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[Continued on next page]

(54) Title: HELICAL PILE LEADS AND EXTENSIONS

(57) Abstract: The present disclosure provides helical pile leads and extensions with closely spaced perimeter shear helical plates that develop a cylindrical failure surface between the perimeter shear helical plates and soil as the helical pile is rotated into the ground, mobilizing soil-to-soil shear strength, and thus increasing the stability, stiffness and load capacity of the helical pile.

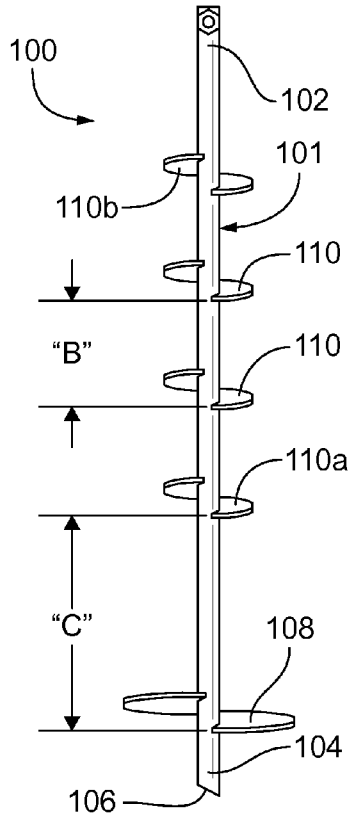


FIG. 4

WO 2016/085837 A1

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Patent Application for

HELICAL PILE LEADS AND EXTENSIONS

BACKGROUND

Field

[001] The present disclosure relates generally to helical piles, and more particularly to leads and extensions for helical piles having perimeter shear helical plates.

Description of the Related Art

[002] Piles are used to support structures, such as buildings, when the soil underlying the structure would be too weak alone to support the structure. To effectively support a structure, a pile has to penetrate the soil to a depth where competent load-bearing stratum is found. Conventional piles can be cast in place by excavating a hole in the place where the pile is needed, or a hollow form can be driven into the ground where the pile is needed, and then filled with cement. These approaches are cumbersome and expensive.

[003] Helical or screw piles are a cost-effective alternative to conventional cement piles because of the speed and ease at which a helical pile can be installed. Helical piles are rotated such that load bearing helical plates at the lower end of the pile effectively screw the pile into the soil to a desired depth. Referring to Fig. 1, a helical pile 10 is typically made of galvanized straight steel square or round shafts sequentially joined together. The bottom most piece of a helical pile is known as the lead 12, which has a lead head portion 14 and a lead end portion 16. The lead end portion 16 is configured to first penetrate the soil, and terminates at a pointed tip 17. As seen in Figs. 1 and 2, the lead end portion 16 typically has one or more spaced apart load bearing helical plates 18 arranged on the lead shaft typically in the lead end portion 16 to penetrate the soil. The load bearing helical plates 18 on the lead may have the same diameter, or the load bearing helical plates may have different diameters that are in a tapered arrangement. For example, the tapered arrangement may be such that the smallest diameter load bearing helical plate is closest to the lead tip 17 and the largest load bearing helical plate is at a distance

away from the lead tip. The load bearing helical plates 18 on the lead 12 are spaced apart at a distance "A" sufficient to promote individual plate load bearing capacity. Typically, the distance "A" is three times the diameter of the smallest load bearing helical plate 18 on the shaft of the lead 12. The diameter of the load bearing helical plates 18 in conventional helical piles may range from between about 6 inches and about 16 inches depending upon the load the pile is to carry. As noted above, helical piles 10 are installed by applying torque to the shaft at the lead head 14 that causes the load bearing helical plates to rotate and screw into the soil with minimal disruption to the surrounding soil. As the lead 12 penetrates the soil, one or more extensions 20 may have to be added to the pile 10 so that the pile can achieve the desired depth and load capacity. Referring to Fig. 1, extensions 20 may be fabricated from traditional straight steel square or round shafts and have an extension end portion 22 and an extension head portion 24 that are configured to connect to a lead head portion 14 and/or another extension 20, typically with a nut and bolt. Referring to Fig. 3, the extensions 20 may have load bearing helical plates 26 spaced apart at a distance "A" sufficient to promote individual plate load bearing capacity. As noted above, typically, the distance "A" is three times the diameter of the smallest load bearing helical plate 26 on the shaft of the extension 12. The diameter of the load bearing helical plates 26 in conventional helical pile extensions may range from between about 12 inches and about 16 inches depending upon the load the pile is to carry. Typically, the load bearing plates 26 on extension 20 are the same diameter as the largest load bearing helical plate on the lead 12.

[004] One drawback of conventional helical piles is that they have a limited load capacity that if exceeded can cause the helical pile to settle or creep. Another drawback of conventional helical piles is that they can succumb to lateral movement. Greater pile stability and stiffness can be achieved by pouring or pumping cement based grout around the pile shaft which hardens to form a grout column. However, adding grout columns increase construction costs from a time and materials point of view. Further, there may be instances where soil conditions or other environmental conditions do not permit the use of grout columns to increase the stability, stiffness, and load capacity of the pile. The present disclosure provides an alternative to using grout columns to increase the stability, stiffness and load capacity of helical piles.

SUMMARY

[005] The present disclosure provides helical piles having helical pile leads and/or extensions with closely spaced perimeter shear helical plates that develop a cylindrical failure surface between the perimeter shear helical plates and soil, mobilizing soil-to-soil shear strength, and thus increasing the stability, stiffness and load capacity of the helical pile. In one embodiment, the helical pile extension includes a shaft having an end portion configured to connect to another helical pile extension or a helical pile lead, and a head portion configured to connect to another helical pile extension. A plurality of perimeter shear helical plates are attached to the shaft, and spaced apart a distance that promotes soil-to-soil shear strength. An example of a distance that promotes soil-to-soil shear strength is less than 3 times a diameter of the perimeter shear helical plates and preferably 1.5 times a diameter of the perimeter shear helical plates. The extension shafts may be square or round and they may be solid or hollow. The diameter of each of the plurality of perimeter shear helical plates can range from between about 4 inches and about 10 inches.

[006] In one embodiment, the helical pile lead includes a shaft having an end portion and a head portion, where the head portion is configured to connect to a helical pile extension. At least one load bearing helical plate is attached at the end portion of the shaft, and a plurality of perimeter shear helical plates are attached to the shaft. The perimeter shear helical plates on the shaft are preferably spaced apart a distance that promotes soil-to-soil shear strength. Preferably, the perimeter shear helical plate closest to the at least one load bearing plate is spaced from the at least one load bearing helical plate a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate. An example of a distance that promotes soil-to-soil shear strength is less than 3 times a diameter of the perimeter shear helical plates, and preferably 1.5 times a diameter of the perimeter shear helical plates. An example of a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate is at least 6 inches. The diameter of each of the plurality of perimeter shear helical plates can range between about 4 inches and 10 inches, and the diameter of the at least one load bearing helical plate can range between 12 inches and 16 inches.

[007] In one embodiment, a helical pile according to the present disclosure may include a lead having a lead shaft with an end portion, a head portion configured to connect to an extension, and at least one load bearing helical plate attached at the end portion of the lead shaft. The helical pile also includes an extension having an extension shaft with an end portion that is configured to connect to the head portion of the lead. The extension also has a head portion, and a plurality of perimeter shear helical plates attached to the extension shaft. The perimeter shear helical plates on the extension shaft are preferably spaced apart a distance that promotes soil-to-soil shear strength, and the perimeter shear helical plate on the extension shaft closest to the lead is spaced from the at least one load bearing helical plate a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate. An example of a distance that promotes soil-to-soil shear strength is less than 3 times a diameter of the perimeter shear helical plates and preferably 1.5 times a diameter of the perimeter shear helical plates. An example of a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate is at least 6 inches. Preferably, the diameter of each of the plurality of perimeter shear helical plates ranges from between 4 inches and 10 inches, and the diameter of the at least one load bearing helical plate ranges from between 12 inches and 16 inches.

[008] In another embodiment, a helical pile according to the present disclosure may include a lead having a lead shaft with an end portion, and a head portion configured to connect to an extension, at least one load bearing helical plate attached at the end portion of the lead shaft, and a plurality of perimeter shear helical plates attached to the shaft. The perimeter shear helical plates on the lead shaft are preferably spaced apart a distance that promotes soil-to-soil shear strength, and the perimeter shear helical plate closest to the at least one load bearing plate is preferably spaced from the at least one load bearing helical plate a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate. The helical pile according to this embodiment also includes an extension having an extension shaft with an end portion configured to connect to the head portion of the lead, and a head portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[009] The figures depict embodiments for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures illustrated herein may be employed without departing from the principles described herein, wherein:

[0010] Fig. 1 is a side view of a conventional helical pile with a single load bearing helical plate lead, and a straight extension attached to the lead;

[0011] Fig. 2 is a side view of a conventional helical pile lead with multiple load bearing helical plates;

[0012] Fig. 3 is a side view of a conventional helical pile extension with multiple load bearing helical plates;

[0013] Fig. 4 is a side view of an embodiment according to the present disclosure of a helical pile lead with multiple perimeter shear helical plates along a length of the lead;

[0014] Fig. 5 is a perspective view of an embodiment of a perimeter shear helical plate according to the present disclosure;

[0015] Fig. 6 is a side view of an embodiment according to the present disclosure of a helical pile extension with multiple perimeter shear helical plates along a length of the extension;

[0016] Fig. 7 is a side view of an embodiment according to the present disclosure of a helical pile having a lead with a single load bearing helical plate, an extension with perimeter shear helical plates, and a straight extension;

[0017] Fig. 8 is a side view of an embodiment according to the present disclosure of a helical pile having a lead with two load bearing helical plates, an extension with perimeter shear helical plates, and a straight extension;

[0018] Fig. 9 is a side view of an embodiment according to the present disclosure of a helical pile having a lead with a single load bearing helical plate and perimeter shear helical plates, an extension with perimeter shear helical plates, and a straight extension; and

[0019] Fig. 10 is a side view of another embodiment of the helical pile of Fig. 9.

DETAILED DESCRIPTION

[0020] The present disclosure provides helical leads and extensions with closely spaced perimeter shear helical plates capable of developing a cylindrical failure surface between the perimeter shear helical plates and soil to mobilize soil-to-soil shear strength. The helical leads and extensions disclosed herein can be used as helical piles or anchors, and are capable of withstanding compression loads and tension loads. Reference herein to helical lead, helical extension, and helical piles also includes helical anchors.

[0021] Referring to Fig. 4, an exemplary embodiment of a lead for helical piles according to the present disclosure is shown. In this embodiment, the lead 100 may be fabricated from steel or galvanized steel, straight square or round shafts 101. The length of the shaft 101 may be between 3 feet and 10 feet, and the length of a lead for a particular installation would depend upon the load the pile is to carry and the type of equipment used for installation. The lead 100 has a lead head portion 102 and a lead end portion 104 that preferably terminates in a pointed tip 106. The lead head portion 102 is configured to connect to an extension, such as extension 200 (shown in Fig. 6), or a conventional extension 20 (shown in Fig. 1). Typically, the lead is connected to an extension using a nut and bolt, and preferably a galvanized nut and bolt. In the embodiment shown, the square or round lead head portion 102 fits within a female receptacle 204a in an extension 200 or an extension 12, and the nut is passed through holes aligned in the lead head portion and the extension female receptacle 204a.

[0022] In the lead end portion 104 is one or more load bearing helical plates 108 that when rotated screw the pile into the soil with minimal disruption to the surrounding soil. The load bearing helical plates 108 on the lead may have the same diameter, or the load bearing helical plates 108 may have different diameters that are in a tapered arrangement. For example, the

tapered arrangement may be such that the smallest diameter load bearing helical plate is closest to the lead tip 106 and the largest load bearing helical plate is at a distance away from the lead tip. If multiple load bearing helical plates are employed, the load bearing helical plates on the lead would be spaced apart at a distance "A" sufficient to promote individual plate load bearing capacity, as described above. In the embodiment of Fig. 4, a single load bearing helical plate 108 for the lead 100 is shown. The present disclosure also contemplates leads with multiple load bearing helical plates, where the distance between the load bearing helical plates 108 is preferably a multiple of, e.g., three times, the diameter of the lower load bearing helical plate. For example, if the lower load bearing helical plate is 10 inches in diameter the distance to the next load bearing helical plate would be 3 times the diameter of that plate, which is 30 inches.

[0023] The lead 100 in this embodiment has a plurality of spaced apart perimeter shear helical plates 110 arranged along the length of the lead shaft 101, as shown. The perimeter shear helical plates are typically welded to the shaft 101, but the perimeter shear helical plates may be secured to the shaft using any other suitable method. The lowest perimeter shear helical plate 110a on lead shaft 101 is positioned on the lead shaft at a distance "C" from the load bearing helical plate 108. The distance "C" is sufficient to promote the individual plate load bearing capacity of plate 108, which is typically 1-1/2 feet to 2 feet. Each perimeter shear helical plate 110 can have the same diameter, or different diameters in a tapered arrangement. In the embodiment shown in Fig. 4, the perimeter shear helical plates 110 have the same diameter. Preferably, the diameter of each perimeter shear helical plate 110 is less than the diameter of the load bearing helical plates 108. Suitable diameters for the perimeter shear helical plates 110 on the lead 100 can range from between about 4 inches and about 10 inches, depending upon the diameter of the load bearing helical plate or plates on the lead, and the desired load capacity.

[0024] Fig. 5 illustrates an exemplary perimeter shear helical plate 110. In this exemplary embodiment, the perimeter shear helical plate has a diameter "D" which is sufficient to promote soil-to-soil shear strength. Preferably, the diameter of the perimeter shear helical plate ranges between about 4 inches and about 10 inches. The perimeter shear helical plate has a helical pitch "P" of between about 2 inches and about 4 inches, and preferably about 3 inches. It is also preferred that the helical pitch "P" of the perimeter shear helical plates is substantially the same

as the helical pitch of the load bearing helical plates used on the lead. The thickness "T" of each perimeter shear helical plate is between about 3/8 inch and about 1/2 inch.

[0025] Referring again to Fig. 4, the perimeter shear helical plates 110 are spaced apart along the shaft 101 at a distance "B" sufficient to promote soil-to-soil shear strength. Preferably, the distance "B" is less than 3 times a diameter of the perimeter shear helical plates 110, and preferably equal to 1.5 times the diameter of the perimeter shear helical plates 110. For example, if the perimeter shear helical plates were 6 inches in diameter and using a distance "B" that is 1.5 times the diameter of the perimeter shear helical plates, the spacing between the perimeter shear helical plates along the shaft 101 would be less than or equal to 9 inches. By closely spacing the perimeter shear helical plates 110 at the distance "B", a cylindrical failure surface between the perimeter shear helical plates 110 and the soil develops as the helical pile is rotated into the ground mobilizing soil-to-soil shear strength, and thus increasing the stability, stiffness and load capacity of the helical pile.

[0026] Referring to Fig. 6, an exemplary embodiment of an extension for helical piles according to the present disclosure is shown. In this embodiment, the extension 200 may be fabricated from steel or galvanized steel, straight square or round shafts 201, which can be hollow or solid shafts. The length of the shaft 201 may be between 3 feet and 10 feet, and the length of an extension for a particular installation would depend upon the load the pile is to carry and the type of equipment used for installation. The extension 200 has an extension head portion 202 and an extension end portion 204. The extension head portion 202 is configured to connect to another extension or with a lead. The extension end portion 204 is also configured to couple with another extension or with a lead. The extension 200 may be connected to another extension or a lead with a nut and bolt, preferably a galvanized nut and bolt. In the embodiment shown, the square or round lead head portion 102 would fit within the female receptacle 204a in extension 200, and the nut is passed through holes aligned in the extension female receptacle 204a and the lead head.

[0027] The extension 200 has a plurality of spaced apart perimeter shear helical plates 206 arranged along the length of the extension shaft 201, as shown. The perimeter shear helical plates are typically welded to the shaft 201, but the perimeter shear helical plates may be secured

to the shaft using any other suitable method. The perimeter shear helical plates 206 are substantially similar to perimeter shear helical plates 110 on the lead 100 and shown in more detail in Fig. 5. Each perimeter shear helical plate 206 can have the same diameter, or different diameters in a tapered arrangement. In the embodiment shown in Fig. 6, the perimeter shear helical plates 206 have the same diameter. Preferably, the diameter of the perimeter shear helical plates 206 are less than the diameter of the load bearing helical plates on the lead. Suitable diameters for the perimeter shear helical plates 206 on the extension 200 can range from between about 4 inches and about 10 inches, depending upon the diameter of the load bearing helical plate or plates on the lead and the load capacity required.

[0028] The perimeter shear helical plates 206 are spaced apart along the shaft 201 at a distance "B" sufficient to promote soil-to-soil shear strength. Preferably, the distance "B" is less than 3 times a diameter of the perimeter shear helical plates 110, and preferably equal to 1.5 times the diameter of the perimeter shear helical plates 206. For example, if the perimeter shear helical plates were 8 inches in diameter and using a distance "B" that is 1.5 times the diameter of the perimeter shear helical plates, the spacing between the perimeter shear helical plates 206 along the shaft 201 would be less than or equal to 12 inches. By closely spacing the perimeter shear helical plates 206 at the distance "B" a cylindrical failure surface between the perimeter shear helical plates 206 and soil develops as the helical pile is rotated into the soil mobilizing soil-to-soil shear strength, and thus increasing the stability, stiffness and load capacity of the helical pile.

[0029] Referring now to Fig. 7, an exemplary embodiment of a helical pile 300 according to the present disclosure is shown. In this embodiment, the helical pile 300 includes a single load bearing helical plate 18 on a lead 12, and extension 200 connected to the lead 12, and an extension 20 connected to the extension 200. In this embodiment, the lowest perimeter shear helical plate 206a on the extension shaft 201 is spaced a distance "E" from the lowest load bearing helical plate 18 on the lead shaft. The distance "E" is determined by the soil conditions, and is typically greater than 1 foot.

[0030] Referring to Fig. 8, an exemplary embodiment of a helical pile 400 according to the present disclosure is shown. In this embodiment, the helical pile 400 includes two load bearing helical plates 18 on a lead 12, and extension 200 connected to the lead 12, and an extension 20

connected to the extension 200. In this embodiment, the lowest perimeter shear helical plate 206a on the extension shaft 201 is spaced a distance "E" from the lowest load bearing helical plate 18 on the lead shaft. The distance "E" is determined by the soil conditions, and is typically greater than 1 foot.

[0031] Referring to Fig. 9, an exemplary embodiment of a helical pile 500 according to the present disclosure is shown. In this embodiment, the helical pile 500 includes a single load bearing helical plate 108 on a lead 100, and extension 200 connected to the lead 100, and an extension 20 connected to the extension 200. In this embodiment, the lowest perimeter shear helical plate 110a on the lead shaft 101 is spaced a distance "C" from the lowest load bearing helical plate 108 on the lead shaft 101, as described above. Further, the lowest perimeter shear helical plate 206a on extension shaft 201 is spaced the distance "B" from the upper most perimeter shear helical plate 110b on the lead shaft 101.

[0032] Referring to Fig. 10, an exemplary embodiment of a helical pile 600 according to the present disclosure is shown. In this embodiment, the helical pile 600 includes a single load bearing helical plate 108 on a lead 100, and extension 200 connected to the lead 100, and an extension 20 connected to the extension 200. In this embodiment, the lowest perimeter shear helical plate 110a on the lead shaft 101 is spaced a distance "C" from the lowest load bearing helical plate 108 on the lead shaft 101, as described above. Further, the lowest perimeter shear helical plate 206a on extension shaft 201 is spaced a distance "F" from the upper most perimeter shear helical plate 110b on the lead shaft 101. The distance "F" is preferably twice the distance "B".

[0033] Other embodiments of the helical pile according to the present disclosure may include a plurality of extensions 200 connected in series to lead 12 or lead 100, or the helical pile may include one or more extensions 200 with one or more extensions 20 connected to the lead 12 or lead 100 in various combinations and arrangements. For example, an alternating arrangement may be employed where an extension 200 is connected to a lead 100 or 12, and then an extension 20 is connected to the extension 200, and then an extension 200 is connected to the extension 20, and so on. As another example, an alternating arrangement may be employed where an

extension 20 is connected to a lead 100 or 12, and then an extension 200 is connected to the extension 20, and then an extension 20 is connected to the extension 200, and so on.

[0034] Helical piles are installed by applying torque to the shaft at the lead head portion that causes the load bearing helical plates to rotate and screw into the soil with minimal disruption to the surrounding soil. As the lead penetrates the soil, one or more extensions may have to be added to the pile so that the pile can achieve the desired depth.

[0035] The helical piles, leads and extensions using the perimeter shear helical plates as described herein provide solutions to develop a cylindrical failure surface between the perimeter shear helical plates and soil as the helical pile is rotated into the soil mobilizing soil-to-soil shear strength, and thus increasing the stability, stiffness and load capacity of the helical piles. The particular configuration of piles, leads and extensions used as well as the diameters of the load bearing helical plates and the perimeter shear helical plates will depend upon the load the piles are to bear, and the soil conditions. However, it will be understood that various modifications can be made to the embodiments of the present disclosure herein without departing from the spirit and scope thereof. Therefore, the above description should not be construed as limiting the disclosure, but merely as embodiments thereof. Those skilled in the art will envision other modifications within the scope and spirit of the invention as defined by the claims appended hereto.

What is claimed is:

1. A helical pile extension, comprising:

a shaft having an end portion configured to connect to another helical pile extension or a helical pile lead, and a head portion configured to connect to another helical pile extension; and

a plurality of perimeter shear helical plates attached to the shaft, wherein each perimeter shear helical plate on the shaft is spaced apart a distance that promotes soil-to-soil shear strength.

2. The helical pile extension according to claim 1, wherein the distance that promotes soil-to-soil shear strength is less than 3 times a diameter of the perimeter shear helical plates.

3. The helical pile extension according to claim 1, wherein the distance that promotes soil-to-soil shear strength is equal to 1.5 times a diameter of the perimeter shear helical plates.

4. The helical pile extension according to claim 1, wherein the shaft is square.

5. The helical pile extension according to claim 1, wherein the shaft is round.

6. The helical pile extension according to claim 1, wherein a diameter of each of the plurality of perimeter shear helical plates ranges between 4 inches and 10 inches.

7. A helical pile lead, comprising:

a shaft having an end portion and a head portion, wherein the head portion is configured to connect to a helical pile extension;

at least one load bearing helical plate attached at the end portion of the shaft; and

a plurality of perimeter shear helical plates attached to the shaft, wherein the perimeter shear helical plates on the shaft are spaced apart a distance that promotes soil-to-soil shear strength, and wherein the perimeter shear helical plate closest to the at least one load bearing plate is spaced from the at least one load bearing helical plate a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate.

8. The helical pile extension according to claim 7, wherein the distance that promotes soil-to-soil shear strength is less than 3 times a diameter of the perimeter shear helical plates.

9. The helical pile extension according to claim 7, wherein the distance that promotes soil-to-soil shear strength is equal to 1.5 times a diameter of the perimeter shear helical plates.

10. The helical pile extension according to claim 7, wherein the distance that promotes the individual load bearing capacity of the at least one load bearing helical plate is at least 6 inches.

11. The helical pile extension according to claim 7, wherein the shaft is square.

12. The helical pile extension according to claim 7, wherein the shaft is round.

13. The helical pile extension according to claim 7, wherein a diameter of each of the plurality of perimeter shear helical plates ranges between 4 inches and 10 inches.

14. The helical pile extension according to claim 7, wherein a diameter of the at least one load bearing helical plate ranges between 12 inches and 16 inches.

15. A helical pile, comprising:

a lead having a lead shaft with an end portion, a head portion configured to connect to an extension, and at least one load bearing helical plate attached at the end portion of the lead shaft; and

an extension having an extension shaft with an end portion configured to connect to the head portion of the lead, a head portion, and a plurality of perimeter shear helical plates attached to the extension shaft,

wherein the perimeter shear helical plates on the extension shaft are spaced apart a distance that promotes soil-to-soil shear strength, and wherein the perimeter shear helical plate on the extension shaft closest to the lead is spaced from the at least one load bearing helical plate a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate.

16. The helical pile extension according to claim 15, wherein the distance that promotes soil-to-soil shear strength is less than 3 times a diameter of the perimeter shear helical plates.

17. The helical pile extension according to claim 15, wherein the distance that promotes soil-to-soil shear strength is equal to 1.5 times a diameter of the perimeter shear helical plates.

18. The helical pile extension according to claim 15, wherein the distance that promotes the individual load bearing capacity of the at least one load bearing helical plate is at least 6 inches.

19. The helical pile extension according to claim 15, wherein the lead shaft is square.

20. The helical pile extension according to claim 15, wherein the lead shaft is round.

21. The helical pile extension according to claim 15, wherein the extension shaft is square.

22. The helical pile extension according to claim 15, wherein the extension shaft is round.

23. The helical pile extension according to claim 15, wherein a diameter of each of the plurality of perimeter shear helical plates ranges between 4 inches and 10 inches.

24. The helical pile extension according to claim 15, wherein a diameter of the at least one load bearing helical plate ranges between 12 inches and 16 inches.

25. A helical pile, comprising:

a lead having,

a lead shaft with an end portion and a head portion, wherein the head portion is configured to connect to an extension;

at least one load bearing helical plate attached at the end portion of the lead shaft; and

a plurality of perimeter shear helical plates attached to the shaft, wherein the perimeter shear helical plates on the lead shaft are spaced apart a distance that promotes soil-to-soil shear strength, and wherein the perimeter shear helical plate closest to the at least one load bearing plate is spaced from the at least one load bearing helical plate a distance that promotes the individual load bearing capacity of the at least one load bearing helical plate; and

an extension having an extension shaft with an end portion configured to connect to the head portion of the lead, and a head portion.

26. The helical pile extension according to claim 25, wherein the distance that promotes soil-to-soil shear strength is less than 3 times a diameter of the perimeter shear helical plates.

27. The helical pile extension according to claim 25, wherein the distance that promotes soil-to-soil shear strength is equal to 1.5 times a diameter of the perimeter shear helical plates.

28. The helical pile extension according to claim 25, wherein the lead shaft is square.

29. The helical pile extension according to claim 25, wherein the lead shaft is round.

30. The helical pile extension according to claim 25, wherein the extension shaft is square.

31. The helical pile extension according to claim 25, wherein the extension shaft is round.

32. The helical pile extension according to claim 25, wherein a diameter of each of the plurality of perimeter shear helical plates ranges between 4 inches and 10 inches.

33. The helical pile extension according to claim 25, wherein the diameter of the at least one load bearing helical plate ranges between 12 inches and 16 inches.

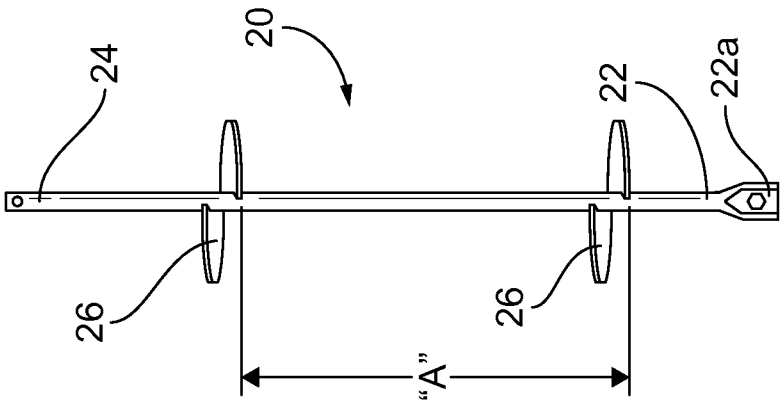


FIG. 3
PRIOR ART

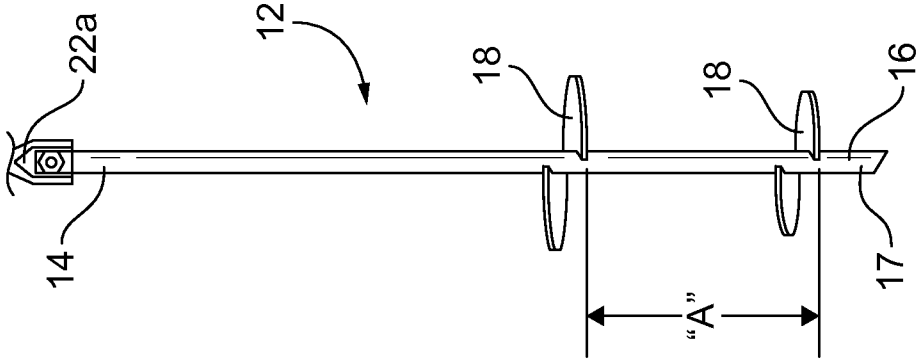


FIG. 2
PRIOR ART

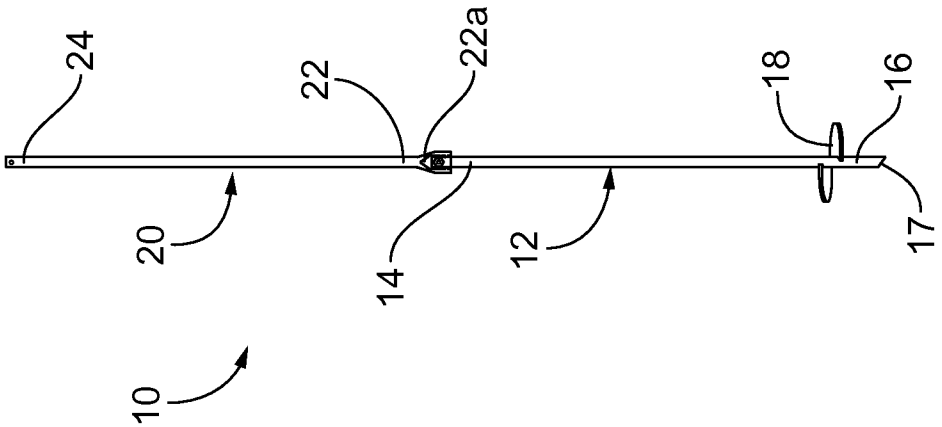


FIG. 1
PRIOR ART

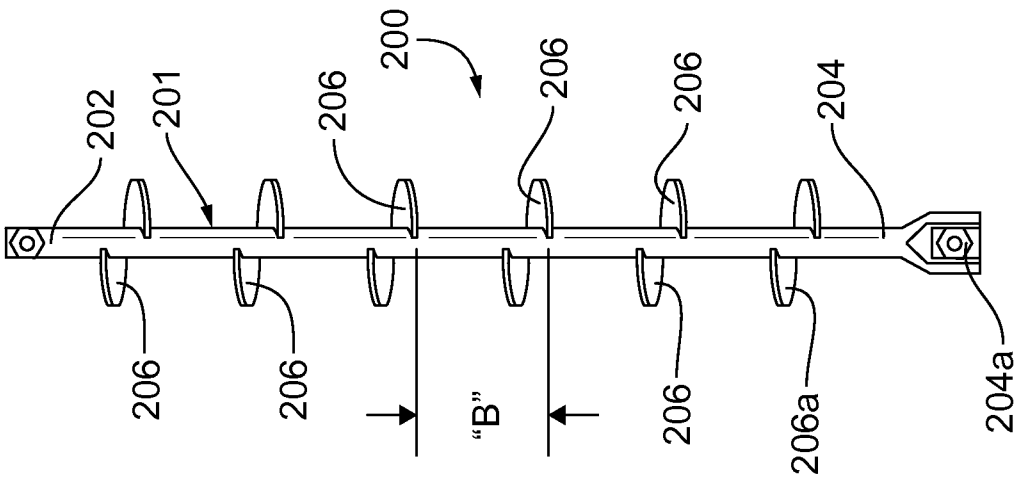

202
201
206
200
206
206
204
206
206
"B"
206
206a
204a

FIG. 6

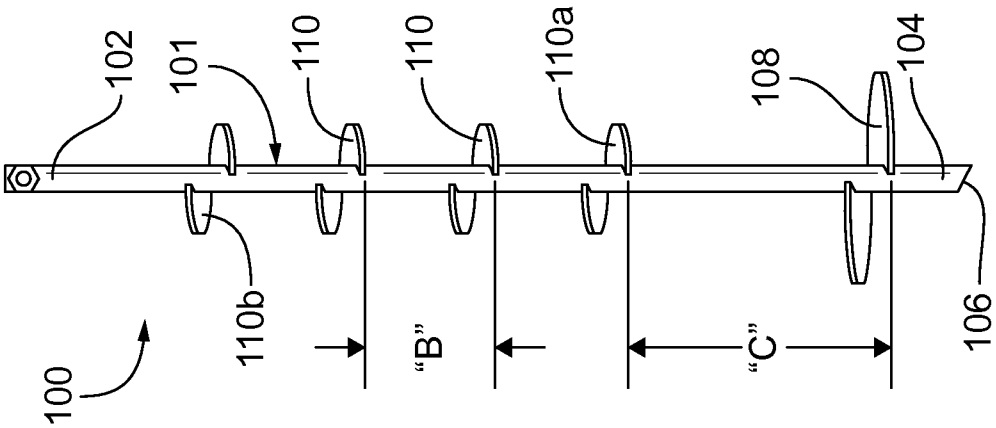

102
101
110
110
110a
108
104
110b
"B"
"C"
106
100

FIG. 4

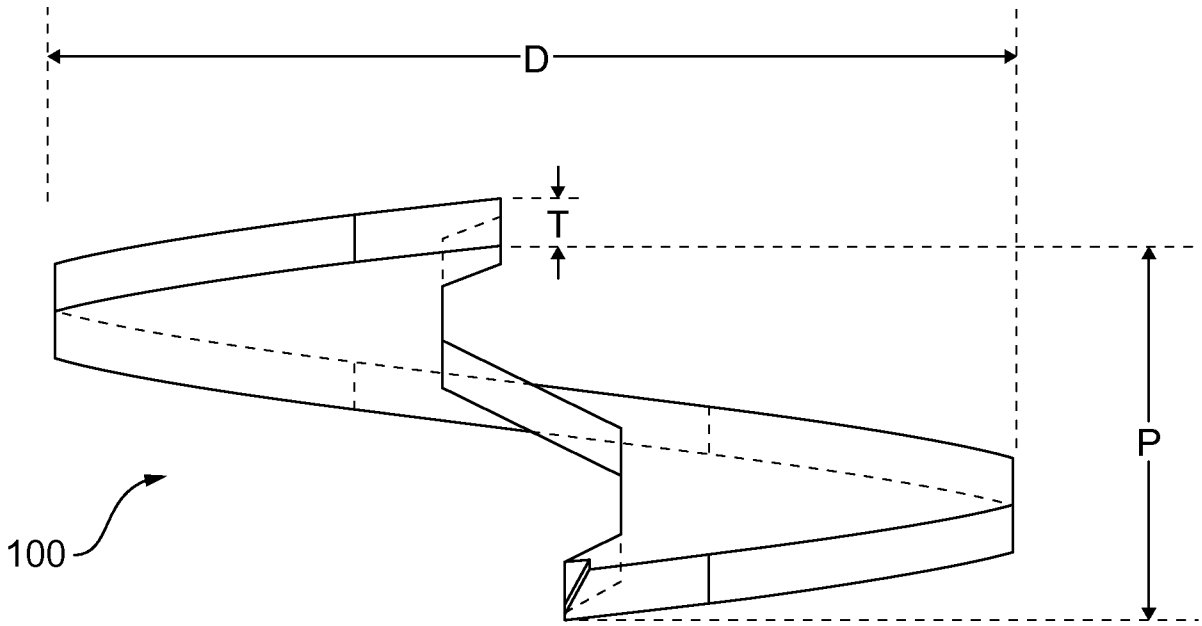


FIG. 5

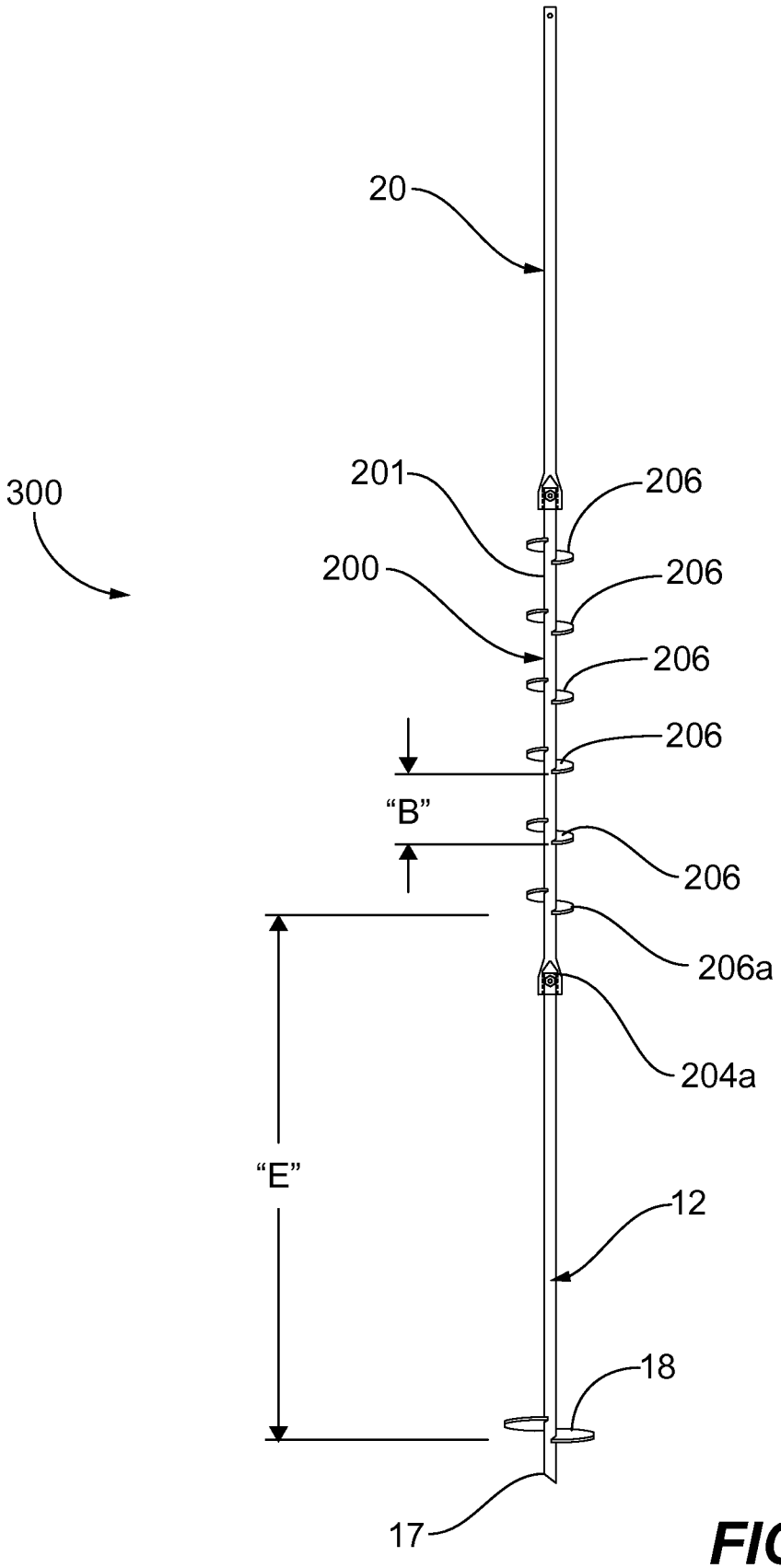


FIG. 7

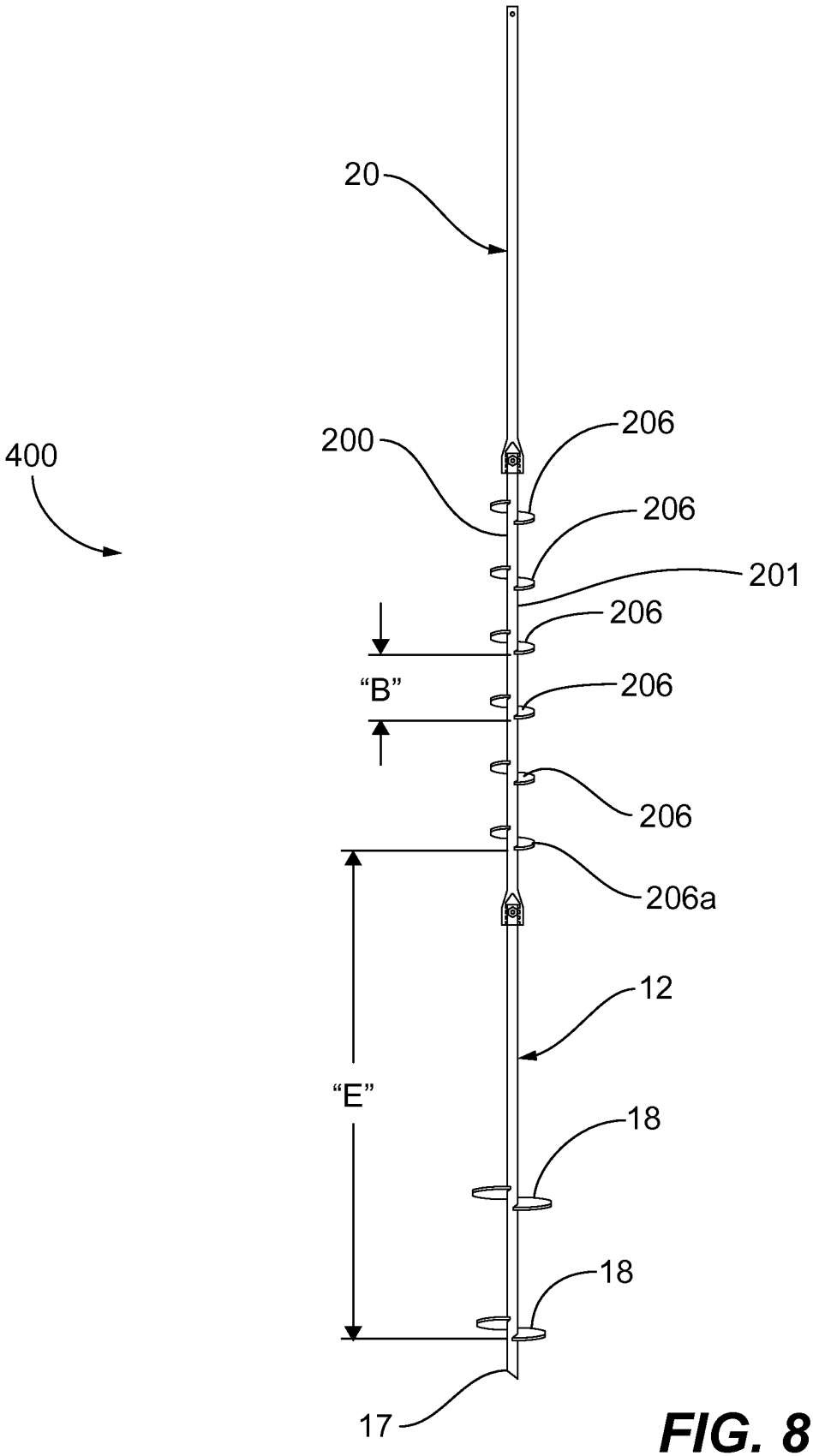


FIG. 8

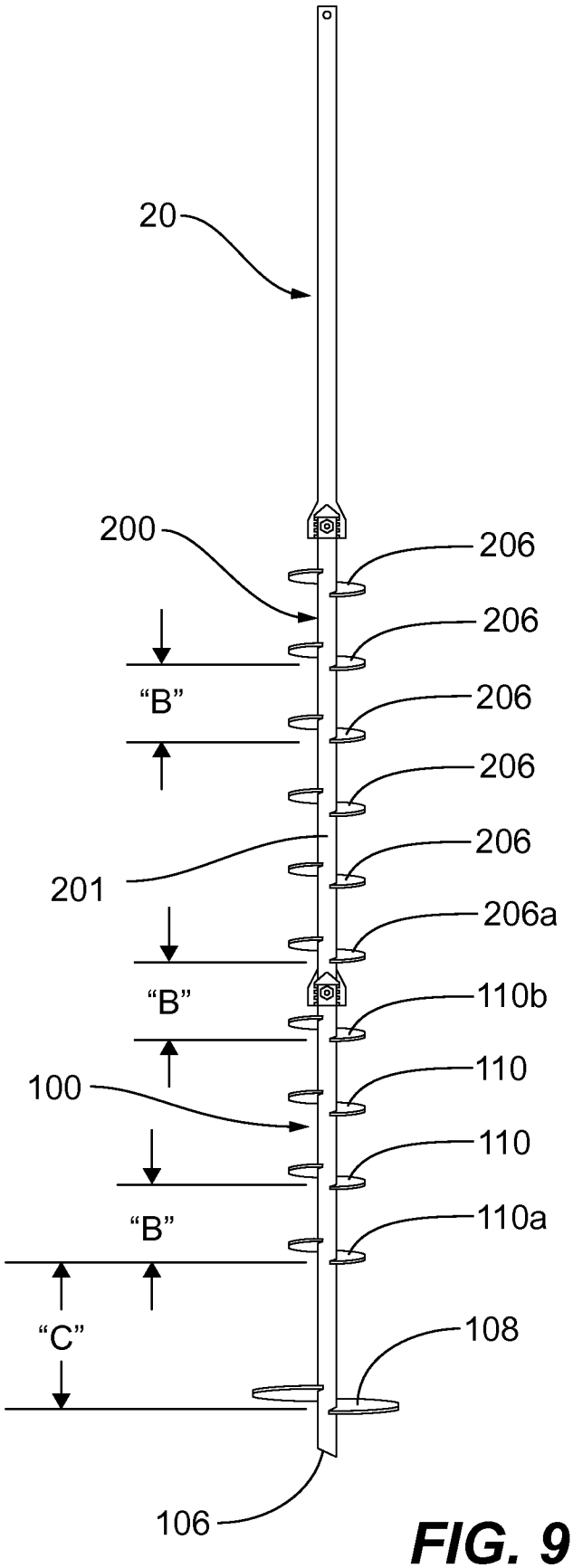

20
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206
206
"B"
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206
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201
206a
"B"
110b
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"B"
110a
"C"
108
106

FIG. 9

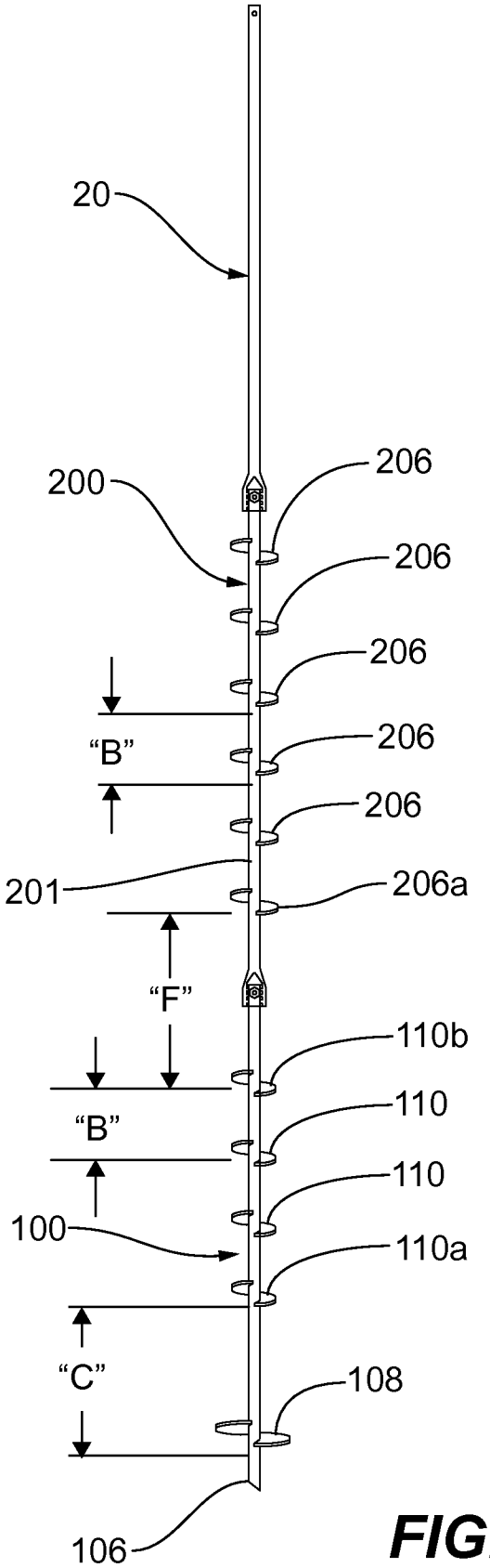

20
200
206
206
206
206
206
206a
"B"
"B"
201
"F"
110b
110
110
110a
100
"C"
108
106

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/62083

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - E02D 5/56; E02D 5/80; E02D 7/22 (2016.01)

CPC - E02D 5/56; E02D 5/801; E02D 7/22

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)

IPC: E02D 5/56, 5/80, 7/22; E21B 10/44, 17/22 (2016.01)
CPC: E02D 5/56, 5/801, 7/22, 2200/1671; E21B 10/44, 17/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC: 405/244, 252.1, 259.1; 411/15, 16; 175/320; 052/157

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google; Google Scholar; EBSCO; Search Terms: pile, pier, anchor, helical, screw, lead, extension, helices, plate, flight, diameter, inch, distance, spacing, between, along, apart, times

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2014/0286712 A1 (LUTENEGGER, A. et al.) 25 September 2014; figures 3, 5-7; paragraphs [0038], [0039], [0041], [0048], [0049], [0051]-[0053]	7-14, 25-33 --- 2-4, 6, 16-19, 21, 23, 24
X -- Y	US 6,722,821 B1 (PERKO, H. et al.) 20 April 2004; figures 1, 2; column 1, lines 60-65; column 4, lines 15-20; column 5, lines 35-40	15, 20, 22 --- 16-19, 21, 23, 24
X -- Y	US 2003/0041535 A1 (RUPIPER, S.) 06 March 2003; figures 1, 5; paragraphs [0023]-[0026], [0208]	1, 5 --- 2-4, 6
A	US 5,575,593 A (RAAF, D.) 19 November 1996; entire document	1-33
A	US 7,635,240 B2 (GANTT, W.) 22 December 2009; entire document	1-33
A	US 2012/0009022 A1 (MELINE, C.) 12 January 2012; entire document	1-33

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* 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

Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2016 (12.01.2016)	05 FEB 2016
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)