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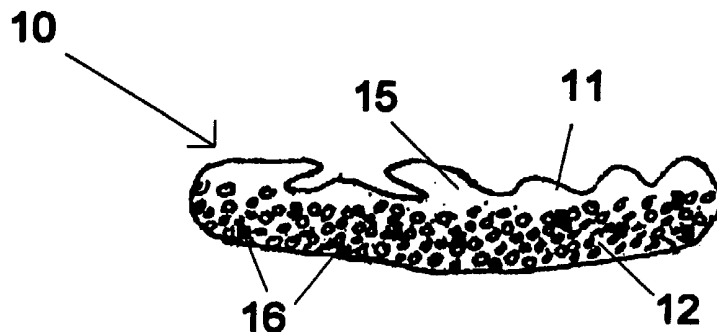
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(54) Title: APPARATUS AND METHOD FOR FLOOD CONTROL



(57) Abstract: Apparatus and method for flood control. The apparatus comprises at least one expandible compartment that may conform to surfaces against which it rests. The compartment comprises a filler material capable of taking up liquid and expandible upon liquid take-up; an outer skin, at least a part of which is liquid permeable; and means for sealing said skin to contain said filler material therein. The compartments may be dried or purged of liquid after use and retained for subsequent re-use.

APPARATUS AND METHOD FOR FLOOD CONTROL

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to the field of flood control, and more particularly to the field of flood control devices that can expand as they absorb flooding liquids to create a barrier.

Description of Related Art

There are numerous situations in which it is desirable to contain or control the spread of flooding liquids. For example, many sites are subject to occasional or infrequent flooding. Often, these floods are controlled by erecting walls or banks of sand bags. However, the use of sand bags is very labor intensive, as sand must often be transported to the site where they are used, and each bag must be filled with sand and placed in position. The process of erecting a barrier is slow. Further, the sand is heavy, adding to the difficulties of transportation and working with the filled sand bags. When the threat of flooding has ended, the sand bags may then be removed. This process also is slow and labor intensive, and may require moving even heavier, water-saturated sand. Moreover, the entire process must be repeated each time a new flood threatens the area.

In some locations, localized weather conditions may create situations where water levels rise rapidly, endangering low-lying areas with little or no warning. For example, unseasonably warm spring weather may dramatically increase run-off due to snow melting in higher, mountainous areas, creating a flood hazard along streams arising in the mountains. Another situation in which flooding can occur rapidly and unpredictably is when severe rain storms dramatically increase local runoff. In these situations, it may be impractical to erect barriers of sand bags quickly enough to prevent localized flooding in lower-lying areas.

Thus, there is a need for a method of controlling floods that is economical and easy to perform and that requires less labor than conventional methods. There is also a need for a flood control device that can easily be transported and emplaced rapidly without requiring extensive labor. There is a further need for a flood control device that can be transported easily to and from a flood site. There is yet a further need for a temporary flood control device that can be stored easily and compactly when not in use.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method of controlling floods that is economical, easy to perform, and requires less labor than conventional methods.

It is also an object of the present invention to provide a flood control device that can easily be transported and deployed rapidly without requiring extensive labor.

It is a further object of the present invention to provide a flood control device that can be transported easily to and from a flood site.

It is a still further object of the present invention to provide a flood control device that can be stored easily and compactly when not in use.

To achieve the foregoing and other objects and in accordance with the purpose of the present invention broadly described herein, one embodiment of this invention comprises a flood control barrier. The barrier includes a filler material capable of taking up liquid and expandible upon liquid take-up; an outer skin, at least a part of which is liquid permeable; and means for sealing the skin to contain the filler material therein. The skin is adapted to accommodate expansion of the filler material. The apparatus may have a pillow-like form, and it may be adapted to conform to surfaces against which it rests. The apparatus may comprise a plurality of compartments which are adapted to be secured to at least one other compartment and/or an adjacent structure. The outer skin and the filler material may be substantially unreactive chemically with and insoluble in the liquid. The filler material may comprise a material selected from the group consisting of biopolymers, synthetic polymers and copolymers, polymer gels, and combinations thereof, and it also may comprise at least one component selected from the group consisting of growth inhibitors, anti-microbial agents, surfactants, and weighting agents. The apparatus may be used as a flood control barrier, and it may be re-usable.

Another embodiment of this invention comprises an expandible flood control barrier unit, including a filler material capable of taking up liquid and expandible upon liquid take-up, and an outer skin enclosing the filler material. The outer skin may be adapted to accommodate expansion of the filler material, and at least a part of the outer skin is permeable to the liquid and impermeable to the filler material.

Another embodiment of this invention comprises a method for containing and controlling floods. The method includes the step of providing an expandible apparatus comprising an outer skin, at least a part of which is partially liquid permeable, and a filler material contained within the outer skin. The filler material is capable of taking up liquid and expandible upon liquid take-up.

The apparatus is adapted to conform to surfaces against which it rests. The method also comprises the steps of placing the apparatus where flooding liquid can contact it and allowing the liquid to penetrate through the outer skin and be taken up by the filler material inside the skin, thereby causing the barrier to expand. The placing step may comprise securing the apparatus to at least one adjacent structure. A weighting agent may be added to the apparatus. Also, the method may also comprise one or more additional steps of removing at least a portion of the liquid which has been taken up by the filler material and storing the apparatus for re-use.

The apparatus may be modular, and the method may further comprise the step of joining a plurality of the modules together. The method may also further comprise the step of selecting a quantity of the modules for use at a desired location.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood with reference to the following description, appended claims, and accompanying drawings, where:

Fig. 1a is a top view of one embodiment of the present invention;

Fig. 1b is a vertical cross sectional view of the embodiment of Fig. 1a along plane A-A, with the filler material in a dry, compact state;

Fig. 1c is a vertical cross sectional view of the embodiment of Fig. 1a along plane A-A, with the filler material in a wet, expanded state;

Fig. 2 is a side view of a dam formed with compartments in accordance with the present invention;

Fig. 3 is a top view of a flood contained by compartments in accordance with the present invention;

Fig. 4a is cross sectional view of part of a series of compartments in accordance with one embodiment of the present invention;

Fig. 4b is aside view of the series of compartments shown in Fig. 4a, with the compartments rolled up for storage and/or transportation;

Fig. 5a is a top view of another embodiment of the present invention; and

Fig. 5b is aside view of two connected compartments of the embodiment shown in Fig. 5a.

DETAILED DESCRIPTION OF THE INVENTION

As used herein, the term "flood" includes inundations, streams, surges, spillovers, runoff, swells, and large or copious flows or rises of liquid.

In accordance with the present invention, one embodiment of an apparatus for controlling floods is shown in Fig. 1 and comprises one or more flexible compartments 10 having an outer skin 11 encasing an absorbent or adsorbent filler material 12. The sack or compartment should be sufficiently flexible to conform to minor variations in surfaces against which it is placed for flood control. Although pillow-like or sausage-like compartments are preferred, apparatus 10 can have any convenient size or shape suitable for the specific manner in which it is to be used. The ends of compartment 10 may be sealed in any manner known in the art. For example the ends may be tied with a suitable cord or wire, as shown at 13, or heat-sealed or crimped, as shown at 14. Alternatively, the ends of compartment 10 could be stitched or glued.

The outer skin 11 should preferably comprise a flexible fabric or other material which will contain the filler material 12. At least a portion of the outer skin 11 is permeable to the type of liquid to be absorbed or adsorbed by the filler material 12, so as to allow liquid contacting the skin to reach the filler material. The permeable portion of the fabric should be porous with a smaller pore size than the particle size of the filler material 12 to prevent filler material from leaking out of the skin. Also, the outer skin 11 should be substantially insoluble in and substantially unreactive chemically with the liquid.

The filler material 12 comprises at least one substance which expands as it absorbs or adsorbs liquid. The filler material 12 may be particulate or single-piece, and it may be a solid, a gel, or sponge-like. The material 12 may comprise a swellable polymeric material, a gel, or a combination thereof. The polymeric material or gel may comprise a synthetic polymer, a biopolymer, copolymers thereof, or combinations thereof. Many such materials are known in the art, and some polymeric materials are capable of absorbing 100 or more times their weight of liquid. The relatively light weight and compactness of the dry filler material make the compartments convenient and easy to store, transport, and deploy. In some applications, it is desirable that the expansion of the filler material is reversible, and, in this case, the filler material should shrink as the adsorbed or absorbed liquid is removed from the compartment, such as by application of pressure to the compartment, or by evaporation, such as during exposure to sunlight and warm ambient air or by application of heat.

In accordance with the present invention, the filler material 12 is selected to be compatible with the liquid to be absorbed. For example, if the invention is to be used to control aqueous floods, the filler material should be hydrophilic. Preferably, the filler material should also be insoluble in the liquid to be taken up and chemically unreactive with the liquid.

5 Preferably, the filler material 12 is somewhat porous when it has taken up less than its full capacity of liquid, allowing the flood liquid to penetrate the material substantially completely. The apparatus may include one or more chemicals that enhance liquid take-up by the filler material. For example, the filler material may include a surfactant to enhance liquid penetration. Preferably, the filler material becomes substantially impermeable to the liquid when the material is
10 substantially fully saturated with the liquid, thereby preventing significant leakage of liquid through a barrier formed by placement of the compartment.

To allow for expansion of the filler material as it takes up liquid, the dry filler material 12 may occupy less than the full interior volume of the outer skin 11, with outer skin 11 also enclosing void space 15, as shown in Fig. 1b. As the filler material 12 takes up liquid, it expands
15 to fill the void space, as shown in Fig. 1c. Alternatively, the outer skin could be formed from a stretchable material which expands as the filler material expands. The apparatus may also include a weighting material to enhance its ability to stay where it is positioned. The weighting material may either be in the form of elements attached to or integrated with the outer skin, or it may be included as particles 16 in the filler material 12. Examples of weighting materials include
20 pieces of metal or stone and particles of insoluble and unreactive compounds containing heavy elements.

In one embodiment, the apparatus of the present invention is reusable. To promote longevity for use on multiple occasions, the skin and filler material are durable and preferably resistant to rot, mildew, and other forms of biological and chemical degradation, including
25 burrowing or ingestion by worms, rodents, and other animals. Either the skin or filler material may include a growth inhibitor or antimicrobial agent. Preferably, the skin is resistant to abrasion.

Two or more compartments may be positioned adjacent each other and/or stacked to form a larger or longer flood control barrier, as shown in Figs. 2 and 3. To facilitate placement in
30 a variety of situations, the compartments 20 or 30 are preferably modular. For example, as shown in Fig. 2, compartments 20 may be stacked in a local low area 21 to create a dam or wall 22 across low area 21 which is prone to flooding. As another example, shown in Fig. 3,

compartments 30 may be placed so as to contain and absorb a flood 31, such as of a liquid in an industrial environment. Preferably, compartments 20 and 30 are capable of conforming to the shape defined by one or more surfaces against which they are placed. Compartments of different sizes may be combined to form a barrier, such as to ensure that the barrier fits in the space where it is erected.

Referring to Fig. 4, in one embodiment of the present invention, compartments 40 are formed from a continuous length of skin 41. As can be seen for the series of compartments 40 shown in Fig. 4a, skin material 41 may be continuous, with filler material 42 sealed in compartments 40 at seals 43, with and portions 44 of unfilled skin material between the seals 43, similar to sausages in a casing.

As shown in Fig. 4b, the connected compartments 40 may be provided wrapped around a drum or reel 45. Compartments 40 can be unrolled from reel 45 and placed where needed to contain and/or absorb a flooding liquid. A number of compartments 40 may be selected, based on the length needed, such as to construct the flood control barrier as shown in Fig. 2 or to contain a flood as shown in Fig. 3. The selected compartments 40 are separated from the supply on the reel by cutting or tearing the portion 44 of skin material between adjacent seals 43. The portions 44 may be perforated or scored to facilitate separation.

Alternatively, as shown in Fig. 5, the modules may be provided as individual units 50 which can be joined together for use. The modules 50 may also be adapted for attachment to the ground or to adjacent structures, such as trees, rocks, abutments, walls, buildings, or other compartments, when it is installed for controlling a flood. The modules 50 may be anchored vertically and/or laterally. For example, as shown in Fig. 5a, compartment 50 has an outer skin 51 with one or more extensions 52 into which grommets 53 may be mounted. A stake 54 or a tie line 55 may be inserted into each grommet hole for anchoring the compartment 50. Also, one or more weights 56 may be secured to compartment 50, such as with connection 57. As shown in Fig. 5b, hooks 58 can be used to connect adjacent compartments 50. Other types of temporary or permanent fasteners known in the art can also be used. For example, hook-and-loop fasteners, such as Velcro®, or adhesives could be used. It should be appreciated that a series of connected compartments 50 could be wound on a reel for storage and transportation, or rolled into a coil without a reel.

The apparatus of the present invention can be quickly and easily installed at a site where flooding is expected or occurring. As discussed above, the apparatus of the present invention

may be provided in the form of a series of linked sausage-like compartments (Fig. 4) or as modular compartments adapted to be connected to each other (Fig. 5). The connections may be temporary or permanent. When the filler material is in its relatively compact and dry state prior to use, it is relatively light weight and easy to transport and emplace.

5 To facilitate use, the compartments are preferably transportable as a roll of material, as shown in Fig. 4b, to be unrolled and possibly anchored at a site where it is deployed. The material may be simply rolled about itself or wrapped around a drum or reel.

If the apparatus is provided with an outer skin which forms a continuous tube, such as is shown in Fig. 4, the tube is unrolled and cut to obtain the desired length of the barrier. The
10 compartments 40 may be filled with filler material and sealed prior to use, or they may be filled and sealed at the time of use. The ends can be sealed by any method known in the art, such as by tying, crimping, heat sealing, stitching, or gluing. The severed compartments are secured in place at the site of deployment.

Alternatively, if the apparatus is provided in the form of modular compartments, as shown
15 in Fig. 5, the compartments can be arranged end-to end to obtain the desired length for the particular site at which the apparatus is deployed. It should be appreciated that the individual compartments may be fastened together at the deployment site, or they may be pre-assembled and transported to the site. For example, an assembled series of compartments can be wrapped around a drum for storage and transportation, similar to the continuous tube discussed above and
20 illustrated in Fig. 4.

Multiple lengths of linked compartments can be placed end-to-end or stacked on top of one another to form a larger barrier. The compartments may be secured in place, such as with stakes, weights, or other means known in the art. Multiple barrier units, in the form of individual compartments or series of linked compartments, may be secured to each other. If weighting
25 elements are used, they may be attached to the units. The weighting elements may be attached in a manner which allows them to be detached at later time, such as for storage of the apparatus for subsequent re-use, or to allow the weighting elements to be reused even when the absorbent units are disposed of.

As the flooding liquid reaches the units, the liquid passes through the outer skin and is
30 absorbed or adsorbed by the filler material, which swells, as shown in Figs. 1b and 1c, thereby increasing the size and weight of the barrier. Once the filler material is swollen, substantial quantities of liquid cannot pass through the barrier, making the apparatus suitable for use in

controlling floods. Also, the compartments become heavier as they absorb water or other liquid, increasing their ability to remain where positioned rather than being moved by flowing liquid which contacts them.

5 The apparatus may be disposed of in a suitable manner after it has taken up the flooded liquid. If the liquid comprises a hazardous material, it may be desirable to dispose of the compartments which have been partly or fully saturated with the liquid. In this case, the preferred filler material may form a gel with the liquid it takes up, allowing the compartments to be transported to a disposal site with minimal leakage of the liquid from the gel.

10 Alternatively, if the present invention is used to control a flood of a non-toxic liquid, the filler material may be allowed to dry out after the flood situation has ended, such as after flood waters recede. Depending on the type of filler material, the units may be squeezed, such as by rolling them up, to remove a large fraction of the water they hold. They can then be unrolled to continue the drying process. The liquid held in the filler material may be allowed to evaporate. Evaporation may be promoted by heating, either with a heating device or due to an increased
15 ambient temperature brought by improved weather and/or direct sunlight on the compartments.

The compartments of the present invention are re-usable. The apparatus may be left in place, such as when it is installed at a location subject to repeated floods. Alternatively, the linked compartments can be rolled up for storage, such as on a reel or drum, when the filler material is substantially dry. If weights have been attached, they may be removed prior to rolling
20 up the units. The rolled up compartments may be conveniently transported and stored in this lightweight, compact form.

The foregoing description is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and process shown as
25 described above. Accordingly, all suitable modifications and equivalents may be resorted to falling within the scope of the invention.

I claim:

- 1 1. An expandible flood control barrier comprising:
2 a filler material capable of taking up liquid and expandible upon liquid take-up;
3 an outer skin, at least a part of which is permeable to said liquid and impermeable to said
4 filler material, wherein said outer skin is adapted to accommodate expansion of said filler
5 material; and
6 means for sealing said filler material in said skin.
- 1 2. The apparatus of Claim 1, wherein said apparatus comprises a plurality of
2 compartments, each compartment including a quantity of said filler material sealed within said
3 outer skin.
- 1 3. The apparatus of Claim 2, wherein said compartments are joined end-to-end.
- 1 4. The apparatus of Claim 2, wherein each of said compartments is adapted to be
2 secured to at least one of another of said compartments and an adjacent structure.
- 1 5. The apparatus of Claim 1, wherein said outer skin is substantially unreactive
2 chemically with and insoluble in said liquid.
- 1 6. The apparatus of Claim 1, wherein said filler material is substantially unreactive
2 chemically with and insoluble in said liquid.
- 1 7. The apparatus of Claim 1, wherein said filler material comprises a material
2 selected from the group consisting of biopolymers, synthetic polymers, polymer gels, copolymers
3 thereof, and combinations thereof.
- 1 8. The apparatus of Claim 1, wherein said filler material comprises at least one
2 component selected from the group consisting of growth inhibitors, anti-microbial agents,
3 surfactants, and weighting agents.

1 9. The apparatus of Claim 1, wherein said outer skin comprises at least one
2 component selected from the group consisting of growth inhibitors, anti-microbial agents,
3 surfactants, and weighting agents.

1 10. The apparatus of Claim 1, wherein said apparatus is re-usable.

1 11. An expandible flood control barrier unit, comprising:
2 a filler material capable of taking up liquid and expandible upon liquid take-up;
3 an outer skin enclosing said filler material, wherein said outer skin is adapted to
4 accommodate expansion of said filler material, and wherein at least a part of said outer skin is
5 permeable to said liquid and impermeable to said filler material.

1 12. The flood control barrier unit of claim 11, wherein said unit has a pillow-like form
2 and can conform to surfaces against which it rests.

1 13. A method for containing and controlling floods, comprising the steps of:
2 providing an expandible apparatus comprising an outer skin, wherein at least a part of said
3 skin is partially liquid permeable, and a filler material contained within said outer skin, wherein
4 the filler material is capable of taking up liquid and expandible upon liquid take-up, wherein said
5 apparatus is adapted to conform to surfaces against which it rests;
6 placing said apparatus where said liquid can contact it and where said apparatus can act as
7 a flood control barrier; and
8 allowing said liquid to penetrate through said outer skin into said barrier and be taken up
9 by said filler material inside said outer skin, thereby causing said barrier to expand.

1 14. The method of Claim 13, wherein said placing step comprises securing said
2 apparatus to at least one adjacent structure.

1 15. The method of Claim 13, further comprising the step of adding a weighting agent
2 to said apparatus.

1 16. The method of Claim 13, wherein apparatus is modular, and wherein said method
2 further comprises the step of joining a plurality of said modules together.

1 17. The method of Claim 13, wherein apparatus is modular, and wherein said method
2 further comprises the step of selecting a quantity of said modules for use at a desired location.

1 18. The method of Claim 13, further comprising the step of removing at least a
2 portion of said liquid which has been taken up by said filler material.

1 19. The method of Claim 19, further comprising the step of storing said apparatus for
2 re-use.

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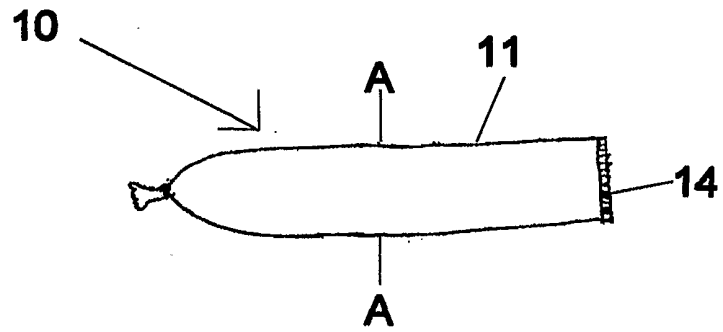


Fig. 1a

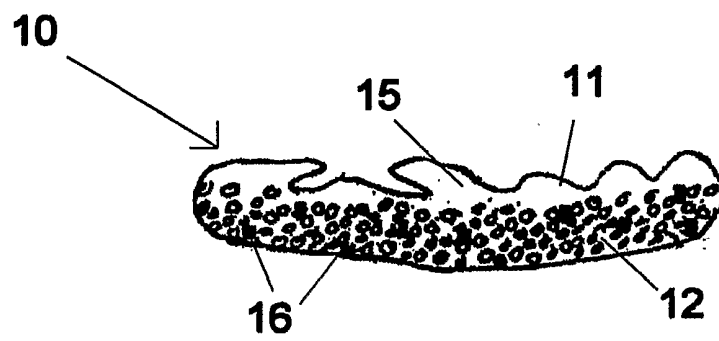


Fig. 1b

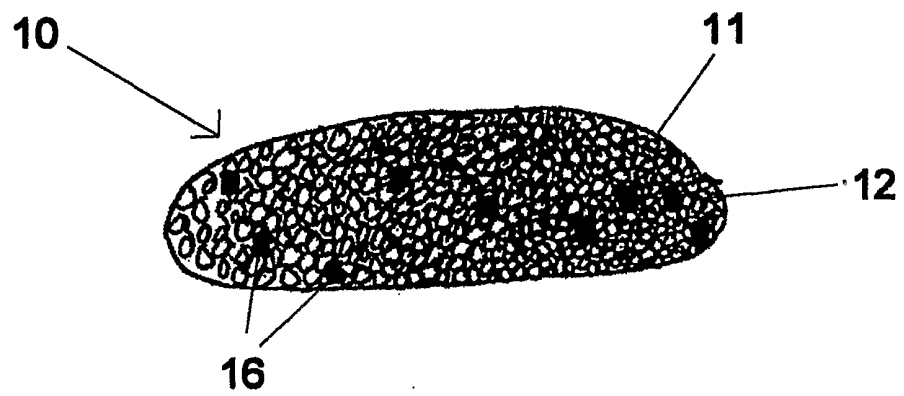


Fig. 1c

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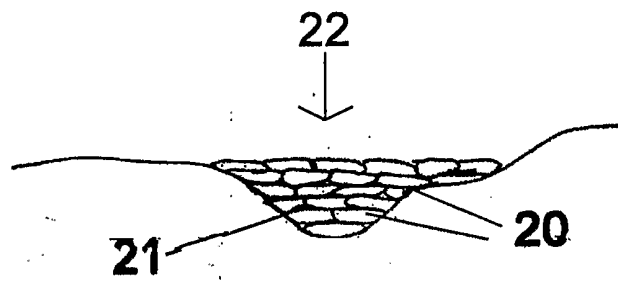


Fig. 2

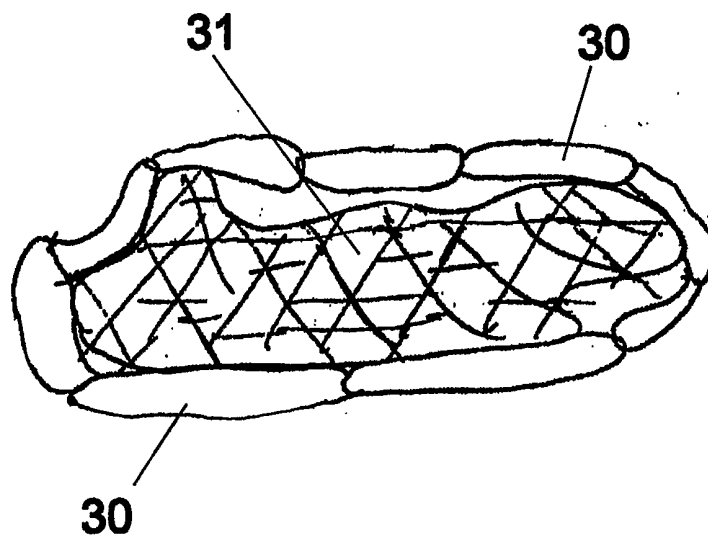


Fig. 3

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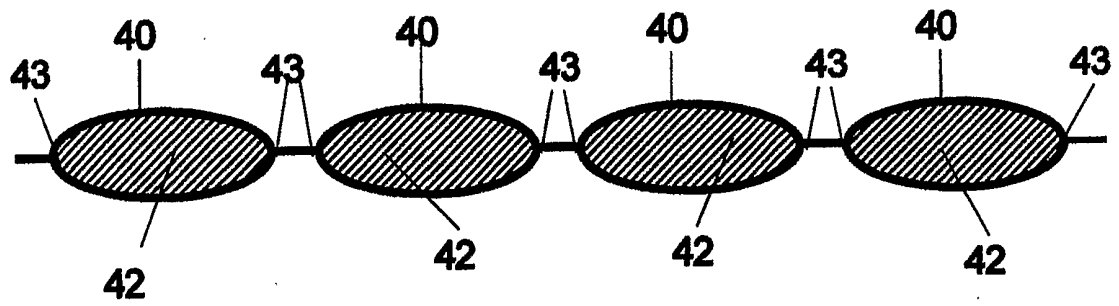


Fig. 4a

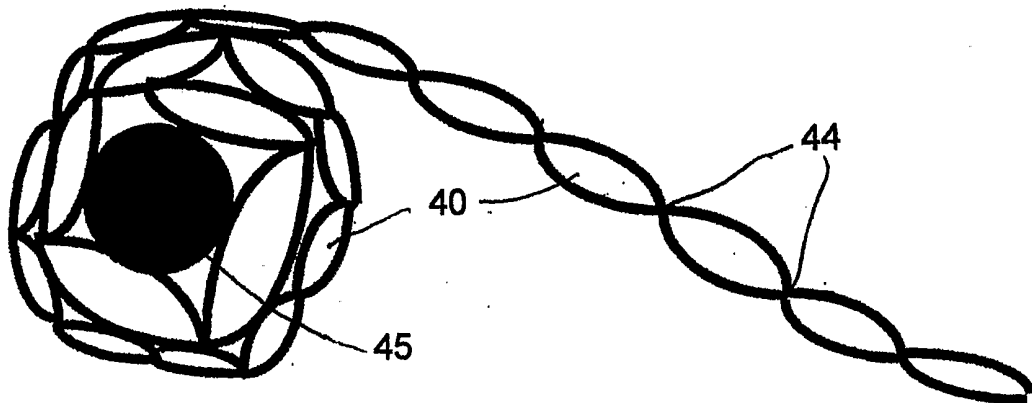


Fig. 4b

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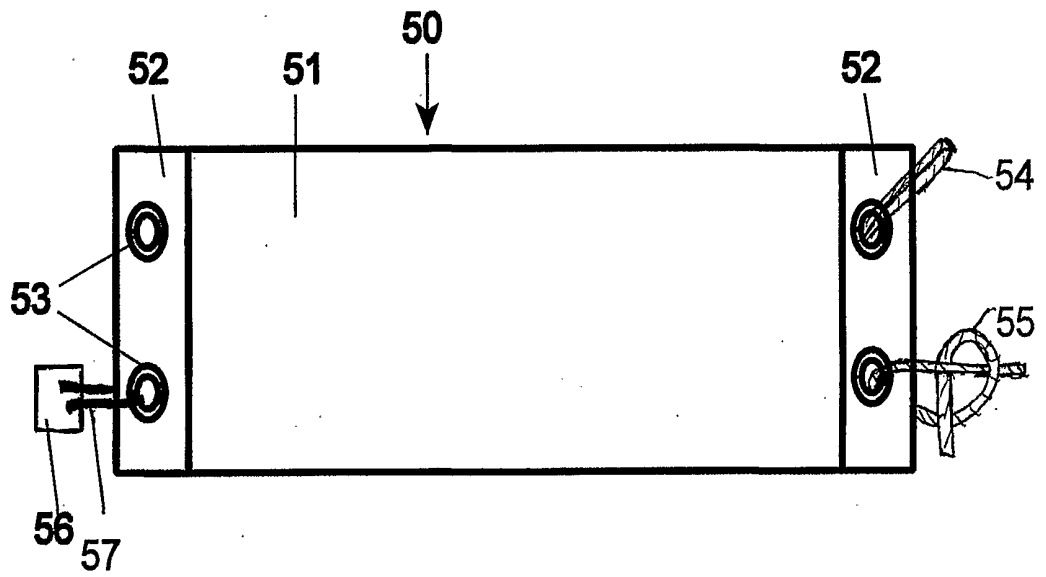


Fig. 5a

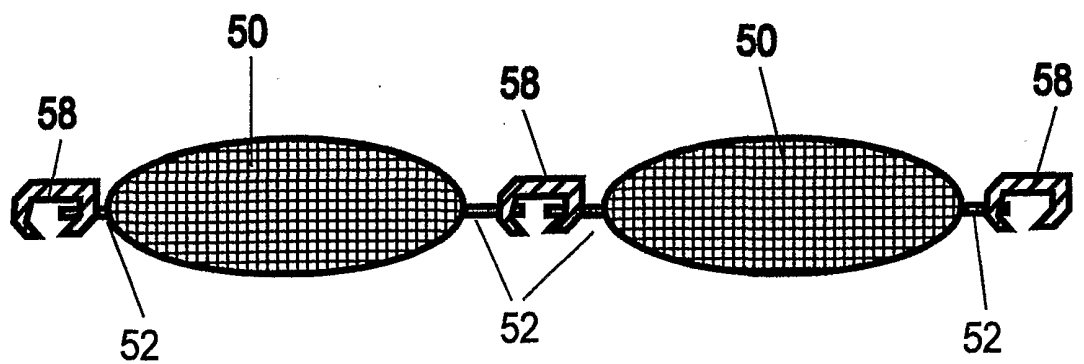


Fig. 5b