the wall assemblies 15 may have other dimensions and spacings depending on the desired size and shape of the frame 11. In the illustrated embodiment, each of the top and bottom members - 21, 23 and the second vertical members 27 have a hollow structural section that is rectangular in shape (built up box member or HSS tube section). However, the members could have other configurations without departing from the scope of the disclosure. For example, the members could comprise wide flange sections.

[079] Optional extension cross members/bars 29 may extend from the top and bottom of the second vertical member 27 generally parallel to and away from the top and bottom members 21, 23, respectively (Figs. 5 and 6). A third vertical member 31 may extend between the optional extension bars 29.

[080] Referring to Figs. 7-10, the ceiling assembly 13 comprises a plurality of parallel ceiling members or beams 33 spaced apart along a length of the ceiling assembly, and a plurality of parallel horizontal ceiling members or rafters 35 extending between the beams. In particular, first beams 33A extend across the ceiling assembly 13, and first rafters 35A extend between the first beams. In the illustrated embodiment, one of the first beams 33A defines an end of the ceiling assembly 13, and the other first beams define intermediate portions of the ceiling assembly. A second beam 33B defines an opposite end of the ceiling assembly 13. Second ceiling members or rafters 35B extend between the second beam 33B and one of the first beams 33A. Third ceiling members or rafters 35C define the outermost ceiling members on the ceiling assembly 13 and extend between the first beams 33A and between the second beam 33B and one of the first beams. In one embodiment, the ceiling assembly 13 may have a length of between about 5 and about 60 feet. In one embodiment, the first and second beams 33A, 33B may have a length of between about 8 and about 15 feet. A horizontal spacing between the rafters 35 may vary. In one embodiment, adjacent rafters 35 are spaced between about 16 and about 24 inches apart. It will be understood that these ranges are exemplary only, and that the components of the ceiling assembly 13 may have other dimensions and spacings depending on the desired size and shape of the frame. The rafters 35 preferably extending in a direction parallel to the axis about which the wall assemblies 15 pivot with respect to the ceiling assembly 13.

[081] In the illustrated embodiment, each of the first and second beams 33A, 33B and the third rafters 35C have a hollow structural section that is rectangular in shape (built up box member or HSS tube section), and each of the first and second rafters 35A, 35B has a channel shape. In one embodiment, the first beams 33A are 6x4 inch HSS tube sections, the second beam 33B is an 8x6 inch HSS tube section, and the third rafters 35C are 6x2$^{1/8}$ inch HSS tube sections. The first beams 33A may also be a 4x4 HSS tube section, and the second beam 33B may be a 6x6 HSS tube section. The ceiling members could still have other configurations without departing from the scope of the disclosure. Diagonal straps 19 (Fig. 23) may be attached to improve the in-plane stability of the ceiling assembly. However, as noted previously, the frame 11 can be configured to withstand the structural requirements to function as the building framework without additional straps or other reinforcement.

[082] Referring to Figs. 11-14, the floor assembly 17 comprises a plurality of parallel cross members/bars 41 spaced apart along a length of the ceiling assembly, and a plurality of parallel horizontal floor members or joists 43 extending between the bars. The floor assembly 17 is configured substantially similarly to the ceiling assembly 13. In particular, first bars 41A extend across the floor assembly 17, and first floor members or joists 43A extend between the first bars. In the illustrated embodiment, one of the first bars 41A defines an end of the floor assembly 17, and the other bars define intermediate portions of the floor assembly. A second cross member/bar 41B defines an opposite end of the floor assembly 17. Second floor members or joists 43B extend between the second bar 41B and one of the first bars 41A. Third floor members or joists 43C define the outermost floor members on the floor assembly 17 and extend between the first bars 41A and between the second bar 41B and one of the first bars. In one embodiment, the floor assembly 17 may have a length of between about 5 and about 60 feet. In one embodiment, the first and second bars 41A, 41B may have a length of between about 8 and about 15 feet. A horizontal spacing between the joists 43 may vary. In one embodiment, adjacent joists 43 are spaced between about 16 and about 24 inches apart. It will be understood that these ranges are exemplary only, and that the components of the floor assembly 17 may have other dimensions depending on the desired size and shape of the frame. In a

preferred embodiment, the joists 43 extend parallel to the axes about which the wall assemblies 15 pivot with respect to the ceiling assembly 13.

[083] In the illustrated embodiment, each of the first and second bars 41A, 41B and the third joists 43C have a hollow structural sections that are rectangular in shape (built up box member or HSS tube section), and each of the first and second joists 43A, 43B has a channel shape. In one embodiment, the first bars 41A are 8x4 inch HSS tube sections, the second bar 41B is an 8x8 inch HSS tube section, and the third joists 43C are $8x2^{1/8}$ inch HSS tube sections. The second bar 41B may also be an 8x6 HSS tube section. The members could still have other configurations without departing from the scope of the disclosure.

[084] Referring to Figs. 1, 6, and 15, the wall assemblies 15 are attached to the ceiling assembly 13 along the sides of the ceiling assembly by connection plates 45. The connection plates 45 are fixedly attached to the top and bottom members 21, 23 of the wall assemblies 15. For example, the connection plates 45 may be welded to the top members. However, the connection plates 45 may be attached to the wall assemblies 15 by other means. In the illustrated embodiment, each connection plate 45 comprises a generally rectangular plate member defining a plurality of fastener holes. In the illustrated embodiment, each connection plate 45 defines four fastener holes. The fastener holes are located generally at the corners of the portion of the connection plate 45 exposed from top members 21, 23 such that the fastener holes are arranged generally in a square or rectangular shape. A first pair of fastener holes are located adjacent a free end of the connection plate 45, and a second pair of fastener holes are located adjacent the top member 21, 23 to which the connection plate is attached. It will be understood that the connection plates 45 may define other numbers of holes arranged in other locations on the plates without departing from the scope of the disclosure. In one embodiment, the connection plates 45 may be considered part of their respective wall assembly 15.

[085] The connection plates 45 are arranged in pairs along the length of the beams 21, 23. In particular, the pairs of connection plates 45 are spaced such that each pair of connection plates 45 on the top members 21 is configured to receive one of the beams 33A, 33B on the ceiling assembly 13, and each pair of connection plates on the bottom members 23 are configured to receive one of the bars 41A, 41B on the floor assembly 17. Fasteners (e.g., bolts) 47 are received in the

fastener holes of the connection plates 45 to attach the plates to the beams 33A, 33B on the ceiling assembly 13 and the bars 41A, 41B on the floor assembly 17. In one embodiment, the bolts 47 are slip critical bolts. Thus, the bolts 47 can be pre-tensioned to eliminate slippage once the frame 11 is erected. There are at least four pairs of connection plates 45 on each top and bottom member 21, 23. Thus, at least a total of 32 bolts are used to attach each top member 21 to one of the ceiling assembly 13 and each bottom member 23 to the floor assembly 17. It will be understood, however, that a different number of bolts may be used without departing from the scope of the disclosure. The attachment of the wall assemblies 15 to the ceiling assembly 13 and floor assembly 17 using the connection plates 45 creates a moment resisting column-to-beam type joint connection structure for resisting vertical moment loads.

[086] Referring to Figs. 2, 16, and 17, the wall assemblies 15 can be attached to the ceiling assembly 13 in such a way to facilitate configuring the frame 11 in the collapsed state. In particular, the left wall assembly 15 (when viewed from the end view of Fig. 16) can be oriented horizontally below the ceiling assembly 13 and attached to the left side of the ceiling assembly such that a single fastener 47 is received in one of the pair of fastener holes in the connection plate 45 located adjacent the vertical member 27, through an aligned fastener hole in the beam 33B of the ceiling assembly and through a corresponding fastener hole in the other connection plate. In the illustrated embodiment, the single fastener 47 is received in the right-side fastener hole of the pair of fastener holes located adjacent the vertical member 27. In this position, the connection plates 45 on an opposite end of the vertical member 27 on the left wall assembly 15 are also positioned to receive the beam 33B of the ceiling assembly 13. The parallel arrangement of the vertical member 27 on the left wall assembly 15 and the rafter 33B on the ceiling assembly 13 facilitate stacking the assemblies in this manner. It will be understood that the opposite end of the left wall assembly 15 may be attached in a suitable manner to the opposite end of the ceiling assembly 13. The pairs of connection plates 45 are spaced along the top and bottom members 21, 23 of the left wall assembly 15 so as to receive and pivotably connect to the beams 33A, 33B of the ceiling assembly 13 in the collapsed state. It is envisioned that some of the connection plates 45 may not be pivotably connected to the left wall assembly 15.

[087] The right wall assembly 15 (when viewed from the end view of Fig. 16) can be oriented horizontally below the left wall assembly 15 and attached to the right side of the ceiling assembly 13 such that a single fastener 47 is received in one of the pair of fastener holes located adjacent the free end of the connection plate 45. In the illustrated embodiment, the single fastener 47 is received in the left-side fastener hole of the pair of fastener holes located adjacent the free end of the connection plate 45. Attaching the end portion of the connection plate 45 to beam 33B positions the right wall assembly 15 below the left wall assembly 15 for a compact configuration where the ceiling assembly 13 and the two wall assemblies are stacked on top of each other. This location of the fastener 47 causes the right wall assembly 15 to be spaced farther away from the ceiling assembly 13 than the left wall assembly in the collapsed position. Further, in this position, the connection plates 45 on an opposite end of the vertical member 27 on the right wall assembly 15 are also positioned to receive the beam 33B of the ceiling assembly 13. The parallel arrangement of the vertical member 27 on the right wall assembly 15 and the beam 33B on the ceiling assembly 13 facilitate stacking the assemblies in this manner. It will be understood that the opposite end of the right wall assembly 15 may be attached in a suitable manner to the opposite end of the ceiling assembly 13. Thus, a total of only four fasteners can be used to configure the assemblies 13, 15 in this stacked configuration. The pairs of connection plates 45 are spaced along the top and bottom members 21, 23 of the right wall assembly 15 so as to receive the beams 33A, 33B of the ceiling assembly 13 in the collapsed state.

[088] The location and geometry of the pivot connections and other components of the frame are particularly configured to permit the frame to be collapsed without interference of the wall assemblies with any part of the ceiling assembly. Moreover, the components are sized and connected together so that the wall assemblies 15 may lie substantially flat one upon the other in the collapse position.

[089] The collapsed ceiling and wall assemblies 13, 15 can then be placed on top of the horizontally oriented floor assembly 17 (Fig. 17) to configure the entire frame 11 in the collapsed state. In this state, multiple frames 11 can be stacked on top of each other in a space-saving manner (Fig. 2B). Accordingly, the multiple frames 11 can be transported in a transportation vehicle in the collapsed state to

a construction site or work site for subsequently erecting the frames during construction of a building framework. Additionally, the assemblies 13, 15, 17 can be stacked on top of each other for transport in a detached configuration such that the wall assemblies are free of attachment, moveable or otherwise, to the ceiling assembly or floor assembly.

[090] Referring to Figs. 18-21, the ("lift version") frame 11 can be reconfigured from the collapsed state into the expanded state by elevating the ceiling assembly 13 above the floor assembly 17 and pivoting the wall assemblies 15 downward until the second vertical members 27 of the wall assemblies are oriented substantially vertically. It will be understood, that the wall assemblies 15 pivot downward under the force of gravity as the ceiling assembly 13 is raised. In one embodiment, cables (not shown) may be attached between the ceiling assembly 13 and the wall assemblies 15 to control the rate of the pivoting movement of the wall assemblies. By pivoting the wall assemblies 15 such that they are oriented generally vertically, the fastener holes in the connection plates 45 will be aligned with fastener holes in the beam 33B of the ceiling assembly 13 for inserting fasteners in the remaining fastener holes of the connection plates to secure the wall assemblies 15 to the ceiling assembly. The connection plates 45 on the top members 21 of the wall assemblies 15 will also receive the beams 33A of the ceiling assembly 13 such that the fastener holes in the connection plates are aligned with fastener holes in beam 33A for fully attaching the wall assemblies to the ceiling assembly. The connection plates 45 on the bottom of the second vertical members 27 of the wall assemblies 15 can then be positioned to receive ends of the bar 41B of the floor assembly 17. The connection plates 45 on the bottom members 23 of the wall assemblies 15 will also receive the bars 41A of the floor assembly 17 such that the fastener holes in the connection plates are aligned with fastener holes in bars 41A. With the fastener holes in the connection plates 45 on the wall assemblies 15 aligned with the fastener holes in the bars 41A, 41B of the floor assembly 17, the wall assemblies can be secured to the floor assembly, thus fully erecting the frame 11 in the expanded state. This assembly method can be used when the assemblies are in a staked or non-stacked pre-assembled configuration. Accordingly, the wall assemblies 15 can be movably attached to the ceiling assembly 13 after the assemblies have been transported to the worksite.

[091] Referring to Fig. 22, an alternative configuration ("standard version") of the frame 11 may be used where the wall assemblies 15 are first attached to the floor assembly 17 in the same manner in which the wall assemblies are first attached to ceiling assembly 13 in the previous embodiment. The wall assemblies 15 can then be pivoted upward and secured to the ceiling assembly 13. This assembly method can also be used when the assemblies are in a staked or non-stacked pre-assembled configuration.

[092] Referring to Figs. 24 and 25, in an alternative embodiment of the wall assemblies 15', top and bottom members 21', 23' may extend continuously all the way to both ends of the wall assembly. Thus, second vertical members 27' will extend from a top surface of the bottom member 23' to a bottom surface of the top member 21'. In this embodiment, the pair of connection plates 45' on the end of the wall assembly adjacent the second vertical member 27' may extend directly from the top and bottom members 21', 23' instead of extending from the second vertical member as is the case in the previous embodiment. Additionally, a continuity plate 49' may be provided in the top and bottom members 21', 23' to increase the strength and stiffness or the top and bottom members. The frame may otherwise be constructed and function in the same manner are previously described.

[093] Referring to Figs. 26-28, another embodiment of a module or frame is generally indicated at 11". The frame 11" is substantially similar to frame 11 of the previous embodiment. However, instead of pairs of connection plates 45, frame 11" includes U-shaped brackets 45" attached to the top and bottom members 21", 23 of the wall assemblies 15" for receiving ends of beams 33 (see beam 33A" in Fig. 27) of the ceiling assembly 13" and ends of bars 41" of the floor assembly 17", respectively. Each bracket 45" includes a base plate 51" and a pair of side plates 53" extending from opposite ends of the base plate. Fasteners (e.g., bolts) 47" are received in the fastener holes of the side plates 53" of the brackets 45" to attach the brackets to the beams on the ceiling assembly 13" and the bars 41" on the floor assembly 17".

[094] Referring to Figs. 29-41, another embodiment of a module or frame is generally indicated at 111. The frame 111 is substantially similar to frame 11 of the previous embodiment. However, the construction of the ceiling assembly 113 and floor assembly 117 is different. In particular, the ceiling assembly 113

comprises a plurality of ceiling units 120A, 120B. Each ceiling unit 120A, 120B includes a plurality of parallel cross members or beams 133 spaced apart along a length of the ceiling unit, and a plurality of parallel horizontal ceiling members or rafters 135 extending between the beams. In the illustrated embodiment, the ceiling assembly 113 includes a pair of ceiling units 120A, 120B. Each ceiling unit includes first beams 133A extending across the ceiling assembly unit, and rafters 135A extending between the first beams. In the illustrated embodiment, one of the first beams 133A defines an end of the ceiling unit 120A, 120B, and the other first beams define intermediate portions of the ceiling unit. A second beam 133B defines an opposite end of the ceiling unit 120A, 120B. Rafters 135A extend between the first means 133A in the interior of the ceiling unit 120A or 120B. Second rafters 135B extend between the second beam 133B and the nearest first beam 133A in the interior of the ceiling unit 120A or 120B. Third ceiling members or rafters 135C extend between both the second beam 133B and the intermediate first beams 133A, and between the two first beams 133A. The rafters 135C are on the perimeter of the ceiling unit 120A or 120B. Each ceiling unit 120A, 120B is a self-contained unit formed separately from any other ceiling unit. In one embodiment, each ceiling unit 120A, 120B may have a length of between about 5 and about 60 feet, and a width of between about 1ft and about 14ft. As will be understood, the width of ceiling units 120A, 120B is determined by the length of the first and second beams 133A, 133B.

[095] Referring to Figs. 30-34, a first ceiling unit 120A defines a right ceiling unit as shown in the orientation of the frame 111 in Figs. 29 and 30. A second ceiling unit 120B is attached to the first ceiling unit 120A and defines a left ceiling unit as shown in Figs. 29 and 30. The first and second beams 133A, 133B of each ceiling unit 120A, 120B extend laterally past the outer-most rafters 135C to define free end margins of the beams on both ends of the rafters. Fastener holes 148 (Fig. 33) are formed in the free end margins to facilitate attachment of the ceiling units 120A, 120B to each other. In particular, left free end margins of the first and second beams 133A, 133B of the first ceiling 120A are configured to be attached to right free end margins of the beams of the second ceiling unit 120B. In the illustrated embodiment, connector plates 150 having fastener holes are used to attach the ceiling units 120A, 120B together to form the ceiling assembly 113. The fastener holes in the connector plates 150 are alignable with the fastener

holes 148 in the first and second beams 133A, 133B, and fasteners 147 are received in the aligned fastener holes to secure the beams to each other (Fig. 34). Each joint between the beams 133A, 133B of the ceiling units 120A, 120B includes a pair of connector plates 150 sandwiching the beams alongside surfaces of the beams. However, it will be understood that the connector plates 150 could sandwich the beams 133A, 133B along top and bottom surfaces of the beams 133A, 133B. Alternatively, a single connector plate 150 could be used to attach the beams 133A, 133B together. In the illustrated embodiment, the connector plates 150 comprise rectangular plate members. However, the connector plates 150 could have an alternative configuration without departing from the scope of the disclosure. Other ways of connecting the ceiling units 120A, 120B may be used within the scope of the present invention.

[096] Referring to Figs. 29, 30, 35, and 36, the free end margins on the right ends of the first and second beams 133A, 133B in the first ceiling unit 120A, and the free end margins on the left end of the beams in the second ceiling unit 120B are configured for attachment to the right and left wall assemblies 115, respectively. U-shaped brackets 145 (Figs. 35 and 36) like the bracket 45" shown in Figs. 26 and 27 are used to attach the wall assemblies to the ceiling units 120A, 120B. In particular, the brackets 145 defining fastener holes 146 (Fig. 36) are attached to interior surfaces of the top members 121 of the wall assemblies 115 for receiving the free end margins of the first and second beams 133A, 133B of the ceiling assembly 113. Fasteners (e.g., bolts) 147 (Fig. 29) are received in the fastener holes 146 of the brackets 145 to quickly attach the brackets to the first and second beams 133A, 133B on the ceiling assembly 113. Additionally, the ceiling assembly 113 may have bracing straps 119 for reinforcing the frame 111 (Fig. 41).

[097] The two ceiling units 120A, 120B allow the ceiling assembly 113 to be transported in separate connectable pieces to the construction site. For example, the ceiling units 120A, 120B can be stacked on top of each other and placed on a bed in a trailer. As a result, the total width of the ceiling assembly 113 in the transportation state will be less than the width of the ceiling assembly in the fully erected state. Additionally, the width of the ceiling assembly 113 in the transportation state will be less than the width, in the transportation state, of the ceiling assembly 13 of the previous embodiment. Therefore, the ceiling assembly

113 will more easily fit within a predetermined width. In one embodiment, the predetermined width is the width of the trailer of the truck allowing for transportation of the frame 111 without modification of a standard semi-trailer and/or without special permitting in most jurisdictions in the United States. Generally, the width of the entire unassembled frame 111 on the semi-trailer will be less than eight feet.

[098] Referring back to Figs. 29 and 35, wall assemblies 115 comprise a top member or beam 121, a bottom member or beam 123, and a plurality of first vertical members or studs 125 extending between the top and bottom members. The top and bottom members 121, 123 extend parallel to each other, and the first vertical members 125 extend parallel to each other. The first studs 125 are spaced inward from longitudinal ends of the top and bottom members 121, 123 such that the first studs extend from a top surface of the bottom member to a bottom surface of the top member. A second vertical member or stud 127 is disposed on one of the longitudinal ends of the top and bottom members 121, 123 and extends generally from a top surface of the bottom member to a bottom surface of the top member. The second studs 127 extend parallel to the first studs 125.

[099] Referring to Figs. 35 and 37-40, the floor assembly 117 comprises spaced apart parallel bars 141 extending along a length of the floor assembly. The bars 141 extend along the left and right sides of the floor assembly 117 and are secured to inner surfaces of the bottom members 123 of the left and right wall assemblies 115. Thus, the bars 141, in part, define the longitudinal sides of the wall assembly 117. A plurality of parallel horizontal first floor members or joists 143A extend laterally between the bars 141 and connect to interior sides of the bars. Second floor members 143B are spaced apart along the length of the floor assembly 117 and extend laterally between the bottom members 123 of the wall assemblies 115. One of the second floor members 143B is disposed at a first longitudinal end of the floor assembly 117, a second and third of the second floor members are disposed at intermediate locations along the length of the floor assembly, and a fourth second floor member is disclosed a second longitudinal end of the floor assembly. The first and third of the second floor members 143B may be attached in a suitable manner such as by welding to the interior surfaces of at least one of the bottom members 123, and the second and fourth of the

second floor members may be bolted to the bottom members 123 as will be explained in greater detail below. It will be understood, however, that the components of the floor assembly 117 may be secured together by any suitable means.

[100] Referring to Figs. 35, 37-39, U-shaped connection brackets 145 are arranged along the length of the bottom members 123 of the wall assemblies 115. In the illustrated embodiment, a first pair of brackets 145 are located in gaps 144 (Fig. 40) between the bars 141, and a second pair of brackets are disposed at the second longitudinal end of the bottom members 123. Therefore, the brackets 145 are spaced such that the first pair of bracket are configured to receive ends of the second of the second floor members 143B, and the second pair of brackets are configured to receive ends of the fourth of the second floor members 143B. Fasteners (e.g., bolts) 147 are received in the fastener holes of the brackets 145 to attach the brackets to the second floor members 143B and thereby attach the wall assemblies 115 to the floor assembly 117.

[101] Referring to Figs. 42-54, another embodiment of a module or frame is generally indicated at 211. The frame 211 is substantially similar to frame 111 of the previous embodiment. However, both the ceiling assembly 213 and floor assembly 217 are comprised of multiple ceiling and floor units, respectively. In particular, each ceiling unit 220A-D includes a pair of parallel cross members or beams 233 spaced apart along a length of the ceiling unit, and a plurality of ceiling members or rafters 235 located between the beams. In the illustrated embodiment, the ceiling assembly 213 includes four ceiling units 220A-D spaced along a length of the ceiling assembly. However, any number of ceiling units 220A-D could be used without departing from the scope of the disclosure. In the illustrated embodiment, the beams 233 define ends of the ceiling units 220 along the length of the ceiling assembly 213. First celling members 235A extend between the beams 233 along the length of the ceiling assembly 213, and second ceiling members 235B extend between the first ceiling members and along a width of the ceiling assembly. In the current embodiment, the ceiling units 220 have lengths extending length-wise with respect to the length of the ceiling assembly 213, and widths extending width-wise of the ceiling assembly. In one embodiment, each ceiling unit 220 may have a length of between about 5ft and about 60ft feet, and a width of between about 1ft and about 15ft. It will be

understood that the length and width of the ceiling units 220A-D could be otherwise defined.

[102] Referring to Figs. 43-46, a first ceiling unit 220A defines a first end ceiling unit as shown in the orientation of the frame 211 in Fig. 43. A second ceiling unit 220B defines a first intermediate ceiling unit, a third ceiling unit 220C defines a second intermediate ceiling unit, and a fourth ceiling unit 220D defines a second end ceiling unit. In the illustrated embodiment, the second and third ceiling units 220B, 220C have the same configuration. The beams 233 of each ceiling unit 220 extend past the outer-most rafters 235 to define free end margins of the beams on both ends of the beams. Fastener holes 248 are formed in the free end margins to facilitate attachment of the ceiling units 220A-D. In particular, the free end margins of the beams 233 in the ceiling units 220A-D are configured for attachment to the wall assemblies 215.

[103] As shown in Figs. 47-50, U-shaped brackets 245 are used to attach the wall assemblies to the ceiling units 220A-D. In particular, the brackets 245 defining fastener holes 246 are attached to the top members 221 of the wall assemblies 215 for receiving the free end margins of the beams 233 of the ceiling assembly 213. Fasteners (e.g., bolts) 247 are received in the fastener holes of the brackets 245 to attach the brackets to the beams 233 on the ceiling assembly 113. In the illustrated embodiment, single brackets 245 receive the free end margins of the outer-most beams 233 on the first and fourth ceiling units 220A, 220D to secure the ceiling units to the wall assemblies 215 (Fig. 42). These beams 233 define the longitudinal ends of the ceiling assembly 213. Referring to Figs. 42 and 47, single brackets 245 also receive free end margins of the beams 233 on adjacent ceiling units 220A-D along the interior of the ceiling assembly. Therefore, these brackets 245 secure adjacent ceiling units 220A-D together, and secure the ceiling units to the wall assemblies 215. Thus, the brackets 245 are sized and shaped to accommodate the component(s) received in the bracket.

[104] Referring to Figs. 49 and 50, the general construction of the brackets 245 is different to the construction of the brackets 45 and 145 of the previous embodiments. In particular, the brackets 245 comprise a U-shaped body 255 and flanges 257 extending from the U-shaped body. The U-shaped body 255 includes a base plate 251 and a pair of side plates 253 extending from opposite ends of the base plate in a direction perpendicular to the base plate. A first

flange 257 extends from one end of the base plate 251 in a direction parallel to the base plate, and a second flange 257 extends from the opposite side of the base plate in a direction parallel to the base plate and opposite of the direction in which the first flange extends. Thus, a base plate 251 and flanges 257 define a continuous plate structure with the side plates 253 extending orthogonally from the continuous plate. The side plates 253 and flanges 257 define the fastener holes 246 so that the brackets 245 can be fastened (e.g., bolted) to the wall assemblies 215 via the flanges, and receive fasteners (e.g., bolts) to attach to the beams 233 of the ceiling assembly 213 via the side plates 253. Other ways of attaching the brackets 245 to the wall assemblies 215 and to the ceiling assembly 213 may be used.

[105] Referring to Figs. 51-54, the floor assembly 217 is configured similar to the ceiling assembly 213 and includes a plurality of floor units 260A-D secured together and connected to the wall assemblies 215 by brackets 245. The floor units 260A-D are secured together and to the wall assemblies in a similar manner to how the ceiling units 220A-220D are secured together. Therefore, a detailed explanation is not provided.

[106] Referring to Figs. 55-62, another embodiment of a module or frame is generally indicated at 311. The frame 311 is substantially similar to frame 211 of the previous embodiment. In particular, both the ceiling assembly 313 and floor assembly 317 are comprised of multiple ceiling and floor units, respectively. In particular, each ceiling unit 320A-C includes a pair of parallel cross members or beams 333 spaced apart along a length of the ceiling assembly 313, and a plurality of ceiling members or rafters 335 located between the beams. In the illustrated embodiment, the ceiling assembly 313 includes three ceiling units 320A-C spaced along a length of the ceiling assembly. However, another number of ceiling units 320A-C could be used without departing from the scope of the disclosure. In the illustrated embodiment, the beams 333 define longitudinal ends of the ceiling units 320A-C. First celling members 335A extend between the beams 333 along the length of the ceiling assembly 313, and second ceiling members 335B extend between the first ceiling members along a width of the ceiling assembly. In the current embodiment, the ceiling units 320A-C may have lengths extending length-wise of the ceiling assembly 313, and widths extending width-wise of the ceiling assembly. In one embodiment, each ceiling unit 320A-C

may have a length of between about 5ft and about 60ft feet, and a width of between about 1ft and about 15ft. However, the length and width of the ceiling units 320A-C may be otherwise defined.

[107] Referring to Figs. 59-62, a first ceiling unit 320A defines a first end ceiling unit as shown in the orientation of the frame 311 in Fig. 55. A second ceiling unit 320B defines an intermediate ceiling unit, and a third ceiling unit 320C defines a second end ceiling unit. The beams 333 of each ceiling unit 320A-C extend past the outer-most rafters 335A to define free end margins of the beams on both ends of the beams. Fastener holes 348 are formed in the free end margins to facilitate attachment of the ceiling units 320A-C within the frame 311. In particular, the free end margins of the beams 333 in the ceiling units 320A-C are configured for attachment to the wall assemblies 315. As shown in Figs. 56-58, U-shaped brackets 345 are used to attach the wall assemblies 315 to the ceiling units 320A-C. In particular, the brackets 345 defining fastener holes 346 are attached (e.g., welded) to the top members 321 of the wall assemblies 315 for receiving the free end margins of the beams 333 of the ceiling assembly 313. Fasteners (e.g., bolts) 347 are received in the fastener holes of the brackets 345 to attach the brackets to the beams 333 on the ceiling assembly 113. In the illustrated embodiment, single brackets 345 receive the free end margins of respective beams 333 on the ceiling units 320A-C to secure the ceiling units to the wall assemblies 315. The difference between the connection of the ceiling units 320A-C of the frame 311 and the ceiling units 220A-D of the frame 211 is that the brackets 345 do not secure adjacent ceiling units directly together. Rather, each ceiling unit 320A-C is separately attached to the wall assemblies 315. Accordingly, gaps 370 (Fig. 56) are formed between adjacent ceiling units 320A-C.

[108] Referring to Figs. 55 and 57 the floor assembly 317 is configured similar to the ceiling assembly 313 and includes a plurality of floor units 360 connected to the wall assemblies 315 by brackets 345. The floor units 360 are secured to the wall assemblies in a similar manner to how the ceiling assembly 313 is secured therefore a detailed explanation is not provided.

[109] Referring to Fig. 63, another embodiment of a module or frame is generally indicated at 411. The frame 411 is substantially similar to frame 111 of the previous embodiment. In particular, the ceiling assembly 413 has the same

configuration as the ceiling assembly 113. However, the construction of floor assembly 417 is different. In particular, the floor assembly 417 comprises a plurality of floor units 460 similar to floor assembly 317. In the illustrated embodiment, the floor assembly 417 includes four separate floor units 460. However, it is understood that the floor assembly 417 could have fewer than four or more than four floor units 460 without departing from the scope of the disclosure.

[110] When introducing elements of the present invention or the preferred embodiments(s) thereof, the articles "a", "an", "the" and "said" are intended to mean that there are one or more of the elements. The terms "comprising", "including" and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[111] In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

[112] As various changes could be made in the above constructions, products, and methods without departing from the scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

OTHER STATEMENTS OF THE DISCLOSURE

[113] A. A module or frame for use in constructing a building framework, the frame comprising a ceiling assembly, a pair of wall assemblies configured for attachment to opposite sides of the ceiling assembly at tops of the wall assemblies, and a floor assembly configured for attachment to a bottom of the wall assemblies.

[114] AB. The module or frame as set forth in claim A wherein the frame is configurable in a collapsed state and an expanded state.

[115] AC. The module or frame as set forth in claim AB wherein in the collapsed state wall members of the wall assemblies extend generally parallel to wall members of the ceiling assembly.

[116] AD. The module or frame as set forth in either claim AB or AC wherein the wall assemblies are movable relative to one of the ceiling assembly and the floor assembly to configure the frame from the collapsed state to the expanded state.

[117] AE. The module or frame as set forth in claim AD wherein the wall assemblies are pivotally attached to said one of the ceiling assembly and floor assembly in the collapsed state.

[118] AF. The module or frame as set forth in claim AE wherein pivot points between the wall assemblies and the ceiling assembly and floor assembly are designed in such a way that the wall assemblies and one of the ceiling assembly and the floor assembly do not collide when collapsed or expanded.

[119] AG. The module or frame as set forth in claim AF wherein a pivot point between a first wall assembly and one of the ceiling assembly and floor assembly is located higher than a pivot point between a second wall assembly and one of the ceiling assembly and floor assembly.

[120] AH. The module or frame as set forth in any one of claims AD-AG wherein the wall assemblies pivot downward under the force of gravity as the ceiling assembly is raised.

[121] AI. The module or frame as set forth in any one of claims AD-AH wherein the frame further comprises a cable extending between the ceiling assembly and one of the wall assemblies to control pivotal movement of the wall assembly when the ceiling assembly is elevated above the ground.

[122] AJ. The module or frame as set forth in claim A wherein the frame further comprises connection plates fixedly attached to the wall assemblies for attaching the wall assemblies to the ceiling assembly and floor assembly.

[123] AK. The module or frame as set forth in claim AJ wherein the connection plates are attached to one of the ceiling assembly and the floor assembly in the collapsed state such that one of the wall assemblies is disposed above the other wall assembly.

[124] AL. The module or frame as set forth in either claim AJ or AK wherein the connection plates are arranged in pairs on the wall assemblies, each pair of connection plates being configured to receive a ceiling member of the ceiling assembly or a floor member of the floor assembly.

[125] AM. The module or frame as set forth in any one of claims AJ-AL wherein the connection plates define fastener holes for receiving fasteners to attach the wall assemblies to the ceiling assembly and floor assembly.

[126] AN. The module or frame as set forth in claim AM wherein at least four fasteners are used to attach the wall assemblies to said one of the ceiling assembly and floor assembly in the collapsed state.

[127] B. A building framework assembly comprising a plurality of frames, each frame being configurable in a collapsed state for stacking the frames on top of each other.

[128] BA. The building framework assembly as set forth in claim B wherein each frame comprises a ceiling assembly, a pair of wall assemblies, and a floor assembly, the wall assemblies being attached to one of the ceiling assembly and the floor assembly in the collapsed state.

[129] BB. The building framework assembly as set forth in claim BA wherein the wall assemblies are free of attachment to the other of the ceiling assembly and floor assembly in the collapsed state.

[130] BC. The building framework assembly as set forth in either one of claims BA or BB wherein at least four fasteners are used to attach the wall assemblies to said one of the ceiling assembly and floor assembly in the collapsed state.

[131] BD. The building framework assembly as set forth in any one of claims BA-BC wherein the wall assemblies are pivotally attached to said one of the ceiling assembly and floor assembly in the collapsed state.

[132] BE. The building framework assembly as set forth in any one of claims BB-BE wherein in the collapsed state wall members of the wall assemblies extend generally parallel to wall members of the ceiling assembly.

[133] BF. The building framework assembly as set forth in claim BD or BE wherein floor members and ceiling members extend parallel to an axis of rotation about which a wall assembly pivots with respect to a ceiling assembly.

WHAT IS CLAIMED IS:

1. A module for use in constructing a building, the module comprising:

a ceiling assembly;

a plurality of wall assemblies configured for attachment to opposite sides of the ceiling assembly generally at tops of the wall assemblies;

a floor assembly configured for attachment generally to bottoms of the wall assemblies; and

a plurality of connector plates attached to the wall assemblies, the connector plates being configured to receive fasteners for attaching the ceiling assembly and floor assembly to the wall assemblies to form a module configured to be placed with other modules to form at least a portion of the building.

2. The module of claim 1, wherein each wall assembly includes a plurality of wall members, and wherein the plurality of connector plates comprise a plurality of planar plate members welded to the wall members of the wall assemblies.

3. The module of claim 1, wherein the plurality of connector plates comprise a plurality of U-shaped brackets.

4. The module of claim 3, wherein the U-shaped brackets include flanges extending from opposite sides of each bracket, the flanges being configured for attachment to at least one of the wall assemblies.

5. The module of claim 1, wherein each wall assembly includes a plurality of wall members, and wherein the wall members of each wall assembly include a top member, a bottom member, and a plurality of vertical members extending between the top and bottom members, the connector plates being attached to the top and bottom members of the wall assemblies.

6. The module of claim 5, wherein the ceiling assembly includes a plurality of ceiling members, and wherein the ceiling members of the ceiling assembly

include a plurality of first members spaced apart along a length of the ceiling assembly, and a plurality of second members disposed between the first members of the ceiling assembly, at least some of the connector plates being attached to the first members of the ceiling assembly to attach the ceiling assembly to the wall assemblies.

7. The module of claim 6, wherein the floor assembly includes a plurality of floor members, and wherein the floor members of the floor assembly include a plurality of first members spaced apart along a length of the floor assembly, and a plurality of second members disposed between the first members of the floor assembly, at least some of the connector plates being attached to the first members of the floor assembly to attach the floor assembly to the wall assemblies.

8. The module of claim 7, wherein the connector plates, the first members of the ceiling assembly, and the first members of the floor assembly each define fastener holes, the fastener holes in the first members being alignable with the connector plates such that fasteners can be inserted through the connector plates and the fastener holes in the first members to attach the ceiling assembly and floor assembly to the wall assemblies.

9. A module for use in constructing a building, the module comprising:

a ceiling assembly including a plurality of ceiling units each including a plurality of ceiling members fixedly attached together such that each ceiling unit is a self-contained unit formed separately from any other ceiling unit, the ceiling units being operatively coupled to each other;

a plurality of wall assemblies configured for attachment to opposite sides of the ceiling assembly generally at tops of the wall assemblies; and

a floor assembly configured for attachment generally to bottoms of the wall assemblies,

wherein the ceiling assembly, wall assemblies and floor assembly form a module configured to be placed with other modules to form at least a portion of the building.

10. The module of claim 9, wherein each ceiling unit comprises at least four ceiling members.

11. The module of claim 10, wherein each ceiling unit comprises a plurality of first members spaced apart along a length of the ceiling assembly, and a plurality of second members disposed between the first members of the ceiling assembly.

12. The module of claim 11, wherein the first members are attached to one of the wall assemblies.

13. The module of claim 11, wherein the first members extend transversely across the length of the ceiling assembly.

14. The module of claim 9, wherein the floor assembly includes a plurality of floor units each including a plurality of floor members fixedly attached together such that each floor unit is a self-contained unit formed separately from any other floor unit, the floor units being operatively connected to each other.

15. The module of claim 14, wherein each floor unit comprises a plurality of first members spaced apart along a length of the floor assembly, and a plurality of second members disposed between the first members of the floor assembly.

16. The module of claim 15, wherein the first members of the floor assembly are attached to at least one of the wall assemblies.

17. A method of assembling a module for a building comprising:

attaching a first wall assembly to a first longitudinal side of a floor assembly generally at a bottom of the first wall assembly;

attaching a second wall assembly to a second longitudinal side of the floor assembly generally at a bottom of the second wall assembly;

coupling a first ceiling unit to a second ceiling unit to at least in part form a ceiling assembly, each of the ceiling units including a plurality of ceiling members fixedly attached together such that each ceiling unit is a self-contained unit formed separately from any other ceiling unit; and

attaching the ceiling assembly generally to tops of the first and second wall assemblies.

18. The method of claim 17, wherein coupling the first ceiling unit to the second ceiling unit comprises bolting the first ceiling unit to the second ceiling unit.

19. The method of claim 17, wherein coupling the first ceiling unit to the second ceiling unit comprises separately bolting the first and second ceiling units to the wall assemblies.

20. The method of claim 17, further comprising coupling a first floor unit to a second floor unit to at least in part form a floor assembly, each of the floor units including a plurality of floor members fixedly attached together such that each floor unit is a self-contained unit formed separately from any other floor unit.

21. A method of building a modular building comprising the steps of:

fabricating modules at a manufacturing facility such that each module is made up of separate component parts;

loading the component parts onto a semi-trailer with the component parts separated from each other and arranged so that a width of the loaded components does not exceed a predetermined dimension;

transporting the component parts of the frame on the semi-trailer to a desired location; and

assembling the component parts from the load on the semi-trailer to form at least part of one module; and

transporting an assembled module to the construction site.

22. The method as set forth in claim 21 further comprising connecting the module to other modules to form at least part of the modular building.

23. The method as set forth in claim 21 wherein a smallest transverse dimension of the module is less than eight feet.

24. The method as set forth in claim 21 wherein the component parts are constructed for quick connection to form the module.

25. The method as set forth in claim 24 wherein the component parts are constructed for bolt-together connection to form the module.

FIG. 1

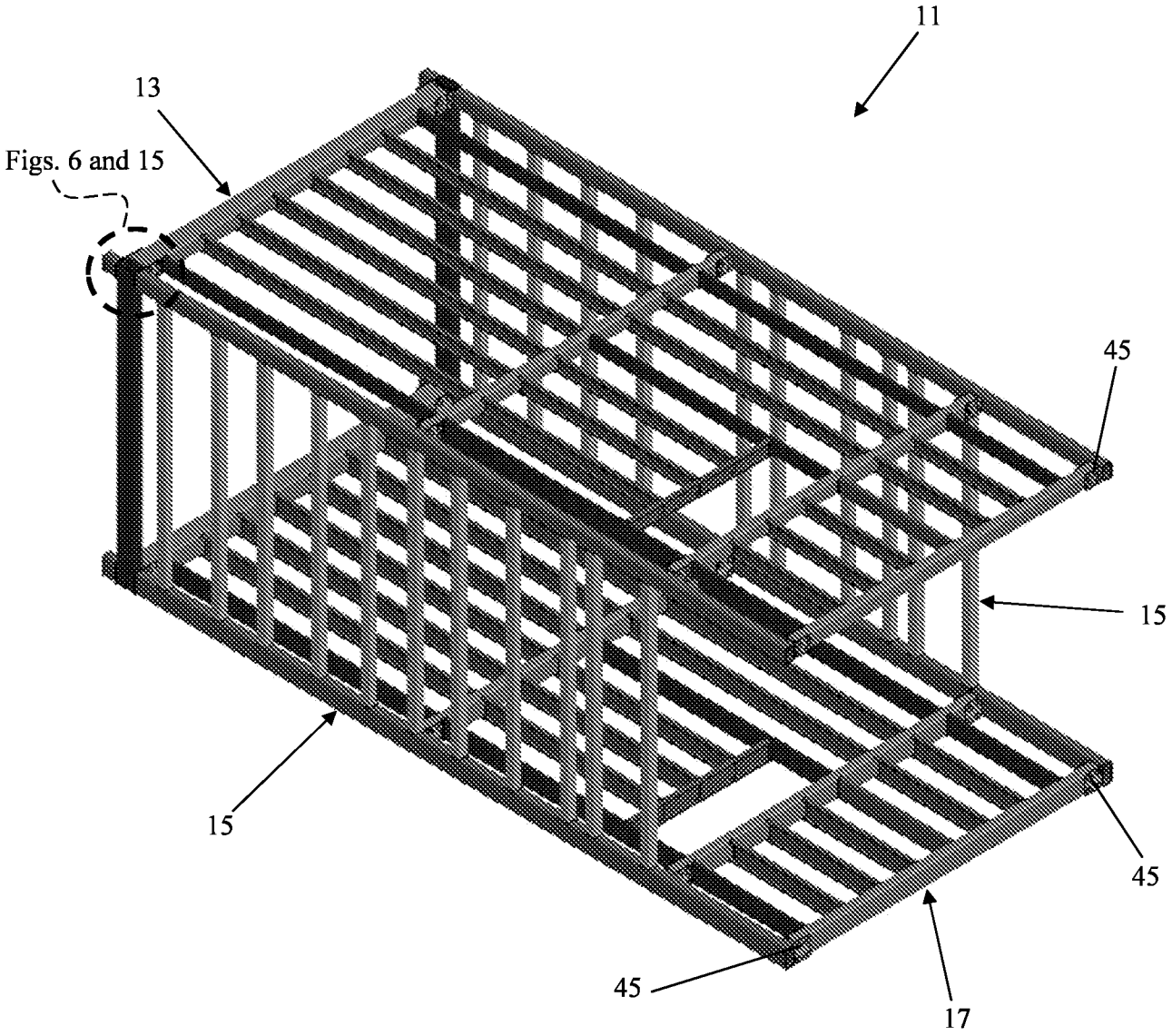


FIG. 2

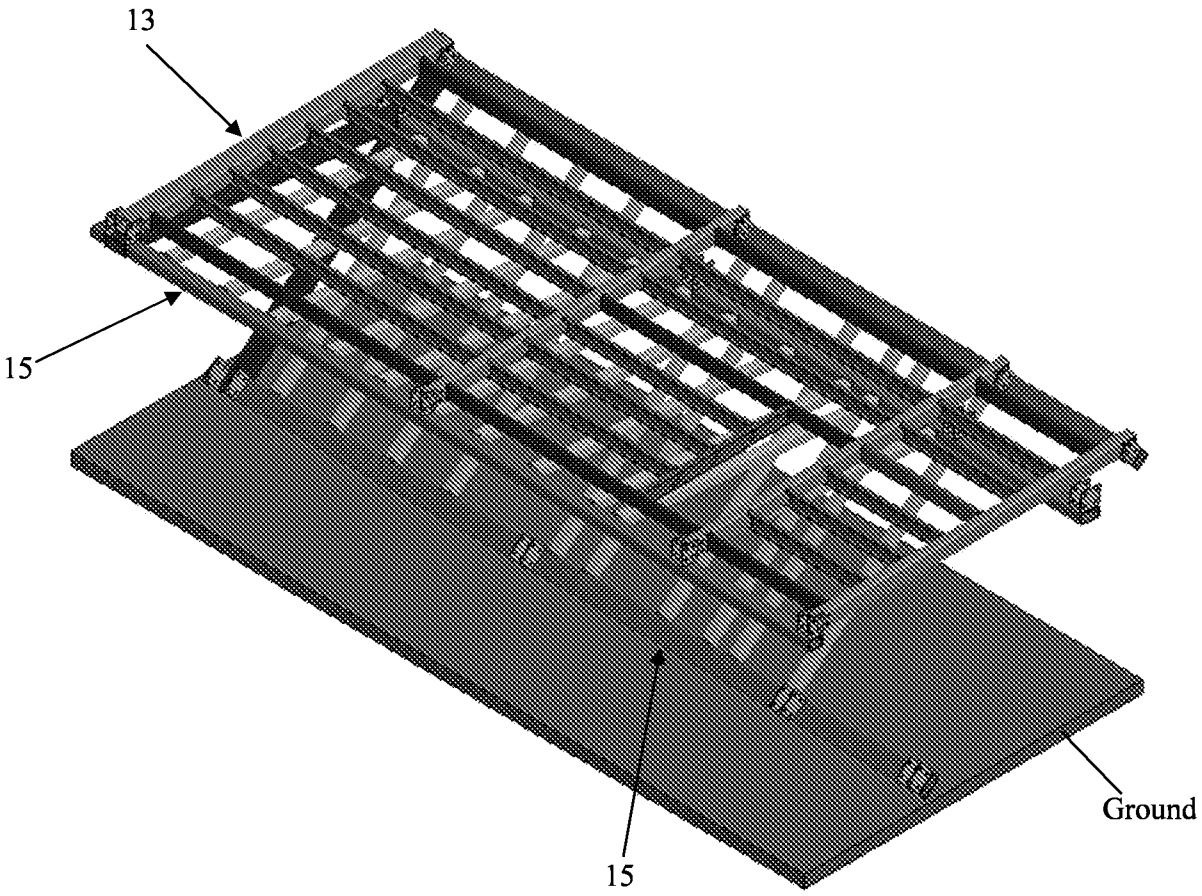


FIG. 2A

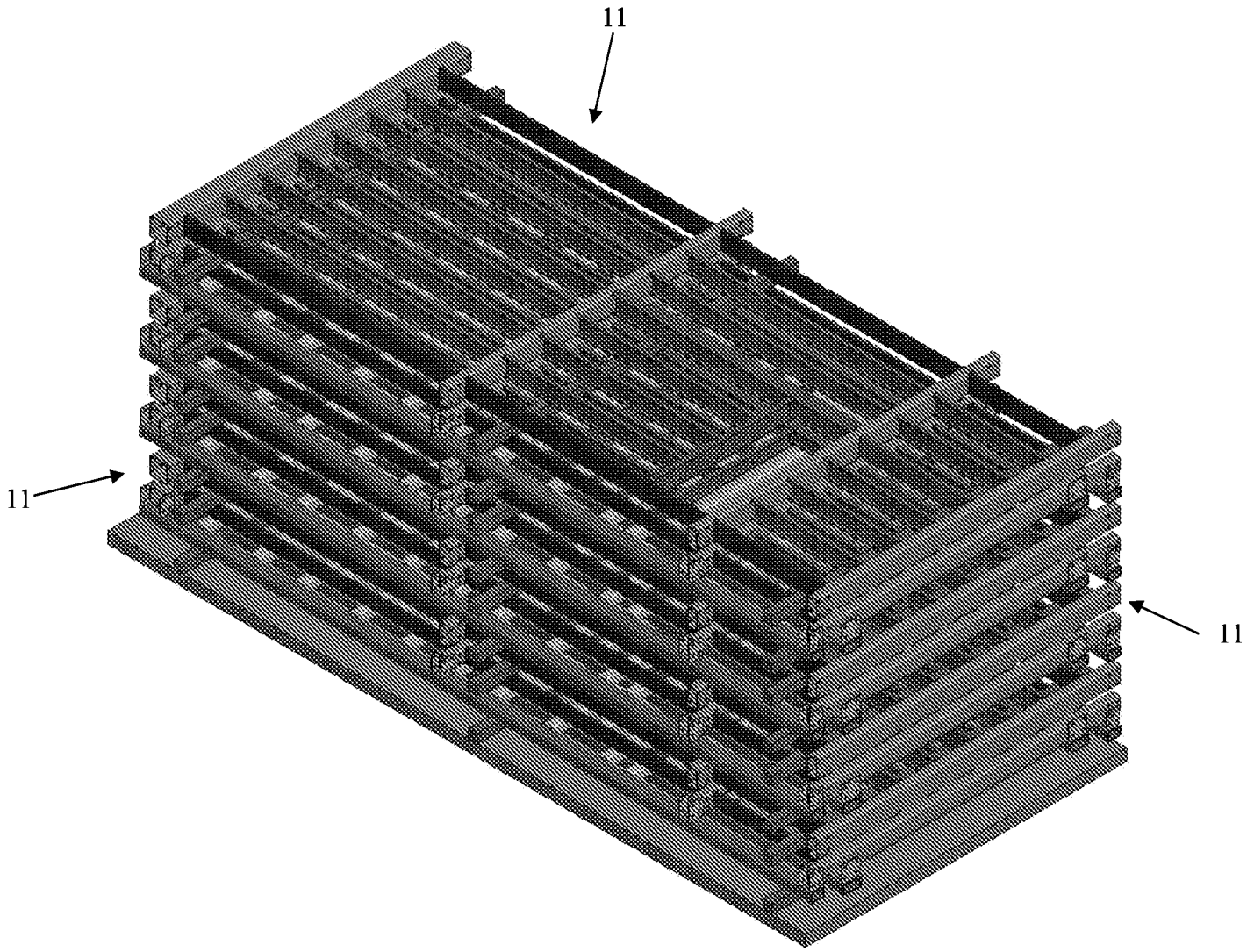


FIG. 2B

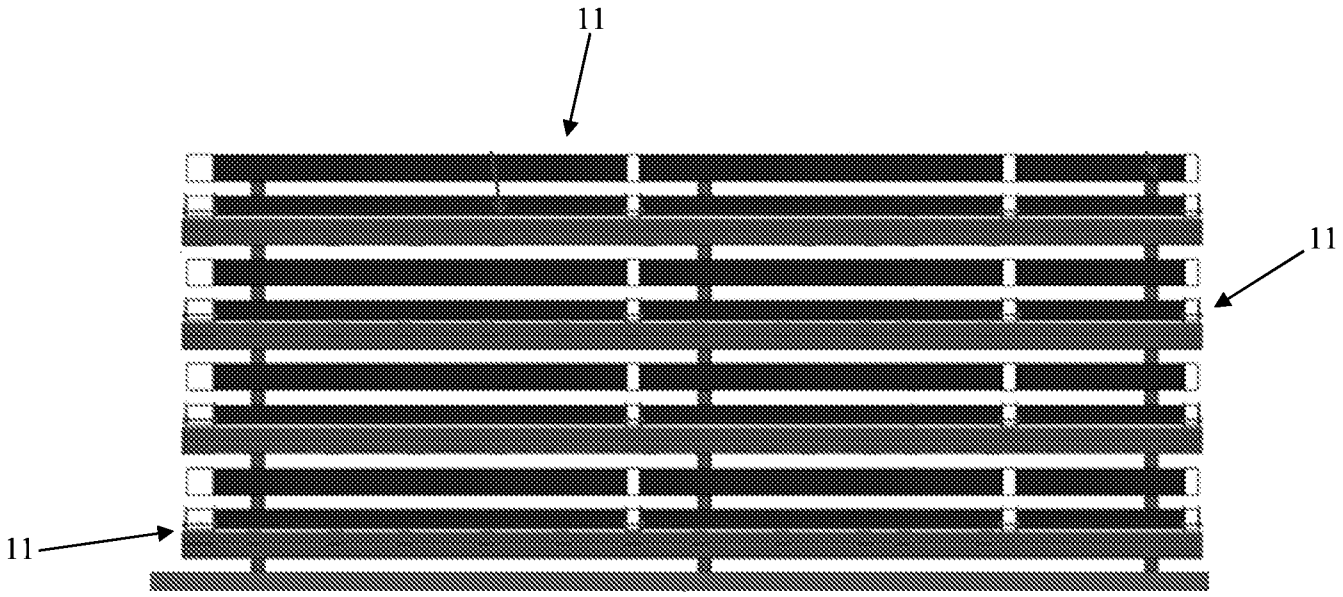


FIG. 3

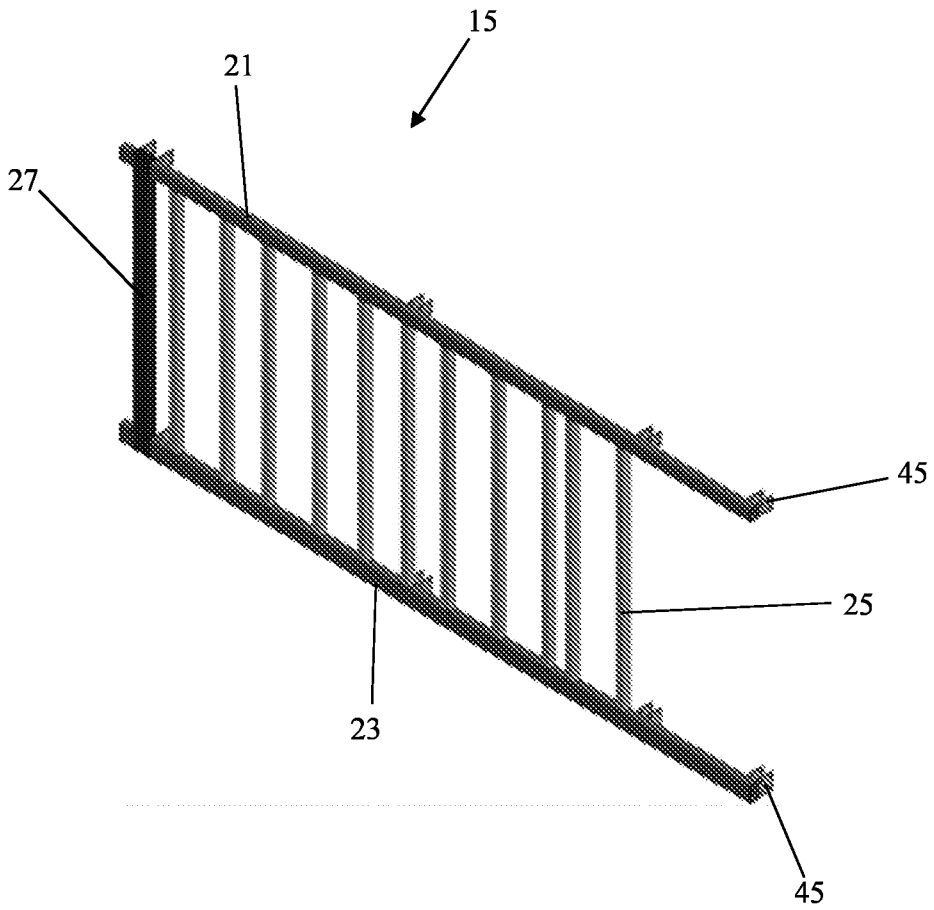


FIG. 4

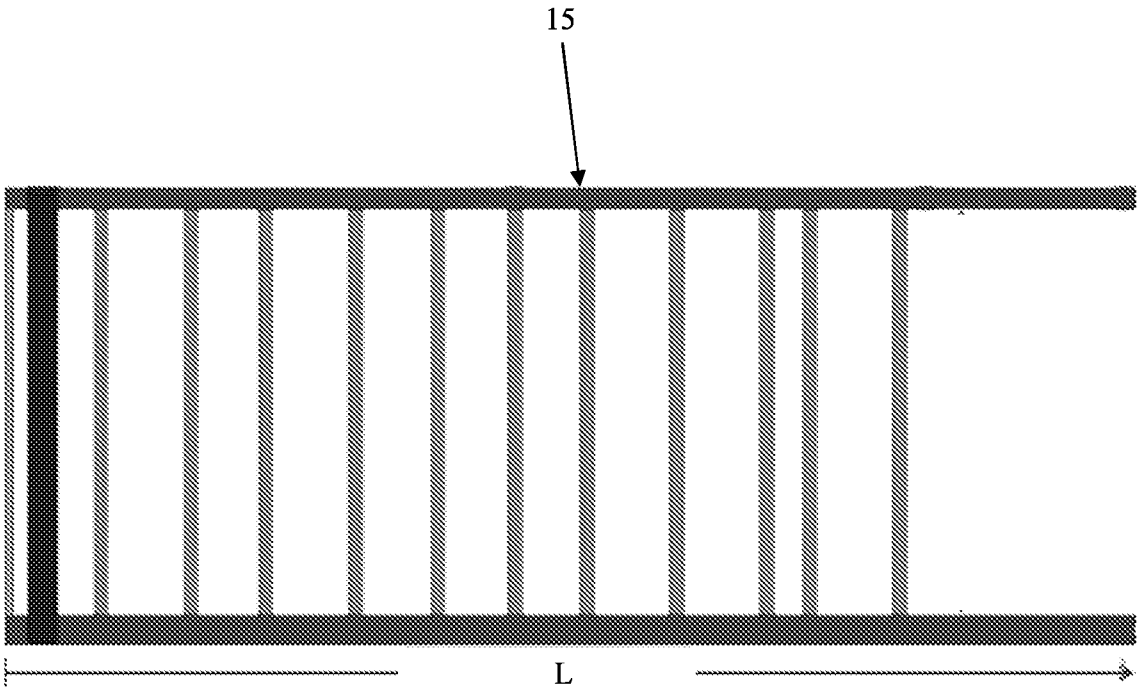


FIG. 5

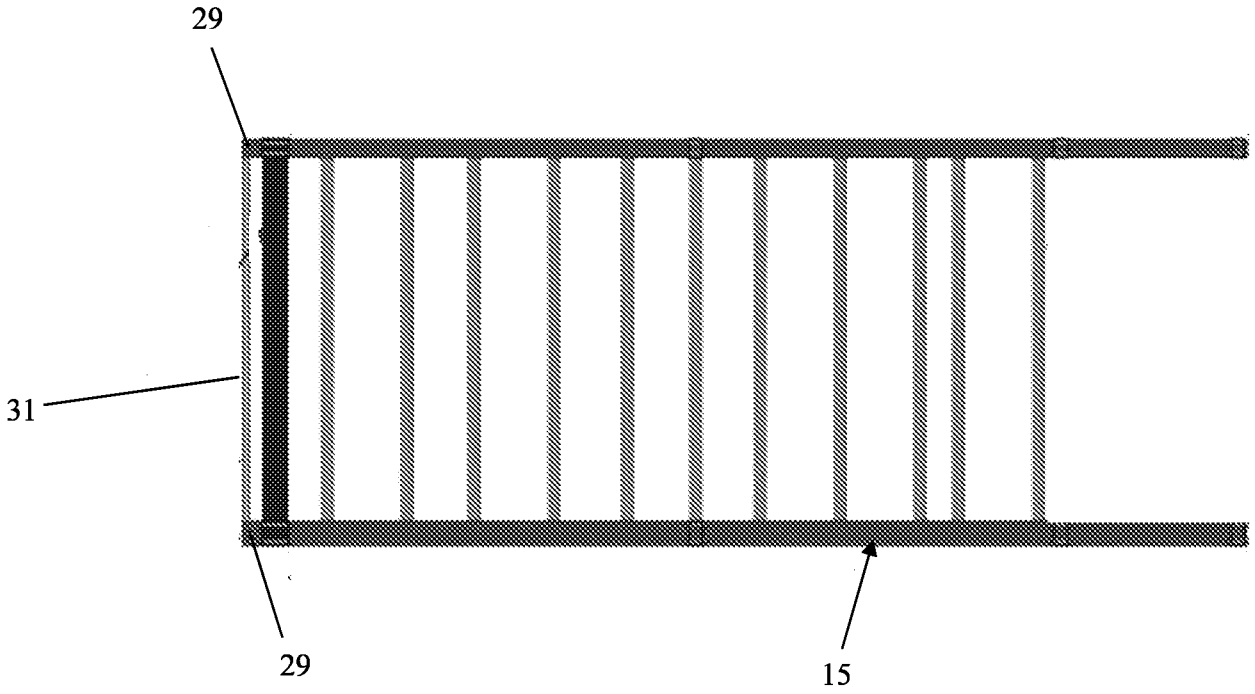


FIG. 6

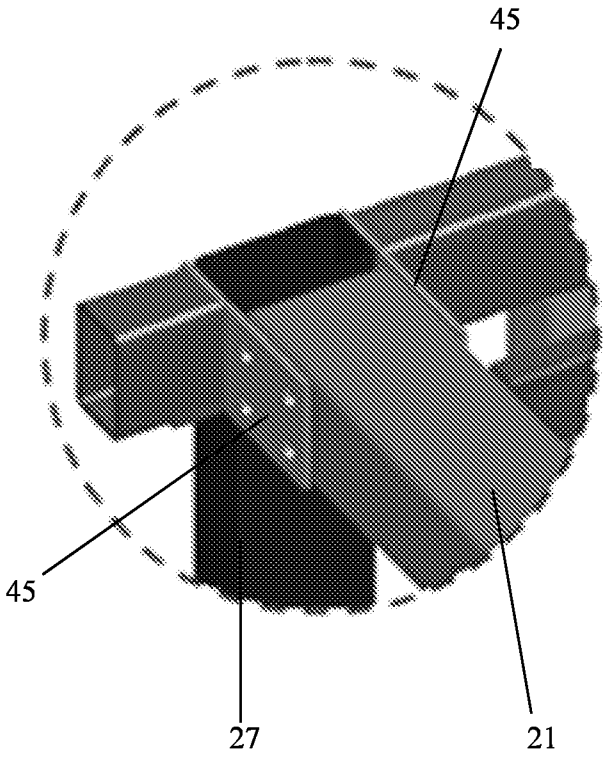


FIG. 7

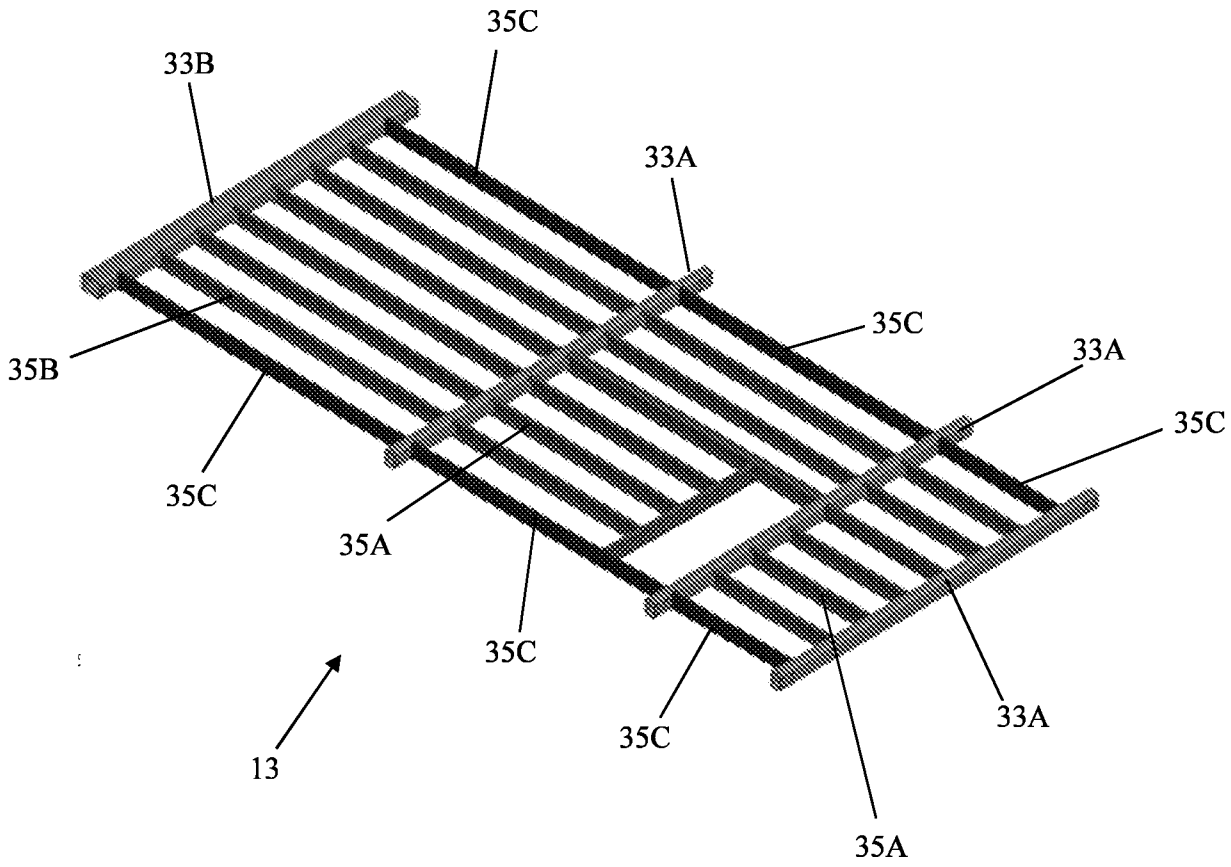


FIG. 8

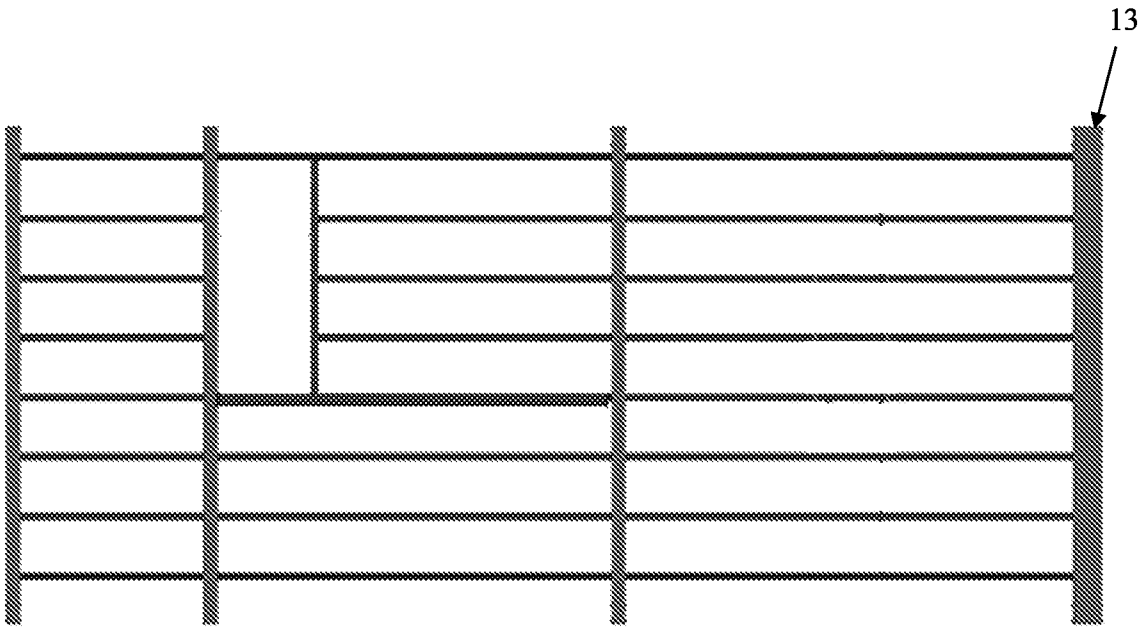


FIG. 9

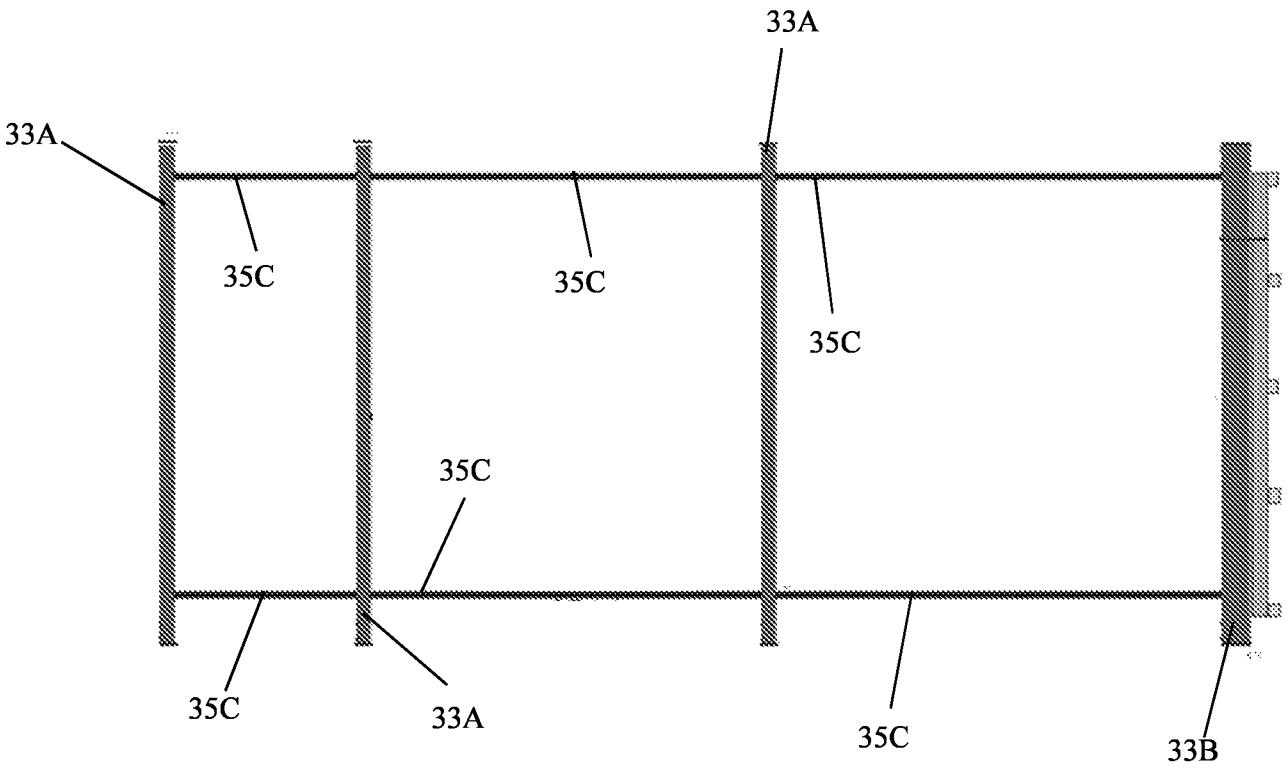


FIG. 10

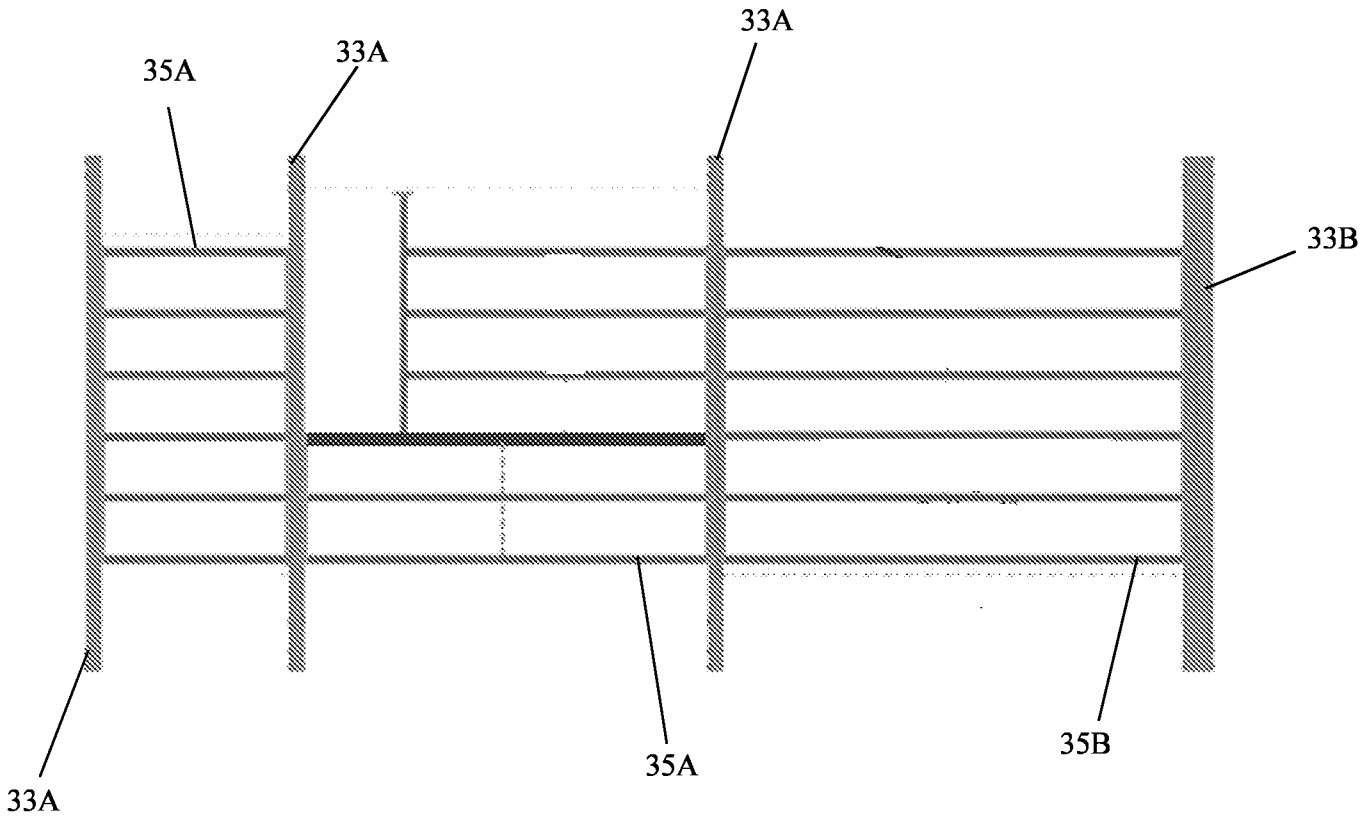


FIG. 11

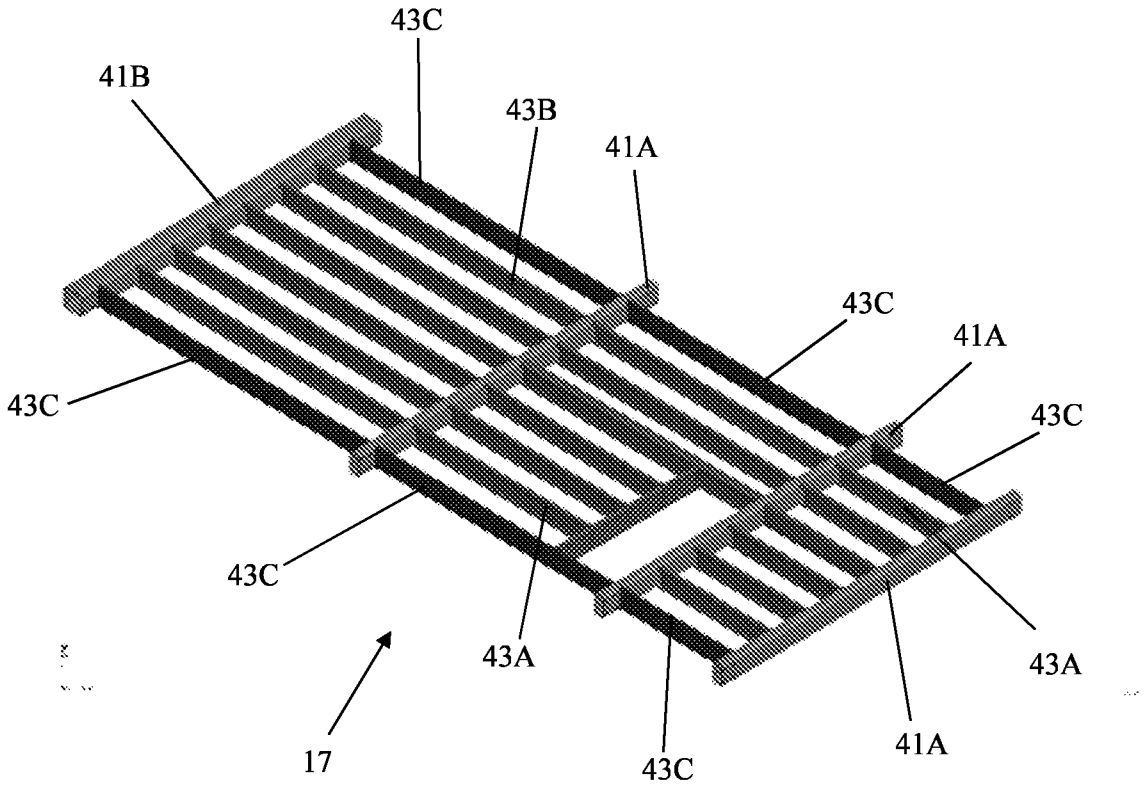


FIG. 12

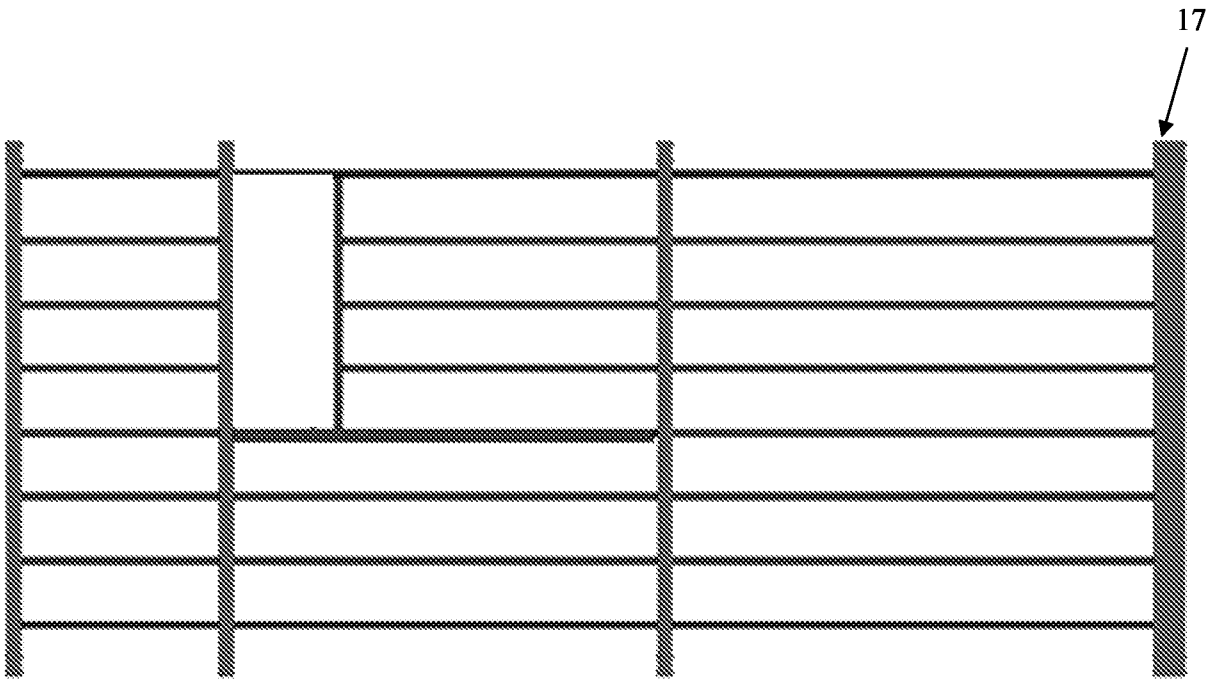


FIG. 13

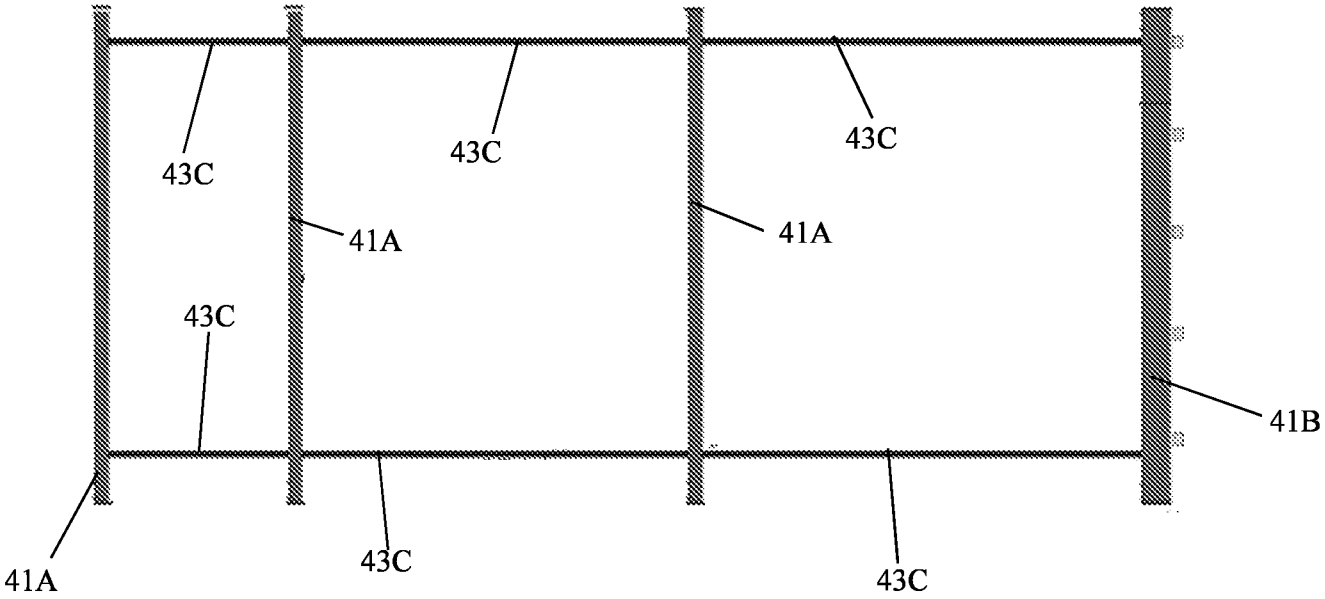


FIG. 14

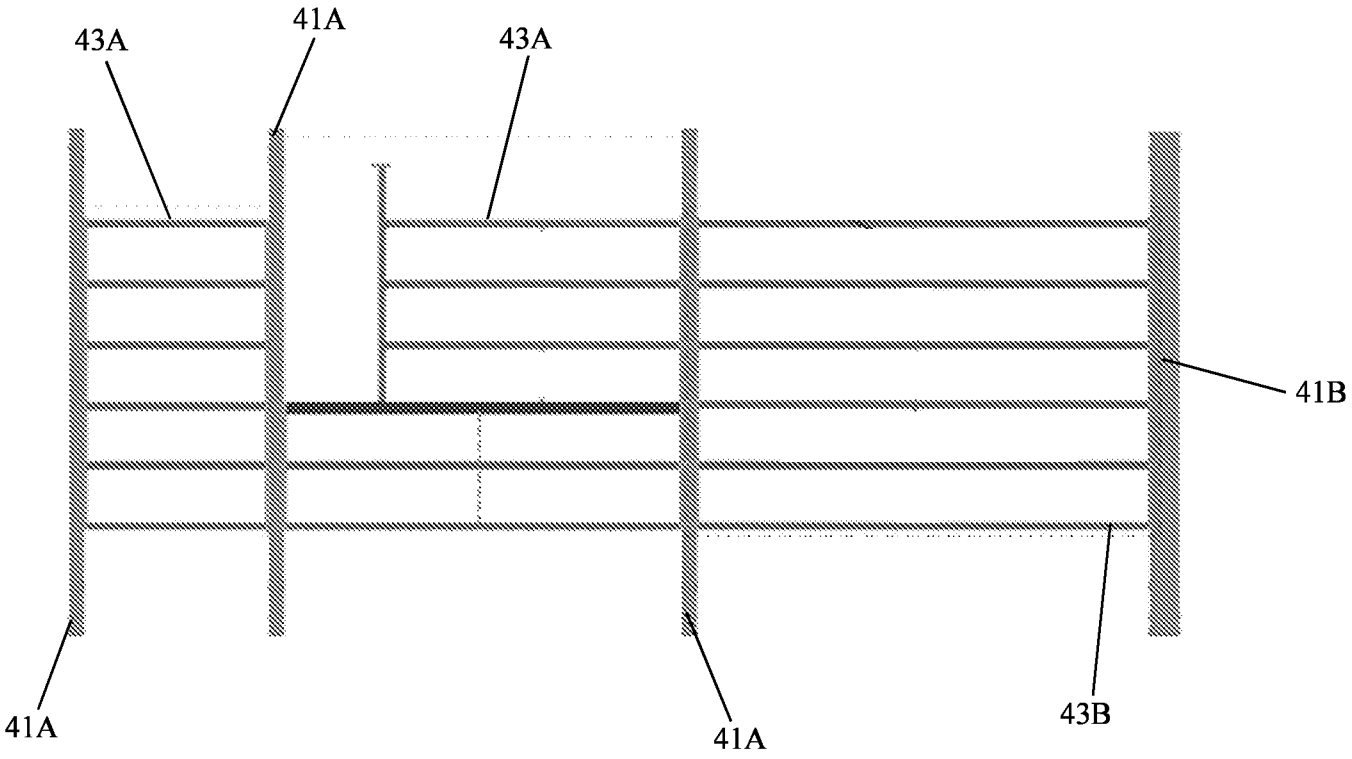


FIG. 15

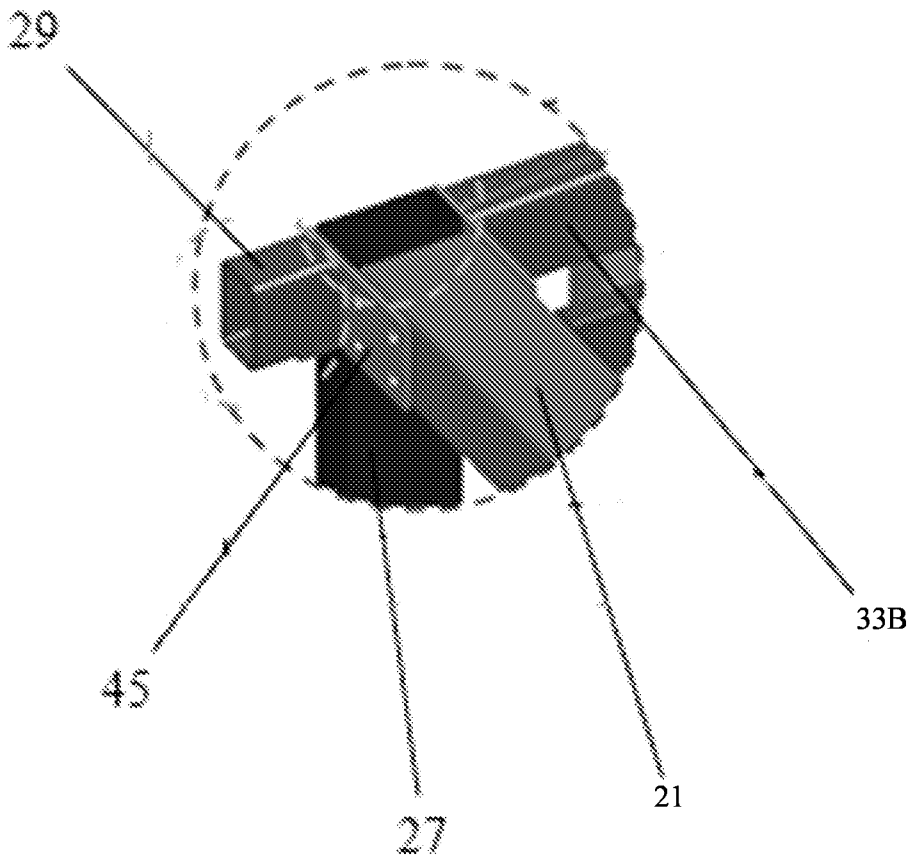


FIG. 16

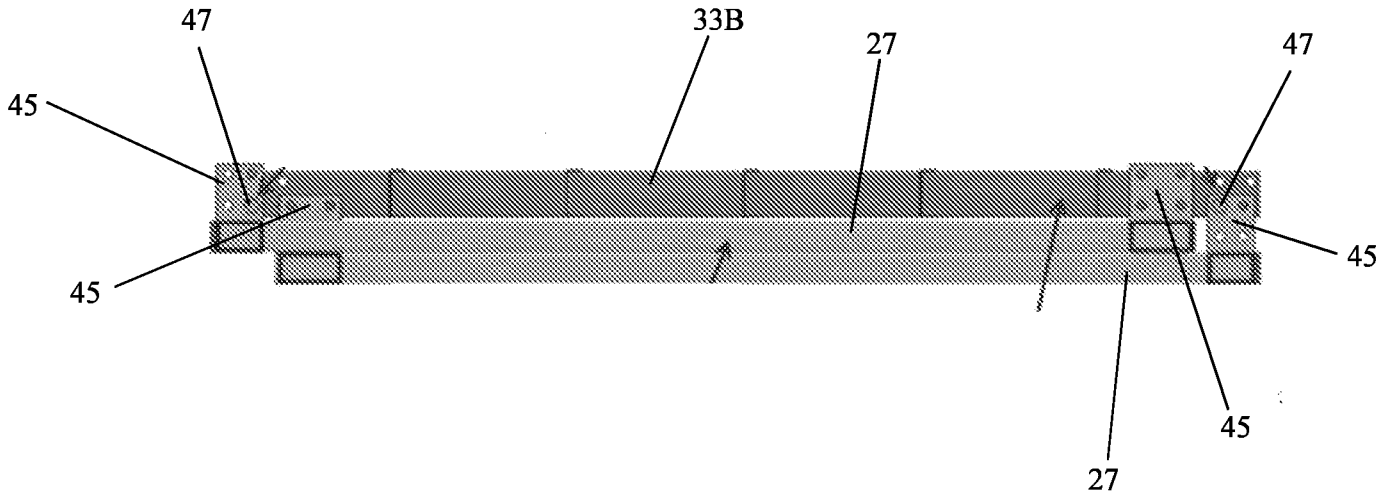


FIG. 17

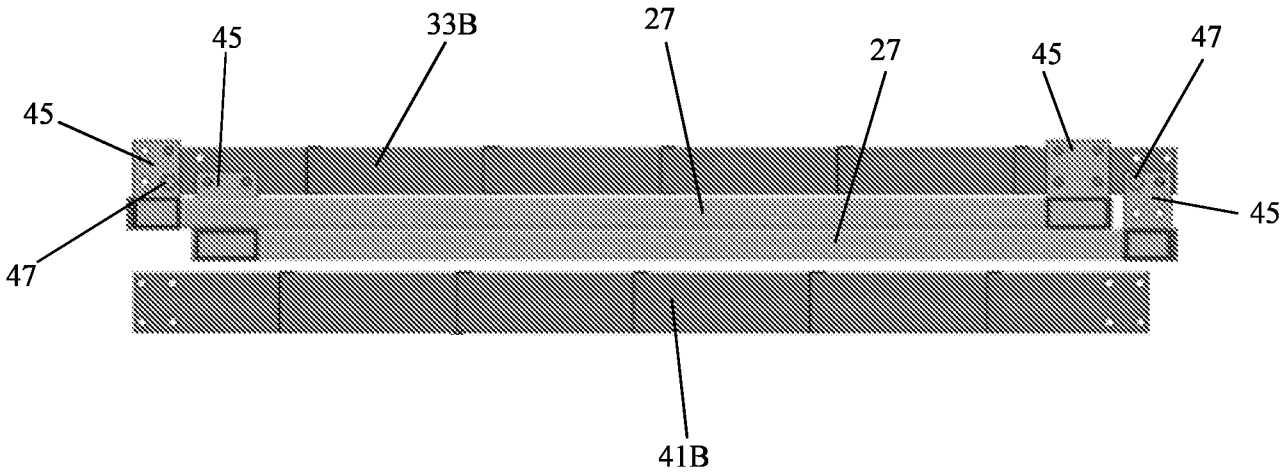


FIG. 18

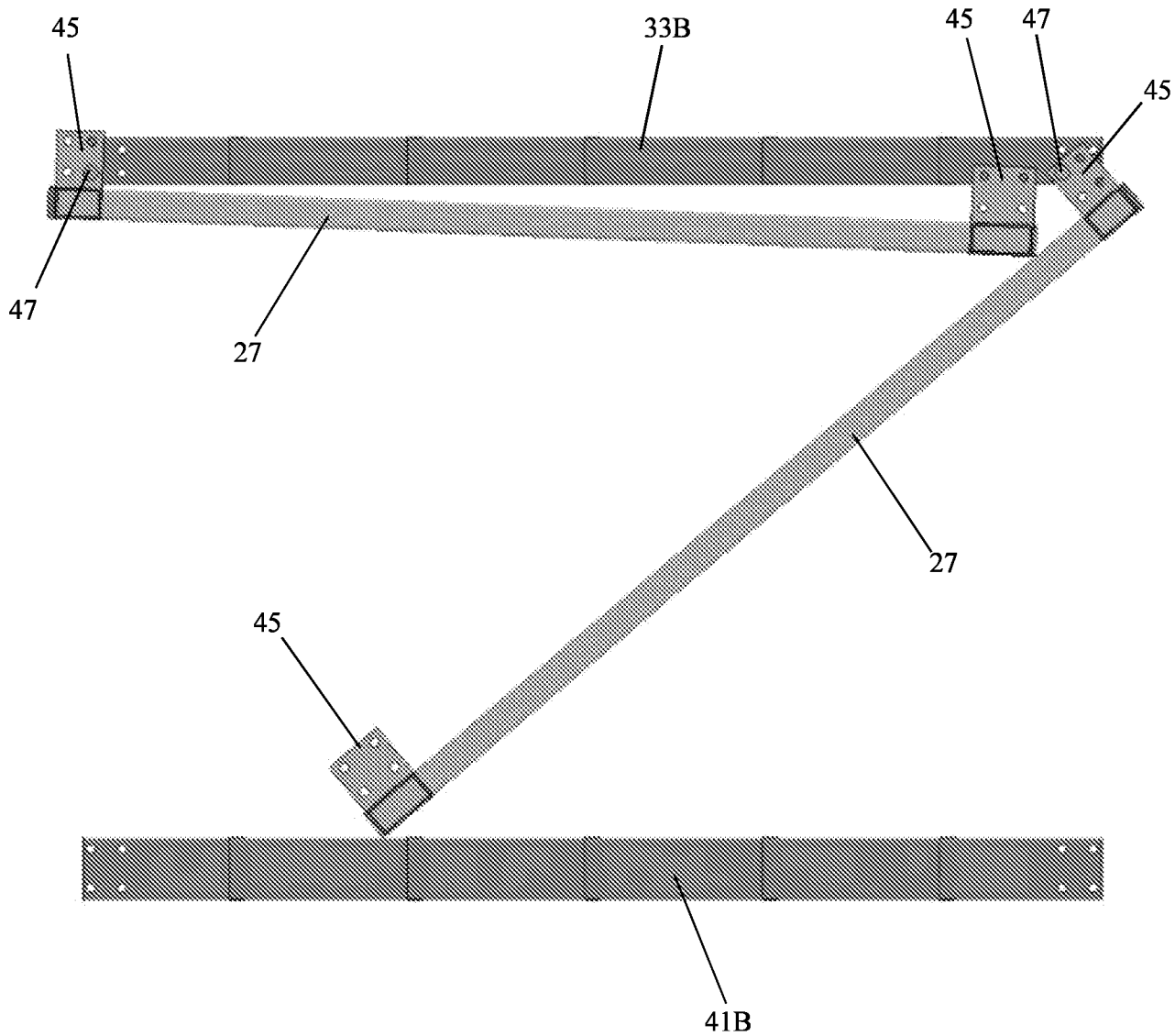


FIG. 19

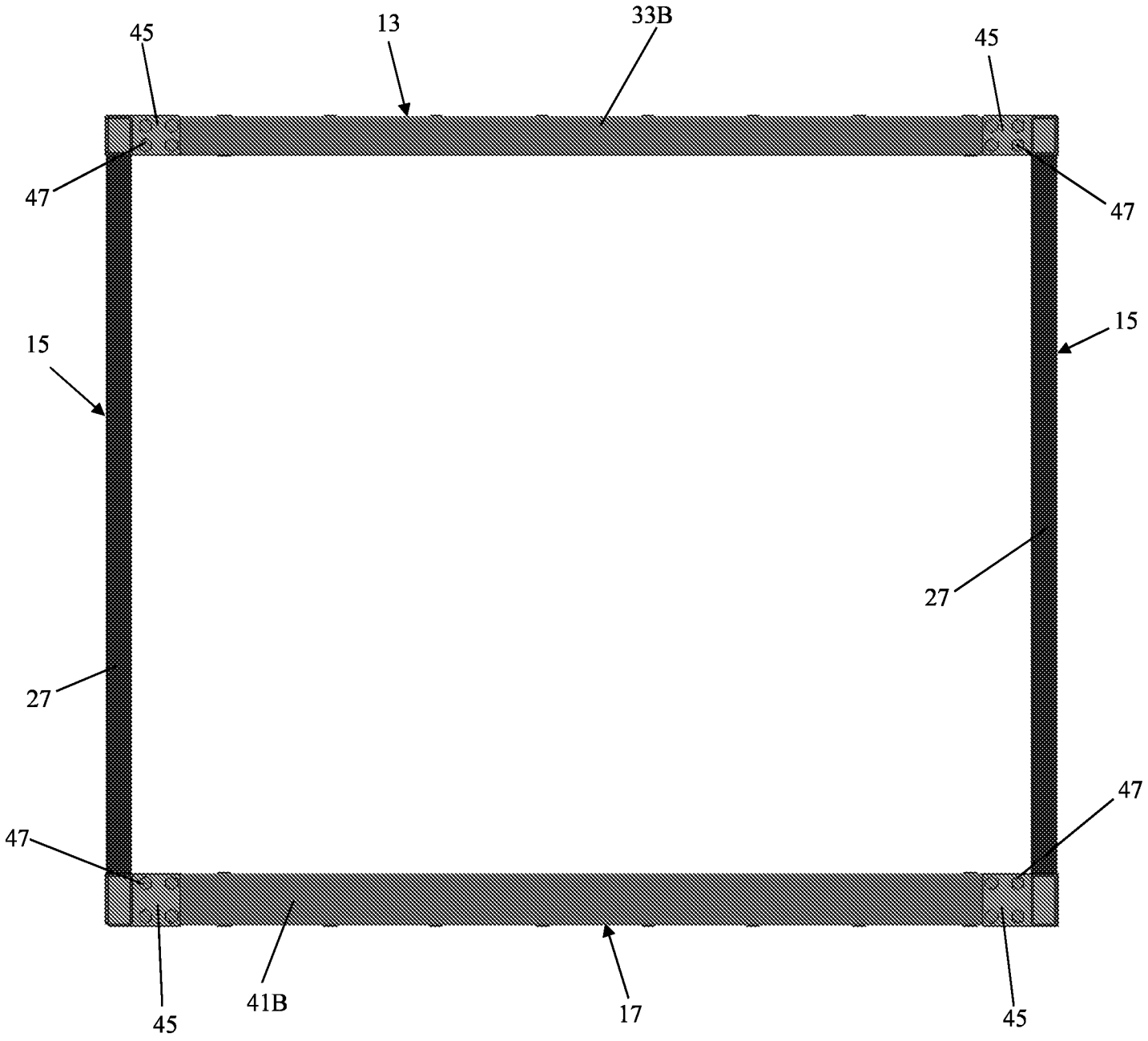


FIG. 20

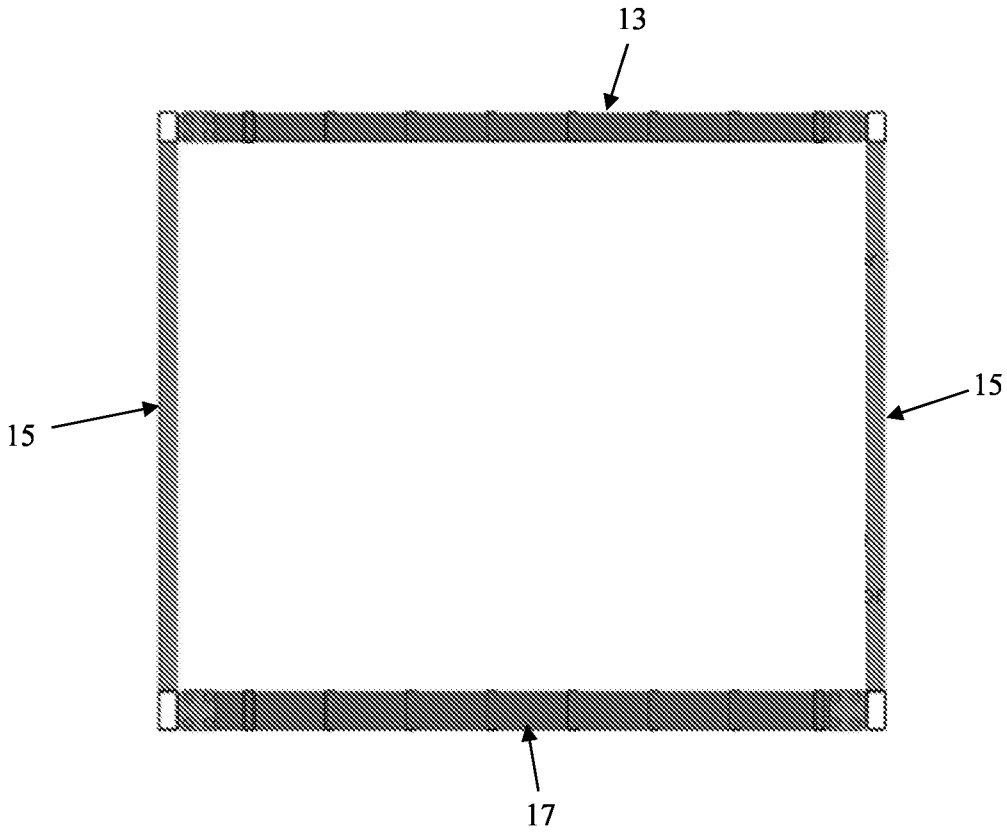


FIG. 21

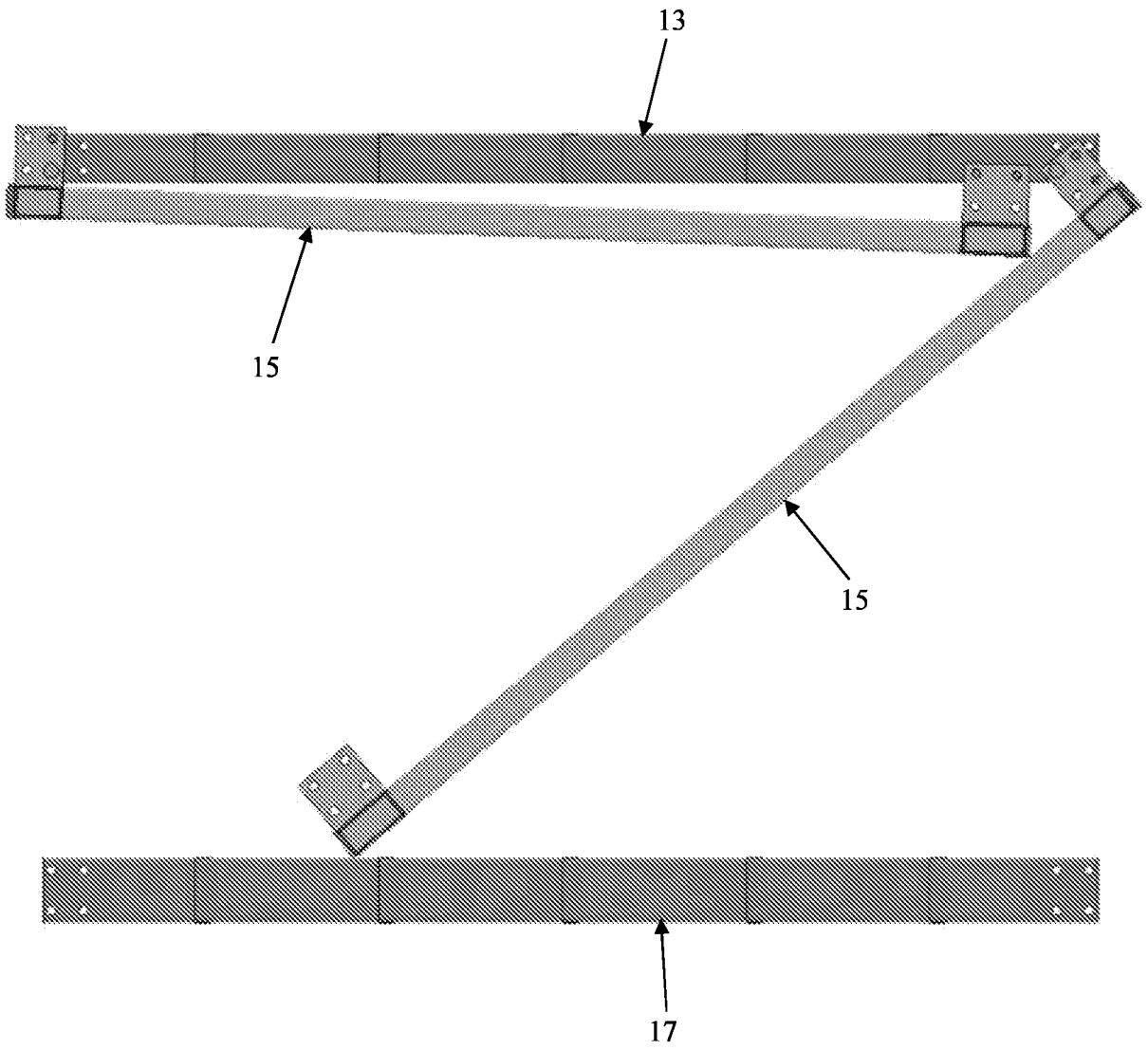


FIG. 22

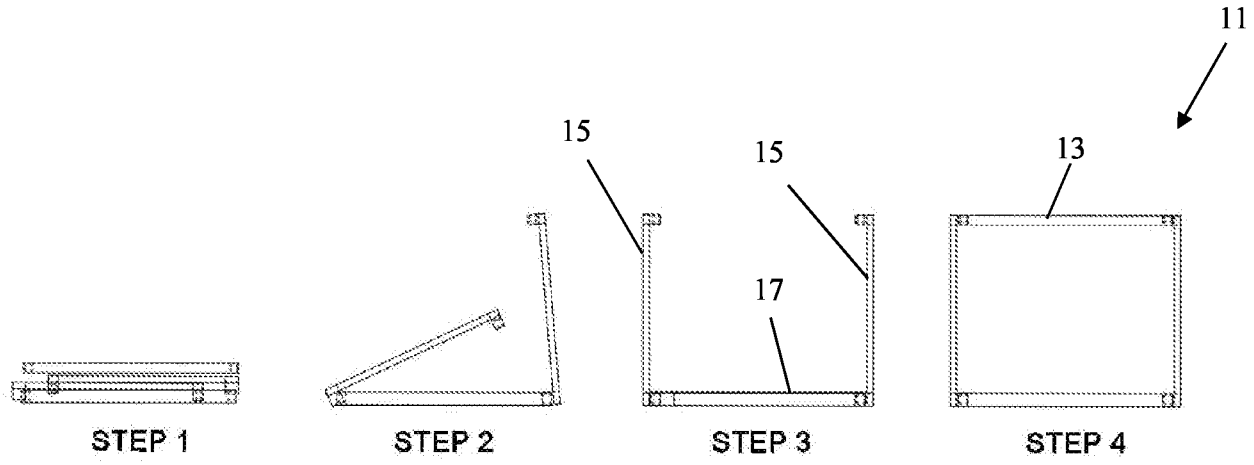


FIG. 23

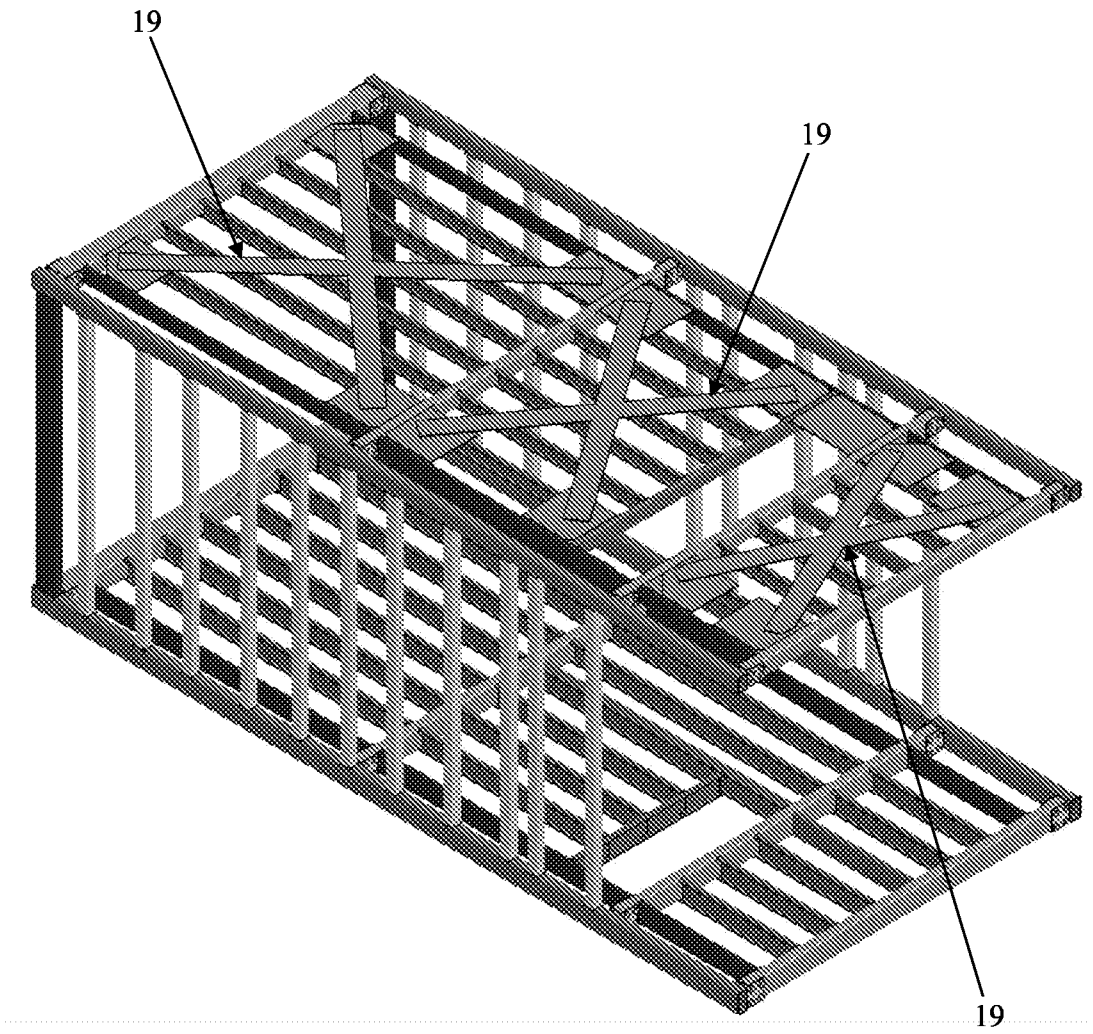


FIG. 24

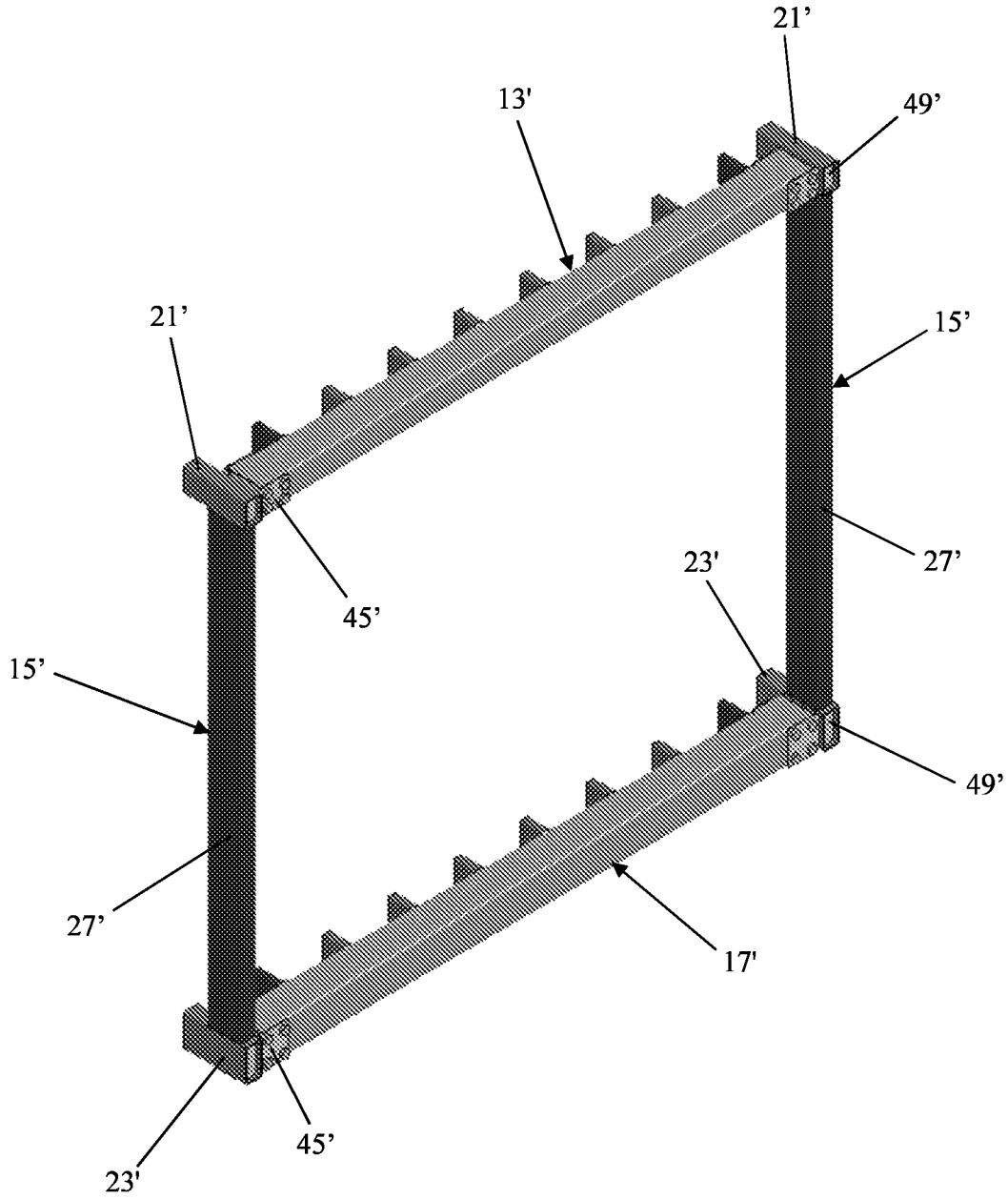


FIG. 25

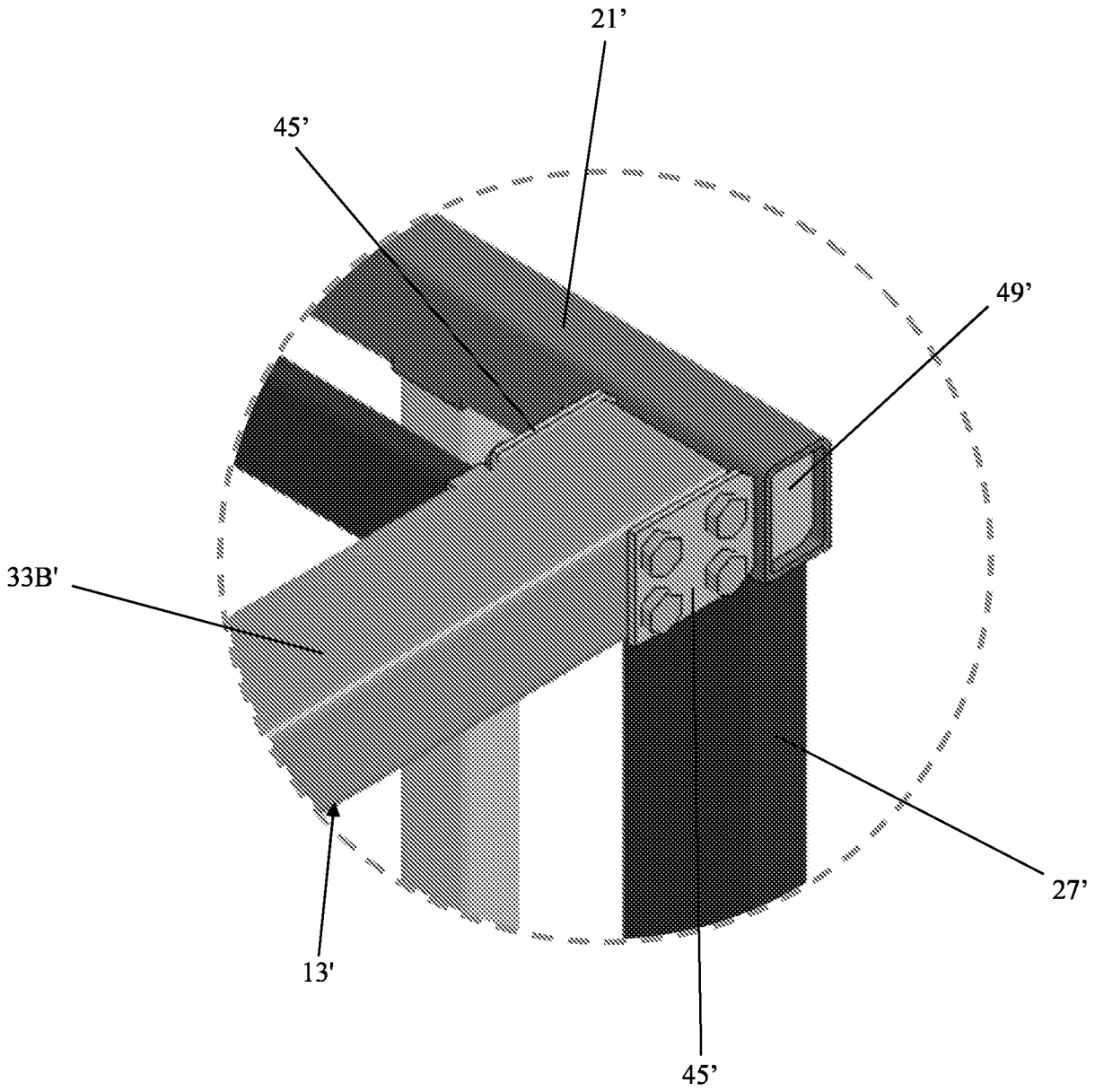


FIG. 26

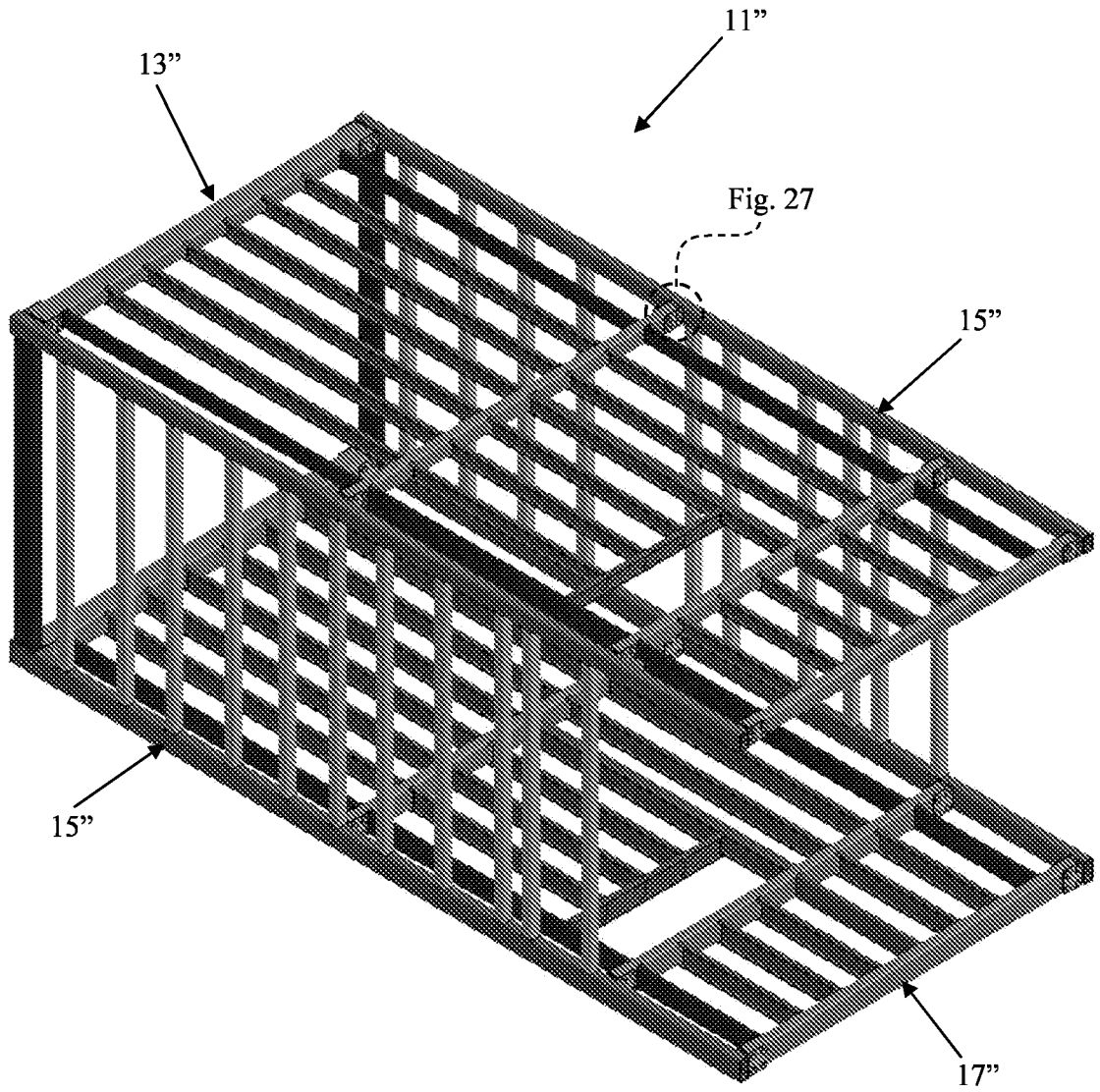


FIG. 27

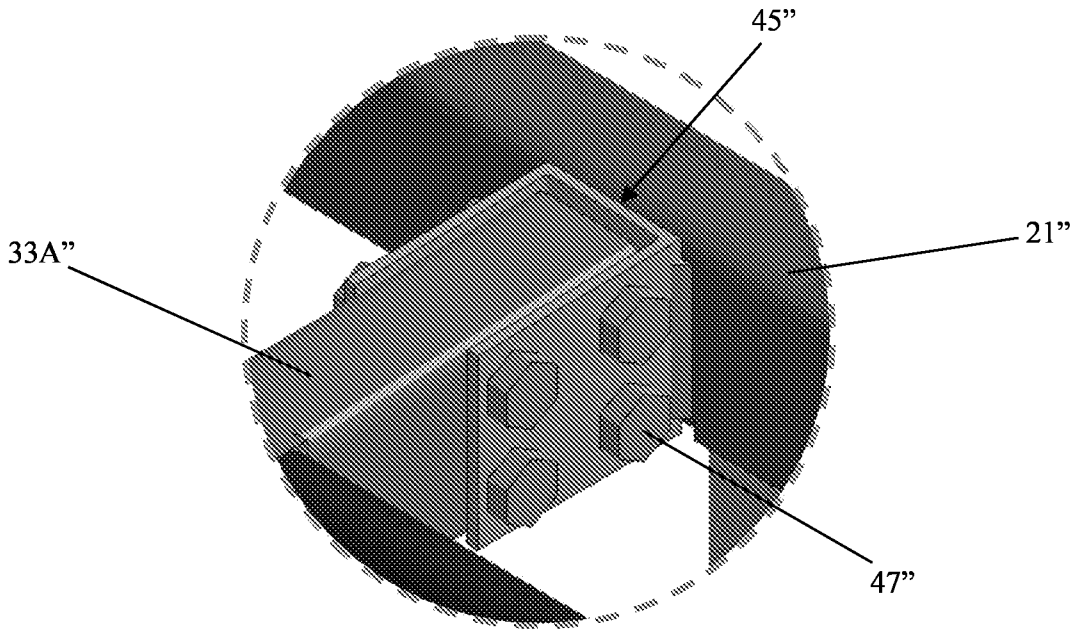


FIG. 28

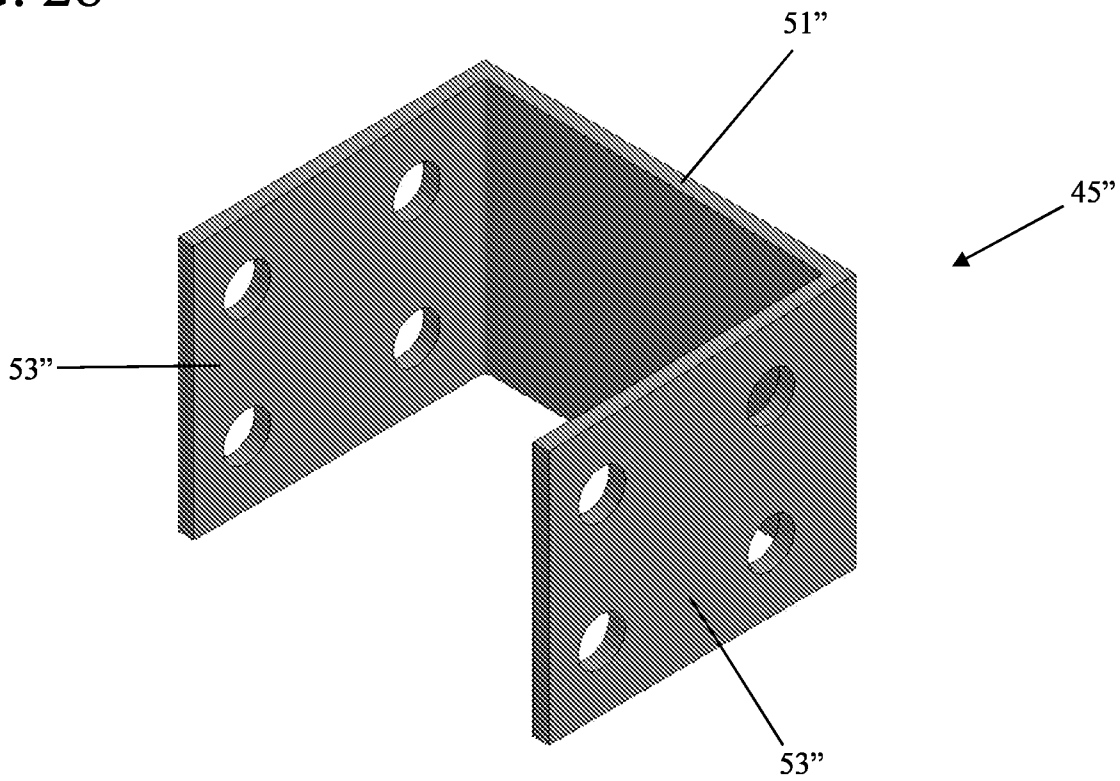


FIG. 29

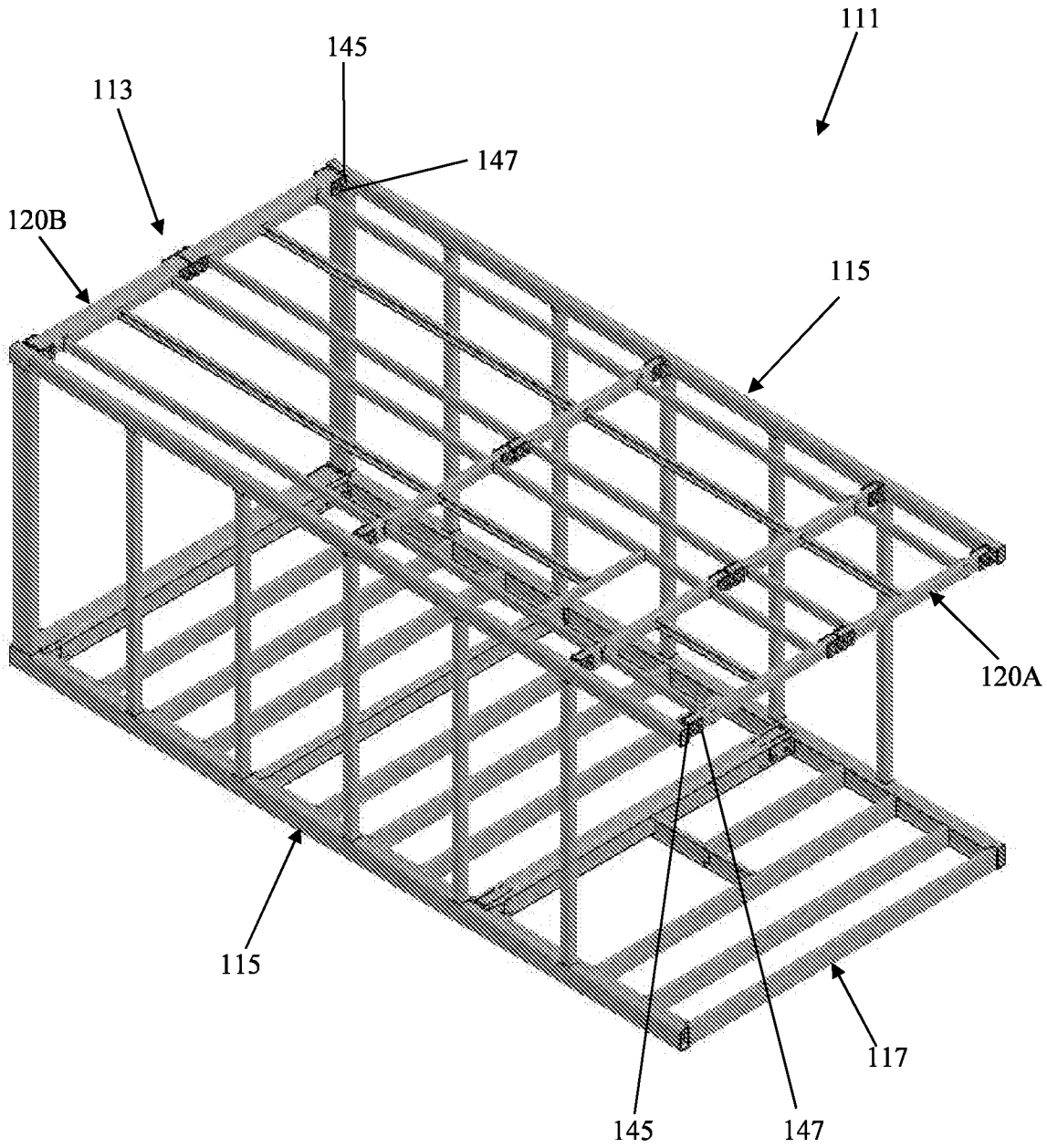
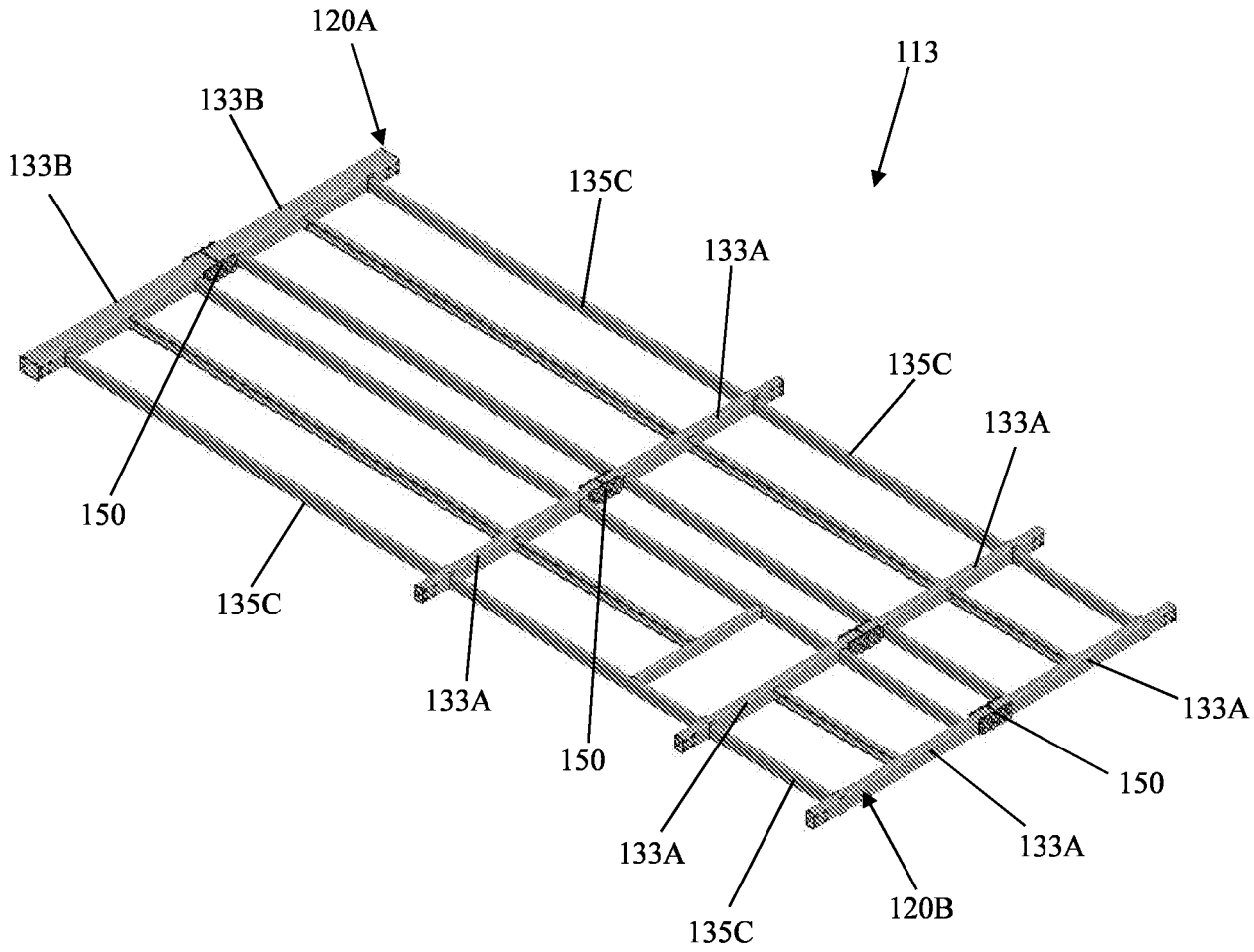


FIG. 30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135C
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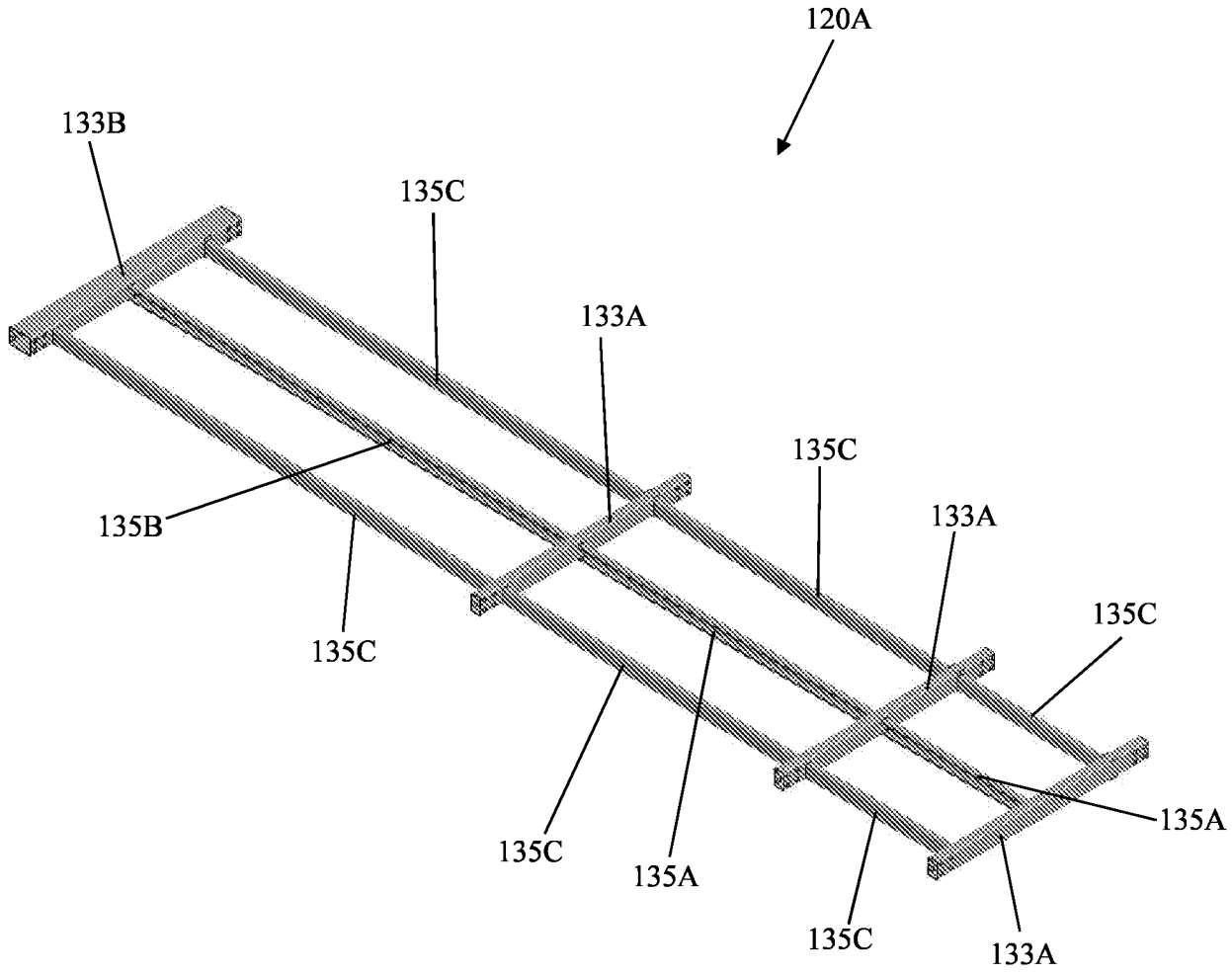
135C
120B

FIG. 31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135C
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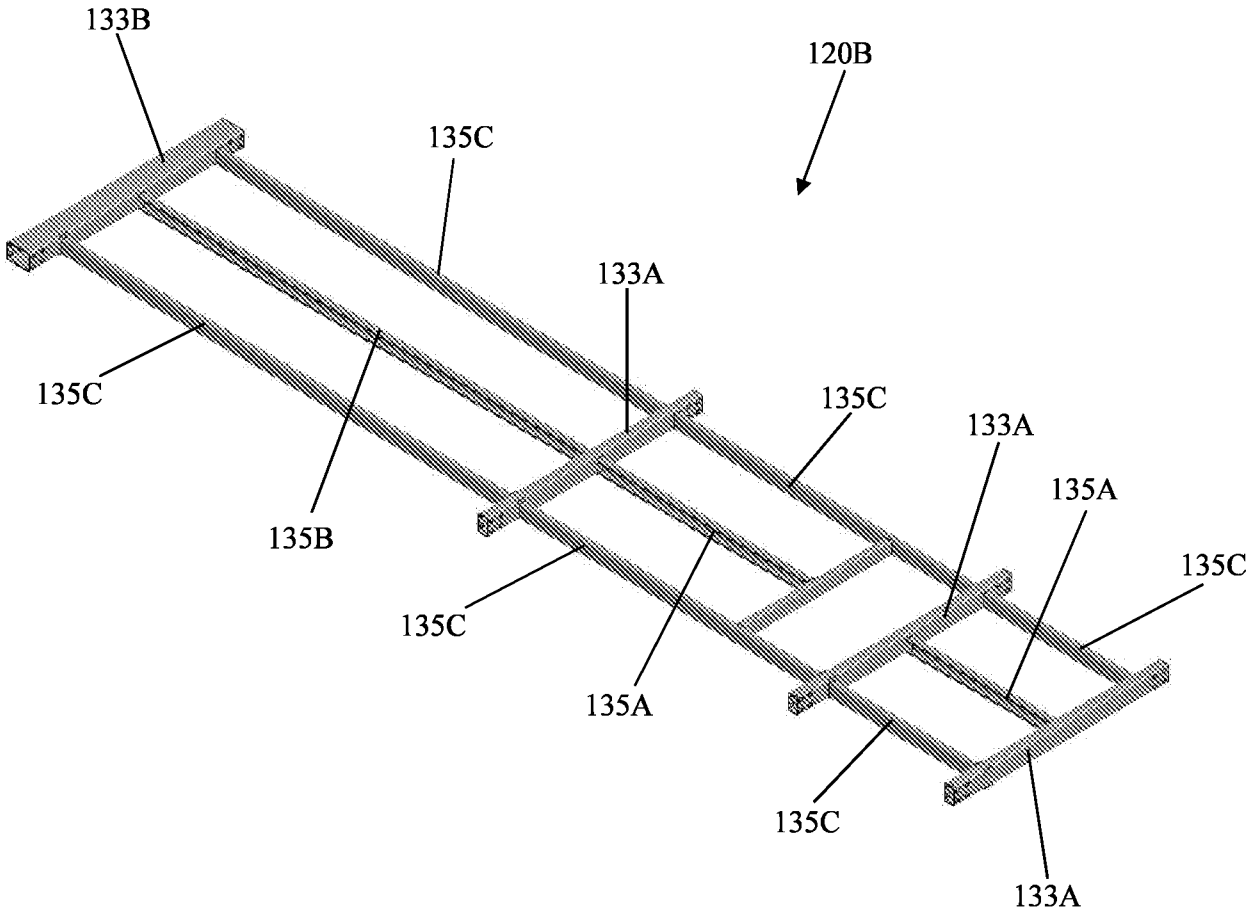
135C
133A

FIG. 32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135C
133A

FIG. 33

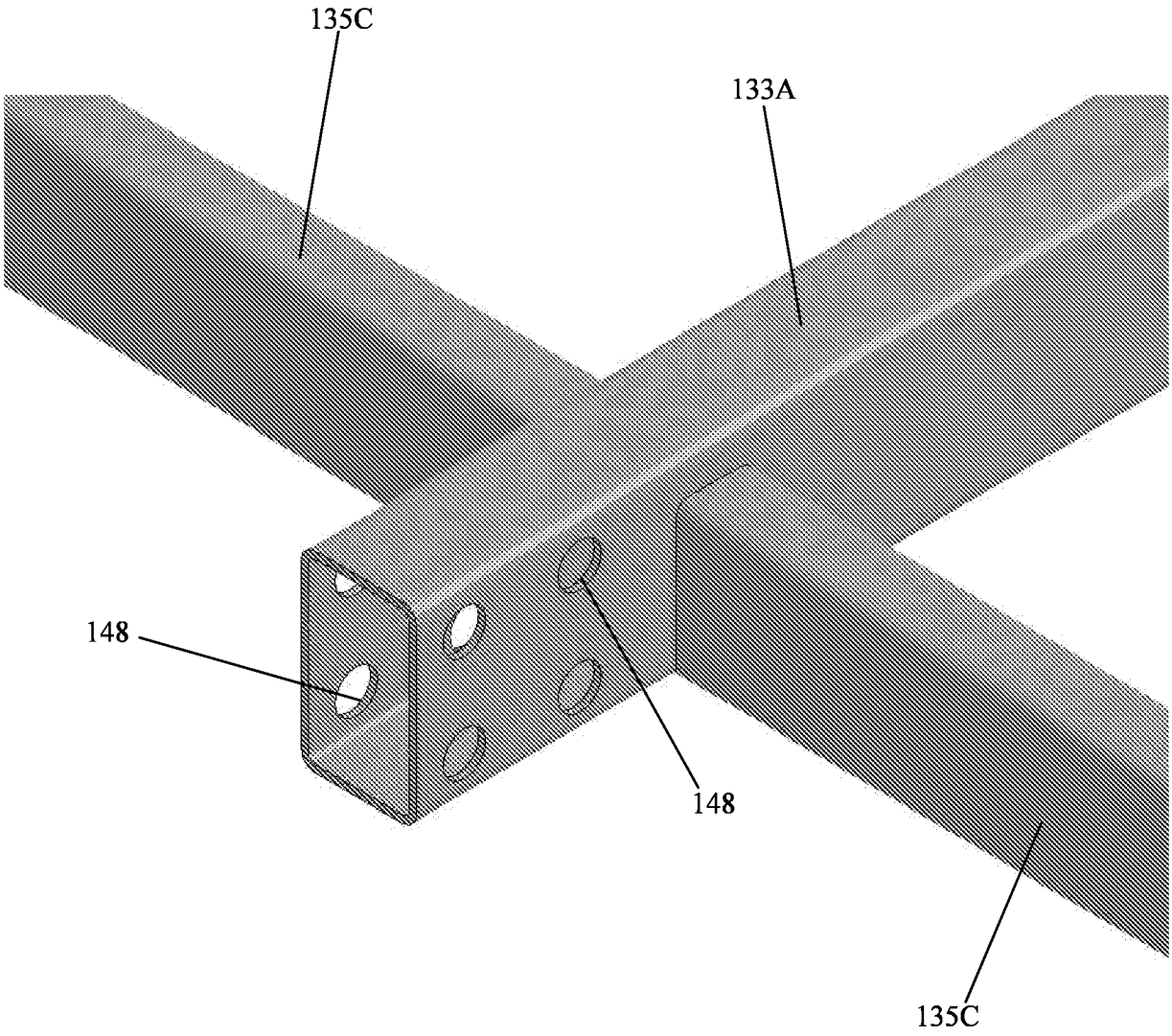


FIG. 34

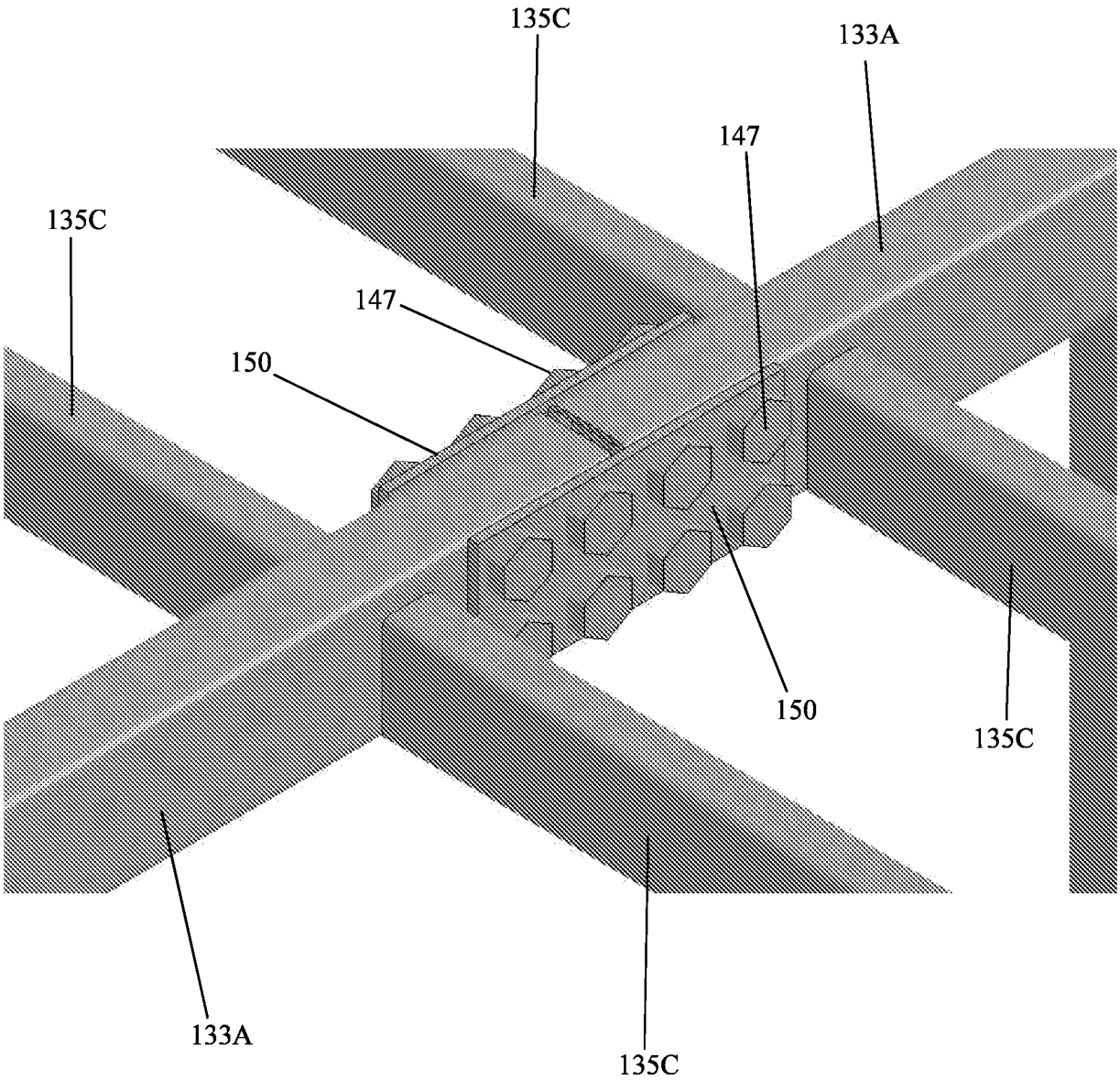
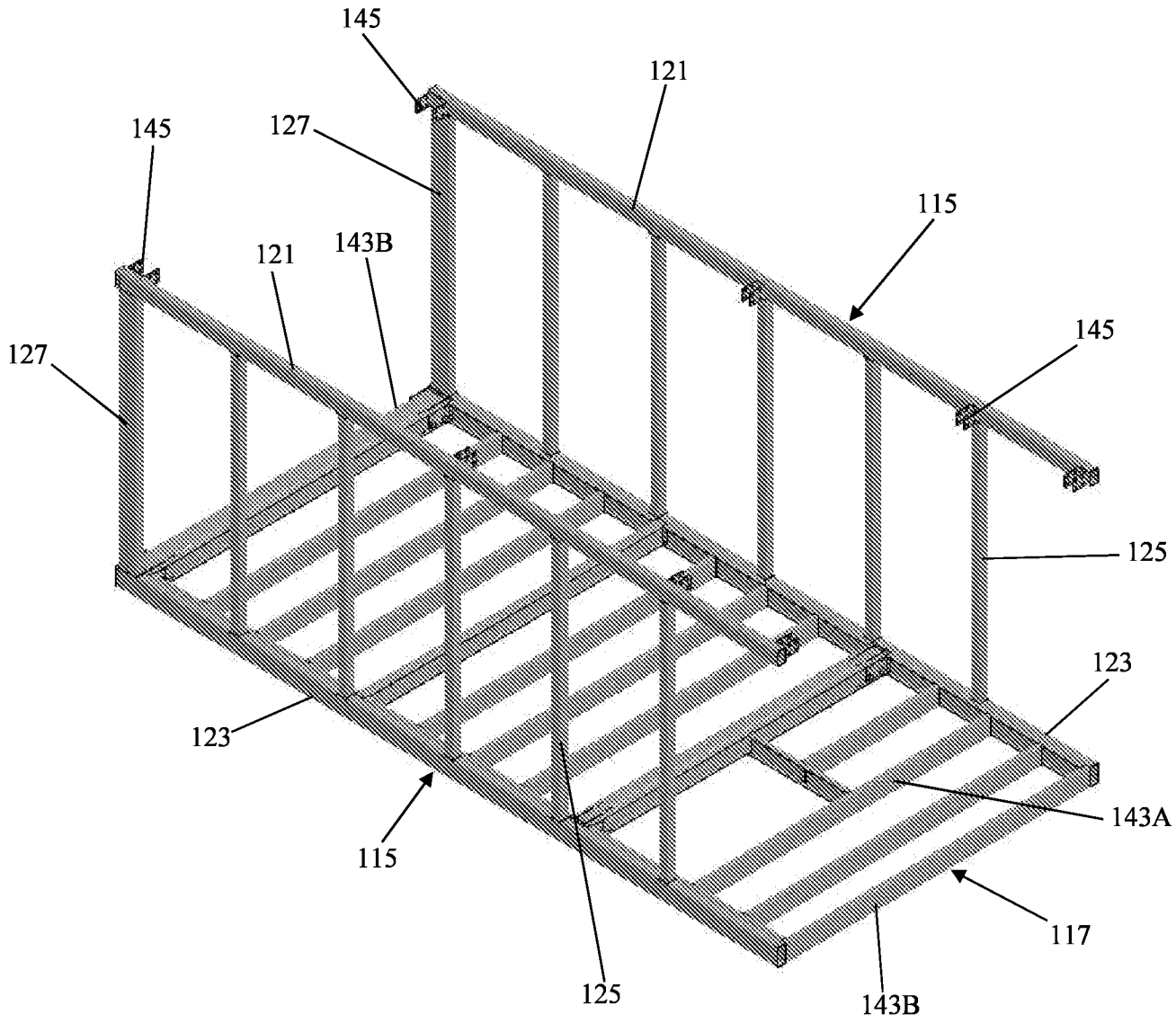


FIG. 35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125
143B

FIG. 36

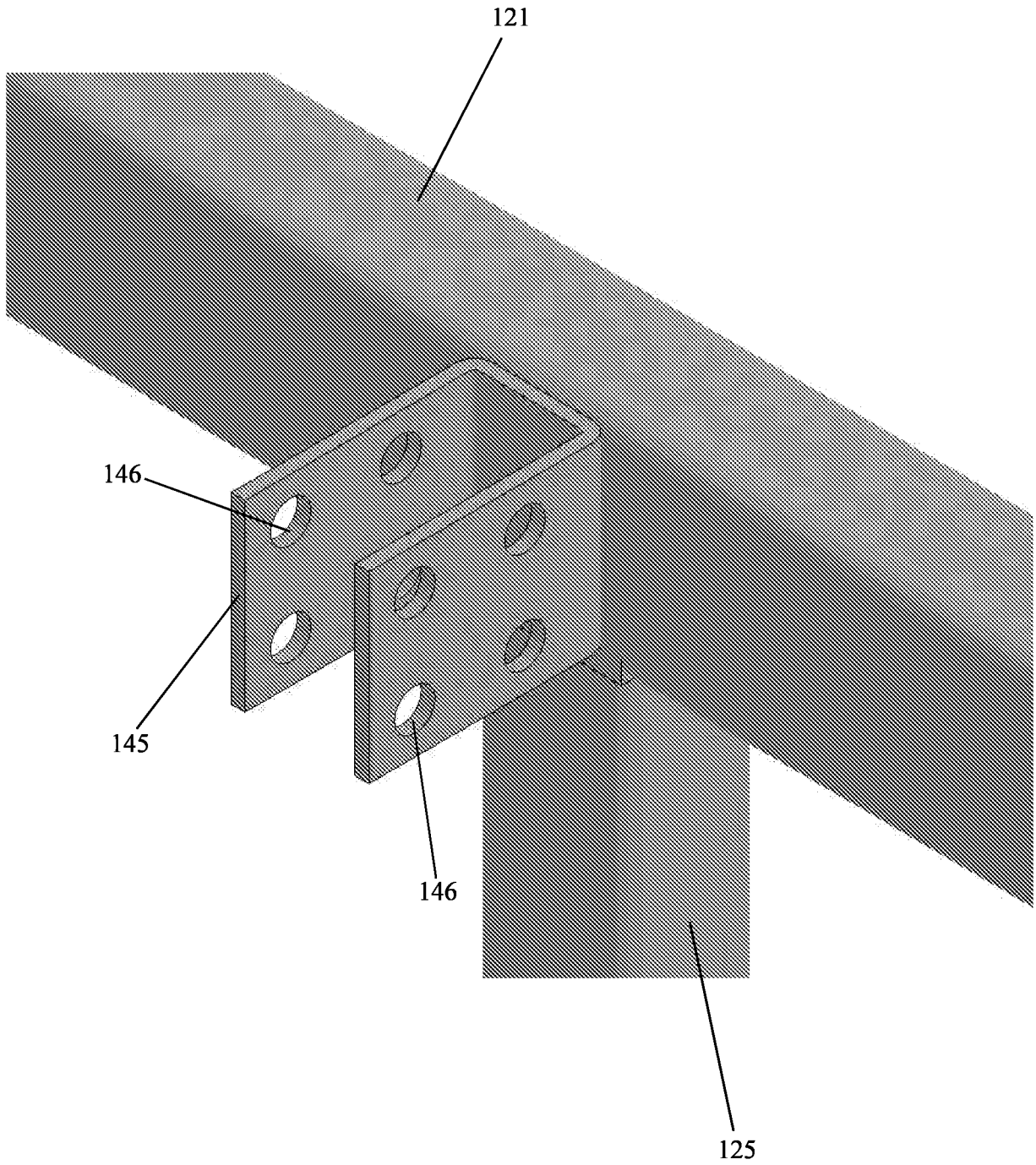

FIG. 37

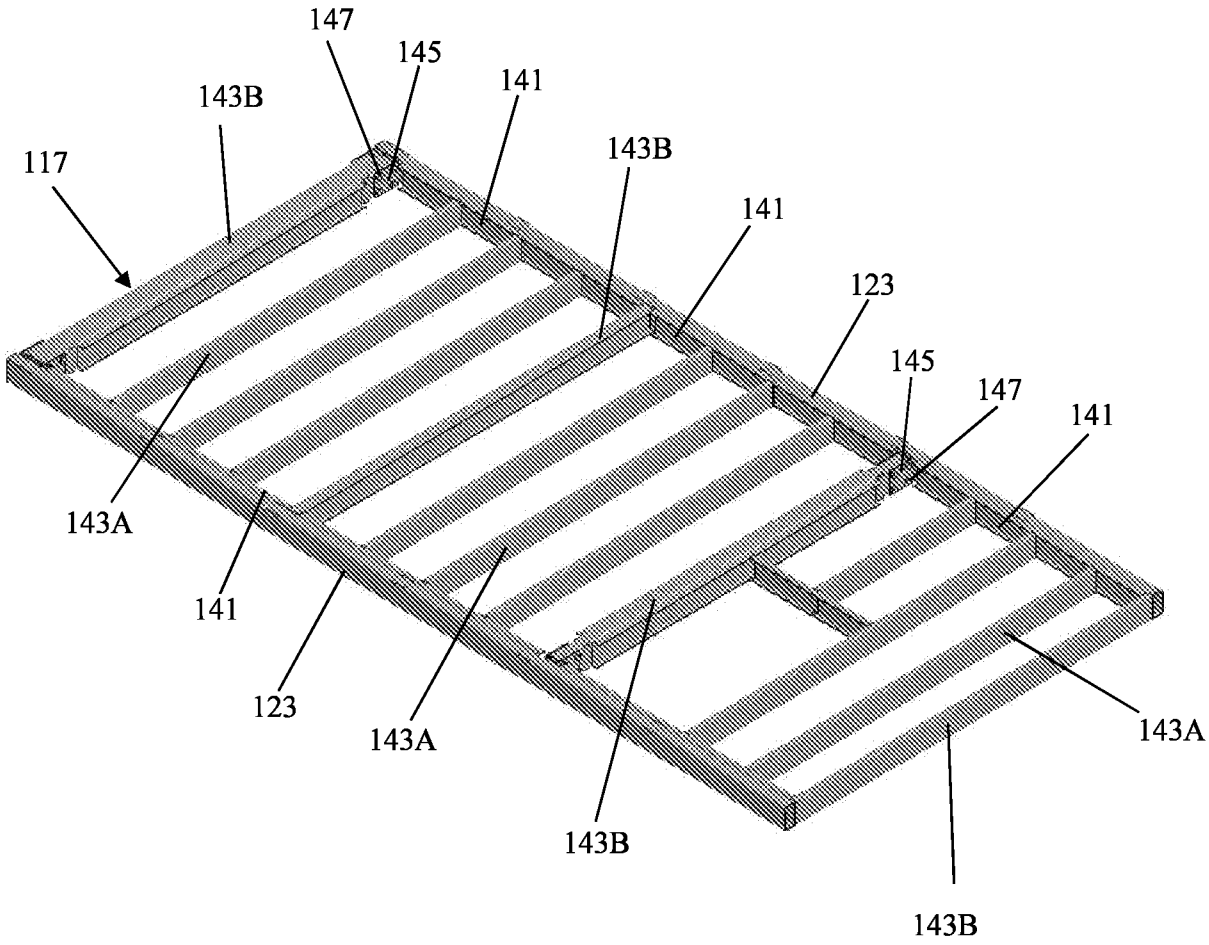
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FIG. 38

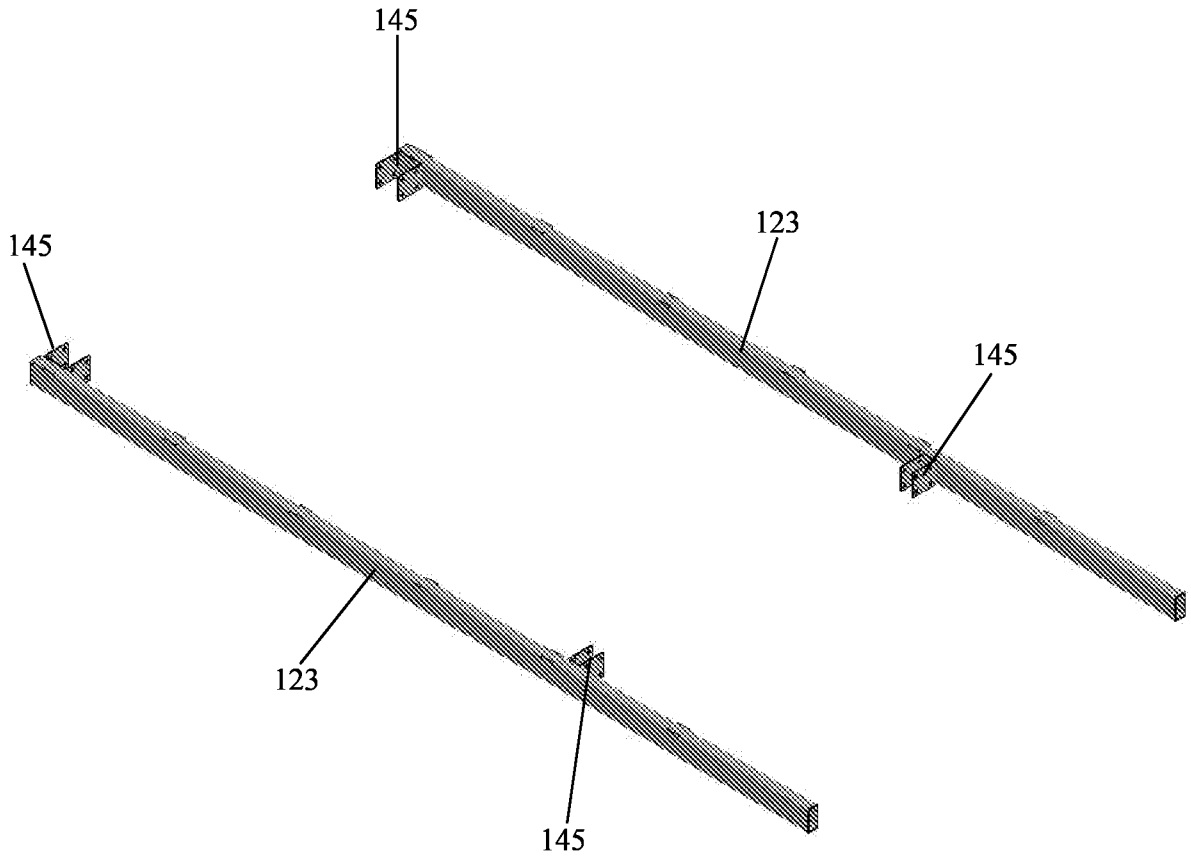

FIG. 39

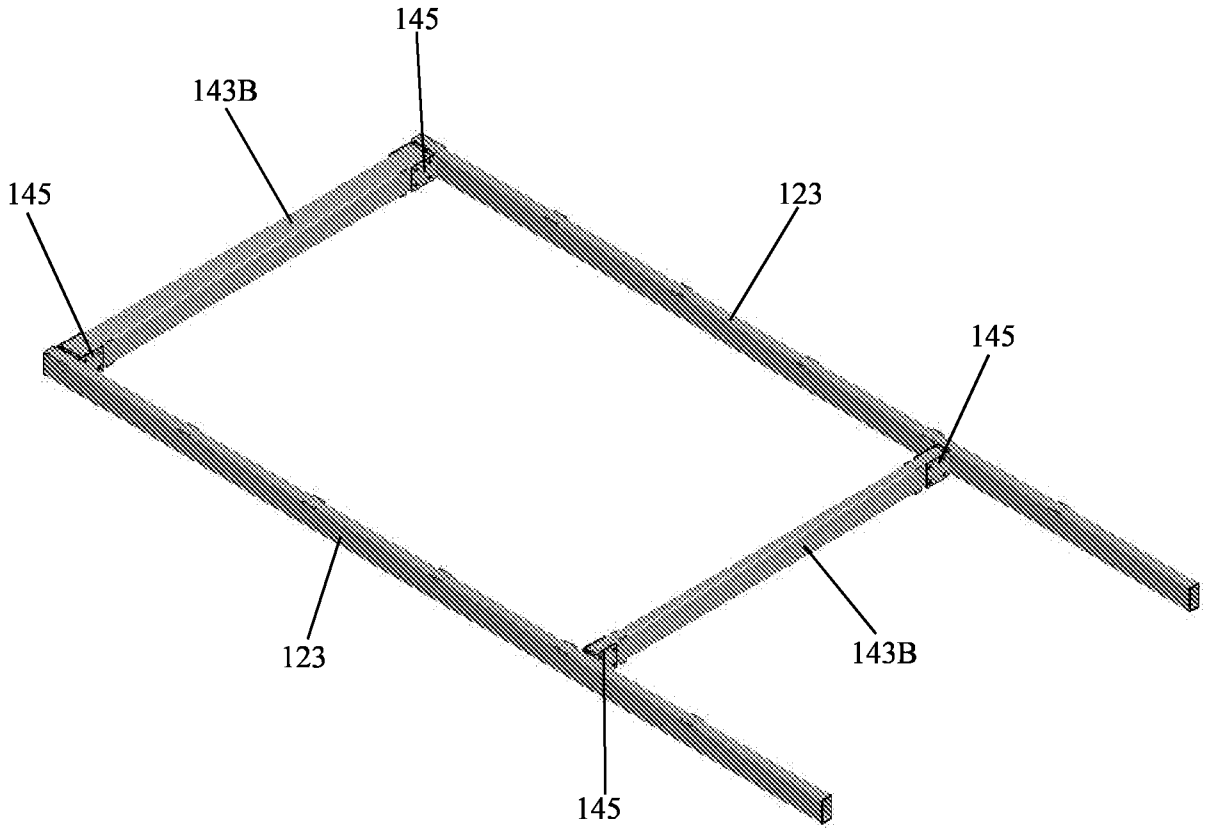

FIG. 40

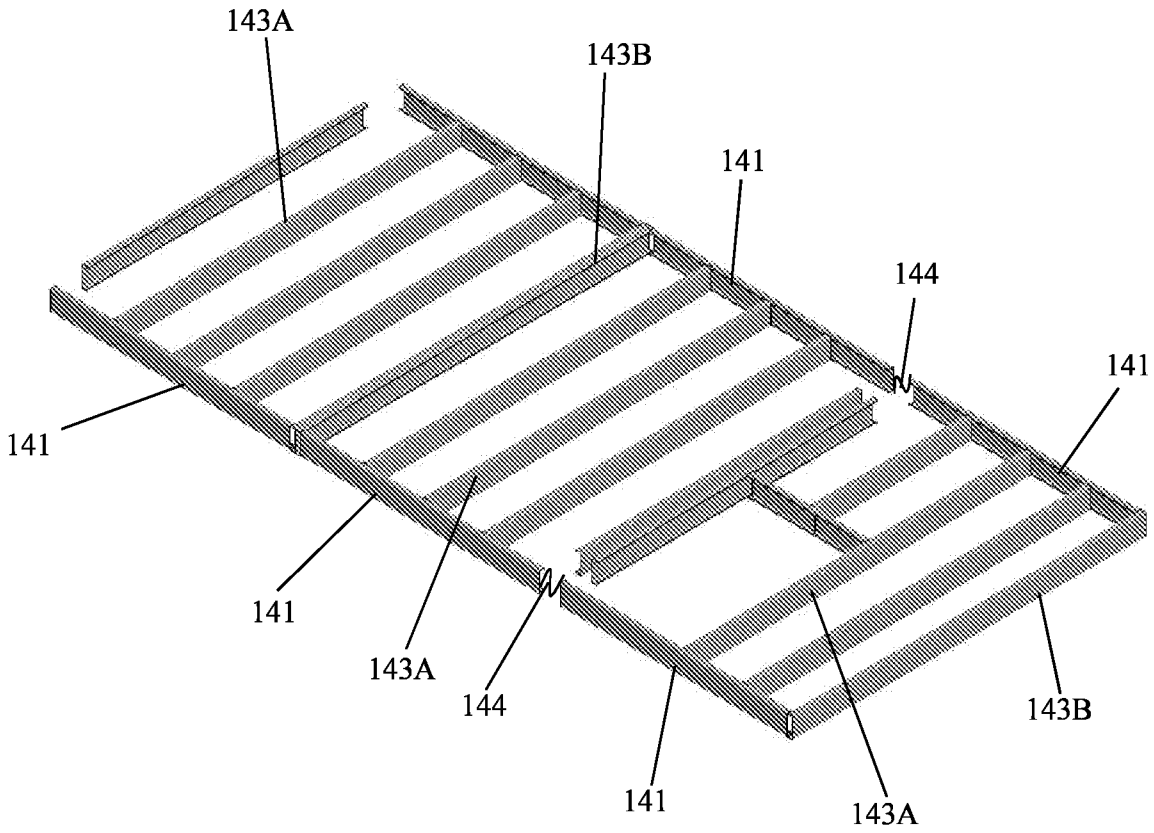

FIG. 41

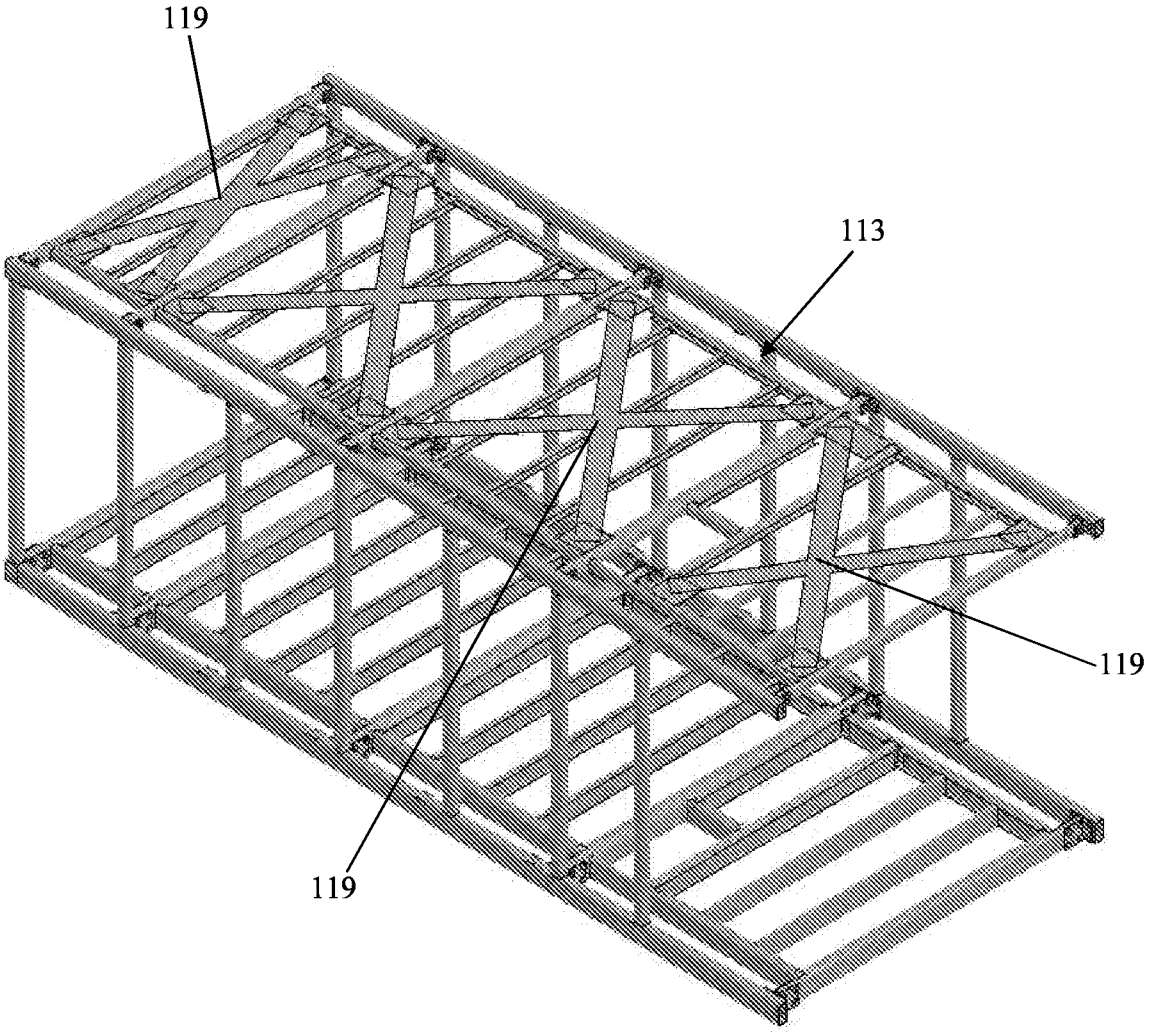

FIG. 42

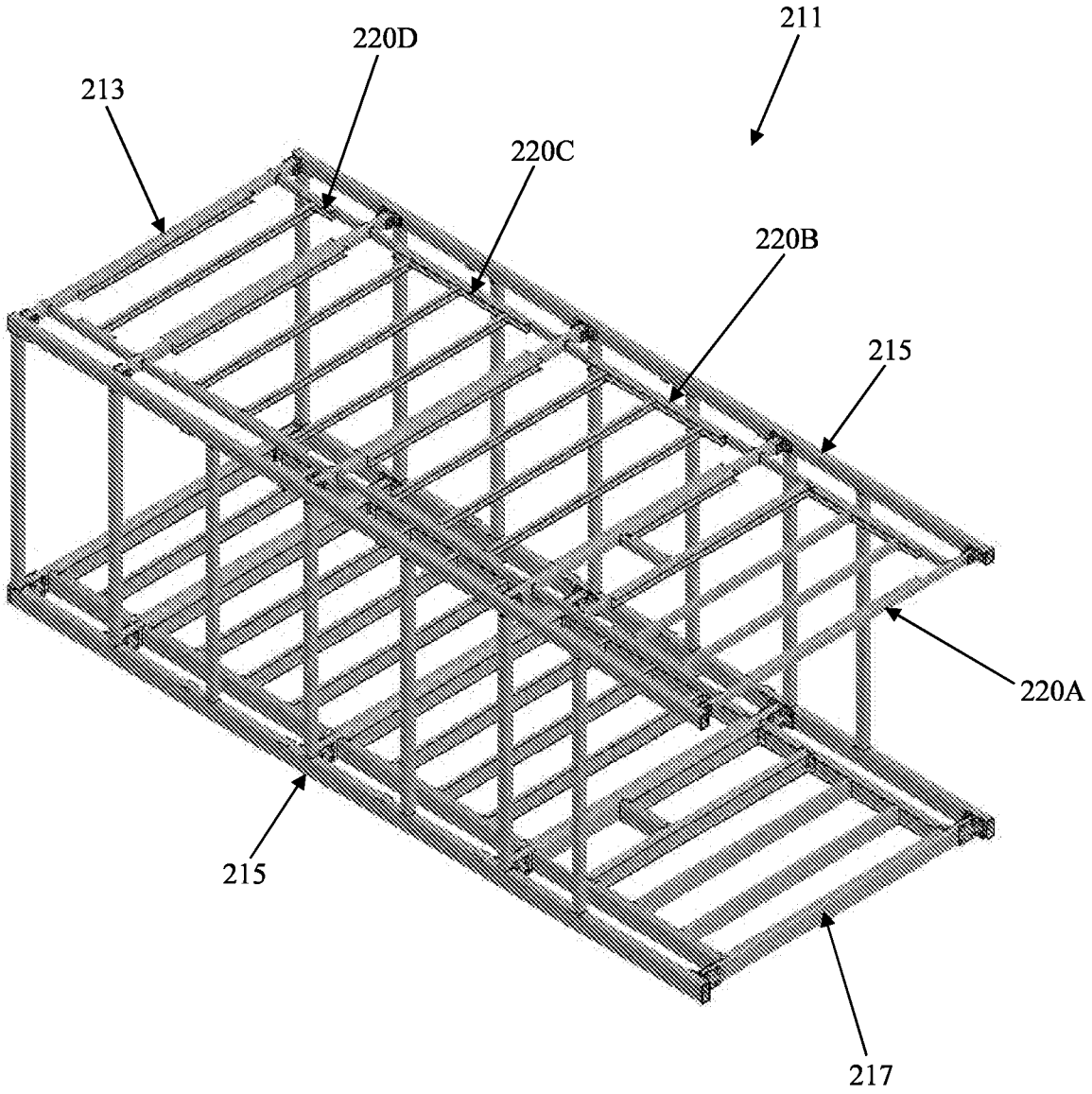

FIG. 43

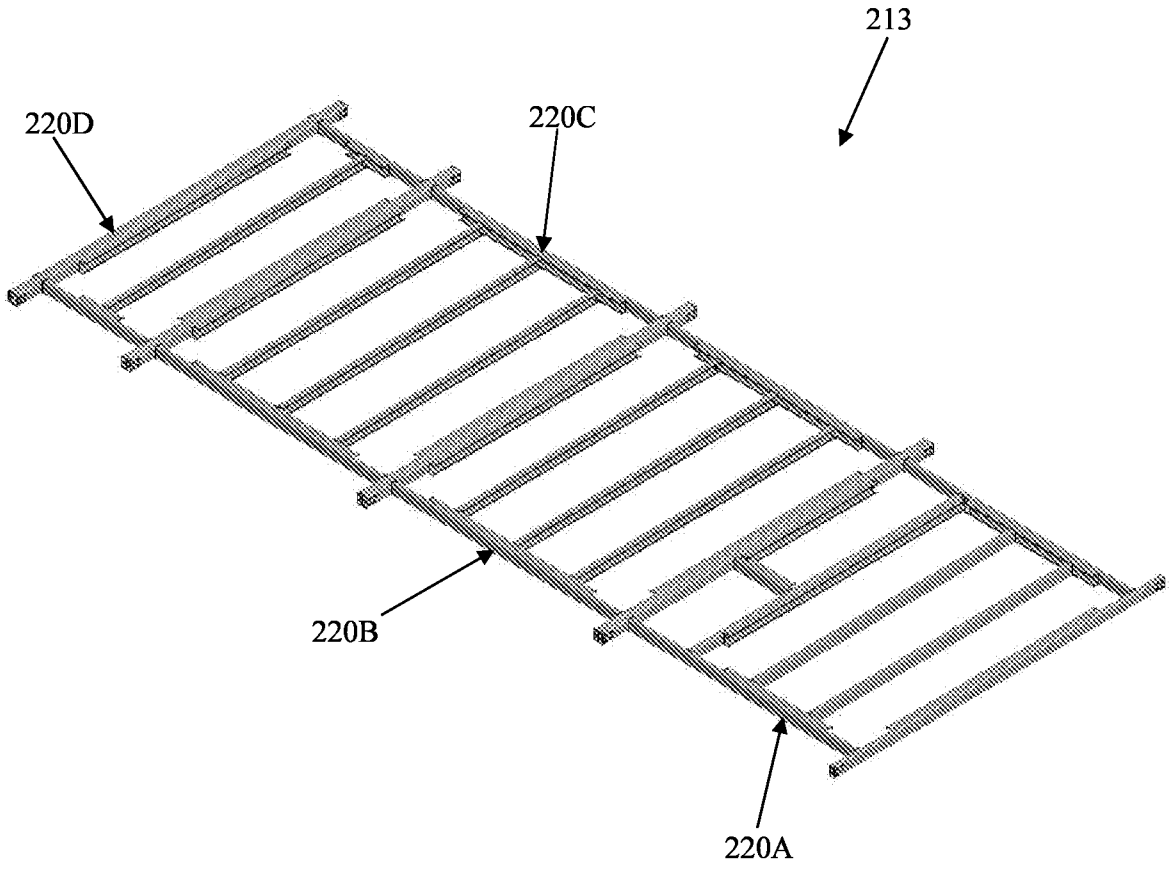

FIG. 44

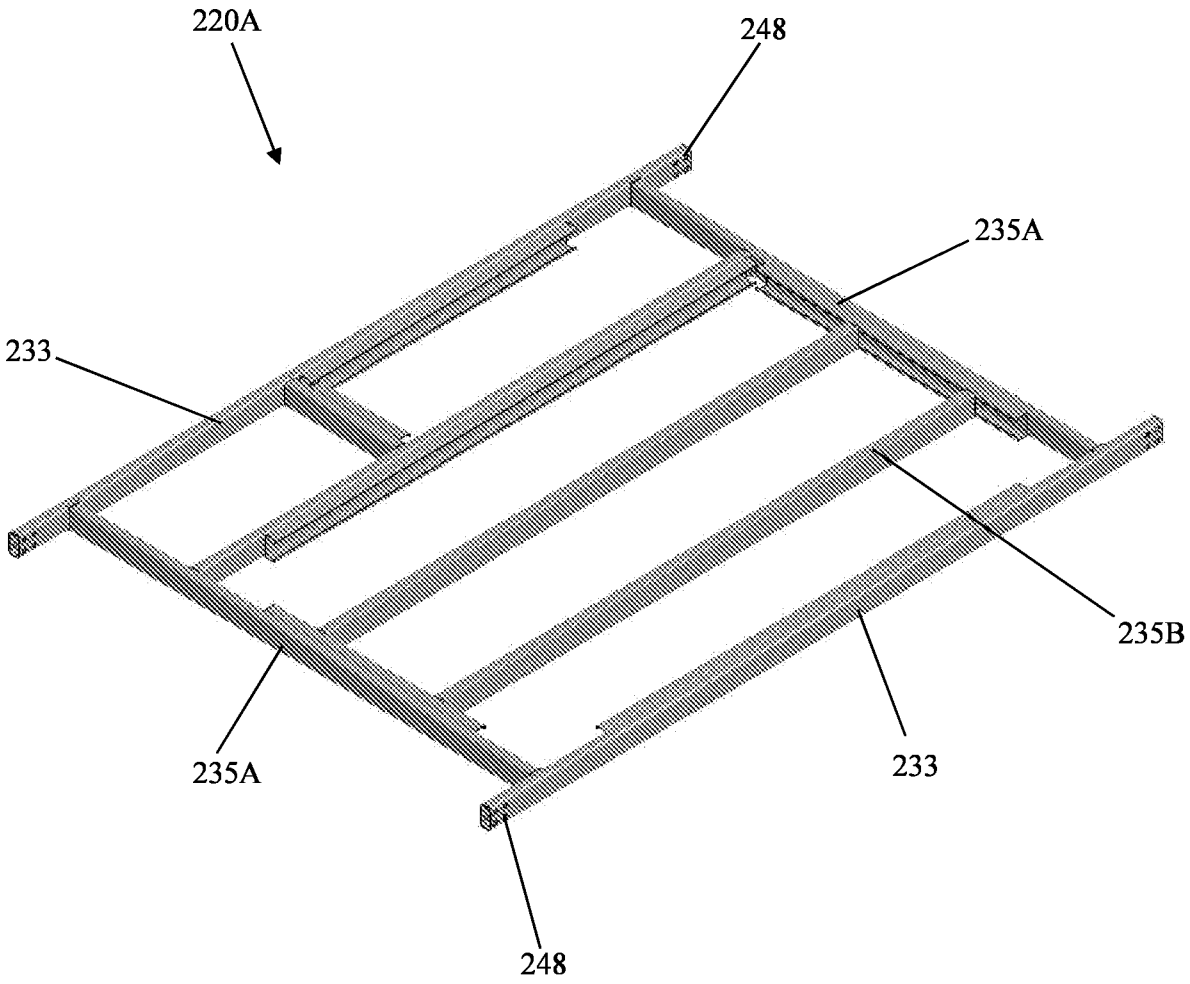

FIG. 45

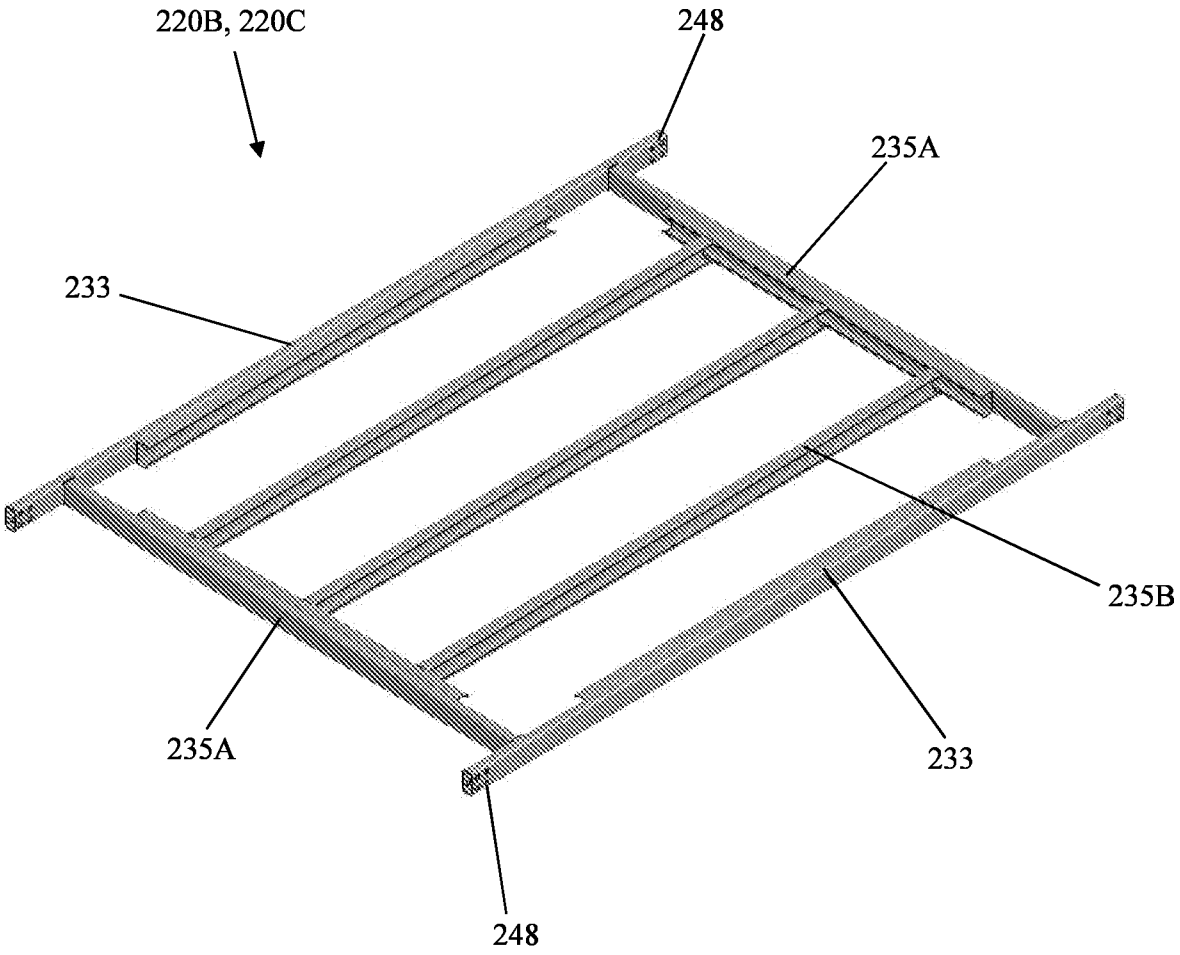

FIG. 46

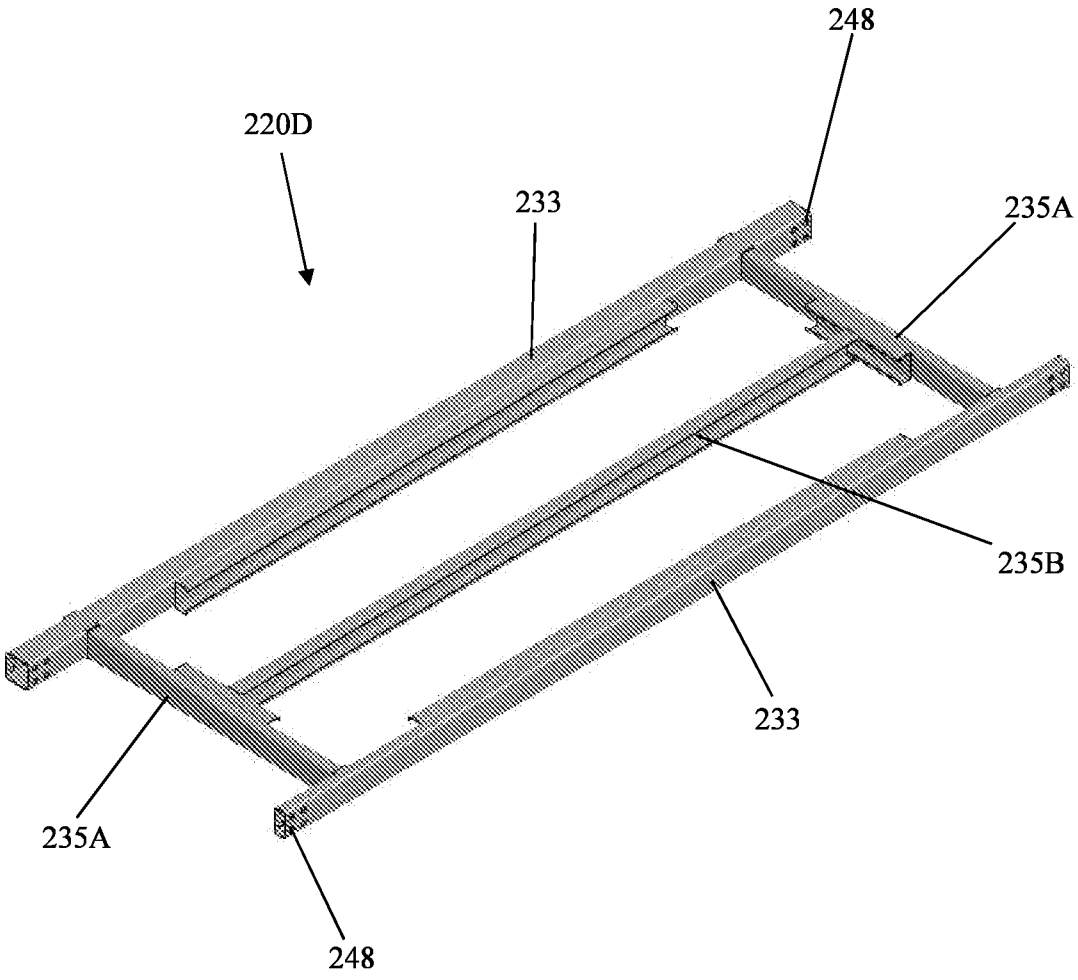

FIG. 47

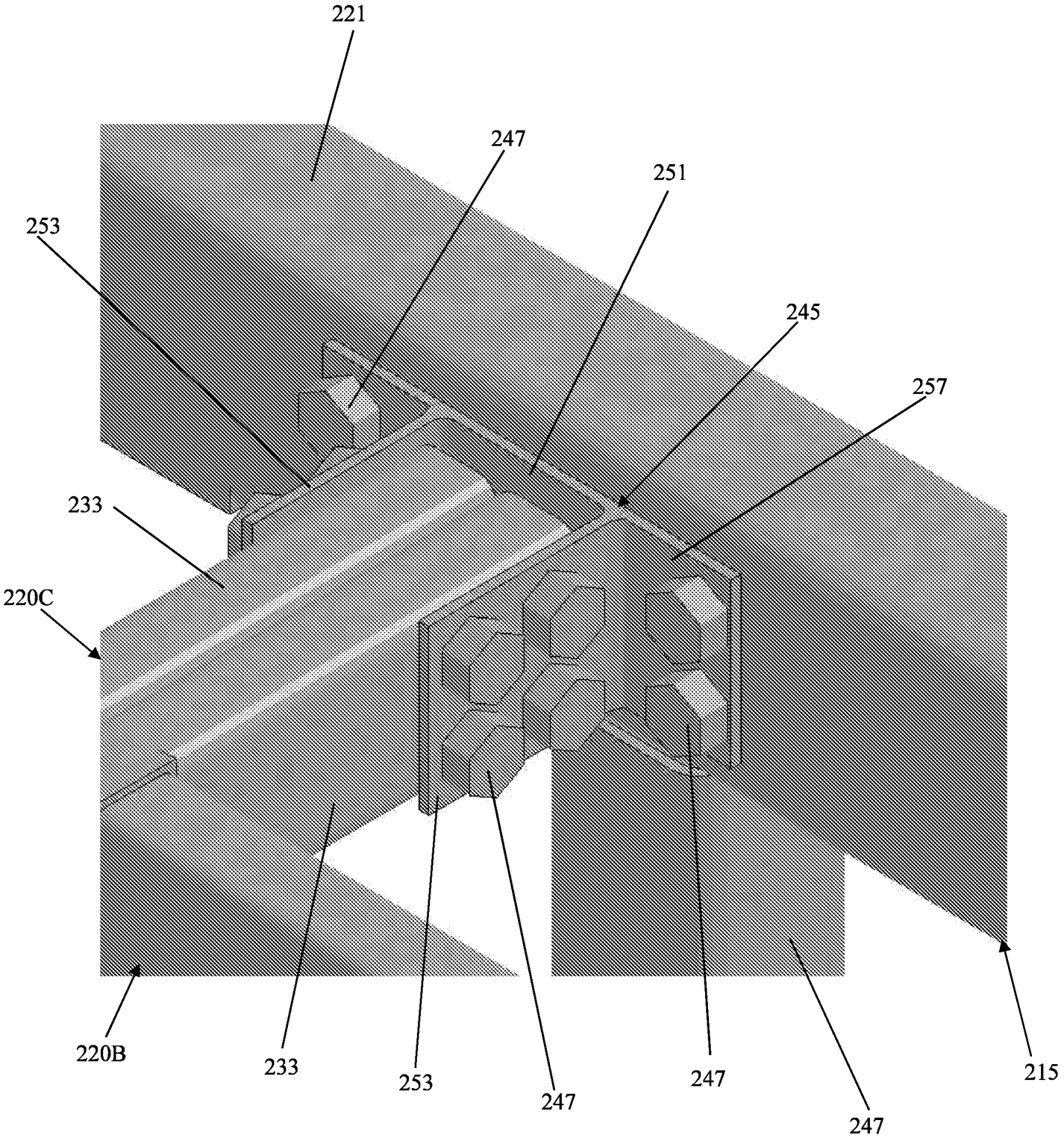

FIG. 48

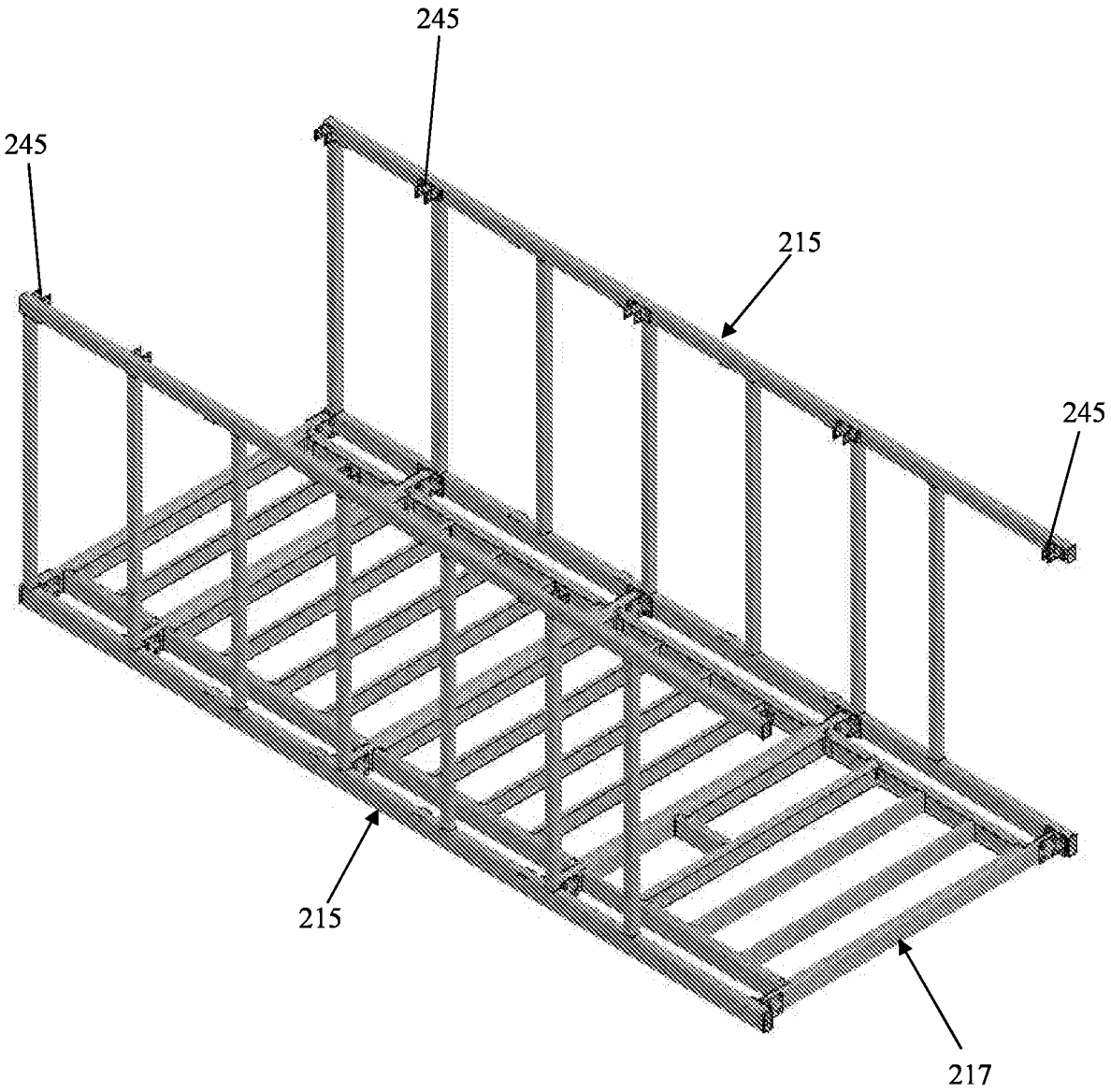

FIG. 49

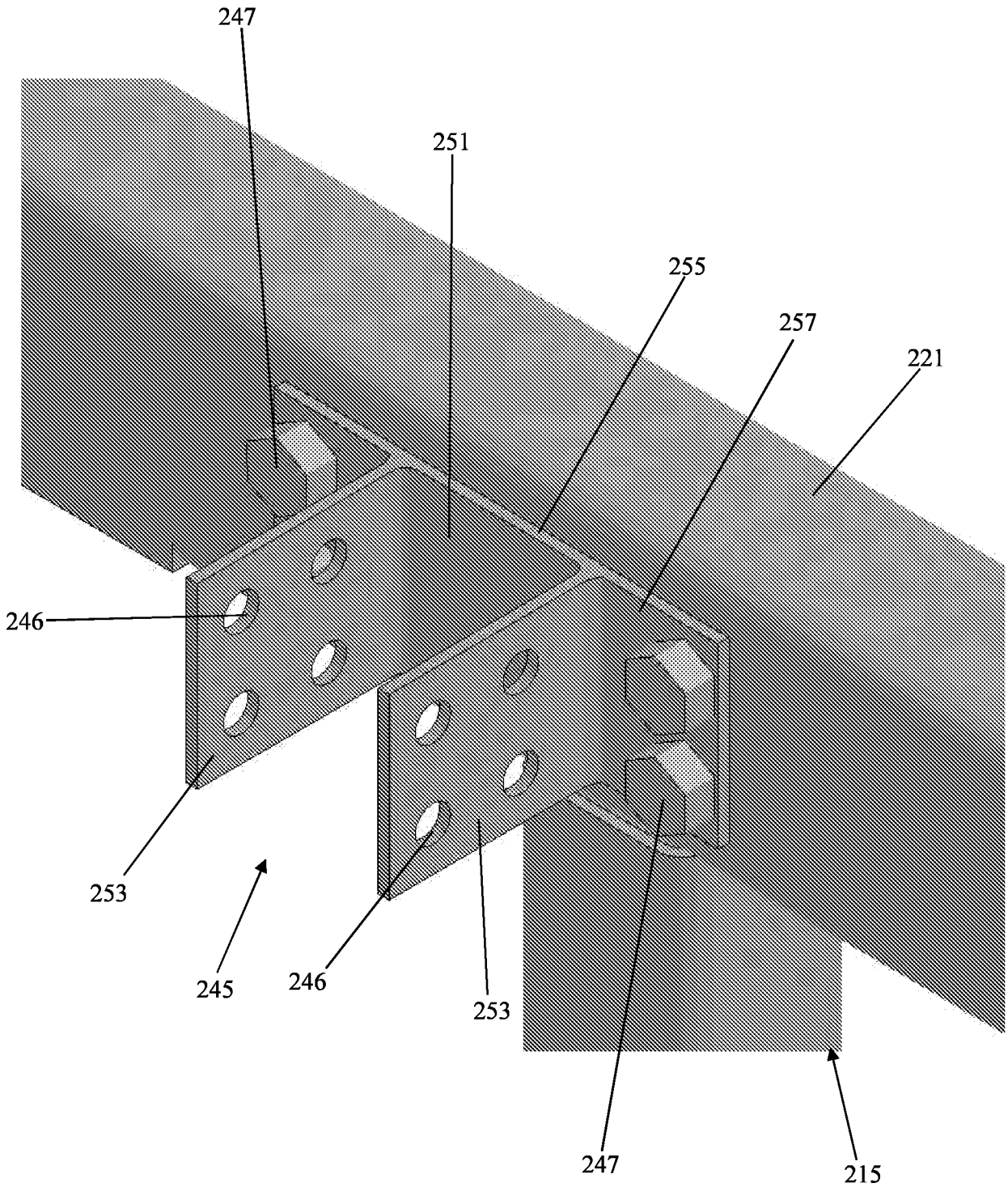

FIG. 50

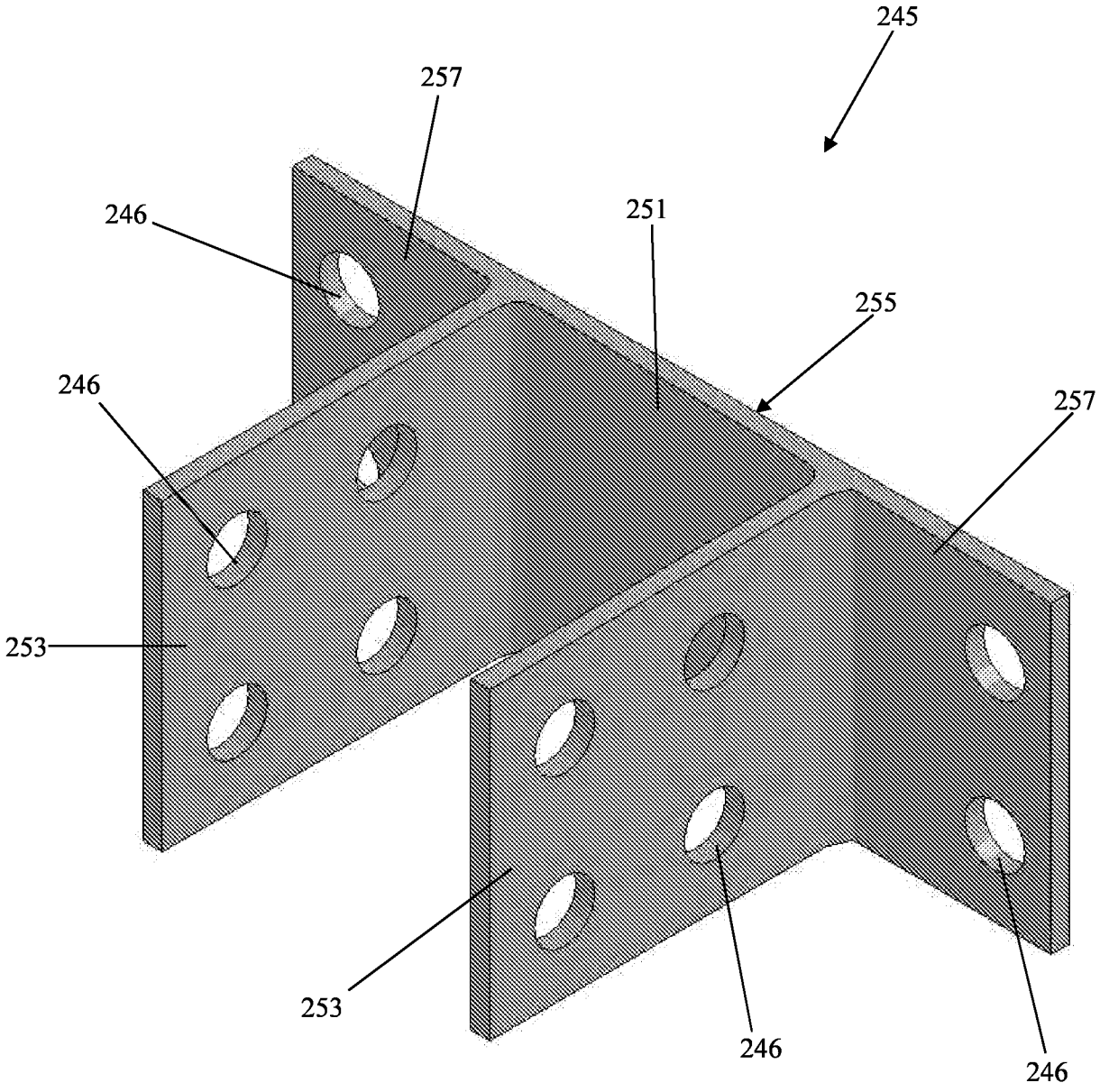

FIG. 51

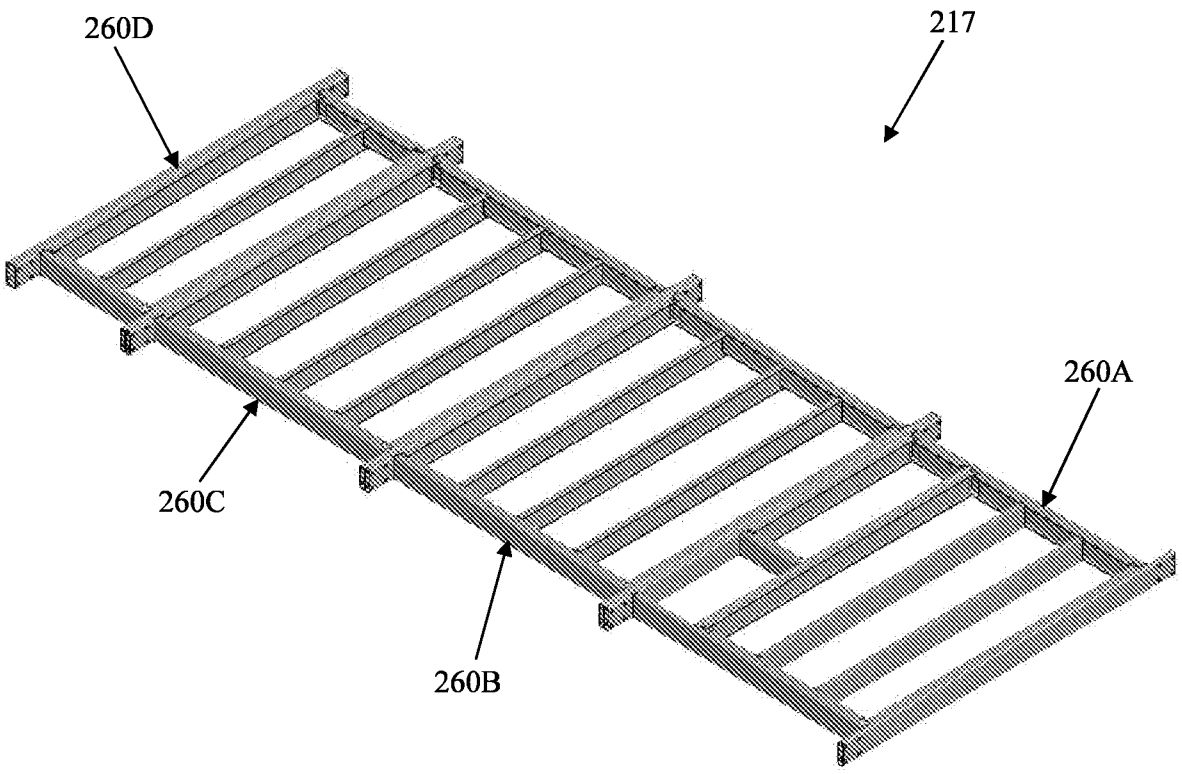

FIG. 52

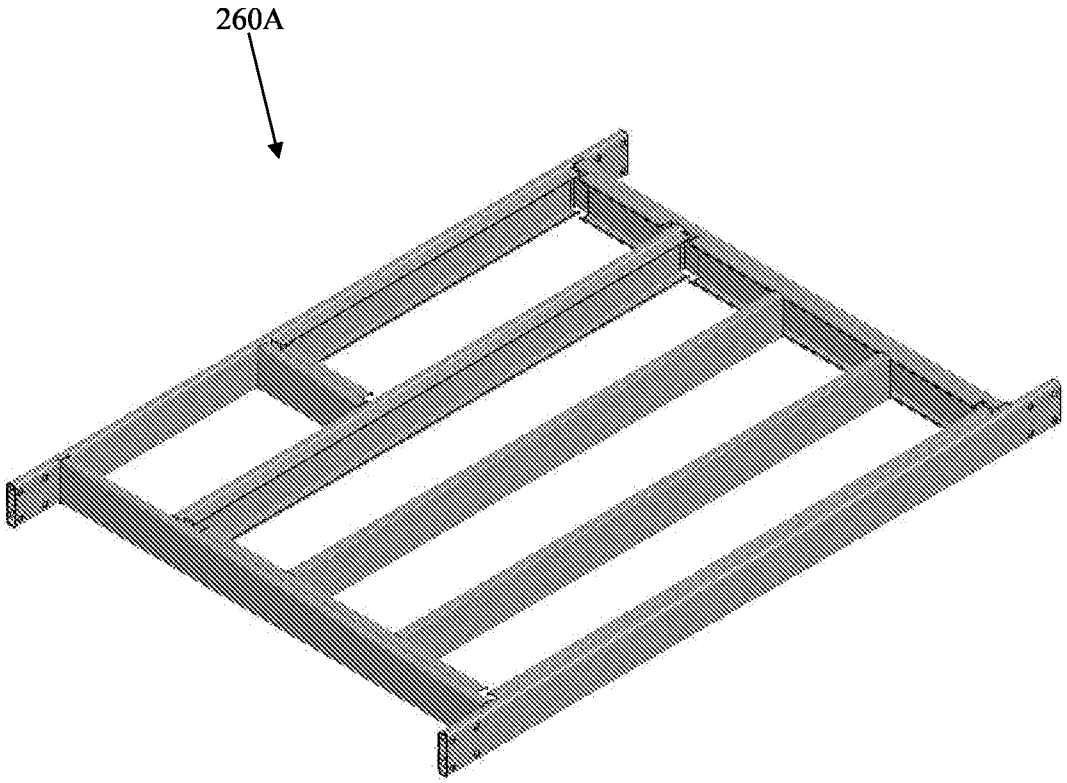

FIG. 53

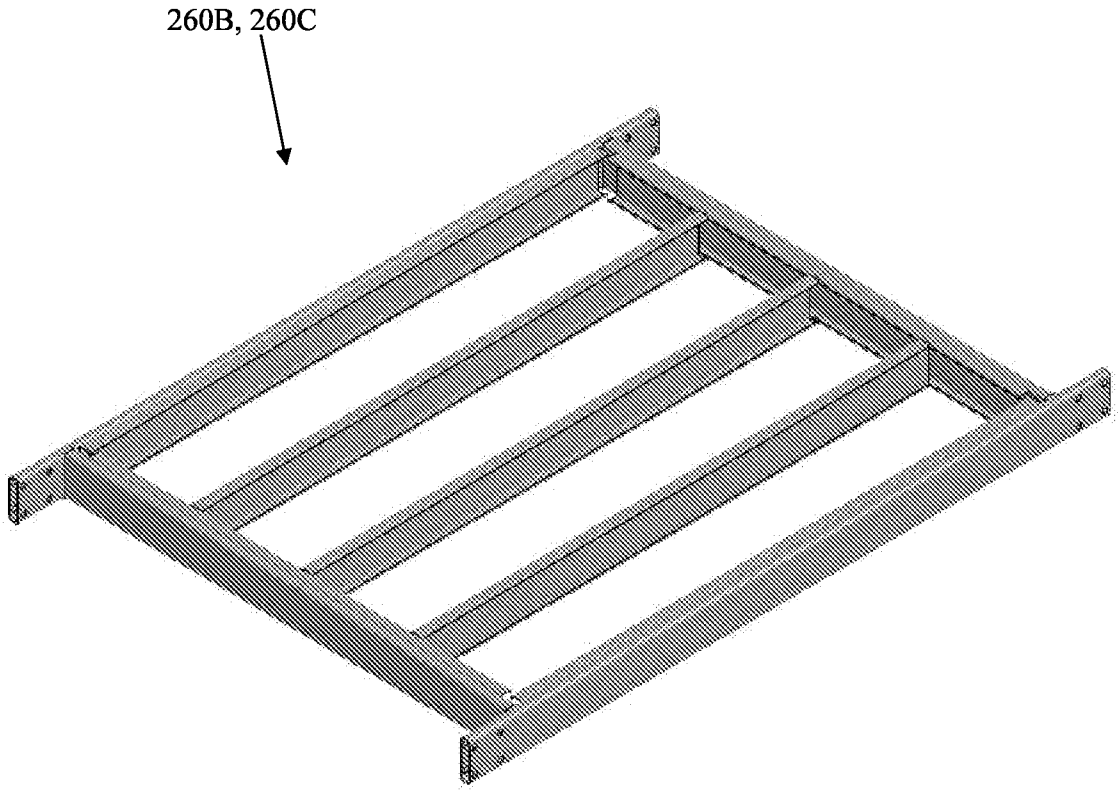

FIG. 54

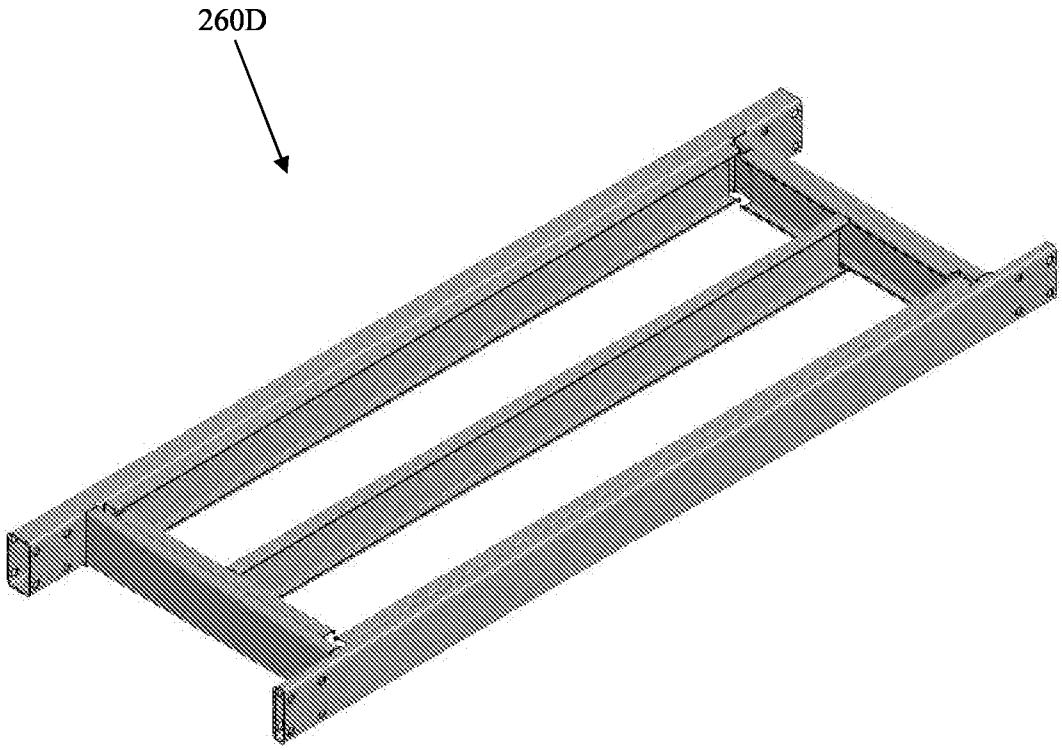

FIG. 55

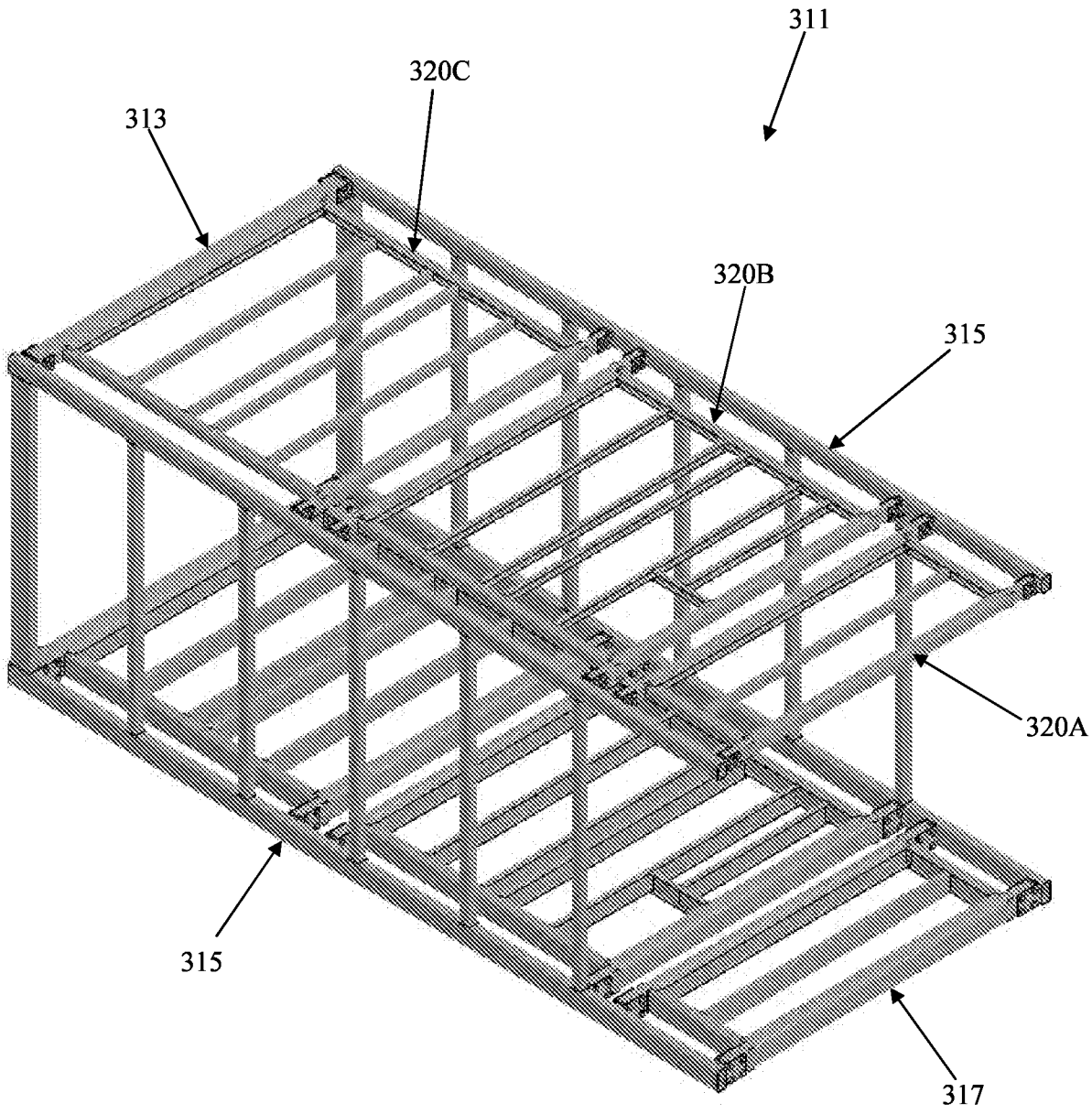

FIG. 56

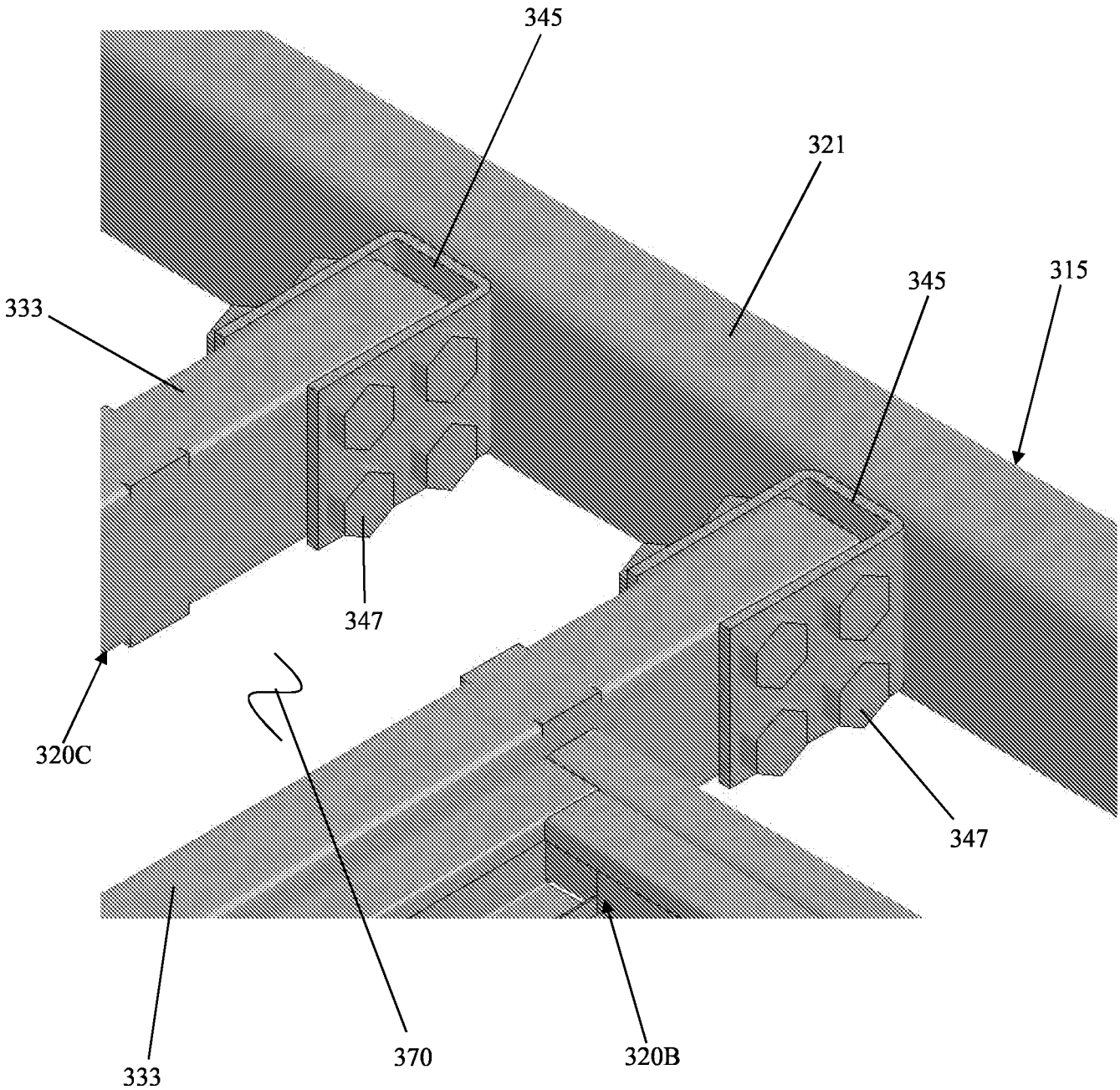

FIG. 57

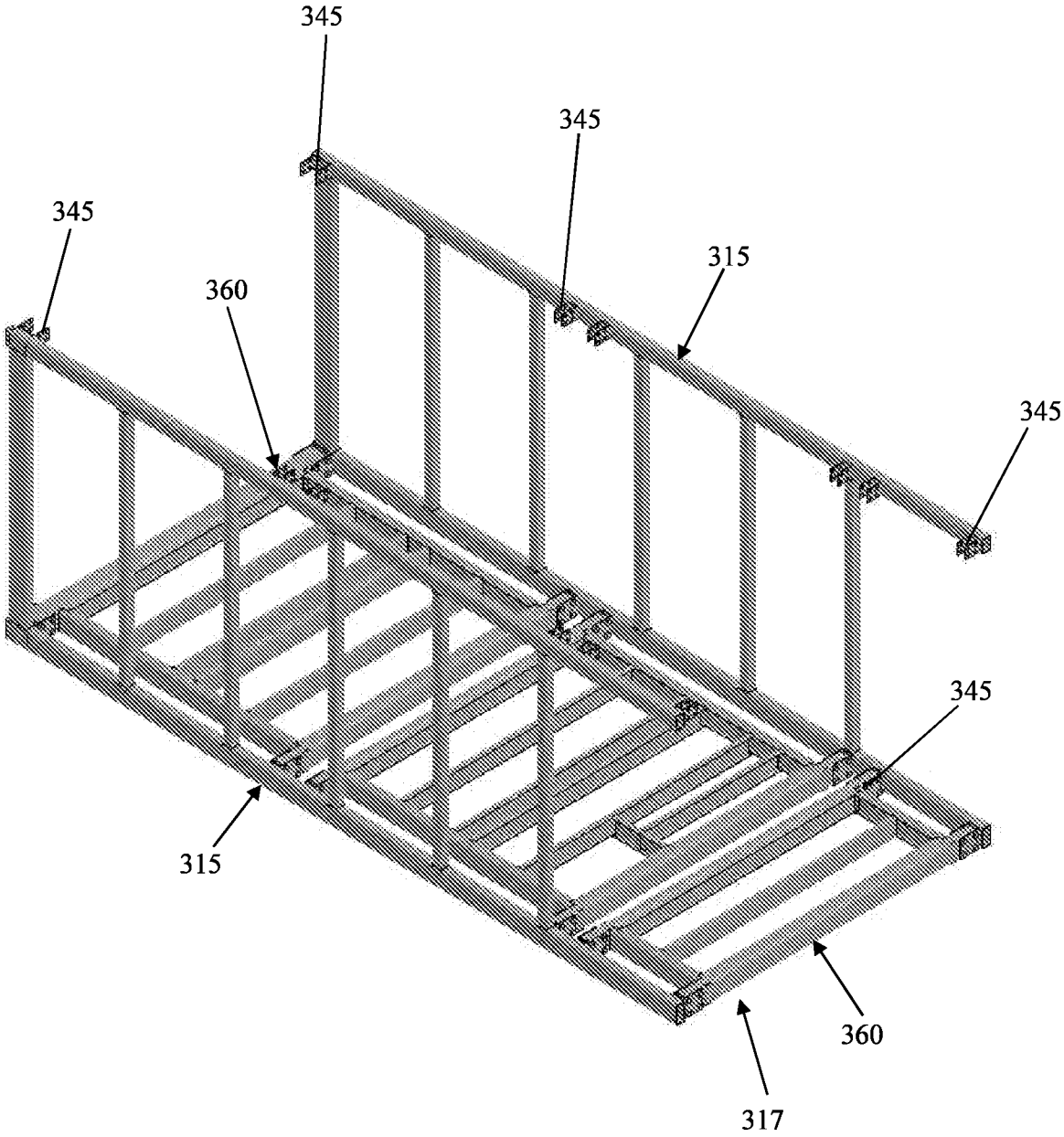

FIG. 58

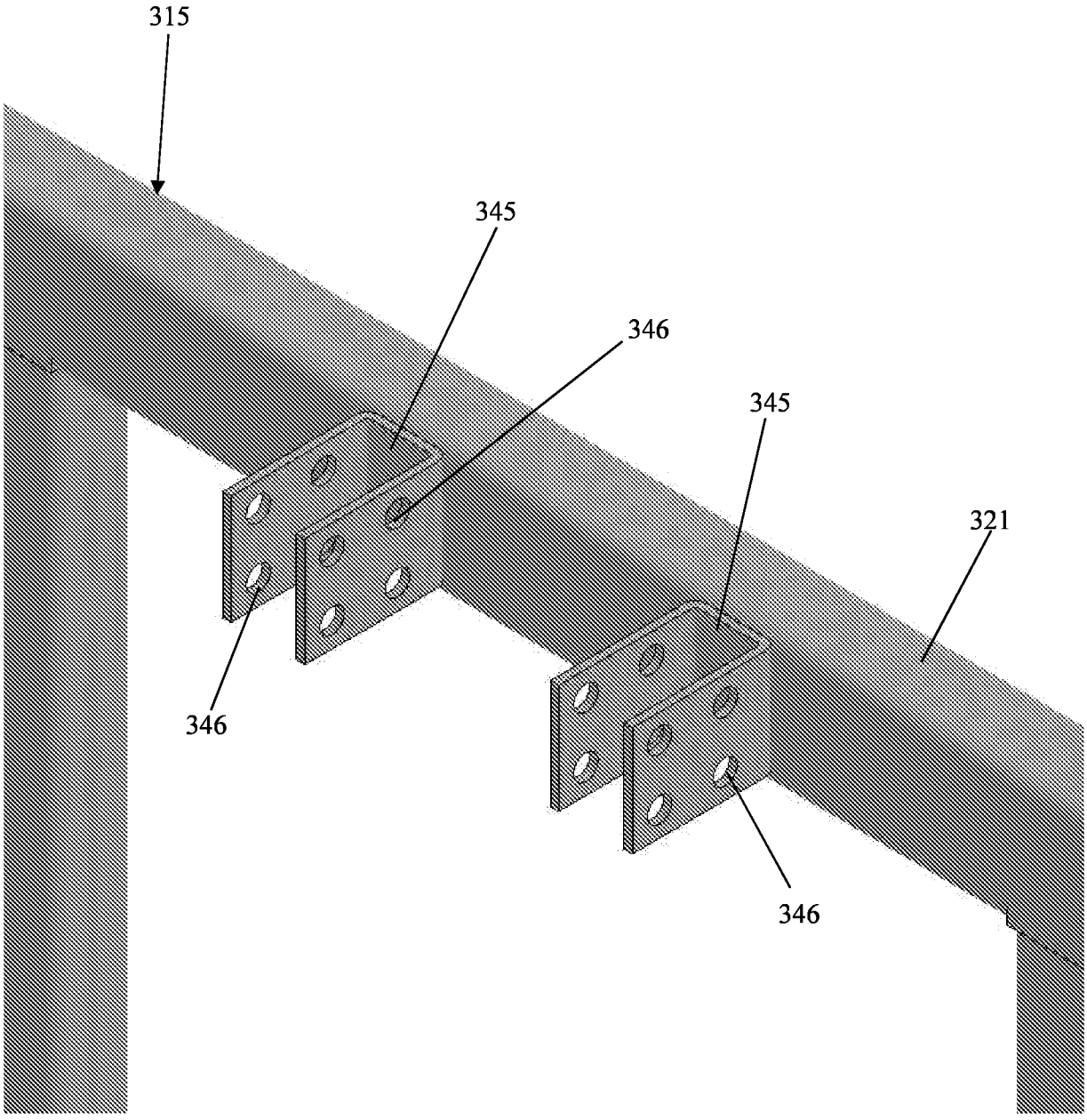

FIG. 59

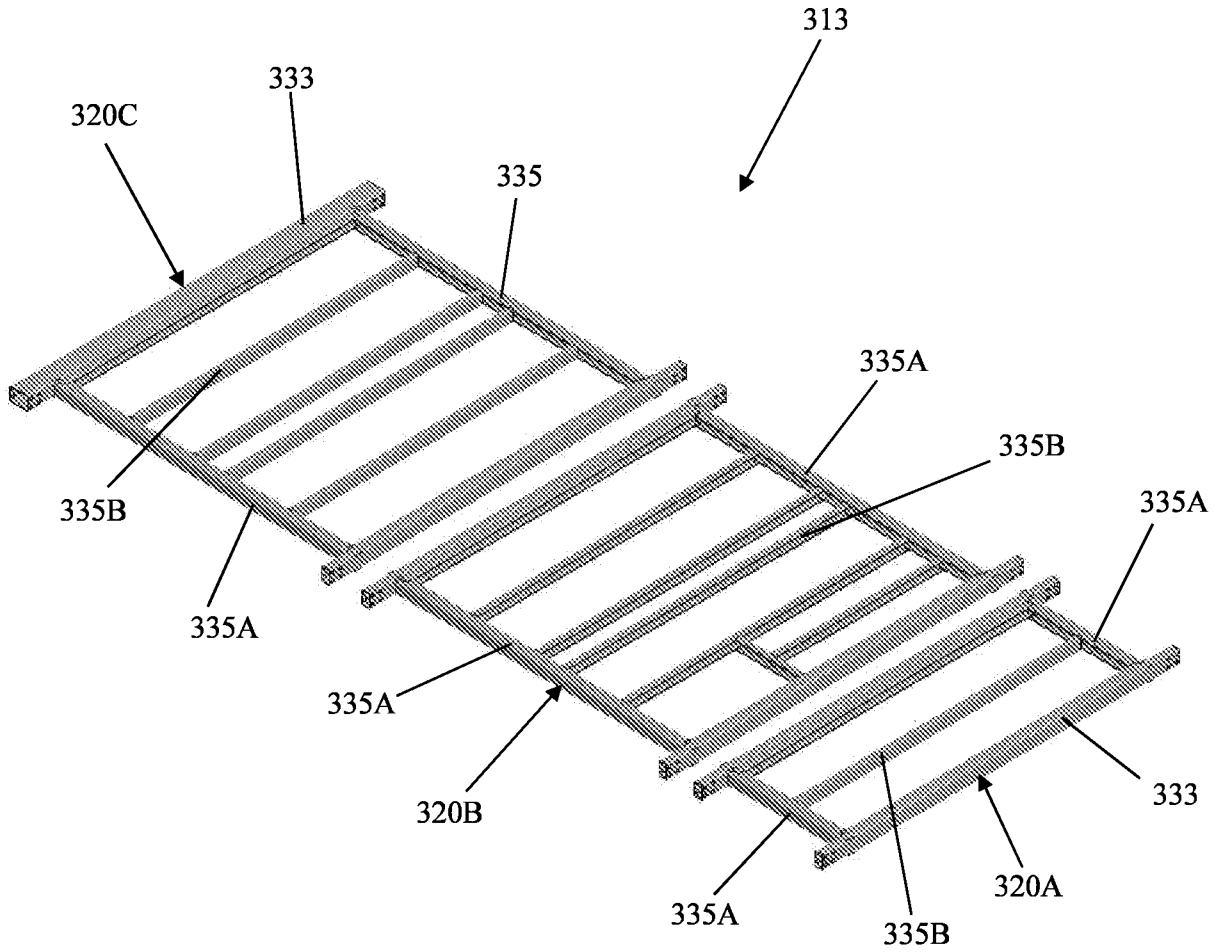
313
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FIG. 60

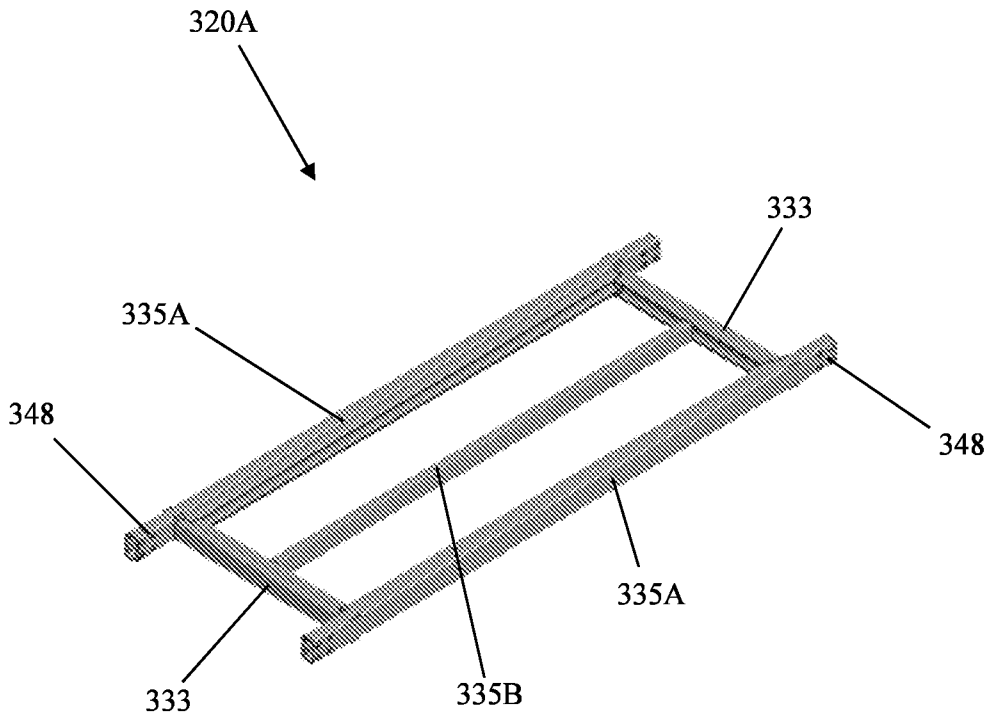


FIG. 61

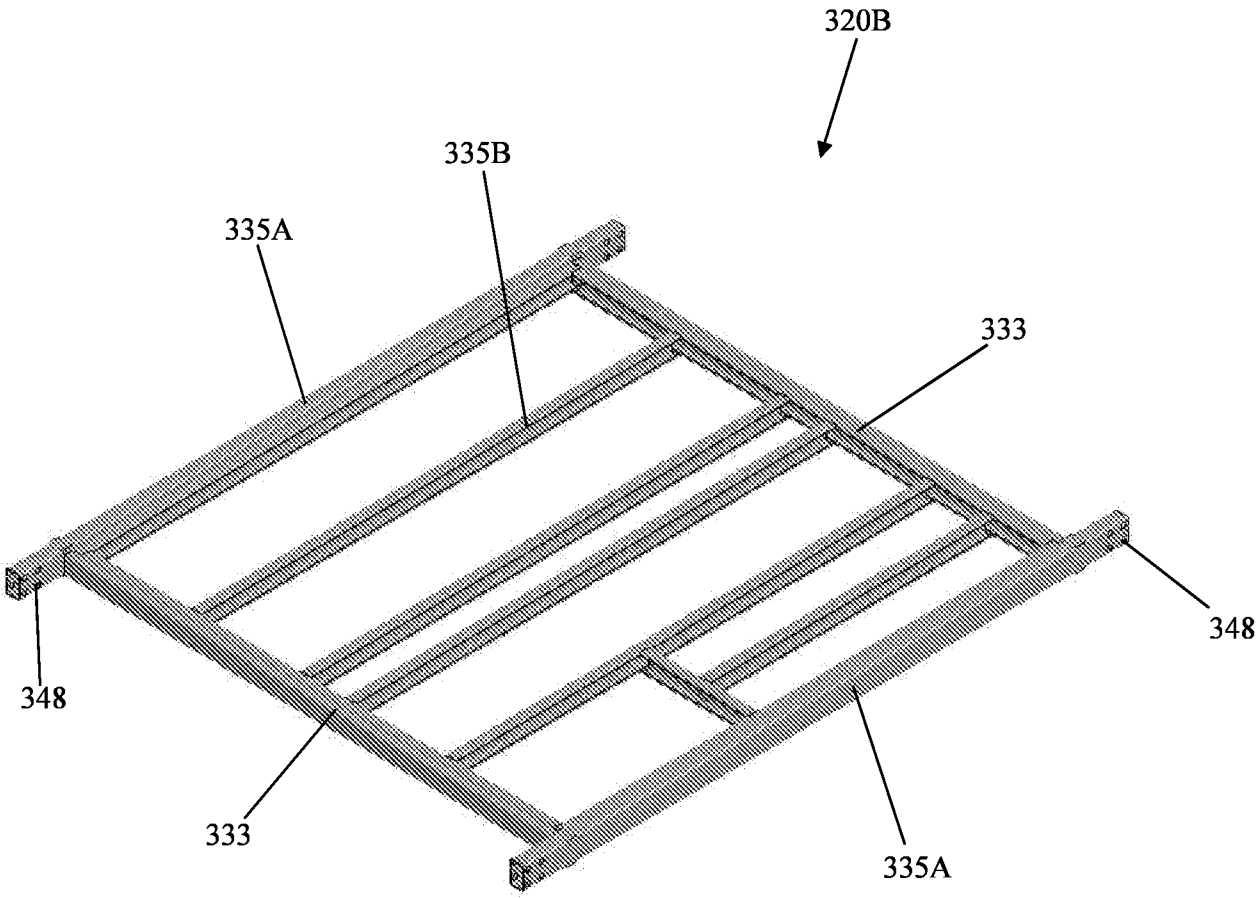


FIG. 62

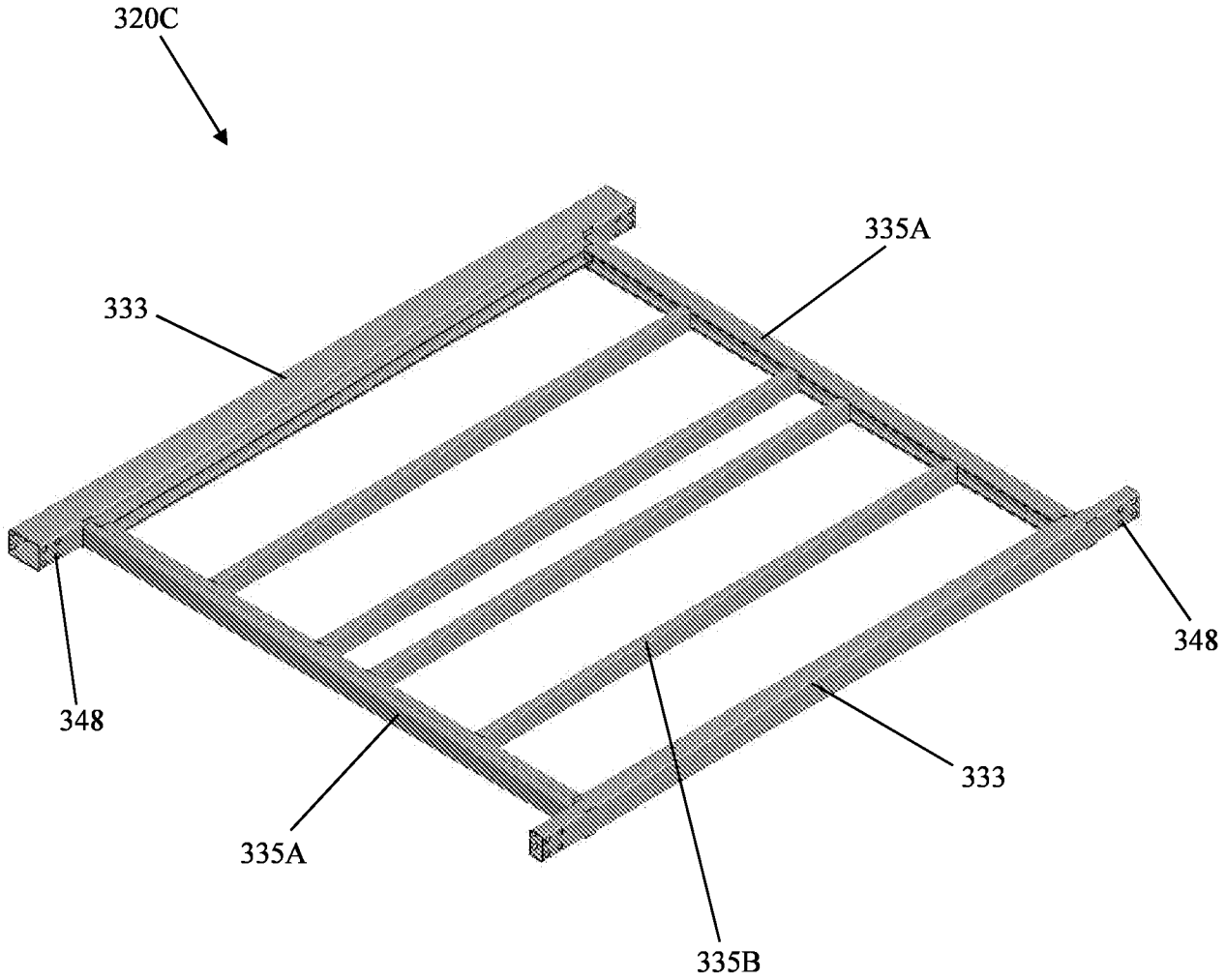
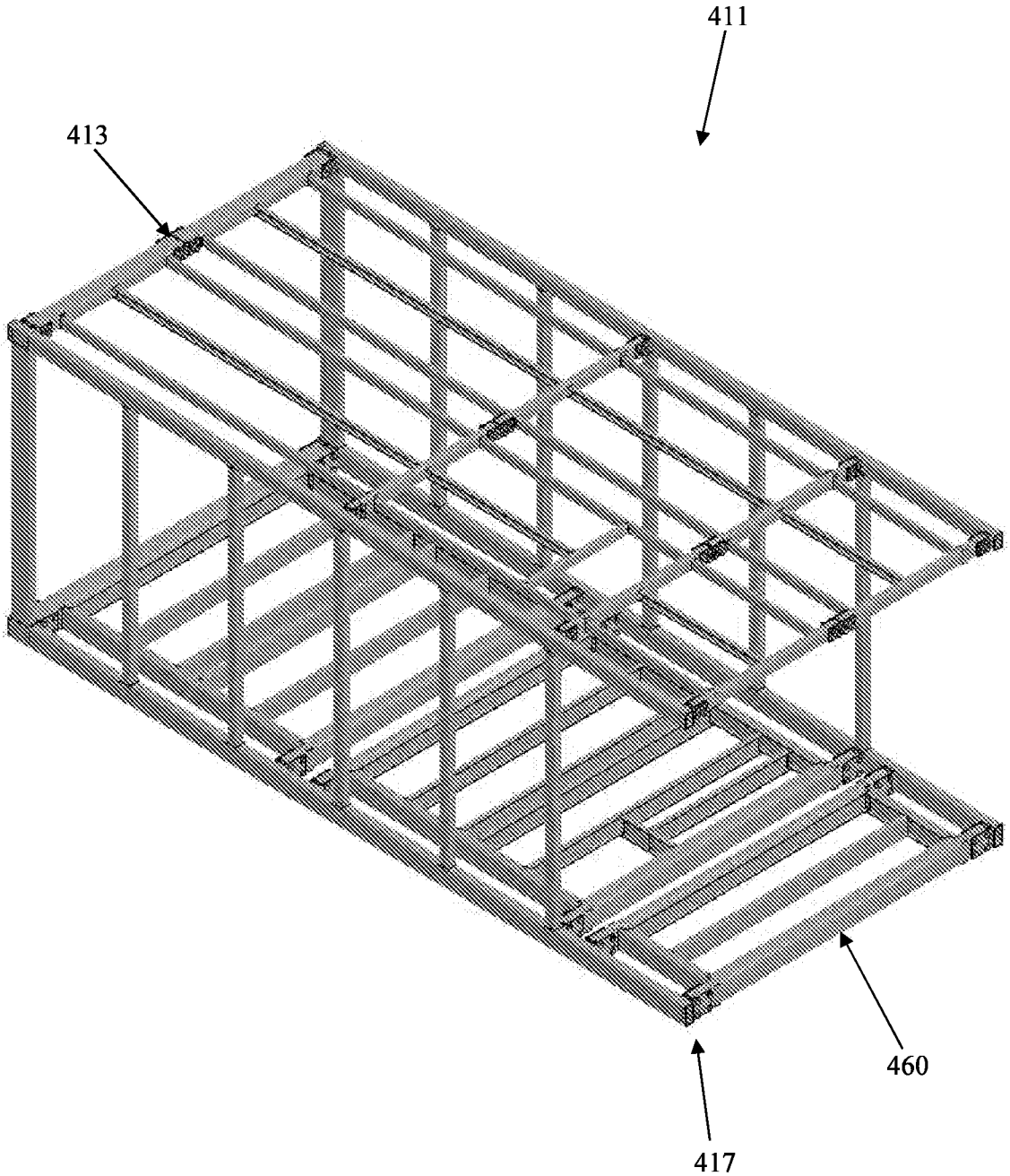


FIG. 63



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 21/65663

A. CLASSIFICATION OF SUBJECT MATTER
IPC - E04B 1/348, E04B 1/19 (2022.01)
CPC - E04B 2001/1978, E04B 1/348, E04B 1/34861, E04B 2001/34389, E04B 1/34807

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)
See Search History document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 200193182 Y1 (Lee) 16 August 2000 (16.08.2000), entire document, especially Fig. 1-5, page 1 paragraph 2, page 2 paragraph 2, 10, page 3 paragraph 1	1, 3-4
X	US 2020/0332512 A1 (FastPaks LLC) 22 October 2020 (22.10.2020), enitre document, especially Fig. 7, para [0054], [0055], [0056], [0058], [0066], [0068]	1-2, 5-13, 17-19
X	US 2008/0053003 A1 (Hockemeyer et al.) 6 March 2008 (06.03.2008), entire document, especially Fig. 1A, 2A, 3, 7A-7D, para [0066], [0067], [0085]	9, 14-16, 17, 20
X	US 3,103,709 A (Bolt) 17 September 1963 (17.09.1963), entire document, especially Fig. 1-3, col. 1 ln. 11-12, 17-22	21-25
A	US 2017/0130475 A1 (Unithouse Co Ltd) 11 May 2017 (11.05.2017), entire document	1-25
A	US 2020/0190788 A1 (Knauf Gips KG) 18 June 2020 (18.06.2020), entire document	1-25
A	US 2019/0226198 A1 (Morgan) 25 July 2019 (25.07.2019), entire document	1-25
A	US 2016/0017601 A1 (Bottin) 21 January 2016 (21.01.2016), entire document	1-25
A	BR 202014016959 U2 (HOUSE MODULAR SOLUTION S L) 01 March 2016 (01.03.2016), entire document	1-25

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" 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	Date of mailing of the international search report
25 April 2022	JUN 01 2022
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Kari Rodriquez Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 21/65663

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I: Claims 1-8 directed to a module comprising a plurality of connector plates.

Group II: Claims 9-20 directed to a module comprising a ceiling assembly including a plurality of ceiling units each including a plurality of ceiling members.

Group III: Claims 21-25 directed to a method of building a modular building comprising a manufacturing facility and a semi-trailer.

-*- See Extra sheet -*-

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

--- Continuation of Box No. III ---

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

SPECIAL TECHNICAL FEATURES

The invention of Group I includes the special technical feature of a module comprising a plurality of connector plates, not required by the claims of Groups II-III.

The invention of Group II includes the special technical feature of a module comprising a ceiling assembly including a plurality of ceiling units each including a plurality of ceiling members, not required by the claims of Groups I and III.

The invention of Group III includes the special technical feature of a method of building a modular building comprising a manufacturing facility and a semi-trailer, not required by the claims of Groups I-II.

COMMON TECHNICAL FEATURES

Groups I and II share the common technical features of a module for use in constructing a building, the module comprising a ceiling assembly, a plurality of wall assemblies configured for attachment to opposite sides of the ceiling assembly generally at tops of the wall assemblies, and a floor assembly configured for attachment generally to bottoms of the wall assemblies, wherein the ceiling assembly, wall assemblies and floor assembly form a module configured to be placed with other modules to form at least a portion of the building.

However, this shared technical feature does not represent a contribution over prior art as being anticipated by US 2017/0130475 A1 to Unithouse Co Ltd (hereinafter "Unithouse"), which discloses a module (Fig. 1, container body 10, para [0029]) for use in constructing a building (See Fig. 1, the building is shown.), the module comprising a ceiling assembly (Fig. 1-2, ceiling part 14, spacing members 30, insulation panels 50 para [0029]), a plurality of wall assemblies (Fig. 1-2, side walls 13, spacing members 20, insulation panels 40, para [0029], and frame assembly 11, para [0030]) configured for attachment to opposite sides of the ceiling assembly generally at tops of the wall assemblies (See Fig. 1-2, the side walls are shown to attach to opposite sides of the ceiling assembly at the tops of the sidewall assembly.), and a floor assembly (Fig. 1-2, floor part 12, para [0030]) configured for attachment generally to bottoms of the wall assemblies (See Fig. 1-2, the floor part 12 is shown to attach to the bottom of the wall assemblies.), wherein the ceiling assembly, wall assemblies and floor assembly form a module configured to be placed with other modules to form at least a portion of the building (See Fig. 1-2, see how the container 10 could be placed adjacent a second container 10 to form a building.) (Note: Intended Use: The module is shown to be capable of being configured to be placed with other modules to form at least a portion of the building.).

As the common technical features were known in the art at the time of the invention, these cannot be considered special technical feature that would otherwise unify the groups.

Therefore, Groups I-III lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.