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Amended claims in accordance with Rule 137(2) EPC.

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(54) **A crane of telescopic segments and control method thereof**

(57) A crane with telescopic segments is mounted on a moving platform (40). It has three segments (10, 20 and 30) and two articulated joints -a first one (11) between segments 10 and 20, and a second one (21) between segments 20 and 30-, said articulated joints (11, 21) being perpendicular to each other and allowing the correction for verticality of the distal end of said crane, provided with a tilt sensor (60) in case the moving platform (40) is not perfectly horizontal. A crane control method comprises measuring the deviations of segment 30 relative to the vertical and carrying out corrections so as to automatically restore the verticality of said crane end, causing segments 20 and/or 30 to rotate relative to their respective articulated joints (11 and 21).

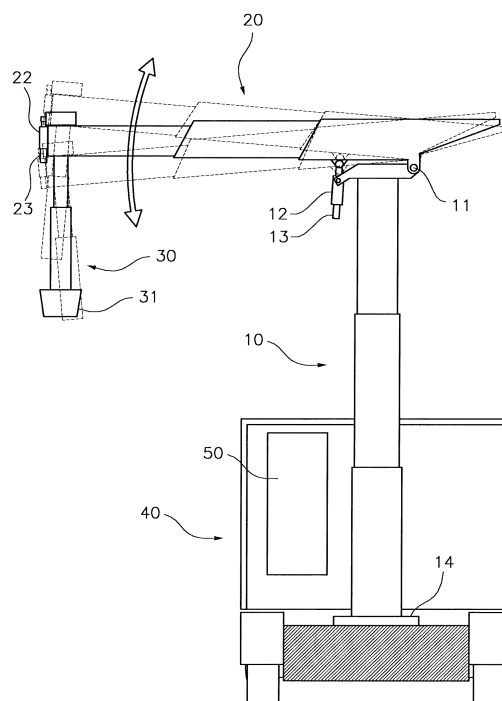


Fig. 1

Description**Field of the invention**

[0001] The present invention relates to a crane of telescopic segments mounted on a moving platform provided with two articulated joints perpendicularly arranged relative to each other, allowing the correction of deviations of the crane end from the vertical in case the moving platform is not horizontal due to the conditions of the corresponding bearing area.

[0002] The invention also relates to a control method of said crane and to the actuator means of said articulated joints so as to carry out corrections that will allow to automatically recover the verticality of said crane end at any time.

State of the art

[0003] Cranes with telescopic segments, mounted on a moving platform or vehicle so as to enable their movement, are known, such as, for instance, the crane described in document EP 1084069, wherein a first vertical segment acts as a rail for the vertical movement of a second horizontal telescopic segment in whose end an engagement device is arranged so as to grasp and lift loads. This invention does not allow altering the angles between the crane segments, so that any tilt of the vehicle or of the terrain where it is outriggered will produce inclined lifting conditions of the load.

[0004] Document WO 2012032438, which constitutes the preamble of claim 1, discloses a crane with mutually articulated telescopic segments that comprise first and second telescopic segments and a third segment with an engagement device in its more distal end, wherein a first articulated joint arranged between the first and second segments allows altering the angle that said two segments form therebetween relative to a vertical plane including both, hereinafter the working plane. In this case, said first articulated joint allows reducing the crane envelope in the retracted position, and increasing its vertical reach in the working position, but it does not allow correcting the verticality of said third segment relative to a vertical plane perpendicular to said working plane. So, if the crane were outriggered on terrain having a sideways slope, the segments would suffer from the same sideways tilt -their correction being impossible- and, when lifting a load, unexpected shifts and undesirable stresses might occur on the segments and the crane base.

[0005] Document US2933210 describes a crane with characteristics similar to those of the aforementioned document and having the same disadvantages.

[0006] It is apparent that there is the need of providing a crane of telescopic segments like the ones mentioned above with means that allow solving the referred disadvantages.

Brief disclosure of the invention

[0007] The present invention helps to solve the above and other disadvantages through a crane of telescopic segments mounted on a moving platform and a method for controlling the actuation thereof.

[0008] The crane consists of three mutually transverse segments, a first segment being arranged perpendicularly on a moving platform and provided with a telescopic mechanism. Attached to the distal end of this first segment, there is a second segment, also provided with a telescopic mechanism, in whose distal end a third segment is found. Said third segment is provided with grasping means that let it secure and lift a load, but said grasping means might be replaced, for instance, with an interdependent platform of said third segment for other functionalities.

[0009] In order to ensure that the third segment is always vertically oriented, even though the moving platform is tilted -typically due to the slope of the ground or the thoroughfare where it is located-, the crane has two mutually perpendicular articulated joints, the first articulated joint having its axis of rotation approximately horizontal and perpendicular to a vertical plane, or working plane, containing the first and second segments, and said second articulated joint having its axis of rotation approximately horizontal and perpendicular to the axis of the first articulated joint, or vice versa. This arrangement allows correcting the tilt of the distal end of the crane along two axes perpendicular to each other, and approximately horizontal, which allows counteracting the effect of the tilt of said third lifting segment derived from whichever tilt of the moving platform, and restoring the vertical orientation of said third segment at all times.

[0010] The first articulated joint allows changing the angle formed by at least one portion of the first segment relative to at least one portion of the second segment, and the second articulated joint allows changing the angle of at least one portion of the second segment relative to at least one portion of the third segment. This way, the tilt, both in the longitudinal direction of the moving platform and transverse thereto, can be corrected.

[0011] Said first and second articulated joints might be located in positions different from those described without thereby altering the operation of the invention, the same way that the segment telescoping means might be sliding, use a scissors mechanism or be any other type of mechanism without thereby altering the scope of the present invention, as will be obvious for a skilled artisan.

[0012] Said third segment has a tilt sensor, which makes it possible to know the deviation of said third segment relative to the vertical, which will have to be corrected for through the corresponding actuation of the articulated joints described in the present invention.

[0013] The method for deviation correction provided by this invention consists of a first measurement step, by means of said tilt sensor, of the spatial orientation of said third crane segment and, in particular, of its deviation

relative to the vertical orientation. The collected information is transmitted to an electronic control device, where, during the second step of the method, the adjustments necessary for reducing or eliminating any deviation relative to the vertical orientation of said third segment are computed. In the third step, the first and second actuator means, responsible for altering the angles of the first and/or second articulated joints, are actuated so that, through their actuation, the adjustment calculated by the electronic control device is effected. During this actuation operation, a first and/or second detecting means, associated with said first and/or second actuator means, analyse the shift caused in the crane segments by said actuator means and transmit information to the electronic control device, thereby allowing the latter to control the correct execution of the calculated adjustment or correction manoeuvre, the vibrations and oscillations produced by the shifts of the segments being unable to alter the results of the readings.

[0014] Once the calculated adjustment has been completed, the tilt sensor proceeds to carry out a new measurement of the deviation of said third segment of the crane and said information is transmitted again to the electronic control device. If the results indicate the deviation has disappeared or it is smaller than pre-established values, the deviation correction operation is considered complete, but if the results do not satisfy these parameters, the entire operation is iteratively repeated from the start until the results are satisfactory.

Description of the figures

[0015] The above and other characteristics and advantages will be more evident from the following detailed description of an embodiment with reference to the attached drawings, wherein:

Fig. 1 shows a side view of the crane, in the extended position and installed on a transport vehicle, such as a lorry, which is shown in cross section. On the other hand, the dotted line depicts the possible angular shift of the second segment relative to the first one by means of the first articulated joint, effected in the plane of said side view containing the first and second segments of the crane;

Fig. 2 shows a front view of the crane, in the extended position and installed on a lorry. The dotted line depicts the possible angular shift of the third segment relative to the second one by means of the second articulated joint, effected in the plane of said front view. The circle indicates the area blown up in Fig. 3;

Fig. 3 shows one blown up detail of the second articulated joint, from the same standpoint shown in Fig. 2; and

Fig. 4 shows a schematic diagram of the sensors,

the actuators and their connection with the electronic control device, wherein only the sensors and actuators related to the correction of verticality have been included, the sensors and actuators related to the shifting and actuation of the crane not being shown.

Detailed description of one embodiment

[0016] Fig. 1 shows a side view of the crane of telescopic segments at an initial position, with its telescopic segments extended and perpendicular to each other.

[0017] In the present example, said crane is formed by a first vertical telescopic segment 10 attached, through a rotating base 14, to a moving platform 40; as a non-limiting example, a refuse collection vehicle. A second telescopic segment 20 is transversely attached, by one of its ends, to the distal end of the first segment. A third segment 30, which may optionally also be telescopic, is transversely attached to the distal or terminating end of the second segment 20. The distal end of said third segment 30 is provided with grasping members 31 that allow securing and hooking a load to the end of said crane for its hoisting.

[0018] The attachment between said first segment 10 and said second segment 20 has a first articulated joint 11 that allows changing the angle between said two segments 10, 20, the axis of said articulated joint being approximately horizontal and perpendicular to the plane formed by the first segment 10 and the second segment 20. A first fluid-dynamic actuating means 12 allows altering and setting a turning angle of the segment 20 around said first articulated joint 11, causing its rise or descent.

[0019] As noticeable in Fig. 2, the attachment between said second segment 20 and said third segment 30 is provided with a second articulated joint 21 that allows altering and setting the angle between said two segments, said second articulated joint 21 being approximately horizontal and perpendicular to the first articulated joint 11. A second fluid-dynamic actuating means 22 for altering and setting the range of the turning angle around said second articulated joint 12 of the third segment 30.

[0020] This arrangement lets the crane extend and retract thanks to its telescopic segments, turn thanks to the rotating base 14 and adjust the existent angle between its segments 10, 20 and/or 20, 30 in two vertical planes perpendicular to each other so as to attain the verticality of the third segment 30 through a number of corrections of the crane tilt relative to a couple of vertical planes perpendicular to each other and respectively containing said first and second segments 10, 20 and said third segment 30, even though the moving platform 40 and the first segment 10 attached thereto are not in the vertical position, due to the fact that, for instance, the moving platform 40 is outriggered on sloping terrain.

[0021] The achievement of the same result by locating said first articulated joint 11 and second articulated joint 21 in locations of the crane different from those discussed so far would be obvious for a skilled artisan, provided

both articulated joints are noticeably perpendicular to each other and horizontal. A similar solution articulating fractions of one same segment, instead of some segments with others would also be obvious.

[0022] For controlling and correcting its tilt, the crane is provided with a tilt sensor 60 located in the third segment 30, such as, for instance, a two-axis sensor 2D that permits measuring the deviation of the longitudinal axis of said third segment 30 relative to two perpendicular vertical planes. The crane is also provided with a first position-detecting means 13 and a second position-detecting means 23 that monitor the position of said first actuating means 12 and second actuating means 22, said position-detecting means possibly being transducers.

[0023] As shown in Fig. 4, all these sensors are connected with an electronic control device 50, which is also responsible for controlling all the crane actuators, this way allowing said electronic control device 50 to shift the crane and, in addition, to execute the method for correcting the vertical deviation, which is described now.

[0024] In a first step, said method allows analysing the deviation of the third segment 30 relative to the vertical by means of the tilt sensor 60, and transmitting said information to the electronic control device 50. In a second step, the electronic control device 50 analyses the received information and, if it is determined that the deviation is higher than a deviation pre-established as admissible, the necessary adjustments are computed in the turning angle around the first articulated joint 11 and/or the second articulated joint 21 in order to correct it. In the third step, the electronic control device 50 activates the first actuating means 12 and/or the second actuating means 22 to execute the calculated correction. During the correction process the first and second position-detecting means 13 and 23 analyse the position of the first and second actuating means 12 and 22 and report it to the electronic control device 50 to ensure the correct execution of the angular adjustment. In a fourth step of the method, the tilt sensor 60 measures again the deviation of the third segment 30 relative to the vertical and sends the data to the electronic control device 50, which determines if it now satisfies the pre-established parameters of maximum deviation. In case it does not satisfy them, it restarts the method iteratively until acceptable results are obtained; in case it satisfies them, it considers the method as finished.

[0025] In this embodiment it is anticipated that articulated joints should allow changing the turn angle around each by up to 10°, but they might have greater or lesser freedom, the essence of the invention not being affected by it.

[0026] Based on the range of said turning angle around the articulated joints 11 and 21, the deviations caused by a larger or smaller tilt of the platform may be corrected for. Thus, for example, a turn of the second stage 20 relative to the first one 10 around the articulated joint 11 by +/- 5° would entail counteracting the effects derived

from a 9% longitudinal slope of the terrain. Likewise, a turn of the third stage 30 relative to the second one 20 around the articulated joint 21 by +/- 5° in a plane perpendicular to the one containing said first and second stages 10, 20 would entail being able to counteract a sideways slope of the terrain of up to 9%.

Claims

1. A crane of telescopic segments of the type consisting of:

- a first segment (10) arranged perpendicularly on a moving platform (40) and attached thereto by means of a rotating base (14), allowing its rotation;
- a second and transverse segment (20) attached to a distal end of said first segment (10); and
- a third segment (30), provided with grasping members (31), attached to the distal end of the second segment (20) and transverse thereto,
- the attachment between said first segment (10) and second segment (20) having a first articulated joint (11) and being provided with first actuating means (12), which, through the rotation around said first articulated joint (11), allows changing the angle between said first segment (10) and second segment (20) relative to the vertical plane formed by said first and second segments (10 and 20),

characterised by integrating:

- a second articulated joint (21) allowing the rotation, through second actuating means (22) around said second articulated joint (21), of at least a distal fraction of the third segment (30) in a plane perpendicular to a plane containing said first and second segments (10 and 20), with an axis of rotation perpendicular to the axis of rotation of the first articulated joint (11); and
- a tilt sensor (60) arranged in a fraction of the crane to the rear of the second articulated joint (21), said tilt sensor (60) being intended for transmitting information about the deviation of the spatial orientation of said third stage (30) relative to the vertical to an electronic control device (50) governing said first and second actuating means (12 and 22).

2. A crane according to claim 1 **characterised in that** said first and second articulated joints (11 and 21) are approximately horizontal.

3. A crane according to claim 1 **characterised in that** said second articulated joint (21) is arranged between the second segment (20) and the third segment (30).

4. A crane according to claims 1 or 3 **characterised by** having first position-detecting means (13) and second position-detecting means (23) respectively connected to the first actuating means (12) and to the second actuating means (22), used to analyse the position of said first and second actuating means (12 and 22) and transmitting said information to said electronic control device (50).
5. A crane according to any one of the preceding claims **characterised in that** said rotation around said first and second articulating joints (11 and 21) is limited to a maximum rotation angle of 20°, and preferably limited to 10°.
6. A crane according to any one of the preceding claims **characterised in that** said third segment (30) has a telescopic mechanism.
7. A control method for a crane of telescopic segments located on a moving platform for controlling a crane according to any one of the previous claims **characterised by** comprising the following steps:
- analysing, through the tilt sensor (60), the deviation of the longitudinal axis of the third segment (30) relative to the vertical, and transmitting the associated information to the electronic control device (50);
 - determining, through the electronic control device (50), based on the value of said deviation information, the necessary angular correction for the rotation of the second segment (20) around the first articulated joint (11) and/or per rotation of the third segment around the second articulated joint (21) in order to reduce or eliminate said deviation;
 - actuating, from the electronic control device (50), the first and/or second actuating means (12 and 22), causing a predetermined rotation of said second (20) and/or third segments (30) of the crane, controlling their correct actuation by means of the first and second position-detecting means (13 and 23), also connected to the electronic control device (50);
 - repeating the measurement with-said tilt sensor (60); and
 - if said measurement gives the result that the deviation of the longitudinal axis of the third segment (30) relative to the vertical is higher than a value pre-established as acceptable, restart the operation iteratively, and, in case it is smaller, consider the correction of the tilt of the longitudinal axis of said third segment (30) as finished.

Amended claims in accordance with Rule 137(2) EPC.

1. A crane of telescopic segments of the type consisting of:
- a first segment (10) arranged perpendicularly on a moving platform (40) and attached thereto by means of a rotating base (14), allowing its rotation;
 - a second and transverse segment (20) attached to a distal end of said first segment (10); and
 - a third segment (30), provided with grasping members (31), attached to the distal end of the second segment (20) and transverse thereto,
- the attachment between said first segment (10) and second segment (20) having a first articulated joint (11) and being provided with first actuating means (12), which, through the rotation around the axis of said first articulated joint (11), allows changing the angle between said first segment (10) and second segment (20) relative to the vertical plane formed by said first and second segments (10 and 20), **characterised by** integrating:
- the first segment (10) is a telescopic segment and the second segment (20) is a telescopic segment;
 - a second articulated joint (21) allowing the rotation, through second actuating means (22) around the second articulated joint (21) axis, of at least a distal fraction of the third segment (30) in a plane perpendicular to a plane containing said first and second segments (10 and 20), with an axis of rotation perpendicular to the axis of rotation of the first articulated joint (11); and
 - a tilt sensor (60) arranged in a fraction of the crane more distal than the second articulated joint (21), said tilt sensor (60) being intended for transmitting information about the deviation of the spatial orientation of said third segment (30) relative to the vertical to an electronic control device (50);
 - said electronic control device (50) is configured to govern said first and second actuating means (12 and 22) to shift the crane to correct said vertical deviation.
2. A crane according to claim 1 **characterised in that** said axis of first and second articulated joints (11 and 21) are approximately horizontal.
3. A crane according to claim 1 **characterised in that** said second articulated joint (21) is arranged between the second segment (20) and the third segment (30).

4. A crane according to claims 1 or 3 **characterised by** having first position-detecting means (13) and second position-detecting means (23) respectively connected to the first actuating means (12) and to the second actuating means (22), used to analyse the position of said first and second actuating means (12 and 22) and transmitting said information to said electronic control device (50). 5
5. A crane according to any one of the preceding claims **characterised in that** said rotation around said first and second articulating joints (11 and 21) is limited to a maximum rotation angle of 20°, and preferably limited to 10°. 10
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6. A crane according to any one of the preceding claims **characterised in that** said third segment (30) has a telescopic mechanism. 15
7. A control method for a crane of telescopic segments located on a moving platform for controlling a crane according to any one of the previous claims **characterised by** comprising the following steps: 20
 - analysing, through the tilt sensor (60), the deviation of the longitudinal axis of the third segment (30) relative to the vertical, and transmitting the associated information to the electronic control device (50); 25
 - determining, through the electronic control device (50), based on the value of said deviation information, the necessary angular correction for the rotation of the second segment (20) around the first articulated joint (11) and/or per rotation of the third segment around the second articulated joint (21) in order to reduce or eliminate said deviation; 30
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 - actuating, from the electronic control device (50), the first and/or second actuating means (12 and 22), causing a predetermined rotation of said second (20) and/or third segments (30) of the crane, controlling their correct actuation by means of the first and second position-detecting means (13 and 23), also connected to the electronic control device (50); 40
45
 - repeating the measurement with said tilt sensor (60); and
 - if said measurement gives the result that the deviation of the longitudinal axis of the third segment (30) relative to the vertical is higher than a value pre-established as acceptable, restant the operation iteratively, and, in case it is smaller, consider the correction of the tilt of the longitudinal axis of said third segment (30) as finished. 50
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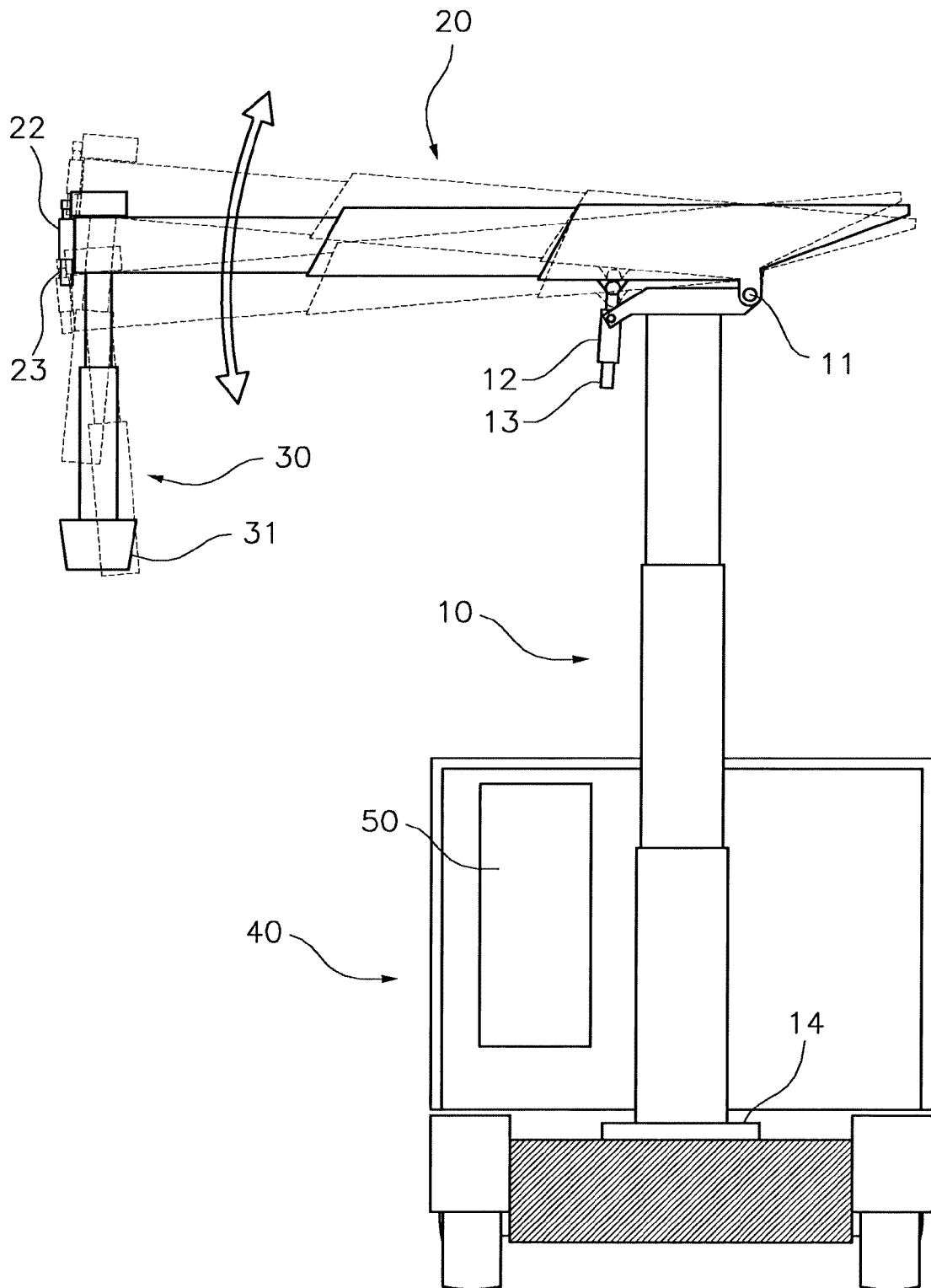


Fig. 1

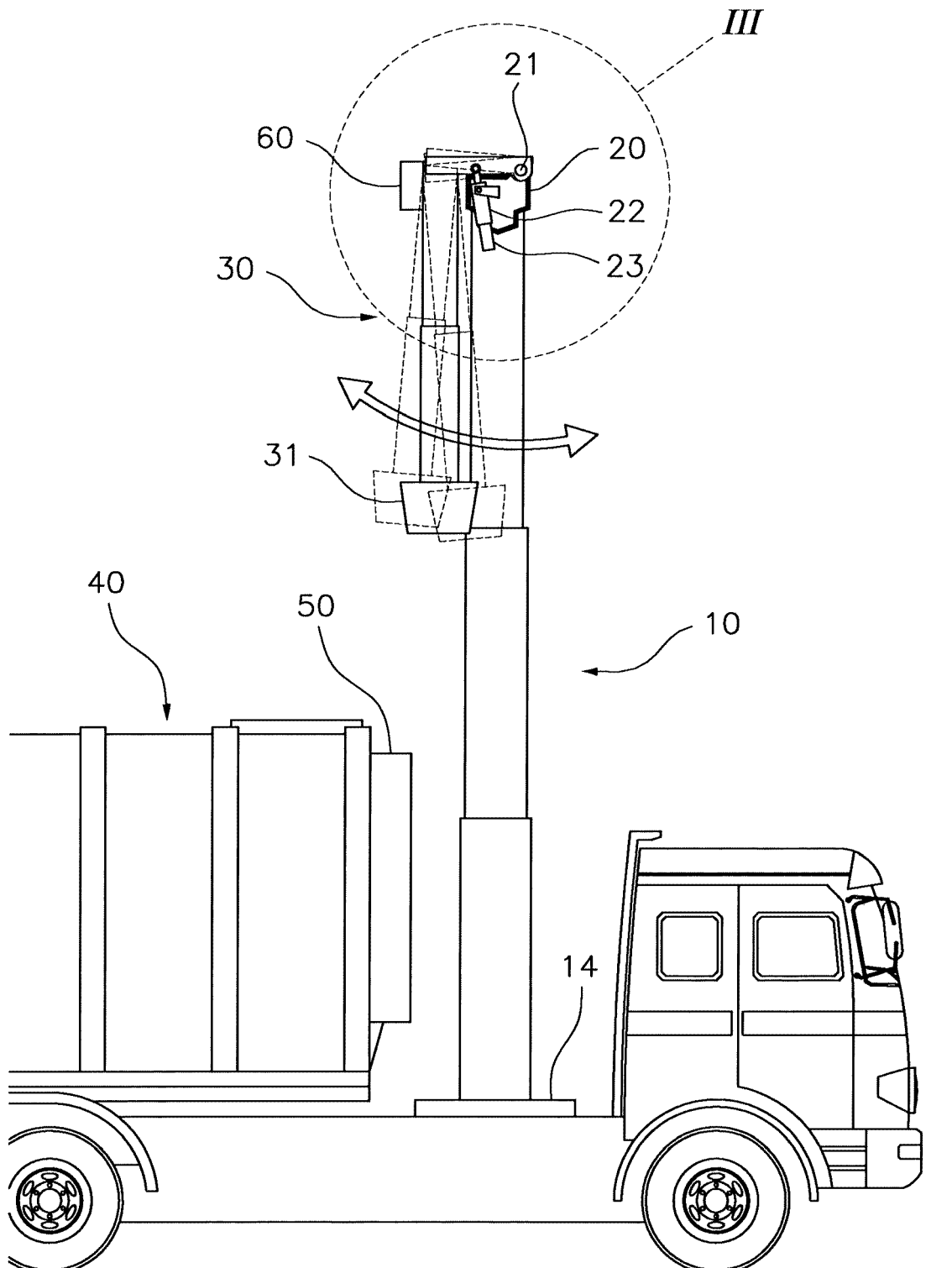


Fig.2

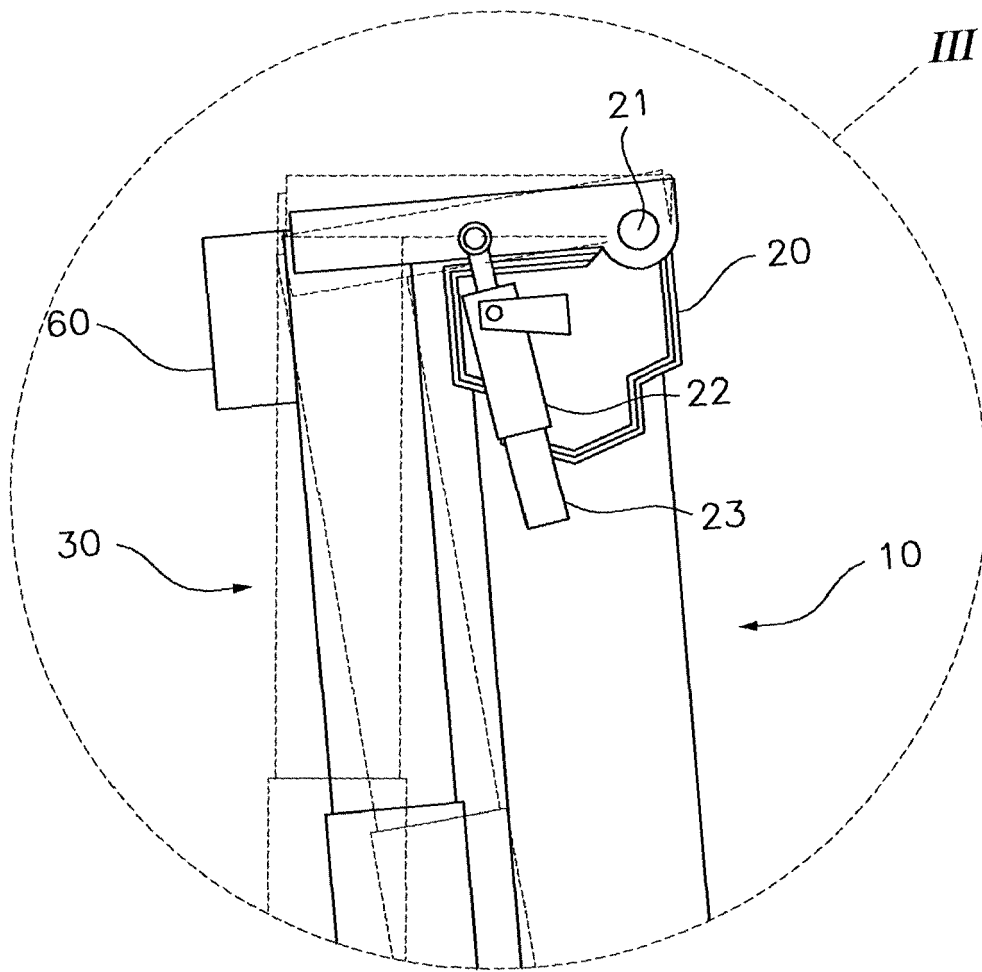


Fig.3

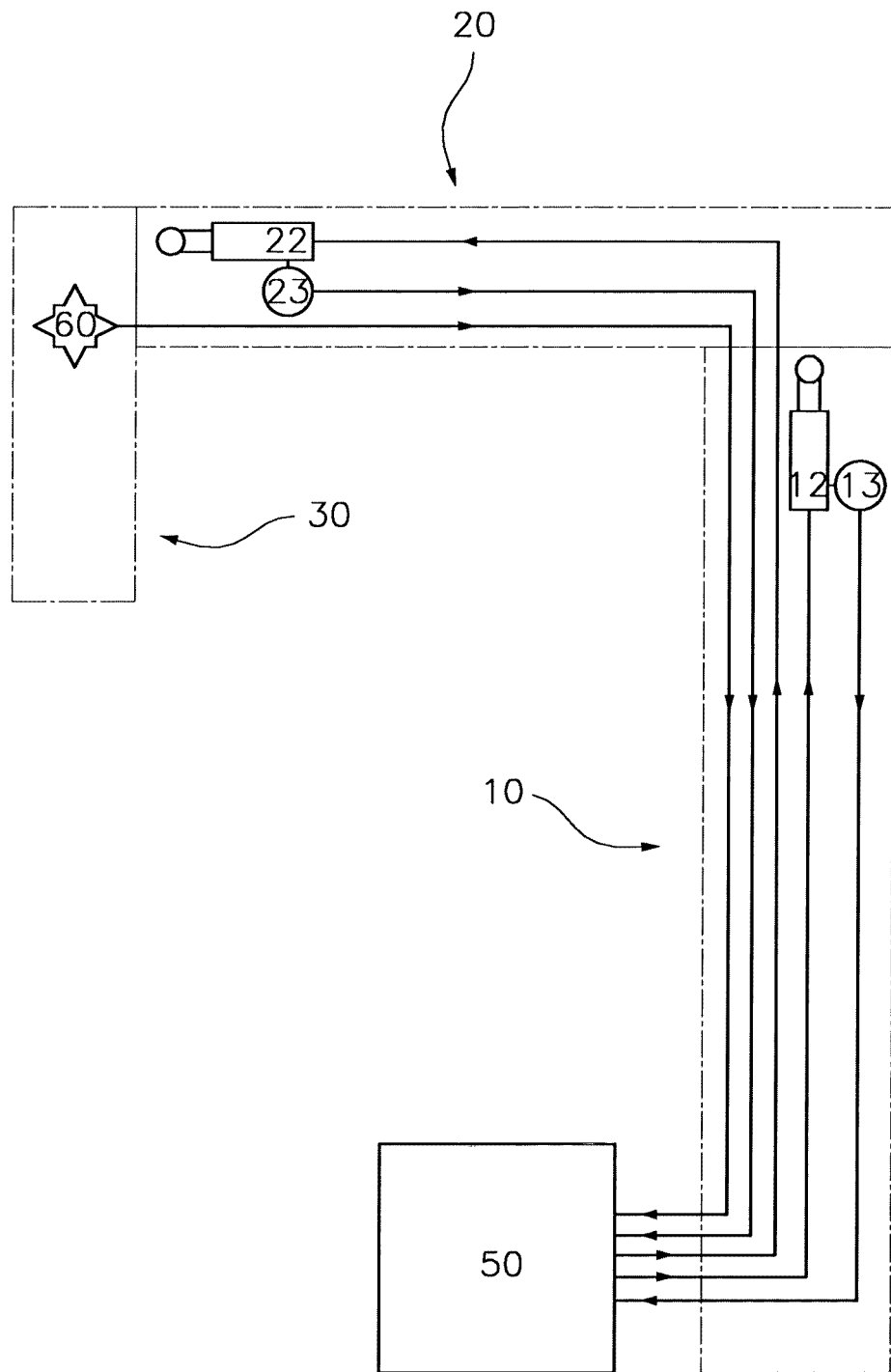


Fig. 4



EUROPEAN SEARCH REPORT

 Application Number
 EP 13 38 0028

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Place of search The Hague		Date of completion of the search 13 November 2013	Examiner Serôdio, Renato
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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