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(54) **SUBSEA TEMPLATE ARCHITECTURE**

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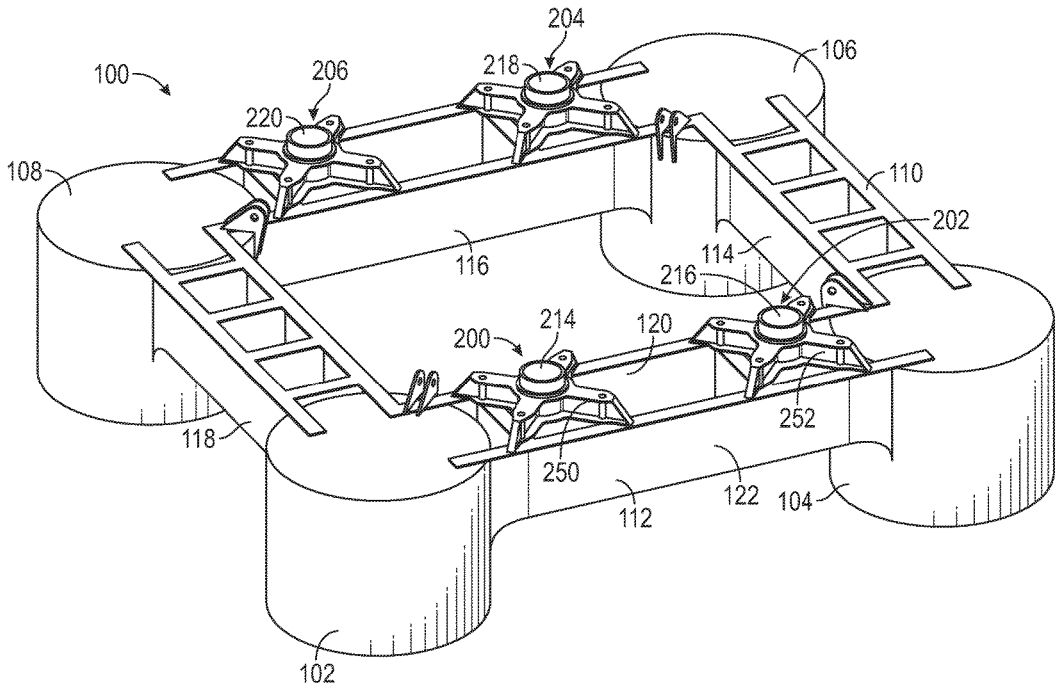
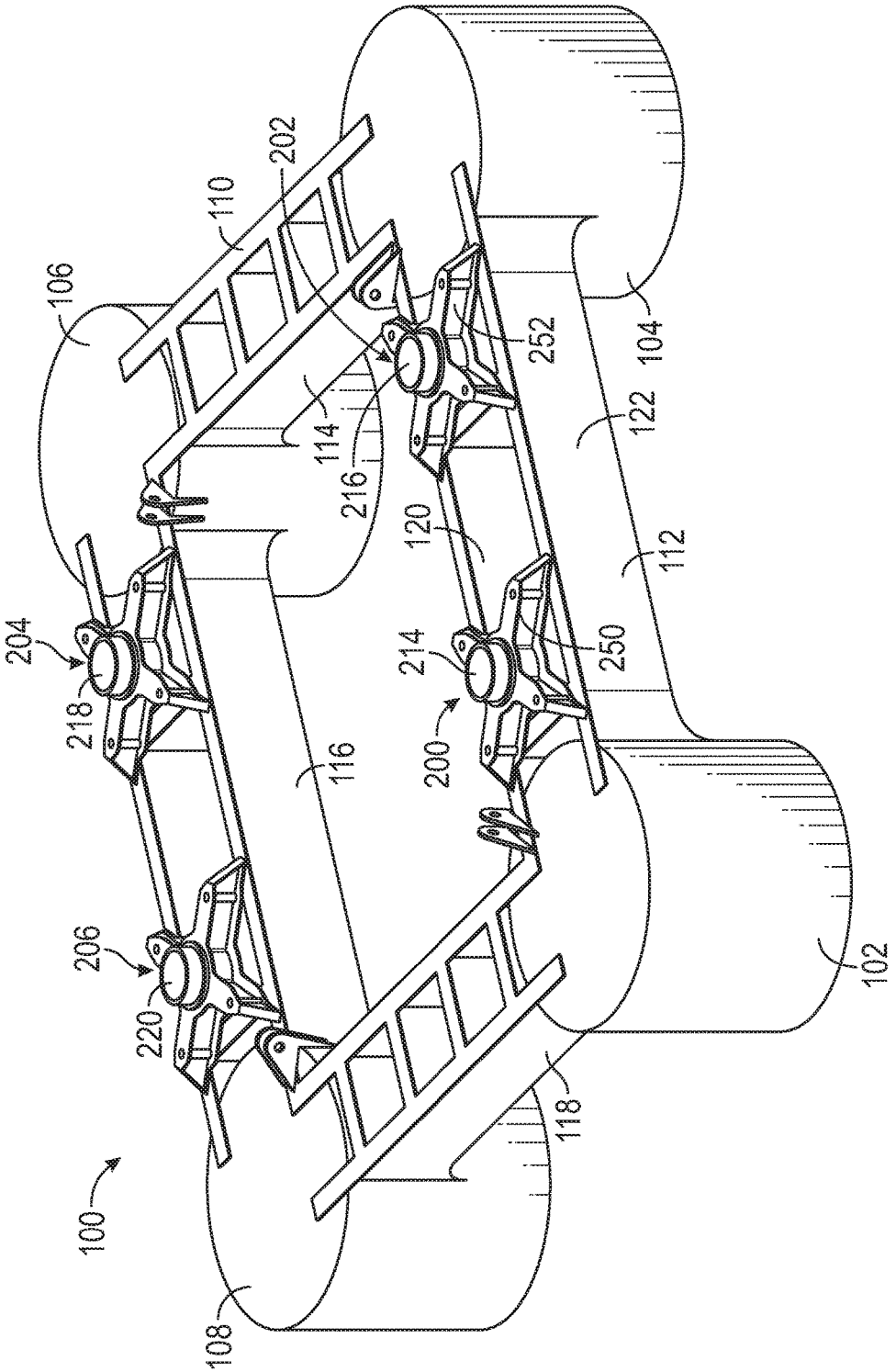
(57) **ABSTRACT**

A subsea template manifold and method, of which the subsea template manifold includes a first suction compartment configured to be at least partially embedded in a sea floor, a second suction compartment configured to be at least partially embedded in the sea floor, and a bridging element extending between and connected to the first and second suction compartments. The bridging element is configured to be at least partially embedded in the sea floor.




100
102
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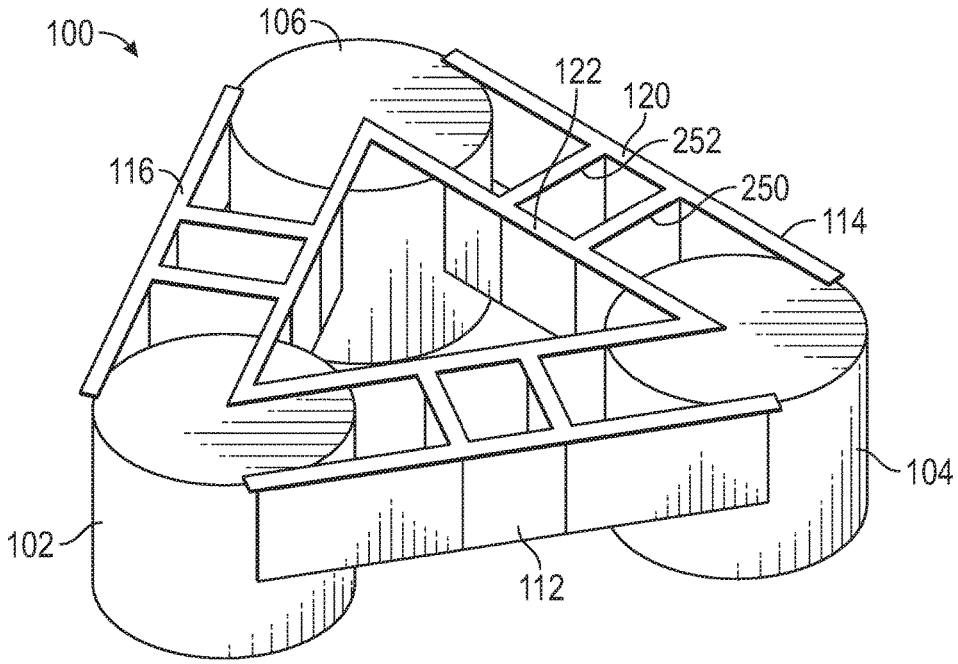
250
252

FIG. 1


100
106
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252
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250
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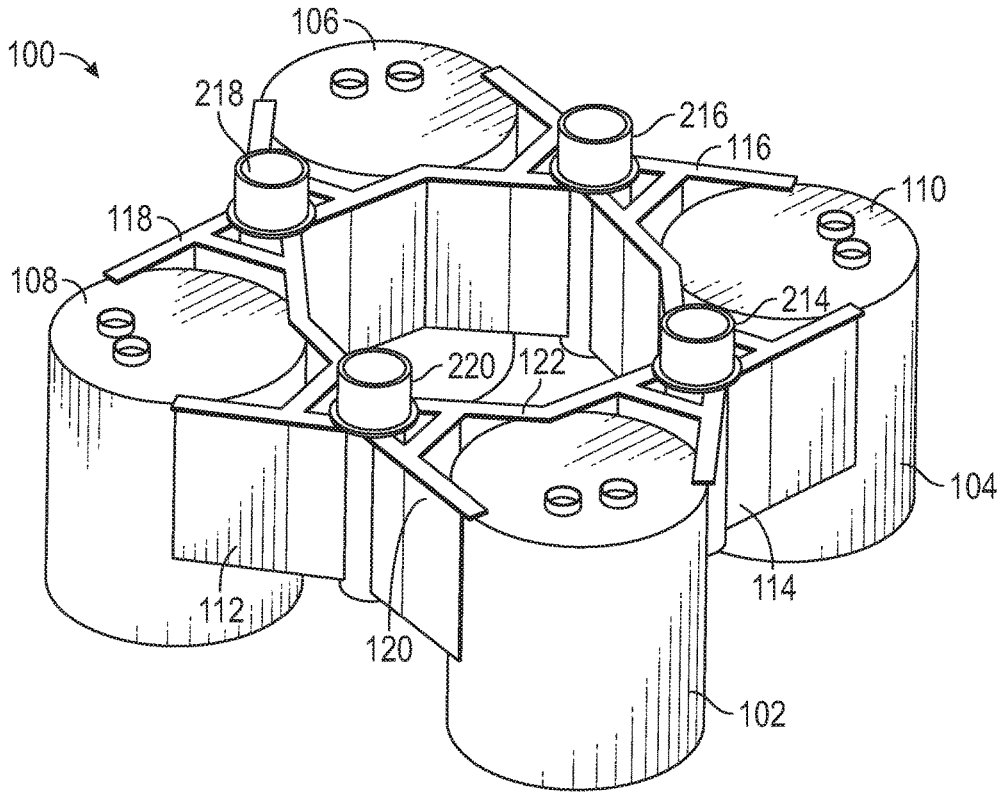
112

FIG. 2


100
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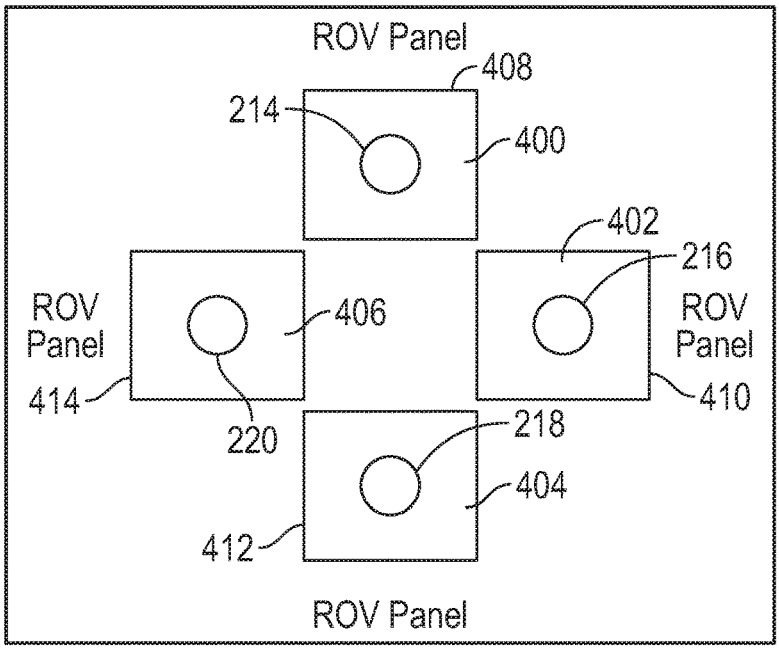
120
102

FIG. 3


ROV Panel
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214
400
402
216
ROV Panel
406
ROV Panel
414
410
220
218
404
412
ROV Panel

FIG. 4

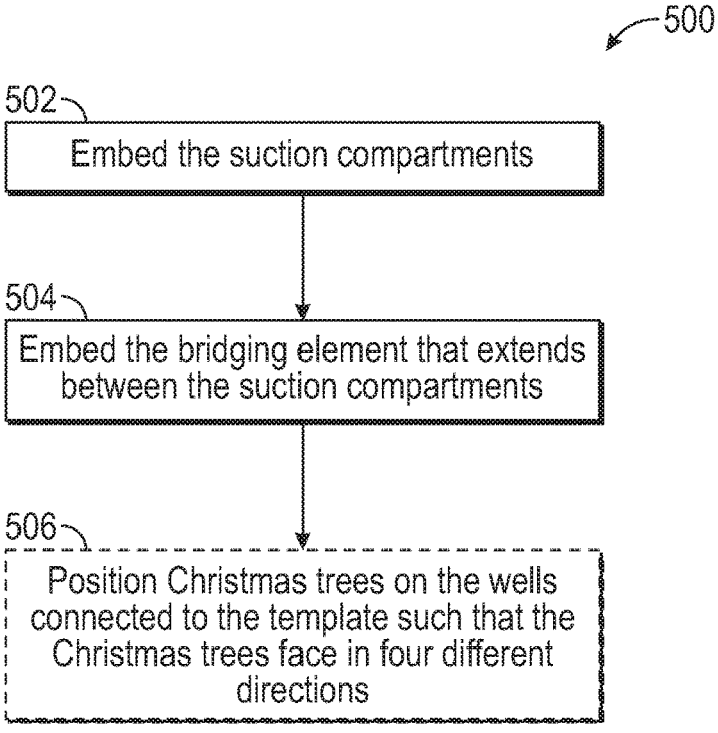
500
502
Embed the suction compartments
504
Embed the bridging element that extends between the suction compartments
506
Position Christmas trees on the wells connected to the template such that the Christmas trees face in four different directions

FIG. 5

SUBSEA TEMPLATE ARCHITECTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application Ser. No. 62/432,968, filed on Dec. 12, 2016, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Subsea templates are large subsea structures that support or otherwise house wellheads, Christmas trees, and manifolds. A subsea manifold is made up of pipes and valves and is designed to transfer hydrocarbons from wellheads into a pipeline. The manifold is mounted onto the template, e.g., at the seafloor.

[0003] Generally, the subsea template includes a foundation that is at least partially embedded within the seafloor. More particularly, the foundation may include several pilings, which may be suction compartments (also referred to as suction anchors), e.g., positioned at the corners of the structure. The suction compartments have an open lower end, which is lowered, and then forced, into the seafloor, thereby anchoring the subsea template manifold in place.

[0004] The remainder of the structure is built up from and supported by these suction compartments. A variety of truss-structures, support beams, etc., are connected to the suction compartments to provide the subsea template with sufficient stability and rigidity to allow for safe and effective operation of the subsea devices associated therewith. This can call for a large amount of material, which can be expensive in itself, and also can be expensive and time-consuming to build onto the suction compartments.

SUMMARY

[0005] Embodiments of the present disclosure may provide a subsea template manifold including a first suction compartment configured to be at least partially embedded in a sea floor, a second suction compartment configured to be at least partially embedded in the sea floor, and a bridging element extending between and connected to the first and second suction compartments. The bridging element is configured to be at least partially embedded in the sea floor.

[0006] Embodiments of the disclosure may also provide a method for supporting a subsea manifold at a sea floor including embedding at least a portion of a suction compartment of a subsea template manifold into a seabed, and embedding at least a portion a bridging element of the subsea template into the seabed. The bridging element extends between and is connected to the first and second suction compartments.

[0007] Embodiments of the disclosure may provide an apparatus for supporting a subsea well system, including a first suction anchor configured to be at least partially embedded in a sea floor, a second suction anchor configured to be at least partially embedded in the sea floor, and a bridging element extending between and connected to the first and second suction anchors. The bridging element is configured to be at least partially embedded in the sea floor.

[0008] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present teachings and together with the description, serve to explain the principles of the present teachings. In the figures:

[0010] FIG. **1** illustrates a perspective view of a subsea template, according to an embodiment.

[0011] FIG. **2** illustrates a perspective view of the template, according to another embodiment.

[0012] FIG. **3** illustrates a perspective view of the template, according to yet another embodiment.

[0013] FIG. **4** illustrates a schematic plan view of four wellhead devices, which may be configured to be landed on and/or otherwise connected to the four wells, respectively, according to an embodiment.

[0014] FIG. **5** illustrates a flowchart of a method for supporting a subsea manifold at a sea floor, according to an embodiment.

DETAILED DESCRIPTION

[0015] Reference will now be made in detail to specific embodiments illustrated in the accompanying drawings and figures. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that embodiments may be practiced without these specific details. In other instances, well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

[0016] It will also be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first object could be termed a second object, and, similarly, a second object could be termed a first object, without departing from the scope of the present disclosure.

[0017] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used in the description and the appended claims, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term "and/or" as used herein refers to and encompasses any and possible combinations of one or more of the associated listed items. It will be further understood that the terms "includes," "including," "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, operations, elements, components, and/or groups thereof. Further, as used herein, the term "if" may be construed to mean "when" or "upon" or "in response to determining" or "in response to detecting," depending on the context.

[0018] FIG. **1** illustrates a perspective view of a subsea template **100**, according to an embodiment. In some embodi-

ments, the subsea template **100** may be configured to support a manifold for transferring process fluids (e.g., hydrocarbons) from one or more wells to a pipeline. The template **100** may include one or more suction compartments (four shown: **102**, **104**, **106**, **108**). The suction compartments **102-108** may be cylindrical pilings, which may be configured to be positioned at least partially below the surface of the seafloor (i.e., "embedded" at least partially in the seafloor). The suction compartments **102-108** may be hollow cylinders, which may be open at the bottom. This may allow for the suction compartments **102-108** to sink into the seafloor upon landing thereon during installation. Suction may then be applied to the upper end of the suction compartments **102-108** so as to drive the suction compartments **102-108** farther into, e.g., entirely into, the seafloor.

[0019] The template **100** may also include a top plate **110**, which may extend laterally (e.g., in a generally horizontal, parallel to the seafloor direction) between the suction compartments **102-108**. Further, the top plate **110** may be coupled to the upper end of the suction compartments **102-108**, and thus may be configured to be positioned slightly above or at the seafloor when the suction compartments **102-108** are installed in the seafloor. In some embodiments, the top plate **110** may be provided by several segments, one extending between each pair of adjacent suction compartments **102-108** as shown, but in other embodiments, may be a single plate.

[0020] One or more bridging elements **112**, **114**, **116**, **118** may extend between and be coupled to the suction compartments **102-108**. For example, respective ones of the bridging elements **112-118** may extend between two of the suction compartments **102-108**. In some embodiments, the bridging elements **112-118** may be coupled to the top plate **110**, but in other embodiments, the bridging elements **112-118** and the top plate **110** may be separate.

[0021] The bridging elements **112-118** may be or include relatively thin, vertically-oriented (i.e., with the thin side facing vertically) plates. In a specific embodiment, each of the bridging elements **112-118** may include two such plates **120**, **122**, one nearer to the center of the template **100** than the other, with the plates **120**, **122** being offset from and extending generally parallel to one another. Between the plates **120**, **122** of at least one of the bridging elements (e.g., elements **112** and **116**), one or more wellheads **200**, **202**, **204**, **206** may be positioned. Each wellhead **200-206** may include connectors for connecting to wellhead equipment (e.g., Christmas trees, blowout preventers, etc.), which may be or include one or more vertically-oriented posts. Within each wellhead **200-206**, a washout sleeve **214**, **216**, **218**, **220** may be positioned, e.g., between the two plates **120**, **122**. The washout sleeves **214-220** may be connected to the top plate **110** and/or one of the bridging elements **112-118**. Further, the washout sleeves **214-220** may be connected to wells, and may represent the upper end of such wells (accordingly, in some cases herein, reference numbers **214-220** may be described as pointing to wells). Well-support brackets **250**, **252** may be connect to the bridging elements **112-118** and the corresponding washout sleeves/wells **214-220**.

[0022] Further, the bridging elements **112**, **116** may include the well-support brackets **250**, **252**. The well-support brackets **250**, **252** may couple to the wells **214-220** (e.g., washout sleeves/wellheads **270** thereof). The well-support brackets **250**, **252** may further couple to one of the plates **120**, **122** and/or to one of the suction containers **102-108**.

[0023] The well-support brackets **250**, **252** may be vertically-oriented plates, brackets, struts, etc. In some embodiments, the well-support brackets **250**, **252** may extend downwards, and may be generally triangular, e.g., so as to facilitate extending and embedding the brackets **250**, **252** into the seafloor. In other embodiments, the well-support brackets **250** may extend between the plates **120**, **122**, as shown, and extend upwards therefrom, such that the brackets **250**, **252** may, in some cases, not be embedded in the seafloor during installation. The well-support brackets **250**, **252** may thus provide lateral support and rigidity for the wells **214-220**.

[0024] FIG. **2** illustrates a perspective view of the template **100**, according to another embodiment. In this embodiment, the template **100** omits the fourth suction chamber **108**, and thus provides a generally triangular footprint. It will be appreciated that embodiments including five or more suction chambers **108**, and any number of shapes for the footprint, are contemplated herein. Further, in this embodiment, the bridging elements **112-116** (bridging element **118** may be omitted) may be generally constructed the same as one another, and may each include well-support brackets **250**, **252**, for positioning a well therebetween (well not shown).

[0025] FIG. **3** illustrates a perspective view of the template **100**, according to yet another embodiment. As shown, the plates **120**, **122** of the bridging elements **112-118** may each be connected to one of the wells **214-220**. For example, the plates **120**, **122** may each provide one of the well-support brackets **250**, **252**, such that the plates **120**, **122** (and thus the bridging elements **112-118**) are connected to the suction compartments **102-108** via the connection with the wells **214-220**.

[0026] With the wells **214-220** positioned (e.g., one each) between the suction compartments **102-108**, the wellhead equipment may be similarly clocked at 90 degree angles. For example, FIG. **4** illustrates a schematic plan view of four wellhead devices **400**, **402**, **404**, **406**, which may be configured to be landed on and/or otherwise connected to the four wells **214-220**, respectively, according to an embodiment. In some embodiments, the four wellhead devices **400-406** may each be a Christmas tree. Accordingly, the four wellhead devices **400-406** may each include a remote operated vehicle (ROV) panel **408**, **410**, **412**, **414**. So as to allow for each of the ROV panels **408-414** to face outwards, each of the wellhead devices **400-406** may be rotated 90 degrees from the adjacent wellhead device **400-406**. In some situations, this may allow for a more compact template **100**.

[0027] With continuing reference to FIGS. **1-4**, FIG. **5** illustrates a flowchart of a method **500** for supporting a subsea manifold, using a subsea template such as the template **100**, at a sea floor, according to an embodiment. The method **500** may include embedding at least a portion of a first suction compartment **102-108** and a second suction compartment **102-108** of a subsea template manifold **100** into a seabed, as at **502**. The method **500** may further include embedding at least a portion a bridging element **112-118** of the subsea template **100** into the seabed, as at **504**. The bridging element **112-118** extends between and is connected to the first and second suction **102-108** compartments.

[0028] In some embodiments, embedding the at least a portion of the first and second suction compartments **102-**

108 at **502** and embedding at least a portion of the bridging element **112-118** at **504** occur at least partially at the same time (i.e., simultaneously or overlapping in time).

[0029] In some embodiments, the bridging element **112-118** includes one or more vertically-oriented plates extending laterally between the first and second suction compartments **102-108** and being fixed thereto. In such embodiments, embedding the at least a portion of the bridging element **112-118** at **504** may include embedding at least a portion of the plates **120**, **122** into the seabed.

[0030] In some embodiments, the method **500** may include positioning, at **506**, a first Christmas tree **700**, a second Christmas tree **702**, a third Christmas tree **704**, and a fourth Christmas tree **706**, on the subsea template **100** and in communication with the wells **214-220**. Each of the first, second, third, and fourth Christmas trees **700-706** faces in a different direction. For example, each of the Christmas trees **700-706** may be rotated 90 degrees in orientation from the adjacent Christmas trees **700-706**.

[0031] As used herein, the terms "inner" and "outer"; "up" and "down"; "upper" and "lower"; "upward" and "downward"; "above" and "below"; "inward" and "outward"; and other like terms as used herein refer to relative positions to one another and are not intended to denote a particular direction or spatial orientation. The terms "couple," "coupled," "connect," "connection," "connected," "in connection with," and "connecting" refer to "in direct connection with" or "in connection with via one or more intermediate elements or members."

[0032] The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. Moreover, the order in which the elements of the methods described herein are illustrate and described may be re-arranged, and/or two or more elements may occur simultaneously. The embodiments were chosen and described in order to best explain the principals of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A subsea template manifold, comprising:

a first suction compartment configured to be at least partially embedded in a sea floor;

a second suction compartment configured to be at least partially embedded in the sea floor; and

a bridging element extending between and connected to the first and second suction compartments, wherein the bridging element is configured to be at least partially embedded in the sea floor.

2. The subsea template manifold of claim **1**, wherein the bridging element comprises one or more vertically-oriented plates extending laterally between the first and second suction compartments and being fixed thereto.

3. The subsea template manifold of claim **1**, wherein the bridging element comprises a first plate and a second plate, the first and second plates each being coupled to the first and second suction compartments and extending generally parallel to one another, the subsea template manifold being configured to connect to a well between the first and second plates.

4. The subsea template manifold of claim **1**, wherein the bridging element comprises a first section and a second section, the first section being connected to the first suction compartment, and the second section being connected to the second suction compartment, the subsea template manifold further comprising a washout sleeve connected to the first and second sections, such that the first and second sections are connected to one another via the washout sleeve.

5. The subsea template manifold of claim **1**, further comprising a well-support bracket and a washout sleeve positioned between the first and second suction compartments and coupled to the bridging element, wherein the well-support bracket is coupled to the washout sleeve, and the first suction compartment, the bridging element, or both, and wherein the well-support bracket is configured to be at least partially embedded below the sea floor.

6. The subsea template manifold of claim **1**, further comprising a top plate coupled to the first suction compartment, the second suction compartment, and the support bracket, wherein the top plate is configured to be above or on the sea floor and to support one more seafloor devices.

7. The subsea template manifold of claim **1**, wherein the bridging element comprises a first bridging element, the subsea template manifold further comprising:

a third suction compartment configured to be at least partially embedded beneath the sea floor;

a fourth suction compartment configured to be at least partially embedded beneath the sea floor;

a second bridging element extending between and connected to the second and third suction compartments;

a third bridging element extending between and connected to the third and fourth suction compartments;

a fourth bridging element extending between and connected to the first and fourth suction compartments;

a plurality of washout sleeves, wherein a respective one of the plurality of washout sleeves connected to each of the first, second, third, and fourth bridging elements.

8. The subsea template manifold of claim **7**, further comprising a first Christmas tree, a second Christmas tree, a third Christmas tree, and a fourth Christmas tree, each facing in a different direction and each being coupled to one of the plurality of washout sleeves.

9. A method for supporting a subsea manifold at a sea floor, comprising:

embedding at least a portion of a suction compartment of a subsea template manifold into a seabed; and

embedding at least a portion a bridging element of the subsea template into the seabed, wherein the bridging element extends between and is connected to the first and second suction compartments.

10. The method of claim **9**, wherein embedding the at least a portion of the suction compartment and the embedding at least a portion of the bridging element occur at least partially at the same time.

11. The method of claim **9**, wherein the bridging element comprises one or more vertically-oriented plates extending laterally between the first and second suction compartments and being fixed thereto, wherein embedding the at least a portion of the bridging element comprises embedding at least a portion of the plates into the seabed.

12. The method of claim **9**, further comprising positioning a first Christmas tree, a second Christmas tree, a third Christmas tree, and a fourth Christmas tree, on the subsea

template and in communication with the wells, wherein each of the first, second, third, and fourth Christmas trees faces in a different direction.

13. The method of claim **12**, wherein the first, second, third, and fourth Christmas trees face in four different directions, 90 degrees offset from one another.

15. An apparatus for supporting a subsea well system, comprising:

a first suction anchor configured to be at least partially embedded in a sea floor;

a second suction anchor configured to be at least partially embedded in the sea floor; and

a bridging element extending between and connected to the first and second suction anchors, wherein the bridging element is configured to be at least partially embedded in the sea floor.

16. The apparatus of claim **15**, wherein the bridging element comprises one or more vertically-oriented plates extending laterally between the first and second suction anchors and being fixed thereto.

17. The apparatus of claim **15**, wherein the bridging element comprises a first plate and a second plate, the first and second plates each being coupled to the first and second suction anchors and extending generally parallel to one another, the subsea template manifold being configured to connect to a well between the first and second plates.

18. The apparatus of claim **15**, further comprising a top plate coupled to the first suction anchor, the second suction anchor, and the support bracket, wherein the top plate is configured to be above or on the sea floor and to support one more subsea devices.

19. The apparatus of claim **15**, wherein the bridging element comprises a first bridging element, the subsea template manifold further comprising:

a third suction anchor configured to be at least partially embedded beneath the sea floor;

a fourth suction anchor configured to be at least partially embedded beneath the sea floor;

a second bridging element extending between and connected to the second and third suction anchors;

a third bridging element extending between and connected to the third and fourth suction anchors;

a fourth bridging element extending between and connected to the first and fourth suction anchors;

a plurality of wellheads, wherein a respective one of the plurality of wellheads is connected to each of the first, second, third, and fourth bridging elements.

20. The apparatus of claim **19**, further comprising a first Christmas tree, a second Christmas tree, a third Christmas tree, and a fourth Christmas tree, each facing in a different direction and each being coupled to one of the plurality of wellheads.

* * * * *