Energy guiding chain

The invention relates to an energy guiding chain for housing and guiding ducts between a fixed base and a mobile driver. Said chain comprises two parallel plate-link lines consisting of plate-links which are opposite to each other in a crosswise direction and connected by means of transverse links. Those plate-links of each plate-link line which are directly adjacent can be pivoted in relation to each other in the direction of bending of the chain and the chain forms a deflection area. At least in an area of the chain adjacent to the driver, the chain links are linked to each other in a traction-stable manner in several sections by means of at least one element which is substantially non-extendible in the longitudinal direction of the chain and flexible in the direction of bending of the chain.

Today, energy guiding chains of this kind are largely made of plastic. Polyamides are a preferred plastic. Like other plastic materials, however, this hygroscopic material has the disadvantage that it has a relatively high coefficient of expansion in very humid and hot environments.

Energy guiding chains are used in different lengths and sizes under various conditions, such as in very humid and hot rooms or buildings. In long chains, the relatively high additional loads resulting from the ducts housed inside them cause high tensile and thrust stresses when the chain travels. In very hot rooms or buildings with high humidity of up to 100%, such as in composting plants where long chains are used, the change in length due to the tensile stress amounts to up to 8%. In a chain with a length of 100 m, the change in length

adds up to 0.8 m.

As the ducts are connected to both the fixed base and the driver, the change in length of the chain due to tensile stress results in a difference in length between the ducts and the chain, meaning that the ducts are subjected to alternating tension. This tension has a particularly pronounced effect on the inside transverse links in the deflection area of the chain. They are deformed in this context and can even fracture.

When the chain is subject to thrust stress due to the return travel of the driver, the chain tends to rise up in the area of the upper strand, i.e. the upper part of the bent chain, and to overlap, even if only weak upward force components act on it. In this context, the bending stresses that occur in the joint areas of the overlapping chain links are so high that the chain can easily break in this area.

An energy guiding chain of the kind specified in the opening paragraph is known from DE 26 09 451 B2. The non-extendible element(s), which is/are flexible in the bending direction of the chain, is/are mounted in the form of a cable or a chain on the underside of the chain links or transverse links, in addition to the articulated joints. They serve to prevent the chain from sagging in the direction opposite the bending direction of the chain. Consequently, no stops are required for this purpose. Instead, the individual chain links of the upper strand are firmly pressed together and held in extended position by the non-extendible element provided on the underside of the chain links. However, a self-supporting upper strand of this kind is not suitable for relatively long chains with relatively long travel paths.

In order to keep the upper strand stretched, the non-extendible element must be mounted on at least every other chain link, as sagging cannot be prevented if the intervals

are any greater. However, mounting the non-extendible element on at least every other chain link makes manufacturing considerably more complex. Mounting the non-extendible element on every other chain link is also a disadvantage in that the chain cannot relax sufficiently in the deflection area.

In order to keep the upper strand stretched, it is further necessary to pre-tension the non-extendible element in the longitudinal direction of the upper strand. Due to this pre-tensioning, there is a tension difference between the chain and the non-extendible element, particularly during thrust motion of the upper strand, which causes an upward force component. As mentioned above, there is a danger of the chain links of the upper strand rising up when the chain is under thrust, this possibly leading to the fracture of the chain in this area.

If the chain links are made of plastic, tension differences between the chain and the non-extendible element that lead to an upward force component can occur particularly as a result of the thermal expansion of the plastic.

Therefore, the object of the present invention is to design an energy guiding chain in which a change in length due to tensile stress can be avoided with relatively little effort, even at high temperatures and high humidity, and in which the rising of the upper strand under tensile stress is prevented.

This object is solved in an energy guiding chain of the type specified in the opening paragraph in that the chain links, in several sections of at least three links, and the driver are fixed to the non-extendible element(s) in such a way that forces transmitted by the fixation to the chain links act approximately at the level of the pivoting axes of the chain links and the tension of the element(s) in the longitudinal

direction of the chain is such that it tends towards zero when the chain is thrust by the driver or comes to a halt after a thrust.

The fact that the chain links are mounted on the non-extendible element(s) in sections of at least three chain links, ensures sufficient relaxation of the chain in the deflection area. As the forces transmitted to the chain links through the mount act approximately at the level of the pivoting axes of the chain links, tension differences between the chain and the non-extendible element(s) cannot cause an upward force component that could be feared to cause the upper strand to rise under thrust against the weight of the chain and the ducts. In this context, the tension of the non-extendible element(s) is adjusted in such a way that, when the chain is thrust or comes to a halt after a thrust, only little or no force acts on the articulated joints of the chain links, so that, in particular, the pivoting motion of the chain links in the deflection area is not restricted.

Energy guiding chains are already known (DE 94 09 082 U1, DD 249 742 A1, DE 1 131 480 C1) in which the chain links are connected to one another in a central area by non-extendible elements that are flexible in the bending direction of the chain. Due to their flexibility, the non-extendible elements form articulated connections between the chain links instead of overlapping joint areas. In these chains, however, the chain links are not mounted in sections of at least three chain links, and the driver on the non-extendible element(s). Furthermore, the publications in question do not indicate that the tension of the non-extendible element(s) in the longitudinal direction of the chain is such that it tends towards zero when the chain is thrust by the driver or comes to a halt after a thrust.

In a preferred configuration of the invention, the chain links are mounted on the non-extendible element(s) in sec-

tions corresponding to at least the arc length extending over 180° of the deflection area of the chain.

The forces transmitted through the mount to the chain links preferably act on an area that is approximately at the level of the pivoting axes of the chain links and extends one-quarter of the link height above and below the level of the pivoting axes. An area that extends one-sixth of the link height above and below the pivoting axes is particularly advantageous.

The sections in which the chain links are mounted on the non-extendible element(s) can be of identical or different length. Preferably, various lengths are used, where the sections become smaller towards the driver due to the fact that the tensile stress of the chain increases towards the driver.

There are preferably between 2 and 5 sections per 50 m chain length.

The chain link of the section-wise division that is nearest to the driver is preferably not the directly adjacent chain link, but rather a chain link positioned at a distance of several chain links away that forms the end of the first section.

The section of the chain adjacent to the driver, in which the non-extendible element(s) is/are arranged, preferably extends over the entire upper strand, the bending area of the chain and into the lower strand when the chain is in a central position of travel, in which the upper strand and lower strand are of roughly the same length.

The element, or at least one of the elements, is preferably positioned roughly in the middle on the inside of the chain.

At least one element can also be positioned on the outside in the vicinity of the plate-links within the chain.

In particular, the element, or at least one of the elements, can be a steel cable. Steel cables have the advantage that they have very low extendibility and can be bent without generating tension. However, any other element that displays these properties can also be used. For example, a metal chain, a horizontally arranged metal strip or a non-extendible, flexible belt can also be used.

As the bending of the steel cable, or of any other corresponding element, in the bending area of the chain occurs without tension, the steel cable is positioned in relaxed fashion in this area, meaning that the bending of the chain is not restricted by the steel cable. In the upper strand of the chain, where tensile forces act when the chain is pulled, the steel cable or corresponding element is positioned in taut fashion in the longitudinal direction of the chain, meaning that it can absorb the tensile stress when tensile forces begin to act on the chain.

In a preferred configuration of the invention, the chain links adjacent to those located at the end of individual sections are connected to one another and, of these, the chain link nearest to the driver is connected to driver, in traction-stable manner by at least one element that is non-extendible in the longitudinal direction of the chain and flexible in the bending direction of the chain.

Two taut cables or corresponding elements are preferably positioned between the chain links adjacent to those located at the end of individual sections and between the one of these chain links nearest to the driver and the driver.

The non-extendible element(s) is/are preferably mounted in traction-stable fashion on rails located separately from the

transverse links that are connected to the opposite plate-links of the chain links.

In an expedient practical example of the invention, the ducts guided in the chain are mounted on these rails by means of clamping blocks, the rails also have mounting elements for the ends of steel cables or other corresponding elements.

The rails can have pins on the ends lying in the transverse direction of the chain that act as the link pins of the associated chain links. This means that the pins on the rails positively engage two flush openings in the overlapping areas of two adjacent chain links and thus form the pivoting axes of these chain links. This arrangement permits the ducts and separate, non-extendible elements mounted on the rails to be arranged in oscillating fashion about the pivoting axes.

In another, preferred configuration, the ends of the rails lying in the transverse direction of the chain have projections that engage correspondingly designed grooves on the insides of the chain links between the joint areas. This arrangement permits the use and replacement of the design according to the invention without changing the associated chain links in any other way. The grooves provided in all chain links of a chain series can also be used for mounting other parts between the plate-links.

Practical examples of the invention are described in more detail below based on the drawings. The drawings show the following:

Figure 1 A cross-sectional side view of a first practical example,

Figure 2 A top view of a connection point of the non-extendible elements in the chain,

Figure 3 A cross-section through the chain along Line III-III in Fig. 2,

Figure 4 A top view of a connection point in a second practical example,

Figure 5 A cross-section through the chain along Line V-V in Fig. 4,

Figure 6 A top view of a connection in a third practical example,

Figure 7 A top view of a connection point in a fourth practical example,

Figure 8 A top view of a connection point in a fifth practical example during thrust motion of the chain,

Figure 9 A top view according to Fig. 8 during pulling motion of the chain,

Figure 10 A top view of a connection point in a sixth practical example during thrust motion of the chain, and

Figure 11 A top view according to Fig. 10 during pulling motion of the chain.

The overall view in Fig. 1 shows an energy guiding chain 1 for housing and guiding ducts 2 between a fixed base 3 and a mobile driver 4. Said chain comprises two parallel plate-link lines consisting of plate links 5 which are opposite to each other in a cross-wise direction and connected by means of transverse links 7. Those plate-links 5a and 5b of each plate-link line which are directly adjacent can be pivoted in relation to each other in the direction of bending of the chain. The pivoting connection between plate-links 5a and 5b can consist of pins and openings (not shown) arranged in

their overlapping joint area. The pivoting radius is restricted in the bending direction and against the bending direction by interacting stops on plate-links 5a and 5b.

As further shown in Fig. 1, non-extendible elements 6 (specifically 6a, 6b, 6c, 6d, 6e, 6f and 6g) that are flexible in the bending direction of the chain are provided in a section of the chain extending from driver 4, via the upper strand and the bending area, to the lower strand of the chain. These elements connect chain links 7a, 7b, 7c, 7d, 7e, 7f and 7g to one another, these being positioned in sections spaced several chain links apart and away from driver 4 in the corresponding area of the chain. Chain link 7a, which is nearest to driver 4, is connected to driver 4 by non-extendible element 6a.

Non-extendible elements 6a, 6b, 6c, 6d, 6e, 6f and 6g are designed as steel cables. As can be seen in the enlargement in Fig. 1, the steel cable of element 6a is mounted on a mounting element 10 of driver 4 by way of a loop 8 that reaches around a bolt 9. Ducts 2 are also mounted on driver 4 by bell-shaped mounting elements 11. Ducts 2 also serve as traction-stable elements in the chain. Like the steel cables, they are fixed in chain links 7a, 7b, 7c, 7d, 7e, 7f and 7g.

As shown in Fig. 1, non-extendible element 6 is positioned in taut fashion in the longitudinal direction of the chain in the horizontal chain links, particularly in the upper strand. This applies to individual elements 6a, 6b, 6c, 6d, 6e, 6f and 6g. Consequently, during the pulling motion of driver 4, non-extendible element 6 absorbs the tensile forces of the chain in the sections of the upper strand, particularly towards driver 4, so that the plastic chain links cannot stretch elastically.

In the bending area of the chain, the linear orientation of non-extendible element 6 in the horizontal plane causes element 6 to be arranged in relaxed fashion on the inside of the chain in this area. In Fig. 1, this specifically applies to element 6e. Due to its relaxed arrangement, non-extendible element 6 cannot impair the unrestricted bending of the chain.

The mounting of non-extendible element 6 and ducts 2 on chain links 7a, 7b, 7c, 7d, 7e, 7f and 7g is shown in more detail in Figs. 2 and 3 for a first practical example. A rail 12 made of metal is provided for mounting, the ends of which extending in the transverse direction of the chain are provided with pins 13, which act as the link pins of the associated chain links. To this end, pins 14 and 15 extend positively through two flush openings in the overlapping joint areas of the adjacent chain links and thus form their pivoting axes.

As shown particularly clearly in Fig. 3, rail 12 has a U-shaped profile, where pins 13 are arranged on legs 16 of the U-profile. Legs 16 can be integrally moulded on the horizontal part of rails 12 or mounted on them, e.g. with screws.

Clamping blocks 17a, 17b and 17c are mounted next to legs 16 with the help of screws, which firmly clamp ducts 2.

In addition, a mounting element 18 is positioned in the middle of rail 12 in order to fix the ends of non-extendible element 6, which connects the chain link to the two adjacent chain links of the two adjacent sections or to driver 4. Each connection consists of two steel cables. In order to fix the steel cables, they are connected by a loop 8 to bolts 9 run-

ning in the transverse direction through mounting element 18, as on driver 4 shown in Fig. 1. Radial expansions 19 on the ends of bolts 9 prevent loops 8 from slipping off the side.

As shown more precisely in Fig. 2, two bolts 9 are provided on mounting element 18, where the looped ends of the two steel cables extending to one of the nearest chain links arranged in the sections are mounted on both sides of mounting element 18.

The mounting of the steel cables and ducts 2 on a rail described above is shown in a second configuration in Figs. 4 and 5. In this practical example, the ends of rails 20 lying in the transverse direction of the chain are provided with projections 22, which engage correspondingly formed grooves 22 on the insides of the chain links between the joint areas. As is shown particularly clearly in Fig. 5, rail 20 is also of U-shaped design, where projections 21 are arranged on the outside of legs 16. The arrangement shown in Figs. 4 and 5 is otherwise the same as that shown in the first practical example in Figs. 2 and 3.

While the two practical examples described above show a central arrangement of the steel cables on rails 12 and 20, the steel cables in the third practical example shown in Fig. 6 are positioned between ducts 2 in symmetrical fashion in reference to the centre of the chain. Mounting elements 23 are used for this purpose, which have opposing recesses in the longitudinal direction of the chain, in which the looped ends of the steel cables are mounted on bolts.

The practical example illustrated in Fig. 7 shows a variation of the practical example according to Fig. 6, in which the steel cables are mounted on the outsides of ducts 2 on rail 20. The arrangement is otherwise identical to the practical example shown in Fig. 6.

Two further practical examples are shown in Figs. 8 and 9 and 10 and 11. In these practical examples, one or more special ducts 2, which are essentially non-extendible in the longitudinal direction, are used as the non-extendible element(s).

The practical example shown in Figs. 8 and 9 corresponds to the arrangement in the practical example shown in Figs. 2 and 3. Ducts 2 are mounted by means of clamping blocks 17a, 17b and 17c on a rail 12, which has pins 13 on the ends lying in the transverse direction of the chain that act as link pins for the two adjacent chain links.

In order to protect ducts 2, they are, in the area in which they are fixed by clamping blocks 17a, 17b and 17c, surrounded by collars 24, with which they are inserted into the clamping blocks. Collars 24 protrude on both face ends of the clamping blocks. Collars 24 are designed as sleeves of elastic material that have been slit along their length and are attached to ducts 2 in pre-tensioned fashion by screws on the edges extending along the length of the slit. In this way, ducts 2 cannot shift in clamping blocks 17a, 17b and 17c, even under high tensile stress.

Figure 8 shows the arrangement in a situation in which the chain moves in the thrust direction, i.e. when no tensile stress is acting on the chain links. As shown in Fig. 8, ducts 2 are arranged in relaxed fashion in the chain, without being subject to tensile stress.

In the situation shown in Fig. 10, the chain is moving in the tension direction, so that ducts 2 are subjected to a tensile stress due to the elongation of the chain links. They are arranged in taut fashion in the longitudinal direction of the chain due to the tensile stress.

Figures 10 and 11 show an arrangement that corresponds to the one in the practical examples shown in Figs. 4 and 5. Rails 20, on which ducts 2 are mounted, have projections 21 on the ends lying in the transverse direction of the chain that engage correspondingly designed grooves 22 on the insides of the chain links between the joint areas. The mounting of ducts 2 on rail 20 is identical to the practical example shown in Figs. 8 and 9.

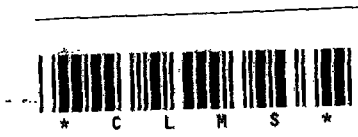
Figure 10 again shows a situation in which the chain moves in the thrust direction (as in Fig. 8), so that ducts 2 are arranged in relaxed fashion in the chain.

Finally, Fig. 11 shows a situation (as in Fig. 9) in which the chain moves in the tension direction and ducts 2 absorb the tensile forces transmitted to ducts 2 by the elongation of the chain links.

List of reference numbers

1	Energy guiding chain
2	Ducts
3	Fixed base
4	Driver
5	Plate-link
5a	Adjacent plate-link
5b	Adjacent plate-link
6	Non-extendible element
6a	Non-extendible element
6b	Non-extendible element
6c	Non-extendible element
6d	Non-extendible element
6e	Non-extendible element
6f	Non-extendible element
6g	Non-extendible element
7	Transverse link
7a	Chain link
7b	Chain link
7c	Chain link
7d	Chain link
7e	Chain link
7f	Chain link
7g	Chain link
8	Loop
9	Bolt
10	Mounting element
11	Mounting element
12	Rail
13	Pin
14	Opening
15	Opening
16	Leg

17	Clamping block
17a	Clamping block
17b	Clamping block
17c	Clamping block
18	Mounting element
19	Expansion
20	Rail
21	Projection
22	Groove
23	Mounting element
24	Collar



Patent claims

1. Energy guiding chain (1) for housing and guiding ducts (2) between a fixed base (3) and a mobile driver (4), said chain comprising two parallel plate-link lines consisting of plate-links (5) which are opposite to each other in a cross-wise direction and connected by means of transverse links (7), where those plate-links (5a, 5b) of each plate-link line which are directly adjacent have overlapping joint areas so that they can be pivoted in relation to each other in the direction of bending of the chain, and where, at least in an area of the chain adjacent to the driver (4), the chain links (7a, 7b, 7c, 7d, 7e, 7f, 7g) are linked to each other in a traction-stable manner in several sections by means of at least one element (6) which is substantially non-extendible in the longitudinal direction of the chain and flexible in the direction of bending of the chain, c h a r a c t e r i s e d i n t h a t the chain links (7a, 7b, 7c, 7d, 7e, 7f, 7g), in several sections of at least three links, and the driver (4) are fixed to the element(s) (6) in such a way that forces transmitted by the fixation to the chain links act approximately at the level of the pivoting axes of the chain links and the tension of the element(s) (6) in the longitudinal direction of the chain is such that it tends towards zero when the chain is thrust by the driver (4) or comes to a halt after a thrust.

2. Energy guiding 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 chain links (7a, 7b, 7c, 7d, 7e, 7f, 7g) are mounted on the non-extendible element(s) (6) in sections corresponding to at least the arc length extending over 180° of the deflection area of the chain.

3. Energy guiding chain as per Claim 1 or 2, characterised in that the element, or at least one of the elements (6), is positioned roughly in the middle on the inside of the chain.

4. Energy guiding chain as per Claim 1 or 2, characterised in that at least one element (6) is positioned on the outside in the vicinity of the plate-links (5) within the chain.

5. Energy guiding chain as per one of Claims 1 to 4, characterised in that the element, or at least one of the elements (6), is a steel cable.

6. Energy guiding chain as per one of Claims 3 to 5, characterised in that the chain links (7a, 7b, 7c, 7d, 7e, 7f, 7g) adjacent to those arranged in sections are connected to one another and, of these, the chain link (7a) nearest to the driver (4) is connected to the driver (4) in traction-stable manner by at least one non-extendible element (6).

7. Energy guiding chain as per one of Claims 1 to 6, characterised in that the non-extendible element(s) (6) is/are mounted in traction-stable fashion on rails (12; 20) located separately from the transverse links that are connected to the opposite plate-links of the chain links.

8. Energy guiding chain as per Claim 7, characterised in that the ducts (2) guided in the chain are mounted on rails the (12; 20) by means of clamping blocks (17a, 17b, 17c) and that the rails (12; 20) have mounting elements (18; 23) for the ends of steel cables.

9. Energy guiding chain as per Claim 7 or 8, characterised in that the rails (12) have pins (13) on the ends lying in the transverse direction of the chain, which positively engage two flush openings (14, 15) in two adjacent chain links and thus form the pivoting axes of these chain links.

10. Energy guiding chain as per Claim 7 or 8, characterised in that the ends of the rails (20) lying in the transverse direction of the chain have projections (21) that engage correspondingly designed grooves (22) on the insides of the chain links between the joint areas.