CLAIMS

1. A fixation device comprising a shaft rotatable about a longitudinal axis with a first cutter at a first, distal end;
a guide body on the shaft shaped to taper outwardly towards the first end of the shaft;
an elongate sleeve disposed surroundingly about the shaft to be rotatable separately from the shaft and translatable in a longitudinal direction relative to the shaft;
a flareable end formation at a first, distal end of the elongate sleeve comprising one or more second cutters;
the guide body and flareable end formation being arranged so that urging the sleeve towards the first end over the guide body flares the end formation outward from the shaft;
a tensioning mechanism associated with a second end of the sleeve operable selectively to urge the shaft relative to the sleeve back towards the second end;
wherein the sleeve is provided in two parts comprising a distal part and a proximal part, the two parts being axially spaced by a torque coupling by means of which they are co-rotatable as the sleeve is driven into the ground, but which torque coupling is adapted to allow relative translation of the two parts to reduce their axial spacing as an axial load is applied.

2. A fixation device in accordance with claim 1 wherein the distal part and proximal part are axially spaced by a frangible torque coupling.

3. A fixation device in accordance with claim 2 wherein the frangible torque coupling is configured to fail at a predetermined axial loading as a pre-tensioning force is applied to the shaft by the tensioning mechanism.

4. A fixation device in accordance with claim 2 or 3 wherein the frangible torque coupling comprises mutually engageable projecting torque surfaces at a distal end of the proximal part and a proximal end of the distal part engaged

together by one or more frangible connectors such as one or more shear pins.

5. A fixation device in accordance with claim 4 wherein the torque surfaces comprise mutually engageable internally and externally splined formations.

6. A fixation device in accordance with any preceding claim wherein the tensioning mechanism is configured co-operably with the flareable end portion at the distal end such that in use with the flareable end portion deployed in flared conformance as an anchor in a substrate below a substrate surface the selective operation of the tensioning mechanism at a second end of the shaft acting to urge the shaft relative to the sleeve back towards the substrate surface and the resistance of this urging force by the flareable end portion at the distal end co-operably effect a pre-tension in the shaft.

7. A fixation device in accordance with any preceding claim wherein the tensioning mechanism is additionally configured to lock the shaft in a fixed mechanical relationship to the second end of the sleeve.

8. A fixation device in accordance with any preceding claim wherein the tensioning mechanism further comprises a locking mechanism to lock the relative positions of the second end of the sleeve and the shaft at a selected relatively translated juxtaposition.

9. A fixation device in accordance with any preceding claim wherein the tensioning mechanism is in direct mechanical association with the second end of the sleeve.

10. A fixation device in accordance with claim 9 wherein the tensioning mechanism is in fixed mechanical relationship to the second end of the sleeve.

11. A fixation device in accordance with any preceding claim wherein a projecting proximal end portion of the shaft is arranged to project beyond a proximal end

of the sleeve through an aperture in the said proximal end, and a shaft engagement system is arranged to engage the projecting end portion and apply a tensioning force to the same by urging the end portion in a direction beyond the proximal end of the sleeve outwardly of the aperture.

12. A fixation device in accordance with any preceding claim wherein the tensioning mechanism includes a threaded formation.

13. A fixation device in accordance with claim 12 wherein the tensioning mechanism is a threaded tensioning nut.

14. A fixation device in accordance with claim 12 or claim 13 wherein a threaded portion on the shaft is provided and configured to engage with a complementary threaded formation provided in mechanical association with the second end of the sleeve.

15. A fixation device in accordance with claim 14 further comprising a tensioning nut disposed to engage in use upon a top bearing surface or cap of the second end of the sleeve whereby tightening of the tensioning nut tends to draw the shaft towards the second end of the fixation device.

16. A fixation device in accordance with any preceding claim wherein a portion of the sleeve at or about a second end is provided in association with a reaction formation having one or more reaction surfaces adapted in use with the fixation device in situ in a substrate to engage with the substrate.

17. A fixation device in accordance with claim 16 wherein the reaction formation is provided with one or more reaction surfaces conformed to engage with one, other or both of a surface of the substrate or the upper part of a hole when the fixation device is in situ within the said hole, whereby in use in situ at least the upper portion of the sleeve is held stably relative to the substrate surface and for example stably in the hole.

18. A fixation device in accordance with claim 16 or 17 wherein the reaction formation comprises an anchoring structure associated with a portion of the sleeve towards the second end.

19. A fixation device in accordance with claim 18 wherein the reaction formation comprises an anchoring structure configured integrally as part of the portion of the sleeve towards the second end.

20. A fixation device in accordance with claim 19 wherein the anchoring structure comprises a tapered formation of the sleeve towards the second end configured to taper outwardly towards the second end.

21. A fixation device in accordance with claim 20 wherein the tapered formation is a a frustoconical formation.

22. A fixation device in accordance with claim 20 or 21 wherein the tapered formation comprises one or more third cutters disposed on an outer surface.

23. A fixation device in accordance with claim 22 wherein the one or more third cutters comprise one or more axially progressive blades.

24. A fixation device in accordance with claim 23 wherein the one or more third cutters comprise one or more helical blades.

25. A fixation device in accordance with one of claims 16 to 24 comprising a surface securing arrangement comprising a formation in direct mechanical association with a portion of the sleeve at or about the second end and configured to be secured on or at the substrate surface.

26. A fixation device in accordance with claim 25 wherein the surface securing arrangement includes a reaction surface disposed to seat upon the substrate surface in use.

27. A fixation device in accordance with claim 26 wherein the surface securing arrangement includes a “pile cap” or “top hat” attachment comprising a laterally extending plate-like member and a cylindrical member.

28. A fixation device in accordance with any preceding claim wherein the shaft comprises a shaft drive coupling for applying torque to the shaft for driving the first cutter and the sleeve comprises a sleeve drive coupling for applying torque to the sleeve for driving the second cutters.

29. A fixation device in accordance with claim 28 wherein the drive couplings are bayonet drive couplings.

30. A fixation device in accordance with any preceding claim wherein the guide body is a frustoconical body shaped to taper outwardly towards the first end of the shaft.

31. A fixation device in accordance with any preceding claim wherein the flareable end portion of the sleeve comprises a pivot arranged to allow the flareable end portion to bend about the pivot and thereby be flared outward.

32. A fixation device in accordance with claim 31 wherein the flareable end portion of the sleeve comprises a plurality of pivotable fingers.

33. A method of installing a fixation device into a substrate, the fixation device comprising a shaft rotatable about a longitudinal axis having a first cutter at a first, distal end; a guide body on the shaft shaped to taper outwardly towards the first end of the shaft; and an elongate sleeve disposed surroundingly about the shaft to be rotatable separately from the shaft and translatable in a longitudinal direction relative to the shaft having a flareable end formation at a first, distal end of the elongate sleeve comprising one or more second cutters; the method comprising:

rotating the shaft and thereby boring a hole into a substrate using the first cutter;

translating the sleeve in a longitudinal direction distally relative to the shaft to urge the flareable end formation over the guide body and flare the end formation outward from the shaft;

rotating the sleeve and thereby reaming out an undercut in the substrate;

urging the shaft relative to the sleeve back towards the second end to apply a tension to the shaft;

wherein the sleeve is provided in two parts comprising a distal part and a proximal part axially spaced apart by a torque coupling, the two parts are co-rotated as the sleeve is translated laterally by means of the torque coupling, and the two parts are then caused to move axially closer together as the shaft is urged relative to the sleeve back towards the second end of the sleeve by a torque coupling by means of which they are co-rotatable as the sleeve is driven into the ground, in that the torque coupling is adapted to allow relative translation of the two parts to reduce their axial spacing as an axial load is applied.

34. The method in accordance with claim 33 wherein the two parts are axially spaced by a frangible torque coupling and an axial load is applied to break this coupling.

35. The method in accordance with claim 33 or 34 wherein:

in a first phase of deployment the shaft is rotatably driven about its longitudinal axis to effect a cutting action via the first cutter and drive the first end of the shaft distally into the substrate;

in a second phase of deployment the flareable end portion of the sleeve is caused to move over the guide body positioned towards the distal end of the shaft behind the first cutter, such that when the flareable end portion of the sleeve reaches and passes over the guide body it is urged outwardly, the sleeve is rotatably driven about the shaft, effecting a cutting action via the second cutters and causing the sleeve to be driven distally relative to the shaft to make an undercut in the substrate;

in a third phase of deployment a pre-tension is applied to the shaft by urging the shaft relative to the sleeve back towards a second end of the device, being the end proximal to the substrate surface, whereby a tensile load is applied the shaft in situ.

36. The method of claim 35 wherein the undercut is formed with a reverse taper.

37. The method in accordance with one of claims 34 to 36 comprising the further step of locking the relative positions of the second end of the sleeve and the shaft when a desired tension has been introduced into the shaft.

38. The method in accordance with one of claims 34 to 37 wherein a projecting proximal end portion of the shaft is arranged to project beyond a proximal end of the sleeve, for example through an aperture in the said proximal end, and the step of urging the shaft relative to the sleeve back towards the second end to apply a tension to the shaft comprises applying an urging force to the projecting proximal end portion.

39. The method in accordance with one of claims 34 to 38 wherein a threaded portion is provided on the shaft configured to engage with a complementary threaded formation provided in mechanical association with the second end of the sleeve and the step of applying a tension to the shaft comprises tightening the thread.

40. The method in accordance with one of claims 34 to 39 wherein an upper portion of the sleeve towards the second end comprises a tapered formation whereby the sleeve is configured to taper outwardly towards the second end with one or more third cutters disposed on an outer surface and the step of translating the sleeve in a longitudinal direction distally relative to the shaft includes driving this tapered formation into the substrate surface to form a complementarily tapered hole.

41. The method in accordance with one of claims 33 to 40 applied to the securing into position of a buoyant subsurface apparatus to a bed of a body of water.