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(54) **Concrete block system**

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Système de bloc en béton

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(56) References cited:
GB-A- 2 291 079
US-A- 4 478 021
US-A- 5 688 078
US-A- 5 788 423

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to concrete blocks, in particular those with a natural stone appearance, that may be used in walls, columns, steps and other types of structures.

BACKGROUND

[0002] Concrete blocks intended to serve as wall blocks (e.g., retaining wall blocks), column blocks, step blocks or other types of structural blocks are sometimes provided with a natural stone appearance over an exposed portion thereof. Such concrete blocks can then be assembled into walls, columns, steps or other structures that have a natural and aesthetic look.

[0003] While various configurations, sizes and looks exist, these concrete blocks are conventionally monolithic elements made of various types of concrete. This monolithic character often detrimentally affects versatility of existing concrete blocks and their capability to accommodate design constraints of structures to be constructed.

[0004] Also, depending on their constituent concrete, concrete blocks can be broadly divided into dry-cast concrete blocks and wet-cast concrete blocks. Different processes are used to manufacture these two types of concrete blocks and, in particular, to provide them with a natural stone appearance.

[0005] Wet-cast concrete blocks may have a natural stone appearance realized directly during casting, but relatively long production times and requirements for numerous molds typically render impractical their efficient mass-production. For their part, dry-cast concrete blocks normally have relatively short production times and require only one or a few molds, which facilitates their mass-production. However, these relatively short production times impose constraints on a degree of surface irregularity that may be imparted to dry-cast concrete blocks during casting, thereby preventing realization of a natural stone appearance during casting. Dry-cast concrete blocks are thus typically subjected after casting to a mechanical artificial aging/weathering process (e.g., tumbling, splitting/breaking, object impacting, etc.) to realize desired natural stone characteristics, which decreases production efficiency.

[0006] U.S. Patent 5,788,423 describes an architectural retaining wall made up of block units each having a masonry block that supports a decorative facing panel. While the masonry block can be made of low-cost concrete material, the decorative facing panel is made of more expensive material such as marble, granite, metal, glass, etc., thereby allowing the retaining wall to match or otherwise compliment an adjacent building or walkway material in a relatively inexpensive manner. Each of the decorative facing panels is coupled to only one masonry block.

[0007] U.S. Patent 5,688,078 describes a retaining wall system made of successive layers several interconnected I-shaped subassemblies, each subassembly having a face block, trunk block and tail block. Each of face blocks is coupled to only one trunk block.

[0008] However, each of the face blocks of these patents does not comprise a cast texture with a natural stone appearance and the stability of such face block can be improved.

SUMMARY OF THE INVENTION

[0009] There is therefore a need of improving the natural appearance and stability of the concrete blocks for retaining walls by providing a dry-cast face block comprising a portion having a cast texture with a natural stone appearance and wherein the dry-cast face block is coupled to a first support block via a first protrusion fitting into and being surrounded by a first groove and to a second support block via a second protrusion fitting into and being surrounded by said second groove. The support blocks are adapted to be embedded in material to be retained by the retaining wall.

[0010] As embodied and broadly described herein, the invention provides a plurality of concrete blocks for use in a retaining wall as defined in claim 1.

[0011] These and other aspects and features of the invention will now become apparent to those of ordinary skill in the art upon review of the following description of embodiments of the invention in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A detailed description of embodiments of the invention is provided below, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a wall portion comprising a plurality of concrete block systems for use in a retaining wall;

Figure 2 shows a side view of part of the wall portion shown in Figure 1;

Figure 3 shows a cross-sectional view of part of the wall portion shown in Figure 2;

Figure 4 shows a perspective view of a given concrete block system of the wall portion shown in Figure 1, comprising a face block and a support block;

Figure 5 shows a cross-sectional view of the face block of Figure 4, illustrating a cast texture of a surface portion of the face block that has a natural stone appearance;

Figure 6 illustrates a cross-sectional view of an em-

bodiment where a surface portion of a face block that has a natural stone appearance is contiguous to a chamfered, rounded or otherwise non-natural looking edge portion of the face block;

Figure 7 illustrates a cross-sectional view of an embodiment in which a minimum level of a surface portion of a face block that has a natural stone appearance is not located at a boundary of that surface portion; and

Figures 8A and 8B show embodiments in which a face block comprises a plurality of surface portions with a cast texture that has a natural stone appearance; and

Figures 9A and 9B respectively show a side view and a top view of the support block of Figure 4;

Figure 10 shows an embodiment in which a wall portion comprises support blocks that are connected in series;

Figures 11A to 11C respectively show a perspective view, a side view and a top view of a support block in accordance with another embodiment;

Figure 12 shows an embodiment in which a wall portion has a nonzero setback angle, illustrating use of alignment keys;

Figures 13A to 13C respectively show a side view, a front view and a top view of an embodiment of one of the alignment keys of Figure 12; and

Figure 14 is a flowchart illustrating an example of implementation of a process for manufacturing face blocks in accordance with an embodiment of the invention.

[0013] It is to be expressly understood that the description and drawings are only for the purpose of illustrating certain embodiments of the invention and are an aid for understanding. They are not intended to be a definition of the limits of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0014] Figures 1 to 3 show a wall portion 10 comprising a plurality of concrete block systems 12_1... 12_N for use in a retaining wall where the wall portion 10 is part of the retaining wall that holds back material 11 such as soil, drainage aggregate, etc. The concrete block systems 12_1...12_N can thus be referred to as retaining wall block systems.

[0015] With additional reference to Figure 4, there is shown a given concrete block system 12_j of the concrete block systems 12, ...12_N ($1 \leq j \leq N$). In this embodiment, the concrete block system 12_j comprises a face block 13 adapted to be coupled to a support block 15.

[0016] The face block 13 is intended to be at least partly exposed when the concrete block system 12_j is positioned in the wall portion 10, i.e., the face block 13 has a surface adapted to be exposed when the face block 13 is coupled to the support block 15. In this embodiment, the face block 13 is a dry-cast concrete block, i.e., it is made of no-slump concrete. No-slump concrete (also known as zero-slump concrete) can be viewed as concrete with a slump of 6 mm or less. It will be appreciated that various types of no-slump concrete are possible and may be used. It will also be appreciated that, in other embodiments, the face block 13 may be made of other types of concrete (e.g., measurable-slump concrete).

[0017] In this embodiment, the face block 13 can be said to have a generally rectangular prism configuration with six surfaces 14_1...14_6. In other embodiments, the face block 13 may have any desired configuration with any desired number of surfaces.

[0018] The surface 14_1 is intended to be exposed when the concrete block system 12_j, including the face block 13, is positioned in the wall portion 10. In this embodiment, at least a portion 16 of the surface 14_1 has a cast texture having a natural stone appearance, i.e., an aged, worn, or weathered appearance that resembles natural stone. As described later on, the cast texture of the portion 16 of the surface 14_1 is realized during casting of the face block 13 and may be based on a natural stone's surface which has been used to produce a mold for casting the face block 13. For ease of reference, the portion 16 of the surface 14_1 and its cast texture with a natural stone appearance will hereinafter be referred to as the "natural stone-like surface portion" 16.

[0019] Referring to Figures 4 and 5, the natural stone-like surface portion 16 has a visually discernible boundary 22. In this embodiment, the natural stone-like surface portion 16 substantially corresponds to the entire surface 14_1 with its boundary 22 substantially corresponding to edges of the surface 14_1. In other embodiments, the natural stone-like surface portion 16 may be only a limited portion of the surface 14_1 (i.e., not all of that surface). In yet other embodiments, the natural stone-like surface portion 16 may be one of a plurality of natural stone-like surface portions of the surface 14_1. For example, Figures 8A and 8B show embodiments in which are provided a plurality of natural stone-like surface portions 16_1...16_Q separated by a surface portion 80 that does not have a natural stone appearance and can serve as a false joint (where Q = 2 in Figure 8A and Q = 4 in Figures 8B). Generally, any number of natural stone-like surface portions may be provided. Such a plurality of natural stone-like surface portions 16_1...16_Q results in a wall portion seeming to include several blocks of various sizes and configurations. Also, as shown in Figure 6, in embodiments where the natural stone-like surface portion 16 is contiguous to a chamfered, rounded, or otherwise non-natural stone looking edge portion 28 of the face block

13 (e.g., an edge portion serving as a joint), the boundary 22 of the natural stone-like surface portion 16 is considered to be configured such that the chamfered, rounded or otherwise non-natural stone looking edge portion 28 is not part of the natural stone-like surface portion 16.

[0020] Continuing with Figures 4 and 5, in this embodiment, the natural stone-like surface portion 16 comprises a pattern of cast relief elements $18_1...18_M$ formed during casting of the face block 13. This pattern of cast relief elements $18_1...18_M$ may include a plurality of bumps or peaks and a plurality of valleys or depressions, which are sized so as to be visually distinguishable when the concrete block system 12_j, including the face block 13, is positioned in the wall portion 10. It is to be understood that various other patterns of cast relief elements are possible. For example, the natural stone-like surface portions $16_1...16_Q$ in Figures 8A and 8B illustrate various other examples of possible patterns of cast relief elements.

[0021] The cast texture of the natural stone-like surface portion 16 defines a "surface level difference" ΔL, which refers to the normal distance between a maximum level L_{max} of that surface portion and a minimum level L_{min} of that surface portion. As shown in Figure 5, the face block 13 can be viewed as defining orthogonal X, Y and Z axes, where the X-Y plane is parallel to a plane that would be formed by the natural stone-like surface portion 16 if that surface portion was flat, i.e., the plane in which lies the boundary 22 of the natural stone-like surface portion 16. A level L at a given point of the natural stone-like surface portion 16 can be viewed as a plane parallel to the X-Y plane, and the surface level difference ΔL can be viewed as being measured along the Z axis.

[0022] In the embodiment shown in Figure 5, the minimum level L_{min} of the natural stone-like surface portion 16 is located at its boundary 22. Generally, the minimum level L_{min} of the natural stone-like surface portion 16 may be located anywhere on that surface portion. For example, Figure 7 illustrates an embodiment in which the minimum level L_{min} of the natural stone-like surface portion 16 is not located at its boundary 22. Similarly, the maximum level L_{max} of the natural stone-like surface portion 16 may also be located anywhere on that surface portion, including at its boundary 22.

[0023] In one embodiment, the surface level difference ΔL may be greater than 15 mm, for example, between 15 mm and 25 mm. For instance, in a particular case, the surface level difference ΔL may be about 20 mm. This enables the natural stone-like surface portion 16 to exhibit desired natural stone appearance characteristics. However, it is generally contemplated that a surface level difference ΔL of greater than 4 mm achieves satisfactory results in terms of natural stone appearance of a surface portion of a face block since it enables presence of visually distinguishable cast texture features mimicking surface texture of natural stone. Also, in embodiments such as those shown in Figures 8A and 8B, different ones of the natural stone-like surface portions $16_1...16_Q$ may define a common or distinct surface level difference ΔL and may have common or distinct maximum levels L_{max} and minimum levels L_{min}.

[0024] With continued reference to Figures 4 and 5, each of the cast relief elements $18_1...18_M$ of the natural stone-like surface portion 16 reaches a respective level L that is the maximum level L_{max}, the minimum level L_{min}, or a level therebetween. In this embodiment, a plurality of the cast relief elements $18_1...18_M$ are seen in Figure 5 as extending to the maximum level L_{max} of the natural stone-like surface portion 16 and separated from each other by other ones of the cast relief elements $18_1...18_M$ that only extend to lower levels. More particularly, the natural stone-like surface portion 16 is configured such that at least three of the cast relief elements $18_1...18_M$ extend to the maximum level L_{max} and are positioned relative to each other to provide an effective support on which at least one other face block may be supported. In other words, the maximum level L_{max} of the natural stone-like surface portion 16 provides at least three points that are located relative to each other such that at least one other face block may be supported thereon in a stable manner. This facilitates stacking or palletizing of face blocks for storage or transportation purposes. In embodiments such as those shown in Figures 8A and 8B, these at least three points may be distributed among the plurality of natural stone-like surface portions $16_1...16_Q$.

[0025] Also, in this embodiment, each of the cast relief $18_1...18_M$ of the natural stone-like surface portion 16 that is a valley (e.g., the cast relief element 18_2) can be viewed as having a respective "depth" D, which refers to the normal distance between the maximum level L_{max} of the surface portion 16 and that valley's deepest point. Depending on the surface level difference ΔL, in some embodiments, the respective depth D of each of one or more valleys of the natural stone-like surface portion 16 may be greater than 4 mm, for example, between 4 mm and 10 mm. This may further enhance natural stone appearance characteristics exhibited by the natural stone-like surface portion 16.

[0026] Continuing with Figures 4 and 5, in this embodiment, the natural stone-like surface portion 16 interacts with ambient light to create shadows that further contribute to its natural stone appearance. More particularly, as shown in Figure 5, each point of the cast texture of the natural stone-like surface portion 16 defines a respective "texture angle" θ, which refers to the angle between a plane parallel to the X-Y plane and a plane tangent to the natural stone-like surface portion 16 at that point. In one embodiment, the respective texture angle θ of each of a plurality of points of the natural stone-like surface portion 16 may be between about 75 ° and about 90°. This may contribute to creation of shadows on the natural stone-like surface portion 16 that further enhance its natural stone appearance. Configuring a dry-cast concrete block with a surface level difference ΔL in the above-mentioned ranges has been found to facilitate, if not al-

together render possible, formation of such texture angles θ during casting. It is noted, however, that the above-mentioned values of texture angle θ are presented for example purposes only and are not to be considered limiting in any respect.

[0027] In the embodiment of Figures 4 and 5, it is recalled that the face block 13 is adapted to be coupled to the support block 15. This is achieved by providing the face block 13 with a plurality of coupling parts 29 each adapted to interact with a complementary coupling part of the support block 15 so as to coupled together the face block 13 and the support block 15, as described later on. Each coupling part 29 is integral with the face block 13 (i.e., not an element distinct from the face block 13). For example, each coupling part 29 may be formed during casting of the face block 13. In this embodiment, each coupling part 29 is a respective female part, which, in this example, is implemented as a respective groove provided on the surface 14_2. In other embodiments, each coupling part 29 may be a respective male part.

[0028] The plurality of coupling parts 29 (in this case, three) allows the face block 13 to be coupled to the support block 15 at different positions relative to the support block 15 and/or to be coupled to the support block 15 and a support block of an adjacent one of the concrete block systems $12_1...12_N$. In other embodiments, the face block 13 may include one or any other number of coupling parts.

[0029] Referring now to Figures 4, 9A and 9B, the support block 15 is adapted to be positioned into the material 11 and its structure and weight, along with that of support blocks of other ones of the concrete block systems $12_1...12_N$, contribute to effecting retention of the material 11 by the wall portion 10. In this embodiment, the support block 15 is a dry-cast concrete block. In other embodiments, the support block 15 may be made of other types of concrete (e.g., measurable-slump concrete).

[0030] The support block 15 comprises a first end portion 34, a second end portion 36, and a central portion 38 therebetween. In this embodiment, the central portion 38 is configured as a neck portion that is relatively narrower than the first end portion 34 and the second end portion 36 such that the support block 15 can be said to have a generally "I"-shaped configuration. This provides a space 40 on each side of the support block 15 that cooperates with a similar space provided by a support block of an adjacent one of the concrete block systems $12_1...12_N$ to receive part of the material 11, thereby enhancing stability of the support block 15 while reducing its weight and cost. In other embodiments, the support block 15 may have various other configurations.

[0031] In this embodiment, the first end portion 34 has a coupling part 41 that is complementary to each coupling part 29 of the face block 13. This enables the face block 13 to be coupled to the support block 15 by positioning the face block 13 above or below the support block 15 such that one of its coupling parts 29 is aligned with the coupling part 41 of the support block 15 and then fitting the coupling part 41 of the support block 15 into the coupling part 29 of the face block 13. As mentioned previously, and as best shown in Figure 10, in some situations, the face block 13 may simultaneously be coupled to a first support block 15 and a second support block 15 of the concrete block systems $12_1...12_N$ via fitting of another one of its coupling parts 29 with a complementary coupling part of the second support block. This may further enhance stability of the wall portion 10. The coupling part 41 is integral with the support block 15 and may be formed during casting of the support block 15. In this embodiment, the coupling part 41 is a male part, which, in this example, is implemented as a protrusion provided on the first end portion 34 and configured to fit into the respective groove forming each coupling part 29 of the face block 13. In other embodiments, the coupling part 41 may be a female part.

[0032] Continuing with Figures 4, 9A and 9B, the second end portion 36 has a coupling part 43 that enables the support block 15 to be coupled to another support block. For example, as shown in Figure 10, it may be useful or necessary in some situations (e.g., relatively high walls) to connect two or more support blocks in series. In such situations, the coupling part 43 of the support block 15 may be coupled to a complementary coupling part of another support block in order to coupled together these two support blocks. In the embodiment of Figures 4, 9A and 9B, the coupling part 43 is integral with the support block 15 and may be formed during casting of the support block 15. Also, the coupling part 43 is a male part, which, in this example, is implemented as a protrusion provided on the second end portion 36 and configured to fit into a complementary female part of another support block. In other embodiments, the coupling part 43 may be a female part. For example, Figures 11A to 11C illustrate an embodiment in which the support block 15 has a male coupling part 41 and a female coupling part 43.

[0033] In the embodiment shown in Figures 4, 9A and 9B, each of the first end portion 34 and the second end portion 36 is provided with a respective depression 50 on each of its top and bottom sides. The depression 50 can take the form of a groove or a recess. The depression 50 can also be an open-ended groove extending from one side to the other side of the support block 15. As shown in Figure 2, each depression 50 is adapted to receive an alignment key 52 that may be used to adjust an angle θ of the support block 15 relative to an overlapping support block of the concrete block systems $12_1...12_N$. This enables the wall portion 10 to have a corresponding setback angle or slope.

[0034] More particularly, the alignment key 52 may be placed in different positions in a given depression 50 to effect the desired angle θ. For example, in Figure 2, each alignment key 52 is placed in a first position, wherein it is aligned longitudinally with and entirely lies within the respective depressions 50 in which it is placed. In this case, the angle θ is substantially zero degrees and it is

then possible to erect a wall that is substantially vertical. In Figure 12, each alignment key 52 is placed in a second position different from the first position, wherein it partly overhangs support block portions contiguous to the respective depressions 50 in which it is placed. In this case, the angle θ has a nonzero value such as 7°, 10° or any other permitted value, and it is then possible to erect an inclined wall.

[0035] Figures 13A to 13C illustrates an example of implementation of the alignment key 52. The alignment key 52 comprises a first portion 54 and a second portion 56 that respectively define overhang sections 58 and 60. Placing the alignment key 52 in a given depression 50 of the support block 15 such that both of the overhang sections 58 and 60 lie within the depression 50 achieves a zero degree value for the angle θ (e.g., Figure 2). When the alignment key 52 is placed such that one of the overhang sections 58 and 60 overhangs a portion of the support block 15 contiguous to the depression 50, a nonzero degree value for the angle θ is achieved (e.g., Figure 12). In one embodiment, the alignment key 52 is made of a polymeric material such as polypropylene. In other embodiments, the alignment key 52 may be made of various other materials.

[0036] While in the embodiment of Figures 4, 9A and 9B each depression 50 is shown as having a certain configuration and as being located at a certain location on the first end portion 34 or the second end portion 36, in other embodiments, each depression 50 may have various other configurations and may be located at various other locations on the support block 15. Also, although in the embodiment of Figures 4, 9A and 9B the alignment key 52 is an element distinct from the support block 15, in other embodiments, the support block 15 may be provided with an alignment key that is integral with the support block 15 (e.g., a male or female key part).

[0037] Continuing with Figures 4, 9A and 9B, the support block 15 has a plurality of fractionation areas 64_1... 64_p for facilitating controlled fractionating of the support block 15 into separate parts. In this embodiment, each of the fractionation areas 64_1...64_P is implemented as a respective groove formed on the support block 15 and sized to facilitate controlled mechanical splitting (e.g., cutting, sawing, etc.) of the support block 15 at that area. This enables removal of selected portions of the support block 15 such as the first end portion 34, the second end portion 36, the central portion 38, or fractions thereof in order to reconfigure the support block 15 such that it may accommodate design requirements of the wall portion 10.

[0038] It will thus be appreciated that when the concrete block systems 12_1...12_N are positioned in the wall portion 10, the natural stone-like surface portion 16 of the face block 13 of each concrete block system contributes to providing a natural and aesthetic look to the wall portion 10. For its part, the support block 15 of each concrete block system contributes to effecting retention of the material 11 by the wall portion 10, may interact with the alignment key 52 to provide a desired setback angle θ to the wall portion 10, and may be selectively reconfigured so as to accommodate design requirements of the wall portion 10. Furthermore, the natural stone appearance of each face block 13 may be realized during casting thereof, without requiring any subsequent mechanical artificial aging/weathering process (e.g., tumbling, splitting/breaking, object impacting, etc.). Moreover, since they may be made of no-slump concrete, production time for the concrete block systems 12_1...12_N may be significantly less than that required for wet-cast concrete blocks. Concrete block systems such as the concrete block systems 12_1...12_N may therefore be mass-produced with high efficiency.

[0039] Referring now to Figure 14, there is shown a flowchart illustrating an example of implementation of a process for manufacturing face blocks of concrete block systems such as the above-described concrete block systems 12_1...12_N.

[0040] At step 200, no-slump concrete is placed into a mold. To facilitate mass-production, in one embodiment, the mold has a plurality of cavities. In other embodiments, a plurality of molds each with a single cavity or each with a respective plurality of cavities may be used. To further facilitate mass-production, the mold may be located such that face blocks are placed on a production board when removed therefrom.

[0041] Each cavity of the mold is configured to form a respective face block comprising a surface that includes a natural stone-like surface portion (e.g., the face block 13 with its natural stone-like surface portion 16). To that end, each cavity is defined in part by a surface of the mold that comprises a portion with a surface texture corresponding to the desired natural stone appearance (hereinafter referred to as "the natural stone-like surface portion of the mold"). This surface portion thus defines a surface level difference $\Delta L'$ that corresponds to the desired surface level difference ΔL (Figure 5) of the face block to be formed. Each point of this surface portion also defines a respective texture angle θ' corresponding to the desired texture angle θ (Figure 5) of each point of the face block to be formed.

[0042] It will be appreciated that, in embodiments directed to producing face blocks with a plurality ofnatural stone-like surface portions (such as those shown in Figures 8A and 8B), each cavity of the mold that is intended to form such face blocks defines a corresponding plurality of natural stone-like surface portions.

[0043] In order to closely simulate natural stone, in one embodiment, each given natural stone-like surface portion of the mold, and thus the corresponding natural stone-like surface portion of face blocks to be formed by the mold, is based on a natural stone's surface. In one example of implementation, data representative of at least a portion of the natural stone's surface is obtained, for instance, via three-dimensional scanning of the natural stone's surface. The obtained data may then be computer processed using software in order to generate data representative of the given natural stone-like surface por-

tion of the mold. In some cases, this processing may include modifying the obtained data representative of at least a portion of the natural stone's surface to set the desired surface level difference $\Delta L'$ and texture angles θ' of the given natural stone-like surface portion. This processing may also ensure that the data representative of the given natural stone-like surface portion of the mold will result in the corresponding natural stone-like surface portion of face blocks to be formed by the mold having at least three points that are located relative to each other such that at least one other concrete block may be supported thereon in a stable manner.

[0044] As another possible consideration, in embodiments where individual ones of the cavities of the mold are intended to form concrete blocks of similar overall dimensions (i.e., length, width and height) but with natural stone-like surface portions that have different configurations (e.g., different patterns of cast relief elements), these individual cavities may be designed to each have a common volume in order to facilitate production. In other words, a first cavity intended to form concrete blocks with natural stone-like surface portions having a first configuration may have a first volume, and a second cavity intended to form concrete blocks with natural stone-like surface portions having a second configuration different from the first configuration may have a second volume substantially corresponding to the first volume. This facilitates provision of substantially the same quantity of concrete into each cavity of the mold, which in turn facilitates efficient casting of concrete blocks in the mold and subsequent removal of the concrete blocks therefrom.

[0045] In embodiments where individual ones of the cavities of the mold are intended to form concrete blocks of significantly different overall dimensions (i.e., length, width and height) and with natural stone-like surface portions that have different configurations (e.g., different patterns of cast relief elements), similar production benefits may be achieved by designing these individual cavities to each have a common volume per unit area.

[0046] The mold may be manufactured via computer-aided manufacturing based on the data representative of each given natural stone-like surface portion of the mold. With no-slump concrete being used, the mold may be made of metal or other rigid material. There is no requirement for one or more portions of the mold to be made of elastomeric material (e.g., rubber), which is typically used in molds for casting wet-cast concrete blocks with a natural stone appearance.

[0047] Thus, during step 200, each cavity of the mold is filled with no-slump concrete in order to form a face block with at least one natural stone-like surface portion.

[0048] At step 202, the no-slump concrete in the mold is consolidated. Consolidation may include inducing vibration of the no-slump concrete in the mold so as to cause it to compact itself and closely conform to each cavity of the mold. A pre-vibration phase may be effected during step 200 to facilitate filling of the no-slump concrete in the mold and its eventual consolidation. Consolidation may also include application of pressure on the concrete in combination with its vibration. It will be appreciated that consolidation may be effected using various other techniques.

[0049] Upon completion of step 202, the no-slump concrete in each cavity of the mold has formed into a face block with at least one natural stone-like surface portion.

[0050] At step 204, the face block in each cavity of the mold is removed therefrom and continues on the production board. The face blocks may be directly stored for curing purposes. Since provision of a natural stone appearance is effected during casting, the face blocks do not require a subsequent mechanical artificial aging/weathering process (e.g., tumbling, splitting/breaking, object impacting, etc.) to impart them with such an appearance. Also, the face blocks may directly be stacked or palletized in a stable manner since the at least one natural stone-like surface portion of each face block has been configured to provide at least three points that are located relative to each other to ensure such stable supporting. With the face blocks being made of no-slump concrete, curing times are relatively short such that they are available for use within a short period of time (e.g., one day).

[0051] At step 206, each cavity of the mold is cleaned such that casting of new face blocks may be effected. In one embodiment, a cleaning unit uses a fluid to clean each cavity of the mold. The fluid may be a gas (e.g., compressed air) or a liquid whose flow relative to each cavity of the mold, and particularly each natural stone-like area of the mold, removes therefrom substantially any remaining no-slump concrete. Such a fluid-based cleaning action advantageously enables rapid cleaning of each cavity of the mold, thereby increasing production efficiency. In some cases, the cleaning unit may also use, in addition to the fluid, one or more brushes to clean each cavity of the mold, whereby the fluid-based cleaning action is combined with a brushing cleaning action. It will be appreciated that other embodiments may employ various other types of cleaning action.

[0052] As shown in Figure 14, in this example, the process returns to step 200 where a new production cycle begins. In some embodiments, utilization of no-slump concrete in combination with rapid cleaning of the mold and other elements of the process may enable a production cycle to take a relatively short period of time (e.g., 15 to 20 seconds in some cases).

[0053] With respect to manufacturing of support blocks of concrete block systems such as the above-described concrete block systems $12_1 ... 12_N$, it will be appreciated that various conventional casting processes may be used.

[0054] Although various embodiments and examples have been presented, this was for the purpose of describing, but not limiting, the invention. Various modifications and enhancements will become apparent to those of ordinary skill in the art and are within the scope of the present invention, which is defined by the attached

claims.

Claims

1. A plurality of concrete blocks for use in a retaining wall, said plurality of concrete blocks comprising: first and second support blocks (15) adapted to be embedded in material to be retained by the retaining wall, said first support block (15) comprising either a first male coupling part being a protrusion (41) or a first female coupling part being a groove (43), said second support block (15) comprising either a second first male coupling part being a protrusion (41) or a second female coupling part being a groove (43); and a face block (13) having a surface (14_1) that is exposed when said face block is positioned in the retaining wall,
characterized in that said face block (13) is a dry-cast block made by a dry-casting process such that said surface (14_1) comprises a surface portion (16) having a cast texture with a natural stone appearance that comprises a pattern of cast relief elements formed during the dry-casting process, said dry-cast face block (13) comprises either a first male coupling part being a protrusion, when said first support block (15) comprises said first female coupling groove (43), or a first female coupling part being a groove, when said first support block (15) comprises said first male coupling protrusion (41) and either a second male coupling part being a protrusion, when said second support block (15) comprises said second female coupling groove (43), or a second female coupling part being a groove when said second support block (15) comprises said second male coupling protrusion (41), said dry-cast face block (13) is configured such that, when said dry-cast face block (13) and said first and second support blocks (15) are positioned in the retaining wall, said dry-cast face block (13) is coupled to said first support block (15) via said first male coupling protrusion fitting into and being surrounded by said first female coupling groove and to said second support block (15) via said second male coupling protrusion fitting into and being surrounded by said second female coupling groove.

2. A plurality of concrete blocks as defined in claim 1, wherein each of said first and second support blocks (15) comprises a first end portion (34)a second end portion (36), and a central portion (38) therebetween, said central portion (38) being narrower than said first end portion (34) and said second end portion (36).

3. A plurality of concrete blocks as defined in claim 1, wherein each of said first and second support blocks (15) comprises a first end portion (34) and a second end portion (36), the one of said first male coupling protrusion (41) and said first female coupling groove (43) being located on said first end portion (34) of said first support block (15), the one of said second first male coupling protrusion (41) and said second female coupling groove (43) being located on said first end portion (34) of said second support block (15), each of said first and second support blocks (15) comprising a second first male coupling part being a protrusion (41) or a second female coupling part being a groove (43) on said second end portion (36) for enabling each of said first and second support blocks to be coupled to another support block.

4. A plurality of concrete blocks as defined in any one of claims 1 to 3, wherein each of said first and second support blocks (15) comprises a depression (50) for receiving an alignment key (52) adapted to set an angle of each of said first and second support blocks relative to an overlapping support block.

5. A plurality of concrete blocks as defined in any one of claims 1 to 4, wherein said cast texture has a surface level difference of greater than 4 mm.

6. A plurality of concrete blocks as defined in claim 5, wherein said surface level difference is greater than 15 mm.

7. A plurality of concrete blocks as defined in any one of claims 1 to 6, wherein said surface portion (16) has a plurality of points defining a texture angle θ measured between a plane parallel to said surface portion (16) and a plane tangent to said surface portion (16) at each respective points and wherein said texture angle θ is between 75° and 90°.

8. A plurality of concrete blocks as defined in any one of claims 1 to 7, wherein said cast texture comprises a plurality of peaks and valleys, wherein at least one valley has a depth D corresponding to the normal distance between a maximum level L_{max} of said surface portion (16) and a deepest point of said at least one valley and wherein said deep D is greater than 4 mm.

9. A plurality of concrete blocks as defined in any one of claims 1 to 8, wherein said surface portion (16) of said surface (14_1) is an entirety of said surface (14_1) with its boundary (22) corresponding to edges of said surface (14_1).

Patentansprüche

1. Mehrzahl an Betonblöcken zur Verwendung in einer Stützwand, wobei die Mehrzahl an Betonblöcken umfasst: erste und zweiten Stützblöcke (15), die ge-

stalltet sind in ein Material eingebettet werden zu können, das von der Stützwand gestützt werden soll, wobei der erste Stützblock (15) entweder ein erstes männliches Kopplungsteil, das eine Vorwölbung (41) ist, oder ein erstes weibliches Kopplungsteil, das eine Rille (43) ist, umfasst, und wobei der zweite Stützblock (15) entweder ein zweites männliches Kopplungsteil, das eine Vorwölbung (41) ist, oder ein zweites weibliches Kopplungsteil, das eine Rille (43) ist, umfasst; und einen Flächenblock (13) mit einer Oberfläche (14_1), die freiliegt, wenn der Flächenblock in die Stützwand eingesetzt wird, umfasst,

dadurch gekennzeichnet, dass der Flächenblock (13) ein Trockengussblock ist, der in einem Trockengussverfahren so hergestellt wurde, dass die Oberfläche (14_1) einen Oberflächenteil (16) umfasst, der ein Gussgefüge mit Natursteineffekt aufweist das ein Muster von während des Trockengussverfahrens gebildeten Gussreliefelementen umfasst,

wobei der Trockenguss-Flächenblock (13) entweder ein erstes männliches Kopplungsteil, das eine Vorwölbung ist, umfasst wenn der erste Stützblock (15) die erste Kopplungsrille (43) umfasst, oder ein erstes weibliches Kopplungsteil, das eine Rille ist, wenn der erste Stützblock (15) das erste männliches Kopplungsteil (41) ist, und entweder ein zweites männliches Kopplungsteil, das eine Vorwölbung ist, umfasst, wenn der zweite Stützblock (15) die zweite Kopplungsrille (43) umfasst, oder ein zweites weibliches Kopplungsteil, das eine Rille ist, wenn der zweite Stützblock (15) das zweite männliches Kopplungsteil (41) ist, wobei der Trockenguss-Flächenblock (13) so konfiguriert ist, dass, wenn der Trokkenguss-Flächenblock (13) und der erste und der zweite Stützblock (15) in die Stützwand eingesetzt werden, der Trockenguss-Flächenblock (13) über die erste männliche Kopplungs-Vorwölbung, die in die erste weibliche Kopplungsrille passt und von ihr umgeben wird, an den ersten Stützblock (15) gekoppelt wird, und über die zweite männliche Kopplungs-Vorwölbung, die in die zweite weibliche Kopplungsrille passt und von ihr umgeben wird, an den zweiten Stützblock (15) gekoppelt wird.

2. Mehrzahl an Betonblöcken nach Anspruch 1, wobei der erste und der zweite Stützblock (15) je einen ersten Endteil (34), einen zweiten Endteil (36) und einen mittleren Bereich (38) dazwischen umfassen, wobei der mittlere Bereich (38) schmäler ist als der erste Endteil (34) und der zweite Endteil (36).

3. Mehrzahl an Betonblöcken nach Anspruch 1, wobei jedem der ersten und der zweiten Stützblöcke (15) einen ersten Endteil (34) und einen zweiten Endteil (36) umfassen, wobei die erste männliche Kopplungs-Vorwölbung (41) oder die erste weibliche Kopplungsrille (43) sich auf dem ersten Endteil (34) des ersten Stützblocks (15) befindet, die zweite männliche Kopplungs-Vorwölbung (41) oder die zweite weibliche Kopplungsrille (43) sich auf dem ersten Endteil (34) des zweiten Stützblocks (15) befindet, wobei der erste und der zweite Stützblock (15) auf dem zweiten Endteil (36) je ein zweites männliches Kopplungsteil, das eine Vorwölbung (41) ist, oder ein zweites weibliches Kopplungsteil, das eine Rille (43) ist, umfasst, so dass der erste und der zweite Stützblock an einen anderen Stützblock gekoppelt werden können.

4. Mehrzahl an Betonblöcken nach jedem der Ansprüche 1 bis 3, wobei der erste und der zweite Stützblock (15) je eine Vertiefung (50) zur Aufnahme eines Ausrichtungsschlüssels (52) umfasst, der angepasst ist zwischen dem ersten und zweiten Stützblock einerseits und einem überragenden Stützblock andererseits einen Winkel zu bilden.

5. Mehrzahl an Betonblöcken nach jedem der Ansprüche 1 bis 4, wobei das Gussgefüge eine Oberflächen-Höhendifferenz von mehr als 4 mm hat.

6. Mehrzahl an Betonblöcken nach in Anspruch 5, wobei die Oberflächen-Höhendifferenz mehr als 15 mm beträgt.

7. Mehrzahl an Betonblöcken nach jedem der Ansprüche 1 bis 6, wobei der Oberflächenteil (16) eine Mehrzahl an Punkten aufweist, die einen Gefügewinkel Θ definieren, der zwischen einer Ebene, die parallel zum Oberflächenteil (16) ist, und einer Ebene, die zum Oberflächenteil (16) abgewinkelt ist, an jedem der betreffenden Punkte gemessen wird, und wobei der Gefügewinkel Θ zwischen 75° und 90° liegt.

8. Mehrzahl an Betonblöcken nach jedem der Ansprüche 1 bis 7, wobei das Gussgefüge eine Mehrzahl an Höckern und Tälern umfasst, wobei mindestens ein Tal eine Tiefe D aufweist, die der normalen Entfernung zwischen einem Höchstniveau L_{max} des Oberflächenteils (16) und einem Tiefpunkt des mindestens einen Tals entspricht, und wobei die Tiefe D größer als 4 mm ist.

9. Mehrzahl an Betonblöcken nach jedem der Ansprüche 1 bis 8, wobei der Oberflächenteil (16) der Oberfläche (14_1) eine Gesamtheit der Oberfläche (14_1) darstellt, wobei ihre Begrenzung (22) Kanten der Oberfläche (14_1) entspricht.

Revendications

1. Pluralité de blocs de béton à utiliser dans un mur de soutènement, ladite pluralité de blocs de béton

comprenant : un premier et un second bloc de support (15) adaptés pour être encastrés dans le matériau à soutenir par le mur de soutènement, ledit premier bloc de support (15) comprenant soit une première pièce d'accouplement mâle formant saillie (41), soit une première pièce d'accouplement femelle formant rainure (43), ledit second bloc de support (15) comprenant soit une seconde pièce d'accouplement mâle formant saillie (41), soit une seconde pièce d'accouplement femelle formant rainure (43), et un bloc de parement (13) comportant une surface (14_1) qui est exposée quand ledit bloc de parement est positionné dans le mur de soutènement,
caractérisé en ce que ledit bloc de parement (13) est un bloc moulé à sec fabriqué au moyen d'un processus de moulage à sec tel que ladite surface (14_1) comprend une partie de surface (16) présentant une texture moulée ayant l'apparence d'une pierre naturelle qui comprend un motif d'éléments moulés en relief formés pendant le processus de moulage à sec, ledit bloc de parement moulé à sec (13) comprenant soit une première pièce d'accouplement mâle formant saillie lorsque ledit premier bloc de support (15) comprend ladite première rainure d'accouplement femelle (43), soit une première pièce d'accouplement femelle formant rainure lorsque ledit premier bloc de support (15) comprend ladite première saillie d'accouplement mâle (41), et soit une seconde pièce d'accouplement mâle formant saillie lorsque ledit second bloc de support (15) comprend ladite seconde rainure d'accouplement femelle (43), soit une seconde pièce d'accouplement femelle formant rainure lorsque ledit second bloc de support (15) comprend ladite seconde saillie d'accouplement mâle (41), ledit bloc de parement moulé à sec (13) étant configuré de telle sorte que, lorsque ledit bloc de parement moulé à sec (13) et lesdits premier et second blocs de support (15) sont positionnés dans le mur de soutènement, ledit bloc de parement moulé à sec (13) est accouplé audit premier bloc de support (15) par ladite première saillie d'accouplement mâle qui s'emboîte dans, et est enveloppée par, ladite première rainure d'accouplement femelle, et audit second bloc de support (15) par ladite seconde saillie d'accouplement mâle qui s'emboîte dans, et est enveloppée par, ladite seconde rainure d'accouplement femelle,

2. Pluralité de blocs de béton selon la revendication 1, étant entendu que chacun desdits premier et second blocs de support (15) comprend une première partie d'extrémité (34), une seconde partie d'extrémité (36) et une partie centrale (38) entre les deux, ladite partie centrale (38) étant plus étroite que ladite première partie d'extrémité (34) et que ladite seconde partie d'extrémité (36).

3. Pluralité de blocs de béton selon la revendication 1, étant entendu que chacun desdits premier et second blocs de support (15) comprend une première partie d'extrémité (34) et une seconde partie d'extrémité (36), ladite première saillie d'accouplement mâle (41) ou ladite première rainure d'accouplement femelle (43) étant située sur ladite première partie d'extrémité (34) dudit premier bloc de support (15), ladite seconde [*première*] saillie d'accouplement mâle (41) ou ladite seconde rainure d'accouplement femelle (43) étant située sur ladite première partie d'extrémité (34) dudit second bloc de support (15), chacun desdits premier et second blocs de support (15) comprenant une seconde [*première*] pièce d'accouplement mâle formant saillie (41) ou une seconde pièce d'accouplement femelle formant rainure (43) sur ladite seconde partie d'extrémité (36) pour permettre que chacun desdits premier et second blocs de support soit accouplé à un autre bloc de support.

4. Pluralité de blocs de béton selon l'une quelconque des revendications 1 à 3, étant entendu que chacun desdits premier et second blocs de support (15) comprend un évidement (50) pour recevoir une clavette d'alignement (52) adaptée pour régler un angle de chacun desdits premier et second blocs de support par rapport à un bloc de support de recouvrement.

5. Pluralité de blocs de béton selon l'une quelconque des revendications 1 à 4, étant entendu que ladite texture moulée présente une différence de niveau des surfaces supérieure à 4 mm.

6. Pluralité de blocs de béton selon la revendication 5, étant entendu que ladite différence de niveau des surfaces est supérieure à 15 mm.

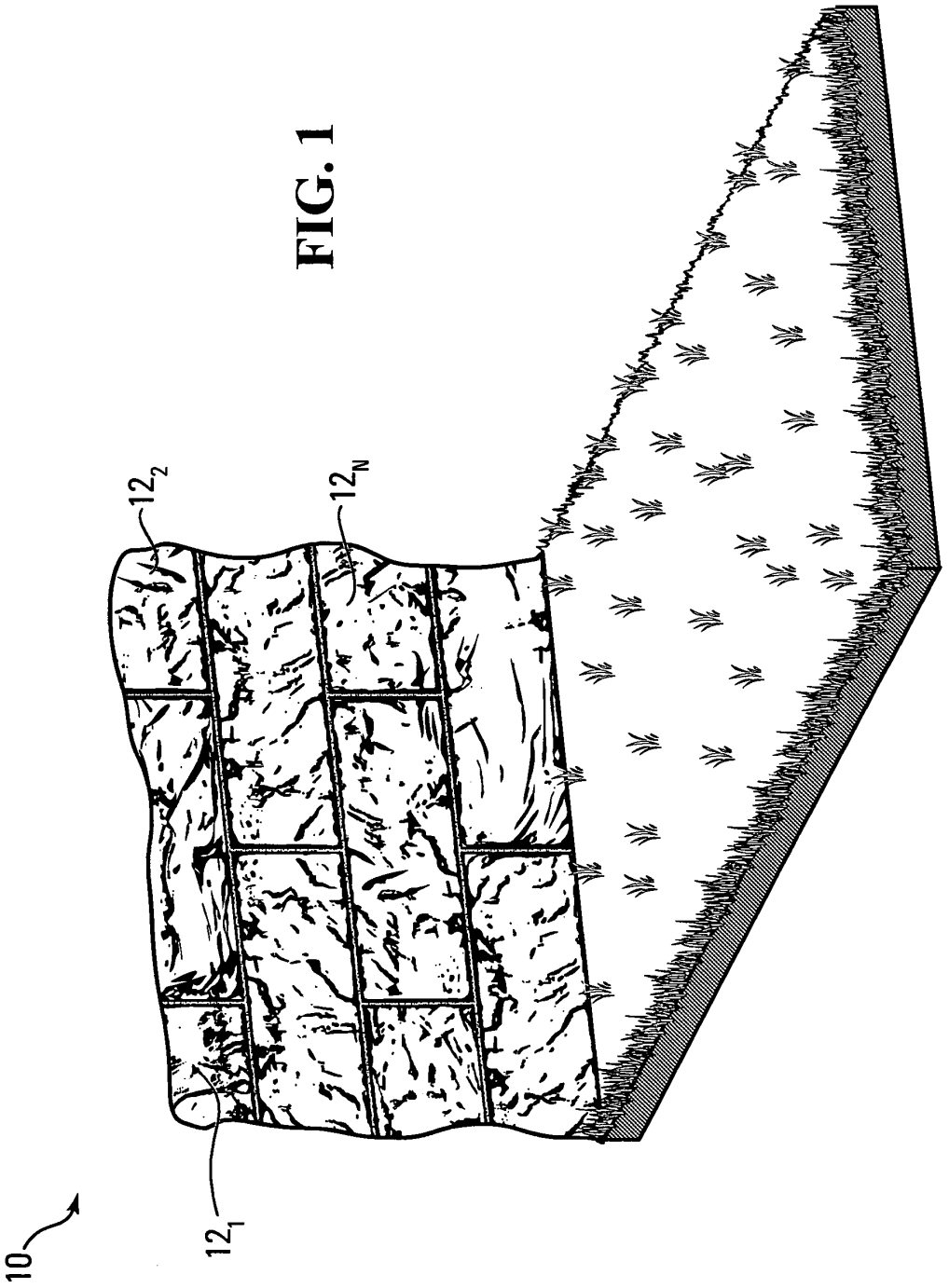
7. Pluralité de blocs de béton selon l'une quelconque des revendications 1 à 6, étant entendu que ladite partie de surface (16) comporte une pluralité de points définissant un angle de texture Θ mesuré entre un plan parallèle à ladite partie de surface (16) et un plan tangent à ladite partie de surface (16) en chaque point respectif et étant entendu que ledit angle de texture Θ fait entre 75° et 90°.

8. Pluralité de blocs de béton selon l'une quelconque des revendications 1 à 7, étant entendu que ladite texture moulée comprend une pluralité de crêtes et de creux, étant entendu qu'au moins un creux a une profondeur D correspondant à la distance normale entre un niveau maximal L_{max} de ladite partie de surface (16) et un point le plus bas dudit au moins un creux et étant entendu que ladite profondeur D est supérieure à 4 mm.

9. Pluralité de blocs de béton selon l'une quelconque des revendications 1 à 8, étant entendu que ladite partie de surface (16) de ladite surface (14_1) est la

totalité de ladite surface (14_1), sa limite (22) correspondant aux bords de ladite surface (14_1).

FIG. 1



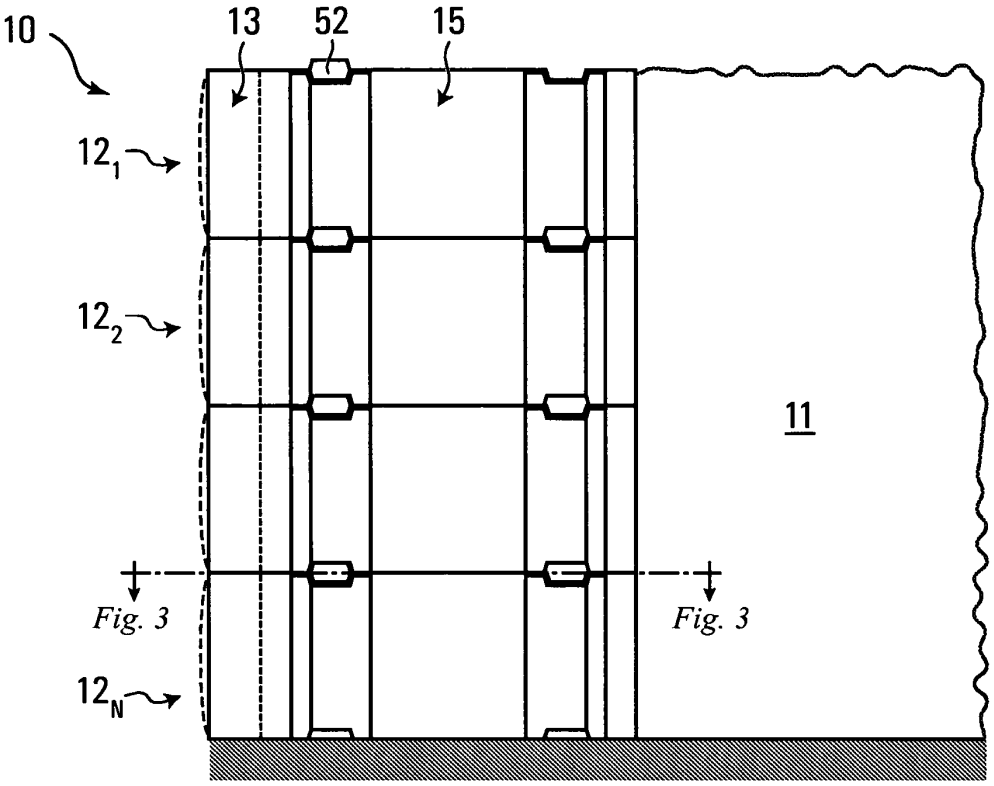


FIG. 2

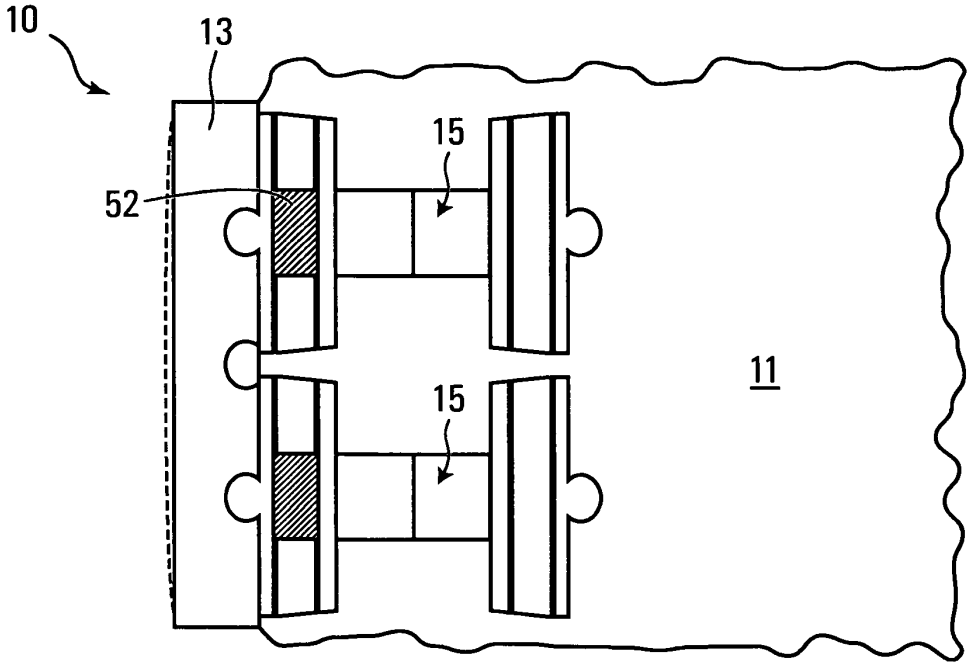


FIG. 3

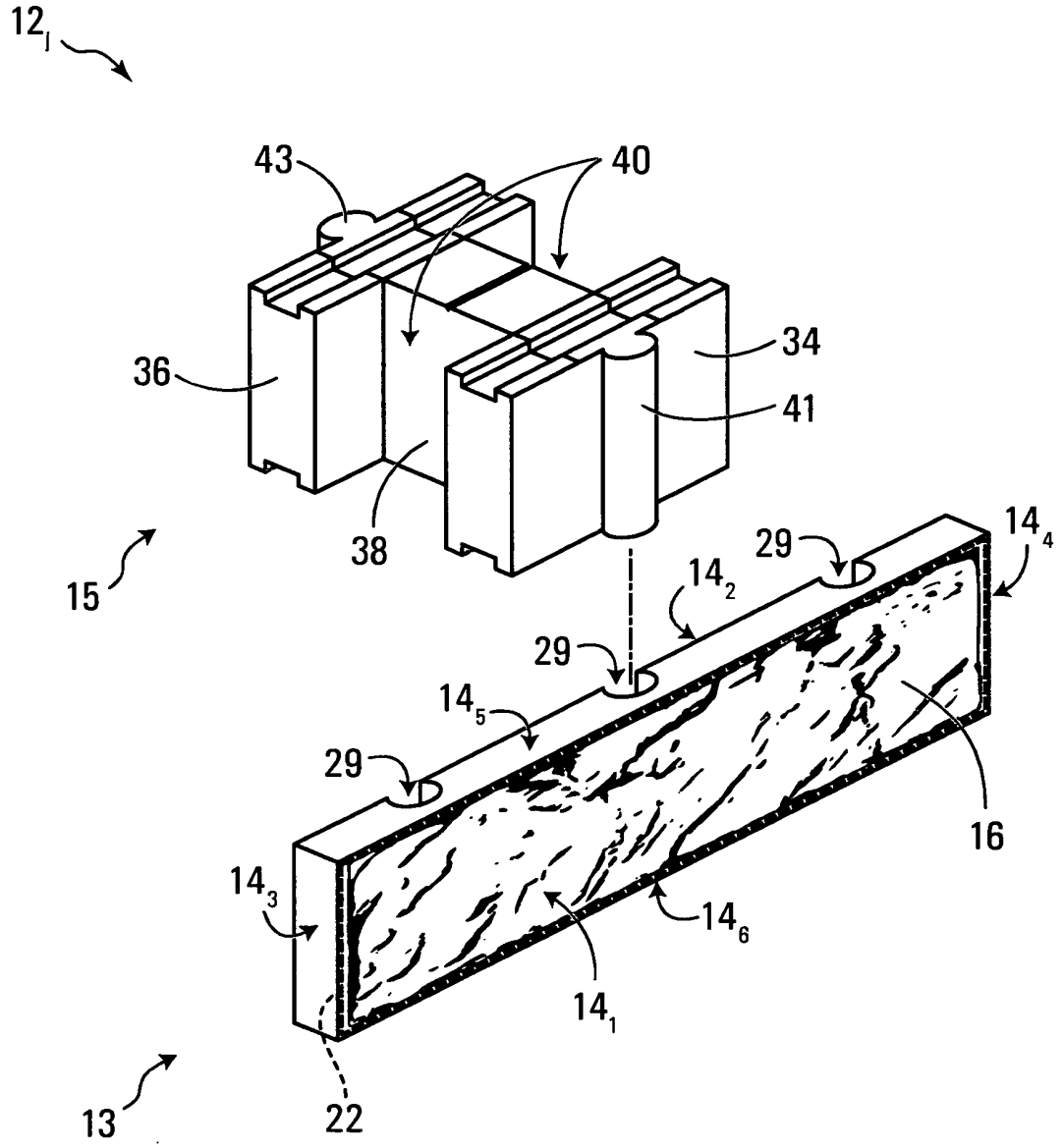


FIG. 4

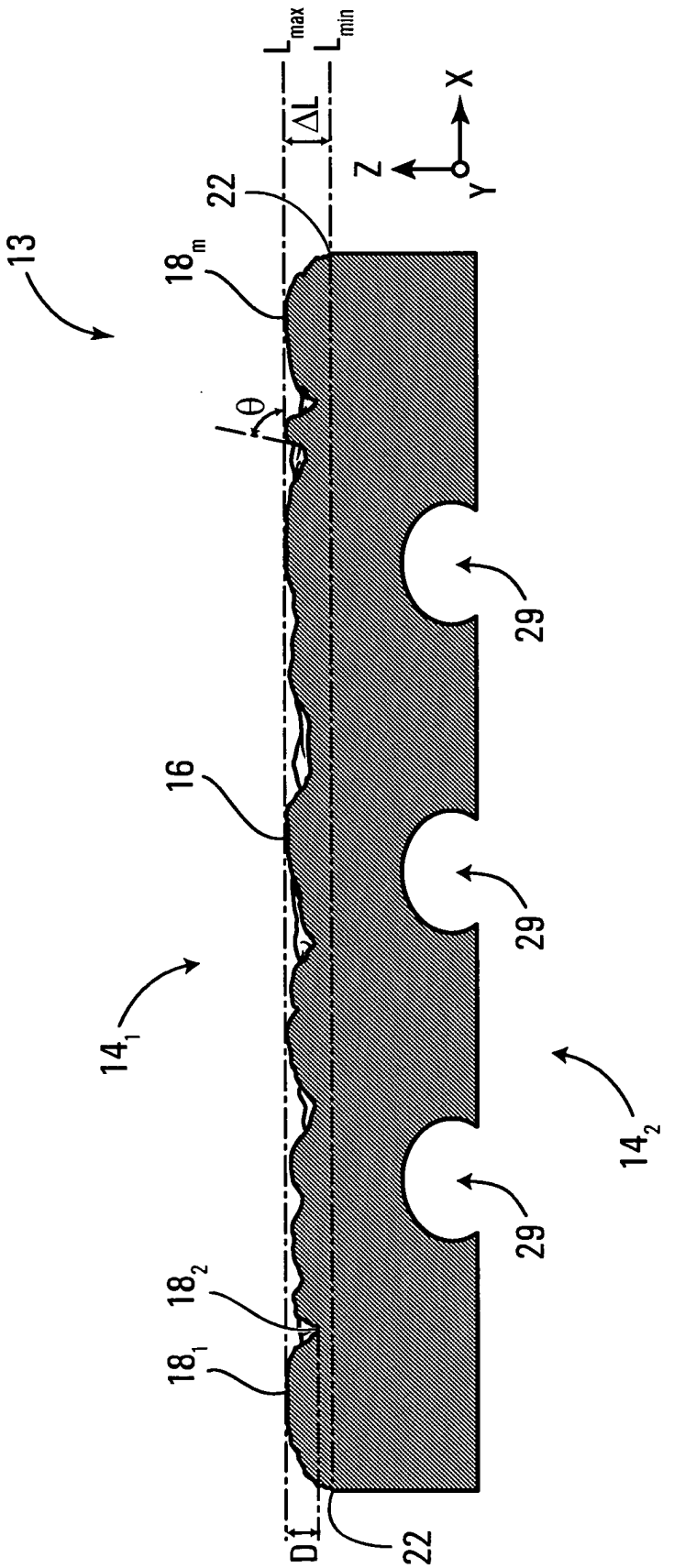


FIG. 5

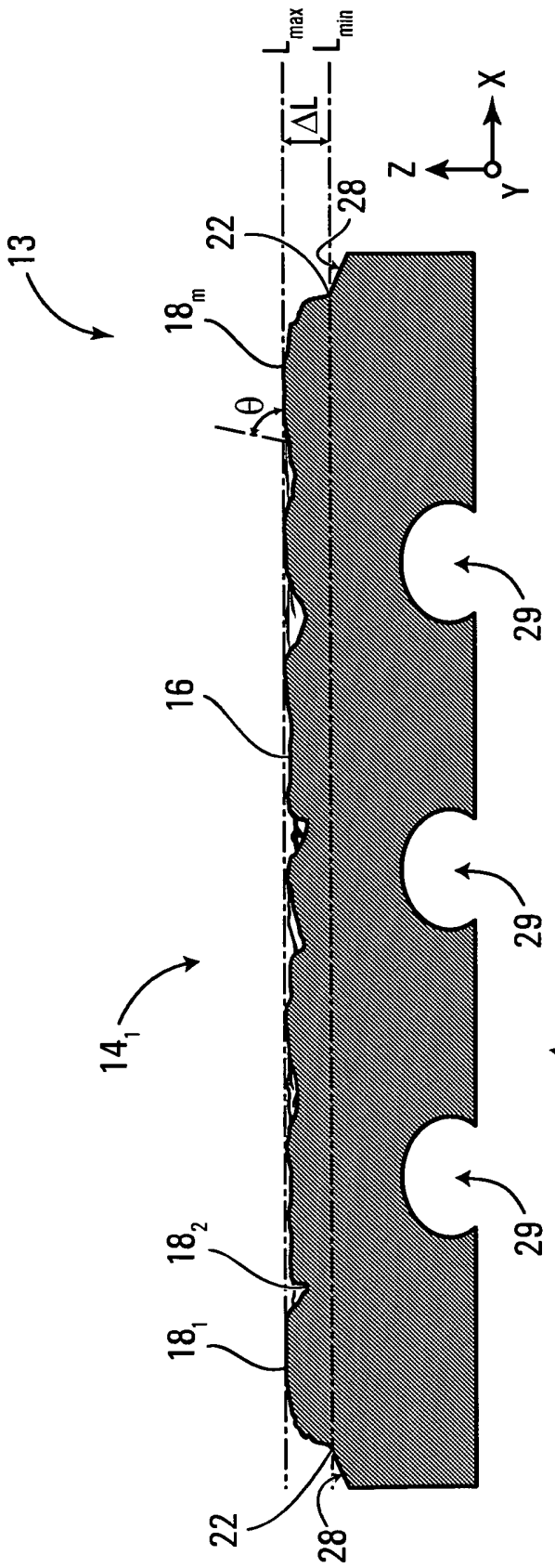

L_{max}
L_{min}
ΔL
Z
X
Y
13
22
28
18_m
θ
16
29
29
29
14_1
14_2
18_2
18_1
22
28

FIG. 6

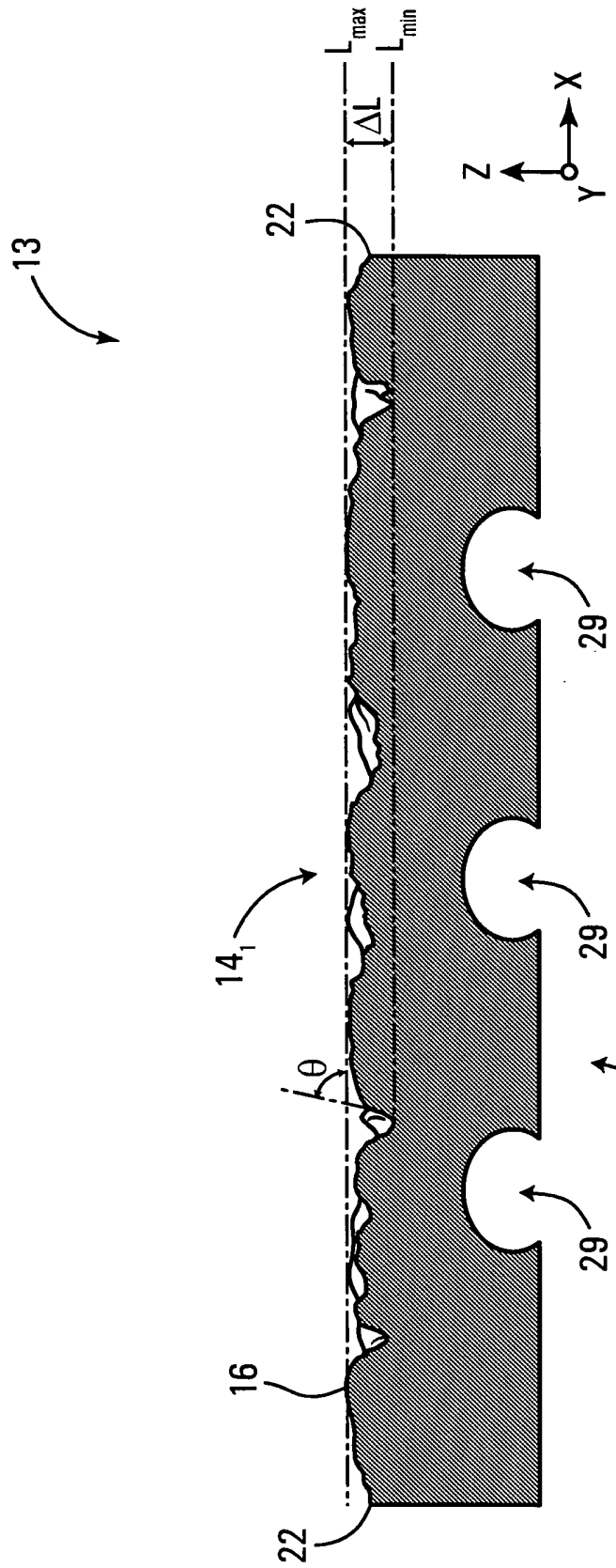


FIG. 7

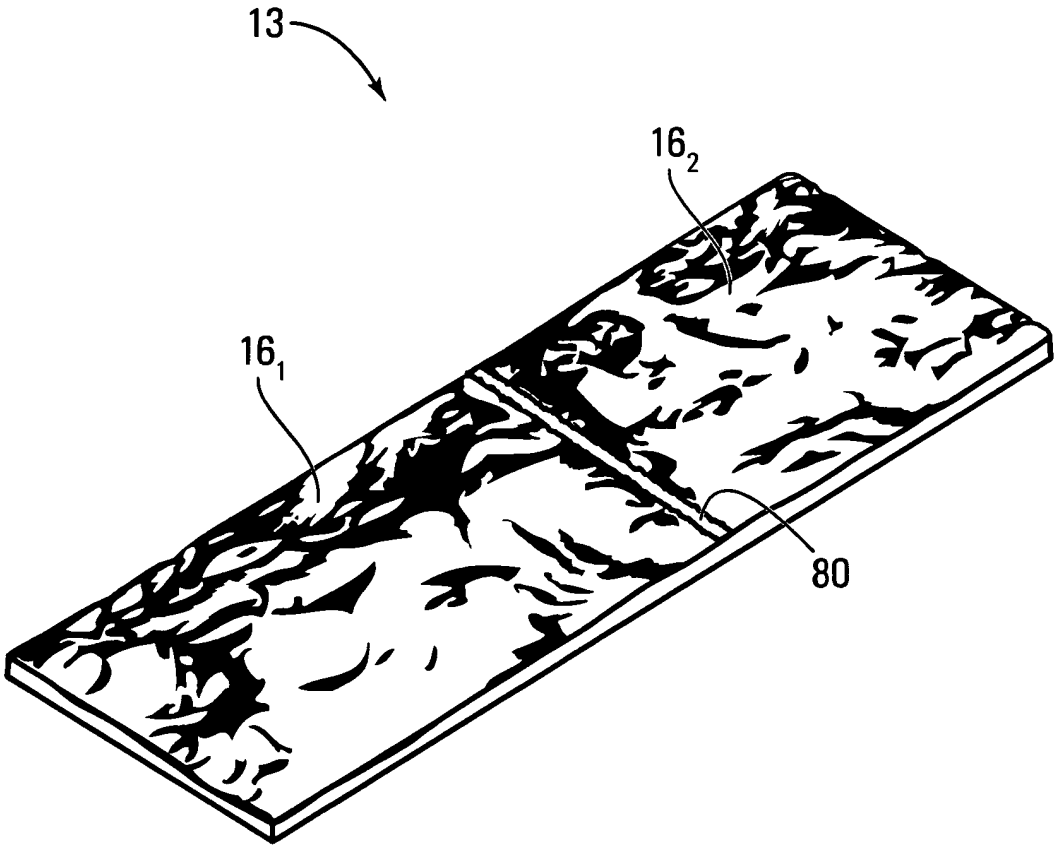


FIG. 8A

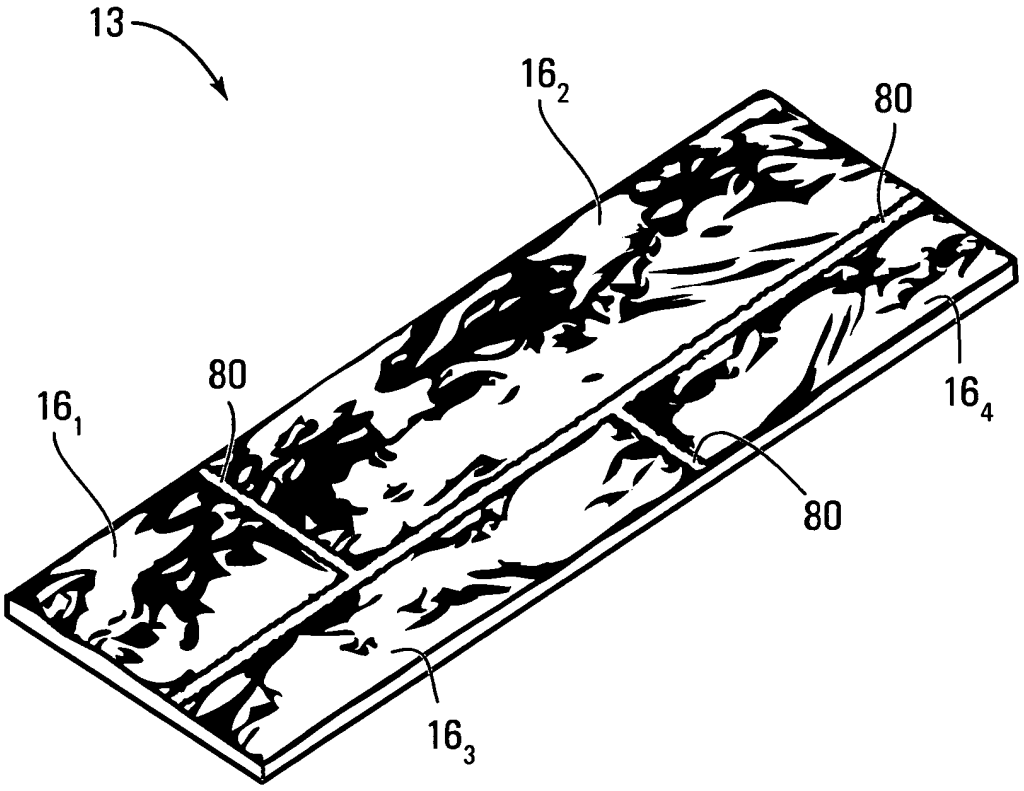


FIG. 8B

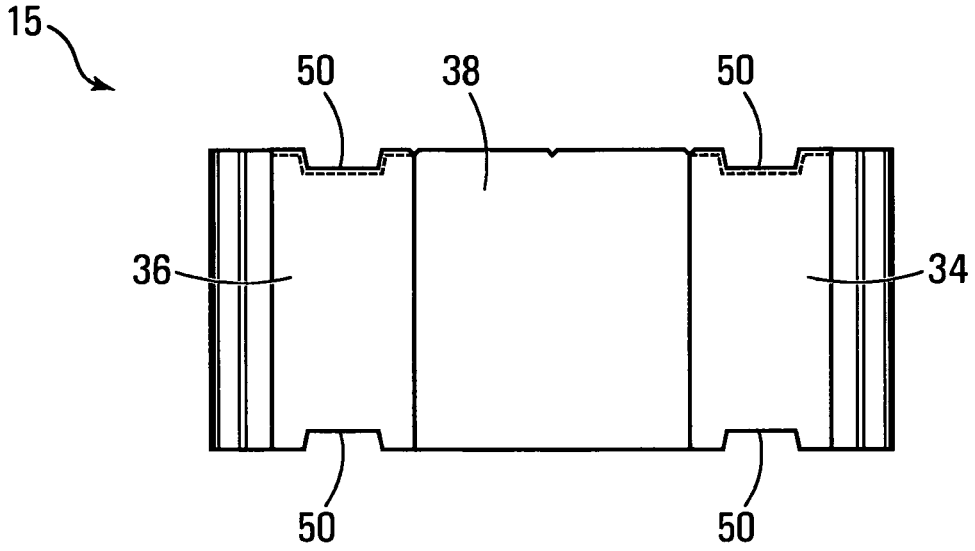


FIG. 9A

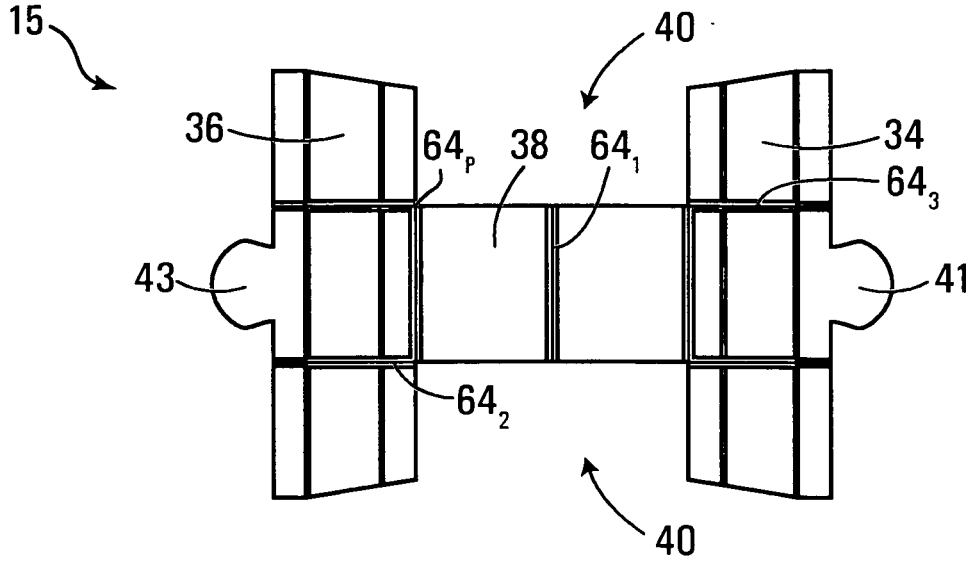


FIG. 9B

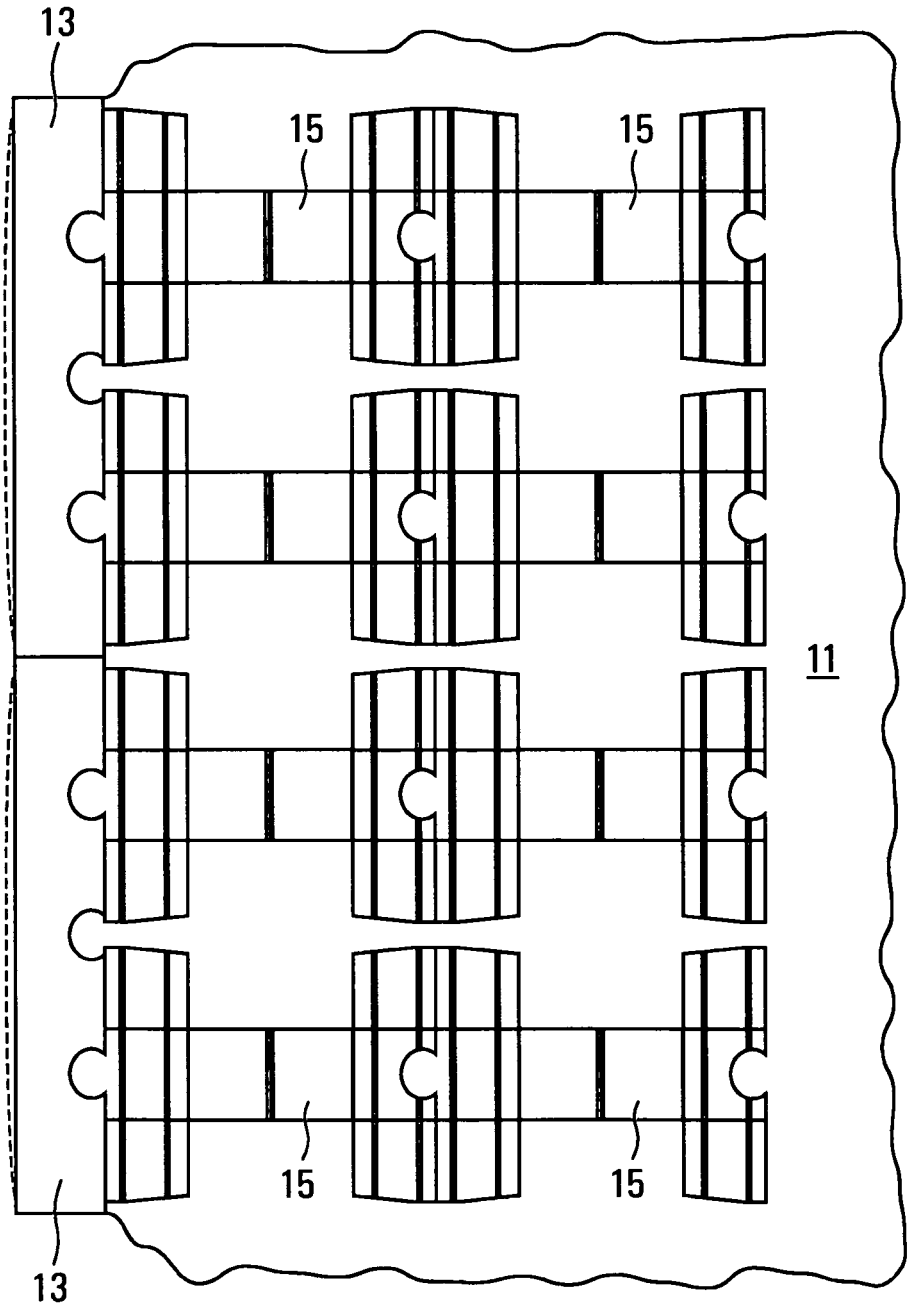


FIG. 10

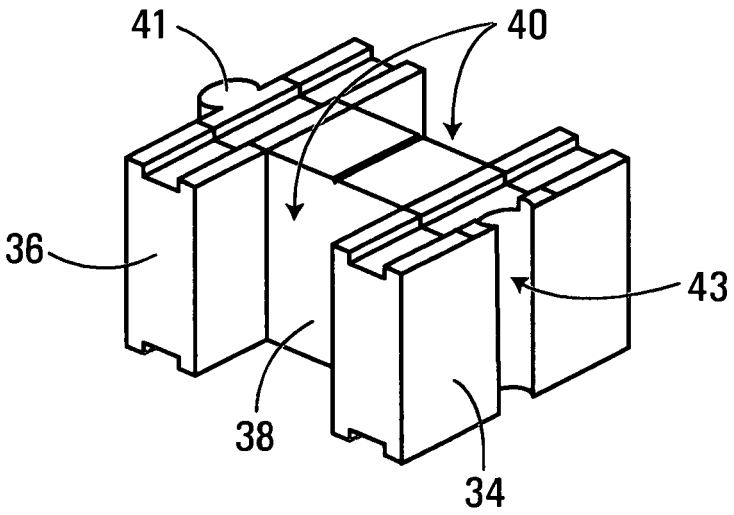


FIG. 11A

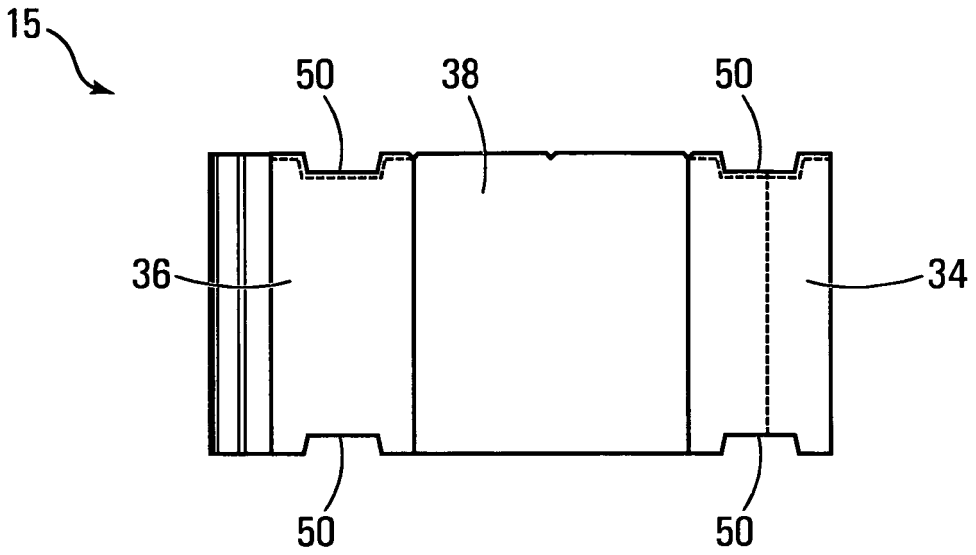


FIG. 11B

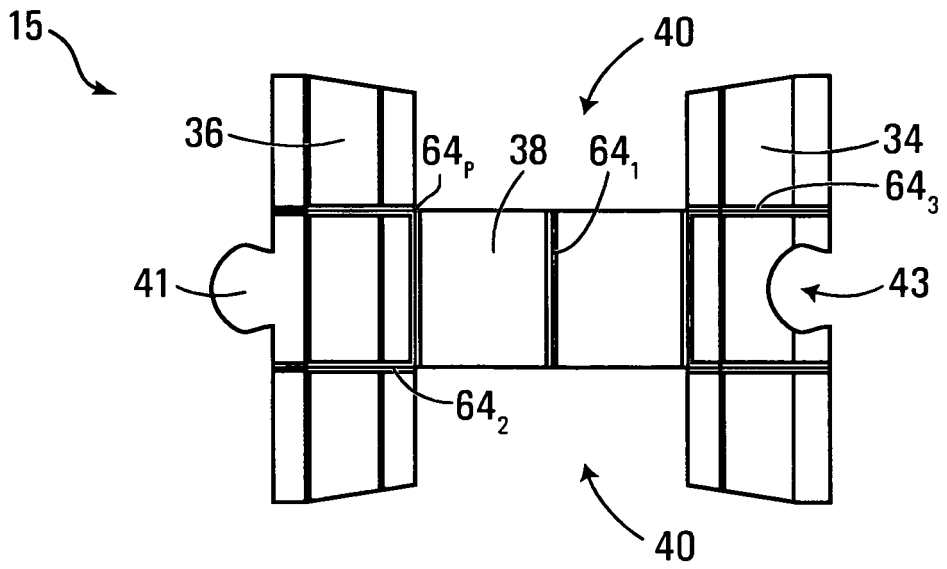


FIG. 11C

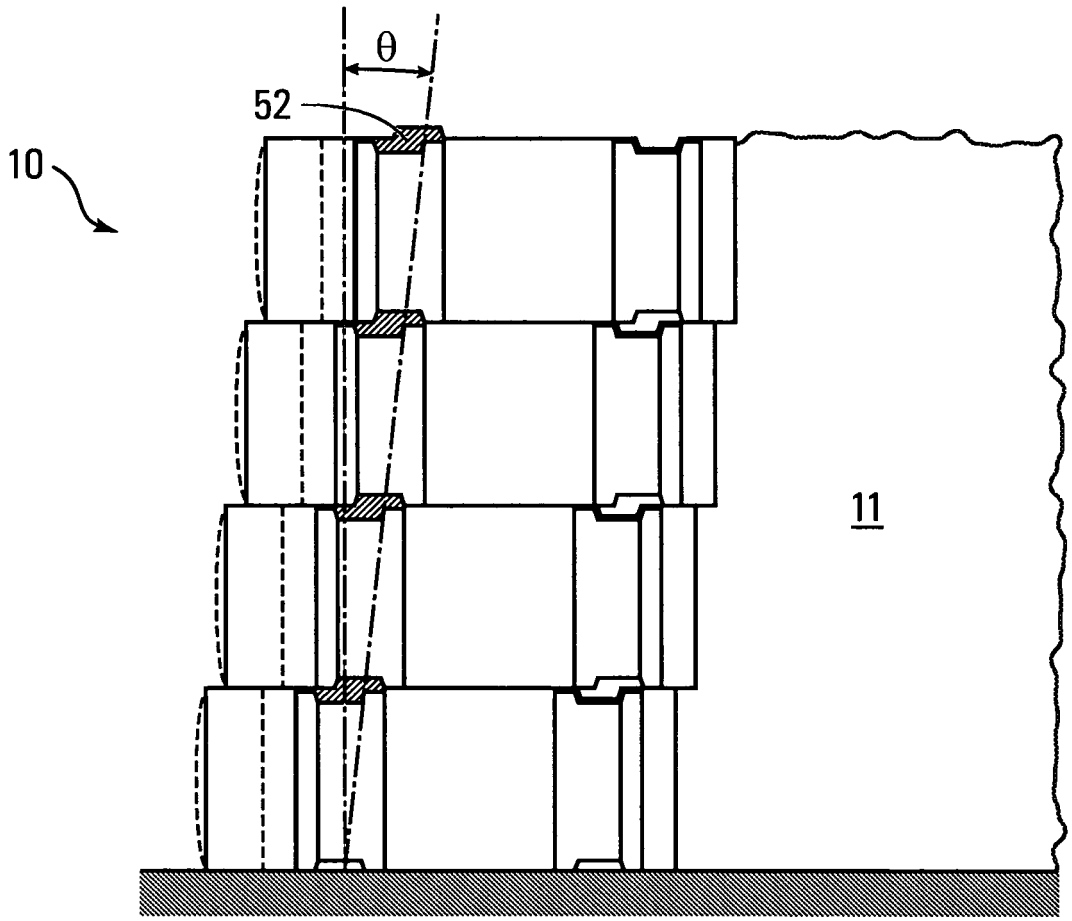


FIG. 12

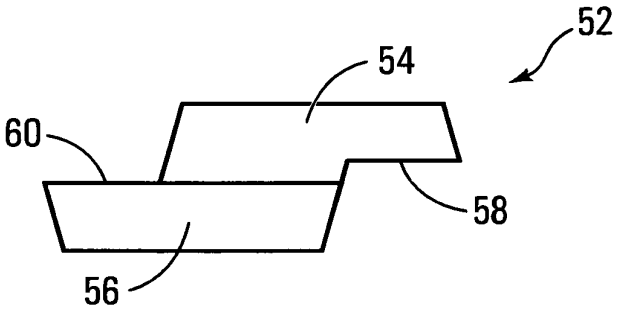


FIG. 13A

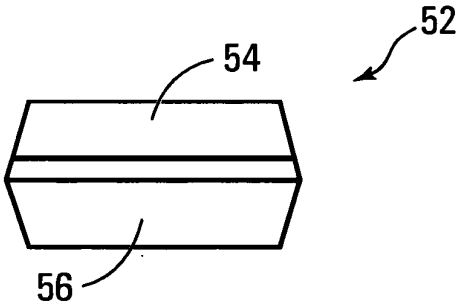


FIG. 13B

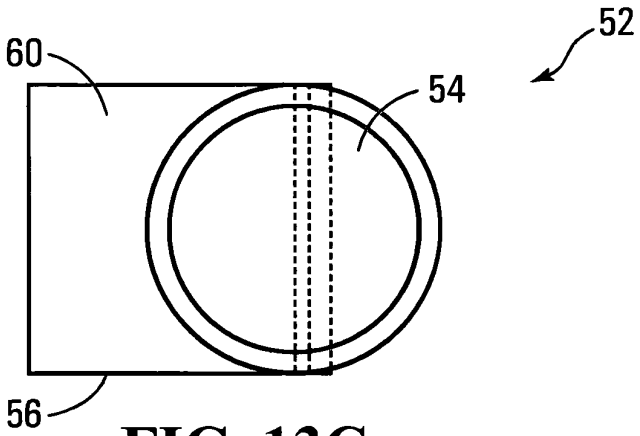


FIG. 13C

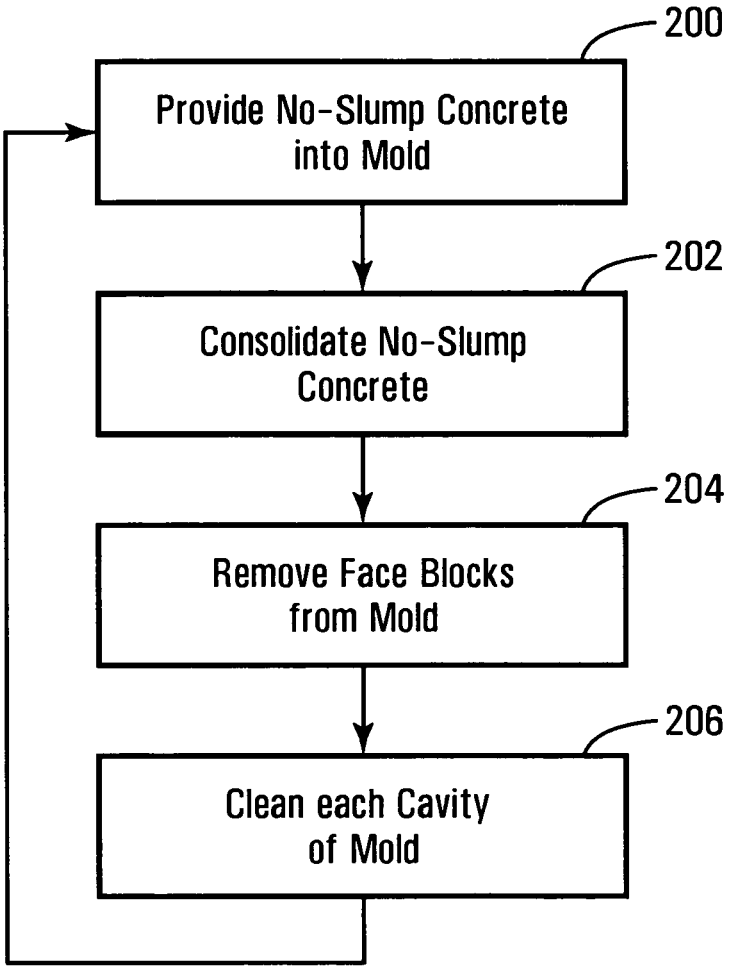

200
Provide No-Slump Concrete into Mold
202
Consolidate No-Slump Concrete
204
Remove Face Blocks from Mold
206
Clean each Cavity of Mold

FIG. 14

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5788423 A **[0006]**
- US 5688078 A **[0007]**