

(19)



(11)

**EP 2 977 289 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**27.01.2016 Bulletin 2016/04**

(51) Int Cl.:  
**B61G 11/16 (2006.01)**

(21) Application number: **14003502.3**

(22) Date of filing: **13.10.2014**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB  
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO  
PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

- **Hedström, Anders**  
**781 90 Borlänge (SE)**
- **Westman, Anders**  
**791 35 Falun (SE)**
- **Skowronek, Jacek**  
**81-587 Gdynia (PL)**

(30) Priority: **23.07.2014 EP 14002551**

(71) Applicant: **Dellner Couplers AB**  
**791 95 Falun (SE)**

(72) Inventors:  
• **Costard, Holger**  
**79 195 Falun (SE)**

(74) Representative: **Tilmann, Max Wilhelm et al**  
**König-Szynka-Tilmann-von Renesse**  
**Patentanwälte Partnerschaft mbB**  
**Mönchenwerther Straße 11**  
**40545 Düsseldorf (DE)**

(54) **Energy dissipating device and multi-car vehicle having such an energy dissipating device**

(57) The invention relates to an energy dissipating device suitable to dissipate energy while a first part (1) of a car of a multi-car vehicle moves relative to a second part (2) of the car, the energy dissipating device comprising a first part and a second part, the first part being arranged to move relative to the second part, if a force of a predetermined magnitude is applied to the first part, the second part comprising a knife (3) that is arranged

such that they cut into a first surface (4) of the first part as the first part moves relative to the second part, wherein the first part has a second surface (5) that is separate from the first surface and arranged in such a manner that the knife cuts into the second surface after having cut the first surface, if the force is continued to be applied to the first part.

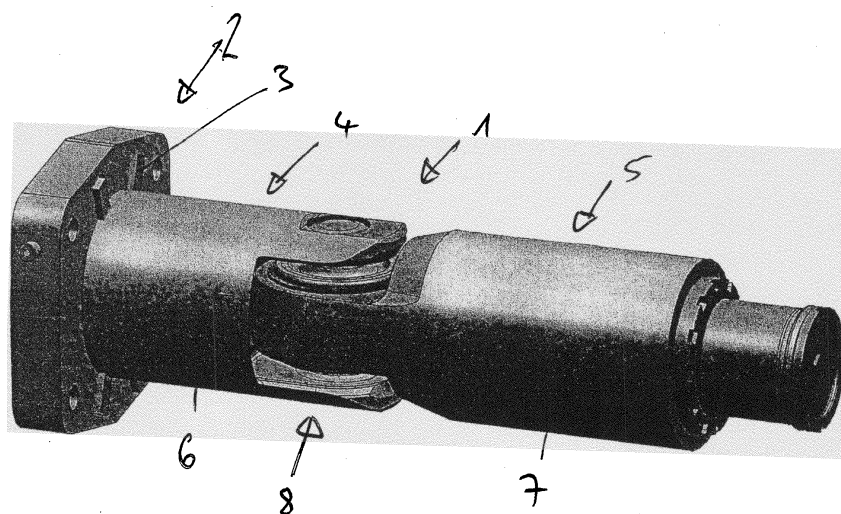


Fig. 1

**EP 2 977 289 A1**

## Description

**[0001]** The invention relates to an energy dissipating device suitable to dissipate energy while a first car of a multi-car vehicle moves relative to a second part of the car. The invention also relates to a multi-car vehicle having such an energy-dissipating device.

**[0002]** From WO 2009/072843 A2 a tube buffer for railway vehicles is known. This energy dissipating device has a first part by way of a tearing tube and a section part by way of a die. The tearing tube is arranged to move relative to the die, if a force of a predetermined magnitude is applied to the tearing tube. The die has blades that are arranged such that they cut into the inner surface of the tearing tube as the tearing tube moves relative to the die.

**[0003]** From PL 202114 B1 an energy dissipating device suitable to dissipate energy while a first part of a car of a multi-car vehicle moves relative to a second part of the car is known. This energy dissipating device has a first part of cylindrical shape that is arranged to move relative to a second part of ring shape, if a force of a predetermined magnitude is applied to the cylindrical part. The ring-shaped second part has several knives that are arranged such that they cut into the outer circumferential surface of the cylinder-shaped part as the cylinder-shaped part moves relative to the ring-shaped part.

**[0004]** Given this background, the problem to be solved by the invention is to provide an energy dissipating device that can provide better energy dissipation and/or is suitable to be arranged in different locations of a car of a multi-car vehicle.

**[0005]** This problem is solved by the subject-matter of the independent claims. Preferred embodiments are described in the subordinate claims and the description following hereafter.

**[0006]** The invention is based on the basic concept to provide a second surface on the first part that is separate from the first surface and is arranged in such a manner that the knife cuts into the second surface after having cut the first surface, if the force is continued to be applied to the first part. The invention thus provides a sequence of at least two surfaces into which the knife can cut as the force is continued to be applied to the first part. The first surface and the second surface can, for example, be separated by a recess. This embodiment will lead to a cutting-action, wherein the knife is freed from cutting as it leaves the first surface and just before it starts to cut the second surface. This can have advantages for the cutting process. Such a design allows, for example for chips or flakes created during the cutting process to be lost before the knife starts to cut the second surface.

**[0007]** The level of the predetermined force that needs to be applied to have the first part move relative to the second part can be chosen to reflect the driving conditions in which the energy dissipation should take place. For example it could be desired that the energy dissipation takes place in a crash scenario. In a typical crash

scenario in trains a force acting from one car to the next car of the order of magnitude of 400 kN, especially preferred of 800 kN and even more preferred of 1200 kN or even 1500 kN will be considered to be an appropriate force level to start destructive energy dissipation. Alternatively, it could be desired that the energy dissipation takes already place at low force levels, for example those force levels that arisen when one car is coupled to another car by way of automatic couplers and the cars have a relative speed just above the typical limit for such coupling actions.

**[0008]** In a preferred embodiment, the first part has at least for a part of its longitudinal extent the shape of a cylinder, preferably of a hollow cylinder. Although geometrical shapes of parts of the first part are feasible, for example rectangular or polygonal shapes (e.g. triangular, pentagonal, etc. cross section) providing the first part with at least for a part of its longitudinal extent with the shape of a cylinder allows for a more simple design of the first part and for the manufacturing process to be facilitated.

**[0009]** In a preferred embodiment the first part is put together of at least a first piece and a separate second piece that is attached to the first piece, whereby the first surface is arranged on the first piece and the second surface is arranged on the second piece. On the one hand, this embodiment allows for the first part to be a more complex structure that is adapted to achieve further purposes, while at the same time obtaining a high level of energy dissipation. This design allows the first part to be put together of separate elements, that can possibly be replaced after use. This design also allows the first part to be made up of pieces that have different resistance to cutting. The first part could thus be designed with a first piece of a material that is cut more easily by the knife than the material of a second piece. Thus, a stepped approach of energy dissipation can be realized, where only a little amount of energy is dissipated while cutting the first piece of the first part and a higher level of energy per distance that the first part moves relative to the second part can be realized while cutting the second piece.

**[0010]** The above mentioned embodiment of the first part being put together of at least a first piece and a separate second piece also allows to implement the invention with devices, whereby the first piece is connected to the second piece by means of a joint. A first car and a second car of a multi-car vehicle are often connected to each other by connection devices that have joints to allow the multi-car vehicle to move around a bend. Designs of such connection devices are known, where the joint is arranged between a first joint arm and a second joint arm. The invention allows energy to be dissipated by cutting into a surface of the first joint arm and then for the cutting to be continued after the knife has passed the joint by cutting into a surface of the second joint arm. Thus, the amount of energy dissipated can be increased.

**[0011]** As mentioned, different designs of connection devices for multi-car vehicles are known. Designs are

known, where the joint is arranged between joint arms, the respective joint arm being connected to a respective car at its respective free end. These joints are often referred to as articulated joints. Other designs are known that make use of a connection rod and two joints. In such designs, a first joint arm is connected to a first car and is connected via a joint to a connection rod. The connection rod is connected via a second joint to a second joint arm, whereby the second joint arm is connected to the second car. Furthermore, designs are known, where instead of the connection rod described above, two coupler heads each being connected to a coupler rod are provided. The invention provides advantages for all of these designs, because the invention is now not limited to simply dissipating energy by cutting into that part of the connection device that ends at the joint, but allows for the energy dissipation to continue once the knife has past the joint as the first part continues to move relative to the second part as the force is continued to be applied to the first part.

**[0012]** In a preferred embodiment, a guide is provided that comes into contact with the second piece while the first part is moved relative to the second part by the application of the force, the guide guiding the second piece of the first part into a predetermined position relative to the second part. Especially for those designs where the first part is designed as a multi-piece part and has a first piece being connected to a second piece by means of a joint, the performance of the cutting action can be enhanced, if the second piece is aligned into a predetermined position relative to the second part. In a preferred embodiment, the second piece is aligned by the guide to be in line with the first piece. For example, if the first piece has a longitudinal axis and if the second piece has a longitudinal axis, the guide could in a preferred embodiment guide the second piece of the first part into a predetermined position, wherein the longitudinal axis of the second piece has the same orientation or is parallel to the longitudinal axis of the first piece. Such guides can be connected to the second part and thus remain stationary, while the first part moves relative to the second part. The guides can, for example, be elements protruding from the second part, for example protruding parallel to a longitudinal axis of the first piece of the first part. If the first part is moved relative to the second part and if the second piece is not in the predetermined alignment to the second part, for example tilted out of the predetermined orientation, the guide will come into contact with the second piece and bring the second piece into alignment.

**[0013]** In a preferred embodiment, the second part has a recess, a cut-out or a hole. The first part moves at least partially into the recess or at least partially through the cut-out or hole, respectively. Providing a recess, a cut-out or a hole provides for good ways of having the first part move relative to the second part in a controlled manner.

**[0014]** In a preferred embodiment, the knife is arranged at the circumference of the recess, the cut-out or the hole

such that the knife cuts the first surface and the second surface as the first part moves at least partially into the recess or at least partially through the cut-out or hole respectively. Although different locations for the knife can be feasible, for example for the knife being arranged at a distance from the circumference of the recess, the cut-out or the hole, the design of the energy dissipating device can be facilitated, if the knife is provided at the circumference of the recess, the cut-out or the hole, because then no additional elements need to be provided to hold the knife.

**[0015]** In a preferred embodiment, the second part has at least two knives. In an even more preferred embodiment, the second part has more than two knives, especially preferred three knives or more than three knives. In a preferred embodiment, the knives are arranged symmetrically around the surfaces of the first part that are to be cut by the knives.

**[0016]** In a preferred embodiment, the first part has a recess and the second part has a guide that engages with the recess, whereby the recess extends for at least a part of the longitudinal extent of the first part. If the first part is moved relative to the second part by the application of the force, the interaction of the guide with the recess will guide the first part to move in a predetermined way relative to the second part. In addition or as an alternative, the first part can have a guide that interacts with a recess of the second part to obtain the same function.

**[0017]** The multi-car vehicle according to the invention has an energy dissipating device according to the invention. In a preferred embodiment, the multi-car vehicle has the energy dissipating device according to the invention as part of a buffer or as part of a connection device that connects a first car of the multi-car vehicle to a second car of the multi-car vehicle.

**[0018]** The multi-car vehicle according to the invention can be of different designs and in different forms of adaptation for uses. The multi-car vehicle, for example, can be a railway-bound train (streetcars and subway-trains also being considered as such trains), which can be used for transporting passengers as well as adapted for transporting goods. Further possible types of the multi-car vehicle according to the invention can be magnetic railway trains or can be busses (road busses as well as busses traveling on fixed tracks). A car of a multi-car vehicle can be a self-supporting car, whereby the car has sufficient wheels that are placed at sufficient locations such that the car can stand by itself without being supported by other cars, for example a three-wheeled car, a four-wheeled car or a car with even more wheels placed at suitable locations. A car of a multi-car vehicle can also be of the non-self-supporting type, whereby the car has no wheels or only wheels provided in such number or arranged at such a place that the car cannot stand by itself but is vertically supported by at least one neighbouring car. To form the multi-car vehicle, the individual cars of the vehicle are connected to one another by

means of a connection device. The connection device can be provided for different types of purposes. In multi-car vehicles where only one or only several of the total of cars is driven, the connection devices are provided so that the driven car can drive a non-driven car and thus ensure that the complete vehicle travels with the same speed. Connection devices are also distinguished between those connecting devices that allow for easy decoupling (uncoupling) of the cars, whereby easy decoupling is understood to be accomplished within a couple of minutes or for what is called "semi-permanent" coupling of the cars, for which decoupling of the cars takes efforts and usually involves the vehicle to have been transported to a specific workshop. Trains, for example, can have coupler-heads as part of their connection devices. These coupler-heads can, for example be so called "automatic couplers" that allow decoupling within minutes, even within seconds.

**[0019]** Below, the invention will be described with reference to Figures that only show an exemplary embodiment of the invention. The Figures show:

**Fig. 1** a perspective view onto parts of a half of a connection device used to connect a first car of a multi-car vehicle with a second car of a multi-car vehicle,

**Fig. 2** a top view onto parts of the connection device shown in Fig. 1 and

**Fig. 3** a side view onto the parts of the connection device shown in Fig. 1.

**[0020]** The parts of the connection device shown in the Fig. 1 to 3 include a first part 1 and a second part 2. The second part 2 comprises four knives 3 that are arranged such that they cut into a first surface 4 of the first part 1, if the first part 1 is made to move relative to the second part 2 by application of a force of a predetermined magnitude that is applied to the first part 1 to act along its longitudinal axis.

**[0021]** The first part 1 has a second surface 5 that is separate from the first surface 4 and is arranged in such a manner that the knives 3 cut into the second surface 5 after having cut the first surface 4, if the force is continued to be applied to the first part 1.

**[0022]** The first part 1 is put together of several pieces. A first piece 6 that at least for a part of its longitudinal extent has the shape of a hollow cylinder is provided. The first surface is the peripheral surface of the first piece 6. The second piece 7 for at least a part of its longitudinal extent also has the shape of a hollow cylinder. The second surface 5 is the peripheral surface of the second piece 7. The first piece 6 and the second piece 7 are separate pieces that are attached to one another. The second piece 7 is attached to the first piece 6 by means of a joint 8.

**[0023]** The second part 2 has a hole, whereby the first part 1 moves at least partially through this hole. The knives 3 are arranged at the circumference of the hole

such that the knives cut the first surface 4 and the second surface 5 as the first part 1 moves at least partially through the hole.

**[0024]** The second part 2 is a plate that can either be connected directly to a car of a multi-car vehicle, for example to the underframe of such a car. Alternatively, further elements can be arranged between the second part 2 and the car.

**[0025]** Depending on the type of multi-car vehicle, in which the energy dissipating device according to the invention is to be used, the end of the first part 1 that is opposite to the second part 2 can be provided with a plate that is directly directed to a second car of a multi-car vehicle, for example the underframe of such a car. In such an embodiment, the energy dissipating device would function as an articulated joint between two cars of a multi-car vehicle. The connection would be of the semi-permanent nature and could only be disconnected by either disconnecting the energy dissipating device from the respective car or by dismantling the joint 8. In an alternative embodiment, the second piece 7 of the energy dissipating device can function as a connection rod with a substantial longitudinal extent. In such an embodiment, a further joint would be provided at the free end of the second piece 7 of the first part 1 and this further joint would then be connected to the next car of the multi-car vehicle. In a further alternative embodiment, the second piece 7 of the first part 1 can function as a coupler rod and a coupler, for example an automatic coupler could be arranged at the free end of the second piece 7 of the first part 1.

**[0026]** In a predetermined driving condition, namely in a driving condition, in which a force of a predetermined magnitude is applied to the first part (for example in a crash), a connection that connects the first part 1 to the second part 2 will be overcome and the force will start to move the first part 1 relative to the second part 2, namely will at first push the first piece 6 of the first part 1 through the hole in the second part 2. In doing so, the knives 3 will cut the peripheral surface (the first surface 4) of the first piece 1. This cutting action will dissipate energy. The connection between the first part 1 and the second part 2 that is overcome upon the application of a force of a predetermined magnitude to the first part 1 can either be by way of the holding force that the knives 3 can provide, if they are cut radially inwards into the uncut first surface 4 of the first piece 1 during assembly of the energy dissipating device. If the knives 3 are moved radially inwards into the first surface 4 and cut into this first surface 4 in a radial direction, they will be able to connect the first piece 6 of the first part 1 to the second part 2 in a manner that can transmit pulling forces as well as pushing forces that are below the predetermined magnitude. In a preferred embodiment, the connection of the first part 1 to the second part 2 is, however, provided by separate means. For example the first piece 6 can have a plate that is arranged behind the first part 2 and that is connected to the first part 2 by shear-off bolts. Upon the

application of a pushing force along the longitudinal axis of the first part 1 that in the Fig. 1 would be directed from right to left, the shear-off bolts would shear off and set the first part 1 free to travel relative to the second part 2 upon continuous application of such a force. As the first part 1 then starts to move through the hole in the second part 2, the knives 3 would cut into the peripheral surface of the first piece 6 and then into the peripheral surface of the second piece 7. Other means of connecting the first part 1 to the second part 2 are also feasible, for example welding, glueing or other shear-off elements, each of these alternatives being designed in such a manner that they set the first part 1 free to travel relative to the second part 2 upon the application of a force of a predetermined magnitude.

**[0027]** To improve the movement of the first part 1 relative to the second part 2 guides (not shown in the Fig.) can be provided attached to the second part 2 and pointing parallel to the longitudinal axis of the first part 1. Because the second piece 7 is connected to the first piece 6 by way of the joint 8, it is possible that at the time when the first part 1 moves relative to the second part 2 for the purpose of having the knives cut the first surface 4 and the second surface 5 that the second piece 7 is not in alignment with the first piece 6, but has pivoted about the joint 8 out of the position shown in the Fig. 1 to 3. For such driving conditions guides attached to the second part 2 that point along the longitudinal axis of the first part 1 as shown in the driving condition shown in Fig. 1 to 3 can help to align the second piece 7 with the first piece 6. Such guides could, for example be bar-like elements that are arranged around the first piece 6. Preferably, such bar-type elements would have slanted surfaces at their free ends that can assist in guiding the second piece 7 back into the alignment position that is shown in the Fig. 1 to 3.

## Claims

1. Energy dissipating device suitable to dissipate energy while a first part of a car of a multi-car vehicle moves relative to a second part of the car, the energy dissipating device comprising:
  - a first part (1) and a second part (2),
  - the first part (1) being arranged to move relative to the second part (2), if a force of a predetermined magnitude is applied to the first part (1),
  - the second part (2) comprising a knife (3) that is arranged such that it cuts into a first surface (4) of the first part (1) as the first part (1) moves relative to the second part (2),**characterized in that** the first part (1) has a second surface (5) that is separate from the first surface (4) and arranged in such a manner that the knife (3) cuts into the second surface (5) after having cut the first sur-

face (4), if the force is continued to be applied to the first part (1).

2. Energy dissipating device according to claim 1, **characterized in that** the first part (1) at least for a part of its longitudinal extend has the shape of a cylinder, preferably a hollow cylinder.
3. Energy dissipating device according to claim 1 or 2, **characterized in that** the first part (1) is put together of at least a first piece (6) and a separate second piece (7) that is attached to the first piece (6), whereby the first surface (4) is arranged on the first piece (6) and the second surface (5) is arranged on the second piece (7).
4. Energy dissipating device according to claim 3, **characterized in that** the second piece (7) is attached to the first piece (6) by means of a joint (8).
5. Energy dissipating device according to any one of claims 3 to 4, **characterized by** a guide that come into contact with the second piece while the first part is moved relative to the second part by the application of the force, the guide guiding the second piece of the first part into a predetermined position relative to the second part.
6. Energy dissipating device according to any one of claims 1 to 5, **characterized in that** the second part (2) has a recess, a cut-out or a hole and that the first part (1) moves at least partially into the recess or at least partially through the cut-out or hole respectively.
7. Energy dissipating device according to claim 6, **characterized in that** the knife (3) is arranged at the circumference of the recess, the cut-out or the hole such that the knife (3) cuts the first surface (4) and the second surface (5) as the first part (1) moves at least partially into the recess or at least partially through the cut-out or hole respectively.
8. Energy dissipating device according to any one of claims 1 to 7, **characterized in that** the second part (2) has at least two knives.
9. Multi-car vehicle having an energy dissipating device according to any one of claims 1 to 8 arranged as part of a buffer or as part of a connection device that connects a first car of the multi-car vehicle to a second car of the multi-car vehicle.

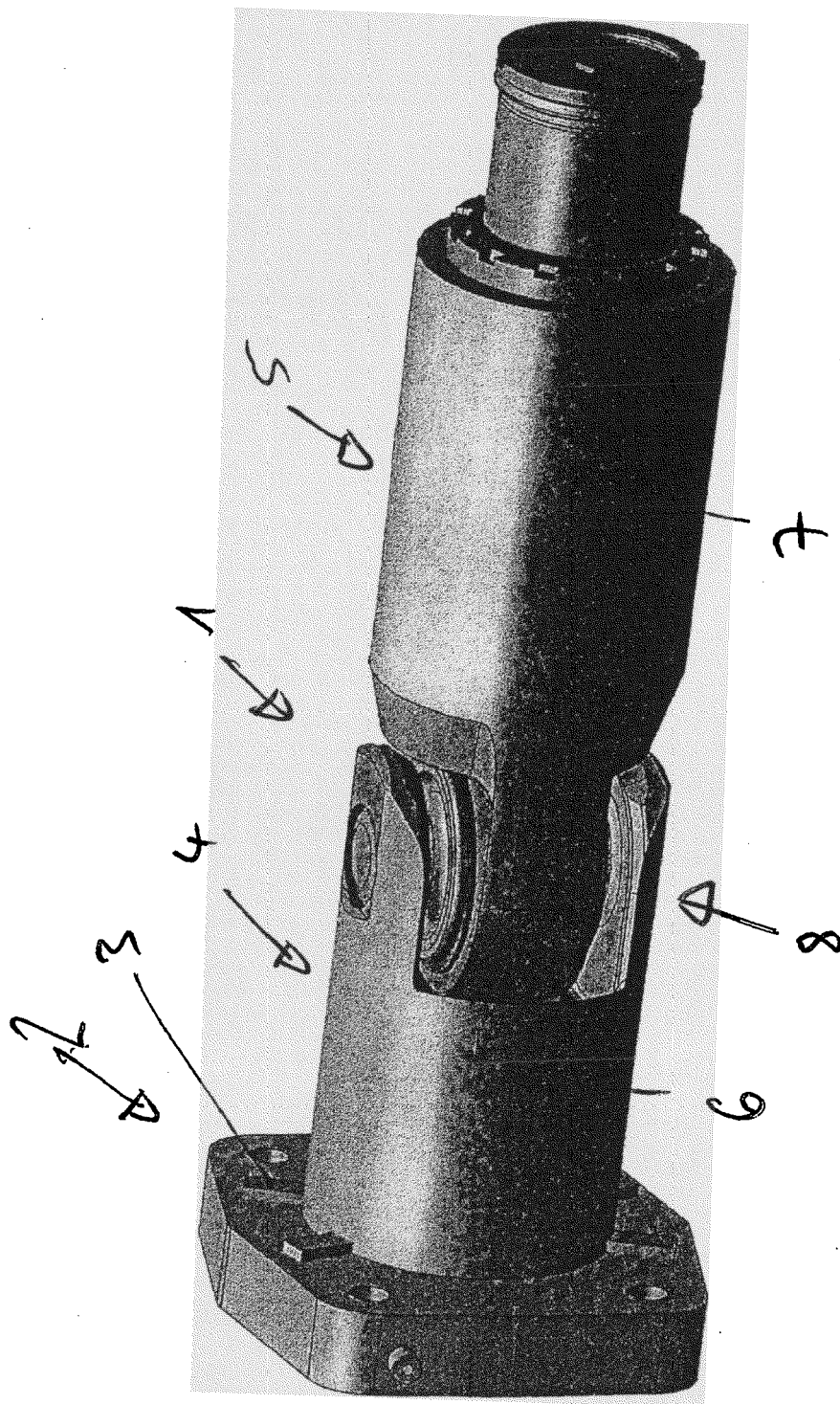


Fig. 7

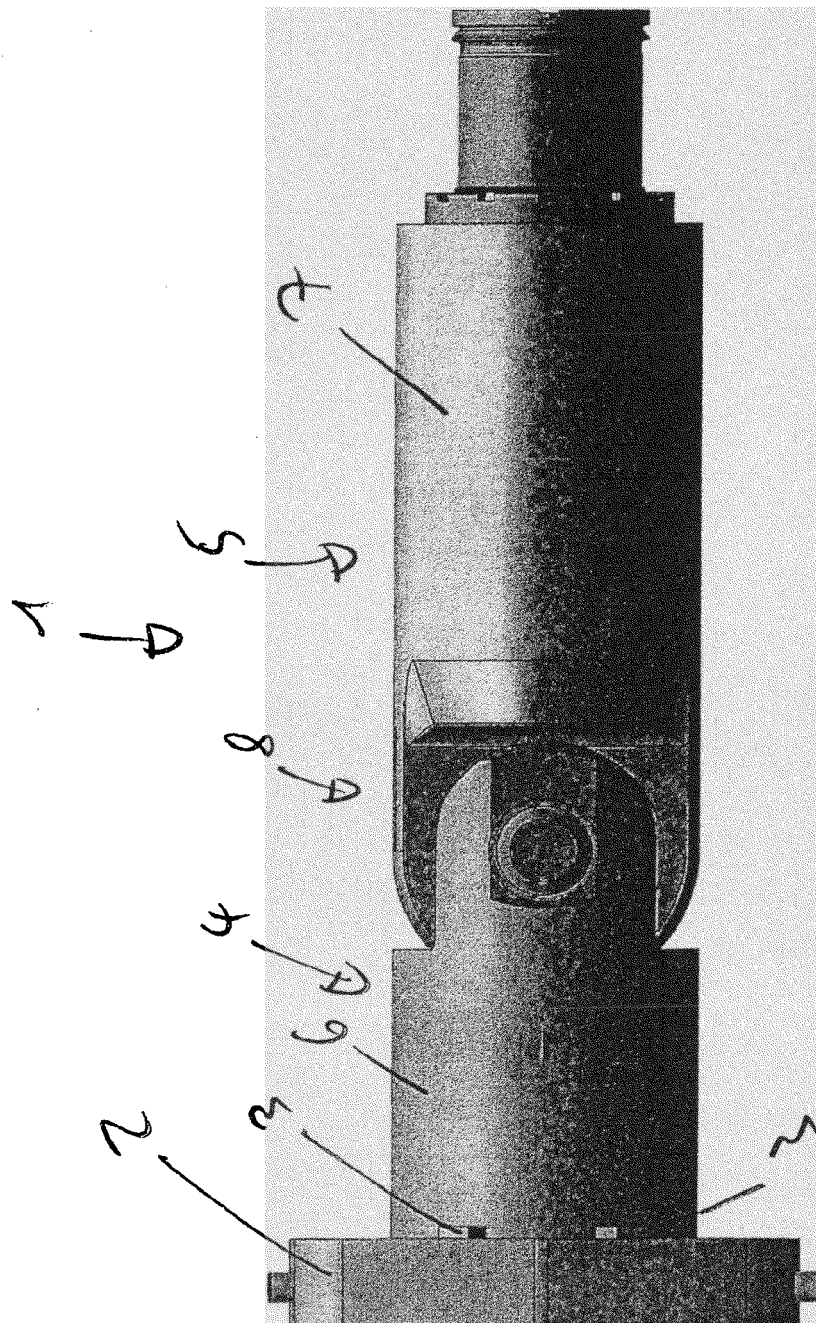


Fig. 2

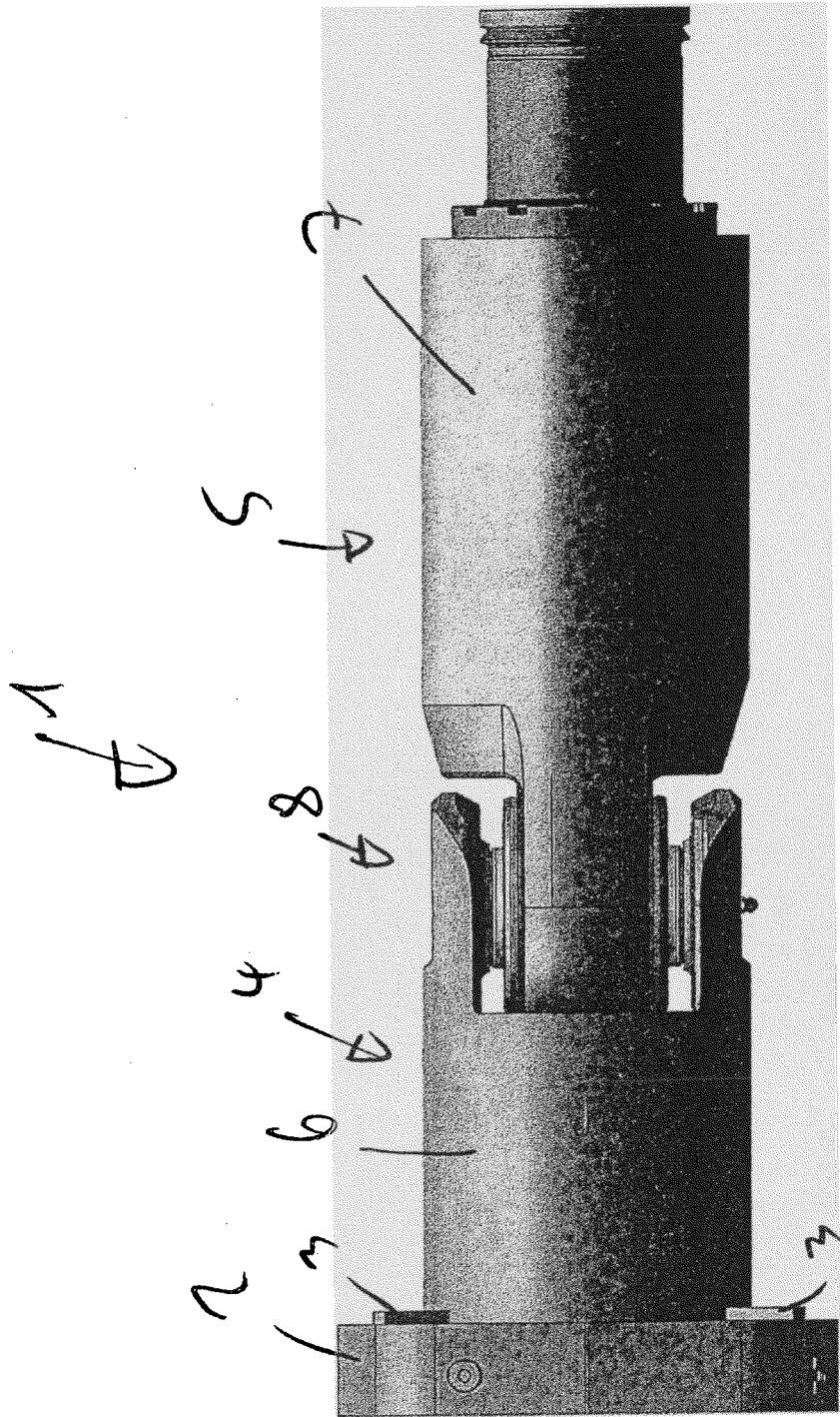


Fig. 3



## EUROPEAN SEARCH REPORT

Application Number  
EP 14 00 3502

5

10

15

20

25

30

35

40

45

50

55

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                    |                                                                                                                                               |                                                                                                                                                                                                                                                                              |                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                 | Relevant to claim                                                                                                                                                                                                                                                            | CLASSIFICATION OF THE APPLICATION (IPC) |
| A                                                                                                                                                                                                                                                      | US 2013/270210 A1 (KUKULSKI JAN [PL] ET AL) 17 October 2013 (2013-10-17)<br>* the whole document *                                            | 1-9                                                                                                                                                                                                                                                                          | INV.<br>B61G11/16                       |
| A,D                                                                                                                                                                                                                                                    | WO 2009/072843 A2 (KOREA RAILROAD RES INST [KR]; KWON TAE-SU [KR]; JUNG HYUN-SEUNG [KR];) 11 June 2009 (2009-06-11)<br>* the whole document * | 1-9                                                                                                                                                                                                                                                                          |                                         |
| A,D                                                                                                                                                                                                                                                    | PL 202 114 B1 (URZADZEN MECHANICZNYCH KAMAX S [PL]) 30 June 2009 (2009-06-30)<br>* the whole document *                                       | 1-9                                                                                                                                                                                                                                                                          |                                         |
| A                                                                                                                                                                                                                                                      | EP 2 554 452 A1 (EGO INT BV [BE]) 6 February 2013 (2013-02-06)<br>* the whole document *                                                      | 1-9                                                                                                                                                                                                                                                                          |                                         |
|                                                                                                                                                                                                                                                        |                                                                                                                                               |                                                                                                                                                                                                                                                                              | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                        |                                                                                                                                               |                                                                                                                                                                                                                                                                              | B61G                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                             |                                                                                                                                               |                                                                                                                                                                                                                                                                              |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                              |                                                                                                                                               | Date of completion of the search<br>23 November 2015                                                                                                                                                                                                                         | Examiner<br>Awad, Philippe              |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                                                               | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                         |

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 00 3502

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-11-2015

10

15

20

25

30

35

40

45

50

55

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) |               | Publication<br>date |
|-------------------------------------------|----|---------------------|----------------------------|---------------|---------------------|
| US 2013270210                             | A1 | 17-10-2013          | EP                         | 2640620 A1    | 25-09-2013          |
|                                           |    |                     | PL                         | 217776 B1     | 29-08-2014          |
|                                           |    |                     | RU                         | 2013122552 A  | 27-12-2014          |
|                                           |    |                     | US                         | 2013270210 A1 | 17-10-2013          |
|                                           |    |                     | WO                         | 2012067526 A1 | 24-05-2012          |
| -----                                     |    |                     |                            |               |                     |
| WO 2009072843                             | A2 | 11-06-2009          | EP                         | 2227410 A2    | 15-09-2010          |
|                                           |    |                     | WO                         | 2009072843 A2 | 11-06-2009          |
| -----                                     |    |                     |                            |               |                     |
| PL 202114                                 | B1 | 30-06-2009          | NONE                       |               |                     |
| -----                                     |    |                     |                            |               |                     |
| EP 2554452                                | A1 | 06-02-2013          | EP                         | 2554452 A1    | 06-02-2013          |
|                                           |    |                     | ES                         | 2527352 T3    | 22-01-2015          |
|                                           |    |                     | WO                         | 2013017265 A1 | 07-02-2013          |
| -----                                     |    |                     |                            |               |                     |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- WO 2009072843 A2 [0002]
- PL 202114 B1 [0003]