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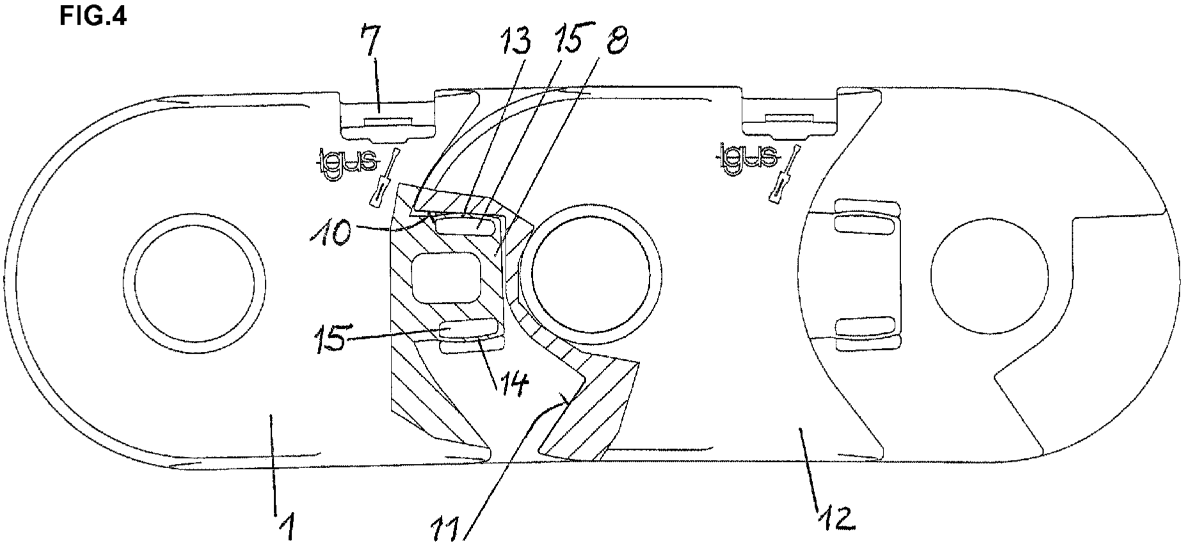
(54) **Title:** CABLE CARRIER HAVING DAMPING ELEMENTS AND SIDE PART FOR SAME

(54) **Bezeichnung:** ENERGIEFÜHRUNGSKETTE MIT DÄMPFUNGSELEMENTEN SOWIE SEITENTEIL DAFÜR

FIG.4



(57) **Abstract:** The invention relates to a cable carrier or to a side part (2, 3) for same. The pivotability of connected chain links (1) with respect to one another in cable carriers is typically limited by interacting stops (8) which have stop surfaces (10) and are arranged on the side parts (2,3). The invention relates to elastically deformable damping elements which dampen the passage over the regions between the stops (8) and the stop surfaces (10). According to the invention, at least some of the stops (8) have a damping bar (13, 14) which is convexly curved in the direction of the other stop surface in each case, behind which damping bar a free space (15) is provided, wherein both ends of the damping bar (13, 14) are connected to the stop (8) in the manner of an arched bridge. The damping bar (13, 14) is further integrally connected to the inner wall (2, 3) of the side part facing the inner guide channel (5).

(57) **Zusammenfassung:** Es wird eine Energieführungskette bzw. ein Seitenteil (2, 3) hierfür vorgeschlagen. Bei Energieführungsketten ist typisch die Verschwenkbarkeit verbundener Kettenglieder (1) gegeneinander durch an den Seitenteilen (2,3) angeordnete, zusammenwirkende Anschläge (8) mit Anschlagflächen (10) begrenzt. Die Erfindung betrifft elastisch deformierbare Dämpfungselemente, die das Auflaufen der Bereiche zwischen den Anschlägen (8) und den Anschlagflächen (10) dämpfen. Erfindungsgemäß haben

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[Fortsetzung auf der nächsten Seite]

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zumindest einige Anschläge (8) einen in Richtung auf die jeweils andere Anschlagfläche konvex gewölbten Dämpfungsbügel (13, 14), hinter welchem ein Freiraum (15) vorgesehen ist, wobei beide Enden des Dämpfungsbügels (13, 14) nach Art einer Bogenbrücke fest mit dem jeweiligen Anschlag (8) verbunden sind. Weiterhin ist der Dämpfungsbügel (13, 14) mit der zum inneren Führungskanal (5) weisenden Innenwand des jeweiligen Seitenteils (2, 3) einteilig verbunden.

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Energy chain with damping elements as well as side part therefor

The invention relates to an energy chain with a guide channel for guiding hoses, cables or the like between two connection points, at least one of which is non-stationary, having a plurality of chain links which are composed of side parts and cross bars and which are connected together in an articulated manner, wherein the pivotability of adjacent or subsequent chain links relative to one another is limited by cooperating abutments and abutment surfaces, which are arranged on the side parts, and wherein there are provided resiliently deformable damping elements which damp abutting of the regions between the abutments and the abutment surfaces. The invention also relates to a side part as such that is having the features according to the invention.

An energy chain of this type is known from DE 296 07 492 U1. Herein, the damping elements are in the form of spring lips, which protrude obliquely from the respective abutment and, upon striking the abutment surface of the following chain link, bend resiliently in the direction towards the respective abutment. Such damping elements have already proved very successful in practice. When the spring lips are bent towards the respective abutment upon striking the abutment surfaces, tensile forces are generated on the upper side of the spring lips and compressive forces are generated on the lower side. The materials from which energy chains are produced are largely insensitive to compressive forces. If, however, tensile forces occur, there is the risk that material fatigue will occur in the materials, in particular in the case of plastics, which contributes towards reducing the service life of the energy chain in question.

In WO 2017/182494 A1 Applicant has already proposed a further development of an energy chain side part with damping element. In this case, the damping element is also a spring lip that can be deformed resiliently.

A further design for shock absorption of the generic type as set out above has been proposed in patent document CN106151379A or in utility model CN205991137U, which also shows the features of claim preamble.

DE 10 2005 026 667 A1 reveals a cable chain with side parts that have V-shaped abutment surfaces that, when pivoted, come into partial point contact with contact regions of the abutments of a following side part. This allows air between the abutment surfaces and abutments to escape, thus reducing collision noise. In addition, the cylindrically shaped abutments are elastically deformable as a whole.

DE 103 39 168 A1 reveals a side part for a cable drag chain, which has shell-shaped or concave and elastically deformable damping elements on abutment surfaces which, when pivoted, interact with abutments of a following side part. The clear width of the damping element according to DE 103 39 168 A1 is slightly smaller than the diameter of the interacting abutment, so that the damping element expands when the abutment strikes. Therefore, the damping elements according to DE 103 39 168 A1 are subject to wear.

It is an object of some embodiments to overcome or ameliorate at least one the disadvantages of the prior art, or to provide a useful alternative.

An object underlying some embodiments is to prolong the service life of energy chains and in particular, to prolong the service life of the damping elements, whilst preferably also improving the damping behavior between the chain links in the deflection regions (bending regions).

Any discussion of documents, acts, materials, devices, articles of the like which has been included in the present specification is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present disclosure as it existed before the priority date of each of the appended claims.

Throughout this specification the word “comprise”, or variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

According to some embodiments, an advantage is achieved in that at least some of the abutments have in their contact regions in which they come into contact with the abutment surfaces at least one damping bow which is curved convexly in the direction towards the respective abutment surface, in that a free space is provided behind the damping bow, and in that both ends of the damping bow are fixedly connected to the

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respective abutment in the manner of an arched bridge. In accordance with the invention, the damping bow can be connected to the inner wall of the respective side part, i.e. the wall facing the inner guide channel, in particular in the lateral direction at least in a partial area between the ends of the damping bow or over its entire dimension. This additional connection of the damping bow can in particular be a one-piece or integral connection, preferably homogenous (made of the same material), with the rest of the body of the side plate. This results in a relatively stable construction and further increases the service life.

Not only do the curved damping bows create an optimal damping effect; when they are deformed, substantially only compressive forces occur, as are predominant, for example, in the case of arched bridges. Tensile forces, which can lead to material fatigue, do not occur in the construction according to the invention or occur to only a very small extent. This already noticeably improves the service life, especially if quite rigid plastics with low elasticity are preferably used.

In combination with the connection of the bow bridges with the inner wall of the side part, i.e. in the lateral direction with respect to the bow length, a particularly robust and durable construction is achieved, as the bow bridges are thereby supported or stabilized. In addition, the degree of deformability of the bow bridge can be adjusted as required via an additional degree of freedom, depending on the dimensions of the connection with the side wall.

Furthermore, it is foreseen that the inner wall of the side part is recessed in the area of the damping bow. Preferably, a

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first recess opening into or connected to the free space as well as an opposite second recess can be provided. Both recesses are recessed in relation to the surrounding area of the surface of the inner wall. This considerably simplifies the manufacture of the bow bridge when using injection-moulding technology, as no expensive tools with means for creating undercuts are required. In addition, the dimensioning of the recess allows sufficient flexibility or deformability of the bow bridge despite the stabilizing connection of the bow bridge with the inner wall, and shear forces on the stabilizing connection can be avoided.

The recesses face the broad sides of the bow bridge and are spatially limited. Both recesses are preferably limited in the longitudinal direction to a dimension which corresponds approximately to the length of the bow bridge or deviates from it only slightly, e.g. by +/- 20%. In height direction, each recess should at least correspond to the bow height.

Some embodiments provide an energy chain with a guide channel for guiding lines, such as hoses, cables or the like, between two connection points, at least one of which is non-stationary, comprising a plurality of chain links which are composed of side parts and cross bars and which are connected together in an articulated manner, wherein the pivotability of adjacent chain links relative to one another is limited by cooperating abutments and abutment surfaces which are arranged on the side parts, and wherein resiliently deformable damping elements are provided which damp abutting of the regions between the abutments and the abutment surfaces, wherein at least some of the abutments comprise in their contact regions in which they come into contact with the abutment surfaces at

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least one damping bow which is curved convexly in the direction towards the respective abutment surface, a free space is provided behind the damping bow, both ends of the damping bow are fixedly connected to the respective abutment in the manner of an arched bridge; and the damping bow is connected in a lateral direction at least in a partial area between the ends of the damping bow or over its entire dimension via a connecting region to an inner wall of the side part that faces towards the inner guide channel, wherein the inner wall of the side part is recessed in the area of the damping bow and presents a first recess opening into to the free space as well as an opposite second recess, the first and second recess being recessed in relation to the surrounding surface of the inner wall.

Some embodiments provide a side part for an energy chain comprising a guide channel for guiding lines, such as hoses, cables or the like between two connection points, at least one of which is non-stationary, with a plurality of chain links which are composed of two side parts and two cross bars and which are connected together in an articulated manner, wherein the side part has abutments which are arranged to limit the pivotability of chain links connected in an articulated manner relative to one another by cooperating with abutment surfaces of a following side part, and wherein on the side part resiliently deformable damping elements are provided, which damp abutting of the regions between the abutments and the abutment surfaces (10), wherein at least one abutment comprises in each of its contact regions, in which it comes into contact with the cooperating abutment surfaces to limit the pivotability, at least one damping bow which is convexly curved in the direction towards the respective cooperating abutment surface, a free space is provided behind the damping bow, both ends of the damping bow are fixedly connected to the respective abutment in the manner of an arched bridge, and the damping bow is connected in a lateral direction at least in a partial area between the ends of the damping bow or over its entire dimension via a connecting region to an inner wall of the side part, wherein the inner wall of the side part is recessed in the area of the damping bow and presents a first recess opening into to the free space as well as an opposite second recess, the first and second recess being recessed in relation to the surrounding surface of the inner wall.

In a preferred embodiment the recesses have a recess depth of at least 50% of the surrounding wall thickness in relation to the surface of the inner wall and/or the depth (viewed in the direction of the material thickness of the side plate) of the recess is at least 33% of the width of the damping bow perpendicular to the longitudinal direction. This results in a particularly good deformability despite the connection with the inner wall.

The side parts of which the energy chain according to the invention is composed can consist in a manner known *per se* of appropriate plastics and can be produced, in particular in one piece or from a single material by an injection-molding process. Fiber-reinforced polymers, e.g. a polyamide, with comparatively high stiffness, are particularly suitable.

In such a construction, the damping bows can be integrally formed at both their ends with the associated abutment. Not only is this particularly advantageous from the point of view of production; a very good damping effect is also achieved with such integrally formed damping bows.

Preferably, a curved damping bow is provided on both sides of the abutments - that is to say both on the upper side thereof and on the lower side thereof - so that the advantageous damping effect is achieved both in the bending procedure of the energy chain and in the extending procedure. In other words, a curved damping bow in accordance with the invention is preferably provided for both swivel directions i.e. into the fully angled position present in the deflection bend and into the fully stretched position respectively, the latter with pretension if necessary.

The radius of the curve of the damping bow is advantageously comparatively large, so that the curve is relatively flat. A flat curve is sufficient to achieve the desired damping effect. When the flatly curved damping bow is deformed, almost exclusively a compression effect occurs during its deformation, so that tensile stresses in the deformed bow can largely be avoided.

The ratio of the chord length of the curve to the height can be approximately 20:1, preferably at least 10:1.

Preferably, the respective damping bow extends over the entire width of the associated abutment. The pressure that occurs in the event of damping is thereby distributed over the entire width of the abutment.

Advantageously, the damping bow and the free space located behind it extend transversely to the longitudinal direction of

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the respective side part. Owing to this construction, the deformation effect of the damping bow is optimized. The term "behind", which refers to the position of the free space relative to the damping bow, refers to the direction of action of the abutment, i.e. the side facing away from the effective abutment surface, the latter being the front side of the damping bow. The abutment surfaces preferably strike one another flatly and are preferably perpendicular to the main plane (i.e. the plane which is spanned by the longitudinal direction and the height of the side plate) of the side plate, i.e. in the direction of the width or material thickness of the side plate.

The invention is illustrated by way of example, without limiting the claim scope, in the drawing and described in detail herein below with reference to the drawing, in which:

Fig. 1 is a perspective view of a chain link of an energy chain according to the invention,

Fig. 2 is a side view of the chain link according to Fig. 1,

Fig. 3 is a partial cross-section perpendicular to the longitudinal direction, along line III-III from Fig. 2, and

Fig. 4 is a side view, partially in section, of two chain links connected together.

According to Fig. 1 of the drawing, the chain link 1 has two side parts 2 and 3, which are connected together by means of a cross bar 4 in their region, which is at the top in the drawing. The region of the two side parts 2 and 3 which is at the bottom in the drawing is connected by means of a further cross bar, which is not shown in the drawing. A guide channel 5 is formed between the two side parts 2 and 3 and the two cross bars, which guide channel is to serve for receiving hoses, cables and the like.

The lower cross bar, not shown in the drawing, is openable, so that access to the guide channel 5 is possible, in order to insert the hoses, cables and the like into the energy chain. With regard to the lower cross bar, only the mounts 6 and 7 are shown on the side part 2 and 3, at least one of which mounts is in the form of a hinge axis.

In the deflection regions of the energy chain, the chain links 1 must be pivoted relative to one another through a given angle. In order to limit the pivot angle, there are provided on each of the side parts 2 and 3 a abutment 8 and a cutout 9 having an upper abutment surface 10 and a lower abutment surface 11, the designations "upper" and "lower" referring only to the representation according to Figures 1 and 2.

The abutments 8 each cooperate with the abutment surfaces 10 and 11 of the following chain link 12 shown in Fig. 4.

Rapid movement of the energy chains was in the past often associated with considerable noise emission, which was perceived as troublesome. For that reason, damping elements came to be provided between the abutments 8 and the abutment surfaces 10 and 11.

In the exemplary embodiment shown in the drawing, the abutments 8 are equipped in their contact regions in which they come into contact with the abutment surfaces 10 and 11 of the following chain link 12 with convexly curved damping bows 13 and 14 in their lateral regions, the convexly curved regions in each case being oriented in the direction towards the corresponding abutment surface 10 or 11.

Behind each damping bow 13 or 14 there is provided a free space 15. When the respective damping bow 13 or 14 strikes the corresponding abutment surface 10 or 11, the damping bow 13 or 14 is able to give way into the free space 15 slightly.

The damping bows 13 and 14 are constructed in the manner of an arched bridge, their two ends being fixedly connected to the abutment 8.

Owing to the bridge-like form of the damping bows 13 and 14, predominantly compressive forces are generated in their material during their deformation.

The chain links according to the invention are generally produced in one piece from plastics material, the respective damping bows 13 and 14 being integrally formed at their two ends with the associated abutment 8.

The plastics material used to produce energy chains can readily absorb compressive stresses without substantial material fatigue occurring as a result. In this respect, on account of the fact that almost exclusively compressive forces occur upon deformation of the damping bows 13, 14, the service life of the energy chains equipped with the features according to the invention can be prolonged considerably.

The radius of the curve of the damping bows 13 and 14 is chosen to be comparatively large, so that the curve is thus relatively flat and the degree of deformation of the damping bows 13 and 14 is relatively small. The ratio of the chord length of the curve to the height is approximately 20:1 in the exemplary embodiment shown in the drawing.

According to the embodiment shown in the drawing, the respective damping bow 13 or 14 extends over the entire width of the associated abutment 8, so that the contact pressure is distributed uniformly over the entire width of the abutment 8. The damping bows 13 and 14 and also the free space 15 located behind them extend transversely to the longitudinal direction of the respective side part 2 or 3.

In the exemplary embodiment shown in the drawing, the damping bows 13 and 14 are connected to the wall of the respective side part 2 or 3 that faces towards the inner guide channel 5.

Alternatively, however, an embodiment is also possible in which the wall of the respective side part 2 or 3 that faces towards the inner guide channel 5 is recessed in the region of the respective damping bow 13 or 14. In such an embodiment, the respective damping bow 13 or 14 is thus not connected to the inside wall of the respective side part 2 or 3 and as a result can be compressed uniformly over its entire width upon striking the respective abutment surface 10 or 11.

Fig. 4 shows a portion of the upper run of an energy chain, consisting of two chain links 1 and 12 connected together. The upper abutment surface 10 of the chain link 12 on the right in the drawing is resting on the abutment 8 of the chain link 1, the upper damping bow 13 of the abutment 8 being depressed slightly.

In the turnaround region of the energy chain, that is to say when one of the two chain links pivots downwards, the lower abutment surface 11 of the chain link 12 strikes the lower damping bow 14, which at the moment of impact gives way slightly into the free space 15.

When the chain links 1 and 12 pivot again into the horizontal region of the lower run, the abutment surface 10 comes into contact again with the damping bow 13 facing it.

As best seen from FIG.3, each damping bow 13, 14 is connected with the inner wall 16 pointing to the guide channel 5 or with the surrounding body of the respective side part 2, 3, along its side that faces away from the guide channel 5 and between both ends over a partial length or preferably completely continuously. This connection is via a connecting region 17 that is homogenous i.e. uniformly having the same material as the damping bow 13, 14.

As can also be seen in FIG.2, the inner wall 16 of the side part 2, 3 is recessed in the area of the damping bow 13, 14. Above and below the damping bows 13, 14 respectively, two recesses 18A, 18B are provided opposite the surface of the inner wall 16. These recesses 18A, 18B are injection moulded together with the side plate 2, 3 as recesses in relation to the damping bow 13, 14 and the material area remaining between them forms the damping bow 13, 14. The recesses 18A, 18B are recessed by a measure corresponding to at least 50% of the surrounding wall thickness and have a depth in FIG.3, which is almost 50% of the width of the damping bow 13, 14 in the plane of FIG.3 i.e. transverse to the longitudinal direction.

As FIG.3 shows, a rear recess 18A is openly connected to or forms the free space 15 and a front or opposite recess 18B is provided on the other side of the damping bow 13, 14. The rear recess 18A, viewed laterally, is located completely within the abutment 8. Both recesses 18A, 18B have the same depth and similar base area in lateral view (FIG.2), each being notably smaller than the protruding abutment 8, as can be seen from FIG.2. If the recesses 18A, 18B are sufficiently deep, in case of a damping deformation of the damping bows 13, 14 only slight torsion occurs over the connection region 17, whereas the desired effect of the arch bridge predominantly occurs, i.e. a resulting predominant compressive load, which is introduced via the ends of the damping bows 13, 14 into the load-bearing solid body areas of the abutment 8.

By means of the construction according to the invention, it is consequently possible, with very simple means, to achieve optimal noise damping of energy chains. Moreover, on account of the advantageous stress ratios in the damping bows 13 and 14, material fatigue in those regions can largely be avoided and as a result the service life of an energy chain can be prolonged considerably.

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Energy chain with damping elements and side part therefor

List of reference numerals

1 chain link
2 side part
3 side part
4 cross bar
5 guide channel
6 mount
7 mount
8 abutment
9 cutout
10 abutment surface
11 abutment surface
12 following chain link
13 damping bow
14 damping bow
15 free space
16 inner wall
17 connection region
18A, 18B recess

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Energy chain with damping elements as well as side part therefor

Claims

1. Energy chain with a guide channel for guiding lines, such as hoses, cables or the like, between two connection points, at least one of which is non-stationary, comprising a plurality of chain links which are composed of side parts and cross bars and which are connected together in an articulated manner, wherein the pivotability of adjacent chain links relative to one another is limited by cooperating abutments and abutment surfaces which are arranged on the side parts, and wherein resiliently deformable damping elements are provided which damp abutting of the regions between the abutments and the abutment surfaces, wherein
   - at least some of the abutments comprise in their contact regions in which they come into contact with the abutment surfaces at least one damping bow which is curved convexly in the direction towards the respective abutment surface,
   - a free space is provided behind the damping bow,
   - both ends of the damping bow are fixedly connected to the respective abutment in the manner of an arched bridge; and
   - the damping bow is connected in a lateral direction at least in a partial area between the ends of the damping bow or over its entire dimension via a connecting region to an inner wall of the side part that faces towards the inner guide channel,

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- wherein the inner wall of the side part is recessed in the area of the damping bow and presents a first recess opening into to the free space as well as an opposite second recess, the first and second recess being recessed in relation to the surrounding surface of the inner wall.

2. Side part for an energy chain comprising a guide channel for guiding lines, such as hoses, cables or the like between two connection points, at least one of which is non-stationary, with a plurality of chain links which are composed of two side parts and two cross bars and which are connected together in an articulated manner,
- wherein the side part has abutments which are arranged to limit the pivotability of chain links connected in an articulated manner relative to one another by cooperating with abutment surfaces of a following side part, and
- wherein on the side part resiliently deformable damping elements are provided, which damp abutting of the regions between the abutments and the abutment surfaces, wherein
- at least one abutment comprises in each of its contact regions, in which it comes into contact with the cooperating abutment surfaces to limit the pivotability, at least one damping bow which is convexly curved in the direction towards the respective cooperating abutment surface,
- a free space is provided behind the damping bow,
- both ends of the damping bow are fixedly connected to the respective abutment in the manner of an arched bridge, and
- the damping bow is connected in a lateral direction at least in a partial area between the ends of the damping

bow or over its entire dimension via a connecting region to an inner wall of the side part,

- wherein the inner wall of the side part is recessed in the area of the damping bow and presents a first recess opening into to the free space as well as an opposite second recess, the first and second recess being recessed in relation to the surrounding surface of the inner wall.

3. Device according to claim 1 or 2, wherein the recesses have a depth of the recess, with respect to the surface of the inner wall, amounting to at least 50% of the surrounding wall thickness and/or the depth of the recess is at least 33% of the width of the damping bow perpendicular to the longitudinal direction.

4. Device according to one of claims 1 to 3, wherein each side part consist of plastics material.

5. Device according to claim 4, wherein the side parts are formed in one piece, and in that the respective damping bow is integrally formed at both its ends with the associated abutment.

6. Device according to any one of claims 1 to 5, wherein a curved damping bow is provided on both sides of the abutments.

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7. Device according to any one of claims 1 to 6, wherein the radius of the curve of the damping bow is comparatively large and the curve is thus relatively flat.

8. Device according to any one of claims 1 to 7, in particular according to claim 8, wherein the ratio of the chord length of the curve to its height is at least 10:1, in particular approximately 20:1.

9. Device according to any one of claims 1 to 8, wherein the damping bow extends at least over the entire width of the associated abutment when seen transversely to the longitudinal direction.

10. Device according to any one of claims 1 to 9, wherein the damping bow and the free space located behind the damping bow extend transversely to the longitudinal direction of the respective side part.

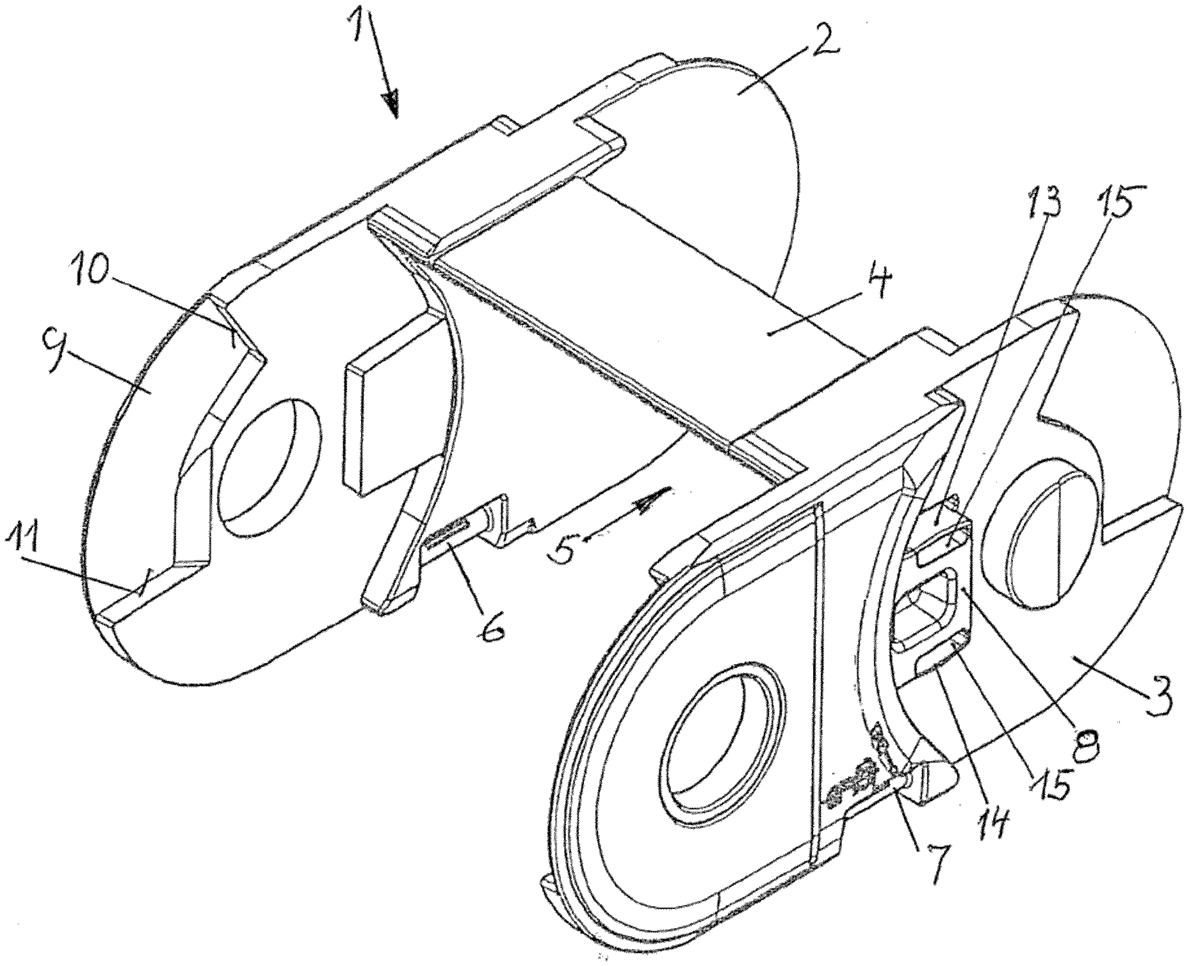

FIG.1

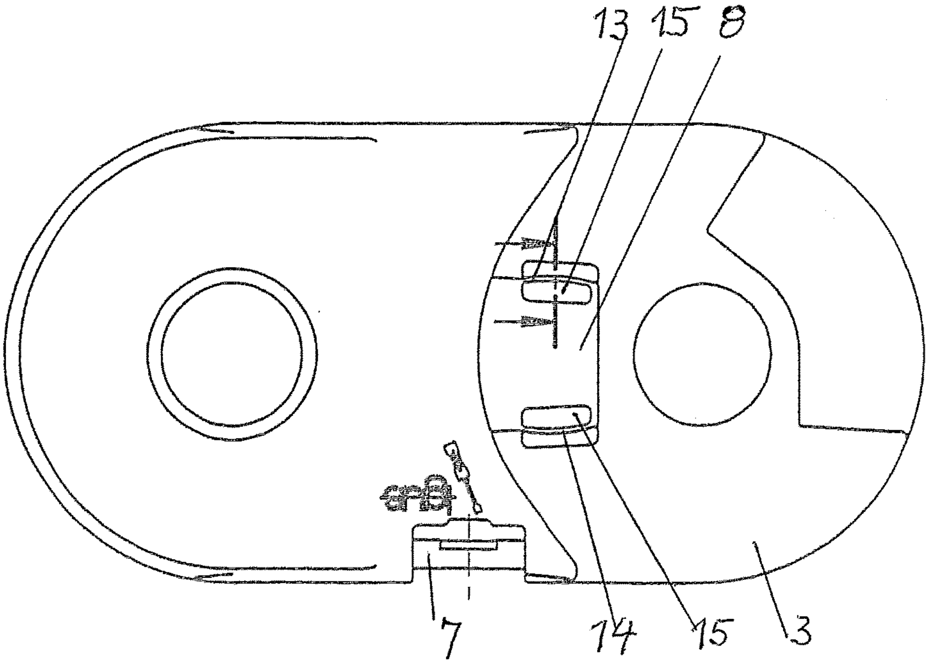

FIG.2

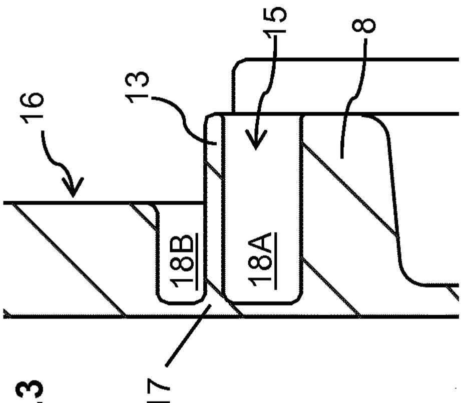

FIG.3

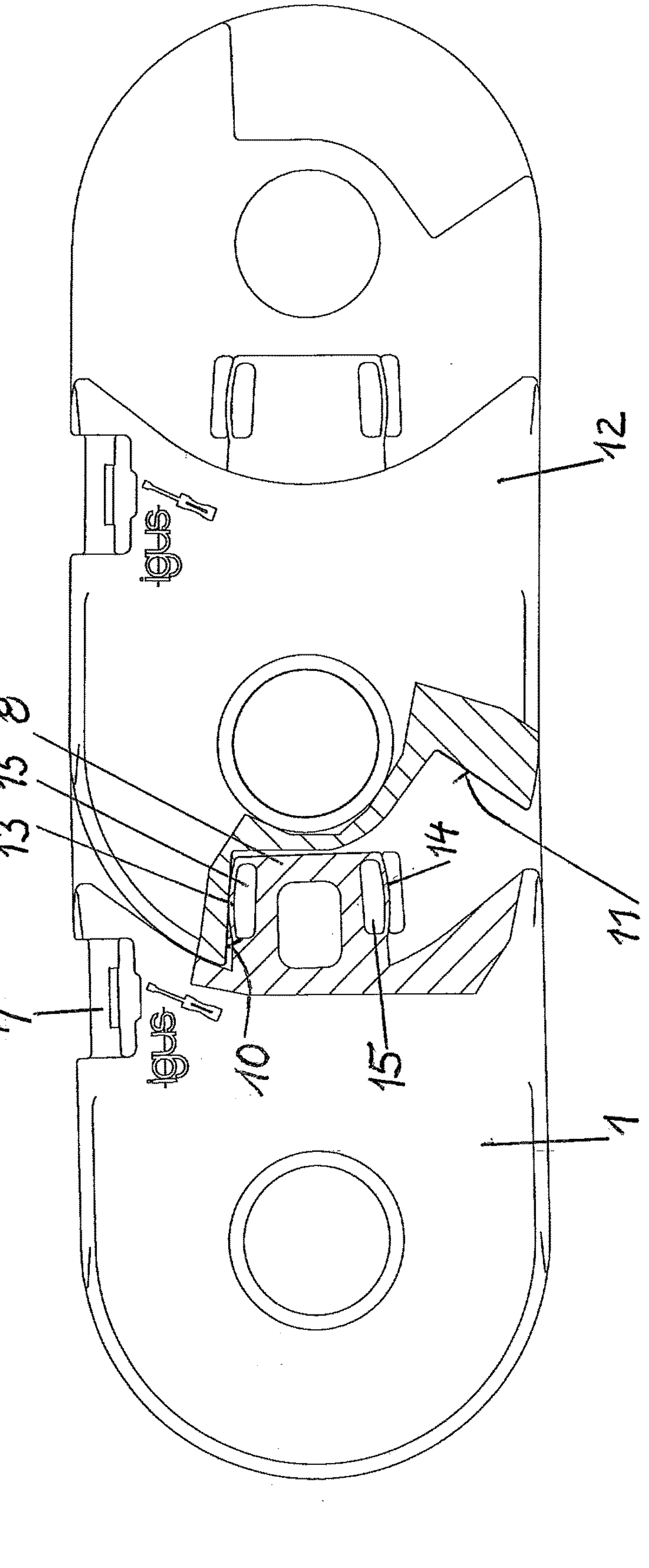

FIG.4