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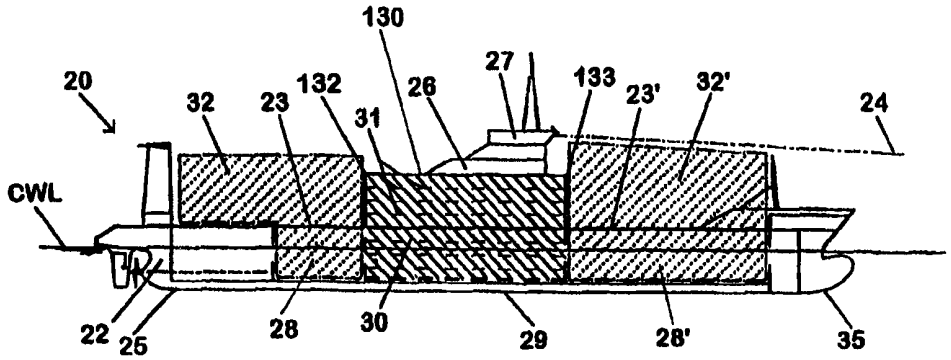

(57) Abstract

The invention relates to a transport ship (20) having a hull comprising a sheathing (22), a weather deck (23, 23') and a hold (28, 28', 30), and having a front part (35), a rear part (25) and a central part (29). The ship is unique in that the front part (35) of the ship comprises a hold section (28') defined by the hull and the weather deck (23'), and access hatches provided in the weather deck (23') to give access to said hold section (28'), that the rear part (25) of the ship comprises a hold section (28) defined by the hull and the weather deck (23), and access hatches provided in the weather deck (23) to give access to said hold section (28), that the central part (29) of the ship comprises a refrigerated hold section (30) defined by an upper thermally insulated refrigerated hold deck (130), a thermally insulated bottom and by thermally insulated walls (132, 133...) extending in the transverse direction and longitudinal direction of the ship, and in that the weather deck (23, 23') is adapted to support a cargo.

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A transport ship

The present invention seeks to solve the problem of providing a transport ship allowing for a high load capacity and flexibility through a unique arrangement of a hold for refrigerated products or a hold for liquid products.

In a first fundamental embodiment the present invention relates to a transport ship having a hull comprising a sheathing and a weather deck and having a front part, a rear part and a central part.

Usually, the rear part of such ships comprises a deck superstructure with the navigating bridge of the ship and the means necessary for the propulsion of the ship, including machinery and fuel tanks, while the front part of the ship comprises the stem and store rooms, if any. The central part of the ship comprises the hold, which is constructed in accordance with the specific type of goods to be transported. The hold may thus be constructed specifically for the transport of one specific type of goods, including e.g. cooled goods, liquid gas, dry cargo, oil or containers. Particularly in former times, the possibilities of utilizing transport ships for carrying combinations of the above-mentioned types of goods were very limited.

To achieve an increased flexibility of goods transport ships to a certain degree, the so-called Ro-Ro ships have been developed in the past twenty years, with a weather deck for the transport of particularly containers and with a plurality of tween decks that may be used for the transport of trailers or e.g. cars which may be loaded using stern ramps.

However, as far as the so-called refrigerator ships are concerned, specifically adapted to transport refrigerated goods, it has not been possible to achieve optimum flexibility and capacity in the past. In particular, the conventional structure of the refrigerator ships and stability deliberations have set a limit to the amounts of additional types of goods that can be carried and to the conditions under which such goods may be carried. Refrigerator ships are typically provided with an internal refrigerated hold over the greater part of the length of the hull, see e.g. European Patent Application No. 0 601 233, said refrigerated hold accommodating a relatively large number of tween decks with a small free height. The reason is that the goods are usually stored on pallets and do not stand stacking in the height. The goods may e.g. be bananas, lemons or vegetables which are to be kept refrigerated during the transport. The goods are typically cargoes which are to be transported over great distances, e.g. from South America to Europe.

In view of the above, it has been attempted to construct the refrigerator ships so as to enable them to carry standard containers which are stacked on the weather deck of the ship. This results in some increased flexibility, as the ship can then be utilized for the transport of refrigerated goods as well as a surface cargo, which may produce increased earnings per voyage. These refrigerator ships, however, are inexpedient, because certain loading situations give rise to stability problems during the voyage of the ship. These problems may occur when the ship, when bound for return, is to sail without refrigerated goods, but with a surface cargo, such as containers. Since the typical surface cargoes are formed by containers of a much greater weight than a corresponding volume of the refrigerated goods, stability deliberations set a

limit to how high the containers may be stacked on the weather deck, also when sailing with refrigerated goods.

An object of the present invention is to provide an improved transport ship by means of which, with fewer stability problems, different combinations of goods may be transported, at least one type of which should preferably be capable of being transported in refrigerated form, while allowing greater amounts of the other goods to be transported at the same time. In this connection, different combinations of goods are taken to mean sailing with or without the refrigerated goods, and it must also be possible optionally to transport at least one other type of goods, particularly in the form of standard containers. This provides a high degree of flexibility, so that the owner of the ship can obtain greater earnings per voyage in relation to the known refrigerator ships.

This object is achieved according to the invention in that the front part of the ship comprises a hold section defined by the hull and the weather deck, and access hatches provided in the weather deck to give access to said hold section, that the rear part of the ship comprises a hold section defined by the hull and the weather deck, and access hatches provided in the weather deck to give access to said hold section, that the central part of the ship comprises a refrigerated hold section defined by an upper, thermally insulated refrigerated hold deck, a thermally insulated bottom and by thermally insulated walls extending in the transverse direction and longitudinal direction of the ship, and in that the weather deck is adapted to support a cargo.

When the ship is constructed in this manner, it will also be possible to sail without goods in the refrigerated hold, as the rest of the goods may be stowed relatively

low against the keel on each side of the refrigerated hold section in the longitudinal direction of the ship. A favourable metacentre height may hereby be maintained, as only the draught of the ship will change. Since, in conventional refrigerator ships, the rest of the goods must necessarily be carried on the weather deck to avoid damage to the insulated walls, the metacentre height in these ships is very unfavourable when sailing without refrigerated goods in the hold.

According to a particularly preferred embodiment, the upper refrigerated hold deck is arranged at a height above the weather deck of between 20% and 200%, preferably between 50% and 150%, of the moulded depth of the ship measured to the weather deck. In this case, the moulded depth is measured from the base line of the ship. It is hereby possible to achieve approximately the same loading volume for refrigerated goods as in a traditional refrigerator ship of approximately the same length, and the refrigerated hold section is easy to insulate thermally. Further, the sunlit surface of the refrigerated hold section will be reduced compared with a traditional refrigerator ship when sailing without surface cargo. In the traditional refrigerator ships, the energy of the sun impinges on the entire weather deck which defines the upper boundary of the refrigerated hold approximately in the entire length of the ship. This will also allow the necessary cooling energy to be reduced. If necessary, the width of the ship may also be slightly greater than that of the traditional refrigerator ship.

It is moreover preferred that the insulated walls extending in the transverse direction directly adjoin the hold section in the front and/or rear part of the ship, and that, optionally, the thermally insulated walls extending in the longitudinal direction also adjoin the sheathing

of the hull. This results in optimum utilization of the ship, as the natural walls are utilized for defining the various holds.

It is particularly preferred that the upper refrigerated hold deck is adapted to support a cargo, and that the navigating bridge of the ship and the premises of the crew are provided on the upper refrigerated hold deck. All horizontal faces may hereby be utilized for supporting the other type of goods, particularly containers. When the navigating bridge is simultaneously arranged amidships, it is possible to arrange an even very high stack of containers on the weather deck, as the current maritime rules on the mate's line of sight to the horizon are still observed.

It is also preferred that the refrigerated hold section is provided with tween decks, and that the distance between the decks is about 2 m - 3 m, preferably about 2.25 m - about 2.5 m. This allows transporting of palleted goods with an optimum utilization of the load volume, as waste of space between the upper side of the pallets and the under side of the tween decks is greatly reduced. Furthermore, like in conventional refrigerator ships, the tween decks may advantageously be constructed as a grating, so that cooling takes place by means of circulating air.

When, according to a particularly expedient embodiment, the access to the refrigerated hold section is provided in the thermally insulated walls, preferably in the longitudinal walls, it is possible to load and unload the refrigerated goods and the surface cargo at the same time.

Further, the length of the refrigerated hold section may advantageously constitute between about 20% and 50%, preferably between about 25% and 45%, of the total length of the ship. Hereby, the longitudinal walls of the refrigerated hold section will, to a great extent, be disposed solely within the area of the hull where the sheathing is almost plane, which simplifies the construction of the insulation of the walls.

To obtain relatively symmetrical loading conditions to ensure a favourable stability as regards the trim moment of the ship, it is preferred that the thermally insulating walls defining the refrigerated hold section extend symmetrically about the midship section and the middleline plane of the ship.

Finally, it is preferred that access hatches to the hold sections are provided substantially in the entire width of the hold sections. The hold sections in the front and rear parts of the ship may thus be filled and emptied basically in the same manner as in the conventional container ships.

In a second fundamental embodiment the present invention relates to a transport ship adapted for simultaneous transport of a cargo consisting of i) a liquid, particularly oil, and ii) a plurality of containers as well as iii) optionally at least one additional type of goods, said transport ship having a hull comprising a sheathing, a bottom, a weather deck and a tank for storing and transporting said liquid, as well as a front part, a rear part and a central part. In this connection, containers are taken to mean standard containers of the type which is generally used for the transport of goods on board containerships.

The prior art (see e.g. DE-A-2 462 202) includes a few examples of tankers having an oil tank intended for carrying crude oil and allowing simultaneous transport of an additional type of goods during one and the same voyage. The rear part of these ships usually comprises a deck superstructure with the navigating bridge of the ship and the means necessary for the propulsion of the ship, including machinery and fuel tanks, while the front part of the ship comprises the stem. The central part of the known ship comprises the oil tank whose boundary walls may be formed by the sheathing of the ship. The central part of the ship additionally comprises a plurality of holds intended to accommodate the additional type of goods. Upwardly, the oil tank is defined by the weather deck of the ship, and this is also the case with the said holds.

However, it has previously not been possible to achieve optimum flexibility and capacity with these ships. Thus, the ships are inexpedient, because the volume capacity, i.e. the volume of goods that can be carried, for the additional type of goods is merely achieved at the expense of the crude oil volume capacity. When the ship sails without crude oil, it is only possible to transport an amount of the additional type of goods corresponding to the volume capacity of the holds provided for this type of goods. Neither when sailing with the additional cargo and with oil, nor when sailing with the additional cargo alone, is the ship thus utilized optimally.

An object of the present invention is to provide an improved transport ship which, with a high load capacity, allows transport of various combinations of goods, at least one type of which is liquid, while allowing simultaneous transport of a considerable number of standard containers and optionally an additional type of goods,

such as e.g. general cargo. It must be possible also to transport containers and e.g. general cargo in relatively large amounts, without this causing any considerable reduction in the volume capacity for the liquid, i.e. the liquid volume that can be carried, relatively to a conventional tanker with corresponding dimensions and a corresponding cost of construction. Hereby, when carrying e.g. oil, the owner of the ship can obtain considerably higher earnings per voyage than per voyage with the known tankers.

The above object is achieved according to the invention in that the ship comprises a plurality of hold sections defined by the bottom and the weather deck, said hold sections being adapted to store containers and/or the optional additional type of goods, that the weather deck is adapted to support containers, that the weather deck comprises access hatches giving access to said hold sections, and that the tank for storing the liquid extends from the area at the bottom of the ship upwards to a height above the weather deck. It is preferred to provide the total volume capacity of the tank essentially corresponding to the volume capacity of the tank on a conventional tanker having a hull of corresponding dimensions.

When the ship is constructed in this manner, it will also be possible to sail without a cargo of liquid, as the rest of the goods may be stowed relatively low against the keel on one or both sides of the liquid tank in the longitudinal direction of the ship. It is noted that it is hereby possible to maintain a favourable metacentre height for the normally occurring combinations of cargo, as only the draught of the ship will change considerably by changed load conditions. As only a small part of the hull itself surrounds the liquid tank, the risk of leak-

age of liquid in case of collision is reduced relatively to conventional tankers.

According to a preferred embodiment of the invention, the tank has a total volume capacity of between about 5,000 and 100,000 m^3, preferably about 40,000 m^3, while the hold sections are adapted to accommodate a total of at least 200, preferably at least about 450 standard containers. A ship with such specifications will typically have dimensions which make it possible to sail through the Panama Canal.

Particularly when the front part of the transport ship comprises one of said hold sections, the rear part of the transport ship comprises one of said hold sections, and the central part of the transport ship comprises said tank, it is possible to ensure a symmetrical load impact on the ship under all load conditions.

It is moreover preferred that the hold sections have transverse walls which are substantially vertical, and which directly adjoin the tank, optionally with intermediate coffer dams, and that the walls of the hold sections extending in the longitudinal direction of the ship are formed by the sheathing of the hull. This provides optimum utilization of the ship, as the natural walls are utilized for defining the various holds.

It is particularly preferred that the tank consists of a plurality of independent compartments which may optionally be cylindrical, box-shaped or spherical, thereby providing the same advantages as in conventional tankers. The cylindrical compartments may be arranged with a vertically or horizontally extending longitudinal axis.

According to a particularly preferred embodiment, the tank extends upwards to a height above the weather deck of between 10% and 200%, preferably between 50% and 150%, of the moulded depth of the ship measured to the weather deck. In this case, the moulded depth is measured from the base line of the ship. In particular, the tank may extend upwards to a height above the weather deck of at least 10 metres, preferably at least 15 metres, and/or be constructed so that its volume above the weather deck constitutes at least 20%, preferably between about 40% and 60%, of the total volume of the tank. This results in a suitable volume capacity ratio for the respective parts of the cargo.

To achieve relatively symmetrical load conditions and thereby ensure a favourable stability as regards the trim moment of the ship, it is preferred that the tank extends symmetrically about the midship section and the middle-line plane.

Finally, it is preferred that access hatches are provided to the hold sections substantially in the entire width of the hold sections. The hold sections may hereby be filled and emptied in the same manner as in conventional containerships.

As will be realized, the invention as defined in the first and second fundamental embodiments seeks to optimize the load capacity and flexibility of transport ships by using the same general concept of providing an optimal positioning of the hold for refrigerated products or the tank for liquid goods.

The invention will be explained more fully below with reference to the preferred embodiment shown in the drawing. In the drawing:

fig. 1 shows an example of a known type of a refrigerator ship, seen in partial vertical longitudinal section, and

fig. 2 shows a preferred embodiment of a refrigerator ship according to the first fundamental embodiment of the invention, seen in partial vertical longitudinal section, and

fig. 3 shows an example of a known type of tanker, seen schematically in a partially vertical longitudinal section, and

fig. 4 shows a preferred embodiment of a transport ship according to the second fundamental embodiment of the invention, seen schematically in a partially vertical longitudinal section, and

fig. 5 shows the embodiment of fig. 4 in more detail, seen from the side and provided with a tank comprising vertical, cylindrical compartments.

First fundamental embodiment of the invention

Fig. 1 shows an example of a known refrigerator ship 1 having a hull comprising a sheathing 2, a weather deck 3 and a hold 10. The refrigerator ship 1 has a rear part 5 comprising the machinery necessary for the propulsion of the ship and a deck superstructure comprising premises 6 for the crew and a navigating bridge 7. In addition, the ship 1 comprises a front part 15 with the stem and bulb of the ship, and a central part 9 with a refrigerated hold 10. The refrigerated hold 10 is defined by thermally insulated walls and a thermally insulated bottom, and also the superjacent weather deck 3 is thermally insulated above the refrigerated hold 10.

The refrigerated hold 10 additionally comprises a plurality of tween decks 11, which are indicated in dashed line, and which may be constructed as a grating, the free height between the tween decks being typically about 2.25 m. This free height is selected in accordance with the height of a standard pallet of refrigerated goods, e.g. bananas, and the tween decks 11 are usually also constructed to allow driving with a fork-lift truck. In the example shown, the ship 1 comprises four tween decks 11, and the height of the ship 1 from the base line to the weather deck is selected so that the desired number of tween decks may be provided. Loading and unloading of the refrigerated hold 10 may take place using elevators or cranes, by means of which the refrigerated goods, indicated in hatched line, may be carried from each tween deck 11 to an access door provided in the side of the ship at a level above the waterline CWL, or optionally to hatches on the weather deck.

The weather deck 3, which forms the closure of the hull upwardly, also serves to support a surface cargo 12, which is indicated in dotted line in the drawing, and which will normally consist of containers stacked on top of each other and lashed to the weather deck 3. The stacking height of the containers 12 will usually be limited partly with a view to the stability of the ship against heeling and partly by international maritime rules, according to which the line of sight 4 from the navigating bridge must reach the surface of the sea at a distance from the stem corresponding to the length of the ship.

The shown conventional refrigerated ship may thus be used for carrying refrigerated goods as well as containers. However, it is clear that the stability of the ship will

be affected considerably if the refrigerated hold 10 is empty and only containers on the weather deck 3 are to be carried. This will typically be the case for a return voyage. To compensate for this load situation, ballast tanks, into which sea water is pumped, will normally be incorporated, in many cases up to 30% of the loading capacity of the ship. These tanks, however, take up space at the bottom of the hull that might be used for goods.

The possible stacking height of the containers on the weather deck 3, however, is limited also in the situation where refrigerated goods are transported in the refrigerated hold. The reason is that, in practice, the weight per volume unit of the refrigerated goods, which will typically be bananas, is considerably smaller than the weight per volume unit of the cargo on the weather deck. It is therefore just possible to carry a relatively small number of containers, which must be stacked very low on the weather deck 3.

Seen from an economic point of view, this situation is undesirable of course, as it reduces the earnings of the shipowner unnecessarily.

Fig. 2 shows a vertical longitudinal section through a transport ship 20 according to the first fundamental embodiment of the invention. The shown transport ship 20, like the conventional transport ship, comprises a hull having a sheathing 22, a weather deck 23, 23' and a hold. The hold is divided into three hold sections, and the rear part 25 of the ship comprises the machinery of the ship and a rear hold section 28. The front part 35 of the ship 20 comprises the stem of the ship and a front hold section 28'. Both the front and rear hold sections 28, 28' are defined upwardly by a respective part 23, 23' of the weather deck, which is formed with access hatches

giving access to the hold sections for vertical lowering of goods, in particular containers. To permit lowering of the containers, the hatches are preferably provided in the entire width of the hold sections like in conventional container ships, and the hatch covers are constructed to support the surface cargo. Moreover, the front part 23' and the rear part 23 of the weather deck are preferably at the same level above the base line as the weather deck 3 in the conventional refrigerator ship 1.

The ship 20 additionally comprises a central part 29 having a refrigerated hold section 30 indicated by hatched lines, and the extent of the refrigerated hold section 30 in the fore-and-aft direction of the ship preferably constitutes about 25% - 40% of the total length of the ship. The width of the refrigerated hold 30 may preferably correspond to the width of the ship. The refrigerated hold section 30 is intended to transport refrigerated goods, such as bananas or similar food products, or alternatively to transport cooled, liquid gas, and is defined upwardly by a thermally insulated refrigerated hold deck 130. The refrigerated hold section 30 additionally has a thermally insulated bottom which may be arranged close to the ships bottom, and thermally insulated longitudinal and transverse walls 132, 133, and the front part 23' and the rear part 23 of the weather deck adjoin the transverse walls 132, 133, as shown. The transverse walls 132, 133 moreover preferably form a transverse boundary of the front and rear hold sections 28, 28'. The refrigerated hold deck 130 is preferably adapted to support a deck superstructure with the navigating bridge 27 of the ship 20 and optionally a surface cargo in the form of a minor stack of containers lashed to the refrigerated hold deck 130.

Like the conventional refrigerated holds, the refrigerated hold section 30 is provided with a plurality of fixed tween decks 31, e.g. in the form of a grating, to which access may be had via an access door (not shown) in the side of the ship and using elevators, and, if necessary, partitions may be provided, dividing the refrigerated hold section 30 into smaller sections in which different temperatures, e.g. above the freezing point and below the freezing point, may be maintained. The distance between the tween decks 31 is determined by the height of a standard pallet and is therefore typically about 2.25 m, like in the conventional refrigerator ships.

In the embodiment shown in fig. 2, the refrigerated hold deck 130 is arranged at a height above the weather deck 23' of about 100% of the moulded depth of the ship measured to the main deck 23' from the base line, which means that the refrigerated hold section 30 comprises a total of eight tween decks, four of which are below the level of the weather deck 23, 23'. It will thus be possible to stack refrigerated goods at a greater height than in the conventional refrigerator ships. When comparing with the conventional refrigerator ship 1 of a corresponding length shown in fig. 1, it will be clear that selection of a suitable height of the refrigerated hold deck 130 will provide the same loading capacity for refrigerated goods.

Fig. 2 moreover shows a situation in which the ship 20 is fully loaded with refrigerated goods (indicated in hatched line) in the refrigerated hold section 30 and with a plurality of containers 32, 32' (indicated in dotted line) stacked on top of each other in the hold sections 28, 28' and on the weather deck 23, 23'. As the weight per volume unit of the refrigerated goods is typically smaller than for the containers, as mentioned be-

fore, the possibility of stacking containers near the keel will mean that the total centre of gravity of the cargo is relatively low in relation to a conventional refrigerator ship of a corresponding length and loaded with the same number of containers. It is hereby possible to stack a larger number of containers on top of each other with approximately the same stability conditions as in the conventional refrigerator ship. In the situation of sailing without refrigerated goods, it may moreover be possible to reduce the size of the water ballast in some embodiments.

Table 1 below serves to illustrate some of the advantages of the invention. In the table, the capacity of a ship according to the invention constructed with a length of 150 metres and with a refrigerated hold with a length of about 50 metres, a width corresponding approximately to the width of the ship (about 25 m) and with eight tween decks (fig. 2) is compared with a conventional refrigerator ship with the same length as shown in fig. 1. The building costs for both ships will typically amount to DKK 220 million (1997). For both vessels, the distance between the base line and the weather deck will be about 13.3 m and the width will approximately be the same.

TABLE 1

(First fundamental embodiment of the invention)

CARGO	THE INVENTION	CONVENTIONAL SHIP
A Bananas	5000 tons	5000 tons
B Bananas	5000 tons	5000 tons
Other cargo	max. 600 containers	max. 150 containers
C Bananas	0	0

Other cargo max. 600 containers max. 150 containers

It should be added that the rear weather deck 23 may very well be arranged at a lower level than the front weather deck 23', and then the first-mentioned part of the vessel does not have to be shielded against the waves to the same high extent. In this situation, the position of the refrigerated hold deck 130 relative to the weather deck may then be determined on the basis of the level of the front weather deck 23'.

Second fundamental embodiment of the invention

Fig. 3 shows an example of a conventional tanker 201 having a hull comprising a sheathing 202 and a weather deck 203 which constitutes the upward closure of the hull. The tanker 201 has a rear part 205 comprising the necessary machinery for the propulsion of the ship, fuel tanks and a deck superstructure comprising premises 206 for the crew and a navigating bridge 207. In addition, the ship 201 comprises a front part 215 with the stem and bulb of the ship, and a central part 209 with a hold 210. The hold 210 is formed by a tank which is shown in hatched line, and which comprises a plurality of independent compartments whose walls may be formed by the sheathing 202. The tank is defined upwardly by the weather deck 203 of the ship and downwardly by the bottom 208 of the ship. Ships of this type are typically constructed solely with a view to carrying an amount of liquid, primarily oil, as large as possible, and the ships will have no cargo in the tank when returning to the oil store. The tank is arranged to extend over about 80% of the total length of the tanker in the fore-and-aft direction of the ship.

Because of the current safety rules it is not allowed to carry a surface cargo in the form of e.g. containers

above the tank on the weather deck 203 on board conventional tankers, which unduly limits the owner's earnings. If the safety rules allowed such surface cargoes, the possible stacking height of e.g. containers on the weather deck 203 would be limited in any event when sailing without liquid in the tank, because the metacentre height in this load situation would be very high. Compensation of such stability conditions will generally require mounting of ballast tanks, the result of which is merely that the ship has to sail with a partial, unprofitable load in the form of pumped water. Tankers are thus generally inexpedient, because, if so allowed by the rules, only a relatively limited number of containers can be carried on the weather deck.

Fig. 4 shows a vertical longitudinal section through a transport ship 220 according to the second fundamental embodiment of the invention. The shown transport ship 220, like the conventional tanker, comprises a hull with a sheathing 222, a weather deck 223, 223', a bottom 218 and a hold. The hold is divided into three sections, and the rear part 225 of the ship comprises the machinery of the ship as well as a rear hold section 228. The front part 235 of the ship 220 comprises the stem of the ship and a front hold section 228'. Both the front and rear hold sections 228, 228' are defined upwardly by a respective part 223, 223' of the weather deck, which is formed with access hatches giving access to the hold sections 228, 228' with a view to vertical lowering of goods, in particular containers. To allow lowering of containers or other goods toward the bottom 218, the hatches are preferably arranged in the entire width of the hold sections 228, 228' like in conventional containerships, and the hatch covers are constructed to support a surface cargo in the form of containers 232, 232' placed on the weather deck 223, 223'. The front part 223' and the rear part 223

of the weather deck are moreover preferably at the same level above the base line of the ship as the weather deck 203 in the conventional tanker 201 (fig. 3).

In addition, the transport ship 220 comprises a central part 229 comprising a tank 230, and the extent of the tank 230 in the fore-and-aft direction of the ship preferably constitutes about 25% - 40% of the total length of the ship. The width of the tank 230 may preferably correspond to the width of the ship. The tank 230 is intended to transport liquid goods, such as wine, oil, chemicals or the like, and is defined upwardly by a horizontal tank wall 330, which may optionally comprise the conventional pipe stubs necessary for the filling and emptying. As shown, the front part 223' and the rear part 223 of the weather deck adjoin the tank 230. The transverse walls of the hold sections 228, 228' closest to the tank 230 are preferably substantially vertical and directly adjoin the tank 230, optionally via intermediate coffer dams.

In the embodiment shown in fig. 4, the upper, horizontal tank wall 330 is arranged at a height above the weather deck 223' of about 100% of the moulded depth of the ship measured to the weather deck 223' from the base line. Furthermore, the volume of the part of the tank 230 extending above the weather deck 223' corresponds to about 50% of the total volume of the tank 230. A comparison with the volume capacity of the conventional tanker 201 of a corresponding length shown in fig. 3 will show that selection of a suitable height of the tank wall 330 will generally provide the same volume capacity for liquid in the tank as in the conventional tanker.

Fig. 4 shows a situation where the ship 220 is fully loaded with liquid (indicated in hatched line) in the tank 230 and with a plurality of containers 232, 232'

(indicated in dot-hatched line) stacked above each other in the hold sections 228, 228' and on the weather deck 223, 223'. The stacking height of the containers 232, 232' will usually be limited partly owing to the stability of the ship against heeling and partly by international maritime rules, according to which the line of sight 204 from the navigating bridge must reach the surface of the sea at a distance from the stem corresponding to the length of the ship. As the containers may be stowed relatively low against the bottom 218 of the ship, a considerable number of containers can be carried without any danger to the stability of the ship, both without and with a cargo of oil in the tank 230.

Fig. 5 is a lateral more detailed view of the transport ship shown in fig. 4. The figure shows an example of an expedient stacking of the containers 232, 232' and a concrete construction of the tank 230. As will be seen, the tank 230 may consist of a plurality of independent cylindrical compartments, which have a vertically extending longitudinal axis, and which extend from the bottom 218 of the ship to the line of sight 204. The compartments may be arranged at a certain mutual distance and may optionally be adapted for the transport of various types of liquid.

Although fig. 5 shows containers 232, 232' arranged in all hold sections, it is clear that some or all of these hold sections 228, 228' may be filled with another type of goods, e.g. general cargo or particulate goods. Owing to the stability of the ship 220, particularly when sailing without liquid in the tank 230, it will be important to place a cargo, be it general cargo or containers, in the hold sections.

Table 2 below serves to illustrate some of the advantages of the invention. The table compares the capacity of e.g. a ship (see fig. 5) according to the invention constructed with a length of 180 metres and a width of about 30 metres, and with a tank 30 having a volume of 20,000 m^3 and a height from the weather deck 23' to the upper horizontal tank wall 130 of about 30 metres, with a conventional tanker as shown in fig. 3 with the same length/width and the same tank capacity. The cost of construction for both ships will typically amount to DKK 220 million (1997). For both vessels, the distance between the base line and the weather deck will be about 14 m.

TABLE 2

(Second fundamental embodiment of the invention)

CARGO COMBINATION		THE INVENTION	CONVENTIONAL SHIP
A	Oil	16,000 tons	16,000 tons
	Containers	0	0
B	Oil	16,000 tons	16,000 tons
	Containers		
	- on deck	about 1000	0
	- in hold	about 500	
C	Oil	0	0
	Containers		
	- on deck	about 1000	0
	- in hold	about 500	0

It should be added that the rear weather deck 223 may very well be arranged at a lower level than the front weather deck 223', as the first-mentioned part of the vessel does not have to be shielded against the waves to the same high extent. In this situation, the position of the upper wall 330 of the tank 230 relative to the

weather deck may be determined on the basis of the level of the front weather deck 223'.

Patent Claims:

1. A transport ship (20) having a hull comprising a sheathing (22), a weather deck (23, 23') and a hold (28, 28', 30), and having a front part (35), a rear part (25) and a central part (29), characterized in
- that the front part (35) of the ship comprises a hold section (28') defined by the hull and the weather deck (23'), and access hatches provided in the weather deck (23') to give access to said hold section (28'),
- that the rear part (25) of the ship comprises a hold section (28) defined by the hull and the weather deck (23), and access hatches provided in the weather deck (23) to give access to said hold section (28),
- that the central part (29) of the ship comprises a refrigerated hold section (30) defined by an upper thermally insulated refrigerated hold deck (130), a thermally insulated bottom and by thermally insulated walls (132, 133...) extending in the transverse direction and longitudinal direction of the ship, and
- that the weather deck (23, 23') is adapted to support a cargo.

2. A transport ship according to claim 1, characterized in
- that the upper refrigerated hold deck (130) is provided at a height above the weather deck (23, 23') of between 20% and 200%, preferably between 50% and 150%, of the moulded depth of the ship (20) measured to the weather deck (23, 23').

3. A transport ship according to claim 1 or 2, characterized in
- that the insulated walls (132, 133) extending in the transverse direction directly adjoin the hold section

(28, 28') in the front and/or rear part (25, 35) of the ship.

4. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that the thermally insulated walls extending in the longitudinal direction adjoin the sheathing (22) of the hull.

5. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that the upper refrigerated hold deck (130) is adapted to support a cargo.

6. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that the navigating bridge (27) of the ship and the premises (26) of the crew are provided on the upper refrigerated hold deck (130).

7. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that the refrigerated hold section (30) is provided with tween decks (31), and
- that the distance between the tween decks is about 2 m - 3 m, preferably about 2.25 m - about 2.5 m.

8. A transport ship according to the preceding claim, c h a r a c t e r i z e d in
- that the tween decks (31) are constructed as a grating, and that the cooling takes place by means of circulating air.

9. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in

- that the access to the refrigerated hold section (30) is provided in the thermally insulated walls.

10. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that the propulsion means of the ship are provided abaft the hold section (28) in the rear part (25).

11. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that the length of the refrigerated hold section (30) constitutes between about 20% and 50%, preferably between about 25% and 45%, of the total length of the ship.

12. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that the thermally insulated walls (132, 133...) of the refrigerated hold section (30) are arranged symmetrically about the midship section and the middle-line plane.

13. A transport ship according to any one of the preceding claims, c h a r a c t e r i z e d in
- that access hatches to the hold sections (28, 28') are provided substantially in the entire width of the hold sections (28, 28').

14. A transport ship (220) adapted for simultaneous transport of a cargo consisting of i) a liquid, particularly oil, and ii) a plurality of containers (232, 232') as well as iii) optionally at least one additional type of goods, said transport ship having:
- a hull comprising a sheathing (222), a weather deck (223, 223'), a bottom (218) and a tank (230) for storing and transporting said liquid, and
- a front part (235), a rear part (225) and a central part (229),

c h a r a c t e r i z e d in

- that the ship comprises a plurality of hold sections (228, 228') defined by the bottom (218) and the weather deck (223, 223'), said hold sections (228, 228') being adapted to store containers (232, 232') and/or the optional additional type of goods,
- that the weather deck (223, 223') is adapted to support containers (232, 232'),
- that the weather deck (223, 223') comprises access hatches giving access to said hold sections (228, 228'), and
- that the tank (230) for storing the liquid extends from the area at the bottom (218) of the ship upwards to a height above the weather deck (223, 223').

15. A transport ship according to claim 14, c h a r a c t e r i z e d in

- that the total volume capacity of the tank (230) essentially corresponds to the volume capacity of the tank in a conventional tanker (201) having a hull of corresponding dimensions.

16. A transport ship according to claim 14 or 15, c h a r a c t e r i z e d in

- that the tank (230) has a total volume capacity of between about 5,000 and 100,000 m^3, preferably about 40,000 m^3, and
- that the hold sections (228, 228') are adapted to accommodate a total of at least about 200, preferably at least about 450 standard containers.

17. A transport ship according to any one of the preceding claims 14-16, c h a r a c t e r i z e d in

- that the hold sections (228, 228') have transverse walls which are substantially vertical and which directly

adjoin the tank (230), optionally with intermediate cofferdams, and

- that the walls of the hold sections (228, 228') extending in the longitudinal direction of the ship are formed by the sheathing (222) of the hull.

18. A transport ship according to any one of the preceding claims 14-17, c h a r a c t e r i z e d in

- that the front part (235) of the transport ship comprises one of said hold sections (228'),
- that the rear part (225) of the transport ship comprises one of said hold sections (228), and
- that the central part (229) of the transport ship comprises said tank (230).

19. A transport ship according to any one of the preceding claims 14-18, c h a r a c t e r i z e d in

- that the tank (230) is divided into a plurality of independent compartments.

20. A transport ship according to the preceding claim, c h a r a c t e r i z e d in

- that the independent compartments are cylindrical or spherical.

21. A transport ship according to any one of the preceding claims 14-20, c h a r a c t e r i z e d in

- that the tank (230) extends upwards to a height above the weather deck (223, 223') of between 10% and 200%, preferably between 50% and 150%, of the moulded depth of the ship (220) measured to the weather deck (223, 223').

22. A transport ship according to any one of the preceding claims 14-21, c h a r a c t e r i z e d in

- that the tank (230) extends upwards to a height above the weather deck (223, 223') of at least about 10 metres, preferably at least 15 metres.

23. A transport ship according to any one of the preceding claims 14-22, c h a r a c t e r i z e d in
- that the volume of the tank above the weather deck (223, 223') constitutes at least 20%, preferably between about 40% and 60%, of the total volume of the tank.

24. A transport ship according to any one of the preceding claims 14-23, c h a r a c t e r i z e d in
- that access hatches to the hold sections (228, 228') are provided substantially in the entire width of the hold sections (228, 228').

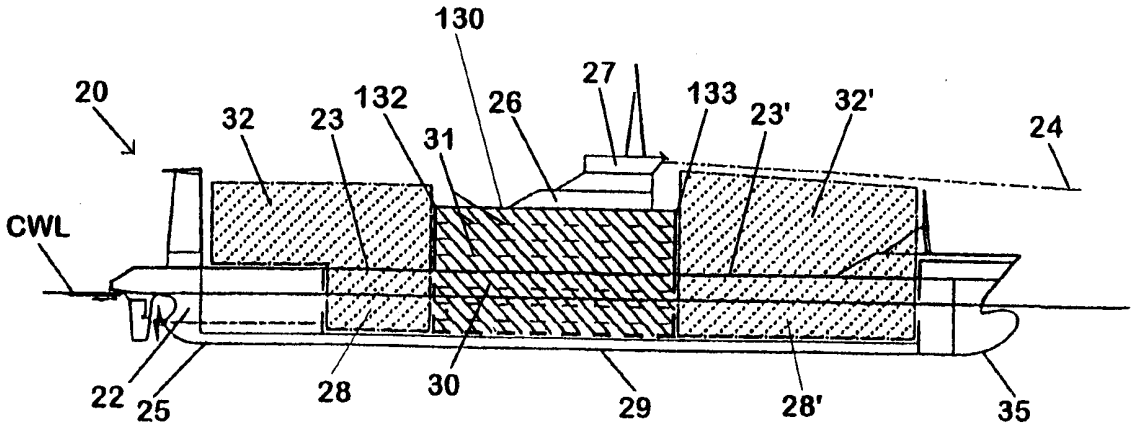
130
20
32
23
132
31
26
27
133
23'
32'
24
CWL
22
25
28
30
29
28'
35

FIG. 2

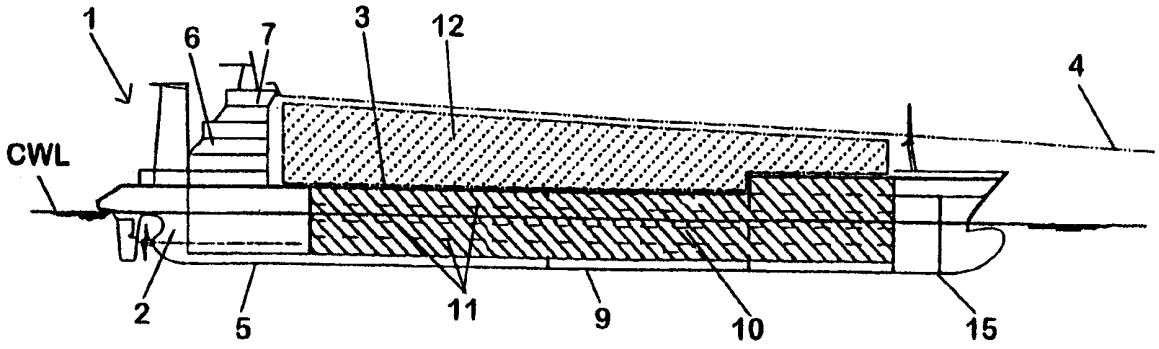
1
6
7
3
12
4
CWL
2
5
11
9
10
15

FIG. 1

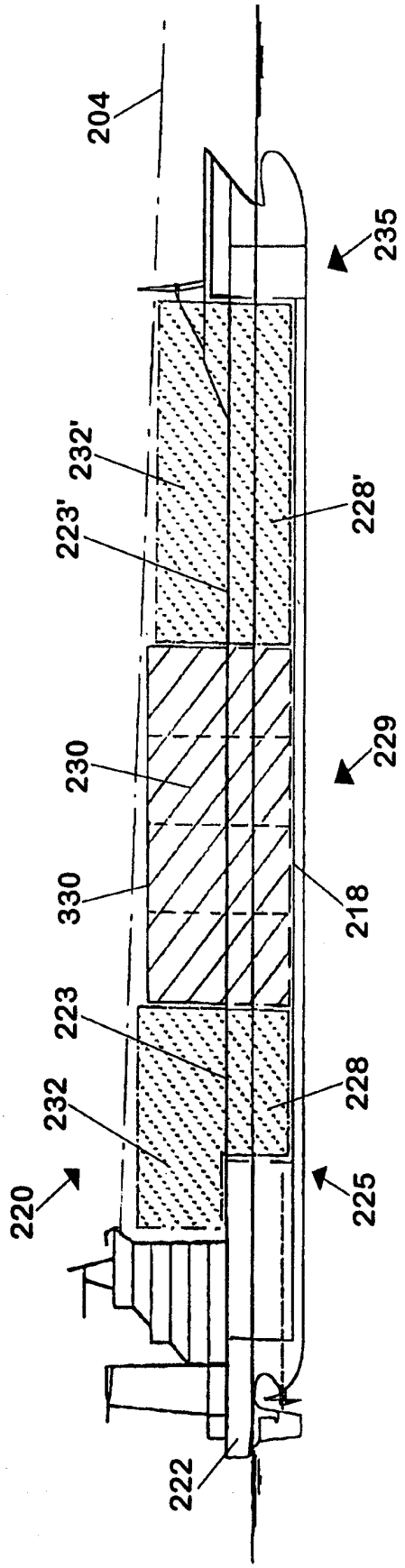
204
235
232'
223'
228'
230
229
330
218
223
228
232
220
225
222

FIG. 4

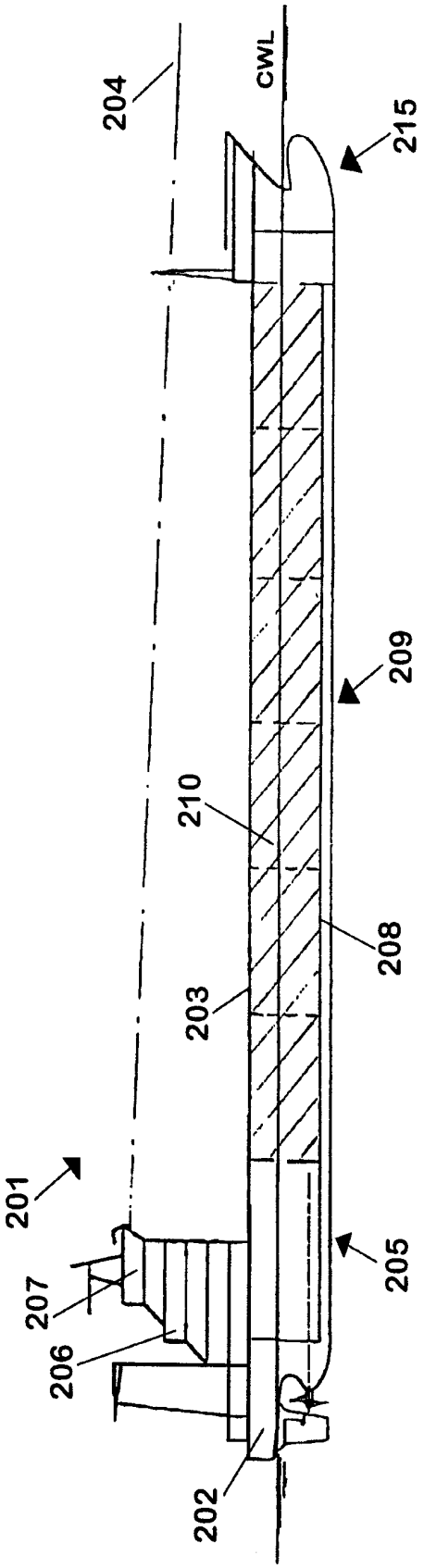
204
CWL
215
209
210
208
203
201
205
207
206
202

FIG. 3

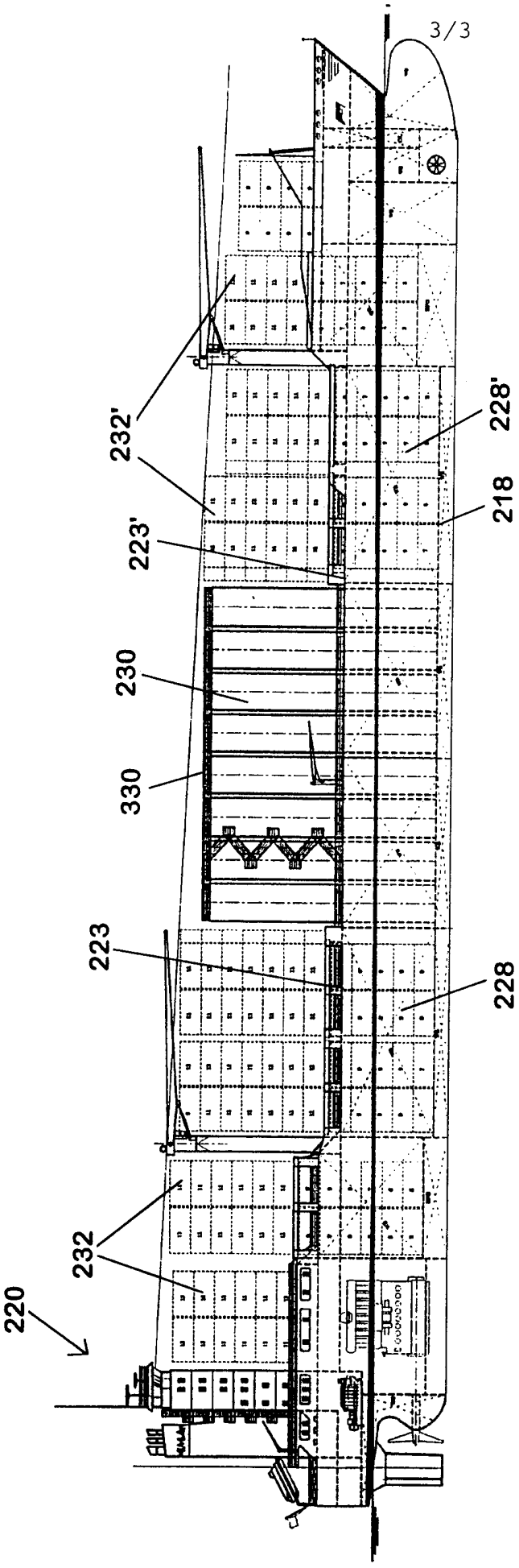

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 98/00527

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B63B 25/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 4225790 A1 (KVAERNER WARNOW WERFT GMBH), 3 February 1994 (03.02.94) --	1-24
A	RU 2081023 C1 (KESL), 10 June 1997 (10.06.97) -- --------	1-24

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 April 1999	10 -03- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Jönsson Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/02/99

International application No.
PCT/DK 98/00527

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4225790 A1	03/02/94	NONE	
RU 2081023 C1	10/06/97	NONE	