

APPARATUS AND METHOD FOR BENDING BARS

The present invention relates to an apparatus for bending bars comprising an input for receiving a plurality of bars for bending, a bending device for bending at least one bar and a transfer unit for
5 transferring at least one bar from said input to said bending device. The invention further relates to a method for bending bars.

Bar bending apparatuses or machines are tools used in the construction industry to bend steel bars, typically used to reinforce concrete structures. These machines are designed to bend steel bars of
10 different sizes and shapes quickly and accurately, saving time and effort compared to manual bending methods.

The technology behind bar bending machines has evolved significantly over the years. Early machines used manual cranks or levers to bend bars, whereas modern machines are equipped with
15 electric motors and hydraulics to make the bending process more efficient and precise.

In order to process bars in batches, apparatuses for bending bars are known comprising an input for receiving a plurality of bars. Bars from the input are transferred, for instance using a transfer unit in the form of a robot unit, to a bending device for actually bending the bars. The bent bars are then
20 outputted for further processing.

It is a goal of the present invention, next to other goals, to provide an improved apparatus for bending bars.

25 This goal, amongst other goals, is met by an apparatus according to appended claim 1. More specifically, this goal, amongst other goals, is met by an apparatus for bending bars comprising an input for receiving a plurality of bars for bending, a bending device for bending at least one bar and a transfer unit for transferring at least one bar from said input to said bending device, wherein the apparatus further comprises a rotating mechanism arranged for rotating a bar along its longitudinal
30 axis towards a predefined orientation on the bending device. Typically, bars used for reinforcing concrete are provided with a longitudinally extending rib. Bars may be provided with a single rib, or a plurality of substantially parallel ribs. It is preferred that the bars, and in particular the ribs on these bars, are aligned according to preferred orientation in the bending device. In some cases it is preferred that a rib extends in the vertical direction (i.e. the bar is oriented with the rib upwards),
35 while in other cases it may be preferred that a rib is aligned at a predetermined angle to the vertical direction.

Preferably, the rotating mechanism is arranged to rotate a bar while being engaged by the transfer unit. The bars can then be rotated individually. The transfer unit preferably receives a single bar from the input and transfers this bar from the input to the bending device along a travel path. That is, the rotating mechanism is preferably movable along a longitudinal axis of the bar with respect
5 to said bar between the engaged position and the disengaged position.

Preferably, the rotating mechanism is movable along a direction having a component in the longitudinal axis of the bar, or preferably along the longitudinal axis of said bar, between an engaged position for engaging and rotating the bar and a disengaged position. By moving the
10 rotating mechanism in the longitudinal direction of the bar, preferably the bar to be rotated, the mechanism can be brought in and out of range of the bar efficiently.

Preferably, in the engaged position of the rotating mechanism, the bar is engaged at an end portion of said bar, seen in the longitudinal direction of the bar. This limits the movement range of the
15 rotating mechanism, while still allowing efficient rotation of the bar. Furthermore, when a bar is engaged at or near an end, the bar is relatively flexible, i.e., is allowed to move relatively easily. This facilitates clamping and centring the bar with respect to the rotating mechanism, for instance when clamping members are used for engaging, by clamping, the bar. Such clamping members may for instance be movable with respect the rotating mechanism towards and away from the bar,
20 seen in a direction perpendicular to the longitudinal axis of a bar.

In the disengaged position the rotating mechanism is preferably moved out of the travel path of the bar as defined by transfer unit. The travel path of the bar is defined by the movement of the transfer unit between a receiving position and a depositing position, as will be explained in greater detail
25 below, and this travel path typically extends in a direction perpendicular to the longitudinal axis of the bar.

It is efficient, as mentioned above, when the rotating mechanism is movable along the longitudinal axis of the bar to this end. In the alternative, the rotating mechanism may be movable in a direction
30 perpendicular to this direction. Preferably, the rotating mechanism is then moved out of the travel path of the bar as held by the transfer unit between the receiving position and the depositing position,

Preferably, in the disengaged position, the rotating mechanism extends at a location, seen in the
35 longitudinal direction of the bar, beyond the length of said bar. This efficiently moves the rotating mechanism out of the travel path of the bar. In the disengaged position of the rotating mechanism,

the bar is engaged by the transfer unit. According to this embodiment, the rotating mechanism and the transfer unit are separate units and are independently movable.

5 In order to detect the orientation of a rib provided on the bar, a further preferred embodiment further comprises an imaging device for imaging the bar. The apparatus is then preferably arranged to determine an orientation of the bar to be bent. The rotating mechanism is then preferably arranged to rotate the bar on the basis of the determined orientation. The determination of the orientation may take place in a suitable controller or processor associated with the apparatus.

10 Preferably, the rotating mechanism comprises the imaging device. The imaging device may for instance comprise a (digital) camera such as a CCD arranged to image the bar. Image processing techniques may then be used to determine, from the received images, an orientation of the bar, preferably as held in the transfer unit. The imaging device is preferably arranged to image a bar held in the transfer unit.

15 Preferably, the imaging device is arranged to image and detect a longitudinal rib on the bar. More preferably, the rotating member is arranged to rotate the bar such that in the bending device, the longitudinal rib, or at least one of the ribs, extends in the predefined orientation. This predetermined orientation may be substantially upwardly or in a desired angle relative to the
20 vertical, for example in the vertical direction, or at a specified nonzero angle to the vertical.

As will be described in greater detail below, during transfer of the bar by the transfer unit along its travel path, the bar may be rotated. The orientation of the bar may thus change between the receiving position and the depositing position. Preferably, the rotating position, in which position
25 of the transfer unit the bar is rotated by the rotating mechanism, is located between the receiving position and the depositing position. Also between the rotating position and the depositing position, the orientation of the bar may change. The rotating mechanism is then preferably arranged to compensate for this change in orientation due the transfer such that in the depositing position, the bar is deposited onto the bending device with the predefined orientation.

30 Next to an alignment in terms of rotation, it is preferred if also a bar to be deposited onto the bending device is aligned in longitudinal direction. The rotating mechanism thereto preferably comprises an alignment member arranged to align the bar in the transfer unit along its longitudinal axis. The rotating mechanism then also aligns the bar along its length. The alignment member
35 preferably comprises an abutment surface engaging the bar when moving from the disengaged towards the engaged position. When moving towards the bar, the bar is then automatically aligned

upon abutment with the abutment surface. Also there, the step of longitudinally aligning the bar takes place while the bar is held in the transfer unit.

Preferably, the transfer unit comprises a hook shaped member, more preferably a plurality of hook
5 shaped members, arranged to receive a bar from the input. The hook shaped member is preferably movable from a receiving position adjacent to the input for received a bar and a depositing position at the bending device for depositing the bar on the bending device. The hook shaped member may be arranged to engage a bar positioned at a lateral position of the input. The hook shaped member may for instance be rotated for engaging and receiving a bar from the input. The input is then
10 preferably arranged with means for properly aligning a bar for receipt in the transfer unit, for instance in the form of a hook shaped member.

It will be appreciated that the concept of the hook shaped members, or the transfer unit in general, may also be used in an apparatus without a rotating unit as mentioned above.

15 In order to prevent the bars from falling out, and possibly to maintain their orientation after rotation, the transfer unit is preferably provided with a clamping mechanism for clamping a bar held in the transfer unit. The transfer unit may further comprise at least one clamping member movable towards and away from the hook shaped member for clamping a received bar in said hook
20 shaped member. The clamping mechanism may be in the form of a member movable towards an inner surface of the hook shaped member for clamping the bar therebetween. The clamping member is then movable between an engaged and disengaged position.

Preferably, the input is hereby arranged to receive the plurality of bars oriented substantially
25 parallel wherein the hook shaped member is rotatable between the two position along a rotation axis substantially parallel to said received bars.

Preferably, prior to rotation of the bar by the rotating mechanism, the clamping member is moved away from the hook shaped member, in particular from the engaged position towards a disengaged
30 position. This releases the bar and allows rotation of the bar received within the transfer unit. Preferably, the clamping member is moved towards the hook shaped member after rotation of the bar. When the rotating mechanism also comprises an alignment member arranged to align the bar in the transfer unit along its longitudinal axis, the clamping member is moved to the disengaged position prior to engagement of the alignment member. After alignment in terms of rotation and
35 translation, the clamping member may be moved to the engaged position to maintain the position of the bar in the transfer unit.

It will be appreciated that although a hook shaped member in the transfer unit, possibly with the clamping member as described, works efficient, other means of transferring a bar may be used.

- In a preferred embodiment, the hook shaped member comprises a contact sensor arranged to detect the presence of a bar or contact between the hook shaped member and a bar. This allows for determining whether the bar is engaged by the hook shaped member. In a further preferred embodiment, the apparatus comprises a plurality of hook shaped members, and at least two of the hook shaped members comprise a contact sensor arranged to detect the presence and/or contact between the bar and the respective hook shaped members. This further allows it to be determined how many hook shaped members contact the bar, to ensure that the required number of hook shaped members engage a bar. The number of hoods in contact should correspond to a predefined length of the bar. A controller may be arranged to control the apparatus to return the bar to the input in case the number of hooks with contact does not correspond to the predefined length.
- Preferably, the contact sensor comprises an electric contact isolated from the apparatus. In particular, preferably at least two of the hook shaped members comprise an electric contact isolated from the apparatus. In a further preferred embodiment, a bar contacting two or more electric contacts on two or more hook shaped members closes an electrical circuit between the two or more hook shaped members. This allows the apparatus to determine the number of hook shaped members in contact with the bar. Too few hook shaped members being in contact with a bar may be indicative of an incomplete engagement of the bar by the hook shaped members. The apparatus may then be arranged to return the bar to input, for instance.

- According to a preferred embodiment, the input is arranged to receive the plurality of bars oriented substantially parallel. The input may comprise a plurality of supports and/or elongate supporting surface for supporting the bars. The input preferably comprises a transfer mechanism for transferring the received bars in a transfer direction substantially perpendicular to the longitudinal axes of the received bars. The bars, preferably one-by-one, can then be transferred into the reach of the transfer unit as described above.

- It will be appreciated that the concept of the input and any further dependent concepts such as its transfer mechanism may also be used in an apparatus without a rotating mechanism as described above.

- Efficient transport is obtained when the transfer mechanism comprises an endless member, preferably a plurality of endless members, extending in the transfer direction. Rotation of the

members then transports the bars received on the members into the transfer direction. To be able to more precisely define the location of the bars in the transfer direction, the transfer mechanism preferably comprises at least one endless roller chain comprising a plurality of interconnected plates. At least some of the interconnected plates may then arranged to engage a bar for specifying
5 the position of the bar with respect to said plate. The position of the bar with respect to the roller chain is then also definier. Preferably, the input is arranged to receive the bars at locations of minimum heights of the interconnected plates. A roller chain typically has a varying height. By arranging the input, including the roller chain such that the bars are supported on the locations of minimum height, the position of the bars can be specified accurately. Preferably, the roller chain is
10 shaped such that a bar is supported in a stable manner on the roller chain.

More preferably, the input comprises a plurality of substantially parallel chains, wherein, seen along the transfer direction, the interconnected plates of the chains are aligned.

15 A further preferred embodiment further comprises a stopping member arranged to limit movement of the bars in the input in the transfer direction. The position of a bar can be then precisely aligned with the transfer unit. To allow remote and preferably automatic adaptation to bars having different diameters, the stopping member preferably comprises a motor for moving the stopping member in a direction having a component in the transfer direction. The input may further be provided with an
20 imaging unit, or other mechanism, to determine the diameter of the bars in the input. The diameter may also be predefined, for instance by a user, in a suitable controller of the apparatus.

In a preferred embodiment, the apparatus comprises a contact sensor for detecting contact between a bar and the input. This allows the verification of the presence and/or proper positioning of a bar in the input. Preferably, the stopping member comprises a contact sensor arranged to detect contact
25 between a stopping member and a bar. The stopping members are not necessarily part of the input, but in a preferred embodiment, a bar that is in contact with a stopping member is also in contact with the input. In a further preferred embodiment comprising a plurality of stopping members, at least two of the stopping members are provided with a contact sensor. This allows the apparatus to determine whether the bar makes contact with each contact sensor, which is indicative of the
30 positioning of the bar in the input. In a preferred embodiment, the apparatus is arranged to detect contact of a bar between a hook shaped member and a stopping member. This allows the apparatus to detect whether a bar is fully engaged by the hook shaped members, or only partially. In case a bar is still (partly) in contact with the input, i.e., a stopping member, the bar is not properly received in the transfer unit and the apparatus may be arranged to return the bar to the input.

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Preferably, the apparatus is arranged to detect contact of a bar with the one or more contact sensors provided on one or more stopping members, and/or contact of a bar with the one or more contact sensor arranged on the hook shaped members. This allows the apparatus to detect whether a bar is fully engaged by the hook shaped members, or only partially. If the bar makes contact with both
5 one or more contact members arranged on the stopping members and with one or more contact members arranged on the hook shaped members, the bar may only be partially engaged by the hook shaped members, indicating an incomplete engagement of the hook shaped members with the bar. In a preferred embodiment the contact sensors on the one or more stopping members, as well as the contact sensors on the one or more hook shaped members comprise electric contacts. A bar
10 contacting both electric contacts on the one or more stopping members and on the one or more hook shaped members closes an electrical circuit between the electric contacts on the one or more hook shaped members and the electric contacts on the one or more stopping members. The presence of such a closed electrical circuit may be indicative of a bar being only partially engaged by the one or more hook shaped members.

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The concept of the stopping member as described above may also be used in an apparatus with a generic input and transfer mechanism, i.e., not in the form of an endless member as mentioned above. Also a rotating mechanism as mentioned above is then not essential.

20 In a preferred embodiment, the transfer unit and/or the input is movable towards and away from the bending device. This allows the transfer unit to move towards the bending device to place a bar in the bending device, and to then move away from the bending device to provide clearance for bending one or more bars by the bending device, in particular in a direction towards the input.

25 In a further preferred embodiment, the transfer unit is coupled to the input, wherein the combination of the input and the transfer unit is movable towards and away from the bending device. This fixes the relative locations of the input and the transfer unit, allowing the transfer unit to reliably pick up bars from the input, and reduces the need for the input unit to move back and forth between the input and the bending device.

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A further preferred embodiment, which may be applied separately from the rotating mechanism, further comprises a bar pickup unit arranged to pick up a bar, preferably a bent bar, from the bending device. Preferably said bar pickup unit is arranged for transferring said bar to an unloading zone at a distance from said bending device. The bars may then be processed further in the
35 unloading zone. Preferably, the loading zone comprises supports for receiving a bent bar,

preferably a plurality of bars, in a stable manner, i.e., such that the orientation of the bar(s) is maintained. This facilitates further processing of the bars.

- 5 Preferably, the bar pickup unit comprises a first pickup member arranged to engage the bar at a first portion at a first longitudinal location and a second pickup member arranged to engage the bar at a second portion at a longitudinal location different from said first longitudinal location, wherein the first and second locations are located on either sides of a location of bending of the bar. Picking up the bar at both sides of a location of bending allows a more stable transport.
- 10 Preferably, the first and second pickup members are arranged to engage two portions of the bar extending under a mutual angle. More preferably, the two pickup members, preferably in the form of two grippers, are mutually rotatable with respect to each other. The pickup unit can then efficiently be adapted to the shape of the bent bars. The position of the pickup members is preferably adjustable based on the bending operation of the bending device. It is further preferred if
- 15 the mutual distance between the pickup members is adjustable.

- The pickup member may for instance comprises a base frame to which the pickup members are movable coupled. Both pickup members may be movable provided on the base frame or at least one of the two pickup members for adjusting the relative position between the two pickup
- 20 members.

- More preferably, the two pickup members are movable, or at least mutually movable, within a plane. The position and relative rotation of the pickup members is then adjustable to be able to pickup and transfer the bent bar from the bending device.
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- Preferably, the bar pickup unit comprises a measurement unit for measuring the angle between the first and second portions. This allows checking the angle between the portions of the bar. The measuring unit may comprise an optical sensor to measure the orientation of a portion of the bar. The pickup unit preferably comprises two measurement units, for instance associated with the
- 30 pickup members, arranged to detect an orientation of a portion of the bar. The relative orientation can then be determined efficiently. The apparatus may comprise a suitable controller or processor to check whether the measured angle corresponds to the angle as set in the bending device. This will be explained in greater detail below.

- 35 A further preferred embodiment further comprises a second unloading zone located at a distance from said first unloading zone, wherein the bar pickup unit is preferably arranged to pick up a bar

from the bending device and for transferring said bar to the first and the second unloading zones. When the bent bars from a first unloading zone are for instance picked up for further processing, which may be done manually or automatically, the apparatus may continue working while outputting the bars in the second unloading zone separate from the first unloading zone. Bending
5 and further processing may then take place in parallel in safe manner. Preferably, seen in the longitudinal direction of the bars to be received in the input, the unloading zones extend at either sides of the input, preferably at either side of the combination of the input and the bending device.

The apparatus preferably further comprises a gantry, wherein the bar pickup unit is coupled to the
10 gantry for transferring the bar from the bending device to at least one unloading zone. Preferably, the gantry is movable between the two unloading zones and the bending device.

Preferably, the bar pickup unit is movably coupled to the gantry, wherein the bar pickup unit is more preferably movable along the length of the gantry, more specifically perpendicular to a
15 moving direction of the gantry. The pick unit is then efficiently movable in at least two degrees of freedom.

A further preferred embodiment comprises a plurality of bar pickup units independently movable with respect to each other. This improves the efficiency of the apparatus. Preferably, at least two
20 bar pickup units are coupled to the gantry. Preferably, the bar pick units on a gantry are independently movable with respect to each other, more preferably along the length of the gantry as mentioned above. The bar pickup units may be arranged at either side of the gantry, seen in the moving direction. Two bar pickup units may also be arranged at the same side of the gantry.

It will be appreciated that the concepts as mentioned above are specifically useful in an apparatus for bending bars. It will however be noted that the concepts can also be applied in other devices for processing bars, such as for instance a cutting station or separation station. Instead of a bending
25 device as mentioned above, such a more generic apparatus may then be provided with a processing device. The transfer unit is then arranged to transfer bars between the input and the processing device. The transfer unit is then arranged to transfer bars between the input and the processing
30 device and the pickup unit may be arranged to pickup bars from the processing device, etc.

Also, the concept of the multiple unloading zones may be applied in more generic apparatuses, for instance comprising a processing device only, i.e., without input and/or transfer unit.

35 According to a further aspect, a method for processing a bar, in particular for bending a bar, is provided, preferably using an apparatus as described above. The method preferably comprises

the steps of:

- providing at least one bar in an input;
- transferring said bar from said input to a bending device using a transfer unit;
- moving a rotating mechanism from an disengaged position towards an engaged position by
- 5 moving the rotating mechanism along the longitudinal axis of the bar;
- engaging said bar;
- rotating the bar along its longitudinal axis towards a predefined orientation on the bending device;
- disengaging the bar;
- 10 - moving the rotating mechanism from the engaged position towards the disengaged position by moving the rotating mechanism along the longitudinal axis of the bar;
- receiving the bar in the with the predefined orientation on the bending device, and;
- bending said bar in the bending device.

- 15 The method further preferably comprises the step of imaging and determining the orientation of the bar prior to rotating said bar, as mentioned above. Imaging of the bar may also include rotation of the bar. The imaging device may be stationary, such that by rotating the bar, a complete view of the surface of the bar can be obtained. Preferably, the step of rotating the bar, that is for aligning the bar, comprises rotating the bar on the basis of the determined orientation of the bar. As
- 20 mentioned above, any further rotation due to movement of the transfer unit towards the depositing position may be compensated when rotating the bar.

- The method preferably further comprises the step of transferring a bar, preferably a bent bar, from the bending device to an unloading zone using a bar pickup unit. Preferably, the bar pickup unit
- 25 comprises a first pickup member and second bar pickup member, wherein the method further comprises engaging, using the first pickup member, the bar at a first portion at a first longitudinal location and engaging the bar with the second pickup member at a second portion at a longitudinal location different from said first longitudinal location, wherein the first and second locations are located on either sides of a location of bending of the bar.

- 30 The method preferably further comprises the step of rotating a pickup member with respect to the other pickup member. The members are preferably mutually adjusted in accordance with any bending instructions provided to the bending device.

- 35 In a preferred embodiment of the method, the step of transferring the bar comprises picking up the bar at either side of a centre of gravity of the bent bar. This prevents that a moment force is applied

to the bar and the one or more pickup members as a result of the centre of gravity being outside of the points where the bar is supported by the one or more pickup members.

5 The method preferably further comprises the step of measuring the angle between two portions of the bent bar and determining, based on the measured angle, whether the bar conforms to a predetermined angle, for instance as specified in the bending instructions as mentioned above.

The method preferably further comprises transferring the bent bar to the unloading zone if the bar is in conformity and transferring the bar to a rejection zone if the bar is not in conformity.

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The method preferably further comprises the step of adjusting the bending device on the basis of the determined angle. The bending instructions as mentioned above may then be adjusted to meet the requirements.

15 Preferably, the step of providing the at least one bar comprises receiving a plurality of bars oriented substantially parallel in the input, wherein the method further comprises transporting at least one bar in the input in a transfer direction substantially perpendicular to the longitudinal axes of the received bars. Preferably, the step of transporting comprises transporting the bar by rotating at least one endless roller chain comprising a plurality of interconnected plates, wherein the bar is
20 received at locations of minimum heights of the interconnected plates. As mentioned above, this allows accurate placement of the bar with respect to the transfer unit.

The method preferably further comprise the step of determining a diameter of the received bars, wherein the method further comprises the step of moving a stopping member in a direction having
25 a component in the transfer direction in dependence of the determined diameter for limiting movement of the bars in the input in the transfer direction.

Preferably, the method further comprises the step of moving the input and/or transfer unit in a direction away from the bending device after receiving the bar in the with the predefined
30 orientation on the bending device and preferably prior to or at least during bending said bar. Collisions between the bent bar and the input and/or transfer unit is then prevented. Moving towards and away from the bending device further allows adjustment of the apparatus to different diameter or out-of-centre bending tools. My moving the transfer unit relative to the bending device, the deposition location can be adapted.

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The method further preferably comprises the step of moving the input in a direction towards the bending device prior to the step of receiving the bar in the bending device. The transfer unit is then brought into range of the bending device, in particular after the input and/or transfer unit has been moved away from the bending device as mentioned above.

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The present invention is further illustrated by the following Figures, which show a preferred embodiment of the device according to the invention, and are not intended to limit the scope of the invention in any way, wherein:

Figure 1 shows an overview of the apparatus for bending bars;

10 Figure 2 shows the input, the transfer unit and the rotating mechanism in more detail;

Figure 3 shows the rotating mechanism in more detail;

Figure 4 shows a side view of the transfer unit and the input;

Figure 5 shows a step-by-step overview of a bar being engaged by the transfer unit;

Figure 6 shows the bending device in more detail;

15 Figures 7A, B show a schematic overview of the rotating mechanism interacting with a bar;

Figures 8A-C show the clamp of the rotating mechanism in more detail;

Figure 9 shows a bar pickup unit;

Figure 10 shows the bar pickup unit in more detail;

Figure 11 shows additional functionality of the bar pickup unit; Figure 12 shows additional

20 functionality of the bar pickup unit; Figures 13A-C show the sliding function of the input and transfer unit in more detail;

Figure 14 shows a further example of a gantry provided with bar pickup units;

Figure 15 shows a detail from the gantry of figure 14 from below;

Figure 16 shows a bar pickup unit in isolation from the gantry, and;

25 Figure 17 shows another example of a bar pickup unit in isolation.

Figure 1 shows an overview of the apparatus for bending bars 1. The apparatus 1 comprises an input 2 for receiving bars 8 to be processed. Unbent bars are supplied to the apparatus by bar carrier 7. The bar carrier may be for example a pallet or a rolling carrier. Embodiments are
 30 envisioned wherein the bar carrier 7 is embodied by a carrier that is part of a vehicle such as a truck or a trailer that can be towed by a vehicle, such as a semi-trailer. The carrier 7 may move into and out of the apparatus, to supply bars, but also to receive bent bars 8b. A transfer unit 100 is provided to pick up one or more bars 8 supplied by the input 2. A rotating mechanism 200 is provided on one end of the transfer unit 100 to rotate the bars 8 along the longitudinal axis of the
 35 bars 8. The transfer unit 100 is further arranged to transfer one or more bars 8 to the bending device 3, and the bending device 3 is arranged to apply one or more bends to the one or more bars

8 supplied to the bending device 3. An overhead crane 4, or gantry crane 4, runs on elevated rails 5a, 5b. The crane 4 is arranged to pick up and transport the bars 8, for example from the bending device 3 to one of the unloading zones 6a, 6b. In another example, the crane 4 picks up one or more bars 8 from the carrier 7 and transfers the one or more bars 8 to the input 2. In yet another
5 example, bent bars 8b are transported from one of the unloading zones 6a, b to the carrier 7. The crane 4 is provided with one or more bar pickup units 42 (shown in figure 9) arranged to grab one or more bars 8, allowing said bars 8 to be picked up by the crane 4.

Figure 2 shows the input 2, the transfer unit 100, and the rotating mechanism 200 in more detail.
10 The bars 8 stored in the input 2 are carried by chains 20, which transfer the bars 8 towards the transfer unit 100 in a transport direction I perpendicular to the longitudinal axes of the bars 8. The transfer units comprises a plurality of movable stopping members 115 comprising a stopping member surface 115a arranged to contact and thereby hold a bar 8 at a predetermined position relative to the transfer unit 100, at least in the horizontal transport direction I towards the transfer
15 unit 100, see also figure 4 as will be discussed further below. A plurality of transfer unit arms 110 are arranged to engage one or more bars 8. A rotation of the transfer unit arms 110 around the rotation axis 111 then moves one or more bars 8 from the input 2 towards a rotating position wherein the rotating mechanism 200 can engage the bar 8 to rotate the bar 8, and move the bar 8 towards the bending device 3 (not shown). The input 2 and transfer unit 100 are rigidly coupled,
20 and arranged to slide along direction I, towards and away from the bending device 3 (not shown). The sliding function of the input 2 and transfer unit 100 is explained in more detail in figures 13A-C. The stopping members 115 are constructed of at least two pieces electrically insulated from one another, such that the stopping member surface 115a is insulated from the transfer unit 100 as a whole. The insulated stopping members 115 are part of a contact sensor, which senses whether a
25 bar that is picked up by the transfer arm 110 is also in contact with one or more stopping members 115. For this purpose, electrodes are also provided on the transfer arms 110, which is described in more detail below.

Figure 3 shows the rotating mechanism 200 in more detail. The rotating mechanism 200 comprises
30 a rotating body 201 arranged to rotate around a rotating axis Ar in direction Rr. The rotating mechanism 201 is mounted on an axle 230 which is rotatably connected to a frame 240 through bearings 231 and 232. An actuator 233 is arranged to rotate the rotating body 201 around the rotating axis Ar. The rotating body 201 comprises an actuator body 210 which is rigidly connected to the axle 230 and a clamp body 211 which is connected to the actuator body 210 through a
35 telescoping mechanism 213, which allows a clamp body 211 to translate relative to the actuator body 210 along a direction Lr parallel to the rotation axis Ar. The actuator body 210 comprises a

linear actuator 212, such as an hydraulic actuator 212 to move the clamp body 211 relative to the actuator body 210.

5 The clamp body 211 comprises a clamp 220 which is arranged to clamp onto or at least near the end of a bar 8 to allow the rotating mechanism 200 to rotate the engaged bar 8. The clamp 220 comprises two clamping members 221 and 222, which are movable with respect to each other, in this example slidably mounted to the clamp body 211 and arranged to slide to and from one another. At least one of the clamping members comprises a globally V-shaped clamping surface 221a, 222a to engage a bar 8. The benefit of a V-shaped, or similarly shaped, clamping surface is
10 that a V-shaped clamping surface comprises a single groove 221b, 222b located in the bottom of the V, and a bar 8 engaged by such V-shaped clamping surface thus automatically moves towards the bottom of the V 221b, 222b, thereby locating the bar 8 at a single point. Preferably, the clamping members 221 and 222 both comprise a V-shaped clamping surface 221a, 222a arranged such that the bottom grooves 221b, 222b and the rotating axis Ar fall in the same plane. The
15 rotating mechanism 200 further comprises an imaging device 250 with a field of view 251 arranged to scan the surface of a bar 8 engaged by the rotating mechanism 200. In the present embodiment, the imaging device 250, and/or any type of processor associated with the imaging device, is arranged to recognize the longitudinal rib 81 on a bar 8.

20 Figure 4 shows a side view of the transfer unit 100 and the input 2. The bars 8 are carried on roller chains 20 arranged around sprockets 26. The roller chains 20 are made up of a series of links 21, 22 which are linked together using pins. Each link 21, 22 comprises two holes through which said pins pass. Each link 21, 22 is thicker around said holes, and comprises a thinner section between the two thicker sections. The horizontally mounted chain 20 thus comprises a series of troughs,
25 each trough provided by a link 21, 22. The roller chains 20 are arranged such that the lowest point of the troughs protrudes above the input surface 24, such that bars 8 on the input 2 are carried and supported entirely by the chains 20 in a trough of a link 21, 22 of the chains 20. Thus, the bars 8 do not substantially contact the surface 24. A scanning unit 25 is provided near at least one chain 20 to measure the position of the chain 20. This allows the chain 20 to move to precise positions, for
30 example for the transfer unit 100 to reliably pick up one or more bars 8.

The transfer unit arms 110 comprises hook shaped members 112, or hooks 112 arranged to engage a bar 8. The hooks 112 are provided with movable clamp members 113 which are arranged to releasably clamp a bar 8 in the hook 112. The movable clamp members 113, or another part of the
35 hook shaped members 112, comprise electrical contacts that make contact with a bar 8 that is engaged by the hook shaped members 113. Said electrical contacts, together with the stopping

members 115 form part of a contact sensor, which senses whether a bar 8 that is engaged by the hook shaped members 112 is also in contact with the stopping members 115.

5 The stopping members 115 comprise a member with a curved contact surface 115a, rotatably mounted to a pivot 116. The contact surface 115a is eccentric relative to the pivot 116 such that a rotation of the stopping member 115 moves the contact surface 115a at a specific vertical position, such as the vertical location of the bars 8, further away from and closer to the pivot. This allows the stopping members 115 to be adjusted for a range of different bar diameters 8. The contact surface 115a is arranged to ensure that the bars 8 are reliably held in a predetermined position
10 when brought in contact with the contact surface 115a, such that for example the tip 112a of the hook shaped passes precisely between two neighboring bars 8, such that only a single bar 8 is engaged by the hook 112, leaving the subsequent bar on the input 2.

Figure 5 shows a step-by-step overview of a bar 8 being engaged by the transfer unit 100, brought
15 to the rotating position to be rotated by the rotating mechanism 200, and then transferred to the bending device 3 (not shown). In step 1 the stopping member 115 are rotated to a predetermined angle, corresponding to the diameter of the bars 8 to be processed. In step 2 the chains 20 of the input 2 holding bars 8 to be processed moves to bring the first bar 8 into contact with the contact surface 115a of the stopping member 115. In step 3 the pickup unit arm 112 rotates in direction Ra
20 so that the hook 112 engages the first bar 8, the hook tip 112a passing between the first bar 8 and the adjacent second bar 8 in line. In step 4 the transfer unit arm 110 continues to be rotated in direction Ra. Initially, the bar 8 continues to rest at least partly on the contact surface 115a. In step 5 the arm 110 continues its rotation, but the clamp 112 rises above the contact surface 115a so that the bar 8 is no longer supported on the contact surface 115a, but entirely by the hooks 112. At this
25 point, the clamping member 113 closes around the bar 8, clamping the bar 8 in the hook 112. In step 6 the transfer unit arm 110 rotates to the rotating position, wherein the rotating mechanism 200 (not shown) may engage the bar 8 to rotate the bar 8 to a desired angular position. For this purpose the clamp 113 opens to release the bar 8, allowing it to be rotated. In step 7 the bar 8 is rotated in direction Rr to the desired angular orientation. Subsequently, in step 8, the clamps 113
30 close again to hold the bar 8 in the desired position. It should be noted that it may not be strictly required to close the clamp 113 between steps 4 and 7, between the bar 8 being first picked up and when it is rotated in the rotating position. The closing of the clamp 113 during this phase serves to stabilize the bar 8, but is, as stated, not strictly necessary. In step 9 the transfer unit arm 110 continues to rotate in direction Ra towards the bending device 3 (not shown). The bending device 3
35 comprises at least one receptacle 31 arranged to receive bars 8 for bending. In step 9 the clamp 113 opens to release the bar 8 in the bending device receptacle 31. A stack of bars 8 is shown to be in

the receptacle 31 in step 10. After step 10, steps 2-10 may be repeated at will. If required, step 1 may be repeated to accommodate a different bar diameter. A bar 8 is picked up by a plurality of transfer unit arms 110 corresponding to a plurality of different contact points along the length of the bar 8. A function of the transfer unit 100 is to initially open only a limited number of clamping members 113, corresponding to a free end of the bar 8 thereby partially releasing the bar 8. Due to the inherent flexibility of the bar 8, the released end drops down into the receptacle 31, as well as a first clamp 32 which is arranged in line with the receptacle 31 (shown in figure 6). The first clamp 32 then clamps the free end of the bar 8, as well as any other bars 8 that may already be placed in the one or more receptacles 31 and the one or more clamps 32. This clamping prevents the bar 8 that partially remains in the transfer unit 100 from accidentally rotating, as well as preventing any bars 8 already stacked in the receptacles 31 and clamps 32 from rotating. After partially clamping the partially released bar 8, the remaining clamping members 113 that still engage the bar 8 are opened, and the bar 8 is fully released from the transfer unit 100. Generally, during transfer of the bar to the bending device, wherein the bending device and the transfer unit are provided with clamping means, at all times one clamping means engages the bar to prevent rotation of the bar.

Figure 6 shows the bending device 3 in more detail. Bars 8 are received in receptacles 31, which hold one bar 8 or a stack of multiple bars 8 to be bent. Two bending units 33 are provided to bend one bar 8 or a stack of bars 8. Each bending unit 33 comprises clamps 32 to clamp the bar(s) 8, and a rotating bending table 36 which is provided with pins 34a, 34b. The clamps 32 are stationary relative to the bending table 36. A rotation of the bending table 36 brings one of the pins 34a, b in contact with the bar(s) 8, and allows a bend to be applied to the bar(s) by further rotating the table 36 to bend the bar(s) around bending dies 38. One of the bending units 33 is mounted on a carriage 35 which is can slide to and from the other bending unit 33 in along direction Db. By engaging the bar(s) 8 with the clamps 32 of either one of the clamping units 33, moving the carriage 35 moves the bar(s) 8 relative to the other bending unit 33. This allows accurate placement of the bar(s) 8 relative to the bending units 33, to apply bends in specific locations on the bar(s) 8. A stop 37 is arranged adjacent to one of the bending units 33 near the location where the ends of the bar(s) are when placed in the bending device 3. The stop 37 may be slid upwards to present a stop surface in a fixed location. By sliding the bar(s) against the stop surface, the bar(s) can be aligned along their longitudinal axis. Storage zones 6a, b are shown to contain a number of bent bars 8b, which are transferred to said storage zones 6a, b after being bent by the bending device 3.

Figures 7A, B show a schematic overview of the rotating mechanism 200 interacting with a bar 8. In figure 7A, the actuator body 210 is seen to comprise the actuator 212, as well as a linear guide 214 to guide an arm 213 connecting to the clamp body 211. An abutment surface 223 is provided

to abut the end of a bar 8, so that the clamp 220 engages the bar 8 at a consistent location relative to the bar end contacting the abutment surface 223. This allows the rotating mechanism to align a bar 8 along its longitudinal axis, by extending or retracting the clamp body 211 relative to the actuator body 210 along direction Lr. Figure 7B shows a cross section of the rotating mechanism
5 200 seen along the longitudinal axis of a bar 8. The bar 8 can be seen to be clamped and centered by the clamps 221, 222 and the V-shaped clamping surfaces 221a, 222a and their grooves 221b, 222b.

Figures 8A-C show the clamp 220 of the rotating mechanism 200 in more detail. Figure 8A shows
10 the clamp 220 in the open position. The clamping members 221, 222 are offset slightly, and provided with notches 221c, 222c in their respective clamping surfaces 221a, 222a. These notches 221c, 222c in combination with the offset allow the clamping members 221, 222 to move into each other slightly, bringing the clamping surface grooves 221b, 222b close together than would be possible without the notches 221c, 222c, allowing the clamp 220 to clamp smaller diameter bars 8.
15 Figure 8B shows the clamp 220 in the closed position, with the clamping members 221, 222 having moved towards each other along direction Lc. Figure 8C shows the clamps 220 clamping onto a bar 8, with the ridge 81 along the length of the bar 8 also being shown.

Figure 9 shows a bar pickup unit 42. Preferably, at least two pickup units 42 are provided on the
20 overhead crane or gantry 4, such that at least a pickup unit 42 is provided at either end of the bars 8. The pickup unit 42 comprises an elongated body, provided with two grabbers 44a, 44b that are provided on grabber bodies 43a, 43b, which are in turn rotatably connected to the pickup unit body 42. The pickup unit 42 is rotatably connected to an articulating arm 41 through connector 42b, allowing the pickup unit 42 to rotate. The articulating arm 41 is connected to a carriage 41b which
25 runs along the length of the overhead crane or gantry 4. The ability of both the pickup unit 42 and the grabbers 44a, 44b to rotate allows the pickup unit to grab bent bars 8b at both sides of a bend. A secondary grabber 46 is provided, mounted on a secondary grabber unit which is arranged to move up and down relative to the overhead gantry 4. The secondary grabbers 46 provide additional support to a bar 8b that is picked up by the pickup units 42. For example, for some bending
30 geometries, it may be such that the centre of gravity of the entire bent bar 8b falls outside of the contact points of the bar pickup units 42 with the bar 8b. The secondary grabbers allow the bars 8b to be engaged for example near the longitudinal centre of the bar 8b, which is usually unbent. The additional support of the secondary grabbers 46 thus ensures that the centre of gravity of the bent bar(s) 8b falls within the contact points provided by the pickup units 42 and the one or more
35 secondary grabbers 46.

Figure 10 shows the pickup unit 42 in more detail. Scanners 48a, 48b with fields of view 49a, 49b are provided on the pickup unit 42 to determine the location of the bar(s) 8b underneath the pickup unit. In this way, the angle of a bend applied to the bar(s) 8b can be measured, for example for quality assurance.

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Figures 11 and 12 show additional functionality of the pickup unit arms 41. Instead of the pickup unit 42, a tool change module 47 can be attached to the arms 41. This allows the pickup unit arms 41 to be used to change the bending tools. In figure 11 a bending die 38 is changed, and figure 12 shows the change of a pin 34a. This allows for the automation of tool changes, improving efficiency and reducing the need for manual labour. Figure 11 additionally shows the location of the stop 37 in more detail.

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Figures 13A-C show the moving or sliding function of the input 2 and transfer unit 100 in more detail. Figures 13A-C show a schematic overview of the placement of various components of the bending device 3' in relation to the transfer unit 100. In figure 13A, the bending device 3' is provided with a bending roller tool 39, which is arranged along the centreline C of the bending device 3'. Thus, the bar(s) 8 to be bent have to be placed at an offset C' relative to the centreline C of the bending device 3'. To accommodate this, the entire transfer unit 100 and input 2 slide away from the bending device 3' in direction I. Figure 13B shows a situation which corresponds to the arrangement of the bending device 3 shown in for example figure 6, where a bending heart 38 is used, and the bar(s) to be bent have to be placed along the centreline C of the bending device. In this situation, the transfer unit 100 and input 2 slide towards the centreline C of the bending device. In some cases, parts of the bar(s) 8b are bent towards the location of the transfer unit 100. To provide clearance for the portion of bar 8b that displaces towards the transfer unit 100, the transfer unit 100 and input 2 slide away from the bending device after placing the bar 8 in the bending device.

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In figure 14, a further example of a gantry 4a is shown in isolation from the remainder of the apparatus 1. The gantry 4a is again in the form of a longitudinal beam shaped element. In this example, four bar pickup units 42 are coupled to the gantry 4a. The gantry 4a is movable along a moving direction X (to the left and right, seen in the context of figure 1). The bar pickup units 42 are further movable along the length of the gantry 4a, indicated with the arrow Y in figure 14. Two bar pickup units 42 are further provided at either side of the gantry 4a.

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With reference to figure 15, it can be seen that a first type pickup unit 42a is provided on one side of the gantry 4a and second type 42b is provided on the other side. Both pickup units 42a, b are

again provided with grabbers, generally indicated with 44, which are arranged to grab and pickup a bar, similar to the example as described above.

As an alternative to the robotlike arm as shown in the example of figure 9, the bar pickup units 42b
5 (see figure 16) is movable upwardly and downwardly using a rack and pinion system 400.

Movement in X direction (see figure 14) is achieved by moving the gantry 4a along rails 5a, 5b
(see figure 1), movement in the Y direction is achieved by moving the unit 42b along the length of
the gantry 4a.

10 To further improve the range of the bar pickup unit 42a, the first type 42a is provided with an arm
401 which is pivotal with respect to the body 402 coupled to the gantry 4a. At the opposite end of
the arm 401, a second body 43 is provided which is again rotatable. As such, the grabbers 44 can
be moved in the XY-plane with respect to the body 402, thus even without moving the bar pickup
unit 42a along the length of the gantry 4a in the Y-direction or by moving the gantry 4a in the X-
15 direction. To further increase the range, the arm 401 may be adjustable in length.

The present invention is not limited to the embodiment shown, but extends also to other
embodiments falling within the scope of the appended claims.

Claims

1. Apparatus for bending bars comprising an input for receiving a plurality of bars for bending,
a bending device for bending at least one bar and a transfer unit for transferring at least one
5 bar from said input to said bending device, wherein the apparatus further comprises a
rotating mechanism arranged for rotating a bar along its longitudinal axis towards a
predefined orientation on the bending device, wherein the rotating mechanism is movable
along a longitudinal axis of the bar with respect to said bar between an engaged position for
engaging and rotating the bar and a disengaged position.
10
2. Apparatus according to claim 1, wherein in the engaged position of the rotating mechanism,
the bar is engaged at an end portion of said bar, seen in the longitudinal direction of the bar.
3. Apparatus according to claim 1 or 2, wherein in the disengaged position, the rotating
15 mechanism extends at a location, seen in the longitudinal direction of the bar, beyond the
length of said bar.
4. Apparatus according to any of the preceding claims, wherein in the disengaged position of
the rotating mechanism, the bar is engaged by the transfer unit.
20
5. Apparatus according to any of the preceding claims, further comprising an imaging device
for imaging the bar and wherein the apparatus is arranged to determine an orientation of the
bar to be bent, wherein the rotating mechanism is arranged to rotate the bar on the basis of
the determined orientation.
25
6. Apparatus according to claim 5, wherein the rotating mechanism comprises the imaging
device.
7. Apparatus according to claim 5 or 6, wherein the imaging device is arranged to image and
30 detect a longitudinal rib on the bar, wherein the rotating member is arranged to rotate the bar
such that in the bending device, the longitudinal rib extends in the predefined orientation,
particularly substantially upwardly.
8. Apparatus according to any of the preceding claims, wherein the rotating mechanism is
35 arranged to rotate a bar while being engaged by the transfer unit.

9. Apparatus according to any of the preceding claims, wherein the rotating mechanism comprises an alignment member arranged to align the bar in the transfer unit along its longitudinal axis, wherein the alignment member comprises an abutment surface engaging the bar when moving from the disengaged towards the engaged position.
- 5
10. Apparatus according to any of the preceding claims, wherein the transfer unit comprises a hook shaped member, preferably a plurality of hook shaped members, arranged to receive a bar from the input, wherein the hook shaped member is movable from a receiving position adjacent to the input for received a bar and a depositing position at the bending device for depositing the bar on the bending device.
- 10
11. Apparatus according to claim 10, wherein the transfer unit further comprises at least one clamping member movable towards and away from the hook shaped member for clamping a received bar in said hook shaped member.
- 15
12. Apparatus according to claim 10 or 11, wherein the input is arranged to receive the plurality of bars oriented substantially parallel wherein the hook shaped member is rotatable between the two position along a rotation axis substantially parallel to said received bars.
- 20
13. Apparatus according to claim 8 and 11 or 12, wherein prior to rotation of the bar by the rotating mechanism, the clamping member is moved away from the hook shaped member.
- 25
14. Apparatus according to any of the preceding claims 10 - 13, wherein the hook shaped member comprises a contact sensor arranged to detect contact between the hook shaped member and a bar.
- 30
15. Apparatus according to claim 14, comprising a plurality of hook shaped members, wherein at least two of the hook shaped members comprise a contact sensor arranged to detect contact between the bar and the respective hook shaped member.
- 35
16. Apparatus according to claim 14 or 15, wherein the contact sensor comprises an electric contact isolated from the apparatus.
17. Apparatus according to any of the preceding claims, wherein the input is arranged to receive the plurality of bars oriented substantially parallel and wherein the input comprises a transfer

mechanism for transferring the received bars in a transfer direction substantially perpendicular to the longitudinal axes of the received bars.

18. Apparatus according to claim 17, wherein the transfer mechanism comprises at least one
5 endless roller chain comprising a plurality of interconnected plates, wherein the input is arranged to receive the bars at locations of minimum heights of the interconnected plates.
19. Apparatus according to claim 18, wherein the input comprises a plurality of substantially parallel chains, wherein, seen along the transfer direction, the interconnected plates of the
10 chains are aligned.
20. Apparatus according to any of the preceding claims 17 - 19, further comprising a stopping member arranged to limit movement of the bars in the input in the transfer direction, wherein the stopping member comprises a motor for moving the stopping member in a
15 direction having a component in the transfer direction.
21. Apparatus according to any of the preceding claims 17 - 20, further comprising a contact sensor for detecting contact between a bar and the input.
- 20 22. Apparatus according to claim 20 and 21, wherein the stopping member comprises a contact sensor arranged to detect contact between the stopping member and a bar.
23. Apparatus according to claim 22, comprising a plurality of stopping members, wherein at least two of the stopping members are provided with a contact sensor.
25
24. Apparatus according to any of the claims 14 - 16 and any of the claims 21 - 23, wherein the apparatus is arranged to detect contact of a bar between a hook shaped member and a stopping member.
- 30 25. Apparatus according to any of the preceding claims, wherein the transfer unit is movable towards and away from the bending device.
26. Apparatus according to claim 25, wherein the transfer unit is coupled to the input and wherein the combination of the input and the transfer unit is movable towards and away
35 from the bending device.

27. Apparatus according to any of the preceding claims, further comprising a bar pickup unit arranged to pick up a bar, preferably a bent bar, from the bending device and for transferring said bar to an unloading zone at a distance from said bending device, wherein the bar pickup unit comprises a first pickup member arranged to engage the bar at a first portion at a first longitudinal location and a second pickup member arranged to engage the bar at a second portion at a longitudinal location different from said first longitudinal location, wherein the first and second locations are located on either sides of a location of bending of the bar.
28. Apparatus according to claim 27, wherein the first and second pickup members are arranged to engage two portions of the bar extending under a mutual angle.
29. Apparatus according to claim 27 or 28, wherein the two pickup members, preferably in the form of two grippers, are mutually rotatable with respect to each other.
30. Apparatus according to claim 27, 28 or 29, wherein the bar pickup unit comprises a measurement unit for measuring the angle between the first and second portions.
31. Apparatus according to any of the preceding claims 27 - 30, further comprising a second unloading zone located at a distance from said first unloading zone, wherein the bar pickup unit is arranged to pick up a bar from the bending device and for transferring said bar to the first and the second unloading zones.
32. Apparatus according to claim 31, wherein, seen in the longitudinal direction of the bars to be received in the input, the unloading zones extend at either sides of the input, preferably at either side of the combination of the input and the bending device.
33. Apparatus according to any of the preceding claims 27 - 32, further comprising a gantry, wherein the bar pickup unit is coupled to the gantry for transferring the bar from the bending device to at least one unloading zone.
34. Apparatus according to claims 32 and 33, wherein the gantry is movable between the two unloading zones and the bending device.
35. Apparatus according to claim 33 or 34, wherein the bar pickup unit is movably coupled to the gantry, wherein the bar pickup unit is movable along the length of the gantry, perpendicular to a moving direction of the gantry.

36. Apparatus according to any of the claims 27 - 34, comprising a plurality of bar pickup units independently movable with respect to each other.
- 5 37. Apparatus according to at least claims 33 and 36, wherein at least two bar pickup units are coupled to the gantry.
38. Method for bending a bar using an apparatus according to any of the preceding claims, comprising the steps of:
- 10 - providing at least one bar in an input;
- transferring said bar from said input to a bending device using a transfer unit;
- moving a rotating mechanism from an disengaged position towards an engaged position by moving the rotating mechanism along the longitudinal axis of the bar;
- engaging said bar;
- 15 - rotating the bar along its longitudinal axis towards a predefined orientation on the bending device;
- disengaging the bar;
- moving the rotating mechanism from the engaged position towards the disengaged position by moving the rotating mechanism along the longitudinal axis of the bar;
- 20 - receiving the bar in the with the predefined orientation on the bending device, and;
- bending said bar in the bending device.
39. Method according to claim 38, further comprising the step of imaging and determining the orientation of the bar prior to rotating said bar.
- 25 40. Method according to claim 39, wherein the step of rotating the bar comprises rotating the bar on the basis of the determined orientation of the bar.
41. Method according to claim 38, 39 or 40, further comprising the step of transferring a bar, preferably a bent bar, from the bending device to an unloading zone using a bar pickup unit.
- 30 42. Method according to claim 41, wherein the bar pickup unit comprises a first pickup member and second bar pickup member, wherein the method further comprises engaging, using the first pickup member, the bar at a first portion at a first longitudinal location and engaging the
- 35 bar with the second pickup member at a second portion at a longitudinal location different

from said first longitudinal location, wherein the first and second locations are located on either sides of a location of bending of the bar.

43. Method according to claim 42, further comprising the step of rotating a pickup member with respect to the other pickup member.
44. Method according to claim 41, 42 or 43, wherein the step of transferring the bar comprises picking up the bar at either side of a centre of gravity of the bent bar.
45. Method according to any of the claims 41 - 44, further comprising the step of measuring the angle between two portions of the bent bar and determining, based on the measured angle, whether the bar conforms to a predetermined angle.
46. Method according to claim 45, further comprising transferring the bent bar to the unloading zone if the bar is in conformity and transferring the bar to a rejection zone if the bar is not in conformity.
47. Method according to claim 45 or 46, further comprising the step of adjusting the bending device on the basis of the determined angle.
48. Method according to any of the preceding claims, wherein the step of providing the at least one bar comprises receiving a plurality of bars oriented substantially parallel in the input, wherein the method further comprises transporting at least one bar in the input in a transfer direction substantially perpendicular to the longitudinal axes of the received bars.
49. Method according to claim 48, wherein the step of transporting comprises transporting the bar by rotating at least one endless roller chain comprising a plurality of interconnected plates, wherein the bar is received at locations of minimum heights of the interconnected plates.
50. Method according to claim 48 or 49, further comprising the step of determining a diameter of the received bars, wherein the method further comprises the step of moving a stopping member in a direction having a component in the transfer direction in dependence of the determined diameter for limiting movement of the bars in the input in the transfer direction.

51. Method according to any of the preceding claims, further comprising the step of moving the input in a direction away from the bending device after receiving the bar in the with the predefined orientation on the bending device and prior to bending said bar.
- 5 52. Method according to any of the preceding claims, further comprising the step of moving the input in a direction towards the bending device prior to the step of receiving the bar in the bending device.