Abstract:

An apparatus is described for assembling a shelving unit consisting of a frame (2) and a plurality of detachable shelves (4) supported by the frame. The apparatus comprises a supply section (22) for supplying a shelf, a testing section (24) for inspecting the supplied shelf, a positioning section (26) for gripping an approved shelf and subsequently mounting the shelf in the frame, and a control unit (28) for controlling the apparatus. It is used in particular for carts for the transport of plants.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
**Apparatus and method for assembling shelving units**

The current invention relates to an apparatus and a method for assembling or putting together shelving units, in particular trolleys for transporting flowers, plants and the like. The invention further relates to systems comprising in combination a plurality of such shelving units and an apparatus for assembling the shelving units.

Shelving units are known in various fields. Particularly in commercial fields, such shelving units may be assembled for use and subsequently require dismantling for the purpose of transport or storage. At certain locations, such as at the wholesaler's, this process may take place frequently and may involve considerable manpower.

It is known in the horticultural industry to use trolleys, sometimes referred to as "Danish carts" to transport flowers and other plants. These trolleys are in the form of mobile shelving units comprising a rectangular base of approximately 1 m by 50 cm, provided with wheels. Upright frame elements are inserted into sockets at the four corners of the base and a number of shelves or planks are supported by the frame elements. The shelves are provided with hooks or pins for engagement with appropriate slots in the frame elements. The number of shelves and their spacing will vary according to the plants being transported. It is estimated that 21 million of such trolleys are in operation worldwide and on average each trolley will rotate back to a central depot four times in a given year.

On returning empty to a depot, the trolleys are preferably knocked-down or dismantled to save space. The shelves are removed one by one from the frame elements by manipulating the hooks out of the slots. Each shelf may then be stacked, e.g. on an empty trolley. Broken or damaged shelves may be discarded or separated. Finally, the uprights are disengaged from the base and the bases and the uprights are stacked separately. This operation involves considerable manpower. At the moment that the market gardener is ready to harvest, a large number of trolleys needs to be put together again to receive the harvest for transport.

Putting together such trolleys is a complex operation. In particular, each trolley may be assembled differently with a different number of shelves and a different spacing between the shelves. Furthermore, different sorts of shelves have been produced and these are now randomly distributed throughout the industry. As a consequence, the shelves encountered in the assembly of a single individual trolley may vary from one another, e.g. in their width by
up to 2 cm. Additionally, the shelves may be deformed or broken and it may be difficult to insert them into the uprights of the base.

Clearly, there is a need to provide a system and an apparatus wherein at least part of the inconveniences arising when assembling such trolleys, may be overcome.

According to the present invention there is provided an apparatus for assembling a shelving unit consisting of a frame and a plurality of detachable shelves supported by the frame, the apparatus comprising: a supply section for supplying a shelf; a testing section for approving or rejecting the supplied shelf; a positioning section for gripping an approved shelf and subsequently mounting the shelf in the frame; and a control unit for controlling the apparatus. The control apparatus may control automatic or semi-automatic operation of the supply section, the testing section and/or the positioning section. By this combination of elements it can be provided that only approved shelves, which meet certain criteria, are mounted in the frame.

According to a preferred embodiment of the invention, the testing section may comprise correcting elements which grip the shelf with such a force to distort it to a desired pattern. Supplied shelves may be deformed to such an extent that they would no longer fit into the frame. In particular, they may be twisted or bent. Also, the support elements which rest on the frame, may be bent or even absent. Such deviations from a standard size may hamper or obstruct assembling a shelving unit. By gripping certain components of the shelf and by exerting a force, certain irregularities may be repaired. To be able to distort and correct the shelf, the correcting elements will preferably exert a force on the gripped section of at least 1000 N. Preferably, this force may even be over 2000 N. In general, the force exerted by the alignment elements will be more than 10 x the force that is necessary to only grip and move the shelf. It is noted that the testing section including the correcting elements may itself form the basis of an invention and that the apparatus may be used without the positioning section or with a simplified version thereof. The device may then function to test a supply of shelves and correct those shelves that deviate from the desired configuration; shelves that after correction still fail to meet the desired configuration being rejected. The accepted shelves may then e.g. be stored for subsequent use.

According to a further feature of a preferred embodiment, the shelf is provided with projecting pins that fit into slots in the frame. These pins are gripped by the correcting
elements such that bent pins are straightened. It will be clear that shelves and pins that do not deviate from the desired size or pattern, will not or hardly be bent.

Preferably, the testing section is further provided with one or more measuring elements, such that a number of dimensions of the shelf may be determined in the testing section. Possible dimensions may include: width, length, depth, degree of concaveness, curvature, torsion, the presence of an edge, position and presence of support pins and the like. The control unit is able to store a number of standard dimensions of a shelf in a memory. Subsequently, the testing section may compare the measured dimensions with the standard dimensions and reject a supplied shelf that deviates as such from the standard data. In a simple preferred alternative, the standard dimensions may be established mechanically by the positions of the sensors.

Shelves that do not meet predetermined requirements will be rejected by the testing section. To this end, the apparatus further comprises a removal facility capable of removing rejected shelves. This may be e.g. an empty cart that is parked under the testing section. On rejecting a shelf, the testing section may release the shelf such that it is dumped into the cart.

A particularly important feature is the centring or other such position determination of the shelf. In order for the shelf to be quickly and correctly mounted in the frame, its precise position and orientation with respect to a known reference point must be known. For a shelf mounted on pins, the positions of the pins are decisive. According to an important aspect of the invention, the testing section is able to determine the location of the shelf during the process of testing. To guarantee accurate handling of a shelf, such that it fits into the frame, preferably, a standardised or tested element of the shelf is then gripped in the positioning section. With shelves that are provided with projecting pins which fit into slots in the frame, preferably, the projecting pins are determined. The positioning section may then be provided with a number of gripping elements that grip the projecting pins. It is also possible that in the positioning section a shelf is gripped at another location, provided that the relative position of the gripped component relative to the pins or possible other support elements is well determined. Alternatively, this relative position may be determined by the positioning section or otherwise, prior to or during the mounting of the shelf in the frame.

In a preferred embodiment, the positioning section further comprises a lifting element to align the relative heights of a gripped shelf with its desired position in the frame. The lifting element may have the form of e.g. a robot arm, which is movable in all directions to position
a shelf from the testing section into the frame. In another alternative, the frame or even the testing section may be mounted on a lifting element for an up- and down-movement. Because of this, it can be provided that a shelf is essentially moved only horizontally from the testing section to the positioning section. This an extremely important factor in determining the speed of the apparatus.

It is also important to be able to level the heights of the individual components of the frame, before a shelf is fitted into the frame. To this end, the apparatus may comprise a levelling system to level the positions of the supports of the separate components of the frame. Certain frames may be provided with extension pieces for increasing the height of the frame. Means to correctly position and level these extension pieces may also be provided.

According to the preferred embodiment, the supply section supplies shelves, one by one, from a stack. The stack is located e.g. on a cart. The supply section may be a similar apparatus to that described in the Dutch patent application No. 1027987, the contents of which are incorporated herein in their entirety. According to that device, belts mounted over rollers grip the stack of shelves. The belts may be inflated to grip the shelves and may also be actuated to rotate such that the gripped shelves may be supplied to the upper side of the belts in a controlled manner. By supplying the shelves on the same level as the testing section, the speed of the apparatus may be maximized.

To put a supplied shelf in its position in the testing section, the supply section may also comprise an arm provided with suction cups. It may cooperate with the aforementioned supply belt or it may take shelves one by one from a stack. Instead of suction cups, depending on the construction of the shelves, other similar holding elements may be used, e.g. magnets.

The control unit may control the apparatus fully automatically. To this end, only e.g. the desired locations of the shelves in the frame should be indicated in advance, as well as the rejection parameters. It is also possible to work partly automatically as a result of which a driver may indicate each desired position of a shelf and also may generate a rejection signal based on measurements disclosed to him.

The current invention also provides a method for assembling a shelving unit, wherein the shelving unit comprises a frame and a plurality of detachable shelves supported by the frame, the method comprising: supplying a shelf to a testing section; measuring a number of features of the shelf and comparing the measurements with predetermined requirements; approving a shelf that meets the requirements; gripping the approved shelf; and mounting
the gripped shelf in the frame. In this way, because each operation may be carried out mechanically, such a shelving unit may be put together accurately and correctly with little effort and manpower.

As indicated above, the method may also comprise other steps, such as correcting deviating shelves and rejecting and removing shelves that do not meet the predetermined requirements. The step of mounting the approved shelves in a frame may also be omitted or performed e.g. manually at a later stage.

According to a preferred embodiment of the method, the measuring, approving, gripping, mounting and optionally also supplying a shelf, occurs at a substantially constant height, as a result of which movement of the shelf is reduced and an increased process speed may be realized.

The invention relates also to a system comprising a combination of a shelving unit or trolley, which comprises a frame and a plurality of detachable shelves supported by the frame, and an apparatus for assembling the shelving unit as described above.

An embodiment of the invention will now be described in more detail and will only serve as an example, with reference to the attached figures in which:

Fig. 1. shows in perspective a cart for flowers for use in the invention, including a detail of the connection between the shelf and the uprights;

Fig. 2. shows a schematic system overview of the components of an apparatus according to the invention;

Fig. 3. shows the supply section of a preferred embodiment of the invention;

Fig. 4. shows the testing section of the preferred embodiment of Fig. 3;

Fig. 4a shows the testing section such as in Fig. 4 when inspecting a shelf;

Fig. 5. shows the positioning section of the preferred embodiment of Fig. 3; and

Fig. 6. shows a plan view of the positioning section of Fig. 5.

Figure 1 shows a perspective view of a cart 1 of the type intensively used in the flower industry. The cart 1 comprises a frame 2 and a plurality of substantially planar shelves 4 mounted on the frame (for reasons of clarity only one shelf is depicted). In the current example the frame comprises a base 6 mounted on wheels 7. Each corner of the base has been provided with a socket 8 for receiving an upright 10. Although the invention will further be
described in relation to such a cart for flowers, it will be immediately apparent for the person
skilled in the art that the invention is also applicable to other forms of trolleys or shelving
units. In this respect, it is assumed that the term shelf is not restricted to simple planar shelves
or plates. The term shelf also comprises: shelving units; planks; baskets; cross elements and
other supporting parts that may be utilized in a shelving system.

As is shown in detail in Figure 1, each upright 10 comprises an essentially U-shaped groove
18 wherein the support surfaces 14 are directed inwardly. The support surfaces 14 are
provided with elongated vertical slots 12 and the shelves 4 are provided with pins 16 that fit
into the slots 12 to keep the shelves 4 at the desired height between the uprights 10. As will be
further described below, the uprights 10 may be removed from the sockets 8 for stacking the
cart 1 for transport or storage. The uprights 10 can also be inserted into the sockets 8 such that
the support surfaces 14 face outwardly. In this orientation the shelves 4 can be stacked on the
cart 1 such that the pins 16 slide in the open U-shaped groove 18 of the uprights 10. Although
not shown, extension pieces may be provided to optionally extend the uprights 10.

Figure 2 shows a schematic overview of the components of an apparatus 20 according to the
invention. The apparatus 20 consists of a supply section 22, a testing section 24, a positioning
section 26 and a control unit 28. Although in the following, reference will be made to
physically separate sections that perform each task separately and interact with one another, it
will be understood, that the sections may be integrated into combined sections that perform a
number of separate tasks.

A full cart 1 on which a number of shelves 4 are stacked, is located in the supply section 22.
The testing section 24 consists of a correcting section 34 and a measuring section 36.
Furthermore, a transport bin 38 is located underneath the testing section 24. A robot arm 40 is
located in the positioning section 26. Within reach of the robot arm 40 a second cart 1', is
positioned which, in this case, is in an uncompleted state. The control unit 28 is electronically
connected with the supply section 22, the testing section 24 and the positioning section 26.

Figure 3 shows in further detail the supply- 22 and testing sections 24 of a preferred
embodiment of the invention with a fully stacked cart 1. As can be seen in the details, the
uprights 10 are inserted into the sockets 8 such that the pins 16 of the shelves 4 slide into the
open U-shaped groove 18 of the uprights 10. For the sake of clarity, not all shelves 4 in the
cart 1 are depicted. A cart 1 may carry e.g. up to sixty shelves.
The supply section 22 includes a robot arm 30 and a supply system 42. The robot arm 30 is provided with suction cups 32 that are able to hold and to move a shelf 4 from the supply system 42. The supply system 42 comprises a number of gripping belts 46, mounted to rotate around a pair of rollers 48, 48'. Each belt 46 is operated by a drive (not shown) provided on the lower roller 48. The belt 46 is made of a resilient material. Within the space defined by the belt 46 and the rollers 48, 48' an inflatable tube 50 is located. The inflatable tube 50 is supported by a plate 52 on the side opposite to the shelves 4. The inflatable tube 50 may be inflated by means not shown, as a result of which the resilient belt 46 inflates and presses outwardly against the shelves 4. The distension of the belt 46 is sufficient to compensate for possible differences in size of the shelves 4. By operating the belts 46 to counter-rotate, the shelves 4 may be moved upwardly to the height of the robot arm 30.

To move a fully-stacked cart 1 into the supply section, the belts 46 can be opened or moved apart from each other. It is also possible to lower the belts 46 over the cart by rolling them down from above.

In Figure 4, the testing section 24 is shown more closely from which it can be seen that the correction section 34 consists of a frame 35 and four alignment elements 54. The frame 35 has a slot 53 with four hinged elements 66 of such a size that a shelf 4 in the slot 53 can be supported by the hinged elements 66. This can be seen in Figure 4a. The alignment elements 54 have the shape of a pair of tongs 56 that are operated by the force of a pneumatic cylinder 58. In a first position of the tongs 56 (Fig. 4) an opening is located to receive the pins 16 of a shelf 4. A shelf 4 can be put in the slot 53 on the hinged elements 66 by the robot arm 30 of the supply section. Subsequently, the pair of tongs 56 will close using a force of approximately 2000 N. Possible deviations of the pins 16 are thereby corrected. A precision of ± 2 mm for the pins is desired to ensure that they will fit well into the slots 12 in the uprights 10.

In Figure 4, a number of measuring elements of the measuring section 36 can also be seen. Each pair of tongs 56 is provided with a pin sensor 60 to guarantee the presence of a pin 16 in the pair of tongs 56. It may have the shape of a contact electrode, possibly in a plastic sleeve, that detects the metal pin 16. Also centering elements 61 are provided with sensors 62 that detect the presence of the metal strip forming the edge of the shelf. Curvature sensors 64 measure the deviation of the centre of the shelf from its desired position, as a result of which shelves that are undesirably curved may be rejected. Although not further described herein,
other sensors e.g. optical, video, contact, piezo, may be applied to determine e.g. the size, weight, cleanliness and otherwise the state of the shelves.

Under control of the control unit 28, the signals of the different sensors are registered. A shelf 4 satisfying the measurements is approved and subsequently supplied to the positioning section 26. A shelf 4 that does not satisfy one or more measurements is rejected. By folding away the hinged elements 66 and opening of the pair of tongs 56, the rejected shelf 4 drops into the waiting transport bin 38. The transport bin 38 may also be an empty cart and the shelf 4 may then be introduced in a controlled manner between the uprights 10.

In the embodiment shown in Figure 4, the sensors are mechanically adjusted feelers. This means that the position of the sensor itself determines the accuracy of the result. Therefore, by adjusting the curvature sensors 64 to a higher position, the tolerance for curvature of a shelf is reduced. In an alternative variant, instead of sensors, actual measuring elements may be used to measure all important dimensions and properties of the shelf 4 and to compare against predetermined standard dimensions. The standard dimensions and the acceptable tolerances are stored in a memory of the control unit as a pattern. The memory could then store several patterns for use with several dimensions or features of a cart. This could also possibly be indicated automatically e.g. by a label or bar code on the shelves.

Figure 5 shows in more detail the positioning section 26 according to the invention. The positioning section 26 comprises a robot arm 40 and a lifting element 68. The robot arm 40 is provided with a gripping part 70 that ensures gripping of the shelf 4. A cart to assemble 1' is mounted on the lifting element 68. By using the lifting element 68, it is possible to move the cart 1' upwards and downwards such that slots 12 for the next shelf 4 to be mounted are always at the same height. This height is then preferably adjusted to the height of the frame 35 of the testing section 24. To ensure that the slots 12 in all four uprights 10 are in the same position, the lifting element 68 is provided with calibration elements 74. The calibration elements 74 register the height of the bottom slot 12 in each upright 10 and transmit it to the control unit 28. By doing so, the uprights 10 may be independently adjusted to the same height by not further specified adjusting facilities. Of course, other ways of adjusting the uprights 10 may also be envisaged.

In Figure 6, a plan view of the positioning section 26 is shown. It can be seen that the gripping part 70 comprises four gripping elements 72 each gripping a pin 16 of the supplied shelf 4. Because the shelf 4 has been inspected closely, the positions of these pins 16 are
known. Also, to fit between the uprights 10 of the cart 1', the gripping part 70 has a size which corresponds substantially with the size of a shelf 4.

With reference to Figures 5 and 6, an approved shelf 4 is gripped by the robot arm 40 from the testing section 24, firstly by a short movement C upwardly over the frame 35. Subsequently or simultaneously, the shelf 4 is tilted D over an angle of 20 degrees. In this position, enough room arises to move the shelf 4 forward E between the uprights 10 of the waiting cart 1'. In a first lateral movement F, the pins 16 are fitted into the slots 12 on the lowest edge. Subsequently, by tilting back G and a second lateral movement H of the shelf 4, the other pins 16 are fitted into their slots 12. By avoiding as much as possible vertical movements of the shelf 4, the transfer from the testing section to the frame can be performed in less than 7 seconds.

The above examples illustrate preferred embodiments of the current invention. It should be noted that several other arrangements and alternatives may also be considered that fall within the spirit and scope of the invention, as defined in the attached claims.
Claims

1. Apparatus for assembling a shelving unit comprising a frame and a plurality of detachable shelves supported by the frame, the apparatus comprising:
   - a supply section for supplying a shelf;
   - a testing section for approving or rejecting the supplied shelf;
   - a positioning section for gripping an approved shelf and subsequently mounting the shelf in the frame; and
   - a control unit for controlling the apparatus.

2. Apparatus according to claim 1, further comprising correcting elements arranged to grip the shelf with a force sufficient to distort it into a desired pattern for approval by the testing section.

3. Apparatus according to claim 2, wherein the correcting elements are arranged to grip the shelf with a force of at least 1000 N.

4. Apparatus according to claim 2 or claim 3, wherein the shelf is provided with support elements which fit on supports in the frame and wherein the correcting elements are arranged to grip the support elements.

5. Apparatus according to any of the preceding claims, wherein the testing section further comprises a measuring element.

6. Apparatus according to claim 5, wherein the testing section is able to determine a number of dimensions of the shelf, selected from the group consisting of: width; length; depth; degree of concavity; curvature; torsion; the presence of an edge; and the position and presence of support elements.

7. Apparatus according to claim 6, wherein the control unit stores a number of standard dimensions of a shelf and the testing section compares the dimensions with the standard dimensions and rejects a supplied shelf that deviates from the standard data.

8. Apparatus according to any of the claims 1 to 6, wherein the testing section comprises a number of sensors and the sensors are mechanically adjustable.

9. Apparatus according to any of the preceding claims, further comprising a disposal section for removal of the rejected shelves.
10. Apparatus according to any of the preceding claims, wherein the shelf is provided with support elements which rest on supports in the frame and wherein the positioning section comprises gripping elements which grip the support elements.

11. Apparatus according to claim 11, wherein the frame consists of separate components that are each provided with supports, the apparatus further comprising a levelling system to level the heights of the supports of the separate components of the frame.

12. Apparatus according to any of the preceding claims, wherein the positioning section further comprises a lifting element for lifting the frame such that a gripped shelf may be mounted at a height in the frame which is substantially in accordance with the height of the testing section.

13. Apparatus according to any of the preceding claims, wherein the supply section supplies the shelves one by one from a stack, preferably at substantially the same height as the testing section.

14. Apparatus according to claim 13, wherein the supply section comprises two belts mounted over rollers, between which belts the stack of shelves can be gripped, which belts may be actuated to rotate such that the gripped shelves may be supplied in a controlled manner.

15. Apparatus according to any of the preceding claims, wherein the supply section comprises suction cups for placing a shelf in the testing section.

16. Method for assembling a shelving unit, the shelving unit comprising a frame and a plurality of detachable shelves supported by the frame, the method comprising:
    supplying a shelf to a testing section;
    testing a number of features of the shelf and comparing the features with predetermined requirements;
    approving shelves that meet the requirements;
    gripping the approved shelf; and
    mounting the gripped shelf in the frame.

17. Method according to claim 16, further comprising distorting the shelf to optionally adjust it to the predetermined requirements.

18. Method according to claim 17, wherein the distortion of the shelf occurs by gripping a part of the shelf with a correcting element with a force of more than 1000 N.
19. Method according to either of the claims 17 or 18, further comprising rejecting and removing shelves that do not meet the predetermined requirements.

20. Method according to any of the claims 16 to 19, in which the checking, approving, gripping, mounting and optionally also supplying of a shelf occurs substantially at a constant height.

21. Method according to any of the claims 16 to 20, further comprising locating the shelf to determine its position prior to mounting the shelf in the frame.

22. System comprising a combination of a shelving unit, having a frame and a plurality of detachable shelves supported by the frame, and an apparatus for assembling the shelving unit according to one of the claims 1 up to and including 15.

23. System according to claim 22, wherein the shelving unit comprises a trolley provided with several wheels.

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A. CLASSIFICATION OF SUBJECT MATTER

INV. A01G9/14 B65G61/00 B23P19/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01G B65G B23P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and where practical search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C

See patent family annex

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Name and mailing address of the ISA:
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Authorized officer: Moeremans, Benoit
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## INTERNATIONAL SEARCH REPORT

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