Claims

1. A capstan reel for transporting an elongated article between a floating vessel and a body of water situated below the vessel, wherein the capstan reel comprises

- a rotatable cylindrical body for spooling the elongated article around the body's axial axis,

said body comprising a cylindrical contacting surface for indirectly supporting at least a portion of the elongated article,

wherein the capstan reel further comprises

- an endless chain spooled at least partly around the cylindrical body in a helical direction relative to the axial axis of the body, acting as an intermediate layer between the cylindrical contacting surface and the intended elongated article, and
- a chain transfer guide extending across the axial length of the cylindrical body for guiding the endless chain between

a chain exit region in a first axial end region of the cylindrical body and

a chain entry region in a second axial end region,

the second axial end region being situated at the opposite axial end of the cylindrical body, wherein, in use, the endless chain enters and exits the cylindrical body with a non-zero entry angle and a non-zero exit angle, respectively, the entry angle and the exit angle being defined as the angle relative to the overall rotational direction of the cylindrical body.

2. Capstan reel in accordance with claim 1, wherein the angles are identical or near identical to each other.

3. Capstan reel in accordance with claims 1 or 2, wherein the capstan reel further comprises helical inducing means at or near either or both of the first axial end region and the second axial end region, wherein the helical inducing means is configured to enforce the helical direction of the endless chain.

4. Capstan reel in accordance with claim 3, wherein at least one of the helical inducing means is situated at or near the chain entry region.

5. Capstan reel in accordance with claims 3 or 4, wherein the helical inducing means partly follows the cylindrical contacting surface.

6. Capstan reel in accordance with one of claims 3 to 5, wherein the enforcement / exertion of the helical direction is at least partly caused by sliding contact between

one or both of the lateral side of the endless chain and the at least one helical inducing means.

7. Capstan reel in accordance with one of the preceding claims, wherein the endless chain is composed of a multiple of support elements arranged in an end-to-end relationship via flexible connecting means, wherein the connecting means allows relative movement between adjacent support elements.

8. Capstan reel in accordance with one of the preceding claims, wherein each support element comprises

- a support face for supporting the elongated article during winding around the cylindrical body, the geometry of the support face being designed to provide support and to restrict relative movement between the intended elongated article and the corresponding one or more support elements,
- side skid surfaces for providing sliding contact between the support element and at least one adjacent support element in the axial direction of the cylindrical body, and
- skid pads arranged on the side opposite of the support face to provide frictional contact between the support element and the cylindrical contacting surface, wherein the skid pads are configured to ensure a frictional contact that both ensure maintenance of a capstan effect on the elongated article during use and to allow relative longitudinal movement between the support elements.

9. Capstan reel in accordance with one of the preceding claims, wherein the capstan reel further comprises a first radial pressure beam and a second radial pressure beam connected to the cylindrical body at or near the chain exit region and the chain entry region, respectively, the radial pressure beams being configured to ensure desired spatial positioning of the endless chain during exit out of, and re-entry into, the cylindrical body.

10. Capstan reel in accordance with claim 9, wherein a helical inducing means is connected, or form an integral part of, either or both the first and the second radial pressure beam.

11. Capstan reel in accordance with one of the preceding claims, wherein the capstan reel further comprises an end termination support (ETS) supportable on the endless chain, wherein the ETS is arranged at or near a spooling-on region or at or near a spooling-off region for the elongated article, for receival, support and release of an end termination arranged at one end of the elongated article.

12. Capstan reel in accordance with claim 11, wherein the ETS is releasably fastened on a first radial pressure beam and a second radial pressure beam by parking means.

13. Capstan reel in accordance with claim 12, wherein the parking means comprises a ETS latch for releasably fixing the ETS in a parked position and

a passable retaining member for preventing the ETS to slide in one of its two longitudinal directions on the respective radial pressure beam while being in a parked position, the longitudinal direction being defined as the direction along the length of the radial pressure beams.

14. Capstan reel in accordance with claim 13, wherein the parking means on the first radial pressure beam differs from the parking means on the second radial pressure beam in that the parking means on the first radial pressure beam further comprises a non-passable stopper preventing the ETS to slide in the other of its two longitudinal directions on the first radial pressure beam.

15. Capstan reel in accordance with one of claims 11 to 14, wherein the ETS is supportable onto at least one ETS support face of the endless chain.

16. Capstan reel in accordance with one of claims 11 to 15, wherein the ETS comprises a second end termination coupling means for receival of a first end termination coupling means during operation, the first end termination couplings means constituting part of the end termination.

17. Capstan reel in accordance with one of the preceding claims, wherein the capstan reel further comprises a radial pressure track (RPT) arranged on at least one of the cylindrical body's axial ends, wherein said RPT is configured to exert a pressure / holding force on at least one part of the elongated article positioned on the cylindrical body during use.

18. Capstan reel in accordance with claim 17, wherein during use, the RPT is exerting the pressure / holding force only when the number of turns of the elongated article around the cylindrical body is less than the predetermined number of turns.

19. A method of controlling the movement of an elongate article suspended by the capstan reel according to of any one of claims 1 – 18, comprising the steps of

a) feeding the elongated article onto the capstan reel at a first speed; and

b) operating the capstan reel at a rotational speed that is related to said first

speed in such a manner as to control the dynamic friction between the endless chain and the cylindrical containing surface of the capstan reel.

20. The method of claim 19, wherein step a) is accomplished by operation of a tensioner.

21. The method of claim 19 or 20, wherein the speed with which the elongated article is allowed to enter the reel is controlled so as to maintain a relative movement between the reel and the elongated article.

22. A vessel for laying and retrieving an elongated article into or out of a body of water, comprising a hull and a deck, and further characterized by comprising a capstan reel in accordance with one of the claims 1-18.

Claims

1. A capstan reel (10) for transporting an elongated article (6,6a,6b,39,42,43,45a,47) between a floating vessel (2) and a body of water situated below the vessel, wherein the capstan reel (10) comprises

- a rotatable cylindrical body (100) for spooling the elongated article (6,6a,6b,39,42,43,45a,47) around the body's (110) axial axis (11),

said body (100) comprising a cylindrical contacting surface (35) for indirectly supporting at least a portion of the elongated article (6,6a,6b,39,42,43,45a,47),

characterized in that

the capstan reel (10) further comprises

- an endless chain (18) spooled at least partly around the cylindrical body (100) in a helical direction relative to the axial axis (11) of the body (100), acting as an intermediate layer between the cylindrical contacting surface (35) and the intended elongated article (6,6a,6b,39,42,43,45a,47), and

- a chain transfer guide (17) extending across the axial length of the cylindrical body (100) for guiding the endless chain (18) between

a chain exit region (T) in a first axial end region (7a) of the cylindrical body (100) and

a chain entry region (E) in a second axial end region (7b),

the second axial end region (7b) being situated at the opposite axial end of the cylindrical body (100).

2. Capstan reel (10) in accordance with claim 1, **characterized in that**, in use, the endless chain (18) enters and exits the cylindrical body (100) with a non-zero entry angle and a non-zero exit angle, respectively, the entry angle and the exit angle being defined as the angle relative to the overall rotational direction of the cylindrical body (100).

3. Capstan reel (10) in accordance with claim 2, **characterized in that** the angles are identical or near identical to each other.

4. Capstan reel (10) in accordance with one of the preceding claims, **characterized in that**, the capstan reel (10) further comprises helical inducing means (110) at or near either or both of the first axial end region (7a) and the second axial end region (7b), wherein the helical inducing means (110) is configured to enforce the helical direction of the endless chain (18).

5. Capstan reel (10) in accordance with claim 4, **characterized in that** at least one of the helical inducing means (110) is situated at or near the chain entry region (E),

6. Capstan reel (10) in accordance with claims 4 or 5, **characterized in that** the helical inducing means (110) partly follows the cylindrical contacting surface (35).

7. Capstan reel (10) in accordance with one of claims 4 to 6, **characterized in that** the enforcement / exertion of the helical direction is at least partly caused by sliding contact between one or both of the lateral side of the endless chain (18) and the at least one helical inducing means (110).

8. Capstan reel (10) in accordance with one of the preceding claims, **characterized in that** the endless chain (18) is composed of a multiple of support elements (19) arranged in an end-to-end relationship via flexible connecting means (27,28), wherein the connecting means (27,28) allows relative movement between adjacent support elements (19).

9. Capstan reel (10) in accordance with one of the preceding claims, **characterized in that** each support element (19) comprises

- a support face (29) for supporting the elongated article (6,6a,6b,39,42,43,45a,47) during winding around the cylindrical body (100), the geometry of the support face (29) being designed to provide support and to restrict relative movement between the intended elongated article (6,6a,6b,39,42,43,45a,47) and the corresponding one or more support elements (19),

- side skid surfaces (32) for providing sliding contact between the support element (19) and at least one adjacent support element (19) in the axial direction of the cylindrical body (100), and

- skid pads (31) arranged on the side opposite of the support face (29) to provide frictional contact between the support element (19) and the cylindrical contacting surface (35), wherein the skid pads (31) are configured to ensure a frictional contact that both ensure maintenance of a capstan effect on the elongated article (6,6a,6b,39,42,43,45a,47) during use and to allow relative longitudinal movement between the support elements (19).

10. Capstan reel (10) in accordance with one of the preceding claims, **characterized in that** the capstan reel (10) further comprises a first radial pressure beam (23a) and a second radial pressure beam (23b) connected to the cylindrical body (100) at or near the chain exit region (T) and the chain entry region (E), respectively, the radial pressure beams (23a,b) being configured to ensure desired spatial positioning of the endless chain (18) during exit out of, and re-entry into, the cylindrical body (100).

11. Capstan reel (10) in accordance with claim 10, **characterized in that** the helical inducing means (110) is connected, or form an integral part of, either or both the first and the second radial pressure beam (23a,b).

12. Capstan reel (10) in accordance with one of the preceding claims, **characterized in that** the capstan reel (10) further comprises an end termination support (ETS) (44) supportable on the endless chain (18), wherein the ETS (44) is arranged at or near a spooling-on region (P) or at or near a spooling-off region (U) for the elongated article (6,6a,6b,39,42,43,45a,47), for receival, support and release of an end termination (42) arranged at one end of the elongated article (6,6a,6b,39,42,43,45a,47).

13. Capstan reel (10) in accordance with claim 12, **characterized in that** the ETS (44) is releasably fastened on the first radial pressure beam (23a) and the second radial pressure beam (23b) by parking means (53a,b,54,48a,b,49).

14. Capstan reel (10) in accordance with claim 13, **characterized in that** the parking means (53a,b,54,48a,b,49) comprises

a ETS latch (53a,b) for releasably fixing the ETS (44) in a parked position and

a passable retaining member (48a,b) for preventing the ETS (44) to slide in one of its two longitudinal directions on the respective radial pressure beam (23a,b) while being in a parked position, the longitudinal direction being defined as the direction along the length of the radial pressure beams (23a,b).

15. Capstan reel (10) in accordance with claim 14, **characterized in that** the parking means (53a,54,48a,49) on the first radial pressure beam (23a) differs from the parking means (53b,54,48b,49) on the second radial pressure beam (23b) in that the parking means (53a,54,48a,49) on the first radial pressure beam (23a) further comprises a non-passable stopper (49) preventing the ETS (44) to slide in the other of its two longitudinal directions on the first radial pressure beam (23a).

16. Capstan reel (10) in accordance with one of claims 11 to 15, **characterized in that** the ETS (44) is supportable onto at least one ETS support face (50) of the endless chain (18).

17. Capstan reel (10) in accordance with one of claims 11 to 16, **characterized in that** the ETS (44) comprises a second end termination coupling means (45b) for receival of a first end termination coupling means (45a) during operation, the first end termination couplings means (45a) constituting part of the end termination (42).

18. Capstan reel (10) in accordance with one of the preceding claims, **characterized in that** the capstan reel (10) further comprises a radial pressure track (RPT) (120) arranged on at least one of the cylindrical body's (100) axial ends, wherein said RPT is configured to exert a pressure / holding force on at least one part of the elongated article (6,6a,6b,39,42,43,45a,47) positioned on the cylindrical body (100) during use.

19. Capstan reel (10) in accordance with claim 18, characterized in that, during use, the RPT (120) is exerting the pressure / holding force only when the number of

turns of the elongated article (6,6a,6b,39,42,43,45a,47) around the cylindrical body (100) is less than the predetermined number of turns.

20. A method of controlling the movement of an elongate article (6) suspended by the capstan reel (10) according to of any one of claims 1 – 19, characterized by the steps of

a) feeding the elongated article (6,6a,6b,39,42,43,45a,47) onto the capstan reel (10) at a first speed; and

b) operating the capstan reel (10) at a rotational speed that is related to said first speed in such a manner as to control the dynamic friction between the elongated article (6,6a,6b,39,42,43,45a,47) and the capstan reel (10) surface.

21. The method of claim 20, wherein step a) is accomplished by operation of a tensioner (20).

22. The method of claim 20 or 21, wherein the speed with which the elongated article (6,6a,6b,39,42,43,45a,47) is allowed to enter the reel (10) is controlled so as to maintain a relative movement between the reel (10) and the elongated article (6,6a,6b,39,42,43,45a,47).

23. A vessel (2) for laying and retrieving an elongated article (6,6a,6b,39,42,43,45a,47) into or out of a body of water, comprising a hull (3) and a deck (4), and further characterized by comprising a capstan reel (10) in accordance with one of the claims 1-19.