

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

A method of producing and protecting deposits of sedimentary material on floors of bodies of water

I, OLE JEPPE FJORD LARSEN "Skedebjerggard", Himmeler or Roskilde, Denmark, Danish, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to a method of depositing and protecting sand and other littoral drift material on the floor of seas, lakes, rivers and other bodies of water where the bottom and sides consist of erosionable material.

Various kinds of bottom protection have been suggested. But not until now has a method been devised which not only allows for trapping of the drifting material, but also for gradual raising of the trapping device so that offshore bars can be created.

The invention comprises a method according to which raisable, plane or arched elements are disposed in a plane or surface at a suitable distance above the floor of the body of water. The waves and currents thereby "loose" the part of the drifting material which is underneath this plane or surface.

The individual element may contain channels of such configuration that water and suspended drift material will be sucked towards the element under the action of the natural currents and waves. The shape of the elements being such that the turbulence in the water caused by the elements is minimized, results in a device which is not undermined by the motion of water, and which can deposit and retain layers of material precipitated on the sea bed. By arranging an assembly of elements in rows on the sea bed and by raising the elements successively, a solid offshore bar can be created consisting of naturally or artificially supplied material.

[Price 4s. 6d.]

Besides serving as foundation for a traditional work such as a breakwater parallel with or a mole perpendicular to the coast, a deposit such as created in the above manner may constitute a reforming of the coastal configuration and in itself act as a coastal protection work.

For a better understanding of my invention, reference is made to the below detailed description in connection with the accompanying drawing, in which:

Fig. 1 is a plan view and

Fig. 2 a large-scale cross-section taken along the line I-I in Fig. 1 of an element of sinusoid cross-section which is mounted on a ring 10 by legs 8.

Fig. 3 is a large-scale cross-section of 60 channels 1.

Fig. 4 is a schematically drawn cross-section of an element consisting of a mesh to the upper surface of which are attached strips 16 of a flexible material of a specific gravity less than that of the water.

Fig. 5 is a plan view and

Fig. 6 a large-scale cross-section taken along the line II-II in Fig. 5 of an element embodying circular concentric widths of flexible material 19 which contain and are supported by radial ribs 20 that rest on circular rings 21.

Fig. 7 is a plan view and

Fig. 8 a cross-section taken along the line III-III in Fig. 7 of an element consisting of a flat ring with a streamlined cross-section and resting on a network 25 via rockers 9.

Fig. 9 is a plan view and

Fig. 10 a cross-section taken along the line IV-IV in Fig. 9 of a plane element with a large opening 5 at its center and resting on rockers 9 and in which the number of channels 1 per unit of surface area decreases gradually from periphery to center of the element.

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Fig. 11 is a cross-section of an element formed in the shape of a double-convex lens resting on rockers 9.

Fig. 12 is a cross-section of double-convex elements in which the convexities are asymmetrical; the elements rest on legs 8 and are interconnected by ties 26.

Fig. 13 shows a plan view of a flexible carpet of elements, in which any two consecutive ground-supported elements 11 are interconnected by an element 12 without direct ground support.

Fig. 14 is a cross-section taken along the line V-V of Fig. 13 in which the elements 11 are supported on rotating balls of network 13.

Fig. 15 is a plan view, and

Fig. 16 a cross-section taken along the line VI-VI in Fig. 15 of a flexible floating carpet 30 perforated with channels 1 and kept in place by anchor cables 27 fastened to anchors 29.

The plane or surface separating a stratum 3 along the floor of the body of water from the currents above this stratum may be made up of elements that form a continuous flexible carpet, or of individual, interspaced elements.

In both cases silting takes place in the stratum 3 because the elements prevent transfer of shearing forces from the water above to the water underneath the elements and thereby decrease the velocity of the natural currents in this stratum.

Depending on the size and permeability of the assembly of elements and on the current conditions the thickness of the stratum 3 in practice can be of the order of 2-100 inches.

The distance of the elements above the floor may be maintained, in principle, by supporting the elements on the floor and/or by utilizing buoyancy.

If the elements are supported by legs 8 in fixed or loose connection with the elements (Figs. 2, 4, 6, 12) these must be as few and slender as possible in order to prevent too much turbulence or catching of seaweed and the like.

Appropriately the legs 8 can be mounted on a ring 10 (Figs. 2, 4, 6) which will serve as a foundation and anchor for the element.

Utilizing buoyancy the required specific gravity less than that of the water may be obtained by means of air-filled cavities in the elements.

Such floating elements may be anchored, for instance, to anchors 29 (Figs. 15-16), to heavier ground-supported elements 11 (Figs. 13-14), or to vertical poles driven down into the bottom. Raising of the elements may be achieved in different ways. Elements supported on legs (Figs. 2, 4, 6, 12) may be vibrated free from the deposited material.

The vibrating may be transferred by a

vibrator which is fixed to the element temporarily during the elevation of the element. The necessary vertical tractive force may be provided by buoyancy, by pumping compressed air into cavities in the elements during the elevation process and afterwards letting it out through valves. Or the tractive force can be provided by attaching a folding balloon which is suitably blown up during the process.

Furthermore, the elements can be mounted on rockers 9 (Figs. 7-11) so that they can rock to and fro on the sea bed, in this way lifting themselves to the top of the deposited material.

This rocking may be imposed by the wave motion. In this case an element of the separate type should be so low and flat that the upstream side of the element always will turn down (Figs. 8, 10, 11) and the downstream side up under the actual direction of current 7. To prevent the rockers from sinking too deep into the bottom material 6, they may be equipped with a network 25 (Fig. 7).

Raising of elements forming a continuous carpet (Figs. 13-14) may be achieved by supporting the carpet on balls of network 13 (Fig. 14) on which it can roll.

An anchored floating carpet of elements (Figs. 15-16) may be raised by gradually increasing the free length of the anchoring ropes 27, possibly by gradual removing of loads 28 keeping the ropes down.

In their simplest form the elements form a continuous, flexible plate perforated with channels 1 (Figs. 15-16). Normally the ratio of diameter to depth of the channels (Fig. 3) will be of the order of 2-5. Appropriately the ratio and/or the number of channels per unit of surface area may decrease gradually towards the center of the individual element or towards the middle of the carpet.

If the carpet is made up of interconnected individual elements (Figs. 13-14) only part of these, 11, need be ground-supported, rest of them, 12, being floating or supported on the ground-supported ones.

In the following are mentioned various examples of constructional details and preferred embodiments of the individual element acting separately or forming part of a blanket of elements.

The current velocity difference between the over- and underside, 4 and 3, of the element may be increased by giving the element an arched shape (Figs. 1-6, 13-14).

If the element contains channels 1 the resulting hydraulic pressure difference will cause an upward flow through the channels at the lee side of the element and consequently a horizontal flow towards the element from the surrounding areas.

As shown in Figs. 1, 2, 5, 6, 9, 10 a larger

opening 5 at the very top (center) of the element may be desirable. It will expedite the upward flow, and any entrained air can escape through here.

5 To prevent a downward flow through the opening 5 a horizontal thin plate 23 (Figs. 9-10) kept at a distance over the opening may be required. Its supporting legs 24 should be as few and thin as possible.

10 The channels 1 may be equipped with strainers 2 of such a mesh width that they permit the water but not the coarser part of the drift material to pass. The strainer can be fixed to the over-pressure side immediately outside the mouths of the channels (Fig. 3) or it may be of rigid material and form a closed space between it and the element (Fig. 2).

A preferred embodiment is shown in Figs. 1-2. Suitable construction material in this case is concrete or plastic.

To ensure the upward flow the edges of the mouths of the channels 1 should be rounded. The number of channels may be lower if the diameter d of the channels is larger, or higher if d is smaller (Fig. 3). The total area of the channels may constitute at least 30/40% of the surface of the element (Fig. 1).

30 The ratio d/l of the channels (Fig. 3) should be so small that the horizontal currents over the element are forced over this, but still so great that the currents under the element can escape through the channels at the downstream side of the element. The ratio therefore should vary with the location of the channel on the element, in dependence of the steepness of the area in which the channel is situated. With increasing steepness the ratio should decrease correspondingly, by varying d and/or l . For example, on an element of a sinusoidal cross-section with channels of a constant diameter d , the thickness l of the shell should vary as shown in Fig. 2.

In order to increase the suction effect the surface of the element may be equipped with some kind of rectifying membrane which regulates the flow through the channels, by allowing for upward flow from the area 3 under the element through the channels 1 to the area 4 above the element, and impeding flow in the opposite direction.

Such rectifier may consist of a large-meshed net 17 (Fig. 2) which covers loosely the element. The net is made of a flexible material and is attached to the element along the circumference only and possibly at the top of the element, so it can be lifted locally from the surface of the element. Over the mouth of each channel 1 the net is provided with a circular piece of impermeable cloth 18 which just covers the mouth. At the upstream side of the element the current will force the cloths tight down to the

surface of the element, thereby preventing downward flow through the channels. At the downstream side the currents will lift the net with the cloths so that the flow from beneath can escape through the channels.

Another type of membrane may consist of strips 16 (Fig. 4) of impermeable, flexible or stiff material which are hinged by one end to the upper side of the element.

The hinge may allow for turning of the strip in one plane radially to the element. This will be the case if flexible strips are placed radially lying on the element, attached by their lower ends about which they can bend backwards in a radial plane. Or the hinge may allow for turning of the strip in all directions. The strips may be formed as threads or leaves attached to the element by thin flexible threads. Consisting of a material of a specific gravity less than that of the water the threads or leaves will stand up in still water (Fig. 4).

With current from one or the other side the strips on the upstream side will be forced tight down on the surface and cover the channels. On the downdrift side the flow through the channels from beneath will prevent the strips from closing the channels, i.e. the holes in the wire net.

In another embodiment (Figs. 5-6) the element consists of consecutive concentric circular widths of impermeable cloth 19. Each width is limited by two concentric circles and is supported by radial ribs 20 on two circular rings 21 along the boundaries of the cloth. The ribs are hinged loosely by their upper ends to the inner ring and are resting loosely on top of the outer ring.

On the upstream side the cloth and ribs will be pressed down against the supporting rings and thereby force the currents over the element. On the downdrift side the flow from beneath will lift and fold the cloth to form channels 1. The amplitude of the turn of the ribs may be limited by strings 22.

Preferred embodiments are shown in Figs. 7-10. These elements of flat configuration are so open and permeable that they separate the two sides 3 and 4 with regard to horizontal currents only, but yield a minimum of hydraulic resistance to vertical flow. Figs. 7-8 show a flat ring of such dimensions that in its diametrical cross-section the two symmetrical halves act independently. Each of these therefore has a streamlined, e.g. elliptical or double-convex cross-section causing a minimum of turbulence.

A type of element with a double-convex cross-section, like a lens (Figs. 11-12) causes a minimum of turbulence. In rivers the cross-section may be even more streamlined, being asymmetrically double-convex (Fig. 12), with its thickest side facing the current.

WHAT I CLAIM IS:--

1. A method of producing and protecting deposits of sedimentary material on floors of bodies of water, comprising disposing of
5 fabricated, plane or arched, raisable elements to form a flow-separating plane or surface at a distance of the order of 2-100 inches above the floor, and successive raising of the elements according as depositing of
10 the sedimentary material takes place underneath the plane or surface.
2. A method according to Claim 1, wherein the elements form a continuous flexible carpet.
- 15 3. A method according to Claim 1, wherein the individual element is resting on few and slender legs which are mounted on a ring the plane of which is parallel with the plane of the element.
- 20 4. A method according to Claim 1, wherein the elements are mounted on rockers permitting them to rock to and fro on the floor.
5. A method according to Claim 2,
25 wherein the carpet is supported on balls of network on which it can roll.
6. A method according to Claim 1, wherein the elements are kept at a distance above the floor by means of buoyancy.
- 30 7. A method according to Claim 1, wherein the individual element is perforated at its center with an opening the area of which constitutes a considerable part of that of the element.
- 35 8. A method according to Claim 1, wherein the elements are perforated with circular cylindrical channels with rounded mouths, and in which the ratio of width to depth of the channels and/or the number of
40 channels per unit of surface area decreases gradually from the periphery towards the

center of the element, or towards the middle of the carpet of elements.

9. A method according to Claim 1, wherein the element consists of a flat ring 45 with a streamlined, e.g. elliptical or double-convex cross-section.

10. A method according to Claim 1, wherein the element is formed in the shape of a double-convex lens. 50

11. A method according to Claim 1, wherein the arched element is perforated with channels with rounded mouths and in which the ratio of width to depth of the channels and/or the number of channels per 55 unit of surface area varies inversely proportionately with the steepness of the area in which the individual channel is situated.

12. A method as claimed in Claim 11, in which the element is loosely covered with 60 a large-meshed net of flexible material attached to the element along its circumference and provided with impermeable pieces of cloth of the same size as the mouths of said channels and covering these when in 65 contact with the element.

13. A method according to Claim 1, wherein the arched element embodies one or more concentric widths of flexible impermeable material, each width being limited by 70 two concentric circles and containing radial ribs spanning over two concentric rings along the boundaries of the width and loosely hinged to the inner ring and loosely 75 resting on the outer ring.

14. A method according to Claim 1, wherein the element consists of a rigid network to the upper side of which strips of impermeable material are loosely hinged by one end.

O. FJORD LARSEN.

