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(54) **Method and plant for manufacturing ceramic tiles and slabs, and tiles and slabs obtained thereby**

(57) A method for manufacturing construction elements such as ceramic tiles and slabs, consisting of pressing in one or two stages a mass consisting of at least two ceramic materials generally in powder form at least partially mixed together and having different properties, generally different colours, followed by firing of the pressed product, characterised by comprising the

following operative steps: separately preparing bodies of generally irregular form starting from at least one ceramic material generally in powder form having properties different from those of said at least two materials of said mass; adding said bodies to said mass before the final pressing; and subjecting the product to a surface finishing operation before or after said firing step.

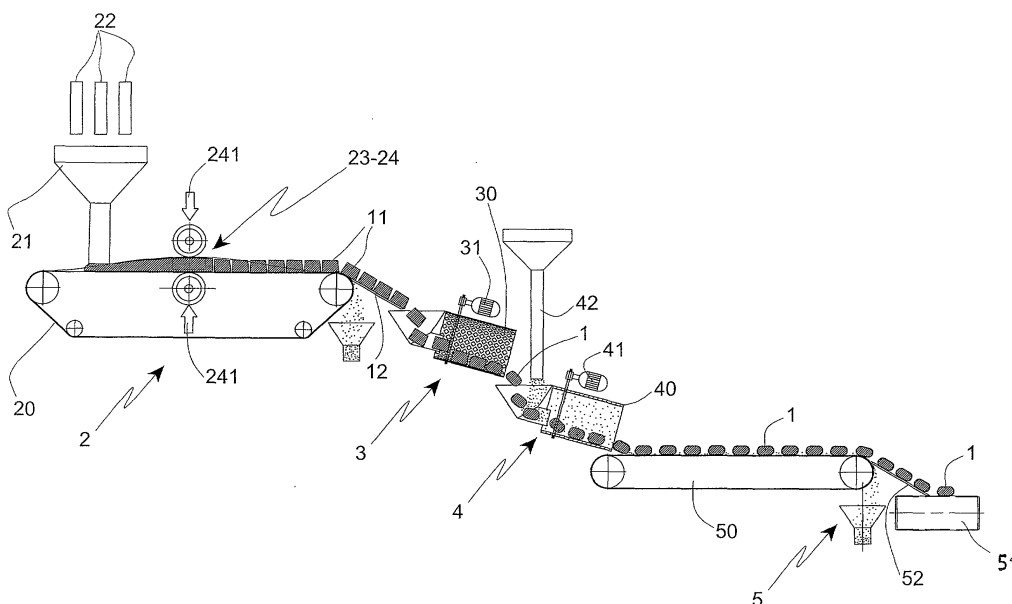


FIG. 1

Description

[0001] This invention relates to the manufacture of ceramic construction materials, generally tiles but also large-dimension slabs intended to be used either as such or to obtain therefrom one or more elements of lesser dimensions and/or generally different shapes.

[0002] The invention also relates to the means for implementing said method and to the materials obtained with them.

[0003] The ceramic tile manufacturing sector is known to be constantly seeking new and innovative ornamental motifs, with current emphasis on decorations reproducing the appearance of natural stone and rock, such a marble, which knowingly presents elongate veining and striations of various form and colour.

[0004] Decorative motifs reproducing said aesthetic element typical of natural stone or rock such as marble or granite can be obtained by the modern ceramic manufacturing technology typical of porcellainized stone, well known to the expert of the art, which will not be described in detail.

[0005] It is sufficient to state that such decorative motifs can concern either the whole mass, i.e. the whole thickness, of the tile or slab, or only that layer at the exposed face of said tile or slab.

[0006] In particular, in the second case double loading is carried out, the first of which uses a not particularly valuable base material intended to form the support part of the tile, whereas the second uses a finishing material possessing properties able to provided the desired characteristics for the exposed face of the tile or slab.

[0007] Said second material can consist of at least two ceramic materials generally in powder form which are at least partly mixed together and have different characteristics, generally different colours.

[0008] As stated, natural stone and rock in general, for example marble, are generally characterised by elongate veining and striations of various form and colour generated by agglomerations of natural elements of various type which are amassed and distributed irregularly, or rather randomly. The appearance of said natural stone and rock such as marble is further characterised by inclusions, nodules and masses of various kinds which are generally very different at least in terms of colour from the base matrix of the respective stone or rock.

[0009] As is well known to the expert of the art, these are often materials deriving for example from secondary recrystallization of natural elements, such as calcite, aragonite in limestone, or dolomite.

[0010] The dimensions and form of such inclusions are extremely varied. Usually they are of elongate form, and in cross-section normally display a marginal surrounding band generally of irregular width, usually accompanied by various shading, and one or more colorations which are also usually considerably different from that or those of the central part.

[0011] The main object of this invention is to provide

means by which ceramic construction materials can be obtained, generally tiles and slabs, having the aforesaid multi-colour appearance typical of natural stone and rock such as marble, in particularly a decoration which in addition to veining and striations of various shapes and colours also presents circumscribed zones of generally irregular shape having an appearance different from that of the surrounding general matrix, and possibly at least partly surrounded by a band or halo of usually irregular width, generally provided with at least one coloration at least partly different from that or those of the zones situated inside and outside it.

[0012] Essentially said zones, also known as stains, constitute the aforesaid inclusions, nodules or masses typical of natural stone and rock such as marble.

[0013] Said objects are attained by virtue of the characteristics defined in the claims.

[0014] In a totally general sense, a decorative ceramic product is prepared consisting of preformed congruent bodies acting as inserts for the final product. According to the invention, said bodies are generally of irregular shape and have relatively small dimensions, by which is meant dimensions generally much less than those of the tiles and slabs which are to be obtained.

[0015] The said bodies generally consist of at least one ceramic material generally in conveniently compacted powder form, which are intended to be added to ceramic materials generally in powder form for manufactures of porcellainized stone type as explained in the introduction.

[0016] Said at least one ceramic material generally in powder form has different characteristics from said porcellainized stone type material, generally a different colour.

[0017] According to an advantageous characteristic of the invention, said bodies of said decorative product can be at least partly covered with at least one ceramic preparation, generally glaze, which has different properties, generally a different coloration, from that or those of the constituent materials of said bodies and the support material of the final product, i.e. the tile or slab.

[0018] Said bodies can have discretionary shapes and dimensions.

[0019] With regard to their shape, this is generally irregular and preferably elongate. The outer surface of said elongate shape is preferably generally smooth, i.e. virtually free from cusps or other sharp edged projections.

[0020] With regard to their dimensions, in particular their transverse dimensions, these are generally proportional to the usual thicknesses of the loads deposited in the moulds for forming ceramic tiles or slabs. From tests carried out with a pilot plant in accordance with the teachings of the invention, bodies of elongate shape having an average transverse dimension and longitudinal dimension of 5-15 mm and 10-50 mm respectively have proved convenient, but these values are to be considered purely as examples.

[0021] The tiles or slabs, with their support material incorporating said bodies preferably only within their surface layer, are subjected to a surface finishing operation, generally a smoothing operation, to expose their external face, which can be partially or totally as described, and of one or more colours.

[0022] Said smoothing is preferably effected immediately after the forming by the press, Alternatively it can be effected after firing.

[0023] The characteristics and merits of the invention will be apparent from the ensuing detailed description, given with reference to the figures of the accompanying drawings which show, by way of non-limiting example, a particular preferred embodiment of the upstream part of a plant for implementing the proposed method.

[0024] Figure 1 is a side view of the invention.

[0025] Figure 2 is a view taken from above the preceding figure.

[0026] Figure 3 is the section III-III indicated in Figure 2 but on an enlarged scale.

[0027] Figure 4 is a perspective view of the elements of Figure 3.

[0028] Figure 5 is the section V-V indicated in Figure 4.

[0029] Figure 6 is a section showing part of a load deposited into the cavity of a mould for forming tiles or slabs according to the invention.

[0030] Figure 7 is a view totally similar to the preceding, showing the compacted tile or slab in section.

[0031] Figure 8 shows the same tile after smoothing.

[0032] Figure 9 is a view taken from above the preceding figure.

[0033] Figure 10 is the computerized representation of a decoration of marble type according to the invention.

[0034] Said figures, and in particular Figures from 1 to 5, show the upstream part of a ceramic tile or slab manufacturing plant, the downstream part of which, not shown for simplicity, comprises essentially, in succession: a supply station for the starting materials, into which the part shown in Figure 1 extends; a forming station, which can be of the single or double pressing type; possibly a smoothing or lapping station; a firing station, for example of the carriage type with single-layer or multi-layer translating tiles; and a smoothing or lapping station if not already provided downstream of the forming station.

[0035] That part of the plant shown in Figures from 1 to 5 constitutes a processing line for forming generally irregular bodies used as decorative inserts (see Figures from 6 to 10) for the finished product, i.e. ceramic tiles and slabs. Said bodies are generally of relatively small dimensions, and are of preferably elongate form, generally of peanut shape as shown in said figures.

[0036] For example said bodies 1 have an average transverse dimension and an average longitudinal dimension of 5-15 mm and 10-50 mm respectively.

[0037] In Figures 1 and 2 said bodies 1 all have prac-

tically the same shape and the same dimensions for reasons of simplicity.

[0038] Said processing line comprises essentially a compacting station 2, a chopping and finishing station 3, a coating station 4, and a collection and removal system 5.

[0039] Specifically the compacting station 2 comprises a motorized belt 20, for example driven by a gearmotor unit with incorporated speed variator, the upstream end of which lies below a vertical dispensing tube 21.

[0040] With the discharge mouth of said tube 21 there is associated an adjustable valve member (not shown), preferably controlled by the system controlling the speed of the belt 20.

[0041] A series of conduits, of which three are shown, discharge into said tube 21, and can be activated in a defined order, for example in the case of the process under discussion this can be in accordance with a random relationship (variable at choice) integrated into the overall plant control system.

[0042] Each individual conduit 22 feeds to the underlying tube 21 at least one ceramic material generally in powder form which mixes more or less extensively with that (or those) fed by the other conduits 22.

[0043] In the case for example of two materials fed by the same conduit 22, these will have generally different properties, for example different colorations, and can be mixed either completely or partially, to provide mixtures of salt and pepper type or veining/striation type respectively.

[0044] For example the materials fed by the individual conduits 22 can consist of atomized, ground or micronized powders obtained from ceramic, semi-glaze or glaze mixes, and mixtures thereof.

[0045] It should also be noted that said materials generally of powder form will have different characteristics, generally different colorations, from those of the ceramic materials generally in powder form provided to form the matrix 100 of the body of the final tile or slab (see Figure 10), to form a decoration of natural stone or rock type such as marble, the veining or striations of which are indicated by 10 in said figure.

[0046] The belt 20 is constructed in such a manner as to be able to deform elastically for the reasons which will be apparent hereinafter, for example it can consist of a rubber belt with suitable filler mixtures in line with its elastic deformability and its mechanical strength.

[0047] At the centre of the outward branch of the belt 20 there is a guide ring 23 at which the belt assumes along a relatively short length a tubular shape as a result of the upward folding of its longitudinal edges (Figures 4 and 5) which are superposed for a certain distance beyond said ring 23, where a compactor unit 24 is located.

[0048] Essentially, said ring 23 and said unit 24 provide a generally funnel-shaped constriction (Figures 4 and 5), upstream and downstream of which the outward branch of the belt 20 substantially assumes the form of

two channels which gradually narrow and widen respectively (Figures 1 and 2).

[0049] Said ring 23 is carried by a support 25 which is positioned on the support structure of the belt 20 (Figure 4), the inner surface of said ring 23 being shaped as a cone frustum the minor base of which is situated downstream and has a circumference smaller than the width of the belt 20 (see Figure 5).

[0050] Said ring 23 and said support 25 are also provided upperly with respective cuts for the insertion and extraction of the belt 20 (Figures 4 and 5). As an alternative at least the ring 23 can be divided into at least two mutually engagable mating parts.

[0051] The compactor unit 24 comprises a circumferential set of equidistant idle wheels 240, four in number in the illustrated example, which are arranged to roll along the tubular portion of the belt 20 leaving the ring 23 (Figures 1-5).

[0052] Specifically, two wheels 240 lie in a horizontal plane, the other two lying in a vertical plane which intersects the preceding along the longitudinal axis of said ring 23, each wheel 240 being constantly elastically urged against the tubular portion of the belt 20 by a respective thrust member schematically indicated by 241 in Figures 1 and 2.

[0053] Said thrust member 241 can consist of a hydraulic or pneumatic cylinder/piston unit, a flat helical or spiral spring, a leaf spring or equivalent.

[0054] In the figures the outer shape of the wheels 240 is cylindrical but there is nothing to prevent it being configured in another manner, for example with a circumferential groove of circular arc cross-section.

[0055] As a variant, instead of the wheels 240 a circumferential series of slide blocks with an arched active surface or equivalent can be provided.

[0056] A mass of loose ceramic material 210 is loaded upstream of the belt 20 without discontinuity and is made continuously consistent by the compactor unit 24, from the exit of which there emerges a cord which divides naturally into pieces 11 (Figures 1 and 2) of various shapes and dimensions when the two previously superposed longitudinal edges of the belt 20 open out.

[0057] It should be noted that said cord is compacted with a specific pressure less than that used to compact the final tile or slab, in general substantially one half of this latter.

[0058] The said pieces are fed to a chute 12 which discharges into the chopping and finishing station 3, between the downstream end of the belt 20 and said chute 12 there being provided an overflow for collecting and removing those pieces of agglomerate of too small dimensions.

[0059] Said belt 20 can also be positioned in combination with at least one other totally similar belt, to compact a loose starting material with different properties, generally at least one different coloration from that (or those) of the loose material 210 compacted by the belt 20. In Figure 2 said at least one other belt is shown sche-

matically by a dashed-line rectangle indicated by 101, and can discharge either onto the chute 12 as indicated by the arrow A, or onto the collection and removal system as indicated by the arrow B.

[0060] The chopping and finishing station 3 comprises an inclined cylinder 30 of off-horizontal axis which is rotated about itself by a suitable drive system 31, such as a gearmotor with incorporated speed variator.

[0061] The interior of said cylinder 30 contains means (not shown for simplicity) with two functions: one is to break the pieces 11 into smaller bodies 1, having for example the aforesaid shapes and dimensions, the other being to smooth the sharp edged parts which said bodies 1 possess after breakage of said pieces 11. Said double-function means can for example comprise fins of various shapes and dimensions, pins, and/or similar means.

[0062] In combination with said means, or instead of them, on the wall of the cylinder 30 there can be provided apertures with sharp edges. In Figures 1 and 2, said apertures are equal and are of rhomboid shape, but this is purely by way of example.

[0063] Said cylinder 30 discharges into the coating station 4, into which there also discharges, by way of a metering valve, not shown, a vertical dispensing tube 42 for a ceramic preparation consisting of at least one material generally in powder form having different properties, at least one different coloration, from that (or those) of the loose starting mass 210.

[0064] Said preparation can consist of powders or granules of different kinds, for example chromophore oxides, or atomized, ground or micronized powders obtained from ceramic, semi-glaze or glaze mixes, and mixtures thereof. Said coating station 4 comprises an inclined cylinder 40 of off-horizontal axis which is rotated about itself by a suitable drive system 41, such as a gearmotor with incorporated speed variator.

[0065] In the interior of said cylinder 40 there are provided means (not shown for simplicity) to aid the coating of said bodies 1 with said preparation, said means possibly consisting of ribs or projections of various shapes and dimensions.

[0066] By regulating the rotational speed of the cylinder 40, and/or the opening of the discharge valve of the tube 42, both the thickness and the extent of the coating covering the bodies 1 can be selected.

[0067] Essentially, the following can be obtained: completely covered bodies (to the left in Figures 6-9, and substantially at the centre of the lower third of Figure 10); partially covered bodies (at the centre in Figures 6-9 and at the bottom right of Figure 10); and totally non-covered bodies 1 (at the right in Figures 6-9 and at the bottom left in Figure 10).

[0068] The non-covered bodies 1 can be obtained either by temporarily closing the dispensing tube 42 while maintaining or not maintaining the cylinder 40 in operation, or by bypassing this latter by means of a suitable deviator and directly feeding the product leaving the sta-

tion 3 to the collection and removal system 5.

[0069] It should be noted that for certain processes, for example the formation of large format ceramic slabs, the aforescribed chopping and finishing station 3 can be bypassed, while either excluding or not excluding the coating step.

[0070] In the illustrated example said coating takes place substantially dry, but there is nothing to prevent different methods being used. For example, the product leaving the cylinder 30 can be fed onto a mesh belt and be subjected to either spraying or dripping with suitably fluidized glazes, then either be dried before being fed to the collection system 5, or be fed directly to the loading means of the plant pressing station.

[0071] As a variant said mesh belt can pass either through a cascading sheet or a bath of ceramic glaze, at its exit from which a suitable fan can be provided.

[0072] There is nothing to prevent a combination of the three stated techniques being used. For example the treated bodies 1 originating from the station 4 can be subjected for example to a subsequent spraying or drip-coating operation, by which the coating on the bodies 1 will comprise a (complete or partial) inner layer consisting of a first ceramic preparation, such as a glaze, and a (complete or partial) outer layer of a second ceramic preparation, such as a glaze having different properties from those of the preceding, typically a different colour.

[0073] Again, downstream of the cylinder 30 there can be provided at least one deviator device arranged, when required, to deviate at least a part of the arriving bodies 1 towards a coating site (glazing) either by spraying, by dripping or by immersion.

[0074] Returning to Figures 1 and 2, it can be seen that the bodies 1 (coated or not) leaving the cylinder 40 are collected by the system 5 which comprises two mutually perpendicular translating belts 50 and 51.

[0075] Between the cylinder 40 and the upstream belt 50 there is provided a chute 52, between this latter and said belt 50 there being an overflow (not visible in the figures) for collecting and recirculating excess glaze powder. The bodies 1 obtained in this manner are fed to the supply system of the plant forming station, and can be used as explained hereinafter.

[0076] In the case of single-stage forming, i.e. if the generally soft ceramic mass for producing a tile or slab is to be compacted to the desired degree using a single pressing in a single press unit, said bodies 1 can be:

- either previously mixed with said generally soft mass if using a single loading method,
- or previously mixed with the second layer of said mass if using a double loading method,
- or deposited directly onto the soft mass on termination of its loading, whichever of the two loading methods is used.

[0077] The aforesaid is also valid for two-stage forming systems, i.e. if the generally soft mass for pro-

ducing a tile or slab is compacted as desired with two successive pressings within two press units. In that case the bodies 1 can also be deposited onto the product on leaving the first press unit, i.e. before the second or final pressing.

[0078] This direct deposition onto said soft mass or onto said product can be effected by any suitable device, for example a distributor belt or a hopper with a strewing device.

[0079] On termination of pressing the formed tile or slab can be subjected to at least one surface finishing operation, generally smoothing or lapping, after which it is fired.

[0080] Alternatively said smoothing or lapping can be effected on the fired product.

[0081] As explained, the bodies 1 according to the invention can be generally used for manufactures of porcellainized stone type, in particular for manufacturing tiles or slabs with decorations of natural stone or rock type, such as marble, as shown by way of example in Figure 10. This however is not limiting.

[0082] In this respect, there is nothing to prevent the use of said bodies 1 for slabs and tiles having a much more regular or uniform matrix than that of Figure 10, for example a matrix having a dotted appearance typical of granite, obtainable with starting ceramic mixtures of salt and pepper type.

Claims

1. A method for manufacturing construction elements such as ceramic tiles and slabs, consisting of pressing in one or two stages a mass consisting of at least two ceramic materials generally in powder form at least partially mixed together and having different properties, generally different colours, followed by firing of the pressed product, **characterised by** comprising the following operative steps:

- separately preparing bodies of generally irregular form starting from at least one ceramic material generally in powder form having properties different from those of said at least two materials of said mass,
- adding said bodies to said mass before the final pressing, and
- subjecting the product to a surface finishing operation before or after said firing step.

2. A method as claimed in claim 1, **characterised in that** said bodies are prepared by chopping a previously compacted accumulation of said at least one material generally in powder form.

3. A method as claimed in claim 2, **characterised in that** said accumulation is compacted with a specific pressure lower than the final forming pressure for

said product.

4. A method as claimed in claim 2, **characterised in that** either during or after said chopping step, said bodies are subjected to a finishing operation aimed at substantially eliminating roughness such as sharp edges.

5. A method as claimed in claim 2, **characterised in that** said bodies are subjected to at least one coating operation aimed at coating at least a part of their outer surface with at least one layer of at least one ceramic preparation having different properties from those of the constituent material of said bodies.

6. A method as claimed in claim 5, **characterised in that** said at least one coating operation is effected by mixing together an accumulation consisting of a mass of said bodies and a generally powder mass of said at least one ceramic preparation.

7. A method as claimed in claim 5, **characterised in that** said at least one coating operation is effected by spraying said bodies with said at least one ceramic preparation suitably fluidized.

8. A method as claimed in claim 5, **characterised in that** said at least one coating operation is effected by exposing said bodies to a dripping distribution of said at least one ceramic preparation in fluid form.

9. A method as claimed in claim 5, **characterised in that** said at least one coating operation is effected by passing said bodies through a cascading sheet or a bath of said at least one ceramic material in substantially liquid form.

10. A method as claimed in claim 5, **characterised by** comprising at least two successive coating operations using ceramic preparations with different characteristics.

11. A method as claimed in claim 1, **characterised in that** the addition of said bodies to said mass is effected before the one or two stage pressing and takes place by distributing said bodies throughout the entire said mass.

12. A method as claimed in claim 1, **characterised in that** the addition of said bodies to said mass is effected before the one or two stage pressing and takes place by distributing said bodies within the upper layer of said mass.

13. A method as claimed in claim 1, **characterised in that** the addition of said bodies to said mass is effected before the one or two stage pressing and

takes place by depositing said bodies onto the upper face of said mass.

14. A method as claimed in claim 1, **characterised in that** the addition of said bodies to said mass is effected before the one or two stage pressing and takes place by depositing said bodies onto the upper face of the compacted mass in correspondence with said first stage.

15. A method as claimed in claim 1, **characterised in that** said finishing operation consists of smoothing.

16. A plant for implementing the method claimed in claims from 1 to 15, comprising a one or two stage pressing station with respective means for supplying the ceramic starting materials, and a firing station for the products formed by said pressing station, **characterised in that** to said supply means there is connected a process line for the formation of bodies acting as inserts for the products produced by the plant, downstream either of said pressing station or of said firing station there being provided an apparatus for finishing the exposed face of said products.

17. A plant as claimed in claim 16, **characterised in that** said process line comprises a translating belt, the outward branch of which is arranged to receive a loose mass consisting of at least one ceramic material generally in powder form having properties different from those of said starting materials, generally a different colour, and is provided with a compacting system which renders the mass present on said outward branch generally consistent.

18. A plant as claimed in claim 17, **characterised in that** said translating belt is operated continuously by an adjustable drive unit.

19. A plant as claimed in claim 17, **characterised in that** said translating belt is elastically deformable.

20. A plant as claimed in claim 17, **characterised in that** said compacting system comprises an intermediate guide member arranged to cause a portion of said moving outward branch to assume a tubular shape, and a downstream compactor unit arranged to press against said tubular portion of the belt.

21. A plant as claimed in claim 20, **characterised in that** said guide member comprises a through aperture which is traversed by said outward branch and is shaped as a cone frustum the minor base of which faces downstream and has a circumference at least slightly less than the width of the belt.

22. A plant as claimed in claim 20, **characterised in**

that said compactor unit comprises a circumferential series of profiled pressing members distributed about said tubular portion of belt, against which they constantly rest by the effect of elastic thrust means positioned to their rear.

23. A plant as claimed in claim 22, **characterised in that** said pressing members each consist of an idle wheel lying in a plane which contains the axis of said frusto-conical aperture.

24. A plant as claimed in claim 17, **characterised in that** downstream of said belt there is provided a chopping station for obtaining said bodies from said compacted mass, and for generally smoothing the sharp edged roughness of said bodies.

25. A plant as claimed in claim 24, **characterised in that** said chopping station comprises a rotating inclined cylinder, on the inner surface of which there are provided means such as pins and/or ribs of various shapes and dimensions.

26. A plant as claimed in claim 25, **characterised in that** in a least a part of the wall of said cylinder there are provided apertures with sharp edges.

27. A plant as claimed in claim 17, **characterised in that** downstream either of said belt or of said chopping station there is provided at least one station for at least partly coating said bodies with a layer of at least one ceramic preparation having properties different from those of the at least one constituent material of said bodies.

28. A plant as claimed in claim 27, **characterised in that** said at least one coating station comprises an inclined rotary cylinder into which said bodies flow and a dispenser for said at least one ceramic preparation, this latter generally in powder form.

29. A plant as claimed in claim 28, **characterised in that** the inner surface of said cylinder presents mixing means such as projections or ribs.

30. A plant as claimed in claim 27, **characterised in that** said at least one coating station comprises for said bodies a support and transport means, with which there is associated at least one spraying unit for said at least one ceramic preparation.

31. A plant as claimed in claim 27, **characterised in that** said at least one coating unit comprises for said bodies a support and transport means, with which there is associated at least one dripping apparatus for said at least one ceramic preparation.

32. A plant as claimed in claim 27, **characterised in**

that said at least one coating unit comprises for said bodies a support and transport means which passes through at least one cascading sheet or a bath of said at least one ceramic preparation.

33. A plant as claimed in claim 16, **characterised in that** said finishing apparatus comprises at least one smoothing or lapping machine.

34. Ceramic construction materials such as tiles and slabs, **characterised by** comprising, on their exposed face, stains of defined contour and of colour and appearance different from the appearance of the surrounding regions.

35. Materials as claimed in claim 34, **characterised in that** said stains are at least partly bounded by a strip of different appearance from that of the stains and the regions surrounding them.

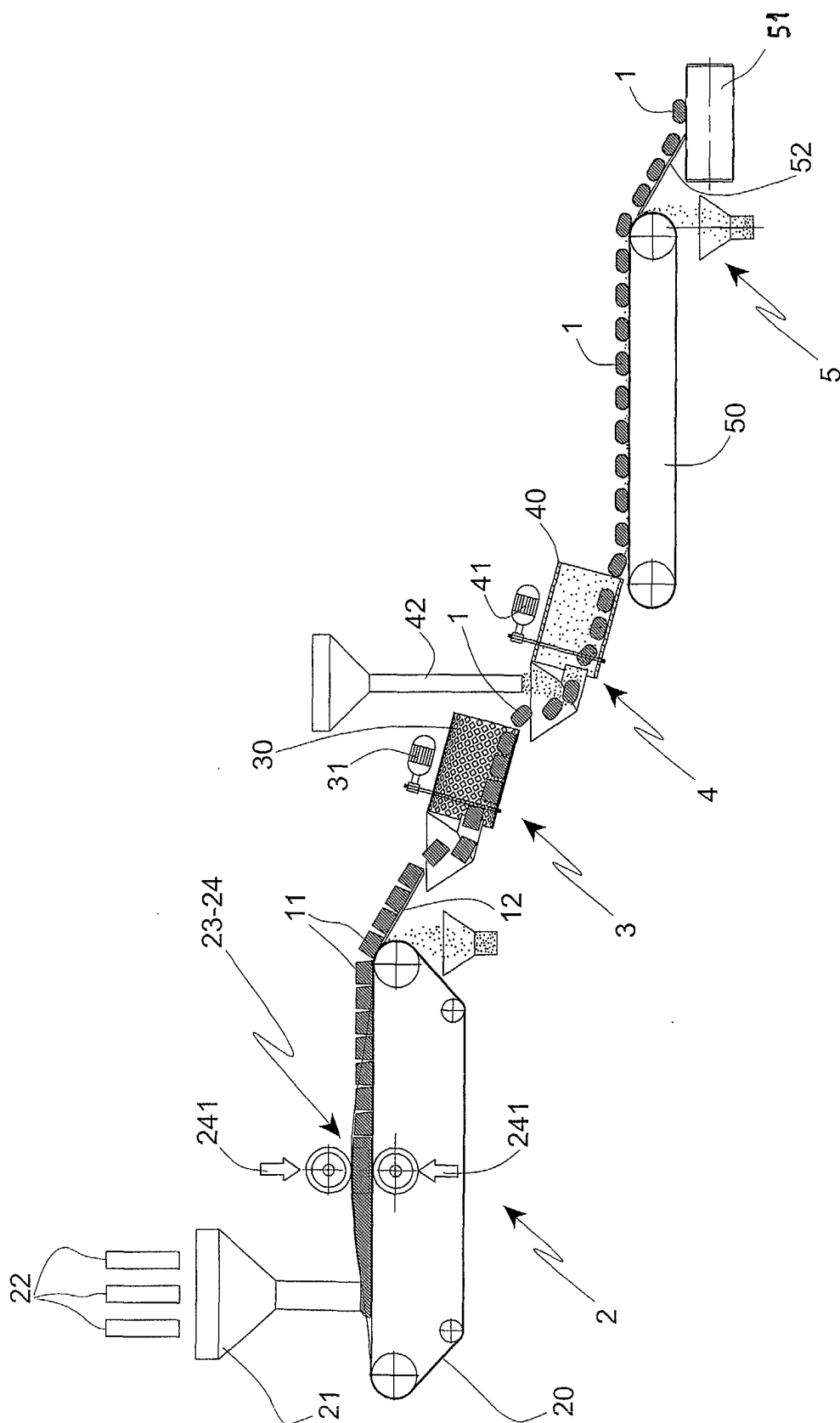
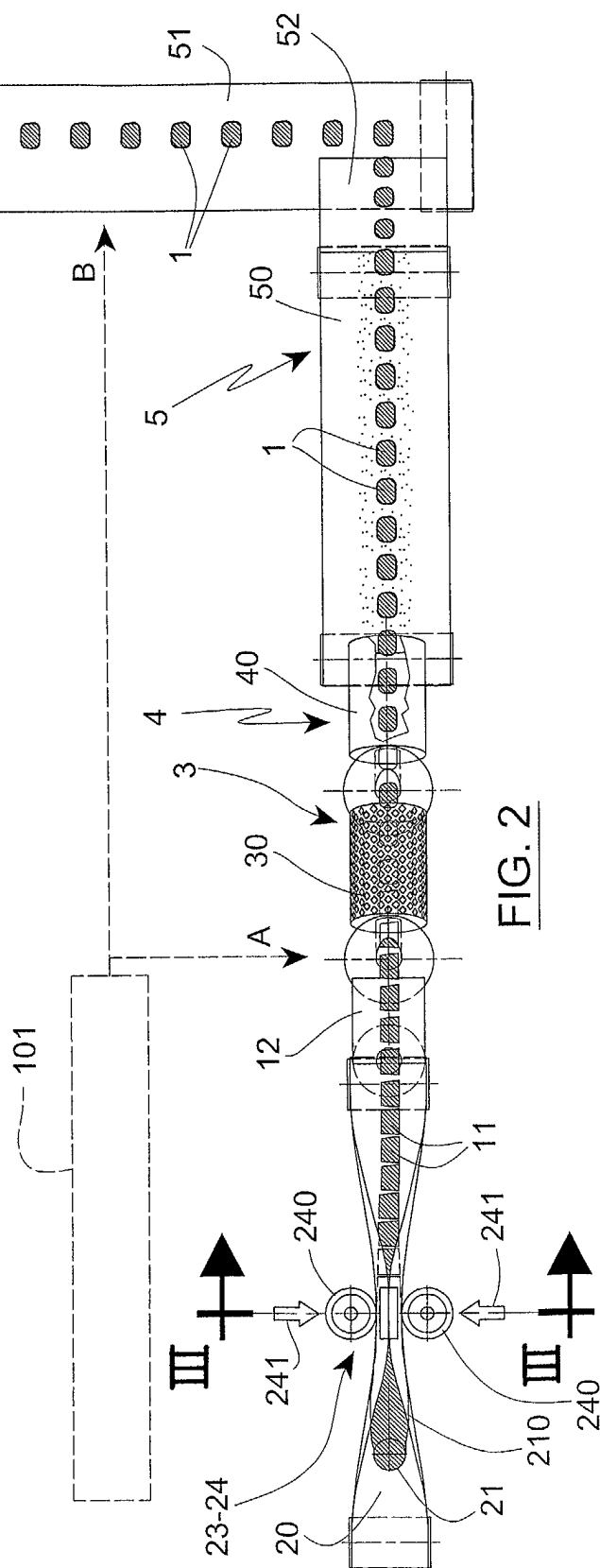
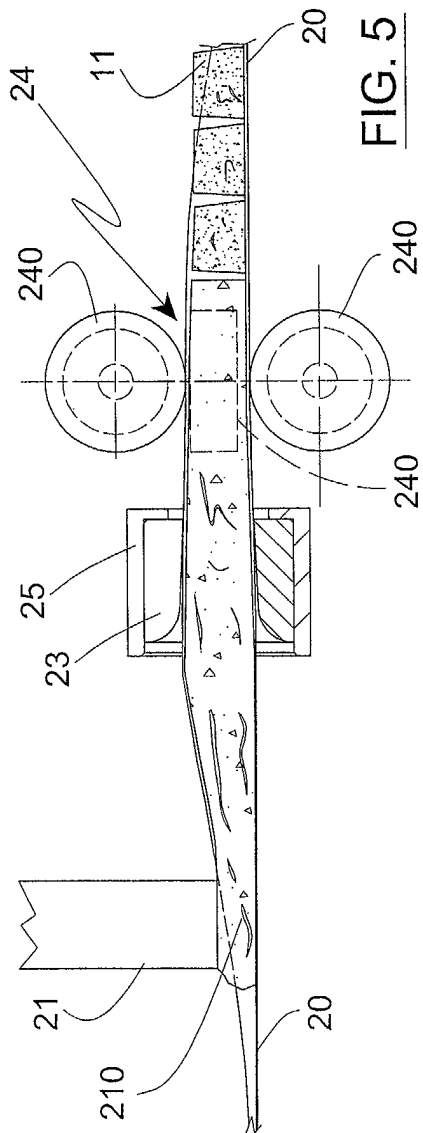
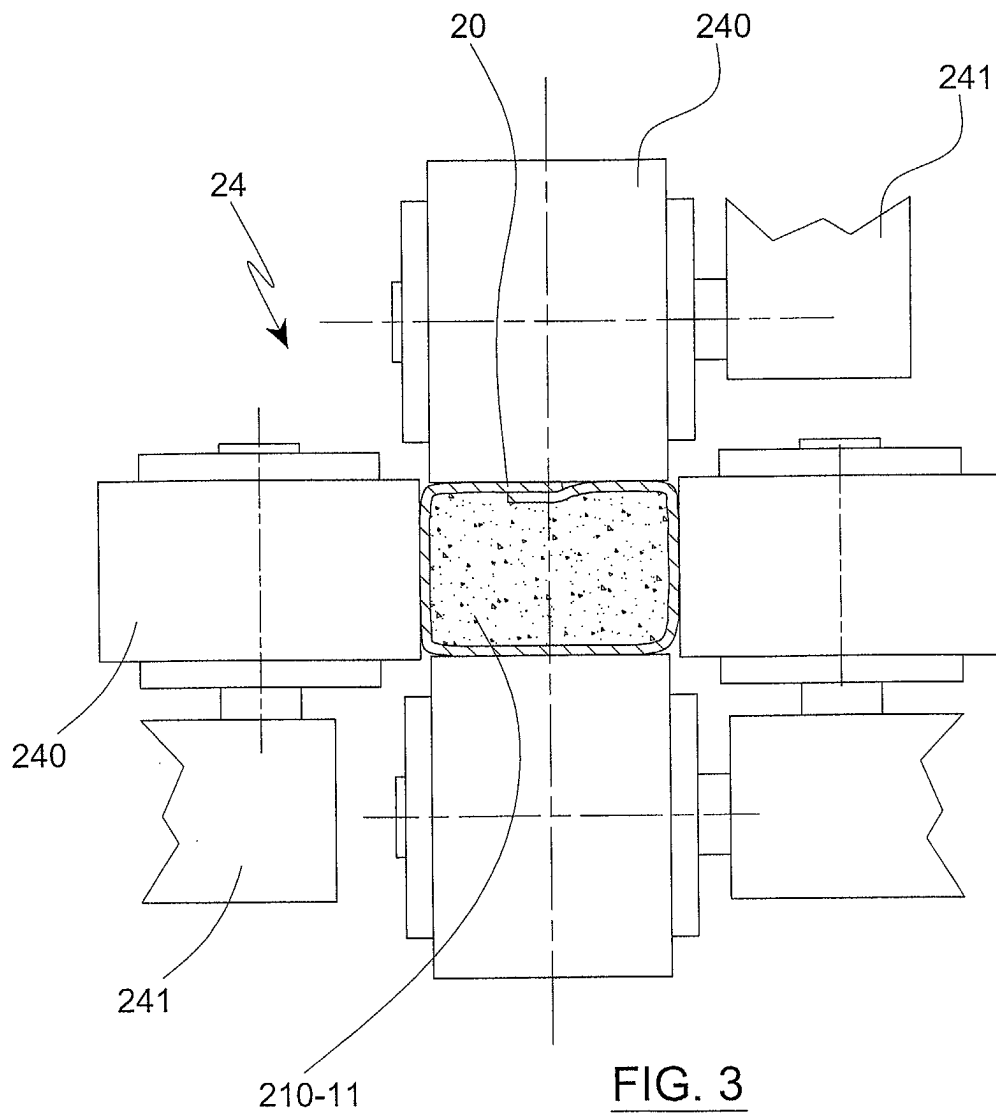
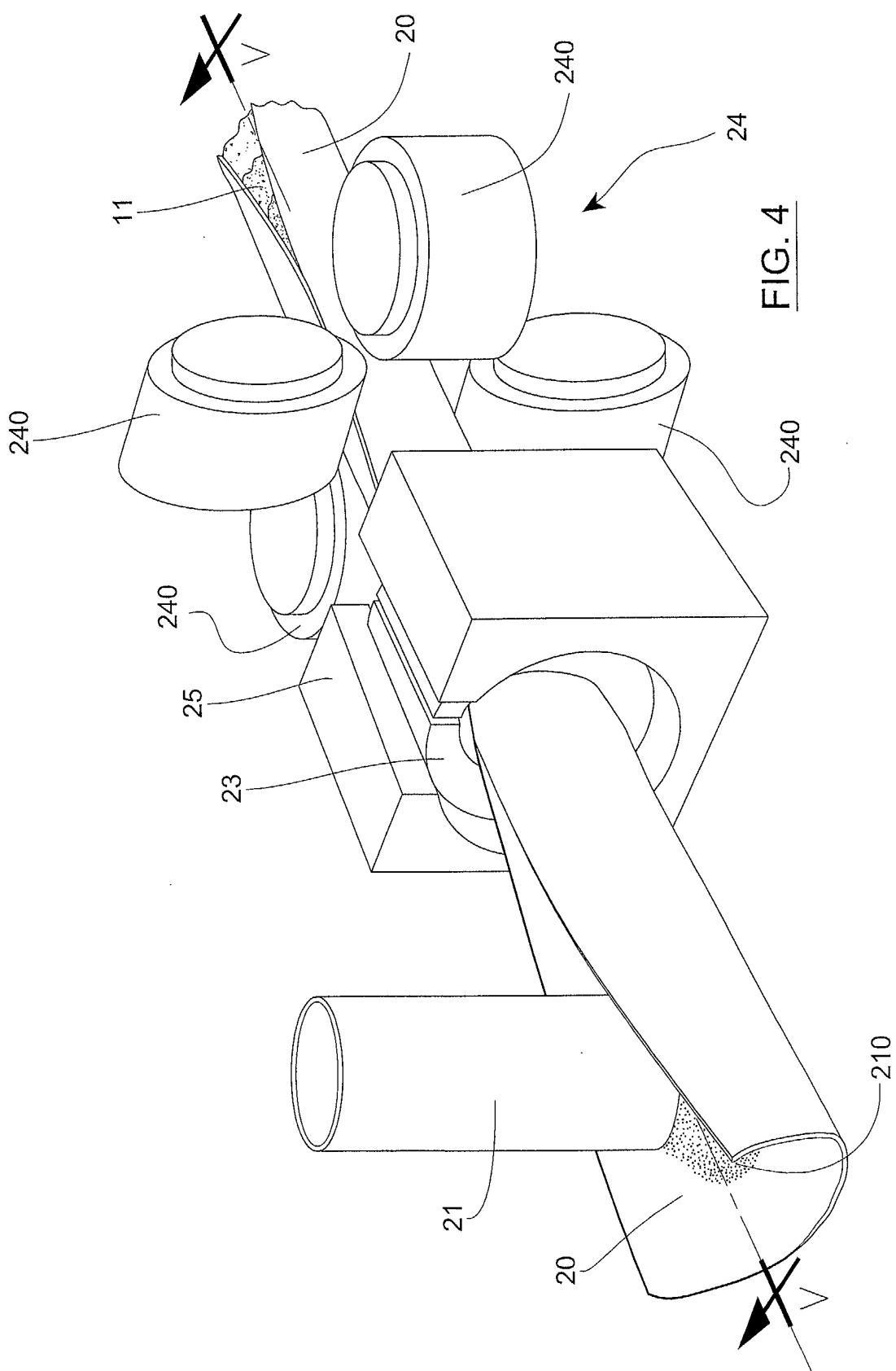


FIG. 1







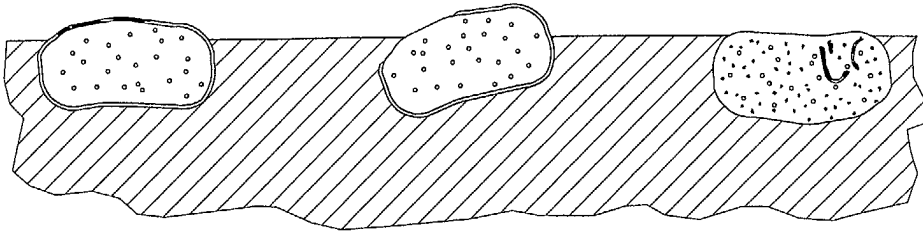


FIG. 6

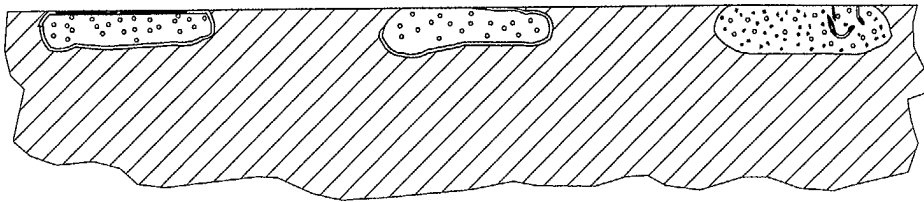


FIG. 7

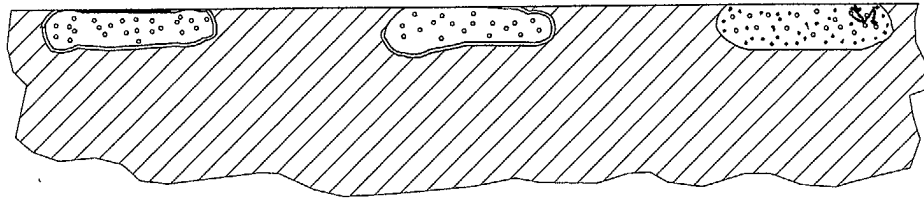


FIG. 8

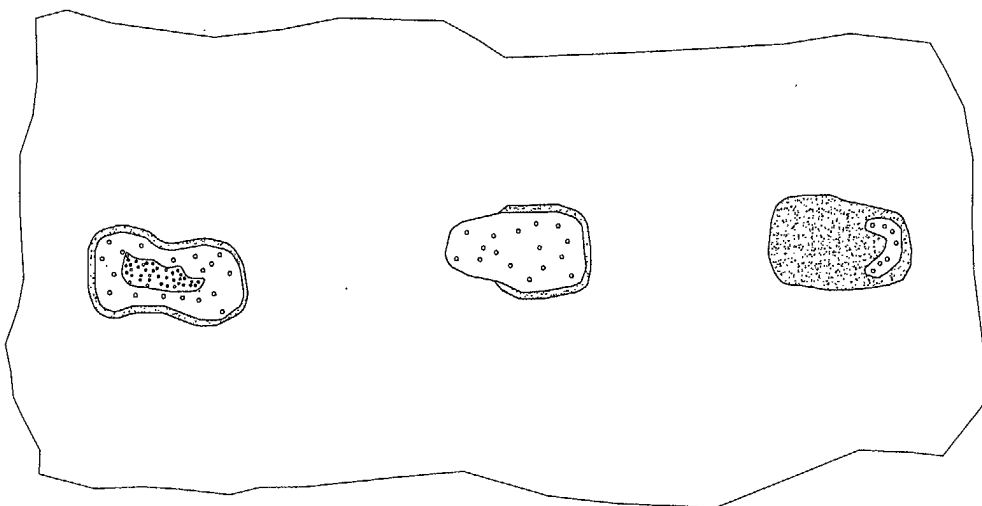


FIG. 9

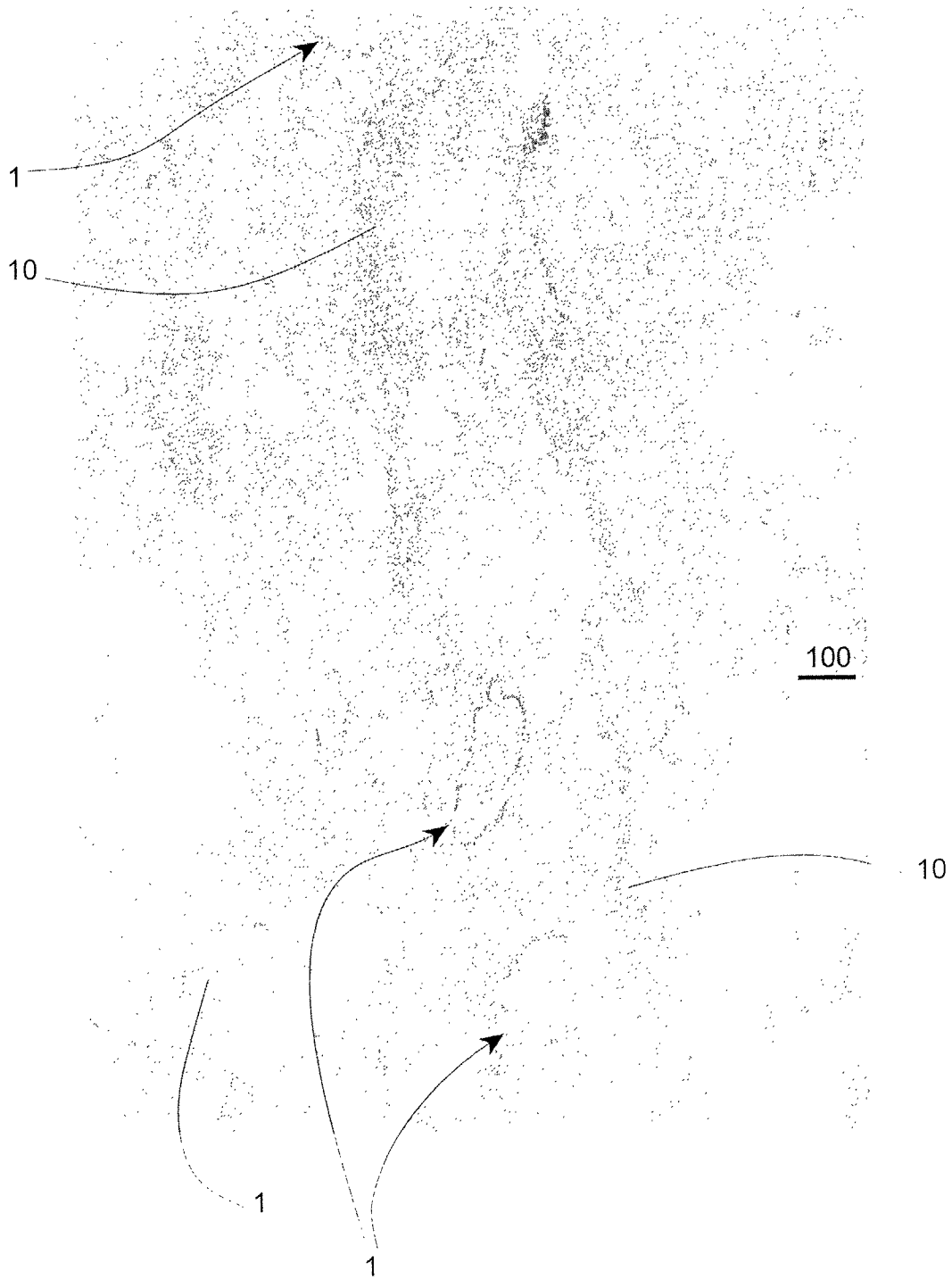


FIG. 10