(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 030 452**
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **11.01.84**

(51) Int. Cl.³: **E 02 B 3/12**, E 02 D 29/06

(21) Application number: **80304363.7**

(22) Date of filing: **03.12.80**

(54) **Reinforced flexible shutter and modular units to form such a shutter.**

(30) Priority: **03.12.79 GB 7941658**

(43) Date of publication of application:
17.06.81 Bulletin 81/24

(45) Publication of the grant of the patent:
11.01.84 Bulletin 84/2

(84) Designated Contracting States:
BE CH DE FR GB IT LI NL

(56) References cited:
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FR - A - 2 297 959
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US - A - 3 524 320
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EP 0 030 452 B1

Reinforced flexible shutter and modular units to form such a shutter

This invention relates to reinforced flexible shutters, that is, structures of flexible material which serve for the controlled placement of settable compositions, e.g. concrete mixes, so that the combination of the shutter and the composition, when the latter has set, becomes a fixed structure. Reinforced flexible shutters and fixed structures made using them can be employed in a variety of ways. One general class of use is under water, where such structures serve to minimize the scouring effect of water action on the beds and banks of water-flow channels, such as rivers, estuaries, canals, reservoirs and the sea. In particular, such structures provide protection for sea and like defences, where the severity of the water action is increased by tidal and storm waves as well as by waves created by shipping and other marine craft. Other uses can involve the placing of such shutters on the ground, which may be under water for periods which alternate with ones where there is no water, e.g. in tidal estuaries, or swampy or marshy ground. Such shutters and filled structures made using them can be very long and can be used, for instance, as causeways or roadways over terrain which could otherwise not be traversed.

Flexible shutters for receiving and retaining concrete and other settable compositions for these and analogous purposes are already known and commonly consist of complex woven or other textile fabric structures, comprising two inter-connected webs which define a double-skin blanket-like structure which conforms to the shape of the ground or other solid material on which it is placed, e.g. a marine foreshore or river bank, and can receive and retain a liquid concrete mix, which sets in the space between the interconnected webs. The term "geotextile engineering" is now commonly applied to the design, manufacture and use of such fabric structures for the protection and stabilization of land by such techniques.

For example, US—A—3,425,228 describes such a flexible shutter or fabric form for making concrete structures, comprising two large continuous sheets of flexible material joined around their periphery and having an intermediate layer also joined to their periphery, the two sheets being interconnected at spaced intervals by means such as strips of material, seams or openings passing through the three sheets. US—A—4,154,061 describes fabric forms for concrete where the upper and lower fabrics are formed of interwoven yarns, with reinforcing means woven into each of the fabric layers and inelastic means such as wires secured between the reinforcing means in the upper and lower fabrics.

One general disadvantage of known flexible cast shutters, such as disclosed in the aforesaid publications, however, resides in the considerable difficulty experienced in obtaining substantially thick structures, i.e. over 300 mm in thickness, and also any form of structure giving pressure relief in respect of underlying water which can lift the structure from the ground it is intended to protect. These difficulties have so far limited the use of textile shutters to specially formulated concretes and grouts i.e. based on small-size aggregates, to thin structures, to structures without in-built pressure relief arrangements and to structures without reinforcing. This has meant that heavy-duty applications where the structures are at least partly under water, e.g. in sea defence projects, have in the main been prevented and other expedients have had to be used.

Another general disadvantage of known flexible cast shutters is the limitation in size imposed by the dimensions of the fabric layers used to make them. There have been a number of proposals for the construction and use of modular elements, employed in large numbers, for underwater constructions. Elements of this kind are disclosed for instance in FR—A—2,255,803, FR—A—2,297,959 and FR—A—2,352,107, which comprise various forms of sandbag-like enclosures which are intended to be assembled together and filled with individual amounts of sand or concrete, so as to form dikes and underwater walls. These modular elements are complex to make and use, however, especially as they require separate filling and manipulation and they do not lend themselves readily to the provision of protective works of extensive size.

The flexible shutters of this invention overcome the difficulty of achieving substantial thickness, provide a practical and economic means of fabricating shutters of large area and facilitate the use of conventional concretes. They also incorporate in-built pressure relief and reinforcement.

According to the invention, a reinforced flexible shutter is provided, for location upon level or sloping ground in order to receive and retain a hydraulic settable filling composition introduced into the shutter and thereby control the form of finished concrete or other structure produced when the settable composition sets, wherein the flexible shutter comprises a textile construction which includes generally co-extensive upper and lower layers of flexible woven material which are connected together at their adjacent edges and define between them a fillable space into which the settable composition is introduced and is characterized in that a plurality of modular units are joined together so as to form the flexible shutter and each modular unit comprises a pair of layers of flexible woven material and includes a respective one of a pair of opposed regions connected to one of the ends of a tubular element, the edges of the

respective layers of the modular units being connected with those of adjacent modular units so as to form the respective co-extensive upper and lower layers of the flexible shutter connected together by the tubular elements, and in that at least some of the tubular elements are impervious to the settable composition and so prevent it from passing into them from the fillable space, whereby, as the shutter is filled in use, the upper and lower layers are prevented from separating, adjacent the tubular elements, by more than the lengths of the tubular elements, and those of the tubular elements which are impervious to the settable composition remain unfilled and so produce throughgoing drainage holes in the finished structure.

Depending upon the intended use of the shutter and the structure made from it, the properties and nature of the layers and the tubular elements can be arranged so that the settable composition occupies the space between the layers, except for the interiors of the tubular elements, or it occupies the space and also some of the interiors of the tubular elements. As will appear from the description further below, the tubular elements can serve as pockets which receive reinforcing or supporting members and reinforced structures of particularly useful properties can be made by putting such supporting members into the pockets and then filling the space across which the tubular elements extend and, if required, some of the reinforced pockets as well.

According to a preferred embodiment of the flexible shutter of the invention, all of the tubular elements are impervious to the settable composition, whereby a drainage hole is produced in the finished structure where each tubular element is located.

The flexible material used to form the layers or webs of the modular units which are assembled to make the shutter of the invention is preferably a woven textile structure of the properties appropriate to the reception and retention of liquid or plastic state settable compositions, such as concrete mixes. An example of a material suitable for forming the layers and, if desired, also for forming the tubular elements, is woven polypropylene fabric, which is excellently suited to the purpose, as it is strong and durable, it retains the concrete mix or other settable composition used to fill the space within the shutter, but allows water to pass through as the mix sets. It will be appreciated that as the tubular elements or at least some of them are made, like the layers or webs, of a material which holds back or retains a concrete mix or other settable composition, then as the composition is introduced between the main coextensive layers into the space it will progressively fill the space, but will not pass into and fill the interiors of the tubular elements impervious to the composition. The finished structure thus takes the form of an integral concrete or other slab with throughgoing holes. A particular feature of the shutter structures of this invention is that by utilizing such tubular elements as the interconnecting members between the respective layers, it is possible to provide drainage holes for the relief of hydrostatic pressure, which may build up behind the filled structure after installation. Another notable advantage is that the tubular elements can also serve as cylindrical pockets in which supporting and reinforcing members are placed. This feature of the invention can be employed whether or not some of the tubular elements are filled and some instead remain empty when the settable composition is introduced into the fillable space. Assembly of the fillable structure from a plurality of modular units simplifies and rationalises manufacture and facilitates quick production of the flexible structure at the intended point of use, to specific site dimensions.

The tubular elements cause the settable composition to assume the general shape of the interior of the flexible structure, though obviously the final shape of the resulting construction is determined by the behaviour of the component parts as they are brought together and as the composition fills the available space and sets. Generally speaking, the final structure conforms to the underlying ground, its upper surface is of broadly similar shape or, at least, area (i.e. it is generally coextensive with the lower surface), but the upper surface consists of a plurality of locally-domed regions where the upper layer allows the shutter to expand upwardly as the settable mix enters. Where the shutter is of the kind in which the settable mix will not pass through the material forming any of the tubular elements, the structure also includes a plurality of throughgoing holes produced by the tubular elements, which holes extend throughout the thickness of the final construction and serve to allow the aforementioned hydrostatic pressure relief to occur. This can apply only to some of the tubular elements, if so desired.

In addition to the reinforcement extending between the respective upper and lower coextensive layers of the shutter so as to join one layer to the other and control the shape of the filled structure eventually made with the mattress or shutter, the reinforcing shutter can itself be further reinforced internally, e.g. by means of reinforcing rods, bars, ties or like components. These desirably extend within the shutter and, most preferably, in two directions broadly parallel to the main layers of the shutter and mutually at right-angles. These reinforcing components can be positioned through the tubular elements, so that they can be carried by supporting members located in the pocket-like tubular elements, though other reinforcing components can also be supported from ones carried by the supporting members. Where the reinforcing members extend in two or more mutually-crossing directions, as is often pre-

ferred, they are desirably interconnected as the crossing points.

In order that the invention may be fully understood, preferred embodiments of it are described below in conjunction with the accompanying drawings, which are given by way of illustration. In the drawings:

Figure 1 shows the principle of construction of one unit of a modular flexible shutter;

Figure 2 shows a diagrammatic plan view of a plurality of the modular units of Figure 1 being assembled to form a fillable structure;

Figure 3 shows one form of supporting and reinforcing member in the tubular element of a flexible shutter of the invention;

Figure 4 shows another embodiment of a supporting and reinforcing member in a view similar to Figure 3;

Figure 5 shows diagrammatically in a part-elevational part-sectional view a reinforced flexible shutter after it has been placed upon the boundary of a region confining a body of water and has been filled and set;

Figure 6 shows a cross-section through a reinforced supporting mattress which protects the bed of a river or the sea and also carries a load, shown in Fig. 6 as a pipeline;

Figure 7 shows a cross-section through another form of reinforced mattress, which has transverse and axial reinforcement.

Figure 1 shows a modular unit comprising spaced first and second generally co-extensive layers 10 and 11, each including a circular or other region 12, the edges of the respective regions 12 being joined by a cylindrical or other tubular element 13. The module can be regarded as having a spool-shaped structure with square flanges, though in practice the webs 10 and 11 constituting these "flanges" can be square or rectangular or can have any other suitable shape, e.g. hexagonal. The module is shown in Figure 1 as having rectangular layers 10 and 11 which measure W units in one direction and X units in the other, the layers 10 and 11 are spaced Y units apart, which also is the length of the tubular element 13, whilst the latter is shown as a cylindrical tube having a diameter of Z units. The dimensions W, X, Y and Z are interrelated, as shown, but are variable to suit the size of the desired module and the corresponding dimensions of a fillable structure made by assembling many of them, in the manner shown in Figure 2. The layers 10, 11 are joined together in regular patchwork fashion and it will be clear that in practice difficulty would normally arise if shapes other than square or rectangular are used, though such other shapes are not excluded. It is also possible to assemble modules of the principle illustrated in Figure 1 with blank portions of the layers, if desired.

The regions 12 can be of the same construction as the rest of the layers 10, 11 or they can be of a different construction, e.g. being woven to have a more open mesh.

Figure 3 shows a cross-section through a module or the portion of a shutter containing a tubular element 13, where the latter is supported and reinforced by a member 14 in the form of a helical rod or wire. The supporting and reinforcing member 14 holds the tubular element 13 open and also retains the layers 10, 11 in their fully-spaced relationship. The supporting member 14 can be put into position in the tubular element 13 before, during or after assembly of the flexible components 10, 11 and 13 constituting the shutter *per se* or the shutter module. For instance, the member 14 can be located in the web portion used to make the tubular element 13, which is then attached at its ends to the layers 10 and 11. Another procedure is to attach the tubular element 13 to one of the layers 10, 11, insert the supporting member 14 into the pocket formed by the element 13 and then attach the latter to the other of the layers 10, 11. A further possibility is to assemble the flexible components and cut into or cut away the region 12 in the layer 10 or 11. This is satisfactory, especially in the case where the cut or removed parts are in the layer which is underneath, i.e. contacts the ground, when the shutter is installed. Yet another possibility is to install the supports 14 after the other components have been assembled, by passing the support 14 through the part forming the region 12 at one end of the tubular pocket. The helical form of the supporting member 14 is particularly suitable for this mode of assembly, as it can be wound through a hole made, say in the layer 10, provided with an eyelet, made as a small aperture in the layer, or even formed by spreading out the yarns it is woven from.

Another form of supporting and reinforcing member is shown at 15 in Figure 4. This member 15 takes the form of a portion of a flexible spun-bonded plastics sheet material, consisting therefore of a mass of interconnected filaments and so having a highly open structure, formed into a cylindrical shape which, when located in position in the tubular element 13 as shown, serves like the member 14 in Fig. 3 to hold the structure open. The cylinder can be made very simply by spirally rolling a long rectangular portion of the spun-bonded plastics sheet material.

In general, all the flexible materials used in forming the layers 10, 11 and the tubular elements 13 of the structure are at least partly porous. The settable compositions used to fill the structures, in one general embodiment of the invention, is prevented from penetrating through the walls of the tubular elements 13, though a degree of penetration may be desirable in some circumstances. In another general embodiment, some of the tubular elements allow the settable composition to pass into them so that the spaces inside these parts of the structure become filled.

In use, as illustrated in Figure 5, a flexible shutter of the invention, whether made from its

component parts or by the assembly of modular units, comprises a pair of generally co-extensive layers. One such layer is shown at 16 in Fig. 5 and the other at 17. At the edges of the blanket-like structure formed from the layers 16, 17, they are joined together, as indicated at 18, either by direct interconnection of the peripheries of the layers 16, 17 or by connection to an edge member of gusset form. At spaced locations, over the resulting mattress or blanket-like structure, opposed regions in the layers 16, 17 are joined by tubular elements 19. In practice, at least some of these and, generally, all of them will accommodate a supporting and reinforcing member 20, e.g. such as shown in Fig. 3 or in Fig. 4 or some other suitable structure.

As indicated in Fig. 5, the flexible shutter shown generally at 21, is used to protect the ground 22, e.g. a foreshore or bank, from the erosive effect of wave and other action of a body of water, shown at 23. The shutter 21 is laid upon the ground 22 over the entire area requiring protection. A liquid or plastic state settable composition, e.g. a pumpable concrete mix, is then introduced through access ports (not shown) in the periphery of the shutter 21 at a convenient location above the water level 24. The mix fills the entire space between the layers 16, 17 leaving the supported tubular elements 19 open. These can serve for receiving fixing members (not shown) for locating the shutter 21 in place, such fixing members being positioned through selected ones of the tubular elements 19 and being driven into the ground 22. The concrete mix expands the fillable space and sets to a concrete structure indicated at 25, whose underside conforms to the shape of the ground 22 and whose top side forms the actual interface with the water 23. Ground water in the ground 22 is allowed to drain into the water space and, unlike many prior art shutters, is not held back, causing difficulty, as it can find its way through the supported apertures defined by the tubular elements 19. A major disadvantage of many known flexible shutters, whereby water seepage tends to lift or undermine them, is thus eliminated or reduced to acceptable levels. The support provided by the steel helixes 14, coiled spun-bonded plastics sheets 15 or other members located in the tubes greatly rigidifies the structure and enables it to have a thickness greater than can be achieved with prior structures whilst using conventional concrete mixes. For example, the finished structure as shown in Fig. 5 can have a thickness well in excess of 300 mm, if required.

Referring to Fig. 6, this shows an embodiment in which the shutter is employed to support a pipeline 26 either over the ground or the sea-bed, indicated at 22. The shutter in this embodiment is made to have a length such that it can extend along the intended course of the pipeline 26 or at least those parts which are under water or where the terrain is swampy or otherwise difficult. The mattress made from the shutter has the great advantage of giving adequate support for the load represented by the pipeline 26 and its contents, by virtue of the way in which the shutter is constructed, which causes its internal reinforcing to support the top layer of fabric.

The mattress of Fig. 6, indicated generally at 28, can have a height to width ratio of as much as 1:3. The shutter from which it is made consists of a bottom layer 29 joined at intervals across its width to the bottom edges of upper layer components 30, each of which extends upwardly and inwardly so that its upper edge is joined to an intermediate part of the next inner component 30. The central component 30*a* upon which the pipeline 26 rests can be a large and integral strip as shown. Where each component 30 joins the next, rows of pockets or tubular elements 31 are provided and three rows of such tubular elements 31 are included in the central component 30*a*. These tubular elements 31 contain supports 32 of open structure, e.g. helical springs. Drainage holes are desirable, at least at some places in the pipeline supporting mattress 28, for instance so as to allow ground water to pass through the mattress 28, and these can be formed by constructing some of the tubular elements 31 so that they do not allow access to the filling mix, when the structure is being installed and filled.

Referring to Fig. 7, a mattress 33 consists of a lower layer 34 and a co-extensive upper layer 35 between which tubular elements 36 are joined. Each element 36 contains a supporting member 37 in the form of a spiral or helical spring or a wound spun-plastics component, as shown in Fig. 3 or Fig. 4 respectively. In the embodiment shown in Fig. 7, the concrete infilling 38 occupies the internal space of the shutter forming the mattress 33 except for the tubular elements 36. Additional internal reinforcement is provided, in the form of reinforcing wires, rods, ties or bars 39, which pass through the mattress 33 approximately in its mid-plane, preferably by passing through and being joined to the associated transverse rows of supporting members 37. Further reinforcing wires, rods, ties or bars 40 run longitudinally of the mattress 33. As shown, these are also approximately in the mid-plane of the mattress 33 and run, as shown for the reinforcing members 40a, through the longitudinal rows of the supporting members 37 and, as shown for the reinforcing members 40*b*, between such rows. A mesh-like or grid-like assembly of transverse and longitudinal reinforcing bars or other reinforcing members 40 is thus given. The members 40 are preferably joined together at their crossing points, as indicated at 41, for additional strength.

The detailed construction of the shutter and therefore of the mattress structure made from it, in accordance with this invention, depends to a large extent upon the nature and type of situa-

tion where reinforcement of the ground is required. It has been found, for instance, that less supporting members are usually sufficient, in a mattress of given construction, when it is to be used on level ground, as compared with inclined ground, e.g. a natural or artificial bank or foreshore.

The invention thus provides a relatively simple structural principle for flexible shutters, which provides a solution to all the main problems inherent in conventional practice.

Claims

1. A reinforced flexible shutter for location upon level or sloping ground in order to receive and retain a hydraulic settable filling composition introduced into the shutter and thereby control the form of finished concrete or other structure produced when the settable composition sets, wherein the flexible shutter (21, 28) comprises a textile construction which includes generally co-extensive upper and lower layers (16, 30, 35; 17, 29, 34) of flexible woven material which are connected together at their adjacent edges (18) and define between them a fillable space into which the settable composition is introduced, characterised in that a plurality of modular units are joined together so as to form the flexible shutter (21, 28) and each modular unit comprises a pair of layers (10, 11) of flexible woven material and includes a respective one of a pair of opposed regions (12) connected to one of the ends of a tubular element (13), the edges of the respective layers of the modular units being connected with those of adjacent modular units so as to form the respective co-extensive upper and lower layers (16, 30, 35; 17, 29, 34) of the flexible shutter (21, 28) connected together by the tubular elements (13, 19, 31, 36), and in that at least some of the tubular elements (13, 19, 31, 36) are impervious to the settable composition and so prevent it from passing into them from the fillable space, whereby, as the shutter (21, 28) is filled in use, the upper (16, 30, 35) and lower (17, 29, 34) layers are prevented from separating, adjacent the tubular elements (13, 19, 31, 36), by more than the lengths of the tubular elements, and those of the tubular elements (13, 19, 31, 36) which are impervious to the settable composition remain unfilled and so produce throughgoing drainage holes in the finished structure.

2. A shutter according to claim 1, wherein all of the tubular elements (13, 19, 31, 36) are impervious to the settable composition, whereby a drainage hole is produced in the finished structure where each tubular element is located.

3. A shutter according to claim 1 or 2, wherein supporting members (14, 15, 20, 32, 37) are located in at least some of the tubular elements (13, 19, 31, 36), so as to hold open the tubular elements containing them.

4. A shutter according to claim 3, wherein the supporting members comprise helical rods or wires (14, 32).

5. A shutter according to claim 3, wherein the supporting members comprise spirally-rolled sheets of flexible spun-bonded plastics material (15, 37).

Patentansprüche

1. Verstärkte biegsame Hülle zur Plazierung auf ebenem oder abfallendem Boden zur Aufnahme und Zurückhaltung einer hydraulisch abbindbaren Füllmasse, die in die Hülle eingeführt wird, so daß die Form einer fertigen, aus Beton oder einem anderen Material bestehenden Struktur beim Abbinden der Füllmasse beeinflußt werden kann, wobei die biegsame Hülle (21, 28) aus einer gewebten Ausführung besteht sowie obere und untere, jeweils eine gleiche Erstreckung aufweisende Schichten (16, 30, 35; 17, 29, 34) aus biegsamem gewebten Material einschließt, die an ihren angrenzenden Umrandungen (18) miteinander verbunden sind und dazwischen einen füllbaren Raum definieren, in welchen die abbindbare Masse eingeführt wird, dadurch gekennzeichnet, daß eine Vielzahl von Modulelementen zur Bildung der biegsamen Hülle (21, 28) miteinander verbunden sind, daß jedes Modulelement ein Paar Schichten (10, 11) aus biegsamen gewebten Material aufweist, wobei jeweils ein Paar einander gegenüberstehender Flächen (12) der Schichten (10, 11) mit den Enden eines röhrenartigen Elementes (13) verbunden sind, daß die Umrandungen der jeweiligen Schichten der Modulelemente mit denjenigen benachbarter Modulelemente zur Bildung der betreffenden (oberen) und (unteren) jeweils eine gleiche Erstreckung aufweisenden Schichten (16, 30, 35; 17, 29, 34) der biegsamen Hülle (21, 28) durch die röhrenförmigen Elemente (13, 19, 31, 36) miteinander verbunden sind, daß wenigstens einige der röhrenförmigen Elemente (13, 19, 31, 36) für die abbindbare Masse undurchlässig sind und verhindern, daß diese aus dem füllbaren Raum heraus—und in diese röhrenförmigen Elemente (13, 19, 31, 36) hineintritt, so daß beim Füllen der Hülle (21, 28) die oberen (16, 30, 35) und unteren (17, 29, 34) Schichten in der Umgebung der röhrenförmigen Elemente (13, 19, 31, 36) daran gehindert werden, sich voneinander um mehr als die Länge der röhrenförmigen Elemente (13, 19, 31, 36) zu entfernen, und die röhrenförmigen Elemente (13, 19, 31, 36), die für die abbindbare Masse undurchlässig sind, ungefüllt bleiben und für die fertige Struktur durchgehende Abflußöffnungen bilden.

2. Hülle nach Anspruch 1, dadurch gekennzeichnet, daß alle röhrenförmigen Elemente (13, 19, 31, 36) für die abbindbare Masse undurchlässig sind, so daß am Ort eines jeden röhrenförmigen Elementes (13, 19, 31, 36) eine Abflußöffnung besteht.

3. Hülle nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß in wenigstens einigen der röhrenförmigen Elemente (13, 19, 31, 36) Unterstützungsglieder (14, 15, 20, 32, 37) angeordnet sind, damit die diese enthaltenden röhrenförmigen Elemente offengehalten werden.

4. Hülle nach Anspruch 3, dadurch gekennzeichnet, daß die Unterstützungsglieder schraubenförmig gewundene Stangen oder Drähte (14, 32) sind.

5. Hülle nach Anspruch 3, dadurch gekennzeichnet, daß die Unterstützungsglieder spiralförmig aufgerollte Lagen von biegsamen Faservliesstoff (15, 37) umfassen.

Revendications

1. Un coffrage flexible renforcé à mettre en place sur un sol de niveau ou en pente, destiné à recevoir et à retenir une composition de remplissage durcissable par voie hydraulique et introduite dans le coffrage et à régler ainsi la forme d'une structure de béton ou autre finie qui est produite lorsque la composition durcissable durcit, le coffrage flexible (21, 28) comprenant une construction textile qui comprend des couches supérieure et inférieure généralement de même étendue (16, 30, 35; 17, 29, 34) en matière tissée flexible qui sont mutuellement reliées à leurs bords adjacents (18) et forment entre elles un espace remplissage dans lequel la composition durcissable est introduite, caractérisé en ce qu'un grand nombre d'unités modulaires sont réunies de façon à former le coffrage flexible (21, 28), en ce que chaque unité modulaire comprend une paire de couches (10, 11) en matière tissée flexible et présente une paire de régions opposées (12) dont chacune est reliée à une des extrémités d'un élément tubulaire (13), les bords des couches respectives des unités modulaires étant reliés à ceux des unités modulaires adjacentes de façon à former les couches supérieure et inférieure respectives de même étendue (16, 30, 35; 17, 29, 34) du coffrage flexible (21, 28), mutuellement reliées par les éléments tubulaires (13, 19, 31, 36), et en ce qu'au moins certains de éléments tubulaires (13, 19, 31, 36) sont imperméables à la composition durcissable et empêchent ainsi celle-ci de passer dans leur intérieur à partir de l'espace remplissable, les couches supérieure (16, 30, 35) et inférieure (17, 29, 34) étant, lorsque le coffrage (21, 28) est rempli, empêchées de se séparer, à proximité des éléments tubulaires (13, 19, 31, 36), d'une distance plus grande que la longueur des éléments tubulaires, ceux des éléments tubulaires (13, 19, 31, 36) qui sont imperméables à la composition durcissable restant non remplis et produisant ainsi des trous de passage pour le drainage dans la structure finie.

2. Coffrage suivant la revendication 1, caractérisé en ce que tous les éléments tubulaires (13, 19, 31, 36) sont imperméables à la composition durcissable, un trou de drainage étant produit dans la structure finie là où chaque élément tubulaire est situé.

3. Coffrage suivant l'une des revendications 1 et 2, caractérisé en ce que des éléments de support (14, 15, 20, 32, 37) sont situés dans au moins certains des éléments tubulaires (13, 19, 31, 36), de façon à maintenir ouverts les éléments tubulaires qui les contiennent.

4. Coffrage suivant la revendication 3, caractérisé en ce que les éléments de support comprennent des tiges ou fils métalliques hélicoïdaux (14, 32).

5. Coffrage suivant la revendication 3, caractérisé en ce que les éléments de support comprennent des feuilles enroulées en spirale en une matière plastique flexible en forme de nappe de fibres (15, 37).

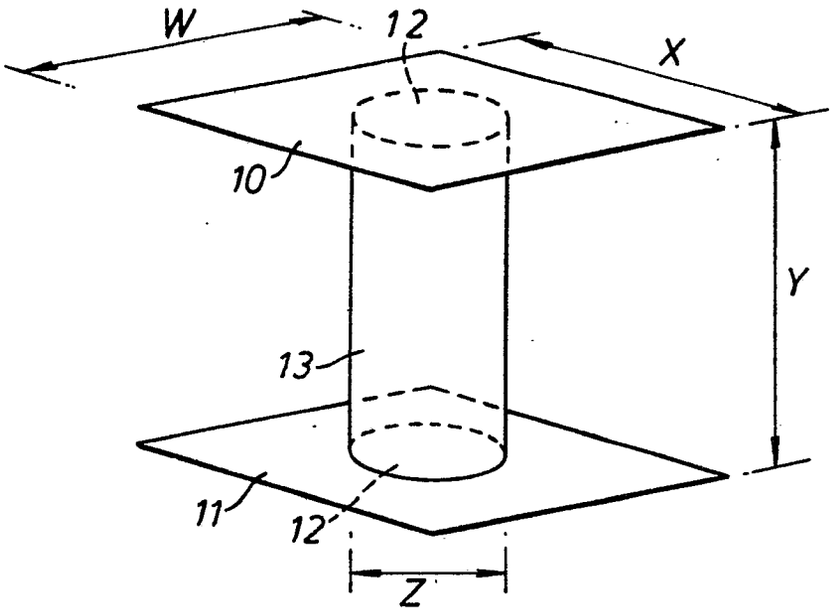

FIG. 1

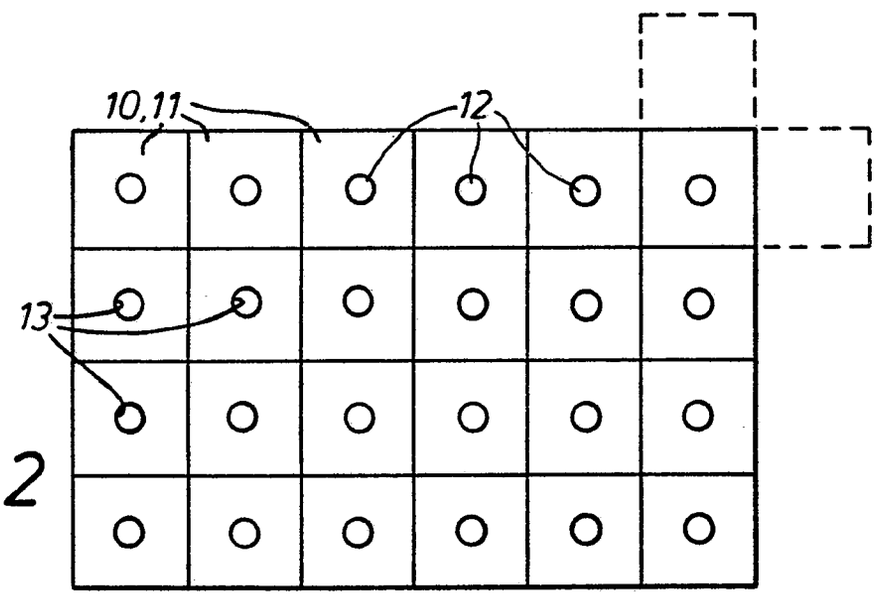

FIG. 2

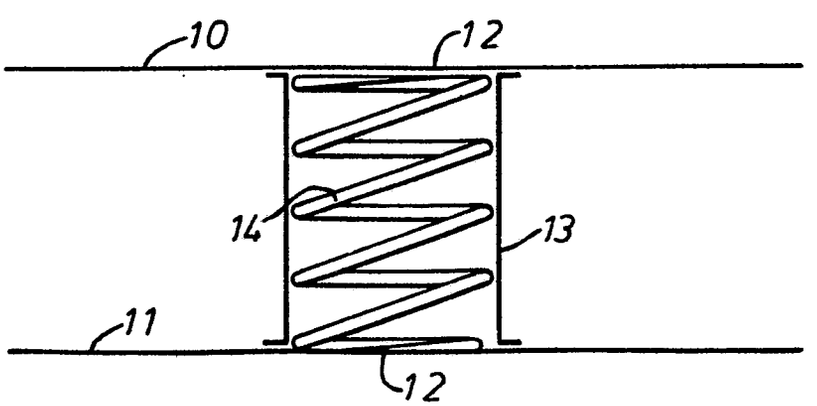

FIG. 3

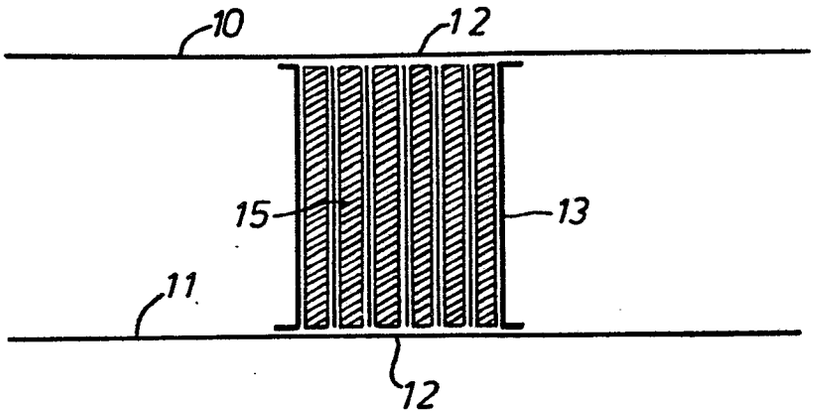

FIG. 4

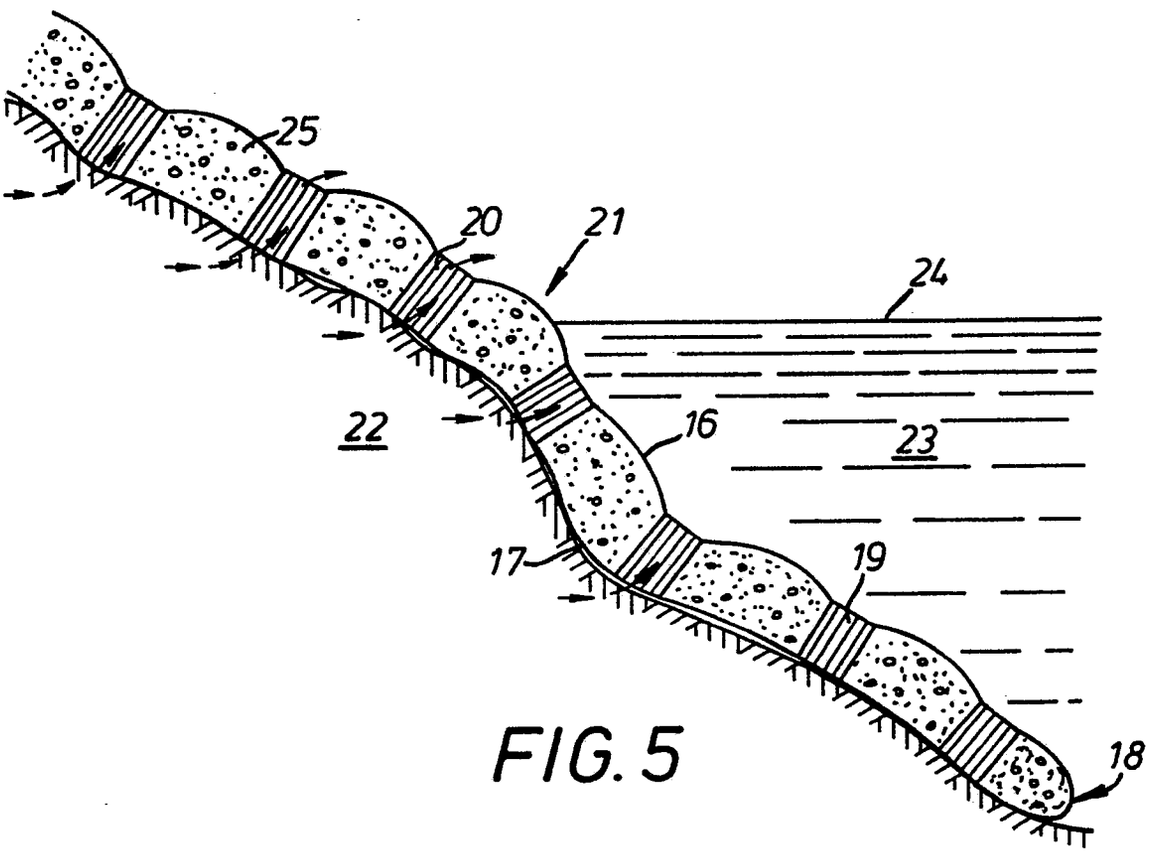

FIG. 5

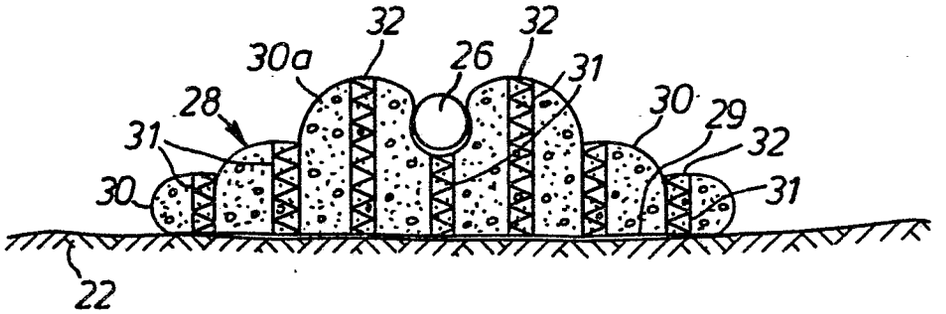
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FIG. 6

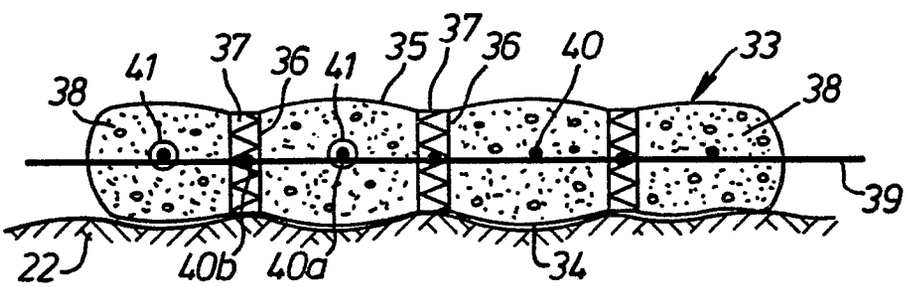
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FIG. 7