The present invention relates to a cargo carrying marine vessel having a cargo deck for carrying at least one independently floating object (10) and means for partially submerging the vessel to flood the cargo deck for floating the at least one floating object (10) above the cargo deck, the cargo deck (44, 54) having a downward and inward slope when the marine vessel is in sailing trim. The present invention relates also to a method of loading and offloading the cargo carrying marine vessel.

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A CARGO CARRYING MARINE VESSEL AND A METHOD OF LOADING AND OFFLOADING SUCH

[0001] The present invention relates to a cargo carrying marine vessel discussed in the preamble of claim 1. The present invention relates also to a method of loading and offloading a cargo carrying marine vessel as discussed in the preamble of the independent method claim 9.

[0002] Prior art knows ships or marine vessels that are designed to transport independently floating objects like pontoons, yachts or different load carrying or cargo barges or lighters etc. As examples of these kinds of ships barge carriers or barge mother vessels, sometimes also called as Lighter Aboard Ship (LASH) or cargo carriers have been discussed in the following. This kind of barge carriers work such that a plurality of independently floating cargo barges are loaded onboard a mother vessel that transports the fully loaded barges to a port or some other appropriate location near inland waterways where the ship is not able to travel but the barges may take their cargo further. The barges are offloaded from the barge carrier so that they can continue their journey to the final destination. Empty barges are, then, loaded onboard and taken to another port for loading.

[0003] The barge carriers may be divided in two groups based on where the loading and offloading takes place. A first group of barge carriers is formed of aft- or stern-, or bow-loadable barge mother vessels where the loading and offloading takes place in the longitudinal direction of the barge carrier. A second group of barge carriers is formed of side-loadable and offloadable carriers where the loading and offloading takes place in transverse direction i.e. from the sides of the ship.

[0004] There are several different ways the offloading of a barge from a barge carrier may take place. The barge mother vessel may be provided with a crane for lifting the barges from the vessel. Another alternative is an elevator that also handles the barges in vertical direction. A third alternative is the use of a so called floating dock principle, which means that the barge carrier may be flooded i.e. partially submerged to lower the entire ship so that the barges aboard remain floating on the water above the barge or cargo deck. The flooding is performed by filling ballast
tanks so that the draught of the ship may be adjusted as desired. A barge mother vessel of prior art utilizing the floating dock principle is operated such that when offloading the barges the ship is carrying, the draught of the entire barge carrier is increased by pumping water or allowing the water to flow in the ballast tanks such that the fully loaded barges start floating above the barge deck, whereby the independently floating barges may be removed from the mother vessel. If the barge carrier has barges in more than one layer, at least one barge from the upper layer/s is then, after one or more of the barges in the lowermost layer has have been removed, lowered by means of an elevator or the like lifting means down to the bottom of the cargo space of the barge carrier, where the barge in question remains floating and can be removed from the carrier.

[0005] However, the prior art barge carriers have a problem common to all barge mother vessel types applying the floating dock principle. The time needed for altering the draught of the vessel i.e. first increasing the draught for offloading and/or loading and then decreasing the draught for bringing the vessel back to its sailing draught takes a long time and requires pumping of huge amounts of water both in and from the ballast tanks, whereby also the energy used for the pumping is considerable. There are several reasons why the draught of the barge carrier has to be altered so much. The main reasons are that:

- the draught of the vessel in sailing trim has to be optimized in view of drag for minimizing the fuel consumption, and
- the transom of the barge carrier has to be positioned in sailing trim at or above waterline level to avoid increases in resistance, whereby
- the barge deck has been positioned at or above waterline.

Thus, it is clear that the draught of the barge carrier has to be altered somewhat more than what the draught of the fully loaded barges is. And further, a prerequisite for proper floating of the barges and especially for guiding the barges off the cargo space is that the direction of the barge deck at a time a barge starts floating is horizontal so that the barge does not tend to move in any direction but remains in its place above the barge deck until it is removed therefrom.

[0006] Another problem that relates closely to the above discussed problem concerning pumping and energy efficiency concerns cases when a barge carrier is used to deliver loaded barges to several ports. In other words, the carrier offloads
one barge or a few barges in a port, loads onboard one or more empty barges, sails to another port and repeats the offloading and loading operations. Now, in each port the ballast tanks are filled to such an extent that all barges (in the bottom layer, if more layers) start floating, and after offloading a barge the tanks are emptied or, more generally, brought to their sailing condition dictated by the draught required by the vessel stability. In other words, even if only one barge should be removed, all barges are floating. This, again, results in huge waste of energy and time needed for filling the ballast tanks to the level required by the desired draught, and, at least partially, emptying the ballast tanks after offloading and/or loading.

[0007] Thus an object of the present invention is to offer a solution to at least some of the above-discussed problems. A solution is to arrange the barge carrier to be floodable only partially.

[0008] Another object of the invention is to offer a solution to the problem relating to offloading one or a few barges by arranging only a part of the fully loaded barges floating prior to offloading.

[0009] Yet another object of the present invention is to offer a new structure for a side-loadable and offloadable barge carrier.

[0010] In a similar manner at least some of the objects of the present invention are met with a cargo carrying marine vessel having a cargo deck for carrying at least one independently floating object and means for partially submerging the vessel to flood the cargo deck for floating the at least one floating object above the cargo deck, the cargo deck having a downward and inward slope when the marine vessel is in sailing trim.

[0011] An at least some of the objects of the present invention are met with the method of loading and offloading a cargo carrying marine vessel, the vessel having cargo space with a cargo deck on which the cargo comprising at least one independently floating object is loaded, the loading and offloading being performed by partially submerging the vessel to flood the cargo deck for floating the at least one object above the cargo deck, and guiding the at least one object out of or in the cargo space, in which method at least a part of the cargo deck of the marine vessel is
leveled to substantially horizontal direction by inclining the marine vessel, whereby the substantially horizontal part of the cargo deck is lowered and flooded to have water level sufficient for allowing the at least one object float above the cargo deck.

[0012] Other characteristic features of the marine vessel and of the method of the present invention will become apparent from the appended dependent claims.

[0013] The present invention, when solving at least some of the above-mentioned problems and drawbacks, also brings about a number of advantages, of which a few has been listed in the following.

- Reduces the energy needed for filling/emptying the ballast tanks
- Reduces the time needed for filling/emptying the ballast tanks
- Improves the vessel stability by bringing the centre of gravity of the cargo (the barges) lower

[0014] However, it should be understood that the listed advantages are only optional, whereby it depends on the way the invention is put into practice if one or more of the advantages were obtained.

[0015] In the following, the present invention is explained in more detail in reference to the accompanying drawings, of which

Figures 1a and 1b illustrate side views of a barge mother vessel of prior art in sailing and loading/offloading positions,

Figures 2a and 2b illustrate cross sections of a barge mother vessel of prior art in sailing and loading/offloading positions,

Figures 3a and 3b illustrate side views of a barge mother vessel in sailing and loading/offloading positions in accordance with a first preferred embodiment of the present invention,

Figures 4a and 4b illustrate two different cross sections of a barge mother vessel of

Figures 3a and 3b,

Figure 5 illustrates a side view of a barge mother vessel in accordance with a second preferred embodiment of the present invention, and

Figures 6a and 6b illustrate cross sections of a barge mother vessel of Figure 5 in sailing and loading/offloading positions.
In Figures 1a and 1b a prior art barge carrier has been illustrated. The control bridge 2, storage and accommodation spaces 4 as well as the engine room 6 have been arranged at the bow 8 of the barge mother vessel or barge or cargo carrier. Most of the length of the vessel is reserved for carrying the cargo i.e. the independently floating barges 10. The cargo deck 14 or barge deck i.e. the floor of the cargo space 12 is substantially horizontal and arranged in such a height that the transom 16 at the stern 18 is at or slightly above the waterline WL level. The waterline WL is, by definition, a line formed by water on the hull of a ship or that of any floating object. The vertical position of the transom is important for minimizing the resistance in sailing. The resistance is at its minimum when the transom is above the waterline. For barge carriers the optimal structure is such that the borderline between the transom and the upwardly sloping vessel bottom is located at or above the waterline, then the resistance is the smallest. The barge deck is as low as possible, leaving enough space between itself and the upwardly sloping vessel bottom for steering gear and/or thruster drive units and steel structure. The barge deck 14 may be open at the stern 18 or closable by means of a gate. For simplicity the means for stacking the barges in two or several layers have not been shown, as it is not a part of the invention. Below the barge deck 14 there are the propeller shafting 20, steering gear and the ballast tanks 22, normally for sea water. The propeller 24 and the rudder 26 of the vessel are located below the transom 16. Here it has been shown that the barge mother vessel is provided with engine-generator package 28 in the engine room 6, and electric motor 30 in connection with the propeller shafting 20. Naturally also direct mechanical drive is an option.

When wishing to offload one or more barges 10 from the barge deck 14 (shown in Figure 1b), the barge carrier is submerged partially by filling the ballast tanks 22 from bow 8 to stern 18 with water to such an extent that the barge deck 14 is flooded by water to such a depth that the fully loaded barges 10 start floating and may be guided off the cargo space 12 of the carrier as shown in Fig. 1b. Thus, the higher the cargo deck is the deeper the cargo carrier has to be ballasted to float the barges in or out. The loading of either empty or loaded barges aboard takes place in a similar manner. The barge mother vessel is partially submerged by filling the ballast tanks to such a depth that the water level above the barge deck is slightly more than the draught of the barges to be loaded aboard. Thereafter the barges are guided in the cargo space and fastened with appropriate fasteners to the barge deck and/or its
side walls. When the barges have been loaded in the cargo space, appropriate amount of water is pumped out of the ballast tanks to reach the desired sailing draught and the barge carrier is trimmed to its sailing trim, whereby the barge deck remains substantially horizontal.

[0018] It is easy to understand that partially submerging the entire barge or cargo carrier to a draught that allows the floating of the barges off the cargo space and/or loading the barges in the cargo space takes a long time and requires pumping of a huge amount of water. In a similar manner the returning of the vessel to its sailing trim i.e. reducing the draught takes also a long time and requires the pumping of ballast back to the sea. Thus a considerable amount of the expenses, work and time needed for loading and offloading a barge carrier originate from the adjustment of the draught of the cargo carrier.

[0019] Figures 2a and 2b illustrate a side loadable barge mother vessel of prior art. Figure 2a illustrates the vessel in its sailing trim/draught and Figure 2b in its loading and offloading trim/draught. The barge deck 34 of a prior art barge carrier is positioned in a substantially horizontal plane i.e. the barge deck is not only substantially horizontal in this transverse cross section but in the longitudinal cross section of the vessel, too. Now that the barges 10 need to be offloaded the entire vessel is, again, partially submerged by flooding the barge deck 34 to such a depth that the barges 10 start floating above the barge deck 34 and may be guided out of the cargo space 32. Thus in this prior art barge carrier the same problem as that in the barge carrier of Figs. 1a and 1b can be seen. I.e. even if only one barge 10 from either side of the vessel need to be offloaded, all barges 10 have to be floated. Also, though the barge deck extends only to a certain length of the barge carrier the entire carrier is partially submerged i.e. such that the draught of the vessel in increased evenly at both the bow and the stern. Thus the problem concerning time, work and energy expenses is the same as that in connection with the barge carrier of Figures 1a and 1b.

[0020] Figures 3a and 3b illustrate a barge mother vessel in accordance with a first preferred embodiment of the present invention offering a solution to the above discussed problem. The barge carrier of the invention resembles closely to that shown in prior art Figure 1a. Thus the control bridge, storage and accommodation
spaces as well as the engine room have been arranged at the bow 40 or above the cargo space 42. The cargo space 42 i.e. the space for the barges 10 occupies most of the length of the vessel. However, a significant difference to the prior art barge carrier can be seen when looking at the barge deck 44. The barge deck 44 originates at the transom 46, which is situated at the stern 48 at or slightly above the waterline level WL. However, the preferred embodiment of the present invention illustrated in Figures 3a and 3b comprises a barge deck 44 that is sloping downwards from the transom 46 towards the bow 40 i.e. inward so that the barges 10 farthest, or deepest, in the cargo space 42 are situated significantly lower than corresponding barges in the prior art barge carrier of Figures 1a and 1b. The positions of the barges 10 in the cargo space have been shown in more detail in Figures 4a and 4b.

[0021] Figure 3b illustrates the barge carrier in its offloading and loading trim. A clear difference to the prior art barge mother vessel of Figure 1b is that now, for both offloading and loading, the barge carrier is trimmed by stern. The vessel is trimmed for flooding the barge deck 44 to such a depth that the barges 10 on the barge deck 44 start floating and may be guided off the cargo space, or barges, in loading phase, may be guided into the cargo space. Preferably, while the vessel is trimmed by stern the barge or cargo deck 44 is leveled into substantially horizontal direction, whereby all the barges 10 start floating substantially simultaneously, provided naturally that their draught is the same. Now that the barges at the front part of the cargo space are significantly lower than at the stern, the bow 40 of the ship need not be partially submerged to increase its draught for making the barges at the front part of the cargo space to float, the need of ballast water and pumping is significantly reduced whereby the time and energy needed for flooding the cargo or barge deck 44 are reduced as well. Thus ballasting is reduced considerably when comparing to prior art barge carriers of Figures 1a and 1b.

[0022] Figures 4a and 4b illustrate two transverse cross sections of a loaded barge carrier of Figure 3a. In other words the Figures show the vertical position of the barges 10 loaded on the cargo deck of the marine vessel in relation to the waterline WL, for instance. Figure 4a shows a transverse cross section taken close to the transom 46 (Figure 3a) and Figure 4b a transverse cross section taken at the front part of the cargo space. As is natural, based on the general structure of a stern
loadable cargo carrier where the loading has to take place over a transom situated at
or slightly above the waterline WL at the stern for minimizing the resistance in sailing,
the barges 10 at the stern are, in this embodiment, entirely above the waterline. However, due to the inclination or slope of the cargo deck 44 the barges 10 in Figure
4b are clearly lower. Since the cargo is placed in the cargo carrier of the invention,
and especially at the front end of the cargo space, substantially lower than in the prior
art cargo carrying marine vessels, the need for increasing the draught of the cargo
carrier at the front end of the cargo space is significantly reduced, and simultaneously
the stability of the cargo carrier is increased considerably. Since, as shown in Figure
4b, the floor of the cargo deck is at least partially below the waterline, the cargo deck
is preferably provided with pumps for removing both rain water and seawater
entrained in the cargo space while loading or offloading the barges. However, in
some cases the entire cargo deck, in spite of its inclination, remains in sailing trim
above the waterline whereby the water having entered into the cargo space may be
drained without the use of pumps.

[0023] Figure 5 illustrates a side view of a cargo carrier in accordance with a
second preferred embodiment of the present invention. It is a question of a side
loadable and offloadable cargo carrier whose cargo deck 54 has been positioned
lower than in prior art cargo carriers illustrated in Figures 2a and 2b. In fact, as an
additional optional embodiment of the present invention the cargo deck 54 is located
at least partially below the waterline for all of its length in the longitudinal direction of
the marine vessel. The transom 58 of the cargo carrier of this particular embodiment
has been shown at or above the waterline WL, though its height has now in this
embodiment no effect in the loadability of the carrier. In this embodiment of the
present invention, it is advantageous to use the propulsion system 60, like for
instance a thruster or a podded propulsion that has been positioned below the
transom 58. This kind of a propulsion system requires more space in vertical direction
than propulsion systems relying on propeller shafting (for instance, an electro-
mechanical drive of Figure 3a) but they need less space in the longitudinal direction.
In other words, such a propulsion system has been chosen that allows the cargo
deck to be arranged as low as is desired, and still increases the length of the cargo
carrier only minimally. In addition to cargo barges 10, Figure 5 shows constructions
62, which may be additional cargo tanks, life rafts, life boats, or fuel tanks, just to
name a few alternatives, and which may be arranged in or on a central structure 56,
which will be discussed somewhat more in detail in connection with Figures 6a and 6b.

[0024] Figures 6a and 6b illustrate two transverse cross sections of a barge carrier in accordance with the second preferred embodiment of the present invention in its sailing and loading/offloading positions. Figure 6a shows a loaded barge 10 on the portside of the vessel whereas the starboard side cargo space 52 is empty. As can be seen from the Figures the cargo or barge decks 54 are here in this embodiment sloping from the sides of the vessel downwardly along the cargo space i.e. inwards towards the centerline of the vessel. Figs. 6a and 6b show a longitudinally, along the centerline of the cargo carrier, arranged central structure 56 between the cargo spaces 52. The central structure 56 may be used for reinforcing the hull as well as for housing, for instance, oil fuel tanks, additional cargo tanks 62, life rafts or life boats and fasteners for the barges. Depending on the overall structure of the barge carrier it is possible that the sides of the cargo spaces are kept open or provided with non-water tight gates whereby the bottom of the cargo space may be either partially or entirely covered with water also in sailing trim. If the cargo deck is flooded, the barges in the cargo space provide part of their own buoyancy the rest of the barge weight being carried by the cargo deck. In accordance with an additional feature of the present invention the side loadable barges and the barge carrier are preferably dimensioned to match together such that the sides of the barges form the side of the barge carrier, whereby no additional sides for the barge mother vessel are needed. Since the barges fill substantially totally the cargo space and rest on the floor thereof, only a marginal amount of water remains in the cargo space. However, pumps may be arranged for emptying the cargo space from seawater or rain water, if such is desired. Further, it should be understood that since the barges are so low in the cargo space, i.e. partially floating, they should preferably be locked in place as, when the barge carrier rolls, the barges may start floating on their own and there is a risk that they escape the cargo space.

[0025] Figure 6b illustrates the barge carrier of the second embodiment of the present invention in its offloading/loading position. Now the barge carrier is made to heel i.e. to lean over to one side (to portside in Figure 6b) by filling the ballast tanks (or allowing the tanks to fill) on one side of the vessel. By doing that the vessel heels...
such that the portside cargo space 52 is flooded to such an extent that the barge
deck 54 at the flooding side turns horizontal and barge/s 10 start floating, whereafter
they may be removed from the barge carrier.

[0026] The above discussed side loadable barge carrier avoids the disadvantage of
prior art side loaded barge mother vessel (shown in Figures 2a and 2b) that to be
able to offload (or load) one barge at one side of the vessel the entire vessel must be
partially submerged. Now by applying the sloping barge deck of the present invention
to side loadable barge carriers it is possible to use a side loadable barge carrier much
more efficiently than before for distribution service i.e. for instance, for offloading a
fully loaded barge, for instance an LNG barge, and for loading an empty barge in a
port, sail to another port for offloading another fully loaded barge and for loading an
empty barge, and continue this sequence as long as the cargo space is filled with
empty barges. The advantages gained by the use of the present invention are
obvious when considering how much the offloading/loading time may be reduced now
that the entire barge carrier need not be partially submerged but only one side
thereof. In a similar manner also the energy needed for the ballasting is significantly
reduced.

[0027] At this stage it has to be understood that a side loadable barge carrier does
not necessarily have to be loadable on both sides, but loading from only one side is a
viable option, too. In such a case, in practice, the reinforcing structure shown by
reference numeral 56 in Figures 6a and 6b is moved to one side of the carrier. The
cargo space extends from the opposite side of the carrier up to the reinforcing
structure. But, also in this case, the floor of the cargo space sloping inwardly from the
loading side i.e. towards the end of the cargo space opposite to the loading end helps
in positioning the barges lower than in prior art barge carriers, whereby the barge
carrier need not be ballasted as much as before to flood the cargo space sufficiently.

[0028] A third embodiment of the present invention is a combination of the two
already discussed embodiments. Now that the first embodiment discusses a cargo
deck originating from the transom at or above the waterline and having a downward
and inward slope i.e. the deck sloping downwardly along the cargo space towards the
bow, and the second embodiment a cargo deck also having a downward and inward
slope, but now sloping downwardly along the cargo space towards the centerline of the cargo carrier, the third embodiment has a cargo deck that slopes in both directions but still has a downward and inward slope when the cargo carrier is in sailing trim. In other words, it is a question of a side loadable cargo carrier, whose cargo deck originates from the transom and slopes downwardly towards the bow as well as from the sides of the vessel towards the centerline. Such a cargo deck is loaded/offloaded by starting to fill the ballast tanks of one side of the carrier and from the stern such that the ballast tanks at the bow and at the opposite side of the vessel remain substantially in their original status. Naturally, the purpose here is the same as in the two earlier embodiments i.e. to incline the cargo carrier for flooding the cargo deck to a sufficient extent to allow the barges to float above the cargo deck and to level one longitudinal half of the cargo deck to substantially horizontal direction. The application of this embodiment may require the arranging of water tight walls or gates to the sides of the cargo carrier in case the existence of seawater in the cargo space in sailing trim is not desired. Otherwise mere side walls preventing the free flow of seawater in the cargo space may be used to minimize the sailing resistance.

[0029] In view of the above description of the present invention it should be understood that the present invention is not only applicable to barge mother vessels or barge carriers, but to any other cargo carriers where the cargo in the form of an independently floating object is removed from and loaded to the cargo space by partially submerging the cargo carrying marine vessel. Thus the invention may be used for loading/offloading, in addition to a barge, also a pontoon, a lighter, a yacht, a tugboat etc.

[0030] Also, it should be understood that the above is only an exemplary description of a novel and inventive cargo carrying marine vessel and of a method of loading and offloading such. Thus the above description of the invention should not be understood as limiting the invention by any means but the entire scope of the invention is defined by the appended claims only. In other words, for instance, it is clear that the cargo carrier of the invention may have several cargo decks, whereby the sloping of the cargo deck is needed at least by the lowermost cargo deck. Naturally, also the upper cargo deck/s may have a corresponding slope. Also, it is possible to arrange the loading and offloading of the cargo to take place at the bow, whereby the cargo deck of the invention is sloping downward toward the stern. From
the above description it should be understood that separate features of the inventive cargo carrying marine vessel and of a method of loading and offloading such may be used in connection with other separate features even if such a combination has not been specifically shown or discussed in the description or in the drawings.
CLAIMS

1. A cargo carrying marine vessel having a cargo deck for carrying at least one independently floating object (10) and means for partially submerging the vessel to flood the cargo deck for floating the at least one floating object (10) above the cargo deck, characterized in that the cargo deck (44, 54) has a downward and inward slope when the marine vessel is in sailing trim.

2. The cargo carrying marine vessel as recited in claim 1, characterized in that the cargo deck (44) is sloping downwardly from the transom (46) towards the bow (40) in the longitudinal direction of the vessel, the marine vessel being a stern loadable one.

3. The cargo carrying marine vessel as recited in claim 1, characterized in that the cargo deck (54) is sloping downwardly from the sides of the vessel towards the longitudinal centerline of the vessel, the marine vessel being a side loadable one.

4. The cargo carrying marine vessel as recited in claim 1, characterized in that the cargo deck is sloping downwardly from one side of the vessel towards the opposite side of the vessel, the marine vessel being a side loadable one.

5. The cargo carrying marine vessel as recited in claim 2 and 3, characterized in that the cargo deck is sloping downwardly in both the longitudinal and the transverse directions of the vessel, the marine vessel being a side loadable one.

6. The cargo carrying marine vessel as recited in any one of the preceding claims, characterized in that the cargo deck (44, 54) is at least partially below the waterline when the marine vessel is in sailing trim.

7. The cargo carrying marine vessel as recited in claim 6, characterized in that the floating object (10) loaded in the cargo space (42, 52) provides part of its buoyancy.
8. The cargo carrying marine vessel as recited in claim 3 or 4, characterized in that the cargo deck (54) is at least partially below the waterline for all of its length in the longitudinal direction of the marine vessel.

9. A method of loading and offloading a cargo carrying marine vessel, the vessel having cargo space with a cargo deck on which the cargo comprising at least one independently floating object (10) is loaded, the loading and offloading being performed by partially submerging the vessel to flood the cargo deck for floating the at least one object (10) above the cargo deck, and guiding the at least one object (10) out of or in the cargo space, characterized by leveling at least a part of the cargo deck (44, 54) of the marine vessel to substantially horizontal direction by inclining the marine vessel whereby the substantially horizontal part of the cargo deck (44, 54) is lowered and flooded to have water level sufficient for allowing the at least one object (10) float above the cargo deck (44, 54).

10. The method as recited in claim 9, characterized by trimming the vessel by stern for leveling at least a part of the cargo deck (44, 54) of the marine vessel.

11. The method as recited in claim 9 or 10, characterized by heeling the vessel for leveling at least a part of the cargo deck (44, 54) of the marine vessel.

12. The method as recited in any one of the preceding claims 9 - 11, characterized by ballasting the vessel to have a desired inclination.