

**A BRAKE MECHANISM, A LIFT MECHANISM AND A DEPLOYMENT MECHANISM
FOR A RAIL CHASSIS FOR A SHIP MOUNTED RAIL SYSTEM**

BACKGROUND

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Flettner Rotors or rotor sails for wind assisted ship propulsion are large rotating cylinders, that are typically between 2 m and 6 m in diameter and between 18 m and 40 m in height. Due to the size and strength requirements of a foundation for a rotor sail and the requirement for unobstructed wind flow for optimum performance, most

10 rotor sails are installed on the weather deck of the ship or vessel. This can present challenges to the vessel's loading and unloading operations in port, as the rotor rails can obstruct the free operation of ship and shore crange when accessing the loading and unloading points on the weather deck – typically cargo holds or fluid manifolds.

15 Several systems exist that aim to overcome the challenges posed by rotor sails during cargo operations.

Known folding systems involve rotating rotor sails about their base and lowering them to the horizontal to avoid crange or overhead vessel air draft restrictions. (Air draft

20 is the distance from the surface of the water to the highest point on a vessel and examples of air draft restrictions includes bridges).

However, an issue with folding systems is that, in the horizontal position, the rotor sail requires a large amount of space and can significantly impact the working areas of the

25 deck. Also, even once folded, a large rotor sail can protrude above the deck and still obstruct any cargo operations that would usually operate at those heights. For example, a large rotor sail may protrude above the deck by 12 m. There is also a risk that a folded rotor sail can be damaged by dropped cargo.

30 As a result of these issues, folding rotor sails are often positioned on ships to minimise their obtrusion of working areas and cargo operations when they are in the folded, horizontal position.

Telescopic systems are also known. Such telescopic systems involve collapsing the

35 rotor sail along their vertical axis to significantly reduce the height of the rotor sail above the deck.

Some known telescopic systems collapse the rotor sail, but the rotor sail still protrudes substantially from the deck such that cargo operations might still be affected, similarly to the folding systems.

- 5 Other known telescopic systems collapse below the level of the weather deck. However, this requires extensive vessel modifications to provide a cavity into which the rotor sail may collapse.

SUMMARY OF THE INVENTION

- 10 According to a first aspect of the invention there is provided a brake mechanism for a rail chassis for a ship mounted rail system, comprising:
a brake unit couplable to a rail such that it may move along the rail with the rail chassis, the brake unit comprising a brake and a resilient bias that biases the brake towards locked engagement with the rail; and,
15 an attachment for coupling a tow assembly to the brake, wherein sufficient actuation of the tow assembly loosens the brake from the rail so that the rail chassis can be transported along the rail by the tow assembly.

- A rail chassis may be suitable for transporting a variety of different types of cargo or ship equipment between different positions on a ship along at least one rail. In particular, although not exclusively, the rail chassis may be used in the field of ship mounted rail systems for the transport of wind assisted ship propulsion devices, such as Flettner Rotors (or "rotor sails"), wing sails, suction wings and masts, between different positions on a ship.

- 25 For any number of reasons, it is important that such a rail chassis can be prevented from moving along the rail. For example, a rotor sail mounted on a rail chassis may have a designated operating position and a separate designated storage position. However, it may not always be possible to move the rotor sail directly from one position to the other. Rather, it may be necessary to halt movement of the rail chassis in
30 between the two positions and ensure it remains stationary so that it cannot roll along the rails unsafely and hit crew or impact loaders.

- The brake mechanism may be used to hold the rail chassis in a particular position along
35 the rail. Due to the resilient bias biasing the brake towards locked engagement with the rail, the brake unit essentially defaults to a state of braking in which the rail is gripped strongly enough to prevent movement of the rail chassis along the rail. This prevents unintentional movement of the rail chassis along the rail, which is particularly

beneficial on a ship mounted rail system where the roll of the ship and wind blowing across the ship might otherwise cause the rail chassis to move along the rail.

5 In order to loosen the brake so that the rail chassis is movable along the rail, a tow assembly attached to the brake mechanism, via the attachment, must be actuated to loosen the brake.

10 In some embodiments of the invention, the brake mechanism may be configured such that actuation of the tow assembly providing a force greater than a predetermined de-braking force required to overcome the resilient bias loosens the brake from the rail. Accordingly, once the force applied on the brake unit by the tow assembly exceeds the predetermined de-braking force will the brake be loosened sufficiently for the rail chassis to be movable along the rail.

15 In embodiments of the invention, the brake unit may further comprise a brake actuator operatively coupling the attachment to the brake and moveable by the tow assembly between a locked configuration in which the brake is in locked engagement with the rail and an unlocked configuration in which the brake is loosened from locked engagement with the rail so that the brake unit is movable along the rail. Further, the
20 brake unit may comprise a plurality of brakes and respective resilient biases. The brake actuator may operatively couple the attachment to each brake whereby movement of the brake actuator causes the plurality of brakes to move between the locked configuration and the unlocked configuration.

25 Once the brake is sufficiently loosened, further actuation of the tow assembly will tow the rail chassis in which ever direction along the rail that the tow assembly is acting on the brake mechanism.

30 To stop the rail chassis, actuation of the tow assembly can be ceased, thereby reducing the force exerted on the brake mechanism, for example until it drops below the predetermined de-braking force. Once the force has reduced sufficiently, the resilient bias moves the brake back towards locked engagement with the rail and friction will increase sufficiently to cease movement of the rail chassis.

35 To accelerate the braking process, the tow assembly could be actuated briefly in the opposite direction in order to reduce the force acting on the brake mechanism more abruptly.

The brake may comprise a moveable brake pad and the resilient bias may comprise a mechanism, such as a mechanical spring or a hydraulic spring, biasing the moveable brake pad towards locked engagement with the rail. The predetermined de-braking force may therefore be dependent on a combination of factors comprising the
5 coefficient of friction between the brake pad and the rail, and the resilience to compression of the spring.

In embodiments of the invention, the brake mechanism further comprises a tow assembly, the tow assembly comprising a direction filtering apparatus. The direction
10 filtering apparatus may be couplable to a winch apparatus, the winch apparatus being operable to apply a force on the direction filtering apparatus in a first direction substantially parallel to the rail or a second direction substantially parallel to the rail and substantially opposite to the first direction.

15 In other words, the rail system may be winch operated wherein a winch is used to actuate a winch line that may tow the rail chassis along the rail in either direction along the rail. This means that force may be applied by the winch apparatus on the tow assembly in one of two opposite directions. However, in order to loosen the brakes before the rail chassis is towed, a force must be applied in just one direction in order
20 to overcome the resilient bias.

To overcome this issue, the direction filtering apparatus may be configured to operatively link the winch apparatus to the brake such that operation of the winch apparatus to apply a force on the direction filtering apparatus in either the first
25 direction or the second direction, loosens the brake so that the rail chassis can be transported along the rail by the tow assembly.

In some embodiments of the invention, the direction filtering apparatus may comprise an assembly of pulleys and/or sheaves that direct a tow line coupling the winch line to
30 the brake so that the winch line may be actuated in either direction, but the tow line will act on the brake in just one direction.

In other embodiments of the invention, the brake may be hydraulically or pneumatically actuated to overcome the resilient bias. In such embodiments of the
35 invention, the tow assembly may comprise a fluid actuated brake coupler coupling the winch apparatus to the brake. The fluid actuated brake coupler may be configured such that, if a force greater than a predetermined de-braking force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake coupler

is pressurised sufficiently to loosen the brake from the rail. For example, actuating the winch line in either one of the first and second direction may cause a tensile force used to compress hydraulic or pneumatic fluid in a cylinder, which pressurisation may be used to overcome the resilient bias.

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In further embodiments of the invention the direction filtering apparatus may comprise electrically actuated elements, or the direction filtering apparatus may be compatible with an electrically actuated brake.

- 10 In one or more embodiments of the invention, the brake mechanism may further comprise a fluid actuated brake coupler operatively coupling the attachment to the brake. The attachment may be couplable to a winch apparatus, the winch apparatus being operable to apply a force on the fluid actuated brake coupler; whereby, if a force greater than a predetermined de-braking force is applied by the winch apparatus on
- 15 the fluid actuated brake coupler, the fluid actuated brake coupler is pressurised sufficiently to loosen the brake from the rail. Also, the fluid actuated brake coupler may comprise a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake from the rail.
- 20 The fluid actuated brake coupler may further comprise a release valve operable between a closed configuration, which maintains pressurisation of the fluid, and an open configuration, which reduces pressurisation of the fluid so that the resilient bias returns the brake to locked engagement with the rail. Optionally, the release valve may default to an open configuration and comprise a controller requiring active control
- 25 by a user to maintain the release valve in the closed configuration.

According to a second aspect of the invention there is provided a brake mechanism for a rail chassis for a ship mounted rail system, comprising:

- a brake unit comprising a brake and a resilient bias that biases the brake
- 30 towards a position of locked engagement causing braking of the rail chassis;
- an attachment for operatively coupling a winch apparatus to the brake; and,
- a fluid actuated brake coupler operatively coupling the attachment to the brake, and comprising a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake, whereby, if a sufficient force is
- 35 applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake coupler is pressurised sufficiently to loosen the brake so that the rail chassis can be transported.

The features and advantages of the first aspect of the invention and its embodiments apply mutatis mutandis to the second aspect of the invention and its embodiments.

5 The brake mechanism may be configured such that actuation of the winch apparatus providing a force on the fluid actuated brake coupler, greater than a predetermined de-braking force required to overcome the resilient bias, pressurises the fluid actuated brake coupler sufficiently such that, once the de-braking valve is operated, the pressurised fluid acting against the resilient bias loosens the brake so that the rail chassis can be transported.

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The fluid actuated brake coupler may further comprise a release valve operable between a closed configuration, which maintains pressurisation of the fluid, and an open configuration, which reduces pressurisation of the fluid so that the resilient bias returns the brake towards the position of locked engagement. Optionally, the release valve may default to an open configuration and comprise a controller requiring active control by a user to maintain the release valve in the closed configuration.

20 According to a third aspect of the invention there is provided a lift mechanism for a rail chassis for a ship mounted rail system, comprising a lift unit couplable to a rail such that it may move along the rail with the rail chassis, the lift unit comprising a lift actuator movable between a first configuration and a second configuration, movement of the lift actuator from the first configuration to the second configuration causing the rail chassis to move relative to the rail from a resting position to a raised position so that the rail chassis can be transported along the rail in a raised position.

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In order that a rail chassis may rest on a rail stably, when it is stationary, it may be preferable that wheels are deployed only when the rail chassis is to be moved and that it rests on solid formations, equivalent to feet, when the rail chassis is stationary. This reduces the stresses and wear that that the wheels are exposed to.

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The lift mechanism provides a means for lifting the rail chassis from the rail, i.e., from a resting position to a raised position in which it can be transported along the rail.

35 In embodiments of the invention, the lift mechanism further comprises a friction formation grippingly engageable with the rail when the lift actuator is in the first configuration. In other words, when the rail chassis rests directly on the rail, the friction formation grippingly engages with the rail to further improve the stability of the rail chassis on the rail.

The friction formation may comprise at least one gripping pad moveable within the friction formation and the friction formation may further comprise a biasing formation engageable with the at least one gripping pad and configured such that, in use,
5 downward force on the friction formation is transmitted from the biasing formation to the at least one gripping pad in more than one direction so that the rail is gripped by the friction formation.

Hence, the weight of the rail chassis and its cargo acting downwardly through the
10 friction formation to the rail biases the gripping formation in more than one direction. For example, the gripping formation may be biased downwardly but also transversely to the rail so that the rail is gripped rather than merely rested upon.

In embodiments of the invention, the lift unit is mountable to a wheel assembly
15 comprising a wheel rotatably engageable with the rail. In such embodiments of the invention, the lift unit may be configured to cause the rail chassis to move relative to the wheel and hence move relative to the rail from the resting position to the raised position. In other words, the lift unit may be considered as deploying the wheel from the rail chassis in order to lift the rail chassis to the raised position.

20 In some such embodiments of the invention, the lift actuator may comprise a lever and a pin. The lever may be coupled to the lift attachment and may be rotatable about a lever axis positioned at a fixed height relative to the rail chassis. Meanwhile, the pin may extend from the lever parallel to, but spaced apart from, the lever axis. Movement
25 of the pin when the lift actuator moves from the first configuration to the second configuration drives the wheel towards the rail and away from the rail chassis, thereby causing the rail chassis to move to the raised position.

The lift unit may further comprise a restraint assembly engageable with the rail and
30 configured to restrain movement of the rail chassis transversely and/or upwardly relative to the rail. The restraint assembly may comprise one or more restraints or pads abutable against a surface of the rail to prevent the rail chassis from sliding off or lifting away from the rail.

35 In embodiments of the invention, the lift unit further comprises a lift attachment for attaching a tow assembly to the lift actuator, wherein sufficient actuation of the tow assembly moves the lift actuator from the first configuration to the second

configuration so that the rail chassis can be transported along the rail in the raised position by the tow assembly.

5 In some embodiments of the invention, the lift mechanism may be configured such that actuation of the tow assembly providing a force greater than a predetermined lifting force required to raise the rail chassis causes the lift actuator to move from the first configuration to the second configuration.

10 Accordingly, in order to raise the rail chassis so that it is transportable along the rail, a tow assembly attached to the lift actuator, via the lift attachment, must be actuated to provide a force that will overcome the weight of the rail chassis and its cargo. Once the force exceeds the predetermined lifting force will the lift actuator be moved from the first configuration to the second configuration so that the rail chassis is raised.

15 Once the rail chassis is in the raised position, further actuation of the tow assembly will tow the rail chassis in which ever direction along the rail that the tow assembly is acting on the lift mechanism.

20 In embodiments of invention, the lift mechanism further comprises a tow assembly, the tow assembly comprising a direction filtering apparatus. The direction control apparatus is couplable to a winch apparatus, the winch apparatus being operable to apply a force on the direction filtering apparatus in a first direction substantially parallel to the rail or a second direction substantially parallel to the rail and substantially opposite to the first direction.

25 Force may be applied by the winch apparatus on the tow assembly in one of two opposite directions. However, in some embodiments of the invention, in order to move the lift actuator from the first configuration to the second configuration before the rail chassis is towed, a force must be applied to the lift actuator in just one direction in order to overcome the weight of the rail chassis and its cargo.

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To overcome this issue, the direction filtering apparatus may be configured to operatively link the winch apparatus to the lift actuator such that operation of the winch apparatus to apply a force on the direction filtering apparatus in either the first direction or the second direction may actuate the lift actuator between the first and second configurations so that the rail chassis can be moved to the raised position by the tow assembly.

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The direction filtering apparatus may comprise an assembly of pulleys and/or sheaves that direct a tow line coupling the winch line to the lift actuator so that the winch line may be actuated in either direction, but the tow line will act on the lift actuator in just one direction.

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In embodiments of the invention, when the rail chassis is in the resting position, the rail chassis is securely engageable with a foundation. Further, the lifting mechanism may be configured such that, when the rail chassis is in the raised position, the rail chassis is separated from the foundation and thereby freely movable relative to the

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Particularly for situations in which a rail chassis is used to carry a wind assisted ship propulsion device such as a rotor sail, the rail chassis may spend the majority of its time in one or more operating and/or storage positions on the ship. In these operating or storage positions it may be preferable for the rail chassis to rest on a specialised foundation rather than on the rail. For example, the foundation may improve the degree to which the wind assisted ship propulsion device may be powered and or maintained. The foundation may also hold the rail chassis more stably and securely than a rail might be able to, even with a robust braking mechanism.

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In some embodiments of the invention, the lift mechanism may be separable from the rail chassis. For example, the lift mechanism may comprise a trolley or frame which may securely hold the rail chassis. In such embodiments, the lift mechanism may be used to lower a rail chassis into engagement with a foundation. The rail chassis may be secured to the foundation and the lift mechanism may subsequently be detached from the rail chassis so that it is therefore movable along the rail independently of the rail chassis. Accordingly, the lift mechanism may be used to manoeuvre a plurality of rail chassis along the rail, albeit only one at a time.

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In other embodiments of the invention, the lift mechanism may be integral to the rail chassis.

According to a fourth aspect of the invention there is provided a deployment mechanism for a rail chassis for a ship mounted rail system, comprising:

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a lift unit couplable to a rail such that it may move along the rail with the rail chassis, the lift unit comprising a lift actuator movable between a first configuration and a second configuration, movement of the lift actuator from the first configuration

to the second configuration causing the rail chassis to move relative to the rail from a resting position to a raised position;

- a brake unit couplable to a rail such that it may move along the rail with the rail chassis, the brake unit comprising a brake and a resilient bias that biases the brake towards locked engagement with the rail; and

a tow assembly operatively couplable to the brake, wherein sufficient actuation of the tow assembly loosens the brake from the rail so that the rail chassis can be transported along the rail in a raised position by the tow assembly.

- 10 The deployment mechanism essentially comprises both a brake unit according to embodiments of the first aspect of the invention, a lift unit according to embodiments of the third aspect of the invention and a tow assembly for actuating the brake as well as towing the rail chassis along the rail.
- 15 The features and advantages of the first and third aspects of the invention, and their embodiments, apply mutatis mutandis to the fourth aspect of the invention and its embodiments.

- In embodiments of the invention, the tow assembly comprises a direction filtering apparatus. The direction filtering apparatus may be couplable to a winch apparatus, the winch apparatus being operable to apply a force on the direction filtering apparatus in a first direction substantially parallel to the rail or a second direction substantially parallel to the rail and substantially opposite to the first direction. Further, the direction filtering apparatus may be configured to operatively link the winch apparatus to the
- 20 brake such that operation of the winch apparatus to apply a force on the direction filtering apparatus in either the first direction or the second direction may loosen the
- 25 brake so that the rail chassis can be transported along the rail in a raised position by the tow assembly.

- 30 The tow assembly may, additionally, be couplable to the lift actuator, wherein sufficient actuation of the tow assembly may move the lift actuator from the first configuration to the second configuration.

- Therefore, the tow assembly may be actuated to lift the rail chassis from the resting
- 35 position to the raised position, loosen the brake and tow the rail chassis.

In embodiments of the invention, the deployment mechanism may be configured such that actuation of the tow assembly providing a force greater than a predetermined de-

braking force required to overcome the resilient bias may loosen the brake from the rail. Further actuation of the tow assembly providing a force greater than a predetermined lifting force required to raise the rail chassis may cause the lift actuator to move from the first configuration to the second configuration. The predetermined
5 de-braking force may be greater than the pre-determined lifting force so that the brake is loosened from the rail once the rail chassis is in the raised position.

This prevents the rail chassis from becoming movable along the rail while still in the resting position. This, in turn, prevents excessive wear on features such as a friction
10 formation that would be caused by movement of the rail chassis along the rail while still resting on the rail.

The predetermined de-braking force being greater than the pre-determined lifting force also ensures the rail chassis will always be in a stable, fully raised position before the
15 brakes are loosened and the rail chassis is allowed to travel along the rail. This may be particularly beneficial if the rail chassis is movable along a pair of rails as it prevents a situation where, for example, the rail chassis is fully raised and movable relative to one rail but not yet fully raised and moveable relative to the other rail. Such an unbalance could cause unpredictable loading of certain components within the
20 deployment mechanism that might increase wear or even lead to a catastrophic failure.

The predetermined de-braking force being greater than the pre-determined lifting force also has the inverse effect that the brake will always be in locked engagement with the rail prior to the rail chassis being lowered from the raised position to the resting
25 position. This is true whether the force being applied to the deployment mechanism via the tow assembly is reduced intentionally by a user of the rail system or because of a failure in the tow assembly or winch apparatus, for example.

The initial braking of the rail chassis prevents there being any momentum present as
30 the rail chassis is lowered and one or more friction formations re-grip the rail. If any momentum were present, a rotor sail or similar wind assisted ship propulsion device would be liable to pivot about a friction formation which could again cause unpredictable loading of certain components that might increase wear or lead to a failure.

35 In embodiments of the invention, the tow assembly comprises a brake coupler, coupling the winch apparatus to the brake, and a lift coupler, coupling the winch apparatus to the lift actuator. The tow assembly may be configured so that an initial

displacement of the winch apparatus causes movement of the lift actuator from the first configuration to the second configuration and a further displacement of the winch apparatus causes loosening of the brake.

- 5 In such embodiments of the invention, the brake may be loosened from the rail only once the rail chassis is in the raised position and the rail chassis is prevented from becoming movable along the rail while still in the resting position. Further, the brake will always be in locked engagement with the rail prior to the rail chassis being lowered from the raised position to the resting position.

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In embodiments of the invention, the deployment mechanism may be hydraulically or pneumatically operable. The tow assembly may comprise a fluid actuated brake coupler coupling the winch apparatus to the brake. If a force greater than a predetermined de-braking force is applied by the winch apparatus on the fluid actuated
15 brake coupler, the fluid actuated brake coupler may be pressurised sufficiently to loosen the brake from the rail.

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In one or more embodiments of the invention, the deployment mechanism may further comprise a fluid actuated brake coupler operatively coupling the tow assembly to the brake. The tow assembly may be couplable to a winch apparatus, the winch apparatus being operable to apply a force on the fluid actuated brake coupler; whereby, if a force greater than a predetermined de-braking force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake coupler is pressurised sufficiently to loosen the brake from the rail. Also, the fluid actuated brake coupler
25 comprises a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake from the rail.

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The fluid actuated brake coupler further comprises a release valve operable between a closed configuration, which maintains pressurisation of the fluid, and an open configuration, which reduces pressurisation of the fluid so that the resilient bias returns the brake to locked engagement with the rail. Optionally, the release valve defaults to an open configuration and comprises a controller requiring active control by a user to maintain the release valve in the closed configuration.

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Meanwhile, the lift actuator may be fluid actuated to move between the first configuration and the second configuration.

The lift actuator may be operable independently of the fluid actuated brake coupler. For example, the lift actuator may be actuated by a manual or electro-hydraulic/pneumatic pump, which may be optionally battery powered.

- 5 However, the lift actuator may also be configured so that pressure is released automatically if pressure in the fluid actuated brake coupler is below a predetermined release threshold. For example, the tow assembly may comprise a pilot line coupling the fluid actuated brake coupler to the lift actuator via a release valve. The release valve may be configured to open automatically if pressure in the fluid actuated brake
10 coupler is below the predetermined release threshold.

Therefore, if a failure in the winch apparatus or the fluid actuated brake coupler causes a reduction in hydraulic or pneumatic pressure that would result in the brake being applied to the rail, the lift actuator may also move from the second configuration to
15 the first configuration (if it is not already in the first configuration). Accordingly, if the brake is applied due to a failure, the rail chassis may also lower to the resting position.

In embodiments of the invention which are hydraulically operable, the deployment mechanism may further comprise a hydraulic accumulator coupled to the lift actuator and configured to hydraulically bias the lift actuator towards the first configuration or
20 the second configuration.

The hydraulic accumulator may automatically pressurise the lift actuator in order to bias it towards the first configuration. The hydraulic accumulator therefore assists gravity in biasing the rail chassis towards the resting position. This may be beneficial
25 if the friction present in the lift unit is high enough that the effect of gravity does not sufficiently bias the lift actuator towards the first configuration and there may be a risk of the rail chassis becoming stuck in the raised position if the hydraulic accumulator were not present.

30 However, the hydraulic accumulator may pressurise the lift actuator only to a predetermined base-level which, even in combination with the effect of gravity, is lower than the pressure that may be provided in order to move the lift actuator from the first configuration to the second configuration. Accordingly, the hydraulic accumulator does
35 not reduce the ability to raise the rail chassis.

Alternatively, the hydraulic accumulator may automatically pressurise the lift actuator in order to bias it towards the second configuration so that less energy and time is

required to raise the rail chassis. The hydraulic accumulator may function otherwise identically compared to a hydraulic accumulator biasing the lift actuator towards the first configuration

- 5 In embodiments of the invention, the winch apparatus may comprise a winch line extending substantially parallel to the rail, the winch line being couplable to the direction filtering apparatus. The winch apparatus may also comprise a winch for actuating the winch line and, thereby, apply a force on the direction filtering apparatus in one or either of the first direction and the second direction.

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The winch line may be an endless winch line to which the direction filtering apparatus is coupled. The winch line may also have separate first and second ends which are each coupled to the direction filtering apparatus.

- 15 Also, the winch may be a capstan-type winch and the winch apparatus may further comprise a tensioning mechanism for maintaining tension in the winch line so that the winch line does not slip on the capstan-type winch. For example, the winch line may loop around a pair of movable sheaves, each biased to move in opposite directions so that tension is maintained in the winch line.

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The winch apparatus may, alternatively, comprise a pair of winches, which may be reel-type winches, configured to apply a force on the direction filtering apparatus in the first direction and the second direction.

- 25 In embodiments of the invention, the deployment mechanism may further comprise a wheel assembly, the wheel assembly comprising a wheel rotatably engageable with the rail.

Further, the wheel assembly may comprise a plurality of wheels and/or the deployment
30 mechanism may comprise a plurality of wheel assemblies.

Accordingly, the deployment mechanism may comprise a plurality of wheels so that the load of the rail chassis can be spread across several wheels.

- 35 At least one of the wheels may be rotatably engageable with a first rail and at least another of the wheels may be rotatably engageable with a second rail spaced apart from the first rail. Accordingly, the load of the rail chassis can be spread across two rails.

If the rail chassis were particularly large, extending across the majority of a ship deck's width for example, there may even be more than two rails and the deployment mechanism may comprise one or more wheels to engage with each rail.

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According to a fifth aspect of the invention there is provided a deployment mechanism for a rail chassis for a ship mounted rail system, comprising:

a lift unit couplable to a rail such that it may move along the rail with the rail chassis, the lift unit comprising a lift actuator movable between a first configuration and a second configuration, movement of the lift actuator from the first configuration to the second configuration causing the rail chassis to move relative to the rail from a resting position to a raised position;

a brake unit comprising a brake and a resilient bias that biases the brake towards a position of locked engagement causing braking of the rail chassis;

an attachment for operatively coupling a winch apparatus to the brake; and,
a fluid actuated brake coupler operatively coupling the attachment to the brake, and comprising a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake, whereby, if a sufficient force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake coupler is pressurised sufficiently to loosen the brake so that the rail chassis can be transported along the rail in a raised position by the winch apparatus.

The features and advantages of the preceding aspects of the invention and their embodiments apply mutatis mutandis to the fifth aspect of the invention and its embodiments.

The deployment mechanism may be configured such that actuation of the winch apparatus providing a force on the fluid actuated brake coupler, greater than a predetermined de-braking force required to overcome the resilient bias, pressurises the fluid actuated brake coupler sufficiently such that, once the de-braking valve is operated, the pressurised fluid acting against the resilient bias loosens the brake so that the rail chassis can be transported.

The fluid actuated brake coupler may further comprise a release valve operable between a closed configuration, which maintains pressurisation of the fluid, and an open configuration, which reduces pressurisation of the fluid so that the resilient bias returns the brake to locked engagement. Optionally, the release valve may default to

an open configuration and comprise a controller requiring active control by a user to maintain the release valve in the closed configuration.

According to a sixth aspect of the invention there is provided a rail chassis set for a ship mounted rail system, the rail chassis set comprising:

- 5 a rail chassis for conveying a wind assisted propulsion device over the deck of a ship; and,
- a brake mechanism according to an embodiment of the first or second aspect of the invention; a lift mechanism according to an embodiment of the third aspect of the invention; the combination of a brake mechanism according to an embodiment of the first or second aspect of the invention and a lift mechanism according to an embodiment of the third aspect of the invention; or, a deployment mechanism according to an embodiment of the fourth or fifth aspect of the invention.

15 The features and advantages of the preceding aspects of the invention, and their embodiments, apply mutatis mutandis to the sixth aspect of the invention and its embodiments.

According to a seventh aspect of the invention there is provided a rail chassis assembly for a ship mounted rail system, the assembly assembled from a rail chassis set according to an embodiment of the sixth aspect of the invention.

The features and advantages of the preceding aspects of the invention, and their embodiments, apply mutatis mutandis to the seventh aspect of the invention and its

25 embodiments.

According to a eighth aspect of the invention there is provided a ship comprising:

- a deck;
- a deck mounted rail system; and,
- 30 a rail chassis assembly according to an embodiment of the seventh aspect of the invention.

The features and advantages of the preceding aspects of the invention, and their embodiments, apply mutatis mutandis to the eighth aspect of the invention and its

35 embodiments.

In embodiments of the invention, the ship may further comprise a wind assisted propulsion device mounted on the rail chassis. Preferably, the wind assisted propulsion device is a Flettner rotor or rotor sail.

- 5 The deck mounted rail system comprises a railway along which the rail chassis, of the rail chassis assembly, may be transported along.

In embodiments of the invention, the ship may further comprise a support structure supporting the railway such that the railway is raised above the deck of the vessel.

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- Additionally, or alternatively, the ship may further comprise a foundation on the deck of the ship for supporting a wind assisted propulsion device. In such embodiments of the invention, the rail chassis set may comprise a rail chassis securely engageable with the foundation when the rail chassis is in the resting position, and a lifting mechanism
15 configured such that, when the rail chassis is in the raised position, the rail chassis is separated from the foundation and thereby freely movable relative to the foundation in the direction of the rail.

BRIEF DESCRIPTION OF THE DRAWINGS

- 20 Examples of the present invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of a ship mounted rail system and a rail chassis therefor, the rail chassis comprising a deployment mechanism according to the fourth aspect of the invention;

- 25 Figures 2 and 3 are schematic representations of the deployment mechanism shown in Figure 1, the deployment mechanism comprising a brake mechanism according to a first aspect of the invention and a lift mechanism according to the third aspect of the invention;

- Figures 4 and 5 are schematic representations of a lift unit forming part of the
30 lift mechanism shown in Figure 2;

Figure 6 is a schematic representation of a friction formation forming part of the lift mechanism shown in Figure 2;

Figure 7 is a schematic representation of a restraint assembly forming part of the lift mechanism shown in Figure 2;

- 35 Figure 8 is a schematic representation of the brake mechanism shown in Figure 2;

Figures 9 and 10 are further schematic representations of the deployment mechanism shown in Figure 2;

Figures 11 and 12 are further schematic representations of the deployment mechanism shown in Figure 2;

Figures 13 and 14 are schematic representations of a winch apparatus forming part of a deployment mechanism according to the fourth aspect of the invention;

5 Figure 15 is a schematic representation of a direction filtering apparatus forming part of a deployment mechanism according to the fourth aspect of the invention;

Figure 16 is a schematic representation of a deployment mechanism according to a further embodiment of the fourth aspect of the invention;

10 Figure 17 is a schematic representation of a hydraulic system which may form part of a deployment mechanism according to a further embodiment of the fourth aspect of the invention;

Figure 18 is a close-up view of the hydraulic system shown in Figure 17;

Figure 19 is a schematic representation of an alternative embodiment of the fluid actuated brake coupler shown in Figures 17 and 18;

15 Figures 20 and 21 are schematic representations of a brake mechanism according to a further embodiment of the first aspect of the invention; and

Figure 22 is another close-up view of the hydraulic system shown in Figure 17.

DETAILED DESCRIPTION

20 The invention may have application in the field of ship mounted rail systems for the transport of a variety of different types of cargo or ship equipment between different positions on the ship. Further, the invention may have particular application, although not exclusively, in the field of ship mounted rail systems for the transport of wind assisted ship propulsion devices, such as Flettner Rotors (or "rotor sails"), wing sails,
25 suction wings and masts, between different positions on the ship.

From here on, the invention will be described with respect to its use for the transport of rotor sails. However, this is not to exclude the use of the invention for transporting other types of wind assisted ship propulsion devices or other types of cargo or ship
30 equipment as many, if not all, of the advantages of the invention would apply when it is used for transporting other types of wind assisted ship propulsion devices, cargo or ship equipment, particularly those that are comparable in size and/or weight to rotor sails.

35 In Figure 1, a rail system 2 is mounted on a ship (or vessel) 4. The ship mounted rail system 2 comprises a rail chassis 6 transportable along a first rail 8, and a second rail 9. The rail chassis 6 is carrying a Flettner Rotor or rotor sail 10.

A rail system facilitates the transport of rotor sails in an upright position along rails. A rotor sail may, for example, be moved between an operating position, in which the rotor sail provides wind assisted propulsion for the ship as it travels between docks, and a storage position, in which the rotor sail is clear of ship or shore cranes during loading and unloading operations.

Rail systems provide a number of benefits over folding or telescopic systems. Firstly, rail systems allow rotor sails to be moved fully away from working areas, thereby removing obstructions and the risk of damage to the rotor sails.

The permanent structures in working areas, i.e., the rails, are low to deck and do not present obstructions to cargo operations. Further, rail systems do not require substantial modification to the existing deck structure, only the addition of above deck steelwork (with minor reinforcement below).

Rail systems also allow a rotor sail to be operated in an optimal position for performance with no compromise required due to consideration of the ship's working area or required cargo operations.

However, unlike land-based rail systems, a ship mounted rail system must operate safely despite, roll and pitch of the ship which cause the rails to change orientation relative to the horizontal.

Referring still to Figure 1, the rail chassis 6 comprises a deployment mechanism 40 according to an embodiment of the invention which is operable to safely transport the rotor sail 10 along the rails 8, 9 as set out in more detail below.

In Figure 2, a first side of both the rail chassis 6 and the deployment mechanism 40 interacts with the first rail 8. Meanwhile, in Figure 3, a second side of both the rail chassis 6 and the deployment mechanism 40 interacts with the second rail 9.

The deployment mechanism 40 comprises a brake mechanism 12, according to an embodiment of the invention, and a lift mechanism 42 according to an embodiment of the invention.

The brake mechanism 12 comprises a brake unit 14 coupled to the first rail 8 such that it may move along the rail 8 with the rail chassis 6.

The lift mechanism 42 comprises a plurality of lift units 44, each of which is coupled to a rail 8, 9 such that it may move along the respective rail 8, 9 with the rail chassis 6. More specifically, the lift mechanism 42 comprises first and second lift units 44a, 44b coupled to the first rail 8 (shown in Figure 2), and also comprises third and fourth lift units 44c, 44d coupled to the second rail 9 (shown in Figure 3).

In other embodiments of the invention, the lift mechanism may comprise any suitable number of lift units which may depend on, for example, the size of the rail chassis and associated rotor sail, or other cargo/ship equipment, to be transported along the rail(s).

In Figures 4 and 5, a lift unit (specifically the lift unit 44a shown in Figure 2, although each of the plurality of lift units 44 comprises equivalent features) is mounted to a wheel assembly 50 comprising a pair of wheels 52 rotatably engaged with the rail 8. The wheel assembly 50 further comprises a housing 58 which forms part of the rail chassis 6 (shown in Figures 2 and 3) and substantially covers the wheels 52. The housing 58 comprises a pair of friction formations 60 and a restraint assembly 82.

The lift unit 44a comprises a lift actuator 46 movable between a first configuration (shown in Figure 4) and a second configuration (shown in Figure 5). In Figure 4, when the lift actuator 46 is in the first configuration, the friction formations 60 are engaged with the rail 8 as the housing 58 rests on the rail 8. Accordingly, when the lift actuator 46 is in the first configuration, the rail chassis 6 is in a resting position.

The lift actuator 46 comprises a lever 54 and a pin 56. The lever 54 is rotatable about a lever axis 55 positioned at a fixed height relative to the housing 58 and, hence, the rail chassis 6. The pin 56 is eccentrically positioned relative to the lever 54 such that it extends from the lever 54 parallel to, but spaced apart from, the lever axis 55. Therefore, when the lift actuator 46 is moved from the first configuration to the second configuration, the pin 56 is moved relative to the housing 58.

The pin 56 is operatively coupled to the wheels 52 such that movement of the pin 56 relative to the housing 58, as the lift actuator moves from the first configuration to the second configuration, causes movement of the wheels 52 towards the rail 8 relative to the housing 58. This movement of the wheels 52 away from the rail chassis 6 causes the rail chassis 6, including the housing 58, to move from the resting position (shown in Figure 4) to a raised position (shown in Figure 5).

The lift unit 44a further comprises a lift attachment 48 for attaching a tow assembly (not shown here but described further below with respect to Figures 9 to 12) to the lift actuator 46.

- 5 The tow assembly is actuatable to move the lift actuator 46 from the first configuration to the second configuration. However, in this embodiment of the invention, the actuation must provide a tensile force greater than a predetermined lifting force required to raise the rail chassis 6. If the tensile force in the tow assembly drops below the predetermined lifting force, the load applied to the lift unit 44a by the rail chassis
10 6 (and the rotor sail 10 it is carrying) will cause the lift actuator 46 to return towards the first configuration, thereby lowering the rail chassis 6 down to the resting position.

Therefore, the rail chassis 6 may stay in the raised position and be transportable along the rails 8, 9 only when the tensile force in the tow assembly acting on the lift actuator
15 46 of each lift unit 44 is greater than the predetermined lifting force.

Reduction of the tensile force in the tow assembly may be controlled by a user of the rail system 2. A reduction of tensile force in the tow assembly could also be caused by, for example, a failure in the tow assembly, pitch or rolling of the ship 4, wind acting
20 on the rotor sail 10, or weather conditions allowing the wheels 52 to slip on the rails 8, 9. Therefore, the fact that the rail chassis 6 will return to the resting position, so that the rotor sail 10 is resting stably on the rails 8, 9, whenever the tensile force in the tow assembly drops below the predetermined lifting force improves the safety of the rails system 2. In the resting position, friction between the rail chassis 6 and the
25 rails 8, 9 is greater than friction between the rail chassis 6 and the wheels 52. This higher friction increases the resistance of the rail chassis 6 to sliding along the rails 8, 9 when the tensile force is removed from the tow assembly.

The friction between the rail chassis 6 and the rails 8, 9 can be further increased by
30 use of a friction formation 60. Referring now to Figure 6, the friction formation 60 comprises a pair of gripping pads 62 and a biasing formation 64. The biasing formation 64 comprises surfaces inclined to the vertical that engage with the gripping pads 62 which are freely moveable within the friction formation 60. When the rail chassis 6 is in the resting position, causing the friction formation 60 to engage with the first rail 8,
35 downward force on the housing 58, caused by the weight of the rail chassis 6 and its cargo (the rotor sail 10 in this embodiment of the invention), is converted to downward and transverse forces applied by the biasing formation 64 on the gripping pads 62. This causes the friction formation 60 to grip the rail 8 with greater force than the

downward force alone (due to the angle of inclination of the surfaces) and on two opposing sides at once. The result of this gripping action is that more than twice as much force is required to overcome the friction between the gripping pads 62 and the rail 8 than if the friction formation merely consisted of a flat pad which rested on the rail 8. (One or more equivalent friction formations 60 may be engaged with the second rail 9.)

The gripping pads 62 may be made from a material with a high coefficient of friction to provide greater friction against the respective rail 8, 9. However, to improve the conversion of downward forces to downward and transverse force, the friction formation 60 further comprises sliding pads 66 mounted to the gripping pads 62. The sliding pads 66 may be made to have a low coefficient of friction so that they slide readily against the inclined biasing formation. For example, the sliding pads 66 may be made from stainless steel sliding against Orkot® or lubricated with grease.

In other embodiments of the invention the friction formation 60 may comprise a single gripping pad that wraps over the rail 8 or may comprise more than two gripping pads which engage with the rail in a plurality of locations.

In Figure 7, the restraint assembly 82 is engaged with the first rail 8 (one or more equivalent restraint assemblies 82 may be engaged with the second rail 9). In particular, the restraint assembly 82 comprises a pair of transverse restraints 84 positioned to engage with either side of the rail 8 so that the wheels 52 is restrained from moving transversely to the rail 8.

The transverse restraints 84 therefore prevent the wheels 52 from slipping off the rails due to, for example, pitch or roll of the ship 4 and/or wind acting against the rotor sail 10 in a direction transverse to the rail 8.

The restraint assembly 82 further comprises a vertical restraint 86 which is fixed relative to the vertical position of the associated wheel 52. In other words, the vertical restraint 86 does not move relative to the wheels 52 as the rail chassis 6 moves between the resting and raised positions. The vertical restraint 86 is positioned to restrain the associated wheels 52 in the vertical direction so that the wheels 52 may not lift away from the rail 8.

The vertical restraint 86 therefore prevents the wheels 52 from lifting away from the rail 8 in the event that, for example, pitch or roll of the ship 4 and/or wind acting

against the rotor sail 10 causes forces that might tip the rotor sail 10 if it were not for the vertical restraints 86.

Although the lift mechanism 42 is shown, in Figures 2 and 3, in combination with the
5 brake mechanism 12, the lift mechanism 42 may be used without a brake mechanism 12. With no brake mechanism, the friction formations 60 may be used to brake the rail chassis 6. This would be most effective for applications in which the loading that would be applied to the friction formations 60 when braking the rail chassis 6 would be low. Examples of such applications might be if the rail chassis 6 was carrying a small,
10 lightweight rotor sail 10 or other cargo/ship equipment that is lighter and/or less exposed to shear forces applied by strong winds. Alternatively, it may be used for higher weight rotor sails or cargo when the angle of heel or pitch of the ship is limited to smaller angles such that the simple friction formation is able to resist the component of force along the rail without a separate brake mechanism.

15 However, the lift mechanism 42 will be largely protected from dynamic loading if used in combination with a brake mechanism 12 that is operable to immobilise the rail chassis 6 on the rails 8, 9 while lifting and lowering actions take place. Therefore, the greater the loads that might be applied to the lifting mechanism, the more
20 advantageous a brake mechanism 12 (described in more detail below) will be.

Referring now to Figure 8, the brake unit 14 (first shown in Figure 2) comprises a plurality of brakes 16 and respective resilient biases 18 that bias the brakes 16 towards locked engagement with the rail 8. More specifically, in this embodiment of the
25 invention, the brake 16 comprises a moveable brake pad 24 and a static brake pad 25 while the resilient bias 18 comprises a pair of springs 26 that bias the moveable brake pad 24 towards the rail 8. This biasing of the movable brake pad 24 towards the rail 8 causes the rail 8 to be gripped by the brake pads 24, 25 so that the brake achieves locked engagement with the rail.

30 In other embodiments of the invention, the brake units 14 may comprise any suitable number of brakes 16 and resilient biases 18. Further, each brake 16 may comprise one, two or more brake pads, at least one of which may be movable.

35 The brake unit 14 further comprises a brake actuator 28.

In Figures 9 and 10, the brake mechanism 12 further comprises an attachment 20 for a tow assembly 22 and the brake unit 14 further comprises a brake housing 15 covering

the brakes 16 and other internal components shown in Figure 8. Also, the brake actuator 28 (here shown in more detail) operatively couples the attachment 20 to the brakes 16 (shown in Figure 8).

- 5 In Figure 9, the brake actuator 28 is shown in a locked configuration in which the brakes 16 are in locked engagement with the rail 8 (as shown in Figure 8).

The brake actuator 28 is movable from the locked configuration to an unlocked configuration, shown in Figure 10, in which the brakes 16 are loosened from locked
10 engagement with the rail 8 so that the brake unit 14 is movable along the rail 8.

In this embodiment of the invention, the brake actuator 28 comprises a release lever 90, first, second and third members 91, 92, 93 and a bridge link 94. The bridge link 94 is movable relative to the brake housing 15 and operatively coupled to each of the
15 brakes 16. The resilient biases 18, as well as biasing the brakes 16 towards locked engagement with the rail 8, bias the bridge link 94 to the position shown in Figure 9 and, hence, the brake actuator 28 to the locked configuration.

However, actuation of the tow assembly 22 providing a tensile force greater than a
20 predetermined de-braking force required to overcome the resilient biases, pulls on the attachment 20 to rotate the release lever 90 (clockwise on the page) about a release axis 95. Rotation of the release lever 90 pulls the first member 91 (to the left on the page) which in turn causes the second and third members 92, 93 to rotate towards positions in which the two members 92, 93 would be in alignment with one another.

25 The second member 92 rotates about a member axis 96 which is fixed relative to the brake housing 15. Meanwhile, the third member 93 rotates about a bridge axis 97 which is fixed relative to the bridge link 94. Therefore, the rotation of the second and third members 92, 93 towards positions in which the two members 92, 93 would be in
30 alignment with one another causes the bridge link 94 to move relative to the brake housing 15, against the bias provided by the resilient biases 18.

In other words, in this embodiment of the invention, actuation of the tow assembly 22 providing a tensile force greater than a predetermined de-braking force required to
35 overcome the resilient biases causes the brake actuator 28 to move from the locked configuration shown in Figure 9 to the unlocked configuration shown in Figure 10 and thereby loosens the brakes 16 from locked engagement with the rail 8 so that the brake unit 14 is movable along the rail 8.

Although the brake mechanism 12 is shown, particularly in Figures 2 and 3, in combination with the lift mechanism 42, the brake mechanism 12 may be used without a lift mechanism 42. For example, an independent brake mechanism 12 may be particularly useful for applications in which lifting and lowering, or some other deployment of apparatus, is not required.

However, the brake mechanism 12 is particularly advantageous when combined with a lift mechanism 24 and even more particularly for rotor sail applications 10, as will be expanded on further below.

Referring now to Figures 11 and 12, the deployment mechanism 40 comprises the tow assembly 22.

The tow assembly 22 comprises a tow line 32, a lift axle 70, a lift pulley 72 and a lift line 74. The tow line 32 has a first end 34 and a second end 35. The first end 34 is operatively coupled to the brakes 16 via the attachment 20 and brake actuator 28, and the second end 35 is actuatable by a user of the rail system 2. Between the first and second ends 34, 35, the tow line 32 is engaged with the lift pulley 72.

The lift pulley 72 is rotatable about the lift axle 70 which is itself movable between a first position (shown in Figure 11) and a second position (shown in Figure 12). Meanwhile, the lift line 74 couples the lift axle 70 to the lift actuator 46 of each lift unit 44.

The tow assembly 22 further comprises a direction filtering apparatus 30 with which the tow line 32 is engageable between its first and second ends 34, 35, more particularly between the lift pulley 72 and the second end 35. The direction filtering apparatus 30 is configured such that the second end 35 may be actuated by a user of the rail system 2 in either direction substantially parallel to the rails 8, 9 and the resulting tensile force in the tow line 32 will apply a force on both the lift axle 70 and the attachment 20.

In this embodiment of the invention, the direction filtering apparatus 30 comprises a first directing pulley 36 and a second directing pulley 37. When the tow line 32 is pulled through the direction filtering apparatus 30 in a first direction (to the right on the page, as shown in figures 11 and 12), the tow line 32 threads through the directing pulleys 36, 37 and a force may be applied to the lift pulley 72 in the same direction

that the second end 35 is being pulled. However, if the tow line 32 is pulled through the direction filtering apparatus 30 in a second, opposite, direction (to the left on the page, not shown), the tow line 32 wraps around the second directing pulley 37 and, although the second end 35 is being pulled in an opposite direction, the force acting
5 on the lift pulley 72 is in the same direction as in the previous case (the direction required to actuate the lift axle 70).

It is to be understood that, in other embodiments of the invention, the brake mechanism 12 or the lift mechanism 42 may independently comprise a tow assembly
10 having equivalent features to those described for the tow assembly shown in Figures 11 and 12. Accordingly, features of the tow assembly 22 described here are as applicable to a brake mechanism according to the first aspect of the invention or a lift mechanism according to the third aspect of the invention as they are to the deployment mechanism 40.

15 However, when the tow assembly 22 forms part of a deployment mechanism 40 (comprising both a lifting mechanism 42 and a brake mechanism 12), a user may access its full range of functionality.

20 The full functionality of the deployment mechanism 40 is described below with respect to how a user might operate the rail system 2 using the deployment mechanism 40.

Firstly, consider a situation in which no tension is applied to the tow line 32 by a user of the rail system. In other words, a situation in which the rail chassis 6 and rotor sail
25 10 is intended to be stationary and resting on the rails 8, 9.

When no tension is applied to the tow line 32, the resilient biases 18 of the brake unit 14 bias the brakes 16 towards locked engagement with the first rail 8 and the brake actuator 28 is in the looked configuration (as shown in Figures 8 and 9). Further, the
30 load of the rotor sail 10 and rail chassis 6 acting on the wheel assemblies 50 biases the lift actuator 46 of each lift unit 44 to the first configuration (shown in Figure 4) so that the rail chassis is in the resting position. In other words, the rail chassis 6 and rotor sail 10 are resting on the rails 8, 9 via the friction formations 60.

35 In this state, the rail chassis 6 and rotor 10 are stable and secure, particularly when friction formations such as the friction formation 60 shown in Figure 6 are used to grip the rails 8, 9. This stable state is the default position and is therefore reliable with no monitoring required.

As set out above with respect to Figures 4 and 5, in order to lift the rail chassis 6 to the raised position the tow line 32 must be actuated providing a tensile force greater than the predetermined lifting force required to raise the rail chassis 6. Similarly, as
5 set out with respect to Figures 9 and 10, in order to loosen the brakes 16 from the first rail 8 the tow line 32 must be actuated providing a tensile force greater than the predetermined de-braking force required to overcome the resilient biases.

In embodiments of the invention such as this where the brake mechanism 12 and the
10 lift mechanism 42 each form part of a deployment mechanism 40, the resilient biases 18 are configured such that the predetermined de-braking force required to overcome the resilient biases is greater than the predetermined lifting force required to raise the rail chassis 6 to the raised position.

Bearing this in mind, if a user of the rail system 2 intends to move the rail chassis 6 in
15 either direction along the rails 8, 9, the user may actuate the second end 35 of the tow line 32 in that direction. Starting from the default, stable configuration shown in Figure 11 (in which the rail chassis 6 is in the resting position and the brakes 16 are in locked engagement with the first rail 8), the user's actuation of the second end 35 may
20 progressively increase the tension in the tow line 32.

The increasing tension in the tow line 32 will apply a force on both the lift pulley 72, with which the tow line 32 is engaged, and the attachment 20, to which the first end 34 is fixed. However, actuation of the lift axle 70 from the first position to the second
25 position and actuation of the brake actuator from the locked configuration to the unlocked configuration may occur only when the tension in the tow line 32 exceeds the predetermined lifting and de-braking forces respectively.

More particularly, once the tension in the tow line 32 is greater than the predetermined
30 lifting force (but not yet greater than the predetermined de-braking force), the rail chassis 6 will be lifted to the raised position but the brakes 16 will not be loosened sufficiently to allow movement. In other words, the rail chassis 6 will be lifted off the rails 8, 9 but will not yet be transportable along the rails 8, 9.

As the rail chassis 6 remains stationary at this stage of a user's operation of the rail
35 system, any changes in the conditions such as pitch or roll of the ship or wind acting on the rotor sail 10 cannot cause movement of the rail chassis 6 and therefore cannot cause the tension in the tow line 32 to reduce so that the rail chassis drops down to

the resting position without the user intending so. In other words, at this stage of a user's operation of the rail system, the tension in the tow line 32 will only reduce if the user intends to reduce it in order to lower the rail chassis 6 back to the resting position.

- 5 This prevents the rail chassis 6 from moving with a 'bunny hopping' motion along the rails 8, 9, due to vessel movements or strong winds, while the user is trying to move it from one position to another. This prevents damage to the friction formations 60 and/or the rails 8, 9 due to high dynamic contact loads being transferred through the friction formations 60 to the rails 8, 9. It also prevents excessive and unnecessary
10 wear to the lifting mechanism 42 due to repeated unintentional lowering and raising of the rail chassis 6.

- The fact that the rail chassis 6 is always stationary before it is lowered also improves the accuracy with which the rail chassis 6 may be positioned along the rails. This is
15 particularly beneficial if the rail chassis is to be precisely positioned above a foundation configured to hold the rail chassis 6 and rotor sail 10 when the rotor sail 10 is operational. Such a foundation can beneficially provide a stronger load path than the rails 8, 9 are able to provide and the foundation may also enable restraint of the rail chassis against larger forces in all directions, including parallel to the rails where friction
20 alone may be insufficient.

- With the rail chassis 6 in the raised position, if the user continues to increase the tension in the tow line 32 so that it surpasses the predetermined de-braking force (as well as the predetermined lifting force), only then will the brakes 16 be loosened
25 sufficiently to allow movement of the rail chassis 6 along the rails 8, 9.

- The rail chassis 6 is then both in the raised position and also freely transportable along the rails 8, 9. In order to transport the rail chassis 6, the user simply continues to actuate the second end 35 of the tow line 32 so that tension in the tow line 32 remains
30 above the predetermined de-braking force. Provided that the tension in the tow line 32 is greater than the predetermined de-braking force, the tow line will apply a force on the direction filtering apparatus 30 in the direction that the second end 35 is actuated which causes the rail chassis 6 to roll along the rails 8, 9 in that direction.

- 35 Accordingly, through simply actuating the second end 35 of the tow line 32 in either direction substantially parallel to the rails 8, 9, providing sufficient tensile force in the tow line, the user of the rail system 2 may (a) lift the rail chassis 6, (b) loosen the brakes 16 and (c) move the rail chassis 6 along the rails 8, 9 in a controlled manner.

The brake 16 can be further configured so that a degree of braking force is always applied, even when fully tension in the tow line 32 has surpassed the predetermined de-braking force so that the rail chassis 6 is movable along the rails 8, 9. This prevents
5 the rail chassis 6 rolling along the rails due to any pitching or rolling of the ship, for example.

Once the rail chassis 6 is in the desired location, the user may simply stop actuating the tow line 32 and the rail chassis will come to a stop as the tensile force drops so
10 that the brakes 16 are again biased to locked engagement with the first rail 8. To lower the rail chassis 6 back to the resting position, the user is simply required to actuate the second end 35 back in the opposite direction to the direction in which the rail chassis 6 was transported so that the tensile force in the tow line 32 drops below the pre-determined lifting force.

15 However, it is important to realise that the tension in the tow line 32 can only increase above the predetermined de-braking force once the lift axle 70 has reached the second position, at which point the lift axle 70 can move no further. In other words, loosening of the brakes may be possible only once the rail chassis 6 is in the raised position.

20 Essentially, due to the predetermined de-braking force being greater than the predetermined lifting force, loosening of the brakes 16 is decoupled from raising of the rail chassis 6 even though they are operated by what is, on the face of it, a single actuation of the same tow line 32. This provides a number of advantages.

25 Firstly, the rail chassis 6 will always be in a stable, fully raised position before the brakes 16 are loosened and the rail chassis 6 is allowed to travel along the rails 8, 9. This prevents a situation where, for example, the rail chassis 6 is fully raised and movable relative to one of the rails 8, 9 but not yet fully raised and moveable relative
30 to the other of the rails. Such an unbalance could cause unpredictable loading of certain components within the deployment mechanism 40 that might increase wear or even lead to a catastrophic failure.

Similarly, the brakes 16 will always be in locked engagement with the first rail 8 before
35 the rail chassis 6 is lowered. This is true whether the tension in the tow line 32 is reduced intentionally by a user of the rail system or because of a failure in the tow assembly, for example. The initial braking of the rail chassis 6 prevents there being any inertia present as the rail chassis 6 is lowered and the friction formations 60 grip

the rails 8, 9. If any inertia were present, the rotor sail would be liable to pivot about the friction formation which could again cause unpredictable loading of certain components that might increase wear or lead to a failure.

- 5 The tow assembly 22 may be actuated using any suitable system for applying the tensile forces required to overcome the predetermined lifting and de-braking forces.

However, in the embodiment of the invention shown in the figures, particularly Figures 11 and 12, a winch line 38 is used.

10

- The winch line 38 forms part of a winch apparatus 39 shown in Figures 13 and 14. The winch apparatus 39 further comprises a pair of fixed sheaves 43, between which the winch line 38 extends, and a capstan-type winch 41 suitable for actuating the winch line 38 in either direction between the pair of fixed sheaves 43. The pair of fixed sheaves 43 are positioned at either ends of the rails 8, 9 so that the winch line 38 extends along, and substantially parallel to, the rails 8, 9.

- The winch apparatus 39 further comprises a tensioning mechanism 45 for maintaining the unloaded portion of the winch line 38 under tension to avoid the winch line 38 slipping on the capstan-type winch 41. In this embodiment of the invention, the tensioning mechanism 45 comprises a pair of biased sheaves 47, each biased away from the capstan-type winch 41.

- The force required to overcome the bias of the biased sheaves 47 is configured to be lower than the pre-determined lifting force so that the bias of the biased sheaves 47 does not interfere with the operation of the brake unit 14 or lift unit 44.

- Known rail systems involve an electrically powered rail chassis. However, these known rail systems are used for relatively small rotor sails, e.g., just 2 m in diameter and 18 m in height. For large rotor sails, with a diameter of 5 m and a height of 35 m for example, an electrically powered rail chassis would either require very large batteries or a very large diameter electric cable to supply the power required to operate the rail chassis under significantly increased loads. Running flexible cables carrying high voltages across the deck of a ship has implications for safety and reliability due to risk of cable damage. A cable reel may also be impractical for runs of rail longer than 30 m, which are required for larger vessel installations.

The winch apparatus 39 removes the need for batteries or cable reels (electric or hydraulic). Vessel crews are also familiar with operating and maintaining winches and therefore require minimal additional training in order to operate the rail system 2. The winch line may also be routed along the deck easily, without requiring any significant modifications to the deck, and in a manner that is unobtrusive to the working area of the deck. Further, in scenarios in which the winch fails, a secondary/backup winch may readily be used to operate the rail system 2. The winch line 38 can be maintained or replaced easily by the crew and is more robust than a flexible electric cable.

10 The winch line 38 may be either a steel wire rope or a fibre rope. In embodiments of the invention a synthetic fibre rope is used due to its strength and safety benefits. In such embodiments of the invention, a low-stretch synthetic fibre rope may be used as it increases the stiffness of the system and may improve the positional control of the rail chassis 6. It is possible to temporarily connect multiple rail chassis 6 to the winch line 38 via the tow assembly of each rail chassis 6 using a gripper (not shown).
15 Alternatively, if only one rail chassis 6 is installed on the rails 8, 9 then the winch line 38 can be permanently spliced or connected to the rail chassis 6 via the tow assembly 22.

20 In Figure 15, a direction filtering apparatus 130 is shown which functions equivalently to the direction filtering apparatus 30 shown in Figures 11 and 12.

However, rather than comprising first and second directing pulleys, the direction filtering apparatus 130 comprises a first directing sheave 136, a second directing sheave 137 and a third directing sheave 131. Also, the tow line 132 splits into a first end portion 151 and a second end portion 153. The first end portion 151 terminates at a second end 135 of the tow line 132 while the second end portion 153 terminates at a third end 133 of the tow line 132 (the first end is coupled to the brake as shown in Figures 11 and 12).

30 Both the second and third ends 135, 133 are coupled to the winch line 138 such that a loop is formed from the combination of the first and second end portions 151, 153.

The first end portion 151 engages with first direction filtering sheave 136 while the second end portion engages with the second and third direction filtering sheaves 137, 131.

When the winch line 38 is actuated in a first direction (to the right of the page), the first end portion 151 is pulled and tension applied to the tow line 132 for operating the lift actuator 46 and brake 16. Alternatively, when the winch line 38 is actuated in a second direction (to the left of the page), the second end portion 153 is pulled but
5 tension is similarly applied to the tow line 132 for operating the lift actuator 46 and brake 16. Accordingly, the winch line 38 may be actuated in either direction along the rails 8, 9 in order to raise the rail chassis 6 and loosen the brake 16 so that the rail chassis 6 can be towed in the respective direction along the rails 8, 9.

10 In Figure 16, a deployment mechanism 240 is similar to the deployment mechanism 40 shown in Figures 9 to 12 except that it comprises a tow assembly 222 which functions differently to the tow assembly 22 of the deployment mechanism 40.

The tow assembly 222 comprises a brake coupler 232 and a lift coupler 234. The brake
15 coupler 232 couples the winch apparatus (specifically, the winch line 38 in this embodiment of the invention) to the brake actuator 28 and, hence, the brakes 16 (shown in Figure 8).

Similarly, the lift coupler 234 couples the winch apparatus to the lift actuator 46.
20

The tow assembly 222 is configured so that an initial displacement of the winch apparatus causes movement of the lift actuator 46 from the first configuration to the second configuration and a further displacement of the winch apparatus causes loosening of the brakes 16.
25

More specifically, in this embodiment of the invention, the brake coupler 232 comprises a rope which is slack when the lift actuator 46 is in the first configuration (and the rail chassis 6 is resting on the rails 8, 9). However, once the lift coupler 234 has been pulled by the winch line 38 sufficiently to move the lift actuator 46 to the second
30 configuration (so that the rail chassis is in the raised position), the brake coupler 232 becomes taut. This means that further actuation of the winch line 38 causes force to be exerted by the brake coupler 232 on the brake actuator, thereby loosening the brakes 16 from the rail 8.

35 In other words, the sequence of lifting and de-braking is controlled by the displacement of the winch line 38, rather than the tension in the tow line 32 of the tow assembly 22 shown in Figures 9 to 12. An advantage of this embodiment of the invention is that the force required to lift does not need to be smaller than the force required to release

the brake. Therefore, for a given amount of lifting work, the travel of the winch line 38 can be smaller, reducing the time taken to lift and lower the rail chassis 6.

5 In other embodiments of the invention, the brake coupler and the lift coupler may comprise means other than ropes (as shown in Figure 16) for applying forces to the brake actuator and lift actuator, respectively. For example, the brake coupler and the lift coupler may comprise mechanical linkages or hydraulic mechanisms.

10 In some embodiments of the invention, a deployment mechanism may comprise a lift unit and a brake unit but the lift unit may be actuated separately to the brake unit, which actuation may be powered manually, electrically, pneumatically and/or hydraulically.

15 Embodiments of such a deployment mechanism using hydraulics comprise a hydraulic system 365 as shown in Figure 17. The hydraulic system comprises a tow assembly 322, a hydraulic lifting assembly 367 and, optionally, a pilot line 369 coupling the tow assembly 322 to the hydraulic lifting assembly 367. It will be appreciated that a deployment mechanism using pneumatics may comprise a pneumatic system that may function similarly, mutatis mutandis, to the hydraulic system 365 described below
20 except that a compressible fluid is used, rather than an incompressible or substantially incompressible fluid, and the system is suitably adapted to the difference in fluid.

The tow assembly 322, shown more clearly in Figure 18, comprises a fluid actuated brake coupler 331 which couples a winch apparatus to a brake actuator 28 of a brake unit 14 (shown in Figures 20 and 21).
25

In this embodiment of the invention, the winch apparatus comprises a winch line with separate first and second ends 336, 338, rather than an endless winch line such as the winch line 38 shown in Figure 13.
30

The fluid actuated brake coupler 331 comprises a pair of master cylinders 332, each of which comprises a respective master piston 333 to which a respective end of the winch line 336, 338 is coupled. Upon actuation of the winch apparatus, one of the first and second ends 336, 338 will actuate the respective master piston 333, thereby causing
35 compression of hydraulic fluid within the respective master cylinder 332.

Each master cylinder 332 is hydraulically coupled to a de-braking cylinder 334 which is configured to exert a force on the brake actuator 28 proportional to the hydraulic

pressure within the de-braking cylinder 334. Accordingly, actuation of the winch apparatus with a force greater than the pre-determined de-braking force will cause a force to be exerted on the brake actuator 28 that overcomes the resilient biases 18 to loosen the brakes 16 from the rail 8.

5

The fluid actuated brake coupler 331 further comprises a hydraulic accumulator 375 coupled to each master cylinder 332. The hydraulic accumulator 375 is configured to increase pressure acting against the respective master piston 333 so as to assist the respective winch apparatus in moving the master piston 333 and cause de-braking to occur. In other words, the hydraulic accumulator 375 pre-pressurises the master cylinders 332 so that less work must be carried out by the winch apparatus to exert a de-braking force. The hydraulic accumulator 375 therefore reduces the response time involved in loosening the brakes 16.

15 However, the hydraulic accumulator 375 will increase pressure acting on each master piston 333 only to a pre-determined base-level which, in isolation, is lower than the pressure that would be required to overcome de-braking. Accordingly, once tension in a winch line is removed the force applied by the resilient biases 18 on the brakes 16 will still be sufficient to overcome the pressure acting on the master pistons 333 so that braking is restored by default.

25 The fluid actuated brake coupler 331 also comprises a safety release valve 337 and a hydraulic reservoir 374. The safety release valve 337 is configured to release hydraulic fluid into the hydraulic reservoir 374 in the event of an unsafe level of pressure building up within the fluid actuated brake coupler 331 between the master pistons 333 and the de-braking cylinder 334.

30 The hydraulic nature of the fluid actuated brake coupler 331 can have advantages of reducing internal friction, size and weight compared to a deployment mechanism using a combination of mechanical levers and pulleys.

Figure 19 shows an alternative embodiment of a fluid actuated brake coupler 431. The fluid actuated brake coupler 431 operatively couples an attachment 422 to the brake (not shown) via the brake actuator 28, the attachment 420 being suitable for operatively coupling a winch apparatus to the brake.

35 The fluid actuated brake coupler 431 comprises a fluid, specifically a hydraulic fluid in this example, and a de-braking valve 437 operable to allow pressurised hydraulic fluid

to act against the resilient bias 18 so as to loosen the brake 16 from the rail 8 (shown in Figure 8). If a sufficient force is applied by the winch apparatus on the fluid actuated brake coupler 431, the fluid actuated brake coupler 431 is pressurised sufficiently to loosen the brake 16. More specifically, actuation of the winch apparatus providing a
5 force on the fluid actuated brake coupler 431 greater than a predetermined de-braking force required to overcome the resilient bias 18 pressurises the fluid actuated brake coupler 431 sufficiently such that, once the de-braking valve 437 is operated, the pressurised hydraulic fluid acting against the resilient bias 18 loosens the brake 16.

10 In this embodiment, the brake 16 engages with, and can be loosened from, the rail 8, as is the case for the embodiment shown in Figure 8, for example. However, the brake unit 14 shown in Figure 8 may be modified so that the brake 16 engages with, and can be loosened from, one or more wheels and still provide the required braking/de-braking actions. It will be appreciated that the necessary modifications would be well within
15 the capability of persons skilled in the art.

In this embodiment, the fluid actuated brake coupler 431 comprises a pair of master cylinders 432, each of which comprises a respective master piston 433 to which a respective end of a winch line (not shown) may be coupled via the attachment 420.
20 The fluid actuated brake coupler 431 further comprises a hydraulic accumulator 475 coupled to each master cylinder 432 via two paths. Along a first path, a first directional valve 436 is configured to allow hydraulic fluid to travel only from the respective master cylinder 432 to the hydraulic accumulator 475 in order to 'charge' the hydraulic accumulator 475. Whereas, along a second path, a second directional valve 438 is
25 configured to allow hydraulic fluid to travel only from the hydraulic accumulator 475 to the respective master cylinder 432. In other words, the first and second directional valves 436, 438 ensure that hydraulic fluid may only travel in one direction along each path.

30 The de-braking valve 437 is located between the hydraulic accumulator and a de-braking cylinder 434, which is configured to exert a force on the brake actuator 28 proportional to the hydraulic pressure within the de-braking cylinder 434. When the de-braking valve 437 is closed, hydraulic fluid is prevented from travelling from the hydraulic accumulator 475 to the de-braking cylinder 434. However, once the de-
35 braking valve is opened, hydraulic fluid is able to flow to the de-braking cylinder 434 such that pressurised fluid stored in the hydraulic accumulator 475 can exert a force on the brake actuator 28 to loosen the brake 16.

If the hydraulic accumulator 475 has been sufficiently charged prior to opening the de-braking valve 437, the hydraulic fluid released into the de-braking cylinder will be sufficiently pressurised to exert a force on the brake 16 that is opposite to the force exerted by the resilient bias 18 and sufficiently large to loosen the brake 16 so that
5 the rail chassis 6 can be transported along the rail 8. 'Sufficient charge' may correspond to a predetermined pressure within the hydraulic accumulator 475 before the de-braking valve 437 is opened. The hydraulic accumulator 475 may comprise a pressure sensor (not shown), for measuring internal pressure, and a pressure indicator to indicate the internal pressure and/or indicate when the predetermined pressure
10 corresponding to sufficient charge has been reached. A user of the rail system is then able to operate the winch apparatus and the de-braking valve accordingly.

The fluid actuated brake coupler 431 also comprises a release valve 439 located between the hydraulic accumulator and each of the second directional valves 438. The
15 release valve 439 is operable between a closed configuration and an open configuration. When in the closed configuration, no hydraulic fluid is able to travel from the hydraulic accumulator 475 to the master cylinders 432 as the combination of the closed release valve 439 and the first directional valves 436 prevent such travel of the hydraulic fluid. Thus, pressurisation of the hydraulic fluid in the hydraulic
20 accumulator 475 may be maintained. However, when the release valve 439 is in the open configuration, hydraulic fluid may travel from the hydraulic accumulator 475 to the master cylinders 432. This will reduce pressure in the hydraulic accumulator 475 and, in turn, the de-braking cylinder 434 so that the resilient bias 18 will cause the brake 16 to return to a position of locked engagement with the rail 8 or, optionally,
25 with one or more wheels.

The de-braking valve 437 and the release valve 439 may be manually-operated, i.e., operated by hand, or remotely-operated wherein a user of the rail system operates a controller that transmits a signal (e.g., a radio signal) to the de-braking valve 437 or
30 release valve 439 which triggers an automated action (either opening or closing of the valve).

The release valve 439 may default to an open configuration and comprise a controller requiring active control by a user to maintain the release valve 439 in the closed
35 configuration. That is, the release valve 439 may only remain closed while a button, lever, trigger or equivalent control device is actively depressed by a user. Thus, once the button/equivalent device is released, the release valve 439 will open and the brake 16 will return to a position of locked engagement as the default position, thereby

improving the safety of the rail system. In other words, the release valve 439 may be controlled using a "dead man's switch" and this may be particularly beneficial if the release valve 439 is remotely operated.

- 5 In use, to loosen the brake 16 from a position of locked engagement, both the de-braking valve 437 and the release valve 439 would be closed. A user of the rail system may then actuate the winch apparatus to actuate a respective master piston 433 (depending on the direction that the winch apparatus is actuated) and cause pressurisation of hydraulic fluid within the respective master cylinder 432. The
10 pressurised hydraulic fluid will then flow to the hydraulic accumulator 475 through the respective first directional valve 436, thereby charging the hydraulic accumulator 475 with pressurised hydraulic fluid.

- Once the hydraulic accumulator 475 is sufficiently charged, actuation of the winch
15 apparatus may be stopped. The winch apparatus may then be actuated a small amount in the reverse direction, thereby relieving pressure in the respective master cylinder 432. This will allow a user of the rail system to check that the directional valves 436 and the release valve 439 are correctly preventing flow of hydraulic fluid back towards the master cylinders 433. It will also prevent the winch apparatus from exerting a
20 force on the rail chassis 6 and, thereby, prevent the rail chassis from moving along the rail 8 immediately once the brake 16 is sufficiently loosened.

- A user of the rail system may then open the de-braking valve 437 to pressurise the de-braking cylinder and cause the brake 16 to be loosened so that the rail chassis 6
25 can be transported along the rail 8.

- When the brake 16 is to be returned to locked engagement (once the rail chassis 6 is in the desired position, for example) the release valve 439 may be opened so that hydraulic fluid can flow from the hydraulic accumulator 475 to one or both of the master
30 cylinders 432, thereby reducing pressure in the hydraulic accumulator 475 and de-braking cylinder 434 and the force exerted on the brake 16 is no longer high enough to loosen the brake 16 against the force exerted by the resilient bias 18.

- In other embodiments of the invention, there may be just one master cylinder and
35 respective master piston. In such embodiments, the winch apparatus may be configured such that a de-braking actuation will pull the master piston in only one direction, irrespective of which direction the rail chassis may be towed. For example, a direction filtering apparatus similar to that shown in Figure 15 may be used.

In Figure 22, the hydraulic lifting assembly 367 comprises a pair of lifting cylinders 370, a lifting pump 372 and a hydraulic reservoir 374 storing hydraulic fluid. (In other embodiments of the invention, the hydraulic lifting assembly may comprise only one
5 lifting cylinder or more than two lifting cylinders). The hydraulic reservoir 374 is hydraulically coupled to the lifting cylinders 370 via the lifting pump 372. The lifting pump 372 is operable to pump hydraulic fluid from the hydraulic reservoir 374 the lifting cylinders 370 and thereby cause a lifting piston 371 within each lifting cylinder 370 to actuate a lift actuator 346 forming part of a lift unit such as the lift unit 44a
10 shown in Figures 4 and 5.

Accordingly, the lift actuator 346 may be hydraulically actuated from the first configuration to the second configuration by operating the lifting pup 372, thereby lifting the rail chassis 6. The lift actuator 346 may therefore be considered a hydraulic
15 lift actuator.

The lifting pump 372 may be a manual or an electro-hydraulic pump, optionally battery powered so that it can be actuated with the rail chassis 6 at any position along the rails 8, 9 without requiring cables or hoses.

20 Other methods could be used for actuating a lift actuator 46 independently from the tension in the winch line, for example an independent winch or screw jack. As a lift unit 44 has to raise the rail chassis 6 by a short distance upwards it only has to do a small amount of work compared to the winch when being used to tow the rail chassis
25 6. Therefore, the size of battery required to power the lift system is small compared to the size of battery that would be required to move the rail chassis 6 along the rails 8, 9.

The hydraulic lifting assembly 367 further comprises a release valve 376 and an orifice 378 that hydraulically couple the lifting cylinders 370 to the hydraulic reservoir 374 in
30 parallel to the lifting pump 372. In order to return the hydraulic lift actuator 346 to the first configuration from the second configuration, thereby lowering the rail chassis 6, the release valve 376 may be opened so that hydraulic fluid may flow back from the lifting cylinders 370 to the hydraulic reservoir 374. The orifice 378 restricts the flow
35 of hydraulic fluid to control the speed at which the rail chassis may lower towards the resting position.

The hydraulic lifting assembly 367 also comprises a hydraulic accumulator 375 coupled to the lifting cylinders 370. The hydraulic accumulator 375 is configured to pressurise the lifting cylinders 370 in such a way as to bias the hydraulic lift actuator 346 towards the first configuration (hence biasing the rail chassis to the resting position).

5

In some embodiments the hydraulic accumulator 375 may not be necessary as the weight of the rail chassis 6 and its cargo may sufficiently bias the hydraulic lift actuator 346 to the first configuration. However, in some cases, the friction present in the lift unit may be high enough that the effect of gravity does not sufficiently bias the hydraulic lift actuator 346 towards the first configuration and there may be a risk of the rail chassis 6 becoming stuck in the raised position if the hydraulic accumulator 375 were not present.

Alternatively, if the weight of the rail chassis 6 and its cargo is more than sufficient to bias the hydraulic lift actuator 346 to the first configuration then the hydraulic accumulator 375 may be configured to bias the hydraulic lift actuator 346 to the second configuration, thereby reducing the work required to lift the rail chassis 6 and its cargo.

Referring back to Figure 17, the pilot line 369 couples the fluid actuated brake coupler 331 to the hydraulic lift actuator 346 via the release valve 376.

A failure in the fluid actuated brake coupler 331 which results in a loss of pressure would result in any de-braking, which was occurring prior to the failure, to cease. Also, a failure in the winch apparatus would result in a loss of tension in the winch line so that neither of the ends 336, 338 are pulling on the respective master pistons 333. This would, in turn, would cause a loss of pressure in the fluid actuated brake coupler 331 and cause any de-braking to cease.

In these circumstances, it is preferable for the rail chassis 6 to be lowered to the resting position, if it is not already there, as would be the case if a failure occurred in embodiments of the deployment mechanism described above.

The release valve 376 is configured to open automatically if pressure in the fluid actuated brake coupler 331 falls below a predetermined failure threshold. This means that a drop in pressure within the fluid actuated brake coupler 331 indicating a failure would cause hydraulic fluid in the lifting cylinders 370 to be released, thereby allowing the hydraulic lift actuator to move towards the first configuration (lowering the rail

chassis 6) by virtue of the gravity, the pressure provided by the hydraulic accumulator 375 or a combination of the two.

5 A sequence of raising, de-braking, towing, braking and lowering a rail chassis 6 using a deployment mechanism incorporating the hydraulic system 365 may be carried out along the lines set out below.

Lifting

1. Actuating the lifting pump 372 to pressurise the lifting cylinders 370.
- 10 2. The lifting cylinders displace the hydraulic lift actuator 346 towards the second configuration to lower the wheels 52 relative to the rail chassis 6 hence raise the rail chassis 6 relative to the rails 8, 9.
3. The rail chassis is now in its raised position and ready to be transported along the rails 8, 9 using the winch apparatus.

15

De-braking

4. There is a residual tension in the winch line maintained by the two biased sheaves 47 each side of the winch 41 (as shown in Figure 14).
5. Operation of the winch 41 in one direction pulls the respective winch line 336, 338 until the biasing sheave 47 on that side "bottoms out" on its end stop and can no longer displace any further.
- 20 6. Further movement of the winch line 336, 338 causes an increase in tension as it pulls on the respective master cylinder 332 (Fig 18).
7. The hydraulic pressure in that master cylinder 332 increases.
- 25 8. Increasing hydraulic pressure is thereby applied to the de-braking cylinder 334.
9. Extension of the de-braking cylinder 334 opposes the bias of the brakes 16 towards the rail 8 (Figures 8 and 20), tending to reduce the available braking force between each of the brake pads 24 and the rail 8.
10. The reduction in braking force reduces the braking friction that the brake can provide. (Braking friction = braking force on each braking pad 24 x coefficient of friction x number of braking pads 24).
- 30

Towing

11. If the winch 41 continues to be operated, a point is reached where the tension in the winch line exceeds the braking friction.
- 35 12. At this point there is a net force on the rail chassis 6 so the rail chassis 6 starts to accelerate along the rails 8, 9.

13. As long as the rail chassis 6 is moving more slowly than the winch line, the tension in the winch line will increase to release further loosen the brake.
14. If the rail chassis 6 accelerates to a speed faster than the winch line speed, the tension in the winch line will decrease, decreasing the hydraulic pressure in the master cylinder 333 and hence in the de-braking cylinder 334.
15. This allows the bias in the brake unit 14 to restore the braking force and hence the friction between the brakes 16 and the rail 8.
16. The rail chassis 6 will then slow down.
17. By this progressive de-braking/braking the motion of the rail chassis 6 matches closely the motion of the winch line, resistant to other influences such as wind or heeling of the ship tending to accelerate or decelerate the rotor sail along the rail.

Braking

18. When the desired stopping point is reached, the winch 41 may be stopped.
19. The tension in the winch line decreases due to the continued movement of the rail chassis for a short distance.
20. The hydraulic pressure in the master cylinder 332 and de-braking cylinder decrease 334.
21. The bias in the brake unit 14 restores the braking force between the brake 16 and the rail 8.
22. The braking friction increases.
23. The rail chassis 6 slows down until it stops moving along the rails 8, 9.
24. To minimise any chance of accidental movement due to other influences, the winch 41 can be driven briefly in the opposite direction.
25. This allows the winch line to go almost slack, until the relevant biasing sheave 47 moves off its end stop.
26. The tension in the winch line is now only what is provided by the biasing sheaves 47, which is much lower than the tension required to overcome the resilient biases 18 of the brake unit 14.

Lowering

27. To lower the rail chassis 6, once stationary, the release valve 376 is opened (Figure 22).
28. Hydraulic fluid flows from the lifting cylinders 370, through the orifice 378, back to the reservoir.
29. Gravity, optionally assisted by the hydraulic accumulator 375, may then pull the rail chassis 6 back down towards the rails 8, 9.

In summary, the sequence of operation involves, firstly, raising the rail chassis 6 using the hydraulic lifting assembly 367, then applying tension to the winch line to loosen the brakes 16. After the tension in the winch line has been released and the brakes 16 reapplied, the hydraulic lifting assembly 367 can be used to the rail chassis 6 back
5 down onto the rail.

Should the winch apparatus fail during the sequence of activity set out above, the sequence will be interrupted and actions along the lines set out below may occur instead.

10

1. The pressure in the master cylinders 332 will decrease completely, and hence the pressure in the pilot line 369 between the fluid actuated brake coupler 331 and the hydraulic lifting accumulator (Figure 17) will also drop.
2. The release valve 376 is opened by the loss of pressure in the pilot line 369.
- 15 3. Hydraulic fluid flows from the lifting cylinders 370, through the orifice 378, back to the hydraulic reservoir 374.
4. The rail chassis 6 will then lower down to rest on the rails 8, 9.
5. The friction formations 60 (Figure 6) will then grip the rails 8, 9, preventing further movement of the rail chassis 6 along the rails 8, 9.

CLAIMS

1. A brake mechanism for a rail chassis for a ship mounted rail system, comprising:
a brake unit couplable to a rail such that it may move along the rail with the rail chassis, the brake unit comprising a brake and a resilient bias that biases the brake
5 towards locked engagement with the rail; and,
an attachment for operatively coupling a tow assembly to the brake, wherein sufficient actuation of the tow assembly loosens the brake from the rail so that the rail chassis can be transported along the rail by the tow assembly.
- 10 2. A brake mechanism according to claim 1, wherein the brake comprises a moveable brake pad and the resilient bias comprises a mechanism biasing the moveable brake pad towards locked engagement with the rail.
3. A brake mechanism according to claim 1 or claim 2, wherein the brake unit
15 further comprises a brake actuator operatively coupling the attachment to the brake and moveable by the tow assembly between a locked configuration in which the brake is in locked engagement with the rail and an unlocked configuration in which the brake is loosened from locked engagement with the rail so that the brake unit is movable
20 along the rail.
4. A brake mechanism according to claim 3, wherein the brake unit comprises a plurality of brakes and respective resilient biases, and the brake actuator operatively couples the attachment to each brake whereby movement of the brake actuator causes the plurality of brakes to move between the locked configuration and the unlocked
25 configuration.
5. A brake mechanism according to any of claims 1 to 4, wherein:
the brake mechanism further comprises a tow assembly, the tow assembly comprising a direction filtering apparatus;
30 the direction filtering apparatus is couplable to a winch apparatus, the winch apparatus being operable to apply a force on the direction filtering apparatus in a first direction substantially parallel to the rail or a second direction substantially parallel to the rail and substantially opposite to the first direction; and,
the direction filtering apparatus is configured to operatively link the winch
35 apparatus to the brake such that operation of the winch apparatus to apply a force on the direction filtering apparatus in either the first direction or the second direction, loosens the brake so that the rail chassis can be transported along the rail by the tow assembly.

6. A brake mechanism according to claim 5, wherein the tow assembly comprises a fluid actuated brake coupler coupling the winch apparatus to the brake; whereby, if a force greater than a predetermined de-braking force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake coupler is pressurised sufficiently to loosen the brake from the rail.
7. A brake mechanism according to any of claims 1 to 5, wherein the brake mechanism is configured such that actuation of the tow assembly providing a force greater than a predetermined de-braking force required to overcome the resilient bias loosens the brake from the rail.
8. A brake mechanism according to any of claims 1 to 4, wherein:
the brake mechanism further comprises a fluid actuated brake coupler operatively coupling the attachment to the brake;
the attachment is couplable to a winch apparatus, the winch apparatus being operable to apply a force on the fluid actuated brake coupler; whereby, if a force greater than a predetermined de-braking force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake coupler is pressurised sufficiently to loosen the brake from the rail; and,
the fluid actuated brake coupler comprises a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake from the rail.
9. A brake mechanism according claim 8, wherein:
the fluid actuated brake coupler further comprises a release valve operable between a closed configuration, which maintains pressurisation of the fluid, and an open configuration, which reduces pressurisation of the fluid so that the resilient bias returns the brake to locked engagement with the rail; and,
optionally, the release valve defaults to an open configuration and comprises a controller requiring active control by a user to maintain the release valve in the closed configuration.
10. A brake mechanism for a rail chassis for a ship mounted rail system, comprising:
a brake unit comprising a brake and a resilient bias that biases the brake towards a position of locked engagement causing braking of the rail chassis;
an attachment for operatively coupling a winch apparatus to the brake; and,

a fluid actuated brake coupler operatively coupling the attachment to the brake, and comprising a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake, whereby, if a sufficient force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated
5 brake coupler is pressurised sufficiently to loosen the brake so that the rail chassis can be transported.

11. A brake mechanism according claim 10, wherein the brake mechanism is configured such that actuation of the winch apparatus providing a force on the fluid
10 actuated brake coupler, greater than a predetermined de-braking force required to overcome the resilient bias, pressurises the fluid actuated brake coupler sufficiently such that, once the de-braking valve is operated, the pressurised fluid acting against the resilient bias loosens the brake so that the rail chassis can be transported.

12. A brake mechanism according claim 10 or claim 11, wherein:
the fluid actuated brake coupler further comprises a release valve operable between a closed configuration, which maintains pressurisation of the fluid, and an open configuration, which reduces pressurisation of the fluid so that the resilient bias returns the brake towards the position of locked engagement; and,
15 optionally, the release valve defaults to an open configuration and comprises a controller requiring active control by a user to maintain the release valve in the closed configuration.

13. A lift mechanism for a rail chassis for a ship mounted rail system, comprising a
25 lift unit couplable to a rail such that it may move along the rail with the rail chassis, the lift unit comprising a lift actuator movable between a first configuration and a second configuration, movement of the lift actuator from the first configuration to the second configuration causing the rail chassis to move relative to the rail from a resting position to a raised position so that the rail chassis can be transported along the rail in
30 a raised position.

14. A lift mechanism according to claim 13, further comprising a friction formation grippingly engageable with the rail when the lift actuator is in the first configuration.

15. A lift mechanism according to claim 14, wherein the friction formation comprises at least one gripping pad moveable within the friction formation and the friction formation further comprises a biasing formation engageable with the at least one gripping pad and configured such that, in use, downward force on the friction formation

is transmitted from the biasing formation to the at least one gripping pad in more than one direction so that the rail is gripped by the friction formation.

16. A lift mechanism according to any of claims 13 to 15, wherein the lift unit is mountable to a wheel assembly comprising a wheel rotatably engageable with the rail.

17. A lift mechanism according to claim 16, wherein:
the lift actuator comprises a lever and a pin, the lever is coupled to the lift attachment and is rotatable about a lever axis positioned at a fixed height relative to the rail chassis, and the pin extends from the lever parallel to, but spaced apart from, the lever axis; and,
movement of the pin when the lift actuator moves from the first configuration to the second configuration drives the wheel towards the rail and away from the rail chassis, thereby causing the rail chassis to move to the raised position.

18. A lift mechanism according to any of claims 13 to 17, wherein the lift unit further comprises a restraint assembly engageable with the rail and configured to restrain movement of the rail chassis transversely and/or upwardly relative to the rail.

19. A lift mechanism according to any of claims 13 to 18, further comprising a lift attachment for attaching a tow assembly to the lift actuator, wherein sufficient actuation of the tow assembly moves the lift actuator from the first configuration to the second configuration so that the rail chassis can be transported along the rail in the raised position by the tow assembly.

20. A lift mechanism according to claim 19, wherein the lift mechanism is configured such that actuation of the tow assembly providing a force greater than a predetermined lifting force required to raise the rail chassis causes the lift actuator to move from the first configuration to the second configuration.

21. A lift mechanism according to any of claims 13 to 20, wherein:
the lift mechanism further comprises a tow assembly, the tow assembly comprising a direction filtering apparatus;
the direction filtering apparatus is couplable to a winch apparatus, the winch apparatus being operable to apply a force on the direction filtering apparatus in a first direction substantially parallel to the rail or a second direction substantially parallel to the rail and substantially opposite to the first direction; and,

the direction filtering apparatus is configured to operatively link the winch apparatus to the lift actuator such that operation of the winch apparatus to apply a force on the direction filtering apparatus in either the first direction or the second direction actuates the lift actuator between the first and second configurations so that
5 the rail chassis can be moved to the raised position by the tow assembly.

22. A lift mechanism according to any of claims 13 to 21, wherein:
when the rail chassis is in the resting position, the rail chassis is securely engageable with a foundation; and
10 the lifting mechanism is configured such that, when the rail chassis is in the raised position, the rail chassis is separated from the foundation and thereby freely movable relative to the foundation in the direction of the rail.

23. A deployment mechanism for a rail chassis for a ship mounted rail system,
15 comprising:

a lift unit couplable to a rail such that it may move along the rail with the rail chassis, the lift unit comprising a lift actuator movable between a first configuration and a second configuration, movement of the lift actuator from the first configuration to the second configuration causing the rail chassis to move relative to the rail from a
20 resting position to a raised position;

a brake unit couplable to a rail such that it may move along the rail with the rail chassis, the brake unit comprising a brake and a resilient bias that biases the brake towards locked engagement with the rail; and

a tow assembly operatively couplable to the brake, wherein sufficient actuation
25 of the tow assembly loosens the brake from the rail so that the rail chassis can be transported along the rail in a raised position by the tow assembly.

24. A deployment mechanism according to claim 23, wherein the brake comprises a moveable brake pad and the resilient bias comprises a spring biasing the moveable
30 brake pad towards locked engagement with the rail.

25. A deployment mechanism according to claim 23 or claim 24, wherein the brake unit further comprises a brake actuator operatively coupling the tow assembly to the brake and moveable by the tow assembly between a locked configuration in which the
35 brake is in locked engagement with the rail and an unlocked configuration in which the brake is loosened from locked engagement with the rail so that the brake unit is movable along the rail.

26. A deployment mechanism according to claim 25, wherein the brake unit comprises a plurality of brakes and respective resilient biases, and the brake actuator operatively couples the attachment to each brake whereby movement of the brake actuator causes the plurality of brakes to move between the locked configuration and the unlocked configuration.

27. A deployment mechanism according to any of claims 23 to 26, wherein:
the tow assembly comprises a direction filtering apparatus;
the direction filtering apparatus is couplable to a winch apparatus, the winch apparatus being operable to apply a force on the direction filtering apparatus in a first direction substantially parallel to the rail or a second direction substantially parallel to the rail and substantially opposite to the first direction; and,
the direction filtering apparatus is configured to operatively link the winch apparatus to the brake such that operation of the winch apparatus to apply a force on the direction filtering apparatus in either the first direction or the second direction loosens the brake so that the rail chassis can be transported along the rail in a raised position by the tow assembly.

28. A deployment mechanism according to any of claims 23 to 27, wherein the tow assembly is additionally couplable to the lift actuator and sufficient actuation of the tow assembly moves the lift actuator from the first configuration to the second configuration.

29. A deployment mechanism according to claim 28, wherein:
the deployment mechanism is configured such that actuation of the tow assembly providing a force greater than a predetermined de-braking force required to overcome the resilient bias loosens the brake from the rail;
actuation of the tow assembly providing a force greater than a predetermined lifting force required to raise the rail chassis causes the lift actuator to move from the first configuration to the second configuration; and,
the predetermined de-braking force is greater than the predetermined lifting force so that the brake is loosened from the rail once the rail chassis is in the raised position.

30. A deployment mechanism according to claim 28, wherein:
the tow assembly comprises a brake coupler, coupling the winch apparatus to the brake, and a lift coupler, coupling the winch apparatus to the lift actuator; and,

the tow assembly is configured so that an initial displacement of the winch apparatus causes movement of the lift actuator from the first configuration to the second configuration and a further displacement of the winch apparatus causes loosening of the brake.

5

31. A deployment mechanism according to any of claims 23 to 30, wherein the tow assembly comprises a fluid actuated brake coupler coupling the winch apparatus to the brake; whereby, if a force greater than a predetermined de-braking force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake
10 coupler is pressurised sufficiently to loosen the brake from the rail.

32. A deployment mechanism according to any of claims 23 to 30, wherein:

the deployment mechanism further comprises a fluid actuated brake coupler operatively coupling the tow assembly to the brake;

15 the tow assembly is couplable to a winch apparatus, the winch apparatus being operable to apply a force on the fluid actuated brake coupler; whereby, if a force greater than a predetermined de-braking force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated brake coupler is pressurised sufficiently to loosen the brake from the rail; and,

20 the fluid actuated brake coupler comprises a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake from the rail.

33. A deployment mechanism according claim 32, wherein:

25 the fluid actuated brake coupler further comprises a release valve operable between a closed configuration, which maintains pressurisation of the fluid, and an open configuration, which reduces pressurisation of the fluid so that the resilient bias returns the brake to locked engagement with the rail; and,

30 optionally, the release valve defaults to an open configuration and comprises a controller requiring active control by a user to maintain the release valve in the closed configuration.

34. A deployment mechanism according to any of claims 31 to 33, wherein:

35 the lift actuator is reversibly fluid actuated to move between the first configuration and the second configuration.

35. A deployment mechanism according to claim 34, wherein the lift actuator is configured so that pressure is released automatically if pressure in the fluid actuated brake coupler is below a predetermined release threshold.
- 5 36. A deployment mechanism according to any of claims 31 to 35, further comprising a hydraulic accumulator coupled to the lift actuator and configured to hydraulically bias the lift actuator towards the first or second configuration.
37. A deployment mechanism according to claim 27 or any claim dependent
10 thereon, wherein the winch apparatus comprises:
a winch line extending substantially parallel to the rail, the winch line couplable to the direction filtering apparatus; and,
a winch for actuating the winch line to apply a force on the direction filtering apparatus in one or either of the first direction and the second direction.
- 15 38. A deployment mechanism according to claim 37, wherein the winch is a capstan-type winch, and the winch apparatus further comprises a tensioning mechanism for maintaining tension in the winch line so that the winch line does not slip on the capstan-type winch.
- 20 39. A deployment mechanism according to any of claims 23 to 38, wherein the lift unit comprises a friction formation grippingly engageable with the rail when the lift actuator is in the first configuration.
- 25 40. A deployment mechanism according to claim 39, further comprising at least one gripping pad moveable within the friction formation and the friction formation further comprises a biasing formation engageable with the at least one gripping pad and configured such that, in use, downward force on the friction formation is transmitted from the biasing formation to the at least one gripping pad in more than one direction
30 so that the rail is gripped by the friction formation.
41. A deployment mechanism according to any of claims 23 to 40 further comprising a wheel assembly, the wheel assembly comprising a wheel rotatably engageable with the rail.
- 35 42. A deployment mechanism according to claim 41, wherein the lift unit is coupled to the wheel assembly.

43. A deployment mechanism according to claim 42, wherein:
the lift actuator comprises a lever and a pin, the lever is coupled to the attachment and is rotatable about a lever axis positioned at a fixed height relative to the wheel assembly, and the pin extends from the lever parallel to, but spaced apart
5 from, the lever axis; and,
movement of the pin when the lift actuator moves from the first configuration to the second configuration drives the wheel in the direction of the rail and away from the wheel assembly, thereby causing the rail chassis to move to the raised position.
- 10 44. A deployment mechanism according to any of claims 41 to 43, wherein the wheel assembly comprises a plurality of wheels.
45. A deployment mechanism according to any of claims 41 to 44, wherein the deployment mechanism comprises a plurality of wheel assemblies.
- 15 46. A deployment mechanism according to claim 44 or claim 45, wherein at least one of the wheels is rotatably engageable with a first rail and at least another of the wheels is rotatably engageable with a second rail spaced apart from the first rail.
- 20 47. A deployment mechanism according to any of claims 23 to 46, wherein the lift unit comprises a restraint assembly engageable with the rail and configured to restrain movement of the rail chassis transversely and/or upwardly relative to the rail.
48. A deployment mechanism for a rail chassis for a ship mounted rail system,
25 comprising:
a lift unit couplable to a rail such that it may move along the rail with the rail chassis, the lift unit comprising a lift actuator movable between a first configuration and a second configuration, movement of the lift actuator from the first configuration to the second configuration causing the rail chassis to move relative to the rail from a
30 resting position to a raised position;
a brake unit comprising a brake and a resilient bias that biases the brake towards a position of locked engagement causing braking of the rail chassis;
an attachment for operatively coupling a winch apparatus to the brake; and,
a fluid actuated brake coupler operatively coupling the attachment to the brake,
35 and comprising a fluid and a de-braking valve operable to allow pressurised fluid to act against the resilient bias so as to loosen the brake, whereby, if a sufficient force is applied by the winch apparatus on the fluid actuated brake coupler, the fluid actuated

brake coupler is pressurised sufficiently to loosen the brake so that the rail chassis can be transported along the rail in a raised position by the winch apparatus.

49. A deployment mechanism according claim 48, wherein the brake mechanism is
5 configured such that actuation of the winch apparatus providing a force on the fluid
actuated brake coupler, greater than a predetermined de-braking force required to
overcome the resilient bias, pressurises the fluid actuated brake coupler sufficiently
such that, once the de-braking valve is operated, the pressurised fluid acting against
the resilient bias loosens the brake so that the rail chassis can be transported.
- 10 50. A deployment mechanism according claim 48 or claim 49, wherein:
the fluid actuated brake coupler further comprises a release valve operable
between a closed configuration, which maintains pressurisation of the fluid, and an
open configuration, which reduces pressurisation of the fluid so that the resilient bias
15 returns the brake to the position of locked engagement; and,
optionally, the release valve defaults to an open configuration and comprises a
controller requiring active control by a user to maintain the release valve in the closed
configuration.
- 20 51. A rail chassis set for a ship mounted rail system, the rail chassis set comprising:
a rail chassis for conveying a wind assisted propulsion device over the deck of
a ship; and,
a brake mechanism according to any of claims 1 to 12; a lift mechanism
according to any of claims 13 to 22; the combination of a brake mechanism according
25 to any of claims 1 to 12 and a lift mechanism according to any of claims 13 to 22; or,
a deployment mechanism according to any of claims 23 to 50.
52. A rail chassis assembly for a ship mounted rail system, the assembly assembled
from a rail chassis set according to claim 51.
- 30 53. A ship comprising:
a deck;
a deck mounted rail system; and,
a rail chassis assembly according to claim 52.
- 35 54. A ship according to claim 53, further comprising a wind assisted propulsion
device mounted on the rail chassis, preferably the wind assisted propulsion device is a
Flettner rotor.

55. A ship according to claim 52 or claim 54, further comprising a support structure supporting the railway such that the railway is raised above the deck of the vessel and/or, wherein the rail chassis set comprises a lift mechanism according to claim 17
- 5 and the ship further comprises a foundation on the deck of the ship for supporting a wind assisted propulsion device.