

**A Bridge Assembly, A bridge member for the bridge assembly; and
Method for deploying a bridge assembly.**

Background and Field of the Invention

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The invention relates to a bridge assembly, a bridge member for the bridge assembly, and method for deploying a bridge assembly.

A landing craft is normally used by the military and during peace-time
10 operations for putting ashore personnel and equipment especially in remote areas such as during oil exploration. However, when the landing craft beaches on a beach or on land, there could be obstacles to clear such as swamp, mud, snow, floating ice, shallow water areas etc. before the personnel and equipment is transferred to stable ground. Portable roadways or ground protection mats
15 may be laid onto the obstacles but laying of such roadways or protection mats is difficult and time consuming.

It is an object of the present invention to provide a bridge assembly, a bridge member and method for deploying a bridge assembly which alleviates at least
20 one of the disadvantages of the prior art and/or to provide the public with a useful choice.

Summary of the Invention

In accordance with a first aspect of the present invention, there is provided a bridge assembly comprising a plurality of bridge members connectable together to form a bridge, each of the bridge members including a blower for producing air and a periphery skirt configured to trap the produced air to create an air
5 cushion for hovering the respective bridge member above a surface.

The surface may be ground, slope, mud flat, water, sea, swamp, floating ice, snow etc.

10 Since each of the bridge members is able to hover above the surface, it is much easier for the bridge members to be moved to where the bridge is needed. For example, if the surface includes a slope, the bridge members would be able to hover and follow the contour of the slope so that it is much easier to deploy the bridge.

15 Each bridge member may include a connecting shoulder for coupling to corresponding shoulders of a like bridge member. Preferably, the blower and the periphery skirt is configured to create the air cushion to hover the respective bridge member at a height of about 0.7m above the surface to take into account
20 ground height contours and obstacles.

Advantageously, the bridge assembly further comprises a loading cassette arranged to store the plurality of bridge members. This may make it easier to transport or deploy the bridge assembly. The loading cassette may be arranged

to store each one of the plurality of bridge members one on top of another. This arrangement saves storage space.

5 A bridge assembly according to claim 5, wherein the loading cassette includes support members for supporting respective ones of the plurality of bridge members one on top of another. This may save space required to transport the bridge assembly. Preferably, the support members are configured to be movable to lower or raise the respective bridge member.

10 The bridge assembly may further comprise a lug arranged to push each of the plurality of bridge members out of the loading cassette when the bridge member is on hover. Accordingly, each bridge member may also use this lug to pull the bridge member back into the loading cassette for recovery. Each bridge member may include a power inlet for receiving power. Each bridge member
15 may also include a power outlet for outputting power. It is also envisaged that the power inlet of a first one of the plurality of bridge members is configured to receive power from the power outlet of a second one of the plurality of bridge members.

20 Preferably, the periphery skirt of each bridge member is arranged to extend between a respective bridge member and the surface.

Various types of vehicles may be used to transport the bridge assembly. For example, a landing craft or a barge may be used.

According to a second aspect, there is provided a bridge member for forming part of a bridge, the bridge member including means for connecting to a like bridge member, a blower for producing air and a periphery skirt configured to trap the produced air to create an air cushion for hovering the respective bridge member above a surface.

In a third aspect, there is provided a method for deploying a bridge assembly to form a bridge, the bridge assembly comprising a plurality of bridge members; the method comprising

- (i) hovering each of the bridge members above a surface;
- (ii) connecting each of the hovering bridge members together to form the bridge; and
- (iii) allowing the bridge to descend on the surface.

Preferably, the method comprises hovering each of the bridge members at about 0.7m above the surface. The method may further comprise prior to step (i), lowering a first one of the plurality of bridge members from a loading cassette; hovering the first one of the plurality of bridge members and pushing the first one of the plurality of bridge members out of the loading cassette.

The method may further comprise, after the first one is pushed out of the loading cassette, lowering a second one of the plurality of bridge members, hovering the second one of the plurality of bridge members, and coupling the second one to the first one of the plurality of bridge members in an end-to-end arrangement. Further, the method may comprise pushing the second one of

the plurality of bridge members out of the loading cassette so as to move the first one of the plurality of bridge members further away from the loading cassette.

- 5 Preferably, step (iii) includes turning off power to the plurality of bridge members to enable the bridge to descend to the surface.

Brief Description of the Drawings

- 10 An example of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a landing craft carrying a bridge assembly comprising a plurality of bridge members in the form of three pontoons according to a preferred embodiment of the present invention;

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Figure 2 is a slightly enlarged view of the bridge assembly of Figure 1 without showing the landing craft;

Figure 3 is a simplified side view of the bridge assembly of Figure 2 to illustrate how the pontoons are arranged one on top of another;

20 Figure 4 is a close-up view of one of the pontoons of Figure 1;

Figures 5a and 5b are simplified side views of the bridge assembly of Figure 2 to illustrate how the lowermost pontoon is powered up to hover;

Figure 6 shows how two of the three pontoons of Figure 1 are arranged in an end-to-end arrangement; and

Figure 7 shows how the three pontoons of Figure 1 are deployed to form a bridge.

Detailed Description of Preferred Embodiment

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Figure 1 shows a landing craft 100 carrying a bridge assembly 200 comprising a plurality of bridge members and in this embodiment, each bridge member is in the form of pontoons 202. The bridge assembly 200 includes a loading cassette 300 with the three pontoons 202 arranged one on top of the other in the loading
10 cassette 300.

Figure 2 shows the loading cassette 300 more clearly and this includes a support frame 302 with lifting lugs 301 for lifting the loading cassette 300 by a crane or other lifting system such as a travel hoist, and onto the landing craft's
15 deck 106. The loading cassette 300 is about 42m in length by about 6m in width and about 5m in height and includes a series of support lugs 304,306,308 for supporting corresponding pontoon 202 one on top of another. As shown in Figure 3, the loading cassette 300 includes a cable lug 312 for pushing each pontoon 202 out of the loading cassette 300 and this will be explained in greater
20 detail later.

For ease of explanation, the three pontoons 202 of Figure 3 are represented with references 210, 1210 and 2210 with reference 210 being the lowermost pontoon and 2210 the uppermost pontoon. It should be mentioned that a gap
25 AA is provided between the lowermost pontoon 210 and the middle pontoon

1210 to enable the lowermost pontoon 210 to hover as will be explained in greater detail later.

Figure 4 is a close up view of a first one of the pontoons 210 which is arranged
5 as the lowermost pontoon in Figure 3. It should be appreciated that all the
pontoons 210,1210,2210 are structurally and functionally similar. The first
pontoon 210 has a substantially rectangular main body 212 and, in this
embodiment, has a dimension of 40m in length by 5m in width and 1m in depth.
Such a dimension is intended to be used by vehicles such as trucks and tanks,
10 and the depth also provides a strong base for vehicles to move over. It would be
appreciated that other dimensions are envisaged depending on the application
of the bridge assembly 200.

The main body 212 has an upper surface 212a and a lower surface 212b and
15 has two end shoulder portions 214, 216. Each of the end shoulder portions
214,216 includes two spaced apart pontoon connectors 214a,216a such as the
ones disclosed in Singapore Patent number 113392 (Application number
200104939-4). The end shoulder portions 214,216 are configured to mate with
corresponding shoulder portions of another pontoon 1210, 2210.

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The main body 212, or at least the top surface 212a is made of lightweight
metal construction or composite material such as carbon fibre reinforced plastic.
In the alternative, the main body 212 may be made of steel or aluminum or a
combination such that the strength of the main body 212 of the first pontoon 210

allows it to be capable of carrying a vehicular load of at least 60 tons when the first pontoon 210 is sitting on land or ground.

The first pontoon 210 has two blowers 218,220, of a similar make, spaced apart
5 from each other along the length of the pontoon 210 and each blower 218,220 is arranged to produce air flow beneath the pontoon 210. The blowers 218,220 are configured for this particular application which may include having a suitable depth to enable them to be mounted to the pontoon 210 and also waterproofed. Each blower 218,220 includes an air vent 219,221, a lift fan unit (not shown)
10 and an electric motor (not shown) to drive the lift fan unit. The air vents 219,221 are arranged to allow air to be drawn into the respective blowers by the lift fan unit so as to create a suitable amount of air beneath the pontoon 210 as shown by arrows BB of Figure 4. Advantageously, the blower 218 (and blower 220) is arranged to create a pressure of about 1 psi (0.07kg/cm^2) on the surface
15 beneath the pontoon 210. The electric motors of the blowers 218,220 are powered by electricity from a power generator 108 of the landing craft 100 (see Figure 1) via first and second power connectors 226, 227 which are respectively located near the first and second shoulder portions 214,216. The first power connector 226 functions as a power inlet and the second power connector
20 functions as a power outlet and the power connectors 226,227 are electrically coupled to each other so that power received by the first power connector 226 is channeled to the second power connector 227.

At the lower surface 212b of the main body 212, the pontoon 210 includes a
25 periphery skirt 228 arranged around the perimeter of the lower surface 212b of

the main body 212. The periphery skirt 228 is made of Hypalon-type material which is light weight and flexible to negotiate uneven ground. Other rubberized material or light-weight material may also be used. The periphery skirt 228 is about 1m in height measured from the lower surface 212b of the main body
5 212. The peripheral skirt 228 has an inner fold which is arranged to trap air produced by the blowers 218,220 so as to create an air cushion beneath the pontoon 210. The air cushion thus allows the pontoon 210 to hover above a surface, such as mud flat.

10 An operation of how to launch the pontoons 210,1210,2210 to form a bridge will now be described.

Referring to Figure 1, when the landing craft 100 arrives close to a landing site, the landing craft 100 lowers its ramp 104 and the bridge assembly 200 is ready
15 to be deployed. It should be appreciated that instead of a landing craft 100, the vehicle may be a barge and the ramp may be a built-in ramp or of such length that the bridge member can be offloaded into the sea through an inclined ramp on the barge.

20 Figures 5a and 5b are simplified side views of the bridge assembly 200 of Figure 2. Figure 5a shows the pontoons 210,1210,2210 in the pre-launch positions which depicts the gap AA between the lowermost pontoon 210 and the middle pontoon 1210. It should be appreciated that each of the pontoons 210,1210,2210 are supported by respective sets of support lugs 304,306,308
25 (see Figures 1 and 2) although the support lugs are not shown in Figures 5a

and 5b. These support lugs 304,306,308 are actuated by conventional means to lower or raise the respective pontoons 210,1210,2210. It should be appreciated that the third set of support lugs 308 may not be necessary as the lowermost pontoon 210 may sit on the deck 106 of the landing craft 100.

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As explained earlier, each of the pontoons 210,1210,2210 are similar and thus, reference is made to the parts of 210 and like parts will have like numerals with the addition of 1000 for the second pontoon 1210, and 2000 for the third pontoon 2210.

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During deployment, a mains electrical cable (not shown) electrically connected to the power generator 108 is connected to the first power connector 226 which turns on the blowers 218,220. With the blowers 218,220 turned on, the blowers 218,220 produce air flow beneath the first pontoon 210 which is trapped by the peripheral skirt 228 to create an air cushion between the landing craft's deck 106 and the main body 212 of the pontoon 210. In this way, the pontoon 210 is able to hover above the deck 206 as illustrated in Figure 5b which shows the skirt 228 extended. The configuration of the blowers 218,220 is arranged to create a hover height of approximately 0.7m above the deck (or ground) and with the peripheral skirt 228 having a 1m height, the peripheral skirt is arranged to drape on the deck 106.

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When the pontoon 210 is hovering, the cable lug 312 is actuated to push or guide the pontoon 210 out of the loading cassette 300 and towards the lowered ramp 104 or bow of the landing craft 100. This clears the way for the next

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pontoon i.e. the second pontoon 1210 to be lowered to the pre-launch position of the first pontoon 210 by lowering the corresponding second set of support lugs 306. The mains electrical cable connected to the first power connector 226 of the first pontoon 210 is then disconnected and the first pontoon 210 goes off
5 hover. A first jumper cable (not shown) is used to connect between the first power connector 226 of the first pontoon 210 and the second power connector 1227 of the second pontoon 1210. The mains electrical cable is next connected to the first power connector 1226 of the second pontoon 1210 to turn on the blowers 1218,1220 and this creates an air cushion below the second pontoon
10 1210 to lift it up and hover above the deck 106 at about 0.7m. The powering up of the second pontoon 1210 also powers up the first pontoon 210 via the second power connector 1227 (i.e. power outlet), the first jumper cable and the first power connector 226 (i.e. power inlet), and thus, the first pontoon 210 also hovers.

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As it can be appreciated, the second pontoon 1210 would hover at around the same height as the first pontoon 210 and the second shoulder portion 216 of the first pontoon 210 is arranged to mate with the first shoulder portion 1214 of the second pontoon 1210 as shown in Figure 6. Connectors (not shown) are
20 then inserted to couple the first and second pontoons 210,1210 together at the pontoon connectors 216,1214a, with both pontoons 210,1210 hovering.

With the first and second pontoons 210,1210 coupled together and hovering, the cable lug 312 is again actuated to push the second shoulder portion 1216 of
25 the second pontoon 1210 horizontally out of the loading cassette 300. In other

words, the first pontoon 210 is pushed further inland. When the second pontoon 1210 is clear of the loading cassette 300, the third and uppermost pontoon 2210 is lowered down by lowering the support lugs 304. The mains electrical cable is next disconnected from the first power connector 1226 of the second pontoon 1210 and the first and second pontoons 210,1210 go off hover and drops down. A second jumper cable (not shown) is used to connect between the first power connector 1226 of the second pontoon 1210 and the second power connector of the third pontoon 2210. Next, the mains electrical cable is connected to the first power connector of the third pontoon 2210 and this powers up together with the first and second pontoons 210,1210. With the three pontoons 210,1210,2210 hovering, the third pontoon 2210 is aligned and coupled to the second pontoon 1210 in an end-to-end arrangement just like between the first and second pontoons 210,1210 to form a bridge 500 as shown in Figure 7.

The cable lug 312 is again used to push the third pontoon 2210 out of the loading cassette 300 and this pushes the first and second pontoons 210,1210 further forward or up onto land depending on the distance that the landing craft 100 is from the land at that point in time.

After the third pontoon 2210 clears the loading cassette 300 and the landing craft 100, the ramp 104 is raised. The landing craft is then used to push the third pontoon 2210 and the rest of the connected pontoons 210,1210 further inland. When the pontoons have arrived at its designated position on land, the mains electrical cable electrically connected to the first connector of the third pontoon 2210 (which also powers the rest of the pontoons 210,1210) is

disconnected from the first connector which turns off the blowers of the pontoons 210,1210,2210. When this happens, the bridge 500 comprising the three pontoons 210,1210,2210 drops or collapses to the ground to provide a stable platform across obstacles such as mud flat.

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With the bridge 500 in place, further landing crafts are used to ferry personnel, equipment, vehicles or other cargo to the bridge 500 so that these may use the bridge 500 to move further inland and to stable ground.

10 In this way, the bridge assembly 200 is useful to form a bridge 500 which is easy to launch. As each pontoon 210,1210,2210 is configured to hover during deployment, the pontoons 210,1210,2210 are able to follow the contour of the terrain and negotiate uneven ground. For example, if the landing site includes a slope, when the pontoons 210,1210,2210 are being pushed out of the landing
15 craft, they are able to follow the gradient of the slope because of the air cushion created below the pontoons 210,1210,2210. The air cushion also effectively supports the weight of the pontoons 210,1210,2210 and acts as a frictionless surface on which the entire connected pontoons (i.e. bridge 500) move. This means that the mechanical forces needed to move the connected pontoons
20 210,1210,2210 over the land or onto a gradient is much less than would otherwise be the case. This makes deployment of the bridge 500 much easier and more effective.

To retrieve or recover the pontoons 210,1210,2210, the reverse process is
25 performed. The landing craft 100 carrying the loading cassette 300 is again

brought close to the landing site with its ramp 104 lowered until it comes into contact with the end of the third pontoon 2210 near the edge of the water. The mains electrical cable is used to connect to the first power connector of the third pontoon 2210 and this powers up the entire bridge 500 (since the first and second jumper cables are still connected to the respective first and second power connectors). As a result, the three pontoons 210,1210,2210 are powered up and hover above ground again at around 0.7m. The landing craft 100 is then connected to the third pontoon 2210 using securing cables. When completed, the landing craft 100 reverses to pull the hovering pontoons 210,1210,2210 off the land and onto the water. If the pontoons 210,1210,2210 are originally on land and on a slope, the connected pontoons would slide down the slope into the water when the landing craft 100 reverses. When ready to recover the pontoons 210,1210,2210 onto the landing craft 100, a winch cable is coupled to the third pontoon 2210 so as to pull the bridge 500 towards the loading cassette 300 and for the third pontoon 2210 to be pulled into the loading cassette 300 (similar to the lowered position of the first pontoon 210 during the deployment as shown in Figure 5b).

The first set of support lugs 304 is then actuated to support the third pontoon 2210 at the hovering height. The second jumper cable between the second power connector of the third pontoon 2210 and the first power connector 1226 of the second pontoon 1210 is disconnected and removed and the first and second pontoons 210,1210 go off hover. Next, the mains electrical cable is then disconnected from the first power connector of the third pontoon 2210 to power off the third pontoon 2210 and the support lugs 304 actuated to raise the third

pontoon 2210 to its rest position (i.e. uppermost position) of the loading cassette 300.

With the third pontoon 2210 raised to the uppermost position, this clears the
5 space for retrieving the second pontoon 1210. The mains electrical cable is next
connected to the first power connector 1226 of the second pontoon 1210 to
hover the first and second pontoons 210,1210 and the winch cable is coupled to
the second pontoon 1210 to pull the second pontoon 1210 (and thus the first
pontoon 210) towards the cassette 300. The above procedure is repeated by
10 first arranging the second set of support lugs 306 to support the second
pontoon 1210, disconnecting the first jumper cable so that the first pontoon
goes off hover, disconnecting the mains electrical cable from the second
pontoon and raising the support lugs 306 to raise the second pontoon and
subsequently the first pontoon 210 is retrieved in a similar manner until each is
15 stacked in the loading cassette as shown in Figure 1.

With the bridge assembly 200 carried by the landing craft 100, it can be
appreciated that the bridge assembly 200 may be used in remote and
unprepared areas in order to transfer cargo ashore in an effective manner
20 without relying on purpose built docks, tides, water depths, roads or rail links. In
particular, the bridge assembly 200 when launched to form the bridge 500 is
useful to be deployed over a mud flat where the gradient could be 1:100. The
hover capability of the pontoons enables the bridge assembly 200 to be used to
overcome soft ground conditions. When off hover, the pontoons provide a
25 strong base which vehicles can move over the mud flat, for example.

It should be appreciated that the use of pontoons 210,1210,2210,3210 also provides buoyancy to the bridge 500 although this may not be necessary depending on operation requirements.

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The amphibious capability of the bridge assembly 200 allows access to landing sites instead of building an expensive and environmentally damaging infrastructure. The cushion pressure when the pontoons 202 are hovering is low so that the pontoons 202 may transverse soft ground such as mud flats without
10 sinking or environmental damage. The pontoons 202 when linked together form the bridge or amphibious causeway which enables bridging of obstacles such as over tidal, shallow water and no water areas that is hydrated ground. When on dry land the bridge assembly 200 may discharge its cargo onto dry land and becomes very stable as the leading edge of the pontoons 202 (i.e. the first
15 pontoon 210) is on the ground. The amphibious capability allows the bridge assembly 200 to be deployed over areas normally inaccessible to conventional vehicles. When the bridge assembly 200 is on hover the cushion pressure means the load on the ground is less than 1psi ground pressure which avoids environmental damage.

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The described embodiment is not to be construed as limitation. For example, in the preferred embodiment, the landing craft 100 is described to carry the bridge assembly 200 but this may not be so. It is envisaged that other vehicles such as trucks and engineer vehicles, may be used. Also, it is envisaged that the bridge

assembly 200 may be mounted in a container (such as a 40-foot container) and transported by road to the required area for deployment.

The described embodiment proposes two blowers for each pontoon
5 210,1210,2210,3210 but this may not be so. It is envisaged that depending on the dimensions of the pontoons, the number of blowers may be reduced or increased. The described embodiment illustrates that the pontoons 210,1210,2210,3210 are of the same size but this may not be necessary. However, it is preferred if the pontoons are of the same size so that it is easier
10 to fabricate the loading cassette 300. The loading cassette 300 in the described embodiment stacks one pontoon on top of another. However, it is envisaged that the pontoons may be arranged side by side or in pairs although this would take up more space.

15 The described embodiment suggests powering the pontoons 210,1210,2210,3210 using electricity from electric cables. It is envisaged that each pontoon may be self-contained with fuel and generator for driving the motor and lift fan unit.

20 In the described embodiment, the blowers of the pontoons 210,1210,2210 are preferably flushed with the top surface of the pontoons 210,1210,2210 or they may protrude only slightly to allow a vehicle to drive over. Otherwise, the blowers may obstruct vehicular movement. It should be appreciated that water tight covers may be used to protect the blowers to prevent water or dirt from
25 getting into the fan units.

The described embodiment uses one mains electrical cable but it is envisaged that more than one electrical cable may be provided for speedier operations.

- 5 Having now fully described the invention, it should be apparent to one of ordinary skill in the art that many modifications can be made hereto without departing from the scope as claimed.

CLAIMS

1. A bridge assembly comprising
 - (i) a plurality of bridge members connectable together to form a bridge,
5 each of the bridge members including a blower for producing air and a
periphery skirt configured to trap the produced air to create an air
cushion for hovering the respective bridge member above a surface; and
 - (ii) a loading cassette arranged to store the plurality of bridge members.
- 10 2. A bridge assembly according to claim 1, wherein each bridge member
includes a connecting shoulder for coupling to corresponding shoulders
of a like bridge member.
- 15 3. A bridge assembly according to claim 1 or 2 wherein the blower and the
periphery skirt is configured to create the air cushion to hover the
respective bridge member at a height of about 0.7m above the surface.
- 20 4. A bridge assembly according to any preceding claim, wherein the loading
cassette is arranged to store each one of the plurality of bridge members
one on top of another.

5. A bridge assembly according to claim 4, wherein the loading cassette includes support members for supporting respective ones of the plurality of bridge members one on top of another.
- 5 6. A bridge assembly according to claim 5, wherein the support members are configured to be movable to lower or raise the respective bridge member.
7. A bridge assembly according to any preceding claim, further comprising
10 a lug arranged to push each of the plurality of bridge members out of the loading cassette when the bridge members are on hover.
8. A bridge assembly according to any preceding claim, wherein each bridge member includes a power inlet for receiving power.
- 15 9. A bridge assembly according to any preceding claim, wherein each bridge member includes a power outlet for outputting power.
10. A bridge assembly according to claim 8 and when dependent on claim 9,
20 wherein the power inlet of a first one of the plurality of bridge members is configured to receive power from the power outlet of a second one of the plurality of bridge members.

11. A bridge assembly according to any preceding claim, wherein the periphery skirt of each bridge member is arranged to extend between a respective bridge member and the surface.
- 5 12. A landing craft comprising a bridge assembly according to any preceding claim.
13. A barge comprising a bridge assembly according to any of claims 1 to 11.
- 10 14. A vehicle comprising a bridge assembly according to any of claims 1 to 11.
- 15 15. A method for deploying a bridge assembly to form a bridge, the bridge assembly comprising a plurality of bridge members; the method comprising
- 20 (i) hovering each of the bridge members above a surface;
- (ii) connecting each of the hovering bridge members together to form the bridge; and
- (iii) allowing the bridge to descend on the surface; wherein the method further comprises, prior to step (i), lowering a first one of the plurality of bridge members from a loading cassette; hovering the first one of the plurality of

bridge members and pushing the first one of the plurality of bridge members out of the loading cassette.

16. A method according to claim 15, further comprising
5 hovering each of the bridge members at about 0.7m above the surface.
17. A method according to claim 15 or 16, further comprising
after the first one is pushed out of the loading cassette, lowering a
10 second one of the plurality of bridge members, hovering the second one of the plurality of bridge members, and coupling the second one to the first one of the plurality of bridge members in an end-to-end arrangement.
- 15 18. A method according to claim 17, further comprising pushing the second one of the plurality of bridge members out of the loading cassette so as to move the first one of the plurality of bridge members further away from the loading cassette.
- 20 19. A method according to claim 18, wherein step (iii) includes turning off power to the plurality of bridge members to enable the bridge to descend to the surface.