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(54) Title: KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM

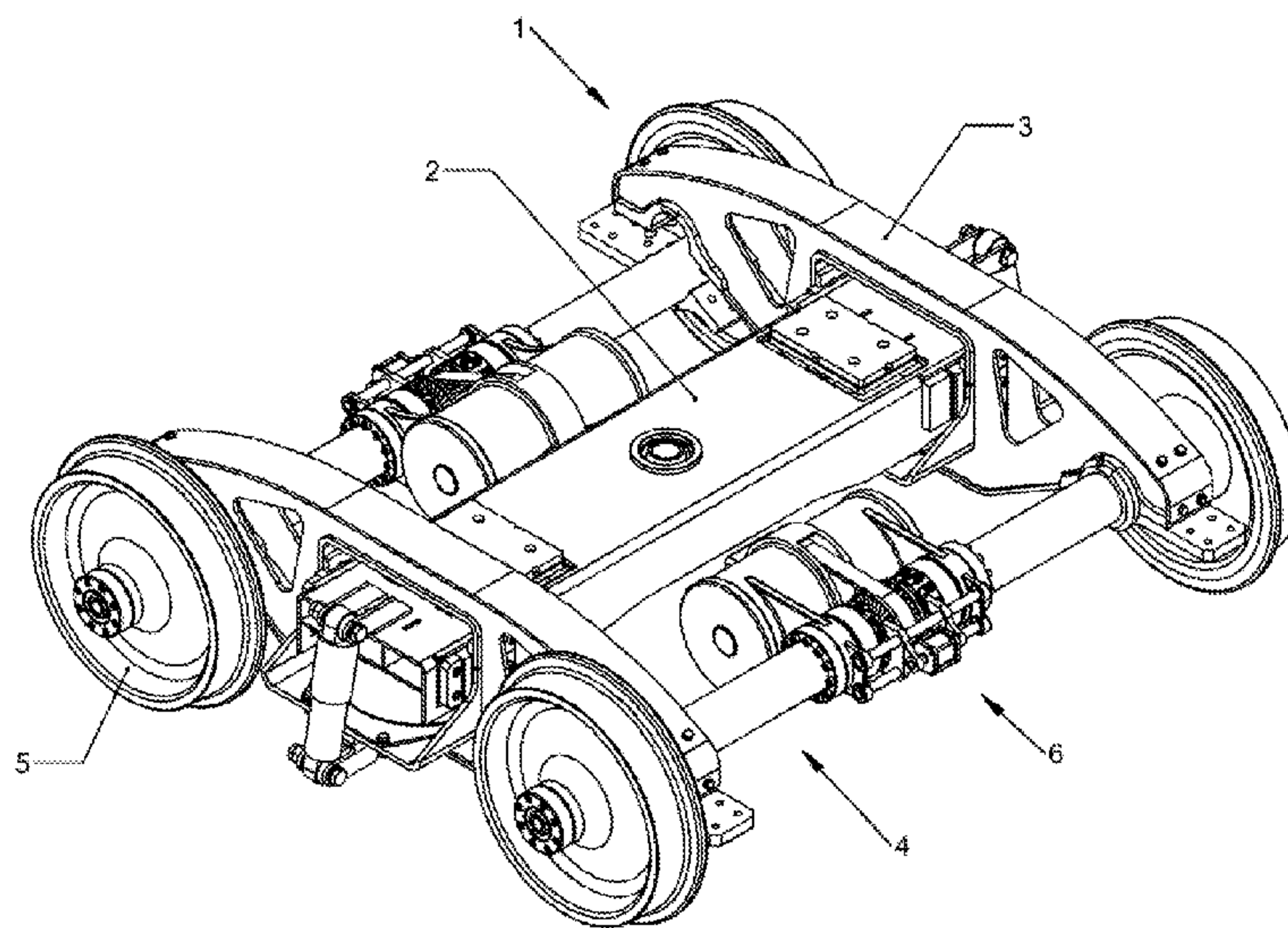


FIG.1

(57) Abstract: The kinetic energy converter is coupled to a bogie of a pneumatic propulsion vehicle for a transportation system of passengers and cargo. The kinetic energy converter (6) is mounted in at least one of the axle sets (4) of the bogie structure (1). The kinetic energy converter (6) is comprised of an electric generator provided with a housing (10) where an electric generator rotor (16) spins, provided with a rotor pulley (15) moved by a belt (11) driven by a freewheel pulley (14) mounted on a drive shaft (13) provided with shaft ends (25) which are mounted onto wheel hubs (24) of the bogie structure (1). The axle set (4) is comprised of guide tubes (7) whose internal ends have flanges (8) which are connected to the supports (9) of the electric generator housing (10).

[Continued on next page]

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KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM

FIELD OF THE INVENTION

[001] This invention refers to a kinetic energy converter which is coupled
5 to a bogie of a pneumatic propulsion vehicle for passengers and cargo with
the purpose of converting kinetic energy of the wheels into rotational
movement in order to preferably generate electric energy to power-up
onboard utilities or, alternatively, to be coupled directly to any other
mechanical rotating machine, such as air conditioning compressors, air
10 compressors, hydraulic pumps and other.

BACKGROUND OF THE INVENTION

[002] The Brazilian patent certificate PI 9912112-3 and its corresponding
US 6,213,026 describe a transportation system for passengers and cargo
whose vehicles are pneumatically propelled onto a guideway by means of
15 a propulsion plate inside the air duct, which is defined by the guideway itself
comprising the vehicle movement alignment.

[003] The pneumatically propelled vehicles are provided with bogies
containing preferably two axles, each one with two metallic wheels which
roll on rails fastened onto the guideway. At least one of the axles is
20 connected to a pylon faced downwards and bolted to a propulsion plate
which has an area equivalent to the air duct inner cross-section, being the
referred plate responsible by the conversion of the air flow thrust into
mechanical work in order to move the vehicles along the rails of the special
elevated guideway.

25 [004] The elevated guideway superstructure is mounted on the vertical
piers having a primary function of supporting and steering the vehicles, and
a not less important secondary function of forming in its interior the
propulsion duct. Therefore, the elevated guideway is responsible for
creating the physical means of support and guidance for the vehicle
30 movement, as well as the means of channeling the air flow generated by

stationary power propulsion units positioned in rooms distributed along the vehicle trackway.

[005] Each power propulsion unit installed into the passenger stations is integrated by a heavy-duty industrial blower and a set of air flow control and direction valves, which are responsible for increasing or decreasing the pressure within the duct created by the superstructure beams.

[006] The pneumatic transportation system operates according to the principle of guideway segmentation into multiple different sections, defining dedicated propulsion circuits and, thus, exclusive and independent automatic control blocks for each vehicle. Therefore, the advance of a specific vehicle into the next control block is only allowed if it is unoccupied.

[007] The referred pneumatic transportation system of the prior art requires a sizeable amount of electric power supply for the vehicle onboard utilities, including air conditioning, controls, lighting, communications, doors etc.

BRIEF DESCRIPTION OF THE INVENTION

[008] The kinetic energy converter for bogies of pneumatic propulsion vehicles for passengers and cargo object of this invention is capable of transforming kinetic energy of the rotating wheels preferably into electric energy using an electric generator as a mean to feed onboard utilities or, alternatively, to drive any other mechanical device directly related to the vehicle. The converter can operate full-time complementing, or even entirely replacing, a conventional power supply system based on current collector shoes and power rails or pantographs and overhead wires (catenary), combined with energy accumulators such as battery packs.

[009] When the kinetic energy converter is used part-time, it can function as a regenerative system in descending grades and during vehicle braking. The energy converter can be conveniently coupled and uncoupled to the bogie axles by a special clutch system. At least one axle can be equipped with its own energy converter with independent operation monitored and

commanded by the vehicle onboard control system.

[010] The kinetic energy converter for the pneumatic propulsion vehicle object of this invention results on the following advantages:

- Increase in the energy efficiency for propulsion of pneumatic propulsion vehicles;
- It can be used full-time or part-time, since it is provided with a mechanism with a clutch which allows to couple and uncouple the converter drive shaft;
- Wear reduction of the energy collectors (shoes or pantographs) and external conductors (power rail bus or overhead wire), or even the complete elimination of those subsystems, which would result in a substantial reduction of the capital and operational expenditures.
- When directly driving a mechanical machine — such as an air conditioning compressor, which demands most of the energy provided onboard — it has the potential to allow the transportation system operation to continue in case of an external power supply unavailability, since the remaining electrical loads can be easily fed by the vehicle own emergency batteries for a certain amount of time, or even indefinitely, when periodically recharged at stations during the dwell time.

BRIEF DESCRIPTION OF THE DRAWINGS

[011] For the kinetic energy converter for pneumatic propulsion vehicle of this invention to be completely understood and taken to practice by any multidisciplinary group of technician of this technological sector, it is clearly and sufficiently described based on the attached drawings listed below:

FIG. 1 – view of the bogie separated from the pneumatic propulsion vehicle and with the kinetic energy converter installed;

FIG. 2 – view of the kinetic energy converter separated from the vehicle bogie;

FIG. 3 – view of the mechanism which comprises the kinetic energy converter;

FIG. 4 – exploded view of the kinetic energy converter mechanism;

FIG. 5A – frontal view of the coupled kinetic energy converter mechanism.

FIG.5B – detail of FIG.5A.

FIG.6A – frontal view of the uncoupled kinetic energy converter
5 mechanism.

FIG.6B – detail of FIG.6A.

DETAILED DESCRIPTION OF THE INVENTION

[012] Fig. 1 illustrates the bogie of the pneumatic propulsion vehicle which encompasses a bogie structure (1) formed by a bolster (2) and side frames
10 (3). In the side frames (3), preferably, two axle sets (4) are mounted into bearings, each one having two metallic wheels (5) which roll on rails fastened onto the guideway (not illustrated). In at least one of the axle sets (4) of the bogie structure (1), a kinetic energy converter (6) is mounted.

[013] Fig. 2 details the kinetic energy converter (6) which encompasses an
15 electric energy generator installed on the axle set (4). The axle set (4) is comprised by guide tubes (7) whose external ends are connected in the side frames (3) of the bogie structure (1) (illustrated in the Fig. 1) and the internal ends have flanges (8) which are connected with the supports (9) of the electric generator housing (10). The electric generator shaft is
20 supported by bearings which are in turn supported in the housing (10) and moved by a belt (11), preferably a synchronous belt.

[014] In a preferred embodiment, the supports (9) of the electric generator housing (10) hold side clutches (12) which transmit torque to a center freewheel pulley (14) (illustrated in the Fig. 3 and 4) and a belt (11).

25 [015] Fig. 3 and 4 detail the kinetic energy converter (6) which is driven by a drive shaft (13) provided with shaft ends (25) where the wheel hub (24) is mounted. In the drive shaft (13), a freewheel pulley (14) with a belt (11) is positioned to transmit the rotational movement to the rotor pulley (15) of the electric generator rotor (16). Two rings (22) are positioned at each side
30 of the freewheel pulley (14) preventing its lateral displacement, and a spline

(23) is put on the center of the drive shaft (13) to gear the belt system.

[016] Returning to the Fig. 2, it is presented a preferential actuation form of the side clutches (12) which occurs by means of commanding an electrical, hydraulic or pneumatic actuator (17), which uncouples the kinetic energy converter whenever needed. To accomplish that, the electric generator housing (10) supports (9) have retractors (18) which are interconnected by sliding guides (19) where the clutch supports (20) slide. When the actuator (17) is commanded to extend, a lateral displacement of the clutch supports (20) occurs guided by the sliding guides (19), disengaging the side clutches (12) by moving them away from the drive shaft (13) splines (23), ceasing the spin of the freewheel pulley (14), hence interrupting the torque transmission to the rotor pulley (15) of the electric generator rotor (16).

[017] This device allows the part-time use of kinetic energy converter (6) to function as a regenerative system, for instance, during descending grades and breaking.

[018] Fig. 5A and Fig. 5B show the kinetic energy converter at the coupled position, while the Fig. 6A and Fig. 6B show the kinetic energy converter at the uncoupled position. When the actuator (17) is pressurized/powerd, the clutch supports (20) move away from the freewheel pulley (14) releasing it by clearing the side clutches (12) from the drive shaft (13) spline (23). The drive shaft (13) is covered by the guide tubes (7).

CLAIMS

1. **A KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** installed in a bogie of a pneumatic propulsion vehicle having a bogie structure (1) formed by a bolster (2) and side frames (3) and at least two axle sets (4), each axle set (4) having two metallic wheels (5) which roll on rails fastened onto a vehicle guideway, said kinetic energy converter (6) comprising:

an electric generator provided with a housing (10) within which a rotor spins, said rotor provided with a rotor pulley (15) which is moved by a belt (11) and driven by a freewheel pulley (14) mounted on a drive shaft (13) provided with shaft ends (25) wherein wheel hubs (24) of the bogie structure (1) are mounted.

2. **THE KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** of claim 1, wherein

the axle set (4) comprises guide tubes (7) having external and internal ends, said external ends connected to the side frames (3) of the bogie structure (1) and said internal ends having flanges (8) which are connected with supports (9) of the electric generator housing (10).

3. **THE KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** of claim 2 wherein

the axle set (4) is provided with side clutches (12) which actuate on the splines (23) and on the freewheel pulley (14), interrupting or transmitting torque to the belt (11) of the electric generator rotor (16).

4. **THE KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** of claim 3 wherein,

the side clutches (12) are laterally displaced by an electrical, hydraulic or pneumatic actuator (17) which allows to uncouple the kinetic energy converter (6).

5. **KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** of claim 3, wherein,

the supports (9) of the electric generator housing (10) are provided with retractors (18) which are interconnected by sliding guides (19) where the clutch supports (20) slide.

6. **A PNEUMATIC PROPULSION VEHICLE FOR PASSENGERS**

5 **AND CARGO** comprising:

at least one kinetic energy converter according to claim 1, wherein said kinetic energy converter (6) is coupled to an onboard utility on said pneumatic propulsion vehicle or directly to the inboard machine.

AMENDED CLAIMS

received by the International Bureau on 28 May 2021 (28.05.2021)

1. **A KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** installed in a bogie of a pneumatic propulsion vehicle having a bogie structure (1) formed by a bolster (2) and side frames (3) and at least two axle sets (4), each axle set (4) having two metallic wheels (5) which roll on rails fastened onto a vehicle guideway, said kinetic energy converter (6) comprising:

an electric generator provided with a housing (10) within which a rotor spins, said rotor provided with a rotor pulley (15) which is moved by a belt (11) and driven by a freewheel pulley (14) mounted on a drive shaft (13) provided with shaft ends (25) wherein wheel hubs (24) of the bogie structure (1) are mounted;

the axle set (4) comprises guide tubes (7) having external and internal ends, said external ends connected to the side frames (3) of the bogie structure (1) and said internal ends having flanges (8) which are connected with supports (9) of the electric generator housing (10);

the axle set (4) is provided with side clutches (12) which actuate on the splines (23) and on the freewheel pulley (14), interrupting or transmitting torque to the belt (11) of the electric generator rotor (16).

2. **THE KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** of claim 3 wherein,

the side clutches (12) are laterally displaced by an electrical, hydraulic or pneumatic actuator (17) which allows to uncouple the kinetic energy converter (6).

3. **THE KINETIC ENERGY CONVERTER FOR A PNEUMATIC TRANSPORTATION SYSTEM** of claim 3, wherein,

the supports (9) of the electric generator housing (10) are provided with retractors (18) which are interconnected by sliding guides (19) where the clutch supports (20) slide.

4. **A PNEUMATIC PROPULSION VEHICLE FOR PASSENGERS**

AND CARGO comprising:

at least one kinetic energy converter according to claim 1, wherein said kinetic energy converter (6) is coupled to an onboard utility on said pneumatic propulsion vehicle or directly to the inboard machine.

5

DECLARATION IN ACCORDANCE WITH THE ARTICLE 19

In accordance with the article 19, it is attached new claims, in which is described the axis is connected to the energy generator. Besides, it is easily installed and disassembled due to its constructiveness and presents a better enjoyment from the rotation movement to the energy conversion. The presented modification does not add new subject to the original claimed.

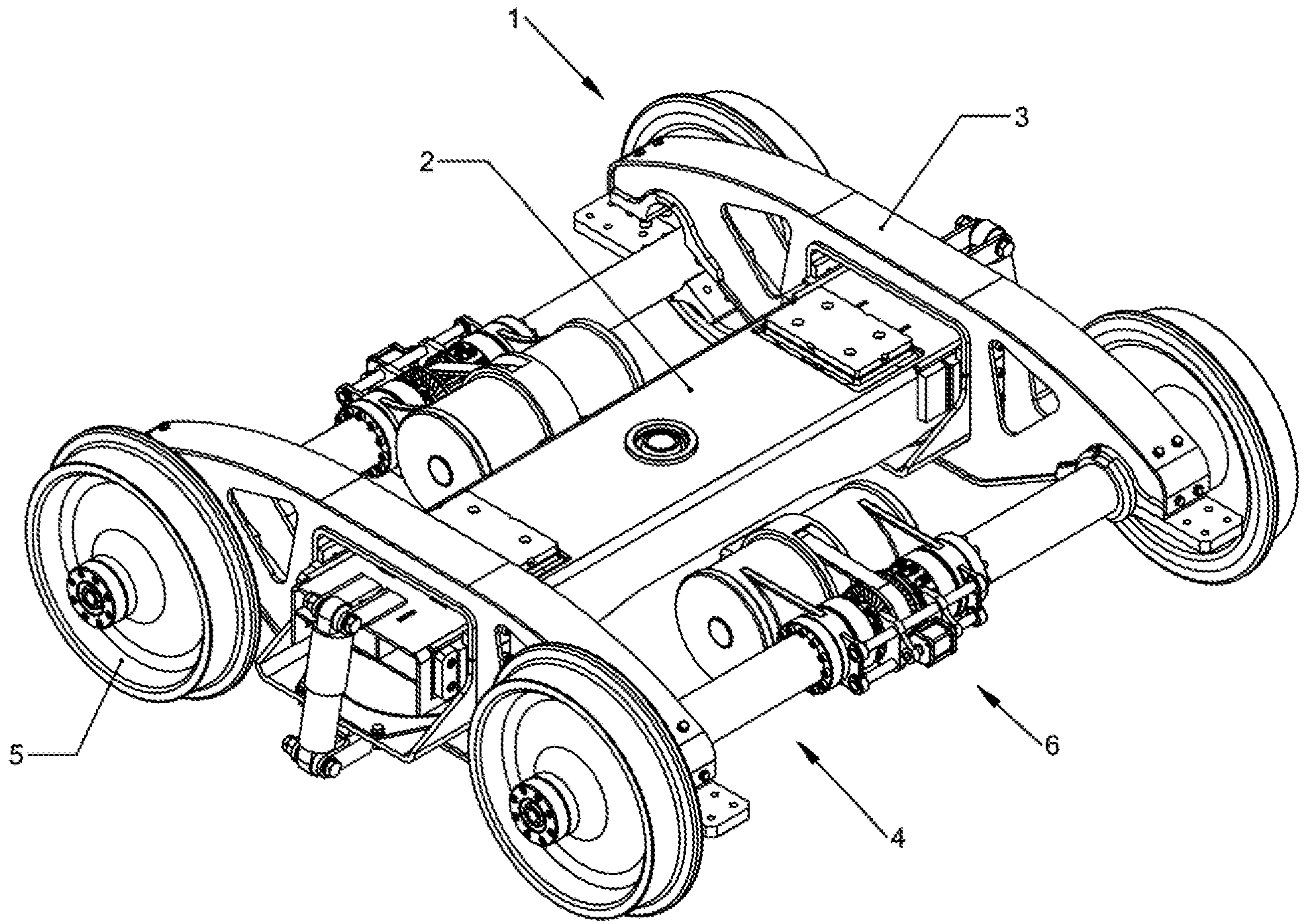


FIG.1

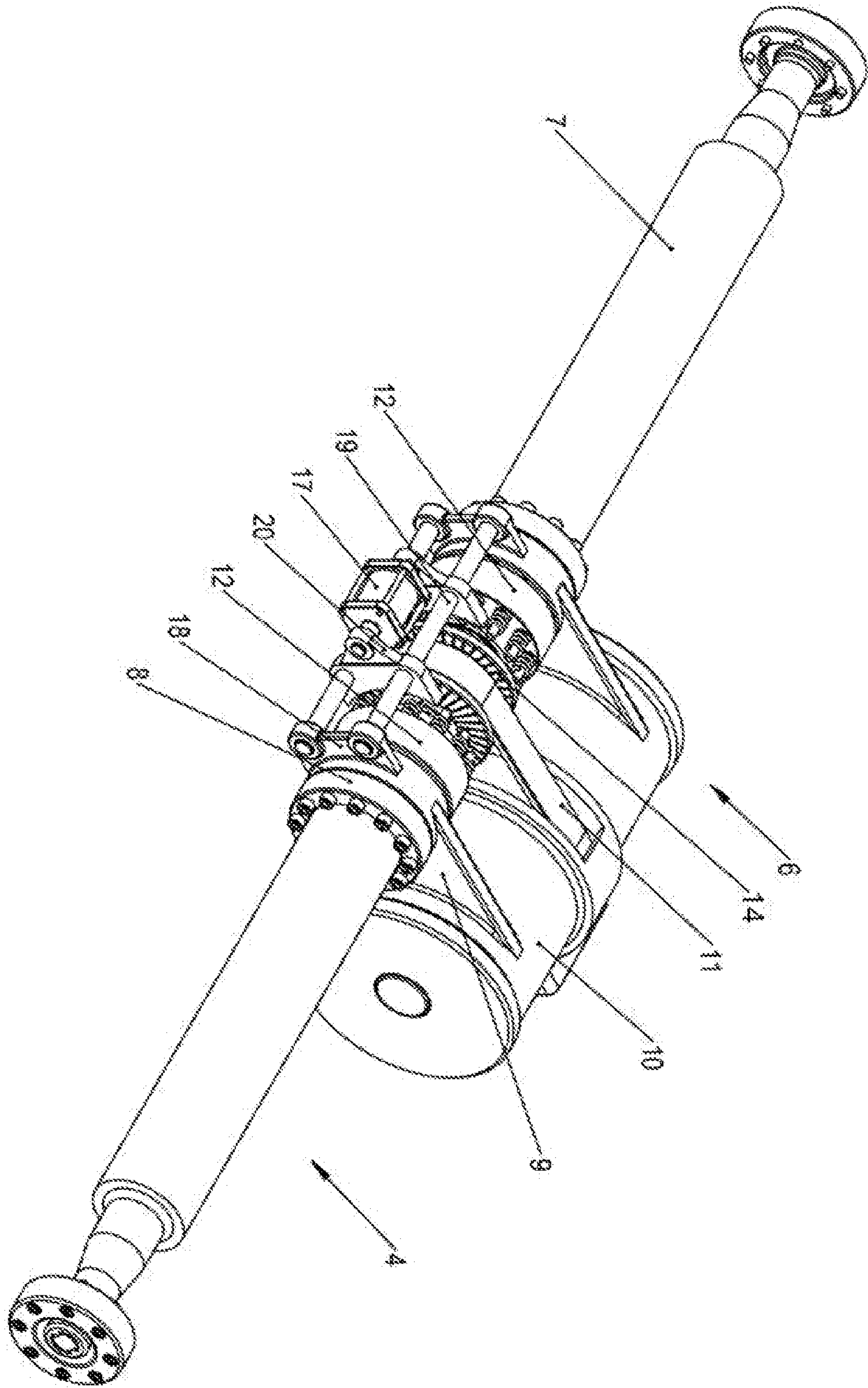


FIG.2

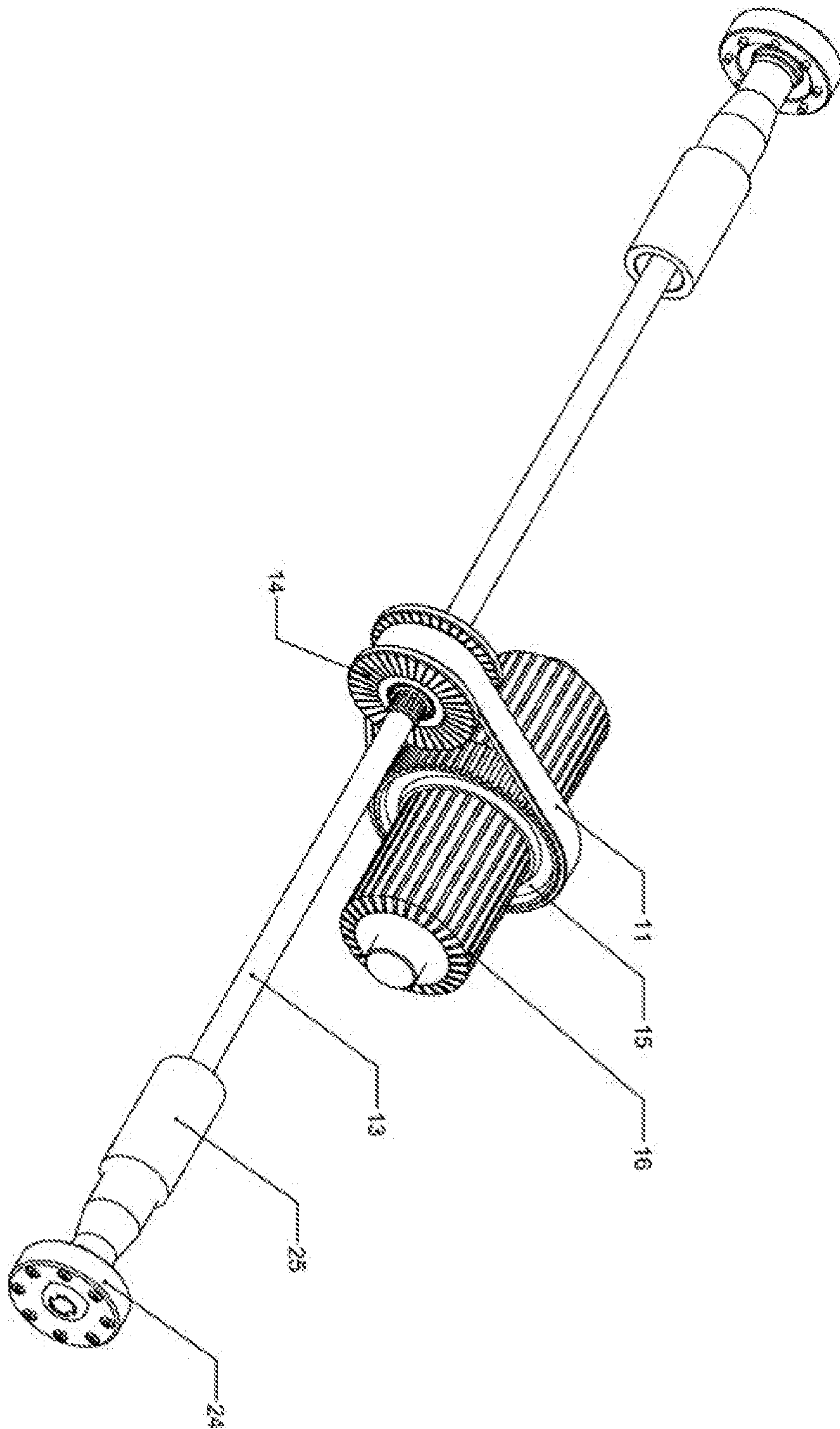


Fig. 3

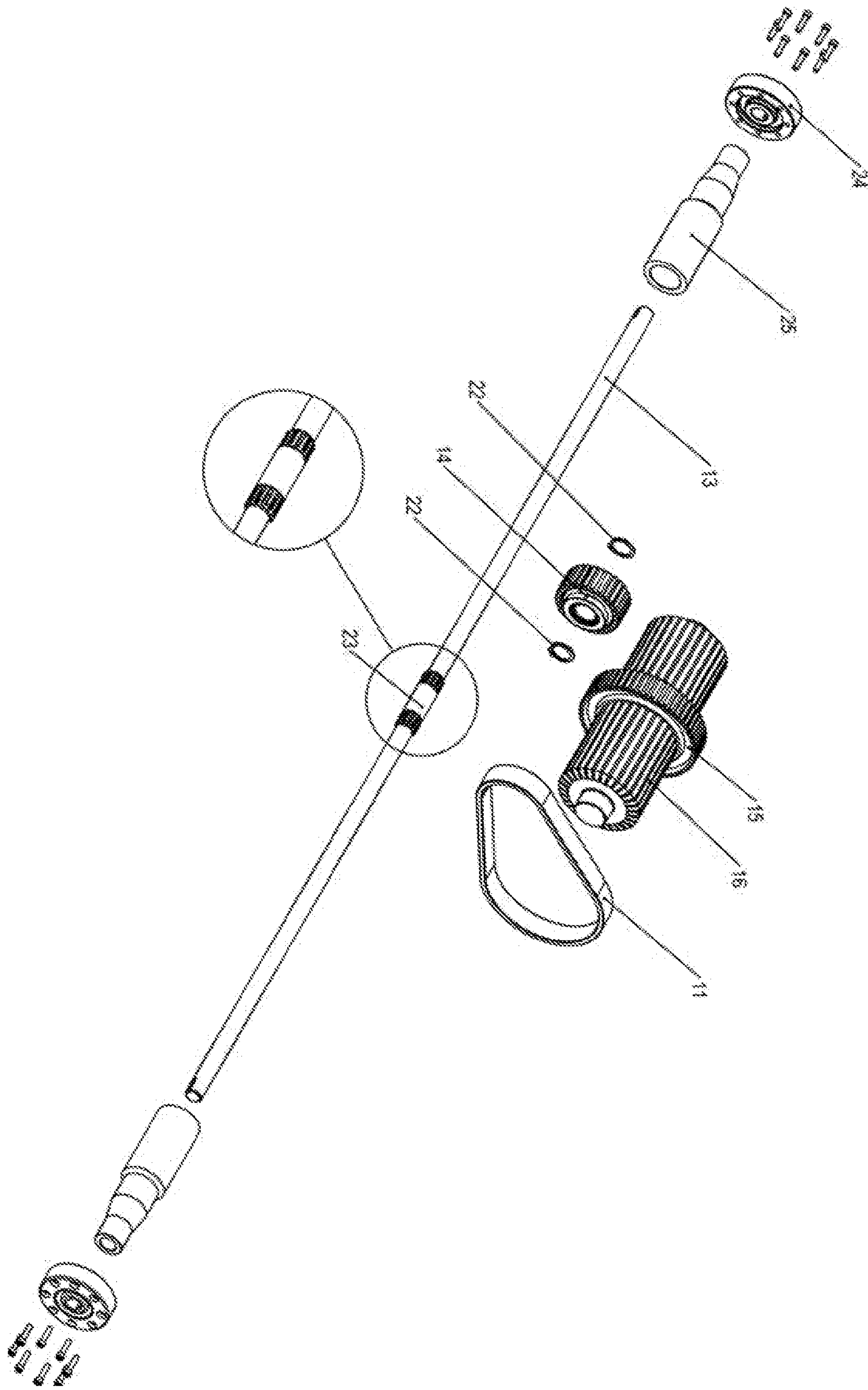


Fig. 4

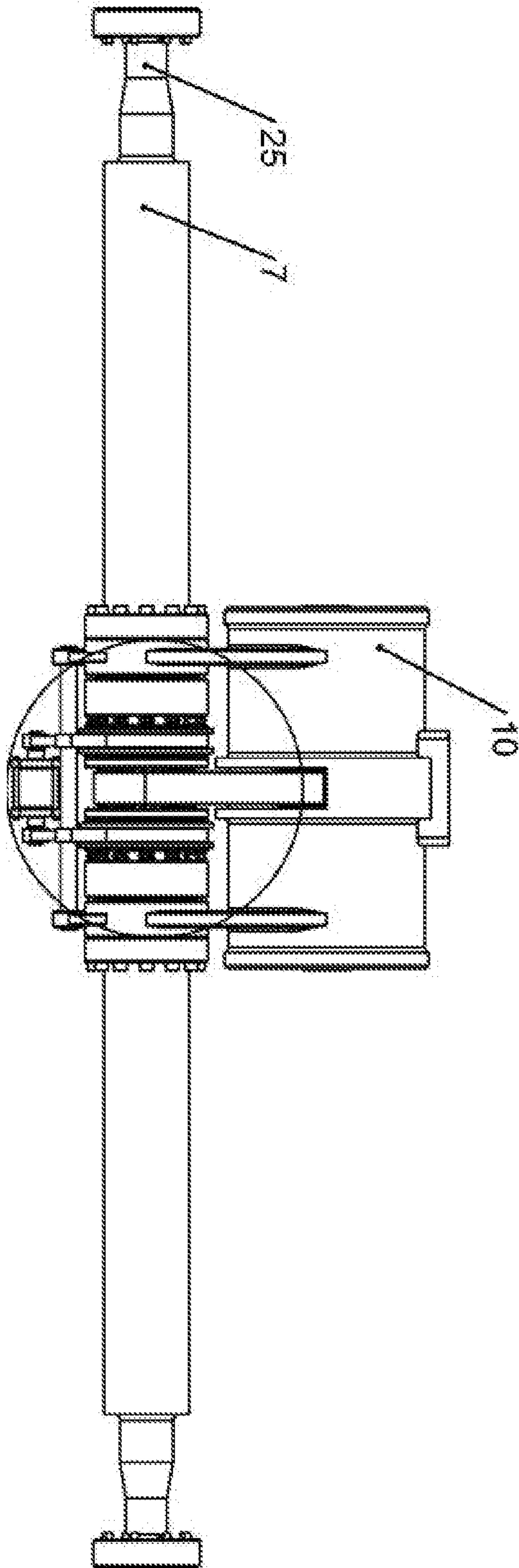


Fig. 5A

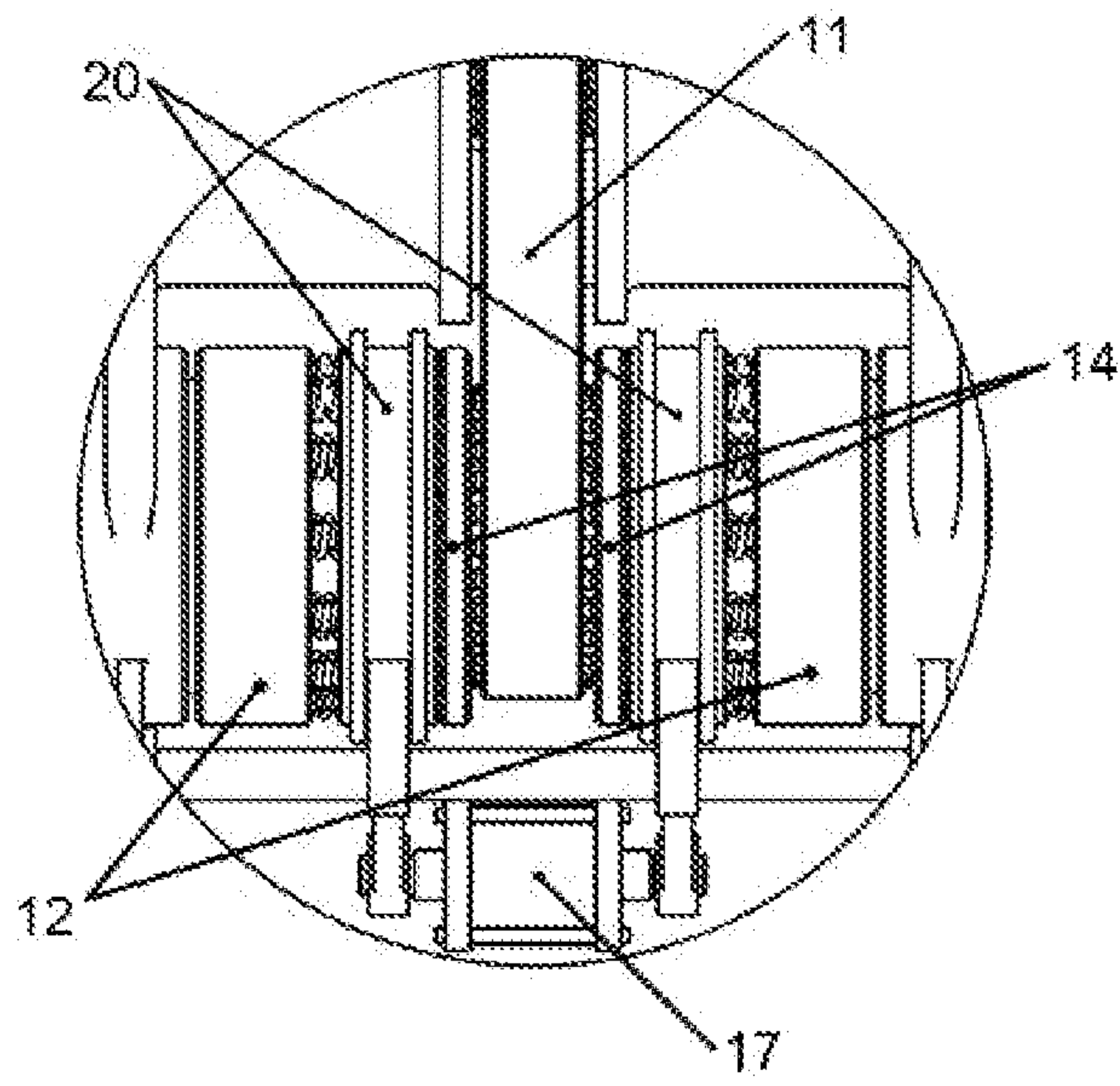


Fig. 5B

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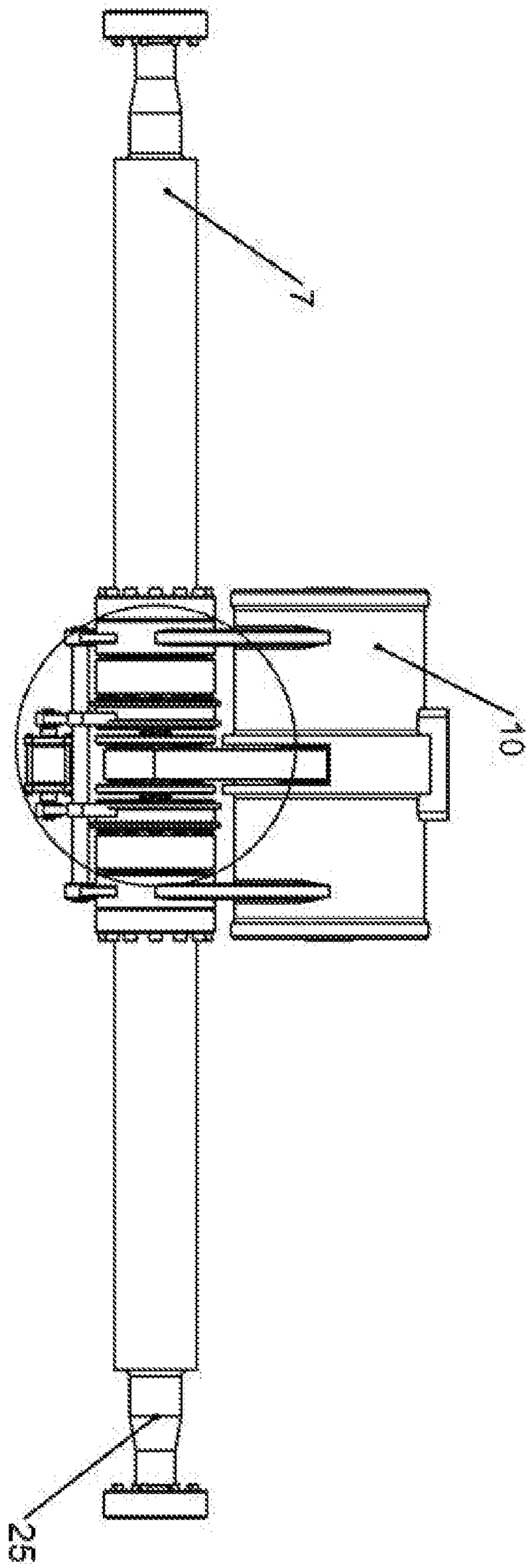


Fig. 6A

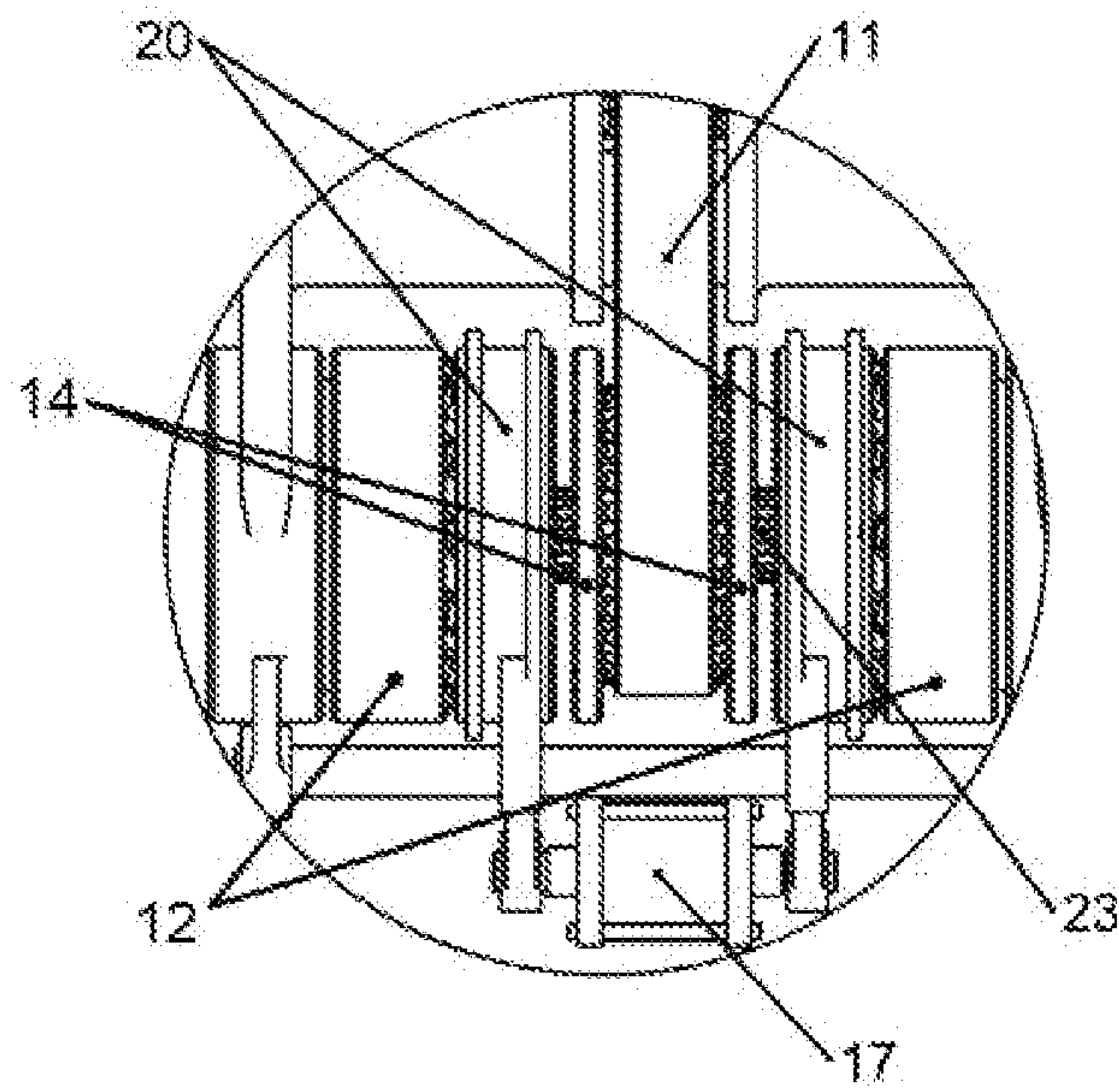


Fig. 6B

A. CLASSIFICATION OF SUBJECT MATTER

B61B13/12 (2006.01), B61D43/00 (2006.01), B61H9/06 (2006.01)

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)

B61B, B61D, B61H

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

Brazilian Patent Office Data Base - INPI/BR

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

Epodoc, Derwent Innovation Index

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claims N°
X	US 4285279 A (CHIAPPETTI ARTHUR B) 25 August 1981 (1981-08-25) *the whole document*	1 – 6
Y	BR 9912112 A (AEROMOVEL USA INC [US]) 02 May 2001 (2001-05-02) *the whole document*	1 – 6
Y	WO 2017017627 A1 (VENTER FRANCOIS [ZA]) 02 February 2017 (2017-02-02) *the whole document*	1 – 6
A	EP 2829727 A1 (IVECO FRANCE SA [FR]) 28 January 2015 (2015-01-28)	1 – 6

 Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search

23/03/2021

Date of mailing of the international search report

30/03/2021

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claims N°
A	EP 3279054 A1 (SRT SOCIETA A RESPONSABILITA LIMITATA CON UNICO SOCIO [IT]) 07 February 2018 (2018-02-07)	1 – 6
A	US 3722424 A (VELDHUIZEN J [US]) 27 March 1973 (1973-03-27)	1 – 6
A	US 4587906 A (COESTER OSKAR H W [BR]) 13 May 1986 (1986-05-13)	1 – 6
A	US 4658732 A (COESTER OSKAR H W [BR]) 21 April 1987 (1987-04-21)	1 – 6

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application N°
PCT/BR2020/050634

Patent documents cited in search report	Publication date	Patent family members	Publication date
US 4285279 A	1981-08-25	None	
-----	-----	-----	-----
BR 9912112 A	2001-05-02	BR 9912112 B1	2013-07-02
		US 6213026 B1	2001-04-10
		WO 0003891 A1	2000-01-27
-----	-----	-----	-----
WO 2017017627 A1	2017-02-02	None	
-----	-----	-----	-----
EP 2829727 A1	2015-01-28	EP 2829727 B1	2018-09-05
		ES 2696603 T3	2019-01-17
-----	-----	-----	-----
EP 3279054 A1	2018-02-07	IT 201600082605 A1	2018-02-04
-----	-----	-----	-----
US 3722424 A	1973-03-27	None	
-----	-----	-----	-----
US 4587906 A	1986-05-13	BR 7906255 A	1980-08-26
-----	-----	-----	-----
US 4658732 A	1987-04-21	BR 8301706 A	1984-11-13
		DE 3412708 A1	1985-03-28
		JP S6012372 A	1985-01-22
		JP S6357268 B2	1988-11-10
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