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STACKER CRANE

The invention relates to a stacker crane unit.

A stacker crane unit is known from European Patent 0329642 for loading containers onto or removing containers from shelves with a trolley or carriage displaceable horizontally on a rail. The trolley has a vertical mast, which is guided at its upper end on a further rail. A platform is vertically displaceable along the mast. A load accommodating means is arranged on the elevating platform, which can be extended and retracted horizontally by means of a drive motor arranged on the elevating platform. Stationarily arranged drive motors are provided for driving the mast in the horizontal direction and the elevating platform in the vertical direction. Power transmission from the drives to the travelling device and the elevating platform is effected via flexible drive elements, which may be especially cables, chains or toothed belts, the elements being guided by means of guide rollers.

Since the mast is driven only on one side via the lower trolley and is guided only at its tip, it is subject to oscillation stress during travel. This stress has therefore to be taken into account in the choice of dimensions for the entire mast and trolley, especially the transition therebetween.

European Patent Application. 0241189-A2 describes a stacker crane unit with a vertical elevating mast for loading shelf with small containers, especially video cassettes. The mast is horizontally displaceable, being guided at its upper and lower ends via linear ball bearings and driven by a drive mechanism. The drive mechanism is fixed to the ends of the elevating mast twice at the sides thereof in the direction of travel and is guided by means of a plurality of rollers to a stationary drive arranged outside the displacement path of the storage and retrieval unit.

Because the drive element is frequently deflected, this type of drive is only suitable for apparatuses of small structural size, i.e. with a small absolute drive

element length, since only then are the drive forces evenly distributed at the two ends of the mast so that no inclination of the mast can arise.

German Utility Model 8607621 describes a palletizer for vertical movement of goods. The palletizer consists substantially of a stationary rectangular support frame, between whose vertical masts there is guided an elevating platform. A horizontally extendable fork is arranged on the elevating platform. Drive of the elevating platform and the fork is effected via a common drive motor. The drive motor drives a shaft arranged at the upper end of the support frame and running horizontally between the masts. When viewed from the drive motor, the shaft has arranged on it a first chain wheel, followed by a clutch and a second chain wheel with a braking device. The first chain wheel drives the fork via a revolving chain when the clutch is disengaged and simultaneously the braking device is actuated. When the clutch is engaged, the second chain wheel drives a chain which is fastened on the one hand to the elevating platform and on the other hand to a counterweight.

Although a common drive is provided for the elevating platform and the fork, this drive is effected via two separate chains, the second chain being connected with a counterweight, and a clutch arrangement is necessary between the chain wheels.

An elevator tower for garages is known from German Patent 1235560, which tower can be displaced horizontally in front of or between storage area rows arranged on several storeys. The vertical elevator tower is provided at one end with a drive which drives the tower via a roller supported on a rail. With very high towers, a parallel cable guide may be used in addition to this drive force transmission. This parallel cable guide consists of two drive elements tensioned horizontally and in parallel with the direction of travel of the tower as well as at their ends, the drive elements being in working connection with

deflection rollers arranged at each end of the tower. A further endless drive element connects the deflection rollers together. Although this document discloses the transmission of forces by means of a parallel cable guide, it relates to a different type of elevator tower and only to attenuation of oscillations arising from the travel motion of the tower.

Amongst the objects of the invention is the provision of a structurally simple stacker crane unit with improved travel properties, especially higher travel speed and better start-up and braking speeds.

A stacker crane unit, in accordance with the invention, comprises a vertical mast displaceable horizontally by at least one trolley, a vertically displaceable elevating platform guided on the mast, an extension unit arranged on the elevating platform for loading and unloading, a driven roller on the elevating platform for moving the extension unit, an endless drive element connected with the elevating platform and drivable by means of a drive roller arranged at the mast foot around a guide roller arranged in the area of the mast tip, the drive roller and the driven roller, and, a stop brake between the mast and the elevating platform, for preventing vertical displacement of the elevating platform along the mast, wherein the driven roller may be braked to allow transmission of the lifting force from the drive element to the elevating platform for vertical displacement thereof or the elevating platform can be fixed by means of the stop brake for movement of the extension unit, the driven roller thereby being released.

An advantage of this is that, through the use of only one drive for the elevating and extension movements in conjunction with two braking means arranged on the elevating platform, elimination of a further drive assembly for the extension movement is achieved. A considerable weight saving thereby results for the storage and retrieval unit, which has a particularly advantageous effect on the

travel properties of the stacker crane unit.

Preferably the stop brake is fixed to the elevating platform and connected with a stop gear, the stop gear being an engagement with a stop element arranged parallel to the longitudinal direction of the mast. A particularly suitable form for the stop element is as a chain.

The introduction of the braking force from the stop brake into the mast via a stop gear connected with the stop brake and a chain engaged with the latter and arranged on the mast is particularly advantageous as it leads to an especially play-free fastening of the elevating platform on the mast. In this way, a high degree of positioning precision of the elevating platform is made possible.

In a preferred embodiment the drive element is deflected in the area of the driven roller by means of two further guide rollers on the elevating platform in such a way that the drive element contacts the driven roller over at least 45° . The drive element may be a toothed belt.

The guidance of the drive element by means of deflecting guide and drive rollers arranged on the elevating platform for the movement of the extension unit, in such a way that the drive roller is contacted as far as possible by the drive element, and by at least approximately 45° , ensures reliable introduction of the forces from the drive element into the drive roller.

The driven roller may be braked by a further stop brake thereon. The stop brake may be an open-circuit brake. The stop brake for fixing the elevating platform may be a closed-circuit brake.

Through construction of the elevating platform stop brake as a closed-circuit brake, the brake is also available as an elevating platform safety catch, for example if the drive element ruptures.

In a particularly preferred embodiment a drive element is provided at the mast foot and the mast tip, the mast being driveable at both ends via the drive elements.

Fastening of the mast on both ends is achieved owing

to the introduction of the drive forces into the mast foot and the mast tip via a drive element at each point. Through this fastening of the mast on both ends, oscillation of the mast tip is prevented and a lightweight mast may be used which has resultant positive effects on the travel properties. All the drive variants for the bilateral mast drive mentioned below provide the aforementioned advantages.

In one variant the mast drive elements are fastened to the mast foot and the mast tip at the front and rear sides respectively when viewed in the direction of travel and are guided via rollers which, when viewed in the direction of travel, are arranged at the ends of the travel paths of the mast ends, at least one of the rollers being driveable by means of a drive. The driven guide roll(s) may be connected with an opposing guide roller via a further drive element.

In this variant, advantageously, one drive unit or gear is provided at the mast tip and one at the mast foot, synchronization of the travelling gears is achieved by means of a common directional control.

In another variant the mast drive elements are fastened to the ends of the travel path of the mast ends, a drive roller being arranged at the mast foot and the mast tip, the drive rollers being in engagement with the drive elements, at least one drive roller being driveable by means of a drive gear. The other drive roller may be connected with the driven drive roller via a further drive element.

In this variant synchronization is achieved by mechanical coupling of the upper and lower drive elements via a further drive element.

Furthermore, the bilateral drive of the mast particularly advantageously enables the mast to be provided with only one running wheel, which is arranged at the mast foot and rollers over a rail. This construction is possible because, due to the fastening of the mast, the

travelling device does not have to compensate for forces which may lead to inclination of the mast. As a result of the construction, a further weight reduction is achieved.

The combination of the two aspects, on the one hand of the alternating movement of the elevating platform and the extension unit via a common drive and on the other hand the bilateral drive of the mast via a drive element at each point, results in a stacker crane unit which is characterized by a particularly lightweight construction and the improved travel properties connected therewith such as good start-up speeds and high travelling speeds. The stacker crane unit is particularly suitable for use in hardware stores, in which working loads of up to approximately 25 kg have to be moved and the necessary mast height is approximately 6 m.

The advantageous use of toothed belts as drive elements leads to a reduction in the motion noise of the stacker crane unit.

The invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a side view of a first embodiment of a stacker crane unit according to the invention;

Figure 2 is a rear view of the mast and elevating platform, of the unit of Figure 1;

Figure 3 is a plan view of the elevating platform of the unit of Figure 1;

Figure 4 is a side view of a second embodiment of the stacker crane unit;

Figure 5 is a side view of a third embodiment of the stacker crane unit; and

Figure 6 is a side view of a fourth embodiment of the stacker crane unit.

Figure 1 shows a stacker crane unit with a vertical mast 1. Trolley or carriages or other suitable running gears 2a and 3a are arranged at the mast foot 2 and the

mast tip 3 respectively. The lower trolley 2a substantially consists of a running wheel 4 rotatable about a horizontal axis, which running wheel 4 runs on a rail 5, and of two pairs of lateral guide rollers 6 rotatable about vertical axes. The upper trolley 3a only comprises two pairs of lateral guide rollers 6, which roller against the sides of the web of a T-shaped guide rail 7, whose flange faces downwards.

The travel paths of the mast ends are defined by the rails 5 and 7 along which they move. The trolleys 2a, 3a are each driven by a respective drive element 8, constructed in particular as a toothed belt. When viewed in the direction of travel of the mast 1, the drive elements 8 are fastened at one end to the front sides of the travelling devices 2a, 3a, run from there parallel with the rail 5 or the guide rail 7, are deflected by approximately 180° by means of deflecting guide rollers 9 arranged at the end of the rails 5, 7, guided to a deflecting guide roller 10 arranged at the other end of the rails 5, 7 and guided thereby to the rear sides of the travelling devices 2a, 3a for fastening. The rollers 10 can be driven by means of directionally controlled stationary electric drives, especially drive units 11 constructed as brushless rotary current servomotors. Electrical synchronization ensures synchronism of the upper and lower drive units 11.

A vertically displaceable elevating platform 12 is arranged on the mast 1. The elevating platform 12 is guided on the mast 1 by means of an elevating platform guide 12a formed of a plurality of rollers. The rollers constituting the elevating platform guide 12a run on guide rails (not shown) on the mast 1 of lightweight construction. The elevating platform 12 can be displaced by a drive 19 arranged at the mast foot 2. The drive 19 receives its control signals via a control mechanism 26 likewise arranged at the mast foot 2, which control mechanism 26 is connected via infrared data transmission

(IR) to a control box 31 arranged at the end of the rail 5.

Figure 2, which is a rear view of the stacker crane unit, shows the guide of the drive element 13 for driving the elevating platform 12. The endless drive element 13 is guided via a drive roller 14 arranged at the mast foot 2, a deflecting guide roller 15 arranged at the mast tip 3 and a combination, arranged on the elevating platform 12, of a driven roller 16 and two further deflecting guide rollers 17, 18 to increase the angle of contact of the driven roller 16 to approximately 180° .

The large angle of contact is obtained in that the drive element 13 coming from the lower deflection roller 14 is deflected by approximately 90° by the deflection roller 17 arranged on the elevating platform, then deflected by approximately 180° by the driven roller 16, thereafter deflected again by 90° by the further deflection roller 18 and then guided to the deflection roller 15 in parallel with the mast. The axes of rotation of the rollers 14 to 18 run horizontally and parallel to the direction of travel of the mast 1. The drive roller 14 arranged at the mast foot 2 can be driven by means of a drive 19 (see Figure 1) arranged on the lower trolley 2a, which drive 19 is connected to the drive roller 14 via an intermediate gear (not shown). The drive 19 is supplied with energy via a contact wire 32 arranged in parallel with the rail 5 and ending in the control box 31. By means of the contact wire 32, it is also possible to exchange the control signals between the mobile control mechanism 26 with the power electronics of the drive 19 and the stationary control box 31. This data exchange is here effected in the conventional manner via infrared data transmission.

Furthermore, the arrangement of a stop element 22 extending parallel to the mast 1 can be seen. The stop element 22 may be a chain, toothed belt or a rack. The stop element 22 is in engagement with a stop gear 23 arranged on the elevating platform and rotatable about a horizontal axis. Power transmission from the drive element

13 to the upper deflection roller 15 can be used for the arrangement of a lifting weight overload safety device.

Figure 3 is a plan view of the elevating platform 12 of the stacker crane unit, which is guided on the mast 1. The driven roller 16 arranged on the elevating platform 12 is connected on the one hand via a shaft to the drive gear 20 to move an extension unit 25 and on the other hand via a shaft to a stop brake 21 supported on the elevating platform 12. Stop element 22, which is preferably constructed as a chain, is arranged integrally in a groove in the mast and is fastened to the mast foot 2 and the mast tip 3. A stop gear 23 arranged on the elevating platform 12 engages in this stop element 22, which stop gear 23 can be arrested by means of a further stop brake 24 supported on the elevating platform 12.

The stop element 22, in conjunction with the stop gear 23 and the stop brake 24 constructed as a closed-circuit brake, fulfils the function of an elevating platform safety catch in the case of power failure or an emergency shutdown.

With the aid of Figures 2 and 3, the manner of operation of the elevating and extension movements by means of a drive 19 will be described below. When elevating movement begins, the stop brake 24, which is constructed for reasons of safety as an electromagnetic closed-circuit brake which brakes by currentless connection, is released and the stop gear 23 is able to roller freely on the stop element 22 during the elevating movement. The elevating moment or lifting force is passed from the drive 19 into the driven roller 16 via the drive roller 14 and the drive element 13. During the elevating movement of the elevating platform 12, the driven roller 16 is prevented from rotating by the stop brake 21. The driven roller 16 may also be stopped by arresting the deflection roller 17 or 18 and thus by means of the drive element 13. The load moment comprising the inherent elevating platform weight and the working load is passed into the elevating platform

guides 12a via the drive element 13, the driven pinion 16 and the stop brake 21.

As soon as the elevating platform has reached its desired position in the vertical direction, the horizontal extension movement of the extension unit 25, which is constructed as a slide, may be initiated, to insert containers in or remove them from a shelf. To this end, the stop brake 24 is actuated by a control mechanism 26 arranged on the elevating platform 12, such that the stop gear 23 can no longer rotate relative to the elevating platform 12. The stop brake 21, which is constructed for reasons of weight as an electromagnetic open-circuit brake, is subsequently released and the self-weights of the elevating platform and the working load are transmitted to the stop element 22 via the stop gear 23. By releasing the stop brake 21, the driven gear 16 is then set in rotary motion relative to the elevating platform 12 under the drive of the endless drive element 13, such that the drive gear 20 can be set in motion via the drive shaft for the horizontal extension movement of the extension slide 25.

Figure 4 shows a stacker and crane unit at the upper and lower trolleys 2a and 3a of which there are arranged drive units 11 which travel with the stacker crane unit. The drive units 11 are connected with a stationary drive element 8 via a drive roller or gear 28. A large angle of contact of the drive roller 28, with the traction mechanism 8 is ensured by means of deflection rollers 29, 30 likewise arranged on the trolleys 2a, 3a, in a similar fashion to the drive element guide on the elevating platform 12. The ends of the drive elements 8 are fixed in the area of the ends of the rails 5 or the guide rail 7.

Figure 5 shows a further drive variant including a stationary drive unit 11. Guidance of the drive element 8 via the deflection rollers 9 and 10 corresponds to the construction according to Figure 1, but the drive 11 of the roller 10 on the guide rail 7 is replaced by a drive element 27, which connects the rollers 10 with each other.

Figure 6 shows a further drive variant of the storage and retrieval unit in which the drive moves therewith. A travelling gear 11 is arranged on the lower trolley 2a. The drive force is transmitted similarly to the drive variant according to Figure 4, but power transmission to the drive roller 28 arranged on the upper trolley 3a is effected via a drive element 27 connecting the drive rollers 28.

In the exemplary embodiment, the drive elements 8, 13 have been described as being advantageously constructed as toothed belts, but construction as chains or cables is also possible. Furthermore, construction of the stop element 22 as a rack or toothed belt is altogether feasible.

**CLAIMS**

1. A stacker crane unit comprising a vertical mast displaceable horizontally by at least one trolley, a vertically displaceable elevating platform guided on the mast, an extension unit arranged on the elevating platform for loading and unloading, a driven roller on the elevating platform for moving the extension unit, an endless drive element connected with the elevating platform and drivable by means of a drive roller arranged at the mast foot around a guide roller arranged in the area of the mast tip, the drive roller and the driven roller, and, a stop brake between the mast and the elevating platform, for preventing vertical displacement of the elevating platform along the mast, wherein the driven roller may be braked to allow transmission of the lifting force from the drive element to the elevating platform for vertical displacement thereof or the elevating platform can be fixed by means of the stop brake for movement of the extension unit, the driven roller thereby being released.

2. A unit as claimed in Claim 1, wherein the stop brake is fixed to the elevating platform and connected with a stop gear, and wherein the stop gear is in engagement with a stop element arranged parallel to the longitudinal direction of the mast.

3. A unit as claimed in Claim 2, wherein the stop element is a chain.

4. A unit as claimed in any preceding Claim, wherein a further stop brake is provided on the driven roller.

5. A unit as claimed in Claim 4, wherein the stop brake of the driven roller is an open-circuit brake.

6. A unit as claimed in any preceding Claim, wherein the drive element is deflected in the area of the driven roller by means of two further guide rollers on the elevating platform in such a way that the drive element



contacts the driven roller over at least 45°.

7. A unit as claimed in any preceding Claim, wherein the stop brake for fixing the elevating platform is a closed-circuit brake.

8. A unit as claimed in any preceding claim further comprising a drive element at the mast foot and the mast tip, the horizontally displaceable mast being drivable at both ends via the drive elements.

9. A unit as claimed in Claim 8, wherein the mast drive elements are fastened to the mast foot and the mast tip at the front and rear sides respectively when viewed in the direction of travel and are guided via rollers which, when viewed in the direction of travel, are arranged at the ends of the travel paths of the mast ends and wherein at least one of the guide rollers is drivable.

10. A unit as claimed in Claim 9, wherein the driven guide roll(s) is connected with an opposing guide roller via a further drive element.

11. A unit as claimed in Claim 8, wherein the mast drive elements are fastened to the ends of the travel paths of the mast ends, a drive roller being arranged at the mast foot and the mast tip, the drive rollers being in engagement with the drive elements and drivable by means of a drive unit.

12. A unit as claimed in either Claim 8 or Claim 9, wherein the mast drive elements are fastened to the ends of the travel paths of the mast ends, a drive roller being arranged at the mast foot and the mast tip, the drive rollers being in engagement with the drive elements and wherein one drive roller is drivable by means of a drive



unit and the other drive roller is connected with the driven drive roller via a further drive element.

13. A unit as claimed in any one of Claims 8 to 12, wherein the trolley(s) moves on a rail and wherein a running wheel rotatable exclusively about a horizontal axis and running on the rail is arranged at the mast foot.

14. A unit as claimed in any preceding Claim, wherein the or each drive element is an endless toothed belt.

16. A stacker crane unit substantially as herein described and illustrated in the accompanying Figures.