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(54) Pile and apparatus for driving thereof into the ground

(57) The present invention relates to a pile, such as a foundation pile, comprising a shaft (2) having on one end a cutting tip (3), wherein the cutting tip has a displacing surface (4) which extends increasing in radius helically and in spiral manner from an end point up to the shaft and wherein the pile has an engaging surface (6) for exerting a torque thereon round its longitudinal axis.

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Description

[0001] The present invention relates to a pile, such as a foundation pile, which is intended for driving over at least a part of its length into the ground.

[0002] There are a number of ways of driving such piles into the ground. In those cases where the noise and the vibrations of pile-driving are not permissible, for instance because of buildings in the vicinity, screw piles are used. These are as it were screwed into the ground.

[0003] The invention relates to a pile of this type.

[0004] Known screw piles are provided along at least a part of their length with screw thread. When the ground is such that such a pile can be driven into the ground at a speed such that no longitudinal slippage occurs and a real screw action thus occurs, the pile driven into the ground can acquire a very high load-bearing capacity. The ground herein lies closely round the whole outer surface of the pile with increased pressure caused by the displacement.

[0005] When the ground does not permit of such a screw action, for instance because it is too heavy, longitudinal slippage of the screw thread occurs relative to the ground, whereby the screw thread begins to act no longer as screw thread but as auger. The displaced ground is transported by this auger upward to the surface. The load-bearing capacity of a thus inserted pile is herein based solely on the load-bearing capacity of the ground layer in which the tip of the pile is situated. The pile derives no load-bearing capacity from shaft friction.

[0006] The invention now has for its object to provide a pile of the type described in the preamble which has a load-bearing capacity at least partly based on shaft friction irrespectively of whether during insertion a screw action can be effected or not.

[0007] This object is achieved with the pile according to the invention as characterized in claim 1. During insertion of the pile the displacing surface displaces and compacts the ground substantially in lateral direction, irrespective of the feed, so that the downward movement is not obstructed by compaction of the ground in that direction, and in the driven situation the ground lies with a certain pressure against the wall of the shaft.

[0008] The insertion of a foundation pile according to the invention takes place with a relatively high efficiency when the measure of claim 2 is applied. During driving the ground is quickly displaced laterally and the friction against rotation on the cutting tip is relatively low.

[0009] Applying the measure of claim 3 ensures that a practically purely radial displacement and compaction occur. A maximum efficiency of the displacement action is herein achieved when the measure of claim 4 is applied.

[0010] The displacement movement exerted on the ground is favourably uniform when the measure according to claim 5 is applied.

[0011] In order to overcome the friction or shaft friction exerted on the shaft by the surrounding ground, a torque is exerted on the pile, particularly on the engaging surface thereof. So as to prevent an inadmissibly high torsion hereby occurring in the shaft, the measure of claim 6 is preferably applied. By engaging on the wall of the central cavity in the pile, the drive power required to overcome the friction can be exerted at any level.

[0012] When in advantageous manner the measure of claim 8 is applied, a simple production method can be obtained. The shaft can be manufactured as a straightforward concrete tube, while the cutting tip with a more complicated form can be moulded separately.

[0013] According to a further development the measure of claim 9 is applied. When the load-bearing capacity of the foundation pile will be provided mainly by the underlying ground and not by shaft friction, the cutting tip can be embodied with a desired large diameter to provide the necessary load-bearing capacity. The shaft itself can then be embodied with a smaller diameter, so that the manufacturing costs of the foundation pile as a whole remains limited.

[0014] The invention likewise relates to an apparatus for driving a pile as specified above into the ground. This is characterized in claim 10.

[0015] In order to expedite penetration of the pile, the apparatus preferably further comprises the measure of claim 11.

[0016] For a good driving of the pile along at least the part over the outer periphery of which the ground pressure causes friction, the measure of claim 12 is preferably applied. The expandable elements engage on the inner surface of the cavity.

[0017] A very suitable further development is characterized in claim 13. By feeding the expandable elements individually with fluid under pressure and thus bringing them into individual driving contact with the wall of the cavity, the forces occurring in the shaft, in particular the torsional forces, can be precisely controlled. If for instance torsion of the core itself were to occur to some extent at the torque required for driving-in, the hose-like elements can be brought successively from the bottom into engagement with the wall of the cavity, so that the transmission of the torque to the pile takes place in the torsional state of the core without torsion of the pile itself herein having to take place.

[0018] The measure of claim 14 is preferably applied. Because the lining is supported along its longitudinal edges in a helical line, there occurs a favourable loaded condition of the lining when torque is exerted on the inner wall of the pile.

[0019] By applying the measure of claim 15 a good friction between the lining and the inner wall of the pile already occurs at a limited pressure behind the lining. Slippage and thereby wear are to a large degree prevented.

[0020] A suitable embodiment is characterized in claim 17.

[0021] A very suitable further development of the apparatus according to the invention is characterized in

claim 18. Each of the core parts can have a length which corresponds with the length of a pile part. A pile can thereby be introduced into the ground by successively adding core parts and pile parts to the parts already placed in the ground. Each pile part can be picked up using a core part by inserting the core part into the relevant pile part and activating the expandable elements of that core part. The core part with the pile part therearound can then be lifted and placed onto the parts already introduced into the ground.

[0022] In preference the measure of claim 19 is herein applied. Because the couplings are self-centring, a rapid connection of the additional pair of core part and pile part to the parts already introduced into the ground can be effected. It is hereby possible to work quickly in efficient manner.

[0023] The core parts are preferably connected mutually in non-releasable manner. This is particularly important for removal of the core parts from the pile arranged in the ground. The whole assembled core can then be lifted out of the arranged pile and dismantled again into parts.

[0024] In favourable manner the measure of claim 20 is herein applied. The desired firm connection can be rapidly effected by rotating the central tube and causing mutual engagement of mutually abutting screw coupling parts of core parts for mutual connection.

[0025] The measure of claim 21 is preferably applied to transmit the drive torque in suitable manner for the purpose of driving the pile into the ground.

[0026] A favourable further development is characterized in claim 22. The fluid feed can herein take place via the central tube, wherein the individual assemblies of one core part and one pile part or a number of mutually coupled core parts with associated pile parts can be held individually under fluid pressure in order to maintain the engagement between the core parts and the pile parts. As soon as a following core part with thereby supported pile part is placed on the already formed assembly, a continuous connection is formed by opening the valves, so that the then realized assembly can subsequently be provided integrally with fluid pressure once again.

[0027] The measure of claim 23 is preferably applied for removal of the core parts from the pile introduced into the ground. In each case the core of which the expandable elements have been deactivated can be hoisted over one core part to a height at which the retractable protrusions come to lie just above the upper edge of the arranged pile. The protrusions can then be extended, preferably as a result of decoupling of the upper core part, whereby the remaining core parts remain suspended on the upper edge of the formed pile using the extending protrusions. The then uppermost core part can subsequently be engaged and the assembly of core parts lifted until the following protrusions again come to lie just above the upper edge of the formed tube, whereafter the cycle is repeated.

[0028] The invention will be further elucidated in the following description with reference to the annexed figures.

Figure 1 shows a partly broken-away view of a pile according to an embodiment of the invention.
Figure 2 shows a cross-section along II-II in figure 1.
Figure 3 shows an alternative embodiment of the cutting tip of a pile according to the invention.
Figure 4 is a perspective view of a cutting tip according to a preferred embodiment.
Figure 5 is a view along arrow V in figure 4.
Figure 6 shows partly schematically an embodiment of a drive core.
Figure 7 shows a view corresponding with figure 1 wherein the drive core is received in the central cavity of the pile.
Figure 8 is a perspective view of an apparatus for driving into the ground a pile assembled from parts.
Figure 9 shows a side view of a core part applied in the apparatus of figure 8.
Figure 10 shows a longitudinal section of a core part of figure 9 received in a pile part.
Figure 11 shows a cross-sectional perspective view along arrow XI in figure 10.
Figure 12 shows a cross-sectional perspective view along arrow XII in figure 10.
Figure 13 is a perspective view of two coupled core parts at the position of the coupling.
Figure 14 shows a longitudinal section of the coupled core parts of figure 13 while these are received in two pile parts placed onto one another.

[0029] The pile 1 shown in figure 1 comprises a shaft 2 which is formed in this embodiment from concrete 8 provided with a reinforcement 7. A cutting tip 3 is arranged on the bottom end of shaft 2. This can likewise be of concrete or of steel and be connected to reinforcement 7.

[0030] Cutting tip 3 has a displacing surface 4 which extends in a number of turns increasing in radius helically and in spiral manner from the bottom end point up to the shaft 3.

[0031] Between the successive turns of displacing surface 4 extends a connecting surface 5 which lies substantially perpendicular to the longitudinal axis of the pile.

[0032] Pile 1 is intended for insertion into the ground by rotation thereof on its longitudinal axis. The cutting tip 3 herein penetrates into the ground due to the own weight of the pile and/or an additional downward force. When the downward feed, i.e. the vertical displacement per rotation, is chosen to be equal to the pitch of displacing surface 4, it will be apparent that ground which comes into contact with this displacing surface 4 is gradually displaced outward. A vertical displacement of the ground does not occur. The ground

under the pile is thus not compacted, whereby the penetration of cutting tip 3 into the ground is not obstructed.

[0033] When the feed is smaller than the pitch, an outward displacement will still occur which, however, no longer progresses continuously but in stepwise manner. This can be advantageous, particularly in the case of heavy ground.

[0034] If the choice of feed is greater than the pitch, a compaction in vertical direction does then occur. The connecting surface 5 in particular will then displace downward ground which is in contact therewith. It is thus possible in principle to compact the ground under pile 1, for instance at the end of the insertion operation, in order to thus maximize the load-bearing capacity of the pile.

[0035] The pile is provided with a central cavity 6, on the wall of which can engage a core, to be described further, for the purpose of exerting the drive torque during insertion of the pile.

[0036] The pile 10 shown in figure 3 has a cutting tip 12 with a displacing surface 11 which is not parallel to the longitudinal axis of pile 10 but which diverges in downward direction. When the feed is equal to the pitch, here also only a lateral displacement and compaction of the ground will occur. At a smaller feed there takes place a minor transport of the ground in the upward direction.

[0037] Owing to the divergent displacing surface 11 the cutting tip 12 supports against the ground whereby a screw action becomes possible. When pile 10 is rotated it is drawn into the ground.

[0038] In the preferred embodiment of cutting tip 13 as shown in figure 4 and 5, the displacing surface 14 extends over less than a full turn from the end point 17 to the periphery of cutting tip 13. Connecting surface 15 hereby has a large width over a considerable part. As shown in figure 4, cutting tip 13 is here also connected to a shaft 16 drawn in cross-section which takes a hollow form.

[0039] For driving of a pile according to the invention in rotation in order to drive it into the ground with lateral displacement of the ground, a core engaging in the central cavity of the pile is suitably used. This core forms part of rotation drive means which will be further elucidated.

[0040] Rotation drive means 18 comprise an elongate core 19 which can be driven for rotation on its longitudinal axis by a transmission 20.

[0041] This core 19 is placed in the central cavity 6 of a pile 1 to be driven and is provided with expandable elements which can engage on the wall of this central cavity 6 in order to drive the pile 1 in rotation.

[0042] A preferred embodiment of core 19 is shown in figure 5. Core 19 comprises a preferably steel tube 22 around which is arranged a rubber hose 23. At regular distances this hose 23 is clamped fixedly against tube 22 by means of clamps. A sealing ring 25 is arranged between hose 23 and tube 22 at the position of each clamp 24.

[0043] The sections of hose 23 lying between two clamps 24 thus form separate hose-like elements. Each of these sections is connected by means of a separate line 26 to a control device 27. This latter controls the feed to each of the lines 26 of fluid under pressure from a pump 28 driven by a motor 29. Control device 27 comprises for this purpose valves 30 with which this fluid under pressure can be fed to each of the lines 26 and drained therefrom.

[0044] When now, by selectively actuating one or more of the valves 30, fluid under pressure is fed to the corresponding hose sections, this fluid under pressure will spread into the space between the hose and tube 22, whereby the piece of hose 23 expands and comes into contact with the wall of central cavity 6. This situation is shown in figure 6.

[0045] Due to the friction between the relevant hose pressed against the wall of the cavity and this wall the torque exerted on core 19 can be transmitted to the pile.

[0046] Selected hose parts can be pressed into contact with the wall of central cavity 6 depending on the loaded condition of pile 1 during driving thereof into the ground. The torque required to overcome the frictional moment acting on the outer surface of pile 1 can hereby be transferred to the pile at the correct height, whereby the torsion on the pile remains within limits. During insertion of the pile a number of the sections can also be relieved of pressure and later loaded again, if this is desired, in order to correct a possible deformation of core 19 under the influence of the drive torque.

[0047] The apparatus 31 shown in figure 8 for driving piles according to the invention into the ground is embodied such that it can operate with piles assembled from a number of pile parts 42.

[0048] Apparatus 31 comprises a frame 33 which is placeable on caterpillar tracks 32 and which can be positioned fixedly on the ground by means of per se known supports 34.

[0049] Mounted on frame 33 is a mast 35 along which a drill motor 36 can move up and downward. This drill motor is provided with a drilling head 40 which can engage a drive core to be further described. Apparatus 31 is positioned such that drilling head 40 comes to lie exactly vertically above the location where a pile must be inserted into the ground.

[0050] Further arranged on frame 32 is a movable jib 38 which bears on its end a second mast 37. A holder 39 with which pile parts and/or core parts 43 can be engaged is displaceable along this mast.

[0051] After the description of figures 9-14 the method of the apparatus 31 will be further elucidated.

[0052] Figure 9 shows a core part 43 in more detail. It will be apparent that a number of these core parts can be mutually coupled in order to form one longer core. Core part 43 co-acts with a pile part 42 which, together with other pile parts 42, can also form one longer pile.

[0053] Core part 43 is constructed substantially

from a hollow steel shaft 45, on the outer surface of which is arranged an expandable lining 44.

[0054] This lining 44 is formed by a strip of flexible material, in particular rubber-like material, extending helically round the shaft 45 and connected at 46 to shaft 45 with its longitudinal edges. In shaft 45 are arranged a number of bores 47 which connect the interior of the shaft to the space behind the lining layers 44. By generating a higher pressure in shaft 45 than outside of it, fluid under pressure will flow via bores 47 behind lining 44 whereby this latter expands and can come into contact with the inner wall 48 of the pile 42 shown in figure 10.

[0055] Each core part 43 is provided on its top and bottom end with complementary coupling parts, respectively an upper coupling part 50 and a lower coupling part 51. A lower coupling 51 of a core part 53 can hereby be coupled to upper coupling part 50 of a core part 43 situated thereunder.

[0056] As shown particularly clearly in figures 11 and 12, coupling parts 50, 51 are self-centring in that lower coupling part 51 has a conical outer surface 54 and upper coupling part 50 has a conical inner surface 53. In the coupled situation shown in figure 14, these surfaces fit closely together.

[0057] On the upper edge of coupling parts 50, 51 are arranged tooth-like protrusions 52, 55 which are mutually engaging in the coupled situation and thus form a non-rotatable connection between the associated core parts.

[0058] Figure 13 shows how the toothings 52, 55 of the coupling parts engage close-fittingly so that one continuous core is formed.

[0059] For fixed mutual connection of the coupling parts in the preferred embodiment of the core parts shown here, a central tube 60 is applied which extends in each core part along its length. Central tube 60 is received in the core part for vertical displacement over a short distance and is urged by a helical spring 62 into a higher position. Central tube 60 is provided on its bottom end with an outer screw thread 64 which can engage on inner screw thread 63 arranged in a coupling part 61 at the position of an upper coupling 50.

[0060] In order to realize the coupling between screw threads 64 and 63 the central tube 60 of the upper core part is pressed downward and simultaneously rotated after two core parts 43 have been placed onto one another. Screw thread 64 hereby comes into engagement with screw thread 63 in coupling part 61 and thus forms a fixed connection between the core parts 43. During coupling of the first and second core parts 43 the central tube 60 of the lower core part will be pressed downward with the central tube 60 of upper core part 43. When the third core part is coupled to the second, the central tube 60 of the second core part is therefore already in its low position, whereby the central tube 60 of the third part can be screwed freely into screw thread 63 of coupling part 61. Alternatively, a cutting tip can be provided with a screw thread corresponding with screw thread 63 of coupling part 61, so that central tube 60 of the lower core part can be screwed into this cutting tip and a firm connection of this cutting tip to the core can thus be effected. The core can of course herein have a coupling part corresponding to an upper coupling part 50.

[0061] Downward pressing and simultaneous rotation of the central tube to form the coupling between two successive core parts takes place with a screwing head (not further shown) which forms part of apparatus 31 and which engages on a hexagon 56 formed on the top end of central tube 60. The screwing head can for instance be integrated with drilling head 40 of drill motor 36.

[0062] Means can simultaneously be arranged in favourable manner in this screwing head for feeding fluid under pressure, and in particular compressed air, into central tube 60 of upper core part 43. The central tube is provided with a number of bores 57 whereby compressed air fed via the central tube can flow behind the expandable lining 44 via the interior of shaft 45 and bores 47. The core part is thus brought into contact with the inner wall 48 of pile part 42.

[0063] Central tube 60 is provided on its upper and lower end with non-return valves 65 respectively 66 which ensure that the increased pressure generated in the interior of core part 43 by the compressed air supplied with the screwing head is maintained even when the screwing head is no longer in engagement with the central tube. The assembly of pile part 42 and core part 43 can thus be displaced as a unit.

[0064] When screw threads 63 and 64 of the central tube are brought into engagement, the respective ends of the central tubes are pressed against each other, whereby the respective valve discs are lifted from their seat and a connection is realized between the central spaces of the thus coupled core parts.

[0065] Driving of a pile into the ground with the apparatus 31 of figure 8 proceeds as follows.

[0066] In the starting situation shown in figure 8 a number of pile parts 42 and a corresponding number of core parts 43 are arranged ready for use. Although not shown here, pile parts 42 can suitably be accommodated in a container or cassette containing the number of pile parts required to form one pile.

[0067] The first pile part is provided with the above described cutting tip. Using holder 39 a first core part 43 is placed in the first pile part 42. Using holder 39 this first assembly is positioned at the location where the pile has to be arranged in the ground. Drill motor 36, guided by mast 35, is then lowered onto this assembly, wherein drilling head 40 comes into engagement with the upper coupling 50 of core part 43.

[0068] While it is ensured that the pressure inside the core part remains at a sufficient level to guarantee a good contact between the expandable lining and the inner wall of pile part 42, motor 36 is set into operation

and the core part is driven in rotation while a vertically downward force is exerted. The ground is displaced to the sides by the action of the cutting tip and the pile part is carried into the ground.

[0069] As soon as the first pile part has been carried to a sufficient depth into the ground, drill motor 36 is disengaged and, using holder 39, a following assembly of pile part and core part is placed onto the assembly already placed in the ground and in the manner described above a coupling is effected between the core parts, whereafter drilling motor 36 is again set into operation to thus drive further into the ground the pile assembly consisting of two parts. This procedure is repeated until all pile parts have been driven into the ground.

[0070] The drive torque is herein transmitted to the cutting tip in each case via the core assembled from parts. Pile parts 42 are only exposed to the friction of the ground relative to the outer surface which is transmitted directly over a very short path to the lining of the core in driving contact with inner wall 48. The pile itself is subject to practically no torsion, so that it can be embodied very simply and reinforcement is unnecessary. The pile parts can be manufactured in simple manner and are thus comparatively inexpensive in the manner of sewer pipes and the like.

[0071] After the first pile has thus been driven, apparatus 31 is repositioned such that the drilling head 40 is situated above the position where the subsequent pile must be arranged in the ground. A cassette filled with the required number of pile parts 42 is placed at a suitable position relative to apparatus 31.

[0072] Using the holder 39 arranged on the jib the core, from which the compressed air has been released beforehand, is picked up and raised through the length of one core part 43. The central tube is then unscrewed from the upper core part, as a result of which the protrusions 68 on the upper end of the remaining core protrude outward in a manner not further shown and can be lowered onto the upper edge of the pile arranged in the ground. The released core part is placed into one of pile parts supplied in the cassette and this pile part is inserted into the ground in the described manner. When this has occurred over a sufficient distance, a core part is again removed from the previously arranged pile, wherein the remaining core is again supported by the expanders 68 of the then uppermost core part. The core parts are thus removed one at a time from the already formed pile and used to drive a following pile part 42 of the subsequent pile into the ground.

[0073] Manipulation of the core parts and the pile parts still to be driven into the ground takes place with the separately controllable jib 38, so that this can take place simultaneously with driving of the pile into the ground. An assembly of pile part and core part can hereby be held in readiness each time and be placed immediately onto the part already driven into the ground as soon as this has been carried far enough into the ground. No extra time is thus lost in the manipulation of the core parts.

[0074] It will be apparent that apparatus 31 can be used in a space of limited height. Only the total height of a pile part plus the height thereabove of the drill motor and some additional space for manoeuvre are required. This implies that with the invention foundation piles can also be arranged in existing buildings.

Claims

1. Pile, such as a foundation pile, comprising a shaft having on one end a cutting tip, wherein the cutting tip has a displacing surface which extends increasing in radius helically and in spiral manner from an end point up to the shaft and wherein the pile has an engaging surface for exerting a torque thereon round its longitudinal axis.

2. Pile as claimed in claim 1, wherein the displacing surface extends through less than a turn.

3. Pile as claimed in claim 2, wherein the displacing surface is parallel to the longitudinal axis of the pile.

4. Pile as claimed in claim 2 or 3, wherein a connecting surface extends between the turns of the displacing surface, which connecting surface is substantially perpendicular to the longitudinal axis of the pile.

5. Pile as claimed in any of the foregoing claims, wherein the pitch of the displacing surface is constant.

6. Pile as claimed in any of the foregoing claims, wherein the engaging surface comprises at least a part of the wall of a central cavity in the pile.

7. Pile as claimed in claim 6, wherein the central cavity is cylindrical.

8. Pile as claimed in any of the foregoing claims, wherein the cutting tip is a separate part of the foundation pile.

9. Pile as claimed in claim 8, wherein the cutting tip has a larger diameter than the shaft.

10. Apparatus for driving a pile as claimed in any of the foregoing claims into the ground, comprising a frame, support means for supporting the pile in a standing position and rotation drive means which can engage on the engaging surface.

11. Apparatus as claimed in claim 10, further comprising pressure means for exerting a force on the pile in longitudinal direction thereof.

12. Apparatus as claimed in claim 10 or 11, wherein the rotation drive means comprise a core which fits into the central cavity of a pile and which is provided with expandable elements over at least a part of its length.

13. Apparatus as claimed in claim 12, wherein the expandable elements comprise an expandable lining arranged round the core and wherein the apparatus further comprises fluid transport means and a control therefor with which fluid under pressure can be transported in controlled manner to and from elements of the expandable lining.

14. Apparatus as claimed in claim 12, wherein the lining comprises a strip of flexible material extending helically round the core and connected with its longitudinal edges to the core.

15. Apparatus as claimed in claim 13 or 14, wherein the lining is of rubber-like material.

16. Apparatus as claimed in claim 13, wherein the fluid transport means for a number of expandable elements are individually controllable.

17. Apparatus as claimed in claim 16, wherein the expandable elements are formed by a piece of hose sealed at intervals and clamped fixedly onto the core.

18. Apparatus as claimed in any of the claims 10-17, wherein the core comprises a number of core parts coupled in their longitudinal direction by couplings.

19. Apparatus as claimed in claim 18, wherein the couplings are self-centring.

20. Apparatus as claimed in claim 18, wherein each core part comprises a rotatable central tube extending along its length which is provided at opposite ends with complementary screw couplings and is axially displaceable to no more than a limited extent.

21. Apparatus as claimed in claim 20, wherein the couplings comprise mutually engaging protrusions blocking the core parts non-rotatably relative to each other.

22. Apparatus as claimed in claim 20, wherein close to its ends the central tube is received in sealed manner in the core part and is provided with valves which can be opened through contact with a central tube of a core part for coupling.

23. Apparatus as claimed in any of the claims 18-22, wherein each core part is provided close to its upper end with retractable protrusions.

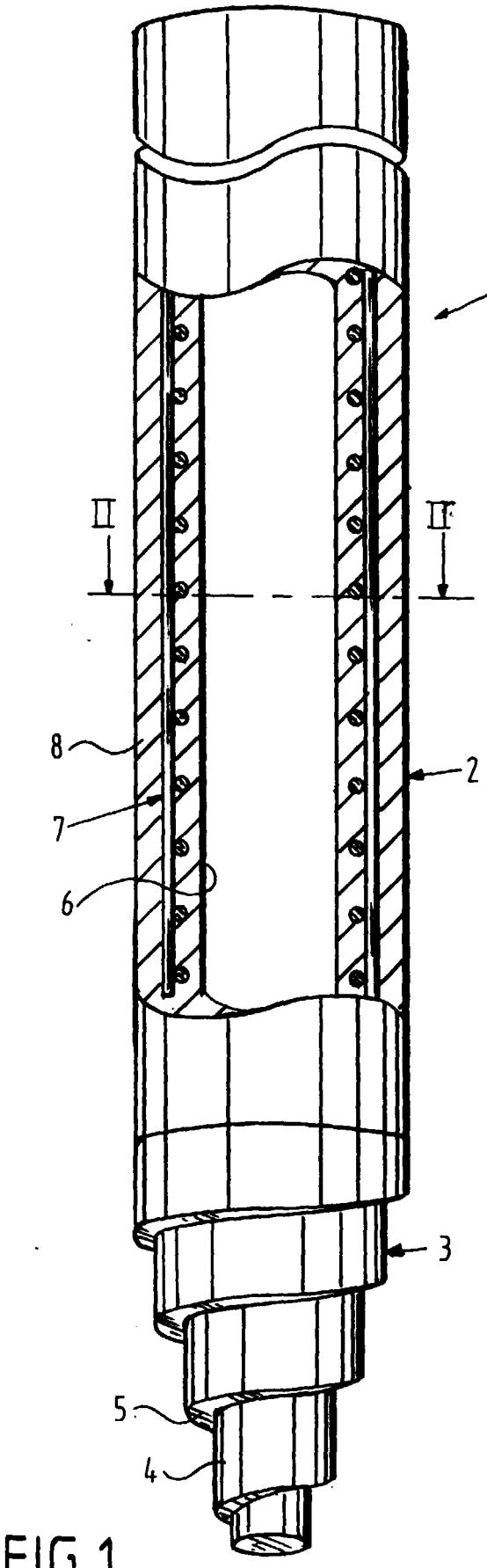

FIG.1

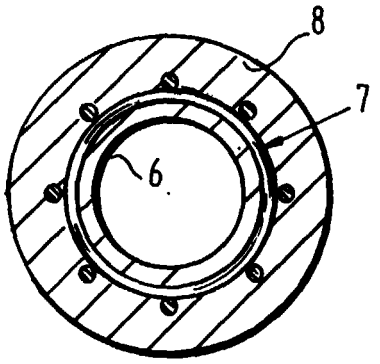

FIG.2

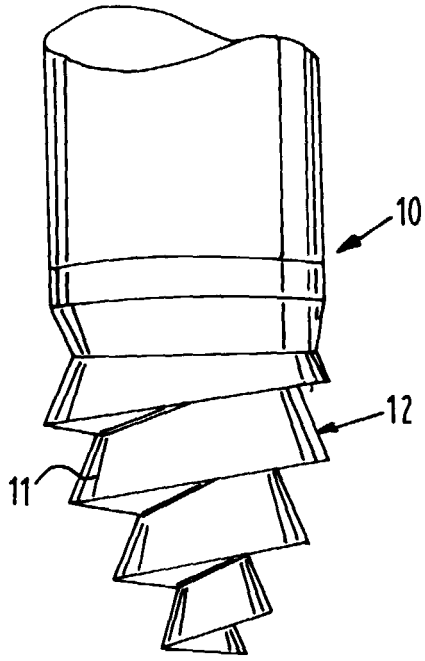

FIG.3

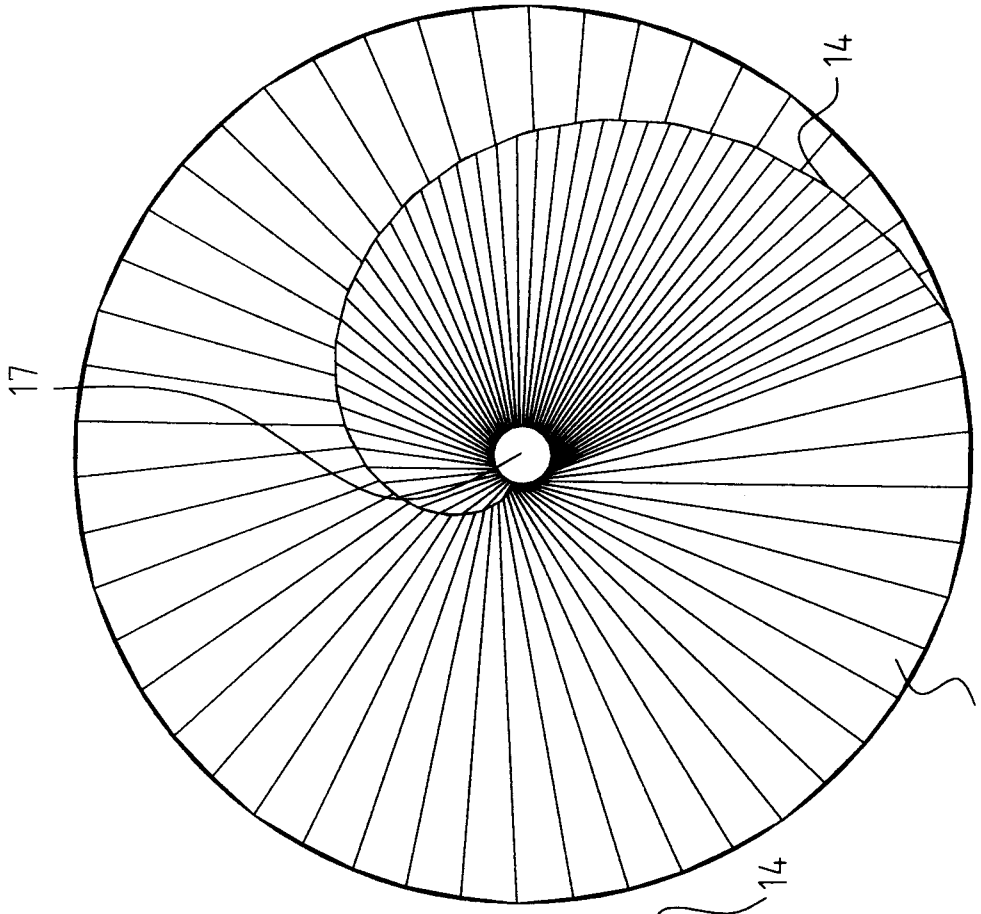

FIG. 5

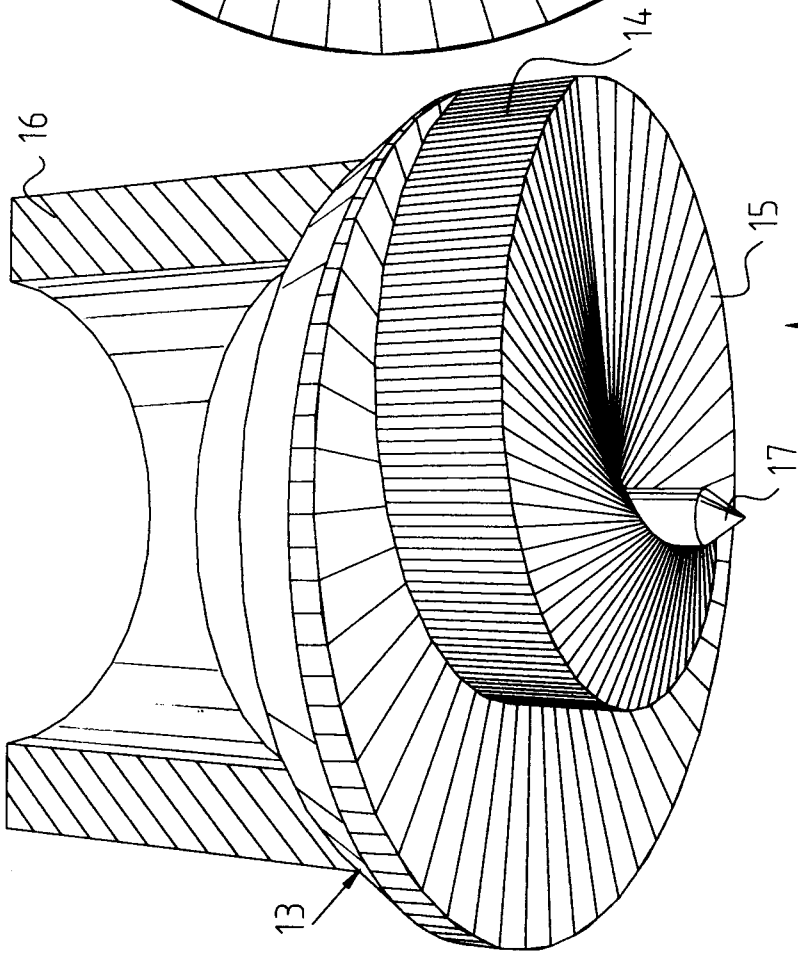

FIG. 4

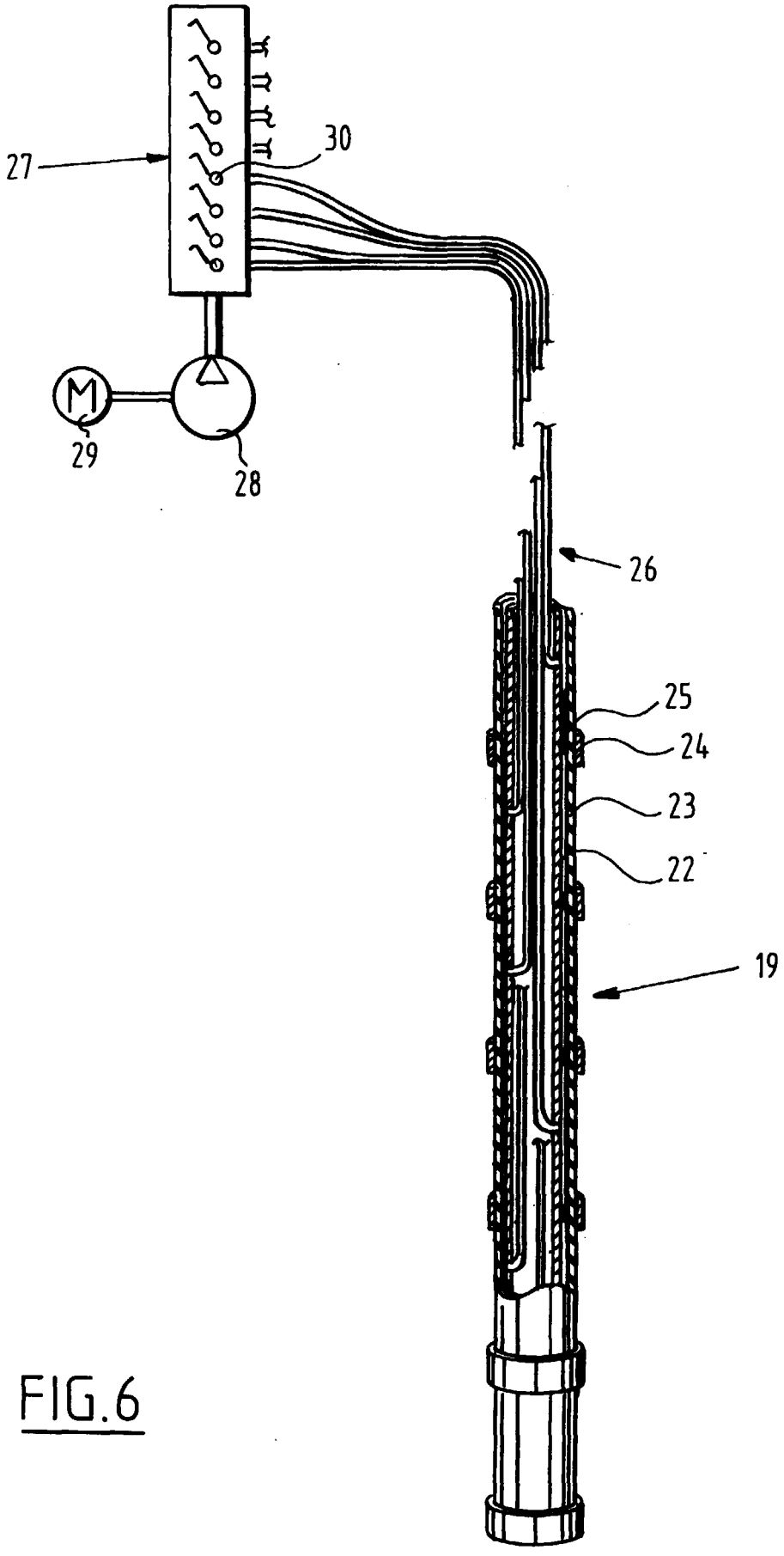

FIG.6

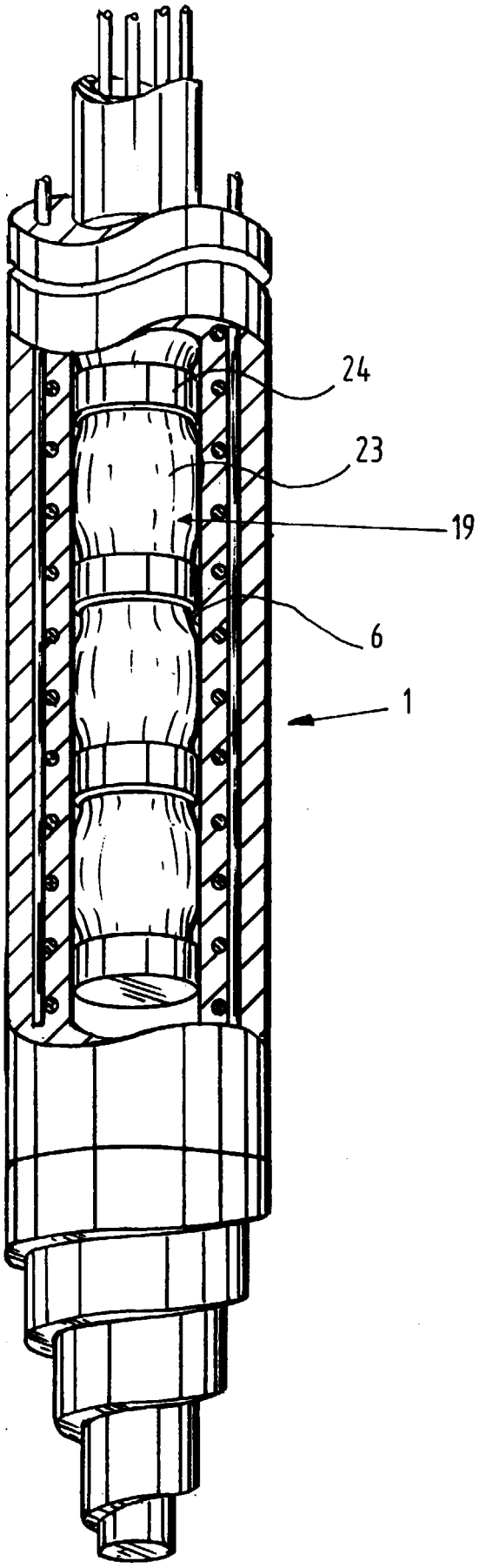

FIG.7

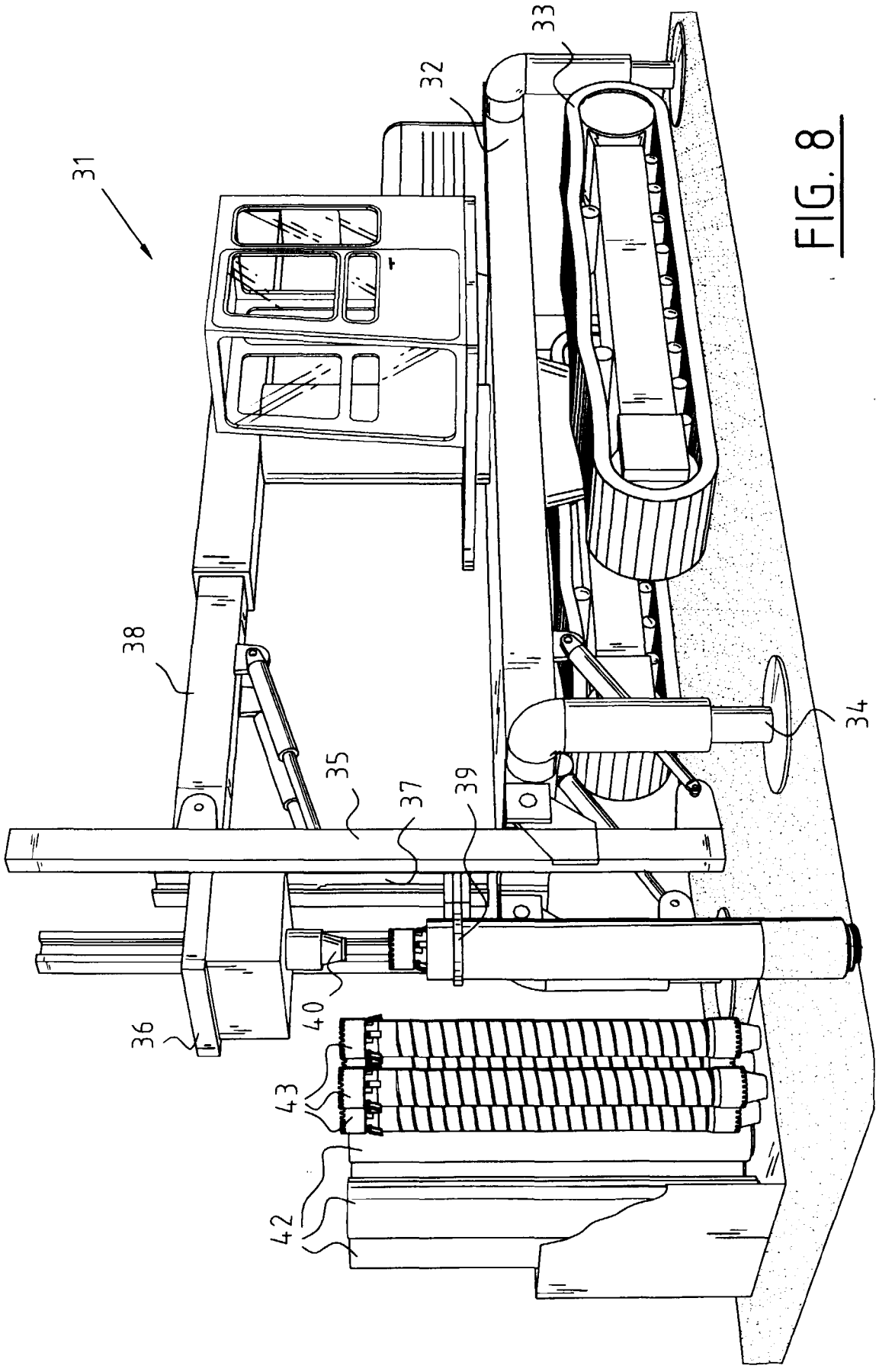

FIG. 8

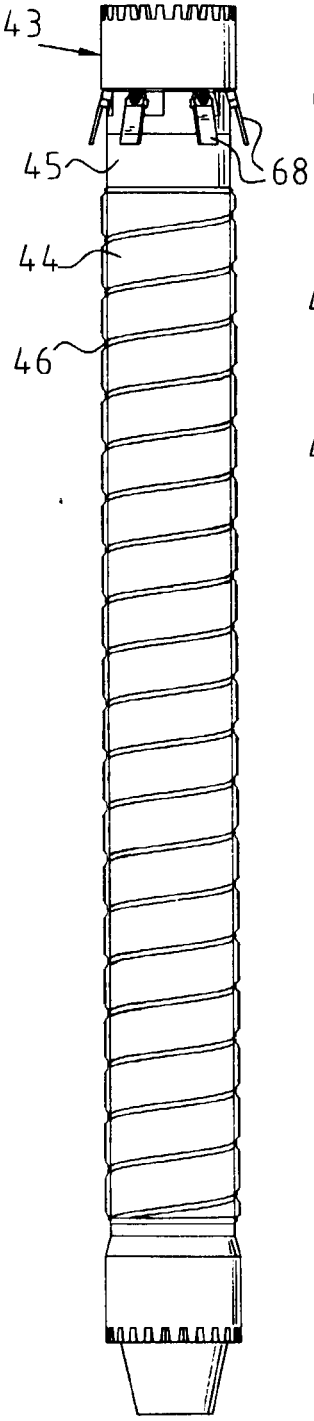

FIG. 9

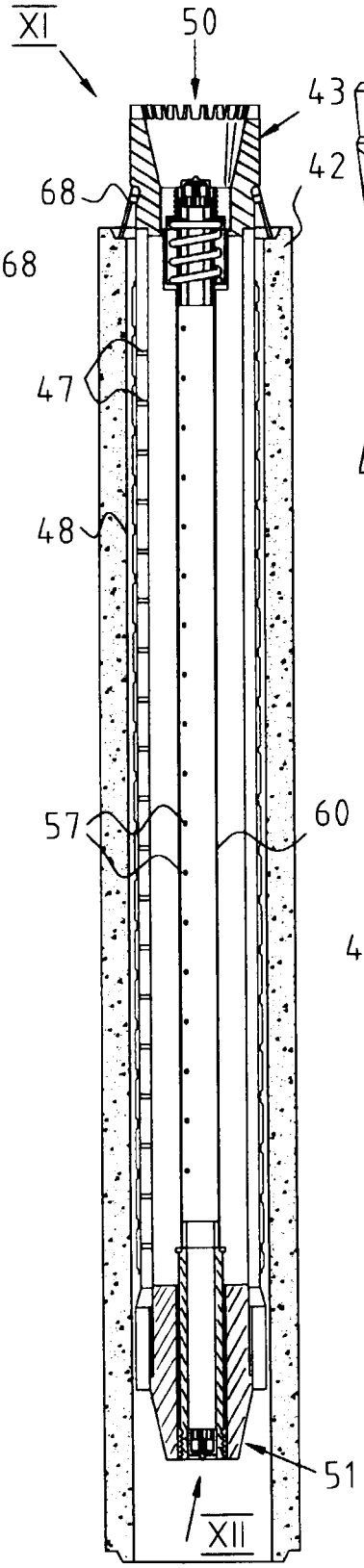

FIG. 10

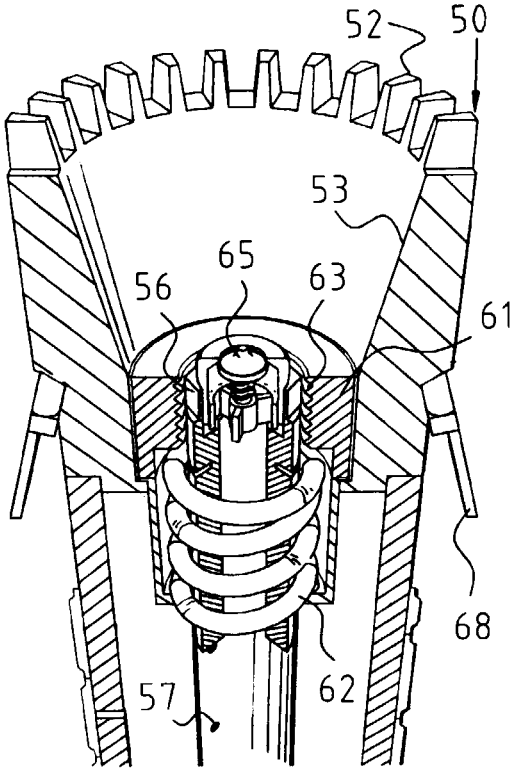

FIG. 11

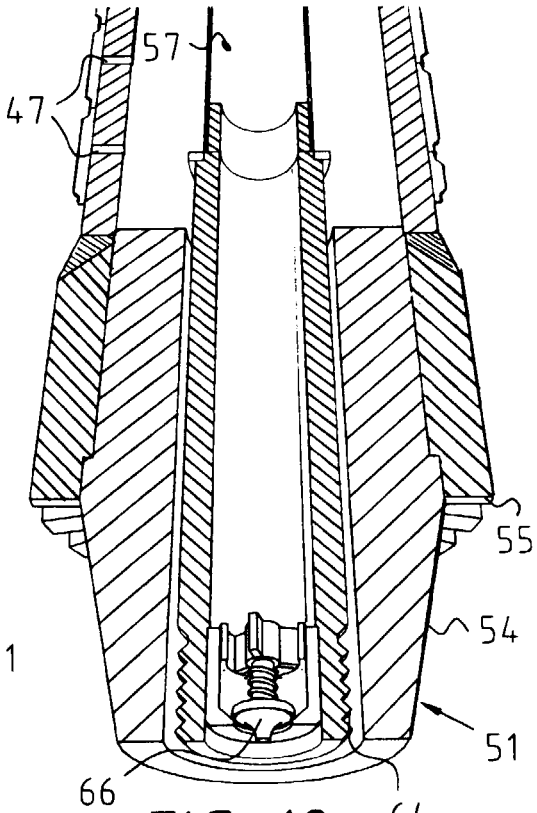

FIG. 12

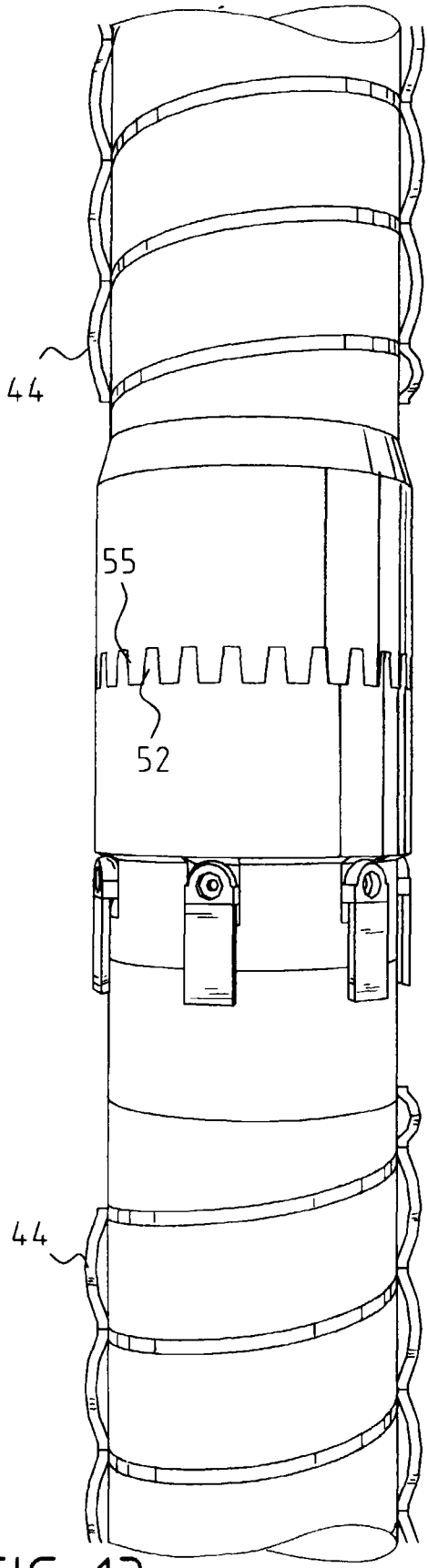

FIG. 13

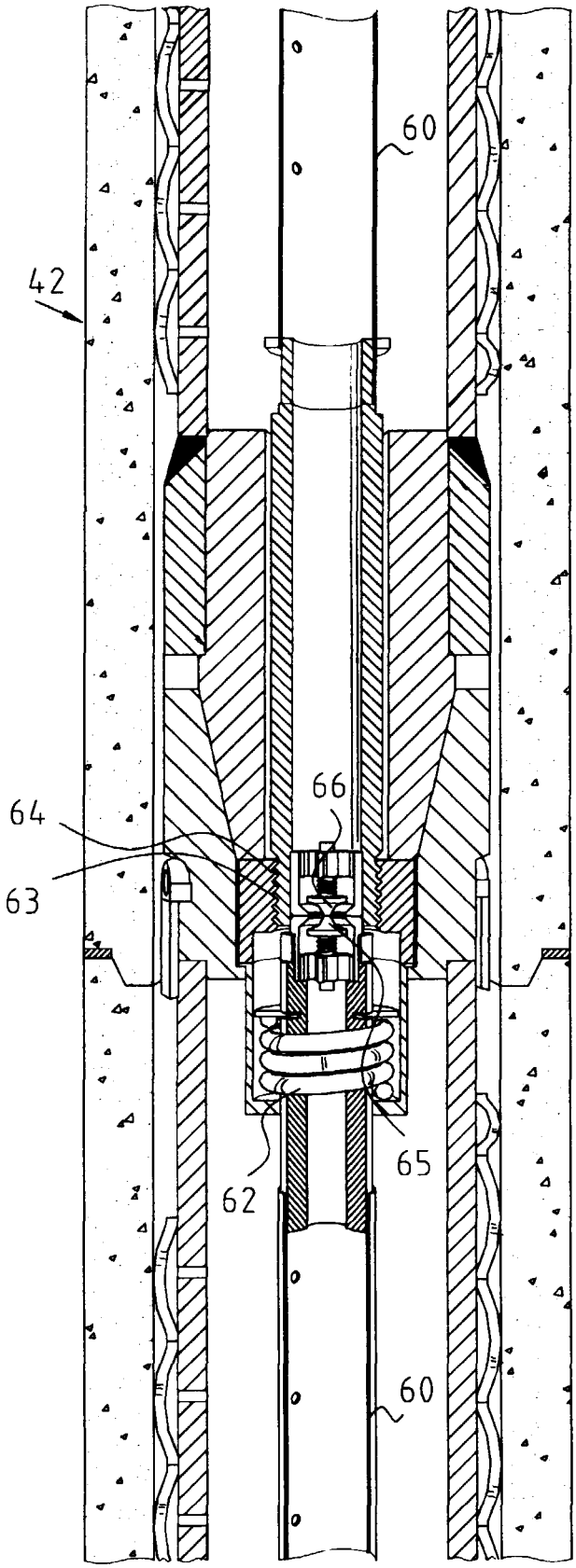

FIG. 14

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EUROPEAN SEARCH REPORT

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EP 00 20 2139

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Place of search	Date of completion of the search	Examiner
THE HAGUE	26 September 2000	Kergueno, J

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