



(51) International Patent Classification:

F16G 13/06 (2006.01) *F16G 13/08* (2006.01)

(21) International Application Number:

PCT/US2017/039725

(22) International Filing Date:

28 June 2017 (28.06.2017)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,

OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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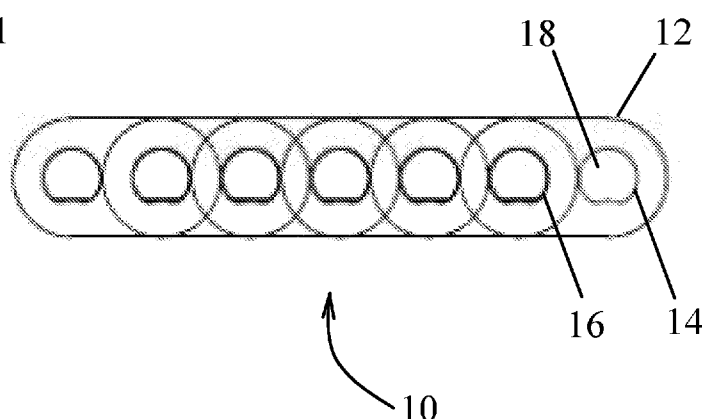
— of inventorship (Rule 4.17(iv))

Published:

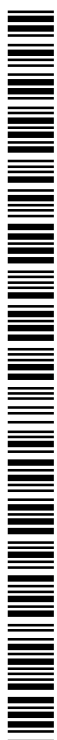
— with international search report (Art. 21(3))

(54) Title: DRIVE CHAIN, PIN, AND LINK

Fig. 1



(57) Abstract: A chain belt for a continuously variable transmission includes a plurality of links and a plurality of pins. Each link defines a first aperture and a second aperture. The pins connect the links, wherein a perimeter of at least one section of a first length of each pin is shaped like a circle with a flat-surfaced portion. In another embodiment, a link for a chain belt includes a body with a thickness, a first aperture and a second aperture through the thickness, wherein the first and the second aperture are each shaped like a cylinder with a convex portion protruding into the cylinder. In another embodiment, a pin for a chain belt includes first and second ends each cut at an angle oblique to a longitudinal axis, and a perimeter of at least one segment of a length of the pin shaped like a cylinder with a flat-surfaced portion.



DRIVE CHAIN, PIN, AND LINK

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

5 The invention pertains to the field of continuously variable transmissions. More particularly, the invention pertains to drive chains, chain pins, and chain links for continuously variable transmissions.

DESCRIPTION OF RELATED ART

10 Some continuously variable transmissions (CVTs) use a chain belt and two pulleys (usually called “sheaves”) which are connected by the chain belt. Each sheave has two halves with sloping inner surfaces. The effective diameter of the sheaves can be varied by changing the distance between the halves of the sheaves, which causes the chain belt load members (pins or struts) to move radially inward or outward from the axis of rotation in contact with the sloping inner faces of the sheaves. By expanding or contracting the sheaves oppositely, the position at which the load members of the chain belt contact the sloping inner surfaces of each of the sheaves changes, thereby changing the ratio of the transmission (the ratio of the rotational speed of the driving and driven sheaves).

20 Chain belts for a continuously variable transmission include lengthwise links with apertures which are connected to each other through pins or struts. Pin and link joint styles have evolved from a round pin joint style to a rocker pin joint style. A round pin joint style uses a cylindrical pin. A rocker joint includes a rocker member having at least two cylindrical rocker pins that contact each other by rolling or sliding on each other. Rocker joints have relatively little or no relative motion between links and pins, reducing friction and wear. Rocker pins, however, are significantly smaller than round pins, and allow more flex. The rocker joint has decreased strength density in the chain belt, resulting in a higher chain pitch and lower noise, vibration, and harshness (NVH) performance of the chain belt.

SUMMARY OF THE INVENTION

According to a first embodiment, a chain belt for a continuously variable transmission includes a plurality of links and a plurality of pins connecting the plurality of chain links. Each link defines a first aperture and a second aperture. The first aperture and the second aperture are each shaped like a cylinder with a convex portion protruding into the cylinder. Each pin has a first length and a perimeter of a section of the first length, the perimeter being shaped like a circle with a flat-surfaced portion. The flat-surfaced portion of the pin is configured to engage the convex portion of the aperture.

In another embodiment, a link for a chain belt of a continuously variable transmission includes a body with a thickness, a first aperture through the thickness of the body, and a second aperture through the thickness of the body. The first aperture and the second aperture are each shaped like a cylinder with a convex portion protruding into the cylinder. The first aperture and the second aperture are adjacent. The convex portion of the first aperture is oriented in the same location with respect to the first aperture as the convex portion of the second aperture is oriented with respect to the second aperture.

In a third embodiment, a pin for a chain belt of a continuously variable transmission includes a longitude having a longitudinal axis, a first end cut at an angle oblique to the longitudinal axis, a second end opposing the first end, the second end cut at an angle oblique to the longitudinal axis, a first length that extends between the first end and the second end from the first end to the second end, a second length that extends the total length of the pin, and a perimeter of at least one segment of the first length shaped like a cylinder with a flat-surfaced portion, the flat-surfaced portion and the first length being on a same side of the pin.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 shows a side view of the chain belt, according to an embodiment of the present invention.

Fig. 2 shows a top view of the chain belt of Fig. 1.

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Fig. 3 shows a side view of a pin of the chain belt, according to an embodiment of the present invention.

Fig. 4 shows a front view of the pin of Fig. 3.

5 Fig. 5 shows a side view of a link of the chain belt, according to an embodiment of the present invention.

Fig. 6 shows a front view of the link of Fig. 5.

Fig. 7 shows a front view of the link of Fig. 5, with detail A.

Fig. 8 shows a magnified view of detail A of Fig. 7.

10 Fig. 9 shows a side view of an articulated chain belt, according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, reference is made to the accompanying drawings that form a part thereof, and in which is shown by way of illustration specific exemplary embodiments in which the present teachings may be practiced. These embodiments are
15 described in sufficient detail to enable those skilled in the art to practice the present teachings and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the scope of the present teachings. The following description is, therefore, merely exemplary.

20 In various embodiments, components described as being “coupled” to one another can be joined along one or more interfaces. In some embodiments, these interfaces can include junctions between distinct components, and in other cases, these interfaces can include a solidly and/or integrally formed interconnection. That is, in some cases, components that are “coupled” to one another can be simultaneously formed to define a single continuous member. However, in other embodiments, these coupled components

can be formed as separate members and be subsequently joined through known processes (e.g., soldering, fastening, ultrasonic welding, bonding).

The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms
5 "a", "an" and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or
10 addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

When an element or layer is referred to as being "on", "engaged to", "connected to" or "coupled to" another element or layer, it may be directly on, engaged, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to",
15 "directly connected to" or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

20 As discussed above, the present disclosure pertains to the field of continuously variable transmissions, and more particularly, to drive chains, chain pins, and chain links for continuously variable transmissions. Figures 1-2 show a chain belt for a continuously variable transmission. The chain belt 10 has a plurality of links 12. Each of the links 12 has a first aperture 14 and a second aperture 16. Each of the first aperture 14 and the
25 second aperture 16 are configured to receive a single pin 18, and the links 12 are stacked on the pins 18 alternating first apertures 14 and second apertures 16, such that a plurality of pins 18 connect the plurality of links 12. Each pin 18 serves as a load member or strut for the CVT. It should be noted that the number of links may vary from the links shown in the Figures within the scope of the invention.

Referring to Fig. 3 and 4, each pin 18 has a first end 20, a second end 22, a first length L_1 , a second length L_2 , and a perimeter P at any section along the second length L_2 . The first end 20 and the second end 22 are each cut at an angle oblique to the first length L_1 and the second length L_2 to facilitate engagement with, or otherwise accommodate space for, the sloping inner faces of the sheaves (not shown). The second length L_2 is longer than the first length L_1 as a result of the oblique angle of the first and second ends 20, 22. The second length L_2 is the total length of the pin 18, and the first length L_1 is a length between the ends 20, 22. The perimeter P at sections along the first length L_1 is generally approximately circular. At least one segment of the first length L_1 , though, is shaped like a cylinder with a flat-surfaced portion 24. The pin 18 in this segment can be completely cylindrical except for the portion that has a flat surface. The flat-surfaced portion 24 can have a surface approximately parallel to a longitudinal axis 26 of the pin 18, and can define a minority of the perimeter of the at least one segment. The entire first length L_1 can have the flat-surfaced portion 24, or one or more segments of the first length L_1 can have the flat-surfaced portion 24. Reducing the flat-surfaced portion 24, and/or reducing the amount of the flat-surfaced portion 24, increases the amount of rounded portion, which can increase the strength of the pin 18.

As discussed below, the flat-surfaced portion 24 engages a feature in the first and second apertures 14, 16, such that the flat-surfaced portion 24 can be located around the perimeter 24 at a specified location to facilitate proper orientation of the obliquely angled first and second ends 20, 22. In the embodiment illustrated, the flat-surfaced portion 24 is on the same side of the pin 18 across which the length L_1 would be measured, so that a face of each obliquely angled, cut end 20, 22, faces toward the sheaves. Each pin 18 can be oriented in the chain belt 10, accordingly, so the flat-surfaced portion 24 matches the appropriate feature in the apertures 14, 16, and the obliquely angled ends 20, 22 match the sloping inner faces of the sheaves.

Referring to Figs. 5-8, each link 12 has a thickness T , and a first aperture 14 and a second aperture 16 extending through the thickness T . The apertures can be adjacent, or directly adjacent with no intervening apertures. Embodiments with more or less than two apertures are conceived as well. The first aperture 14 and the second aperture 16 are each

shaped like a cylinder 26 with a convex portion 28 protruding into the cylinder 26. The first and second apertures 14, 16 can be completely cylindrical except for the convex portion 28. The convex portion 28 is shown as a bump, bulge, protrusion, or tab upon which the flat-surfaced portion 24 of the pin 18 can abut to facilitate rotation of the pin 18 to a degree. Each convex portion 28 can be oriented in the same location with respect to the corresponding aperture. The convex portion 28 includes a first stop surface 30 to stop rotational movement of the pin 18 in the clockwise direction, and a second stop surface 32 to stop rotational movement of the pin 18 in the counter-clockwise direction relative to a point of contact 34. The convex portion 28 is shown as symmetrical in the figures, with rounded transitions between each of the first stop surface 30, the second stop surface 32, and the remainder of the cylinder 26. These rounded features can facilitate smooth rotational movement of the pin 18, relative to a corresponding one of the apertures 14, 16, through the desired range of rotational movement. The consistency and degree of curvature of the convex portion 28 can also cause movement of the pin 18 beyond rotational. For example, due to the rounded transition between each stop surface 30, 32, the point of contact 34 between the convex portion 28 and the pin 18 can shift as the pin 18 rotates relative to the respective aperture 14, 16, against the convex portion 28. In this case, the pin 18 can revolve around a center of the curvature of the convex portion 28 or can roll on the surface of the convex portion 28. Other particular shapes of the convex portion 28 are conceived, however. In one embodiment, for example the convex portion 28 can have a point, such that in the limited range of rotation of the pin 18, the point of contact 34 does not change, and the rotational movement of the pin 18 relative to the respective aperture 14, 16, is purely rotational and not revolutionary. In these and other embodiments, the pin 18 can have enough clearance 36 that the pin 18 might rotate at times without contact with the convex portion 28.

Further, the size of the convex portion 28 can vary, in coordination with the size of the pin 18 and flat-surfaced portion 24, to create a greater or lesser range of rotation and articulation, a greater or less strength, and a greater or lesser pitch. Increasing the size of clearance 36 between the convex portion 28 and the flat-surfaced portion 24 increases the amount of possible rotation of the pin 18 in the respective aperture 14, 16, and increases

the chain belt articulation angle capability. Fig. 9 shows the chain belt 10 articulated to a degree. To assist articulation and reduce friction, the pins 18 and/or links 12 can be coated with a suitable material, such as an electroless nickel with silicon carbide particles. The chain articulates at each joint similar to a chain with fully round pins, in contrast to the articulation of a chain with rocker pins, and prevents excessive rotation of the pins. The pins 18 are stronger than rocker pins, allowing use of a less massive link, and facilitating a higher strength density in the chain belt 10, and/or a smaller pitch in the chain belt 10, than in a comparable rocker joint chain belt.

Decreasing the size of the flat-surfaced portion 24 of the pin 18 (i.e., increasing the size of the rounded portion) and the size of the convex portion 28 of the first and second apertures 14, 16 increases the mass and strength of the pin 18, and enables the links 12 to have less mass. While the convex portion 28 can extend around a majority of a circumference of the first aperture 14 and around a majority of a circumference of the second aperture 16, in the embodiment of Figs. 1-9, the convex portion 28 can extend around a minority of a circumference of the first aperture 14 and around a minority of a circumference of the second aperture 16.

When the chain belt 10 is assembled, the plurality of links 12 can be arranged in rows on the plurality of pins 18. A second, now-known or future-developed type of link (not shown), that is different than the links 12, can be used in conjunction with the links 12. The second type of link can be compatible with a round pin, and can have apertures that are entirely cylindrical, for example, or that can otherwise work with a round pin. In one embodiment, at least one link 12 from the plurality of links 12 can be in each row, and the other links can be the second type of link. In this case, the articulation of each row of links is restricted by the at least one link 12 in each respective row. In another embodiment, at least one pin 18 extends consecutively through the first aperture 14 on a first of the links 12 and the second aperture 16 on a second of the links 12. In other words, the links 12 can be stacked on the pins 18 alternately between the first aperture 14 and the second aperture 16. Various similar patterns of stacking the links 12 on the pins 18 can be implemented. For example, the links can be stacked, amongst other ways, in a 2-way lacing pattern or a 3-way lacing pattern. A 2-way laced chain includes the following

material between 1 pitch length: $\frac{1}{2}$ pin + link + clearance + link + $\frac{1}{2}$ pin. A 3-way laced chain includes the following material between 1 pitch length: $\frac{1}{2}$ pin + link + clearance + $\frac{1}{2}$ pin. The one fewer link in the 3-way laced chain, an example of which is shown in Fig. 2, allows an increased pin thickness and/or link thickness.

5 In one embodiment, referring to Fig. 2, the links 12 are placed on any single pin 18 alternating between the right and left apertures 14, 16, but every few (e.g., second, third, fourth, etc.) links in a stack on the single pin, the same aperture is placed on the pin consecutively. Alternatively, the two links 12 placed consecutively with the same aperture (i.e., both right apertures 12 or both left apertures 14) on the pin 18 can instead be a single
10 thicker link – in some cases having a thickness anywhere from 1.1 times as thick to 2 times as thick, or more. This feature balances load across the chain belt 10. The more space between the links 12, the more bending that can occur. Particularly, the distance from the sheave contact to the first link 12 is important. The third link row counting link rows from the sheave contact can display the most bending, such that a consecutively
15 placed link 12 in this third link row can best be placed in this location in the chain belt 10, to help support the bending load.

 In embodiments of the chain belt 10 that include the plurality of links 12 and the second type of link, the pins 18 may need to have a flat-surfaced portion 24 only in a location along the first length L_1 where the pins 18 will engage the links 12. In these
20 embodiments, locations where the pins 18 engage the second links may be more suitably shaped entirely round, or another shape. Accordingly, the entire perimeter of at least one segment of the first length L_1 of each pin 18 can be shaped like a circle or a shape different from the shape at a section of the pins 18 having the flat-surfaced portions 24. Further, the perimeter of at least one segment of the length L_1 of at least one pin 18 can be shaped
25 entirely cylindrically or of a shape different from the shape at a section of the pins 18 having the flat-surfaced portions 24.

 Accordingly, it is to be understood that the embodiments of the invention herein described are merely illustrative of the application of the principles of the invention. Reference herein to details of the illustrated embodiments is not intended to limit the

scope of the claims, which themselves recite those features regarded as essential to the invention.

What is claimed is:

1. A chain belt for a continuously variable transmission, the chain belt comprising:

a plurality of links, each link defining a first aperture and a second aperture; and

a plurality of pins connecting the plurality of links, each pin having a first length, a
5 perimeter of at least one section of the first length shaped like a circle with a
flat-surfaced portion,

wherein the first aperture and the second aperture are each shaped like a cylinder with
a convex portion protruding into the cylinder,

wherein the flat-surfaced portion of the pin is configured to engage the convex portion
10 of the first aperture and the second aperture.

2. The chain belt of claim 1, wherein each convex portion is oriented in each respective
aperture in the same location relative to each respective aperture.

3. The chain belt of claim 1, wherein each convex portion includes a first stop surface to
stop rotation of the pins in the clockwise direction relative to each respective
15 aperture, and a second stop surface to stop rotation of the pins in the counter-
clockwise direction relative to each respective aperture.

4. The chain belt of claim 1, further comprising at least one second link, the second link
having a first aperture and a second aperture, at least one of the first aperture and
the second aperture shaped entirely cylindrically.

20 5. The chain belt of claim 1, further comprising at least one second link with two apertures
different in shape from the first aperture and the second aperture, the plurality of
links and the at least one second link arranged in rows on the plurality of pins, at
least one link from the plurality of links in each row.

6. The chain belt of claim 1, wherein at least one pin from the plurality of pins extends consecutively through the first aperture on a first link from the plurality of links and a second aperture on a second link from the plurality of links.
- 5 7. The chain belt of claim 1, wherein the flat-surfaced portion defines a minority of the perimeter of the at least one section.
8. The chain belt of claim 1, wherein each pin comprises a first end, a second end, and a second length, the first end and the second end each cut at an angle oblique to a longitudinal axis of the first length, the second end defining an overall length of the pin, the first length being a length between the first end and the second end.
- 10 9. The chain belt of claim 7, wherein the flat-surfaced portion and the first length of each pin are on a same side of each respective pin.
10. The chain belt of claim 1, wherein the perimeter at any section of at least one segment of the first length of at least one from the plurality of pins is shaped entirely cylindrically.
- 15 11. The chain belt of claim 1, wherein the entire perimeter of at least a second section of the length of each pin is shaped like a circle.
12. The chain belt of claim 1, wherein each of the first aperture and the second aperture of each of the plurality of links is configured to receive a single pin.
- 20 13. The chain belt of claim 1, wherein each convex portion includes a first stop surface to stop rotation of the pins in the clockwise direction relative to each respective aperture, and a second stop surface to stop rotation of the pins in the counter-clockwise direction relative to each respective aperture, each convex portion having a rounded transition between the respective first stop surface and the respective second stop surface.
- 25 14. The chain belt of claim 1, wherein a single pin from the plurality of pins extends through one aperture of each of a plurality of links of the plurality of links, the

apertures consecutively alternating between left and right, wherein at least two consecutive apertures through which the single pin extends repeat left or right.

15. The chain belt of claim 1, wherein the plurality of links comprise first links of a first thickness and second links of a second thickness, the second thickness being
5 greater than the first thickness.
16. A link for a chain belt of a continuously variable transmission, the link comprising:
- a body with a thickness;
 - a first aperture through the thickness of the body; and
 - a second aperture through the thickness of the body,
 - 10 the second aperture adjacent the first aperture,
 - the first aperture and the second aperture each shaped as a cylinder with a convex portion protruding into the cylinder,
 - the convex portion of the first aperture oriented in the same location with respect to the first aperture as the convex portion of the second aperture is oriented with
15 respect to the second aperture.
17. A pin for a chain belt of a continuously variable transmission, the pin comprising:
- a longitude including a longitudinal axis;
 - a first end being cut at an angle oblique to the longitudinal axis;
 - a second end opposing the first end, the second end being cut at an angle oblique to
20 the longitudinal axis;
 - a first length, the first length extending between the first end and the second end from the first end to the second end; and
 - a second length, the second length extending the total length of the pin,

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a perimeter of at least one segment of the first length being shaped like a cylinder
with a flat-surfaced portion,

the flat-surfaced portion and the first length being on a same side of the pin.

Fig. 2

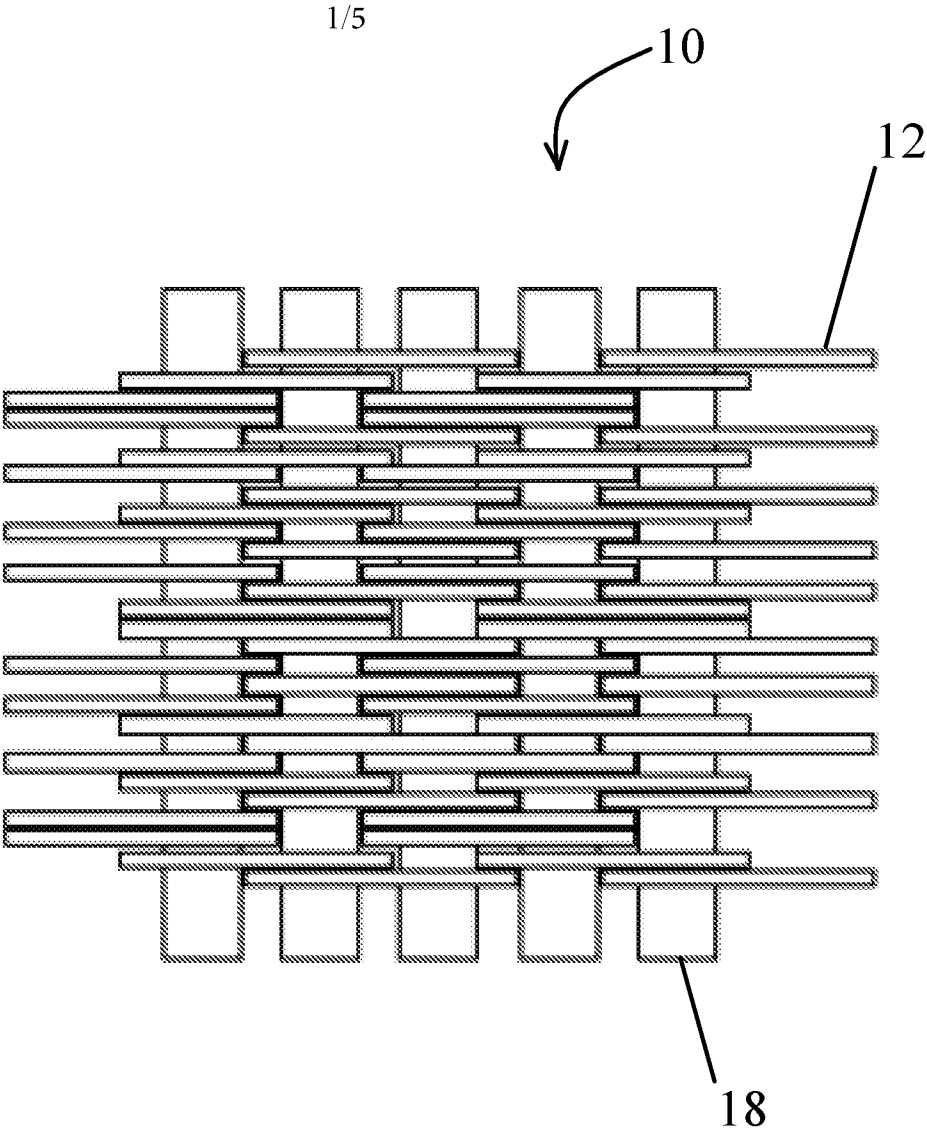


Fig. 1

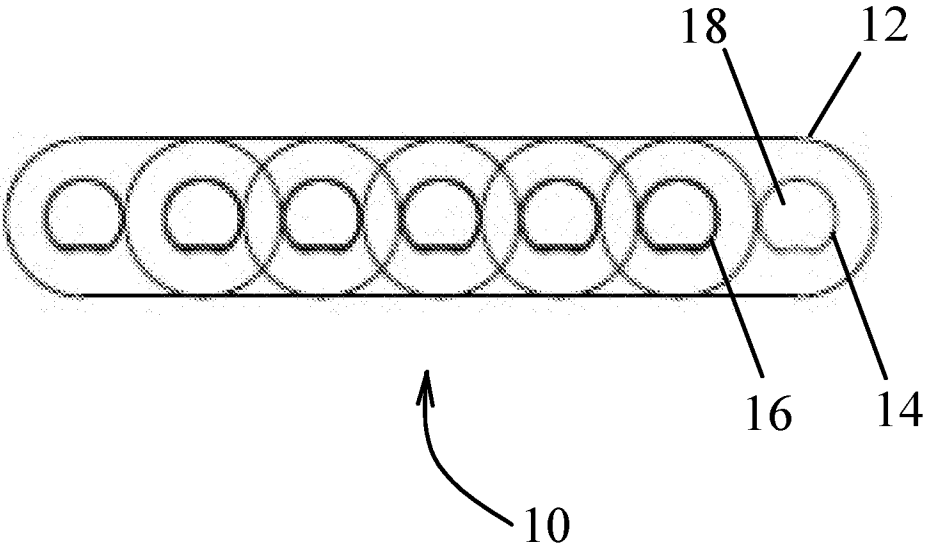


Fig. 3

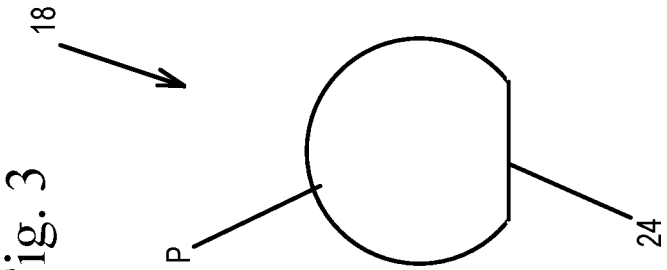


Fig. 4

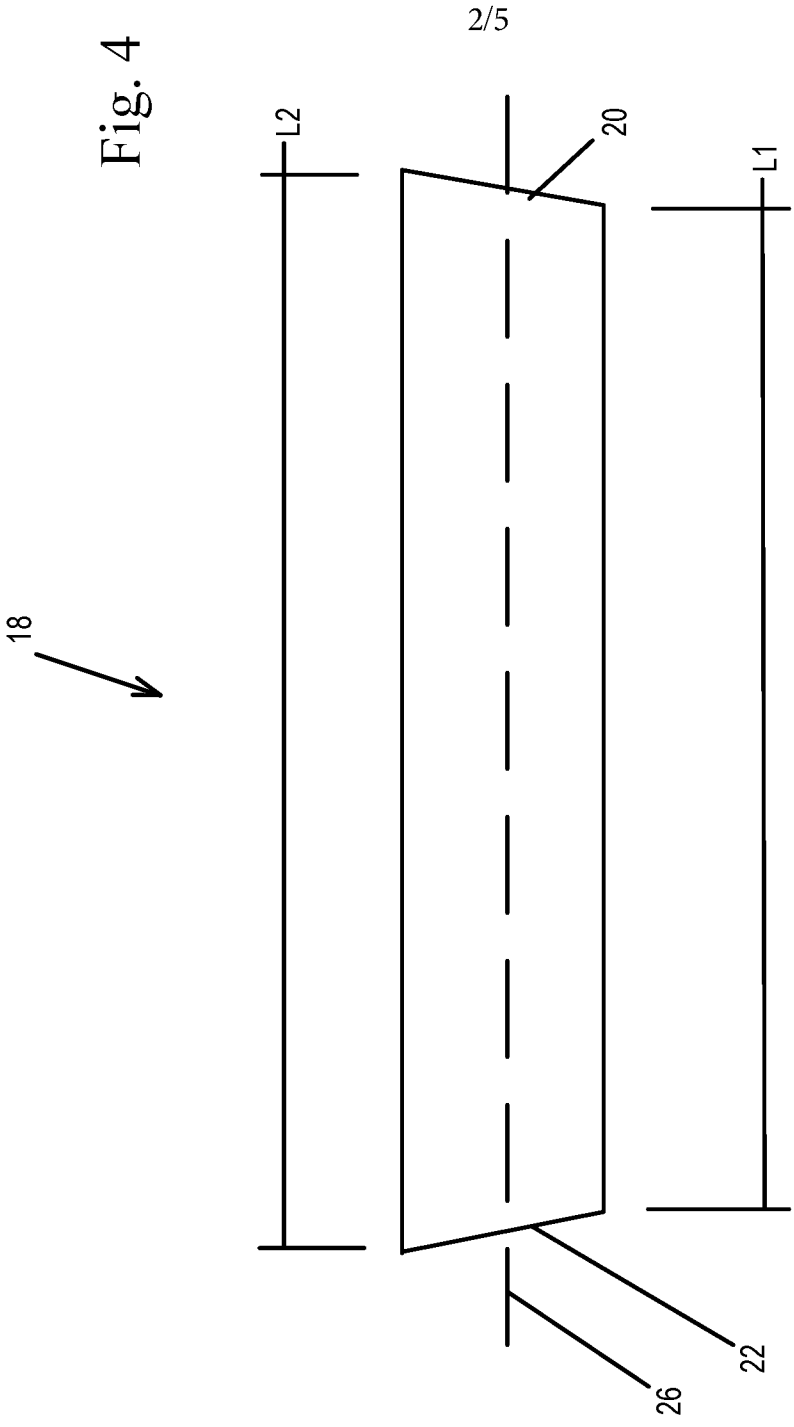


Fig. 5

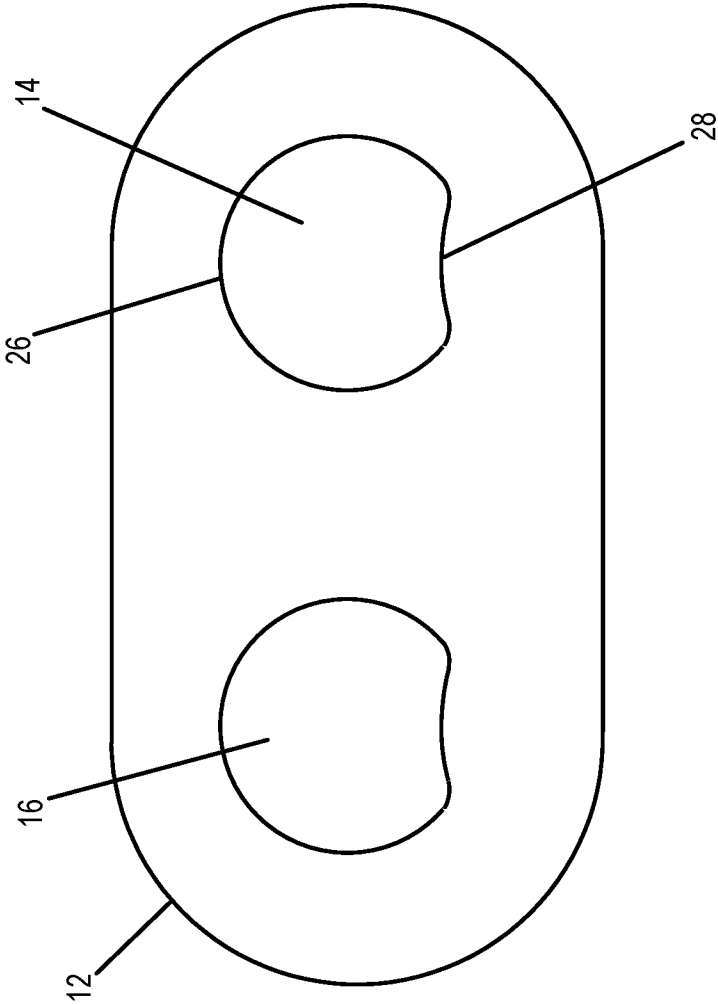


Fig. 6



Fig. 7

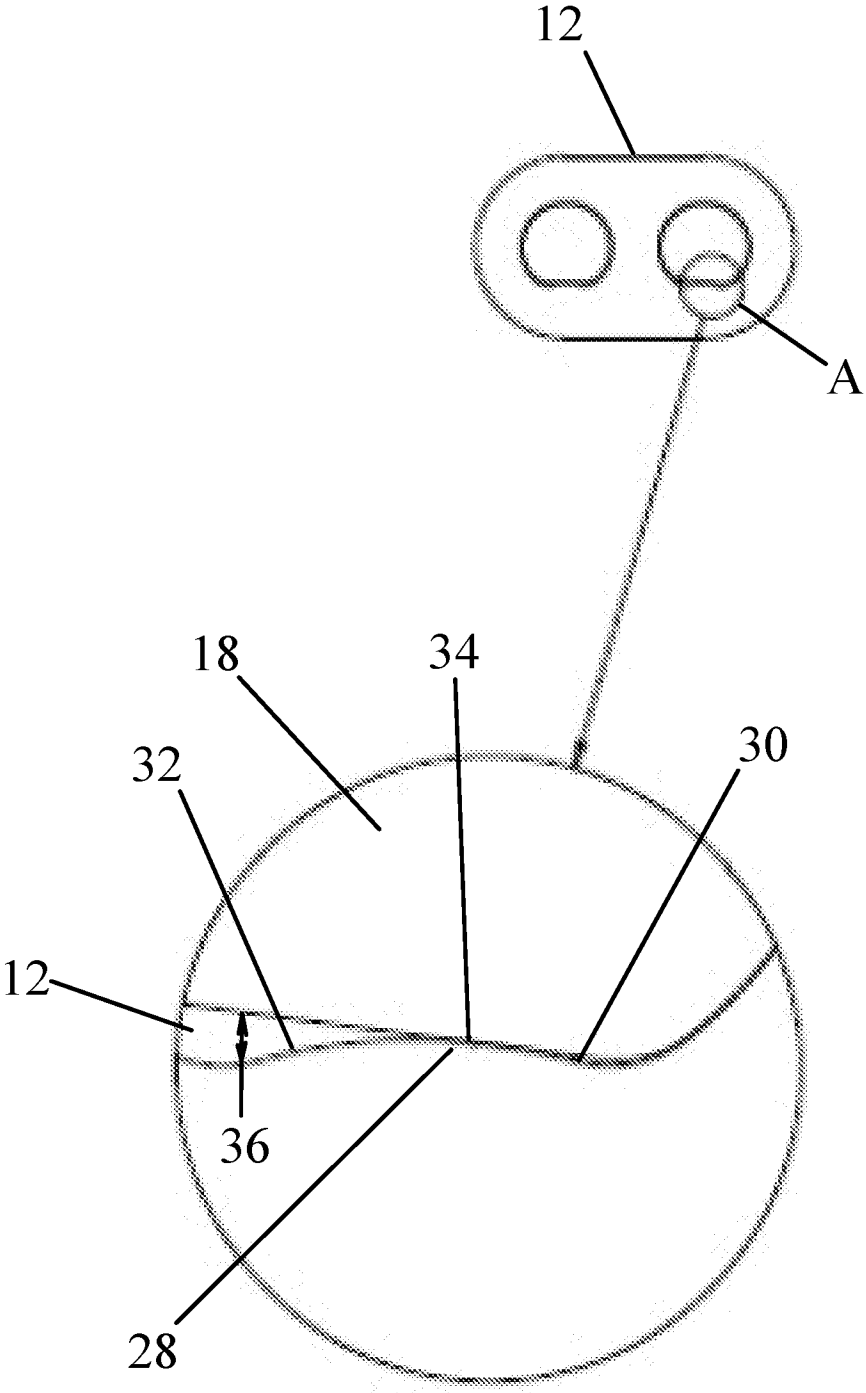


Fig. 8

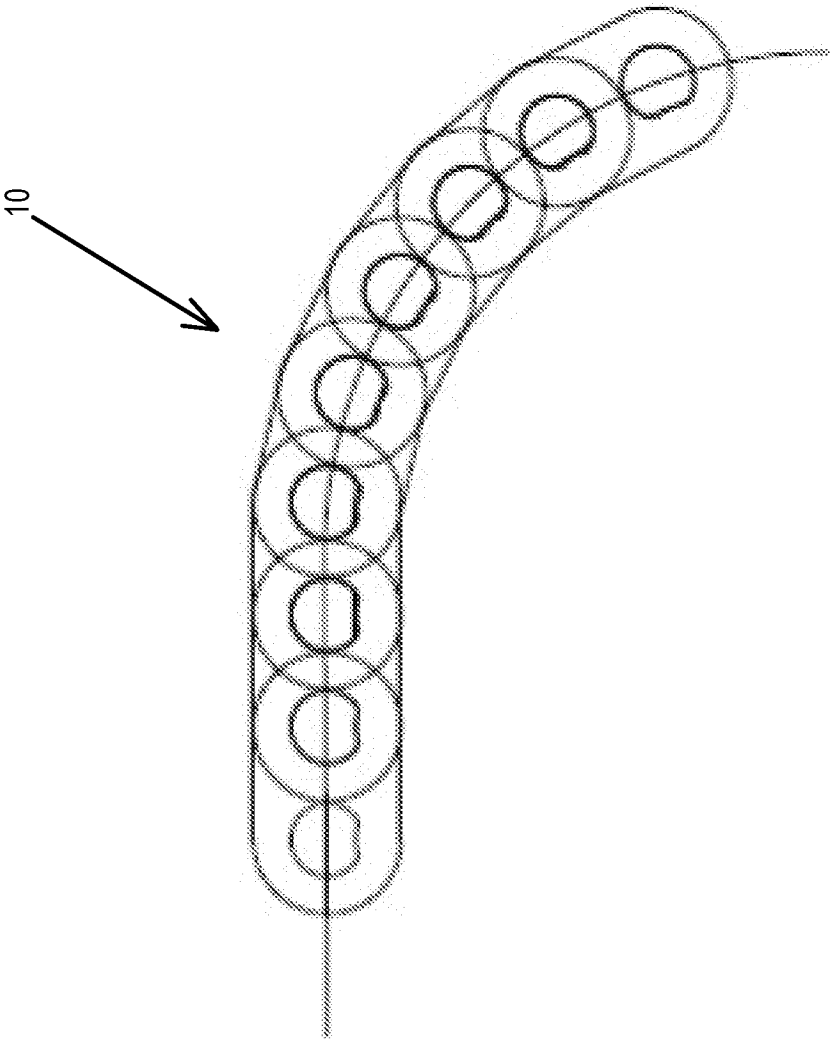


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/039725**A. CLASSIFICATION OF SUBJECT MATTER****F16G 13/06(2006.01)i, F16G 13/08(2006.01)i**

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)

F16G 13/06; F16G 13/04; F16G 1/00; F16G 15/02; F16G 5/18; F16G 13/08

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: chain belt, link, aperture, convex portion, pin, flat-surfaced portion

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5192253 A (COLE, JR. et al.) 09 March 1993 See column 4, line 37 - column 6, line 38; and figures 1-9.	1-7, 9-16
Y		8, 17
Y	EP 2706264 A2 (JTEKT CORPORATION) 12 March 2014 See paragraphs [0016]-[0023]; and figures 1-4, 5A-5B.	8, 17
A	US 4500305 A (RATTUNDE, MANFRED) 19 February 1985 See column 4, line 64 - column 5, line 40; and figures 4-8.	1-17
A	US 5464374 A (MOTT, PHILIP J.) 07 November 1995 See column 5, line 57 - column 6, line 2; and figures 8-9.	1-17
A	US 2003-0036450 A1 (LINNENBRUGGER et al.) 20 February 2003 See paragraphs [0050]-[0051]; and figure 5.	1-17



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

21 December 2017 (21.12.2017)

Date of mailing of the international search report

22 December 2017 (22.12.2017)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

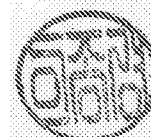
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/039725

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5192253 A	09/03/1993	EP 0563362 A1	06/10/1993
		EP 0563362 B1	18/12/1996
		JP 07-286643 A	31/10/1995
		JP 2003-000002 U	28/03/2003
		JP 2607890 Y2	18/08/2004
		JP 3695785 B2	14/09/2005
		US 5334111 A	02/08/1994
		US 5423724 A	13/06/1995
		WO 93-08418 A1	29/04/1993
EP 2706264 A2	12/03/2014	CN 103671716 A	26/03/2014
		CN 103671716 B	26/04/2017
		EP 2706264 A3	13/05/2015
		EP 2706264 B1	08/03/2017
		JP 2014-052018 A	20/03/2014
		JP 5951418 B2	13/07/2016
		US 2014-0066243 A1	06/03/2014
		US 9316287 B2	19/04/2016
US 4500305 A	19/02/1985	DE 000003129631 A1	17/02/1983
		DE 000003129631 C2	08/12/1983
		JP 58-024641 A	14/02/1983
		JP 58-049746 B2	07/11/1983
US 5464374 A	07/11/1995	JP 08-100838 A	16/04/1996
US 2003-0036450 A1	20/02/2003	AU 1692801 A	04/06/2001
		DE 10052473 A1	23/05/2001
		FR 2801357 A1	25/05/2001
		FR 2801357 B1	09/06/2006
		IT 1319348 B1	10/10/2003
		IT MI20002489 A1	21/05/2001
		JP 2001-140987 A	22/05/2001
		JP 2003-515076 A	22/04/2003
		JP 4945822 B2	06/06/2012
		KR 10-0671687 B1	18/01/2007
		KR 10-2002-0077873 A	14/10/2002
		NL 1016647 A1	22/05/2001
		NL 1016647 C2	27/07/2001
		NL 1018594 A1	30/08/2001
		NL 1018594 C2	28/12/2001
		NL 1018595 A1	30/08/2001
		NL 1018595 C2	28/12/2001
		NL 1018596 A1	30/08/2001
		NL 1018596 C2	28/12/2001
		NL 1018597 A1	30/08/2001
		NL 1018597 C2	28/12/2001
		US 2003-0186767 A1	02/10/2003
		US 2009-0192001 A1	30/07/2009

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/039725Patent document
cited in search reportPublication
datePatent family
member(s)Publication
date

US 6558281 B1	06/05/2003
US 6824484 B2	30/11/2004
US 7320656 B2	22/01/2008
US 7937925 B2	10/05/2011
WO 01-38755 A1	31/05/2001