



(11) **EP 4 353 374 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication: **17.04.2024 Bulletin 2024/16**

(51) International Patent Classification (IPC):
B21B 27/02 ^(2006.01) **B21H 8/02** ^(2006.01)
B21B 37/16 ^(2006.01)

(21) Application number: **22200880.7**

(52) Cooperative Patent Classification (CPC):
B21B 27/02; B21B 37/16; B21B 27/021;
B21B 2205/02

(22) Date of filing: **11.10.2022**

(84) Designated Contracting States: AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR Designated Extension States: BA Designated Validation States: KH MA MD TN	(71) Applicant: VOLVO TRUCK CORPORATION 405 08 Göteborg (SE) (72) Inventor: Vaidyeshwaran, Shreyas Bengaluru (IN) (74) Representative: Ström & Gulliksson AB P.O. Box 793 220 07 Lund (SE)
--	--

(54) **METHOD AND SYSTEM FOR PRODUCING A PROFILE SHEET**

(57) Method (1000) for producing a profile sheet (200) for a load-bearing structure of a vehicle through forming a work piece (101) by feeding the work piece along a feeding direction (FD) through a plurality of rollers (110), wherein the work piece (101) extends along a reference plane (RP) and the plurality of rollers (110) comprises a first roller (121) and a second roller (122) displaced relative the first roller (121) in relation to a first reference axis (RA1) extending along the reference plane (RP) and orthogonally to the feeding direction (FD).

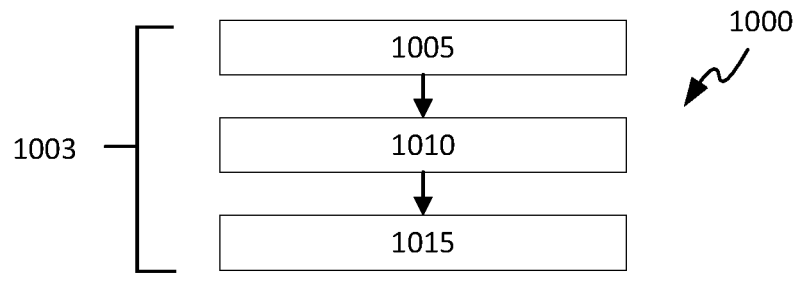


FIG. 2

EP 4 353 374 A1

Description

TECHNICAL FIELD

[0001] The disclosure relates generally to a method for producing a profile sheet. In particular aspects, the disclosure relates to a method for producing a profile sheet intended for a load-bearing structure of a vehicle. The disclosure also generally relates to a system for producing a profile sheet. The disclosure can be applied in heavy-duty vehicles, such as trucks, buses, and construction equipment. Although the disclosure may be described with respect to a particular vehicle, the disclosure is not restricted to any particular vehicle.

BACKGROUND

[0002] Profile sheets are commonly used for the manufacturing of components. Such components are often utilized for load bearing structures. In the case of vehicles such load bearing structures may include frame rails, reinforcements, liners, tie-plates and cross-member centerpieces.

[0003] Commonly, the profile sheets are produced from a slab. The slab is often in a metal such as steel or aluminum. The slab is initially hot milled to reduce the thickness of the material. The thickness of the material may be reduced further by cold milling to achieve the intended thickness. After the intended thickness the material is achieved, the material may be treated for finish and may be machined into a profile sheet which may be provided as a flat sheet or a coil.

[0004] The profile sheets are utilized for the production of any type of components. In the field of vehicles, weight optimization is of great importance due to the unnecessary weight negatively impacting the energy consumption of the vehicle. Hence, the profile sheet may have to be machined or reinforced in an additional step in order to optimize the weight of the final component.

SUMMARY

[0005] According to a first aspect of the disclosure, a method for producing a profile sheet for a load-bearing structure is provided. The method is performed through forming a work piece by feeding the work piece along a feeding direction through a plurality of rollers. The work piece may extend along a reference plane and the plurality of rollers may comprise a first roller and a second roller displaced relative the first roller in relation to a first reference axis. The first reference axis may extend along the reference plane and orthogonally to the feeding direction.

[0006] The method may comprise adjusting the position of at least one of the first and second roller relative a second reference axis extending orthogonally to the first reference axis and the reference plane such that the first roller is displaced relative the second roller in relation

to the second reference axis.

[0007] The method may comprise feeding the work piece through the plurality of rollers along the feeding direction to form the profile sheet.

[0008] The method may comprise operating the plurality of rollers to process the work piece along the feeding direction to form the work piece to the profile sheet.

[0009] The first aspect of the disclosure may seek to provide a method allowing for an adaptable weight optimization of a profile sheet. A technical benefit may include that this may be achieved without additional machining steps or changing of the rollers, due to the first and second roller allowing for controlling the achieved deformation of separate parts of the cross-section of the profile sheet by means of the adjustment of the position relative the second reference axis. Thus, a non-complex and cost-efficient manner of weight optimization may be achieved.

[0010] In some examples, the method may comprise operating the plurality of rollers such that the first and second roller causes the perpendicular distance between a side of the profile sheet extending along the feeding direction and the reference plane to vary along the first reference axis. A technical benefit may include that a profile sheet with a varying cross-section may be achieved in one operation, whereby weight optimization and/or a particular intended shape may be achieved in a non-complex and fast manner.

[0011] In some examples, the method may comprise operating the plurality of rollers such that the first roller reduces the thickness of a first portion of the cross-section of the work piece relative the feeding direction to a first thickness and the second roller reduces the thickness of a second portion of the cross-section of the work piece relative the feeding direction to a second thickness. The first thickness may be different from the second thickness.

[0012] In some examples, the plurality of rollers may comprise a first roller arrangement. The first roller arrangement may comprise the first roller and a first associated roller. The plurality of rollers may comprise a second roller arrangement. The second roller arrangement may comprise the second roller and a second associated roller. The method may further comprise feeding the work piece between the first roller and the first associated roller and between the second the roller and the second associated roller. A technical benefit may include that the independently operable roller arrangements allows for a higher degree of control and speed compared to a system where the work piece is rolled between the first and second roller and a common auxiliary roller. Further, the independently operable roller arrangements allows for control of the shape of the cross-section in both directions along the second reference axis further increasing the flexibility of the method and potential achievable shapes available by use of the method.

[0013] In some examples, the method may comprise operating the rollers such that the first and second roller

arrangement causes the perpendicular distance between a side of the profile sheet extending along the feeding direction and the reference plane to vary along the first reference axis.

[0014] In some examples, the method may comprise operating the plurality of rollers such that the first roller arrangement reduces the thickness of a first portion of the cross-section of the work piece relative the feeding direction to a first thickness and the second roller arrangement reduces the thickness of a second portion of the cross-section of the work piece relative the feeding direction to a second thickness, wherein the first thickness is different from the second thickness.

[0015] In some examples, the method may comprise adjusting the position of the at least one of the first and second roller by adjusting the distance between the first roller and the first associated roller and/or the distance between the second roller and the second associated roller.

[0016] In some examples, the first roller and the second roller may be aligned along a second reference plane. The second reference plane may be orthogonal to the reference plane. A technical benefit may include that the profile sheet may be obtained without the need of a long production line due to the first and second roller being arranged side-by-side.

[0017] In some examples, the method may further comprise operating the plurality of rollers to feed the work piece along feeding direction.

[0018] In some examples, the plurality of rollers may comprise a third roller. The third roller may be displaced relative the first roller and the second roller in relation to the first reference axis. The method may further comprise adjusting the position of at least one of the first, second and third roller relative to the second reference axis such that the first roller is displaced relative to the second and/or third roller in relation to the second reference axis. A technical benefit may include that the third roller may allow for additional flexibility in terms of weight-optimization since the method may enable rolling of the work piece to obtain a profile sheet with three different sections with different thicknesses.

[0019] In some examples, the method may further comprise heating the work piece to a predetermined temperature such that the work piece is mechanically workable when fed through the plurality of rollers. A technical benefit may include ensuring proper deformation of the work piece without the introduction of substantial stress loads in the material.

[0020] In some examples the work piece may be in any one of a cast or rolled ferrous alloy, non-ferrous alloy, or a combination thereof such as steel, aluminum, titanium, ceramic, and magnesium alloy.

[0021] In some examples, the method may comprise cutting the profile sheet into a plurality of profile sheet elements. The method may further comprise stacking the profile sheet elements. A technical benefit may include to enable more space-efficient transportation and storing

of the profile sheet.

[0022] In some examples, the method may further comprise folding the profile sheet along a folding axis extending along or across the profile sheet. A technical benefit may include that the profile sheet is formed to get a desirable cross-section for subsequent production of a weight-optimized profile element in a rapid and relatively non-complex manner.

[0023] According to a second aspect of the disclosure a profile sheet is provided. The profile sheet may be obtained by the method of the disclosure.

[0024] According to a third aspect of the disclosure a load-bearing structure for a vehicle is provided. The load-bearing structure may comprise a profile element made of the profile sheet of the disclosure.

[0025] According to a fourth aspect of the disclosure a system for producing a profile sheet for a load-bearing structure of a vehicle is provided. The system may comprise a plurality of rollers. The plurality of rollers may be adapted to form a work piece fed along a feeding direction through the plurality of rollers to the profile sheet. The work piece may extend along a reference plane and the plurality of rollers may comprise a first roller and a second roller displaced relative the first roller in relation to a first reference axis extending along the reference plane and orthogonally to the feeding direction.

[0026] The position of at least one of the first and second roller may be adjustable relative a second reference axis extending orthogonally to the first reference axis and the reference plane such that the first roller is displaceable relative the second roller and/or the second roller is displaceable relative the first roller in relation to the second reference axis.

[0027] The plurality of rollers may be operable to process the work piece along the feeding direction to form the work piece to the profile sheet.

[0028] The fourth aspect of the disclosure may seek to provide a system allowing for an adaptable weight optimization of a profile sheet. A technical benefit may include that this may be achieved without additional machining steps or changing of the rollers, due to the first and second roller allowing for controlling the achieved deformation of separate parts of the cross-section of the profile sheet by means of the adjustment of the position relative the second reference axis. Thus, a non-complex and cost-efficient manner of weight optimization may be achieved.

[0029] In some examples, the system may comprise a first roller arrangement. The first roller arrangement may comprise the first roller and a first associated roller. The system may comprise a second roller arrangement. The second roller arrangement may comprise the second roller and a second associated roller. The system may be adapted to roll the work piece between the first roller and the first associated and between the second roller and the second associated roller. A technical benefit may include that the independently operable roller arrangements allows for a higher degree of control and speed

compared to a system where the work piece is rolled between the first and second roller and a common auxiliary roller. Further, the independently operable roller arrangements allows for control of the shape of the cross-section in both directions along the second reference axis further increasing the flexibility of the system and potential achievable shapes available by use of the system.

[0030] In some examples, the position of least one of the first and second roller may be adjustable by means of adjustment of the distance between the first roller and the first associated roller and/or the distance between the second roller and the second associated roller.

[0031] In some examples, the first roller and the second roller may be aligned along a second reference plane. The second reference plane may be orthogonal to the reference plane. A technical benefit may include that the profile sheet may be obtained without the need of a long production line due to the first and second roller being arranged in parallel.

[0032] In some examples, the first roller arrangement and the second roller arrangement may be aligned along the second reference plane.

[0033] In some examples, the first and second roller arrangement may be provided as a first four high rolling mill arrangement and a second four high rolling mill arrangement, respectively. The first and second roller and the first and second associated rollers may be main rollers of said first and second four high rolling mill arrangements, respectively. A technical benefit may include that the four high rolling mill arrangements allows for a higher production speed compared to a conventional rolling mill arrangement.

[0034] In some examples, the system may comprise a drive arrangement. The drive arrangement may be adapted to drive at least one roller of the plurality of rollers to feed the work piece along the feeding direction.

[0035] In some examples, the plurality of rollers may comprise a third roller. The third roller may be displaced relative the first roller and the second roller in relation to the first reference axis. The position of at least one of the first, second and third roller may be adjustable relative to the second reference axis such that said at least one of the first, second and third roller is displaceable relative to at one of the other roll of the first, second and third roller in relation to said second reference axis. A technical benefit may include that the third roller may allow for additional flexibility in terms of weight-optimization since the system may enable rolling of the work piece to obtain a profile sheet with three different sections with different thicknesses.

[0036] The above aspects, accompanying claims, and/or examples disclosed herein above and later below may be suitably combined with each other as would be apparent to anyone of ordinary skill in the art.

[0037] Additional features and advantages are disclosed in the following description, claims, and drawings, and in part will be readily apparent therefrom to those skilled in the art or recognized by practicing the disclosure

as described herein. There are also disclosed herein control units, computer readable media, and computer program products associated with the above discussed technical benefits.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] With reference to the appended drawings, below follows a more detailed description of aspects of the disclosure cited as examples.

FIG. 1A is an exemplary system for producing a profile sheet according to one example.

FIG. 1B is another view of **FIG. 1A** according to one example.

FIG. 1C is another view of **FIG. 1B** and **FIG. 1C** according to one example.

FIG. 2 is an exemplary flow chart of a method for producing a profile sheet according to one example.

FIG. 3 is an exemplary flow chart of a method for producing a profile sheet according to another example.

FIG. 4 is an exemplary flow chart of a method for producing a profile sheet according to another example.

FIG. 5 is an exemplary profile sheet according to one example.

FIG. 6 is an exemplary profile sheet according to another example.

FIG. 7 is an exemplary profile sheet according to another example.

FIG. 8 is an exemplary load-bearing structure according to one example.

FIG. 9 is an exemplary load-bearing structure according to another example.

FIG. 10 is an exemplary load-bearing structure according to another example.

FIG. 11 is an exemplary load-bearing structure according to another example.

FIG. 12 is an exemplary load-bearing structure according to another example.

FIG. 13 is an exemplary load-bearing structure according to another example.

DETAILED DESCRIPTION

[0039] Aspects set forth below represent the necessary information to enable those skilled in the art to practice the disclosure.

[0040] In conventional milling methods for forming profile sheets, a profile sheet with an even thickness is produced. However, in the field of load bearing structures and in particular load bearing structures for vehicles, weight optimization is of great importance. Thus, the obtained profile sheet has to be machined or provided with reinforcements in order to optimize the weight such that portions of the profile manufactured from the profile sheet which is subjected to loads are reinforced compared to

other portions of said profile.

[0041] The weight optimization obtained with machining or the addition of reinforcing parts is expensive and time consuming. Further, such weight optimization is not easily adapted to accommodate for obtaining differently shaped profile sheets and therefore provides a low-degree of flexibility.

[0042] The method and system of this disclosure may be intended to address any of the drawbacks mentioned above and in the background section.

[0043] FIG. 1A-C is an exemplary system according to one example depicted from the back, front and the side.

[0044] The system 100 is intended to produce a profile sheet for a load-bearing structure of a vehicle. The system 100 may comprise a plurality of rollers 110. The plurality of rollers 110 may be adapted to form a work piece 101 fed along a feeding direction FD to the profile sheet. Hence, the plurality of rollers 110 may be adapted to deform the work piece 101 to obtain the cross-section of the work piece 101.

[0045] The system 100 may be a roll milling system for roll milling the work piece 101 to the profile sheet. The plurality of rollers 110 may be roll milling rollers. The plurality of rollers 110 may be operable to roll mill the work piece 101.

[0046] The work piece 101 may extend along a reference plane RP.

[0047] The plurality of rollers 110 may comprise a first roller 121 and a second roller 122. The second roller 122 is displaced relative the first roller 121 in relation to a first reference axis RA1. The first reference axis RA1 may extend along the reference plane RP and orthogonally to the feeding direction FD.

[0048] Displaced herein refers to a component being arranged at an offset to another component. Displaceable herein refers to a component being movable to a position in which it is arranged at an offset to another component.

[0049] The position of at least one of the first roller 121 and the second roller 122 may be adjustable relative a second reference axis RA2. Hence, the position of the first roller 121 or the second roller 122 may be adjustable relative the second reference axis RA2. Alternatively, both the position of the first roller 121 and the second roller 122 may be adjustable relative the second reference axis RA2. The relative distance along the second reference axis RA2 between the first roller 121 and the second roller 122 may thus be adjustable. Accordingly, the first roller 121 and/or the second roller 122 may be adjustable (movable) along the second reference axis RA2.

[0050] The second reference axis RA2 may extend orthogonally to the first reference axis RA1 and the reference plane RP such that the first roller 121 is displaceable relative the second roller 122 and/or the second roller 122 is displaceable relative the first roller 121 in relation to the second reference axis RA2.

[0051] The plurality of rollers 110 may be operable to

process the work piece 101 along the feeding direction FD to form the work piece 101 to the profile sheet.

[0052] The system 100 may be configured to feed the work piece 101 along the feeding direction FD. The feeding direction FD may extend horizontally. The work piece 101 may thus also extend horizontally. The reference plane RP may be a horizontal plane. The first reference axis RA1 may be a horizontal reference axis. The second reference axis RA2 may be a vertical reference axis.

[0053] The plurality of rollers 110 may comprise a first roller arrangement 111 and a second roller arrangement 112. The first roller arrangement 111 may comprise the first roller 121 and a first associated roller 124. The second roller arrangement 112 may comprise the second roller 122 and a second associated roller 125. The system 100 may be adapted to roll the work piece between the first roller 121 and the first associated roller 124 and between the second roller 122 and the second associated roller 125.

[0054] The position of the at least one of the first roller 121 and the second roller 122 may be adjustable by means of adjustment of the distance between the first roller 121 and the first associated roller 124 and/or the distance between the second roller 122 and the second associated roller 125. The distance between the first roller 121 and the first associated roller 124 may extend along the second reference axis RA2. The distance between the second roller 122 and the second associated roller 125 may extend along the second reference axis RA2.

[0055] The first roller 121 and the second roller 122 may be aligned along a second reference plane RP2. The second reference plane RP2 may be orthogonal to the reference plane RP. The second reference plane RP2 may be a vertical reference plane. Hence, the first roller 121 and the second roller 122 may be arranged side-by-side in the second reference plane RP2.

[0056] The system 100 may be a four high rolling mill system. Thus, the first roller arrangement 111 may be a four high rolling mill arrangement, the first roller arrangement 111 may accordingly be provided as a first four high rolling mill arrangement. The second roller arrangement 112 may be a four high rolling mill arrangement, the second roller arrangement 112 may accordingly be provided as a second four high rolling mill arrangement.

[0057] The first roller 121 and the first associated roller 124 may accordingly be considered main rollers of the first roller arrangement 111. The first roller arrangement 111 may further comprise a driven pair of backup rollers 131, 134. One of the driven pair of backup rollers 131 is adapted to drive the first roller 121 and the other of the driven pair of backup rollers 134 is adapted to drive the first associated roller 124. The diameter of the backup rollers 131, 134 may be larger than the diameter of the first roller 121 and the first associated roller 124. Thus, the first roller 121 and the first associated roller 124 will be driven at a relatively high speed even when the backup rollers 131, 134 are operated at a moderate or relatively

low speed due to the difference in diameter between the backup rollers **131**, **134** and the first roller **121** and first associated roller **124**.

[0058] The second roller **122** and the second associated roller **125** may accordingly be considered main rollers of the second roller arrangement **112**. The second roller arrangement **112** may further comprise a driven pair of backup rollers **132**, **135**. One of the driven pair of backup rollers **132** is adapted to drive the first roller **122** and the other of the driven pair of backup rollers **135** is adapted to drive the second associated roller **125**. The diameter of the backup rollers **132**, **135** may be larger than the diameter of the second roller **122** and the second associated roller **125**. Thus, the second roller **122** and the second associated roller **125** will be driven at a relatively high speed even when the backup rollers **132**, **135** are operated at a moderate or relatively low speed due to the difference in diameter between the backup rollers **132**, **135** and the second roller **122** and second associated roller **125**.

[0059] The system **100** may comprise a drive arrangement **190**. The drive arrangement **190** may be adapted to drive at least one roller of the plurality of rollers **110** to feed the work piece **101** along the feeding direction **FD**.

[0060] The drive arrangement **190** may be adapted to drive the first roller **121** and the second roller **122** to feed the work piece **101** along the feeding direction **FD**. The drive arrangement **190** may be adapted to drive the first roller arrangement **111** and the second roller arrangement **112**. Hence, the drive arrangement **190** may be adapted to drive the first roller **121** and the first associated roller **124** and the second roller **122** and the second associated roller **125**.

[0061] The drive arrangement **190** may be operably connected to the back up rollers **131**, **132**, **134**, **135** to drive said back up rollers. The drive arrangement **190** may comprise a plurality of drive units for individually driving the rollers and/or a gear mechanism for driving multiple rollers with a single drive unit.

[0062] The adjustment of the position of the first roller **121** and/or the second roller **122** along the second reference axis **RA2** may be performed by means of an actuating arrangement **191**. The system **100** may thus comprise the actuating arrangement **191**.

[0063] The plurality of rollers **110** may be hydraulically or pneumatically operated. The actuating arrangement **191** may accordingly be a hydraulic or pneumatic actuating arrangement. The actuating arrangement **191** may comprise a first actuator operably connected to the first roller **121** for adjusting the position of the first roller **121**. The actuating arrangement **191** may comprise a second actuator operably connected to the second roller **122** for adjusting the position of the second roller **122**.

[0064] The plurality of rollers **110** may comprise a third roller **123**. The third roller **123** may be displaced relative to the first roller **121** and the second roller **122** in relation to the first reference axis **RA1**. The position of at least one of the first roller **121**, the second roller **122** and the

third roller **123** may be adjustable relative to the second reference axis **RA2**, e.g. adjustable along the second reference axis **RA2**, such that said at least one of the first roller **121**, the second roller **122** and the third roller **123** is displaceable relative to at least one other roller of the first roller **121**, the second roller **122** and the third roller **123** in relation to the second reference axis **RA2**. Preferably, each of the first roller **121**, the second roller **122** and the third roller **123** is adjustable relative to the second reference axis **RA2**.

[0065] The plurality of rollers **110** may hence comprise a third roller arrangement **113**. The third roller arrangement **113** may comprise the third roller **123** and a third associated roller **126**. The system **100** may be adapted to roll the work piece **101** between the third roller **123** and the third associated roller **126**.

[0066] The position of the third roller **123** may be adjustable by means of the adjustment of adjustment of the distance between the third roller **123** and the third associated roller **126**. The distance between the third roller **123** and the third associated roller **126** may extend along the second reference axis **RA2**.

[0067] The third roller **123** may aligned with the first roller **121** and the second roller **122** along the second reference plane **RP2**. Hence, the first roller **121**, the second roller **122** and the third roller **123** may be arranged side-by-side in the second reference plane **RP2**.

[0068] The third roller **123** may be provided as a third four high rolling mill arrangement. The third roller **123** and the third associated roller **126** may accordingly be considered main rollers of the third roller arrangement **113**. The third roller arrangement **113** may further comprise a driven pair of backup rollers **133**, **136**. One of the driven pair of backup rollers **133** is adapted to drive the third roller **123** and the other of the driven pair of backup rollers **136** is adapted to drive the third associated roller **126**. The diameter of the backup rollers **133**, **136** may be larger than the diameter of the third roller **123** and the third associated roller **126**. Thus, the third roller **123** and the third associated roller **126** will be driven at a relatively high speed even when the backup rollers **133**, **136** are operated at a moderate or relatively low speed due to the difference in diameter between the backup rollers **133**, **136** and the third roller **123** and third associated roller **126**.

[0069] The drive arrangement **190** may be adapted to drive the third roller **123** to feed the work piece **101** along the feeding direction **FD**. The drive arrangement **190** may be adapted to drive the third roller arrangement **113**. Hence the drive arrangement **190** may be adapted to drive the third roller **123** and the third associated roller **126**.

[0070] The adjustment of the position of the third roller **123** along the second reference axis **RA2** may be performed by means of the actuating arrangement **191**. The actuating arrangement **191** may comprise a third actuator operably connected to the third roller **123** for adjusting the position of the third roller **123**.

[0071] Although only depicted with a first roller, second roller and third roller, it is recognized that the system may include additional rollers implemented in the same manner.

[0072] Referencing FIG. 1A-C, the system 1000 of one example is depicted from a back, side and front view.

[0073] FIG. 1A depicts the system 1000 in a back view. The work piece 101 in the form of a planar plate is fed towards the first roller arrangement 111, the second roller arrangement 112 and the third roller arrangement 113 along the feeding direction FD. The first roller arrangement 111, the second roller arrangement 112 and the third roller arrangement 113 may be arranged side-by-side. The work piece 101 may be fed towards the roller arrangements by means of driven rollers.

[0074] FIG. 1B depicts the system 1000 in a side view. The work piece 101 is fed through the first roller arrangement 111, the second roller arrangement 112 and the third roller arrangement 113. The aforementioned roller arrangements are driven by means of the drive arrangement 190 to feed the work piece 101 through said roller arrangements along the feeding direction FD. The first roller arrangement 111, the second roller arrangement 112 and the third roller arrangement 113 may have been adjusted such that one of the rollers of the first, second and third rollers is displaced relative one of the remaining rollers of the first, second and third rollers.

[0075] FIG. 1C depicts the system 1000 in a front view. Upon feeding of the work piece 101 through the first, second and third roller arrangement, a first portion of the work piece 101 is rolled between the first roller 121 and the first associated roller 124 to a first thickness, a second portion of the work piece 101 is rolled between the second roller 122 and the second associated roller 125 to a second thickness, a third portion of the work piece 101 is rolled between the third roller 123 and third associated roller 126 to a third thickness. The adjusted distance between the first roller 121 and the first associated roller 124 of the first roller arrangement 111 thus sets the first thickness. The adjusted distance between the second roller 122 and the second associated roller 125 of the second roller arrangement 112 thus sets the second thickness. The adjusted distance between the third roller 123 and the third associated roller 126 of the third roller arrangement 113 thus sets the third thickness. The profile sheet may thus be weight optimized based on how the first, second and third roller arrangement are adjusted.

[0076] FIG. 2-4 depicts exemplary methods in accordance with the present disclosure. The above-described system may be configured to perform said method.

[0077] A method 1000 for producing a profile sheet for a load-bearing structure of a vehicle is provided. The profile sheet is produced through forming a work piece 101 by feeding the work piece along a feeding direction FD through the plurality of rollers 110.

[0078] The work piece may extend along a reference plane RP. The plurality of rollers 110 may comprise a first roller 121 and a second roller 122 displaced relative

the first roller 121 in relation to a first reference axis RA1. The first reference axis RA1 may extend along the reference plane RP and orthogonal to the feeding direction FD.

[0079] The work piece 101 may be in any one of a ferrous alloy, non-ferrous alloy, or a combination thereof such as steel, aluminum, titanium, ceramic, and magnesium alloy. The work piece 101 may be cast or rolled. The work piece 101 may be in the form of a plate.

[0080] Referencing FIG. 2, the method may comprise adjusting 1005 the position of at least one of the first roller 121 and second roller 122 relative a second reference axis RA2, e.g. adjusting the first and/or second roller along the second reference axis RA2. The second reference axis RA2 may extend orthogonally to the first reference axis RA1 and the reference plane RP such that the first roller 121 is displaced relative the second roller 122 in relation to the second reference axis RA2. The adjustment may be performed by means of the actuating arrangement 191.

[0081] The method 1000 may comprise feeding 1010 the work piece 101 through the plurality of rollers along the feeding direction FD to form the profile sheet.

[0082] The method 1000 may comprise operating 1015 the plurality of rollers 101 to process the work piece along the feeding direction FD to form the work piece to the profile sheet.

[0083] The plurality of rollers 110 may be operated such that the first roller 121 and the second roller 122 causes the perpendicular distance between a side of the profile sheet extending along the feeding direction FD and the reference plane RP to vary along the first reference axis RA1.

[0084] The plurality of rollers 110 may be operated such that the first roller 121 reduces the thickness of a first portion of the cross-section of the work piece relative the feeding direction FD to a first thickness. The plurality of rollers 110 may be operated such that the second roller 122 reduces the thickness of a second portion of the cross-section of the work piece 101 relative the feeding direction FD to a second thickness. The first thickness may be different from the second thickness. Hence, the first thickness may be thinner than the second thickness or alternatively thicker than the second thickness.

[0085] The plurality of rollers 110 may comprise a first roller arrangement 111 and a second roller arrangement 112. The first roller arrangement 111 may comprise the first roller 121 and a first associated roller 124. The second roller arrangement 112 may comprise the second roller 122 and a second associated roller 125. The method 1000 may further comprise feeding the work piece between the first roller 121 and the first associated roller 124 and between the second roller 122 and the second associated roller 125.

[0086] The position of the at least one of the first roller 121 and the second roller 122 may be adjusted by adjusting the distance between the first roller 121 and the first associated roller 124 and/or the distance between

the second roller **122** and the second associated roller **125**.

[0087] The first roller **121** and the second roller **122** may be aligned along a second reference plane **RP2** or orthogonal to the reference plane **RP**.

[0088] The plurality of rollers **110** may be operated to feed the work piece **101** along the feeding direction **FD**.

[0089] The plurality of rollers **110** may comprise a third roller **123**. The third roller may be displaced relative the first roller **121** and the second roller **122** in relation to the first reference axis **RA1**. The method **1000** may further comprise adjusting the position of at least one of the first, second and third roller relative to the second reference axis **RA2** such that the first roller **121** is displaced relative to the second and/or third roller in relation to the second reference axis **RA2**.

[0090] Referencing **FIG. 3**, the method may be performed as a separate production step to be implemented as a part of larger scale production method in which a slab is processed into a work piece and the work piece in turn is formed to a profile sheet as per the present disclosure.

[0091] A slab is provided **1001** for being processed to form the work piece **101**. The slab is often relatively thick. In order to efficiently reduce the thickness of the slab, the slab may be hot milled **1002**. As the skilled person is aware, hot milling is a process where the heated-up work piece is rolled to a thinner thickness. The slab may be hot milled **1002** to a desired predetermined thickness.

[0092] The example described with reference to **FIG. 2**, may be denoted a reduction milling process **1003** in which the work piece **101** is formed to the profile sheet. The reduction milling process **1003** may include adjusting **1005** the position of at least one of the first and second roller, feeding **1010** the work piece and operating **1015** the plurality of rollers to form the work piece to the profile sheet.

[0093] Once the profile sheet is obtained, the profile sheet may be coiled **1031**.

[0094] In some cases, the thickness of the profile sheet may require additional reduction. Thus, the profile sheet may be cold milled **1007** to obtain a final desired thickness. Hence, the method may in one example further comprise cold milling **1007** the profile sheet. During cold milling the profile sheet is while being in a cooled down state (compared to hot milling and the reduction milling) is rolled between a plurality of rollers to reduce the thickness of the profile sheet to a desired predetermined thickness. Hence, the profile sheet may be allowed to cool after the reduction milling **1003** before cold milling **1007** is initiated. If the profile sheet has been coiled prior to cold milling, the profile sheet may be de-coiled prior to cold milling.

[0095] The cold milling **1007** may be performed to reduce the thickness of the profile sheet or only some parts of the profile sheet. In one example, the profile sheet may be cold milled **1007** to reduce the thickness of the profile sheet across the entire profile sheet with a predetermined

final thickness. In one example, selected portions extending along the profile sheet may be cold milled **1007** to a predetermined final thickness.

[0096] In one example, the system **1000** may be utilized for the cold milling. the plurality of rollers **110** may be operated to cold mill **1007** the profile sheet. In one example, the first roller **121** and the second roller **122** may be operated to cold mill **1007** the profile sheet. Thus, the first roller **121** and the second roller **122** may be adjusted to a cold milling position. The profile sheet may then be fed through the plurality of rollers, whereby the first roller **121** and the second roller **122**, and preferably the first roller arrangement **111** and the second roller arrangement **112**, reduces the thickness of the profile sheet. In one example, the position of the first roller **121** and the second roller **122** (and potentially the third roller **123**) may be aligned along a plane orthogonal to the second reference axis **RA2** when adjusted to their cold milling positions. The first roller **121** and the second roller **122** (and potentially the third roller **123**) may be aligned such that the reduction of the thickness of the profile sheet is uniform and the variation in thickness of the profile sheet is maintained.

[0097] To exemplify, the profile sheet prior to cold milling may have thicknesses ranging between 6 and 8 mm. After the cold milling, the thickness of the profile sheet may be reduced with 2 mm uniformly, whereby the profile sheet may have thicknesses ranging between 4 and 6 mm after cold milling. Thus, the cross-section of the profile sheet is maintained but with an overall thickness reduction.

[0098] Although depicted as being performed after the reduction milling process **1003**, the cold milling **1007** may also be performed on the slab to reduce the thickness of the slab after hot milling and before the reduction milling process **1003**.

[0099] After the final desired thickness has been achieved for example after the reduction milling **1003** or the cold milling **1007**, the profile sheet may be treated for finishing **1005**. The treatment for finishing **1005** may include but not be limited to grinding, sand blasting, submerging the profile sheet in acid and polishing. Hence, the method may further comprise treating the profile sheet for finishing **1005**.

[0100] In order to form a final cross-section of the profile sheet, the profile sheet may be slit **1060** to achieve folding lines for folding of the profile sheet. The folding lines may extend across or along the length of the profile sheet.

[0101] Referencing **FIG. 4**, the method may further include preparation of the profile sheet and alteration of the profile sheet in order to enable transport and subsequent manufacturing of a profile element.

[0102] The work piece may be heated **1009** to a predetermined temperature such that work piece **101** is mechanically workable when fed through the plurality of rollers. The temperature may depend on the material of the work piece **101**. It is preferred that the work piece **101** is

in a recrystallization phase or a semi solid phase when it is fed through the plurality of rollers to be formed into the profile sheet. During this phase, the work piece is easily workable without being in a molten state.

[0103] For steel and steel-based alloys the predetermined temperature may be over 800 °C. Preferably, the predetermined temperature may be between 800 °C and 1500 °C.

[0104] For aluminum and aluminum-based alloys, the predetermined temperature may be over 300 °C. Preferably, the predetermined temperature may be between 300 °C and 600 °C.

[0105] To achieve the desired cross-section, the method 1000 may comprise folding 1020 the profile sheet. The profile sheet may be folded along or across its length, i.e. along a folding axis extending along or across the profile sheet. Thus, the profile sheet may be folded after the desired thickness and shape of the profile sheet has been obtained after the reduction milling and potential cold milling.

[0106] In one example, the method 1000 may comprise cutting 1032 the profile sheet into a plurality of profile sheet elements. The method 1000 may further comprise stacking 1033 the plurality of profile sheet elements, i.e. stacking the plurality of sheet elements on top of each other. Thereby, the profile sheet elements may be transported in a simple manner.

[0107] In one example, the method 1000 may comprise coiling 1031 the profile sheet onto a coil.

[0108] FIG. 5-7 depicts a profile sheet 200 according to different examples. The profile sheet 200 may have been obtained by the above described method.

[0109] Referencing FIG. 5, the profile sheet 200 has been folded along a folding axis FA extending along the profile sheet 200, i.e. along the length of the profile sheet. The profile sheet 200 has been folded twice to form a U-profile. In the depicted example, the thickness of a first portion of the cross-section of the work piece has been reduced to a first thickness t1. This may have been achieved by means of the first roller. The thickness of a second portion of the cross-section of the work piece has been reduced to a second thickness t2. This may have been achieved by means of the second roller. The thickness of a third portion of the cross-section of the work piece has been reduced to a third thickness t3. This may have been achieved by means of the third roller. As depicted in FIG. 5, the first thickness t1 and the third thickness t3 may be thicker than the second thickness t2.

[0110] Referencing FIG. 6, the profile sheet 200 has similar to FIG. 5, been folded twice to form a U-profile. However, the second thickness t2 may be thicker than the first thickness t1 and the third thickness t3.

[0111] Referencing FIG. 7, the profile sheet 200 has been folded along a folding axis FA extending across the profile sheet 200, i.e. across the length of the profile sheet. The profile sheet 200 has been folded twice to form a U-profile. Hence, the obtained profile element may have varying thickness in a lengthwise direction.

[0112] In the depicted example, the thickness of a first portion of the cross-section of the work piece has been reduced to a first thickness t1. This may have been achieved by means of the first roller. The thickness of a second portion of the cross-section of the work piece has been reduced to a second thickness t2. This may have been achieved by means of the second roller. The thickness of a third portion of the cross-section of the work piece has been reduced to a third thickness t3. This may have been achieved by means of the third roller. As depicted in FIG. 7, the first thickness t1 and the third thickness t3 may be thicker than the second thickness t2.

[0113] Although only U-profiles are depicted herein, it may be envisioned that the profile sheet may be folded into any type of conventional profile available to the skilled person.

[0114] FIG. 8-13 depicts a load-bearing structure according to different examples. The load-bearing structure may comprise a profile element made of the profile sheet described above. The profile element may have been obtained by cutting the folded profile sheet into profile elements of a desired length. Hence, the profile element may have a cross-section corresponding to the cross-section of the folded profile sheet.

[0115] Referencing FIG. 8, the load-bearing structure may be a frame rail 301, i.e. a frame rail 301 for a vehicle, i.e. a frame rail of a vehicle frame. The frame rail 301 may comprise a curved portion 331 as is common for commercial vehicles.

[0116] Referencing FIG. 9, the load-bearing structure may be a cross-member 302 for a vehicle, i.e. a cross-member for a vehicle frame. The cross-member may be in the form of an elongated beam.

[0117] Referencing FIG. 10, the load-bearing structure may be a reinforcement 303 for a vehicle, i.e. a reinforcement for a vehicle frame.

[0118] Referencing FIG. 11, the load-bearing structure may be a cross-member centerpiece 305 for a vehicle, i.e. a cross-member centerpiece 304 for a vehicle frame.

[0119] Referencing FIG. 12, the load-bearing structure may be a tie plate 305 for a vehicle.

[0120] Referencing FIG. 13, the load-bearing structure may be a mounting bracket 306 for a vehicle.

[0121] The terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting of the disclosure. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. It will be further understood that the terms "comprises," "comprising," "includes," and/or "including" when used herein specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0122] It will be understood that, although the terms first, second, etc., may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element without departing from the scope of the present disclosure.

[0123] Relative terms such as "below" or "above" or "upper" or "lower" or "horizontal" or "vertical" may be used herein to describe a relationship of one element to another element as illustrated in the Figures. It will be understood that these terms and those discussed above are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element, or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present.

[0124] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. It will be further understood that terms used herein should be interpreted as having a meaning consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0125] It is to be understood that the present disclosure is not limited to the aspects described above and illustrated in the drawings; rather, the skilled person will recognize that many changes and modifications may be made within the scope of the present disclosure and appended claims. In the drawings and specification, there have been disclosed aspects for purposes of illustration only and not for purposes of limitation, the scope of the inventive concepts being set forth in the following claims.

Claims

1. Method (1000) for producing a profile sheet (200) for a load-bearing structure of a vehicle through forming a work piece (101) by feeding the work piece along a feeding direction (FD) through a plurality of rollers (110), wherein the work piece (101) extends along a reference plane (RP) and the plurality of rollers (110) comprises a first roller (121) and a second roller (122) displaced relative the first roller (121) in relation to a first reference axis (RA1) extending along the reference plane (RP) and orthogonally to the feeding direction (FD),
the method comprising:

- adjusting (1005) the position of at least one of

the first and second roller (121, 122) relative a second reference axis (RA2) extending orthogonally to the first reference axis (RA1) and the reference plane (RP) such that the first roller (121) is displaced relative the second roller (122) in relation to said second reference axis (RA2);
- feeding (1010) the work piece (101) through the plurality of rollers (110) along the feeding direction (FD) to form the profile sheet (200); and
- operating (1015) the plurality of rollers (110) to process the work piece (101) along the feeding direction (FD) to form the work piece (101) to the profile sheet (200).

2. The method (1000) of claim 1, further comprising operating the plurality of rollers (110) such that the first and second roller (121, 122) causes the perpendicular distance between a side of the profile sheet (200) extending along the feeding direction (FD) and the reference plane (RP) to vary along the first reference axis (RA1).

3. The method (1000) of any of claims 1-2, further comprising operating the plurality of rollers (110) such that the first roller (121) reduces the thickness of a first portion of the cross-section of the work piece (101) relative the feeding direction (FD) to a first thickness (t1) and the second roller (122) reduces the thickness of a second portion of the cross-section of the work piece (101) relative the feeding direction (FD) to a second thickness (t2), wherein the first thickness (t1) is different from the second thickness (t2).

4. The method (1000) of any of claims 1-3, wherein the plurality of rollers (110) comprises a first roller arrangement (111) and a second roller arrangement (112), the first roller arrangement (111) comprising the first roller (121) and a first associated roller (124) and the second roller arrangement (112) comprising the second roller (122) and a second associated roller (125), the method further comprising feeding the work piece (101) between the first roller (121) and the first associated roller (124) and between the second roller (122) and the second associated roller (125).

5. The method (1000) of claim 4, further comprising adjusting the position of the at least one of the first and second roller (121, 122) by adjusting the distance between the first roller (121) and the first associated roller (124) and/or the distance between the second roller (122) and the second associated roller (125).

6. The method (1000) of any of claims 1-5, wherein the first roller (121) and the second roller (122) are aligned along a second reference plane (RP2) or-

thogonal to the reference plane (RP).

7. The method (1000) of any of claims 1-6, further comprising operating the plurality of rollers (110) to feed the work piece (101) along the feeding direction (FD). 5
8. The method (1000) of any of claims 1-7, wherein the plurality of rollers (110) comprises a third roller (123) displaced relative the first roller (121) and the second roller (122) in relation to the first reference axis (RA1), the method further comprising adjusting the position of at least one of the first, second and third roller (121, 122, 123) relative to the second reference axis (RA2) such that the first roller (121) is displaced relative to the second and/or third roller (122, 123) in relation to said second reference axis (RA2). 10 15
9. The method (1000) of any of claims 1-8, further comprising heating (1009) the work piece (101) to a predetermined temperature such that the work piece (101) is mechanically workable when fed through the plurality of rollers (110). 20
10. The method (1000) of any of claims 1-9, wherein the work piece (101) is in any one of a cast or rolled ferrous alloy, non-ferrous alloy, or a combination thereof such as steel, aluminium, titanium, ceramic, and magnesium alloy. 25
11. The method (1000) of any of claims 1-10, further comprising cutting (1032) the profile sheet (200) into a plurality of profile sheet elements. 30
12. The method (1000) of claim 11, further comprises stacking (1033) the profile sheet elements. 35
13. The method of any of claims 1-10, further comprising coiling (1031) the profile sheet (200) onto a coil.
14. The method (1000) of any of claim 1-13, further comprising folding (1020) the profile sheet (200) along a folding axis (FA) extending along or across the profile sheet (200). 40
15. A profile sheet (200) obtained by the method according to any of claim 1-14. 45
16. A load bearing structure (301, 302, 303, 304, 305, 306) for a vehicle comprising a profile element made of the profile sheet (200) according to claim 15. 50
17. System (100) for producing a profile sheet (200) for a load-bearing structure of a vehicle, the system (100) comprising a plurality of rollers (110), wherein the plurality of rollers (110) are adapted to form a work piece (101) fed along a feeding direction (FD) through said plurality of rollers (110) to the profile sheet (101), wherein the work piece (101) extends 55

along a reference plane (RP) and the plurality of rollers (110) comprises a first roller (121) and a second roller (122) displaced relative the first roller (121) in relation to a first reference axis (RA1) extending along the reference plane (RP) and orthogonally to the feeding direction (FD),

- wherein the position of at least one of the first and second roller (121, 122) is adjustable relative a second reference axis (RA2) extending orthogonally to the first reference axis (RA1) and the reference plane (RP) such that the first roller (121) is displaceable relative the second roller (122) and/or the second roller (122) is displaceable relative the first roller (121) in relation to said second reference axis (RA2); and
- wherein the plurality of rollers (110) are operable to process the work piece (101) along the feeding direction (FD) to form the work piece (101) to the profile sheet (200).

18. The system (100) of claim 17, wherein the plurality of rollers (110) comprises a first roller arrangement (111) and a second roller arrangement (112), the first roller arrangement (111) comprising the first roller (121) and a first associated roller (124) and the second roller arrangement (112) comprising the second roller (122) and a second associated roller (125), wherein the system (100) is adapted to roll the work piece (101) between the first roller (121) and the first associated roller (124) and between the second roller (122) and the second associated roller (125).
19. The system (100) of claim 18, wherein the position of the at least one of the first and second roller (121, 122) is adjustable by means of adjustment of the distance between the first roller (121) and the first associated roller (124) and/or the distance between the second roller (122) and the second associated roller (125).
20. The system (100) of any of claims 17-19, wherein the first roller (121) and the second roller (122) are aligned along a second reference plane (RP2) orthogonal to the reference plane (RP).
21. The system (100) of any of claim 18-20, wherein the first and second roller arrangement (111, 112) are provided as a first and second four high rolling mill arrangement, whereby the first and second roller (121, 122) and the first and second associated rollers (124, 125) are main rollers of said first and second four high rolling mill arrangements, respectively.
22. The system (100) of any of claim 17-21, further comprising a drive arrangement (190) adapted to drive at least one roller of the plurality of rollers (110) to feed the work piece (101) along the feeding direction

(FD).

- 23.** The system (100) of any of claims 17-22, wherein the plurality of rollers (110) comprises a third roller (123) displaced relative the first roller (121) and the second roller (122) in relation to the first reference axis (RA1), wherein the position of at least one of the first, second and third roller (121, 122, 123) is adjustable relative to the second reference axis (RA2) such that said at least one of the first, second and third roller (121, 122, 123) is displaceable relative to at least one other roller of the first, second and third roller (121, 122, 123) in relation to said second reference axis (RA2).

5

10

15

20

25

30

35

40

45

50

55

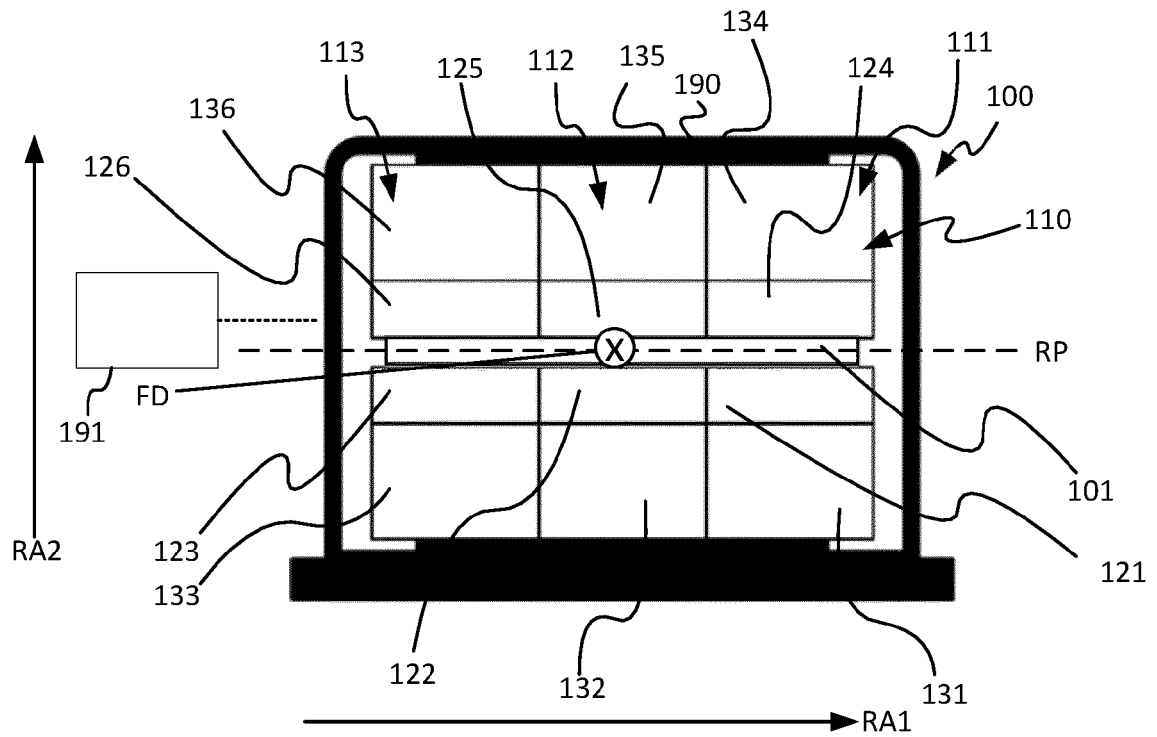


FIG. 1A

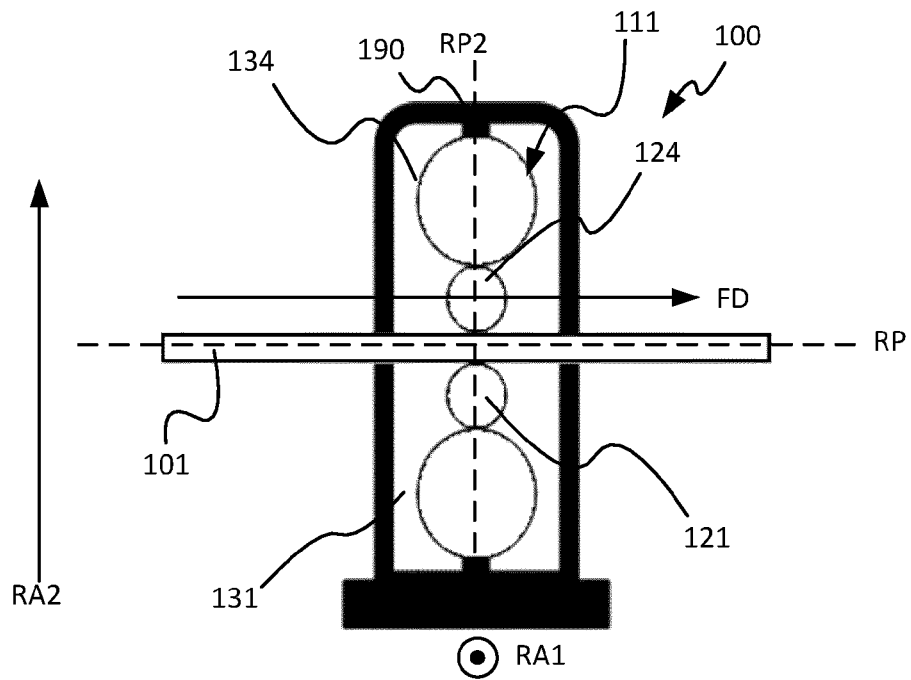


FIG. 1B

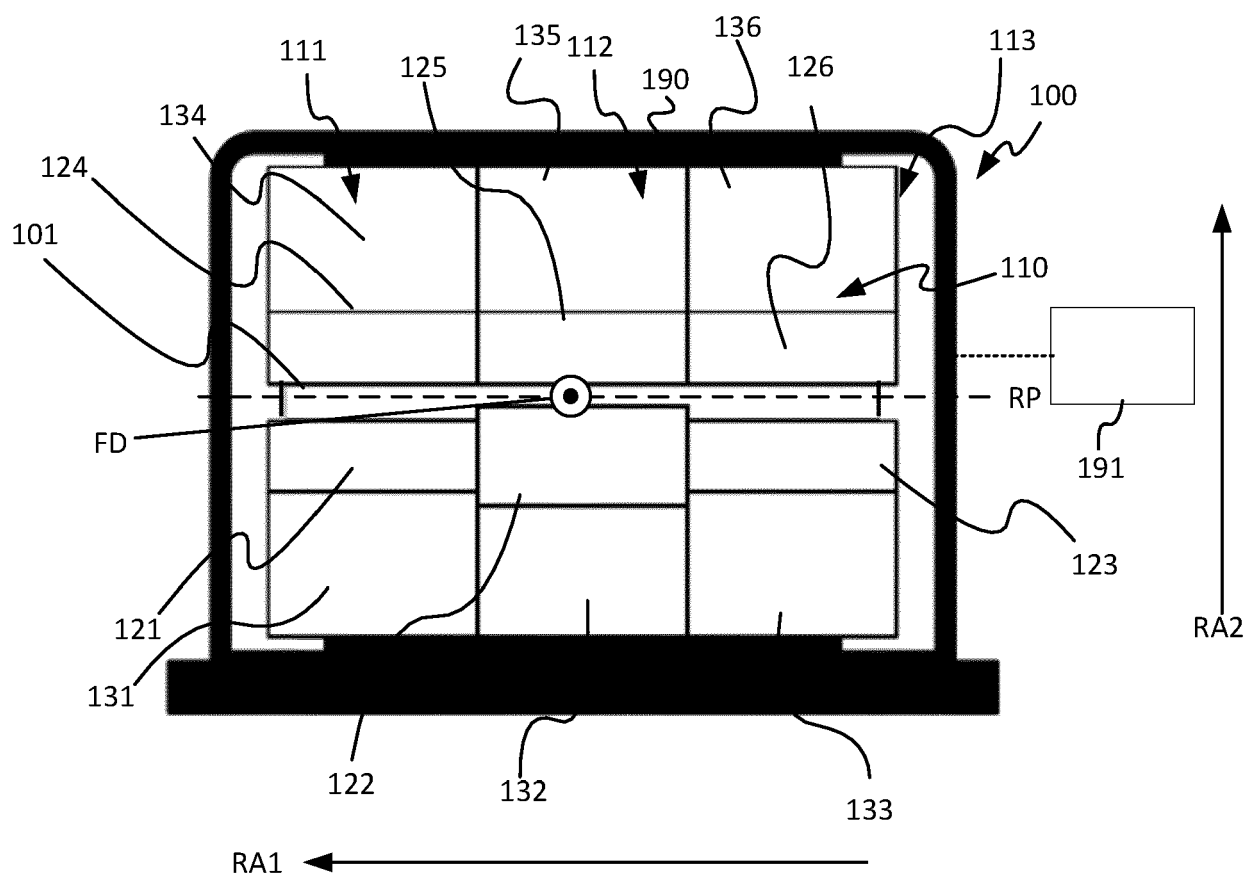


FIG. 1C

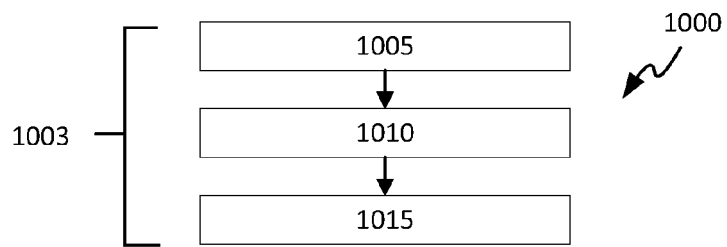


FIG. 2

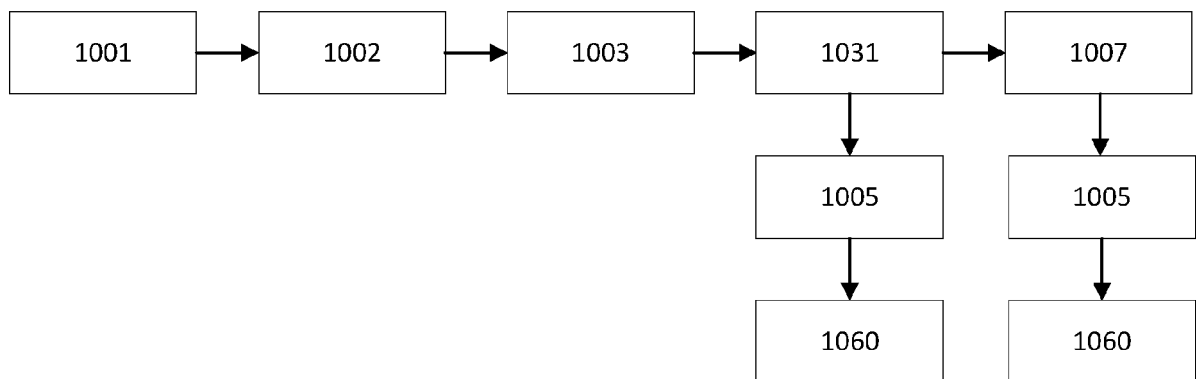


FIG. 3

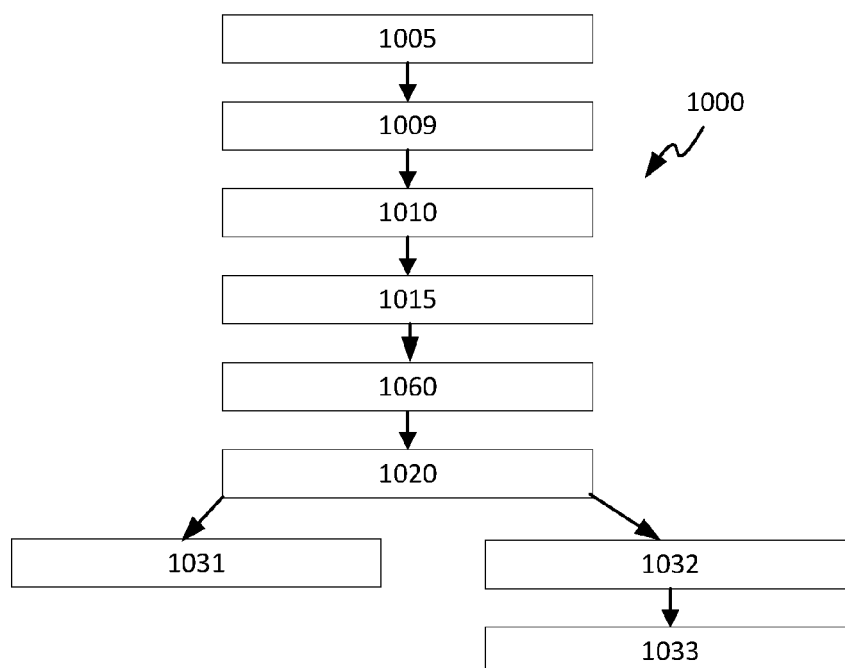


FIG. 4

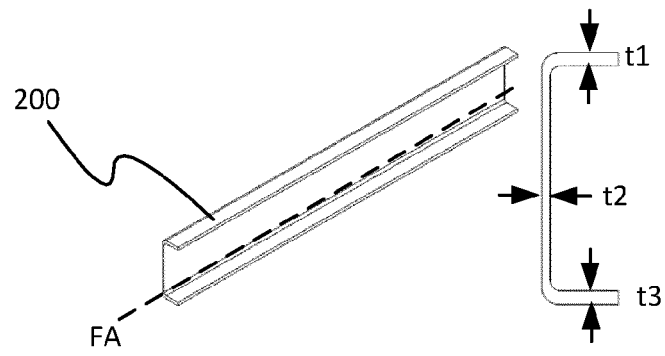


FIG. 5

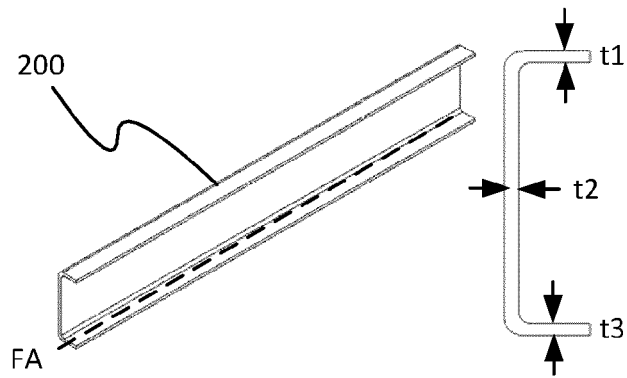


FIG. 6

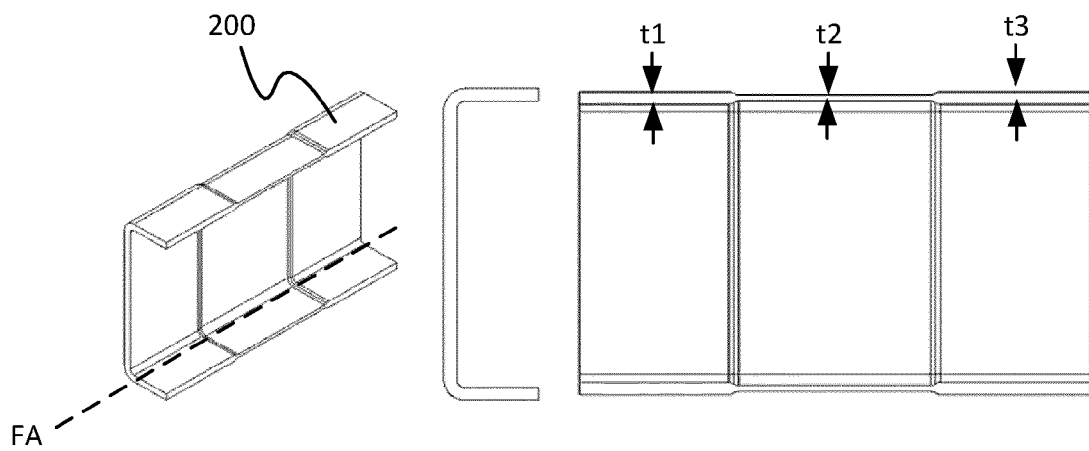


FIG. 7

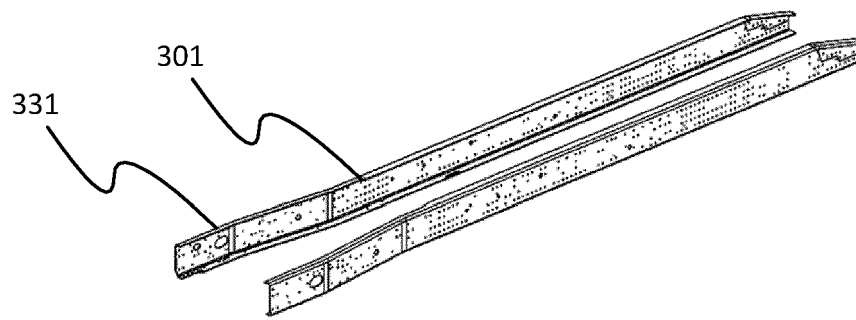


FIG. 8

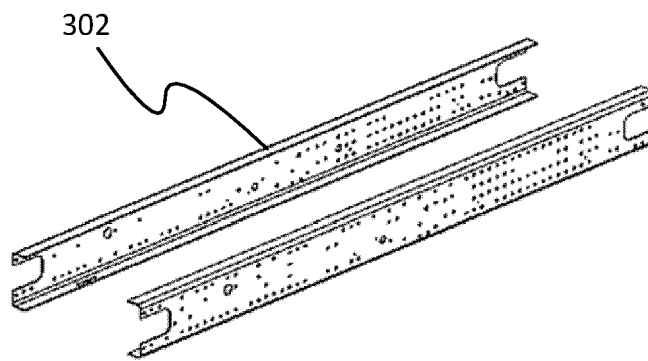


FIG. 9

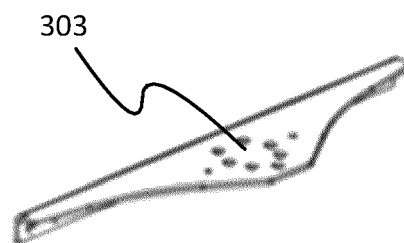


FIG. 10

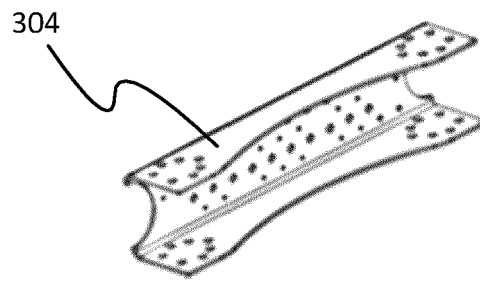


FIG. 11

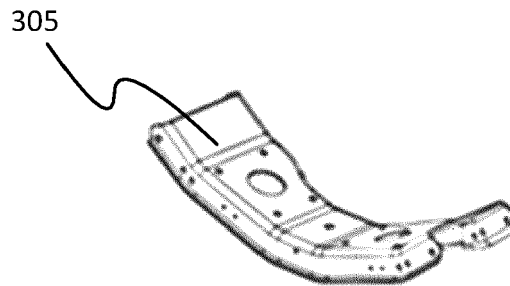


FIG. 12

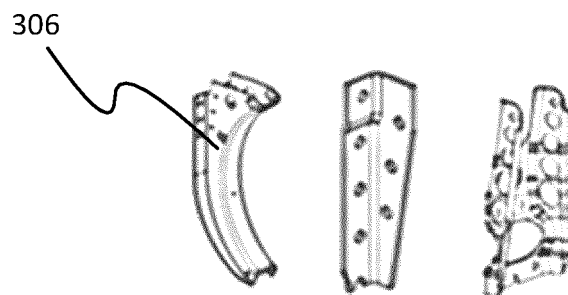


FIG. 13



EUROPEAN SEARCH REPORT

Application Number

EP 22 20 0880

5

10

15

20

25

30

35

40

45

50

55

1

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2006 024775 A1 (SMS DEMAG AG [DE]) 29 November 2007 (2007-11-29)	1-13, 15, 17-23	INV. B21B27/02
Y	* paragraph [0024] - paragraph [0026]; figures 1-3 *	14, 16	B21H8/02 B21B37/16
Y	----- SCHWARZ N ET AL: "FLEXIBEL GEWALZTE BLECH FÜR BELASTUNGSANGEPASSTE WERKSTÜCKE", WERKSTATT UND BETRIEB, HANSER, MÜNCHEN, vol. 131, no. 5, 1 May 1998 (1998-05-01), pages 424-427, XP000776752, ISSN: 0043-2792 * page 425, left-hand column, paragraph 2 * -----	14, 16	
			TECHNICAL FIELDS SEARCHED (IPC)
			B21B B21L B21H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 March 2023	Examiner Frisch, Ulrich
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 22 20 0880

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-03-2023

	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
10	DE 102006024775 A1	29-11-2007	AR 061183 A1	13-08-2008
15			AT 546239 T	15-03-2012
			AU 2007237329 A1	06-12-2007
			BR PI0702844 A	01-04-2008
			CA 2620789 A1	06-12-2007
			CN 101309762 A	19-11-2008
			DE 102006024775 A1	29-11-2007
			EA 200702412 A1	28-04-2008
20			EG 24888 A	13-12-2010
			EP 1879706 A1	23-01-2008
			ES 2379647 T3	30-04-2012
			JP 4535401 B2	01-09-2010
			JP 2008536695 A	11-09-2008
25			KR 20090012017 A	02-02-2009
			MY 147029 A	15-10-2012
			TW 200822982 A	01-06-2008
			UA 90514 C2	11-05-2010
			US 2009100890 A1	23-04-2009
			WO 2007137669 A1	06-12-2007
30			ZA 200711237 B	31-12-2008

35				
40				
45				
50				
55				

FORM P0459