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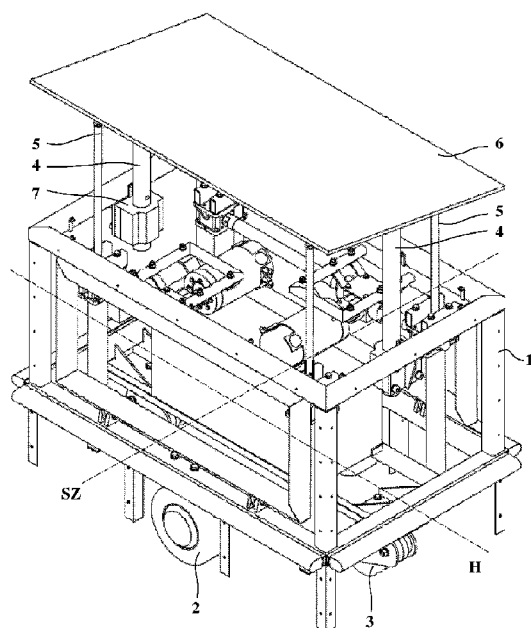


Figure 1

(57) Abstract: The invention relates to a transport robot for assembly lines, comprising a frame (1); wheels attached to the frame, wherein at least one of the wheels is a driven wheel (2); at least one motor connected to the at least one driven wheel (2); movable carrier platform (6); at least two linear actuators (5), which are connected to the frame (1) at one of their ends and are in articulated connection with the carrier platform (6) at their other ends; and a control unit that is connected at least to the motor, wherein the transport robot for assembly lines further comprises at least one vertical guiding column (4) that is in articulated connection with the carrier platform (6), and is vertically movably engaged with at least one guiding element (7) that is fixed to the frame (1).



TRANSPORT ROBOT FOR MANUFACTURING LINES

The invention relates to a transport robot, particularly to a transport robot for assembly lines, which is suitable for transporting one or more workpieces between separate workstations and for facilitating ergonomic execution of manual operations on the workpiece.

- 5 There are numerous products, whose manufacturing requires execution of several manual assembling operations on a semi-finished product. The different assembling operations are usually carried out at different workstations, thus workpieces have to be transported therebetween. Manually operated wheeled transport devices, i.e. carts, are often used for transporting workpieces of larger size and weight, e.g. engines of motor vehicles. The
- 10 workpieces are placed on the cart for the time of transportation, then placed on a worktable at the workstation, there the assembling operations are performed, then after finishing the assembling operation, the workpiece is placed again onto the cart and transferred to the next workstation. The cart requires manual handling and repeated loading/deloading of the workpiece between each workstation and the cart increases the total assembly time.
- 15 Accordingly, a device is needed that is capable to perform the transportation independently and that provides the conditions required for assembly.

The international publication no. WO2018108867 discloses a transport robot configured for cooperation with human workforce. The robot has a carrier surface at a fixed height and a robotic arm. The carrier surface is situated at the height of a usual worktable, but neither its

20 height nor its inclination is adjustable in a manner that would provide ergonomic work conditions for persons of different height. The lifting capacity of the robotic arm of the robot is about 15 kg and thus larger workpieces cannot be brought into a convenient assembling position by the robotic arm. A robot of this size is not capable of carrying a robotic arm with a suitable lifting capacity of up to 200 kg. The movement of the robot is provided by Mecanum-

25 wheels arranged near the four bottom corners of the cuboid shaped frame. The robot is substantially configured as a universal-purpose robot for moving smaller objects, thus it is not suitable for handling heavy workpieces, furthermore it is unnecessarily complex for the above purpose.

The United States Patent No. 9,731,641 discloses a transport robot for warehouses, having a

30 platform that is both liftable and tiltable. The robot is suitable for lifting and stably transporting warehouse inventory holders by compensating inertial forces acting on the load

during movement. The transport robot operates in a completely automated manner, the height and inclination angle of its carrying platform cannot be manually adjusted and its small height does not allow performing ergonomic assembling operations on a carried object.

Thus a common drawback of the prior art solutions is that they are not suitable for transporting, lifting and tilting heavy workpieces in a manner that provides ergonomic working conditions for a current assembler worker.

The objective of the present invention is to eliminate or at least alleviate the drawbacks of the known solutions by providing a transport robot for assembly lines that is suitable for safely transporting heavy workpieces, e.g. engine blocks of motor vehicles, without human intervention, and that allows performing manual operations ergonomically on the workpiece by allowing manual adjustment of the height and inclination angle of the workpiece.

The above objective is achieved by providing a transport robot for assembly lines according to Claim 1. Preferred exemplary embodiments of the transport robot for assembly lines are set out in Claims 2 to 3.

In what follows, the transport robot according to the invention, particularly its preferred exemplary embodiments and their operation are described in detail with reference to the attached drawing, wherein

– Figure 1 shows a preferred exemplary embodiment of the transport robot according to the invention in perspective view.

Figure 1 shows a preferred exemplary embodiment of the transport robot according to the invention in perspective view. The transport robot comprises a frame 1, driven wheels 2 secured to the frame 1, casters 3 secured on the frame 1, guiding columns 4 that are vertically movable relative to the frame 1 and are engaged with guiding elements 7 fixed to the frame 1, a carrier platform 6 in articulated connection with the guiding columns, and linear actuators 5 connected to the platform 6 on one end and connected to the frame 1 on another end.

For achieving the objectives, the transport robot according to the invention shall fulfill the following criteria:

- capability for independent movement;
- the height of the carrier platform 6 shall be adjustable in a range allowing ergonomic manual operation, i.e. between approx. 74 cm and 114 cm measured from the floor, and the carrier platform 6 shall be tiltable;

- the transport robot shall have suitable load bearing capacity, i.e. it shall be capable to move a payload of approx. 200 kg;
- the transport robot shall be sufficiently stable, i.e. it should not be tipped over by a force of approx. 500 N.

5 Furthermore, the horizontal dimensions of the transport robot are preferably minimized, because this improves the mobility of the transport robot in a factory environment, reduces the manufacturing costs of the robot, and provides comfortable access to the workpiece present on the transport robot by a person performing assembling operations.

10 In the embodiment shown in Figure 1, the workpieces that are usually elongated are held by a substantially rectangular carrier platform 6. For preventing unintended movement of the workpiece, the carrier platform 6 is preferably provided by suitable fixing means (not shown in the Figure). The linear actuators 5 suitable for adjusting the height and inclination angle of the carrier platform 6 are in articulated connection with the carrier platform 6 in the proximity of its four corners in order to provide maximal stability. The linear actuators 5 are preferably
15 formed by elevating spindles that are secured to the frame 1 in a manner that allows pivoting around an axis parallel with a longitudinal direction H of the frame. Sideways movement of the platform is prevented by the two guiding columns 4 that are vertically movable and that are connected to the carrier platform 6 in an articulated manner. The guiding columns also ensure that the linear actuators 5 are only acted upon by forces in a direction parallel to their
20 respective longitudinal axes when the carrier platform 6 is tilted.

Height adjustment of the carrier platform 6 in a suitable range, approximately 74 to 114 cm, requires elevating spindles that are relatively long with respect to the height of the transport robot and that are preferably arranged in vertical orientation. Accordingly, the driven wheels 2 and the casters 3 are preferably arranged in a position other than under the linear actuators 5.
25 This allows the elevating spindles to extend into a space next to the wheels, e.g. into a space between a bottom plate of the frame 1 and the floor.

In the embodiment shown in Figure 1, the self-propelled motion of the transport robot is provided by two driven wheels 2, two swivel casters 3, electric motors (not shown in the figure) driving the driven wheels 2, and a control unit (not shown in the figure) driving these.
30 In order to accommodate the carrier platform 6, the shape of the frame 1 is preferably cuboid and the driven wheels 2 are located under the bottom side of the cuboid, at the middle of the longer sides, while the casters are preferably located under the bottom side of the cuboid, at the middle of the shorter sides.

Naturally, the transport robot according to the invention has further obvious components, e.g. an internal power source and/or power receiving connection, data communication device, control means, outer housing, elements for connecting and fixing the components, but the use of these is obvious to a person skilled in the art, and thus these are not detailed further.

5 One of the substantial recognitions leading to the invention was that a simple and robust solution with suitable mechanical parameters may be obtained by utilizing linear actuators 5 and vertically movable guiding columns 4 together. A further substantial recognition leading to the invention was that a suitable movement range of the carrier platform 6 may be achieved by such a relative arrangement of the wheels and elevating spindles used as linear actuators 5,
10 in which the wheels are sufficiently far away from the longitudinal axes of the elevating spindles for avoiding hindering their motion in any state of operation. Following these two recognitions, numerous further variants of the transport robot may be conceived within the claimed scope of protection.

In a further embodiment, the transport robot comprises only one guiding column and only two
15 linear actuators, which are arranged so that the guiding column is in central position along the longitudinal direction H and the a width direction SZ, while the linear actuators are arranged centrally in the longitudinal direction H and on two opposite sides of the guiding column in the width direction SZ. With this arrangement a plurality of different three-wheeled or four-wheeled configuration may be used for moving the transport robot without limiting the
20 movement range of the linear actuators. Applying these solutions is an obvious task to a person skilled in the art and thus only a few possibilities are mentioned.

For providing the greatest agility, the four-wheeled configuration may comprise at the four corners four Mecanum-wheels or four driven and steered wheels. A less agile, but simpler solution may be provided by using two driven and steered wheels at the front and two casters
25 with fixed orientation at the rear, or vice versa. An even simpler solution is to use two driven and non-steered wheels in the front and two swivel casters at the rear or vice versa. In three-wheeled solutions a pair of wheels may be arranged at one end in the longitudinal direction H and the third wheel may be arranged at the other end in the longitudinal direction H and centrally in the width direction. In such a configuration, either the one that stands alone and is
30 arranged centrally in the width direction SZ is driven and steered and both members of the pair are casters with fixed orientation or the members of the pair are driven and non-steered and the third wheel is a swivel caster.

In the present specification, a particularly preferred embodiment of the transport robot has been described in detail, however numerous further embodiments thereof may be conceived within the scope of protection in a manner obvious to a skilled person.

CLAIMS

1. Transport robot for assembly lines, comprising:

a frame (1);

wheels attached to the frame, wherein at least one of the wheels is a driven wheel (2);

5 at least one motor connected to the at least one driven wheel (2);

movable carrier platform (6);

at least two linear actuators (5), which are connected to the frame (1) at one of their ends and are in articulated connection with the carrier platform (6) at their other ends; and

10 a control unit that is connected at least to the motor,

characterized by further comprising

at least one vertical guiding column (4) that is in articulated connection with the carrier platform (6), and is vertically movably engaged with at least one guiding element (7) that is fixed to the frame (1).

15 2. The transport robot according to Claim 1, **characterized in that** the carrier platform (6) is substantially rectangular, the shape of the frame (1) is substantially cuboid, the transport robot comprises four linear actuators (5) that are connected to the carrier platform (6) in the proximity of four corners of the carrier platform, and are connected to the frame (1) in the proximity of four corners of the frame (1).

20 3. The transport robot according to Claim 2, **characterized in that** the transport robot comprises two driven wheels (2) connected to the frame (1) at the bottom of the frame (1) in locations that are central in the longitudinal direction (H) and terminal in the width direction (SZ), wherein the transport robot further comprises two swivel casters (3) connected to the frame (1) in locations that are central in the width direction (SZ) and terminal in the
25 longitudinal direction (H).

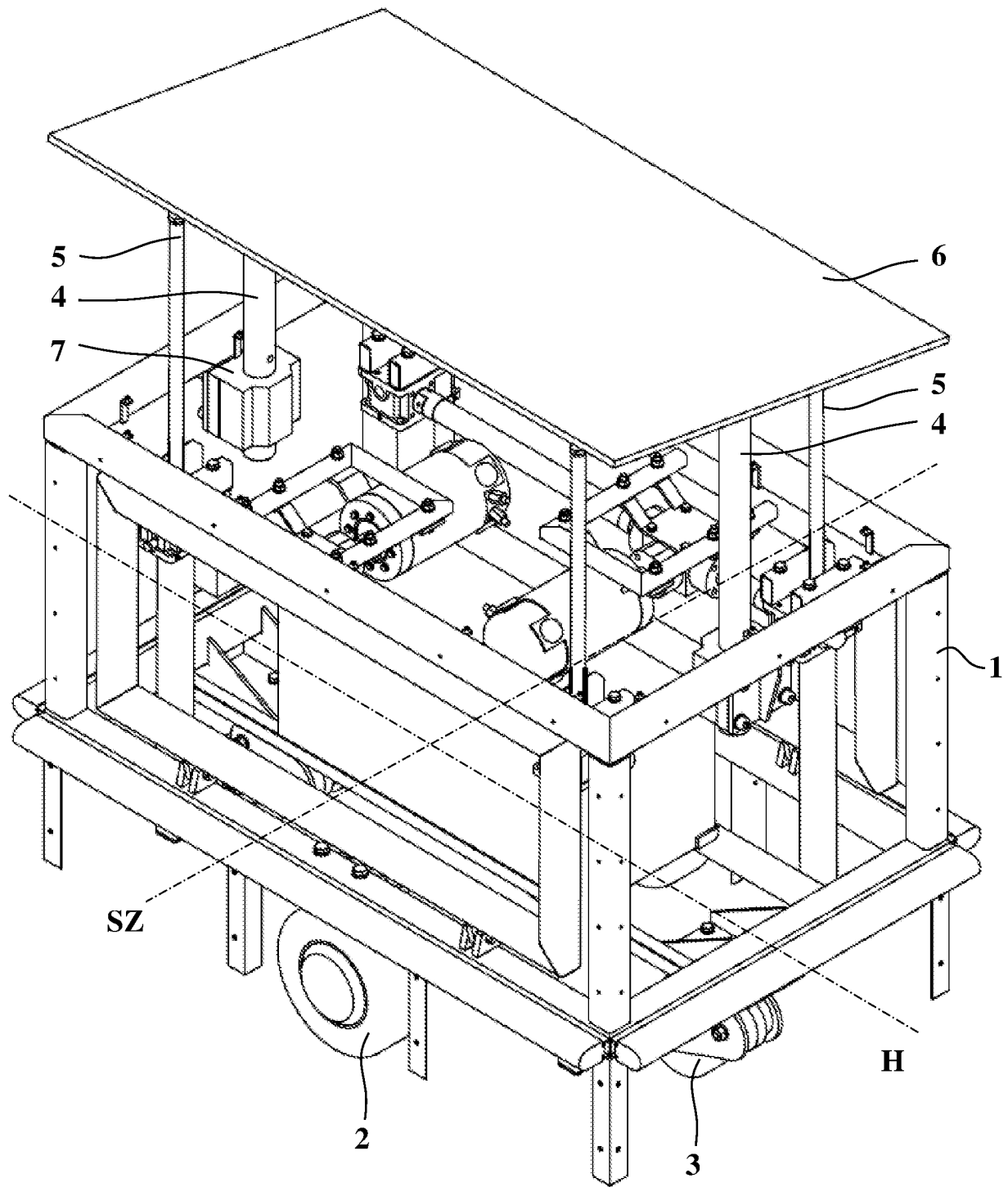


Figure 1