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(54) **CLIMBING DEVICE FOR MOVING LARGE MOVABLE STRUCTURES**

(57) Climbing device for moving large movable structures, which is constituted by a series of toothed members (2), each mounted on two identical crankshafts (3), which pass through them transversely and rotate, in unison and in synchrony, such that the two eccentrics corresponding to each toothed member have the same arrangement at all times so the toothed member is always in the horizontal position, carrying out a rotational movement about two lateral axis, which coincide with the re-

spective crankshafts, which movement is translated longitudinally into an approximation and dragging movement of the device upon its resting onto the rack immediately followed by its separation from the rack and backwards movement to a previous position. At all times, at least one toothed member is in contact with the rack and consequently all the teeth of said toothed member are in gear with said rack.

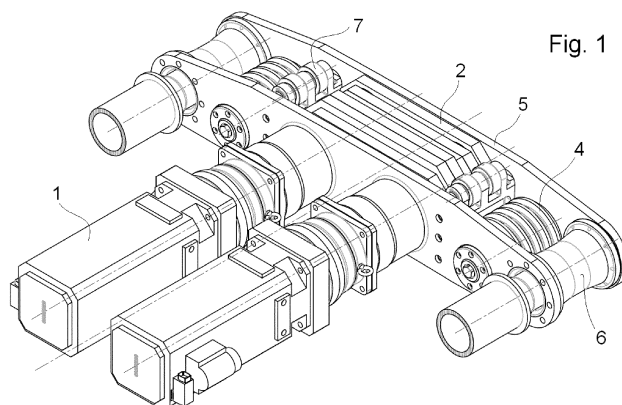


Fig. 1

Description

Object of the invention

[0001] The present invention, as the title suggests, relates to a device both for moving large movable or rotatable structures, such as stadium covers, astronomical telescopes gates, wind turbine structures, scenarios for shows, and for loading and/or unloading merchant ships, etc.

Background of the invention

[0002] The driving systems of large movable structures have shown little evolution since large retractable stadiums started to be build. These systems usually are based on solutions available in different industrial applications, for example in large equipment intended to move machinery, cranes, etc. Said elements while available on the market are nevertheless bulky and inefficient in terms of mass and volume, and are not sufficiently reliable when applied to large flexible structures.

[0003] One of the mechanisms most widely used to date consists of a coupling between a mobile pinion and a fixed rack. If we study the movement of this mechanism, we observe that only one or two teeth of the pinion do contribute efficiently to driving the structure, therefore, if the power transmitted by the movement is too high it may cause the breakage of some of the coupling elements; furthermore, their reliability and precision are quite low.

[0004] The caterpillar mechanisms offer a larger number of teeth in contact and therefore are more compact, rigid and stronger. Mechanisms of this type are used, for example to move a drag chain that rests directly on the ground (this type of traction is commonly used in heavy vehicles).

Description of the invention

[0005] The mechanism of the present invention is similar to a caterpillar-like mechanism; insofar it consists of a rack on which a number of toothed members move. Said toothed members are arranged longitudinally with regard to said rack and are driven by means of a crankshaft-like eccentric mechanism, in such away that each toothed member describes a circular movement above the rack, coupling itself into the rack while pushes it in the forward direction and then separates from it to move backwards, opposite to the forward direction thereof, to couple itself once again in a rearmost position and begin pushing anew, once that due to its circular motion it has come down to couple itself one more time into the rack. The movement is more accurate than that of a conventional mechanism given that the teeth pitch of each toothed member may be substantially shorter than that of any circular pinion developed for the same drag power.

[0006] Inasmuch the number of toothed members is relatively high, a minimum of 3 to 9 toothed members are

placed, preferably 6, and at all times at least one these toothed members is in gear with the rack, thus realizing a very precise displacement, and even if a strong traction force is exerted, the stress on each tooth is substantially lower than that of on a conventional rack-pinion mechanism, given that the total force is divided by the number of teeth. Moreover, the mechanism is designed so that at least all the teeth of one toothed member (and sometimes two) are in contact with the rack at any given time, such that there will always be a high number of teeth in contact, unlike the pinion-rack type mechanisms in which the average number of teeth in contact is always less than two; consequently, the effort at each tooth is minimized, even with a drag force substantially weaker, therefore the teeth can be much smaller and a more accurate and reliable displacement system can be achieved.

[0007] Thus, the main benefits of the mechanism when compared with traditional transmission systems of large movable structures is that it is more efficient and compact if we take into consideration the speed required for a given application. It further provides a very strong connection between the fixed portion (referential) of the structure and the movable structure, thus ensuring a great degree of accuracy of the required position and a smooth operation.

[0008] To carry out the circular movement of the toothed members, coupled into the rack during the forward motion and uncoupled during their backward motion, these are mounted on two crankshafts whose eccentrics determine through their rotation the position of each toothed member. Both crankshafts are equal and are synchronized or mounted in the same position so the movement at the ends of the two toothed member is uniform and the body thereof remains in a horizontal position above the rack at all times. The set of toothed members along with their crankshafts and remaining elements of the device are mounted on a frame that has two closing plates, which incorporate bushes for the crankshafts and bearings for a series of rollers supporting the mechanism on the rack, upon which falls the burden of supporting the weight of the system, in such a way that the driving toothed members do not suffer in this sense, since they do not support any weight. The fact that the device is supported on a set of rollers makes it possible to prevent sliding friction from building up at the point of contact of the drive mechanism, which increases efficiency in the mechanism and reduces wear in the toothed members and rollers. The one single point of friction takes place at the contact point between the rollers and pins of the rack, where the distribution of pressure is more uniform. In this sense, the operation of the device is more similar to a pinion-chain system than to a rack system.

[0009] At the ends, said frame incorporates trunnions mounted on spherical knuckle joints, on which the movable structure is supported, transmitting the weight to the mechanism, and the latter, through the supporting wheels transmits it to the fixed structure, made up in this case by a rack upon which the load moves. On the frame

of the climbing device another additional set of vertical wheels is mounted, which prevents it from rising at any given time; these wheels rest on another track installed opposite, enduring the reactions caused by the pressure angle of the toothed member contact.

Description of the figures

[0010] In order to complement the description being made, and with the aim of gaining a better understanding of the characteristics of the invention, a set of drawings is attached to this specification, wherein in an illustrative rather than limiting manner, the following has been represented:

Figure 1 shows a view in perspective of the dragging device, object of the invention.

Figure 2 corresponds to an exploded view of the device, equivalent to that of the previous figure 1.

Figure 3 represents a plan view of the same device.

[0011] Finally, figure 4 is a sectional view according to a vertical plane cut along the line indicated as A-A in the previous figure.

Preferred embodiment of the invention

[0012] As it can be seen in the referenced figures, the device for moving large movable structures is interposed within the fixed structure, which incorporates a rack on which moves the mobile structure, supported on different devices of this kind positioned at various locations conveniently distributed in accordance with the structure to move.

[0013] Each device is driven by two synchronized servomotors (1) that move the respective crankshafts (3), which are mounted on a frame formed by two closing plates (5), in which the bushes and bearings by means of which said crankshafts and various wheels or rollers (4,6) rotate, are mounted. In the crankshafts (3) a series of toothed members (2) are mounted, arranged parallel to one another and relative to the rack or forward line of the device. The teeth (8) of the toothed members (2) are configured according to the pitch of the fixed rack, so they can be mechanically coupled into it. When the two crankshafts (3), crossing them transversally, rotate, each one of the toothed members performs a movement determined by the respective eccentrics of the respective crankshafts in the coupling area of the toothed member, which present at all moments the same arrangement so the toothed member is always in the horizontal position and carries out a rotational movement about two lateral axis, which coincide with the respective crankshafts, which movement is translated longitudinally into an approximation and dragging movement of the device upon its resting onto the rack immediately followed by its separation from the rack and backwards movement to a previous position.

[0014] In the example depicted in the figures, the number of toothed members is 6, which is the number that was considered to be the most suitable for this solution; however, a device could be designed and constructed with a number of toothed members comprised between 3 and 9. The angular offset between the eccentrics, which coincide with each toothed member (2) of each crankshaft (3) is such that at all times at least one toothed member is coupled into the rack pushing the movable portion of the device; although sometimes there are two toothed members coupled into the rack on which the device moves, in such a way that there is a high number of teeth in gear with the rack

[0015] As it has already been mentioned, the set of toothed members (2) and crankshafts (3) is mounted on a frame having two closing plates (5) in which the bushes for the two crankshafts (3) are mounted. Between said plates (5), on a number of bearings, two rollers or crenelated wheels (4) are mounted, by means of which the device is supported on the rack, in such a way that those rollers are the ones supporting the weight of the movable structure instead of the toothed members that only assumes the displacement function so their teeth are not subject to a high stress.

[0016] Likewise, between the plates (5) making up the frame of the device, two trunnions (6) are mounted at both ends, by means of bearings or spherical knuckle joints. The purpose of these trunnions is to support the movable structure, which transmits its weight at these points to the frame and the latter through the supporting wheels (4) to the fixed structure through the rack with which is provided.

[0017] As it can be appreciated in the figures, the device is completed by the respective bushes on which a series of vertical wheels (7) are mounted, which rest on a track located opposite. The purpose of these wheels is to avoid the device from rising for any reason whatsoever.

[0018] Once the nature of the invention and a preferred embodiment thereof have been sufficiently described, it is noted for pertinent purposes that the materials, shape, size and arrangement of the elements described may be modified provided that this does not involve an alteration of the essential characteristics of the invention claimed below:

Claims

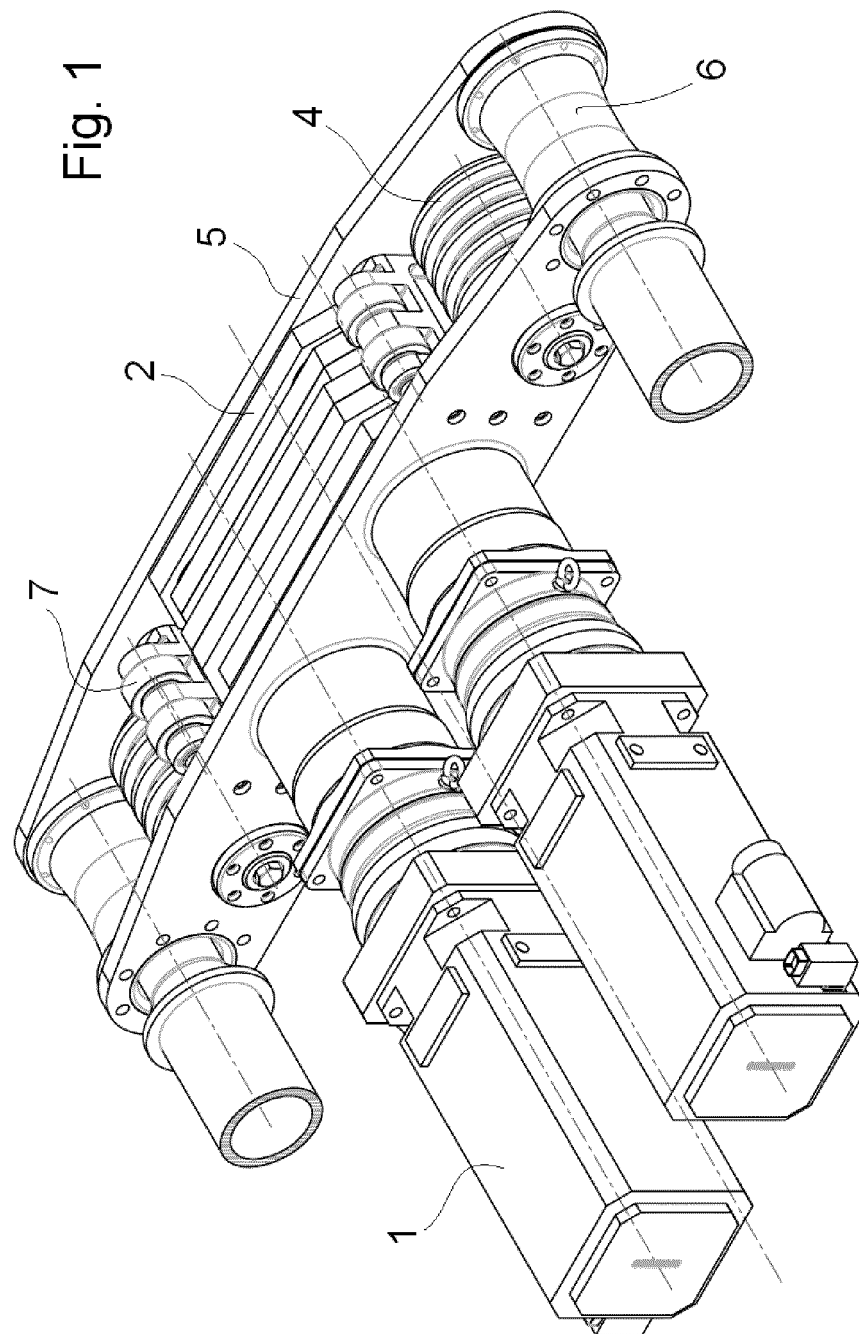
1. Climbing device for moving large movable structures of the type having a fixed rack, on which the dragging mechanism supporting the movable structure moves, said mechanism being located at various points conveniently distributed in accordance with the structure to move, each one of which is driven by one or two synchronized servomotors, **characterized in that** said device is constituted by a series of toothed members (2), parallel to one another and

relative to the rack, whose teeth (8) are configured according to the pitch of the fixed rack so they can couple themselves mechanically into it; each one of said toothed members is mounted in two equal crankshafts (3), which cross them transversally and rotate, in unison and in synchrony, in end bushes, performing a rotational movement in which the two eccentrics, corresponding to each toothed member, have the same arrangement at all times so the toothed member is always in the horizontal position, carrying out a rotational movement about two lateral axis, which coincide with the respective crankshafts, which movement is translated longitudinally into an approximation and dragging movement of the device upon its resting onto the rack immediately followed by its separation from the rack and backwards movement to a previous position.

2. Device, according to claim 1, **characterized in that** the number of toothed members is comprised between 3 and 9, whereas the angular offset between the eccentrics that coincide with each toothed member (2), of each crankshaft (3), is such that at all moments at least one toothed member is coupled in the rack pushing the movable portion of the device.
3. Device, according to the previous claims, **characterized in that** the set of toothed members (2) and crankshafts (3) is mounted on a frame presenting two closing plates (5) in which the bushes for the two crankshafts (3) are mounted, as well as bearings for at least two rollers (4), through which the device is supported on the rack, falling upon them the burden of supporting the weight of the movable structure.
4. Device, according to the previous claims, **characterized in that** the frame (5) has at its ends, respective trunnions (6), mounted in bearings or circular knuckle joints, on which the movable structure is supported, thus transmitting the weight to the rotary rollers (4) and the latter to the fixed structure through the rack with which is provided.
5. Device, according to the previous claims, **characterized in that** the frame (5) incorporates at least a couple of vertical wheels (7) that rest on a track located opposite, wheels which prevent the device from rising at any given time.

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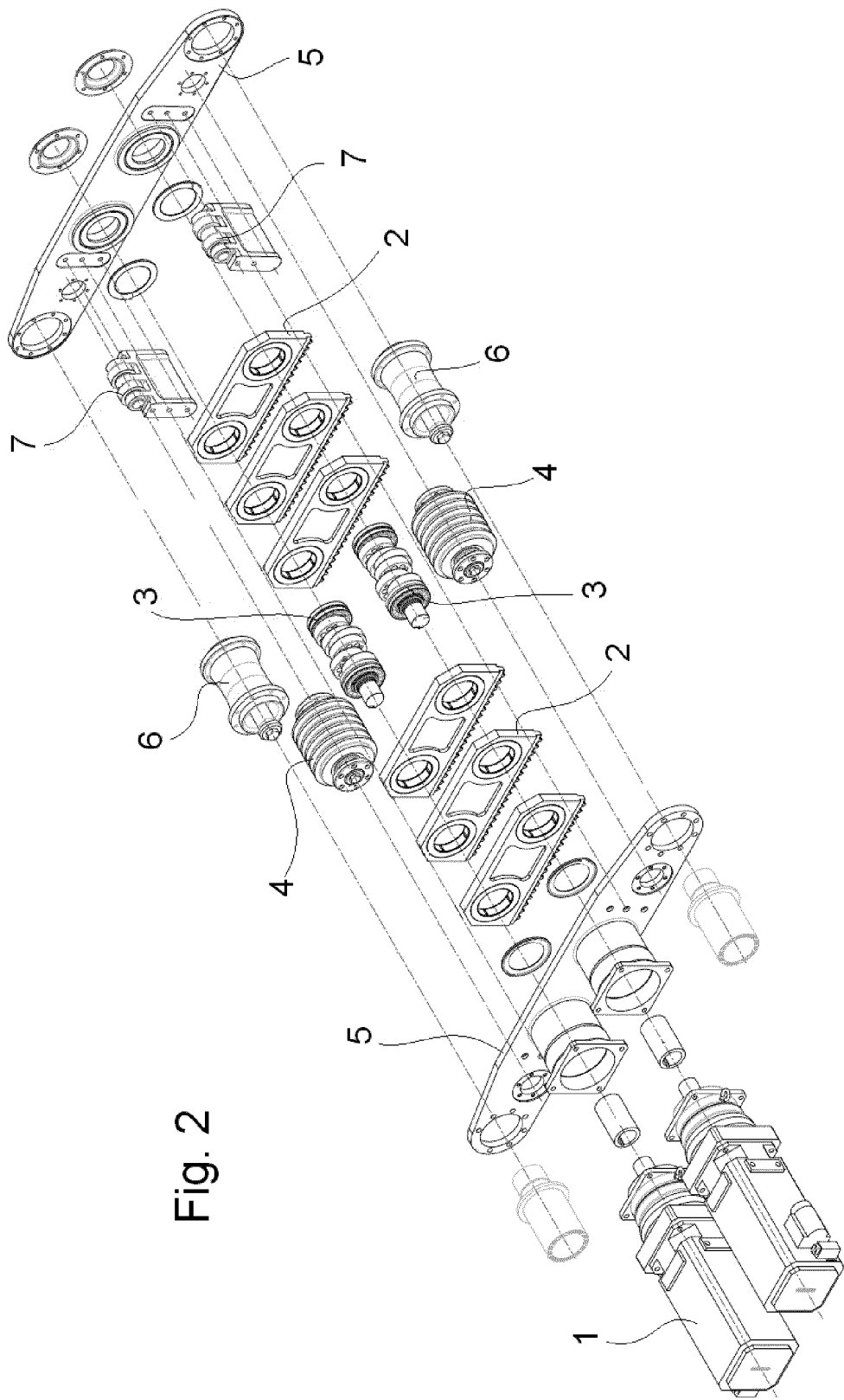


Fig. 2

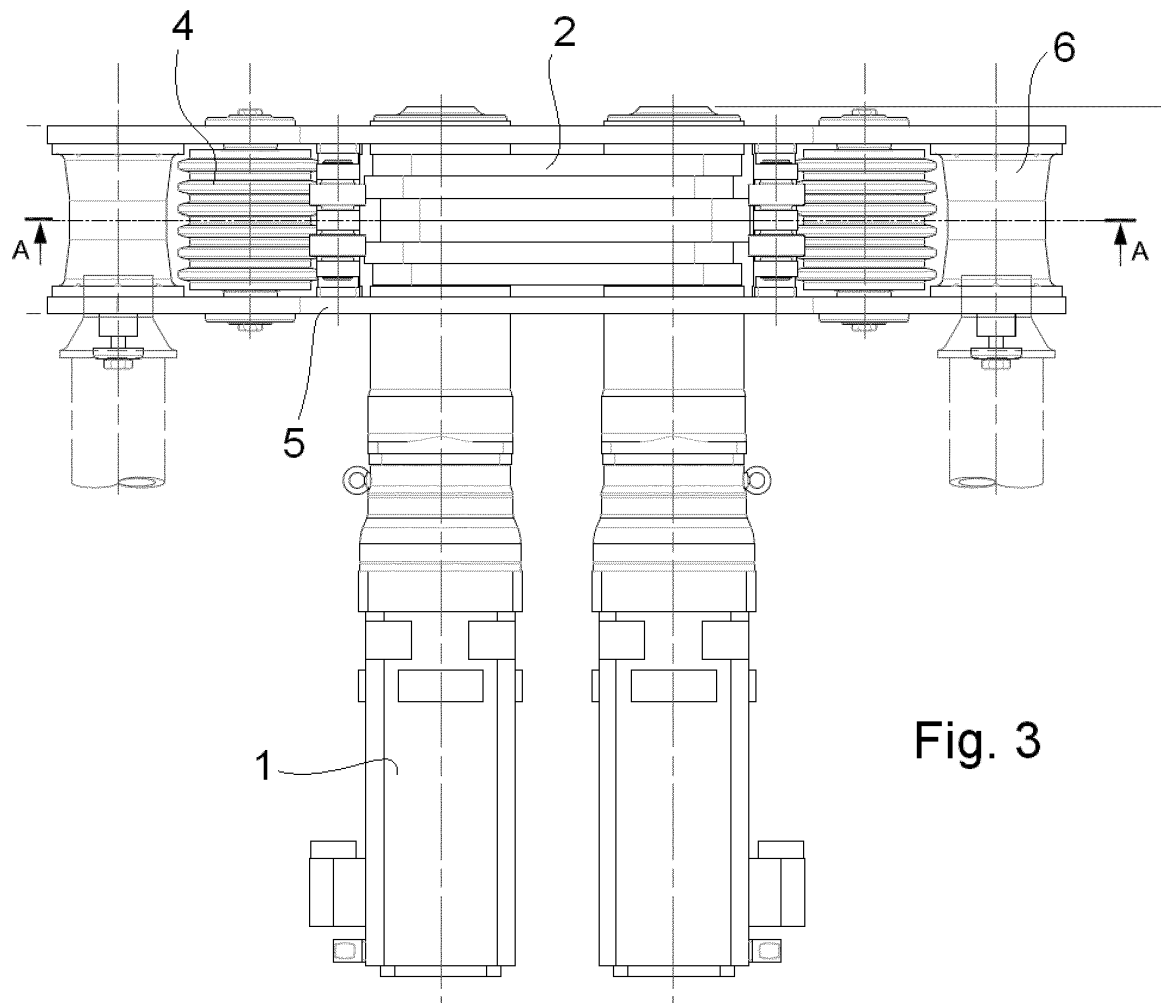
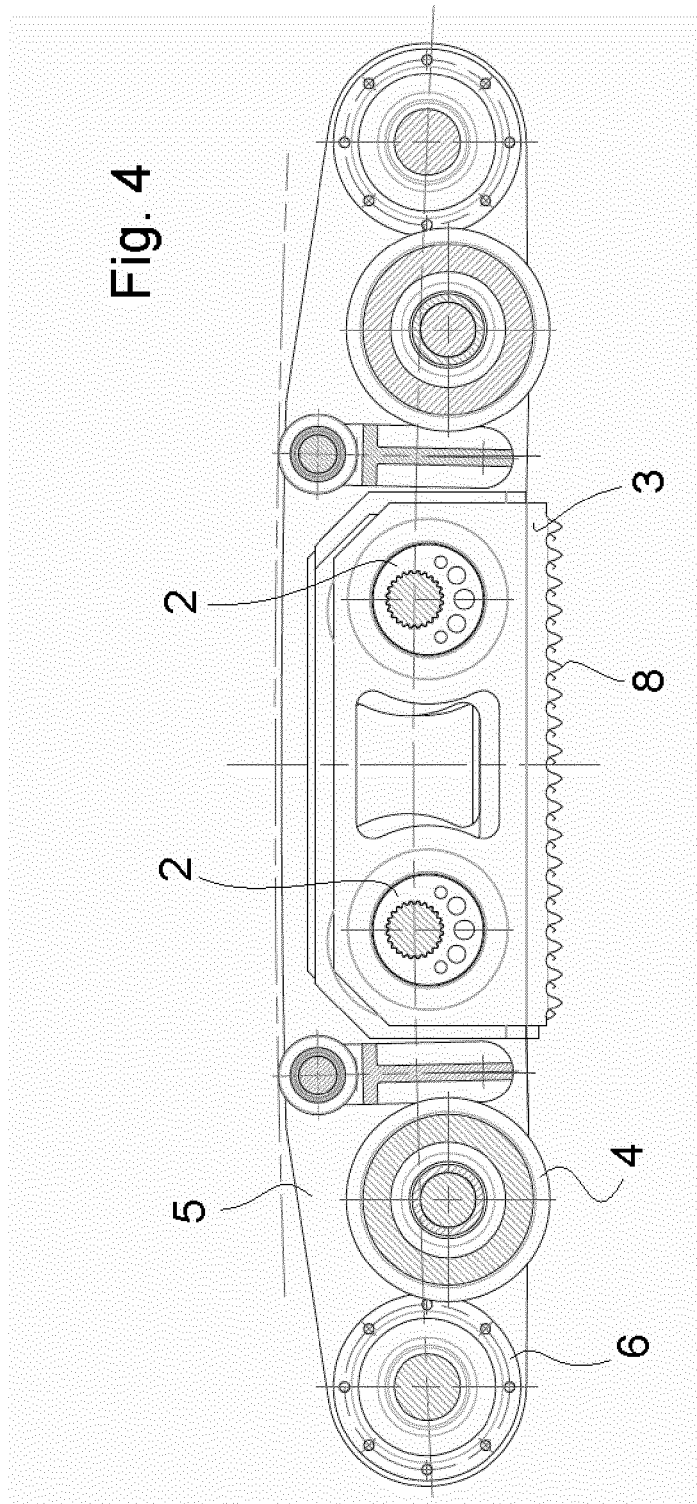


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2011/070568

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

B66B, B66F, F16H

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 practicable, search terms used)

EPODOC, INVENES, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9711290 A2 (LINGEN PAUL) 27.03.1997, pages 10-11; figure 1.	1-5
A	DE 3939762 A1 (BOECKER ALBERT GMBH & CO KG) 06.06.1991, column 2, line 62 – column 3, line 63; figures.	1-5
A	GB 2130682 A (WICKHAM & CO LIMITED D) 06.06.1984, page 2, line 73 – page 3, line 101; figures.	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance.	
"E" earlier document but published on or after the international filing date	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"O" document referring to an oral disclosure use, exhibition, or other means.	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents, such combination being obvious to a person skilled in the art
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search
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Form PCT/ISA/210 (second sheet) (July 2009)

EP 2 740 701 A1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2011/070568

Information on patent family members

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WO9711290 A	27.03.1997	DE19534647 A	20.03.1997
----- DE3939762 A	----- 06.06.1991	----- NONE	-----
----- GB2130682 AB	----- 06.06.1984	----- NONE	-----
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Form PCT/ISA/210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2011/070568

CLASSIFICATION OF SUBJECT MATTER

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B66F3/02 (2006.01)

F16H19/00 (2006.01)