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(54) Method and multiple-tool apparatus for surface flaming of stone or stone-like products

(57) A multi-tool apparatus for surface flaming of stone products comprises a support frame (2), a tool holding head (3), means (4) for surface flaming of the product (P), having at least one first jet tool (6) designed to direct a jet (J_A) of a high-temperature fluid to the surface (S) being processed, means (5) for locally cooling the product (P) being processed, having at least one second jet tool (7) for directing a low-temperature jet (J_B) to the surface (S) being processed. The flaming means (4) comprise at least one series (8) of first jet tools (6, 6', 6'', ...) mounted to said head (3) in a predetermined arrangement for directing respective high-temperature jets (J_A, J'_A, J''_A, ...) to the surface (S) being processed, said at least one second tool (7) being susceptible of directing its respective low-temperature jet (J_B) in close proximity to at least one of said high-temperature jets (J_A, J'_A, J''_A, ...).

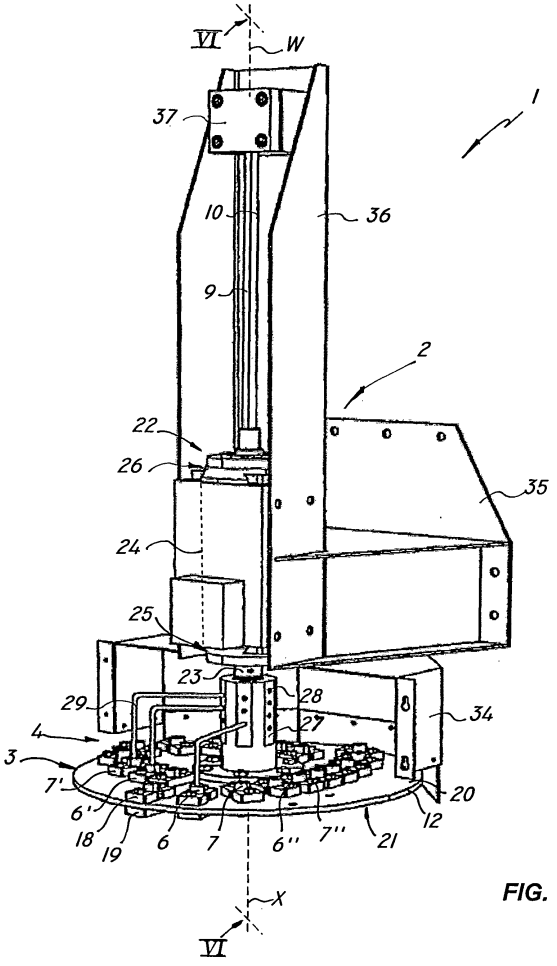

FIG. 1

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Description

Field of the invention

[0001] The present invention generally finds application in the field of stone working and particularly relates to a method and a multi-tool apparatus for surface flaming of stone products using burning liquids or mixtures thereof.

[0002] The method and multi-tool apparatus of the invention are particularly suitable for surface flaming of slabs or blocks of stone, marble, granite or stone or cementitious or the like agglomerates or materials.

Background art

[0003] Surface treatment and finishing processes are known to be carried out on stone products, particularly slabs or blocks of stone, marble, granite, cementitious agglomerates or the like, to add ornamental value to such products by creating particular aesthetic effects.

[0004] Such processes, which may be also aimed at improving certain features of the product, such as its non-slip properties, create surface deformations on the product, possibly associated with material removal, i.e. abrasion, roughening, scratching, marking or similar alterations of the processed surface.

[0005] A typical surface treatment is flaming, which consists in exposing the product surface to local surface heating by the direct action of one or more high-temperature flames, generated by burning a gas or a gas mixture coming out of one or more jet tools.

[0006] The jet tools are mounted in a predetermined arrangement to a holding head, which is displaced above the surface to be treated by programmable, automatic or semiautomatic machines, according to predetermined patterns.

[0007] One exemplary flaming process is disclosed in European Patent EP 0229318, in which a tool holding head is moved above a slab with combined longitudinal and transverse translational movements to obtain a resulting undulatory motion.

[0008] An apparent drawback of this solution is that the cyclic pattern of these schematic repetitive movements imparted to the hot jets creates grooves on the surface being processed, which highlight the effects of the flame, thereby affecting the final quality of the products

[0009] Furthermore, the continuous action of the flame may easily lead to an unacceptable increase of product temperature through a depth of a few millimeters and can thus cause ruptures and/or fractures of various lengths depending on the compositions of the materials being treated.

[0010] DE3914573 discloses a method for surface treatment of stone slabs which combines the action of a local high-temperature jet with the action of a direct cooling fluid, simultaneous with the flame, at the periphery of the area against which the flame impinges, to limit the heat load on the slab.

[0011] EP1520673 also discloses a method for treatment of stone slabs in which a high-temperature jet is directed to the surface of a slab which is constantly cooled by a layer of cooling liquid.

[0012] The burner is equipped with both a high-temperature jet tool and one or more jet tools that are designed to direct aid jets to the area to be treated, to temporarily remove the cooling liquid layer and assist the thermal action of the flame.

[0013] Nevertheless, the uncontrolled use of cooling liquids in these prior art solutions provides no control over thermal shocks but only prevents overheating of the surface being processed, and it can conversely contrast the action of the flame, when inappropriately directed.

[0014] Furthermore, the use of an uncontrolled jet of cooling liquid apparently involves energy wastes which can affect the cost-effectiveness of the whole process.

[0015] Another serious drawback of the above methods is that they are implemented by a single flaming nozzle which is cyclically and repetitively moved over the surface to be treated, thereby leaving well-visible effects of the flame action, and degrading the aesthetic quality of the final product.

[0016] EP0471692 discloses a method for surface treatment of granite in which a high jet and a cold jet are directed to the same area to be treated in quick succession, to control thermal shocks and prevent the flame action from propagating to the inner layers of the product, thereby achieving an improved aesthetic effect.

[0017] The high-temperature jet is a plasma jet of ionized gas, particularly nitrogen, heated to temperatures from 10000°C to 12000°C.

[0018] While this solution provides some control of the thermal shocks to which a flamed product is naturally exposed, it still suffers from certain drawbacks.

[0019] Once again in this case, a single flaming tool is provided, which is cyclically and repetitively moved over the surface to be treated, integral to a single cooling tool, whereby the effects of the flame action will still be visible, and the final product will still have a poor aesthetic quality.

[0020] Also, when plasma is used as a flaming agent, special means shall be provided for igniting it, which will apparently increase the complexity and cost of the whole flaming apparatus.

[0021] Furthermore the use of plasma, which is characterized by very high temperatures, may easily cause damages to the product, when it is not combined with adequate cooling, therefore this flaming method may be unsuitable for certain stone products.

Disclosure of the invention

[0022] The main object of this invention is to overcome the above drawbacks, by providing a multi-tool jet apparatus for surface flaming of stone or stone-like products that is highly efficient and relatively cost-effective.

[0023] A particular object is to provide a multi-tool flaming apparatus that allows quick surface finishing, while obtaining a final product with aesthetic and functional effects as similar as possible to those that can be obtained by manual processing, and while eliminating or at least substantially reducing the presence of repeated patterns on the treated surface.

[0024] A further object is to provide a multi-tool flaming apparatus that allows automatic change of the surface texture created by the burning jets on the product being processed.

[0025] Yet another object of the present invention is to provide a multi-tool flaming apparatus that can cool the product surface during flaming, thereby controlling the thermal shocks to which the material is exposed and changing the amount and quality of the micro-fractures caused by the jets during processing.

[0026] A further object of the present invention is to provide a multi-tool flaming apparatus that can optimize consumption of the burning fluid and the cooling fluid, thereby improving the cost-effectiveness of the whole flaming process.

[0027] A further object of the present invention is to provide a multi-tool flaming apparatus that can be moved along a plurality of axes to form surface textures that can provide a final product with aesthetic and functional effects as similar as possible to those that can be obtained by manual processing.

[0028] Another important object of the present invention is to provide a method for surface flaming of stone products that can perform flaming processes with the effects of manual flaming.

[0029] These and other objects, as better explained hereafter, are fulfilled by a multi-tool flaming apparatus for stone or stone-like products as defined in claim 1.

[0030] Thanks to this particular configuration, the apparatus will combine the effects of high-temperature jet heating and low-temperature jet cooling on the surface being processed, thereby controlling and regulating the thermal stress on the material being processed.

[0031] Preferably, the apparatus may include a first microprocessor control unit for selectively and sequentially enabling/disabling one or more of said first and/or said second tools.

[0032] Thus, it will be possible to set the times and characteristics of the high- and low-temperature jets discharged by the first and second tools to change the amount and characteristics of the micro-fractures created on the surface being processed.

[0033] Conveniently, first and second actuator means may be provided for promoting the translation of the tool holding head or the whole apparatus parallel to the surface to be processed and/or rotation of the apparatus about a transverse axis.

[0034] With this configuration of the invention, the jets from the tools may be directed in complex paths defined by combinations of rotary and translational movements along one or more axes, which will make the whole process even more similar to a manual process, with the surface texture of the process being changed in a highly customizable manner.

[0035] In another aspect, the invention relates to a method of flaming stone or stone-like products as defined in claim 12.

Brief description of the drawings

[0036] Further characteristics and advantages of the invention will be more apparent upon reading of the detailed description of a preferred, non-exclusive embodiment of an apparatus and method for flaming stone products according to the invention, which are described as a non-limiting example with the help of the annexed drawings, in which:

FIG. 1 is a perspective view of an apparatus of the invention according to a first preferred embodiment;
FIG. 2 is a top view of a tool holding head of the apparatus of Fig. 1, in a first preferred configuration;
FIG. 3 is a top view of the tool holding head in a second preferred configuration;
FIG. 4 is a top view of the tool holding head in yet another preferred configuration;
FIG. 5 is a front broken away view of the tool holding head of Fig. 2;
FIG. 6 is a front view of the apparatus of Fig. 1 during a particular operating step;
FIG. 7 is a cross sectional view of the apparatus of FIG. 1;
FIG. 8 is a front view of an apparatus of the invention in a second preferred configuration and in an operating state;
FIG. 9 shows a chart of a flaming method of the invention.

Detailed description of a preferred embodiment

[0037] Referring to the above figures, the multi-tool jet apparatus of the invention, generally designated by numeral 1, may be used for surface working of stone products, e.g. made of stone, marble, granite or stone, cementitious or the like agglomerates or materials, by flaming with high-temperature fluid jets.

[0038] The product P to be flamed may be a slab, a block or similar articles, whose outer surface S is not necessarily flat, and may be laid on a movable or stationary support plane R to have a forward motion in a predetermined direction.

[0039] As shown in Fig. 1, an apparatus of the invention comprises a support frame 2 defining a first longitudinal axis X, with a tool holding head 3 mounted thereto, and associated with flaming jet means 4, that are designed to be fed with a flammable fluid or mixture of flammable fluids, for high-temperature flaming of the surface S being processed and with local cooling means 5 using jets of cooling fluid for cooling the surface S being processed,

that are designed to be fed with a fluid or mixture of fluids for forming low-temperature jets J_B, J'_B, J''_B, ...

[0040] The flaming means 4 include at least one first jet tool 6 susceptible of directing a high-temperature jet J_A to the surface S to be processed, whereas the local cooling means 5 include at least one second jet tool 7 susceptible of emitting a low-temperature jet J_B onto the same surface S.

[0041] According to a peculiar characteristic of the invention, the flaming means 4 comprise at least one series 8 of first jet tools 6, 6', 6'', ... emitting jets of a flammable fluid or a mixture of flammable fluids, mounted to the head 3 for generating high-temperature fluid jets J_A, J'_A, J''_A, ... to be directed to the product P to be processed to interact with the surface S thereof, thereby causing surface deformations, possibly associated with material removal, to obtain the surface texture of the product P.

[0042] Furthermore, the second jet tool 7 is designed to direct its low-temperature jet J_B to the surface S in close proximity to one of the high-temperature fluid jets J_A.

[0043] For simplicity, non-indexed references will be used for the first tools and their jets, but it shall be intended that all the parts in the first tool, designated by numeral 6 will be also found in a substantially identical manner in all the other first tools 6', 6'', ...

[0044] This particular arrangement of the first tools 6 and the second tool 7 will provide a combined effect of strong local heating, obtained by the high-temperature jets J_A delivered by the first tools 6 and of substantially simultaneous cooling by the action of the low-temperature jet J_B.

[0045] This will create micro-cracks, fractures and marks in an seemingly random arrangement on the surface S, to emulate fully manual processing.

[0046] According to a preferred, non-limiting embodiment of the invention, the first tools 6 may be arranged in non-aligned positions to direct their jets J_A, upon displacement of the head 3 relative to the surface S being processed, along respective paths that do not form repetitive processing patterns.

[0047] Conveniently, the jets J_A may texture the surface S along partially overlapping paths, so that the surface S will not exhibit the grooves produced by each jet J_A, and will achieve an effect very close to that of manual flaming.

[0048] According to an advantageous aspect of the invention, the cooling means 5 may include a plurality of second jet tools 7, 7', 7'', ... which are arranged to direct respective low temperature jets J_B, J'_B, J''_B, ... to the surface S being processed.

[0049] Once again, for simplicity, non-indexed references will be used both for the second tools and their jets, but it shall be intended that all the parts in one of the second tools 7 will be also found in a substantially identical manner in all the others.

[0050] According to an advantageous aspect of the invention, the second jet tools 7 may be arranged relative to the first tools 6 to direct their respective low-temperature jets J_B in close proximity to the high-temperature fluid jets J_A.

[0051] The number of second tools 7 will not necessarily correspond to the number of first tools 6, a single second tool 7 being even possibly provided, and their arrangement may be also differ from the arrangement of the first tools 6.

[0052] Certain particular arrangements of the tools 6 and 7, are shown in Figs. 2 to 4 to illustrate the invention without limitation.

[0053] For example, the first tools 6 of the series 8 may be arranged in approximately curved lines or form a triangle or another geometrical shape, possibly irregular, or also other predetermined arrangements selected to define paths for the jets J_A and J_B that are not parallel and/or equally spaced and do not define repetitive patterns.

[0054] More generally, the first tools 6 may be provided in such arrangements that upon translational and/or rotational displacement of the head 3 relative to the product P, the jet J_A delivered by one of the first tools 6 textures the surface S being processed at an area other than the area that was previously treated by the jet J'_A delivered by the tool 6' located adjacent thereto.

[0055] Furthermore, the head 3 may be also equipped with two or more series 8, 8', ... of first tools 6, not necessarily of similar type, located at the output of a first feed line 9 that is designed to feed the first tools 6 with a flammable fluid or a mixture of flammable fluids.

[0056] The local cooling means 5 will in turn include a second feed line 10 for a cooling fluid, such as a cooling liquid or a cryogenic gas, connected at its output to the second tools 7.

[0057] Also, the second tools 7 may be directly mounted to the head 3, as shown in Figs. 6 to 7, so that their motion relative to the product P coincides with the motion of the head 3 and the first tools 6.

[0058] For example, at least some of the first and second tools 6 and 7 may be arranged along the same curve, possibly in alternate arrangements, to expose the surface S being processed to a high thermal stress, and thus create an aesthetic effect of improved quality as compared with the one obtained by normal flaming.

[0059] In an alternative embodiment, as shown in Fig. 8, the second tools 7 may be arranged outside the tool holding head 3 and may be fixedly or removably anchored directly to the frame 2, e.g. using suitable support arms 11 connected to the second feed line 10, to be moved integrally with or separately from the head 2 and the first tools 6.

[0060] In yet another configuration, not shown, an arrangement of a plurality of second tools 7 may be provided, some of which are integral with the head 7 and others are directly mounted to the frame 2.

[0061] In any case, a combined effect of high local heating and immediate cooling will be achieved to cause the material to be deformed as desired.

[0062] Preferably, the first feed line 9 may be designed to feed the first tools 6 with a flammable fluid or a mixture of flammable fluids, particularly a gas or mixtures of gases, such as mixtures of oxygen and a gas fuel selected from the group comprising acetylene, propane and the like, for producing a flame having a temperature from 1000°C to 4000°C.

[0063] Furthermore, the flaming means 4 may include an ignition device, e.g. of piezoelectric type, not shown, located in the proximity of the output of at least one of the first tools 6 to cause ignition of the fluid jets J_A.

[0064] The number of ignition devices may considerably vary according to the particular arrangement of the tools 6 on the tool holding head 3, with a single ignition device being even possibly sufficient, due to the possibility of utilizing the flame propagation effect during displacement of the head 3 to cause ignition of all the remaining jets J_A.

[0065] Advantageously, the tool holding head 3 may have a substantially plate-like main body 12 having one or more anchor seats 14 for one or more weights, not shown, arranged thereon, for balancing the head 3 during rotation and whose position will be selected according to the particular arrangement of the tools 6 and 7.

[0066] The first tools 6 and possibly the second tools 7, if these are mounted to the head 3, may be inserted in the main body 12, each locked in one seat 13 of the head 3 by pairs of anchor plates 18, 19 removably fixed to the top face 20 and the bottom face 21 of the main body 12 of the head 3, so that the tools 6, 7 at least partially project out of its bottom.

[0067] According to an advantageous embodiment of the invention, means 22 may be also provided for moving the tool holding head 3 relative to the product P being processed, above the surface S, along a reference plane π substantially parallel to the support plane R of the product P, which may be a roller conveyor, like in the figures, or a motorized belt.

[0068] The moving means 22 may be associated with the frame 2 or the support plane R for the product P, or with both, to cause relative motion of the head 3 and the surface S to be treated.

[0069] Advantageously, the head 3 may be driven into rotation by a motor-driven spindle 23 which is mounted for rotation about the first axis X.

[0070] Thus, as the head 3 moves, the first and second tools 6, 7 will direct their respective jets J_A, J_B along complex paths that may create hot and cold areas over the surface S being processed, in concentric, parallel or transverse positions, possibly of different lengths and with random arrangements.

[0071] High-temperature jets J_A may form respective paths resulting from a combination of the rotation of the tools 6 about the first longitudinal axis X and the translation thereof along the reference plane n.

[0072] As shown in the figures, the moving means 22 may include a drive shaft 24, indicated by partially dashed lines, which defines a second longitudinal axis W substantially parallel to the first axis X to allow the whole apparatus 1 to move in one or more directions above the product P being processed.

[0073] Furthermore, the drive shaft 24 may have a first axial end 25 with the spindle 23 rotatably mounted thereto, and a second axial end 26 adapted to be associated with an external motor, not shown, for moving the first and second longitudinal axes X, W.

[0074] The second end 26 of the shaft 24 may be equipped with a rotary joint, or a similar device, not shown, for connection of the apparatus 1 to an external manipulator, for the apparatus to be allowed one or more degrees of freedom.

[0075] The drive shaft 24 may have a hollow interior for receiving and holding the first and second feed lines 9, 10.

[0076] First actuator means may be also provided, also not shown and known per se, which are associated to the joint or similar device to promote translation of the second longitudinal axis W parallel to the surface S to be processed and/or rotation thereof about a first transverse axis Y.

[0077] The spindle 23 may be associated with second actuator means, not shown, which are designed to allow it to move within the frame 2 by promoting translation of the first longitudinal axis X towards/away from the second longitudinal axis W parallel to a second transverse axis Z.

[0078] Thus, the whole apparatus 1 may translate and/or rotate relative to one or more orthogonal 3-axis systems and the final path of each high- or low-temperature jet J_A, J_B will be generated by the combination of the rotation and translation of the frame 2 and the rotation and translation of the head 3, caused by the motion of the spindle 23.

[0079] These movements may be controlled by a control unit, not shown, according to an appropriately configured program, to further increase random variations of movements, and provide an even more enhanced random aesthetic effect, with no visible effect being caused by overlapped processing lines.

[0080] In a preferred non-limiting embodiment of the invention, the first feed line 9 may have an upper mixer, not shown, connected to a manifold 27 with the spindle 23 interposed therebetween.

[0081] The manifold 27 may be of substantially cylindrical shape and have a plurality of outlets, generally designated by numeral 28, for the fluid or fluid mixture, the outlets 28 being connected via corresponding feed conduits 29 to respective first tools 6.

[0082] For clarity, the accompanying figures only show some of the feed conduits 29 extending from the manifold 29, their number varying according to the number of first and/or second nozzles 6, 7 mounted to the head 3.

[0083] The manifold 27 may be connected at its top to the spindle 23 and secured at its bottom to the head 3, at a central passage thereof, using a pair of anchor flanges on the opposite faces 20 and 21 of the head 3, with only one of them being shown, and designated by nu-

meral 30.

[0084] This particular configuration of the tool holding head 3 is particularly advantageous in that the head and the tools 6 and/or 7 designed to be connected to fluid feed lines, are allowed to be mounted to any external moving means, even those not specially designed for the head, with minor technical changes.

[0085] The second feed line 10 may be connected to the same manifold 27 which will be divided, in this case, into two separate chambers communicating with their respective tools 6 and 7 via the conduits 29, some of which will be associated with the flaming means 4 and the others will be associated with the local cooling means 5.

[0086] Alternatively, the second feed line 10 may be directly connected to the support arms 11, which will also act as conduits for the cooling fluid, and may be connected to the shaft 24, as shown in Fig. 8.

[0087] The flaming and cooling means 4 and 5 may be operably associated with additional means, not shown, for selectively and sequentially enabling/disabling one or more of the first and second tools 6, 7.

[0088] The enabling/disabling means may include an additional control unit, preferably of the microprocessor and possibly of programmable type, for adjusting the number of first and second tools 6, 7 from time to time operating and enabled to emit respective jets J_A, J_B.

[0089] Furthermore, these enabling/disabling means may be configured for allowing adjustment of the jets J_A and J_B, so that the action of the jets J_A, J_B in each flaming process can be calibrated according to the particular structural properties of the product P and even more random jets J_A, J_B can be obtained, with apparent benefits for the final quality.

[0090] An additional advantage achieved by these means is that they allow processing of materials of poor quality or with structural defects, which might easily break with traditional processing.

[0091] For this purpose, one may simply reduce the number of first tools 6 enabled for emission of high-temperature jets J_A and/or reduce their flow or emission time, with the number and flow of low-temperature jets J_B being possibly increased to enhance the cooling effect.

[0092] An optimized use of cooling fluid will be also obtained, which will afford considerable cost savings.

[0093] The apparatus 1 may be also equipped with additional cooling means, not shown, designed to direct a cooling fluid to the tool holding head 3. The cooling means may either have a dedicated feed line or be served by the second feed line 10 that is part of the means 5 for local cooling of the surface S.

[0094] The support frame 2 may include a shell 34 for the head 3, with an anchor portion 35 for attachment to an external machine that is adapted to move it above the surface S of the product P being processed.

[0095] In a particular application, the anchor portion 35 may be mounted to a carriage, not shown, that slides in a predetermined direction, e.g. transverse to the forward direction of the product P, designated by arrow F or to equivalent means, also not shown and known per se, such as an anthropomorphic arm, with the product P that can also have its own translational motion.

[0096] The shell 34 may also include an additional support portion 36 for the motion imparting means 22, having lock means 37 for locking the feed lines 9, 10, such as a clamp, to prevent any undesired twisting thereof during rotation of the manifold 27.

[0097] Fig. 9 diagrammatically shows a method for surface flaming of stone products of the invention, which includes the steps of a) laying a product P to be processed onto a movable or stationary support plane R, b) providing a multi-tool head as described herein above the product P, with at least one series 8 of first jet tools 6 emitting a high-temperature fluid or mixture of fluids, and at least one second jet tool 7 emitting a low-temperature fluid or mixture of fluids.

[0098] The steps of c) performing surface flaming of the product P and d) locally cooling the surface S of the product P are then provided.

[0099] The flaming step c) is carried out by feeding (step c') a flammable fluid or mixture of flammable fluids to the first tools 6 for generating flammable jets and igniting (step c'') the flammable jets emitted from the first tools 6 for generating a plurality of high-temperature jets J_A designed to be directed to the surface S of the product being processed for flaming thereof.

[0100] The local cooling step d) includes in turn a step of d) feeding a cooling fluid or mixture of cooling fluids to the second tool 7 for generating (step d'') low-temperature fluid jets J_B to cool the surface S being processed.

[0101] Finally, there will be the step e) of moving the head 3 relative to the support plane R for interaction of high- and low-temperature jets J_A, J_B with the surface S of the product P being processed.

[0102] According to a peculiar aspect of the invention the step of d) cooling the surface S is carried out at the same time as the flaming step c), to avoid overheating of the product P being processed, and prevent it from breaking or fracturing.

[0103] Furthermore, the low-temperature jet J_B is moved over the surface S being processed to interact with a portion thereof which has been treated immediately before by one of the high-temperature jets J_A.

[0104] Thus, the surface S will undergo a number of thermal shocks, which will create micro-cracks, fractures and surface marks, and produce a final aesthetic effect as close as possible to the one that would be obtained by manual processing.

[0105] Advantageously, the first tools 6 may be moved so that their respective high-temperature jets J_A will be directed to the surface S being processed along respective paths partially overlapping in seemingly random fashion, so that the grooves created by each jet will not be visible on the processed surface S.

[0106] Conveniently, the cooling step d) may be carried out using a plurality of second fluid jet tools 7 mounted to the tool holding head 3 or external thereto.

[0107] Preferably, the moving step e) may include rotation (step e') of the first and second tools 6, 7 about a first longitudinal axis X and/or translation (step e'') of the head 3 parallel to a reference plane π substantially parallel to the support plane R.

[0108] The method may also include the step f) of adjusting the number and/or flow of the high- and/or low-temperature jets J_A, J_B emitted from the first and/or second tools 6, 7 to calibrate the combined surface heating and cooling actions according to the properties of the particular material being processed.

[0109] This adjustment step f) may be carried out either upstream from the flaming step c) and the cooling step d) or simultaneously therewith after assessing v) the actual quality of the material and its resistance to the strong heating action of the flame.

[0110] For instance, if the flamed product P breaks, any subsequent process may be carried out with high-temperature jets J_A of reduced intensity, by disabling some of the first tools 6 or reducing their emission time or intensity.

[0111] Alternative to or in combination with this kind of processing, enhanced cooling may be provided, by increasing the number of second tools 7 enabled or the flow of low-temperature jets J_B.

[0112] Likewise, if an inadequate surface effect is found, for instance when processing very hard materials, it will be possible to increase the flaming effect and simultaneously reducing the cooling effect, such as by increasing the number or flow of the first tools 6 enabled and/or reducing the number or flow of the second tools 7 enabled.

[0113] The above disclosure clearly shows that the invention fulfils the intended objects and particularly meets the requirement of allowing quick, efficient and safe surface flaming of slabs or blocks of stone, marble, granite or stone or cementitious or the like agglomerates or materials, by directing the burning jets with such arrangements as to obtain evenly, homogeneously treated surfaces, with no or little repetition of patterns, and as close as possible to those obtained by manual processing.

Claims

1. A multi-tool apparatus for surface flaming of stone or stone-like products, wherein the product (P) being processed is laid onto a movable or stationary support plane (R), which comprises:

- a support frame (2) defining a first longitudinal axis (X);
- a tool holding head (3) mounted to said first axis (X);
- means (4) for surface flaming of the product (P) being processed having at least one first jet tool (6) designed to direct a jet (J_A) of a high-temperature fluid to the surface (S) of the product (P) being processed;
- means (5) for locally cooling the product (P) being processed, having at least one second jet tool (7), which is designed to direct a low-temperature jet (J_B) to the surface (S) of the product (P) being processed;

characterized in that said flaming means (4) comprise at least one series (8) of first jet tools (6, 6', 6'', ...) mounted to said head (3) in a predetermined arrangement for directing respective high-temperature fluid jets (J_A, J'_A, J''_A, ...) to the surface (S) being processed, said at least one second tool (7) being susceptible of directing its respective low-temperature jet (J_B) in close proximity to at least one of said high-temperature jets (J_A, J'_A, J''_A, ...).

2. An apparatus as claimed in claim 1, **characterized in that** the first tools (6, 6', 6'', ...) of said at least one series (8) are arranged in non-aligned positions to direct their high-temperature fluid jets (J_A) along respective paths partially overlapping in seemingly random fashion, so that the grooves created by each jet will not be visible on the processed surface.

3. An apparatus as claimed in claim 2, **characterized in that** said local cooling means (5) include a plurality of second jet tools (7, 7', 7'', ...) which are located, relative to said at least one series (8) of first tools (6, 6', 6'', ...) with an arrangement selected to direct the low-temperature jets (J_B, J'_B, J''_B, ...) in close proximity to the high temperature jets (J_A, J'_A, J''_A, ...) .

4. An apparatus as claimed in claim 3, **characterized in that** said second tools (7, 7', 7'', ...) are mounted to said tool holding head (3) to move integrally therewith and/or to said support frame (2) outside said tool holding head (3).

5. An apparatus as claimed in any preceding claim, **characterized in that** said flaming means (4) comprise a plurality of said series (8, 8', ...) of first tools (6, 6', 6'', ...) arranged on said head (3) in non aligned positions and a first feed line (9) for said first tools (6, 6', 6'', ...) which is designed to feed them with a flammable fluid or mixture of fluids selected from the group comprising acetylene, propane and the like, and for generating a flame at a temperature from 1000°C to 4000°C.

6. An apparatus as claimed in any preceding claim, **characterized in that** said local cooling means (5) comprise a second feed line (10) for feeding said second tools (7, 7', 7'', ...) with a cooling or cryogenic fluid or mixture of fluids.

7. An apparatus as claimed in any preceding claim, **characterized by** comprising means for selectively and sequentially enabling/disabling one or more of said first and/or said second tools (6, 6', 6'', ...; 7, 7', 7'', ...), said enabling/disabling means being designed to adjust the number and/or flow of said high- and/or low-temperature jets (J_A, J'_A, J''_A, ...; J_B, J'_B, J''_B,...) emitted from said first and/or second tools (6, 6', 6'', ...; 7, 7', 7'', ...).

8. An apparatus as claimed in any preceding claim, **characterized by** comprising means (22) for moving said head (3) over a reference plane (π) substantially parallel to the support surface for the product (P) being processed, said moving means (22) further comprising a motor-driven spindle (23) which is mounted for rotation about said first axis (X) and is removably attached to said tool holding head (3) to drive the latter into rotation about said first axis (X).

9. An apparatus as claimed in claim 8, **characterized in that** said first feed line (9) comprises an upper mixer and a lower manifold (27) which is integral with said spindle (23) and has a plurality of feed conduits (29) in fluid communication with respective first tools (6, 6', 6'', ...).

10. An apparatus as claimed in claim 9, **characterized in that** said moving means (22) further comprise a drive shaft (24) which defines a second longitudinal axis (W) and has a first axial end (25) associated with said manifold (27) and a second axial end (26) coupable to a motor for moving said first and said second axes (X, W).

11. An apparatus as claimed in claim 10, **characterized in that** said second end (26) of said shaft (23) is provided with a rotary joint coupable to first actuator means susceptible of promoting translation of said second axis (W) parallel to the surface (S) of the product (P) being processed and/or rotation of said first and second axes (X, W) about a first transverse axis (Y), there being further provided second actuator means operably associated with said spindle (23) and designed to promote translation of said first axis (X) relative to said second axis (W).

12. A method for surface flaming of stone products, comprising the steps of:

a) laying a product (P) to be processed onto a movable or stationary support plane;
b) providing a multi-tool head (3) above said product (P) to be processed, with at least one series (8) of first jet tools (6, 6', 6'', ...) emitting a high-temperature fluid or mixture of fluids, and at least one second jet tool (7) emitting a low-temperature fluid or mixture of fluids;
c) performing surface flaming of the product (P) by feeding (c') a flammable fluid or mixture of fluids to said first tools (6, 6', 6'', ...) of said at least one series (8) for generating flammable jets and igniting (c'') said flammable jets emitted from said first tools (6, 6', 6'', ...) for generating a plurality of high-temperature jets (J_A, J'_A, J''_A);
d) locally cooling the surface of the product (P) by feeding (d') a cooling fluid or mixture of fluids to said at least one second tool (7) and generating (d'') at least one low-temperature fluid jet (J_B);
e) moving said head (3) relative to said support surface for interaction of high- and low-temperature jets (J_A, J_B) with the surface (S) of the product (P) being processed;

characterized in that said local surface cooling step (d) is carried out at the same time as said flaming step (c), said at least one low-temperature jet (J_B) being moved over the surface (S) to be processed to interact with a portion thereof that had been treated immediately before by one of said high-temperature jets (J_A, J'_A, J''_A, ...).

13. A method as claimed in claim 12, **characterized in that** said first tools (6, 6', 6'', ...) are moved so that their respective high-temperature jets (J_A, J'_A, J''_A, ...) will be directed to the surface (S) being processed along respective paths partially overlapping in seemingly random fashion, so that the grooves created by each jet will not be visible on the processed surface.

14. A method as claimed in any preceding claims, **characterized in that** said motion imparting step (e) includes rotation (e') of said first tools (6, 6', 6'', 6...) and said second tools (7, 7', 7'', ...) about a first longitudinal axis (X) and/or translation (e'') of said head (3) parallel to at least one transverse axis (Z) substantially parallel to said support surface.

15. A method as claimed in any preceding claim, **characterized by** comprising the step (f) of adjusting the number and/or the flow of the high- and/or low-temperature jets (J_A, J'_A, J''_A, ... ; J_B, J'_B, J''_B, ...) emitted from said first and/or second tools (6, 6', 6'', ... ; 7, 7', 7'', ...) respectively.

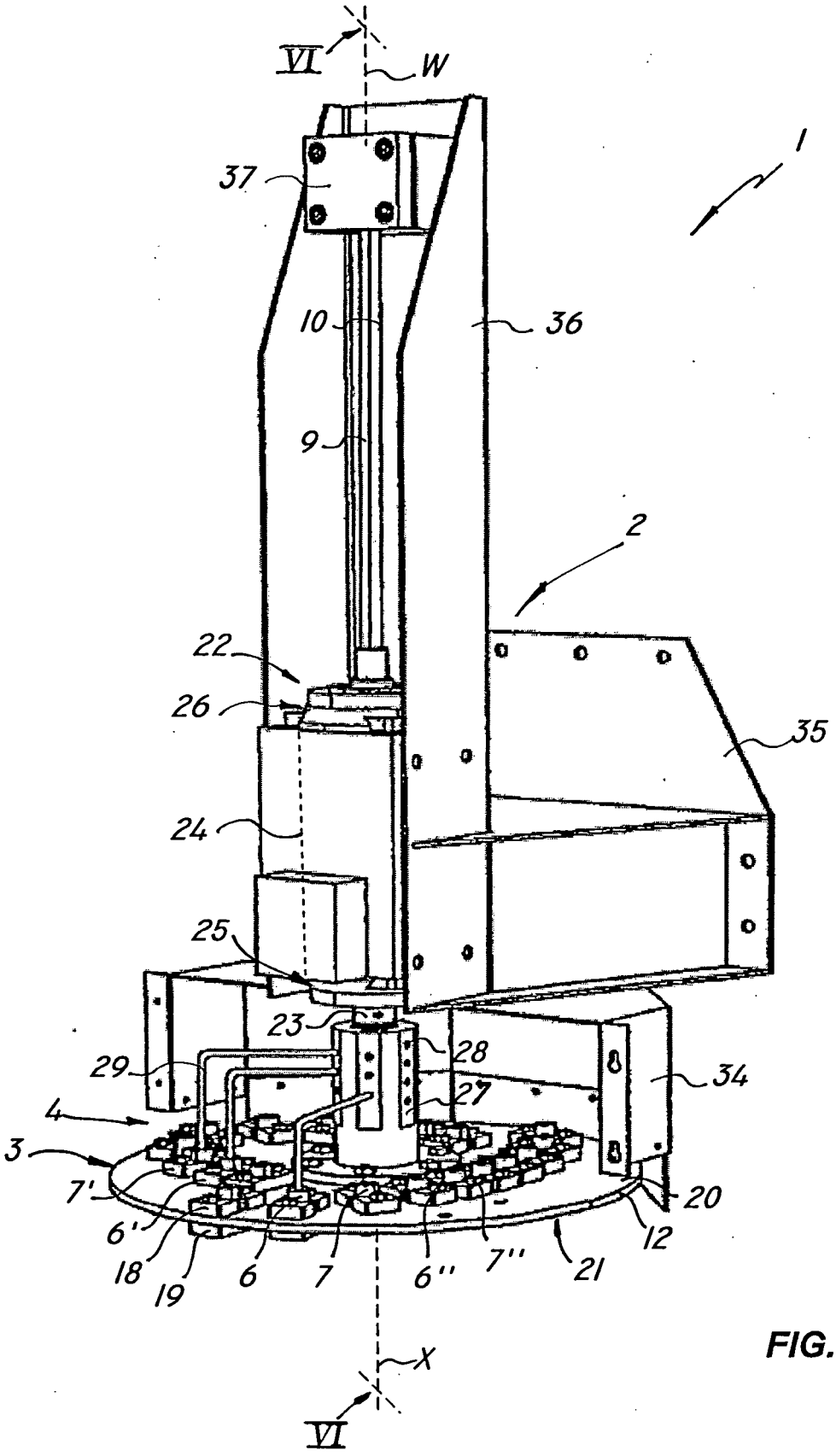
VI
W
1
37
10
36
9
2
22
26
35
24
25
23
28
29
34
27
4
3
7'
20
6'
12
18
19
6
7
6''
7''
21
X
VI

FIG. 1

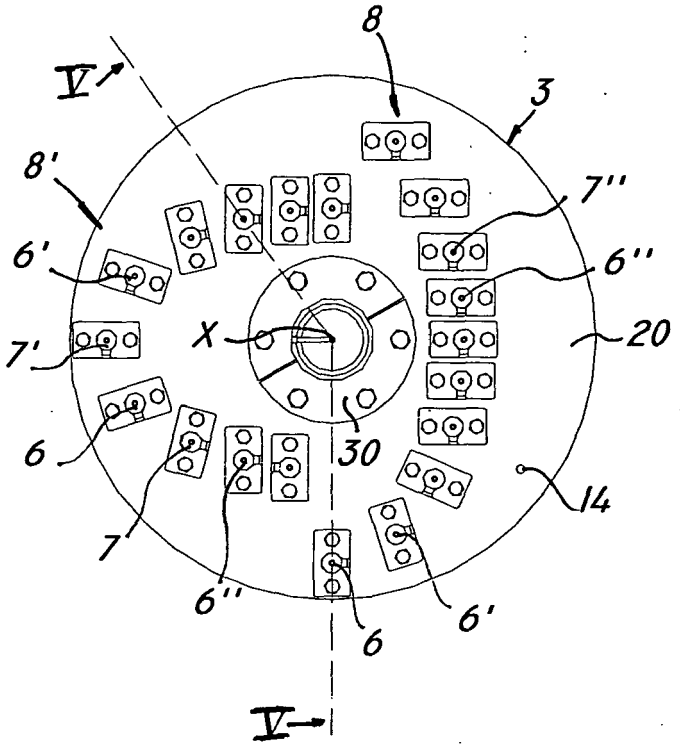

FIG. 2

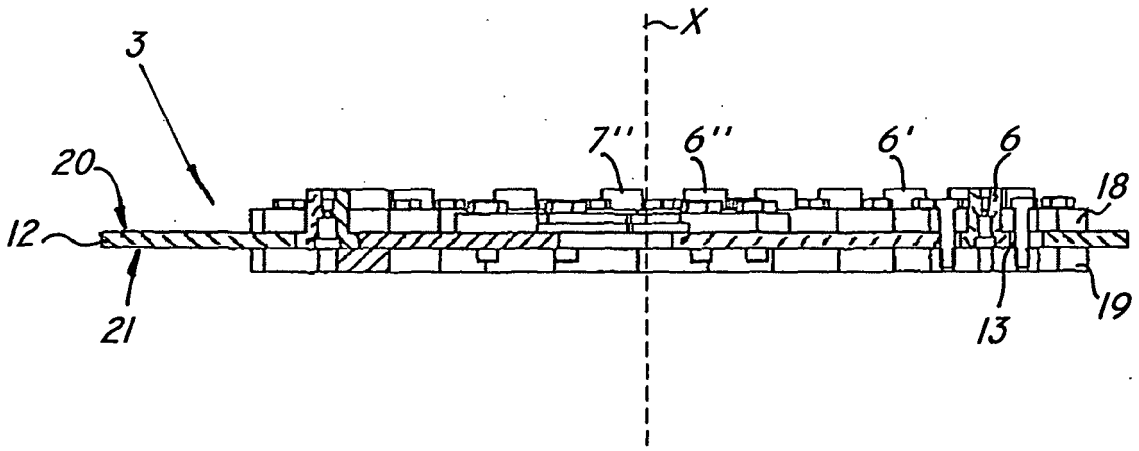

FIG. 5

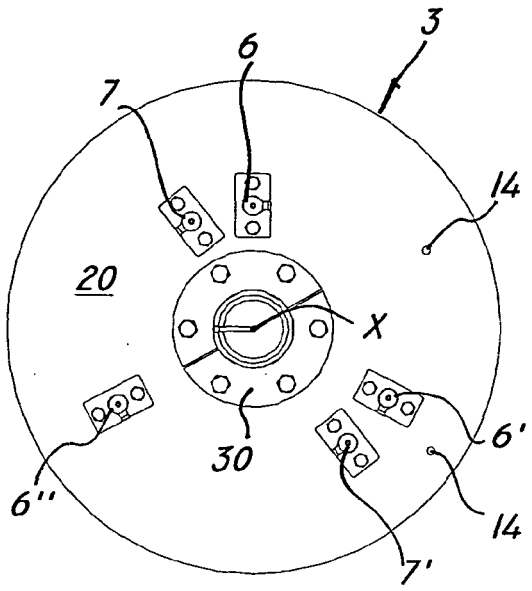

FIG. 3

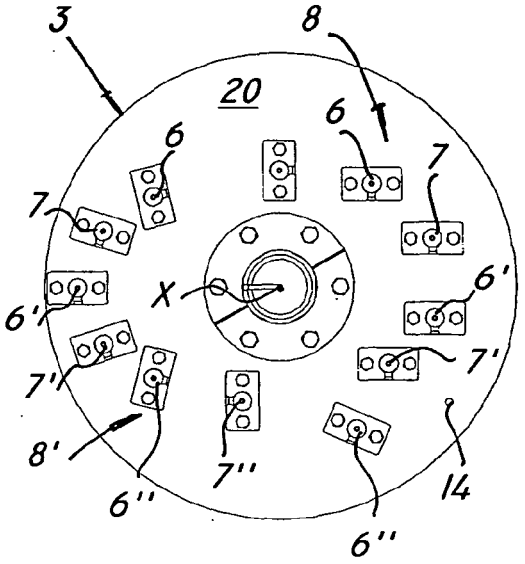

FIG. 4

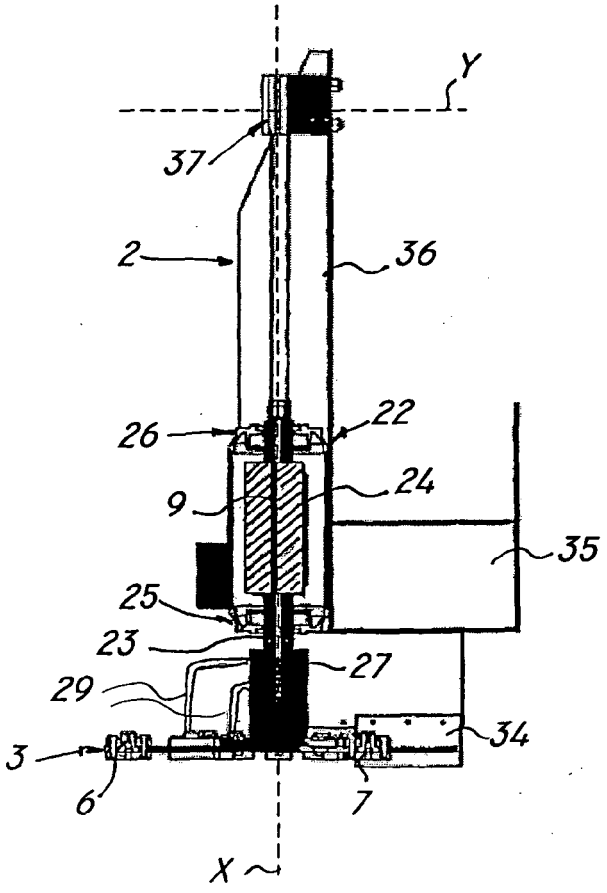

FIG. 7

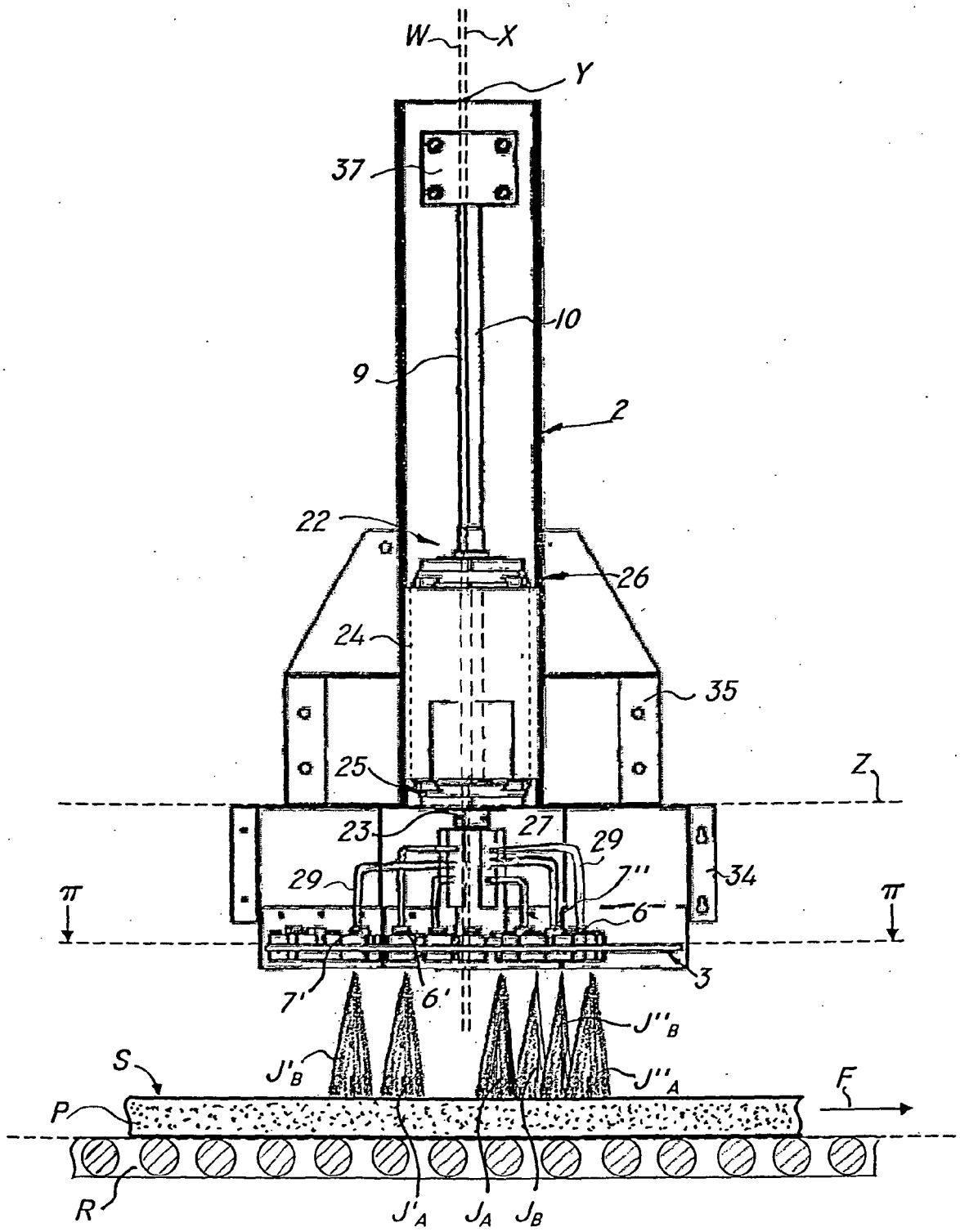
W
X
Y
37
10
9
2
22
26
24
35
25
Z
23
27
29
29
7''
34
π
π
6
6'
7'
3
J''B
J'B
J''A
S
F
P
R
J'A
JA
JB

FIG. 6

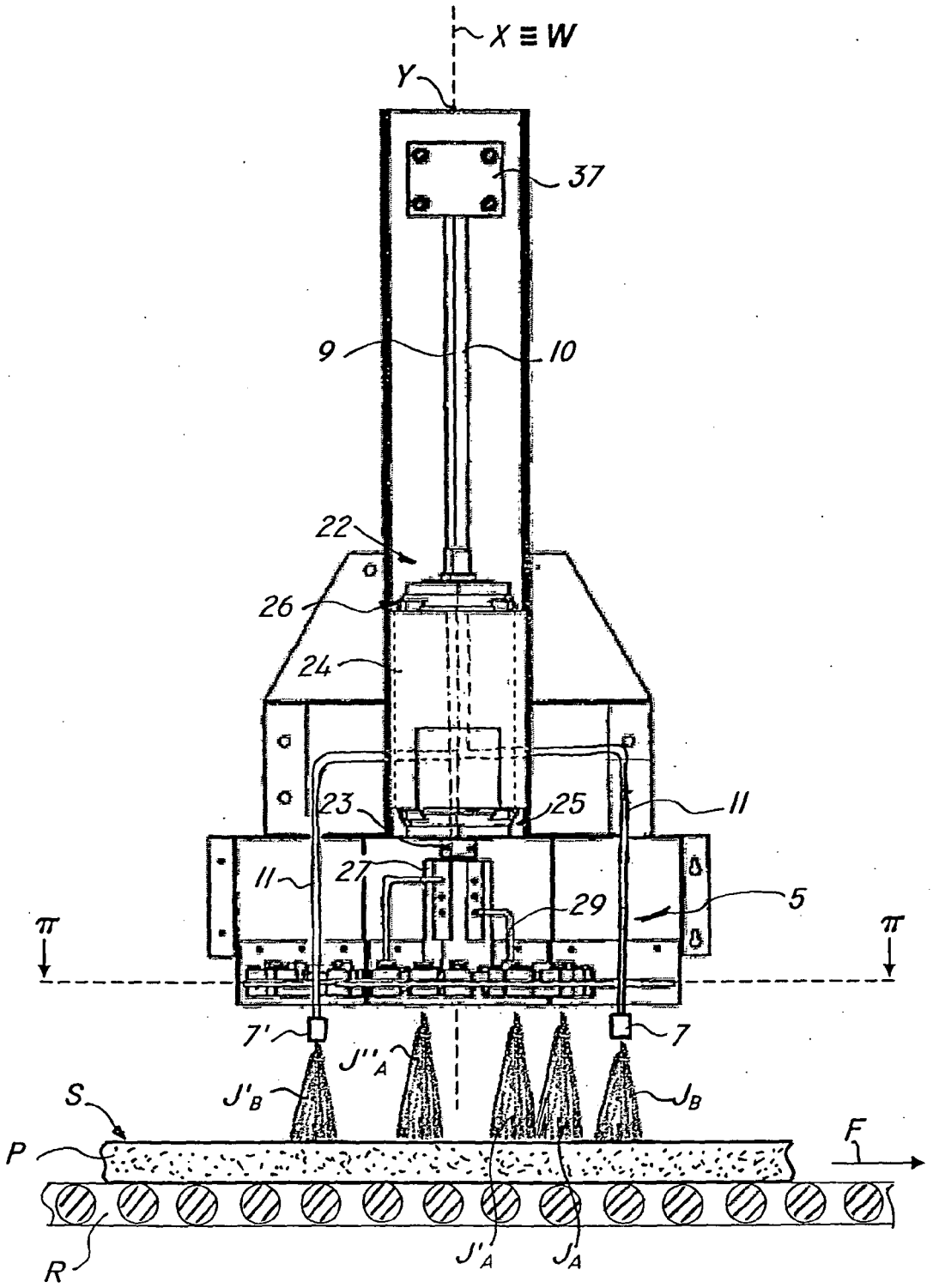

FIG. 8

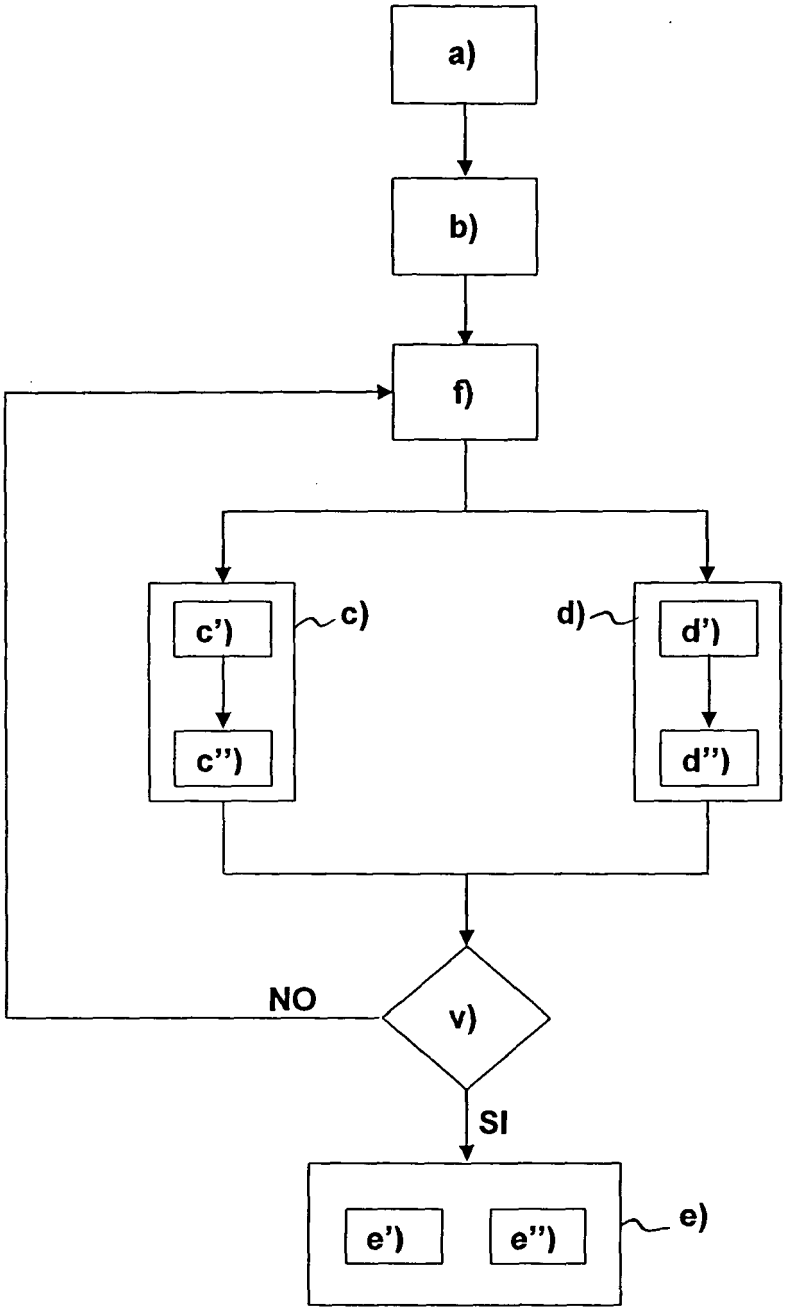

FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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- DE 3914573 **[0010]**
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