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Energy chain

The invention relates to an energy chain for guiding hoses, cables and the like between a fixed and a moveable connection point, whose chain links are of a lightweight, thin-walled design, each consisting of two chain straps and at least one cross-member connecting them, where the chain straps of adjacent chain links are joined in pivoting fashion by pegs integrally moulded on the straps of one chain link which reach through corresponding openings in the straps of the other chain link, and where the energy chain is designed to be torsionally elastic and/or flexurally elastic in the lateral direction.

An energy chain of this kind is suitable for easy and flexible guidance of the hoses, cables and the like of low weight located therein and, having short pitch lengths, permits an almost circular course of the mutually angled chain links. A torsionally elastic and/or laterally flexurally elastic design is present in the case of open or semi-open chains or chains with discontinuous or openable cross-members, in particular. The chains links, whose chain straps are usually of cranked design and are positioned symmetrically opposite each other, where outward-pointing pegs are integrally moulded on the outside of the inward-cranked area and the openings matching the pegs are located in the outward-cranked area, can easily be joined to each other in pivoting fashion. To this end, the corresponding strap areas are elastically deformed in such a way that the pegs of one chain link can latch into the openings in the adjacent chain link.

Although no drawbacks are to be expected as a result of the design described, it has been found that the snap-in connections between the pegs and openings of the chain straps can come apart when the energy chain is exposed to certain load conditions. The

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applicant thus set himself the task of finding a simple means for preventing separation of the pivoting joint between the chain links of the energy chain mentioned at the start.

According to the invention, the task is solved in that, on an energy chain of the kind mentioned at the start, the pegs are provided with snap-in elements around their circumference, with which the pegs engage the openings in locking fashion and which can be released from the openings by applying a certain force.

It has been found that the additional snap-in connection between the pegs and the openings in accordance with the invention ensures an optimum hold of the pivoting joints between the chain links, even when exposed to comparatively high loads. The following technical relationships come into play in this context. The pegs and the walls of the openings of the pivoting joints are exposed to strong tensile and compressive forces, particularly if there is a relatively long, freely suspended upper strand with corresponding weights, as well as during rapid traversing of such energy chains with corresponding forces of inertia. Even the slightest deviations of the position of the contiguous surfaces of the chain straps from a position exactly parallel to the direction of force induce a force component perpendicular to the straps which causes spreading of the straps in the region of the pivoting joints. Even slight spreading causes the spreading forces to rise in a non-linear manner to such an extent that they would easily overcome the snap-in joints between the pegs and openings. Surprisingly, however, it has been found that the snap-in elements provided on the circumference of the pegs in accordance with the invention are capable of preventing the development of spreading forces, even in the initial phase, or of keeping them to such a low level that the pivoting joints cannot come apart. A decisive contribution to this situation is made by the fact that the snap-in elements on the circumference of the pegs force the chain straps into precise linear alignment. As the plastic components take on a form imposed upon them, the solution according to the invention leads to

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parallel alignment of all contiguous parts of the chain straps, meaning that the development of transverse forces upon exposure of the energy chain to tensile or compressive stresses can be largely avoided.

In a preferred embodiment of the invention, the straps opposite to each other in the joint area make contact with each other without axial clearance. In particular, provision can be made for the snap-in elements on the circumference of the pegs to press together the contiguous straps in the joint area under slight pretension. This further improves the parallel alignment of the contiguous chain straps owing to the form imposed upon them.

The snap-in elements provided on the pegs are preferably designed as radial projections located on the free ends of the pegs. These can take the form of all-round wider areas. These wider areas preferably have a bellied surface extending from a cylindrical part of the peg.

In this embodiment of the pegs, the outer ends of the openings preferably display extensions into which the radial projections located on the free ends of the pegs reach. This achieves a state where the face end of the pegs is essentially in flush alignment with the outer side of the straps, this resulting in a largely smooth overall outer surface of the strap strand.

On the other hand, the snap-in elements provided on the pegs can, for example, be designed as all-round grooves into which corresponding annular projections in the openings reach. This snap-in connection can also be designed in such a way that the face end of the pegs is aligned flush with the outer side of the straps.

The invention is particularly suitable for chains whose chain links display an upper and lower cross-member, with one of these cross-members being discontinuous in order to facilitate inser-

tion of the hoses, cables and the like. Owing to the discontinuous cross-members, the straps of the chain links tend to be forced apart when exposed to tensile or compressive stresses, this being avoided by snap-in elements located on the circumference of the pegs. As a result, a sufficient hold of the pivoting joint is achieved in the event of exposure to substantial stresses, particularly if the two elements of the discontinuous cross-member lie on the same level and are separated by a narrow gap. On the other hand, the end of one element of the discontinuous cross-member which faces the other element can have a downward step which reaches under the opposite end of the other element. In a third example, the two elements of the discontinuous cross-member can lie at different levels, their ends thus being located one above the other.

In order to improve the hold of the pivoting joint of chain links with discontinuous cross-members even further, two different materials can be used to manufacture the chain straps and the continuous cross-member joining them, on the one hand, and the discontinuous cross-member, on the other. While the chain straps and the continuous cross-member consist of a relatively rigid material, the discontinuous cross-member can be made of a relatively flexible, resilient material. In this way, despite the flexible, resilient cross-member for easy insertion of the hoses, cables or the like, the chain link still has sufficient stability, owing to the relatively rigid material, which, in conjunction with the radial snap-in projections provided on the pegs, guarantees that the pivoting joints hold reliably.

An example of the invention is illustrated in the drawings and described in more detail below on the basis of the drawings. The drawings show the following:

Fig. 1 A top view of the chain link,

Fig. 2 A longitudinal cross-section along Line II-II in Fig. 1,

Fig. 3 A face-end view of the chain link shown in Fig. 1,

Fig. 4 An enlarged representation of the area of the upper cross-member marked by a circle in Fig. 3,

Fig. 5 A top view of the gap area of another embodiment of the upper cross-member,

Fig. 6 A face-end view of another practical example of the discontinuous cross-member of a chain link and

Fig. 7 A top view of the gap area of another embodiment of the upper cross-member.

The chain link of an energy chain illustrated in Figs. 1 to 3 essentially comprises two chain straps 1 and 2, together with a lower cross-member 3, joining the two chain straps 1 and 2, and an upper cross-member 4.

In the practical example of a chain link under consideration, chain links 1 and 2 are of cranked design, where outward-facing pegs 5 are integrally moulded on the outer side of the inward-cranked area (shown on the left in Figs. 1 and 2), these reaching through corresponding openings 6 in the outward-cranked area (shown on the right in Figs. 1 and 2) of an adjacent chain link and thus establishing a pivoting connection between the adjacent chain links of the energy chain.

As can be seen in detail in Figs. 1 to 4, the upper cross-member 4 has a discontinuity in the middle region. This makes it possible to press in the two cross-member elements 7 and 8 from above when inserting hoses, cables or other lines into the chain links. Owing to the relatively low thickness of cross-member elements 7 and 8, and the flexible material of which they are made, cross-member elements 7 and 8 give relatively easily when pressed in, thus clearing sufficient space for insertion of the lines. Following insertion, cross-member elements 7 and 8 spring

back into the closed position illustrated in Fig. 3.

In the practical example illustrated in Figs. 1 to 4, the cross-member elements 7 and 8 lie essentially on the same level. At the end opposite cross-member element 7, cross-member element 8 has a downward step 9 which reaches under the opposite end of cross-member element 7. As a result, the space accommodating the lines is also closed off over its entire width on the top side.

This closure can also be achieved by the two cross-member elements 10 and 11 of the discontinuous cross-member being located at different levels on cheeks 1 and 2, as illustrated in Fig. 6, so that the opposite ends of the two cross-member elements 10 and 11 are located one above the other.

In the practical examples illustrated in Figs. 1 to 4 and 6, the gap between the two cross-member elements 7 and 8 or 10 and 11 runs in the longitudinal direction of the chain.

On the other hand, it may be advantageous for the gap to be inclined in relation to the longitudinal direction of the chain, as illustrated in Fig. 5. The two cross-member elements 12 and 13 extend towards each other with mutually opposed pointed ends which give more easily when pressed in.

Furthermore, it can be advantageous to locate the cross-member elements in laterally staggered positions relative to each other, as in the case of the cross-member elements 16 and 17 illustrated in Fig. 7.

In order to prevent the chain links, which are relatively elastic owing to the discontinuous cross-members 4, from disengaging from their pivoting joints when straps 1 and 2 are exposed to flexural and/or torsional stress, pegs 5 have all-round wider areas 14 on their free ends, the largest diameter of which is greater than that of the openings 6. The wider areas 14 are designed in such a way that the pegs 5 reach through the open-

ings 6 in snap-in fashion and can be released from these again by applying a certain force. The wider area 14 has a bellied surface 15, extending from the cylindrical part of the peg 5, for the purpose of making and breaking the snap-fit connection.

List of reference numbers

1	Chain strap
2	Chain strap
3	Lower cross-member
4	Upper cross-member
5	Peg
6	Opening
7	Cross-member element
8	Cross-member element
9	Downward step
10	Cross-member element
11	Cross-member element
12	Cross-member element
13	Cross-member element
14	Wider area
15	Bellied surface
16	Cross-member element
17	Cross-member element

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Patent claims

1. Energy chain for guiding hoses, cables and the like between a fixed and a moveable connection point, whose chain links are of a lightweight, thin-walled design, each consisting of two chain straps (1, 2) and at least one cross-member (3, 4) connecting them, where the chain straps (1, 2) of adjacent chain links are joined in pivoting fashion by pegs (5) integrally moulded on the straps of one chain link which reach through corresponding openings (6) in the straps of the other chain link, and where the energy chain is designed to be torsionally elastic and/or flexurally elastic in the lateral direction, characterised in that the pegs (5) display snap-in elements around their circumference, with which the pegs (5) engage the opening (6) in locking fashion and can be released from the openings (6) again by applying a certain force.

2. Energy chain as per Claim 1, characterised in that the straps (1 and 2) opposite to each other in the joint area make contact with each other without axial clearance.

3. Energy chain as per Claim 2, characterised in that the snap-in elements on the circumference of the pegs (5) press together the contiguous straps (1 and 2) in the joint area under slight pretension.

4. Energy chain as per one of the Claims 1 to 3, characterised in that the snap-in elements provided on the pegs (5) are designed as all-round wider areas (14) on the free ends of the pegs (5).

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5. Energy chain as per Claim 4, characterised in that the wider areas (14) display a bellied surface (15), extending from a cylindrical part of the peg (5).

6. Energy chain as per Claim 4 or 5, characterised in that the outer ends of the openings (6) display extensions into which the wider areas (14) on the free ends of the pegs reach, with the result that the face end of the pegs (5) is essentially in flush alignment with the outer side of the straps (1, 2).

7. Energy chain as per one of the Claims 1 to 6, with a discontinuous cross-member (4), characterised in that the two elements (7, 8) of the discontinuous cross-member (4) lie on the same level and are separated from each other by a narrow gap.

8. Energy chain as per Claim 7, characterised in that the end of one element (8) of the discontinuous cross-member (4) which faces the other element (7) has a downward step (9) which reaches under the opposite end of the other element.

9. Energy chain as per one of the Claims 1 to 6, with a discontinuous cross-member (4), characterised in that the two elements (10, 11) of the discontinuous cross-member lie on different levels and their ends are located one above the other.

10. Energy chain as per one of the Claims 1 to 6, with a discontinuous cross-member (4), characterised in that the chain straps (1, 2) and the cross-member (3) connecting them are made of a relatively rigid material and the discontinuous cross-member (4) is made of a relatively flexible, resilient material.

Summary

In an energy chain for guiding hoses, cables and the like between a fixed and a moveable connection point, whose chain links are of a lightweight, thin-walled design, each consisting of two chain straps (1, 2) and at least one cross-member (3) connecting them, where the chain straps (1 or 2) of adjacent chain links are joined in pivoting fashion by pegs (5) integrally moulded on the straps of one chain link which reach through corresponding openings (6) in the straps of the other chain link, and where the energy chain is designed to be torsionally elastic and/or flexurally elastic in the lateral direction, it is envisaged that, in order to prevent separation of the pivoting joint between the chain links, the pegs (5) display snap-in elements around their circumference, with which the pegs (5) engage the openings (6) in locking fashion and can be released from the openings (6) again by applying a certain force. (Fig. 1)

connections between the links in the chain from loosening in the circumstances described above.

The invention solves this problem with the features of claim 1.

Neither the complex problem described above nor a solution suggests itself in the chain guides described in the prior art. The invention clearly involves an inventive step.

Independent claim 1: Industrial applicability YES

The subject matter of claim 1 is evidently industrially applicable.

Dependent claims 2-10:

Dependent claims 2-10 describe advantageous developments of the subject matter of claim 1 and therefore likewise satisfy the novelty, inventive step and industrial applicability requirements.

REPLACEMENT SHEET
03 APR 1997

Energy chain

The invention relates to an energy chain for guiding hoses, cables and the like between a fixed and a moveable connection point, whose chain links are of a lightweight, thin-walled design, each consisting of two chain straps and at least one cross-member connecting them, where the chain straps of adjacent chain links are joined in pivoting fashion by pegs integrally moulded on the straps of one chain link which reach through corresponding openings in the straps of the other chain link, and where the energy chain is designed to be torsionally elastic and/or flexurally elastic in the lateral direction, elastic deformation of the corresponding strap areas being necessary to insert the pegs of one chain link into the openings in the adjacent chain link.

An energy chain of this kind is suitable for easy and flexible guidance of the hoses, cables and the like of low weight located therein and, having short pitch lengths, permits an almost circular course of the mutually angled chain links. A torsionally elastic and/or laterally flexurally elastic design is present in the case of open or semi-open chains or chains with discontinuous or openable cross-members, in particular. The chain links, whose chain straps are usually of cranked design and are positioned symmetrically opposite each other, where outward-pointing pegs are integrally moulded on the outside of the inward-cranked area and the openings matching the pegs are located in the outward-cranked area, can easily be joined to each other in pivoting fashion. To this end, the corresponding strap areas are elastically deformed in such a way that the pegs of one chain link can latch into the openings in the adjacent chain link.

Although no drawbacks are to be expected as a result of the

REPLACEMENT SHEET
03 APR 1997

design described, it has been found that the snap-in connections between the pegs and openings in the chain straps can come apart when the energy chain is exposed to certain load conditions. The applicant thus set himself the task of finding a simple means for preventing separation of the pivoting joint between the chain links of the energy chain mentioned at the start.

Such an energy chain is known from the Patent Abstracts of Japan, Vol. 9, No. 124 (M-383 60-8643 A), for example. The chain links described in this publication are such that their straps are firmly connected by stable lower cross-members. The cross-members are integrally moulded as a single piece, meaning that, in order to connect adjacent chain links, it is necessary to press the inward-cranked areas of one strap slightly inwards using the outward-pointing pegs, while simultaneously bending apart the outward-cranked areas of the straps of the adjacent chain link, which are provided with holes, so that the pegs of one chain link can latch into the openings in the adjacent chain link.

An energy chain is known from EP 0 286 442, whose chain links display hollow pegs pointing inwards, which in turn display snap-in elements around their circumference, with which these engage corresponding openings in locking fashion. The energy chain described there consists of links, which are in turn made up of two straps and two cross-members fastened in detachable fashion. The strap strands of the energy chain are held together reliably by the upper and lower cross-members, the hollow pegs provided with snap-in elements serve exclusively to pre-assemble the strap strands and the ultimate coherence of the chain is ensured by the attached upper and lower cross-members. A chain pursuant to the characterising section of Claim 1 is not described in EP 0 286 442.

Similar designs are known from GB.A.1 431 382 and EP.A.0 154 882, for example. These examples are not torsionally elastic and/or flexurally elastic designs, which necessitate elastic

REPLACEMENT SHEET
03 APR 1997

deformation of the strap areas when connecting the individual chain links.

The invention is thus based on the task of finding a simple means for preventing separation of the pivoting joint between the chain links of the energy chain pursuant to the characterising section of Claim 1.

According to the invention, the task is solved in that, as an additional safeguard against unintentional separation when the chain is placed under stress, the pegs display snap-in elements around their circumference, with which the pegs engage the openings in locking fashion and which can be released from the openings by applying a certain force.

It has been found that the additional snap-in connection between the pegs and the openings in accordance with the invention ensures an optimum hold of the pivoting joints between the chain links, even when exposed to comparatively high loads. The following technical relationships come into play in this context. The pegs and the walls of the openings of the pivoting joints are exposed to high tensile and compressive forces, particularly if there is a relatively long, freely suspended upper strand with corresponding weights, as well as during rapid traversing of such energy chains with corresponding forces of inertia. Even the slightest deviations of the position of the contiguous surfaces of the chain straps from a position exactly parallel to the direction of force induce a force component perpendicular to the straps which causes spreading of the straps in the region of the pivoting joints. Even slight spreading causes the spreading forces to rise in a non-linear manner to such an extent that they would easily overcome the snap-in joints between the pegs and openings. Surprisingly, however, it has been found that the snap-in elements provided on the circumference of the pegs in accordance with the invention are capable of preventing the development of spreading forces, even in the initial phase, or of keeping them to such a low level that the pivoting joints

REPLACEMENT SHEET
03 APR 1997

cannot come apart. A decisive contribution to this situation is made by the fact that the snap-in elements on the circumference of the pegs force the chain straps into precise linear alignment. As the plastic components take on a form imposed upon them, the solution according to the invention leads to

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REPLACEMENT SHEET
18 MAR 1997

Energy Chain

New Patent Claims

1. Energy chain for guiding hoses, cables and the like between a fixed and a moveable connection point, whose chain links are of a lightweight, thin-walled design, each consisting of two chain straps (1, 2) and at least one cross-member (3, 4) connecting them, where the chain straps (1, 2) of adjacent chain links are joined in pivoting fashion by pegs (5) integrally moulded on the straps of one chain link which reach through corresponding openings (6) in the straps of the other chain links, and where the energy chain is designed to be torsionally elastic and/or flexurally elastic in the lateral direction, elastic deformation of the corresponding strap areas being necessary to insert the pegs of one chain link into the openings in the adjacent chain link, c h a r a c t e r i s e d i n t h a t, as an additional safeguard against unintentional separation when the chain is placed under stress, the pegs (5) display snap-in elements around their circumference, with which the pegs (5) engage the openings (6) in locking fashion and which can be released from the openings (6) by applying a certain force.

2. Energy chain as per Claim 1, c h a r a c t e r i s e d i n t h a t the straps (1 and 2) opposite to each other in the joint area make contact with each other without axial clearance.

3. Energy chain as per Claim 2, c h a r a c t e r i s e d i n t h a t the snap-in elements on the circumference of the pegs (5) press together the contiguous straps (1 and 2) in the joint area under slight pretension.

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REPLACEMENT SHEET
18 MAR 1997

4. Energy chain as per one of the Claims 1 to 3, characterised in that the snap-in elements provided on the pegs (5) are designed as all-round wider areas (14) on the free ends of the pegs (5).

5. Energy chain as per Claim 4, characterised in that the wider areas (14) display a bellied surface (15), extending from a cylindrical part of the peg (5).

6. Energy chain as per Claim 4 or 5, characterised in that the outer ends of the openings (6) display extensions into which the wider areas (14) on the free ends of the pegs reach, with the result that the face end of the pegs (5) is essentially in flush alignment with the outer side of the straps (1, 2).

7. Energy chain as per one of the Claims 1 to 6, with a discontinuous cross-member (4), characterised in that the two elements (7, 8) of the discontinuous cross-member (4) lie on the same level and are separated from each other by a narrow gap.

8. Energy chain as per Claim 7, characterised in that the end of one element (8) of the discontinuous cross-member (4) which faces the other element (7) has a downward step (9) which reaches under the opposite end of the other element.

9. Energy chain as per one of the Claims 1 to 6, with a discontinuous cross-member (4), characterised in that the two elements (10, 11) of the discontinuous cross-member lie on different levels and their ends are located one above the other.

10. Energy chain as per one of the Claims 1 to 6, with a discontinuous cross-member (4), characterised in that the chain straps (1, 2) and the cross-member

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(3) connecting them are made of a relatively rigid material and the discontinuous cross-member (4) is made of a relatively flexible, resilient material.

REPLACEMENT SHEET
18 MAR 1997