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(54) **AUTOMATED FORK SYSTEM AND METHOD AND AUTOMATED GUIDED VEHICLE HAVING SUCH FORK SYSTEM**

(57) An automated fork system (1) is described, comprising: at least two arms (7); at least one fork-carrier plate (9) connected to such extensible shaped arms (7); at least two fork arms (3) each connected to an arm (7); and a plurality of retractable prongs (5) connected to at least one fork arm (3). An automated guided vehicle equipped with such system (1) and a method for automatically lifting a pallet are.also described.

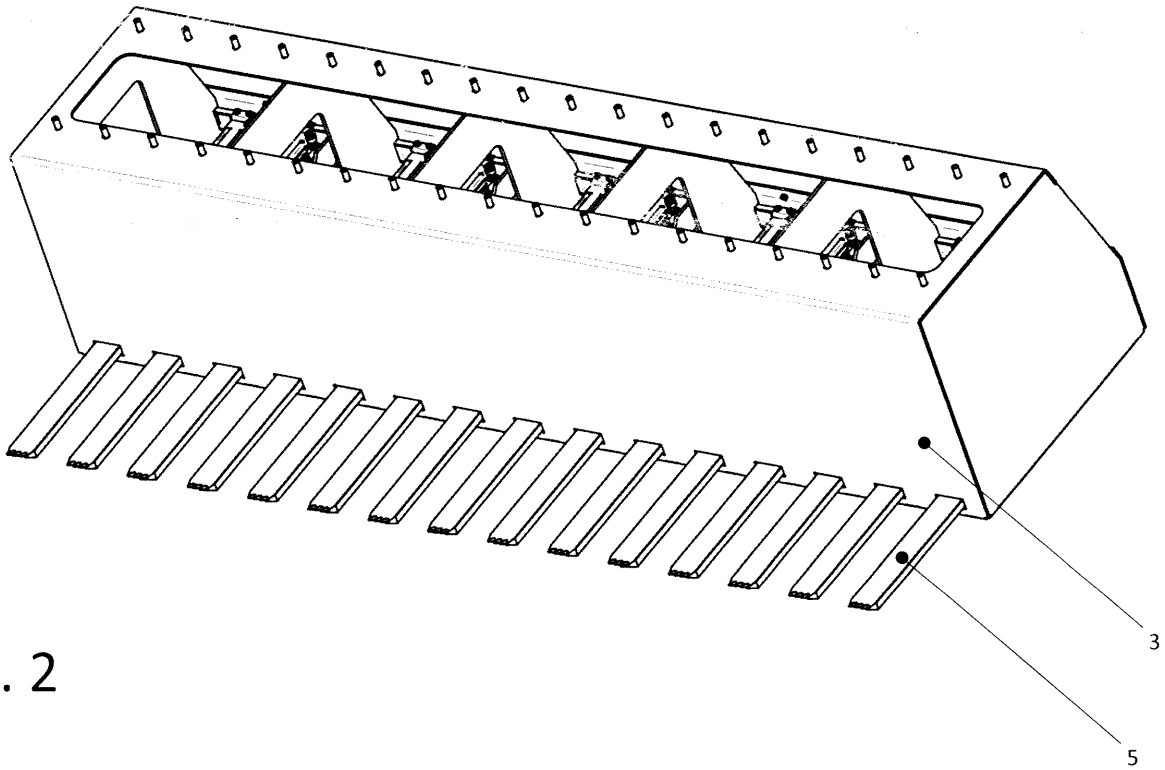

FIG. 2

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Description

[0001] The present invention relates to an automated fork system. The present invention further relates to an automated guided vehicle having such a fork system. Still further, the present invention relates to a method of lifting an object, such as a pallet.

[0002] A forks unit is known in the art, for transporting pallets by means of a fork-lift.

[0003] None of the known units, however, allows automatically working pallets having different sizes, without having to arrange every time forks with a suitable width, with obvious problems of tooling times and costs.

[0004] Object of the present invention is solving the above prior art problems by providing a system of automated forks, and its related method, which allow automatically working pallets having different sizes, from the smallest ones (e.g. sizes of 480 x 550 mm, height 500 mm, mass 375 kg) to the biggest ones (e.g. sizes of 2600 x 1200 mm, height 2400 mm, mass 1000 kg).

[0005] The above and other objects and advantages of the invention, as will result from the following description, are obtained with an automated fork system as claimed in Claim 1. Preferred embodiments and non-trivial variations of the present invention are the subject matter of the dependent claims.

[0006] It is intended that all enclosed claims are an integral part of the present description.

[0007] According to a further aspect there is provided an automated guided vehicle comprising an automated fork system of the above type. This automated guided vehicle can automatically lift an arbitrary pallet from a floor, and automatically move it to a desired position.

[0008] Still further, there is also provided a method for lifting a pallet. This method provides for efficient and easy lifting of a pallet, without the need of manual adjustment of the fork to different types of pallets.

[0009] It will be immediately obvious that numerous variations and modifications (for example related to shape, sizes, arrangements and parts with equivalent functionality) can be made to what is described, without departing from the scope of the invention, as appears in the enclosed claims.

[0010] The present invention will be better described by some preferred embodiments thereof, provided as a non-limiting example, with reference to the enclosed drawings, in which:

- Figure 1 shows a top perspective view of an embodiment of the automated fork system according to the present invention;
- Figure 1A shows a bottom perspective view of the automated fork system of Figure 1;
- Figure 2 shows a perspective view of a fork arm and of the retractable prongs being connected;
- Figure 3 shows another perspective view of the fork arm;
- Figure 4 shows a perspective view of the retractable prong;
- Figure 5 shows a top view of the fork arm of Figure 2; and
- Figure 6 shows an automated guided vehicle having an automated fork system.

[0011] With reference to the Figures, a preferred, but absolutely not limiting, embodiment of the automated fork system 1 of the present invention is shown and described. Such system is equipped with a fork-carrier plate 9 and has two parallel and extensible shaped arms 7. The two parallel arms 7 can be moved in a lateral direction by means of, for example, hydraulic actuators arranged in the fork-carrier plate 9, to alter the horizontal distance between the two arms 7 in order to embrace pallet 8 having different widths, by engaging the recess available below the pallet 8 with a different size. In addition, respective fork arms 3 are arranged under the respective arms 7. The fork arms 3 can be moved along the arms 7, meaning the fork arms 3 can be moved away or towards the fork-carrier plate 9, to accommodate for long and short pallets 8. It will be appreciated that the pallet 8 is typically loaded with a stack of packages or other items to be transported, although this is not illustrated in Fig. 1 for clarity of illustration.

[0012] The pallet 8, in fact, due to its arrangement, rests on the ground on feet 10 which leave opening spaces 11 as in Figure 1. The retractable prongs 5, described below, will be inserted inside such spaces 11. The feet 10 can be arranged on different positions, meaning the spaces 11 will also have different locations that cannot easily be predicted. Figure 1A, in which the pallet itself is not shown for clarity of illustration, shows the arms 7 and fork arms 3 having some of the prongs 5 extend out from the fork arms 3 and into such spaces of the pallet, while other prongs remain retracted, because their positions are in register with feet of the pallet.

[0013] As shown in Figures 2, 3 and 5, each of the two fork arms 3 has quite a number of integral or independent retractable prongs 5: Each fork arm 3 typically has five or more prongs 5, more preferably ten or more prongs 5, and most preferably from twelve to twenty prongs 5. In the Figures, fifteen prongs 5 for each fork arm 3, drawn in their maximum extension position, are shown in this specific case.

[0014] Number, structural strength and extension stroke of the prongs 5, mutually equal or different, are variable and will be adapted to a specific coupling need with the types of pallets 8 to be lifted.

[0015] Each fork arm 3 contains electric, magnetic, pneumatic or hydraulic devices in order to perform the autonomous, simultaneous or coordinate movement of the prongs 5 by which the prongs 5 that are located in register with a space 11 extends into such a space 11, while prongs 5 that are in register with a foot 10 is stopped in its movement. Hence, a number of prongs 5 will find a respective space 11 and extend into such space 11, and those prongs 5 will be the ones that enable the arms

7 to lift the pallet 8 from the ground.

[0016] The extension of the prongs 5 can be obtained, for example, by pneumatic actuators which could drive a single prong 5 or a group of prongs 5.

[0017] In Figure 4, every single prong 5 is driven by a single pneumatic actuator 4.

[0018] Suitable rollers 6 and sliding plates 12 ensure the desired stroke for the prong 5; for such purpose, every prong 5 is placed on a sliding plate 12 adapted to alternatively slide through rollers 6 with which it is equipped.

[0019] Moreover, every prong 5 on the tip 5' can comprise a cutter, preferably a heated cutter, if the prong 5 itself has to open its way by penetrating a coating film which overhangs on the pallet 8 preventing the respective space 11 from being engaged.

[0020] The extension force of every single prong 5 is regulated to win frictions and penetrate possible plastic film coatings, without however damaging the pallet 8 should the prong stroke be prevented by the abutment on structural elements, such as a foot 10, of the pallet 8 itself. For this purpose the pneumatic actuator 4 may be provided with a pressure regulator 13, such that the prong 5 cannot push with a too high force if a foot 10 is in its way of movement. Other types of sensors are also possible, such sensors using mechanical, hydraulic, pneumatic or optical sensing principles to detect if the prong 5 is extended against a foot 10, or another structural element of the pallet 8, and that therefore the further extension of the prong 5 should be stopped.

[0021] Electric, pneumatic, hydraulic, magnetic or optical sensors monitor the actual stroke of every single prong 5, so that an operator or the controlling computer can decide whether an enough and correctly distributed number of prongs 5 has embraced the pallet 8, by extending into spaces 11, on both fork arms 3 and therefore it is safe to proceed with a lifting of the pallet 8.

[0022] Lifting of the pallet 8 occurs after the due fork arms 3 have been closed to the width of the pallet 8 to be transported and after that the number and distribution of the engaged prongs 5, meaning prongs extending into spaces 11, has been judged enough for lifting the pallet 8 and any load placed thereon.

[0023] Each of the extensible shaped arms 7 can be equipped with standard assembling connections 2 on commercial fork-carrier plates, namely fork-carrier plates already present on the market to use standard lifting accessories, or can be directly assembled on a new and different fork-carrier plate suitably obtained for this exclusive use.

[0024] Figure 6 illustrates an automated guided vehicle 14. The automated guided vehicle or automatic guided vehicle (AGV) is a portable robot that may be guided by, e.g., lines or wires on the floor, or by radio waves, vision cameras, magnets, laser etc. for navigation. The automated guided vehicle 14 is provided with the automated fork system 1 described hereinabove. The automated fork system 1 may be attached by means of the standard assembling connections 2. By means of the automated fork system 1, the automated guided vehicle 14 can automatically pick up a pallet 8, wherein the prongs 5 of the fork arms 3 of the automated fork system 1 automatically can find and extend into spaces 11, and avoid damaging feet 10, such that the automated guided vehicle 14 can automatically and safely lift and then transport the pallet 8 from one location to another.

[0025] The invention further deals with a method for automatically lifting a pallet, this method comprising the steps of:

- moving two arms 7 to embrace the pallet 8 between them,
- activating at least one fork arm 3 arranged on at least one of the arms 7 to extend a plurality of prongs 5 in the direction of the pallet 8,
- sensing which of said prongs 5 that are extending towards an obstacle 10 of the pallet 8 and stopping the extension of such prongs 5,
- inserting other prongs 5 into spaces 11 between obstacles 10 of the pallet 8, and
- raising the arms 7 to lift the pallet 8 from a floor.

Claims

1. Automated fork system (1) comprising:

- at least two arms (7);
- at least one fork-carrier plate (9) connected to said arms (7);

characterized in that it further comprises:

- at least two fork arms (3), each connected to an arm (7);
- a plurality of retractable prongs (5) connected to at least one fork arm (3).

2. System (1) according to the previous claim, **characterized in that** each of the at least two fork arms (3) comprises a plurality of prongs (5), preferably each fork arm (3) contains electric, magnetic, pneumatic or hydraulic devices to perform an autonomous, simultaneous or coordinate movement of the prongs (5).

3. System (1) according to claim 1 or 2, **characterized in that** an extension of said prongs (5) is obtained through pneumatic actuators (4) which drive a single prong (5) or a group of said prongs (5).

4. System (1) according to claim 1, 2 or 3, **characterized in that** every prong (5) is placed on a sliding plate (12) and is adapted to slide through rollers (6) with which the sliding plate (12) is equipped.

5. System (1) according to any one of the previous

claims, **characterized in that** at least some of said prongs (5) have on their respective tip (5') a cutter, preferably a heated cutter, if the prong (5) has to open its way by penetrating a coating film which overhangs on the pallet (8) preventing a space (11) from being engaged by the prong (5).

6. System (1) according to any one of the previous claims, **characterized in that** said prongs (5) are designed, when finding an obstacle (10), not to be further extended and to remain inside said fork arms (3)

7. System (1) according to claim 6, wherein at least some of said prongs (5) are provided with individual sensors arranged for sensing when said prong (5) is extended toward an obstacle (10), preferably said sensor of the prong (5) being arranged for distinguishing between impenetrable obstacles, such as feet (10) of a pallet (8), and penetrable obstacles, such as coating film of a pallet (8).

8. System (1) according to any one of the previous claims, **characterized in that** it is further equipped with electric, pneumatic, hydraulic, magnetic or optical sensors which monitor the actual stroke of every single prong (5).

9. System (1) according to any one of the previous claims, **characterized in that** the number of retractable prongs (5), integral or independent, is at least five for every fork arm (3), more preferably at least ten for every fork arm (3), and most preferably from twelve to twenty for every fork arm (3).

10. System (1) according to any one of the previous claims, **characterized in that** the system is a pallet lifting fork lift system (1) arranged for lifting pallets (8) of the type having feet (10) and spaces (11) between the feet (10).

11. Automated quided vehicle, **characterised in that** it comprises an automated fork system (1) according to any of claims 1-10.

12. Method for automatically lifting a pallet, said method comprising the steps of:

- moving two arms (7) to embrace the pallet (8) between them,

activating at least one fork arm (3) arranged on at least one of the arms (7) to extend a plurality of prongs (5) in the direction of the pallet (8),
sensing which of said prongs (5) that are extending towards an obstacle (10) of the pallet (8) and stopping the extension of such prongs (5),
inserting other prongs (5) into spaces (11) between obstacles (10) of said pallet (8), and raising said arms (7) to lift the pallet (8) from a floor.

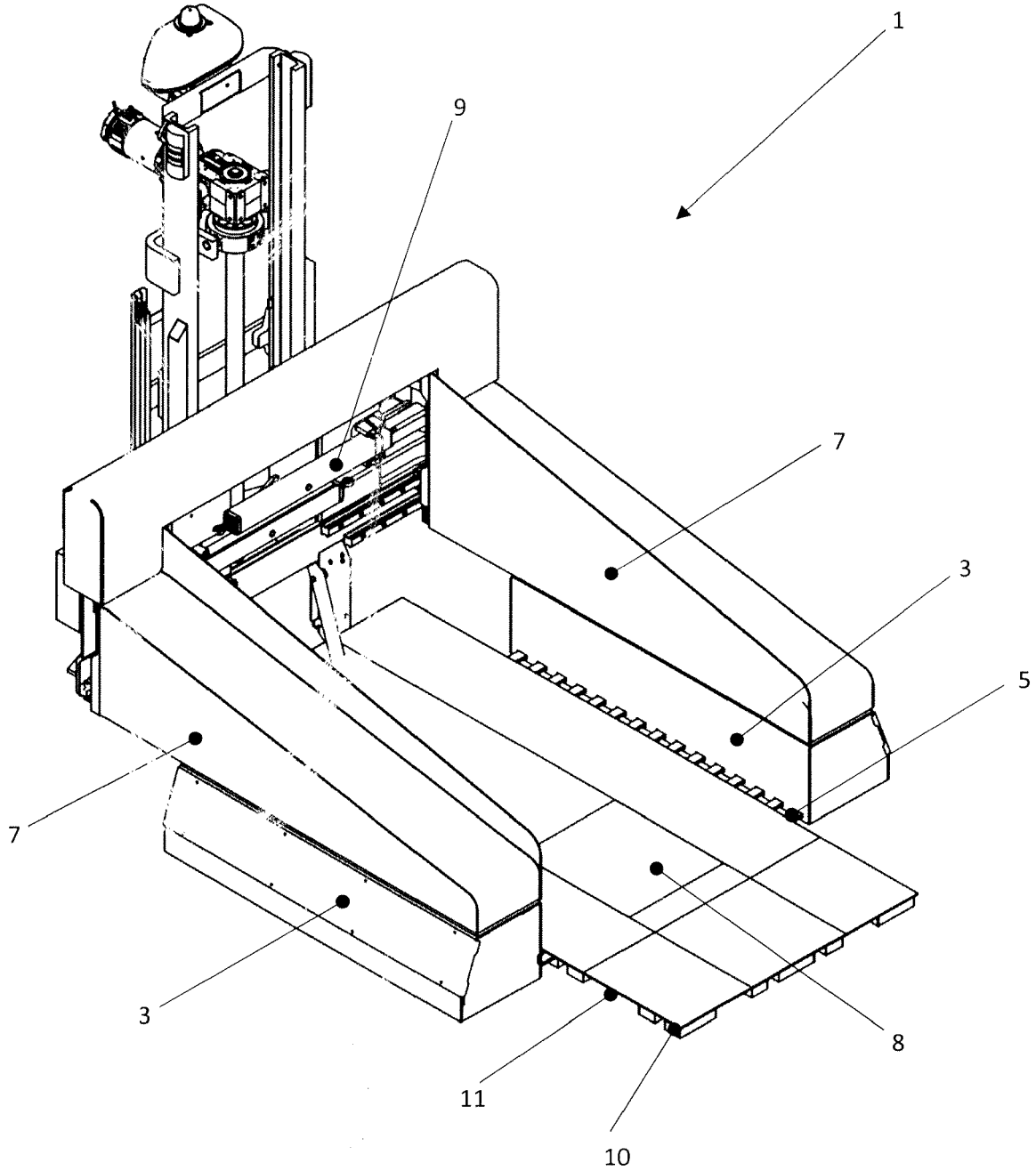

FIG. 1

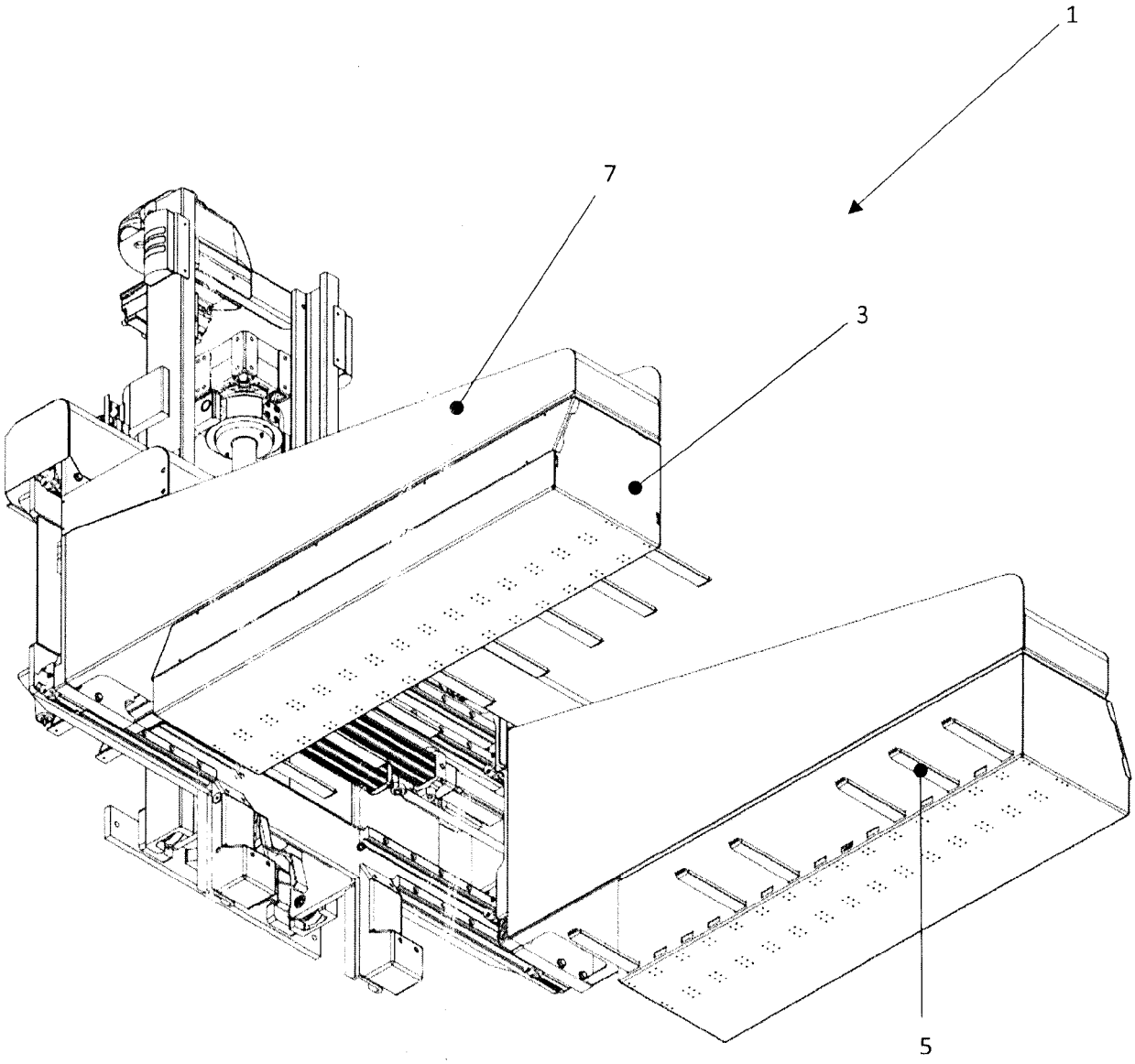

FIG. 1A

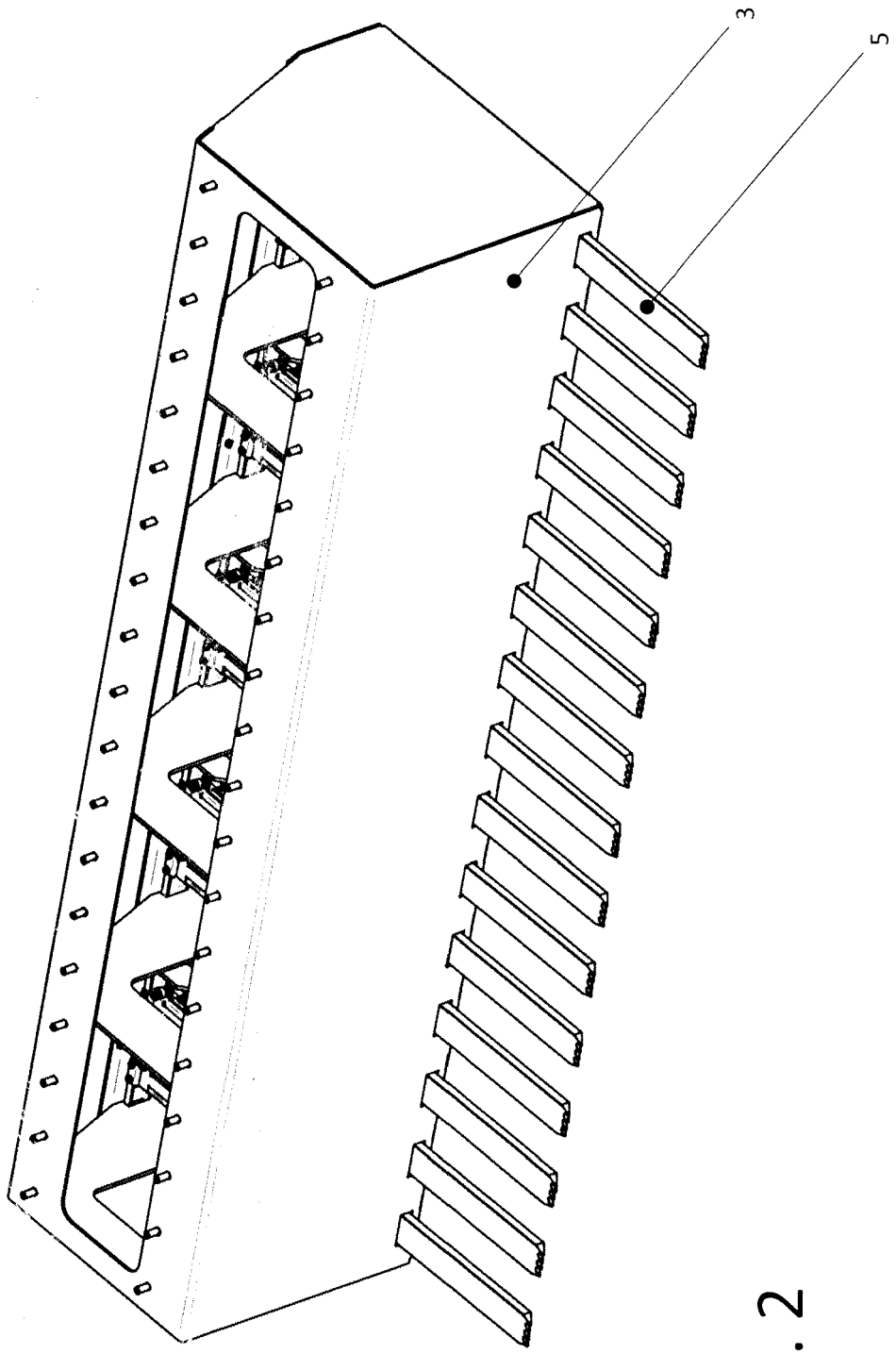

FIG. 2

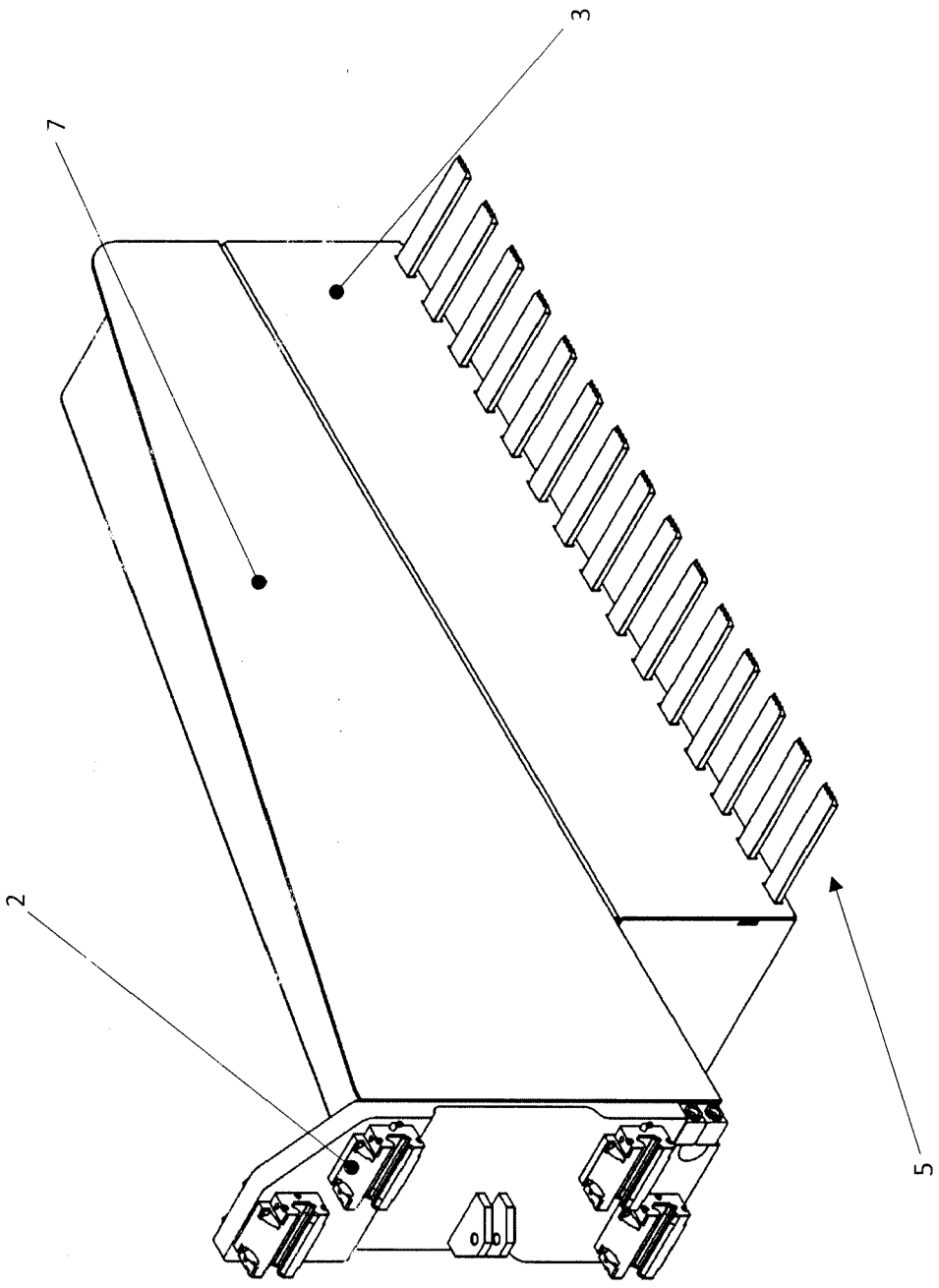

FIG. 3

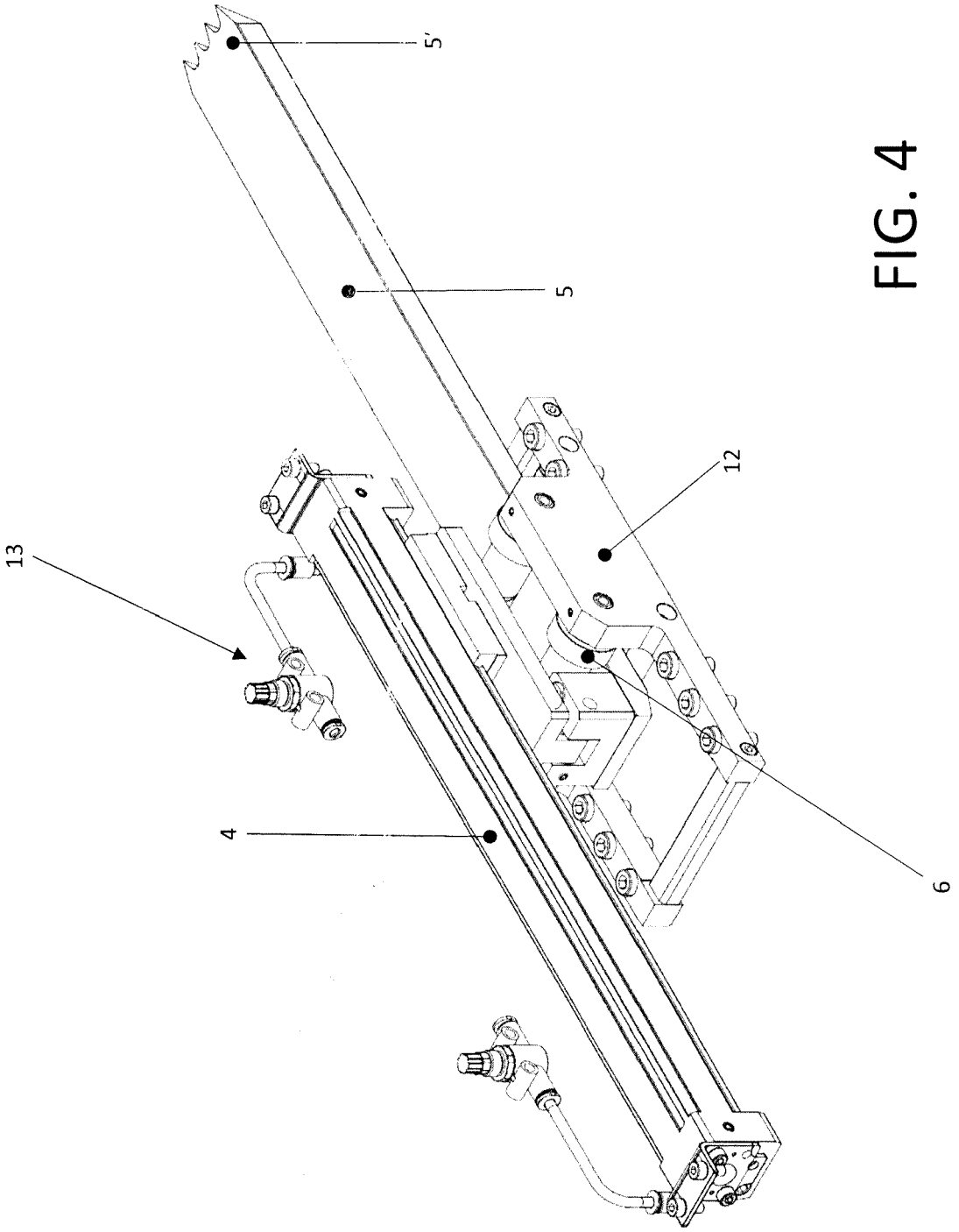

FIG. 4

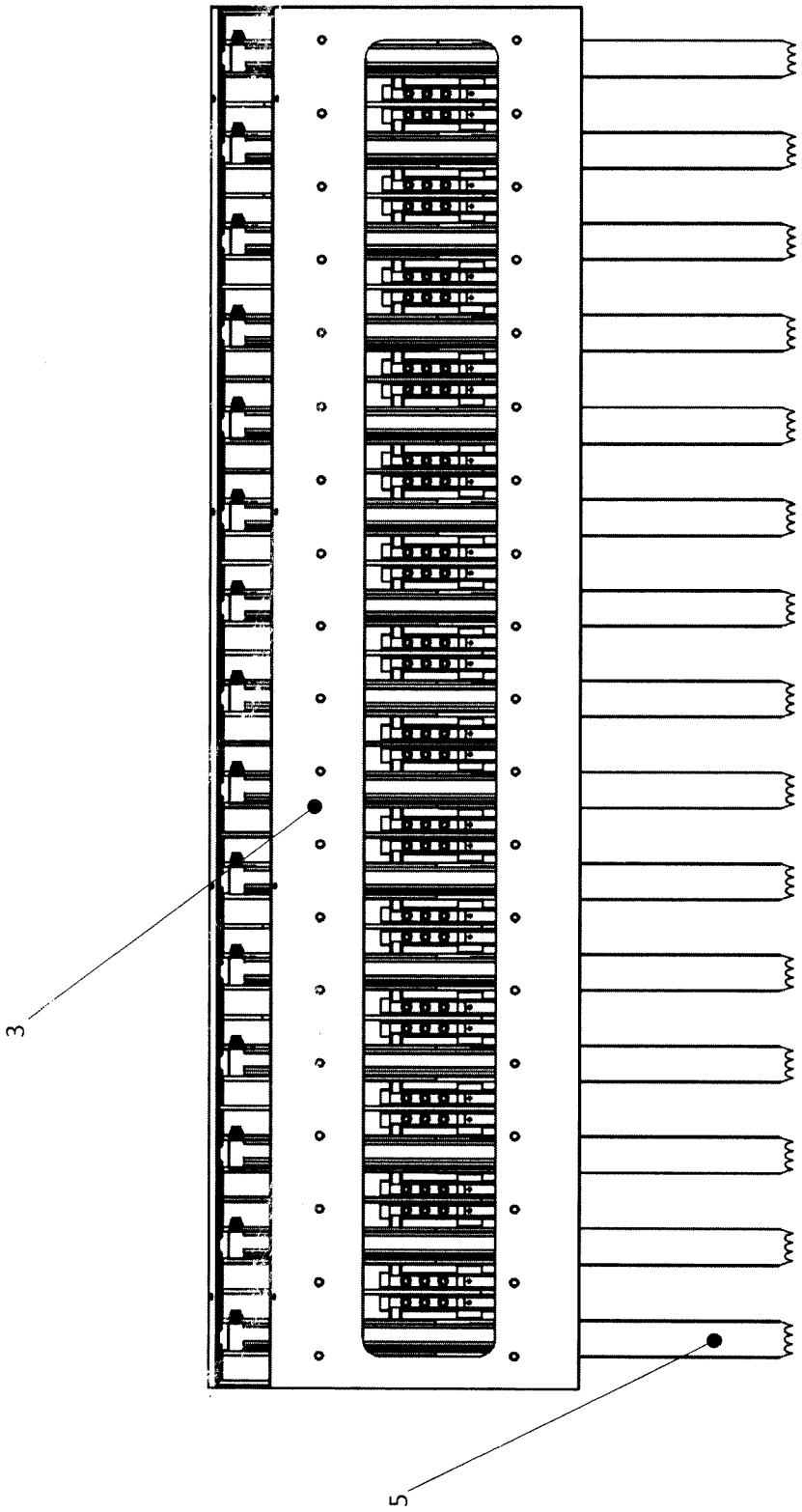

FIG. 5

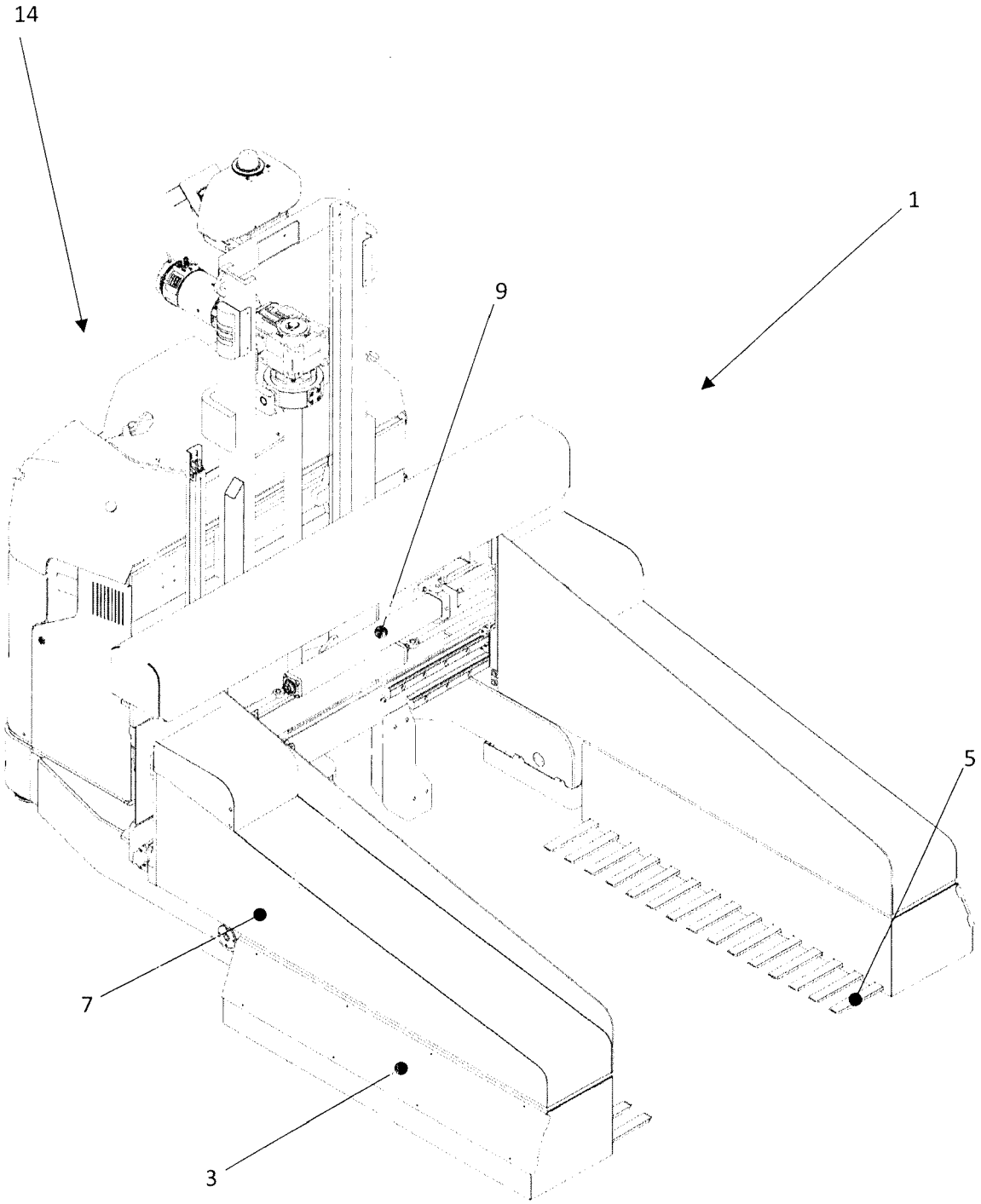

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 19 42 5058

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 January 2020	Popescu, Alexandru

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