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(54) **Method and apparatus for producing ceramic products**

(57) The present invention relates to a method of and an apparatus for producing natural rock-imitating ceramic products. The method of producing a natural-stone-imitating ceramic product includes steps of using a hopper for delivering raw ceramic material onto a spreader, using the spreader to spread the raw ceramic material onto a surface of virgin ceramic material located in a pressing position of a pressing machine, pressing the raw ceramic material into the virgin ceramic material using the pressing machine, and sintering the pressed virgin ceramic material and finally processing the sintered virgin ceramic material. The apparatus for producing the natural-stone-imitating ceramic product includes a hopper, a spreader, and a pressing machine provided with an upper punch and a lower punch.

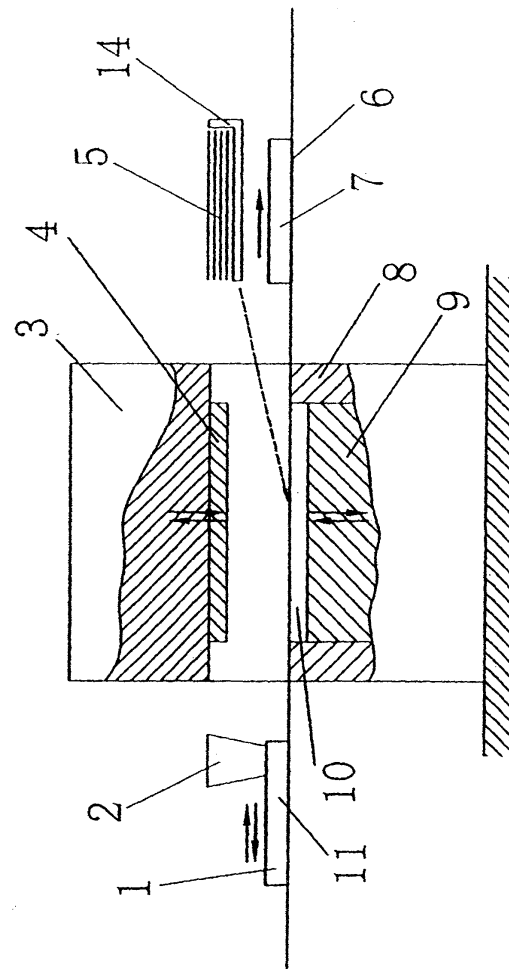


Fig. 1

## Description

### Field of the invention

[0001] The present invention relates to methods of producing ceramic products, for example as employed in ceramics industries; in particular, but not exclusively, the invention relates to a method of producing ceramic products imitating natural rock. Moreover, the invention also relates to apparatus for producing such ceramic products imitating natural rock.

### Background to the invention

[0002] In modern society, ceramic products have become increasingly indispensable in daily life. Moreover, such products are widely used for providing building decoration and parts of building structures. On account of contemporary aesthetic perception being more acute, the level of refinement of ceramic products for decoration purposes is becoming increasingly developed. In order to satisfy such contemporary expectations concerning ceramic products, three methods of decorating ceramic substrates are known in the prior art.

[0003] A first method of the three methods relates to decorating an exposed surface of a virgin ceramic material during formation of the material. The first method has associated therewith a dry powder printing method and a die-pressing method; the die-pressing method is also known as an "emblema method". In the die-pressing method, a concavo-convex surface formed on a die is applied to the virgin ceramic material to form a surface texture thereon corresponding to an imprint of the concavo-convex surface. However, the ceramic material thereby produced only shows the effect of the imprinted concavo-convex surface texture without colour detail, the first method thereby generating a result dissimilar to that of the texture of natural rock. In the dry powder printing method, a pigment powder is allowed to fall via a prepared film onto an exposed surface of raw ceramic material, the film having formed therein a plurality of holes; a web fabric including holes formed therein is alternatively useable in substitution for the film. The holes of the film are spatially arranged to form a desired design. Moreover, the raw ceramic material is then subsequently pressed into the virgin ceramic material. Thus, in this dry powder printing method, on account of there being a certain space between the film or web fabric and the surface of the raw ceramic material, and on account of the printing powder added onto the web or film falling freely onto the surface of the raw ceramic material without any artificial interference, it is possible for the powder falling on the surface of the raw ceramic material to be laterally displaced a small distance on impact. Consequently, there arises a problem that an outline of the design is formed on the raw ceramic material such that the outline is indefinite resulting in colour of the design not standing out in vivid contrast against the base colour

of the ceramic product.

[0004] A second method of the three methods concerns decorating the surface of the virgin ceramic material after the process of forming the virgin material, such decoration being achieved by way of screen printing, rotogravure printing, decalcomania decal printing and so forth.

[0005] A third method of the three methods concerns decorating an exposed surface of the virgin ceramic material after the process of forming the virgin material, such decoration being achieved by way of decal decoration, hand-painting and so forth.

[0006] In the aforementioned second and third methods, although screen printing, rotogravure printing and decal decoration are suitable for defining outline or elaborate colours, it is required that the exposed surface of the virgin ceramic material is flat or has relatively smaller concavo-convex texture. However, in contradistinction, for a ceramic product imitating natural rock stone, there is a need for relatively large concavo-convex surface features, even relatively sharp convex surface features. A problem arises in that the aforementioned design cannot be printed onto convex surfaces on the substrate, the outline of the resulting printed design being discontinuous and the decal being distorted due to corner features of the article thereby generated. Therefore, the second and third methods are not suitable for decorate stone-like ceramic products.

[0007] In recent years, on account of changes in aesthetic taste, stone-like ceramic products having large concavo-convex features have become popular with associated market demand for such products arising. At the present time, stone-like ceramic products have become a major product class in the field of ceramics in the European-American market. At an international exhibition held at Bologna in Italy in year 2000 concerning Ceramics and Machines of Producing Ceramics, natural rock-imitating ceramic articles produced by a two-stage pressing method and a machine for producing the same were exhibited. In the two-stage pressing method, first and second pressing machines are used in sequence for producing the ceramic product, the two pressing machines being series-mounted, and the second pressing machine having mounted thereon the aforementioned die including a concavo-convex surface; a dry-printing machine and a spreader are placed between the first and second pressing machines. The process for producing the ceramic articles using the two-stage pressing method is as follows:

- (a) a flat virgin ceramic substrate is formed using the first pressing machine under a relatively low pressure in a range of 40 to 80 kg/m<sup>2</sup> corresponding to a pressure in a range of 400 to 800 Pascals;
- (b) a decoration is applied to the flat substrate using the aforesaid dry-printing method and the substrate is then moved into the second pressing machine;
- (c) in the second pressing machine, the flat ceramic

ic substrate is pressed under a relatively high pressure of 300 kg/m<sup>2</sup> corresponding to 3000 Pascals to form the substrate into a virgin ceramic product having rock-like texture; and

(d) the formed virgin ceramic product is then processed by sintering and further processed to produce the final ceramic articles.

**[0008]** However, a need for two pressing machines to press the virgin ceramic material in the above method, and a need for a decoration device such as a dry-powder printing machine and associated spreader, results in more processes and more complicated devices being required with a corresponding increase in the cost of ceramic products thereby produced.

**[0009]** From the foregoing description of prior art, it will be appreciated that there has not yet been invented a method or an apparatus which can satisfactorily decorate the surface of virgin ceramic material to achieve convincing colours and designs.

### Summary of the invention

**[0010]** An object of the present invention is to address problems associated with the aforementioned prior art and to provide a method of and an apparatus for producing a ceramic product having fine outline and continuous rock-like texture by using a one-step pressing process, the method and apparatus being appropriate even when relatively large concavo-convex and even sharp convex surface features are present on the ceramic product.

**[0011]** According to a first aspect of the present invention, there is provided a method of producing a natural-stone-imitating ceramic product, characterized in that the method includes the steps of:

- (a) delivering a raw ceramic material from a hopper for spreading;
- (b) spreading the raw ceramic material on a surface of a virgin ceramic material located in a pressing position of a pressing machine;
- (c) pressing the raw ceramic material into the virgin ceramic material using an upper punch of the pressing machine, said upper punch being provided with a natural-imitating design on its underside pressing surface; and
- (d) sintering the virgin ceramic material from step (c) and finally processing the sintered virgin ceramic material to provide the ceramic product,

wherein decal is delivered onto a surface of the raw ceramic material when located in the pressing position rendering a pigment powder side of the decal applied towards the raw ceramic material prior to pressing the raw ceramic material in step (c) onto the virgin ceramic material.

**[0012]** Preferably, the pressing machine is selected

from a grid-delivering type pressing machine and a belt-delivering type pressing machine, whose grid or belt are operable to function as spreaders. In the case of the grid-delivering type pressing machine, decal is preferably delivered onto an upper surface of the raw ceramic material located in the pressing position. In the case of the belt-delivering type pressing machine, decal is preferably delivered onto an upper surface of the raw ceramic material when located between the hopper and the pressing machine.

**[0013]** According to a second aspect of the present invention, there is provided an apparatus for producing a natural-stone-imitating ceramic product, the apparatus characterized in that it includes a hopper for delivering a raw ceramic material, a spreader for spreading the raw ceramic material delivered from the hopper, a pressing machine including an upper punch and a lower punch for pressing the spread raw ceramic material wherein the upper punch is provided with a natural-imitating design on its underside pressing surface, a sintering device for sintering pressed ceramic from the pressing machine and a final processing device for receiving sintered ceramic from the sintering device, the apparatus further including an automatic decal delivering device for delivering decal onto the raw ceramic material to be pressed rendering a pigment powder-attaching side of the decal applied towards a surface of the raw ceramic material.

**[0014]** Preferably, the pressing machine is selected from a grid-delivering type pressing machine and a belt-delivering type machine whose grid or belt is operable to function as the spreader. In the case of the grid-delivering type pressing machine, the automatic decal delivering is preferably mounted over a virgin ceramic output platform used for temporarily placing the formed virgin ceramic material. In the case of the belt-delivering type pressing machine, the automatic decal delivering device is preferably mounted over and between the pressing machine and the hopper.

**[0015]** In the context of the present invention, "decal" is a known material used in the ceramics field, said material exhibiting flexibility and permeability, for example when a colour design is finely printed using ceramic pigment powder onto a surface. In a situation where pressing is performed when decal is applied to the raw ceramic material, the pigment powder and design on the decal may be laminated on the surface of the virgin ceramic. Moreover, the laminated decal is not susceptible to being damaged on account of its complexity when the decal is laminated onto concavo-convex surfaces of the virgin ceramic material. Therefore, the present invention is capable of resulting in a decoration having a definite colour and a continuous design outline being achieved on the concavo-convex surface of the sintered natural-stone-imitating ceramic product.

**[0016]** Moreover, "automatic delivering devices" as utilized in the present invention are known in the field of ceramics.

**[0017]** In contradistinction to the prior art, the present invention is susceptible to providing the following advantages:

- (1) one of the pressing machines utilized in the prior art two-stage pressing method is rendered superfluous, such omission corresponding to saving of a large investment which such a pressing machine represents in the ceramics industry; the present invention utilizes a one-stage pressing method using a single pressing machine to form the virgin ceramic material bearing the aforementioned decoration;
- (2) a more definite colour and outline of the design is obtainable than by screen printing, and rotogravure printing which belongs to contact type printing, and dry powder printing which belongs to non-contact type printing;
- (3) a decorating method according to the present invention is a simpler and regular method in the decal industry, such that apparatus for producing ceramic products according to the present invention is susceptible to being implemented from prior art devices including a pressing machine, decal and an automatic decal delivering device without substantial modifications thereto; and
- (4) the cost of producing a natural-stone-imitating ceramic product is susceptible to being decreased greatly.

**[0018]** It will be appreciated that features of the present invention are susceptible to being combined in any combination without departing from the scope of the invention.

**[0019]** In the context of the present invention, it will be appreciated that the expression "virgin ceramic material" is also known as "green ceramic".

#### Description of the diagrams

**[0020]** Embodiments of the invention will now be described, by way of example only, with reference to the following diagrams wherein:

Figure 1 is an illustration of an apparatus for producing a first example of a natural-stone-imitating ceramic product according to the present invention;

Figure 2 is an illustration of an apparatus for producing a second example of a natural-stone-imitating ceramic product according to the present invention; and

wherein numbers included in the diagrams are used to identify the following features as listed in Table 1:

TABLE 1:

1	grid
2	hopper
3	pressing machine
4	upper punch
5	decal
6	virgin ceramic material output platform
7	virgin ceramic material
8	die frame
9	lower punch
10	die cavity
11	grid moving platform
12	raw ceramic material
13	level tray
14	automatic decal delivering device

#### Description of embodiments of the invention

**[0021]** Embodiments of the present invention will now be described in detail with reference to the accompanying diagrams Figures 1 and 2.

#### Example 1:

**[0022]** In Figure 1, there is shown a view of an apparatus for producing natural-stone-imitating ceramic products according to a first embodiment, namely Example 1, of the present invention. The apparatus comprises a pressing machine of known grid-delivering type including a grid 1 configured to deliver raw ceramic material, a hopper 2, a pressing machine 3, an upper punch 4 and a lower punch 9 mounted on the pressing machine 3, a die frame 8, a die cavity 10, a grid moving platform 11, and a virgin ceramic material output platform 6. The upper punch 4 has a natural-imitating design on its underside pressing surface. Moreover, the automatic decal delivering device 14 is operable to deliver decal on the surface of raw ceramic material to be pressed in the die cavity 10 and to render the pigment powder side of the decal towards the raw ceramic material and to apply it to the surface of the raw ceramic material; the delivering device 14 is mounted over the virgin ceramic material output platform 6.

**[0023]** The apparatus of Figure 1 is operable to produce natural-stone-imitating ceramic products according to a method comprising the steps of:

- (a) moving the grid 1 towards the pressing machine 3 along the grid moving platform 11;
- (b) adding the raw ceramic material onto the grid 1

using the hopper 2;  
 (c) when the grid 1 reaches above the lower punch 9, moving the lower punch 9 downwards so as to add raw ceramic material via the grid 1 into the die frame 8;  
 (d) returning the grid 1 to its starting point when it contacts the surface of the added raw ceramic material;  
 (e) using the automatic decal delivering device 14 to deliver decal onto the surface of the raw ceramic material to be pressed in the die frame 8 and rendering the pigment powder side of the decal towards the raw ceramic material and depositing it on the surface of the raw ceramic material;  
 (f) moving the upper punch 4 downwards so that the raw ceramic material is pressed onto a virgin ceramic material 7;  
 (g) pushing the virgin ceramic material 7 from step (f) bearing a decoration of the natural-stone-imitating article onto the virgin ceramic material output platform 6;  
 (h) on the output platform 6, applying pigment powder on the decal for firmly printing the design onto the surface of the virgin ceramic material; and  
 (i) sintering the virgin ceramic material from step (h) using a sintering device (not shown) and finally processing the sintered ceramic material using a processing device (not shown) in order to obtain the natural-stone-imitating ceramic product.

#### Example 2:

[0024] In Figure 2, there is shown an apparatus for producing natural-stone-imitating ceramic products according to a second embodiment, namely Example 2, of the present invention. A pressing machine used in this second embodiment is a known tray delivering type comprising the aforesaid hopper 2, a level tray 13 operable to move by way of cyclical motion to deliver raw ceramic material, the aforesaid pressing machine 3, the aforesaid upper punch 4 and the aforesaid lower punch 9 mounted on the pressing machine 3. The automatic decal delivering device 14 is mounted over and between the pressing machine 3 mounted above the level tray 13 and the hopper 2. The upper punch 4 includes a natural-imitating design on its underside pressing surface.

[0025] The apparatus of Figure 2 is operable to produce natural-stone-imitating ceramic products according to a method comprising the steps of:

(a) spreading raw ceramic material on the level tray 13 using the hopper 2;  
 (b) using the automatic decal delivering device 14 to deliver decal onto the surface of the raw ceramic material to be pressed 12 and rendering the pigment powder side of the decal towards the raw ceramic material and applying it to the surface of the raw ceramic material;

(c) transporting using the level tray 13 the raw ceramic material between the upper punch 4 and the lower punch 9;  
 (d) pressing the raw ceramic material 12 from step (b) and the decal 5 into the virgin ceramic material having a decoration formed thereon; and  
 (e) sintering the resulting virgin ceramic material from step (d) using a sintering device (not shown) and finally processing the sintered virgin ceramic material in a processing device (not shown) to provide the natural-stone-imitating ceramic products.

[0026] It is found that the surface of the natural-stone-imitating ceramic products, said products having concavo-convex surface features, have definite colour and design, wherein the outline of the design is continuous without any discontinuities. Moreover, the aforementioned methods of the present invention for producing the ceramic products involve fewer processing steps and are hence simplified in comparison to the prior art, thereby reducing the cost of producing the ceramic products.

[0027] It will be appreciated that embodiments of the invention described in the foregoing are susceptible to being modified without departing from the scope of the invention as defined by the appended claims.

[0028] It will be further appreciated that expressions such as "comprise", "include", "incorporate" employed to describe the present invention are to be construed as non-exclusive, namely that other unspecified items or components may also be present.

#### Claims

1. A method of producing a natural-stone-imitating ceramic product, **characterized in that** the method includes the steps of:

(a) delivering a raw ceramic material from a hopper for spreading;  
 (b) spreading the raw ceramic material on a surface of a virgin ceramic material located in a pressing position of a pressing machine;  
 (c) pressing the raw ceramic material into the virgin ceramic material using an upper punch of the pressing machine, said upper punch being provided with a natural-imitating design on its underside pressing surface; and  
 (d) sintering the virgin ceramic material from step (c) and finally processing the sintered virgin ceramic material to provide the ceramic product,

wherein decal is delivered onto a surface of the raw ceramic material when located in the pressing position rendering a pigment powder side of the decal applied towards the raw ceramic material prior to

pressing the raw ceramic material in step (c) onto the virgin ceramic material.

2. A method according to Claim 1, wherein said pressing machine is a grid-delivering type pressing machine, and the decal is delivered on an upper surface of the raw ceramic material when located in the pressing position. 5
  
3. A method according to Claim 1, wherein said pressing machine is a belt-delivering type pressing machine, and the decal is delivered on an upper surface of the raw ceramic material between the hopper and the pressing machine. 10  
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4. An apparatus for producing a natural-stone-imitating ceramic product, the apparatus **characterized in that** it includes a hopper (2) for delivering a raw ceramic material, a spreader (3) for spreading the raw ceramic material delivered from the hopper (2), a pressing machine (3) including an upper punch (4) and a lower punch (9) for pressing the spread raw ceramic material wherein the upper punch (4) is provided with a natural-imitating design on its underside pressing surface, a sintering device for sintering pressed ceramic from the pressing machine (3) and a final processing device for receiving sintered ceramic from the sintering device, the apparatus further including an automatic decal delivering device (14) for delivering decal (5) onto the raw ceramic material to be pressed rendering a pigment powder-attaching side of the decal (5) applied towards a surface of the raw ceramic material. 20  
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5. An apparatus according to Claim 4, wherein said pressing machine (3) is a grid-delivering type pressing machine whose grid is operable as the spreader (3), and said automatic decal delivering device (14) is mounted above a virgin ceramic output platform of said apparatus. 35  
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6. An apparatus according to Claim 4, wherein said pressing machine (3) is a belt-delivering type pressing machine whose belt (13) is operable as the spreader (3), and said automatic decal delivering device (14) is mounted over and between the pressing machine (3) and the hopper (2). 45

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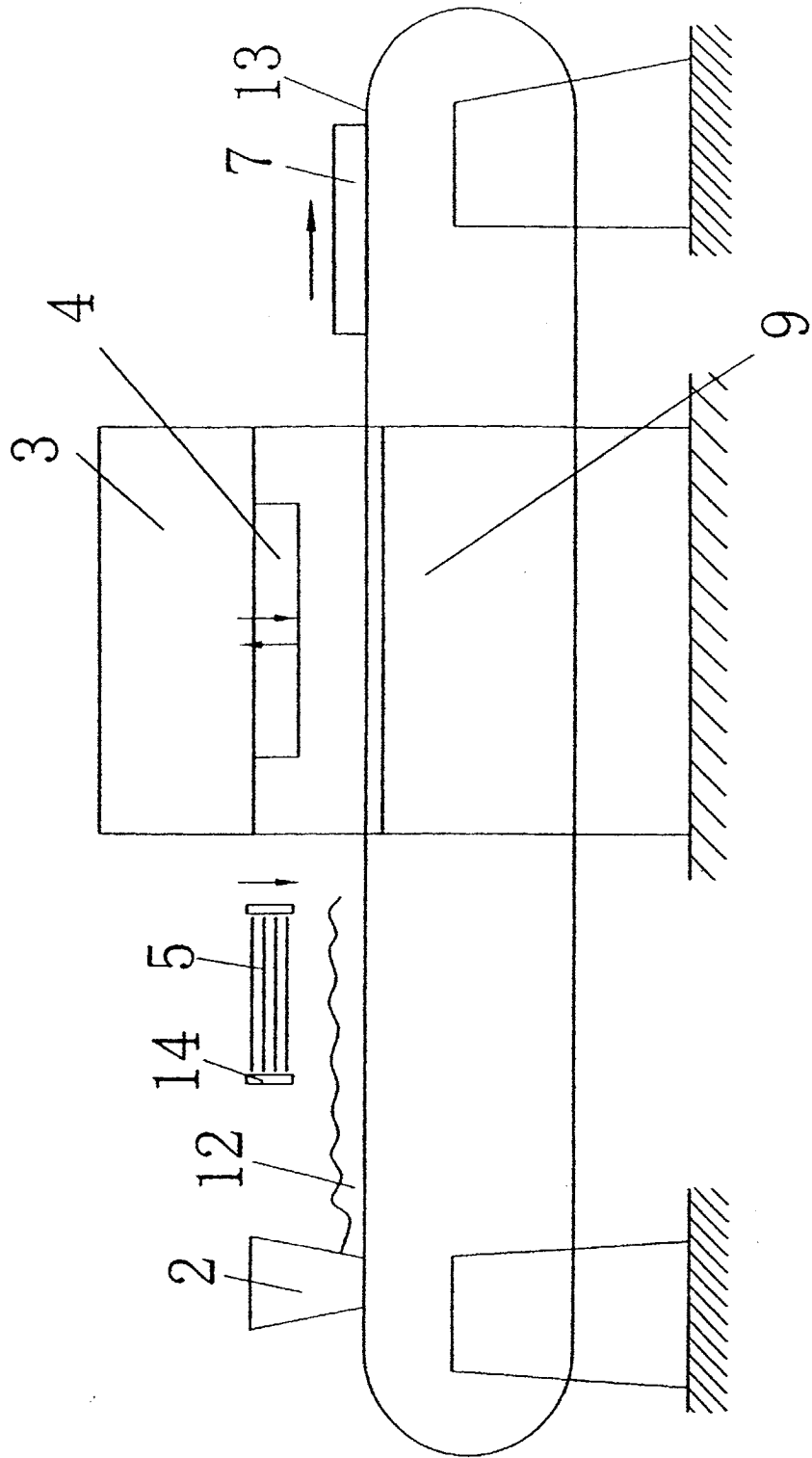


Fig. 2