Dec. 17, 1968 F. TAYLOR 3,416,481

CONSTRUCTION OF SHIPS' HULLS

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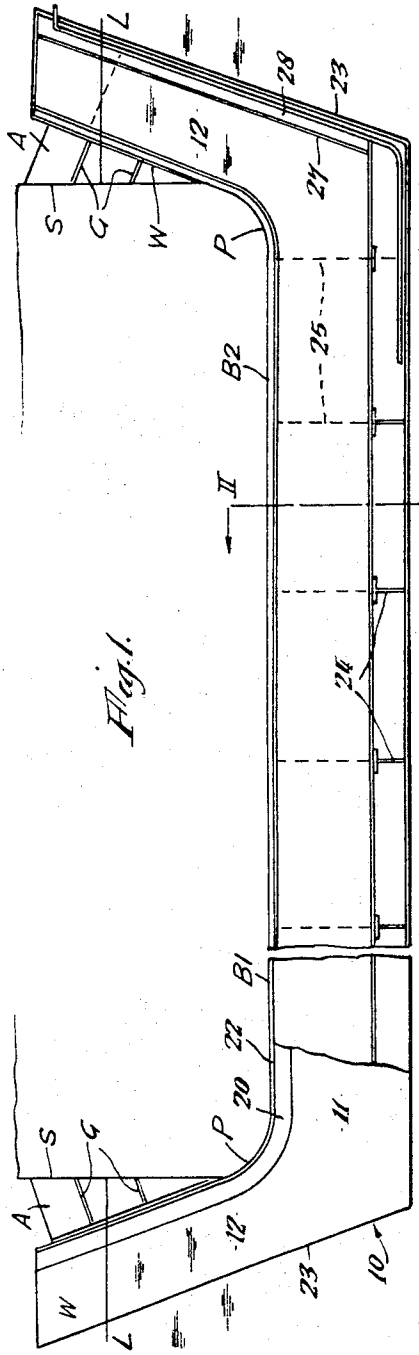

Fig. 1.

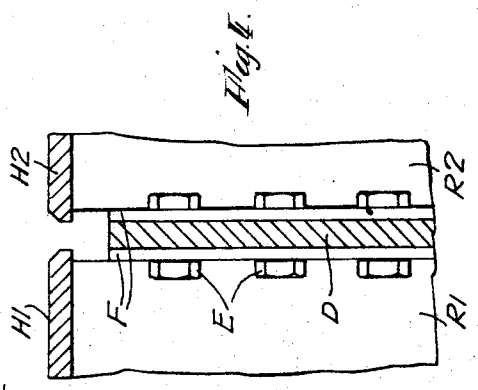

Fig. 4.

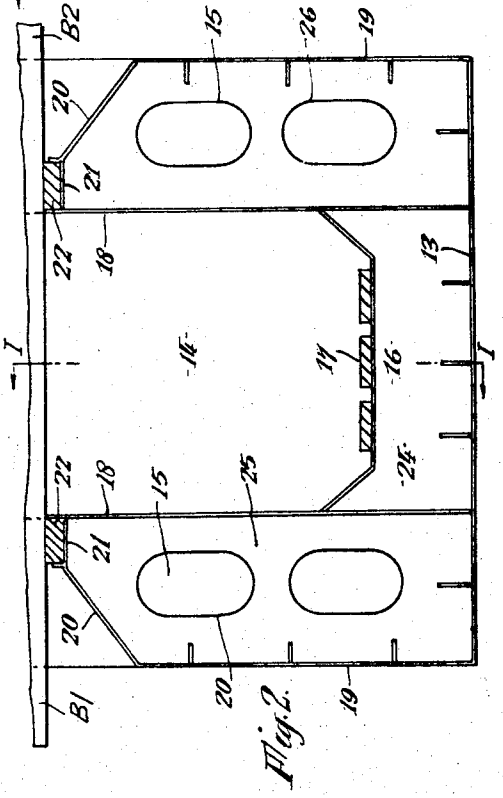

Fig. 2.

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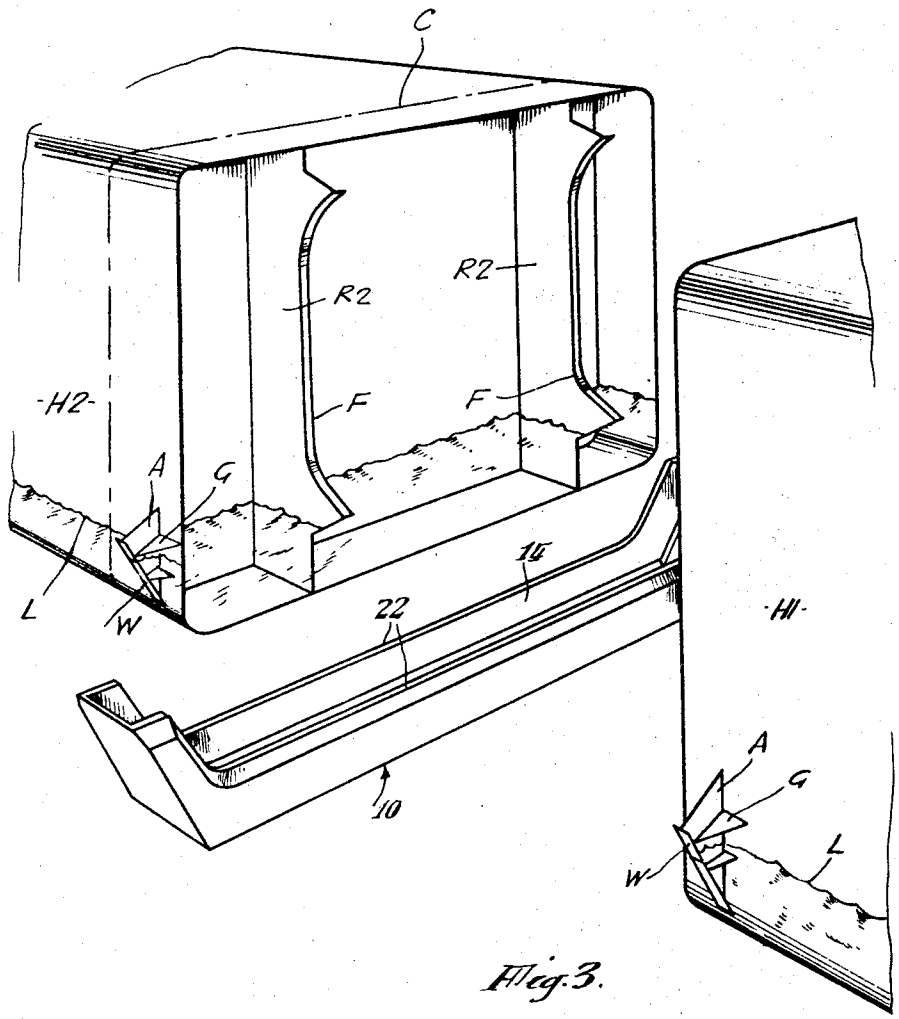

Fig. 3.

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CONSTRUCTION OF SHIPS' HULLS

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13 Claims. (Cl. 114—77)

ABSTRACT OF THE DISCLOSURE

This invention has for an object to provide an improved method of and means for constructing a hull from two or more portions that are subsequently secured together.

The invention provides a method of constructing a ship's hull from at least two prefabricated portions wherein said portions are brought into alignment while afloat and temporarily secured together to form a region of jointing between them, temporary watertight sealing means is applied to the exterior of said region below the waterline to form an access space, the region of jointing is then freed from water and permanent securing of said portions is performed by a watertight jointing operation at least partly applied to the exterior of said portions from within said temporary sealing means access space.

Said temporary sealing means may be arranged to provide access from above the waterline for a welding operation to be performed on the exterior of the portions to secure said portions permanently together. Said temporary sealing means may be adjusted in buoyancy to bear against the hull portions and to form seals therewith at opposite sides of the region of jointing, and further, said portions may be held spaced apart at said region so that below the waterline hull plates may be inserted and welded externally from within said access space.

The invention further provides apparatus for performing the aforesaid method, comprising a caisson having a generally horizontal intermediate section and respective upwardly extending end sections, watertight seals on said caisson arranged to bear against the hull portions at the region of jointing, a transversely extending compartment within said intermediate section, said end sections extending above the waterline of the hull portions and at least one of said end sections providing an external access passage to said compartment. Advantageously, the caisson comprises a central gallery extending between the end sections and providing access by an operator to the exterior of the jointing region, and buoyancy chambers arranged on both sides of said gallery for floatation of the caisson.

This invention relates to the construction of a ship's hull, and has for an object to provide an improved method of and means for constructing a hull from two or more portions that are subsequently secured together.

Present trends favour the building of ships, of the tanker and bulk dry cargo types, which are substantially larger than those under construction hitherto. Such an increase of size involves substantial increases of length, depth and beam. While the increase of beam can be accommodated by the adaptation of existing building facilities, the increase of length is such as to present often insoluble launching problems if the hull is built and launched as a single unit.

Proposals have been made for building ships in two or more portions and bringing them together in a dry dock to be united into a single hull, but this practice is limited to ships of a size, particularly beam, that can be housed in existing dry docks, and the construction of dry docks

to accommodate larger ships would require substantial amounts of both finance and time.

It has also been proposed to build a hull in a plurality of sections which are brought into alignment when afloat, a U-section flexible sealing strip then being passed under the sections and drawn against the region of jointing between them so that the sections can be pumped dry and their adjacent edges welded together from within. However, some external welding is also necessary and the joined sections must then be removed to a dry dock for that operation so that the disadvantages referred to above are not avoided.

In the method of the present invention, the hull portions are brought into alignment while afloat and temporarily secured together to form a region of jointing between them, temporary watertight sealing means being applied to the exterior of said region below the waterline to form an access space, the region of jointing then being freed from water and permanent securing of said portions being performed by a watertight jointing operation at least partly applied to the exterior of said portions from within said temporary sealing means access space.

In order to ensure that two portions of a hull as aforesaid, when brought together to be united, fit one another, the method may be carried out by severing an end section of a first portion after completing the construction of said portion, moving the severed section towards the launching end of the slipway or in the dry dock after launching said first portion, and building another portion of the hull permanently on to said severed section. When the two portions of the hull are brought together to be united, the junction at which such union is to be effected consists of two ends which were built at the same time and as parts of a unit, and thereafter cut apart, so that said two ends perfectly match with one another when brought together and can be united without difficulty.

The method of the present invention is also applicable to the "stretching" of the hull of an existing ship when the original hull is severed in two and an additional portion inserted between the two parts. In this case, it is clear that the particular technique described above to achieve matching contours for two hull portions at their jointing regions cannot be achieved without severing further portions on which to build the new portion. To avoid this complication, it is possible to arrange that when a joint is made, the portions are held spaced apart and hull plates are inserted in said space to form a watertight joint between the portions. These additional hull plates can then provide a relatively smooth transition between any disconformities in the end contours of the original and inserted portions. In order to allow the jointing operation below the waterline to be made within the access space afforded by the temporary sealing means, the gap to be filled there may be kept relatively narrow while above the waterline it may be a full plate length.

The alignment and temporary connection of the hull portions may be obtained by the provision, at the ends to be joined, of suitable mating internal structure. For example, in a ship of the larger size under consideration, where there is a gap in the external plating as aforesaid there may be provided several, for example up to seven, longitudinal girders, the ends of which in the two portions may be adapted for securing together in alignment prior to the completion of the exterior plating.

For carrying out the method as aforesaid, there may be provided a caisson having a generally horizontal intermediate section and respective upwardly extending end sections, adapted to extend transversely beneath the assembled ends of two portions of a ship's hull to provide an external access passage to the bottom plating. The caisson, including the upwardly extending ends, may comprise three chambers side by side, namely a middle cham-

ber preferably without division from end to end and adapted to be drained of water after being submerged to form an access gallery, and two lateral chambers, preferably sub-divided, adapted to serve as buoyancy tanks. The upper parts of said lateral chambers are provided along their entire length with substantial sealing strips adapted to seal against the bottoms of the portions of the hull when the caisson, after having been submerged to be located beneath said portions, is at least partially pumped out so as to float up into firm contact with the two ends of said hull portions.

The construction of a caisson as aforesaid and the operation of the method according to the invention will be better understood from the following description, by way of example, of an embodiment thereof, with reference to the accompanying drawings, wherein:

FIG. 1 is a front elevation of the caisson, partly in transverse section on the line I—I of FIG. 2, applied to the bottom of a ship's hull,

FIG. 2 is a section on the line II—II of FIG. 1,

FIG. 3 is a perspective illustration of the hull portions and a caisson, and

FIG. 4 is a detail section showing internal securing means between the two hull portions of FIG. 3.

Referring to FIGS. 1 to 3 of the drawings, caisson **10** is a long, relatively narrow structure comprising a horizontal base portion **11** with upwardly extending ends **12**, and of channel section throughout as shown in FIG. 2. The channel section is afforded by three compartments built upon a flat bottom **13**, namely, a middle compartment **14** which when pumped free of water serves as a working gallery, and two lateral compartments **15** which serve as buoyancy tanks. The middle compartment **14** is provided with a working floor or platform **17**, and is defined by vertical walls **18** which extend throughout the length and up the ends of the caisson. The lateral compartments are enclosed by said walls **18** and bottom **13** together with outer vertical walls **19**, inwardly sloping top portions **20** and horizontal portions **21** which provide seatings for sealing strips **22**, all of which likewise extend throughout the length and up the ends of the caisson. The floor **17** extends horizontally between oblique end walls **23** of said upwardly extending portions **12**, and is supported by gusset plates **24**, between which there are wells **16**. The lateral compartments **15**, which are subject to substantial differential pressures, are braced at intervals by bulkheads **25**, some of which are provided with manholes **26**, while others are continuous to divide each of the compartments **15** into a plurality of buoyancy tanks.

At least one upwardly extending end **12** is provided with an access ladder **27** for the working compartment **14**, and pipe connections **28** for the filling and emptying of the several buoyancy tanks comprised in the lateral compartments **15**.

The caisson is shown in FIGS. 1 and 2 disposed transversely so that the sealing strips **22** fit closely across the bottom plates B1, B2 of two portions of a ship's hull, and at least partly around the curved hull plating P through which the bottom merges into the side plating S. Extending above the curved plating P are brackets temporarily secured to the side plating, each bracket comprising a pair of triangular plates A extending above the waterline L—L, supported by gussets G and having flange webs W so disposed that the upwardly extending ends of the sealing strips **22** bear against said flange webs.

Evidently, the length of the caisson needs to be adapted to each individual hull unless it happens that two hulls of which portions are to be joined together have exactly the same section. However, such adaption will in general require only cutting out or insertion of sections of the base portion **11** of the caisson to modify its length.

Provided that the structure of the caisson is sufficient to avoid collapse, it is not necessary that it should be absolutely rigid, since a degree of flexibility will facilitate the obtaining of a completely watertight seal between the sealing strips **22** on the caisson and the hull plating under differential pressure.

In the construction of a ship's hull by the method of the invention, one hull portion may be built on a slipway or in a dry dock in extended form so that a short length of the plating and internal stress-bearing structure of a second hull portion is erected integrally with it. Thus, referring to FIG. 3, portion H1 may have been constructed integrally with the end region of portion H2 as far as the plane C. As FIG. 4 shows, at their junction internal ribs R1, R2 of the respective hull portions have flanges F secured together by bolts E after a packing strip D has been interposed between the flanges. The external plating extends continuously across the junction of the hull portions and before launching of the portion H1 the end region of the portion H2, completion of which is to follow, is detached by removal of the bolts E and severance of the external plating by a flame-cutting operation.

When the second hull portion has been constructed and launched, the two portions are adjusted for equal draught by means of trimming or ballast tanks within them and are then brought into alignment. The prior severance of the plating at the junction of the two portions and any edge preparation on that plating for the subsequent welding together of the portions effectively shortens the plating and the packing D is omitted when the sections are eventually reconnected by the flanges F before welding, so compensating for the change in length.

In an alternative constructional form that is particularly suitable for the insertion of an additional hull portion to lengthen an existing ship, when the above-described matching of the portion contours at their junctions cannot be so conveniently achieved, the means securing a pair of portions together prior to welding, for example the ribs R1, R2, are arranged to leave a gap between the external plates of the respective portions. The gap is then filled by the welding of further plates between the hull portions.

The underwater operations, whether of simple butt-welding or of welding-in a band of plating, are carried out within the compartment **14**, which may, for example, be up to 2 metres wide to afford sufficient space, even if it is required to weld a band of plating across the ship's bottom and around the lateral curves up to the waterline within the hull brackets A. When a band of plating is to be applied between the sections, the width of the band can be greater above the waterline than below where a limiting dimension is the spacing of the sealing strips of the caisson.

It will be appreciated that initial or temporary connecting means other than the bolted flanges illustrated may be provided. For example, the ribs R may be initially continuous with the plating and be severed by flame-cutting, temporary connection means being attached to the two portions, possibly externally. In addition, it will be appreciated that although the preceding description is of a joint between two sections, a complete hull may comprise a series of such joined sections and a plurality of new sections may be inserted in an existing hull by use of the method and apparatus of the invention.

To apply the caisson to a ship's bottom for the purpose described, it is partially submerged and displaced along the length of one of the portions of the ship's hull, or alternatively one of the ends may be totally submerged and passed transversely beneath the ship's hull, the buoyancy then being adjusted to level the caisson and float it up into engagement with the ship's bottom as shown in the drawings. Evidently, by sufficiently increasing the buoyancy of the caisson, that is, by emptying as required tanks in the lateral compartments **15**, the caisson may be made so buoyant relative to the hull that the differential water pressure will create a completely watertight joint between the sealing strips **22** and the existing plating of the

hull, prior to the working compartment **14** being completely emptied of water. This may include removal of water which drains into the compartment **14** from the two parts of the hull. The work of completing the joining together of the two portions by welding can then proceed by men working in dry conditions and under normal atmospheric pressure in compartment **14** which is readily accessible from above the waterline by means of at least one of the upturned ends of the caisson, and the access ladder **27** therein.

The various pumping operations may be carried out on a tender or tenders. The working compartment **14** may be pumped clear of water by way of a suction hose lowered to the floor **17**, or a sump therein, through one of the upwardly extending ends of the caisson, and selective filling or emptying of the buoyancy tanks may be carried out by means of pump hoses connected to the piping **28**.

When the welding together below the waterline of the two portions of the hull has been completed, the caisson may be removed by reducing its buoyancy sufficiently to enable it to be displaced from beneath the hull either lengthwise or transversely, and it is then only necessary to remove the brakckets A, G, W to provide a unitary hull completely faired at the joint.

What I claim and desire to protect by Letters Patent is:

1. A method of constructing a ship's hull from at least two prefabricated portions which comprises bringing said portions into alignment while afloat and temporarily securing them together to form a region of jointing between them, applying temporary watertight sealing means to the exterior to said region below the waterline to form an access space, freeing the region of jointing from water and permanently securing said portions by a watertight jointing operation at least partly applied to the exterior of said portions from within said temporary sealing means access space.

2. A method according to claim **1**, wherein said temporary securing is effected by means located within the hull portions.

3. A method according to claim **1**, wherein said temporary sealing means is arranged to provide access from above the waterline for a welding operation to be performed on the exterior of the portions to secure said portions permanently together.

4. A method according to claim **1**, wherein said temporary sealing means is adjusted in buoyancy to bear against the hull portions and to form seals therewith at opposite sides of the region of jointing.

5. A method according to claim **3**, wherein said temporary sealing means is adjusted in buoyancy to bear against the hull portions and to form seals therewith at opposite sides of the region of jointing.

6. A method according to claim **1**, wherein said portions are held spaced apart by said temporary securing means and hull plates are inserted where the portions are spaced apart to form a watertight joint between the portions.

7. A method according to claim **5**, wherein said portions are held spaced apart by said temporary securing means, hull plates are inserted where the portions are spaced apart, and below the waterline said plates are externally welded from within said access space to form a watertight joint between said portions.

8. A method according to claim **6**, wherein the spacing of the portions is arranged to be smaller below the waterline than above the waterline.

9. Apparatus for constructing a ship's hull from at least two prefabricated portions, comprising a caisson having a generally horizontal intermediate section and respective upwardly extending end sections, watertight seals on said caisson arranged to bear against the hull portions at the region to be jointed, a transversely extending compartment within said intermediate section, said end sections extending above the waterline of the hull portions and at least one of said end sections providing an external access passage to said compartment.

10. Apparatus according to claim **9**, wherein the caisson comprises a central gallery extending between the end sections and providing access to the exterior of the jointing region, and buoyancy chambers arranged on both sides of said gallery for floatation of the caisson.

11. Apparatus according to claim **9**, wherein the caisson end sections have upper sealing faces that are outwardly and upwardly inclined to extend away from the sides of the hull portions, and temporary sealing brackets provided on the hull portions for engagement by said sealing faces.

12. Apparatus according to claim **10**, further comprising pipe connections extending through at least one of said end sections to said central gallery for emptying water therefrom.

13. Apparatus according to claim **10**, further comprising pipe connections extending through at least one of said end sections to said buoyancy chambers and constructed and arranged for selective emptying and filling thereof.

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FERGUS S. MIDDLETON, *Primary Examiner.*

TRYGVE M. BLIX, *Assistant Examiner.*