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(54) **IMPROVED DRILLING DEVICE**

VERBESSERTE BOHRVORRICHTUNG

DISPOSITIF DE FORAGE AMÉLIORÉ

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Description

[0001] The present invention relates to a drilling device for in situ mixing of soil with a binder to form a pile in the ground comprising

- a drivable shaft with a bottom end,
- pre-mixing means mounted at the bottom end of the shaft for loosening the soil;
- injection means for injecting the binder into the loosened soil;
- a bore-crown mounted on the shaft above the bottom end, which bore-crown is provided on at least a part of its periphery with cutting means.

[0002] Such a drilling device is known and disclosed in the European patent application with application No. 05 077 778.8 in the name of the applicant, which discloses, in combination, all the features of claim 1. Those drilling devices are typically used in ground improvement and the construction of earth retaining walls, such as a sheet piling for a pit excavation. One of the most important aspects of such a drilling device relates to obtaining a good mixture of the soil with the binder.

[0003] Therefore the invention has for its object to provide a drilling device of the type stated in the preamble of claim 1 wherein the mixing of the soil with a binder is further improved, whilst maintaining the possibility to overcut adjacent piles without problems.

[0004] For this purpose the drilling device according to the invention is distinguished in that the pre-mixing means for loosening the soil comprise at least one arm having a first and a second end, said first end being connected to the bottom end, said second end lying at a distance of the bore-crown, the distance between the second end and the shaft being smaller than the radius of the bore-crown, wherein said at least one arm is provided with teeth.

[0005] The provision of pre-mixing means with arms at the bottom end of the shaft ensures a good pre-mixing of the soil with the binder. The bore-crown with teeth further allows adjacent piles to be overcut, while simultaneously forming a pile by in situ mixing. Of course, as is the case for the existing drilling devices, additional mixing means may be provided above the bottom end of the shaft, such as arms with teeth between the bore-crown and the shaft.

[0006] The length of the at least one arm, and/or the number of teeth on the at least one arm, and/or the shape of the arm, and/or the angle between the arm and the shaft, can be adapted in function of the type of soil to obtain an optimal pre-mixing. Preferably, the at least one arm extends upwardly and away from the bottom end. Preferably, the teeth of an arm point downwardly substantially in the same direction making a sharp angle with the axis of the shaft. The distance between the second end of the at least one arm and the shaft is preferably at least one fourth of the radius of the bore-crown, and more preferably at least one third of the radius of the bore-crown. According to a possible configuration the at least one arm extends substantially along a helical line around the shaft.

[0007] According to a preferred embodiment the shaft comprises a main part and a bottom part, wherein the at least one arm of the pre-mixing means is connected to the bottom part of the shaft, the bottom part being removably connected with the main part. Such an embodiment has the advantage that the bottom part can be removed and replaced with a different bottom part in function of the soil to be treated. Such a removable connection can for example be realised by providing the bottom part with screw thread, and the lower end of the main part with a correspondingly threaded bore, so that the bottom part can be screwed into the main part.

[0008] According to a further developed embodiment there is provided at least one spray opening of the binder for each arm of the pre-mixing means. This at least one spray opening for each arm is preferably provided in the bottom end of the shaft, substantially next to the arm. In that way the binder will be injected substantially at a location where the teeth of an arm of the pre-mixing means cut into the soil. This further contributes to the good pre-mixing of the soil.

[0009] According to a possible embodiment the pre-mixing means comprise at least two arms being positioned at regular intervals around the bottom end of the shaft. In that way a regular pre-mixing and a stable functioning of the drilling device is ensured.

[0010] According to a preferred embodiment the drilling device is provided with further mixing means comprising at least one arm extending substantially between the shaft and the bore-crown, said at least one arm being provided with teeth. The cutting points of the teeth are preferably positioned on a line through the axis of the shaft. In that way the soil which has been pre-mixed with the binder is further mixed, so that a continuous mixing is obtained, starting at the bottom end of the shaft and continuing until the periphery of the bore-crown. In that way the mixing of the soil with the binder will be very good in the complete volume of the pile.

[0011] The invention further relates to a multi-shaft drilling installation comprising at least two drilling devices as described above, wherein the two drilling devices are mounted such that partially overlapping piles can be formed.

[0012] Finally the invention relates to a bottom part for a drilling device, said bottom part being provided with pre-mixing means for loosening the soil comprising at least one arm having a first and a second end, said first end being connected to the bottom part, and said at least one arm being provided with teeth.

[0013] According to a further developed embodiment further spray nozzles may be provided in the shaft, and/or in the second arms of the mixing means, and/or in the bore-crown, and/or at the bottom end of the shaft. It is noted that these spray openings may be arranged for

placement therein of a nozzle with a suitable opening. For certain types of soil less or more spray openings may be necessary. It is then also possible to close a spray opening with a plug.

[0014] The invention will now be further elucidated on the basis of the following figure description of a number of examplery embodiments which have in no way a limiting character, and which are illustrated in the accompanying figures, in which:

figure 1 is a perspective view of a first embodiment of a drilling device according to the invention;
figures 2A-2D show perspective views of four different types of pre-mixing means which can be used in the embodiment of figure 1;
figure 3 is a schematic bottom view of the embodiment of figure 1;
figure 4 is a schematic front view of an embodiment of a two-shaft drilling installation according to the invention.

[0015] Figure 1 shows an embodiment of a drilling device for in situ mixing of a soil with a binder for the purpose of forming a pile in the ground. The drilling device comprises a drivable shaft 1 with a bottom end 2. The bottom end 2 is realised by a bottom part which is removably connectable to the main part of the shaft 1. The pre-mixing means are mounted on the bottom part and will be described in detail below. The drilling device further comprises a bore-crown 4 mounted on the shaft by means of a bracket 7. The periphery of the bore-crown is provided with cutting means in the form of teeth 6. The teeth 6 are inclined with respect to the axis of the shaft and point outward of the bore-crown 4. The teeth 6 are suitable for overcutting a pile adjacent to the pile for forming. The cutting teeth can take different forms and could for instance also take the form of a number of cutting blocks orientated substantially axially downward. The bracket 7 ensures the strengthening of the drilling device and also contributes to the mixing of the binder with the soil above the bore-crown 4.

[0016] Between the bore-crown 4 and the shaft mixing means are provided in the form of two arms 5 between the shaft 1 and the bore-crown 4. The arms 5 are provided with teeth 3 and spray openings 13 for the binder. In figure 3 it can be seen that the arms 5 and the teeth 3 are arranged in such a way that the cutting point of the teeth 3 is positioned on a line through the axis of the shaft 1. To this end the arms 5 are shifted over a small amount with respect to the centre of the shaft 1, as is visible in figure 3.

[0017] Now the pre-mixing means will be described. The pre-mixing means which are provided on the bottom part 2 comprise in the embodiment of figure 1 two pairs of two arms 20, 21. The bottom end of the bottom part 2 is realised as a cutting point 22. Each arm 20 is provided with four teeth 23, and each arm 21 is provided with three teeth 24. For each arm 20, 21 there is provided a spray opening 25 next to the end of the arm which is connected to the shaft. At one end the bottom part 2 is removably connected with the main part of the shaft 1.

[0018] Figure 2 shows a number of different types of bottom parts which can be used with the embodiment of figure 2. The type shown in figure 2A has three arms 3 with each three teeth 33. The lower end of the bottom part is provided with a cutting point 32 and the upper end is provided with screw thread 36 for mounting in the main part of the shaft 1. Figure 2B shows an embodiment with three arms 41, one tooth 43 for each arm 41, and one spray opening 45 for each arm 41. Figure 2C shows an embodiment with two pairs of two arms 50, 51 with respectively three and two teeth per arm 53, 54. Finally, figure 2D shows a type of pre-mixing means with two pairs of two arms 60, 61 with two teeth 63, 64 for each arm. One or more spray openings may be provided per arm. In function of the soil different types of nozzles may be mounted in the spray openings. Also it is possible to close certain openings using plugs.

[0019] Figure 4 illustrates an embodiment of a two-shaft drilling installation according to the invention. This installation comprises a first drilling device A and a second drilling device B. The first drilling device A mainly corresponds with the embodiment of figure 1 and further indicates that spray openings may be provided in the bore-crown to inject a binder in the upward axial direction. Further spray openings 16 may be provided in the shaft 1. The second drilling device B differs from the first drilling device A in that its bracket 7', as seen in axial direction, is shorter than bracket 7 of the first drilling device. In this manner brackets 7 and 7' do not touch each other during the rotation of the shafts 1, 1'. These two drilling devices are mounted such that two partially overlapping piles can be formed in one movement. The second drilling device B is further provided with mixing arms 10a-10c above bracket 7', which arms partly fulfill the function of the larger bracket 7 of the first drilling device A. The pre-mixing means provided on the bottom part 2, 2' ensure a good pre-mixing of the binder with the soil, and the second arms 5, 5' guarantee a further mixing, so that a continuous mixing area is created below the bore-crown giving excellent mixing qualities in the complete volume of the pile.

[0020] The skilled person will understand that many modifications and variations of the above described embodiments are possible within the scope of the claims. For instance, depending on the desired applications and the available driving means, one-, two-, three- and multi-shaft installations can be provided. The scope of protection is not limited by the above examplary embodiments, and is determined by the following claims.

Claims

1. Drilling device for in situ mixing of soil with a binder to form a pile in the ground, comprising

- a drivable shaft (1) with a bottom end,
- pre-mixing means mounted at the bottom end of the shaft for loosening the soil,
- injection means (13) for injecting the binder into the loosened soil,
- a bore-crown (4) mounted on the shaft above the bottom end, which bore-crown is provided on at least a part of its periphery with cutting means (6), **characterized in that** the pre-mixing means for loosening the soil comprise at least one arm (20, 21), (31), (41), (50, 51), (60,61) having a first and a second end, said first end being connected at one end to the bottom end, said second end lying at a distance of the bore-crown, the distance between the second end and the shaft being smaller than the radius of the bore-crown, wherein said at least one arm is provided with teeth (23, 24), (33), (43), (53) , (63) .

2. Drilling device as claimed in claim 1, **characterized in that** the at least one arm extends upwardly and away from the bottom end.

3. Drilling device as claimed in any of the previous claims, **characterized in that** the teeth of an arm of the at least one arm point in substantially the same direction making a sharp angle with the axis of the shaft.

4. Drilling device as claimed in any of the previous claims, **characterized in that** for each arm there is provided at least one spray opening (25) , (35) , (45) , (55) , (65) of the binder.

5. Drilling device as claimed in claim 4, **characterized in that** the at least one spray opening for each arm is provided in the bottom end of the shaft, substantially next to the first end of said arm.

6. Drilling device as claimed in any of the previous claims, **characterized in that** the at least one arm extends substantially along a helical line around the shaft.

7. Drilling device as claimed in any of the previous claims, **characterized in that** the teeth provided on each of the at one least arm have cutting points which are positioned substantially on a line extending through the centre of the shaft.

8. Drilling device as claimed in any of the previous claims, **characterized in that** the pre-mixing means comprise at least two arms being positioned at regular intervals around the bottom end of the shaft.

9. Drilling device as claimed in any of the previous claims, **characterized in that** further mixing means are provided comprising at least one second arm (5) extending substantially between the shaft and the bore-crown, said at least one second arm being provided with teeth (3).

10. Drilling device as claimed in claim 9, **characterized in that** the cutting points of the teeth of the at least one second arm are positioned on a line through the axis of the shaft.

11. Drilling device as claimed in any of the previous claims, **characterized in that** the at least one arm (20, 21) , (31), (41), (50, 51), (60, 61) is connected to the bottom part of the shaft, which bottom part is removably connected with the main part.

12. Drilling device as claimed in claim 11, **characterized in that** the bottom part is provided with screw thread (36) , (46), (56), (66) and that the main part is provided at its lower end with a correspondingly threaded bore.

13. Drilling system for in situ mixing of soil with a binder to form a pile in the ground, suitable for different types of soil, comprising a drilling device according to claim 11 or 12, **characterized in that** the system comprises
a first bottom part with at least one arm provided with teeth; a second bottom part with at least one arm provided with teeth; said first and second bottom parts being alternatively connectable to the shaft;
wherein the at least one arm and teeth of the first bottom part are dimensioned and orientated for a first type of soil, and the at least one arm and teeth of the second bottom part are dimensioned and orientated for a second type of soil,
so that depending on the type of soil either the first or second part can be, connected to the shaft.

14. Multi-shaft drilling installation, comprising at least two drilling devices as claimed in any of the claims 1-12, wherein the two drilling devices are mounted such that partially overlapping piles can be formed.

15. Use of a bottom part in a drilling device as claimed in any of the claims 11-12, said bottom part being provided with pre-mixing means for loosening the soil, comprising at least one arm (20, 21), (31), (41), (50, 51), (60, 61) having a first and a second end, said first end being connected to the bottom part; wherein said at least one arm is provided with teeth (23, 24), (33), (43), (53), (63).

Patentansprüche

1. Bohrvorrichtung zum In-Situ-Mischen von Erdreich mit einem Bindemittel, um einen Pfeiler im Boden

auszubilden, aufweisend:

- einen antreibbaren Schaft (1) mit einem unteren Ende,
- Vormischer-Mittel, die an dem unteren Ende des Schaftes montiert sind, um das Erdreich zu lockern,
- Einspritzmittel (13), zum Einspritzen des Bindemittels in das gelockerte Erdreich,
- eine Bohrkrone (4), die an dem Schaft über dem unteren Ende montiert ist, wobei die Bohrkrone an mindestens einem Teil ihres Umfangs mit Schneidmitteln (6) versehen ist, **dadurch gekennzeichnet, dass** die Vormischer-Mittel zum Lockern des Erdreichs mindestens einen Arm (20, 21), (31), (41), (50, 51), (60, 61) aufweisen, der ein erstes und ein zweites Ende aufweist, wobei das erste Ende an einem Ende mit dem unteren Ende verbunden ist und das zweite Ende in einem Abstand von der Bohrkrone angeordnet ist, wobei der Abstand zwischen dem zweiten Ende und dem Schaft kleiner als der Radius der Bohrkrone ist, wobei

der mindestens eine Arm mit Zähnen (23, 24), (33), (43), (53), (63) versehen ist.

2. Bohrvorrichtung gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der mindestens eine Arm sich nach oben und von dem unteren Ende weg erstreckt.

3. Bohrvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Zähne eines Arms des mindestens einen Arms im Wesentlichen in dieselbe Richtung zeigen, wobei sie mit der Achse des Schafts einen spitzen Winkel ausbilden.

4. Bohrvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** für jeden Arm mindestens eine Sprühöffnung (25), (35), (45), (55), (65) für das Bindemittel vorgesehen ist.

5. Bohrvorrichtung gemäß Anspruch 4, **dadurch gekennzeichnet, dass** die mindestens eine Sprühöffnung für jeden Arm in dem unteren Ende des Schaftes im Wesentlichen neben dem ersten Ende des Arms vorgesehen ist.

6. Bohrvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sich der mindestens eine Arm im Wesentlichen entlang einer Schraubenlinie um den Schaft herum erstreckt.

7. Bohrvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Zähne, die an jedem von dem mindestens einen Arm vorgesehen sind, Schneidspitzen aufweisen, die im Wesentlichen auf einer Linie angeordnet sind, die sich durch die Mitte des Schaftes erstreckt.

8. Bohrvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Vormischer-Mittel mindestens zwei Arme aufweisen, die in regelmäßigen Abständen um das unteren Ende des Schaftes herum positioniert sind.

9. Bohrvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** weitere Mischermittel vorgesehen sind, die mindestens einen zweiten Arm (5) aufweisen, der sich im Wesentlichen zwischen dem Schaft und der Bohrkrone erstreckt, wobei der mindestens eine zweite Arm mit Zähnen (3) versehen ist.

10. Bohrvorrichtung gemäß Anspruch 9, **dadurch gekennzeichnet, dass** die Schneidspitzen der Zähne des mindestens einen zweiten Arms auf einer Linie durch die Achse des Schaftes hindurch angeordnet sind.

11. Bohrvorrichtung gemäß irgendeinem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der mindestens eine Arm (20, 21), (31), (41), (50, 51), (60, 61) mit dem unteren Teil des Schaftes verbunden ist, wobei der untere Teil lösbar mit dem Hauptteil verbunden ist.

12. Bohrvorrichtung gemäß Anspruch 11, **dadurch gekennzeichnet, dass** der untere Teil mit einem Schraubengewinde (36), (46), (56), (66) versehen ist, und dass der Hauptteil an seinem unteren Ende mit einer korrespondierenden Gewindebohrung versehen ist.

13. Bohrsystem zum In-Situ-Mischen von Erdreich mit einem Bindemittel, um einen Pfeiler im Boden auszubilden, das für verschiedene Arten von Erdreich geeignet ist, aufweisend eine Bohrvorrichtung gemäß Anspruch 11 oder 12, **dadurch gekennzeichnet, dass** das System aufweist:

einen ersten unteren Teil mit mindestens einem mit Zähnen versehenen Arm,
einen zweiten unteren Teil mit mindestens einem mit Zähnen versehenen Arm,
wobei der erste und der zweite untere Teil wahlweise mit dem Schaft verbindbar sind,
wobei der mindestens eine Arm und die Zähne des ersten unteren Teils für eine erste Art von Erdreich bemessen und ausgerichtet sind und der mindestens eine Arm und die Zähne des zweiten unteren Teils für eine zweite Art von Erdreich bemessen und ausgerichtet sind,

so dass, abhängig von der Art des Erdreichs, entweder der erste oder der zweite Teil mit dem Schaft verbunden werden kann.

14. Mehrschaft-Bohranlage, aufweisend mindestens zwei Bohrvorrichtungen gemäß irgendeinem der Ansprüche 1 bis 12, wobei die beiden Bohrvorrichtungen derart montiert sind, dass teilweise überlappende Pfeiler ausgebildet werden können.

15. Verwendung eines unteren Teils in einer Bohrvorrichtung gemäß irgendeinem der Ansprüche 11 bis 12, wobei der untere Teil mit Vormischer-Mitteln zum Lokkern des Erdreichs versehen ist, aufweisend mindestens einen Arm (20, 21), (31), (41), (50, 51), (60, 61), der ein erstes und ein zweites Ende aufweist, wobei das erste Ende mit dem unteren Teil verbunden ist, wobei der mindestens eine Arm mit Zähnen (23, 24), (33), (43), (53), (63) versehen ist.

Revendications

1. Dispositif de forage pour mélanger in situ de la terre avec un liant afin de former un pilier dans le sol, comprenant :

un arbre pouvant être dirigé (1) avec une extrémité inférieure,
des moyens de pré-mélange montés au niveau de l'extrémité inférieure de l'arbre pour ameublir la terre,
des moyens d'injection (13) pour injecter le liant dans la terre ameublie,
une couronne de sondage (4) montée sur l'arbre au-dessus de l'extrémité inférieure, laquelle couronne de sondage est prévue sur au moins une partie de sa périphérie, avec des moyens de coupe (6), **caractérisé en ce que** les moyens de pré-mélange pour ameublir la terre comprennent au moins un bras (20, 21), (31), (41), (50, 51), (60, 61) ayant des première et deuxième extrémités, ladite première extrémité étant raccordée au niveau d'une extrémité à l'extrémité inférieure, ladite deuxième extrémité se trouvant à une certaine distance de la couronne de sondage, la distance entre la deuxième extrémité et l'arbre étant inférieure au rayon de la couronne de sondage, dans lequel :

ledit au moins un bras est prévu avec des dents (23, 24), (33), (43), (53), (63).

2. Dispositif de forage selon la revendication 1, **caractérisé en ce que** le au moins un bras s'étend vers le haut et à distance de l'extrémité inférieure.

3. Dispositif de forage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les dents d'un bras du au moins un bras pointent sensiblement dans la même direction en réalisant un angle aigu avec l'axe de l'arbre.

4. Dispositif de forage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** pour chaque bras, on prévoit au moins une ouverture de pulvérisation (25), (35), (45), (55), (65) du liant.

5. Dispositif de forage selon la revendication 4, **caractérisé en ce que** la au moins une ouverture de pulvérisation pour chaque bras est prévue dans l'extrémité inférieure de l'arbre, sensiblement à proximité de la première extrémité dudit bras.

6. Dispositif de forage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le au moins un bras s'étend sensiblement le long d'une ligne hélicoïdale le long de l'arbre.

7. Dispositif de forage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les dents prévues sur chacun du au moins un bras ont des pointes de coupe qui sont positionnées sensiblement sur une ligne s'étendant par le centre de l'arbre.

8. Dispositif de forage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les moyens de pré-mélange comprennent au moins deux bras qui sont positionnés à intervalles réguliers autour de l'extrémité inférieure de l'arbre.

9. Dispositif de forage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'on prévoit d'autres moyens de mélange comprenant au moins un deuxième bras (5) s'étendant sensiblement entre l'arbre et la couronne de sondage, ledit au moins un deuxième arbre étant prévu avec des dents (3).

10. Dispositif de forage selon la revendication 9, **caractérisé en ce que** les pointes de coupe des dents du au moins un deuxième bras sont positionnées sur une ligne passant par l'axe de l'arbre.

11. Dispositif de forage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le au moins un bras (20, 21), (31), (41), (50, 51), (60, 61) est raccordé à la partie inférieure de l'arbre, laquelle partie inférieure est raccordée de manière amovible avec la partie principale.

12. Dispositif de forage selon la revendication 11, **caractérisé en ce que** la partie inférieure est prévue avec un filetage de vis (36), (46), (56), (66) et **en ce que** la partie principale est prévue au niveau de son

extrémité inférieure, avec un alésage fileté de manière correspondante.

13. Système de forage pour mélanger in situ de la terre avec un liant afin de former un pilier dans le sol, approprié pour différents types de terre, comprenant un dispositif de forage selon la revendication 11 ou 12, **caractérisé en ce que** le système comprend :

une première partie inférieure avec au moins un bras prévu avec des dents ;
une deuxième partie inférieure avec au moins un bras prévu avec des dents ;
lesdites première et deuxième parties inférieures pouvant être raccordées de manière alternée à l'arbre ;
dans lequel le au moins un bras et les dents de la première partie inférieure sont dimensionnés et orientés pour un premier type de terre, et au moins un bras et les dents de la deuxième partie inférieure sont dimensionnés et orientés pour un deuxième type de terre, de sorte qu'en fonction du type de terre, la première ou la deuxième partie peut être raccordée à l'arbre.

14. Installation de forage à plusieurs arbres, comprenant au moins deux dispositifs de forage selon l'une quelconque des revendications 1 à 12, dans laquelle les deux dispositifs de forage sont montés de sorte que des piles se chevauchant partiellement peuvent être formées.

15. Utilisation d'une partie inférieure dans un dispositif de forage selon l'une quelconque des revendications 11 à 12, ladite partie inférieure étant prévue avec des moyens de pré-mélange pour détacher la terre, comprenant au moins un bras (20, 21), (31), (41), (50, 51), (60, 61) ayant une première et une deuxième extrémité, ladite première extrémité étant raccordée à la partie inférieure, dans laquelle ledit au moins un bras est prévu avec des dents (23, 24), (33), (43), (53), (63).

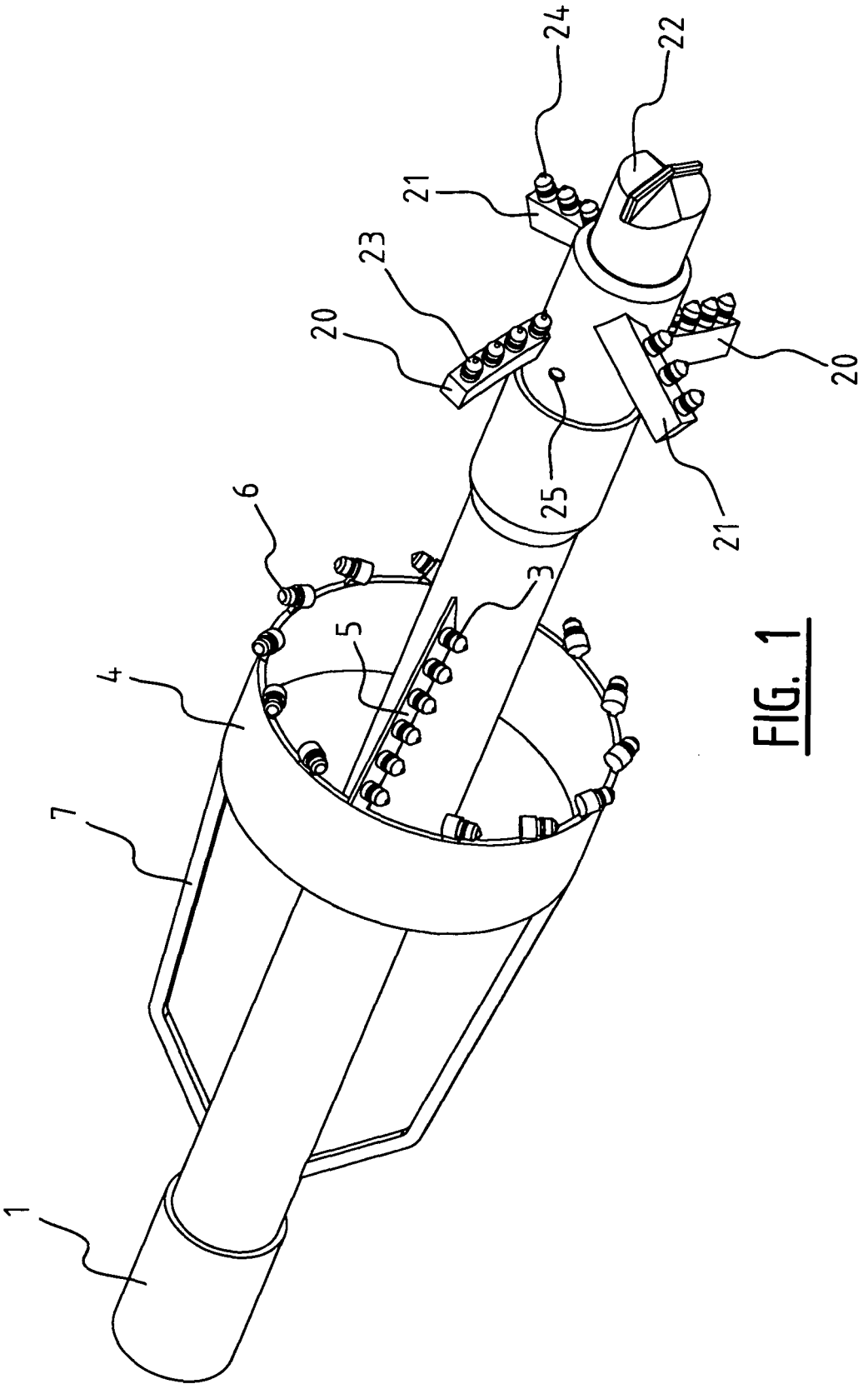


FIG. 1

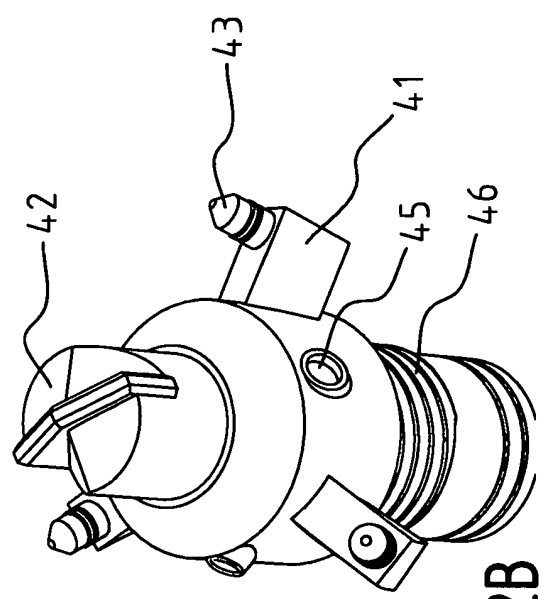


FIG. 2B

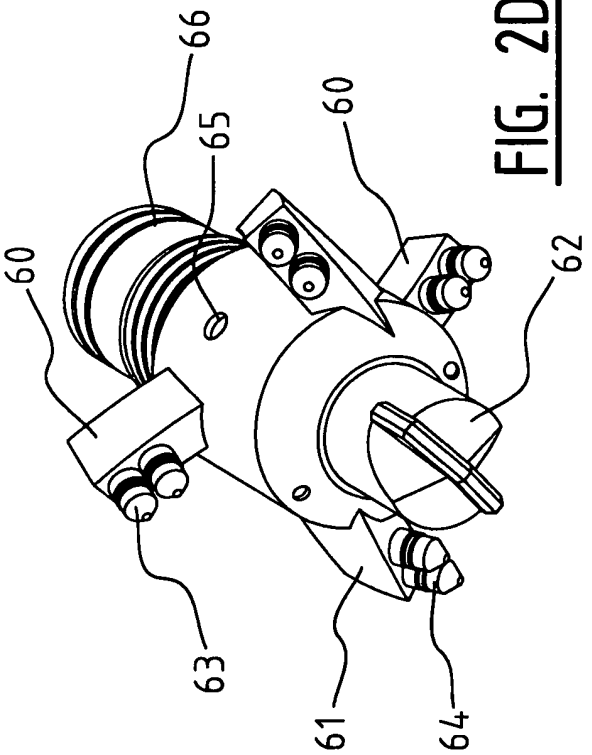


FIG. 2D

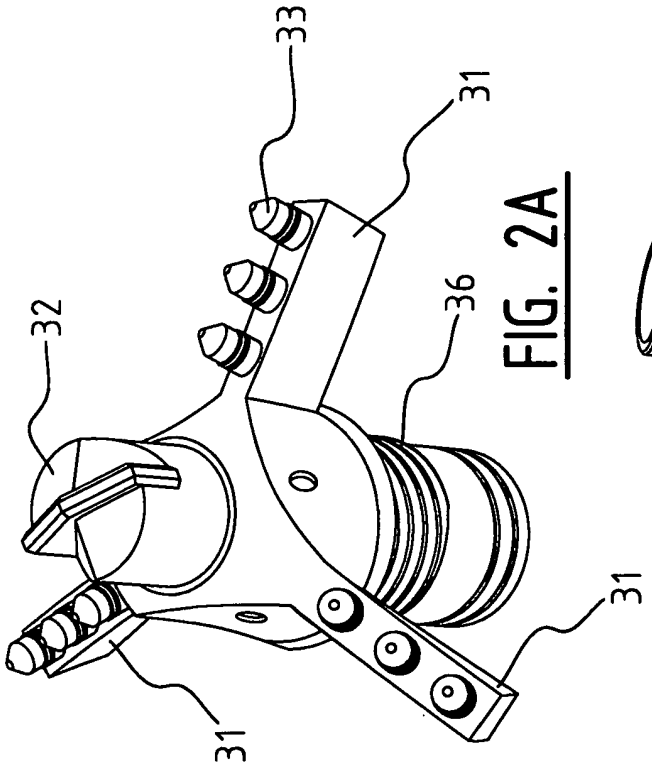


FIG. 2A

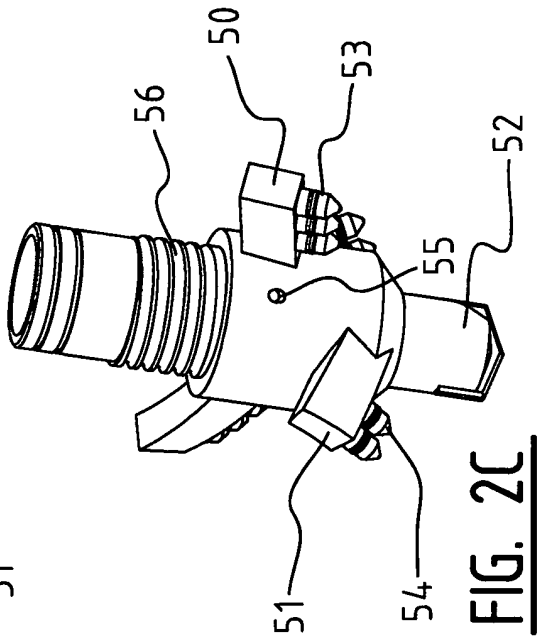


FIG. 2C

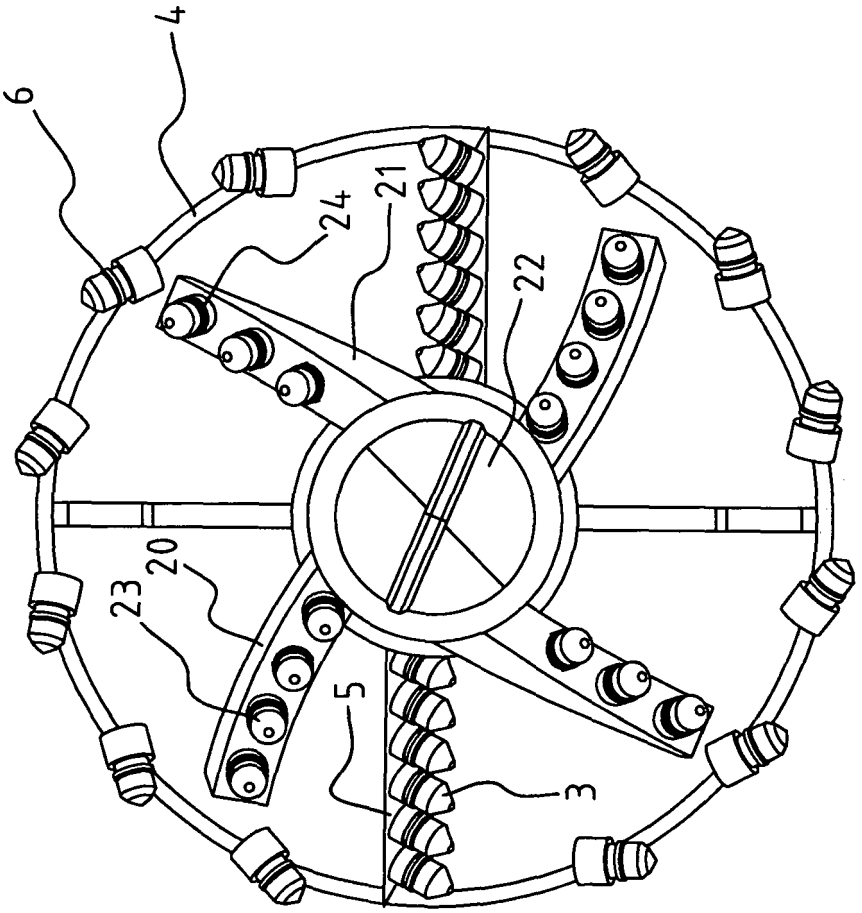


FIG. 3

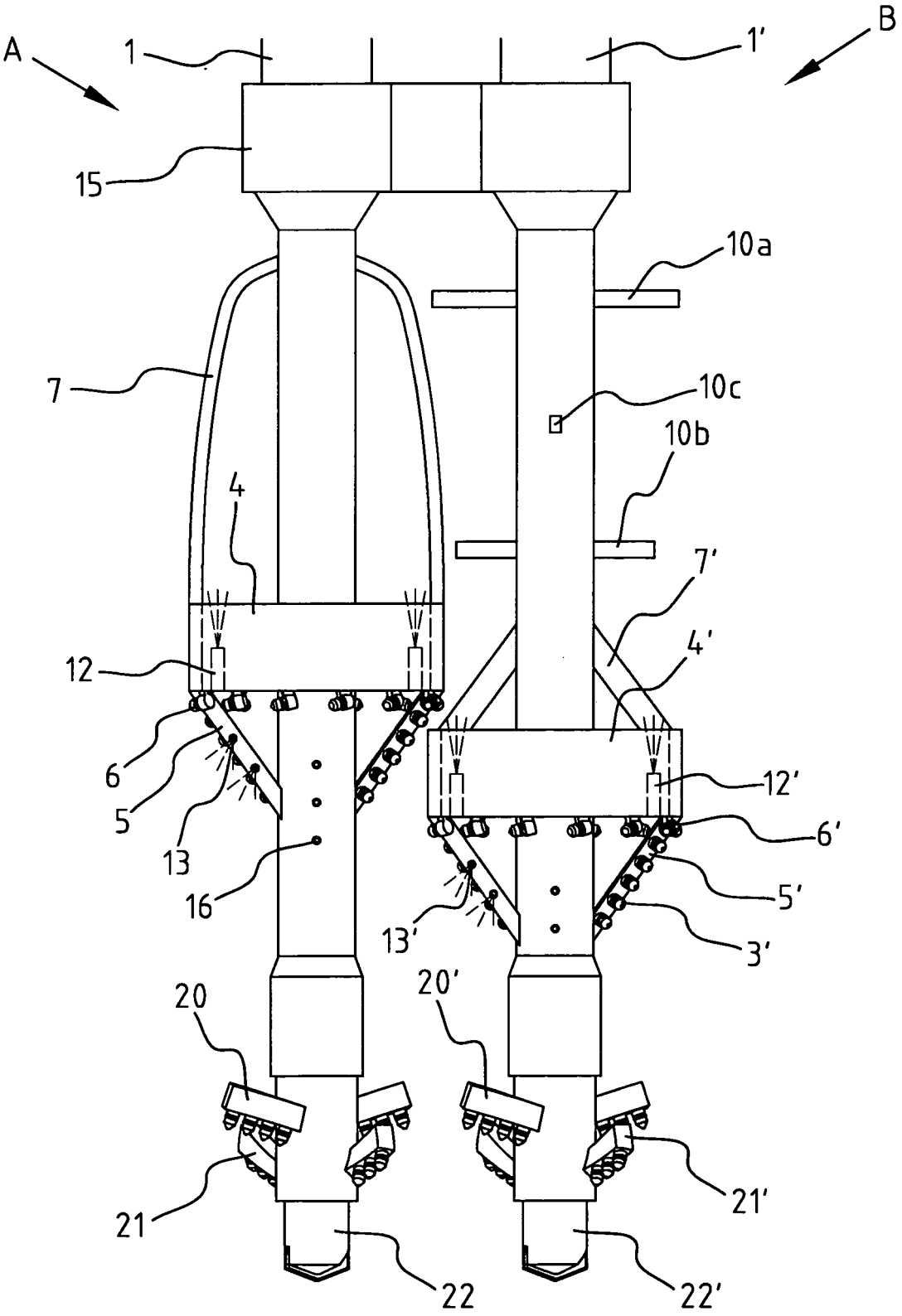


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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