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(54) Benævnelse: **Fremgangsmåde til fremstilling af et betonfærdigdel-segment af et vindenergianlægstårn og en betonfærdigdel-tårnsegment-forskalling**

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Description

The present invention relates to a method for producing a precast concrete segment of a wind turbine tower and to a precast concrete tower segment formwork.

A tower of a wind turbine consists for example of a plurality of concrete segments where the tower in question is a concrete tower. The respective concrete segments are stacked on one another and can be braced with one another by means of steel cables or steel cords.

When producing concrete segments of a wind turbine tower, an inner formwork and an outer formwork are provided. Between them can be provided a metal cage or a reinforcement for improving the static behaviour of the concrete segment. When the inner and the outer formwork have been constructed, concrete can then be introduced into the volume between the inner and outer formwork. After the concrete has been cured, the outer formwork can be removed and the concrete segment can be transported away for further processing.

Various installation parts, such as, for example, a climbing ladder or the like, must be provided within the tower of the wind turbine. These installation parts must of course be fastened securely to or within the tower wall (of the concrete segment). The fastening must also proceed in such a way that the static behaviour of the tower is not negatively influenced as a result.

The installation parts can be installed in that, for example, holes are bored at the appropriate points and the installation parts are then fastened, for example by means of dowels, in or on the tower wall.

In the priority-founding German application, the German Patent and Trade Mark Office searched the following documents: DE 16 84 221, US 6,315,077 B1 and US 7,108,101 B1.

DE 16 84 221 A1 discloses a holding unit for an anchor which is adapted to hold the concrete anchor in a desired position while the concrete wall is produced.

An object of the present invention is to provide a method for producing precast concrete segments of a wind turbine tower which allows more cost-effective production of the concrete segments.

This object is achieved by a method according to Claim 1, a precast concrete tower segment frame work according to claim 3 and a holding unit according to claim 4.

Therefore, a method for producing a precast concrete tower segment of a wind turbine tower is provided. An inner formwork having at least one bore and at least one holding unit on an inner side of the inner formwork in the region of the bore is placed. A first end of a concrete anchor or a first end of a removable element at the first end of the concrete anchor is introduced from the outer side of the inner formwork through the bore into the holding unit in order to hold the concrete anchor. An outer formwork is placed. Concrete is introduced or poured between the inner and outer formwork. The removable element in the first end or the first end of the concrete anchor is removed and the precast concrete segment is removed.

According to the present invention, the holding unit is designed in such a way that the removable element or the first end of the concrete anchor is introduced in one direction and blocked in an opposite direction.

According to the present invention, the holding unit has a spring action when introducing the removable element and a locking action in the opposite direction.

According to a further aspect of the present invention, the first end of the concrete anchor has an internal thread into which a removable end can be screwed and by means of which attachment or installation parts can be fastened in the tower segment.

The invention relates to a concept of providing bores at the appropriate points in the inner formwork and also of providing holding units on the inner side of the inner formwork at the bores before the outer formwork is mounted (for example after the lattice bars for reinforcing the concrete segment are mounted). This can be carried out by welding the holding units to the inner side of the inner formwork. A first end of a concrete anchor can then be introduced through the bore in the inner formwork into the holding unit, where the concrete anchor is held. The outer formwork can then be placed and the concrete can be introduced into the volume between the inner and outer formwork. After the concrete has cured, the outer formwork can be mounted. The concrete segment can then be lifted from the inner formwork. The inner formwork can optionally remain where it is and the holding unit can optionally still remain on the inner formwork or can be removed.

At the free end of the concrete anchor there can be provided a removable element, for example in the form of a screw which engages in the holding unit and is held by the holding unit. The removable element can be removed before removal of the inner formwork. The inner formwork can then be removed together with the holding unit or units. Thus, the concrete segment remains with a plurality of holes on the inner side of the concrete segment which are in each case firmly connected to the concrete formwork via the concrete anchor.

Further refinements of the invention form the subject matter of the dependent claims.

Advantages and exemplary embodiments of the invention are explained in more detail below with reference to the drawing.

Figure 1 shows a schematic representation of a wind turbine according to the invention,

Figure 2 shows a schematic sectional view of a precast concrete part of a tower segment of a tower of a wind turbine according to a first exemplary embodiment,

Figure 3 shows a schematic sectional view of a detail of a precast concrete tower segment according to a second exemplary embodiment,

Figures 4A and 4B show two different schematic views of a holding unit according to the second exemplary embodiment,

Figure 4C shows a schematic sectional view of the holding unit of Figures 4A and 4B, and

Figure 5 shows a perspective sectional view of a detail of a precast concrete tower segment according to the second exemplary embodiment.

Figure 1 shows a schematic representation of a wind turbine according to the invention. The wind turbine 100 has a tower 102 and a nacelle 104. A rotor 106 having three rotor blades 108 and a spinner 110 is provided on the nacelle 104. During operation, the rotor 106 is set in a rotary movement by the wind and thus also rotates the rotor of the generator in the nacelle 104. The pitch angle of the

rotor blades 108 can be adjusted by pitch motors at the rotor blade roots of the respective rotor blades 108. The tower 102 can be constructed from a plurality of tower segments or tower sections 200.

Figure 2 shows a sectional view of a precast concrete tower segment for a tower of a wind turbine during its production according to a first exemplary embodiment. To produce the concrete tower segment, an inner formwork 220 having at least one holding unit 400 in the region of at least one hole 240 in the inner formwork 220 and on an inner side of the inner formwork is provided or fastened. This can take place, for example, by welding. A concrete anchor 300 is guided at its first end 310 through the hole 240 in the inner formwork from an outer side and plugged into the holding unit 400 and is held there. After an outer formwork 210 is provided, the volume between the inner and outer formwork 220, 210 can be filled with concrete 230. A metal cage or a reinforcement can be provided between the inner and outer formwork 220, 210 in order to improve the mechanical stability of the precast concrete part. When the concrete is filled between the inner and outer formwork 220, 210, the concrete then also surrounds the concrete anchor 230. When the concrete of the concrete tower segment has a sufficient hardness, the outer and inner formwork 210, 220 can then be removed. The concrete anchor 230 is then securely held by the concrete 230 and attachment parts can be fastened to the concrete anchor 300.

At the first end 310 of the concrete anchor 300 there can be provided a removable element 410, such as, for example, a screw 410 which can be introduced into the holding unit 400 in order to hold the concrete anchor 300. After the removable element (for example a screw) has been removed, the concrete segment can be removed while the inner formwork 220 remains in its place (without the holding units 400 being removed), with the result that only the precast concrete part 200 with at least one concrete anchor 300 remains. The first end 310 of the concrete anchor 300 can be designed for example in such a way that installation parts or attachment parts can be fastened thereto in the interior of the tower of the wind turbine. This can be achieved, for example, by the provision of an (internal) thread.

After the concrete 230 has cured, the concrete anchor 300 is anchored sufficiently firmly in the precast concrete tower segment such that installation and attachment parts can be fastened to the concrete anchor or to its first end 310.

The holding unit 400 according to the invention is fastened on the inner side of the inner formwork 220 in the region of the bores or holes 240. The holding unit 400 is designed such that a first end 230 of a concrete anchor or a removable element 410 provided on or in the first end can be introduced into the holding unit 400 in such a way that the concrete anchor is fastened by the holding unit 400, i.e. the concrete anchor is held by the holding unit. This fastening takes place, for example, by inserting the removable element 410 of the first end 310 of the concrete anchor through the hole 240 into the holding unit 400. After the concrete anchor 300 has been introduced into the holding unit by way of the removable element 410, the concrete anchor 300 is securely fastened, with the result that concrete 230 can then be introduced between the inner and outer formwork.

The provision of the holding unit 400 on the inner side of the inner formwork 220 means that only one person is required to fit the concrete anchor 230 since it is consequently possible for one person to fit the concrete anchor 300 from outside the inner formwork. The holding unit 400 can optionally be designed in such a way that an introduction of the first end 310 of the concrete anchor is possible, but a movement in the opposite direction is blocked.

The holding unit 400 has a spring action when introducing the concrete anchor and a locking action for the removal of the concrete anchor.

The holding unit according to the invention serves for holding the concrete anchor in position during the production of the precast concrete tower segment without the concrete anchors having to be secured in any other way.

Figure 3 shows a schematic sectional view of a detail of a precast concrete tower segment according to a second exemplary embodiment. The precast concrete tower segment according to the second exemplary embodiment can be based on the precast concrete tower segment according to the first exemplary embodiment of Figure 2. A holding unit 400 is fastened in an inner side of the inner formwork 220, for example by welding. The holding unit 400 is provided in particular in the surrounds of bores 240 in the inner formwork 220. A concrete anchor 300 with a first end 310 which has a removable element 410 is introduced through the hole 240 into the holding unit 400. The holding unit 400 holds and locks the removable element 410, with the result that the concrete anchor 300 can no longer be removed.

The holding unit 400 has two plates 420 which are arranged parallel to one another and can be fastened on or to one another by means of bolts 426. The plates 420 have at their first end two fastening portions 425 by means of which the holding unit 400 can be fastened to an inner formwork 220. The fastening can be achieved for example by means of welding. A cutout 423 and optionally mounting-facilitating portions 422a, 422b are provided between the two fastening portions 425, 425. The cutout 423 is provided so that emerging concrete can flow down through this cutout 423. The portions 422a, 422b serve to facilitate mounting.

The plates 420 each have a cutout 424 at their second end. The cutout 424 is provided so that the removable element 410 can be removed by a fitter, preferably after the concrete 230 has cured, with the result that the concrete anchor 300 can no longer move.

The concrete anchor 300 has a first end 310 and a second end 320. The first end 310 has an (internal) thread and is provided on the inner formwork 220. The second end 320 projects into the concrete 230. Attachment or installation parts can be fastened in the interior of the tower segment 200 by means of the internal thread 311 on the first end 310.

Figure 4A shows a plan view of a plate 420 of the holding unit according to the second exemplary embodiment. The plate 420 has at its one end the fastening portions 425 and, between them, the cutout 423 and the cutouts 422a, 422b which serve to facilitate mounting. A cutout 424 is provided at the second end of the plate 420. The plate 420 also has a plurality of openings or bores 421 for the bolts 426.

Figure 4B shows a plan view of the holding unit according to the second exemplary embodiment. The holding unit has two holding plates 420 arranged in parallel, spacer plates 440 and two holding elements 430. The holding elements 430 have a first resilient end 433, a latching portion 431 and a second end 434. The second end 432 is held by means of two bolts while the resilient end 433 is held by one bolt.

Figure 5 shows a perspective sectional view of a holding unit according to the invention. In the representation of Figure 5, one of the plates 420 is omitted. In Figure 5, the concrete anchor 300 is shown with its first and second end 310, 320 a removable element 410 being fastened in the first end 310. The removable element 310 can take the form of a screw, for example, which is screwed into an (internal)

thread 311 at the first end 310 of the concrete anchor. When mounting the concrete anchor 300, the first end is introduced with the removable element 410 through the bore 240 into a holding unit 400 fastened to the inner formwork 220. By means of the two latching portions 431, the holding unit 400 engages in an external thread of the removable element 410 and holds the removable element in the introduced position. The two latching portions 431 are each coupled to a spring 433 such that the latching action also has a spring action. By virtue of the design of the latching portions 431, the concrete anchor 300 with the removable element 410 can only be introduced into the holding unit, but not removed again.

According to an aspect of the present invention, the holding unit 400 can be designed in the form of clamping jaws. The clamping jaws can then be fastened or welded to the inner formwork from inside. The position of the holding elements 400 is determined by the position of the holes or bores 240 in the inner formwork 220. After the inner formwork 220 with the holding elements 400 fastened thereto has been mounted, a worker can introduce a concrete anchor 310 with a removable element, for example in the form of a hexagon socket screw, from outside the inner formwork through the bore 240 into the clamping jaw 400. Optionally, the concrete anchor can then be rotated by, for example, 40°, with the result that an external thread of the screw engages in noses on the latching portion 431 and the concrete anchor is thus drawn into the inner formwork for fastening. After the volume between the inner and outer formwork has been filled with concrete 230, the hexagon socket screw 410 can be unscrewed from the holding unit or from the clamping jaw and the inner formwork 220 can be removed.

According to the invention, during the production of the precast concrete tower segment of a wind turbine tower, a reinforcing cage can optionally be set or placed by means of a crane on an inner core with an inner formwork. Concrete anchors (for example a wavy anchor or a socket dowel) with a screwed-in threaded bolt can then be introduced or pressed into the holding units according to the invention, which holding units are fastened to the inner side of the inner formwork. According to the invention, the concrete anchors can be used, for example, to fasten a tower ladder, a cable holder, etc. It is then possible (also after the cage has been placed on the inner core) for the outer formwork to be placed and for all concrete anchors to be positioned and screwed. Concrete can then be introduced into the formwork. After the concrete has cured, the threaded pins or the removable elements can be unscrewed from the holding units according to the invention such that there is no longer any connection between the concrete segment and the inner formwork. The

outer formwork can then be released and mounted such that the concrete segment is freely accessible from outside. The finished concrete segment can then be lifted, for example by means of a crane, from the inner formwork and can be further transported for further processing.

Patentkrav

1. Fremgangsmåde til fremstilling af et betonfærdigdel-tårnsegment af et vindenergianlægstårn med de følgende trin:

placering af en indvendig forskalling (220) med mindst en boring (240) og mindst en holdeenhed (400) på en inderside af den indvendige forskalling (220) i området ved boringen (240),

indføring af et aftageligt element (410) gennem boringen (240) i holdeenheden (400) ved den første ende (310) af betonankeret fra ydersiden af den indvendige forskalling (220) med henblik på fastholdelse af betonankeret (300),

placering af en udvendig forskalling (210),

støbning af beton mellem den indvendige og den udvendige forskalling (220, 210),

fjernelse af det aftagelige element (410) i den første ende (310) af betonankeret (300) og

fjernelse af den indvendige og den udvendige forskalling (220, 210),

hvor holdeenheden (400) er udformet således, at det aftagelige element (410) er indført i en retning og er blokeret i den modsatte retning,

hvor holdeenheden (400) har en fjedring ved indføringen af det aftagelige element (410) og en låseanordning i modsat retning,

hvor holdeenheden (400) har to parallelt anbragte holdeplader (420), som er fastgjort til hinanden ved hjælp af bolte (426), afstandsplader (440) samt to holdeelementer (430), hvor holdeelementerne (430) har en første fjedrende ende (433), et låseafsnit (431) samt en anden ende (434), hvor den anden ende (432) fastholdes ved hjælp af to bolte (426), mens den fjedrende ende (433) fastholdes ved hjælp af en bolt (426),

hvor holdepladerne (420) ved deres første ende har hver især to fastgørelsesafsnit (425),

hvor der mellem de to fastgørelsesafsnit (425) er tilvejebragt en udsparing (423),

hvor holdepladerne (420) ved deres anden ende hver især har en udsparing (424).

2. Fremgangsmåde ifølge krav 1, hvor

den første ende (310) af betonankeret (300) har et indvendigt gevind (311), i

hvilket det aftagelige element (410) er indskruet, og ved hjælp af hvilket der kan fastgøres påbygnings- eller indbygningsdele i tårnsegmentet.

3. Betonfærdigdel-tårnsegment-forskalling til fremstilling af et vindenergianlægstårn, med
en indvendig forskalling (220) med mindst en boring (240), og
mindst en holdeenhed (400) på den indvendige forskalling (220) i området ved boringen (240),
hvor holdeenheden (400) er udformet til at holde et betonanker (300), når et aftageligt element (410) indføres gennem boringen (240) i holdeenheden (400) ved den første ende (310) af betonankeret fra en yderside af den indvendige forskalling (220)
hvor
holdeenheden (400) er udformet således, at det aftagelige element (410) er indført i en retning og er blokeret i den modsatte retning
hvor
holdeenheden (400) har en fjedring til indføring af det aftagelige element (410) og en låseanordning i modsat retning,
hvor holdeenheden (400) har to parallelt anbragte holdeplader (420), som er fastgjort til hinanden ved hjælp af bolte (426), afstandsplader (440) samt to holdeelementer (430), hvor holdeelementerne (430) har en første fjedrende ende (433), et låseafsnit (431) samt en anden ende (434), hvor den anden ende (432) fastholdes ved hjælp af to bolte (426), mens den fjedrende ende (433) fastholdes ved hjælp af en bolt (426),
hvor holdepladerne (420) ved deres første ende har hver især to fastgørelsesafsnit (425),
hvor der mellem de to fastgørelsesafsnit (425) er tilvejebragt en udsparing (423),
hvor holdepladerne (420) ved deres anden ende har hver deres udsparing (424).

4. Holdeenhed (400) til fastholdelse af et betonanker (300) med en første ende (310), som har et aftageligt element (410), ved fremstillingen af et betonfærdigdel-tårnsegment af et vindenergianlægstårn, med

mindst et fjedrende holdeelement (430), som tillader en indføring af et betonanker (300) i en første retning og forhindrer en fjernelse af betonankeret (300) i en anden retning,
hvor den anden retning er modsat den første retning, og
har en fjedring til indføring af det aftagelige element (410) og en låseanordning i modsat retning, **kendetegnet ved, at** holdeenheden (400) har to parallelt anbragte holdeplader (420), som er fastgjort til hinanden ved hjælp af bolte (426), afstandsplader (440) samt to holdeelementer (430), hvor holdeelementerne (430) har en første fjedrende ende (433), et låseafsnit (431) samt en anden ende (434), hvor den anden ende (432) fastholdes ved hjælp af to bolte (426), mens den fjedrende ende (433) fastholdes ved hjælp af en bolt (426),
hvor holdepladerne (420) ved deres første ende har hver især to fastgørelsesafsnit (425) til fastgørelse af holdeenheden (400) på en indvendig forskalling (220),
hvor der mellem de to fastgørelsesafsnit (425) er tilvejebragt en udsparing (423),
hvor holdepladerne (420) ved deres anden ende har hver deres udsparing (424).

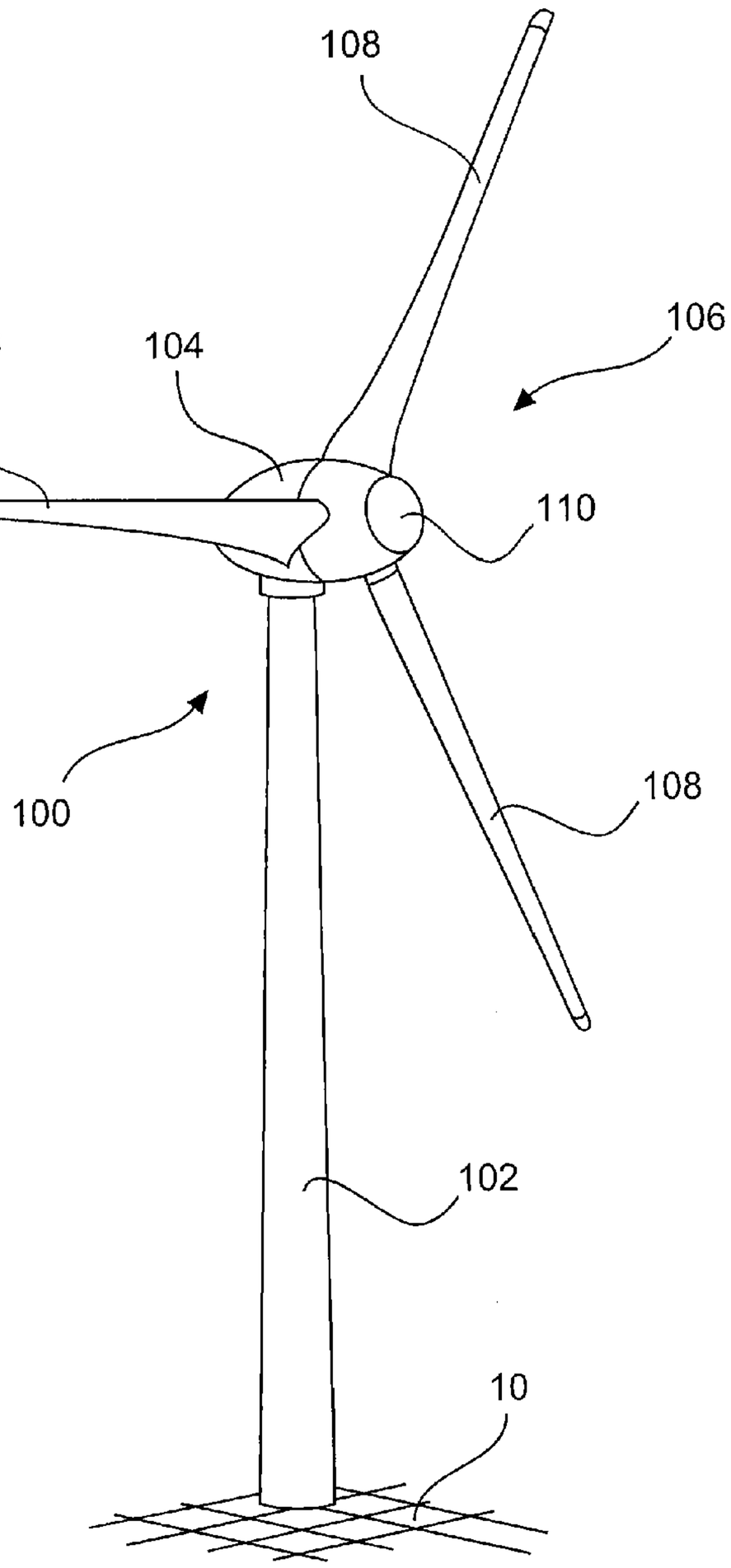


Fig. 1

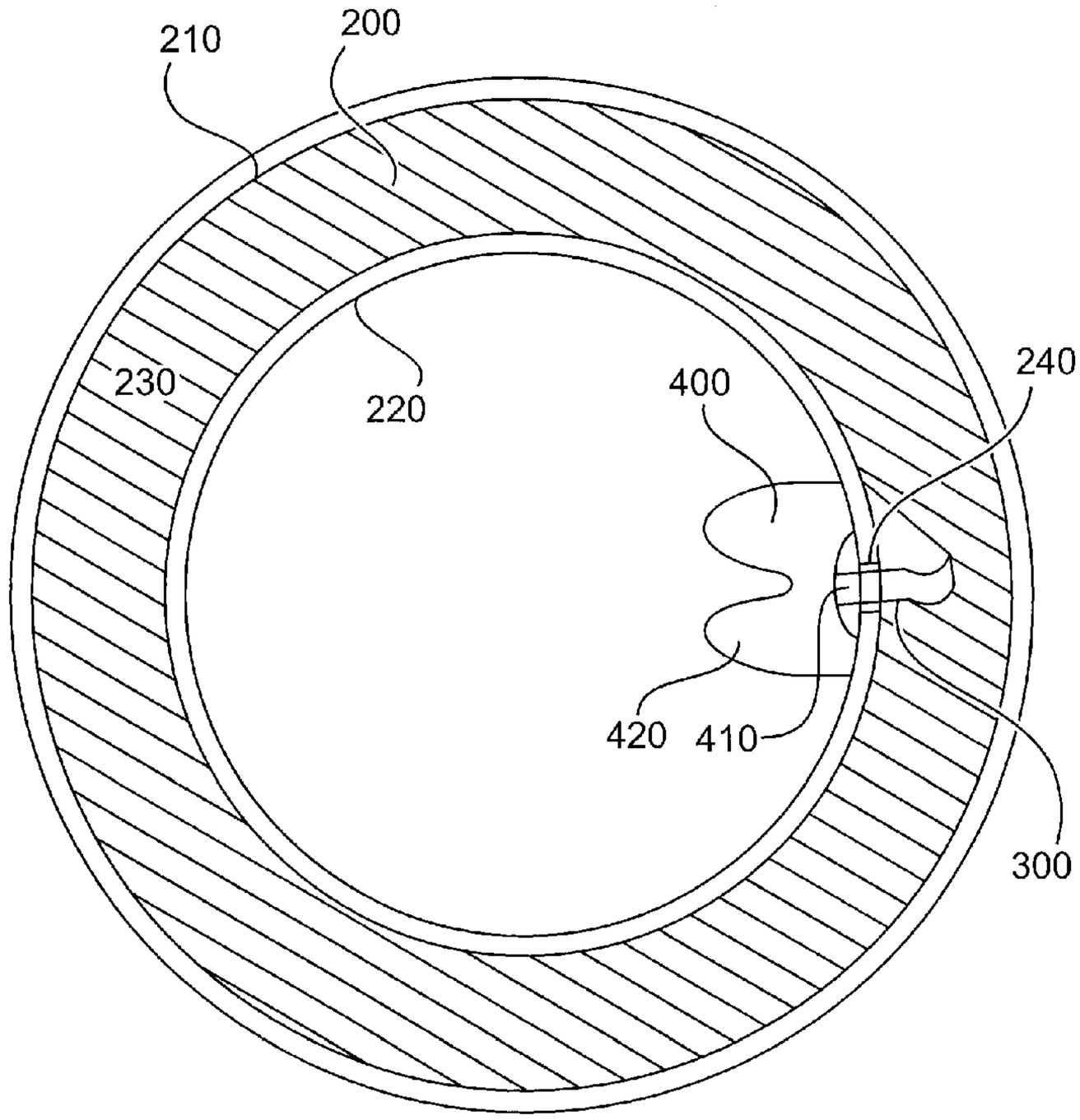
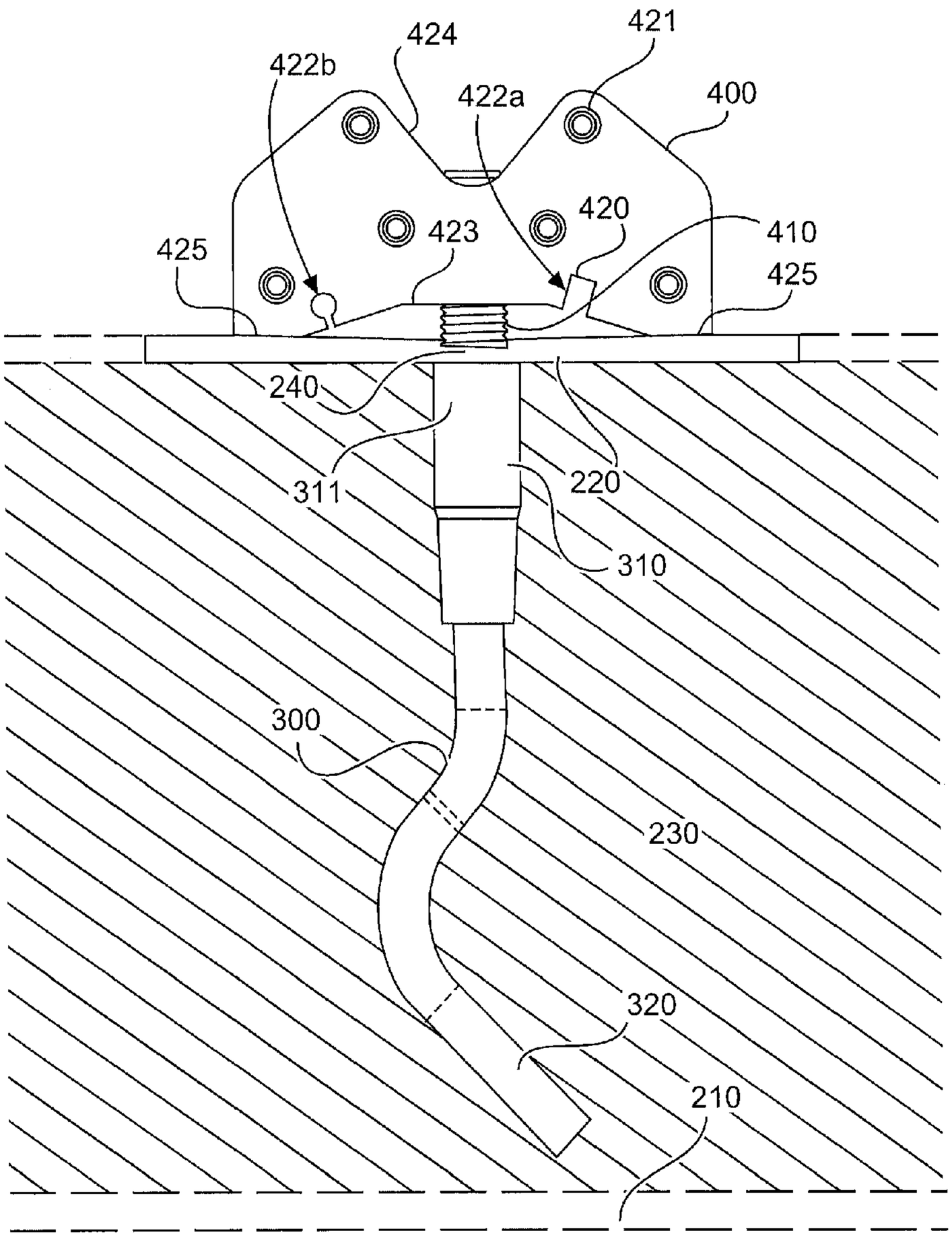


Fig. 2


424
421
422b
422a
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423
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425
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311
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300
230
320
210

Fig. 3

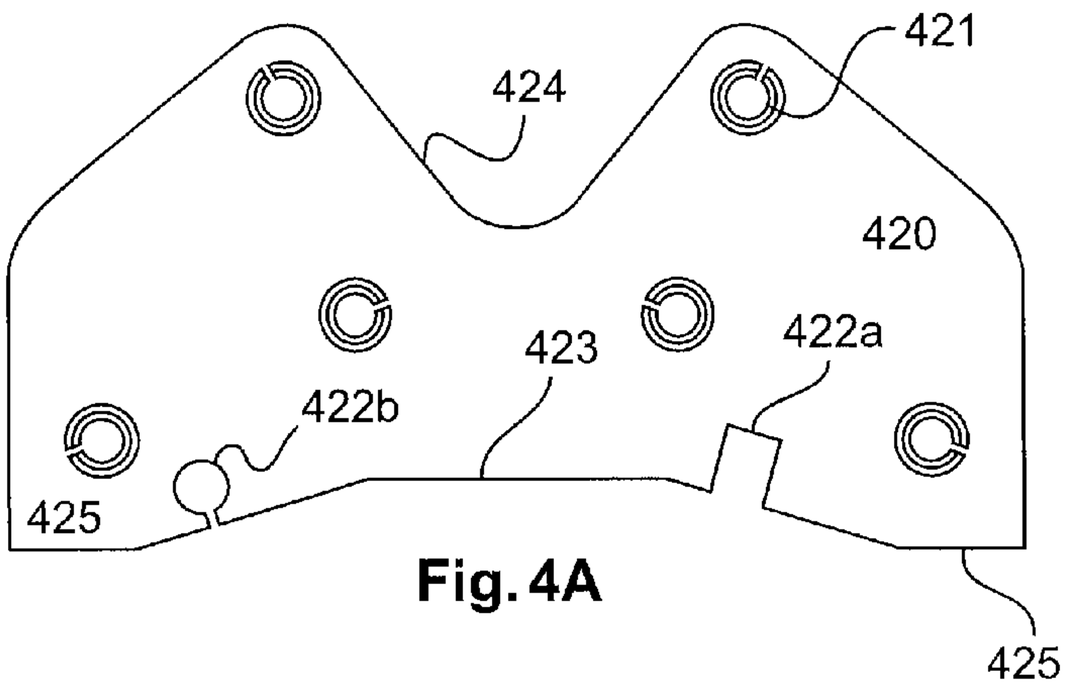


Fig. 4A

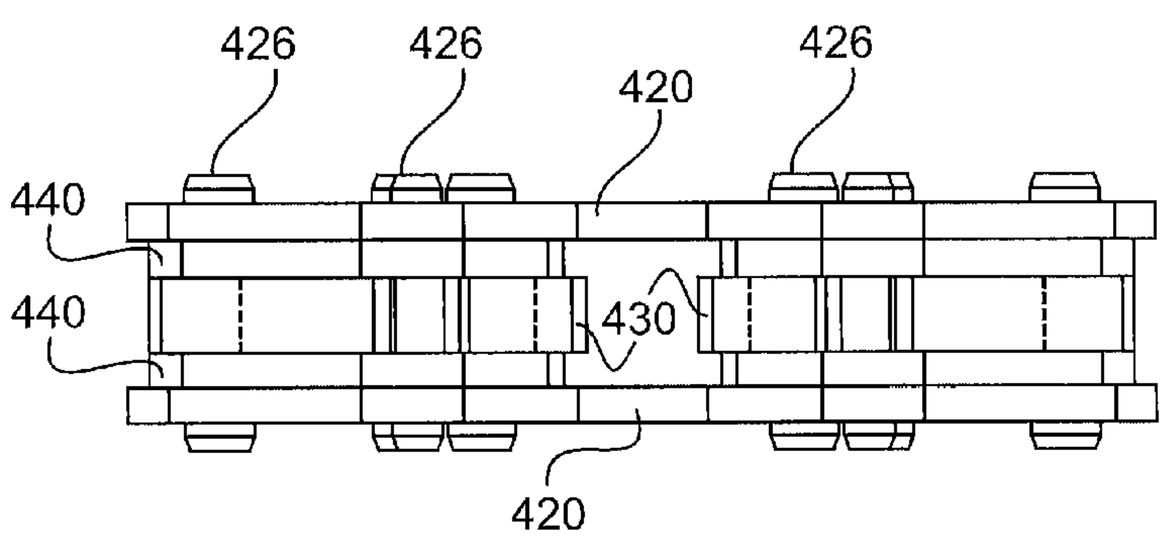


Fig. 4B

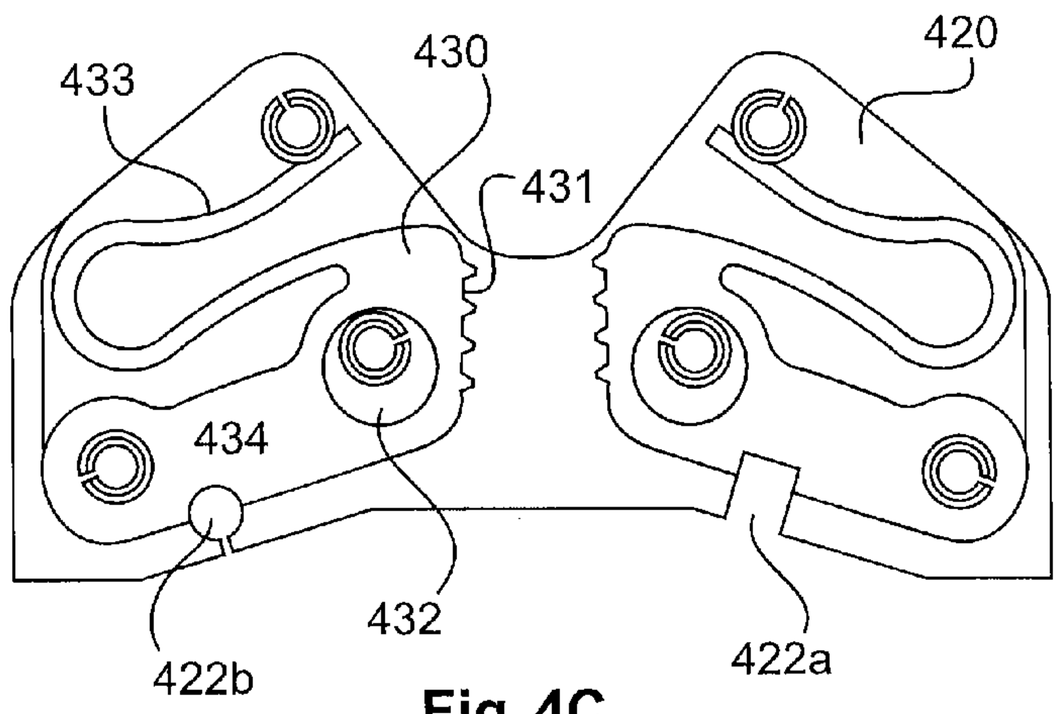
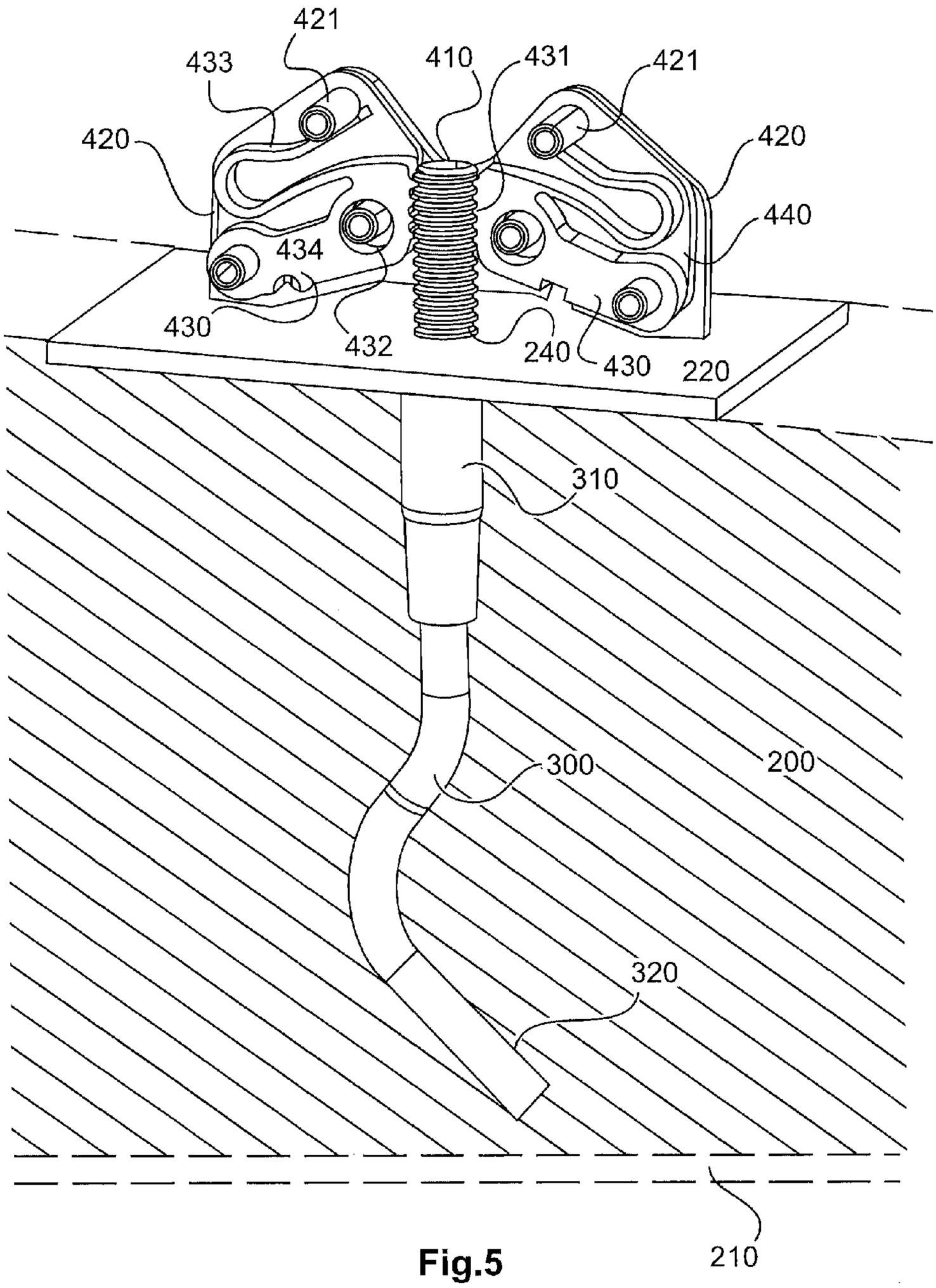


Fig. 4C


421
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210

Fig.5