SYSTEM AND METHOD FOR LIFTING ONE OR MORE BARS

The present invention relates to a system for processing bars, wherein the system comprises a processing device for processing one or more bars and a storage comprising a plurality of bins, wherein each bin is arranged for storing a plurality of bars, wherein the system further comprises a lifting apparatus for lifting one or more bars for transferring one or more bars between the processing device and/or the bins of the storage.

Systems for processing bars, such as steel bars or rods, that are used for reinforcement in concrete structures, as such are generally known. Such bars are typically cut, bent, and shaped according to the design specifications of the concrete structure. The systems for processing bars may include machines and devices for performing various operations on the bars, such as cutting, bending, twisting, welding, or assembling.

Once the bars are processed, the bars are stored in a storage. Typically, such a storage comprises a plurality of (storage) bins, each arranged to receive a plurality of bins. The bins are typically separated from each other in a row in a direction perpendicular to the longitudinal axes of the bars to be received. A lifting apparatus is then provided to transfer the bars between a processing device, such as a bending device or a conveyor, and a bin or between bins and an output.

When depositing one or more bars (also simply referred to as ‘bars’) or retrieving bars from a storage bin, parts of the lifting apparatus move in the space on either side of the bin. In case a row of bins is used, the lifting apparatus moves in the space between bins. To allow this, there must be a certain clearance between neighbouring bins. A problem of this is that this required clearance takes up floor space in the location where the system is installed.

It is a goal of the present invention, next to other goals, to provide an improved system for processing bars, wherein at least one of the above-mentioned problems is at least partly alleviated.

This goal, amongst other goals, is met by a system according to appended claim 1. More specifically, this goal, amongst other goals, is met by a system for processing bars, wherein the system comprises a processing device for processing one or more bars and a storage comprising a plurality of bins, wherein each bin is arranged for storing a plurality of bars, wherein the system further comprises a lifting apparatus for lifting one or more bars for transfer between the processing device and/or the bins of the storage, wherein the lifting apparatus comprises a plurality of lifting grippers for engaging the one or more bars, wherein at least one lifting gripper comprises

two gripper arm members, wherein at least one gripper, or a gripper arm member thereof, is movable between an open position arranged to receive or dispose the one or more bars and a closed position wherein the gripper arm members at least partially enclose the one or more bars, wherein at least one of the gripper arm members is rotatable around a rotation axis having a component in the vertical direction, preferably around a substantially vertical rotation axis, for moving between the closed and the open position.

In lifting apparatuses known in the art, gripper arm members rotate around a horizontal axis between the closed and the open position. By rotating at least one gripper arm member around an axis having a component in the vertical direction, the clearance required for the gripper arm to move from the closed position to the open position is less than for known gripper arms. This results in less clearance being required between bins, allowing the bins to be placed closer together. This reduces the total floor area required for the same amount of bins, or allows for more bins to be placed in the same floor area.

Preferably, two of the gripper arm members, more preferably in a gripper, are rotatable around rotation axes having vertical components, more preferably around substantially vertical rotation axes. This increases the aforementioned benefit achieved by the lifting apparatus, because both gripper arm members of a gripper require less clearance to move between the open and closed position. In addition, this allows the distance between the outermost points of the gripper arm members of at least one lifting gripper in the first open position to be equal to, or smaller than, the distance between the outermost points of the gripper members of said at least one lifting gripper in the closed position.

Preferably, at least one of the gripper arm member is further rotatable around a rotation axis having a component in the horizontal direction, wherein the gripper arm member is more preferably rotatable around a substantially horizontal rotation axis. In a preferred embodiment, the axis having a vertical component and the axis having a horizontal component extend substantially perpendicular to each other. Said rotation axis having a component in the horizontal direction is similar to the rotation axis around which gripper arm members of grippers known in the art rotate. Thus, said rotation is a ‘conventional’ rotation of the at least one gripper arm member. This conventional rotation allows for more functionality of the gripper. For example, a conventional rotation of the at least one gripper arm is better suited for picking up bars from a horizontal plane such as the floor, than a rotation around the aforementioned axis having a component in the vertical direction. In addition, a drawback of at least one gripper arm member rotating around an axis having a vertical component, is that the rotation towards the open or closed position involves a

displacement of at least part of the gripper arm member in a direction parallel to the longitudinal direction of the bars. This requires more force than opening or closing in the conventional manner. This further means that the bars may inadvertently be moved in the longitudinal direction when opening or closing the at least one gripping member to the open position around the axis having a vertical component. Opening or closing the at least one gripping member in the 'conventional' manner does not entail this drawback. Thus, it is beneficial to have a gripper arm member be rotatable around both axes.

Preferably, two of the gripper arm members, more preferably in one gripper, are rotatable around rotation axes having horizontal components, preferably around substantially horizontal rotation axes. This increases the aforementioned benefit achieved by the lifting apparatus, as both gripper arm members of a gripper can also function in the 'conventional' manner.

Preferably, at least one of the gripper arm members is rotatable around a rotation axis having a vertical component, preferably a substantially vertical rotation axis, and around a rotation axis having a horizontal component, preferably a substantially horizontal rotation axis. This allows the at least one gripper arm member to rotate around both axes, thereby bringing the aforementioned benefits associated with rotating around both the axis with a horizontal component and the axis with a vertical component.

Preferably, two of the gripper arm members, more preferably in one gripper, are rotatable around a rotation axis having a vertical component, preferably a substantially vertical rotation axis, and around a rotation axis having a horizontal component, preferably a substantially horizontal rotation axis. This allows both gripper arm members to rotate around both axes, increasing the aforementioned benefits.

Preferably, the two gripper arm members of all gripper arm members of the plurality of gripper arm members are rotatable around both aforementioned axes. This allows the entire lifting apparatus to function both in the 'conventional' manner, and in the manner wherein the gripper arm members rotate around an axis having a horizontal component between closed and open positions.

It will be appreciated that neither an axis having a vertical component as previously described, nor an axis having a horizontal component as previously described, have to be respectively fully vertical or horizontal for the described effect to be achieved. Preferably, the axis having a vertical component extends at an angle of less than 45° relative to the vertical direction, and the axis having

a horizontal component extends at an angle of less than 45° relative to the horizontal direction. This allows the aforementioned benefits to be achieved.

Preferably, the gripper arm member comprises an upper part and a lower part under an angle with respect to the upper part, wherein preferably the gripper arm member is rotatable around an axis having a vertical component and substantially coinciding with the longitudinal axis of the upper part for moving the gripper between an open position and the closed position. In the closed position, the lower part is preferably parallel to a plane substantially perpendicular to the longitudinal axis of the bars. In the open position, the lower part is preferably parallel to a plane substantially parallel to the longitudinal axis of the bars. This allows the overall width of the gripper, of which both gripper arm members are rotatable around both axes with a vertical component and with a horizontal component, to be substantially similar in the closed position and the open position reached after having rotated around an axis having a vertical component.

Preferably, at least one gripper arm member comprises a substantially C-, J- or L-shaped member. The top section of the gripper arm member having said shape is then preferably parallel to the axis with a vertical component around which the gripper arm member rotates between the closed and an open position, while bottom section of said gripper arm member curves inwards towards the bars in the closed position of the gripper. Said shapes are relatively easy to manufacture, and inherently possess adequate mechanical properties.

Preferably, for a gripper of which at least one gripper arm member is rotatable around both the axis having a vertical component and the axis having a horizontal component, the width of the projection of the gripper arm in the horizontal plane, in a direction perpendicular to the longitudinal axis of the one or more bars, is larger for the gripper arm having rotated to an open position around the axis having a horizontal component than for the gripper arm having rotated to an open position around the axis having a vertical component. This allows the gripper to open by rotating around the axis having a vertical component to release bars in a bin when the clearance between bins is reduced.

Preferably, the lifting apparatus comprises a substantially longitudinal support body, wherein the plurality of lifting grippers is arranged along the longitudinal axis of the support body. This provides for a relatively simple arrangement of the lifting apparatus.

Preferably, the gripper arm member of at least one gripper is connected to the support body by means of a hinging body, wherein the hinging body comprises a hinge arranged to rotate the body

and the at least one gripper around an axis having a horizontal component. The hinging body may add stiffness to the assembly including the longitudinal support body.

Preferably, at least two gripper arm members of at least two grippers are connected to the hinging body for simultaneously rotating the two gripper arm members around an axis having a horizontal component. This both simplifies construction of the lifting apparatus and increases the overall stiffness of the assembly. Especially when the gripper arm members of more than two grippers are connected to a single hinging body, construction is simplified because the hinging body may be connected to the support body using fewer hinges than if each gripper arm member was individually hingedly connected to the support body.

Preferably, at least one gripper arm member is rotatable around an axis having a vertical component with respect to the hinging body. For this purpose, the at least one gripper arm member is preferably connected to the hinging body by means of a hinge, or another connection allowing a rotating motion. This allows the at least one gripper arm member to rotate around the axis having a vertical component, and for the at least one gripper arm member to rotate around the axis having a horizontal component by rotating the hinging body. Preferably, the hinging connection of the at least one gripper arm member with the hinging body is stationary relative to the hinging body, such that said hinge, as well as the gripper arm connected to it, rotates with the hinging body when the hinging body rotates around the axis having a horizontal component.

Preferably, the lifting apparatus comprises a first hinging body arranged parallel to the longitudinal axis of the support body, wherein one gripper member of at least two lifting grippers are connected to the first hinging body, and a second hinging body arranged parallel to the longitudinal axis of the support body, wherein the other gripper members of said at least two lifting grippers are connected to the second hinging body, wherein the second hinging body is arranged to rotate around an axis having a horizontal component. This allows for an overall simple and rigid construction of the lifting apparatus, increasing the aforementioned benefits.

Preferably, a gripper arm member of a first lifting gripper is connected to a gripper arm member of at least a second lifting gripper by means of a gripper linkage, wherein a movement of the gripper linkage along the direction extending between said at least two gripper arm members induces a rotation of the at least two gripper arm members around the axis having a vertical component to move the at least two gripper arm members between the closed and an open position. This beneficially allows for example for only a single actuator, for example a linear actuator, to be used to move multiple gripper arm members. Preferably, the at least two gripper members comprise a

lever extending in a direction with a component perpendicular to the rotation axis having a vertical component of the at least two gripper members.

Preferably, at least a first lifting gripper is movable between the closed and an open position independently from at least a second lifting gripper. This allows separate control of the lifting grippers, for example controlling them in two or more groups. This allows only part of the grippers to open and/or close, increasing operational flexibility of the lifting apparatus.

In a preferred embodiment, at least one bin is formed by at least two support members arranged along a longitudinal direction, wherein each support member comprises a receptacle that is open in the upward direction to receive bars, wherein the receptacles of the support members of the at least one bin are arranged along the longitudinal direction, wherein the receptacles of the support members of the at least one bin define a volume, wherein the lifting apparatus is movable between the bins in the lateral direction, perpendicular to the longitudinal direction. The lifting apparatus as described above works especially beneficially with said at least one bin.

Preferably, the storage comprises at least two adjacent bins, wherein the receptacles of the two bins define two adjacent volumes extending at a mutual lateral distance, wherein the distance between the outermost points of at least one gripper in an open position with the gripper arm members having rotated around an axis having a vertical component to the open position is smaller than said sum of the width of a volume and double the mutual lateral distance between the volumes. This allows the lifting grippers to move between adjacent bins to deposit or retrieve bars by moving between the closed and an open position by rotating around the axis having a vertical component.

In an embodiment, a distance between the outermost points of the at least one gripper of the apparatus in an open position with the gripper arm members having rotated around an axis having a horizontal component is larger than the sum of the width of a volume and double the mutual lateral distance between the volumes.

Preferably, at least one gripper arm member is arranged to open and close by rotating the gripper arm members around the axis with a horizontal component to engage one or more bars in the processing device. Typically, there is enough space to engage bars on a processing device, for instance in the form of a conveyor. Preferably, at least one gripper arm member is arranged to open by rotating the gripper arm members around the axis with a horizontal component when depositing one or more bars in a bin. Typically, when depositing bars, there is sufficient room to open the gripper in the conventional manner. In case a bin already contains some bars, the gripper may be

located higher in order to drop the bars in said bin. It may also be possible, when the space is limited, that the bars are released by rotating around the vertical axis.

Preferably, the system, in particular the lifting apparatus thereof, is arranged to move a gripper, preferably a plurality of grippers, from the open to the closed position by rotation of the gripper arm members around the vertical axis when engaging and lifting bars from a bin. In particular when engaging bars from the bins, space is limited such that rotation around the vertical axis is preferable.

Another aspect relates to a lifting apparatus as described above.

Another aspect relates to a method for lifting one or more bars in a system as described above, comprising the step of rotating one or more gripper arm members around an axis having a vertical component, preferably a substantially vertical axis, for moving at least one gripper between open and closed positions. This method requires less clearance for the one or more gripper arms to move between the closed and the open position than the clearance required for a 'conventional' opening or closing as described above.

The method preferably comprises the step of rotating one or more gripper arm members around an axis having the vertical component for moving at least one gripper from the open position to the closed position. In particular when engaging bars for lifting said bars, and in particular for engaging and lifting bars from a bin of the storage, space is limited. By rotating the gripper arm members around the vertical axes, less space is needed, such that the bins can be placed closer to each other as mentioned above. When engaging bars for lifting from for instance a processing device such as a conveyor where space is less critical, the gripper arm members may be rotated around horizontal axes for moving from the open to the closed position in conventional manner as explained below.

To also allow conventional opening and closing, the method further preferably comprises rotating one or more gripper arm members around an axis having a horizontal component, preferably a substantially horizontal axis, for moving at least one gripper between open and closed positions.

As for releasing bars in a bin or processing device space is less critical, the method preferably comprises the step of rotating one or more gripper arm members around the axis having the horizontal component for moving at least one gripper from the closed to the open position for

releasing bars held in the gripper. Releasing the bars more preferably takes place only by rotating round said horizontal axes.

The present invention is further illustrated by the following Figures, which show a preferred embodiment of the system and apparatus 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 system;
- Figure 2 shows the system in more detail;
- Figure 3 shows the grippers in the second open position;
- Figure 4 shows the grippers in the first open position; and
- Figures 5A-C show a view of the grippers from the X direction.

Figure 1 shows an overview of the system 100, comprising an apparatus 1 for lifting one or more bars. The bars are represented by a volume Vb. The system 100 further comprises a plurality of bins 30 for receiving bars. The apparatus 1 comprises a longitudinal support body 11 suspended from an overhead gantry 4 by means of lifting mechanisms 41. The support body 11 is movable in the vertical direction Z by means of the lifting mechanisms 41. The gantry 4 is supported on rails 5, and movable along said rails 5 in the lateral direction Y. The apparatus 1 comprises a plurality of lifting grippers 10 arranged to grip one or more bars. The grippers 10 are connected to the support body 11 by a first hinging body 21 and a second hinging body 22. The apparatus 1 is arranged to deposit bars in the bins 30 and remove bars from said bins 30, as well as transfer the bars between bins 30. The apparatus 1 is further arranged to pick up bars from another location to deposit said bars in one or more bins 30, as well as to remove one or more bars from one or more bins 30 to transfer said bars to another location.

Figure 2 shows the system 100 in more detail. The grippers 10 are shown in the closed position. The grippers 10 comprise a first gripper arm member 12 and a second gripper arm member 13 (both also referred to as ‘gripper arms’), which are connected to respectively the first hinging body 21 and the second hinging body 22 by means of hinges 14, 15. The hinges 14, 15 are respectively arranged to allow a rotation of the gripping arms 12, 13 around axes A2 and A3. In the shown closed position of the grippers 10, the axes A2, A3 are substantially aligned with the vertical direction Z. Gripper arms 12, 13 respectively comprise levers 141, 151. The levers 141 of the gripping arms 12 on the first hinging body 21 are connected to each other by means of linkages (not shown). The levers 151 of the gripping arms 13 on the second hinging body 22 are connected to each other by means of linkages 24. Said linkages 24 allow for the use of a single linear actuator

23 to move multiple gripper arms 13. The same applies to the gripper arms 12, the linear actuator is however not shown.

The bins 30 comprise receptacles 32 to receive one or more bars, represented by volumes Vb. The receptacles 32 are separated by separators 31. In the shown embodiment, the separators 31 essentially define the receptacles 32. In the shown embodiment, multiple separators 31 and receptacles 32 are formed by a single bin member 33. The width between bins 30 is defined by the width Ws of the separators 31. The width Wb of the bins 30 is defined by the distance between two adjacent separators 31.

Figure 3 shows the grippers 10 in an open position with the gripper arm members 12, 13 and the hinging bodies 21, 22 having rotated around an axis having a horizontal component, or the 'conventional' open position, wherein the first hinging body 21 and the second hinging body 22 rotate around horizontal axes that are substantially aligned with the X direction. The gripper arms 12, 13 rotate with the first hinging body 21 and the second hinging body 22 respectively to release one or more bars. The first hinging body 21 and second hinging body 22 are respectively rotated by linear actuators 18, 19. The hinges 14, 15 rotate together with respectively the first hinging body 21 and the second hinging body 22. As a result, the axes A2, A3 rotate accordingly with respectively the first hinging body 21 and the second hinging body 22.

Figure 4 shows the grippers 10 in an open position with the gripper arm members 12, 13 having rotated around axes with a component in the vertical direction, wherein the first hinging body 21 and the second hinging body 22 are in substantially the same position as in the closed position shown in figure 2. Instead, the gripper arms 12, 13 are respectively rotated around the axes A2 and A3. This rotation of the gripper arms 13 connected to the second hinging body 22 is induced by an extension of the linear actuator 23, which is connected to the levers 151 of the gripper arms 13. The gripper arms 12 connected to the first hinging body 21 are rotated in a similar manner, but the relevant linkages and linear actuator are not shown.

Figures 5A-C show a view of a gripper 10 from the X direction. In figure 5A the gripper 10 is shown in the closed position. The first hinging body 21 and the second hinging body 22 are respectively connected to the support body 11 by hinges 16, 17. Said hinges 16, 17 respectively allow a rotation of the first and second hinging bodies 21, 22 around an axis A1 that is substantially aligned with the X direction. In the closed position, the distance D1 between the outermost points 12' and 13' of respective gripper arms 12, 13 is smaller than 2 x Ws + Wb, wherein Ws is the width

of the separators 31 and Wb is the width of the bins 30. This allows the closed grippers 10 to move into a bin 30 between two other bins 30 (not shown).

Figure 5B shows a view of the gripper 10 in an open position with gripper arm members 12, 13 and hinging bodies 21, 22 having rotated around axes with a horizontal component. In this second open position the linear actuators 18, 19 retract to respectively rotate the first and second hinging bodies 21, 22 around respective hinges 16, 17. It can be seen that axes A2 and A3 rotate in accordance with the first and second hinging bodies 21, 22 respectively. In the second open position, the distance D2 between the outermost points 12', 13' of the respective gripper arms 12, 13 is larger than 2 x Ws + Wb, wherein Ws is the width of the separators 31 and Wb is the width of the bins 30.

Figure 5C shows a view of the gripper 10 in an open position with gripper arms 12, 13 having rotating around axes A2, A3 with a vertical component. In this first open position, the linear actuators 18, 19 are extended, and as such the first and second hinging bodies 21, 22 are in the same position as in the closed position shown in figure 5A. The linear actuators 23 move the linkages 24 move the gripper arms 12, 13 to the first open position. In the first open position the distance D3 between the gripper arms 12, 13 is at least smaller than D2, and in the shown embodiment similar, if not smaller, than D1.

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

The present invention is further illustrated by the following embodiments, which are not intended to limit the scope of the invention in any way.

1. System for processing bars, wherein the system comprises a processing device for processing one or more bars and a storage comprising a plurality of bins, wherein each bin is arranged for storing a plurality of bars, wherein the system further comprises a lifting apparatus for lifting one or more bars for transfer between the processing device and/or the bins of the storage, wherein the lifting apparatus comprises a plurality of lifting grippers for engaging the one or more bars, wherein at least one lifting gripper comprises two gripper arm members, wherein at least one gripper is movable between an open position arranged to receive or dispose the one or more bars and a closed position wherein the gripper arm members at least partially enclose the one or more bars, wherein at least one of the gripper arm members is rotatable around a rotation axis having a

component in the vertical direction, preferably around a substantially vertical rotation axis, for moving between the closed and open position.

2. System according to embodiment 1, wherein two of the gripper arm members are rotatable around rotation axes having vertical components, preferably around substantially vertical rotation axes.

3. System according to embodiment 1 or 2, wherein at least one of the gripper arm member is further rotatable around a rotation axis having a component in the horizontal direction, wherein the gripper arm member is preferably rotatable around a substantially horizontal rotation axis.

4. System according to embodiment 3, wherein two of the gripper arm members are rotatable around rotation axes having horizontal components, preferably around substantially horizontal rotation axes.

5. System according to at least embodiments 1 and 3, wherein at least one of the gripper arm members is rotatable around both a rotation axis having a vertical component, preferably a substantially vertical rotation axis, and a rotation axis having a horizontal component, preferably a substantially horizontal rotation axis.

6. System according to the preceding embodiment, wherein two of the gripper arm members are rotatable around a rotation axis having a vertical component, preferably a substantially vertical rotation axis, and around a rotation axis having a horizontal component, preferably a substantially horizontal rotation axis.

7. System according to any of the preceding embodiments, wherein the gripper arm member comprises an upper part and a lower part under an angle with respect to the upper part, wherein the gripper arm member is rotatable around an axis substantially coinciding with the longitudinal axis of the upper part.

8. System according to any of the preceding embodiments, wherein at least one gripper arm member comprises a substantially C-, J- or L-shaped member.

9. System according to any of the preceding embodiments 5 – 8, wherein the width of the projection of the gripper arm in the horizontal plane, in a direction perpendicular to the longitudinal axis of the one or more bars, is larger for the gripper arm having rotated to an open

position around the axis having a horizontal component than for the gripper arm having rotated to an open position around the axis having a vertical component.

10. System according to any of the preceding embodiments, wherein the lifting apparatus comprises a substantially longitudinal support body, wherein the plurality of lifting grippers are arranged along the longitudinal axis of the support body.

11. System according to the preceding embodiment, wherein the gripper arm member of at least one gripper is connected to the support body by means of a hinging body, wherein the hinging body comprises a hinge arranged to rotate the body and the at least one gripper around an axis having a horizontal component.

12. System according to embodiment 11, wherein at least two gripper arm members of at least two grippers are connected to the hinging body for simultaneously rotating the two gripper arm members around an axis having a horizontal component.

13. System according to embodiment 11 or 12, wherein at least one gripper arm member is rotatable around an axis having a vertical component with respect to the hinging body.

14. System according to any of the preceding embodiments 11–- 13, comprising a first hinging body arranged parallel to the longitudinal axis of the support body, wherein one gripper member of at least two lifting grippers are connected to the first hinging body, and a second hinging body arranged parallel to the longitudinal axis of the support body, wherein the other gripper member of said at least two lifting grippers are connected to the second hinging body, wherein the second hinging body is arranged to rotate around an axis having a horizontal component.

15. System according to any of the preceding embodiments, wherein at least a first lifting gripper is movable between the closed and an open position independently from at least a second lifting gripper.

16. System according to any of the preceding embodiments, wherein at least one bin is formed by at least two support members arranged along a longitudinal direction, wherein each support member comprises a receptacle that is open in the upward direction to receive bars, wherein the receptacles of the support members of the at least one bin are arranged along the longitudinal direction, wherein the receptacles of the support members of the at least one bin define a volume,

wherein the lifting apparatus is movable between the bins in the lateral direction, perpendicular to the longitudinal direction.

17. System according to the preceding embodiment and at least embodiment 2, wherein the storage comprises at least two adjacent bins, wherein the receptacles of the two bins define two adjacent volumes extending at a mutual lateral distance, wherein the distance between the outermost points of at least one gripper in an open position with the gripper arm members having rotated around an axis having a vertical component to the open position is smaller than the sum of the width of a volume and double the mutual lateral distance between the volumes.

18. System according to at least embodiment 5 and 17, wherein a distance between the outermost points of the at least one gripper of the apparatus in an open position with the gripper arm members having rotated around an axis having a horizontal component is larger than the sum of the width of a volume and double the mutual lateral distance between the volumes.

19. System according to any of the preceding embodiments 5 - 18, wherein at least one gripper arm member is arranged to open and close by rotating the gripper arm members around the axis with a horizontal component to engage one or more bars in the processing device, and wherein the at least one gripper arm member is arranged to open by rotating the gripper arm members around the axis with a vertical component when depositing one or more bars in a bin.

20. Lifting apparatus as defined in any of the preceding embodiments.

21. Method for lifting one or more bars in a system according to any of the preceding embodiments, comprising the step of rotating one or more gripper arm members around an axis having a vertical component, preferably a substantially vertical axis, for moving at least one gripper between open and closed positions.

22. Method according to embodiment 21, comprising the step of rotating one or more gripper arm members around an axis having the vertical component for moving at least one gripper from the open position to the closed position.

23. Method according to embodiment 22, comprising the step of rotating one or more gripper arm members around an axis having the vertical component for moving at least one gripper from the open position to the closed position for engaging and lifting bars from a bin of the storage.

24. Method according to embodiment 21, 22 or 23, further comprising rotating one or more gripper arm members around an axis having a horizontal component, preferably a substantially horizontal axis, for moving at least one gripper between open and closed positions.

25. Method according to embodiment 24, comprising the step of rotating one or more gripper arm members around the axis having the horizontal component for moving at least one gripper from the closed to the open position for releasing bars held in the gripper.

Claims

1. System for processing bars, wherein the system comprises a processing device for processing one or more bars and a storage comprising a plurality of bins, wherein each bin is arranged for storing a plurality of bars, wherein the system further comprises a lifting apparatus for lifting one or more bars for transfer between the processing device and/or the bins of the storage, wherein the lifting apparatus comprises a plurality of lifting grippers for engaging the one or more bars, wherein at least one lifting gripper comprises two gripper arm members, wherein at least one gripper is movable between an open position arranged to receive or dispose the one or more bars and a closed position wherein the gripper arm members at least partially enclose the one or more bars, wherein at least one of the gripper arm members is rotatable around a rotation axis having a component in the vertical direction, preferably around a substantially vertical rotation axis, for moving between the closed and open position, wherein at least one of the gripper arm member is further rotatable around a rotation axis having a component in the horizontal direction, wherein the gripper arm member is preferably rotatable around a substantially horizontal rotation axis.

2. System according to claim 1, wherein two of the gripper arm members are rotatable around rotation axes having vertical components, preferably around substantially vertical rotation axes.

3. System according to any of the preceding claims, wherein two of the gripper arm members are rotatable around rotation axes having horizontal components, preferably around substantially horizontal rotation axes.

4. System according to any of the preceding claims, wherein at least one of the gripper arm members is rotatable around both a rotation axis having a vertical component, preferably a substantially vertical rotation axis, and a rotation axis having a horizontal component, preferably a substantially horizontal rotation axis.

5. System according to the preceding claim, wherein two of the gripper arm members are rotatable around a rotation axis having a vertical component, preferably a substantially vertical rotation axis, and around a rotation axis having a horizontal component, preferably a substantially horizontal rotation axis.

6. System according to any of the preceding claims, wherein the gripper arm member comprises an upper part and a lower part under an angle with respect to the upper part, wherein the gripper arm member is rotatable around an axis substantially coinciding with the longitudinal axis of the upper part.

7. System according to any of the preceding claims, wherein at least one gripper arm member comprises a substantially C-, J- or L-shaped member.

8. System according to any of the preceding claims 4 – 7, wherein the width of the projection of the gripper arm in the horizontal plane, in a direction perpendicular to the longitudinal axis of the one or more bars, is larger for the gripper arm having rotated to an open position around the axis having a horizontal component than for the gripper arm having rotated to an open position around the axis having a vertical component.

9. System according to any of the preceding claims, wherein the lifting apparatus comprises a substantially longitudinal support body, wherein the plurality of lifting grippers are arranged along the longitudinal axis of the support body.

10. System according to the preceding claim, wherein the gripper arm member of at least one gripper is connected to the support body by means of a hinging body, wherein the hinging body comprises a hinge arranged to rotate the body and the at least one gripper around an axis having a horizontal component.

11. System according to claim 10, wherein at least two gripper arm members of at least two grippers are connected to the hinging body for simultaneously rotating the two gripper arm members around an axis having a horizontal component.

12. System according to claim 10 or 11, wherein at least one gripper arm member is rotatable around an axis having a vertical component with respect to the hinging body.

13. System according to any of the preceding claims 10–- 12, comprising a first hinging body arranged parallel to the longitudinal axis of the support body, wherein one gripper member of at least two lifting grippers are connected to the first hinging body, and a second hinging body arranged parallel to the longitudinal axis of the support body, wherein the other gripper member of said at least two lifting grippers are connected to the second hinging body,

wherein the second hinging body is arranged to rotate around an axis having a horizontal component.

14. System according to any of the preceding claims, wherein at least a first lifting gripper is movable between the closed and an open position independently from at least a second lifting gripper.

15. System according to any of the preceding claims, wherein at least one bin is formed by at least two support members arranged along a longitudinal direction, wherein each support member comprises a receptacle that is open in the upward direction to receive bars, wherein the receptacles of the support members of the at least one bin are arranged along the longitudinal direction, wherein the receptacles of the support members of the at least one bin define a volume, wherein the lifting apparatus is movable between the bins in the lateral direction, perpendicular to the longitudinal direction.

16. System according to the preceding claim and at least claim 2, wherein the storage comprises at least two adjacent bins, wherein the receptacles of the two bins define two adjacent volumes extending at a mutual lateral distance, wherein the distance between the outermost points of at least one gripper in an open position with the gripper arm members having rotated around an axis having a vertical component to the open position is smaller than the sum of the width of a volume and double the mutual lateral distance between the volumes.

17. System according to at least claim 4 and 16, wherein a distance between the outermost points of the at least one gripper of the apparatus in an open position with the gripper arm members having rotated around an axis having a horizontal component is larger than the sum of the width of a volume and double the mutual lateral distance between the volumes.

18. System according to any of the preceding claims 4 - 17, wherein at least one gripper arm member is arranged to open and close by rotating the gripper arm members around the axis with a horizontal component to engage one or more bars in the processing device, and wherein the at least one gripper arm member is arranged to open by rotating the gripper arm members around the axis with a vertical component when depositing one or more bars in a bin.

19. Lifting apparatus as defined in any of the preceding claims.

20. Method for lifting one or more bars in a system according to any of the preceding claims, comprising the step of rotating one or more gripper arm members around an axis having a vertical component, preferably a substantially vertical axis, for moving at least one gripper between open and closed positions.

21. Method according to claim 20, comprising the step of rotating one or more gripper arm members around an axis having the vertical component for moving at least one gripper from the open position to the closed position.

22. Method according to claim 21, comprising the step of rotating one or more gripper arm members around an axis having the vertical component for moving at least one gripper from the open position to the closed position for engaging and lifting bars from a bin of the storage.

23. Method according to claim 20, 21 or 22, further comprising rotating one or more gripper arm members around an axis having a horizontal component, preferably a substantially horizontal axis, for moving at least one gripper between open and closed positions.

24. Method according to claim 23, comprising the step of rotating one or more gripper arm members around the axis having the horizontal component for moving at least one gripper from the closed to the open position for releasing bars held in the gripper.