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- (54) Title: DRIVETRAIN SYSTEM AND USE THEREOF

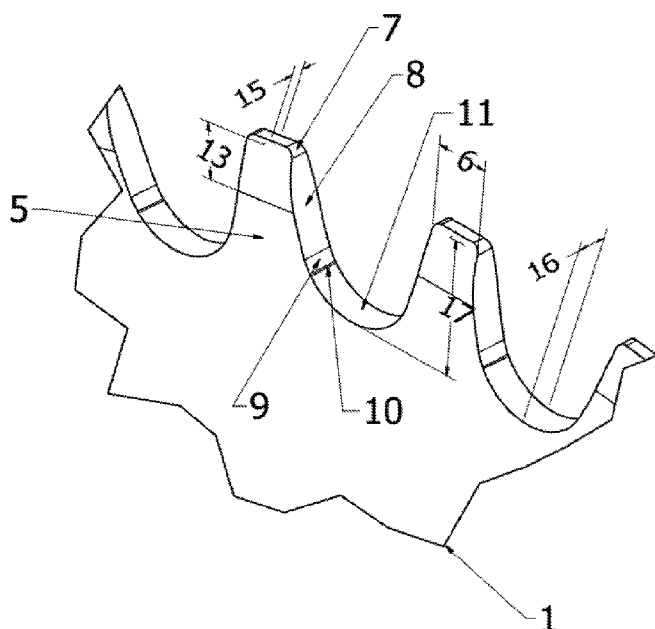


Figure 1

(57) Abstract: The present application describes a drivetrain system which includes a sprocket tooth profile and use thereof. This drivetrain system enables improved guidance of the chain (2) through the use of a non-standard tooth profile (1) so that when a rear gearbox is used it is possible to have a single speed in the chainset. This drivetrain system is utilised in vehicles, preferably bicycles.

DESCRIPTION**"DRIVETRAIN SYSTEM AND USE THEREOF"****Technical field**

The present application discloses a drivetrain system which includes a sprocket tooth profile and use thereof.

Prior art

With the introduction of chain drivetrain systems where a rear derailleur is used and a single speed on the chainset in bicycles, it became extremely important to ensure optimum performance of the guidance system of the chain in the chainset so as to avoid ungearing.

This technical problem has complex resolution given that the chain undergoes a considerable and never constant deviation.

The known state-of-the-art systems for traction in bicycles, particularly when the chain is submitted to a particular deviation when rear derailleurs and cassettes are used and a single-speed in the chainset, cannot ensure good gearing, may be noisy, and may even lead to ungearing of the chain in this situation which in no way contributes to user comfort and safety.

In standard sprocket systems for bicycle chains, wherein the chain is subject to deviations, the system cannot ensure good and continuous gearing due to the existing clearance on the top of the tooth and to the distance between rollers which means that when a chain deviates from the teeth, it touches the lateral chain plates at the start of gearing and not the rollers.

Also systems designated as "*Narrow wide teeth*" are known in the art, such as those disclosed in US4174642 and US201113311735, wherein chain guidance is made laterally on the chain plates. This solution leads to notable wear of the sprocket due to the considerable friction of the chain plates on the sprocket teeth lateral side, which means that after a certain period of use and due to the friction between the sprocket and the chain plates, guidance may become seriously compromised. Due also to this friction, the chain does not have the necessary fluidity when gearing leading to considerable waste of energy, which is especially important in competition situations.

US5876296 A discloses a set of toothed wheels comprising a small sprocket and a large sprocket coaxial with the small pinion. The pinion is provided with an axially-oriented recess in the bottom portion located between the first tooth and the second tooth of the pinion. The recess has a supporting curved face extending from the second tooth. The pinion is further provided with a supporting protrusion located under the supporting curved face such that the supporting protrusion is separated from the supporting curved face by a distance corresponding to about one tooth pitch. The supporting curved face and the supporting protrusion act to support the inner and the outer chain plates of a drive chain at such time when the gear shifting takes place. On the contrary, the technical problem which the solution herein disclosed seeks to resolve is a completely different one, especially that of improving the guidance of the chain in situations where the vibration thereof is very high. In addition, the technical solution herein disclosed is significantly different from the

technical solution presented in this document as a result of the reading thereof.

EP1489338 A2 discloses a roller chain sprocket including a plurality of teeth alternating with furrows at an equal pitch. Each tooth and each furrow are designed in a manner such that a chain roller comes into contact with only a pressure transmitting flank of the tooth, or only the pressure transmitting flank and a flank of an adjacent tooth facing the pressure transmitting flank for preventing the roller from contacting a furrow bottom when the sprocket transmits a driving force to and receives a driving force from the roller chain. On the contrary, the technical solution disclosed herein is significantly different from the technical solution presented in this document as a result of the reading thereof.

Summary

The present application describes a drivetrain system comprising:

- a sprocket with a non-standard tooth profile which has a height greater than 7.5 mm;
- two lateral curvatures, for each tooth, at a tangent to the respective laterals and with a height greater to that of half of the height of the chain plates.

In one embodiment, the height of the tooth profile used in the drivetrain system is between 7.5 and 12 mm.

In another embodiment, the height of the tooth profile used in the drivetrain system is between 7.5 and 7.8 mm.

In another embodiment, the roller passage radius and first guidance used in the drivetrain system is greater than 0.3 mm.

Still in another embodiment, the radius for the start of accommodation in the roller for the drivetrain system is at a tangent to the intermediate radius.

In another embodiment, the radius for the start of accommodation of the roller used in the drivetrain system is greater than 20 mm.

In another embodiment, the smoothing radius used in the drive train system is tangential to the intermediate ratio and to the roller accommodation start ratio.

Still in another embodiment, the intermediate radius used in the drivetrain system is less than 10.5 mm.

In one embodiment, the gearing radius used in the drivetrain system is greater than 3.5 mm.

In another embodiment, the thickness of the tooth top used in the drivetrain system is less than 1.2 mm.

Still in another embodiment, the thickness of the tooth bottom in the drivetrain system is between 1.6 and 3.0 mm.

In one embodiment, the sprocket guidance used in the drivetrain system is carried out through the rollers.

The present application also discloses a vehicle comprising the drivetrain system described above.

Finally, the present application also discloses a bicycle comprising the drivetrain system described above.

General Description

The present application describes a drivetrain system which enables improved guidance of the chain (2) through the use of a non-standard tooth profile (1) so that when a rear gearbox is used it is possible to have a single speed in the chainset.

Throughout the present text a non-standard tooth profile (1) is considered as a tooth profile wherein the dimensions, specifically the height, weight and depth, are not suitably standardised. In this way, the dimensions used are outside the intervals considered usual and/or the values achievable through constructions obtained through CAD software.

In case of varying speeds in the rear axle and a single speed in the chainset, this leads to the chain (2) undergoing major deviation mainly when the changes take place at the end-points of the cassette. Due to this fact a reinforced guidance for the chain (2) is necessary in the sprocket of the chain set, as illustrated in Figure 2, so as to avoid the chain (2) disengaging itself and so that the traction fluidity is improved, thus enabling the chain (2) to function in a smooth manner. In this way the noise caused by the gearing of the chain in the sprocket, as well as the loss of energy due to friction are reduced. This guidance is more important as the oscillation to which the chain is subjected is greater.

As such, this technology has the following advantages in relation to prior art drivetrain systems:

- Better chain guidance (2) wherein a rear derailleur and cassette in the rear axle and a single speed in the chain set are used;
- Constant guidance in the chain (2) rollers (3) and not in the side chain plates (4) which provides smooth and precise gearing;
- Less friction between the chain (2) and the sprocket;
- Less lateral wear in the sprocket;
- Greater energy efficiency with fewer energy losses due to friction;
- Less noise in all situations especially situations involving greater chain deviation (2);
- Less wear on the side area of the sprocket (5).

The technical solution disclosed herein has special application for off-road bicycles, rear suspension bicycles, toothed wheels of electrical bicycles and for any other application where oscillation of the chain is a very important and significant variable.

Description of the figures

Figures are herein attached for a better understanding of the art, which show preferred embodiments and which are however not intended to limit the scope of the present application.

Figure 1 schematically illustrates a view of a non-standard sprocket profile, wherein the reference numbers indicate:

1 - Non-standard tooth profile;

- 5 -Lateral side of the sprocket;
- 6 -Width of tooth top;
- 7 - Roller passage radius and first guidance;
- 8 - Radius of roller accommodation start;
- 9 - Smoothing radius;
- 10 - Intermediate radius;
- 11 - Gearing radius;
- 13 - Height of the lateral radii;
- 15 - Thickness of the tooth top;
- 16 - Thickness of tooth bottom;
- 17 - Tooth height.

Figure 2 schematically illustrates a perspective view of the chain, wherein the reference numbers indicate:

- 2 - Chain;
- 3 - Rollers;
- 4 - Lateral current plates;
- 14 - Chain plate height.

Figure 3 schematically illustrates a gearing of the chain on the sprocket, wherein the reference numbers indicate:

- 3 - Rollers;
- 7 - Roller passage radius and first guidance;
- 8 - Radius of roller accommodation start;
- 11 - Gearing radius;
- 18 - Primitive radius.

Figure 4 schematically illustrates a chain with deviation on the sprocket, wherein the reference numbers indicate:

- 3 - Rollers;
- 4 - Lateral current plates;
- 12 - Lateral curvature.

Figure 5 schematically illustrates the gearing of a chain with standard profile, wherein the reference numbers indicate:

3 - Rollers;

18 - Primitive radius.

19 - Clearance between roller and top of the sprocket profile.

Figure 6 schematically illustrates a perspective view of the chain, wherein the reference numbers indicate:

1 - Non-standard tooth profile;

2 - Chain.

Description of embodiments

The present application describes a drivetrain system comprising a non-standard tooth profile (1), allowing for an improved guidance in the chain (2) so that when a rear gearbox is used a single speed in the chainset is made possible.

This technology provides for a drivetrain system comprising a sprocket which enables better guidance and gearing of the chain (2). The sprocket tooth profile used is not standard, i.e. its geometrical construction is not based on any standard or "CAD" book.

In one embodiment, the system comprises a sprocket tooth profile type which has a tooth height (17) greater than the standard tooth profile height so that the gearing start occurs as quickly as possible. This feature enables the system to start implementing the long guidance immediately before the roller reaches the gearing point.

The height of the tooth used in the drivetrain system should be greater than 7.5 mm, preferably between 7.5 mm and 12.0 mm. In one embodiment where a low number of teeth is used in the sprocket and wherein the chain has been considerably tightened, the height of the tooth should be between 8.0 mm and 12.0 mm. However, where the embodiment comprises a low number of teeth in the sprocket but wherein a low quality chain is used which cannot achieve such tightening, the height of the tooth should be between 7.8 mm and 12.0 mm. In another embodiment where a high number of teeth is used in the sprocket and the chain has been considerably tightened, the height of the tooth should be between 8.5 mm and 12.0 mm. However, where the embodiment comprises a high number of teeth in the sprocket but wherein a low quality chain is used which cannot achieve such tightening, the height of the tooth should be between 8.3 mm and 12.0 mm. Still in another embodiment, the height of the tooth may be between 7.5 mm and 7.8 mm in the cases where the pressure to be applied in the chain is not so high.

The sprocket tooth may have a tooth top width (6) such that at the posterior gearing point, the tooth top starts the guidance phase on the chain (2) roller (3) much earlier than in the case of a standard sprocket. This thus allows for the correct gearing in the roller (3) which is a revolving element of the chain (2), thus also ensuring low wear on the sprocket since there is a reduction in the friction between the sprocket and the chain (2). This tooth top width (6) should be greater than 3 mm, preferably between 3 and 4 mm.

The roller passage radius and first guidance (7) should function so as to immediately allow a first guidance and leave the next roller free for gearing. This roller passage radius and first guidance (7) should be greater than 0.3 mm, preferably between 0.3 and 1 mm.

The roller accommodation start (8), where the first roller (3) accommodation of the chain (2) is carried out and wherein the roller (3) starts to be directed to the tooth bottom should be at a tangent to the intermediate radius (10) in order to ensure smooth dislocation of the chain (2). This roller accommodation start (8) should be greater than 20 mm, preferably between 20 and 200 mm.

The smoothing radius (9) which has the function of directing the chain (2) to the intermediate radius (10) should be at a tangent to this same intermediate radius (10) and to the roller accommodation start radius (8) so that the path of the chain (2) is smooth.

The intermediate radius (10) has the function, at the moment of the traction, of keeping the chain (2) housed in the gearing radius zone (11) which will house the roller (3) of the chain (2), thus gearing the system. This intermediate radius (10) should be less than 10.5 mm, preferably between 1.0 and 10.5 mm.

The centre of the intermediate radius (10) may be the interception of the centre line which passes through the centre of the gearing radius (11) with the primitive radius line (18). The gearing radius (11) should be greater than 3.5 mm, preferably between 3.5 and 5.0 mm.

The system should also comprise two lateral curvatures (12) in each sprocket tooth so that the chain (2) smoothly enters in the tooth when there is a deviation. This radius is at a tangent to the sprocket lateral (5) and has the height of the lateral radii (13) greater than half of the height of the chain plates (14). In this way the chain engages the gear smoothly, and there is a reduction in the lateral friction.

The tooth top thickness (15) ensures that even if the chain (2) has a deviation it will enter the sprocket profile. This tooth top thickness (15) should be less than 1.2 mm, preferably between 0.5 and 1.2 mm.

The tooth bottom thickness (16) enables the chain (2) to be geared only by the roller (3) and not just by the lateral plates. This thickness of the tooth bottom (16) is between 1.6 and 3.0 mm.

All radii of the geometrical construction of the system are at tangents to each other so as to ensure the smoothness of the system. This entire construction aims at reducing the clearance between roller and top of the sprocket (19) profile in the state of the art solutions thus allowing the chain (2) to be geared by the rollers (3) and/or by the lateral chain plates (4).

Figures 5 and 6 illustrate show how the gearing of the bicycle chain is achieved, making note that the existence of a non-standard tooth profile, in particular with a more raised height, enables a faster and more correct guidance for the chain. In this way it is possible to obtain a system of sprockets which avoids lateral chain support thus

contributing to it being more difficult for the aforementioned chain to jump out of the system.

One way of obtaining an embodiment of this technology would be through a machining process through cutting tools using a CNC milling machine for the embodiment of the non-standard tooth profile (1) while the lateral radii would be made through a CNC lathe. Another way of obtaining this would be through a forging process.

The present embodiment is not, of course, in any way restricted to the embodiments described in this document and a person with average skill in the art may envisage many modification possibilities thereof without departing from the general idea, such as is defined in the claims.

The preferential embodiments described above are obviously able to be combined with each other. The following claims further define preferential embodiments.

CLAIMS

1. Drivetrain system comprising:
 - a sprocket with a non-standard tooth profile which has a height greater than 7.5 mm;
 - two lateral curvatures, for each tooth, at a tangent to the respective laterals and with a height greater to that of half of the height of the chain plates.
2. Drivetrain system according to the preceding claim, wherein the height of the tooth profile is between 7.5 and 12.0 mm.
3. Drivetrain system according to any of the preceding claims, wherein the height of the tooth profile is between 7.5 and 7.8 mm.
4. Drivetrain system according to any of the preceding claims, wherein the roller passage radius and first guidance is greater than 0.3 mm.
5. Drivetrain system according to any of the preceding claims, wherein the radius of the roller accommodation start is at a tangent to the intermediate radius.
6. Drivetrain system according to any of the preceding claims, wherein the radius of the roller accommodation start is greater than 20 mm.
7. Drivetrain system according to any of the preceding claims, wherein the smoothing radius is at a tangent to the intermediate radius and to the radius of the roller accommodation start.

8. Drivetrain system according to any of the preceding claims, wherein the intermediate radius is less than 10.5 mm.
9. Drivetrain system according to any of the preceding claims, wherein the gearing radius is greater than 3.5 mm.
10. Drivetrain system according to any of the preceding claims, wherein the thickness of the tooth top is less than 1.2 mm.
11. Drivetrain system according to any of the preceding claims, wherein the thickness of the tooth bottom is between 1.6 and 3.0 mm.
12. Drivetrain system according to any of the preceding claims, wherein the sprocket guidance is carried out through rollers.
13. Vehicle comprising the drivetrain system according to any of the claims 1 to 12.
14. Bicycle comprising the drivetrain system according to any of the claims 1 to 12.

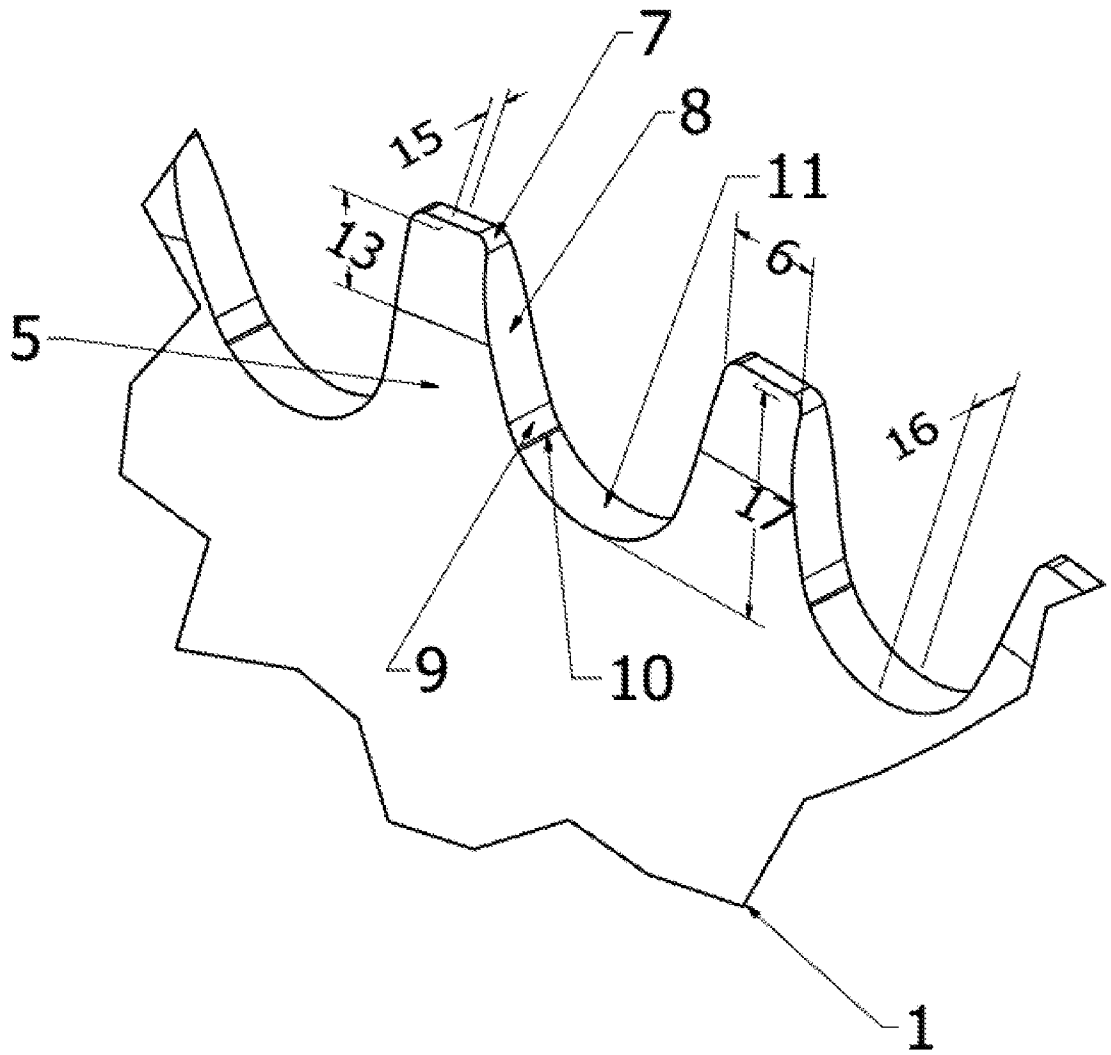


Figure 1

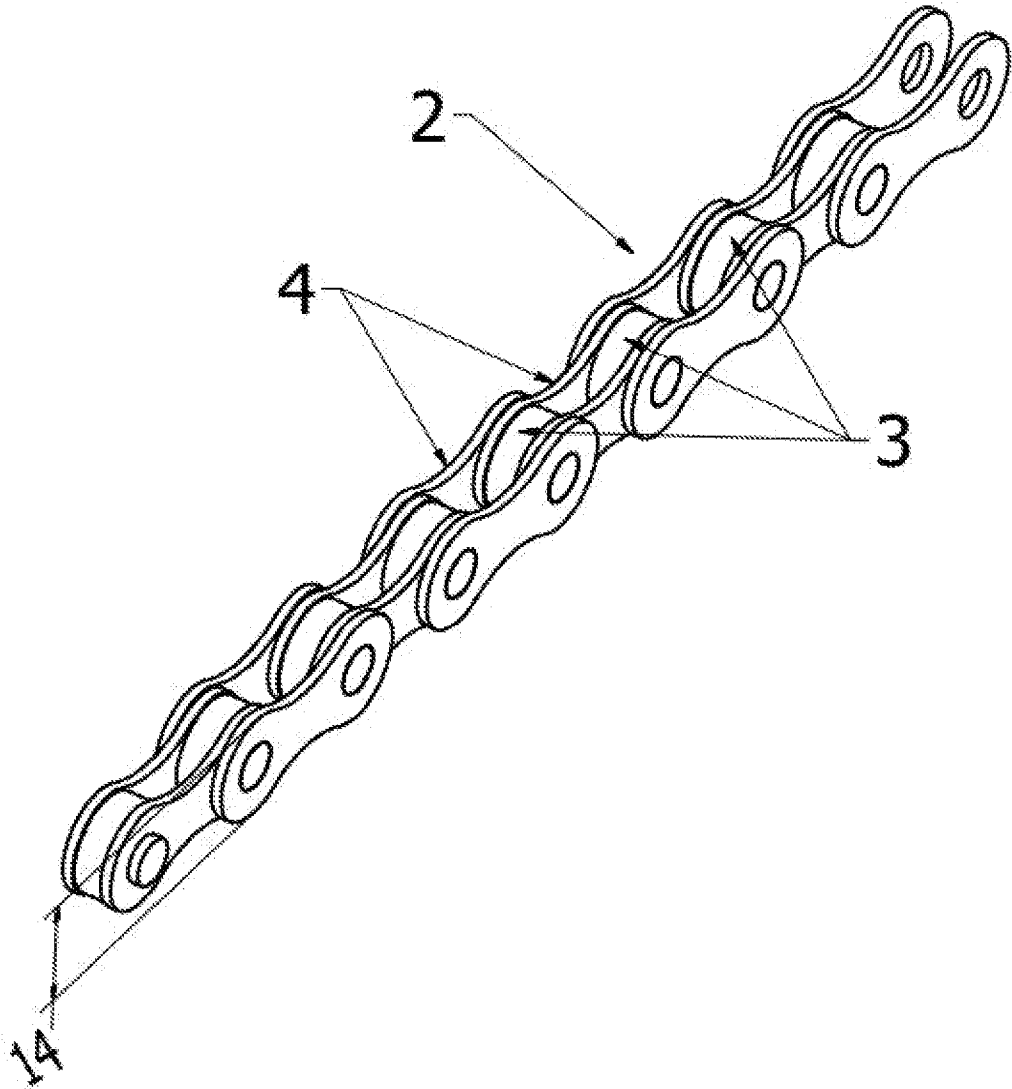


Figure 2

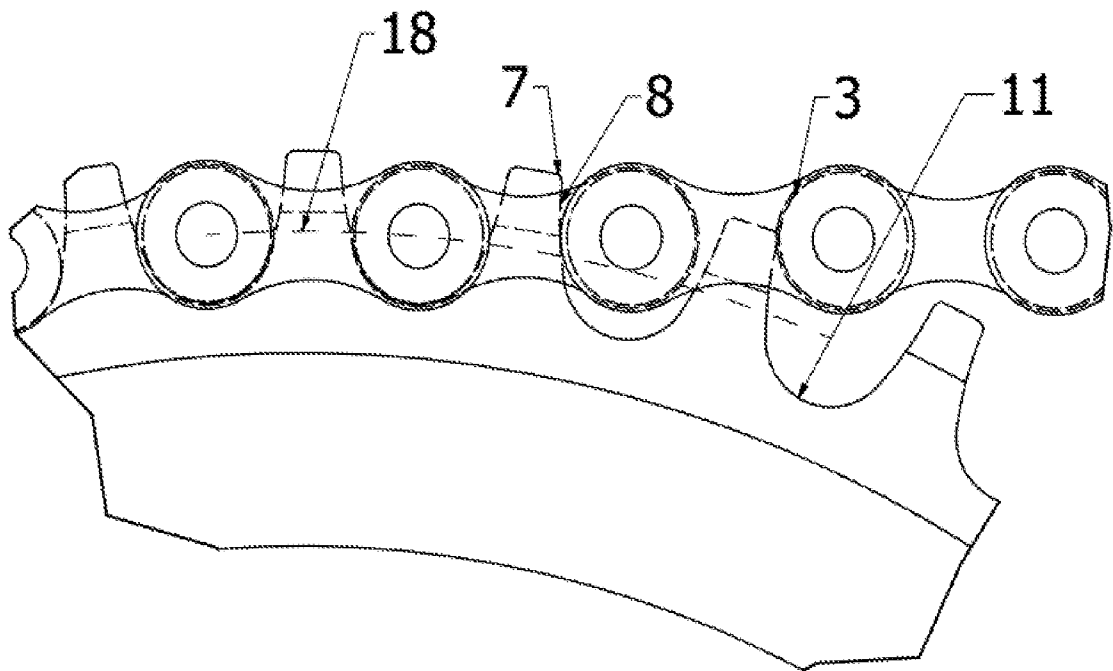


Figure 3

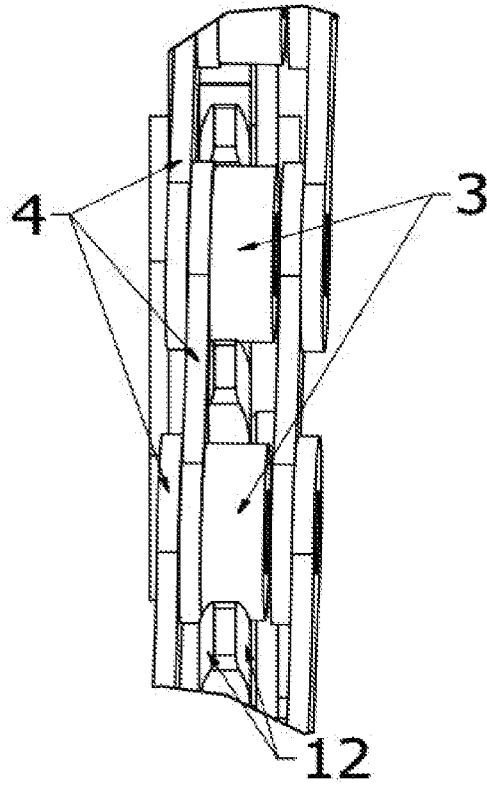


Figure 4

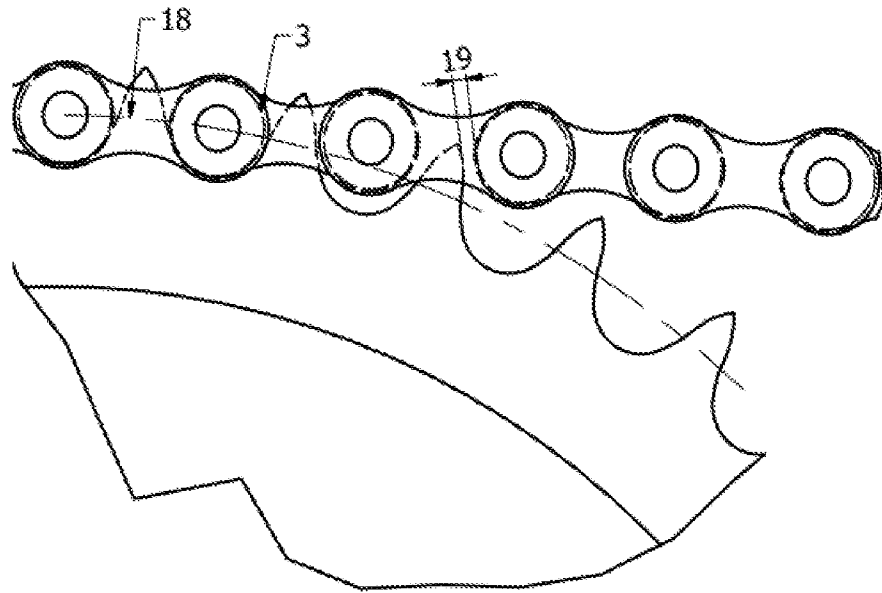


Figure 5

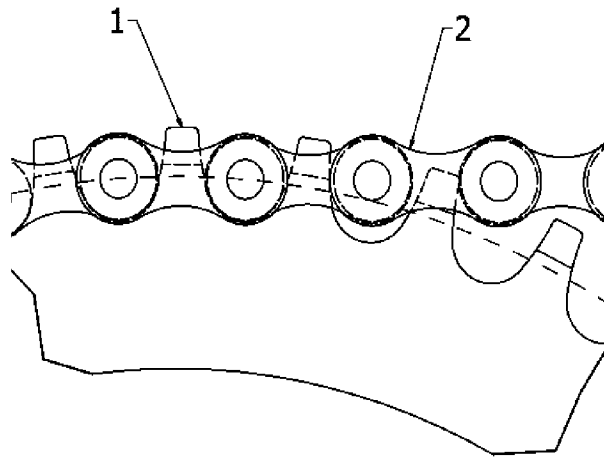


Figure 6

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER

INV. F16H7/06 F16H55/30
ADD.

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)

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2010 242913 A (ENUMA CHAIN MFG CO LTD) 28 October 2010 (2010-10-28) paragraphs [[0010]], [[0020]]; figures 1-3 -----	1-14
X	JP 2010 265996 A (TSUBAKIMOTO CHAIN CO) 25 November 2010 (2010-11-25) paragraphs [[0009]], [[0014]], [[0015]], [and[0019]]; figures 1-6 -----	1-14
X	JP 2002 068449 A (DAIKIN IND LTD) 8 March 2002 (2002-03-08) paragraph [[0058]]; figures 1-3 ----- -/--	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2014/065169

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101 273 221 A (CLOYES GEAR & PRODUCTS INC [US] CLOYES GEAR & PRODUCTS INC) 24 September 2008 (2008-09-24) Translated paragraph 2 after the figure description.; figure 6 -----	1-14
X	FR 2 657 134 A1 (SACHS IND SA [FR]) 19 July 1991 (1991-07-19) claim 4; figures 3,4 -----	1-14
X	EP 1 489 338 A2 (SUGINOCYCLE IND LTD [JP] SUGINO CYCLE IND LTD [JP]) 22 December 2004 (2004-12-22) cited in the application paragraph [[0035]]; figure 5 -----	1-14
A	CN 1 379 195 A (XUE RONGSHENG [CN]) 13 November 2002 (2002-11-13) figures 1 - 210 -----	1-14
A	EP 1 348 891 A1 (INST OF HIGH PERFORMANCE COMPU [SG]; SUNSTAR LOGISTIC SINGAPORE PTE [S]) 1 October 2003 (2003-10-01) figures 1 - 7 -----	1-14
A	EP 1 609 713 A2 (SHIMANO KK [JP]) 28 December 2005 (2005-12-28) figures 1 - 22 -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2014/065169

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 2010242913	A	28-10-2010	JP 5271777 B2	21-08-2013
			JP 2010242913 A	28-10-2010
JP 2010265996	A	25-11-2010	JP 5171728 B2	27-03-2013
			JP 2010265996 A	25-11-2010
JP 2002068449	A	08-03-2002	JP 3687508 B2	24-08-2005
			JP 2002068449 A	08-03-2002
CN 101273221	A	24-09-2008	CN 101273221 A	24-09-2008
			CN 101278145 A	01-10-2008
FR 2657134	A1	19-07-1991	NONE	
EP 1489338	A2	22-12-2004	CN 1573168 A	02-02-2005
			EP 1489338 A2	22-12-2004
			JP 3749904 B2	01-03-2006
			JP 2005009516 A	13-01-2005
CN 1379195	A	13-11-2002	NONE	
EP 1348891	A1	01-10-2003	AT 323248 T	15-04-2006
			DE 60304503 T2	21-12-2006
			EP 1348891 A1	01-10-2003
			JP 4435495 B2	17-03-2010
			JP 2003301927 A	24-10-2003
			SG 126693 A1	29-11-2006
			US 2003186766 A1	02-10-2003
EP 1609713	A2	28-12-2005	CN 1712307 A	28-12-2005
			EP 1609713 A2	28-12-2005
			JP 2006008111 A	12-01-2006
			TW 1255249 B	21-05-2006
			US 2005282671 A1	22-12-2005