

Warehouse loading machine

The subject of the patent is a warehouse loading machine for the handling of goods stored in a suspended manner in an automated warehousing system, including a frame structure consisting of posts and beams, a forklader unit to receive the goods and a loading unit equipped with hooks.

There are automated warehousing systems, known from literature, with end points functioning as loading or dispatching stations.

Patent announcement document No. US 2021/130094 A1 describes a loading station for the loading and unloading of unit packages in a warehousing system built as a three-dimensional modular network. The warehousing system has transport equipment that carry a line of unit packages between the loading position and the storage position, enabling an operator to manually load into, or unload from, the packages.

Patent announcement document No. US 2011/142581 A1 describes a product dispatching station that allows manual dispatch of individually packaged products in accordance with an individual order sequence. The products are transported automatically in boxes, sorted according to type, after the products in question have been identified. Then a belt conveyor carries the packages to the appropriate track of a spatial series of chutes, at the endpoint of which the operator manually forwards the package the type of which matches the order.

The above solutions, however, are not suitable for the individual handling of products, as they have been designed for storing volumes of goods packed in packaging units. On the other hand, these pieces of equipment have been developed for boxed packages and not for suspended products.

Patent announcement document No. US 2001/051085 A1 describes a multi-level storage system for the suspended storage of goods, primarily garments on coat hangers, whose automated loading unit is built in the form of an elevator stand rolling on rails, moving a unit volume of coat hangers hung on beams horizontally, loading into and lifting them out of spaces at predefined locations of the warehousing system.

Patent announcement document No. WO 2023/178405 A1 describes an automated warehousing and retrieval system for the storage of suspended products, primarily garments on coat hangers. The system has a loading/picking station supervised by an operator, where an automatically operated, tracked transport vehicle enters, and which the operator fills with suspended products. The transport vehicle rolls with a unit load to a specific point of the warehouse, where a loading machine, moving likewise on a tracked path, transfers the load to

the desired position. Upon dispatch of the product, the operation is performed in reverse order. The latter two warehouse systems have already been developed for the storage, handling, loading, and unloading of suspended products, but these solutions have been designed for the handling of a specific type of goods in predetermined quantities, and as such are not capable of handling products individually, regardless of their type and quantity.

By developing our invention, our objective was to devise a warehouse loading machine that is capable of receiving the products in an automated warehousing system individually, regardless of type and size, and load them onto a common transport vehicle.

In line with this, our objective was to design a loading machine that allows individual storage of suspended goods, with the products loaded independently of type and size, such that the loading machine is capable of forwarding a randomly mixed group of products towards a transport vehicle, as well as is capable of reloading a consignment selected from individually arriving goods in a precisely traceable and documentable way, the machine thereby combining the advantages of individual manual loading and automated warehousing.

The solution of the target task is given by the loading machine specified in claim 1. The advantageous solutions of the invention are represented by the variants specified in claims 2 - 9.

Hereinafter, the invention is introduced by means of figures, wherein

Figure 1 is the schematic perspective view of the loading machine,

Figure 2 is the schematic perspective view of the loading machine,

Figure 3 is the perspective view of the forkloder unit,

Figure 4 is the perspective view of the loading unit,

Figure 5 is the perspective view of the fork,

Figure 6 is the perspective view of the forkloder unit's eccentric cam,

Figures 7 and 8 show two different types of hangers,

Figure 9 shows the operation of the forkloder unit,

Figure 10 illustrates the operation of the hooks of the mobile hanger holder schematically, while

Figures 11 and 12 illustrate the operation of the equipment schematically.

Figures 1 and 2 show a schematic drawing of the elements of the loading machine, with the frame structure consisting of posts 101 and beams 102, which carry loading unit 2, its linear actuator units, and forkloder unit 1, whose one end is connected to the linear actuator unit mounted on the frame structure with its other end holding a suspender element 12 connected

to another element of the storage system, in the given case a schematically illustrated frame 103, which does not form part of the invention. This other equipment may be the labelling machine mentioned in the following. The loading machine practically places the moved goods on material handling machines (hereinafter: transport carriages) moving on suspended tracks. For this, the material handling machines move along tracks that are connected to the loading machine and are practically equipped with suspension points, on which the loading machine can hang the products stored in a suspended manner. For the sake of better clarity of the figures, the material handling machine designed this way and the suspended track are not included, and only the suspension points 19 serving to hang the products and the hooks 20 on them are shown in the figure. The figures also show a fitting cabinet 104, which contains the electronic control system elements of the loading machine.

As the loading machine being the subject of our study may, for example, be operated in a fully automated warehouse, we note for the sake of completeness, that it is applied in automated merchandise handling warehouses in which products are stored in a suspended manner on the warehouse racking system. The product first arrives to a labelling station (not shown), where the products in the unit package, e.g. ten light bulbs packed in a single box, are unpacked, and every product receives an individual label, i.e. a unique identification code is placed on the product. Then, a hanger is placed on it, e.g. the hanger 30 shown in Figures 7 and 8. The product equipped with a hanger is put on the fork of the present loading machine 4. Then, optionally, a device may determine the three dimensions of the product hung on the fork 4, e.g. with the use of several light panels, illuminating the product from multiple sides, while the three dimensions of the product are determined by cameras positioned at the sides and on top, using the light blockage method. Based on the determined size, the control system of the warehouse creates a task, designating which storage space a particular product with a particular label fits into, and the product is placed in there. The product is taken to the given storage space by a transport carriage, e.g. a carriage on an overhead conveyor, a so-called "shuttle". The task of the loading machine being the subject of the present invention is to load the products hung on the forks 4 onto the transport carriage. The labelling station and the transport carriage are not part of the invention, but it is necessary to include them in the description for the better understanding of how the loading machine being the object of the invention functions.

Figure 3 shows the position and design of the forkloder unit 1. It contains an arm 3, whose farther end is connected by means of a suspension element 12 to an element of the racking system, e.g. the frame 103 of a labelling station. The suspension element 12 includes a vertical

pin not shown in the figure, around which the arm 3 can rotate in a horizontal plane. A connecting member 6 is mounted to the other end of the arm 3, which is connected to the linear actuator unit installed on the frame structure. The linear actuator unit in the present case consists of a linear rail 24, a linear carriage 25 and a toothed belt 7 driven over toothed pulleys 8, powered by the motor 31.

The connecting member 6 is connected to the toothed belt 7 by the fastener 26. The overrun of the connecting member 6 and the linear carriage 25 on the linear rail 24 are prevented by stoppers 27. Fork 4 is connected through a linear actuator unit to the arm 3, which linear actuator unit, in the present case, consists of a linear rail 28, a linear carriage, a toothed belt 13, cooperating with toothed pulleys 14, and which are driven by the drive motor 11. The fork 4 is connected to the toothed belt 13 with the fastener 32, to enable the fork 4 to move on the linear rail 28. The overrun of the fork 4 and the linear carriage 29 on the linear rail 28 are also prevented by stoppers in this case (the stoppers are not shown). The product to be loaded on to fork 4 is suspended by means of a hanger 30. Figures 7 and 8 show two variants of such hangers 30. We note in advance that the product hung on the fork 4 is moved by the motor 11 through the toothed belt 13 towards the frame structure, which then hangs the product on one of the hooks 9 described below. From the hooks 9 arranged in a row, the control system selects a particular hook 9, and the toothed belt 7, by means of the connecting member 6, turns the arm 3 into the desired angular position in a horizontal plane, allowing the fork 4 moving forward to hang the product onto the appropriate hook 9. Therefore, before the fork 4 begins to move towards the selected hook 9, the arm 3 rotates in a horizontal plane along a circular path towards the particular hook 9, as shown in Figure 9. As a result of the circular motion, the frame structure end of the arm 3 moves away from the given beam 102, therefore the connecting member 6 connects to the arm 3 with a pin 22 that slides out of the arm 3 and back into it, therefore the movement of the pin 22 ensures the necessary change of length for the fork unit. Pin 22 moves in the slide bearing 33 placed on the connecting member 6, which, due to the pin capable of sliding in and out, enables the angular change brought about by the horizontal movement of the arm 3 between the connecting member 6 and the arm 3. The fork 4 is designed so that it can extend in any position of the arm 3, at every point of its curved trajectory from the arm's end 2 to the target hook 9, and is able to tilt it. Therefore, fork 4 can carry the product to any of the hooks 9 hung in a row on the mobile hanger holder 10.

Figure 4 shows the position of the loading unit 2 in the frame structure. Tilting arms 35 are connected to beams 101 of the frame structure with axles in bearing housings 42, axles in

bearing housings 43, and eccentric cams 51. The tilting arm 35 is equipped with linear rails 36, with linear carriages 37 running on the linear rails 36, toothed belts 15 driven over toothed pulleys 16, and a motor 21, which together form linear actuator units. The linear carriages 37, the mobile hanger holder 10 and the toothed belts 15 are connected with the fasteners 38 and 39. The overrun of the mobile hanger holder 10 and the linear carriages 37 on the linear rails 36 are prevented by stoppers 48. The toothed pulleys 16 and the toothed belts 15 are powered by the motor 21. To enable the driving of the toothed belts 15 on both tilting arms 35, the rotational motion of the motor is transferred between the tilting arms 35 with an axle 40. The props 23 are mounted on the mobile hanger holder 10, with the hooks 9 suspended on the props 23 with pins 17 such that the hooks 9 can be tilted forward around the pins 17 in a vertical plane.

Upon loading products, an operator or an automatic machine hangs the product with a hanger 30 onto the fork 4. The fork 4 travels forward with the product on the arm 3 by means of the toothed belt 13 such that it contacts the hook 9 and tilts it forward into a quasi-horizontal position. The fork 4, still moving forward slightly with the product, moves past underneath the hook 9, so the hook 9 turns back into its original vertical position. The rear surface of the hanger 30 of the product on the fork 4 starting to move back is caught in the hook 9, now already in vertical position, which then pulls the product off the prong 5 of the fork 4. The product is thereby transferred onto hook 9. The particular product then remains in suspended position with the hanger 30 on the particular hook 9. The hook 9 is mounted such that it is free to rotate about the pins 17 up to approximately the horizontal position, but is propped up in vertical position when moving rearwards, therefore the hanger 30 hung on the hook 9 and the product along with it are held stable in this position, preventing the product from falling down.

The tilting arms 35 are designed such that, on their forklower unit 1 sides, they connect to the beams 101 via axles in bearing housings 42. The tilting arms 35 can therefore tilt about the axles in the bearing housings 42 as pivots (they can be lifted and lowered). The tilting arms 35 on the sides farther from the forklower unit 1 connect to the beams 101 via axles 43 in bearing housings and eccentric cams 51. To lift and lower the tilting arms 35, the eccentric cams 51 are rotated by the toothed belts 47, driven over the toothed pulleys 45. The toothed belts 47 are run by the motor 41. In order to enable the rotation of the eccentric cams 51 connected to both tilting arms 35, the rotational motion of the motor 41 is transferred to the two sides of the loading machine by the axle 46 and the bearing 44.

Figure 5 shows the perspective view of the fork 4. The fork 4 is connected to the linear actuator

unit placed on arm 3. The linear actuator unit is, in the present case, a linear rail 28 with a linear carriage 29, a toothed pulley and a toothed belt connected to it. A further element of the fork 4 is a prong 5, whose upper flange has a groove in it. The hanger, hung on the prong 5, such as the hanger 30 shown in Figure 7, carrying the product not shown in the figure, rests in this groove. The prong 5 is bordered by the frameplates 18, whose task is to protect the hanger 30 and the product suspended on it, and to orient the movement of the fork if required.

Figure 6 shows details of the eccentric cams 51 of the forklower unit 2. The eccentric cams 51 are connected to the beam 101 with axles installed in bearing housings 43. The eccentric cams 51 can therefore be rotated about pivots 34 with toothed belts 47 driven over toothed pulleys 45. Offset from the pivot 34, an axle 50 is driven through the eccentric cams. The axle 50 is also driven through the groove 49 created in tilting arm 35. The axle 50 is able to slide in the groove 49. By rotating the eccentric cam 50, the axle offset from the pivot 34 moves in the groove 49, lifting or lowering the tilting arm 35.

Figures 7 and 8 show two variants of the hangers 30; Figure 7 shows a so-called “hanger with foot”, while Figure 8 shows a so-called “hanger with hook”. The hangers may be of several other possible designs, for example, the width of the hanger 30 may be increased and so the front plate of the hanger will have several cutouts (windows) adjacent to one another.

Figure 10 shows the design of the hook 9. As shown in the figure, the hook 9 is connected to the mobile hanger holder 10 by means of a prop 23 so that it is able to rotate about the pin 17 implanted into the prop 23; it is able to tilt forward up to about the horizontal position – when the fork 4 contacts it and pushes it forward – then, as the fork is moved slightly further forward, the hook drops back against the prop 23 into vertical position, and does not tilt further back, but it is stopped by the prop in vertical position instead.

Figures 11 and 12 provide a schematic illustration of the operation of the warehouse loading machine. According to Figure 11.A, an operator or an automatic machine hangs the product fitted with a hanger 52 onto the fork 4. Then, optionally, a device may determine the three dimensions of the product hung on the fork 4, e.g. with the use of several light panels, illuminating the product from multiple sides, while the three dimensions of the product are determined by cameras positioned at the sides and on top, using the light blockage method. After determining the size, the control system selects a particular hook 9 from among the hooks 9 arranged in a row, and the arm 3 is turned into the desired angular position in a horizontal plane, allowing the fork 4 traveling forward to move the product towards the appropriate hook

9. Therefore, before the fork 4 begins to move towards the selected hook 9, the arm 3 rotates in a horizontal plane along a circular path towards the particular hook 9, as shown in Figure 9. Since the operator – for example, after labelling – hangs the products individually onto the fork 4, which likewise take them and hang them onto the hooks 9 of the mobile hanger holder 10 one by one, the mobile hanger holder 10 also functions as a buffer storage unit, i.e. it remains stationary until goods are hung on all hooks 9, and until the full width of the mobile hanger holder 10 between the beams 102 are filled up with goods. The selection of the direction of the fork 4, the positioning of the products, and other movement operations are carried out by the control system of the warehousing system, for example, by using the data of the size determination unit mentioned above.

It is noted at this point that, depending on the size of the product in question, one product may occupy the space of several hooks 9. In case of narrow products, a product is hung on every hook 9, but wider products may occupy spaces of several hooks. Based on the data of the aforementioned size determining device, the machine's control system determines the positions of the products on the mobile hanger holder 10. In case of narrow products, for example, the fork 4 will be moved by the toothed belt 7 product by product towards the hooks 9, and therefore the fork 4 will be able to fill up the mobile hanger holder 10 with products one by one.

Buffer-type storage is necessary so as to prevent the mobile hanger holder 10 carrying one product only, but move a particular group of products towards the transport carriage instead (not part of the invention). A significant part of the transport carriage is not included in the figure, and only the row of hooks 20 and the machinery part holding it are shown.

According to Figure 11.B, to hang the product 52 on the hook 9, the fork 4 moves forward on the arm 3 so the product 52 and the hanger 30 contacts the selected hook 9 and tilts it forward into quasi-horizontal position. According to Figure 11.C, the fork 4, still moving forward slightly with the product, moves past underneath the hook 9, so the hook 9 turns back into its original vertical position. After this, according to Figure 11.D, the rear surface of the hanger 30 of the product on the fork 4 starting to move back is caught in the hook 9, now already in vertical position, which then pulls the product off the prong 5 of the fork 4. The product is thereby transferred to the hook 9. The given product then remains in suspended position with the hanger 30 on the particular hook 9

The transfer of the product onto the hooks 20 takes place similarly to the motion sequence described above. According to Figure 12.A, the tilting arms 35 are tilted upwards by means of

the eccentric cams around the pivoting point created by the bearing housing 42, creating a sloping track thereby. According to Figure 12.B, by moving the mobile hanger holder 10, the hooks 9 are moved towards the hooks 20. The mobile hanger holder 10 approaches the hooks 20 in a position lifted by the eccentric cam 51. When elevated, the position of the hooks 9 has been determined such that the hangers of the products on the hooks 9 moving forward are driven onto the hooks 20. Therefore, in this position, the product 52 is hung on the hanger 9, but the hook 20 is also driven through the hole of the hanger. Then, according to Figure 12.C, the eccentric cam 51 turns, and lowers the mobile hanger holder 10. As a result of this motion, a reverse of the D position is brought about. The product is already hanging on the hook 20, but the hook 9 is also driven through the hole in the hanger. After this, the hook 9 can be driven out of the hanger 30, and the now empty mobile hanger holder 10 can be driven back to its original position. The products have now been hung on hooks 20.

It is noted at this point that, in the present form of implementation, the linear actuator units have been presented by means of toothed pulley and belt drives, but the same can be constructed from compact linear units as well, for example, pneumatic, electric or mechatronic linear actuators, ball screw mechanisms, or similar custom drives.

The advantages of the warehouse loading machine according to the invention are the following:

- it enables the individual storage of suspended products,
- products may be loaded regardless of type and size,
- a transport carriage can forward an arbitrary mix of products from the loading machine,
- the equipment is able to transfer units picked from individually arriving products in a precisely traceable and documentable manner
- the equipment combines the advantages of manual, individual loading and automated warehousing.

List of reference codes:

- 1 forkloder unit
- 2 loading unit
- 3 arm
- 4 fork
- 5 prong
- 6 connecting member
- 7 toothed belt
- 8 toothed pulley
- 9 hook
- 10 mobile hanger holder
- 11 motor
- 12 suspension element
- 13 toothed belt
- 14 gear
- 15 toothed belt
- 16 toothed pulley
- 17 pin
- 18 frameplate
- 19 suspension point
- 20 hook
- 21 motor
- 22 pin
- 23 prop
- 24 linear rail
- 25 linear carriage
- 26 fastener
- 27 stopper
- 28 linear rail
- 29 linear carriage
- 30 hanger
- 31 motor
- 32 fastener
- 33 slide bearing

34 pivoting point
35 tilting arm
36 linear rail
37 linear carriage
38 fastener
39 fastener
40 axle
41 motor
42 bearing housing
43 bearing housing
44 bearing housing
45 toothed pulley
46 axle
47 toothed belt
48 stopper
49 groove
50 axle
51 eccentric cam
52 product
101 post
102 beam
103 rack
104 fitting cabinet

Claims:

1. A warehouse loading machine for the handling of goods stored in a suspended manner in an automated warehousing system, including a frame structure consisting of posts (101) and beams (102), a forklader unit (1) to receive the goods and a loading unit (2) equipped with hooks, characterised in that

the forklader unit (1) includes an arm (3) rotating horizontally about a suspending element (12), a loading fork (4) moving longitudinally along this arm (3) and a member (6) connected to the said arm (3), which is also connected to a horizontal linear actuator unit mounted to a beam (102) of the said frame structure,

the loading unit (2) includes a mobile hanger holder (10), onto which hooks (9) cooperating with the fork (4) are suspended, and the mobile hanger holder (10) is connected to a linear actuator unit placed on tilting arms (35) in a tilt able manner.

2. A loading machine according to claim 1, characterised in that the connecting member (6) connects to the arm (3) by means of a pin (22) extendable from the arm and a slide bearing (33).

3. A loading machine according to claims 1 or 2, characterised in that the linear actuator unit connected to the connecting member (6) consists of a linear rail (24), a linear carriage (25) and a toothed belt (7), connected to a motor (31) by means of toothed pulleys (8).

4. A loading machine according to any of claims 1 - 3, characterised in that the linear actuator unit connected to the mobile hanger holder (10) consists of a linear rail (36), a linear carriage (37) and a toothed belt (15), connected to a motor (21) by means of toothed pulleys (16).

5. A loading machine according to any of claims 1 - 4, characterised in that the fork (4) is connected to the arm (3) with a linear actuator unit, which is connected to a motor (11), and the linear actuator unit consists of a linear rail (28), a linear carriage (2) and a toothed belt (13), connected to a motor (11) by means of toothed pulleys (14).

6. A loading machine according to any of claims 1 - 5, characterised in that the linear actuator installed on the frame structure consists of a linear rail (24), a linear carriage (25), a toothed pulley (8) and a toothed belt (7), and the connecting member (6) is connected with a fastener (26) to the toothed

belt (7) and the connecting member (6) is connected to the arm (3) by means of a pin extendable from the said arm (3) and a slide bearing (33).

7. A loading machine according to any of claims 1 - 6, characterised in that the mobile hanger holder (10) is connected to the linear actuator units placed on tilting arms (35), to which a drive motor (11) is connected, and the hooks (9) are hung on horizontal pins (17) on the mobile hanger holder (10) in a way enabling them to tilt about the pins in a vertical plane, and the tilting range of the hooks (9) is limited between the vertical and the horizontal position.

8. A loading machine according to claim 7, characterised in that linear actuator units placed on the tilting arms (35) consist of linear carriages (37), linear rails (36) and toothed belts (15), which toothed belts are driven over toothed pulleys (16) supported by bearings on the tilting arms (35), and the fasteners (38, 39) of the mobile hanger holder (10) fasten them to the toothed belts (15) and the linear carriages (37).

9. A loading machine according to any of claims 1 - 8, characterised in that the end of the tilting arms (35) nearer to the fork (4) are connected to the post (101) with axles driven through the bearing housing (42) in a tilt able manner.

10. A loading machine according to any of claims 1 - 9, characterised in that the end of the tilting arms (35) farther away from the fork (4) are connected to the post (101) with eccentric cams (51), and the eccentric cams (51) are connected to the motor (41) with toothed belts (47) driven over toothed pulleys (45).

11. A loading machine according to any of claims 1 - 10, characterised in that a toothed belt (15) is connected to the motor (21) and an axle (40) supported by bearings is connected to the toothed belt (15).

12. A loading machine according to any of claims 1 - 11, characterised in that a toothed belt (47) is connected to the motor (41) and an axle (46) supported by bearings (44) is connected to the toothed belt (47).

13. A loading machine according to any of claims 1 - 12, characterised in that the mobile hanger holder (10) is equipped with props (23) and the hooks (9) are suspended from the props (23) such that they are able to tilt about horizontal pins (17) in a vertical plane, and the tilting range of the hooks (9) is limited between the vertical and the horizontal position.