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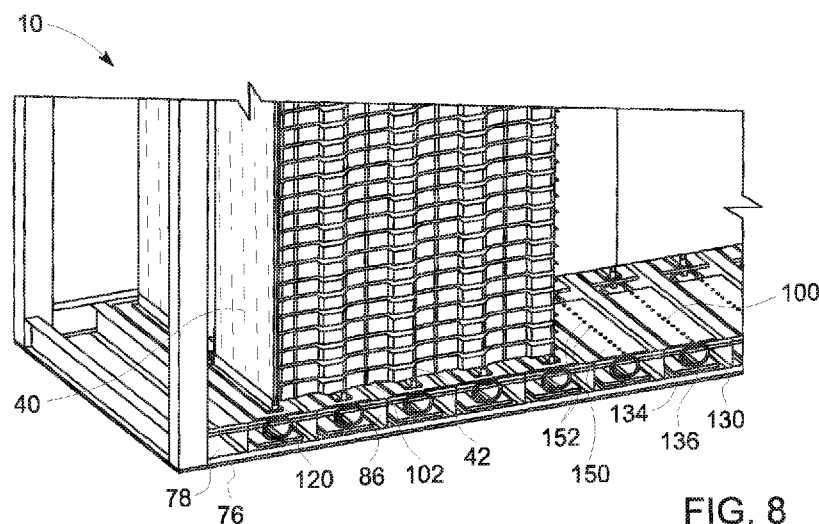


FIG. 8

(57) Abstract: A transportable storage container (10) mountable on a transportation device is provided. The transportable storage container includes a housing (12) including a floor plate (14) having an interior face and an exterior face and a plurality of beams (32) coupled to said interior face of said floor plate. The transportable storage container also includes at least one isolator assembly (100) positioned between a pair of adjacent beams of said plurality of beams. The transportable storage container further includes an energy storage system (40) coupled to said at least one isolator assembly, wherein said energy storage system comprises a battery rack (44) and a plurality of battery modules (42), wherein said at least one isolator assembly is configured to allow movement of said energy storage system towards and away from said plurality of beams.



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SYSTEMS AND METHODS FOR MECHANICAL
LOAD ISOLATION IN TRANSPORTABLE
STORAGE CONTAINER

BACKGROUND

[0001] The subject matter described herein relates generally to transportable storage containers and, more particularly, to mechanical load isolation in transportable storage containers.

[0002] Transportable storage containers are used to transport a variety of goods between multiple locations. Storage containers are transported from a starting location to a destination by transportation devices such as trucks, railcars, forklifts, cranes, and ships. Often, storage containers transport goods that are fragile and/or may be damaged if the storage container experiences mechanical load events such as shocks or vibrations. Shocks to the storage container may occur as the storage container is loaded onto a transportation device. Such shocks result in movement of the goods relative to the storage container. The relative movement of the goods may cause the goods to contact an interior surface of the storage container and/or other goods within the storage container, resulting in damage to or destruction of the goods.

[0003] Some transportable storage containers are used to transport and house energy storage systems. Such systems are used to store and provide energy in a variety of settings including industrial applications. Some known energy storage systems utilize a plurality of battery modules housed within a storage container to store and provide energy. In the energy storage market, it is advantageous to fill the storage container with as many battery modules as possible to achieve a greater energy capacity of an energy storage system. However, clearances are required around the battery modules to allow for movement of the battery modules and to prevent battery damage resulting from contact with other objects inside the transportable storage container. Such energy storage systems additionally require passages of cooling air in the container to allow a heating, ventilation, and air conditioning ("HVAC") system to keep the battery modules within a required temperature range. These clearances and passages require space within the storage container that cannot be occupied by battery modules.

[0004] Accordingly, battery modules contained within a transportable storage container may be subjected to multiple shock and vibrational loads during transport. These mechanical loads can damage the battery modules, resulting in significant operational issues. Alternatively, some known energy storage systems are assembled into a storage container on site after transporting the unassembled system components to an installation site. Such techniques complicate logistics as each component may be shipped separately and from separate suppliers. Additionally, installing each component of the energy storage system at the installation site is highly time consuming and costly.

BRIEF DESCRIPTION

[0005] In one aspect, a transportable storage container is provided. The transportable storage container includes a housing mountable to a transportation device. The housing includes a floor plate having an interior face and an exterior face and a plurality of beams coupled to the interior face of the floor plate. The transportable storage container also includes at least one isolator assembly coupled to the floor plate and positioned between a pair of adjacent beams. The transportable storage container further includes a transportation product coupled to the at least one isolator assembly.

[0006] In another aspect, a transportable storage container mountable on a transportation device is provided. The transportable storage container includes a housing including a floor plate having an interior face and an exterior face and a plurality of beams coupled to the interior face of the floor plate. The transportable storage container also includes at least one isolator assembly positioned between a pair of adjacent beams and an energy storage system coupled to the at least one isolator assembly. The energy storage system includes a battery rack and a plurality of battery modules. The at least one isolator assembly is configured to allow movement of the energy storage system towards and away from the plurality of beams.

[0007] In yet another aspect, a method of assembling a transportable storage container is provided. The method includes providing a floor plate having an interior face and an exterior face, the floor plate at least partially defining a housing mountable to a transportation device. The method also includes coupling a plurality of beams to the interior face of the floor plate. The method further includes coupling at least one isolator assembly to the interior face of the floor plate. The at least one isolator

assembly is positioned between a pair of adjacent beams. The method further includes coupling a transportation product to the at least one isolator assembly. The at least one isolator assembly is configured to allow movement of the transportation product towards and away from the plurality of beams.

DRAWINGS

[0008] These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0009] FIG. 1 is a perspective view of an exemplary transportable storage container;

[0010] FIG. 2 is a perspective view of the transportable storage container of FIG. 1 with its ceiling plate removed that includes an energy storage system;

[0011] FIG. 3 is a perspective view of an exemplary housing structure of the transportable storage container of FIG. 1;

[0012] FIG. 4 is a perspective view of an exemplary transportable storage container that includes an energy storage system;

[0013] FIG. 5 is a perspective view of an exemplary energy storage system transportable by the transportable storage container of FIG. 1;

[0014] FIG. 6 is a perspective view of an exemplary configuration of battery racks coupled to an exemplary floor structure of the transportable storage container of FIG. 1;

[0015] FIG. 7 is a perspective view of a wire rope isolator;

[0016] FIG. 8 is a perspective view of an embodiment of an isolator assembly within the transportable storage container of FIG. 1 that includes the wire rope isolator of FIG. 7; and

[0017] FIG. 9 is a perspective view of an embodiment of an isolator assembly within the transportable storage container of FIG. 1 that includes a rubber pad isolator.

[0018] Unless otherwise indicated, the drawings provided herein are meant to illustrate features of embodiments of the disclosure. These features are believed to be applicable in a wide variety of systems comprising one or more embodiments of the disclosure. As such, the drawings are not meant to include all conventional features known by those of ordinary skill in the art to be required for the practice of the embodiments disclosed herein.

DETAILED DESCRIPTION

[0019] In the following specification and the claims, reference will be made to a number of terms, which shall be defined to have the following meanings.

[0020] The singular forms “a”, “an”, and “the” include plural references unless the context clearly dictates otherwise.

[0021] “Optional” or “optionally” means that the subsequently described event or circumstance may or may not occur, and that the description includes instances where the event occurs and instances where it does not.

[0022] Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as “about,” “substantially,” and “approximately,” are not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Here and throughout the specification and claims, range limitations may be combined and/or interchanged, such ranges are identified and include all the sub-ranges contained therein unless context or language indicates otherwise.

[0023] The systems and methods described herein include a transportable storage container configured to maximize storage space within the container and to reduce mechanical loads or disturbances caused during transport that are experienced by

transportation products or goods stored within the container. The transportable storage containers described herein include a housing that can be mounted on a transportation device such as a truck, a railcar, a forklift, a crane, and/or a ship. The housing includes a floor having a floor plate and a plurality of floor beams in contact with an interior face of the floor plate. By placing the floor plate below the floor beams, more volume is created within the container as the floor plate is positioned lower with respect to the rest of the housing, thus maximizing storage space within the container. To prevent damage to the goods during transport of the transportable storage container, the systems and methods described herein also include one or more isolator assemblies. The isolator assemblies are coupled to the interior face of the floor plate and positioned between the floor beams to create a load path between the goods and the housing and to account for any vertical movement and/or rotational movement of the goods by allowing the goods to move towards and away from the housing without contacting the floor beams. By positioning the isolator assemblies between the floor beams and positioning the floor plate below the floor beams, the isolator assemblies provide a cushion for goods without decreasing the space available within the container for goods. In contrast, in known shipping containers having a floor plate positioned above the floor beams, i.e., external floor beams, isolator assemblies must be positioned above the floor plate to maintain the load path between the goods and the housing, thus reducing storage space within the container and reducing the number of goods, such as battery modules, that may be included within the storage container. As such, the systems and methods described herein maximize storage space within the container and reduce mechanical loads or disturbances caused during transport that is experienced by goods stored within the container.

[0024] In one embodiment, the systems and methods described herein are directed to an energy storage system coupled to the isolator assemblies within the transportable storage container. By including one or more isolator assemblies, the systems and methods described herein facilitate the installation of an energy storage system within the storage container prior to shipment of the container to the final site where the energy storage system stores and provides power. As such, the systems and methods described herein decrease installation time and costs and simplify logistics for energy storage systems.

[0025] FIG. 1 is an exemplary transportable storage container 10. In the exemplary embodiment, transportable storage container 10 includes a housing 12 having a floor 14, a ceiling 16, and a plurality of side walls 18. Housing 12 may be made of steel or other suitable materials. Ceiling 16 includes a ceiling plate 20 having an interior face 22 and an exterior face 24. Each side wall 18 includes an interior face 26 and an exterior face 28. In some embodiments, side wall 18 also includes one or more doors 30 for accessing the interior of housing 12. Housing 12 includes vertical posts 32 that are coupled to floor 14, ceiling 16, and side walls 18. In the exemplary embodiment, floor 14, ceiling 16, and side walls 18 form a generally cuboid and/or box configuration. In some embodiments, vertical posts 32 include interlocking assemblies 34 positioned on upper and/or lower ends of vertical posts 32. In some embodiments, interlocking assemblies 34 are configured to interface with interlocking assemblies of standardized shipping containers such as intermodal or ISO shipping containers. Interlocking assemblies 34 are configured to interlock a plurality of transportable storage containers 10 and/or interlock transportable storage container 10 with one or more various shipping containers during transport. In some embodiments, the dimensions of housing 12 comply with at least some standardized ISO shipping container dimension requirements. In the exemplary embodiment, the dimensions of housing 12 comply with at least some of the dimension requirements of a standardized twenty foot ISO shipping container. In some embodiments, floor 14 includes forklift pockets 36 that are generally rectangular in shape and configured to receive forks of a forklift. Forklift pockets 36 allow for placement and/or movement of transportable storage container 10 by the forklift.

[0026] Transportable storage container 10 is used to transport one or more goods, also referred to as transportation products 38, from a first location to a second location. Transportation products 38 include fragile goods, i.e., goods that may be damaged or destroyed by shocks and/or vibrations experienced during transportation of transportable storage container 10 by a transportation device. In the exemplary embodiment, transportation products 38 are able to be accessed through door 30 of side wall 18. In the exemplary embodiment, transportation products 38 are an energy storage system 40, also referred to as a battery rack system, that includes a plurality of battery modules 42 and one or more battery racks 44.

[0027] FIG. 2 is an exemplary transportable storage container 10, with ceiling plate 20 (shown in FIG. 1) removed, that includes energy storage system 40. Transportable storage container 10 includes a first end 50, a second end 52, a first side 54, and a second side 56. In the exemplary embodiment, transportable storage container 10 includes power electronics (not shown) positioned adjacent second end 52 of transportable storage container 10. The power electronics are operatively coupled to energy storage system 40 and are configured to enable charging and discharging of battery modules 42 (shown in FIG. 1) of energy storage system 40. In some embodiments, door 30 is positioned adjacent the power electronics to facilitate access to the power electronics. That is, door 30 is positioned on side wall 18 that is near second end 52 of transportable storage container 10. Alternatively, the power electronics are positioned in any orientation and manner that enables transportable storage container 10 to function as described herein.

[0028] In the exemplary embodiment, transportable storage container 10 includes an HVAC system 62 having a first unit 58 and a second unit 59. HVAC system 62 includes a plurality of ducts and/or volumes of air 64 for heating and/or cooling transportable storage container 10. In one embodiment, air conditioning volume 64 is positioned between energy storage system 40 and ceiling 16 and functions as a return duct of HVAC system 62. In an alternative embodiment, air conditioning volume 64 functions as a supply duct of HVAC system 62. When battery modules 42 (shown in FIG. 1) of energy storage system 40 are in an operational state (i.e., charging or discharging), transportable storage container 10 experiences a heat load caused by the charging or discharging of energy storage system 40. HVAC system 62 counteracts this heat load and maintains the temperature of energy storage system 40 within a predetermined temperature range. When transportable storage container 10 is in a non-operational state (i.e., during transportation of transportable storage container 10), transportable storage container 10 experiences minimal heat loads for HVAC system 62 to counteract or neutralize. For HVAC system 62 to maintain the temperature of energy storage system 40 within the predetermined temperature range within transportable storage container 10, a larger air conditioning volume 64 may be needed during the operational state than during the non-operational state in some embodiments.

[0029] In the exemplary embodiment, ceiling 16 of transportable storage container 10 includes a plurality of ceiling beams 60 that are laterally spaced and extend between first side 54 and second side 56 of transportable storage container 10. Ceiling beams 60 are coupled to interior face 22 of ceiling plate 20 (shown in FIG. 1) and are configured to provide structural support for transportable storage container 10. Ceiling beams 60 are also configured to increase rigidity of transportable storage container 10.

[0030] FIG. 3 is an exemplary configuration of housing 12 of transportable storage container 10, with ceiling plate 20 and side walls 18 (both shown in FIG. 1) omitted for clarity. Ceiling 16 of housing 12 includes ceiling end rails 70 and ceiling longitudinal beams 72. Ceiling beams 60 extend between and are coupled to ceiling longitudinal beams 72. Ceiling beams 60 are positioned substantially parallel to ceiling end rails 70. Ceiling 16 also includes a central ceiling beam 74 that extends between ceiling end rails 70. In one embodiment, central ceiling beam 74 is positioned substantially parallel to and midway between ceiling longitudinal beams 72. In one embodiment, ceiling beams 60 are coupled to interior face of ceiling plate 20 (shown in FIG. 1) and to central ceiling beam 74. In an alternative embodiment, central ceiling beam 74 is coupled to interior face 22 of ceiling plate 20 and to ceiling beams 60.

[0031] Floor 14 of housing 12 includes a floor plate 76 having an interior face 78 and an exterior face 80. Floor plate 76 at least partially defines housing 12. Floor 14 also includes floor end rails 82 and floor longitudinal beams 84. In the exemplary embodiment, housing 12 includes a plurality of floor cross beams 86 which are laterally spaced and positioned substantially parallel to floor end rails 82. Floor cross beams 86 are coupled to interior face 78 of floor plate 76. In one embodiment, floor 14 includes a central beam 88 that extends the longitudinal length of housing 12, i.e., from first end 50 to second end 52 of housing 12. Central beam 88 is coupled to interior face 22 of floor plate 76 and extends between floor end rails 82. Floor cross beams 86 extend between and are coupled to floor longitudinal beams 84 and central beam 88. In some embodiments, floor 14 does not include central beam 88. In those embodiments, each floor cross beam 86 extends laterally between and is connected to floor longitudinal beams 84 such that each floor cross beam 86 extends between first side 54 and second side 56 of housing 12. Alternatively, floor cross beams 86 and central beam 88 are positioned in any orientation and manner that enables transportable storage container 10 to function as described herein.

[0032] In the exemplary embodiment, ceiling end rails 70, floor end rails 82, ceiling longitudinal beams 72, and floor longitudinal beams 84 are coupled to vertical posts 32 to form a generally cuboid configuration. Ceiling end rails 70 and floor end rails 82 are positioned at a first end 50 and a second end 52 of housing 12 and ceiling longitudinal beams 72 and floor longitudinal beams 84 are positioned at a first side 54 and a second side 56 of housing 12.

[0033] In some embodiments, housing 12 includes a plurality of columns 90 coupled to interior face 26 of side wall 18 (shown in FIG. 1). Columns 90 extend between ceiling longitudinal beams 72 and floor longitudinal beams 84 and between ceiling end rails 70 and floor end rails 82. Columns 90 are configured to provide support for housing 12. Columns 90 are also configured to increase rigidity of housing 12. In alternative embodiments, housing 12 does not include a plurality of columns 90 and side walls 18 (shown in FIG. 1) include a corrugated profile to provide support for and increase rigidity of housing 12.

[0034] FIG. 4 illustrates transportable storage container 10 including energy storage system 40. In the exemplary embodiment, transportable storage container 10 is used to transport energy storage system 40 from a first location to a second location. In the exemplary embodiment, the first location is an assembly location and the second location is a use location. At the use location, energy storage system 40 of the transportable storage container 10 is in the operational state. In alternative embodiments, the first location is a prior use location. Energy storage system 40 includes battery modules 42 which require a cushion to prevent damage caused by mechanical load events during transport of transportable storage container 10. During transportation, transportable storage container 10 may experience mechanical load events such as shocks or vibrations. Shocks to transportable storage container 10 may occur as transportable storage container 10 is loaded onto a transportation device such as a truck, a railcar, a ship, and/or a forklift. For example, transportable storage container 10 may experience a shock if transportable storage container 10 is improperly loaded or unloaded by a forklift operator, dropped onto the transportation device, and/or dropped during unloading of the transportable storage container at its second location. Transportable storage container 10 may also experience vibrations as the transportation device transports transportable storage container 10 from the first location to the second location. Such shocks and/or vibrations may result in

vertical, lateral, longitudinal, and/or rotational movement of transportable storage container 10. The movement of transportable storage container 10 causes relative movement of energy storage system 40 which may cause energy storage system 40 to contact an interior surface of transportable storage container 10, resulting in damage to the energy storage system 40.

[0035] To allow movement of energy storage system 40 relative to transportable storage container 10 while preventing damaging contact between energy storage system 40 and housing 12, transportable storage container 10 includes one or more isolator assemblies 100 to provide a cushion for battery modules 42. In the exemplary embodiment, battery rack 44 of energy storage system 40 is coupled to floor plate 76 by one or more isolator assemblies 100. In some embodiments, battery rack 44 is coupled to ceiling plate 20 and/or side wall 18 (both shown in FIG. 1) by one or more isolator assemblies 100. In the exemplary embodiment, isolator assembly 100 is coupled to interior face 78 of floor plate 76 and is positioned between adjacent cross beams 86. In some embodiments, isolator assembly 100 is positioned between a pair of adjacent columns 90 and/or a pair of adjacent ceiling beams 60 (both shown in FIG. 3). By positioning isolator assemblies 100 between floor cross beams 86 and positioning floor plate 76 below floor cross beams 86, isolator assemblies 100 provide a cushion for energy storage system 40 without decreasing the space available within transportable storage container 10 for battery modules 42 of energy storage system 40. Alternatively, isolator assembly 100 is positioned in any orientation and manner that enables transportable storage container 10 to function as described herein.

[0036] Transportable storage container 10 utilizes a plurality of clearances 102 to prevent damage to energy storage system 40 during a shock and/or vibrational disturbance caused by a mechanical load event. Isolator assemblies 100 facilitate movement of energy storage system 40 within clearance 102, e.g., movement of energy storage system 40 towards and away from floor cross beams 86, without energy storage system 40 contacting floor cross beams 86. Floor cross beams 86 are separated from battery modules 42 of energy storage system 40 by one or more clearances 102 to prevent battery modules 42 and battery rack 44 from contacting floor cross beams 86. In some embodiments, energy storage system 40 is separated from ceiling 16 and/or side wall 18 (both shown in FIG. 1) by one or more clearances 102. Dimensions of clearance 102 are

based on at least the magnitude of expected mechanical disturbances, dimensions of housing 12, and/or isolator assembly 100 parameters such as geometry, material, mass, and stiffness.

[0037] In some embodiments, housing 12 additionally includes insulation to help maintain a desired temperature within transportable storage container 10. Insulation is applied to the interior of housing 12 (e.g., interior face 78 of floor plate 76, interior face 22 of ceiling plate 20 (shown in FIG. 1), and/or interior face 26 of side wall 18 (shown in FIG. 1)) and/or the exterior of housing 12 (e.g., exterior face 80 of floor plate 76, exterior face 24 of ceiling plate 20 (shown in FIG. 1), and/or exterior face 28 of side wall 18 (shown in FIG. 1)). In some embodiments, housing 12 includes insulation positioned between adjacent cross beams 86 and on interior face 78 of floor plate 76. In some embodiments, insulation at least partially fills a void 104 that is at least partially defined by isolator assembly 100, energy storage system 40, central beam 88 (shown in FIG. 3), floor cross beams 86, and/or floor plate 76. Various types of insulation may be used to fill void 104 such as spray foam insulation, fiber glass insulation, and/or other types of insulation that allow transportable storage container 10 to function as described herein. In some embodiments, insulation provides additional damping for energy storage system 40 during a mechanical disturbance caused by a shock or vibration event.

[0038] FIG. 5 is an exemplary energy storage system 40 that may be transported by transportable storage container 10 as shown in FIG. 1. Energy storage system 40 includes at least one battery module 42 coupled to and received in one or more battery racks 44. Battery module 42 may be a lithium ion battery or any other suitable battery that enables transportable storage container 10 to function as described herein. In the exemplary embodiment, each battery rack 44 includes one or more upright panels 110 and a plurality of supports 112, also referred to as battery shelves, extending perpendicularly from upright panels 110. In the exemplary embodiment, supports 112 are generally L-shaped. Upright panels 110 may be substantially planar, substantially corrugated, and/or any other configuration that enables energy storage system 40 to function as described herein.

[0039] Battery rack 44 includes a plurality of compartments 114 for receiving battery modules 42. In the exemplary embodiment, each compartment 114 receives one or more battery modules 42. Upright panels 110 and supports 112 at least partially define compartments 114. In some embodiments, battery modules 42 rest on supports 112. In alternative embodiments, battery modules 42 are suspended from supports 112. Battery modules 42 are coupled to supports 112 through contact, friction fit, snap fit, and/or fasteners. In some embodiments, battery modules 42 include a notch, and each compartment 114 of battery rack 44 includes a latch so that the latch may snap into and/or engage with the notch of battery modules 42 to secure battery modules 42 within compartment 114. Alternatively, battery modules 42 and battery rack 44 are positioned in any orientation and manner that enables energy storage system 40 to function as described herein.

[0040] Energy storage system 40 includes at least one bracket 120 configured to couple battery rack 44 to isolator assembly 100 (shown in FIG. 4). In the exemplary embodiment, a cross section of bracket 120 is substantially T-shaped. Bracket 120 includes a slot 122 for receiving upright panel 110 of battery rack 44. In the exemplary embodiment, upright panel 110 of battery rack 44 is coupled to slot 122 through friction. In some embodiments, bracket 120 also includes a plurality of holes for receiving fasteners to couple bracket 120 to isolator assembly 100 (shown in FIG. 4).

[0041] When loaded with battery modules 42, each battery rack 44 creates a column of battery modules 42. In the exemplary embodiment, two columns of battery modules 42 are positioned on battery rack 44. In other embodiments, each battery rack 44 is loaded with any amount of columns of battery modules 42 that enables transportable storage container 10 to function as described herein. Battery modules 42 of energy storage system 40 are operatively connected to power electronics 58 (shown in FIG. 2). In one embodiment, power electronics 58 (shown in FIG. 2) are connected to battery modules 42 by one or more cables that pass through a plurality of openings 116 in battery rack 44. In the exemplary embodiment, openings 116 are positioned on a rear upright panel 118. Alternatively, openings 116 are positioned in any orientation and manner that enables transportable storage container 10 to function as described herein.

[0042] FIG. 6 is an exemplary configuration of a plurality of battery racks 44 coupled to an exemplary floor 14. In the exemplary embodiment, battery racks 44 are positioned to facilitate access of compartments 114 from first side 54 and/or second side 56. In some embodiments, as shown in FIG. 2, transportable storage container 10 includes doors 30 positioned on first side 54 and second side 56 to allow access to compartments 114 of battery racks 44. In the exemplary embodiment, battery racks 44 are positioned such that upright panel 110 of one battery rack 44 is adjacent upright panel 110 of a second battery rack 44 to form a longitudinal row. Additionally, rear upright panel 118 of one battery rack 44 is adjacent rear upright panel 118 of a second battery rack 44 to form two longitudinal rows. The two longitudinal rows of battery racks 44 are positioned substantially parallel to floor longitudinal beams 84 and central beam 88. Alternatively, battery racks 44 are positioned in any orientation and manner that enables transportable storage container 10 to function as described herein. Battery racks 44 are coupled to isolator assemblies 100 that are configured to allow movement of battery racks 44 towards and away from floor cross beams 86 during a mechanical load event. In the exemplary embodiment, each battery rack 44 is able to move independently of other battery racks 44, e.g., battery racks 44 are not directly coupled together. In some embodiments, battery racks 44 are coupled together such that all battery racks 44 move in unison.

[0043] FIG. 7 illustrates a wire rope isolator 130 included in one embodiment of isolator assembly 100. Wire rope isolator 130 functions as a shock and/or vibration isolator for use with deployable isolator assembly 100. Other embodiments of the shock and/or vibration isolator include a pad or sheet of flexible material such as elastomers, rubber, cork, dense foam, and laminate materials, a pneumatic isolator, an air spring, and/or a mechanical spring. Wire rope isolator 130 includes a coil 132 of wire rope and at least two pairs of retaining bars 134. Coil 132 may be steel cable and retaining bars 134 may be aluminum, however other suitable materials may be used. In the exemplary embodiment, wire rope isolator 130 includes a first pair 136 of retaining bars 134 and a second pair 138 of retaining bars 134 that are equally spaced about coil 132. First pair 136 and second pair 138 of retaining bars 134 each include a clamp block 140 and a mount plate 142. In the exemplary embodiment, clamp block 140 and mount plate 142 include a plurality of holes 144 for receiving a plurality of fasteners such as bolts 146. Clamp block 140 is coupled to mount plate 142 using a plurality of bolts 146 such that when bolts 146

are tightened, coil 132 is secured between clamp block 140 and mount plate 142. In some embodiments, a subset of the plurality of holes 144 of clamp block 140 and mount plate 142 are configured to mount wire rope isolator 130 in a desired location using fasteners such as bolts 146.

[0044] FIG. 8 is a portion of an exemplary transportable storage container 10 including isolator assembly 100 that includes wire rope isolator 130 shown in FIG. 7. Mount plate 142 (shown in FIG. 7) of first pair 136 of retaining bars 134 is coupled to interior face 78 of floor plate 76 using suitable fasteners such as bolts. Wire rope isolator 130 is positioned between a pair of adjacent floor cross beams 86. In alternative embodiments, wire rope isolator 130 is positioned between a pair of adjacent columns 90 and/or a pair of adjacent ceiling beams 60 (both shown in FIG. 3). In the exemplary embodiment, wire rope isolator 130 is positioned substantially parallel with floor cross beams 86 such that retaining bars 134 of wire rope isolator 130 are substantially parallel with floor cross beams 86. Alternatively, wire rope isolator 130 is positioned in any orientation and manner that enables transportable storage container 10 to function as described herein.

[0045] In the exemplary embodiment, isolator assembly 100 includes an interfacing bracket 150 that connects energy storage system 40 to one or more wire rope isolators 130. In the exemplary embodiment, interfacing bracket 150 is substantially planar and rectangular in shape and includes a plurality of holes 152 for receiving a plurality of fasteners such as bolts. In the exemplary embodiment, energy storage system 40 and wire rope isolator 130 are coupled to interfacing bracket 150 using fasteners. In the exemplary embodiment, interfacing bracket 150 is coupled to one or more wire rope isolators 130. In the exemplary embodiment, holes 152 of interfacing bracket 150 are positioned in a generally linear configuration to allow attachment of both bracket 120 of energy storage system 40 and wire rope isolator 130 to interfacing bracket 150. Alternatively, interfacing bracket 150 is configured in any orientation and manner that enables energy storage system 40 to be coupled to wire rope isolator 130.

[0046] In the exemplary embodiment, battery 42 is separated from floor cross beams 86 by clearance 102 to prevent damage to battery modules 42 during a shock and/or vibrational disturbance caused by a mechanical load event. Wire rope isolator 130

allows relative movement of energy storage system 40 within clearance 102 while preventing damage to energy storage system 40. Wire rope isolators 130, when coupled to interior face 78 of floor plate 76, are configured to allow movement of energy storage system 40 towards and away from the plurality of floor cross beams 86 without battery modules 42 contacting floor cross beams 86. Dimensions of clearance 102 are based on at least the magnitude of expected mechanical disturbances, dimensions of housing 12, and/or wire rope isolator 130 parameters such as geometry, material, mass, and stiffness.

[0047] FIG. 9 is a portion of an alternative transportable storage container 200 including isolator assembly 202 that includes a rubber pad isolator 204. Transportable storage container 200 differs from transportable storage container 10 (shown in Fig 1) in that transportable storage container 200 includes isolator assembly 202 rather than isolator assembly 100 (shown in Fig. 4). Rubber pad isolator 204 functions as a shock and/or vibration isolator and is made of a flexible and/or elastomeric material. In the exemplary embodiment, rubber pad isolator 204 is generally cuboid shaped and includes an upper surface 206 and a lower surface 208. Alternatively, rubber pad isolator 204 is configured in any orientation and manner that enables rubber pad isolator 204 to function as described herein. In some embodiments, upper surface 206 and lower surface 208 include bores for receiving a plurality of fasteners such as bolts 210 to couple rubber pad isolator 204 in a desired location. Lower surface 208 of rubber pad isolator 204 is coupled to interior face 212 of floor plate 214.

[0048] Isolator assembly 202 includes an interfacing bracket 216 that includes one or more plates 218 having one or more holes for receiving bolts 210. In the exemplary embodiment, plates 218 are substantially planar and rectangular in shape. Interfacing bracket 216 includes an upper frame 220 connecting one or more plates 218 such that interfacing bracket 216 at least partially surrounds floor cross beam 222. Upper frame 220 also includes a plurality of openings 224 configured to allow access to plates 218 for coupling interfacing bracket 216 to rubber pad isolator 204. In the exemplary embodiment, upper surface 206 of rubber pad isolator 204 is coupled to at least one plate 218 of interfacing bracket 216, and upper frame 220 of interfacing bracket 216 is coupled to battery rack 226. Alternatively, interfacing bracket 216 is configured in any orientation and manner that enables battery rack 226 to be coupled to rubber pad isolator 204.

[0049] In some embodiments, rubber pad isolator 204 includes at least one air pocket 228 filled with air which may, in part, act as insulation for transportable storage container 200. Air pocket 228 is configured to help maintain a desired temperature within transportable storage container 200. In some embodiments, air within air pocket 228 also provides additional damping and/or isolation for energy storage system 40 (shown in Fig. 5) during mechanical load events. For example, in some embodiments, rubber pad isolator 204 may include one air pocket 228 such that rubber pad isolator 204 functions as an air spring isolator. In some embodiments, rubber pad isolator 204 includes a plurality of projections 230 extending from rubber pad isolator 204. Projections 230 are configured as fins to dissipate heat from rubber pad isolator 204.

[0050] In the exemplary embodiment, upper frame 220 of interfacing bracket 216 is separated from floor cross beams 222 by clearance 232 to prevent damage to battery modules 42 (shown in FIG. 5) during a shock and/or vibrational disturbance caused by a mechanical load event. Rubber pad isolator 204 prevents battery modules 42 from contacting floor cross beams 222 by allowing relative movement of battery rack 226 and upper frame 220 of interfacing bracket 216 within clearance 232. Rubber pad isolator 204, when coupled to interior face 212 of floor plate 214, is configured to allow movement of battery rack 226 towards and away from the plurality of floor cross beams 222 without battery modules 42, battery rack 226, and/or interfacing bracket 216 contacting floor cross beams 222. Dimensions of clearance 232 are based on at least the magnitude of expected mechanical disturbances, dimensions of housing 12 (shown in Fig. 1), and/or rubber pad isolator 204 parameters such as geometry, material, mass, and stiffness.

[0051] The embodiments described herein include a transportable storage container configured to maximize storage space within the container and to reduce mechanical loads or disturbances caused during transport that is experienced by transportation products, such as energy storage systems, stored within the container. The transportable storage containers described herein include a housing that can be mounted on a transportation device such as a truck, a railcar, a forklift and/or a ship. The housing includes a floor having a floor plate and a plurality of floor beams in contact with an interior face of the floor plate. To account for the relative movement of the goods during mechanical load events experienced by the transportable storage container, the container also includes one or more isolator assemblies. The isolator assemblies are positioned

between the floor beams to create a load path between the goods and the housing. The transportable storage containers described herein may be used to transport energy storage systems from a first location to a second location. The energy storage systems may be installed prior to shipment of the transportable storage container to the second location. As such, the transportable storage containers described herein reduce damage to goods housed within the containers during transport of the containers. The transportable storage containers described herein also maximize storage space for goods within the container and maximize space within the container such that the energy capacity of an energy storage system stored within the container is maximized while complying with clearance and HVAC requirements. The transportable storage containers described herein also reduce mechanical loads or disturbances caused during transport that is experienced by goods stored within the container, reduce installation time and costs for energy storage systems housed within the container, and simplify logistics for energy storage systems housed within the container.

[0052] An exemplary technical effect of the methods, systems, and apparatus described herein includes at least one of: a) reducing damage to goods housed within a transportable storage container caused by mechanical load events during transport of the transportable storage container, b) maximizing space for transportation products within a transportable storage container, c) maximizing space within a transportable storage container such that the energy capacity of an energy storage system stored within the transportable storage container is maximized while complying with clearance and HVAC requirements, d) reducing time and costs for installing an energy storage system housed within a transportable storage container, and e) simplifying logistics for installing an energy storage system housed within a transportable storage container.

[0053] Exemplary embodiments of transportable storage containers configured to provide shock or vibration isolation are described above in detail. The transportable storage containers, and methods of using and manufacturing such systems are not limited to the specific embodiments described herein, but rather, components of systems and/or steps of the methods may be utilized independently and separately from other components and/or steps described herein. For example, the methods may also be used in combination with other transportable storage containers, and are not limited to practice with only the transportable storage containers, and methods as described herein.

Rather, the exemplary embodiment can be implemented and utilized in connection with many other transportation systems.

[0054] Although specific features of various embodiments of the disclosure may be shown in some drawings and not in others, this is for convenience only. In accordance with the principles of the disclosure, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

[0055] This written description uses examples to disclose the embodiments, including the best mode, and also to enable any person skilled in the art to practice the embodiments, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the disclosure is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

WHAT IS CLAIMED IS:

1. A transportable storage container comprising:
 - a housing mountable to a transportation device, said housing comprising a floor plate having an interior face and an exterior face, and a plurality of beams coupled to said interior face of said floor plate;
- 5 at least one isolator assembly coupled to said floor plate and positioned between a pair of adjacent beams of said plurality of beams; and
 - a transportation product coupled to said at least one isolator assembly.
2. The transportable storage container of Claim 1, wherein said transportation product is an energy storage system that comprises a battery rack and a plurality of battery modules, said battery rack coupled to said at least one isolator assembly.
3. The transportable storage container of Claim 1, wherein said at least one isolator assembly is configured to allow movement of said transportation product relative to said housing during a mechanical load event without said transportation product contacting said plurality of beams.
4. The transportable storage container of Claim 1, further comprising an interfacing bracket coupled between said transportation product and said at least one isolator assembly.
5. The transportable storage container of Claim 1, further comprising insulation positioned between said pair of adjacent beams.
6. The transportable storage container of Claim 1, wherein said at least one isolator assembly comprises a wire rope isolator.
7. The transportable storage container of Claim 1, wherein said at least one isolator assembly comprises a rubber pad isolator.
8. The transportable storage container of Claim 7, wherein said rubber pad isolator defines at least one air pocket.

9. The transportable storage container of Claim 7, wherein said rubber pad isolator comprises a plurality of projections.

10. The transportable storage container of Claim 1, further comprising a wall plate that at least partially defines said housing, wherein at least one second isolator assembly contacts said wall plate and said transportation product.

11. A transportable storage container mountable on a transportation device, said transportable storage container comprising:

a housing comprising a floor plate having an interior face and an exterior face, and a plurality of beams coupled to said interior face of said floor plate;

5 at least one isolator assembly positioned between a pair of adjacent beams of said plurality of beams; and

an energy storage system coupled to said at least one isolator assembly, wherein said energy storage system comprises a battery rack and a plurality of battery modules, wherein said at least one isolator assembly is configured to allow movement of said energy storage system towards and away from said plurality of beams.

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12. The transportable storage container of Claim 11, wherein said at least one isolator assembly is configured to allow movement of said energy storage system during a mechanical load event without said battery rack and said plurality of battery modules contacting said plurality of beams.

13. The transportable storage container of Claim 11, further comprising an interfacing bracket coupled to said energy storage system and said at least one isolator assembly.

14. The transportable storage container of Claim 11, further comprising a wall plate that at least partially defines said housing, wherein at least one second isolator assembly contacts said wall plate and said energy storage system.

15. The transportable storage container of Claim 11, wherein said at least one isolator assembly comprises a wire rope isolator.

16. A method of assembling a transportable storage container comprising:
- providing a floor plate having an interior face and an exterior face, the floor plate at least partially defining a housing mountable to a transportation device;
- coupling a plurality of beams to the interior face of the floor plate;
- 5 coupling at least one isolator assembly to the interior face of the floor plate, wherein the at least one isolator assembly is positioned between a pair of adjacent beams of the plurality of beams; and
- coupling a transportation product to the at least one isolator assembly, wherein the at least one isolator assembly is configured to allow movement of the transportation product towards and away from the plurality of beams.
- 10
17. The method of Claim 16, wherein coupling a transportation product to the at least one isolator assembly comprises:
- coupling at least one battery rack to the at least one isolator assembly; and
- coupling a plurality of battery modules to the at least one battery rack.
18. The method of Claim 16, wherein coupling at least one isolator assembly to the interior face of the floor plate comprises:
- coupling a wire rope isolator having at least two pairs of retaining bars to the floor plate, wherein the at least two pairs of retaining bars are substantially parallel to the plurality of beams.
- 5
19. The method of Claim 16, further comprising:
- providing an interfacing bracket; and
- coupling the interfacing bracket between the transportation product and the at least one isolator assembly.

20. The method of Claim 16, further comprising:

providing a wall plate that at least partially defines the housing; and

coupling at least one second isolator assembly to the wall plate and the transportation product.

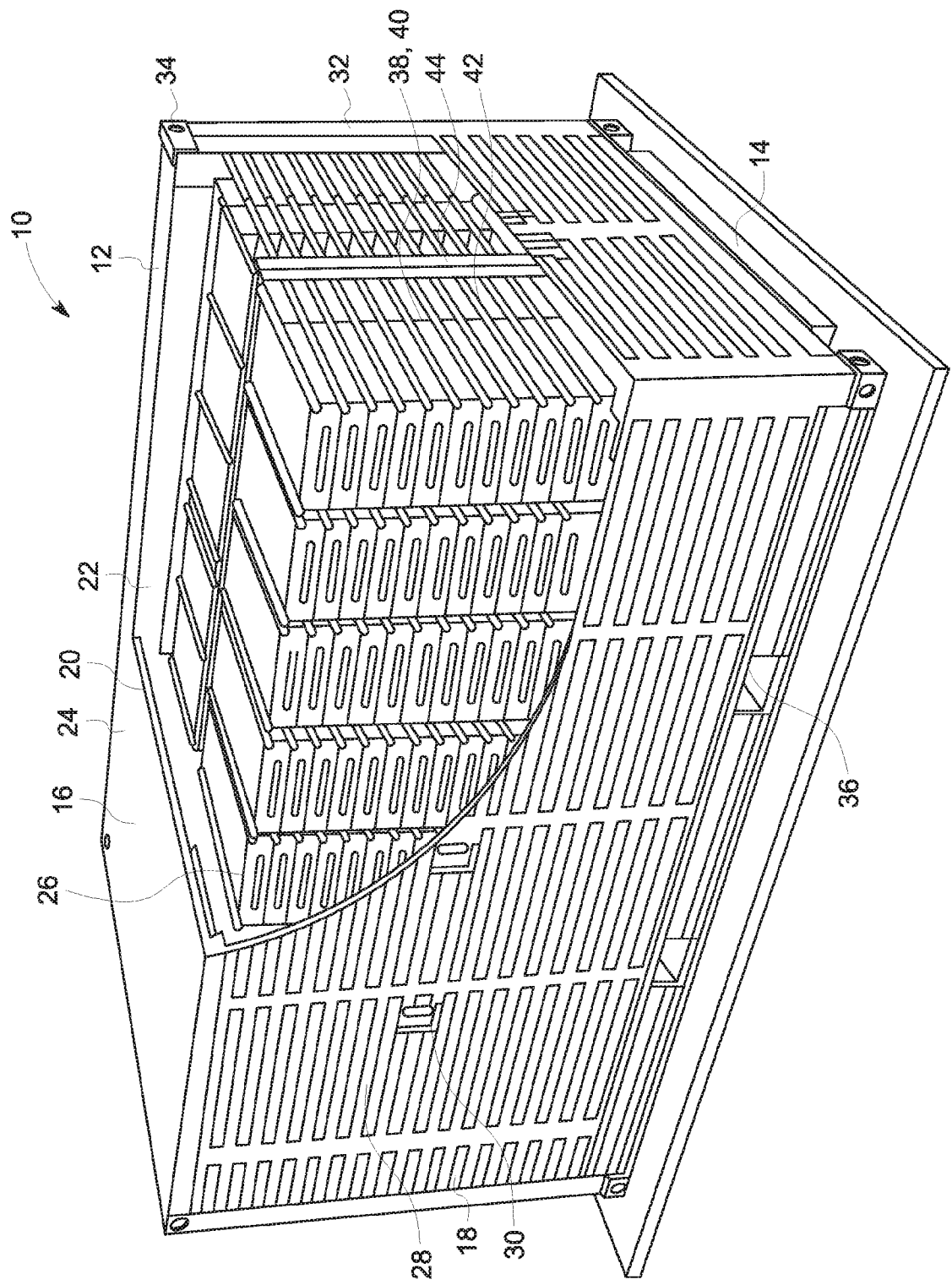
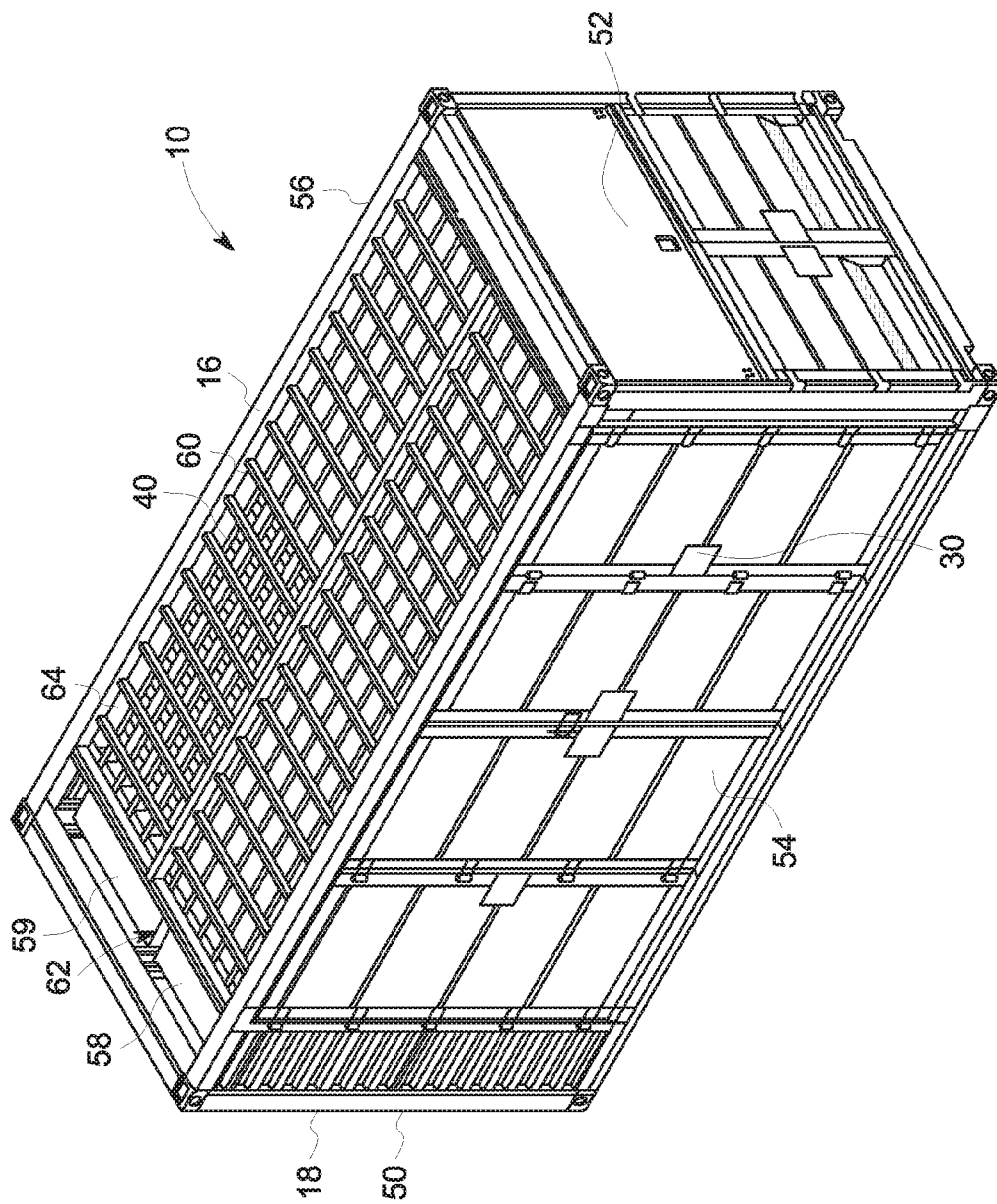


FIG. 1

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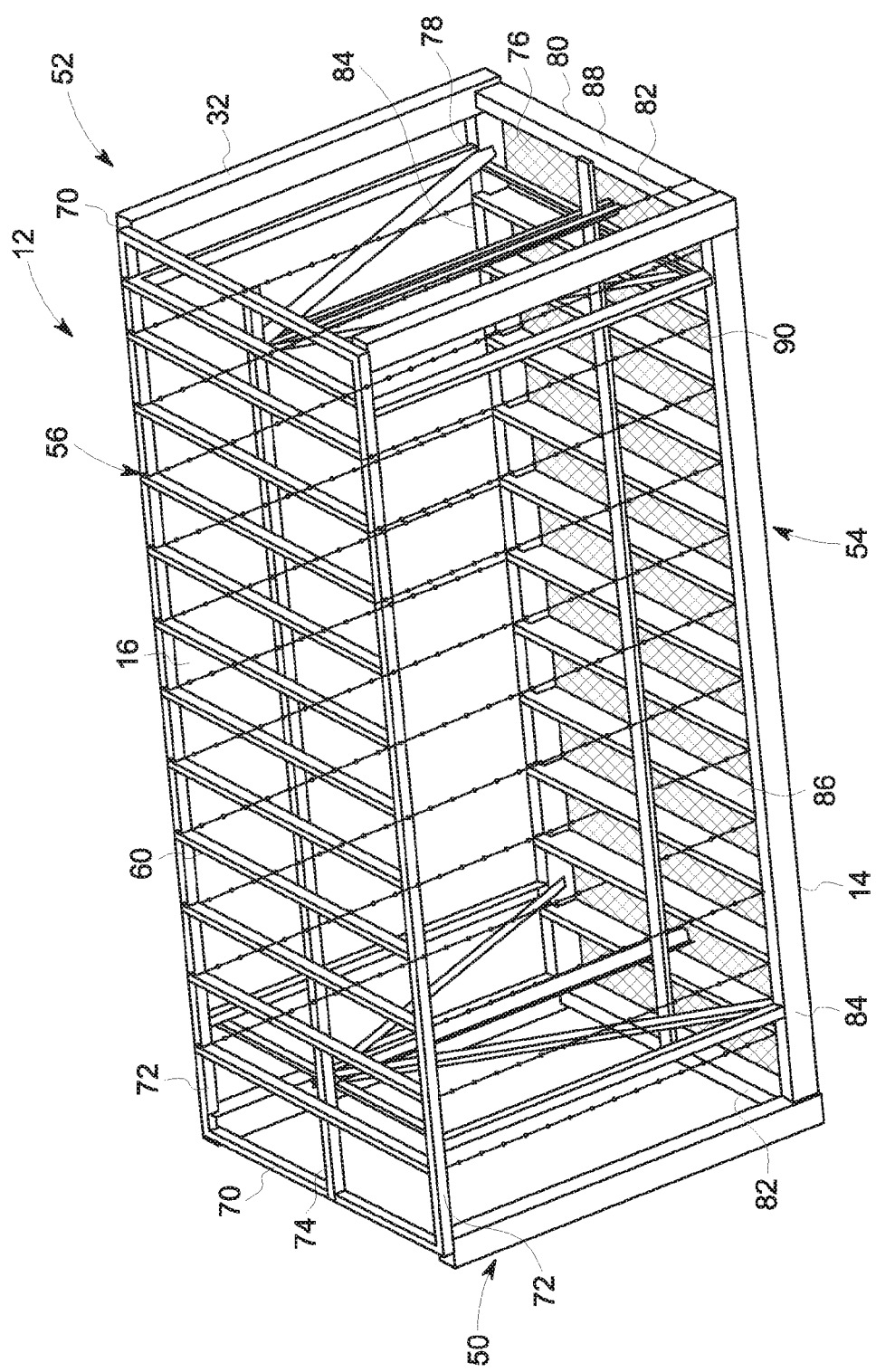


FIG. 3

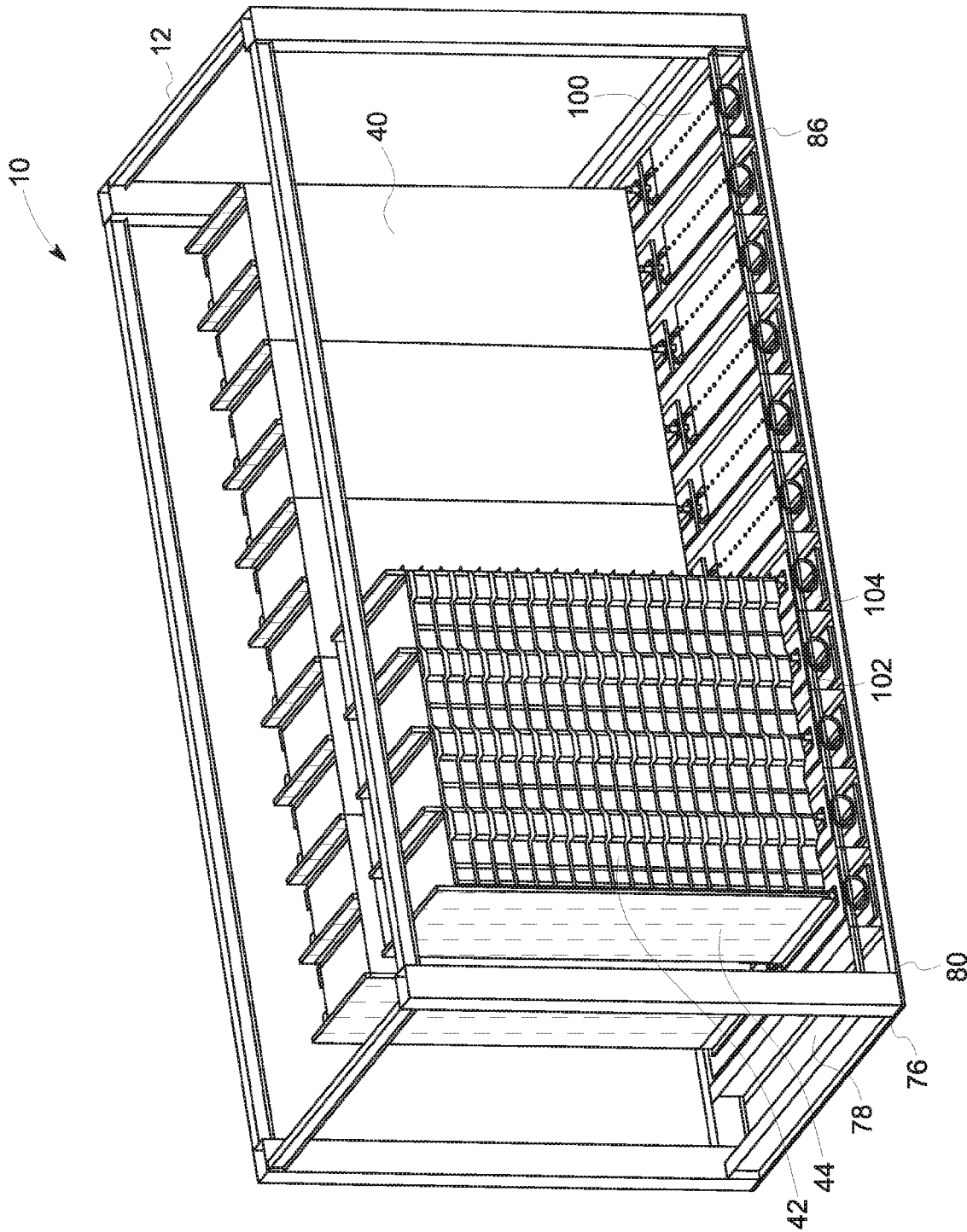


FIG. 4

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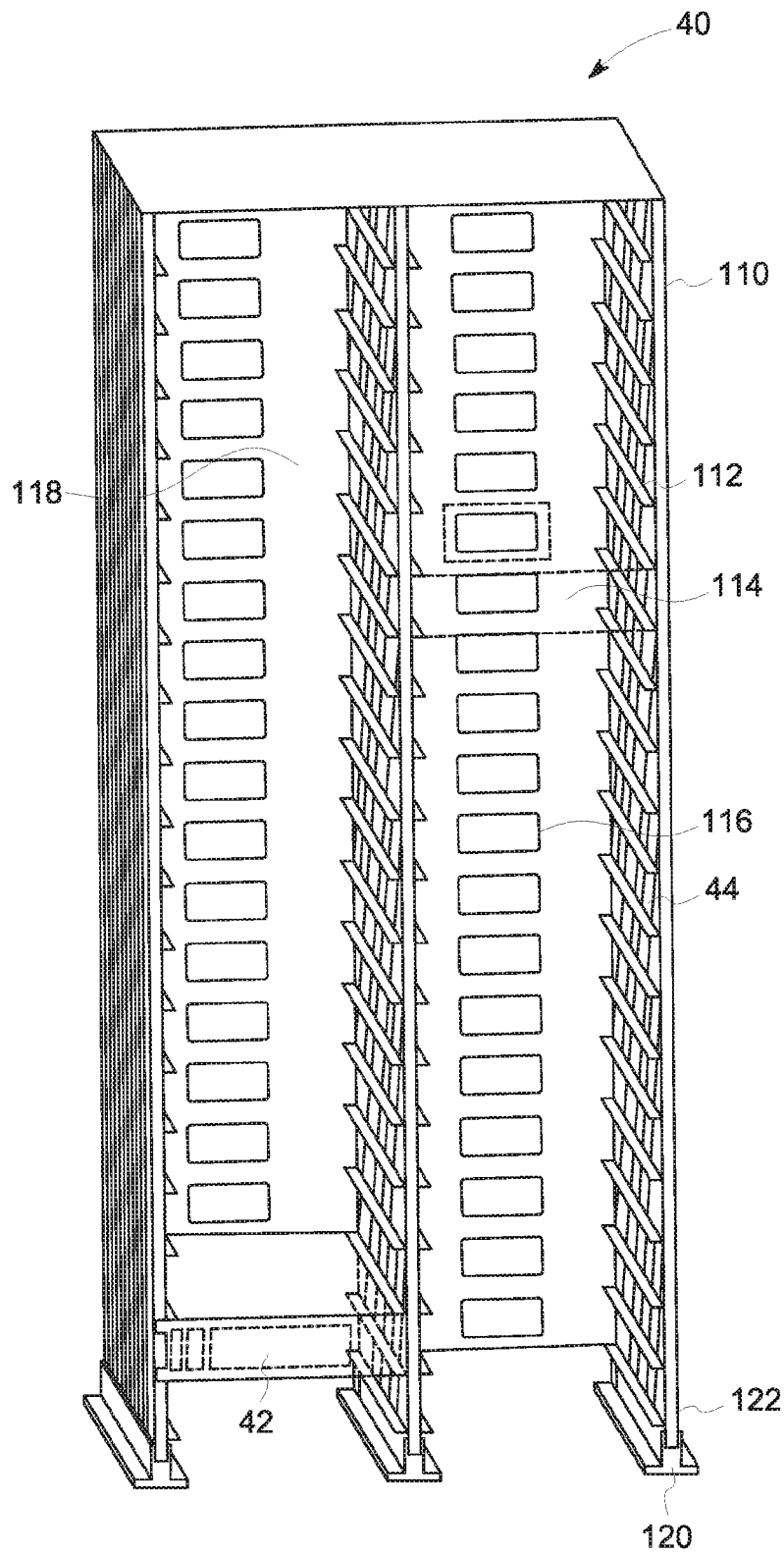


FIG. 5

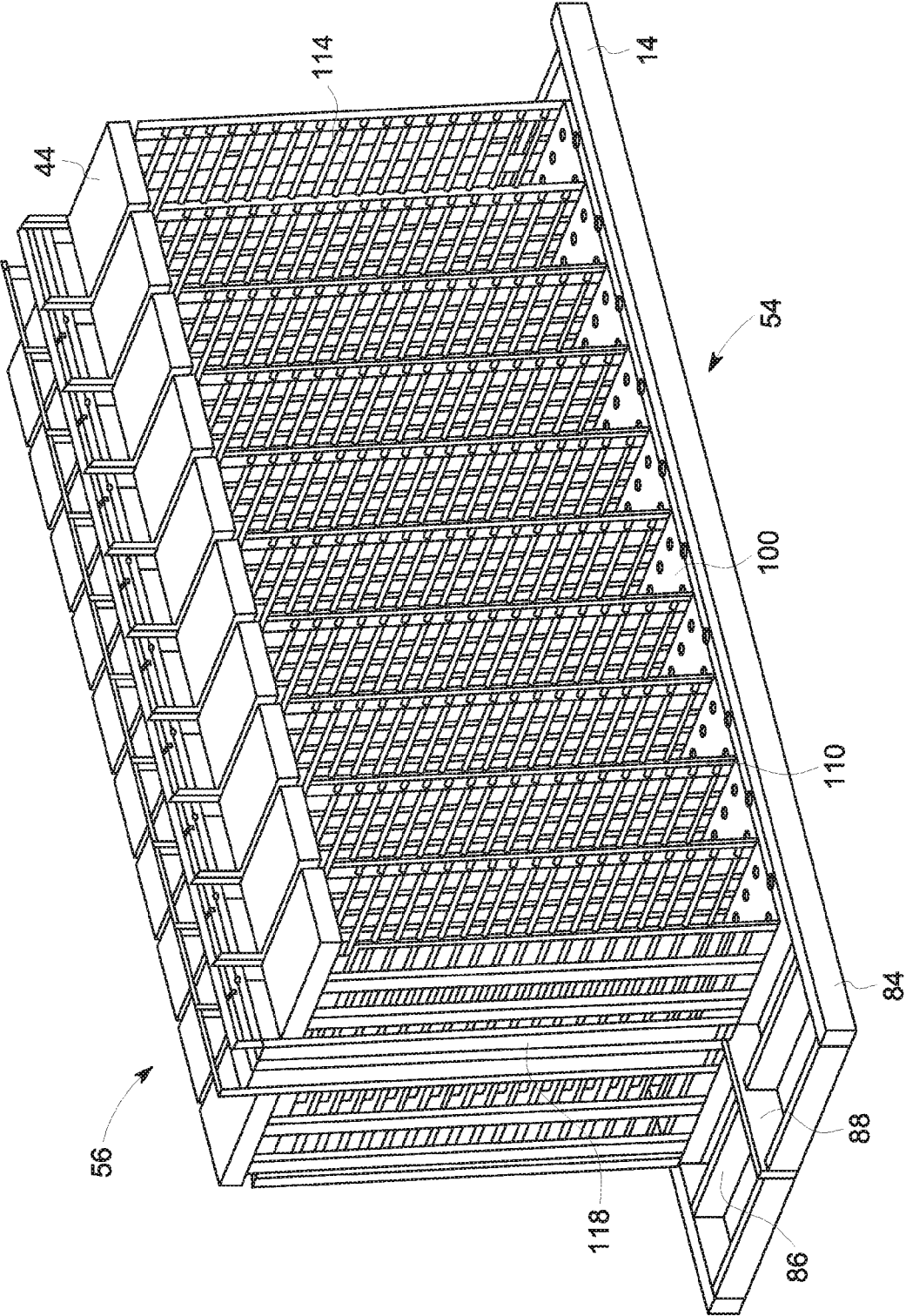


FIG. 6

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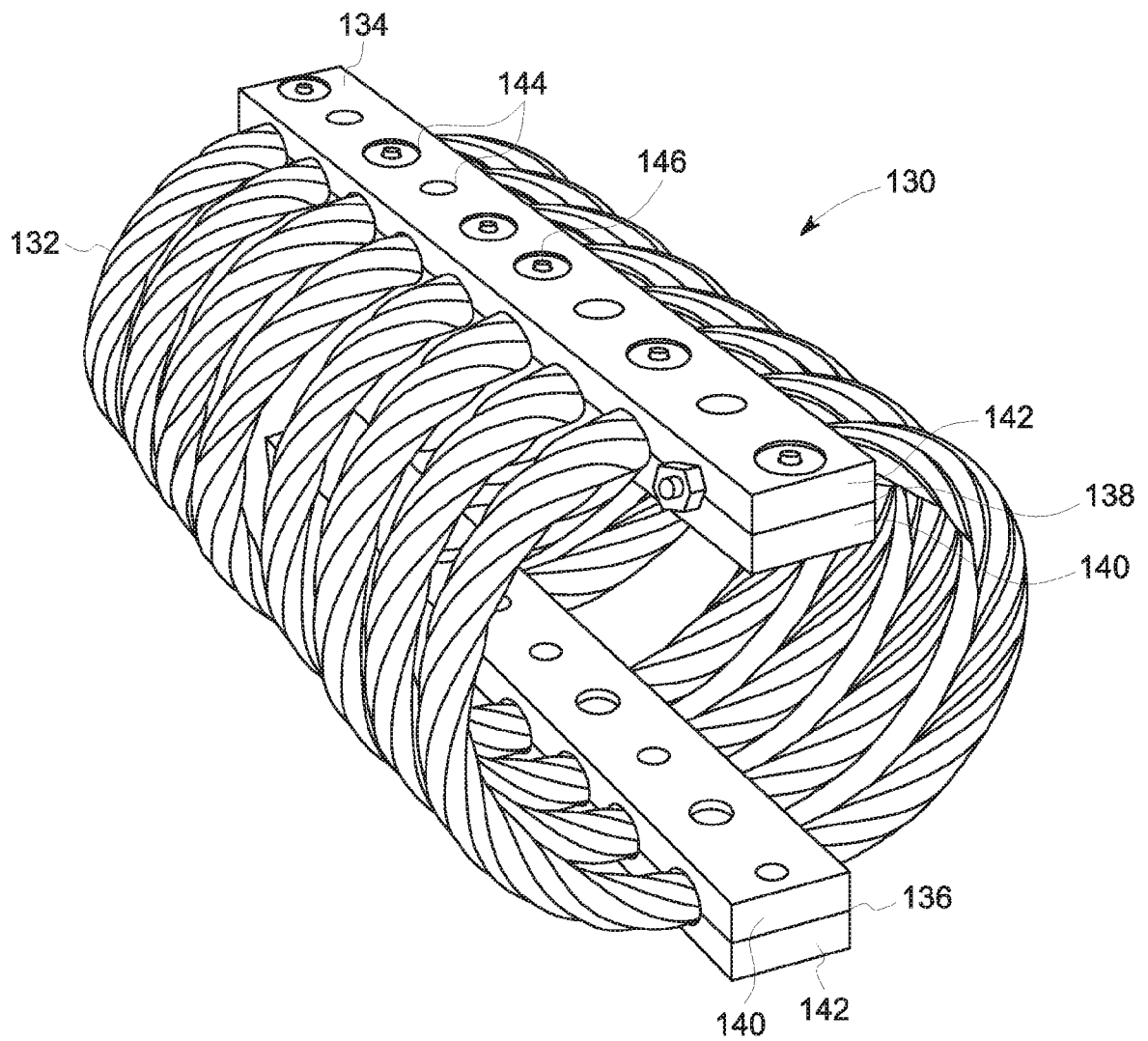


FIG. 7

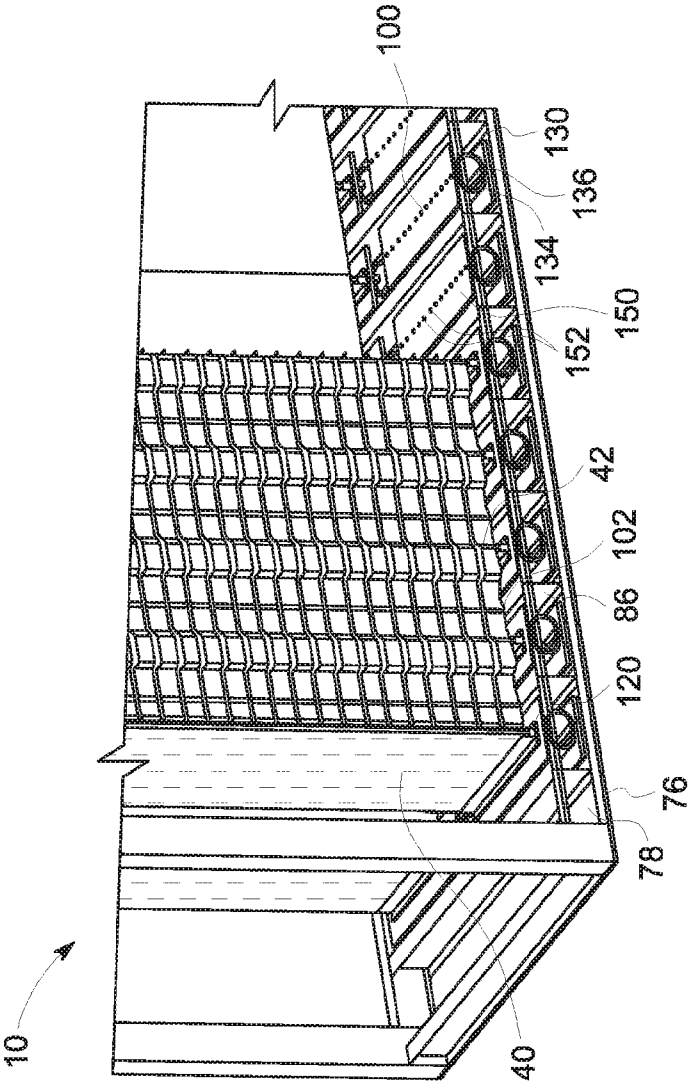


FIG. 8

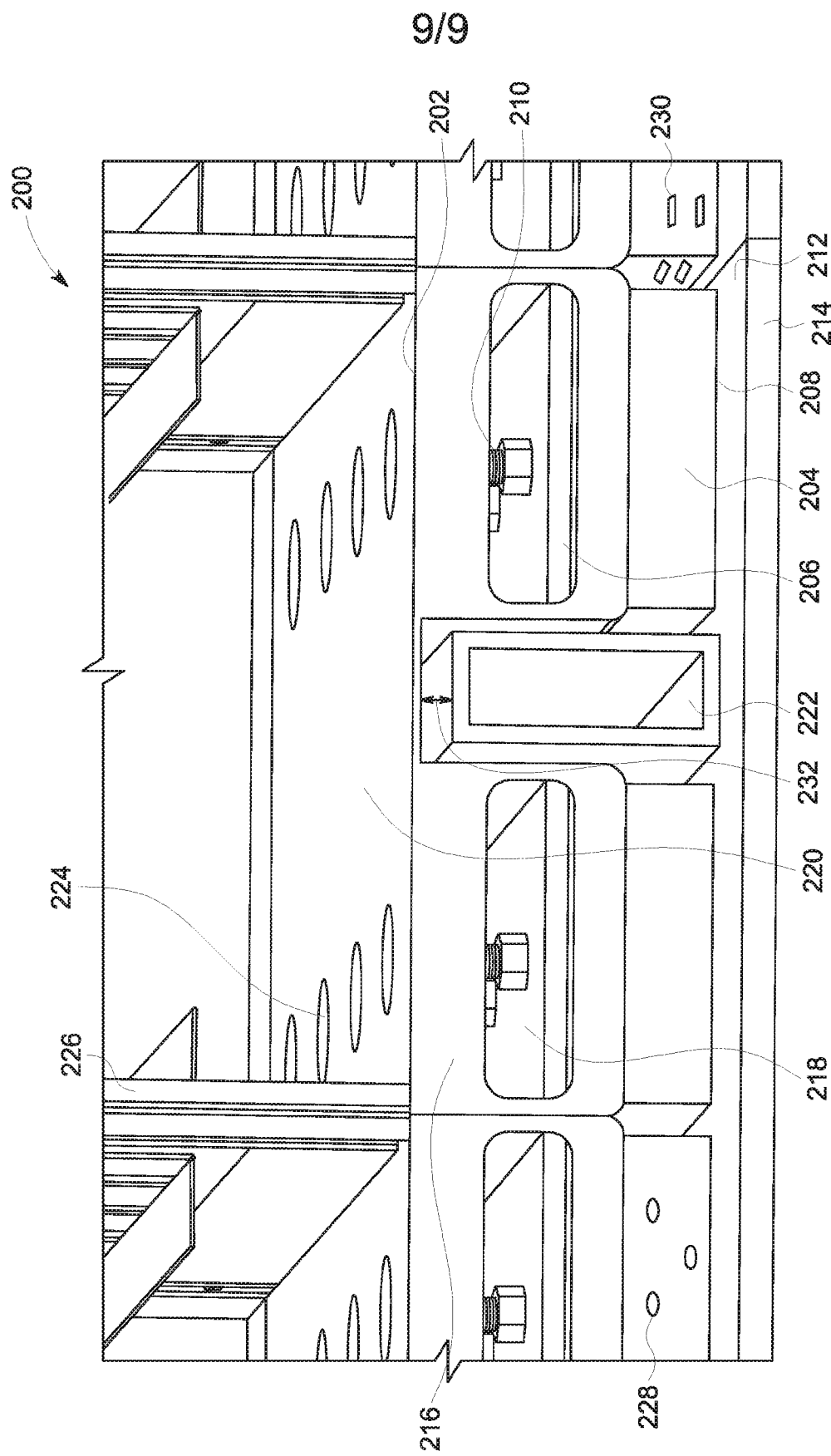


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/055378

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04H5/02 H01M2/10
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04H H01M H05K

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

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

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/165565 A1 (HELLRIEGAL STEPHEN V R [US] ET AL) 1 July 2010 (2010-07-01) the whole document	1-20
X	----- WO 2007/047809 A2 (RAILPOWER TECHNOLOGIES CORP [CA]; PIKE JAMES A [US] ET AL.) 26 April 2007 (2007-04-26) the whole document -----	1-5,7, 11-13, 15,17,19

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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"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

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"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

6 June 2019

Date of mailing of the international search report

18/06/2019

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2018/055378

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