

June 23, 1936.

H. M. KNIGHT

2,044,795

HARBOR

Filed Feb. 12, 1934

4 Sheets-Sheet 1

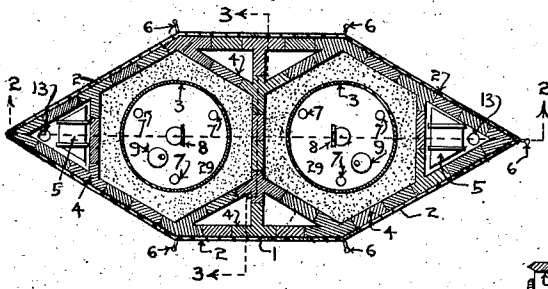


Fig. 1

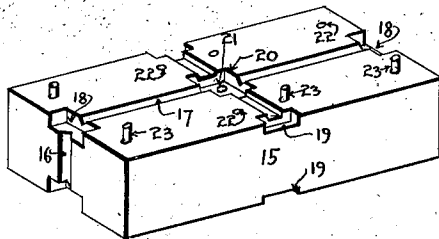


Fig. 5

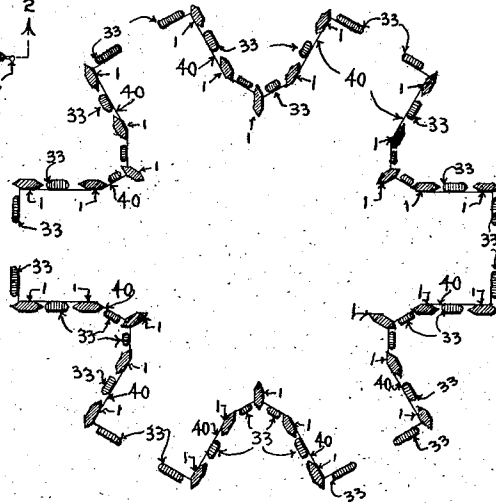


Fig. 4

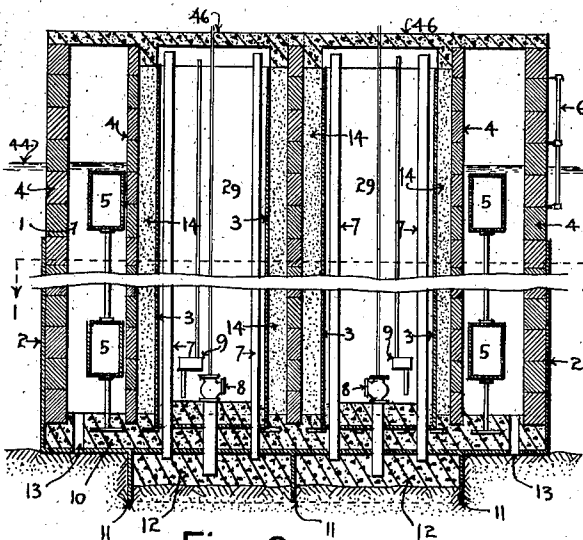


Fig. 2

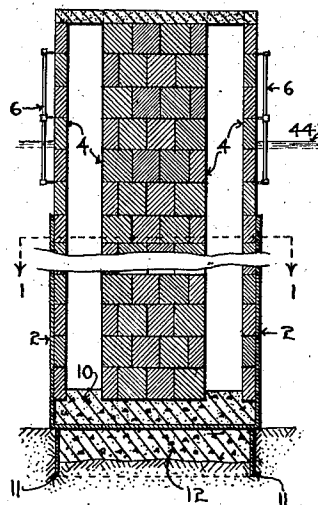


Fig. 3

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4 Sheets-Sheet 2

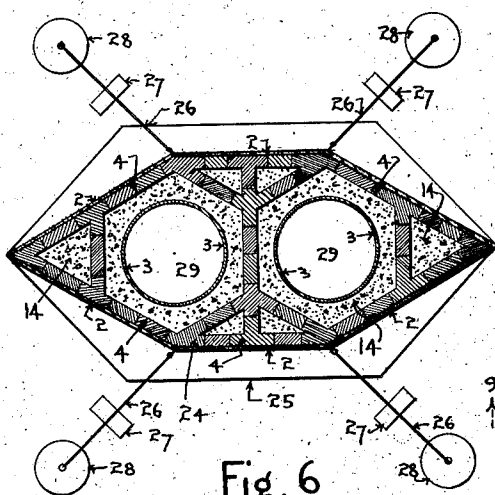


Fig. 6

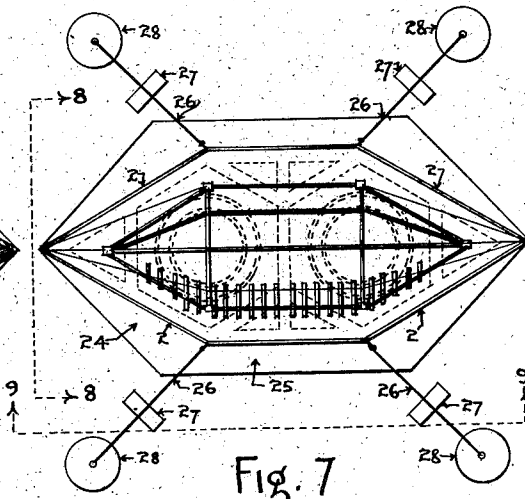


Fig. 7

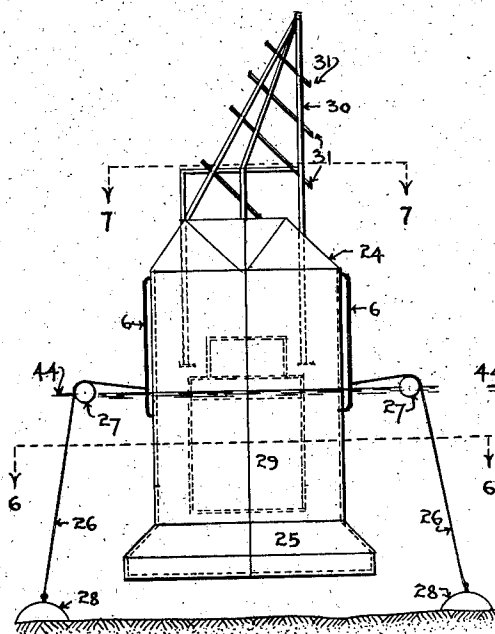


Fig. 8

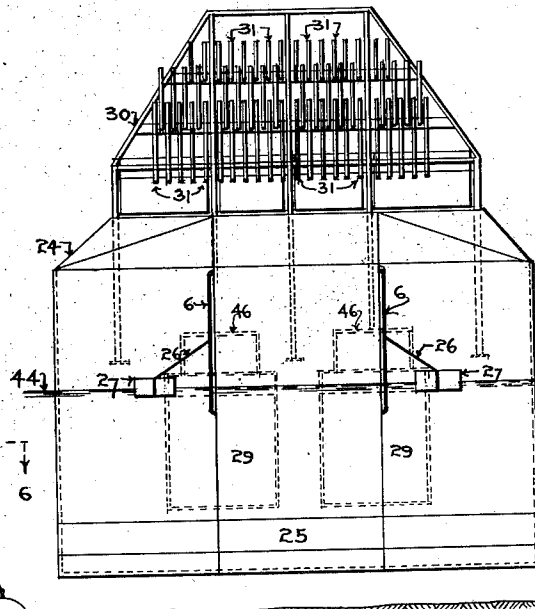


Fig. 9

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4 Sheets-Sheet 3

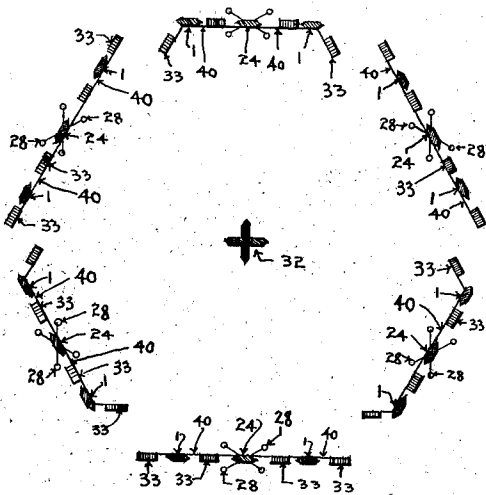


Fig. 10

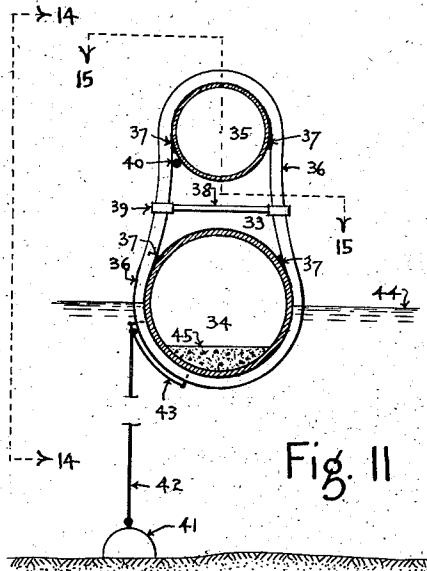


Fig. 11

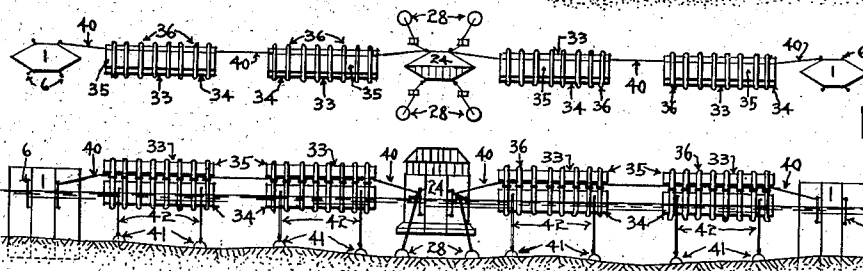


Fig. 12

Fig. 13

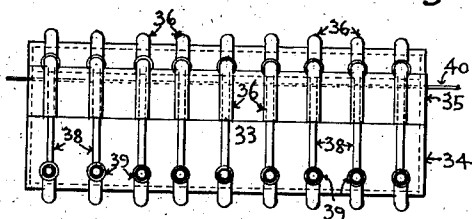


Fig. 14

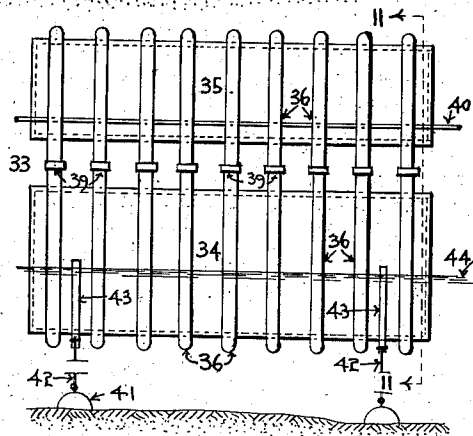


Fig. 15

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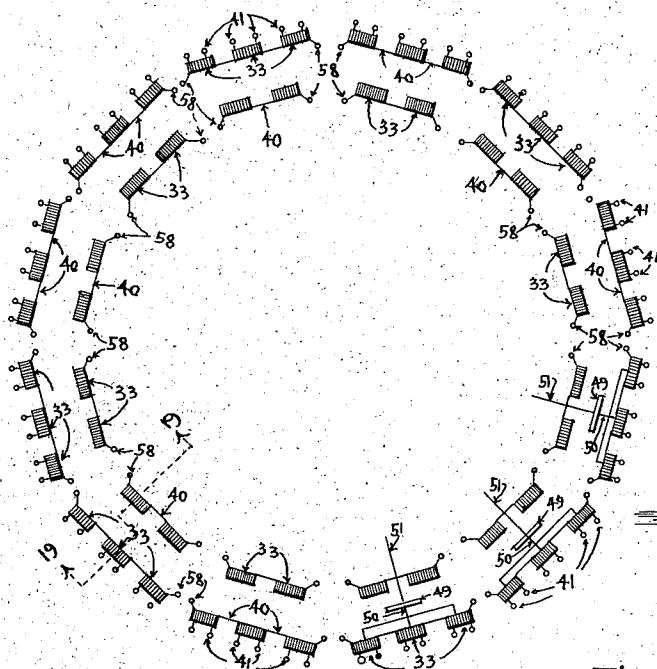


Fig. 16

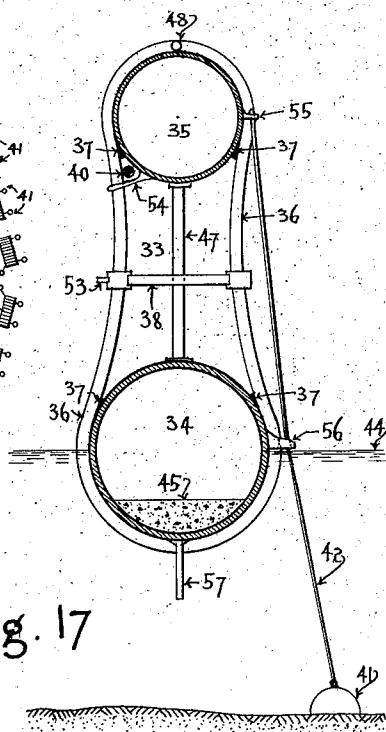


Fig. 17

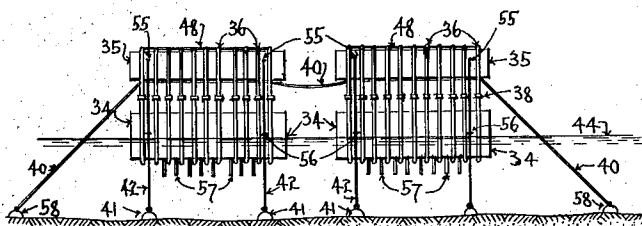


Fig. 18

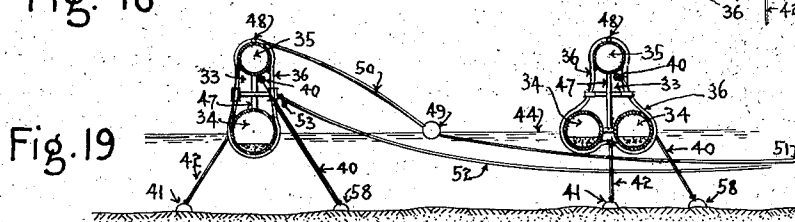
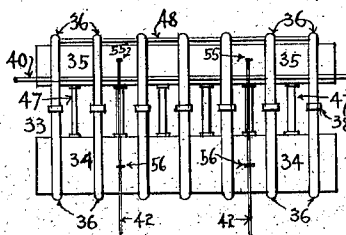
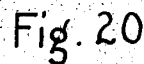


Fig. 19



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HARBOR

Herbert M. Knight, Upper Montclair, N. J.

Application February 12, 1934, Serial No. 710,828

28 Claims. (Cl. 61—5)

This invention relates to improvements in harbors, more particularly to oceanic harbors, and especially to harbors for the landing of sea-planes, such harbors usually being designated by the term "sea-drome".

One of the objects of this invention is to provide an area of quiet water in the ocean, even though such area be surrounded by turbulent waves. Another object of the invention is to provide a series of piers or pontoons, immovably located in, and resting upon, the bed of, the ocean, gaps between said piers being closed by a mobile baffle, or barrier, flexibly connected to said piers. Another object of the invention is to provide a series of radiating avenues in the oceans, said avenues lying between isolated piers which are connected by mobile barriers. A further object of the invention is to provide a pier which can be partially constructed a distance from the site of final and fixed position, and, subsequently, towed to such point of fixed location, and by further and complete construction thereof, be sunk to, or below, the bed of the ocean. Still another object of the invention is to provide such piers, so located, and constructed, as that after the completion of construction, they shall rest upon, or beneath, the bed of the ocean, and, at the same time, extend to any desired height above the surface thereof. A further object of the invention is to employ such fixed piers in conjunction with other, and floating piers. A further object of the invention is the employment of fixed and floating piers with floating barriers in connection therewith. Still another object of the invention is the use of beacon clusters in combination with such barriers. Another object of the invention is the utilization of such barriers in multiple lines. Still other objects of the invention will appear from the accompanying drawings and the specifications.

I illustrate my invention by the accompanying drawings which indicate the usual and preferred embodiment of the invention, but such illustration is not to be deemed as including all forms in which the invention may be embodied, nor as excluding other forms not shown.

In the accompanying drawings Fig. 1 is a horizontal cross-section of a fixed pier on the line 1—1 of Figs. 2 and 3. Fig. 2 is a vertical cross-section of a fixed pier on the line 2—2 of Fig. 1. Fig. 3 is a vertical transverse cross-section of a fixed pier on the line 3—3 of Fig. 1. Fig. 4 is a plan view of a harbor arranged on a radiating basis. Fig. 5 is an isometric view of a form of block employed in the construction of such piers.

Fig. 6 is a horizontal cross section of a floating pier on the line 6—6 of Fig. 8. Fig. 7 is a horizontal view of a floating pier on the line 7—7 of Fig. 8. Fig. 8 is an end elevation of a floating pier on the line 8—8 of Fig. 7. Fig. 9 is a side elevation of a floating pier on the line 9—9 of Fig. 7. Fig. 10 is a plan view of a harbor arranged on a polygonal barrier basis. Fig. 11 is a cross-section of a floating barrier unit. Fig. 12 is a plan view of a combined fixed and floating pier barrier with floating barrier units. Fig. 13 is an elevation of such a combination. Fig. 14 is an elevation of a floating barrier unit on the line 14—14 of Fig. 11. Fig. 15 is a longitudinal view of such barrier unit on the line 15—15 of Fig. 11. Fig. 16 is a plan view of a harbor in which the barrier is a multiple of approximately parallel barrier lines. Fig. 17 is a cross-section of a floating barrier unit specially adapted for use in a multiple lined barrier. Fig. 18 is an elevation of a group of such floating barriers. Fig. 19 is a cross-section of a multiple lined barrier, on the line 19—19 of Fig. 16, and Fig. 20 is an elevation of a single floating barrier unit.

Referring to the drawings, in which similar numerals of reference indicate similar or identical parts throughout, the invention comprises a fixed pier 1, at least the lower part of which is within a cofferdam for convenience identified as the outer cofferdam 2, and within both the outer cofferdam and the pier is another or inner cofferdam 3. Within the outer cofferdam are provided a plurality of masonry shells 4, forming both a peripheral wall and interior dividing walls dividing the pier into numerous compartments. Within some of these compartments are buoyancy tanks 5. On the outside of the pier are secured towing and anchoring bitts 6. Within the pier, and particularly within the inner cofferdam are shown concrete conveying pipes 7, and at the bottom of the pier also within the inner cofferdam are shown scuttle valves 8, and likewise within the inner cofferdam are shown unwatering devices. The bottom of the cofferdam is shown filled to a desired height with a permanent mass concrete ballast 10. Projecting downwardly from the cofferdam are cutting edges 11, and the space defined thereby and between the bed to which the pier is sunk is filled through pipe 7 with a concrete filling 12. Ports 13 are provided through the bottom of the cofferdam and the permanent concrete ballast 10 into the compartments having the buoyancy tanks. The compartment surrounding the inner cofferdam has concrete filling 14 therein. It may be here noted that the several

walls are preferably constructed with pre-cast blocks 15 having end grooves 16, face grooves 17 extending in a direction to intersect the end grooves, and end pockets 18 at the edges where said grooves would normally intersect. Similar pockets 19 are arranged at the other sides of the block, and a center pocket 20 is provided in the face of the block midway of the face grooves 17. In the middle of this center pocket 20 is shown a reinforcement perforation 21, and at appropriate points upon the face of the block is provided a plurality of dowel holes 22 for receiving dowels 23 therein.

While the pier so far described is adapted to rest upon the bottom of the body of water, my invention enables the utilization of a floating, but anchored, ballasted pier, and Figure 6 et sequel, designates such a floating pier by numeral 24, the same having an extended bottom 25 for increase ballast. The floating pier is maintained in place by anchoring cables 26 secured to bitts 6 on the pier and to cable floats 27 and finally to anchors 28. The buoyancy of the pier is maintained by suitable buoyancy chambers 29 which may conveniently comprise the space, in whole or in part, within the inner cofferdam 3. On the top of the floating piers I have shown a "combing" frame 30 having grillage beams 31 for impeding wave motion in the water. The piers, fixed and/or floating, are arranged in the ocean or elsewhere to form defining points for an area to be enclosed, and conveniently this area may be marked by a beacon cluster 32 here shown as at the center thereof.

Associated with the piers to provide therewith an adequate barrier are a plurality of floating barriers 33 comprising a lower float 34 and an upper float 35 connected by a "comb" 36 attached to both of said floats as part of the floating barrier unit. The comb is attached to the floats by suitable means such as indicated at 37, and the elements comprising the comb may be connected between the floats by transverse struts 38 with suitable joining means 39 at the juncture of said struts and comb elements. The barrier units are secured in proper relation to the piers by main barrier cables 40 extending in a direction corresponding to that of the series of barriers. Anchors 41 offset laterally from the line of barriers are connected by cables 42 to cleats 43 on the barrier for holding the barrier units from undue lateral displacement from the general line of the barrier. It is to be understood that the barrier units stand in upright position largely above the surface of the water indicated at 44, and are held in this upright position by permanent ballast 45 within the bottom part of the lower float 34. Access to the buoyancy chamber may be secured through cap 46. If found necessary or desirable, posts 47 may be provided between the two buoyancy chambers for holding them apart and increasing the rigidity.

As it is part of my invention to prevent formation of ice upon the barriers, I have shown the same equipped with a heat conveyor 48 thereon receiving heat in the form of steam or otherwise from a heat conveyor reservoir 49 disposed in convenient relation to several of the barrier units and supplying heat to said units through appropriate distributors or pipe connections 50, said reservoirs in turn receiving the heat through main conveyors 51 from the source of supply. Return flow, direct to the source of supply, if so desired, is obtained through return heat conveyors or pipes 52 having connections 53 with the

heat conveyor 48 or associated parts. Further details of construction include a guide 54 for the main cable to pass the same longitudinally of the barrier, and also includes anchor cable connections 55 on the barrier, preferably at an upper part thereof with anchor cable ring-guides 56 near a lower part thereof. Furthermore, depending tines or fingers 57 may project below the lower float chamber for interference with wave influences attempting to pass beneath the barrier. The main cables 40 may be suitably anchored to piers 1, 1 at opposite ends of the series of barrier units if prevailing depths will permit, as shown in Figures 10 and 12, or may be attached to dropped anchors 58, 58 as shown in Figure 18 if such method is preferred or necessary.

Navigating the oceans has been from the earliest attempts fraught with great hazard and danger. Three causes have most largely contributed to these conditions, viz:—the great distances involved, the high waves induced by storms and the great depths which precluded satisfactory anchorage. With the building of larger and faster vessels these dangers have been materially reduced. With the advent of the air plane, and the demand that it be employed in trans-oceanic commerce, the problem of safe traverse of the great ocean distances has again become a problem of major importance.

On account of the great distances, and the lack of sufficient islands or bodies of land upon a direct or nearly direct route between the major cities upon the several continents, this very desirable and quite important adjunct of modern commercial life, has failed of solution. Many expedients have been proposed, most of which are for the utilization of lines far from direct, but on which land areas in the oceans can be utilized as mid-station landing fields. But these longer routes add materially to the distances, and therefore reduce both the business which can be carried, and the return therefrom. Floating landing fields have also been suggested and attempted, which contemplate a huge platform, set upon floats, high above the waves, and anchored to the ocean bed. The major defect of this method is that sea-boats and amphibians cannot be used, traffic being limited to planes equipped with a ground landing gear. This defect becomes the more apparent when it is realized that safety in transit across large bodies of water is more positively assured when the seas are traversed by carriers capable of landing safely upon the water surface.

This invention seeks to overcome the above recited difficulties by establishing areas of comparatively quiet water, upon which amphibian and sea-boats, may land with safety and comfort. Certain natural phenomena lend themselves directly to accomplishment of this purpose.

Usually the ocean depths, both of the Atlantic and Pacific Oceans are of great depth, in many places averaging from 12,000 to 13,000 feet. There are however, and especially in the Atlantic Ocean great variations in depth, there being several spots where the ocean bed rises to a comparatively slight depth, and such rise results in depths sufficiently shallow to permit of the anchoring and permanent locating of an artificial harbor on the surface of the quiet water of which such sea-boats, amphibian and similar aircraft could safely land, and in which storm driven vessels could find safe anchorage.

It is evident from the foregoing that the essen-

5 tial of this invention consists in quieting the surface of the ocean by isolating an area thereof within a barrier, so as to reduce and deflect the waves exterior to such barrier before any portion of such waves could penetrate to the area isolated. There exist in nature remarkable exam-
 10 ples of this quieting of oceanic waters in the atolls which are so numerous in the south seas. These atolls consist of a circular, or nearly circular, ring, or strip, of coral rock, projecting a short distance above the surface of the water, and surrounding, or nearly surrounding a central lagoon, which central lagoon is still and quiet water, while exterior to the encompassing coral rim, the
 15 waves or surf may be high and violent.

The object of this invention is to reproduce these natural conditions in bodies of water where natural conditions, while not yielding themselves to the creation of atolls, are such as to permit the location and anchoring of artificial barriers instead of the coral rock rim, thereby securing the quiet interior area so admirably obtained naturally in the atoll.

25 The above purpose is secured by the use of certain appliances, such as fixed piers 1, floating piers 24 or barrier "combs" 33, either used separately, or in combination, as the particular case may make desirable or essential. While primarily the system has been developed with a view to offering safe trans-oceanic commercial transport, the system is not to be assumed as limited solely and alone to oceanic locations and conditions. It has a wide application to inland locations, where in connection with lakes and rivers, a floating
 30 landing field offers greater advantages as regards economy and adaptability, than an earth field.

The piers, whether fixed or floating, are of nearly identical design. They consist of an outer metal cofferdam 2, sealed against the infiltration of water from without. Such cofferdam is constructed in the same manner as the outer skin of ships, and covering the bottom and the sides, and being water tight, assures that the piers will float, either while being towed to their final locations, or continuously after having been located in position. Against this outer cofferdam is built up a masonry shell 4, usually of pre-cast concrete, of a block, or similar type of material. This pre-cast structure is usually of pre-cast concrete of specially formed blocks, which may, or may not, be heavily reinforced. Within, and interior of both the outer cofferdam and the pre-cast masonry shell 4, are located inner cofferdams 3, usually in multiple, which are of metal. In fixed
 40 piers, provision is made for scuttling, if necessary, by scuttle-valves 8, operated from the roof 46 of the piers. The fixed piers likewise have a cutting edge 11 at the bottom which will penetrate the mud and ooze of the bottom of the body of water, until the pier reaches a condition of stability or rest, after which any space between the base of the pier and the bed will be filled with mass concrete 12, forced through concrete pressure pipes 7 to the said area, so filling it as to distribute the weight of the pier evenly over the foundation. In addition, the fixed piers, because of their greater height and bulk, are provided with open end sections, with ports 13 thereto, for the entrance of water from the surrounding body of water. Within these ends are located metal buoyancy chambers 5 which add to the buoyant effect, and aid in the flotation and regulation of the pier during location.

75 Between the inner cofferdam and the exterior pre-cast masonry shell is an area in which filling

14 is placed for the purpose of sinking the pier to the bed, or to some definite depth of flotation. This filling 14 may be earth, rock, or similar material, or it may be mass concrete, all of pre-determined amount and weight, so as to overcome the upward buoyant effect of the water and secure the desired amount of immersion. This mass filling likewise becomes an element of greatly added strength to the structure, preventing fracturing, either of the exterior cofferdam or its inner pre-cast masonry shell. This feature of a fill between the shell and the interior cofferdam, is common to either the fixed or floating type of pier.

Towing and anchoring bitts 6 are a part of both types of piers, such bitts being located at or near the angles of said pier. To these bitts towing cables are attached during towing to location, and subsequently, and when in final position, these bitts become the attachment members for the anchor cables 26. The anchor cables attached to the piers are usually passed over cable floats 27 so as to raise them above the water surface in proximity to the piers, but also to relieve the cable and the piers from sudden shocks and strains, these cable floats acting as accumulators, or equalizers, to mitigate the effects of sudden or severe wave action.

The area within the enclosing walls of the inner cofferdam becomes an inner buoyancy chamber 29, in all respects similar to the hold of a ship, and in fact the entire pier becomes a large, heavy masonry boat, of relatively small superficial area and relatively great depth. These buoyancy chambers are usually covered, for, although they are carefully protected from infiltration or leakage rain or spray may enter, and thereby interfere with the net buoyancy, which is relatively low.

In order to break up spray, or the tips of high waves, the piers are, in some instances, capped with a "combing", either of bars or of pipe 31, supported by a frame 30 attached to the pier. This "combing" is not intended to resist the wave action, only to retard it, such retardation reducing the amount of water which will overtop the pier and find itself on the pool side thereof. The lower of these frame supported "combs", unlike the upper, is usually a full and unperforated plate, its office being to return a part of the water to the source from which it came. The upper "combing" is preferably a grizzly of pipes 31, such an arrangement acting most effectively in slowing up the wave during its passage, without undue, or excessive impacts.

Between the piers, and also sometimes extraneous thereto, are anchored floating barriers 33. The purpose of these barriers is to retard wave action, rather than to resist it. These floating barriers are usually connected to the piers by 60 slack cables 40, admitting of considerable latitude of motion of the floating barriers. The barriers are securely anchored in position, but the cables are attached to the barriers so as to permit motion of the barriers without unduly stressing the cables. These barriers may be of various forms. The preferred form of barrier consists of an upper tank 35 and a lower tank or float 34, usually of circular cross-section, these tanks being water tight. The lower tank 34 is always the larger of the two, and, in addition to its size, and as a further element in securing a stable condition of flotation, a permanent ballast 45, usually of concrete masonry, is placed in the bottom of the lower tank. The tanks are immovably connected
 75

together with a "combing 36", usually of tubing or piping, this combing partially surrounding both tanks in such manner as to hold them irrevocably in position and at a certain determined distance apart. This "combing" does not entirely encircle each tank, but is so formed around both tanks as to retain them in their relative positions. In addition the tanks and the "combing" are attached rigidly together, preferably by welding 37, thereby ensuring that both elements of the barrier shall act together. Further a system of struts or braces 38, rigidly strengthens the "combing", so that the impact of waves is prevented from demolishing the barrier.

The barriers are anchored at 41 so that the anchor cable 42 is slack at any position between trough and mean height of wave. Waves striking the barrier cause it to rise until the anchor cables are taut. After the cables 42 have become taut the barrier revolves slightly, and in the direction of the advancing wave, until restrained from further revolution by the pier cable 40. The waves then rise to the combing 36, through which their passage is retarded, only a portion of the wave passing through the openings between the grid of which the combing is composed. This combing 36 is usually composed of tubes or pipes, by which form of construction the opening is gradually reduced, rather than an opening the full amount of which is immediately offered in opposition to the passage of a wave. The interference of this barrier "combing" so delays the crest of the wave as that the trough arrives before all of the crest can force its way through the tube-bars of the "comb", with the result, that the retarded wave flows backward into the sea, instead of forward into the pool. All of this action reduces the turbulence of the pool, and quiets the water therein, relative to the water exterior to the barrier. An area of water surface, free from large waves, and safe and satisfactory for the landing of sea-planes and amphibians under all conditions, and a harbor safe for the anchoring of vessels far from land, is the result.

In lieu of a harbor periphery composed of a combination of piers and floating barriers, a periphery composed of barriers alone can be used. Piers are used where the depths are comparatively slight, and where the founding of piers is both comparatively inexpensive and not difficult. Where depths are greater the expense and difficulty of this method of construction becomes prohibitive, and harbors having peripheries of floating barriers alone are employed. Such a form of construction is illustrated in Fig. 16. This illustration indicates the preferred distribution of the several units. The floating barriers are located in multiple parallel, or approximately parallel, lines. It will be observed that the inner line has its barriers staggered as regards the outer row of barriers, the barriers on the inner line being positioned so as to cover the gaps between the barrier units on the outer line, thereby having in the two lines of barrier units an unbroken line of barrier units opposed to the waves coming from any direction, except for those openings between the individual barrier groups which are left for the entrance and exit of vessels. In this arrangement the double line of barriers are located in groups between such entrance and exit openings.

Substantial anchors 58 are located at each end of the inner and outer barriers of each group. Attached to these anchors is a cable 40 which passes, directly or indirectly, through the "comb"

portion of each barrier unit, such cable by attachment or location uniting the several barrier units of each line of each group, holding the barrier units in position and causing them to act, to a certain extent, in unison. This connecting anchor cable is flexible, instead of taut, permitting, within regulatable limits, independent movement of the several barrier units. In addition, each of the barrier units is fastened by one or more independent anchors 41 by anchor cables 42. These latter anchors and anchor cables preserve and maintain the relative alignment of the barrier units, and limit their vertical, and to a lesser degree, their horizontal movement or displacement. The individual anchor cables of the inner and outer groups may be differently attached to the floats, and for specific reasons. Usually the outer barrier anchor cables are attached to the upper float cylinder 35, and pass downwardly through a ring 56 attached to the lower float cylinder 34, and from thence to the anchor 41. These anchor cables are usually attached to the seaward side of the barrier units. Such an arrangement, and such a mode of attachment causes the outer barrier unit to stand up more nearly vertical under wave action, and yet with such flexibility of movement as not to unduly stress the cables. At points of contact between cables and barrier units, the cables are considerably enlarged and armored, in order to provide for, and to protect against, abrasion and wear.

In some locations where such artificial harbors are located, temperatures will be met with during the winter season at, or below, freezing, and as a result the upper float, and the upper portion of the "comb" may become heavily encrusted with ice or frozen spray. The added weight of this material will materially decrease the buoyancy of the barrier units, and seriously interfere with the action of the "comb". In order to overcome these injurious effects, means 49, 50 and 51, are provided for heating such portions of the barrier units as are liable to become so encrusted, such heating being carried only to such a temperature as will prevent an undue accumulation. As previously referred to, the "comb" is usually built of tubing or pipe, and, the mid-stay may likewise be of tubular construction. Connection 48 is made with the upper portion of the "comb" and with the mid-stay 38, and through these and return connection 53 a heating medium is allowed to circulate.

Both the outer and the inner floating barriers are usually anchored so as to have their upward limit of vertical amplitude at or about midway between crest and trough, that is at or about the level of still or quiet water. When a wave approaches the outer barrier it raises the barrier unit until the anchor cable 42 is taut, after which, and because the barrier unit can rise no further (that is higher), the wave piles up above the lower float cylinder and strikes the "comb". A portion, and usually about $\frac{2}{3}$ of the wave volume, passes through the "comb", but in such passage it is impeded. The unimpeded portion of the wave adjacent to the ends of the barrier units, passes unimpeded through the spaces or gaps between the several barrier units, into the annular ring between the two lines of barrier units. But, because the height of the water in this annular space, and behind the outer barrier units is lower than the crest and lower than the height of wave passing through the gaps between the barrier units, this advancing wave through the gap is deflected sidewise and passes into the annular

space, instead of moving toward the inner pool. As the quantity passing through these gaps is comparatively small the elevation of the water in the annular space is only slightly elevated above mean elevation, and there is no marked movement from the annular space toward the pool, or toward the inner line of barrier units which are positioned to prevent any secondary wave, of measurable height, passing into the inner area, or pool. That is, the combined action of the "comb" and the annular space is to flatten out the wave, destroy its synchrony, and therefore eliminate it from influence upon the pool area. In fact, the pool is discharging into the annular space as much and as often as that space is discharging into the pool, and such motion and currents as do exist are insufficient to create any turbulent effect. Likewise, a large portion of the entangled and retarded wave flows backward from the barrier unit into the sea, because the crest has passed before any material reduction in the height of water on the barrier unit has manifested itself, the level of the seaward side of the barrier unit being at that time, lower than the entangled water on the barrier unit.

What I claim is:—

1. In a harbor, a barrier unit, said unit having an upper float, a lower float and a comb enclosing said floats.

2. In a harbor, a barrier unit, said unit having an upper float, a lower float, a permanent ballast in said lower float and a comb enclosing said floats.

3. In a harbor, a barrier unit, said unit having an upper float, a lower float, a comb enclosing said floats, anchors and means connecting said floats and said anchors.

4. In a harbor, a barrier unit, said unit having an upper float, a lower float, a post between said upper and said lower float and a comb enclosing said floats.

5. In a harbor, a barrier unit, said unit having an upper float, a lower float, a comb enclosing said floats and struts between opposing sections of said comb.

6. In a harbor, a barrier unit, said unit having an upper float, a lower float, posts between said upper and said lower float and a comb enclosing said floats, said comb consisting of a plurality of enclosing bands, said posts and said bands being staggered relatively to each other longitudinal of said floats.

7. In a harbor, a barrier unit, said unit having an upper float, a lower float, a comb enclosing said floats, means permanently connecting said comb to said upper float and other means permanently connecting said comb to said lower float.

8. In a harbor, a barrier unit, said unit having an upper float, a lower float and a comb enclosing said floats, said comb consisting of a plurality of enclosing tubes.

9. In a barrier unit, the combination of an upper float, a lower float and a comb, said comb being exterior of and connected to said floats, and said comb consisting of a plurality of continuous bands.

10. In a barrier unit, the combination of an upper float, a lower float and a comb, said comb being exterior of and connected to said floats, and said comb consisting of a plurality of continuous tubular bands.

11. In a barrier unit, the combination of an upper float, a lower float and a comb, said comb being exterior of and connected to said floats, and said comb consisting of a plurality of bands,

said bands being positioned longitudinal of said floats, adjacent bands being in non-contact relation with each other.

12. In a harbor, a barrier unit, said unit having an upper float, lower floats in multiple and a comb enclosing said floats.

13. In a harbor, a barrier unit, said unit having an upper float, a lower float, a comb enclosing said floats and means conveying heat to said unit.

14. In a harbor, a barrier unit, said unit having an upper float, a lower float, a comb enclosing said floats and fingers depending from said lower float.

15. In a harbor, a plurality of barrier units, said units having an upper float, a lower float, a comb enclosing said floats, anchors and means connecting said units, and said anchors.

16. In a harbor, a periphery composed of a plurality of barrier units, said units having upper floats, lower floats and combs enclosing said floats.

17. In a harbor, a periphery composed of a plurality of barrier units, said units having upper floats, lower floats and combs enclosing said floats, said units being arranged in separated groups.

18. In a harbor, a periphery composed of a plurality of barrier units, said units having upper floats, lower floats and combs enclosing said floats, anchors, and means connecting said units and said anchors, said units being arranged in separated groups.

19. In a harbor, separated, external groups of barrier units, said units having upper floats, lower floats and combs enclosing said floats.

20. In a harbor, separated, peripheral groups of barrier units, said units having upper floats, lower floats and enclosing combs, a main cable connected to the units of each group and anchors attached to said main cable.

21. In a harbor, an outer, peripheral line of barrier units and an inner, peripheral line of barrier units, each of said units having an upper float, a lower float and a comb enclosing said floats.

22. In a harbor, a plurality of exterior barrier units, said units having their longitudinal axes located upon an exterior peripheral line and a plurality of interior barrier units, said units having their longitudinal axes located upon an interior peripheral line, said exterior and said interior lines being substantially parallel, each of said units having an upper float, a lower float and a comb enclosing said floats, a line normal to said exterior and said interior peripheral lines and passing through the centre of said interior barrier unit being eccentric relative to the centre of the adjacent exterior barrier unit.

23. In a harbor, an outer peripheral line of barrier units, said units having an upper float, a lower float and a comb enclosing said floats, a main cable, anchors, means connecting said units and said cable, means connecting said anchors and said cable, an inner peripheral line of barrier units, said units having an upper float, a lower float and a comb enclosing said floats, a main cable, anchors, means connecting said units and said cable and other means connecting said anchors and said cable.

24. In a harbor, the combination of piers, said piers having outer and inner cofferdams, masonry walls, and interior filling, barrier units, said units having upper floats, lower floats and enclosing combs and means connecting said piers and said units.

25. In a barrier unit, the combination of an upper float, lower floats in multiple, and a comb, said comb being exterior of and connected to said floats, said comb consisting of a plurality of continuous bands.
26. In a barrier unit, the combination of an upper float, lower floats in multiple, and a comb, said comb being exterior of and connected with said floats, said comb consisting of a plurality of continuous tubular bands.
27. In a harbor, the combination of a line of outer barrier units, a line of inner barrier units, anchors for said outer units, anchors for said inner units, said units consisting of an upper float, a lower float, a comb engaging said floats and beacon clusters interior of said line of inner barrier units.
28. In a harbor, the combination of a line of outer barrier units, a line of inner barrier units, anchors for said outer units, anchors for said inner units, said units consisting of an upper float, lower floats in multiple, a comb engaging said floats, and beacon clusters interior of said line of inner barrier units.

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