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(54) FLOATING BARRIER FOR OIL

(71) We, MITSUBISHI JUKOGYO KABUSHIKI KAISHA, a Japanese body corporate, of 5-1 Marunouchi 2-chome, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to floating barriers, principally for oil.

The design of floating barriers for preventing oil spilled on the sea from dispersing are quite different depending upon the marine environment in the region where the barrier is to be used, the way it is transported and deployed, and the materials from which it is constructed. However, in general a floating barrier of any desired length can be assembled by connecting individual units together by means of water-proof flexible connecting members, each said unit being formed of a float of a given length and having an oil leakage preventing plate provided along the bottom edge of the float.

When an accidental oil spillage has occurred, the barrier is transported to the site of the accident and is deployed so as to encircle the oil spill, and it can then be anchored without drifting by means of anchoring chains provided with weights secured to the bottom of the oil leakage preventing plate. However, in the case of such barriers of the prior art, there is always the possibility that some of the captive oil spill may escape by passing under the oil leakage preventing plate due to the action of wind, waves and a tide.

This is an inherent weakness of floating barriers constructed according to the prior art since the principal leakage route for oil escaping from the surrounding barrier is under the leakage prevention plate in difficult weather conditions.

Experiments have shown that in the case of the conventional floating barriers, leakage of oil begins at a tidal current of about 0.36 m/s (0.7 knots). This is because the reservoir of captured oil on the upstream side of the barrier is converted into an emulsion of oil and sea water by tangential

forces between water and oil due to the action of waves and tidal current, and this emulsion is aggregated by the tidal current until it drifts to the downstream side by passing under the bottom of the barrier.

To solve the problem of the oil passing under the barrier in the form of an emulsion, a method of designing the barrier so as to have a deeper draught, making the oil leakage preventing plate deeper, or surrounding one barrier by another at a given spacing, is known. However, in the case of the former two methods, the build-up of the emulsion by the tidal current against the barrier may so increase that it becomes difficult to deepen the barrier sufficiently, and if the barriers surround each other in a plurality of rows or strings according to the last method, for instance, if the barriers are deployed in two parallel rows, depending upon the depth of the emulsion, the speed of the tide and the timing of the waves, it may happen that a part of the emulsion which has passed under the inner barrier arrives at the bottom of the outer barrier just in time to escape under it. To deploy barriers on the sea in three or more rows to counter the above disadvantage, takes a great deal of time and trouble, and in any case is very difficult to do in the face of adverse weather conditions.

In addition, units of the above-described barriers in the prior art are liable to be destroyed when struck by a ship, or drifting debris etc., and they are also liable to be damaged due to repeated buffeting by the waves.

Accordingly, one object of the present invention is to provide an improved oil barrier which can positively collect oil spills and reliably prevent them from contaminating a wider region of the sea upon the occurrence of an accident oil spillage.

Another object of the present invention is to provide an improved oil barrier which can attenuate wave motion, thus preventing the surrounded oil from leaking out by dissipating the energy of the waves, and at the same time reducing the possibility of dam-

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age to the barrier by the continual buffeting of waves.

According to the invention a floating barrier for oil is characterised in that barrier units, each of which is constructed by connecting a plurality of floats disposed in parallel to each other at a given spacing by means of chains cables or the like and by interposing buffer members between adjacent ones of the parallel floats, are arranged in series, in that the corresponding floats of the adjacent barrier units are connected by means of chains, cables or the like, and in that flexible shielding plate means is interposed between adjacent ends of said barrier units.

The invention may be put into practice in a number of ways, but two specific embodiments and a number of modifications thereof will now be described with reference to the accompanying drawings in which:—

Figure 1 is a vertical side view in cross-section showing one preferred embodiment of a floating barrier in accordance with the present invention.

Figure 2 is a vertical side view in cross-section showing a modified form of a float or barrier body.

Figure 3 is a fragmentary part-sectioned front view of the float of Figure 2.

Figure 4 is an isometric view, partly cut away, of the float of Figure 2, showing the state where the screen is extended.

Figure 5 is a vertical side view in cross-section showing an operating state of the float of Figure 2 in a floating barrier according to the invention.

Figure 6 is a plan view of a portion of the same barrier.

Figure 7 is a plan view showing a modification of the arrangement of Figure 6.

Figure 8 is an isometric view showing another preferred embodiment of a floating barrier in accordance with the present invention.

Figure 9 is an isometric view of a buffer member of the Figure 8 embodiment, and

Figures 10 and 11 are side views, respectively, showing operating states of the embodiment illustrated in Figure 8.

Referring to Figure 1, one barrier unit of the floating barrier comprises a first float or barrier body 10 provided with side plates 7 and 8 and a buffer member 9 on its outer face, and a second float or barrier body 10 also provided with a buffer member 9 on its outer face, the two bodies being spaced apart and arranged parallel to each other. Flat plate type buffer members 17 are attached to the inner faces of the respective bodies 10 and 10¹ and in the space between the respective buffer members 17 another buffer member 18 is provided which also serves as a spacer between the bodies 10 and 10¹. The bodies 10 and 10¹ are also interconnected

via securing eyes 19 and a chain 20. Further, a plurality of the barrier units are connected together in series: thus, longitudinally adjacent floats (10, 10 or 10¹, 10¹) are connected together at their adjacent ends by a chain (not shown) extending between securing eyes (not shown) provided at those ends, and, further, flexible shielding plate means in the form of a concertina-shaped connecting fence (compare Figure 4) is provided between each pair of said adjacent ends. The floating barrier is anchored in position by anchoring chains 15.

In a modification of the arrangement of Figure 1, the floats or barrier bodies 10 or 10¹ of Figure 1 may have the modified form of the float or barrier body 21 of Figures 2—6. As shown, a tubular casing 22 is fixedly secured along the length of the bottom edge of the barrier body 21, and the bottom surface of the tubular casing provides a slit 23.

In addition, along the axis of the casing 22, a winding spindle 24 is provided the ends of which are pivotably supported by bearings 25 provided at either end of the casing. A roller blind type screen 26 extends through the slit 23 and has one end fixedly secured to the winding spindle 24, and a weight 27 is fixedly secured to the other end of the said screen. The weight 27 is wedge-shaped in cross-section, so that when it is inserted into the bottom of the slit 23, the interior of the casing 22 can be made watertight.

A lower end of a compressed air inlet pipe 28 opens in the casing 22, so that compressed air may be fed into the said casing through piping led from a compressed air source (not shown) via connecting plug 29 and an air introduction pipe 28.

Referring to Figure 4, it is to be noted that the adjacent ends of the floats or barrier bodies 21 are connected by flexible shielding plate means in the form of a concertina-shaped connecting fence 13, by means of bolts 14, and that the bottom part of said fence 13 is extended so as to have substantially the same depth as the screen 26 when the latter is fully deployed. Further, the said adjacent ends of the floats or barrier bodies 21 are connected together by a chain (not shown) extending within said fence 13, between securing eyes (not shown) provided at those ends.

Referring to Figure 4, each float or barrier 21 comprises a cylindrical buoyant member 1, an above-water fence 2 provided at the top of and along the length of the member 1, and an underwater fence 3 provided at the bottom of and along the length of the member 1. Upper brackets or formers 4 are mounted between the member 1 and the above-water fence 2 at intervals, whilst lower brackets or formers 5 are mounted between

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the member 1 and the underwater fence 3 at intervals. Intermediate brackets or longerons 6 are mounted between the float 1 and the respective formers 4 and 5. An upper side plate 7 is fixed to the top edge of the above-water fence 2 so as to extend along the length of the member 1, and a lower side plate 8 is fixed to the bottom edge of the underwater fence 3 and also extends along the length of the member 1.

A buffer member 9 is fixed to the respective side plates 7 and 8 and the outer surfaces of the respective side plates 7 and 8 and the outer surface of the buffer member 9 form a continuously curved convex surface connecting the top edge of the above-water fence 2 and the bottom edge of the underwater fence 3. The maximum cross-sectional width of the float or barrier body 21 is in close proximity to the water line of the buoyant member 1.

With the arrangement being discussed, in a case where oil has spilled out onto a calm sea, the barrier bodies 21, each with its screen 26 retracted on the winding spindle 24 and the weight 27 pressed into the slit 23, could be deployed so as to encircle the spillage, and the anchor chains 30 could moor the barrier bodies 21.

Under such deployed condition, the weight 27 is wedged into the slit 23 of the casing, so as to make it water-tight, and the spillage dispersed on the sea can be collected by the barrier bodies 21 and the connecting fences 13 and thereby prevented from drifting outwardly.

However, if the weather deteriorates so as to produce violent waves and strong tidal currents, so that the oil spill encircled by the barrier is gradually emulsified and begins to escape by passing under the barrier bodies 21, high pressure compressed air can be admitted to the casing 22 via the inlet pipe 28 from a compressed air source (not shown) so that the wedge-shaped weight 27 is released from the slit 23 urged by this air pressure, and descends. As shown in Figure 5, as this happens the screen 26 is paid out from the winding spindle 24 and is extended downwardly, so that even if the emulsified oil (b) should sink lower than the bottom of the barrier body 21 due to wave action (c), it would be prevented from drifting out to sea by the said screen.

It is to be noted that at the junction of the barrier body 21 and the connecting fence 13, even if a small gap should arise between the fence 13 and the screen 26, the flow of the emulsified oil (b) through the gap is quite small in comparison to the case where no screen 26 is fitted.

In normal circumstances, since it is only necessary to deploy the barrier bodies 21 with the screens 26 retracted, the installation of the oil barrier is very simple and easy, and

as the screen 26 is protected from damage by the casing 22, this greatly adds to its durability.

If there is any likelihood of the emulsified oil escaping from the barrier, the screen 26 can be easily and quickly deployed even in the severest weather conditions by activating the compressed air system.

Whilst the screen 26 is constructed from sheet material, it could also be constructed from fine mesh net material.

Whilst the connecting fences 13 in this arrangement are provided on both sides of each row of the barrier bodies 21 as shown in Figure 6, in a modification the connecting fences 13 could be provided only on one side of each row as shown in Figure 7.

In another preferred embodiment of the present invention illustrated in Figures 8 to 11 each barrier unit of the floating barrier comprises a pair of floats or barrier bodies 31 disposed in parallel relationship at a given spacing and each in the form of a hollow rectangular box, and which are attached to each other by means of transverse chains 32 and are further anchored to the sea bed by means of chains 33.

In this embodiment, a buffer member in the form of an assembly 34, which is itself buoyant, also serves as a spacer which is interposed between the pair of floats 31. A framework 34b surrounding a rectangular float 34a supports used vehicle tyres 34c on the sides of the float 34a adjacent to the floats 31. It is to be understood, of course, that the buffer member 34 can be constructed of any other suitable buoyant and floatable resilient material.

In this way, barrier units can be constructed each comprising the pair of floats 31, 31 attached to each other by means of the chains 32 and having the buffer assemblies 34 interposed in the space between the floats.

The opposed end surfaces of the corresponding floats 31 of the adjacent barrier units are connected via a flexible shielding plate 35, and also corresponding adjacent floats 31 are attached to each other by a chain 36 so that they may not separate from each other by exceeding more than a predetermined spacing, thereby preventing damage to the shielding plate 35.

The barrier units constructed in the above-described manner can be connected in series and made to float on the water surface to be used as an oil barrier, and in the case where a large quantity of oil has been spilled due to accidents or the like, even if the floats 31 completely encircle the spillage (a), it may be aggregated into a thick layer of oil somewhere within the barrier. A part of this pool of oil may be converted into an emulsion (b) by the bobbing action of the floats 31, and some of the emulsion (b) may

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pass under the bottom surface of the floats 31 and float up to lay stagnant on the water surface between the inner and outer floats (see Figure 10).

5 Even when this happens it will still be difficult for the said emulsion to pass beyond the outer line of floats 31 and therefore the design illustrated in Figures 8 and 10 will make a quite effective oil barrier.

10 In addition, as shown in Figure 11, if a ship 16 should accidentally strike against the float 31, imparting momentum to it then the said float would pull against the chain 33, and simultaneously the buffer member 34 would be compressed between the pair of floats 31. Since the large number of resilient used vehicle tyres 34c are mounted on the buffer member 34, much of the kinetic energy of the collision 16 would be absorbed by it.

Also, by effectively making use of frictional attenuation caused by relative movements of water in the space between the pair of floats 31 and the buffer member 34, the kinetic energy of waves can be dissipated.

It is to be noted that since the above-described respective floats 31 are attached by means of chains 32 and a buffer member 34 is interposed between parallel pairs of floats 31, there are no rigid connections anywhere in the system, and therefore no excessive force can be exerted upon any member, and thus the durability of the barrier can be greatly enhanced.

While the present invention has been described above in connection with a number of preferred embodiments, it is a matter of course that the present invention is limited to such embodiments, but many changes in design could be made without departing from the scope of the present invention as claimed in the following Claims.

WHAT WE CLAIM IS:—

1. A floating barrier for oil, characterized in that barrier units, each of which is constructed by connecting a plurality of floats disposed in parallel to each other at a given spacing by means of chains, cables or the like and by interposing buffer members between adjacent ones of the parallel floats, are arranged in series, in that the corresponding floats of the adjacent barrier units are connected by means of chains,

cables or the like, and in that flexible shielding plate means is interposed between adjacent ends of said barrier units.

2. A barrier according to Claim 1, characterized in that each said float is elongated and comprises a buoyant body, an above-water fence extending along the top of said buoyant body, an underwater fence extending along the bottom of said buoyant body, a buffer body provided on at least one side of said float, and side plates disposed on at least one side of said float and extending along the float.

3. A barrier according to Claim 2, further characterized in that outer surfaces of said side plates and said buffer body are made to form a continuously curved convex surface connecting the upper and lower edges of said float, and in that the maximum cross-sectional width of the float is in close proximity to the water line of said buoyant body.

4. A barrier according to Claim 1, characterized in that each said float comprises an elongated hollow rectangular box.

5. A barrier as claimed in any preceding Claim, further characterized in that, for at least one said float, a tubular casing is connected to and extends along the bottom of that float, the casing defining a longitudinally extending slit which opens downwardly, in that the casing houses a screen which is wound onto a winding spindle pivotally supported at either end of said tubular casing, one end of said screen extending through the slit and having a weight fixedly secured thereto, in that the weight is adapted so as to be detachably fitted into said slit from the outside in a wedge-like manner whereby to make said slit water-tight, and in that said casing is connectable to a source of compressed air for releasing the weight from the slit to permit the screen to descend downwardly in the water.

6. A floating barrier for oil constructed, arranged and adapted for use substantially as hereinbefore described with reference to the accompanying drawings.

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pass under the bottom surface of the floats 31 and float up to lay stagnant on the water surface between the inner and outer floats (see Figure 10).

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