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(71) Applicant: **Cidieffe S.r.l.**
20149 Milano (IT)

(72) Inventor: **CERUTTI, Cesare**
20122 Milano (IT)

(74) Representative: **Robba, Pierpaolo et al**
INTERPATENT S.R.L.,
Via Caboto No.35
10129 Torino (IT)

Remarks:
Amended claims in accordance with Rule 86 (2) EPC.

(54) A multilayer sealing mat

(57) A composite sealing mat comprising a substrate supporting layer (2), a cover layer (4), joined to the former through a needling technique, and an interlayer of a swellable material (3), particularly bentonite, between said two layers, characterised in that at least one of said supporting (2) and cover (4) layers consists - at least partially - of a biodegradable material. A further swellable layer (33) can be provided for between said substrate supporting layer (2) and said auxiliary layer (5).

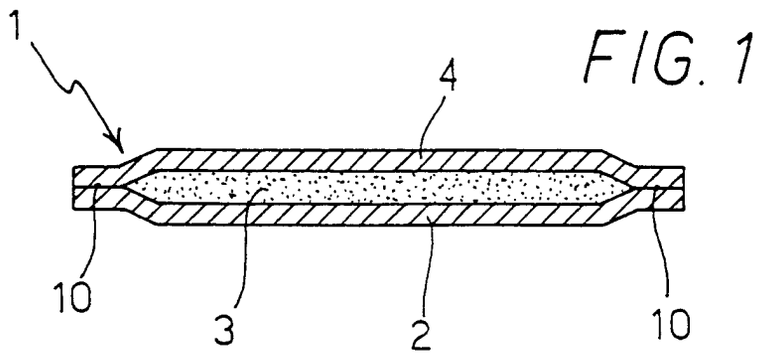

FIG. 1

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Description

[0001] The present invention relates to an article in form of mat, and more precisely to a multilayer mat particularly adapted for making impermeable soil surfaces forming both the bottom flat surfaces and the sloping surfaces of waste dumps, storage basins, irrigation channels, building foundations and other works.

[0002] At present, the impermeabilization of structures laid underground and subjected to chemical attack of the water table such as foundations, underground parking, tunnels, subways, underground railways, containment walls and so on has been accomplished with sealing mats incorporating bentonite between two supporting layers of woven and/or non-woven fabrics: these fabrics having only the purpose of withstanding mechanical stresses and/or chemical attacks, as disclosed for example by EP 0 278 419.

[0003] Among the swellable materials, the use is known of geocomposite sealing mats based on sodium-activated bentonite with excellent properties of impermeabilization and mechanical strength. Upon contact with water or ground moisture, the natural sodium bentonite is hydrated and becomes an impermeable gel which can expand more than 16 times its initial volume and increase its weight up 5 times while remaining in a gel condition.

[0004] However in many applications the known bentonite sealing mats do not satisfactorily bind or stick to the materials with which they are in contact. For instance, in the case of cement structures, an adhesion of the cement to the swellable material is strongly required to prevent the forming of channels along which liquids could flow since the cover layer is degradable and would allow the swellable material to expand into the cement unevenness.

[0005] Therefore, it is an object of the present invention to overcome the prior art drawbacks and limitations and more precisely to provide a structure containing bentonite and which actively interfaces with the materials with which it comes into contact.

[0006] These objects are achieved through the present invention which consists of a multilayer sealing mat as claimed in claim 1. Further advantageous features are recited in the appended claims.

In accordance with the present invention there is used a combination of supporting and containment materials, incorporating at least one layer of a swellable material, in which at least some of the layers are to be implemented, at least partially, through (bio)degradable materials.

[0007] The present invention will be disclosed hereinbelow with reference to the attached drawings that illustrate nonlimiting embodiments thereof, in which:

Fig. 1 is a schematic cross-section view which illustrates the structure of an impermeable sealing mat according to the invention;

Figs. 2, 3 and 4 show rolls of sealing mat according to the invention in three different configurations thereof;

Fig. 5 illustrates a process for manufacturing a sealing mat according to the present invention; and

Fig. 6 illustrates a process for manufacturing a sealing mat according to the present invention and comprising five layers.

[0008] Throughout all the Figures, similar or substantially equivalent parts have been designated by the same references.

[0009] With reference to Fig. 1, a sealing mat 1 according to the present invention comprises a substrate layer 2, an interlayer 3 of a material capable to swell, particularly in form of granules, and a cover layer 4. Layers 2, 3 and 4 are joined together by needling techniques which form "stitched" portions designated by reference 10.

[0010] Preferably, the supporting substrate layer 2 is made of a needled non-woven fabric consisting of synthetic fibers, such as for example polypropylene and/or polyester and/or polythene and/or polyamide.

[0011] The swellable intermediate layer 3 preferably comprises clay or bentonite (in form of granular or powdery bentonite with high swelling capacity).

[0012] The cover layer 4 consists of a biodegradable material selected among papers, corrugated paperboards and water-soluble films, non-woven fabrics of natural or synthetic degradable fibers.

[0013] According to an alternate embodiment of the invention, also the cover layer 2 can be of a biodegradable material.

[0014] Advantageously, the biodegradable cover layer 4 is positioned in contact with the soil or the slab to be protected. After coming in contact with water, this layer is degraded and dissolved thus allowing to the bentonite or other swellable material of the interlayer 3 to lie down and fill in the existing hollows and interstices, and the bentonite (or in general the swellable material) thus made free from the containment supporting layer quickly expands and effectively seals the bottom.

[0015] In the embodiment illustrated in Fig. 2, the mat is obtained in form of a material roll with a peripheral needling closing the swellable material laterally and at the mat ends. More precisely, the peripheral edges of the mat strips are closed by a sewing 10 of the selvages obtained through a needling technique. This needling prevents the powdery or granular bentonite from dispersing during the mat handling so as to ensure its integrity when it is laid down. This closing sewing is obtained by needling the strips of the layers 2 and 4 only (and of layers 5 and 2 and 4 only in the below illustrated other embodiment of the invention) without the presence of bentonite between them. The dimensions of the needled strips range from 5 to 500 mm. A transversal

sewing 11 is further realised at the beginning and at the end of the mat roll in order to obtain a complete containment of the swellable material within the mat.

[0016] Advantageously, as illustrated in Figs. 3 and 4 other strips joined through needling are (or can be) provided for, in particular the longitudinal stitchings indicated by 12 and transversal stitchings indicated by 13. This way composite or multilayer sealing mats are obtained with generally rectangular adjacent elements, where the swellable material 3 can not go out laterally. The sealing mats can be for example in the form of square pieces having sizes comprised between cm 60 x 60 and 150 x 150, even with a rectangular shape, or respectively as rolled or lapped strips in containers with sizes between cm 5 and cm 30.

[0017] In such a way, a generally improved containment of the swellable material is ensured, particularly when the sealing mat is being cut for laying.

[0018] Fig. 5 schematically illustrates the manufacturing of a sealing mat which comprises a roll 22 of a substrate supporting material 2, a roll 24 of a cover material 4, and a dispenser 23 of a swellable material 3. The rolls of materials 2 and 4 are properly supported above the production line and are unwound through a non-illustrated pulling device. The material 3 is deposited by gravity and with an appropriate or desired distribution onto the advancing strip 2, and later on the so formed sandwich passes through a needle loom 8 with one or more tables for joining the layers according to the configurations illustrated in the Figs. 2-4 or according to others configurations.

[0019] According to a further embodiment of the invention, the sealing mat can provide for a further outer auxiliary layer 5 of non-woven fabric or biodegradable material selected among papers, corrugated paperboards and water-soluble films, non-woven fabrics of natural or synthetic degradable fibers, with a layer 33 of bentonite or other swellable material placed between this auxiliary layer 5 and the substrate supporting layer 2. This auxiliary (bottom) section formed by layers 5, 33 and 2 forms an additional sealing layer to ensure a proper proofing in the most critical situations, particularly where the sealing mat can be "attacked" by water on both the its faces.

[0020] Fig. 6 schematically illustrates the arrangement for manufacturing such sealing mat equipped with an auxiliary layer, that comprises a roll 25 of the auxiliary material 5, a roll 22 of a substrate supporting material 2, a roll 24 of a cover material 4, and two dispensers 21 and 23 of swellable materials 33 and 3 which can be also different from one another, or can be deposited with different modalities for each layer.

[0021] Although the invention has been illustrated with reference to preferred embodiments thereof, it is generally subjected to other applications and modifications which fall within the scope of the invention as will result evident to the skilled of the art.

Claims

1. A multiplayer sealing mat (1) comprising: a substrate supporting layer (2), a cover layer (4) joined to the former, and an interlayer of a swellable material (3) disposed between said two layer (2, 4) **characterised in that** said two layers (2, 4) are joined to each other along stitched portions (10) by needling together said substrate (2) and supporting (2) and cover (4) layers is of an at least partially biodegradable material.

2. A multiplayer sealing mat according to claim 1, **characterised in that** said biodegradable layer is said cover layer (4).

3. A multiplayer sealing mat according to claims 1 or 2, **characterised in that** said interlayer of swellable material (3) comprises granular or powdery bentonite.

4. A multiplayer sealing mat according to the preceding claims, **characterised in that** said substrate supporting layer (2) comprises a non-woven needled fabric made of synthetic fibers.

5. A multiplayer sealing mat according to the preceding claims, **characterised in that** said cover layer (4) comprises a biodegradable material selected among papers, corrugated paperboards, water-soluble films, non-woven fabrics of natural or synthetic degradable fibers.

6. A multiplayer sealing mat according to the preceding claims, **characterised in that** it comprises a further auxiliary outer layer (5) consisting of non-woven fabrics or biodegradable material selected among papers, corrugated paperboards, water-soluble films, non-woven fabrics of natural or synthetic degradable fibers, with a further layer (33) of swellable material or bentonite being placed between said auxiliary (5) and supporting (4) layers.

7. A multiplayer sealing mat according to the preceding claims, **characterised in that** said needling comprises sewings (10) of the selvages for preventing the dispersion of the powdery or granular bentonite (3, 33) during handling.

8. A multiplayer sealing mat according to claim 7, **characterised in that** it is formed as generally rectangular adjacent elements obtained through longitudinal (10, 12) and transversal sewings (11) whereby the swellable material (3) can not escape laterally.

Amended claims in accordance with Rule 86(2) EPC.

1. A multilayer sealing mat (1) comprising: a substrate supporting layer (2), a cover layer (4), joined to the former through a needling process, and an interlayer of a swellable material (3) disposed between said two layers (2, 4), **characterised in that** at least one of said supporting (2) and cover (4) layers is of an at least partially biodegradable material.

2. A multilayer sealing mat according to claim 1, **characterised in that** said biodegradable layer is said cover layer (4).

3. A multilayer sealing mat according to claims 1 or 2, **characterised in that** said interlayer of swellable material (3) comprises granular or powdery bentonite.

4. A multilayer sealing mat according to the preceding claims, **characterised in that** said substrate supporting layer (2) comprises a non-woven needled fabric made of synthetic fibers.

5. A multilayer sealing mat according to the preceding claims, **characterised in that** said cover layer (4) comprises a biodegradable material selected among papers, corrugated paperboards, water-soluble films, non-woven fabrics of natural or synthetic degradable fibers.

6. A multilayer sealing mat according to the preceding claims, **characterised in that** it comprises a further auxiliary outer layer (5) consisting of non-woven fabric or biodegradable material selected among papers, corrugated paperboards, water-soluble films, non-woven fabrics of natural or synthetic degradable fibers, with a further layer (33) of swellable material or bentonite being placed between said auxiliary (5) and supporting (4) layers.

7. A multilayer sealing mat according to the preceding claims, **characterised in that** said needling comprises sewings (10) of the selvages for preventing the dispersion of the powdery or granular bentonite (3, 33) during handling.

8. A multilayer sealing mat according to claim 7, **characterised in that** it is formed as generally rectangular adjacent elements obtained through longitudinal (10, 12) and transversal sewings (11) whereby the swellable material (3) can not escape laterally.

FIG. 1

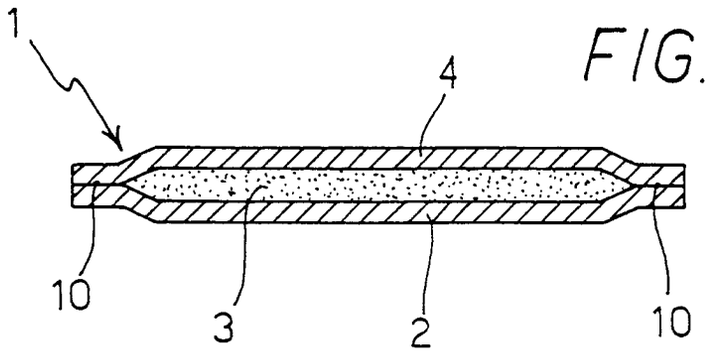


FIG. 2

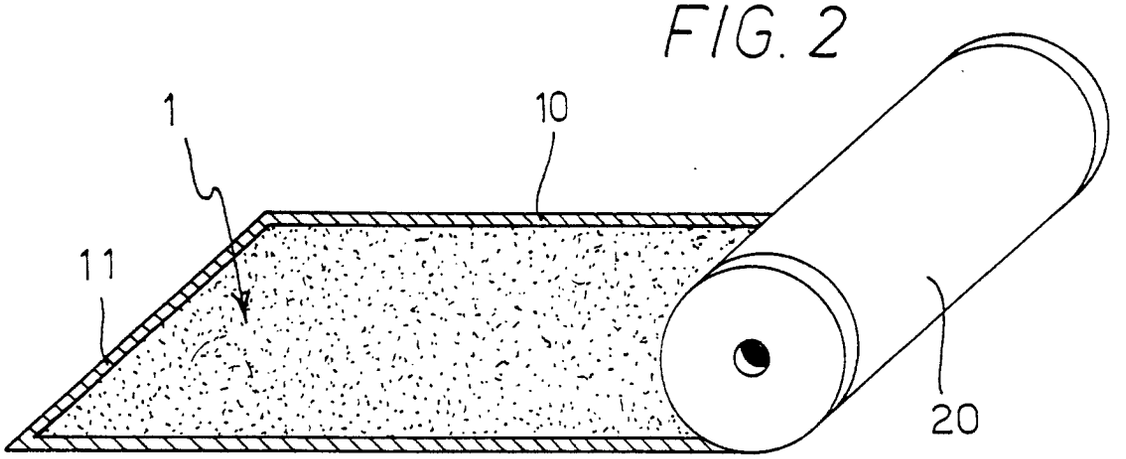


FIG. 3

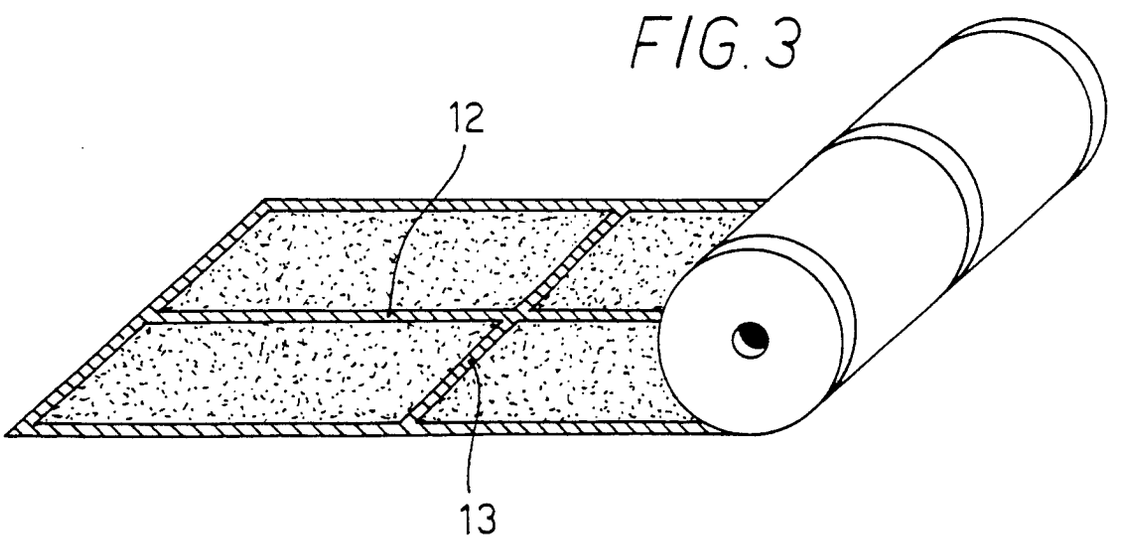


FIG. 4

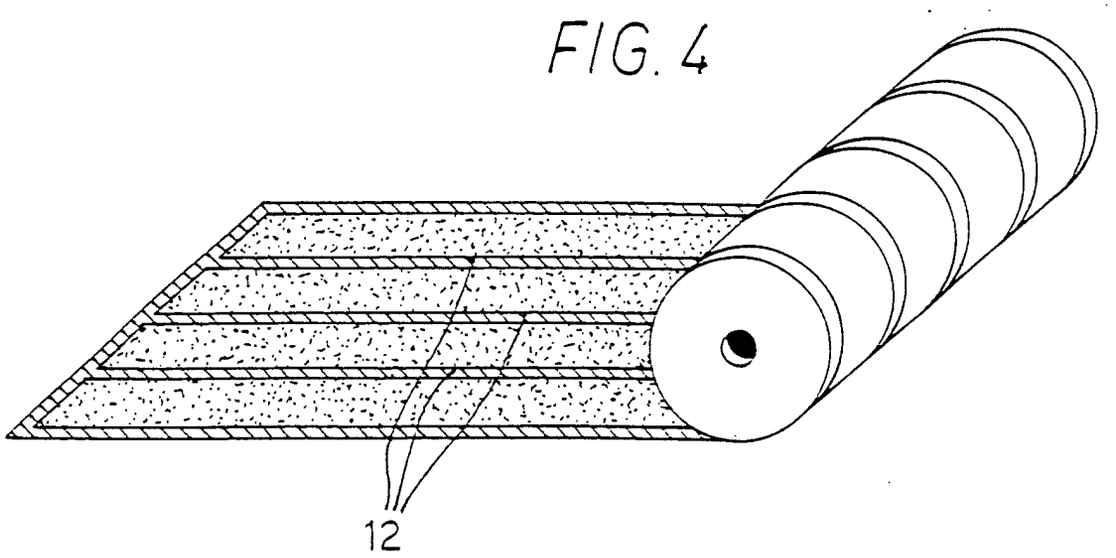


FIG. 5

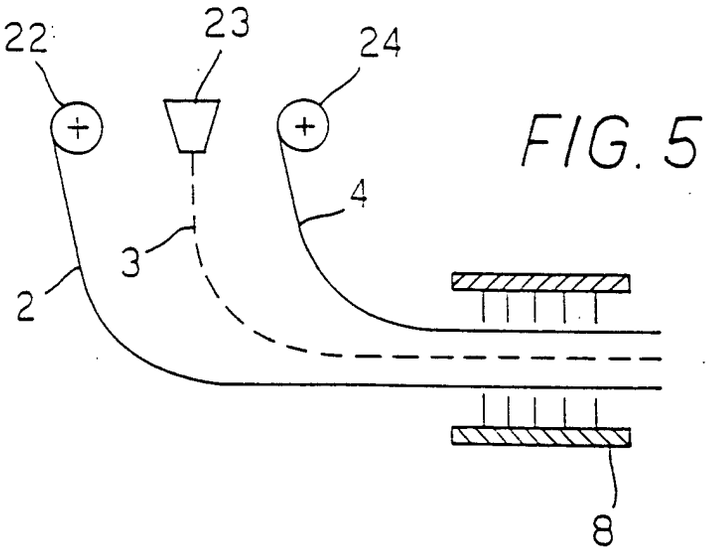
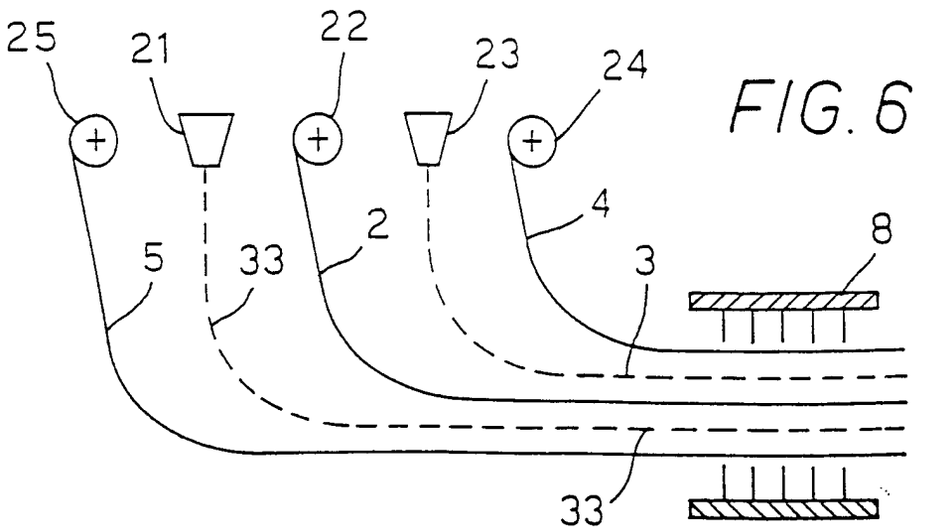


FIG. 6



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EUROPEAN SEARCH REPORT

Application Number
EP 02 42 5614

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	4 March 2003	Geiger, H

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