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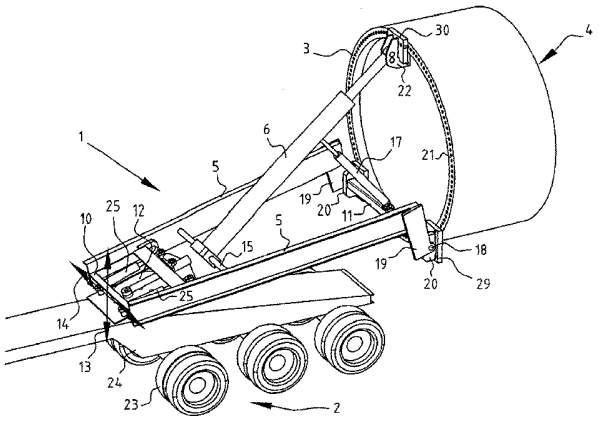
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(54) Title: METHOD AND DEVICE FOR SUPPORTING A SELF-SUPPORTING LOAD AN UNDERCARRIAGES



(57) Abstract: The invention relates to a method for supporting on an undercarriage (2) an end of a self-supporting load (4), in particular a tower section, wherein the end of the load is engaged directly by at least one lower (5) and at least one upper (6) support, which supports are connected to the undercarriage (2) and enclose and angle in a vertical plane. The angle between the supports can herein be adapted to the dimensions of the end of the load (4), for instance such that some of the supports absorb the weight of the load and the rest of the supports absorb only longitudinal forces from the load. The invention also relates to a device for performing this method, provided with at least one lower (5) and at least one upper (6) support which enclose an angle with each other in a vertical plane, which are each connected with one end to the undercarriage (2), and the other end of which is adapted to engage on the end of the load (4). Finally, the invention further relates to a combination of an undercarriage and such a support device.

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METHOD AND DEVICE FOR SUPPORTING A SELF-SUPPORTING LOAD ON UNDERCARRIAGES

The invention relates to a method for supporting a self-supporting load on undercarriages or axle systems for the purpose of transport thereof. The term 'undercarriage' or 'axle system' is here understood to mean any chassis part with one or more axles.

It is known to suspend a self-supporting load, for instance so-called tower sections, i.e. parts of the mast of a wind turbine, for transport on the road or on a construction site, between two undercarriages, for instance a tractive unit and a rear axle system such as a rear dolly. On both ends of the tower section is then mounted an adapter, the foremost of which is provided with a coupling pin which can be connected to the kingpin of the tractive unit. The rear adapter is placed in similar manner on the rear dolly. The tower section itself herein functions as it were as the chassis of the trailer formed by the tower section, the two adapters and the rear dolly.

The adapter used in this known method consists of a rigid, rectangular or square, standing frame which is fixed to an end surface of the tower section. Protruding from this standing frame are two lying and two inclining beams which form two triangular side frames. These side frames are in turn connected by a cross beam which carries the coupling pin in the middle.

A drawback of the known method is that the adapter used therein cannot be adapted to the dimensions of the tower section for transporting. Since masts of wind turbines generally taper toward the top, the tower sections all have different diameters, so that the adapter, which will be dimensioned for the largest (lower) tower part, is in fact

too large for the other tower parts. In addition, the adapter comes under relatively great strain of bending, since at the top and bottom the standing frame protrudes beyond the lying and inclining beams of the side frames. This in turn entails the adapter having to be very strong and therefore of heavy construction, whereby the payload of the combination of tractive unit and trailer for a given total weight or axle load is limited. Finally, the adapter is relatively long, whereby the length of the tractive unit-trailer combination becomes very great and it is difficult to manoeuvre.

In addition, an adapter is already known which has a standing frame with a telescopic embodiment and can thus be adapted to the dimensions of the tower section by being retracted or extended. This adapter is even heavier than a fixed adapter and has the same drawbacks in respect of the construction length.

The invention therefore has for its object to provide a method wherein these drawbacks no longer occur, or do so to a lesser extent. According to the invention this is achieved by a method for supporting on an undercarriage an end of a self-supporting load, in particular a tower section, wherein the end of the load is engaged directly by at least one lower and at least one upper support, which supports are connected to the undercarriage and enclose an angle in a vertical plane. By making use for the support of the load of supports which engage directly on the load, it is possible to dispense with the use of separate adapters with heavy frames taking up much space.

The angle between the supports can preferably be adapted to the dimensions of the end of the load. Any load can thus be supported optimally.

When the angle between the supports is adapted such that only some of the supports absorb the weight of the load

and the rest of the supports absorb only longitudinal forces from the load, the supports are loaded substantially by only longitudinal forces and can be given a relatively light form. The support(s) taking up the weight of the load can herein enclose an acute angle with the horizontal, and the rest of the supports can run substantially horizontally.

In order to limit the loads on the supports as much as possible, the supports preferably converge at or close to a point where the forces are transmitted into the undercarriage.

The different supports are preferably placed successively into engagement with a load and then moved to a position in which the load is lifted. In this manner the load can be picked up quickly and easily.

The invention also relates to a device with which the above described method can be performed. The invention provides for this purpose a device for supporting on an undercarriage an end of a self-supporting load, in particular a tower section, comprising at least one lower and at least one upper support which enclose an angle with each other in a vertical plane and which are each connected with one end to the undercarriage, and the other end of which is adapted to engage on the end of the load.

The supports are preferably movable relative to each other for the purpose of adjusting the angle enclosed therebetween, whereby the device can be adapted to the dimensions of the load. A device which is easy to handle is obtained here when hydraulic, pneumatic and/or mechanical means are present to cause movement of the supports relative to each other.

The supports can advantageously be loaded substantially in only lengthwise direction, so that the device can be embodied in relatively light form.

So as to enable optimal adjustment of the geometry of the device to the load for transporting, at least one of the supports can be adjustable in lengthwise direction. An efficient construction is achieved herein when the support adjustable in lengthwise direction encloses an acute angle with the horizontal, and at least one non-adjustable support runs substantially horizontally.

The device is advantageously provided with means for coupling the supports to the undercarriage, wherein the supports converge in the vicinity of the coupling means. The loads are thus transmitted along the shortest possible path onto the undercarriage.

In respect of the manoeuvrability of the trailer formed by the load and the undercarriages, the coupling means are preferably rotatable relative to the undercarriage. So as to prevent the trailer, which is formed by the undercarriages with the supports and the load therebetween, here becoming unstable at higher speeds, means can be provided for blocking the rotation movement of the coupling means.

In order to ensure a stable support of the load, the device preferably has two supports running substantially horizontally. The ends of the two supports running substantially horizontally can herein be further connected by a beam so that they are oriented accurately relative to each other under all conditions.

The invention finally also relates to a combination of an undercarriage and a device of the above described type. In such a combination the undercarriage can form part of a tractive unit or form a separate carriage or dolly.

The invention is now elucidated on the basis of four embodiments, wherein reference is made to the annexed drawing, in which:

Fig. 1 is a schematic perspective view of a first

embodiment of the support device according to the invention in engagement with an end of a load,

Fig. 2 shows a view corresponding with fig. 1 of a second embodiment of the support device in combination with an undercarriage,

Fig. 3-6 show schematic perspective views of different steps for picking up a load with a support device according to a third embodiment of the invention,

Fig. 7 shows a detail view along arrow VII in fig. 5,

Fig. 8 is a side view of a fourth embodiment of the support device during use on the front side of the load,

Fig. 9 shows a view corresponding with fig. 8 during use on the rear side, and

Fig. 10 and 11 show top views of the support device and the undercarriage in a bend when the coupling means arranged therebetween are rotatable, respectively when the rotation movement thereof is blocked.

A device 1 for supporting on an undercarriage 2 (not shown here) an end 3 of a self-supporting load 4, here a tower section (fig. 1), comprises two lower supports 5 and two upper supports 6 which can be connected to undercarriage 2 and engage with their ends 7, 8 on the end edge or flange 3 of load 4. Both the lower supports 5 here enclose an angle in the horizontal plane and are connected close to their ends 9 by a relatively short cross beam 10 and close to their ends 7 by a longer cross beam 11. In the middle of the short cross beam 10 are arranged means 12 for coupling the support device 1 to undercarriage 2. These coupling means 12 are rotatable on both a vertical axis 13 and a horizontal axis 14.

The upper supports 6 are here only loadable in their lengthwise direction, while the lower supports 5 can absorb both longitudinal and transverse forces. Upper

supports 6 are further adjustable in their lengthwise direction, while the angle α in the vertical plane between upper supports 6 and lower supports 5 is likewise adjustable. In the shown embodiment the upper supports 6 are embodied as hydraulic cylinders which are connected with their lower ends 15 to lower supports 5 for pivoting in different directions, for instance by means of ball joints. In the shown embodiment the upper ends 8 of upper supports 6 are connected to each other by a cross beam 16. For the purpose of adjusting the angle α between the upper and lower supports 6, 5 there are provided moving means 17, here in the form of two vertically oriented hydraulic cylinders engaging on the ends 8 of upper supports 6.

By adjusting the angle α while simultaneously adapting the length of upper supports 6 and optionally tilting the lower supports 5 about the horizontal axis 14, the four outer ends 7, 8 of supports 5, 6 can be placed in engagement with the end 3 of load 4 in a manner such that the upward inclining supports 6 exert a pressure force on the end surface of load 4, the vertical component of which is substantially equal to the weight of the load, or at least the part thereof which must be carried by this undercarriage 2, while the lower supports 5 running substantially horizontally exert virtually only a tensile force on load 4. The ends 7, 8 of the lower and upper supports 5, 6 do not therefore have to be connected in force-transmitting manner, and the vertical cylinders 17 are in principle not loaded.

In an alternative embodiment of the support device 1 (fig. 2), only a single upper support 6 is provided. The angle adjusting means 17 are therefore formed here by a single hydraulic cylinder which engages on the housing of the support 6 embodied as hydraulic cylinder. Cross beam 11 between the ends 7 of lower supports 5 is here suspended from

arms 19 for pivoting about a horizontal axis 18 and carries two engaging plates 20 which are fastened to a flange 21 on the end 3 of load 4. A third engaging plate 22 is pivotally mounted on the end 8 of upper support 6. In the shown embodiment the undercarriage 2 forms a so-called jeep dolly 36, a short intermediate trailer coupled to a tractive vehicle (not shown here). This jeep dolly has three axle systems 23 accommodated in a chassis 24. Arranged here between the rotatable coupling means 12 and cross beam 10 are two master cylinders 25 which are connected hydraulically to steering cylinders of a rear undercarriage, and whereby a rotation of support device 1 relative to undercarriage 2 is converted into a steering movement of the wheels of the rear undercarriage, the so-called trailer steering (fig. 11). The connection between the front and rear undercarriage can be broken by short-circuiting the hydraulic circuit of these cylinders 25, whereby the rear undercarriage can be steered as rear dolly (fig. 10).

The manner in which the load 4 can be picked up by support device 1 according to the invention is now elucidated with reference to fig. 3-6 in which a third embodiment is shown. This is distinguished from the second embodiment according to fig. 2 in that the engaging elements 20, 22 are mutually connected by a sub-frame 26 standing on cross beam 11. The angle adjusting means 17 in the form of a hydraulic cylinder are mounted on this sub-frame 26. In addition, this embodiment of support device 1 is provided with an additional cross beam 27 bearing two lifting cylinders 28 which can support on undercarriage 2 during coupling and uncoupling of load 4.

In order to pick up load 4 the upper support 6 and angle adjusting means 17 are in the first instance fully retracted (fig. 3). Lifting cylinders 28 are extended so far

that the lower engaging elements 20 are just clear of the road. In this position the support device 1 is moved toward load 4 by moving undercarriage 2. Engaging plates 29,30 are herein already fixed onto the end surface 3 of load 4. Undercarriage 2 is moved so closely against load 4 that hooks 31 of the lower engaging elements 20, after being brought to the correct height using lifting cylinders 28, are placed in openings 32 of the lower engaging plates 29 (fig. 4). Lifting cylinders 28 are then extended further until hooks 31 each press against an upper edge 32 of the associated opening 32. This movement could optionally also be performed using the suspension of undercarriage 2. Hooks 31 are locked in this position by placing filling blocks 34 thereunder (fig. 7). By extending the cylinders 6 and 17 a recess 35 of element 22 is then brought into engagement with the lower edge of the upper engaging plate 30 (fig. 5). Finally, lifting cylinders 28 are retracted until they are free of the chassis 24 of undercarriage 2, and the load is brought to a desired height by extending the upper support 6. The lower supports 5 herein follow the movement of load 4 and are thus also moved upward, wherein the formed triangle of forces changes shape, although the weight of the load is still taken up almost solely as a pressure force by the upper support 6, while the lower supports 5 absorb only longitudinal forces (tensile forces).

The configuration of the upper support 6 can also be other than in the foregoing examples, for instance have a relatively short cylinder 6A standing on a triangular support frame 6B (fig. 8). A similar configuration can also be chosen for the device 1 on the rear of load 4, which supports on a rear axle system 37 (fig. 9).

The rotation of coupling 12 about vertical axis 13 is useful for optimal manoeuvrability of the combination of tractive vehicle, load and rear dolly (fig. 10). The rotation

of the support device relative to the axle system can herein be automatically converted into a steering movement of axles 33, for instance by making use of cylinders corresponding to the master cylinders 25 shown in fig. 2-7. It is however also possible to manually operate the rear steering, which is used in manoeuvring at very low speed, using a separate steering pump which feeds the steering cylinders of axles 23.

During road transport of load 4, wherein relatively high speeds are reached, there is the danger of the movement of the rear axle system (rear dolly 37) on the vertical axis 13 becoming unstable. In this case the coupling 12 can be blocked against rotation (fig. 11), for instance by pins 38 which can be retracted and extended manually, pneumatically or hydraulically and which form a rigid connection between chassis 24 of dolly 37 and the lower supports 5 of support device 1. The rear axle system 37 hereby follows load 4 and displays the steering behaviour of a semi-trailer.

Owing to the chosen construction of device 1 with the movable supports 5, 6 which engage directly on the load 4 for transporting, loads of very diverse dimensions can be picked up. Furthermore, because some of the supports absorb the weight of the load and only tensile forces act on the other supports, the use of relatively heavy and voluminous adapters can be dispensed with, whereby the payload can be higher at a given weight of the combination, and the combination is easier to manoeuvre.

Although the invention is elucidated above with reference to a number of embodiments, it will be apparent that it is not limited thereto. More or fewer supports could thus be used than shown here, while the form and configuration thereof could also be varied. In addition, moving mechanisms other than the shown hydraulic cylinders could also be applied. Connections between the supports and

the load other than the plates shown here can of course also be envisaged. Different support devices can further be used on the front and rear side of the load, wherein a device according to the invention could optionally even be combined with a conventional adapter.

The scope of the invention is therefore defined solely by the following claims.

Claims

1. Method for supporting on an undercarriage an end of a self-supporting load, in particular a tower section, wherein the end of the load is engaged directly by at least one lower and at least one upper support, which supports are connected to the undercarriage and enclose an angle in a vertical plane.

2. Method as claimed in claim 1, **characterized in that** the angle between the supports can be adapted to the dimensions of the end of the load.

3. Method as claimed in claim 2, **characterized in that** the angle between the supports is adapted such that only some of the supports absorb the weight of the load and the rest of the supports absorb only longitudinal forces from the load.

4. Method as claimed in claim 3, **characterized in that** the support(s) taking up the weight of the load enclose(s) an acute angle with the horizontal, and the rest of the supports runs substantially horizontally.

5. Method as claimed in any of the foregoing claims, **characterized in that** the supports converge at or close to a point where the forces are transmitted into the undercarriage.

6. Method as claimed in any of the foregoing claims, **characterized in that** the different supports are placed successively into engagement with the load and then moved to a position in which the load is lifted.

7. Device for supporting on an undercarriage an end of a self-supporting load, in particular a tower section, comprising at least one lower and at least one upper support which enclose an angle with each other in a vertical plane, which are each connected with one end to the undercarriage,

and the other end of which is adapted to engage on the end of the load.

8. Device as claimed in claim 7, **characterized in that** the supports are movable relative to each other for the purpose of adjusting the angle enclosed therebetween.

9. Device as claimed in claim 8, **characterized by** hydraulic, pneumatic and/or mechanical means to cause movement of the supports relative to each other.

10. Device as claimed in claim 8 or 9, **characterized in that** the supports are loadable substantially in only lengthwise direction.

11. Device as claimed in claim 9, **characterized in that** at least one of the supports is adjustable in lengthwise direction.

12. Device as claimed in claim 9 or 10, **characterized in that** the support adjustable in lengthwise direction encloses an acute angle with the horizontal, and at least one non-adjustable support runs substantially horizontally.

13. Device as claimed in any of the claims 7-12, **characterized by** means for coupling the supports to the undercarriage, wherein the supports converge in the vicinity of the coupling means.

14. Device as claimed in claim 13, **characterized in that** the coupling means are rotatable relative to the undercarriage.

15. Device as claimed in claim 14, **characterized by** means for blocking the rotation movement of the coupling means.

16. Device as claimed in any of the claims 12-15, **characterized by** two non-adjustable supports lying in the same substantially horizontal plane.

17. Device as claimed in claim 16, **characterized in**

that the ends of the two supports running substantially horizontally are connected by a beam.

18. Combination of an undercarriage and a device as claimed in claims 7-17.

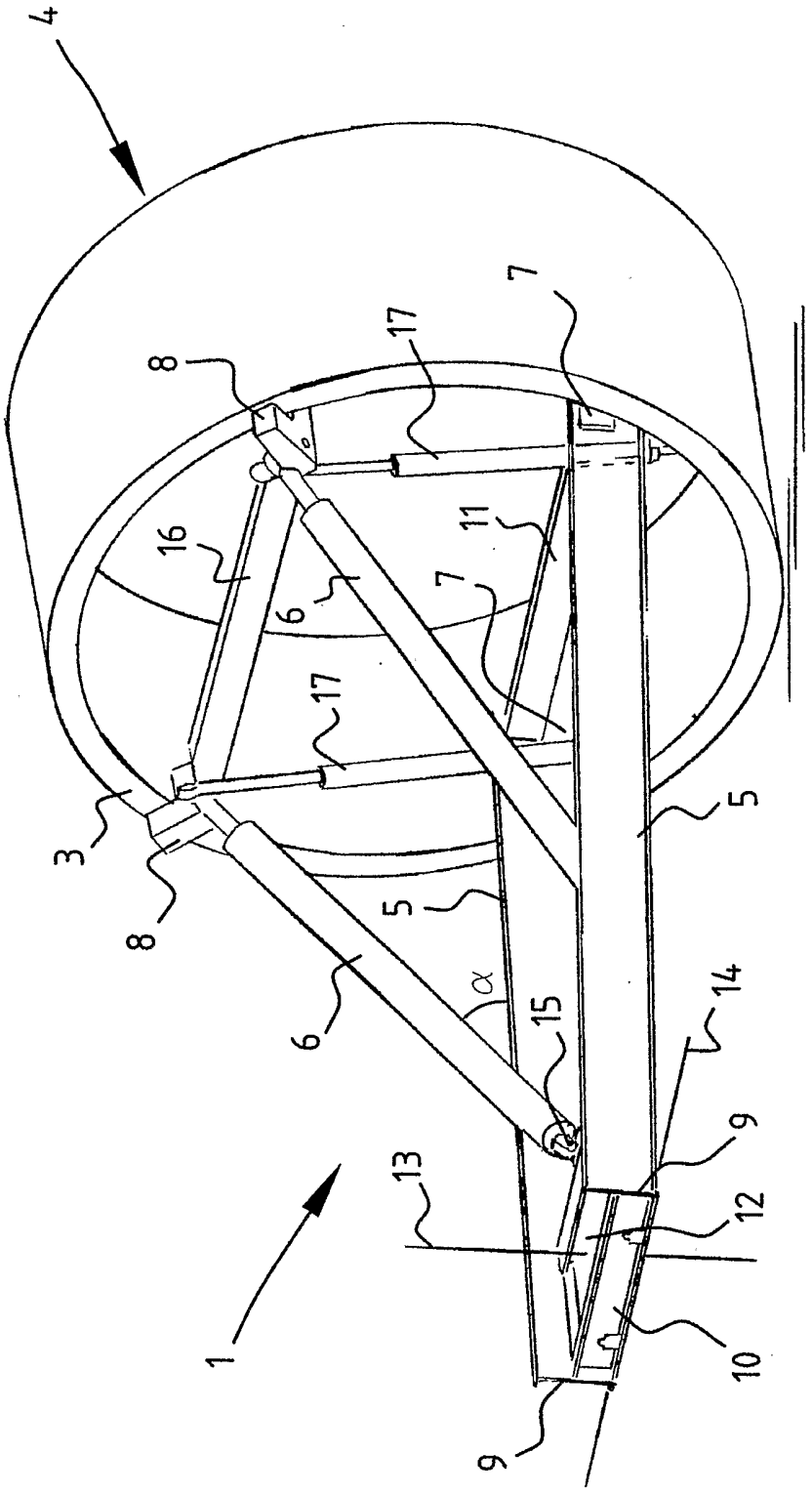


FIG. 1

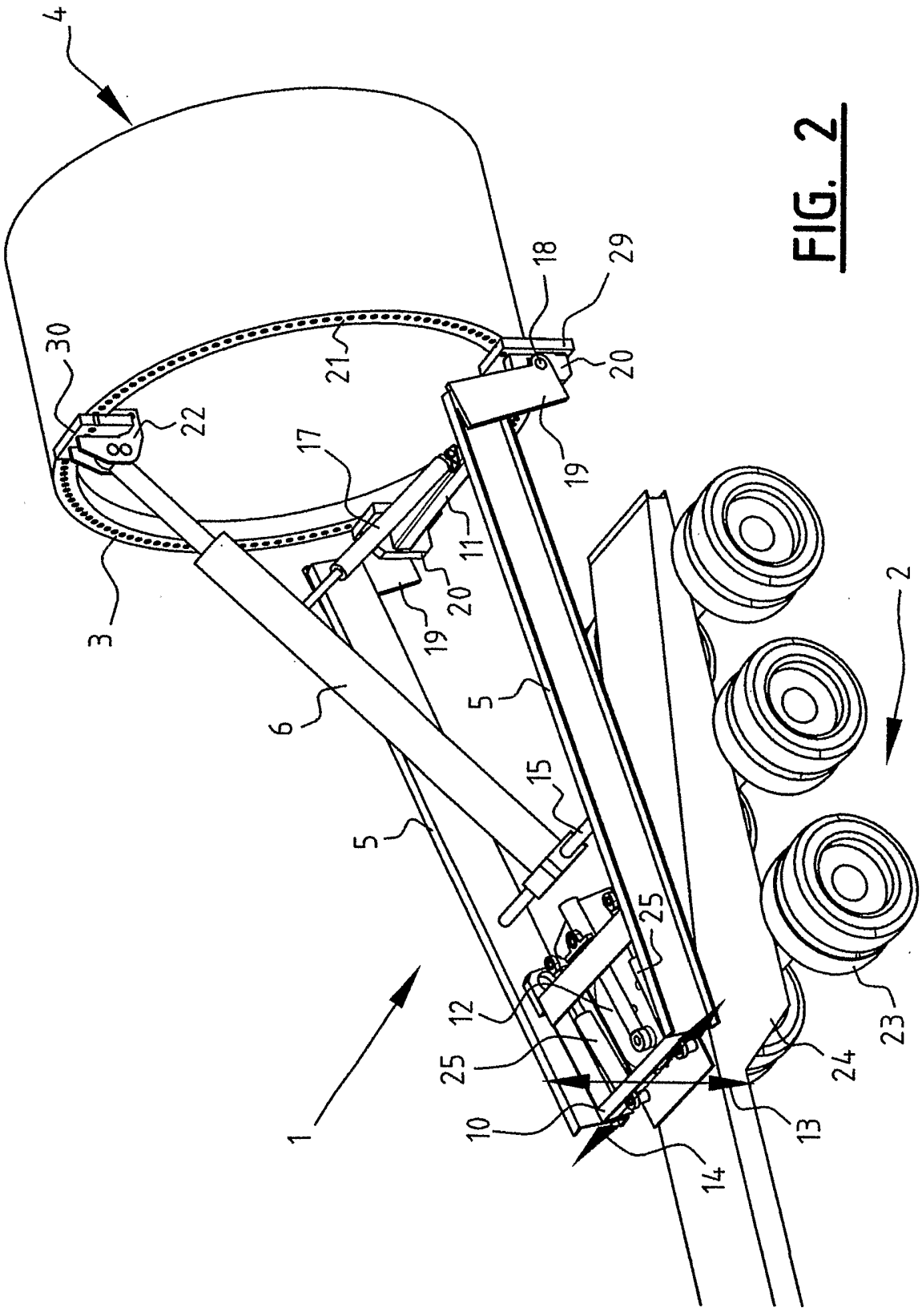


FIG. 2

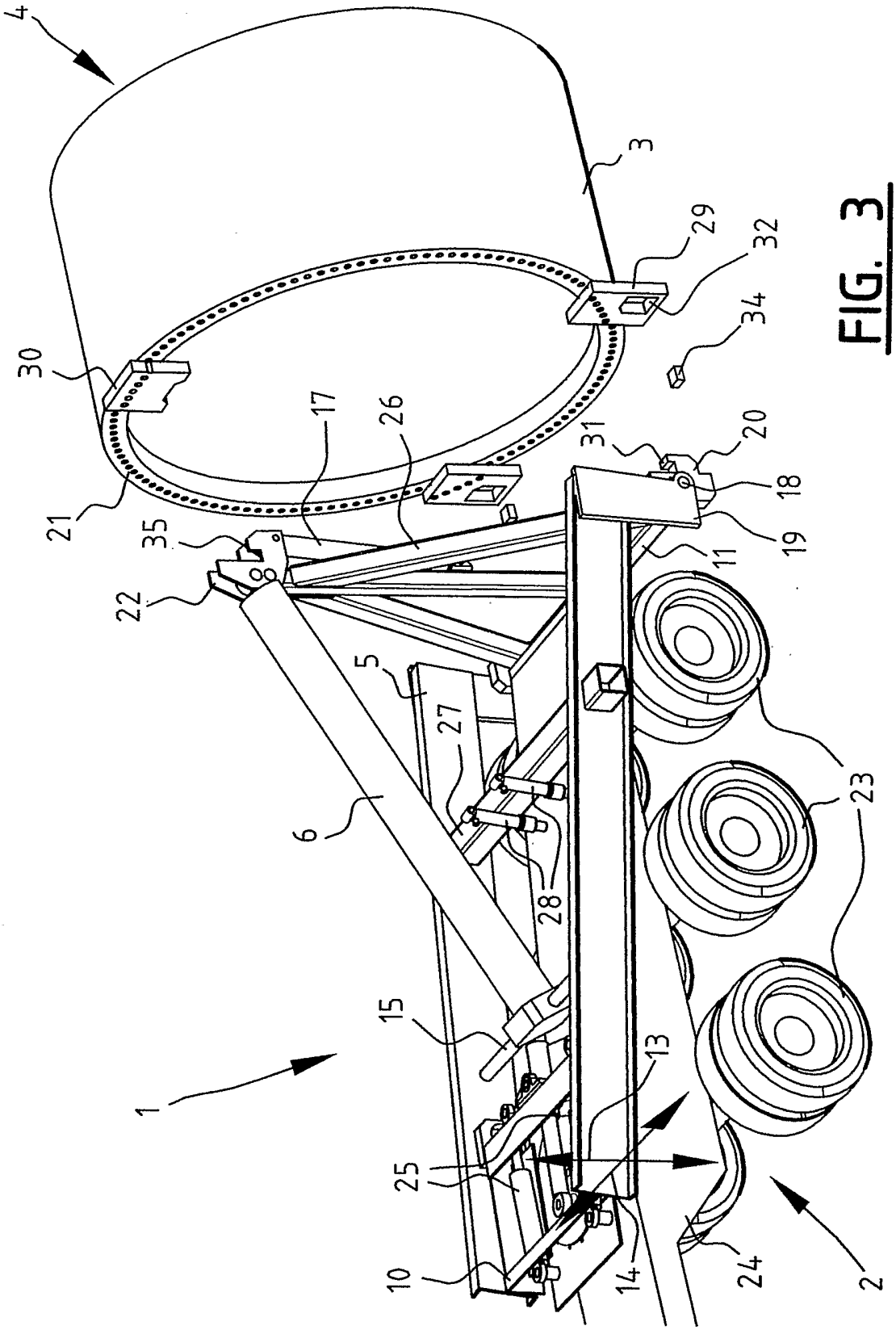

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FIG. 3

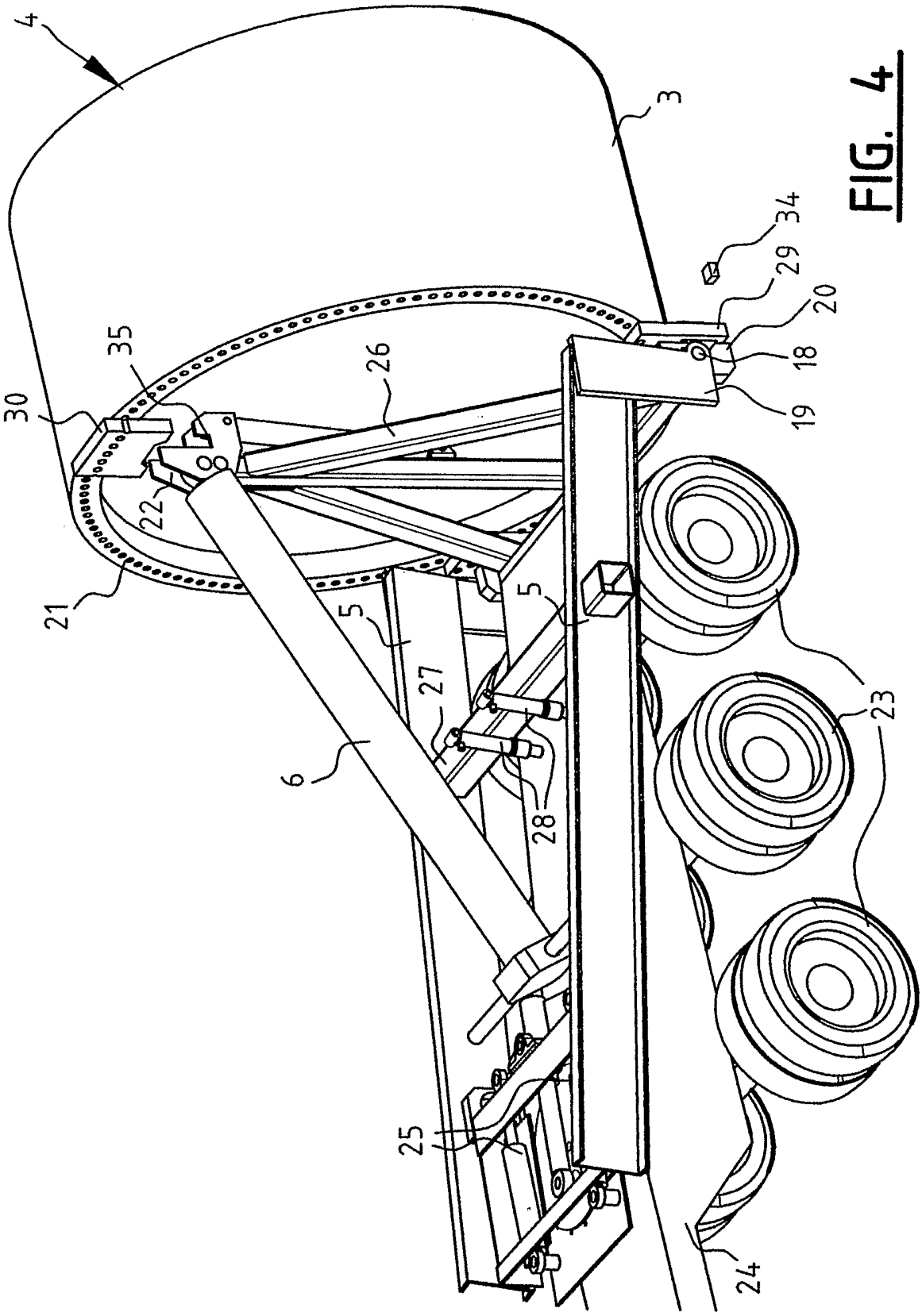


FIG. 4

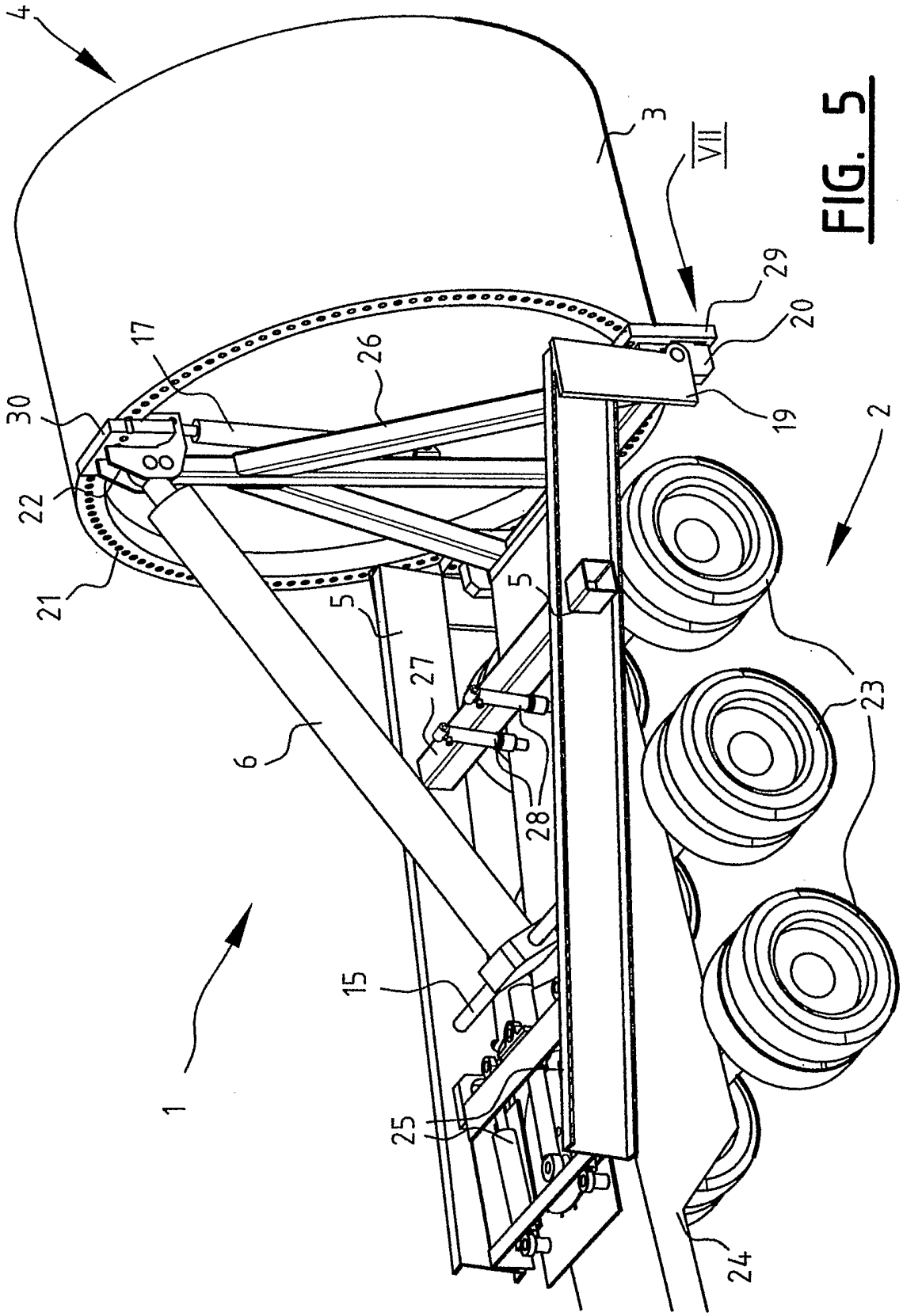


FIG. 5

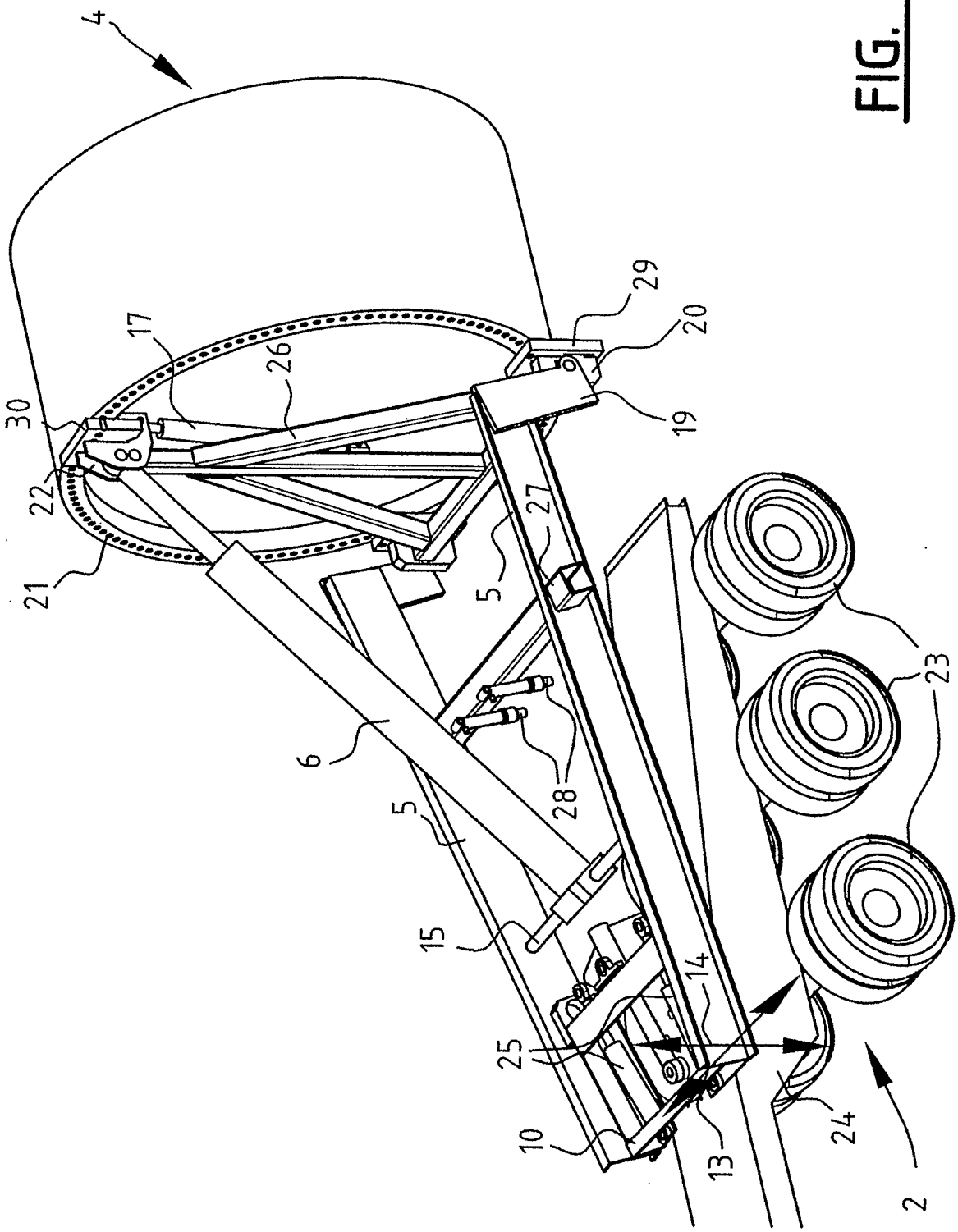


FIG. 6

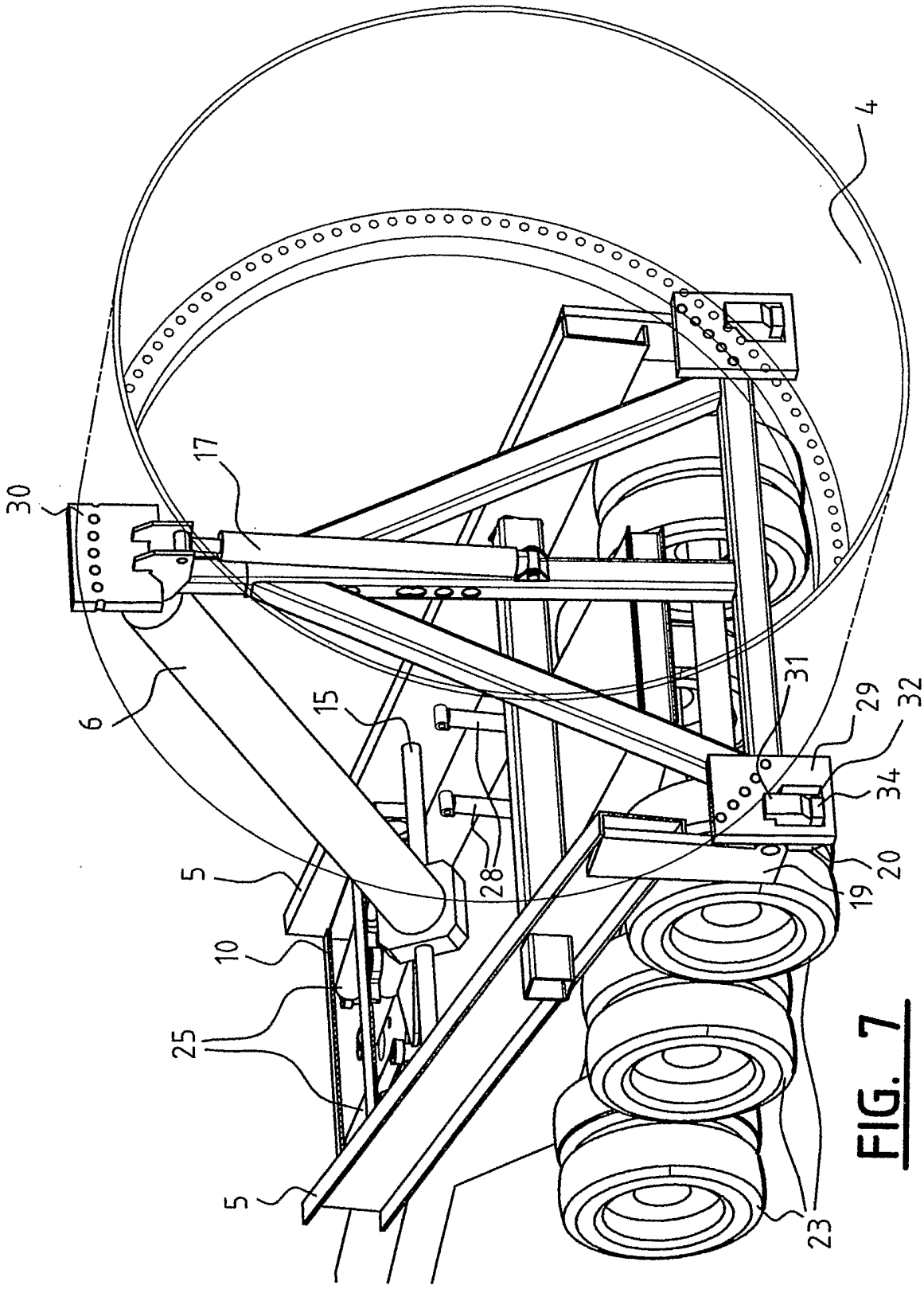


FIG. 7

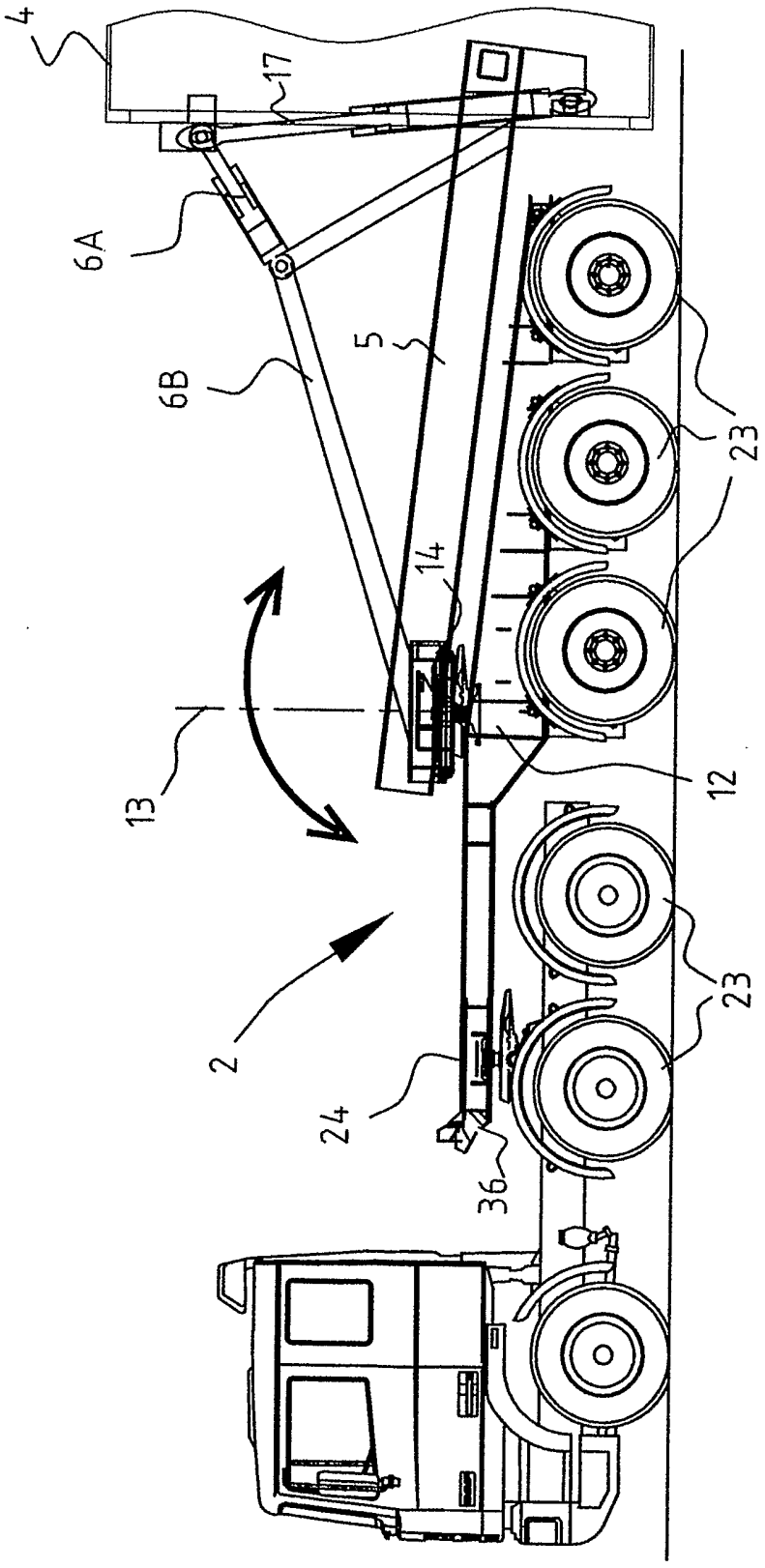


FIG. 8

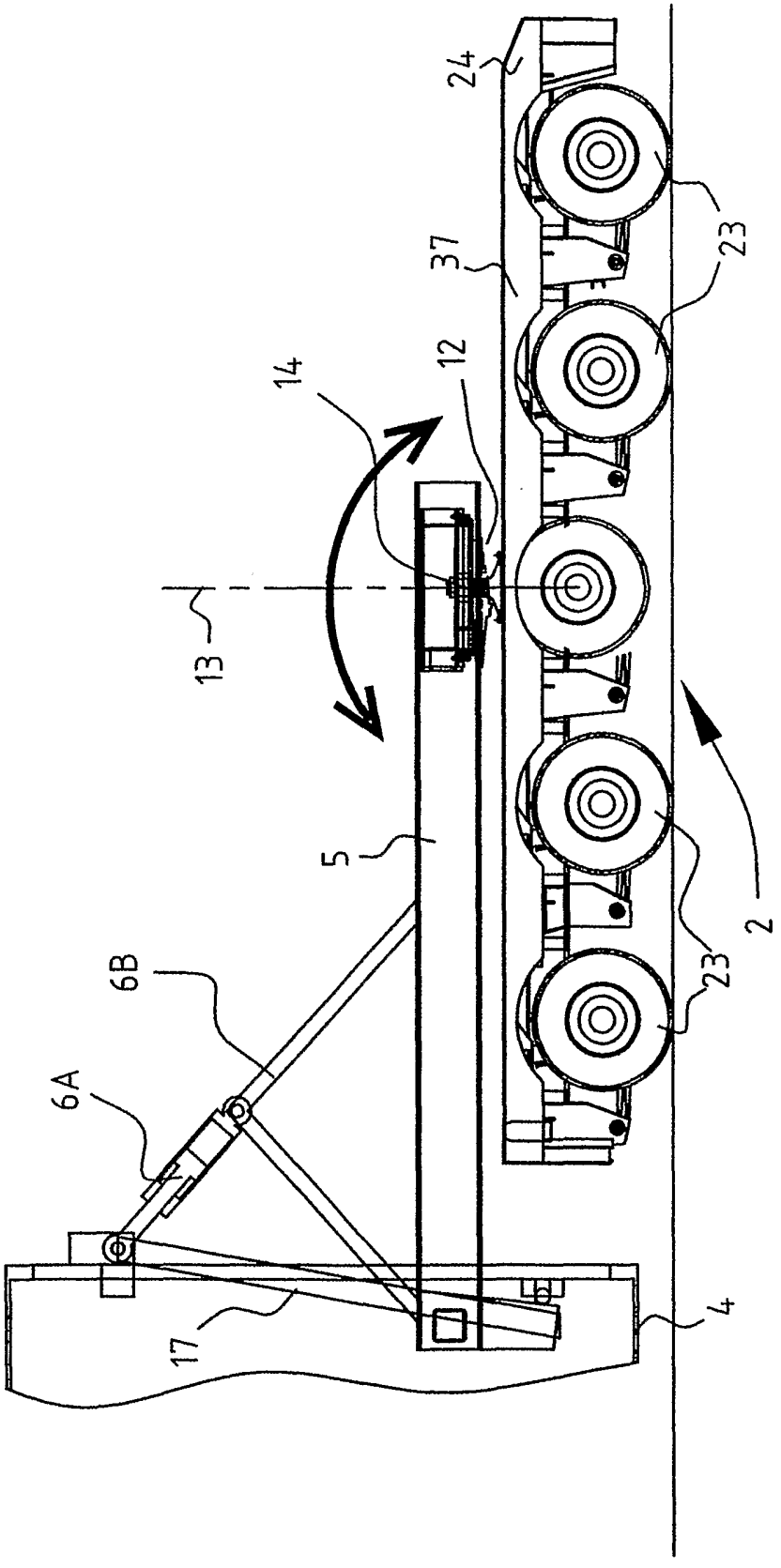


FIG. 9

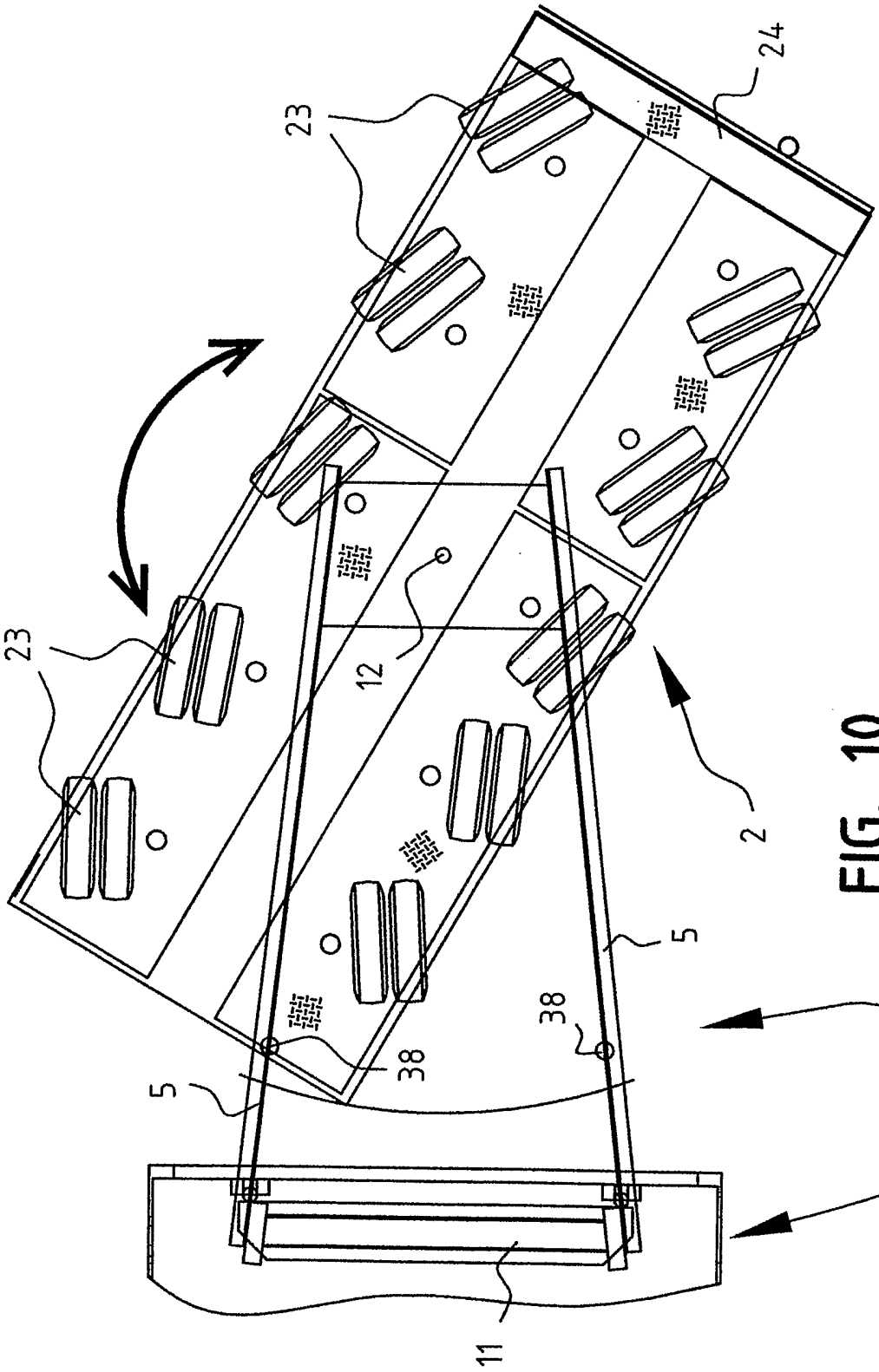


FIG. 10

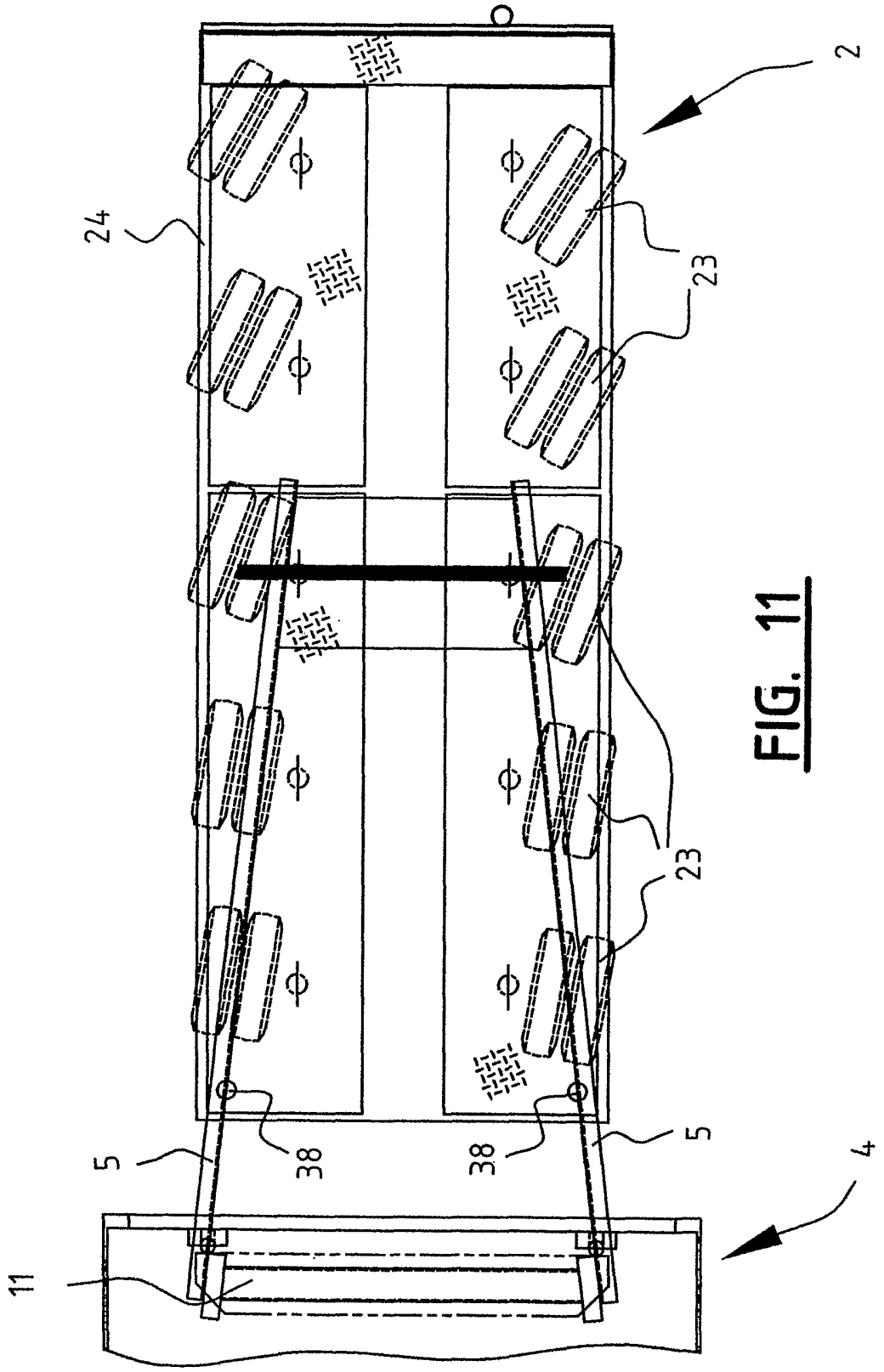


FIG. 11

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60P3/40 F03D1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60P F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 4 231 709 A (CORSETTI) 4 November 1980 (1980-11-04) column 5, line 52 -column 6, line 23; figures column 3, line 34 - line 49 column 1, line 31 - line 39 ---	1-18
X	US 4 168 931 A (HARRIS) 25 September 1979 (1979-09-25) column 2, line 3 - line 50; figures ---	1-3,6,7, 18
X	DE 100 63 136 A (WOBBEN) 31 January 2002 (2002-01-31) column 4, line 16 - line 37 column 6, line 59 - line 66 column 7, line 3 - line 29; figures 5-7 --- -/--	1,7

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 March 2004	07/04/2004

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 06, 4 June 2002 (2002-06-04) & JP 2002 059776 A (NIPPON EXPRESS CO LTD), 26 February 2002 (2002-02-26) abstract	1
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