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Jeon et al.

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(54) **OFFSHORE WIND POWER FOUNDATION WITH IMPROVED WATER-TIGHTNESS AND CONSTRUCTION METHOD THEREOF**

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F03D 13/25 (2016.01)
E02B 17/00 (2006.01)

(52) **U.S. Cl.**
CPC ***E02D 27/425*** (2013.01); ***F03D 13/25*** (2016.05); *E02B 2017/0039* (2013.01); *E02B 2017/0073* (2013.01); *E02B 2017/0091* (2013.01)

(58) **Field of Classification Search**
CPC E02D 27/425
See application file for complete search history.

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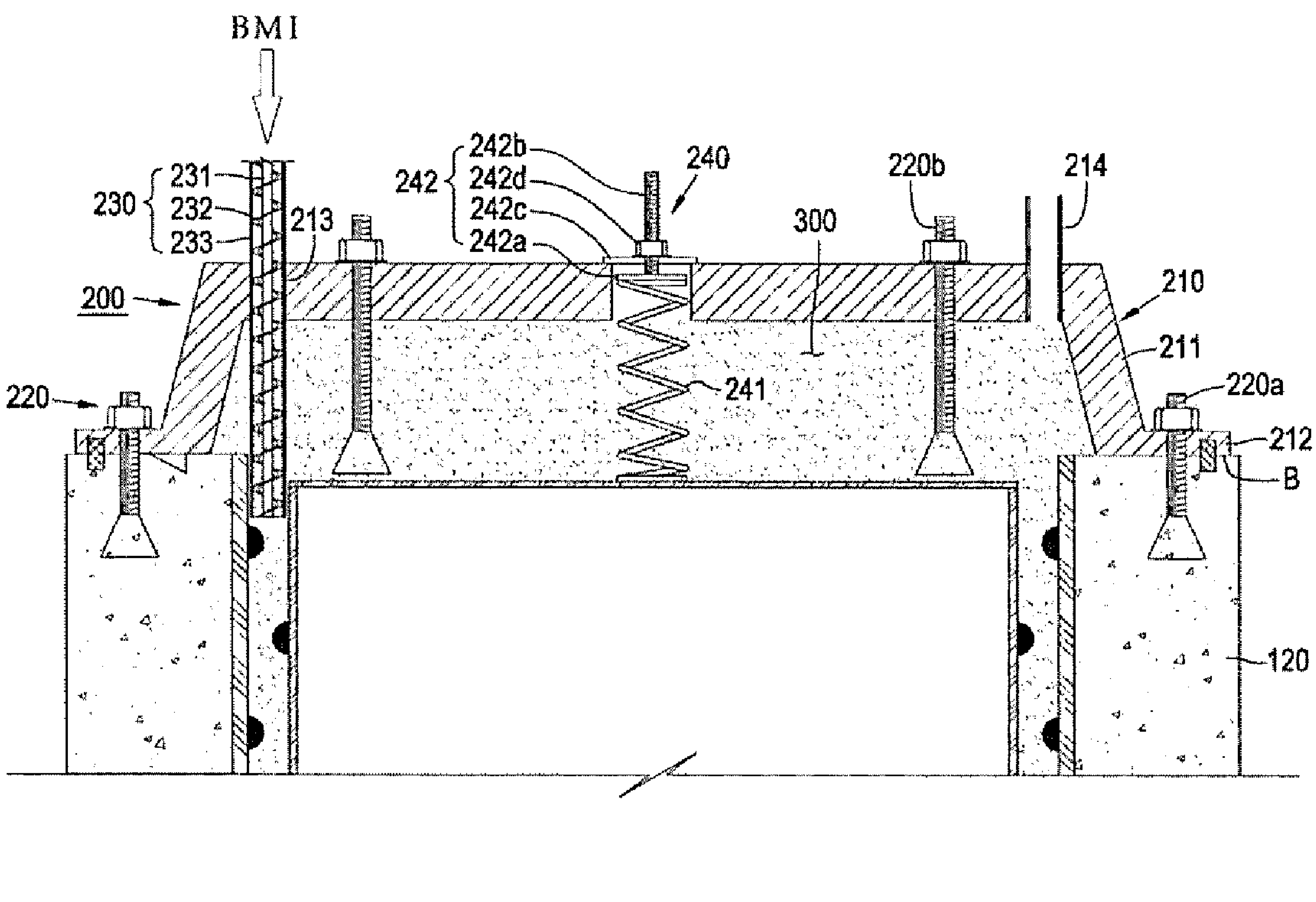
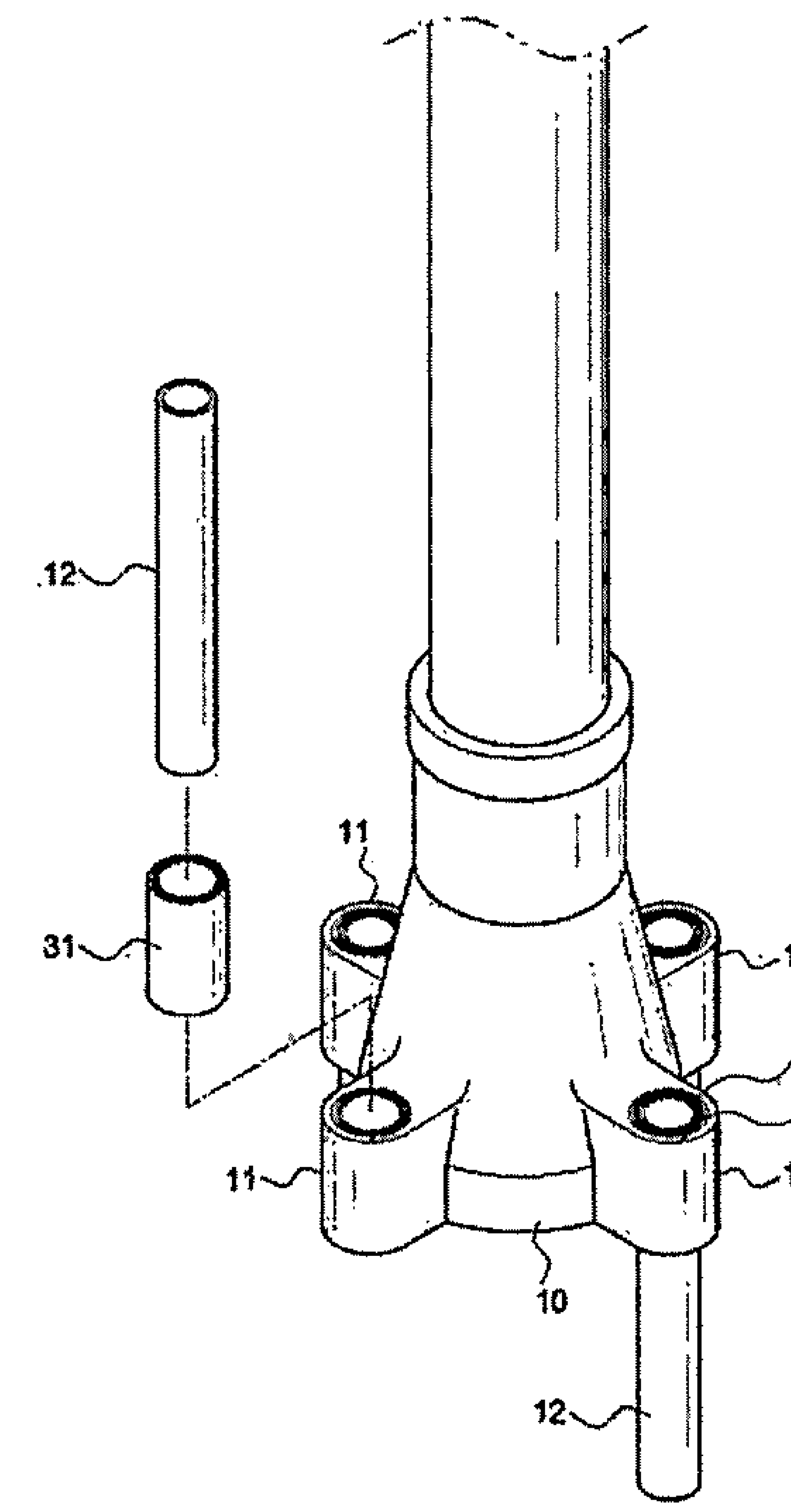
(57) **ABSTRACT**

An offshore wind power foundation with improved water-tightness and a construction method thereof are provided. The offshore wind power foundation is configured such that a bonding material is injected into a space between a pile and a leg using a precast cap member to integrate the leg and the pile, and includes a precast cap member including a pre-casting housing, a bonding material rotation-injection port, and an elastic spring.

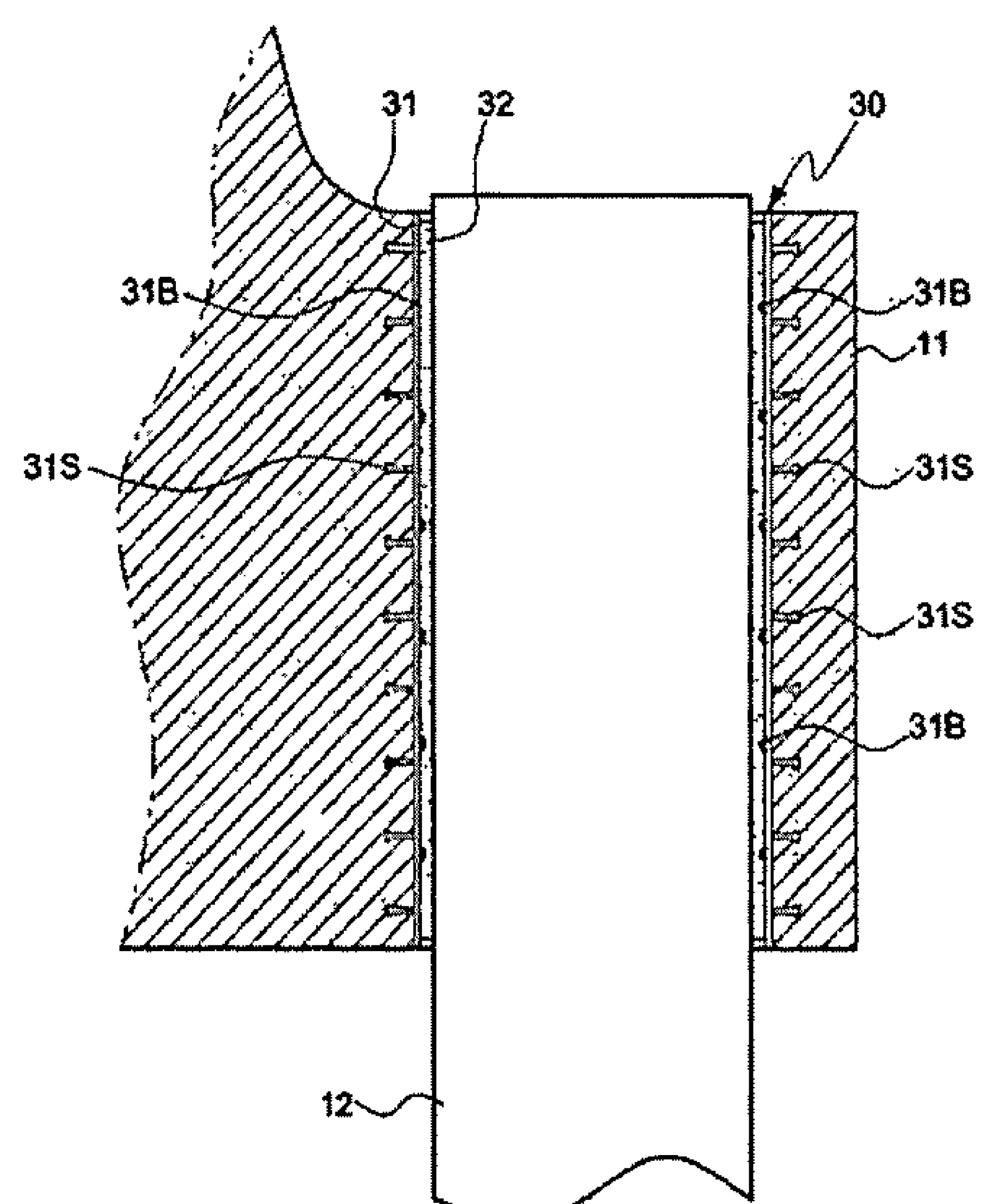
9 Claims, 10 Drawing Sheets





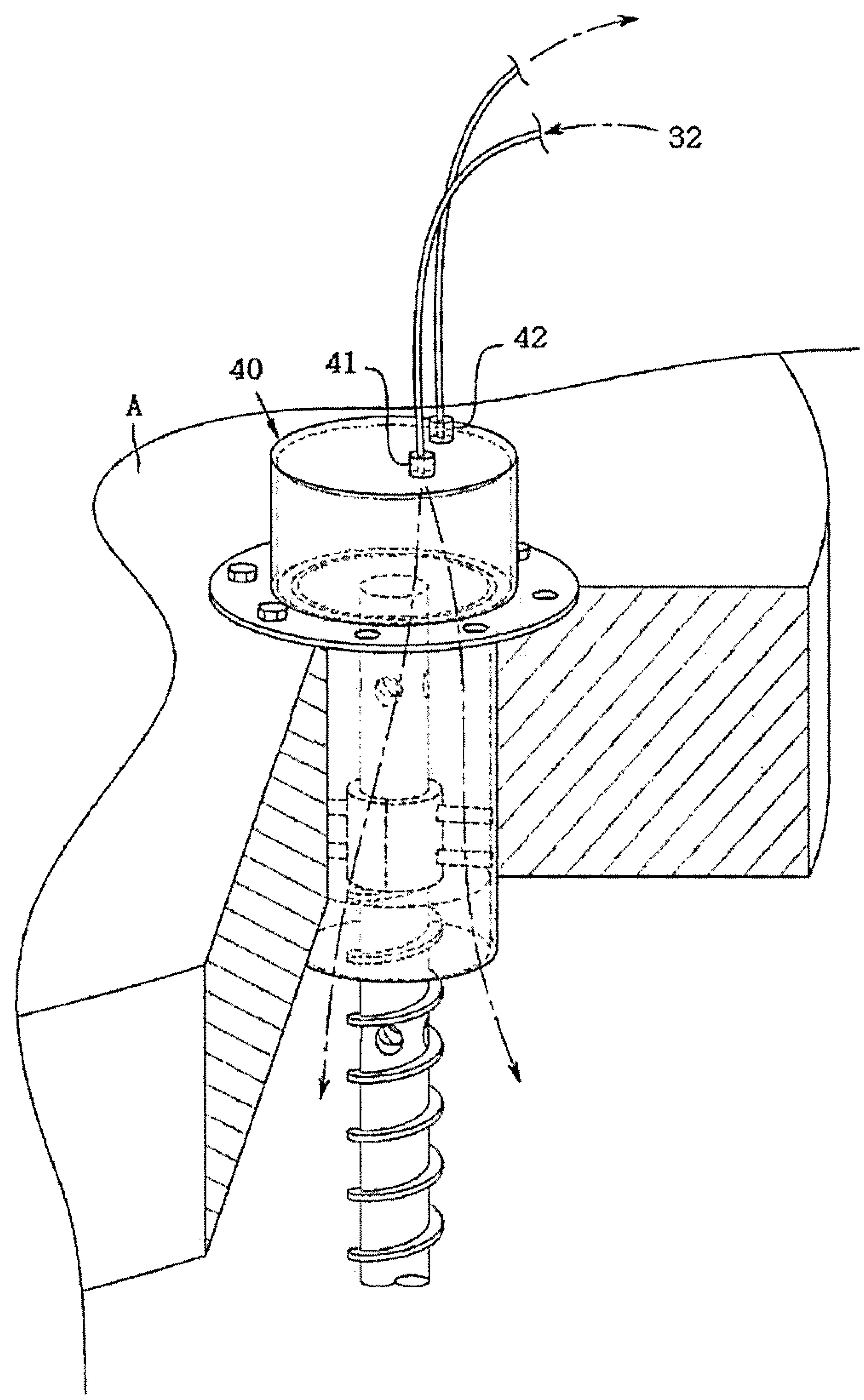
RELATED ART

FIG. 1A-1



RELATED ART

FIG. 1A-2



RELATED ART

FIG. 1B

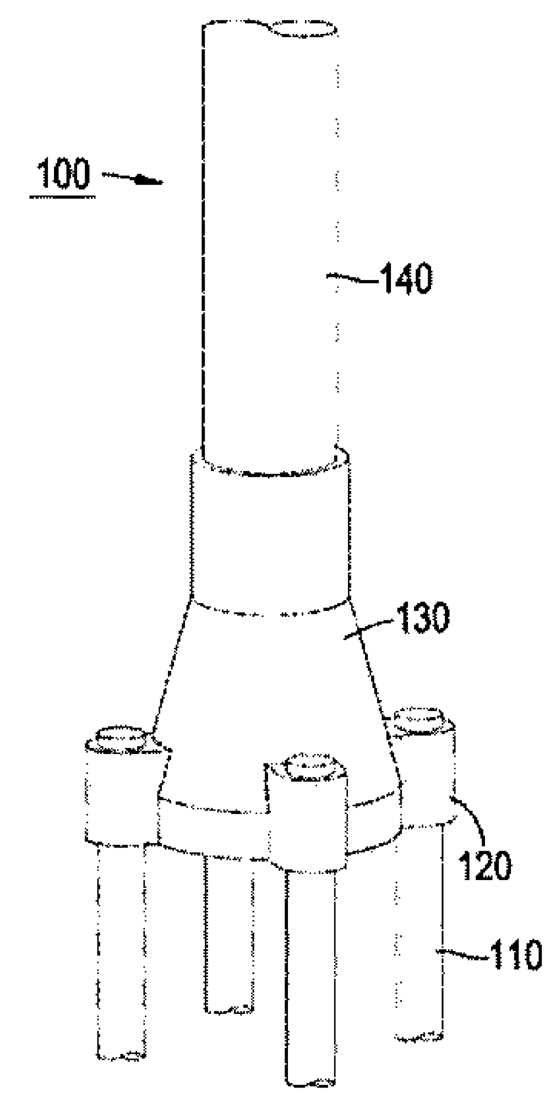


FIG. 2A-1

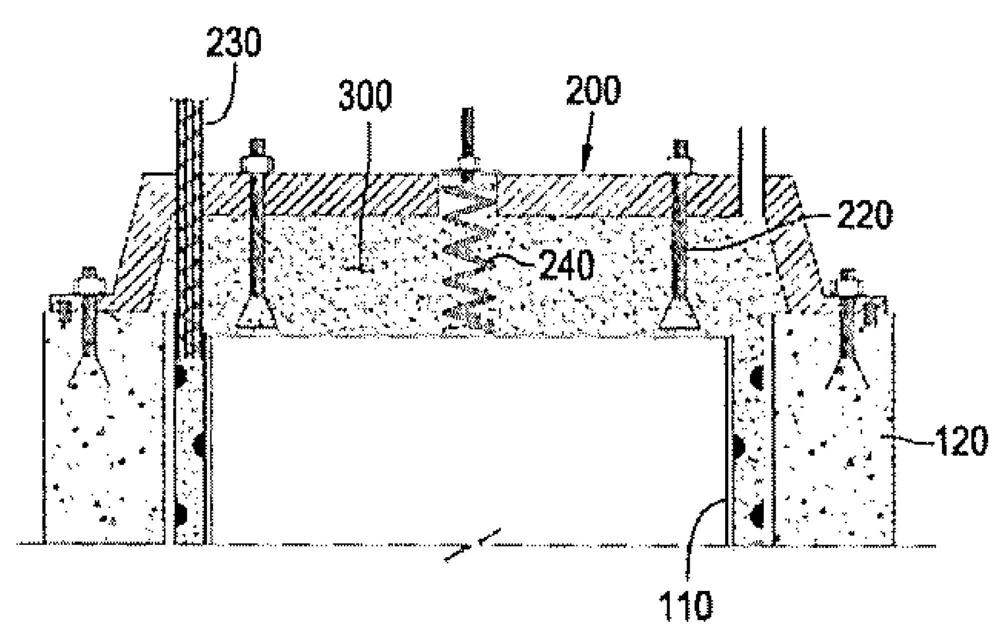


FIG. 2A-2

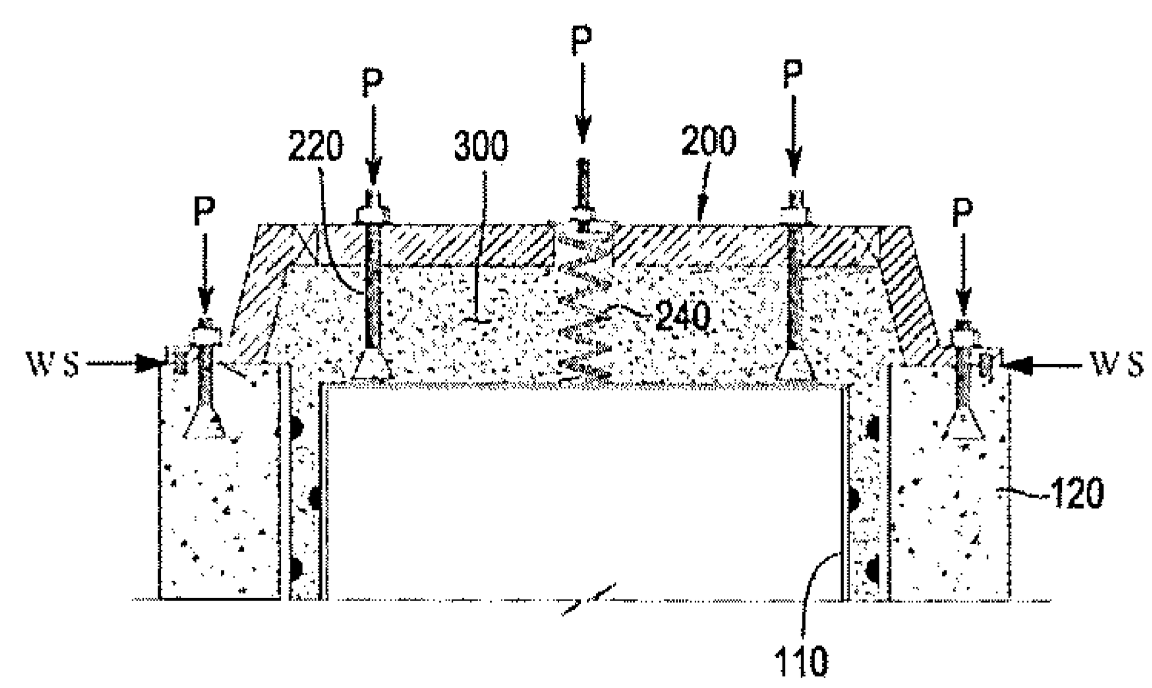
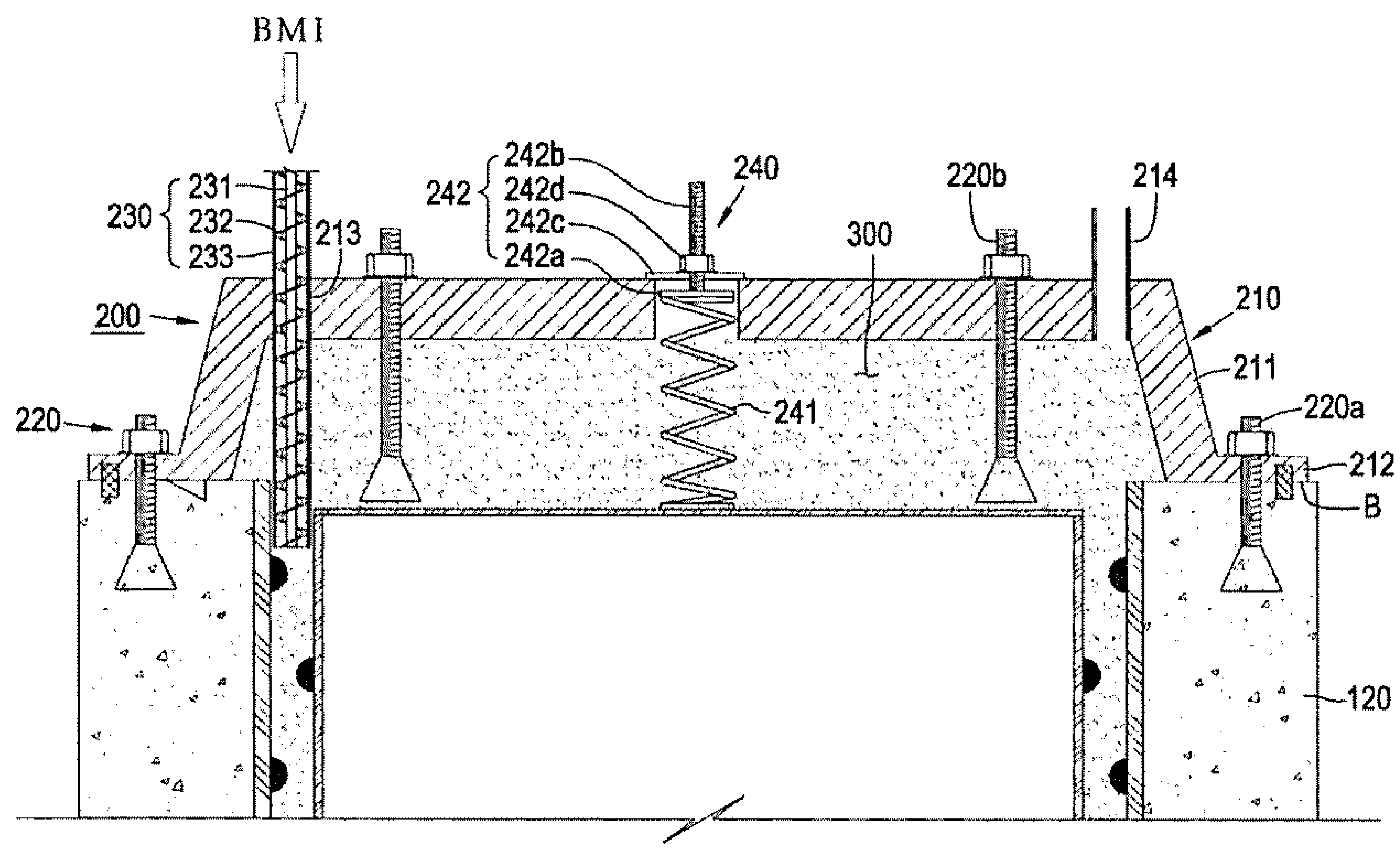


FIG. 2A-3



BMI
242b
240
220b
214
242
242d
242c
242a
300
231
230
232
233
213
200
210
211
241
220a
220
212
B
120

FIG. 2B

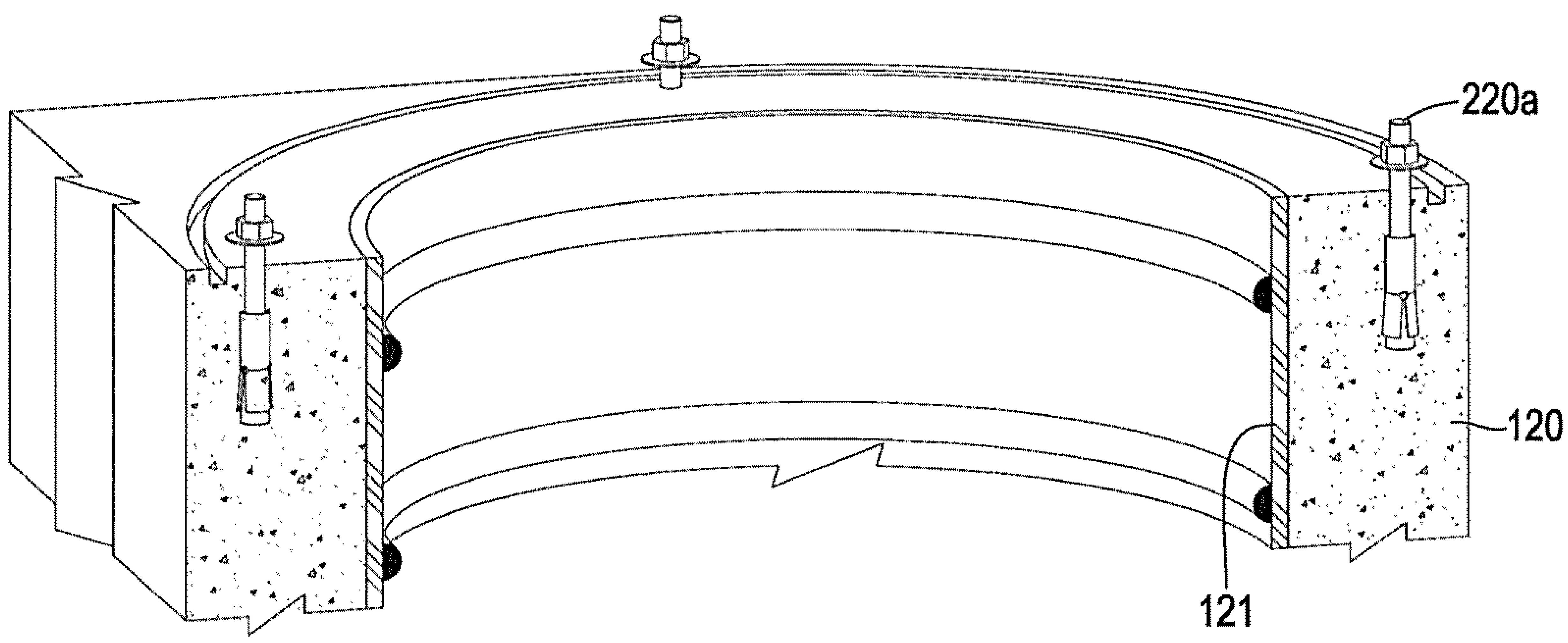


FIG. 3A

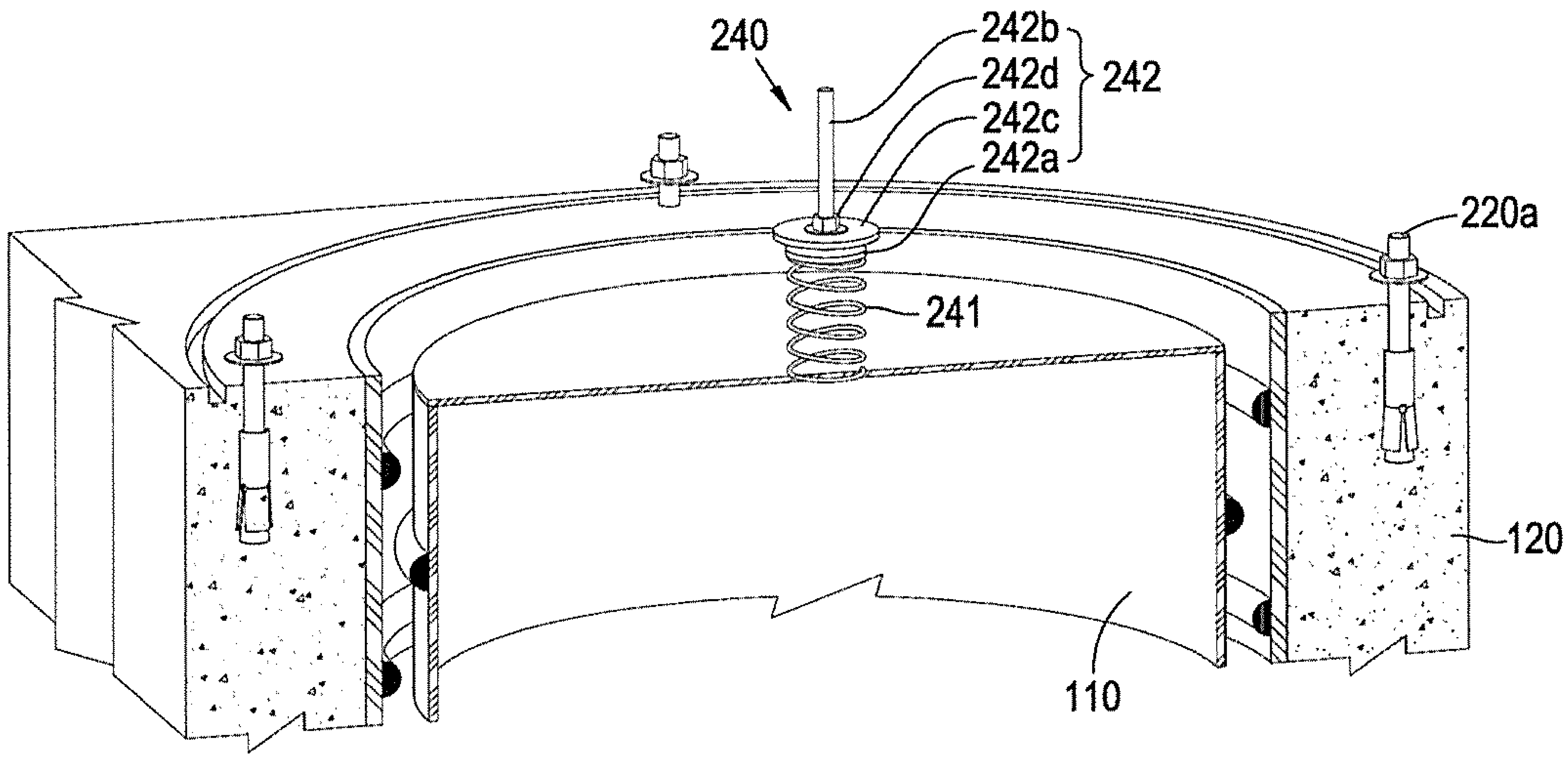


FIG. 3B

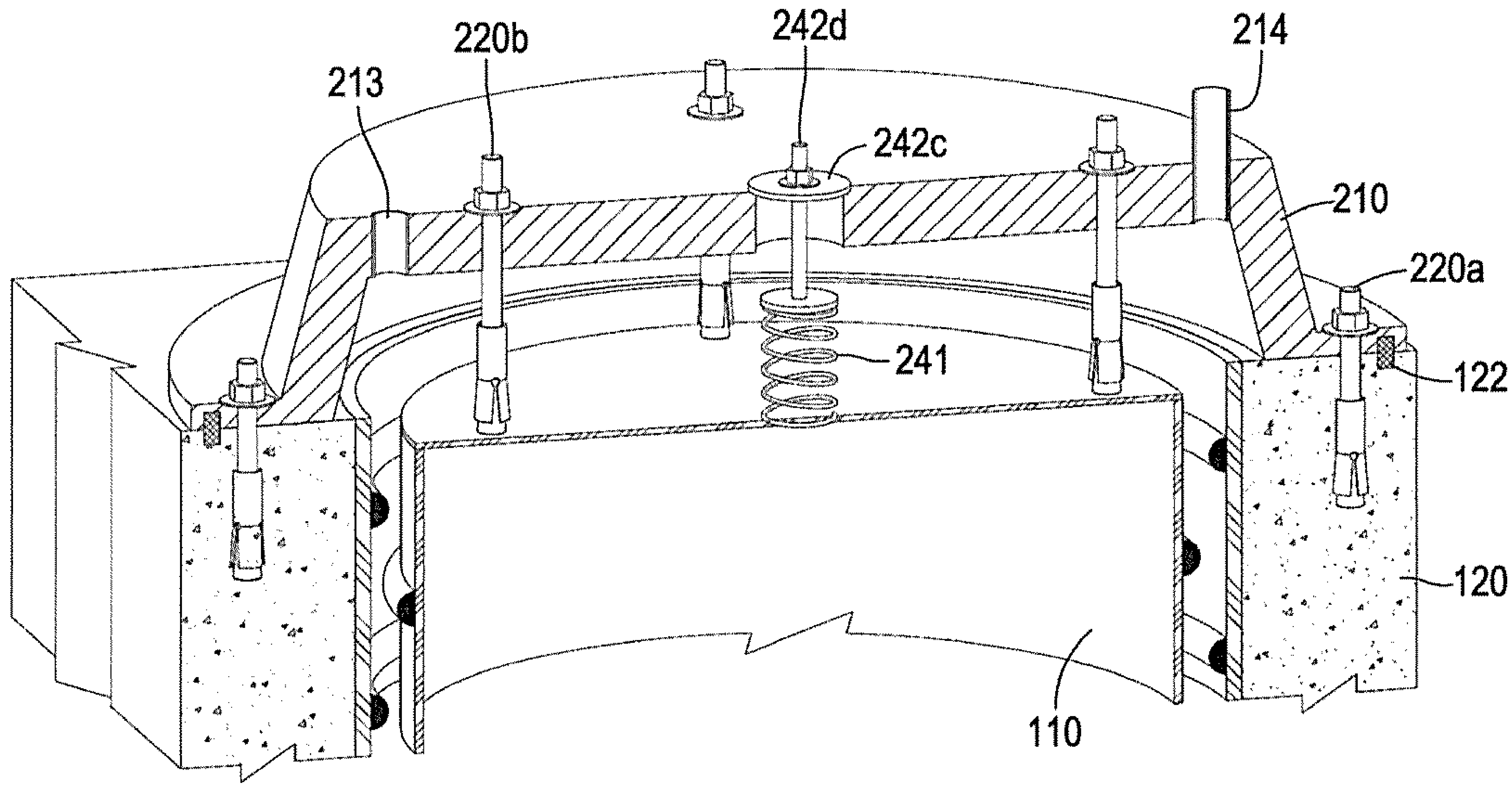


FIG. 3C

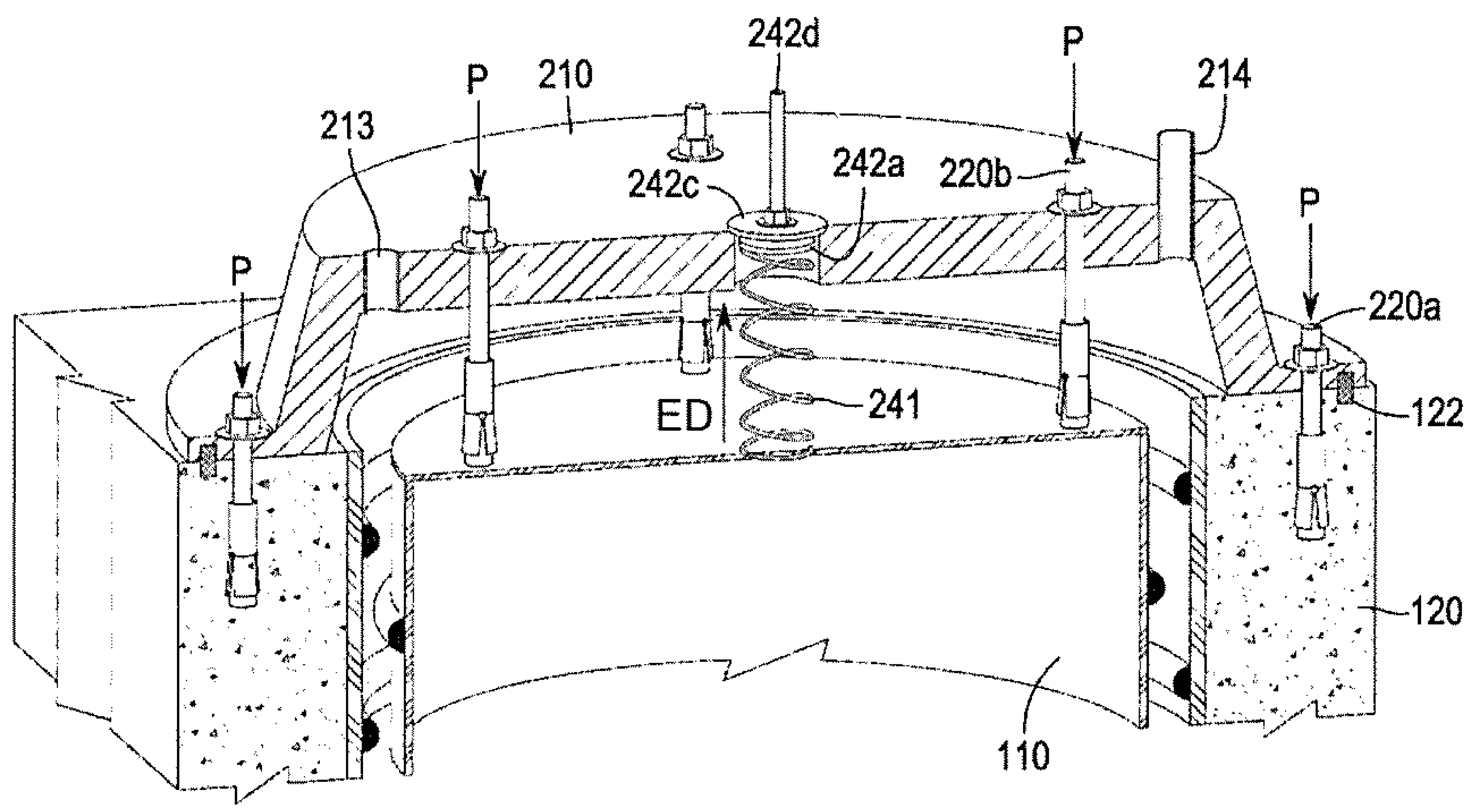


FIG. 3D

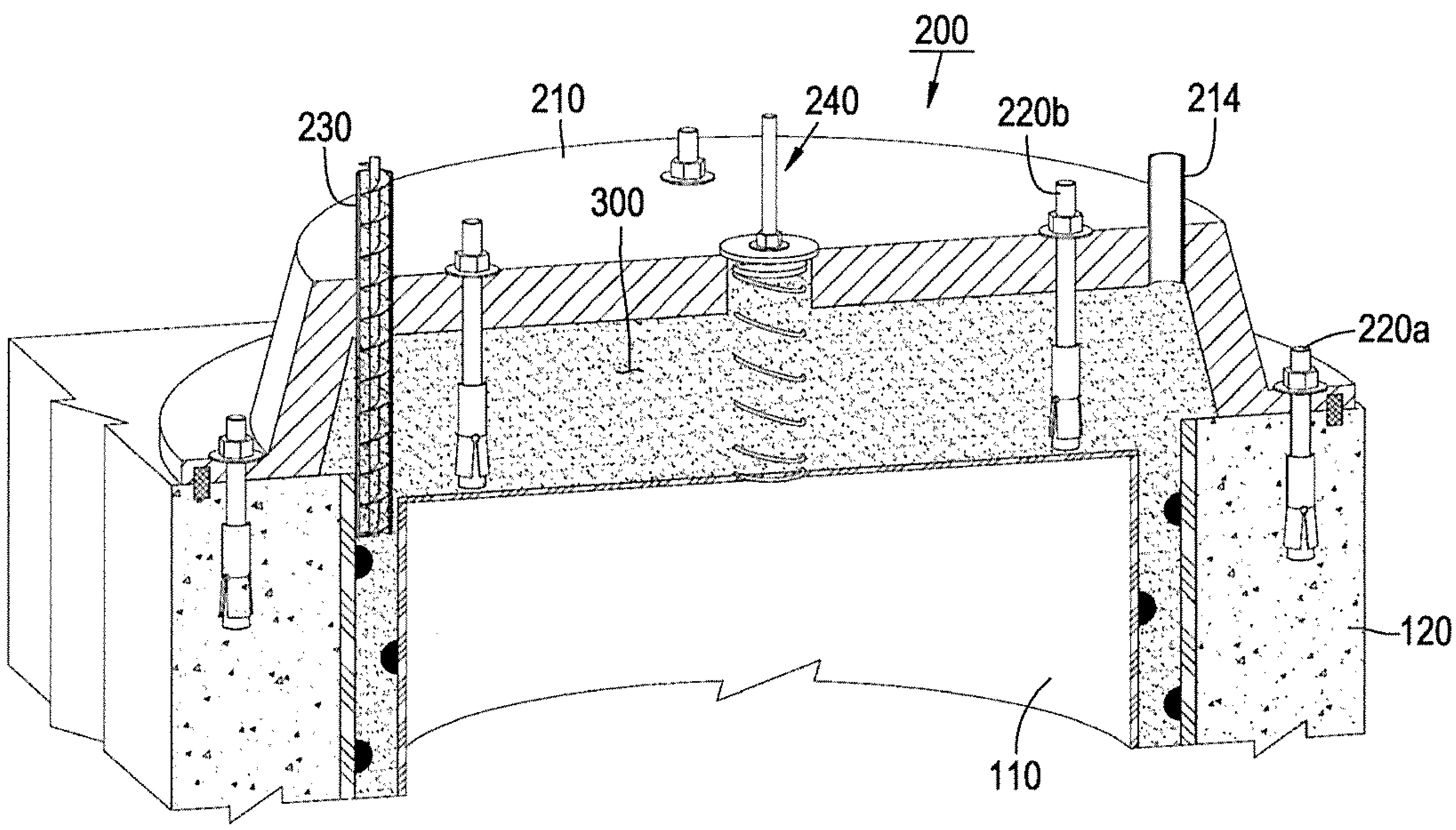


FIG. 3E

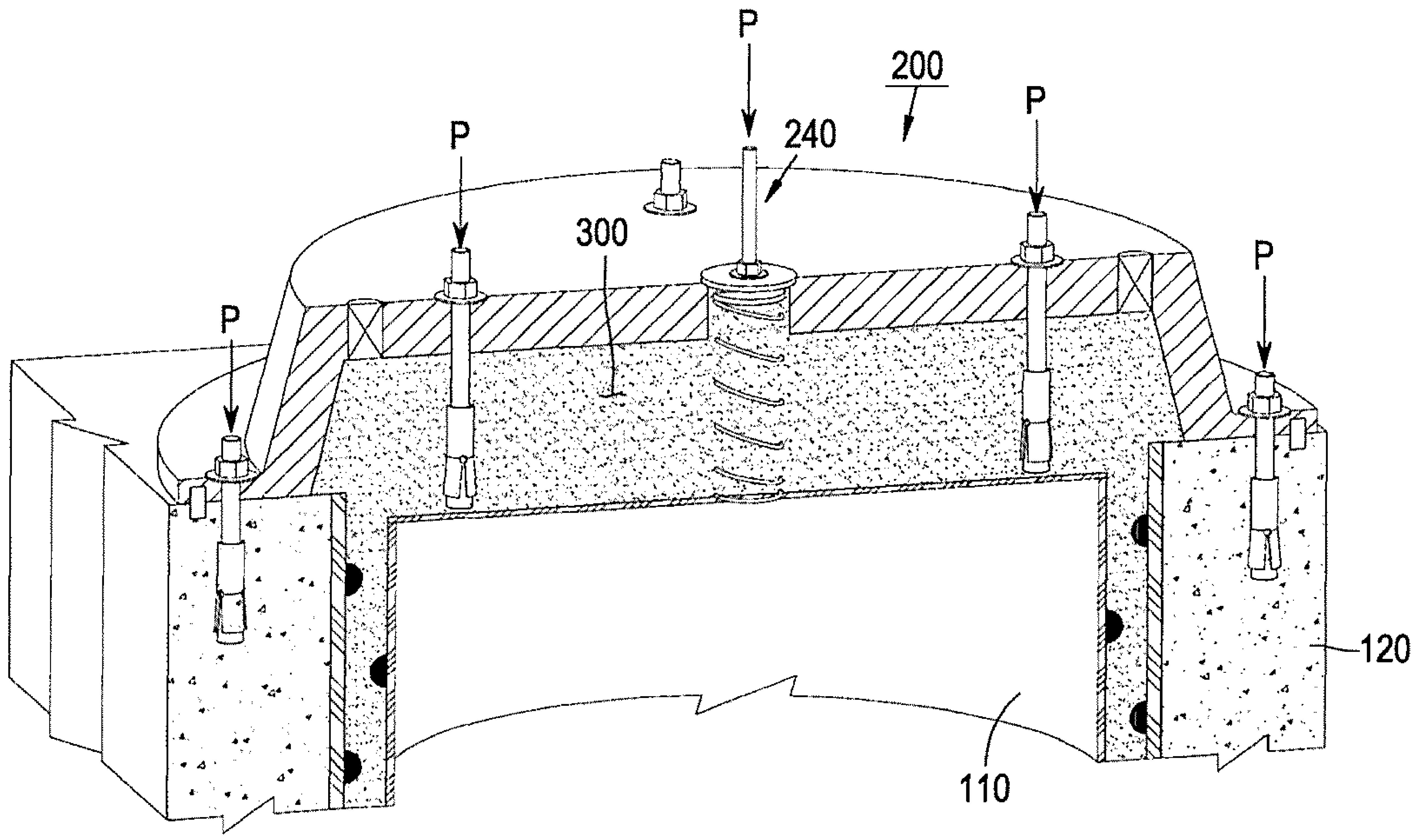


FIG. 3F

OFFSHORE WIND POWER FOUNDATION WITH IMPROVED WATER-TIGHTNESS AND CONSTRUCTION METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 2017-0057253, filed on May 8, 2017, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field of the Invention

The present invention relates to an offshore wind power foundation with improved water-tightness and a construction method thereof, and more specifically, to an offshore wind power foundation with improved water-tightness which is advantageous in constructability and quality management due to structural integrity and water-tightness required to inject a bonding material being secured when an offshore wind foundation is fixed to the seabed ground using a pile, and a construction method thereof.

2. Discussion of Related Art

FIG. **1A-1** and FIG. **1A-2** are respectively a perspective view and a cross-sectional view of a conventional offshore wind power generator concrete foundation structure.

The concrete foundation structure, which is installed on the seabed ground to support an upper structure including a nacelle for an offshore wind power generator, a blade, and a tower, includes:

a concrete structure **10** including a leg flange **11** having a plurality of shaft holes disposed at an outer circumference of a block-type body at regular intervals;

steel piles **12** inserted into and passing through the shaft holes to support the concrete structure **10** in a state in which the concrete structure **10** is fixed to the seabed ground, and installed in the seabed ground; and

a connector member **30** for dissimilar material synthesis reinforcement interposed between the shaft holes and the steel pile to form a synthesized structure of the steel pile and the concrete structure.

The connector member **30** includes steel sleeves **31** installed in the shaft holes to allow the steel piles to pass therethrough, and a grouting material **32** injected between the steel sleeve and the steel pile.

In this case, a welding bid **31**B and a stud **31**S are formed between the grouting materials **32** injected into a space between the steel sleeve and the steel pile to ensure synthesis performance.

In this case, since the injection of the grouting material **32** is performed under water, workability is degraded when the grouting material **32** is injected into a space between the steel sleeve and the steel pile. Thus, defects inevitably occur when quality control is not managed.

FIG. **1**B shows a unit for injecting the grouting material **32** of the conventional offshore wind power generator concrete foundation structure.

That is, it can be seen that the guide pipe cap **40** including an injection hole **41** and a discharge hole **42** allows the grouting material **32** to be press-fitted into the guide pipe cap **40** and inserted into the ground under a support structure foundation A.

In this case, when water-tightness is not secured when the guide pipe cap **40** is fixed to an upper surface of the support structure foundation A by an anchor bolt, a problem in which the grouting material **32** and seawater are mixed is caused.

Therefore, it is very important for the grouting material (a bonding material) to be press-fitted into a watertight space when the conventional offshore wind power foundation is fixed to the seabed ground using a pile, but since the press-fitting is performed under water, it is practically difficult for quality control to be managed, and a technology in which both structural integration of the pile, the guide pipe cap, and the offshore wind power foundation and water-tightness are secured is required.

(Patent Document 1) Korean patent No. 10-1595490 (Title: Support Concrete Structure Construction Method, Published on Feb. 18, 2016)

(Patent Document 2) Korean laid open patent No. 10-2016-0143599 (Title: Hybrid Type Concrete Foundation of Offshore Wind Turbine using Composite of Concrete and Steel Sleeve and Fabrication Method Thereof, Published on Dec. 14, 2016)

SUMMARY OF THE INVENTION

The present invention is directed to an offshore wind power foundation with improved water-tightness allowing quality control thereof to be easily managed by allowing a pile and a bonding material between a leg of the offshore wind power foundation and the pile to be processed under a water-tight condition when the offshore wind power foundation is fixed to the seabed ground using the pile, and a construction method thereof.

Further, the present invention is also directed to an offshore wind power foundation with improved water-tightness allowing stability of the offshore wind power foundation to be increased by securing water-tightness and applying pre-stress to a head of a pile from a leg of the wind power foundation such that a bonding force of the offshore wind power foundation and the pile is increased, and a construction method thereof

According to another aspect of the present invention, there is provided a method of constructing an offshore wind power foundation with improved water-tightness includes (a) a step of providing an offshore wind power foundation (**100**) having a lower end passing through a leg (**120**) from an upper surface of the leg (**120**), wherein a first front expanding anchor (**220***a*) is pre-installed at the upper surface of the leg (**120**) so that an upper end of the offshore wind power foundation (**100**) is exposed upward, (b) a step of mounting the offshore wind power foundation (**100**) on a seabed ground by inserting a hollow part of the leg (**120**) into a head of a pile (**110**) pre-constructed on a seabed surface and installing an elastic spring unit (**240**) including an elastic spring (**241**) having a lower end fixed to an upper surface of the finished pile, (c) a step of setting a precast cap member (**200**) on an upper surface of the leg (**110**) by allowing the first front expanding anchor (**220***a*) installed at the upper surface of the leg to pass through the flanges (**212**) of a precast housing (**210**) of the precast cap member (**200**), allowing a second front expanding anchor (**220***b*) to pass through a housing body (**211**) of the precast housing (**210**), and allowing an upper end of the elastic spring unit (**240**) to be set on a lower surface of the center of the housing body (**211**) of the precast housing (**210**), (d) a step of injecting a bonding material (**300**) into a space formed between the precast cap member (**200**), the pile (**100**), and the leg (**120**) through an injection port of the precast cap member (**200**) using a bonding material rotation-injection port (**230**) in a state in which a lower plate (**242***a*) integrated with an upper end of the elastic spring (**241**) extends upward, and (e) a step of increasing a water stopping effect (WS) by introducing a pre-stress (P) applied to the first front expanding anchor (**220***a*) downward by re-fastening an upper plate (**242***c*) of the elastic spring unit to an upper surface of the precast cap member (**200**) using a fixing nut (**242***d*), the upper plate (**242***c*) restraining an elastic spring using the bonding material (**300**) with secured strength as a support, and compressing the offshore wind power foundation (**100**) and the pile (**110**) by allowing the pre-stress (P) to also be introduced to the front expanding anchor (**220***b*).

According to another aspect of the present invention, there is provided a method of constructing an offshore wind power foundation with improved water-tightness includes (a) a step of providing an offshore wind power foundation (**100**) having a lower end passing through a leg (**120**) from an upper surface of the leg (**120**), wherein a first front expanding anchor (**220***a*) is pre-installed at the upper surface of the leg (**120**) so that an upper end of the offshore wind power foundation (**100**) is exposed upward, (b) a step of mounting the offshore wind power foundation (**100**) on a seabed ground by inserting a hollow part of the leg (**120**) into a head of a pile (**110**) pre-constructed on a seabed surface and installing an elastic spring unit (**240**) including an elastic spring (**241**) having a lower end fixed to an upper surface of the finished pile, (c) a step of setting a precast cap member (**200**) on an upper surface of the leg (**110**) by allowing the first front expanding anchor (**220***a*) installed at the upper surface of the leg to pass through the flanges (**212**) of a precast housing (**210**) of the precast cap member (**200**), allowing a second front expanding anchor (**220***b*) to pass through a housing body (**211**) of the precast housing (**210**), and allowing an upper end of the elastic spring unit (**240**) to be set on a lower surface of the center of the housing body (**211**) of the precast housing (**210**), (d) a step of injecting a bonding material (**300**) into a space formed between the precast cap member (**200**), the pile (**100**), and the leg (**120**) through an injection port of the precast cap member (**200**) using a bonding material rotation-injection port (**230**) in a state in which a lower plate (**242***a*) integrated with an upper end of the elastic spring (**241**) extends upward, and (e) a step of increasing a water stopping effect by introducing a pre-stress (P) applied to the first front expanding anchor (**220***a*) downward by re-fastening an upper plate (**242***c*) of the elastic spring unit to an upper surface of the precast cap member (**200**) using a fixing nut (**242***d*), the upper plate (**242***c*) restraining an elastic spring using the bonding material (**300**) with secured strength as a support, and compressing the offshore wind power foundation (**100**) and the pile (**110**) by allowing the pre-stress (P) to also be introduced to the front expanding anchor (**220***b*).

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent to those of ordinary skill in the art by describing exemplary embodiments thereof in detail with reference to the accompanying drawings, in which:

FIG. **1A-1** and FIG. **1A-2** are respectively a perspective view and a cross-sectional view of a conventional offshore wind power generator concrete foundation structure;

FIG. **1B** shows an example of a grouting material injection unit of the conventional wind power generator concrete foundation structure;

FIGS. **2A-1**, **2A-2**, **2A-3** and **2B** are a perspective view and three extracted views of an offshore wind power foundation parts with improved water-tightness of one embodiment of the present invention; and

FIGS. **3A** to **3F** are a flowchart of a construction method of the offshore wind power foundation with improved water-tightness of one embodiment of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Hereinafter, embodiments that are easily performed by those skilled in the art will be described in detail with reference to the accompanying drawings. However, the embodiments of the present invention may be implemented in several different forms, and are not limited to embodiments described herein. In addition, parts irrelevant to description will be omitted in the drawings to clearly explain the embodiments of the present invention. Similar parts will be denoted by similar reference numerals throughout this specification.

Throughout the specification, when a portion "includes" an element, the portion may include the element, and another element may be further included therein unless otherwise described.

[Offshore Wind Power Foundation Unit **100** with Improved Water-Tightness of the Present Invention]

FIGS. **2A-1**, **2A-2**, **2A-3** and **2B** are a perspective view and three extracted views of an offshore wind power foundation with improved water-tightness of one embodiment of the present invention.

The offshore wind power foundation **100** includes a pile **110**, a foundation **130** with a leg **120**, and a column **140**, and further includes a precast cap member **200** for injecting a bonding material **300** into an upper surface of the leg **120**.

The pile **110** is fixed to the seabed ground through the leg **120** of the offshore wind power foundation **100**, may use a steel pile and a concrete pile, and may support the precast cap member **200** through an elastic spring unit **240**, which will be described below, by finishing an upper surface as a horizontal surface.

The leg **120** has a vertical hollow shape formed at an outer circumferential surface of the foundation **130**, is a member allowing an upper end of the pile **110** to be inserted thereinto from a lower side, and is integrated with the foundation **130**.

The foundation **130** includes the leg **120** to be fixed to the seabed ground by the pile **110**, and the column **140** (a tower) may be installed above the foundation **130**.

A nacelle for an offshore wind power generator and a blade (not shown) are installed at an upper end of the column **140**, and a lower end of the column **140** is integrally installed with the foundation **130**.

Generally, the nacelle, a blade, and the column refer to an upper structure of the offshore wind power foundation, and the foundation with the leg and the pile is referred to as a lower structure thereof.

In this case, the upper end of the pile **110** is integrated with the leg **120** while being inserted into the leg **120**, and thus the upper end of the pile **110** is coupled to the leg **120** using a bonding material **300** (a grouting material) under water.

The bonding material **300** should be injected into a space between an inner surface of the leg and the pile **110** while water-tightness is secured, and the precast cap member **200** of the present invention can sufficiently secure water-tightness and integration (the offshore wind power foundation) of the foundation **130** with the leg **120** and the pile **110** by compressing the pile **110**.

As shown in FIGS. 2A-**1**, 2A-**2**, 2A-**3** and 2B, the precast cap member **200** includes a precast housing **210**, front expanding anchors **220** (**220***a* and **220***b*), a bonding material rotation injection port **230**, and an elastic spring unit **240**.

As shown in FIGS. 2A-**1**, 2A-**2**, 2A-**3** and 2B, the precast housing **210** includes a housing body **211** and a flange **212** and has a hat shape, and the flange **212** is supported on an upper surface B of the leg **120**.

The precast housing **210** should be manufactured of a steel material, but may be manufactured of precast concrete to secure a weight thereof.

As shown in FIGS. 2A-**1**, 2A-**2**, 2A-**3** and 2B, the front expanding anchors **220** have a difference between positions, that is, the front expanding anchors **220** are positioned at the upper surface of the leg **120** or the precast housing **210**, but the same front expanding anchors **220** are used.

The front expanding anchor **220***a* installed at the upper surface of the leg **120** passes through the flange **212** of the precast housing **210**, and has an upper end fixed to the flange **212** of the precast housing **210** by a fastening member, such as a nut, and a front end formed as an expansion front end with an expanded diameter to be embedded in the leg **120** such that a pull-out force is efficiently resisted.

Next, the front expanding anchor **220***b* installed in the precast housing passes through the housing body **211** of the precast housing **210** via a fastening port, such as a nut, and has an upper end fixed to the housing body **211** of the precast housing **210** and a front end formed as an expansion front end with an expanded diameter to be embedded in the bonding material **300** injected into the precast housing **210** to be set to be supported by the upper surface of the pile **110**.

As shown in FIGS. 2A-**1**, 2A-**2**, 2A-**3** and 2B, the bonding material rotation injection port **230** is inserted into an injection port **213** so that the bonding material **300** is injected along a bonding material injection direction BMI into a space between the pile **110** and the leg **120** and the lower portion of the precast housing **210**, and the injection port **213** and a discharge port **214** are formed at the housing body **211** of the precast housing **210**.

Since many intervening factors due to water pressure are generated when the bonding material **300** is injected into the space using pumping under water, the bonding material **300** passes through the injection port **213** of the precast housing **210**, and the bonding material rotation injection port **230** with an open lower portion is used in the space of the injection port **213**.

In this case, the injection port **213** is formed as a hole passing through the housing body **211**, and the discharge port **214** is formed as a hole functioning as an observation hole through which observation is performed so that the bonding material **300** may be hermetically injected into the space.

The bonding material rotation injection port **230** includes an inner pipe **231**, an outer pipe **233**, and an upper fixing cap **242**.

First, the outer pipe **231** has a diameter to be inserted into the injection port **213**. The bonding material **300** may not be injected when negative pressure is generated when the bonding material **300** is directly injected into the outer pipe **233**.

Therefore, the inner pipe **231** having a rotating blade **232** formed at an outer circumferential surface thereof is inserted into the outer pipe **233**, and the bonding material **300** is rotation-injected by the rotating blade **232** as the rotating blade **232** is rotated.

Therefore, the bonding material **300** is injected into the inner pipe **231** of the bonding material rotation injection port **230** through a separated pipe.

The elastic spring unit **240** may increase a bonding force of the offshore wind power foundation **100** and the pile **110** by introducing a pre-stress to the front expanding anchors **220***a* and **220***b* using the bonding material **300** with strength injected through the precast cap member **200** as a support to increases stability of the structure.

Therefore, as shown in FIGS. 2A-**1**, 2A-**2**, 2A-**3** and 2B, the elastic spring unit **240** includes an elastic spring **241** and the upper fixing cap **242**.

That is, the precast housing **210** has a hat shape and has a through hole formed in the center of the housing body **211** so that an upper end of the elastic spring **241** is inserted through the through hole to be positioned at an upper surface of the housing body **211** by the upper fixing cap **242**.

Therefore, the elastic spring **241** may uses a steel spring, and the upper fixing cap **242** includes a lower plate **242***a*, an upper plate fixing bolt **242***b*, an upper plate **242***c*, and a fixing nut **242***d* that are installed above the elastic spring **241**.

That is, the upper plate fixing bolt **242***b*, the upper plate **242***c*, and the fixing nut **242***d* are integrated with the upper end of the elastic spring **241** and are fixed and attached to the housing body **211** of the precast housing **210** and the elastic spring **241**.

Therefore, the lower plate **242***a* is integrated with an upper surface of the elastic spring **241**, and the upper plate **242***c* is fixed to an upper surface of the center of the lower plate **242***a* and has the upper plate fixing bolt **242***b* extending upward therethrough.

The upper plate **242***c* is supported on the upper surface of the housing body **211** of the precast housing **210**.

The fixing nut **242***d* is rotation-fastened to the upper plate fixing bolt **242***b* and is configured to maintain a state in which the upper plate **242***c* is pressed onto the upper surface of the housing body **211** of the precast housing **210**.

The bonding material **300** is injected into a space between a lower portion of the precast cap member **200** and the pile, and a space between a sleeve, which is a steel plate formed on an inner surface of the leg **120**, and the pile **110** by the bonding material rotation injection port **230** of the precast cap member **200** fixed to an upper surface of the leg **120**, and uses a grouting material.

The bonding material **300** is injected through the injection port by the bonding material rotation injection port **230**, and is injected using pressure and rotation.

[Method of Constructing Offshore Wind Power Foundation **100** with Improved Water-Tightness]

FIGS. 3A to 3F are a flowchart of a construction method of the offshore wind power foundation with improved water-tightness of one embodiment of the present invention.

The offshore wind power foundation **100** pre-manufactured on the ground is constructed so that an upper end of the pile **110** pre-constructed at a position to be constructed using a barge and the like is inserted into the leg **120**, a tower of the offshore wind power foundation **100** extends above a sea surface, and a nacelle and blade are installed at an upper end of the tower.

The present invention will be described on the basis of the pile **110**, the leg **120**, the precast cap member **200**, and the bonding material **300**.

First, as shown in FIG. **3**A, the front expanding anchor **220***a* is pre-installed at the leg **120** of the offshore wind power foundation **100** pre-manufactured on the ground.

A lower end of the front expanding anchor **220***a* installed at an upper surface of the leg is installed to pass through the leg from an upper surface of the leg **120**, and an upper end to the front expanding anchor **220***a* is exposed upward.

Further, the sleeve **121** is formed at an inner surface of a hollow part of the leg **120**, and a protrusion is further formed on the sleeve **121** such that synthetic performance with the bonding material **300** can be secured.

Next, as shown in FIG. **3**B, in the offshore wind power foundation **100** transferred to the sea, a hollow part of the leg **120** is inserted into a head of the pile **110** pre-installed on the seabed ground, and the offshore wind power foundation **100** is finally seated on the seabed ground. Therefore, an upper surface of the pile **110** is seated to be almost in line with an upper surface of the leg **120**.

Therefore, since the upper surface of the pile **110** is finished, the elastic spring unit **240** is installed. That is, a lower end of the elastic spring unit **240** is set to be supported and fixed to the upper surface of the pile **110**.

That is, the lower plate **242***a* is integrated with an upper surface of the elastic spring **241**, the upper plate fixing bolt **242***b* extending from an upper surface of the center of the lower plate **242***a* passes through the upper plate **242***c*, and the fixing nut **242***d* is rotation-fastened to the upper plate fixing bolt **242***b*.

Next, as shown in FIG. **3**C, the precast housing **210** of the precast cap member **200** is set on the upper surface of the leg **120**.

That is, the front expanding anchor **220***a* installed at an upper surface of the leg passes through the flange **212** of the precast housing **210** constituting the precast cap member **200**.

The front expanding anchor **220***b* passes through the through hole formed at the housing body **211** of the precast housing **210**, and a front end thereof is supported at the upper surface of the pile.

The upper plate **242***c* and the upper plate fixing bolt **242***b* of the elastic spring unit **240** are inserted from a bottom of the through hole formed in the center of the housing body **211** of the precast housing **210** into the through hole, and the upper plate **242***c* is set to be supported at an upper surface of the center of the housing body **211**.

In this case, the flange **212** of the precast housing **210** secures water-tightness of the inner space of the precast cap member **200** using a water stopping material **122**, which is not shown, on the upper surface of the leg **120**, and an uneven part with or instead of the water stopping material **122** may be formed at the upper surface of the leg and the flange **212** to improve water stopping functionality.

Also, the injection port **213** and the discharge port **214** are formed at the housing body **211** of the precast housing **210**.

Next, as shown in FIG. **3**D, the lower plate **242***a* integrated with an upper end of the elastic spring **241** extends upward along an extending direction ED. That is, the upper plate fixing bolt **242***b* fixed to the upper surface of the center of the lower plate **242***a* extends upward by unfastening the fixing nut **242***d*, and the lower plate and the elastic spring **241** extend.

Next, as shown in FIG. **3**E, the bonding material **300** is injected in a state in which the lower plate **242***a* extends upward.

Water-tightness of the precast cap member **200** is secured by the water stopping material **122**, and thus the bonding material **300** may be injected without an effect of a tide and the like at a still-water level.

The bonding material **300** is integrated with the precast cap member **200**, the pile **110**, and the leg **120** as a grouting material and, as described above, is hermetically injected into a space between an inner surface of the leg **120** and an outer surface of the pile **110**, and a space between the precast cap member **200** and the upper surface of the pile using the bonding material rotation injection port **230** including the outer pipe **233**, the inner pipe **231**, and the upper fixing cap **242**.

As shown in FIG. **3**F, when the bonding material **300** has sufficient strength (curing), the fixing nut **242***d* is set so that the upper plate **242***c* is supported on the upper surface of the center of the housing body **211** using the bonding material **300** as a support. Therefore, the front expanding anchor **220***a* allowing a downwardly applied pre-stress to be introduced such that a water stopping effect (WS) is further increased. A pre-stress P is also introduced to the front expanding anchor **220***b* so that the offshore wind power foundation **100** and the pile **110** are efficiently compressed (increase bonding).

Therefore, when the bonding material **300** is finally cured, the precast cap member **200**, the leg **120**, and the pile **110** are efficiently integrated and compressed, and the injection port and the discharge port are finished.

Although not shown, the tower is installed at the offshore wind power foundation **100**, and the nacelle and the blade are mounted at the upper portion of the exposed tower so that the offshore wind power generator may be constructed.

According to the offshore wind power foundation with improved water-tightness and a construction method thereof, a precast cap member is installed at a pile and an upper end of an offshore wind power foundation bonding part to maintain a stillwater level, and thus prevents a bonding material from being lost due to a tide.

Further, the precast cap material functioning as a conventional guide pipe cap is installed to block a tide and the bonding material from coming into direct contact, and thus prevents the bonding material from being lost and prevents contamination caused by leakage of the bonding material.

Further, after a front expanding anchor is installed in the offshore wind power foundation and the pile and the bonding material (the grouting material) is prepared, a pre-stress is introduced to the front expanding anchor using the precast cap member as a support to increase a bonding force of the offshore wind power foundation and the pile and increase stability of a structure.

Further, the elastic spring unit is installed at an upper end of the pile, a bonding material is prepared in a state in which an elastic spring installed at an upper end of the pile extends using the precast cap member as a support, and a tensile force introduced to the elastic spring unit is released when the bonding material exerts sufficient strength so that the pre-stress introduced to the offshore wind power foundation and the pile is introduced to increase a bonding force of the offshore wind power foundation and the pile and increase stability of the structure.

Further, an inner pipe and outer pipe separation-type bonding material rotation injection port having a rotating blade attached to the inside of the outer pipe is installed and the bonding material is injected via the rotating blade when a bonding material is injected, thereby preventing material separation due to freefall and hermetically pouring the bonding material so that quality of the bonding material can be secured.

Further, an observation port, which is an injection port and a discharge port is installed at an upper portion of the precast cap member to allow a condition of the filled bonding material to be directly checked such that construction and management of the bonding material can be easy and quality of the bonding material can be secured.

Further, an uneven part or a water stopping material is installed at an upper surface of the precast cap member and the offshore wind power foundation to secure water-tightness of a contact surface between the precast cap member and the offshore wind power foundation such that water-tightness can be increased.

The above description is only exemplary, and it should be understood by those skilled in the art that the invention may be performed in other concrete forms without changing the technological scope and essential features. Therefore, the above-described embodiments should be considered only as examples in all aspects and not for purposes of limitation. For example, each component described as a single type may be realized in a distributed manner, and similarly, components that are described as being distributed may be realized in a coupled manner.

The scope of the present invention is defined not by the detailed description but by the appended claims, and encompasses all modifications or alterations derived from meanings, the scope, and equivalents of the appended claims.

What is claimed is:

1. An offshore wind power foundation with improved water-tightness, configured such that a bonding material is injected into a space between a pile and a leg using a precast cap member to integrate the leg and the pile, wherein the precast cap member comprising:

a precast housing, comprising flanges fixed to an upper surface of the leg by a first front expanding anchor and a housing body formed between the flanges;

a bonding material rotation injection port, being an inner pipe having a rotating blade inserted into an outer pipe and formed at an outer circumferential surface of the inner pipe, wherein the bonding material is rotation-injected into the space between the pile and the leg through the injection port formed in the housing body via the rotating blade; and

an elastic spring unit, configured to extend an elastic spring installed between the housing body of the precast housing and an upper surface of the pile upward, fix the elastic spring to an upper surface of the housing body via an upper fixing cap, and allow a downwardly applied pre-stress to be introduced to the first front expanding anchor using the injected bonding material as a support,

wherein the elastic spring unit includes the elastic spring set so that an upper end of the elastic spring unit is inserted into a through hole formed in the housing body of the precast housing and the upper fixing cap formed at the upper surface of the housing body, and the upper fixing cap includes a lower plate integrated with an upper surface of the elastic spring, an upper plate fixed to an upper surface of a center portion of the lower plate and having an upper plate fixing bolt extending upward and passing therethrough, and a fixing nut rotation-fastened to the upper plate fixing bolt and configured to maintain a state in which the upper plate is pressed onto the upper surface of the housing body of the precast housing.

2. The offshore wind power foundation of claim **1**, wherein the precast housing further comprises a second front expanding anchor between the housing body and the upper surface of the pile to integrate the pile and the offshore wind power foundation via the downwardly applied pre-stress due to the elastic spring using the bonding material injected into the precast housing and the pile.

3. The offshore wind power foundation of claim **1**, wherein the flanges of the precast housing are configured to secure water-tightness of an inner space of the precast cap member using an uneven part or a water stopping material on the leg in addition to the pre-stress introduced to the first front expanding anchor.

4. A method of constructing an offshore wind power foundation with improved water-tightness, the method comprising:

(a) a step of providing an offshore wind power foundation having a lower end passing through a leg from an upper surface of the leg, wherein a first front expanding anchor is pre-installed at the upper surface of the leg so that an upper end of the offshore wind power foundation is exposed upward;

(b) a step of mounting the offshore wind power foundation on a seabed ground by inserting a hollow part of the leg into a head of a pile pre-constructed on a seabed surface and installing an elastic spring unit including an elastic spring having a lower end fixed to an upper surface of the finished pile;

(c) a step of setting a precast cap member on an upper surface of the leg by allowing the first front expanding anchor installed at the upper surface of the leg to pass through flanges of a precast housing of the precast cap member, allowing a second front expanding anchor to pass through a housing body of the precast housing, and allowing an upper end of the elastic spring unit to be set on a lower surface of a center portion of the housing body of the precast housing;

(d) a step of injecting a bonding material into a space formed between the precast cap member, the pile, and the leg through an injection port of the precast cap member using a bonding material rotation-injection port in a state in which a lower plate integrated with an upper end of the elastic spring extends upward; and

(e) a step of increasing a water stopping effect by introducing a pre-stress applied to the first front expanding anchor downward by re-fastening an upper plate of the elastic spring unit to an upper surface of the precast cap member using a fixing nut, the upper plate restraining an elastic spring using the bonding material with secured strength as a support, and compressing the offshore wind power foundation and the pile by allowing the pre-stress to also be introduced to the second front expanding anchor.

5. The method of claim **4**, wherein the precast cap member in step (c) comprises:

the precast housing, including the flanges fixed to the upper surface of the leg by the first front expanding anchor and the housing body formed between the flanges;

the bonding material rotation injection port, being an inner pipe having an outer circumferential surface at which a rotating blade inserted into an outer pipe is formed; and

the elastic spring unit, configured to extend the elastic spring installed between the housing body of the precast housing and an upper surface of the pile upward, fix the elastic spring to an upper surface of the housing body via an upper fixing cap, and allow the downwardly applied pre-stress to be introduced to the first front expanding anchor using the injected bonding material as a support.

6. The method of claim **5**, wherein:

in the step (c), the pre-stress of step (e) extends the lower plate integrated with the upper end of the elastic spring upward and extends the lower plate and the elastic spring by extending an upper plate fixing bolt, which is fixed to an upper surface of a center portion of the lower plate, upward by the fixing nut being unfastened; and

in the step (d), the pre-stress couples the upper plate of the elastic spring unit configured to restrain the elastic spring using the injected bonding material with secured strength as a support to the upper surface of the precast cap member by the fixing nut to introduce the downwardly applied pre-stress to the first front expanding anchor.

7. The method of claim **6**, wherein:

the elastic spring unit in the step (c) comprises the elastic spring having an upper end inserted into a through hole formed on the housing body of the precast housing, and an upper fixing cap formed at the upper surface of the housing body; and

the upper fixing cap comprises the lower plate integrated with an upper surface of the elastic spring, the upper plate fixed to the upper surface of the center portion of the lower plate and the upper plate fixing bolt extending upward and passing therethrough, and the fixing nut configured to be rotation-fastened to the upper plate fixing bolt and maintain a state in which the upper plate is pressed onto the upper surface of the housing body of the precast housing.

8. The method of claim **4**, wherein the bonding material rotation-injection port in the step (d) is an inner pipe having an outer circumferential surface to which a rotating blade inserted into an outer pipe is formed, and allows the bonding material to be rotation-injected into a space between the pile and the leg through an injection port formed in the housing body by the rotating blade.

9. The method of claim **4**, wherein:

in the step (d), whether the bonding material is injected is measured through a discharge port formed in the precast cap member; and

in the precast housing of the precast cap member, the flanges secure water-tightness of an inner space of the precast cap member by using a water stopping material or an uneven part on the upper surface of the leg.

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