

Jan. 14, 1969

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3,421,469

WATERTIGHT SEAL ASSEMBLY

Filed Feb. 14, 1968

Sheet 1 of 2

FIG. 1

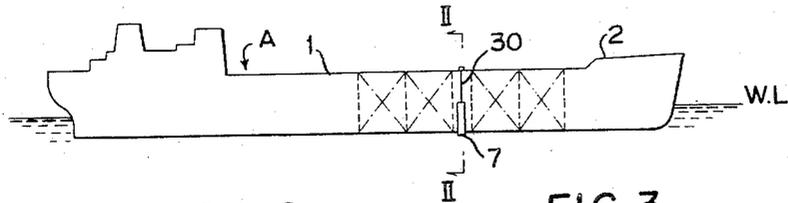


FIG. 2

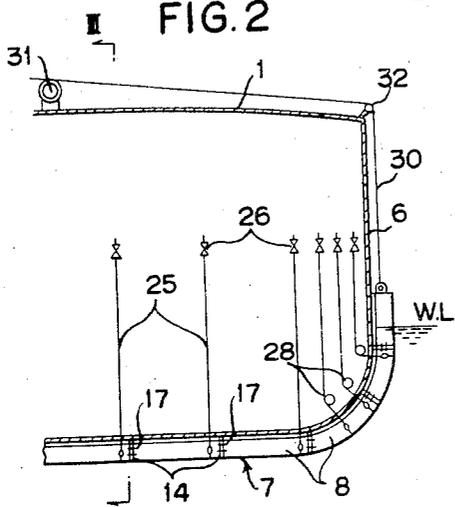


FIG. 3

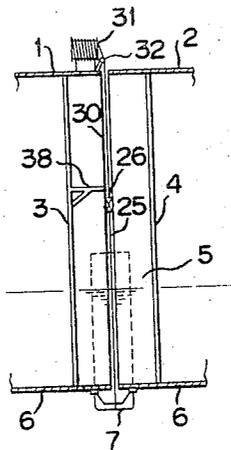


FIG. 4

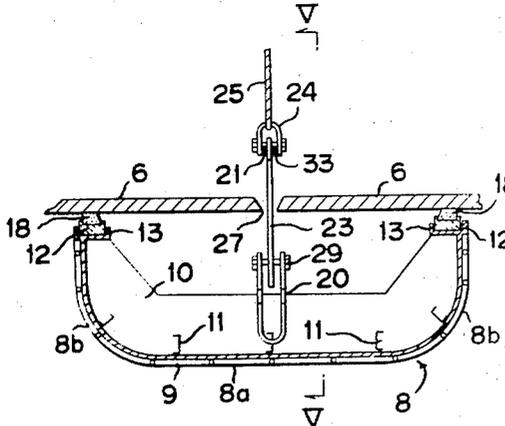
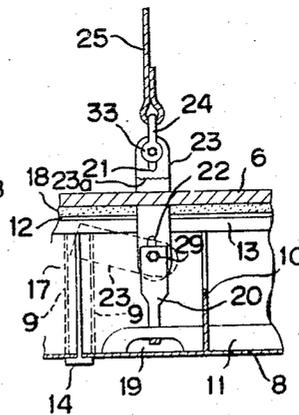


FIG. 5



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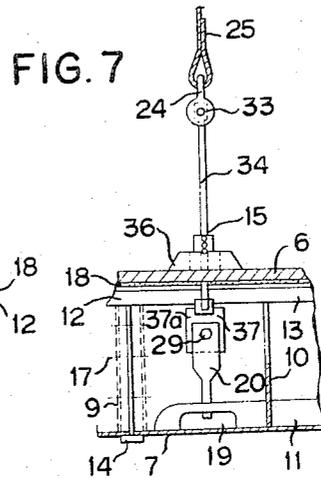
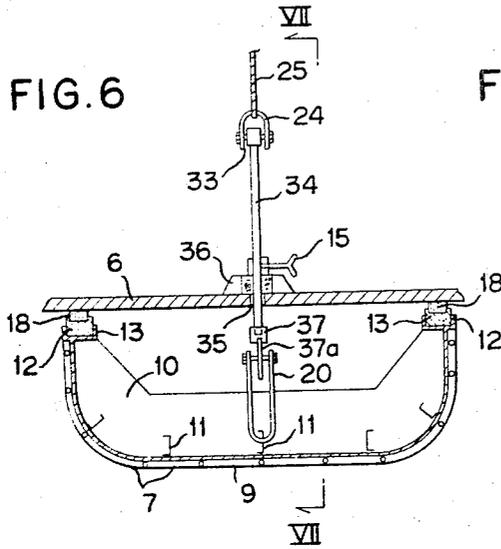
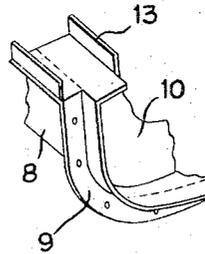
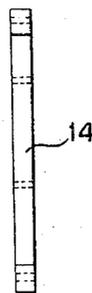
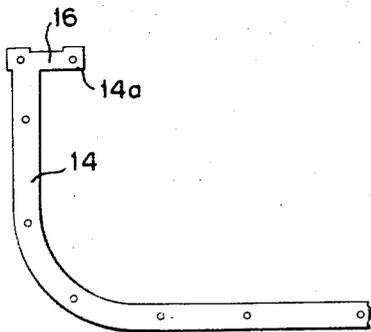


FIG. 8

FIG. 9

FIG. 10



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WATERTIGHT SEAL ASSEMBLY

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Filed Feb. 14, 1968, Ser. No. 705,521

Claims priority, application Japan, Apr. 10, 1967,
42/22,768

19 Claims

U.S. Cl. 114—77
Int. Cl. B63b 3/02

ABSTRACT OF THE DISCLOSURE

A removable watertight seal assembly for the exterior of a ship's hull is formed of a plurality of flexibly interconnected longitudinally extending U-shaped wall members with a sealing member disposed between adjacent wall members. Transverse and longitudinally extending reinforcing sections are located within the wall members to provide adequate strength to withstand exterior water pressure. Additional sealing members are disposed along the longitudinal edges of the wall members for contacting the surface of the hull. Support means are attached to individual wall members for securing the assembly in water tight engagement with the exterior underwater surface of the hull. After being secured to the hull, the interior of the wall members can be dewatered and the hull cut in two, or if the hull comprises two separate sections, they can be joined together along a line in register with the assembly of wall members. After the cutting or joining operation is completed, the assembly can be easily removed by disconnecting the support means and flooding the compartment provided between the wall members and the floating structure.

Summary of the invention

The present invention is directed to an apparatus for forming a watertight compartment on the exterior underwater surface of a floating structure, such as the hull of a ship, and more particularly, it is directed to an assembly of individual wall members flexibly interconnected and arranged to be secured to the exterior surface of the floating structure in water tight engagement for permitting either the cutting of the floating structure into two separate sections or the joining together of two separate sections of the structure.

In recent years there has been an increasing need for ships of greater size. To construct larger vessels, it has become necessary either to erect new facilities of increased size to accommodate the vessels, or to enlarge the existing facilities to the extent that they will accommodate larger vessels. In either case the cost of the new or enlarged existing facility is considerable and with it there is the increased cost of maintenance and repair. Accordingly, to overcome this cost factor various methods of building separate parts of the hull of the ship have been developed using existing facilities and then joining the separately constructed parts together after they have been launched. In addition to the construction of new vessels it has also been proposed to increase the size of existing vessels by adding to their length, depth of breadth. Such operations are preferably performed while the existing structure is still in the water, rather than having it berthed in a dry dock or a similar facility. In any of the above operations in which separate sections of a hull are joined together or where a hull is separated for increasing its size, a most important consideration is to assure a water tight compartment about the exterior of the hull for performing either the cutting or joining steps.

In the past various means have been employed to provide this water tight arrangement about the exterior surface of a floating structure. In one arrangement, a water-proof band, made of a water impervious resilient material such as rubber or a synthetic resin, is fixed to the underwater part of a ship's hull with the band being secured to the vessel along its edges by means of a wire. To achieve the desired watertight relationship with the hull, it is necessary to exert a tension on the wire and for this purpose hydraulic means or other apparatus for securing the band in place such as lever mechanisms have been used. However, in applying tension to the wires, it is difficult to apply a sufficient force to assure a watertight engagement between the band and the surface of the hull. The inability to obtain an adequate watertight engagement is complicated further by the configuration of the hull. As a result additional means have been required to assure the watertight engagement of the band with the hull. Additionally, if the above mentioned hydraulic means or lever mechanisms are employed then special fittings have to be devised for securing the band to the hull and the procedure of attaching and subsequently removing such members can be exceedingly troublesome and time consuming.

Therefore, the primary object of the present invention is to afford an apparatus which can be easily secured to and removed from the exterior underwater surface of a floating structure and which will avoid the various difficulties experienced in the apparatus used in the past.

Another object of the present invention is to provide a plurality of individual members which can be assembled together into a watertight structure on the exterior surface of a floating structure.

Still another object of the present invention is to provide a flexible assembly of individual members which will readily adapt to the configuration of the exterior surface of a floating structure.

Moreover, another object of the invention is to provide a watertight compartment-like arrangement on the exterior surface of a floating structure which can be dewatered either to cut the floating structure into separate parts or to join separate parts together into an integral structure.

Therefore, in the present invention a water tight seal assembly is formed of a plurality of longitudinally extending wall members having a generally U-shaped transverse section with the individual wall members being formed of sheet steel. Sealing members are disposed between the individual wall members to provide water tightness for the points between the members and flexibility so that the assembly can adapt to the configuration of the floating structure. Additional sealing members are provided along the longitudinal edges of the wall members to provide water tightness between these edges and the surface of the floating structure.

After assembly on a floating structure the interior of the wall members is dewatered to permit either cutting or joining operations under dry conditions. Additionally, horizontally and longitudinally extending reinforcing sections are provided within the wall members to supply adequate strength to counteract the water pressure exerted against the exterior of the wall members.

In securing the seal assembly in position, carrying means are used for supporting the individual wall members from the interior of the floating structure. After the seal assembly is in place and has been dewatered the exterior water pressure is sufficient to hold it against the floating structure and the carrying means can be disconnected, particularly when separate parts of a floating structure are to be joined together into a single unit.

The various features of novelty which characterize the

invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

FIG. 1 is a schematic side view of the hull of the ship showing a seal assembly according to the present invention secured to the exterior of the hull;

FIG. 2 is a partial sectional view taken along line II—II as shown in FIG. 1;

FIG. 3 is a partial sectional view taken along line III—III in FIG. 2;

FIG. 4 is a horizontal sectional view through the seal assembly secured to the hull of a ship in which separate portions of the hull are arranged to be welded together;

FIG. 5 is a partial sectional view taken along line V—V as shown in FIG. 4;

FIG. 6 is a horizontal sectional view similar to the one shown in FIG. 4, however, with the hull of the ship arranged to be cut into separate sections;

FIG. 7 is a partial sectional view taken along line VII—VII in FIG. 6;

FIG. 8 is a partial elevational view of a sealing member employed between individual wall sections of seal assembly;

FIG. 9 is a side view of the sealing member shown in FIG. 8; and

FIG. 10 is a partial perspective view of the flanged end of one of the wall members of the seal assembly.

Description of the invention

Referring to the drawings, a seal assembly 7 is shown in FIG. 1 secured to the exterior surface of the hull of a ship A. For the most part the seal assembly 7 is disposed below the water level (W.L.) and extends about the exterior of the hull in a transverse plane along which the hull is to be cut into separate parts, or if it is in separate parts, in which it is to be joined into a single unit. In the various drawings the reference numerals employed for the various parts of the seal assembly are the same, however, certain parts of the support arrangement for the seal assembly differs depending upon whether it is being used to cut or to weld the hull structure and different reference numerals are employed for these parts.

In FIG. 3 a cofferdam 5 is formed with the hull A between a pair of spaced bulkheads 3 and 4 secured respectively to the separate parts 1 and 2 of the hull A. Additionally, the shell plates 6 of the hull form the sides of the cofferdam 5 and the space between the separate parts 1 and 2 is sealed below the water level by means of the seal assembly 7.

The ends of the seal assembly 7 are located above the water level and the remainder of its structure extends downwardly about the hull A below the water level. The seal assembly 7 is comprised of a plurality of wall members 8 which are in contact along their longitudinal edges with the exterior shell plates 6 of the hull. Each of the wall members 8 has a form adapted to conform to the exterior shape of the hull and in transverse section the wall members have a U-shaped configuration. In assembled position on the exterior of the hull A each of the wall members 8 is formed of a web 8a spaced outwardly from the surface of the hull and a pair of spaced legs 8b which extend from the opposite longitudinal edges of the web 8a toward the exterior shell plates 6 of the hull A. An outwardly extending flange 9 is located on the outer surface of each of the wall members, see FIG. 10. The interior of the wall members are provided with transverse reinforcing sections 10 which contact the interior surface of the wall members extending between the oppositely disposed legs 8b. Channel shaped longitudinal reinforcing sections 11 are secured to the interior surface of

the wall members and extend inwardly from both the web 8a and the legs 8b.

Channel shaped members 13 extend along the outer ends of the legs 8b of the wall members and provide a groove or trough like holder for sealing members 12. Further, sealing members 14 made of rubber or a similar material are positioned at the joints between adjacent wall members 8 to afford a watertight connection. As can be seen in FIGS. 8 and 9 the sealing member 14 has a shape similar to that of the flanges 9, and at each end the sealing member 14 has a right angle section 14a containing a groove 16 similar to the trough-like member 13 in the wall member for receiving the sealing member 12 when assembled at the joint between adjacent wall members 8. As shown in FIGS. 8 to 10, the sealing member 14 and the flanges 9 are provided with similar holes through which bolts 17 are fitted for securing the sealing member 14 and adjacent wall members 8 together. The sealing member 14 provides a water tight seal for the joint between adjacent wall members 8 and also affords a flexible connection which will permit the assembly to adapt to the outside surface configuration of the hull A.

Similar to the sealing member 14 the sealing member 12 located in the member 13 is made of rubber or the like and a longitudinally extending strip 18 is superimposed on the sealing member 12 for direct contact with the exterior surface of the shell plates 6 of the hull, see FIGS. 4 and 6. The superimposed strip 18 is made of porous elastic material such as sponge and is employed to increase the water tightness of the joint between the longitudinal edges of the wall members 8 and the exterior surface of the hull.

In FIGS. 4 and 5 an arrangement is shown for supporting the wall members 8 when the hull A is formed in two separate parts and the shell plates 6 are to be welded together. A U-shaped shackle 20 is secured within a slot 19 located in the longitudinal axis of the seal assembly. The bight of the shackle 20 is located within the slot 19 and faces upwardly with a pin 29 extending between the upper ends of the opposite legs of the shackle. The entire shackle 20 is located within the wall member 8 and a bar member 23 having a hole 22 is fitted onto the pin 29 and extends upwardly passing through the slot 27 between the shell plates 6 into the interior of the hull A. At its upper end the bar member 23 has a hole 21 in which another shackle 24 is secured by means of a pin 33. A supporting cable 25 is secured to the shackle 24 and extends upwardly to a connector element 26, such as a turnbuckle, attached to an arm 38 mounted on the bulkhead 3 of the hull, see FIGS. 2 and 3. In this manner the individual wall members 8 which make up the seal assembly 7 are hung or supported from the interior of the hull by means of the shackle 20, the bar member 23, the shackle 24 and the supporting cable 25 which is secured to the connector element 26. As mentioned previously, in the support arrangement the bar member 23 extends through the slot 27 provided between the shell plates 6 which are beveled, as shown in FIG. 4, in preparation for the welding operation in which the plates are joined together. The support arrangement shown in FIG. 4, is adapted for the wall members 8 which are located on the generally horizontal portion of the hull, a similar arrangement is provided for the wall members 8 which are disposed about the curved or vertical sections of the hull in which instances the supporting cable 25 passes over sheaves or pulleys 28 attached to the bulkhead 3 for providing the proper support for the individual wall members.

To facilitate the assembly and placement of the seal assembly 7 on the exterior of the hull A a buoyant body made of a foam of a synthetic resin, not shown, may be fixed to the outer or inner surface of the individual wall members.

The following is a description of the manner in which the seal assembly 7 is employed when two sections 1,

2 of a hull are to be welded together to form a single unit.

First, a number of the wall members 8 are connected together using the sealing members 14 and bolts 17 to form a longitudinally extending seal assembly 7. The sealing members 12 are positioned within the channel shaped members 13 with the strips 18 secured to the sealing member 12 by means of an adhesive. Initially, the assembly 7 is hung by means of a cable 30 secured to its opposite ends, the cable 30 is wound on a winch 31 and passes over a sheave 32 mounted at the upper section of part 1 of the hull A. With the seal assembly hung about the exterior of part 1 of the hull A, the individual wall members 8 are attached to the support arrangement by fitting the shackles 20 into the slots 19 in the longitudinal reinforcing sections 11. The bar member 23 is secured to the shackle 20 and at its other end to the shackle 24 which, in turn, is attached to the cable 25. Initially, the seal assembly 7 is held at its ends by the cable 30 and at intermediate points by support arrangement and by adjusting the connector elements 26 the seal assembly is lowered a short distance outwardly from the part 1 of the hull to which it is connected. The other part 2 of the hull is then aligned opposite the first part 1 and is temporarily attached to it by means of joining pieces not shown. As the part 2 of the hull is brought into position the support arrangement for the wall members is situated in the slot 27 formed between the opposing shell plates 6 which are to be joined together. With the two hull parts 1, 2 in position the seal assembly 7 is drawn tightly against the exterior surface of the shell plates 6 providing the exterior surface of the shell plates 6 providing a water tight engagement between the strip 18 on the sealing member 12 and the exterior surface of the shell plates.

Since this operation is performed in the water the cofferdam 5 and the interior of the seal assembly, that is the individual wall sections 8, are filled with water which cannot escape because of the watertight seal effected between the strips 18 and the shell plates 6 and also because of the watertight seal formed between the individual wall sections by means of the sealing members 14. With the seal assembly in position the cofferdam 5 and the interior of the seal assembly is pumped out and due to the watertight seal effected between the seal assembly and the exterior surface of the hull a dry or dewatered condition is effected within the cofferdam and within the compartment formed between the wall members 8 and the exterior surface of the hull. In this condition the water pressure acting on the exterior of the seal assembly 7 is sufficient to hold the seal assembly on the exterior surface of the hull and the support arrangement for the individual wall sections can now be removed. It can be appreciated that it would not be possible to weld the shell plates together of the support arrangement is not removed. Therefore, the bar member 23 is cut along the line 23a, see FIG. 5, and is pivoted about the pin 29 in the shackle 20 so that the portion of the bar member connected to the shackle is disposed outwardly of the exterior surface of the hull within the compartment formed within the wall members 8. After the individual support arrangements have been cut and the joint between the two hull parts 1 and 2 is clear of any obstructions, the two parts may be welded together to form a unitary hull section. As mentioned above, the welding operation is performed in the dry, that is, the water has been removed from the wall sections 8 and from the cofferdam 5 so that the joining steps can be performed expeditiously and effectively to afford an effective integral seal between the two hull parts.

After the welding operation has been completed, water may be admitted between the wall member and the hull which equalizes the water pressure exerted on the exterior of the seal member and the seal assembly can be removed from the hull without any difficulty by relaxing the tension exerted by the cable 30 secured to the ends of the seal assembly. Each of the wall members can be disassembled and removed as a unit with the shackles 20 and the cut off

portion of the bar section 23. The remainder of the support assembly is contained within the vessel and is easily accessible for removal.

As indicated previously, the arrangement of the seal assembly can be employed for either joining separate parts of the hull together or for cutting the hull in two. When the hull is to be cut into two parts, the support assembly shown in FIGS. 6 and 7 is employed. It should be noted that the shackle 20 attached to the individual wall members 8 and the support cable 25 and the shackle 24 shown in FIGS. 6 and 7 are of similar construction to the ones shown in FIGS. 4 and 5. However, the difference in the support arrangement resides in the members which extend through the hull for interconnecting the shackles 20, 24.

To secure the seal assembly to the exterior of the hull a plurality of holes 35 must be bored through the shell plate 6. Water has a tendency to enter the hull through the holes, however, as each hole is completed a supporting rod 34 is inserted through it and each rod is provided with a stuffing box 36 which is securely attached to the interior surface of the hull as shown in FIG. 6. With the supporting rod 34 extending outwardly beyond the exterior surface of the hull, it is then clamped in place by means of a set screw 15 located immediately above the stuffing box 36. The upper end of the rod 34 is secured to the shackle 24 and a nut 37 is threaded onto the lower end of the rod by divers. The nut 37 has a plate 37a attached to it which contains an opening for securing the rod to the pin 29 of the shackle 20. Therefore, in the operation of cutting the hull into two separate parts instead of using a bar member 23, which extends through the slit formed between the two separate sections of the hull a rod 34 is employed which extends through a sealed hole formed in the hull.

In preparing to cut the hull into two separate parts, the seal assembly 7 is disposed about the exterior surface of the hull approximately in the plane in which the hull is to be cut and is supported by means of the cable 30 attached to the winch 31. Next the holes 35 are bored at predetermined positions along the plane in which the hull is to be cut and as each hole 35 is completed a supporting rod 34 is inserted through it so that the attached nut 37 may protrude to the extent that the pin 29 can be secured and a stuffing box 36 is attached to the interior surface of the hull to prevent any leakage of water into the hull. With all of the supporting rods in position divers can attach the nuts 37 to the lower ends of the supporting rods. Next the divers attach the individual wall members 8 of the seal assembly 7 to the supporting rod 34 by securing the pin 29 in the shackle 20 through the hole in the plate 37a attached to the nut 37. After all the necessary connections exterior of the hull have been made the seal assembly is pulled into the watertight relationship with the exterior of the hull by means of the cables 25. The water which was contained within the seal assembly 7 during the assembly operation on the hull is removed by pumping and as with the joining operation a dewatered or dry condition obtains within the seal assembly so that the cutting operation can be performed in the dry. The rod 34 is then removed by unscrewing and is recovered. The stuffing box 36 is also removed. The cutting operation comes to be performed. After the cutting operation has been completed the coffer dam 5, similar to that shown in FIG. 3, can be flooded and the seal assembly simply and easily removed from the hull.

As described above the present invention has the following advantages:

(1) The seal assembly 7 made of individual wall members 8 is sufficiently light in weight so that it can be easily handled and assembled in position and it is sufficiently reinforced to withstand the water pressure to which it is exposed during the cutting and joining operations.

(2) The manner in which the seal assembly is made up of individual wall sections joined together with seal-

ing members 14 provides a flexible unit which easily conforms to the exterior configuration of a hull.

(3) In the event of any damage to the seal assembly individual sections can be removed and repaired or replaced. The simplicity of the seal assembly 7 and the facile manner in which it can be assembled on the exterior of a hull reduces the amount of underwater work required of divers in completing the assembly operation.

(4) The attachment of the seal assembly in watertight engagement with the exterior of the hull can be easily accomplished from within the hull.

(5) Though the hull may have a curved configuration the flexibility of the seal assembly and the disposition of its sealing members along the longitudinal edges of the wall members assures a completely watertight assembly.

What is claimed is:

1. A watertight seal assembly for use on the exterior underwater surface of a floating structure, such as the hull of a ship, comprises a plurality of longitudinally extending wall members having a generally U-shaped transverse section, means for securing adjacent said wall members together, a first sealing member disposed at each joint between adjacent said wall members for providing a watertight seal therebetween and combining with said means for securing adjacent said wall members together to form a flexibility assembly of said wall members, second sealing members located along the longitudinally extending edges of said wall members, and means attached to said wall members and arranged to secure the assembly to the exterior surface of a floating structure along the longitudinally extending edges of said wall members whereby said second sealing members are arranged to form a watertight seal with the exterior surface of a floating structure and a compartment is arranged to be formed between said wall members and the oppositely disposed exterior surface of the floating structure.

2. A watertight seal assembly as set forth in claim 1, wherein said wall members are formed of sheet steel.

3. A watertight seal assembly as set forth in claim 1, wherein each of said wall members comprise a web and pair of spaced legs extending outwardly from the opposite longitudinally extending edges of said web.

4. A watertight seal assembly as set forth in claim 3, wherein transverse reinforcing sections are positioned on the interior of said wall members being secured to said legs and said web therein.

5. A watertight seal assembly as set forth in claim 4, wherein longitudinally extending reinforcing sections are disposed on the interior surface of said wall members.

6. A watertight seal assembly as set forth in claim 3, wherein transversely arranged flanges are located on the outer surfaces of and at each end of said wall members.

7. A watertight seal assembly as set forth in claim 6, wherein said first sealing members have a configuration similar to that of said flanges and said first sealing members are positioned between said flanges at the ends of adjacent said wall members and provide a seal for the joint therebetween.

8. A watertight seal assembly as set forth in claim 7, wherein aligned bolt holes are provided in said flanges and in said first sealing member, and bolts are positioned through said bolt holes for securing said flanges and said

first sealing members together in watertight engagement.

9. A watertight seal assembly as set forth in claim 3, wherein a longitudinally extending U-shaped section is secured to the outer end of each of said legs of said wall member with the opening in said U-shaped section facing in the same direction as the opening in said U-shaped wall member.

10. A watertight seal assembly as set forth in claim 9, wherein one of said second sealing members is disposed within each of said U-shaped sections.

11. A watertight seal assembly as set forth in claim 10, wherein said second sealing member comprises a two part unit, a first part formed of a resilient material disposed within a U-shaped section and a second part superposed on said first part and formed of a sponge-like material and arranged to deformedly contact the exterior surface of a floating structure for forming a water tight seal therewith.

12. A watertight seal assembly as set forth in claim 5, wherein said means attached to said wall members comprises a support assembly attached to one of said longitudinally extending reinforcing section at one end and arranged to be secured to the floating structure at the other end thereof.

13. A water tight seal assembly as set forth in claim 12, wherein said support assembly is secured to said longitudinally extending reinforcing section located on the longitudinal axis of said wall members.

14. A watertight seal assembly as set forth in claim 13, wherein said support assembly comprises a first support member movably secured to said longitudinally extending reinforcing section and entirely disposed within said wall member.

15. A water tight seal assembly as set forth in claim 14, wherein a second support member is movably secured to said first support member and is arranged to extend outwardly from said wall member into the interior of the floating structure.

16. A watertight seal assembly as set forth in claim 15, wherein said second support member is a bar-like element pivotally connected to said first member.

17. A watertight seal assembly as set forth in claim 15, wherein said second support member is a multiple part element comprising a first part having a rod like shape and arranged to extend through the surface of a floating structure and a second part secured to the end of said first part and attached to said first support member.

18. A watertight seal assembly as set forth in claim 15, wherein said support assembly comprises a third member including a tensioning element attached to said second member and arranged to be secured to a support structure within the floating structure.

19. A watertight seal assembly as set forth in claim 12 wherein said support assembly comprises cable means secured to the ends of said assembly of wall members and arranged for supporting said assembly from a floating structure.

References Cited

- UNITED STATES PATENTS
3,370,565 2/1968 Takezawa et al. ----- 114-77
TRYGVE M. BLIX, *Primary Examiner*.