Claims

1. An elongate fixation device for use in subsea anchoring, the fixation device comprising:

an inner stem having a first length in an axial direction and a cutter disposed at a distal end and a tapered section located adjacent to and proximally of the cutter;

an intermediate stem having a second length less than the first length in the axial direction and having a generally tubular shape, the intermediate stem surrounding a central portion of the inner stem and extending distally towards the taper section, wherein the intermediate stem has one or more flareable cutting fingers at its distal end; and

an outer stem having a generally tubular shape and a portion for retaining the fixation device in a substrate, the outer stem further having a third length in an axial direction less than the first length, the outer stem surrounding a proximal portion of the intermediate stem and extending proximally beyond a proximal end of the intermediate stem;

a first releasable coupling between the inner and intermediate stems; and

a second releasable coupling between the outer and intermediate stems; wherein

the inner, intermediate and outer stems are rotationally coupled to one another; wherein

the first releasable coupling has a coupled configuration in which relative axial motion between the inner and intermediate stems is prevented and an uncoupled configuration in which relative axial motion between the inner and intermediate stems along a first distance is possible; wherein

the second releasable coupling has a coupled configuration in which relative axial motion between the intermediate and outer stems is prevented and an uncoupled configuration in which relative axial motion between the intermediate and outer stems along a second distance is possible; wherein

the outer stem has a driving portion for coupling to a rotational drive and the inner stem has a tensioning nut located proximally of the driving portion for adjusting the relative axial positions of the inner and outer stems, the tensioning nut being located on the inner stem and adjustable by coupling to a rotational drive; and wherein

the tensioning nut and the driving portion are configured to couple to the same rotational drive.

2. The fixation device according to claim 1, wherein the driving portion is spaced in a distal direction from the proximal end of the outer stem.

3. The fixation device according to claim 1, wherein the proximal end of the outer stem is narrower than the driving portion.

4. The fixation device according to any preceding claim, wherein:

the intermediate stem is nested within the outer stem for at least a majority of the outer stem.

5. The fixation device according to any preceding claim, wherein the first and/or second releasable coupling(s) is/are located towards the proximal end of the device.

6. The fixation device according to any preceding claim, wherein the relative axial motion between the intermediate and inner stems is restricted to the first distance by a first axial coupling and/or wherein the relative axial motion between the intermediate and outer stems is restricted to the second distance by a second axial coupling.

7. The fixation device according to claim 6, wherein the or each axial coupling is located towards the proximal end of the device.

8. The fixation device according to claim 6 or claim 7, wherein the or each axial coupling is located in a different axial location from each releasable coupling.

9. The fixation device according to any one of claims 6 to 8, wherein the or each axial coupling is located a different angular location around the device from each releasable coupling.

10. The fixation device according to any one of claims 6 to 9, wherein the or each axial coupling comprises a slot and pin arrangement.

11. The fixation device according to any one of claims 6 to 10, wherein the or each axial coupling comprises a pair of slots and corresponding pins located on diametrically opposed portions of the device.

12. The fixation device according to any one of the preceding claims, wherein the releasable coupling between the inner stem and the intermediate stem and/or the releasable coupling between the intermediate stem and the outer stem comprises a shear pin.

13. The fixation device according to claim 12, wherein both releasable couplings comprise shear pins and the shear strength of the shear pin between the intermediate stem and the outer stem has a greater shear strength than a shear strength of the shear pin between the inner stem and the intermediate stem.

14. The fixation device according to claim 12 or claim 13 wherein the or each releasable coupling comprises a pair of shear pin couplings on diametrically opposed portions of the device.

15. The fixation device according to any one of the preceding claims, wherein the first distance is larger than the second distance.

16. The fixation device according to any one of the preceding claims, wherein the first distance is at least as long as a longest cutting finger.

17. The fixation device according to any one of the preceding claims, wherein the portion for retaining the fixation device in the substrate comprises a portion which tapers from its proximal end towards its distal end.

18. The fixation device according to any one of the preceding claims, wherein the flareable cutting fingers are hingedly attached to the distal end of the intermediate stem.

19. The fixation device according to any one of claims 1 to 17, wherein the flareable fingers form part of the distal end of the intermediate stem.

20. The fixation device according to claim 19, wherein the portion of the intermediate stem corresponding to the flareable fingers is coupled to a main body of the intermediate stem via a portion of the intermediate stem which is thinner than the main body of the intermediate stem.

21. The fixation device according to any one of the preceding claims, wherein the inner stem comprises a lumen for flushing a hole drilled by the cutter.

22. The fixation device according to any one of the preceding claims, further having an attachment point located towards a proximal end of the device.

23. The fixation device according to claim 22, wherein the attachment point is located on the outer stem.

24. The fixation device according to claim 22 or claim 23, wherein the attachment point is rotationally coupled to the device to rotate around a central axis of the device.

25. The fixation device according to any one of the preceding claims, further comprising a structural connection portion for providing a location on which to construct an underwater structure.

26. A remotely operated drive system for installing the fixation device of any one of the preceding claims, the remotely operated drive system comprising:

a rotational drive;

a first connection rotationally driven by the rotational drive for rotationally driving both the outer stem of the fixation device and the tensioning nut;

a second connection for coupling to the inner stem of the fixation device;

a first axial drive for axial movement of the first connection to decouple it from the outer stem while retaining the tensioning nut; and

a second axial drive for axial movement of the inner stem relative to the intermediate stem.

27. The remotely operated drive system according to claim 26, wherein the second connection is also rotationally driven by the rotational drive.

28. The remotely operated drive system according to claim 27, wherein the second connection is coupled to the rotational drive via a clutch mechanism.

29. The remotely operated drive system according to any one of claims 26 to 28, further comprising pumping means for flushing a hole drilled by the cutter.

30. The remotely operated drive system according to claim 29, further comprising a store of fluid for flushing or grouting the hole.

31. An anchoring installation system comprising the fixation device of any one of claims 1 to 25, and the remotely operated drive system of any one of claims 26 to 30, wherein:

the first connection is coupled to the tensioning nut and the driving portion; and

the second connection is coupled to the inner stem.

32. The anchoring installation system according to claim 31, wherein the first axial drive is in a deployed position, in which the first axial drive is extended in the distal direction.

33. The anchoring installation system according to claim 31 or claim 32, wherein the second axial drive is in a retracted position, in which the second axial drive is retracted and is arranged in a most distal arrangement.

34. A method of installing into a substrate the fixation device according to any of claims 1 to 25, the method comprising the steps of:

rotationally driving the driving portion of the outer stem and the tensioning nut with a single rotational drive to cause the outer, intermediate and inner stems to rotate due to their rotational coupling, wherein the rotations of the inner stem causes the cutter to drill into a substrate;

drawing the inner stem in a proximal direction relative to the intermediate stem while rotationally driving the intermediate stem, to cause the fingers to flare out and ream an undercut in the substrate;

decoupling the rotational drive from the outer stem while retaining the tensioning nut in the rotational drive; and

driving the tensioning nut in a distal direction relative to the outer stem.

35. The method according to claim 34, wherein the method is performed using the remotely operated drive system according to any one of claims 26 to 30.

36. The method according to claim 35, wherein the drawing step is performed by deploying the second axial drive.

37. The method according to claim 35 or claim 36, wherein the decoupling step is performed by retracting the first axial drive.

38. The method according to any one of claims 35 to 37, wherein prior to performing the method, the remotely operated drive system is coupled to the fixation device.

39. The method according to any one of claims 34 to 38, further including a flushing and clearing step performed while the device is drilling and reaming.

40. The method according to any one of claims 34 to 39, further including coupling a buoyant device to the fixation device once the fixation device is installed in the substrate.