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**LINE GUIDE DEVICE AND SUPPORT CHAIN FOR CLEANROOM
APPLICATIONS**

The invention relates in general to a line guide device, in particular for cleanroom applications, for protected dynamic guiding of supply lines, such as cables, hoses or the like, in a longitudinal direction between two connection points at least one of which is mobile relative to the other. Such dynamic or active line guide devices protect the lines from unintended stresses during movement, usually between a stationary connection and a mobile consumer, for example on a machine. They are typically displaceable to-and-fro linearly or in a movement plane in the longitudinal direction and typically form two runs extended substantially in the longitudinal direction of guidance and a deflection arc therebetween. The deflection arc is typically curved approximately in a U shape about a deflection axis extending in a transverse direction transversely of the longitudinal direction. Thus the deflection arc is approximately U-shaped in a plane in which the longitudinal direction and a height direction lie. In the intended, operational state, the line guide device is turned back in the deflection arc, such that one of the runs can merge into the deflection arc and thereby into the other run.

The invention relates in particular also to a support chain as such, for such a line guide device.

The invention specifically relates to a line guide device for cleanroom applications with a flexible envelope which has a number of receiving ducts arranged next to one another and extending in the longitudinal direction for enclosing supply lines

so as to protect them from dust, each of which ducts typically receives at least one supply line. The envelope is in particular intended to prevent any material abraded from the lines, which is unavoidably formed during travel motion, from being released into the surroundings. In addition, an envelope made of a suitable material can improve abrasion behavior overall.

For stabilization or for longer lengths, use is made of what are known as support chains to support the line guide, in particular in the extended position of a self-supporting or unsupported run. To this end, the support chain, rather than a line, may be arranged in a receiving duct and assume extended positions to form the runs and an arcuate position to form a deflection arc, wherein the support chain also predetermines the desired radius.

Depending on the load weight, for example two support chains are used laterally on the outside in an envelope. Multilayer structures are also known in which more than two support chains are used in the envelope of a supporting layer, even including layers entirely without a line, i.e. with only support chains in the envelope of one layer.

Such a line guide device with support chains was proposed, for example, in WO 2021/116467 A1. A generic support chain of this type comprises a plurality of chain links, which are connectable or connected together in articulated manner in the longitudinal direction. Each pair of adjacent or successive chain links are connected swivelably relative to one another by an articulated joint in or contrary to a bending direction.

The two chain links are embodied to be swivelable relative to one another between an extended and a bent position in the plane in which the longitudinal direction and the height direction lie. In this way, the support chain is displaceable, forming two runs extended substantially in the longitudinal direction and a deflection arc connecting the runs. The deflection arc is in this case conventionally substantially U-shaped in the plane in which the longitudinal direction and the height direction lie. Such

support chains in particular ensure that a specific radius is maintained in the deflection arc, i.e. the lines are protected from kinking. In addition, the length is increased because the support chains enable greater self-supporting lengths, mainly of the upper run. So that such a support chain can be used instead of a line in the envelope, it typically has particularly compact dimensions, at least cross-sectionally, in particular in comparison with usual energy chains. A generic support chain itself thus typically and preferably does not have a receiving duct for lines.

The articulated joint in WO 2021/116467 A1 is embodied in the manner of a pin/receptacle revolute joint connection, wherein each chain link has two transversely protruding joint pins and two complementary joint receptacles, in which the joint pins are received rotatably. A disadvantage here is that the friction between the respective joint pin and the joint receptacle releases particles during operation, which is especially undesirable in cleanrooms. As mentioned above, the support chains and the guided supply lines are inserted in envelopes. Support chains may wear sooner than the supply lines, which either requires replacing the entire envelope or opening the envelope and replacing the support chain or providing a separate envelope unit specific to the support chain. There is thus a need to increase the service life of the support chains. A weak point of known support chains may be the articulated joints, which, for example in the case of a pin/receptacle revolute joint, are exposed to considerable shear forces and alternating stresses during travel to-and-fro.

The chain links according to WO 2021 116467 A1 each have, relative to the longitudinal direction, a front longitudinal portion and a rear longitudinal portion. The two longitudinal portions are suitably shaped to connect the chain links together in predetermined articulated manner, in particular such that a predetermined geometry of the deflection arc is maintained.

The chain link according to WO 2021 116467 A1 has a space between two side parts in the rear longitudinal portion, into which space the front longitudinal portion of a further, rear

chain link or an adjacent chain link following in the support chain can be inserted in the longitudinal direction, and two recesses spaced from one another in the longitudinal direction - one on the top of the chain link, i.e. on the side on the outside in the deflection arc, and one on the bottom, i.e. on the side on the inside in the deflection arc. The front longitudinal portion has two projections protruding in the height direction for interaction with the transverse connections. When the chain links are joined together, the lower projection protrudes into the lower recess in the extended position of the two chain links, and the upper projection protruding into the upper recess in the fully bent position of the two chain links.

In a configuration of the support chain according to the teaching of WO 2021 116467 A1, however, there is a position of the two chain links relative to one another between the straight position and the completely bent position in which none of the projections is interacting with a recess or there is only a very small common active area. In such a position, the chain links can be separated from one another in the longitudinal direction or excessive loading may lead to breakage.

In the case of intended displacement, the support chains are subject in particular to tensile or compressive stress in the longitudinal direction. Thus, according to WO 2021 116467 A1, in the above-mentioned intermediate position, the tensile force can only be transferred by the pin/bore articulated joint. In this case, the hinge pin is in particular subject to shear stress. This reduces the maximum service life of the support chain or requires an undesirably bulky construction.

It is therefore an object of the present invention to propose a line guide device with a support chain or the support chain therefor which is more robust and better suited to the transfer of tensile and compressive forces and has a longer service life, and at the same time is intended to have a maximally compact structure, in particular in the cross-section of the chain links. This object is achieved by a line guide device or a support

chain according to Claim 1 or 2 and independently thereof by a support chain according to independent Claim 7.

FIRST ASPECT

5 According to an independent first aspect, in a generic line guide device according to the preamble of Claim 1 or in a support chain according to the preamble of Claim 2, the above-mentioned object is achieved simply in that the support chain consists at least in a longitudinal portion of a strand which in the longitudinal direction has alternating successive chain links and
10 joint connectors, wherein the joint connectors in each case comprise a deformable region which is in particular elastically deformable in a bending direction, wherein the joint connectors in each case hold two adjacent chain links together, in particular in the longitudinal direction.

15 The joint connectors or joint elements with bendable or deformable region here inter alia make it possible to avoid a pin/receptacle articulated joint typical of link chains and the concomitant abrasion.

The chain links are here in particular swivelable relative
20 to one another in or contrary to the bending direction, in particular between an extended and a bent position of the in each case two adjacent, connected chain links relative to one another.

Furthermore, according to the first aspect, provision may in particular be made for at least some of the chain links and/or
25 joint connectors of the strand to be connectable together and/or detachable from one another in a joining direction other than the longitudinal direction, in particular perpendicular to the longitudinal direction. Thus, under normal operating conditions, the connection between the links, in particular the articulated
30 joint, cannot be separated or detached non-destructively by a tensile force acting in the longitudinal direction. Such a connection is robust, and the service life of the support chain is thus increased.

In one particularly preferred configuration, on swiveling of
35 two adjacent chain links connected by a joint connector between an

extended and a bent position, the joint connectors or joint elements are intentionally subject to bending stress. The joint connectors or joint elements in this case have a resilient configuration at least in the deformable region.

5 The joint connectors or joint elements may in particular be embodied as separate, segregated components, which are detachably or non-destructively connectable with the chain links. However, an alternative configuration is likewise conceivable in which the joint connectors or joint elements are one-part constituents of
10 the chain links, for example are molded onto the chain links using two-component injection molding. At least one end region of each joint connector is here preferably detachably connectable with an adjoining chain link. It is however also conceivable for the chain links to be formed by fitting together two separate components,
15 which in each case comprise a joint connector produced in one piece therewith. In this case too, the joining direction of the link components is preferably different from the longitudinal direction and may for example correspond to the transverse direction.

20 The respective chain link may have two external side faces spaced from one another in a transverse direction perpendicular to the longitudinal direction, facing away from one another and bounding the chain link in the transverse direction. In this case, the chain link is embodied at least in places between the external
25 side faces with a continuous cross-section or at least in places cross-sectionally as a solid body.

A particularly preferred configuration is one in which the joining direction, at least between joint connectors and chain links, runs substantially in the transverse direction.

30 In one embodiment, provision is made for the strand to be configured as a concatenation of a plurality of chain links and separate joint connectors connected alternately together and embodied as separate components, wherein each of the plurality of joint connectors is preferably connected detachably with in each
35 case two adjacent chain links.

In one particularly preferred configuration, the chain links are configured according to the following independent second aspect of the invention, the preferred features of which are likewise applicable to the first aspect and vice versa.

5 Further preferred configuration features relating to both aspects are revealed by the relevant subclaims.

SECOND ASPECT

As an alternative or in addition to the first aspect, the above-mentioned object is achieved according to an independent
10 second aspect in that in the case of a support chain, in particular according to the preamble of Claim 7, provision is made for the front upper part and the front lower part of the respective chain link to be spaced apart from one another in a height direction transverse relative to the longitudinal direction
15 by a front space, into which the rear lower part of a first adjacent chain link is insertable or inserted, and for the rear upper part and the rear lower part of the respective chain link to be spaced apart from one another in the height direction by a rear space, into which the front upper part of a second adjacent chain
20 link is insertable or inserted.

This in particular enables a robust configuration of the connection of the chain links in the longitudinal direction, in which, in each relative bending position, intended tensile and compressive forces are transferred at least predominantly via the chain links themselves, such that particularly preferably provided
25 joint connectors according to the first aspect are not stressed or are only slightly stressed.

Also in the case of the second aspect, provision is preferably made for at least some of the chain links to be
30 connectable together and/or detachable from one another in a joining direction other than the longitudinal direction, in particular perpendicular to the longitudinal direction, wherein the joining direction runs preferably substantially in the transverse direction and/or the height direction. The direction in
35 which the links are joined to one another particularly preferably

has no significant component in the longitudinal direction, such that unintended detachment during operation can be reliably avoided.

In the second aspect, the joint connectors are preferably used inter alia according to the first aspect, i.e. the support chain preferably comprises a plurality of joint connectors, which are preferably embodied as separate components. In the bending direction of the chain links, the joint connectors in particular have elastically deformable regions. In this case, each of the plurality of joint connectors is particularly preferably detachably connectable with in each case two adjacent chain links.

In one advantageous further development of the second aspect, provision is made for the front upper part to have an upper projection protruding in the height direction and for the rear upper part to have an upper recess; and for the rear lower part to have a lower projection protruding in the height direction and for the front lower part to have a lower recess. In this case, further provision is in particular made for the upper projection of the respective chain link to be configured for engagement both in the extended and in the bent position in the upper recess of the first adjacent chain link, and for the lower projection of the respective chain link to be configured for engagement both in the extended and in the bent position in the lower recess of the second adjacent chain link. In this way, both tensile and compressive force can be transferred by the interaction of the projections and recesses in the extended and bent positions.

Provision is further preferably made for the upper projection to be configured to engage in the upper recess from the rear space of the one adjacent chain link toward the top thereof and for the lower projection to be configured to engage in the lower recess from the front space of the other adjacent chain link toward the bottom thereof, the internal height of the front space preferably being the same or greater than the dimension of the rear lower part including the lower projection in the height direction and the internal height of the rear space being the same or greater than the dimension of the front upper part including

the upper projection in the height direction. In this way, the projections are inserted into or brought into engagement with the corresponding recesses by joining the chain links in the transverse direction Q or in the longitudinal direction L and shifting them relative to one another in the height direction H. This may thus be achieved without distortion and without twisting or torsion of the chain links and thus also allows simple assembly of the support chain and simple replacement of individual portions if needed, for example for preventive maintenance.

The links are preferably configured such that the upper recess forms an opening toward the top starting from the rear space and/or the lower recess forms an opening toward the bottom starting from the front space. In this way, a maximum stop face may inter alia be provided.

Provision may moreover advantageously be made for the upper projection, the lower projection, the upper recess and the lower recess of the respective chain link in each case to have a contact surface for resting in a compressive and/or tensile force-absorbing manner on a corresponding mating contact surface of an adjacent chain link in the extended position and a contact surface for resting in a compressive and/or tensile force-absorbing manner on a corresponding mating contact surface of an adjacent chain link in the bent position, wherein each of the stop faces preferably extends transversely of the longitudinal direction.

All the contact surfaces run as a whole preferably perpendicular to the displacement plane, i.e. parallel to the transverse direction or such that transverse forces are avoided.

In the bent and extended relative positions, preferably at least in each case two pairs of stop faces interact in a force-transmitting manner, wherein the pairs lie diametrically opposite one another in longitudinal section relative to the center of the link.

Provision is advantageously made for the contact surfaces of the upper projection or the contact surfaces of the lower projection to be at a respective angle to one another, and for the

contact surfaces of the upper recess or the contact surfaces of the lower recess to be at a respective angle to one another, wherein the difference in the angular dimension between the angles of the upper projection and of the upper recess, and the
5 difference in the angular dimension between the angles of the lower projection and of the lower recess, are preferably substantially equal or equal. Corresponding configuration of the angles ensures simultaneous paired interaction of a plurality of limit stops and thus enlarges the force-transmitting area as a
10 whole.

In one further development, provision is advantageously made for the upper projection to be embodied, in the bent position, flush with the top of the chain link in the upper recess of which it engages, and/or for the lower projection to be embodied, in the
15 extended position, flush with the bottom of the chain link in the lower recess of which it engages. Overall, the intention is to achieve projection-free, flush outer faces in every operating position to avoid damage or wear to the envelope.

Further enlargement of the faces for force transmission is
20 achieved if the respective chain link in each case has end contact surfaces at the front and rear upper parts and at the front and rear lower parts which are configured in such a way that end contact surfaces of the front and rear upper parts rest in the extended position on the end contact surfaces of the front and
25 rear upper parts of the adjacent chain link, and end contact surfaces of the front and rear lower parts rest in a bent position on the end contact surfaces of the adjacent chain link.

Preferably, both the front and rear spaces are open into or lead in an open manner into each of the external side faces, the
30 spaces thus in each case being accessible for insertion of the rear lower part or of the front upper part and/or of a joint connector. This facilitates and simplifies assembly and maintenance.

It is advantageous for force flow and/or mechanical
35 conditions if the dimension of the respective joint connector in

the transverse direction amounts to more than 30%, in particular between 50% and 100%, of the distance between the external side faces of the respective chain link. The width of the joint connectors is preferably substantially equal to this distance.

5 Furthermore, it is favorable for force flow if the respective joint connector extends in a middle region, relative to the transverse direction, between the external side faces of the chain links or is arranged centered on the middle, such that no transverse forces can arise.

10 In one particularly robust embodiment, provision is made for each joint connector to extend, relative to a height direction, at least in part between the front upper part and the front lower part of one of the two adjacent chain links and the rear upper part and the rear lower part of the other of the two adjacent
15 chain links. In this way, the joint connector simultaneously forms an interlock against detachment of the chain links from their engagement. The joint connector may in this case preferably prevent shifting of in each case two adjacent chain links in the height direction relative to one another through the associated
20 joint connector, for example by blocking the movement play necessary therefor.

FURTHER ADVANTAGEOUS FEATURES (BOTH ASPECTS)

Some preferred further developments are explained below, which (like the above features) are to be considered advantageous
25 with regard to both core aspects of the invention.

The joint connectors are preferably embodied as spring elements which, on bending of adjacent chain links, exert elastic restoring forces on these chain links, which bring about an at least partial restoring movement of the chain links contrary to
30 the bending direction. This results in damping of vibrations on movement of the support chain and optionally of the line guide as a whole.

The length of the elastically deformable region of each or of the respective joint connector in the longitudinal direction

amounts in each case to a multiple of the thickness of the respective joint connector in the height direction.

For detachable fastening of separate joint connectors, it is in particular advantageous for each joint connector to have two fastening regions spaced from one another in the longitudinal direction and to be fastened to each of the two adjacent chain links by in each case one of the fastening regions against shifting in the longitudinal direction. The joint connector may be configured in such a way that, relative to the longitudinal direction, between the fastening regions at least two regions of the joint connector are provided with at least one different property selected from the group comprising cross-section, material thickness and modulus of elasticity.

Preferably, each of the respective chain link has two fastening receptacles for form-locking and/or force-locking interaction with in each case one fastening region of the joint connector. Each fastening receptacle may preferably be configured respectively between the front upper part and the front lower part or the rear upper part and the rear lower part of the respective chain link and/or the respective fastening receptacle may be openly accessible or lead in open manner into at least one of the side faces of the chain link, preferably on both sides.

The joint connector may preferably be inserted, in particular pressed, in the transverse direction from either side into the fastening receptacles of two adjacent chain links, meaning that assembly is particularly simple.

The respective fastening receptacle is advantageously arranged in a middle region relative to the height direction between the top and the bottom. The fastening receptacle is preferably at substantially the same distance from the top and from the bottom.

For further avoidance of abrasion, it is favorable for the respective chain link to have mutually facing clamping surfaces spaced from one another in the height direction at the respective fastening receptacle, in particular at the transition from the

fastening receptacle to the front or rear space. These are configured for force-locking retention of a fastening region of the associated joint connector and counteract movement of the fastening region relative to the corresponding fastening
5 receptacle, for example against shifting in the transverse direction and/or against twisting in the fastening receptacle. In this case, the respective joint connector may preferably have thickened portions at the fastening regions, for interaction with the clamping surfaces.

10 In particular for securing the position of assembled joint connectors or joint elements in the transverse direction, provision may advantageously be made for the respective joint connector to have catch means in the fastening regions, which catch means are embodied for interaction with complementary mating
15 catch means of the associated chain links.

Preferably all or at least some of the joint connectors are embodied as substantially plate-like components or as components curved in the plane in which the longitudinal direction and the height direction lie.

20 The joint connectors are preferably made from a plastics material which is elastic relative to the chain links and exhibits long-term bending resistance. The joint connectors and the chain links are preferably made from different materials.

To prevent transverse forces during operation, each chain
25 link and/or each joint connector consists of a body which is mirror-symmetrical with regard to its longitudinal central plane.

Each chain link may preferably consist of a block member, preferably of a one-piece block member, i.e. a body which, apart from weight-reducing tapers and openings, lacks any completely
30 internal cavities, in particular any passage opening in the longitudinal direction.

The two essential or sole components of the support chain, i.e. the chain links and the joint connectors, may in each case favorably be produced in particular as separate components, of
35 plastics material, in particular by injection molding.

The chain links and joint connectors may in particular be produced as mutually isolated, separate components which are connected detachably together. For concatenation of the strand forming the support chain, each joint connector is preferably detachably connectable at least to at least one of the two chain links of an adjacent pair. However, detachable connection within the chain links is also conceivable, in particular as a variant according to the first aspect. Preferred, however, is a configuration of the support chain with a plurality of separate joint elements or joint connectors which are embodied as separate components and in each case have two end regions for detachable connection with chain links and at least one deformable region therebetween.

The proposed support chain, according to both the first and the second aspects, is suitable in particular for use in a line guide device for cleanroom applications.

Further details and advantages of the individual aspects of the invention may be inferred, without restricting the general nature of the above, from the following explanation of preferred exemplary embodiments on the basis of the appended drawings. Features of corresponding or identical structure or function have corresponding reference signs and may not be repeatedly described. In the figures:

FIG. 1 is a perspective view of a line guide device for cleanroom applications, here with two envelopes, in a purely exemplary operating position with an extended self-supporting upper run, an extended resting lower run and a deflection arc therebetween;

FIG. 2 is a cross-section (perpendicular to the longitudinal direction) through an exemplary multilayer structure with a number of stacked envelopes for a plurality of lines, wherein support chains are accommodated in the receiving ducts of a number of envelopes;

FIG. 3 is a side view of a support chain according to an exemplary embodiment of the invention;

FIG. 4: shows structural views of an individual chain link of a support chain according to FIG. 3 in side view (A), view from below (B), plan view (C), front view (D), rear view (E) and in longitudinal section (F);

5 **FIGS. 5A-5B:** show perspective views of the chain link according to FIG. 4;

10 **FIG. 6:** shows a longitudinal section through a portion of the length of the support chain consisting of chain links according to FIGS. 3-5, in the extended position (left in FIG. 6) and the fully bent position (right in FIG. 6), and

FIG. 7: shows structural views of an individual joint element according to an exemplary embodiment in side view (A), plan view (B), and in perspective view (C), for a support chain according to FIGS. 3-5.

15 FIG. 1 shows an exemplary line guide device 1 which guides supply lines 3 (FIG. 2) between a stationary connection point 2 on a base and a mobile connection point 4 on a moving end. The moving end is not shown in any greater detail and can typically be displaced to-and-fro in linear manner in the longitudinal
20 direction L. The supply lines 3 are cables, hoses or the like and supply the mobile part of a machine for example with power, signals and/or operating media. FIG. 1 shows a snapshot of the line guide assembly 1 with a self-supporting, extended upper run 5, a lower run 6 optionally lying on a bearing surface and a
25 deflection arc 7. The deflection arc 7 has a predetermined bending radius or deflection radius about a notional deflection axis U. When in operation, the deflection arc 7 travels to-and-fro relative to the stationary connection point 2 when the upper run 5 with the mobile connection point 4 travels forward or backward in
30 the longitudinal direction L.

 The line guide device 1 is suitable and intended in particular for cleanrooms or other fields of application in which the release of particles must be reduced or prevented. To this end, it has one or more flexible envelopes 8 of flexible plastics
35 material extended in the longitudinal direction L, which envelopes

enclose the supply lines 3 in dust-tight manner along their entire length between the connection points 2 and 4. The ends of each envelope 8 and of the lines 3 are fastened at the end to the connection points 2, 4, for example using end fastening devices 11 or end connections.

According to FIG. 2, each envelope 8 has a number of tube-shaped receiving ducts 9 for guiding in each case at least one or more supply lines 3. Each envelope 8 is hose-like overall and sufficiently flexible, inter alia through suitable design and/or material selection, to allow reversibly flexible curvature of the deflection arc 7 with little application of force and to follow the movement in the longitudinal direction L with the least possible resistance.

The line guide device 1 further includes a number of support chains 10 which extend along the entire length of the line guide device 1 from connection point 2 to connection point 4. In the purely exemplary arrangement according to FIG. 2, a multilayer structure is shown with a plurality of stacked layers of envelopes 8 with lines 3. In this respect, an inner support layer facing the deflection arc 7 is provided, in which support chains 10 are provided in all the receiving ducts 9 of the envelope(s) 8, i.e. this inner support layer does not guide any lines 3. Additional support chains 10 may also be arranged in the envelope(s) 8 in further layers, e.g. on the outer sides, for the purpose of stabilization against transverse forces, cf. FIG. 2. The envelope 8 may comprise a plurality of separate envelope units, which are connected detachably together in the transverse direction, for example by fastening profiles or fastening bands 13 extending in the longitudinal direction L, as shown for example in FIG. 2. The respective envelope unit may for example have just one receiving duct 9, in which a support chain 10 is accommodated, and be connectable with further envelope units by the fastening profiles or fastening bands 13. This allows replacement of individual support chains 10 when required. Reference is here made to the teaching of WO 2020/148300 A1 with regard to configuration of the envelope 8. WO 2020/148300 A1 for example describes, with regard

to FIGS. 9D, 10C, 10D, 13A-C, and 18A, 18B, envelope units with just one receptacle and with fastening profiles or fastening bands for connecting the envelope units.

A core function of the support chains 10 consists in
5 predetermining the radius of curvature of the deflection arc 7 or limiting the minimum radius thereof about the deflection axis U. A further core function of each support chain 10 consists in supporting the self-supporting length of the upper run 5 or indeed enabling a sufficiently self-supporting length, in particular in
10 the fully advanced position of the moving end (not shown in FIG. 1). Each support chain 10 in this case supports the envelope 8, in particular against gravity-induced sagging in the height direction H, or has a load-bearing action. A sufficient number of support chains 10 is provided for the load weight and length of
15 the line guide device 1.

An exemplary embodiment of a support chain 10 according to the invention is described in greater detail below with reference to FIGS. 3-7.

FIG. 3 shows a support chain 10 according to the invention
20 in the intended position, namely turned back around the deflection axis U, wherein the support chain 10 forms two runs, an upper run 5 and a lower run 6, these extending in the longitudinal direction L, and a deflection arc 7. The deflection arc 7 is substantially U-shaped in the plane of FIG. 3, in which lie the longitudinal
25 direction L and the height direction H. The configuration of the support chain 10 determines the shape of the deflection arc 7 and of the entire line guide device 1. The deflection axis U runs perpendicular to the plane of FIG. 3, i.e. in the transverse direction Q perpendicular to longitudinal direction L and
30 perpendicular to height direction H. The support chain 10 is configured to support a self-supporting upper run 5, i.e. in the height direction H the runs 5, 6 remain spaced from one another over the entire displacement path.

The support chain 10 is embodied as a type of link chain and
35 consists of precisely one strand 12, comprising a plurality of

individual chain links 20 which are connected detachably together by in each case one articulated joint. Thanks to the articulated joint, adjacent chain links 20, 20' of each pair can be bent relative to one another in a bending direction over a limited angle, for example around 5-20°. The chain links 20, 20' are swivelable relative to one another between an extended position (as within the runs 5, 6) and a bent position (as within the deflection arc 7), which allows the support chain 10 to turn back on itself while maintaining the minimum allowable or possible radius of the deflection arc 7.

The respective articulated joint comprises a joint connector 30, which in each case connects two chain links 20, 20' which are adjacent or successive in the longitudinal direction L to be connected detachably together, and is explained in greater detail below with reference to FIGS. 7A-7C. In the example shown, precisely one separate, segregated joint connector 30 is provided for each pair of adjacent chain links 20, 20', and is connected detachably with one of its ends to the one chain link 20 and with the other end to the other chain link 20'. Each chain link 20 within the strand 12 is, for its part, connected on both sides or at both end regions of its longitudinal direction in each case with one joint connector 30.

Chain links 20 and joint connectors 30 thus alternate in the longitudinal direction within the strand 12. The respective joint connector 30 comprises a deformable middle region 32, which is elastically deformable through the action of intended bending forces acting on the joint connector 30 during displacement of the line guide device 1 or of the support chain 10. In this respect, the deformable region 32 is equally elastically deformable in the bending direction or against the bending direction of the associated adjacent chain links 20, 20'.

As FIGS. 3-5 show, the adjacent chain links 20, 20' are interdigitated and configured to fit inside one another in such a way that the chain links 20, 20' themselves contribute through their shaping to the respective articulated joint or influence the degrees of mutual swiveling freedom. The chain links 20 here

interact in such a way together and with the joint connectors 30 that the runs 5, 6 remain extended in the longitudinal direction L and do not sag downward, and the deflection arc 7 may achieve and not fall below its desired radius. In the example illustrated, all the chain links 20 of the support chain 10 are of identical configuration, and all the joint connectors 30 are of identical configuration, such that the support chain 10 may be manufactured from just two essential components.

FIGS. 4-5 show a preferred first embodiment of an individual chain link 20 which combines two core aspects of the invention. FIG. 6 shows a portion of the length of a support chain 10 in longitudinal section, wherein the extended and bent positions of in each case two chain links 20 are illustrated. What is not shown in FIG. 6 is a likewise possible or advantageous pretensioning of the support chain 10 in its extended position. Reference is made below to FIG. 3 and FIGS. 4 to 6 to explain the configuration of the chain link 20.

The chain link 20 is preferably embodied in one piece or one part and in particular is made integrally of plastics by injection molding. It may however also be assembled from a plurality of parts. The chain link 20 is embodied in the form of a block, with a top 204A, a bottom 204B, two external side faces 23, and front and rear end faces 231, 232. The dimension of the chain link 20 in the transverse direction Q, i.e. the width of the chain link 20, is of roughly the same order of magnitude as the dimensions in the height direction H, i.e. the height or thickness of the chain link 20. The width of the chain link 20 may also be greater than the height thereof, in order further to reduce torsion about the longitudinal direction L. In the example shown, the dimension in the longitudinal direction L, i.e. the length of the chain link, is at least twice as great as the width and/or twice as great as the height. The selected length depends on the desired chain pitch. The top 204A is the external side of the chain link 20, which, in an intended position of the chain link 20 within the support chain 10, is arranged on the side of the chain link 20 located on the outside in relation to the deflection arc 7, i.e.

on the side which is remote from the deflection axis U or the opposing run (cf. FIG. 3). The bottom 204A is the external side of the chain link 20, which, in an intended position of the chain link 20 within the support chain 10, is arranged on the side of the chain link 20 located on the inside in relation to the deflection arc 7, i.e. on the side which faces the deflection axis U or the opposing run (cf. FIG. 3). The external side faces 23 of the chain link 20 are the outer faces of the chain link 20 which bound the respective chain link 20 in the transverse direction Q, i.e. are spaced from one another and remote from one another in the transverse direction Q. The front end face 231 faces the adjacent chain link 20' located in front of the chain link 20 within the support chain 10, and the rear end face 232 faces the adjacent chain link 20'' located behind the chain link 20 within the support chain 10. With regard to surface area, the top 204A (FIG. 4C), the bottom 204B (FIG. 4B), and the external side faces 23 (FIG. 4A) are of a roughly equal order of magnitude and are at least twice as large as a cross-sectional area of the chain link 20 perpendicular to longitudinal direction L.

The respective chain link 20 may be notionally subdivided, relative to the longitudinal direction L, into a front longitudinal portion 21 (on the right in FIG. 4) and a rear longitudinal portion 22 (on the left in FIG. 4) (the terms "front" and "back" here serve merely for the purpose of differentiation and are in principle interchangeable). The front longitudinal portion 21 comprises a front upper part 201A at the top 204A and a front lower part 201B at the bottom 204B, these being spaced from one another by a front space 241 in the height direction H. The rear longitudinal portion 22 in turn comprises a rear upper part 202A at the top 204A and a rear lower part 202B at the bottom 204B, these being spaced from one another by a rear space 242 in the height direction H. Both the front space 241 and the rear space 242 are transversely continuous and open on each of the two external side faces 23. Space 241 and space 242 are thus accessible before the respective external side face 23 for

insertion of the rear lower part 202B or of the front upper part 201A respectively and of a joint connector 30 (see below).

For the purpose of explanation, just three arbitrary chain links 20', 20 and 20" succeeding one another within the support chain 10 are considered, these having been pushed together and connected together by joint connectors 30, wherein the middle chain link 20 is arranged between the first adjacent, i.e. the front chain link 20' and the second adjacent, i.e. the rear chain link 20" (cf. FIG. 6). The front upper part 201A of the middle chain link 20 is inserted into the rear space 242 of the front chain link 20'. The rear upper part 202A of the middle chain link 20 is inserted into the front space 241 of the rear chain link 20".

The adjacent chain links 20, 20', 20" are interdigitated together in the longitudinal direction in such a way as to transfer tension or compression or tensile force and thrust, such that they are inseparable from one another in the longitudinal direction L, at least in some or preferably all bent relative positions relative to one another. To this end, the front upper part 201A has an upper projection 206A pointing upward in the height direction H, and the rear upper part 202A has an upper recess 208A complementary to the upper projection 206A. The upper projection 206A engages in the upper recess 208A in the front chain link 20', specifically from the rear space 242 of the front chain link 20' toward the top 204A thereof. The rear lower part 202B has a lower projection 206B pointing downward in the height direction H, and the front lower part 201A has a lower recess 208B complementary to the lower projection 206B. The lower projection 206B engages in the lower recess 208B in the rear chain link 20", specifically from the front space 241 of the rear chain link 20" toward the bottom 204B thereof. The projections 206A, 206B are configured such that they are engaged in each case with the corresponding recesses 208A, 208B both in the extended position and in the bent position of the adjacent chain links 20, 20' or of the adjacent chain links 20, 20". This allows the tensile and compressive forces in the longitudinal direction L to be

transferred on displacement of the support chain 10 by interaction of the projections 206A, 206B and the recesses 208A, 208B, such that the joint connectors 30 need not be or need only insignificantly to be subject to tensile or compressive stress.

5 The recesses 208A, 208B are in each case continuously embodied in the height direction H, i.e. as openings in the height direction H through the rear upper part 202A or front lower part 201B. However, the upper projection 206A does not protrude beyond the top 204A, i.e. it does not protrude either in the extended or
10 in the bent position of the adjacent chain links 20, 20' beyond the upper external edge of the upper recess 208A (i.e. out of the recess 208A at the top 204A). Likewise, the lower projection 206B does not protrude beyond the bottom 204B, i.e. it does not protrude either in the extended or in the bent position of the
15 adjacent chain links 20, 20' beyond the lower external edge of the lower recess 208A (i.e. out of the recess 208B at the bottom 204B). In the maximally possible, fully bent position, the upper projection 206A is flush with the top 204 of the front chain link 20', in the upper recess 208A of which it engages. In the straight
20 or extended position, the lower projection 206B is flush with the bottom 204B of the rear chain link 20'', in the lower recess 208B of which it engages.

As is most readily visible in FIG. 6, the respective chain link has contact surfaces in each case at its projections and
25 recesses, which contact surfaces rest, in the extended or bent position, on corresponding mating contact surfaces of the adjacent chain link 20', 20'' and thereby transfer compressive or tensile force in the longitudinal direction L. In the extended position, the contact surface 216A of the upper projection 206A rests on the
30 mating contact surface 218A of the upper recess 208A. Accordingly, the contact surface 216B of the lower projection 206A rests on the mating contact surface 218B of the lower recess 208B. In the completely or maximally possible bent position, the contact surface 226A of the upper projection 206A rests on the mating
35 contact surface 228A of the upper recess 208A. Accordingly, the contact surface 226B of the lower projection 206A here rests on

the mating contact surface 228B of the lower recess 208B. The contact surfaces 216A, 216B, 218A, 218B, 226A, 226B, 228A, 228B run, when viewed in longitudinal section, in each case parallel to the transverse direction Q but obliquely relative to the longitudinal direction L.

The two contact surfaces 216A, 226A of the upper projection 206A are inclined at an angle α_A to one another, and the contact surfaces 216B, 226B of the lower projection 206B are inclined at a respective angle α_B to one another. The contact surfaces 218A, 228A of the upper recess 208A are inclined at an angle β_A to one another, and the contact surfaces 218B, 228B of the lower recess 208B are inclined at an angle β_B to one another. The difference in angular dimension between angles α_A of the projection 206A and β_A of the upper recess 208A is equal to the difference in angular dimension between the angle α_B of the lower projection 206B and the angle β_B of the lower recess 208B. In this way, both in the extended and in the fully bent position, in each case two contact surfaces of the respective chain link 20, and specifically a lower one and an upper one, rest on the corresponding mating contact surfaces of an adjacent chain link 20', such that tensile or compressive forces are more effectively transferred and the projections are subject to less stress, in particular shear.

Furthermore, each chain link 20 has end contact surfaces at its end faces 231, 232. In the extended position, the end contact surface 231A of the front upper part 201A rests on the end contact surface 232A of the rear upper part 202A of the front chain link 20'. In the fully bent position, the end contact surface 231B of the front lower part 201B rests on the end contact surface 232B of the rear upper part 202B of the front chain link 20'. This allows effective thrust transfer in the extended position or in the bent position.

The internal height of the front space 241 is slightly greater than the corresponding dimension of the rear lower part 202B, i.e. the greatest dimension in the height direction H in the region of the lower projection 206B. The rear lower part 202B of a front adjacent chain link 20' is thus insertable into the front

space 241 of the chain link 20, in the example shown specifically in both the transverse direction Q and the longitudinal direction L. The lower projection 206B of the front chain link 20' can then be inserted downward in the height direction H out of the front

5 space 241 into the lower recess 208B of the middle chain link 20. The internal height of the rear space 242 is in turn slightly greater than the largest dimension of the front upper part 201A, i.e. the dimension in the height direction H in the region of the upper projection 206A. The front lower part 201A of a rear

10 adjacent chain link 20'' is thus insertable into the rear space 242 of the middle chain link 20, in the example shown specifically in both the transverse direction Q and the longitudinal direction L. The upper projection 206A of the rear chain link 20' can then be inserted upward in the height direction H out of the rear space

15 242 into the upper recess 208A of the middle chain link 20. Thus, the chain links 20, 20', 20'' (before they are secured by joint connectors 30) have two possible joining directions for pushing the chain links together or taking them apart without twisting: in the transverse direction Q and in the longitudinal direction L,

20 with subsequent movement in the height direction H. By inserting the projections 206A, 206B in the height direction, i.e. perpendicular to each joining direction, into engagement with the following chain link 20, 20', 20'', a type of interlocking is achieved. This may also prevent the support chain 12 from coming

25 to pieces during operation, in particular in interaction with the obliquely positioned contact surfaces 216A, 226A or 216B, 226B and 218A, 228A or 218B, 228B, which pull those of the projections 206A, 206B into engagement in the case of tensile stress. Accordingly, the end contact surfaces 231A, 231B, 232A, 232B also

30 have the effect that, on thrust loading, the chain links 20, 20', 20'' move more strongly into the engagement position by a sort of wedge effect.

When a joint connector 30 has been inserted between in each case two chain links 20, 20', it extends between the front upper

35 part 241A and front lower part 241B of the one chain link 20 and the rear upper part 242A and the rear lower part 242B of the front

chain link 20', and here occupies a part of the front space 241 of the chain link 20 and a part of the rear space 242 of the front chain link 20', such that the internal height of the respective space becomes smaller, specifically smaller than the largest
5 dimension of the front upper part 201A or of the rear lower part 202B. As a result of this alone, the chain links 20 are reliably and non-detachably secured against unintentional separation from one another with a type of interlocking, since the projections 206A, 206B cannot be removed from the recesses 208A, 208B in the
10 adjacent chain link without twisting or even braking the chain links 20, 20', 20".

The chain link 20 consists of a body which is mirror-symmetrical relative to the longitudinal central plane thereof, such that force transfer between the interacting surfaces takes
15 place in the case of tensile and thrust loading without components in the transverse direction Q.

FIGS. 3-6 further show that each chain link 20 has a cutout 25 for weight reduction purposes, which, in the example shown, is embodied as a roughly circular cylindrical passage opening in the
20 transverse direction Q which opens in the two external side faces 23 and lies in the middle between the fastening receptacles 36 relative to the longitudinal direction L. The cutout 25 may also have a different shape in side view as in FIG. 4A, for example an oval section. The transitions between the cutout 25 and the side
25 faces 23 are preferably rounded.

FIGS. 7A-7C show an exemplary embodiment of the joint connector 30, which here is embodied as a substantially flat or plate-like component of plastics material. The main extent and main plane of the joint connector 30 runs in the longitudinal direction
30 L and transverse direction Q. It may also be embodied as a component curved or partly curved in the height direction H. The joint connector 30 has a deformable region 32 in the middle region relative to the longitudinal direction L. The joint connector 30 has a fastening region 34 at each of its longitudinal ends. Each fastening
35 region 34 serves for fastening to one of the two adjacent chain links 20, 20'. The fastening region 34 may have a uniform shape and

size in the transverse direction Q. The chain link 20 in turn has two fastening receptacles 36 spaced from one another in the longitudinal direction L and facing away from one another, in each case for accommodating a fastening region 34. Each chain link 20
5 may be connected with two joint connectors 30 and thereby with a front and a rear chain link 20', 20''. The one or front fastening receptacle 36 is arranged between the front upper part 201A and the front lower part 201B of the chain link 20 relative to the height direction H and constitutes an indentation of the front space 241.
10 The other or rear fastening receptacle 36 is arranged between the rear upper part 202A and the rear lower part 202B of the chain link 20 relative to the height direction H and constitutes an indentation of the rear space 242. The respective fastening receptacle 36 is preferably equidistant from the top 204A and the bottom 204B of the
15 chain link 20. The respective fastening receptacle 36 additionally opens out into each of the external side faces 23 of the chain link 20. Each fastening receptacle 36 has a uniform shape and size in the transverse direction Q and is conformed to the shape of the fastening region 34, such that the fastening region 34 is,
20 preferably exclusively, insertable in the transverse direction Q into the fastening receptacle 36 and secured in the fastening receptacle 36 at least in form-locking manner against shifting in the longitudinal direction L. The joint connector 30 can thus be connected with in each case two successive chain links 20, 20'
25 through insertion of the joint connector 30 between the chain links 20, 20' in the transverse direction Q and removed again in the transverse direction Q. The dimension of the joint connector 30 in the transverse direction Q, i.e. the width thereof, is equal to the distance between the external side faces 23 of the chain link 20,
30 such that, in the intended connected state, the joint connector 30 ends in the transverse direction Q flush on both sides with the respective external side face 23 of the chain link.

A joint connector 30 connected with the two successive chain links 20, 20' prevents the chain links 20, 20' from shifting relative
35 to one another in the height direction H and thus also detachment of the projections 206A, 206B of the chain link 20 from the recesses

208A, 208B in the adjacent chain link 20', 20". The tensile and compressive forces, however, are at least predominantly absorbed and transferred through interaction of the contact surfaces of the chain links 20, 20', 20" (specifically preferably simultaneously at least two contact surfaces per chain link, as described above, such that the forces are distributed over a larger area), such that the articulated connection of concatenated chain links 20 can absorb particularly high tensile/compressive forces. The above configuration is also enabled in that the chain links 20, 20', 20" cannot be connected together or separated from one another in the longitudinal direction L, but rather only substantially perpendicular thereto. During operation, the joint connectors 30 are at least predominantly subject to bending stresses, and only slightly or not at all to tension or compression (being relieved of the tensile/compressive stress by the interdigitated chain links 20). The joint connectors 30 may therefore be produced from a different material which is particularly suitable for frequent bending cycles, this being different from the more inflexible, high tensile strength chain links 20.

In the example shown, the respective fastening region 34 is embodied as a circular cylindrical thickened portion relative to the middle, deformable region 32 and roundish in longitudinal section. Other forms are likewise possible, for example a goblet shape or a triangular shape, to prevent rotation of the fastening region 34, which would cause abrasion. In the example shown, rotation of the fastening regions 34 is also avoided in that the chain link 20 has, at the fastening receptacle 36, two mutually facing clamping surfaces 37 spaced from one another in the height direction H, which clamping surfaces extend in the longitudinal direction L and the transverse direction Q and interact with a slightly thickened portion 38 at the fastening region 34 of the joint connector 30 and hold the latter in force-locked manner against twisting, and also against shifting in the transverse direction Q. The thickened portion 38 is thus accommodated in the intended operational state of the support chain 10 by pressing in or by interference fit between the clamping surfaces 37. In this

way, not only is twisting of the fastening region 34 in the fastening receptacle 36 prevented, but at the same time so too is unintentional detachment of the joint connector 30 from the support chain 10 in the transverse direction Q. To remove the joint connector, force
5 has to be applied in the transverse direction Q, which cannot arise under normal operating conditions.

In addition, the respective fastening region 34 and the fastening receptacle 36 have corresponding catch means 39, 39', which snap together to prevent shifting in the transverse direction
10 Q and here for example take the form of a notch or groove 39 in the circumference of the fastening region 34 of the joint connector 30 (cf. FIGS. 7B, 7C) and a corresponding raised portion 39' in the fastening receptacle 36 of the chain link 20 (cf. FIGS. 4D, 4E).

The joint connector 30 is embodied in the manner of a hinge-
15 like spring element, which acts like a leaf spring when the two chain links 20 are bent, i.e. has resilient properties. In the event of intended deformation, i.e. in the event of swiveling relative to one another of the adjacent chain links 20, 20', which are connected together with the joint element 30, the joint connector 30 exerts
20 an elastic restoring force on these chain links 20, 20' in the opposite direction from the swiveling. This results in uniform, low-vibration displacement of the support chain 10, which, inter alia, reduces wear of the projections 206A, 206B of the chain links and overall counteracts the occurrence of abrasion.

At least the elastically or resiliently deformable region 32
25 or the entire joint connector 30 is made of a material which differs from the material of the chain link 20, for example of another plastics material with a different modulus of elasticity. The shape of the deformable region 32 moreover also determines the resilient
30 properties thereof. The length of the deformable region 32 in the longitudinal direction L, and optionally also the width thereof in the transverse direction Q, in each case amount to a multiple of its material thickness or dimension in the height direction H. Bending forces on swiveling of the chain links 20 act on the
35 deformable region 32 of the joint connector 30 inter alia in the height direction H transversely of the longitudinal direction L. In

other embodiments, the deformable region 32 may be curved in its longitudinal section to influence the flexibility thereof, or for example be formed of two layers or plies spaced from one another in the height direction H by a space, which layers or plies meet in the fastening regions 34. Other shapes are also possible for the longitudinal section and optionally also the cross-section in order to influence the area moment of inertia of the deformable region 32.

Alternatively, the joint connector may however also be embodied such that substantially no restoring forces are exerted, to which end for example a film hinge-like joint region may be provided.

Through use according to the invention of the flexible joint connector 30 in the support chain 10, it is in particular possible to avoid the typical joint/pin articulated joint of typical support chains, so also avoiding the abrasion which is unavoidably concomitant therewith.

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List of reference signs

	1	Line guide device
	2, 4	Connection points
10	3	Supply lines
	5, 6	Runs
	7	Deflection arc
	8	Envelope
	9	Receiving ducts
15	10	Support chain
	11	End fastening device
	12	Strand
	13	Fastening profiles or fastening bands
	20, 20', 20"	Chain link
20	21	Front longitudinal portion of a chain link
	22	Rear longitudinal portion of a chain link
	23	External side faces
	25	Cutout for weight reduction
	30	Joint connector
25	32	Deformable region of the joint connector
	34	Fastening region of the joint connector
	36	Fastening receptacle of the chain link
	37	Clamping surface of the chain link
	38	Thickened portion on the fastening region of the joint
30	connector	
	39	Catch means of the joint connector
	39'	Mating catch means of the chain link
	201A	Front upper part of a chain link
	201B	Front lower part of chain link
35	202A	Rear upper part of a chain link

	202B	Rear lower part of a chain link
	204A	Top of a chain link
	204B	Bottom of a chain link
	206A	Upper projection
5	206B	Lower projection
	208A	Upper recess
	208B	Lower recess
	216A, 226A	Stop faces of the upper projection
	216B, 226B	Stop faces of the lower projection
10	αA	Angle between the stop faces of the upper projection
	αB	Angle between the stop faces of the lower projection
	218A, 228A	Stop faces of the upper recess
	218B, 228B	Stop faces of the lower recess
	βA	Angle between the stop faces of the upper recess
15	βB	Angle between the stop faces of the lower recess
	231, 232	Front or rear end face of a chain link
	231A	End contact surface of the front upper part
	232A	End contact surface of the rear upper part
	231B	End contact surface of the front lower part
20	232B	End contact surface of the rear lower part
	241	Front space of a chain link
	242	Rear space of a chain link
	A	Distance between the external side faces of the chain link
25	H	Height direction
	L	Longitudinal direction
	Q	Transverse direction
	U	Deflection axis

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Claims

1. **A line guide device** (1), in particular for cleanroom applications, for protected dynamic guiding of supply lines (3), such as for example cables, hoses or the like, between two connection points (2, 4) at least one of which is mobile relative to the other, the line guide device (1) being displaceable to-and-fro in a longitudinal direction (L), forming two runs (5, 6) and a deflection arc (7) connecting the runs and lying in a plane in which the longitudinal direction (L) and a height direction (H) lie, the line guide device (1) comprising:
- a flexible envelope (8) with a number of receiving ducts (9) arranged next to one another and extending in the longitudinal direction (L), in each case for at least one supply line (3), and
 - at least one support chain (10), which is arrangeable or arranged in a receiving duct (9) to support the line guide device (1), the support chain (10) being configured to form the runs (5, 6) and the deflection arc (7), **characterized in that**
- the support chain (10) consists at least in a longitudinal portion of a strand (12) which in the longitudinal direction (L) has alternating successive chain links (20) and joint connectors (30), wherein the joint connectors (30) in each case comprise a deformable region (32) which is in particular elastically deformable in a bending direction, wherein the joint connectors (30) in each case hold two adjacent chain links (20, 20') together, the chain links (20, 20') being swivelable relative to one another in or contrary to the bending direction, in particular between an extended and a bent position, and
- in that** at least some of the chain links (20) and/or joint

connectors (30) of the strand (12) are connectable together and/or detachable from one another in a joining direction other than the longitudinal direction (L), in particular perpendicular to the longitudinal direction (L).

- 5 2. **A support chain** (10) for supporting a line guide device (1) with a flexible envelope (8), in particular according to Claim 1, the support chain (10) running in a longitudinal direction (L) and being configured to form two runs (5, 6) and a deflection arc (7) connecting the runs (5, 6) and lying in a
10 plane in which the longitudinal direction (L) and a height direction (H) lie, **characterized in that** the support chain (10) consists at least in a longitudinal portion of a strand (12) which in the longitudinal direction (L) has alternating successive chain links (20) and joint connectors (30), wherein
15 the joint connectors (30) in each case comprise a deformable region (32) which is in particular elastically deformable in a bending direction, wherein the joint connectors (30) in each case hold two adjacent chain links (20, 20') together, the chain links (20, 20') being swivelable relative to one another
20 in or contrary to the bending direction, in particular between an extended and a bent position, and
in that at least some of the chain links (20) and/or joint connectors (30) of the strand (12) are connectable together and/or detachable from one another in a joining direction
25 other than the longitudinal direction (L), in particular perpendicular to the longitudinal direction (L).
3. The device according to Claim 1 or 2, wherein the respective chain link (20) has two external side faces (23) spaced from one another in a transverse direction (Q) perpendicular to the
30 longitudinal direction (L), facing away from one another and bounding the chain link (20) in the transverse direction (Q), the chain link (20) preferably being embodied at least in places between the external side faces (23) with a continuous cross-section or as a solid body.

4. The device according to one of Claims 1 to 3, in particular according to Claim 3, characterized in that the joining direction runs substantially in the transverse direction (Q).
5. The device according to Claim 3 or 4, characterized in that the strand (12) is configured as a concatenation of a plurality of chain links (20) and separate joint connectors (30) connected alternately together and embodied as separate components, wherein each of the plurality of joint connectors (30) is preferably connected detachably with in each case two adjacent chain links (20, 20').
6. The device (1, 10) according to one of Claims 1 to 5, characterized in that the respective chain link (20) of the plurality of chain links (20) has, relative to the longitudinal direction (L), a front longitudinal portion (21) and a rear longitudinal portion (22), wherein the front longitudinal portion (21) of the respective chain link (20) is configured for form-locking interaction with a rear longitudinal portion (22) of an adjacent chain link (20) to transfer tensile and/or compressive forces in the longitudinal direction (L), wherein the front longitudinal portion (21) has a front upper part (201A) at a top (204A) on the outside relative to the deflection arc (7) and a front lower part (201B) at a bottom (204B) on the inside relative to the deflection arc (7), and the rear longitudinal portion (22) has a rear upper part (202A) at the top (204A) and a rear lower part (202B) at the bottom (204B), wherein the front upper part (201A) and the front lower part (201B) of the respective chain link (20) are spaced apart from one another in the height direction (H) by a front space (241), into which the lower rear part (202B) of a first adjacent chain link (20') is insertable or inserted, and wherein the rear upper part (202A) and the rear lower part (202B) of the respective chain link (20) are spaced apart from one another in the height direction (H) by a rear space (242), into which the front upper part (201A) of a second adjacent chain link (20'') is insertable or inserted.

7. **A support chain (10)** for supporting a line guide device (1) with a flexible envelope (8), in particular according to Claim 1, the support chain (10) having a plurality of individual chain links (20) which are connectable or connected together in articulated manner to form runs (5, 6) extended in a longitudinal direction (L) and a U-shaped deflection arc (7) connecting the runs and lying in a plane in which the longitudinal direction (L) and a height direction (H) lie, in each case two adjacent chain links (20) being swivelable between an extended and a bent position relative to one another, the respective chain link (20) of the plurality of chain links (20) having, relative to the longitudinal direction (L), a front longitudinal portion (21) and a rear longitudinal portion (22), the front longitudinal portion (21) of the respective chain link (20) being configured for form-locking interaction with a rear longitudinal portion (22) of an adjacent chain link (20) to transfer tensile and/or compressive forces in the longitudinal direction (L), the front longitudinal portion (21) having a front upper part (201A) at a top (204A) of the chain link (20) on the outside relative to the deflection arc (7) and a front lower part (201B) at a bottom (204B) of the chain link (20) on the inside relative to the deflection arc (7), and the rear longitudinal portion (22) having a rear upper part (202A) at the top (204A) and a rear lower part (202B) at the bottom (204B) of the chain link (20), the respective chain link (20) having two external side faces (23) facing away from one another and spaced from one another in a transverse direction (Q) perpendicular to the longitudinal direction (L), which side faces bound the chain link (20) in the transverse direction (Q),

characterized in that

- the front upper part (201A) and the front lower part (201B) of the respective chain link (20) are spaced apart from one another in a height direction (H) transverse relative to the longitudinal direction (L) by a front space (241), into which the rear lower part (202B) of a first adjacent chain link (20')

is insertable or inserted, and **in that**

- the rear upper part (202A) and the rear lower part (202B) of the respective chain link (20) are spaced apart from one another in the height direction (H) by a rear space (242), into which the front upper part (201A) of a second adjacent chain link (20'') is insertable or inserted.

8. The support chain according to Claim 7, characterized in that at least some of the chain links (20) are connectable together and/or detachable from one another in a joining direction other than the longitudinal direction (L), in particular perpendicular to the longitudinal direction (L), wherein the joining direction runs preferably substantially in the transverse direction (Q).

9. The support chain (10) according to Claim 7 or 8, characterized in that the support chain (10) comprises a plurality of joint connectors (30), which are preferably embodied as separate components, wherein, in the bending direction of the chain links (20), the joint connectors (30) in particular have elastically deformable regions (32), wherein each of the plurality of joint connectors (30) is connectable particularly preferably detachably with in each case two adjacent chain links (20).

10. A device (1, 10) according to one of Claims 6 to 9, characterized in that

- the front upper part (201A) has an upper projection (206A) protruding in the height direction (H), and the rear upper part (202A) has an upper recess (208A); and
- the rear lower part (202B) has a lower projection (206B) protruding in the height direction (H), and the front lower part (201B) has a lower recess (208B);

wherein the upper projection (206A) of the respective chain link (20) is configured for engagement both in the extended and in the bent position in the upper recess (208A) of the first adjacent chain link (20'), and the lower projection (206B) of the respective chain link (20) is configured for engagement both in the extended and in the bent position in

the lower recess (208B) of the second adjacent chain link (20''), preferably wherein the upper projection (206A) is configured to engage in the upper recess (208A) from the rear space (242) of the one adjacent chain link (20') toward the top thereof (204A) and the lower projection (206B) is configured to engage in the lower recess (208B) from the front space (241) of the other adjacent chain link (20'') toward the bottom thereof (204B), the internal height of the front space (241) particularly preferably being the same or greater than the dimension of the rear lower part (202B) including the lower projection (206B) in the height direction (H) and the internal height of the rear space (242) being the same or greater than the dimension of the front upper part (202A) including the upper projection (206A) in the height direction (H).

11. The device (1, 10) according to Claim 10, characterized in that the upper recess (208A) forms an opening toward the top (204A) starting from the rear space (242) and/or the lower recess (208B) forms an opening toward the bottom (204B) starting from the front space (241).

12. The device (1, 10) according to one of Claims 10 or 11, characterized in that the upper projection (206A), the lower projection (206B), the upper recess (208A) and the lower recess (208B) of the respective chain link (20) in each case have a contact surface (216A, 216B, 218A, 218B) for resting in a compressive and/or tensile force-absorbing manner on a corresponding mating contact surface of an adjacent chain link (20') in the extended position and a contact surface (226A, 226B, 228A, 228B) for resting in a compressive and/or tensile force-absorbing manner on a corresponding mating contact surface of an adjacent chain link (20') in the bent position, wherein each of the stop faces (216A, 216B, 218A, 218B, 226A, 226B, 228A, 228B) preferably extend transversely of the longitudinal direction (L).

13. The device (1, 10) according to Claim 12, characterized in that the contact surfaces (216A, 226A) of the upper projection (206A) or the contact surfaces (216A, 226B) of the lower projection (206B) are at a respective angle (α_A , α_B) to one another, and the contact surfaces (218A, 228A) of the upper recess (208A) or the contact surfaces (218A, 228B) of the lower recess (208B) are at a respective angle (β_A , β_B) to one another, wherein the difference in the angular dimension between the angles (α_A , α_B) of the upper projection (206A) and of the upper recess (208A), and the difference in the angular dimension between the angle (α_B , β_B) of the lower projection (206B) and of the lower recess (208B), are preferably substantially equal or equal.
14. The device (1, 10) according to one of Claims 10 to 13, characterized in that the upper projection (206B) is embodied, in the bent position, flush with the top (204A) of the chain link (20') in the upper recess (208A) of which it engages, and/or the lower projection (206B) is embodied, in the extended position, flush with the bottom (204B) of the chain link (20") in the lower recess (208B) of which it engages.
15. The device (1, 10) according to one of Claims 6 to 14, characterized in that the respective chain link (20) in each case has end contact surfaces (231A, 232A, 231B, 232B) at the front and rear upper parts (201A, 202A) and at the front and rear lower parts (201B, 202B) which are configured in such a way that end contact surfaces (231A, 232A) of the front and rear upper parts (201A, 202A) rest in the extended position on the end contact surfaces (231A, 232A) of the front and rear upper parts (201A, 202A) of the adjacent chain link (20'), and end contact surfaces (231B, 232B) of the front and rear lower parts (201B, 202B) rest in a bent position on the end contact surfaces (231B, 232B) of the adjacent chain link (20').
16. The device (1, 10) according to one of Claims 6 to 15, characterized in that both the front and the rear space (241, 242) lead in an open manner into each of the external side faces (23).

17. The device (1, 10) according to one of Claims 1 to 16, characterized in that
- the dimension of the respective joint connector (30) in the transverse direction (Q) amounts to more than 30%, in particular between 50% and 100%, of the distance (A) between the external side faces (23) of the respective chain link (20), preferably is substantially equal to the distance (A), and/or
 - the respective joint connector (30) extends in a middle region, relative to the transverse direction, between the external side faces (23) of the chain links (20).
18. The device (1, 10) according to one of Claims 6 or 9 to 17, characterized in that each joint connector (30) extends, relative to a height direction (H), at least in part between the front upper part (201A) and the front lower part (201B) of one of the two adjacent chain links (20) and the rear upper part (202A) and the rear lower part (202B) of the other of the two adjacent chain links (20).
19. The device (1, 10) according to one of Claims 1 to 18, characterized in that the joint connectors (30) are embodied as spring elements which, on bending of adjacent chain links (20), exert elastic restoring forces on these chain links (20), which bring about an at least partial restoring movement of the chain links (20) contrary to the bending direction.
20. The device (1, 10) according to one of Claims 1 to 19, characterized in that the length of the elastically deformable region (32) of the respective joint connector (30) in the longitudinal direction (L) amounts in each case to a multiple of the thickness of the respective joint connector (30) in the height direction (H).
21. The device (1, 10) according to one of Claims 1 to 20, characterized in that the respective joint connector (30) has two fastening regions (34) spaced from one another in the longitudinal direction (L) and is fastened to each of the two adjacent chain links (20) by in each case one of the fastening

regions (34) against shifting in the longitudinal direction (L).

22. The device (1, 10) according to Claim 21, characterized in that, relative to the longitudinal direction (L), between the fastening regions (34) at least two regions of the joint connector (30) are provided with at least one different property selected from the group comprising cross-section, material thickness and modulus of elasticity.

23. The device (1, 10) according to Claim 21 or 22, characterized in that the respective chain link (20) has two fastening receptacles (36) for form-locking and/or force-locking interaction with in each case one fastening region (34), wherein each fastening receptacle (36) is preferably configured respectively between the front upper part (201A) and the front lower part (201B) or the rear upper part (202A) and the rear lower part (202B) of the respective chain link (20); and/or wherein the respective fastening receptacle (36) preferably leads in open manner into at least one of the side faces (23) of the chain link (20), preferably into both.

24. The device (1, 10) according to Claim 23, characterized in that the respective fastening receptacle (36) is arranged in a middle region relative to the height direction (H) between the top (204A) and the bottom (204B), preferably wherein the fastening receptacle (36) is at substantially the same distance from the top (204A) and from the bottom (204B).

25. The device (1, 10) according to Claim 23 or 24, characterized in that the respective chain link (20) has mutually facing clamping surfaces (37) spaced from one another in the height direction (H) at the respective fastening receptacle (36), in particular at the transition from the fastening receptacle (36) to the front or rear space (241, 242), which clamping surfaces are configured for force-locking retention of a fastening region (34) of the associated joint connector (30) and counteract movement of the fastening region (34) relative to the

corresponding fastening receptacle (36), wherein the respective joint connector (30) has thickened portions (38) at the fastening regions (34), for interaction with the clamping surfaces (37).

- 5 26. The device (1, 10) according to any one of the preceding claims, characterized in that the respective joint connector (30) has catch means (39) in the fastening regions (34), which catch means are embodied for interaction with complementary mating catch means (39') of the associated chain links (20), preferably
10 against shifting in the transverse direction (Q).
27. The device (1, 10) according to one of the preceding claims, characterized in that some of the joint connectors (30) are embodied as substantially plate-like components or as components curved in the plane in which the longitudinal
15 direction (L) and the height direction (H) lie.
28. The device (1, 10) according to one of the preceding claims, characterized in that the joint connectors (30) are made from plastics material, and/or in that the joint connectors (30) and the chain links (20) consist of different materials.
- 20 29. The device (1, 10) according to one of the preceding claims, characterized in that
each chain link (20) and/or each joint connector (30) consists of a body which is mirror-symmetrical with regard to its longitudinal central plane (L-H); and/or
25 each chain link (20) consists of a block member, preferably of a one-piece block member.
30. The device (1, 10) according to one of the preceding claims, characterized in that each chain link (20) and/or each joint connector (30) is made in one piece from plastics material, in
30 particular by injection molding.