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Description

The present invention relates to an apparatus and to a method for expanding elongated ribbon-like metal elements moving in the longitudinal direction and suitable for forming open section elements such as upright sections or plaster sections or closed section elements such as passages or pipes. The invention is further directed to a corresponding method for expanding such metal elements.

Such metal elements are described, for example, in the German patent application, not pre-published, DE 10 2010 026 320. These metal elements have two longitudinal portions having meandering longitudinal edges which are connected to one another portion-wise to produce a metal element widened with respect to the original ribbon-like metal element without any additional material effort.

It is problematic in this respect to connect the separate longitudinal portions of the metal element to one another at a high feed speed in inline operation with an economically justifiable effort. The part portions of the longitudinal edges to be connected, preferably to be welded, must be set exactly at one another to be able to ensure the desired quality of the connections. To achieve a sufficiently high throughput, this must also be ensured at the usually high speeds such as occur in inline production (for example 40 m/min to more than 100 m/min).

An apparatus and a method for expanding elongated ribbon-like metal elements which move in the longitudinal direction and which are suitable for forming open or closed section elements are described in US 4,896,818 on which the preambles of claims 1 and 17 are based. However, this document does not contain any reference to how two longitudinal portions of the respective metal elements can be positioned exactly with respect to one another at the high feed speeds which occur in inline operation.

It is therefore an object of the present invention to provide an apparatus and a method of the initially named kind which ensure a high throughput with a simultaneously simple and reliable construction.

In accordance with the invention, this object is satisfied by an apparatus of the initially named kind having a feed station, a cutting station, a positioning station and a connection station, with the feed station being formed for the at least substantially continuous feed of at least one metal element to the cutting station; the cutting station being formed for producing at least one continuous,

meandering incision which extends in the longitudinal direction of the at least one metal element and by which at least two longitudinal portions of the at least one metal element having meandering longitudinal edges are produced; the positioning station including at least one positioning device, in particular a revolving positioning device, having a plurality of positioning elements, with the positioning elements being formed for engaging into openings formed in the at least one metal element and for positioning part portions of the meandering longitudinal edges with respect to one another in predefined positions; and with the connection station being formed for connecting the mutually positioned part portions of the meandering longitudinal edges.

10 In the method in accordance with the invention, the at least one metal element is supplied from a feed station at least substantially continuously to a cutting station; at least one continuous meandering incision which extends in the longitudinal direction of the at least one metal element is produced in the cutting station by which incision at least two longitudinal portions of the at least one metal element having meandering longitudinal edges are formed; the longitudinal portions are
15 guided by a positioning station such that positioning elements provided at a positioning device, in particular a revolving positioning device, engage into openings formed in the at least one metal element so that part portions of the meandering longitudinal edges are mutually positioned in predefined positions and the mutually positioned part portions of the meandering longitudinal edges are connected to one another in a connection station.

20 An automatic and exact alignment of the part portions of the meandering longitudinal edges to be connected with respect to one another thus takes place by the invention so that the longitudinal portions of the metal element can be connected to one another at high speed. The section elements can thereby be manufactured in inline processes at a high throughput in an economical manner.

25 In accordance with an advantageous embodiment of the invention, an offset station for forming a loop, in particular a slack loop, of at least one of the longitudinal portions of the metal element is provided between the cutting station and the positioning station so that the mutually separate longitudinal portions of the at least one metal element can be offset with respect to one another in
30 the longitudinal direction and/or in the transverse direction. Since the guided metal elements have a relatively high stiffness in the longitudinal direction and the transverse direction, a mutual offset in the longitudinal direction or transverse direction is advantageously carried out using a corresponding offset station. The loop can in this respect only include one or more longitudinal portions of the metal element or all longitudinal portions, i.e. the total metal element. A slack
35 region of the at least one metal element or of the longitudinal portion or portions is produced within

the production line by the loop which is formed and it is ensured by said slack region that the longitudinal portions of the at least one metal element can be mutually offset both in the longitudinal direction and, or alternatively, in the transverse direction. The displacement of the two longitudinal portions with respect to one another or the separation of the longitudinal portions required for the final positioning of the part portions of the meandering longitudinal edges to be connected to one another can be achieved without problem in this manner. The respective offset transversely or longitudinally to the direction of transport is in this respect defined by the desired kind of connection of the two longitudinal portions, as will be explained in even more detail within the framework of this application.

In accordance with a further advantageous embodiment of the invention, two respective rows of positioning elements are provided which are disposed next to one another in the direction of transport. Depending on the kind of connection of the two longitudinal portions, it is, however, also possible that the positioning device only includes one row of positioning elements disposed behind one another.

Depending on the arrangement of the openings in the at least one metal element, the positioning elements of the two rows can be arranged not mutually offset or mutually offset in the transport direction. It is equally dependent on the arrangement of the openings whether one row of positioning elements disposed behind one another or two rows of positioning elements disposed arranged next to one another in the transport direction are provided.

The positioning device is advantageously formed as a toothed wheel, a toothed belt or as a gear rack or as a chain conveyor or belt conveyor having positioning elements. Other elements suitable for feeding and having corresponding positioning elements can also form a positioning device in accordance with the invention.

In accordance with a further advantageous embodiment, the positioning elements have, in particular in their base surface, a cross-sectional shape formed substantially complementary to the openings of the at least one metal element. A shape-matched connection between the positioning elements and the openings of the at least one metal element is thereby achieved so that the part portions of the meandering longitudinal edges to be welded to one another can be exactly aligned with one another.

In accordance with a further preferred embodiment of the invention, the positioning elements are formed for engaging into openings formed by the meandering longitudinal edges. Such openings can be produced in that the longitudinal portions are mutually displaced in the transverse direction or in the transverse and longitudinal directions after introduction of the meandering incision.

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It is, however, also possible that the positioning elements are formed for engaging in openings provided independently of the meandering longitudinal edges in the at least one metal element, in particular in its marginal regions. The positioning device can in this case be formed in the manner of a traction apparatus, for example as a chain conveyor having needle grippers. An exact positioning of the part portions to be mutually connected is also ensured in this case by the fixed spacings between the openings provided in the marginal regions and the part portions of the meandering longitudinal edges provided for welding.

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The feed station advantageously includes a reel on which the at least one metal element is wound.

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In this manner, a uniform feed of the at least one metal element to the other stations of the apparatus in accordance with the invention can be achieved. The feed station can advantageously include an apparatus for welding together mutually following metal elements. On a complete unwinding of the at least one metal element from the reel, continuous operation can thereby be maintained in that a respect further metal element is welded to the end of the preceding metal element.

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In accordance with a further preferred embodiment of the invention, a straightening station for the at least one metal element and the longitudinal portions produced therefrom is provided between the feed station and the cutting station and/or between the cutting station and the positioning station. Irregularities in the surface or stresses in the at least one metal element, which arise, for example, by welding of two mutually following portions on the exchange of a coil of the feed reel or on the production of the meandering incision, can thereby be compensated. Bent-up portions of the at least one metal element, which can arise in the cutting process, can in particular again be bent back into the plane of the respective metal ribbon, for example.

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The positioning device is advantageously actively driven. This means that the positioning device acts as a feed device for the at least one metal element. It is, however, generally also possible that the positioning device is only passively driven and a separate feed device is provided. In this case, only the positioning of the two longitudinal portions with respect to one another is effected by the

positioning device, whereas the actual forward movement of the at least one metal element is achieved by a separate feed device.

5 The positioning station is advantageously arranged in front of the connection station, in particular in the run-in region of the connection station, i.e. close in front of the connection station. It is, however, also possible that the positioning station is arranged after the connection station, in particular in the run-out region of the connection station, i.e. close to the outlet of the connection station.

10 In accordance with a further advantageous embodiment, the connection station includes a lateral belt guide by which the longitudinal portions of the at least one metal element are mutually positioned and in particular held together so that the part portions of the meandering longitudinal edges to be welded together contact one another, in particular under pressure. It is achieved in this manner that the positioning of the part portions of the meandering longitudinal edges to be
15 connected to one another achieved by the positioning station is also exactly observed within the connection station. It can in particular be achieved by the pressing together of the part portions of the meandering longitudinal edges to be connected to one another that an exact connection seam, in particular an exact weld seam, can be produced.

20 The connection station can advantageously include a vertical belt guidance by which the longitudinal portions of the at least one metal element are guided substantially in the same plane or lying areally over one another. A high quality of the connection and in particular an ideal surface of the metal ribbon are also thereby achieved.

25 The cutting station can advantageously include a rotational cutting apparatus or a laser cutting apparatus. A stroke cutting process is generally also conceivable if it is made so that a substantially continuous manufacturing process is made possible.

30 Equally preferably, the connection station is configured as a welding station which in particular includes a laser welding apparatus. Very exact and clean weld seams can be produced using a laser welding apparatus so that the quality of the section element produced is very high. Furthermore, a very small region of great heat is produced at the two contacting edges of the longitudinal portions by a laser welding process. The melted zone produced by the laser welding process in this region has a much smaller transverse extent than a correspondingly melted zone in other fusion welding

connections so that an increased strength of the final metal section is achieved exactly at the center between the two longitudinal portions.

5 A feed unit for the at least one metal element can advantageously be provided after the connection station, in particular in the form of a roll guide. A stamping station and/or a reshaping station for the at least one metal element can furthermore likewise preferably be provided after the connection station by which stamping station/reshaping station, on the one hand, desired stampings in the form of stiffening beads or deep-drawn regions can be produced, in particular in the region of the openings, and, on the other hand, the cross-section of the at least one metal element can be brought
10 into an intermediate shape or into its final shape. The at least one metal element can, for example, be reshaped into a C-section or a U-section or any other suitable open, or also closed, section.

On use of a laser welding process, the laser beam is preferably moved during the welding process along with the moving at least one metal element, with the forward movement of the laser beam
15 being slower than the transport speed of the at least one metal element. In this respect, in particular the forward movement of the laser beam and thus the welding speed can be substantially half as fast as the transport speed of the at least one metal element.

In each case after welding of two mutually positioned part portions of the meandering longitudinal
20 edges, the laser beam can advantageously be positioned onto part portions of the meandering longitudinal edges disposed opposite to the direction of transport and they can subsequently welded to one another.

Since the welding speed is restricted in laser welding, a higher transport speed of the at least one
25 metal element can be achieved in this manner with respect to the maximum welding speed. The maximum welding speed is only defined by the relative speed between the laser beam and the at least one metal element due to the moving of the laser beam along with the moving at least one metal element during the welding process. The absolute transport speed of the at least one metal element can thereby be higher than the maximum possible welding speed. Since no uninterrupted
30 weld connection, but rather only an interrupted weld connection, is necessary due to the meandering longitudinal edges, the laser beam can be positioned at high speed at the part portion disposed against the transport direction and to be welded next after respectively producing a part weld connection. The connection of these next part portions can then in turn be produced by moving along the laser beam at reduced speed with respect to the transport speed.

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In this respect, it is generally also possible that a plurality of laser beams are used in parallel which each weld mutually following part portions of the meandering longitudinal edges to one another. After the welding process has taken place, the laser beams can then be offset in parallel by a corresponding plurality of part portions and can be repositioned. The transport speed of the metal
5 element can be increased even further in this manner.

At least two metal elements contacting one another areally can advantageously be fed to the cutting station and the metal elements contacting one another can jointly be divided by the meandering incision in the cutting station into two longitudinal portions each, with the respective longitudinal
10 portions of the metal elements disposed on the same side of the meandering incision contacting one another and respective part portions of the meandering longitudinal edges of the mutually contacting longitudinal portions respectively extending in the longitudinal direction forming directly mutually contacting connection edges, the one mutually connecting longitudinal portions being separated from the other mutually connecting longitudinal portions, the connection edges of
15 the one longitudinal portion being connected, in particular welded, to the connection edges of the longitudinal portion contacting it and one of the two longitudinal portions being pivoted about the connection edges with respect to the other longitudinal portion connected to it so that the longitudinal portions are mutually connected along bent over abutting edges and the openings being formed between portions of the meandering longitudinal edges.

20 In this embodiment, it is thus not an individual metal element which is cut by the meandering incision into two longitudinal portions which are then mutually displaced and ultimately connected to one another, but rather at least two areally contacting metal elements are used as the starting material. They are provided while mutually contacting with a common meandering incision so that
25 each of the metal elements is divided into two longitudinal portions. Unlike the other embodiments, the at least two mutually contacting longitudinal portions, i.e. one longitudinal portion from the one and one longitudinal portion from the other metal element or elements are each connected to one another along the connection edges and are ultimately unfolded to form the desired section element with openings. The individual processing steps of the two halves separated by the meandering slit
30 can in this respect be carried out in parallel in the same respective stations or in separate stations. A plurality of meandering slits can generally also be introduced so that a plurality of longitudinal portions are formed.

Further advantageous embodiments of the invention are set forth in the dependent claims.

The invention will be described in more detail in the following with reference to embodiments and to the drawings; there are shown in these:

- Fig. 1 a schematic perspective representation of a section element manufactured
5 using a method in accordance with the invention or an apparatus in
accordance with the invention;
- Figs. 2 to 4 different intermediate steps for the manufacture of a section element in
10 accordance with Fig. 1;
- Figs. 5 and 6 two further section elements;
- Fig. 7 a schematic side view of an apparatus formed in accordance with the
15 invention for widening metal elements;
- Fig. 8 a side view of a positioning device;
- Fig. 9 a plan view of the positioning device in accordance with Fig. 8;
- 20 Fig. 10 a plan view of a further positioning device formed in accordance with the
invention;
- Fig. 11 a plan view of a section element cooperating with a positioning device;
- 25 Fig. 12 a further embodiment of a positioning device formed in accordance with
the invention;
- Fig. 13 a side view of a further positioning device formed in accordance with the
30 invention;
- Fig. 14 a further section element;
- Fig. 15 a further positioning device;
- 35 Fig. 16 a further section element;

- Fig. 17 a further positioning element;
- Fig. 18 a schematic plan view of a part of a welding station formed in accordance
5 with the invention;
- Fig. 19 a schematic perspective representation of a section element for illustrating the welding process;
- 10 Figs. 20a) to d) four steps of the welding process in accordance with the invention in a schematic representation;
- Fig. 21 a perspective representation of two mutually contacting material portions for manufacturing a section element in accordance with a further
15 embodiment of the invention;
- Fig. 22 an intermediate step in the manufacture of the section element; and
- Fig. 23 the section element after the folding open of the two longitudinal
20 portions.

Fig. 1 shows a section element 1 which is formed as a C section. The section 1 includes a section body 2 which has a section web 3 as well as two section limbs 4 laterally adjoining thereat which are each angled at a right angle with respect to the section web 3. The free longitudinal edges of the
25 section limbs 4 are in turn each angled by 90° to form the C section. The section element 1 can generally also be formed, for example, as a U section, an L section, a T section, an H section, a hat section or a Z section.

A plurality of openings 5 are formed in the section web 3 and can serve, for example, as passage
30 openings for cables or other elements to be laid.

The openings 5 of the section element 2 are manufactured without material loss in accordance with the invention, as will be explained in more detail in the following with reference to Figs. 2 to 4.

Fig. 2 shows a metal element 54 in the form of a material strip 6, for example a strip of sheet metal, which serves as a starting material for the section body 2. Whereas in Figs. 2 to 4, only one relatively narrow region of the material strip 6 is shown in each case which is ultimately used to form the section web 3, further material regions can in each case adjoin its outer edges 7, 8, with the section limbs 4, for example, being formed by said further material regions by corresponding bending over.

A meandering slit 9 which extends in the longitudinal extent of the material strip 6 and by which the material strip 6 and thus the section body 2 is divided into two separate longitudinal portions 10, 11 is formed in the material strip 6. The longitudinal portions 10, 11 are each given meandering longitudinal edges 12, 13 by the meandering slit 9 which contact one another seamlessly in the representation in accordance with Fig. 2. The meandering longitudinal edges 12, 13 each include edge portions extending in the longitudinal direction and extending perpendicular thereto.

Web-shaped connection portions 14, 15 of the longitudinal portions 10, 11 are respectively formed by the meandering longitudinal edges 12, 13 and are each connected in one piece to elongated portions 16, 17 of the longitudinal portions 10, 11 and project laterally beyond them. As can furthermore be recognized from Fig. 2, the web-shaped connection portions 14 are bordered by the meandering longitudinal edge 12 and the web-shaped connection portions 15 are bordered by the meandering longitudinal edge 13.

To produce the final shape of the section web 3, the two longitudinal portions 10, 11 are moved apart in accordance with two arrows 18, 19 transverse to the longitudinal extent of the material strip 6 until they adopt the position shown in Fig. 3. In this position, connection edges 20, 21 of the connection portions 14, 15 extending in the longitudinal direction of the longitudinal portions 10, 11 lie on a straight line 22 which is shown by dashed lines and which likewise extends in the longitudinal direction of the longitudinal portions 10, 11.

In accordance with Fig. 4, in a next step, the two longitudinal portions 10, 11 are displaced with respect to one another in accordance with arrows 25, 26 in the longitudinal direction of the longitudinal portions 10, 11 until a respective connection portion 14 lies opposite a connection portion 15. In this position, a respective connection edge 20 accordingly contacts a connection edge 21, as is shown in Fig. 4.

Subsequently, the longitudinal portions 10, 11 are welded to one another, for example laser welded, along the mutually contacting connection edges 20, 21, whereby the final shape of the section web 3 with the openings 5 is achieved.

- 5 In Fig. 4, stiffening beads 30, 31 are drawn by dashed lines and extend, on the one hand, in the longitudinal direction of the material strip 6 and, on the other hand, transversely thereto. An increased stiffness of the section element produced is achieved by the stiffening beads 30, 31.

10 The embodiment in accordance with Fig. 5 differs from the embodiment in accordance with Figs. 2 to 4 in that the two longitudinal portions 10, 11 are only pulled apart transverse to the longitudinal extent of the material strip 6 by so much that the connection portions 14, 15 still engage into one another in the manner of a comb, as is shown in Fig. 5. In this position, the edges of the connection portions 14, 15 contacting one another end-to-end form the connection edges 20, 21 which are butt welded to one another.

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In the embodiment in accordance with Fig. 6, the connection portions are formed as hexagonal connection portions 37, 38. The hexagonal connection portions 37, 38 each include a hexagonal region 39 as well as a trapezoidal region 40 which adjoins thereat and which is respectively connected to the elongated portions 16 and 17 respectively. The connection edges 20, 21 are
 20 formed as obliquely extending edges of the hexagonal regions 39 and in particular extend at a 45° angle to the longitudinal extent of the material strip 6. The connection edges 20, 21 and edges 41 of the hexagonal regions 39 adjoining thereat each include an angle of 90° so that corresponding angles □ □ of the openings 5 are also formed as 90° angles.

- 25 The connection edges 20, 21 abut one another end-to-end and are, analog to the embodiment in accordance with Fig. 5, butt welded, in particular laser welded, to one another.

Whereas in the embodiment in accordance with Figs. 2 to 4, the longitudinal portions 10, 11 have to be mutually offset both in the longitudinal direction and transversely thereto, the longitudinal
 30 portions 10, 11 in the embodiments in accordance with Figs. 5 and 6 are only mutually offset transversely to the longitudinal direction of the metal element or transversely to its transport direction.

In all cases, the two longitudinal portions 10, 11 are, however, welded to one another end-to-end via part portions 50, 51 of the meandering longitudinal edges 12, 13 so that an exact alignment of the two longitudinal portions 10, 11 to one another is required.

- 5 In accordance with the invention, an apparatus is used for this purpose such as is shown schematically, for example in Fig. 7 with reference to an embodiment.

The apparatus includes a feed station 52 at the input side which includes a roll of the elongated ribbon-like metal element 54 wound onto a reel 53. The reel 53 is rotatably supported in
10 accordance with an arrow 55 about an axis of rotation 56 so that the metal element 54 can be unwound from the reel 53 in accordance with an arrow 57.

The metal element 54 is fed via guide rollers 58 to a cutting station 59 which is formed as a rotational cutting apparatus 60 having a rotational cutting roll 61 and a counter-roll 62. A
15 meandering incision 9 such as is shown in Fig. 2 is introduced into the elongated metal element 54 using the rotational cutting apparatus 60. The invention is not restricted to the cutting patterns shown in Figs. 2 to 6, but any desired meandering incisions can rather be used. In this respect reference is in particular made to DE 10 2010 026 320 in which a variety of suitable cutting patterns is shown. Reference is in particular explicitly made to this document, whose content is
20 explicitly included in the disclosure content of the present application, with respect to the shape of these cutting patterns and to the manner how the longitudinal portions of the metal element created by the cutting pattern are moved apart from one another and ultimately welded to one another.

The metal element 54 provided with the meandering incision 9 is subsequently guided through a
25 straightening station 63 which includes a plurality of alignment rolls 64. The straightening station can generally also include other alignment units such as a press. Upright regions of the metal element 54, which were bent upward in the cutting process in the cutting station 59, for example, are in particular rolled smooth again in the straightening station 63 so that the metal element 54 has a substantially smooth surface after leaving the straightening station 63.

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After running through the straightening station 63, the metal element 54 is fed to an offset station 65 in which a slack loop 66 of the metal element 54 is formed. The slack loop 66 is in this respect formed so long that both a moving apart movement of the longitudinal portions 10, 11 of the metal element 54 transversely to the transport direction and a mutual displacement in the transport
35 direction is possible without substantial strains acting on the metal element 54. A corresponding

offset in the longitudinal direction by an offset of the two longitudinal portions 10, 11 is shown in Fig. 7.

A positioning station 67 which includes a positioning device 69 formed as a toothed wheel 68 adjoins the offset station 65. The positioning device 69 includes positioning elements 71 formed as teeth 70 of the toothed wheel 68 which engage into the openings 5 of the metal element 54 so that the part portions 50, 51 of the meandering longitudinal edges 12, 13 to be welded to one another are aligned exactly with one another in predefined positions, such as will be presented in even more detail in the following.

The longitudinal portions 10, 11 of the metal element 54 aligned with one another in this manner are subsequently fed to a welding station 72 which is in particular formed as a laser welding station. A laser welding head 73 which is pivotable in accordance with an arrow 74 so that a laser beam 75 can be pivoted accordingly is arranged within the welding station 72. The pivoting of the laser beam can also take place, for example, by a pivotal mirror or a rotating mirror wheel, with the laser welding head being able to be arranged in a fixed position.

The welding station 72 furthermore includes a vertical belt guide 76 by which the longitudinal portions 10, 11 of the metal element 54 are substantially guided in the same plane. The vertical belt guide 76 can in this respect include upper and lower belt guides 77, 79, for example, in accordance with Fig. 4. Any kind of guide can generally be used with which the two planar longitudinal portions 10, 11 of the metal element 54 are held in parallel next to one another in the same plane. For example, spring-loaded, hydraulic, pneumatic or mechanical guides in the form of rollers, plates, belts or crawlers can be used for this purpose. The guides can in this respect additionally also serve as transport means for the metal element 54 and be formed, for example, as a clamping, magnetic, hydraulic, mechanical or pneumatic transport guide.

A feed unit 79 which can, for example, be formed by two rollers 80 or other suitable elements is provided at the outlet of the welding station 72.

After the feed unit 79, a stamping station and/or a reshaping station 81 is provided in which the metal element 54 can be given an intermediate shape or its final cross-sectional shape, for example a C-shape or a U-shape or another suitable open or closed section shape. The metal element can also be provided with stiffening beads in the stamping station or in the reshaping station.

It can be recognized in Figs. 8 to 10 that the positioning device 69 can include positioning elements 71 formed, for example, as teeth 70 which can extend either over the total width of the positioning device 69 formed as a toothed wheel 68 or only over a part thereof.

5 It is important that the positioning elements 71 are formed so that they engage in accordance with Fig. 11 into the openings 5 of the metal element 54 such that a clear positional fixing of the longitudinal portions 10, 11 takes place in the longitudinal direction and/or in the transverse direction. It is, for example, shown in Fig. 11 how the two longitudinal portions 10, 11 are arranged offset with respect to the starting position shown in Fig. 3 by half a period of the meandering incision 9 in the longitudinal direction and are held in this position non-displaceably with respect to
10 one another in the longitudinal direction by a positioning element 71, shown hatched, of the positioning device 69. Since the two longitudinal portions 10, 11 are still formed in one piece in the upstream cutting station 59 or are disposed closer to one another after the cutting process than in the offset station 65, only a fixing of the longitudinal portions 10, 11 in the longitudinal direction is
15 absolutely necessary since the two longitudinal portions 10, 11 are pressed together in the transverse direction due to their original single-piece formation. To amplify this pressing together even further, lateral guide elements can additionally be provided, as are indicated by rolls 82 in Fig. 11. Instead of the rolls 82, other suitable guide elements such as guide surfaces, plates, crawlers, belts or other suitable elements such as worms, gear racks, toothed belts with dies can also be
20 provided.

It is also possible that, in accordance with Fig. 12, corresponding peripheral shoulders 83 are formed at the positioning device 69 itself by which a corresponding guidance of the outer edges of the metal element 54 is ensured.

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It is shown schematically in Fig. 13 that the positioning device can also be formed as an in particular continuous belt-like or chain-like positioning device 84. A guidance of the metal element 54 over a longer path section is thereby ensured so that the guidance is again improved.

30 Figs. 14 and 15 show how a section element in accordance with Fig. 5 can be guided using a positioning device in accordance with the invention. In the section element in accordance with Fig. 14, the two longitudinal portions 10, 11 are only mutually displaced in the transverse direction, whereby the openings 5 are formed. The openings 5 are in this case arranged alternately offset with respect to one another, as can be seen from Fig. 14.

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In a corresponding manner, in the roll-like positioning device 85 shown in Fig. 15, the positioning elements 86 are likewise arranged alternately. The positioning device 85 thus includes two rows of positioning elements 86 arranged lying next to one another in the longitudinal direction, with the positioning elements 86 of the two rows being arranged offset to one another in each case in the transport direction.

Both an exact offset of the two longitudinal portions 10, 11 transverse to the transport direction and an exact alignment in the transport direction are thus ensured using the positioning device 85 in accordance with Fig. 15 so that the part portions 50, 51 of the meandering longitudinal edges 12, 13 which should be welded to one another contact one another exactly.

Figs. 16 and 17 show that the openings used for the alignment of the longitudinal portions 10, 11 do not necessarily have to be formed by the meandering longitudinal edges 12, 13, but can rather also be formed as separate openings 87. These openings 87 are in particular formed in the marginal regions of the longitudinal portions 10, 11 and can, for example, ensure an alignment of the two longitudinal portions 10, 11 with respect to one another in accordance with the principle of traction, for example. The positioning device 88 shown in Fig. 17 can thus have corresponding pins 89 or needles arranged in the marginal region which are formed for engaging in the openings 87. The pins 89 or needles can in this respect, as shown in Fig. 17, be arranged on a roll-like base body or, for example, in accordance with Fig. 13, can be provided at a belt conveyor or chain conveyor.

It can be recognized in the plan view of the welding station 72 in accordance with Fig. 18 that it includes two lateral belt guides 90 which are in turn formed only by way of example as belt guides. The lateral belt guides 90 can again also be formed in any other suitable manner, for example by roller guides, plate guides, chain guides or by other suitable guide elements. It is important that the corresponding guides exert in accordance with arrows 91 a force onto the two longitudinal portions 10, 11 of the metal element 54 so that the part portions 50, 51 of the meandering longitudinal edges 12, 13 to be welded together come into contact with one another and can optionally easily be pressed toward one another. The belt guides can in this respect additionally also serve as transport means for the metal element 54 and can be formed, for example, as clamping, magnetic, hydraulic, mechanical or pneumatic transport guides, in particular with a correction possibility.

The welding by means of the laser welding head 73 will be described in more detail in the following with reference to Figs. 19 and 20.

Fig. 19 first shows in a schematic perspective representation the two longitudinal portions 10, 11 which are arranged in the welding station 72 so that the part portions 50, 51 of the meandering longitudinal edges 12, 13 to be welded to one another contact one another. The laser welding head 73 is formed so that the laser beam 75 is directed to the two mutually contacting part portions 50, 51 and can be pivoted in accordance with the arrow 74 so that the laser beam 75 is ultimately guided along the mutually contacting part portions 50, 51.

The guidance of the laser beam 75 in this respect takes place as shown in Figs. 20a) to d). In this respect, three respective mutually following part portions 50, 51 to be welded are shown in Fig. 20 by lines 92, 93, 94 which move from left to right in accordance with the movement of the metal element 54 in Figs. 20a) to c).

At the time shown in Fig. 20a), the laser beam 75 is incident onto the right hand end of the part portions 50, 51 shown by the line 92. The metal element 54 is moved in accordance with an arrow 95 in the transport direction, with the laser beam 75 simultaneously being guided in accordance with the arrow 74 in the same direction, but at half the speed.

At the time shown in Fig. 20b), the metal element 54 has already covered the path $0.5x$, whereas the laser beam 75 was only pivoted so that the welding spot incident on the metal element 54 has covered the path $0.25x$. At this time, the part portions 50, 51 are half welded to one another along the line 92.

When the metal element 54 in accordance with Fig. 20c) has moved by the path x in the transport direction, the welding spot of the laser beam 75 incident on the metal element 54 has covered the path $0.5x$ and is thus located in accordance with Fig. 20c) at the left hand end of the line 92 which represents the weld seam and is thus completed.

At this time, the laser beam is pivoted in accordance with an arrow 101 quickly against the previous adjustment direction to the right hand end of the next weld seam to be produced shown by the line 93 or is directly positioned there, whereupon this weld seam is produced in the same manner.

The transport speed of the metal element 54 can be set twice as high as the maximum possible welding speed by this intermittent welding so that the throughput for the production of the welded section element can be considerably increased.

A multiple of the transport speed can be achieved in a corresponding manner by the use of a plurality of laser beams 75 extending in parallel.

5 In Fig. 21, two substantially equally thick, flat material strips 6, 6' are arranged so that they lie flat over one another. A uniform meandering slit 9 was introduced into both material strips 6, 6' by which the material strips 6, 6' are divided into two longitudinal portions 10, 11 and 10', 11' respectively. In contrast to the previously described embodiments, in this embodiment the section element 1 is not formed by the originally contiguous longitudinal portions 10, 11 or 10', 11' respectively, but two section elements are rather formed of which one comprises the longitudinal portions 10, 10' and the other the longitudinal portions 11, 11'.

For this purpose, after producing the meandering slit 9, the longitudinal portions 10, 10' lying over one another are together separated from the respective other longitudinal portions 11, 11' in order together to form section elements independent of one another.

In Figs. 22 and 23, the manufacture of the section element 1 with the longitudinal portions 11, 11' is shown by way of example. The longitudinal portions 11, 11' lying over one another are welded together at connection edges 97 extending in the longitudinal direction so that weld seams 99 are produced which extend along the end faces 98 of the connection edges 97. Subsequently, the longitudinal portions 11, 11' are folded apart, as is indicated by an arrow 100 in Fig. 22. For this purpose, the longitudinal portion 11 is, for example, pivoted by approximately 180° about the connection edges 97 in accordance with the arrow 100 until it adopts the position shown in Fig. 23. In this position, the longitudinal portions 11, 11' lie substantially in a common plane.

25 The mutually connected connection edges 97 are bent over by the pivoting so that they form bent-over abutment edges 96 via which the longitudinal portions 11, 11' are connected to one another end-to-end. At the same time, the openings 5 are formed by the pivoting between portions of the meandering longitudinal edges 12, 13, without this being associated with material loss.

30 The connection between the bent-over abutment edges 96 can generally also be produced by other kinds of connection such as overlap welding, folding, adhesive bonding, clinching, riveting or clamping. This also applies to the connection of the part portions of the meandering longitudinal edges for all other embodiment described in this application. In addition, the pivoting of the longitudinal portions can also take place about an angle different from 180°, in particular about a

smaller or also larger angle, depending on which shape the final section element should have. The manufacture of the section element by folding open was admittedly only explicitly described in connection with the web-shaped connection portions 14, 15, but this manufacture is also possible with the other connection portions described within the framework of this application as long as the connection edges to be connected extend in the longitudinal direction of the material strip.

Individual elements of the apparatus in accordance with the invention can preferably be synchronized with one another. The positioning device and the respectively present feed devices, the guide device and the adjustment of the laser beam can thus be mutually synchronized, for example. In this respect, it is possible that a detection of the movement of the metal element is provided, for example in an optical, mechanical or electronic manner, to realize a corresponding feed regulation, for example by means of a closed loop.

Furthermore, during and after completion of the section element, inspection points for checking the quality of the manufactured section element can be provided. They can, for example, check the mutually coinciding portions of the meandering longitudinal edges for minimum offset or the weld seam produced for cleanliness by optical or electronic means.

Reference numeral list

	1	section element
	2	section body
5	3	section web
	4	section limb
	5	openings
	6, 6'	material strip
	7	outer edge
10	8	outer edge
	9	meandering slit
	10, 10'	longitudinal portion
	11, 11'	longitudinal portion
	12	meandering longitudinal edge
15	13	meandering longitudinal edge
	14	web-shaped connection portions
	15	web-shaped connection portions
	16	elongated portions
	17	elongated portions
20	18	arrow
	19	arrow
	20	connection edges
	21	connection edges
	22	line
25	30	stiffening beads
	31	stiffening beads
	37	hexagonal connection portions
	38	hexagonal connection portions
	39	hexagonal regions
30	40	trapezoidal regions
	41	edges
	50	part portions
	51	part portions
	52	feed station
35	53	reel

	54	metal element
	55	arrow
	56	axis of rotation
	57	arrow
5	58	guide rollers
	59	cutting station
	60	rotational cutting apparatus
	61	cutting roll
	62	counter-roll
10	63	straightening station
	64	alignment rollers
	65	offset station
	66	loop
	67	positioning station
15	68	toothed wheel
	69	positioning device
	70	teeth
	71	positioning elements
	72	welding station
20	73	laser welding head
	74	arrow
	75	laser beam
	76	vertical belt guide
	77	upper belt guide
25	78	lower belt guide
	79	feed unit
	80	rollers
	81	stamping station/reshaping station
	82	rollers
30	83	shoulders
	84	positioning device
	85	positioning device
	86	positioning elements
	87	openings
35	88	positioning device

	89	pins
	90	lateral belt guide
	91	arrows
	92	line
5	93	line
	94	line
	95	arrow
	96	bent-over abutment edges
	97	connection edges
10	98	end faces
	99	weld seams
	100	arrow
	101	arrow

Patentkrav

1. Anordning, der er udformet til udvidelse af langstrakte båndformede metalelementer (54),
der bevæger sig i længderetningen og er egnet til dannelsen af åbne profilelementer (1), som
5 eksempelvis stolpe- eller pudsprofiler eller lukkede profilelementer, som eksempelvis
kanaler eller rør,

med en tilførselsstation (52), en skærestation (59), en positioneringsstation (67) og en
forbindelsesstation (72), hvor tilførselsstationen (52) er udformet til en i det mindste i det
10 væsentlige kontinuerlig tilførsel af i det mindste et metalelement (54) til skærestationen
(59),

skærestationen (59) er udformet til frembringelse af i det mindste et kontinuerligt,
mæanderformet snit (9), som strækker sig i længderetningen af det i det mindste ene
15 metalelement (54), og gennem hvilket der frembringes i det mindste to længdeafsnit (10,
11) af det i det mindste ene metalelement (54) med mæanderformede længdekanter (12,
13),

og hvor forbindelsesstationen (72) er udformet til at forbinde de i forhold til hinanden
20 positionerede delafsnit (50, 51) af de mæanderformede længdekanter (12, 13),

kendetegnet ved,

at positioneringsstationen (67) omfatter i det mindste en særligt omløbende
25 positioneringsanordning (69, 84, 85, 88) med et stort antal af positioneringselementer (71,
86), hvor positioneringselementerne (71, 86) er udformet til at gribe ind i åbninger (5, 87),
der er udformet i det i det mindste ene metalelement (54), og til at positionere delafsnit (50,
51) af de mæanderformede længdekanter (12, 13) i forhold til hinanden i på forhånd
30 definerede positioner.
2. Anordning ifølge krav 1,

kendetegnet ved,

at der mellem skærestationen (59) og positioneringsstationen (67) er tilvejebragt en forskydningsstation (65) til dannelsen af en særligt nedhængende sløjfe (66) på i det mindste et af metalelementets (54) længdeafsnit (10, 11), således at længdeafsnittene (10, 11), der er adskilt fra hinanden, på det i det mindste ene metalelement (54) kan forskydes i forhold til hinanden i længderetningen og/eller i tværretningen.

3. Anordning ifølge krav 1 eller 2,

kendetegnet ved,

at der er tilvejebragt i hvert enkelt tilfælde to rækker af positioneringselementer (71, 86), der ligger ved siden af hinanden i transportretningen.

4. Anordning ifølge krav 3,

kendetegnet ved,

at positioneringselementerne (71, 86) i de to rækker i transportretningen ikke er placeret forskudt i forhold til hinanden,

eller

at positioneringselementerne (71, 86) i de to rækker i transportretningen er placeret forskudt i forhold til hinanden.

5. Anordning ifølge i det mindste et af de foregående krav,

kendetegnet ved,

at positioneringsanordningen (69, 84, 85, 88) er udformet som tandhjul (68), tandrem eller tandstang eller som kæde- eller båndtransportør med positioneringselementer (71, 86).

6. Anordning ifølge i det mindste et af de foregående krav,

kendetegnet ved,

at positioneringselementerne (71, 86) er udformet til at gribe ind i åbninger (5), der er dannet af de mæanderformede længdekanter (12, 13),

5 og/eller

at positioneringselementerne (71, 86) er udformet til at gribe ind i åbninger (87), der er tilvejebragt uafhængigt af de mæanderformede længdekanter (12, 13) i det i det mindste ene metalelement (54), særligt i randområderne på dette.

10

7. Anordning ifølge i det mindste et af de foregående krav,

kendetegnet ved,

15

at tilførselsstationen (52) omfatter en vinde (53), på hvilken det i det mindste ene metalelement (54) er opviklet,

og/eller

20

at tilførselsstationen (52) omfatter en anordning til sammensvejsning af på hinanden følgende metalelementer (54).

8. Anordning ifølge i det mindste et af de foregående krav,

25

kendetegnet ved,

at der mellem tilførselsstationen (52) og skærestationen (59) og/eller mellem skærestationen (59) og positioneringsstationen (67) er tilvejebragt en justeringsstation (63) til det i det mindste ene metalelement (54).

30

9. Anordning ifølge i det mindste et af de foregående krav,

kendetegnet ved,

at positioneringsstationen (67) er placeret før forbindelsesstationen (72), særligt i forbindelsesstationens (72) indløbsområde,

eller

5

at positioneringsstationen (67) er placeret efter forbindelsesstationen (72), særligt i forbindelsesstationens (72) udløbsområde.

10. Anordning ifølge i det mindste et af de foregående krav,

10

kendetegnet ved,

at forbindelsesstationen (72) omfatter en lateral båndføring (90), ved hjælp af hvilken længdeafsnittene (10, 11) af det i det mindste ene metalelement (54) positioneres i forhold til hinanden og særligt holdes sammen på en sådan måde, at delafsnittene (50, 51) af de mæanderformede længdekanter (12, 13), der skal svejses sammen med hinanden, støder op til hinanden, særligt under tryk,

15

og/eller

20

at forbindelsesstationen (72) omfatter en vertikal båndføring (76), ved hjælp af hvilken længdeafsnittene (10, 11) af det i det mindste ene metalelement (54) i det væsentlige føres således, at de ligger oven på hinanden i det samme plan eller i en fladeform.

25

11. Anordning ifølge i det mindste et af de foregående krav,

kendetegnet ved,

at skærestationen (59) omfatter en rotationsskæreanordning (60) eller en laserskæreanordning.

30

12. Anordning ifølge i det mindste et af de foregående krav,

kendetegnet ved,

35

at der inden i og/eller før og/eller efter forbindelsesstationen (72) er tilvejebragt en fremføringsenhed (79) til metalelementet (54), særligt i form af en valseføring.

5 13. Fremgangsmåde til udvidelse af langstrakte båndformede metalelementer (54), der bevæger sig i længderetningen og er egnet til dannelse af åbne profilelementer (1), som eksempelvis stolpe- eller pudsprofiler eller lukkede profilelementer, som eksempelvis kanaler eller rør, ved hvilken fremgangsmåde i det mindste et metalelement (54) fra en tilførselsstation (52) føres i det mindste i det væsentlige kontinuerligt hen til en skærestation (59),

10

hvor der i skærestationen (59) frembringes i det mindste et kontinuerligt mæanderformet snit (9), som strækker sig i længderetningen af det i det mindste ene metalelement (54), og gennem hvilket der frembringes i det mindste to længdeafsnit (10, 11) af det i det mindste ene metalelement (54) med mæanderformede længdekanter (12, 13),

15

og delafsnittene (50, 51), der skal positioneres i forhold til hinanden, af de mæanderformede længdekanter (12, 13) forbindes med hinanden i en forbindelsesstation (72),

20

kendetegnet ved,

at hvor delafsnittene (10, 11) føres på en sådan måde af en positioneringsstation (67), at positioneringselementer (71, 86), der er tilvejebragt på en særligt omløbende positioneringsanordning (69, 84, 85, 88), griber ind i åbninger (5, 87), der er udformet i det i det mindste ene metalelement (54), således at delafsnit (50, 51) af de mæanderformede længdekanter (12, 13) positioneres i forhold til hinanden i på forhånd definerede positioner.

25

14. Fremgangsmåde ifølge krav 13,

30

kendetegnet ved,

at det i det mindste ene metalelement (54) føres hen til en forskydningsstation (65), i hvilken der dannes en særligt nedhængende sløjfe (66) på i det mindste et af længdeafsnittene (10, 11) af det i det mindste ene metalelement (54), således at længdeafsnittene (10, 11), der er adskilt fra hinanden, på det i det mindste ene

35

metalelement (54) kan forskydes i forhold til hinanden i længderetningen og/eller i tværretningen.

15. Fremgangsmåde ifølge krav 13 eller 14,

5

kendetegnet ved,

at de i forhold til hinanden positionerede delafsnit (50, 51) af de mæanderformede længdekanter (12, 13) svejses sammen og særligt lasersvejses sammen ved hjælp af en laserstråle (75).

10

16. Fremgangsmåde ifølge krav 15,

kendetegnet ved,

15

at laserstrålen (75) under svejseprocessen bevæges sammen med det i det mindste ene metalelement (54), der bevæger sig, idet laserstrålens (75) fremadgående bevægelse er langsommere end transporthastigheden af det i det mindste ene metalelement (54), særligt at laserstrålens (75) fremadgående bevægelse og dermed svejsehastigheden i det væsentlige er halvt så hurtig som transporthastigheden af det i det mindste ene metalelement (54).

20

17. Fremgangsmåde ifølge krav 16,

kendetegnet ved,

25

at laserstrålen (75) i hvert enkelt tilfælde efter sammensvejsning af to i forhold til hinanden positionerede delafsnit (50, 51) af de mæanderformede længdekanter (12, 13) positioneres mod delafsnit (50, 51) af de mæanderformede længdekanter (12, 13), der ligger modsat af transportretningen, hvorefter disse svejses sammen med hinanden.

30

18. Fremgangsmåde ifølge i det mindste et kravene 13 til 17,

kendetegnet ved,

at i et mindste to metalelementer (54), der ligger op til hinanden med deres flader, føres hen til skærestationen (59),

5 at metalelementerne (54), der ligger op til hinanden, ved hjælp af det mæanderformede snit (9) sammen opdeles i i hvert enkelt tilfælde to længdeafsnit (10, 10', 11, 11') i skærestationen (59), idet længdeafsnittene (10, 10', 11, 11'), der i hvert enkelt tilfælde ligger på samme side af det mæanderformede snit (9), af metalelementerne (54) ligger op til hinanden med deres flader, og delafsnit (50, 51), der hver især forløber i længderetningen, af de mæanderformede længdekanter (12, 13) på længdeafsnittene (10, 10', 11, 11'), der ligger op til hinanden, danner forbindelseskanter (97), der ligger umiddelbart op til hinanden,

15 at den ene gruppe af længdeafsnit (10, 10'), der ligger op til hinanden, adskilles fra den anden gruppe af længdeafsnit (11, 11'), der ligger op til hinanden,

20 at forbindelseskanterne (97) på det ene længdeafsnit (10, 11), forbindes, særligt svejses sammen med forbindelseskanterne (97) på længdeafsnittet (10', 11'), der ligger op til dette,

og

25 at et af de to længdeafsnit (10, 10', 11, 11') svinges i forhold til det andet længdeafsnit (10, 10', 11, 11'), der er forbundet med det, omkring forbindelseskanterne (97) på en sådan måde, at længdeafsnittene (10, 10', 11, 11') er forbundet med hinanden langs ombøjede stødkanter (96), og at åbningerne (5) dannes mellem afsnit af de mæanderformede længdekanter (12, 13).

Fig.1

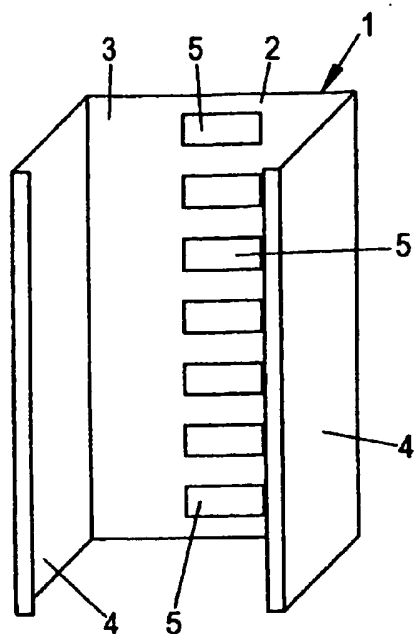


Fig.2

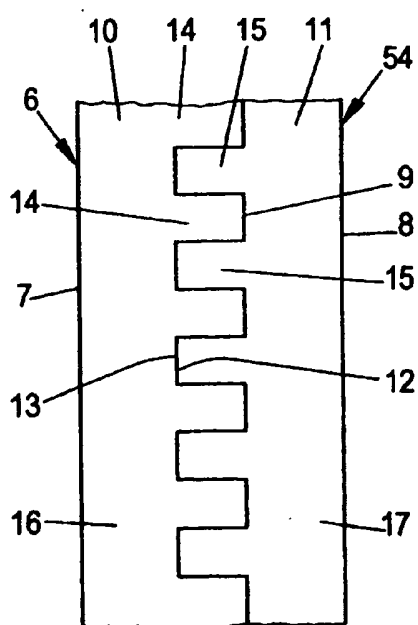


Fig.3

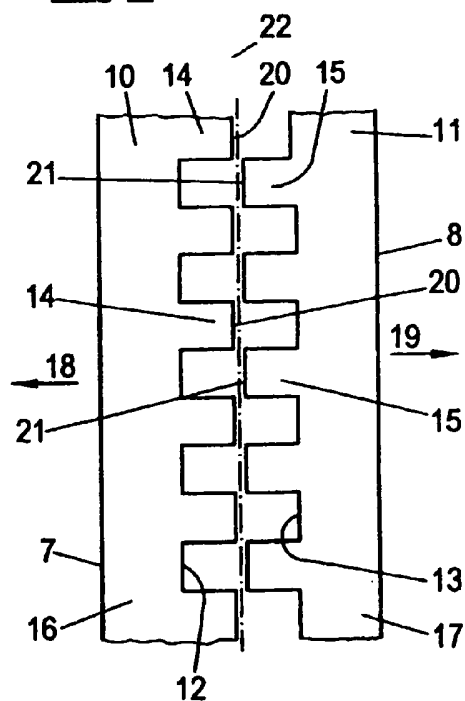
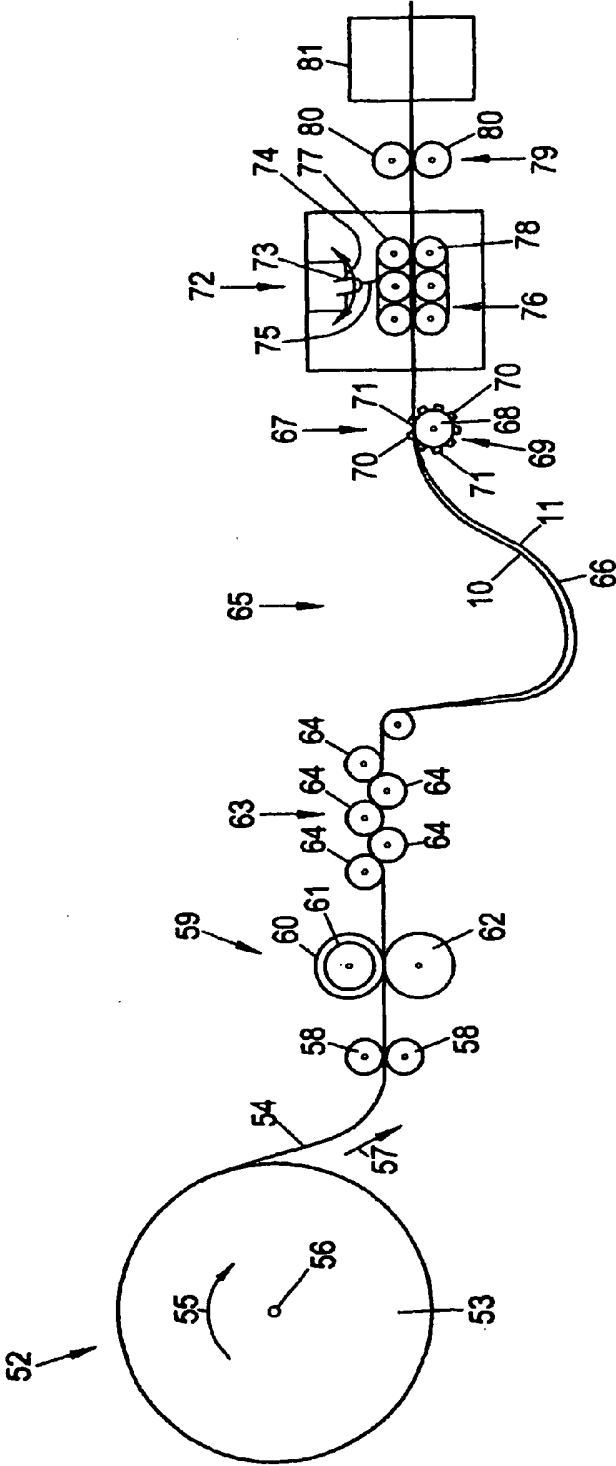


Fig. 7



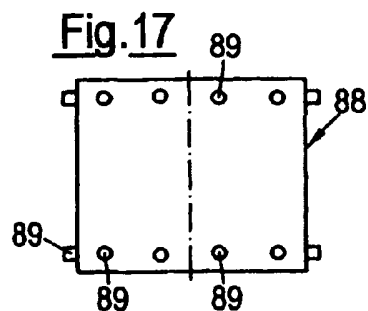
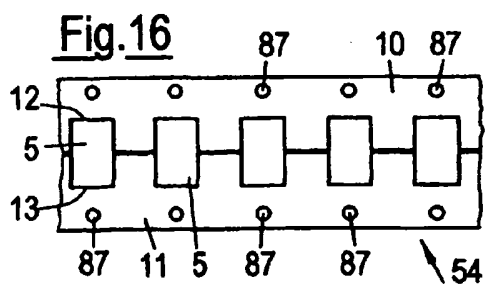
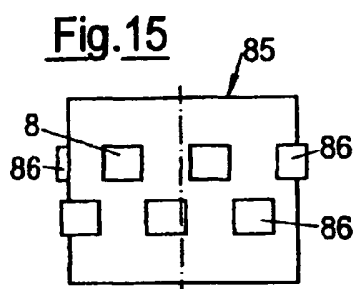
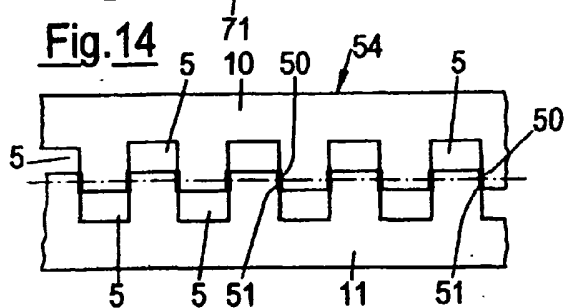
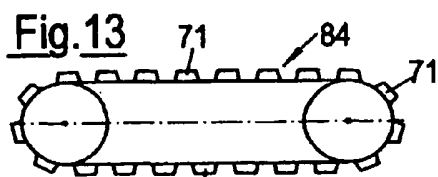
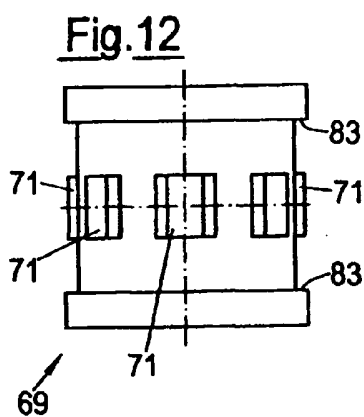
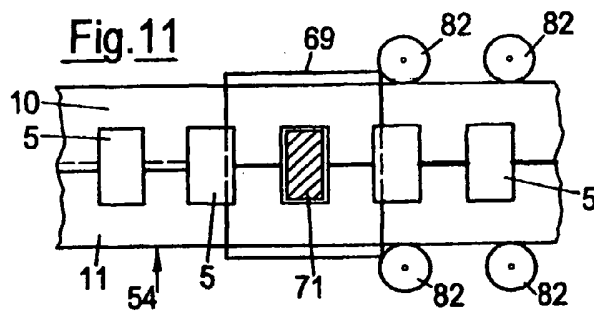
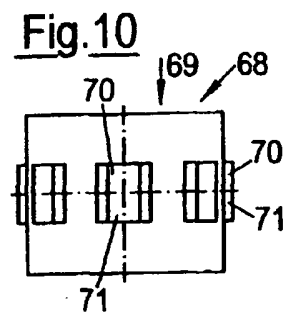
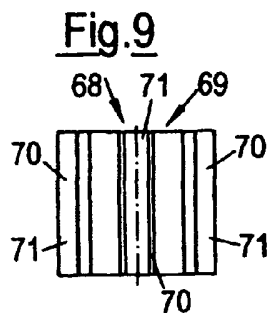
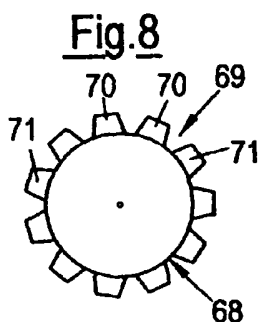


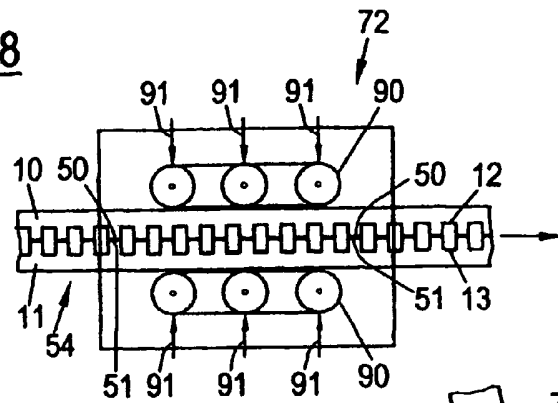
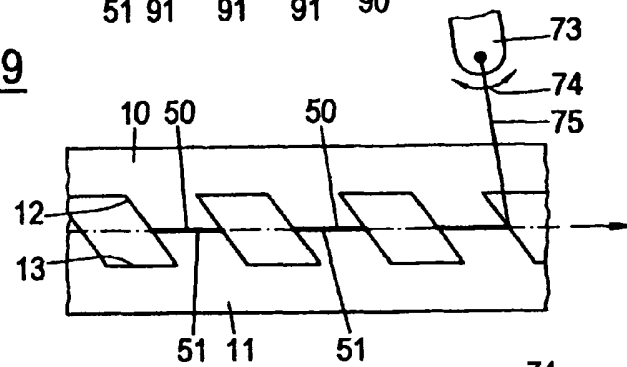
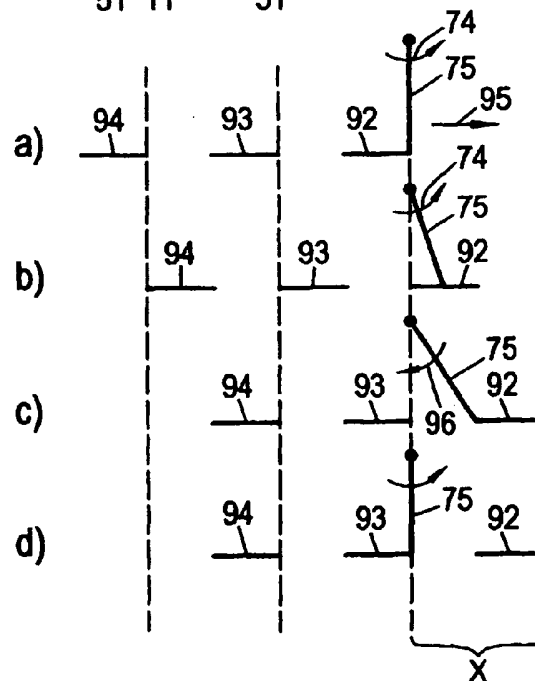
Fig.18Fig.19Fig.20

Fig.21

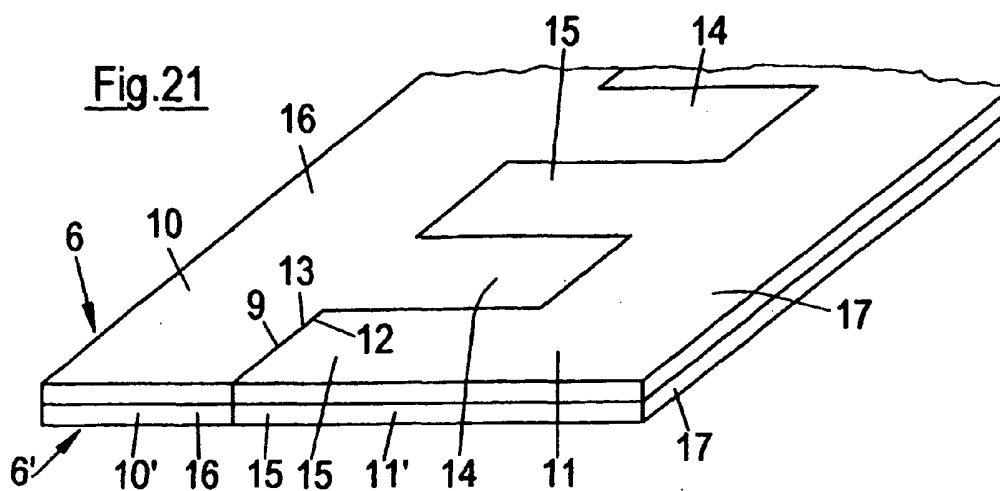


Fig.22

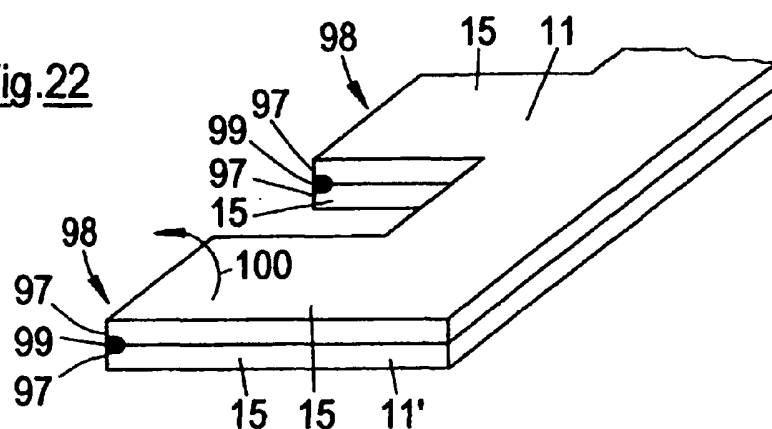


Fig.23

