

(19) World Intellectual Property Organization
International Bureau



(10) International Publication Number
WO 2009/134986 A2

(43) International Publication Date
5 November 2009 (05.11.2009)

(51) International Patent Classification:
E21B 17/10 (2006.01)

(21) International Application Number:
PCT/US2009/042285

(22) International Filing Date:
30 April 2009 (30.04.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/049,054 30 April 2008 (30.04.2008) US

(71) Applicant (for all designated States except US): **PARKER HANNIFIN CORPORATION** [US/US]; 6035 Parkland Boulevard, Cleveland, OH 44124-4141 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **SESSIONS, Travis, L.** [US/US]; 9752 North Dorchester, Cedar Hills, UT

84062 (US). **SCHRODER, Gary, W.** [US/US]; 4333 S. 4580 W., West Valley City, UT 84120 (US). **MINER, Tyler, B.** [US/US]; 6592 West 10250 North, Highland, UT 84003 (US). **COBB, Larry, G.** [US/US]; 3626 Sweetgum Hill Lane, Kingwood, TX 77345 (US).

(74) Agent: **MURPHY, Cynthia, S.**; Renner, Otto, Boisselle & Sklar, Llp, 1621 Euclid Avenue, 19th Floor, Cleveland, OH 44115 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[Continued on next page]

(54) Title: RISER CLAMP

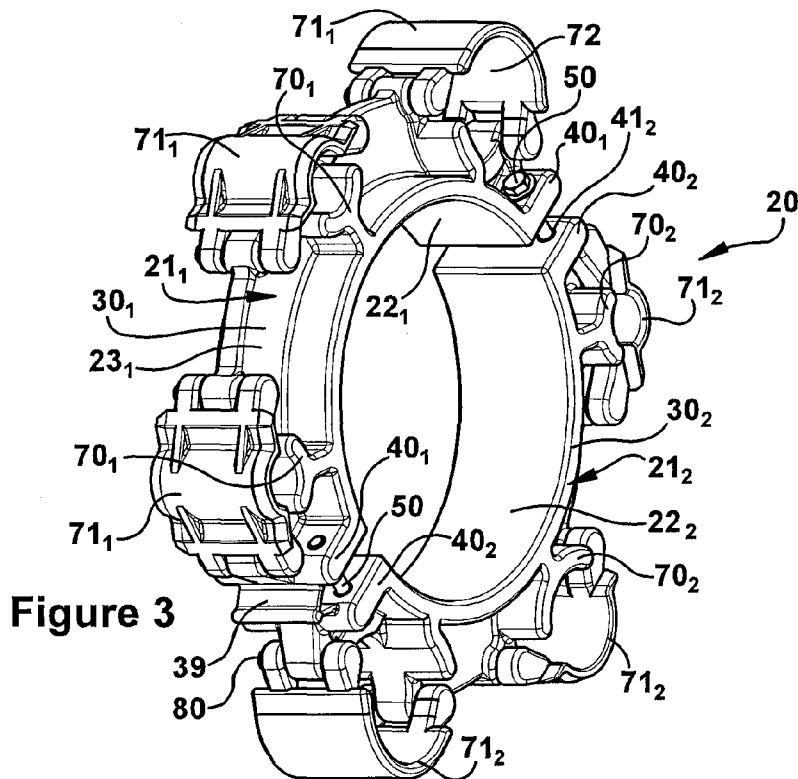
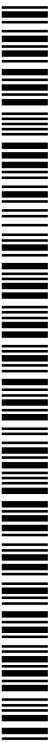


Figure 3

[Continued on next page]



WO 2009/134986 A2



(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR),

OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(57) Abstract: A riser clamp (20) comprising a first jaw portion (211) and a second jaw portion (212) that can be opened and closed relative to each other. The jaw portions (211/212) each comprise a thermoplastic body (301/302) that can be, for example, injection molded pieces of polyethylene (e.g., HDPE). The jaw portions (211/212) can be connected by a hinge (39) that is integrally formed therewith. The clamp (20) can also include cradles (701/702) and caps (711/712) for holding auxiliary lines.

RISER CLAMP

In an offshore drilling operation, a drillstring extends from a rig into a wellbore whereat it drills deeper and deeper into the sea floor. The drillstring extends through a riser which reaches from the rig platform to the wellhead, usually with a subsea blowout prevention stack between it and the ocean floor. During drilling, mud removed from the wellbore is drained to the surface through the riser. The riser can be over 30 cm wide (e.g., it can have about a 53 cm diameter) and it may be thousands of meters long. The riser is typically made of a succession of riser pipes having adjacent ends that are connected and disconnected on the rig to raise and lower the riser into the ocean.

SUMMARY

A riser clamp is provided that comprises thermoplastic jaw portions formed by injection molding of a polyethylene (e.g., HPDE). The clamp can be constructed to have greater strength than its casted cousins made of thermoset plastic (e.g., urethane). Additionally or alternatively, the clamp can be more corrosion-resistant and/or much lighter than an analogous metal riser clamp.

DRAWINGS

Figure 1 is a schematic diagram of an offshore drilling operation.

Figure 2 is a close-up schematic view of a riser clamp connecting adjacent ends of two riser pipes.

Figures 3 and 4 are perspective and plan views, respectively of the riser clamp.

Figures 5, 6, and 7 are front, top and side views, respectively of another riser clamp, (the clamp being shown without its caps in Figure 7.)

DETAILED DESCRIPTION

An offshore drilling operation is shown schematically in Figure 1. In this operation 10, a drillstring 11 extends from the rig 12 into a wellbore whereat it drills deeper and deeper into the sea floor. The drillstring 11 extends through a riser 13 which reaches from the rig platform to the wellhead, usually with a subsea blowout prevention stack 14 between it and the ocean floor. During drilling, mud removed from the wellbore is drained to the surface through the riser 13. The drilling operation 10 will often also include auxiliary lines 15 (e.g., choke lines, kill lines, pneumatic lines, hydraulic lines, equipment control lines, and/or logging lines) that can run alongside the riser 13.

As is best seen by referring additionally to Figure 2, the riser 13 is typically made of a succession of riser pipes 16. The adjacent ends of neighboring riser pipes (*i.e.*, the trailing end of one riser pipe and the leading end of the next riser pipe) can be joined together by a riser clamp 20. The pipes 16 can thereby be connected and disconnected on the rig 12 to raise and lower the riser 13 into the ocean. The auxiliary lines 15 can also be held by the riser clamp 30.

Referring now to Figures 3 – 4, the riser clamp 20 is shown in more detail. While some riser clamps require a loose metal strap to hold them onto the riser, the illustrated clamp 20 can be characterized by the absence of such an external strap. That being said, the use of the clamp 20 in conjunction with an external strap is possible and contemplated.

The clamp 20 can comprise a first jaw portion 21₁ and a second jaw portion 21₂ and these jaw portions 21 can be opened and closed relative to each other. The jaw portions 21 each have an inner wall 22 (*i.e.*, jaw portion 21₁ has an inner wall 22₁ and jaw portion 21₂ has an inner wall 22₂) and an outer wall 23 (*i.e.*, jaw portion 21₁ has an outer wall 23₁ and jaw portion 21₂ has an outer wall 23₂). When the riser clamp 20 is closed, the inner walls 22₁ and 22₂ together form the clamp's radially inner surface and an embrace 24 for the adjacent ends of the to-be-connected riser pipes 16. The outer walls 23₁ and 23₂ together form the clamp's radially outer surface.

The first jaw portion 21₁ comprises a thermoplastic body 30₁ that at least partially forms its inner wall 22₁ and its outer wall 23₁. The second jaw portion 21₂ likewise comprises a thermoplastic body 30₂ that at least partially forms its inner wall 22₂ and its outer wall 23₂. The first thermoplastic body 30₁ and/or the second thermoplastic body 30₂ can be made from a polyethylene thermoplastic, such as a high density polyethylene HDPE thermoplastic. They can be formed in one piece and/or they can be injection molded. With certain clamp designs (such as the hinged design shown in Figures 2-3), it may be possible to form the first thermoplastic body 30₁ in one piece with the second thermoplastic body 30₂.

The riser embrace 24 is sized and shaped in accordance with the riser 13 and/or riser pipes 16. Thus, the embrace 24 can be, for example, circular in shape and it can have a diameter greater than 30 cm and/or greater than 50 cm. With a circular embrace, the inner walls 22 of the jaw portions 21 can each have a semi-cylindrical shape and they can be symmetrically positioned relative to each other when the clamp 20 is closed.

The riser clamp 20 can further comprise a hinge 39 between its first jaw portion 21₁ and its second jaw portion 21₂. The hinge 39 can form, for example, an elbow-like pivot connection that expands/contracts when the jaw portions 20 are opened and closed. The hinge 39 can be integrally formed with the first jaw portion 21₁ and/or the second jaw portion 21₂, and more specifically, part of one or both of the thermoplastic bodies 30. In either or any event, the hinge 39 can be made of thermoplastic (*e.g.*, a polyethylene thermoplastic, such as a high density polyethylene HDPE thermoplastic).

In the illustrated riser clamp 20, the each jaw portion 21 includes a pair of jaw-connecting flanges 40 (*i.e.*, the first jaw portion 21₁ has two jaw-connecting flanges 40₁ and the second jaw portion 21₂ has two jaw-connecting flanges 40₂). The connecting flanges 40 extend radially outward from the respective inner wall 22 of its jaw's thermoplastic body 30, with the flanges 40 of each jaw portion 21 being positioned approximately 180° apart. Each jaw-connecting flange 40₁ of the first jaw portion 21₁ faces a corresponding jaw-connecting flange 40₂ of the second jaw portion 21₂.

The jaw-connecting flanges 40 can each have fastener openings 41 extending therethrough. When the riser clamp 20 is in a closed condition, the opening 41₁ on each flange 40₁ of the first jaw portion 21₁ is aligned with the opening 41₂ on the facing flange 40₂ of the second jaw portion 21₂. A fastener 50 can extend into and/or through each set of aligned openings 41. The fasteners 50 can comprise for example, metal (e.g., stainless steel) bolts.

The jaw-connecting flanges 40 can be part of the thermoplastic body 30 of the respective jaw portion 21. In the riser clamp 20 shown in Figures 2-3, the hinge 39 extends between the distal (*i.e.*, radially outer) ends of one set of facing flanges 40. When opening and closing the riser clamp 20, the opposing set of flanges are diverged and converged relative to each other.

Either or both jaw portions 21 can have one or more cradles 70 for holding auxiliary lines 15 and they can have a cap 71 for one, some, or all the cradles 70. When the cap 71₁/71₂ is open, an auxiliary line 15 can be placed in the cradle 70₁/70₂, and when the cap 71₁/71₂ is closed, an embrace 72 is formed for the auxiliary line 15. The aux-line embrace 72 can have circular shape with a diameter less than that of the riser embrace 24. For example, the diameter of the aux-line embrace 72 can be less than 25 cm, less than 20 cm, less than 15 cm, less than 10 cm, and/or less than 5 cm.

The riser clamp 20, and/or each jaw portion 21, can have cradles 70 that are the same size and/or cradles that are of different sizes. In the clamp 20 shown in Figures 2 – 3, for example, the first jaw portion 21₁ has three cradles 70₁ of three different diameters. The second jaw portion 21₂ has three cradles 70₂ with different diameters, with its largest cradle 70₂ and its smallest cradle 70₂ being substantially the same size as the largest and smallest cradles 70₁ in the first jaw portion 21₁. Each cradle 70 is provided with its own cap 71 sized in an a corresponding manner.

The cradles 70 can be part of the thermoplastic body 30 of their respective jaw portion 21 (and thus formed in one piece therewith). The caps 31 can be formed separately from the cradles 70 and/or the thermoplastic body 30, and then attached thereto (e.g., with pins 80) during assembly of the riser clamp

20. An advantageous attachment technique may be one wherein the cap 71 can remain attached to its corresponding cradle 70 with, for example, a pivotal connection.

5 The caps 71 can be made of any suitable material (e.g., a thermoplastic, a polyethylene thermoplastic and/or a HDPE thermoplastic) by any appropriate method (e.g., injection molding). The caps 71 can (or cannot) be made of the same material as the thermoplastic body 30 of their jaw portion 21 and/or they can (or cannot) be made of the same material as their corresponding cradle 70.

10 Referring now to Figures 5 – 7, another version of the riser clamp 120 is shown. The riser clamp 120 is similar in many ways to the riser clamp 20 shown in Figures 2 - 3, whereby like reference numerals are used to designate like parts.

The riser clamp 20, like the riser clamp 20, has a first jaw portion 21₁ comprising a thermoplastic body 30₁ (that at least partially forms its inner wall 22₁ and its outer wall 23₁) and a second jaw portion 21₂ comprising a thermoplastic body 30₂ (that at least partially forms its inner wall 22₂ and its outer wall 23₂). The clamp 120 also has a reinforcement strap 60₁ embedded in the elastomeric body 30₁ of the first jaw portion 21₁ and/or a reinforcement strap 60₂ embedded in the elastomeric body 30₂ of the second jaw portion 21₂. Preferably, but not necessarily, one or both of the reinforcement straps 60 are completely encapsulated within its embedding thermoplastic body 30. The straps 60 can be made from a material which is harder than that used to form the thermoplastic body 30. For example, each reinforcement strap 60 can be made from metal (e.g., stainless steel). The straps 60₁ and 60₂, like the thermoplastic bodies 30₁ and 30₂, can be approximately symmetrical when the clamp 120 is closed. In the illustrated clamp 120, the reinforcement straps 60 form part of the connecting flanges 40 and part of at least some of the cradles 70.

25 The jaw-connecting flanges 40 in the riser clamp 120, like those in the riser clamp 20, can each have fastener openings 41 extending therethrough for receipt of fastener 50. The clamp 120 also incorporates fastener-receiving inserts 42 in each these openings 41, which are surrounded by the thermoplastic

body 30 of the respective jaw portion 21. The inserts 42₁/42₂ can have internal threads (*e.g.* to mate with external threads on the fasteners 50) and/or they can be made of metal. Additionally or alternatively, each insert can be welded or otherwise attached to the internal reinforcement strap 80₁/80₂ of the respective jaw portion 21₁/21₂ for further buttressing purpose.

The riser clamp 120, like the riser clamp 20, has cradles 70 that form auxiliary-line embraces 72. But in the riser clamp 120, they share projecting leg portions (of the respective jaw portions 21) with the connecting flanges 40. In one facing set of flanges 40 (the bottom set in Figure 5), a cradle 70 extends from each flange 40 and they together form the embrace 72. (In riser clamp 120, the hinge 39 extends between these embrace-forming cradles 70₁ and 70₂.) In the other facing set of flange 40 (the top set in Figure 5), a cradle 70 also extends from each flange 40, but they are oriented to form two separate embraces 72 when covered by a common cap 71.

The riser clamp 120 can further comprise a pad 90₁ positioned against the inner wall 22₁ of the first jaw portion 21₁ and a pad 90₂ positioned against the inner wall 22₂ of the second jaw portion 21₂. The pads 90 are intended to contact the riser pipe 16 and to reduce friction between the inner walls 22. To this end, they can be made from an elastomeric material, such as rubber. The pads 90 can have a plan shape following the profile of the inner walls 22 of the jaw portions 21.

The riser clamp 120, like the riser clamp 20 can be used without a loose metal strap to hold it onto the riser 13. But, the use of such an external strap (not shown) may be advantageous with the clamp 120. The strap could be made of, for example, stainless steel, and include openings or slots to accommodate the radial projection of auxiliary lines 15, hinge 39, flanges 40, fasteners 50, cradles 70, caps 71, and/or pins 80.

Although the riser clamp 20/120 has been shown and described with respect to a certain embodiments, equivalent alterations and modifications should occur to others skilled in the art upon review of this specification and drawings. If an element (*e.g.*, component, assembly, system, device,

composition, method, process, step, means, etc.), has been described as performing a particular function or functions, this element corresponds to any functional equivalent (*i.e.*, any element performing the same or equivalent function) thereof, regardless of whether it is structurally equivalent thereto. And
5 while a particular feature may have been described with respect to less than all of embodiments, such feature can be combined with one or more other features of the other embodiments.

CLAIMS

- 5 1. A riser clamp (20/120) for connecting adjacent ends of successive riser pipes (16);
- the clamp (20/120) comprising a first jaw portion (21₁) and a second jaw portion (21₂) that can be opened and closed relative to each other;
- the jaw portions (21₁)/21₂) each having an inner wall (22₁/22₂) and an outer wall (23₁/23₂);
- 10 the inner walls (22₁₂, 22₁₂) together forming, when the clamp (20/120) is closed, the clamp's radially inner surface and an embrace (24) for the adjacent ends of the to-be-connected riser pipes (16);
- the outer walls (23₁, 23₂) together forming, when the clamp (20/120) is closed, the clamp's radially outer surface;
- 15 the first jaw portion (21₁) comprising a first thermoplastic body (30₁) at least partially forming its inner wall (22₁) and its outer wall (23₁); and
- the second jaw portion (21₂) comprising a second thermoplastic body (30₂) at least partially forming its inner wall (22₂) and its outer wall (23₂).
- 20 2. A riser clamp (20/120) as set forth in the preceding claim, wherein the first thermoplastic body (30₁) is injection molded.
3. A riser clamp (20/120) as set forth in either of the two preceding claims, wherein the second thermoplastic body (30₂) is injection molded.
- 25 4. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first thermoplastic body (30₁) is formed in one piece.
5. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the second thermoplastic body (30₂) is formed in one piece.
- 30

6. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first thermoplastic body (30₁) is formed in one piece with the second thermoplastic body (30₂).

5 7. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first thermoplastic body (30₁) is made from polyethylene thermoplastic.

10 8. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the second thermoplastic body (30₂) is made from polyethylene thermoplastic.

15 9. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first thermoplastic body (30₁) is made from high density polyethylene (HDPE) thermoplastic.

20 10. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the second thermoplastic body (30₂) is made from high density polyethylene (HDPE) thermoplastic.

11. A riser clamp (20/120) as set forth in any the preceding claims, wherein the embrace (24) is a cylindrical embrace.

25 12. A riser clamp (20/120) as set forth in the preceding claim, wherein the cylindrical embrace has a diameter of greater than 30 cm.

13. A riser clamp (20/120) as set forth in the preceding claim, wherein the cylindrical embrace has a diameter greater than 50 cm.

14. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the inner wall (22₁) of the first jaw portion (21₁) and/or the inner wall (22₂) of the second jaw portion (21₂) has a semi-cylindrical shape.

5 15. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the inner walls (22₁, 22₂) are symmetrically positioned relative to each other when the clamp (20/120) is closed.

10 16. A riser clamp (20/120) as set forth in any of the preceding B claims, further comprising hinge (39) between the first jaw portion (21₁) and the second jaw portion (21₂), which forms a pivot when the jaw portions (20₁, 20₂) are opened and closed.

15 17. A riser clamp (20/120) as set forth in the preceding claim, wherein the hinge (39) is integrally formed with the first jaw portion (21₁).

20 18. A riser clamp (20/120) as set forth in either of the two preceding claims, wherein the hinge (39) is integrally formed with the second jaw portion (21₂).

19. A riser clamp (20/120) as set forth in any of claim 16 – 18, wherein the hinge (39) is made of thermoplastic.

25 20. A riser clamp (20) as set forth in any of claims 16 - 19, wherein the hinge (39) bridges facing flanges (40₁, 40₂) of the first jaw portion (21₁) and the second jaw portion (21₂).

30 21. A riser clamp (120) as set forth in any of claims 16 - 19, wherein the hinge (39) bridges facing cradles (70₁, 70₂) of the first jaw portion (21₁) and the second jaw portion (21₂).

22. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first jaw portion (21₁) includes at least one jaw-connecting flange (40₁).

5 23. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the second jaw portion (21₂) includes at least one jaw-connecting flanges (40₂).

10 24. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first jaw portion (21₁) includes at least two jaw-connecting flanges (40₁).

15 25. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the second jaw portion (21₂) includes at least two jaw-connecting flanges (40₂).

20 26. A riser clamp (20/120) as set forth in any of the preceding claims, wherein each jaw-connecting flange (40₁/40₂) extends radially outward from the respective inner wall (22₁/22₂) of the thermoplastic body (30₁/30₂).

27. A riser clamp (20/120) as set forth in any of the preceding claims, wherein each jaw portion (21₁/21₂) comprises two jaw-connecting flange (40₁)/40₂).

25 28. A riser clamp (20/120) as set forth in the preceding claim, wherein each jaw portion's connecting flanges (40₁/40₂) are positioned approximately 180 degrees apart.

30 29. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the thermoplastic body (30₁/30₂) at least partially forms the jaw-connecting flange(s) (40₁/40₂) of its jaw portion (21₁/21₂).

30. A riser clamp (120) as set forth in any of the preceding claims, wherein a reinforcing strap (60₁/60₂) at least partially forms the jaw-connecting flange(s) (40₁/40₂) of its jaw portion (21₁/21₂).

5

31. A riser clamp (20/120) as set forth in any of the preceding claims, wherein each jaw-connecting flange (40₁) of the first jaw portion (21₁) faces a corresponding jaw-connecting flange (40₂) of the second jaw portion (21₂).

10

32. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the jaw-connecting flanges (40₁/40₂) have openings (41₁/41₂) for receipt of fasteners (50).

15

33. A riser clamp (20/120) as set forth in any of the preceding claims, wherein each jaw portion (20₁/20₂) has openings (41₁/41₂) for receipt of fasteners (50).

20

34. A riser clamp (20/120) as set forth in either of the two preceding claims, wherein the openings (41₁) of the first jaw portion (21₁) are aligned with corresponding openings (41₂) of the second jaw portion (21₂) when the clamp (20/120) is in its closed position.

25

35. A riser clamp (20/120) as set forth in the preceding claim, further comprising fasteners (50) extending into and/or through aligned openings (41₁/41₂).

30

36. A riser clamp (20/120) as set forth in the preceding claim, wherein the fasteners (50) comprise bolts.

30

37. A riser clamp (20/120) as set forth in either of the two preceding claims, wherein the fasteners (50) are made of metal.

38. A riser clamp (20/120) as set forth in the preceding claim, wherein the fasteners (50) are made of stainless steel.

5 39. A riser clamp (120) as set forth in any of claims 30 - 38, wherein the openings (41₁/41₂) comprise fastener-receiving inserts (42₁/42₂) surrounded by the thermoplastic body (30₁₂) of the respective jaw portion (21₁/21₂).

10 40. A riser clamp (120) as set forth in the preceding claim, wherein the fastener-receiving inserts (42₁/42₂) are attached to a/the reinforcement strap (80₁/80₂) of the respective jaw portion (21₁/21₂).

15 41. A riser clamp (120) as set forth in the preceding claim, wherein the fastener-receiving inserts (42₁/42₂) are welded to the reinforcement strap (80₁/80₂) of the respective jaw portion (21₁/21₂).

42. A riser clamp (120) as set forth in any of claims 22 - 31, wherein the fastener-receiving inserts (42₁/42₂) have internal threads.

20 43. A riser clamp (120) as set forth in any of claims 22 - 31, wherein the fastener-receiving inserts (42₁/42₂) are made of metal.

25 44. A riser clamp (120) as set forth in any of the preceding claims, further comprising a reinforcement strap (60₁) embedded in the elastomeric body (30₁) of the first jaw portion (21₁).

30 45. A riser clamp (120) as set forth in any of the preceding claims, further comprising a reinforcement strap (60₂) embedded in the elastomeric body (30₂) of the second jaw portion (21₂).

46. A riser clamp (120) as set forth in any of the preceding claims, wherein a reinforcement strap (60₁/60₂) is embedded in the elastomeric body (30₁/30₂) of each jaw portion (21₁/21₂).

5 47. A riser clamp (120) as set forth in the preceding claim, wherein the reinforcement strap (60₁) embedded in the elastomeric body (30₁) of the first jaw portion (21₁) is approximately symmetrical to the reinforcement strap (60₂) embedded in the elastomeric body (30₁/30₂) of the second jaw portion (21₁) when the clamp (20/120) is closed.

10

48. A riser clamp (120) as set forth in any of claims 44 - 47, wherein each reinforcement strap (60₁/60₂) is made from a material which is harder than its embedded-by thermoplastic body (30₁/30₂).

15

49. A riser clamp (120) as set forth in any of claims 44 - 48, wherein each reinforcement straps (60₁/60₂) is made from metal.

20

50. A riser clamp (120) as set forth in any of claims 44 – 49, wherein the first and second reinforcement straps (60₁, 60₂) are made from stainless steel.

25

51. A riser clamp (120) as set forth in any of claims 44 – 50, wherein at least one reinforcement strap (60₁/60₂) is completely encapsulated by the thermoplastic body (30₁) of its jaw portion (21₁/21₂).

52. A riser clamp (120) as set forth in any of claims 44 – 51, wherein each reinforcement strap (60₁/60₂) is completely encapsulated by the thermoplastic body (30₁) of its jaw portion (21₁/21₂).

53. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first jaw portion (21₁) has a cradle (70₁) for holding an auxiliary line (20/120).

5 54. A riser clamp (20/120) as set forth in the preceding claim, wherein the thermoplastic body (30₁) of the first jaw portion (21₁) forms the cradle (70₁).

55. A riser clamp (20/120) as set forth in claim 54, wherein the cradle (70₁) of the first jaw portion (21₁) does not include a reinforcing strap (60₁).

10

56. A riser clamp (120) as set forth in claim 54, wherein a reinforcing strap (60₁) of the first jaw portion (21₁) also forms the cradle (70₁).

57. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the first jaw portion (21₁) has a plurality of cradles (70₁), each for holding an auxiliary line (15).

15

58. A riser clamp (20/120) as set forth in the preceding claim, wherein the thermoplastic body (30₁) of the first jaw portion (21₁) forms each cradle (70₁).

20

59. A riser clamp (20) as set forth in claim 58, wherein each cradle (70₂) of the first jaw portion (21₂) does not include a reinforcing strap (80₂).

60. A riser clamp (120) as set forth in claim 58, wherein a reinforcing strap (60₁) of the first jaw portion (21₁) also forms each cradle (70₁).

25

61. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the second jaw portion (21₂) has a cradle (70₂) for holding an auxiliary line (20/120).

30

62. A riser clamp (20/120) as set forth in the preceding claim, wherein the thermoplastic body (30₂) of the second jaw portion (21₂) forms the cradle (70₂).

5 63. A riser clamp (20) as set forth in claim 62, wherein the cradle (70₂) of the second jaw portion (21₂) does not include a reinforcing strap (60₂).

64. A riser clamp (120) as set forth in claim 62, wherein a reinforcing strap (60₂) of the second jaw portion (21₂) also forms the cradle (70₂).

10

65. A riser clamp (20/120) as set forth in any of the preceding claims, wherein the second jaw portion (21₂) has a plurality of cradles (70₂), each for holding an auxiliary line (20/120).

15 66. A riser clamp (20/120) as set forth in the preceding claim, wherein the thermoplastic body (30₂) of the second jaw portion (21₂) forms each cradle (70₂).

20 67. A riser clamp (20) as set forth in claim 66, wherein each cradle (70₂) of the second jaw portion (21₂) does not include a reinforcing strap (60₂).

68. A riser clamp (120) as set forth in claim 66, wherein a reinforcing strap (60₂) of the second jaw portion (21₂) also forms each cradle (70₂).

25 69. A riser clamp (20/120) as set forth in any of the preceding claims, wherein each jaw portion (21₁/21₂) includes at least one cradle (70₁/70₂).

70. A riser clamp (20/120) as set forth in the preceding claim, wherein each jaw portion (21₁/21₂) includes a plurality of cradles (70₁/70₂).

30

71. A riser clamp (20/120) as set forth in either claim 69 or claim 70, wherein at least some of the cradles (70₁, 70₂) are the same size.

5 72. A riser clamp (20/120) as set forth in any of claims 69 – 71, wherein at least some of the cradles (70₁, 70₂) are different sizes.

73. A riser clamp (20/120) as set forth in any of claims 53 - 72, further comprising a cap (71₁/71₂) for at least one cradle (70₁/70₂).

10 74. A riser clamp (20/120) as set forth in any of claims 53 - 73, further comprising a cap (71₁/71₂) for at least some of the cradles (70₁/70₂).

75. A riser clamp (20) as set forth in any of the preceding 53 - 74 claims, further comprising a cap (71₁/71₂) for each cradle (70₁/70₂).

15

76. A riser clamp (20/120) as set forth in any of claims 73 - 75, wherein when the cap (71₁/71₂) is open, the auxiliary line (15) can be placed in the cradle (70₁/70₂), and wherein when the cap (71₁/71₂) is closed, an embrace (72) is formed for an auxiliary line (15).

20

77. A riser clamp (120) as set forth in any of claims 73 – 76, wherein a plurality of cradles (70₁/70₂) share a common cap (71).

78. A riser clamp (120) as set forth in any of claims 53 – 77, wherein
25 a/the embrace (72) formed for the auxiliary line (15) is formed by a cradle (70₁) on the first jaw portion (20₁) and a cradle (70₂) on the second jaw portion (20₂).

79. A riser claim (120) as set forth in the preceding claim, wherein the
30 embrace-forming cradles (70₁, 70₂) share projecting leg portions of respective jaw portions (21₁, 21₂) with the connecting flanges (40₁, 40₂).

80. A riser clamp (20/120) as set forth in any of claims 76 - 79, wherein the aux-line embrace (72) is a circular embrace.

5 81. A riser clamp (20/120) as set forth in claim 80, wherein the aux-line embrace (72) has a diameter less than that of the riser embrace (24).

82. A riser clamp (20/120) as set forth in claim 80, wherein the aux-line embrace (72) has a diameter less than 25 cm.

10 83. A riser clamp (20/120) as set forth in claim 80, wherein the aux-line embrace (72) has a diameter less than 20 cm.

84. A riser clamp (20/120) as set forth in claim 80, wherein the aux-line embrace (72) has a diameter less than 15 cm.

15

85. A riser clamp (20/120) as set forth in claim 80, wherein the aux-line embrace (72) has a diameter less than 10 cm.

20 86. A riser clamp (20/120) as set forth in claim 80, wherein the aux-line embrace (72) has a diameter less than 5 cm.

87. A riser clamp (20/120) as set forth in claim 80, wherein the aux-line embrace has a diameter less than about 5 inches.

25 88. A riser clamp (20/120) as set forth in any of the preceding 76 - 87 claims, wherein the cap (71₁/71₂) remains attached to its corresponding cradle (70₁/70₂) when it is open.

30 89. A riser clamp (20/120) as set forth in the preceding claim, wherein the cap (71₁/71₂) is pivotally connected to the cradle (70₁/70₂).

90. A riser clamp (20/120) as set in any of the preceding 76 - 89 claims, wherein the cap (71₁/71₂) includes openings for receiving fasteners (80).

5 91. A riser clamp (20/120) as set forth in the preceding claim, further comprising fasteners (80) that mount each cap (71₁/71₂) onto its cradle (70₁/70₂).

92. A riser clamp (20/120) as set forth in any of claims 76 - 91, wherein the cap (71₁/71₂) is made of thermoplastic material.

10 93. A riser clamp (20/120) as set forth in the preceding claim, wherein the cap (71₁/71₂) is injection molded.

94. A riser clamp (20/120) as set forth in any of claims 92 - 93, wherein the cap (71₁/71₂) is made of the same material as the thermoplastic
15 bodies (30₁/30₂) of its jaw portions (21₁/21₂).

95. A riser clamp (20/120) as set forth in any of claims 92 - 94, wherein the cap (71₁/71₂) is made from polyethylene thermoplastic.

20 96. A riser clamp (20/120) as set forth in any of claims 92 - 95, the cap (71₁/71₂) is made from high density polyethylene (HDPE) thermoplastic.

97. A riser clamp (120) as set forth in any of preceding claims, further comprising a pad (90₁) positioned against the inner wall (22₁) of the first jaw
25 portion (21₁).

98. A riser clamp (120) as set forth in any of the preceding claims, further comprising a pad (90₂) positioned against the inner wall (22₂) of the
30 second jaw portion (21₂).

99. A riser clamp (120) as set forth in either of the two preceding claims, wherein the pad (90₁/90₂) is intended to contact the riser pipes (16).

5 100. A riser clamp (120) as set forth in either of the two preceding claims, wherein the pad (90₁/90₂) is intended to reduce friction between the inner walls (22₁/22₂) and the riser pipes (16).

10 101. A riser clamp (120) as set forth in any of the three preceding claims, wherein each pad (90₁/90₂) is made from elastomeric material.

102. A riser clamp (120) as set forth in the preceding claim, wherein each pad (90₁/90₂) is made from rubber.

15 103. A riser (13) comprising successive riser pipes (16) and the clamp (20/120) of any of the preceding claims between each pair of adjacent ends of the riser pipes (16).

20 104. A riser (13) as set forth in the preceding claim, further comprising an auxiliary line (15) held by a/the cradle (70₁/70₂).

105. A riser (13) as set forth in the preceding claim, further comprising a plurality of auxiliary lines (15) each being held by a/the cradle (70₁/70₂).

25 106. A riser (13) as set forth in any of claims 103 - 105, characterized by the absence of loose metal strap holding the clamp (20/120) to the riser pipes (16).

30 107. An offshore drilling operation (10) comprising a drillstring (11), a rig (12), and the riser (13) set forth in any of claims 103 - 106; wherein the drillstring (11) extends through the riser (13) and from the rig (12) into a wellbore; and

wherein mud removed from the wellbore is drained to the surface through the riser (13).

* * *

5

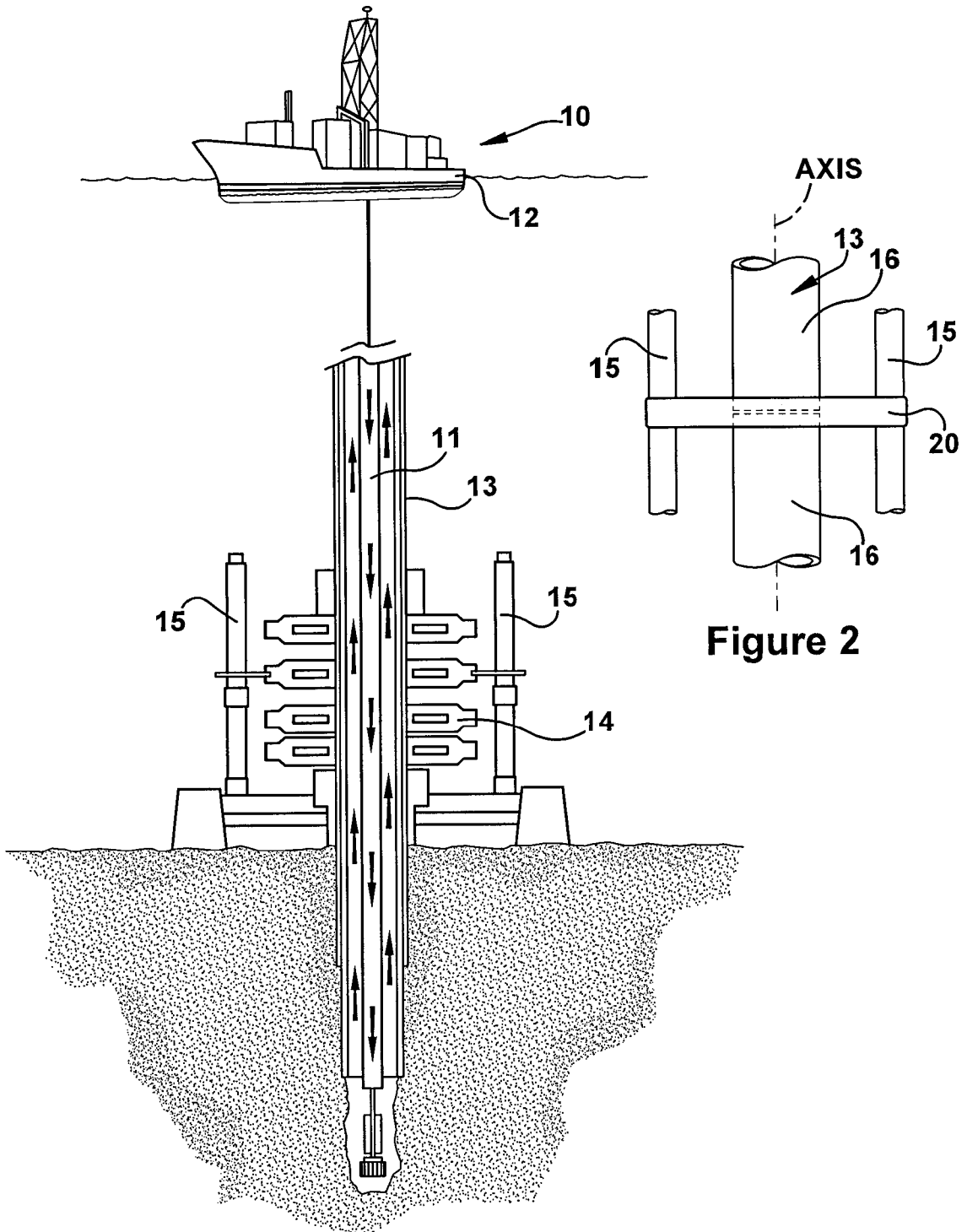


Figure 1

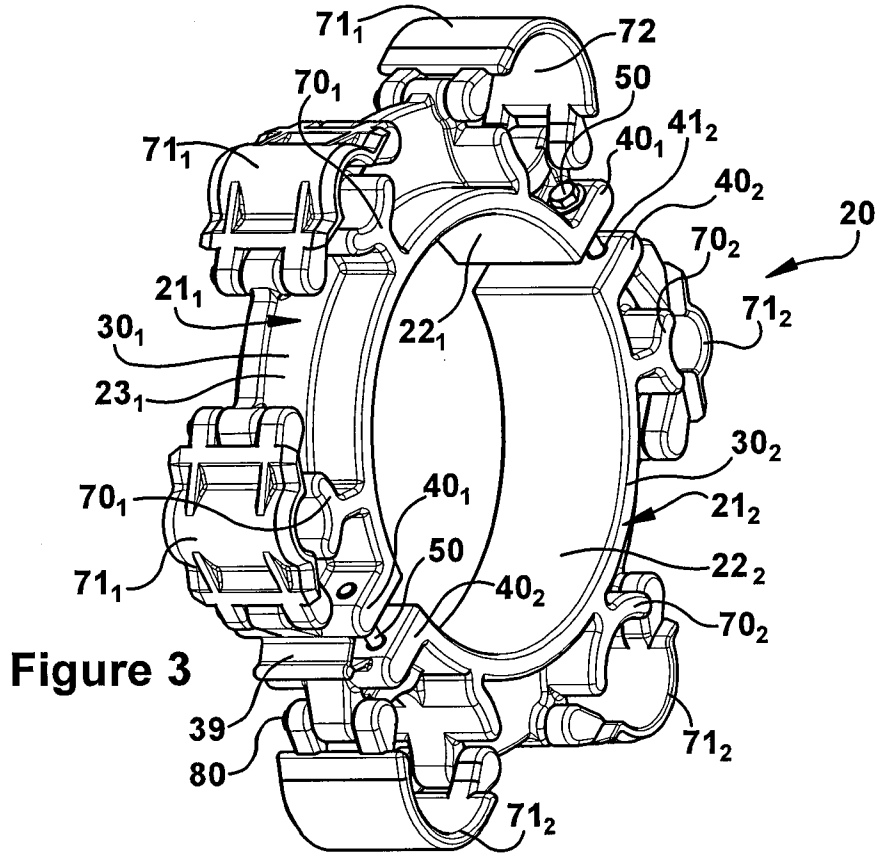


Figure 3

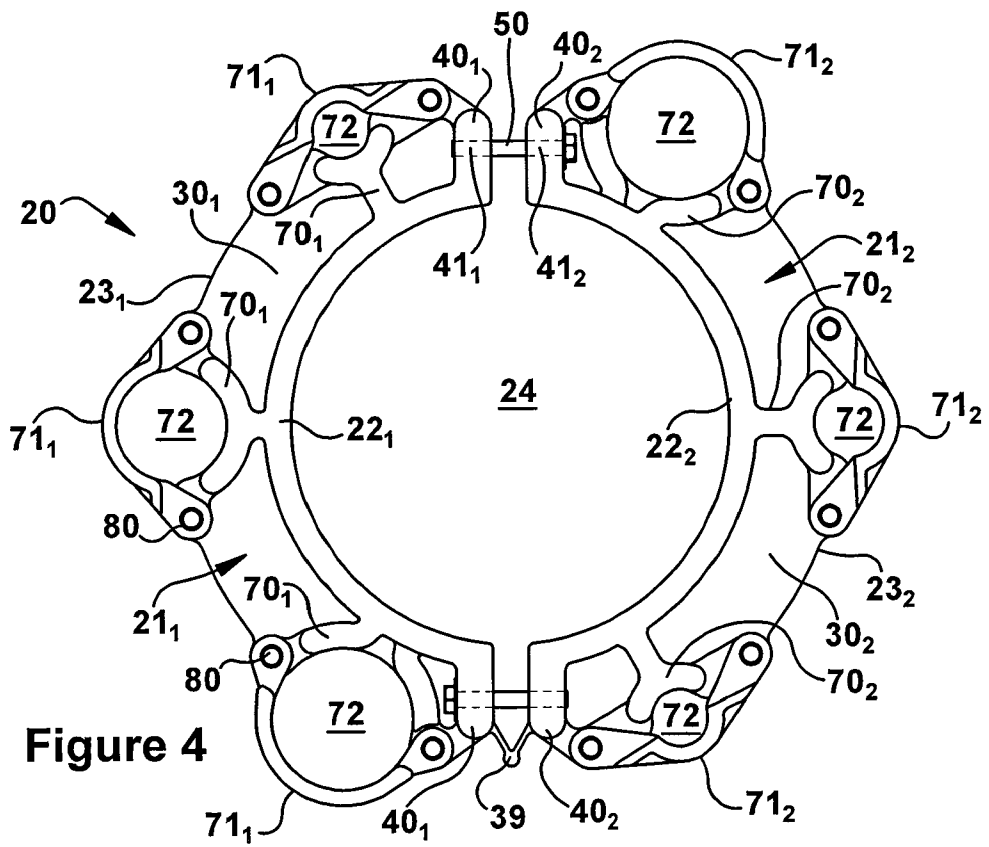


Figure 4

