A caisson for use in constructing seaworks which comprises a plurality of compartments for receiving ballast and a plurality of enclosures each of which is sealed at the top and bottom by hermetic closures and including between the seals a retractable floor, means such as a compressor being provided to pressurize each enclosure to extend the lower seal, which is flexible, and ducting being provided to inject a binder into granular material, initially loaded on the floors, when discharged on to the lower seals, upon retraction of the floors, the caisson in use being towed to the site, being ballasted to sink it on to the bottom where it rests through the extended lower seals and the granular material then being discharged on to the lower seals where a binder is added to it.

4 Claims, 6 Drawing Figures
CAISSON FOR SEAWORKS CONSTRUCTION AND TO A METHOD OF USING THE CAISSON

The invention relates to a caisson for seaways construction and to a method of using the caisson. It is an object of this invention to enable seaways to be built without the need to use floating equipment and divers. The works can be, for instance, protective dykes, elements of artificial islands and berthing quays. Works of this kind are built by using large caissons which are made for instance, of reinforced or prestressed concrete and which are constructed in prefabrication workshops situated in the nearest port. The water drawn by caissons when afloat must be compatible with available depths, and caisson width must be such that the caissons can be dealt with by existing access works, including locks. These caissons may be very large and displace, for instance, more than 50,000 tons. They are towed on the open sea like large vessels to the place where they are to be sunk into position.

A difficulty in the construction of seaways using caissons of this kind is that the sea bed is not absolutely flat but has unevennesses which are often relatively substantial, and the required works cannot be produced just by stranding the caissons.

It is an object of this invention to provide caissons and a method for sinking the same in a horizontal position without any need to use specialized equipment and personnel.

According to the present invention there is provided a caisson for seaways construction, characterized in that it has compartments adapted to receive a ballast, such as water, and a number of enclosures, wherein are retractable floors, for receiving a granular substance such as pebbles, each enclosure being sealed by a hermetic partition above the floor and by a hermetic member below the floor and compressor means communicating with the enclosures for the supply thereto of fluid such as air, the caisson also having binder supply ducts for the injection of a binder, such as a cement, into the chambers defined by the flexible members below the retractable floors.

The invention also relates to a process for using the caisson, characterized in that the enclosures receive a granular substance above the retractable floors, the caisson is brought to the position where it is to be used, the compartments are ballasted with water, the enclosures are inflated with fluid so that the flexible pockets rest on the sea bottom, the floors are retracted so that the granular substance fills the flexible pockets, and a binder is injected into the chambers disposed in the pockets.

The invention will now be described in greater detail with reference to an embodiment of a caisson and to an embodiment of a method for using the same, both given by way of example only, reference being made to the accompanying drawings wherein:

FIG. 1 is a vertical cross-section through a caisson according to the invention;
FIG. 2 is a diagrammatic plan view of the caisson shown in FIG. 1;
FIG. 3 is a vertical section on the line III—III of FIG. 2;
FIG. 4 is a section similar to FIG. 3 but with the caisson ballasted with seawater;

FIG. 5 is a section similar to the sections in FIGS. 3 and 4 but with the retractable floor in its retracted position so that pebbles can drop into the flexible pocket, and
FIG. 6 is a view similar to FIG. 1 but with the caisson resting on the sea bed on the completion of positioning.

The caisson shown in the drawings comprises compartments 1 separated from one another by vertical walls or partitions 2. The caisson is closed at the bottom by a base 3 and has peripheral contiguous compartments 4 which at the bottom have a number of retractable floors or partitions 5, in the form of hinging flaps which can be actuated by any appropriate facility. For instance, the various floors 5 associated with one side of the caisson can be disposed on a single shaft 6 operated by a lever 7 disposed at one or both ends of shaft 6. Any other system can be used, including pawl devices for keeping the floors 5 horizontal, the floors being released to pivot when it is required to discharge below the compartments the granular substances and, for instance, the pebbles 8 disposed in such compartments.

The pebbles 8 in the compartments help towards the floating stability of the caisson just described and are used for the final foundation of the caisson in a manner which will be described hereinafter.

The compartments are closed at the top by a sealing element, for example, in the form of a plastics pocket 9, of, say, laminated nylon. Flexible pockets 10 below the floors 5 provide a sealing-tight closure for the bottom part of the compartments.

The compartments are separated from one another in groups or individually and communicate individually or in groups with compressors 11 adapted to supply them with a fluid, such as air. The compartments can therefore be inflated to different extents depending upon how they make contact with the sea bed—I.e., depending on sea bed shape. The vertical partitions of the caisson have ducts 12 for the injection of a binder, such as cement, into that zone of the pockets 9 which is below the floors 5. Also provided are ducts 13 for the injection of a filling, such as sand, below the caisson base 3.

The caisson just described can be used as follows:
The caisson is brought to the site by tugs and immobilized by cables connected, for instance, to fixed moorings. The peripheral compartments are then pressurized, for instance, by compressed air from compressors 11. The pressure produced thereby must be sufficient to inflate the flexible pockets, particularly the pocket 10, into a hemicylindrical shape. A liquid ballast is then introduced into the central compartments and the caisson sinks until contacting the sea bed, contact being by way of the flexible cushions formed by the air-inflated pockets. The quantity of liquid ballast is adjusted to ensure that neither the tide nor more generally any variation in water level can re-float the caisson. There is therefore a relatively high balancing pressure in the pockets and a corresponding contact pressure with the sea bed. This pressure is adjusted in the various enclosures containing pebbles 8 until the caisson, weighing down on the resulting air cushions and sinking down fairly unevenly on the uneven sea bed, comes into a horizontal position. The floors 5 of the enclosures are always pressurized but the pressures
on each floor varies; the floors are then retracted and the pebbles drop down to the bottom of the pockets and intimately follow the shape of the sea bed.

A binder, such as cement, is then injected through ducts, so that the bottom part of the enclosures becomes a continuous solid wall which bears the complete structure. Since the enclosures are isolated from one another either individually or in groups and can be inflated to different pressures, the final horizontal position of the caisson can be adjusted and, once it has been adjusted, the ballast can be dropped and solidified by the binder, with the result that the caisson is set up completely horizontal without any maritime facilities or diver having to be used.

Once the caisson is properly seated on the sea bed, sand can be injected through ducts; the sand fills the part below the caisson base and improves the distribution of pressures in the device in operation. The pressures are thus reduced to below the level operative below the periphery during the sinking operation.

Finally, the caisson itself can be given a ballasting of sand or any appropriate filling material in the compartments. It can even be used as a liquid reservoir while still enabling the seawork to fulfill its protective or berthing function.

The invention has a number of advantages. First, provided that the differences between the levels of the highest and lowest points of the sea bed do not exceed the thickness of the flexible pockets, there is no need for any preparation of the ground, a job which is a difficult one to carry out in the open sea with conventional founding means. Second, perfect levelling can be achieved by using different pressures in the various peripheral enclosures receiving the pebbles. Also, to raise the caisson if anything happens to it, all that is necessary is to pump out the liquid ballast contained in the compartments. All the operations can be performed from the caisson itself without external assistance and relatively quickly, a very valuable feature for operations in the open sea. The invention is completely independent of the shape, dimensions and required use of the caissons.

The invention is not of course limited by details hereinbefore mentioned, which can vary without exceeding the scope of the invention.

What is claimed is:

1. A caisson for seafards construction comprising compartments to receive a ballast, and a plurality of enclosures, retractable partitions for said enclosures receiving a granular substance, each of said enclosures being sealed by a hermetic partition above the floor and by a hermetic flexible member below the floor and compressor means communicating with the enclosures for supplying a fluid thereto extending said flexible members below the caisson for engagement with the bottom, binder supply ducts for injecting a binder into the chambers defined by said flexible members below said retractable partitions.

2. A caisson according to claim 1, including ducts extending vertically right through the caisson to below the base thereof and communicating with the top part of the caisson for the conveyance of sand to the zone below the caisson.

3. A caisson according to claim 1, said enclosures being disposed around said compartments.

4. A method of using a caisson having ballast compartments and enclosures adjacent the compartment the steps of filling the enclosures with a granular substance above retractable partitions, moving the caisson into position where it is to be used, ballasting the compartments with water, inflating the enclosures with fluid forming flexible pockets resting on the sea bottom, retracting the partitions and filling the flexible pockets with the granular substance, and then injecting a binder into the pockets.

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CERTIFICATE OF CORRECTION

Patent No. 3,704,595 Dated December 5, 1972

Inventor(s) Pierre Launay

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Application Priority Data

July 30, 1969 France No. 6926066, is omitted.
Claim 1, line 18, before "into" --extending-- is omitted.

Signed and sealed this 15th day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCALK
Commissioner of Patents