A hull (2) for a container ship (1) with a length and a beam (b) comprising two hull sides (5) each comprising outer shell plating (22) spaced from inner skin plating (23), a bottom (6) connecting the hull sides (5), a cargo hold area for stowing shipping containers (19) below deck, a plurality of transverse bulkheads (16, 17) dividing the cargo area into cargo holds and container bays (12), each container bay (12) having a hatch opening (35), a transverse box structure (20) forming the upper part of the transverse bulkheads (16, 17), the transverse box structures (20) connecting the hull sides (5), a deck (29) surrounding the hatch openings (35), the deck (29) being formed by deck plating (30) and being adapted for supporting hatch covers (24) that cover the hatch openings (35) and support above deck shipping containers (19), the deck plating (30) forming an upper side (25) of the transverse box structure (20), the deck plating (30) being connected to an upper end of the inner skin plating (23), a lengthwise torsion box (31) being formed by connecting the outer shell plating (22) to the deck plating (30), two outer support structures (32), each extending lengthwise along a portion of one of the hull sides (5), the outer support structures (32) providing support for at least one outer row of above deck shipping containers (19) at a level that corresponds to the level of the upper surface of a hatch cover (24) placed over the hatch opening (35) and wherein each hull side (5) comprises at least one lengthwise extending crew passageway (18) arranged in the hull side (5) between the outer shell plating (22) and the inner skin plating (23).
Fortsættes ...
CONTAINER SHIP WITH REINFORCED HULL

TECHNICAL FIELD

The disclosure relates to a hull for a container ship and to a container ship, i.e. a marine vessel configured for storage and transport of shipping containers. The disclosure relates in particular to a container ship with a reinforced hull.

BACKGROUND

Container ships are marine vessels (cargo ships) that are designed and constructed for storing and transporting shipping containers (intermodal containers). Typically, container ships carry all of their load in truck-size intermodal containers. Container ships are a common means of commercial intermodal freight transport and now carry most seagoing non-bulk cargo. Container ship capacity is measured in 20-foot equivalent units (TEU). Typical loads are a mix of 20-foot and 40-foot (2-TEU) ISO-standard containers, with the latter predominant.

Shipping containers are stowed in the cargo holds in the hull, i.e. below the main deck, and above the main deck of a container ship. In the longitudinal direction of the container ship storage space is divided into container bays, in the transverse direction of the hull the storage space is divided in a number of rows, and in the vertical direction the storage space is divided in a number of horizontal container layers called tiers. The shipping containers are stowed as high as
possible with some container ships operating with up to ten
or eleven tiers above the main deck.

Container ships are provided with a deckhouse housing the
navigation bridge and accommodation. The deckhouse is
conventionally arranged towards the stern of the ship,
immediately above the main engine room (single island design),
with most of the cargo holds arranged in front of the
deckhouse and the remaining holds aft of the deckhouse.

In order to maintain good forward visibility from the
navigational bridge, necessary to comply with maritime
regulations, there is a limitation as to how high shipping
containers can be stowed in front of the deckhouse/bridge,
i.e. how many tiers of shipping containers can be carried by
the ship above the main deck on the most forward bays in front
of the deckhouse.

The prior art discloses container ships where the
deckhouse/bridge has been moved somewhat forward towards the
bow of the ship (twin island design). By moving the deckhouse
forward, the capacity of the ship is increased since the
shipping containers can be stowed higher in the most forward
bays due to a steeper line of sight from the bridge to the
water surface ahead of the bow.

Due to cost and environmental considerations, there is a
desire to further increase the capacity of such container
ships. The capacity of container ships can for example be
increased by moving the deckhouse completely forward i.e.
ahead of the container bays. Thus, there are no above deck
containers ahead of the deckhouse that could obstruct view from the bridge to the water ahead of the containership.

However, the deckhouse provides for a significant part of the torsional strength of the hull when it is placed in the conventional location above the engine room or approximately amidships. Therefore, arranging the deckhouse at the bow has a negative effect on the torsional strength.

SUMMARY

It is an object to provide a hull for a container ship that overcomes or at least reduces the problems above.

The foregoing and other objects are achieved by the features of the independent claims. Further implementation forms are apparent from the dependent claims, the description and the figures.

According to a first aspect, there is provided a hull for a container ship, the hull having a length and a beam, the hull comprising two hull sides, each hull side comprising outer shell plating spaced from inner skin plating, a bottom connecting the hull sides, cargo holds for stowing shipping containers below deck, a plurality of transverse bulkheads dividing the cargo area longitudinally into cargo holds and container bays, each container bay having an opening that provides access from above, a transverse box structure forming the upper part of the transverse bulkheads, the transverse box structures connecting the hull sides, a deck surrounding the openings, the deck being formed by deck plating and the
deck being adapted for supporting hatch covers for covering the container bays, the hatch covers supporting shipping containers stowed above deck, the deck plating forming an upper side of the transverse box structure and the deck plating being connected to an upper end of the inner skin plating, wherein a lengthwise torsion box is formed by connecting the outer shell plating to the deck plating.

By providing a lengthwise torsion box where in the prior art there is a passageway that is open laterally and upwardly, the torsional strength of the hull is significantly increased. This increased torsional strength allows the deckhouse of the ship to be positioned ahead of the cargo bays, at the bow of the ship, which not only improves the visibility from the bridge, but also increases the number of containers, which can be stacked above deck, since they are stacked behind the bridge.

In a first possible implementation form of the first aspect the deck plating (in prior art forming top of transverse coaming) extends transversely to the outer shell plating and the outer shell plating extends upwardly at least to the extended deck plating. In the prior art the deck plating formed part of transverse coaming.

By providing a deck with deck plating which not only surrounds the openings of the container bays, but also extends all the way to, and connects with, the outer shell plating, the upper area of the hull sides (the shear strake) is reinforced.
In a second possible implementation form of the first aspect the hull further comprises two outer support structures, each outer support structure extending lengthwise along one of the hull sides and projecting upwardly from the deck plating, and wherein the outer support structures provide support for at least one outer row of containers stowed above deck.

In a third possible implementation form of the first aspect the deck plating is connected to an upper edge of the inner skin plating.

In a fourth possible implementation form of the first aspect the deck plating is connected to a side of the outer shell plating, such that the outer shell plating extends upwards past the deck plating.

In a fifth possible implementation form of the first aspect the outer shell plating extends upwards such that it forms part of the outer support structure.

In a sixth possible implementation form of the first aspect each hull side further comprises at least one lengthwise extending crew passageway arranged in the hull side between the outer shell plating and the inner skin plating.

In a seventh possible implementation form of the first aspect the vertical sides of the lengthwise torsion box are formed by the outer shell plating and the inner skin plating.

In an eighth possible implementation form of the first aspect the top side of the lengthwise torsion box forms part of the
deck plating, and a bottom side of the lengthwise torsion box is formed by a stringer that connects the outer shell plating with the inner skin plating.

In a ninth possible implementation form of the first aspect the lengthwise torsion box comprises a crew passageway.

In a tenth possible implementation form of the first aspect the crew passageway is shaped and sized for allowing an individual to walk through the passageway in an upright position.

In an eleventh possible implementation form of the first aspect the lengthwise torsion box extends at least over 0.4 times the rule length of the hull.

In a twelfth possible implementation form of the first aspect the lengthwise torsion box is centered around the midship point.

In a thirteenth possible implementation form of the first aspect the outer support structure provides support for the outer row of shipping containers at a level that substantially corresponds to the level of an upper surface of the at least one hatch cover when the latter is placed over the opening.

In a fourteenth possible implementation form of the first aspect the vertical extent of the outer support structure is preferably less than 1.5 m, even more preferably less than 1 m.
According to a second aspect, there is provided an assembly comprising a hull according to the above, further comprising at least one hatch cover.

According to a third aspect, there is provided a container ship comprising a hull according to the first aspect or an assembly according to the second aspect.

In a first possible implementation form of the third aspect the container ship further comprises a deckhouse arranged ahead of the cargo holds. By arranging the deckhouse ahead of the cargo holds, there is no restriction in the number of tiers of containers that can be stacked in the forward container bays and the cargo space under the deckhouse that is “lost” for stowing shipping containers is much smaller when the deckhouse is arranged ahead of the cargo holds due to the V-shaped cross-section of the hull in the forward portion of the hull compared to the U-shaped midship cross-section.

In a second possible implementation form of the third aspect the container ship comprising a bridge arranged ahead for the cargo holds and an accommodation unit arranged lengthwise at a distance from the bridge in the direction of the stern.

In a third possible implementation form of the third aspect the lengthwise torsion box extends at least over 0.4 times the length of the container ship as defined in International Convention on Load Lines.
These and other aspects will be apparent from the embodiments described below.

**BRIEF DESCRIPTION OF THE DRAWINGS**

In the following detailed portion of the present disclosure, the aspects, embodiments, and implementations will be explained in more detail with reference to the example embodiments shown in the drawings, in which:

Fig. 1 is a side view of a prior art container ship,
Fig. 2 is an elevated view of a hull of a prior art container ship,
Fig. 3 is a partially transparent side view of a container ship in accordance with an embodiment,
Fig. 4 is a cross-sectional view of the container ship of Fig. 3,
Fig. 5 is a cross-sectional front view of an upper section of a hull side according to prior art,
Fig. 6a is a cross-sectional front view of an upper section of a hull side in accordance with an embodiment,
Fig. 6b is an elevated view of a detail of the upper portion of the hull,
Fig. 6c is transparent and partially sectional version of the view of Fig. 6b,
Fig. 7 is a top view of a hull according to prior art,
Fig. 8 is a top view of a portion of the hull of the container ship of Fig. 3,
Fig. 9 is a cross-sectional front view of an upper section of a hull side in accordance with a further embodiment, and
Fig. 10 is a top view of the container ship in Fig. 3.
DETAILED DESCRIPTION

Fig. 1 shows a prior art container ship 1, i.e. a ship suitable for stowing and transporting a large number of shipping containers, in side view. Fig. 2 shows a hull 2 of a different container ship 1 in perspective view.

A container ship 1 comprises a hull 2 that extends over the full length of the container ship 1 between the bulbous bow 7 and the stern 8. The hull 2 houses one or more engine rooms, fuel tanks, and other facilities required for the operation of the container ship 1. A major part of the interior of the hull 2, in the form of cargo holds, is used for stowing shipping containers 19, and some cargo holds are shown by the cutaway view 11 in Fig. 1. The container ship 1 is provided with one or more large internal combustion engines for propulsion, or driving the propellers(s) 9, and there will be one or more auxiliary engines (generator sets) that provide electrical power and heat for various consumers of electrical power and heat aboard the container ship 1. One or more rudders 10 provide for directional control of the container ship 1.

The container ship 1 is further provided with a deckhouse 3 comprising a bridge and crew accommodation, and a casing containing one or more funnels 4. In the embodiment of Fig. 1 the deckhouse 3 is separate from the casing 4, and therefore a design of this type of container ship 1 is called “twin island”. Fig. 2 shows an embodiment where the container ship
is of the so-called “single island” design, where the deckhouse and the casing are a single unit.

Shipping containers 19 are stowed inside the hull 2 and above deck in a plurality of cargo bays 12 distributed over the length of the container ship 1. The stowed shipping containers 19 are arranged in a plurality of rows 15 distributed over the breadth, i.e. the beam b (Fig. 7,8), of the hull 2 / container ship 1, and arranged in a plurality of tiers 14 in the direction of the height of the container ship 1. The container bays 12 are typically separated by lashing bridges 13 above deck and are separated by watertight transverse bulkheads 16 and open bulkheads 17 in the cargo holds below deck. The lashing bridges 13 may extend from one to four tiers 14 high and serve to secure the containers 19 by lashing.

As shown in Fig. 2, the hull 2 has an elongated shape with a length, breadth, and height. The hull 2 is a complex arrangement of stiffened plates, floors, web frames, webs and girders. Bottom floors, girders, inner and outer bottom stiffened plates form the bottom 6 of the hull 2. The side 5, formed by web frames, stringers, inner skin and outer shell stiffened plates, is connected to the bottom 6 at the raised inner bottom, close to the bilge strake 21.

A top deck 30, is supported by transverse box structures 20 that are attached to the tops of the side frames and the transverse box structures 20 run the full breadth of the container ship 1, thereby connecting the hull sides 5. The transverse box structures 20 contribute to the overall strength of the hull 2 and thus not only support the top deck
30, but along with the deck, frames, and transverse bulkheads 16, 17, strengthen and reinforce the hull 2.

Transverse bulkheads 16, 17 divide the cargo hold longitudinally into container bays 12. Typically, the lengthwise distance between the bulkheads 16, 17 corresponds to two 20-foot intermodal containers 19 or to one 40-foot intermodal container 19. The transverse bulkheads 16, 17 extend between the sides 5 of the hull 2 and from the bottom 6 of the hull 2 to the transverse box structures 20. The transverse bulkheads 16, 17 are connected by welds to the sides 5 (web frames), to the bottom 6 (floors) of the hull 2, and to the transverse box structures 20. Each transverse bulkhead 16, 17 is connected to a transverse box structure 20. Thus, a transverse box structure 20 forms a part of each transverse bulkhead 16, 17. The transverse bulkheads 16, 17 can be closed (watertight) or open. In the Figs. reference numeral 16 is associated with a closed transverse bulkhead and reference numeral 17 is associated with an open transverse bulkhead. Typically, the cargo holds are separated by closed transverse bulkheads 16 and the cargo holds are longitudinally divided into container bays 12 by open transverse bulkheads 17.

Both the open and closed transverse bulkheads 16, 17 are provided with a plurality of stringer decks at levels that correspond roughly to tiers 14. The stringer decks serve as platforms for the crew, and together with vertical webs the stringer decks form a frame for the transverse bulkheads 16, 17. The closed transverse bulkheads 16 are open to one side and closed to the other side by steel plating that is welded
to the stringer decks and to the vertical webs. The crew can access and service the longitudinal end of containers 19 that face the open side of the closed bulkheads 16 from the stringer decks. The open bulkheads 17 are open to both sides and therefore the crew can access and service the longitudinal end of containers 19 at both sides of the open bulkhead 17.

The transverse box structure 20 at the upper end of the transverse bulkheads 16, 17 is a hollow box constructed from metal plates, such as e.g. mild steel plates normally used in the construction of the hull of a marine vessel, although other materials could be used, such as e.g. high-grade steel or composite materials. The transverse box structure 20 has a substantially rectangular cross section, but does not need to be perfectly rectangular, i.e. the transverse box structure 20 should merely be substantially box shaped and one or more of the sides of the box can have a screened angle relative to a neighboring or opposing side.

In an embodiment, the transverse box structure 20 has four sides, each side formed by plates. The lower horizontal side 28 (Fig. 5) of the transverse box structure 20 is welded to the upper end of a transverse bulkhead 16, 17. The upper side 25 of the transverse box structure 20 is substantially level with the deck 29. The inside of the transverse box structure 20 forms a (transverse) passageway for the crew, and typically there is provided a staircase or ladder that allows access from the upper side 25 / deck 29 into the transverse box structure 20.
The hull 2 can be divided into a number of main structural elements, each element having its own function in strengthening and reinforcing the hull: bottom, sides, deck, hatch coaming and transverse bulkheads.

A double bottom 6 structure essentially comprises of outer bottom plating, inner bottom plating, and frame work formed by tight or non-tight floors and girders. The mid-section of the ship 1, i.e. the midship 38, is preferably U-shaped with large areas of the hull sides 5 being planar and at a right angle with the planar hull bottom 6, and with the hull 2 gradually being more and more V-shaped towards the bow 7 and stern 8. Hence, the major part of the bottom 6 is flat and suitable for supporting tiers 14 of shipping containers 19.

The sides 5 of the hull 2 comprise of a framework, inner skin plating 23 connected to and spaced from, and outer shell plating 22. In the mid-ship 38 section, the inner skin plating 23 form a planar wall at a right angle with the planar hull bottom 6 thereby delimiting the cargo space. Conventionally, the outer shell plating 22 is arranged at a constant distance from the inner skin plating 23, so that the outer shell plating 22 in the midship section 38 extends at a right angle to the bottom 6 of the hull 2. The framework comprises a longitudinal bulkhead, side stringers, extending transversely and contributing to the stiffness of the hull 2, side longitudinals and side web frames. The sides take up shear forces resulting from the hull girder bending moment and the weight and buoyancy distribution along the length of the ship 1. The hull girder is theoretically a box girder formed by the longitudinal members of the hull 2.
The deck 29 forms an upper surface of the hull 2 and provides support for the hatch covers 24 that carry the above-deck containers 19. The deck 29 is provided with openings 35 that give access to the container bays 12 (Fig. 7). Hatch covers 24 (Fig. 5) are placed over the openings 35 to provide a weathertight deck and for supporting shipping containers 19 that are placed on the hatch covers 24. In the prior art deck 29 is surrounded by a slightly lower placed deck that is formed at least in part by top shell plating 26 (Fig. 5).

The support structure for the hatch covers 24, in the art referred to as the hatch coaming, extends vertically from the top shell plating in the prior art, and is designed to prevent entry of water. It usually refers to a raised section of deck plating around the cargo bay hatch openings 35. Hatch coamings may also provide a frame onto which to fit a hatch cover 24.

The transverse bulkheads 16, 17 divide the cargo hold into a number of compartments, container bays 12, along the length of the ship 1. The closed transverse bulkhead 16, is essentially a grillage and wall structure, the open transverse bulkhead 17 is essentially a grillage structure; both supporting the container 19 stacks and adding stiffness to the hull 2.

The container ship 1 is provided with at least one longitudinal crew passageway 18. Two such longitudinal passageways 18 are conventionally arranged on the deck formed by the top shell plating 26, with one passageway 18 extending along a hull side 5.
In the prior art, side structures 39 are provided to support an outer row 15 of containers 19, see Fig. 5. These side structures 39 comprise beams, longitudinally spaced stanchions, as well as railing and/or plating for security of the crew.

Conventionally, the side structure 39 is arranged such that the passageway 18 is a mainly open structure towards the exterior of the ship 1, so that crew members have a substantially unobstructed view to the sea or port, and the side structure 39 is often provided with openings for boarding and disembarking of the crew or a pilot. The passageways 18 are sized and shaped to at least allow a crew member to pass through, walking upright.

The torsional stresses on the hull 2 are at their highest around midship, and a deckhouse 3 (and its below-deck structure) placed towards the middle of the ship 1 reinforces the midship and thereby contributes to the torsional strength of the hull 2. A casing 4 and engine room, placed towards the stern 8 of the ship 1, also contribute to the torsional strength of the hull 2. Consequently, a ship 1 as shown in Figs. 3, where the deckhouse 3 is arranged at the bow 7 of the ship, needs additional hull reinforcement.

In an embodiment the hull 2 comprises two hull sides 5 and a, at least partially planar, hull bottom 6 which is connected to the hull sides 5 by bilge sections 21. The middle of the hull 2, i.e. the midship 38, has a cross section which is U-shaped, as shown in Fig. 4, while the ends, i.e. bow 7 and
stern 8, have a more V-shaped cross section. Each hull side 5 comprises an outer shell plating 22 and an inner skin plating 23, spaced apart from each other by means of various pieces of framework (stringers). The hull sides 5 enclose cargo holds used for stowing shipping containers 19 below deck. Alternating closed- and open transverse bulkheads 16, 17 extend across the width of the hull 2, and the closed transverse bulkheads 16 divide the hull longitudinally into several cargo holds and the open transverse bulkheads divide the cargo holds into container bays 12. Each container bay 12 has an opening 35 that provides access from above.

The hull 2 further comprises several transverse box structures 20, extending across the width of the hull 2 and connecting the hull sides 5, and each transverse box structure 20 forms the upper part of a transverse bulkhead 16, 17. The hull 2 is also provided with a deck 29 which surrounds the openings 35. The deck 29 comprises deck plating 30 that forms an upper side of the transverse box structures 20, and the deck 29 is adapted for supporting hatch covers 24 which are used to cover the container bays 12, more particularly the previously mentioned openings 35. The hatch covers 24 also support the containers 19 which are stowed above deck.

In the prior art, the deck 29 / deck plating 30 extends transversely between and slightly over the upper ends of the two opposing inner skin plating 23 of the hull 2 (Fig. 5 and 7). A passageway 18 is provided between the inner skin plating 23 and the outer shell plating 22, at a level below that of the deck 29/upper side 25 (Figs. 5 and 7). The floor of the passageway 18 is formed by top shell plating 26 that connects
the top of the outer shell plating 22 to the inner skin plating 23.

As shown in the embodiments of Figs. 6, 8, and 9 the deck 29 comprises deck plating 30, which surrounds the above mentioned openings 35 of the container bays 12, and the deck plating 30 also extends laterally to the outer shell plating 22. The deck plating 30 is connected to the outer shell plating 22 and to the inner skin plating 23 by means of welding. Thus, deck 29 extends transversely to the outer shell plating 22. The deck 29 is preferably formed by planar deck plating 30. By “planar” is meant that the plating extends continuously and in alignment, without any height differences. Alternatively, the portion of the deck 29 extending between the inner skin plating 23 and the outer shell plating 23 may be downwardly or upwardly inclined.

The hull 2 is reinforced by extending the deck plating 30 transversely all the way to the outer side plating 22, across the breadth b of the hull 2. By connecting the deck plating 30 to the outer side plating 22, a lengthwise torsion box 31 is formed where there was a laterally and upwardly open passageway in the prior art hull construction.

The embodiment of Fig. 6a shows an outer support structure 32. An outer support structure 32 extends lengthwise along one of the hull sides 5 and projects upwardly from the deck plating 30. The support structure 32 may comprise of e.g. a longitudinally extending beam, a number of vertically extending longitudinally spaced stanchions, or plating. Each outer support structure 32 provides support for the outer row
of containers 19 stowed above deck at a level that substantially corresponds to, i.e. is aligned with, the level of the upper surface of the hatch cover 24 when the hatch cover 24 is placed over the opening 35 to the container bay 12. The vertical extent $h$ of the outer support structure 32 is preferably less than 1.5 m, even more preferably less than 1 m.

Since the passageways 18 are laterally shielded from the exterior of the hull 2 by the outer shell plating 22, a boarding opening 36 is provided in the outer shell plating 22 for providing access for crew and supplies, e.g. via a boarding gangway. This boarding opening 36 is preferably provided just below the passageway 18 i.e. the boarding opening 36 is provided in the shear strake (the upper part of the outer side plating 22). From a strength point of view, it is preferred to leave shear strake untouched. However, it is often necessary to create openings in the shear strake for boarding gangway and tug lines, etc.

Further, several viewing openings 37 are in an embodiment provided in the outer shell plating 22 primarily to enable handling of tug lines that are connected to bollards on the deck/passage way and secondarily for giving crew members a lateral view to the exterior from the passageways 18. Thus, these viewing openings 37 are located in the shear strake, spaced along the length of the midship part 38.

The embodiment of Fig. 9 shows an outer support structure 32, the vertical extent $h$ of which is such that a passageway 18 can be arranged in between the outer support structure 32,
the outer row of containers 19, and the deck plating 30. In this embodiment, the outer support structure 32 provides support for the outer row of containers 19 stowed above deck at a level that substantially corresponds to, i.e. is aligned with, the level where the second above-deck tier 14 begins.

As shown in Figs. 6, 8, and 9, the deck plating 30 is connected to an upper edge of the inner skin plating 23 and to the side of the outer shell plating 22, such that the outer shell plating 22 extends upwards past the deck plating 30. The outer shell plating 22 preferably extends upwards such that it forms part of the outer support structure 32.

Each hull side 5 is provided with at least one lengthwise extending crew passageway 18 arranged in the hull side 5 between the outer shell plating 22 and the inner skin plating 23. The crew passageway 18 is shaped and sized for allowing an individual to walk through the passageway 18 in an upright position.

The hull 2 is provided with at least one lengthwise torsion box 31, extending along each hull side 5. The vertical sides of the lengthwise torsion box 31 are formed by the outer shell plating 22 and the inner skin plating 23. The bottom of the lengthwise torsion box 31 is formed by a stringer 40 and the top side of the lengthwise torsion box 31 forms part of the top plating 30. The top shell plating 30 is connected to the outer shell plating by welding. The top shell plating 30 extends transversely all the way to the outer shell plating 22 and compared to prior art constructions the outer shell
plating 22 extends higher and at least to the height of the top shell plating 30.

The lengthwise torsion box 31 extends at least over 0.4 times the length of the ship as defined in accordance with the International Convention on Load Lines or 0.4 times the (overall) length of the hull 2. The lengthwise torsion box 31 is preferably centered around the amidship point. The torsion box 31 max extend over a longer portion of the hull 2 than 0.4 times the ship length as defined in International Convention on Load Lines (or the length of the hull 2), however the torsion box 31 will typically not start before the stern part and end slightly before the bow part.

The lengthwise torsion box 31 is preferably provided with a crew passageway 18 extending lengthwise inside the torsion box 30. The crew passageway can alternatively be provided in a section of the hull side below the lengthwise torsion box 31.

The embodiment of Fig. 3 shows a pilot door 33 being arranged in one of the hull sides 5. The pilot door 33 is connected to one of the crew passageways 18, hence giving the crew easy access to the ship 1. The pilot door 33 is accessed by means of a ladder 34 extending vertically along a hull side 5 of the ship 1. Preferably, the pilot door 33 is located in the hull side 5 at a level below the crew passageway 18.

The embodiment of Figs. 3 and 4 show a container ship 1, as disclosed above, with its deckhouse 3 arranged ahead of the cargo holds. The view in Fig. 4 is a cross-section taken in
approximately the middle of the length of hull 2 (view towards bow). The deckhouse 3 preferably comprises the bridge and crew accommodation, but could also comprise further areas such as room for miscellaneous machinery or tanks.

In an embodiment the deckhouse 3 is conventionally located (as shown in Figs. 1 and 2), i.e. not moved ahead of the cargo bays, or only the navigation bridge is located in the bow. In this embodiment the advantages of the increased torsional strength of the hull 2 can be exploited in other ways.

The various aspects and implementations have been described in conjunction with various embodiments herein. However, other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed subject-matter, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The reference signs used in the claims shall not be construed as limiting the scope.
CLAIMS

1. A hull (2) for a container ship (1), said hull (2) having a length and a beam (b), said hull (2) comprising:
   two hull sides (5), each hull side comprising outer shell plating (22) spaced from inner skin plating (23),
   a bottom (6) connecting said hull sides (5),
   a cargo hold area for stowing shipping containers (19) below deck,
   a plurality of transverse bulkheads (16, 17) dividing said cargo area longitudinally into cargo holds and container bays (12), each container bay (12) having a hatch opening (35),
   a transverse box structure (20) forming the upper part of said transverse bulkheads (16, 17), said transverse box structures (20) connecting said hull sides (5),
   a deck (29) surrounding said hatch openings (35), said deck (29) being formed by deck plating (30) and said deck (29) being adapted for supporting hatch covers (24) for covering said hatch openings (35) and for supporting above deck shipping containers (19),
   said deck plating (30) forming an upper side (25) of said transverse box structure (20) and said deck plating (30) being connected to an upper end of said inner skin plating (23),
   a lengthwise torsion box (31) being formed by connecting said outer shell plating (22) to said deck plating (30),
   two outer support structures (32), each outer support structure (32) extending lengthwise along a portion of one of the hull sides (5) characterized in that said outer support structures (32) provide support for at least one outer row of above deck shipping containers (19) at a level that substantially corresponds to the level of an upper surface of said at least one hatch cover (24) placed over said opening
and in that each hull side (5) comprises at least one lengthwise extending crew passageway (18) arranged in said hull side (5) between said outer shell plating (22) and said inner skin plating (23).

2. A hull (2) according to claim 1, wherein said lengthwise torsion box (31) comprises said crew passageway (18).

3. A hull (2) according to claim 1 or 2, wherein said deck plating (30) extends transversely to said outer shell plating (22) and said outer shell plating (22) extends at least upwardly to said deck plating (30).

4. A hull (2) according to any one of the previous claims, wherein said deck plating (30) is connected to a side of said outer shell plating (22), such that said outer shell plating (22) extends upwards past said deck plating (30).

5. A hull (2) according to claim 4, wherein said outer shell plating (22) extends upwards beyond a position where it connects to said deck plating such that it forms part of said outer support structure (32).

6. A hull (2) according to any one of the previous claims, wherein the vertical sides of said lengthwise torsion box (31) being formed by said outer shell plating (22) and said inner skin plating (23).

7. A hull (2) according to any of the previous claims, wherein the top side of said lengthwise torsion box (31) forms part of said deck plating (30), and wherein a bottom side of said
lengthwise torsion box (31) is formed by a stringer (40) that connects said outer shell plating (22) with said inner skin plating (23).

8. A hull (2) according to any one of claims 1 to 7, wherein said crew passageway (18) is shaped and sized for allowing an individual to walk through said passageway (18) in an upright position.

9. A hull (2) according to any one of claims 1 to 8, wherein said lengthwise torsion box (31) extends at least over 0.4 times the length of the hull (2), preferably as defined in International Convention on Load Lines.

10. A hull (2) according to claim 9, wherein said lengthwise torsion box (31) is centered around the amidship point.

11. A hull (2) according to claim to any one of claims 1 to 10, wherein the vertical extent (h) of said outer support structure (32) is preferably less than 1.5 m, even more preferably less than 1 m.

12. An assembly comprising a hull (2) according to any one of claims 1 to 11, further comprising at least one hatch cover (24).

13. A container ship (1) comprising a hull (2) according to any one of claims 1 to 11 or an assembly according to claim 12.
14. A container ship (1) according to claim 13, comprising a deckhouse (3) arranged ahead of said cargo holds.

15. A container ship (1) according to claim 14, comprising a bridge arranged ahead of said cargo holds and an accommodation unit arranged lengthwise at a distance from the bridge in the direction of the stern.

16. A container ship (1) according to claim 14 or 15, wherein said lengthwise torsion box (31) extends at least over 0.4 times the length of the container ship (1) as defined in International Convention on Load Lines.
**SEARCH REPORT - PATENT**

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<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant for claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y A</td>
<td>WO 2009/109188 A2 (NIELSEN, JENS MAGNUS) 2009.09.11. See abstract, claim 1, description page 15, lines 13-22, page 18, line 30 - page 19, line 4, and figures 1, 3-6, 8 and 9.</td>
<td>1-4, 6-16 5</td>
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<tr>
<td>Y A</td>
<td>CN 106043595 A (MAERSK LINE AS) 2016.10.26. See abstract, claim 1, figures 1, 3-6, 12 and 13.</td>
<td>1-4, 6-16 5</td>
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<td>A</td>
<td>US 2005/0193937 A1 (FREELUND et al.) 2005.09.08. See abstract, [0052], and figures 1, 3, 5 and 6.</td>
<td>1-16</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

**DOCUMENTS CONSIDERED TO BE RELEVANT**

- **Y** Document published prior to the filing date but later than the priority date claimed.
- **T** Document not in conflict with the application but cited to understand the principle or theory underlying the invention.
- **X** Document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone.
- **Y** Document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- **O** Document member of the same patent family.

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Date of completion of the search report  
14 June 2017

Authorized officer  
Basel Hayatleh  
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Search Report 1
<table>
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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant for claim No.</th>
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<tr>
<td>A</td>
<td>US 5359953 A (SKAARUP et al.) 1994.11.01. See abstract, col. 4, lines 15-29, and figures 1 and 4-6.</td>
<td>1-8, 12, 13</td>
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<td>A</td>
<td>DE 19623238 A1 (SISMAN YAZICI, HALUK) 1997.08.14. See abstract and figures 1-3, 7 and 10.</td>
<td>1-8, 12, 13</td>
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<td>A</td>
<td>US 3440990 A (J. H. VAN RIET et al.) 1969.04.29. See abstract and the figures.</td>
<td>1-8, 12, 13</td>
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<td>A</td>
<td>WO 2013/110274 A1 (NIELSEN, HANS C.) 2013.08.01. See figure 1.</td>
<td>14, 15</td>
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<td>A</td>
<td>US 6105525 A (RAPELI) 2000.08.22. See abstract, description p. 10, lin. 7-12, p. 17, lin. 60-63, and figures 1, 2 and 4.</td>
<td>1-8, 12, 13</td>
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<tr>
<td>A</td>
<td>KR 20120002214 A (DAEWOO SHIPBUILDING &amp; MARINE) 2012.01.05. See in figures 1-3, &quot;torsion box (26)&quot; connected to &quot;solid plate (25)&quot; about amidship point.</td>
<td>10</td>
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</tbody>
</table>
**Box No. I  Observations where certain claims were found unsearchable**

This search report has not been established in respect of certain claims for the following reasons:

1. **☐** Claims Nos.:
   - because they relate to subject matter not required to be searched, namely:

2. **☐** Claims Nos.:
   - because they relate to parts of the patent application that do not comply with the prescribed requirements to such an extent that no meaningful search can be carried out, specifically:

3. **☐** Claims Nos.:
   - because of other matters.

**Box No. II  Observations where unity of invention is lacking prior to the search**

The Danish Patent and Trademark Office found multiple inventions in this patent application, as follows:
| SEARCH REPORT - PATENT | Application No.  
<table>
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<td>SUPPLEMENTAL BOX</td>
<td>PA 2016 70944</td>
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Continuation of Box [.]