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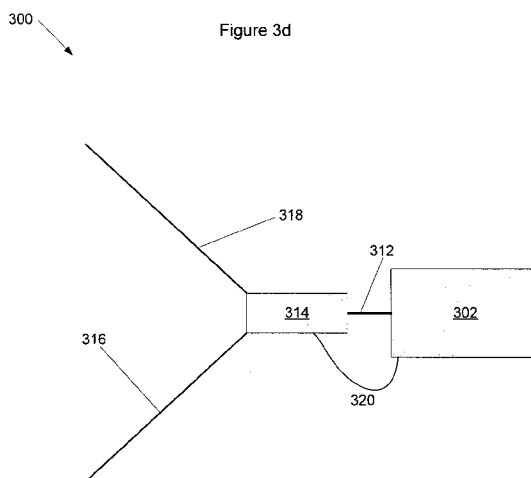
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(54) Title: VESSEL MOORING SYSTEMS AND METHODS



(57) Abstract: A mooring system comprising a structure in a body of water; a vessel in the body of water; a first anchor in the body of water; a second anchor in the body of water; a first line connecting the first anchor and the vessel; a second line connecting the second anchor and the vessel; and a third line connecting the structure and the vessel.

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VESSEL MOORING SYSTEMS AND METHODS

Field of the Invention

The invention relates generally to vessel mooring systems and methods. In particular, the invention relates to vessel mooring systems and methods to connect a vessel to another structure.

Summary of the Invention

In one aspect, the invention relates to a mooring system comprising a structure in a body of water; a vessel in the body of water; a first anchor in the body of water; a second anchor in the body of water; a first line connecting the first anchor and the vessel; a second line connecting the second anchor and the vessel; and a third line connecting the structure and the vessel.

Advantages of the invention include one or more of the following:

- Vessel mooring systems and methods with lower operating costs;
- Vessel mooring systems and methods with lower capital costs;
- Vessel mooring systems and methods with a lower risk of disconnecting;
- Vessel mooring systems and methods which enable faster connection and disconnection;

Other aspects and/or advantages of the invention will be apparent from the following description and the appended claims.

Brief Description of Drawings

- Figure 1 is a side view of a vessel mooring system.
- Figure 2 is a side view of a vessel mooring system.
- Figure 3a is a side view of a vessel mooring system.
- Figure 3b is a top view of a vessel mooring system.
- Figure 3c is a side view of a vessel mooring system.
- Figure 3d is a top view of a vessel mooring system.
- Figure 4 is a side view of a vessel mooring system.
- Figure 5 is a side view of a vessel mooring system.
- Figure 6 is a side view of a vessel mooring system.

Detailed Description of the InventionFigure 1

Referring now to Figure 1, there is illustrated system 100. System 100 includes offshore structure 102 in body of water 104 with seafloor 106. As illustrated, structure 102 is a floating structure with catenary mooring lines 108. When it is desired to load or unload materials through a line 112, such as liquids or gases, vessel 114 connects to line 116, which is connected to buoy 110, which is connected to line 112. Buoy may also be provided with a hawser to connect the vessel 114 to buoy 110. Buoy 110 may be located a distance from structure 102 so that there is limited danger of contact between structure 102 and vessel 114. Although this approach provides for a safe transfer system between structure 102 and vessel 114, it requires the construction of line 112 and buoy 110. Buoy may have station-keeping capabilities by the use of one or more mooring lines.

Figure 2

Referring now to Figure 2, there is illustrated system 200. System 200 includes offshore structure 202 in body of water 204 with seafloor 206. As illustrated, structure 202 is a floating structure with catenary mooring lines 208. When it is desired to load or unload materials through line 212, such as liquids or gases, vessel 214 connects to line 212, and one or more other smaller vessels 216 may be used to keep vessel 214 on station so that there is limited danger of contact between structure 202 and vessel 214. One or more lines, such as towing lines, may be used to connect vessels 214 and 216. Structure 202 may also be provided with a hawser to connect the vessel 214 to structure 202. Although this approach provides for a safe transfer system between structure 202 and vessel 214, it requires the use of one or more additional vessels 216.

U.S. Patent Number 6,983,712 discloses a mooring arrangement between a floating storage body spread moored in deep water and a shuttle tanker, the arrangement including a single point buoyant member that is adapted for mooring a shuttle tanker in offloading position relative to a floating production, storage and offloading vessel (FPSO) with a link between the floating storage body and the single point buoyant member. One embodiment employs a submerged yoke, having one end rotatably coupled to a FPSO and a second end, supported by a buoy. A mooring hawser extends from the buoy to the shuttle tanker and product

hoses connect the shuttle tanker with the FPSO and extend along the submerged yoke. The mooring buoy may be stationed by a hold-back mooring system and the FPSO or the tanker or both is provided with a traction device to move the tanker into loading position with respect to the FPSO. U.S. Patent Number 6,983,712 is
5 herein incorporated by reference in its entirety.

There is a need in the art for improved vessel mooring systems and methods. There is a need in the art for lower operating cost vessel mooring systems and methods. There is a need in the art for lower capital cost vessel mooring systems and methods.

10 Figures 3a – 3d

Referring now to Figure 3a, there is illustrated system 300. System 300 includes offshore structure 302 in body of water 304 with seafloor 306. Structure 302 could be a floating structure such as an FPSO, a spar, a TLP, a ship, a semi-submersible, or other floating structures as are known in the art. Structure 302
15 could be connected to the sea floor with catenary or taut mooring lines. Alternatively, structure could be a fixed structure such as a pier, tower or platform which rests on the sea floor 306.

As illustrated, structure 302 is a floating structure with catenary mooring lines 308. When it is desired to load or unload materials from structure 302, such
20 as liquids or gases, a vessel may be connected to lines 312, 316, and 318 to keep the vessel on station so that there is limited danger of contact between structure 302 and the vessel. Line 316 may be connected to line locator buoy 320, and line 318 may be connected to line locator buoy 322. Locator buoys 320 and 322 may be used by a vessel to locate the lines 316 and 318, and/or to guide the approach
25 of the vessel towards structure 302.

As illustrated in Figure 3b, there is shown a top view of vessel 314, which may travel in direction of arrow 315 between buoys 320 and 322 towards structure 302 and line 312. As vessel 314 pulls alongside buoy 320, it can pull up buoy 320 and connect to line 316. Similarly, as vessel 314 pulls alongside buoy 322, it can
30 pull up buoy 322 and connect to line 318. Then vessel 314 can approach and connect to line 312, and pull all the lines 316, 318, and 312 taut, then transfer to vessel 314 from structure 302, and/or from vessel 314 to structure 302.

As illustrated in Figure 3c, vessel 314 is shown connected to line 312, with all the lines 316, 318, and 312 taut, so that a transfer can be made to vessel 314 from structure 302, and/or from vessel 314 to structure 302. Figure 3d shows a top view of vessel 314 connected to lines 316, 318, and 312, with hose 320 being
5 used to transfer fluids to and/or from structure 302 to and/or from vessel 314.

Figure 4

Referring now to Figure 4, there is illustrated system 400. System 400 includes offshore structure 402 in body of water 404 with seafloor 406. Structure 402 could be a floating structure such as an FPSO, a spar, a TLP, a ship, a semi-
10 submersible, or other floating structures as are known in the art. Structure 402 could be connected to the sea floor with catenary or taut mooring lines. Alternatively, structure could be a fixed structure such as a pier, tower or platform which rests on the sea floor 406.

As illustrated, structure 402 is a floating structure with taut mooring lines
15 408. When it is desired to load or unload materials from structure 402, such as liquids or gases, a vessel may be connected to lines 412, 440, and 442 to keep the vessel on station so that there is limited danger of contact between structure 402 and the vessel. Line 416 may be connected to buoy 420, and line 418 may be connected to buoy 422. Buoys 420 and 422 may be used by a vessel to locate the
20 lines 440 and 442, and/or to guide the approach of the vessel towards structure 402.

Buoy 420 may be used to keep line 416 taut, while line 440 is slack. Likewise, buoy 422 may be used to keep line 418 taut, while line 442 is slack. In operation, a vessel approaches buoy 420 and locates line 440 and attaches it to
25 the vessel. The vessel then approaches buoy 422 and locates line 442 and attaches it to the vessel. Then the vessel approaches line 412 and attaches it to the vessel. Structure 402 and/or the vessel may be provided with a winch or other tightening mechanism to add tension to line 412 and pull the vessel to a desired location, which also tightens lines 440 and 442 to keep the vessel on station.

30 After the completion of the operations, line 412 may be loosened, and all of the lines 412, 440, and 442 disconnected from the vessel, so that the vessel can leave the location after loading and/or unloading.

Figure 5

Referring now to Figure 5, there is illustrated system 500. System 500 includes offshore structure 502 in body of water 504 with seafloor 506. Structure 502 could be a floating structure such as an FPSO, a spar, a TLP, a ship, a semi-submersible, or other floating structures as are known in the art. Structure 502 could be connected to the sea floor with catenary or taut mooring lines. Alternatively, structure could be a fixed structure such as a pier, tower or platform which rests on the sea floor 506.

As illustrated, structure 502 is a floating structure with taut mooring lines 508. When it is desired to load or unload materials from structure 502, such as liquids or gases, a vessel may be connected to lines 512, 540, and 542 to keep the vessel on station so that there is limited danger of contact between structure 502 and the vessel. Line 516 may be connected to buoy 520, and line 518 may be connected to buoy 522. Line 540 may be connected between buoys 520 and 541, and line 542 may be connected between buoys 522 and 543. Buoys 541 and 543 may be used by a vessel to locate the lines 540 and 542, and/or to guide the approach of the vessel towards structure 502.

Buoy 520 may be used to keep line 516 taut, while line 540 is slack since line 540 is longer than the vertical distance between buoys 520 and 541. Likewise, buoy 522 may be used to keep line 518 taut, while line 542 is slack since line 542 is longer than the vertical distance between buoys 522 and 543.

In operation, a vessel approaches buoy 541 and locates line 540 and attaches line 540 to the vessel. The vessel then approaches buoy 543 and locates line 542 and attaches line 542 to the vessel. Then the vessel approaches line 512 and attaches it to the vessel. Structure 502 and/or the vessel may be provided with a winch or other tightening mechanism to add tension to line 512 and pull the vessel to a desired location, which also tightens lines 540 and 542 to keep the vessel on station. Alternatively, a smaller vessel may be used to locate the lines, and pull them to the larger vessel to be attached and tightened.

After the completion of the operations, line 512 may be loosened, and all of the lines 512, 540, and 542 disconnected from the vessel, so that the vessel can leave the location after loading and/or unloading.

Figure 6

Referring now to Figure 6, there is illustrated system 600. System 600 includes offshore structure 602 in body of water 604 with seafloor 606. Structure 602 could be a floating structure such as an FPSO, a spar, a TLP, a ship, a semi-submersible, or other floating structures as are known in the art. Structure 602 could be connected to the sea floor with catenary or taut mooring lines. Alternatively, structure could be a fixed structure such as a pier, tower or platform which rests on the sea floor 606.

As illustrated, structure 602 is a floating structure with taut mooring lines 608. When it is desired to load or unload materials from structure 602, such as liquids or gases, a vessel may be connected to lines 612, 640, and 642 to keep the vessel on station so that there is limited danger of contact between structure 602 and the vessel. Line 616 may be connected to buoy 620, and line 618 may be connected to buoy 622. Line 650 may be connected between buoys 620 and 622. Line 640 may be connected between line 650 and buoy 641, and line 642 may be connected between line 650 and buoy 643. Line 640 may be connected to line 650 at a point closer to buoy 620 than 622. Line 642 may be connected to line 650 at a point closer to buoy 622 than 620. Buoys 641 and 643 may be used by a vessel to locate the lines 640 and 642, and/or to guide the approach of the vessel towards structure 602.

Buoy 620 may be used to keep line 616 taut, while line 640 is slack since line 640 is longer than the vertical distance between line 650 and buoy 641. Likewise, buoy 622 may be used to keep line 618 taut, while line 642 is slack since line 642 is longer than the vertical distance between line 650 and buoy 643.

In operation, a vessel approaches buoy 641 and locates line 640 and attaches line 640 to the vessel. The vessel then approaches buoy 643 and locates line 642 and attaches line 642 to the vessel. Then the vessel approaches line 612 and attaches it to the vessel. Structure 602 and/or the vessel may be provided with a winch or other tightening mechanism to add tension to line 612 and pull the vessel to a desired location, which also tightens lines 640 and 642 to keep the vessel on station. Alternatively, a smaller vessel may be used to locate the lines, and pull them to the larger vessel to be attached and tightened.

After the completion of the operations, line 612 may be loosened, and all of the lines 612, 640, and 642 disconnected from the vessel, so that the vessel can leave the location after loading and/or unloading.

Illustrative Embodiments

5 In one embodiment, there is disclosed a mooring system comprising a structure in a body of water; a vessel in the body of water; a first anchor in the body of water; a second anchor in the body of water; a first line connecting the first anchor and the vessel; a second line connecting the second anchor and the vessel; and a third line connecting the structure and the vessel. In some
10 embodiments, the system also includes a buoy attached to the first line. In some embodiments, the buoy is submerged. In some embodiments, the system also includes a chord line connecting the first line and the second line. In some embodiments, the system also includes a hose connecting the structure and the vessel.

15 In one embodiment, there is disclosed a method of mooring a vessel comprising locating a first line and connecting the first line to the vessel at a first end and to a permanent anchoring mechanism at the second end; locating a second line and connecting the second line to the vessel at a first end and to a permanent anchoring mechanism at the second end; and connecting a third line
20 between the vessel and an offshore structure. In some embodiments, the method also includes tightening the third line. In some embodiments, tightening the third line further comprises pulling the first line and the second line taut. In some embodiments, the method also includes attaching a buoy to the first end of the first line. In some embodiments, the method also includes attaching a buoy to the first
25 end of the second line. In some embodiments, the first line is attached to an aft portion of the vessel on a port side. In some embodiments, the second line is attached to an aft portion of the vessel on a starboard side. In some embodiments, the third line is attached to a bow portion of the vessel.

 Buoys 320 and 322, 420 and 422, 520 and 522, and/or 620 and 622 may be
30 from about 500 meters to about 3000 meters apart from each other, for example from about 1000 meters to about 2000 meters apart from each other.

 Buoys 320 and 322, 420 and 422, 520 and 522, and/or 620 and 622 may be from about 500 meters to about 5000 meters apart from structure 302, 402, 502,

and/or 602, for example from about 1500 meters to about 3000 meters apart from the structure.

Lines 316, 318, 416, 418, 516, 518, 616, and/or 618 may be connected to the sea floor with mooring piles, vertical load anchors, and/or other anchoring systems as are known in the art.

Vessel 314 may be a Aframax, Suezmax, or VLCC capacity vessel. Vessel 314 may have a liquid capacity of at least about 0.75 million barrels, or at least about 1 million barrels, or at least about 2 million barrels.

Buoys 520, 522, 620, and/or 622 may be submerged to a depth of at least about 30 meters, for example from about 40 to about 80 meters.

A workboat may be used to attach and/or disconnect lines to the vessel.

Lines 318 and 318 when taut and connected to vessel 314 have an angle from about 60 to about 120 degrees between them, for example from about 75 to about 115 degrees.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

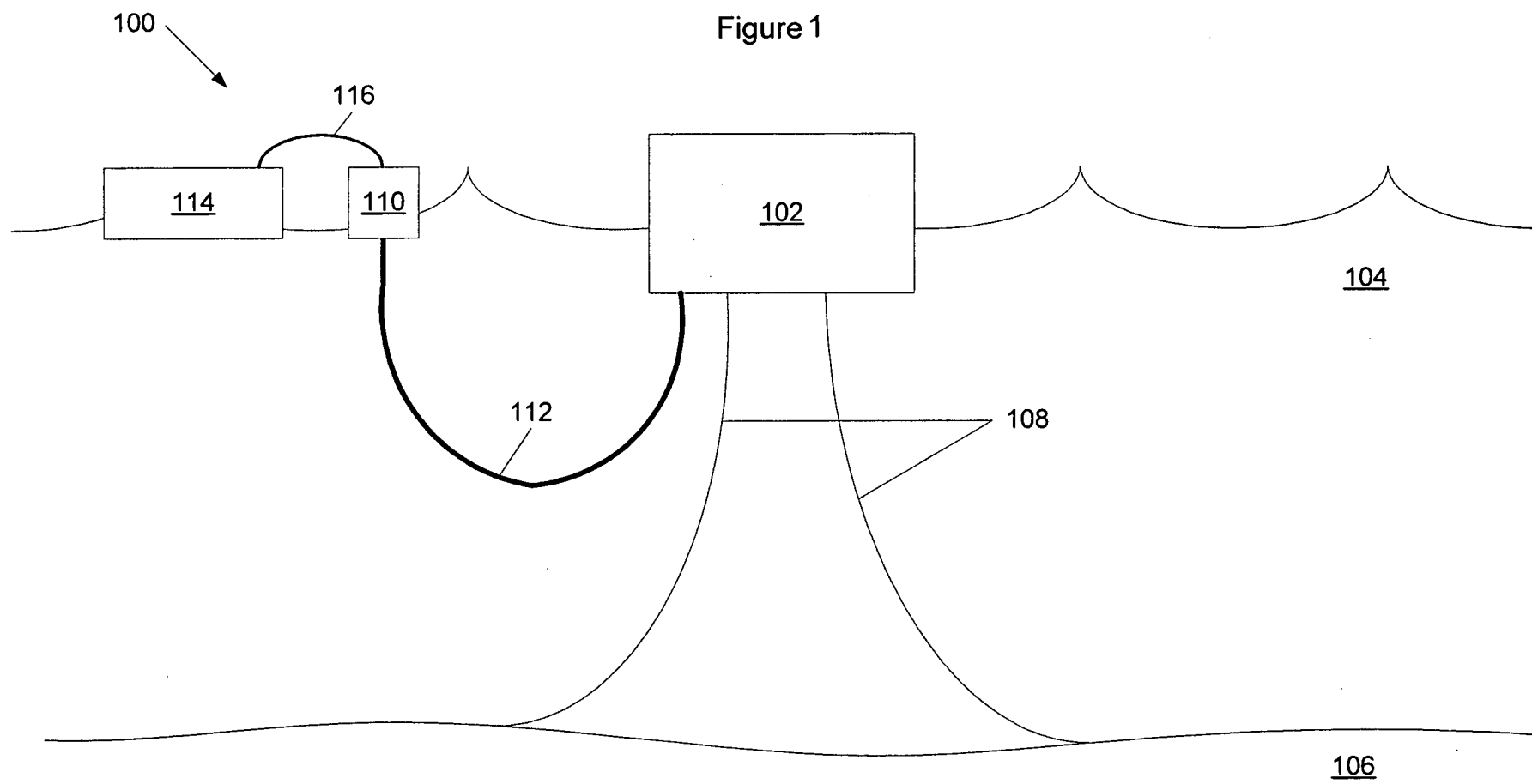
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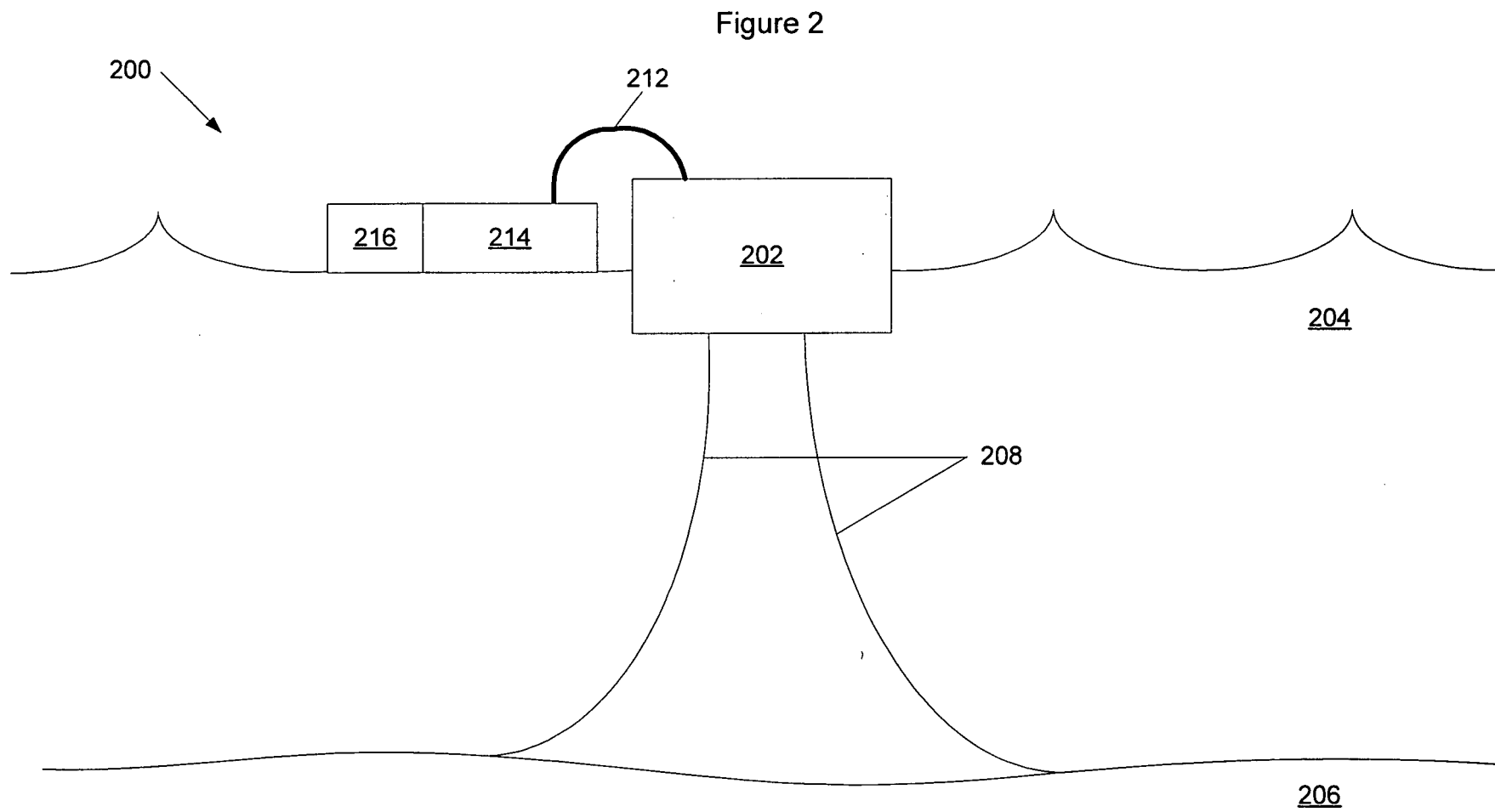
1. A mooring system comprising:
 - a structure in a body of water;
 - 5 a vessel in the body of water;
 - a first anchor in the body of water;
 - a second anchor in the body of water;
 - a first line connecting the first anchor and the vessel;
 - a second line connecting the second anchor and the vessel; and
 - 10 a third line connecting the structure and the vessel.
2. The mooring system of claim 1, further comprising a buoy attached to the first line.
- 15 3. The mooring system of claim 2, wherein the buoy is submerged.
4. The mooring system of one or more of claims 1-3, further comprising a chord line connecting the first line and the second line.
- 20 5. The mooring system of one or more of claims 1-4, further comprising a hose connecting the structure and the vessel.
6. A method of mooring a vessel comprising:
 - locating a first line and connecting the first line to the vessel at a first end
 - 25 and to a permanent anchoring mechanism at the second end;
 - locating a second line and connecting the second line to the vessel at a first end and to a permanent anchoring mechanism at the second end; and
 - connecting a third line between the vessel and an offshore structure.
- 30 7. The method of claim 6, further comprising tightening the third line.
8. The method of claim 7, wherein tightening the third line further comprises pulling the first line and the second line taut.

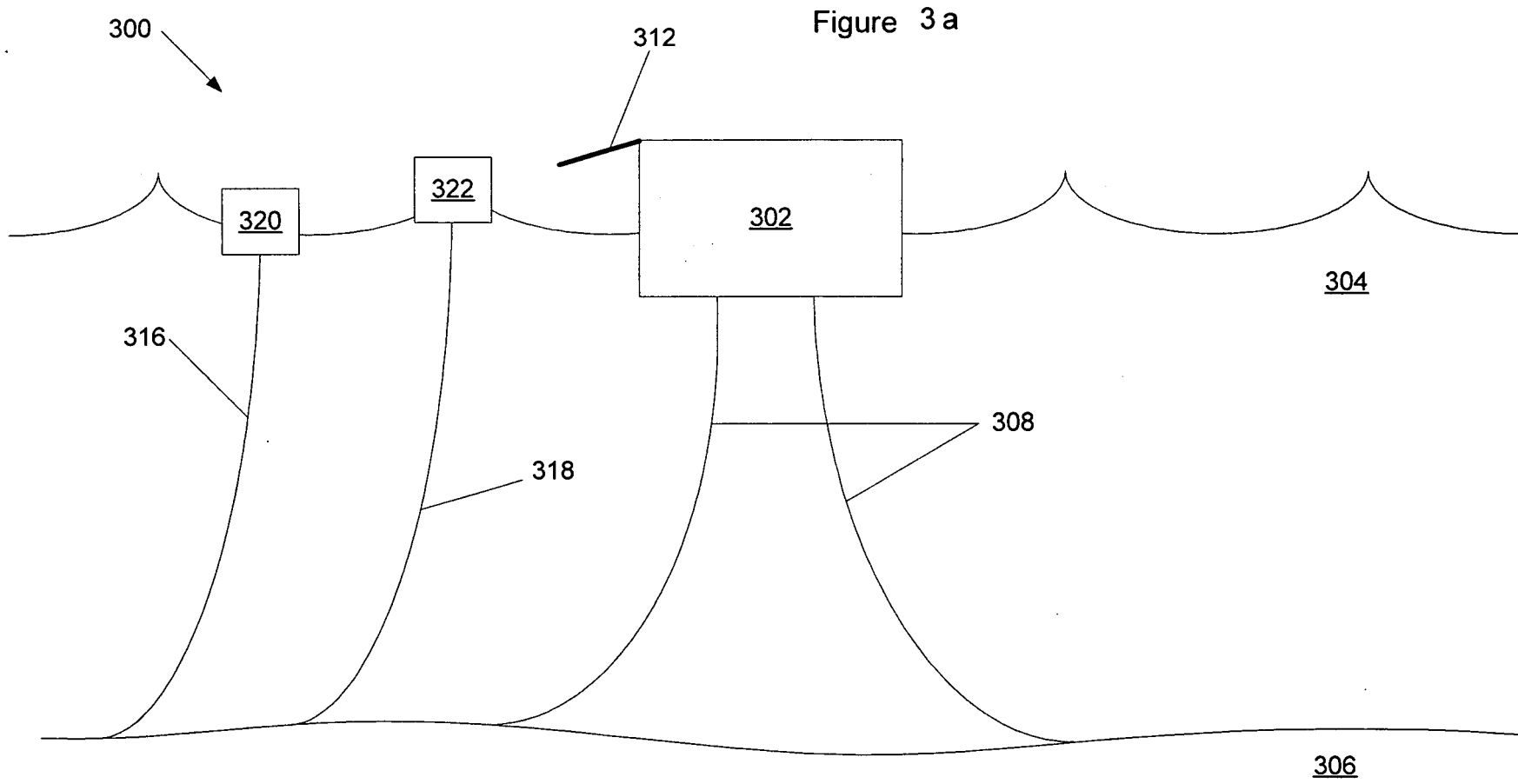
9. The method of one or more of claims 6-8, further comprising attaching a buoy to the first end of the first line.
10. The method of one or more of claims 6-9, further comprising attaching a
5 buoy to the first end of the second line.
11. The method of one or more of claims 6-10, wherein the first line is attached to an aft portion of the vessel on a port side.
- 10 12. The method of one or more of claims 6-11, wherein the second line is attached to an aft portion of the vessel on a starboard side.
13. The method of one or more of claims 6-12, wherein the third line is attached to a bow portion of the vessel.

15

Figure 1







300



Figure 3b

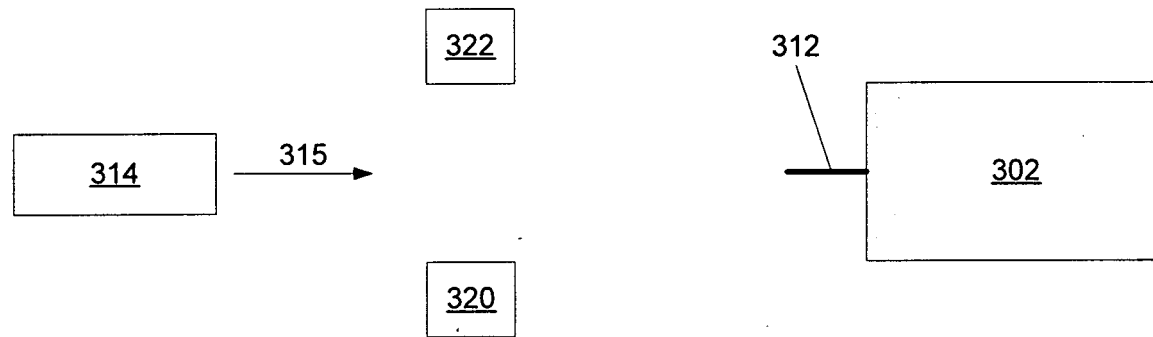


Figure 3c

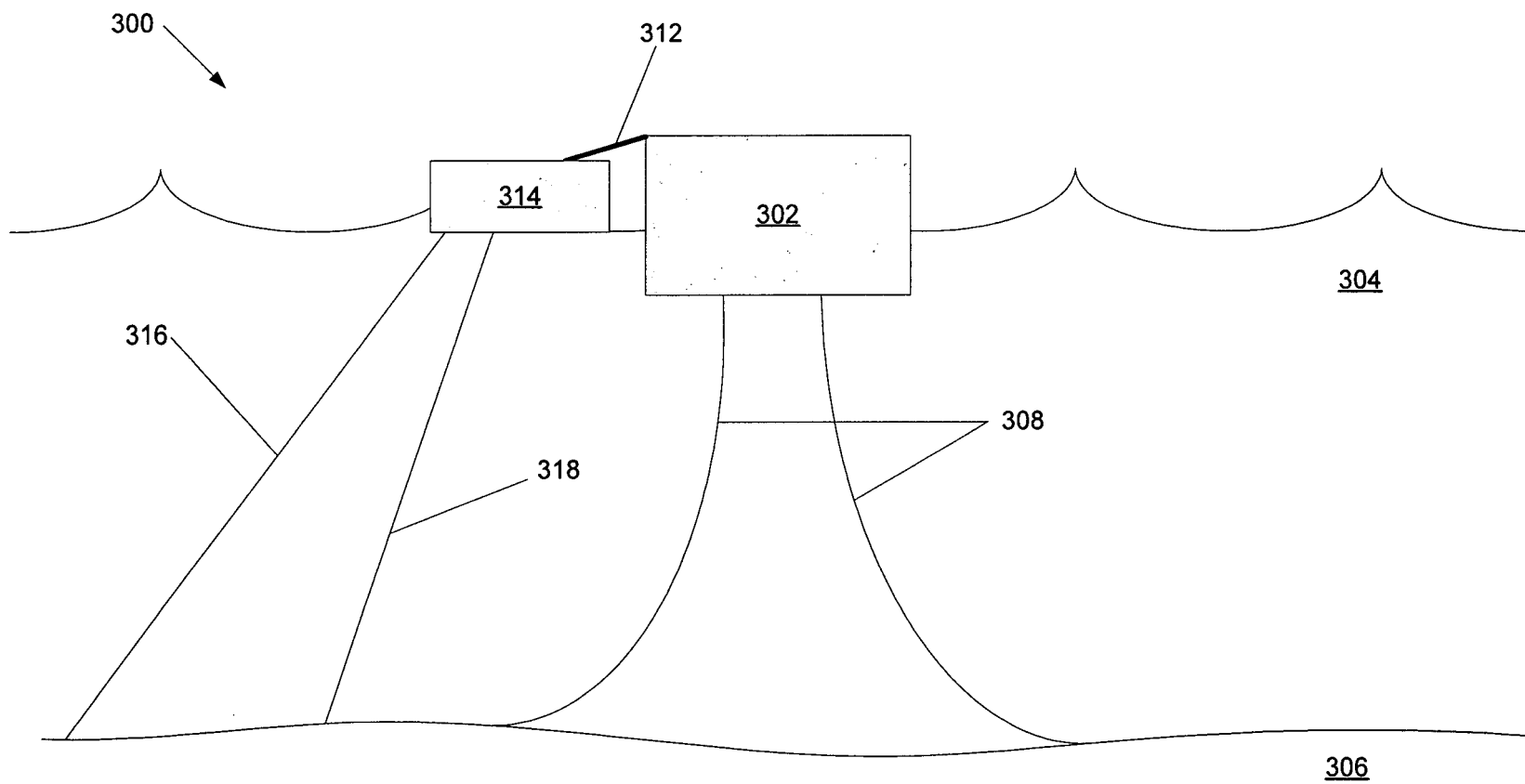
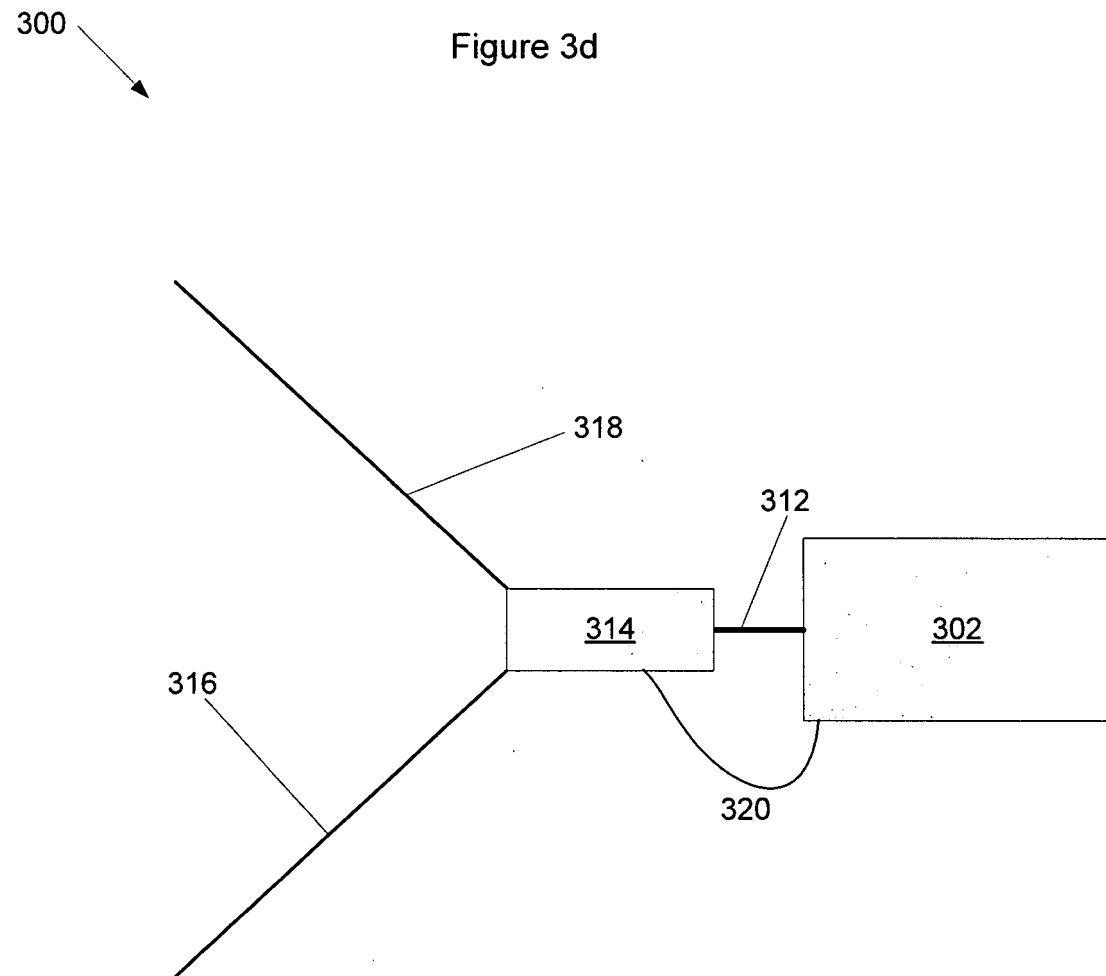
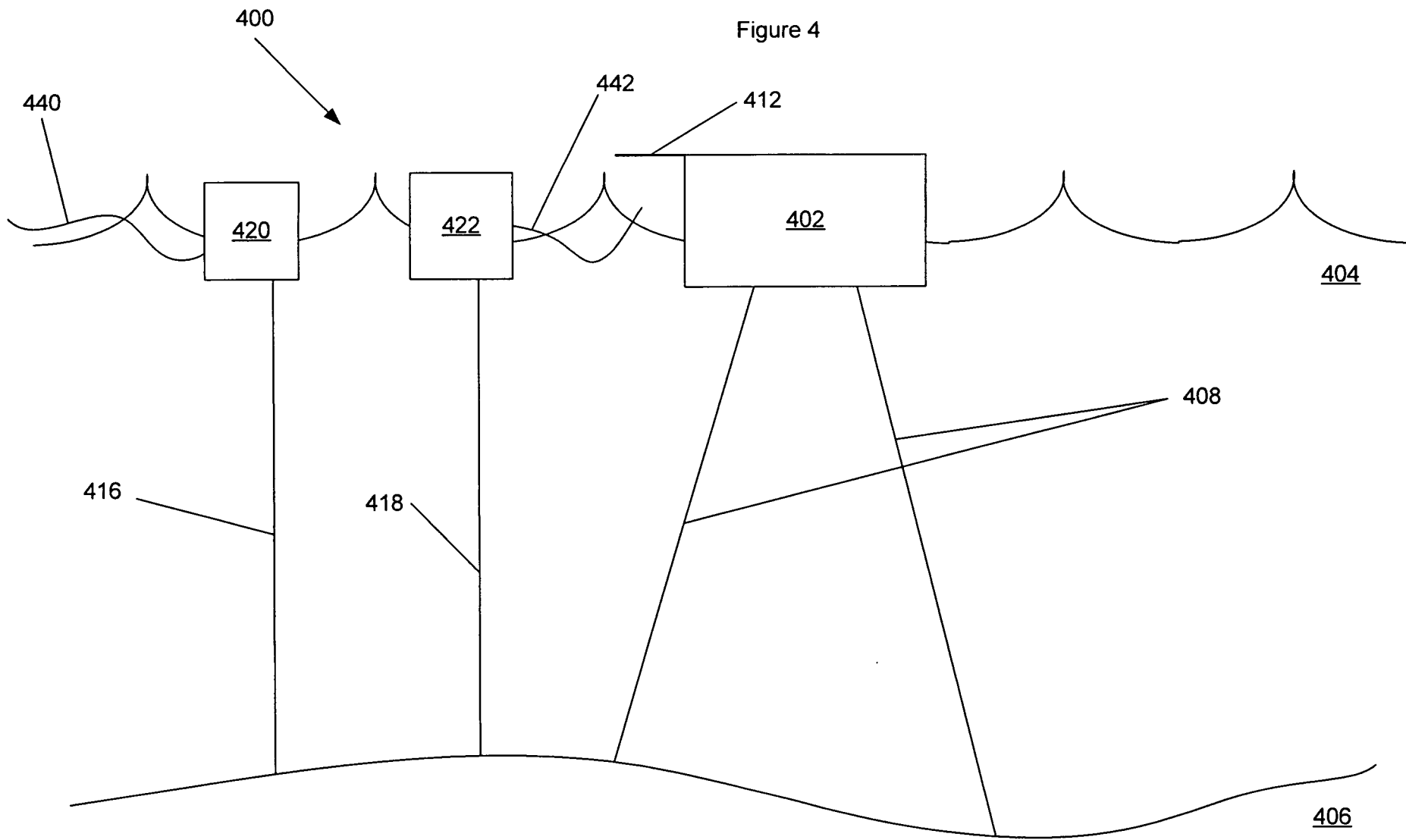


Figure 3d





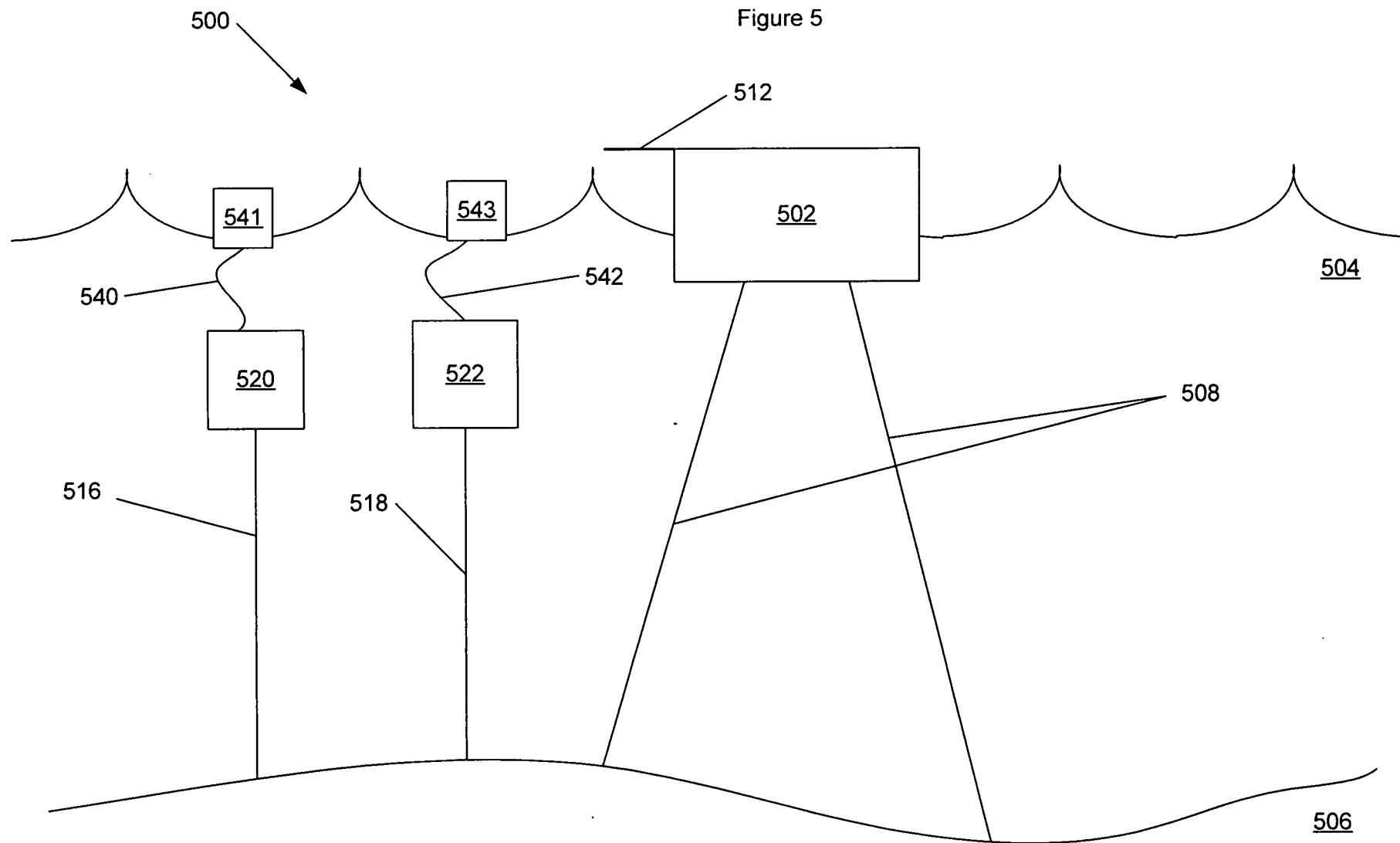
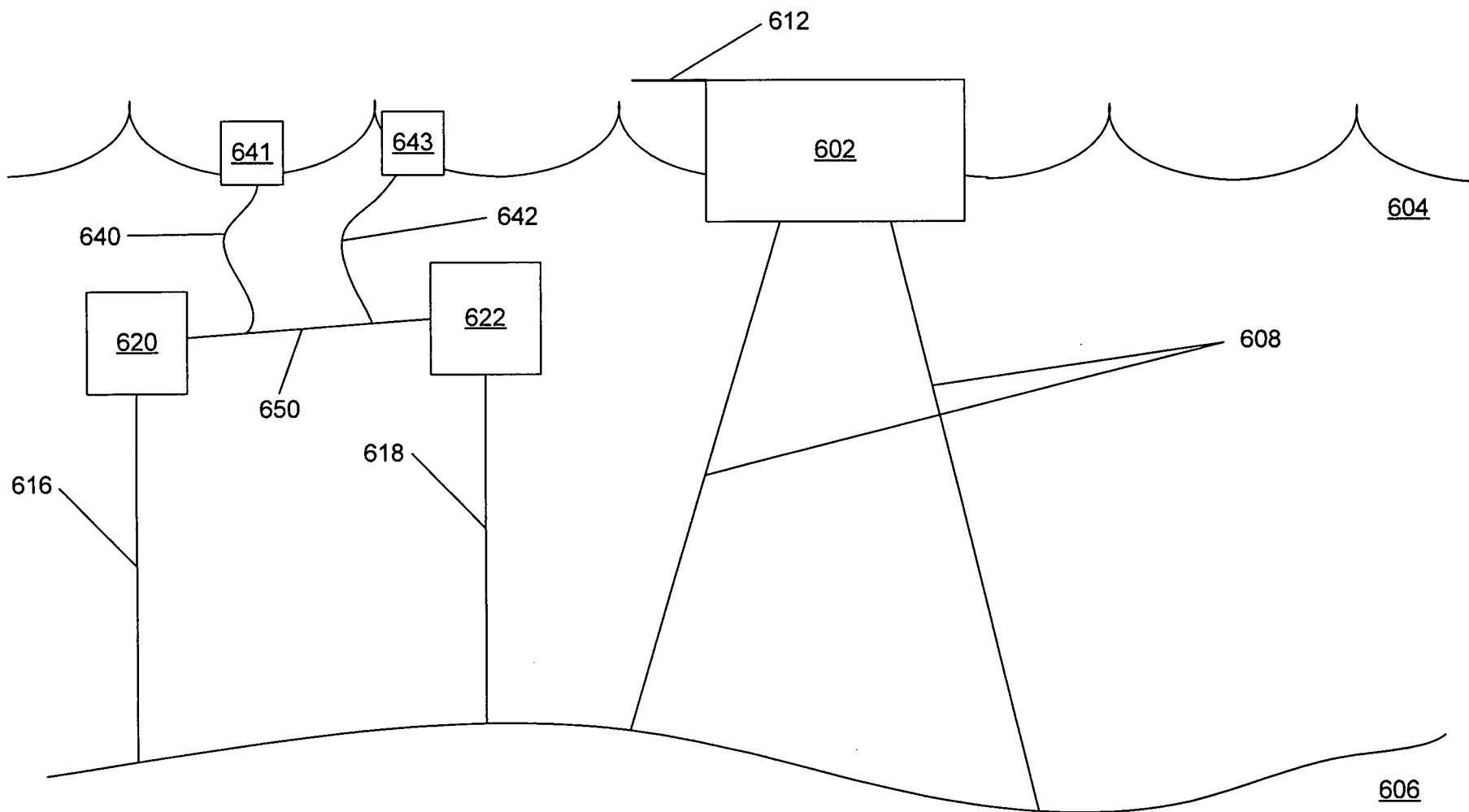


Figure 5

Figure 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 08/68098

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - B63B 21/00 (2008.04) USPC - 114/230.2 According to International Patent Classification (IPC) or to both national classification and IPC																	
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) USPC 114/230.2 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC 114/230.2, 293, 294; 441/3; search terms below Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Google, PubWEST (PGPB,USPT,EPAB,JPAB), moor, mooring, vessel, boat, ship, ferry, liner, yacht, buoy, marker, float, anchor, secure, connect, line, cable, rope, hawser, hose, pipe, tube, transfer, move, convey, pull, tight, taught, multiple, first, second																	
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X ----- Y</td> <td>US 6,571,723 B1 (BECH et al.) 03 June 2003 (03.06.2003), abstract, Fig 3, 6, col 2, ln 13-17, col 3, ln 10-12, 18-24, 33-36, 51-56, and col 4, ln 42-64.</td> <td>1-3, 6 ----- 7-8</td> </tr> <tr> <td>Y</td> <td>US 6,651,577 (GATES) 25 November 2003 (25.11.2003), abstract, Fig 1, col 3, ln 34-50.</td> <td>7-8</td> </tr> <tr> <td>A</td> <td>US 6,408,781 B1 (DANIELS) 25 June 2002 (25.06.2002), abstract, fig 1-2.</td> <td>1-3, 6-8</td> </tr> <tr> <td>A</td> <td>US 5,944,448 A (WILLIAMS) 31 August 1999 (31.08.1999), abstract, fig 1-9.</td> <td>1-3, 6-8</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X ----- Y	US 6,571,723 B1 (BECH et al.) 03 June 2003 (03.06.2003), abstract, Fig 3, 6, col 2, ln 13-17, col 3, ln 10-12, 18-24, 33-36, 51-56, and col 4, ln 42-64.	1-3, 6 ----- 7-8	Y	US 6,651,577 (GATES) 25 November 2003 (25.11.2003), abstract, Fig 1, col 3, ln 34-50.	7-8	A	US 6,408,781 B1 (DANIELS) 25 June 2002 (25.06.2002), abstract, fig 1-2.	1-3, 6-8	A	US 5,944,448 A (WILLIAMS) 31 August 1999 (31.08.1999), abstract, fig 1-9.	1-3, 6-8
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<table border="0"> <tr> <td> * Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family </td> </tr> </table>			* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family													
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Date of the actual completion of the international search 28 September 2008 (28.09.2008)		Date of mailing of the international search report 07 OCT 2008															
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774															

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 08/68098

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4, 5, 9-13
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.