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(54) **TONGUE AND GROOVE CONNECTOR AND PILE**

(57) The present invention relates to an injection
bored pile arranged to be installed at least partly into a
hole in ground. The injection bored pile comprises a
longitudinal pile body having an upper end and a lower
end and a female connector element and/or a male
connector element extending substantially along the
longitudinal direction of the pile body on the outer surface

of the pile body for providing a tongue and groove con-
nection with an adjacent injection bored pile having a pile
body being provided with a male connector element or
female connector element extending substantially along
the longitudinal direction of the pile body of the adjacent
injection bored pile.

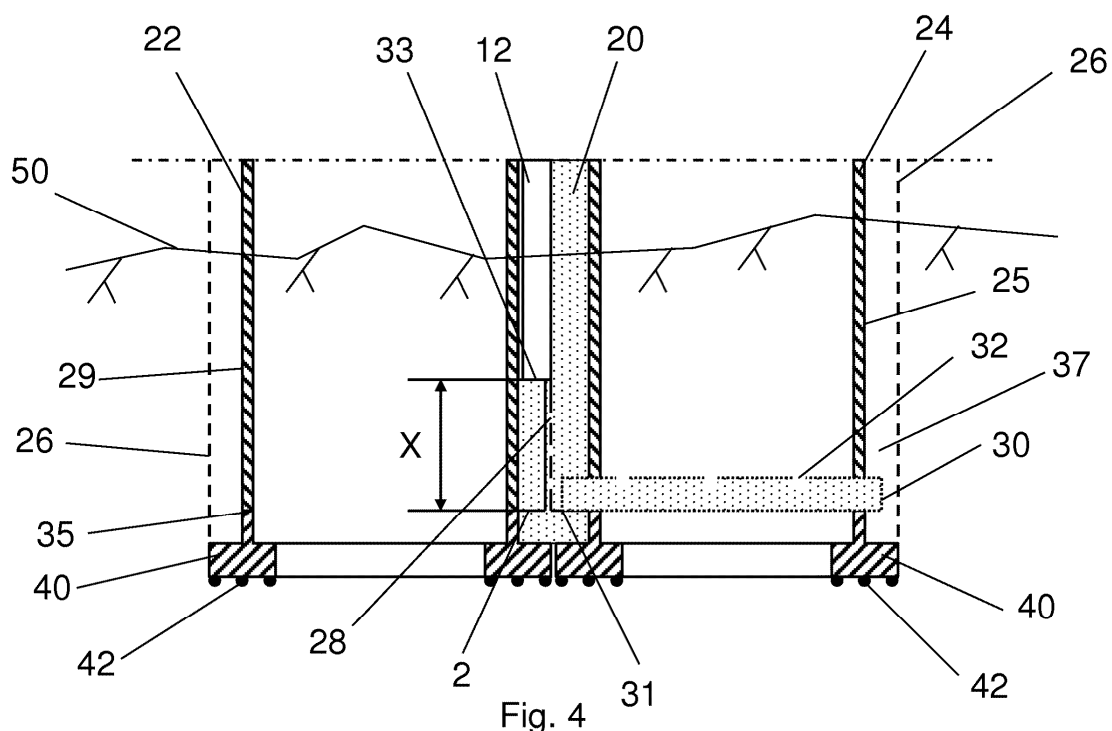


Fig. 4

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Description

[0001] The present invention relates to an injection bored pile according to the preamble of item 1, and especially to an injection bored pile, comprising a longitudinal pile body arranged to be installed at least partly into a hole in ground, the pile body having an upper end and a lower end. The present further relates to a tongue and groove connector according to the preamble of item 19, and especially to a tongue and groove connector for connecting two adjacent bored piles together, the connection comprising a male connector element having a tongue and a female connector having a groove arranged to receive the tongue of the male connector for providing a connection between the male and female connector element, the male and female connector element being formed as longitudinal profiles.

Background of the invention

[0002] Bored piles are installed into ground by boring a hole into the ground and placing the pile into the hole. Usually the lower end of the bored pile is provided with a drill bit for boring the hole into the ground at the same the pile is installed to the ground. The largest diameter of the drill bit is always larger than the largest diameter of the bored pile and therefore there is a gap between the inner surface of the hole and the outer surface of the bored pile. This gap is usually sealed with a sealing material after bored pile is installed into the ground for sealing the bored pile firmly to the hole and for providing a water sealing at the lower end of the bored pile. Two or more piles may also be installed adjacent to each other and thus also the gap between adjacent bored piles is often sealed with the sealing agent.

[0003] Piles may also be pressed into a soft ground, but then no gap is formed between the outer surface of the pile body and the hole in the ground as there is no drill bit in the pile.

[0004] In some applications piles are used for forming pile walls in which two or more piles are installed adjacent to each other and connected to each other with a tongue and groove connection. This kind of bored pile walls are sealed from the lower end of the piles for firmly installing the piles to the holes and together and for providing a water sealing.

[0005] In the prior art the gap between the inner surface of the hole and the outer surface of the pile is sealed by injecting sealing material to the gap after the bored pile is installed into the hole. The sealing material is injected to the hole between the inner surface of the hole and the outer surface of the pile through several separate injection pipes. These separate injection pipes may be attached to the outer wall of the bored pile or they may be installed to the ground after installation of the bored pile. In the prior art several injection pipes are used for providing sealing material to space between the hole and the outer surface of the pile around the whole pile. Thus these

separate injection pipes are arranged symmetrically or asymmetrically around the bored pile.

[0006] The disadvantage of the prior art piles is that several separate injection pipes has to be installed to the piles. The installation of the injection pipes makes the piles complicated and enlarges outer diameter of the piles. The enlarged diameter requires that also the holes on the ground must be larger and thus the space or gap between the inner surface of the hole and the outer surface of the pile becomes larger. Thus more sealing material has to be injected to the hole and the placement and orientation of the piles becomes more difficult. Installing separate injection pipes after installing the pile is inefficient, delays construction work and also provides uncertainty to the sealing process as precise placing of the injection pipes is difficult.

Brief description of the invention

[0007] The object of the present invention is to provide an injection bored pile and tongue and groove connection so as to overcome or at least alleviate the prior art disadvantages. The objects of the present invention are achieved with an injection bored pile according to the characterizing portions of the independent claims.

[0008] The preferred embodiments of the invention are disclosed in the dependent claims.

[0009] The present invention is based on the idea of providing for connecting two adjacent bored piles together. The connection comprising a male connector element having a tongue and a female connector having a groove arranged to receive the tongue of the male connector for providing a connection between the male and female connector element. The male and female connector element being formed as longitudinal profiles and the tongue has a first length and the groove has a second length. According to the present invention the tongue and groove connection further comprises a separate injection channel for injecting fluid material along the tongue and groove connection, the separate injection channel having a third length, the third length being greater than the first length of the tongue and/or the second length of the groove. The tongue and groove connection according to the present invention is provided with a separate injection channel for injecting sealing material along the connection. The separate injection channel means that the female groove of the tongue and groove connection is not used as an injection channel, but the tongue and groove connection is arranged to form an injection channel which does not take part in providing the actual connection. Therefore, the present invention provides a tongue and groove connection which may be used for injecting sealing material from the upper part of the bored pile to the lower end of the bored pile after the bored pile is installed into the hole in the ground.

[0010] The present invention furthermore relates to an injection bored pile arranged to be installed at least partly

into a hole in ground, the injection bored pile comprising, a longitudinal pile body having an upper end and a lower end, a crown drill provided to the lower end of the longitudinal pile body and a female connector element and/or a male connector element extending substantially along the longitudinal direction of the pile body on the outer surface of the pile body for providing a tongue and groove connection with an adjacent bored pile. According to the present invention the female connector element and/or the male connector element is arranged to extend along the longitudinal direction of the pile body from the upper end of the pile body or from the vicinity thereof towards the lower end of the pile body to distance from the lower end of the pile body. Furthermore the female connector element and/or the male connector element is provided with at least one separate injection channel for supplying injection material to the lower end of the pile body and vicinity thereof for sealing the space between the hole and the outer surface of the pile body. The injection channel may be tube pipe extending along the female or male connector element. In one embodiment the injection channel is formed on the outer surface of the pile. Thus the outer surface may form at least a portion of the side walls of the injection channel. The injection channel may be formed between the outer surface of the pile and a groove of the female connector or between the outer surface of the pile and a tongue of the male connector element. Therefore, the injection channel may be formed with the male or female connector element or together with the male or female connector element and the outer surface of the pile. The lower end of the injection bored pile may be provided with a transversal injection channel which is arranged to supply sealing material around the pile such that the gap between the outer surface of the pile and the inner surface of the hole may be sealed with the sealing material along the whole or at least major part of the circumference of the pile. The transversal injection channel is arranged in fluid connection with the injection channel formed in connection with the tongue and groove connection. In one embodiment the transversal injection channel is provided as a tube or tube ring attached to the outer surface of the pile and extending transversely to the longitudinal direction of the pile. The transversal injection channel is further provided distribution opening for distributing the sealing material to the gap between the inner surface of the hole and outer surface of the pile at the lower end of the pile.

[0011] The tongue and groove connection according to the present invention provides a simple arrangement for forming an injection channel for bored piles. The injection channel formed in connection with the tongue and groove connection enables minimizing the diameter of the bored pile and especially the gap between the inner surface of the hole and the outer surface of the pile. The injection arrangement of the present invention eliminates the need for several injection pipes attached to the outer surface of the pile. Furthermore, the present invention enables simultaneously sealing the gap between the inner sur-

face of the hole and outer surface of pile as well as tongue and groove connection between two adjacent piles. Therefore, the present invention makes the sealing process quicker and more efficient. Furthermore, the different lengths between the injection channel and the tongue and/or groove of the connection enable injecting sealing material to the vicinity of the lower end of the pile body such that the injection material may be provided along a distance from the lower end of the pile body. Additionally, as the tongue and/or groove does not extend all the way to the lower end of the pile body adjacent piles may be arranged easily at a different level of depth in the ground and the gap at the lower end of the piles may still be sealed using the injection channel.

Brief description of the figures

[0012] In the following the invention will be described in greater detail, in connection with preferred embodiments, with reference to the attached drawings, in which

Figures 1A and 1B are schematic views of one embodiment of the tongue and groove connection according to the present invention;

Figure 2A and 2B are schematic views of another embodiment of the tongue and groove connection according to the present invention;

Figure 3 is a schematic upper view of one embodiment of piles and pile wall according to the present invention; and

Figure 4 is a cross sectional side view of the embodiment of figure 3.

Detailed description of the invention

[0013] Figures 1A and 1B shows one embodiment of a tongue and groove connection for connecting bored piles together according to the present invention. The tongue and groove connection comprises or consists of a male connector element 2 and a female connector element 10. The male connector element 2 of figure 1A comprises a tongue 6 and a male base 4. The male connector element 2 may thus be attached to an outer surface of bored pile via the male base 4. The female connector 10 of figure 1B comprises a groove 12 arranged to receive the tongue 6 of the male connector element 2. Therefore the shape of the groove 12 and tongue 6 may correspond to each other. However, the shape of the tongue 6 does not necessarily correspond the groove 12, but the shape of the tongue 6 have to be such that the tongue 6 cannot slide away from the groove 12 in the depth direction of the groove 12. The tongue 6 may be for example T-shaped or triangular. The connection between the male connector element 2 and the female connector element 10 is achieved sliding the tongue 6 into the groove 12 in the

longitudinal direction of the groove 12 by moving the male and female connector element 2, 10 relative to each other.

[0014] As shown in figure 1B the female connector element 10 is a profile having a longitudinal direction in the length direction of the groove 12. The groove 12 is formed with the first side walls 14 and with the bottom wall 16. The first side walls 14 are formed such that they approach each other for forming a groove opening 13 having height d_3 . The height d_3 of the groove opening 13 may substantially correspond the width of the male base 4 of the male connector element 2. The groove 12 also has a depth d_2 and width d_1 . In the figures 1A and 1B the depth d_2 of the groove substantially corresponds the height of the tongue 6 and the width d_1 of the groove 12 substantially corresponds the width of the tongue 6. However, in another embodiment the relative dimensions of the groove 12 and the tongue may vary. In figure 1B the groove has substantially triangular cross sectional area, but it may also be formed as rectangular, circular elliptical or some other design.

[0015] According to the present invention tongue and groove connection further comprises a separate injection channel for injecting fluid material along the tongue and groove connection. In the embodiment of figures 1A and 1B the injection channel is provided to the female connector element 10. The injection channel 20 of the female connector element 10 is formed with the second side walls 18 and with the bottom wall 16. In figure 1B the injection channel 20 is formed as a groove extending in the longitudinal direction and along the female connector element 10. The second side walls 18 are formed such that they approach each other for forming a first injection channel opening 15 having height D_3 . The second side walls 18 are also formed and arranged such that the female connector element 10 may be attached to a bored pile from the tips 19 of the second side walls 18. The male and female connector elements 2, 10 may be attached to a bored pile by welding. In figure 1B the injection channel 20 is formed as a groove having the first injection channel opening 15 extending along the injection channel 20. In another embodiment the injection channel 20 may be also formed as tube or pipe such that the second side walls 18 are connected to each other to form a closed circumference and side walls for the injection channel 20. Accordingly, the female connector element 10 comprises a groove 12 and a female base, formed with the second side walls 18. The female base 18 is formed as a bifurcated base 18 for forming the injection channel 20. When the female connector element 10 is attached to the outer surface of the bored pile from the second side walls 18, the outer surface of the bored pile may close the first injection opening 15 of the injection channel 20 for forming a tubular injection channel 20. Therefore, the outer surface of a bored pile may form part of the walls of the injection channel 20.

[0016] In the embodiment of figure 1B the injection channel 20 and the groove 12 are separated from each

other with the bottom wall 16 forming a common partition wall for the injection channel 20 and the groove 12. This enables compact structure for the female connector element 10, and especially minimal dimension in the depth direction of the groove 12. This means that the groove 12 and the injection channel 20 are formed on the opposite sides of the bottom wall 16.

[0017] Figures 2A and 2B show an alternative embodiment of the tongue and groove connection according to the present invention. In this embodiment the injection channel 20 is provided to the male connector element 2. For simplicity, the tongue 6 of the male connector element 2 and the groove 12 of the female connector element 10 correspond tongue and groove 6, 12 shown disclosed in connection with figures 1A and 1B. Thus the same reference numerals denoted corresponding parts in figures 1A, 1B, 2A and 2B. In figure 2B the female connector element 10 comprises a female base wall 21 for attaching the female connector element 10 to an outer surface of a bored pile. The female base wall 21 forms also the bottom wall of the groove 12. In figure 2A the male connector element 2 is provided with an injection channel 23 formed as groove. The injection channel 23 of the male connector element 2 is formed with the third side walls 27 and with the male base 4. In figure 2A the injection channel 23 is formed as a groove extending in the longitudinal direction and along the male connector element 2. The third side walls 27 are formed such that they approach each other for forming a second injection channel opening 17 having height D_3 . The third side walls 27 are also formed and arranged such that the male connector element 2 may be attached to a bored pile from the tips 25 of the third side walls 27. The male and female connector elements 2, 10 may be attached to a bored pile by welding. In figure 2A the injection channel 23 is formed as a groove having the second injection channel opening 17 extending along the injection channel 23. In another embodiment the injection channel 23 may be also formed as tube or pipe such that the third side walls 27 are connected to each other to form a closed circumference and side walls for the injection channel 23. Accordingly, the male connector element 2 comprises a tongue 6 and a male base 4, formed with the third side walls 27. The male base 4 is formed as a bifurcated base by the third side walls 27 for forming the injection channel 23. When the male connector element 2 is attached to the outer surface of the bored pile from the third side walls 27, the outer surface of the bored pile may close the injection opening 17 of the injection channel 23 for forming a tubular injection channel 23. Therefore, the outer surface of a bored pile may form part of the walls of the injection channel 23. Accordingly the male connector element 2 comprises a tongue 6 and a male base 4, and the male base 4 is formed as a bifurcated base 4, 27 for forming the injection channel 23.

[0018] According to the above mentioned in the present invention the tongue and groove connector comprises a separate injection channel 20, 23 for injecting fluid material along the tongue and groove connector.

The injection channel 20, 23 may be formed to male or female connector element 2, 10 or to both. The injection channel 20, 23 may be a groove, pipe or tube. The injection channel 20, 23 have to have certain minimum dimensions such that sealing material may be injected through the injection channel 20, 23. Furthermore, the dimensions of the injection channel 20, 23 have to be such that the overall dimensions male and female connector elements do not become too large and increase the maximum outer diameter of a bore pile. Additionally, the injection channel 20, 23 has to be formed and arranged such that the strength properties of the male and female connector elements are not compromised. Therefore it has been surprisingly discovered that the injection channel 20, 23 preferably fulfills at least one of the following criteria:

- the cross sectional surface area of the injection channel 20 is at least 0,7 times the cross sectional surface area of the groove 12 of the female connector element 10;
- the first diameter D_1 of the injection channel 20, 23 in the width direction of the groove 12 is at least 0,8 times the width d_1 of the groove 12 or substantially corresponds the width d_1 of the groove 12; and
- the second diameter D_2 of the injection channel in the depth direction of the groove 12 is at least 0,8 times the depth d_2 of the groove 12 or at least 15 mm. When the above criteria are fulfilled the injection channel 20, 23 has suitable dimensions for injecting sealing material without compromising the strength and size demands for the male and female connector elements 2, 10.

[0019] Figure 3 shows one embodiment of bored piles provided with a tongue and groove connection according to the above description. The bored piles are installed into a hole 26 in the ground 50. A space 37 is formed between the inner surface of the hole and the outer surface 25 of the pile. The bored pile and the tongue and groove connection together form an injection bored pile. The injection bored pile means bored pile with an integral injection channel and a drill bit at the lower end of the pile. The injection bored pile comprises a longitudinal pile body 22, 24 having an upper and lower end. The pile body 22, 23 is further provided with a female connector element 10 and/or a male connector element 2 extending substantially along the longitudinal direction of the pile body 22, 24 on the outer surface 25 of the pile body 22, 24 for providing a tongue and groove connection with an adjacent bored pile. In figure 3 the first injection bored pile is provided with a male connector element 2 on the outer surface 29 of the pile body 22 and the second bored pile is provided with a female connector element 10 on the outer surface 25 of the pile body 24. The tongue 6 of the male connector element 2 is received into the groove 12 of the female connector element 12 for providing a tongue and groove connection between the adjacent piles. Accord-

ing to the present invention the female connector element 10 and/or the male connector element 2 is provided with at least one separate injection channel 20, 23 for injecting fluid material from the upper end of the pile body 22, 24 to the lower end or vicinity thereof of the pile body 22, 24. In the embodiment of figure 3 the injection channel 20 is provided to, or in connection with, the female connector element 10, but in alternative embodiments the injection channel 20 may also be provided to, or in connection with, the male connector element 2. The tongue and groove connection and the male and female connector elements 2, 10 may be formed in any way as disclosed above.

[0020] As shown in figure 3 the injection channel 20 is provided on the outer surface 25 of the pile body 24. The injection channel 20 furthermore extends substantially in the longitudinal direction of the pile body 24. The female connector element 10 comprises a groove 12 for receiving a tongue 6 of the male connector element 2 of a corresponding adjacent bored pile, and the injection channel 20 is provided between the groove 12 and the outer surface 25 of the pile body 24. When the injection channel 23 is provided to the male connector element 2, the male connector element 2 comprises a tongue 6 to be arranged into a groove 12 of the female connector element 10 of a corresponding adjacent bored pile, and that the injection channel 23 is provided between the tongue 6 and the outer surface 29 of the pile body 22. Forming the injection channel 20, 23 between the outer surface 29, 25 of the pile body 22, 24 and the tongue 6 or groove 12, the dimension of the male or female connector element 2, 10 in the direction away from the pile body 22, 24 may be minimized. Thus also the maximum outer diameter of the pile may be minimized.

[0021] The injection channel 20, 23 provided in connection with the male or female connector element 2, 10 may be separate tube or pipe. Alternatively the outer surface 29, 25 of the pile body 22, 24 may form part of the side walls of the injection channel 20, 23 for forming a tubular injection channel 20, 23 extending substantially in the longitudinal direction of the pile body 22, 24. The injection channel 20, 23 may extend substantially along the whole length of the pile body 22, 24, or the injection channel 20, 23 may extend from the upper end of the pile body 22, 24 or from vicinity thereof to the lower end of the pile body 22, 24 or to the vicinity thereof.

[0022] Figure 4 shows a cross sectional side view of the embodiment of figure 3. As shown in figure 4 the pile bodies 22, 24 are provided at the lower end 35 with a crown drill 40 comprising drill bits 42. The diameter of the crown drill 40 is larger than the maximum outer diameter of the bored piles, together with the tongue and groove connections. The crown drill 40 forms a hole 26 into the ground simultaneously with installation of the bored piles. As shown in figure 4, the injection channel 20 extends substantially to the lower end 35 of the pile body 24, and the groove 12 of the female connector element 10 extends to a distance X from the lower end 35 of the pile body 24. Thus the injection channel 20 extends further

along the pile body 24 than the groove 12. The injection channel 20 is also provided with first distribution openings 28 between the lower end of the groove 12 and the lower end of the injection channel 20 for supplying injection material between the inner surface of the hole 26 and the outer surface 25 of the pile body 24. The first injection openings 28 may be holes or slits or the like. The lower end 31 of the injection channel 20 is closed and the sealing material thus flow out of the injection channel through the first injection openings 28. The first distribution opening 28 may be provided between the lower end 33 of the female connector element 12 and the lower end 31 of the injection channel 20, 23 for supplying injection material to the lower end 35 of the pile body 22, 24 and vicinity thereof between the inner surface of the hole 26 and the outer surface 25 of the pile body 22, 24. Alternatively the first distribution openings 28 may be provided between the lower end 33 of the male connector element 6 and the lower end 31 of the injection channel 20, 23 for supplying injection material to the lower end 35 of the pile body 22, 24 and vicinity thereof between the inner surface of the hole 26 and the outer surface 25 of the pile body 22, 24.

[0023] In an alternative embodiment in which the injection channel 23 is provided in connection of the male connector element 2, the injection channel 23 may extend substantially to the lower edge of the pile body 22, and the tongue 6 of the male connector element 2 may extend to a distance X from the lower end 35 of the pile body 22. Then the injection channel 23 may be provided with first distribution openings between the lower end of the tongue 6 and the lower end of the injection channel 23 for supplying injection material between the inner surface of the hole 26 and the outer surface 29 of the pile body 22. In a yet alternative embodiment the lower end 31 of the injection channel 20, 23 may be open such that sealing material may be injected through the lower of the injection channel 20, 23. When the lower end of the injection channel 20, 23 is open, the first injection openings may be omitted. In this kind of embodiment it may also be possible that the tongue and groove also extends substantially to the lower end of the pile body 22, 24.

[0024] According to the present invention the female connector element 10 and/or the male connector element 2 are arranged to extend along the longitudinal direction of the pile body 22, 24 from the upper end of the pile body 22, 24 or from the vicinity thereof towards the lower end 35 of the pile body 22, 24 to distance X from the lower end 35 of the pile body 22, 24. As described, the female connector element 10 and/or the male connector element 2 is provided with at least one separate injection channel 20, 23 for supplying injection material to the lower end 35 of the pile body 22, 24 and vicinity thereof for sealing the space 37 between the hole 26 and the outer surface 25 of the pile body 22, 24. Thus the lower end 33 of the female connector element 10 and/or the male connector element 2 is arranged at a distance X from the lower end 35 pile body 22, 24, as is shown in figure 4.

[0025] In one embodiment the injection channel 20, 23 may extend substantially along the whole length of the pile body 20, 23. In an alternative embodiment the injection channel 20, 23 extends from the upper end of the pile body 22, 24 or from vicinity thereof to the lower end 35 of the pile body 22, 24 or to the vicinity thereof. Therefore the injection channel 20, 23 may extend towards the lower end 35 of the pile body 22, 24 to distance X from the lower end 35 of the pile body 22, 24 or the lower end 31 of the injection channel 20, 23 is provided to the lower end 33 of the female connector element 10 and/or the male connector element 2 arranged at a distance X from the lower end 35 pile body 22, 24. Alternatively the the injection channel 20, 23 extends towards the lower end 35 of the pile body 22, 24 between the lower end 35 of the pile body 22, 24 or the crow drill 40 and the distance X from the lower end 35 of the pile body 22, 24 or the lower end 31 of the injection channel 20, 23 is provided between the lower end 35 pile body 22, 24 and the lower end 33 of the female connector element 10 and/or the male connector element 2 arranged at a distance X from the lower end 35 pile body 22, 24.

[0026] In the embodiment of figure 4 the injection channel 20, 23 in provided in connection with the female connector element 10, the lower 33 of the female connector element 10 is provided to a distance X from the lower end 35 of the pile body 22, 24 and the lower end 31 of the injection channel 20, 23 is provided to lower end 33 of the female connector element 10 or to the lower end 35 of the pile body 22, 24 or between the lower end 35 of the pile body 22, 24 and the lower end 33 of the female connector element 10. In an alternative embodiment the injection channel 20, 23 may be provided in connection with the male connector element 2, the lower 33 of the male connector element 2 may be provided to a distance X from the lower end 35 of the pile body 22, 24 and the lower end 31 of the injection channel 20, 23 is provided to lower end 33 of the male connector element 2 or to the lower end 35 of the pile body 22, 24 or between the lower end 35 of the pile body 22, 24 and the lower end 33 of the male connector element 2. Accordingly the injection channel (20, 23) is provided on the outer surface (25) of the pile body (22, 24) in connection with the female connector element (10) and/or the male connector element (2).

[0027] As shown in figures 3 and 4, the injection bored pile is further provided with at least one transversal injection channel 30. The transversal injection channel 30 is provided to the lower end of the pile body 24 or in the vicinity thereof or between the lower end of the lower 33 of the male or female connector element 2, 10 provided to the distance X from the lower end 35 of the pile body 22, 24 and the lower end 35 of the pile body 22, 24 for supplying injection material at least partly around the pile body 24 and between the inner surface of the hole 26 and the outer surface 25 of the pile body 24. The transversal injection channel 30 may extends substantially perpendicularly to the longitudinal direction of the pile body 24

and/or substantially transversal or perpendicularly to the injection channel 20, 23. The transversal injection channel 30 is provided in fluid communication with the injection channel 20, 23 such that injection material may be supplied from the injection channel 20, 23 to the transversal injection channel 30. The transversal injection channel 30 may be a pipe or tube surrounding at least part of the circumference of the pile body 24. In a preferred embodiment the transversal injection channel is arranged to at least partly conform the outer surface 25 of the pile body 24. The transversal injection channel 30 may also be formed with a profile having a groove such that the outer surface 25 of the pile body 24 forms part of the side walls of the transversal injection channel 30, in the same as discussed with the injection channel 20, 23.

[0028] The transversal injection channel is provided with a supply opening 34 for receiving sealing material from the injection channel 20, 23, as shown in figure 3. The transversal injection channel 30 may further comprise one or more second distribution openings 32 for supplying injection material between the inner surface of the hole 26 and the outer surface 25 of the pile body 24. In the embodiment of figures 3 and 5 the second distribution openings 32 are provided on the upper surface of the transversal injection channel 30. This is preferable, as it prevents the second distribution openings 32 from becoming clogged from dirt during installation of the bored piles. It should be noted that the transversal injection channel 30 may also be used with other kind of injection channels than the one described in this context in connection with the tongue and groove connection. For example the transversal injection channel may be used with prior art injection pipes attached outer surface of the pile body apart from the tongue and groove connection.

[0029] In an alternative embodiment the transversal injection channel 30 may be provided inside the at least partly tubular pile body 24. The transversal injection channel 30 may be attached or formed on the inner surface of the pile body 24 to the lower end of the pile body 24 or in the vicinity thereof. The transversal injection channel 30 may correspond or substantially correspond the transversal injection as described in connection with figures 3 and 4. In this embodiment the transversal injection channel an inlet opening or inlet conduit which is in fluid connection with the injection channel provided in connection with the tongue and groove connector. Therefore the sealing material injected along the injection channel may enter transversal injection channel. The inlet opening or inlet conduit may be formed through the wall the pile body. The transversal injection channel of this embodiment is further provided with outlet openings or outlet conduits for supplying the sealing material from the transversal injection channel between the outer surface of the pile body and the inner surface of the hole at least partly around the pile body. The outlet opening or outlet conduits are formed to provide fluid connection from the transversal injection channel to outside of the pile body. Therefore the outlet openings or outlet conduits

extend through the wall of the pile body in the substantially transversal direction in relation to the longitudinal direction of the pile body.

[0030] The bored piles described above may be used for forming an injection bored pile wall consisting of two or more separate injection bored piles connected together with a tongue and groove connection and installed to a hole 26 in the ground 50. Thus the injection bored pile wall comprises at least one injection channel 20, 23 provided to at least one of the tongue and groove connections of the injection bored pile wall for injecting sealing material between the inner surface of the hole 26 and the outer surface 25, 29 of the injection bored pile and between adjacent injection bored piles. In the injection bored pile wall at least one of the injection bored piles is an injection bored pile as disclosed above. Furthermore least one pair of adjacent injection bored piles is connected to each other with a tongue and groove connection as disclosed above.

[0031] The present invention further provides a tongue and groove connection or connector comprising a male connector element 2 having a tongue 6 and a female connector 10 having a groove 12 arranged to receive the tongue 6 of the male connector 12 for providing a connection between the male and female connector element 2, 10. The male and female connector element 2, 10 being formed as longitudinal profiles and the tongue 6 has a first length and the groove 12 has a second length. According to the present invention the tongue and groove connection further comprises a separate injection channel 20, 23 for injecting fluid material along the tongue and groove connection, the separate injection channel having a third length, the third length being greater than the first length of the tongue 6 and/or the second length of the groove 12. In the embodiment of figure 4 the injection channel 20 is provided to the female connector element 10 and the third length of the injection channel 20, 23 is greater than second length of the groove 12. The injection channel 20 and the groove 12 are separated from each other with a common partition wall 16 and the female connector element 10 comprises a groove 6 and a female base 18, the female base 18 being formed as a bifurcated base 18 for forming the injection channel 20. In an alternative embodiment the injection channel 23 is provided to the male connector element 2 and the third length of the injection channel 20, 23 is greater than first length of the tongue 6. The male connector element 2 may comprise a tongue 6 and a male base 4, and that the male base 4 is formed as a bifurcated base 4 for forming the injection channel 23. The first length of the tongue 6 and the second length of the groove 12 may be substantially identical or different.

[0032] The present invention relates also to use of a transversal injection channel 30 provided to the lower end 35 of a longitudinal pile body 22, 24 or vicinity thereof for sealing the lower end 35 of an injection bored pile comprising a crown drill 40 provided to the lower end 35 of the longitudinal pile body 22, 24 and a female connector

element 10 and/or a male connector element 2 extending substantially along the longitudinal direction of the pile body 22, 24 on the outer surface 25 of the pile body 22, 24 for providing a tongue and groove connection with an adjacent bored pile.

[0033] According to the present invention the tongue and groove connection may be used for injecting sealing material to lower end of an injection bored pile installed into a hole in ground. Therefore the present invention also provides a sealing method for bored piles in which the sealing material is injected to the space between the inner surface of the hole and the outer surface of the pile via tongue and groove connection between two adjacent piles.

[0034] It should be noted that the shapes of the male and female connector elements of the tongue and groove connector may vary depending on the application and the requirements for the tongue and groove connection. Therefore the present invention is not restricted any special shape of the male and female connector elements. Especially the shape of the base 4, 21 and the connections elements, side walls 18, 27, with which the male and female connector elements are attached to the pile body may vary and formed in alternative ways and shapes. The base and connection elements 4, 21, 18, 27 may vary as the production technology and attachment or bonding technology, such as welding technology and automation, advance.

[0035] It is apparent to a person skilled in the art that as technology advanced, the basic idea of the invention can be implemented in various ways. The invention and its embodiments are therefore not restricted to the above examples, but they may vary within the scope of the claims.

ITEMIZED LIST OF EMBODIMENTS

[0036]

1. An injection bored pile arranged to be installed at least partly into a hole (26) in ground (50), the injection bored pile comprising:

- a longitudinal pile body (22, 24) having an upper end and a lower end;
- a crown drill (40) provided to the lower end (35) of the longitudinal pile body (22, 24); and
- a female connector element (10) and/or a male connector element (2) extending substantially along the longitudinal direction of the pile body (22, 24) on the outer surface (25) of the pile body (22, 24) for providing a tongue and groove connection with an adjacent bored pile,

characterized in that:

- the female connector element (10) and/or the male connector element (2) is arranged to ex-

tend along the longitudinal direction of the pile body (22, 24) from the upper end of the pile body (22, 24) or from the vicinity thereof towards the lower end (35) of the pile body (22, 24) to distance (X) from the lower end (35) of the pile body (22, 24), and

- the female connector element (10) and/or the male connector element (2) is provided with at least one separate injection channel (20, 23) for supplying injection material to the lower end (35) of the pile body (22, 24) and vicinity thereof for sealing the space (37) between the hole (26) and the outer surface (25) of the pile body (22, 24).

2. An injection bored pile according to item 1, characterized in that the lower end (33) of the female connector element (10) and/or the male connector element (2) is arranged at a distance (X) from the lower end (35) pile body (22, 24).

3. An injection bored pile according to item 1 or 2, characterized in that the injection channel (20, 23) extends substantially along the whole length of the pile body (20, 23), or that the injection channel (20, 23) extends from the upper end of the pile body (22, 24) or from vicinity thereof to the lower end (35) of the pile body (22, 24) or to the vicinity thereof.

4. An injection bored pile according to item 3, characterized in that:

- the injection channel (20, 23) extends towards the lower end (35) of the pile body (22, 24) to distance (X) from the lower end (35) of the pile body (22, 24); or
- the lower end (31) of the injection channel (20, 23) is provided to the lower end (33) of the female connector element (10) and/or the male connector element (2) arranged at a distance (X) from the lower end (35) pile body (22, 24); or
- the the injection channel (20, 23) extends towards the lower end (35) of the pile body (22, 24) between the lower end (35) of the pile body (22, 24) or the crown drill (40) and the distance (X) from the lower end (35) of the pile body (22, 24); or
- the lower end (31) of the injection channel (20, 23) is provided between

the lower end (35) pile body (22, 24) and the lower end (33) of the female connector element (10) and/or the male connector element (2) arranged at a distance (X) from the lower end (35) pile body (22, 24).

5. An injection bored pile according to item 3 or 4, characterized in that:

- the injection channel (20, 23) is provided in connection with the female connector element (10), the lower (33) of the female connector element (10) is provided to a distance (X) from the lower end (35) of the pile body (22, 24) and the lower end (31) of the injection channel (20, 23) is provided to lower end (33) of the female connector element (10) or to the lower end (35) of the pile body (22, 24) or between the lower end (35) of the pile body (22, 24) and the lower end (33) of the female connector element (10); or
 - the injection channel (20, 23) is provided in connection with the male connector element (2), the lower (33) of the male connector element (2) is provided to a distance (X) from the lower end (35) of the pile body (22, 24) and the lower end (31) of the injection channel (20, 23) is provided to lower end (33) of the male connector element (2) or to the lower end (35) of the pile body (22, 24) or between the lower end (35) of the pile body (22, 24) and the lower end (33) of the male connector element (2).
6. An injection bored pile according to any one of items 1 to 5, characterized in that the injection channel (20, 23) is provided on the outer surface (25) of the pile body (22, 24) in connection with the female connector element (10) and/or the male connector element (2).
7. An injection bored pile according to any one of items 1 to 6, characterized in that the injection channel (20, 23) is a pipe, tube or profile.
8. An injection bored pile according to any one of items 5 to 7, characterized in that the female connector element (10) comprises a groove (12) for receiving a tongue (6) of the male connector element (2) of a corresponding adjacent bored pile, and that the injection channel (20, 23) is provided between the groove (12) and the outer surface (25) of the pile body (22, 24).
9. An injection bored pile according to any one of items 5 to 7, characterized in that the male connector element (2) comprises a tongue (6) to be arranged into a groove (12) of the female connector element (10) of a corresponding adjacent bored pile, and that the injection channel (20, 23) is provided between the tongue (6) and the outer surface (25) of the pile body (22, 24).
10. An injection bored pile according to any one of items 5 to 9, characterized in that the outer surface (25) of the pile body (22, 24) forms part of the side walls of the injection channel (20, 23).

11. An injection bored pile according to any one of items 4 to 10, characterized in that:

- the injection channel (20, 23) is provided with first distribution openings (28) between the lower end (33) of the female connector element (12) and the lower end (31) of the injection channel (20, 23) for supplying injection material to the lower end (35) of the pile body (22, 24) and vicinity thereof between the inner surface of the hole (26) and the outer surface (25) of the pile body (22, 24); or
- the injection channel (20, 23) is provided with first distribution openings (28) between the lower end (33) of the male connector element (6) and the lower end (31) of the injection channel (20, 23) for supplying injection material to the lower end (35) of the pile body (22, 24) and vicinity thereof between the inner surface of the hole (26) and the outer surface (25) of the pile body (22, 24).

12. An injection bored pile according to any one of items 4 to 11, characterized in that the lower end (31) the injection channel (20, 23) is closed, or that the lower end (31) of the injection channel (20, 23) comprises a distribution opening.

13. An injection bored pile according to any one of items 1 to 12, characterized in that the injection bored pile is further provided with at least one transversal injection channel (30), the transversal injection channel (30) being provided to the lower end of the pile body (22, 24) or in the vicinity thereof or between the lower end of the lower (33) of the male or female connector element (2, 10) provided to the distance (X) from the lower end (35) of the pile body (22, 24) and the lower end (35) of the pile body (22, 24) for supplying injection material at least partly around the pile body (22, 24) and between the inner surface of the hole (26) and the outer surface (25) of the pile body (22, 24).

14. An injection bored pile according to item 13, characterized in that the transversal injection channel (30) extends substantially perpendicularly to the longitudinal direction of the pile body (22, 24).

15. An injection bored pile according to item 13 or 14, characterized in that the transversal injection channel (30) is in fluid communication with the injection channel (20, 23).

16. An injection bored pile according to any one of items 13 to 15, characterized in that the transversal injection channel (30) is pipe or tube surrounding at least part of the circumference of the pile body (22,

24).

17. An injection bored pile according to any one of items 13 to 16, characterized in that the transversal injection channel (30) comprises one or more second distribution openings (32) for supplying injection material between the inner surface of the hole (26) and the outer surface (25) of the pile body (22, 24).

18. An injection bored pile according to item 17, characterized in that the at least one of the second distribution openings (32) is provided on the upper surface of the transversal injection channel (30).

19. A tongue and groove connection for connecting two adjacent bored piles together, the connection comprising:

- a male connector element (2) having a tongue (6); and
- a female connector (10) having a groove (12) arranged to receive the tongue (6) of the male connector (12) for providing a connection between the male and female connector element (2, 10);
- the male and female connector element (2, 10) being formed as longitudinal profiles; and
- the tongue (6) has a first length and the groove (12) has a second length, characterized in that the tongue and groove connection further comprises a separate injection channel (20, 23) for injecting fluid material along the tongue and groove connection, the separate injection channel having a third length, the third length being greater than the first length of the tongue (6) and/or the second length of the groove (12).

20. A tongue and groove connection according to item 19, characterized in that the injection channel (20, 23) is a groove, pipe or tube.

21. A tongue and groove connection according to item 19 or 20, characterized in that the injection channel (23) is provided to the male connector element (2) and the third length of the injection channel (20, 23) is greater than first length of the tongue (6).

22. A tongue and groove connection according to any one of items 19 or 21, characterized in that the male connector element (2) comprises a tongue (6) and a male base (4), and that the male base (4) is formed as a bifurcated base (4) for forming the injection channel (23).

23. A tongue and groove connection according to item 19 or 22, characterized in that the injection channel (20) is provided to the female connector element (10) and the third length of the injection

channel (20, 23) is greater than second length of the groove (12).

24. A tongue and groove connection according to item 23, characterized in that the injection channel (20) and the groove (12) are separated from each other with a common partition wall (16).

25. A tongue and groove connection according to item 23 or 24, characterized in that the female connector element (10) comprises a groove (6) and a female base (18), and that the female base (18) is formed as a bifurcated base (18) for forming the injection channel (20).

26. A tongue and groove connection according to any one of items 19 to 25, characterized in that the injection channel (20, 23) fulfills at least one of the following:

- the cross sectional surface area of the injection channel (20, 23) is at least 0,7 times the cross sectional surface area of the groove (12);
- the first diameter (D_1) of the injection channel (20, 23) in the width direction of the groove (12) is at least 0,8 times the width (d_1) of the groove (12) or substantially corresponds the width (d_1) of the groove (12); and
- the second diameter (D_2) of the injection channel (20, 23) in the depth direction of the groove (12) is at least 0,8 times the depth (d_2) of the groove (12) or at least 15 mm.

27. A tongue and groove connection according to any one of items 19 to 26, characterized in that first length of the tongue (6) and the second length of the groove (12) are substantially identical or different.

28. Use of a transversal injection channel (30) provided to the lower end (35) of a longitudinal pile body (22, 24) or vicinity thereof for sealing the lower end (35) of an injection bored pile comprising a crown drill (40) provided to the lower end (35) of the longitudinal pile body (22, 24) and a female connector element (10) and/or a male connector element (2) extending substantially along the longitudinal direction of the pile body (22, 24) on the outer surface (25) of the pile body (22, 24) for providing a tongue and groove connection with an adjacent bored pile.

Claims

1. An injection bored pile arranged to be installed at least partly into a hole (26) in ground (50), the injection bored pile comprising:

a longitudinal pile body (24) having an upper end

and a lower end;

a crown drill (40) provided to the lower end (35) of the longitudinal pile body (22, 24); and a female connector element (10) and/or a male connector element (2) extending substantially along the longitudinal direction of the pile body (24) on the outer surface (25) of the pile body (24) for providing a tongue and groove connection with an adjacent injection bored pile having a pile body (22) being provided with a male connector element or female connector element extending substantially along the longitudinal direction of the pile body (22) of the adjacent injection bored pile, the female connector element (10) and/or the male connector element (2) is arranged to extend along the longitudinal direction of the pile body (24) from the upper end of the pile body (24) or from the vicinity thereof towards the lower end (35) of the pile body (24) to a distance (X) from the lower end (35) of the pile body (24), and the female connector element (10) and/or the male connector element (2) is provided with at least one separate injection channel (20, 23) for supplying injection material to the lower end (35) of the pile body (24) and vicinity thereof for sealing the space (37) between the hole (26) and the outer surface (25) of the pile body (24), wherein the separate injection channel (20, 23) means that the female groove (12) of the tongue and groove connection is not used as an injection channel, but the tongue and groove connection is arranged to form an injection channel which does not take part in providing the actual connection,

characterized in that

the injection bored pile is further provided with at least one transversal injection channel (30), the transversal injection channel (30) being provided to the lower end of the pile body (24) or in the vicinity thereof or between the lower end of the lower (33) of the male or female connector element (2, 10) provided to the distance (X) from the lower end (35) of the pile body (24) and the lower end (35) of the pile body (24) for supplying injection material at least partly around the pile body (24) and between the inner surface of the hole (26) and the outer surface (25) of the pile body (24), and

the transversal injection channel (30) is in fluid communication with the injection channel (20, 23) and is provided with a supply opening (34) for receiving sealing material from the injection channel (20, 23), and one or more distribution openings (32) for supplying injection material between the inner surface of the hole (26) and the outer surface (25) of the pile body (24).

2. An injection bored pile arranged to be installed at least partly into a hole (26) in ground (50), the injection bored pile comprising:

a longitudinal pile body (24) having an upper end and a lower end;

a crown drill (40) provided to the lower end (35) of the longitudinal pile body (22, 24); and a female connector element (10) and/or a male connector element (2) extending substantially along the longitudinal direction of the pile body (24) on the outer surface (25) of the pile body (24) for providing a tongue and groove connection with an adjacent injection bored pile having a pile body (22) being provided with a male connector element or female connector element extending substantially along the longitudinal direction of the pile body (22) of the adjacent injection bored pile,

the female connector element (10) and/or the male connector element (2) is arranged to extend along the longitudinal direction of the pile body (24) from the upper end of the pile body (24) or from the vicinity thereof towards the lower end (35) of the pile body (24) to a distance (X) from the lower end (35) of the pile body (24), and the female connector element (10) and/or the male connector element (2) is provided with at least one separate injection channel (20, 23) for supplying injection material to the lower end (35) of the pile body (24) and vicinity thereof for sealing the space (37) between the hole (26) and the outer surface (25) of the pile body (24), wherein the separate injection channel (20, 23) means that the female groove (12) of the tongue and groove connection is not used as an injection channel, but the tongue and groove connection is arranged to form an injection channel which does not take part in providing the actual connection,

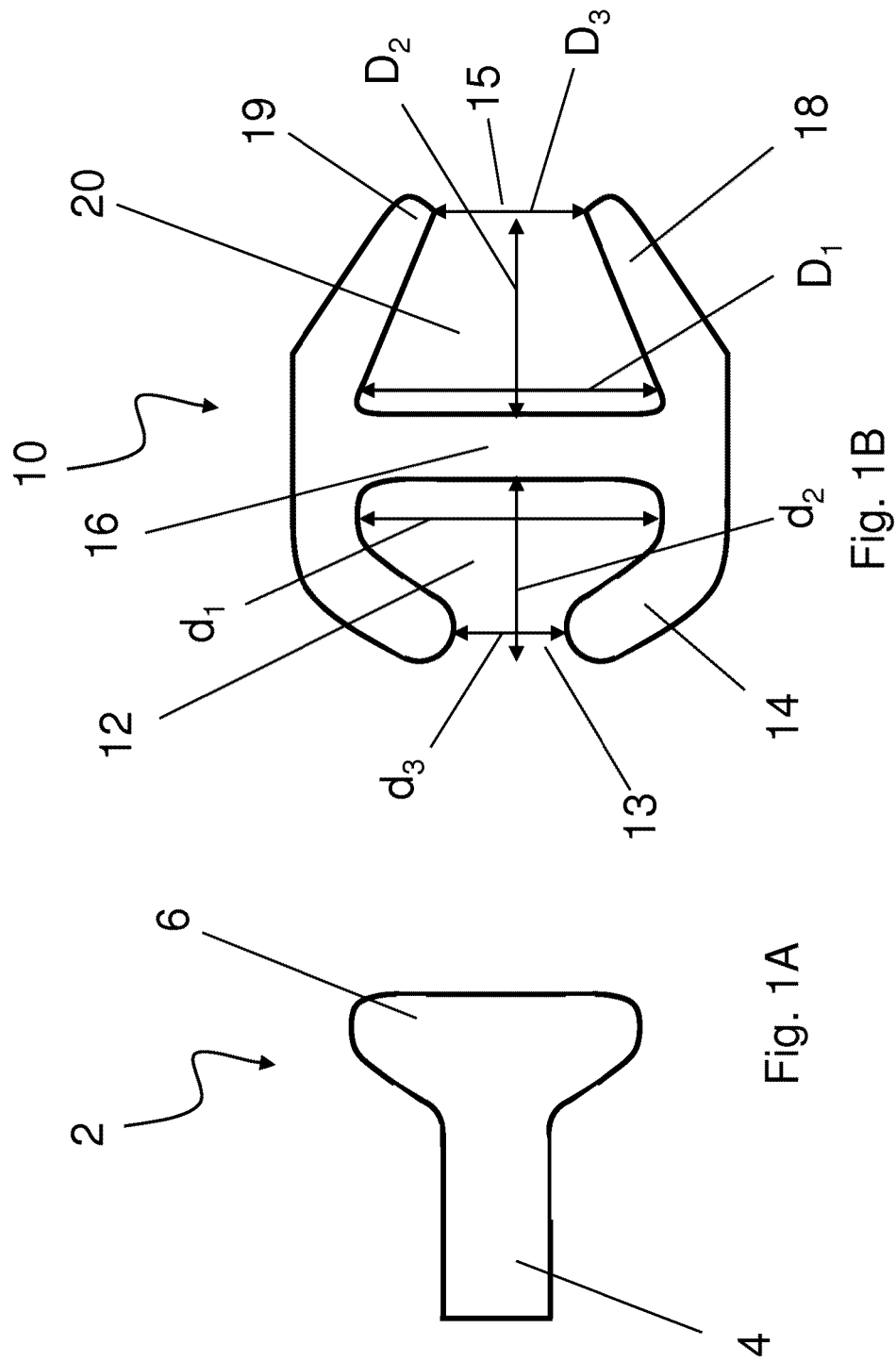
characterized in that

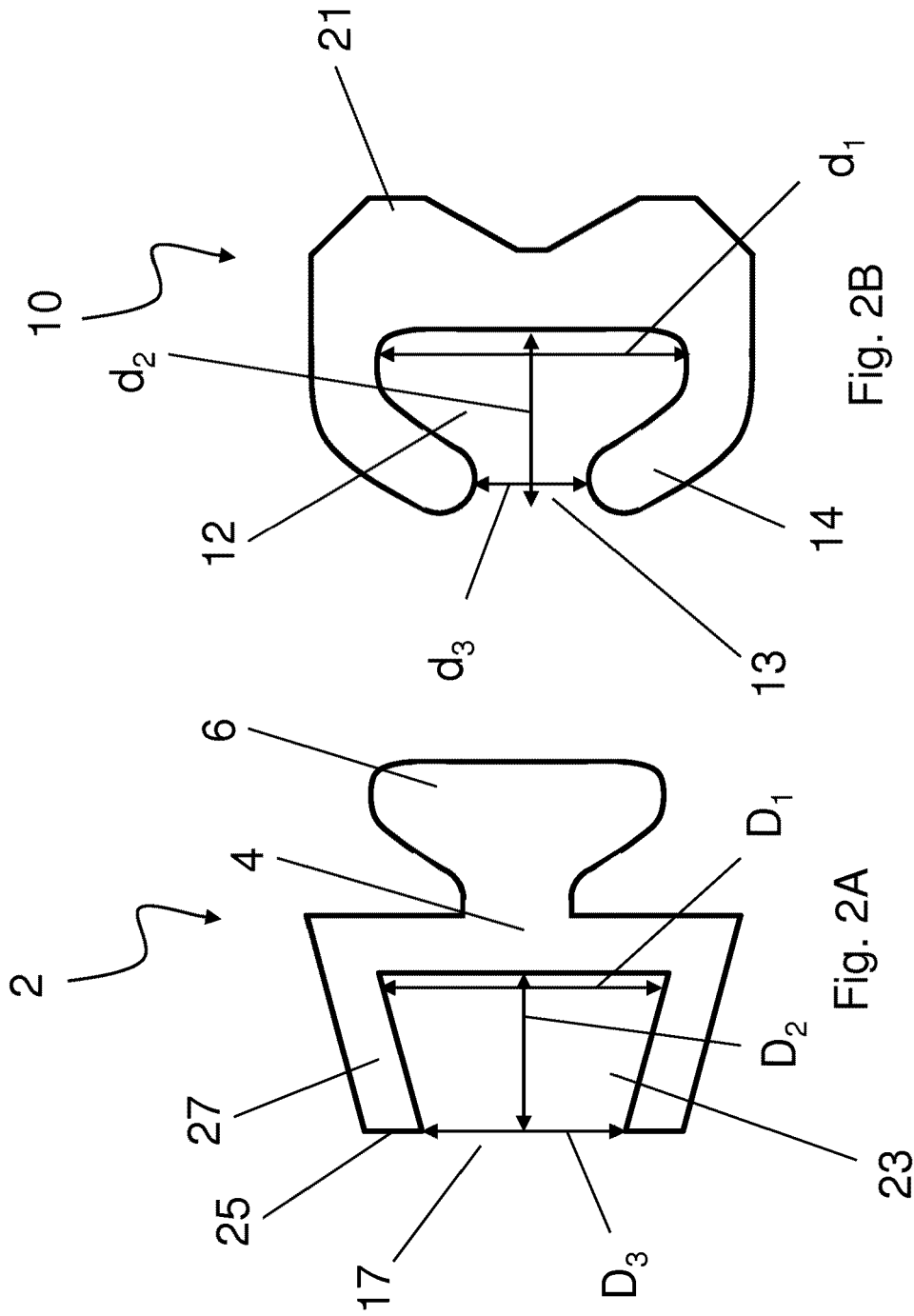
the lower end (31) the injection channel (20, 23) is closed, and

when the injection channel (20, 23) is provided in connection with the female connector element (12), the injection channel (20, 23) is provided with first distribution openings (28) between the lower end (33) of the female connector element (12) and the lower end (31) of the injection channel (20, 23) for supplying injection material to the lower end (35) of the pile body (24) and vicinity thereof between the inner surface of the hole (26) and the outer surface (25) of the pile body (24); or

when the injection channel (20, 23) is provided in connection with the male connector element (6), the injection channel (20, 23) is provided with first distribution openings (28) between the low-

- er end (33) of the male connector element (6) and the lower end (31) of the injection channel (20, 23) for supplying injection material to the lower end (35) of the pile body (24) and vicinity thereof between the inner surface of the hole (26) and the outer surface (25) of the pile body (24). 5
3. An injection bored pile according to claim 1 or 2, **characterized in that** the lower end (33) of the female connector element (10) and/or the male connector element (2) is arranged at a distance (X) from the lower end (35) pile body (24). 10
4. An injection bored pile according to any one of claims 1-3, **characterized in that** the injection channel (20, 23) extends substantially along the whole length of the pile body (20, 23), or that the injection channel (20, 23) extends from the upper end of the pile body (24) or from vicinity thereof to the lower end (35) of the pile body (24) or to the vicinity thereof. 15 20
5. An injection bored pile according to claim 4, **characterized in that:** 25
- the injection channel (20, 23) extends towards the lower end (35) of the pile body (24) to distance (X) from the lower end (35) of the pile body (24); or
- the lower end (31) of the injection channel (20, 23) is provided to the lower end (33) of the female connector element (10) and/or the male connector element (2) arranged at a distance (X) from the lower end (35) pile body (24); or
- the injection channel (20, 23) extends towards the lower end (35) of the pile body (24) between the lower end (35) of the pile body (24) or the crow drill (40) and the distance (X) from the lower end (35) of the pile body (24); or
- the lower end (31) of the injection channel (20, 23) is provided between the lower end (35) pile body (24) and the lower end (33) of the female connector element (10) and/or the male connector element (2) arranged at a distance (X) from the lower end (35) pile body (24). 30 35 40 45
6. An injection bored pile according to claim 4 or 5, **characterized in that:** 50
- the injection channel (20, 23) in provided in connection with the female connector element (10), the lower (33) of the female connector element (10) is provided to a distance (X) from the lower end (35) of the pile body (24) and the lower end (31) of the injection channel (20, 23) is provided to lower end (33) of the female connector element (10) or to the lower end (35) of the pile body (24) or between the lower end (35) 55
- of the pile body (24) and the lower end (33) of the female connector element (10); or
- the injection channel (20, 23) in provided in connection with the male connector element (2), the lower (33) of the male connector element (2) is provided to a distance (X) from the lower end (35) of the pile body (24) and the lower end (31) of the injection channel (20, 23) is provided to lower end (33) of the male connector element (2) or to the lower end (35) of the pile body (24) or between the lower end (35) of the pile body (24) and the lower end (33) of the male connector element (2). 60
7. An injection bored pile according to any one of claims 1 to 6, **characterized in that** the injection channel (20, 23) is provided on the outer surface (25) of the pile body (24) in connection with the female connector element (10) and/or the male connector element (2). 65
8. An injection bored pile according to any one of claims 1 to 7, **characterized in that** the injection channel (20, 23) is a pipe, tube or profile. 70
9. An injection bored pile according to any one of claims 6 to 8, **characterized in that** the female connector element (10) comprises a groove (12) for receiving a tongue (6) of the male connector element (2) of a corresponding adjacent bored pile, and that the injection channel (20, 23) is provided between the groove (12) and the outer surface (25) of the pile body (24). 75
10. An injection bored pile according to any one of claims 6 to 8, **characterized in that** the male connector element (2) comprises a tongue (6) to be arranged into a groove (12) of the female connector element (10) of a corresponding adjacent bored pile, and that the injection channel (20, 23) is provided between the tongue (6) and the outer surface (25) of the pile body (24). 80
11. An injection bored pile according to any one of claims 6 to 10, **characterized in that** the outer surface (25) of the pile body (24) forms part of the side walls of the injection channel (20, 23). 85
12. An injection bored pile according to any one of claims 3-11 when dependent upon claim 1, **characterized in that** the transversal injection channel (30) extends substantially perpendicularly to the longitudinal direction of the pile body (24). 90





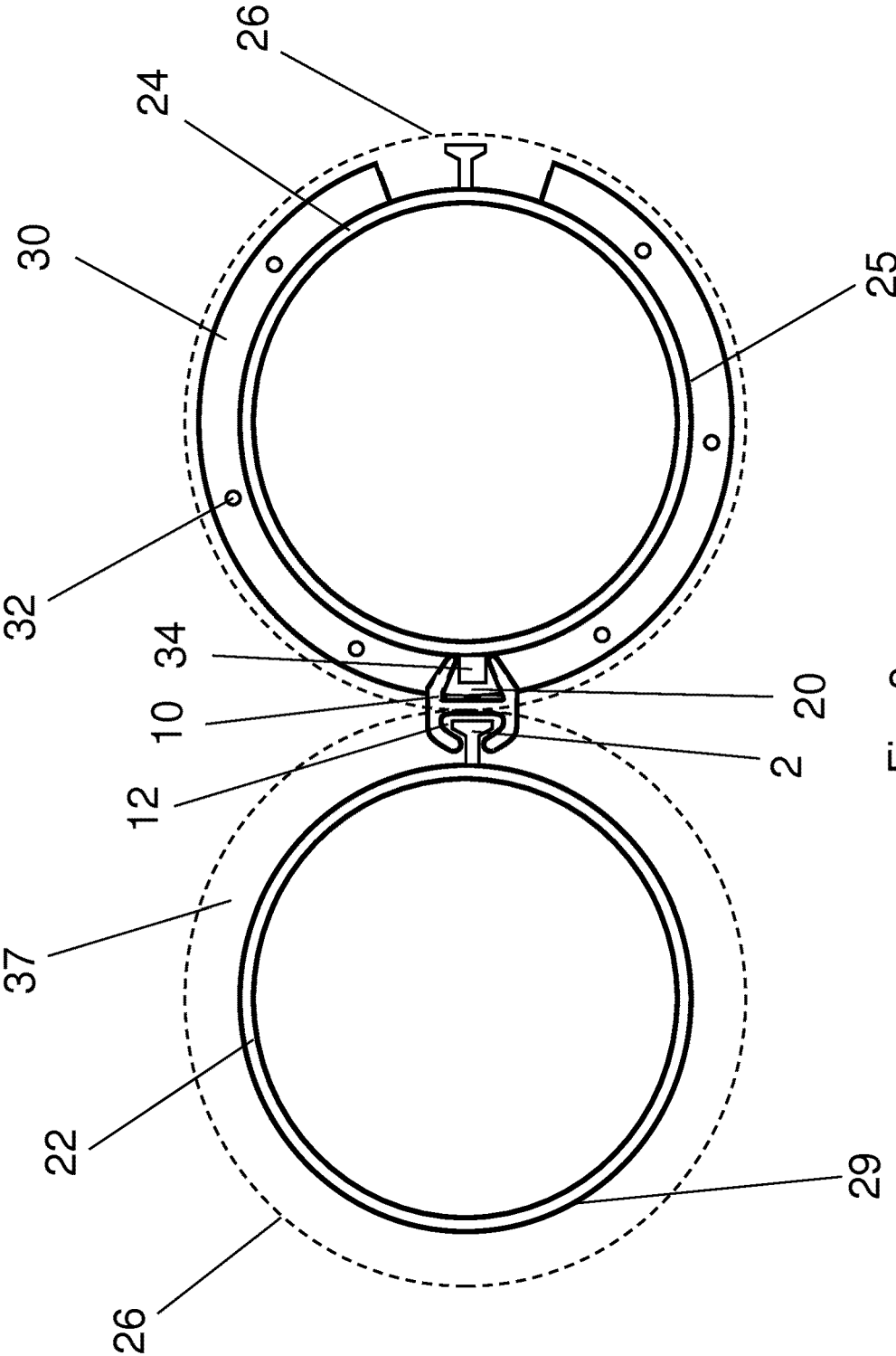


Fig. 3

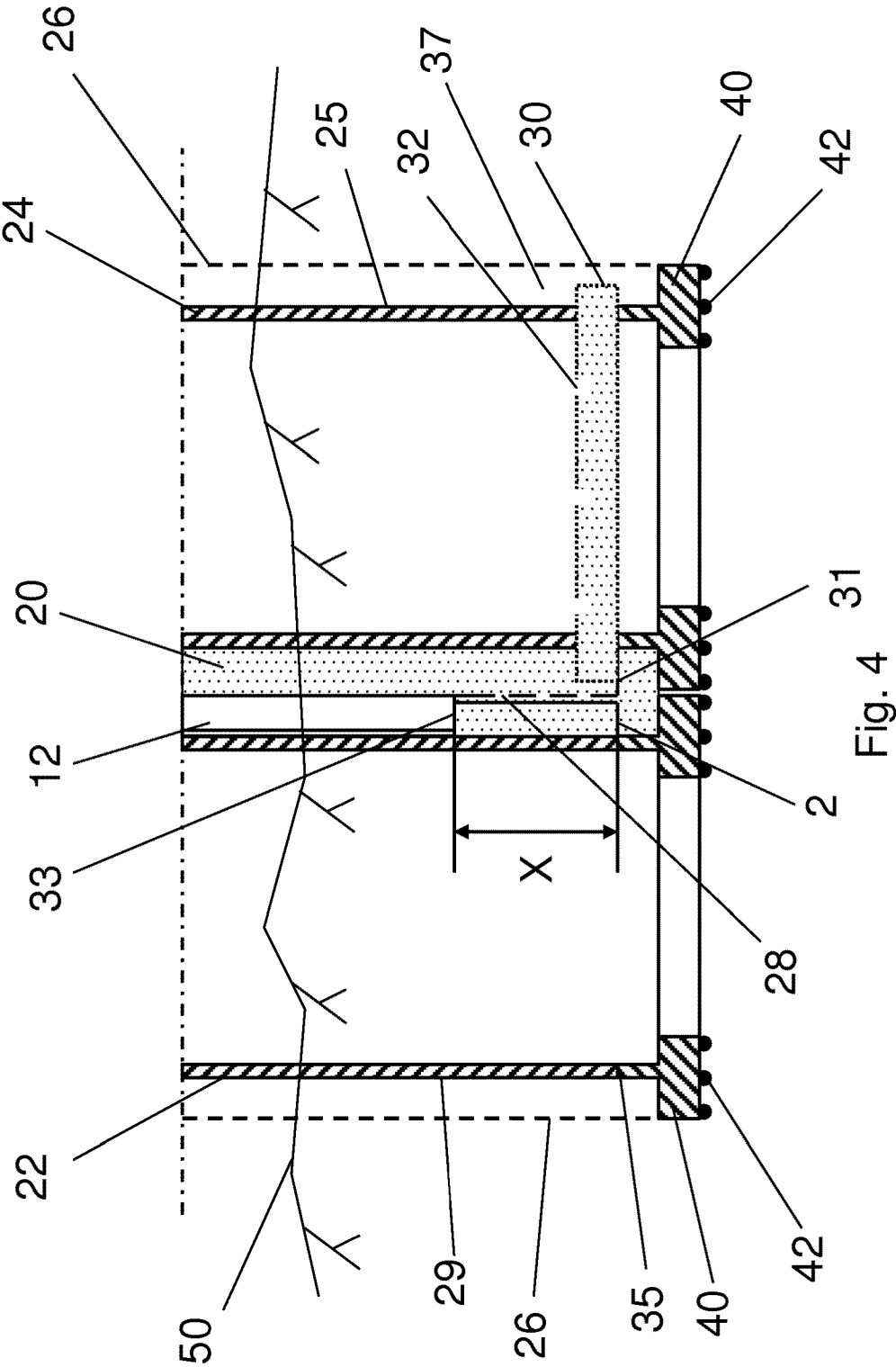


Fig. 4