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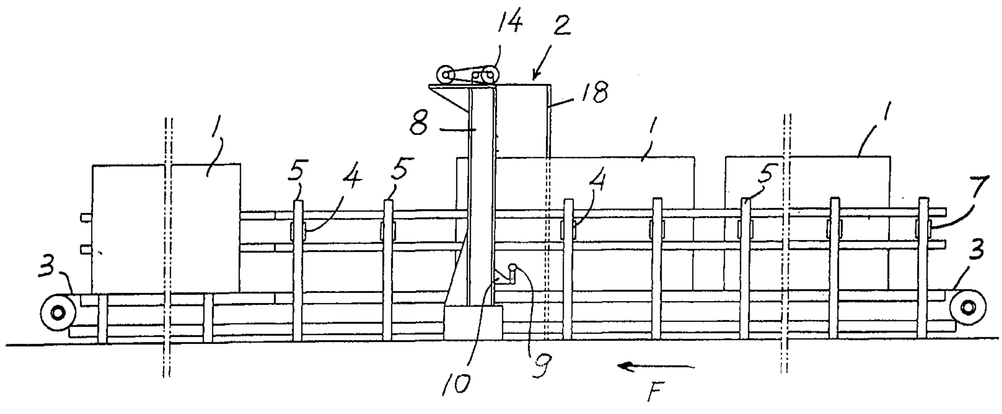

(57) Abstract

The invention relates to a method and a plant for surface abrasive treatment of stone materials, particularly stone slabs, especially granite slabs and the like. According to the invention, the stone surface is submitted to the action of one or more high– or very high–pressure water jets, having a pressure, for example, of 400 to 1500 bar, selected – together with other parameters, particularly with the distance (being of the order of 1 to 10 cm) between said surface and the nozzle(s) generating said water jet(s) – so that the specific incidence force of the water jet(s) on the surface under treatment causes crystals of the stone materials to be underwashed and/or crushed, to an extent corresponding to the desired effect.

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Method and plant for surface abrasive treatment of stone materials, particularly stone slabs

The present invention relates to a method for surface abrasive treatment of stone materials, particularly stone slabs, especially granite slabs and the like.

Polishing, smoothing, flaming and blasting operations are mainly used, until present, for surface abrasive treatment of stone slabs. These processes cause different surface effects and all have their specific drawbacks. Therefore, for example, polishing and smoothing operations are carried out by the combined use of water and abrasive materials, the latter requiring purified process water. Flaming, which involves a considerable fuel gas consumption and considerable pollutant emissions, also causes thermal shocks, which may affect the strength of the processed stone materials. Blasting also requires large amounts of sand and involves a considerable development of pollutant dust, which may cause health problems for the working staff.

The present invention relates to a surface abrasive treatment of the same kind as that which may be obtained by flaming and blasting, and aims at removing the drawbacks of prior art methods, while obtaining processed stone surfaces, having better quality and aspect than those obtained by flaming and blasting.

To this end, the invention provides a method for surface abrasive treatment of stone surfaces, substantially characterized in that the surface to be treated is submitted to the action of one or more high or very high-pressure jets of pure water, i.e. without abrasives, particularly having a pressure in the range of 400 to 1500 bar, preferably of 800 to 1200 bar, which water jet/s are generated by individual nozzles, preferably placed at a distance of 1 to 10 cm from the treated surface.

The invention is based on the acknowledgement that the water jet/s generated by one or more nozzles placed at the aforementioned distances from the stone surface under treatment, which jet/s have a pressure within the aforementioned range, measured, for example, at the outlet of the nozzle/s, may exert a specific force on the stone material under treatment, such as to obtain an abrasive effect, due to the underwashing and/or crushing of crystals of stone material, while avoiding the drawbacks of flaming and blasting operations, i.e. eliminating their polluting effects (gas and dust emissions) and reducing costs (no consumption of fuel and sand). The thermal shocks caused by flaming may be also avoided, thus preserving the original strength of the stone material. The water used for processing may be easily recovered and reused in a closed-circuit. At the same time, the stone material treated by using the method according to the invention has a better quality and a better aspect than flamed and blasted surfaces. By treating stone materials with the method according to the invention, the effects obtained are similar to those created by nature in time, therefore the user is more pleased with this treatment, also from a psychological point of view.

Further, the characteristics of the stone surface treated by using the method according to the invention may be continuously and easily modified within very broad limits, by changing some simple treatment parameters, such as the pressure of the water jet/s, the distance of the individual nozzles from the surface under treatment, the incidence angle of the water jet/s on the surface under treatment, and the treatment time, depending on composition, on crystalline grain and on the structure of the stone material under treatment, as well as according to the starting condition of the surface to be treated. So, for example, particularly for granites or similar, when the water jet/s have a pressure of about 400 bar, a velvety surface of the processed stone material is obtained, whereas at a pressure of 400 to 600 bar, a slightly bush-hammered surface may be obtained. When pressure is increased above 600 bar and up to 1500 bar, an increasingly deep bush hammering is obtained.

The water jet/s used in the method according to the invention for surface abrasive treatment of stone surfaces may be perpendicular to the surface under treatment or inclined through any angle, preferably 10° to 30°, with respect to the perpendicular to said surface.

The treatment of the processed surface of stone material by using the water jet/s may be executed in any suitable manner, but preferably, particularly in the case of stone slabs, by a relative movement between the stone material under treatment and the water jet/s directed towards the surface of said material, in such a way that, by one or more passes, a more or less uniform treatment of the whole surface being processed or of the part/s thereof to be processed is obtained.

According to a possible embodiment of the invention, particularly fit for stone slabs, the slabs are fed in a preferably uniform motion, while being vertical, or more or less inclined with respect to the vertical, before a vertical line or several successive vertical lines, of stationary nozzles or of stationary sets of nozzles, which line/s or nozzles or sets of nozzles extend all along the height of the stone surface to be processed or along a part thereof. According to another possible embodiment, the stone slabs are fed, while being vertical, or more or less inclined with respect to the vertical, before at least one nozzle or one set of nozzles, which are substantially horizontal or more or less inclined with respect to the horizontal line and driven in a reciprocating up and down motion all along the height of the surface under treatment of the stone slabs, or along a part of said height. In both these embodiments of the method according to the invention, the processing time for the surface of the stone slab depends on the speed whereat the stone slabs are fed before the nozzle/s or the set/s of nozzles and may be adjusted by changing said speed, for example, in a particular case of treatment of granite slabs, from 300 mm/min to 1500 mm/min.

Naturally, according to the invention, in other possible embodiments the stone slabs may be also fed in a horizontal position or in a more or less inclined position with respect to the horizontal line, before one or more nozzles or one or more sets of nozzles, which are vertical or more or less inclined with respect to the vertical, stationary or driven in a reciprocating motion.

According to a preferred embodiment of the invention, the stone surface is treated by using one or more high- or very high-pressure water jets, driven in a motion of revolution about an axis which is eccentric with respect to the jet/s, preferably in combination with a relative translational motion between the rotary jet/s and the stone surface under treatment, transverse to the axis of revolution of the water jet/s.

According to a further improvement, the treatment according the invention may comprise a preventive treatment step of the stone surface, which is carried out with other means than the water jet. Particularly in stones whose structure renders difficult to the water jet to work the surface, the invention comprises a preventive treatment step with mechanical abrasion means, as for example chamfering or flaming.

It has been found that in the most cases there is no need to extend the preventive treatment to the entire surface of the stone, but it is sufficient to execute the preventive treatment on a partial area of the stone surface at the leading edge of it with reference to the displacement of the stone relating to water ejecting nozzles. This limited area may be a stripe at the said leading edge of the stone or part of a stripe. The surface thus subjected to the preventive treatment acts as a surface of attack for the water jet, which can begin to slightly dig the stone enabling then the digging also of the rest of the surface which has not been subjected to the preventive treatment.

The above characteristics, and more, of the method according to the invention and those relating to a plant provided by the invention for implementing a preferred embodiment of this method, will appear in further detail from the following description of said plant, schematically shown by way of a non-limiting example, in the accompanying drawings, in which:

Fig. 1 is a longitudinal elevational side view of the plant for implementing the method according to the invention.

Fig. 2 is a plan view thereof.

Fig. 3 is a partial transverse sectional view of the processing station of the plant as shown in figs. 1 and 2.

Fig. 4 shows the processing station as taken along the arrows IV-IV of fig. 3.

Fig. 5 is a side, partly sectional view of a rotary head nozzle, which may be used in the plant as shown in figs. 1 to 4.

Fig. 6 is a front end view of the nozzle as shown in fig. 5, taken in the direction of arrows VI-VI of said figure.

Fig. 7 is a side, partly sectional view of a rotary set of nozzles, which may be used in the plant as shown in figs. 1 to 4.

Fig. 8 is a front end view of the rotary set of nozzles as shown in fig. 7, taken in the direction of arrows VII-VII of said figure.

Fig. 9 is a perspective view of the rotary set of nozzles as shown in figs. 7 and 8.

Fig. 10 schematically shows the incidence mark on the surface under treatment left by the water jets generated by the rotary nozzles as shown in figs. 5 to 9.

Fig. 11 is a schematic view in the direction of displacement of the stone of a operating station according to an alternative embodiment.

Referring to figures, the processed stone slabs 1, for example consisting of granite slabs, or similar, are fed one after the other, in a vertical position or a substantially vertical position, i.e more or less inclined with respect to the vertical, in a uniform continuous motion, for example in the direction of arrow F, through a processing station 2. To this end, the slabs 1 rest by their lower edge on a continuous bottom conveyor 3 and are guided and supported in their position by guide rollers 4, placed on the two sides of the slabs 1 and fitted - for example by means of angularly displaceable and adjustable arms - on columns 5 of the machine casing. At the input and output ends of the plant, the stone slabs 1 are loaded on the bottom conveyor 3 in the direction of arrow A and unloaded from said bottom conveyor 3 in the direction of arrow B, transverse to the conveyor 3 on one side thereof, and rest in an inclined position with respect to the vertical, on side rollers 6 and 7, only provided on one side of the slabs 1, leaving the opposite side of the bottom conveyor 3 free for loading and unloading the stone slabs 1. The bottom conveyor 3 is driven by an electrical motor M, preferably having a variable speed, which may be adjusted within certain limits.

The processing station 2 consists of a portal 8, through which the stone slabs 1 under treatment pass. On one side of these slabs, there is provided a nozzle 9 directed towards the slabs 1, which is substantially horizontal or more or less inclined with respect to the horizontal line. This nozzle 9 is fitted on a nozzle carrier 10, which extends inside one of the hollow uprights of the portal 8, through a vertical slot 11 formed therein. Inside the hollow upright of the portal 8, the nozzle-carrier 10 is slidably guided on a vertical guide 12 and is fastened to a branch of an endless chain or rope 13, which is outlined by dotted and dashed lines in fig. 4 and is led around upper and lower gears or pulleys or rollers 16 and 17. Said chain or rope or belt 13 may be alternately driven in one direction and in the other by a reversible gearmotor 14, having a preferably variable speed, provided at the top of the portal 8. A splash guard 18 is provided in front of the nozzle 9 opposite to the bottom conveyor

3.

In the application example as shown in figs. 1 to 4, a single nozzle 9, whose axis is stationary during operation, is fitted on the nozzle-carrier. Instead of this simple stationary-axis nozzle 9, a set of two or more superposed and/or adjacent nozzles may be fitted on the nozzle-carrier 10. Two or more nozzle-carriers 10 may be also fitted at certain vertical distances on the same vertical branch of the chain, rope or belt 13, each having one or more nozzles 9 or sets of nozzles, and/or one or more nozzle-carriers, guided as described above, may be fitted also on the other vertical branch of the chain, rope or belt 12, each carrying one or more nozzles 9 or sets of nozzles, directed towards the stone slabs 1.

Instead of one or more nozzles 9, whose axis are stationary during operation, one or more nozzles rotating about an axis eccentric with respect to the water jet/s generated thereby, may be also fitted on each nozzle-carrier 10.

Thus, for example, in the application example as shown in figs. 1 to 4 the nozzle 9 may be replaced by a rotary-head nozzle 9', as shown in figs. 5 and 6. This nozzle 9' comprises a rotary head 19, provided with two nozzle branches 20 branching off from an axial supply duct and are inclined with respect to each other, i.e. radially outwardly diverging through a certain angle, so as to come out in diametrically opposite positions, eccentric to the central axis of rotation of the head 19. Fig. 5 shows a section of one of said nozzle branches 20 of the rotary head 19, whereas the other is simply indicated by its axis 20'. The rotary head 19 is provided with a cap 21 which has, at the outlet of each divergent nozzle branch 20, a corresponding coaxial outlet hole 22 for the respective jet. The rotary head 19 with eccentric nozzles 20 is rotated about its longitudinal central axis by pressurized water supplied to the axial central duct through the connection rear end 23 of this nozzle 9'. The corresponding driving means are not shown, since they are known per se. A nozzle 9' having a rotary head 19 with two eccentric nozzles of the type as described hereinbefore and illustrated in figs. 5 and 6 is manufactured and sold, for example, with the mark RD 1500 by Paul Hammelmann Maschinenfabrik, in Oelde, Germany. Obviously, the rotary head 19 may also have one single eccentric nozzle or more than two eccentric nozzles generating, like the two nozzles, their respective jets, rotating about the longitudinal central axis of the head 19.

The nozzle 9 of the plant as shown in figs. 1 to 4 may be also replaced by a rotary set of nozzles 9" as shown in figs. 7, 8, and 9. This rotary set of nozzles consists of a supply pipe 24 which forms the through-shaft of an electric motor 25 or is passed through the tubular shaft of said motor and is connected thereto in such a way as to be rotatably driven by the motor 25. At the end facing the stone slab 1 under treatment, the pipe 24 carries one or more radial tubular branches 26 (four branches 26 in the illustrated application example), communicating with the central pipe 24 and provided at their free ends each with at least one nozzle 29, facing the stone slab under treatment 1. The opposite end 124 of the pipe 24 is connected to the water supply.

Preferably, all the aforesaid nozzles or sets of nozzles 9, 9', 9" are horizontally movable, for example slidable on their respective nozzle-carrier 10, with the help of any suitable adjusting means (not shown), so as to vary and adjust their distance from the facing surface of the stone slab 1 under treatment. Moreover, there are provided any type of suitable means (also not shown) for varying and adjusting the inclination angle of the nozzle/s or of the set/s of nozzles 9, 9', 9" with respect to the facing surface of the stone slab 1 under treatment, from a direction substantially perpendicular to said surface to a direction vertically or horizontally inclined through a certain angle, for example up to 25°-30°, with respect to the surface under treatment. To this end, the nozzle/s or the set/s of nozzles 9, 9', 9" may angularly removably fitted on their respective nozzle-carrier 10, with the help of any suitable type of adjustable means (not shown) and/or the position of the stone slabs 1 under treatment may be made to be variable and adjustable, by inclining it more or less with respect to the vertical, once again with the help of any suitable type of adjusting means (not shown) for example acting on the angular position of the branches which carry the side guide rollers 4.

The nozzle/s or the set/s of nozzles 9, 9', 9" of the processing station 2 are supplied with pure water, i.e. free of abrasives, having a high or very high pressure, typically of about 300 bar or higher and up to about 1500 bar, by means of a pumping system comprising a known high-pressure pump 27 and a high-pressure resistant supply pipe 28. The delivery pressure of the pump 27 may be varied and adjusted, for example within the aforesaid limits. Pumps of this type are known per se and, for example, are manufactured and sold with the mark HD/113 by the aforementioned firm Paul Hammelmann Maschinenfabrik.

Preferably, the pumping system also comprises driving and controlling means 30 which adjust the delivery pressure of the pump 27, with respect to the up-and-down motion of the nozzle-carrier 10 and/or with respect to the movement of the bottom conveyor 3, and stop, for example, the operation of the pump 27, when the nozzle-carrier 10 and/or the bottom conveyor 3 stop, and/or allow to automatically select and adjust, and also to maintain a certain ratio of the delivery pressure of the pump 27 to the up-and-down speed of the nozzle-carrier 10 and/or to the conveying speed of the bottom conveyor 3.

The plant for supplying high-pressure water to the processing station 2 is further completed by a console, preferably placed in the proximity of the processing station 2, as well as by a quality control and certification board, preferably placed at the output where the processed slabs 1 are unloaded from the bottom conveyor 3.

When the stone slabs 1 pass through the processing station 2, the surface thereof turned towards the nozzle/s fitted on the nozzle-carrier 10 is hit by the high-pressure water jet/s generated by said nozzles, all along the height of the slab 1 or along a part thereof, i.e. along the height of a longitudinal horizontal strip of the slab 1, according to the level and to the vertical extension of the reciprocating up-and-down stroke of the nozzle-carrier 10. Anyway, according to the invention, the delivery pressure of the pump 27, the feed speed of the stone slabs in the direction of arrow F impressed by the bottom conveyor 3, and hence the speed whereat the stone slabs 1 pass before the nozzles 9, 9', 9" generating high-pressure water jets, as well as the distance of this/these nozzle/s from the opposite surface under treatment of the stone slabs 1 and the incidence angle of the high-pressure water jet/s with respect to said surface, that is the inclination angle of the nozzle/s with respect to the facing surface of the stone slabs 1, as well as the speed of the up-and-down reciprocating motion of the nozzle-carrier 10 and - in case of one or more rotary nozzles 29, driven by a special motor associated thereto 25, like in the application example of figs. 7 to 9 - the driving and rotational speed of this/these nozzle/s, are selected both as regards their absolute values and as regards the ratios therebetween, depending on the type and characteristics and particularly on the crystalline structure of the stone material of the slabs 1, in such a way that the high-pressure water jet/s generated by the nozzle/s hit the surface of the slab 1 under treatment with such a specific force as to exert an abrasive action on that surface, caused by the crystals of stone material being underwashed and/or crushed, with a depth and an extension as required by the desired surface effect. The values of the above parameters and the ratios therebetween are easy to determine for example by means of tests. Thus, for example, for granite processing (Sardinia Gray, Zimbabwe Black, Imperial Red) satisfactory to optimum results were obtained with the following parameters: pressure of water jets = 400 to 1300 bar (measured, for example, at the outlet of the respective nozzle/s); distance of the nozzles from the stone surface under treatment = 1 cm to 10 cm; inclination angle of the water jet/s with respect to the surface under treatment = 0° to 25° with respect to the perpendicular to said surface; feed speed of the granite slabs under treatment before the nozzle/s generating high-pressure water jet/s = 300 to 1450 mm/min.

The shape of the incidence marks of the high-pressure water jet/s on the stone surface under treatment substantially depends on the ratio of the speed whereat the stone slabs are conveyed (rate of feed before the nozzle/s generating the high-pressure water jet/s) to the speed of the up-and-down vertical motion of said nozzle/s. In the case of one or more nozzles driven by a motion of rotation about an axis eccentric thereto, for example in the case of a rotary set of nozzles as shown in figs. 7 to 9, the incidence mark of water jets on the surface of the stone slab 1 under treatment is as shown in fig. 10.

According to the alternative embodiment of fig. 11 the slabs 1 are guided and supported in a inclined position relatively to the vertical upright position, also by means of fixed roller 4′ also when they pass the columns 8 carrying the nozzle 9. The inclination is chosen in such a way that the upper edge of the slabs 1 show a greater distance from the nozzle. The slabs are held in position against the rollers 4 which are supported rigidly by means of rollers 4 which are similar to the ones of the preceding example. The rollers 4 are mounted on angularly displaceable and adjustable arms on columns 5 of the machine casing. The inclination of the slabs 1 in the region of the columns 8 carrying the nozzle 9 may be almost the same as the inclination which the slabs show at the input and output ends of the plant. The inclined position of the slabs during exposure to the water jet allows to better support the displacing pressure the water jet exerts onto the slab 1. The roller 4′ may be supported rigidly and being inclined the opposite roller 4 on the angularly displaceable arms which are elastically driven against the slab may show e less strong and correspondingly expensive construction than they would need if the slab has to be supported with a vertical orientation. At the same time any risk is avoided that the slab may for any reason fall laterally against the nozzle. Another effect achieved at the same time consists in the fact that the slightly inclined surface on which the water jet is directed facilitates the water flowing away and reduces the sprinkling back of water by the surface under treatment.

The rigidly supported rollers 4' offers also the opportunity to provide a simple supporting frame which may be mounted slidably in the direction perpendicular to the slabs surfaces in order to regulate the distance. The frame supporting the rollers 4' may show any kind of construction. A preferred embodiment, not shown in detail provides on the bottom of the frame two or more sliding guides oriented perpendicularly to the slab surface. Furthermore, the frame could be mounted oscillating around an horizontal axis parallel to the longitudinal axis of the bottom conveyor 3, in order to regulate the angle of inclination of the slabs.

According to a further feature of this embodiment, the vertical path of the nozzle or of the nozzles generating the water jet or jets is oriented also inclined and parallel to the facing surface of the slab. This may achieved by simply providing a properly inclined frame of the machine, or positioning the relevant part of the plant on an inclined plane.

Naturally, the invention is not intended to be limited to the application examples as described and illustrated herein, but may be greatly varied and modified, both as regards the values of the different parameters of the method and as regards the construction means for implementing it. Thus, for example, in a plant similar to the one described herein both faces of the stone slabs 1 may be either simultaneously or alternately successively processed, by providing high-pressure nozzles on both sides of the stone slabs 1, in the same processing station or in two successive processing stations, and/or there may be provided other methods and directions wherein the stone slabs may be loaded and unloaded, for example by insertion and removal in line with the bottom conveyor 3 through the ends thereof. A further improvement could consists in one or more additional treatment stations which may be provided before the station carrying the water nozzle 9. One of this additional station could be advantageously used for carrying out a preventive surface treatment of the slabs in which, at least a small area, for example a thin vertical stripe at the leading edge of the slab, is mechanically treated in order to create a zone in which the surface of the slab is less resistant to the water jet, relating to its surface digging action. In this way, particularly with stones which structure is strongly resistant to the action of the water jet a small surface area of attack for the said jet is provided, so that from this area the jet may better engrave the rest of the slab surface to be treated without needing to carry out the preventive treatment on the whole surface. A preventive treatment of this kind could be for example a chamfering. Also other different treatment as flaming or other may result effective as a preventive treatment for achieving the same results with different kind of stones. All this is intended without departure from the guiding principle disclosed above and claimed below.

CLAIMS

1. A method for surface abrasive treatment of stone materials, particularly stone slabs, especially granite slabs and the like, characterized in that the stone surface to be processed is submitted to the action of one or more high- or very high-pressure water jets, which pressure is selected - with respect to the distance of said surface to the nozzle/s generating said water jet/s - so that the specific incidence force of the water jet/s on the surface under treatment causes crystals of the stone materials to be underwashed and/or crushed, to an extent corresponding to the desired effect.

2. A method as claimed in claim 1, characterized in that the pressure of the water jet/s, having an incidence on the stone surface under treatment is of 300 to 1500 bar.

3. A method as claimed in claim 1 or 2, characterized in that the high-pressure water jet/s are generated by one or more nozzles, being at a distance of 1 to 10 cm from the stone surface under treatment.

4. A method as claimed in one or more of claims 1 to 3, characterized in that the high-pressure water jet/s strike the stone surface under treatment in such a way as to be perpendicular thereto, or inclined through a certain angle, preferably up to about 25°-30°, with respect to the perpendicular to said surface.

5. A method as claimed in one or more of claims 1 to 4, characterized in that the action of the high-pressure water jet/s on the stone surface under

treatment is exerted with a relative movement between the stone material under treatment and one or more water jet/s directed towards this surface, so that a more or less uniform treatment of the whole surface or of one part thereof is obtained.

6. A method as claimed in claim 5, for surface abrasive treatment of stone slabs, characterized in that the stone slabs are fed in a preferably continuous and uniform motion before one or more successive vertical lines of nozzles or sets of nozzles, directed towards the slab surface to be processed, which lines of nozzles or sets of nozzles extend transverse to the feed direction of the slabs, all along the respective transverse extension of the slabs or along the part thereof to be processed.

7. A method as claimed in claim 5, for surface abrasive treatment of stone slabs, characterized in that the stone slabs are fed in a preferably continuous and uniform motion before one nozzle or one set of nozzles, directed towards the slab surface to be processed, and driven in a reciprocating motion transverse to the feed direction of the slabs, all along the respective transverse extension of the slabs or along the part thereof to be processed.

8. A method as claimed in claim 6 or 7, characterized in that the stone slabs are fed, while being substantially vertical or inclined with respect to the vertical, before the nozzle/s, which are oriented in such a way as to be substantially horizontal or inclined with respect to the horizontal

line.

9. A method as claimed in claim 6 or 7, characterized in that the stone slabs are fed, while being substantially horizontal or inclined with respect to the horizontal line, before the nozzle/s, which are oriented in such a way as to be substantially vertical or inclined with respect to the vertical.

10. A method as claimed in one or more of claims 5 to 9, characterized in that the relative speed between the stone slabs and the nozzle/s generating the high-pressure water jet/s is of 60 mm/min to 1500 mm/min.

11. A method as claimed in one or more of claims 1 to 10, characterized in that the high-pressure water jet/s are driven in a rotational motion about an axis which is eccentric to each water jet.

12. A method as claimed in one or more of claims 1 to 11, characterized in that one or more of the following parameters are variable and adjustable: pressure of the water jet/s, distance of the individual nozzles from the stone surface under treatment, incidence angle of the water jet/s on the stone surface under treatment, relative speed between the stone surface under treatment and the nozzle/s generating the water jet/s, rotational speed of the rotary nozzles and/or ratios between two or more of these parameters.

13. A method as claimed in claim 12, characterized in that the incidence angle of the water jet/s on the stone surface under treatment is adjusted by varying the angular position of said surface with respect to the water jet/s and/or the angular direction of the

water jet/s with respect to the surface under treatment.

14. A method according one or more of the preceding claims, characterized in that at least a preventive step of treatment is executed before working the surface of the stone with the water jet.

15. A method according to claim 14, characterized in that the preventive treatment comprises an abrasion treatment of the surface, like chamfering and/or other treatments like flaming.

16. A method according to claims 14 or 15, characterized in that with reference to the direction of advancement of the stone before the water jet, the preventive treatment is applied to a limited part of the surface to be treated at the leading edge of the stone, as a thin stripe along the entire leading edge and parallel to the displacement of the water jet or only part of such a stripe.

17. A plant for implementing the method as claimed in one or more of claims 1 to 16, particularly for processing stone slabs, characterized in that it comprises a continuous bottom conveyor (3), whereon the stone slabs rest by their lower edges while being substantially vertical or inclined with respect to the vertical, having a preferably adjustable inclination, and are guided, for example, by side rollers (4) and fed, at a uniform and preferably adjustable speed, through at least one processing station (2), wherein there is provided, at least on one side of the slabs, a processing apparatus, having one or more nozzles (9,

9', 9") directed towards their respective slab surface and supplied with high- or very high-pressure water by means of a feed pump (27) preferably provided with pressure adjustment.

18. A plant as claimed in claim 16, characterized in that the processing apparatus comprises at least one stationary and substantially vertical line of nozzles or sets of nozzles, which line extends all along the height of its respective facing surface of the stone slabs (1) or along a part of said height.

19. A plant as claimed in claim 16, characterized in that the processing apparatus comprises at least one nozzle (9) or one set of nozzles (9', 9"), driven in a reciprocating vertical up-and-down motion, preferably at an adjustable speed, all along the height of its respective facing surface of the stone slabs (1), or along a part of said height.

20. A plant as claimed in one or more of claims 16 to 19, characterized by at least one nozzle (9') comprising a rotary head (19) which is preferably driven by pressurized water supplied through the nozzle and is provided with at least one outlet (20), which is eccentric to its axis of rotation.

21. A plant as claimed in one or more of claims 16 to 19, characterized by at least one nozzle (29) placed on a radial extension (26) of a rotating tubular shaft (24) which is rotatably driven by a special electric motor (25) and communicates both with said nozzle (29) and with the high-pressure water feeding pump (27).

22. A plant as claimed in claim 21, characterized

in that the rotating tubular shaft (24) is the tubular through shaft of the electric motor (25).

23. A plant as claimed in claim 21 or 22, characterized in that the rotating tubular shaft (24) has several radial extensions (26), preferably angularly equally spaced and each provided with at least one nozzle (29) communicating with the tubular shaft (24).

24. A plant as claimed in one or more of claims 16 to 19, characterized by a control apparatus (30), controlling the operation and particularly the delivery pressure of the feeding pump (27), depending on the up-and-down and/or rotational motion of the nozzle/s (9, 9', 9") and/or depending on the movement of the bottom conveyor (3).

25. A plant as claimed in claim 24, characterized in that the control apparatus (30) automatically keeps the preset and adjustable ratio of the delivery pressure of the pump (27) to the conveying speed of the bottom conveyor (3) and/or of the delivery pressure of the pump (27) to the speed of the up-and-down motion of the nozzle (9) or set of nozzles (9', 9") and/or of the rotational motion of the rotary nozzle/s (9', 9") on constant values.

26. A plant according to one or more of the preceding claims 16 to 25, characterized in that at least in the operative station, i.e. in the zone where the water jet is directed against the stone, there are provided supporting means (4') of the slabs which are inclined backwords relatively to the upright vertical

position of the slabs.

27. A plant according to claim 26, characterized in that said supporting means consist in a certain number of roller (4′) which are supported rotatable in direction of advancement of the slabs and with their axis of rotation parallel to the backwords surface of the inclined slabs.

28. A plant according to claims 26 or 27, characterized in that rollers (4) are provided on the side of the slabs opposite to the inclined rollers (4′) which are elastically (5) forced against the inclined stationary rollers (4′).

29. A plant according to one or more of the preceding claims 26 to 28, characterized in that the vertical path of the nozzle or of the nozzles generating the water jet or jets is oriented also inclined and parallel to the facing surface of the slab.

30. A plant according to one or more of the preceding claims 16 a 29, characterized in that with reference to the direction of advancement of the stones or slabs, before the station in which the surface is treated with one or more water jets, there is provided at least a further station for executing a preventive treatment of the stones or slabs, like chamfring or flaming.

31. A plant according to claim 30, characterized in that the utensils or the devices for carrying out the preventive treatment are supported in the same way as the water jet nozzle or nozzles.

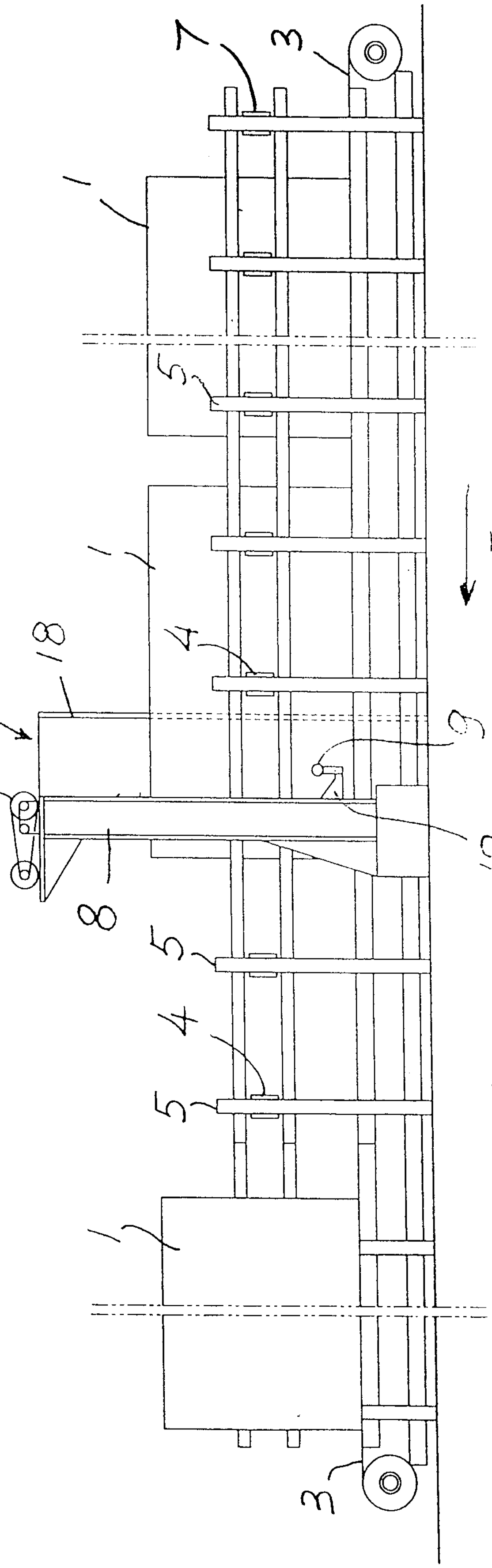


FIG. 1

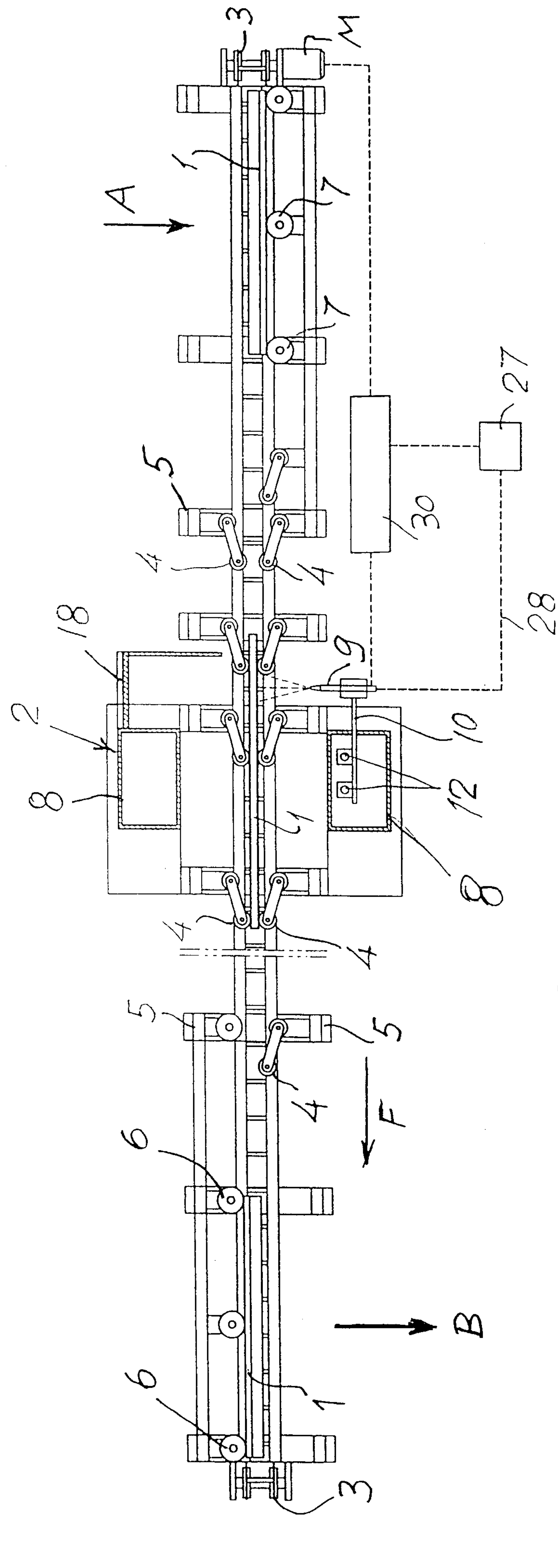
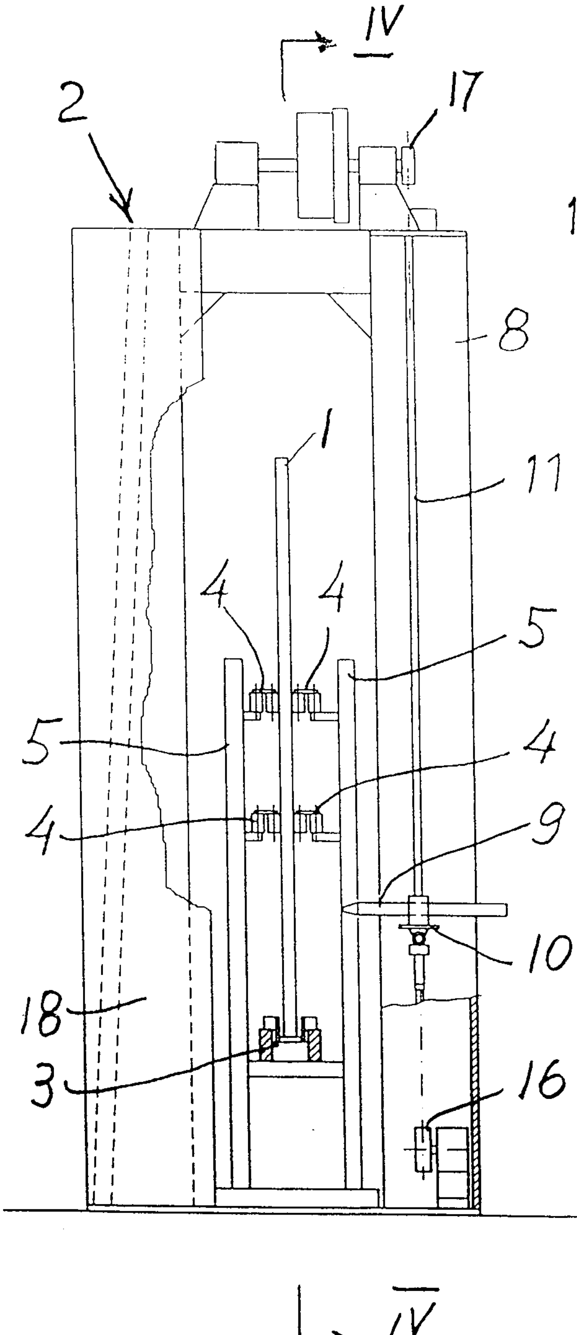


FIG. 2

FIG.3


IV
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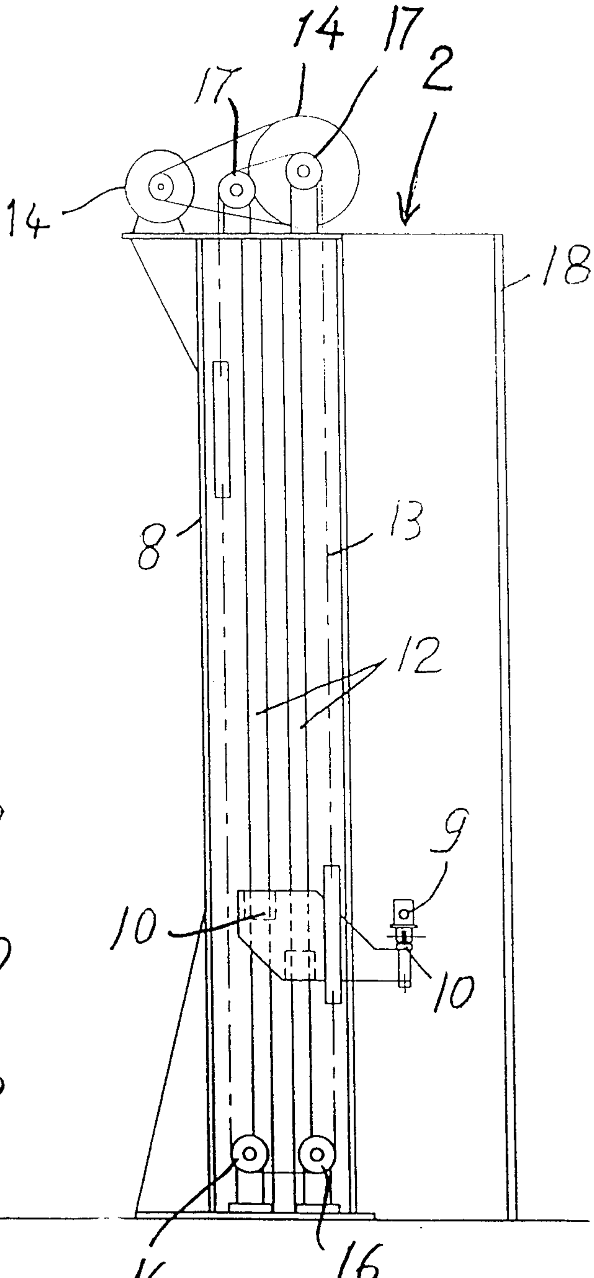
IV

FIG.4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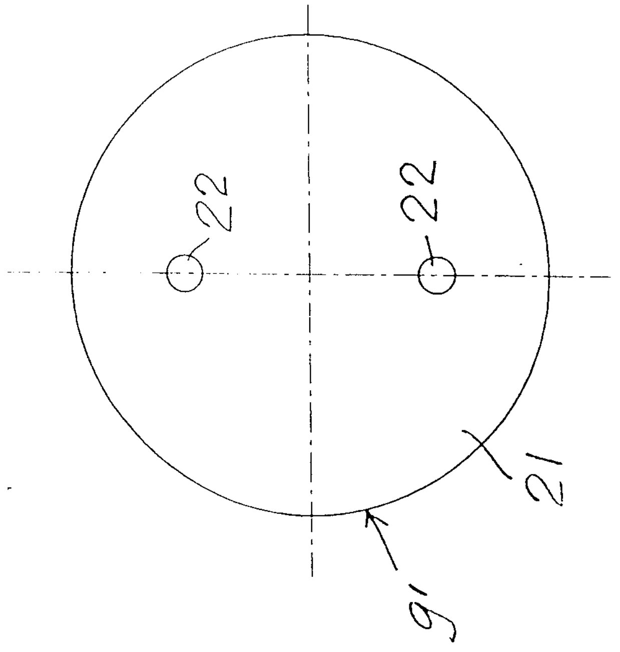

FIG. 6

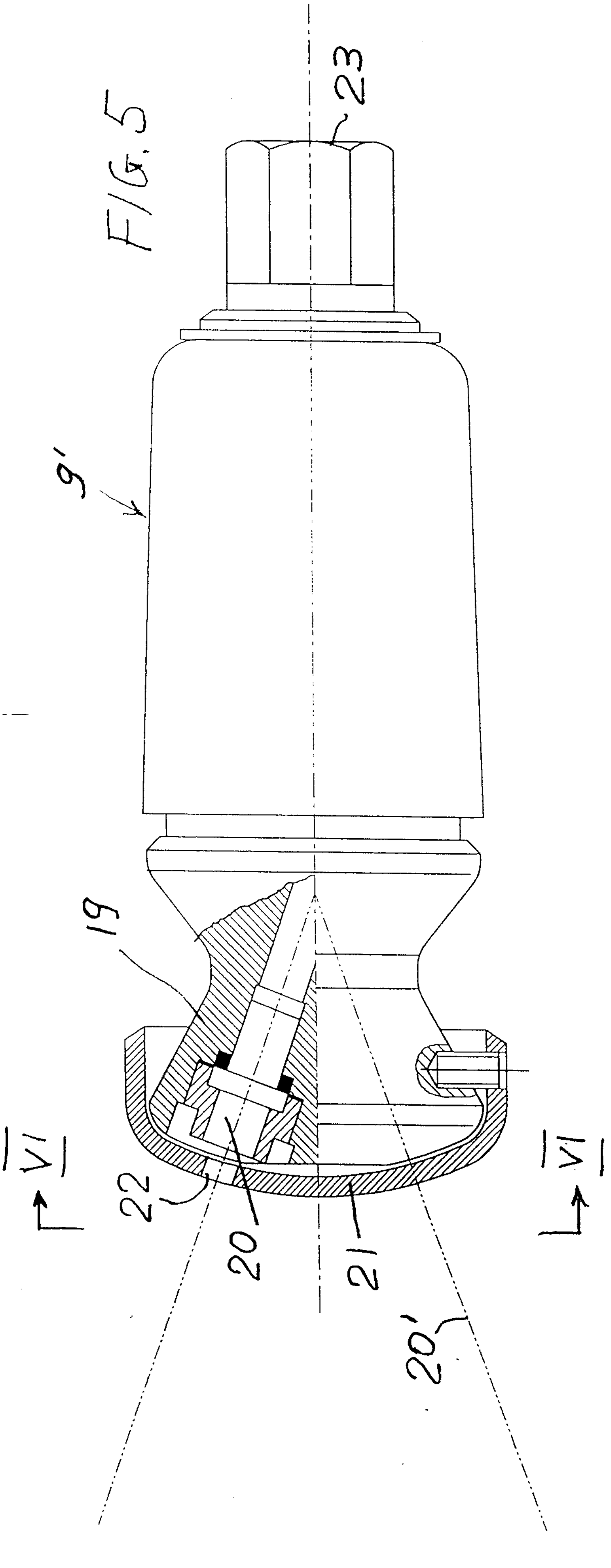

FIG. 5

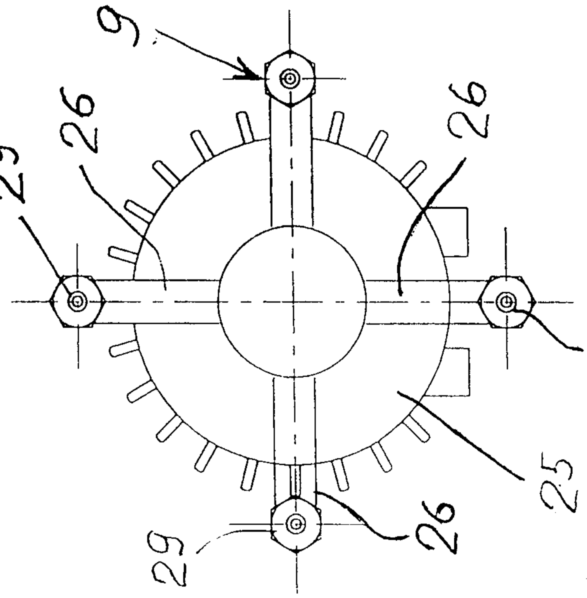

FIG. 8

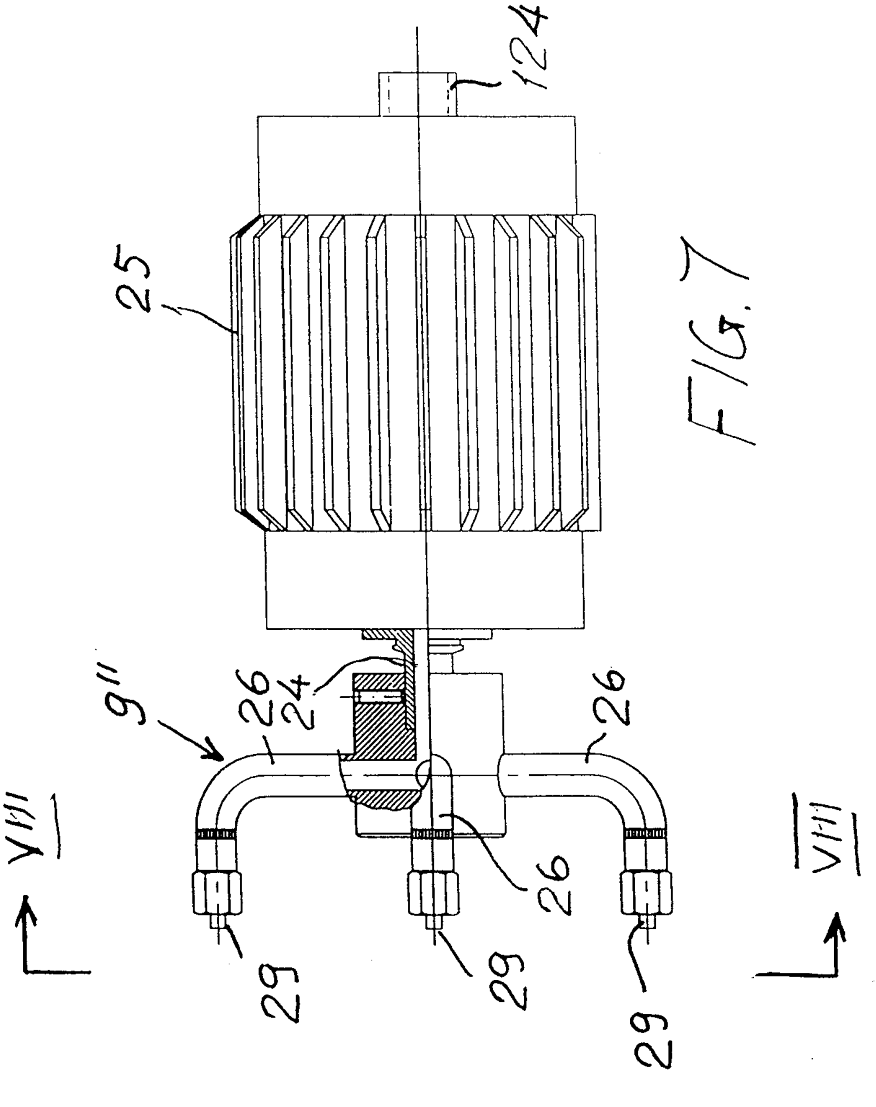

FIG. 7

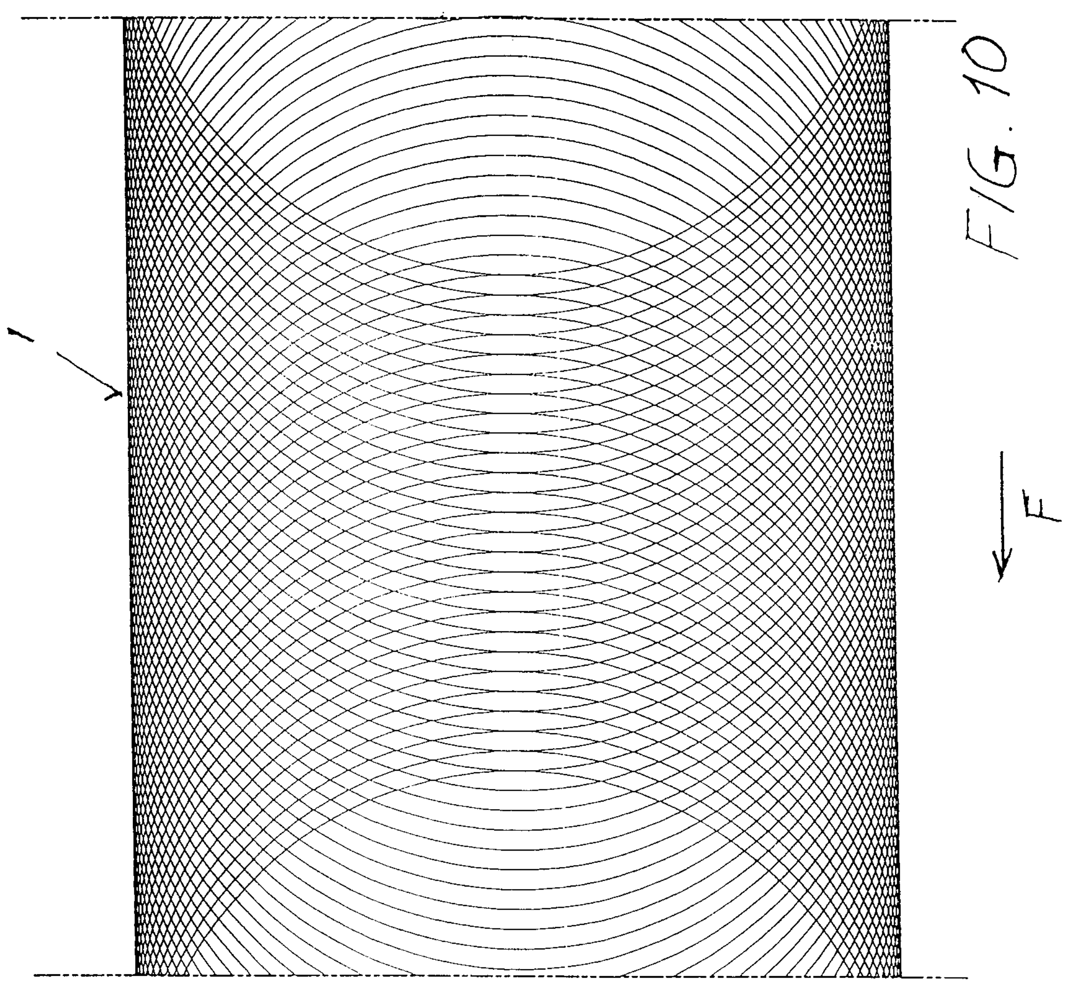

FIG. 10

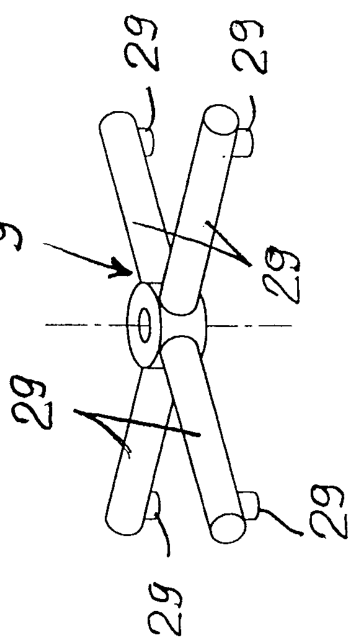

FIG. 9

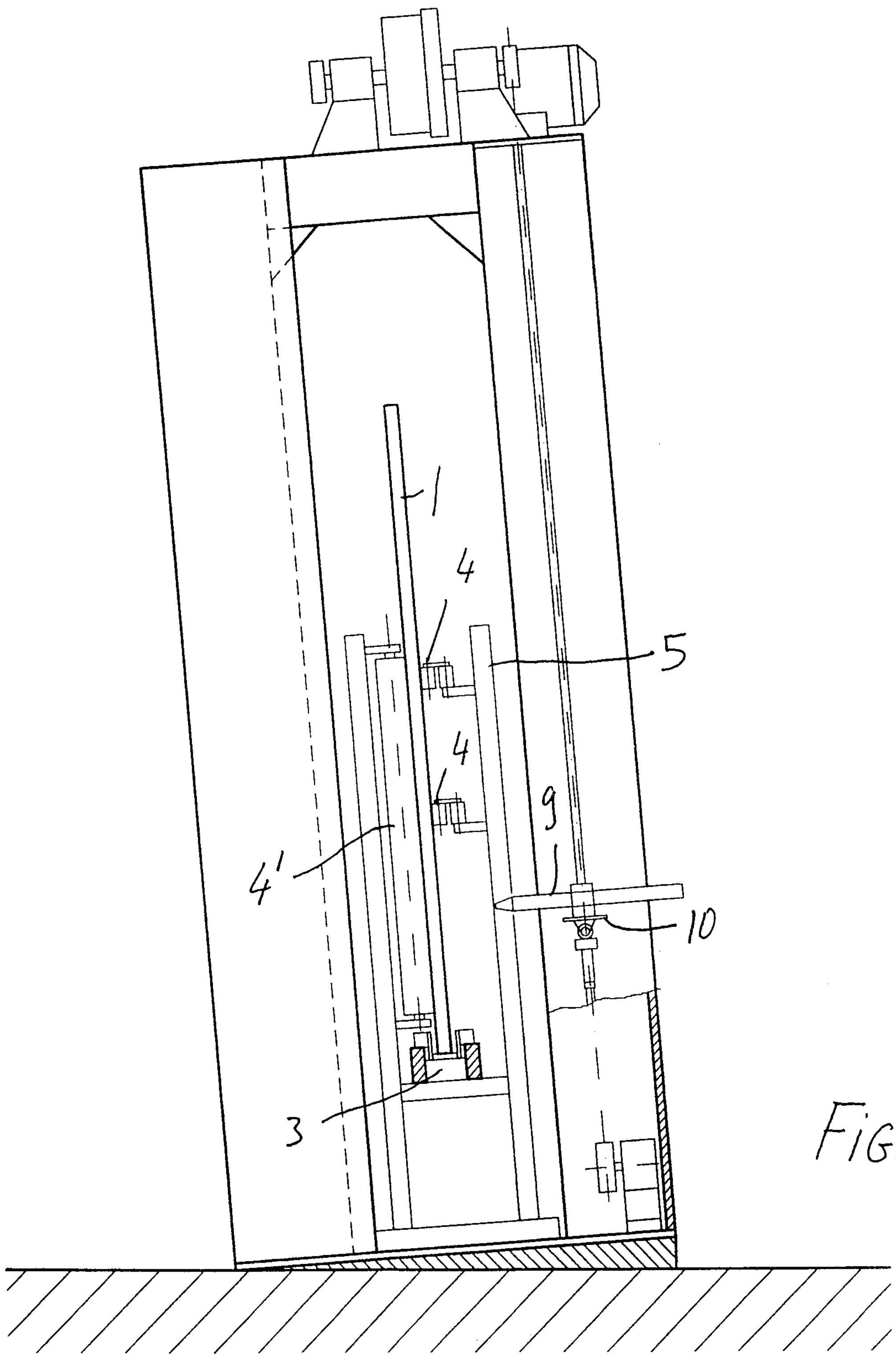

Fig. 11

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 98/08089

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B24C1/00 B24C1/04 B24C1/06 B24C3/12 B28D1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B24C B28D B26F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 517 048 A (JSE CORPORATION) 9 December 1992 see the whole document	1-5,7, 9-11,14
Y		6,8, 17-20
A		27,30
Y	US 1 829 599 A (MCCRERY) 27 October 1931 see page 1, line 58-64; figures 1-6	6,8, 17-20
A	DE 30 18 206 A (KRAPF & LEX) 19 November 1981 see claims 1-6; figures 1,2	26
A	DE 22 58 536 A (INGENJÖRSFIRMA HEBE AKTIEBOLAG) 7 June 1973 see claim 1; figure 1	27

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 May 1999	18/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Matzdorf, U

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Form PCT/ISA/210 (second sheet) (July 1992)

International Application No
PCT/EP 98/08089

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 643 057 A (ISAACSON) 1 July 1997 see column 3, line 37-42; figures 1,2 -----	6,8,12, 25

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 98/08089

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