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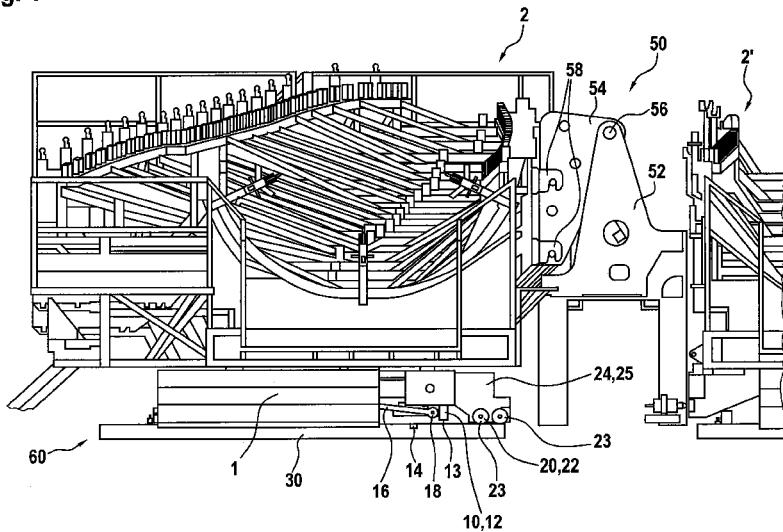
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[Fortsetzung auf der nächsten Seite]

(54) Title: HANDLING DEVICE FOR HANDLING A ROTOR BLADE MOLD FOR PRODUCING A ROTOR BLADE OF A WIND TURBINE

(54) Bezeichnung : HANDHABUNGSVORRICHTUNG ZUM HANDHABEN EINER ROTORBLATTFORM ZUM FERTIGEN EINES ROTORBLATTES EINER WINDENERGIEANLAGE

Fig. 1



(57) Abstract: The invention relates to a transport vehicle (1) for handling a rotor blade mold for producing a rotor blade of a wind turbine or a partial shell of a rotor blade of a wind turbine, prepared for use in a handling device (60). The handling device (60) comprises a first rail set for moving the transport vehicle in a first direction and a second rail set for moving the transport vehicle in a second direction. Furthermore, the transport vehicle has a first wheelset (10) comprising a plurality of wheels (13), for travelling on the first rail set, and a second wheelset (20) comprising a plurality of wheels (23), for travelling on the second rail set.

(57) Zusammenfassung:

[Fortsetzung auf der nächsten Seite]



Veröffentlicht:

- mit internationalem Recherchenbericht (Artikel 21 Absatz 3)
- vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eingehen (Regel 48 Absatz 2 Buchstabe h)

Die Erfindung betrifft ein Transportfahrzeug (1) zum Handhaben einer Rotorblattform zum Fertigen eines Rotorblattes einer Windenergieanlage oder einer Teilschale eines Rotorblattes einer Windenergieanlage, vorbereitet zur Verwendung in einer Handhabungsvorrichtung (60). Die Handhabungsvorrichtung (60) umfasst einen ersten Schienensatz zum Verfahren des Transportfahrzeugs in einer ersten Richtung und einen zweiten Schienensatz zum Verfahren des Transportfahrzeugs in einer zweiten Richtung. Ferner umfasst das Transportfahrzeug einen mehrere Räder (13) umfassenden ersten Radsatz (10) zum Fahren auf dem ersten Schienensatz und einen mehrere Räder (23) umfassenden zweiten Radsatz (20) zum Fahren auf dem zweiten Schienensatz.

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5 Handling device for handling a rotor blade mold for
 producing a rotor blade of a wind turbine

The present invention concerns a transport vehicle for handling a
10 rotor blade mould for the production of a rotor blade of a wind power
 installation. The invention further concerns a handling apparatus which
 includes such a transport vehicle. Furthermore the invention concerns a
 process for the production of a rotor blade of a wind power installation.

Wind power installations are generally known and usually require at
least one and usually three rotor blades which are to be driven by the wind.
15 Modern wind power installations like for example the one shown in Figure 1
 can have a nominal power of several megawatts and require suitably large
 rotor blades for that purpose. Such rotor blades can nowadays already be
 of lengths of about 50 m and more. In that respect such a rotor blade is
 frequently made, at least in a large portion thereof, from glass fibre-
20 reinforced plastic or similar material. A common possible form of production
 involves making the rotor blade or the rotor blade portion from two shell
 portions. The two shell portions are firstly produced substantially separately
 and are then fitted together. The production of such shell portions involves
 using a rotor blade mould which in particular predetermines the shape of
25 the rotor blade to be produced or the corresponding portion thereof. In this
 case for example fibre mats can be placed in position, which are then
 impregnated with a suitable resin. Impregnation of the resin can for
 example be carried out in such a way that the fibre mat is closely enclosed
 in an air-tight space and then the corresponding resin is fed into that air-
30 tight space by means of reduced pressure, in most cases similarly to a
 vacuum, that is to say it is sucked thereinto.

Such rotor blade moulds are accordingly of sizes of the order of
magnitude of the rotor blade to be produced or the rotor portion to be
produced and accordingly for example can be about 50 m in length and
35 about 5 m in width. At the latest if in that respect two separately produced

shell portions have to be fitted together at least one of the rotor blade moulds has to be moved in the production factory in which rotor blade production takes place. For optimisation of working procedures in such a factory it may be advantageous for different working steps to be performed 5 at different stations. That requires further movements of the rotor blade moulds in the factory.

Moving large and also unwieldy loads in industrial production plants is basically known. By way of example suitably large and powerful lifting trucks which are generally adapted to the specific situation of use are used 10 for that purpose, which can travel on a flat smooth surface of the floor of the factory. Such lifting trucks can then move with the application of a comparatively small amount of energy, due to a very flat and horizontal configuration of such a factory floor, with a high degree of precision.

It is precisely in relation to unwieldy objects like such a long rotor 15 blade mould however that displacement is difficult and caution is required to ensure that the rotor blade mould does not knock by mistake against an article in the factory when being moved. In addition the connection of such a lifting truck also presupposes a suitable quality in respect of the factory floor and meticulous cleaning of the factory floor to ensure the travel 20 operation of the lifting truck.

Such previously known solutions are therefore complicated and expensive and in operation require personnel with a great deal of experience and a high level of attentiveness.

Therefore the object of the present invention is to address at least 25 one of the above-indicated problems. In particular the invention seeks to improve handling of rotor blade moulds. At least the invention seeks to propose an alternative solution.

According to the invention there is proposed a transport vehicle according to claim 1. It is adapted for handling a rotor blade mould for the 30 production of a rotor blade of a wind power installation or for the production of a shell portion of a rotor blade of a wind power installation. In particular the transport vehicle carries such a rotor blade mould which for example can measure 48 m in length and/or wherein the transport vehicle

can measure 48 m in length. The transport vehicle is adapted for use in a handling apparatus which in particular is part of a production factory.

Such a handling apparatus includes a first rail set for displacement of the transport vehicle in a first direction and a second rail set for

5 displacement of the transport vehicle in a second direction. The mention of two directions is used here to mean two directions which are arranged at an angle relative to each other, that is to say not merely a forward direction and a reverse direction. In that arrangement a rail set includes at least two parallel rail tracks. It is however also possible to provide three or

10 more parallel rail tracks for each rail set. The first and second rail sets can also have respective differing numbers of parallel rail tracks. Preferably the first or second direction is a longitudinal direction of the transport vehicle and accordingly the second or first direction respectively is a transverse direction of the transport vehicle. In that case a rail set is preferably used

15 in the longitudinal direction, with fewer rail tracks than in the transverse direction. For example four rail tracks can be provided in mutually juxtaposed relationship in the transverse direction in order thereby to be able to better distribute the weight of the transport vehicle over the width of the vehicle to the rails.

20 In that arrangement the transport vehicle includes a first wheel set comprising a plurality of wheels for travel on the first rail set and a second wheel set comprising a plurality of wheels for travel on the second rail set. That therefore provides the option of displacement of the transport vehicle and thus a rotor blade mould arranged thereon in two different directions,

25 wherein the use of the rails enables guided transport which avoids any collisions with other fixed articles in the proximity of the transport vehicle. Thus by virtue of the use of a respective wheel set for the corresponding rail set, there is proposed the use of a respective wheel set for each direction. A change in the directions can thus be effected by a change in

30 the wheel set. Accordingly, switching points for changing from one rail set to another are avoided.

Preferably the transport vehicle has a change device for changing from the first wheel set for travel on the first rail set to the second wheel

set for travel on the second rail set. Thus for example the transport vehicle can be displaced in the first direction to an intersection point of the first rail set with the second rail set. There the change device is then used to change from the first wheel set to the second wheel set. It will be
5 appreciated that a change from the second wheel set to the first wheel set is also conversely possible.

Such a change from the first wheel set to the second wheel set is correspondingly effected in such a way that the first wheel set thus firstly travelled on the first rail set and now after the change to the second wheel
10 set the latter is supported on the second rail set and the vehicle can now travel on the second rail set.

It is desirable for the transport vehicle to be of such a design configuration that the change device is adapted for raising and lowering the wheels of the first wheel set, wherein the wheels of the first wheel set can
15 be moved from a lowered condition into a raised condition and vice-versa. The transport vehicle is lifted by the lowering movement of the wheels of the first wheel set. There are thus basically two conditions, namely a lowered condition in which the first wheel set is completely lowered in the appropriate fashion and a lifted condition in which the first wheel set is
20 completely lifted in the appropriate fashion. In the lowered condition the transport vehicle rests with the wheels of the first wheel set on the first rail set and the wheels of the second wheel set are higher than those of the first wheel set, but at any event no longer rest on the second wheel set. In the lifted condition it is precisely the reverse and the transport vehicle rests
25 with the wheels of the second wheel set on the second rail set and the wheels of the first wheel set no longer rest on the first rail set.

This means that, upon lowering of the wheels of the first wheel set, the change device moves the latter downwardly on to the rails of the first rail set in such a way that as a result the entire transport vehicle, with the
30 exception of the wheels of the first wheel set and a part of the change device, is lifted, including articles accommodated thereon like the rotor blade mould and possibly also inserted elements of the rotor blade to be produced. Considerable forces have to be applied in that case, in particular

in dependence on the weight of the equipped transport vehicle and in dependence on the number of wheels of the first wheel set on which the change device is acting.

The dimensions of the individual elements, in particular the required 5 heights for the respectively active wheel set can be predetermined with comparatively small tolerances, by virtue of the use of the rail system, that is to say the use of the first rail set and the second rail set. Thus in the event of that change from the second wheel set to the first wheel set by lowering the first wheel set, a short lifting travel can be sufficient. The 10 required lifting force when lowering the wheels of the first wheel set is admittedly great, but the necessary lifting work due to the short lifting travel can nonetheless be kept comparatively low.

Preferably therefore it is also proposed that the change device lowers and/or lifts the wheels of the first wheel set by means of an elbow lever 15 mechanism, also referred to as a knee lever mechanism. Such a knee lever mechanism is distinguished in that – as in the case of the human knee which gave its name to that mechanism – it is possible to achieve an extension effect with enormous force, but a short travel, by virtue of the angles used. Such a knee or elbow lever mechanism can thus be 20 advantageously employed for the proposed use in the change device, namely powerful lowering of the wheels of the first wheel set with a short stroke movement. In addition the extended condition in which namely the wheels of the first wheel set are lowered and carry the entire load of the transport vehicle can be held with little or no force.

25 Preferably the change device is operated hydraulically and/or electrically. Enormous forces are possible by means of a hydraulic operating mechanism, with at the same time a precise movement. A similar situation can be achieved by an electric drive, possibly with a suitable transmission. Preferably the electric drive however is proposed for generating the 30 hydraulic pressure. In that case the change device operates hydraulically when it is operated by means of electrically driven pumps and preferably also electrically controlled valves.

According to an embodiment it is proposed that the change device, for each wheel of the first wheel set, includes a lifting means, in particular using an elbow lever mechanism, for lifting and lowering the respective wheel, wherein the lifting means can preferably be actuated synchronously.

5 In that way the necessary force which ultimately is more specifically afforded from the weight of the equipped transport vehicle divided by the number of lifting means – with uniform distribution – can be divided up and can thus be reduced for each individual lifting device. That applies in particular in an arrangement involving a uniform distribution and

10 synchronous actuation in which in the optimum case all wheels of the first wheel set reach the rails of the first rail set at the same time and then have to take over the forces hitherto applying a load to the wheels of the second wheel set. The transport vehicle can also be designed in such a way that the wheels of the first or second wheel set are grouped. For example the

15 wheels can occur in pairs or in a group of four. In that case it is proposed that a lifting means is provided for a respective such wheel group.

Preferably the change device is supplied with electric energy from an electric, rechargeable energy storage means. Such an electric energy storage means can be in particular a battery storage means, that is to say

20 a storage means comprising one or more chargeable batteries which can also be referred to as accumulators. That permits actuation of the change device, in particular the above-mentioned lifting means in the transport vehicle, without the transport vehicle having to be connected to a suitable power supply line during such a change operation. In particular such a

25 change in direction in which the change device is also actuated is effected at an intersection region between the two rail sets and thus generally not at a working position. The electric rechargeable energy storage means is thus preferably carried on the transport vehicle.

Preferably there is provided a connection coupling for connecting the

30 transport vehicle and/or a rotor blade mould accommodated on the transport vehicle to supply lines for electric power, compressed air, vacuum and/or control data. Such a connection coupling permits displacement of the transport vehicle without coupling to corresponding supply lines so that

coupling has to be implemented only in the respectively required working positions. Such a connection coupling also makes it possible to effect recharging of an electric energy storage means for powering the charge device. The coupling operation itself is also effected by means of an electric drive 5 which is supplied with power from the accumulator of the vehicle.

In an embodiment it is proposed that a plurality of wheels are driven by a common drive motor and the drive is effected by means of drive shafts and universal joints. That is proposed in particular for a longitudinal drive. In the case of the transverse drive each driven wheel unit has its 10 own drive, at any event in accordance with an embodiment. The common drive motor therefore drives at least two and preferably four drive shafts which are respectively connected to at least one wheel by way of a universal joint. Thus it is sufficient to provide a drive motor for a plurality of wheels. The drive torque can be distributed to the transport vehicle by way 15 of drive shafts and fed to the respective wheels for driving them. Because the transport vehicle is preferably intended for travel on respective straight, non-curved rail sets, the wheels at any event of a wheel set which are therefore intended to travel on the same rail set can be driven in synchronous relationship. In addition, by virtue of the rail system, it is 20 basically possible to count on all wheels of a wheel set involving the same rolling properties without trouble.

Preferably at least one universal joint is arranged respectively at the end of a drive train, more specifically therefore between a drive shaft and the respective wheel to be driven. That is advantageous in particular for the 25 wheels of the first wheel set which can be lifted or lowered. The respective drive train can be uninfluenced or influenced little by lifting or lowering of the respective wheel by virtue of the universal joint and in particular a long drive shaft.

Preferably there is provided a transmission between the universal 30 joint and the wheel to reduce a high speed of rotation of the drive shaft which is referred to as the shaft speed to a lower speed of rotation of the wheel referred to here as the wheel speed. Accordingly the same transmissions are to be provided, at least in respect of the transmission

ratio, for each driven wheel of a wheel set. It is thus possible to achieve synchronous relationship between the wheels, with a common drive. In the case of the described longitudinal drive that synchronous relationship is mechanically imposed. The drive can be effected by a high-speed drive 5 motor and the use of a respective transmission at the respective wheel to be driven permits the use of transmissions of a weaker design. In addition, a transmission ratio provides that a high rotary speed of the drive shafts is also achieved only directly at the wheel and thus the respective drive moment to those faster rotating drive shafts can be kept low, which can 10 lead to a correspondingly weight-saving design configuration both in respect of the drive motor and also the drive shafts. That means that the weight of the transport vehicle overall can be kept correspondingly low. In the case of the described transverse drive the individual drives are electrically coupled and synchronised.

15 Preferably the drive motor is electrically driven and is supplied with electric energy by a or the electric battery storage means which is carried on the transport vehicle.

According to the invention there is also proposed a handling apparatus for handling a rotor blade mould for the production of a rotor 20 blade of a wind power installation or a shell portion of a rotor blade of a wind power installation, wherein the handling apparatus includes a transport vehicle according to at least one of the above-described embodiments, and a first rail set for displacement of the transport vehicle in a first direction and a second transport set for displacement of the 25 transport vehicle in a second direction. The effects and advantages and fashion of implementing the handling operation will be apparent from the foregoing description relating to the transport vehicle according to one of the described embodiments.

30 Preferably the first rail set is oriented substantially in the longitudinal direction and thus transversely relative to the second rail set in order to cause the transport vehicle to move substantially in two mutually transversely arranged directions. In particular the handling apparatus, that is to say the two rail sets and also the transport vehicle, is so designed that

the transport vehicle can be displaced in the longitudinal direction and in the transverse direction.

Preferably the first rail set and/or the second rail set has round rails let into a floor. In particular the first rail set and/or the second rail set are 5 formed by such round rails which are let into a floor. In that case the rails are let into the floor in such a way that in a sectional view with a section transversely relative to the longitudinal direction of the rails in question, a semicircular portion or less of the round rail projects beyond the floor. Thus there is provided a rail system in which only a semicylindrical bar or less 10 projects from the floor. Preferably the respective wheels, that is to say the wheels of the first wheel set and the wheels of the second wheel set respectively, are adapted to that convex curvature. Thus the transport vehicle can be guided with its adapted wheels on rails, in particular on rails of a factory floor of a production factory, wherein at the same time those 15 rails scarcely project out of the floor and further vehicles which are not rail-guided can cross those rails. There is also less injury potential for people who are moving in the proximity of the rails and in particular crossing them. In particular the risk of someone tripping over the rails is reduced.

In a configuration it is proposed that the handling apparatus includes 20 a first rotor blade mould for the production of a first rotor shell portion and also a second rotor blade mould arranged on the transport vehicle for the production of a second rotor blade shell portion. The first rotor blade mould can be arranged stationarily or can also be arranged on a transport vehicle which can correspond to an embodiment as described hereinbefore of a 25 transport vehicle, or can also be of another configuration.

In addition there is provided a hinge device adapted for pivotal movement of the second rotor blade mould, more specifically in such a way that a second rotor blade shell portion accommodated by the second rotor blade mould is pivoted on to a first rotor blade shell portion accommodated 30 in the first rotor blade mould in order in that way to assemble those two rotor blade shell portions and to finish the rotor blade or to produce a corresponding sub-portion of the rotor blade.

Preferably the hinge device is adapted to be fixedly but releasably connected to the second rotor blade mould for the pivotal movement. Provided for that purpose are for example fixing means which are part of the pivotal device and which have an extendable cylinder which can be 5 respectively retracted into a corresponding receiving means on the rotor blade mould. In addition there can be provided a locking means so that a and in particular a plurality of fixed connections can be made between the pivotal device of the respective rotor blade mould. Those connections are fixed insofar as now the second rotor blade mould can be pivoted by means 10 of the pivotal device, in particular about an approximately horizontal pivot axis, and in particular through about 180 degrees about that horizontal pivotal axis, without the rotor blade mould being released from the pivotal device. Later, in particular when the rotor blade mould has been pivoted back again and placed on the transport vehicle again, that connection can 15 be released again by the locking means being released and by the cylinder referred to by way of example being extended out of the receiving means again.

In accordance with the invention there is also proposed a process for the production of a rotor blade which includes the following steps:

- 20 - displacing a second rotor blade mould by means of a transport vehicle in a first direction into the proximity of a hinge device,
- displacing the second rotor blade mould by means of the transport vehicle in a second direction to the hinge device,
- connecting the second rotor blade mould to the hinge device, in 25 particular in such a way that the hinge device moves in a first substantially vertical movement into at least one receiving means of the second rotor blade mould into a connecting position and locking is effected in that connecting position, and
- pivoting the second rotor blade mould by means of the hinge 30 device, in particular about a substantially horizontal axis until the second shell portion comes to lie on a first shell portion accommodated in a first rotor blade mould in order in that position to connect the two rotor blade shell portions for production of the rotor blade.

Accordingly the rotor blade mould is firstly moved by means of a transport vehicle in a first direction into the proximity of the hinge device. That is in particular a displacement in the longitudinal direction of the transport vehicle, which is thus also substantially in the longitudinal direction of the rotor blade to be produced. In that case the second rotor blade mould can be moved from a previous working position.

Then the second rotor blade mould is moved to the hinge device by means of the transport vehicle in a second direction, in particular in a transverse direction. The rotor blade mould is now arranged in an attainable proximity for fixing to the hinge device and the process accordingly proposes connecting the second rotor blade mould to the hinge device, in particular in such a way that the hinge device moves in a first substantially vertical movement into at least one receiving means of the second rotor blade mould into a connecting position and locking is effected in that connecting position. That locking can also be such that the movement that the hinge device performed for the connection procedure can initially not be reversed by itself and the rotor blade mould connected in that way can also not slip out of the connection.

Preferably the rotor blade mould is lifted from the truck by means of hydraulic cylinders and is hung in the power hinge and is then lowered again and locked in the power hinge.

Finally the second rotor blade mould is pivoted by means of the hinge device, in particular about a substantially horizontal axis, until the second shell portion which is laid in the second rotor blade mould comes to lie on a first shell portion accommodated in a first rotor blade mould. In that respect it is provided that those two shell portions come to bear against each other in such a way that in that position the two rotor blade shell portions can be joined to produce the rotor blade. In particular the two shell portions can be fixed together by adhesive at a suitable contact edge.

Preferably a transport vehicle according to one of the above-described embodiments is used and/or a handling apparatus according to one of the foregoing embodiments is used.

The invention will now be described by way of example by means of embodiments with reference to the accompanying Figures.

Figure 1 shows a transport vehicle with a mould carrier for a rotor blade mould and a hinge device in a diagrammatic perspective view in the 5 longitudinal direction,

Figure 2 shows a plan view of a transport vehicle without mould carrier and without rotor blade mould,

Figure 3 shows a perspective view illustrating substantially the transport device in Figure 2,

10 Figure 4 shows an end view in the longitudinal direction of a transport vehicle,

Figure 5 shows a perspective view of a portion of a transport vehicle,

Figure 6 shows a vehicle indexing device in a partly sectional view with a partial portion of the transport vehicle, and

15 Figures 7 and 8 show a partly sectional view in a longitudinal direction illustrating a portion of a transport vehicle in different conditions for illustrating lifting and lowering of a wheel set.

Figure 1 shows a perspective view of a transport vehicle 1 with a truss frame structure 2 arranged thereon. The truss frame structure 2 is 20 already roughly adapted to the shape of a rotor blade to be produced and is provided for receiving a rotor blade mould. Such a rotor blade mould is appropriately laid in or placed on that truss frame structure as shown in the drawing. A rotor blade mould provided for the illustrated case is intended for the production of a shell portion of a rotor blade. A further rotor blade 25 mould for a further shell portion would be placed in the truss frame structure 2' which is only partly shown in Figure 1. The rotor blade to be produced is finally assembled substantially from those two shell portions. For the sake of simplicity a truss frame structure like the truss frame structure 2 can also be referred to as the mould carrier.

30 To fit the two rotor blade shell portions produced in that way together, there is provided a hinge device 50 which has a fixed limb 52 and a movable limb 54. The movable limb 54 can be pivoted relative to the fixed limb 52 about a pivot axis 56 in order thereby to pivot the mould

carrier 2 on to the mould carrier 2'. In that case the mould carrier 2 is pivoted from above on to the mould carrier 2' substantially as shown in Figure 1 and is placed thereon from above.

For that purpose the mould carrier 2 is fixed to the movable limb 54 by way of two fixing elements 58, while in addition there is provided an arresting means to secure the connection even in the pivoting operation. Accordingly pivotal movement of the movable limb 54 can now provide that the entire mould carrier 2 including the rotor blade mould fitted therein is pivoted to the further mould carrier 2' in order to assemble the two rotor blade portion moulds. To carry the mould carrier 2 on the transport vehicle 1, there are provided cones which are arranged substantially perpendicularly for receiving the mould carrier when it is pivoted back from the further mould carrier 2'. For that purpose conical receiving means in the transport vehicle 1 can co-operate with conical pins on the mould carrier 2, or vice-versa.

Figure 1 also shows a part of a first wheel set 10 and a part of a second wheel set 20. In this case only one pair of wheels 12 and 22 respectively of the first and second wheel sets 10 and 20 respectively is shown. The first wheel set 10 in this case is provided for displacement of the transport vehicle 1 in the longitudinal direction, namely in the longitudinal direction of the rotor blade to be produced. That approximately corresponds to the direction into the plane of the drawing. Provided for displacement in the longitudinal direction are a plurality of rails of a first rail set of which one rail 14 of that first rail set is shown as being let into the ground or floor 30. In this case the rail 14 is in the form of a round bar and is let as such into the floor 30. It will be seen that the wheel pair 12 of the first wheel set 10 does not touch either the floor 30 or the rail 14. Rather the first wheel set 10 is lifted relative to the floor 30 and the first rail set. In this case the transport vehicle 1 is also shown as being displaced in a direction transversely relative to the path of the rail 14 so that the wheel pair 12 is also not arranged directly over the rail 14 but displaced relative thereto. Of the wheel pair 12, a part of a wheel 13 can be seen. That wheel 13 is adapted in respect of its shape to run on the rail 14. In that respect

the wheel 13 has a concave surface which is substantially adapted to the shape of the rail 14, namely the round bar.

For drive purposes, there is provided a drive shaft 16 coupled by way of a universal joint 18 to the wheel set 12 to drive at least the wheel 13.

5 The first wheel set 10 of the transport vehicle 1 includes a plurality of wheel pairs, like twenty four wheel pairs 12, of which however not all are driven. It is however also possible, depending on the respective demands involved, to drive more or fewer wheel pairs or in particular also all wheel pairs of the first wheel set 10.

10 The wheel pair 12 of the first wheel set 10 is fixedly connected to the transport vehicle 1. The situation shown in Figure 1, where the first wheel set 10 and thus also the wheel pair 12 is lifted in relation to the floor 30, is afforded by the transport vehicle 1 overall being lifted.

15 The second wheel set 20 which includes the pair of wheels 22 with the two wheels 23 is supported on the floor 30 or a corresponding rail of a second rail set. That second rail is let into the floor 30 in such a way that it can scarcely be seen in Figure 1. That rail of the second rail set is of a shape like the rail 14 of the first rail set and can therefore also be in the form of a round bar and is also similarly let into the floor 30. In this case 20 the rail of the second rail set extends transversely to the rail 14 of the first rail set.

25 The pair of wheels 22 of the second wheel set 20 is connected to the transport vehicle 1 by way of a change device 24, wherein the change device 24 is only diagrammatically shown here and is described in further detail hereinafter. In this case the change device 24 of which only a part is shown here is provided for lifting and lowering the second wheel set 20. The part shown in Figure 1 is provided for lifting and lowering the wheel pair 22 of the second wheel set 20. Lifting and lowering of the second wheel set is effected in such a way, in particular with a suitable force, that 30 upon lowering of the second wheel set 20 the entire remaining transport vehicle 1 rises. Figure 1 shows that raised condition of the transport vehicle 1. In that situation the transport vehicle 1 can be displaced in the transverse direction, namely transversely relative to the longitudinal axis of

the rotor blade to be produced and thus approximately parallel to the plane of the drawing in Figure 1. In particular the transport vehicle 1 can be displaced in the direction of the hinge device 50 in such a way that fixing between the movable limb 54 and the mould carrier 2 can be effected by 5 way of the fixing elements 58 with the aid of a hydraulic lifting device which raises and lowers at least the mould carrier 2. That hydraulic device can be part of the transport vehicle 1.

Figure 1 shows a part of a handling apparatus 60 which includes the transport vehicle 1, a first rail set including the rail 14 and a second rail set, 10 wherein the first and second rails sets are at least partially let into the floor 30.

The transport vehicle 1 is shown in a plan view in Figure 2 diagrammatically but in its entirety. In this case, for illustration purposes, a longitudinal direction 11 is denoted by a double-headed arrow and a 15 transverse direction 21 is also denoted by a double-headed arrow. The longitudinal direction 11 and the transverse direction 21 are arranged substantially at a right angle to each other. In this respect an exact angle of 90 degrees between those two directions 11 and 21 is not an important consideration, but they should not extend parallel to each other.

20 It can be seen from Figure 2 that there are provided sixteen change device portions 25 which together form the change device 24. Associated with each change device portion 25 is a pair of wheels 22 of the second wheel set 20. Two respective change device portions 25 are fixed together with a connecting carrier 32 on longitudinal bearers 34. In that case joint 25 lowering of the pairs of wheels 22 by the change device portions 25 and thus by the change device 24 leads to a lifting movement of the transport vehicle 1, in particular by way of those longitudinal bearers 34. In that arrangement a plurality of transverse bearers 36 are arranged on the longitudinal bearers 34 or the longitudinal bearers 34 and the transverse 30 bearers 36 are connected together to give a stable structure for the vehicle 1. In addition there are provided various support bearers 38 arranged in the longitudinal direction. The longitudinal bearers 34, the transverse bearers 36 and the support bearers 38 which do not have to be respectively

identical although here only one respective reference is used for same substantially form the transport vehicle 1, or at least its stable carrier structure.

For driving the pairs of wheels 22 of the second wheel set 20 there
5 are provided some transverse drives 26 which also have a transmission
means 28. The coupling to the respective pair of wheels 22 cannot be seen
in the overview drawing of Figure 2. The transverse drives 26 are
respective mechanically mutually independent transmission means which
however are electrically coupled or synchronised in order to provide a
10 movement of the transport vehicle that is as uniform and identical as
possible, upon a movement in the transverse direction 23. In that case, not
all pairs of wheels 22 of the second wheel set 20 are driven.

Pairs of wheels 12 of the first wheel set 10 are disposed beneath the
longitudinal bearers 34 and cannot therefore be seen in Figure 2 but are
15 shown at least by way of indication at some locations in Figure 3. For
driving at least some of the pairs of wheels 12 of the first wheel set 10
there is provided a common drive which mechanically transmits the drive
energy or drive moments by way of shafts. Those shafts are arranged or
guided substantially beneath the bearers, namely in particular the
20 longitudinal bearers 34, and can also be diverted by means of universal
joint shafts or in some other fashion.

In addition there is provided a hydraulic assembly 40 for actuation of
the change device 24 and therewith the individual change device portions
25.

25 Figure 4 is an end view on to the transport vehicle 1, showing a view
in the longitudinal direction of the transport vehicle 1. The longitudinal
direction therefore extends here into the plane of the drawing. The view
shows two pairs of wheels 12 of the first wheel set 10 and two pairs of
30 wheels 22 of the second wheel set 20. The drive for the illustrated pairs of
wheels 12 is implemented by way of a distribution transmission 42 which
basically operates like a differential transmission and respectively transmits
a drive moment to the drive shafts 16 so that the respective drive moment

reaches the respective pair of wheels 12. Universal joint shafts 18 are also provided for deflection purposes.

In that arrangement the distribution transmission 42 receives a torque from a central drive by way of a corresponding drive shaft.

5 Vehicle indexing devices 44 are provided for orienting and/or detecting a position of the transport vehicle 1 in the transverse direction. Those vehicle indexing devices 44 are arranged fixedly on the floor and can determine a position of the transport vehicle 1. In addition the vehicle indexing device 44 can hold the transport vehicle 1 on the floor 30 when
10 the mould carrier 2 is pivoted from the transport vehicle 1 to the second mould carrier 2'.

Arranged on the transport vehicle 1 are transverse thrust elements 46 having connecting arms in order thereby to receive a truss frame or mould carrier 2, as shown in Figure 1, and to fix it at many locations. The
15 transverse thrust elements 46 can be fixed to the transverse bearers 36 by pins, bolts or the like, they can however be released there and in particular can be changed in their position relative to the transport vehicle 1. In that way they can be adjusted to changes like a change in the truss frame or mould carrier to be carried and/or a change in the rotor blade shape.

20 Details of the vehicle indexing device 44 are shown in Figure 5. In that case the vehicle indexing device 44 has an indexing pin 62 which in turn has a conical tip 64. Adapted to that conical tip 64 on the transport vehicle 1 is a corresponding indexing receiving means 66 with a corresponding recess 68 which corresponds approximately to a converging
25 blind hole. In this case the indexing pin 62 is introduced into that recess 68 in the indexing receiving means 66 and when it is completely introduced the precise position at any event of the indexing receiving means 66 is determined. Insofar as such indexing is effected at a plurality of locations, namely at least at the two locations shown in Figure 4 which have a vehicle
30 indexing device 44, it is thus possible to determine the precise position of the transport vehicle 1. In that respect moreover Figure 5 shows a portion from Figure 4, as indicated there by the circle around the indexing device 44.

Figure 6 shows a portion of a transport vehicle 1 and in that respect a portion of a longitudinal bearer 34 to which a pair of wheels 12 of the first wheel set 10 and a change device portion 25 of the change device 24 is fixed. A pair of wheels 22 of the second wheel set 20 is fixed to that change device portion 25 and shown in a lowered position. The Figure shows diagrammatically, without illustrating a floor, a rail 14 of a first rail system and a rail 27 of a second rail system. In this arrangement the pair of wheels 20 of the second wheel set 22 rests on the rail 27 of the second rail system.

Figure 6 also shows a transverse drive 26 which by way of the transmission 28 reduces its speed of rotation and correspondingly increases the torque. The drive moment is then fed from the transmission 28 by way of the drive shaft 16 to the pair of wheels 22. Functionally, the drive shafts 16 which lead to the pair of wheels 12 of the first wheel set 10 and those which lead to the pair of wheels 22 of the second wheel set 20 are at least functionally identical or similar so that the same reference numeral is adopted here to emphasise the functional similarity. Universal joints 18 are also provided for the drive moment to the pair of wheels 22 of the second wheel set 20.

Of the change device portion 25 it is possible to see an elbow lever mechanism 70. The elbow lever mechanism 70 has an elbow joint 72 and an upper and a lower fixing joint 74 and 76 respectively. From the elbow joint 72 there is a pivotal connection to the upper fixing joint 74 by way of an upper limb 78 and to the lower fixing joint 76 by way of a lower limb 80. Provided for actuation of the elbow lever mechanism 70 is a hydraulic drive 82 which in Figure 6 is largely concealed and which acts directly on the elbow joint 72.

In the condition shown in Figure 6 the hydraulic drive 82 is extended to such an extent that it has pushed the elbow joint 72 into a position in which the elbow lever mechanism 70 is straightened. The upper limb 78 and the lower limb 80 are thus substantially in alignment.

It can further be seen that the pair of wheels 22 of the second wheel set 20 is fixed to a pivot arm 84. In that respect the pivot arm 84 is fixed

to the change device portion 25 pivotably about the pivot arm axis 86. The pair of wheels 22 of the second wheel set 20 is in turn fixed pivotably to the pivot arm 84, namely in the region of the fixing axis 88. The elbow lever mechanism thus firstly acts on the pivot arm 84 which can pivot the 5 elbow lever mechanism 70, wherein the pivotal angle is very small.

To lift the pivot arm 84 and therewith the pair of wheels 22 and thereby to lower the transport vehicle 1 the hydraulic drive 82 pulls the elbow joint 72 towards it, whereby the upper and lower fixing joints 74, 76 move towards each other. As a result the pivot arm 84 rises in the region 10 and thereby also lifts the pair of wheels 22 of the second wheel set 20.

In the case of such a pulling movement the elbow lever mechanism has comparatively little force. As however the transport vehicle 1 is lowered by that movement that elbow lever mechanism, when lowering the transport vehicle 1, also does not need any force, or at least no pulling 15 force. At most it would be possible to counteract an excessively fast lowering movement of the transport vehicle 1. It is only when the transport vehicle 1 is lowered to such an extent that the pair of wheels 12 is resting on the rail 14 and thus the first wheel set 10 is overall resting on the first rail set, that the pair of wheels 22 of the second wheel set 20 are lifted by a 20 continuation of the movement of the elbow lever mechanism 70, for which however comparatively little force is required.

The greatest amount of force is required when lifting the transport vehicle and it is here that the effect of the lever mechanism 70 comes into effect, providing a very strong lever action. In addition, in the lifted 25 condition shown in Figure 6, the transport vehicle 1 can be held almost without any force by the hydraulic drive 82 because the elbow lever mechanism is straightened there.

The mode of operation of the elbow lever mechanism 70 is also clearly shown in Figures 7 and 8, in which Figure 7 shows a lifted condition 30 of the pair of wheels 22 of the second wheel set 20 and Figure 8 shows a lowered condition of the pair of wheels 22 of the second wheel set. Figure 8 in that respect shows the condition which is also that in Figure 6.

It will be seen from Figure 7 that the pair of wheels 12 of the first wheel set 10 rests with a wheel 13 on the rail 14. The pair of wheels 22 of the second wheel set 20 is not in contact with the rail 27 of the second rail system. In the condition shown in Figure 7 therefore the transport vehicle 1

5 can be displaced in the longitudinal direction whereas the condition shown in Figure 8 permits displacement in the transverse direction. In regard to the sequences of movements attention is directed to the description relating to Figure 6 which here equally applies.

CLAIMS

1. A transport vehicle (1) for handling a rotor blade mould for the production of a rotor blade of a wind power installation or a shell portion of a rotor blade of a wind power installation, adapted for use in a handling apparatus (60) and the handling apparatus (60) includes:

- a first rail set for displacement of the transport vehicle in a first direction, and

- a second rail set for displacement of the transport vehicle in a second direction, wherein the second rail set is not parallel to the first rail set,

- a first rotor blade mould for the production of a first rotor blade shell portion,

- a second rotor blade mould arranged on the transport vehicle (1) for the production of a second rotor blade shell portion, and

- a hinge device (50) adapted for pivotal movement of the second rotor blade mould in such a way that a second rotor blade shell portion accommodated in the second rotor blade mould is pivoted on to a first rotor blade shell portion accommodated in the first rotor blade mould in order to assemble the two rotor blade shell portions and to finish the rotor blade,

- and the transport vehicle includes:

- a first wheel set (10) including a plurality of wheels (13) for movement on the first rail set, and

- a second wheel set (20) including a plurality of wheels (23) for movement on the second rail set, such that the transport vehicle (1) enables displacing the second rotor blade mould in said first direction into the proximity of the hinge device and in said second direction to the hinge device (50).

2. A transport vehicle (1) according to claim 1 characterised in that the transport vehicle has a change device (24) for changing from the first wheel set (10) for movement on the first rail set to the second wheel set (20) for movement on the second rail set.

3. A transport vehicle (1) according to claim 1 or claim 2 characterised in that

a or the change device (24) is adapted to lift and lower the wheels (23) of the first wheel set (10), wherein the wheels of the first wheel set (10) can be moved from a lowered condition into a lifted condition and vice-versa and wherein the transport vehicle is lifted by the lowering movement of the wheels (23) of the first wheel set (10) and the transport vehicle

- in the lowered condition rests with the wheels (13) of the first wheel set (10) on the first rail set and the wheels (23) of the second wheel set (20) do not rest on the second rail set, and

- in the lifted condition rests with the wheels (23) of the second wheel set (20) on the second rail set and the wheels (13) of the first wheel set (10) do not rest on the first rail set.

4. A transport vehicle (1) according to one of the preceding claims characterised in that a or the change device (24) lowers and/or lifts the wheels (13) of the first wheel set (10) by means of an elbow lever mechanism (17).

5. A transport vehicle (1) according to one of the preceding claims characterised in that a or the change device (24) is operated hydraulically and/or electrically.

6. A transport vehicle (1) according to one of the preceding claims characterised in that a or the change device (24) for each wheel of the first wheel set (10) or for each group of wheels of the first wheel set (10), when the wheels of the first wheel set (10) are grouped in a plurality of groups, includes a lifting means for lifting and lowering the respective wheel or the respective group of wheels and wherein the lifting means are preferably synchronously actuated.

7. A transport vehicle (1) according to one of the preceding claims characterised in that a or the change device (24) is supplied with electric

energy from an electric rechargeable energy storage means, in particular a battery storage means, and the electric rechargeable energy storage means is arranged and fixed on the transport vehicle (1) and/or a connection coupling is provided on the transport vehicle (1) to connect the transport vehicle (1) and/or a rotor blade mould accommodated on the transport vehicle (1) to supply lines for electric current, compressed air, vacuum and/or control data.

8. A transport vehicle (1) according to one of the preceding claims characterised in that a plurality of or all wheels of the first and/or a plurality of or all wheels of the second wheel set (10, 20) are respectively driven by a common drive motor and that corresponding drive torques are transmitted from the drive motor by way of drive shafts (16) and universal joints (18) to the driven wheels, wherein in particular a respective universal joint is arranged between a driven wheel and a drive shaft (16) and optionally arranged between the universal joint (18) and the driven wheel is a transmission which converts a shaft rotary speed of the drive shaft (16) at the universal joint (18) into a lower wheel rotary speed.

9. A handling apparatus (60) for handling a rotor blade mould for the production of a rotor blade of a wind power installation or a shell portion of a rotor blade of a wind power installation, including:

- a transport vehicle (1) for transporting the rotor blade mould,
- a first rail set for displacement of the transport vehicle (1) in a first direction, and
- a second rail set for displacement of the transport vehicle (1) in a second direction, wherein the second rail set is not parallel to the first rail set, and
- a hinge device (50) adapted for pivotal movement of the second rotor blade mould in such a way that a second rotor blade shell portion accommodated in the second rotor blade mould is pivoted on to a first rotor blade shell portion accommodated in the first rotor blade mould in order to assemble the two rotor blade shell portions and to finish the rotor blade,

wherein the transport vehicle (1) is in accordance with one of the preceding claims.

10. A handling apparatus (60) according to claim 9 characterised in that the first rail set is substantially transverse relative to the second rail set in order to allow the transport vehicle (1) to move substantially in two mutually transversely arranged directions.

11. A handling apparatus (60) according to claim 9 or claim 10 characterised in that the first rail set and/or the second rail set has round rails let into a floor (30), wherein the rails are so let into the floor (30) that in a sectional view with a section transversely relative to the longitudinal direction of the round rail in question a semicircular portion or less of the round rail projects beyond the floor (30).

12. A handling apparatus (60) according to claim 9 characterised in that the hinge device (50) is adapted to be fixedly but releasably connected to the second rotor blade mould for the pivotal movement and in particular for the pivotal movement about a substantially horizontal pivot axis (56).

13. A process for the production of a rotor blade including the steps:

- displacing a second rotor blade mould by means of a transport vehicle (1) in a first direction into the proximity of a hinge device (50),

- displacing the second rotor blade mould by means of the transport vehicle (1) in a second direction to the hinge device (50),

- connecting the second rotor blade mould to the hinge device (50), in particular in such a way that the hinge device (50) moves in a first substantially vertical movement into at least one receiving means of the second rotor blade mould into a connecting position and locking is effected in that connecting position, and

- pivoting the second rotor blade mould by means of the hinge device (50), in particular about a substantially horizontal axis until a second rotor blade shell portion comes to lie on a first rotor blade shell portion

accommodated in a first rotor blade mould in order in that position to connect the two rotor blade shell portions for production of the rotor blade.

14. A process according to claim 13 characterised in that a transport vehicle according to one of claims 1 to 8 and/or a handling apparatus (60) according to one of claims 9 to 12 is used.

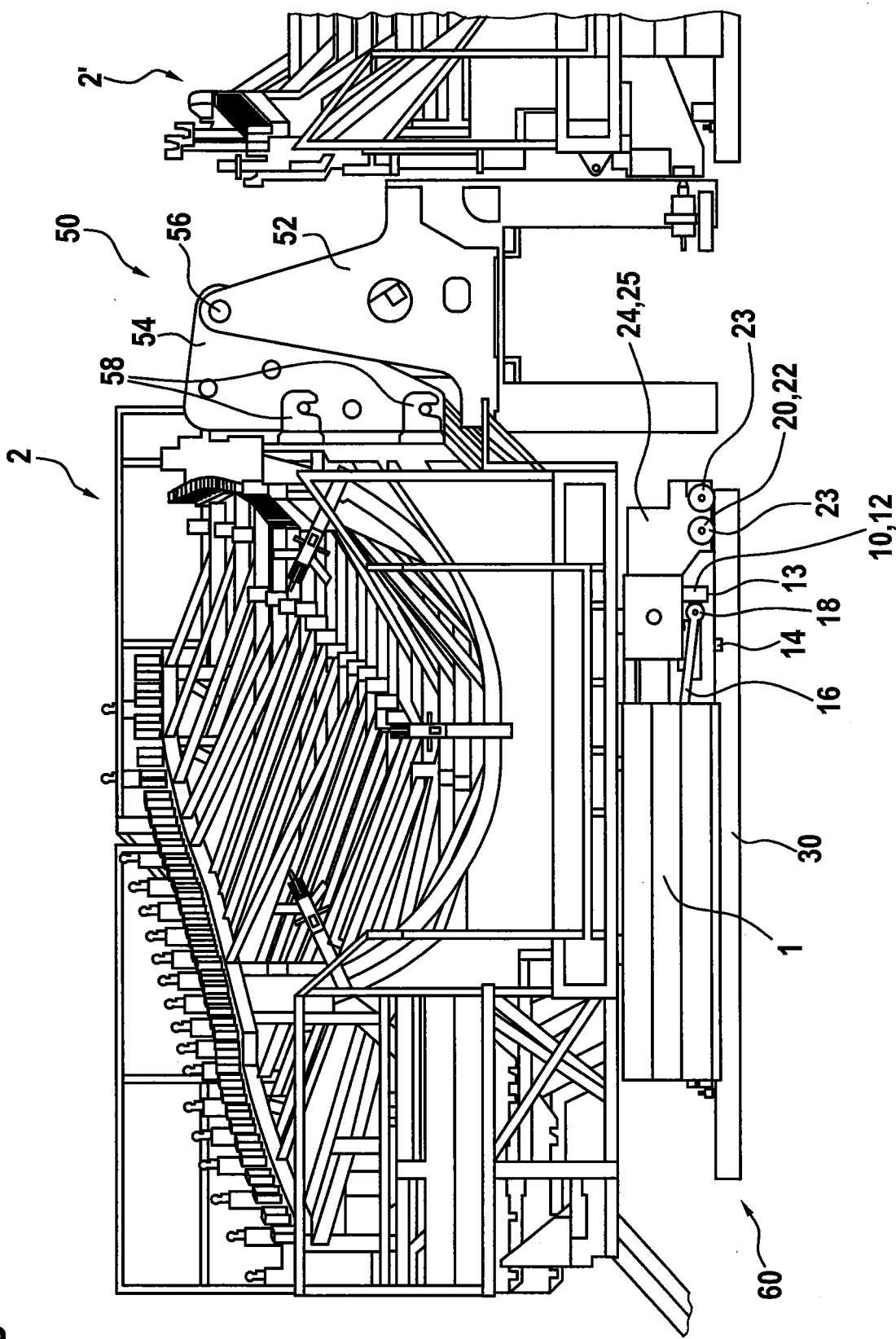


Fig. 1

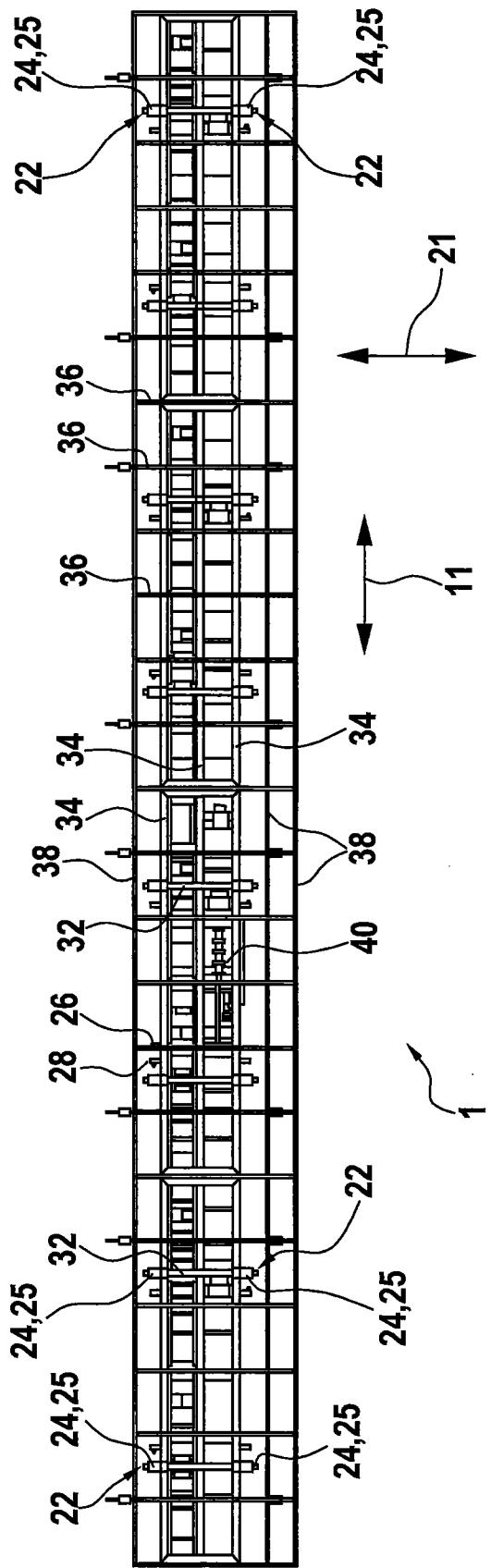


Fig. 2

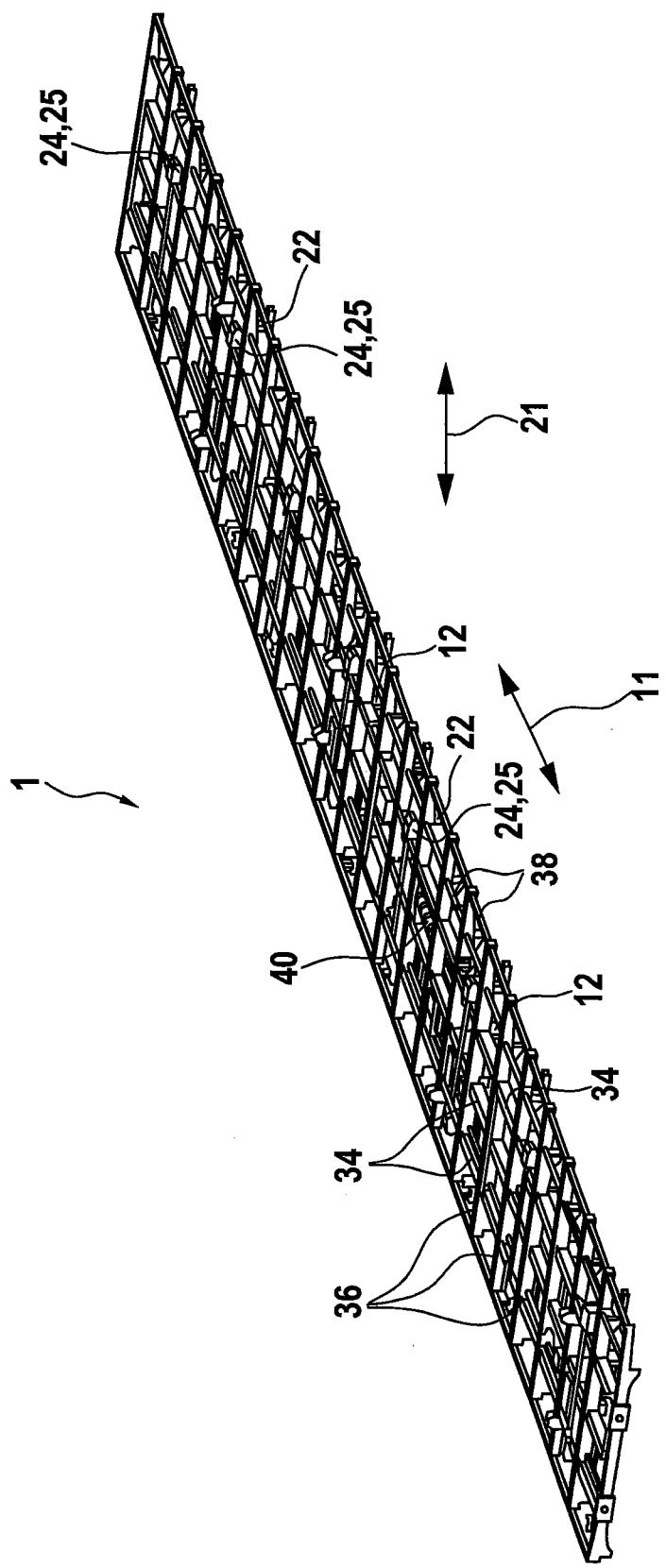


Fig. 3

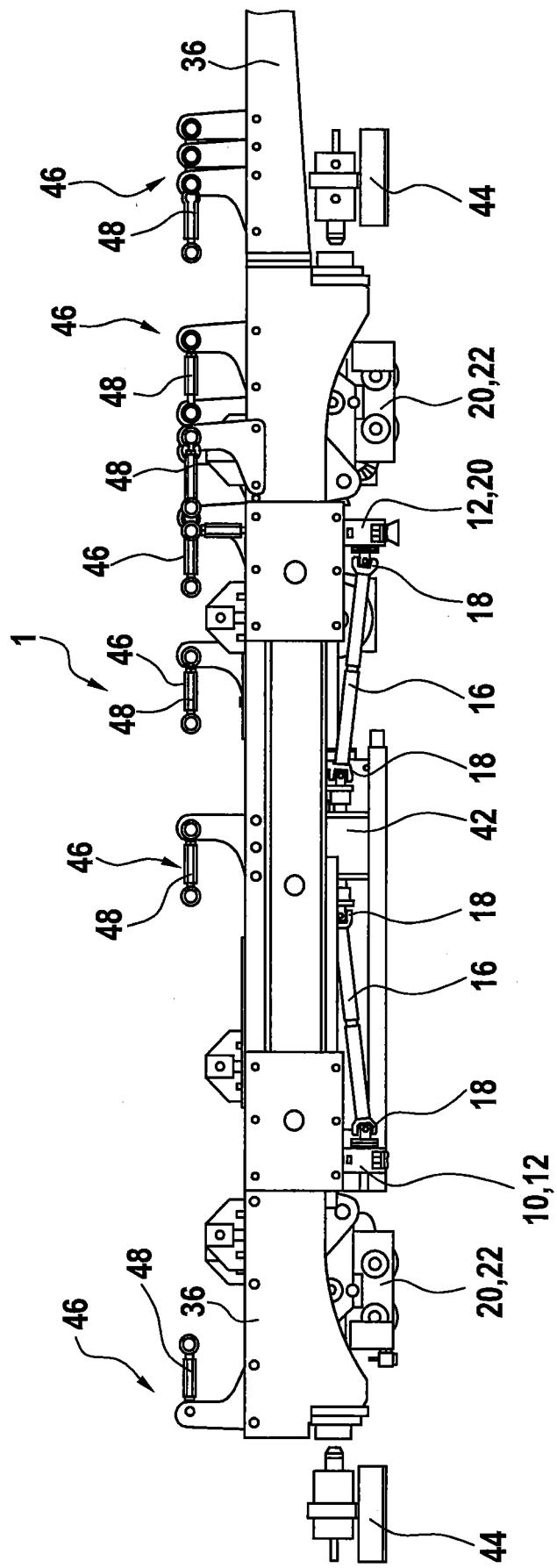


Fig. 4

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Fig. 5

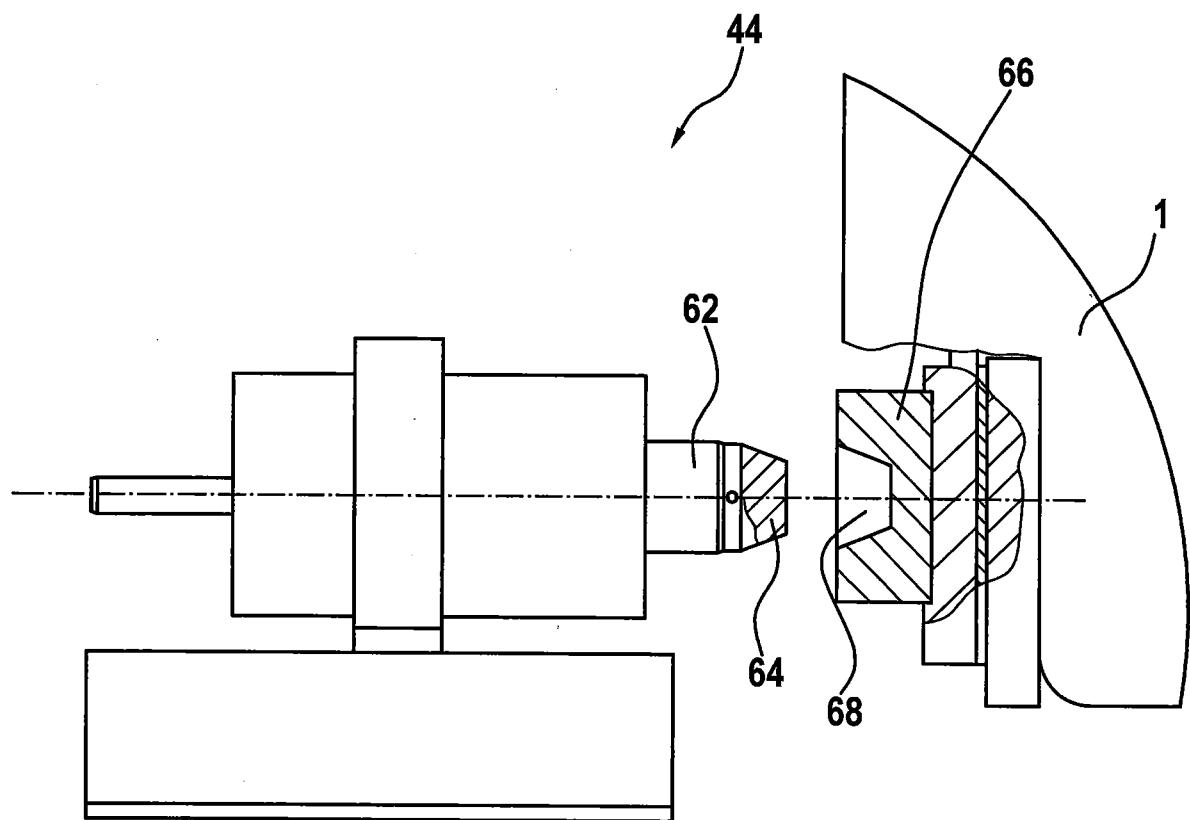
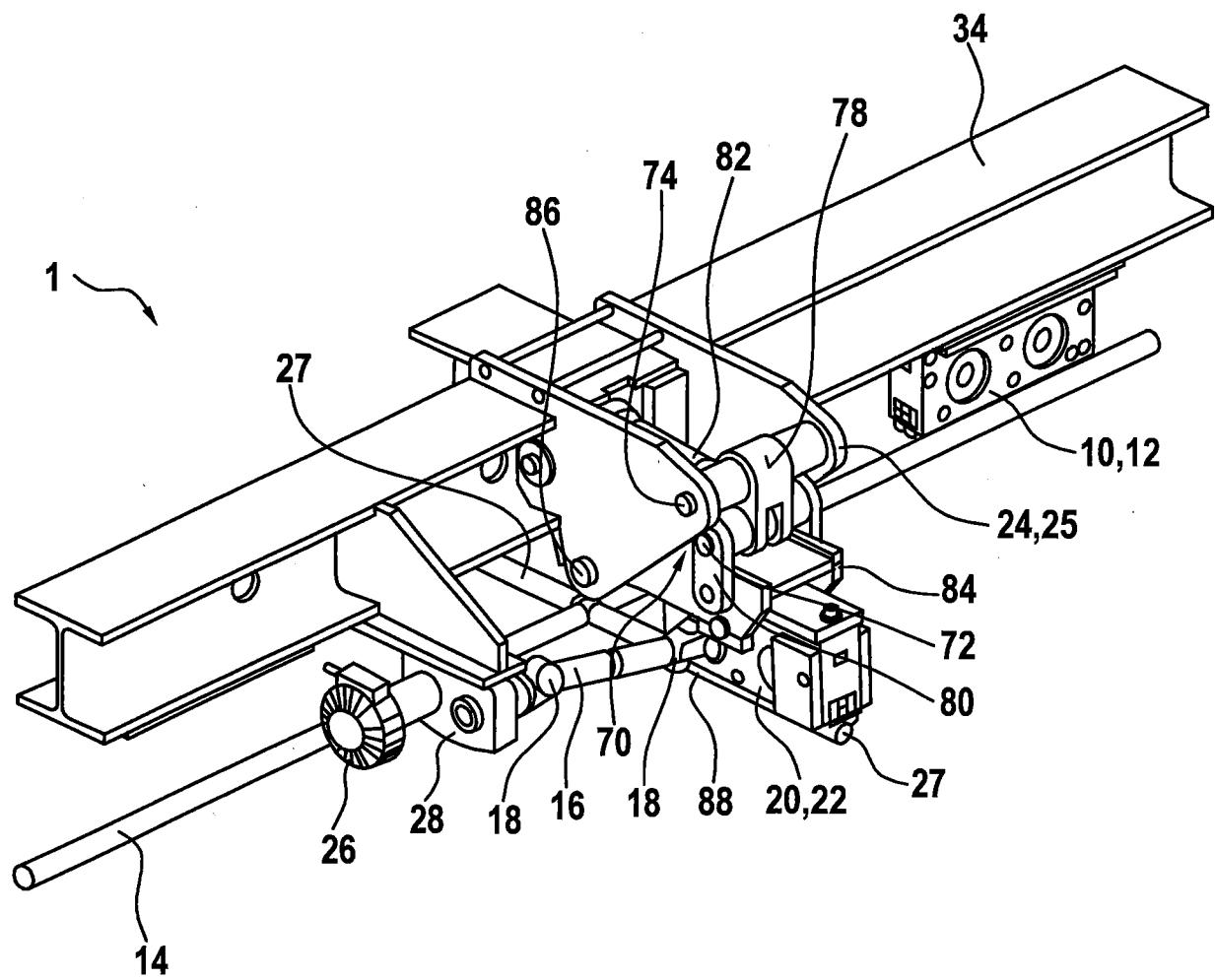


Fig. 6



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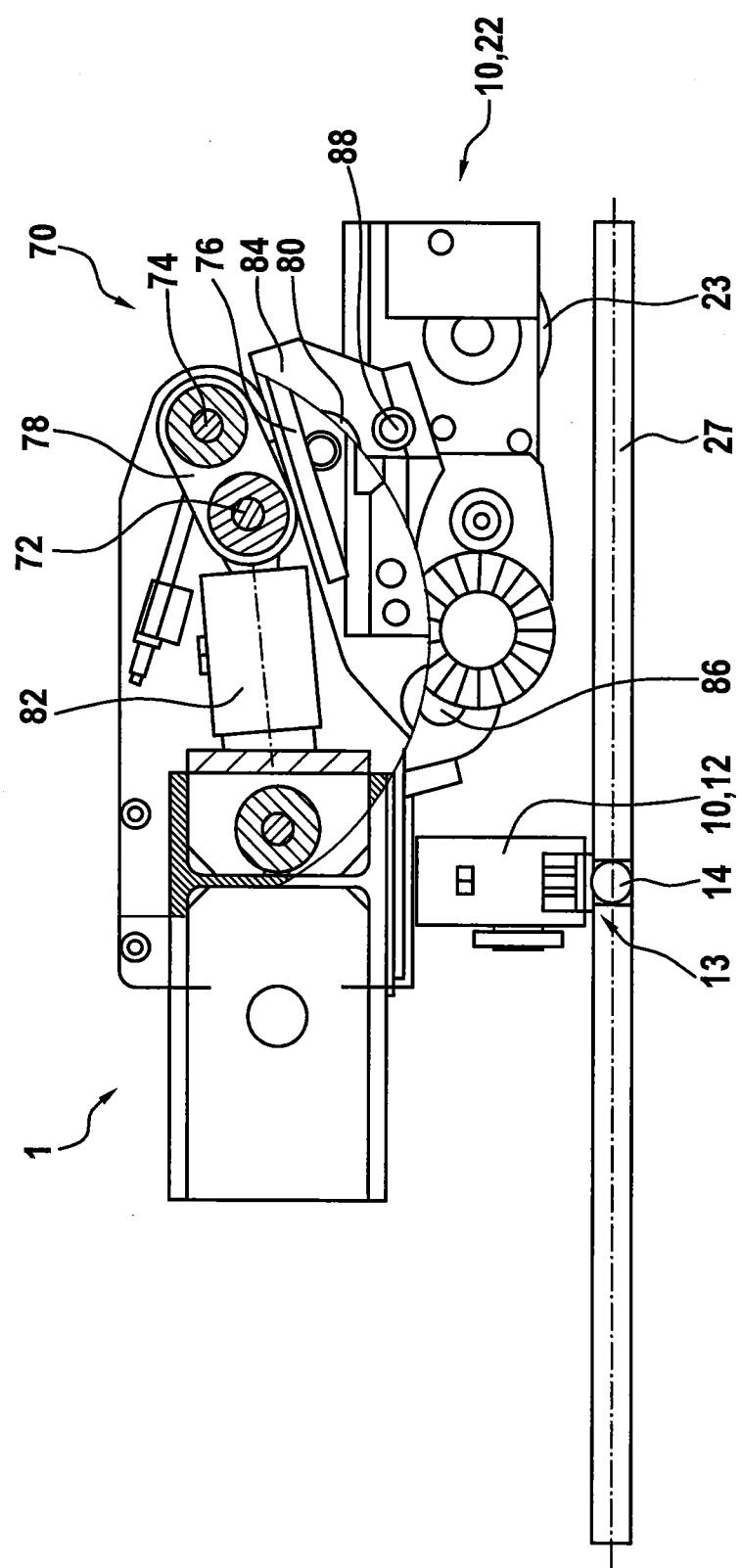


Fig. 7

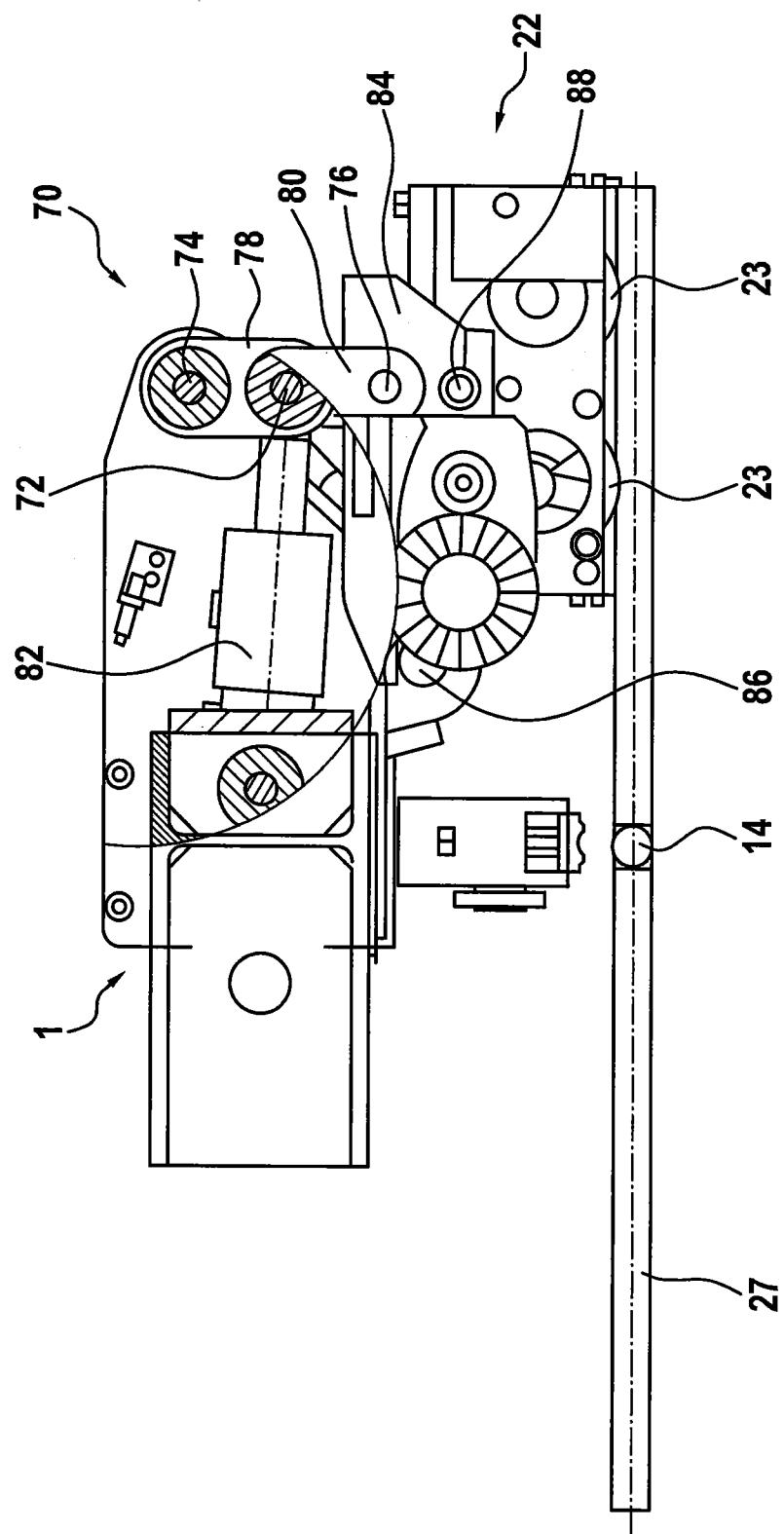


Fig. 8