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(54) **AUTOMATIC ASSEMBLY SYSTEM AND METHOD**

(57) Automatic assembly system for pallets formed of a plurality of runners and a deck, comprising a supply and positioning system; a framing and nailing area; a framing system and a nailer, in which the supply and positioning system supplies and positions the components of the pallet in the framing and nailing area, in which the framing system comprises movable actuation elements which frame the deck and the runners of the pallet using said movable actuation elements, and in which a nailing unit performs the function of nailing the runners to the deck, in which the movable actuation elements are arranged around the framing and nailing area and comprise pressure surfaces to frame the deck and a single runner of the pallet at the same time, without framing the rest of the runners, using said movable actuation elements.

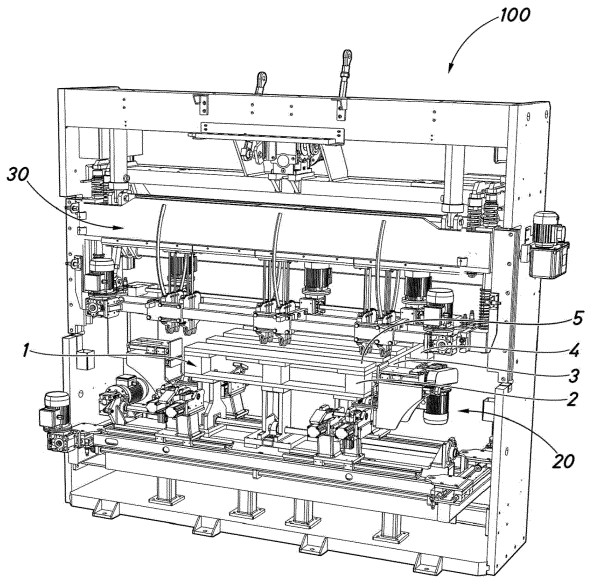

Fig.5

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Description

[0001] The present invention relates to machines for the automatic assembly of pallets.

[0002] In particular, the present invention relates to an automatic assembly system for pallets formed of a plurality of runners and a deck, which are connected together by nailing which connects each runner to the deck by means of nails.

[0003] The deck of pallets is usually formed of a plurality of planar, elongate boards arranged with their longitudinal axes parallel, forming a planar outer surface of the pallet and another planar inner surface of the pallet. These elements are connected together by means of connection elements arranged perpendicular to the previous ones along said inner surface. Furthermore, each runner of the pallet is usually formed of a planar, elongate board connected to one or more prismatic elements or blocks. In the final assembled position, the runners are connected to the deck in such a way that the blocks of said runners are in contact with the connection elements of the deck and parallel to the plurality of planar elements that form the deck of the pallet. However, the invention is not limited to a specific pallet construction, also referred in the industry as "skid".

[0004] Nailing machines for the assembly of pallets which use robots are known in the prior art. Machines exist in the prior art which comprise rigid nailing bases on which nailing is carried out using a robotic arm which controls a unit of nailers. Said machines position the elements of the assembly on the nailing bases by moving robotic positioning arms based on pre-established three-dimensional coordinates. Moreover, said machines hold all the runners simultaneously, which results in a substantial reduction in overall positioning accuracy, owing to the existence of irregularities on the surfaces thereof. These machines are slow and have low productivity. Adapting the machine to pallets of different sizes is also slow.

[0005] Other assembly machines exist in which robotic arms hold the deck and the runners, while a nailing station carries out the nailing. These machines result in faulty nailing. The applicant has determined that this is due to inherent irregularities in the pieces of wood and slight positioning errors in the system during the movement of the robot between the pick-up point and the nailing point, which prevent correct alignment of the runners relative to the deck of the pallet from being achieved during assembly. In addition, said machines usually hold the runners using a clamp provided with suckers and/or similar elements, resulting in significant positioning tolerances. Although said machines have acceptable productivity, the assembled end product suffers from alignment/framing errors of the runners relative to the deck of the pallet. This means that a good quality end product in accordance with current market standards cannot be guaranteed.

[0006] An object of the present invention is to provide a pallet assembly machine that allows automatic, versatile and accurate assembly, such that the end product does not have imperfections at its periphery that could affect adjacent items, such as other pallets or delicate items that could be torn.

[0007] To achieve this object, the pallet assembly system according to the present invention comprises a framing device so as to be able to align the runners with the deck of the pallet prior to a nailing operation, and this is carried out using a structure that allows a positioning system to move the deck and the runners during assembly. More particularly, the present invention allows the framing action, which is preferably maintained during nailing, to apply to just one runner and the deck - preferably only in the area of the deck close to said runner. Assembly may continue with the framing of the next runner in the same area in which the previous runner was framed. By only framing one runner at a time, accurate nailing is achieved but it also allows for streamlined assembly.

[0008] As may be concluded from the above, the present invention also discloses a novel automatic pallet assembly method. Furthermore, the present invention also comprises a clamp for the runner, which ensures the accurate position and gripping thereof throughout the nailing process, ensuring stability and preventing unwanted misalignments.

[0009] In some embodiments, the framing system according to the present invention is responsible for the positioning and framing of the deck on a first outer runner, on inner runners and on a second outer runner. Thus, the framing system ensures accurate framing of the unit around the entire periphery of the pallet for assembly.

[0010] In some embodiments, the framing system according to the present invention is positioned around the nailing unit and comprises movable elements for the front, rear and lateral framing in order to ensure the correct relative position between the deck and said outer and inner runners.

[0011] More specifically, the present invention discloses an automatic assembly system for pallets formed of a plurality of runners and a deck, which comprises:

- a supply and positioning system;
- a framing and nailing area;
- a framing system;
- and a nailing unit,

in which the supply and positioning system supplies and positions the components of the pallet in the framing and nailing area, in which the framing system comprises movable actuation elements which frame the deck and the runners of the pallet using said actuation elements, and in which a nailing unit performs the function of nailing the runners to the deck. The movable actuation elements are arranged around the framing and nailing area and comprise pressure surfaces to frame the deck and a single runner of the pallet at the same time, without framing the rest of the runners, using said movable actuation elements.

[0012] Preferably, the assembly system comprises control means which synchronise the movement of the deck and the runners of the pallet with the actuation of the nailing unit and the framing system to allow the framing system to act sequentially on different runners of the pallet.

[0013] Preferably, the movable actuation elements are arranged around the framing and nailing area and comprise pressure surfaces to frame the deck of the pallet on a single runner at a time separately from the rest of the runners. Preferably, the supply and positioning system of the automatic pallet assembly system comprises control means, such as position sensors and electric or hydraulic actuators, or actuators of any other known type, which synchronise the movement of the deck and the runners of the pallet with the actuation of the nailing unit and the framing system, so that the deck and the runners of the pallet move through the assembly system in unison as assembly thereof takes place.

[0014] Preferably, the movable actuation elements comprise a longitudinal framing system and a transverse framing system with respect to the runner for assembly, in order to apply pressure to the runner and/or deck of the pallet longitudinally and/or transversely to said runner for assembly, respectively.

[0015] Also preferably, the movable actuation elements can be actuated independently of one another.

[0016] Still more preferably, the longitudinal framing system comprises two dual heads, in which an upper unit moves along a first guide and comes in contact at least with the deck of the pallet and a lower unit moves along a second guide and comes in contact with the runner of the pallet, in order to apply pressure along a longitudinal axis of a runner on which framing is carried out.

[0017] In preferred embodiments, the upper and lower units of the longitudinal framing system comprise independent control means.

[0018] In still more preferred embodiments, the transverse framing system comprises movable actuation elements with independent control means which allow actuation thereof on the runner, on the deck and/or on the runner and the deck independently.

[0019] More preferably, the transverse framing system comprises movable actuation elements with planar contact surfaces and with curved contact surfaces which act on the runner, on the deck and/or on the runner and the deck.

[0020] Still more preferably, the transverse actuation elements follow a curved travel path from the position in which said elements are not actuated to the position in which said elements act on the runner, on the deck and/or on the runner and the deck. Other types of translation/rotation are also possible. Rectilinear translation, for example, is also possible.

[0021] In even more preferred embodiments, the transverse framing system is arranged on positioning guides and comprises means for adjusting the position thereof along said guides.

[0022] Preferably, the supply and positioning system for the components of the pallet comprises a robotic system, in which a first robotic arm is configured to manipulate the deck of the pallet and a second robotic arm is configured to manipulate the runners of the pallet.

[0023] More preferably, the robotic arm responsible for manipulating the runners of the pallet comprises a clamp having a plurality of pairs of gripper fingers for securing the runners of the pallet.

[0024] Still more preferably, the pairs of gripper fingers comprise a first self-adjusting gripper finger which is movable and a second gripper finger which is fixed.

[0025] Even more preferably, the fixed gripper finger can move from a reception position to a gripping position to facilitate reception of the runners of the pallet.

[0026] Thus, the movable front framing and rear framing elements press the runner and the deck in the framing steps for the outer runners. Moreover, the framing system may comprise lower pusher elements for positioning the inner runners, and also lateral framing elements which are automatically adjusted depending on the morphology of the pallet for assembly. Said lateral pushers on both sides of the unit for assembly ensure lateral alignment between the deck and the runners of the pallet; and, having independent heads, allow the selective positioning of said runners, including configurations that comprise projecting runners and/or sections of the deck.

[0027] Being independent, said lateral framing elements may be configured to have different travel paths, in order to apply the corresponding pressure to elements arranged at a different distance. This allows assembly of a large number of pallets having different morphologies and dimensions.

[0028] Thus, the framing elements and the pusher elements can be adjusted either manually or automatically using control elements associated with special software in which different pallet morphologies can be predefined.

[0029] The assembly system according to the present invention also comprises a clamp suitable for picking up and manipulating the runners of the pallet. Said clamp may be installed on a robotic arm responsible for manipulating the runners. Said clamp comprises two rigid parallel elements separated from each other by a distance that is less than the length of the runner, on which a plurality of pairs of gripper fingers are arranged, which are adapted to the components of the pallet for assembly. Said pairs of fingers in turn comprise a fixed finger having a dual position (a pick-up position and a gripping position) and a self-adjusting movable finger which is adapted to the width of the runners to be picked up and secured. The use of a fixed finger in each pair of fingers allows the position of the outer side of each runner to be accurately established, as said outer side of the runner will always be in direct contact with the corresponding fixed finger, said fixed finger acting as a reference when assembly is carried out, ensuring the alignment of the components of the pallet.

[0030] Moreover, the framing elements and the pusher

elements are made of a mechanically strong material, so as to be able to apply pressure to the components of the pallet for assembly without being deformed.

[0031] Thus, the use of an assembly system that comprises a framing system and a clamp for picking up and manipulating the runners according to the present invention substantially improves the final alignment of the assembled unit, and is also versatile with regard to pallet morphology, allowing assembly with high productivity.

[0032] The present invention also comprises an automatic pallet assembly method using an automatic pallet assembly system as described, which comprises the following steps:

a) Supplying and positioning the deck and the runners of the pallet for assembly using the supply and positioning system in the framing and nailing area;
b) Actuating the framing elements to frame the pallet deck and a first runner of the pallet with the movable actuation elements in a longitudinal direction and a transverse direction thereof;
c) Nailing the deck to a first runner using a nailing unit;
d) Deactuating the framing elements;
e) Translating the deck and the runners of the pallet by means of the supply and positioning system until a second runner reaches the framing and nailing area.

[0033] Preferably, the automatic pallet assembly method also comprises the following steps:

f) Actuating the framing elements to frame the pallet deck and a second runner of the pallet using the movable actuation elements in a longitudinal direction and a transverse direction thereof;
g) Nailing the deck to a second runner using a nailing unit;
h) Deactuating the framing elements.

[0034] Even more preferably, the automatic pallet assembly method also comprises the following additional steps:

i) Translating the deck and the runners of the pallet by means of the supply and positioning system until a third runner reaches the framing and nailing area.
j) Actuating the framing elements to frame the pallet deck and a third runner of the pallet using the movable actuation elements in a longitudinal direction and a transverse direction thereof;
k) Nailing the deck to a third runner using a nailing unit;
l) Deactuating the framing elements.

[0035] Preferably, the automatic pallet assembly method comprises the actuation of front and lateral framing elements and of lower rear pusher elements to frame the deck and a first runner, in which said first runner is a first outer runner, using said movable actuation elements in the longitudinal direction and the transverse direction thereof.

[0036] More preferably, the automatic pallet assembly method comprises the actuation of lateral framing elements and of the lower front and lower rear pusher elements to frame the deck and a second runner, in which said second runner is an inner runner, using said movable actuation elements in the longitudinal direction and in the transverse direction thereof.

[0037] Even more preferably, the automatic pallet assembly method includes the use of rear and lateral framing elements and of lower front pusher elements to frame the deck and a third runner, in which said third runner is a second outer runner, using said movable actuation elements in the longitudinal direction and in the transverse direction thereof.

[0038] Still more preferably, the automatic pallet assembly method includes an additional step of removing the assembled pallet by means of the supply and positioning system.

[0039] These and other advantages and features of the invention will become clear on viewing the figures and the detailed description of the invention. Said figures should be understood as an explanatory but nonlimiting example of an embodiment of the assembly system that is the object of the present invention.

[0040] Fig. 1 is a perspective view of a runner of the pallet.

[0041] Fig. 2 is a perspective view of a deck of the pallet.

[0042] Fig. 3 is a perspective view of an assembled pallet.

[0043] Fig. 4 is a front view of the automatic pallet assembly system of the present invention.

[0044] Fig. 5 is a perspective view of the automatic pallet assembly system of the present invention.

[0045] Fig. 6 is a view from above of the framing system of the present invention with the framing elements not actuated.

[0046] Fig. 7 is a perspective view of the framing system of the present invention with the framing elements not actuated.

[0047] Fig. 8A is a perspective view of the framing system of the present invention in the framing position for a first outer runner.

[0048] Fig. 8B is a view in cross section through the plane A-A' shown in Fig. 4 of the framing system as shown in Fig. 8A.

[0049] Fig. 8C is an enlarged perspective view of a connection area between the deck and a first outer runner.

[0050] Fig. 9A is a perspective view of the framing system of the present invention in the framing position for an inner runner.

[0051] Fig. 9B is a view in cross section through the plane A-A' shown in Fig. 4 of the framing system as shown in Fig. 9A.

[0052] Fig. 9C is an enlarged perspective view of a connection area between the deck and an inner runner.

[0053] Fig. 10A is a perspective view of the framing system of the present invention in the framing position for a second outer runner.

[0054] Fig. 10B is a view in cross section through the plane A-A' shown in Fig. 4 of the framing system as shown in Fig. 10A.

[0055] Fig. 10C is an enlarged perspective view of a connection area between the deck and a second outer runner.

[0056] Fig. 11 is a perspective view of the clamp suitable for securing runners of the present invention.

[0057] The term "framing area" or "nailing area" refers to the area comprised between the support pillars, in which both the framing and the nailing of the runners for assembly takes place. The term "outer runner" refers to a runner in which one of the longitudinal sides thereof is aligned with the periphery of the deck of the pallet. The term "inner runner" refers to a runner that has both longitudinal sides arranged within the periphery of the deck of the pallet. The terms front, rear and lateral refer to the relative arrangement of the devices to which they are connected; these terms should not be understood as limiting the arrangement of said devices with respect to the general orientation of the assembly system. The term "nailing" refers to the act of nailing.

[0058] Fig. 1 shows, as an example, a runner 6 of the pallet which comprises a planar, elongate board 61 and a plurality of prismatic blocks 62 arranged on said board.

[0059] Fig. 2 shows, as an example, a deck 5 of the pallet which is formed by a plurality of planar, elongate boards 51 arranged with the longitudinal axes thereof parallel, which comprise a planar outer surface of the pallet and another planar inner surface of the pallet; and said elements are connected together by connection elements 52 arranged perpendicular to the previous ones along said inner surface.

[0060] Fig. 3 shows, as an example, an assembled pallet which comprises a deck 5 having two assembled runners 6, such that the runners are connected to the deck with the prismatic blocks 62 of said runners in contact with the connection elements 52 of the deck and parallel to the plurality of planar boards 51 that form the deck of the pallet.

[0061] Fig. 4 and 5 show a fixed station belonging to the automatic pallet assembly system 100 of the present invention, which comprises a framing system 20 and a nailing unit 30. An assembled pallet 1 has been included for reference. In order not to adversely affect the clarity of the figures, no pallet supply and positioning system has been shown. In particular, the supply and positioning system in the example consists of two robots, for example two commercially available, programmable robotic arms, one responsible for supplying and positioning the deck and the other responsible for supplying and positioning the runners of the pallet.

[0062] Fig. 6 to 10C show the framing system of the fixed station shown in Fig. 4 and 5, although the supply and positioning system, the nailing station and other secondary components have been omitted to make it easier to see.

[0063] In Fig. 6 and 7, the components of the framing system 20 of the example shown can be seen, with the framing elements 21, 22, 23, 24, 25, 26, 21', 22', 23', 24', 25', 26' not actuated. These figures also show the longitudinal adjustment means 28 on which the front and rear framing elements 21, 22, 24, 26, 21', 22', 24', 26' are arranged, and also the support means 29 on which the runner rests, on which the framing and assembly action is carried out. The lateral framing elements 23, 25, 23', 25' are arranged on guides which allow movement thereof in a direction parallel to a longitudinal direction of the runner.

[0064] Fig. 8A, 8B and 8C show the framing system of the present invention in the same framing step, corresponding to the framing of a first outer runner.

[0065] Fig. 8A shows the framing system of the present invention carrying out a framing action on a first outer runner 2 and the deck 5 of the pallet, with the object of being able to produce accurate nailing. In said action, the front framing elements 21, 21', the lateral framing elements 23, 25, 23', 25' and the lower rear pushers are actuated and therefore in contact with the outer runner 2 and/or the deck 5. The lower rear pusher elements are hidden behind the outer runner 2. This figure shows how the front framing elements 21, 21' press both the runner 2 and the deck 5 simultaneously. Similarly, the lateral framing elements 23, 23' also press both the runner 2 and the deck 5 but in a direction aligned with the longitudinal axis of the runner, that is, orthogonal to the pressure applied by the front framing elements. This will become clear following the description of the figures below.

[0066] Fig. 8B is a view in cross section through the plane A-A' shown in Fig. 4 of the framing system as shown in Fig. 8A. This figure also shows the arrangement of the lower rear pusher elements 26', which apply pressure to the runner 2 in the same trajectory as the pressure applied by the front framing elements 21', but in the opposite direction. Thus, the outer runner 2 is held and arranged perfectly relative to the deck 5 on which said runner will be assembled.

[0067] Fig. 8C shows a framing area of the first outer runner and the deck of the pallet. This figure shows some of the faces of a first outer runner 2 and of the deck 5 to which the different framing elements apply pressure. Thus, bearing in mind what was explained earlier in the description of Fig. 8A and 8B, the front framing element 21 acts on the faces A, A' of the runner and of the deck, respectively, the lower rear pusher element 26 acts on the hidden face D, the lateral framing element 23 on the faces B and C of the deck and of the runner, respectively, and the lateral framing element 25 on the face of the runner C. Note that, although this figure refers exclusively to one side of the unit for assembly, similar elements are also arranged on the opposite side of the unit, and there-

fore pressure is applied in an analogous or similar way on both sides of the unit. The same applies to Fig. 9C and 10C.

[0068] Fig. 9A, 9B and 9C show the framing system of the present invention in the same framing step, corresponding to the framing of a first inner runner.

[0069] Fig. 9A shows the framing system of the present invention applying framing between a first inner runner 3 and the deck 5 of the pallet, in which the lower front pusher elements 22, 22', the lateral framing elements 23, 25, 23', 25' and the lower rear pushers are actuated and therefore in contact with the inner runner 3 and/or the deck 5. The lower rear pusher elements are hidden behind the inner runner 3. This figure shows how the lower front pusher elements 22, 22' press the runner 3. Similarly, the lateral framing elements 23, 23' press both the runner 3 and the deck 5 in a direction aligned with the longitudinal axis of the runner, that is, orthogonal to the pressure applied by the front and rear pusher elements. This will become clear following the description of the figures below.

[0070] Fig. 9B is a view in cross section through the plane A-A' shown in Fig. 4 of the framing system as shown in Fig. 9A. This figure also shows the arrangement of the lower rear pusher elements 26', which apply pressure to the runner in the same trajectory as the pressure applied by the lower front pushers 22', but in the opposite direction. Thus, the inner runner 3 is held and arranged perfectly relative to the deck 5 on which said runner will be assembled.

[0071] Fig. 9C shows a framing area of the first inner runner and the deck of the pallet. This figure shows some of the faces of an inner runner and of the deck to which the different framing elements apply pressure. Thus, and bearing in mind what was explained earlier in the description of Fig. 9A and 9B, the lower front pusher element 22 acts on the face H of the runner, the lower rear pusher element 26 acts on the hidden face G, the lateral framing element 23 on the faces E and F of the deck and of the runner, respectively, and the lateral framing element 25 on the face F of the runner.

[0072] Fig. 10A, 10B and 10C show the framing system of the present invention in the same framing step, corresponding to the framing of a second outer runner.

[0073] Fig. 10A shows the framing system of the present invention applying framing to a second outer runner 4 and the deck 5 of the pallet, in which the lower front pusher elements 22, 22', the lateral framing elements 23, 25, 23', 25' and the rear framing elements 24, 24' are actuated and therefore in contact with the outer runner 4 and/or the deck 5. The rear framing elements are hidden behind the outer runner 4. This figure shows how the lower front pusher elements 22, 22' press the runner 4. Similarly, the lateral framing elements 23, 23' press both the runner 4 and the deck 5 but in a direction aligned with the longitudinal axis of the runner, that is, orthogonal to the pressure applied by the lower front pushers. This will become clear following the description of the figures below.

[0074] Fig. 10B is a view in cross section through the plane A-A' shown in Fig. 4 of the framing system as shown in Fig. 10A. This figure also shows the arrangement of the lower front pusher elements 22', which apply pressure to the runner in the same trajectory as the pressure applied by the rear framing elements 24', but in the opposite direction. Thus, the outer runner 4 is held and arranged perfectly relative to the deck 5 on which said runner will be assembled.

[0075] Fig. 10C shows a framing area of the first outer runner and the deck of the pallet. This figure shows some of the faces of a first outer runner 4 and of the deck 5 to which the different framing elements apply pressure. Thus, and bearing in mind what was explained earlier in the description of Fig. 10A and 10B, the rear framing element 24 acts on the hidden faces I, I' of the runner and of the deck, respectively, the lower front pusher element 22 acts on the face L, the lateral framing element 23 on the faces J and K of the deck and of the runner, respectively, and the lateral framing element 25 on the face K of the runner.

[0076] Fig. 11 shows a clamp 10 which comprises two rigid, elongate elements 101, 102 along the longitudinal axes of which pairs of gripper fingers 11-12, 13-14, 15-16, 11'-12', 13'-14', 15'-16' are arranged. In this embodiment, the clamp is provided with three pairs of fingers on each rigid, elongate element and said pairs of gripper fingers on a first rigid element 101 are aligned with the pairs of fingers of a second, opposite, rigid element 102. Thus, each pallet runner can be gripped by a set of two pairs of fingers, for example the set formed by the pairs 11-12 and 11'-12'. This clamp may be attached to a robotic arm. Thus, the robotic arm can simultaneously hold the different runners of a pallet for assembly.

[0077] Next, bearing in mind what was explained earlier, a method for automatically assembling the deck 5 with the runners 2, 3, 4 of the pallet using the assembly system of the present invention will be explained in detail.

[0078] The pallet assembly method begins by picking up the components for assembly, that are, the deck 5 and the runners 2, 3, 4 of the pallet. The deck 5 is picked up by a supply and positioning system, such as a conveyor belt system, a robotic system or other known supply and positioning systems. If the system is robotic, it may be provided with a conventional clamp, which may be either mechanical, suction or combined. It is preferable that the clamp should be able to take hold mechanically. The runners 2, 3, 4 of the pallet are picked up by a second supply and positioning system, such as a conveyor belt, robotic or other known supply and positioning system. If the system is robotic, it may be provided with a clamp 10 as detailed in the present invention, which allows said clamp to hold all the runners simultaneously with great positioning accuracy. Said system, which comprises a clamp 10, picks up the runners such that the longitudinal axis thereof is arranged transversely to a longitudinal axis of the elements 101, 102 of the clamp 10. This arrange-

ment allows the fixed fingers 11, 11', 13, 13', 16, 16' and the self-adjusting movable fingers 12, 12', 14, 14', 15, 15' to press the sides of the runners. In the present embodiment, three runners have been shown, but another larger or smaller number of runners may be used to form the pallet. Similarly, not all the runners need necessarily be the same length or width.

[0079] In the process of picking up of the runners, the fixed fingers 11, 11', 13, 13', 16, 16' arranged on the clamp 10 move slightly with respect to the gripping position to allow faster positioning of the robot on picking up the runners. Once the robot is positioned above the runners, the fixed finger 11, 11', 13, 13', 16, 16' moves to the gripping position, and the self-adjusting movable finger 12, 12', 14, 14', 15, 15' is actuated to press the runner against the fixed finger. The self-adjusting nature of the movable finger allows a wide range of runner widths to be encompassed, which ensures that said range of runner widths are held accurately during the assembly process. Accordingly, the runners are gripped by two pairs of gripper fingers, one pair arranged above the rigid element 101 and the other pair arranged above the rigid element 102.

[0080] Prior to positioning the runners and the deck of the pallet in the framing area, the framing system and the nailing device have been configured to perform the assembly operation based on the morphology of the pallet to be assembled. This configuration comprises the specification of the nailing points, the adjustment of the position of the framing elements and pushers on the positioning guides 28, the travel path of the lateral pusher elements and the travel path of the front and rear pusher elements, among others.

[0081] Once the assembly system is ready, the positioning system secures the deck 5 and the first outer runner 2 against the front framing elements 21, 21' which have been actuated. Next, the lateral framing elements 23, 23', 25, 25' are actuated and then the lower, rear pushers 26, 26' are actuated to press and secure the first outer runner 2 between said pushers and the front framing elements 21, 21'. Note that the actuation of the framing elements need not necessarily follow the proposed order. With all the elements actuated, the alignment between the components of the pallet is ensured, and said components are prevented from being exposed to unintended movements during nailing. Thus, once the unit to be assembled is framed, the nailing unit 30 performs the nailing operation.

[0082] When the front runner has been nailed, the lower, rear pusher elements 26, 26' and the front 21, 21' and lateral 23, 23', 25, 25' framing elements are deactuated, leaving the unit free with no impediment to the linear movement of the pallet to be assembled. Said movement, in a direction transverse to the pallet runners, occurs synchronously by actuating both positioning systems, that is, that of the deck and that of the runners of the pallet. When the first outer runner 2, which is now nailed, passes through the framing area, the lower, front pusher elements 22, 22' are actuated to limit the movement of the first inner runner 3. Thus, once the inner runner 3 is resting against the lower, front pushers 22, 22', the lower, rear pushers 26, 26' and the lateral framing elements 23, 23', 25, 25' are actuated to secure and align said runner 3 with the unit formed by the deck 5 and the first outer runner 2. Once said elements are secured and aligned, the nailing unit 30 performs the nailing operation as previously configured. Immediately afterwards, the lower front 22, 22' and lower rear 26, 26' pusher elements are deactuated, the lateral framing elements 23, 23', 25, 25' are deactuated and the same procedure is repeated for each of the inner runners of the pallet to be assembled.

[0083] When all the inner runners have been nailed and the positioning systems have moved the unit for assembly to the final position in which the second outer runner 4 is in contact with the already actuated lower, front pushers 22, 22', the rear framing elements 24, 24' and the lateral framing elements 23, 23', 25, 25' are actuated. Said pushers secure and frame the unit to be assembled until the nailer 30 completes the nailing operation.

[0084] Once the entire pallet is assembled, the framing elements and pushers are deactuated, and the positioning system removes the assembled pallet 1.

[0085] Although the invention has been described in relation to a preferred embodiment, this should not be considered as limiting the invention, and structural or other types of details which may be clear to a person skilled in the art after interpreting the subject matter disclosed in the present description, claims and drawings may be changed. In particular, in principle and unless explicitly cited, all the features of the different embodiments and alternatives shown and/or suggested may be combined. Therefore, the protection of the present invention includes any variant or equivalent that could be thought to be covered by the widest interpretation of the following claims.

Claims

1. Automatic assembly system (100) for pallets formed of a plurality of runners (2, 3, 4) and a deck (5), comprising:

   a supply and positioning system;
   a framing and nailing area;
   a framing system (20);
   and a nailing unit (30),
   in which the supply and positioning system supplies and positions the components (2, 3, 4, 5) of the pallet in the framing and nailing area,
   in which the framing system (20) comprises movable actuation elements (21, 22, 23, 24, 25, 21', 22', 23', 24', 25, 26') which frame the deck (5) and the runners (2, 3, 4) of the pallet with said actuation elements,

and in which a nailing unit (30) performs the function of nailing the runners to the deck,
characterised in that the movable actuation elements (21, 22, 23, 24, 25, 21', 22', 23', 24', 25, 26') are arranged around the framing and nailing area and comprise pressure surfaces which frame the deck and a single runner of the pallet at the same time, without framing the rest of the runners, using said movable actuation elements.

2. Automatic pallet assembly system (100) according to claim 1, **characterised in that** it comprises control means which synchronise the movement of the deck (5) and the runners (2, 3, 4) of the pallet with the actuation of the nailing unit (30) and the framing system (20) to allow the framing system to act sequentially on different runners of the pallet.

3. Automatic pallet assembly system (100) according to either claim 1 or claim 2, **characterised in that** the movable actuation elements (21, 22, 23, 24, 25, 21', 22', 23', 24', 25, 26') comprise a longitudinal framing system (23, 25, 23', 25') and a transverse framing system (21, 22, 24, 21', 22', 24', 26') with respect to the runner for assembly, in order to apply pressure to the runner and/or deck of the pallet longitudinally and transversely to said runner, respectively.

4. Automatic pallet assembly system (100) according to claim 3, **characterised in that** the longitudinal framing system comprises two dual heads (23, 25, 23', 25'), in which an upper unit (23, 23') moves along a first guide and comes in contact at least with the deck of the pallet and a lower unit (25, 25') moves along a second guide and comes in contact with the runner of pallet, in order to apply pressure along a longitudinal axis of a runner on which framing is carried out.

5. Automatic pallet assembly system (100) according to either claim 3 or claim 4, **characterised in that** the transverse framing system comprises movable actuation elements with planar contact surfaces and with curved contact surfaces which act on the runner, on the deck and/or on the runner and the deck.

6. Automatic pallet assembly system (100) according to any one of claims 3 to 5, **characterised in that** the transverse framing system is arranged on positioning guides (28) and comprises means for adjusting the position thereof along said guides.

7. Automatic pallet assembly system (100) according to any one of the preceding claims, **characterised in that** the supply and positioning system for the components of the pallet comprises robotic arms, in which a first robotic arm is configured to manipulate the deck (5) of the pallet and a second robotic arm is configured to manipulate the runners (2, 3, 4) of the pallet.

8. Automatic pallet assembly system (100) according to claim 7, **characterised in that** the robotic arm responsible for manipulating the runners (2, 3, 4) of the pallet comprises a clamp (10) with a plurality of pairs of gripper fingers (11-12, 11'-12', 13-14, 13'-14', 15-16, 15'-16') for securing the runners of the pallet.

9. Automatic pallet assembly method using an automatic pallet assembly system according to any one of the preceding claims, **characterised in that** it comprises the following steps:

a) Supplying and positioning the deck (5) and the runners (2, 3, 4) of the pallet for assembly using the supply and positioning system in the framing and nailing area;
b) Actuating the framing elements to frame the deck (5) and a first runner of the pallet with the movable actuation elements in a longitudinal direction and a transverse direction thereof;
c) Nailing the deck (5) to a first runner using a nailing unit (30);
d) Deactuating the framing elements;
e) Translating the deck (5) and the runners (2, 3, 4) of the pallet by means of the supply and positioning system until a second runner reaches the framing and nailing area.

10. Automatic pallet assembly method according to the preceding claim, **characterised in that** it also comprises the following steps:

f) Actuating the framing elements to frame the deck (5) and a second runner of the pallet with the movable actuation elements in a longitudinal direction and a transverse direction thereof;
g) Nailing the deck (5) to a second runner using a nailing unit (30);
h) Deactuating the framing elements.

11. Automatic pallet assembly method according to the preceding claim, **characterised in that** it also comprises the following steps:

i) Translating the deck (5) and the runners (2, 3, 4) of the pallet by means of the supply and positioning system until a third runner reaches the framing and nailing area.
j) Actuating the framing elements to frame the deck (5) and a third runner of the pallet with the movable actuation elements in a longitudinal direction and a transverse direction thereof;

k) Nailing the deck (5) to a third runner using a nailing unit (30);
l) Deactuating the framing elements.

12. Automatic pallet assembly method according to any one of claims 9 to 11, which comprises the actuation of front (21, 21') and lateral (23, 25, 23', 25') framing elements and of lower rear pusher elements (26, 26') to frame the deck (5) and a first runner, in which said first runner is a first outer runner (2), with said movable actuation elements in the longitudinal direction and the transverse direction thereof.

13. Automatic pallet assembly method according to any one of claims 10 to 12, which comprises the actuation of lateral framing elements (23, 25, 23', 25') and of the lower front (22, 22') and lower rear (26, 26') pusher elements to frame the deck (5) and a second runner, in which said second runner is a first inner runner (3), with said movable actuation elements in the longitudinal direction and in the transverse direction thereof.

14. Automatic pallet assembly method according to any one of claims 11 to 13, which comprises the actuation of rear (24, 24') and lateral (23, 25, 23', 25') framing elements and of the lower front pusher element (22, 22') to frame the deck (5) and a third runner, in which said third runner is a second outer runner (4), with said movable actuation elements in the longitudinal direction and in the transverse direction thereof.

15. Automatic pallet assembly method according to any one of claims 9 to 14, which comprises an additional step of removing the assembled pallet (1) by means of the supply and positioning system.

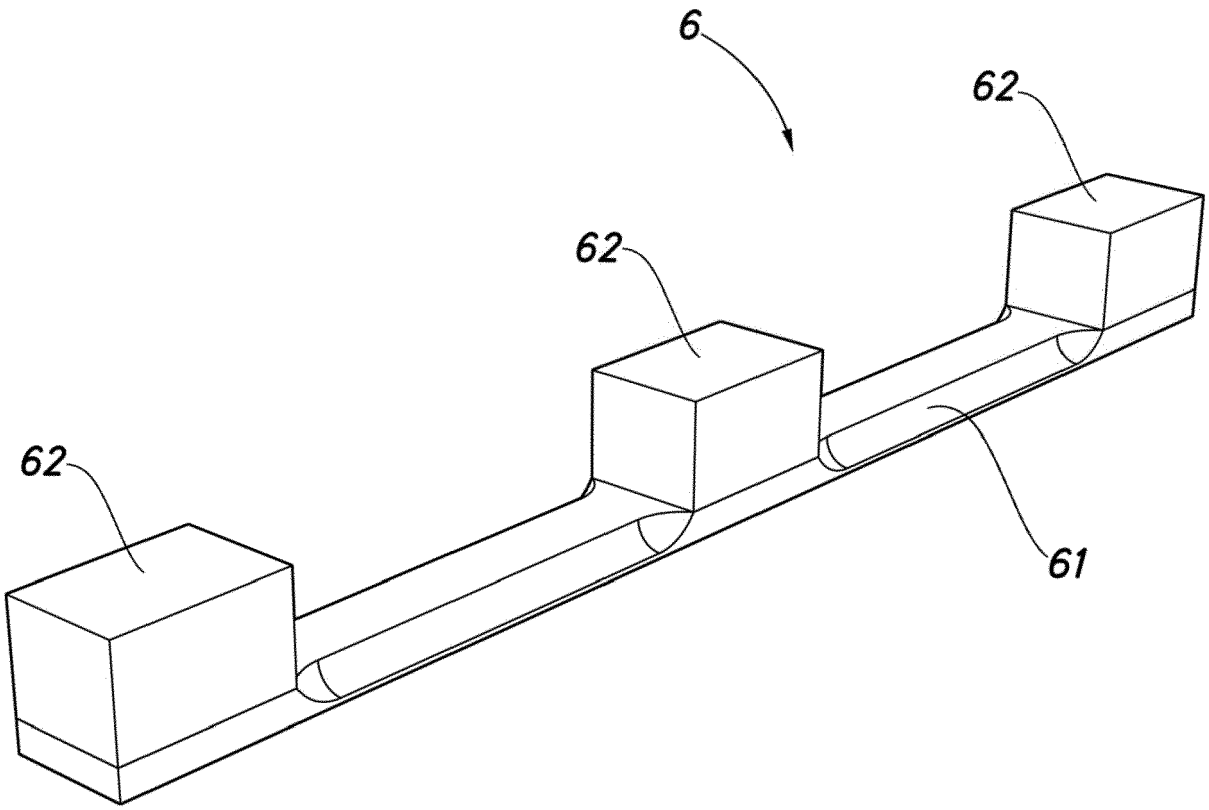

Fig.1

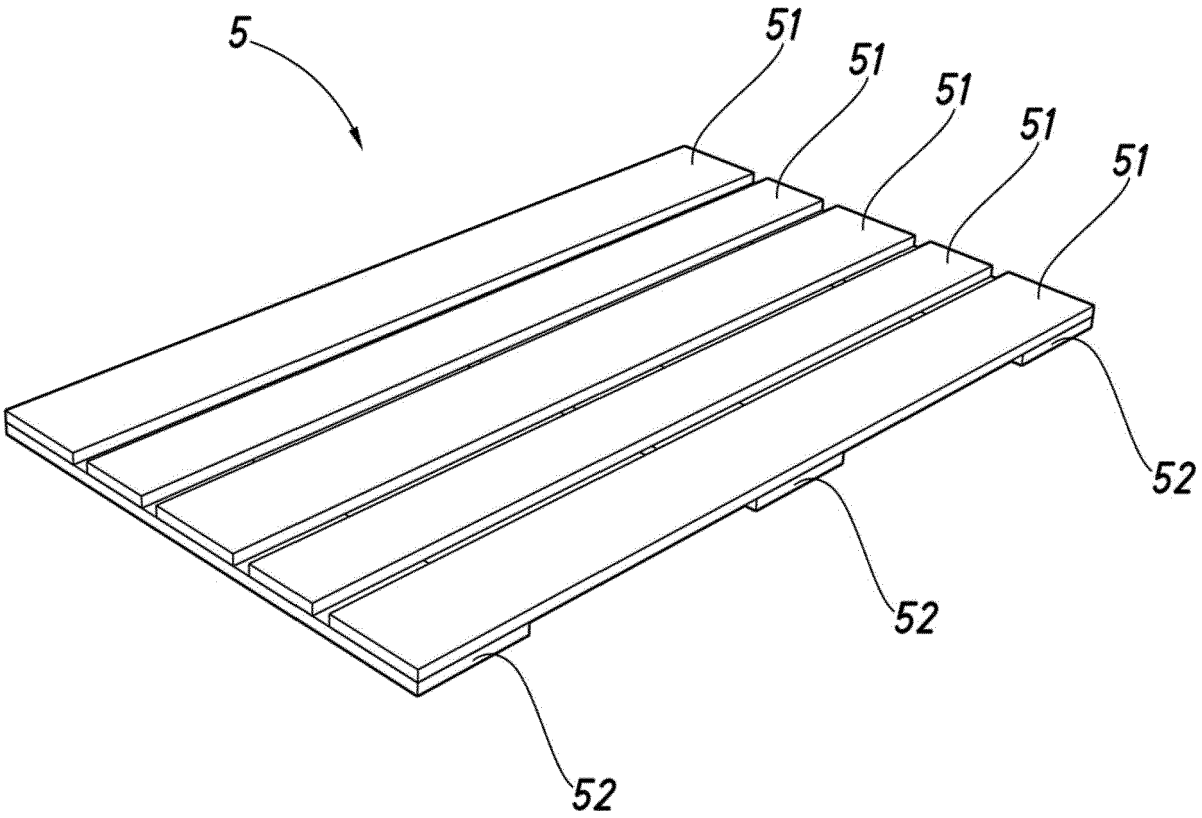

Fig.2

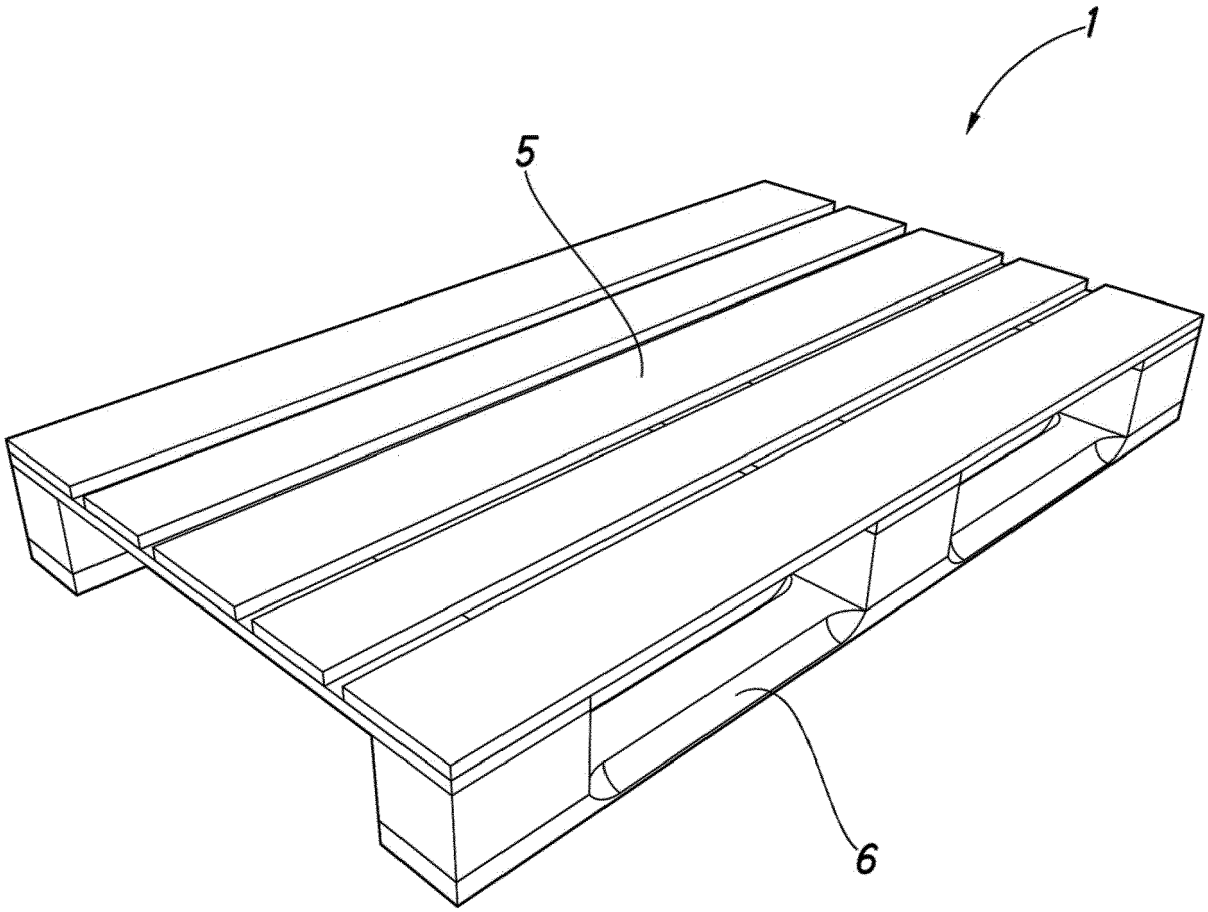

Fig.3

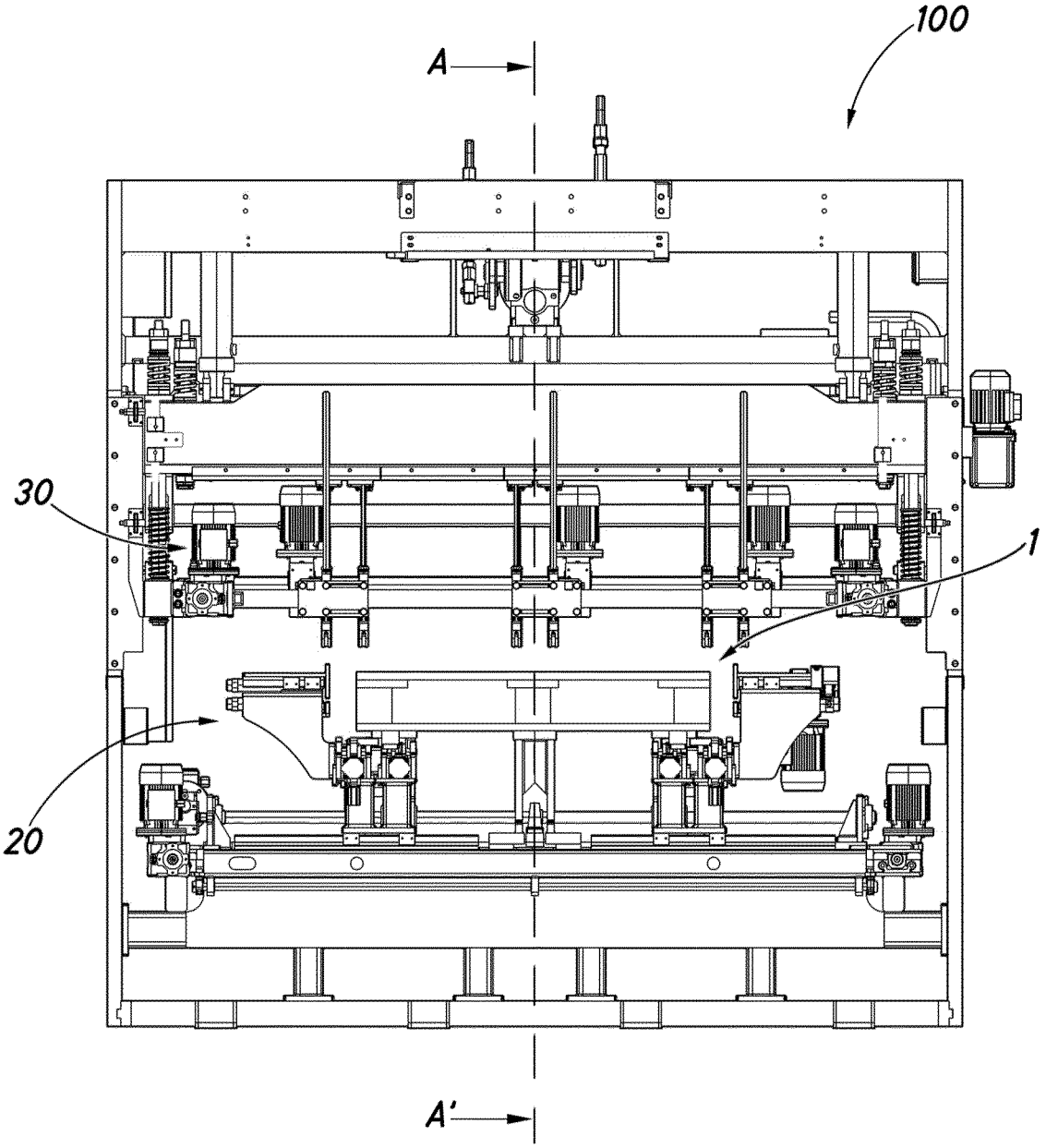

Fig.4

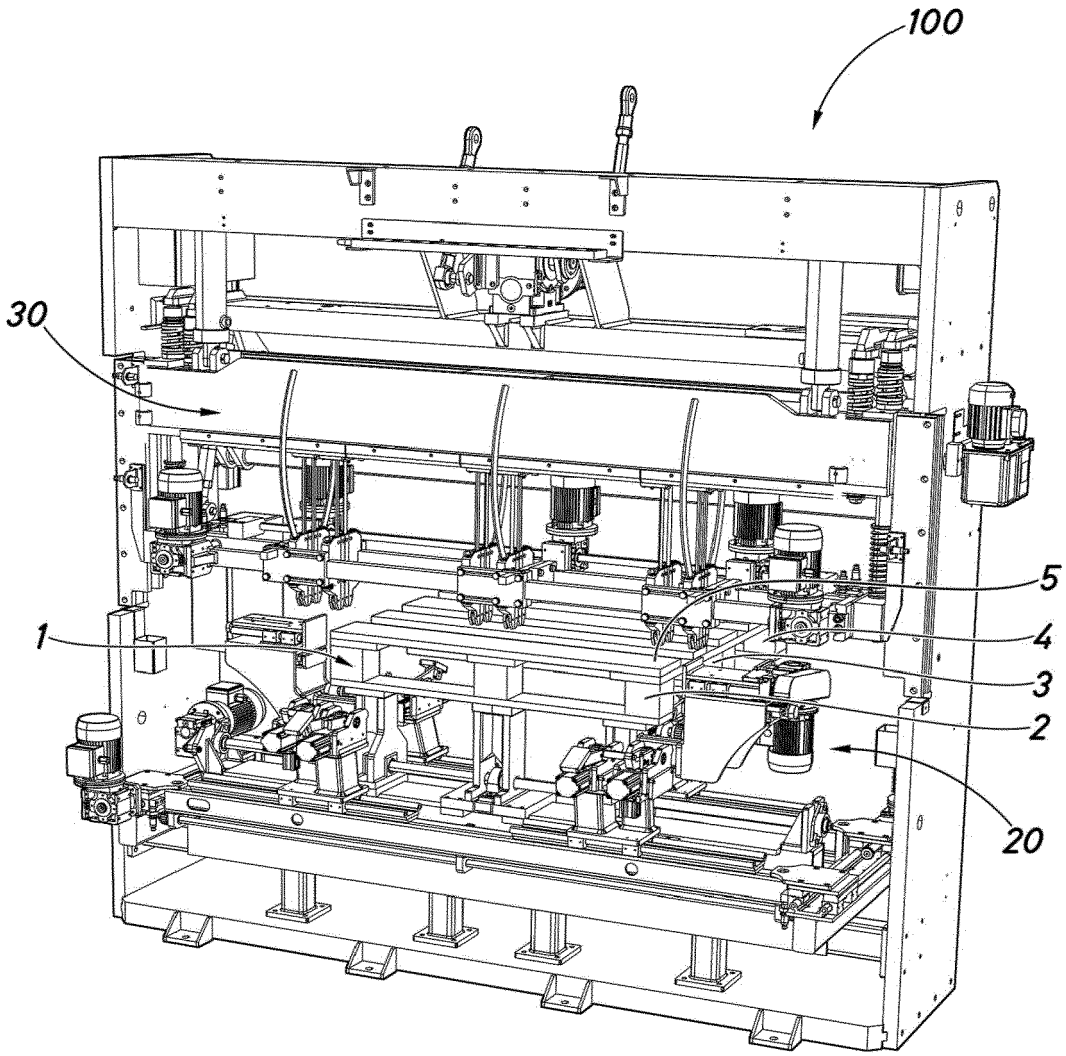

Fig.5

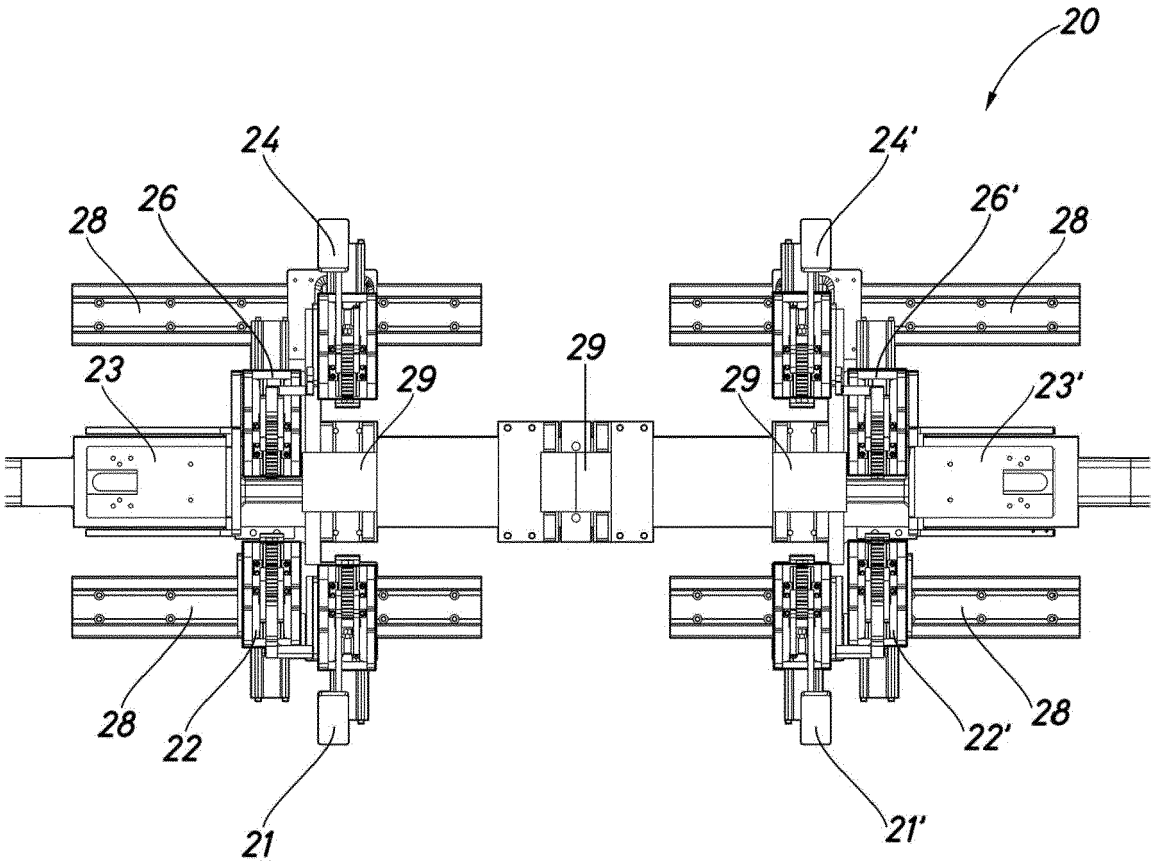

Fig.6

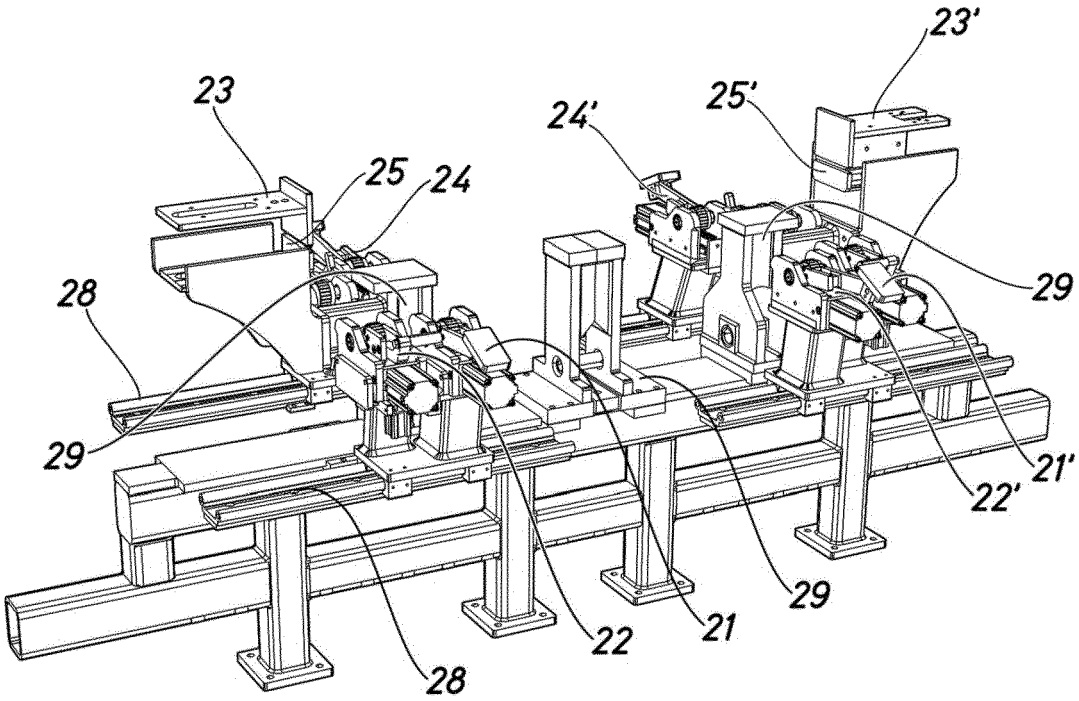

Fig.7

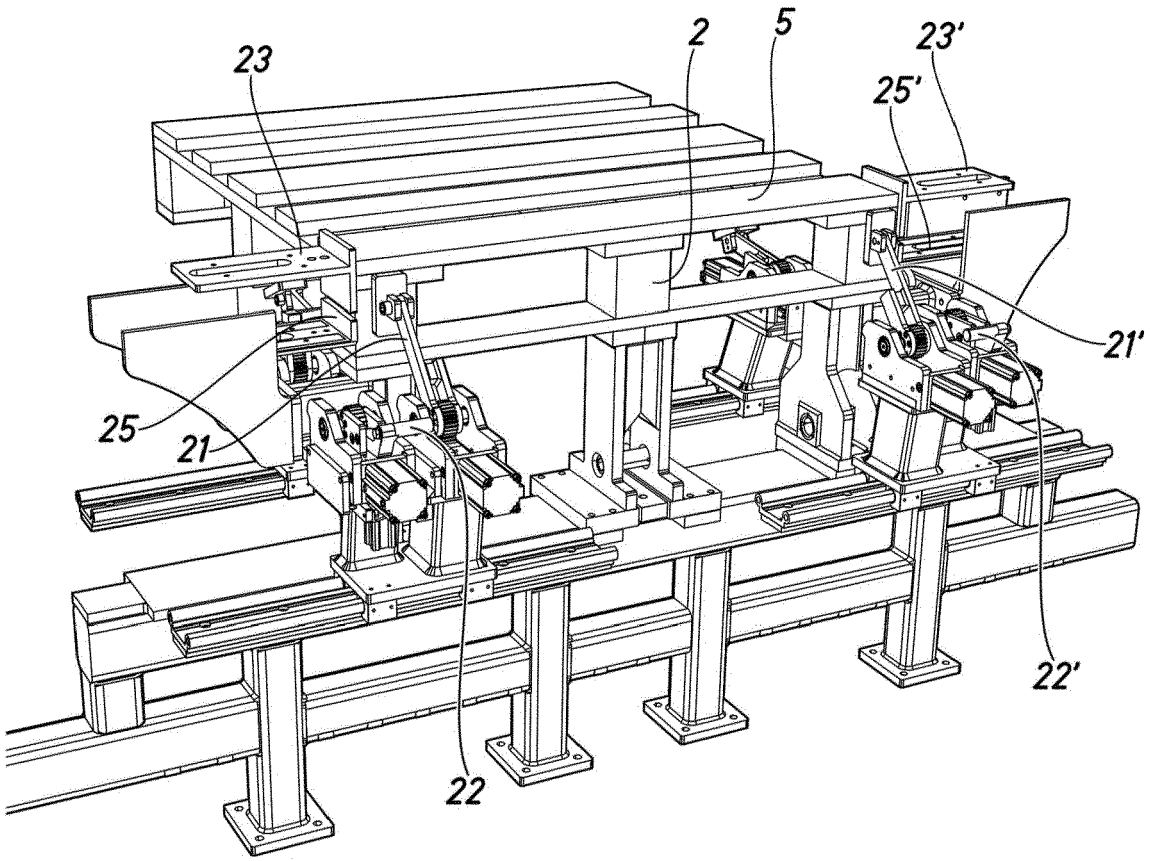

Fig.8A

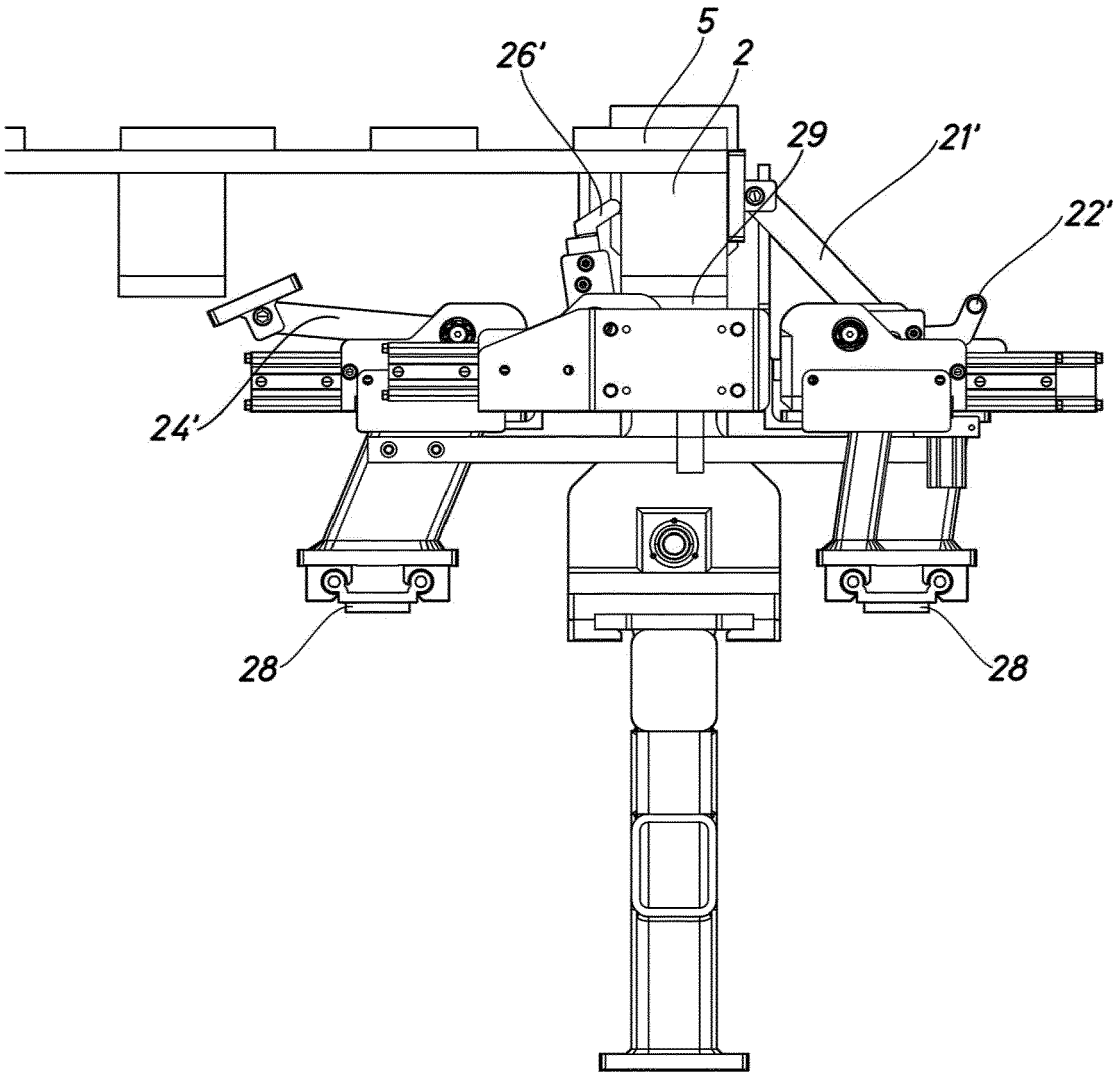

Fig.8B

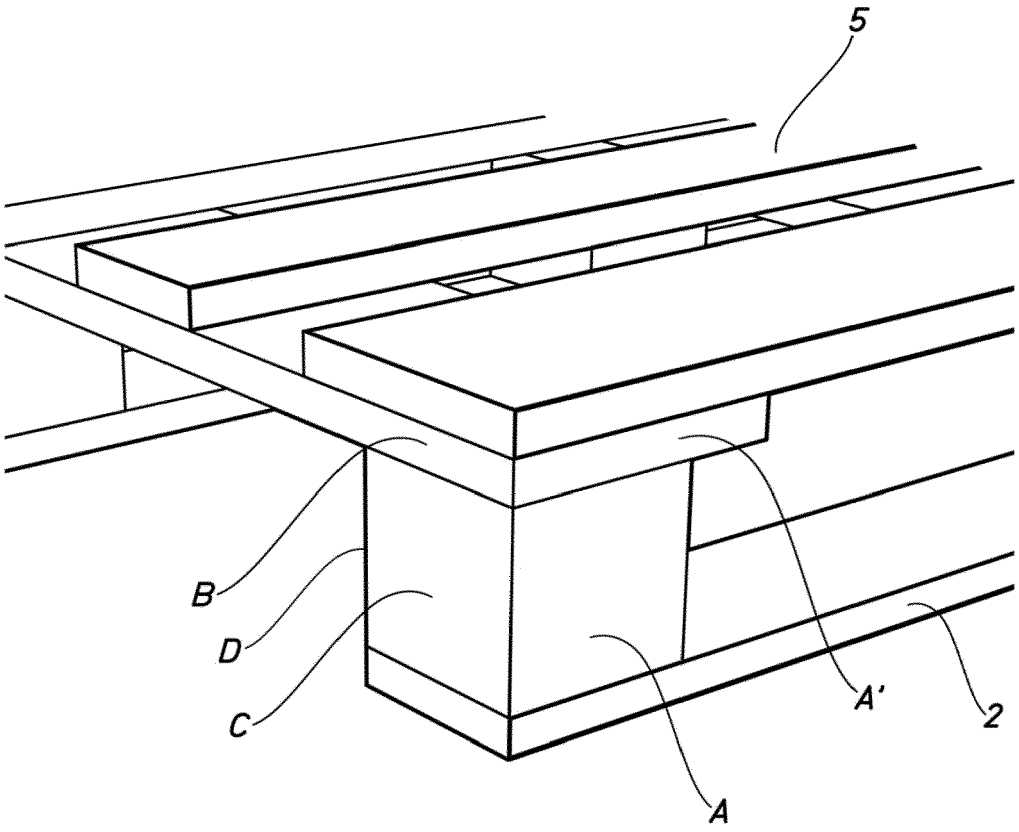

Fig.8C

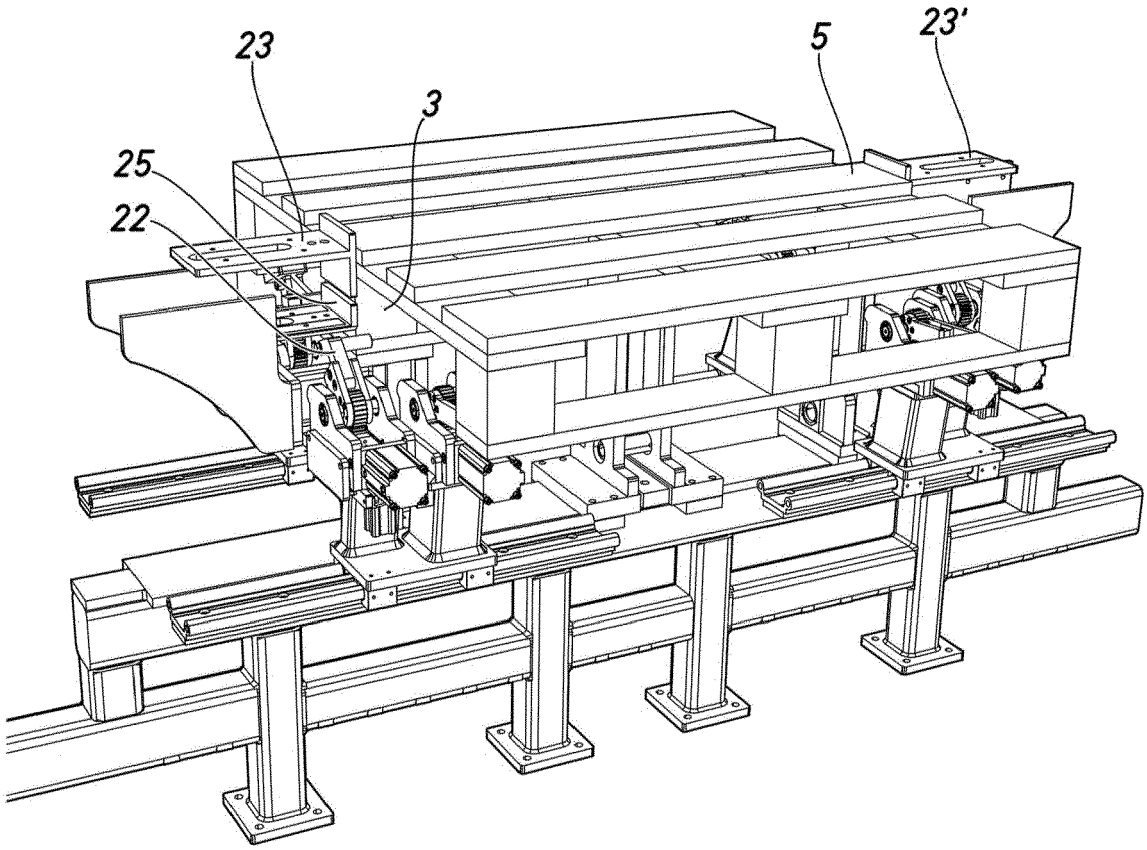

Fig.9A

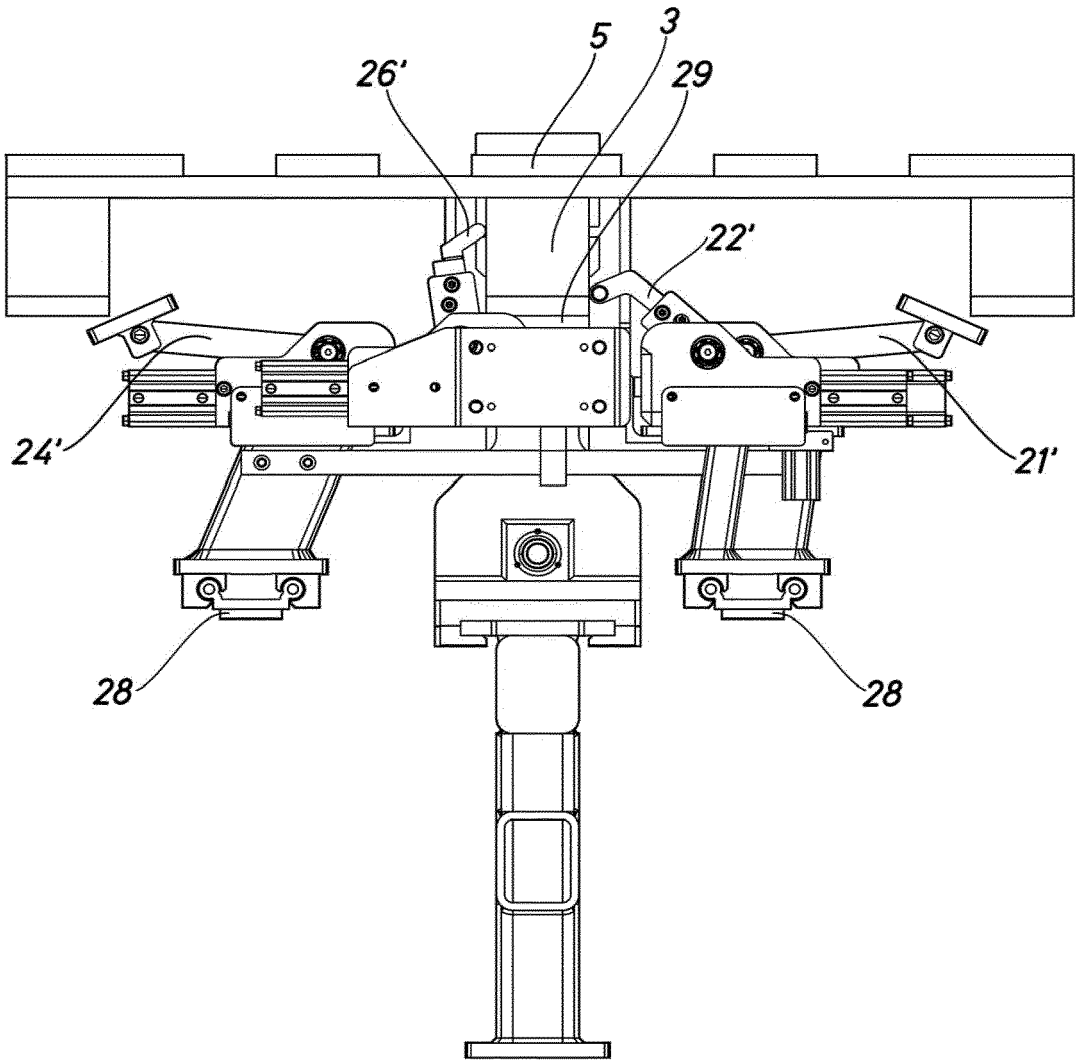

Fig.9B

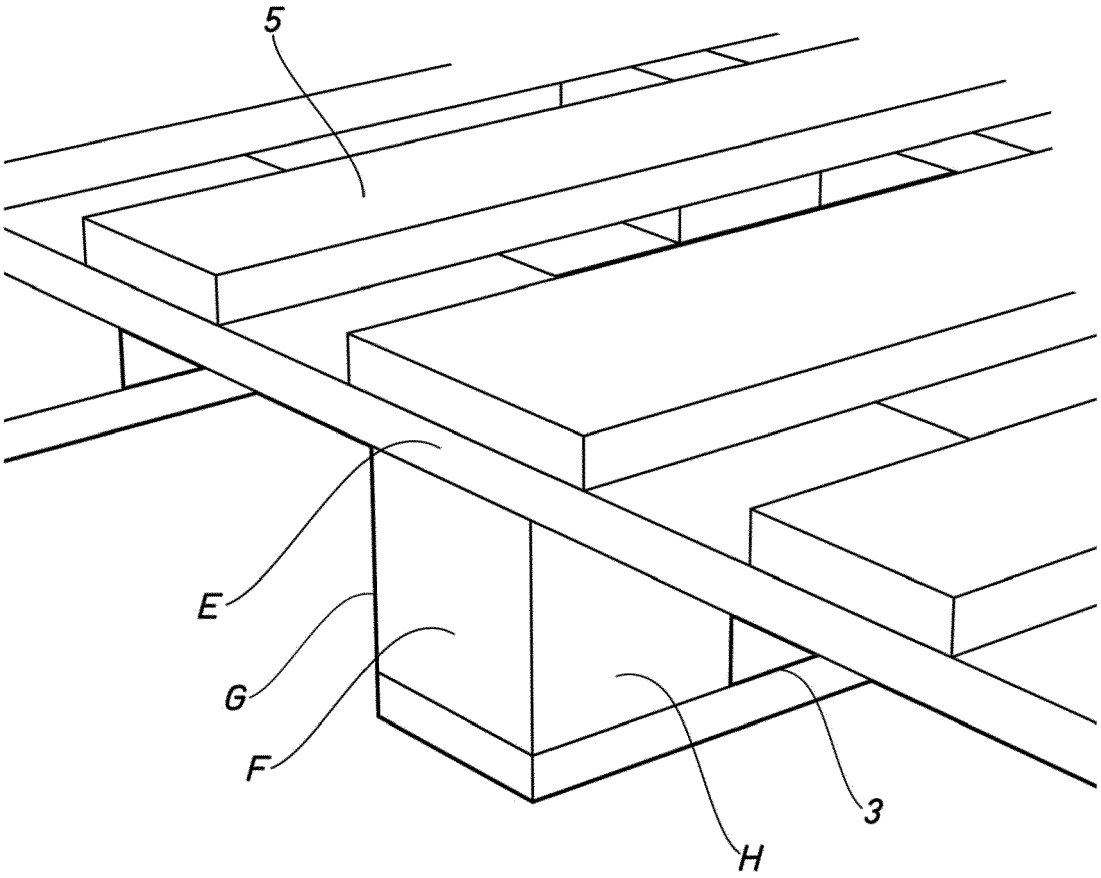

Fig.9C

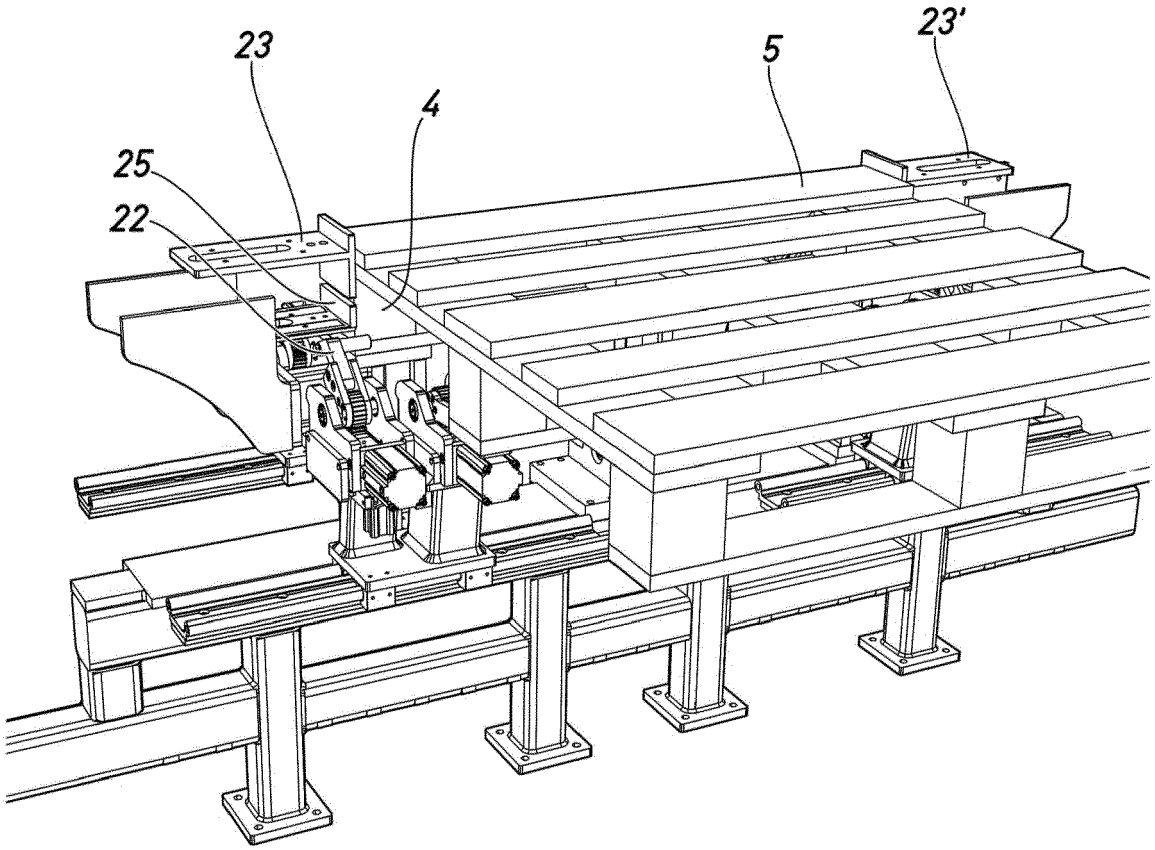

Fig.10 A

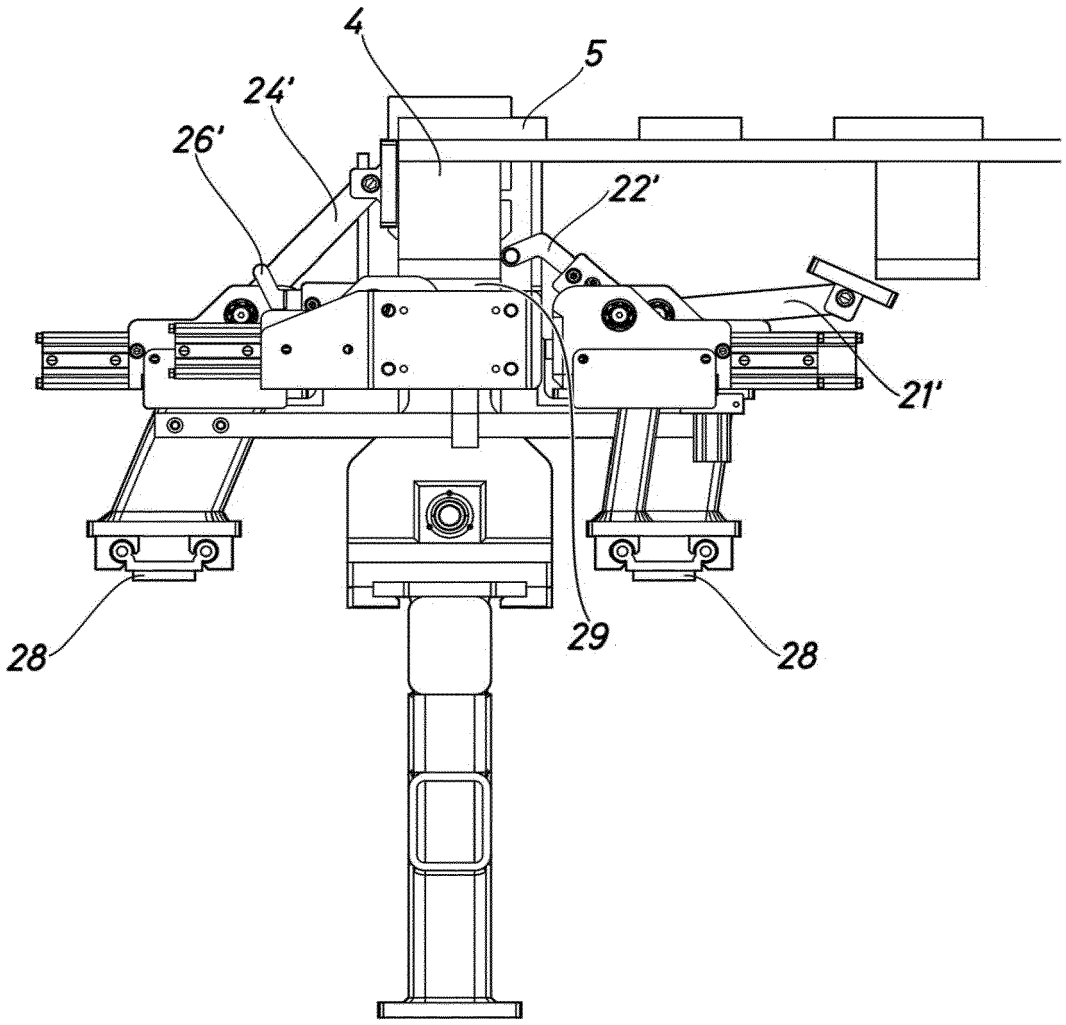

Fig.10B

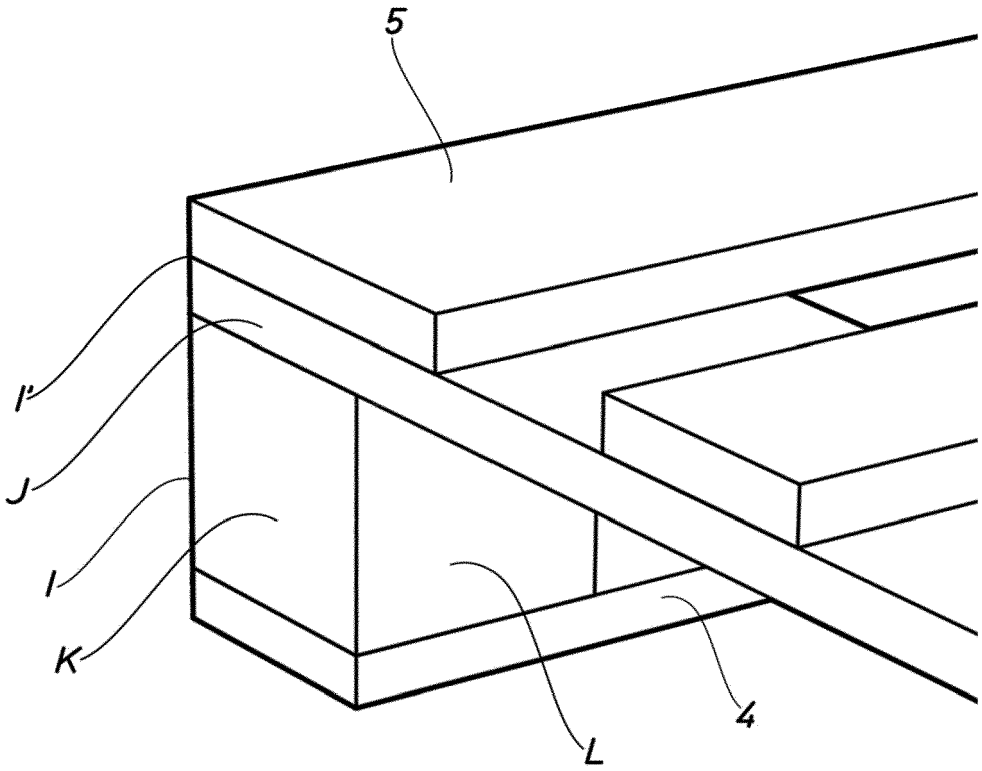

Fig.10C

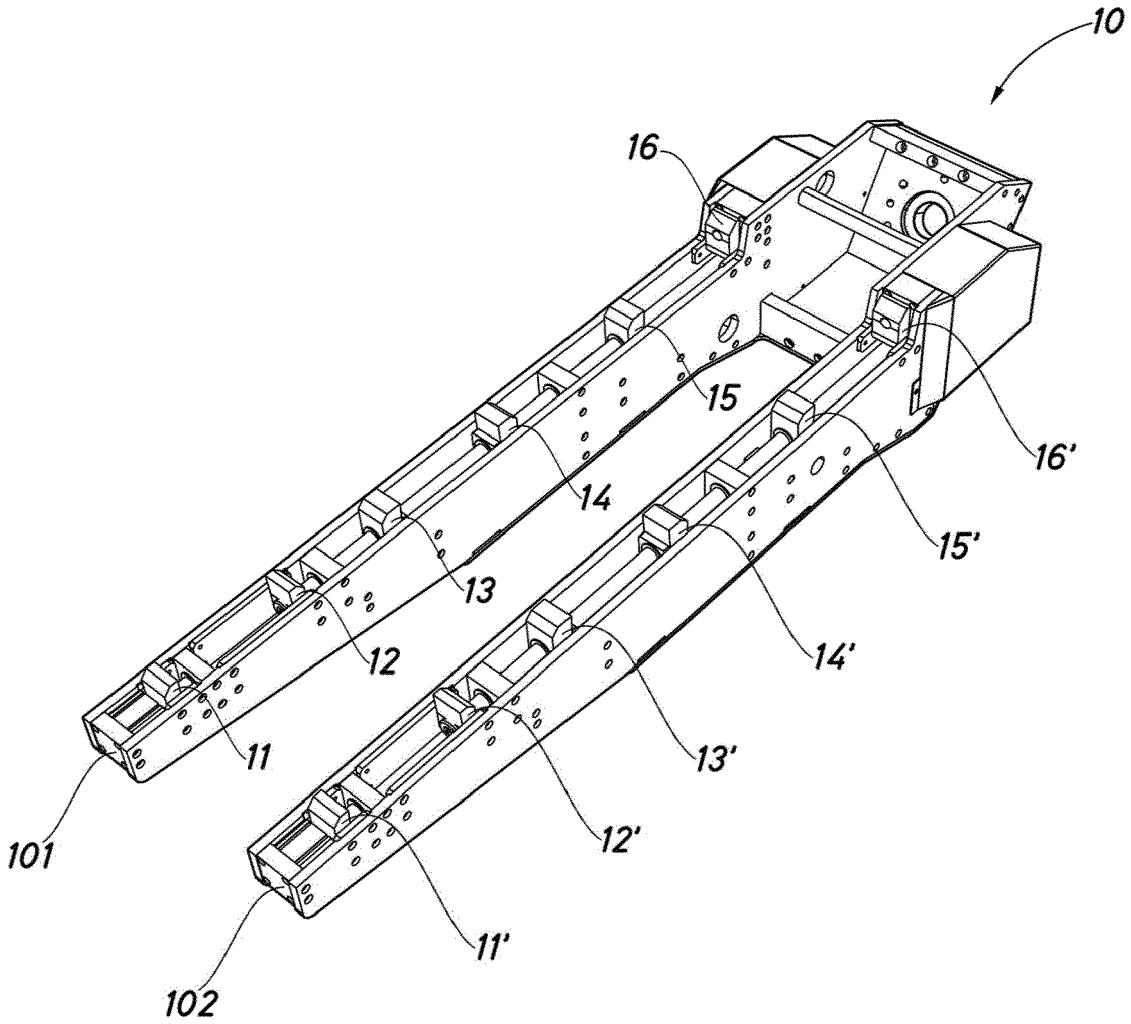

Fig.11

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EUROPEAN SEARCH REPORT

Application Number
EP 20 38 2951

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 4 489 819 A (PERRIN LLOYD E [US] ET AL) 25 December 1984 (1984-12-25) * column 1, line 31 - line 52; figure 2 * * column 2, line 28 - line 68 * -----	1-15	INV. B27M3/00
A	GB 2 005 181 A (TRUE BROS MFG LTD) 19 April 1979 (1979-04-19) * the whole document * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

B27M
B27F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 April 2021	Mirza, Anita

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 38 2951

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21-04-2021

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