(19) Europäisches Patentamt
European Patent Office
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(11) **EP 4 585 751 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.07.2025 Bulletin 2025/29

(21) Application number: **24151594.9**

(22) Date of filing: **12.01.2024**

(51) International Patent Classification (IPC):
E02D 5/52 *(2006.01)* ***B28B 23/00*** *(2006.01)*
E02D 27/01 *(2006.01)* ***E04C 3/34*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E02D 5/523; B28B 23/024; B28B 23/026; B28B 23/18; E02D 5/526; E02D 27/016; E04C 3/34; E04B 2001/4192

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(54) PILE JOINT, CONCRETE PILE, CASTING GUIDE AND METHOD FOR MANUFACTURING A CONCRETE PILE

(57) The present invention relates to a pile joint (100) that comprises a bottom plate (101) having a plurality of through-holes (105), a plurality of locking elements (102, 103), each locking element (102, 103) being inserted into one of the through-holes (105), and a plurality of reinforcement bars (104) having a first end and a second end, the first end of each reinforcement bar (104) being attached to one of the locking elements (102, 103). In the pile joint (100), the locking elements (102, 103) are not attached to the bottom plate (101). The present invention also relates to a concrete pile (200), a casting guide (300), and a method for manufacturing a concrete pile (200).

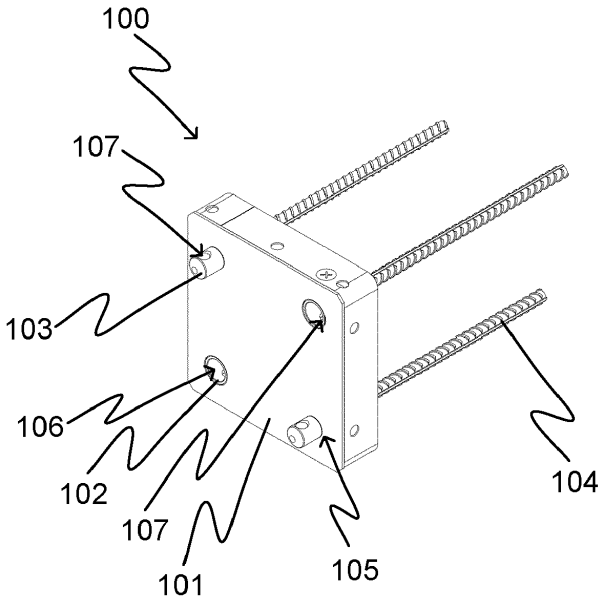

Fig. 1

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a pile joint, a casting guide, and a method for manufacturing a concrete pile according to the preambles of the appended independent claims. The invention also relates to a concrete pile having a pile joint in at least one of its ends.

BACKGROUND OF THE INVENTION

[0002] Pile joints are used in ends of concrete piles to join the concrete piles together. A conventional pile joint comprises a bottom plate having a plurality of through-holes, and a plurality of locking elements, which are placed into the through-holes and welded to the bottom plate. A reinforcement bar is welded to each locking element to ensure that the pile joint remains firmly attached to the concrete pile.

[0003] A concrete pile is typically manufactured by placing a pile joint and a pile reinforcement in a casting mould. A casting guide is attached to the pile joint and locked in place in the casting mould, for example, by wedging it against the sides of the casting mould so that the pile joint is aligned with the casting mould. The concrete pile is cast by pouring concrete into the casting mould. After the concrete has cured, the casting guide is detached from the pile joint, and the concrete pile is taken out of the casting mould.

[0004] A problem associated with the known pile joints is that they are difficult to handle. The problem is related to the reinforcement bars, which can easily bend during transportation of the pile joint and manufacturing of a concrete pile. Another problem associated with the known pile joints is that the bottom plate can easily bend as a result of the bending of the reinforcement bars. Yet another problem associated with the known pile joints is that their transportation requires a lot of space, resulting in low transportation efficiency and thus high transportation costs.

OBJECTIVES OF THE INVENTION

[0005] It is the main objective of the present invention to reduce or even eliminate the prior art problems presented above.

[0006] It is an objective of the present invention to provide a pile joint that is easy to handle and transport. It is also an objective of the invention to provide a pile joint that facilitates the manufacturing of a concrete pile. It is a further objective of the invention to provide a concrete pile that is easy and quick to join to another concrete pile. It is yet a further objective of the invention to provide a concrete pile that is easy and quick to manufacture. It is yet a further objective of the invention to provide a casting guide that facilitates the manufacturing of a concrete pile. It is yet a further objective of the invention to provide a method for manufacturing a concrete pile in an easy and quick manner.

[0007] In order to realise the above-mentioned objectives, the pile joint, the casting guide, and the method according to the invention are characterised by what is presented in the characterising portions of the appended independent claims. Advantageous embodiments of the invention are described in the dependent claims.

DESCRIPTION OF THE INVENTION

[0008] A pile joint according to the invention comprises a bottom plate having a plurality of through-holes, a plurality of locking elements, each locking element being inserted into one of the through-holes, and a plurality of reinforcement bars having a first end and a second end, the first end of each reinforcement bar being attached to one of the locking elements. In the pile joint according to the invention the locking elements are unattached to the bottom plate.

[0009] The pile joint according to the invention can be used in an end of a concrete pile to join the concrete pile end-to-end to another concrete pile. The pile joint is attached to the end of the concrete pile during the manufacturing of the pile, whereby the pile joint forms an integrated part of the concrete pile.

[0010] The pile joint is intended to be attached to an end of a concrete pile in such a manner that the bottom plate is essentially perpendicular to the longitudinal axis of the concrete pile. A first side of the bottom plate is intended to be arranged against a first side of a bottom plate of another pile joint when concrete piles are joined together. A second side of the bottom plate is intended to be arranged against an end of a concrete pile element of the pile. The bottom plate is preferably square or rectangular. The length and width of the bottom plate can be, for example, 150-600 mm. The thickness of the bottom plate can be, for example, 1.5-20 mm. The bottom plate is preferably made of steel. The through-holes can be located close to corners of the bottom plate. The diameter of the through-holes can be, for example, 15-80 mm.

[0011] In the pile joint according to the invention, the locking elements are placed into the through-holes of the bottom plate. The number of locking elements can vary depending on the application, but it is typically one, two, four or eight. The locking elements are preferably made of steel. One or more of the locking elements can be a locking housing that comprises a cavity into which a locking dowel of another pile joint can be inserted. One or more of the locking elements can be a locking dowel that can be inserted into a cavity of a locking housing of another pile joint. The locking dowel as well as the cavity in the locking housing have preferably circular cross sections. The length of the locking dowel and the depth of the cavity in the locking housing can be, for example, 20-100 mm. The diameter of the locking dowel can be, for example, 20-100 mm. The diameter of the cavity in the locking housing can be, for example, 1-10 mm larger than

the diameter of the locking dowel that it receives.

[0012] In the pile joint according to the invention, the reinforcement bars are attached to the locking elements. The reinforcement bars are used to ensure that the pile joint remains firmly attached to an end of a concrete pile. When the locking elements are in place in the through-holes, the reinforcement bars are essentially perpendicular to the bottom plate. The reinforcement bars are preferably made of steel. The length of the reinforcement bars can be, for example, 400-2000 mm. The diameter of the reinforcement bars can be, for example, 10-32 mm.

[0013] It has now been surprisingly found that instead of attaching the locking elements to the bottom plate, it is beneficial to leave the locking elements unattached to the bottom plate. In other words, in the pile joint according to the invention the locking elements are not welded or attached in any other way to the bottom plate.

[0014] An advantage of the pile joint according to the invention is that because the locking elements are not attached to the bottom plate, the pile joint is easy to handle and transport. The pile joint according to the invention can be handled and transported in pieces, which reduces the risk of bending the bottom plate and the reinforcement bars. Another advantage of the pile joint according to the invention is that it enables mass customisation of pile joints, wherein the task of differentiating a pile joint for a specific customer can be postponed until the point where a concrete pile is manufactured. Yet another advantage of the pile joint according to the invention is that it facilitates the manufacturing of a concrete pile. Yet another advantage of the pile joint according to the invention is that it can be transported cost-efficiently.

[0015] According to an embodiment of the invention at least one of the locking elements comprises a collar having a diameter larger than the diameter of the through-hole. The locking element is inserted into the through-hole in such a manner that the collar is located at the same side of the bottom plate with the reinforcement bar, i.e., at the second side of the bottom plate. The collar prevents the locking element going through the through-hole when the locking element is pulled from the first side of the bottom plate. A casting guide that is used in the manufacturing of a concrete pile can be attached to the pile joint so that the collar of the locking element is pulled against the second side of the bottom plate. In some applications, each locking element comprises a collar having a diameter larger than the diameter of the through-hole into which the locking element is inserted. The diameter of the collar can be, for example, less than 20 mm larger than the diameter of the through-hole.

[0016] According to an embodiment of the invention at least one of the locking elements comprises a hole provided with internal threads, into which hole the first end of the reinforcement bar provided with external threads is screwed. The use of threads enables the reinforcement bar to be attached to the locking element without welding. In some applications, each locking element comprises a hole provided with internal threads, into which hole the first end of the reinforcement bar provided with external threads is screwed.

[0017] According to an embodiment of the invention at least one of the locking elements comprises a transverse through-hole. The transverse through-hole can be utilised in locking pile joints together, wherein a locking pin is inserted through transverse through-holes of an interconnected locking dowel and locking housing. The transverse through-hole can also be utilised in the manufacturing of a concrete pile to lock a casting guide to the pile joint. The transverse through-hole can be arranged close to an end of the locking element. The diameter of the transverse through-hole can be, for example, 10-40 mm. In some applications, each locking element comprises a transverse through-hole.

[0018] The present invention also relates to a concrete pile. The concrete pile according to the invention comprises a concrete pile element having a first end and a second end, and a pile joint according to the invention attached to the first end of the concrete pile element.

[0019] The pile joint is attached to the end of the concrete pile element during the manufacturing of the concrete pile, whereby the pile joint forms an integrated part of the concrete pile. The concrete pile element is preferably provided with steel reinforcement to improve structural strength. The concrete pile element may have a circular, square, or rectangular cross-section. The length of the concrete pile element can be, for example, 3-40 m.

[0020] An advantage of the concrete pile according to the invention is that it is easy and quick to join to another concrete pile. Another advantage of the concrete pile according to the invention is that it is easy and quick to manufacture.

[0021] According to an embodiment of the invention the concrete pile comprises another pile joint according to the invention attached to the second end of the concrete pile element. This enables the concrete pile to be joined between two concrete piles.

[0022] The present invention also relates to a casting guide for a pile joint. The casting guide according to the invention comprises an end plate arrangeable in connection with a bottom plate of a pile joint, means for releasably attaching to the bottom plate of the pile joint, said means being mounted to the end plate, and means for releasably attaching to a plurality of locking elements of the pile joint, said means being mounted to the end plate.

[0023] The casting guide according to the invention is intended for a pile joint according to the invention to keep the pile joint in place during the casting of a concrete pile. The casting guide can be locked in place in a pile casting mould, for example, by wedging it against the sides of the pile casting mould so that the pile joint is aligned with the pile casting mould.

[0024] The casting guide according to the invention can releasably attach to both the bottom plate and the locking elements of the pile joint. The casting guide can

be such that the end plate is intended to be arranged in contact with or at a distance from the bottom plate of the pile joint. The end plate is preferably square or rectangular. The length and width of the end plate can be, for example, 150-600 mm. The thickness of the end plate can be, for example, 3-16 mm. The end plate is preferably made of steel.

[0025] The casting guide may comprise a frame to which the end plate is attached. The frame may comprise, for example, a plurality of tubes or rods which are attached perpendicularly to the end plate. The casting guide may comprise another end plate having means for releasably attaching to a bottom plate of a pile joint and means for releasably attaching to a plurality of locking elements of a pile joint. In this case, the end plates are preferably attached to the frame so that the end plates are aligned with and parallel to each other. The casting guide which has two end plates can be used in the manufacturing of two concrete piles simultaneously.

[0026] An advantage of the casting guide according to the invention is that it facilitates the manufacturing of a concrete pile.

[0027] According to an embodiment of the invention the means for releasably attaching to the bottom plate of the pile joint comprises a plurality of magnets. The magnets are attached to the end plate. One or more of the magnets are preferably arranged close to corners of the end plate. One of the magnets can be arranged at the centre of the end plate. The magnets can be attached directly or by using suitable spacers to the end plate. The magnets are preferably permanent magnets. The number of magnets can be, for example, 3-10.

[0028] According to an embodiment of the invention the means for releasably attaching to a plurality of locking elements of the pile joint comprises a plurality of attachment elements, each attachment element being arranged to releasably attach to one of the locking elements. The number of attachment elements preferably corresponds to the number of locking elements. The attachment elements are preferably made of steel. The attachment elements can be electrically, pneumatically, or hydraulically operated.

[0029] According to an embodiment of the invention each attachment element comprises two longitudinal parts and means for moving the two longitudinal parts towards and away from each other in a transverse direction.

[0030] The two longitudinal parts can be, for example, halves of a rod which can be inserted into a cavity of a locking housing of a pile joint and attached therein by moving the rod halves away from each other in a transverse direction. Alternatively, the two longitudinal parts can be, for example, halves of a tube inside which a locking dowel of a pile joint can be inserted. The tube halves can be attached to the locking dowel by moving the tube halves towards each other in a transverse direction. The two longitudinal parts can be moveable, for example, 5-50 mm with respect to each other in a transverse direction. The length of the two longitudinal parts can be, for example, 5-30 mm. The means for moving the two longitudinal parts towards and away from each other in a transverse direction may comprise an electric, pneumatic, or hydraulic actuator.

[0031] According to an embodiment of the invention each longitudinal part is provided with a projecting part extending in the transverse direction. The projecting part is arranged to the longitudinal part in such a manner that when the attachment element is attached to the locking element the projecting part protrudes into the transverse through-hole of the locking element.

[0032] According to an embodiment of the invention the means for moving the two longitudinal parts towards and away from each other in a transverse direction comprises a threaded rod arranged to go through a threaded through-hole in at least one of the two longitudinal parts. The two longitudinal parts can be moved towards and away from each other by rotating the threaded rod in opposite directions. Preferably one threaded rod is connected to two attachment elements so that the attachment elements can be operated simultaneously.

[0033] The present invention also relates to a method for manufacturing a concrete pile. The method according to the invention comprises attaching a casting guide according to the invention to a pile joint according to the invention, placing the casting guide and the pile joint in a pile casting mould, and pouring concrete into the pile casting mould. After the concrete has cured, the casting guide is detached from the pile joint, and the (precast) concrete pile is taken out of the pile casting mould. The concrete pile element is preferably provided with steel reinforcement to improve structural strength.

[0034] An advantage of the method according to the invention is that it enables to manufacture a concrete pile in an easy and quick manner.

[0035] The exemplary embodiments of the invention presented in this text are not interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" is used in this text as an open limitation that does not exclude the existence of also unrecited features. The features recited in the dependent claims are mutually freely combinable unless otherwise explicitly stated.

[0036] The exemplary embodiments presented in this text and their advantages relate by applicable parts to the pile joint, the concrete pile, the casting guide as well as the method according to the invention, even though this is not always separately mentioned.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037]

Fig. 1 illustrates a pile joint according to an embodiment of the invention,

fig. 2 illustrates a concrete pile according to an embodiment of the invention,

fig. 3 illustrates a casting guide according to an embodiment of the invention, and

figs. 4A-4F illustrate the manufacturing of a concrete pile according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0038] The same reference signs are used of the same or like components in different embodiments.

[0039] Fig. 1 illustrates a pile joint according to an embodiment of the invention. The pile joint 100 can be used in an end of a concrete pile to join the concrete pile end-to-end to another concrete pile.

[0040] The pile joint 100 comprises a bottom plate 101, two locking housings 102, two locking dowels 103 and four reinforcement bars 104. The bottom plate 101 has four through-holes 105 into which the locking housings 102 and the locking dowels 103 are inserted. The locking housings 102 and the locking dowels 103 are not attached to the bottom plate 101. The reinforcement bars 104 are attached at their ends to the locking housings 102 and the locking dowels 103. The reinforcement bars 104 are used to ensure that the pile joint 100 remains firmly attached to a concrete pile.

[0041] Each locking housing 102 comprises a cavity 106 into which a locking dowel of another pile joint can be inserted. Each locking dowel 103 can be inserted into a cavity of a locking housing of another pile joint.

[0042] Each locking housing 102 and locking dowel 103 comprises a transverse through-hole 107 that can be utilised in locking pile joints together. A locking pin can be inserted through the transverse through-holes 107. The transverse through-holes 107 can also be utilised in the manufacturing of a concrete pile to lock a casting guide to the pile joint 100.

[0043] Each locking housing 102 and locking dowel 103 comprises a collar having a diameter larger than the diameter of the through-hole 105. The collar is located at the same side of the bottom plate 101 with the reinforcement bar 104. A casting guide that is used in the manufacturing of a concrete pile can be attached to the pile joint 100 so that the collar is pulled against the bottom plate 101. The collars prevent the locking housings 102 and the locking dowels 103 going through the through-holes 105.

[0044] Fig. 2 illustrates a concrete pile according to an embodiment of the invention. The concrete pile 200 comprises a concrete pile element 201 to an end of which is attached a pile joint 100 of fig. 1. The pile joint 100 is attached to the end of the concrete pile element 201 during the manufacturing of the concrete pile 200, whereby the pile joint 100 forms an integrated part of the concrete pile 200. The concrete pile element 201 is provided with steel reinforcement to improve structural strength.

[0045] Fig. 3 illustrates a casting guide according to an embodiment of the invention. The casting guide 300 can be used in the manufacturing of two concrete piles. The casting guide 300 can keep two pile joints in place during the casting of the concrete piles. The casting guide 300 can be locked in place in a pile casting mould, for example, by wedging it against the sides of the pile casting mould so that the pile joints are aligned with the pile casting mould.

[0046] The casting guide 300 comprises four parallelly arranged tubes 301 and two end plates 302 which are attached to opposite ends of the tubes 301. Each end plate 302 is provided with five permanent magnets 303 for releasably attaching to a bottom plate of a pile joint. Four of the permanent magnets 303 are arranged close to corners of the end plate 302, and one of the permanent magnets 303 is arranged at the centre of the end plate 302.

[0047] Each end plate 302 is provided with two attachment housings 304 for releasably attaching to locking dowels of a pile joint, and two attachment dowels 305 for releasably attaching to locking housings of a pile joint.

[0048] Each attachment housing 304 comprises two opposing tube halves 306 inside which a locking dowel of a pile joint can be inserted. The tube halves 306 can be moved towards and away from each other in a transverse direction by rotating a threaded rod 307 that is arranged to go through threaded through-holes 308 in the tube halves 306. The tube halves 306 can be attached to a locking dowel by moving the tube halves 306 towards each other and detached from the locking dowel by moving the tube halves 306 away from each other.

[0049] Each attachment dowel 305 comprises two opposing rod halves 309 which can be inserted into a cavity of a locking housing of a pile joint. The rod halves 309 can be moved towards and away from each other in a transverse direction by rotating the threaded rod 307 that is arranged to go through threaded through-holes 310 in the rod halves 309. The rod halves 309 can be attached to a locking housing by moving the rod halves 309 away from each other and detached from the locking housing by moving the rod halves 309 towards each other.

[0050] Each tube half 306 and rod half 309 is provided with a projecting part 311 extending in the transverse direction. The projecting parts 311 are arranged to the tube halves 306 and the rod halves 309 in such a manner that the projecting parts 311 can protrude into the transverse through-holes of the locking dowels and the locking housings.

[0051] Figs. 4A-4F illustrate the manufacturing of a concrete pile according to an embodiment of the invention. The concrete pile 200 is manufactured by using a pile casting mould 401.

[0052] In the first phase of the manufacturing process, a bottom plate 101 is placed in the pile casting mould 401, and two locking housings 102 and two locking dowels 103

provided with reinforcement bars 104 are inserted into through-holes 105 of the bottom plate 101. The locking housings 102 and the locking dowels 103 are not attached to the bottom plate 101. The first phase is shown figs. 4A-4B.

[0053] In the second phase of the manufacturing process, a casting guide 300 is attached to the pile joint 100. The attachment of the casting guide 300 to the pile joint 100 is achieved by using permanent magnets 303 of the casting guide 300 which attach to the bottom plate 101 of the pile joint 100, and by using attachment housings 304 and attachment dowels 305 of the casting guide 300 which attach to the locking housings 102 and the locking dowels 103 of the pile joint 100. The second phase is shown in figs. 4C-4D.

[0054] In the third phase of the manufacturing process, concrete is poured into the pile casting mould 401 while the pile joint 100 is kept in place with the casting guide 300. The third phase is shown in fig. 4E.

[0055] In the fourth phase of the manufacturing process, after the concrete has cured, the casting guide is detached from the pile joint 100. The (precast) concrete pile 200 can now be taken out of the pile casting mould 401. The fourth phase is shown in fig. 4F.

[0056] Only advantageous exemplary embodiments of the invention are described in the figures. It is clear to a person skilled in the art that the invention is not restricted only to the examples presented above, but the invention may vary within the limits of the claims presented hereafter. Some possible embodiments of the invention are described in the dependent claims, and they are not to be considered to restrict the scope of protection of the invention as such.

Claims

1. A pile joint, comprising:

- a bottom plate having a plurality of through-holes,
- a plurality of locking elements, each locking element being inserted into one of the through-holes, and
- a plurality of reinforcement bars having a first end and a second end, the first end of each reinforcement bar being attached to one of the locking elements,

characterised in that the locking elements are unattached to the bottom plate.

2. The pile joint according to claim 1, **characterised in that** at least one of the locking elements comprises a collar having a diameter larger than the diameter of the through-hole.

3. The pile joint according to claim 1 or 2, **characterised in that** at least one of the locking elements comprises a hole provided with internal threads, into which hole the first end of the reinforcement bar provided with external threads is screwed.

4. The pile joint according to any of the preceding claims, **characterised in that** at least one of the locking elements comprises a transverse through-hole.

5. A concrete pile, comprising:

- a concrete pile element having a first end and a second end,

characterised in that the concrete pile comprises a pile joint according to any of the preceding claims attached to the first end of the concrete pile element.

6. A casting guide, comprising:

- an end plate arrangeable in connection with a bottom plate of a pile joint,

characterised in that the casting guide comprises:

- means for releasably attaching to the bottom plate of the pile joint, said means being mounted to the end plate, and
- means for releasably attaching to a plurality of locking elements of the pile joint, said means being mounted to the end plate.

7. The casting guide according to claim 6, **characterised in that** the means for releasably attaching to the bottom plate of the pile joint comprises a plurality of magnets.

8. The casting guide according to claim 6 or 7, **characterised in that** the means for releasably attaching to a plurality of locking elements of the pile joint comprises a plurality of attachment elements, each attachment element being arranged to releasably attach to one of the locking elements.

9. The casting guide according to claim 8, **characterised in that** each attachment element comprises two longitudinal parts and means for moving the two longitudinal parts towards and away from each other in a transverse direction.

10. The casting guide according to claim 9, **characterised in that** each longitudinal part is provided with a projecting part extending in the transverse direction.

11. The casting guide according to claim 9 or 10, **characterised in that** the means for moving the two

longitudinal parts towards and away from each other in a transverse direction comprises a threaded rod arranged to go through a threaded through-hole in at least one of the two longitudinal parts.

12. A method for manufacturing a concrete pile, **characterised in that** the method comprises:

- attaching a casting guide according to any of claims 6 to 11 to a pile joint according to any of claims 1 to 4,
- placing the casting guide and the pile joint in a pile casting mould, and
- pouring concrete into the pile casting mould.

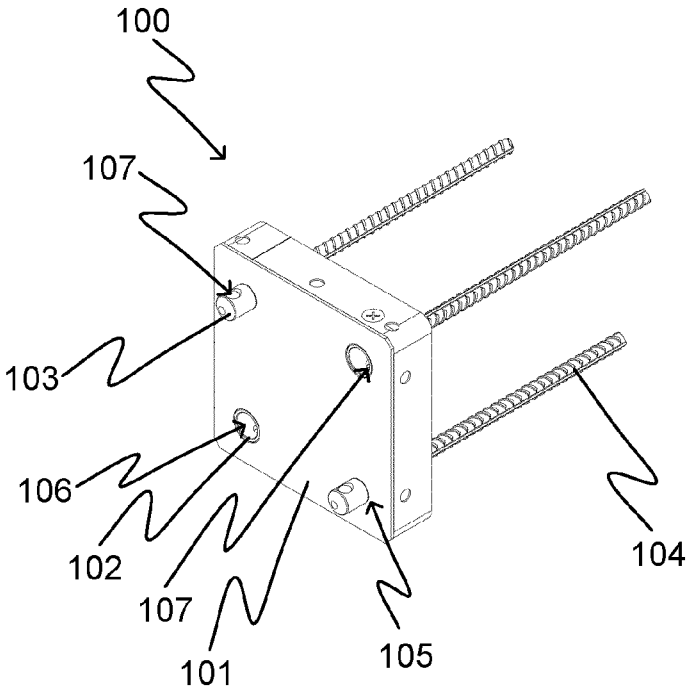

Fig. 1

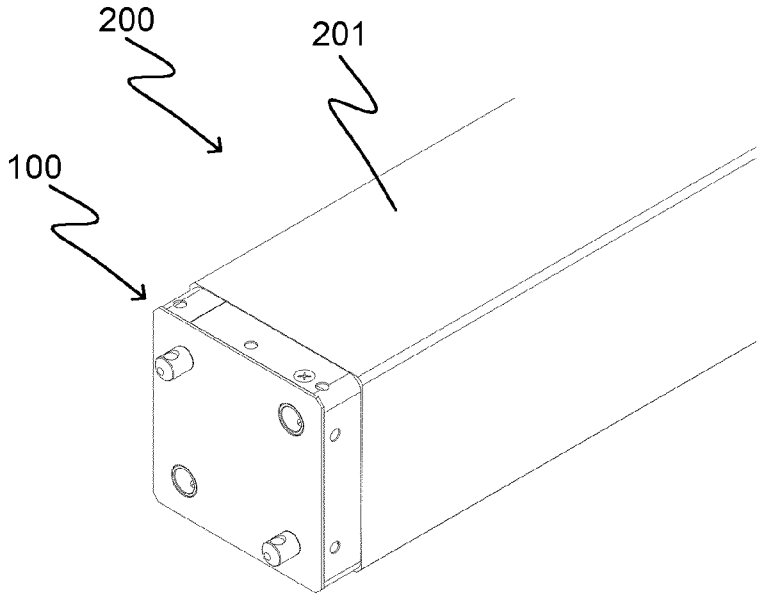

Fig. 2

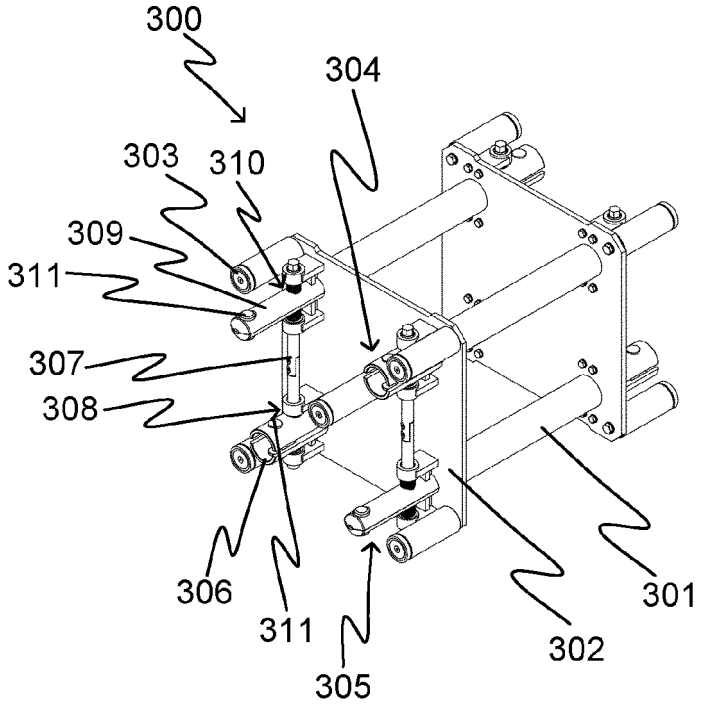

Fig. 3

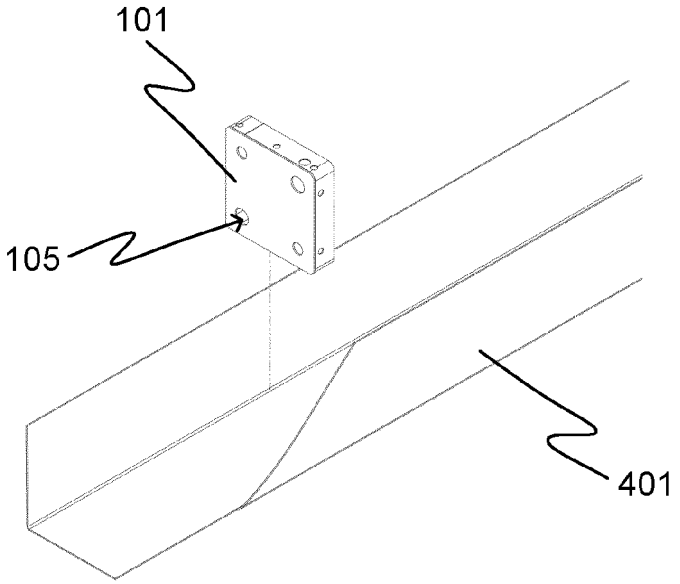

Fig. 4A

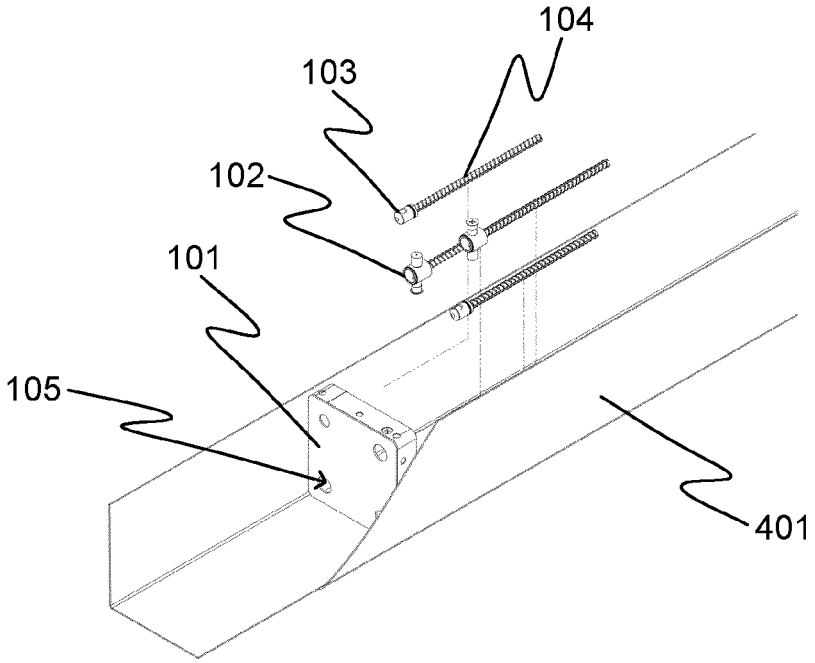

Fig. 4B

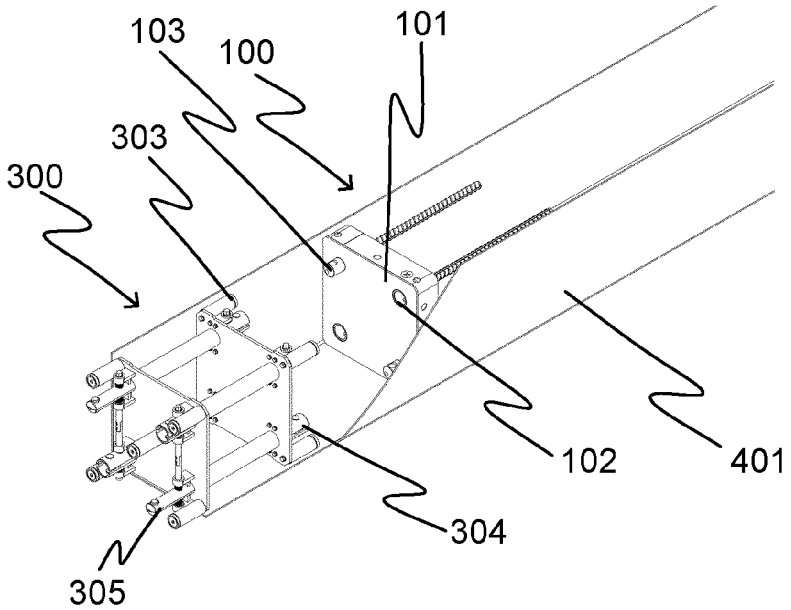

Fig. 4C

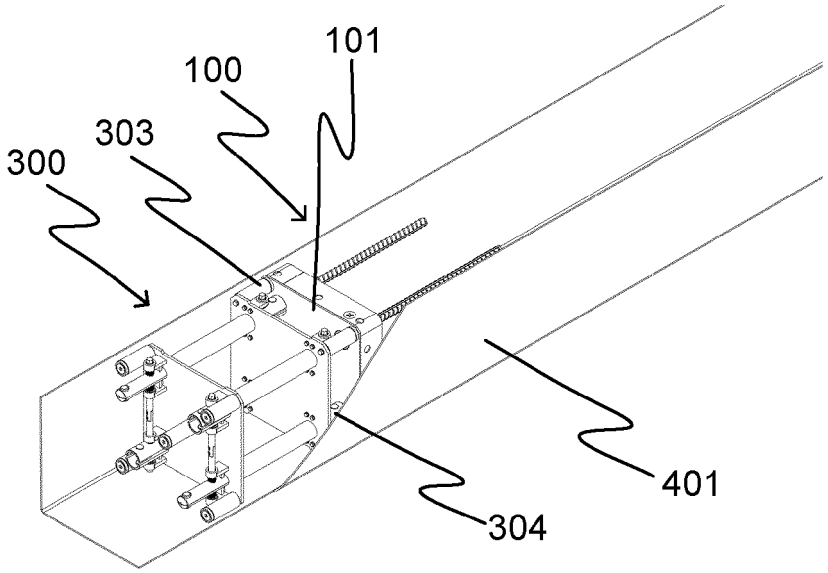

Fig. 4D

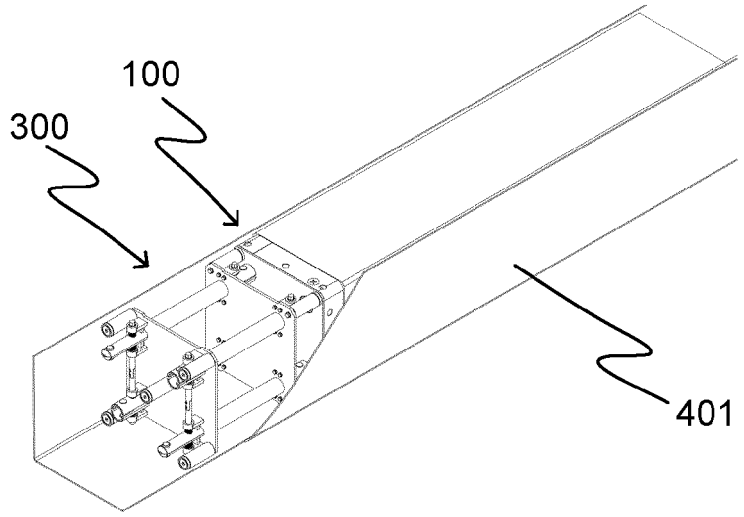

Fig. 4E

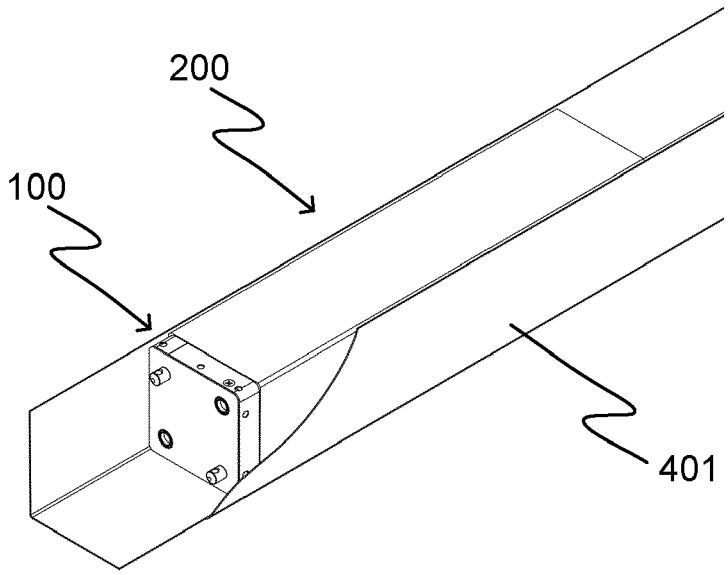

Fig. 4F

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PARTIAL EUROPEAN SEARCH REPORT

under Rule 62a and/or 63 of the European Patent Convention. This report shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number
EP 24 15 1594

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2023/332366 A1 (TAY KOK HUAT [MY]) 19 October 2023 (2023-10-19) * paragraph [0015] - paragraph [0027]; figure 2 *	1-5	INV. E02D5/52 B28B23/00 E02D27/01 E04C3/34
X	EP 2 204 498 A1 (CT PAELE AS [DK]) 7 July 2010 (2010-07-07) * paragraph [0023] - paragraph [0037]; figures 1a-1d *	1-5	
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TECHNICAL FIELDS SEARCHED (IPC)

E02D
E04B
B29C
B28B
E04C

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

Place of search	Date of completion of the search	Examiner
Munich	22 July 2024	Geiger, Harald

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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INCOMPLETE SEARCH
SHEET C

Application Number
EP 24 15 1594

Claim(s) completely searchable:
1-5

Claim(s) not searched:
6-12

Reason for the limitation of the search:

According to the request of the applicant only the claims 1-5 were searched.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 15 1594

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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22-07-2024

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