The invention relates to a transport system for simultaneously transporting workpieces and assemblers on a production line comprising at least one rectilinear production section for several guided motor vehicles, each of which is provided with a mounting platform which extends along the entire vehicle length and on which the assemblers can move, wherein said vehicles can form a train during the displacement thereof along the production line. Each mounting platform is provided with its own drive. Said drives are controllable in such a way that the vehicles are driven in the form of a train during the displacement thereof along the production section. A method for simultaneously transporting workpieces and assemblers along the production line provided with at least one rectilinear production section. The inventive method consists in driving the vehicles in the form of a train by means of the drives mounted on the vehicles during the displacement thereof along the production section.
TRANSPORT SYSTEM AND METHOD FOR SIMULTANEOUSLY TRANSPORTING WORKPIECES AND ASSEMBLERS ON A PRODUCTION LINE

[0001] The invention relates to a transport system and to a method for simultaneously transporting workpieces and assemblers on a production line having at least one rectilinear production section, the transport system including several track-guided vehicles which

[0002] a) each have an assembly platform extending over and beyond the entire length of the vehicle and accessible to assemblers;
[0003] b) in the course of travelling along the production line are able to form a train in which the assembly platforms of adjacent vehicles adjoin one another in practically gap-free manner; and
[0004] c) each have their own drive.

[0005] Transport systems of such a type are known from DE 40 20 286 C2 and are employed, for example, in the course of the final assembly of motor vehicles. In contrast with transport systems that are designed for transporting workpieces only, the transport systems described therein enable assemblers to be carried along together with the workpieces over a relatively long period. In this way, the assemblers are able to undertake assembly work or other work on the workpieces without having to walk alongside the workpieces.

[0006] To this end, the vehicles form a push-train along a rectilinear production section of the production line. The last vehicle in the given case pushes the vehicles in front through the rectilinear production section, said vehicle being propelled by stationary external drive means. These drive means may be, for example, friction wheels which engage the longitudinal sides of the assembly platforms from the outside and in this way apply the thrust force necessary for the forward motion. As a result of the pushing from the rear, it is ensured that the push-platforms within the push-train always adjoin one another in practically gap-free manner, so that the assemblers move on the assembly platforms in a manner that is as unhindered and safe as possible and, in particular, are able to walk from one assembly platform to the next.

[0007] At the end of a rectilinear production section the push-train is dispersed by the individual vehicles being transferred vertically or horizontally in a transfer station or being transported on a curved section to a further rectilinear production section. In the transport system known from DE 40 20 286 C2 the vehicles have their own drives, so that the vehicles are able to move away independently between the rectilinear production sections. As soon as a vehicle is taken up into the push-train, its own drive is switched off.

[0008] The assembly platforms do not only have to carry the assemblers and the workpiece but also have to absorb and divert high longitudinal forces and frequently also transverse forces. In the longitudinal direction there act, in particular, the thrust forces that act on the individual vehicles by virtue of their travelling in the push-train. These longitudinal forces are greatest in the case of the vehicle that is being propelled in the given case and hence that is rearmost in the direction of travel, since the kinetic resistance of the entire push-train acts on said vehicle. Transverse forces may be caused, above all, by the external drive means, such as friction wheels for example.

[0009] By reason of these forces being exerted on them, the assembly platforms are subjected to high loadings, which is why they have to be manufactured with a rigidity and stability that exceed the requirements resulting from the weight of the workpiece to be carried and the weight of the assembler.

[0010] It is an object of the invention to create a transport system of the type specified in the introduction in which the forces exerted on an assembly platform are reduced.

[0011] In the case of a transport system of the type specified in the introduction, this object is achieved by the drives of the vehicles being controllable in such a manner that they propel the vehicles in the course of travelling along the rectilinear production section in the train.

[0012] In this way, external drive means exerting transverse forces—such as friction wheels, for example—can be dispensed with. Each vehicle is propelled at all times by its own drive, so also smaller longitudinal forces act on the vehicle in the push-train that is rearmost in the direction of travel, since said vehicle now no longer experiences the entire kinetic resistance of the push-train.

[0013] In this connection it is advantageous if the drives of the vehicles are controllable in such a manner that the torques generated by the drives of the vehicles are greater, the further back a vehicle is located in the train. As a result, it is guaranteed that the entire train is driven forward uniformly and, at the same time, the assembly platforms of adjacent vehicles adjoin one another in practically gap-free manner. In the case of identical torques, there would be a risk of adjacent vehicles being separated from one another as a consequence of differing frictional resistances.

[0014] The expression ‘in practically gap-free manner’ here is understood to mean that a spacing of maximally 5 cm, preferably less than 1 cm, may remain between the assembly plates of two adjacent vehicles, said spacing being bridged by a rubber bead, for example.

[0015] In order not to allow thrust forces acting on the assembly platforms to become too great, it is favourable if the drives of the vehicles are controllable in such a manner that no thrust forces above a threshold value act between adjacent vehicles in the direction of travel thereof. Overall, the threshold value depends on the requirements of the production line and/or of the transport system, which, in particular, are influenced by the workpiece to be assembled and/or processed.

[0016] Furthermore, it is favourable if, in the course of travelling in the train, the vehicles are capable of being connected to one another via couplings. As a result, the train is secured, and hence a safe movement of an assembler between two adjacent vehicles is ensured, even if the control system of an individual vehicle or the drive thereof were to fail or if the control system, by reason of its design, cannot in principle prevent a separation of vehicles in the train.

[0017] It proves particularly favourable if the couplings lock together automatically upon colliding.

[0018] In order to ensure that the vehicles do not separate when travelling in the train, it is advantageous if a device—a pressure sensor, for example—for ascertaining the thrust forces generated by the drives of the vehicles is provided on the vehicles.

[0019] The drives of the vehicles travelling in the train are then controlled in such a way that the ascertained thrust forces lie within a predetermined interval.

[0020] In order to make stepping from the assembly platform of one vehicle across to the assembly platform of an adjacent vehicle safe for an assembler, it is advantageous if, in
the course of travelling in the train, the assembly platforms of adjacent vehicles are spaced from one another by less than 5 cm, preferably less than 1 cm. The spacing should then be bridged by a rubber bead or the like.

[0021] In order that the workpiece to be assembled and/or processed can be arranged on an assembly platform in an easily accessible manner for an assembler, it is favorable if a functional unit is arranged on the vehicle. Said unit may be, in technically simple manner, a lifting table with which a workpiece arranged thereon is capable of being displaced to varying heights.

[0022] In addition, it is an object of the invention to create a method of the type specified in the introduction by which the forces exerted on an assembly platform are reduced.

[0023] This object is achieved by means of a method of the type specified in the introduction wherein, in the course of travelling along the rectilinear production section in the train, the vehicles are propelled by means of drives arranged on the vehicles.

[0024] Advantageous further developments of the method are to be found in claims 14 to 22, the advantages of which are evident—with due alteration of details—from that which has been elucidated above.

[0025] An exemplary embodiment of the invention is elucidated in greater detail below on the basis of the drawing. Shown in the latter are:

[0026] FIG. 1 a greatly simplified top view of an exemplary embodiment of a transport system;

[0027] FIG. 2 an enlarged top view of an individual vehicle of the transport system shown in FIG. 1;

[0028] FIG. 3 an enlarged side view of a vehicle of the transport system shown in FIG. 1, without a workpiece located thereon;

[0029] FIG. 4 an enlarged rear view of a vehicle of the transport system shown in FIG. 1, without a workpiece located thereon;

[0030] FIG. 5 a further enlarged simplified side view of a coupling for connecting the vehicles during the latching operation; and

[0031] FIG. 6 the coupling shown in FIG. 5, in the latched state.

[0032] FIG. 1 shows, in a greatly simplified top view, an exemplary embodiment of a transport system 10 which is provided for simultaneously transporting workpieces and assemblers on a production line 12 shown partially in FIG. 1. The transport system 10 includes a travel path which is constituted by rails 14, 16. In the simplified exemplary embodiment that is represented, two production sections 18, 20 are provided, along which the rails 14, 16 extend rectilinearly. The rails 14, 16 are laid out as flat as possible in an assembly shop, it being possible for the production line 12 overall to include further such rectilinear production sections 18, 20. Between the production sections 18, 20 the rails 14, 16 are arcuately curved in sections 17, as a result of which a closed travel path is formed.

[0033] On the rails 14, 16 there circulate vehicles 22 of similar construction, one of which is shown enlarged in a top view in FIG. 2. The vehicles 22 each have an assembly platform 24 and each bear centrally a lifting table 26 on which a workpiece 28 to be assembled is fastened so as to be capable of being displaced in height. In the exemplary embodiment shown here, the workpiece 28 is intended to be a motor-vehicle body that has been prepared for final assembly, this being indicated in FIGS. 1 and 2 merely in greatly schematized manner.

[0034] Along the production sections 18, 20 the vehicles 22 form a train 30 in which the assembly platforms 24 adjoin one another in practically gap-free manner. In this way, a continuously accessible surface is formed for the assemblers, on which they are able to move during the assembly of the workpieces 28.

[0035] In FIGS. 3 and 4, in which—for the sake of clarity—the workpiece 28 is not shown, the lifting table 26 can be discerned better. The latter is adjustable in height with the aid of a scissors-type mechanism 34, as is known as such in the state of the art. In order to prevent the assemblers from falling into the scissors-type mechanism 34, the lifting table 26 is closed off all round with respect to the assembly platform 24 with bellows 36, the bellows 36 transverse to the rails 14, 16 having been omitted in FIG. 4, in order that the scissors-type mechanism 34 is visible.

[0036] As can be discerned in FIGS. 3 and 4, the vehicle 22 runs on the rails 14, 16 by means of running wheels 38. One pair of wheels 40 is capable of being propelled by means of a drive, for example an electric motor. Of the electrical way of an electric motor 42 capable of being propelled. The electric motor 42 is connected via a line 44 to a vehicle control system 46 which controls the electric motor 42. The vehicle control system 44 may be, for example, a processor unit which is known as such.

[0037] The vehicle control system 46 includes a receiving unit 48 and also a transmitting unit 50, by means of which it communicates in wireless manner with a central control system 52 which can be discerned in FIG. 1, this being elucidated in still more detail below. Of course, the communication between the vehicle control system 46 and the central control system 52 may also be effected via contact rails with the aid of sliding con ... or may also be effected in non-contacting manner.

[0038] Provided on the vehicle 22 is a position sensor 54 having a read-head 56 which reads out a position code 58 which is affixed, for example, to the inside of a rail 14, 16. The position sensor 54 transmits the position data of the vehicle 22 that have been ascertained in this way, via a line 60, to the vehicle control system 46 which in turn communicates these data to the central control system 52 in conjunction with a signal that is capable of being assigned to the particular vehicle 22.

[0039] FIGS. 5 and 6 show a coupling 62 with which the assembly platforms 24 of adjacent vehicles 22 can be coupled. The coupling 62 includes a hook 64 fastened to an assembly platform 24, and also a swivelling latch 66 fastened to the adjacent assembly platform 24. Both the hook 64 and the swivelling latch 66 are substantially L-shaped and have bevelled shunting surfaces 68. The swivelling latch 66 is supported in swivelling manner at its long end, the swivel axis extending transversely in relation to the direction of travel of the vehicles 22, which in FIGS. 5 and 6, as in FIG. 1, is indicated by arrows 70.

[0040] On the end face, pointing in the direction of travel, of the assembly platform 24 of a vehicle 22 a pressure sensor 72 is fitted for the purpose of ascertaining the thrust forces acting in the direction of travel 70 that are generated by the electric motors 42 of the vehicles 22, the output signal of said pressure sensor being transmitted via a line 74 to the vehicle control system 46 of the respective vehicle 22 and, from said control
system, to the central control system 52 in combination with a signal that is capable of being assigned to the vehicle 22.

[0041] On the assembly platforms 24 a rubber bead 76 is provided above the pressure sensor.

[0042] The transport system 10 described above operates as follows:

[0043] At transitions 78, 80, 82, 84 (FIG. 1) between an arcuately curved section 17 of the rails 14, 16 and a rectilinear production section 18, 20, a position code 58 is provided in each instance. In the exemplary embodiment represented here, the position codes are stationed at the transitions 78, 80 in accordance with the direction of travel 70 of the vehicles 22 for the transition between an arcuately curved section 17 and a rectilinear production section 18, 20. The two remaining position codes 58 are stationed at the transitions 82, 84 correspondingly for the transition between a rectilinear production section 18, 20 and an arcuately curved section 17.

[0044] When a vehicle 22A located at the head of the train 30 passes over a position code 58, for example at the transition 82, the central control system 52 detects, on the basis of the position signal communicated, that the vehicle 22A in question is now leaving the rectilinear production section 18 and is moving into an arcuately curved section 17 of the rails 14, 16.

[0045] In the latter case the central control system 52 transmits to the vehicle control system 46 of vehicle 22A a control signal that causes the torque of the electric motor 42 to be increased. The vehicle control system 46 of vehicle 22A now activates the drive 42 appropriately, so that the speed of vehicle 22A increases in comparison with its speed in the train 30.

[0046] Vehicle 22A now travels at increased speed through the arcuately curved section 17 of the rails 14, 16 until it reaches the point 78—that is to say, the point that corresponds to vehicle 22B in FIG. 1. The speed that is increased in comparison with the speed of vehicle 22A in the train 30 is desirable with regard to the throughput of the production line 12, in order that the vehicles 22 get from one production section 18, 20 to the next as quickly as possible.

[0047] In the case of vehicle 22B, the central control system 52 detects, on the basis of the position signal communicated at the transition 78, that the vehicle 22B in question is now leaving the arcuately curved section 17 of the rails 14, 16 and is moving into the rectilinear production section 20.

[0048] The central control system 52 now transmits to the vehicle control system 46 of vehicle 22B a control signal that causes the torque of the electric motor 42 to be reduced.

[0049] In order that it is ensured that vehicle 22B collides with vehicle 22C travelling ahead of it, however, the torque of the electric motor 42 of vehicle 22B lies above that of the electric motor 42 of vehicle 22C which is already located in the train 30.

[0050] Now by the time vehicle 22B reaches vehicle 22C, and the assembly plate 24 of vehicle 22A runs into the assembly plate 24 of vehicle 22C, the pressure sensor 72 of vehicle 22B generates a zero signal, since it cannot register a counter-pressure.

[0051] When the pressure sensor 72 of vehicle 22B comes into contact with the end face, facing towards it, of the assembly plate 24 of vehicle 22C, as is shown in FIG. 6, the pressure sensor 72 communicates to the central control system 52, via the vehicle control system 46 of vehicle 22B, a signal that reflects how great the thrust forces are that are being exerted by vehicle 22B on vehicle 22C.

[0052] The central control system 52 controls the individual vehicles 22 in the train 30 in such a manner that the torques or thrust forces generated by the electric motors 42 of the vehicles 22 lie within a predetermined interval.

[0053] As a result, it is guaranteed that a vehicle 22—for example, vehicle 22B—always exerts small thrust forces on a vehicle 22 travelling ahead, for example 22C, in which case the opening of a gap between the assembly platforms is prevented.

[0054] In the case of assembly platforms 24 which are separated from one another by rubber beads 76, detection of the thrust forces can also be implemented with the aid of spacing sensors. Since the rubber beads 76 give way resiliently, the spacing between adjacent assembly platforms 24 is smaller, the greater the thrust forces.

[0055] As an alternative to the control of the vehicles 22 via the thrust forces that are exerted on the push-train between the individual assembly platforms 24, it is also possible to activate the drives 42 of the vehicles 22 via a combined speed/torque regulation. In this case the set speed is defined to be somewhat higher than the speed actually attained. A torquelimiter ensures that the thrust forces between the assembly platforms 24 do not become unnecessarily large. In this connection the current through the electric motors 42 can be used as a measure of the torque generated by the electric motors 42.

[0056] In order to enhance the safety still further, the couplings 62 are provided on the vehicles.

[0057] If the spacing between the two assembly platforms 24—for example, of vehicles 22B and 22C—is diminished when vehicle 22B has moved into the rectilinear production section 20, the two shunting surfaces 68 of the coupling 62 run up against one another, as a result of which the swivelling latch 66 is raised, as can be discerned in FIG. 5. If the spacing between the assembly platforms 24 continues to diminish, the swivelling latch 66 locks, as represented in FIG. 6. If the process, the rubber bead 76 which is fastened to the assembly platforms 24 of vehicle 22B closes the remaining narrow gap between the mutually adjacent assembly platforms 24.

[0059] As can be discerned in FIG. 6, in the case of vehicles 22 in the train 30 a gap 86 remains between the detent lugs of the latches 64, 66. The swivelling latch 66 is consequently not subjected to a tensile loading in the case of the customarily desired spacing between the assembly platforms of two adjacent vehicles 22, which amounts to at least less than 5 cm, preferably less than 1 cm.

[0060] By virtue of the coupling 62 which is additionally provided, in any case two adjacent vehicles 22 are prevented from moving away from one another so long as they are travelling within the rectilinear production section 18, 20 in the train 30.

[0061] At, or shortly before, the transitions 82 and 84 between, in each instance, the rectilinear production sections 18, 20 and the arcuately curved sections 17 of the tracks 14, 16, at the coupling which is provided in each instance a device is provided for releasing the coupling 62. Said device may be, for example, a lifter pressing from below against the swivelling latch 66 of the coupling 62.

[0062] Where appropriate, the couplings 62 alone are also able to secure the train 30. In this case the vehicles 22 would not have to be activated in such a manner that the thrust forces generated by the electric motors 42 of the vehicles 22 lie within a predetermined interval.
As an alternative to mechanically releasable couplings, electromagnets may also be employed that are fastened to the end faces of the vehicles and capable of being switched electrically.

1. A transport system for simultaneously transporting workpieces and assemblers on a production line having at least one rectilinear production section, the transport system including several track-guided vehicles which
   a) each have an assembly platform extending over and beyond the entire length of the vehicle and accessible to assemblers;
   b) in the course of travelling along the production line are able to form a train in which the assembly platforms of adjacent vehicles adjoin one another in a practically gap-free manner; and
   c) each have their own drive, wherein the drives of the vehicles are controllable in such a manner that they propel the vehicles in the course of travelling along the rectilinear production section in the train.

2. The transport system of claim 1, wherein the drives of the vehicles are controllable in such a manner that the torques generated by the drives of the vehicles are the greater, the further back a vehicle is located in the train.

3. The transport system according to claim 1, wherein the drives of the vehicles are controllable in such a manner that no thrust forces above a threshold value act between adjacent vehicles in the direction of travel thereof.

4. The transport system of claim 1, wherein during the course of travelling in the train the vehicles are capable of being connected to one another via couplings.

5. The transport system of claim 4, wherein the couplings lock together automatically upon colliding.

6. The transport system of claim 4, wherein the couplings include electromagnets.

7. The transport system of claim 1, further comprising a device for ascertaining the thrust forces generated by the drives of the vehicles is provided on the vehicles.

8. The transport system of claim 7, wherein the device for ascertaining the thrust forces generated by the drives of the vehicles is a pressure sensor.

9. The transport system of claim 1, further comprising a spacing sensor for determining the spacing between adjacent assembly platforms being arranged on the vehicles.

10. The transport system of claim 1, wherein during in the course of travelling in the train the assembly platforms of adjacent vehicles are spaced from one another by less than 5 cm.

11. The transport system of claim 1, further comprising a functional unit being arranged on the vehicles.

12. The transport system of claim 1, wherein the functional unit is a lifting table with which a workpiece arranged thereon is capable of being displaced to varying heights.

13. A method for simultaneously transporting workpieces and assemblers along a production line having at least one rectilinear production section, wherein several track-guided vehicles, which each have an assembly platform extending over and beyond the entire length of the vehicle and accessible to assemblers, in the course of travelling along the production line are able to form a train in which the assembly platforms of adjacent vehicles adjoin one another in a practically gap-free manner, wherein during the course of travelling along the rectilinear production section in the train the vehicles are propelled by means of drives arranged on the vehicles.

14. The method of claim 13, wherein the vehicles are propelled by means of the drives in such a manner that the thrust forces generated by the drives are the greater, the further back a vehicle is located in the train.

15. The method of claim 13, wherein the vehicles are propelled by means of the drives in such a manner that no thrust forces above a threshold value act between adjacent vehicles in the direction of travel thereof.

16. The method of claim 13, wherein the vehicles are connected to one another via couplings in the course of travelling in the train.

17. The method of claim 16, wherein the couplings lock together automatically upon colliding.

18. The method of claim 13, wherein the thrust forces generated by the drives of the vehicles are ascertained by means of a device provided on the vehicles.

19. The method of claim 18, wherein the thrust forces generated by the drives of the vehicles are ascertained by means of a pressure sensor.

20. The method of claim 13, wherein during the course of travelling in the train the assembly platforms of adjacent vehicles are spaced from one another by less than 5 cm.

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