



(12)

EUROPEAN PATENT APPLICATION

- (43)

Date of publication:
26.06.2024 Bulletin 2024/26
- (51)

International Patent Classification (IPC):
B66B 7/06 (2006.01)
- (21)

Application number: 22216075.6
- (52)

Cooperative Patent Classification (CPC):
B66B 7/062
- (22)

Date of filing: 22.12.2022

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR Designated Extension States: BA Designated Validation States: KH MA MD TN (71) Applicant: Wittur Holding GmbH 85259 Wiedenzhausen (DE)	(72) Inventors: • SELEK, Mesut Istanbul (TR) • ERGEN, Baris Istanbul (TR) • YILDIZ, Oguzhan Istanbul (TR) (74) Representative: Misselhorn, Hein-Martin Patent- und Rechtsanwalt Am Stein 10 85049 Ingolstadt (DE)
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(54)

SUSPENSION MEANS FOR A TRACTION SHEAVE ELEVATOR

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Suspension means having a width B and a thick-
ness D for a traction sheave elevator in the form of a flat
belt with a plurality of traction means strands which are
embedded in a friction-increasing belt base material via
which they contact the traction sheave and optionally at
- least one further deflection pulley during regular opera-
tion, characterized in that directly adjacent traction
means strands are spaced apart from one another by a
smaller distance in the region of the belt center (at B/2)
than in the regions of the flat belt near the flanks.

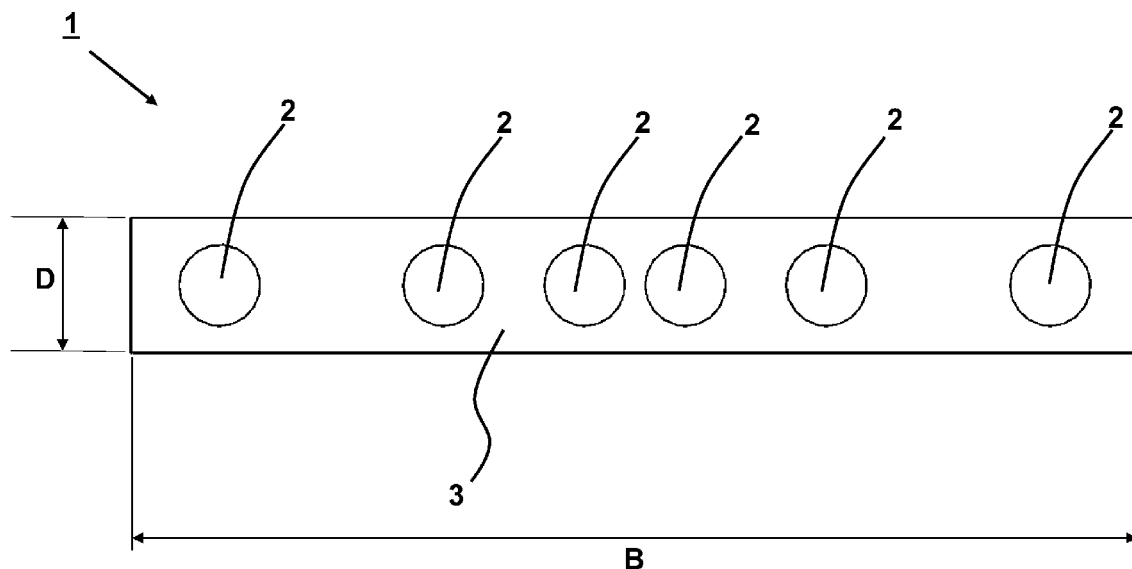


Fig. 3

Description

FIELD OF INVENTION

[0001] The invention relates to a suspension means for a traction sheave elevator according to the generic term of claim 1 as well as the use of such a suspension means according to the generic term of claim 6 and a suspension means elevator with such a suspension means according to the generic term of claim 7.

TECHNICAL BACKGROUND

[0002] Lifting and lowering of the elevator car along the elevator shaft is typically accomplished by means of driven suspension means such as ropes or belts - especially when large differences in height have to be overcome. In order to reduce the drive torque required to operate a corresponding suspension means elevator, the suspension means is usually deflected several times with the aid of deflection pulleys in accordance with the principles of a pulley block. This allows the use of small, high-speed drive motors, which are much easier to integrate into the elevator shaft.

[0003] To further reduce the installation space required in the elevator shaft, flat belts are also increasingly being used as suspension means instead of steel ropes. This is because the use of flat belts generally allows the diameter of the traction sheave(s) and deflection pulley(s) to be further reduced due to the geometry of flat belts as well as their material.

[0004] Flat belts usually have a rectangular cross-section. When the elevator is in operation, one of the two long sides of the rectangular cross-section runs along the deflection pulleys and/or the traction sheave, so that the pulleys roll along this side of the suspension means. The two short sides of the cross-section, which are perpendicular to the long sides, are typically much shorter than the diameter of steel cables used as suspension means instead of flat belts. Also, flat belts are typically not, or at least not predominantly, made of steel, as is the case with cables used as suspension means. Instead, flat belts are usually made at least predominantly of polyurethane plastic. These two circumstances mean that flat belts are significantly more flexible than steel cords in the direction of rotation of the deflection pulleys or traction sheaves. When the suspension means is deflected by 180° - as is typically the case along the outer circumferential surface of the traction sheave - the radius that can be realized with flat belts is significantly smaller than is the case with steel cords. As a result, significantly smaller deflection pulleys and traction sheaves can be used. In terms of the available installation space, these can in turn be integrated into the elevator shaft much more easily.

[0005] It is true that there are usually several steel cords inside the flat belts, as the flat belts made of plastic would otherwise not be able to withstand the tensile forces occurring during operation of the elevator. However,

these steel cords have a diameter many times smaller than the steel cords used instead of flat belts as suspension means. Accordingly, the steel cords installed inside flat belts can complete a radius many times smaller than the steel cords used instead of shed belts for the same deflection angle.

STATE OF THE ART

[0006] In order to ensure that the flat belt cannot slip off the traction sheave or the deflection pulleys during unwinding or collide with any lateral limiting element and cause excessive wear, the flat belt must be centered on the traction sheave and the deflection pulleys. Traction sheaves and deflection pulleys with a convex curved rotating surface are typically used for this purpose. Figs. 1 and 2 show such a deflection pulley 4 (or traction sheave 4) known from the prior art together with a flat belt 1 running on it. Here it can be seen that the belt running surface 5 is convexly curved. The flat belt 1 lies on the belt running surface 5 in such a way that - if it were completely rigid - it would form the tangent to the apex of the belt running surface 5. Due to its elasticity, however, the flat belt 1 adapts at least to a certain extent to the course of the belt running surface 5. Since the flat belt 1 is tensioned between a number of deflection pulleys 4 (and at least one traction sheave 4) during operation, tensile forces act on the flat belt at the deflection pulleys 4. These tensile forces then ensure that the flat belt 1 does not move in the direction of one of the flanks 6 bounding the belt running surface 5, but remains centered in the area of the apex of the convex belt running surface 5.

[0007] As has been shown from an FEM analysis, however, there are also disadvantages associated with this type of centering. Due to the traction means strands 2 arranged in the belt base material 3, which are here designed as steel cords and are therefore relatively inelastic compared to the belt base material, the flat belt 1 exhibits a certain rigidity. This has the effect that the flat belt 1 does not rest on the convex belt running surface 5 over its entire width running in the direction orthogonal to the flanks 6 of the deflection pulley 4. This in turn has the consequence that the tensile forces exerted by the deflection pulleys 4 on the flat belt 1 do not result in a constant tension curve along the width of the flat belt 1. Rather, there is a maximum tensile stress in the center of the flat belt 1, which is centrally located above the apex of the convex belt running surface, which decreases towards the edges of the flat belt 1. This is illustrated schematically by the arrows in Fig. 2.

[0008] The steel cords 2 provided for absorbing the tensile forces in the flat belt 1 are therefore subjected to different loads. The steel cords 2 in the area of the center are subjected to maximum tensile stress, while the outer steel cords 2 are subjected to much lower stress. This is problematic in that the steel cords 2 exposed to the maximum tensile stress (with the same dimensions) have a significantly shorter service life than the outer steel cords

2. As soon as one of the steel cords 2 has exceeded its service life, the entire flat belt 1 must be replaced. Accordingly, the problem described leads to a relatively short service life of the flat belt. It would be conceivable in principle to make the flat belts in the center area of the belt base material 3 thicker or of a different material than the steel cords 2 in the edge area. However, this would lead to a significant increase in the cost of manufacturing the flat belts.

TASK OF THE INVENTION

[0009] In view of this, it is the task of the invention to provide suspension means in the form of a flat belt with increased service life.

SOLUTION ACCORDING TO THE INVENTION

[0010] The solution to the above problem is provided by a suspension means elevator with a suspension means according to the invention, from which the car is suspended and raised or lowered. The suspension means elevator comprises a deflection pulley designed as a traction sheave, and preferably at least one further deflection pulley. The elevator is characterized in that at least one deflection pulley contacts the suspension means with its convex jacket. The jacket of the deflection pulley has a curvature which is designed in such a way that traction means strands enclosed near the flank in the flat belt tend to be less heavily loaded than traction means strands enclosed centrally or near the center.

[0011] Due to the convex jacket surface or the convex belt running surface of the deflection pulley, the traction means is centered on the belt running surface during operation - as already described above. Since the traction means strands in the flat belt have a smaller distance from each other in the area of the belt center (at B/2) than in the areas of the flat belt near the flanks, the tensile stress occurring in the flat belt is better distributed over the individual traction means strands. This increases the service life of the suspension means and reduces the amount of maintenance required to operate the elevator.

[0012] The fact that the car is "suspended" from the suspension means can mean both that the suspension means is rigidly connected to the car at one end, i.e. the car is literally suspended from the suspension means. However, it also includes that at least one deflection pulley is attached to the elevator car, which rolls along a loop formed by the suspension means. In any case, the car is attached to the suspension means in such a way that driving the suspension means by means of a traction sheave raises or lowers the car.

[0013] In this context, "a" suspension means does not mean a single suspension means, but preferably four suspension means in the form of flat belts arranged parallel to each other and either flank to flank or at least close to each other. The word "a" is therefore not used as a number word, but as an indefinite article.

PREFERRED EMBODIMENTS OF THE INVENTION

[0014] There are a number of ways in which the invention can be designed to further improve its effectiveness or usefulness.

[0015] For example, it is particularly preferable for the two central traction means strands to be spaced less apart than all other pairs of traction means strands.

[0016] In the area of the belt center - i.e. at B/2 - maximum tensile stresses occur due to the type of centering of the traction means by means of a convex belt running surface already described. Since the distance between the traction means strands is smallest here, the highest traction means strand density is achieved in this area. The tensile forces occurring in the traction means strands are thus reduced.

[0017] Due to the centering of the suspension means, it is advantageous if the traction means strands are always arranged in pairs. This results in a symmetrical distribution of tensile forces over the traction means strands arranged along the width B of the flat belt.

[0018] In a further preferred embodiment, the three central traction means strands form two traction means strand pairs. These two pairs of traction means strands are spaced less apart than all other pairs of traction means strands.

[0019] Ideally, one of the traction means strands is arranged exactly in the center of the flat belt and the other two traction means strands are arranged symmetrically to the left and right of the first traction means strand.

[0020] This ensures that the maximum possible traction means strand density is achieved in the center of the flat belt, i.e. in the area of maximum tensile stress.

[0021] And also in the area adjacent to the center of the flat belt, which is also subjected to high tensile stresses, a good distribution of the tensile stress across the traction means strands is achieved by the two pairs of traction means strands, which are spaced a short distance apart compared to the other pairs of traction means strands.

[0022] In a further preferred embodiment, the two traction means strands adjoining the center traction means strands on the left and right in the direction along the longitudinal axis L of the flat belt each form a traction means strand pair with a traction means strand of the central traction means strands. The traction means strands each forming such a pair of traction means strands are spaced further apart than the central traction means strands. In addition, the traction means strands forming such a pair of traction means strands are spaced apart by a smaller distance than the traction means strands adjoining them laterally on the left and right.

[0023] As a result, the density of the traction means strands is increasingly increased from the edge regions of the flat belt toward the longitudinal axis L of the flat belt. Most of the central traction means strands are therefore provided in the area of maximum tensile stress. The difference in the tensile forces occurring in the traction

means strands is thus reduced.

[0024] It is conceivable that the central traction means strands are three traction means strands, one of which is arranged exactly at B/2 and the other two symmetrically to the left and right of this. However, it is equally conceivable that the "central" traction means strands are only two traction means strands arranged to the left and right of the flat belt's longitudinal axis.

[0025] The "flat belt's longitudinal axis" is the axis of the flat belt extending through the B/2 and D/2 and parallel to the longitudinal axis of the individual traction means strands.

[0026] In another preferred embodiment, the traction means strands are at least partially ropes and preferably metal ropes. More preferably, the traction means strands are predominantly ropes and preferably metal ropes. Ideally, the traction means strands are even completely ropes and preferably metal ropes.

[0027] In the case of the use of metal ropes as traction means strands, the ropes are preferably steel ropes, each of which is formed from a plurality of individual steel wire strands.

[0028] For this purpose, the individual steel wire strands are each braided together to form a steel rope. It is also conceivable that different types of wires are used in one rope, thus combining the advantages of different materials. In this way, the required tensile strength of the traction means strands can be ensured while at the same time achieving sufficient flexibility.

[0029] Preferably, the at least one deflection pulley and the suspension means assigned to it are matched to each other in such a way that the stress difference that occurs when the suspension means circulates over the at least one deflection pulley between the central traction means strand or strands and each of the two traction means strands closest to the flank is less than 35%. It is better if the tension difference is less than 25%.

[0030] The design of the suspension means or the traction means strands must be based on the traction means strands subjected to the highest loads. If the traction means strands in the center area (at B/2) of the flat belt are no longer loaded many times more than the traction means strands in the edge area, the less heavily loaded traction means strands no longer have to be so heavily oversized. This has a positive effect on the manufacturing costs of the suspension means.

[0031] Ideally, the at least one deflection pulley has a belt running surface on its jacket that is wider than the width of the suspension means.

[0032] This allows a sufficient safety distance to be maintained from the edge area of the deflection pulley. This reduces the risk of the suspension means slipping off the deflection pulley or colliding with any sections of the deflection pulley that limit the belt running surface of the deflection pulley.

FIGURE LIST

[0033]

5 Figs. 1 - 2 show a known prior art suspension device in an operationally mounted state together with a deflection pulley.

10 Fig. 3 shows a suspension means according to the invention in cross-section.

Fig. 4 shows a suspension means according to the invention in the operationally mounted state together with a deflection pulley.

15 Fig. 5 shows the structure of a traction means strand.

PREFERRED DESIGN OPTION

20 **[0034]** The operation of the invention is explained by way of example with reference to Figures 3-5.

[0035] Fig. 3 shows a cross-section of a flat belt 1, which clearly illustrates its structure. The flat belt 1 consists of a belt base material 3 and six traction means strands 2 arranged inside the belt base material 3. The traction means strands 2 are steel cords with a round cross-section. The belt base material 3 is polyurethane with a rectangular cross-section. While the traction means strands 2 serve to absorb the tensile stresses occurring during operation of the flat belt 1, the belt base material 3 serves to ensure sufficient static friction between the deflection pulleys 4 and the flat belt 1, or the drive pulley and the flat belt 1. The diameter of the individual traction means strands 2 is approximately 60% of the thickness D of the belt base material 3, which corresponds to the short side of the rectangular cross-section of the belt base material 3.

[0036] The traction means strands 2 are not arranged uniformly over the width B of the flat belt 1 corresponding to the long side of the belt base material 3. It is true that the traction means strands 2 are arranged mirror-symmetrically in relation to an imaginary plane running through half the width B of the belt base material 3. However, the distances between the individual traction means strands 2 increase starting from the traction means strands 2 arranged in the center of the belt base material 3 to the traction means strands 2 arranged at the edge of the belt base material 3. The distance between the two central traction means strands 2 is less than their respective radius. There is already a distance to each of the traction means strands 2 adjacent to the two central traction means strands 2, which corresponds approximately to the diameter of the individual traction means strands 2. By contrast, there is a distance between the traction means strands 2 adjacent to the central traction means strands 2 and the respective (near-flank) traction means strands 2 adjacent thereto which corresponds approximately to twice the diameter of the individual traction

means strands 2. Between the last-mentioned near-flank traction means strands 2 and the lateral edge of the belt base material 3 there is in each case a distance of approximately half the diameter of an individual traction means strand 2.

[0037] The longitudinal axes of the individual traction means strands 2 all lie on an imaginary line running through half the thickness D of the belt base material 3 and orthogonal to the short sides of the belt base material 3.

[0038] Due to the described arrangement of the traction means strands 2, a relatively uniform stress distribution is achieved on the individual traction means strands 2. This is illustrated by Fig. 4. There, the flat belt 1 can be seen together with a deflection pulley 4. The flat belt 1 is in contact with the belt running surface 5 of the deflection pulley 4 in such a way that a movement of the flat belt 1 in the circumferential direction of the deflection pulley 4 leads to a rotational movement of the deflection pulley 4. To ensure that the flat belt 1 does not shift in the direction of the flanks 6 of the deflection pulley 4 during operation, the flat belt 1 is centered on the deflection pulley 4. For this purpose, the belt running surface 5 is convexly curved. The flat belt 1 can then be mounted on the deflection pulley 4 in such a way that the apex of the convex curvature of the belt running surface 5 lies exactly below the center of the flat belt 1. Then the symmetrical structure of the flat belt 1 in combination with the tensile forces acting on the flat belt 1 during operation ensures the required centering. Due to the relatively large distance between the traction means strands 2 in the edge area of the flat belt 1, it is ensured on the one hand that the flat belt 1 is less stiff and lies better against the convex curved belt running surface 5. In addition, the small distance between the traction means strands 2 in the central area of the flat belt 1 ensures that the maximum tensile stresses occurring in this area are distributed over as many traction means strands 2 as possible. Since there are fewer traction means strands 2 in the edge area of the flat belt 1, but the tensile stresses are also lower, the individual traction means strands 2 of the flat belt 1 are subjected to a much more uniform load overall. The tensile stresses acting on the individual traction means strands 2 are illustrated schematically by the arrows in Fig. 4.

[0039] The structure of an individual traction means strand 2 can be understood from Fig. 5. This shows that the individual traction means strands 2 are not made of solid material but are formed by a large number of thin steel wires 7 which are interwoven with one another.

REFERENCE LIST

[0040]

- 1 Suspension means/ flat belt
- 2 Traction means strand or steel cord
- 3 Belt base material

- 4 Traction sheave or deflection pulley
- 5 Belt contact area/belt running surface
- 6 Flanks of the deflection pulley or traction sheave
- 7 Single wires

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- B Width of the suspension means or belt
- D Thickness of the suspension means or belt

10 Claims

1. Suspension means (1) having a width B and a thickness D for a traction sheave elevator in the form of a flat belt (1) with a plurality of traction means strands (2) which are embedded in a friction-increasing belt base material (3) via which they contact the traction sheave (4) and optionally at least one further deflection pulley (4) during regular operation, **characterized in that** directly adjacent traction means strands (2) are spaced apart from one another by a smaller distance in the region of the belt center (at B/2) than in the regions of the flat belt (1) near the flanks.

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2. Suspension means (1) for a traction sheave elevator according to claim 1, **characterized in that** the two central traction means strands (2) have a smaller distance from each other than all other pairs of traction means strands (2).

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3. Suspension means (1) for a traction sheave elevator according to claim 1, **characterized in that** the three central traction means strands (2) form two pairs of traction means strands (2), each of which has a smaller distance from each other than all other pairs of traction means strands (2).

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4. Suspension means (1) for a traction sheave elevator according to claim 2 or 3, **characterized in that** the two traction means strands (2) adjoining the central traction means strands (2) on the left and right in the direction along the longitudinal flat belt axis L each form a pair of traction means strands with a traction means strand (2) of the central traction means strands (2), wherein the traction means strands (2) of said pair of traction means strands have a greater distance from one another than the central traction means strands (2) and the traction means strand (2) of which are at a smaller distance from one another than the laterally adjoining traction means strands (2) on the left and right.

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5. Suspension means (1) according to one of the preceding claims, **characterized in that** the traction means strands (2) are ropes, preferably metal ropes.

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6. Use of a suspension means (1) according to one of the preceding claims in such a way that it is deflected in another direction, preferably by at least 170°, via

at least one deflection pulley (4) with a convexly curved belt contact area (5).

7. Suspension means elevator with a suspension means (1) according to one of the preceding claims with a deflection pulley (4) designed as a traction sheave (4) and preferably at least one further deflection pulley (4), **characterized in that** at least one deflection pulley (4) contacts the suspension means (1) with its convex jacket, the curvature of which is such that traction means strands (2) enclosed near the flank in the flat belt (1) tend to be less heavily loaded than traction means strands (2) enclosed centrally or near the center.
8. Suspension means elevator according to the immediately preceding claim, **characterized in that** the at least one deflection pulley (4) and the suspension means (1) associated therewith are matched to one another in such a way that the tension difference which arises during the circulation of the suspension means (1) over the at least one deflection pulley (4) between the central traction means strand or strands (2) and each of the two traction means strands (2) lying closest to the flank is less than 35% and preferably less than 25%.
9. Suspension means elevator according to the two immediately preceding claims, **characterized in that** the at least one deflection pulley (4) has on its jacket a belt running surface (5) which is wider than the suspension means width (B).

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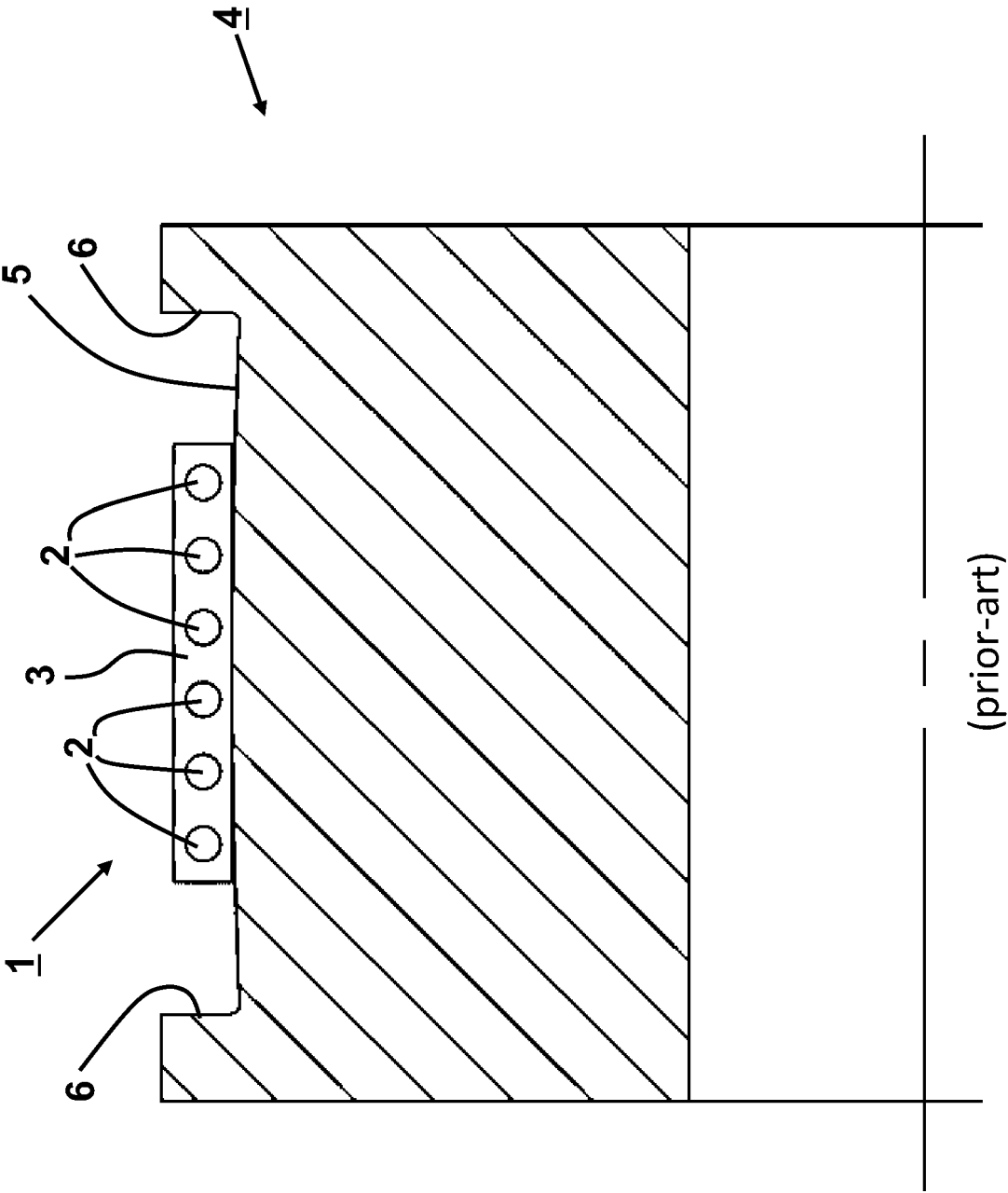


Fig. 1

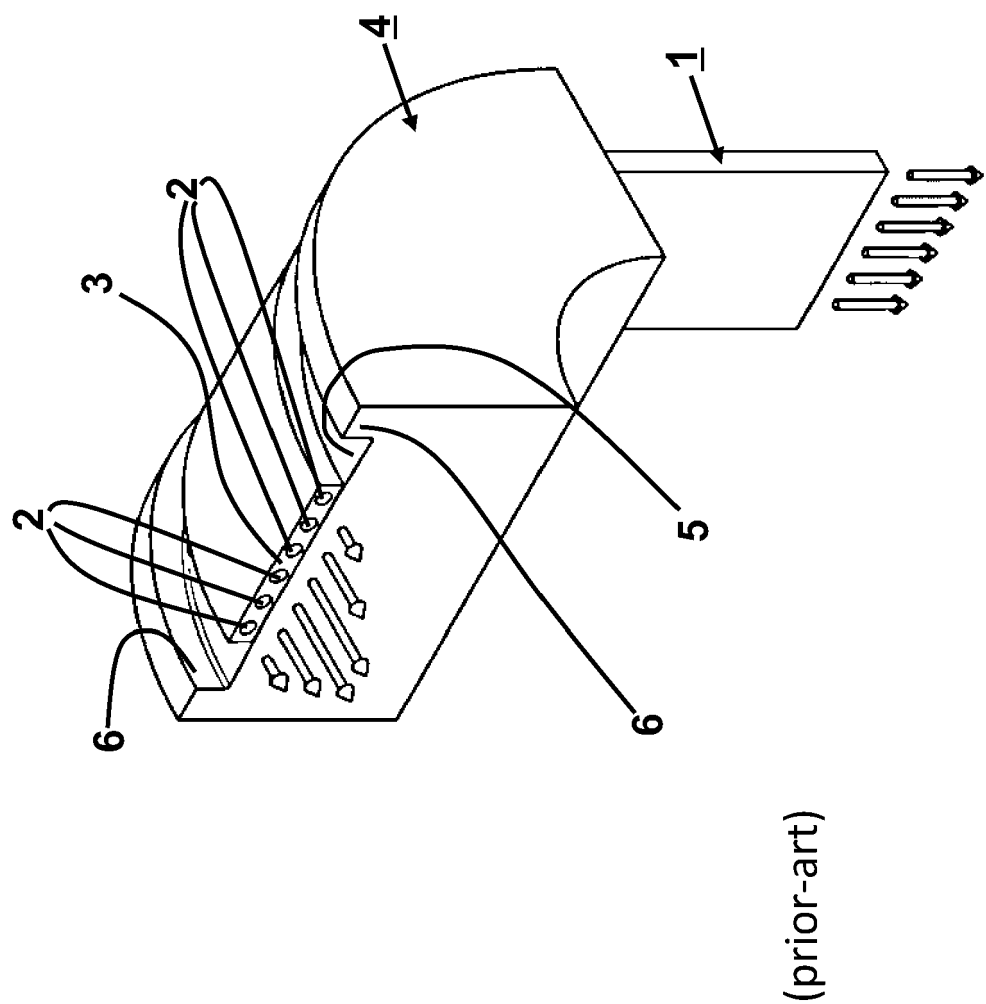


Fig. 2

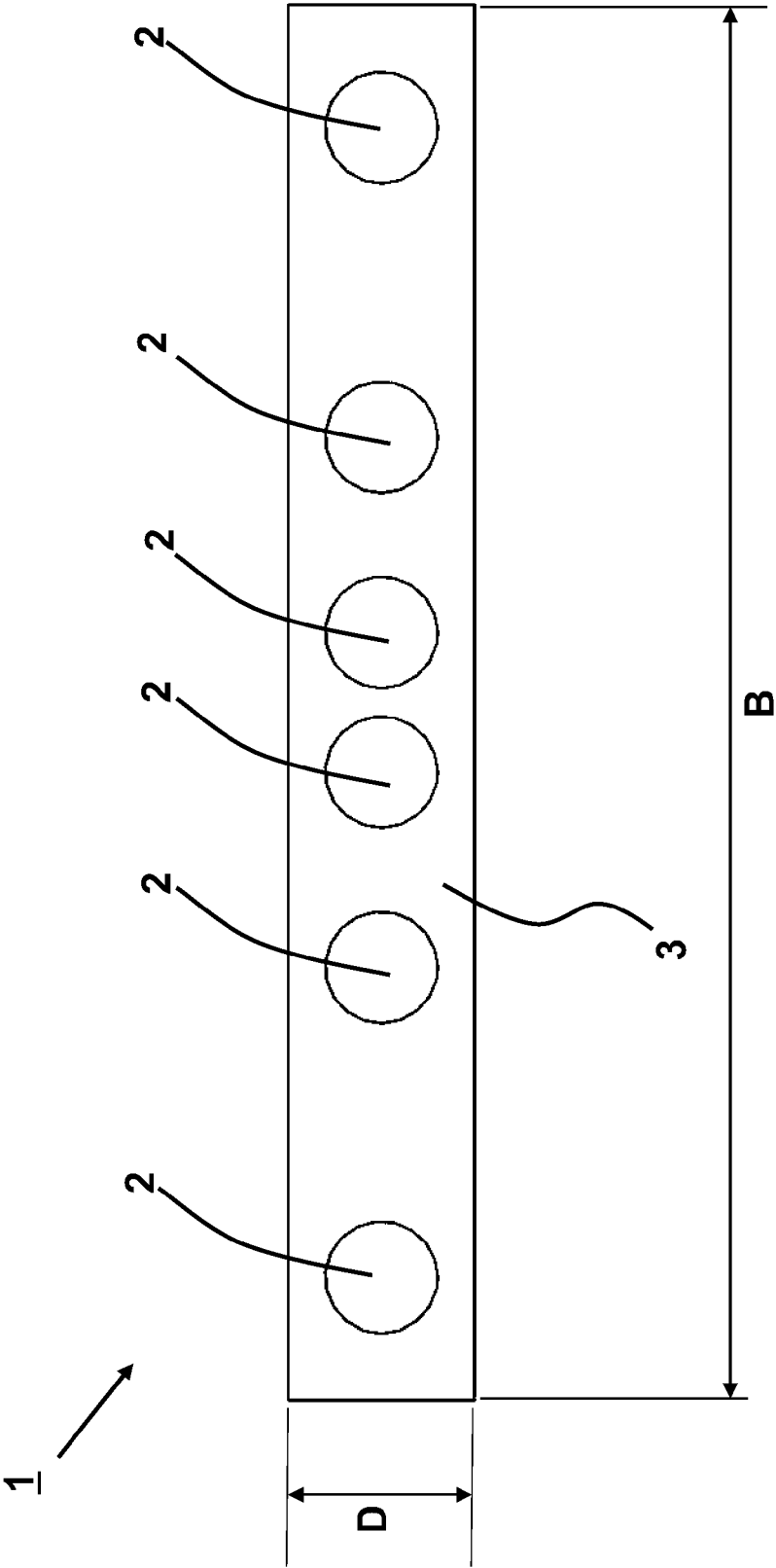


Fig. 3

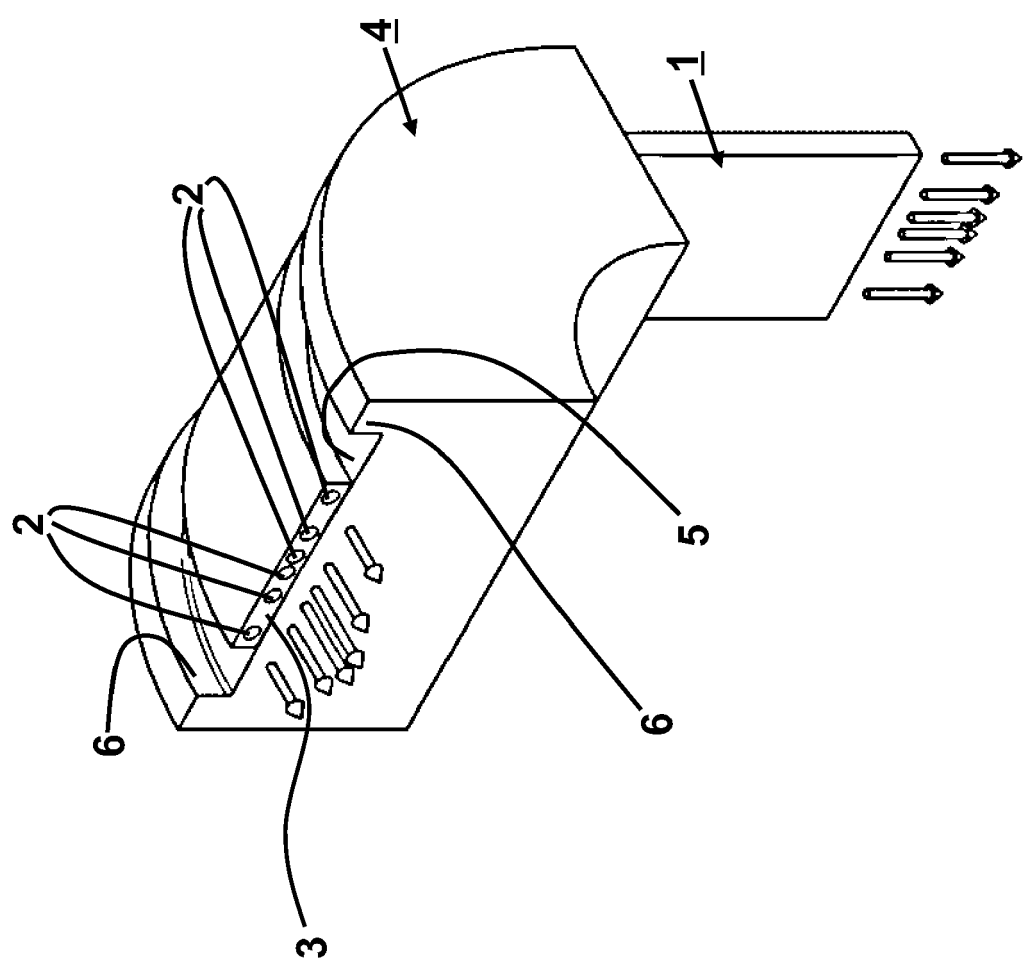


Fig. 4

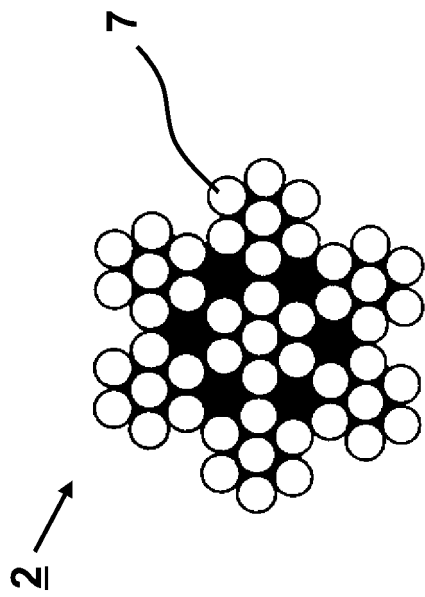


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

EP 22 21 6075

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2022/044213 A1 (MITSUBISHI ELECTRIC CORP [JP]) 3 March 2022 (2022-03-03)	1, 2, 5-9	INV. B66B7/06
A	* figures 1, 3, 4, 29 * & DATABASE WPI Week 2022002 Thomson Scientific, London, GB; AN 2022-39679T & WO 2022/044213 A1 (MITSUBISHI ELECTRIC CORP) 3 March 2022 (2022-03-03) * abstract *	3, 4	
X	JP H03 176912 A (HITACHI CABLE) 31 July 1991 (1991-07-31)	1-8	TECHNICAL FIELDS SEARCHED (IPC) B66B D07B
A	* figure 2 * & DATABASE WPI Week 199137 Thomson Scientific, London, GB; AN 1991-269935 & JP H03 176912 A (HITACHI CABLE LTD) 31 July 1991 (1991-07-31) * abstract *	9	
X	WO 2006/057641 A2 (OTIS ELEVATOR CO [US]; VERONESI WILLIAM A [US] ET AL.) 1 June 2006 (2006-06-01)	1, 2, 5-8	
A	* page 1, line 1 - line 4 * * figure 5 *	3, 4, 9	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 24 April 2023	Examiner Dijoux, Adrien
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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

EP 22 21 6075

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
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24-04-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2022044213 A1	03-03-2022	CN 115956059 A	11-04-2023
		JP WO2022044213 A1	03-03-2022
		KR 20230039708 A	21-03-2023
		WO 2022044213 A1	03-03-2022
JP H03176912 A	31-07-1991	NONE	
WO 2006057641 A2	01-06-2006	CN 101065549 A	31-10-2007
		EP 1828502 A2	05-09-2007
		ES 2570602 T3	19-05-2016
		HK 1114889 A1	14-11-2008
		JP 4763714 B2	31-08-2011
		JP 2008521728 A	26-06-2008
		KR 20070086370 A	27-08-2007
		US 2009126296 A1	21-05-2009
		WO 2006057641 A2	01-06-2006