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(54) **Underwater modular structure, module of or for said underwater modular structure and method of constructing an underwater modular structure**

(57) The invention relates to an underwater modular structure comprising a plurality of modules, at least one connector that interlocks the plurality of modules and a labyrinth defined by contours of at least the plurality of modules. The labyrinth of such underwater modular structure may at least in part be defined by outer and/or inner contours of the plurality of modules. The invention also relates to a module of or for an underwater modular structure according to the invention. Finally, the invention relates to a method of constructing an underwater modular structure, the method comprising the steps of sinking a plurality of modules to a seabed interlocking the plurality of modules with at least one connector to form a labyrinth defined by contours of at least the plurality of modules. Such method may further comprise the step of filling at least part of the underwater modular structure with a filler.

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Underwater modular structure, module of or for said underwater modular structure and method of constructing an underwater modular structure

The invention relates to the technical field of underwater structures and methods of constructing underwater structures.

Various known underwater structures are used to protect coasts. Such underwater structures are generally constructed in the form of a dam, which may or may not extend above the surface of the water. In either case, when a wave of the water moves towards the dam, it is urged upwards and may pass over the dam in addition to being partially reflected off the dam. Said wave may reach and impact on a coast or structure beyond the underwater structure. This process encourages undesired alterations of the coast or structure such as erosion and deposition of sediments, deterioration of coastal protection installations such as dikes, floods of hinterland and/or disturbances of an underwater environment.

A purpose of the invention is to provide an underwater structure which is improved relative to the prior art and which abates incoming wave energy. Such underwater structure may thereby protect a coast beyond said underwater structure.

This is achieved by an underwater modular structure according to the invention, which underwater modular structure comprises a plurality of modules, at least one connector that interlocks the plurality of modules and a labyrinth defined by contours of at least the plurality of modules. The purpose is also achieved by a method of constructing an underwater modular structure according to the invention, which method comprises the steps of sinking a plurality of modules to a seabed and interlocking the plurality of modules with at least one connector to form a labyrinth defined by contours of at least the plurality of modules.

The invention further relates to a module of or for an underwater modular structure as described in this application.

Advantageous embodiments of the invention are the subject of dependent claims.

The underwater modular structure forces incoming water to pass through the labyrinth, thereby dissipating wave energy. Wave energy may be dissipated, for example due to turbulence and friction, as the wave is at least in part directed along and/or through the labyrinth. Dissipating wave energy has the effect of reducing wave impact beyond the underwater modular structure, for instance on a nearby coastline or structure. This reduces the erosion of said coastline or structure, especially when this involves sandy beaches. Furthermore, the upwards urge of the wave as it moves

towards the underwater modular structure is reduced compared to conventional underwater structures, such as a dam.

The labyrinth is defined by contours of at least the plurality of modules and may be further defined by the at least one connector.

The term labyrinth in this context is employed to indicate a continuous space defined by contours of at least the plurality of modules. Such continuous space may be filled with water when the underwater modular structure is positioned underwater. The labyrinth may thus comprise paths along which the water may flow both through as well as past the contours of at least the plurality of modules. The labyrinth comprises said paths along which water may flow past the contours to the extent in which these contours affect the flowing past of water, for example through generating turbulence and friction.

The at least one connector that interlocks the plurality of modules may be of a substantially solid form, such as a pipe, rod, beam, hook, rail or plank, and/or of a substantially flexible form, such as a chain or cable. Preferably, the plurality of modules as well as the at least one connector are made of materials suitable for underwater use as known in the art, such as concrete, cement, durable plastics and stainless steel. The material for the plurality of modules need not be the same as that for the at least one connector. For example, modules may comprise concrete while the at least one connector may comprise stainless steel. Furthermore, the at least one connector may at least partly be incorporated in at least one of the plurality of modules.

The underwater modular structure may serve various ends, including coastal protection, protection of off-shore structures, coastal preservation, supporting an underwater ecological habitat and/or forming an artificial reef. These ends may be served by the underwater modular structure in combination or simultaneously. For example, the underwater modular structure may be formed as a breakwater to protect a coastline while also preserving a sandy beach from eroding and further forming a support structure for development of a reef ecosystem. In a further example, the underwater modular structure may form a barrier around an off-shore windfarm to reduce incoming waves and promote a reef habitat for local species.

The invention is illustrated using the following figures, in which:

- FIG. 1 shows a schematic perspective overview of an underwater modular structure according to an embodiment of the invention in construction;
- FIG. 2A, 2B and 2C show schematic perspective overviews of modules of or for an underwater modular structure according to embodiments of the invention;

- FIG. 3A and 3B show schematic cross-sections of a conventional underwater structure and an underwater modular structure according to an embodiment of the invention, respectively, and their resulting dissipation of wave energy;
- FIG. 4 shows a plan view of a cross-section of the underwater modular structure of FIG. 3B along the line IV-IV; and
- FIG. 5 diagrammatically shows steps of a method according to an embodiment of the invention.

The following reference numbers are used in the figures as well as in the accompanying description:

1 underwater modular structure,
2 module,
3 connector,
4 labyrinth,
5 contours,
6 seabed,
7 coast,
8 outer contour of module,
9 inner contour of module,
10 wave,
11 connector insertion opening,
12 outer contour of connector,
13 inner contour of connector,
14 tortuous path,
15 underwater ecological habitat,
16 chamber,
17 filler,
18 sediment,
19 module parts,
20 outer wall,
21 inner wall,
21-1 inner wall defining module part of first type,
21-2 inner wall defining module part of second type,
22 slots,
23 outline,
24 anti-scour apron,

25 anchoring,
26 three-dimensional geometric complexity,
27 textured surface,
28 porous surface,
29 interconnected inlets and outlets,
30 cavity,
31 reef-forming species,
32 dam.

In FIG. 1, an underwater modular structure 1 is shown while being constructed at an underwater construction site. The underwater structure 1 comprises a plurality of modules 2, at least one connector 3 that interlocks the plurality of modules 2 and a labyrinth 4 defined by contours 5 of at least the plurality of modules 2. The underwater modular structure 1 is shown as being constructed on a seabed 6 near a coast 7. Typical depths at which the underwater modular structure 1 may be constructed range from 2 to 10 m below sea surface.

The modular nature of the underwater modular structure 1 presents advantages, for example that the structure 1 is adaptable to local situations, that it is scalable and may be assembled on-site, even under water. Furthermore, local sediments 18 may be used in its construction, as illustrated in FIG. 1, which saves transportation efforts and limits introduction of potentially harmful elements to the underwater construction site.

Interlocking of the plurality of modules 2 by means of the at least one connector 3 ensures stability of the underwater modular structure 1. The at least one connector 3 may thus prevent movement and/or displacement of the underwater modular structure 1 and modules 2 thereof.

The labyrinth 4 of the underwater structure may at least in part be defined by outer contours 8 and/or inner contours 9 of the plurality of modules 2. The seabed 6 may also in part define the labyrinth 4. When a wave 10 approaches the underwater modular structure 1, it is forced to pass through and/or past the labyrinth 4 and thus at least some of the wave energy of wave 10 is dissipated. This is further explained in relation to FIG. 3 below.

The plurality of modules 2 may comprise at least one connector insertion opening 11. Additionally, the at least one connector 3 may interlock the plurality of modules 2 via the at least one connector insertion opening 11. Preferably, connector insertion openings 11 are provided in a sufficient number of the plurality of modules 2 so that the plurality of modules 2 are fully interlocked by means of the at least one connector 3 through the at least one connector insertion opening 11. This

enhances stability of the underwater modular structure 1. More preferably, the connector insertion openings 11 are provided in each module 2 of the plurality of modules 2. This facilitates compatibility between the plurality of modules 2, enhances variability of the underwater modular structure 1 and reduces constructional effort at the underwater construction site.

The at least one connector 3 may be an elongate member. Preferably, the at least one connector 3 is a hollow member. The at least one connector 3 may thus be both elongate as well as hollow, though either elongate or hollow is also possible. For example, the at least one connector 3 may be a pipe with a perimeter of circular, rectangular or polygonal shape and may be a rail, hook or bar. When a connector 3 is designed as a hollow member, such connector 3 may be inserted into connector insertion openings 11 of modules 2 and thereby retain passage through these modules 2 when interlocking these modules 2 through their connector insertion openings 11.

Alternatively or additionally, the at least one connector 3 may comprise a mating recess and protrusion, preferably comprised with the plurality of modules 2. Upon engaging two of the plurality of modules 2, one comprising such recess and the other comprising such protrusion, the recess and protrusion may interlock. The mating recess and protrusion may be provided on each of the plurality of modules 2 to ensure mutual interlocking.

In an advantageous embodiment, the mating recess and protrusion are provided on outer contours 8 of modules 2 at the connector insertion openings 11. This facilitates alignment of the connector insertion openings 11 of the plurality of modules 2 when construction the underwater modular structure 1, especially when this is performed underwater with limited visibility. The at least one connector 3 may then be readily introduced through the connecter insertion openings 11, their alignment being assured through the mating recess and protrusion.

The labyrinth 4 may at least partly be defined by outer contours 12 and/or inner contours 13 of the at least one connector 3. For example, when the at least one connector 3 is the hollow member, it may contribute to the labyrinth 4 with its hollow interior.

At least one of the modules 2 may further comprise a tortuous path 14 further defining the labyrinth. The tortuous path 14 may be internal to the at least one of the modules 2. The tortuous path 14 adds complexity to the labyrinth 4, thus offering an increased number of possible paths for the wave 10 to pass through, thereby enhancing dissipation of wave energy of the wave 10.

Furthermore, the tortuous path 14 may be configured to allow passage of underwater life into and out of the underwater modular structure 1 and/or to offer shelter for underwater life. The underwater modular structure 1 may thus foster underwater life of or for an underwater ecological

habitat 15, in contrast to conventional underwater structures that generally reduce or damage such underwater life and underwater ecological habitat 15.

The underwater modular structure 1 may further comprise at least one chamber 16 that is at least partly filled with a filler 17. The at least one chamber 16 may be comprised within individual modules 2 and/or connectors 3. Alternatively or additionally, the at least one chamber 16 may be comprised between the plurality of modules 2 or may be defined by the plurality of modules 2. Preferably, the at least one chamber 16 is comprised within at least one module 2 of the plurality of modules 1 of the underwater modular structure 1.

The filler 17 may be used to add mass to the underwater modular structure 1, so that it is not easily worn down, moved or displaced by movements of the water, such as arising from waves, tides and passing of ships. Known underwater structures are generally made from solid concrete to prevent such structure from being affected by movements of the water. Solid concrete structures require a large amount of raw materials and correspondingly large transportation and installation equipment resulting in large costs and high environmental impact.

Preferably, the filler 17 is a sediment 18. The sediment 18 may be taken from the seabed 6 on or near the underwater construction site at which the underwater modular structure 1 is built and/or positioned. This allows for easy provision of additional mass to sink and/or stabilise the underwater modular structure 1. Alternatively or additionally, the sediment 18 may be taken from dredging activities or other convenient sources. In this way, residual material may be repurposed.

Furthermore, the modules 2 and/or connectors 3 may be executed in a hollow or light-weight fashion, so that transportation and production effort may be reduced. For example, some of the modules 2 may each comprise the chamber 16 so that these modules 2 may be configured as substantially empty for transportation to the underwater construction site to be filled at the underwater construction site. This limits transportation and installation efforts for such modules 2 and thus also for the underwater modular structure 1 as a whole.

In FIG. 2A, FIG. 2B and FIG. 2C, embodiments of the module 2 are illustrated. Though these three embodiments are presented separately, features of these embodiments may be combined at least in ways that follow from the dependencies in the claims. It should in particular be noted that the plurality of modules 2 may comprise several types of modules 2 and that within each type different versions of modules 2 may be employed.

FIG. 2A illustrates an embodiment of a module 2 comprising module parts 19 that are configured for assembly into said module 2. An assembled view as well as an exploded view of said module 2 are

shown at the top and bottom of FIG. 2A, respectively. At least one of the modules 2 of the underwater modular structure 1 may thus comprise module parts 19 that are configured for assembly into said at least one of the modules 2. The at least one of the modules 2 comprising a tortuous path 14 may be the same as or distinct from the at least one of the modules 2 comprising module parts 19.

The module parts 19 may be configured is various ways, examples of which are presented in FIG. 2A and FIG. 2B. The module parts 19 may be configured for assembly into the module 2 by means of mating edges and/or known fastening elements.

Preferably, the module parts 19 define at least one of an outer wall 20 of said module 2 and an inner wall 21 of said module 2. The modular parts 19 that define the outer wall 20 of said module 2 may mutually engage, mate, interdigitate or couple to form the outer contour 8 of said module 2. The modular parts 19 that define the inner wall 21 of said module 2 may equally engage mutually to form the inner contour 9 of said module 2. Furthermore, the module parts 19 may mutually engage to form both the outer wall 20 as well as the inner wall 21 of said module 2.

In the example of FIG. 2A, the module parts 19 are illustrated to define both the outer wall 20 as well as the inner wall 21 of the module 2 in its assembled state. Furthermore, the outer wall 20 may define the outer contour 8 and the inner wall 21 may define the inner contour 9 of such module 2. FIG. 2A shows three inner wall 20 defining module parts 19, two of a first type 21-1, having five orthogonal openings, and a second type 21-2, having four orthogonal openings. Alternatively, this example may be modified to contain only three inner wall 20 defining module parts 19, all of a third type having six orthogonal openings, said third type ensuring mutual interconnection along the longer axis of the illustrated module 2.

In an advantageous embodiment of the module 2, the chamber 16 may be formed by the module parts 19, for example between the outer wall 20 and the inner wall 21 of said module 2. One of the module parts 19 may be configured for closing the chamber 16 after the chamber 16 is filled with the filler 17, for example as illustrated in FIG. 1.

FIG. 2B illustrates another embodiment of a module 2 which comprises module parts 19 that are configured for assembly into said module 2. An assembled view as well as an exploded view of said module 2 are shown in FIG. 2B. Here, the module parts 19 comprise slots 22 configured for mutual engagement. The module parts 19 with the slots 22 mutually engage or interdigitate to form said module 2. Such module parts 19 may advantageously be formed in a board-like shape with slots cut into sides of the board-like shape. Additionally or alternatively, such module parts 19 may comprise

an outline 23. The outline 23 may be configured to fall within the outer contour 9 of other modules 2 so that, for example, the various illustrated embodiments of modules 2 are mutually compatible.

As illustrated in FIG. 2B, upon assembly of the module 2 comprising of module parts 19 with slots 22, said module 2 may comprise connector insertion openings 11. The slots 22 of the module parts 19 are spaced apart to obtain appropriate dimensions for the connector insertion opening 11.

Though FIG. 2B shows six module parts 19, this is an example only and other numbers of module parts 19 with slots 22 may be employed. For example, the slots 22 may be configured with twice the number of modules parts 19 shown in FIG. 2B while decreasing mutual spacing between the module parts 19 within the module 2, thereby creating smaller openings, paths and/or channels through said module 2 adding to the labyrinth 4. The slots 22 may thus be configured in different arrangements that create openings of different sizes, further dissipating wave energy. In addition or as an alternative, such arrangements which may be optimised for fish and other marine species to shelter and thereby foster the underwater ecological habitat 15.

The various modules 2 disclosed here are preferably configured as mutually compatible. For example, the various modules 2 may be used with the same connectors 3, be placed substantially flush against each other and/or support each other. Furthermore, the various modules 2 may be provided in dimensions such that these are mutually compatible. For example, the module 2 illustrated in FIG. 2A delineates three times the volume of the module 2 illustrated in FIG. 2B, facilitating mutual stacking, interlocking and/or positioning of these modules 2. This compatibility is also illustrated in FIG. 1.

Any embodiment of the underwater modular structure 1 may further comprise an anti-scour apron 24. The anti-scour apron 24 may be formed from, for example, sheet material and/or a cellular confinement system. The anti-scour apron 24 may comprise an anchoring 25 fixed into the seabed 6. The anchoring 25 may be configured to connect to at least one of the plurality of modules 2. Alternatively or additionally, the anchoring 25 may be comprised within the underwater modular structure 1 without the anti-scour apron 24 being present. The anchoring 25 need not be connected to the anti-scour apron 24. In any case, as the plurality of modules 2 are also interlocked by means of the connectors 3, the whole of the underwater modular structure 1 may thus be fixed to the seabed 6. Preferably, multiple anchorings 25 are employed to strongly fix the underwater modular structure 1 to the seabed 6.

FIG. 2C illustrates yet another embodiment of a module 2. Here, at least one of the modules 2 comprises a three-dimensional geometric complexity 26 that further defines the labyrinth 4. The

three-dimensional geometric complexity 26 may equally be combined with any other variant of the modules 2, such as the examples presented in FIG. 2A and FIG. 2B.

The three-dimensional geometric complexity 26 may be configured to stimulate development of the underwater ecological habitat 15. The underwater ecological habitat 15, such as a reef, adds to the three-dimensional geometric complexity 26 which may already be comprised in some of the modules 2 and thus further enhances dissipation of wave energy.

Additionally, the three-dimensional geometric complexity 26 may comprise at least one of a textured surface 27, a porous surface 28, a plurality of interconnected inlets and outlets 29 and a cavity 30. The porous surface 28 is preferably configured to be colonised by underwater organisms, thereby promoting additional geometric complexity that dissipates wave energy and/or development of the underwater ecological habitat 15. For example, the porous surface 28 may promote growth of micro-organisms, mollusca and/or anthozoa that produce nutrients for other marine species of the underwater ecological habitat 15.The three-dimensional geometric complexity 26 may vary between modules 2 and may even vary on a single module 2. For example, the module 2 illustrated in FIG. 2C contains the textured surface 27 on most of its faces, while another face contains the porous surface 28 and cavities 30 are dispersed over all its face. The plurality of interconnected inlets and outlets 29 in the example of FIG. 2C comprise the connector insertion openings 11. Another example of the plurality of interconnected inlets and outlets 29 is illustrated in FIG. 2B. Variation within the plurality of modules 2 and their three-dimensional geometric complexity 26 allows optimization of the dissipation of wave energy and/or of the underwater ecological habitat 15 fostered by the underwater modular structure 1. The invention thus presents a versatile solution that may be implemented in various circumstances.

The plurality of interconnected inlets and outlets 29 may differ from the tortuous path 14 or may at least partly comprise or be at least partly comprised by the tortuous path 14.

The underwater modular structure 1 may be seeded with reef-forming species 31 to promote development of an underwater ecological habitat 15. The reef-forming species 31 may include anthozoa, such as soft and stony corals, and/or mollusca, such as oysters. The reef-forming species 31 may encourage growth of a reef as the underwater ecological habitat 15, which aids in texturizing contours 5 defining the labyrinth 4. The reef-forming species 31 thus in particular stimulate the growth of a reef on the underwater modular structure 1, which adds a layer of complexity to it and aids in further reducing wave energy.

The seeding of the reef-forming species 31 may be arranged on any surface of the underwater modular structure, for example on the contours 5, on outer contours 8 and/or inner contours 9 of the modules 2 and/or on outer contours 12 and/or inner contours 13 of the at least one connector 3. Preferably, the reef-forming species 31 are seeded in specifically prepared cavities on surfaces of the underwater modular structure 1 such as may be comprised with the three-dimensional geometric complexity 26.

The invention may thus also result in a preservation of nature and encouragement of development of the underwater ecological habitat 15 rather than destroying one as is generally the case with conventional underwater structures.

The reef-forming species 31 may be selected based on environmental circumstances at the underwater construction site. This may promote growth of the underwater ecological habitat 15, in particular a reef habitat, within a reduced period of time.

In FIG. 3A, a cross-section of a conventional underwater structure is illustrated near a coast 7 with an incoming wave 10. The conventional underwater structure comprises a dam 32. As the wave 10 approaches this dam 32, the wave 10 results in an upward surge of water along and over the dam 32 which enlarges the wave 10, measured from sea level, as it passes over the dam 32 and approaches the coast 7. In this case, the wave energy is redirected. The wave 10 continues to propagate past the dam 32 with high wave energy which has an impact on the coast 7.

In contrast to this, FIG. 3B illustrates a cross-section of an underwater modular structure 1 according to the invention near the same coast 7 with the same incoming wave 10. The underwater modular structure 1 comprises a labyrinth 4 through which the wave 10 is forced, in part by its own wave energy. This reduces the upward surge of water along and over the underwater modular structure 1 compared to the dam 32. With the invention, the wave energy of the wave 10 is effectively dissipated and only a small amount of this wave energy approaches the coast 7. This may reduce coastal erosion and achieve other effects described in this application.

The underwater modular structure 1 of the invention may dissipate wave energy by depth wave breaking as well as by friction-turbulence. Depth wave breaking is induced because the underwater modular structure 1 makes the water shallower, causing instability to the incoming wave 10, making it fall and break. Friction-turbulence is induced by the underwater modular structure 1 because of its labyrinth 4, which creates turbulence in the incoming wave 10 which through friction dissipates wave energy.

According to the invention, a vast underwater modular structure 1 may be assembled to provide an underwater structure that mimics natural coral reef, which may dissipate up to 97% of the wave energy, contrary to smaller underwater structures according to the prior art. The invention may provide such underwater modular structure 1 as an artificial reef that is stabile with respect to incoming waves 10 and promotes development of an underwater ecological habitat 15.

In FIG. 4, a plan view of the underwater modular structure 1 in cross-section along the line IV-IV is shown. This view illustrates a possible arrangement of the plurality of modules 2 for the underwater modular structure 2. Here, the plurality of modules 2 is interlocked and leaves open areas where modules 2 are absent. This arrangement partially forms the contours 5 that define the labyrinth 4. The wave 10 may flow through the labyrinth 4 and thereby wave energy is dissipated. The illustrated underwater modular structure 1 is further configured to foster an underwater ecological habitat 15 due to its wave dissipation and/or its labyrinth 4. Furthermore, the underwater modular structure 1 according to the invention may work equally well for the wave 10 incident from either side. That is, for incoming waves and waves reflected back from the coast 7 that lies beyond the underwater modular structure 1.

The labyrinth 4 may be defined by any of the features disclosed here and in any combination. In particular, the labyrinth 4 may be defined by one or more than one of:

- contours 5 of at least the plurality of modules 2;
- outer contours 8 and/or inner contours 9 of the plurality of modules 2;
- outer contours 12 and/or inner contours 13 of the at least one connector 3;
- a tortuous path 14 of at least one of the modules 2;
- a three-dimensional geometric complexity 26 of at least one of the modules 2; and/or
- an underwater ecological habitat 15 in or on the underwater modular structure 1.

Any combination of the above features is possible with the invention. The underwater modular structure 1 of the invention thus has an intrinsic versatility in the design of the labyrinth 4 which may be adapted to circumstances at the underwater construction site. The underwater modular structure 1 may also be dismantled and/or adapted as said circumstances change over time.

In FIG. 1, 2A-2C, 3B and 4, several embodiments of modules 2 of or for an underwater modular structure 1 according to the invention are shown. Features described for each of these modules 2 may be combined in any way to form further embodiments of modules 2 of or for an underwater modular 1 structure according to the invention. For example, the plurality of modules 2 may comprise modules 2 including the tortuous path 14, the module parts 19 with slots 22, the chamber

16 and be seeded with reef-forming species 31 and other modules 2 including the three-dimensional complexity 26 with cavities 30 and connector insertion openings 11 with all modules compatibly dimensioned.

In FIG. 5, a method according to an embodiment of the invention is shown. This embodiment comprises the step S1 of sinking the plurality of modules 2 to the seabed 6 and the step S2 of interlocking the plurality of modules 2 with the at least one connector 3 to form the labyrinth 4 defined by contours 5 of at least the plurality of modules 2. Though it is preferred that step S2 follows step S1, as illustrated in FIG. 5, the order may be inverted so that step S1 follows step S2. Furthermore, these steps may be taken simultaneously or partly simultaneously. For example, while step S1 is performed and yet to be completed, the step S2 may be commenced in that a part of the plurality of modules 2 may be interlocked before being sunk to the seabed 6 and/or may be interlocked at the seabed 6 before all of the plurality of modules 2 have been sunk to the seabed 6.

Preferably, the method further comprises the step S3 of filling at least part of the underwater modular structure 1 with the filler 17. Step S3 may be performed after the steps S1 and S2 are completed, before any of the steps S1 and S2 are commenced or at least partly simultaneously with either or both of the steps S1 and S2. In FIG. 5, step S3 is illustrated after performing step S2, which has the advantage that the filler 17 is yet absent from the underwater structure and therefore may not interfere with interlocking the plurality of modules 2 with the at least one connector 3. An alternative is illustrated in FIG. 1, where one of the plurality of modules 2 is being filled while the underwater modular structure 1 is being constructed, *i.e.* steps S1 and S2 are ongoing.

More preferably, the step S3 further comprises the step S3A of pumping the sediment 18 from the seabed 6 into the underwater modular structure 1. The use of the sediment 18 from the seabed 6 to fill the modules 2 has several advantages, including that the method need not comprise transporting, sinking or producing filler 17 at or to the construction site. This saves times and effort, especially when compared to pre-filled modules 2 or solid construction elements that are conventionally made of concrete.

As illustrated in FIG. 1, the sediment 18 may be pumped from the seabed 6 into a partially assembled module 2, preferably into the chamber 16 of said module 2, by means of a pump, such as a submergible pump or a pump on a ship.

Preferably, the method further comprises the step S4 of assembling at least one of the modules 2 from module parts 19. This has the advantage that merely the module parts 19, which are preferably prefabricated, rather than whole modules 2 need transportation to the underwater construction

site. Step S4 may be performed before S1, as illustrated in FIG. 5, though this order is not restrictive. For instance, S4 may be performed after S1. In other words, the module parts 19 may be sunk to the seabed 6 for assembly at the seabed 6 into the at least one of the modules 2. Alternatively or additionally, step S4 may be performed above sea surface, for instance on board a construction vessel, a platform or a nearby coast such as the coast 7. Step S4 may further be subdivided into constructional steps performed at various locations above and/or under water.

Preferably, the method further comprises the step S5 of mounting the anti-scour apron 24 on the seabed 6. As illustrated in FIG. 5, step S5 is preferably executed before step S1, irrespective of if or when step S4 is performed. However, this order is not restrictive. Other sequences may be envisaged, such as performing step S5 after step S1 with or without performing step S4. The anti-scour apron 24 may be mounted after some or all of the plurality of modules 2 has been sunk to the seabed 6 so that, for example, the anti-scour apron 24 is only mounted on part of the seabed 6 surrounding the underwater modular structure 1.

Preferably, the method further comprises the step S6 of seeding the underwater modular structure 1 with reef-forming species 31. The advantages of the reef-forming species 31 are described above and equally apply for the method according to the invention. Step S6 is preferably performed near or at the end of the method, as is also illustrated in FIG. 5. However, the sequence is not restrictive as, for example, step S6 may be performed straight after step S1 or even before S1. That is, the reef-forming species 31 may be seeded on the plurality of modules 2 before and/or after these are sunk to the seabed 6. Care should be taken to ensure survival of the seeded reef-forming species 31 whenever step S6 is included in the method. For example, it is preferred that step S3, if included in the method with or without S3A, is performed before S6 and waters are left to sufficiently clear before performing step S6.

The method may further include the step S7 of shaping the seabed 6. This may serve to enhance stability of the underwater modular structure 1, facilitate step S5, influence flow of water or may form part of step S3A. As illustrated in FIG. 5, step S7 is preferably performed before S5, though this order is not restrictive. Step S7 may be performed at any time within the method, for example after step S2 when step S7 may serve to embed the underwater modular structure 1 in the seabed 6 or to cover part of the underwater modular structure 1 with the sediment 18 and/or the seabed 6.

The order in which the steps are illustrated in FIG. 5 is not intended as restrictive. The steps S3, S3A, S4, S5, S6 and/or S7 may be left out according to circumstances, though steps S1 and S2 are preferred in all embodiments of the method according to the invention.

The method performed according to any combination of the above steps may comprise constructing an underwater modular structure 1 according to the invention. In this particular case, the steps S1 and S2 are essential.

Though the invention is described in the context of an underwater modular structure 1 near the coast 7, the nearness of said coast 7 is not required. For example, the invention may equally be employed in a preferably shallow sea distant from coasts. Alternatively or additionally, the underwater modular structure 1 may be positioned near a coastal or off-shore structure such as a sandbank, pier, platform, quay, lighthouse and wind turbine.

The invention thus provides an underwater modular structure 1 of configurable complexity. This complexity may be optimised for particular circumstances at the underwater construction site. The underwater modular structure 1 may thus be configured to promote a particular underwater ecological habitat 15 including target species. For example, growth of oysters may be promoted in colder waters while corals may be promoted in warmer waters. As a further example, the underwater modular structure 1 may provide areas accessible to sunlight and shadow areas, promoting corals and sponges, respectively, each contributing to the underwater ecological habitat 15.

Although preferred embodiments of the invention have been described above, these embodiments are intended only to illustrate the invention and not to limit in any way the scope of the invention. Accordingly, it should be understood that where features mentioned in the appended claims are followed by reference signs, such signs are included solely for the purpose of enhancing the intelligibility of the claims and are in no way limiting on the scope of the claims. Furthermore, it is particularly noted that the skilled person can combine technical measures of the different embodiments, such as the module parts 19 that define the inner wall 21 of at least one of the plurality of modules 2 wherein the inner wall 21 comprises the three-dimensional geometric complexity 26. The scope of the invention is therefore defined solely by the following claims.

Conclusies

1. Modulaire onderwaterstructuur (1) omvattende:
- een veelvoud van modules (2);
- ten minste één connector (3), die het veelvoud van modules (2) aaneensluit; en
- een labyrint (4), dat door contouren (5) van ten minste het veelvoud van modules (2) is gedefinieerd.

2. Modulaire onderwaterstructuur (1) volgens conclusie 1, waarbij het labyrint (4) ten minste gedeeltelijk is gedefinieerd door uitwendige contouren (8) en/of inwendige contouren (9) van het veelvoud van modules (2).

3. Modulaire onderwaterstructuur (1) volgens conclusie 1 of 2, waarbij:
- het veelvoud van modules (2) ten minste één connectorinsteekopening omvat; en
- de ten minste éne connector (3) het veelvoud van modules (2) via de ten minste éne connectorinsteekopening (11) aaneensluit.

4. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, waarbij de ten minste éne connector (3) een langgerekt orgaan is.

5. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, waarbij de ten minste éne connector (3) een hol orgaan is.

6. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, waarbij het labyrint (4) ten minste gedeeltelijke is gedefinieerd door uitwendige contouren (12) en/of inwendige contouren (13) van de ten minste éne connector (3).

7. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, waarbij ten minste één van de modules (2) verder een kronkelend pad (14) omvat dat het labyrint (4) verder definieert.

8. Modulaire onderwaterstructuur (1) volgens conclusie 7, waarbij het kronkelende pad (14) verder is geconfigureerd om het passeren van onderwaterleven in en uit de modulaire onderwaterstructuur (1) mogelijk te maken en/of schuilplaatsen voor onderwaterleven te bieden.

9. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, waarbij de modulaire onderwaterstructuur (1) verder ten minste één kamer (16) omvat die ten minste gedeeltelijk met een vuller (17) is gevuld.

10. Modulaire onderwaterstructuur (1) volgens conclusie 9, waarbij de vuller (17) een sediment (18) is.

11. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, waarbij ten minste één van de modules (2) moduledelen (19) omvat die voor assemblage tot een module (2) zijn geconfigureerd.

12. Modulaire onderwaterstructuur (1) volgens conclusie 11, waarbij de moduledelen(19) ten minste één definiëren van:

- een buitenwand (20) van genoemde module (2); en
- een binnenwand (21) van genoemde module (2).

13. Modulaire onderwaterstructuur (1) volgens conclusie 11 of 12, waarbij de moduledelen (19) sleuven (22) omvatten die voor onderling ineengrijpen zijn geconfigureerd.

14. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, verder omvattende een erosie-belemmerend schort (24).

15. Modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies, waarbij ten minste één van de modules (2) een driedimensionale geometrische complexiteit (26) omvat die het labyrint (4) verder definieert.

16. Modulaire onderwaterstructuur (1) volgens conclusie 15, waarbij de driedimensionale geometrische complexiteit (26) is geconfigureerd om ontwikkeling van een ecologische onderwaterhabitat (15) te stimuleren.

17. Modulaire onderwaterstructuur (1) volgens conclusie 15 of 16, waarbij de driedimensionale geometrische complexiteit (26) ten minste omvat één van:

- een van een textuur voorzien oppervlak (27);
- een poreus oppervlak (28);
- een veelvoud van onderling verbonden in- en uitgangen (29); en
- een holte (30).

18. Modulaire onderwaterstructuur (1) van een willekeurige van de voorgaande conclusies, bezaaid/beplant met rif-vormende soorten (31) om ontwikkeling van een ecologische onderwaterhabitat (15) te bevorderen.

19. Module (2) van of voor een modulaire onderwaterstructuur (1) volgens een willekeurige van de voorgaande conclusies.

20. Werkwijze van het construeren van een modulaire onderwaterstructuur (1), de werkwijze omvattende de stappen van:

- het afzinken (S1) van een veelvoud van modules (2) naar een zeebodem (6); en
- het aaneenkoppelen (S2) van het veelvoud van modules (2) met ten minste één connector (3) om een labyrint (4) te vormen dat door contouren (5) van ten minste het veelvoud van modules (2) wordt gedefinieerd.

21. Werkwijze volgens conclusie 20, verder omvattende de stap van het vullen (S3) van ten minste een deel van de modulaire onderwaterstructuur (1) met een vuller (17).

22. Werkwijze volgens conclusie 21, waarbij de stap van het vullen (S3) van ten minste het deel van de modulaire onderwaterstructuur (1) met een vuller (17) verder het pompen (S3A) omvat van een sediment (18) van de zeebodem (6) in de modulaire onderwaterstructuur (1).

23. Werkwijze volgens een willekeurige van de conclusies 20 tot en met 22, verder omvattende de stap van het assembleren (S4) van ten minste één van de modules (2) uit moduledelen (19).

24. Werkwijze volgens een willekeurige van de conclusies 20 tot en met 23, verder omvattende de stap van het op de zeebodem (6) aanbrengen (S5) van een erosie-belemmerend schort (24).

25. Werkwijze volgens een willekeurige van de conclusies 20 tot en met 24, verder omvattende de stap van het bezaaien/beplanten (S6) van de modulaire onderwaterstructuur (1) met rif-vormende soorten (31).

26. Werkwijze volgens een willekeurige van de conclusies 20 tot en met 25, omvattende het construeren van een modulaire onderwaterstructuur (1) volgens een willekeurige van de conclusies 1 tot en met 18.

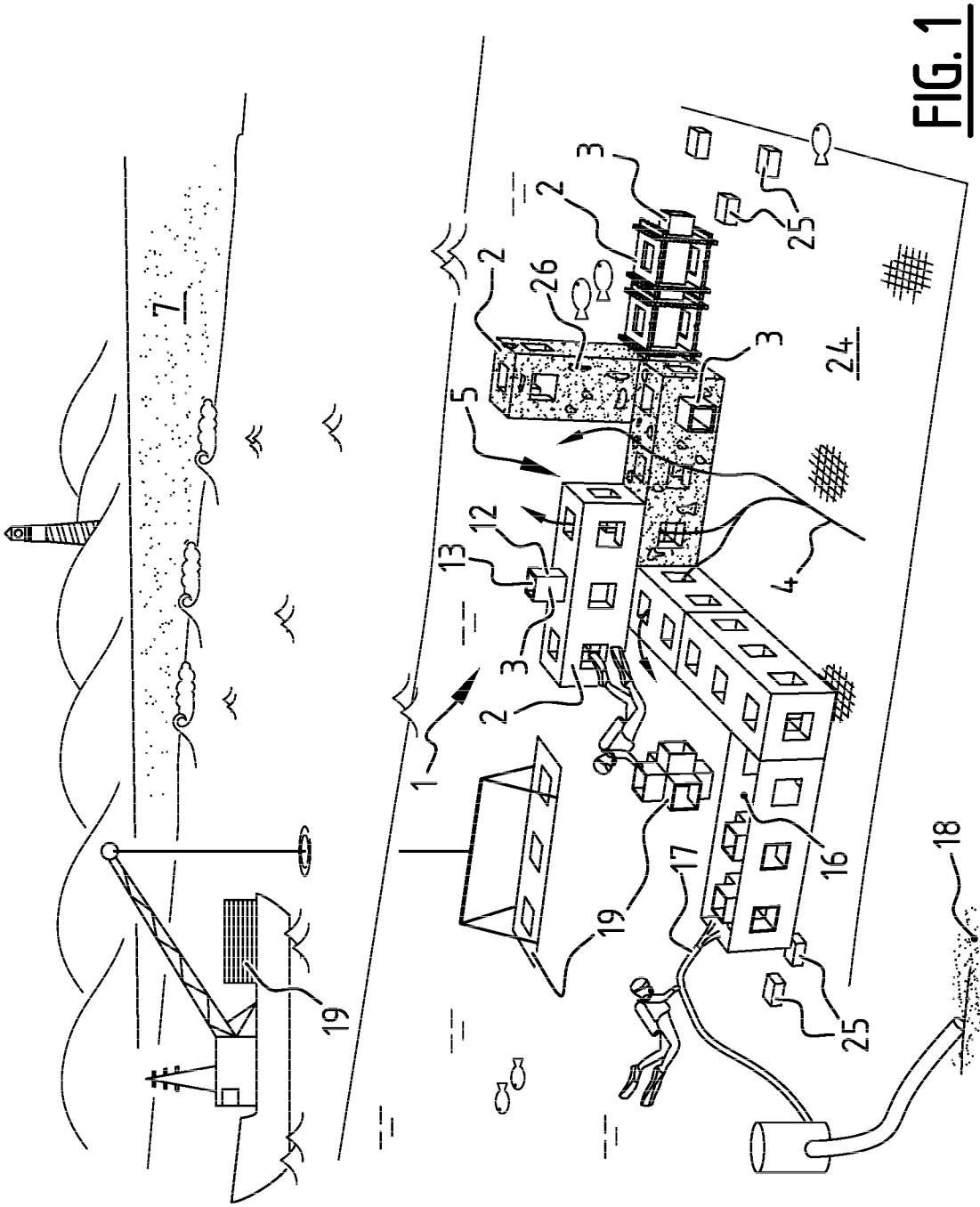

FIG. 1

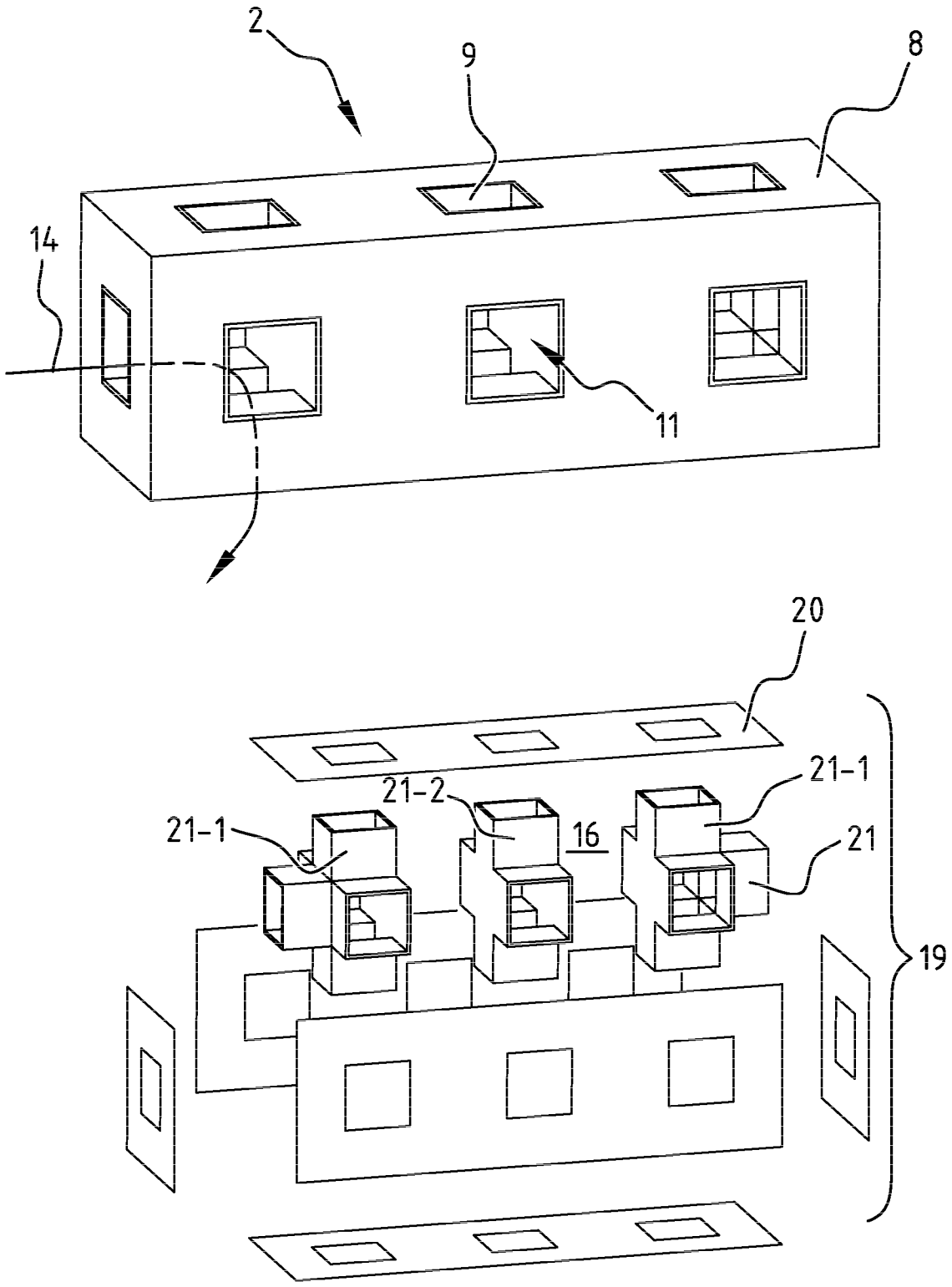

FIG. 2A

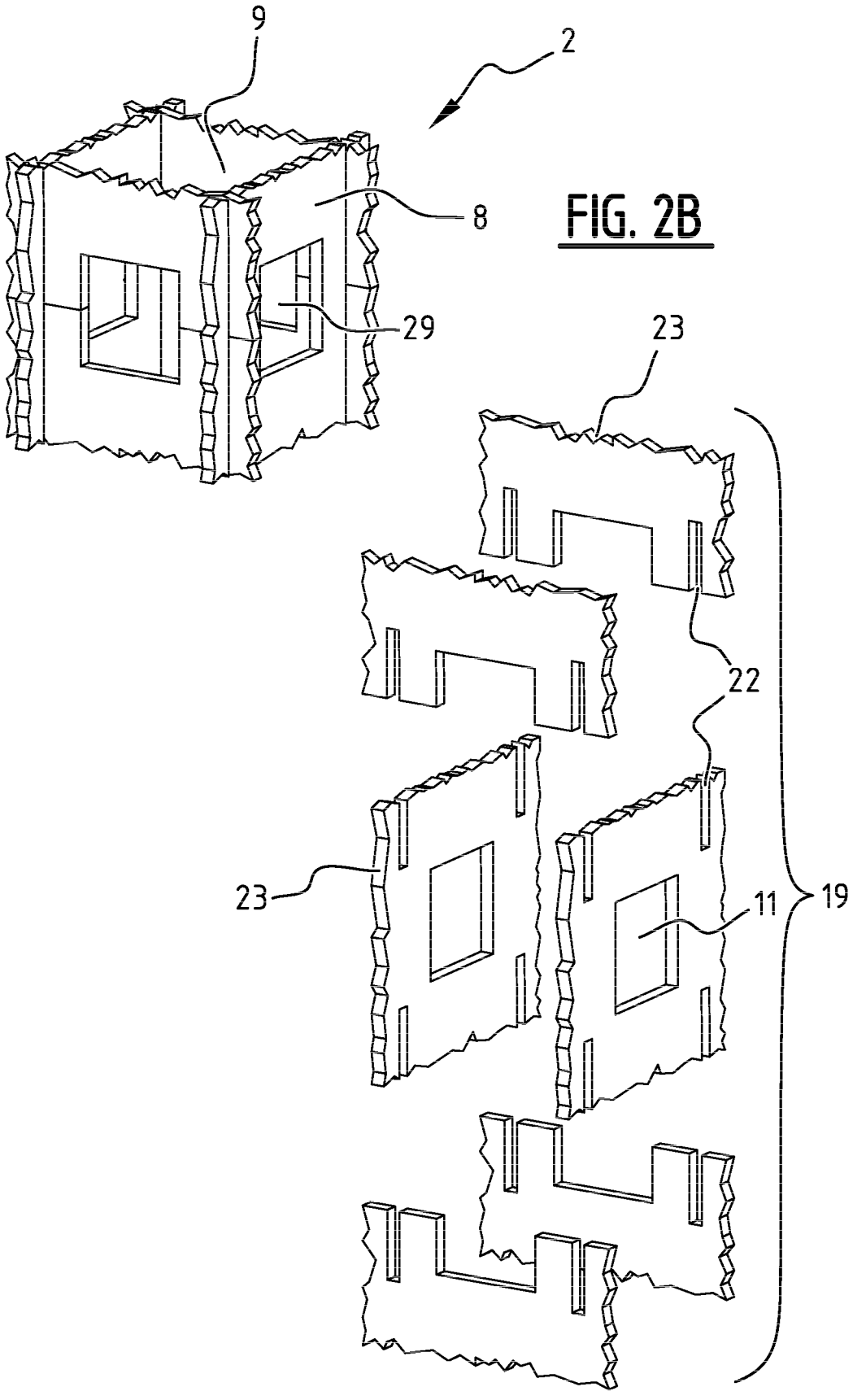

FIG. 2B

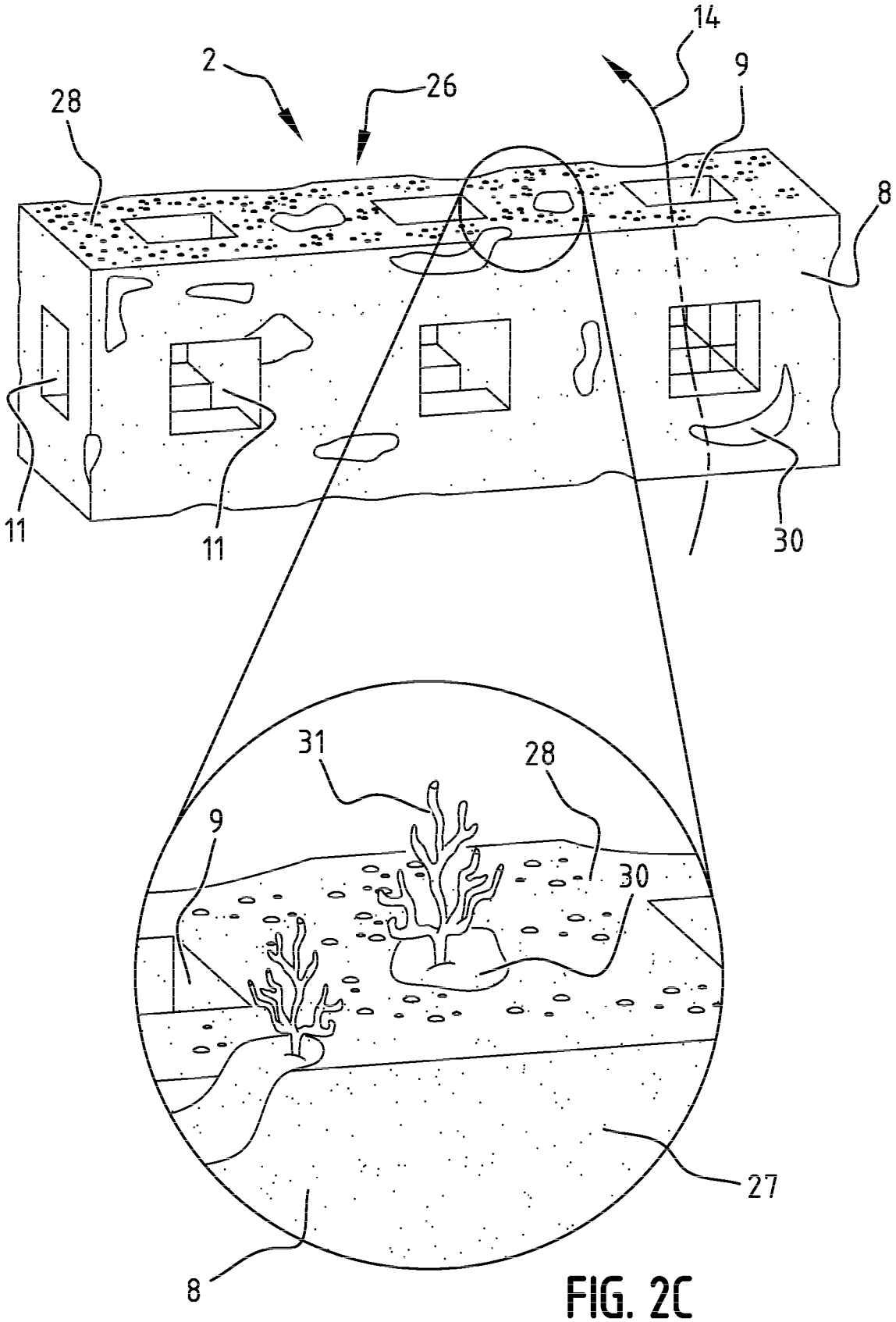

FIG. 2C

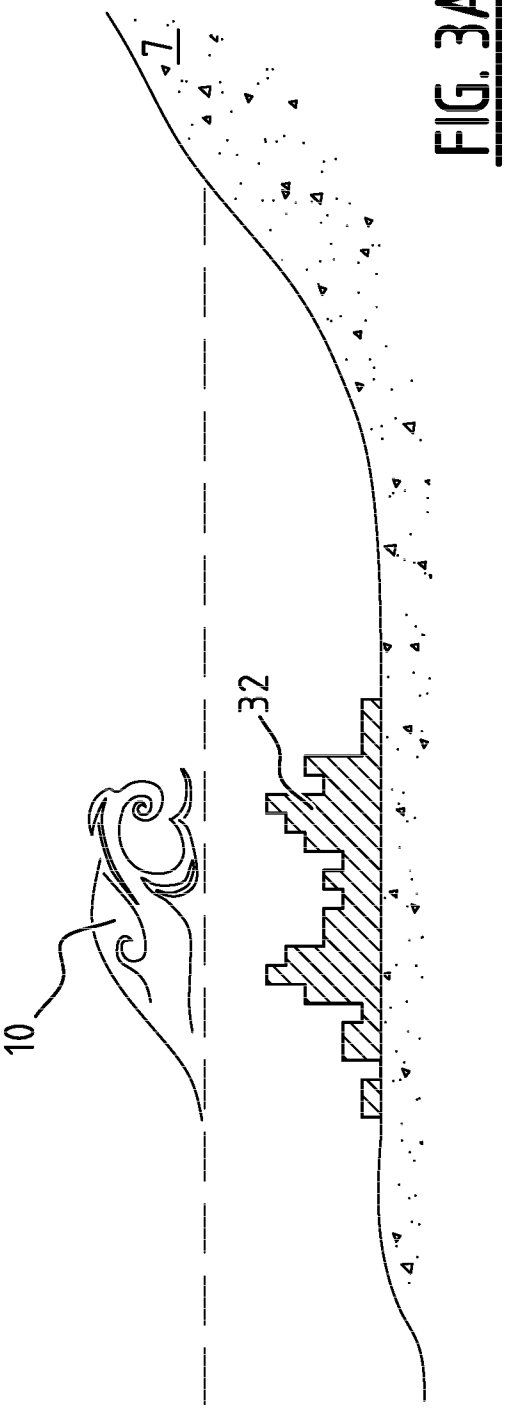

FIG. 3A

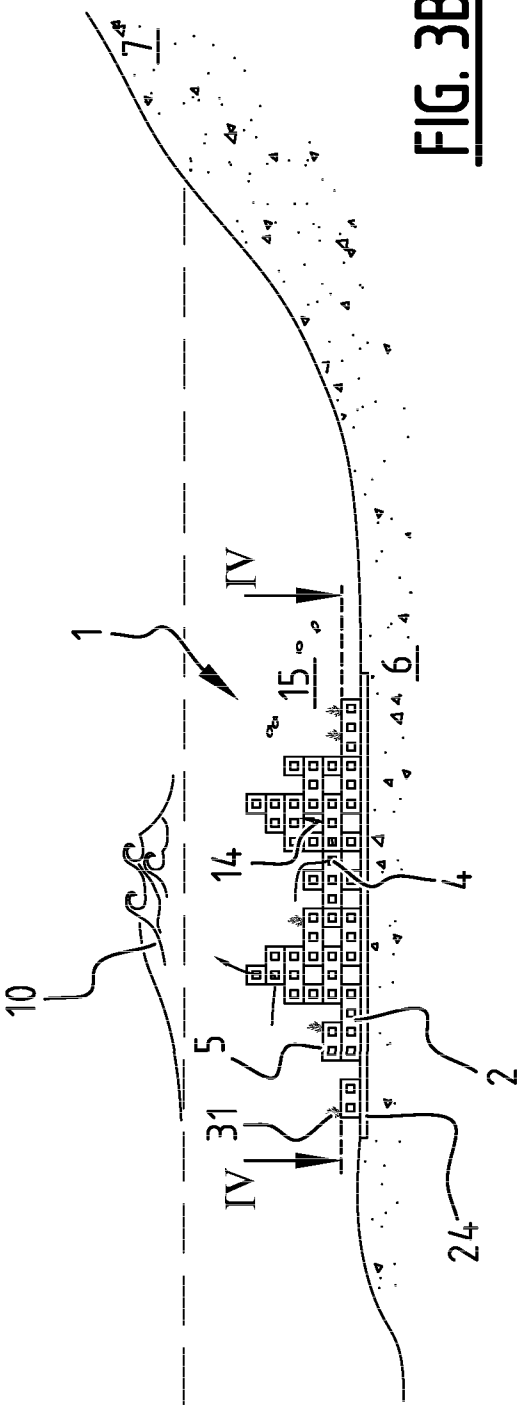

FIG. 3B

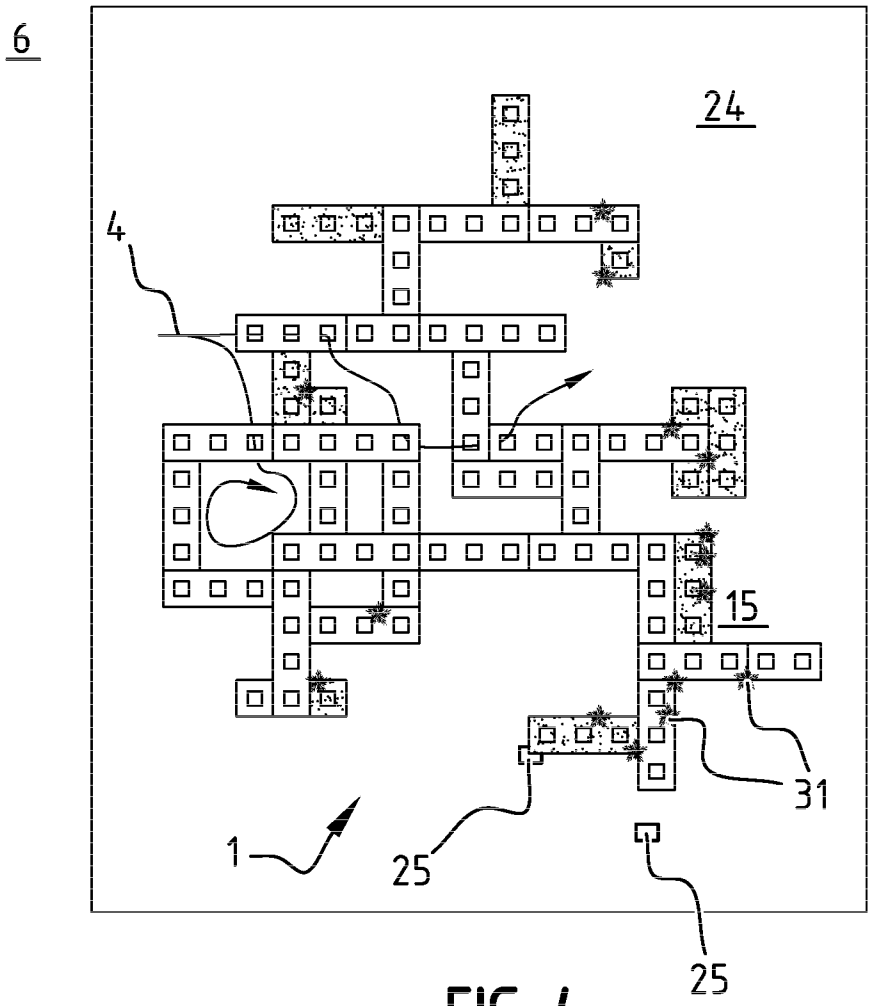

FIG. 4

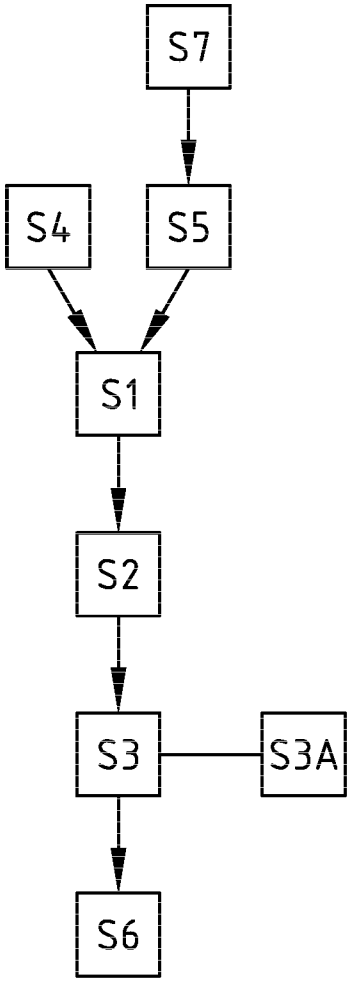

FIG. 5

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	5Y/P167726NL00
Nederlands aanvraag nr. **2024156**	Indieningsdatum **04-11-2019**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Jaime Alejandro Ascencio Ascencio, et al**	
Datum van het verzoek voor een onderzoek van internationaal type **08-02-2020**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN75468**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

Zie onderzoeksrapport

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**Zie onderzoeksrapport**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III. ☐ **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES** (opmerkingen op aanvullingsblad)

IV. ☐ **GEBREK AAN EENHEID VAN UITVINDING** (opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2024156

A. CLASSIFICATIE VAN HET ONDERWERP
INV. E02B3/04 E02B3/06
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
E02B E02C

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X Y	WO 2014/068151 A1 (UNDEROCEANS MARINE INNOVATION S L [ES] ET AL.) 8 mei 2014 (2014-05-08) * het gehele document *	1-8,14, 19,20, 24,26 9-13, 15-18, 21-23,25

Y A	WO 03/002827 A1 (TAMNOR MAN & CONSULTING LTD [IL]; KENT ELIYAHU [IL]; ALKON YORAM [IL]) 9 januari 2003 (2003-01-09) * bladzijde 2, alinea 1 * * bladzijde 9, regels 12-23 * * bladzijde 13, regel 1 - regel 4 * * bladzijde 18, regel 24 - bladzijde 19, regel 9; figuren *	9,10, 15-18, 21,22,25 1,20

	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
17 juli 2020	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fordham, Alan

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2024156

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
Y	BG 110 575 A (PURLICHEV DIMITUR [BG]) 29 juli 2011 (2011-07-29)	11-13,23
A	* het gehele document *	1,20

A	WO 2010/082198 A2 (OCEAN BRICK SYSTEM OBS LTD [IL]; ALKON YORAM [IL]; BIRNHACK KOBI [IL]) 22 juli 2010 (2010-07-22) * conclusies 1,5; figuren *	15-17,25

A	US 6 896 445 B1 (ENGLER ERIC [US]) 24 mei 2005 (2005-05-24) * het gehele document *	1-26

A	JP H09 242044 A (KASHIWAZAKI AKIRA; FUKAYA SADAYOSHI) 16 september 1997 (1997-09-16) * het gehele document *	1-26

A	WO 2011/016068 A1 (LAI EUGENIO [IT]) 10 februari 2011 (2011-02-10) * het gehele document *	1-26

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek: NL 2024156

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2014068151 A1	08-05-2014	GEEN	
WO 03002827 A1	09-01-2003	AT 357564 T	15-04-2007
		DE 60219014 T2	03-01-2008
		DK 1404927 T3	30-07-2007
		EP 1404927 A1	07-04-2004
		ES 2286261 T3	01-12-2007
		JP 4060790 B2	12-03-2008
		JP 2004530822 A	07-10-2004
		PT 1404927 E	29-06-2007
		US 2004182299 A1	23-09-2004
		WO 03002827 A1	09-01-2003
BG 110575 A	29-07-2011	---	
WO 2010082198 A2	22-07-2010	BR PI1007892 A2	13-03-2018
		CN 102348853 A	08-02-2012
		EP 2376712 A2	19-10-2011
		JP 5658168 B2	21-01-2015
		JP 2012515280 A	05-07-2012
		US 2012051845 A1	01-03-2012
		WO 2010082198 A2	22-07-2010
US 6896445 B1	24-05-2005	US 6896445 B1	24-05-2005
		WO 2005068728 A1	28-07-2005
JP H09242044 A	16-09-1997	GEEN	
WO 2011016068 A1	10-02-2011	GEEN	

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN75468	04.11.2019		NL2024156

International Patent Classification (IPC)
INV. E02B3/04 E02B3/06

Applicant
Jaime Alejandro Ascencio Ascencio, et al

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

	Examiner
	Fordham, Alan

Application number

WRITTEN OPINION

NL2024156

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	9-18, 21-25
	No:	Claims	1-8, 19, 20, 26
Inventive step	Yes:	Claims	
	No:	Claims	1-26
Industrial applicability	Yes:	Claims	1-26
	No:	Claims	

2. Citations and explanations

see separate sheet

1 **Re Item V**

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.1 Reference may be made to any of the following documents:

D1 WO 2014/068151 A1 (UNDEROCEANS MARINE INNOVATION S L [ES] ET AL.) 8 mei 2014 (2014-05-08)

D2 WO 03/002827 A1 (TAMNOR MAN & CONSULTING LTD [IL]; KENT ELIYAHU [IL]; ALKON YORAM [IL]) 9 januari 2003 (2003-01-09)

D3 BG 110 575 A (PURLICHEV DIMITUR [BG]) 29 juli 2011 (2011-07-29)

D4 WO 2010/082198 A2 (OCEAN BRICK SYSTEM OBS LTD [IL]; ALKON YORAM [IL]; BIRNHACK KOBI [IL]) 22 juli 2010 (2010-07-22)

D5 US 6 896 445 B1 (ENGLER ERIC [US]) 24 mei 2005 (2005-05-24)

D6 JP H09 242044 A (KASHIWAZAKI AKIRA; FUKAYA SADAYOSHI) 16 september 1997 (1997-09-16)

D7 WO 2011/016068 A1 (LAI EUGENIO [IT]) 10 februari 2011 (2011-02-10)

1.2 The present application does not meet the criteria of patentability, because the subject-matter of claims 1 and 20 is not new.

1.2.1 Document D1 discloses (see the whole document):

een modulaire onderwaterstructuur omvattende:
- een veelvoud van modules (1);
- ten minste één connector (9, 10, 11, 13), die het veelvoud van modules aaneensluit; en
- een labyrint (see figures, in particular marine current 12 and baffles 15), dat door contouren van ten minste het veelvoud van modules is gedefinieerd.

1.2.2 Document D1 also discloses (see again the whole document, in particular paragraphs [0026] to [0029] and figures):

een werkwijze van het construeren van een modulaire onderwaterstructuur, de werkwijze omvattende de stappen van:
- het afzinken van een veelvoud van modules (1) naar een zeebodem; en
- het aaneenkoppelen van het veelvoud van modules met ten minste één connector (9, 10, 11, 13) om een labyrint te vormen dat door contouren van ten minste het veelvoud van modules wordt gedefinieerd (see figures, in particular marine current 12 and baffles 15).

1.2.3 Therefore, combinations of all of the features of at least one variant of the subject matter of each of claims 1 and 20 - and also of dependent claim 26 - already are known from the prior art.

1.3 Dependent claims 2 to 19 and 21 to 25 do not meet the requirements of novelty and/or inventive step for the following reasons:

1.3.1 All of the features introduced by claims 2 to 8 and 19 also are disclosed, in combination with those mentioned above in paragraph 1.2.1, in document D1. See in particular, with regard to all claims, the figures.

1.3.2 The features introduced by at least one variant of each of claims 9, 10, 15-17*, 21, 22 and 25* have already been employed for the same respective purposes in a similar onderwaterstructuur or werkwijze: see document D2, in particular bladzijde 2, alinea 1, bladzijde 9, regels 12-23; bladzijde 13, regel 1 - regel 4; bladzijde 18, regel 24 - bladzijde 19, regel 9; figuren.

*implicitly disclosed in D2: see also document D4, in which these features are explicitly related to an almost identical onderwaterstructuur

1.3.3 The features introduced by at least one variant of claims 11 to 13 and 23 have already been employed for the same respective purposes in a similar onderwaterstructuur or werkwijze: see document D3, in het gehele document, in particular Figs. 1 and 2.

1.3.4 It would therefore be obvious to the person skilled in the art to apply the features referred to above in paragraphs 1.3.2 and 1.3.3 with their respective corresponding effects to a modulaire onderwaterstructuur or a werkwijze according to document D1, thus arriving at a modulair onderwaterstructuur or a werkwijze according to each of these claims.

1.3.5 The features introduced by at least one variant of each of claims 14 and 24 both appear to represent nothing more than the customary practice followed by persons skilled in the art, especially as the advantages - prevention of scour in situations where the sea bed is susceptible to it - thus achieved can readily be foreseen. Consequently, the subject-matter of these claims also lacks an inventive step.