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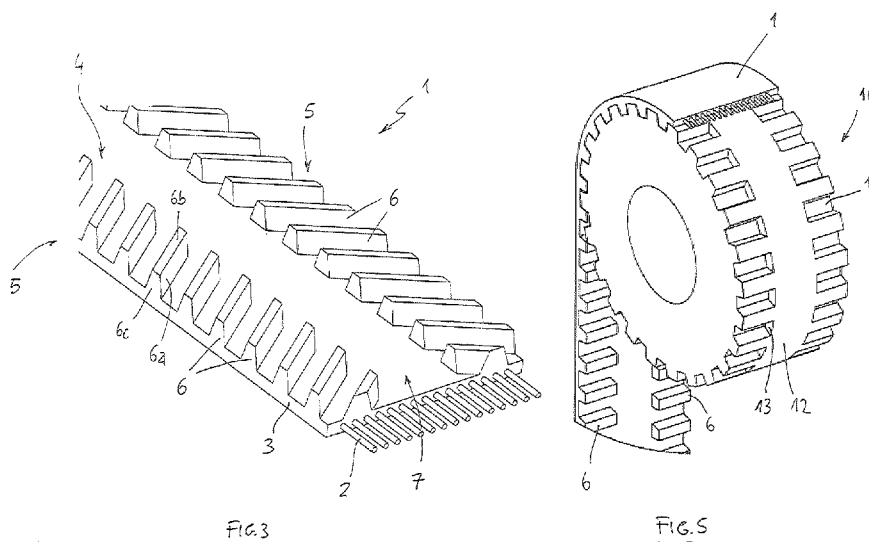
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, 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.

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(54) **Title:** POWER TRANSMISSION BELT



(57) **Abstract:** A load-bearing belt (1), in particular for an elevator without counterweight, comprising a plurality of tensile elements (2) encapsulated in a case (3), and a working side (4) for contact with sheaves, said working side comprising: at least one row (5) of tooth members (6) projecting from the surface of said working side, thus forming at least one toothed band portion of said working side, and at least one non-toothed band portion (7) with a flat surface for contact with sheaves.

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POWER TRANSMISSION BELT

DESCRIPTION

5 Field of the invention

The present invention discloses a load-bearing belt. Said belt is adapted, in particular, for use in the drive system of an elevator. The invention also relates to a belt drive system and an elevator including said drive system.

Prior art

- 10 A known embodiment for a load-bearing belt comprises a plurality of tensile elements encapsulated in a case. Such load-bearing belts are widely used, for example, to suspend the cabin of an elevator.

- Known load bearing members for elevators include conventional ropes and belts reinforced by internal tensile members. In modern elevators, a reinforced
- 15 load-bearing belt is generally preferred to ropes because of a number of advantages including, for example, reduced diameter of the sheaves. GB-A-1362514 discloses a traction member for elevators having a number of steel cords encapsulated in a plastic medium. WO 2011/032787 discloses a traction member comprising a plurality of tensile ropes encapsulated in a case, said
- 20 case having a flat non-working surface and a concave working surface, for contact with a sheave of the drive assembly of an elevator, and where the tensile ropes lie in a plane which is parallel to said non-working surface.

More in detail, prior-art belts for elevators include flat belts and toothed belts.

- A flat belt has a substantially flat surface for contact with the sheave. This kind
- 25 of belt is simple and has a low cost; however it suffers some drawbacks. With a flat contact surface with the sheave, the transmissible torque depends purely on the friction between the sheave and the belt. It has been observed that a

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flat belt is highly sensitive to the environment and can easily slip if contaminated with oil or water. Another drawback is that a flat belt can be deviate from a centered position relative to the sheave; such deviation may induce a stress other than pure traction, which is detrimental for the life of the
5 belt.

A toothed belt overcomes the disadvantage of slipping because the teeth of the belt engage recesses on a traction sheave and, hence, slipping is prevented. However the conventional toothed belts has proven to produce a significant noise. In this respect, a disadvantage of a toothed belt is that
10 deflection (idle) sheaves must also have the same recesses of a traction sheave, for a proper engagement with the belt, despite the fact that they need not transmit torque. Hence a deflection sheaves produce more contact noise than necessary. Moreover, a conventional toothed belt does not solve the problem of centering since the teeth may slip in the transverse direction.

15 Summary of the invention

The present invention aims to overcome the above drawbacks. This aim is reached with a load-bearing belt comprising a plurality of tensile elements encapsulated in a case, and a working side for contact with sheaves, said working side comprising:

- 20 - at least one row of tooth members projecting from the surface of said working side, thus forming at least one toothed band portion of said working side, and
- at least one non-toothed band portion with a flat surface for contact with at least one sheave.

25 The term of longitudinal band is used to denote a stripe extended lengthwise on the working side of the belt.

The number of row or rows of tooth members may vary. In a first embodiment, for example, the working side of the belt comprises two lateral rows of tooth

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members leaving a non-toothed band in the middle of the belt; in a second embodiment which could be seen as specular to said first embodiment, the belt has one central row of tooth members leaving two lateral non-toothed bands.

- 5 The tooth members are designed to transmit the full torque or at least a fraction thereof. In some embodiments also the non-toothed flat band(s) may contribute to torque transmission. In a preferred embodiment, the radial load is substantially born by the flat portion(s) of the belt, whilst the traction is born by the toothed portion(s).
- 10 The cross section of the tooth members can be, for example, rectangular or, in some preferred embodiments, tapered from base to tip with front and rear surfaces inclined relative to the surface of the working side.

- In some embodiments the tooth members are inclined. An inclination of tooth members can be defined as the angle formed by a direction perpendicular to
- 15 front or rear surfaces of the tooth members, when projected on the plane of the working side of the belt, and the longitudinal direction of the belt. Said angle is null in straight (non-inclined) embodiments. In a preferred embodiment with inclined tooth members, said angle is 30 to 60 degrees and more preferably around 45 degrees.

- 20 According to an embodiment, the belt comprises a left row and a right row of toothed members with opposite angle of inclination, leading to tooth members appearing in a "chevron" or "fish bone" arrangement.

- A traction sheave designed for operation with the inventive belt has an appropriate distribution of recesses for engagement with the tooth members,
- 25 and a flat surface for contact with the flat (non-toothed) part of the belt.

A deflection sheave may have one or more grooves for accommodation of the row or rows of tooth members on the belt. More preferably, only the flat part of the belt is in contact with the surface of a deflection sheave. To this purpose, a

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deflection sheave may have a groove or a plurality of grooves in correspondence of the row or rows of tooth members, and the depth of said groove(s) is greater than the projection of the tooth members in such a way that the top surface of the tooth members does not come into contact with the
5 bottom surface of said groove(s).

The invention provides a hybrid load-bearing belt including features of a flat belt and of a toothed belt. Said belt is preferably used for an elevator and more preferably for an elevator without counterweight.

A first advantage is that the tooth members avoid the slipping drawback of
10 conventional fully flat belts and at the same time they ensure a proper traction. Another advantage is that the tooth members provide a self-centering feature upon engagement with corresponding recesses of a sheave. Another advantage is that the contact area with idle sheaves can be reduced and hence the operation is less noisy. A further advantage of the "fishbone"
15 embodiment is a progressive, smooth engagement between the toothed members and the respective recesses of a traction sheave, thus allowing a further reduction of noise.

The tensile elements may have a circular cross section (wires) or any non-circular cross section. According to preferred embodiments, the tensile
20 elements are metal wires but non-metal tensile elements could also be adopted. The case may be made of a suitable plastic material.

An object of the invention is also a belt drive system comprising said belt. In preferred embodiments, the belt drive system includes at least one toothed sheave and at least one non-toothed sheave. Preferably, a toothed sheave
25 acts as traction sheave and a non-toothed sheave acts as deflection sheave. More preferably a belt drive system according to the invention comprises:

- at least one toothed sheave;
- at least one non-toothed sheave;

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- a belt wherein a plurality of tensile elements are encapsulated in a case and the belt has a working side for contact with sheaves, said working side comprising:
 - at least one row of tooth members projecting from the surface of said working side, thus forming at least one toothed band portion of said working side, and
 - at least one non-toothed band portion with a flat surface for contact with a non-toothed sheave.

A preferred and important field for application of the present invention is the field of elevators and more preferably of elevators without counterweight. Hence the belt drive system of the invention is preferably a drive system of an elevator and more preferably of an elevator without counterweight. Small elevators without a counterweight (homelifts) are suitable in particular for serving a small number of people and a small number of floors; they are attractive in particular for new buildings under construction as well as renovation of old buildings where installation of a conventional elevator with counterweight is impossible or too expensive.

These and other advantages of the invention will be elucidated hereinbelow with reference to preferred and non-limiting embodiments.

Description of the figures

Figs. 1-2 are a perspective view and a top view of a belt according to a first embodiment of the invention.

Figs. 3-4 are a perspective view and a top view of a belt according to a second embodiment of the invention

Figs. 5, 6 show a belt according to Figs. 1-2 when engaged with specifically designed pulleys.

Fig. 7 is a detail of Fig. 6.

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Figs. 8-9 show a belt according to Figs. 3-4 when engaged with specifically designed pulleys.

Fig. 10 is a perspective view of a belt according to another embodiment.

Fig. 11 is a cross section of the belt of Fig. 10.

5 Detailed description of preferred embodiments

Figs. 1 and 2 depict a first embodiment of a load-bearing belt 1 comprising a plurality of tensile ropes 2 encapsulated in a case 3, and a working side 4 for contact with sheaves. The working side 4 carry two rows 5 of tooth members 6, projecting from the surface of said working side 4. The two rows 5 of tooth members 6 leave a longitudinal flat band 7 on the belt 1.

The tooth members 6 can be integrally made with the case 3. A tooth member 6 comprises front/rear faces 6a, a top face 6b and side faces 6c. Preferably said tooth members 6 have an elongated shape of a prism; more preferably said members 6 have a tapered section from a base to a tip, which means that front and rear faces 6a are inclined relative to a plane perpendicular to the surface of the working side 4.

Figs. 1 and 2 relate to an embodiment where the said tooth members 6 are straight, i.e. they are transversal with respect to the longitudinal direction of the belt 1.

Figs. 3-4 show an embodiment where inclined tooth members 6 are arranged in two rows 5 and with a "fishbone" arrangement. The left tooth members 6 form a first inclination angle α_1 with the longitudinal direction of the belt. Said angle of inclination can be seen as the angle formed by a projection on the surface of side 4 of a vector 8 perpendicular to a front face 6a (Fig. 4). The right tooth members 6 have an inclination by a second angle α_2 equal and opposite to said first angle α_1 , i.e. $\alpha_2 = -\alpha_1$. Hence, a tangential force transmitted to the rows 5 is compensated.

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The height **h** of a tooth member 6 and the thickness **s** of the belt are also shown in Fig. 1. In preferred embodiments of the invention, the ratio h/s ranges from 0.5 to 5. For example in a belt 2 mm thick, the height of tooth members 6 may range from 1 to 10 mm. The width of a non-toothed band portion of the belt is preferably at least 1/5 of the width of the belt; more preferably the rows 5 and the band 7 in Figs. 1-4 have a width around 1/3 (one third) of the overall width.

Fig. 5 shows the load-bearing belt 1 according to the embodiment of Figs. 1-2 when engaged with a traction sheave 10. Said sheave 10 has recesses 11 for engagement with the tooth members 6; in this example the recesses 11 are distributed in accordance with the embodiment of the belt 1, namely at the sides of the contact face of the pulley 10 for engagement with the two rows 5 of tooth members 6, leaving a flat section 12 in the middle of the pulley.

Fig. 6 show the belt 1 in contact with a deflection sheave 20. A deflection sheave is not powered and need not deliver torque to the belt. Hence said sheave 20 need no recesses for singular, torque-transmitting engagement with the tooth members 6. In a preferred embodiment, said sheave 20 has continuous grooves 21 for accommodation of the rows 5 of tooth members 6. More preferably, the depth of said grooves 21 is greater than the projection distance (height) of the tooth members 6, in such a way that the top surface 6b of the tooth members 6 does not come into contact with the bottom surface 22 of said grooves 21. The sheave 20 is contacted on flat surface 23 by the surface of flat portion 7 of the belt 1 (Fig. 7).

It can be appreciated from both Figs. 5 and 6 the self-centering feature of the belt 1, thanks to side faces 6c of the tooth members 6 resting again flanks 13 of recess 11 in the traction sheave 10 or, respectively, flanks 24 of the grooves 21 in deflection sheave 20.

Figs. 8 and 9 show another embodiment of a belt 1 and a corresponding embodiment of sheaves 10, 20. In this case, the belt 1 has one central row 5 of

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tooth members 6, and two lateral flat bands 7. Correspondingly, a traction sheave 10 has one set of recesses 11 and a deflection sheave 20 has one central groove 21 for accommodation of the tooth members 6.

5 Figs. 10 and 11 relate to another embodiment where the inner side face 6c of tooth members 6 is inclined by an angle β . Said angle β is preferably in the range $5^\circ - 45^\circ$ and more preferably around 10° . Said angled inner face allows a smooth engagement with the recesses 11 of a traction sheave and reduces belt stress and noise. Said embodiment is applicable also to belts with inclined tooth members as in Figs. 3-4.

10 Preferably, the traction is transmitted by the engagement of tooth members 6 with recesses 11 of one (or more) traction sheave(s) 10, whilst radial forces are borne by the flat portion(s) 7 of the working belt side 4 in contact with the corresponding flat sections 12, 23 of the sheaves.

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CLAIMS

1. A load-bearing belt (1) comprising a plurality of tensile elements (2) encapsulated in a case (3), and a working side (4) for contact with sheaves, said working side comprising:
 - 5 - at least one row (5) of tooth members (6) projecting from the surface of said working side, thus forming at least one toothed band portion of said working side, and
 - at least one non-toothed band portion (7) with a flat surface for contact with at least one sheave.
- 10 2. A belt according to claim 1, said working side comprising two lateral rows (5) of tooth members (6) and a central non-toothed flat portion (7), or a central row of tooth members leaving two lateral non-toothed flat portions.
3. A belt according to any of the preceding claims, each of said tooth members having a shape of an elongated prism stemming from said
15 working side of the belt, with front and rear surfaces (6a), a top face (6b) and side faces (6c).
4. A belt according to claim 3, the tooth members (6) having a rectangular cross section with front and rear surfaces (6a) perpendicular to the surface
20 of the working side, or said tooth members (6) having a tapered cross section from base to tip, with front and rear surfaces (6a) inclined relative to the surface of the working side.
5. A belt according to claim 3 or 4, where a direction perpendicular to said front or rear surfaces (6a), when projected on the plane of the working side of the belt, forms an angle of inclination (a1) with the longitudinal direction
25 of the belt, said angle being preferably 30 to 60 degrees.
6. A belt according to claim 5, comprising two lateral rows (5) of toothed members, and where tooth members of one row have a first angle of

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inclination (a1) and tooth members of the other row have a second angle of inclination (a2) equal and opposite to said first angle.

7. A belt according to any of the preceding claims, said tooth members (6) being integrally with the encapsulation case (3) of the belt.
- 5 8. A belt according to any of the preceding claims for an elevator, in particular for an elevator without counterweight.
9. A belt drive system, comprising
 - at least one toothed sheave,
 - at least one non-toothed sheave,
 - 10 - a belt wherein a plurality of tensile elements (2) are encapsulated in a case (3), and said belt having a working side (4) for contact with sheaves, said working side comprising:
 - at least one row (5) of tooth members (6) projecting from the surface of said working side, thus forming at least one toothed band portion of
 - 15 said working side, and
 - at least one non-toothed band portion (7) with a flat surface for contact with a non-toothed sheave.
10. A belt drive system according to claim 9 for an elevator, in particular for an elevator without counterweight.
- 20 11. A belt drive system comprising a load-bearing belt (1) according to any of the claims 1 to 8.
12. A belt drive system according to any of claims 9 to 11, said drive system comprising at least one traction sheave (10) and at least one deflection sheave (20), said traction sheave having recesses (11) for singular
- 25 engagement with the tooth members (6), and said deflection sheave

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having one or more grooves (21) for accommodation of the row or rows of tooth members on the belt.

13. A belt drive system according to claim 12, the depth of said groove or grooves (21) of said deflection sheave (20) being greater than the
5 projection of the tooth members (6) of the belt (1), in such a way that the top surface (6b) of the tooth members does not come into contact with the bottom surface of said groove or grooves.
14. An elevator, preferably an elevator without counterweight, comprising a belt drive system according to any of claims 9 to 13.

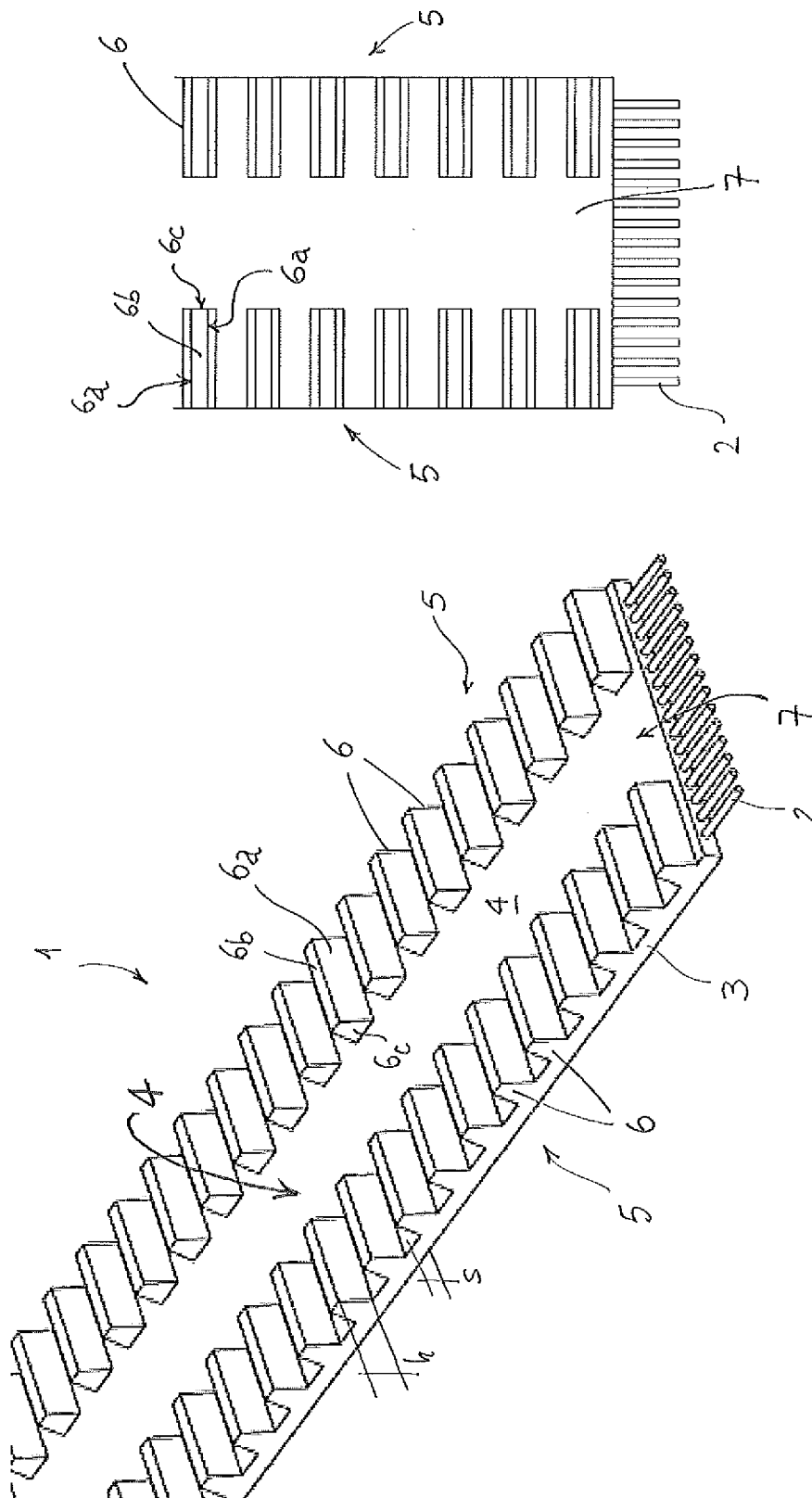
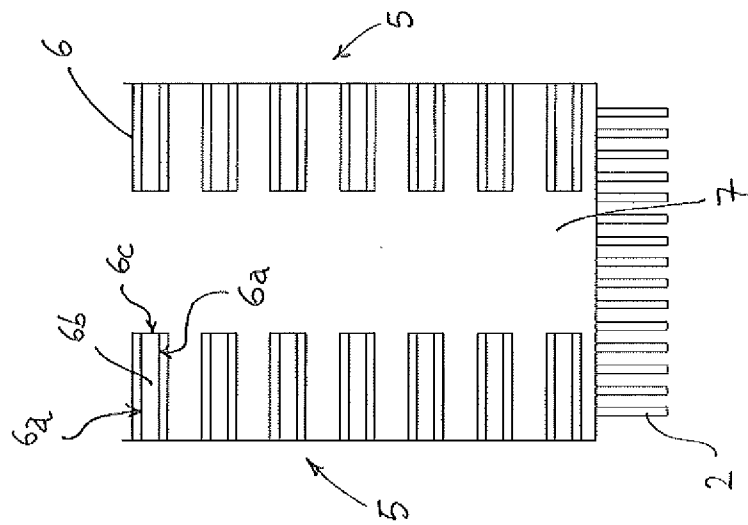
FIG. 1

Fig. 2

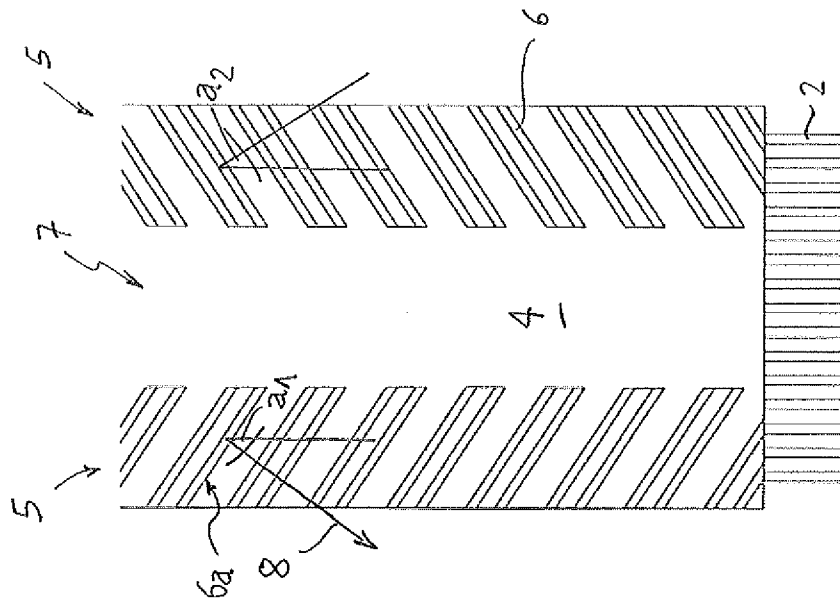
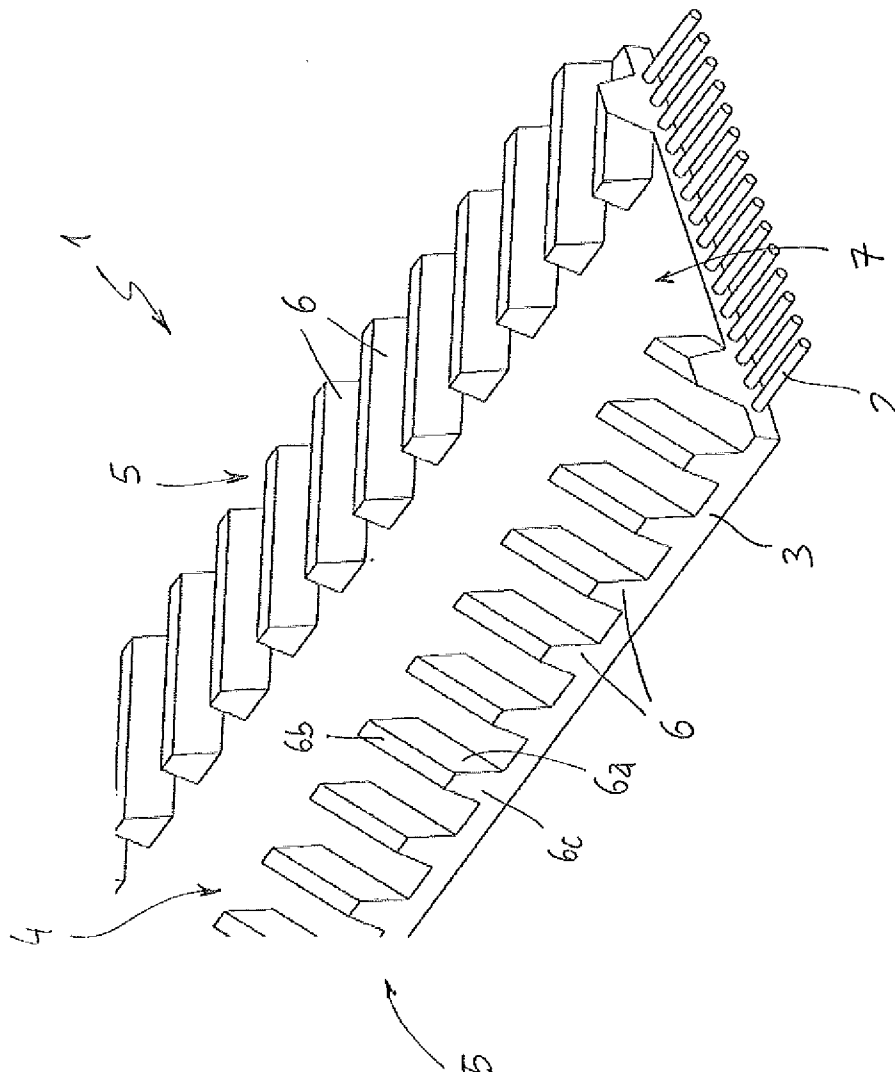


Fig. 4

FIG. 3

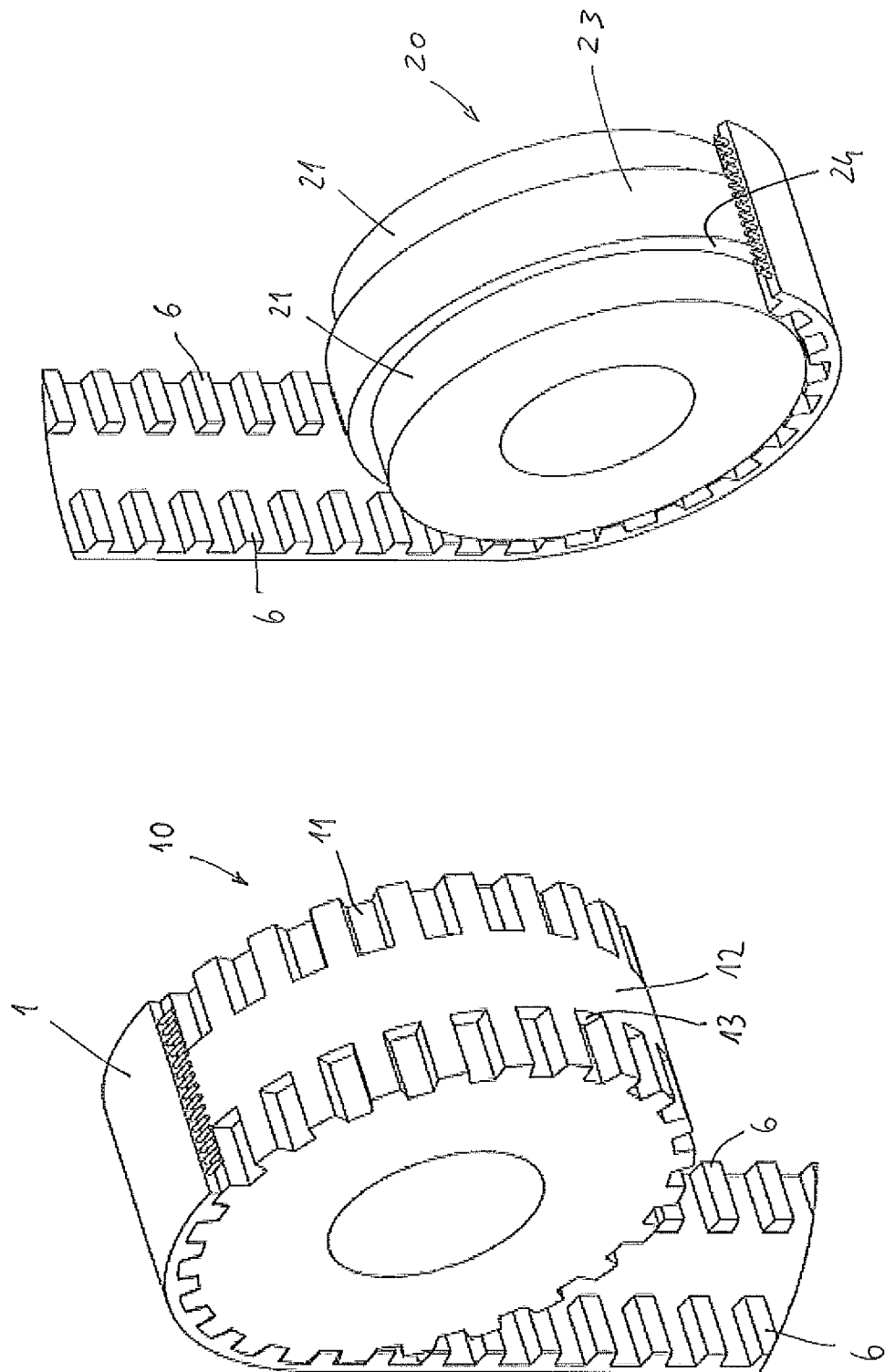
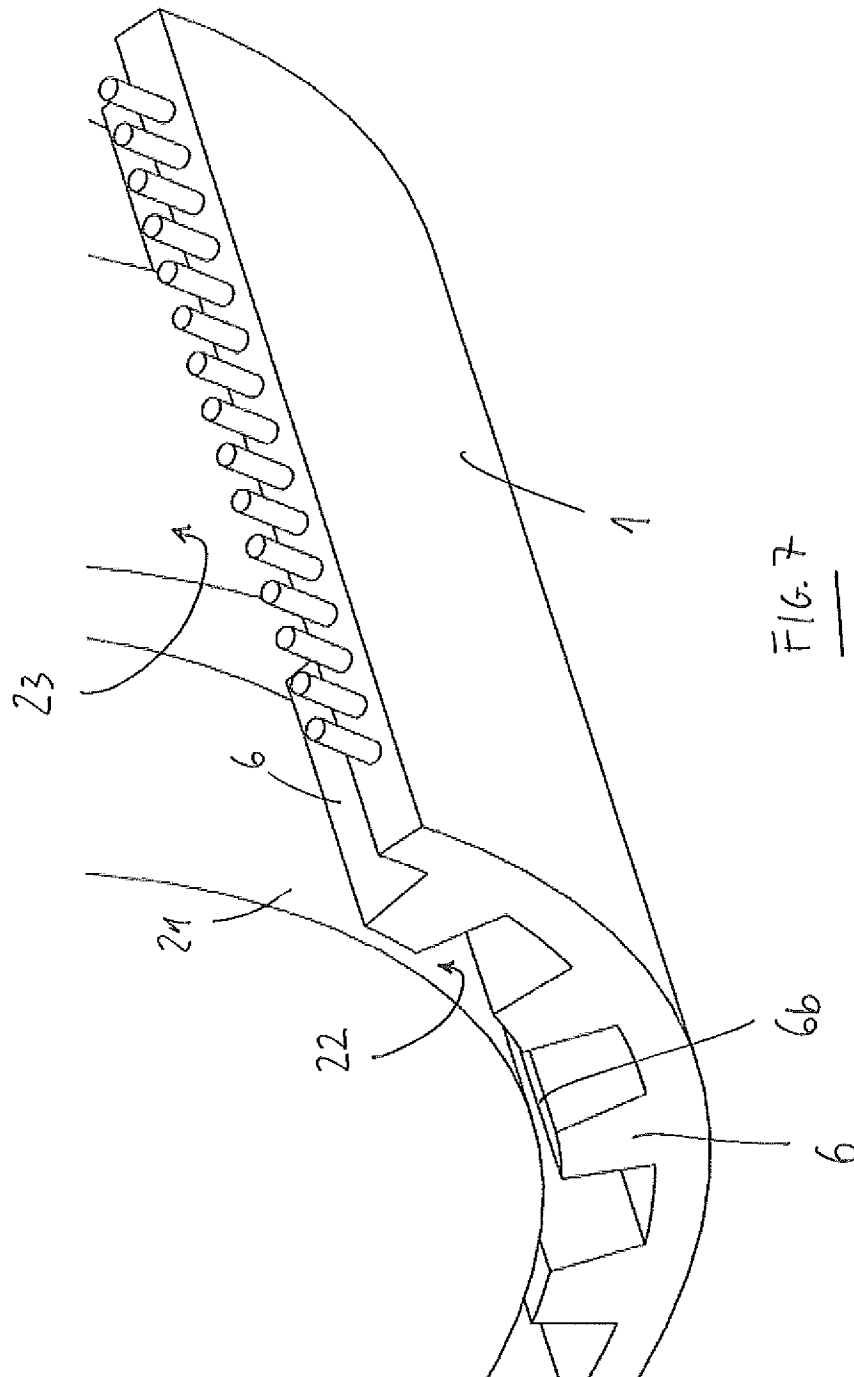


Fig. 6

Fig. 5



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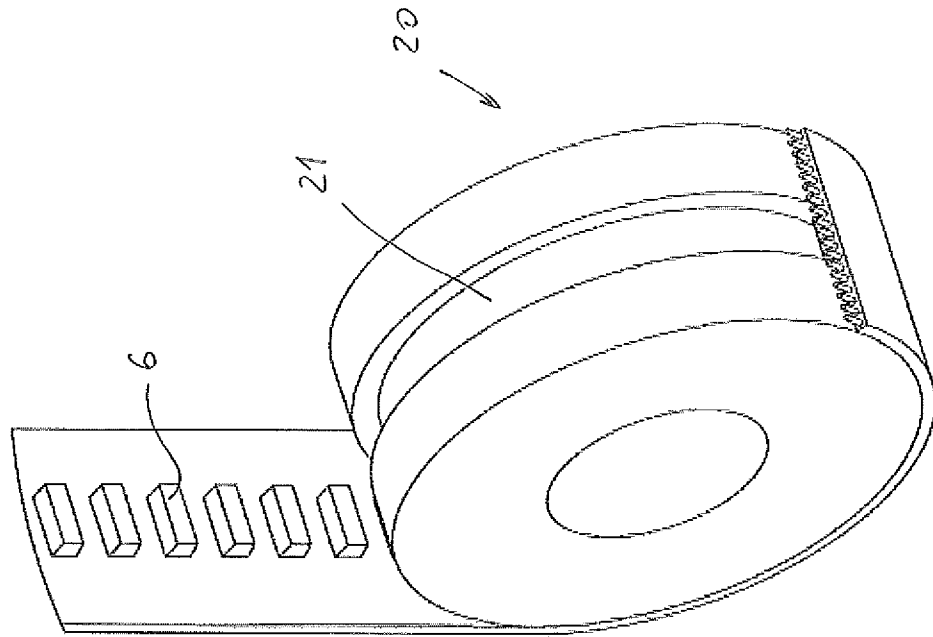


Fig. 9

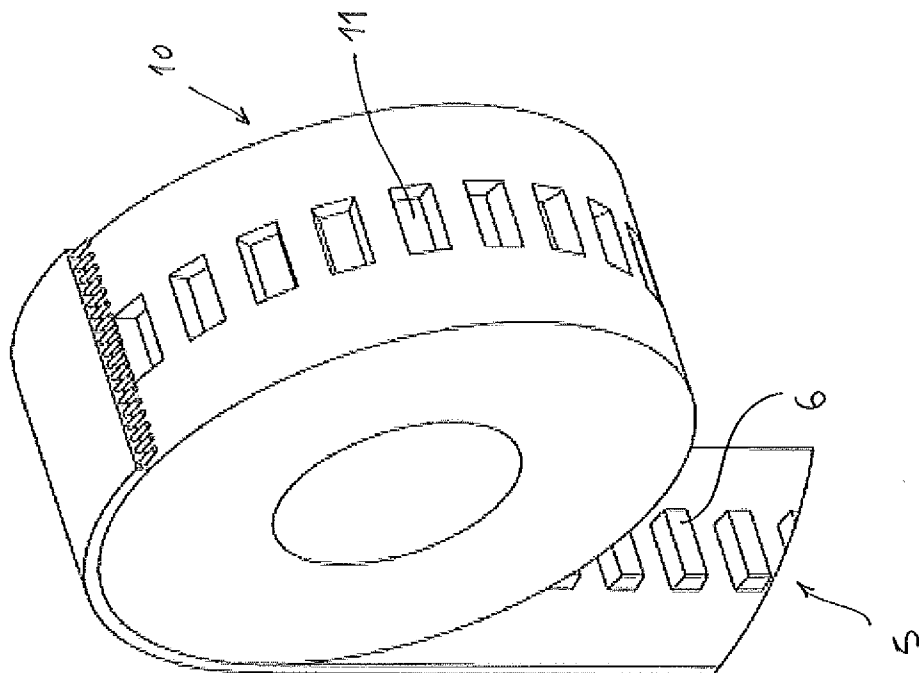


Fig. 8

FIG. 10

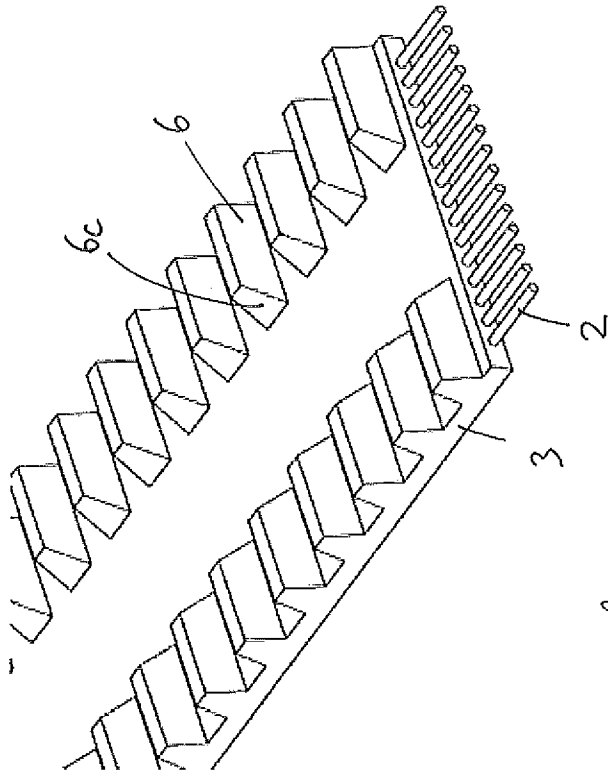
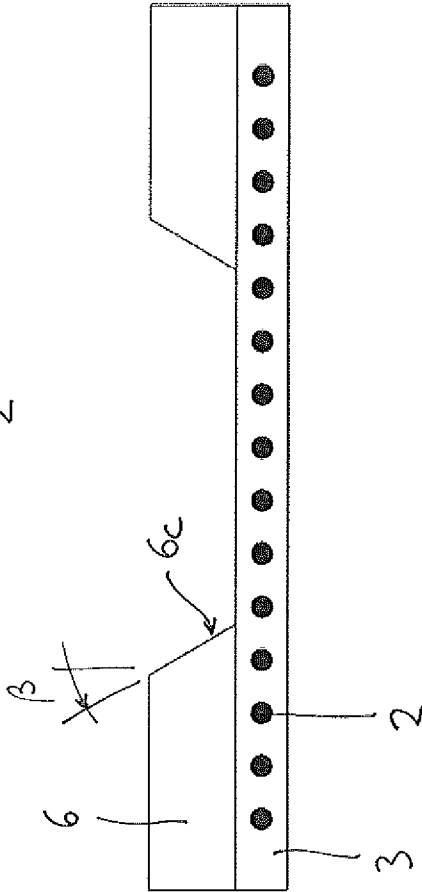


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/071007

A. CLASSIFICATION OF SUBJECT MATTER
 INV. F16G1/28
 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)
 F16G

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	US 4 634 409 A (JOHNSON DAVID W [US] ET AL) 6 January 1987 (1987-01-06) column 2, line 31 - line 68; figures 1-5 column 3, line 4 - line 24 column 3, line 66 - column 4, line 55 -----	1-14
X	DE 20 2006 000927 U1 (NORIDTEC ANTRIEBSTECHNIK GMBH [DE]) 27 April 2006 (2006-04-27) paragraph [0031] - paragraph [0038]; claim 4; figures 4-9 -----	1-4,7,8, 11
X A	US 2005/159262 A1 (SCHOENDIENST RUDOLPH [US]) 21 July 2005 (2005-07-21) paragraph [0020] - paragraph [0021]; figures 1-4 ----- -/--	1,2,7,8, 11 9



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

17 August 2012

Date of mailing of the international search report

24/08/2012

Name and mailing address of the ISA/

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Afanasiev, Andrey

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/071007

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 372 186 A1 (HANGZHOU KINGLAND TRANSMISSION INDUSTRY CO LTD [CN]) 5 October 2011 (2011-10-05) column 10, line 15 - line 20; figure 1 -----	1,2,7,8, 11
A	US 3 033 050 A (HISSEICH CHARLES A) 8 May 1962 (1962-05-08) column 2, line 37 - line 42; figures 3,4 column 3, line 54 - column 4, line 8 column 4, lines 47-50; 55-60 -----	5,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/071007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4634409	A	06-01-1987	CA 1251658 A1 28-03-1989
		US 4634409 A	06-01-1987

DE 202006000927	U1	27-04-2006	NONE

US 2005159262	A1	21-07-2005	NONE

EP 2372186	A1	05-10-2011	CA 2750573 A1 29-12-2010
		CN 102216647	A 12-10-2011
		EP 2372186	A1 05-10-2011
		KR 20110100318	A 09-09-2011
		US 2012077631	A1 29-03-2012
		WO 2010149047	A1 29-12-2010

US 3033050	A	08-05-1962	NONE
