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(71) Applicant: **ROLIC INTERNATIONAL S.A R.L.**
1528 Luxembourg (LU)

(72) Inventor: **Wieser, Hartmut**
39040 RACINES (IT)

(74) Representative: **Bernotti, Andrea et al**
Studio Torta S.p.A.
Via Viotti, 9
10121 Torino (IT)

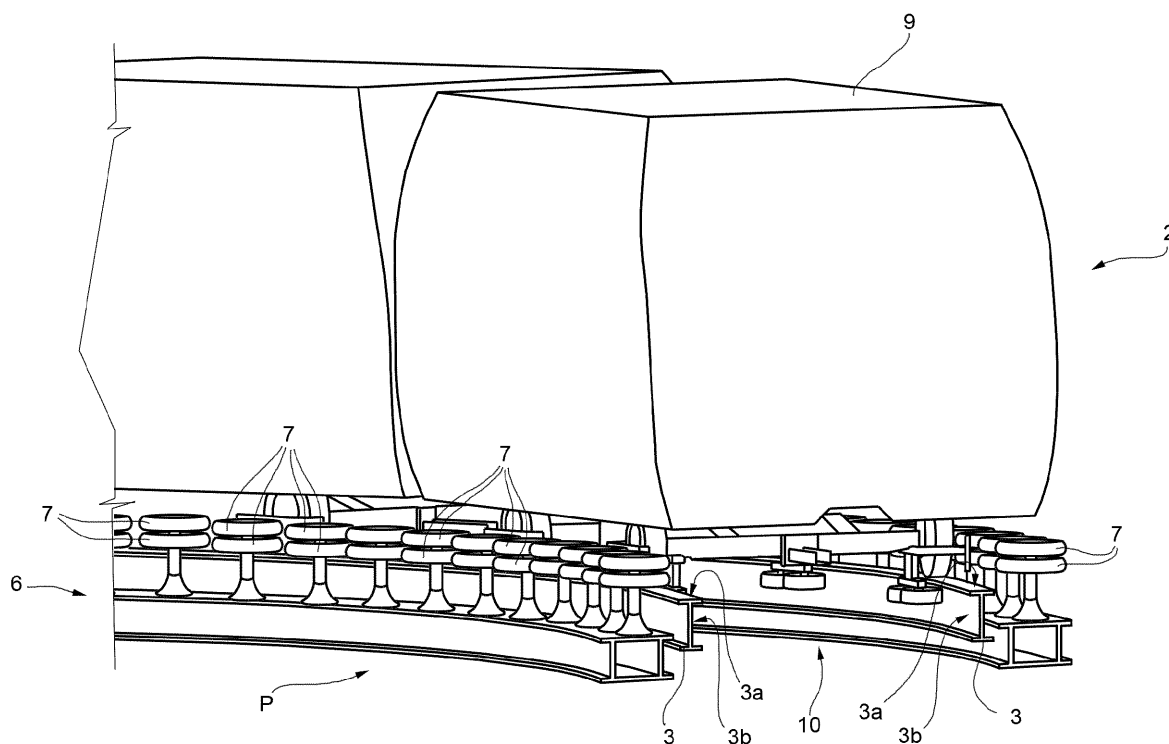
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(54) **Cable transportation system trolley, and cable transportation system equipped with such a trolley**

(57) A cable transportation system trolley has: a frame (11; 111; 211) connectable to a haul cable (5) of a cable transportation system (1); and at least one pair of auxiliary drive members (15; 115; 215) having respective friction surfaces (20a; 120a; 220a) designed to en-

gage drive wheels (7) of an auxiliary drive device (6) of a cable transportation system (1). The auxiliary drive members (15; 115; 215) are connected pivotally to the frame (11; 111; 211).

FIG. 2



Description

[0001] The present invention relates to a cable transportation system trolley, and to a cable transportation system comprising such a trolley.

[0002] Cable transportation systems are known in which transportation units travel along a path defined by guides, e.g. two parallel rails. The transportation units normally comprise a trolley, to which a passenger or freight car is fitted, and may be either single or connected to one another in trains.

[0003] A haul cable is connected to clamps on the single transportation unit or train to draw the transportation units along the path.

[0004] The transportation units are supported on carrier wheels, which rest on respective rails and are kept along the path by a guide system.

[0005] The path may comprise portions, i.e. arrival and departure stations, where the transportation units are detached from the haul cable and driven by an auxiliary drive device, in particular a conveyor.

[0006] The auxiliary drive device normally comprises one or two sets of drive or guide wheels aligned along the rails at such a distance as to engage friction surfaces on the transportation units. The wheels are powered by an auxiliary motor, rotate co-ordinatedly clockwise along one rail and anticlockwise along the other, and cooperate to drive the transportation units forward.

[0007] The friction surfaces are normally located on the sides of the transportation units and fixed to the frame, close to the front and rear carrier wheels.

[0008] When driven by conveyors of the type described above, the design of known transportation units makes it difficult, if not impossible, to travel along curved paths.

[0009] It is therefore an object of the present invention to provide a cable transportation system trolley designed to overcome the above limitations.

[0010] According to the present invention, there is provided a cable transportation system trolley comprising:

- a frame connectable to a haul cable of a cable transportation system; and
- auxiliary drive members having respective friction surfaces configured to engage drive wheels of an auxiliary drive device of a cable transportation system;
- and wherein the auxiliary drive members are connected pivotally to the frame.

[0011] The pivotal movement of the auxiliary drive members allows the auxiliary drive device to also drive the trolley along non-straight path portions.

[0012] This is particularly advantageous, for example, in the case of intermediate stations with switch points for trains of transportation units travelling in opposite directions. The invention, in fact, allows the auxiliary drive devices to be used to slow down the transportation units (on entering the station) and to accelerate them (on leaving the station) even along curved portions of the switch points, which may even be used to load and unload passengers (or freight)

ing the station) even along curved portions of the switch points, which may even be used to load and unload passengers (or freight)

[0013] In conventional cable transportation systems, on the other hand, the auxiliary drive devices cannot be used along the curved portions of the switch points, so the transportation units must continue to be drawn along by the main drive devices, by means of the haul cables. In this way, however, the transportation units cannot be accelerated or decelerated without altering the travelling speed of the entire system, which is normally undesirable and best avoided. The auxiliary drive devices must therefore be located along straight path portions downstream from the station entry switch points and upstream from the station exit switch points.

[0014] The present invention therefore provides for achieving more compact intermediate stations, with big advantages in terms of cost, or, vice versa, for employing longer trains for a given station size (by making it possible, within the same space, to use a larger loading and unloading area comprising not only straight but also curved portions).

[0015] A number of non-limiting embodiments of the present invention will be described by way of example with reference to the attached drawings, in which :

Figure 1 shows a simplified schematic of a cable transportation system in accordance with one embodiment of the present invention;

Figure 2 shows a view in perspective of a train of transportation units along part of the Figure 1 system path;

Figure 3 shows a top plan view of a Figure 1 system trolley in accordance with one embodiment of the present invention;

Figure 4 shows a right side view of the Figure 3 trolley;

Figure 5 shows a top plan view of the Figure 3 trolley along a portion of the Figure 1 system and in a different operating configuration;

Figure 6 shows a schematic top plan view of a cable transportation system trolley in accordance with a different embodiment of the present invention;

Figure 7 shows a simplified block diagram of a cable transportation system trolley in accordance with a further embodiment of the present invention;

Figure 8 shows a schematic top plan view of a cable transportation system trolley in accordance with a further embodiment of the present invention.

[0016] Number 1 in Figure 1 indicates as a whole a cable transportation system comprising a number of transportation units 2, rails 3, main drive devices 4, haul cables 5, and an auxiliary drive device 6.

[0017] Rails 3 extend in parallel pairs along a path P, and define guides for transportation units 2. Each rail 3 (Figures 2-4) has a supporting surface 3a, and a guide surface 3b substantially perpendicular to supporting sur-

face 3a.

[0018] As shown in Figure 1, haul cables 5 extend along first portions P1 of path P, and are operated by respective main drive devices 4 to draw transportation units 2 along first portions P1 of path P.

[0019] Auxiliary drive device 6 is located along second portions P2 of path P, e.g. at an intermediate station, and provides for driving transportation units 2 along second portions P2 where, in one embodiment, rails 3 comprise curved portions. More specifically, second portions P2 of path P comprise two straight parallel branches to allow transportation units 2 travelling in opposite directions to pass; and curved switch portions connecting the straight branches to first portions P1.

[0020] Auxiliary drive device 6 provides for decelerating, driving at constant speed, and accelerating transportation units 2 with no need for haul cables. As shown in Figures 2 and 5, auxiliary drive device 6 comprises sets of drive wheels 7 aligned along rails 3 at such a distance as to engage transportation units 2 as explained in detail below. More specifically, each rail 3 is flanked by a respective set of drive wheels 7 located outwards of path P. Drive wheels 7 are powered co-ordinately by an auxiliary motor 8 (shown schematically in Figure 1) and cooperate to drive transportation units 2 along second portions P2 of path P. More specifically, drive wheels 7 rotate clockwise on one side of rails 3, and anticlockwise on the other side. In one embodiment not shown, the drive wheels are only located on one side of rails 3.

[0021] In the embodiment described, transportation units 2 are arranged in trains running in opposite directions along path P, and each comprise a car 9 and a trolley 10. In an alternative embodiment not shown, each car is fitted to two separate trolleys, and each trolley supports two separate cars, respectively a front portion and a rear portion thereof.

[0022] One of trolleys 10, to which reference is made below, is shown in more detail in figures 3-5.

[0023] Trolley 10 comprises a frame 11 supported on supporting wheels 12, a system of guide rollers 13 and auxiliary drive members 15.

[0024] Frame 11 is connectable selectively to one of haul cables 5 of system 1 by a clamp, not shown for the sake of simplicity. In one embodiment, frame 11 comprises longitudinal bars 16 and axles 17, each fitted with two turnable supporting wheels 12 (in the example shown, two axles 17 and four supporting wheels 12). In an alternative embodiment not shown, the supporting wheels are not turnable.

[0025] Guide rollers 13 are associated with respective supporting wheels 12 to keep supporting wheels 12 on rails 3 and prevent trolley 10 from derailing. In one embodiment, each supporting wheel is associated with two guide rollers 13 connected to the end of respective axle 17 by a pivot structure 18. More specifically, pivot structures 18 comprise guide bars 19 fitted on the ends with two respective guide rollers 13. Guide bars 19 in turn are connected pivotally to the end of respective axles 17, in

such a position that guide rollers 13 contact guide surface 3b of a respective rail 3. Moreover, guide bars 19 are hinged to the frame to pivot about axes crosswise to the axis of supporting wheel 12, e.g. in a horizontal plane.

5 More specifically, guide bars 19 are positioned crosswise to axles 17 and, on account of pivoting and contact with guide surface 3b, the centres of rotation of guide rollers 13 are aligned at all times in a direction parallel to path P (along both the straight and curved portions).

10 **[0026]** Auxiliary drive members 15, arranged on either side of frame 11, are at least two in number and, in the embodiment of Figure 2-4, equal the number of pivot structures and supporting wheels 12. In one embodiment not shown, auxiliary drive members 15 are only provided on one side of frame 11.

15 **[0027]** Each auxiliary drive member 15 comprises a body 20 having a friction surface 20a configured to engage a set of drive wheels 7 of auxiliary drive device 6, and lead-in portions 20b and 20c. Friction surface 20a is substantially flat and is defined by an outer face of body 20, which, in one embodiment, comprises a substantially vertical grille. Alternatively, body 20 may be a plate with a outer face rough enough to avoid slipping with respect to drive wheels 7. Lead-in portions 20b, 20c extend at the front and rear of friction surface 20a, and bend towards frame 11.

20 **[0028]** Auxiliary drive members 15 are connected pivotally to frame 11, and are positioned so that respective friction surfaces 20a are parallel to the travelling direction of trolley 10, i.e. to the direction of path P at the location point of trolley 10. More specifically, auxiliary drive members 15 are fixed rigidly by arms 21 to guide bars 19 of respective pivot structures 18, so that supporting wheels 12 are located between the ends of axles 17 and respective auxiliary drive members 15. Friction surfaces 20a are substantially parallel to the line joining the centres of rotation of guide rollers 13. So, auxiliary drive members 15 are oriented in the direction of path P by the action of guide rollers 13.

30 **[0029]** Auxiliary drive members 15 of the same axle 17 are spaced apart so that respective friction surfaces 20a contact drive wheels 7 of auxiliary drive device 6 with a given pressure. Coordinated rotation of drive wheels 7 thus drives trolley 10 forward, with no macroscopic slippage on friction surfaces 20a.

35 **[0030]** Auxiliary drive members 15 being mounted pivotally, friction surfaces 20a can be oriented in the direction of path P, and trolley 10 also driven by auxiliary drive device 6 along non-straight portions, such as intermediate stations. In the embodiment described, orientation of auxiliary drive members 15, which are fixed to pivot structures 18, is determined by guide rollers 13.

40 **[0031]** In a different embodiment shown only schematically in Figure 6, a trolley 110 of a cable transportation system transportation unit (neither shown) comprises a frame 111, supporting wheels 112, guide rollers 113 and auxiliary drive members 115 connected to frame 111 pivotally and independently of guide rollers 113.

[0032] Auxiliary drive members 115 are mounted at respective supporting wheels 112, and each comprise a body 120 with a friction surface 120a, and a supporting pivot structure 118. In one embodiment, supporting pivot structure 118 is defined by a substantially C-shaped rod fixed at the ends to respective body 120. Supporting pivot structure 118 is hinged at the middle to frame 111, so as to pivot about an axis perpendicular to the axis of supporting wheel 112, and is connected to frame 111 by elastic restoring members 121 and dampers 122. Elastic restoring members 121, e.g. straight springs, coil springs, or torsion bars, tend to restore respective auxiliary drive member 115 to a rest position. In one embodiment, in the rest position, friction surfaces 120a of auxiliary drive members 115 are parallel to the longitudinal axis of frame 111. Dampers 122 are connected between pivot structure 118 of respective auxiliary drive member 15 and frame 111, in parallel to elastic restoring members 121.

[0033] Figure 7 shows a further embodiment of the invention, in which a trolley 210 of a cable transportation system transportation unit comprises a frame 211, supporting wheels 212 and auxiliary drive members 215 connected pivotally directly to frame 211 by a hinge connection. Auxiliary drive members 215 have friction surfaces 220a configured to engage drive wheels 7 of auxiliary drive device 6.

[0034] Trolley 210 also comprises actuators 221 connected to respective auxiliary drive members 215; at least one sensor 222; and a control device 223. Actuators 221 are operable to orient auxiliary drive members 215 according to the direction of path P of the cable transportation system at trolley 210, and more specifically at auxiliary drive members 215.

[0035] Sensor 222 is fixed rigidly to frame 211, and supplies a signal S indicating the direction of path P at a position corresponding to auxiliary drive members 215. Sensor 222 may, for example, be an optical distance sensor mounted a fixed distance from one of rails 3, or a feeler contacting rail 3.

[0036] Control device 223 receives signal S from sensor 222, and is configured to operate actuators 221 on the basis of signal S, to minimize error between the current value of signal S and a reference value.

[0037] In one embodiment, the trolley comprises a sensor for each axle.

[0038] In a further embodiment of the invention shown in Figure 8, a trolley 310 of a cable transportation system transportation unit comprises a frame 311, a pneumatic suspension device 312 and auxiliary drive members 315 connected pivotally to frame 311. Auxiliary drive members 315 are located on either side, on the outside, of frame 311, and have friction surfaces 320a designed to engage drive wheels 7 of auxiliary drive device 6.

[0039] In this case, the cable transportation system comprises tracks 303 instead of rails 3. Pneumatic suspension device 312 creates an air cushion between frame 311 and tracks 303, to support frame 311 and the whole of trolley 310 in use.

[0040] Clearly, changes may be made to the trolley described herein without, however, departing from the scope of the present invention as defined in the accompanying Claims.

Claims

1. A cable transportation system trolley comprising:
 - a frame (11; 111; 211; 311) connectable to a haul cable (5) of a cable transportation system (1); and
 - auxiliary drive members (15; 115; 215; 315) having respective friction surfaces (20a; 120a; 220a; 320a) configured to engage drive wheels (7) of an auxiliary drive device (6) of a cable transportation system (1);
 - and wherein the auxiliary drive members (15; 115; 215; 315) are pivotally connected to the frame (11; 111; 211; 311).
2. A trolley as claimed in Claim 1, wherein the auxiliary drive members (15; 115; 215; 315) are connected to the frame (11; 111; 211; 311) so that the auxiliary drive members (15; 115; 215; 315) pivot substantially in a horizontal plane.
3. A trolley as claimed in Claim 1 or 2, comprising guide rollers (13; 113) connected to the frame (11; 111) by respective pivot structures (18; 118).
4. A trolley as claimed in Claim 3, wherein the auxiliary drive members (15) are fitted to the pivot structures (18) of respective guide rollers (13).
5. A trolley as claimed in Claim 3, wherein the auxiliary drive members (115) are connected to the frame (111) independently of the guide rollers (113).
6. A trolley as claimed in any one of the foregoing Claims, wherein the auxiliary drive members (115; 215; 315) are hinged to the frame (111; 211; 311).
7. A trolley as claimed in any one of the foregoing Claims, wherein the auxiliary drive members (115) are connected to the frame (111) by respective elastic restoring members (121) configured to restore the auxiliary drive members (115) to respective rest positions with respect to the frame (111).
8. A trolley as claimed in Claim 7, wherein the auxiliary drive members (115) are also connected to the frame (111) by respective damping members (122) in parallel to the elastic restoring members (121).
9. A trolley as claimed in any one of the foregoing Claims, comprising actuators (221) connected to re-

spective auxiliary drive members (215) and operable to orient the auxiliary drive members (215) according to a direction of a path (P) of the cable transportation system (1) at the auxiliary drive members (215).

10. A trolley as claimed in Claim 9, comprising a sensor (222), which supplies a signal (S) indicating the direction of the path (P) at the auxiliary drive members (215), and a control device (223) configured to operate the actuators (221) on the basis of the signal (S).
11. A trolley as claimed in any one of the foregoing Claims, wherein the auxiliary drive members (15; 115; 215; 315) are arranged on sides of the frame (11; 111; 211; 311).
12. A trolley as claimed in any one of the foregoing Claims, wherein the auxiliary drive members (15; 115; 215; 315) are arranged so that the friction surfaces (20a; 120a; 220a; 320) are parallel to a travelling direction.
13. A trolley as claimed in any one of the foregoing Claims, wherein the friction surfaces (20a) are flat, and the auxiliary drive members (15) comprise respective lead-in portions (20b, 20c) extending frontwards and rearwards from the friction surfaces (20a) and bent towards the frame (11).
14. A trolley as claimed in any one of the foregoing Claims, comprising supporting wheels (12; 112; 212), each arranged between the frame (11; 111; 211) and a respective auxiliary drive member (15; 115; 215).
15. A trolley as claimed in any one of the foregoing Claims, comprising a pneumatic suspension device (312) structured to create an air cushion between the frame (311) and a supporting surface (303) to support the frame (311) in use.
16. A cable transportation system (1) comprising at least one trolley (10; 110; 210; 310) as claimed in any one of the foregoing Claims.
17. A cable transportation system (1) as claimed in Claim 16, comprising guides (3; 303) extending along a path (P), a main cable drive device (4) for driving the trolley (10; 110; 210; 310) along first portions (P1) of the guides (3), and at least one auxiliary drive device (6) for driving the trolley (10; 110; 210; 310) along second portions (P2) of the guides (3; 303); and wherein the auxiliary drive device (6) comprises sets of drive wheels (7) aligned along the guides (3; 303) at such a distance as to engage the friction surfaces (20a, 120a, 220a, 320a) of respective auxiliary drive members (15; 115; 215; 315), and operated

co-ordinatedly by an auxiliary motor (8) to drive the trolley (10; 110; 210; 310) along the second portions (P2) of the guides (3; 303).

18. A cable transportation system (1) as claimed in Claim 16 or 17, wherein the second portions (P2) of the guides (3) comprise curved portions.
19. A cable transportation system (1) as claimed in any one of Claims 16 to 18, wherein the guides (3) comprise parallel rails extending along the path (P), and each having a supporting surface (3a) and a guide surface (3b).
20. A cable transportation system (1) as claimed in Claim 19 dependent on Claim 3, wherein the guide rollers (13) are in contact with the guide surface (3b) of a respective rail.
21. A cable transportation system (1) as claimed in any one of Claims 16 to 20 dependent on Claim 9, wherein the sensor (222) is fixed to the frame (211) and is configured to determine a distance from at least one of the guides (3).

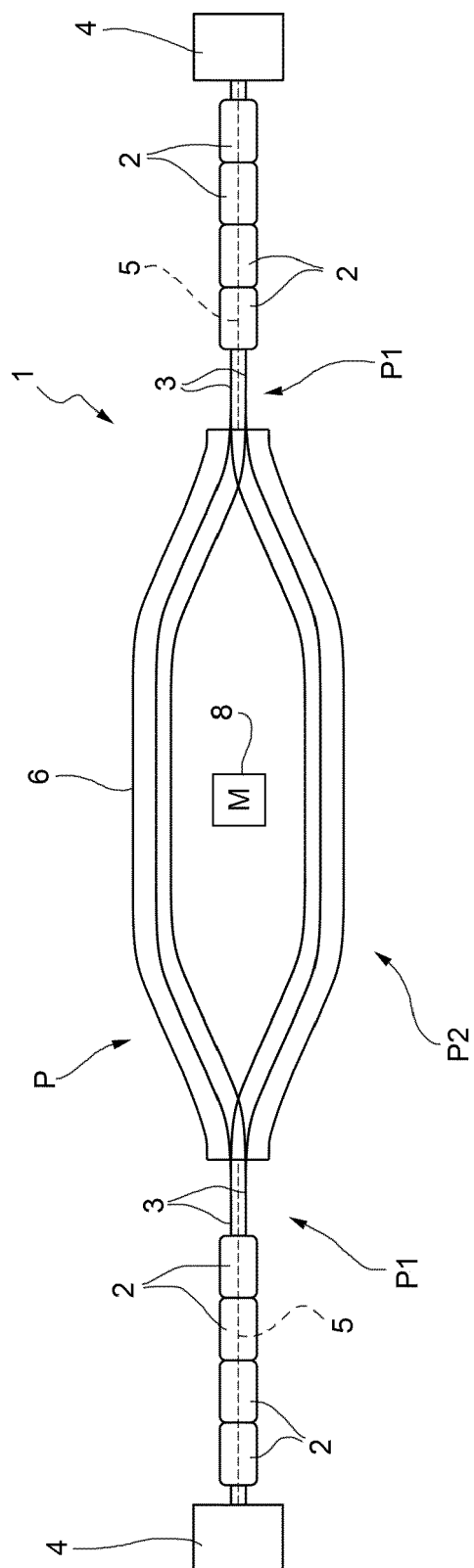


FIG. 1

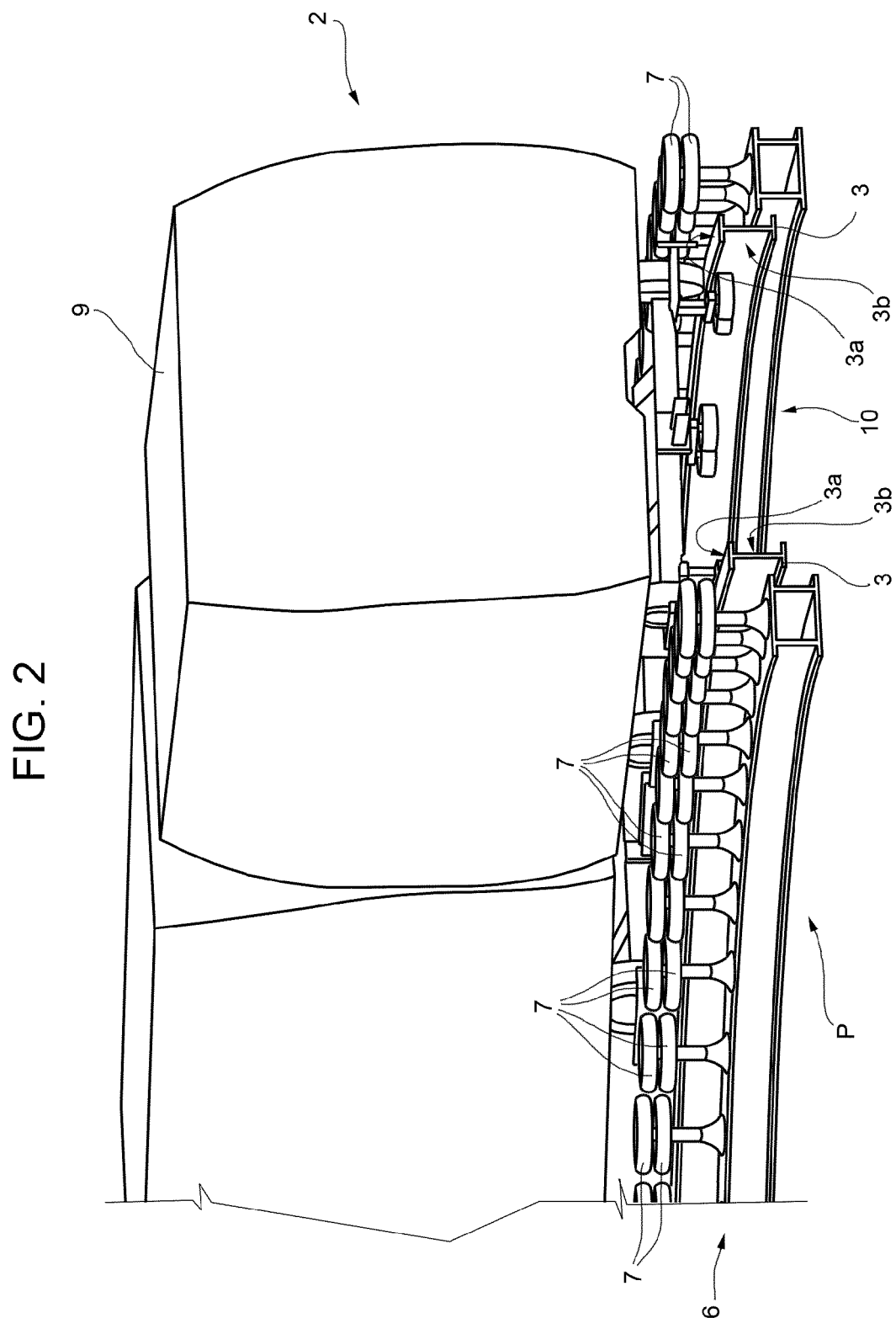


FIG. 3

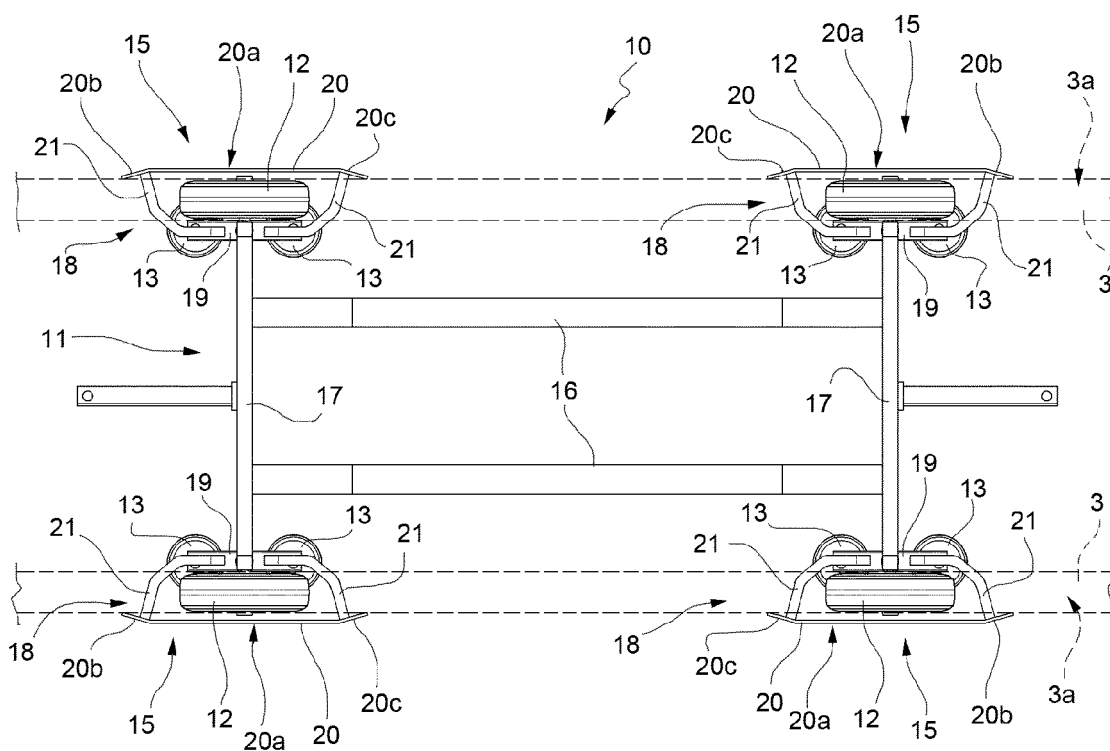


FIG. 4

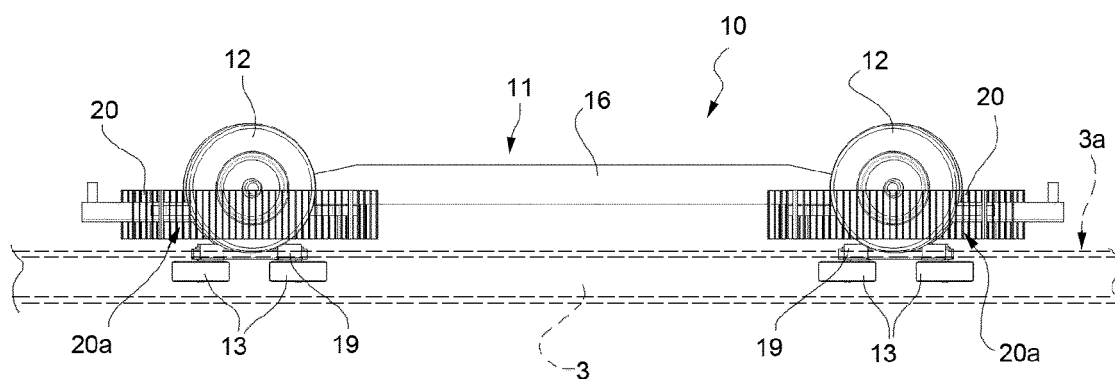


FIG. 5

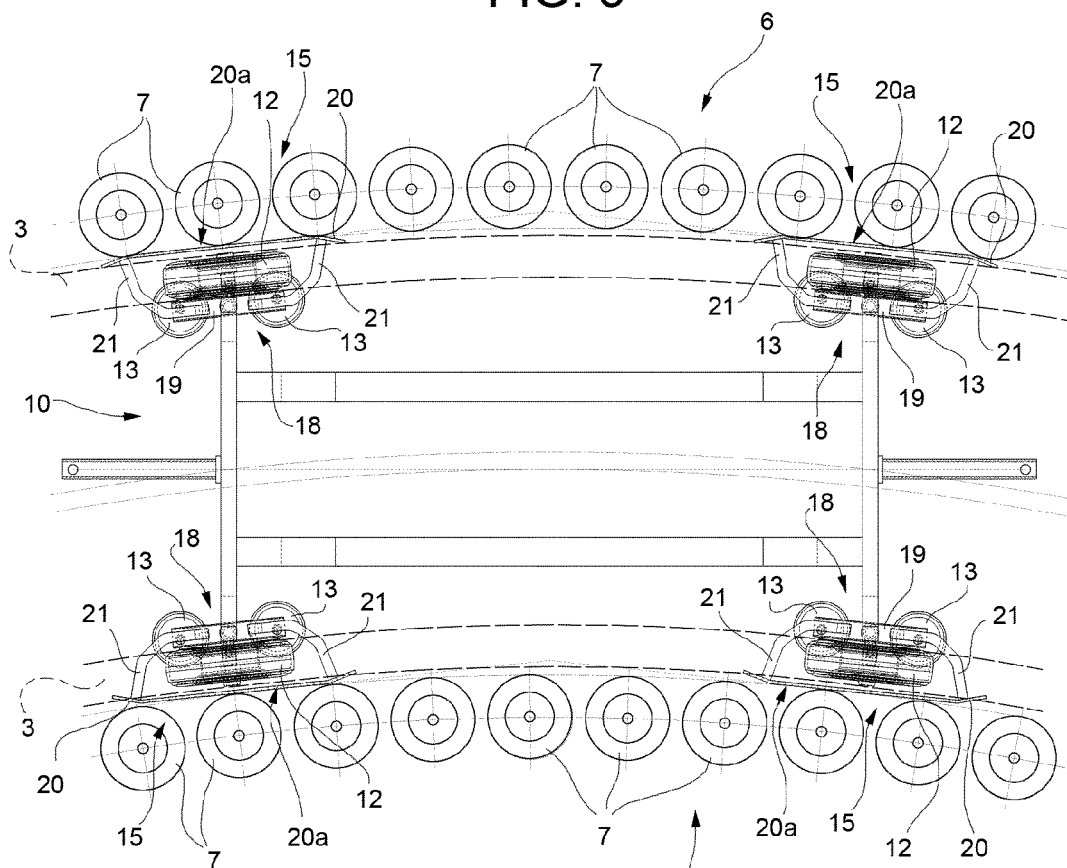


FIG. 6

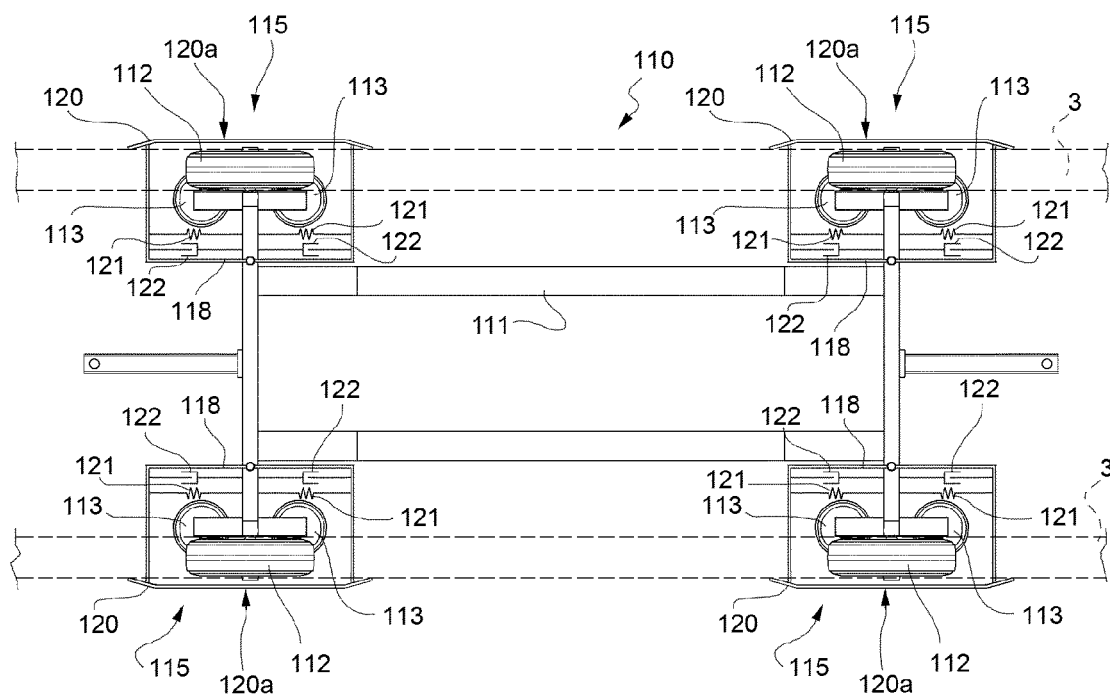


FIG. 7

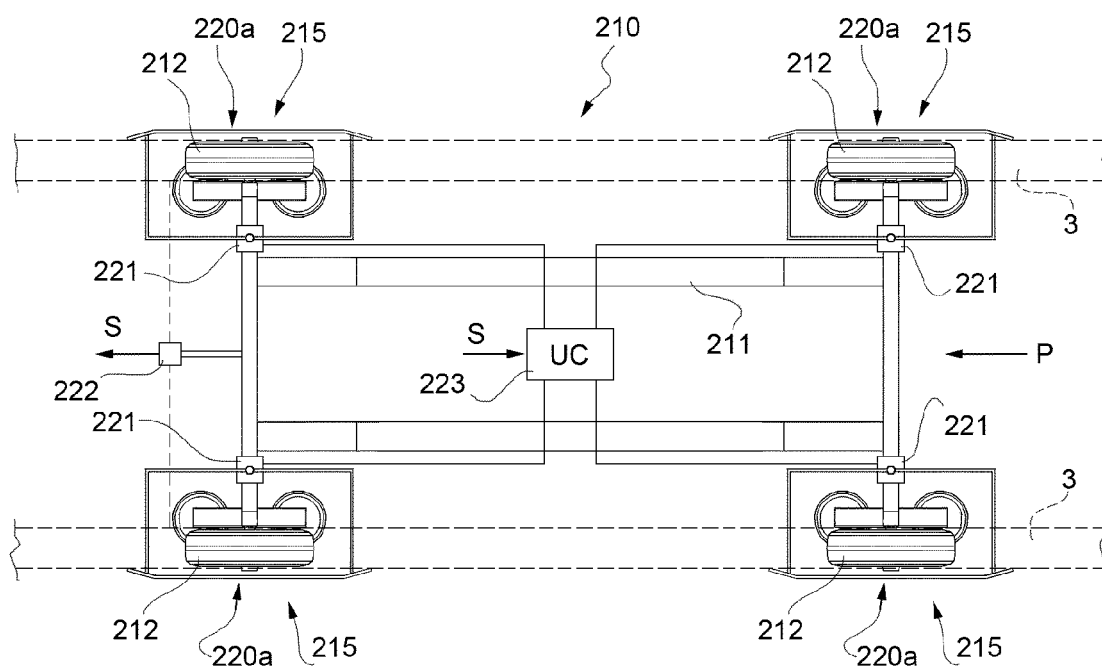
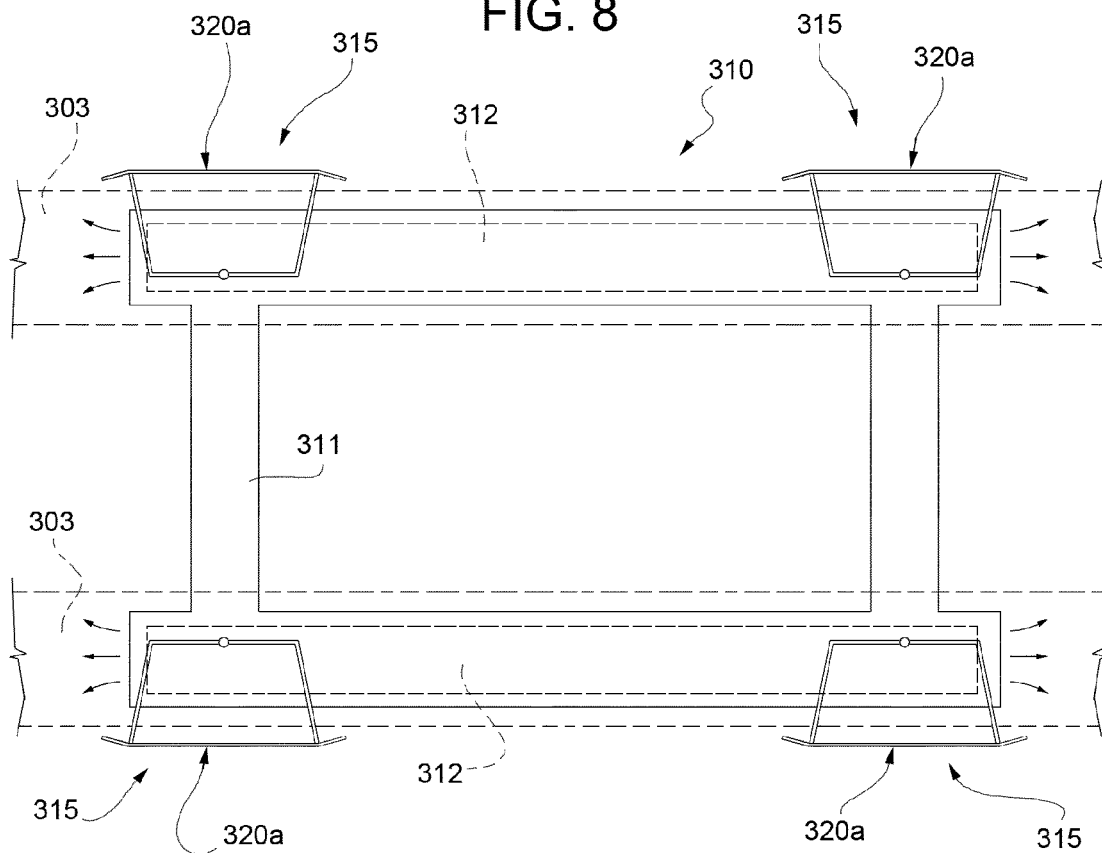


FIG. 8





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Application Number
EP 13 19 9859

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 February 2014	Examiner Lorandi, Lorenzo
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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