United States Patent [19]

Thomson

[11] **3,799,093**

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[54] **FLOATING PRESTRESSED CONCRETE WHARF**

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[21] Appl. No.: **357,909**

[52] **U.S. Cl.** ..... **114/.5 F**

[51] **Int. Cl.** **B63b 35/00**

[58] **Field of Search** ..... 114/.5 BD, .5 F, .5 T, 114/43.5, 61, 65 A, 66.5 F; 264/228; 61/5, 61/48, 59

[56] **References Cited**

UNITED STATES PATENTS

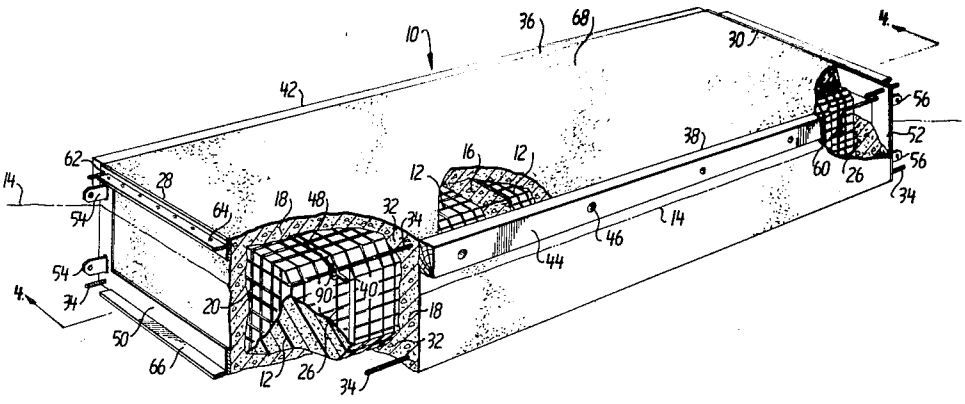
3,091,203	5/1963	Usab	114/.5 F
3,022,759	2/1962	McCall	114/.5 F
3,306,053	2/1967	Fulton	114/.5 F

Primary Examiner—George E. A. Halvosa
Assistant Examiner—Charles E. Frankfort
Attorney, Agent, or Firm—J. Gibson Semmes

[57] **ABSTRACT**

A floating prestressed concrete wharf and a method of manufacturing the same are disclosed. The wharf includes pretensioned strands in critical disposition, may include transverse pretensioned cables in its uppermost slab, has wire reinforcing mesh in the concrete and a core of buoyant material.

7 Claims, 9 Drawing Figures



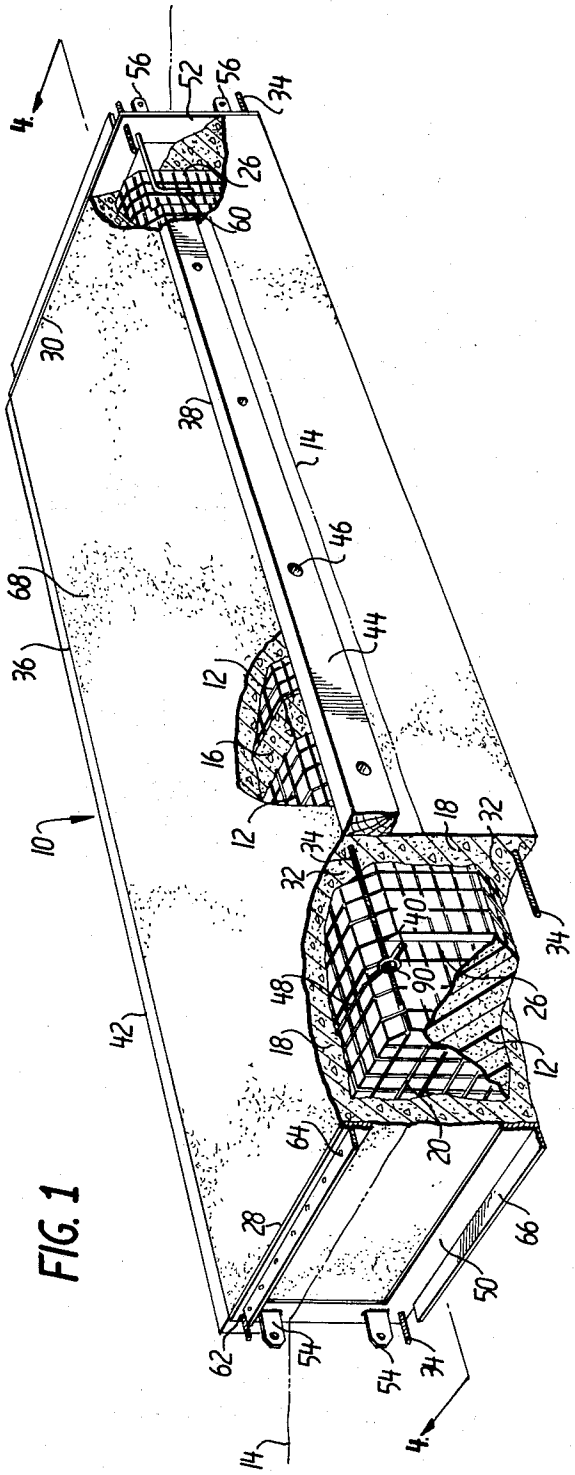

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FIG. 1

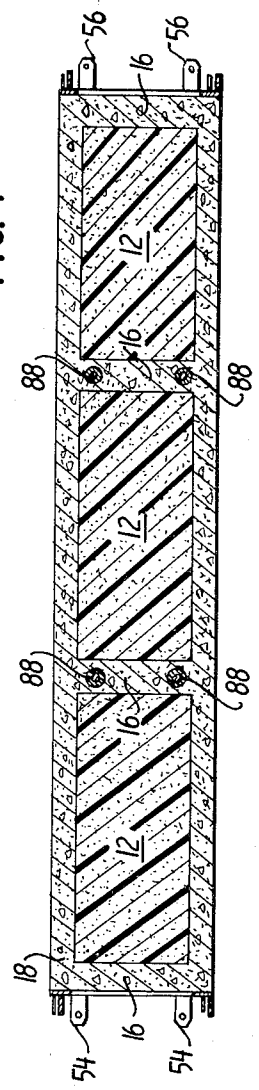
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FIG. 4

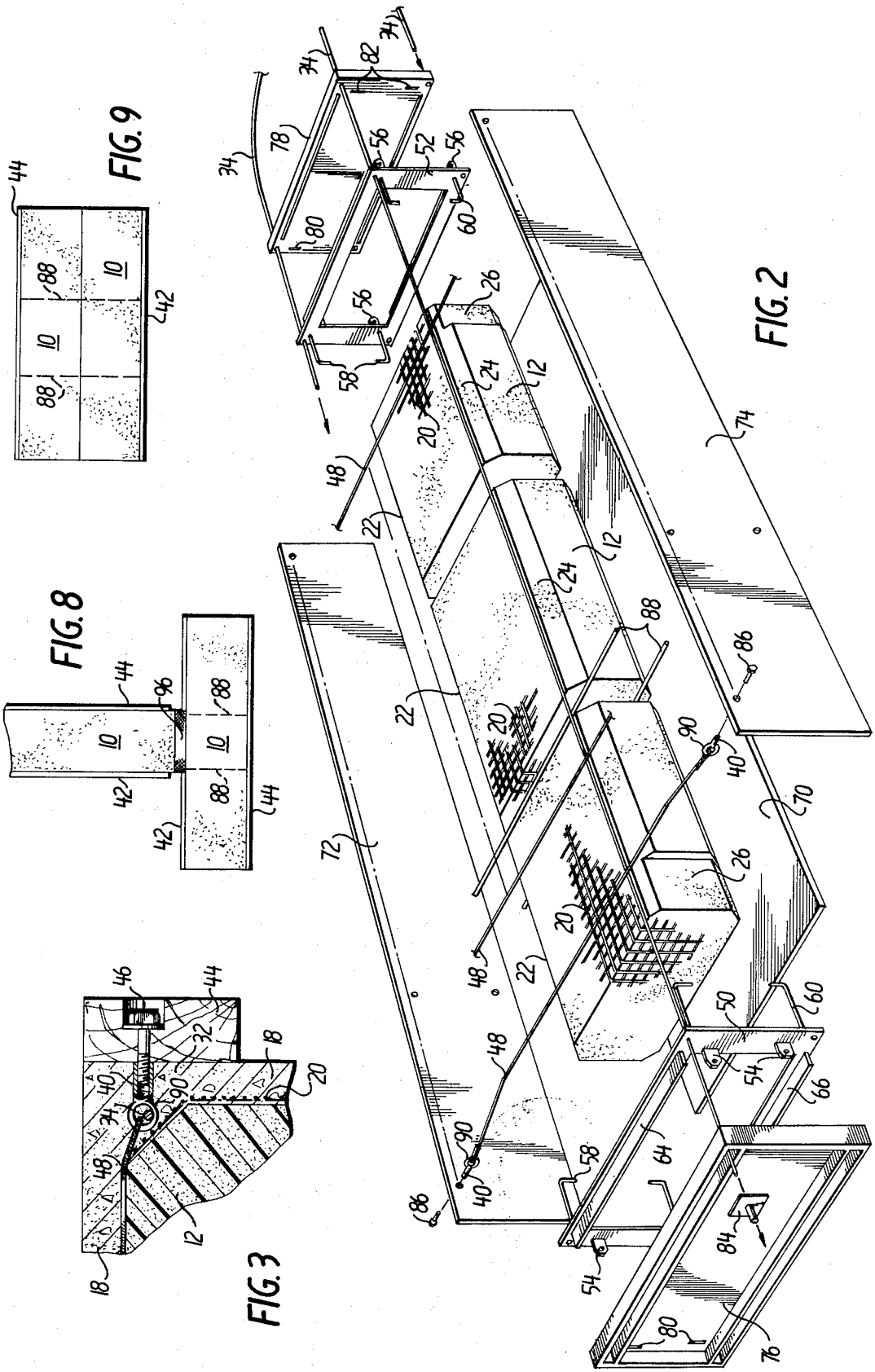

FIG. 2

FIG. 3

FIG. 8

FIG. 9

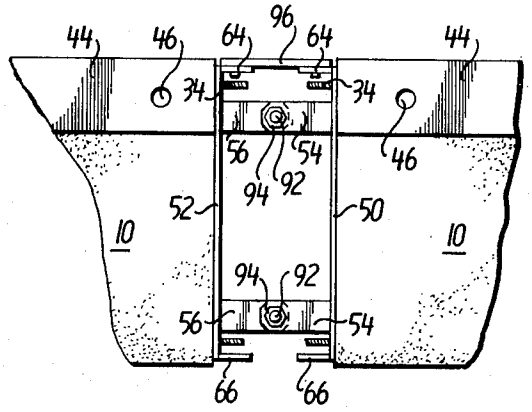

FIG. 5

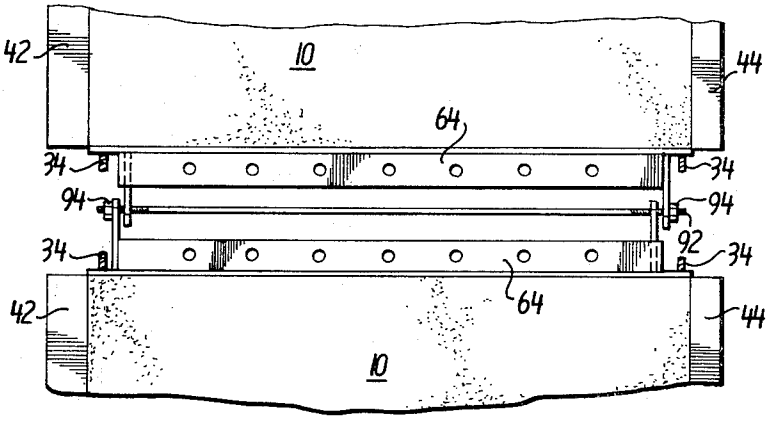

FIG. 6

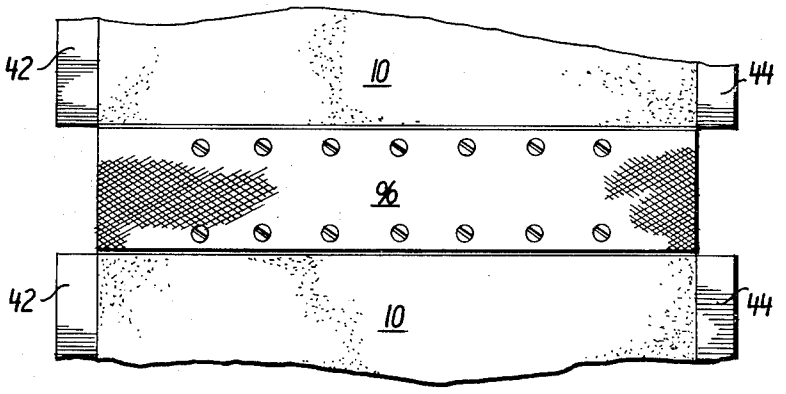

FIG. 7

FLOATING PRESTRESSED CONCRETE WHARF

FIELD OF THE INVENTION

This invention relates to the art of prestressed concrete structures, and more particularly to floating prestressed concrete wharves which comprise cables pretensioned before the concrete is poured into the form for the wharf; and to the methods of making such wharves. After the wharf is removed from the form, the cables tend to hold the concrete in compression, thereby permitting the wharf to withstand both tension and compression loadings, hence increasing its flexibility in service.

DESCRIPTION OF THE PRIOR ART

Prestressed and reinforced concrete wharf structures of the floating and stationary types have been in use for many years. Similarly, the methods for making such structures have received considerable attention. U.S. Pat. No. 2,153,741 to Cobi discloses a process for making prestressed hollow slabs; however, no teaching is found of the unique apparatus of the applicant's invention wherein both longitudinal and transverse pretensioning may be accomplished. U.S. Pat. No. 2,518,091, to Stopkevyc, shows means for interconnecting pontoon assemblies; however, no suggestion is made of the applicant's connecting apparatus which provides either a flexible or rigid joint between wharf sections and a support for an optional protective deck plate over the joint. U.S. Pat. No. Re. 24,837 to Usab shows a reinforced concrete wharf structure made up of hollow, waterproof floats, but no disclosure is made of the applicant's structure having pretensioned cables located critically in the overall structure. U.S. Pat. No. 3,022,759 to McCall shows a concrete floating wharf in which a longitudinally prestressed deck slab rests on hollow reinforced concrete floats. Applicant's integral, prestressed structure having both longitudinal and transverse prestressed cables is neither shown nor suggested.

U.S. Pat. No. 3,073,271 to Brill discloses another means for interconnecting float assemblies; but, as discussed above, no provision is made for installation of a protective deck plate over the joint. U.S. Pat. No. 3,091,203 to Usab shows a concrete floating wharf structure having extensive wire mesh reinforcements and an elaborate post-tensioning cable system. No suggestion of the applicant's longitudinal pretensioning system is made. U.S. Pat. No. 3,128,737 to Usab shows a reinforced concrete float having transverse cross-rods for attachment of tie rails, but no mention is made of applicant's unique transverse pretensioned cables or wires which help retain threaded inserts used for attachment of side rails.

U.S. Pat. No. 3,207,829 to Nieber, et al. describes means and a method for pretensioning wires such as might be useful in practicing the inventive method disclosed herein; however, no teaching is found of applicant's method of making a longitudinally and transversely prestressed wharf structure. U.S. Pat. No. 3,276,209 to Mosdell discloses the use of reinforcing rods in a floating wharf structure; but once again, no mention is made of the applicant's structure wherein the float is prestressed as claimed herein. U.S. Pat. No. 3,323,479 to Filak shows a float structure having a buoyant core of lightweight material; however, no prestressed float structure is used.

U.S. Pat. No. 3,448,709 to Hardwick shows a float construction comprising lightweight floats and a reinforced deck slab. No suggestion is found of a unitary, prestressed structure as now disclosed. U.S. Pat. No. 3,580,202 to Thompson shows a wharf structure having reinforcing bars and wire mesh, and further including a lightweight core; but no prestressed structure is mentioned. U.S. Pat. No. 3,616,774 to Thompson shows yet another floating dock structure which does not comprise prestressed concrete in the manner of this invention.

SUMMARY OF THE INVENTION

The apparatus and method of this invention provide concrete floating wharf structure capable of being used in greater overall length per unit than the known prior art devices, while providing a wharf that is resilient and flexible under in-service conditions. The increased wharf length permits the use of fewer units in assembling a wharf, thereby minimizing the number of connections to be made between units and minimizing costs.

These advantages are embodied in the invention by providing a block of lightweight buoyant material such as expanded polystyrene, encased in wire reinforcing mesh, which acts as a temperature and shrinkage reinforcement for the concrete. The enclosed block is placed in a form of similar configuration having pretensioned cables strung along the longitudinal corners thereof or as otherwise disposed. Preferably lightweight concrete is poured around the block in the form so as to encase the block, mesh and cables in an integral float or wharf unit. When the concrete has set, the cables are cut at the form and the form removed, leaving a prestressed wharf unit, compressed under the action of the cables or wires. If desired for greater flexibility, transverse pretensioned cables may be provided within the top surface of the float unit so as to provide prestressing in all directions in the upper portion of the unit, thereby increasing its resiliency and flexibility. Means are provided for joining one float unit to another and for attaching bumper rails along the longitudinal edges of the float units.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of a wharf unit according to the invention, partially cut away to reveal the orientation of its components;

FIG. 2 shows an exploded perspective view of the components used to manufacture the invention, exclusive of the concrete;

FIG. 3 shows a partial section through a longitudinal corner of the invention, particularly the lightweight core, the pretensioned longitudinal cable and the threaded inserts for the bumper rails;

FIG. 4 shows a side elevation in section taken along line 4—4 of FIG. 1;

FIG. 5 shows an elevation view of the means for connecting neighboring float units;

FIG. 6 shows a plan view of the means for connecting neighboring float units;

FIG. 7 shows a plan view of the joint between neighboring float units, an optional cover plate being in place;

FIGS. 8 and 9 show alternate configurations for connecting the inventive float units.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

There follows a detailed description of the preferred embodiments of the invention, reference being had to the FIGURES in which like numerals identify like elements of structure.

FIG. 1 shows a perspective view of a floating wharf unit, partially cut away to reveal the interior structure of the unit. Unit **10** comprises one or more cores **12** of lightweight (density less than water) material such as expanded polystyrene, which provide the necessary buoyancy for the unit when it is in place in the water as indicated by phantom water line **14.** If desired hollow watertight enclosed volumes of similar configuration may be used as cores. When two or more cores **12** are used, they are spaced so as to provide a membrane **16** of concrete therebetween, which provides lateral stability in the overall structure and prevents one core from transmitting water to the next in the event that leakage into the wharf unit should occur. The cores are preferably surrounded on all sides by a blanket **18** of lightweight concrete, which forms end wall membranes **16** at either end. Embedded in the concrete adjacent to and surrounding each core is a layer **20** of wire screening or mesh which provides reinforcement to strengthen the concrete against normal loading, temperature effects and shrinkage. Whereas lightweight concrete is specified, standard concrete may be applied as the blanket **18.**

The cores **12** are preferably but not necessarily bevelled along their longitudinal corners **22** and **24,** as shown, and further include a cutaway portion **26** in the longitudinal sides near the ends **28** and **30** of the wharf unit. See also FIG. **2.** These bevelled portions provide a longitudinal space **32** within the concrete blanket **18** in which are located pretensioned cables **34,** extending the entire length of the wharf unit. The size and number of the cables varies, depending on the length of the wharf unit. Attached to cables **34** along the upper longitudinal edges **36** and **38,** are threaded inserts **40** which extend flush to the outer side surfaces of the unit. Bumpers **42** and **44,** of wood, rubber or other resilient material, are attached to the unit along edges **36** and **38** using suitable bolt fasteners **46** threaded into inserts **40.** See also FIG. **3.** The threaded inserts may also be installed flush to the upper surface to provide attachment points for hand rails, and so forth. Where desired to provide additional strength and flexibility in the upper portion of blanket **18,** transverse pretensioned wires or cables **48** may be included which may be attached to each threaded insert as shown or merely stretched between the longitudinal pretensioned cables **34.** The size of the wires varies depending on the width of the wharf unit.

Affixed to each end of the wharf unit **10** are combined end plates **50** and **52,** and connectors **54** and **56.** These plates, which may be of galvanized steel, include on one side pairs of hooked anchor bars **58** and **60** which extend into the concrete which fills the cutaway portions **26** of the ends of cores **12,** thereby securely holding the end plates to the wharf unit. The cut ends **62** of cables **34** extend through apertures in the corners of the end plates. If desired, the end plates **50** and **52** may be secured by attaching gripping means to the ends of cables **34,** in which case anchor bars **58** and **60** may be omitted; however, the use of anchor bars is preferred. Attached to the end plates **50** and **52** are vertically disposed pairs of connector lugs **54** and **56** which are used to join individual wharf units in use. The upper and lower edges of end plates **50** and **52** include outwardly projecting flanges **64** and **66.** The top surface of the wharf unit **10** may be textured as desired to provide a safe walking surface as shown at **68.**

FIG. **2** shows an exploded perspective view of the components used to manufacture the wharf unit **10** in accordance with the method of the invention. A form having inner dimensions of the size desired for the wharf units is assembled from a bottom plate **70,** side plates **72** and **74** and end plates **76** and **78.** If desired, the side and end plates may be hinged to bottom plate **70** so as to facilitate their set up and removal during manufacture. Any suitable means for securing the form together prior to insertion of the components of the wharf unit may be used, for example, the side and end plates may be prewelded together.

End plates **50** and **52** are inserted into the form with anchor bars **58** and **60** facing into the form. If desired, apertures **80** and **82** may be provided in end plates **76** and **78** to accommodate connectors **54** and **56;** or connectors **54** and **56** may be attached to end plates **50** and **52** after the wharf unit has been removed from the form. In any event, end plates **50** and **52** must be secured in the form to prevent movement during pouring of the concrete. The cables **34** are then threaded through end plates **76** and **78** and end plates **50** and **52,** usually first at the bottom of the form, and then at the top. As the cables **34** are threaded through the top of the form, threaded fasteners **40** are strung thereon, one for each attachment point desired for bumpers **42** and **44.** At this point cores **12** may be inserted into the forms after having been wrapped with layer **20** of wire mesh. Cables **34** remain slack until this time, to facilitate insertion of cores **12.** Cables **34** are then pretensioned or stretched using hydraulic or mechanical tensioning means as are well known in the art. Cable chucks **84** or similar gripping means are affixed over the ends of cables **34** prior to tensioning and serve to hold the cables in the stretched position when the tensioning means (not shown) are removed. Threaded inserts **40** are pulled against the form side plates **72** and **74** using bolts **86,** which may be identical to fasteners **46.**

If it is desired to provide transverse pretensioned cables or wires **48** in the upper portion of blanket **18,** these may now be threaded between the threaded inserts **40** and pretensioned using any suitable means. The combined effects of the cables **34** and wire or cables **48** attached to threaded insert **40** is thus to ensure that insert **40** cannot pull out of the wharf unit in service. Also at this time, it may be desirable to install sleeves through which lateral connecting rods **88** are passed. Rods **88** are threaded on each end in the upper and lower portions of the membranes **16,** and are located in the spaces between the cores **12,** under the cables **48,** and in similar locations in the end walls, to provide attachment points for wharf units attached side by side or end to side. See also FIGS. **8** and **9.**

After the above preparations have been completed, the preferred lightweight concrete is poured into the form. This concrete is of such consistency that it will flow under the cores **12** and raise them until the lower portion of blanket **18** has flowed into place. To prevent further upward movement of the cores **12** and to main-

tain them in their proper position in the mold, it is sometimes necessary to fix the cores in place by any suitable means, especially if the transverse pretensioned wires or cables **48** are not being used in the particular wharf unit. If the wires **48** are being used, they restrain the cores **12** from excessive upward movement and thereby acquire some added pretensioning. The form is filled carefully to avoid the inclusion of any void spaces in blanket **18,** after which the top surface may be finished or textured as desired depending on the intended use. The concrete is then permitted to set, the pretensioning cables are cut outboard of end plates **50** and **52** and the form walls may be removed. The completed wharf unit is then ready for attachment of bumper rails **42** and **44** and other connection fittings prior to being placed in the water.

FIG. **3** shows a partial section through a longitudinal corner of the wharf unit. Concrete blanket **18** provides an essentially uniform coating all around core **12.** The upward force applied to transverse cable or wire **48** has deformed it slightly as shown. The relationship of transverse wire **48** and longitudinal cables **34** to the integral eye **90** of threaded insert **40** is clearly shown.

FIG. **4** shows a side elevation in section taken along lines **4—4** of FIG. **1.** The spaces between the cores **12** form membranes **16.** Lateral connecting sleeve and rod elements **88,** if used, extend through the upper portion of membrane **16** approximately on a level with threaded inserts **40,** and through the lower portion of membrane **16.**

FIG. **5** shows an elevation view of the means for connecting neighboring floats end-to-end. Connector lugs **54** and **56** are joined using long bolt **92,** threaded at either end, and fasteners **94.** Both the top and bottom pairs of lugs may be so joined, or only one, depending on the amount of flexure desired in the joint. To provide a suitable walkway over the joint between wharf units **10,** a cover plate **96,** suitably textured for safe walking, may be attached to flanges **64** and **66.** FIG. **6** shows a plan view of the connecting means without cover plate **96** and FIG. **7** shows the optional cover plate in place.

FIGS. **8** and **9** suggest alternate means of joining one wharf unit to another. In FIG. **8,** lateral connecting rods **88** have been installed through sleeves, not shown, in the membranes **16** of a first wharf unit so as to extend from one side only thereof. See also FIG. **2.** Affixed to the extending end of the connecting rods is a connecting plate identical to end plates **50** and **52** except for the anchor bars, having connecting lugs similar to lugs **56** for connection to lugs **54** of a second adjacent wharf unit to form a "T" structure. In FIG. **9,** two wharf units similar to the first unit in FIG. **8** are joined side by side in like manner. These modes of joining one wharf unit to another are merely exemplary, and other configurations will occur to one of ordinary skill in the art without departing from the spirit of this invention.

In practice, it has been found feasible to manufacture wharf units up to 24 feet long, 4 feet wide and from 2 to 3 feet in depth. This compares favorably with prior art, non-prestressed units which typically are available in 8 foot lengths. The increased length made possible by this invention reduces the number of connections required for a given installation, simplifies manufacture and reduces expense.

Having described my invention in such detail as to enable one skilled in the art to make and use it, I claim:

1. A floating wharf unit of a rectangular parallelepiped configuration comprising:

A. at least one core of light weight material

B. a layer of concrete substantially surrounding the at least one core to define a volume having top, bottom and sidewall surfaces; and

C. a first plurality of pretensioned strands of resilient material, a first portion of the first plurality being located within the layer of concrete above the bottom surface of the unit along the bottom longitudinal corners and a second portion of the first plurality being located within the layer of concrete below the upper surface of the unit along the upper longitudinal corners, thereby maintaining the concrete layer in compression.

2. The wharf unit of claim **1** further comprising:

D. a layer of reinforcing wire mesh located in the concrete layer and substantially surrounding the at least one core.

3. The wharf unit of claim **1** further comprising:

D. a second plurality of pretensioned strands of resilient material within the layer of concrete below the upper surface of the unit and transverse to the second portion of the first plurality of pretensioned strands, thereby maintaining the portion of the wharf unit below the upper surface in bilateral compression.

4. The wharf unit of claim **3** further comprising:

D. means attached to the second portion of the first plurality of pretensioned strands below the top wall surface and extending to the side wall surface for attaching a bumper rail;

E. bumper rails extending along the longitudinal sides of the unit; and

F. means coacting with the attaching means for securing the bumper rail to the wharf unit.

5. The wharf unit of claim **4** wherein the means for attaching a bumper rail comprises a plurality of threaded inserts each having an eye integral therewith, at least one of the second portion of the first plurality of pretensioned strands being threaded through the eye of each of the plurality of threaded inserts and the second plurality of pretensioned strands of resilient material being stretched between the eyes of the plurality of inserts on opposite sides of the unit.

6. A floating wharf unit comprising:

A. at least one core of light weight material including longitudinal sides having cutaway portions at either end of the core,

B. a layer of concrete substantially surrounding the at least one core to define a volume having top, bottom and sidewall surfaces; and

C. a first plurality of pretensioned strands of resilient material, a first portion of the first plurality being located within the layer of concrete above the bottom surface of the unit and a second portion of the first plurality being located within the layer of concrete below the upper surface of the unit, thereby maintaining the concrete layer in compression,

D. means for joining one float to another comprising an end plate having on one side a plurality of hook-shaped anchor bars extending into the concrete located in the cutaway portions and on the other side

a plurality of spaced connector lugs for joining one float to another.

7. The wharf unit of claim 6 wherein there are a plurality of cores of lightweight material separated by membranes of concrete and wherein the means for joining one float to another further comprises hollow sleeves extending through the concrete membranes to the walls of the unit, the sleeves surrounding threaded connecting rods.

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