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(54) **AMUSEMENT RIDE VEHICLE INCLUDING AN ARTICULATION JOINT**

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(52) **U.S. Cl.** **104/63**

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See application file for complete search history.

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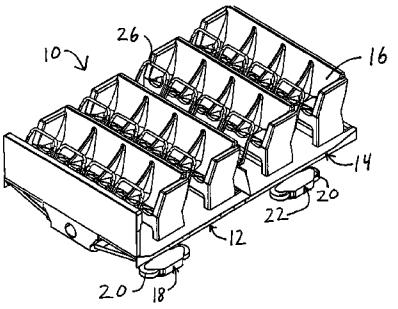
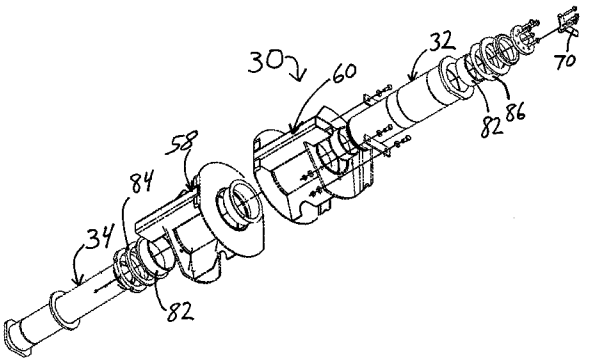
(57) **ABSTRACT**

An amusement ride vehicle includes a first vehicle section, a second vehicle section, and an articulation joint connecting, and providing rotational movement between, the first and second vehicle sections. The articulation joint comprises a first shaft for bearing loads during normal operation of the joint, and a second shaft within the first shaft for bearing loads when the first shaft is inoperable. A test element, such as a lever, is attached to the second shaft. The second shaft is rotatable via the test element during normal operation of the joint. When the first shaft is inoperable, the second shaft handles loads acting on the articulation joint, and is not rotatable via the test element, thus indicating a failure of the first shaft.

20 Claims, 3 Drawing Sheets





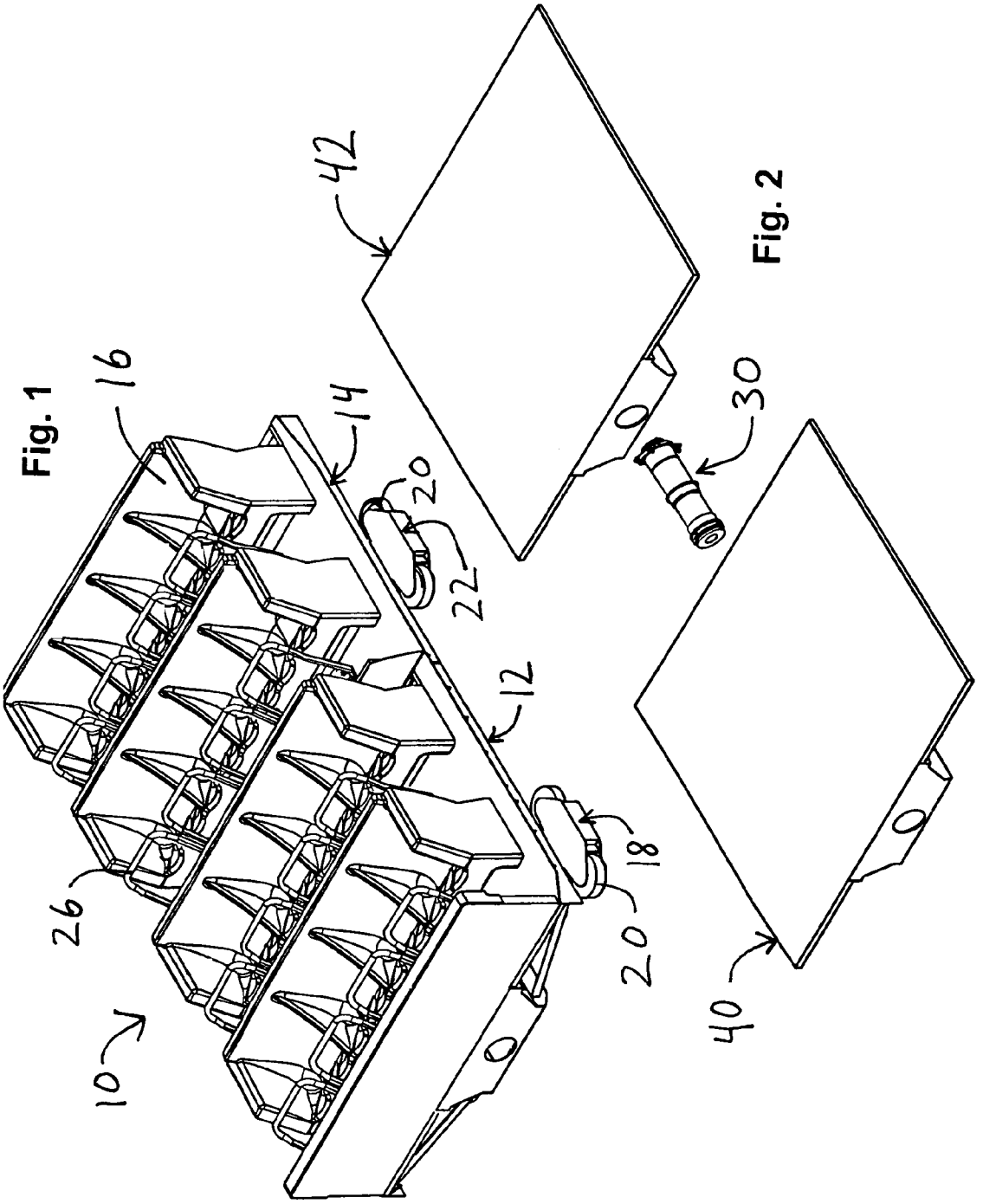


Fig. 1

Fig. 2

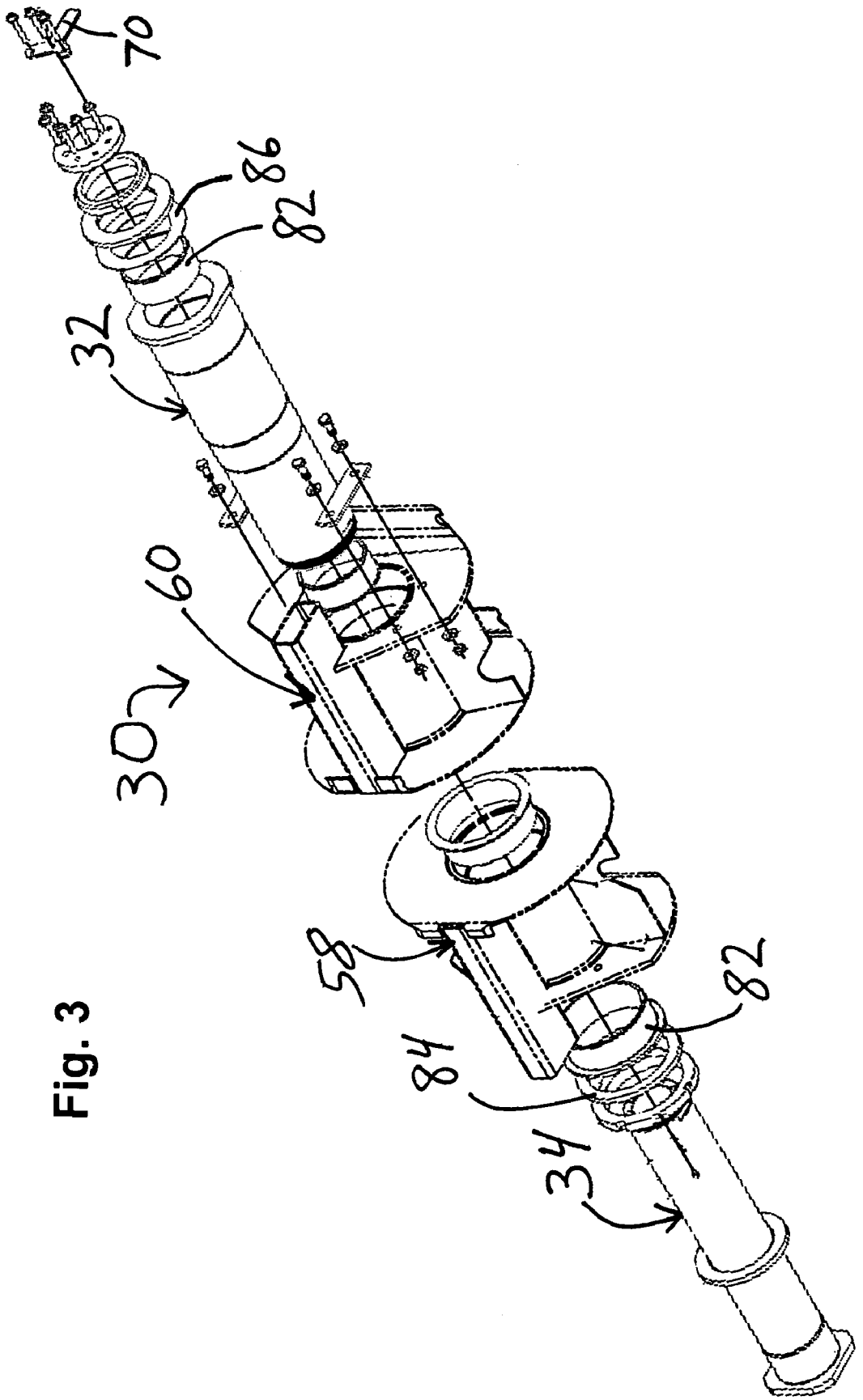


Fig. 3

Fig. 5

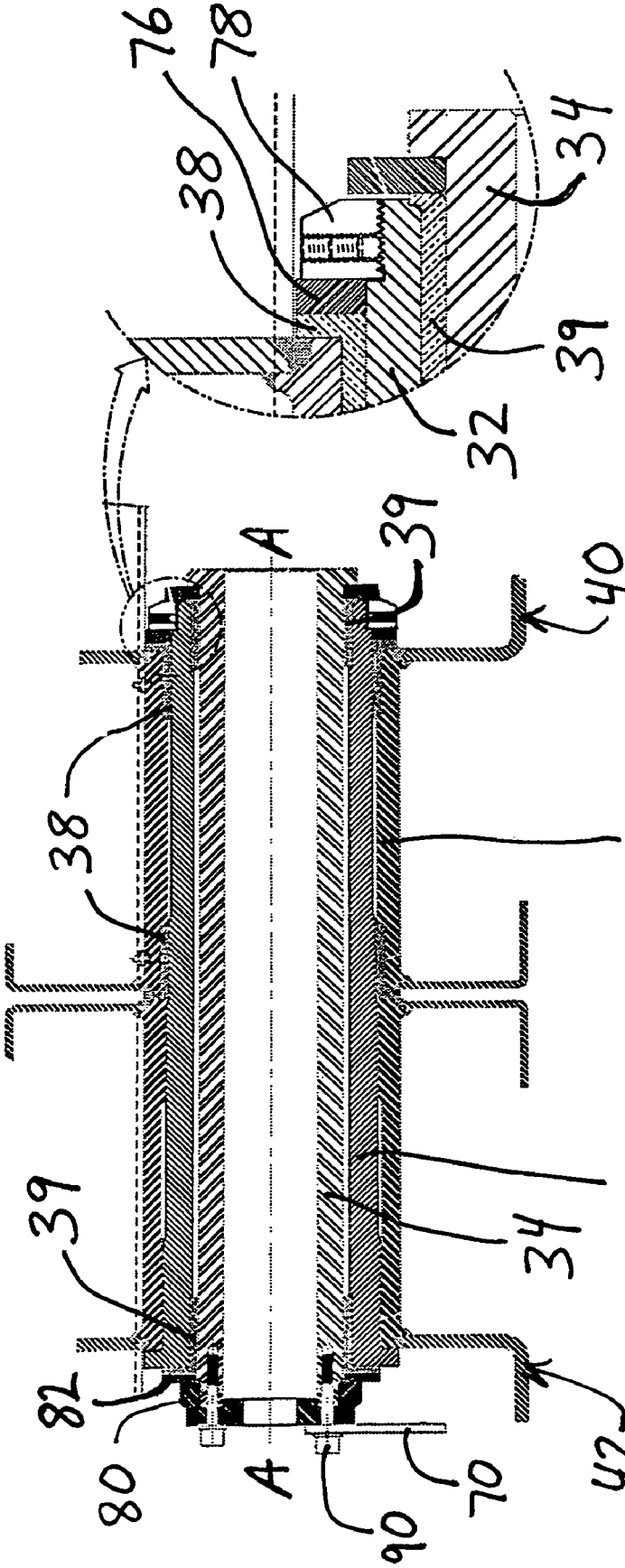


Fig. 4

AMUSEMENT RIDE VEHICLE INCLUDING AN ARTICULATION JOINT

BACKGROUND OF THE INVENTION

Amusement rides, such as roller coasters, typically include vehicles that ride on tracks or rails. The vehicles or cars may include multiple vehicle sections connected by couplings. Several vehicle sections are often connected to one another to increase the rider capacity of the amusement ride. Depending on the track configuration and the relative size of the vehicle sections, two or more vehicle sections may be required to turn and/or rotate relative to one another to accommodate curves in the track.

Amusement rides often include very tight curves, particularly if a ride is set up in a relatively small area, e.g., in an indoor facility, or in a compact outdoor area. Tight or small radius curves may also be used to enhance the overall ride sensation, by creating larger "g" forces on the riders, even at lower speeds. One resulting disadvantage of tight curves is that the ride vehicle typically has to be shortened in overall length, so that it can safely and effectively navigate through the tight curves. As a result, the rider capacity, or number of seats, is typically reduced. This often leads to longer lines and wait times for the amusement ride.

Another common problem associated with amusement rides or coasters is downtime resulting from a malfunctioning ride vehicle. This can result when a joint or coupling between vehicle sections malfunctions. If a joint or coupling malfunctions during use, the entire amusement ride generally has to be temporarily stopped, at least until the joint can be fixed or the vehicle can be removed from the track.

Even with thorough daily inspections and maintenance, vehicle couplings can still malfunction during ride operation. For this reason, current ride systems that have an articulation joint as part of their assembly may be equipped with a backup system. These backup systems, however, are typically not designed to bear the same loads, or to permit the same articulation between vehicle sections, as the primary articulation system. As a result, the ride vehicle will generally have to be taken offline for repairs when a joint malfunction occurs. Accordingly, a need exists for an improved amusement ride vehicle that can accommodate tight curves, while seating several passengers, and allowing the amusement ride to continue to operate when a joint or coupling between vehicle sections malfunctions.

SUMMARY OF THE INVENTION

The invention is directed to an amusement ride vehicle including a first vehicle section, a second vehicle section, and an articulation or pivot joint connecting, and providing rotational or pivotal movement between, the first and second vehicle sections.

In one aspect, the articulation joint comprises a first shaft for bearing loads during normal operation of the joint, and a second shaft within the first shaft for bearing loads when the first shaft is inoperable.

In another aspect, a test element, such as a handle or lever, is attached to the second shaft. The second shaft is rotatable via the test element during normal operation of the joint, i.e., when the first shaft is bearing the loads acting on the joint. When the first shaft fails, or is otherwise inoperable, the second shaft handles the loads acting on the joint, and is therefore not rotatable via the test element, thus indicating that the first shaft is out of order.

Other features and advantages of the invention will appear hereinafter. The features of the invention described above can be used separately or together, or in various combinations of one or more of them. The invention resides as well in sub-combinations of the features described.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, wherein similar reference characters denote similar elements throughout the several views:

FIG. **1** is a perspective view of an amusement ride vehicle.

FIG. **2** is a partial exploded view of the chassis and articulation joint of the amusement ride vehicle shown in FIG. **1**.

FIG. **3** is an exploded view of the articulation joint shown in FIG. **2**.

FIG. **4** is a side-sectional view of the articulation joint illustrated in FIG. **3** connected to front and rear vehicle chassis sections.

FIG. **5** is a magnified sectional view of Section A from FIG. **4**.

DETAILED DESCRIPTION OF THE DRAWINGS

Turning now in detail to the drawings, FIG. **1** illustrates an amusement ride or roller coaster vehicle **10** having a first or front vehicle section **12** attached to a second or rear vehicle section **14**. Each of the first and second vehicle sections **12**, **14** includes two rows of four seats **16**, such that the amusement ride vehicle **10** includes a total of sixteen seats **16**. Any other suitable number of vehicle sections, having any suitable number of seat rows, may alternatively be used.

A passenger restraint device, such as a lap bar **26**, a shoulder bar, and/or a seat belt, etc., is preferably provided at each seat **16** for holding a passenger in the seat **16** during movement of the vehicle **10**. The types of restraints used typically depend on the types of movements that the amusement ride vehicle **10** performs. For example, if the amusement ride vehicle **10** performs upside down movements, shoulder restraints may be used.

A pair of front wheel assemblies **18** is attached to opposite sides of the first vehicle section **12**, adjacent to the bottom of the first vehicle section **12**. A pair of rear wheel assemblies **22** is similarly attached to the bottom of the second vehicle section **14**. Wheels **20** on the front and rear wheel assemblies **18**, **22** are configured to engage the track or rails of an amusement ride. The front and rear wheel assemblies **18**, **22** roll along, and secure the ride vehicle **10** to, the track or rails. A greater or lesser number of wheel assemblies may be used to meet the requirements of any given amusement ride.

The front and rear wheel assemblies **18**, **22** preferably each include two or more vertically-oriented wheels (not visible in the drawings) attached to an arm or shaft that is pivotable about a horizontal axis and a vertical axis. The vertically-oriented wheels preferably ride on top of the track or rails. When the amusement ride **10** enters a vertical pitch in the track, the arm or shaft pivots about the horizontal axis so that the wheels navigate the track and the ride vehicle **10** does not undergo significant vertical bending stresses. When the amusement ride **10** enters a horizontal turn in the track, the arm or shaft pivots about the vertical axis so that the wheels navigate the track and the ride vehicle **10** does not undergo significant horizontal bending stresses. Any other suitable wheel assembly configuration may alternatively be

used to accommodate pitch and yaw movements of the ride vehicle **10**, as is well known in the art.

FIG. **2** is a partially exploded view of a first chassis section **40** of the first vehicle section **12**, and a second chassis section **42** of the second vehicle section **14**. The first and second chassis sections **40**, **42** are preferably constructed from steel or any other suitable material, and are connected by a joint **30**. The joint **30** provides relative rotation about a longitudinal axis of the joint **30** between the first and second vehicle sections **12**, **14**, and is thus referred to as an articulation joint **30**. The articulation joint **30** allows the amusement ride vehicle **10** to travel through tight curves in the ride track. The degree of relative rotation between the first and second vehicle sections **12**, **14**, provided by the articulation joint **30**, is preferably limited only by the configuration of the ride track.

FIGS. **3**–**5** illustrate details of the articulation joint **30** according to a preferred embodiment. The articulation joint **30** preferably includes a hollow cylindrical primary shaft **32** connected to the first and second vehicle sections **12**, **14**, and a hollow cylindrical secondary shaft **34** positioned concentrically within the primary shaft **32** and connected to the first and second vehicle sections **12**, **14**. The primary shaft **32** is preferably positioned concentrically within a chassis tube **36**. The chassis tube **36** connects into the first and second chassis sections **40**, **42**, and is rotatable or pivotable about the primary shaft **32** to provide relative rotation about a longitudinal axis (front-to-back axis A—A) between the first and second vehicle sections **12**, **14**.

The primary shaft **32** preferably has a length of approximately 18 to 24 inches, or approximately 21 inches, an outer diameter of approximately 5.5 to 6.0 inches, or approximately 5.75 inches, and an inner diameter of approximately 4.1 to 4.7 inches, or approximately 4.4 inches. The secondary shaft **34** preferably has a length of approximately 20 to 26 inches, or approximately 23 inches, an outer diameter of approximately 3.75 to 4.25 inches, or approximately 4.0 inches, and an inner diameter of approximately 2.25 to 2.75 inches, or approximately 2.5 inches. Of course, the primary and secondary shafts **32**, **34** may be larger or smaller depending on the size and weight of the first and second vehicle sections **12**,**14**.

A first or outer set of bearings **38** is preferably pressed into the chassis tube **36** such that the bearings **38** are positioned between the chassis tube **36** and the primary shaft **32**. Alternatively, roller bearings, ball bearings, or other suitable bearings could be are positioned between the chassis tube **36** and the primary shaft **32**. A second or inner set of bearings **39** is preferably positioned between the primary shaft **32** and the secondary shaft **34**. The first and second sets of bearings **38**, **39** are preferably made of brass or another suitable material. The chassis tube **36** is rotatable against the first set of bearings **38**, about the primary shaft **32**, during normal operation of the amusement ride vehicle **10**. The primary shaft **32** is rotatable against the second set of bearings **39**, about the secondary shaft **34**, when the primary shaft **32** fails or is otherwise inoperable, as further described below.

As illustrated in FIG. **3**, the articulation joint **30** preferably includes a first chassis assembly **58** for attachment to a rear face of the first chassis section **40** or to a front face of the second chassis section **42**, and a second chassis assembly **60** for attachment to the other of the front face of the second chassis section **42** and the rear face of the first chassis section **40**. The primary and secondary shafts **32**, **34** enter and engage the first and second chassis sections **40**, **42** through central openings in the first and second chassis assemblies **58**, **60**. The articulation joint **30** preferably further includes bushings **82**, spacers **84**, washers **86**, etc., to facilitate articulating movement and/or secure connection between the various joint components.

As illustrated in FIG. **5**, the primary shaft **32** is preferably threaded into a primary lock ring, or primary lock nut **78**, that is separated from one of the bearings **38** by a spacer **76**. The primary lock nut **78** applies a force in the axial, or longitudinal (along axis A—A) direction, and handles and distributes thrust loads acting on the articulation joint **30** during normal operation of the articulation joint **30**. As illustrated in FIG. **4**, the secondary shaft **34** is preferably threaded into a secondary lock ring, or secondary lock nut **80**, that is separated from one of the bearings **39** by a spacer **82**. The secondary lock nut **80** handles and distributes thrust loads acting on the articulation joint **30** when the primary shaft **32** is broken, or otherwise inoperable, as described below.

A test element, such as a handle, lever, nut, access hole, or other suitable means, is attached to or otherwise in communication with the secondary shaft **34** for providing rotation to the secondary shaft **34**. A test handle **70**, which is attached to the secondary shaft **34** via one or more bolts **90** or other suitable attachment means, will be described herein by way of example only. During normal operation of the articulation joint **30**, the test handle **70** may be pushed or pulled by an inspector to rotate the secondary shaft **34**, indicating that the primary shaft **32** is operating properly, as described below. When the ride vehicle **10** is at rest on a track, the test handle **70** preferably projects downwardly (due to gravity) and extends nearly to the bottom of the amusement ride vehicle **10**, so that an inspector standing beneath the track may reach up and push or pull the handle **70**.

In use, one or more amusement ride vehicles **10** are positioned on the track or rails of an amusement ride. Riders board an amusement ride vehicle **10** and sit in the vehicle seats **16**. The lap bars **26** and/or other restraints are then lowered or engaged and locked into place, to secure the riders in the vehicle **10**. Once the riders are safely restrained in their seats **16**, the amusement ride vehicle **10** begins to move along the track or rails, via a pulling mechanism located under the track, a launch mechanism, or other propulsion systems.

When the ride vehicle **10** comes to a combined horizontal and vertical curve in the track, the first vehicle section **12** enters the curve and rotates about axis A—A relative to the second vehicle section **14**, via the articulation joint **30**. Specifically, the chassis tube **36** rotates against the bearings **38** about the primary shaft **32**, allowing the first vehicle section **12** to rotate relative to the second vehicle section **14** as it enters the curve. The second vehicle section **14** then enters the curve and rotates relative to the first vehicle **12** in a similar manner. As the amusement ride vehicle **10** continues along the track, it moves through the various turns and curves in the track in the same manner.

Under normal ride vehicle operating conditions, the primary shaft **32** handles the radial and axial loads acting on the articulation joint **30**. The primary shaft **32**, accordingly, remains relatively stationary (although it may rotate somewhat) while the chassis tube **36** rotates about the primary shaft **32**. The secondary shaft **34**, conversely, does not handle any of the loads under normal operating conditions, and is therefore free to rotate within the primary shaft **32**.

If the primary shaft **32** fails, breaks, or otherwise becomes inoperable, the secondary shaft **34** takes on the role of the primary shaft **32**, due to the arrangement of the primary and secondary shafts **32**, **34**, and handles the loads acting on the

articulation joint **30**, i.e., the secondary shaft **34** assumes the load-bearing role of the primary shaft **32**. The secondary shaft **34** is preferably at least as strong as the primary shaft **32** for handling the loads. As a result, the amusement ride vehicle **10** can continue to operate if the primary shaft **32** fails during ride operation.

Between daily operations, an inspector preferably inspects the amusement ride vehicle **10** to ensure that all of the ride vehicle components are functioning properly. To verify that the articulation joint **30** is working properly, the inspector pushes or pulls the test handle **70** (or other test element), in a direction of rotation of the secondary shaft **34**, in an attempt to rotate the secondary shaft **34**. If the secondary shaft **34** rotates, it is an indication that the secondary shaft **34** is not handling the loads acting on the articulation joint **30**, and that the primary shaft **32** is therefore handling the loads and functioning properly.

If the secondary shaft **34** does not freely rotate when the inspector pushes or pulls the test handle **70**, it is an indication that the secondary shaft **34** is handling the loads acting on the articulation joint **30**, and that the primary shaft **32** has therefore failed or is otherwise inoperable. In this case, the amusement ride vehicle **10** may be taken off the track for further inspection and repair. If the primary shaft **32** malfunctions during ride operation, the ride need not be stopped, because the secondary shaft then carries the loads acting on the joint **30**.

The amusement ride vehicle **10** provides several advantages over existing amusement ride vehicles. First, the amusement ride vehicle **10** can be used on a track having tight curves, which is common on indoor amusement rides and outdoor rides located in compact areas. Without the articulation joint **30**, the ride vehicle would have to be shorter to travel through the tight curves on these types of tracks. As a result, fewer passengers could ride in each vehicle, which often leads to longer waiting lines.

Even if a greater number of smaller ride vehicles were used, fewer people would be able to ride on the amusement ride when it is operating at or near full capacity, since the ride vehicles must be spaced apart from one another by a predetermined time interval and/or distance as a safety precaution. Thus, over a given time interval, more people can ride on an amusement ride that includes larger amusement ride vehicles **10**, than on an amusement ride that includes several smaller vehicles.

Additionally, by using the dual-shaft articulation joint **30**, the amusement ride vehicle **10** can continue to operate if the primary shaft **32** fails or is otherwise inoperable. The amusement ride vehicle **10** may then be removed from the track during non-operation hours and repaired off-line. As a result, the amusement ride is not shut down during operational hours when the primary shaft **32** on a ride vehicle **10** fails. Delays and line backups resulting from such a failure are therefore avoided.

While embodiments and applications of the present invention have been shown and described, it will be apparent to one skilled in the art that other modifications are possible without departing from the inventive concepts herein. The invention, therefore, is not to be restricted except by the following claims and their equivalents.

What is claimed is:

1. An amusement ride vehicle, comprising:

a first vehicle section including passenger means therein for holding passengers during motion of the ride vehicle;

a second vehicle section including second passenger means therein for holding passengers during motion of the ride vehicle; and

an articulation joint connecting, and providing rotational movement between, the first and second vehicle sections, with the articulation joint comprising:

a first shaft for bearing loads acting on the articulation joint during normal operation of the articulation joint; and

a second shaft located within the first shaft and being freely movable with respect to the first shaft and being free of any loads during normal operation of the articulation joint, the second shaft being configured for bearing loads acting on the articulation joint where the first shaft malfunctions.

2. The amusement ride vehicle of claim **1** further comprising a test element attached to the second shaft, wherein the second shaft is rotatable via the test element when the first shaft is operable.

3. The amusement ride vehicle of claim **2**, wherein the second shaft is not rotatable via the test element when the second shaft is bearing loads acting on the articulation joint.

4. The amusement ride vehicle of claim **1** further comprising at least one bearing between the first and second shafts for providing relative rotation between the first and second shafts.

5. The amusement ride vehicle of claim **1** further comprising a chassis tube positioned concentrically around the first and second shafts, with the chassis tube connected to the first and second vehicle sections.

6. The amusement ride vehicle of claim **5** further comprising at least one bearing between the chassis tube and the first shaft for providing relative rotation between the chassis tube and the first shaft.

7. The amusement ride vehicle of claim **1** wherein the first shaft bears radial and axial loads during normal operation of the articulation joint.

8. The amusement ride vehicle of claim **1** wherein the second shaft bears radial and axial loads if the first shaft malfunctions.

9. An amusement ride vehicle, comprising:

a first vehicle section including a first chassis section;

a second vehicle section including a second chassis section;

a chassis tube rotatably connected to the first and second chassis sections for providing rotation between the first and second vehicle sections;

a primary shaft connected to the first and second chassis sections and positioned concentrically within the chassis tube for bearing loads during normal operation of the primary shaft; and

a secondary shaft connected to the first and second chassis sections and positioned concentrically within the primary shaft and the secondary shaft being freely movable with respect to the primary shaft and being free of any loads during normal operation of the primary shaft, the second shaft being configured for bearing loads when the primary shaft is inoperable.

10. The amusement ride vehicle of claim **9** further comprising a test element attached to the secondary shaft, wherein the secondary shaft is rotatable via the test element when the primary shaft is operable.

11. The amusement ride of claim **9** further comprising at least one bearing positioned between the chassis tube and the primary shaft for providing relative rotation between the chassis tube and the primary shaft.

12. The amusement ride of claim 9 further comprising at least one bearing positioned between the primary shaft and the secondary shaft for providing relative rotation between the primary shaft and the secondary shaft.

13. The amusement ride vehicle of claim 9 wherein the primary shaft bears radial and axial loads when operable.

14. The amusement ride vehicle of claim 9 wherein the second shaft bears radial and axial loads if the primary shaft is inoperable.

15. An amusement ride vehicle, comprising:

a first vehicle section including passenger means therein for holding passengers during motion of the ride vehicle;

a second vehicle section including second passenger means therein for holding passengers during motion of the ride vehicle; and

a joint connecting, and providing rotational movement between, the first and second vehicle sections, with the joint comprising:

a first shaft; and

a second shaft positioned concentrically with respect to the first shaft, wherein the first and second shafts are rotatable relative to one another; and

a test element connected to the second shaft, wherein the second shaft is rotatable via the test element when the second shaft is not bearing loads.

16. The amusement ride vehicle of claim 15 further comprising at least one bearing between the first and second shafts for providing relative rotation between the first and second shafts.

17. The amusement ride vehicle of claim 15 wherein the joint further comprises a chassis tube positioned concentrically around the first and second shafts, with the chassis tube connected to the first and second vehicle sections.

18. An amusement ride vehicle, comprising:

a first vehicle section including passenger means therein for holding passengers during motion of the vehicle;

a second vehicle section including second passenger means therein for holding passengers during motion of the vehicle; and

articulating means for providing rotational movement between the first and second vehicle sections, wherein the articulating means comprises:

a first load-bearing means for bearing loads during normal operation of the articulating means; and

a second load-bearing means for bearing loads when the first load-bearing means is inoperable and the second load-bearing means being located within the first load-bearing means, being freely movable with respect to the first load-bearing means and being free of any loads during normal operation of the articulating means.

19. The amusement ride vehicle of claim 18 wherein the first load-bearing means bears radial and axial loads during normal operation of the articulation means.

20. The amusement ride vehicle of claim 18 wherein the second load-bearing means bears radial and axial loads when the first load-bearing means is inoperable.

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