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(54) MODULAR AIR COOLED CONDENSER APPARATUS AND METHOD

MODULARE LUFTGEKÜHLTE KONDENSATORVORRICHTUNG UND VERFAHREN
PROCÉDÉ ET APPAREIL CONDENSEUR MODULAIRE REFROIDI PAR AIR

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Description

CROSS REFERENCE TO RELATED APPLICATIONS

- 5 **[0001]** This application claims priority to U.S. Provisional Application Serial No. 61/828,076, filed on May 28, 2013, titled "MODULAR AIR COOLED CONDENSER APPARATUS AND METHOD,".

FIELD OF THE INVENTION

- 10 **[0002]** The present invention relates to a mechanical draft cooling tower that utilizes air cooled condenser modules. The aforementioned cooling tower operates by mechanical draft and achieves the exchange of heat between two fluids such as atmospheric air, ordinarily, and another fluid which is usually steam or some sort of industrial process fluid. The aforementioned cooling tower operates by mechanical draft which utilizes an air current generator such as a fan or the like.

15 BACKGROUND OF THE INVENTION

- [0003]** Cooling towers are heat exchangers of a type widely used to emanate low grade heat to the atmosphere and are typically utilized in electricity generation, air conditioning installations and the like. In a mechanical draft cooling tower for the aforementioned applications, airflow is induced or forced via an air flow generator such as a driven impeller, driven fan or the like. Cooling towers may be wet or dry. Dry cooling towers can be either "direct dry," in which steam is directly condensed by air passing over a heat exchange medium containing the steam or an "indirect dry" type cooling towers, in which the steam first passes through a surface condenser cooled by a fluid and this warmed fluid is sent to a cooling tower heat exchanger where the fluid remains isolated from the air, similar to an automobile radiator. Dry cooling has the advantage of no evaporative water losses. Both types of dry cooling towers dissipate heat by conduction and convection and both types are presently in use. Wet cooling towers provide direct air contact to a fluid being cooled. Wet cooling towers benefit from the latent heat of vaporization which provides for very efficient heat transfer but at the expense of evaporating a small percentage of the circulating fluid.

- [0004]** To accomplish the required direct dry cooling the condenser typically requires a large surface area to dissipate the thermal energy in the gas or steam and oftentimes may present several challenges to the design engineer. It sometimes can be difficult to efficiently and effectively direct the steam to all the inner surface areas of the condenser because of nonuniformity in the delivery of the steam due to system ducting pressure losses and velocity distribution. Therefore, uniform steam distribution is desirable in air cooled condensers and is critical for optimum performance. Another challenge or drawback is, while it is desirable to provide a large surface area, steam side pressure drop may be generated thus increasing turbine back pressure and consequently reducing efficiency of the power plant. Therefore it is desirable to have a condenser with a strategic layout of ducting and condenser surfaces that allows for an even distribution of steam throughout the condenser that reduces back pressure, while permitting a maximum of cooling airflow throughout and across the condenser surfaces.

- [0005]** Another drawback to the current air cooled condenser towers is that they are typically very labor intensive in their assembly at the job site. The assembly of such towers oftentimes requires a dedicated labor force, investing a large amount of hours. Accordingly, such assembly is labor intensive requiring a large amount of time and therefore can be costly. Accordingly, it is desirable and more efficient to assemble as much of the tower structure at the manufacturing plant or facility, prior to shipping it to the installation site.

- [0006]** It is well known in the art that improving cooling tower performance (i.e. the ability to extract an increased quantity of waste heat in a given surface) can lead to improved overall efficiency of a steam plant's conversion of heat to electric power and/or to increases in power output in particular conditions. Moreover, cost-effective methods of manufacture and assembly also improve the overall efficiency of cooling towers in terms of cost-effectiveness of manufacture and operation. Accordingly, it is desirable for cooling tower that are efficient in both in the heat exchange properties and assembly. The present invention addresses this desire.

- [0007]** Therefore it would be desirable to have an economical, mechanical draft, modular cooling tower that is efficient not only in its heat exchange properties but also in its time required for assembly and cost for doing the same. WO 2008/110154 discloses a method for assembling an understructure for a modular air cooled condenser according to the preamble of claim 1 and a modular understructure for an air cooled condenser according to the preamble of claim 11.

SUMMARY OF THE INVENTION

- 55 **[0008]** Embodiments of the present invention advantageously provides for a fluid, usually steam and method for a modular mechanical draft cooling tower for condensing said steam.
- [0009]** An embodiment of the invention includes a method for assembling a modular air cooled condenser extending

along a vertical axis away from horizontal, comprising the steps of: assembling a first condenser bundle assembly having a first set of tubes having first and second ends, a steam manifold connected to the first ends of the tubes, and a condensate header connected to the second ends of the tubes; assembling a second condenser bundle having a second set of tubes having first and second ends, a steam manifold connected to the first ends of the tubes, and a condensate header connected to the second ends of the tubes; placing the first and second condenser bundle assemblies in to a container; transporting the container to a location upon which the modular air cooled condenser will be assembled; assembling a heat exchange delta by placing the first condenser bundle and the second condenser bundle; and positioning the heat exchange delta on a modular tower frame.

[0010] Another embodiment of the present invention includes a modular air cooled condenser extending along a vertical axis away from horizontal, comprising: means for assembling a first condenser bundle assembly having a first set of tubes having first and second ends, a steam manifold connected to the first ends of the tubes, and a condensate header connected to the second ends of the tubes; means for assembling a second condenser bundle assembly having a second set of tubes having first and second ends, a steam manifold connected to the first end of the tubes, and a condensate header connected to the second ends of the tubes; means for placing the first and second condenser bundle assemblies in to a container; means for transporting the container to a location upon which the modular air cooled condenser will be assembled; means for assembling a heat exchange delta by placing using the first condenser bundle and the second condenser bundle; and means for positioning the heat exchange delta on a modular tower frame.

[0011] Another embodiment of the present invention, A mechanical draft modular air cooled condenser that cools an industrial fluid is disclosed, comprising: a plenum with which at least one delta resides wherein said at least one delta comprises first condenser bundle having a first set of tubes having first and second ends, a steam manifold connected to the first ends of the tubes, and a condensate header connected to the second ends of the tubes; and a second condenser bundle having a second set of tubes having first and second ends, a steam manifold connected to the first ends of the tubes, and a condensate header connected to the second ends of the tubes; a support frame that supports said plenum; and a shroud that houses an air current generator.

[0012] In yet another embodiment of the present invention, a method for assembling a modular air cooled condenser extending along a vertical axis is disclosed, comprising: assembling a first condenser bundle having a first set of tubes having first and second ends and a condensate header connected to the second end of the tubes; assembling a second condenser bundle having a second set of tubes having first and second ends, and a condensate header connected to the second end of the tubes; placing the first and second condenser bundles in to a container; transporting the container to a location upon which the modular air cooled condenser will be assembled; assembling a heat exchange delta by placing using the first condenser bundle and the second condenser bundle; and positioning the heat exchange delta on a modular tower frame.

[0013] There has thus been outlined, rather broadly, certain embodiments of the invention in order that the detailed description thereof herein may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional embodiments of the invention that will be described below and which will form the subject matter of the claims appended hereto.

[0014] In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of embodiments in addition to those described and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

[0015] As such, those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above-mentioned and other features and advantages of this disclosure, and the manner of attaining them, will become more apparent and the disclosure itself will be better understood by reference to the following description of various embodiments of the disclosure taken in conjunction with the accompanying figures.

FIG. 1 is a top view of a power plant with heat exchanger having an air cooled condenser module in accordance with an embodiment of the present invention.

FIG. 2 is an elevation view of the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 3 is a sectional view of the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 4 is a perspective view of the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 5 is a perspective view of a braced bay for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 6 is a perspective view of a duct, risers, and middle truss for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 7 is a perspective view of an assembled duct, risers, and middle truss for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 8 is a perspective view of the assembled duct, risers, and middle truss disposed on the braced bay for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 9 is a perspective view of transversal structures on the assembled duct, risers, and middle truss disposed on the braced bay for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 10 is a perspective view of a transversal truss for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 11 is a perspective view of the transversal truss and transversal structures on the assembled duct, risers, and middle truss disposed on the braced bay for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 12 is a perspective view of a longitudinal truss for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 13 is a perspective view of the longitudinal truss, transversal truss, and transversal structures on the assembled duct, risers, and middle truss disposed on the braced bay for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 14 is a perspective view of a bridge for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 15 is a perspective view of the bridges, longitudinal trusses, transversal trusses, and transversal structures on the assembled duct, risers, and middle truss disposed on the braced bay for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 16 is a perspective view of a partial placement of headers and deltas for the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 17 is a perspective view of an air cooled condenser module in accordance with an embodiment of the present invention.

FIG. 18 is a schematic side view of the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 19 is another schematic side view of the air cooled condenser module depicted in FIG. 1 in accordance with an embodiment of the present invention.

FIG. 20 is a perspective view of an A-type condenser configuration in accordance with an embodiment of the present invention.

FIG. 21 illustrates the condenser bundles in a packaged arrangement for shipping in accordance with an embodiment of the present invention.

FIG. 22 schematically illustrates the steps of assembly of an air cooled condenser in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0017] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof and show by way of illustration specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice them, and it is to be understood that other embodiments may be utilized, and that structural, logical, processing, and electrical changes may be made. It should be appreciated that any list of materials or arrangements of elements is for example purposes only and is by no means intended to be exhaustive. The progression of processing steps described is an example; however, the sequence of steps is not limited to that set forth herein and may be changed as is known in the art, with the exception of steps necessarily occurring in a certain order.

[0018] Embodiments described herein provide a heat exchange system, a support structure for an air cooled condenser ("ACC"), and a method of constructing a support structure for an ACC. As described herein, some or all of these embodiments provide substantial benefit over standard A-frame ACC. Examples of benefits over standard A-frame ACC include reduced cost of about 25%, improved constructability, higher annual output of power plant, improved cleanability due to use of motorized cleaning shuttle standard, lower visual impact due to reduced height (26m vs. 32.6m) and reduced occupied ground area, and reduced foundations (40 columns vs 48 for A-frame ACC with equivalent output). This height reduction is due to the reduced height of the multi-deltas described herein compared to conventional A-Frame-type bundles that have longer tubes and increased overall height.

[0019] Specific examples of reduced cost and improved constructability include: Steam manifolds and steam condensate headers already welded on finned tube bundles in the manufacturing factory; Less total weight of steel structure (- 25% vs A-Frame ACC); Less total weight of ducting (- 25% vs A-Frame ACC); Reduced number of bundles (25% for A-Frame ACC); Fewer elements of steel structure to be assembled on site by bolting (- 50% vs A-Frame ACC); Reduced site welding length on ducting (- 50% vs A-frame ACC); Fewer lifting operations; Shorter construction duration; Fewer man activities at height due to more preassembly which results in improved overall safety level; Less scaffolding required; Higher proportion of piping and piping supports preassembled in the manufacturing factory on the finned tube bundles; Important proportion of assembly on site is at ground level (bolting of delta, liaison duct, ...); No cleaning ladder required; and More containerized deliveries.

[0020] Specific examples of higher annual output of power plant include: Lower back-pressure during low ambient temperature periods (e.g., below 9 °C) which results in higher power plant output during low temperature periods; and lower minimum back-pressure (62 mbar vs 70 mbar for A-Frame ACC) which results in higher power plant electricity production on a yearly basis (+ 0.4 % vs A-Frame ACC). More particularly, the back-pressure may be reduced because the heat exchange tubes in the bundles (described herein) may be made shorter and more numerous in comparison to an A-Frame ACC. In this manner, the total surface area may be equivalent while the velocity in the tubes is reduced. It is yet another advantage that the reduced velocity results in a corresponding reduction in erosion of the tubing.

[0021] FIG. 1 is a top view of a heat exchange system 10 having an air cooled condenser module 12 in accordance with an embodiment of the present invention that is suitable for use with a heat generating facility such as a power plant 14. As shown in FIG. 1, the heat exchange system 10 includes an understructure 20 to support the other elements of the heat exchange system 10 such as a supply line 22, risers 24, headers 26, top manifold 28, coils or bundles 30, fan 32 and bell housing 34. In addition, a return line 36 is configured to return condensate to the power plant 14.

[0022] In use, the power plant 14 generates heat to create steam to drive turbines to generate power in a manner generally known to those skilled in the art. After steam has passed through the turbines, the steam still retains substantial waste heat which is removed by the heat exchange system 10 and the condensate is returned via the return line 36.

[0023] FIG. 2 is an elevation view of the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. As shown in FIG. 2, the understructure 20 occupies a relatively small area which results in great open space below the air cooled condenser module 12.

[0024] FIG. 3 is a sectional view of the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. As shown in FIG. 3, the supply line 22 is depicted reducing in size as it proceeds along the air cooled condenser module 12. In general, as the risers 24 channel steam from the supply line 22 to the top manifold 28 and bundles 30, the size of the supply line 22 is reduced accordingly.

[0025] FIG. 4 is a perspective view of the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. As shown in FIG. 4, the headers 26, top manifold 28 and bundles 30 as well as the fan 32 and bell housing have been removed for clarity to show the understructure 20. In the following FIGS. 5-16

an inventive sequence of construction for the air cooled condenser module 12 is illustrated in accordance to an embodiment.

[0026] At FIG. 5, a braced bay 50 is disposed a construction site for the air cooled condenser module 12 depicted in FIG. 1. The braced bay 50 is configured to support one of the air cooled condenser modules 12 on four feet 52. In typical construction, a foundation is disposed in the ground below each of the feet 52.

[0027] FIG. 6 is a perspective view of a duct 60, the risers 24, and a middle truss 62 for the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. As shown in FIG. 6, the risers 24 and duct 60 may be pre-assembled at a manufacturing facility and container shipped to the building site. Similarly, the middle truss 62 may be pre-assembled at a manufacturing facility and container shipped to the building site. This and other pre-assembly described herein facilitates a reduction in labor costs and improvement in quality of construction. For example, at the production facility, welders may be protected from rain and other elements that may otherwise reduce weld quality. However, in other embodiments, the risers 24 may be affixed to the duct 60 after placement on the understructure 20.

[0028] FIG. 7 is a perspective view of an assembled duct 60, risers 24, and middle truss 62 for the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. In an embodiment, the assembly may be performed on the ground at the building site or at the manufacturing facility. At FIG. 8, the assembled duct 60, risers 24, and middle truss 62 is shown disposed on the braced bay 50 for the air cooled condenser module 12 depicted in FIG. 1. For example, the assembled duct 60, risers 24, and middle truss 62 may be lifted by a crane and disposed on the braced bay 50.

[0029] At FIG. 9, a plurality of transversal structures 90 are disposed on the assembled duct 60, risers 24, and middle truss 62 disposed on the braced bay 50 for the air cooled condenser module 12 depicted in FIG. 1. For example, the transversal structures 90 may be welded or bolted to the braced bay 50 after being lifted by the crane.

[0030] FIG. 10 is a perspective view of a transversal truss 100 for the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. The transversal truss 100 may be pre-assembled at a manufacturing facility and container shipped to the building site. At FIG. 11, the transversal truss 100 is shown attached to the transversal structures 90 on the assembled duct 60, risers 24, and middle truss 62 disposed on the braced bay 50 for the air cooled condenser module 12 depicted in FIG. 1. For example, the transversal truss 100 may be welded or bolted to the transversal structures 90 after being lifted by the crane.

[0031] FIG. 12 is a perspective view of a longitudinal truss 120 for the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. The longitudinal truss 120 may be pre-assembled at a manufacturing facility and container shipped to the building site. At FIG. 13, the longitudinal truss 120 is shown attached to the transversal truss 100. For example, the longitudinal truss 120 may be welded or bolted to the transversal truss 100 after being lifted by the crane.

[0032] FIG. 14 is a perspective view of a bridge 140 for the air cooled condenser module 12 depicted in FIG. 1 in accordance with an embodiment of the present invention. At FIG. 15, the bridges 140 are connected to the transversal trusses 100 on the braced bay 50. For example, the bridges 140 may be welded or bolted to the transversal truss 100 after being lifted by the crane.

[0033] FIG. 16 is a perspective view of a partial placement of the headers 26 disposed on the risers 24. The headers 26 are shown connected to the top manifolds 28 which supply steam to the bundles 30. A delta 160 is an assembled set of top manifolds 28 and bundles 30.

[0034] Turning now to FIG. 17, the modular air cooled condenser module 12 is illustrated on a simplified understructure. The air cooled condenser module 12 generally includes a plenum 170, having an air current generator or fan disposed within a fan shroud or inlet bell 34 and the understructure 20 is shown in a simplified form for the sake of clarity. The air cooled condenser module 12 further includes multiple A-type geometry deltas, each designated 160. Each delta 160 comprises two tube bundle assemblies 30 with a series of finned tubes to conduct heat transfer. The deltas 160 will be discussed in further detail below.

[0035] Turning now to FIGS. 18 and 19, schematic side views of the air cooled condenser module 12 are depicted. As specifically illustrated in FIG. 18, the air cooled condenser employs risers 24 which are welded to the main steam duct 22. The risers 24 are connected to a steam manifold 28 which operates to keep the steam flow velocity more constant. This above described configuration is part the A-type condenser bundles 30 that are shipped as a unit from the factory, which will be discussed in further detail below. The condenser bundles 30 are preferably welded to the risers 24 via a transition piece 26 to accommodate the geometry of the steam manifold.

[0036] Turning now to FIG. 20, a delta 160 is illustrated. As depicted, each delta 160 is comprised of two individual heat exchange bundle assemblies 30, each having a series of finned tubes. The individual tubes are approximately two (2) meters in length whereas the bundle length is approximately twelve (12) meters. As illustrated, each bundle assembly 30 is positioned at an angle to one another to form the A-type configuration of the delta 160. While the bundle assemblies 30 may be positioned at any desired angle, they preferably are positioned at an angle approximately twenty degrees (20°) to approximately thirty degrees (30°) from vertical and approximately sixty degrees (60°) to approximately seventy

degrees (70°) from horizontal. More specifically, the bundle assemblies 30 are positioned at twenty-six degrees (26°) from vertical and sixty-four degrees (64°) from horizontal.

[0037] Each of the bundle assemblies 30 are assembled prior to shipping wherein each comprises a riser to header transition piece 202, steam manifold 204, finned tubes 206, and steam condensate headers 200. As can be seen in FIG. 17, due to the modular design and orientation of the bundle assemblies 30, the air cooled condenser design 10 has approximately five (5) times more tubes as compared to typical designs. Moreover, the embodiments of the current invention not only utilize five (5) times the tubes, but employ condenser tubes that are much shorter in length. As result of the aforementioned design and orientation, the steam velocity traveling through the tube bundles 30 is reduced as result of the increased number of tubes in combination with the reduced tube length, and therefore steam pressure drop within the deltas 160 is reduced, making the air cool condenser 10 more efficient.

[0038] Typically, turbine back pressure of an air cooled condenser or the like is limited by the maximum steam velocity in the tubes (to limit erosion) wherein the steam velocity is increasing with a decrease of back pressure (due to density of steam). Thus, due to the addition of tubes in accordance with the present invention, the steam is still maintained at the maximum allowable steam velocity but at a lower back pressure. The other limitation the current delta design addresses is that the pressure at the exit of the secondary bundles cannot be less than the vacuum group capability. This pressure typically results from turbine back pressure minus the pressure drop in ducting minus the pressure drop in the tubes. Accordingly, due to the reduced pressure drop in the tubes, the allowable turbine back pressure is lower with the delta 160 design.

[0039] Furthermore, the above-described bundle design also reduces the pressure drop within the individual delta 160. For example, the heat exchange that takes place via the deltas 160, is dependent upon the heat exchange coefficient, i.e., the mean temperature difference between air and steam and the exchange surface. Due to the reduced pressure drop as previously described, the mean pressure (average between inlet pressure and exit pressure) in the exchanger is higher with the design of the current condenser configuration 12. In other words, because steam is saturated, the mean steam temperature is also higher for the same heat exchange surface resulting in increased heat exchange.

[0040] Turning now to FIG. 21, a transport container, generally designated 210 is illustrated. As the name suggests, the transport container 210 is used to transport the bundles 30, from the factory to the job site. As illustrated, the condenser bundles 30, are manufactured and assembled at the factory with the respective steam manifold 204 and steam condensate headers 200. While five (5) bundles are illustrated positioned in the transport container, more or less individual bundles may be shipped per container depending as needed or required.

[0041] Alternatively, the above described embodiments of the present employ tube bundles manufactured and assembled, prior to shipping, having steam manifold 204 and steam condensate headers 200, alternative embodiment bundles may not include a manifold prior to shipping. More specifically, in such embodiments, the tube bundles may be ship without steam manifolds 28 attached thereto. In said embodiments, the tube bundles 30 may be assembled in field to form the A-type configuration, as discussed above. However, instead of employing two steam manifolds, this alternative embodiment may employ a single steam manifold wherein the single steam manifold extends along the "apex" of the A configuration.

[0042] Referring now to FIG. 22, a flow chart is illustrated, schematically depicting the steps of assembly of the air cooled condenser tower 12. As previously described, the individual tube bundles 30 are assembled prior to shipment to the job site, as referenced by numeral 212. Each individual bundle assembly 30 includes a plurality of finned tubes 206 along with a steam manifold 204 and steam condensate header 200. As previously discussed in connection with the previous figures of the specification, the bundle assemblies 30 are pre-manufactured at the factory prior to placing the individual bundle assemblies 30 in the shipping container 210 as identified by numeral 42. The shipping containers 210 are then shipped to the erection field site.

[0043] Next, the delta, generally indicated as 160, is assembled in the field as identified by numerals 216 and 218. As previously described, while the bundles may be positioned at any desired angle, they preferably are positioned at an angle (y) approximately twenty degrees (20°) to approximately thirty degrees (30°) from vertical and an angle (x) approximately sixty degrees (60°) to approximately seventy degrees (70°) from horizontal. More specifically, the bundles are positioned at twenty-six degrees (26°) from vertical and sixty-four degrees (64°) from horizontal. As designated by numeral 220, a single A-type delta is illustrated 160 formed by two bundle assemblies 30 to form the "A" configuration. The bundle assemblies 30 self support one another in this configuration.

[0044] Turning now to the air cooled condenser module 12 as referenced by the numeral 220, it is depicted employing five deltas 160. As discussed above, the air cooled condenser is an improvement over current air cooled condenser types and it has a high "prefabrication" level which equates to reduced installation cost and reduced installation time. Moreover, the above-described design reduces the pressure drop, thereby providing a more efficient heat exchange apparatus.

[0045] Tables 1 and 2 below show the number of parts utilized for a 32 module Multi-Delta and a 30 module A-Frame ACC designed for the same duty. There is a very dramatic decrease in pieces which translates in to substantially less construction labor and construction time.

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Table 1: Multidelta								
Type 1		Number	2		Type 4			
Understrucure	Columns	12		Type 4	Columns	2		
	Bracing	36			Bracing	6		
Plenum	Horizontal beams	8		Plenum	Horizontal beams	6		
	Other	26			Other	13		
	Middle truss	1			Middle truss	1		
	Transversal truss	4			Transversal truss	2		
	Longitudinal truss	2			Longitudinal truss	0.5		
	Octogonal structure	16			Octogonal structure	16		
	Fan deck plate	24			Fan deck plate	24		
	Bridge	4			Bridge	4		
		Horizontal wind bracing			4		Horizontal wind bracing	2
Wind wall longitudinal	Horizontal girder	2		Wind wall longitudinal	Horizontal girder	0		
Wind wall transversal	Horizontal girder	0		Wind wall transversal	Horizontal girder	0		
Sum of elements			278	Sum of elements			161	
Type 2		Number	2		Type 5			
Understrucure	Columns	12		Type 5	Columns	4		
	Bracing	36			Bracing	6		
	Horizontal beams	8			Horizontal beams	6		
	Other	26			Other	13		
Plenum	Middle truss	1		Plenum	Middle truss	1		
	Transversal truss	4			Transversal truss	2		
	Longitudinal truss	1			Longitudinal truss	2		
	Octogonal structure	16			Octogonal structure	16		
	Fan deck plate	24			Fan deck plate	24		
	Bridge	4			Bridge	4		
		Horizontal wind bracing			4		Horizontal wind bracing	2
Wind wall longitudinal	Horizontal girder	0		Wind wall longitudinal	Horizontal girder	2		
Wind wall transversal	Horizontal girder	0		Wind wall transversal	sheeting support	1.5		
Sum of elements			272	Sum of elements			342	
Type 3		Number	2		Type 6			
Understrucure	Columns	6		Type 6	Columns	4		
	Bracing	6			Bracing	6		
	Horizontal beams	6			Horizontal beams	6		
	Other	13			Other	13		
Plenum	Middle truss	1		Plenum	Middle truss	1		
	Transversal truss	2			Transversal truss	2		
	Longitudinal truss	2			Longitudinal truss	0.5		
	Octogonal structure	16			Octogonal structure	16		
	Fan deck plate	24			Fan deck plate	24		
	Bridge	4			Bridge	4		

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(continued)

Type 3	Number	2	Type 6	Number	4
	Horizontal wind bracing	2		Horizontal wind bracing	2
Wind wall longitudinal	Horizontal girder	2	Wind wall longitudinal	Horizontal girder	0
Wind wall transversal	Horizontal girder	0	Wind wall transversal	Horizontal girder	1.5
Sum of elements		168	Sum of elements		328
Bundle bottom girder					256
External transversal walkways (with grating)					320
Total assembly part for 32 modules multidelta					2125

20

Table 2: ACC

	Type 1	Number	1		Type 4	Number	2
	Understrucure	Columns	8		Understrucure	Columns	4
25		Bracing	24			Bracing	10
		Horizontal beams	4			Horizontal beams	3
		Support longitudinal wind wall	0			Support longitudinal wind wall	4
	Fan deck	Main beams	4		Fan deck	Main beams	3
30		Octogonal structure	16			Octogonal structure	16
	Bridge	Main truss	1		Bridge	Main truss	1
		Bridge foot	4			Bridge foot	4
		Handrails	4			Handrails	4
		Gratings	10			Gratings	10
35	A-frame	Columns	6		A-frame	Columns	6
		Top A	3			Top A	3
		Bracings	8			Bracings	8
		Top girder	2			Top girder	2
40		Mini a-frame	4			Mini a-frame	4
		Stick to middle of bridge	4			Stick to middle of bridge	4
		Hoist beam and support	4			Hoist beam and support	4
		Mid a-frame transversal	3			Mid a-frame transversal	3
		Mid a-frame longitudinal	4			Mid a-frame longitudinal	4
45		Stick to end of bridge	4			Stick to end of bridge	4
		Internal girder and door frame	16			Internal girder and door frame	16
		Angle for middle valley sheeting	4			Angle for middle valley sheeting	4
50	Wind wall longitudinal	Columns	0		Wind wall longitudinal	Columns	7
		Horizontal girder	0			Horizontal girder	30
		Bracings	0			Bracings	6
55		Link to SDM	0			Link to SDM	7
		Tranversal walkway	0			Tranversal walkway	1
		Diamond plate	0			Diamond plate	10

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(continued)

Table 2: ACC									
5	Type 1	Number	1		Type 4	Number	2		
	Wind wall transversal	Columns	0		Wind wall transversal	Columns	0		
		Girders	0			Girders	0		
	Cleaning system	Bottom rail	4		Cleaning system	Bottom rail	4		
		Top rail	4			Top rail	4		
Grating		10	Grating	0					
10	Sum of elements155			Sum of elements380					
15									
20	Type 2	Number	2		Type 5	Number	4		
	Understrucure	Columns	4		Understrucure	Columns	2		
		Bracing	10			Bracing	4		
		Horizontal beams	3			Horizontal beams	2		
		Support longitudinal wind wall	0			Support longitudinal wind wall	2		
	Fan deck	Main beams	3		Fan deck	Main beams	2		
		Octogonal structure	16			Octogonal structure	16		
	Bridge	Main truss	1		Bridge	Main truss	1		
		Bridge foot	4			Bridge foot	4		
		Handrails	4			Handrails	4		
	A-frame	Gratings	10		A-frame	Gratings	10		
		Columns	4			Columns	4		
		Top A	2			Top A	2		
		Bracings	0			Bracings	0		
		Top girder	2			Top girder	2		
		Mini a-frame	2			Mini a-frame	2		
		Stick to middle of bridge	4			Stick to middle of bridge	4		
		Hoist beam and support	4			Hoist beam and support	4		
		Mid a-frame tranversal	2			Mid a-frame tranversal	2		
		Mid a-frame longitudinal	4			Mid a-frame longitudinal	4		
		Stick to end of bridge	2			Stick to end of bridge	2		
		Internal girder and door frame	8			Internal girder and door frame	8		
		Angle for middle valley sheeting	4			Angle for middle valley sheeting	4		
		Wind wall longitudinal	Columns			0	Wind wall longitudinal	Columns	6
			Horizontal girder			0		Horizontal girder	30
	Bracings		0		Bracings	6			
	Link to SDM		0		Link to SDM	6			
	Longitudinal walkway		0		Longitudinal walkway	1			
		Diamond plate	0			Diamond plate	10		
		Wind wall transversal	Columns			0	Wind wall transversal	Columns	0
			Girders			0		Girders	0
55	Cleaning system	Bottom rail	4	Cleaning system	Bottom rail	4			

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(continued)

5	Type 2	Number	2	Type 5	Number	4	
		Top rail	4		Top rail	4	
		Grating	6		Grating	0	
	Sum of elements214			Sum of elements608			
10	Type 3	Number	2	Type 6	Number	4	
	Understrucure	Columns	4		Understrucure	Columns	2
		Bracing	10			Bracing	4
15		Horizontal beams	3		Horizontal beams	2	
		Support longitudinal wind wall	0		Support longitudinal wind wall	2	
	Fan deck	Main beams	3	Fan deck	Main beams	2	
20		Octogonal structure	16		Octogonal structure	16	
	Bridge	Main truss	1	Bridge	Main truss	1	
		Bridge foot	4		Bridge foot	4	
25		Handrails	4		Handrails	4	
		Gratings	10		Gratings	10	
	A-frame	Columns	4	A-frame	Columns	4	
30		Top A	2		Top A	2	
		Bracings	0		Bracings	0	
		Top girder	2		Top girder	2	
35		Mini a-frame	2		Mini a-frame	2	
		Stick to middle of bridge	4		Stick to middle of bridge	4	
		Hoist beam and support	4		Hoist beam and support	4	
40		Mid a-frame transversal	2		Mid a-frame transversal	2	
		Mid a-frame longitudinal	4		Mid a-frame longitudinal	4	
		Stick to end of bridge	2		Stick to end of bridge	2	
45		Internal girder and door frame	3		Internal girder and door frame	3	
		Angle for middle valley sheeting	4		Angle for middle valley sheeting	4	
	Wind wall longitudinal	Columns	0	Wind wall longitudinal	Columns	6	
50		Horizontal girder	0		Horizontal girder	30	
		Bracings	0		Bracings	14	
		Link to SDM	0		Link to SDM	5	
55		Longitudinal walkway	0		Longitudinal walkway	1	
		Diamond plate	0		Diamond plate	10	
	Wind wall transversal	Columns	4	Wind wall transversal	Columns	3	
		Girders	20		Girders	17.5	
	Cleaning system	Bottom rail	4	Cleaning system	Bottom rail	4	
		Top rail	4		Top rail	4	
		Grating	6		Grating	0	
	Sum of elements252			Sum of elements698			

(continued)

Type 3	Number	2	Type 6	Number	4
Top Platform					21
Cleaning ladder					6
External transversal walkways (with grating)					240
Total assembly part for 30 modules ACC (2 units of 15 modules)					5148

[0046] As shown in Tables 1 and 2, the multidelta ACC of an embodiment disclosed herein includes less than half the parts of a comparable conventional A-Frame ACC (2125 parts versus 5148 parts). This reduction in part numbers has a corresponding reduction in labor costs, construction time, and the like.

[0047] The many features and advantages of the invention are apparent from the detailed specification, and, thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, for example a forced draft air cooled condenser has been illustrated but an induced draft design can be adapted to gain the same benefits and, accordingly, all suitable modifications and equivalents may be resorted to that fall within the scope of the invention as described by the appended claims.

Claims

1. A method for assembling an understructure (20) for a modular air cooled condenser (12) extending along a vertical axis away from horizontal, comprising the method steps of:

preparing a foundation for a braced bay (50); placing the braced bay (50) on the foundation;
 assembling a pre-constructed middle truss (62) with a pre-constructed duct (60) and risers;
 placing the assembled middle truss (62) and duct (60) on the braced bay (50);
 affixing a plurality of pre-constructed transversal structures (90) to the braced bay (50);
 affixing a plurality of pre-constructed transversal trusses (100) to the affixed transversal structures (90);
 affixing a plurality of pre-constructed longitudinal trusses (120) to ends of the (100) affixed transversal trusses (100); and
 affixing a plurality of pre-constructed bridges (140) between ones of the affixed transversal trusses (100).

2. The method according to claim 1, further comprising the method step of:

affixing a header (26) to each respective riser (24).

3. The method according to claim 2, further comprising the method step of:

affixing a top manifold (28) to each respective header (26).

4. The method according to claim 3, further comprising the method step of:

affixing four of the top manifolds (28) to each respective header (26).

5. The method according to claim 4, further comprising the method step of:

affixing a bundle (30) to each respective top manifold (28).

6. The method according to claim 1, further comprising the method step of:

fluidly connecting a return line (36) to each bundle (30).

7. The method according to claim 6, further comprising the method step of:

fluidly connecting the return line (36) to a power plant (14).

8. The method according to claim 1, further comprising the method step of:

fluidly connecting a main steam line (22) to the duct (60).

9. The method according to claim 8, further comprising the method step of:

fluidly connecting the main steam line (22) to a power plant (14).

10. The method according to claim 1, further comprising the method step of:

affixing a bell housing (34) and a fan (32) to the understructure.

11. A modular understructure (20) for an air cooled condenser (12) extending along a vertical axis away from horizontal, comprising:

a braced bay (50) disposed on a foundation;

an assembled pre-constructed middle truss (62) with a pre-constructed duct (60) and risers (24) disposed on the braced bay (50);

a plurality of pre-constructed transversal structures (90) affixed to the braced bay (50);

a plurality of pre-constructed transversal trusses (100) affixed to the affixed transversal structures (90);

a plurality of pre-constructed longitudinal trusses (120) affixed to ends of the transversal trusses (100); and

a plurality of pre-constructed bridges (140) affixed between ones of the transversal trusses (100).

12. The modular understructure according to claim 11, further comprising:

a header (26) affixed to each respective riser (24).

13. The modular understructure according to claim 12, further comprising:

a top manifold (28) affixed to each respective header (26).

14. The modular understructure according to claim 13, further comprising:

four of the top manifolds (28) affixed to each respective header (26).

15. The modular understructure according to claim 14, further comprising:

a bundle (30) affixed to each respective top manifold (28).

Patentansprüche

1. Verfahren zum Zusammenbau einer Unterstruktur (20) für einen modularen luftgekühlten Kondensator, der sich entlang einer vertikalen Achse weg von der Horizontalen erstreckt, umfassend die Verfahrensschritte:

- Vorbereiten eines Fundaments für ein abgestrebtes Gestell (50);

- Platzieren des abgestrehten Gestells (50) auf dem Fundament;

- Montieren eines vorgefertigten mittleren Gitterträgers (62) mit einer vorgefertigten Leitung (60) und Steigleitungen;

- Platzieren des montierten mittleren Gitterträgers (62) und der Leitung (60) auf das abgestrebte Gestell (50);

- Befestigen einer Vielzahl von vorgefertigten transversalen Strukturen (90) an dem abgestrehten Gestell (50);

- Befestigen einer Vielzahl von vorgefertigten transversalen Gitterträgern (100) an den befestigten transversalen Strukturen (90);

- Befestigen einer Vielzahl von vorgefertigten länglichen Gitterträgern (120) an Enden der befestigten transversalen Gitterträger (100); und

- Befestigen einer Vielzahl von vorgefertigten Brücken (140) zwischen denen der befestigten transversalen

Gitterträger (100).

2. Verfahren gemäß Anspruch 1, weiterhin umfassend den Verfahrensschritt:

- Befestigen eines Verteilerkopfes (26) an jeder jeweiligen Steigleitung (24).

3. Verfahren gemäß Anspruch 2, weiterhin umfassend den Verfahrensschritt:

- Befestigen eines oberen Sammelrohrs (28) an jedem jeweiligen Verteilerkopf (26).

4. Verfahren gemäß Anspruch 3, weiterhin umfassend den Verfahrensschritt:

- Befestigen von vier der oberen Sammelleitungen (28) an jedem jeweiligen Verteilerkopf (26).

5. Verfahren gemäß Anspruch 4, weiterhin umfassend den Verfahrensschritt:

- Befestigen eines Bündels (30) an jeder jeweiligen oberen Sammelleitung (28).

6. Verfahren gemäß Anspruch 1, weiterhin umfassend den Verfahrensschritt:

- flüssiges Anschließen einer Rücklaufleitung (36) an jedes Bündel (30).

7. Verfahren gemäß Anspruch 6, weiterhin umfassend den Verfahrensschritt:

- flüssiges Anschließen der Rücklaufleitung (36) an ein Kraftwerk (14).

8. Verfahren gemäß Anspruch 1, weiterhin umfassend den Verfahrensschritt:

- flüssiges Anschließen einer Hauptdampfleitung (22) an die Leitung (60).

9. Verfahren gemäß Anspruch 8, weiterhin umfassend den Verfahrensschritt:

- flüssiges Anschließen der Hauptdampfleitung (22) an ein Kraftwerk (14).

10. Verfahren gemäß Anspruch 1, weiterhin umfassend den Verfahrensschritt:

- Befestigen eines Glockengehäuses (34) und eines Gebläses (32) an der Unterstruktur.

11. Modulare Unterstruktur (20) für einen luftgekühlten Kondensator (12), der sich entlang einer vertikalen Achse von der Horizontalen weg erstreckt, umfassend:

- ein abgestrebtes Gestell (50), das auf einem Fundament angeordnet ist;

- einen montierten, vorgefertigten, mittleren Gitterträger (62) mit einer vorgefertigten Leitung (60) und Steigleitungen (24), die auf dem abgestrehten Gestell (50) angeordnet sind;

- eine Vielzahl von vorgefertigten, transversalen Strukturen (90), die an dem abgestrehten Gestell (50) befestigt sind;

- eine Vielzahl von vorgefertigten, transversalen Gitterträgern (100), die an den befestigten transversalen Strukturen (90) befestigt sind;

- eine Vielzahl von vorgefertigten, länglichen Gitterträgern (120), die an den Enden der transversalen Gitterträger (100) befestigt sind; und

- eine Vielzahl von vorgefertigten Brücken (140), die zwischen denen der transversalen Gitterträger (100) befestigt sind.

12. Modulare Unterstruktur gemäß Anspruch 11, weiterhin umfassend:

- einen Verteilerkopf (26), der an jeder jeweiligen Steigleitung (24) befestigt ist.

13. Modulare Unterstruktur gemäß Anspruch 12, weiterhin umfassend:

- eine obere Sammelleitung (28), die an jedem jeweiligen Verteilerkopf (26) befestigt ist.

14. Modulare Unterstruktur gemäß Anspruch 13, weiterhin umfassend:

- vier der oberen Sammelleitungen (28), die an jedem jeweiligen Verteilerkopf (26) befestigt sind.

15. Modulare Unterstruktur gemäß Anspruch 14, weiterhin umfassend:

- ein Bündel (30), das an jeder jeweiligen oberen Sammelleitung (28) befestigt ist.

Revendications

1. Procédé pour assembler une sous-structure (20) pour un condenseur modulaire refroidi par air (12) s'étendant le long d'un axe vertical à distance de l'horizontale, comprenant les étapes de procédé suivantes:

préparer une fondation pour une baie renforcée (50);

placer la baie renforcée (50) sur la fondation;

assembler une armature intermédiaire préconstruite (62) avec un conduit (60) et des colonnes montantes préconstruits;

placer l'armature intermédiaire (62) et le conduit (60) assemblés sur la baie renforcée (50);

fixer une pluralité de structures transversales préconstruites (90) à la baie renforcée (50);

fixer une pluralité d'armatures transversales préconstruites (100) aux structures transversales fixées (90);

fixer une pluralité d'armatures longitudinales préconstruites (120) à des extrémités des armatures transversales fixées (100); et

fixer une pluralité de ponts préconstruits (140) entre certaines des armatures transversales fixées (100).

2. Procédé selon la revendication 1, comprenant en outre l'étape de procédé consistant à fixer une tête (26) à chaque colonne montante respective (24).

3. Procédé selon la revendication 2, comprenant en outre l'étape de procédé consistant à fixer un collecteur supérieur (28) à chaque tête respective (26).

4. Procédé selon la revendication 3, comprenant en outre l'étape de procédé consistant à fixer quatre des collecteurs supérieurs (28) à chaque tête respective (26).

5. Procédé selon la revendication 4, comprenant en outre l'étape de procédé consistant à fixer un faisceau (30) à chaque collecteur supérieur respectif (28).

6. Procédé selon la revendication 1, comprenant en outre l'étape de procédé consistant à connecter de façon fluide une ligne de retour (26) à chaque faisceau (30).

7. Procédé selon la revendication 6, comprenant en outre l'étape de procédé consistant à connecter de façon fluide la ligne de retour (36) à une centrale électrique (14).

8. Procédé selon la revendication 1, comprenant en outre l'étape de procédé consistant à connecter de façon fluide une ligne de vapeur principale (22) au conduit (60).

9. Procédé selon la revendication 8, comprenant en outre l'étape de procédé consistant à connecter de façon fluide la ligne de vapeur principale (22) à une centrale électrique (14).

10. Procédé selon la revendication 1, comprenant en outre l'étape de procédé consistant à fixer un boîtier en cloche (34) et un ventilateur (32) à la sous-structure.

11. Sous-structure modulaire (20) pour un condenseur refroidi par air (12) s'étendant le long d'un axe vertical à distance de l'horizontale, comprenant:

une baie renforcée (50) disposée sur une fondation;

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une armature intermédiaire préconstruite assemblée (62) avec un conduit (60) et des colonnes montantes (24) préconstruits disposés sur la baie renforcée (50);
une pluralité de structures transversales préconstruites (90) fixées à la baie renforcée (50);
une pluralité d'armatures transversales préconstruites (100) fixées aux structures transversales fixées (90);
une pluralité d'armatures longitudinales préconstruites (120) fixées à des extrémités des armatures transversales (100); et
une pluralité de ponts préconstruits (140) fixés entre certaines des armatures transversales (100).

12. Sous-structure modulaire selon la revendication 11, comprenant en outre une tête (26) fixée à chaque colonne montante respective (24).

13. Sous-structure modulaire selon la revendication 12, comprenant en outre un collecteur supérieur (28) fixé à chaque tête respective (26).

14. Sous-structure modulaire selon la revendication 13, comprenant en outre quatre des collecteurs supérieurs (28) fixés à chaque tête respective (26).

15. Sous-structure modulaire selon la revendication 14, comprenant en outre un faisceau (30) fixé à chaque collecteur supérieur respectif (28).

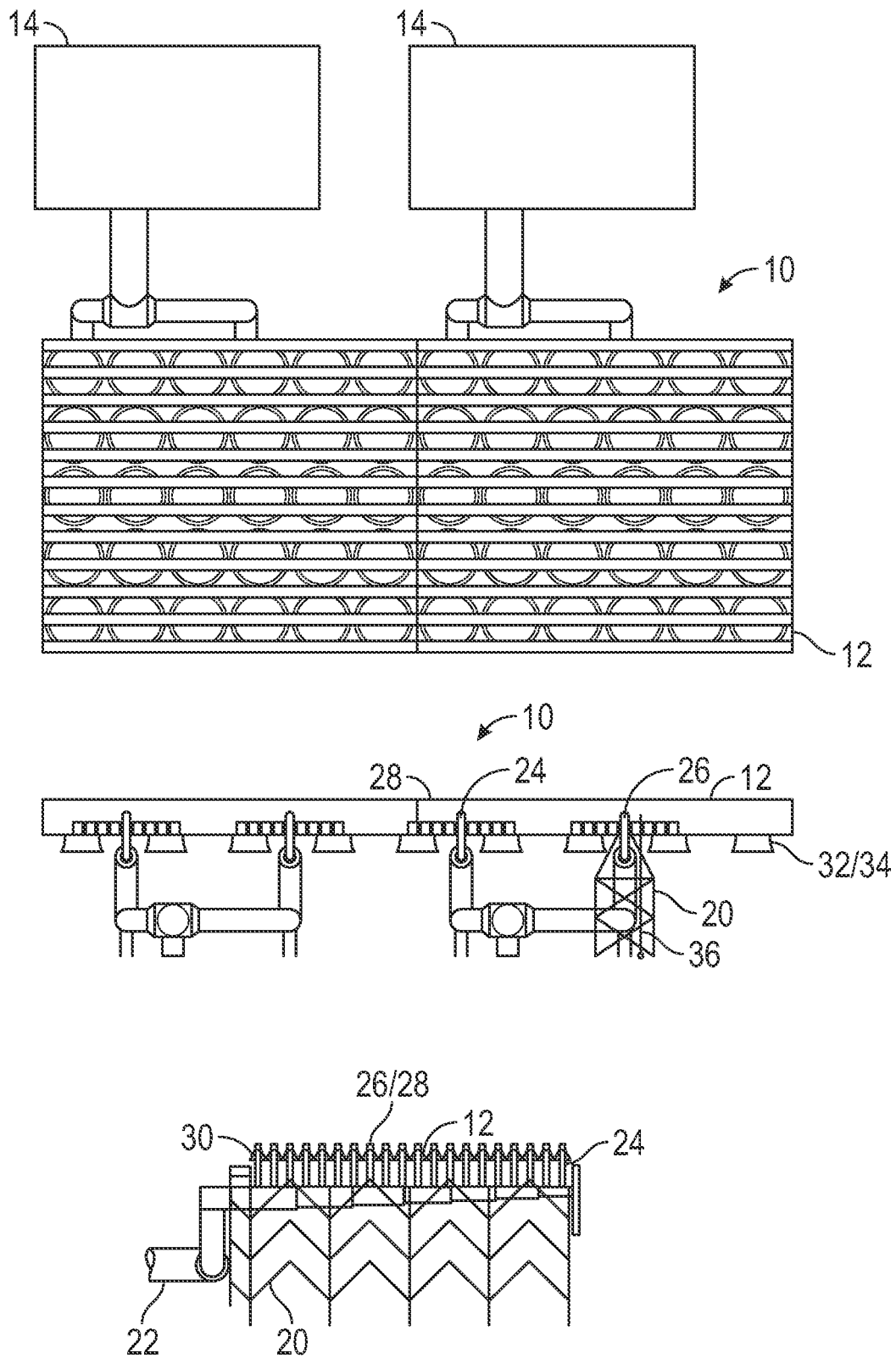


FIG. 1

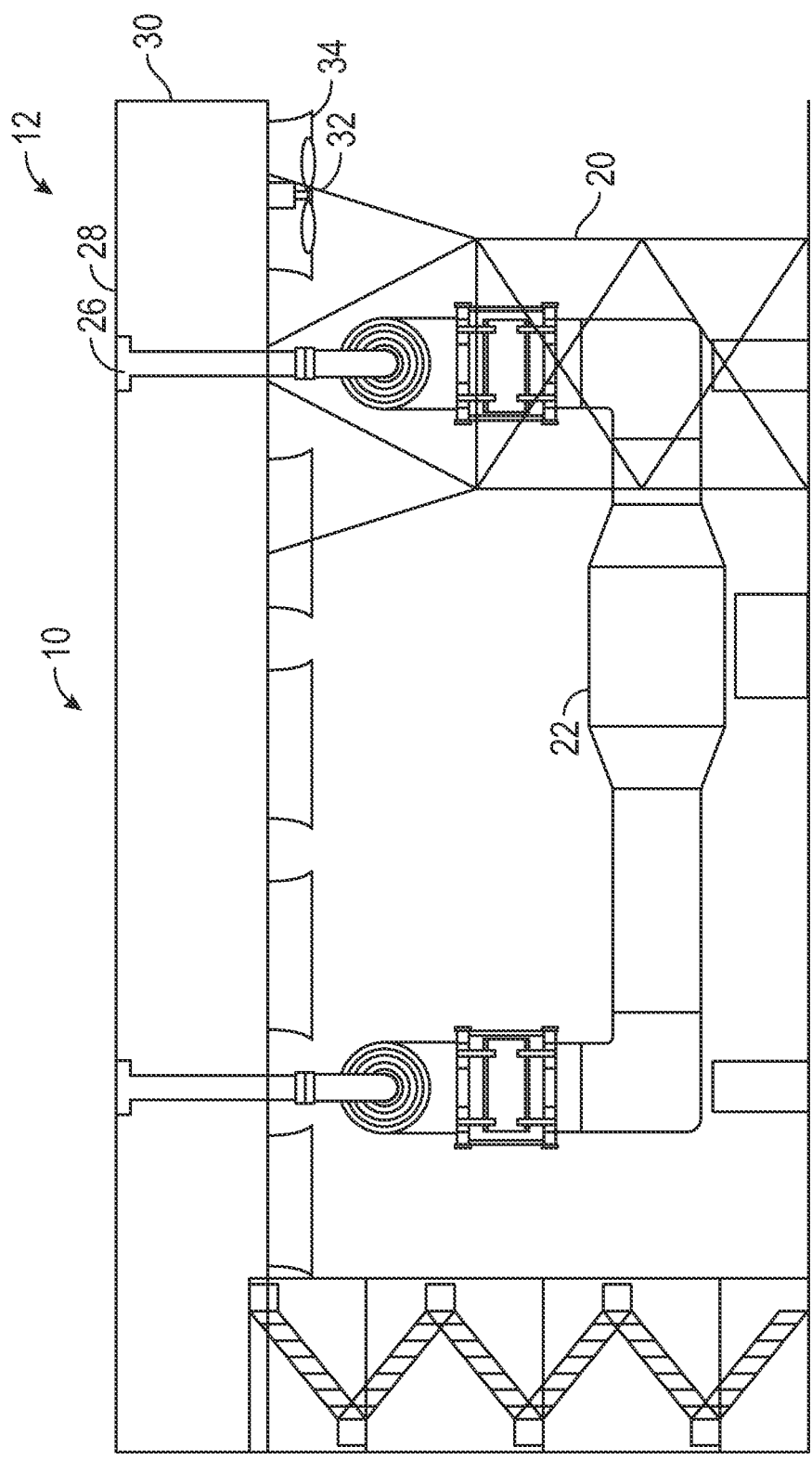


FIG. 2

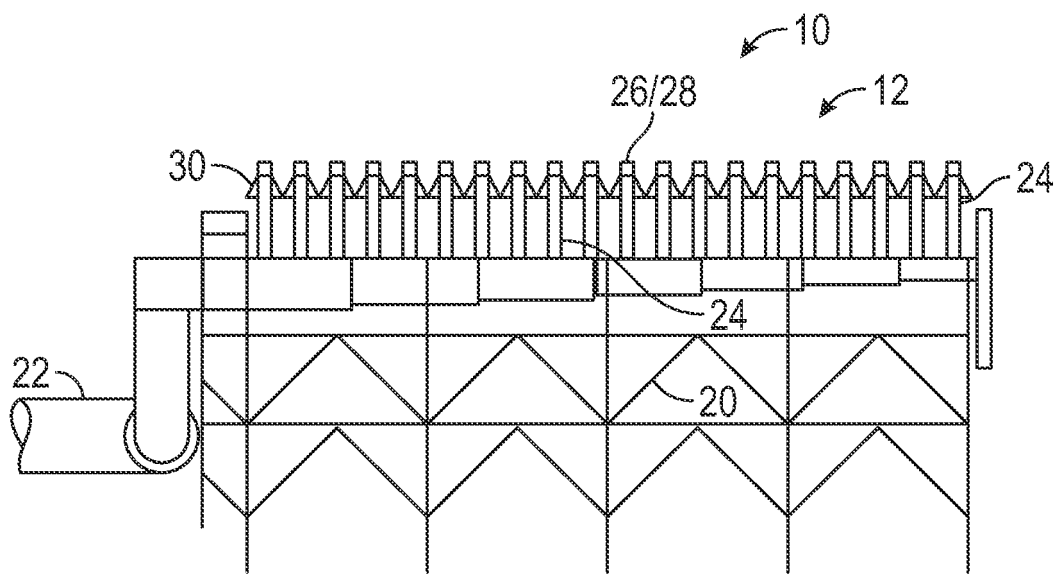


FIG. 3

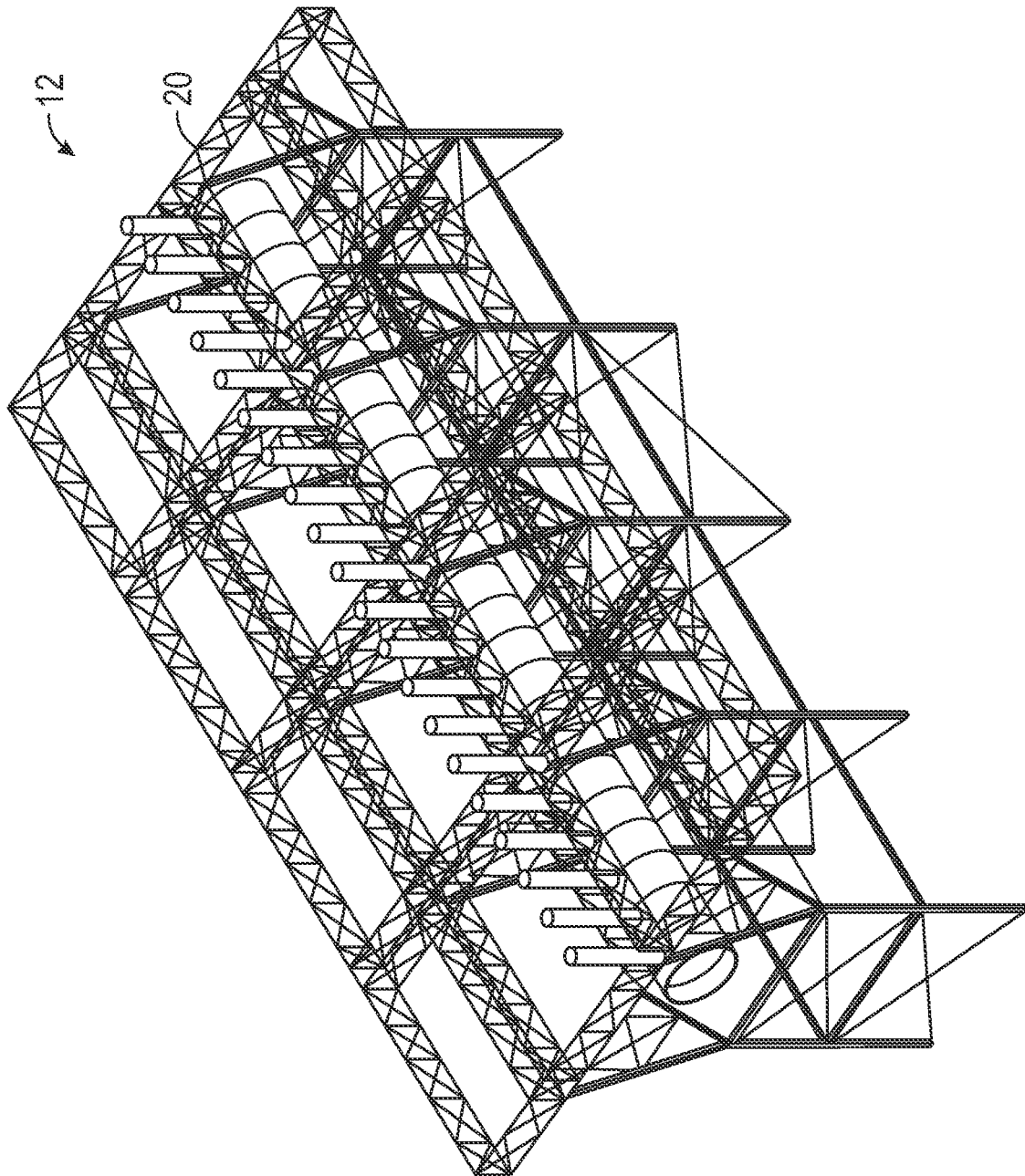


FIG. 4

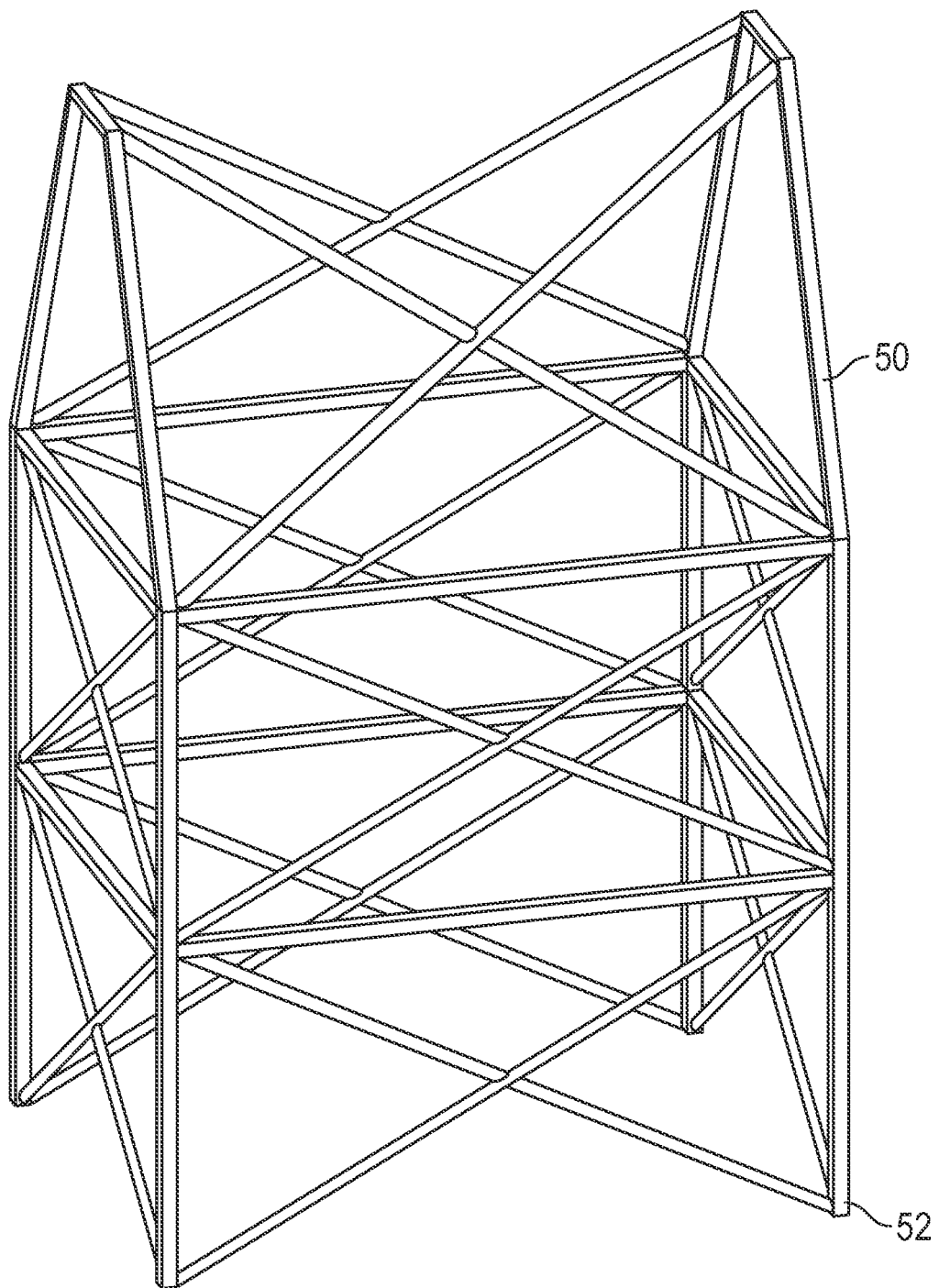


FIG. 5

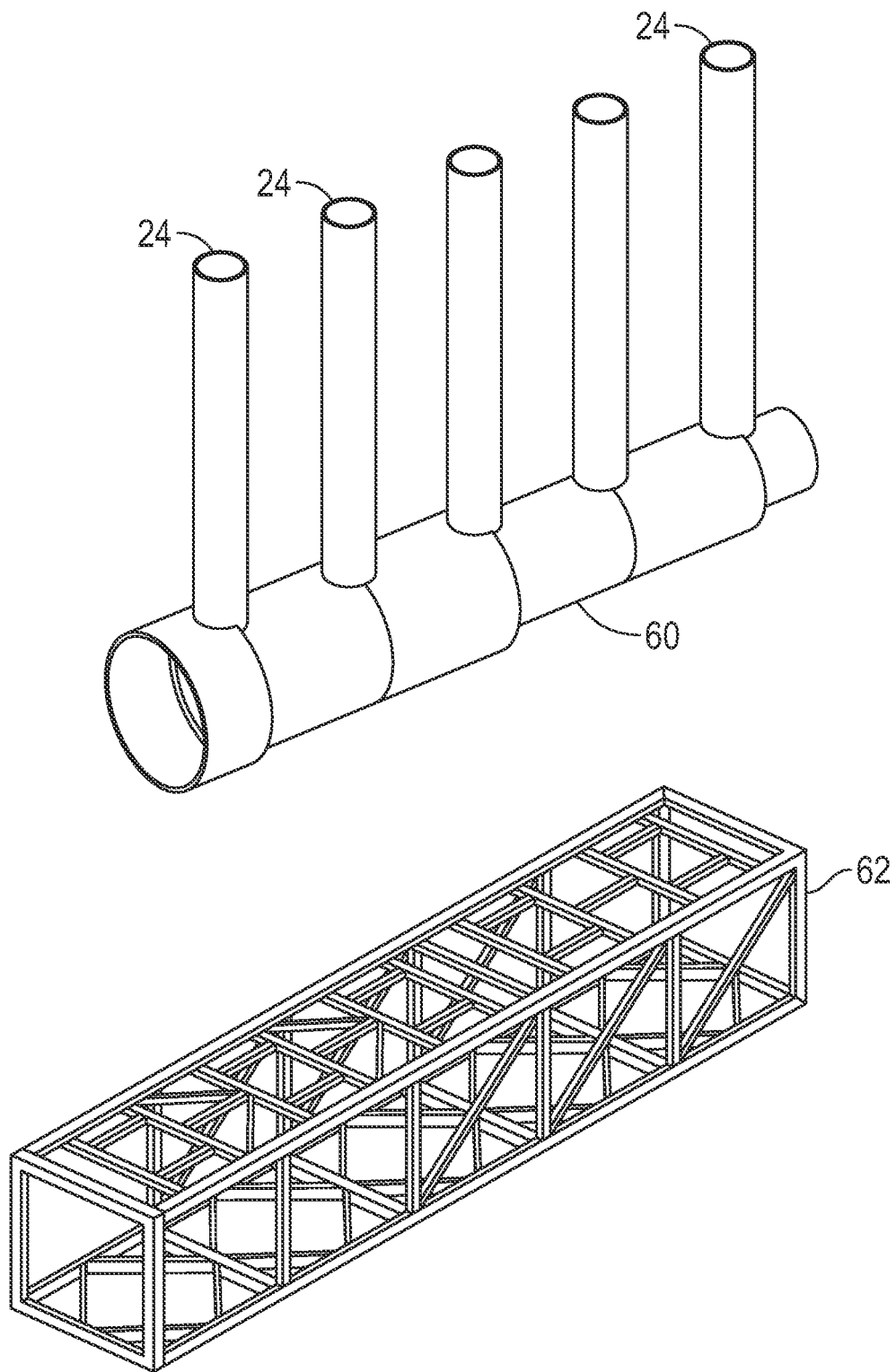


FIG. 6

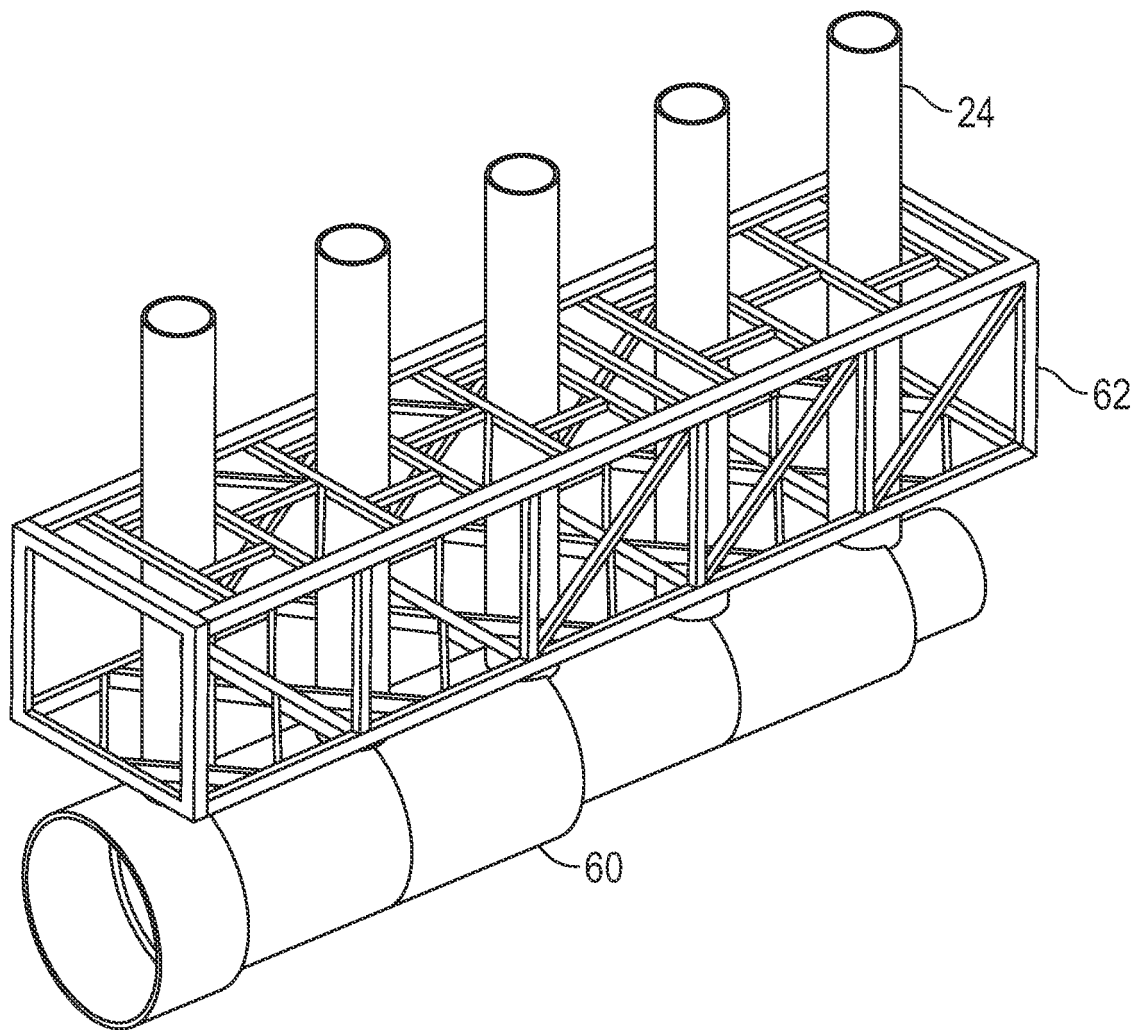


FIG. 7

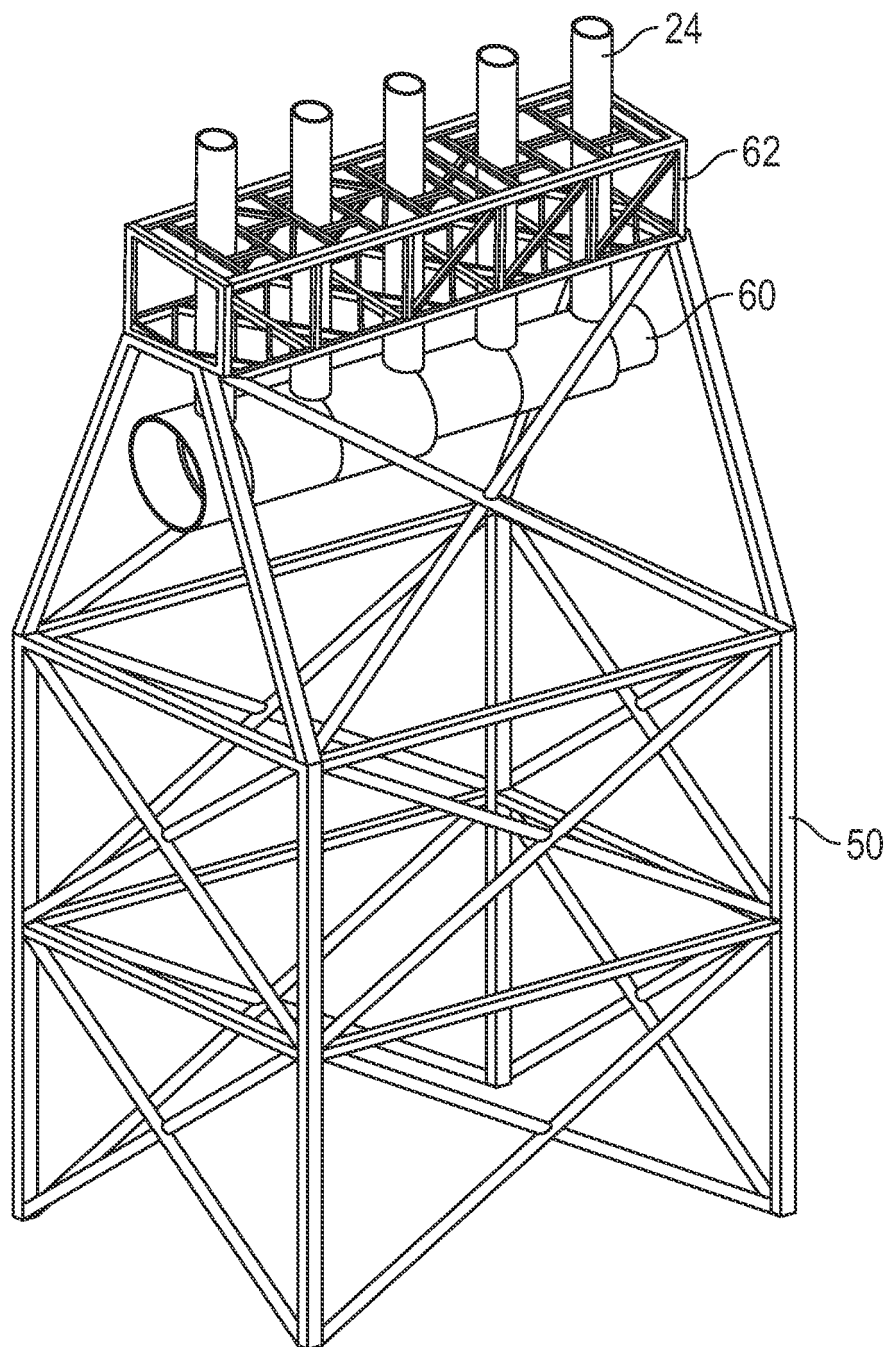


FIG. 8

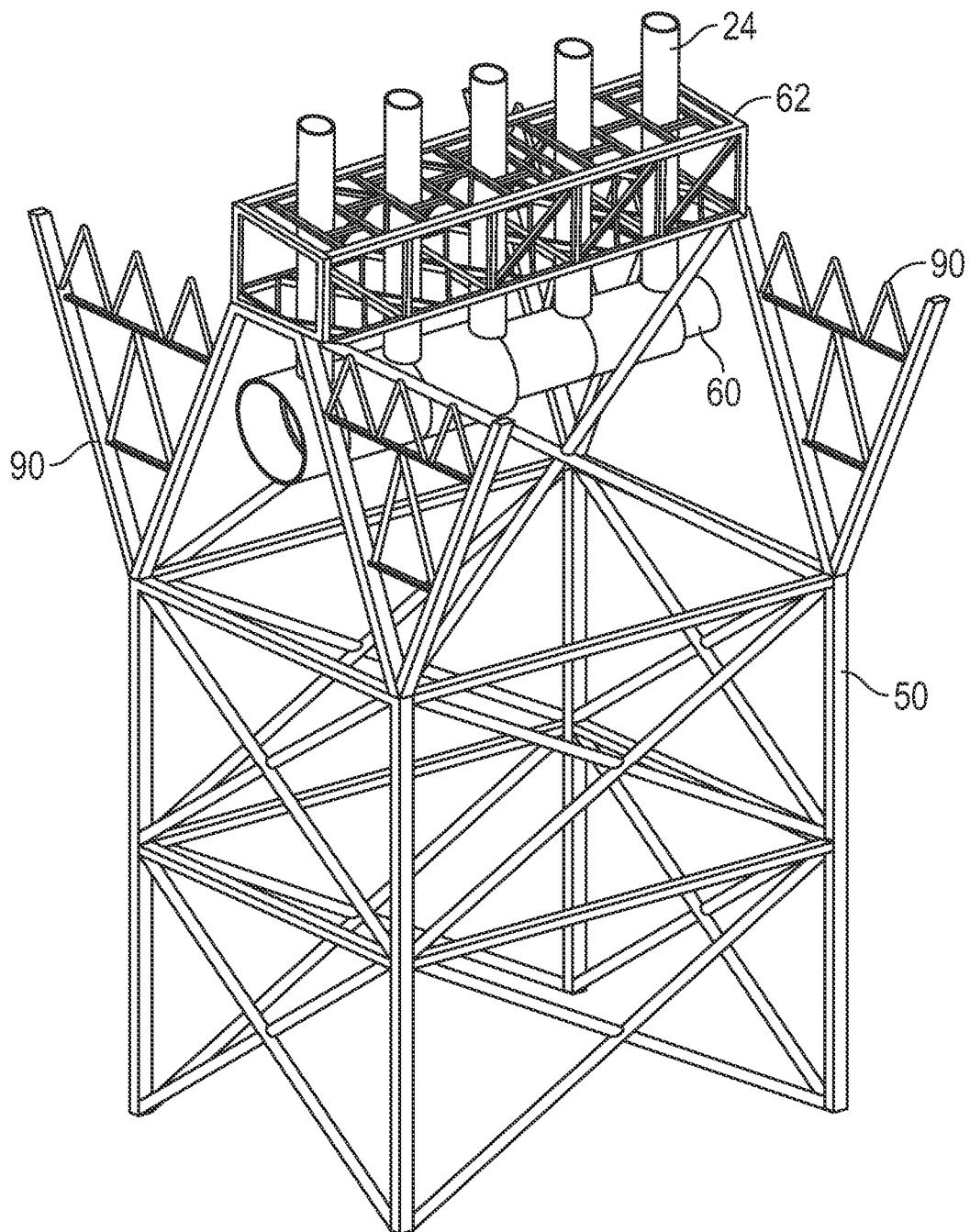


FIG. 9

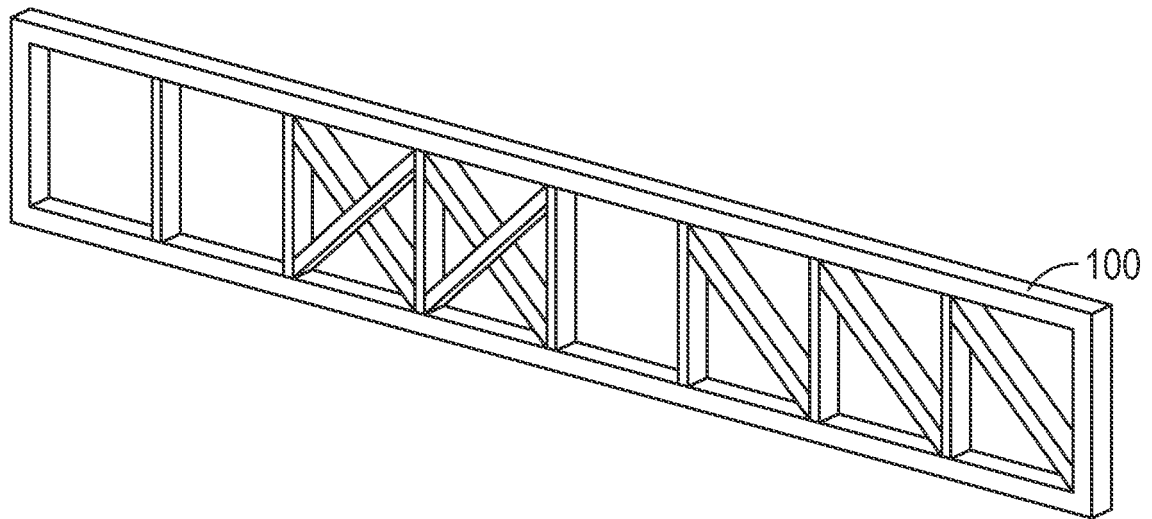


FIG. 10

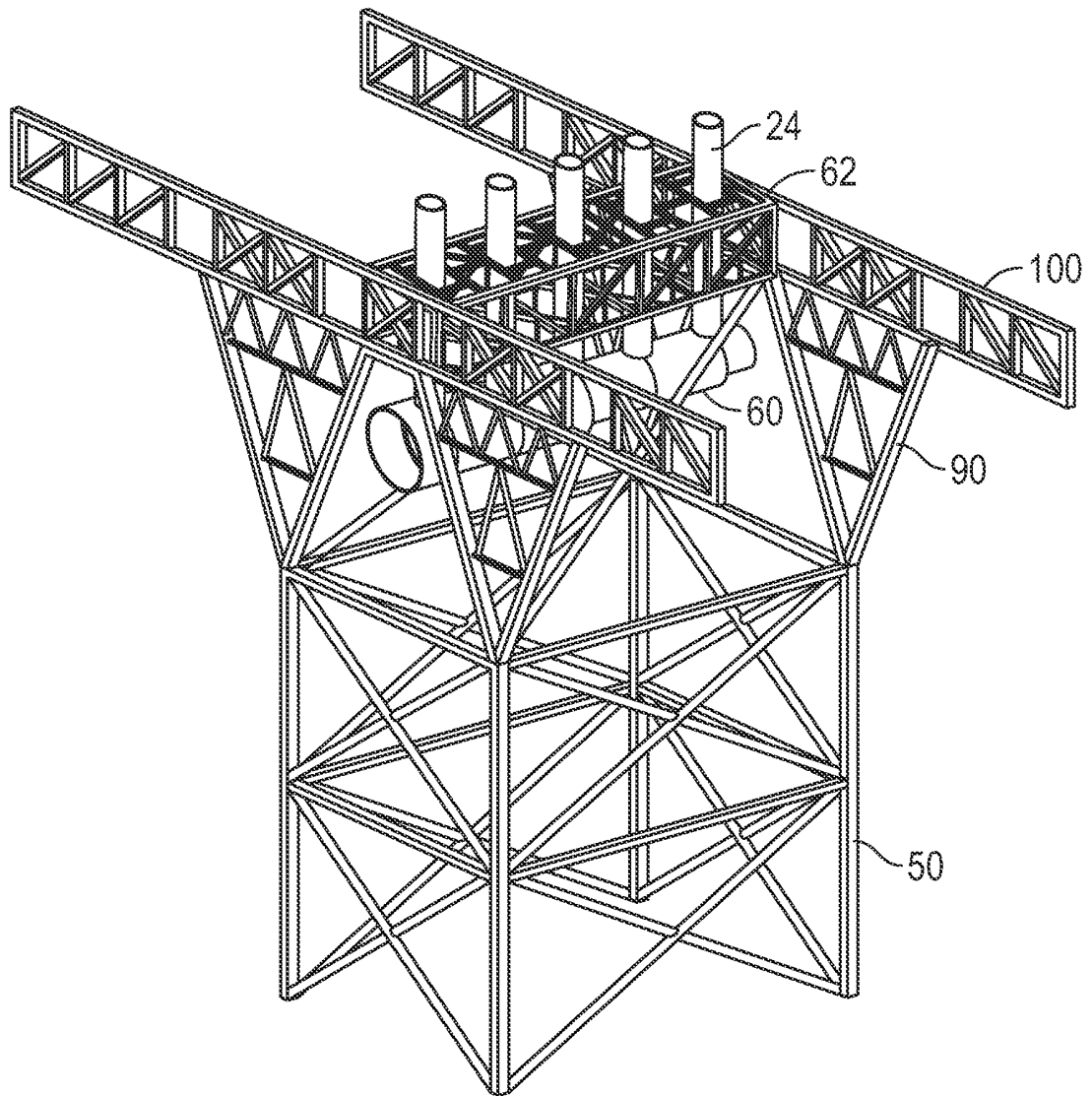


FIG. 11

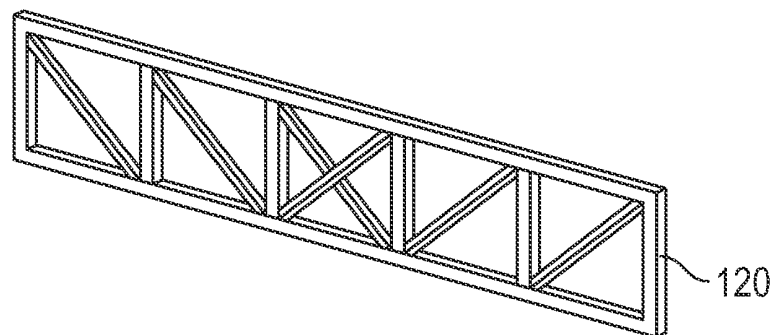


FIG. 12

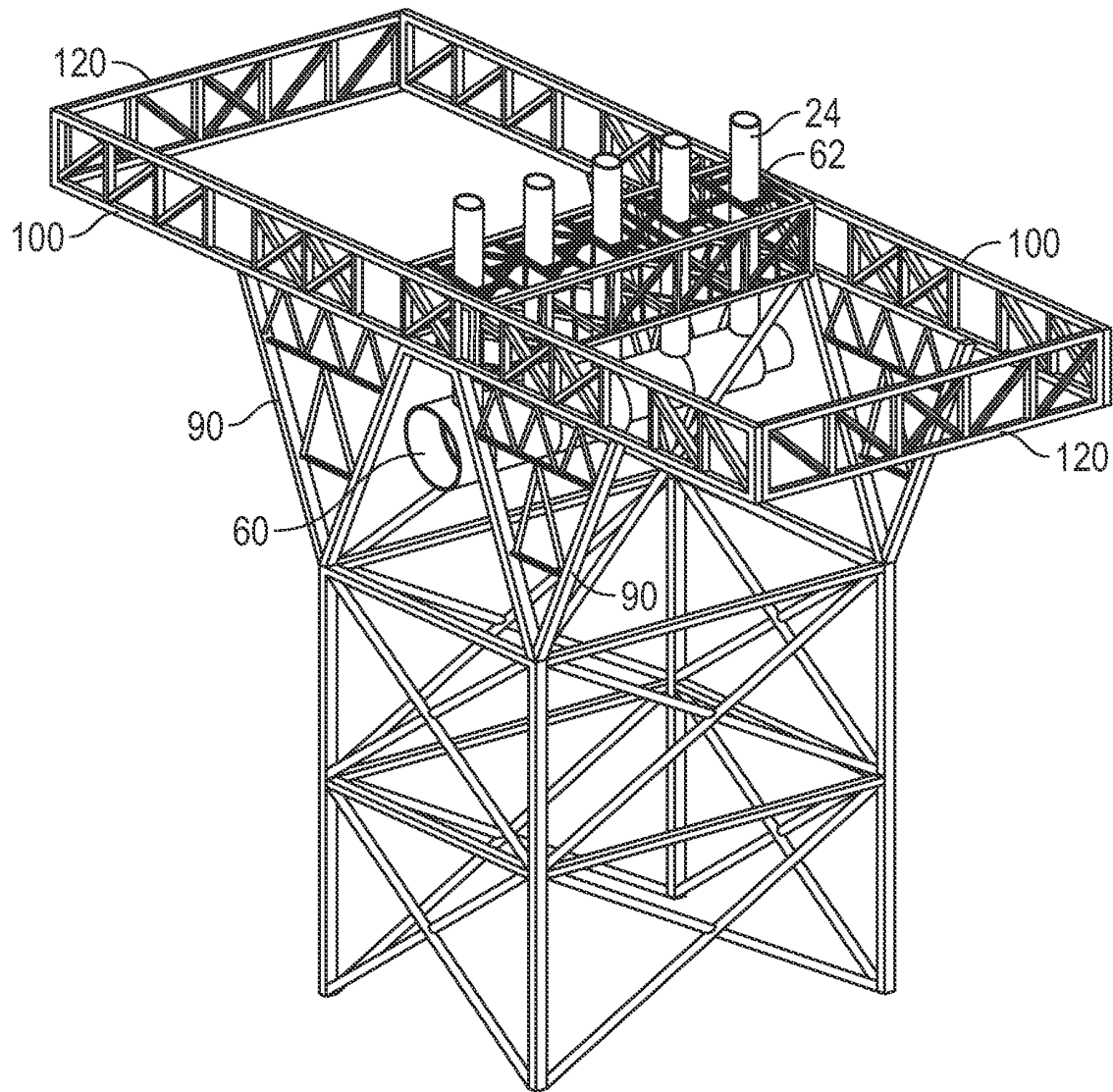


FIG. 13

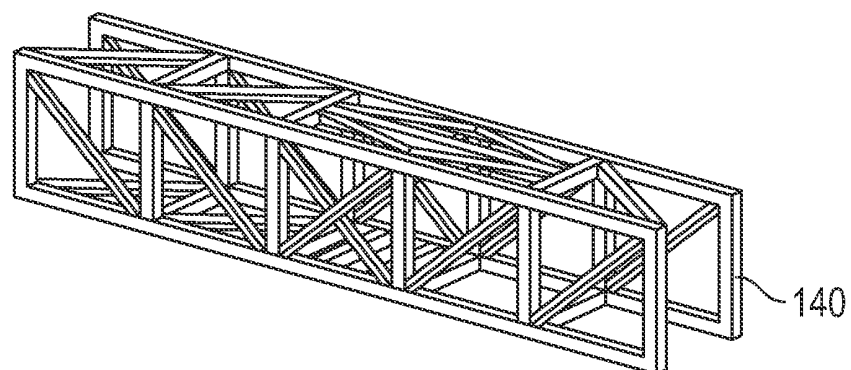


FIG. 14

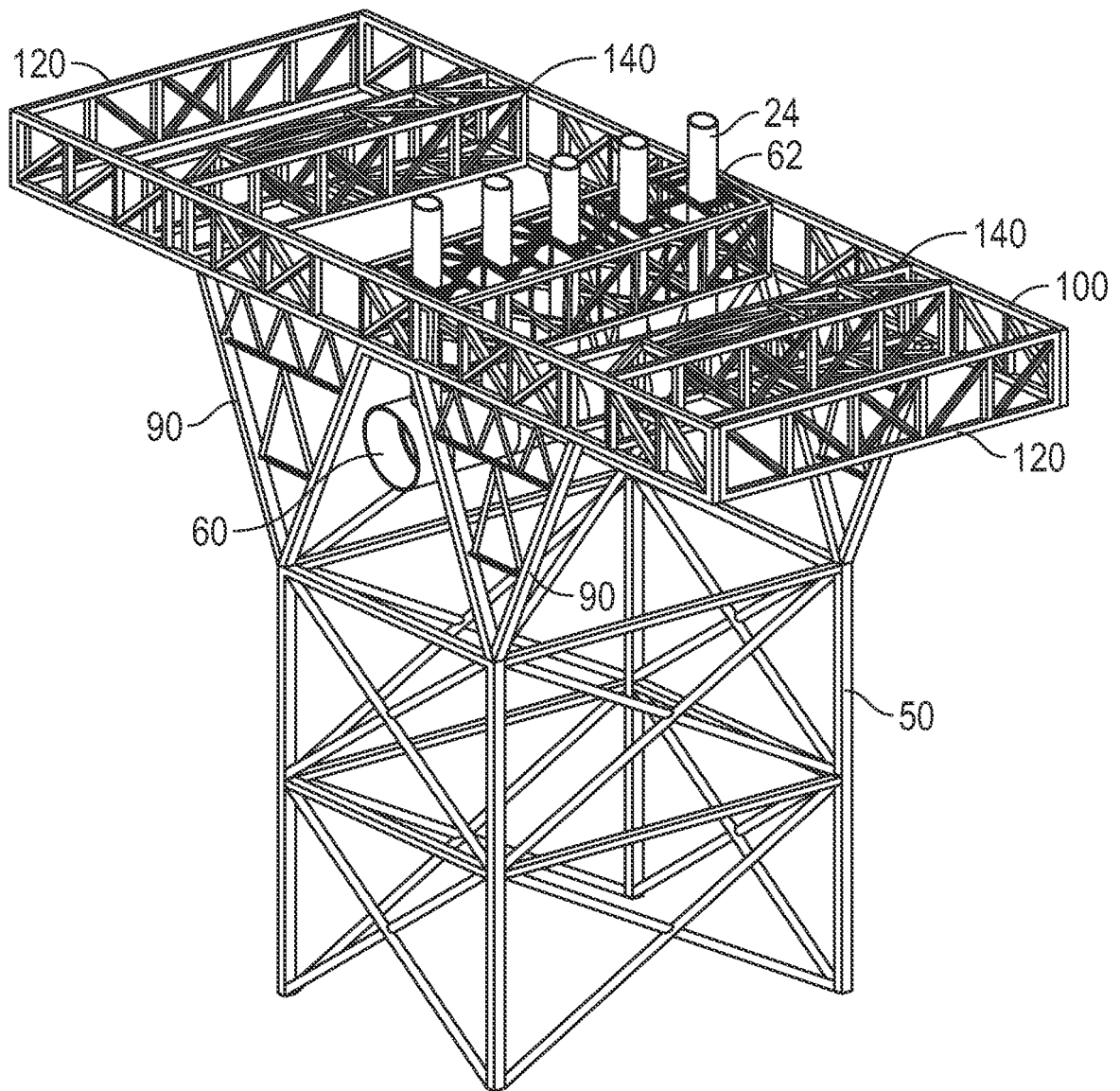


FIG. 15

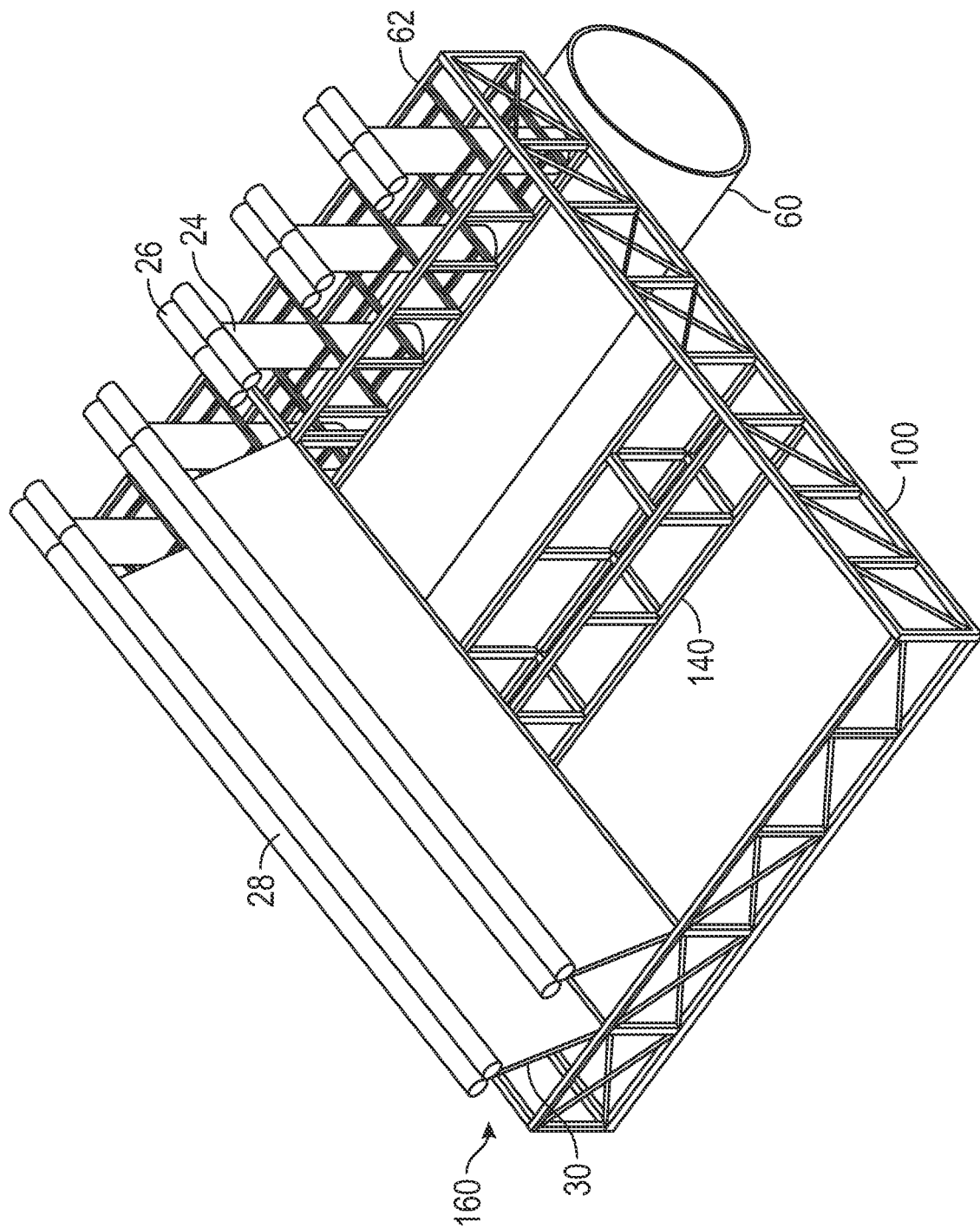


FIG. 16

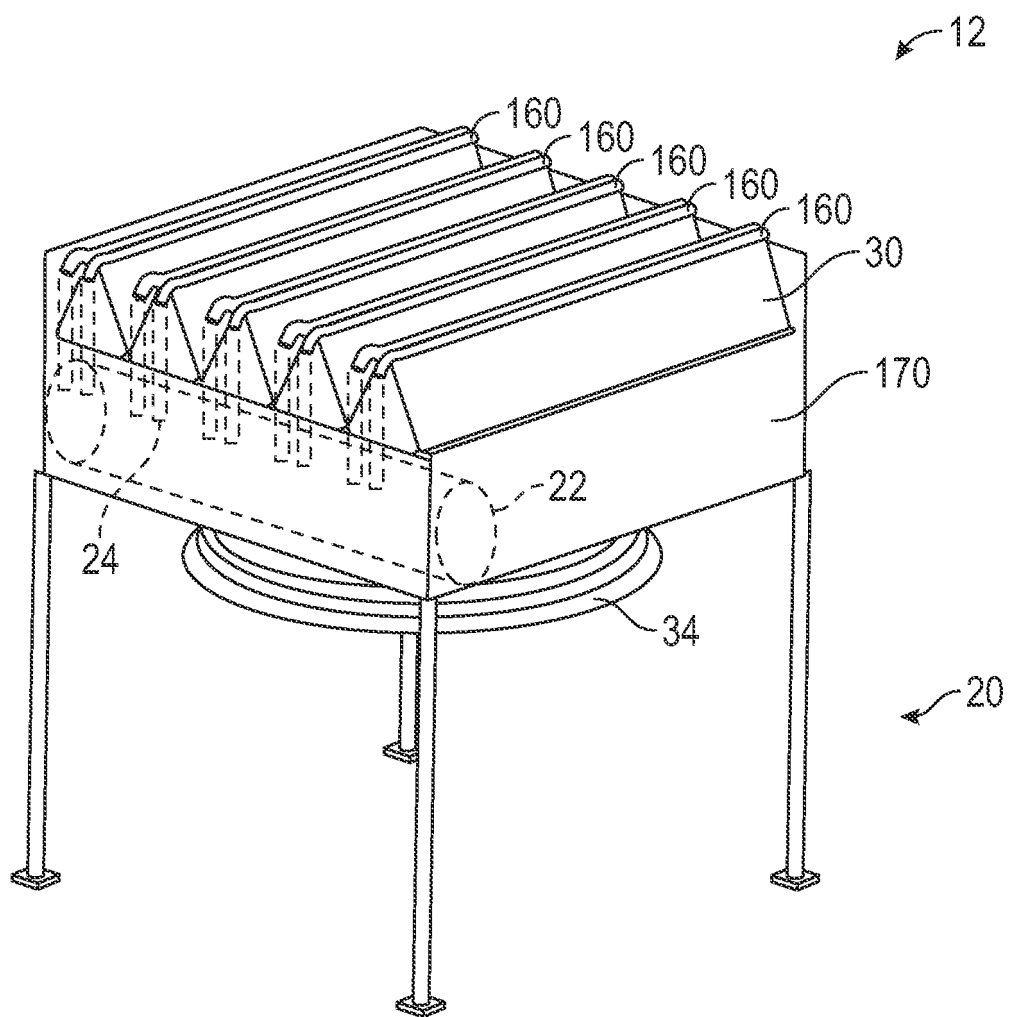


FIG. 17

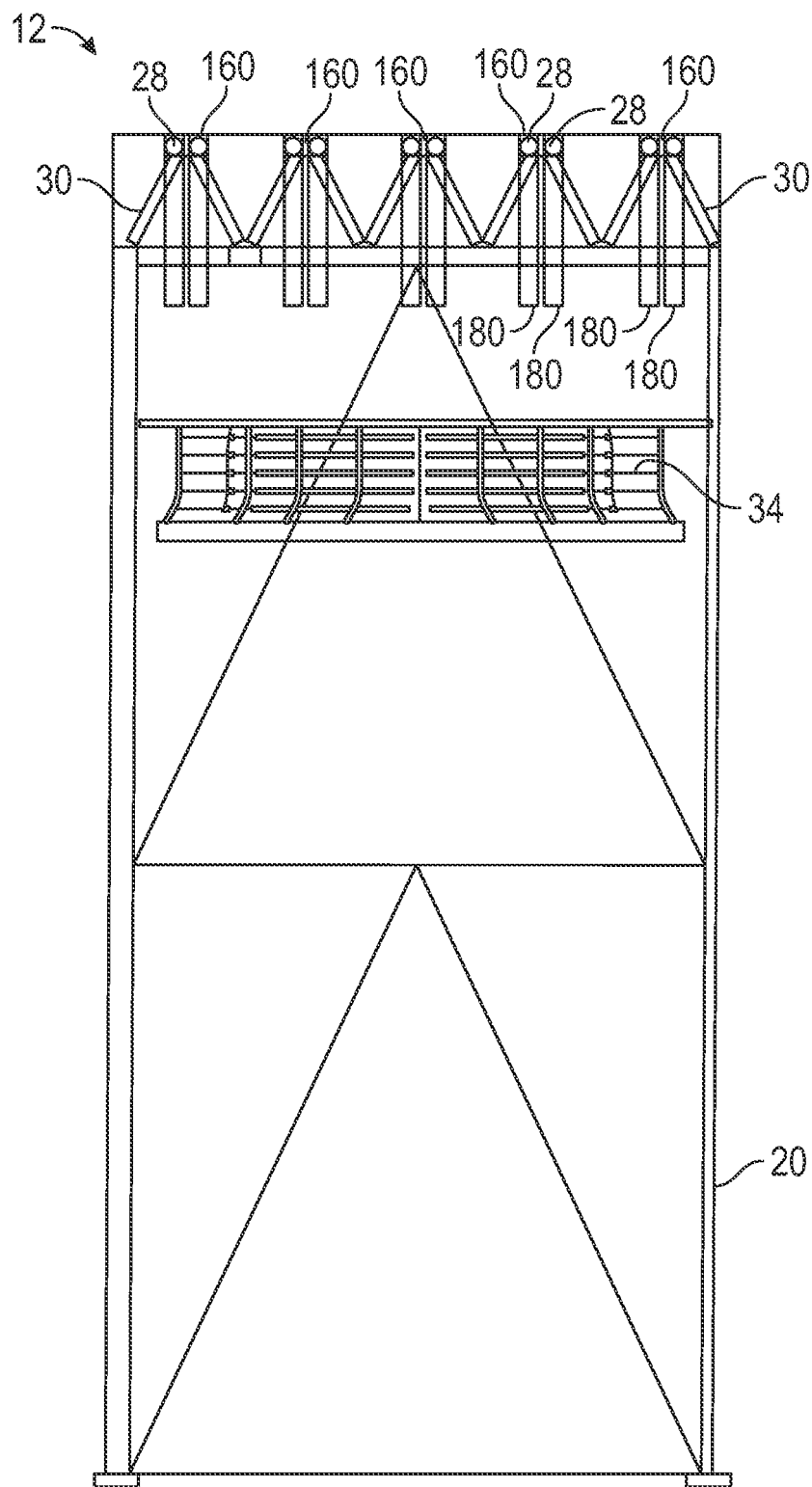


FIG. 18

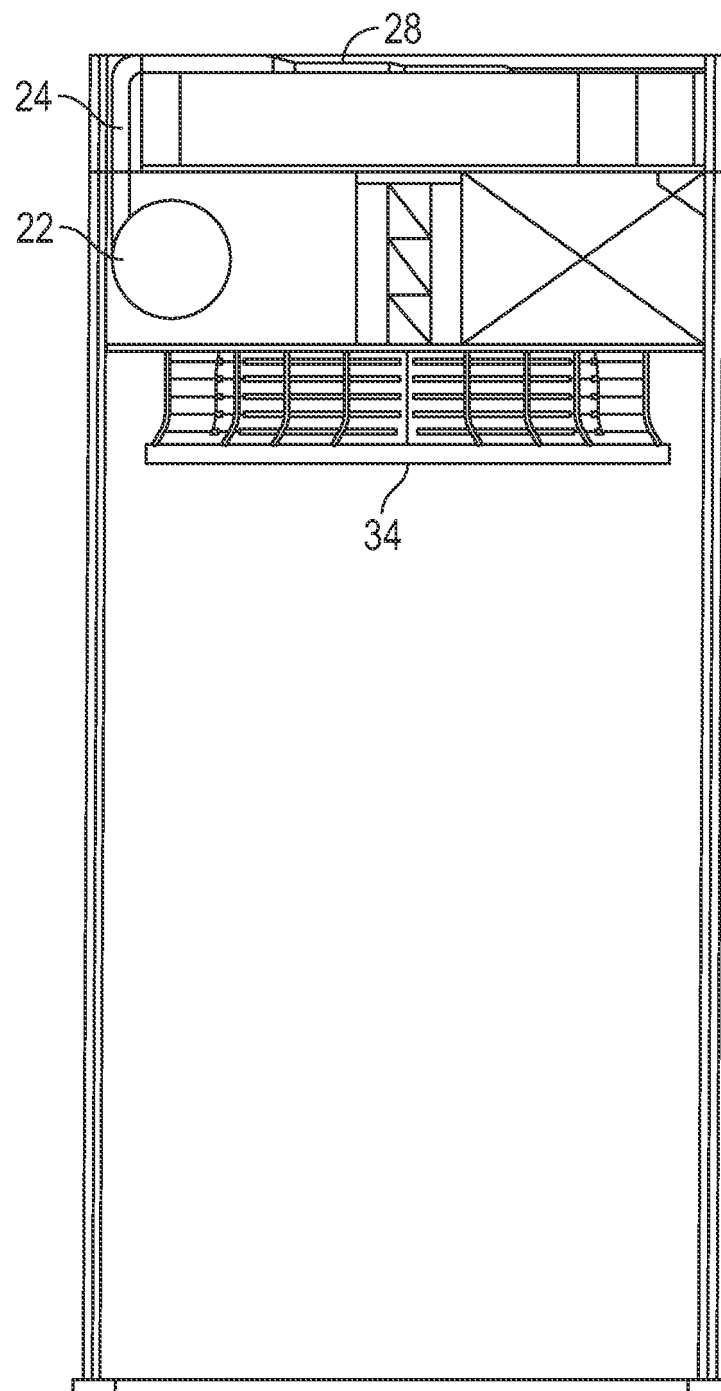


FIG. 19

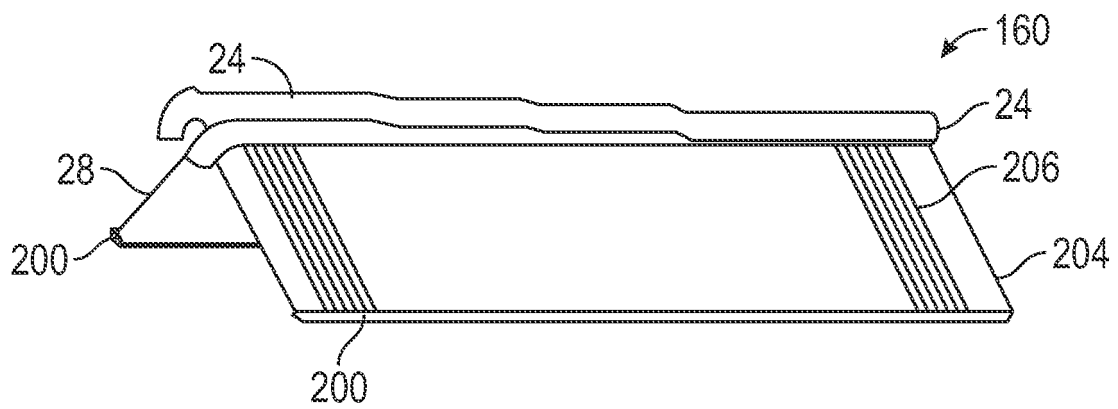


FIG. 20

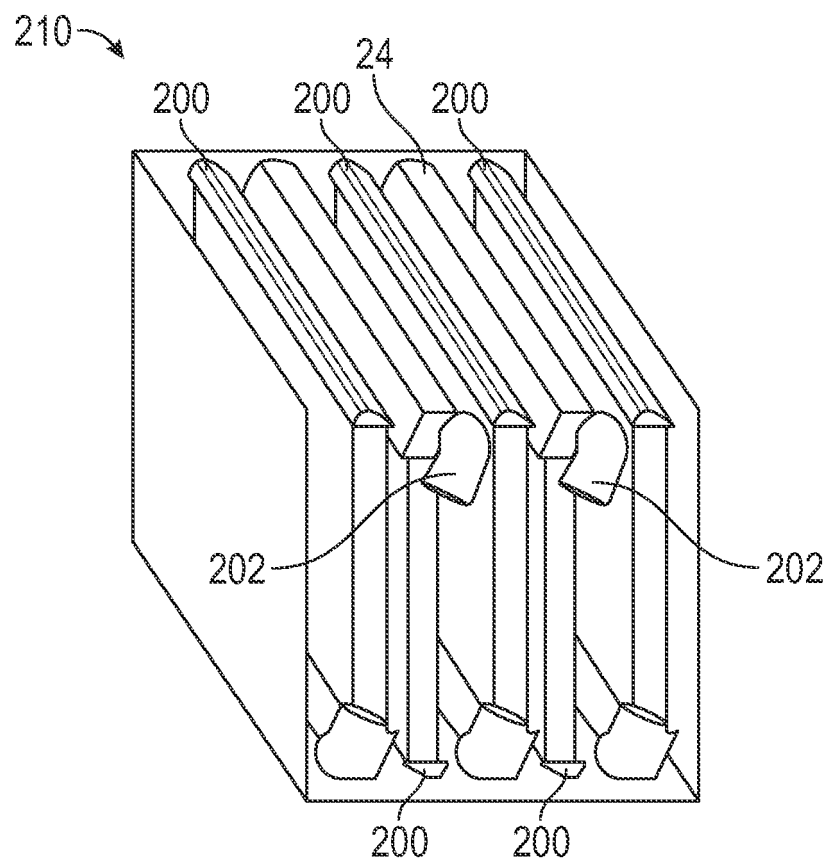


FIG. 21

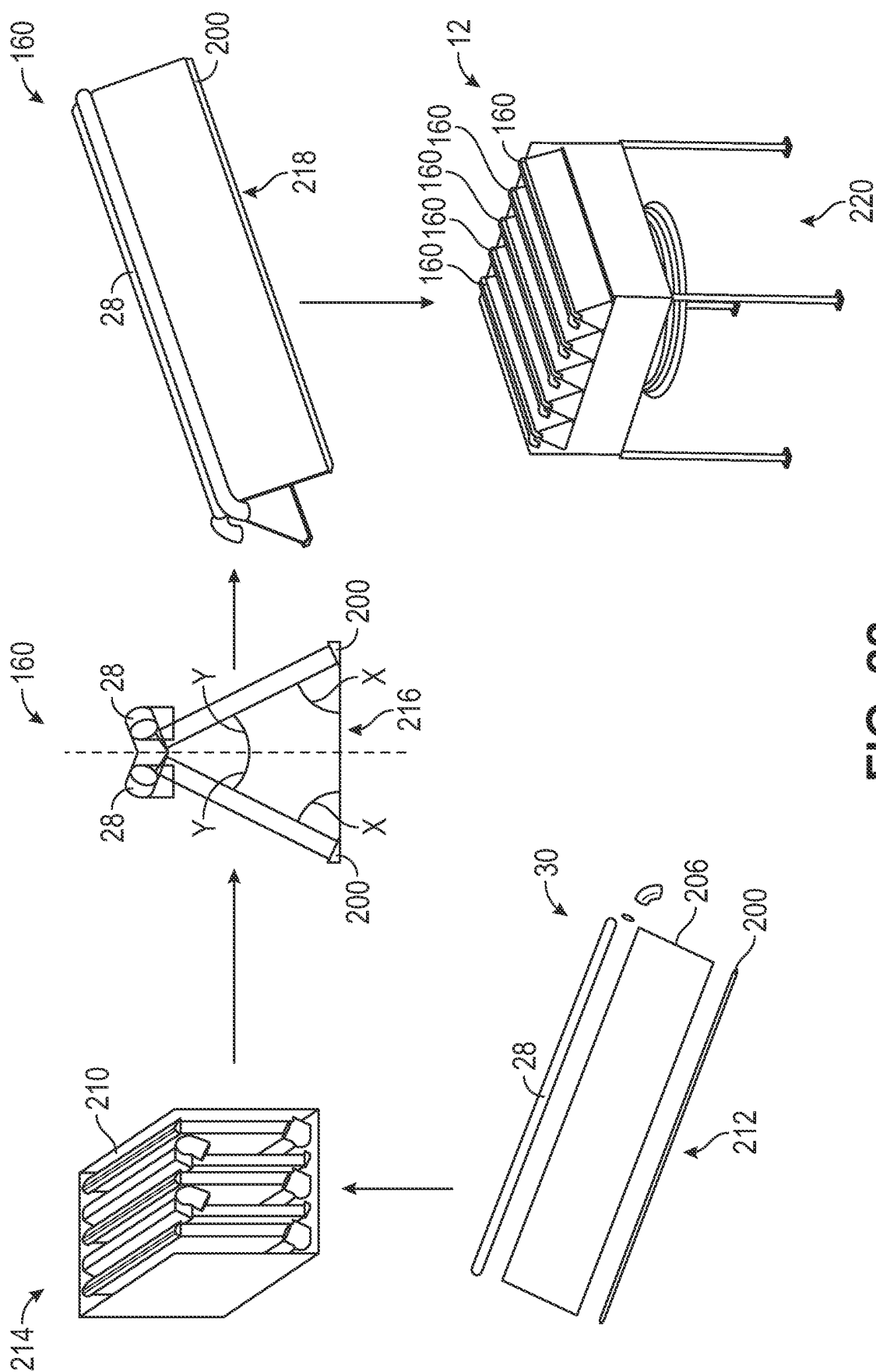


Fig. 22

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 61828076 A [0001]
- WO 2008110154 A [0007]