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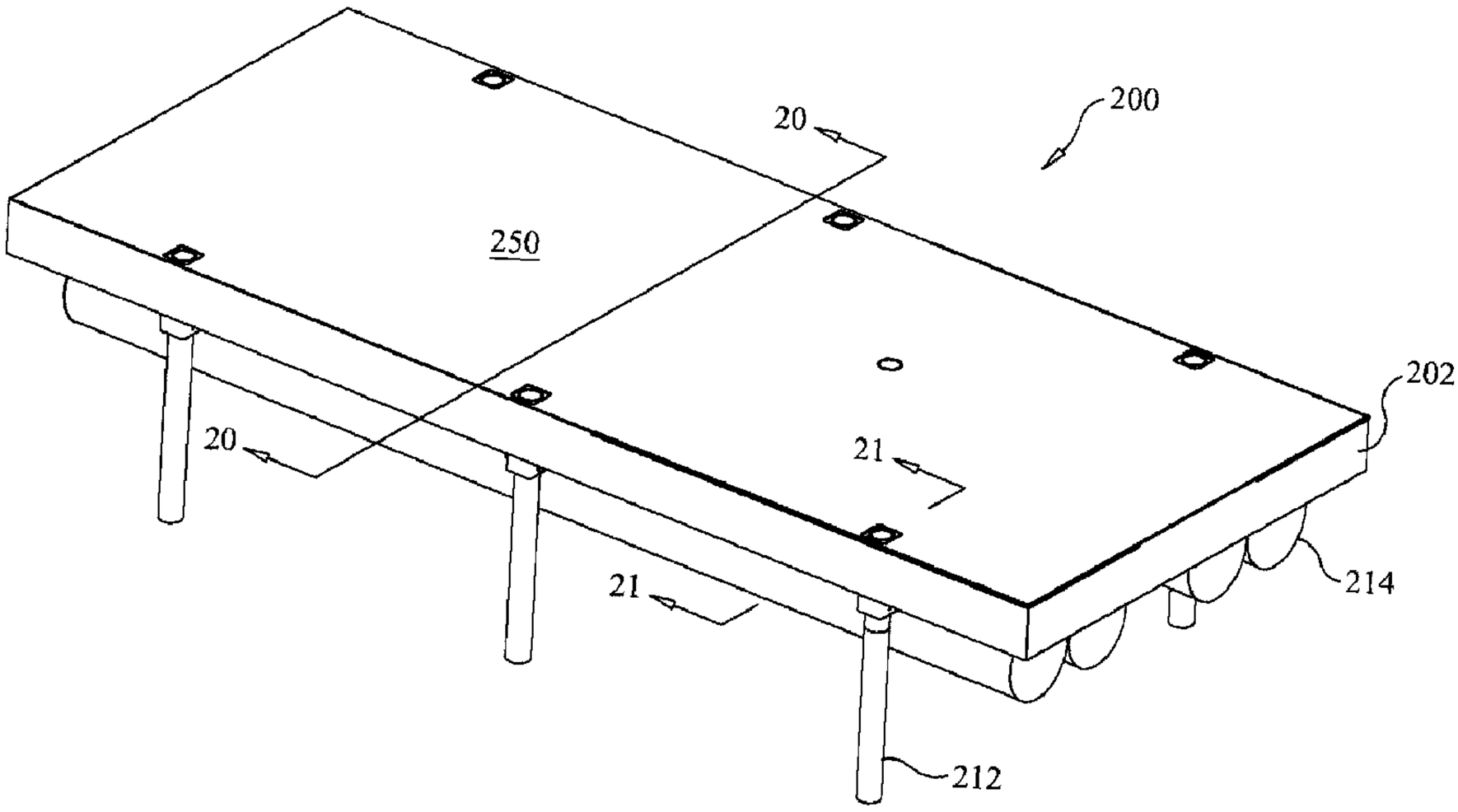

(57) Abrégé/Abstract:
We disclose a kit for installing a boat dock to an underlying bed of a body of water, comprising a deck frame for supporting a deck surface and guide members configured to slideably engage a support pillar to the deck frame; dock flotation members for floating

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(57) Abrégé(suite)/Abstract(continued):
the deck frame on the body of water; and pillars configured to be engaged to deck frame by the guide member and to be anchored to the bed to secure the deck frame to the bed. We further disclose a deck panel consisting of an external frame with a reinforced concrete panel within the frame, and a method for assembling and installing a dock, supporting a deck frame on or above a body of water; inserting pillars through guide members on the frame to contact the underlying lake bed; and anchoring the pillars to the underlying bed.

Abstract

We disclose a kit for installing a boat dock to an underlying bed of a body of water, comprising a deck frame for supporting a deck surface and guide members configured to slideably engage a support pillar to the deck frame; dock flotation members for floating the deck frame on the body of water; and pillars configured to be engaged to deck frame by the guide member and to be anchored to the bed to secure the deck frame to the bed. We further disclose a deck panel consisting of an external frame with a reinforced concrete panel within the frame, and a method for assembling and installing a dock, supporting a deck frame on or above a body of water; inserting pillars through guide members on the frame to contact the underlying lake bed; and anchoring the pillars to the underlying bed.

BOAT DOCK AND METHOD OF INSTALLATION

Field

[001] The invention relates to docks such as boat docks, in particular docks supported or retained by fixed posts anchored to an underlying lake or sea bed.

Background

[002] Boat docks, such as cottage docks, are typically floating or fixed. A non-floating (i.e. fixed) boat dock typically comprises a solid deck supported on pillars or similar supports. Typically, the pillars are sunk into the lake bed to a depth that is suitable for anchoring the dock to provide year-round stability.

[003] Conventional fixed docks have certain advantages over floating docks, since they are less subject to damage or becoming unmoored from storms or high waves. As well, they can be better able to withstand factors such as ice, tides etc. that might disrupt a floating dock, and they form a more stable surface for the user. However, in many locations, it can be difficult to obtain regulatory approval to install a fixed dock, due to the disruption to the lake bed during the installation process. As well, installation of a fixed dock can be complex, time-consuming and costly.

[004] On the other hand, conventional floating docks, which are anchored by various means to the lake bed or solid ground, tend to be easy to install and are useful in some applications. However, they tend to become unmoored and float away in storms or high waves. As well, they can lack stability when subjected to waves, and as well tend to tilt when unbalanced.

[005] The prior art discloses various fixed dock assemblies and methods for fabricating and installing these. Examples include U.S. patent 4647257, which

describes a dock assembly consisting of horizontal girders cross-linked by transoms. Sleeves are provided at the ends of the girders to receive and guide support posts. U.S. patent 8529158 describes a structure for driving pilings into the ground, such as a lakebed. The system includes a frame (a "cap structure") having vertical sleeves for receiving the pilings. U.S. patent 8668407 describes a dock system having an open frame for supporting decking slabs. The frame also includes sleeves for receiving vertical posts for supporting the dock on a lakebed.

[006] Boat docks and other platforms are typically provided with removable decking members to provide a useful surface, such as planks or other panels. These members may be pre- installed prior to installation of the dock or installed on-site. For on-site installation, a dock frame may be installed initially, followed by installing the decking on the frame, for example by screwing or bolting the panels onto the frame.

[007] Traditional wood deck boards have drawbacks, such as limited lifespan, splinters and others problems. There exist various alternatives to wood in the market for deck materials, such as plastics and plastic composites, precast concrete and others. The use of precast concrete has particular advantages for outdoor decking surfaces. However, precast concrete panels can be heavy and consequently difficult to transport and install. As well, it can be difficult to install dock fixtures such as boat cleats onto a concrete surface.

Summary

[008] According to one aspect, we disclose a method for installing a boat dock in which the dock comprises a deck and rigid deck pillars which engage the dock to a lake bed or other underlying surface. The method comprises the steps of:

a) supporting the deck frame in an elevated position above the surface with at least one deck support member;

b) inserting the pillars through pilot sleeves, wherein the pilot sleeves are connected to the deck frame and are configured to permit the pillars to slide

and/or rotate within the sleeves to accurately guide the pillars to the underlying surface;

c) installing the pillars to the surface and the deck frame; and

d) removing the pilot sleeves and the deck support member whereby the weight of the deck bears on the pillars.

[0009] Decking members may then be attached to the deck frame. We also disclose the option whereby the decking members comprise precast concrete members, as described herein, which are individually attached to the frame.

[0010] We further disclose a kit for installing a boat dock, which is useful for performing the method described herein. The kit comprises:

a) a deck frame;

b) a plurality of sleeves configured to be removably attached to the deck frame; and

c) a plurality of pillars configured to be installed to the frame, whereby the pillars are configured to be slideably and/or rotatably engaged within the sleeves during installation of the deck frame.

[0011] The kit may further comprise deck members that are configured to be attached to the deck frame. Optionally, the deck members may comprise the precast members described herein. Optionally, the kit may also comprise flotation members such as pontoons for floating the dock, for assembling a floating dock in which lateral and tilting movement is restrained by fixed pillars.

[0012] In one example, the decking members are installed on the deck frame independently of installing the deck to the pillars. According to one option, the deck members each comprise a frame with a precast reinforced concrete insert. The deck member frame may comprise a reinforcement structure that is partially embedded within the concrete and also partially external to the concrete insert.

[0013] We further describe kit for installing a boat dock to an underlying bed of a body of water, comprising:

a) a deck frame comprising frame members for supporting a deck surface and guide members configured to slideably engage a support pillar to the deck frame;

b) at least one dock flotation member for floating the deck frame on the body of water; and

c) at least one pillar configured to be engaged to deck frame by the guide member and to be anchored to the bed whereby the deck frame is secured to the underlying bed.

[0014] Optionally, a deck surface such as a precast concrete slab, may be pre-installed on the deck frame. According to this aspect, the deck frame and concrete slab may consist of an assembly in which the slab is integral with the frame which is supplied in the kit as a pre-formed unit.

[0015] There also exists a need for improvements in precast concrete decking members, including but not limited to decking members that are relatively lightweight and which can be included within modules that include deck fixtures such as boat cleats.

[0016] According to one general aspect, we disclose a deck member which may be used to provide the decking surface on a boat dock, patio deck or other structure. In this general aspect, the deck member comprises a concrete panel and a reinforcement structure. The reinforcement structure comprises a frame composed of frame members arranged in opposition to each other configured to form the peripheral border extending around the edges of the concrete panel, at least one reinforcement member (such as a reinforcement rod or bar) extending between opposing ones of the frame members and at least one post extending from the reinforcement bar(s). The post(s) is/are at least partially embedded in the concrete and the reinforcement bar(s) is/are at least partially exposed to reinforce the concrete panel through the post(s). In this fashion, the reinforcement bars may be spaced apart from the concrete panel, or in contact with the concrete panel but not embedded in it, or partially embedded in the concrete panel.

[0017] The deck member may further comprise a gasket on an exposed rim of the frame members, such that the gasket extends upwardly therefrom to be flush with a surface of the concrete panel. The gasket can provide a seal between adjacent deck members.

[0018] The concrete may overlie the reinforcement bar(s) such that the reinforcement bars are beneath the concrete panel in a horizontal installation of the deck member and the post(s) protrudes upwardly into the concrete.

[0019] The reinforcement structure optionally includes a fixture such as boat cleat attached thereto which is configured to project from the concrete panel.

[0020] According to another aspect, we disclose a method of fabricating a deck member, comprising the steps of:

a) positioning a reinforcement structure on a forming surface (preferably in an inverted position), said reinforcement structure comprising a frame configured to form the periphery of the member and composed of frame members arranged in opposition to each other, at least one reinforcement bar extending between opposing frame members and at least one upright post engaged to the at least one reinforcement bar;

b) partially filling said reinforcement structure with liquid concrete whereby said at least one post is at least partially embedded in the concrete and said at least one reinforcement bar is at least partially exposed;

c) allowing the concrete to harden whereby a concrete surface is formed in contact with the forming surface;

d) separating the concrete from the forming surface whereby the concrete surface comprises the upwardly-facing surface of the deck member when this is installed horizontally.

[0021]

We further disclose a method for installing a dock to an underlying bed of a body of water, wherein the dock comprises a deck frame, rigid deck pillars for connecting the deck frame to an underlying surface and a plurality of guide

members connected to the deck and configured to secure the deck frame to the pillars. According to this aspect, the method comprises the steps of:

a) floating the deck frame on the body of water;

b) guiding the pillars to the bed by inserting the pillars through said guide members, whereby the pillars extend downwardly from the deck to contact the underlying bed; and

c) anchoring the pillars to the underlying bed.

[0022] The present dock, its component parts and its installation method, including the improved deck member, will now be further described and illustrated by a detailed description of embodiments thereof, which is not intended to limit the scope of the invention in any respect.

[0023] In the present specification, directional references are provided for ease of description and clarity; these are not intended to limit the scope of the invention. For example, such references include terms such as "horizontal", "vertical" and the like. Such terms are by reference to a dock having a horizontally-disposed main deck. It will be understood that in practice, the dock may depart from such angles. Furthermore, any dimensions, materials and fabrication methods described herein are by way of example unless otherwise stated, and are not intended to limit the scope of the invention.

Brief description of the drawings:

[0024] Figure 1 is a perspective view from above of a dock frame according to an example of the present invention, shown in partial transparency to show underlying and internal structures.

[0025] Figure 2 is a transverse cross-sectional view of a portion of the dock frame, along line 2-2 of figure 1.

[0026] Figure 3 is a further cross-sectional view, taken along line 3-3 of Figure 5, showing a portion of an assembled and installed dock.

[0027] Figure 4 is a perspective view of a portion of the assembled dock, shown in transparency to show internal structures.

[0028] Figure 5 is a perspective view of a fully assembled dock according to the present example, with the deck slabs shown in transparency to show underlying structure.

[0029] Figure 6 shows a kit of parts for assembling a boat dock according to the first example.

[0030] Figure 7 is a flow chart of a method of assembling a dock according to the present example.

[0031] Figure 8 is a perspective view from above of a steel reinforcement frame for fabricating a concrete deck panel according to one example.

[0032] Figure 9 cross-sectional view along line 9-9 of figure 8.

[0033] Figure 10 is a perspective view from above of a complete deck panel.

[0034] Figure 11 is a cross-sectional view along line 11–11 of figure 10, in an inverted position as during fabrication.

[0035] Figure 12 is an enlarged view of the encircled portion of Figure 11.

[0036] Figure 13 is cross sectional view of a deck panel similar to Figure 11, showing the panel in an inverted position during the step of pouring concrete to form the panel.

[0037] Figure 14 is an enlarged view showing the encircled portion of Figure 13.

[0038] Figure 15 is a perspective exploded view showing a portion of a deck panel frame, showing a deck cleat fixture in a disassembled state.

[0039] Figure 16 is a side view that schematically illustrates assembly of individual decking panels into an assembled deck.

[0040] Figure 17 is a plan view of a deck panel frame according to a further embodiment.

[0041] Figure 18 is a perspective view of an assembled dock according to a third embodiment.

[0042] Figure 19 is a perspective view of a dock frame according to the third embodiment.

[0043] Figure 20 is a sectional view along line 20-20 of Figure 18.

[0044] Figure 21 is a sectional view along line 21-21 of Figure 18 of a portion of the dock.

[0045] Figure 22 shows an enlarged portion of Figure 20.

[0046] Figure 23 is a cross-sectional view of a further embodiment of a deck according to a still further embodiment.

[0047] Figure 24 is an enlarged sectional view showing the encircled portion of Figure 23.

[0048] Figure 25 is a plan view of a deck frame according to the embodiment of Figure 23.

Detailed description

[0049] Referring to figures 1-7, there is shown a first embodiment of a dock assembly kit 1 for installing and assembling a fixed (i.e. non-floating) boat dock 10 (shown in kit form in Figure 6 and fully assembled in Figure 5). It will be seen that although the present embodiment relates to a boat dock which may be installed in a lake or other body of water, the kit may be adapted to provide other types of deck structures that provide an elevated deck supported by pillars that are sunk into an underlying surface. The term "dock" as used in this specification is intended to be broadly understood as including other types of

elevated platforms in which the platform is supported above a surface on supports such as posts or pillars.

[0050] Dock 10 comprises a dock platform 20 which comprises a flat surface which is configured for being supported above the water surface. For directional reference, as shown in Figure 1, a longitudinal axis 28 of platform 20 extends lengthwise between opposing ends of the dock and a transverse axis 29 is perpendicular to axis 28 on a horizontal plane (see Fig. 5). Dock platform 20 comprises a rectangular frame 22 which forms the primary load-bearing component of dock 10.

[0051] Frame 22 is composed of opposing lateral frame members 23 which are parallel to longitudinal axis 28 and end frame members 25 which are parallel to transverse axis 29. As discussed below, frame 22 may be secured to pillars 60 which support the installed dock above a lake bed or the like.

[0052] A pair of spaced apart parallel stringers 24 are attached to frame 22 and extend the length of dock 10, parallel to longitudinal axis 28, to provide attachment surfaces for the decking members, described below. Stringers 24 are supported by frame 22 and form load-bearing members for the assembled dock.

[0053] The frame members of platform 20, including frame 22 and stringers 24, are configured to bear a substantial load without deformation. The load that the frame is designed to bear will depend on the projected use of the dock, as well as its overall size, and will usually include a conventional margin of safety. The configuration and dimensions of platform are designed in accordance with known methods for engineering such structures to accommodate a projected load and other stresses. As seen in Figures 1-3, Frame members 23, 24 and 25 may each have a generally box-like configuration in cross-section, comprising a horizontal floor 33, opposing side walls 35 and a top panel 37. Frame members 23, 24 and 25 may comprise, for example, structural steel tubing or similar framing members. The dimensions and specifications of the structural members of frame 22 will depend on the overall deck dimensions, expected loads, the materials used and other known factors.

[0054] Frame 22 further comprises cross bracing members 32 which extend from the corners of frame 22 to form an X–shaped structure meeting in the middle of frame 22.

[0055] The various frame members of platform 20 may be fabricated from any suitable material such as steel or other metal which inherently resists can corrosion or is coated to do so, or these can be fabricated from a synthetic material such as a composite or suitable polymer, or wood.

[0056] Frame 22 further comprises an array of sockets 34, seen in detail in figures 2-4, located at the four corners of frame 22. Sockets 34 are rectangular in plan view (when seen from above or below) and are formed from a steel plate which is formed into a rectangular structure with flat sidewalls and an open top and bottom. Frame members 23 and 25 abut the flat sidewalls of sockets 34 and are welded thereto to seal the open ends of the respective frame members. The open upper and lower ends of sockets 34 permit dock pillars 60 to slide through sockets 34 during installation of dock 10. As will be described below, sockets 34 are vertically aligned with temporary pilot sleeves 40 (see Fig. 2), which in turn are temporarily secured to frame 22 as described below. Pilot sleeves 40 are slidingly engaged within sockets 34 and for this purpose, the outside diameter of sleeve 40 is very slightly less than the inside diameter of socket 34. Sockets 34 also engage and retain permanent dock pillars 60 when these are installed. As such, the dimensions and specifications of sockets 34 will be based on the requirements and dimensions of pillars 60, which in turn will depend on various known factors such as the overall size of the deck and its weight–bearing requirements, any applicable regulatory requirements, the lake bed properties and characteristics and other factors.

[0057] Sockets 34 each comprise a box–shaped member having vertical side walls 47, an open upper end 44 and an opposing open lower end 45. Socket 34 is capped at its upper end with a ring plate 50 (seen in detail in Figure 4), which in turn is fastened to frame member 24, for example with welding. Ring plate 50

comprises a flat plate which has a central circular opening 52, which in turn is aligned with openings 44 and 45 of socket 34 when attached to socket 34.

[0058] As seen in Figure 6, a dock assembly kit 1 further comprises removable pilot sleeves 40 which serve as temporary guides and retainers for pillars 60. A separate sleeve 40 is provided for each of sockets 34. Sleeves 40 comprise cylindrical tubular members that are open at their opposing upper and lower ends to permit a support pillar 60 to be inserted through the sleeves 40. Pilot sleeves 40 may have, in one example, an inside diameter of about 7" to accommodate a pillar having an outside diameter of this size, and may be fabricated from 0.1" thickness A36 steel. Sleeves 40 are configured to snugly engage pillars 60 within the sleeve without significant lateral movement, but with sufficient space between these members to permit free rotation and/or sliding movement of pillars 60 within sleeves 40.

[0059] Pilot sleeves 40 are temporarily attached to frame members 23 and 25 by any convenient temporary attachment means, for example with removable clamps. For example, a tubular, cylindrical bracket 55 may be provided at the base of socket 34, having an L-shaped cross-section as seen in Figures 4 and 5. Bracket 55 is temporarily welded to frame members 23 and 25, and is positioned to align with lower opening 46 of socket 34. Sleeves 40 are vertically aligned with opening 52 of ring plate 50 when installed to frame 22, whereby a pillar 60 inserted through opening 52 slides into sleeve 40 to be guided and supported thereby.

[0060] According to another method, pillars 60 are initially slid into sleeves 40 to form an assembly. The sleeve/pillar assembly is then inserted into socket 34, where sleeve 40 is snugly retained. Pillar 60 is then accurately lowered to the lake bed by sliding this within sleeve 40, and may then be drilled into the lake bed while being held accurately in position by sleeve 40. After installation of pillar 60, sleeve 40 may then be removed from pillar 60 and socket 34, for re-use. Pillar 60 is then permanently fastened to socket 34 by attachment to ring plate 50.

[0061] As shown more particularly in Figure 7, installation of dock 10 comprises an initial step of temporarily positioning frame 22 in the location where it is desired to permanently install the dock. This may be accomplished, for example, by suspending frame 22 from an overhead crane and/or supporting frame 22 on temporary supports that rest on the lake bed. Once frame 22 has been precisely positioned in its end position, sleeves 40 are than temporarily secured to frame 22, for example by temporarily welded angle brackets, clamps, or other temporary securement members. Sleeves 40 are mounted to extend downwardly from sockets 34 whereby the interiors of these parts are vertically aligned and coaxial, to permit a pillar 60 to be inserted through socket 34 and sleeve 40. Sleeves 40 may extend the full distance between the lake bed and frame 22, or alternatively may extend only a portion of this distance and be suspended above the lake bed.

[0062] Support pillars 60 are then inserted vertically through sockets 34 and into sleeves 40 whereby a separate pillar 60 is inserted into each sleeve 40. Pillars 60 and sleeves 40 are configured to provide a moderately snug fit to precisely guide the pillars 60 in a selected orientation (such as vertical), but whereby a small gap is provided to permit pillars 60 to easily slide through the sleeves even if there is contamination or irregularities that would otherwise restrict pillars 60 from easily sliding through sleeves 40.

[0063] Pillars 60 are of sufficient length to extend from the lake bed to frame 22, with a portion of the pillars 60 extending above frame 22 for penetrating into the lake bed during installation. The required depth of penetration is based on properties of the lake bed and other factors which determine the penetration depth of pillars 60 required to adequately support the dock. For example, if the lake bed is highly unconsolidated to a relatively large depth, such as a deep layer of sediment with no bedrock or other hard surface for a large distance, it will be necessary to install pillars 60 relatively deeply into the lake bed. Alternatively, if the lake bottom is underlain by shallow bedrock or other hard surface below the lake bed, the pillars maybe shorter in length. The selected depth by which pillars 60 are sunk into the lake bed will be determined by engineering factors

that are known to the art. Typically, one should over-estimate the length of the pillars 60 , which may be trimmed after installation to be flush with the deck surface.

[0064] Pillars 60 are sunk into the lake bed by various means, for example pile-driving or drilling pillars 60 into the lake bed using conventional methods. Pillar 60 may be provided with a sacrificial bit 62 (see Figure 6) at its lower end to allow pillar 60 to be drilled into the lake bed. The bit 62 may subsequently (and permanently) remain connected to the pillar 60. The use of drilling as an installation method of pillars 60 is in some cases preferred so as to minimize disturbing of the lake bed and environmental impact. As well, pillars 60 can be drilled into solid bedrock or other solidified formations if required.

[0065] At this point, sleeves 40 are then detached from deck frame 22 and removed from pillars 60. For this step, the temporary securements of sleeves 40 are released, for example by unclamping them from frame 22 or grinding off temporary brackets 55 that may have been used to attach sleeves 40 to frame 22. Once detached from frame 22, sleeves 40 may be slid upwardly to remove them from pillars 60. Pillars 60 are then fastened to frame 22 as discussed below. In order to retain frame 22 in position without slipping downwardly during this stage, especially in cases where the temporary deck support may be susceptible to movement, sleeves 40 may be removed one at a time, with pillars 60 being individually attached to frame 22 as each sleeve 40 is removed. In this fashion, the position of frame 22 is retained without downward movement as sleeves 40 are removed. Sleeves 40 may be re-used in another deck installation.

[0066] Pillars 60 are permanently secured to frame 22 by securing the upper ends of pillars 60 to ring plate 50, for example by welding. Pillars 60 are further secured to frame 22 by a permanently welded bracket 62 (see Figure 3) that encircles pillar 60 and is welded to a corresponding frame member 24. Bracket 62 may comprise a collar that encircles pillar 60. In this fashion, pillar 60 is secured at two spaced apart positions to socket 34 and deck frame 22.

[0067] Once deck frame 22 has been permanently attached to pillars 60, the temporary deck support may be detached such that deck platform 20 bears on pillars 60.

[0068] If necessary, any surplus lengths of pillars 60 extending upwardly from frame 22 is trimmed.

[0069] At this stage, stringers 24 may be attached to frame 22, for example by welding, bolting or any other suitable attachment means. Stringers 24 may be provided in a pre-set length or cut to size after installation.

[0070] Turning to Figure 5, decking slabs 70 are then installed on platform 20 to finish dock 10. In the present example, the decking slabs consist of multiple individual slabs 70a through 70g. Slabs 70a and 70g comprising end slabs at the opposing ends of deck platform 20 and interior slabs 70b to 70f are located between these end slabs. Slabs 70 comprise any suitable decking material. In the present example, slabs 70 comprise pre-fabricated concrete slabs. Slabs 70 may have a textured upper surface which may, for example, simulate wood grain or any other desired texture and appearance.

[0071] Slabs 70 are secured to stringers 24 by any suitable means, for example slabs 70 may be secured using J-bolts or clamps that fasten brackets on the slabs to stringers 24.

[0072] In one embodiment, slabs 70 may be pre-installed onto stringers 24, whereby the assembled combination of stringers 24 and slabs 70 is installed onto frame 22.

[0073] As seen in Figure 3, in one example, a slab 70 may comprise a metal decking member frame 80 with a precast concrete insert 82. According to this example, frame 80 is rectangular, and is spanned by reinforcement bars 84 that extend across the open interior of frame 80. An array of posts 86 extend upwardly from bars 84. Concrete insert 82 is poured in place within frame 80. Slabs 70 may be attached to dock frame 22 at any suitable juncture in the dock

assembly process, for example after frame 22 has been permanently anchored on the lake bed.

[0074] As seen in Figure 3, an upwardly projecting second tier column 90 may be installed on dock 10, stacked onto pillar 60 and vertically aligned therewith. For this option, slab 70 may have an aperture to permit the column 90 to protrude through the deck surface. Column 90 may be attached to the deck by any suitable attachment means.

[0075] Turning to figures 8-16, we describe a precast concrete deck member 110 (seen in fully assembled form in Figure 10) which comprises a panel-like structure having a steel reinforcement structure 112 (seen in figures 8 and 9) that is partially embedded within a concrete layer 114 (see Figures 11 to 14). Concrete layer 114 comprises a flat panel having opposing upper and lower surfaces 115 and 117 and an edge 119 extending between surfaces 115 and 117. As discussed below, deck member 110 comprises a reinforced concrete panel, as seen in figure 10, which may be used in a variety of end uses such as for a boat dock, patio deck and others.

[0076] Reinforcement structure 112 may be coated with a suitable corrosion-resistant coating (examples include paint and galvanized coatings) to prevent corrosion or oxidation of the metal from exposure to air, water, salt etc. Alternatively, reinforcement frame 112 may be fabricated from a corrosion resistant material which does not require a coating and which also provides suitable reinforcement for the concrete component of member 110. As discussed below, the reinforcing structural members of structure 112 are external to concrete layer 114 and are integrated with layer 114 through posts 130 embedded within layer 114.

[0077] Reinforcement structure 112 comprises a rectangular frame having side members 116 and opposing end members 118, welded together to form a rectangular frame. Reinforcement structure 112 is defined by a longitudinal axis 105 that extends between opposing end members 118 and a transverse axis 106 that is perpendicular thereto, extending between side members 116 (see Figure

10). Frame members 116 and 118 are each L- shaped in cross-section and are each composed of a vertical wall 120 and a horizontal base 122. Walls 120 form a continuous bumper-like periphery around frame 112 and also, since concrete layer 114 is contained within walls 120, these walls form a bumper around the finished deck member 110. Walls 120 are in contact with edge 119 of concrete layer 114 and serve to protect this against chipping and other damage. Walls 120 also serve the function of providing a form for containing liquid concrete during the fabrication process, described below.

[0078] Referring to Figure 15, an array of transverse reinforcement bars 124 span the interior of frame 112 between side members 116, parallel to axis 106, and longitudinal reinforcement bars 125 that span the interior between end members 118 aligned with axis 105. Reinforcement bars 124 and 125 are welded to side members 116 and 118 and form a rectangular grid pattern. As well, bars 124 and 125 are welded at their respective ends to opposing horizontal bases 122. The number of reinforcement bars 124 and 125 will vary depending on the required properties of the decking panel 110.

[0079] An array of vertical metal posts 130 protrude upwardly from reinforcement bars 24 . Posts 130 are recessed from the upper rim of sidewalls 116 and 118. In this fashion, when frame 112 is filled with concrete, posts 130 are fully embedded within the concrete 142 that fills frame 112. The embedded portions of posts 130 are thus not exposed to the elements in the finished assembly. In the present example, each reinforcement bar 124 is provided with five posts 130. However, this number may vary. Posts 130 provide a structural link between the concrete 114 and reinforcement frame 112 whereby the concrete is effectively reinforced by the frame 112.

[0080] Side walls 116 and 118 of wall 120 have an exposed upper rim that is capped with a resilient gasket 138, as seen in figure 14. Gasket 138 may be fabricated from neoprene or a similar material that resists exposure to the elements and provides suitable resiliency properties to prevent moisture leakage around its edges. Gaskets 138 also form a seal between adjacent panels 10 where these abut in a finished deck assembly.

[0081] As seen in detail in figure 15, an attachment for a dock fixture 132 such as a boat cleat may optionally be provided on frame 112. Fixtures 132 may be selected from a wide range of conventional dock fixture such as an anchor for a slide or ladder, etc. In this example, fixture 132 is a boat cleat that comprises a vertical fixture post 134 and a horizontal cleat member 136. Fixture 132 is mounted to a base 152 which in turn is attached to frame member 116 or 118. Base 152 may be positioned at a location which places it adjacent to an outside edge of the installed deck panel, to position the dock fixture adjacent to an edge of the assembled dock. Base 152 comprises an upright member with a flat upper surface 158 for contacting and supporting fixture 132. Surface 158 is flush with the upper concrete surface 115 of concrete layer 114 when deck member 10 is fabricated. A peg 160 protrudes upwardly from upper surface 158, whereby peg 160 is exposed above concrete surface 115 to allow peg 160 to secure fixture 132. Post 134 of fixture 132 has an internal socket 162 open to its base, which allows post 134 to receive peg 160. Fixture 132 may be secured to peg 160 by various means, such as a screw-threaded attachment between peg 160 and socket 162. In this fashion, fixture 132 may be either permanently or removably installed to deck member 110. Furthermore, forces acting on fixture 132 are transmitted directly to reinforcement structure 112 whereby damage to concrete panel 114 is prevented.

[0082] Installation of fixture 132 is preferably performed after a deck has been fully assembled within a boat dock or the like.

[0083] Figure 17 shows an embodiment wherein the deck member 110 is provided with rectangular apertures 170 to permit columns or posts (not shown) to penetrate the deck. Apertures 170 may be created during the fabrication process by positioning an open frame-shaped form (not shown) in a desired position within reinforcement structure 112 before concrete is poured into structure 112. Apertures 170 are thus formed when structure 112 is filled with concrete, as described below. It will be seen that apertures 170 may comprise any suitable dimensions or configuration, to accommodate a wide range of posts, pillars and

other members that may protrude through deck member 110 in the finished dock assembly.

[0084] A method of fabricating a deck member 110 is illustrated in Figure 13 whereby reinforcement structure 112 is inverted and filled with concrete to form the finished deck member 110. Fabrication is relatively simple and is typically performed at a remote facility whereby the finished members are transported to the installation site.

[0085] In one example of a fabrication method, a reinforcement structure 112 is provided. Optionally, reinforcement structure 112 may have one or more fixture-mounting bases 152 pre-installed for mounting a dock fixture. Alternatively, a base 152 may be welded onto structure 112 at a desired location. Next, a gasket 138 is installed onto the upper rim of walls 120 so as to fully encircle structure 112. Gasket 138 may be provided from a large roll which is cut to the appropriate length and the opposing ends glued together where these meet. Alternatively, gasket 138 may be provided as a loop of a pre-set size which is fitted onto structure 112.

[0086] Next, reinforcement structure 112 is then positioned in an inverted position (i.e. posts 38 protruding downwardly) on a surface 140, as seen in figure 13. In this position, gasket 138 rests on surface 140. Surface 120 may have a three dimensional structure to emboss a textured surface into the concrete layer 114. For example, surface 140 may emboss a wood grain appearance that simulates a wood surface into concrete 114. Using conventional concrete forming practices, surface 40 comprises a non-stick surface that permits concrete 114 to be easily removed from surface 40 after hardening. Alternatively, surface 140 may be spray–coated with a liquid coating to achieve this purpose.

[0087] When reinforcement structure 112 is placed on surface 140 in an inverted position as seen in figure 10, it will be seen that side walls 116/118 and gasket 138 effectively form a dike that encloses a central area defined by frame members 116 and 118, which may be partially filled with concrete. Surface 140 is configured whereby gasket 138 forms a leak- proof seal with surface 140 to

prevent leakage of liquid concrete during the fabrication process. In this fashion, reinforcement structure 112 effectively defines a form which may be partially filled with concrete to fabricate a pre-case, reinforced deck platform member.

[0088] Reinforcement structure 112, in the inverted position, is then partially filled with liquid concrete to a level whereby reinforcement bars 124 and 125 are exposed above the uppermost surface of the concrete 114. In this fashion, the finished deck member 10 comprises exposed reinforcement bars 124. Reinforcement bars 124 and 125 may be fully exposed whereby the concrete layer 114 is out of contact there with, leaving a gap between concrete layer 142 and bars 124.

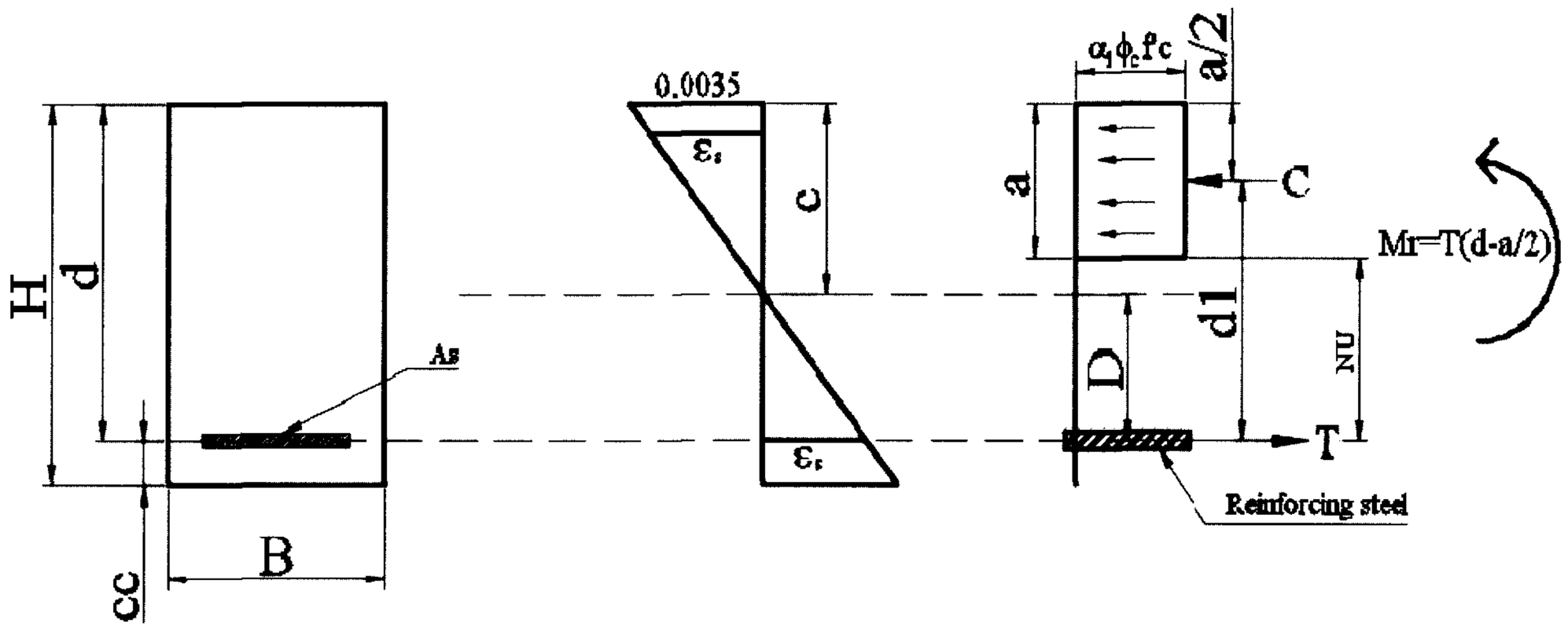
[0089] Concrete panel 114 is fabricated to leave a gap between lower concrete surface 117 and bars 124 and 125. This gap is represented as dimension "e" in Figure 12. Dimension "e" is determined by reference to a theoretical region within spacing "d" which, if it were to comprise concrete, it would not contribute to the structural properties of concrete layer 114. This theoretical region is represented by NU, which also represents the theoretical maximum value of "e".

[0090] The value for NU depends on stress properties of the concrete layer 114 and the external reinforcement structure 112 which is structurally connected to the concrete layer 114 via posts 130. As such, the external reinforcement of concrete layer 114 by structure 112 provides essentially the same degree of structural reinforcement as a conventional fully embedded reinforcement structure. Distance "d" is determined based on the principle that in a conventional reinforced concrete panel in which the reinforcement mesh is embedded within the concrete, a layer of concrete of thickness "NU" exists, consisting of the embedded region and a region extending partially into the concrete layer, that does not provide significant structural support. The value for NU may comprise the smallest thickness of concrete that is necessary to provide a selected stress block for the panel.

[0091] In the present example, layer NU is hypothetical, and its value is determined in order to determine a suitable (maximum) value for distance "e" for fabricating a panel 110.

[0092] Hypothetical layer NU equals the distance between the reinforcement mesh and the center of the concrete panel. The present invention is thus based on the principle that at least some of this concrete layer may be eliminated without substantially affecting the structural integrity or strength of the reinforced panel. As such, distance "e" in assembly 10 may be the same as or less than hypothetical distance NU as determined for the particular configuration of concrete layer 114 and reinforcement structure 112.

[0093] According to one aspect, the values for NU and d may be calculating according a conventional methodology of structural engineering. An example of such calculation is shown by reference to the following diagram:



[0094] An initial step in the calculations of NU and d is to determine a factored moment. Following this determination, one generates a concrete layer with sufficient reinforcement to create the necessary resistance member to equilibrate that factored moment.

Mf = factored moment

Mr = resistance moment

Material properties=

concrete	F'c (MPa)=	35
steele	Fy (MPa)=	400
	E_{steel}=	200.000
	Ec=	26.622

Cross section properties=

	L=	3.700
	B=	1.200
	H=	57
	rec=	1

Material reduction factors=

O_c=	0.70
O_{steel}=	0.85

Mu = 1.5 kN-m (arbitrary value selected for example)

Steel used for reinforcement:

A_s = 100 mm²

[0095] Section Calculations:

a= $\emptyset_s A_s F_y/(\alpha_1 \emptyset_c F'_c B)$
= 1.45 mm — this value is the least amount of concrete we need to form the stress block
α_1 = 0.85-0.0015f'c>0.67
= 0.7975

d1= d-a/2
= 55.27 — Distance between stress block and reinforcing steel
d= H-rec
= 56

Mr= $O_S F_y A_s(d-a/2)$ — Mr has to be larger than acting moment from analysis
= 1.88 kN-m

NU = d-a

= 54.55 <= thickness of layer that may be free of concrete between the reinforcement bars and the concrete layer.

[0096] Distance "e" may be less than its hypothetical maximum value of NU. In one aspect, layer 114 may contact reinforcement bars 124 and 125 or even partially embed them.

[0097] Optionally, the concrete layer 114 may be dyed or otherwise coloured, for example to emulate natural wood or other desirable visual effect.

[0098] The concrete is allowed to harden and cure on surface 140, following which the fully assembled deck assembly 110 is then lifted off of surface 140.

[0099] It will be seen that after concrete layer 114 hardens and deck member 110 is inverted into its normal "use" position, exposed reinforcement bars 124 and 125 are located to be beneath the lower surface of concrete layer 114. As well, the upper surface of concrete layer 114 in the finished structure 10 is flush with the upper surface of gasket 138.

[00100] In the completed assembly 110, gasket 138 comprises an exposed upper edge extending around the periphery of the dock member. Gasket 138 effectively seals the finished assembly against water leakage that might penetrate into frame 212. As well, gasket 138 forms a seal between adjacent deck assemblies 110, whereby assemblies 110 are assembled into a finished dock or other structure in which the respective deck members 110 are installed in abutment, the respective gaskets 138 of adjacent members 110 contact each other to seal against penetration by the elements through the surface of the assembled deck.

[00101] Figure 16 illustrates assembly of a dock platform 20 from multiple deck members 110. According to this method, a dock frame 22 is provided, having spaced-apart frame members 23. The finished deck members 110 are placed on frame members 23 such decking side and end walls 116 and 118 are supported on frame 22. Side/end walls 116 and 118 are then secured to frame 22 by a convenient and reliable securing means such as clamps 180. After installing a deck member 110, the next in line member 110 is then positioned and secured to frame 22. Individual members 110 are installed one at a time, such that the members 110 can be brought into abutment to slightly compress gaskets 138 to form a seal between the deck members 110.

[00102] A further embodiment of the dock is shown in Figures 18-25. According to this embodiment, a dock 200 comprises a floating deck frame 202. Deck frame 202 supports a deck surface that comprises a solid concrete slab 250, which covers essentially the entire surface of dock 200 to form an essentially continuous deck surface.

[00103] Dock 200 includes an array of vertically aligned sockets 210, seen in detail in Figure 21, which are similar in configuration to sockets 34 described above of the first embodiment. In the present example, six sockets 210 are provided for dock 200, three on each side, for engaging six dock pillars 212 (see Figure 19). It will be seen that different numbers and arrangements of sockets 210 may be provided depending on the size of dock 200 and other factors.

[00104] Socket 210 may have a square outer configuration to provide contact surface with frame 202. Socket 210 may further comprise an inner tubular sleeve having a circular cross section to receive a cylindrical pillar 212.

[00105] Dock 200 is supported on a water surface by flotation on an array of floating pontoons 214, which consist of hollow sealed tubes that extend substantially the length of frame 202. Frame 202 may be attached to pontoons 214 by welding, straps or other suitable attachment means. Horizontal movement of dock 200 is limited by pillars 212 that are sunk into the lake bed or otherwise anchored to the bed. As well, pillars 212 minimize tilting of dock 200, for example when unbalanced by a person diving from the dock or other unbalancing of the dock, by maintaining dock 200 on a level plane.

[00106] Pillars 212 are similar in structure to pillars 60 of the first embodiment. However, unlike the first embodiment in which pillars bear the weight of the dock, pillars 212 are not weight bearing but are instead provided only to anchor dock 200 in a selected position. Dock 200 is thus free to travel vertically, guided by pillars 212 but with lateral and tilting movement of dock 200 being restricted by pillars 212.

[00107] Installation of dock 200 comprises the initial step of floating frame 202 on a water surface in its desired location on pontoons 214 at a selected location and optionally anchoring frame 202 in this position with guy lines, anchors or other temporary fixation means. Pillars 212 are then inserted into sleeves similar to the first embodiment described above. The sleeve and pillar assemblies are then inserted through sockets 210 and pillars 212 brought into contact with the underlying lake or sea bed or other surface, as described above for the first embodiment. Pillars 212 are then sunk into the surface or otherwise securely and permanently anchored to the surface. Following this step, the sleeves are removed, as in the first embodiment. However, in contrast with the first embodiment, pillars 212 are then slideably engaged within sockets 210 whereby pillars 212 may freely slide vertically through sockets 210 such that frame 202 may travel vertically to accommodate tidal movement, waves and other sources of vertical movement of frame 202. As well, any guy lines or other temporary anchors or other restraints may be removed, such that horizontal travel and tilting of frame 202 is afterwards restrained solely by pillars 212.

[00108] According to this embodiment, pillars 212 project upwardly above frame 202 to permit vertical travel of frame 202. The extent of such projection depends on the expected amount of vertical travel, for example a more substantial projection is required in a location of high tidal or seasonal water level movement.

[00109] The deck assembly of dock 200 according to the present embodiment is shown in more detail in Figures 23 to 25. According to this embodiment, concrete slab 250 fully covers the upper surface of frame 202 and comprises a monolithic concrete slab supported and contained within frame 202. Frame 202 comprises steel side and end walls 262 and 264, the upper edges of which are capped with a gasket 260. Gasket 260 may comprise rubber or similar pliable material. Walls 262 and 264 form the exposed sidewalls of dock 200. Frame 202 further comprises transverse joists 266 that extend between sidewalls 262, parallel to end walls 264. Joists 266 may be attached to sidewalls 262 with brackets, welding or other fastening means. Joists 266 are recessed below the

upper edge of side and end walls 262 and 264 to accommodate concrete slab 250, whereby slab 250 rests on joists 266 and is flush with side and end walls 262 and 264. Frame 202 further comprises cross-bracing members 268 that comprise steel girders arranged in a series of X-shaped patterns between respective pairs of joists 266.

[00110] Sockets 210 are attached to frame 202 at the frame corners where sidewalls 262 meet joists 266. In the present example, frame 202 has six sockets, although this number may be increased or decreased based on the overall size of the dock 200 and other factors. Sockets 210 protrude through concrete slab 250 whereby the open upper and lower ends of sockets 210 are exposed. As such, pillars 212 may be inserted through sockets 210 for installation of dock 200 on a lake bed or other surface.

[00111] As seen in Figure 24, concrete slab 250 is 56 mm thick in the present example. In this example, joists 266 are recessed by the same amount whereby slab 250 may bear directly on joists 266 with the upper surface of slab 250 being flush with side and end walls 262 and 264. Precast concrete slab 202 has a reinforcement structure 270 embedded therein, comprising glass fiber reinforced polymer (GFRP). Reinforcement structure 270 comprises GFRP rods 272 whereby the entire reinforcement structure 270 is fully embedded within slab 250.

[00112] Dock 200 is fabricated in a manner similar to the first embodiment, wherein reinforcement structure 270 is initially secured to deck frame 202 whereby structure 270 is overlaid on joists 266 and is thus recessed from the uppermost edge of frame 204. Frame 202 is then placed in an inverted position on a smooth forming surface, which optionally has a pattern for embossing into the upper surface of slab 250. Concrete is then poured into frame 202 and allowed to harden and cure to form the finished slab 250, which incorporates reinforcement structure 270 embedded therein. The uppermost layer of concrete covering frame 202 is clear of the reinforcement structure 270. The exposed upper surface of slab 250 is optionally embossed with a pattern during the

concrete forming step. In the assembled dock 200, frame 202 fits tightly around slab 250 with no natural deformations.

[00113]

In the above example, frame 202 and slab 250 form an integral assembly that may be fabricated in advance and shipped as a unit to the dock installation site. Furthermore, additional dock components may be assembled prior to shipping, such as pontoons 214. The assembled dock unit may then be installed on-site with pillars 212 as described herein.

[00114] The scope of the present invention should not be limited by specific embodiments or examples set forth in the description or elsewhere but should be given the broadest interpretation consistent with the specification as a whole. The claims are not limited in scope to any preferred or exemplified embodiments of the invention.

Claims:

1. A method for installing a dock, wherein the dock comprises a deck frame and rigid deck pillars for connecting the deck frame to an underlying surface, the method comprising the steps of:
a) supporting the deck frame in an elevated position above the surface with at least one deck support member;
b) inserting the pillars through pilot sleeves, wherein the pilot sleeves are connected to the deck frame and are configured to permit the pillars to slide and/or rotate within the sleeves to accurately guide the pillars to the underlying surface;
c) anchoring the pillars to the surface;
d) engaging the pillars to the deck frame and
e) removing the pilot sleeves from the pillars and the deck frame.

2. The method of claim 1 comprising the further step of attaching decking members to the deck frame.

3. The method of claim 1 wherein a solid precast concrete deck is pre-installed on the deck frame prior to said step (a).

4. The method of claim 1 comprising the further step (f) of removing the at least one deck support member whereby the weight of the deck bears on the pillars.

5. The method of claim 4 wherein said step (a) comprises temporarily suspending the deck from overhead until said step (f) is performed.

6. The method of claim 1 wherein said step (b) comprises inserting the pillars into corresponding ones of the sleeves, followed by engaging the pilot sleeves and pillar assemblies to the frame.

7. A method for installing a dock to an underlying bed of a body of water, wherein the dock comprises a deck frame, rigid deck pillars for connecting the deck frame to an underlying surface and a plurality of guide members connected to the deck and configured to secure the deck frame to the pillars , the method comprising the steps of:

a) floating the deck frame on the body of water;

b) guiding the pillars to the bed by inserting the pillars through said guide members, whereby the pillars extend downwardly from the deck to contact the underlying bed; and

c) anchoring the pillars to the underlying bed.

8. The method of claim 7 wherein the guide members slideably engage the pillars to permit the deck frame to travel vertically relative to the pillars following said step (c).

9. The method of claim 7 comprising the further step of fixedly securing the pillars to the guide members wherein vertical travel of the deck frame is restricted following said step (c).

10. The method of claim 7 wherein the guide members comprise sockets and said step (b) comprises sliding the pillars through the sockets.

11. The method of claim 7 wherein said dock further comprises a deck surface pre-installed on the deck frame prior to said step (a).

12. The method of claim 10 wherein the deck surface comprises a concrete slab which is installed to the deck frame by pouring concrete into the frame whereby frame members of the deck frame form a rim around the slab and support members underlying the slab.

13. The method of claim 7 further comprising the step of installing a deck surface on said frame.

14. The method of claim 7 wherein said step (b) comprises inserting the pillars through pilot sleeves, wherein the pilot sleeves are connected to the deck frame and are configured to permit the pillars to slide and/or rotate within the sleeves to accurately guide the pillars to the surface; said method comprising the further steps following said step (d) of e) removing the pilot sleeves from the pillars and the deck frame.

15. The method of claim 14 wherein the pilot sleeves are placed onto the pillars prior to inserting the pillars into the guide members, followed by placing the pilot sleeve and pillar assembly into the guide members.

16. A kit for installing a boat dock to an underlying bed of a body of water, comprising:

a) a deck frame comprising frame members for supporting a deck surface and guide members configured to slideably engage a support pillar to the deck frame;

b) at least one dock flotation member for floating the deck frame on the body of water; and

c) at least one pillar configured to be engaged to deck frame by the guide member and to be anchored to the bed whereby the deck frame is secured to the bed.

17. The kit of claim 16 wherein the guide member is configured to slideably engage the pillar to the deck frame upon installation of the deck frame to the pillar.

18. The kit of claim 16 further comprising a solid deck surface configure to be supported on the deck frame.

19. The kit of claim 18 wherein the solid deck surface comprises a precast concrete slab, and wherein the deck frame includes a solid rim that surrounds the slab.

20. The kit of claim 19 wherein the slab and frame are supplied as an integral unit.

21. The kit of claim 16 further comprising at least one pilot sleeve configured to rotatably and/or slideably engage the at least pillar and to in turn be engaged to the deck frame whereby the sleeve can be removed following installation of the dock to the bed.

22. A deck member comprising a concrete panel and a reinforcement structure, the concrete panel comprising upper and lower surfaces and a peripheral edge, the reinforcement structure comprising an outer frame composed of frame members arranged in opposition to each other and configured to surround the concrete panel, at least one reinforcement member extending between opposing ones of the frame members and at least one post engaged to the at least one reinforcement member, wherein the post is at least partially embedded in the concrete and the at least one reinforcement member is at least partially exposed to reinforce the concrete panel through the at least one post.

23. The deck member of claim 22 further comprising a gasket on an exposed rim of said frame members, said gasket extending upwardly therefrom to be approximately flush with a surface of the concrete panel.

24. The deck member of claim 22 wherein said reinforcement members are fully exposed from the concrete panel.

25. The deck member of claim 24 wherein the reinforcement members are spaced apart from the lower surface of the concrete panel by a distance "e" which is less than or equal to a value NU for the deck member, wherein NU represents a thickness of concrete that would provide no significant structural support to a hypothetical reinforced concrete structure having the same thickness as the deck member and composed of a reinforcement layer embedded within the concrete panel.

26. The deck member of claim 22 wherein the concrete panel overlays the at least one reinforcement member and the at least one post protrudes upwardly into the concrete.

27. The deck member of claim 22, comprising multiple ones of said reinforcement members spanning opposing ones of said frame members are fixedly attached thereto and multiple ones of said posts protruding upwardly from each of the reinforcement members.

28. The deck member of claim 24 wherein said reinforcement structure further includes a base member attached thereto which is embedded in the concrete panel and which is configured to attach a fixture thereto to project from the concrete panel.

29. A method of fabricating a deck member, comprising the steps of:

a) positioning a reinforcement structure on a forming surface, said reinforcement structure comprising an outer frame configured to form the periphery of the deck member and composed of frame members arranged in opposition to each other, at least one reinforcement member extending between opposing one of the frame members and at least one post engaged to the at least one reinforcement member;

b) partially filling said frame with liquid concrete whereby said at least one post is at least partially embedded in the concrete and said at least one reinforcement member is at least partially exposed;

c) allowing the concrete to harden whereby a concrete panel is formed within the frame with a finished concrete surface in contact with the forming surface; and

d) separating the concrete from the forming surface to form the deck member, wherein the deck member comprises a concrete panel within the frame and wherein the posts are at least partially embedded in the concrete panel.

30. The method of claim 29 wherein said reinforcement structure further comprises multiple ones of said reinforcement members and multiple ones of said posts.

31. The method of claim 29 wherein said reinforcement members are fully exposed from the concrete panel.

32. The method of claim 31 wherein the reinforcement members are spaced apart from the lower surface of the concrete panel by a distance "e" Which is less than or equal to a value NU for the deck member, wherein NU is comprises a thickness of concrete that would provide no significant structural support to a hypothetical reinforced concrete structure having the same thickness as the deck member and composed of a reinforcement layer embedded within the concrete panel.

33. The method of claim 29 further comprising installing a gasket on an exposed rim of said frame members prior to said step b, said gasket extending upwardly therefrom to be approximately flush with a surface of the concrete panel.

34. The method of claim 29 wherein the concrete overlays the at least one reinforcement member and the at least one post protrudes upwardly into the concrete when the concrete panel is above the reinforcement members.

35. The method of claim 29 wherein said reinforcement structure further includes a base member attached thereto which is embedded in the concrete panel and is configured to attach a fixture thereto to project from the concrete panel.

36. The method of any one of claims 29 to 35 wherein the deck member is integral with a deck frame that is configured to mount to dock pillars.

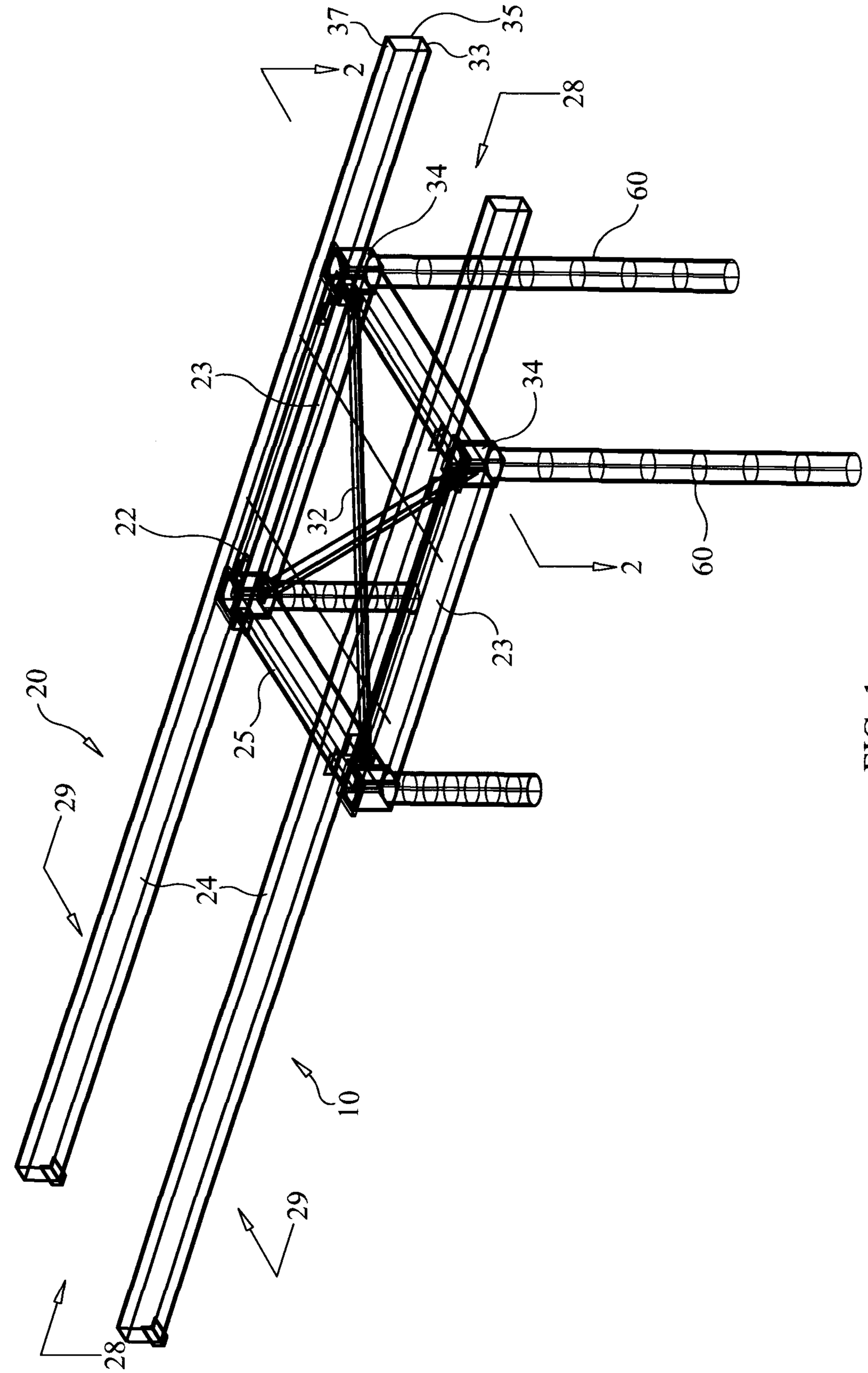


FIG. 1

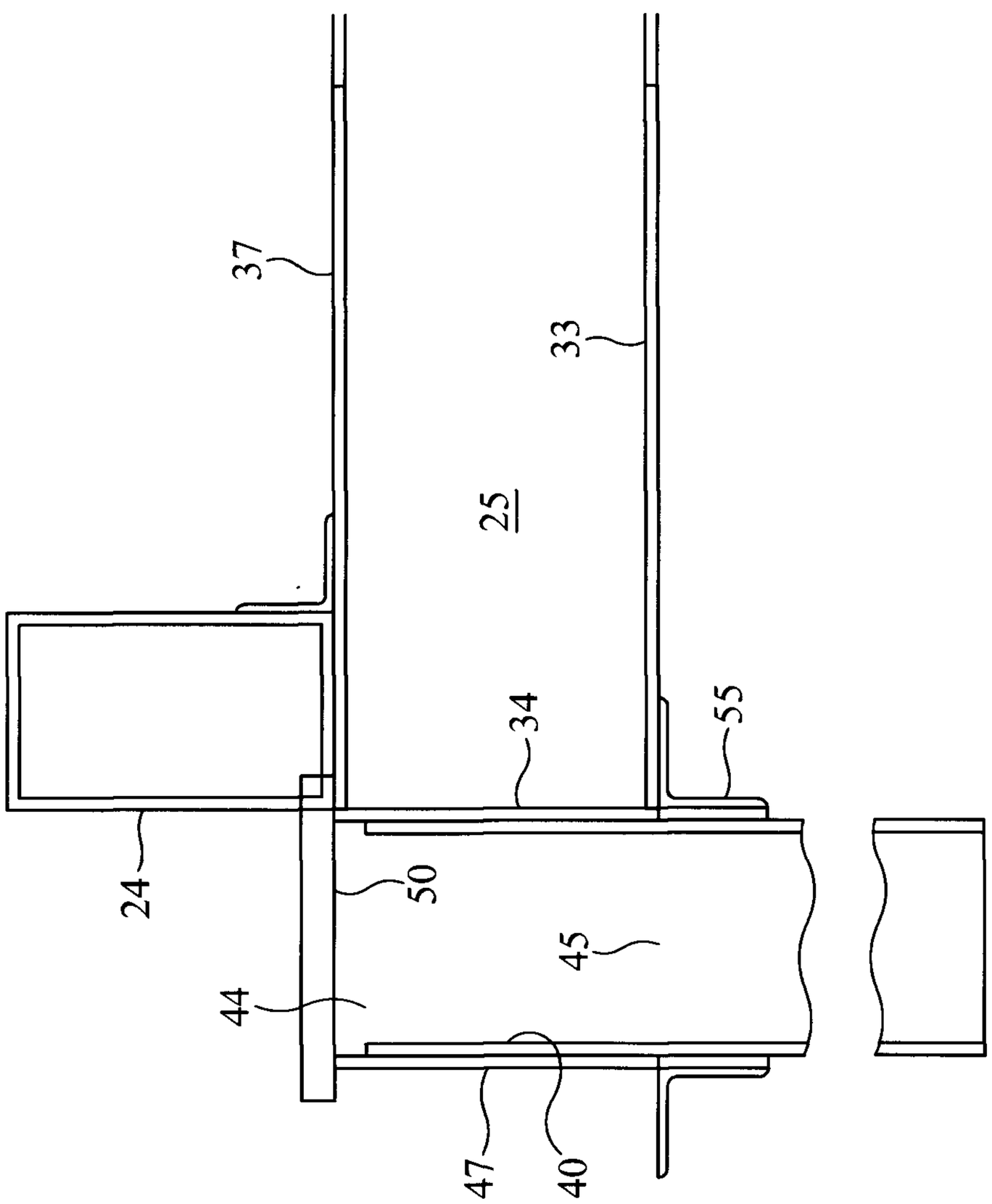


FIG. 2

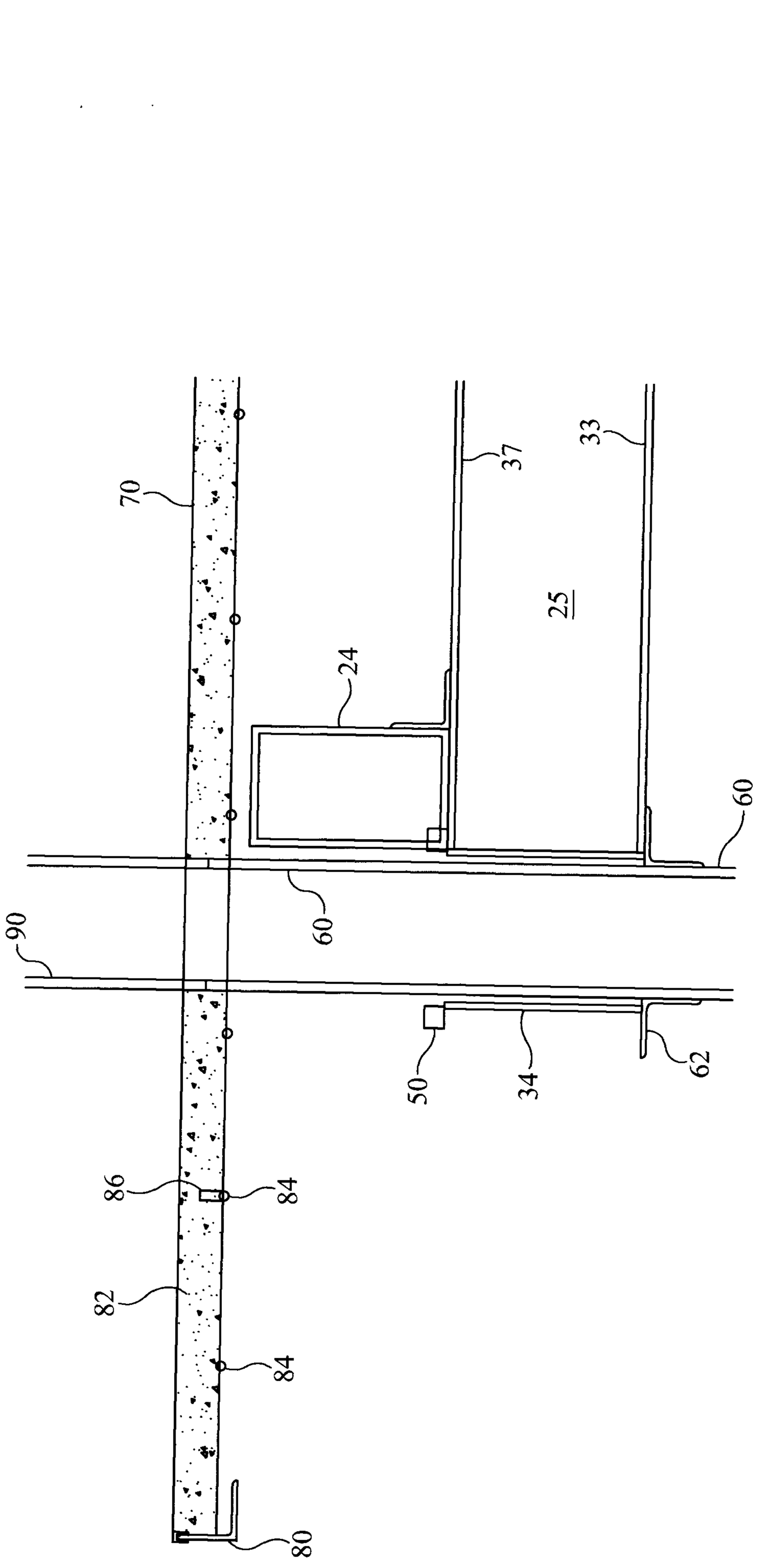


FIG. 3

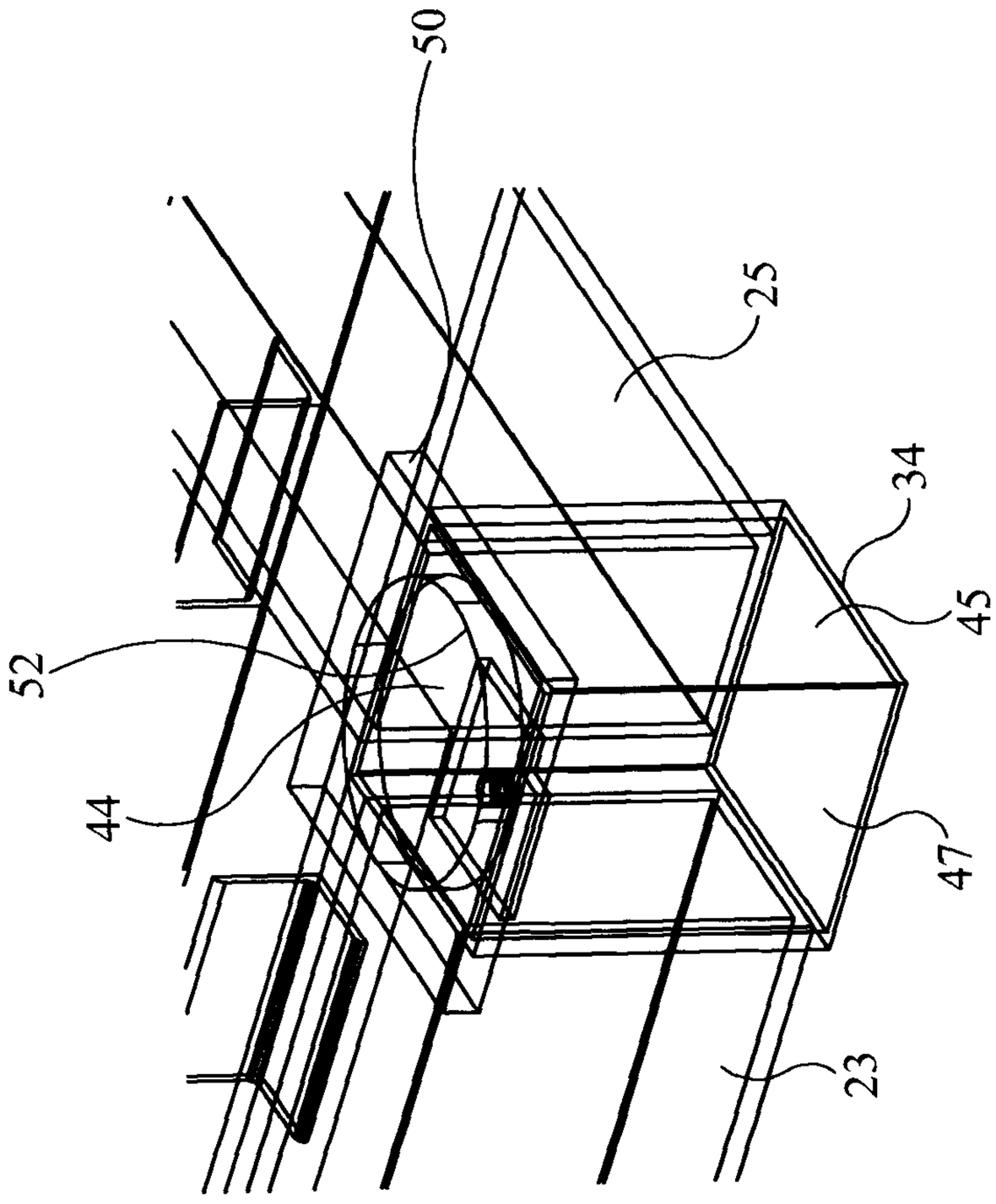


FIG. 4

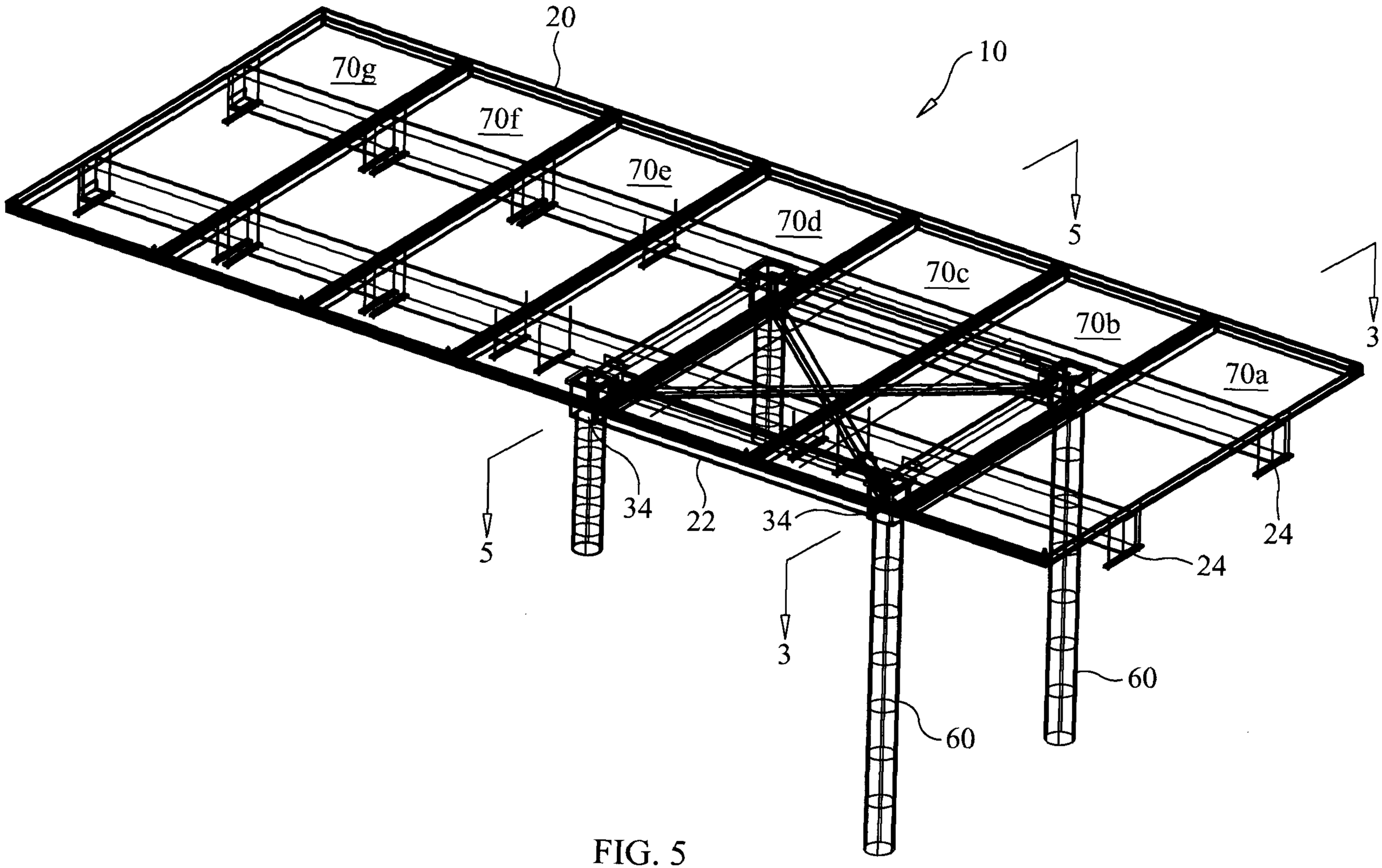


FIG. 5

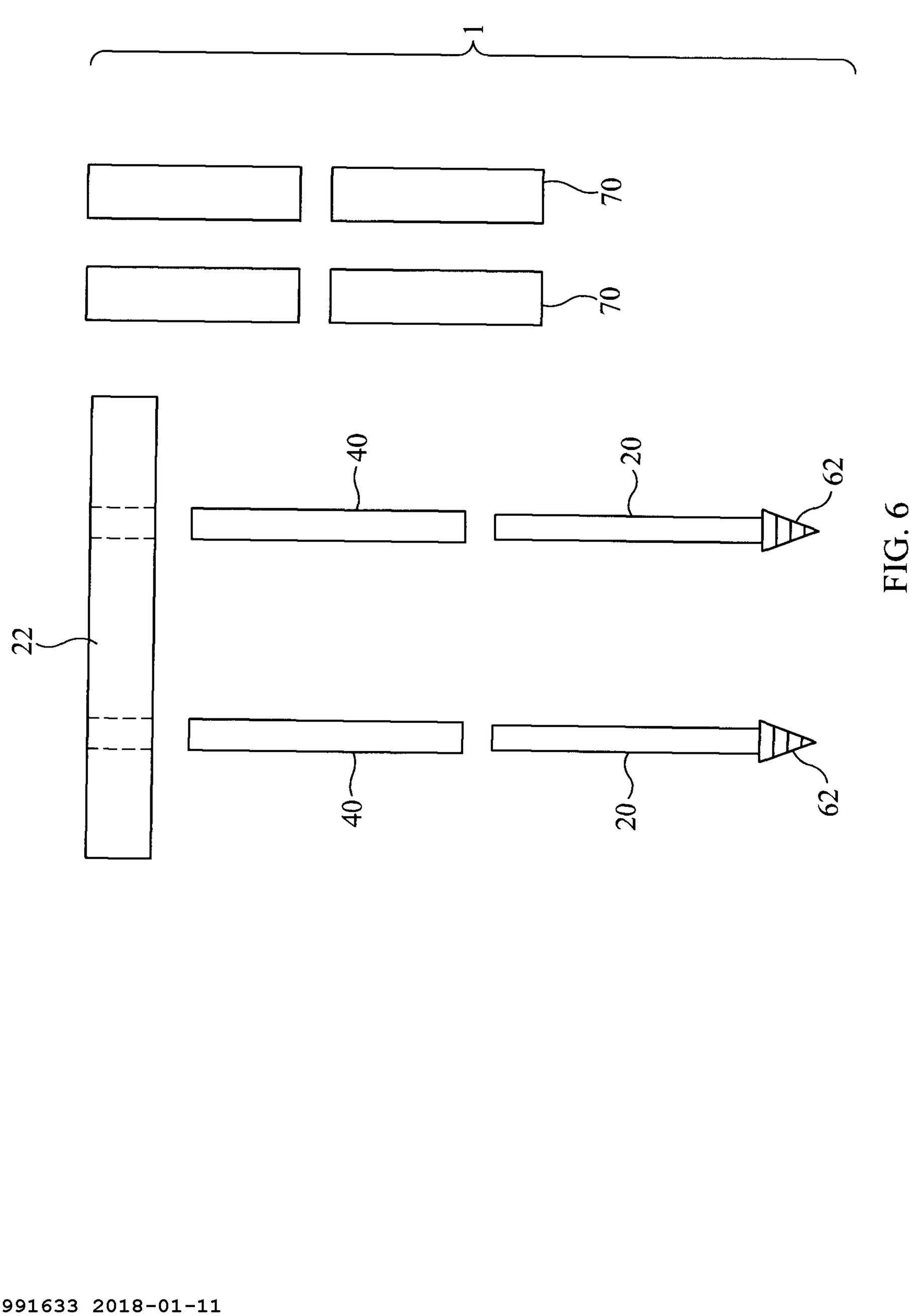


FIG. 6

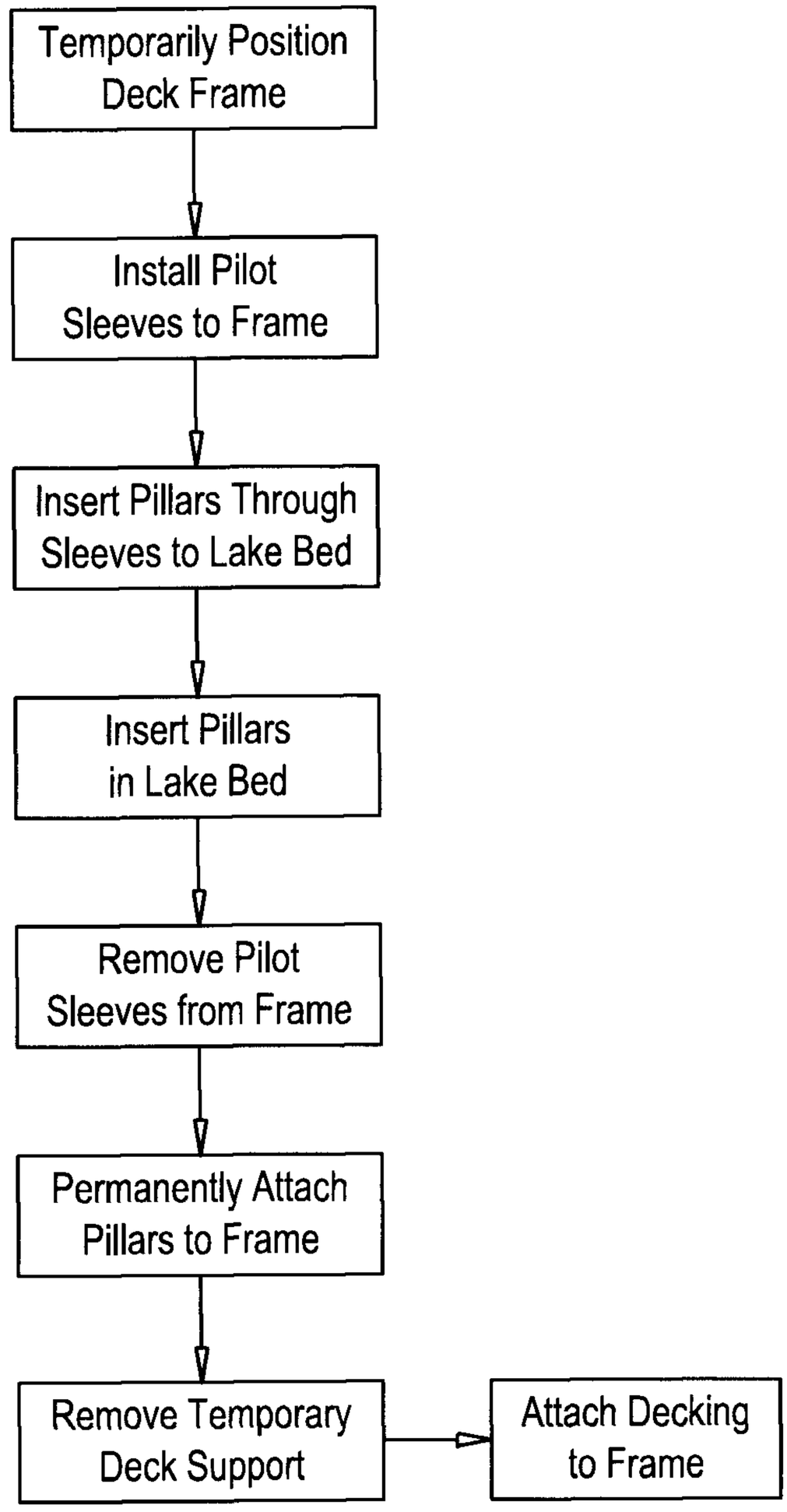

Temporarily Position Deck Frame
Install Pilot Sleeves to Frame
Insert Pillars Through Sleeves to Lake Bed
Insert Pillars in Lake Bed
Remove Pilot Sleeves from Frame
Permanently Attach Pillars to Frame
Remove Temporary Deck Support
Attach Decking to Frame

FIG. 7

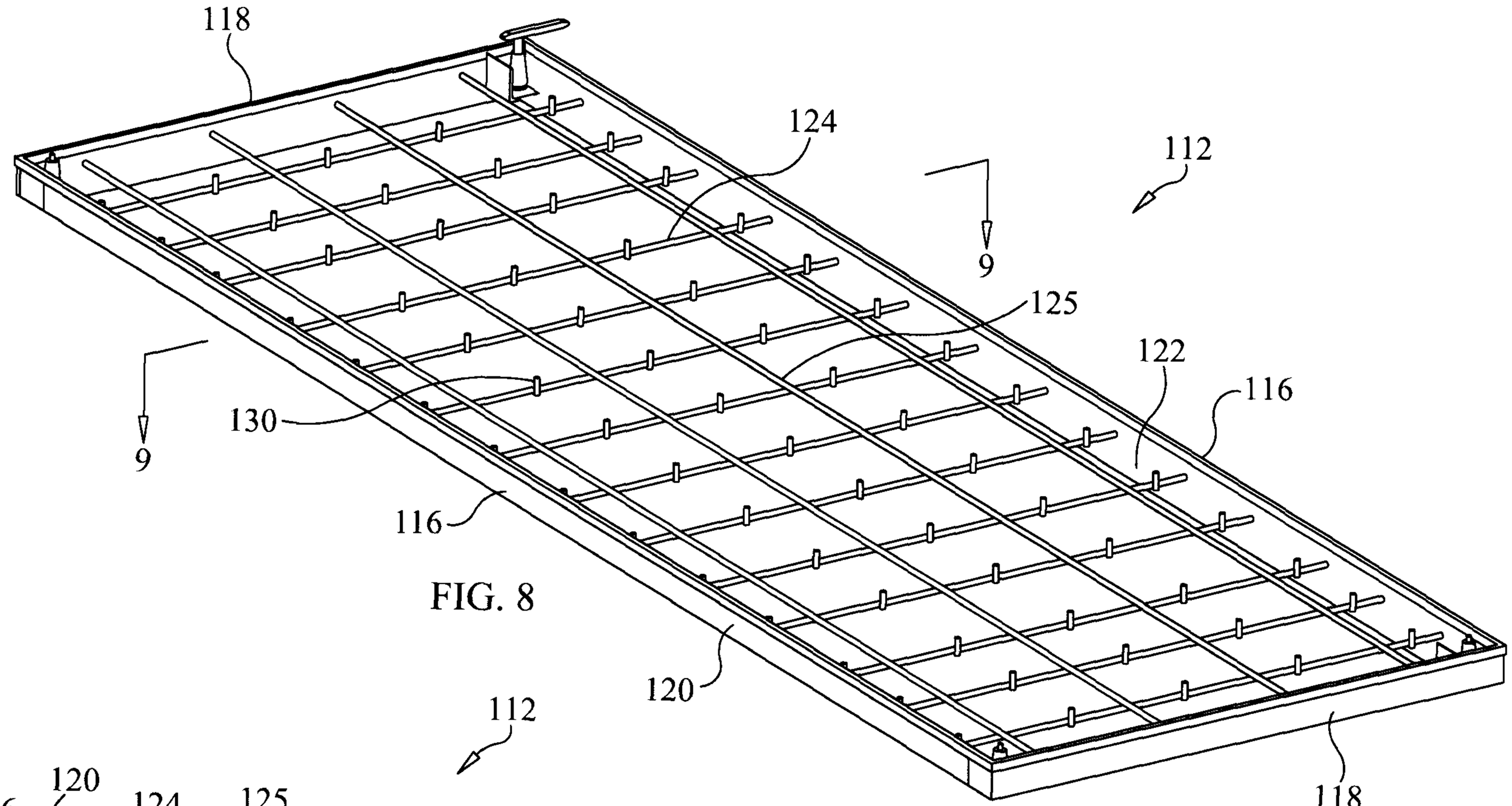

118
124
112
9
125
122
116
130
9
116
120
118

FIG. 8

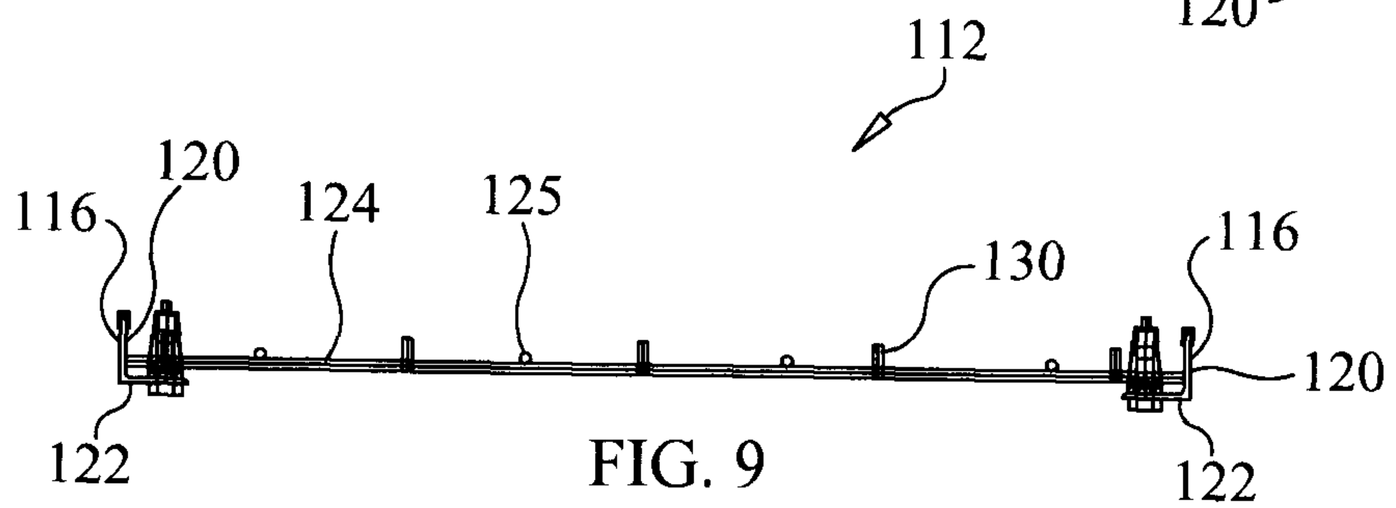
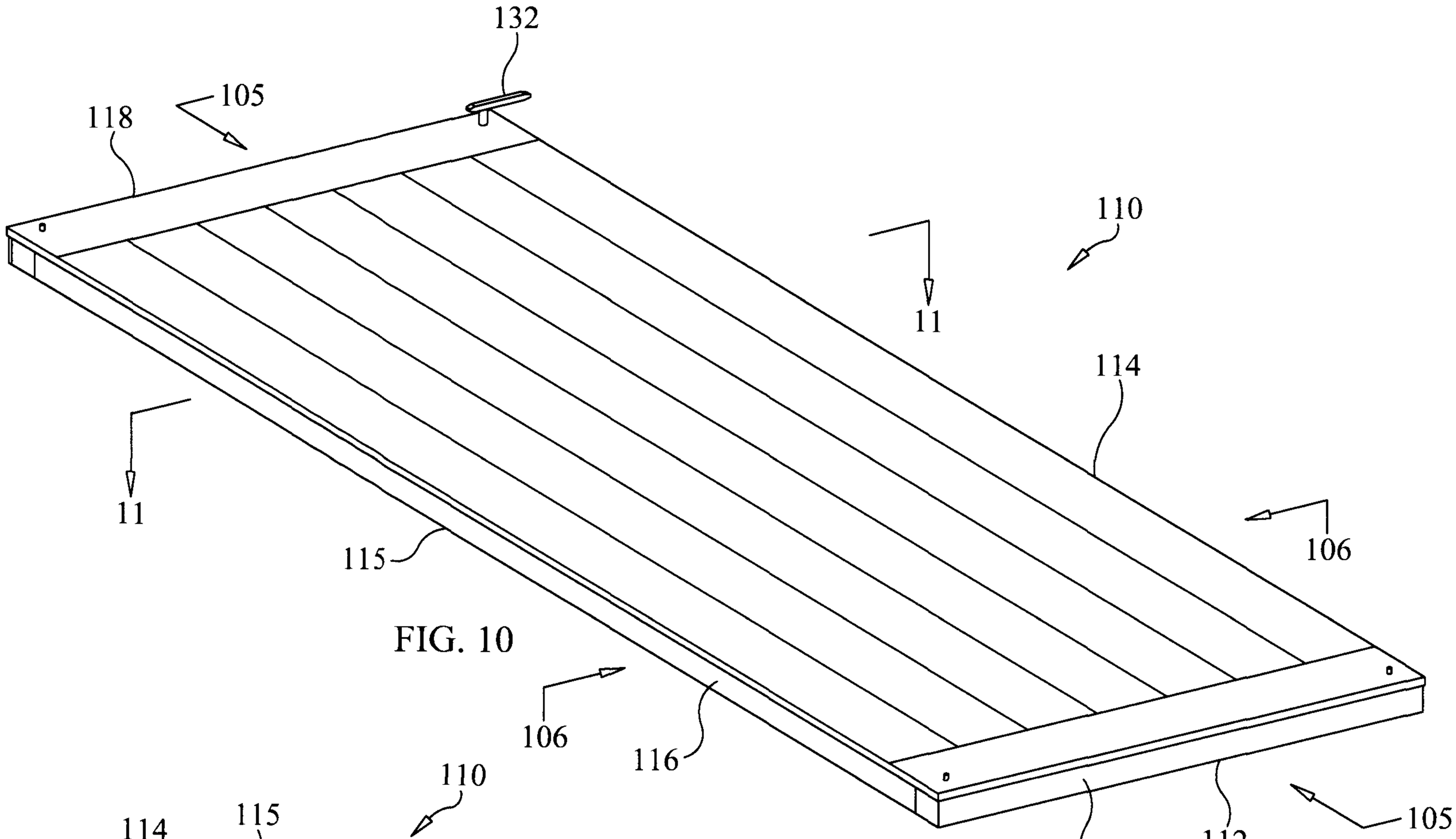

112
120
116
124
125
130
116
120
122
122

FIG. 9


132
105
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110
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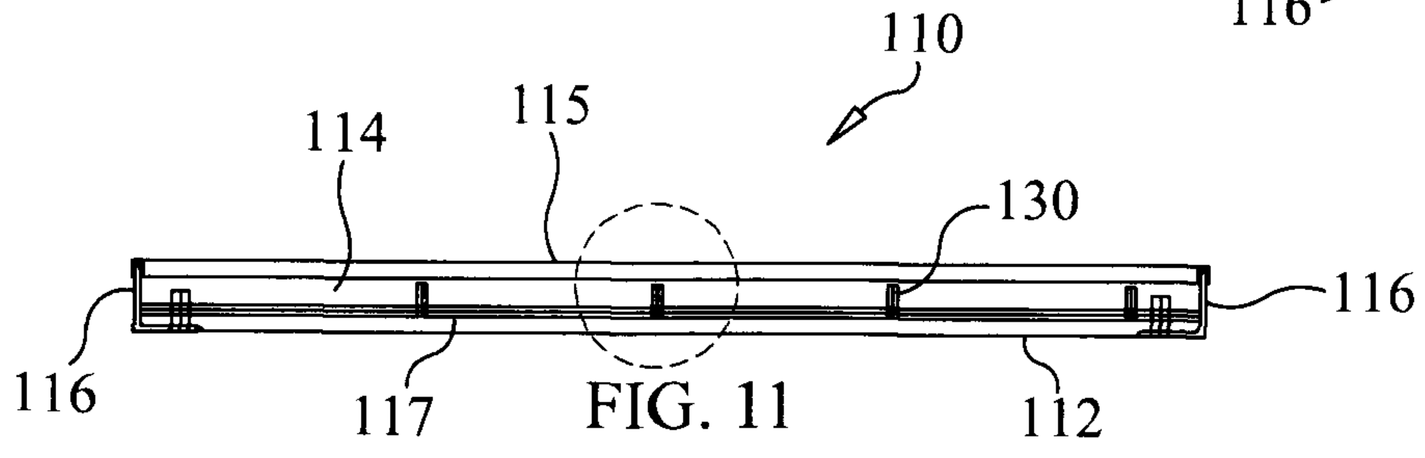
105

FIG. 10


110
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116
116
117
112

FIG. 11

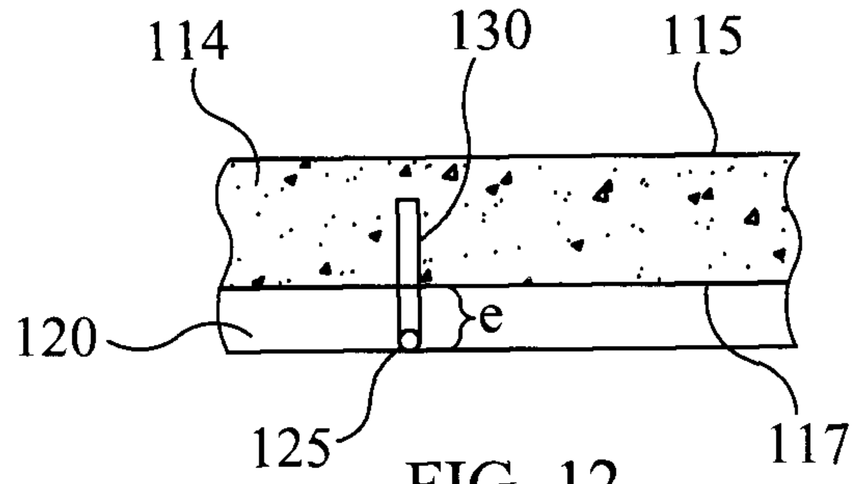


FIG. 12

FIG. 14

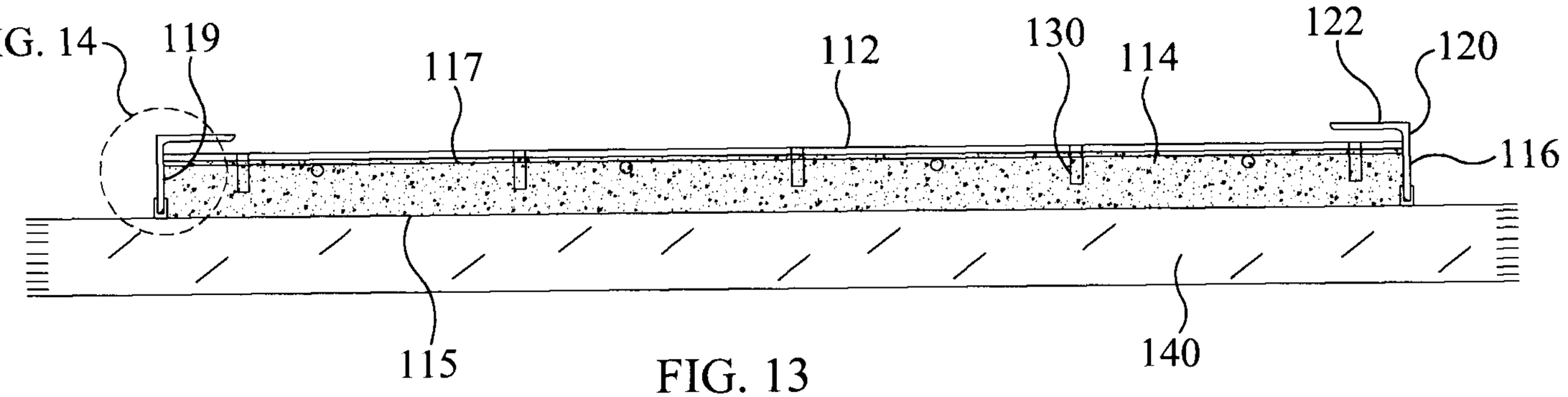


FIG. 13

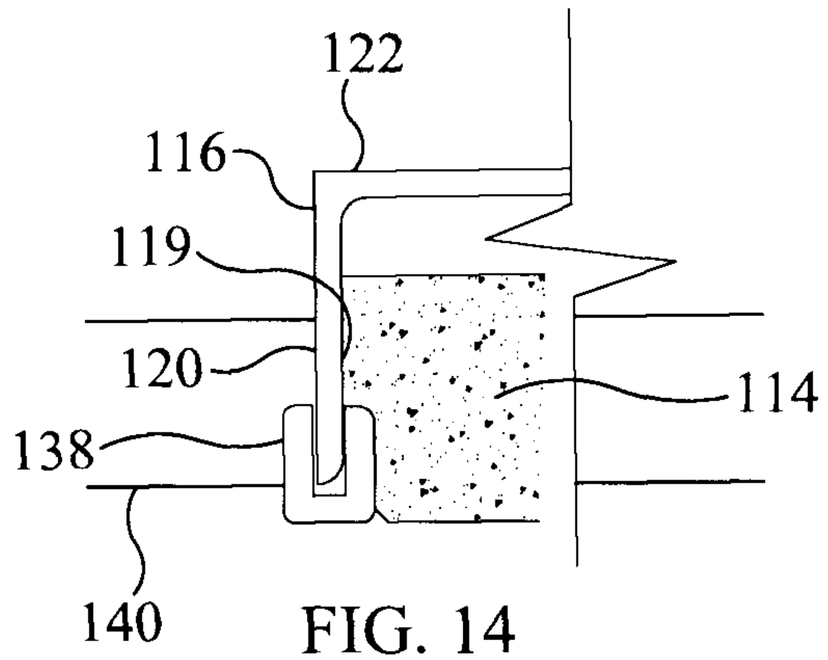


FIG. 14

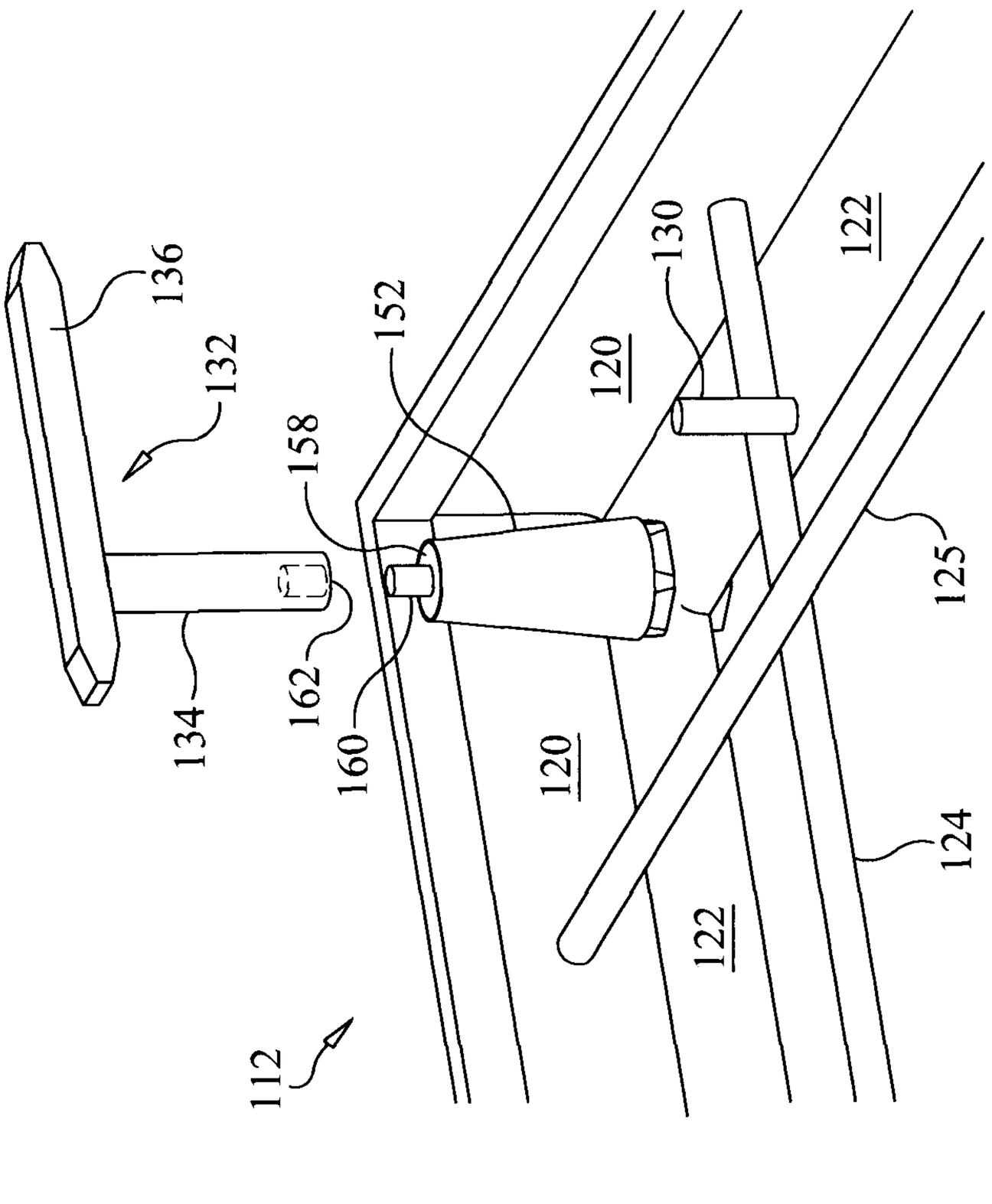


FIG. 15

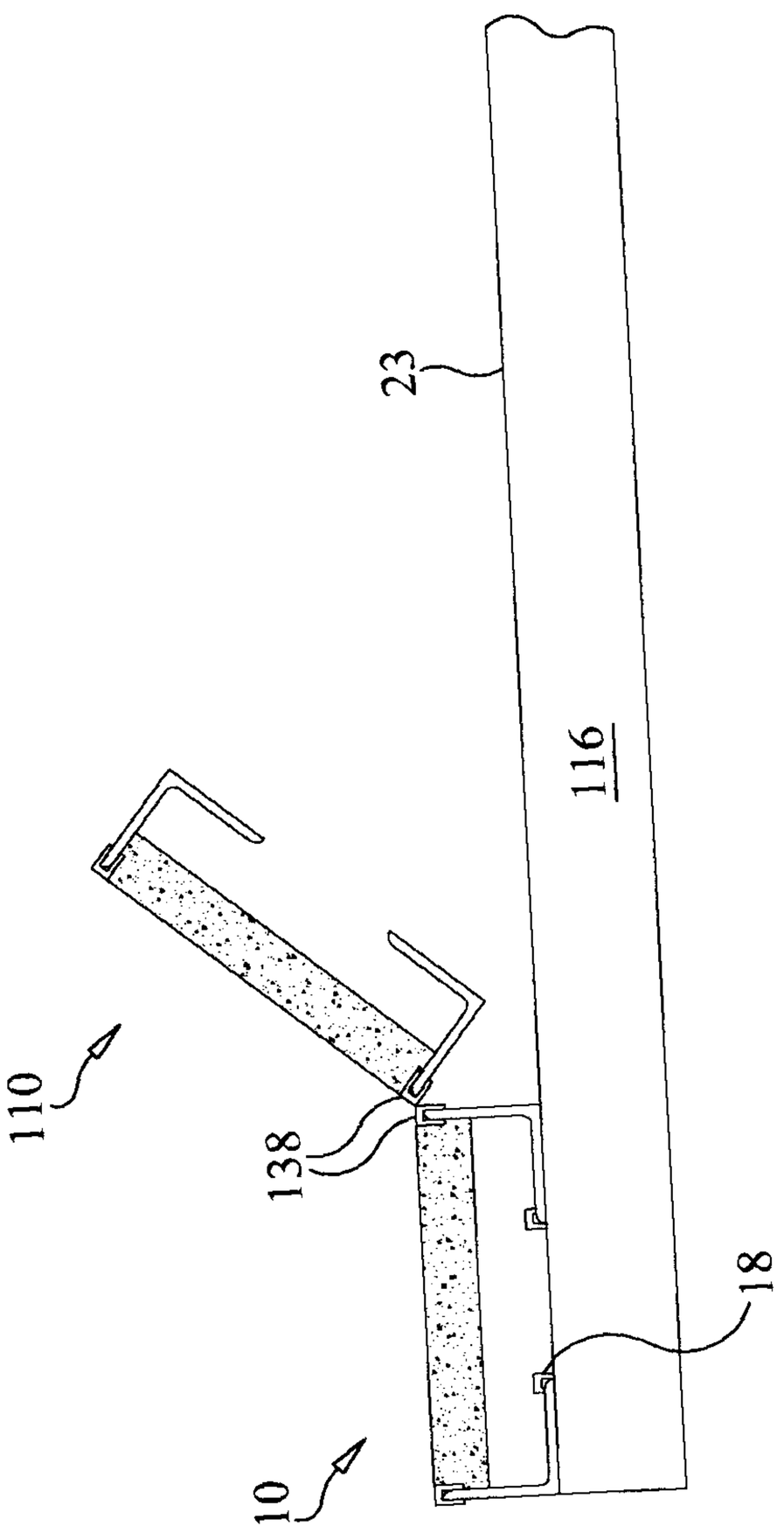


FIG. 16

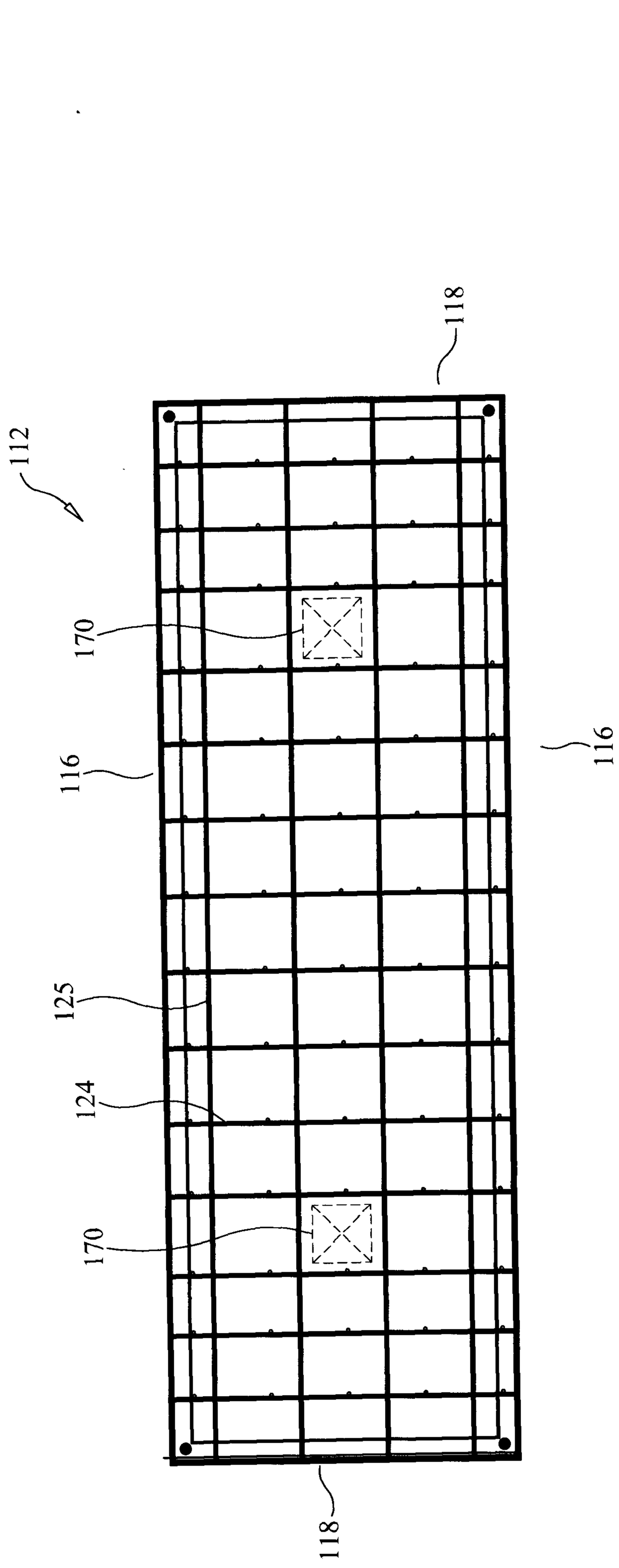


FIG. 17

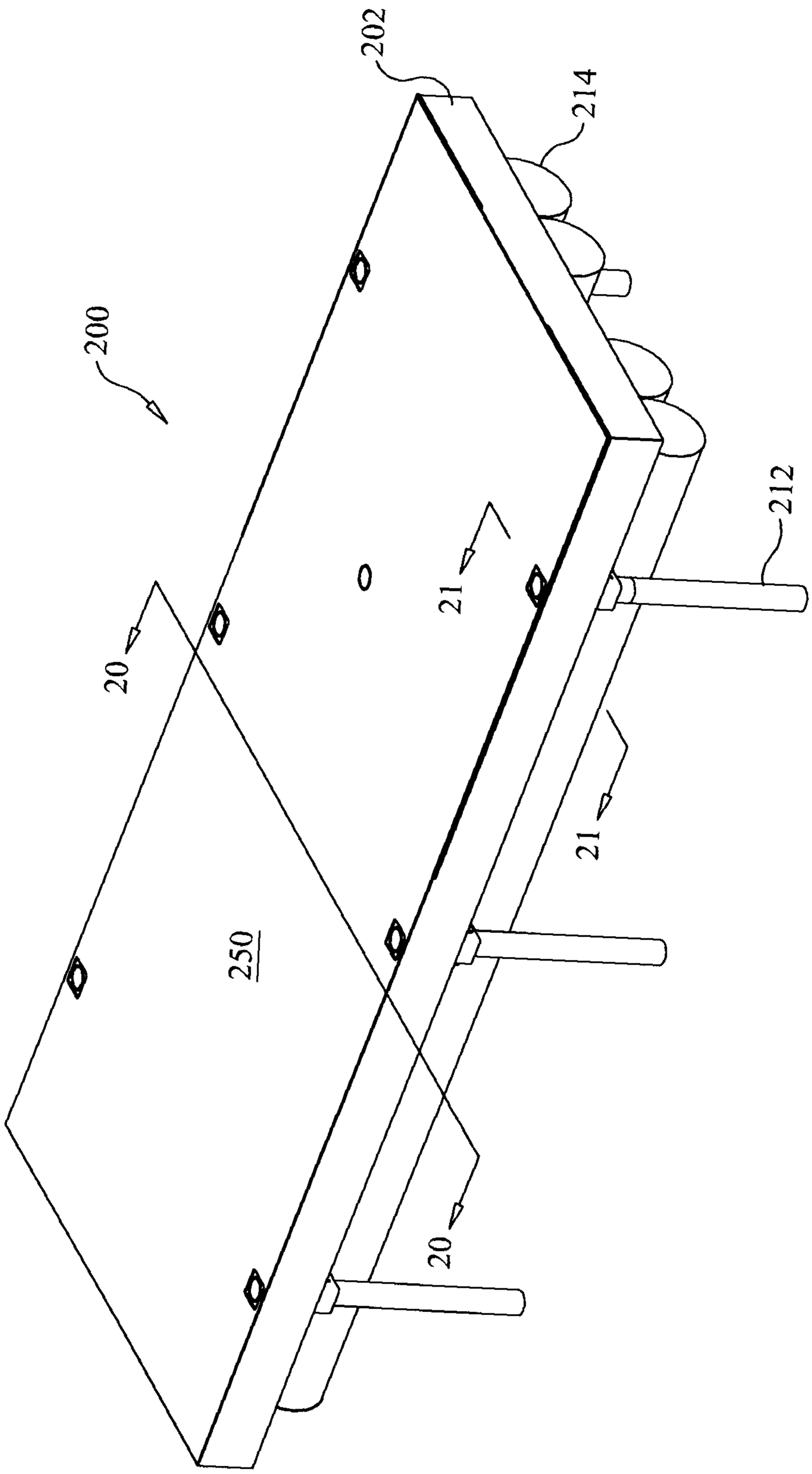


FIG. 18

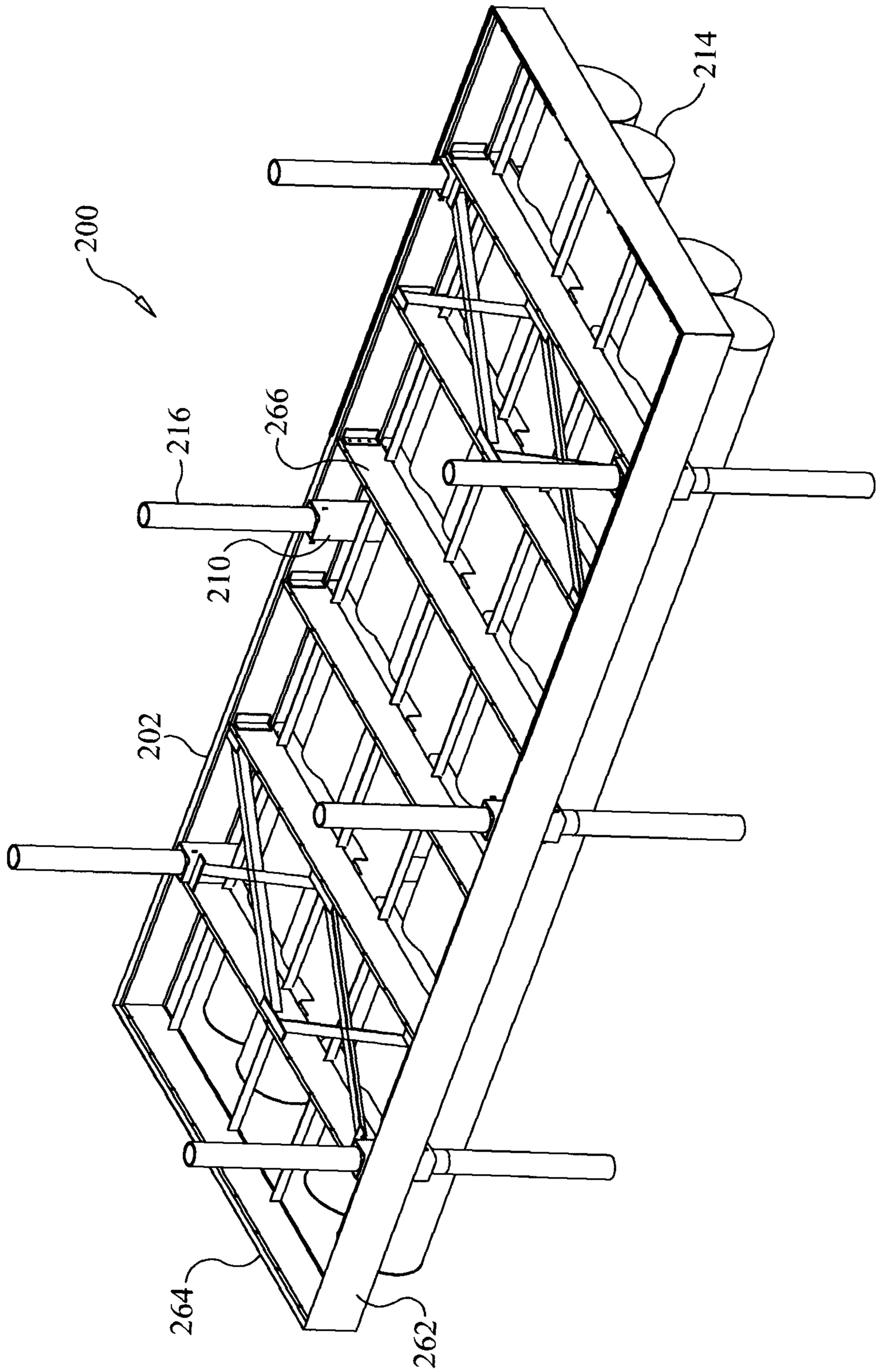


FIG. 19

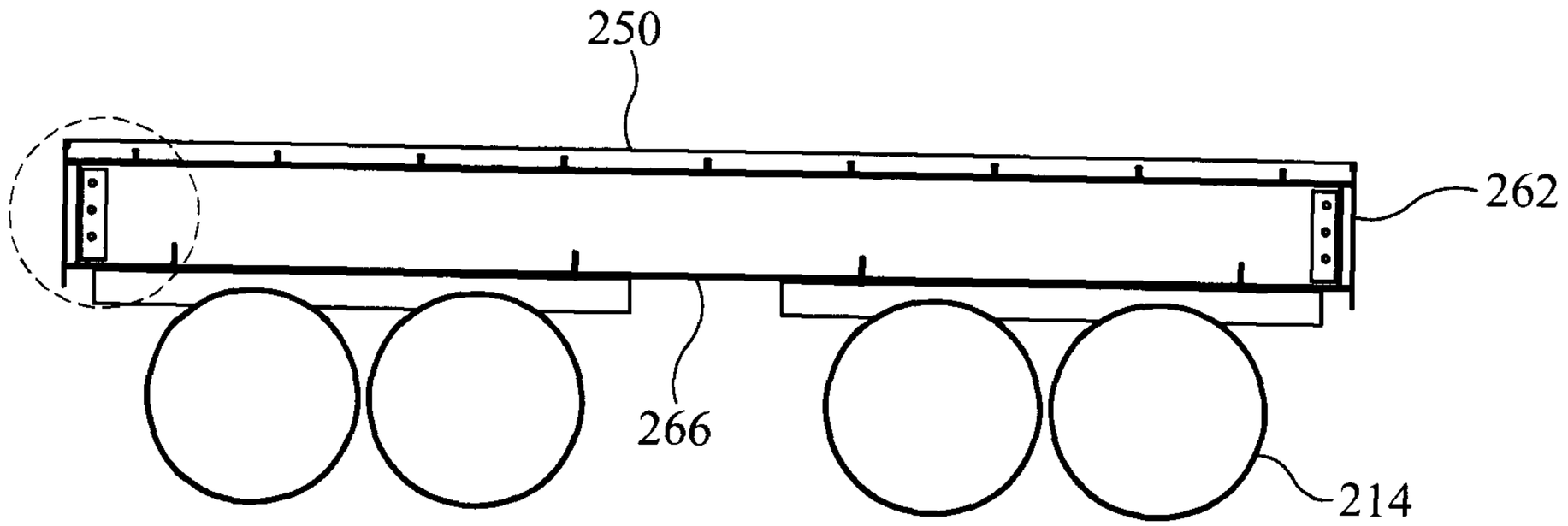


FIG. 20

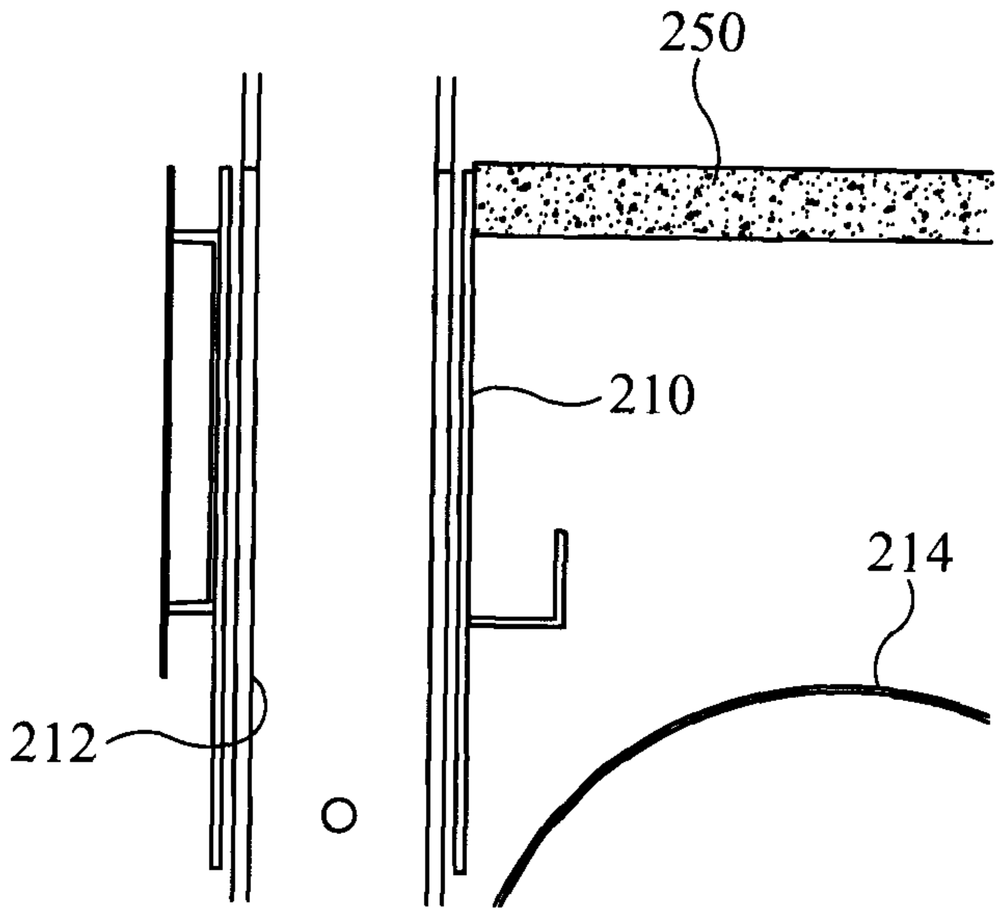


FIG. 21

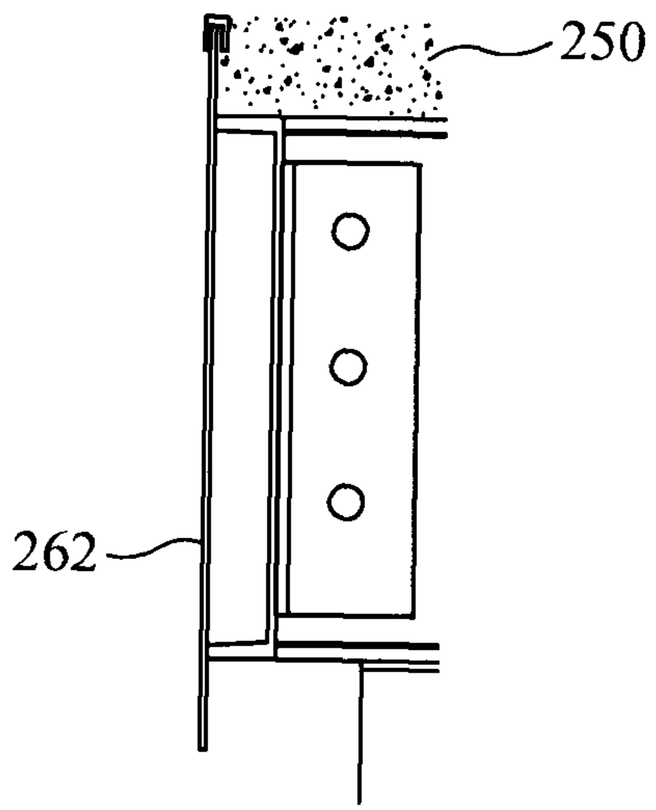


FIG. 22

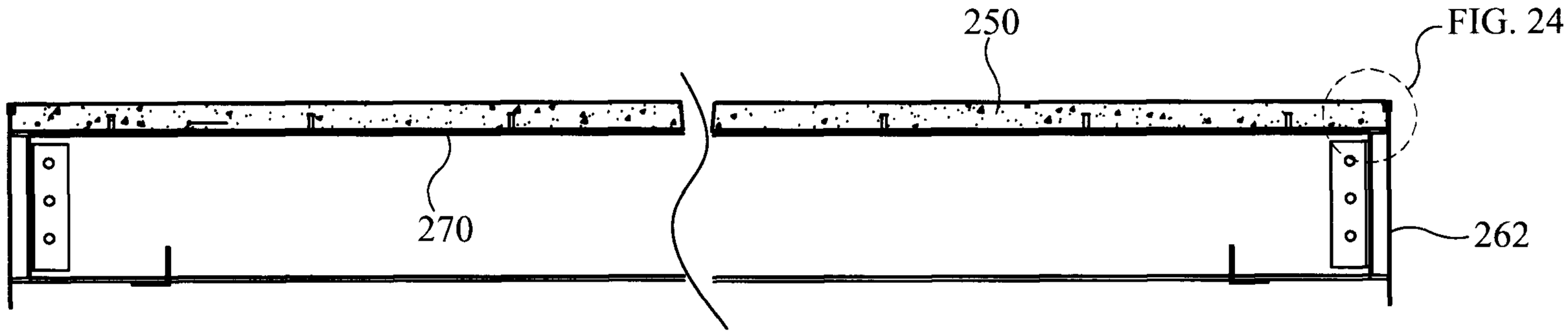


FIG. 23

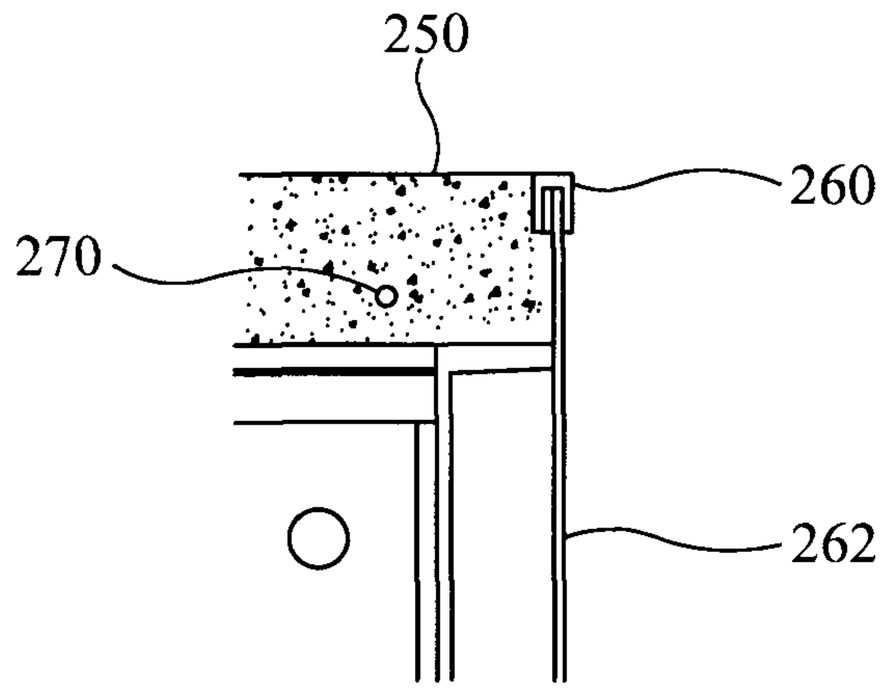


FIG. 24

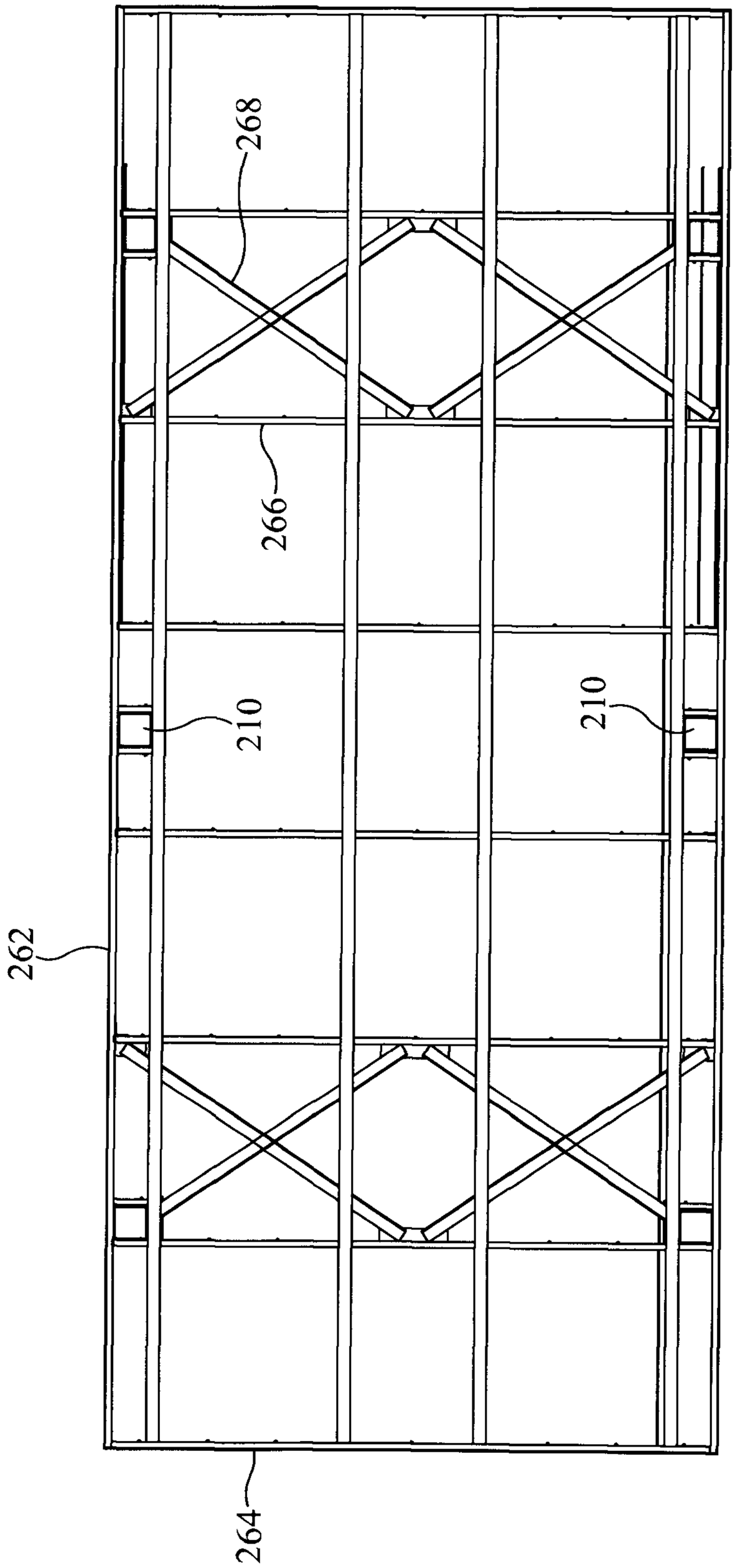
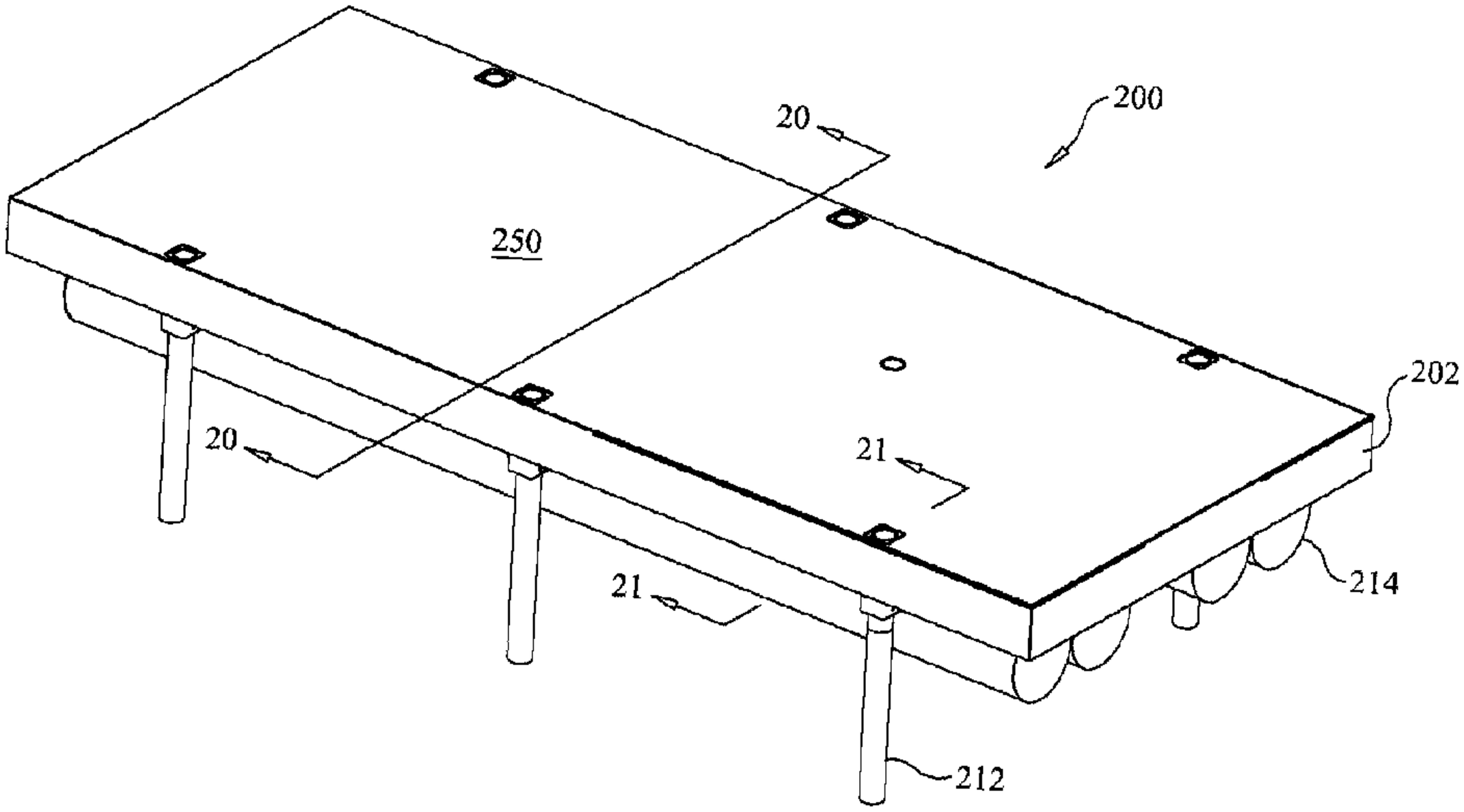


FIG. 25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