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(71) Applicant: **Elematic Oyj**
37801 Akaa (FI)

(72) Inventor: **EILOLA, Jani**
37560 Lempäälä (FI)

(74) Representative: **Berggren Oy**
P.O. Box 16
Eteläinen Rautatiekatu 10A
00101 Helsinki (FI)

(54) **APPARATUS FOR DRILLING DRAINAGE HOLES**

(57) Apparatus (1) for drilling drainage holes in a lower surface of a prefabricated hollow-core concrete product (7) during lifting of the product, which apparatus comprises a lifting beam (2) with at least two lifting clamps (3, 3') for clamping the concrete product, and at least one drilling beam (4, 4') with at least one drilling unit (8a-8c), wherein the at least one drilling beam (4, 4') is connected to the lifting beam (2) movably in the longitudinal direction of the lifting beam and that the at least one drilling beam is movable in a direction perpendicular to the longitudinal direction of the lifting beam.

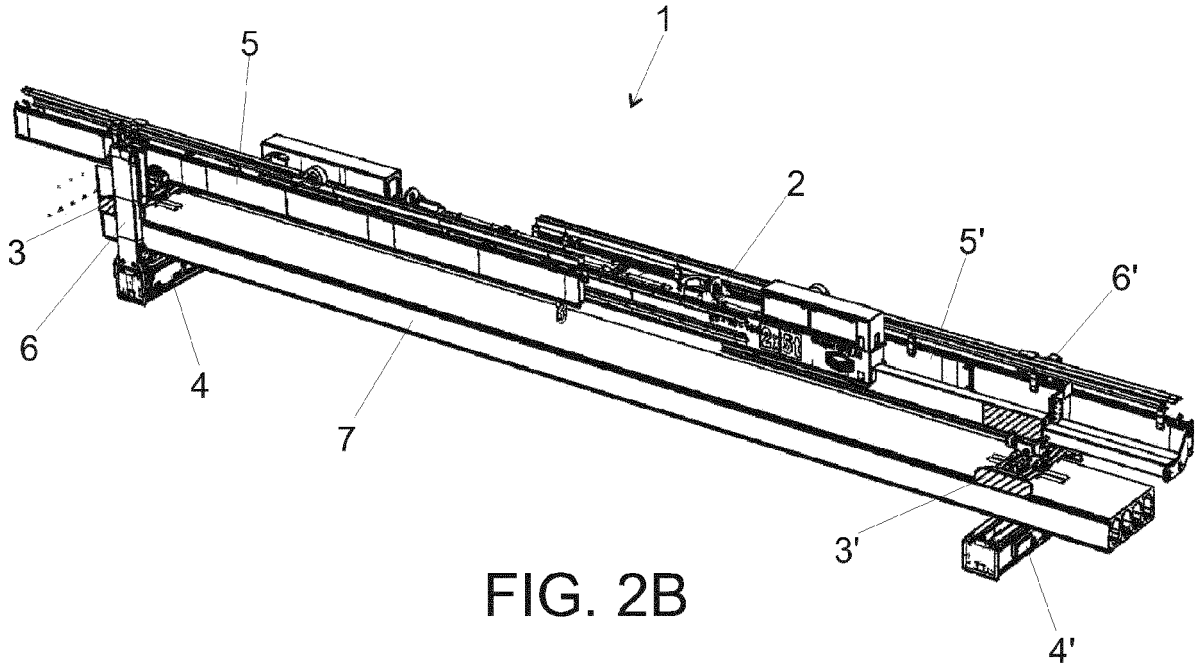

FIG. 2B

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Description

[0001] The present invention relates to drilling drainage holes in prefabricated concrete hollow-core products. More precisely the invention relates to an apparatus for drilling drainage holes in prefabricated concrete hollow-core products during the lifting and transfer or the products.

[0002] Drainage holes are typically drilled in the lower surface of hollow-core products at the areas of the hollow cores in order to remove water from the hollow cores of the product. Water gets typically into the hollow cores during sawing of the hollow-core products on the casting bed for final product length(s), from rain during storage of the hollow-core products before transfer to construction sites, at the construction sites before final installation of the products, and by condensation as a result of temperature variations during storage. The drainage holes are typically drilled at both longitudinal end areas of each of the hollow cores in the product, and there are typically between 4 and 9, or even more, hollow-cores in a single product. The amount of drainage holes in product also typically increases, if portion of the hollow core or cores are filled along the length of the product, or if a portion of the product if cut away which cut also cuts the hollow core(s) of the product.

[0003] Drainage holes can be drilled to fresh concrete hollow-core products before curing of the concrete, wherein the holes are drilled through the whole product via its upper surface when the product is on casting bed. Alternatively, the holes can be drilled to cured hollow-core concrete products via their lower surface, but this requires lifting of the products and is typically done either during their transporting with lifting or in a separate drilling station where the products are lifted from casting bed. Drilling the holes in fresh hollow-core concrete products is problematic due to the quality of holes and can cause fresh concrete to detach itself from the upper area of the hollow core lowering the quality of the product itself. Drilling the holes in cured concrete products add work phases in the handling of the products, which slows down the prefabrication process and can cause formation of bottlenecks in the prefabrication process.

[0004] Drainage holes are typically drilled at the longitudinal end areas of the concrete hollow-core products, but some products require drilling of the drainage holes at various positions along the length of the products.

[0005] Publication EP 0 940 236 A2 discloses an apparatus for drilling drainage holes into the lower surface of a concrete hollow-core slab, wherein at least two drills are attached to a detachable beam connected to a slab lifting crane. In this solution the drainage holes can be dilled to the slab during the lifting of the slab, but the location of the drainage holes is restricted to the place of the lifting tongs of the slab lifting crane, which is typically at the end portions of the slab.

[0006] Publication EP 0 455 495 A1 discloses an apparatus for transferring concrete slabs, wherein the apparatus comprises drilling units which are swung under the slab during lifting of the slab for drilling drainage holes. Also in this solution the location of the drainage holes is restricted to the end portions of the slab

[0007] Publication EP 1 738 885 A1 discloses an apparatus for drilling drainage holes, which apparatus is in form of a separate drilling station with three sections equipped with drilling units and movable in relation to each other. In this solution the section movable between the end sections allows drilling of drainage holes along the length of the hollow-core slab. This solution, however, requires additional work steps in the handling the cured hollow-core slabs since the slabs need to be moved to the separate drilling station for drilling of the drainage holes.

[0008] The present invention provides a solution for drilling the drainage holes in hollow-core concrete products during the lifting of the products, wherein the drilling of the drainage holes is not restricted at the end portions of the products. This eliminates the need for a separate drilling station in cases where the drainage holes need to be drilled in areas away from the end portions of the product. Further, the solution of the present invention allows also drilling of the drainage holes at the ends of the hollow-core concrete products which have their ends cut at an angle.

[0009] The apparatus of the invention for drilling drainage holes in a lower surface of a prefabricated hollow-core concrete product during lifting of the product comprises a lifting beam with at least two lifting clamps for clamping the product, and at least one drilling beam with at least one drilling unit, wherein the at least one drilling beam is connected to the lifting beam movably in the longitudinal direction of the lifting beam and that the at least one drilling beam is movable in a direction perpendicular to the longitudinal direction of the lifting beam.

[0010] The perpendicular direction is in this context vertical direction, i.e. the direction towards a concrete hollow-core product to be lifted in a cross-sectional plane of the lifting beam when the product is clamped between the lifting clamps of the lifting beam and lifted.

[0011] The present invention allows the drilling beam or beams to be located substantially at the level of the lifting beam, and preferably at the end areas of the lifting beam, when the lifting beam is moved. When a hollow-core product is lifted with the lifting beam the drilling beam can be vertically lowered below the lower surface of the product outside the longitudinal end of the product, and then moved under the product with movement in the longitudinal direction of the lifting beam. This way the drilling beam ban be moved below the lower surface of the lifted hollow-core concrete product around the longitudinal end of the product without any turning or swiveling movements, and the drilling beam can preferably be freely moved along the length of the lifted hollow-core product.

[0012] In an embodiment of the apparatus of the invention the apparatus comprises two drilling beams connected to the lifting beam movably. This embodiment pro-

vides the drilling beam at both ends of the lifting beam and speeds up the drilling process.

[0013] In an embodiment of the apparatus of the invention the drilling beam, or beams, comprises three or four drilling units, which drilling units are movable along the length of the drilling beam. This embodiment allows deactivation of one or two of the drilling units by moving drilling unit at the end of the drilling beam and thus outside of the area of the lower surface of the hollow-core concrete product lifted with the lifting beam.

[0014] In an embodiment of the apparatus of the invention the drilling units are configured to be connected to the at least one drilling beam from one side of the drilling unit. This allows the drilling units to be connected to different sides of the drilling beam, or different sides of a groove in the drilling beam, which enhances the movability of the different drilling units in the same drilling beam in relation to each other.

[0015] In an embodiment of the apparatus of the invention the at least one drilling unit is configured to be deactivated by moving the drilling unit at longitudinal end of the at least one drilling beam. This way the deactivation of the drilling unit(s) is simply obtained by moving the drilling units not required for drilling at the closest longitudinal end of the drilling beam and thus away from under the concrete product.

[0016] In an embodiment of the apparatus of the invention the drilling beam, or beams, is connected to the lifting beam with a guide rail for providing the movement in the perpendicular direction, i.e. vertical direction, which guide rail is connected to the lifting beam movably along the length of the of the lifting beam, i.e. for providing the movement in longitudinal direction of the lifting beam. In this embodiment the drilling movement of the drilling units, i.e. movement of the drilling units towards the lower surface of the hollow-core concrete product during drilling of the drainage holes, is preferably obtained with the movement of the guide rail in the perpendicular direction, i.e. vertical direction. This allows simplified construction of the apparatus of the invention by eliminating the need for separate drive for the drilling movement of the drilling units. Further, in this embodiment the drilling beam is preferably connected to the guide rail only from one of the longitudinal ends of the drilling beam.

[0017] The connection between the lifting beam and the guide rail preferable comprises a longitudinal part extending in the longitudinal direction of the lifting beam, which longitudinal part is movable in the longitudinal direction along the length of the lifting beam, and the guide rail is preferably connected to the longitudinal part movably along the length of the longitudinal part. This allows telescopic connection between the lifting beam and the guide rail, wherein the guide rail and the drilling beam connected to it can be moved further in the longitudinal direction of the lifting beam than the length of the lifting beam allows by moving the longitudinal part in relation to the lifting beam.

[0018] In an embodiment of the apparatus of the invention the apparatus comprises a control system for positioning the at least one drilling unit in a predefined position for drilling draining hole. This control system can be fully automatic, wherein the positions for drainage holes are retrieved from design specifics of the prefabricated concrete product, or semi-automatic, wherein the operator of the apparatus selects locations for the drainage holes to be drilled from preset options, for example.

[0019] More precisely the features defining an apparatus in accordance with the present invention are presented in claim 1. Dependent claims present advantageous features and embodiments of the invention.

[0020] Exemplifying embodiment of the invention and its advantages are explained in greater detail below in the sense of example and with reference to accompanying drawings, where

Figure 1 shows schematically an embodiment of the apparatus of the invention,

Figures 2A and 2B shows schematically the apparatus of figure 1 during lifting of a concrete product, and

Figure 3 shows schematical enlargement of one longitudinal end of the apparatus of figure 1.

[0021] Figure 1 shows schematically an embodiment of the apparatus 1 of the invention, which comprises a lifting beam 2 with lifting clamps 3, 3'.

[0022] In this embodiment the apparatus 1 comprises two drilling beams 4, 4' arranged at the longitudinal ends of the lifting beam 2. The drilling beams 4, 4' are connected to the lifting beam 2 with longitudinal parts 5, 5' which are movable in relation to the lifting beam in the longitudinal direction of the lifting beam, with rail and drive arrangements for example. The drilling beams 4, 4' are connected to the longitudinal parts 5, 5' with guide rails 6, 6', which guide rails allow the drilling beams to be moved in vertical direction, which vertical direction is perpendicular in relation to the longitudinal direction of the lifting beam 2. The guide rails 6, 6' are connected to the longitudinal parts 5, 5' movably along the length of the longitudinal parts.

[0023] In the embodiment of figure 1 the longitudinal parts 5, 5' are located on opposite sides of the lifting beam 2.

[0024] In the position of figure 1 the drilling beams 4, 4' are located in stored position, in which position the drilling beams does not prevent or obstruct the operation of the lifting beam 2. In this position the lifting beam 2 can be moved over a hollow-core concrete product to be lifted so that the product can be clamped with the lifting clamps 3, 3'.

[0025] In the lifting process the lifting beam 2 is positioned over the hollow-core concrete product 7, the lifting clamps 3, 3' are moved along the length of the lifting beam at the end areas of the product to be lifted, and the

product is clamped with the lifting clamps, as shown in figure 2A.

[0026] Once the product has been lifted sufficiently high from the lifting place, the drilling beams 4, 4' are activated and moved first downwards with the guide rails 6, 6' below the lower surface level of the lifted product 7 outside and front of the longitudinal ends of the product. Once the drilling beams 4, 4' are located below the lower surface level of the lifted product 7, the drilling beams are moved below the lifted product with the movement of the longitudinal parts 5, 5' in the longitudinal direction of the lifting beam 2 and/or moving the guide rails 6, 6' along the length of the longitudinal parts. This way the drilling beams 4, 4' can be moved at any locations under the lifted product 7 for drilling the drainage holes at any position along the length of the product, as shown in figure 2B.

[0027] When the drilling beams 4, 4' and the drilling unit or drilling units in the drilling beams are positioned in the predefined positions for drilling the drainage hole or holes, the drilling units or units are activated and the drilling beams 4, 4' are moved towards the lower surface of the product 7 along the guide rails 6, 6' until the drainage holes reaching the hollow-cores inside the concrete product are achieved. Then the drilling beams 4, 4' are moved downwards, i.e. away from the lower surface of the concrete product 7, the drilling units are stopped once the drill bits have cleared the drilled drainage holes, and the drilling beams with the drilling units are moved to next drainage hole location and positioned for drilling. This is repeated until all drainage holes are drilled, after which the drilling beams 4, 4' are moved back to the position shown in figure 2A to wait for releasing of the product 7 and for next lifting and drilling operation.

[0028] Figure 3 shows an enlargement of the longitudinal end of the apparatus 1 showing the drilling beam 4' connected to the lifting beam 2 vial the guide rail 6' and the longitudinal part 5'. In this embodiment the drilling beam 4' is equipped with three drilling units 8a-8c, which drilling units are movable along the length of the drilling beam.

[0029] The movability of the drilling units 8a-8c in relation to the drilling beam 4' is obtained with suitable drives. Further, the two drilling units 8a and 8c can be deactivated by moving one or both of them at the corresponding ends of the drilling beam. This deactivation of the drilling units 8a and 8c allows drilling of 1-3 drainage holes simultaneously wherein no vertical movement of the drilling units 8a-8c in relation to the drilling beam 4' is required and the drilling movement during the drilling of drainage holes can be obtained by vertical movement of the drilling beam with the guide rail 6'. The deactivation of drilling units 8a and 8c this way requires that the length of the drilling beam 4' is longer that the width of the hollow-core concrete product 7 so that the drilling units, especially drilling unit 8a, can be moved to area outside the lower surface of the concrete product.

[0030] As can be seen from the embodiments of the figures, the drilling beams 4, 4' are connected to a single guide rail 6, 6' from one of the longitudinal ends of the drilling beams. This L-shaped structure formed by the drilling beams 4, 4' and the guide rails 6, 6' allows simple structural entity which can be controlled with minimum number of operating drives. In this structure, however, the connection between the guide rail 6, 6' and the drilling beam 4, 4' must be very stiff, i.e. it must be strong enough to bear the load caused to the drilling beam during the drilling operation without significant flexing, since this flexing could easily break the drill bits of the drilling units 8a-8c during drilling operation. Alternatively, there could be guide rails on both longitudinal ends of the drilling beam, but this would lead to more complex structure for the apparatus of the invention.

[0031] In relation to the longitudinal parts 5, 5' utilized in the embodiment of the figures it is to be noted that these parts are optional. The apparatus of the invention can also be implemented without these longitudinal parts by directly connecting the guide rails 6, 6' to the structure of the lifting beam 2 movably along the length of the lifting beam, for example with a suitable sledge construction.

[0032] In the embodiment of the figures the apparatus 1 is equipped with two drilling beams 4, 4', wherein the drilling of the drainage holes along the whole length of the hollow-core concrete product 7 lifted can be implement sufficiently quickly and without significant hindrance to the prefabrication process. However, the apparatus of the invention can evidently also be implemented with a single drilling beam.

[0033] The specific exemplifying embodiment of the invention shown in figures and discussed above should not be construed as limiting. A person skilled in the art can amend and modify the embodiment described in many evident ways within the scope of the attached claims. Thus, the invention is not limited merely to the embodiment described above.

Claims

1. Apparatus (1) for drilling drainage holes in a lower surface of a prefabricated hollow-core concrete product (7) during lifting of the product, which apparatus comprises a lifting beam (2) with at least two lifting clamps (3, 3') for clamping the concrete product, and at least one drilling beam (4, 4') with at least one drilling unit (8a-8c), **characterized in that** the at least one drilling beam (4, 4') is connected to the lifting beam (2) movably in the longitudinal direction of the lifting beam and that the at least one drilling beam is movable in a direction perpendicular to the longitudinal direction of the lifting beam.

2. Apparatus (1) of claim 1, wherein the apparatus (1) comprises two drilling beams (4, 4') connected to the lifting beam (2) movably.

3. Apparatus (1) of claim 1 or 2, wherein the at least one drilling beam (4, 4') comprises three or four drilling units (8a-8c), which drilling units are movable along the length of the drilling beam.

4. Apparatus (1) of any of claims 1-3, wherein the at least one drilling unit (8a-8c) is configured to be connected to the at least one drilling beam (4, 4') from one side of the drilling unit.

5. Apparatus (1) of any of claims 1-4, wherein the at least one drilling unit (8a-8c) is configured to be deactivated by moving the drilling unit at the end of the at least one drilling beam (4, 4').

6. Apparatus (1) of any of claims 1-5, wherein at least one drilling beam (4, 4') is connected to the lifting beam (2) with a guide rail (6, 6') providing the movement in the perpendicular direction, which guide rail is connected to the lifting beam movably along at least part of the length of the lifting beam.

7. Apparatus (1) of claim 6, wherein the drilling movement of the at least one drilling unit (8a-8c) is obtained with the movement of the guide rail (6, 6') in the perpendicular direction.

8. Apparatus (1) of claim 6 or 7, wherein the at least one drilling beam (4, 4') connects from one of its longitudinal ends to the guide rail (6, 6').

9. Apparatus (1) of any of claims 6-8, wherein the connection between the lifting beam (2) and the guide rail (6, 6') comprises a longitudinal part (5, 5') extending in the longitudinal direction of the lifting beam, which longitudinal part is movable in the longitudinal direction along the length of the lifting beam, and the guide rail is connected to the longitudinal part movably along the length of the longitudinal part.

10. Apparatus (1) of any of claims 1-9, wherein the apparatus (1) comprises a control system for positioning the at least one drilling unit (8a-8c) in a predefined position for drilling drainage hole and for drilling of the drainage hole.

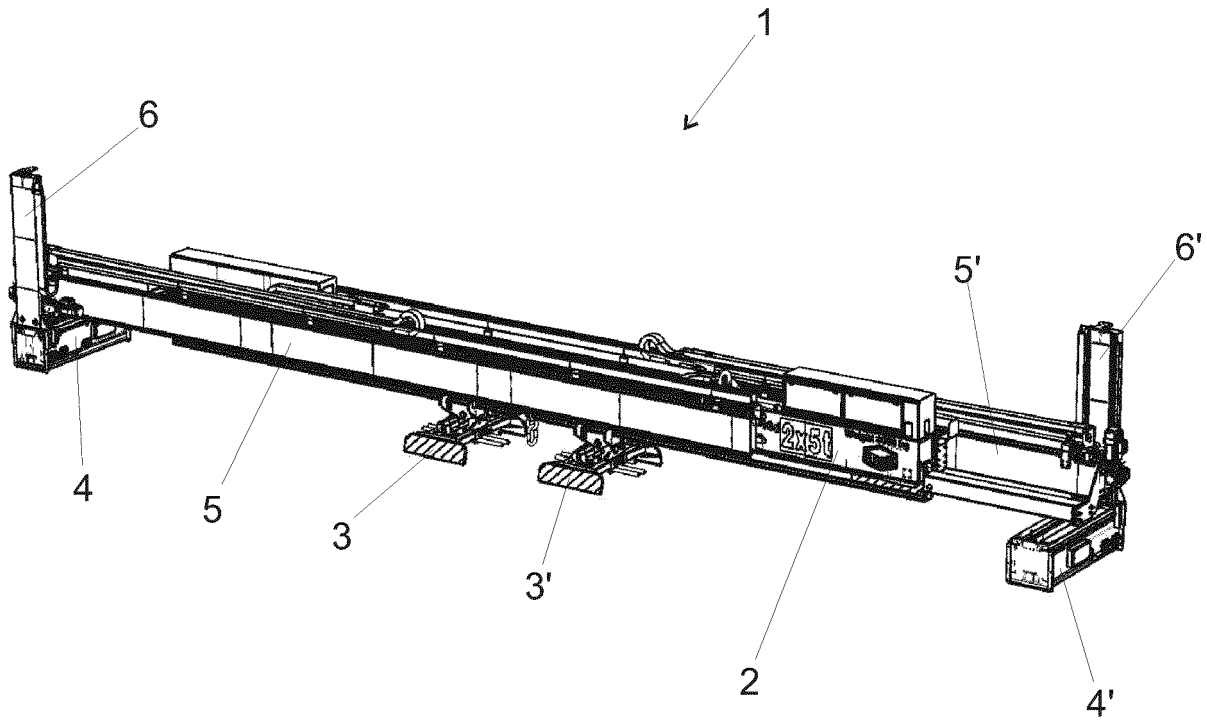

FIG. 1

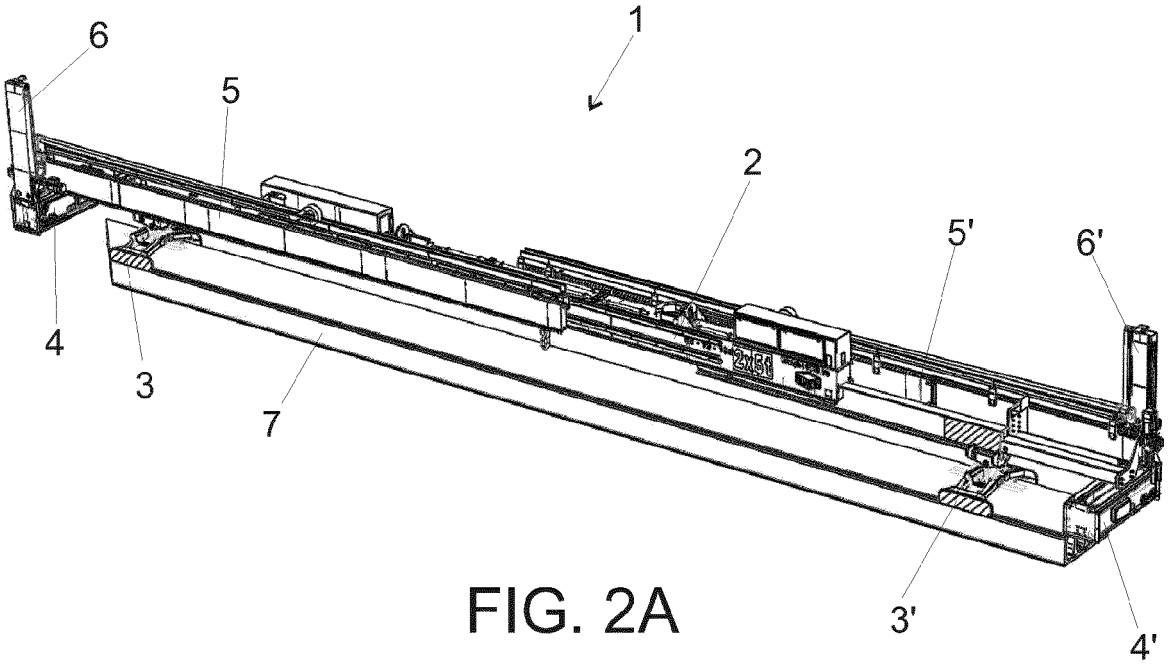

FIG. 2A

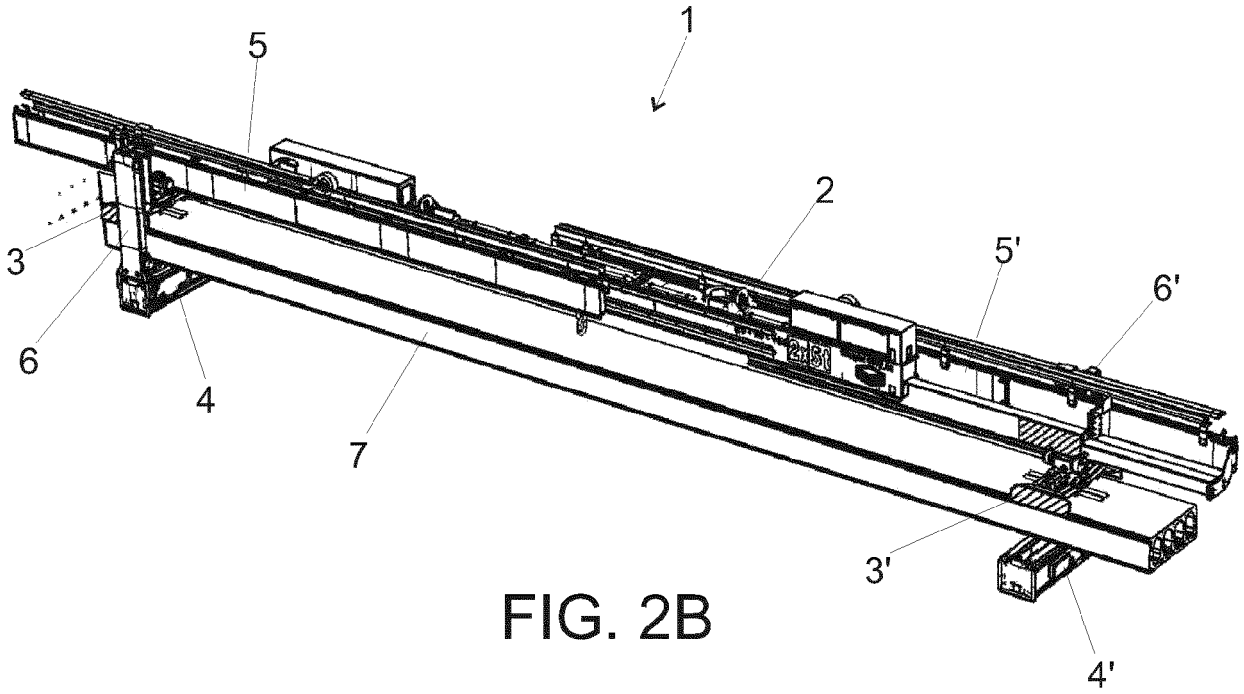

FIG. 2B

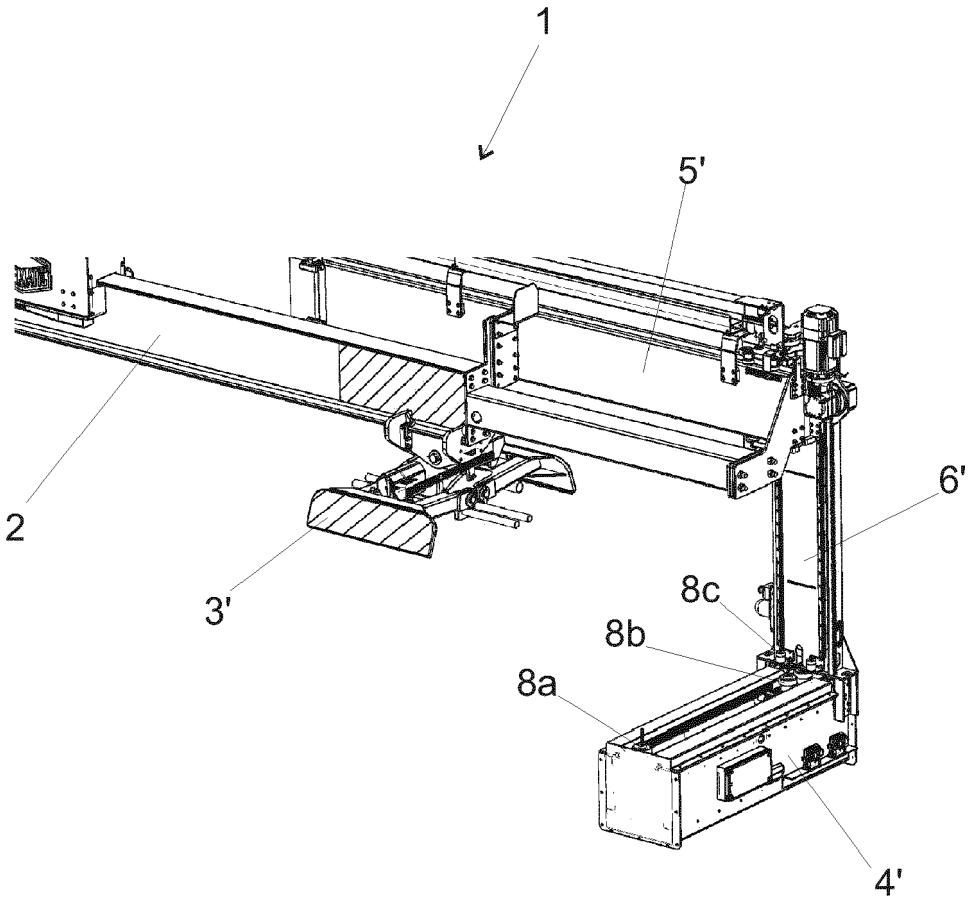

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 4317

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	FI 82 631 B (PARTEK AB [FI]) 31 December 1990 (1990-12-31) * page 2, line 18 - page 4, line 28 * * figures *	1-10	INV. B28D1/14
X,D	EP 0 940 236 A2 (ADDTEK RES & DEV OY AB [FI]) 8 September 1999 (1999-09-08) * paragraph [0007] - paragraph [0016] * * figures *	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

B28D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 October 2022	Rijks, Mark

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- EP 0455495 A1 **[0006]**
- EP 1738885 A1 **[0007]**