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(54) **APPARATUS AND METHOD FOR MANUFACTURING CERAMIC PRODUCTS**

(57) An apparatus and method for manufacturing ceramic products (2); a blank (4) comprising clay and up to 25% by weight of water is pressed between a first half-shell (5) of a mold (3) and at least a second half-shell (6) of the mold (3), so as to obtain a ceramic product (2); the first half-shell (5) comprises a molding body (7) having a molding surface (8) provided with a given shape which is pressed onto a face (10) of the blank (4) so as to obtain at least part of a face (11) of the ceramic product (2); during the compression of the blank (4), a gas is pressed through the molding body (7) towards the second half-shell (6); the ceramic product is subsequently fired.

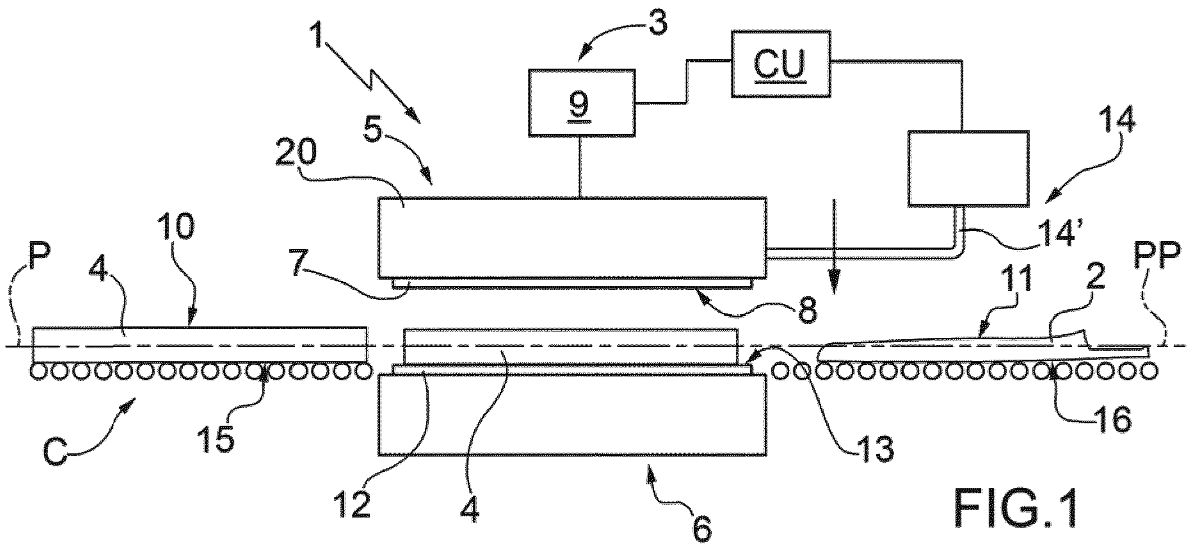

FIG.1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from Italian Patent Application No. 102017000076893 filed on 07/07/2017.

TECHNICAL FIELD

[0002] The present invention relates to an apparatus and a method for manufacturing ceramic products.

BACKGROUND TO THE INVENTION

[0003] In the field of manufacturing ceramic products, for example tiles, crockery (such as cups, oven-proof dishes etc.) and decorative items, molds with half-shells provided with plaster molding bodies are commonly used, which are adapted to transfer their surface shape to blanks (clay parallelepipeds with a water percentage lower than 25%). This type of mold allows the manufacture of ceramic products of good aesthetic quality with shape very similar to that of the surfaces of the molding bodies. It is possible to obtain these types of results because the ceramic products are easily de-molded from the half-shells. The ease of separation is probably due to the fact that a thin surface layer of the molding bodies detaches together with the ceramic product.

[0004] The plaster molds, however, are not without drawbacks. For example, they are relatively delicate (subject to wear) and must be replaced after approximately every hour and a half/two hours of work (after approximately 1500-2000 strokes).

[0005] Molds with metal or plastic half-shells are also used, interposing a layer of soft rubber (for example India rubber) between the molds and the blanks. These types of molds are stronger than those made of plaster but nevertheless are not able to produce high aesthetic quality ceramic products since the layer of rubber alters the geometry of the mold (also reducing the definition).

[0006] The object of the present invention is to provide an apparatus and a method for manufacturing ceramic products, which allows to overcome, at least partially, the drawbacks of the known art and are, at the same time, easy and inexpensive to produce.

SUMMARY

[0007] According to the present invention, an apparatus and a method are provided according to the following independent claims and, advantageously, according to any one of the claims directly or indirectly depending on the independent claims.

BRIEF DESCRIPTION OF THE FIGURES

[0008] The present invention will now be described with reference to the accompanying drawings, which illustrate non-limiting embodiments thereof, in which:

- figure 1 is a schematic side view of an apparatus according to the present invention;
- figures 2-4 are schematic side views of successive operating configurations of the apparatus of figure 1 with details removed for clarity;
- figure 5 is a view from the bottom of a detail of a part of the apparatus of figures 1-4;
- figure 6 is a view from the bottom of figure 5 in which the internal elements of the part are illustrated by a broken line;
- figure 7 is a side view of the part illustrated in figures 5 and 6;
- figure 8 is a side section view of the part of figures 5 to 7;
- figure 9 is a side view of a different embodiment of the part of figures 5 to 8;
- figure 10 is a side section view of the part of figure 9;
- figure 11 is a perspective view of the part of figures 5 to 7;
- figure 12 is a perspective view of a further part of the apparatus of figures 1 to 4;
- figure 13 is a plan view of instruments used for the manufacture of a component of the part illustrated in figures 5 to 11; and
- figure 14 is a plan view of instruments used for manufacturing a component of the part illustrated in figure 12.

DETAILED DISCLOSURE

[0009] In figure 1, the number 1 indicates overall an apparatus for manufacturing ceramic products 2 (for example tiles and/or crockery - such as cups, oven-proof dishes etc.). The apparatus 1 comprises a mold 3, which is adapted to compress a blank 4, comprising (consisting of) clay (which can be a mixture of different clays) and up to (i.e. a value lower than or equal to) 25% by weight, in respect to the total weight of the blank 4, of water, so as to obtain a ceramic product 2. In particular, the blank 4 comprises at least 14% (up to 25%) by weight, in respect to the total weight of the blank 4, of water.

[0010] The mold 3, in turn, comprises a half-shell 5 and at least one half-shell 6.

[0011] The apparatus further comprises an actuator 9 to move the half-shells 5 and 6 relative to each other, in particular towards each other (and possibly away from each other).

[0012] The half-shell 5 comprises a molding body 7 having a molding surface 8 provided with a predetermined shape, which is adapted to be pressed on a face 10 of the blank 4 so as to obtain at least part of a face 11 of the ceramic product 2. In particular, the molding surface 8 is exposed towards the outside (in other words, it is not covered by further elements).

[0013] The half-shell 6 comprises a molding body 12 (which, in particular, is arranged below the half-shell 5) having a molding surface 13.

[0014] Advantageously, but not necessarily, the half-shell 5 is arranged above the half-shell 6.

[0015] The molding body 7 comprises (in particular, is made of) an at least partially porous resin (in particular, a porous resin).

[0016] The mold 3 further comprises a pressure device 14 adapted to press a gas (in particular, air) through the molding body 7 towards the second half-shell 6 (in figures 7, 8 and 9 the arrows facing downwards indicate, by way of non-limiting example, the movement of the gas flowing out of the molding body 7). More precisely, the pressure device 14 is adapted to keep under pressure a gas inside the first molding body 7. According to some non-limiting embodiments, the pressure device 14 comprises a pump connected to the molding body 7 by means of at least one duct 14'.

[0017] In the embodiment illustrated (see in particular figure 6), the pressure device 14 comprises two channels 14'. In use, the pressure device 14 exerts a pressure on the (feeds the) gas towards the molding body 7 along both the channels 14'.

[0018] In particular, the pressure device 14 is adapted to press the gas through the molding body 7 towards the half-shell 6 so that, in use, a layer of gas is at least partially interposed between the molding surface 8 and the face 10 of the blank 4. In other words, the pressure device 14 is adapted to press the gas through the molding body 7 towards the half-shell 6 so that gas flows out of the molding surface 8. In figures 7, 8 and 10 the outflow of the gas from the molding surface 8 is schematically illustrated by arrows.

[0019] The particular structure of the apparatus 1 (more precisely of the mold 3) surprisingly improves the aesthetic quality of the face 11, limiting the possibility of the blank 4 sticking too closely to the molding body 7 (which, it should be remembered, comprises a resin) while the blank 4 itself is compressed between the half-shells 5 and 6.

[0020] According to some non-limiting embodiments, the pressure device 14 (or the further pressure device) is (also) adapted to apply a negative pressure (in particular, a suction) through the molding body 7. In this way, in particular, air (and/or liquid - for example water) can be sucked through the molding surface 8.

[0021] In the embodiment illustrated in figure 1, the actuator 9 is adapted to move only the half-shell 5 (towards and away from the half-shell 6). It should be noted, however, that according to alternative embodiments (not illustrated) the actuator 9 is adapted to also move the half-shell 6 (or only the half-shell 6).

[0022] In particular, the molding surface 13 has a given shape adapted to be pressed on a face 15 of the blank 4 so as to obtain at least part of a face 16 of the ceramic product 2.

[0023] Advantageously, but not necessarily, the molding body 12 comprises (in particular, is made of) a resin (identical to or different from the resin of the molding body 7) which is at least partially porous (in particular, a porous resin).

[0024] Advantageously but not necessarily (see figures 6, 8 and 10), the molding body 7 has, internally, at least one channel 17, in particular having a cross section of at least 4 mm^2, more precisely at least 7 mm^2 (in particular, up to 80 mm^2) connected to the pressure device 14, which is adapted to maintain (feed) the gas under pressure into the channel so as to press the gas through the molding body 7 towards the half-shell 6.

[0025] In this way it is possible to obtain a relatively uniform distribution of the gas over a large part of the molding surface 8.

[0026] In particular, the molding body 7 has, internally, a plurality of channels 17 and 18. In this way it is possible to further improve the uniformity of distribution of the gas over the molding surface 8.

[0027] According to some embodiments (for example the one illustrated), the channels 17 and 18 are fluidically connected to each other so as to create a network of channels (or one single branched channel).

[0028] In particular, the channel 17 (and possibly also the channels 18) is made in the above-mentioned resins (in other words it extends through the resin).

[0029] Advantageously, but not necessarily, the channel 17 is arranged (or the channels 17 and 18 are arranged) at a distance up to (in other words, less than or equal to) 5 cm (in particular, at least 0.5 cm) from the molding surface 8.

[0030] In this way a good air distribution uniformity is obtained relative to the pressure applied by the pressure device 14 (reducing the pressure losses).

[0031] In particular, the channel is arranged at a distance of at least 1 cm from the molding surface 8.

[0032] To measure the water content of the resin, the article (in particular, the molding body 7 or possibly 12) comprising the (made of) resin (in the case in point the molding body 7) is placed in a kiln at 50°C for the time necessary to reach a constant weight (at this point the article can be considered substantially dry). The percentage difference in weight, in respect to the initial weight, of the article before and after the treatment indicates the water percentage by weight contained in the article. Said procedure applies *mutatis mutandis* (the main difference being that the kiln is kept at 110°C) also for measuring the percentage by weight of water of the blanks 4.

[0033] Advantageously, but not necessarily, the (the entire) molding body 7 comprises up to (in particular, less than) 18% by weight, relative to the total weight of the molding body 7, of water. More precisely, the resin of the molding body 7 comprises up to (in particular, less than) 18% by weight, relative to the total weight of the resin of the molding body 7, of water.

[0034] Advantageously, but not necessarily, the (the entire) molding body 7 comprises up to 60% (in particular, 40% to 50%) by weight, relative to the total weight of the water contained in the molding body 7 at saturation, of water. More precisely, the resin of the molding body 7 comprises up to 60% (in particular, 40% to 50%) by weight, relative to the total weight of the water contained in the resin at saturation, of water.

[0035] The weight of the molding body 7 (and/or of the resin) at saturation is measured by maintaining the molding body (and/or the resin) immersed in water and performing periodic measurements of the weight of the molding body (and/or of the resin), for the time necessary to reach a constant weight.

The weight of the substantially dry molding body 7 (and/or of the resin) is measured by weighing the substantially dry molding body 7 (and/or the resin) obtained as described above (i.e. after treatment in the kiln until reaching a constant weight).

[0036] The difference in weight between the weight of the molding body 7 (and/or the resin) at saturation and the weight of the substantially dry molding body 7 (and/or resin) indicates the total weight of the water contained in the molding body 7 (and/or in the resin) at saturation.

[0037] According to some non-limiting embodiments (for example like the one illustrated in the figures), the channels 18 are substantially parallel to one another and the channel 17 is transverse to them (so as to connect them). In particular, the channel 17 extends according to a U-shaped path.

[0038] In some cases, the molding body 7 has at least one lateral hole 19, which is arranged at one end of the channel 17. In particular, the hole 19 places the channel 17 in communication with the pressure device 14. More precisely, the duct 14' has one end fitted in a fluid-tight manner in the hole 19.

[0039] Advantageously, but not necessarily, the half-shell 5 comprises a frame 20, to (on) which (more precisely, inside which) the molding body 7 is fitted. In particular, the frame 20 laterally envelops the molding body 7. In particular, the frame 20 comprises (is made of) metal.

[0040] According to some non-limiting embodiments not illustrated, the frame 20 also comprises a cover arranged on the opposite side of the molding body 7 relative to the molding surface 8.

[0041] Advantageously but not necessarily (figures 9 and 10), the frame 20 comprises a protuberance 21 (for example a blade), which projects from the frame 20 towards the half-shell 6 beyond the molding surface 8. The protuberance 21 is adapted to (partially) penetrate the blank 4 so as to limit the passage of the gas from the molding surface 8 towards the outside and/or the relative movement of the blank 4 relative to the molding surface 8 (which is therefore less subject to wear).

[0042] According to some non-limiting embodiments, the protuberance 21 extends around the molding body 7. In this way, the passage of the gas from the molding surface 8 is limited towards the outside.

[0043] More precisely, in some cases, the protuberance 21 extends partially around the molding body 7. According to some specific non-limiting embodiments, the protuberance 21 extends all around the molding body 7.

[0044] Advantageously, but not necessarily, the half-shell 5 comprises a layer of impermeable material arranged between the frame 20 and the molding body 7.

[0045] According to some non-limiting embodiments, the half-shell 6 (which can be identical to or different from the half-shell 5) is defined according to the characteristics indicated above and below for the half-shell 5.

[0046] In particular, the molding body 12 (which can be identical to or different from the molding body 7) is defined according to the characteristics indicated above and below for the molding body 7.

[0047] More in particular, therefore, the pressure device 14 (or a further pressure device of known type and not illustrated) is adapted to press a gas (in particular, air) through the molding body 12 towards the second half-shell 5. More precisely, the pressure device 14 (or the further pressure device) is adapted to keep a gas under pressure inside the molding body 12. According to some non-limiting embodiments, the pressure device 14 (or the further pressure device) comprises a pump connected to the molding body 12 by means of at least one duct (known per se and not illustrated).

[0048] Advantageously, but not necessarily, the pressure device 14 (or the further pressure device) is (also) adapted to apply a negative pressure (in particular, a suction) through the molding body 12. In particular, in this way, the pressure device 14 (or the further pressure device) is (also) adapted to apply a negative pressure (in particular, a suction) through the molding body 12 on the ceramic product 2 and/or so as to suck air through the molding surface 13.

[0049] According to some non-limiting embodiments not illustrated, the apparatus 1 also comprises a kiln (of per se known type and not illustrated) adapted to fire the ceramic product 2. In particular, the mentioned kiln is adapted to fire (so as to obtain a fired ceramic product) the ceramic product 2 at a temperature of at least 950°C (more precisely, at a temperature from 1000°C to 1150°C).

[0050] According to some non-limiting embodiments (figure 1), the apparatus 1 comprises a conveying assembly C which is adapted to move the blank 4 along a path P to the mold 3 and the ceramic product 2 along a path PP from the mold 3 to the above-mentioned kiln.

[0051] In accordance with some non-limiting embodiments (like the one illustrated in figure 1), the conveying assembly C comprises a motorized roller conveyor to move the blank 4 along the path P and the ceramic product 2 along the path PP and an automated manipulator (known per se and not illustrated) to bring the blank 4 from the roller conveyor to the mold 3 and the ceramic product 2 from the mold 3 to the roller conveyor.

[0052] Advantageously, but not necessarily, the apparatus 1 further comprises a control unit CU, which is connected to the conveying assembly C, to the pressure device 14 and to the actuator 9 and is adapted to control the conveying assembly C, the pressure device 14 and the actuator 9 so as to operate them in a coordinated manner, in particular so that the method described below is implemented.

[0053] Advantageously, but not necessarily, the molding body 7 (the cited resin) has a (total open) porosity of at least 10%, in particular up to 50% (more in particular, up to 28%) by volume, relative to the total volume of the molding body 7.

[0054] The porosity is measured by mercury porosimetry with a Pascal 140/240 porosimeter by Thermo Fisher Scientific (following the instructions provided with it). The principles and operation of mercury porosimetry are well known and are described for example in: Mercury Porosimetry: a General (Practical) Overview, Part. Part. Syst. Charact. 23 (2006) 1-11, Herbert Giesche, DOI: 10.1002/ppsc.200601009; Characterization of Porous Solids and Powders: Surface Area, Pore Size and Density, S. Lowell, Joan E. Shields, Martin A. Thomas e Mathias Thommes, Kluwer Academic Publishers 2004, ISBN 1-4020-2302-2 (HB), ISBN 1-4020-2302-0 (e-book). In particular, porosity is measured according to the ISO 15901-1:2016 standard.

[0055] The total open porosity is the porosity measured considering the open pores (and not the closed pores), namely the pores that are accessible by a fluid (ISO 15901-1:2016).

[0056] Advantageously, but not necessarily, the molding body 7 (in particular, the cited resin) has a flexural strength of at least 7 MPa (in particular, at least approximately 30 MPa), more precisely up to 42 MPa (in particular, up to approximately 35 MPa) .

[0057] The flexural strength is measured as established by the DIN 53452 standard.

[0058] Advantageously, but not necessarily, the molding body 7 (in particular, the cited resin) has a tensile strength of at least approximately 5 MPa, in particular up to approximately 30 MPa.

[0059] The tensile strength is measured as established by the DIN 53455 standard.

[0060] Advantageously, but not necessarily, the molding body 7 (in particular, the cited resin) has pores with a mean diameter from 0.5 (in particular, approximately 5 μm) to 80 μm (in particular, approximately 15μm).

[0061] Unless specified to the contrary, in this text by diameter of a pore we mean the limiting diameter, namely the diameter of a circle having the same area as the smaller (cross) section of the pore.

[0062] The mean diameter of the pores is measured by mercury porosimetry with a Pascal 140/240 porosimeter by Thermo Fisher Scientific (following the instructions provided with it). The principles and operation of mercury porosimetry are well known (see the documents cited above in this regard). In particular, the mean diameter of the pores is measured as established by the ISO 15901-1:2016 standard.

[0063] It should be noted that by diameter we mean the diameter corresponding to the fiftieth percentile of the volume of the pores, namely the diameter for which half of the volume of the pores is in the largest pores and half of the volume of the pores is in the smallest pores (ISO 15901-1:2016, in particular paragraph 3.16).

[0064] Advantageously, but not necessarily, the molding body 7 (in particular, the cited resin) has a flexural elastic modulus (measured as established by the DIN 53457 standard) from approximately 440 MPa to approximately 2100 MPa.

[0065] Advantageously, but not necessarily, the molding body 7 (in particular, the cited resin) has a tensile elastic modulus (measured as established by the DIN 53457 standard) from approximately 570 MPa to approximately 2100 MPa.

[0066] Advantageously, but not necessarily, the molding body 7 (in particular, the cited resin) has a compression strength (measured as established by the DIN 53454 standard) from approximately 11 MPa to approximately 130 MPa.

[0067] Advantageously, but not necessarily, the molding body 7 (in particular, the cited resin) has a compression elastic modulus (measured as established by the DIN 53457 standard) from approximately 300 MPa to approximately 1700 MPa.

[0068] According to some embodiments, the molding body 12 (in particular, the cited resin) has a total open porosity as indicated above. Additionally or alternatively, the molding body 12 (in particular, the cited resin) has a flexural strength as indicated above. Additionally or alternatively, the molding body 12 (in particular, the cited resin) has a tensile strength as indicated above. Additionally or alternatively, the molding body 12 (in particular, the cited resin) has pores with a mean diameter as indicated above.

[0069] Advantageously, but not necessarily, the molding body 7 (and/or the molding body 12) comprises, in particular is made of, a resin selected from the group consisting of: acrylic resins, polyester resins, polyurethane resins, epoxy resins and a combination thereof.

[0070] In accordance with what is commonly known, the acrylic resins are obtained from the polymerization of acrylic and/or methacrylic monomers, mainly acrylic acid and acrylic or methacrylic esters.

[0071] According to some non-limiting embodiments, the cited resin is and is produced as described in one or more of the patent documents EP165952, GB1284890 and US4727092.

[0072] With particular reference to figure 13, according to some non-limiting embodiments, to obtain the molding body 7 a suspension of water and oil (containing the precursors of the cited resin) is inserted in a master die (or matrix) 28, which is open at the top and closed at the bottom by a plate 22 (for example made of epoxy resin), the surface of which has the form in negative of the molding surface 8. A silicone tube 23, which extends between two holes 19, a plurality of bars 24, which extend from one side to the other of the frame 20 and a further tube 25, which is partially wrapped around the tube 23, are arranged inside the space delimited by the frame 20 and by the plate 22.

[0073] Clamping ties 26 are provided to hold the tubes 23 and 25 and the bars 24 together so that they are in contact.

[0074] The bars 24 are made of rigid material (e.g. metal or plastic or a combination thereof). According to some non-limiting embodiments, the bars 24 have a silicone and/or nylon coating.

[0075] After the cited suspension has been inserted in the space delimited by the master die 28 and by the plate 22, the polymerization takes place. Once at least most of the polymerization has taken place and the resin has been substantially obtained, the tubes 23 and 25 and the bars 24 are removed by sliding them out of the resin so as to create the channels 17 and 18. At this point, the molding body 7 is removed from the master die 28, inserted in the frame 20 and connected (more precisely, the channels 17 and 18 are connected) to the pressure device 14. The resin is dried (the water is removed) by feeding the gas (more precisely, the air). The resin is thus freed of the water present in the porosity.

[0076] In the embodiment illustrated in figure 13, the master die 28 (which is typically made of metal - e.g. aluminum) consists of one single piece. According to alternative embodiments not illustrated, the master die 28 comprises (substantially consists of) four lateral sideboards fitted rigidly but separable from one another.

[0077] According to some non-limiting embodiments (like the one illustrated in figures 13 and 14), pins 29 are fitted in a releasable manner on the inner surfaces of the walls of the master die 28. Said pins remain embedded (once the polymerization has been obtained) in the resin of the molding body 12 and are subsequently used to couple in a fixed manner the molding body 12 with the frame 20 (for example by means of screws which are screwed into the pins 29).

[0078] The molding body 12 is obtained by following an analogous procedure to the one described above relative to the molding body 7. In this case, according to some embodiments, the structure illustrated in figure 14 is used which differs from the one in figure 13 due mainly to the fact that both the tubes 23 and 25 have one end connected to a respective hole 19 and that the plate 27 replaces the plate 22. The plate 27 (which can be identical to or different from the plate 22) has a surface with the form in negative of the molding surface 13.

[0079] According to alternative non-illustrated embodiments, any vertical channels (alternative to the channels 17 and 18) are obtained by milling.

[0080] In accordance with one aspect of the present invention, a method is provided for manufacturing ceramic products (for example tiles and/or crockery - such as cups, oven-proof dishes etc.).

[0081] The method comprises a molding step, during which the blank 4 comprising clay and up to 25% by weight, relative to the total weight of the blank 4, of water, is compressed between the half-shell 5 of the mold 3 and at least the half-shell 6 of the mold 3, so as to obtain the ceramic product 2 (e.g. a semi-finished product which, once fired, becomes a tile and/or a piece of crockery - such as a cup or an oven-proof dish). In particular, during the molding step, the blank 4 is compressed (between the half-shells 5 and 6) with a pressure from approximately 25Kg/cm^2 to approximately 35 Kg/cm^2 (more precisely with a pressure of approximately 30Kg/cm^2).

[0082] During the (at least part of the) molding step, a gas (air) is pressed through the molding body 7 towards the half-shell 6 (in particular, so that gas flows out of the molding surface 8). More precisely, during at least part of the molding step, the gas is kept under pressure inside the molding body 7 (where the half-shell 5 is closed on the blank 4 in a fluid-tight manner).

[0083] In particular, during the (at least part of the) molding step, the gas is pressed (fed) (from the pressure device 14) through the molding body 7 towards the half-shell 6 at a pressure from approximately 1.5 bar to approximately 6 bar.

[0084] Advantageously, but not necessarily, a gas (air) is pressed through the molding body 12 towards the half-shell 5 (in particular, so that gas flows out of the molding surface 13) . More precisely, during at least part of the molding step, the gas is kept under pressure inside the molding body 12 (where the half-shell 6 is closed on the blank 4 in a fluid-tight manner).

[0085] In particular, during the (at least part of the) molding step, the gas is pressed (fed) (from the pressure device 14) through the molding body 12 towards the half-shell 5 at a pressure from approximately 1.5 bar to approximately 6 bar.

[0086] In particular, the blank 4 comprises from 14% to 25% by weight, relative to the total weight of the blank 4, of water. According to some non-limiting embodiments, the blank 4 comprises (is) water, clay (for the most part), silica and any feldspars. In some cases, the blank 4 comprises (is) clay (including a mixture of clays).

[0087] More precisely, the half-shell 5 (in particular, the molding body 7) is as described above relative to the apparatus 1. Additionally or alternatively, the half-shell 6 (in particular, the molding body 12) is as described above relative to the apparatus 1.

[0088] According to some non-limiting embodiments, the molding step comprises an initial pressing sub-step, during which the blank 4 begins to be compressed between the half-shells 5 and 6 (figures 1 and 2); a tightening sub-step, which is subsequent to the initial pressing sub-step and during which the blank 4 is compressed between the half-shells 5 and 6 with an increasing pressure (figure 2); and a release sub-step, which is subsequent to the tightening sub-step and during which the blank 4 is compressed between the half-shells 5 and 6 with a decreasing pressure (figures 3 and 4).

[0089] In particular, during the (at least part of the) initial pressing sub-step, the gas is pressed (by the pressure device 14) through the molding body 7 towards the half-shell 6 (in particular, so that gas flows out of the molding surface 8). More precisely, during the (at least part of the) initial pressing sub-step, the gas is kept under pressure inside the molding body 7 (where the half-shell 5 is closed on the blank 4 in a fluid-tight manner).

[0090] Additionally or alternatively, during the (at least part of the) tightening sub-step, the gas is pressed (by the pressure device 14) through the molding body 7 towards the half-shell 6. In particular, during (at least part) of the tightening sub-step, the gas is kept under pressure inside the molding body 7 (where the half-shell 5 is closed on the blank 4 in a fluid-tight manner).

[0091] According to some non-limiting embodiments, during (all) the (entire) initial pressing, tightening and release sub-steps, the gas is pressed through the molding body 7 towards the half-shell 6.

[0092] In particular, the gas is pressed through the molding body 7 towards the half-shell 6 so that a layer of gas is at least partially interposed between the molding surface 8 and the first face 10 of the blank 4 during the molding step, more precisely during the initial pressing and tightening sub-steps (in some cases, also during the release sub-step).

[0093] Advantageously, but not necessarily, during at least part of the tightening sub-step, the gas is not pressed through the molding body 7 towards the half-shell 6. This allows the molding quality to be improved. In particular, during at least part of the tightening sub-step, the gas is not pressed by the pressure device 14 through the molding body 7 towards the half-shell 6.

[0094] In other words, during at least part of the tightening sub-step, the pressure device 14 interrupts pressing of the gas through the molding body 7 towards the half-shell 6.

[0095] In these cases, according to some non-limiting embodiments, during at least part of the release sub-step, the gas is not pressed through the molding body 7 towards the half-shell 6. In particular, during at least part of the release sub-step, the gas is not pressed by the pressure device 14 through the molding body 7 towards the half-shell 6 (in particular, so that gas flows out of the molding surface 8).

[0096] More in particular, the gas is pressed through the molding body 7 towards the half-shell 6 so that a layer of gas is at least partially interposed between the molding surface 8 and the face 10 of the blank 4 during the (at least part of the) tightening sub-step.

[0097] It should be noted that when the gas is pressed through the molding body 7 towards the half-shell 6, the gas moves or does not move (or moves partially), as the case may be, through the molding body 7 (more precisely, through the molding surface 8). In particular, when the molding body 7 is coupled to the blank 4, the substantially pressed gas does not move (but is kept under pressure) through the molding body 7; when the molding body 7 is far from the blank 4, the pressed gas moves through the molding body 7.

[0098] Advantageously, but not necessarily, the method comprises an approaching step, during which the half-shells 5 and 6 move towards each other until the blank 4 begins to be compressed. During at least part of the approaching step, the gas is fed through the first molding body 7 towards the half-shell 6 (in particular, so that gas flows out of the molding surface 8).

[0099] Advantageously, but not necessarily, the method comprises a surface treatment step, which is previous to the molding step and during which a detaching compound is applied on the molding surface 8 and/or on the face 10 (preferably, on the face 10 of the blank).

[0100] In particular, the detaching compound is applied in powder or by spraying. According to some embodiments, the detaching compound is organic or inorganic and comprises: solutions of polyvinyl alcohol, silicone solutions, suspensions of talc, suspensions of calcium sulfate and/or esters of polyvinyl alcohol.

[0101] Advantageously, but not necessarily, during at least part of the molding step, the gas is pressed (by the pressing device 14) through the molding body 12 towards the half-shell 5 (in particular, so that gas flows out of the molding surface 8). More precisely, during at least part of the molding step, the gas is kept under pressure inside the molding body 12.

[0102] According to some non-limiting embodiments, during the (at least part of the) initial pressing sub-step, the gas is pressed (by the pressure device 14) through the molding body 12 towards the half-shell 5 (in particular, so that gas flows out of the molding surface 13). More precisely, during the (at least part of the) initial pressing sub-step, the gas is kept under pressure inside the molding body 12 (where the half-shell 6 is closed with the blank 4 in a fluid-tight manner).

[0103] Additionally or alternatively, during the (at least part of the) tightening sub-step, the gas is pressed (by the pressure device 14) through the molding body 12 towards the half-shell 5. In particular, during (at least part) of the tightening sub-step, the gas is kept under pressure inside the molding body 12 (where the half-shell 6 is closed with the blank 4 in a fluid-tight manner).

[0104] According to some non-limiting embodiments, during (all) the (entire) initial pressing, tightening and release sub-steps, the gas is pressed through the molding body 12 towards the half-shell 5.

[0105] In particular, the gas is pressed through the molding body 12 towards the half-shell 5 so that a layer of gas is at least partially interposed between the molding surface 13 and the face 11 of the blank 4 during the molding step, more precisely during the initial pressing and tightening sub-steps (in some cases, also during the release sub-step).

[0106] Advantageously, but not necessarily, during at least part of the tightening sub-step, the gas is not pressed through the molding body 12 towards the half-shell 5. In particular, during at least part of the tightening sub-step, the gas is not pressed by the pressure device 14 through the molding body 12 towards the half-shell 5.

[0107] In other words, during at least part of the tightening sub-step, the pressure device 14 interrupts pressing of the gas through the molding body 12 towards the half-shell 5.

[0108] In these cases, according to some non-limiting embodiments, during at least part of the release sub-step, the gas is not pressed through the molding body 12 towards the half-shell 5. In particular, during at least part of the release sub-step, the gas is not pressed by the pressure 14 through the molding body 12 towards the half-shell 5 (in particular, so that gas flows out of the molding surface 8).

[0109] According to some non-limiting embodiments, the method comprises a step of extraction of the ceramic product 2 from the mold 3 (in particular, the extraction step is subsequent to the molding step). In particular, the method also comprises a further molding step, which is subsequent to the molding step and the extraction step and during which a further blank 4, in particular comprising clay and up to 25% (in particular, at least 14%) by weight, relative to the total weight of the further blank 4, of water, is compressed between the half-shell 5 and at least the half-shell 6, so as to obtain a further ceramic product 2.

[0110] Advantageously, but not necessarily, between the molding step and the further molding step (in particular, between the extraction step and the further molding step) the gas is fed through the molding body 7 towards the half-shell 6 (in particular, so that gas flows out of the molding surface 8). In this way it is possible to obtain a reduction of the water content in the molding body 7, making the subsequent molding step more efficient and accurate.

[0111] Advantageously, but not necessarily, between the molding step and the further molding step (in particular, between the extraction step and the further molding step) the gas is fed through the molding body 12 towards the half-shell 5 (in particular, so that gas flows out of the molding surface 13). In this way it is possible to obtain a reduction of the water content in the molding body 12 making the subsequent molding step more efficient and accurate.

[0112] Alternatively or additionally, between the molding step and the further molding step (in particular, between the molding step and the extraction step) a negative pressure is applied (in particular, a suction) through the molding body 12 (which, in particular, is arranged below the half-shell 5) (and/or the molding body 7) (in particular, so that gas enters through the molding surface 13 - and/or the molding surface 8). In this way it is possible to obtain a reduction of the water content in the molding body 12 (and/or in the molding body 7) making the subsequent molding step more efficient and accurate.

[0113] In particular, the extraction step comprises a moving away sub-step, during which the half-shells 5 and 6 are moved away from each other (one of the two half-shells 5 and 6 is moved relative to the other one - as specifically illustrated in figures 3 and 4 - or both are moved).

[0114] According to some non-limiting embodiments, during at least part of the moving away sub-step (more precisely, during an initial part of the moving away sub-step; even more precisely, not after the molding body 7 has a distance - minimum - from the ceramic product 2 of 1 millimeter), a negative pressure is applied (in particular, a suction) on the ceramic product 2 through the molding body 12 of the half-shell 6 (which, in particular, is arranged below the half-shell 5). In particular, in this way, a force is exerted opposite to the relative loosening movement between the half-shell 5 and the ceramic product 2. This allows a more correct separation to be obtained between the half-shell 5 and the ceramic product 2 and, consequently, a better aesthetic quality of the face 10 (fewer risks of the face 10 being damaged during the loosening relative to the molding body 7).

[0115] Advantageously, but not necessarily, the method comprises a firing step, which is subsequent to the molding step and during which the ceramic product 2 is treated (fired) at a temperature of at least 950°C (more precisely, at a temperature ranging from 1000°C to 1150°C) (inside a suitable kiln).

[0116] The apparatus 1 and the method according to the present invention have several advantages relative to the state of the art. For example, with the present invention it is possible to obtain ceramic products 2 with good aesthetic qualities, at the same time significantly reducing the wear on the molding body 7 and therefore the need to replace it.

[0117] Unless explicitly indicated otherwise, the contents of the references (articles, books, patent applications etc.) cited in this text are referred to in full here. In particular the mentioned references are incorporated here for reference.

Claims

1. A method for manufacturing ceramic products (2); the method comprises a molding step, during which a blank (4), comprising clay and up to 25% (in particular, at least 14%) by weight, relative to the total weight of the blank (4), of water, is pressed between a first half-shell (5) of a mold (3) and at least a second half-shell (6) of the mold (3), so as to obtain a ceramic product (2);
   the method being **characterized in that** the first half-shell (5) comprises a first molding body (7) having a first molding surface (8) provided with a first given shape, which, during the molding step, is pressed onto a first face (10) of the blank (4) so as to obtain at least part of a first face (11) of the ceramic product (2); the second half-shell (6) comprises a second molding body (12) having a second molding surface (13); the first molding body (7) comprises (in particular, is made of) an at least partially porous resin and has inside it at least one channel (17), which is arranged at a distance of at least 0.5 cm and up to 5 cm from the first molding surface (8) and, in partic-

ular, has a cross section of at least 4 mm^2;
during at least part of the molding step, a gas is pressed through the first molding body (7) towards the second half-shell (6) ;
the mold (3) comprises a pressure device (14), which is connected to the channel (17) and feeds the gas under pressure into the channel (17) to press the gas through the first molding body (7) towards the second half-shell (6).

2. The method according to claim 1, wherein the molding step comprises an initial pressing sub-step, during which the blank (4) starts being compressed between the first and the second half-shell (5, 6); a tightening sub-step, which is subsequent to the initial pressing sub-step and during which the blank (4) is compressed between the first and the second half-shell (5, 6) with an increasing pressure; and a release sub-step, which is subsequent to the tightening sub-step and during which the blank (4) is compressed between the first and the second half-shell (5, 6) with a decreasing pressure;
during at least part of the initial pressing sub-step, the gas is pressed through the first molding body (7) towards the second half-shell (6); in particular, said channel (17) has a cross section of at least 7 mm^2.

3. The method according to claim 2, wherein during at least part of the tightening sub-step, the gas is pressed through the first molding body (7) towards the second half-shell (6).

4. The method according to claim 2 or 3, wherein the gas is pressed through the first molding body (7) towards the second half-shell (6) so that gas is at least partially interposed between the first molding surface (8) and the first face (10) of the blank (4) during at least part of the tightening sub-step; in particular, the gas is pressed through the first molding body (7) towards the second half-shell (6) so that gas is at least partially interposed between the first molding surface (8) and the first face (10) of the blank (4) during the molding step, more precisely during the initial pressing sub-step, the tightening sub-step and the release sub-step.

5. The method according to any one of the preceding claims, and comprising an approaching step, during which the first and the second half-shell (5, 6) move towards one another until the blank (4) starts being compressed; during at least part of the approaching step, the gas being fed through the first molding body (7) towards the second half-shell (6).

6. The method according to any one of the preceding claims, and comprising an extraction step for extracting the ceramic product (2) from the mold (3) and a further molding step, which is subsequent to the molding step and to the extraction step and during which a further blank (4), comprising clay and up to 25% (in particular, at least 14%) by weight, relative to the total weight of the further blank (4), of water, is compressed between the first half-shell (5) and at least the second half-shell (6), so as to obtain a further ceramic product (2); between the molding step and the further molding step, the gas being fed at least through the first molding body (7) towards the second half-shell (6).

7. The method according to any one of the preceding claims, wherein the first molding body (7) has, on the inside, at least one channel (17; 18), in particular having a cross section of at least 4 mm^2, more in particular at least 7 mm^2, connected to a pressure device (14), which introduces the gas under pressure into the channel (17; 18) so as to press the gas through the first molding body (7) towards the second half-shell (6).

8. The method according to any one of the preceding claims, wherein the first molding body (7) is made of resin and has a total open porosity ranging from 10% to 50% by volume, relative to the total volume of the first molding body (7); in particular, the first molding body (7) has a flexural strength of at least 7 MPa; in particular, the first molding body (7) has a tensile strength of at least 5 MPa; and, in particular, the first molding body (7) has pores with a mean diameter ranging from 0.5 to 80 μm; in particular, the first molding body (7) comprises a resin selected from the group consisting of: acrylic resins, polyester resins, polyurethane resins, epoxy resins and a combination thereof.

9. The method according to any one of the preceding claims, and comprising a surface treatment step, which is prior to the molding step and during which a detaching compound is applied on the first molding surface (8) and/or on the first face (10) of the blank (4).

10. The method according to any one of the preceding claims and comprising a firing step, which is subsequent to the molding step and during which the ceramic product (2) is fired at a temperature of at least 950°C

11. The method according to any one of the preceding claims, wherein the first molding body (7), in particular its resin, comprises up to 18% by weight, relative to the total weight of the molding body (7), of water.

12. The method according to any one of the preceding claims, wherein the first half-shell (5) comprises a frame (20), where the first molding body (7) is fitted and which comprises a protuberance (21) projecting towards the second half-shell (6) beyond the first molding surface (8); the method comprising an approaching step, during which the first and the second half-shell (5, 6) move towards one another and the protuberance (21) penetrates the blank (4); in particular, the protuberance (21) extends around the molding surface (8).

13. The method according to any one of the preceding claims, wherein the second molding body (12) comprises an at least partially porous second resin; during at least part of the molding step, a gas is pressed through the second molding body (12) towards the first half-shell (5); in particular, the second molding body (12) comprises a resin and has a total open porosity ranging from 10% to 50% by volume, relative to the total volume of the second molding body (12), and a flexural strength of at least 7 MPa; in particular, the second molding body (12) has a tensile strength of at least 5 MPa and pores with a median diameter ranging from 0.5 to 80 μm; in particular, the resin of the second molding body (12) is selected from the group consisting of: acrylic resins, polyester resins, polyurethane resins and a combination thereof.

14. The method according to any one of the preceding claims, and comprising an extraction step to extract the ceramic product (2) from the mold (3) and a further molding step, which is after the molding step and during which a further blank (4), comprising clay and up to 25% (in particular, at least 14%) by weight, relative to the total weight of the blank (4), of water, is pressed between the first half-shell (5) and at least the second half-shell (6), so as to obtain a further ceramic product (2); between the extraction step and the further molding step, a negative pressure (in particular, a suction) is applied through at least the first molding body (7), in particular also through the second molding body (12).

15. The method according to any one of the preceding claims, and comprising an extraction step for extracting the ceramic product (2) from the mold (3); the extraction step comprises a moving away sub-step, during which the first and the second half-shell (5, 6) are moved away from one another; during at least part of the moving away sub-step, a negative pressure (in particular, a suction) is applied to the ceramic product (2) through at least the second molding body (12).

16. An apparatus for manufacturing ceramic products (2); the apparatus (1) comprises a mold (3), which is adapted to press a blank (4), comprising clay and up to 25% (in particular, at least 14%) by weight, relative to the total weight of the blank (4), of water, so as to obtain a ceramic product (2), and, in turn, comprises a first half-shell (5) and at least a second half-shell (6); and at least an actuator (9) to move the first and the second half-shell (5, 6) towards one another;
the apparatus (1) being **characterized in that** the first half-shell (5) comprises a first molding body (7) having a first molding surface (8) provided with a first given shape, which is adapted to be pressed onto a first face (10) of the blank (4) so as to obtain at least part of a first face (11) of the ceramic product (2); the second half-shell (6) comprises a second molding body (12) having a second molding surface (13); the first molding body (7) comprises an at least partially porous resin;
the mold (3) comprising, furthermore, a pressure device (14) to press a gas through the first molding body (7) towards the second half-shell (6);
the first molding body (7) having, internally, at least one channel (17; 18), which is arranged at a distance of up to 5 cm from the first molding surface (8); in particular, the first molding body (7) being arranged at a distance of at least 0.5 cm from the first molding surface and having a cross section of at least 4 mm^2; the pressure device (14) being adapted to feed into the channel (17; 18) the gas under pressure to press the gas through the first molding body (7) towards the second half-shell (6).

17. The apparatus according to claim 16, wherein the first molding body (7) has a total open porosity ranging from 10% to 50% by volume, relative to the total volume of the first molding body (7) and a flexural strength of at least 7 MPa; in particular, the channel (17) has a cross section of at least 7 mm^2.

18. The apparatus according to claim 16 or 17, wherein the first molding body (7) has a tensile strength of at least 5 MPa and pores with a mean diameter ranging from 0.5 to 80 μm.

19. The apparatus according to one of the claims 16 to 18, wherein the first molding body (7) is made of a resin selected from the group consisting of: acrylic resins, polyester resins, polyurethane resins, epoxy resins and a combination thereof.

20. The apparatus according to any one of the claims 16 to 19, wherein the first molding body (7) has, internally, a plurality of channels (17; 18); in particular, the channels (17; 18) are arranged at a distance of up to 5 cm from the first molding surface (8) .

21. The apparatus according to one of the claims 16 to 20, wherein the first half-shell (5) comprises a frame (20), to which the first molding body (7) is fitted and which comprises a protuberance (21) projecting towards the second half-shell (6) beyond the first molding surface (8); in particular, the frame (20) and the protuberance (21) extend around the first molding body (7).

22. The apparatus according to one of the claims 16 to 21, wherein the first molding body (7), in particular its resin, comprises up to 18% by weight, relative to the total weight of the molding body (7), of water.

23. The apparatus according to one of the claims 16 to 22, wherein the second molding body (12) comprises an at least partially porous resin; the pressure device (14) is adapted to press a gas through the second molding body (12) towards the first half-shell (5); in particular, the second molding body (12) has a total open porosity ranging from 10% to 50% by volume, relative to the total volume of the molding body; in particular, the second molding body (12) comprises, more in particular is made of, a resin selected from the group consisting of: acrylic resins, polyester resins, polyurethane resins and a combination thereof; in particular, the second molding body (12) has a flexural strength of at least 7 MPa, a tensile strength of at least 5 MPa and pores with a mean diameter ranging from 0.5 to 80 μm.

24. The apparatus according to one of the claims from 16 to 23 and comprising a kiln, which is adapted to fire the ceramic product (2) at at least 950°C.

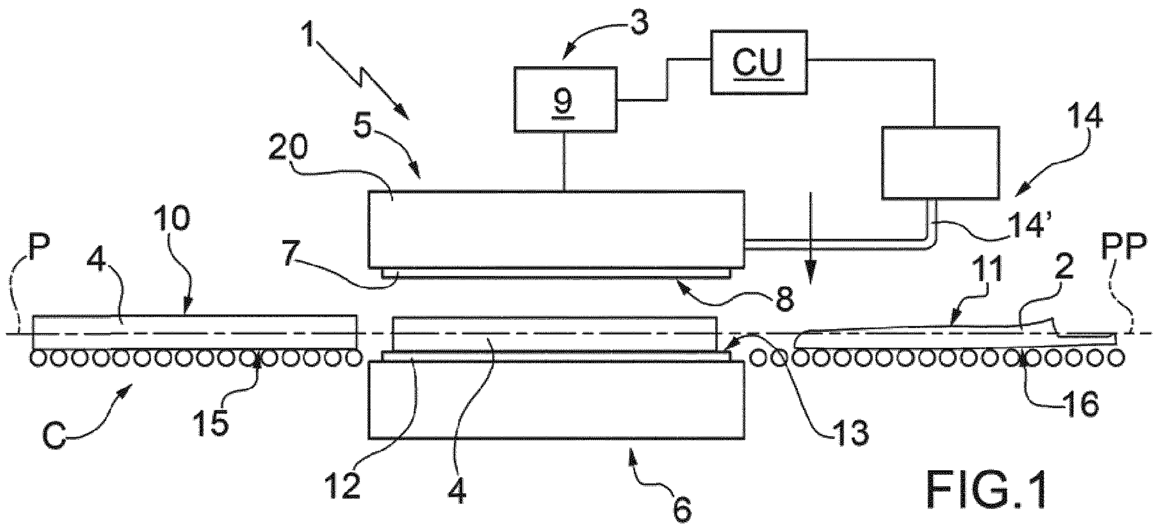

FIG.1

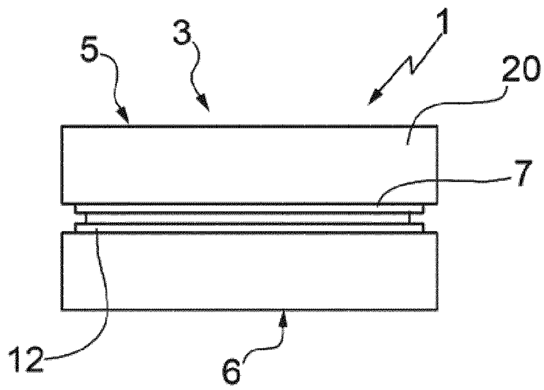

FIG.2

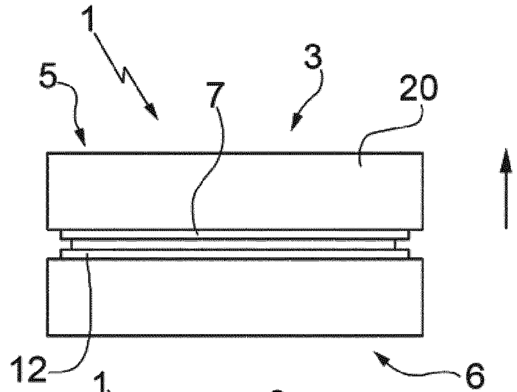

FIG.3

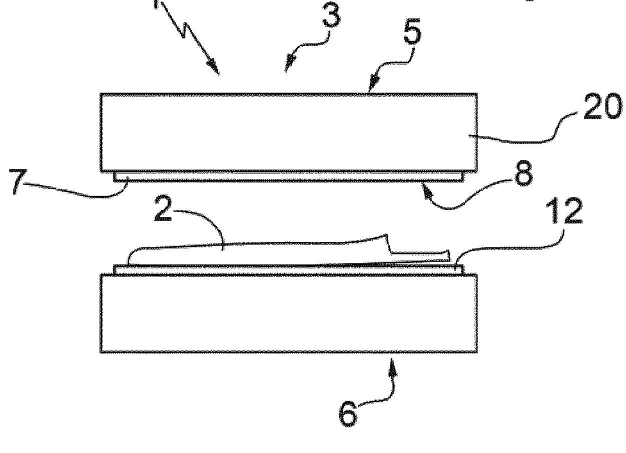

FIG.4

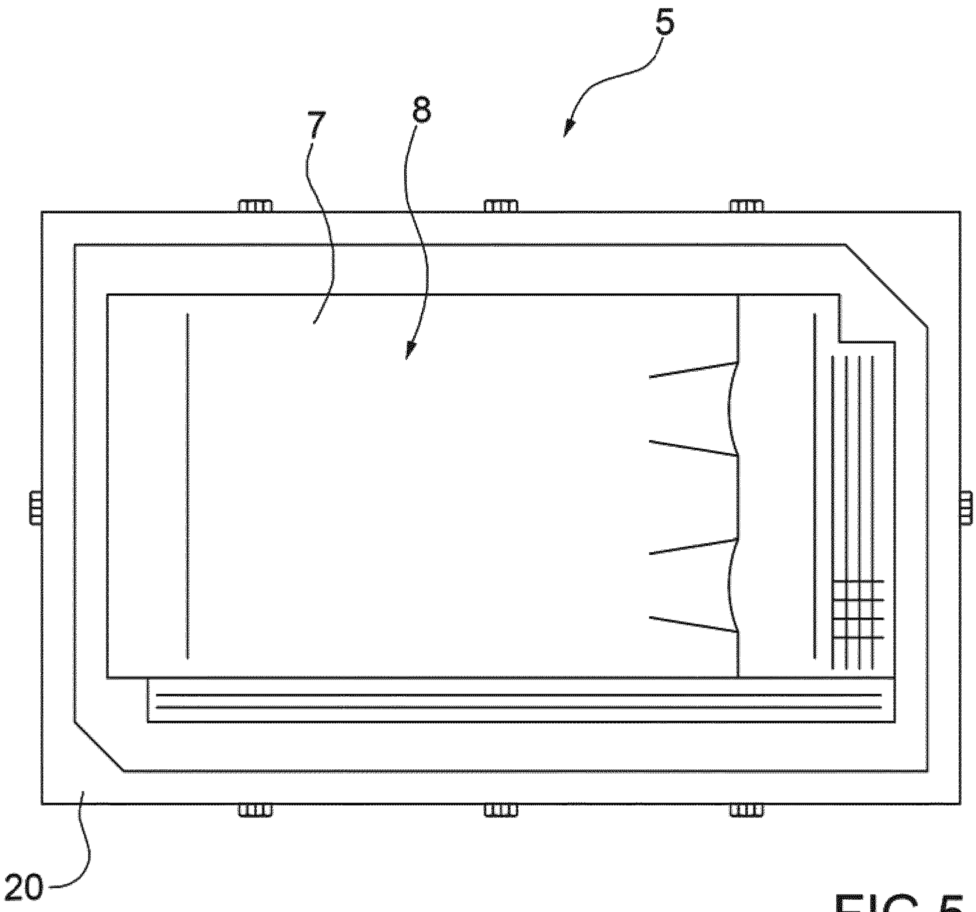

FIG.5

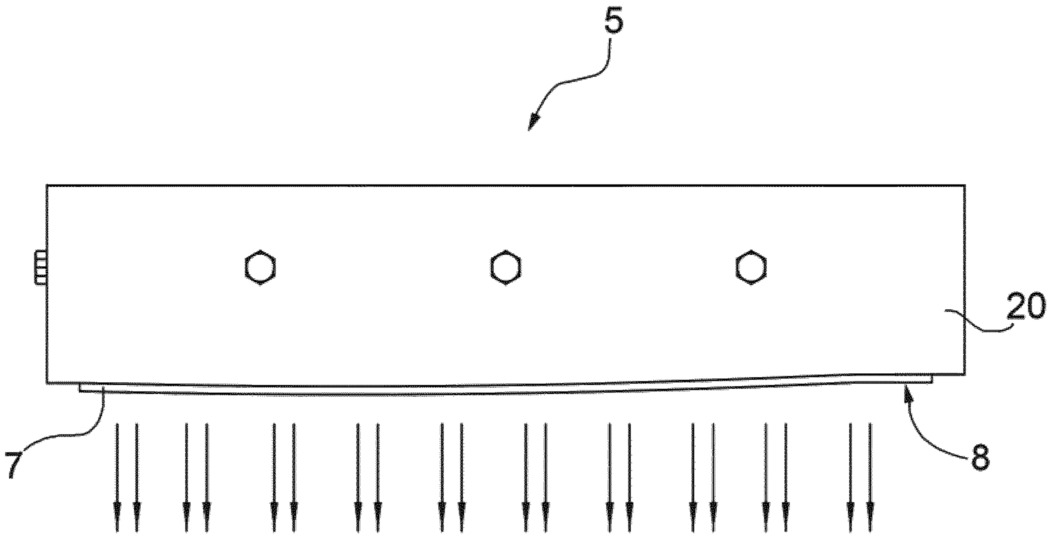

FIG.7

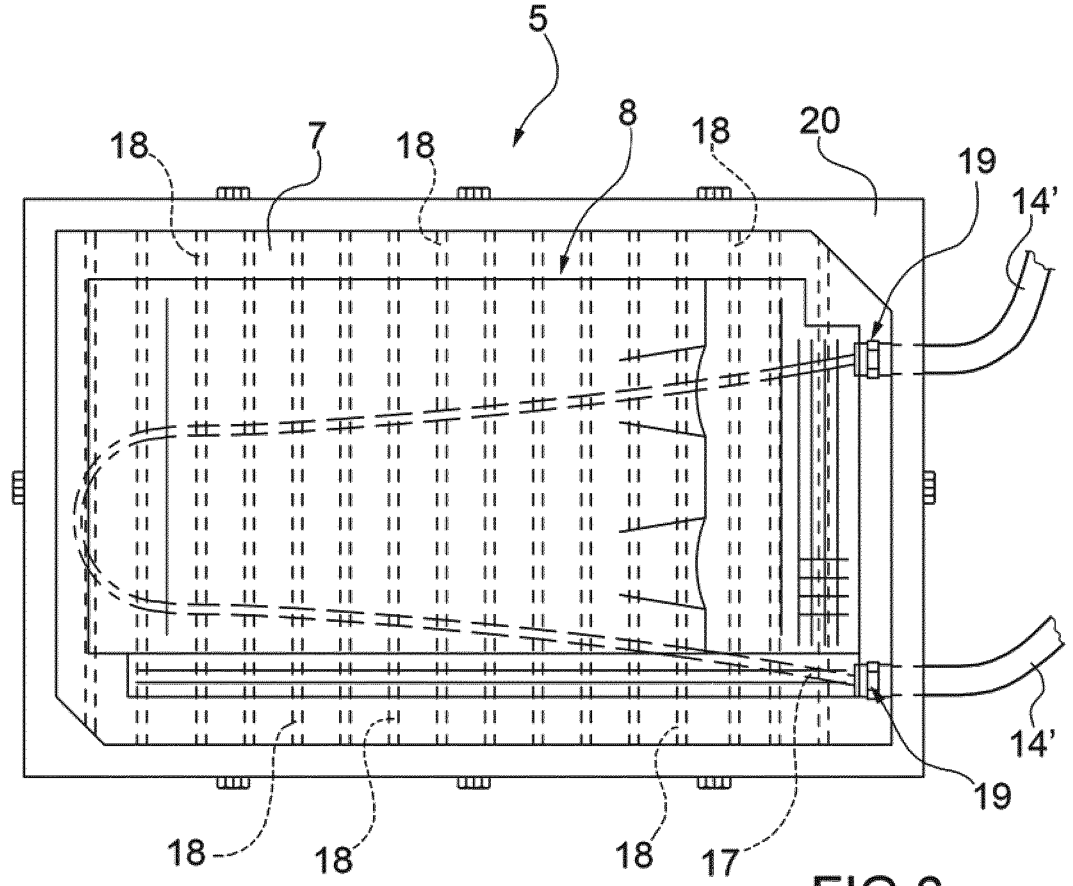

FIG.6

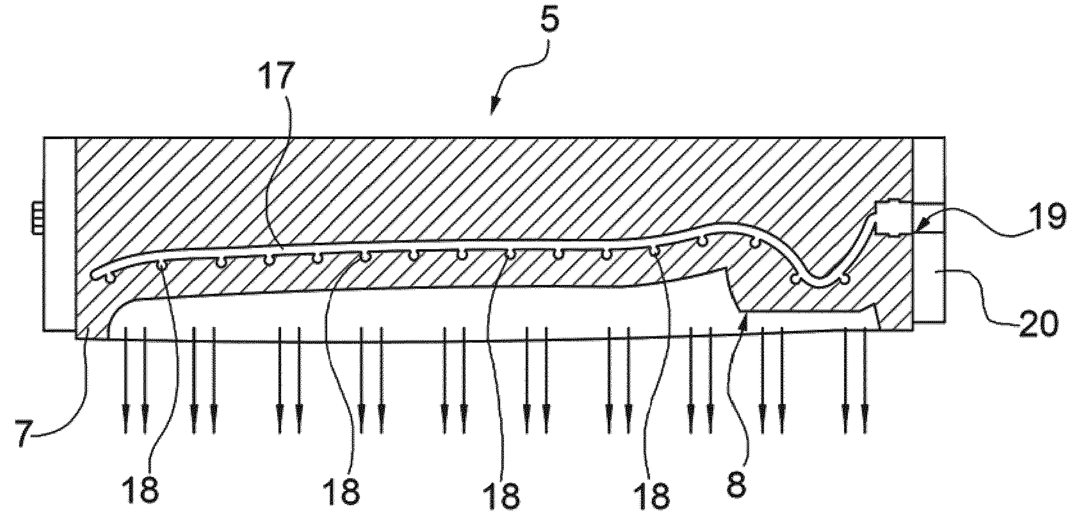

FIG.8

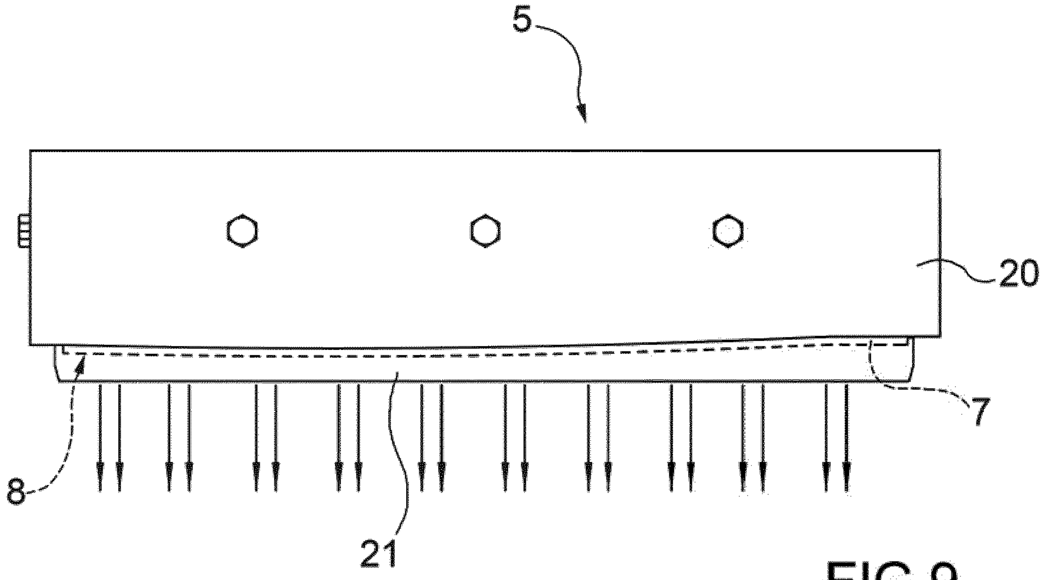

FIG.9

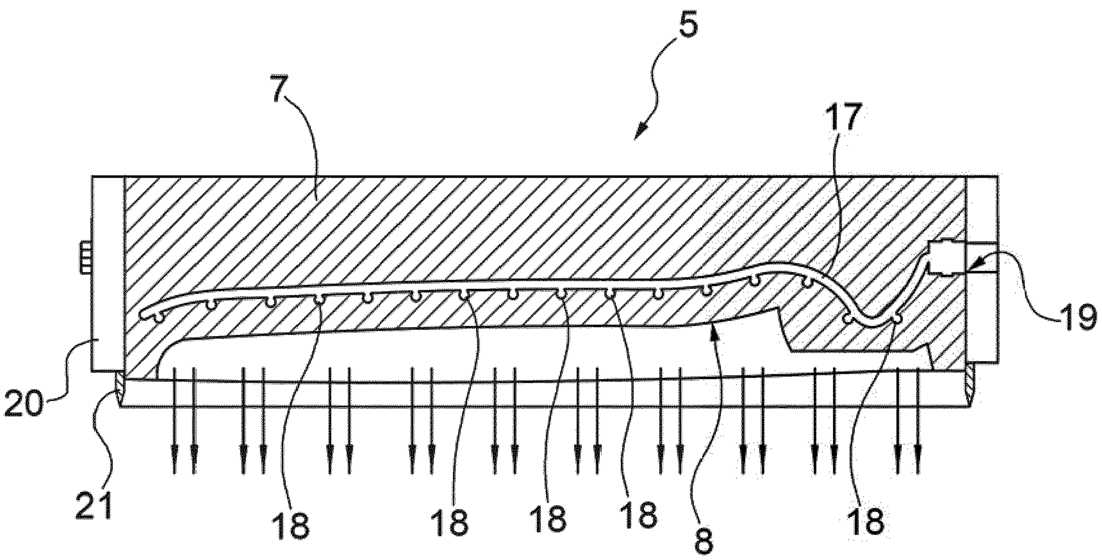

FIG.10

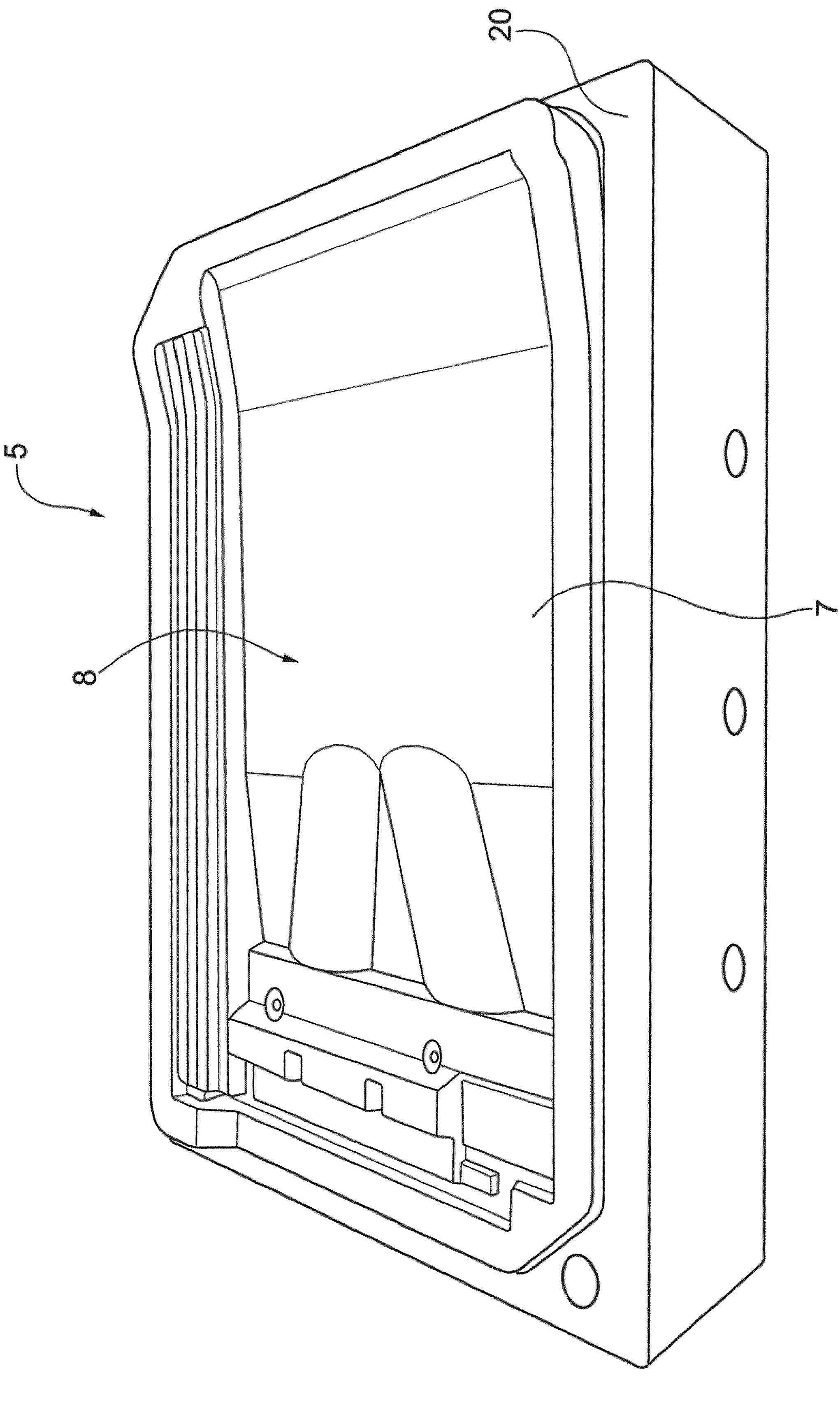

FIG.11

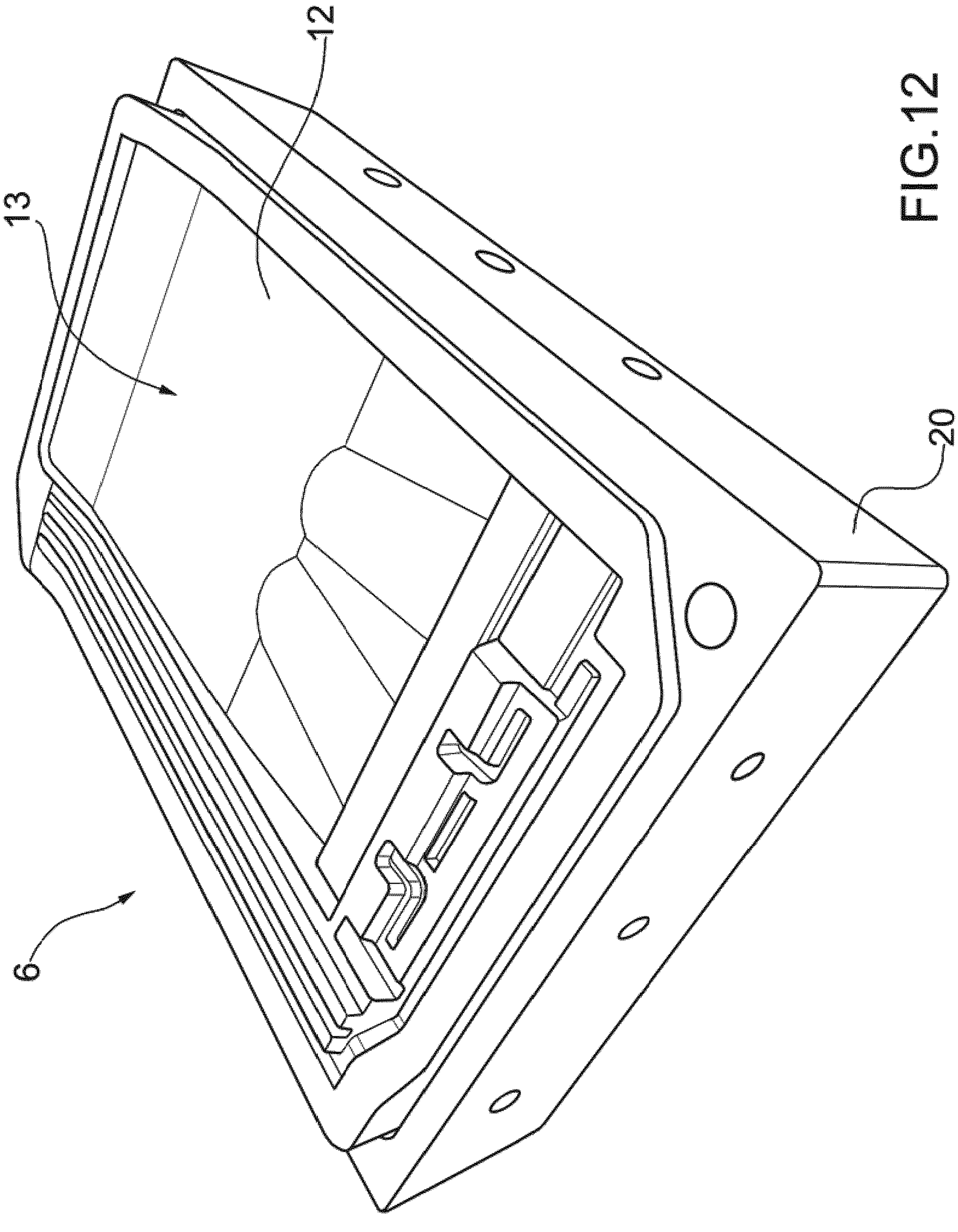

FIG.12

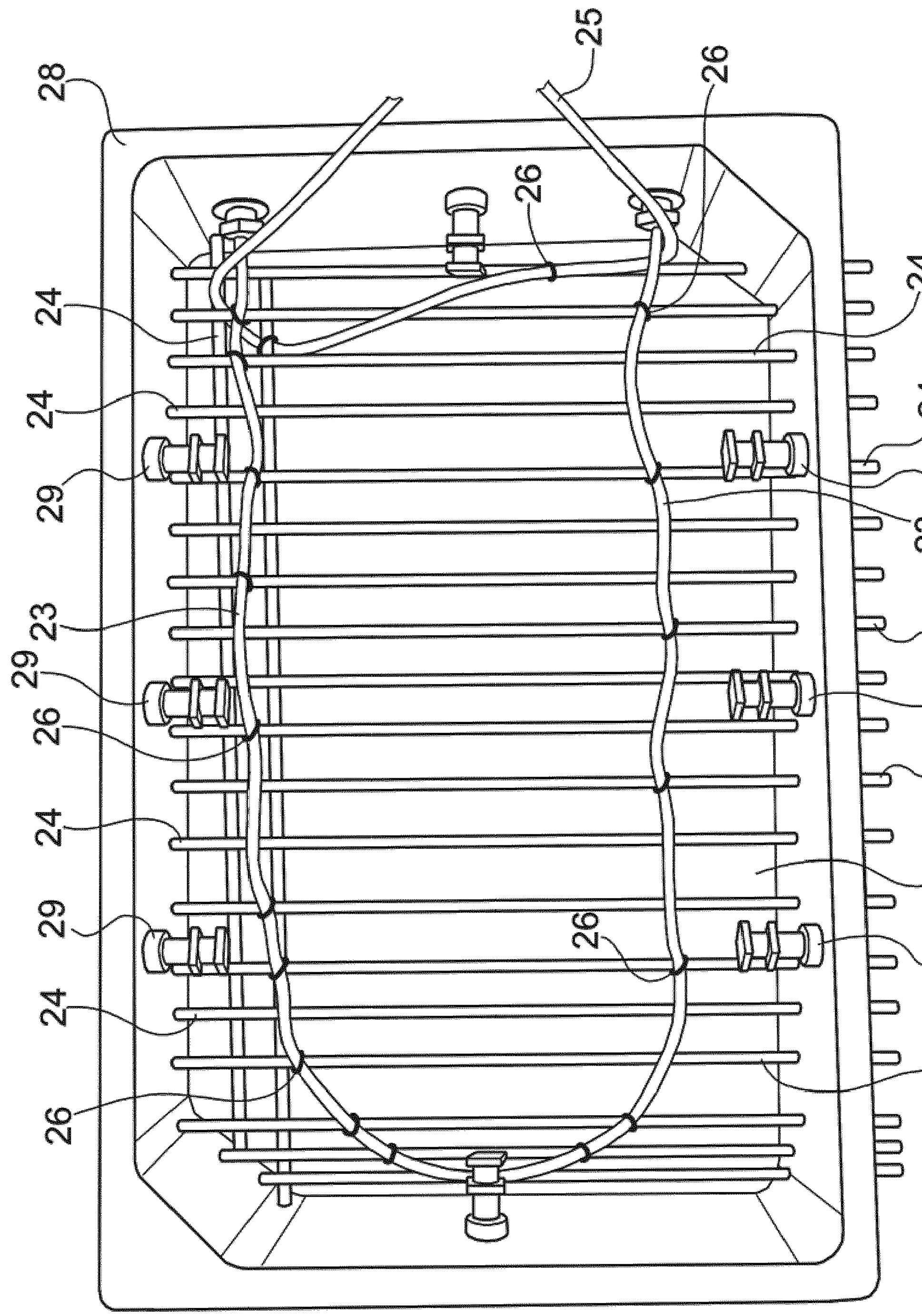

FIG.13

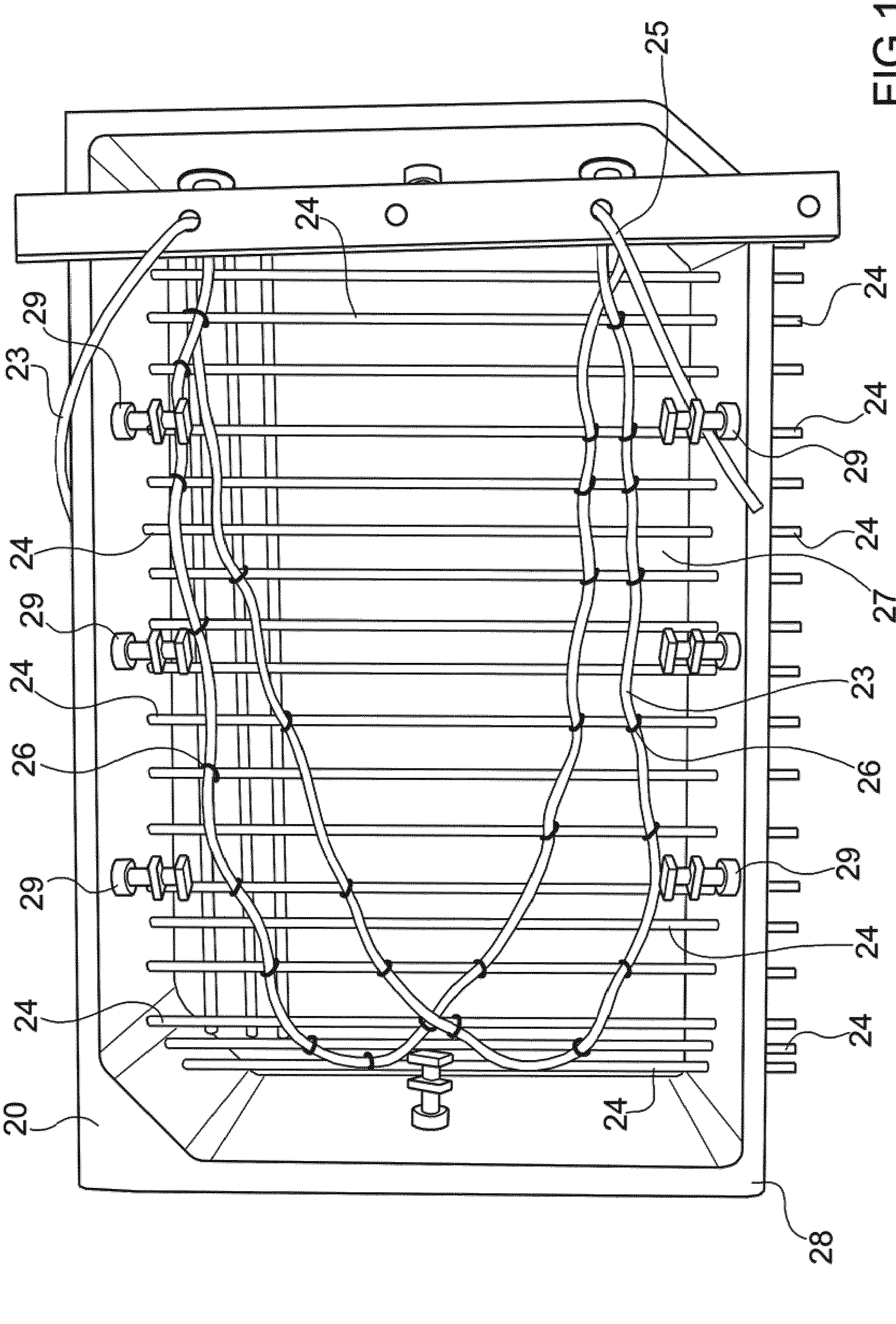

FIG.14

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EUROPEAN SEARCH REPORT

Application Number
EP 18 18 2550

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	7 November 2018	Voltz, Eric

CATEGORY OF CITED DOCUMENTS

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