United States Patent [19]

Larsen

[11] **3,928,978**

[45] **Dec. 30, 1975**

[54] **APPARATUS FOR PRODUCING AND PROTECTING DEPOSITS OF SEDIMENTARY MATERIAL ON FLOORS OF BODIES OF WATER**

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[21] Appl. No.: **518,050**

Related U.S. Application Data

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[52] **U.S. Cl.** **61/3**

[51] **Int. Cl.²** **L02B 3/04**

[58] **Field of Search** ..... 61/1 R, 2, 3, 4, 37, 38

[56] **References Cited**

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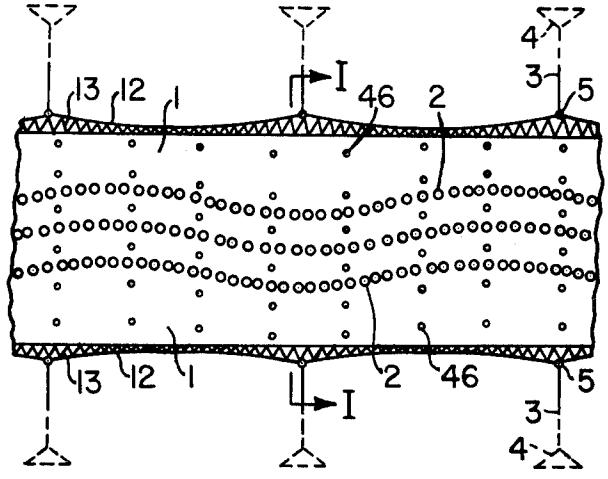
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Primary Examiner—Paul R. Gilliam
Assistant Examiner—Alex Grosz
Attorney, Agent, or Firm—Diller, Brown, Ramik & Wight

[57] **ABSTRACT**

This disclosure relates to apparatus for producing and protecting deposits of sedimentary material on a floor of a body of water, the apparatus including a flexible sheet located beneath the surface of the water in at least partially upwardly spaced relationship, close to, but above the floor, and means for maintaining the flexible sheet so positioned.

3 Claims, 22 Drawing Figures



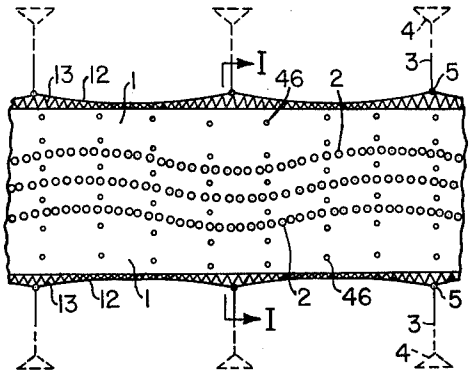


FIG. 1

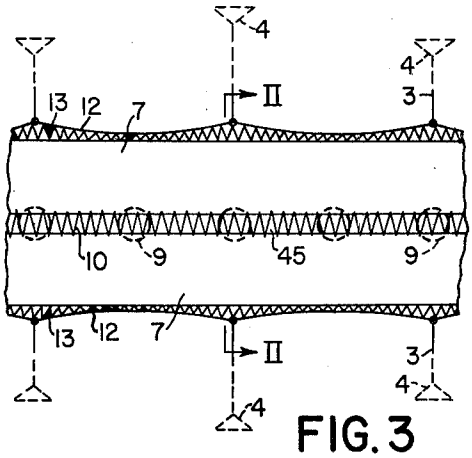


FIG. 3

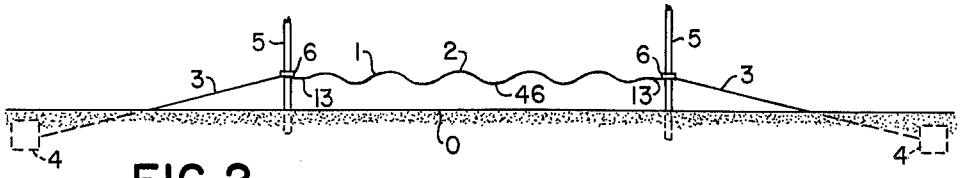


FIG. 2

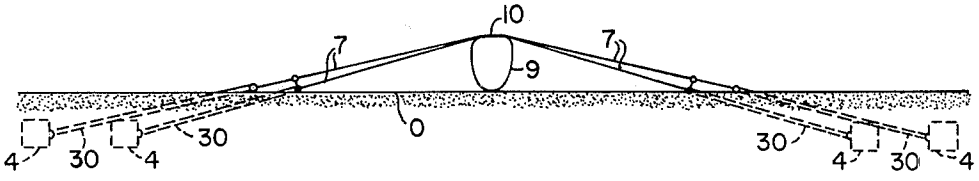


FIG. 4

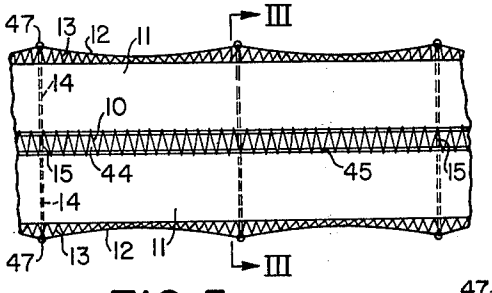


FIG. 5

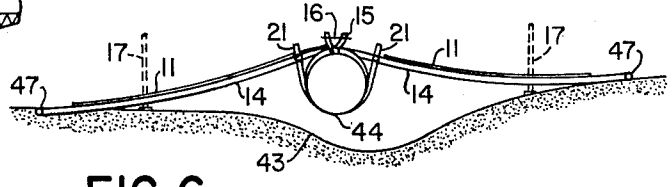


FIG. 6

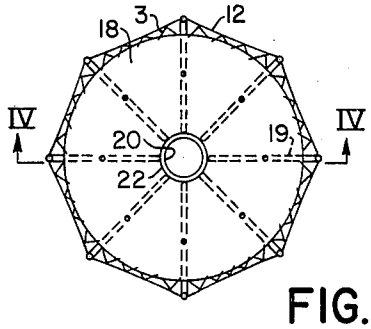


FIG. 7

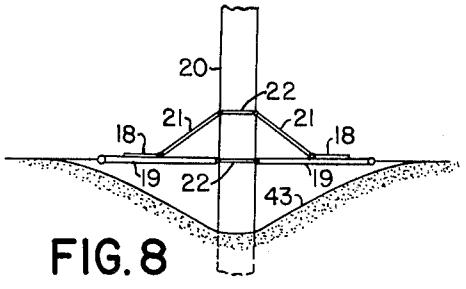


FIG. 8

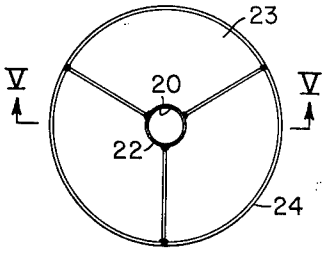


FIG. 9

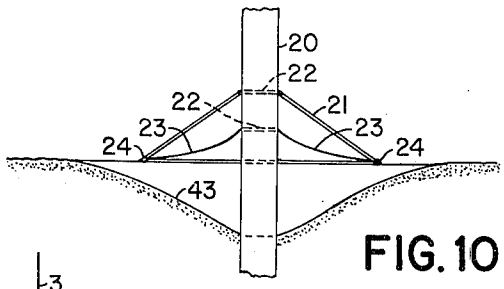


FIG. 10

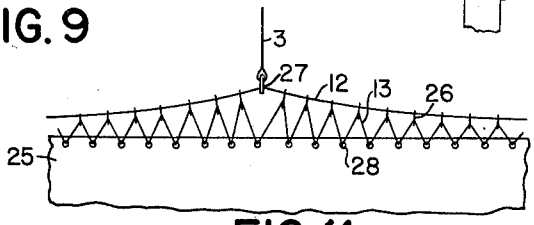


FIG. 11

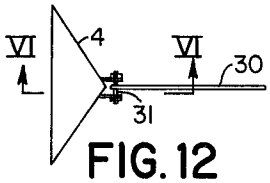


FIG. 12

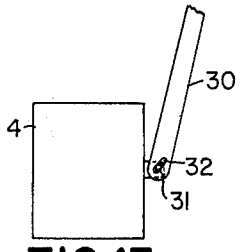


FIG. 13

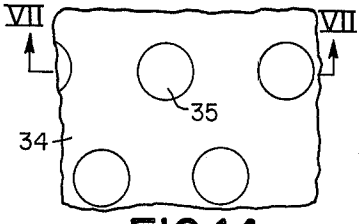


FIG. 14

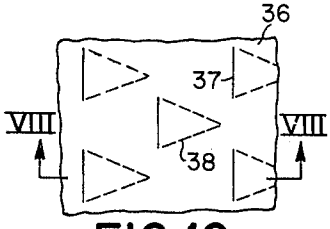


FIG. 16

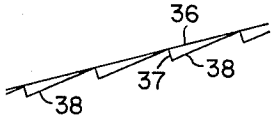


FIG. 17

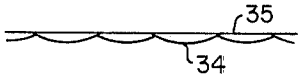


FIG. 15

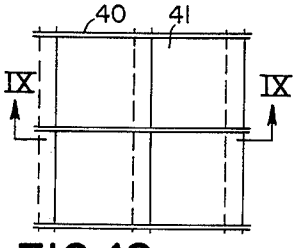


FIG. 18



FIG. 19



FIG. 21

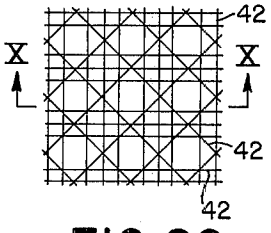


FIG. 20

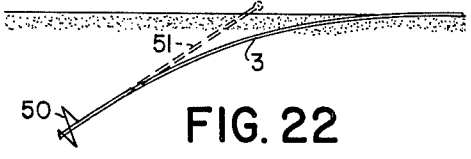


FIG. 22

APPARATUS FOR PRODUCING AND PROTECTING DEPOSITS OF SEDIMENTARY MATERIAL ON FLOORS OF BODIES OF WATER

This is a divisional application of application Ser. No. 212,056, filed Dec. 27, 1971.

The invention relates to a device for depositing and protecting sand and other littoral drift material on the floors of seas, lakes, rivers and other bodies of water where the bed and sides consist of erosionable material.

Various kinds of bottom protection in the forms of mattresses, artificial seaweed, etc., have been proposed. But all of them are placed directly on the floor, without space between the device and the floor. The height of the obtained deposits of sedimentary material therefore is dependent on the height of the device itself.

According to the present invention the device is placed at a certain level above the floor, thereby allowing for a height of the deposition underneath the device greater than corresponding to the height of the device itself.

The invention comprises plane or curved, flexible or stiff, plate-like members disposed to form a surface in upwardly spaced relation to and generally parallel to the floor. The waves and currents thereby "loose" a part of the material drifting underneath this surface. The consequent deposition of material is protected by the depositing device against scouring.

The plate-like members may form a continuous, flexible carpet or stiff plate, or individual, interspaced elements.

For the purposes of reducing pressure differences and of increasing the depositing effect the members may be perforated with holes. In some cases, e.g. where the purpose is creation of offshore bars for coastal protection and reforming, the device is raised according as deposition of the drift material takes place, so that one layer of material is precipitated on top of the other until the required height is reached.

In other cases the purpose is to re-establish and protect the seabed at offshore structures such as pipelines and oil production platforms and mobile rigs.

The description will be illustrated by reference to the drawing in which:

FIG. 1 is a plan view of a wavy carpet 1 perforated with holes 2 and 46 and stretched out by longitudinal ropes 12 which are connected with the carpet by continuous transverse zig-zag ropes 13 and via anchor ropes 3 fastened to anchors 4. The carpet is supported on adjustable poles 5 via attachments 6,

FIG. 2 is a large-scale cross-section taken along the line I—I of FIG. 1 and shows the installation in relation to the original floor 0,

FIG. 3 is a plan view of a carpet 7 consisting of two halves tied together by a continuous zig-zag rope 10 leaving an opening 45 free at the top. The carpet is stretched out by means of staggered anchors 4 and is supported on folding balloons 9,

FIG. 4 is a large-scale cross-section taken along the line II—II of FIG. 3,

FIG. 5 is a plan view of a carpet 11 stretched out by and/or supported on beams 14, which are hinged to the clamps 15 at one end and possibly supported on the ground or on adjustable props 17 at the other end,

FIG. 6 is a large-scale cross-section taken along the line III—III of FIG. 5 and shows the scoured seabed 43 as before installation of the carpet,

FIG. 7 is a plan view of a flexible carpet or stiff plate 18 mounted on the vertical leg 20 via supporting beams 19 hinged to the clamp 22,

FIG. 8 is a cross-section taken along the line IV—IV of FIG. 7. The beams 19 are carried by struts 21 hinged to a clamp 22,

FIG. 9 is a plan view of a carpet 23 mounted on a vertical leg 20 and stretched out by a rigid ring 24 sewn into the edge of the carpet. The ring is pressed down by struts 21 hinged on a clamp 22,

FIG. 10 is a cross-section taken along the line V—V of FIG. 9,

FIG. 11 is a large-scale plan view of the fastening of a carpet 25. The longitudinal rope 12 is stretched out by the anchor ropes 3 attached via the pawl rings 27, and runs through the rings 26 mounted on the transverse rope 13 running alternately through the rings 26 and eyelets 28 of the carpet,

FIG. 12 is a large-scale plan view of a special anchor 4 consisting of a vertical metal plate forming a triangle. A rod 30 made of flat or round metal contains an inclined slot 32 and is hinged on the anchor 4 by a bolt 31 going through this slot,

FIG. 13 is a cross-section taken along the line VI—VI of FIG. 12,

FIG. 14 is a plan view of a segment of a carpet or plate 34 shaped to form conical channels 35,

FIG. 15 is a cross-section taken along the line VII—VII of FIG. 14,

FIG. 16 is a plan view of a segment of a carpet or plate 36 containing slits 37 and folds 38,

FIG. 17 is a cross-section taken along the line VIII—VIII of FIG. 16,

FIG. 18 is a plan view of a segment of a carpet or plate forming an open grid with vertical 40 and/or slanting 41 sidewalls,

FIG. 19 is a cross-section taken along the line IX—IX of FIG. 18,

FIG. 20 is a plan view of a segment of a carpet consisting of several layers of mesh 42 forming conical channels,

FIG. 21 is a cross-section taken along the line X—X of FIG. 20.

FIG. 22 is a vertical cross-section of a spiral-formed anchor plate 50 screwed into the ground by means of a detachable rod 51. The anchor rope 3 is in this case fastened directly to the anchor plate 60.

Depending on the size and permeability of the device and on the current conditions, the distance between the device and the floor may be of the order of 0 – 400 cm.

In most cases a continuous flexible carpet or stiff plate will be more advantageous and economical than separate elements as to manufacture, installation and the possible successive raising of the device.

The following description presents various constructional principles and details as to such flexible carpet and stiff plate in typical cases of application of the invention.

Whether a flexible carpet or a stiff plate should be preferred in the individual case depends on several conditions.

In shallow water where the vertical forces of the waves are significant, only flexible carpets that can yield sufficiently to the vertical water motions (FIGS. 1 – 4), or stiff plates of a very open structure (FIGS. 19 – 21) can stand the action.

In most cases the manufacture and installation of carpets will be more economical than of plates.

Stiff plates are appropriate in cases of bottom-protection at offshore structures if they can be mounted in advance, before the launching of the structures, or in cases where the structures beforehand have been equipped with the necessary clamps for the subsequent installation of the plates.

The carpets may be made of, for instance, polyester- or nylon-reinforced polyvinylchloride which may be impregnated against microorganisms and oil.

Any curved shape of the carpet — e.g. wavy (FIGS. **1, 2**) or streamlined (FIG. **6**) — may be obtained by forming of the carpet itself with the desired shape, using plastic, e.g. PVC, of suitable stiffness, or by attaching flexible stays of the desired shape to the carpet at suitable intervals, or by attaching the carpet alternately to a row of upper and a row of lower transverse flexible bands stretched out horizontally. A carpet supported at its middle as shown in FIGS. **3, 4, 5, 6,** may be given a wavy configuration by staggering vertically and/or horizontally of the anchoring points of the edge of the carpet. As shown in FIGS. **3, 4** this may, for instance, be done by staggering horizontally of the anchors.

The plates may be made of plastic, e.g., glassfiber-reinforced polyester, of steel or aluminium. They may be plane or — for hydraulic and/or reasons of strength — be curved, e.g. wavy.

Depending on the nature of the project in question, the current conditions and the shape, the carpet or the plate may be even, only perforated with an adequate number of holes at appropriate locations (FIGS. **5 – 10**). The holes may be provided with sheltering pockets (FIGS. **16, 17**). Or the carpet or the plate may have an uneven surface, be wavy (FIGS. **1, 2**) — the height of the waves of the device appropriately increasing from the periphery towards the middle of the device —, have a grid structure (FIGS. **18, 19**), or form conical channels with upwardly or downwardly decreasing cross-section area (FIGS. **14, 15, 20, 21**).

The functions of anyone of these different designs may be to avoid overloading of the device due to the impact of waves or due to deposition of drift material on top of the device, and/or to increase the rate of deposition of drift material underneath the device. These different designs are detailed as follows:

The amount and location of holes **2, 46** and/or openings **45** should be adjusted to the shape of the device and the current conditions so that the currents are always guided over the device or upwards through the holes and openings located at the middle and downstream side of the carpet or plate. Such upward flow may decrease the velocity under the device and thereby increase the depositing effect. On the other hand, perforations inducing increased flow velocity under the upstream edge of the device should be avoided. For example, in a wavy device (FIGS. **1, 2**) contains no holes **2** in the near of the edges.

At greater water depths where the waves have negligible influence, the device may in some cases be without any perforation.

A device for stabilization of the bottom along a submarine pipeline (FIGS. **5, 6**) or for coastal protection (FIGS. **3, 4**) may have an opening **45** along the top of the device if the slopes of the device are not steeper than about **1:4.**

In other cases the perforation should be spread all over the device, and in still other cases be concentrated along the periphery of the device.

To prevent the coarser part of the drift material from becoming conducted up through the holes **2** or openings **45** these may be covered with strainers made, for instance, of nylon mesh.

Pockets **38** (FIGS. **16, 17**) sheltering holes **2** prevent the currents over the device from running through the holes but allow for falling down of drift material deposited on the device. The pockets, made of flexible or stiff material, may be attached on the surface of the device or be formed in the carpet or the plate itself by slitting and folding it like the raised teeth of a shredder (FIGS. **16, 17**), if necessary stiffened by attached forms. The pockets may be placed on the top side and/or the underside of the carpet or the plate.

A wavy form of a carpet or plate should be orientated so that the waves of the device are perpendicular to the significant orbital, littoral or tidal current. In lengthy devices near a coast the waves of the devices therefore should be parallel to the depth-contours, in round devices at greater depths, radially. Where considerable current velocities parallel to the waves of the device may occur, these waves may also be wavy in the horizontal plane about their longitudinal axes (FIG. **1**). The top of the waves of the device is perforated with holes **2** (FIGS. **1, 2**) to cause a maximum of upward flow through the holes. The underside of the waves contains a minimal amount of holes **46** to hinder deposition of drift material on top of the device.

As to the installation of a carpet a perfect stretching out of the carpet is essential. Therefore the carpet itself or the anchoring ropes **3, 12, 13** should include elements of sufficient elasticity to maintain the tensioning of the carpet under all conditions. A wavy carpet (FIGS. **1, 2**) has such elasticity itself.

The dispersion of the anchoring forces over the periphery of the carpet may be obtained by forming of the carpet with a garland-like periphery in which the anchoring ropes **3** are attached at the points. A more flexible design is shown in FIGS. **1, 3, 5, 7, 11,** in which the anchoring rope **3** can be attached to any point of the longitudinal rope **12** by means of pawl rings **27** (FIG. **11**) or pulleys **47** (FIGS. **5, 6**) which disperses the forces on to the carpet via the rings **26** and the transverse rope **13.**

The dispersion of the anchoring forces over the entire periphery of a flexible carpet may also be achieved by means of a rigid rod attached to the periphery. A special design is shown in FIGS. **9, 10,** in which the carpet is suspended at its center and includes a circumferential ring **24** pressed down by struts **21.**

The means of supporting the carpet or the plate can be adjusted to suit the circumstances. For instance, in coastal protection projects the device may be stretched out between and supported by vertical piles, e.g. pipes, water-jetted, vibrated, driven or screwed down into the seabed. As the piles extend above the water surface it is simple to raise the device according as the deposition of drift material takes place.

To avoid pile-driving the device may be stretched out by anchors **4** and supported on poles **5** at the periphery and/or at the middle of the device (FIGS. **1, 2**). The raising of the device may be achieved by screwing of the poles **5.** The lower section of the poles may be formed with screw blading so that the poles can be screwed upwards through the ground. Or the attachment **6** may fit into screw thread of the pole so that the device but not the pole will rise by the screwing of the pole.

Instead of poles 5 the device may be supported on folding balloons 9 at the middle and/or at other points of the device (FIGS. 3, 4). The mounting and the possible subsequent raisings of the device is achieved by gradually filling of the balloons with compressed air. The balloons may have rounded, stiff underside and be formed in such way, for instance wider at the top than at the foot (FIG. 4), or have such buoyancy that the waves will roll or rock the balloons to the top of the deposited material and thereby successively raise the device according as the deposition takes place.

The separate balloons may be joined to formed one or more continuous hoses whereby an even height of the carpet is obtained throughout its length.

Where the purpose is to stabilize the bottom along a submarine pipeline (FIGS. 5, 6) or around the legs of offshore structures (FIGS. 7, 8) the middle of the carpet or the plate will be supported by the structure in question. In some cases a deposition of material coming up to a level above the top of a pipeline is required. In such case a framework of rods attached to the pipeline or independent of this, supports the device so that the top of the device comes up to the desired level. The periphery may be supported by the anchoring ropes 3 which may also stretch the carpet out (cf. FIGS. 3, 4), or be supported on the bottom, possibly by adjustable props 17 (FIGS. 5, 6), or — where the dimensions of the devices are not too large — all of the devices may be supported on the offshore structure (FIGS. 7 – 10), whereby complete independence of the quality and configuration of the seabed is obtained. In the last-mentioned case, the supporting beams 14 or 19 may be formed as lattice-girders or pipes and be hinged to the structure and be supported by struts 21 at the other end. To prevent scouring outside the device a streamlined design, with gradually decreasing angle of slope towards the periphery of the device, is desirable (FIG. 6). On submarine pipelines the clamps to hold the supporting beams 14 may be formed as a pair of tongs 15 (FIGS. 5, 6) clipped around the pipe and held in position by a screw 16.

Anchors may be made up of vertical poles, e.g., pipes, water-jetted, vibrated, driven or screwed into the ground. A special anchor-design is shown in FIGS. 12, 13 where the anchor 4 consists of iron or other metal plate bent and welded to form a vertical, hollow tube of triangular or other cross-section, without top and bottom. The transfer of the anchoring force from the device to the anchor is done by a rod 30.

If the forces to be withstood are comparatively weak (FIG. 2) the anchors 4 may be placed on the floor of the body of water. After some time the waves and currents will have undermined and caused the anchors to sink to a sufficient depth. The rod 30 may in this case be positioned vertically and the anchoring rope 3 fastened to its top above the floor.

Stronger forces require greater depth of the anchors (FIG. 4). Such depth may be achieved by vibrating of the anchor through the rod 30. When pressed downwards in vertical position, the hinged rod will be pressed against the anchor 4, due to the inclined slot 32. Vibrations applied to the flat or round rod made of iron or other metal will consequently be transmitted to the anchor 4 which thereby will sink to the desired depth. By twisting and pulling the rod upwards and thereby freeing it from its fixed vertical position as to the anchor, the rod can thereafter be turned to a nearly horizontal position by means of vibration so that it can transfer the anchoring forces without tipping over of the anchor.

Another special anchor design, of interest in particular in clayey bottom, consists of a spiral-formed plate 50 (FIG. 22) which is screwed into the ground by means of a rod 51. This rod may be an inseparable connection with the plate 50, and the anchor rope 3 be attached to the top of the rod 51. Or the rod may be in screw- or the like connection with the plate 50. When this anchor plate has been screwed sufficiently deep into the bottom the rod is freed from the plate by twisting the rod the opposite direction so that the rod can be re-used for screwing of the other anchor plates. The anchor rope 3 is in this case fastened directly to the anchor plate 50 (FIG. 22).

I claim:

1. Apparatus for producing and protecting deposits of sedimentary material on a floor of a body of water, said apparatus comprising an elongated sheet located beneath the surface of the water in at least partially upwardly spaced relationship close to but above said floor, means for maintaining said elongated sheet so positioned, said maintaining means are a plurality of elements supporting said sheet along spaced points of the length thereof, and said sheet is of undulating configuration as viewed in transverse cross section along the length thereof.

2. The apparatus as defined in claim 1 wherein the sheet is constructed of relatively rigid material.

3. Apparatus for producing and protecting deposits of sedimentary material on a floor of a body of water, said apparatus comprising a flexible elongated sheet located beneath the surface of the water in at least partially upwardly spaced relationship close to but above said floor, means for maintaining said flexible elongated sheet so positioned, said flexible elongated sheet includes a longitudinally extending central portion and longitudinally extending side portions diverging relative to said floor, first aperture means along the length of said central portion, and second aperture means along the length of each of said side portions.

* * * * *