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PATENT SPECIFICATION

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(72) Inventor NAOJI TOKI



(54) FLOATING OIL AND WAVE BARRIER

(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 a floating type barrier, and has application for example as a floating oil, impact and wave barrier established semi-permanently around a marine installation.

Heretofore, floating oil and wave barriers have been known and commonly used. One example of known barrier is illustrated in Figures 1 and 2. Figure 1 is a perspective view showing an installation of the known barrier, and Figure 2 is a more detailed isometric view of a wall portion of the barrier. With reference to Figure 1, a float consisting of a plurality of float units 2' is established around a marine installation 1'. An end surface of an elongate float unit 2' is coupled to an end surface of an adjacent float unit 2' by means of a flexible connection 3'. The marine installation 1' and the floating units 2' are moored by means of chains 4' or ropes. As is well-known, in the aforementioned art, because the float units 2' and the flexible connections 3' appropriately project above and below the sea surface, floating oil can be intercepted and wave motion significantly damped.

Another example of the known barrier is illustrated in perspective in Figure 3(a) and in transverse cross-section in Figure 3(b). In this example, a twin-body type float unit is employed, in which hollow cylindrical hulls 5' are arranged in parallel to each other and are held apart by means of spacers 6' therebetween, and adjacent float units are coupled by means of a flexible or hinge-type intercepting plate 7'. In this way, a plurality of float units are connected in series so as to surround a marine installation, and thereby

the oil may be intercepted and waves damped as before.

With one row of single-body float units 2' arranged as shown in Figure 1, leakage of oil by the process of diffusion cannot be prevented. This is because the action of waves, wind and tide may drift the oil against the barrier, resulting in an increase of the thickness of the oil layer to about the same order as that of the draught of the float unit 2', so that some of the oil may escape over or under the float units 2'. In addition, due to vertical movements of the float units 2' and the wave action of the sea surface, it is difficult to completely prevent some of the oil from escaping. Accordingly, one may think of arranging the float units 2' in a plurality of rows rather than in a single row, but in such a case difficulties may be experienced in mooring the float units 2'.

The twin-body type float unit shown in Figure 3(a) was introduced to overcome the aforementioned shortcoming, with the intention of achieving the effect of a double-row arrangement of the float units 2' in Figure 1. If such twin-body type float units are used, then it is believed that they will be more effective at intercepting oil, damping wave motion and absorbing the shock effect should a ship collide with them than the system employing one row of float units 2' as described above. However, with regard to currently used twin-body type float units, the spacers 6' provided between the twin bodies and the interception plates 7' may be accidentally broken due to repeated buffetting by the waves, and so, there remains some uncertainty as to their durability. Accordingly, development of a more effective float unit has been desired.

As described above, the float unit in the prior art is, in most cases, used as an oil fence against an accidental spillage of oil, and it was considered that the float could be deployed upon the occurrence of an accident and removed after collection of the spillage was completed, so that it was useful even if its durability was somewhat suspect.

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However, in the case where the float is semi-permanently established around a marine installation exposed to a severe marine environment its strength and durability are inadequate.

5 An object of the present invention is to provide a strong and durable barrier that can be utilized for several purposes such as a barrier against oil, impact and waves, if necessary, as a semi-permanent installation.

10 According to the present invention, there is provided a floating-type barrier, comprising a string of elongate floats flexibly connected together, characterized in that at least two similar strings of elongate floats are provided, said strings being disposed in substantially parallel relationship, but with the floats of each string being located at staggered positions relative to the floats of the next-adjacent string(s), in that spacers are provided between the floats of next-adjacent strings, and in that said strings and the individual floats thereof are linked together by elongate flexible members, such as chains or ropes, in such a manner that component parts of the barrier are free to move relatively to each other within the restrictions imposed by said elongate flexible members.

30 A floating-type barrier according to the present invention can be utilized particularly as a permanently installed oil and impact breakwater for a marine oil storage tank, an offshore platform, or a marine air-port.

35 In order that the invention may be readily understood and other features and objects made more apparent two embodiments thereof will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view showing the manner in which one example of an oil and wave barrier of the prior art is used,

45 Figure 2 is a detailed isometric view of a wall portion of the same,

Figure 3(a) is a perspective view of another example of oil and wave barrier of the prior art,

50 Figure 3(b) is a cross-section of a float unit of the barrier shown in Figure 3(a),

Figure 4 is an isometric view of one preferred embodiment of a floating oil, impact and wave barrier according to the present invention,

55 Figure 5 is a plan view of another preferred embodiment of the present invention.

60 Figure 6 is a plan view showing a mooring state of the embodiment shown in Figure 5,

Figure 7 is a diagrammatic end view of the barrier of Figure 5 showing its function as an oil barrier when a large amount of oil has spilled, and,

65 Figure 8 is a diagrammatic end view of the

barrier of Figure 5 showing its function as an impact barrier.

Referring now to Figures 4 to 8, in one preferred embodiment (Fig. 4), the floating barrier comprises a first multiplicity of floats 11, each of hollow rectangular form, which are arranged end-to-end to form a first string of floats. The opposed end faces of adjacent floats 11 are provided with fenders 12 made of elastic material so as to prevent damage when the end surfaces collide with each other. Also, the adjacent ends are linked to each other by lengths of chain 13. A second multiplicity of floats 11, of the same size and shape as said floats 11, and also arranged in end-to-end relationship is in parallel with, but in staggered relation to, said floats 11 to form a second string of floats. The two strings of floats are linked together by means of lengths of chain 15. Anchor chains 16 are provided for anchoring the floats 11 and 11' to the sea bed or the like. In this embodiment the two float strings are spaced apart by spacers 14. The spacers are made of buoyant material(s), such as rubber made oil-proof, foamed styrole, or polyurethane, which are essentially resilient against external forces.

A modified embodiment of the barrier is shown in Figure 5, where the float strings are arranged and aligned in parallel with each other and have two rows of spacers 14 interposed therebetween. Another preferred embodiment is shown in Figure 6, in which a jetty 42 projecting from a quay 41 is connected to the strings of floats 11 and 11'. In this case, the jetty 42 is elongated and, as shown, the float strings are connected along their opposite faces via the spacers 14, the jetty 42 effectively forming an extension of the central float string.

The operation of a floating-type barrier according to the present invention will be explained.

Firstly, its function as an oil barrier will be described with reference to Figure 7 in the case where a large amount of oil has spilled due to an accident or the like and where a marine installation is surrounded by a barrier constructed as shown in Figure 5. Even if the barrier completely surrounds the oil spillage 51, at certain locations of the barrier, the spillage 51 is driven by the action of tide and waves into a thick accumulation, and due to the vertical movements of the floats in response to the waves, a part of the spillage 51 breaks up into oil drops 52 which pass underneath the floats and their spacers 14, if only one string of floats were provided the oil drops would then float up to the sea surface in the space confined by the barrier. Accordingly, with the three float string arrangement of Figure 5, even if movements of oil drops 52 are

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such that they drift under the first string of floats, they would have to further drift so as to pass under the second and third strings of floats comprising the barrier, which is unlikely. Thus, the function as an oil barrier is realized. Furthermore, if the number of parallel rows of floats 11' is sufficiently increased, then its function as an oil barrier can be realized even against the action of the most violet waves.

Next, the function as an impact barrier will be described with reference to Figure 8. If a ship 60 should accidentally collide with the outer string of floats 11, then said floats would tend to be displaced by the ship, against the pull of the anchor chains 16, and the spacer 14 would then be compressed between this string of float boxes 11 and the next adjacent string of boxes 11'. Since the spacers 14 are made up of buoyant and resilient material(s), they can absorb some of the kinetic energy of the ship collision. This energy absorbing effect becomes more effective as the number of parallel strings of floats is increased and the number of rows of spacers 14 is correspondingly increased.

In addition, the function as a wave barrier is also remarkable, because the energy of wave motion can be dissipated by effectively making use of the friction damping caused by the relative movements between the floats 11 and 11' and their spacers 14 and the water confined therein.

A floating-type barrier according to the present invention, and constructed as described above, can be utilized for many purposes such as against oil; impacts and wave, and can achieve the following effects:

(1) While the flexible connections provided between the ends of the floats of the prior art are liable to be broken by wave motion, a floating-type barrier according to the present invention may have a semi-permanent durability by constructing the spacer itself to provide an intercepting area such that oil cannot flow across it.

(2) In the case of two-string float units, there have been examples in which spacers in the form of a rigid structure were destroyed by continual buffeting. However, in the case of the present invention, the flexible spacers and the flexible nature of the connecting arrangement for the floats, virtually eliminates the possibility of such destruction.

It will be appreciated that many modifications can be carried out within the scope of the invention as defined in the following Claims. For example, while

elongated rectangular floats as described hereinbefore (such floats having a width and a height of about 1 and 5 m respectively and a length of from 10—50 m have already been tested), a cylindrical hull could also be used. In this case, the contacting faces of the spacer should have a configuration conforming to the outer, circumferential surface of the hull. With regard to the spacer, various buoyant and resilient materials could be used either singly or in combination. For instance, rubber materials, foamed styrole, or polyurethane, would be suitable materials for the spacers.

WHAT WE CLAIM IS:—

1. A floating-type barrier, comprising a string of elongate floats flexibly connected together, characterized in that at least two similar strings of elongate floats are provided, said strings being disposed in substantially parallel relationship, but with the floats of each string being located at staggered positions relative to the floats of the next-adjacent string(s), in that spacers are provided between the floats of next-adjacent strings, and in that said strings and the individual floats thereof are linked together by elongate flexible members, such as chains or ropes, in such a manner that component parts of the barrier are free to move relatively to each other, within the restrictions imposed by said elongate flexible members.

2. A barrier according to Claim 1, wherein a first set of said elongate flexible members connect between the ends of next-adjacent floats of each string to limit the floats in spaced relationship, and a second set of said elongate flexible members connect between opposed inner surfaces of the floats of the two strings to limit said strings in spaced relationship.

3. A barrier according to Claim 1 or Claim 2, wherein each spacer is made of buoyant material(s) resilient against external forces.

4. A floating-type barrier constructed, arranged and adapted for use substantially as hereinbefore described with reference to Figures 4 to 8 of the accompanying drawings.

SOMMERVILLE & RUSHTON,
Chartered Patent Agents,
89 St. Peters Street,
St. Albans,
Herts. AL1 3EN.



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such that they drift under the first string of floats, they would have to further drift so as to pass under the second and third strings of floats comprising the barrier, which is unlikely. Thus, the function as an oil barrier is realized. Furthermore, if the number of parallel rows of floats 11' is sufficiently increased, then its function as an oil barrier can be realized even against the action of the most violet waves.

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