

AN AUTOMATED PEOPLE MOVER (APM) MONORAIL SYSTEM

BACKGROUND OF THE INVENTION

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Conventional Automated People Mover (APM), People Mover and monorail system designs are known to have several drawbacks. Firstly, these conventional designs typically require rubber tires for the suspension, guidance and propulsion sub-systems, which creates restrictions in both high-speed and
10 extreme-temperature applications where excessive tire rotational speeds and dynamic vibrations would normally cause high tire wear and premature suspension failure. Furthermore, the use of rubber tires creates the need for guideway heating in cold weather (i.e. snow and ice conditions), such that the conventional designs are often neither suitable nor economical for all weather
15 operations.

The conventional APM and monorail systems are typically supported and guided by a guideway beam surface and, due to vehicle weight and limited tire load ratings, often have restrictions for passenger capacity and high speed
20 applications. In addition, the fact that mid-support/propulsion tires occupy the inner vehicle floor space of most monorail vehicles results in limited passenger space and prevents passenger movement (walk-through) between coupled cars, which is necessary for emergency evacuation. In the past, economical designs of monorail vehicles have not been classed as APMs, since the cars
25 have great difficulty in meeting certain structural and operational safety-regulated specifications.

Several different designs of monorail vehicles have been introduced in the market in the past few years; however, all of these prior art designs are
30 restricted in passenger carrying capacity, safety limitations, operating speeds and all-weather operating capabilities. Furthermore, inter-car walk-through capabilities are typically neither present nor possible in the existing designs. Those monorail designs that have the walk-through capability require the floor

of the vehicle to be located above the tires. This creates a vehicle which sits higher above the beam, decreasing stability to lateral loads and preventing the achievement of the typical, attractive low-profile look of most monorails, which is quite important to many monorail purchasers.

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A further drawback of the conventional APM and monorail vehicles is their inherent requirement to use switches that move the complete beam. This type of switch is necessary because it is the beam that guides and, in some instances, even carries the load of the vehicle. Obviously, these switches are not standard and are more expensive and slower to operate than standard switches used for conventional rail vehicles.

Thus, due to current propulsion and technology arrangements, existing APM and monorail system designs are neither economical nor suitable for high-speed, all-weather operations where improved ride and noise comfort at reduced supply and operating costs are necessary requirements.

In light of the foregoing, a need clearly exists in the industry for an improved APM monorail system.

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SUMMARY OF THE INVENTION

In a first broad aspect, the present invention provides a bogie assembly for supporting and guiding a vehicle car body on a monorail track, the monorail track having a guideway portion and a narrower guideway beam extending upwardly from the guideway portion. The guideway portion includes a pair of rails, while the guideway beam defines a top surface and a pair of side surfaces. The bogie assembly includes a frame operative to support the vehicle car body above the guideway beam, where this frame includes an upper surface adapted to be pivotably mounted to the underside of the vehicle car body and a pair of side members extending downwardly from the upper surface.

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Each side member of the frame has an inner surface and an outer surface, the inner surface of each side member adapted to be positioned adjacent a respective one of the side surfaces of the guideway beam. The bogie assembly also includes a pair of load wheels, each load wheel being mounted to a
5 respective one of the side members of the frame and being operative to engage a respective one of the rails of the guideway portion. Each load wheel is characterized by a flange portion capable to engage the respective rail for assisting in the guidance of the vehicle car body as it travels along the monorail track.

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Advantageously, the use of flanged load wheels allows the monorail vehicle to switch between different monorail tracks using conventional switches and trackwork elements.

15 In a second broad aspect, the invention provides a vehicle for travelling on a monorail track, the monorail track having a guideway portion and a narrower guideway beam extending upwardly from the guideway portion. The guideway portion includes a pair of rails, while the guideway beam defines a top surface and a pair of side surfaces. The vehicle has at least one pair of load wheels,
20 each load wheel being operative to engage a respective one of the rails of the guideway portion. Each load wheel is characterized by a flange portion capable to engage the respective rail for assisting in the guidance of the vehicle car body along the monorail track.

25 In a third broad aspect, the invention provides a transportation system including a monorail track and at least one vehicle adapted to travel on the monorail track. The monorail track includes a guideway portion and a narrower guideway beam extending upwardly from the guideway portion, the guideway beam defining a top surface and a pair of side surfaces. The monorail track
30 also includes a pair of rails mounted on the guideway portion. The vehicle includes a car body and a pair of load wheels, each load wheel being operative to engage a respective one of the rails of the monorail track. Each load wheel

is characterized by a flange portion capable to engage the respective rail for assisting in the guidance of the vehicle car body along the monorail track.

5 **BRIEF DESCRIPTION OF THE DRAWINGS**

A detailed description of examples of implementation of the present invention is provided hereinbelow with reference to the following drawings, in which:

- 10 Figure 1 is a side view of an ATM monorail system, in accordance with an example of implementation of the present invention;

Figure 2 is a front planar view of the monorail track shown in Figure 1, in accordance with an example of implementation of the present invention;

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Figure 3 is a front planar view of the suspension/guidance sub-system of a car of the monorail vehicle shown in Figure 1, in accordance with an example of implementation of the present invention; and

- 20 Figure 4 is a top view of a monorail track switch, in accordance with an example of implementation of the present invention.

In the drawings, embodiments of the invention are illustrated by way of example. It is to be expressly understood that the description and drawings are
25 only for the purposes of illustration and as an aid to understanding, and are not intended to be a definition of the limits of the invention.

DETAILED DESCRIPTION

The Automated People Mover (APM) monorail system shown in Figure 1 is an integrated system approach to the vehicle / guideway beam arrangement, in accordance with a non-limiting example of implementation of the present invention.

The APM monorail vehicle 100 includes various operational sub-systems (not shown), such as the propulsion sub-system, the braking sub-system and the power sub-system, among many others. These sub-systems all work together to drive and control the motion of the vehicle 100 along the monorail track 110. Since the functionality and various possible implementations of these sub-systems are well known to those skilled in the art, and are not critical to the present invention, they will not be described in further detail.

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In the example shown in Figure 1, the APM monorail vehicle 100 is composed of three inter-connected cars 120, each of which is provided with a suspension sub-system, as will be described in further detail below. Note that the APM monorail vehicle 100 may have more or less than three cars 110 without departing from the scope of the present invention.

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Although in Figure 1, the monorail track 110 along which the APM monorail vehicle 100 travels is elevated with respect to ground level, it should be clear that different sites and installation setups for the monorail track 110 are possible without departing from the scope of the present invention. For example, the monorail track 110 may be installed at ground level, similar to a train track installation.

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With reference to Figure 2, the monorail track 110 includes a guideway portion 200 and a narrower guideway beam 210 extending upwardly from the guideway portion 200. The guideway beam 210 defines a top surface 212 and a pair of side surfaces 214, 216. The guideway beam 210 is used by the vehicle

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guidance sub-system to aid in preventing derailment, to improve steering capabilities within curved track sections and to provide protection to the train from leaving the guideway portion 200 in the event of a track failure.

- 5 A pair of rails 218 are mounted on the guideway portion 200 of the monorail track 110. In a specific example, each of rails 218 is a conventional AREA (American Railway Engineering Association) steel rail. However, various different types of rails 218 may be used without departing from the scope of the present invention. The trackwork system and fasteners are supported and fixed
10 by structural extensions, such as concrete re-enforced cord belts, extending near the bottom surfaces of the guideway beam 210.

Figure 3 is a front planar view of the suspension/guidance sub-system of each car 120 of the monorail vehicle 100 shown in Figure 1, with the car body 300
15 itself being shown in dotted line, in accordance with an example of implementation of the present invention. The suspension/guidance sub-system includes a pivoting bogie assembly 310, for supporting and guiding the vehicle car body 300 on the monorail track 110. The bogie assembly 310 is positioned over the top surface 212 of the guideway beam 210, and includes a frame 312
20 characterized by an inverted-U shape. Each side member 314, 316 of the frame 312 is positioned adjacent to a respective side surface 214, 216 of the guideway beam 210, such that the frame 312 follows the outer perimeter of the guideway beam 210. The pivoting bogie assembly 310 may be adapted for use with any standard or non-standard track gauge (i.e. distance between rails 218),
25 including for example a conventional track gauge of 1435 mm.

In a specific, non-limiting example, the APM monorail vehicle 100 incorporates a low-profile Linear Induction Motor (LIM) propulsion sub-system, instead of a conventional propulsion system using electric motors driving rubber tires, the latter
30 being restricted by tire friction and environmental / surface conditions. Accordingly, a LIM propulsion unit is installed at each end of the vehicle 100 (not shown in Figure 1). Assuming that the car 120 shown in Figure 3 is a cab of the

vehicle 100, the bogie assembly 310 is adapted to support a LIM propulsion unit 318 under its top surface. Alternatively, the LIM propulsion unit 318 may be installed under the car body 300. Note that, in this example of implementation, a LIM rail 220 is mounted to the upper surface 212 of the guideway beam 210 (shown in Figs. 2 and 3). When driving the APM monorail vehicle 100, the LIM propulsion units 318 travel along the LIM rail 220. Since LIM propulsion sub-systems have been well documented and are well known to those skilled in the art, the structure and operation of the LIM propulsion sub-system will not be described in further detail.

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With reference to Figure 3, a pair of flanged wheels 320 (also referred to as load wheels) are mounted to the outer surface 322 of the bogie frame 312 at each end of the car 120, one wheel 320 per side of the frame 312. In a variant, two or more load wheels 320 may be provided on each side of the frame 312, at each end of the car 120. In a specific example, the wheels 320 are stub-axle steel wheels. Each wheel 320 is characterized by a flange 328 that is operative to assist with guidance of the vehicle 100 as it travels along the monorail track 100, as will be discussed in further detail below.

20 The wheels 320 engage and run along rails 218, for providing at least in part the suspension interface between the car body 300 and the guideway beam 210. Thus, the wheels 320 in combination with the rails 218 provide a suspension sub-system that is able to support a greater load, being more load resistant. Furthermore, in the case of steel wheels 320 on steel AREA rails 25 218, the suspension sub-system is quieter in motion than the conventional rubber wheels on concrete.

A pair of guide wheels 324 are mounted to the inner surface 326 of the bogie frame 312 at each end of the car 120, one guide wheel 324 per side of the frame 312. Each guide wheel 324 runs along a respective side surface 214, 216 of the guideway beam 210, for stabilizing the car body 300. In a variant, 30

two or more guide wheels 324 may be provided on each side of the frame 312, at each end of the car 120.

Advantageously, the use of bogie assemblies 310 for supporting the car bodies
5 300 on the guideway beam 210 and for interfacing between the car bodies 300 and the wheels 320 provides a double suspension system. More specifically, a primary suspension is provided between each bogie frame 312 and the respective wheels 320, while a secondary suspension is provided between each bogie frame 312 and the respective car body 300 supported on the bogie
10 frame 312. Accordingly, fewer vibrations are transmitted to the car body 300 than in existing designs, making for a smoother and quieter ride for passengers. Furthermore, the APM monorail system described herein is suitable for all-weather operation and meets the requirements of existing APM design and safety regulated specifications.

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As seen in Figure 3, the contact area between each wheel 320 and the respective rail 218 is just below the lower skirt envelope of the car body 300, permitting conventional track switches and elements to be installed as part of the trackwork system. The relocation of all of the suspension wheels below the
20 top surface 212 of the guideway beam 210 also permits a clear interior car envelope, for increased passenger floor space and a walk-through connection between married cars.

Advantageously, the flanges 328 of the steel wheels 320 allow the vehicle 100
25 to switch between monorail tracks 110 using conventional switch elements. More specifically, and with reference to Figure 4, at a switch 400 the guideway beams 210 are interrupted (i.e. discontinued) between different track 110 ends. However, the steel rails 218 continue throughout the switch 400, the engagement between the flanges 328 of the steel wheels 26 and the rails 218
30 being sufficient to guide the vehicle 100 through the switch 400. Once through the switch 400, the guide wheels 324 located on the inner surfaces 326 of the bogies 310 re-engage the guideway beam 210 of the new monorail track 110,

and the vehicle 100 continues its travel, supported on the new guideway beam 210 by the bogies 310.

Note that, in between switches 400, the guide wheels 324 are used to center the
5 ATM monorail vehicle 100 on the monorail track 110. As a result, the flanges 328
of the wheels 320 do not come into contact with the rails 218, thereby decreasing
the noise level and helping in high-speed stability. The wheel flanges 328 only
provide guidance to the vehicle 100 when the vehicle 100 is travelling through a
switch 400.

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In a preferred embodiment, both the flanged guide wheels 320 and the rails 218
are made of steel, forming a dual steel rail interface just below the lower skirt edge
of the car body 300. By integrating this dual steel rail interface with a 1435mm
standard track gauge, conventional and existing AREA switch and trackwork
15 elements can be used as part of the monorail track 110 installation. Furthermore,
the design and location of such a steel wheel interface permits ATM monorail
vehicles to be manufactured, tested, and maintained on existing AREA
compliant transit trackwork facilities and associated track infrastructures,
presently in use with conventional rail transit manufacturing companies.

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Typically, the front and rear cars 130 of the ATM monorail vehicle 100 are
configured to guide and tunnel compressed moving air along the guideway beam
210, in order to assist in cooling undercar propulsion equipment and to increase
the operating efficiency thereof. In a variant example of implementation of the
25 present invention, the suspension/guidance sub-system of the ATM monorail
vehicle 100 may incorporate acoustic damping extension skirts (not shown)
mounted adjacent to the wheels 320. Such acoustic damping extension skirts
serve to reduce wheel / rail noise emissions generated at the interface between
the wheels 320 and the rails 218, and also to assist in containing the tunnel air
30 effect.

Although various embodiments have been illustrated herein above, this was for the purpose of describing, but not limiting, the present invention. Various modifications will become apparent to those skilled in the art and are within the scope of this invention, which is defined more particularly by the attached
5 claims.

CLAIMS:

1. A bogie assembly for supporting and guiding a vehicle car body on a monorail track, the monorail track having a guideway portion and a narrower guideway beam extending upwardly from the guideway portion, the guideway portion including a pair of rails, the guideway beam defining a top surface and a pair of side surfaces, said bogie assembly comprising:
 - a frame operative to support the vehicle car body above the guideway beam, said frame including:
 - a) an upper surface adapted to be pivotably mounted to the underside of the vehicle car body;
 - b) a pair of side members extending downwardly from said upper surface, each side member having an inner surface and an outer surface, said inner surface of each side member adapted to be positioned adjacent a respective one of the side surfaces of the guideway beam;
 - a pair of load wheels, each load wheel being mounted to a respective one of said side members of said frame and being operative to engage a respective one of the pair of rails of the monorail track, each load wheel having a flange portion capable to engage the respective rail for assisting in the guidance of the vehicle car body along the monorail track.
2. A bogie assembly as defined in claim 1, wherein said bogie assembly further comprises a Linear Induction Motor propulsion system for driving the vehicle car body.
3. A bogie assembly as defined in claim 1 or 2, further comprising a pair of guide wheels, each guide wheel adapted to be mounted to the inner surface of a respective one of said side members of said frame for engaging the respective side surface of the guideway beam, when the

vehicle car body is in motion said guide wheels guiding the motion of the vehicle car body along the monorail track.

4. A bogie assembly as defined in claim 1, 2 or 3, wherein said load wheels
5 are made of steel.
5. A bogie assembly as defined in any one of the preceding claims, wherein
said flange portion of each load wheel is operative to guide the motion of
the vehicle car body as the vehicle car body travels through a guideway
10 switch of the monorail track.
6. A bogie assembly as defined in any one of the preceding claims, wherein
said frame extends along at least a portion of the length of the vehicle
car body.
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7. A vehicle for travelling on a monorail track, the monorail track having a
guideway portion and a narrower guideway beam extending upwardly
from the guideway portion, the guideway portion including a pair of rails,
the guideway beam defining a top surface and a pair of side surfaces,
20 said vehicle having at least one pair of load wheels, each load wheel
being operative to engage a respective one of the pair of rails of the
monorail track, each load wheel being characterized by a flange portion
capable to engage the respective rail for assisting in the guidance of the
vehicle along the monorail track
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8. A vehicle as defined in claim 7, said vehicle further comprising:
 - a bogie assembly having a frame for supporting the vehicle car
body above the guideway beam, said frame including:
 - a) an upper surface adapted to be pivotably mounted to the
30 underside of the vehicle car body;
 - b) a pair of side members extending downwardly from said
upper surface, each side member having an inner surface

and an outer surface, said inner surface of each side member adapted to be positioned adjacent a respective one of the side surfaces of the guideway beam.

- 5 9. A vehicle as defined in claim 7 or 8, wherein each said load wheel is mounted to a respective one of said side members of said frame.
- 10 10. A vehicle as defined in claim 7, 8 or 9, wherein said vehicle further includes a Linear Induction Motor propulsion system for driving the vehicle.
- 11 11. A vehicle as defined in claim 10, wherein said Linear Induction Motor is mounted on said bogie.
- 15 12. A vehicle as defined in claim 10, wherein said Linear Induction Motor is mounted to the underside of the vehicle car body.
- 20 13. A vehicle as defined in any one of claims 7 to 12, further comprising a pair of guide wheels, each guide wheel adapted to be mounted to the inner surface of a respective one of said side members of said frame for engaging the respective side surface of the guideway beam, when the vehicle is in motion said guide wheels guiding the motion of the vehicle along the monorail track.
- 25 14. A vehicle as defined in any one of claims 7 to 13, wherein said load wheels are made of steel.
- 30 15. A vehicle as defined in any one of claims 7 to 14, wherein said flange portion of each load wheel is operative to guide the motion of said vehicle as said vehicle travels through a guideway switch of the monorail track.

16. A vehicle as defined in claim 8, wherein said frame extends along at least a portion of the length of the vehicle car body.
17. A transportation system comprising:
- 5 - a monorail track having a guideway portion and a narrower guideway beam extending upwardly from the guideway portion, the guideway beam defining a top surface and a pair of side surfaces;
 - a pair of rails mounted on the guideway portion;
 - 10 - at least one vehicle adapted to travel on said monorail track, said vehicle including:
 - a) a car body;
 - b) a pair of load wheels, each load wheel being operative to engage a respective one of said pair of rails, each load wheel being characterized by a flange portion capable to
 - 15 engage said respective rail for assisting in the guidance of said vehicle along said monorail track.
18. A transportation system as defined in claim 17, said vehicle further comprising:
- 20 - a bogie assembly having a frame for supporting said car body above the guideway beam, said frame including:
 - (1) an upper surface adapted to be pivotably mounted to the underside of said car body;
 - 25 (2) a pair of side members extending downwardly from said upper surface, each side member having an inner surface and an outer surface, said inner surface of each side member adapted to be positioned adjacent a respective one of the side
 - 30 surfaces of the guideway beam.

19. A transportation system as defined in claim 17 or 18, wherein each said load wheel is mounted to a respective one of said side members of said frame.
- 5 20. A transportation system as defined in any one of claims 17 to 19, wherein said vehicle further includes a Linear Induction Motor propulsion system for driving said vehicle.
21. A transportation system as defined in claim 20, wherein said Linear
10 Induction Motor is mounted on said bogie.
22. A transportation system as defined in claim 20, wherein said Linear Induction Motor is mounted to the underside of the vehicle car body.
- 15 23. A transportation system as defined in any one of claims 17 to 22, further comprising a pair of guide wheels, each guide wheel adapted to be mounted to the inner surface of a respective one of said side members of said frame for engaging the respective side surface of the guideway beam, when the vehicle is in motion said guide wheels guiding the
20 motion of the vehicle along the monorail track.
24. A transportation system as defined in any one of claims 17 to 23, wherein said load wheels are made of steel.
- 25 25. A transportation system as defined in any one of claims 17 to 24, wherein said monorail track includes at least one guideway switch, said flange portion of each load wheel being operative to engage said
25 respective rail for guiding the motion of said vehicle as said vehicle travels through said guideway switch of said monorail track.
- 30 26. A transportation system as defined in claim 18, wherein said frame extends along at least a portion of the length of the vehicle car body.

27. A transportation system as defined in claim 25, wherein said narrower guideway beam is interrupted throughout said guideway switch.
- 5 28. A transportation system as defined in claim 25 or 27, wherein said guideway switch is a standard AREA track switch.
29. A transportation system as defined in any one of claims 17 to 28, wherein said pair of rails is a pair of standard track rails.
- 10 30. A transportation system as defined in any one of claims 17 to 29, wherein said pair of rails includes a gauge, said gauge being a standard 1453mm gauge.