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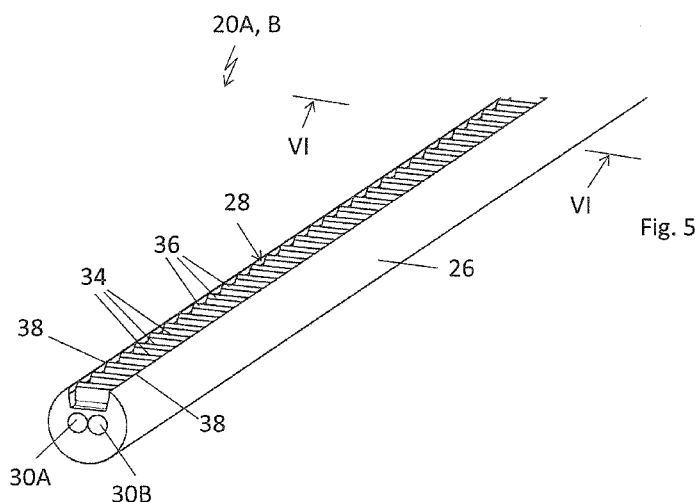
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(54) Title: DRIVE CABLE AND DRIVE UNIT FOR VEHICLE MEMBER



(57) Abstract: The invention relates to a drive cable for actuating a vehicle member being movable as against a vehicle structure, comprising a cable body (26) which is made of plastics, and which includes an denticulation (28) extending in the axial direction for engaging with a driving toothed wheel (24) and through which an armouring extending in the axial direction reaches. The denticulation (28) is formed by pocket-like recesses (34) which are spaced apart in the axial direction at regular intervals, and which are limited, in the longitudinal direction of the cable, by flanks of resulting tips of teeth (36) formed by the cable body (26) and in the transverse direction of the cable, on each of their two sides, by a pocket flank (38) and which are in each instance limited by a root of a tooth (40) on the bottom side, the armouring reaching through said cable body (26) beneath said recesses (34) and said tips of teeth (36), the armouring defining an armouring plane (A) which extends in the transverse direction of the cable and in the longitudinal direction of the cable, and in which at least two continuous armouring harnesses (30A, 30B, 30C) extending in the axial direction are arranged side by side and/or in which at least one armouring harness (30) having a flat cross-section is arranged.

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### Drive cable and drive unit for vehicle member

10 The invention relates to a drive cable for actuating a vehicle member being movable as against a vehicle structure as well as to a drive unit comprising a driving toothed wheel and at least one drive cable of this kind.

Drive cables for actuating a vehicle member being movable as against a vehicle structure are known from practice and serve to actuate, for example, a lid member of a retractable roof arrangement, with the aid of which a roof opening of the relevant vehicle may selectively be closed or at the very least partially be cleared. The drive cables transmit a drive force from a drive motor onto the movable vehicle member and may be formed from a flexible plastic body, which is joined to the vehicle member and includes a denticulation, which engages with a driving toothed wheel of the drive motor or a gearing. In order to give the needed stability to the plastic drive cable, a reinforcement extending in the axial direction may reach through the cable body, at which the denticulation is realised.

The known plastic drive cables present the problem that either a satisfactory noise behaviour cannot be obtained in operation since the denticulation slides at a guide face, which in turn leads to rattling, or the flexibility in the transverse direction of the cable does not meet the requirements existing in conjunction with a retractable roof.

Moreover, it is known from practice to employ compression-proof drive cables for driving lid members of a retractable roof arrangement, which cables are termed gradient cables and include a gradient helix at their periphery, which helix engages with a driving toothed wheel of the relevant drive motor. In addition, a flock coating is realised at the periphery. In the context of such drive cables, it may, however, happen that cables are skipped in the region of the drive pinion, which is in turn connected to an undesired

noise behaviour and to high wear. Since the periphery of a gradient cable is not realised in a homogeneous fashion and is also provided with the flock coating, a guiding in corresponding guide tubes is not possible without any noise that might be troublesome being generated.

- 5 It is the object of the invention to create a drive cable having a plastic cable body, which cable meets high requirements regarding the noise behaviour, as well as a drive unit having such a drive cable.

In accordance with the invention, this object is attained by the drive cable having the features of claim 1 and by the drive unit having the features of claim 15.

- 10 Consequently, the essence of the invention is that the cable body is realised such that the denticulation, with its tips of teeth, is arranged in a guide tube or the like, at the very least largely without being in contact, by reason of the pocket flanks, so that the risk of rattling, that means an undesired noise behaviour, is reduced. The tips of teeth, which may be considered to be fins or ribs, are thus set back as against a virtually
- 15 circumferential peripheral face of the cable body in the direction of the cable axis. By way of the continuous armouring/reinforcement which is arranged in the bottom of the recesses, that means in the root of a tooth of the denticulation, and which consists of at least two uninterrupted armouring harnesses/strands and/or of at least one uninterrupted armouring harness/strand having a flat cross-section, it is guaranteed that the drive cable
- 20 gets neatly justified in its guide, to be more precise with a pretension preventing a rattling. A root of a tooth is a region of the cable body between two tips of teeth.

- The drive cable according to the invention is a polymer cable, which may, without any flock coating, have established a contact with little friction to a guide member, such as a guide tube. By way of the flexibility, which is made available by the plastic cable body,
- 25 the best possible engaging behaviour may in addition be established at a driving toothed wheel since a plurality of teeth may simultaneously engage the denticulation of the cable body. The denticulation running along the axial peripheral line defines, in a clear manner, the position of the drive cable as against the driving toothed wheel. As a matter of course, the drive cable has to be prevented from being distorted about its longitudinal

axis in the region of engaging in order to guarantee a proper operation of the resulting drive system.

The armouring harnesses may in each instance be formed from a wire, from a wire mesh, from glass fibres, carbon fibres and/or the like. Preferably, a steel wire or a steel  
5 wire mesh is employed.

If the drive cable according to the invention includes at least two armouring harnesses, the same, in an expedient embodiment, in particular have a round cross-section, but may have also a non-round cross-section.

In the embodiment having at least one armouring harness having a flat cross-section, a  
10 long cross-section axis of the armouring harness is preferably oriented in the transverse direction of the cable and a short cross-section axis, which is at a right angle to the long cross-section axis, is oriented in the vertical direction of the cable. This armouring band is, for example, formed from a metal band.

By way of the armouring that is realised in accordance with the invention, it can be  
15 achieved that the drive cable, parallel to the armouring plane, has a higher flexural stiffness compared to the flexural stiffness at a right angle to the armouring plane. Thereby, the correct orientation of the drive cable with respect to a drive pinion can be maintained under most operating conditions.

In the armouring plane, the armouring harnesses can be in contact to each other or have  
20 a certain distance to each other within the limits of the diameter of the cable body, in each case depending on the diameter of the armouring harnesses and the diameter of the cable body, wherein the diameter of the armouring harnesses is 0.5 times the diameter of the cable body at the most.

In order to guarantee that the relevant driving toothed wheel does not make an imprint  
25 in the armouring harnesses, the armouring harnesses preferably have a certain distance from the recesses.

The flexural stiffness of the cable is defined by the sum of the individual stiffnesses of the cable body and the armouring harnesses.

As a matter of course, the peel strength or racking strength between the polymer of the cable body and the armouring harnesses is configured such that retracting the cable body out from the armouring harness is not possible during operation.

If the armouring harnesses are in each instance formed from a wire mesh, said harnesses  
5 may have the same or opposite directions of lay.

The denticulation, in the context of the drive cable according to the invention, runs along an axial peripheral line of the cable body. The regions of the peripheral face without any denticulation, which form a continuous and homogeneous profiled face without any cracks in the longitudinal direction of the cable, may be used for guiding. In  
10 principle, the cable body does not present any flock coating.

Expediently, the cable body of the drive cable according to the invention is an extruded polymer member, which follows a circular or also an oval cross-section. The denticulation or the tips of teeth of the denticulation, in relation to a peripheral face being defined by the cable body in the region without any denticulation and virtually  
15 being continued in the denticulation region, are set back in the direction of the cable body axis, such that the denticulation is completely within the guide face being formed by the cable body periphery. The basic radius of the cable body is thus larger than the maximum radius of the front faces of the teeth in relation to a geometric central axis of the cable body and is for example between 3 mm and 8 mm. Thus, a contact between a  
20 cable guide and the denticulation can be prevented, which in turn benefits the noise behaviour upon actuation of the drive cable.

In order to achieve a preferred direction of flexure of the drive cable according to the invention, a material weakening, in the form of a groove or of an axial recess, may be introduced at the periphery of the cable body along a defined line.

25 An eccentric or off-centre arrangement of the armouring plane at a distance to a longitudinal centre plane of the cable body or the axial recess may bring about an additional torsion of the drive cable within a cable guide, such that the cable is arranged in the cable guide with a certain pretension, which can in turn prevent an undesired rattling. In addition, by way of the correspondingly advantageous arrangement of the

armouring plane or of the recess, it may be achieved that the drive cable gets automatically justified in the correct manner at the driving toothed wheel, without special guide faces being needed hereunto at the drive cable since the cable always gets justified in the direction of the smallest geometrical moment of inertia.

- 5 The distance between the armouring plane and the longitudinal centre plane of the cable body being arranged so as to be parallel thereto preferably amounts to 0.1 times the diameter of the cable body at most.

In order to ensure that the fins of the drive cable being formed by the denticulation are guided in corresponding guides of a drive system without being in contact, each of the  
10 recesses, in relation to the peripheral direction of the cable body, has an opening cross-section, which occupies less than  $180^\circ$  of the periphery of the cable body. This means that the guide section of the drive cable is formed by a face of the drive cable, which section faces away from the recesses and which extends, in the peripheral direction of the cable body, over a region of more than  $180^\circ$ , to be more precise without any  
15 interruption in the longitudinal direction of the cable.

Each of the pocket flanks has a lateral pocket edge. A guide section of the cable body hence extends between the two lateral pocket edges of a recess.

The guide section of the cable body, in a special embodiment of the drive cable according to the invention, includes at least three guide faces which are spaced apart  
20 from one another in the peripheral direction, and which are realised so as to be curved in the peripheral direction. Planar faces or also recesses of the cable body may be arranged between the guide faces.

In order to achieve the best possible guide behaviour of the drive cable in a cable guide, the guide faces or axial centre lines of the guide faces, in the peripheral direction, are in  
25 each instance offset one with respect to the other by approximately  $120^\circ$ .

In order to exactly define the position of the cable body or its rotational position in the assembled position, the cable body may additionally include an axial recess at its periphery, a guide fin of the cable guide engaging said recess. In particular, the recess may also be formed by a bevel of the cable body, which rests against a corresponding

support face of the cable guide. A fin may also be realised at the periphery of the cable body, which engages a groove of the cable guide.

Moreover, subject-matter of the invention is a drive unit for a vehicle member being movable as against a vehicle structure, comprising a driving toothed wheel and at least  
5 one drive cable in accordance with the aforescribed kind.

In order to prevent a skipping of teeth in the engaging region between the drive cable and the driving toothed wheel, said two members, in a preferred embodiment of the drive unit according to the invention, engage with each other via a contact line following a circular line. Hence, it is always guaranteed that multiple teeth of the  
10 driving toothed wheel engage the denticulation of the drive cable.

In a special embodiment of the drive unit according to the invention, the contact line extends over at least  $30^\circ$  in relation to the periphery of the driving toothed wheel. It is also conceivable that the contact line extends over  $180^\circ$  and more.

In a further special embodiment of the drive unit according to the invention, the driving  
15 toothed wheel engages with two drive cables of the above-described kind, wherein the two drive cables, in the direction of the axis of the driving toothed wheel, are offset one with respect to the other. The driving toothed wheel then preferably includes two denticulations being spaced apart from each other in the axial direction, each of which is assigned to one of the two drive cables. In particular in the context of drive cables,  
20 which engage with the driving toothed wheel in different planes, a wrap angle of at least approximately  $180^\circ$  may be realised. The driving toothed wheel preferably has a diameter that corresponds to at least 6 times the diameter of the drive cable.

Further advantages and advantageous configurations of the subject-matter of the invention can be taken from the description, from the drawing and from the claims.

25 Exemplary embodiments of a drive unit according to the invention and of drive cables according to the invention are illustrated in a schematically simplified way in the drawing and will be explained in more detail in the following description.

In the figures:

- Figure 1 shows a schematic view from above onto a vehicle roof having a drive unit for a movable lid member;
- Figure 2 shows a perspective illustration of a driving toothed wheel and of two drive cables of the drive unit;
- Figure 3 shows an enlarged view of one of the drive cables engaging with the driving toothed wheel;
- Figure 4 shows the drive cable on its own in the bent state;
- Figure 5 shows a further perspective view of the drive cable in the elongated state;
- Figure 6 shows a section through the drive cable according to Figure 5 along line VI-VI in Figure 5;
- Figure 7 shows a section through the drive cable according to Figure 5 along the longitudinal centre plane thereof;
- Figure 8 shows a perspective view of an alternative embodiment of a drive cable according to the invention;
- Figure 9 shows a section through the drive cable according to Figure 8 along line IX-IX in Figure 8;
- Figure 10 shows a section through the drive cable according to Figure 8 along the longitudinal centre plane thereof;
- Figure 11 shows a perspective view of a further embodiment of a drive cable according to the invention;
- Figure 12 shows a section through the drive cable according to Figure 11 along line XII-XII in Figure 11;
- Figure 13 shows a section through the drive cable according to Figure 11 along the longitudinal centre plane thereof;



Figure 14 shows a perspective view of a further embodiment of a drive cable according to the invention;

Figure 15 shows a section through the drive cable according to Figure 14 along line XV-XV in Figure 14; and

5 Figure 16 shows a longitudinal section through the drive cable according to Figure 14 along the longitudinal centre plane thereof.

In Figure 1, a vehicle roof 10 is shown which appertains to a passenger car not being illustrated otherwise, and which includes a roof opening 12, which may selectively be closed or at the very least partially be cleared with the aid of a lid member 14. The lid member 14 thus constitutes a vehicle member that is movable as against the vehicle structure.

In order to be able to displace the lid member 14, it is connected to displacing kinematics, which, in relation to a vertical longitudinal centre plane of the roof on each of their two sides, include a drive slide 16A or 16B, which is guided in a respective guide rail 18A or 18B extending in the longitudinal direction of the roof.

A drive cable 20A or 20B that is rigid in compression is in each instance joined to the drive slides 16A and 16B. The drive cables 20A and 20B are guided to a common drive motor 22 via corresponding guide tubes and engage with a common driving toothed wheel 24 of said drive motor. The drive motor 22, with its driving toothed wheel 24, and the drive cables 20A and 20B form a drive unit for the lid member 14.

The driving toothed wheel 24, in relation to its axis of rotation, has two denticulations being axially offset with respect to each other, one of said denticulations engaging with drive cable 20A and the other one engaging with drive cable 20B. Drive cables 20A and 20B in each instance wrap the driving toothed wheel 24 in the peripheral direction in a region of approximately 180°. Hence, a secure engagement of the driving toothed wheel 24 is guaranteed.

Drive cables 20A and 20B are configured so as to be identical and are described in the following using Figures 3 to 7.

Drive cables 20A and 20B are in each instance configured as plastic drive cables and comprise a cable body 26 being made of plastics, whose periphery constitutes a cylinder face being interrupted in the peripheral direction. The cable body 26 thus has a peripheral face extending over an angle of approximately  $270^\circ$  to  $300^\circ$  in the peripheral direction and forming a guide section 25 of the cable body 26, which section 25 is interrupted by a denticulation 28.

As it can in particular be taken from Figures 5 and 6, two armouring harnesses/strands 30A and 30B forming a reinforcement reach through the cable body 26, which harnesses are in each instance formed from a steel wire mesh without any recesses and define an armouring plane A, which extends in the transverse direction of the cable and in the longitudinal direction of the cable. The armouring harnesses 30A and 30B are arranged side by side in the armouring plane A.

The armouring plane A is approximately in a longitudinal centre plane L of the drive cable and extending transversely to the denticulation 28, in relation to the cylinder face being formed by the cable body 26.

The denticulation 28 is engraved into the cable body 26 and formed by pocket-like recesses 34 which are spaced apart in the longitudinal direction of the cable body 26 at regular intervals, and which are limited by flanks of resulting tips of teeth 36 in the longitudinal direction of the cable in each instance, and by a pocket flank 38 being formed by the cable body 26 in the transverse direction of the cable on each of their two sides. With their bottom, the recesses 34 in each instance limit a root of a tooth 40, the armouring harnesses 30A and 30B reaching through or under the same.

Each of the pocket flanks 38 has an edge 42, the top front faces of teeth 36 being set back as against said edge in the direction of the armouring plane A. A small step is thus realised between the front faces of the tips of teeth 36 and the periphery of the cable body 26. By way of the pocket flanks 38 and the front faces of teeth 36 being lower as against the pocket flanks 38, the front faces of teeth 36 can be prevented from being in contact with guides of the respective drive cable 20A or 20B, such that rattling that might occur thereby can be prevented.

The aforementioned reinforcement strands 30A and 30B made from steel wire mesh generate a strong preferential bending direction along a primary bending axis. This bending direction can be used to ensure the correct orientation of the drive cable 20A during assembly and provide a reliable operation of the drive system, as the  
5 denticulation or indentation 28 faces the drive pinion teeth. Therefore, misalignment between the drive cables 20A and 20B and the drive pinion 24 can be avoided, as the preferential bending direction of the drive cables 20A and 20B is identical with the gear teeth of the drive pinion 24. This orientation is also stable for different load conditions.

Further, the aforementioned design of the drive cables 20A and 20B creates pretension  
10 in the guides of the cables to avoid rattling. A load change noise can also be avoided or reduced.

Uniform and robust behaviour of the drive cables 20A and 20B can be achieved under all operation conditions. By the reinforcement strands 30A and 30B, a high tensile strength of the drive cables 20A and 20B can be achieved without limiting the  
15 indentation depth. Rather, a deep indentation for a given tensile strength can be realised.

In Figures 8 to 10, an alternative embodiment of a drive cable 50 is illustrated, which largely corresponds to the drive cable being illustrated in Figures 2 to 7, but differs from the same in that it includes an armouring likewise being formed from two armouring harnesses 30A and 30B, however, being in an armouring plane A, which has a  
20 distance D from a longitudinal centre plane L of the drive cable 50. The armouring harnesses 30A and 30B, which run next to each other side by side in the longitudinal direction of the cable in the armouring plane A, are thus arranged on the other side of the longitudinal centre plane L of the cable than a denticulation 28 of the drive cable 50. By way of the off-centre arrangement of the armouring plane A, it is possible to enlarge  
25 the imprint depth of the driving toothed wheel 24 into the cable 50 or to realise the recesses 34, forming the denticulation 28 deeper than with the drive cable according to Figures 2 to 7.

This has no limiting effect on the bending properties of the drive cable, as the effect on the flexural behaviour of multiple reinforcement strands can exceed the effect of  
30 eccentric reinforcement strand position.

The desired cable properties can largely be varied and be controlled more easily compared to a single core wire, e. g. favourable bending direction and rotational properties, pretension in guides, tensile strength etc.

In Figures 11 to 13, a further embodiment of a drive cable 60 is illustrated, which  
5 largely corresponds to the embodiment according to Figures 2 to 7, but differs from the same in that three armouring harnesses 30A, 30B and 30C are arranged in an armouring plane A, which approximately coincides with a longitudinal centre plane L of the drive cable 60, said armouring harnesses being formed from a steel wire mesh in each instance and reaching through the cable body 26 being formed from plastics or from a  
10 polymer in the axial direction, in this process also reaching through or under the roots of the teeth 40 of the denticulation 28.

Apart from that, drive cable 60 corresponds to the embodiment according to Figures 2 to 7.

In Figures 14 to 16, a further embodiment of a drive cable 70 is illustrated, which  
15 likewise largely corresponds to the embodiment according to Figures 2 to 7, but differs from the same in that it includes an armouring harness 30, which is formed by a metal band being made of a steel wire mesh and whose plane is in an armouring plane A, which is arranged so as to be parallel to a longitudinal centre plane L of drive cable 70. The armouring plane A defined by the armouring harness 30 having an almost  
20 rectangular cross-section is arranged so as to be spaced apart from the longitudinal centre plane L, to be more precise on the side facing away from a denticulation 28.

Apart from that, drive cable 70 corresponds to the embodiment according to Figures 2 to 7.

**List of reference numerals**

|    |             |                       |
|----|-------------|-----------------------|
|    | 10          | vehicle roof          |
|    | 12          | roof opening          |
|    | 14          | lid member            |
| 5  | 16A, B      | drive slide           |
|    | 18A, B      | guide rail            |
|    | 20A, B      | drive cable           |
|    | 22          | drive motor           |
|    | 24          | driving toothed wheel |
| 10 | 25          | guide section         |
|    | 26          | cable body            |
|    | 28          | denticulation         |
|    | 30, A, B, C | armouring harness     |
|    | 34          | recess                |
| 15 | 36          | tip of a tooth        |
|    | 38          | pocket flank          |
|    | 40          | root of a tooth       |
|    | 42          | edge                  |
|    | 50          | drive cable           |
| 20 | 60          | drive cable           |
|    | 70          | drive cable           |

## Claims

1. A drive cable for actuating a vehicle member being movable as against a vehicle structure, comprising a cable body (26) which is made of plastics, and which  
5 includes an denticulation (28) extending in the axial direction for engaging with a driving toothed wheel (24) and through which an armouring extending in the axial direction reaches, characterised in that the denticulation (28) is formed by pocket-like recesses (34) which are spaced apart in the axial direction at regular intervals, and which are limited, in the longitudinal direction of the cable, by flanks of  
10 resulting tips of teeth (36) formed by the cable body (26) and in the transverse direction of the cable, on each of their two sides, by a pocket flank (38) and which are in each instance limited by a root of a tooth (40) on the bottom side, the armouring reaching through said cable body (26) beneath said recesses (34) and said tips of teeth (36), the armouring defining an armouring plane (A) which  
15 extends in the transverse direction of the cable and in the longitudinal direction of the cable, and in which at least two continuous armouring harnesses (30A, 30B, 30C) extending in the axial direction are arranged side by side and/or in which at least one armouring harness (30) having a flat cross-section is arranged.
2. The drive cable according to claim 1, characterised in that each of the at least two  
20 armouring harnesses (30A, 30B, 30C) has a round cross-section.
3. The drive cable according to claim 1, characterised in that the at least one armouring harness (30) having the flat cross-section has a long cross-section axis, which extends in the transverse direction of the cable, and a short cross-section axis, which extends in the vertical direction of the cable.
- 25 4. The drive cable according to claim 3, characterised in that the armouring harness (30) is formed from a metal band.
5. The drive cable according to any one of the claims 1 to 4, characterised in that the at least one armouring harness (30A, 30B, 30C) is formed from a wire, from a wire

mesh, from carbon fibres and/or glass fibres.

6. The drive cable according to any one of the claims 1 to 5, characterised in that the armouring plane (A) is arranged so as to be parallel to and spaced apart from a longitudinal centre plane (L) of the cable body (26).
- 5 7. The drive cable according to any one of the claims 1 to 6, characterised in that top front faces of teeth (36) of the denticulation (28), in relation to a peripheral face being defined by the cable body (26) in the region without any denticulation and being virtually continued in the denticulation region, are set back in the direction of the cable body axis, such that the denticulation (28) is completely within the  
10 peripheral face being defined by the cable body (26).
8. The drive cable according to any one of the claims 1 to 7, characterised in that each of the recesses (34), in relation to the peripheral direction of the cable body (26), has an opening cross-section, which extends over less than  $180^\circ$  in the peripheral direction of the cable body (26).
- 15 9. The drive cable according to any one of the claims 1 to 8, characterised in that the recesses (34), in the transverse direction of the cable, have a lateral pocket edge (42) on each of their two sides and in that a guide section (25) of the cable body (26) extends between the two lateral pocket edges (42) of a recess (34).
- 20 10. The drive cable according to claim 9, characterised in that the guide section includes at least three guide faces being spaced apart from one another in the peripheral direction.
11. The drive cable according to claim 10, characterised in that the guide faces include axial centre lines, which are in each instance offset one with respect to the other in the peripheral direction by approximately  $120^\circ$ .
- 25 12. The drive cable according to any one of the claims 1 to 11, characterised in that the cable body (26), in the region of the tips of teeth (36), has a cross-section that is at

the very least nearly circular.

13. The drive cable according to any one of the claims 1 to 12, characterised in that the cable body (26) has an axial recess at its periphery.
14. The drive cable according to claim 13, characterised in that the recess is formed by  
5 a bevel of the cable body (26), with the aid of which the drive cable can be justified in the peripheral direction by way of resting against a corresponding guide face of a cable guide.
15. A drive unit for a vehicle member being movable as against a vehicle structure, comprising a driving toothed wheel (24) and at least one drive cable (20A, 20B)  
10 according to any one of the claims 1 to 14.
16. The drive unit according to claim 15, characterised in that the drive cable (20A, 20B) and the driving toothed wheel (24) engage with each other via a contact line following a circular line.
17. The drive unit according to claim 16, characterised in that the contact line extends  
15 over at least 30° in relation to the periphery of the driving toothed wheel (24).
18. The drive unit according to claim 17, characterised in that the driving toothed wheel (24) engages with two drive cables (20A, 20B) according to any one of the claims 1 to 11 and in that the two drive cables (20A, 20B), in relation to the axis of the driving toothed wheel (24), are offset one with respect to the other.
- 20 19. The drive unit according to claim 18, characterised in that the two drive cables (20A, 20B) and the driving toothed wheel (24) in each instance engage with each other via a wrap angle of approximately 180°.



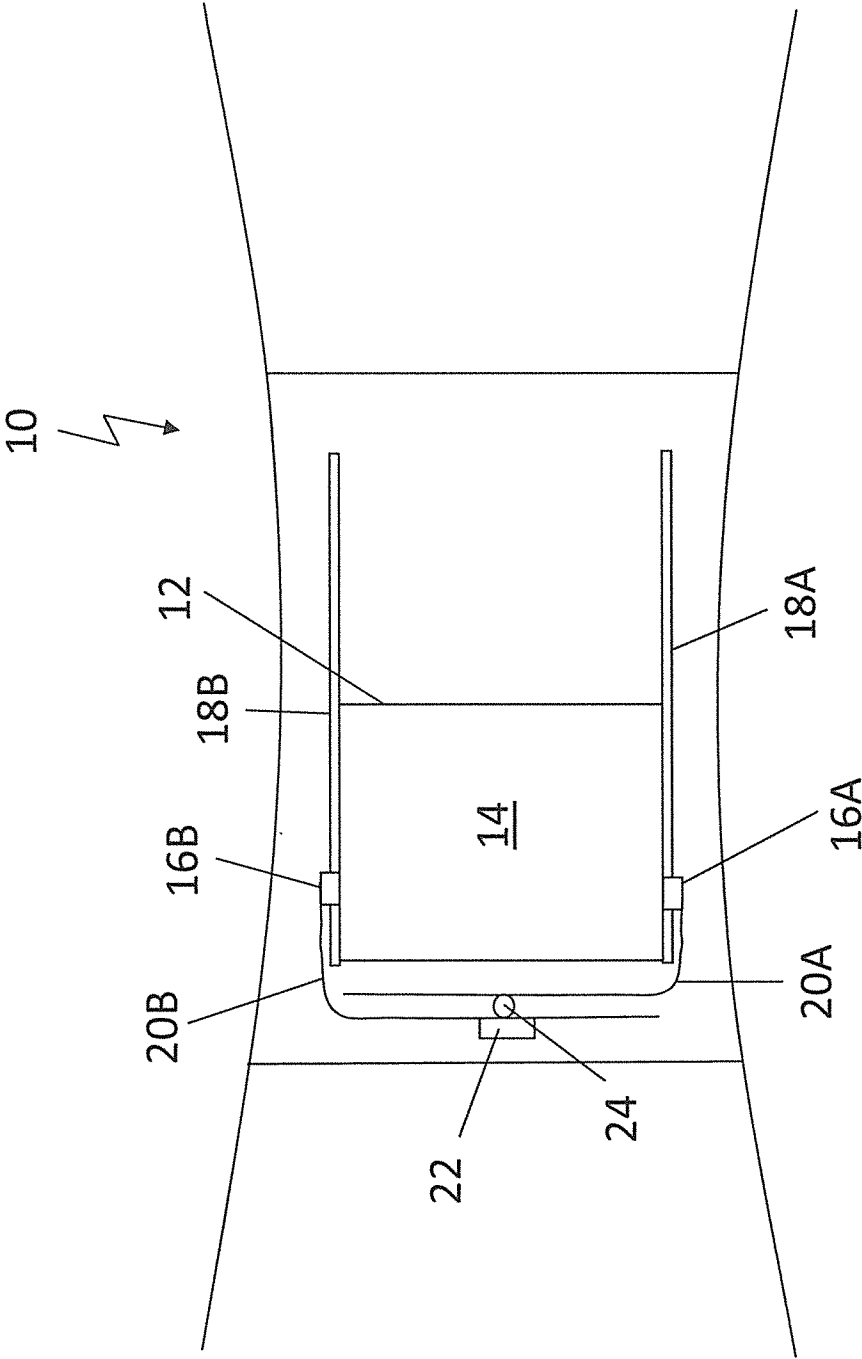


Fig. 1

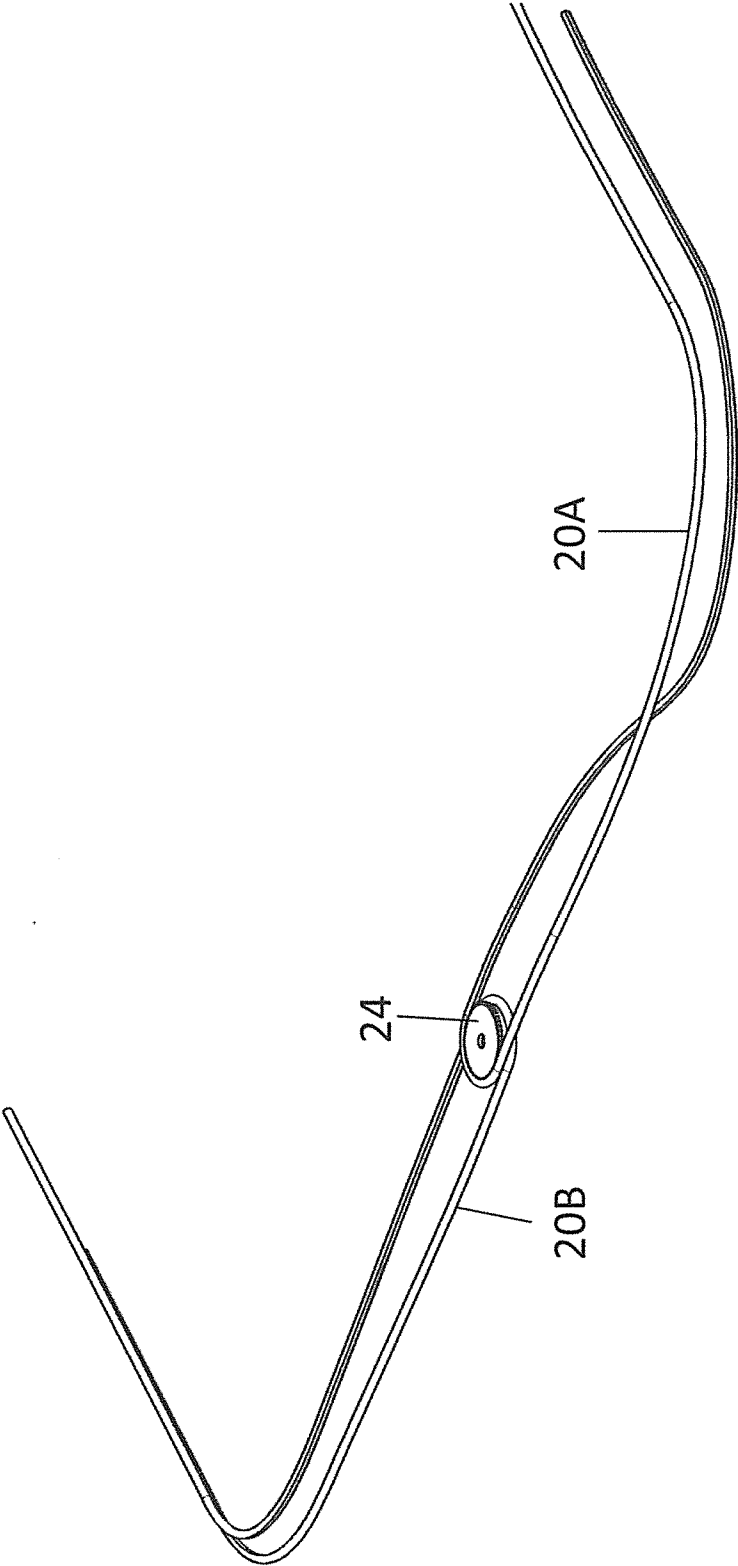


Fig. 2

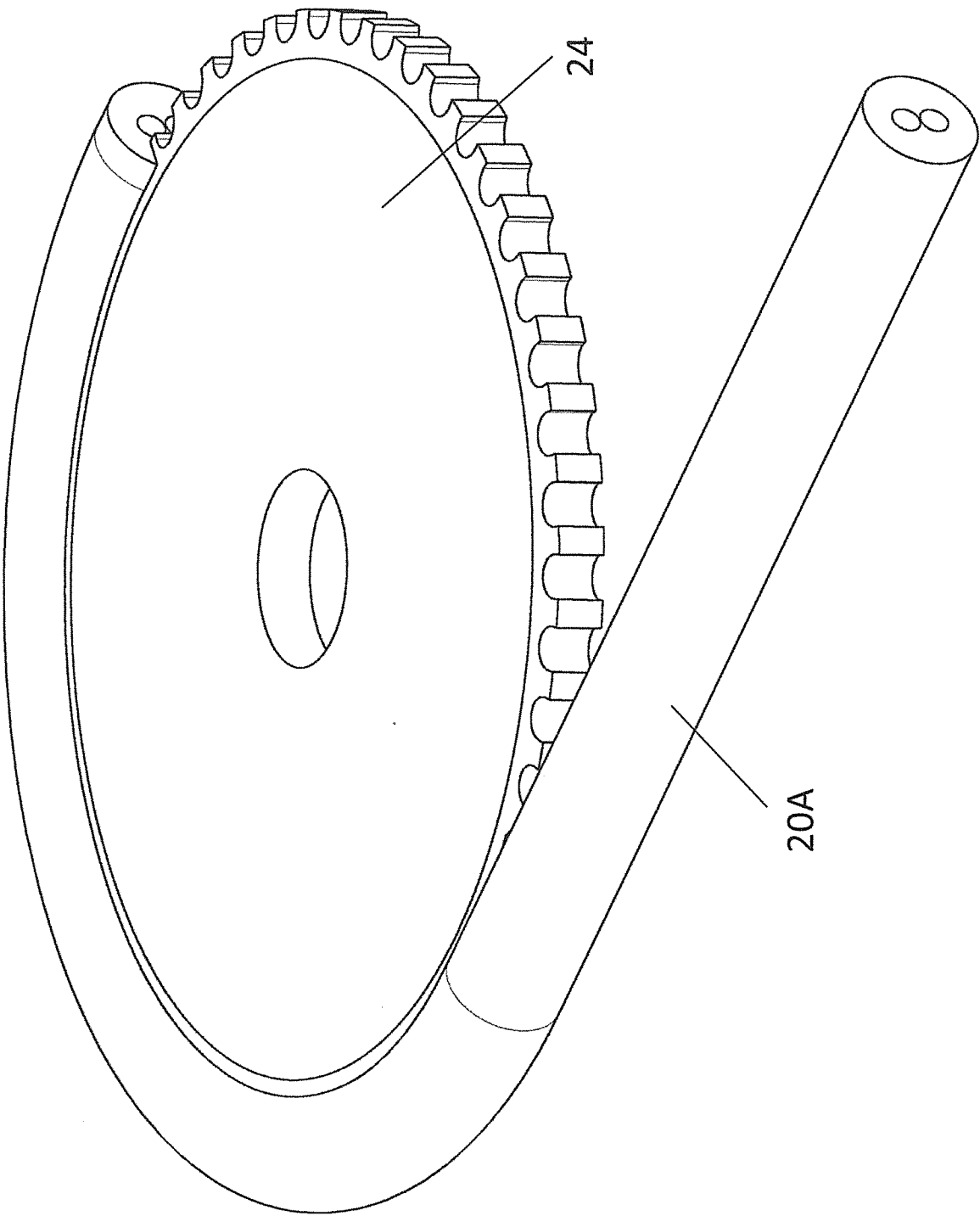


Fig. 3

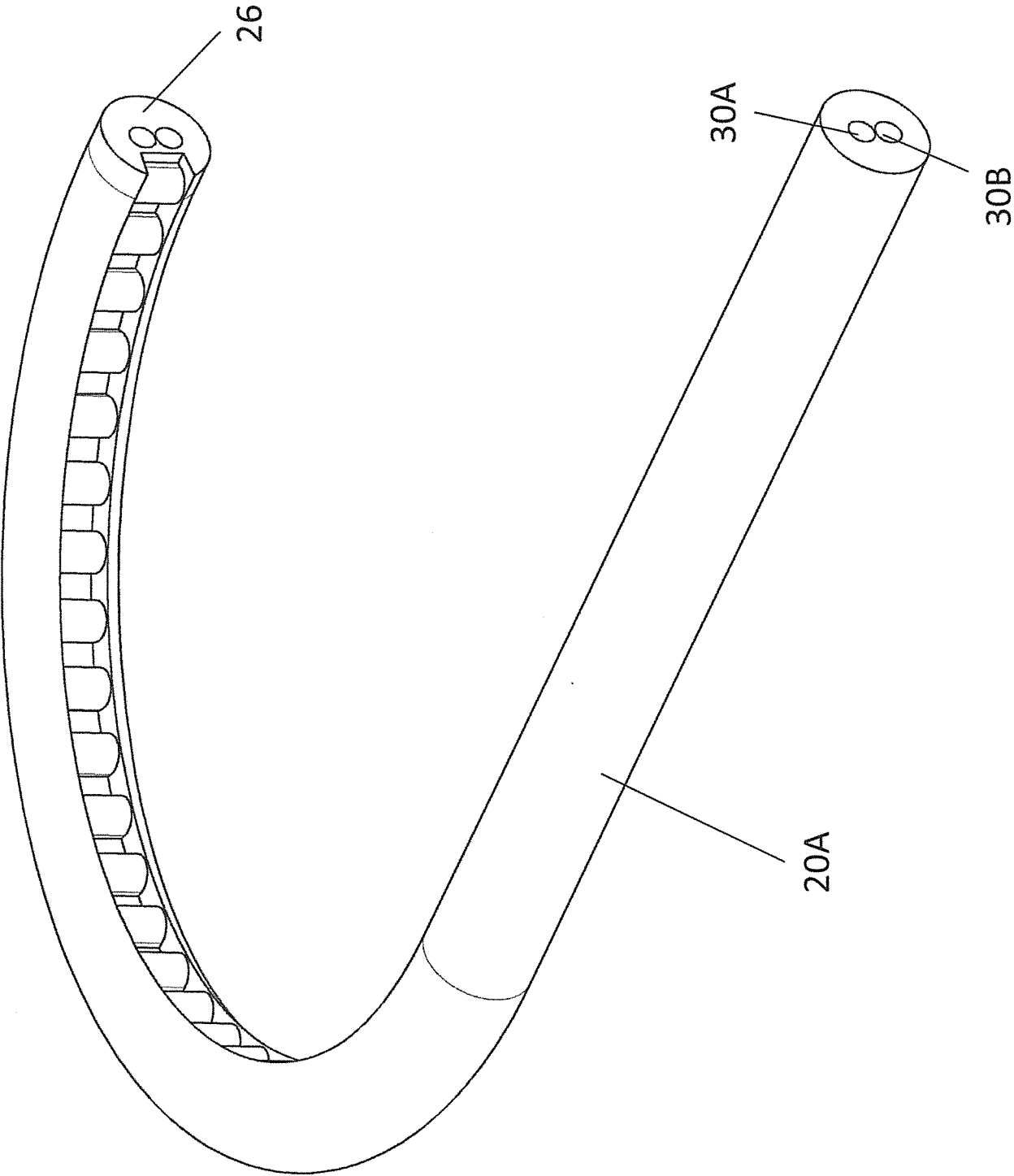
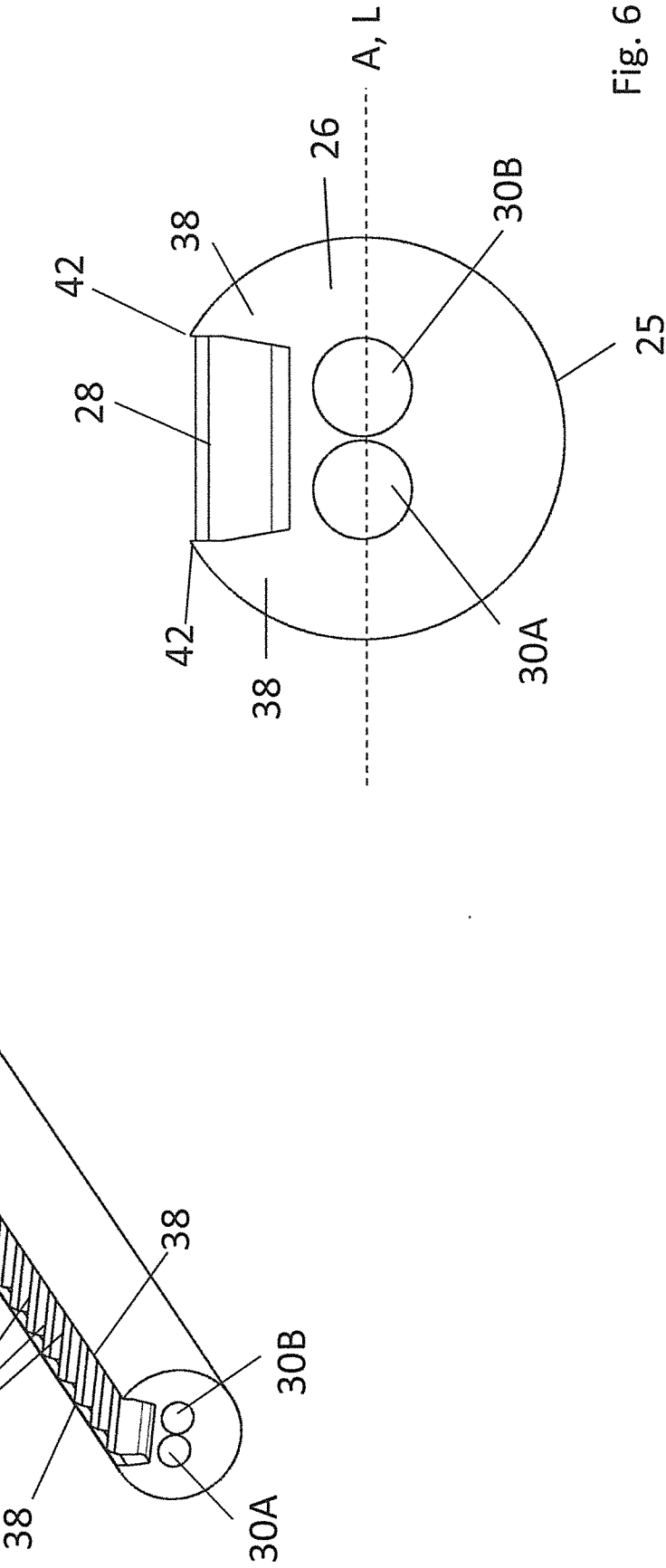
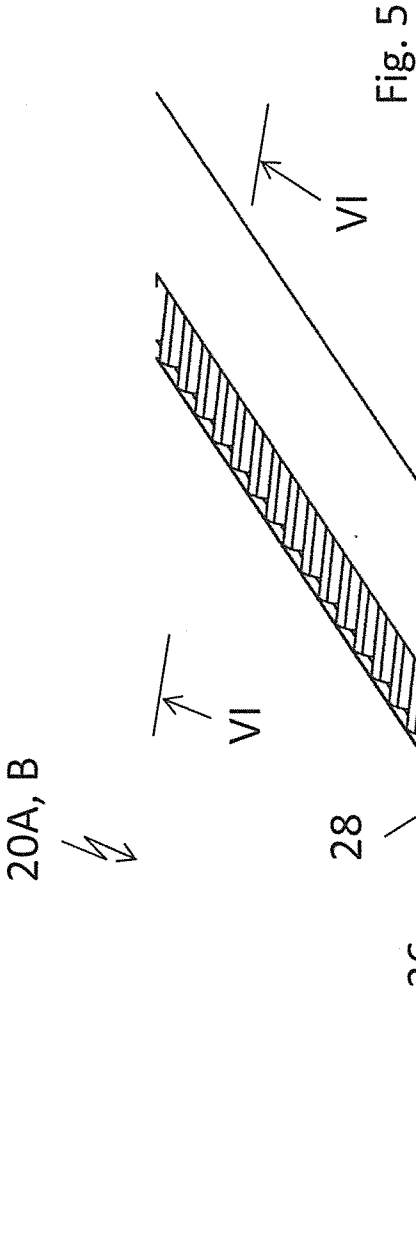


Fig. 4



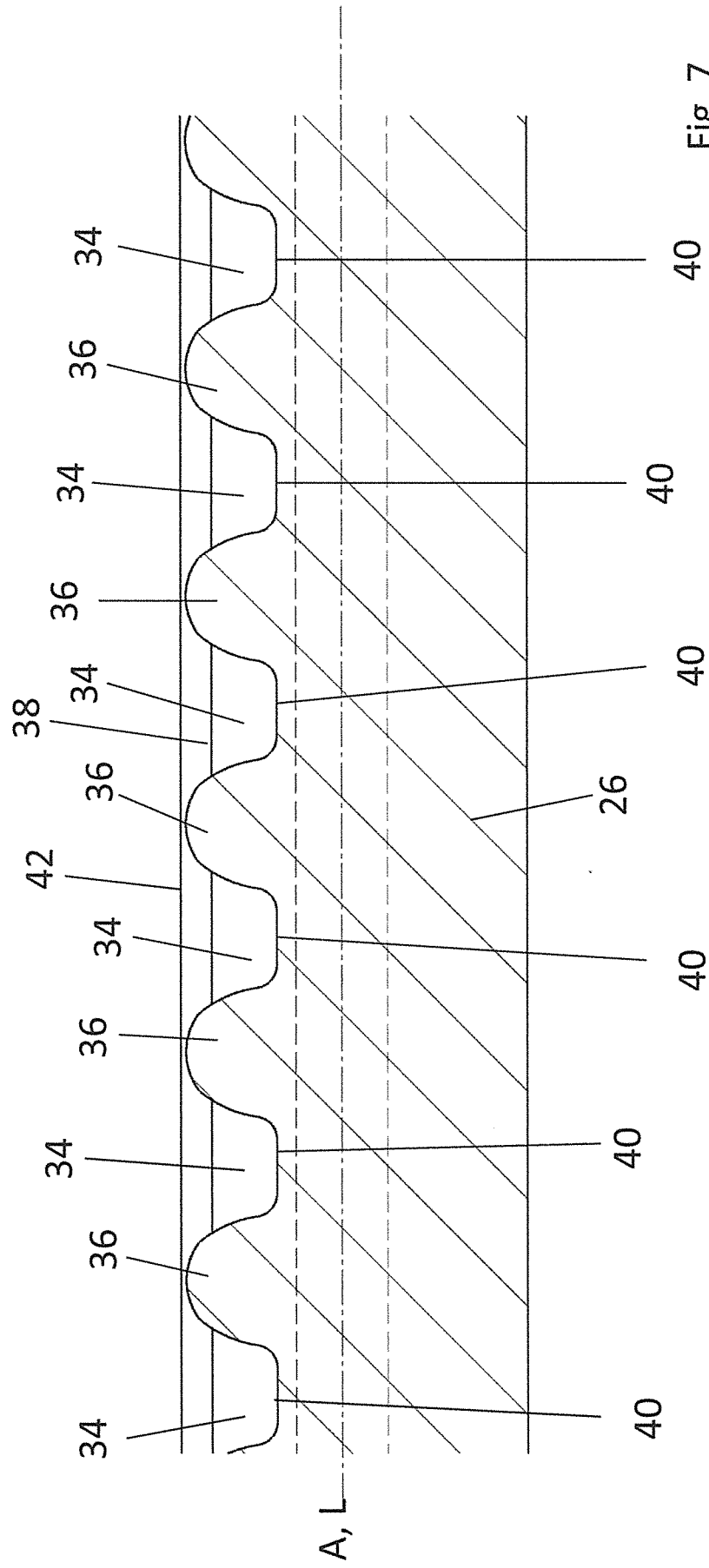
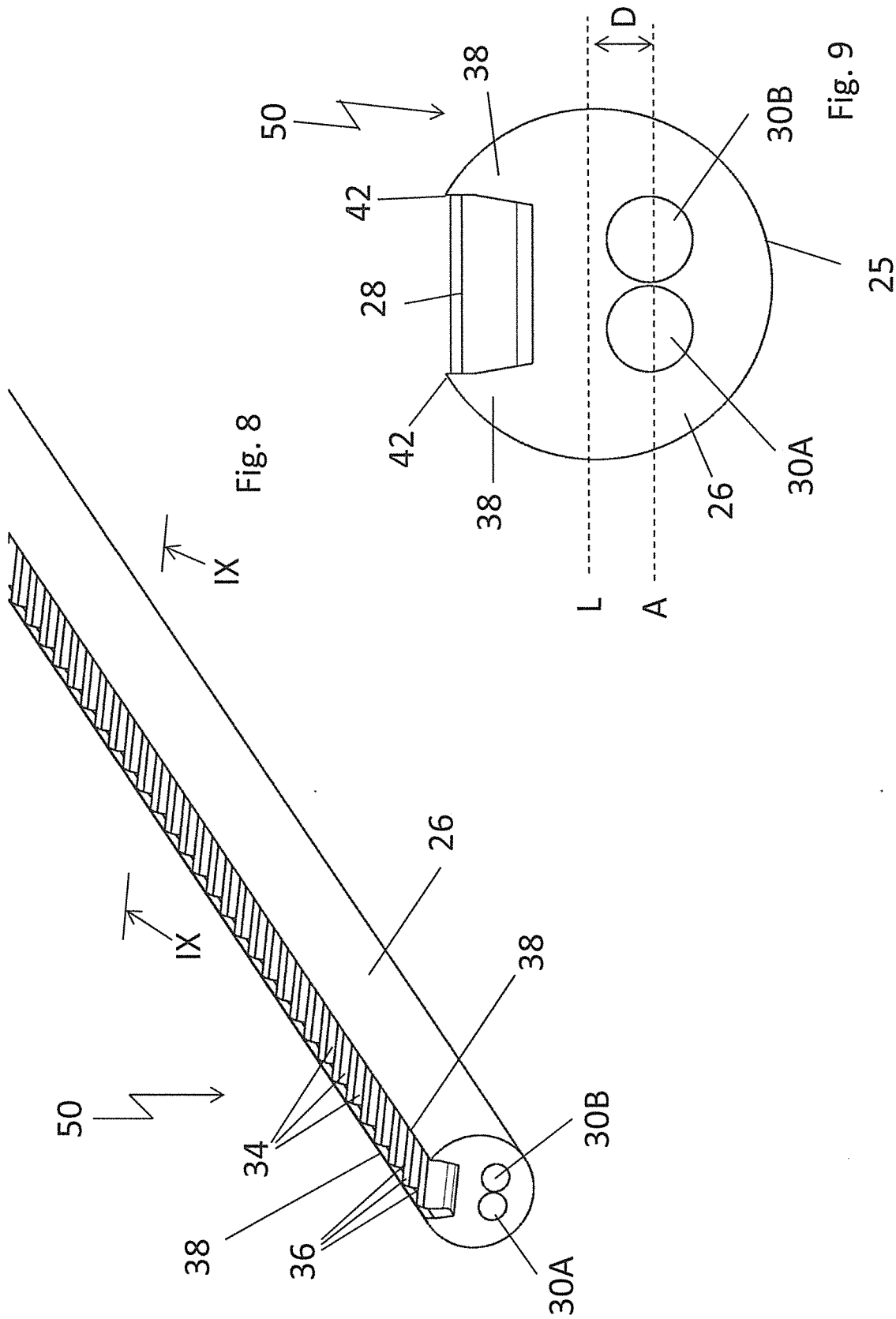


Fig. 7



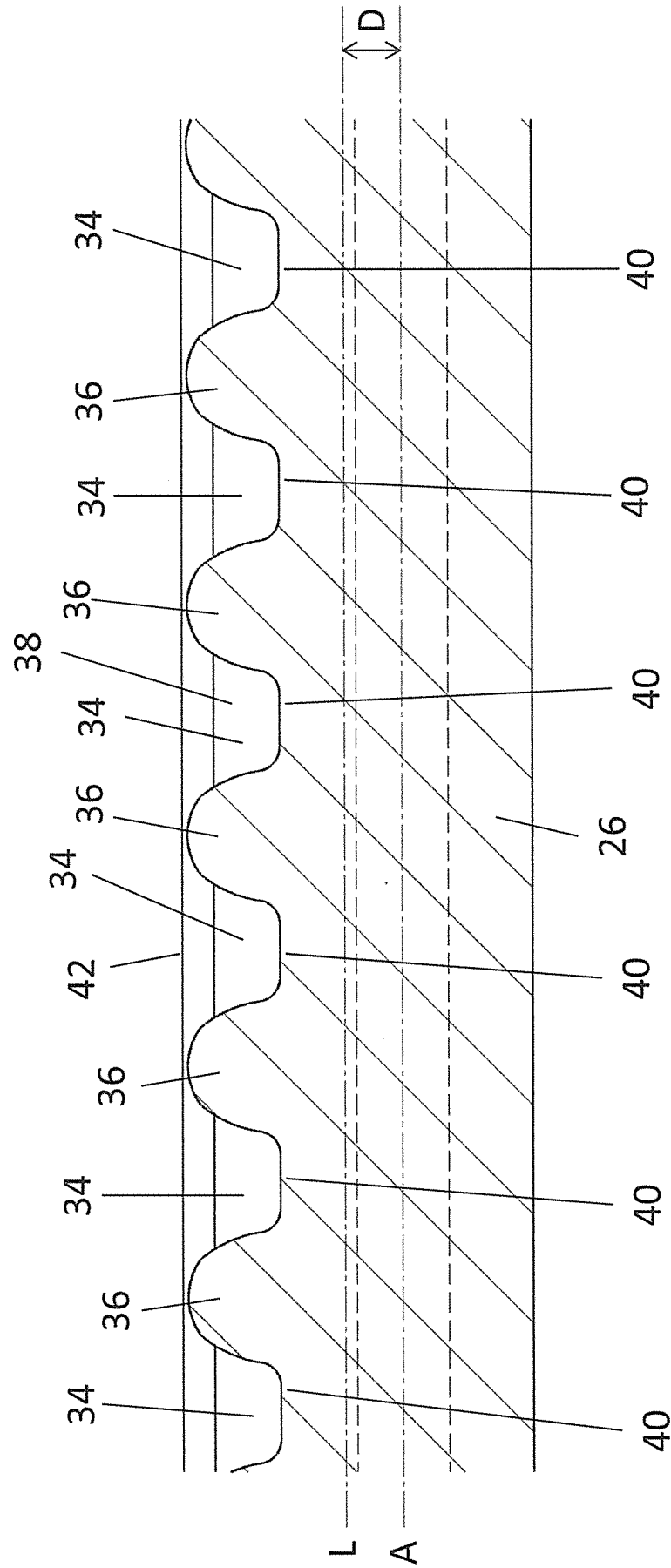
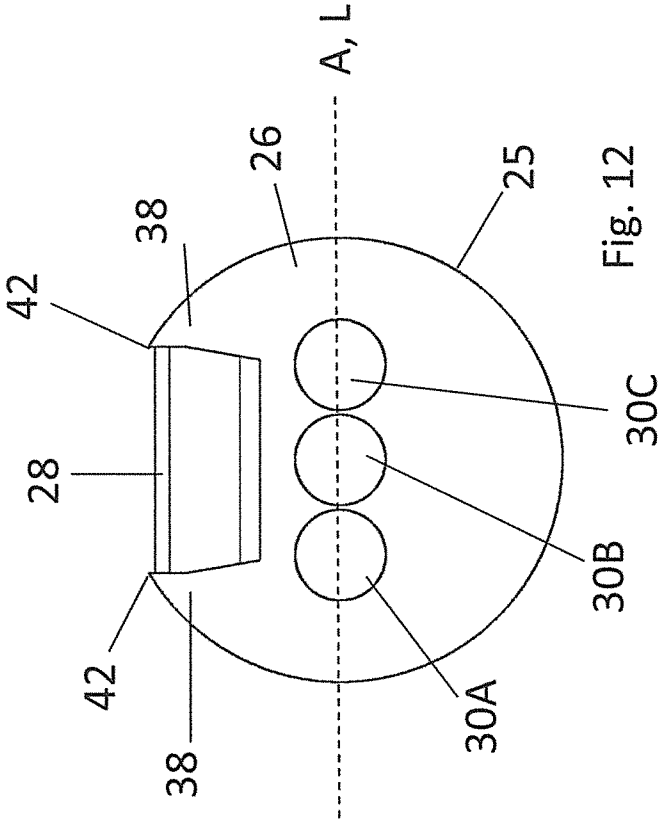
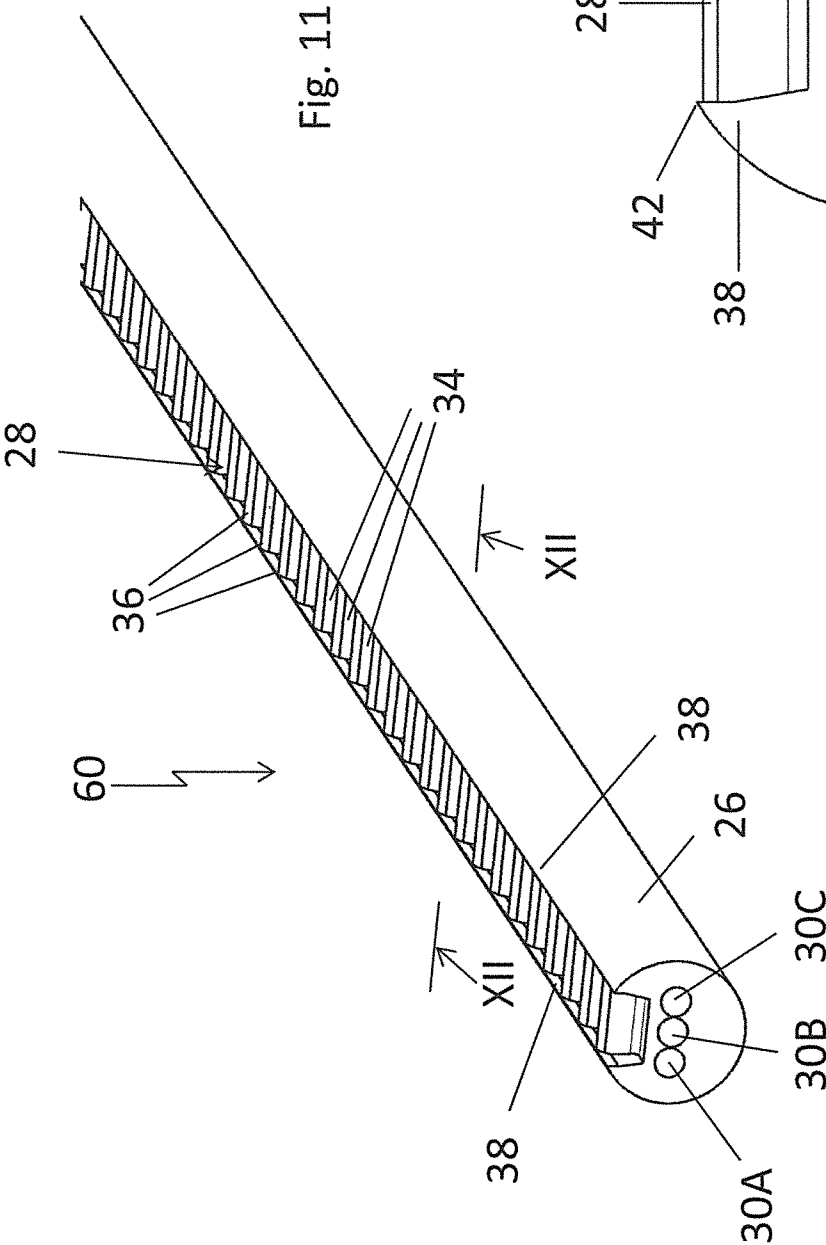


Fig. 10





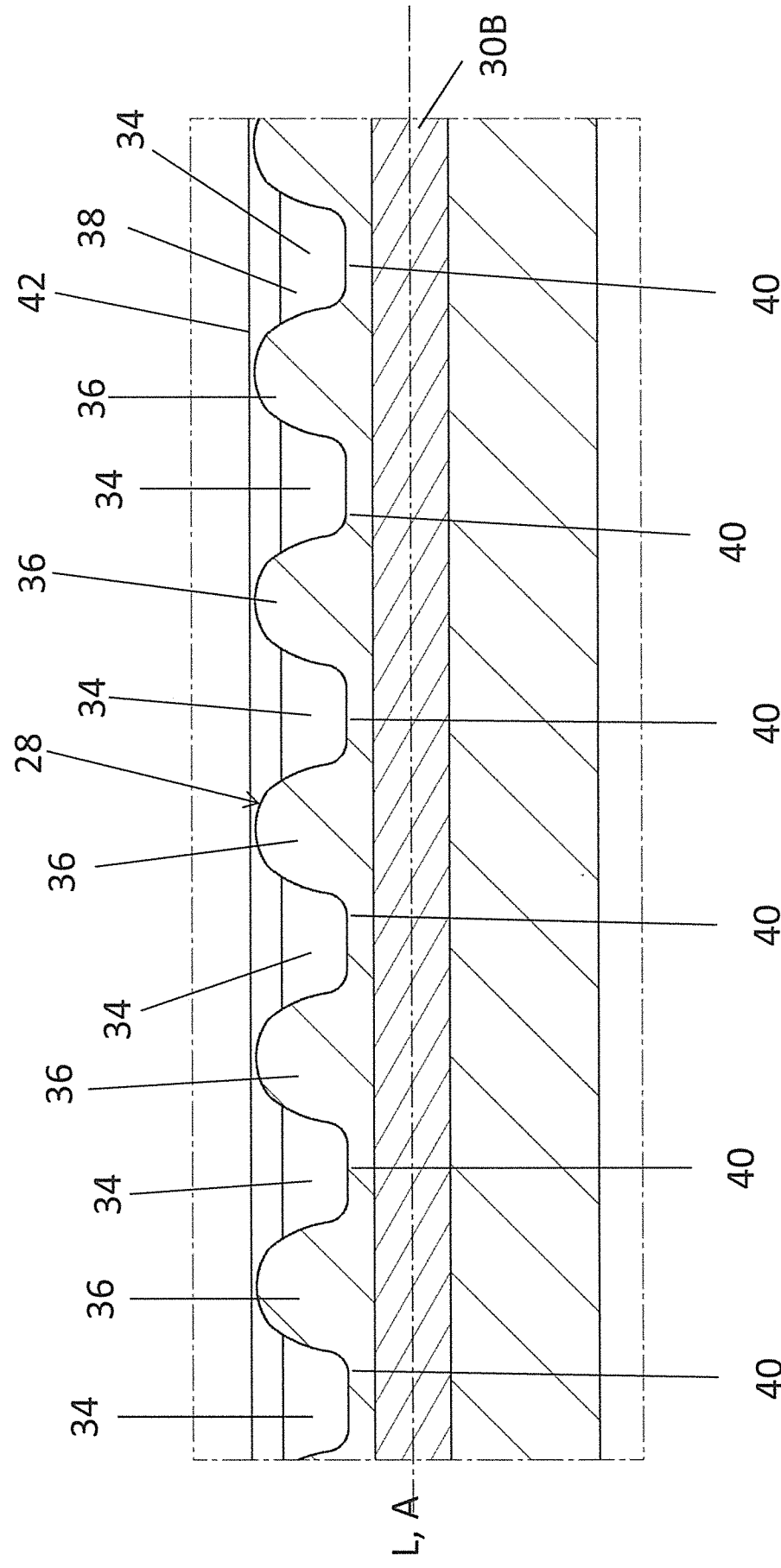
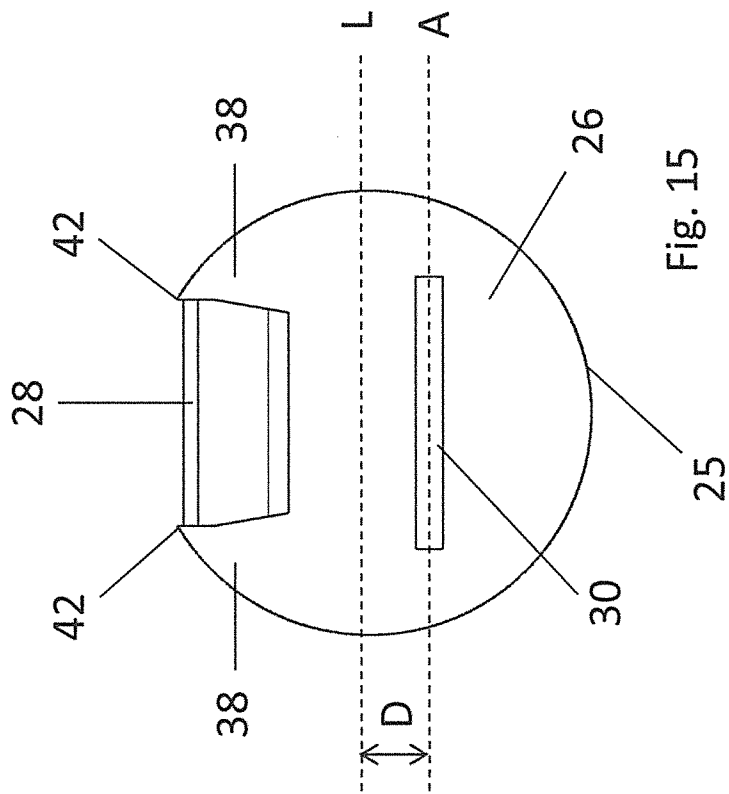
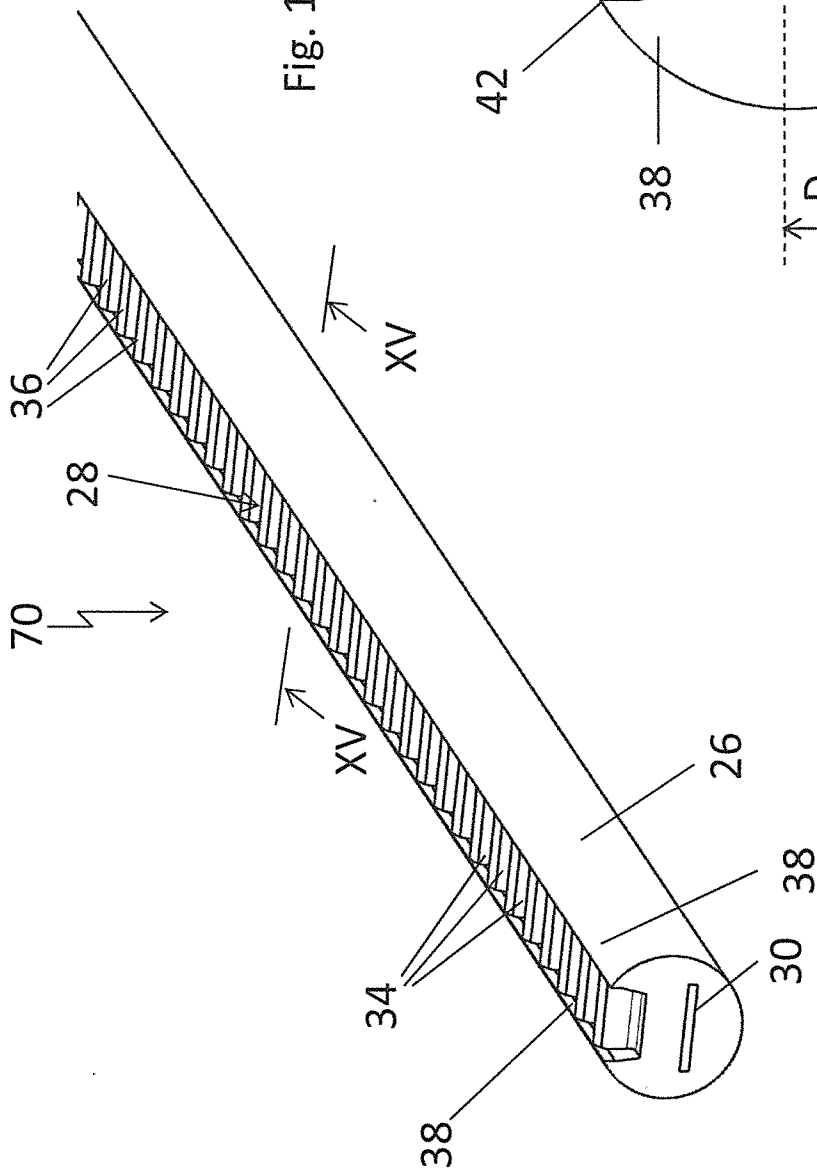


Fig. 13



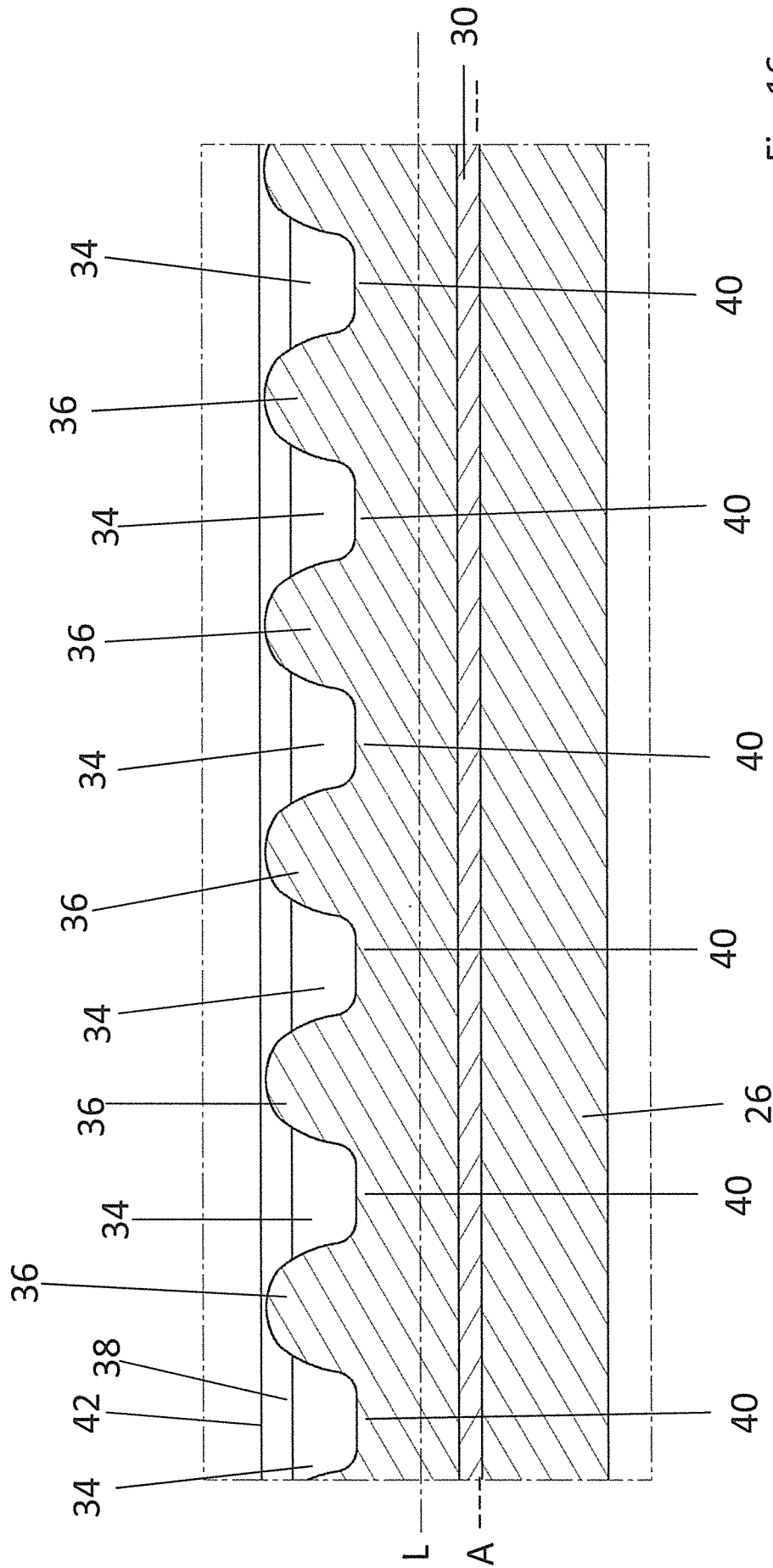


Fig. 16

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2016/079803

A. CLASSIFICATION OF SUBJECT MATTER  
INV. F16C1/18 F16C1/20 F16H19/04 B60J7/057 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)  
F16C F16H B60J 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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                             | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------|-----------------------|
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| Y         | paragraph [0017] - paragraph [0019];<br>figures 1,3,4                                                                          | 1-9,<br>15-19         |
| X         | US 2 770 977 A (RICHARD BECKADOLPH ET AL)<br>20 November 1956 (1956-11-20)                                                     | 1,2,5,6,<br>8,15,16   |
| Y         | column 2, line 33 - column 3, line 3;<br>figures 1,3                                                                           | 1-9,<br>15-19         |
| Y         | DE 10 03 517 B (VORBRUEGGEN VOFA WERK)<br>28 February 1957 (1957-02-28)<br>column 4, line 15 - line 57; figures 1-6            | 1-19                  |
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|           | -----<br>-/-                                                                                                                   |                       |



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

22 March 2017

Date of mailing of the international search report

30/03/2017

Name and mailing address of the ISA/

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Authorized officer

Fischbach, Gerhard

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/079803

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                       |                       |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category*                                            | Citation of document, with indication, where appropriate, of the relevant passages                                                    | Relevant to claim No. |
| Y                                                    | EP 0 499 135 A1 (GATE SPA [IT])<br>19 August 1992 (1992-08-19)<br>column 3, line 10 - column 6, line 58;<br>figures 1-3,8-11<br>----- | 1-15                  |

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Information on patent family members

International application No

PCT/EP2016/079803

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date       |
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