

May 23, 1961

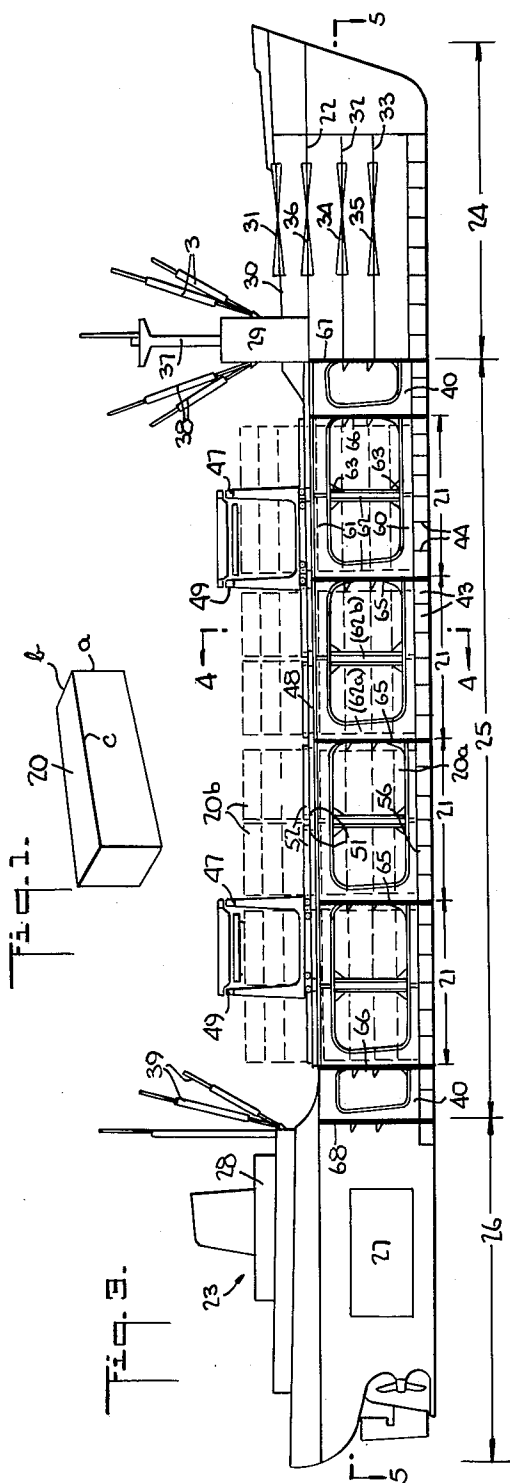
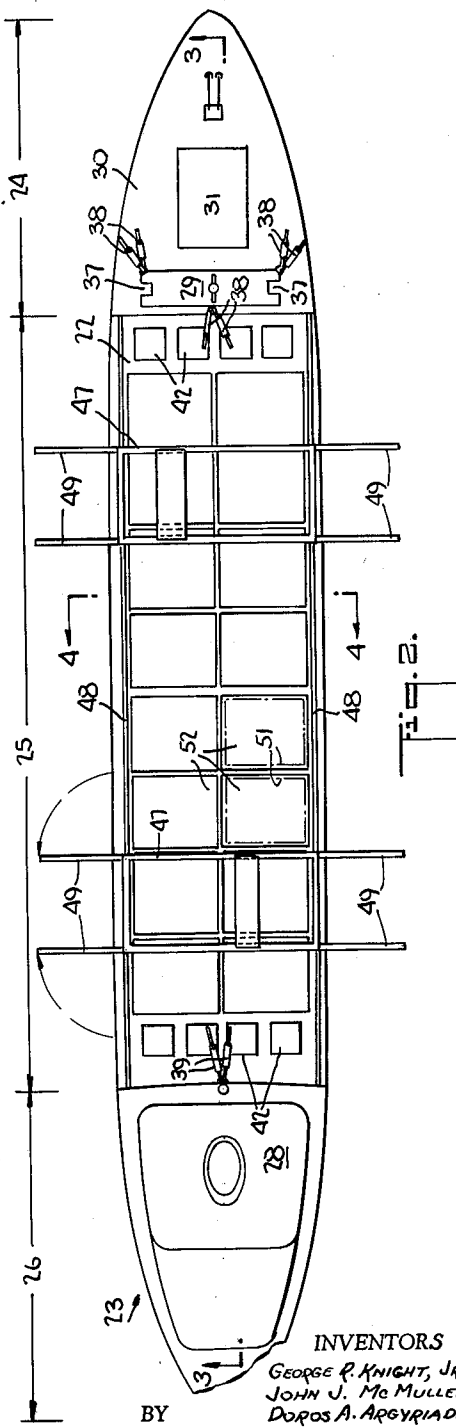
G. R. KNIGHT, JR., ET AL

2,985,131

CONTAINER SHIP

Filed March 24, 1959

5 Sheets-Sheet 1



BY

INVENTORS

GEORGE R. KNIGHT, JR.  
JOHN J. Mc MULLEN  
DOROS A. ARGYRIADIS

Kenny & Kenny  
ATTORNEYS

**2,985,131**

5 Sheets-Sheet 2



INVENTORS  
GEORGE P. KNIGHT, JR.  
JOHN J. McMULLEN  
DOROS A. ARGYRIADIS

*terryon terryon*  
ATTORNEYS

**May 23, 1961**

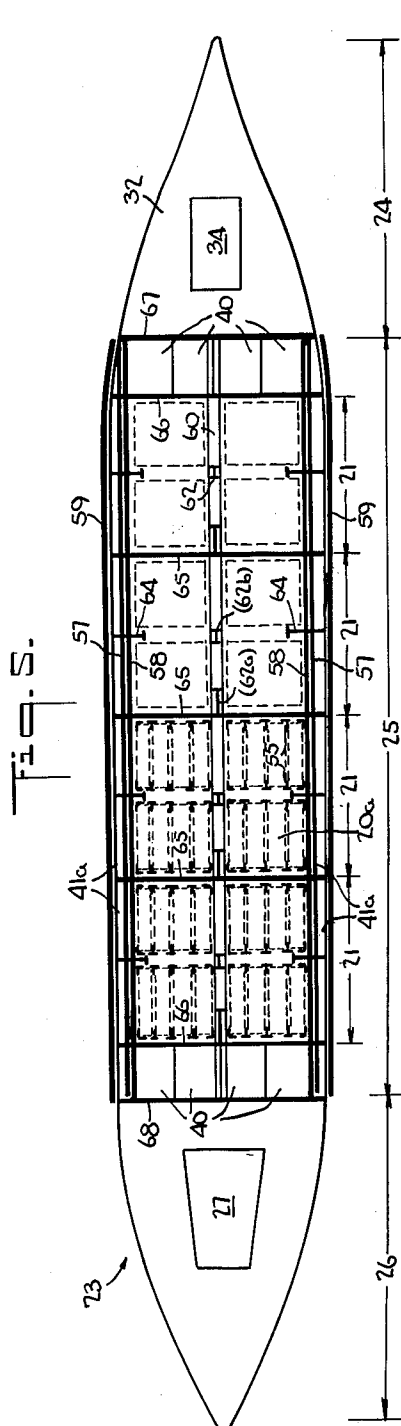
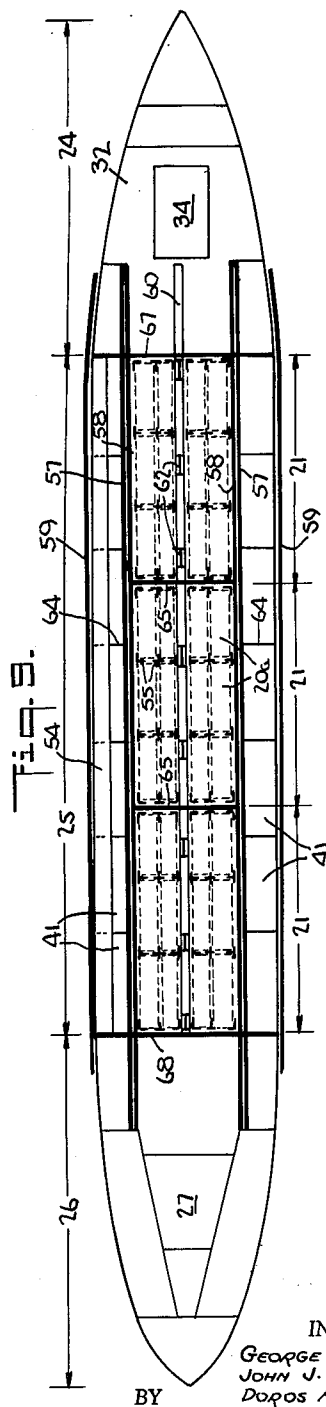
G. R. KNIGHT, JR., ET AL

**2,985,131**

CONTAINER SHIP

Filed March 24, 1959

5 Sheets-Sheet 3.



INVENTORS

GEORGE R. KNIGHT, JR.  
JOHN J. McMULLEN  
DOROS A. ARGYRIADIS

BY

Kenyon Kenyon  
ATTORNEYS

May 23, 1961

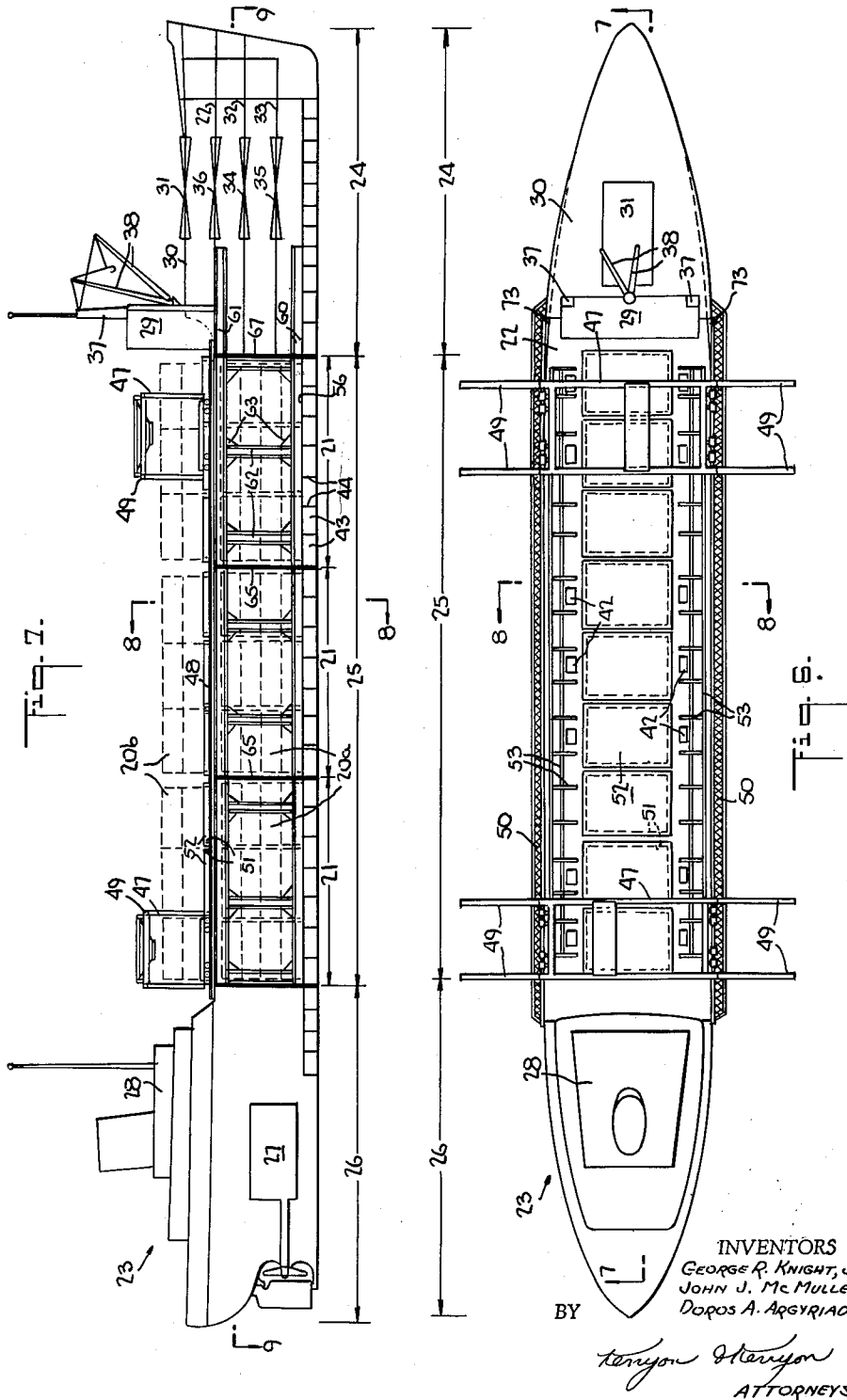
G. R. KNIGHT, JR., ET AL

2,985,131

CONTAINER SHIP

Filed March 24, 1959

5 Sheets-Sheet 4



May 23, 1961

G. R. KNIGHT, JR., ET AL

2,985,131

CONTAINER SHIP

Filed March 24, 1959

5 Sheets-Sheet 5

Fig. 10.

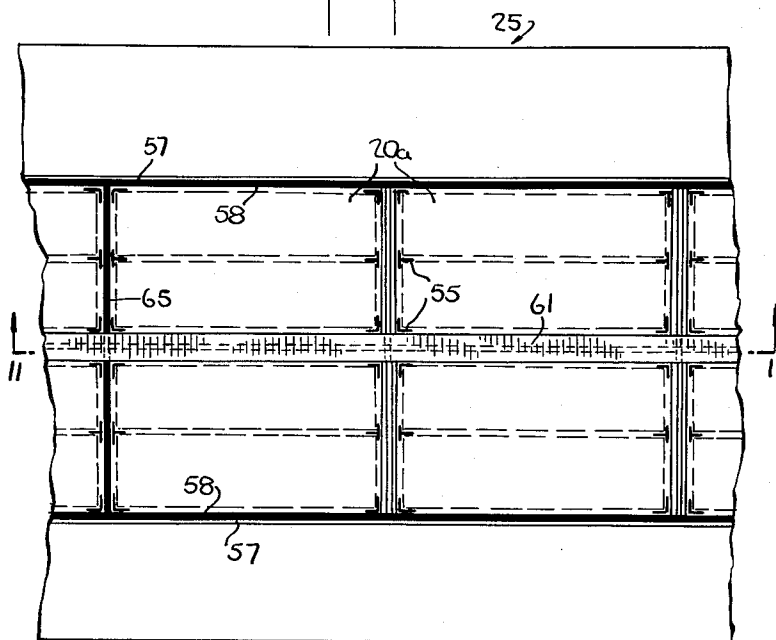
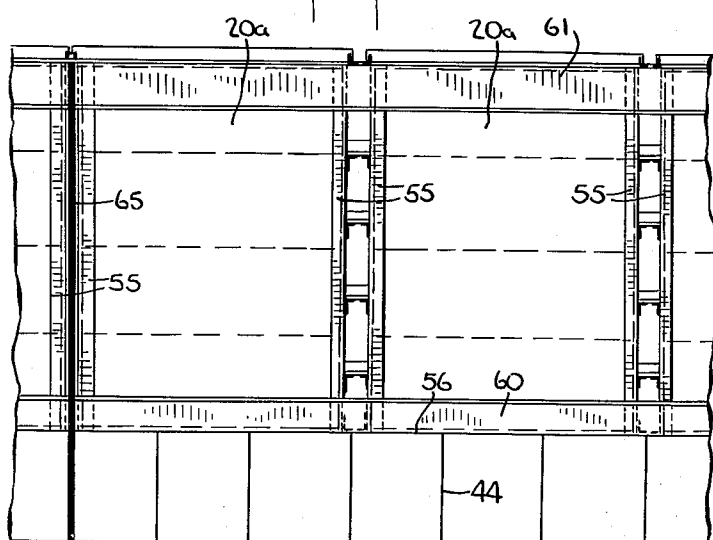


Fig. 11.



INVENTORS

GEORGE R. KNIGHT, JR.

JOHN J. MC MULLEN

DOROS A. ARGYRIADIS

BY

*Kenny H. Henson*  
ATTORNEYS

1

2,985,131

## CONTAINER SHIP

George R. Knight, Jr., 10 Glamford Ave., Port Washington, N.Y., John J. McMullen, E. Saddle River Road, Saddle River, N.J., and Doros A. Argyriadis, 10 East End Ave., New York, N.Y.

Filed Mar. 24, 1959, Ser. No. 801,588

5 Claims. (Cl. 114—72)

This invention relates to ships for storing and transporting by sea a quantity of relatively large, dry-cargo carrying containers. More particularly it relates to the arrangement and construction of such a vessel, which may be generally described as a container ship. The invention contemplates the conversion of existing tanker ships to such arrangement and construction.

It is well-known that a convenient method of transporting cargo between distant points would be to load the cargo into containers approximating in size truck trailer bodies for truck or rail transportation to water shipping points, and thereafter to load the containers into a ship for transportation to a seaport in the vicinity of the cargo destination. Upon arrival at the seaport, the containers would be unloaded from the ship to be delivered by truck or rail to the cargo destination point. It has not been understood, however, how a ship might be effectively arranged to load, unload, store and transport a sufficient quantity of such containers to make the operation profitable. The arrangement of the ship, at least in part, will be limited by the construction of the ship which must conform within conventional limitations imposed upon the design of ocean-going vessels.

It is therefore an object of the invention to provide a container ship arranged and constructed for the efficient, safe, and economical storing and transporting of cargo carrying containers, the ship construction being acceptable within conventional ship design limitations. The conventional limitations referred to are those relating to strength, floodability, and other seaworthiness characteristics of ships as propounded by the American Bureau of Shipping or other classification or regulating agencies.

It is intended that the arrangement of the ship will include efficient utilization of space which may be available for carrying container-cargo and further will include means for loading, unloading, and storing the containers aboard the ship in convenient and economical manner. Effective utilization of space may include provision for carrying cargo other than containers, such as bulk-cargo, and such is contemplated by the arrangement.

Because effective utilization of space involves storage of the containers in close proximity to each other and to structural portions of the ship, containers may be subject to damage by movement and pressure against each other caused by the longitudinal bending of the ship under working stresses as it passes through a seaway. It is therefore intended that the container ship will have the characteristic that its longitudinal deflection under working stresses will be a minimal amount. The invention provides a container ship construction having this characteristic.

It is realized that initial investment costs to build a ship for such a special purpose might be high. It has not been known, however, that a class of ships exists which may be economically converted into an efficient container ship. It is therefore an object of the invention to determine that an existing ship of a relatively common type may be altered so as to have the novel ar-

2

range and construction for the purpose. Furthermore, it is an object of the invention to teach a method whereby such an existing ship may be converted into a container ship at comparatively little expense.

5 Generally described the invention consists of a ship designed to carry a large quantity of relatively large size containers. The containers will be stored in container holds located in the middle body portion of the ship, and on the upper deck of the ship. The containers which  
10 are stored in the holds will be closely spaced and stacked between container guides in the holds in a manner eliminating necessity for lateral shoring thereof. The stacks of containers may rest on an inner bottom of the ship. The hatch covers over the container holds at the upper  
15 deck of the ship will be relatively large and strong enough to support additional containers thereon as deck-stored cargo. At least one rolling gantry bridge crane is provided on the upper deck, to move on rails located therealong. The gantry bridge crane may be constructed so  
20 as to provide a self-loading and self-unloading feature in the arrangement. To afford a measure of protection to deck-stored containers from the sea, the navigation bridge superstructure of the ship may be located forward of the middle body portion, and a forecastle of the ship may  
25 extend all the way forward of this superstructure. Tween decks may be provided in the forebody portion of the ship for carrying general cargo, and bulk-cargo deep tanks may be provided in the middle body portion at the forward and after ends thereof or as wing tanks of the  
30 ship. The arrangement may also include provision of ballast tanks located within the middle body portion for control of heeling of the ship, or to pre-heel the ship during loading or unloading operations.

To effectuate the novel arrangement, the ship should  
35 have relatively great longitudinal rigidity so that longitudinal deflection of the ship in a seaway will be negligible in amount, as aforesaid. Therefore, the invention includes a novel ship construction in which the ship is girdered to resist deflection. Generally described, the  
40 ship has two longitudinal bulkheads extending at least the length of its middle body portion and spaced apart on either side of the centerline of the ship to provide the container-cargo storage space therebetween. These bulkheads may be watertight. The longitudinal bulkheads  
45 have attached doubler plating along their entire lengths and located beneath the upper deck of the ship. In addition, doubler plating is attached to the sheer strake of shell plating of the ship, which is the first strake of plating below the upper deck at sides. The upper deck has  
50 relatively heavy deck plating extending the length of the middle body portion outboard of each longitudinal bulkhead to the sides of the ship. Between the longitudinal bulkheads, of course, the formation of relatively large hatchways over the container-cargo holds of the ship has  
55 eliminated plating which would ordinarily form the upper deck. The ship has at its longitudinal centerline a centerline girder construction which is formed by a center vertical upper deck girder, a center vertical keel of the ship, and centerline pillars therebetween. This centerline  
60 girder construction extends at least the length of the middle body portion of the ship. In addition, a number of transverse web frames of the ship are formed within the length of its middle body portion. To compartmentalize the ship at its middle body portion, several  
65 watertight transverse bulkheads are installed between the two longitudinal bulkheads. Watertight transverse bulkheads, of course, should be located at either end of the middle body portion to further compartmentalize the ship. A double-bottom of the ship formed between the  
70 longitudinal bulkheads provides an inner bottom for the container-cargo holds as well as ballast or fuel oil stor-

3

age tanks at either side of the center vertical keel which is preferably watertight.

It has been discovered that a ship having the general arrangement and construction described may be built by the simple expedient of converting thereto a tanker ship of ordinary design. Such a tanker ship would be one presently having a design classification referred to as "T-2." Thus, when altered for the purpose, the type T-2 tanker will determine a modified form of the invention.

The method of converting a tanker ship, such as that designated T-2, to the novel arrangement and construction will generally consist of removing all superstructure and all upper deck plating from the middle body portion of the ship, reinforcing the two existing longitudinal bulkheads and the sheer strakes of shell plating of the ship with longitudinally extending doubler plating beneath the upper deck, installing relatively heavy upper deck plating outboard of the longitudinal bulkheads to the sides of the ship, modifying a number of frames of the ship within the middle body portion effectively to form web frames, forming ballast storage tanks outboard of the longitudinal bulkheads at the turn of bilge of the ship, removing existing transverse bulkheads from between the longitudinal bulkheads in the middle body portion in a manner to leave the centerline bulkhead webs and other construction thereof to form the pillars of the previously described centerline girder construction, installing two new transverse watertight bulkheads within the length of the middle body portion between the longitudinal bulkheads, installing an inner bottom in the middle body portion between the longitudinal bulkheads, building a new navigation bridge superstructure of the ship forward of the middle body portion, and extending the existing forecastle of the ship in after direction to the navigation bridge superstructure.

Other modifications may be made outboard of the longitudinal bulkheads in the middle body portion to provide wing tanks for carrying bulk-cargo, and to the forebody of the ship to provide tween decks for carrying general cargo therein or truck chassis. Installation of preferably two rolling gantry bridge cranes and rails therefor at the upper deck will be necessary in the general arrangement. Also in the general arrangement will be the provision of relatively large hatch covers over the container-cargo holds, the hatch covers being adapted for storage of containers thereon. Because the existing ship may have camber and sheer at its upper deck, the method of conversion will include installation of a structural grid platform, or other container support means, outboard of the hatch covers to provide a flat surface for storage of other containers thereon.

Further objects and achievements of the invention will become apparent by reference to the drawings and to the following description thereof.

Figure 1 is a perspective view of a container to be carried aboard a container ship.

Figure 2 is a plan view of a container ship built in accordance with the invention as it would appear with hatch covers in place and without deck-stored containers.

Figure 3 is a sectional profile view taken along line 3—3 in Figures 2 and 4, showing locations of storage of containers. To show gantry crane operation, the view is not in section above the upper deck at the middle body portion of the ship.

Figure 4 is a sectional view taken along line 4—4 in Figures 2 and 3, which is a location somewhat forward of the midship section, showing locations of storage of containers.

Figure 5 is a section plan view of the ship taken along line 5—5 in Figures 3 and 4 to show the interior arrangement of the ship, showing the locations of storage of containers.

Figure 6 is a plan view of a modified form of a container ship formed by conversion of a type T-2 tanker

4

thereto as it would appear with hatch covers in place and without deck-stored containers.

Figure 7 is a sectional profile view of the converted ship taken along line 7—7 in Figures 6 and 8, showing locations of storage of containers. To show gantry crane operation, the view is not in section above the upper deck at the middle body portion of the ship.

Figure 8 is a sectional view of the converted ship taken along line 8—8 in Figures 6 and 7, which is a location somewhat forward of the midship section, showing the locations of storage of containers.

Figure 9 is a sectional plan view taken along line 9—9 in Figures 7 and 8 to show the interior arrangement of the converted ship, showing the location of storage of containers.

Figure 10 is a plan view of a middle body portion of a container ship to show in detail the container guide arrangement in the holds thereof, showing the positioning of the containers therebetween.

Figure 11 is a sectional profile view of the same middle body portion of a container ship, further to show the container guide arrangement in the holds thereof.

Referring to Figure 1, a typical container 20 to be loaded aboard the container ship 23 may be of relatively large size, approximating that of a truck trailer body. As an example, the height *a* of each of the containers 20 will be 8 feet, the width *b* will also be 8 feet, and the length *c* will be 27 feet. When loaded to a maximum each container will weigh approximately 30 tons. As shown in Figures 3 through 5, and 7 through 9, several hundreds of such containers will be carried aboard the container ship both below the deck as hold-stored containers 20*a* in the container holds 21, and on the upper deck 22 as deck-stored containers 20*b*.

Container ship 23 may be generally considered as being a wall-sided vessel having a forebody portion 24, a generally parallel middle body portion 25, and an afterbody portion 26. Propulsion machinery 27 is located in the afterbody portion 26, as is the deckhouse superstructure 28. The navigation bridge superstructure 29 is located at the forebody portion 24 to afford a measure of protection to deck-stored containers 20*b* from damage by the sea when the ship is under way. The forecastle 30 of the ship extends from the navigation bridge superstructure 29 to the bow of the ship, and may have therein a cargo hatch 31 for access to the upper deck 22 and to tween decks 32 and 33 located in the forebody portion 24. Cargo hatches 34 and 35 may be located in each of the tween decks 32 and 33, and cargo hatch 36 may be located in upper deck 22 of the forebody portion 24. The tween deck space may be used to carry any type of general cargo, such as vehicles or freight, but might also be used for storing and transporting additional numbers of containers 20. King posts 37 may be built into the navigation bridge superstructure 29, as may be forward-cargo handling gear 38. After-cargo handling gear 38 may be supported by deckhouse superstructure 28.

Further with reference to the general arrangement of the ship, the middle body portion 25 may have bulk-cargo deep tank storage spaces 40 at its forward and after end portions, as shown in Figures 3 and 5, or bulk-cargo wing tank storage spaces 41 at the sides of the ship, as shown in Figures 8 and 9. These spaces have hatch covers 42 thereabove, at upper deck 22, as shown in Figures 2 and 6. The ship may also have bottom tanks 43 in double-bottom 44 for storage of liquid ballast or fuel oil, and will have ballast storage tanks 45 at the bottom of the ship near its turn of bilge 46 to contain ballast to control heeling action of the ship, or to pre-heel the ship during loading or unloading operations. As shown in Figures 4 and 5, where narrow wing tanks 41*a* are provided at the sides of the ship, these may be used to carry fuel oil rather than bulk-cargo.

The general arrangement also includes rolling gantry bridge cranes 47 which move in longitudinal direction

along upper deck 22 within the length of the middle body portion 25. Cranes 47 roll along rails 48 which are attached at upper deck 22. The cranes 47, which are used to load and unload containers 20 aboard the ship, may be provided with folding jib extensions 49 which extend outboard of the ship over the dock during such operations, as will be apparent from reference to Figures 2 and 6.

The ship may have catwalks 50 extending outboard at either side thereof for walking passage between deck-house 28 and navigation bridge 29. Such a catwalk appears in Figures 6 and 8. It may be hinged at the side of the ship to fold upwardly, in the direction of the arrow shown in Figure 8, to form a liferail along the sides of the ship when not in use as a catwalk. Additionally, an interior passageway 54 may be formed below the upper deck at a side of the ship, as shown in Figures 4, 8 and 9.

Container holds 21 have large container-cargo hatchways 51 at upper deck 22 for access to each of the holds. Each of the container-cargo hatchways 51 has a large container hold hatch cover 52, and each hatch cover 52 may span a cargo hold completely in transverse direction, as shown in Figure 6, or may span the half-width of a cargo hold, as shown in Figure 2. These container hold hatch covers 52 may be of a pontoon-type, and are adapted to support deck-stored containers 20b thereon. They are built strong enough for the purpose, and are provided with flush-type cast steel inserts (not shown), or other container attachment means spaced to suit the locations of the corners of the containers which are attached thereto. Each of the containers may be provided with corresponding attachment means (not shown) at the corners thereof.

The container ship 23 is preferably built without sheer and without camber within the length of its middle body portion 25 so that deck-stored containers 20b may rest on a flat surface. However, where the ship may be built with sheer and camber, a structural grid platform 53, or similar container support means may be built on upper deck 22 in a manner to compensate for such sheer and camber to provide a level surface for additional deck-stored containers. Preferably, such a platform will be built flush with the tops of the container hold hatch covers 52, as appears in Figure 8. This structural grid platform 53 should also be provided with flush-type cast steel inserts, spaced thereon to suit the locations of corners of containers, for attachment of deck-stored containers 20b thereto.

As shown in Figures 5, 9, 10 and 11, each of the container holds 21 have container guides 55 for positioning hold-stored containers 20a therein. These container guides 55 extend vertically the height of each container hold, and may be formed of angle-iron or other similar simple steel shape welded in place. They are spaced to guide the corners of the containers as they are lowered into the hold. Because longitudinal deflection of the ship will be minimal in amount due to the construction thereof to be described, the container guides 55 may be spaced to provide relatively small clearance between themselves and the containers. For example, each guide need only clear a corner of a container by  $\frac{3}{8}$  of an inch as the container is lowered into the hold. The containers 20a are arranged in stacks within each of the container holds 21, and rest on an inner bottom 56 of the ship. Because of the close clearance between the containers and the guides, no lateral shoring of the containers will be necessary. The containers may be attached to each other at their tops and bottoms and to the inner bottom 56 to prevent vertical movement thereof.

Thus, the novel arrangement described facilitates efficient loading, storing, and unloading of containers to be carried aboard the ship. The ship is moored alongside the loading dock, and the folding jib extensions 49

of the cranes 47 are swung out thereover permitting the hoisting apparatus of the crane to move out over the dock to hoist the containers aboard the ship. The cranes 47 may be moved longitudinally along the length of the middle body portion 25 of the ship to position hoisted containers for lowering into container holds 21. Prior to this operation the hatch covers 52 over the container holds 21 have been removed. After a number of containers have been loaded into the container holds it may be advisable to compensate for natural heeling of the ship due to their weight prior to loading additional containers aboard the ship. The heeling of the ship under the weight of loaded containers may cause difficulty when lowering the additional containers between container guides 55 because the guides will no longer be vertically arranged with respect to the containers to be lowered therebetween. Compensation for heeling may be brought about by flooding a proper number and selection of ballast storage tanks 45 at either side of the ship. Hatch covers 52 are replaced after the container holds 21 have been filled, whereupon additional containers may be similarly loaded aboard the ship and stored on the hatch covers 52, as aforesaid. Because no dock crane or other means exterior of the ship will be required to load containers thereaboard, the container ship may be described as self-loading. General cargo, including bulk-cargo, may be loaded aboard the ship to be placed in bulk-cargo deep tanks 40, or in wing tanks 41, or into the spaces provided by tween decks 32 and 33.

Self-unloading of the containers from the vessel is performed by reversing the procedure above described. During unloading it may be desirable to pre-heel the ship by flooding a proper number and selection of ballast tanks 45 located on the side of the ship from which a container will first be taken. Thus, prior to lifting the container the ship will be in heeled condition and the container guides will not be vertical. But as soon as a crane 47 lifts and fully supports the weight of a container, the ship will heel of its own accord in opposite direction to cause the container guides 55 to be vertically aligned for the lifting of the container out of the hold.

To prevent flexing of the ship as it passes through a seaway, which flexing or bending may cause damage to the containers stored thereaboard as aforesaid, the container ship 23 should be constructed so as to possess a characteristic relatively great longitudinal rigidity and resistance to longitudinal deflection. For example, whereas a ship of the length contemplated having ordinary design, but which might be arranged to carry containers of the type described, may deflect longitudinally over its length a distance of about 9 inches, the construction herein to be described will cause longitudinal deflection not to exceed 1 inch.

Referring to Figures 4 and 5, and 8 and 9, the construction of the container ship 23 includes two vertical longitudinal bulkheads 57 which extend at least the length of the middle body portion 25 of the ship. These longitudinal bulkheads 57, which are preferably continuous, are spaced apart, one on either side of the longitudinal centerline of the ship, to provide space for storage of containers therebetween. Longitudinally extending doubler plating 58 is attached to each of the longitudinal bulkheads 57 along their entire lengths and located just beneath upper deck 22. Sheer strake doubler plating 59 is attached along each of the sides of the ship to extend at least the length of middle body portion 25. It is preferred that all doubler plating be riveted on.

Upper deck 22, outboard of each of the longitudinal bulkheads 57, is formed by relatively heavy plating which extends at least the length of middle body portion 25. The deck plating should be sufficiently heavy to compensate for removed deck strength inboard of the longitudinal bulkheads 57 due to the presence of the large container-cargo hatchways 51.

A longitudinal centerline girder construction extends at least the length of middle body portion 25. This girder construction is formed by the center vertical keel 60 of the ship, a center vertical upper deck girder 61 of the ship, and pillars 62 therebetween. Preferably, as shown in Figure 3, the pillar arrangement may include web pillar construction (62a) as well as structural shaped pillars (62b). Alternatively, as generally shown in Figure 7, all of the pillars 62 may be of structural shape. Where structural shaped pillars 62 are employed, gussets 63 should be installed between the pillars and the upper deck girder 61 and center vertical keel 60.

Referring to Figures 5 and 9, a number of transverse web frames 64 of the ship are installed within the length of the middle body portion 25. Web frames 64 may be shaped as shown in Figure 4. Alternatively, as shown in Figure 8, web frames 64 may be of built-up construction. The locations of the web frames 64 within the length of middle body portion 25 should be generally as shown in the figures of the drawings.

To compartmentalize the middle body portion 25 of the ship, and also further to reduce longitudinal deflection, a number of transverse bulkheads 65 are installed to extend between longitudinal bulkheads 57 within the middle body portion 25. Because the spacing of transverse bulkheads 65 will determine the size of container holds 21, these bulkheads should be spaced apart a distance related to the size of the containers 20 so that cargo space may be conserved. Thus, as shown in Figures 3 and 5, transverse bulkheads 65 may be spaced apart for lengthwise storage of two stacks of containers, or, as shown in Figures 7 and 9, they may be spaced apart for lengthwise storage of three such stacks. Additional transverse bulkheads 66 may be located within the middle body portion 25, towards either end thereof, to determine bulk-cargo deep tank spaces 40, as shown in Figures 3 and 5. Middle body portion 25 is further separated from forebody portion 24 and afterbody portion 26 by a transverse bulkhead 67 at the forward end thereof and a transverse bulkhead 68 at the after end thereof, as shown in the several figures of the drawings.

The space outboard of each of the longitudinal bulkheads 57 may be partitioned along its length as desired to form wing tanks 41 and ballast tanks 45. The longitudinal bulkheads 57 are preferably watertight, as should be the center vertical keel 60. Inner bottom 56 between the longitudinal bulkheads 57 permits formation of fuel oil or additional ballast storage space within double-bottom 44. A second inner bottom 56a, outboard of each longitudinal bulkhead 57, forms the tops of ballast storage tanks 45.

The construction of container ship 23 as well as its general arrangement will become more fully apparent from the following detailed description of each of the modified forms thereof illustrated in the drawings. In addition, a feature of the container ship construction and arrangement is its adaptability to formation by conversion thereto of a tanker vessel having ordinary design. Thus, a novel method of converting a type "T-2" tanker into container ship will be described within Example 2.

#### Example 1

As an example of the container ship construction and arrangement described, reference is made to Figures 2, 3, 4, and 5 of the drawings. Appropriate general dimensions of a ship so constructed and arranged for storage and transportation of 512 containers would be as follows:

|                               |         |
|-------------------------------|---------|
| Length over all               | 542' 6" |
| Length between perpendiculars | 510' 0" |
| Molded beam                   | 80' 6"  |
| Molded depth                  | 43' 0"  |
| Approximate draft             | 29' 0"  |

Pertinent information relating to the containers to be carried is as follows:

|                                   |                         |
|-----------------------------------|-------------------------|
| Container size                    | 27' 0" x 8' 0" x 8' 0". |
| Maximum container weight (loaded) | 30 tons each.           |
| Number of containers stored:      |                         |
| In holds                          | 320.                    |
| On upper deck                     | 192.                    |

The ship will be built without sheer and without camber within the length of its middle body portion 25.

Longitudinal bulkheads 57 are each located about 34' 3" from the longitudinal centerline of the ship, leaving approximately 6' 0" outboard thereof for wing tanks 41a along either side of the ship. Doubler plating 58, attached to each of the longitudinal bulkheads 57, is of 40.8# (1.0") plate, 86" high, the upper edge thereof being located 26" above the level of the upper deck 22. The sheer strake doubler 59 is of 35.7# (.875") plate, 50" high, and is attached to 45.9# (1.125") plating, 72" high, which forms the sheer strake of the ship. Upper deck 22, outboard of each of the longitudinal bulkheads 57 to the sides of the ship, is of 40.8# (1.0") plate, and has a deck doubler plating thereabove which is of the same sized plate.

Center vertical upper deck girder 61 of the ship is of 20.4# (.50") plate, 10' 2" high, with 18" x 40.8# (1.0") flanges, the upper edge thereof being also located 26" above the level of upper deck 22. Upper deck girder 61 has vertical stiffeners (not shown) therealong which are generally of 8" x 1/2" flat bar.

The center vertical keel 60 of the ship is 10' 0" high and is of 26.5# (.65") plate below the level of inner bottom 56, and of 20.4# (.50") plate above that level. It has an upper flange generally therealong of 18" x 40.8# (1.0") plate, and vertical stiffeners (not shown) therealong which are generally of 5" x 3 1/2" x 5/16" angle-iron. The height of double-bottom 44, and thus the level of inner bottom 56, is 5' 0" above the molded base line.

Web frames 64, which are shaped generally as shown in Figure 4, are of 20.4# (.50") plate, with a 15" x 40.8# (1.0") flange as indicated therearound. They have generally 6" x 3/8" flat bar stiffeners (not shown), except at the areas immediately above inner bottom 56 where stiffeners (not shown) are of 7" x 4" x 3/8" angle-iron.

All stiffeners (not shown) are arranged in usual manner, following standard practice.

Web pillar construction (62a) tapers in width from 6' 0" at an upper region thereof to 7' 0" at a lower region, and is of 20.4# (.50") plate, with a 6" x .50" flange. It has 6" x 3/8" flat bar stiffeners (not shown), and should be bracketed to a transverse bulkhead 65 at several locations along its height by generally 3' 6" x 3' 6", 45 degrees, horizontally extending brackets (not shown), according to good practice. Structural shaped pillars (62b), which are located at the web frames 64, are of 20.4# (.50") plate, 24" wide, with 18" x 40.8# (1.0") flanges. Gussets 63 are 4' 0" x 4' 0", 45 degrees, and are also of 20.4# (.50") plate, with an 18" x 40.8# (1.0") flange.

Middle body portion 25 of the ship is arranged to include four container holds 21 and eight bulk-cargo deep tanks 40, four of the latter being located at each end thereof, as shown in Figures 3, 4 and 5.

It is suggested that salt water ballast be carried within the bottom tanks 43, and that fuel oil be stored within wing tanks 41a.

Rails 48 for two rolling gantry bridge cranes 47 are attached at upper deck 22 just outboard of each of the longitudinal bulkheads 57, as generally indicated in Figure 4. Cranes 47 may be diesel driven, or may be electrically operated off the main electrical power supply system of the ship.

Other features of the construction and arrangement of

the ship will be apparent from the drawings, all of which may be included within the constructed ship by application of ordinary skill to the disclosed principles thereof.

The novel arrangement and construction may be more often employed when building a container ship anew. The following Example 2 describes how an existing ship may be altered, or converted into a container ship having essentially the same novel arrangement and construction.

#### Example 2

Heretofore it has not been understood that an ordinary tanker ship within a class having a common designation "T-2" might be altered, or converted into a container ship, and that such conversion might be economically effected. Accordingly, as aforesaid, it is a distinct object of the present invention to provide a method whereby such a tanker ship may be made over into a container ship for the safe, economical, storing and transporting of 288 containers, the converted ship being a modified form of the invention having all of the characteristics, features, and achievements hereinabove described. The novel method generally comprises the steps of eliminating, modifying and adding to structural portions of a T-2 tanker, the steps being considered in combination and not involving any particular sequence in the performance thereof. It may be that other ships, regardless of type designation, may have structural features similar to those of a type T-2 tanker causing them to be adapted for the practice of the method herein disclosed. Such ships also are within the contemplation of the invention.

Reference is made to Figures 6, 7, 8 and 9 of the drawings which show a modified form of container ship arrangement and construction. To illustrate the method of converting a ship thereto, a tanker having the following specifications has been selected:

|                               |          |
|-------------------------------|----------|
| Type                          | T2-SE-A1 |
| Length over all               | 523' 6"  |
| Length between perpendiculars | 503' 0"  |
| Molded beam                   | 68' 0"   |
| Molded depth                  | 39' 3"   |
| Molded draft                  | 29' 11½" |

Pertinent information relating to the containers to be carried is as follows:

|                                   |                         |
|-----------------------------------|-------------------------|
| Container size                    | 27' 0" x 8' 0" x 8' 0". |
| Maximum container weight (loaded) | 30 tons each.           |
| Number of containers stored:      |                         |
| In holds                          | 144.                    |
| On upper deck                     | 144.                    |

The ship has existing longitudinal bulkheads 57, which are continuous and watertight, each located about 17' 6" from the longitudinal centerline of the ship, leaving approximately 16' 6" outboard thereof for wing tanks 41 along either side of the ship. The ship also has six existing transverse bulkheads (not shown) extending between longitudinal bulkheads 57 within the length of its middle body portion 25 at locations approximately those of the most centrally located pillars 62 as shown in Figures 7 and 9. Each of these six bulkheads will be removed in a manner to be described. The ship further has an existing navigation bridge superstructure (not shown), and other superstructure (not shown) at its upper deck 22 within the length of its middle body portion 25. All of this superstructure will be removed. Transverse bulkheads 67 and 68 are existing bulkheads. The ship should be considered as in a condition stripped of all fluid-cargo piping and handling equipment which might ordinarily be found both above and below decks when in use as a tanker. In general, no relocation or alteration of the propulsion machinery of the ship will be necessary, and it is here contemplated that the ship will be arranged to carry bulk-cargo in wing tanks 41 to be formed, and general cargo or vehicle chassis on

tween decks 32 and 33 also to be formed generally as shown.

Essentially what is done during conversion is to remove all existing upper deck plating and superstructure from the middle body portion 25 of the ship as well as the aforementioned six transverse bulkheads, and to divide that portion of the ship into three large container holds 21 by installing two new watertight transverse bulkheads 65 between longitudinal bulkheads 57. The existing length of the middle body portion 25 of a T-2 tanker is such that three container holds 21 of relatively ideal size will be provided. On other ships of different size but having similar structure it may be that certain existing bulkheads are so located as to serve the purpose without removal, or that fewer or more than two new transverse bulkheads 65 will be desirable. Such arrangements are contemplated by the invention. In the example being described, it is thought that only two such bulkheads may be required to cause the ship to be within a recommended floodability classification, or to contribute sufficiently to the desired reduction of longitudinal deflection of the ship under working stresses. Vertically extending container guides 55, made of angle-iron shapes, are installed in each container holds 21 in the manner illustrated in Figures 10 and 11.

The aforesaid six existing transverse bulkheads are not entirely removed, but a portion of each, including its existing centerline web, is left standing as a pillar 62 between the existing center vertical keel 60 and the existing center vertical upper deck girder 61 of the ship. The transverse length of that portion of each to remain may be about 18". Gussets 63 are also existing. This remaining structure effectively forms the referred to central ship girder construction which contributes to longitudinal rigidity and consequent reduction of longitudinal deflection of the ship.

Doubler plating 58 is riveted on to each of the longitudinal bulkheads 57. The doubler is of 40.8# (1.0") plate, 42" high, the upper edge thereof being located about 40' 10" above the molded base line when the existing camber of upper deck 22 is considered. A sheer strake doubler 59, formed of 60.0# (1.25") plate, 4' 0" high, is riveted on to each sheer strake of shell plating of the ship. A new upper deck 22 is installed outboard of each of the longitudinal bulkheads 57 to the sides of the ship. New upper deck 22 should be of 60.0# (1.25") plate, and should have longitudinal stringers 69 of 8" x 4" x ½" angle-iron therebelow, as shown in Figure 8.

An inner bottom 56 is installed between longitudinal bulkheads 57 to extend at least the length of middle body portion 25. Inner bottom 56 should be located about 6' 0" above the molded base line, and should be made of .50" plate. It is of usual construction, having longitudinal stringers (not shown) of 10" x 4" x .44" angle-iron. In addition, another new inner bottom 56a is installed outboard of each of the longitudinal bulkheads 57 at a height of about 8' 7" above the molded base line to form the tops of ballast storage tanks 45. Inner bottom 56a is of .50" plate, and also involves usual construction, including longitudinal stringers (not shown) of 10" x 4" x .44" angle-iron.

Partly to improve installation of both inner bottoms 56 and 56a, and partly in connection with modification to be performed on existing frames of the ship to effectively form web frames 64 thereof, the existing floors and webs of the ship below both new inner bottoms 56 and 56a should be extended in height to that of the respective inner bottom. Also, the aforementioned six existing transverse bulkheads (not shown) should be burned off at the height of inner bottom 56 during their removal.

A number of existing transverse frames of the ship within the length of middle body portion 25 are modified to effectively form web frames 64. The general shape of each web frame 64 is shown in Figure 8. Inboard of

longitudinal bulkheads 57, the height of the floor of the ship at each of such frames is increased to that of inner bottom 56 by addition of .50" plate thereto, and the height of the lower web of the frame, outboard of longitudinal bulkheads 57, is increased to that of inner bottom 56a by addition of .50" plate thereto. In addition, new bracket 70 is formed of .50" plate with 5" flange. Bracket 70 is about 3' 9", x 3' 9", 45 degrees. Bracket 71 is also added, and is of .50 plate with 5" flange, being about 2' 9" long by 2' 0" high. A new strut 72 is of 10" x 3 1/2" x 28.3# channel iron, welded between existing ship members. Although suitable modifications of the frames to form web frames 64 has thus been accomplished, it is understood that by application of ordinary skill to the principles involved other equivalent web frame construction might be formed. Such other construction is contemplated by the invention.

An interior passageway 54 may be formed within the length of middle body portion 25 generally in the manner indicated in Figures 8 and 9.

The ship has three large container-cargo hatchways 51 formed at upper deck 22 above each container hold 21. Each hatchway 51 is closed by a single pontoon-type hatch cover 52 which extends in transverse direction the full distance between longitudinal bulkheads 57. These hatch covers 52 will be dogged over knife edges for watertightness, in a usual manner. They are adapted by their strength and by inclusion of attachment means to support deck-stored containers 20b thereon.

Structural grid platform 53 is constructed flush with the tops of hatch covers 52 outboard thereof, as indicated in Figures 6 and 8. Additional containers 20b will be stored thereon, as aforesaid.

Two rolling gantry bridge cranes 47, each with folding or retractable jib extensions 49, are provided at upper deck 22, as shown in Figures 6 and 7. Cranes 47 are mounted on rails 48 which, as may be seen in Figure 8, are attached along the length of middle body portion 25 at the sides of the ship atop the sheer strake of shell plating and sheer strake doubler 59. Referring to Figure 6, because in plan view the sides of upper deck 22 of a T-2 tanker begin to curve toward the bow of the ship at the forward end of middle body portion 25, a flared sponson 73 should be attached to the shell plating at both sides of the ship below upper deck 22 to extend the width of upper deck 22 in these regions to permit rails 48 to extend a proper length so that a crane 47 may be positioned over the forwardmost hatchway 51. Gantry bridge cranes 47 may be electrically operated off the main electrical power supply of the ship.

Catwalks 50, which may pivot upwardly to form a liferail as previously explained, are attached along the sides of the ship.

A new navigation bridge superstructure 29 is built in the location shown in Figures 6 and 7, which is forward of middle body portion 25 for the purpose above described. The ship has an existing forecastle extending in after direction from the bow about half the length of forebody portion 24. This forecastle is extended further in after direction all the way to navigation bridge superstructure 29, thus forming the indicated forecastle 30 of the ship.

Outboard of each of the longitudinal bulkheads 57 the middle body portion 25 is suitably partitioned along its length to form wing tanks 41, as shown in Figure 9, for carrying grain, or other bulk-cargo. Watertight hatch covers 42 are provided over hatchways thereabove at upper deck 22.

Forebody portion 24 of the existing ship is substantially altered by removal of decks, bulkheads and other structures, to install tween decks 34 and 35 therein. This alteration may be made in a manner conforming to usual good practice.

Thus, a modified form of container ship 23 has been

constructed using a novel method for converting a type T2-SE-A1 tanker ship thereto.

By the construction and arrangement herein disclosed, a container ship has been devised to store and transport an economical number of large, cargo-carrying containers as well as other cargo. At the same time, and because the construction of the ship will limit the amount of longitudinal deflection thereof under working stresses, the containers so stored and transported will remain free from damage which might otherwise be caused by bending action of the ship. Furthermore, it has been demonstrated that an existing ship, having a relatively common type designation, may be readily converted into the novel construction and arrangement.

Using the principles herein disclosed, it may be that equivalent arrangements and construction may be devised. It is therefore intended that the scope of the invention not be limited to the modified forms described, but that the principles thereof are applicable wherever the objects of the invention are sought to be achieved.

What is claimed is:

1. A method for converting a tanker ship into a container ship for storing and transporting by sea a quantity of cargo-carrying containers, each of said containers being approximately the size of a truck trailer body, said ship having two vertical longitudinal watertight bulkheads extending at least the length of a middle body portion of said ship, said longitudinal bulkheads being spaced apart one on either side of the longitudinal centerline of said ship providing container storage space therebetween, said ship having at least a watertight transverse bulkhead extending between said longitudinal bulkheads and a plurality of web frames of said ship located within the length of said middle body portion, said ship having a centerline girder construction extending at least the length of said middle body portion and formed by a center vertical keel, a center vertical upper deck girder and centerline pillars therebetween, substantially all fluid-cargo handling equipment including pipe lines having been removed from said ship, said method comprising in combination the steps of forming a plurality of container-cargo hatchways in the upper deck of said ship in said middle body portion, said hatchways effecting removal of substantially all upper deck plating from said middle body portion between said longitudinal bulkheads, installing hatch cover means to close said hatchways, adapting said hatch cover means for upper deck storage of other containers thereon, attaching longitudinally extending doubler plating to each of said longitudinal bulkheads beneath said upper deck, installing relatively heavy upper deck plating of said ship extending at least the length of said middle body portion and located outboard of each said longitudinal bulkheads to the respective sides of said ship, attaching longitudinally extending sheer strake doubler plating to each of the sides of said ship and extending at least the length of said middle body portion, installing container support means in said container storage space between said longitudinal bulkheads, and installing rolling gantry bridge crane means at said upper deck for operation within the length of said middle body portion for loading and unloading each of said containers aboard said ship.

2. A method for converting a tanker ship into a container ship for storing and transporting by sea a quantity of cargo-carrying containers, each of said containers being approximately the size of a truck trailer body, said ship having two vertical longitudinal watertight bulkheads extending at least the length of a middle body portion of said ship, said longitudinal bulkheads being spaced apart one on either side of the longitudinal centerline of said ship providing container storage space therebetween, said ship having a plurality of spaced apart watertight transverse bulkheads each extending between

13

said longitudinal bulkheads at a location within the length of said middle body portion, and said ship having a centerline girder construction extending at least the length of said middle body portion and formed by a center vertical keel, a center vertical upper deck girder and centerline pillars therebetween, said pillars being centerline bulkhead webs of said transverse bulkheads; substantially all fluid-cargo handling equipment including pipe lines having been removed from said ship, said method comprising in combination the steps of removing said existing transverse bulkheads except for a centerline portion of each including said bulkhead webs, modifying a plurality of existing frames of said ship located within the length of said middle body portion to effectively form web frames thereof, installing a plurality of other watertight transverse bulkheads each extending between said longitudinal bulkheads at a location within the length of said middle body portion, said other transverse bulkheads being spaced apart a distance related to the size of said containers to form container holds therebetween, forming a plurality of container-cargo hatchways in the upper deck of said ship in said middle body portion above each of said container holds, said hatchways effecting removal of substantially all upper deck plating from said middle body portion between said longitudinal bulkheads, installing hatch cover means to close said hatchways, adapting said hatch cover means for upper deck storage of other containers thereon, attaching longitudinally extending doubler plating to each of said longitudinal bulkheads beneath said upper deck, installing relatively heavy upper deck plating of said ship extending at least the length of said middle body portion and located outboard of each of said longitudinal bulkheads to the respective sides of said ship, attaching longitudinally extending sheer strake doubler plating to each of the sides of the said ship, and extending at least the length of said middle body portion, installing container support means at said container storage space between said longitudinal bulkheads, and installing rolling gantry bridge crane means at said upper deck for operation within the length of said middle body portion for loading and unloading each of said containers aboard said ship.

3. A method for converting a tanker ship into a container ship for storing and transporting by sea a quantity of cargo-carrying containers, each of said containers being approximately the size of a truck trailer body, said ship having two vertical longitudinal watertight bulkheads extending at least the length of a middle body portion of said ship, said longitudinal bulkheads being spaced apart one on either side of the longitudinal centerline of said ship providing container storage space therebetween, said ship having a plurality of spaced apart watertight transverse bulkheads each extending between said longitudinal bulkheads at a location within the length of said middle body portion, and said ship having a centerline girder construction extending at least the length of said middle body portion and formed by a center vertical keel, a center vertical upper deck girder and centerline pillars therebetween, said pillars being centerline bulkhead webs of said transverse bulkheads, substantially all fluid-cargo handling equipment including pipe lines having been removed from said ship, said method comprising in combination the steps of removing said existing transverse bulkheads except for a centerline portion of each including said bulkhead webs, modifying a plurality of existing frames of said ship located within the length of said middle body portion to effectively form web frames thereof, installing a plurality of other watertight transverse bulkheads each extending between said longitudinal bulkheads at a location within the length of said middle body portion, said other transverse bulkheads being spaced apart a distance related to the size of said containers to form container holds therebetween, forming a plurality of container-cargo hatchways in the upper deck of said ship in said middle body portion above each of said container holds, said

14

hatchways effecting removal of substantially all upper deck plating from said middle body portion between said longitudinal bulkheads, installing hatch cover means to close said hatchways, adapting said hatch cover means for upper deck storage of other containers thereon, attaching longitudinally extending doubler plating to each longitudinal bulkheads beneath said upper deck, installing relatively heavy upper deck plating of said ship extending at least the length of said middle body portion and located outboard of each of said longitudinal bulkheads to the respective sides of said ship, attaching longitudinally extending sheer strake doubler plating to each of the sides of said ship and extending at least the length of said middle body portion, installing container support means at said container storage space between said longitudinal bulkheads, installing rolling gantry bridge crane means at said upper deck for operation within the length of said middle body portion for loading and unloading each of said containers aboard said ship, and forming liquid ballast storage tanks at a bottom portion of said middle body portion at either side thereof to contain ballast for control of ship heeling action during said loading and unloading of containers.

4. A method for converting a tanker ship into a container ship for storing and transporting by sea a quantity of cargo-carrying containers, each of said containers being approximately the size of a truck trailer body, said ship having two vertical longitudinal watertight bulkheads extending at least the length of a middle body portion of said ship, said longitudinal bulkheads being spaced apart one on either side of the longitudinal centerline of said ship providing container storage space therebetween, said ship having a plurality of spaced apart watertight transverse bulkheads each extending between said longitudinal bulkheads at a location within the length of said middle body portion, and said ship having a centerline girder construction extending at least the length of said middle body portion and formed by a center vertical keel, a center vertical upper deck girder and centerline pillars therebetween, said pillars being centerline bulkhead webs of said transverse bulkheads, substantially all fluid-cargo handling equipment including pipe lines having been removed from said ship, said method comprising in combination the steps of removing said existing transverse bulkheads except for a centerline portion of each including said bulkhead webs, modifying a plurality of existing frames of said ship located within the length of said middle body portion to effectively form web frames thereof, installing a plurality of other watertight transverse bulkheads each extending between said longitudinal bulkheads at a location within the length of said middle body portion, said other transverse bulkheads being spaced apart a distance related to the size of said containers to form container holds therebetween, forming a plurality of container-cargo hatchways in the upper deck of said ship in said middle body portion above each of said container holds, said hatchways effecting removal of substantially all upper deck plating from said middle body portion between said longitudinal bulkheads, installing hatch cover means to close said hatchways, adapting said hatch cover means for upper deck storage of other containers thereon, attaching longitudinally extending doubler plating to each of said longitudinal bulkheads beneath said upper deck, installing relatively heavy upper deck plating of said ship extending at least the length of said middle body portion and located outboard of each of said longitudinal bulkheads to the respective sides of said ship, attaching longitudinally extending sheer strake doubler plating to each of the sides of said ship and extending at least the length of said middle body portion, installing container support means at said container storage space between said longitudinal bulkheads, installing rolling gantry bridge crane means at said upper deck for operation within the length of said middle body portion for loading and unloading each of said containers aboard said ship, an installing

15

superstructure means located forward of said middle body portion at said upper deck to provide a measure of protection from the sea to said other containers stored on said hatch cover means.

5. A method for converting a type "T-2" tanker ship into a container ship for storing and transporting by sea at least 288 cargo-carrying containers, each of said containers being approximately the size of a truck trailer body, said ship having two vertical longitudinal watertight bulkheads extending at least the length of a middle body portion of said ship, said longitudinal bulkheads being spaced apart one on either side of the longitudinal centerline of said ship providing container storage space therebetween, said ship having six spaced apart watertight transverse bulkheads each extending between said longitudinal bulkheads at a location within the length of said middle body portion, and said ship having a centerline girder construction extending at least the length of said middle body portion and formed by a center vertical keel, a center vertical deck girder and centerline pillars therebetween, said pillars being centerline bulkhead webs of said transverse bulkheads, substantially all fluid-cargo handling equipment including pipe lines having been removed from said ship, said method comprising in combination the steps of removing substantially all superstructure of said ship within said middle body portion, removing said six existing transverse bulkheads except for a centerline portion of each including said bulkhead webs, modifying a plurality of existing frames of said ship located within the length of said middle body portion to effectively form web frames thereof, installing two other watertight transverse bulkheads each extending between said longitudinal bulkheads at a location within the length of two other transverse bulkheads being spaced apart a distance related to the length of said containers to form container holds therebetween, forming a plurality of container-cargo hatchways in the upper deck of said ship in said middle body portion above each of said container holds, said hatchways effecting removal of substantially all upper deck plating from said middle body portion between said longitudinal bulkheads, installing hatch cover means to close said hatchways, adapting said hatch cover means for upper deck storage

16

of other containers thereon, riveting on longitudinally extending doubler plating to each of said longitudinal bulkheads beneath said upper deck, removing existing upper deck plating of said ship extending at least the length of said middle body portion and located outboard of each of said longitudinal bulkheads to the respective sides of said ship and replacing the same with relatively heavy upper deck plating, riveting on longitudinally extending sheer strake doubler plating to each of the sides of said ship and extending at least the length of said middle body portion, installing an inner bottom of said ship at the bottom of each of said container holds, installing vertically extending container guides in each of said holds for locating containers stored therein in a plurality of stacks thereof as determined by said guides, installing container support means at said upper deck outboard of said hatch cover means for storage of additional other containers thereon, installing at least one rolling gantry bridge crane at said upper deck for operation within the length of said middle body portion for loading and unloading each of said containers aboard said ship, installing two longitudinally extending rails at said upper deck each at a side of said ship for guiding longitudinal movement of said crane, forming liquid ballast storage tanks at a bottom portion of said middle body portion at either side thereof outboard of each of said longitudinal bulkheads to contain ballast for control of ship heeling action during said loading and unloading of containers, building a navigation bridge superstructure of said ship forward of said middle body portion to provide a measure of protection from the sea to said other containers stored on said hatch cover means and on said container support means at said upper deck, and extending in after direction the length of a forecastle portion of said ship to said superstructure.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |              |                |
|-----------|--------------|----------------|
| 1,111,740 | Frear        | Sept. 29, 1914 |
| 2,440,307 | Smith        | Apr. 27, 1948  |
| 2,513,004 | Cooley       | June 27, 1950  |
| 2,539,168 | Smith et al. | Jan. 23, 1951  |
| 2,853,968 | McLean       | Sept. 30, 1958 |