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(54) **A FOUNDATION AND A METHOD OF ESTABLISHING PILE FOUNDATION**

(57) A foundation (10) for an overhead line mast (12), comprising a reinforced concrete pile (20) including threaded bolt connectors (30), a number of gaskets (40) and a corresponding number of tightening nuts (50), wherein the reinforced concrete pile (20) defines an elongated structure having a first end part and a second end part, steel reinforcement elements extending between the first end part and the second end part and the threaded bolt connectors (30) are connected to the steel reinforcement elements of the reinforced concrete pile (20), wherein the tightening nuts (50) include an internal threaded portion complementing the threaded portion of the threaded bolt connectors (30), wherein the tightening nuts (50) are configured to be rotated relative to the threaded portion of the threaded bolt connectors (30) for allowing the gaskets (40) to be compressed towards the threaded bolt connectors (30), the inner tapered portion of the tightening nuts (50) and the planar abutment surface for providing sealing relative to the threaded bolt connectors (30) and the planar abutment surface.

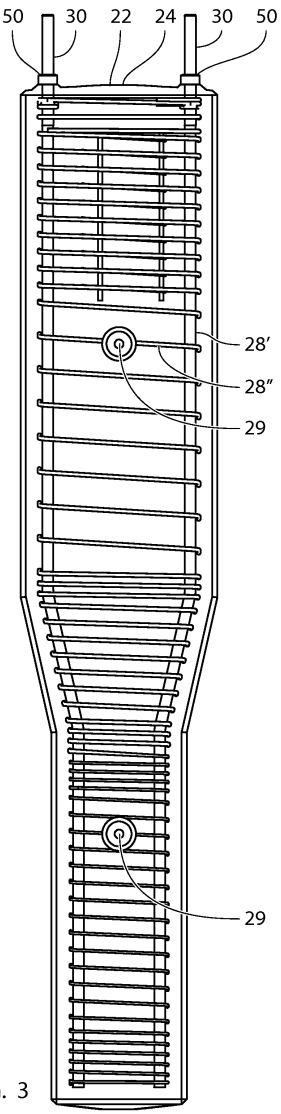

FIG. 3

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Description

TECHNICAL FIELD

[0001] The present invention relates to a foundation or a pile driven foundation for an overhead line mast, power line mast or the like, comprising a reinforced concrete pile including threaded bolt connectors, a number of gaskets and a corresponding number of tightening nuts.

BACKGROUND OF THE INVENTION

[0002] Prefabricated concrete piles are normally used for foundations at location where the upper soil layers are not suitable for accommodating a shallow foundation. At location where the bearing capacity of the ground is weak in relation to the construction, piles are preferred option compared to shallow foundations. Through the use of a piling foundation the load from the construction may be transferred from the weaker upper layers of the soil to lower stronger layers, which are typically found deeper level in the ground. The piles are driven into the ground by using a pile driver or hammer or the like.

[0003] The piles are intended for embedment deep into the ground for providing a stable foundation for various structures such as buildings, bridges and similar constructions. The pile foundation can be used in soil layers along railways.

[0004] For purposes where prefabricated concrete foundations used with threaded bolt connections it is necessary to protect the reinforcement from water penetrating into the concrete at the bolt shaft. The water will penetrate the foundations, more precisely the water will penetrate into the reinforced concrete piles between the bolt shaft and the reinforcing concrete causing the reinforcement elements of the reinforced concrete piles to corrode and eventually cause the reinforced concrete supporting the bolt shaft to break, which will reduce the stability of the overlying construction. The penetrating water may also freeze when subjected to temperatures below 0° C and cause damage to the pile. There is consequently a need for technologies for avoiding water penetration into the concrete foundation, especially reinforced concrete bolt-foundations for railway powerlines, or similar with demand for long durability being exposed to outside weather conditions.

[0005] The general object of the present invention is to provide a prefabricated reinforced concrete pile, which is able to withstand the environment impact and exposure occuring over time on the structure at the installation location.

[0006] The above need and object together with numerous other needs and objects, which will be evident from below detailed description, are according to a first aspect of the present invention obtained by a foundation for an overhead line mast, power line mast or the like, comprising a reinforced concrete pile including threaded bolt, a number of gaskets and a corresponding number of tightening nuts:

- the reinforced concrete pile defining an elongated structure having a first end part including a planar abutment surface of a first polygonal geometry and a second end part, steel reinforcement elements extending between the first end part and the second end parts, the threaded bolt connectors being embedded in the reinforced concrete pile and each having an exposed part extending beyond the first end part and positioned in a second polygonal geometry and connected to the steel reinforcement elements of the reinforced concrete pile, the second polygonal geometry being equivalent to the first polygonal geometry,
- each of the exposed part of the threaded bolt connectors having a first portion including a threaded portion, a second portion having a circular cross sectional configuration of a first outer diameter and a transition portion interconnecting the first portion and the second portion,
- a first interface being located between the first portion and the transition portion of each of the threaded bolt connectors at a first distance from the planar abutment surface,
- a second interface being located between the transition portion and the second portion of each of the threaded bolt connectors at a second distance from the planar abutment surface, the first distance being larger than the second distance,
- each of the gaskets having an annual shape forming a second inner diameter and second outer diameter,
- the tightening nuts having a first end surface, a second end surface and a central aperture including a tapered portion at the second surface end for providing a larger opening compared to the central aperture, the central aperture further including a third internal threaded portion at the first end surface complimenting the threaded portion of the threaded bolt connectors,
- the second inner diameter of the gasket being congruent to the first outer diameter of each of the second portions of each the threaded bolt connectors and the second outer diameter being larger than the inner diameter of the third internal threaded part of the tightening nuts,
- the tightening nuts being configured to be rotated relative to the threaded portion of the threaded bolt connectors for allowing the gaskets to be compressed towards the threaded bolt connectors, the inner tapered portion of the tightening nuts and the planar abutment surface for providing sealing relative to the threaded bolt connectors and the planar abutment surface.

[0007] The reinforced concrete pile is an elongated prefabricated concrete pile. The reinforced concrete pile is provided in various lengths.

[0008] The threaded bolt connectors would preferably be made from a stainless steel material, as the threaded bolt connectors are exposed to the environment and have to be able to withstand the weather. Stainless steel is the preferred material due to its corrosion resistance as stainless does not corrode or rust as ordinary steel (carbon steel) does. However, it is possible to use carbon steel for the steel reinforcement elements as the steel reinforcement element are embedded into the reinforcement concrete pile,

[0009] The gasket is preferably made from an elastomer material with a round cross-section and being designed to be compressed during assembly and would create a sealing at the interface between the plain unthreaded surface of the threaded bolt connectors and the planar abutment surface. Each gasket has an annual shape forming a second inner diameter being congruent to the first outer diameter of the threaded bolt connectors and second outer diameter being larger than the inner diameter of the third internal threaded part of the tightening nut.

[0010] Each of the tightening nuts is configured to be rotated relative to the threaded portion of a threaded bolt connector and by rotating the tightening nut, the tapered portion of the tightening nuts will be moved towards the gasket. Rotation of the tightening nut would cause the gasket to be compressed towards the outer surface of the threaded bolt connectors and the planar abutment surface and the compression of the gasket will provide a sealing between the threaded bolt connectors and the planar abutment surface.

[0011] In a further embodiment according to the first aspect, the transition portions have threaded portions being tapered over two revolutions from a fully threaded shaft to a plain unthreaded shaft. Through the use of threaded bolt connectors having a threaded portions being tapered over two revolutions from a fully threaded shaft to a plain unthreaded shaft, it is possible to obtain a sealing for preventing water to penetrate into the structure.

[0012] In a further embodiment according to the first aspect, the central aperture of the tightening nuts have an intermediate section having a second threaded section, the second threaded section extending between the tapered portion and the third internal threaded portion, the second threaded section having a diameter being larger than the threaded diameter of the third internal threaded portion. Through the use of tightening nuts having a second threaded section with a diameter being larger than the inner diameter of the third internal threaded portion, it is possible for the tightening nut to be rotated beyond the threaded portion of the threaded bolt connectors. The second threaded section being an inner threaded section and the diameter of the second threaded section corresponds to the major diameter.

[0013] In a further embodiment according to the first aspect, the third internal threaded portion is tapered over two revolutions. Through the use of tightening nuts having third internal threaded portion being tapered over two revolutions, it is possible to improve the sealing capability further and prevent penetration of water into the reinforced concrete pile.

[0014] In a further embodiment according to the first aspect, the second portions of the threaded bolt connectors are plain unthreaded portions. By using threaded bolt connectors with second portions having a plain unthreaded surface, it is possible to enhance the sealing capability at the interface between the outer surface of the gasket and the plain surface of the threaded bolt connectors. The plain contact surface improves the sealing capability compared to a threaded contact surface, hereby serving a first function. The plain unthreaded portion of the threaded bolt connectors will prevent the gasket from getting damaged or torn during tightening of tightening nuts during installation, where the overhead line mast is installed on top of the reinforced concrete pile, hereby serving a second function.

[0015] In a further embodiment according to the first aspect, the reinforcement elements include additional steel reinforcement elements extending in the circumference of the reinforced concrete. By using an additional steel reinforcement element extending in the circumference, it is possible to obtain a steel mesh structure, which allows easier handling and positioning of the steel mesh structure during casting and fabrication of the reinforcement concrete pile. The of additional steel reinforcement elements forms a steel mesh or mesh cage together with the steel reinforcing bar.

[0016] The mesh cage or reinforcement cage consists of two parts: longitudinal bars and transverse bars or spiral bar. The steel bar has vertical rib and transverse rib on the surface for better application in concrete reinforcement and the steel bar is preferable made from cold drawn or hot drawn carbon steel wire rod, galvanized or mill black finish.

[0017] The longitudinal steel bars confine the core concrete, and the transverse steel bars or spiral bars fit around the longitudinal bars. The steel mesh cage provides reinforcement in the longitudinal and lateral strength to prevent cracking, and reduce the deflections occurrence probability.

[0018] The reinforcement cage has a polygonal geometry e.g. triangle or square and the reinforcement cages is positioned in the casting mould before the concrete is poured the casting form. The steel reinforcement elements are spot welded to form a reinforcement cage, preferably by an automatic spot welding machine and the spot welding machine furthermore is able to program for being able to adjust the spacing and opening of the reinforcement cage.

[0019] In a further embodiment according to the first aspect, the reinforced concrete pile is a prefabricated structure. Through the use of a prefabricated reinforced concrete pile, it is faster to establish the foundation as the reinforced concrete does not need to casted in-situ and await the hardening of the concrete before the over-

head line mast can be connected to the foundation.

[0020] In a further embodiment according to the first aspect, the second polygonal geometry and the first polygonal geometry being 3-12, preferably 4. By using a polygonal geometry it is optional, where the geometry should be rectangular, pentagonal, hexagonal etc.

[0021] In a further embodiment according to the first aspect, the reinforced concrete pile have visual markings on the outer surface for positioning the end part 0.1-1 meter above ground level, when the reinforced concrete pile is being driven into the ground. By using visual markings on the reinforced concrete pile, the installation of the reinforced concrete pile can be done in a more precise manner, as the worker at the installation site can visual determine and inspect whether the reinforced concrete pile needs to be driven further into the ground.

[0022] In a further embodiment according to the first aspect, the threaded bolt connectors are connected to the steel reinforcement elements of the reinforced concrete pile by welding, preferably friction welding. By welding the threaded bolt connectors to the steel reinforcement bars, the structural loads from the mast can be transferred from the threaded bolt connectors to the steel reinforcement elements embedded in the reinforced concrete pile.

[0023] The term pile foundation should in this context be understood as a prepared ground or base on which the overhead line mast, the power line mast or the like structure can be mounted. The pile foundation consists of an elongated structural element being driven or drilled into the deep of the ground and belong to the category also referred to as deep foundation.

[0024] The term deep foundation should in the context be understood as the type of foundation, which transfers load into the soil farther down from the ground level in contrast to shallow foundation, which primarily transfers loads from the structure to the surface layer at the vicinity of the ground level.

[0025] The term congruent is used in this context to describe a gasket being able to provide a tight fit relative to the outer diameter of the second portion of the threaded bolt connectors. Each gasket would have an inner diameter being identical to the outer diameter of the second portion of each of the threaded bolt connectors or an inner diameter substantial smaller than the outer diameter of the second portion of each of the threaded bolt connectors.

[0026] The term internal threaded portion is used in this context to describe an internal thread of the tightening nut is divided into two sections, which both have a major diameter and a minor diameter. The diameter of the internal threaded portion would in this context refer to the major diameter.

[0027] Although the invention has been described above with reference to a number of specific and advantageous embodiments, it is to be understood that the present invention is by no means limited to the above disclosure of the above described advantageous embodiments, as the features of the above-identified embodiments may be combined to provide additional embodiments. The additional embodiments are all construed to be part of the present invention. Furthermore, the present invention is to be understood encompassed by any equivalent or similar structure as described above and also to be encompassed by the scope limited by the below claims defining the protective scope of the present patent application.

DETAILED DESCRIPTION

[0028] The invention will now be explained in more detail by means of examples of embodiments with reference to the schematic drawing.

Figure 1 shows a foundation installed along a railway track.

Figure 2 shows of a first and presently preferred embodiment of the reinforced concrete pile.

Figure 3 shows the steel reinforcement elements embedded inside the reinforced.

Figure 4A-4D shows the tightening of the tightening nut.

Figure 5A-5E shows a first and presently preferred embodiment of the threaded bolt connectors and a tightening nut.

Figure 6A-6D shows a second preferred embodiment of casting a reinforced concrete pile according to first embodiment of the invention.

[0029] Fig. 1 shows foundation 10 comprising a reinforced concrete pile 20 having threaded bolt connectors for allowing an overhead line mast 12 to be connected to the reinforced concrete pile 20 of the pile foundation.

[0030] The overhead power line 16 is suspended above the railway track 14 between the overhead line mast, supporting posts or arched catenary support or other carrying structures spaced along the railway track 14. The overhead power line 16 is kept at a high electric potential for suppling electric power to the train. The reinforced concrete pile 20 penetrates the upper soil layers and will be embedded in the lower, more rigid lower soil layers. The reinforced concrete pile 20 is a precasted element and the reinforced concrete pile 20 is casted in a standardized length between 4 meter and 20 meter.

[0031] Figs. 2 and 3 show a reinforced concrete pile 20 having an elongated structure with a first end part 22 including a planar abutment surface of a first polygonal geometry and a second end part 26. Steel reinforcement elements 28 extend between the first end part 22 and the second end parts 28.

[0032] Four threaded bolt connectors 30 are embed-

ded in the reinforced concrete pile 20 and each of threaded bolt connectors 30 has an exposed part extending beyond the first end part 22. The four threaded bolt connectors 30 are positioned in a second polygonal geometry and connected to the steel reinforcement elements 28 of the reinforced concrete pile 20.

[0033] The connection between each of the threaded bolt connectors 30 and the steel reinforcement elements 28 of the reinforced concrete pile 20 is obtained by welding process e.g. friction welding and the connection will be embedded inside the reinforced concrete pile 20. The threaded bolt connectors 30 would be made from a stainless steel material, as the threaded bolt connectors are exposed to the environment and have to be able to withstand the corrosion.

[0034] The steel reinforcement elements 28 are fabricated from an assembly of steel reinforcing bar 28', also commonly referred to as rebars, held together in the desired configuration by means of additional steel reinforcement elements 28" extending in the circumference of the reinforced concrete pile 20. The additional steel reinforcement elements 28" form a steel mesh or mesh cage incorporation with the steel reinforcing bar 28'.

[0035] Two lifting sockets 29 are embedded into the reinforced concrete pile 20 and the lifting sockets 29 are placed at equal distance from the center of gravity of the reinforced concrete pile 20 for allowing as stable lifting of the reinforced concrete pile 20. Each of the lifting sockets 29 is connected to the steel reinforcement elements 28 by welding.

[0036] The lifting sockets 29 comprise an inner threaded portion and the threaded portion makes it possible for a worker to insert a swivel lifting eye into the lifting socket prior to lifting the reinforced concrete pile 20. The lifting socket could also be formed as tubular lifting socket, flat plate lifting socket or the like. Each of the lifting sockets 29 is covered by a sealing cap for preventing any foreign objects from entering the socket and the sealing cap fits inside the lifting socket 29.

[0037] The steel reinforcement elements 28 have the same polygonal geometry as the reinforced concrete pile 20 and the 28' steel reinforcing bars are placed along the circumference of the reinforced concrete pile 20 more specific near the edges of the polygonal geometry.

[0038] The second polygonal geometry is defined by the number of threaded bolt connectors embedded in the reinforced concrete pile 20 and the first polygonal geometry corresponds the outer geometry of the reinforced concrete pile 20. The first polygonal geometry is equivalent to the second polygonal geometry in fig. 2.

[0039] It is contemplated, that the tightening the tightening nut 501, 502, 503, 504 can be done in two steps, 'Initial Torque' and 'Final torque' using a calibrated torque wrench. This can be either a manual wrench or power tool fitted with a torque cut-out that must first be calibrated on a bolt from the job batch using a bolt load meter or similar device for determining bolt tension.

[0040] Figs. 4-5 show the threaded bolt connector 30 having a first portion 32 including a threaded portion 33, a second portion 34 having a circular cross sectional configuration of a first outer diameter and a transition portion 38 interconnecting the first portion 32 and the second portion 32. The gaskets 40 having an annual shape forming a second inner diameter 42 and second outer diameter 44.

[0041] Fig. 4A shows threaded bolt connector 30 connected to the steel reinforcement elements 28 in the reinforced concrete pile 20. The second portion 34 of the threaded bolt connector 30 has a circular cross sectional and the second portion 34 is connected to the steel reinforcing bar 28' by welding. The second portion 34 of the threaded bolt connector 30 has a plain unthreaded portion. 6. The steel reinforcement elements 28 comprising of a number of steel reinforcing bars 28' and additional steel reinforcement elements 28" extending in the circumference of the reinforced concrete pile 20. The additional steel reinforcement elements 28" form a steel mesh or mesh cage incorporation with the steel reinforcing bar 28'.

[0042] In fig. 4A-4D, the gasket 40 has a second inner diameter 42 being congruent to the first outer diameter of the second portions 36 of the threaded bolt connector and the second outer diameter 44 is larger than the inner diameter of the third internal threaded part of the tightening nuts 59.

[0043] In Fig. 4D, the first interface 60 is located between the first portion 32 and the transition portion 38 the threaded bolt connector at a first distance d_1 from the planar abutment surface 24. The second interface 62 is located between the transition portion 38 and the second portion 34 of the threaded bolt connector 30 at a second distance d_2 from the planar abutment surface 24

[0044] As indicated in fig. 4D, the first distance d_1 is larger than the second distance d_2 and the second distance d_2 is also larger the height h_g of the gasket. The height h_g of the gasket 40 corresponds to the thickness of the gasket 40. The second portion 34 of the threaded bolt connector 30 has a plain unthreaded portion, which will prevent the gasket 40 from getting damaged or torn during tightening of tightening nut 50 during installation of the mast on top of the reinforced concrete pile.

[0045] Fig. 4B-4D shows the sequence of tightening the tightening nut 50, where the tightening nut is configured to be rotated relative to the threaded portion of the threaded bolt connector.

[0046] Fig. 4B shows the tightening nut 50, where the tightening nut 50 does not exert any compression force on the gasket 40 and the gasket 40 is positioned around the plain unthreaded portion of the threaded bolt connector 30 and abuts the planar abutment surface of the first end part 22.

[0047] Fig. 4C shows the tightening nut 50, where the tightening nut 50 is rotated further towards the planar abutment surface of the first end part 22. The tightening nut 50 begins to compress onto the gasket 40. The gasket 40 is positioned around the plain unthreaded portion of

the threaded bolt connector 30 and abuts the planar abutment surface of the first end part 22.

[0048] Fig. 4D shows a final position, where the tightening nut 50 is rotated relative to the threaded portion of the threaded bolt connector 30 to the position, where the tightening nut 50 exerts the full compression load on the gasket. The amount of load on the gasket 40 causes the gasket to deform and the deformation of the gasket results in the gasket 40 being compressed towards the threaded bolt connectors, the inner tapered portion 55 of the tightening nuts and the planar abutment surface 24 for providing sealing relative to the threaded bolt connector 30 and the planar abutment surface 24.

[0049] As shown in fig. 5B, the tightening nut 50 has an intermediate section including a second threaded section 56 and the second threaded section 56 extends between the tapered portion 55 and the third internal threaded portion 58. The second threaded section 56 has a threaded diameter d_4 being larger than the threaded diameter d_3 of the third internal threaded portion 58. By using a tightening nut 50 having an inner second threaded section 56 having a threaded diameter d_4 being larger than the inner diameter d_3 of the third internal threaded portion, it is possible for the tightening nut 50 to be rotating beyond the threaded portion 33 of the threaded bolt connectors. The second threaded section being an inner threaded section and the threaded diameter corresponds to the major diameter of an internal thread.

[0050] As indicated in fig. 5B-5D, the tightening nut has first end surface 51, a second end surface 52 and a central aperture 54 including a tapered portion 55 at the second end surface 52 for providing a larger opening compared to the central aperture.

[0051] The central aperture 54 further includes a third internal threaded portion 58 at the first end surface 54 complimenting the threaded portion 33 of the threaded bolt connector 30.

[0052] Fig. 5D shows a first embodiment of the tightening nut 50 having a third internal threaded portion being tapered over two revolutions.

[0053] Fig. 5C shows a first embodiment of the transition portions having threaded portions being tapered over two revolutions from a fully threaded shaft to a plain unthreaded shaft.

[0054] Fig. 6A-6D shows a second preferred embodiment of casting of the reinforced concrete pile. The method of casting a reinforced concrete pile for a foundation, wherein the foundation comprising a reinforced concrete pile including threaded bolt connectors, a number of gaskets and a corresponding number of tightening nuts, comprising the step of:

- providing a casting mould 70 having two mould side walls 72, a first mould end part 74 including apertures 75, a second mould end part 76 and a bottom mould part 78,
- inserting a number of anti-adherent elements 80 made of a synthetic material, Teflon or the like into the apertures 75 of the first mould end part 74,
- placing steel reinforcement elements into the casting mould, the steel reinforcement elements extending between the first end part and the second end parts of the casting mould and a number of threaded bolt connectors being connected to the steel reinforcement elements and allowing the threaded bolt connectors to extend beyond the first mould end part,
- pouring concrete into the casting mould.
- casting a reinforced concrete pile defining an elongated structure having a first end part including a planar abutment surface of a first polygonal geometry and a second end part, steel reinforcement elements extending between the first end part and the second end parts, the threaded bolt connectors being embedded in the reinforced concrete pile and each having an exposed part extending beyond the first end part and positioned in a second polygonal geometry and connected to the steel reinforcement elements of the reinforced concrete pile, the second polygonal geometry being equivalent to the first polygonal geometry.

[0055] By using a number of anti-adherent elements 80 made of a synthetic material, Teflon or the like into the apertures 75 of the first mould end part 74, it is possible to establish a reinforced concrete pile having a smooth planar abutment surface. By having a smooth planar abutment surface, the sealing capability is enhanced and the smooth surface of first end part 22 prevent water from gathering in void created in an otherwise uneven first end part 22.

[0056] In figure 6A-6D, the four threaded bolt connectors 30 are placed in the casting mould 70 and each of threaded bolt connectors 30 has an exposed part extending into the apertures 75 of the first mould end part 74 and beyond the first end part 22.

[0057] The steel reinforcement elements 28 consists of steel bars 28' 28" forming a steel reinforcement cage 28'" fabricated from an assembly of longitudinal steel reinforcing bar 28' and transverse steel reinforcement bar 28" extending in the circumference of the reinforced concrete pile 20. The four threaded bolt connectors 30 are positioned in a second polygonal geometry and connected to the steel reinforcement bars 28' of the steel reinforcement cage. The steel reinforcement cage 28'" forms a recgtangular polygonal geometry.

[0058] Two lifting sockets 29 are placed at equal distance in the casting mould 70 and the lifting sockets 29 is connected to the steel reinforcement elements 28 by welding.

[0059] The lifting socket 29 comprises an inner threaded portion and the threaded portion makes it possible for a worker to insert a swivel lifting eye into the lifting socket prior to lifting the casted reinforced concrete pile 20 out of the casting mould 70.

[0060] The casting mould 70 is used for casting reinforced concrete pile 20 having an elongated structure

with a first end part 22 including a planar abutment surface of a first polygonal geometry and a second end part 26.

[0061] The reinforced concrete piles are preferably precasted concrete elements manufactured in at a larger manufacturing facility and delivered, ready to use, to the installation site. Pre-casted reinforced concrete piles can also be fabricated on site and tilted or lifted into position.

[0062] Fig. 6A shows the step of placing the steel reinforcement cage 28'" into the casting mould 70 and steel reinforcement cage 28" comprising of a number of steel reinforcing bars 28' and additional steel reinforcement elements 28" extending in the circumference of the steel reinforcement cage 28"'.

[0063] The insert 80 is made of anti-adherent synthetic material, without or with a built-in supporting body, made of metal or synthetic material.

[0064] The method further comprising the step of:

- arranging the threaded bolt connectors in the casting mould for providing a reinforced concrete pile having a first interface being located between the first portion and the transition portion of each of the threaded bolt connectors at a first distance from the planar abutment surface, and a second interface being located between the transition portion and the second portion of each of the threaded bolt connectors at a second distance from the planar abutment surface, the first distance being larger than the second distance,

REFERENCE NUMBERS

[0065]

10 foundation
12 mast
14 railway track
16 overhead line, power line mast or the like,
18 support structure
20 reinforced concrete pile
22 first end part
24 planar abutment surface
26 second end part,
28 steel reinforcement elements
28' steel reinforcing bar
28" additional steel reinforcement elements
steel reinforcement cage 28"'
29 lifting socket
30 threaded bolt connectors
31 exposed part
32 first portion,
33 threaded portion
34 second portion
36 first outer diameter of the second portion
38 transition portion
40 gaskets
42 second inner diameter
44 second outer diameter
50 tightening nut
501, 502, 503, 504 tightening nuts
51 first end surface
52 second end surface
54 central aperture
55 tapered portion
56 second threaded section
57 intermediate section
58 third internal threaded portion
59 inner diameter of the third internal threaded
60 first interface
62 second interface
d_1 first distance
d_2 second distance
d_3 diameter, third distance
d_4 diameter, fourth distance
h_g height of the gasket
70 casting mould
72 mould side wall
73 mould side wall
74 first mould end part
75 apertures
76 second mould end part
78 bottom mould part
80 anti-adherent element

Claims

1. A foundation for an overhead line mast, power line mast or the like, comprising a reinforced concrete pile including threaded bolt connectors, a number of gaskets and a corresponding number of tightening nuts:

   - said reinforced concrete pile defining an elongated structure having a first end part including a planar abutment surface of a first polygonal geometry and a second end part, steel reinforcement elements extending between said first end part and said second end parts, said threaded bolt connectors being embedded in said reinforced concrete pile and each having an exposed part extending beyond said first end part and positioned in a second polygonal geometry and connected to said steel reinforcement elements of said reinforced concrete pile, said second polygonal geometry being equivalent to said first polygonal geometry,
   - each of said exposed parts of said threaded bolt connectors having a first portion including a threaded portion, a second portion having a circular cross sectional configuration of a first outer diameter and a transition portion interconnecting said first portion and said second portion,
   - a first interface being located between said first

portion and said transition portion of each of said threaded bolt connectors at a first distance from said planar abutment surface,

- a second interface being located between said transition portion and said second portion of each of said threaded bolt connectors at a second distance from said planar abutment surface, said first distance being larger than said second distance,
- each of said gaskets having an annual shape defining a second inner diameter and second outer diameter,
- said tightening nuts having a first end surface, a second end surface and a central aperture including a tapered portion at said second surface end for providing a larger opening compared to said central aperture, said central aperture further including a third internal threaded portion at said first end surface complimenting said threaded portion of said threaded bolt connectors,
- said second inner diameter of said gasket being congruent to said first outer diameter of each of said second portions of each of said threaded bolt connectors and said second outer diameter being larger than said inner diameter of said third internal threaded part of said tightening nuts,
- said tightening nuts being configured to be rotated relative to said threaded portion of said threaded bolt connectors for allowing said gaskets to be compressed towards said threaded bolt connectors, said tapered portion of said tightening nuts and said planar abutment surface for providing sealing relative to said threaded bolt connectors and said planar abutment surface.

2. A foundation according to claim 1, wherein said transition portions having threaded portions being tapered over two revolutions from a fully threaded shaft to a plain unthreaded shaft.

3. A foundation according to any of the preceding claims, said central aperture of said tightening nuts having an intermediate section having a second threaded section, said second threaded section extending between said tapered portion and said third internal threaded portion, said second threaded section having a diameter being larger than the thread angle of the said third internal threaded portion.

4. A foundation according to claim 1, wherein said third internal threaded portion being tapered over two revolutions.

5. A foundation according to any of the preceding claims, wherein said second portions of said threaded bolt connectors being plain unthreaded portions.

6. A foundation according to any of the preceding claims, wherein said reinforcement elements including additional steel reinforcement elements extending in the circumference of said reinforced concrete.

7. A foundation according to any of the preceding claims, wherein said reinforced concrete pile is a prefabricated structure.

8. A foundation according to any of the preceding claims, wherein said second polygonal geometry and said first polygonal geometry being 3-12, preferably 4.

9. A foundation according to any of the preceding claims, wherein said reinforced concrete pile having visual markings on the outer surface for positioning said end part 0,1-1 meter above ground level, when said reinforced concrete pile is being driven into the ground.

10. A foundation according to any of the preceding claims, wherein said threaded bolt connectors being connected to said steel reinforcement elements of said reinforced concrete pile by welding, preferably friction welding.

11. A method of establishing a foundation for an overhead line mast, power line mast or the like, comprising a reinforced concrete pile including threaded bolt connectors, a number of gaskets and a corresponding number of tightening nuts:

- providing said reinforced concrete pile defining an elongated structure having a first end part including a planar abutment surface of a first polygonal geometry and a second end part, steel reinforcement elements extending between said first end part and said second end parts, said threaded bolt connectors being embedded in said reinforced concrete pile and each having an exposed part extending beyond said first end part and positioned in a second polygonal geometry and connected to said steel reinforcement elements of said reinforced concrete pile, said second polygonal geometry being equivalent to said first polygonal geometry,
- providing each of said exposed part of said threaded bolt connectors having a first portion including a threaded portion, a second portion having a circular cross sectional configuration of a first outer diameter and a transition portion interconnecting said first portion and said second portion,
- providing a first interface being located between said first portion and said transition portion of each of said threaded bolt connectors at a first distance from said planar abutment sur-

face,

- providing a second interface being located between said transition portion and said second portion of each of said threaded bolt connectors at a second distance from said planar abutment surface, said first distance being larger than said second distance,
- each of said gaskets having an annual shape forming a second inner diameter and second outer diameter,
- providing said tightening nuts having a first end surface, a second end surface and a central aperture including a tapered portion at said second surface end for providing a larger opening compared to said central aperture, said central aperture further including a third internal threaded portion at said first end surface complimenting said threaded portion of said threaded bolt connectors,
- said second inner diameter of said gasket being congruent to said first outer diameter of each of said second portions of each said threaded bolt connectors and said second outer diameter being larger than the inner diameter of said third internal threaded part of said tightening nuts,
- rotating said tightening nuts relative to said threaded portion of said threaded bolt connectors, compressing said gaskets towards said threaded bolt connectors, said inner tapered portion of said tightening nuts and said planar abutment surface and establishing sealing relative to said threaded bolt connectors and said planar abutment surface.

12. A method of establishing a foundation according to claim 11 further rotating said tightening nuts in a predetermined tightening sequence providing a preloaded connecting between said reinforced concrete pile and the overhead line mast, power line mast or the like.

13. A method of establishing a foundation according to claim 11 or 12 further including any of the features of the system according to claims 1-10.

14. A method of casting a reinforced concrete pile for a foundation, wherein said foundation comprising a reinforced concrete pile including threaded bolt connectors, a number of gaskets and a corresponding number of tightening nuts, said method comprising the step of:

- providing a casting mould having two mould side walls, a first mould end part including apertures, a second mould end part and a bottom mould part,
- inserting a number of anti-adherent elements made of a synthetic material, Teflon or the like into the apertures of the first mould end part,
- placing steel reinforcement elements into the casting mould and said steel reinforcement elements extending between said first end part and said second end parts of the casting mould, a number of threaded bolt connectors being connected to said steel reinforcement elements and allowing said threaded bolt connectors to extend beyond said first mould end part,
- pouring concrete into the casting mould.
- casting a reinforced concrete pile defining an elongated structure having a first end part including a planar abutment surface of a first polygonal geometry and a second end part, steel reinforcement elements extending between said first end part and said second end parts, said threaded bolt connectors being embedded in said reinforced concrete pile and each having an exposed part extending beyond said first end part and positioned in a second polygonal geometry and connected to said steel reinforcement elements of said reinforced concrete pile, said second polygonal geometry being equivalent to said first polygonal geometry.

15. A method of casting a reinforced concrete pile for a foundation according to claim 14, wherein said method further comprising the step of:

- arranging said threaded bolt connectors in the casting mould for providing a reinforced concrete pile having a first interface being located between said first portion and said transition portion of each of said threaded bolt connectors at a first distance from said planar abutment surface, and a second interface being located between said transition portion and said second portion of each of said threaded bolt connectors at a second distance from said planar abutment surface, said first distance being larger than said second distance.

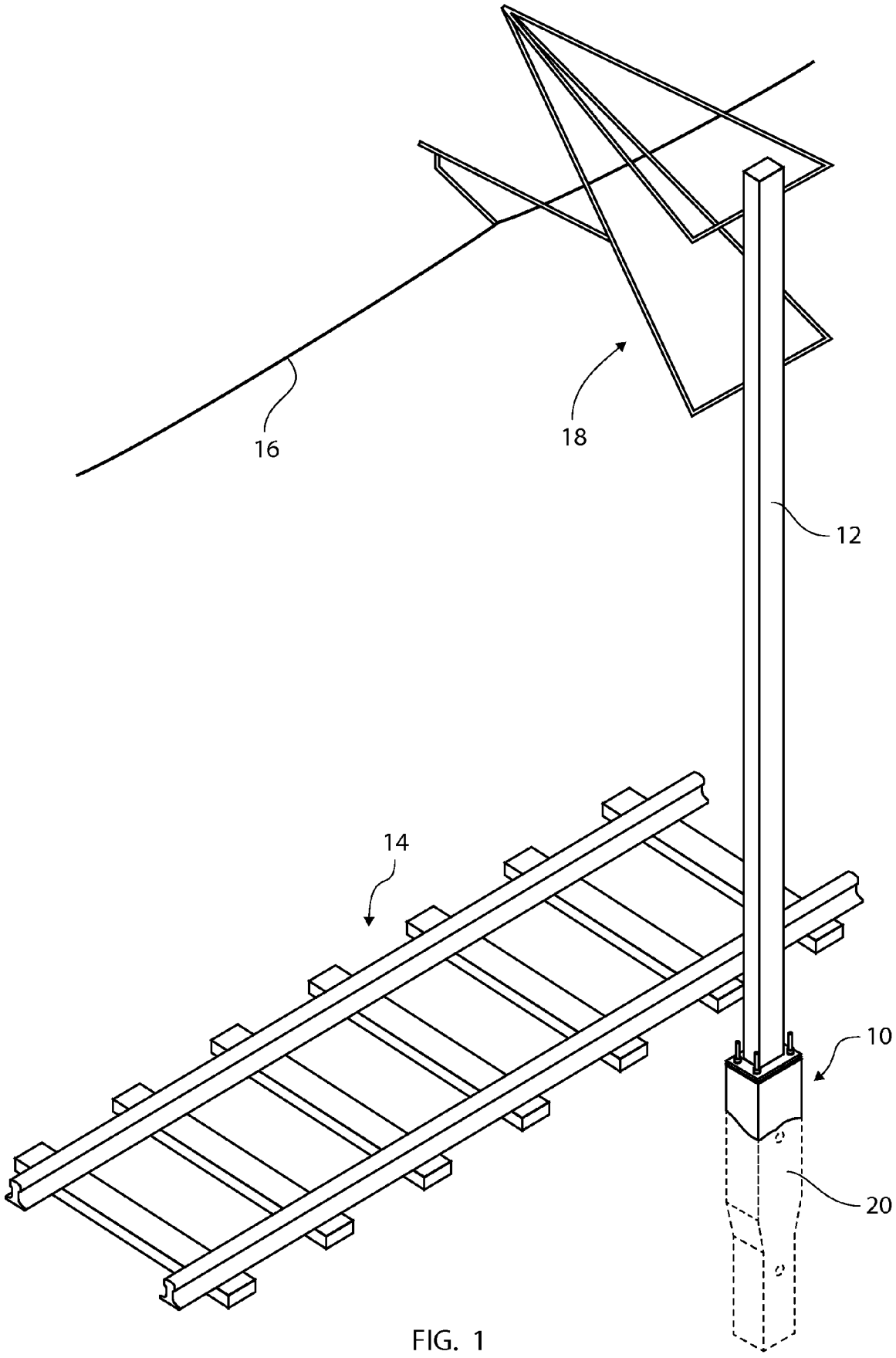


FIG. 1

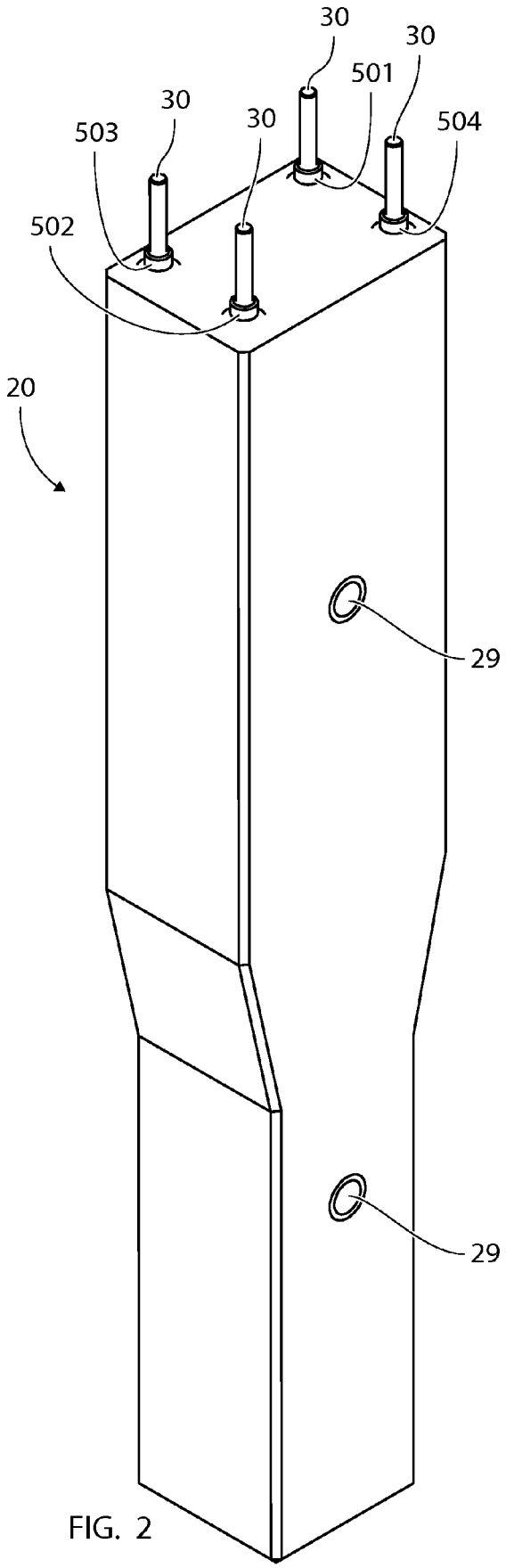


FIG. 2

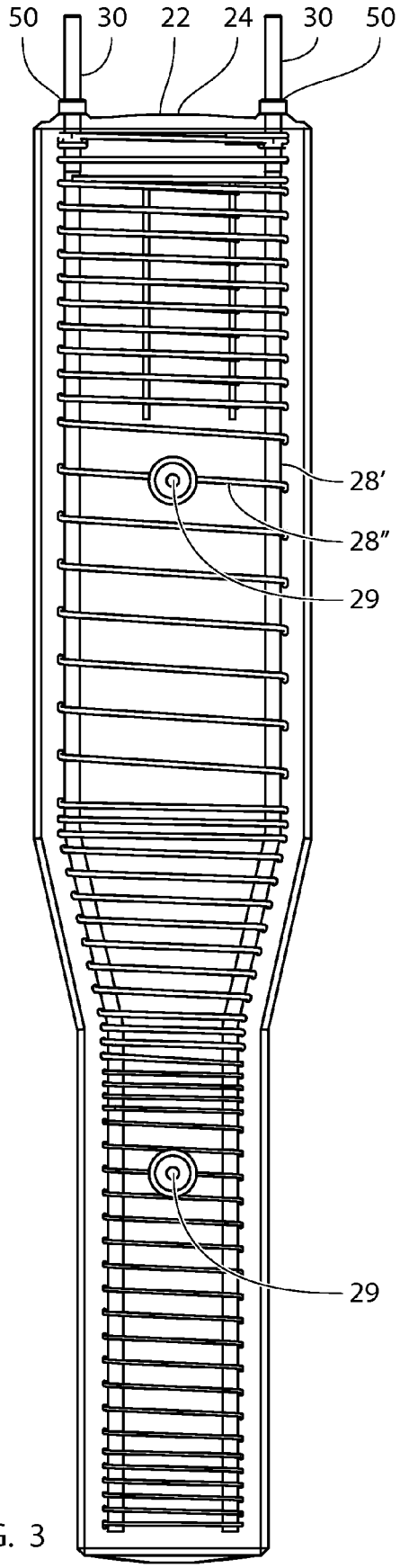


FIG. 3

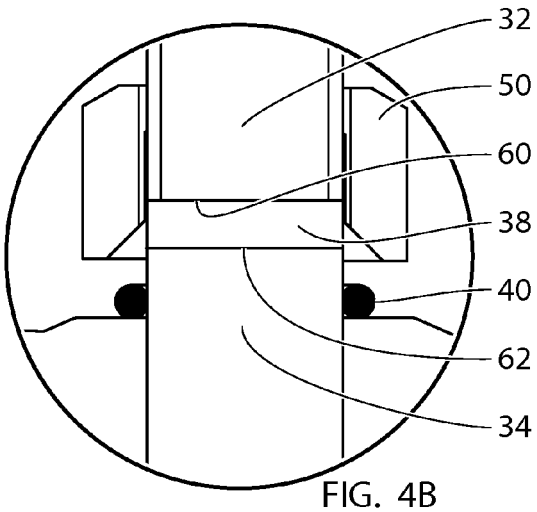


FIG. 4B

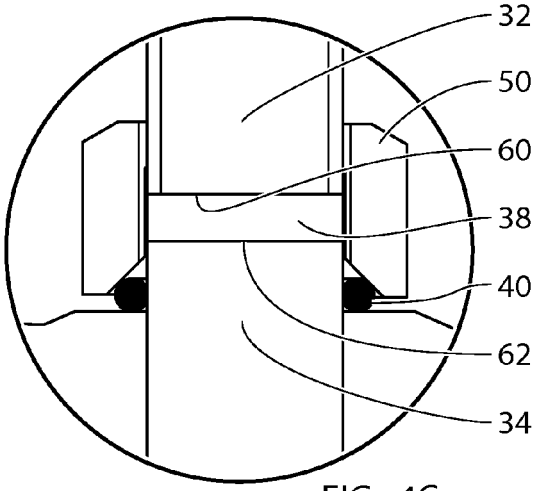
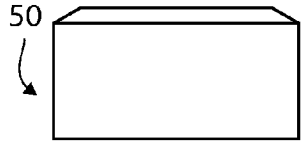


FIG. 4C

FIG. 4D

FIG. 4A



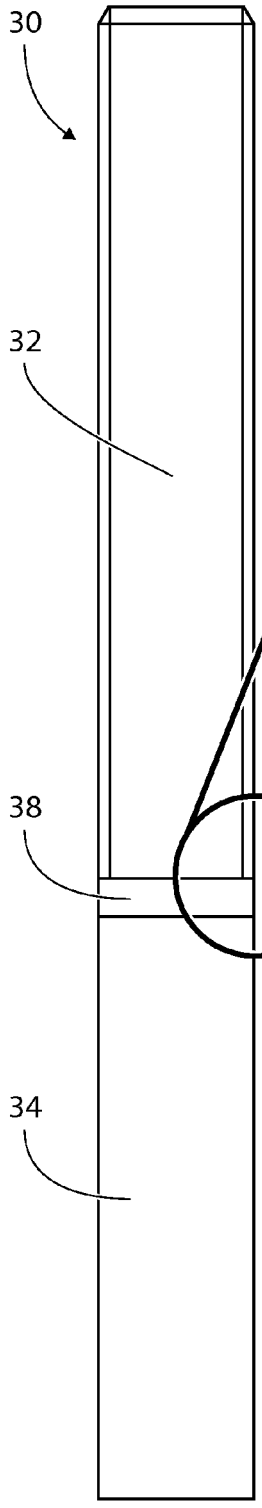


FIG. 5A

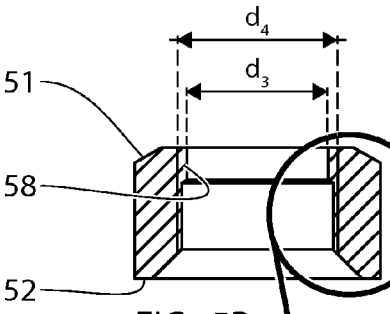


FIG. 5B

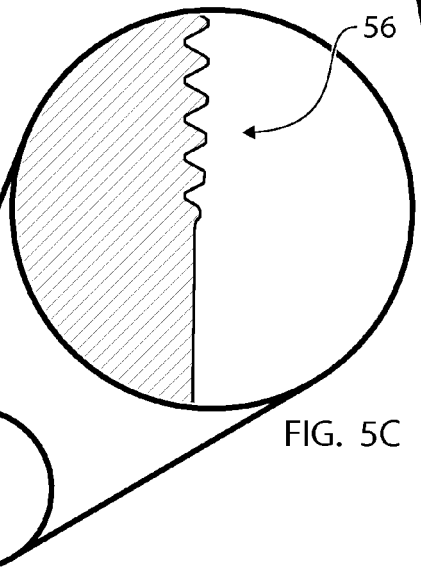


FIG. 5C

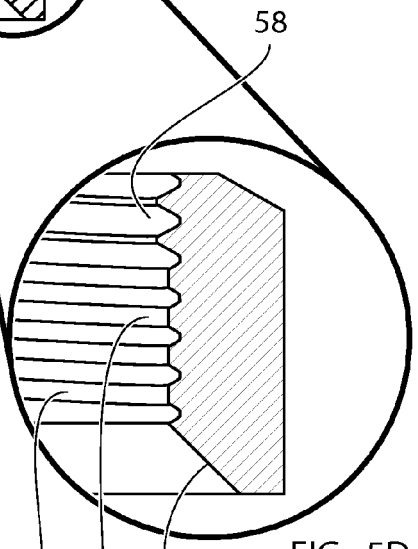


FIG. 5D

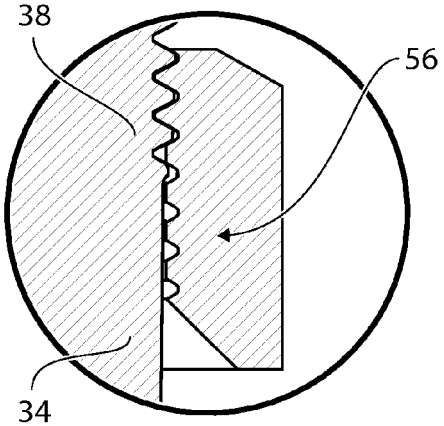
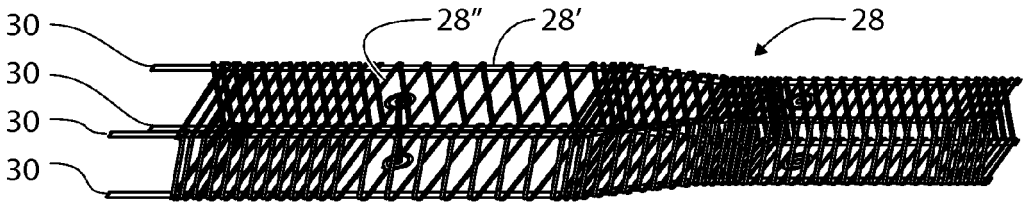


FIG. 5E



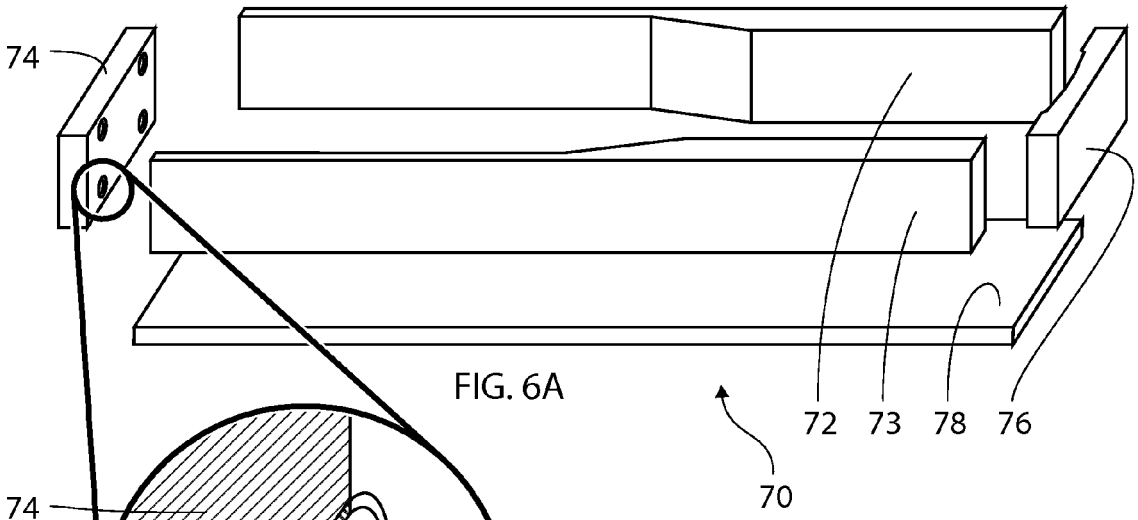


FIG. 6A

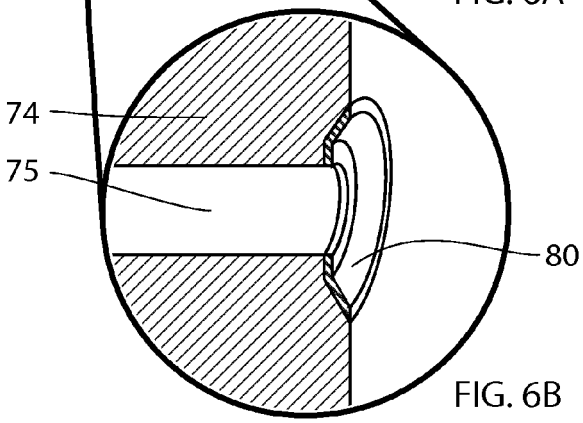


FIG. 6B

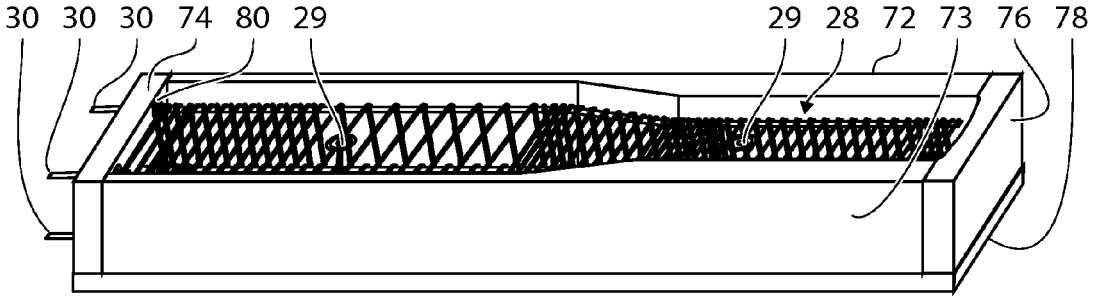


FIG. 6C

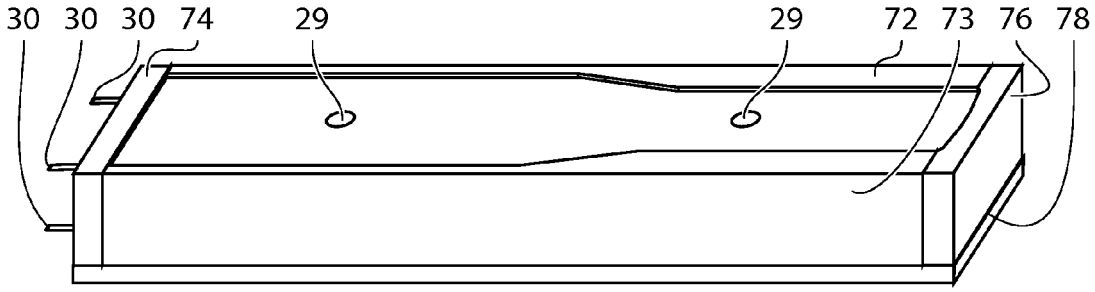


FIG. 6D

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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 7707

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	PL 67 224 Y1 (TORPOL SPÓLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA [PL]) 30 June 2014 (2014-06-30) * page 2, lines 1-13, 40-53; figures 1-6 *	1-15	INV. E02D27/42 E02D5/30
A	DE 20 2012 100412 U1 (INDUO GES ZUR VERWERTUNG VON SCHUTZRECHTEN MBH & CO KG [DE]) 5 December 2012 (2012-12-05) * paragraphs [0002], [0066]; figures 4-7,11,18,19 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)
E02D
E04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 November 2017	Koulo, G

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 18 7707

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24-11-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
PL 67224 Y1	30-06-2014	NONE	
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		EP 2565349 A2	06-03-2013

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82