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(54) Plant for water jet surface treatment of stony material elements

(57) A plant for surface working of semi-finished products made of a stone material or the like, using abrasive-free liquid jets comprises a support base (2) for a workpiece (P), a head (3) facing the support base (2) and having a plurality of nozzles (4, 4', 4", ...) for generating jets (J), feed means (5) for feeding the nozzles (4, 4', 4", ...) with a high-pressure liquid to create cuts on the product (P) being worked, first drive means (6) for forwardly moving the product (P) relative to the head (3) in the longitudinal direction (X). The nozzles (4, 4', 4",...) are mutually offset in a transverse direction (Y) with a predetermined pitch (p), adjustment means (7) being associated therewith for continuous adjustment of the projection of their pitch (p) on a substantially transverse vertical plane (π), during operation, to change the transverse distance (d) between the longitudinal cuts made by the jets (J).

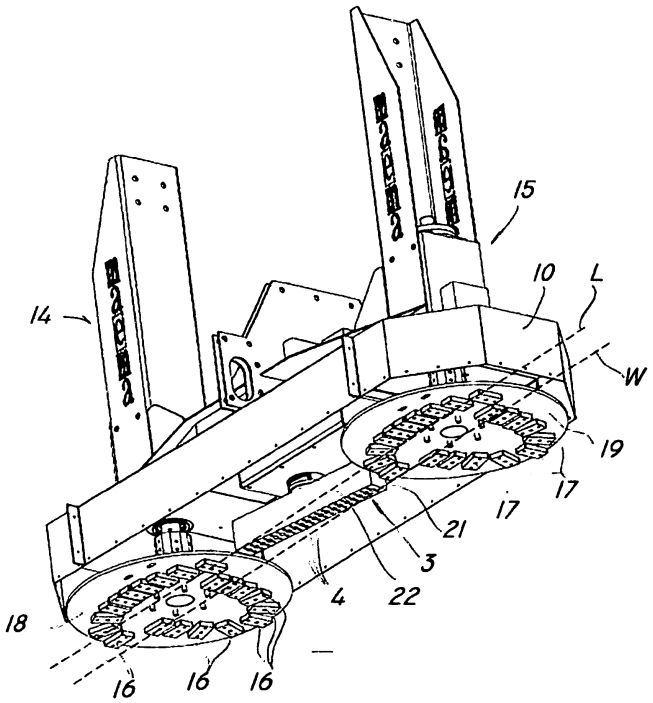

FIG. 2

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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 multi-jet plant for water-jet surface working of semi-finished products made of stone, cementitious materials, conglomerates, granites and the like.

Background art

[0002] Surface working of products made of stone materials or the like, is known to be obtained by directing one or more high-pressure and/or high-speed fluid jets to the surface of the product.

[0003] The action of such jets is adapted to create surface deformations, possibly associated with material removal, to provide technical and/or aesthetic effects, such as abrasion, scratching, roughening, scraping, marking or similar surface alterations.

[0004] Particularly, it is known to use multi-jet plants having a multi-jet head that is moved above the surface of the product to be worked, which is generally in slab form, to direct a plurality of high-pressure water jets thereon.

[0005] In order to obtain the required abrading effect the water jet is mixed with a powdered abrasive material, which is adapted to be propelled at high speed with the jet on the surface to be worked.

[0006] Thus, the deformation effect is mainly caused by the action of the abrasive material, and water pressures may be maintained at relatively low levels.

[0007] Nevertheless, the use of abrasive materials involves a variety of problems, mainly associated with the management of the abrasive material, that has to be stored and recovered after use.

[0008] Furthermore, during processing the particles of abrasive material should be prevented from dispersing in the environment, as this might constitute a serious hazard for the operators that control the apparatus.

[0009] Not the least, the abrasive material has a deteriorating effect on the parts of the plant contacted thereby, particularly with the mixture feeding line, and with the jet emitting nozzles.

[0010] Therefore, these prior art apparatus require frequent maintenance, involving downtimes and throughput losses, as well as replacement of the parts under stress.

[0011] In an attempt to obviate these drawbacks machines have been proposed for surface working of products of stone material that only use water jets, without the assistance of abrasive material.

[0012] US 5,291,694 discloses an apparatus for surface working of slabs of stone materials, comprising one or more multi-jet guns, each designed to emit a plurality of high-pressure water jets to be directed to the surface to be worked.

[0013] Nevertheless, the jet emitting pressure, ranging from 200 Kg/cm^2 to 800 Kg/cm^2) is inadequate to obtain a surface working effect with a satisfactory definition. Indeed, this prior art apparatus is mainly used for finishing of pre-processed surfaces.

[0014] A further drawback is that a single rotational and translational motion is imparted to the nozzles, which causes repetitive and schematic reproduction of the working patterns, thereby affecting the aesthetic value of the final product.

[0015] European Patent EP1045742 discloses a further machine for fluid-jet surface working of stone products using only water.

[0016] In this machine, one or more water jets are directed to the surface to be worked at a pressure ranging from 300 bar to 1500 bar.

[0017] Nevertheless, this solution also proved to be inadequate, as these water jet pressures affect jet effectiveness and do not provide the desired surface effects.

[0018] Furthermore, also in this machine, nozzles are displaced relative to the surface to be worked with schematic movements that create repetitive patterns, showing that the product is industrially worked, thereby affecting the aesthetic value of the final product.

[0019] Not the least, the use of relatively low pressures requires operation at high flow rates, with nozzles having relatively large outlet diameters. This will produce particularly rough working patterns, and will prevent the formation of fine designs.

Disclosure of the invention

[0020] The main object of this invention is to obviate the above drawbacks, by providing a plant for water jet surface working of products made of stone or the like that is highly efficient and relatively cost-effective.

[0021] A particular object is to provide a plant for surface working of products made of stone materials that provides particularly distinct surface effects, reproducing the effects of manual processing, only using water jets with no abrasive material therein.

[0022] Yet another object is to provide a plant for surface working of products made of stone materials, that can create any decorative pattern, possibly of figurative type, or even texts, barcodes, QR codes, or the like, without particular limitation, and with a single jet tool driving cycle.

[0023] A further object is to provide a plant for surface working of products made of stone materials, that affords high operational flexibility, with the possibility of changing the surface texture even while the head is moving.

[0024] Another important object of the present invention is to provide a method for surface working of products made of stone materials that can provide multiple processing operations of high aesthetic value.

[0025] These and other objects, as better explained hereafter, are fulfilled by a plant for surface working of semi-finished products made of a stone material or the like, using abrasive-free liquid jets, which comprises a

moving or stationary support base for the products to be worked, a head facing the support base and having a plurality of nozzles for generating jets oriented toward the surface of the products to be worked, feed means for feeding the nozzles with a high-pressure liquid to create cuts on the product being worked, first drive means for forwardly moving the product relative to the head in the longitudinal direction.

[0026] The plant is **characterized in that** the nozzles are mutually offset in a transverse direction with a predetermined pitch, adjustment means being associated with the nozzles for continuous adjustment of the projection of their pitch on a vertical plane, substantially parallel to the transverse direction, during operation, to change the transverse distance between the longitudinal cuts made by the jets.

[0027] This particular combination of characteristics will allow the relative positions of cuts to be changed to create a multiplicity of processing effects and obtain decorative patterns that mimic manual operations, possibly figurative patterns.

[0028] Conveniently, the feeding pressure will be above 1500 bar to obtain an evident surface cutting effect.

[0029] Advantageously, the nozzles may have an outlet with a maximum diameter ranging from 0.10 mm to 0.60 mm, preferably from 0.20 to 0.40 mm, and more preferably of about 0.30 mm.

[0030] Also, pressure regulator means may be provided, for selective adjustment of the impact pressure of jets on such products being worked.

[0031] With this additional combination of characteristics, water jets of high strength and high concentration may be directed to the surface, to act like a tool bit, to form particularly sharp cuts.

[0032] Furthermore, the possibility of adjusting the impact pressure of the individual jets allows the cutting action to be limited or locally omitted to create decorative patterns, texts, codes and the like, at a high definition.

[0033] Advantageous embodiments of the invention are defined in accordance with the dependent claims.

Brief description of the drawings

[0034] Further features and advantages of the invention will be more apparent from the detailed description of a preferred, non-exclusive embodiment of a plant according to the invention, which is described as a non-limiting example with the help of the annexed drawings, in which:

FIG. 1 is a top view of the plant of the invention;
FIG. 2 is a perspective view of the block that is part of the plant and comprises the multi-jet head;
FIG. 3 is a front view of the block of Fig. 2;
FIG. 4 is a broken-away front view of the block of Fig. 2;
FIGS. 5 to 7 are bottom views of the block of Fig. 2 in three different operating conditions;
FIG. 8 is a perspective view of a nozzle head that is part of the plant of the invention, according to a first preferred configuration;
FIGS. 9 to 12 are views of a detail of the head of Fig. 8;
FIG. 13 is a sectional front view of the detail of Fig. 9;
FIG. 14 is a top view of the head of Fig. 8 in a particular operating mode;
FIGS. 15 and 16 are front views of the head of Fig. 8 in a second preferred configuration and in two distinct operating conditions;
FIG. 17 is a side view of the head of Fig. 8 in a third operating configuration;
FIG. 18 is a side view of the head of Fig. 8 in a fourth operating configuration.

Detailed description of preferred embodiments

[0035] Referring to the above mentioned figures, a liquid jet plant of the invention, generally designated by numeral 1, may be used for working products made of a stone material such as stone, marble, granite or stone materials in general, cementitious materials, conglomerates or the like, for surface working thereof.

[0036] The working process may be aimed at creating deformations on the surface S of a product P, possibly caused by material removal, thereby forming a predetermined pattern or texture, or an image, even a complex image. The product P may be in the form of a slab, a block or have a not necessarily regular three-dimensional shape.

[0037] As shown in Fig. 1, the plant 1 comprises a moving or stationary support base 2 for the products P to be worked and a head 3 facing the support base 2 and having a plurality of nozzles 4, 4', 4", ... for generating jets J oriented toward the surface S of the product P to be worked.

[0038] In the illustrated configuration, the support base 2 is stationary and has a substantially horizontal orientation, such that the surface S to be worked may face upwards, the head 3 being movable above the base 2. Nevertheless, the plant 1 can also process inclined surfaces S, or surfaces lying on a support base that is inclined to the horizontal, possibly even vertical.

[0039] The plant 1 also comprises feed means 5 for feeding the nozzles 4, 4', 4",... with a high pressure liquid, preferably water with no abrasive material therein, adapted to generate high-pressure jets J to make cuts on the products P being worked.

[0040] While reference will be made herein, for simplicity, to a single nozzle, designated with numeral 4, unless otherwise stated all the parts related to such nozzle 4 shall apply in a substantially identical and operatively equivalent manner to the other nozzles 4', 4",....

[0041] The head 3 is also associated with first drive means 6 for forward movement thereof in a longitudinal direction X relative to the support base 2, and hence rel-

ative to the products P thereon.

[0042] These first drive means 6 may be designed to longitudinally transfer the head 3 in the longitudinal direction X, like in the illustrated configuration, and/or may be associated with the support base 2, e.g. via a roller bed or a conveyor belt, for longitudinally transferring the product P.

[0043] As more clearly shown in Figs. 2 and 12, according to a peculiar feature of the invention, the nozzles 4 are mutually offset in a transverse direction Y with a predetermined pitch p.

[0044] Furthermore, the plant comprises adjustment means 7 associated with the nozzles 4 for continuous adjustment of the projection of their pitch p on a vertical plane π substantially parallel to the transverse direction Y during operation, to change the transverse distance d between the longitudinal cuts made by the jets J.

[0045] Particularly, Figs. 2 to 5 show three different operating conditions, in which the nozzles 4 are aligned in a direction W coplanar with the transverse direction Y but inclined thereto at three different angles α,β,γ, to change their projection relative to the vertical plane π.

[0046] Namely, in this configuration there will be a maximum distance d between cuts when the direction of alignment W of the nozzles 4 is parallel to the transverse direction Y and a minimum distance when it is orthogonal thereto, i.e. longitudinal. In this case, cuts will substantially overlap.

[0047] According to a further particularly advantageous aspect of the invention, the feed means 5 will be adapted to feed the working liquid at a minimum pressure above 1500 bar, with maximum values that may be continuously regulated without limitation, according to the material to be worked and to the thickness of the product P, particularly when the latter is a slab.

[0048] These feeding pressure values will provide the required definition of the cuts without the use of abrasive materials, thereby eliminating all the drawbacks associated with this operating condition.

[0049] In a particularly preferred embodiment, as shown in Fig. 1, the plant 1 comprises a stationary load-bearing structure 8 that surrounds the support base 2 and has a pair of substantially longitudinal lateral shoulders 9.

[0050] The head 3 is supported by a substantially horizontal frame 10, as more clearly shown in Figs. 2 to 7, which is in turn mounted to a substantially transversely oriented beam 11, having opposite ends 12 that slide on respective longitudinal guides 13 associated with corresponding shoulders 9.

[0051] The figures also show that the frame 10 supports two additional multi-jet heads 14, 15, disposed at the sides of the first head 3, which heads may be configured as taught in Patent Applications EP1977867 and EP2105275 by the applicant hereof, and have nozzles, generally designated 16 and 17, disposed on respective rotating plates 18 and 19, are connected to the feed means 5 of the first head 3, which allows them to be fed at the above mentioned feeding pressures.

[0052] The two lateral heads 14, 15 are supported by the frame 10, to be integral with the central head 2, such that they can follow its translational motion.

[0053] In this configuration, the first drive means 6 may be associated with the ends 12 of the beam 11 and may be of the carriage-driven type, allowing the longitudinal sliding motion of the beam 11.

[0054] The latter may also have second drive means 20, also possibly of the carriage-driven type, for imparting a longitudinal sliding motion to the frame 10 and hence to the nozzle heads 2, 14 and 15, thereby allowing the working process to be also carried out on surfaces S larger than the maximum transverse dimension of the head 2.

[0055] The plant 2 may further comprise electronic control means, not shown, which are adapted to interpolate the movements imparted by the first drive means 6 and the second drive means 20 and by the adjustment means 7, as well as any other movement as described hereinbelow, to obtain complex motions of the head 2.

[0056] The central head 2 comprises an elongate body 21 mainly extending in the direction L, with the nozzles 4 being mounted thereto in mutually offset positions and with jets J oriented toward the products being worked.

[0057] As more clearly shown in Figs. 8 to 12, the elongate body 21 is fixed to a support shaft 22, that is pivotally mounted to the horizontal frame 10 to rotate about an axis of rotation R that is substantially perpendicular to the elongate body 21.

[0058] As more clearly shown in Fig. 13, the feed means 5 may comprise a feed line 23 which is disposed at the periphery of the shaft 22, and is connected to a distribution channel 24 formed in the head 3 and connected to the nozzles 4.

[0059] The adjustment means 7 may act on the rotating shaft 22 to promote its rotation about the axis of rotation R, which will change the projection of the pitch p and the relative distance d between cuts. Furthermore, they may be designed to also allow the shaft 22 to rotate by 360°, as schematically shown in Fig. 14, in which the elongate body 21 is outlined by dashed lines, in the possible rotated positions.

[0060] The rotation of the shaft 22 during processing may be either continuous or discrete, such that corrugated, helical or other complex cuts may be formed without stopping the plant 1.

[0061] Nevertheless, the angular orientation of the head 2 with respect to the transverse direction Y may be also obtained in a non-dynamic manner, i.e. by inclining the elongate body 2 relative to the transverse direction Y at an angle that is kept constant during processing.

[0062] In an alternative configuration, as shown in Figs. 15 and 16, the nozzles 4 are mounted to the head 3 via respective sections 25 that are movable relative to the elongate body 21 along its main extension axis L.

[0063] The adjustment means 7 comprise third drive means 26 which act on the sections 25 to change their

mutual distance along the extension axis L, thereby adjusting the projection of the nozzles 4 on the vertical transverse plane π and hence the transverse distance d between cuts.

[0064] The third drive means 26 in turn comprise interface means 27 for selectively actuating each section 25 relative to the others and changing the relative distance between at least one pair of nozzles 4. The interface means 27 may be of mechanical type, i.e. a rack, or of electromechanical or electronic type or the like, without limitation.

[0065] Furthermore, in both configurations of Fig. 8 and Fig. 14, the adjustment means 7 may comprise fourth drive means 28 for imparting an inclination □ to the axis of rotation R relative to the vertical, to change the distance of the nozzles from the support base 2. The fourth drive means 28 may be associated directly with the head or with the rotating shaft 22 or the frame 10.

[0066] In a particularly advantageous configuration, the nozzles 4 of the central head 3 may have an outlet 29 with a maximum diameter ϕ preferably ranging from 0,15 mm to 0,60 mm and more preferably from 0,20 mm to 0,40 mm, e.g. of about 0,30 mm, to ,obtain jets J of very small sizes, and make very neat and accurate cuts.

[0067] The outlets 29 may be of any shape, e.g. of circular, elliptical, square, rectangular, polygonal or the like shape, without limitation, to obtain cuts of various shapes.

[0068] Furthermore, pressure regulator means 30 may be provided, for selective adjustment of the impact pressure of jets J on the products P being worked. The pressure regulator means 30 are conveniently associated with electronic control means, not shown, for selective interaction of the pressure regulator means 30 with the nozzles 4, such that the intensity of the individual jets J may be adjusted independently of one another.

[0069] This additional feature, as well as the relatively small size of the outflowing jets J will allow not only abstract decorative patterns, but also figurative patterns, text, barcodes, QR codes and the like, to be formed on the surface S being worked.

[0070] In a first embodiment, as shown in Fig. 17, the pressure regulator means 30 comprise deflector members 31 located downstream from each nozzle 4 to intercept the jet J and change the impact force on the surface S to be worked.

[0071] The deflector members 31 may be of mechanical or electromechanical type and may comprise a plate 32, which is designed to move between an inoperative position, external to the relevant jet J and an operative position in which the plate 32 at least partially obstructs the outlet 29 of the corresponding nozzle 4, thereby reducing the flow rate of the jet J and hence impact pressure.

[0072] In an alternative configuration, not shown, the deflector means may be of the compressed-air type, with respective nozzles arranged at the water jet nozzles 4, to blow a high-speed air flow to the jets J, and deflect the latter, thereby reducing impact pressure on the surface S to considerably reduce the cut.

[0073] In a further alternative configuration, also not shown, the pressure regulator means 30 may be associated with the feed means 5 and comprise a plurality of electronically controlled valves operatively connected to each nozzle 4 for selective adjustment of their feeding pressure.

[0074] In another embodiment not shown in the drawings, the water for feeding the nozzles 4 may be added with electrically polarizing materials, such as mineral salts, whereas the feed means 5 may comprise means for electrically charging the water that flows out of the nozzles. The pressure regulator means 30 may be in turn associated with an electric or electromagnetic field generator, which is adapted to deflect the electrically charged jets J, to impart a repulsive electric or electromagnetic force thereto.

[0075] Advantageously, the feed means 5 may be designed to draw the abrasive-free water of the emitted jets J and recirculate it after filtration, to convey it to the nozzles 4, thereby allowing recycling and avoiding water waste.

[0076] In yet another aspect of the invention, the pressure regulator means 30 may comprise fifth drive means, not shown, for selectively rotating the elongate body 21 about its main extension axis L and/or one or more of the nozzles 4, as schematically shown in Fig. 18, thereby allowing the jets J to be inclined to the vertical.

[0077] This configuration is particularly advantageous, as the jets J may be inclined to operate in the same direction as the longitudinal transfer direction X of the head 3, or in a direction opposite thereto, thereby further increasing the operativity of the plant 1.

[0078] All the above mentioned drive means may include mechanical, electromechanical, hydraulic, oil-hydraulic, pneumatic, manual or automated actuators, possibly controlled in an independent manner, and with procedures that are typical for this type of plants, and within the skill of the art.

[0079] Next, a method for liquid-jet surface working of semi-finished products made of a stone material or the like, that can be preferably but without limitation carried out using the above described plant 1, will be described.

[0080] The method basically comprises a step a) of providing a moving or stationary support base for the products P to be worked, a step b) of providing a plurality of nozzles 4 for generating jets J oriented toward the products P to be worked, a step c) of feeding the nozzles with a high-pressure liquid to create cuts on the products P being worked, a step d) of forwardly moving the products P relative to the nozzles 4 in a longitudinal direction X.

[0081] The nozzles 4 are placed in mutually offset positions with a predetermined pitch p in a transverse direction Y, and the method comprises a step e) of continuously adjusting the projection of their pitch p on a vertical plane □ substantially parallel to the transverse direction

Y, to change the transverse distance d between the longitudinal cuts made by the jets J.

[0082] Conveniently, the step c) of feeding the jets comprises feeding totally abrasive-free water, at a feeding pressure above 1500 bar.

[0083] The method may also comprise one or more additional steps of controlled displacement of the jets J relative to the product P being worked in one or more directions of translation and/or rotation, and a step of selective regulation of the impact pressure of jets, for carrying out all the operations as described above for the plant.

[0084] Particularly, the step e) of adjusting the pitch p of the nozzles 4 may comprise a step f) of joined rotation of the nozzles 4 about an axis of rotation R substantially orthogonal to the support base 2.

[0085] Alternatively, the pitch p may be adjusted by mutually transferring the nozzles 4 parallel to the transverse direction Y, possibly but not necessarily combining the above mentioned joined rotation about the axis R.

[0086] Furthermore, a step g) may be provided of selectively regulating the impact pressure of the jets J on the products P being worked, said step being carried out by deflecting the individual jets J such that they do not impact the surface S being worked or impact it with not enough energy to deform the material and/or by selectively stopping water feeding to the individual nozzles 4.

[0087] Furthermore, a step h) may be provided of inclining the jets J relative to the vertical to selectively change their distance from the support base 2.

[0088] Not the least, a step i) may be provided for recovering the feeding water of the emitted jets to recirculate and reuse it for feeding the nozzles 4, possibly after filtration, thereby creating a closed loop.

[0089] Thus, the use of simple water as a working fluid will not only ensure environmental friendliness of the method, but also provide the additional cost-saving advantage.

[0090] The above disclosure clearly shows that the plant of the invention fulfills the intended objects and particularly meets the requirement of allowing the formation of a multiplicity of well-defined decorative patterns on the surface of the products, which patterns may be of either abstract or figurative type, or possibly consist of text, barcodes, QR codes or the like.

[0091] The plant of the invention is susceptible of a number of changes and variants, within the inventive concept as disclosed in the appended claims. All the details thereof may be replaced by other technically equivalent parts, and the materials may vary depending on different needs, without departure from the scope of the invention.

[0092] While the plant has been described with particular reference to the accompanying figures, the numerals referred to in the disclosure and claims are only used for the sake of a better intelligibility of the invention and shall not be intended to limit the claimed scope in any manner.

Claims

1. A plant for surface working of semi-finished products made of a stone or the like base material using abrasive-free liquids jets, comprising:

   - a moving or stationary support base (2) for a product (P) to be worked;
   - a head (3) facing said support base (2) and having a plurality of nozzles (4, 4', 4",...) for generating jets (J) oriented toward the surface of the product (P) to be worked;
   - feed means (5) for feeding said nozzles (4, 4', 4",...) with a high-pressure liquid to create cuts on the product (P) being worked;
   - first drive means (6) for moving the product (P) relative to said head (3) along a longitudinal direction (X);

   characterized in that said nozzles (4, 4', 4",...) are mutually offset in a transverse direction (Y) with a predetermined pitch (p), adjustment means (7) being associated with said nozzles (4, 4', 4",...) for continuously adjustment of the projection of their pitch (p) on a vertical plane (π), substantially parallel to said transverse direction (Y) during operation to change the transverse distance (d) between the longitudinal cuts made by said jets (J).

2. Plant as claimed in claim 1, wherein said working liquid is water without abrasives and wherein said pressure is higher than 1500 bar.

3. Plant as claimed in claim 1 or 2, wherein said head (3) comprises an elongate body (21) on which said nozzles (4, 4', 4",...) are mounted in mutually offset positions and with jets (J) oriented toward the product (P) being worked, said elongate body (21) being fixed to a support shaft (22) journalled supported on a substantially horizontal frame (10) to pivot about a rotation axis (R) substantially orthogonal to said elongate body (21).

4. Plant as claimed in claim 3, wherein said adjustment means (7) interact with said rotating shaft (22) to promote the rotation of this latter with about said first axis (R), with consequent variation of the projection of the pitch (p) and of the relative distance (d) between the cuts on said vertical plane (π).

5. Plant as claimed in claim 3 or 4, wherein said frame (10) is mounted on a substantially transverse beam (11) movable along substantially longitudinal guides (13) fixed on a supporting frame (8) stationary with respect to said support base (2), second drive means (20) being provided for moving said head (3) relative to said support base (2) along said beam (11).

6. Plant as claimed in claim 5, wherein said elongate body (21) defines a main extension direction (L), said nozzles (4, 4', 4",...) being mounted on said head (3) through respective sections (25) movable relative to said elongate body (21) along said main extension direction (L), third moving means (26) being provided which act on said sections (25) to change their mutual distance along said extension direction (L).

7. Plant as claimed in claim 6, wherein said third moving means (26) comprise interface means (27) to selectively actuate each single section (25) with respect to the others and to vary the relative distance between at least one pair of said nozzles (4, 4', 4",...).

8. Plan as claimed in any claim from 3 to 7, wherein said adjustment means (7) comprise fourth drive means (28) to impart an inclination (χ) of said rotation axis (R) relative to the vertical, in such a manner to change the projection of the distance of said nozzles (4, 4', 4",...) with respect to said support base (2).

9. Plant as claimed in any preceding claim, wherein said nozzles (4, 4', 4",...) have an outlet port (29) with a maximum diameter (ϕ) ranging from 0,15mm to 0,60mm, preferably from 0,20mm to 0,40mm and more preferably close to 0,30mm.

10. Plant as claimed in any preceding claim, wherein regulator means (30) are provided to selectively adjust the impact pressure of the jets (J) on the product (P) being worked.

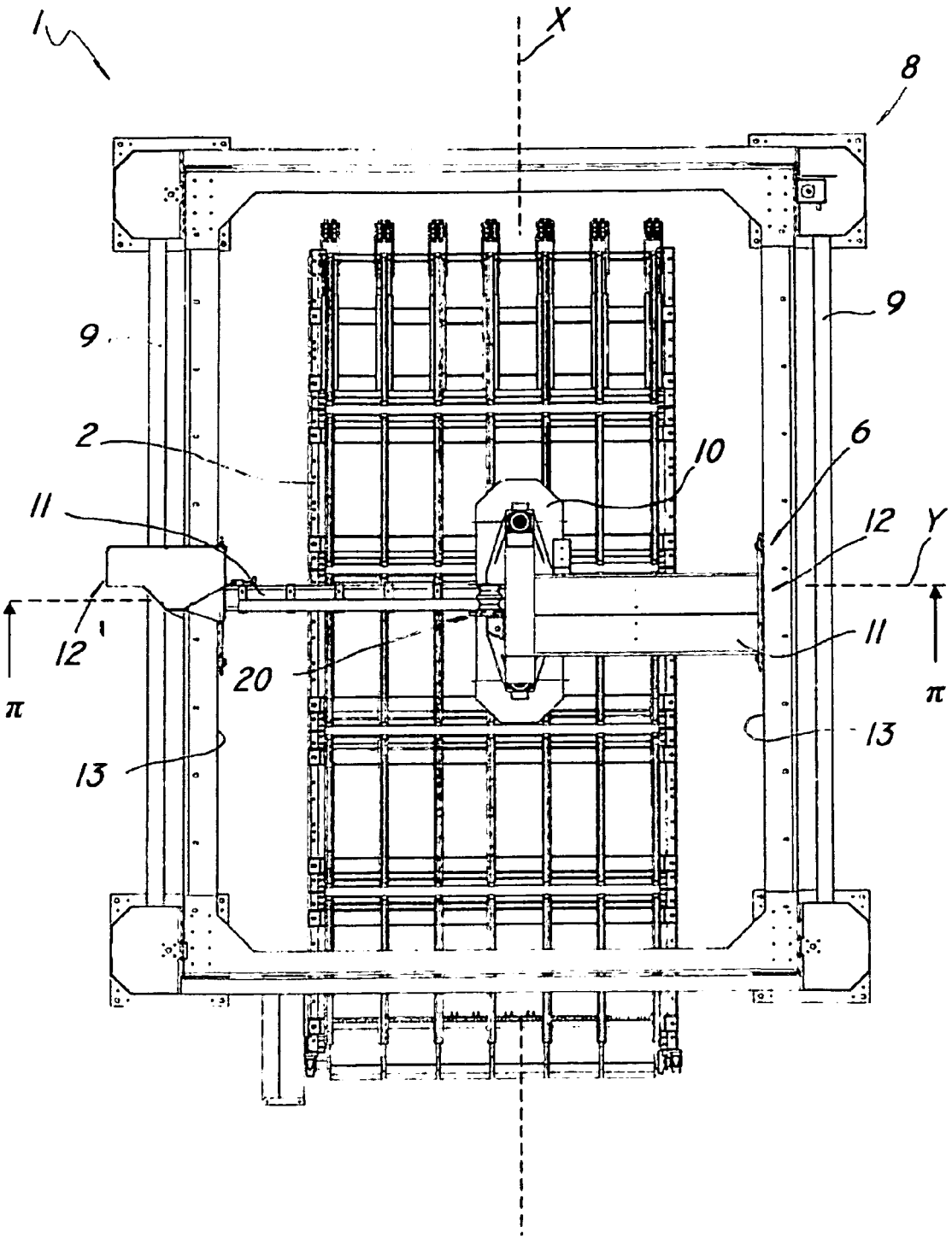

FIG. 1

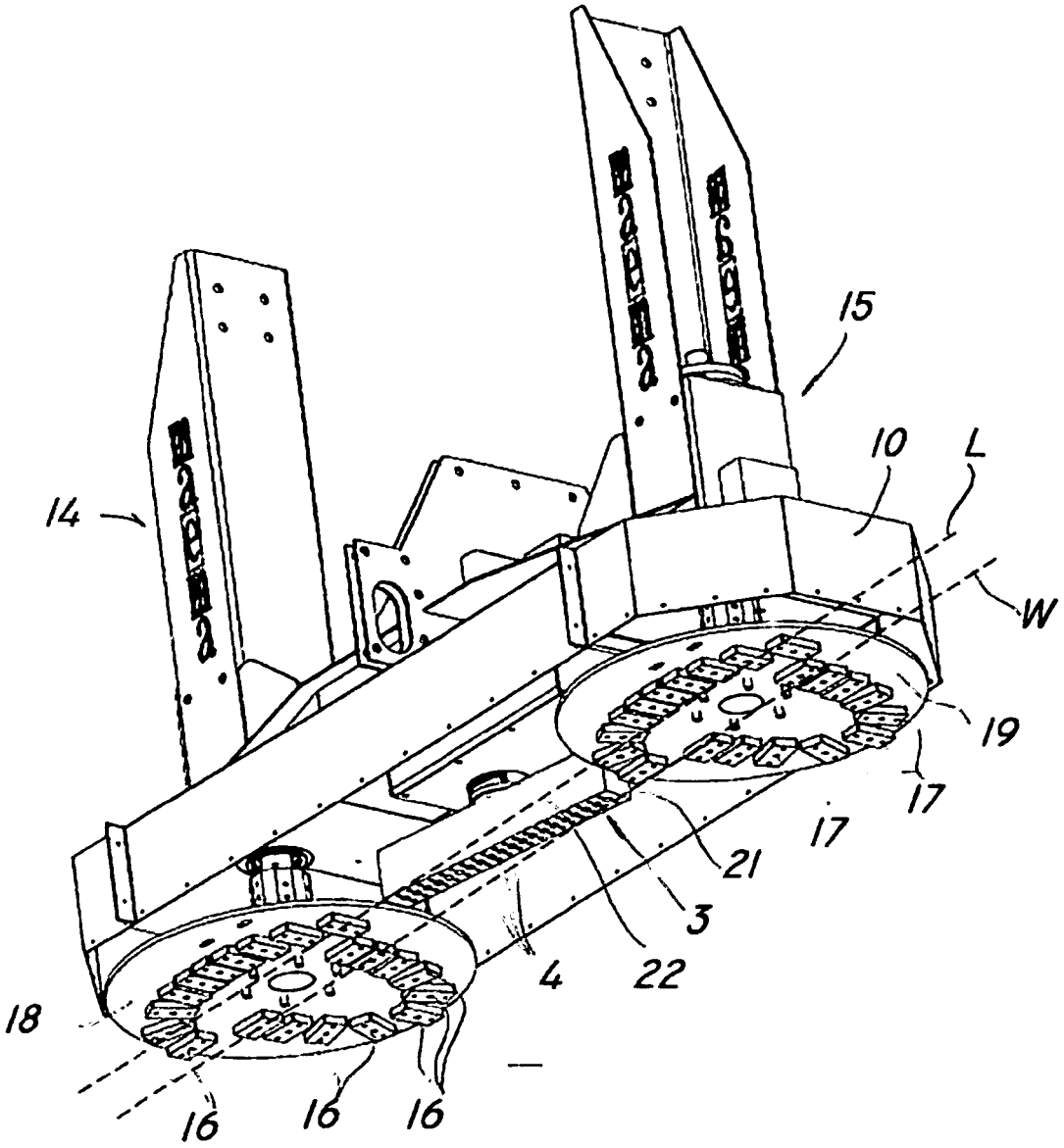

FIG. 2

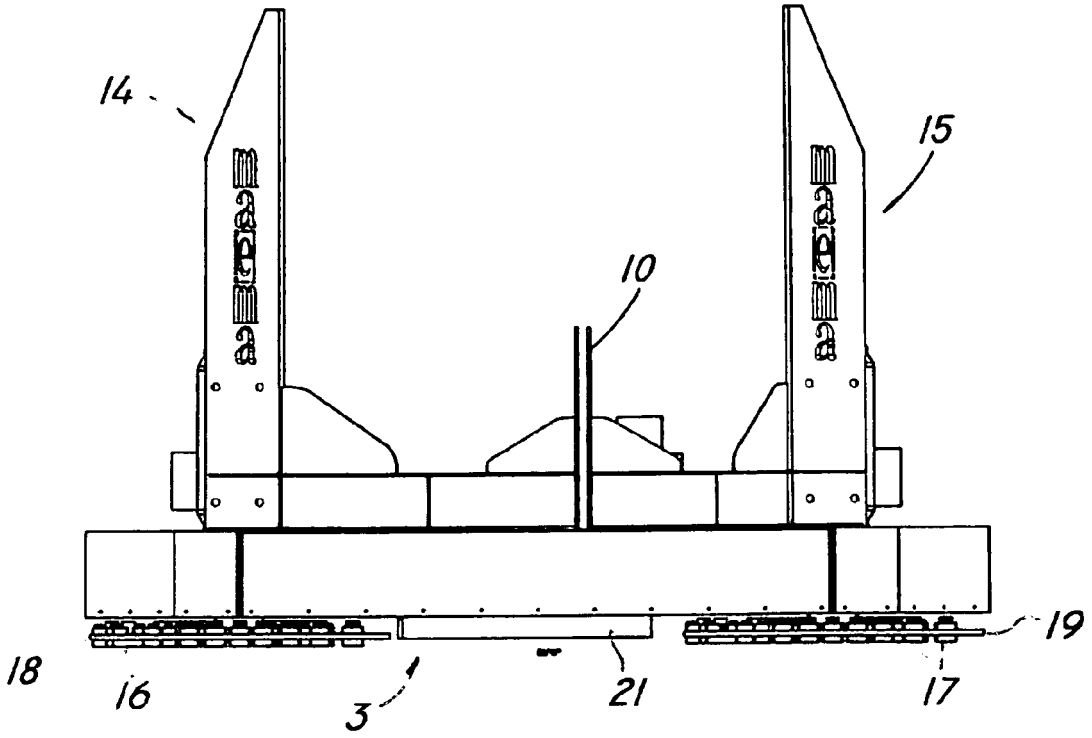

FIG. 3

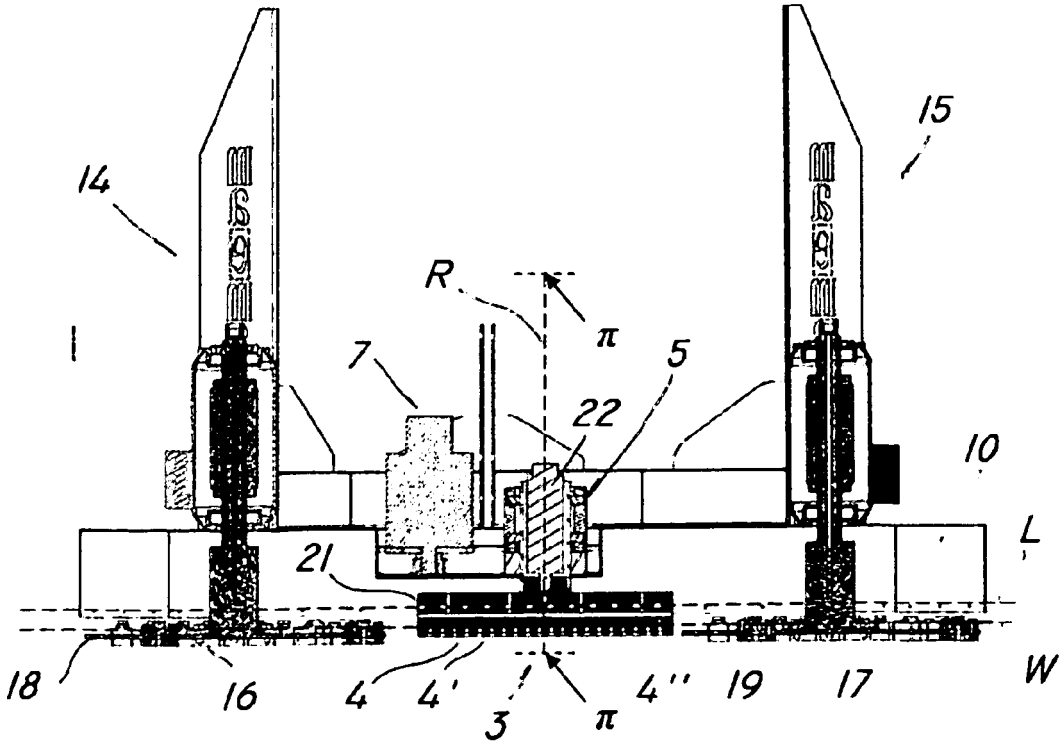

FIG. 4

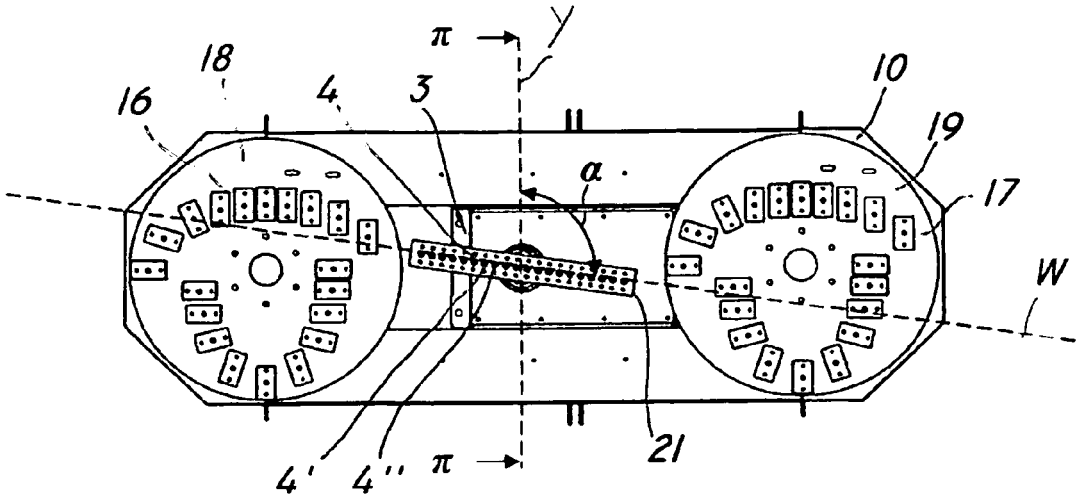

FIG. 5

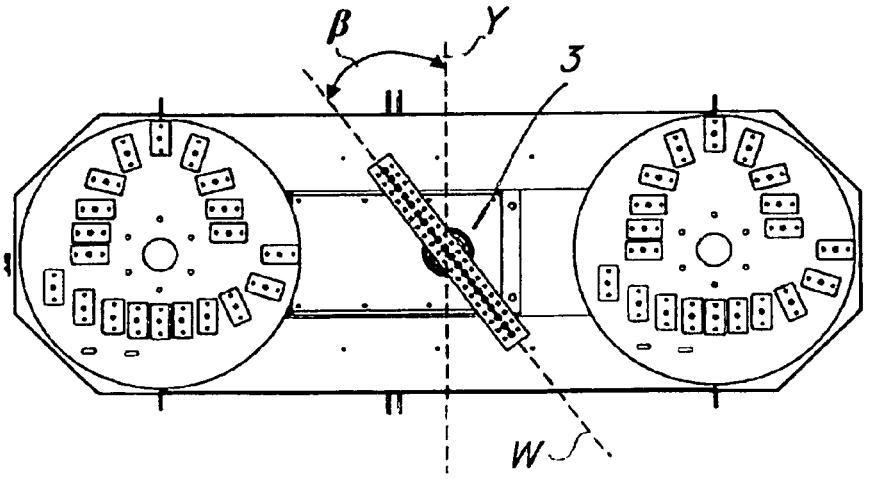

FIG. 6

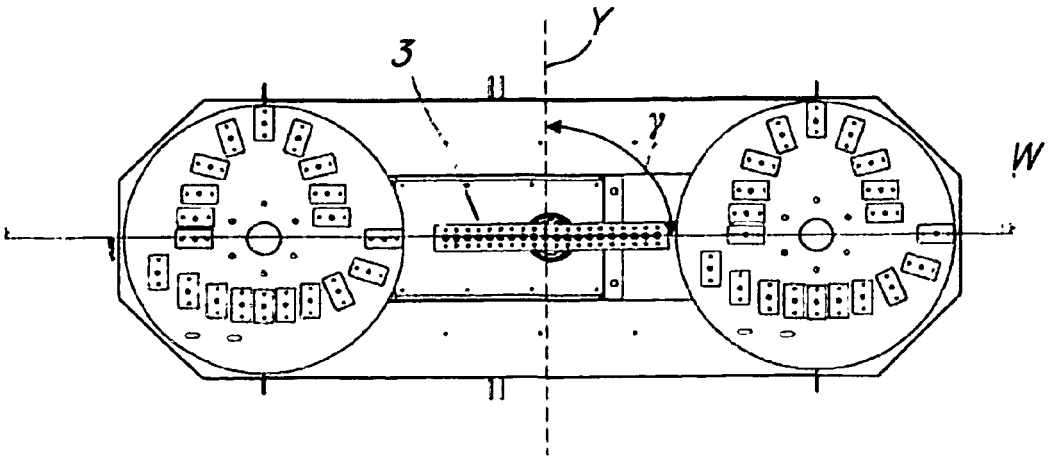

FIG. 7

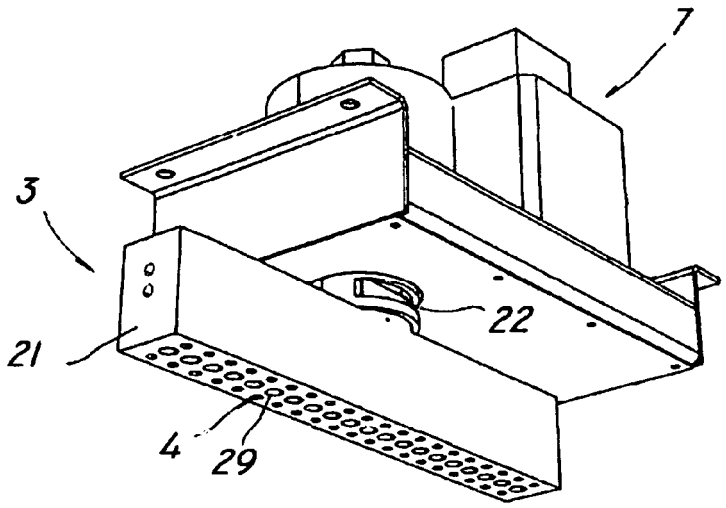

FIG. 8

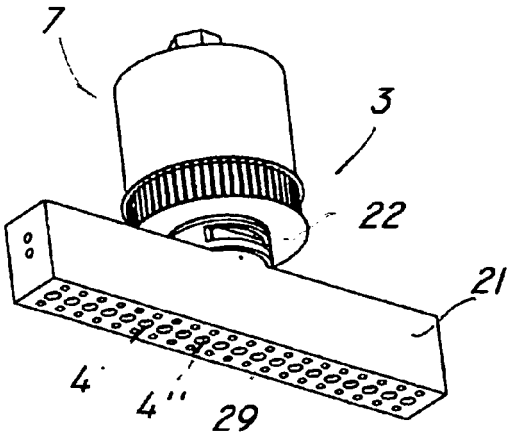

FIG. 9

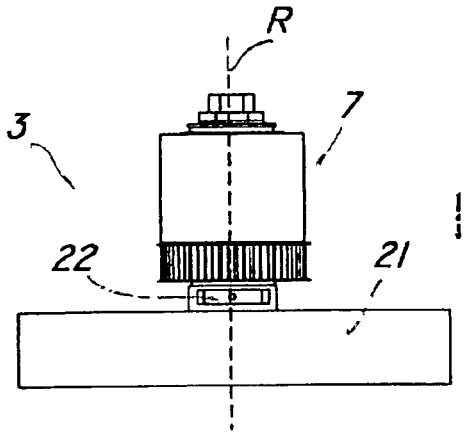

FIG. 10

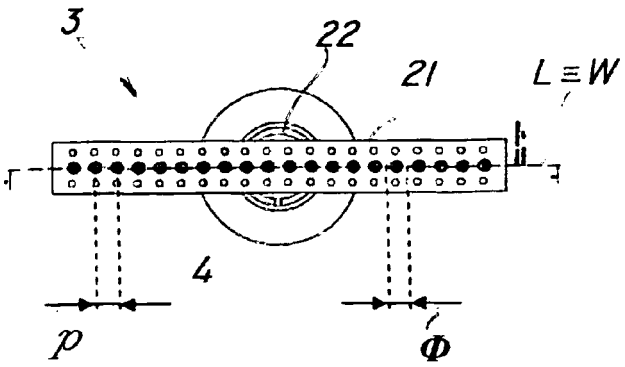

FIG. 11

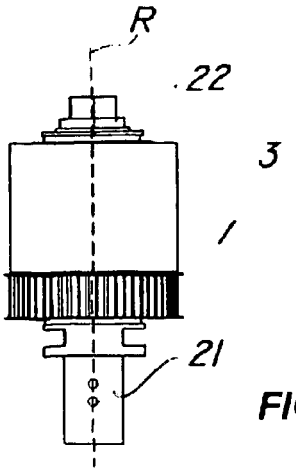

FIG. 12

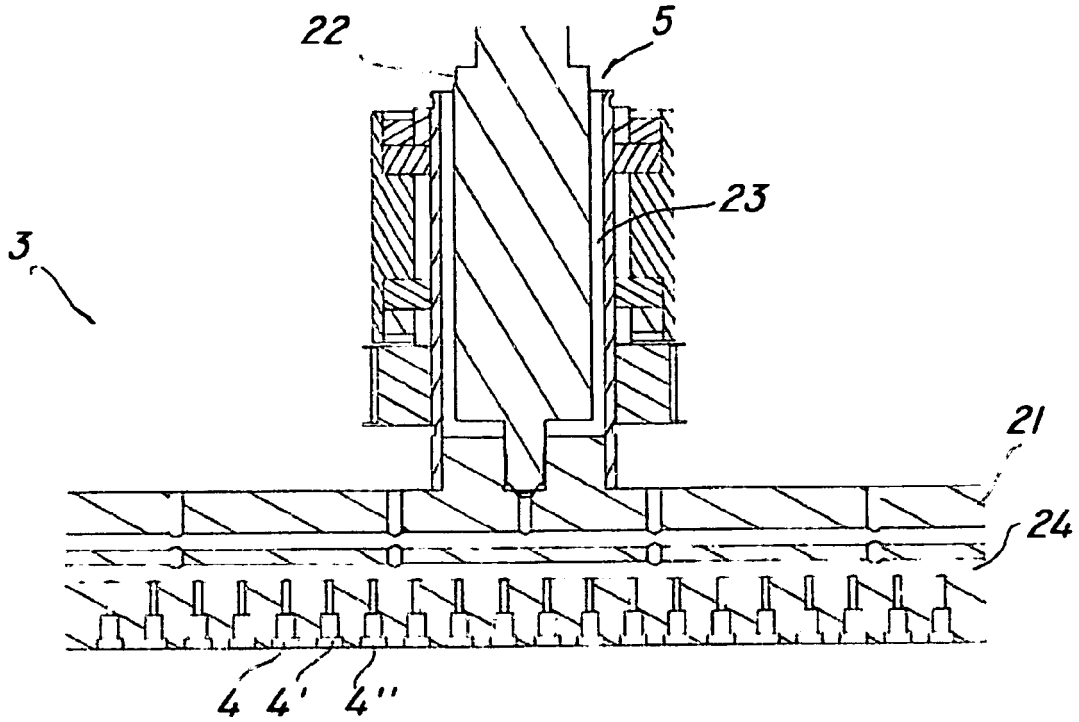

FIG. 13

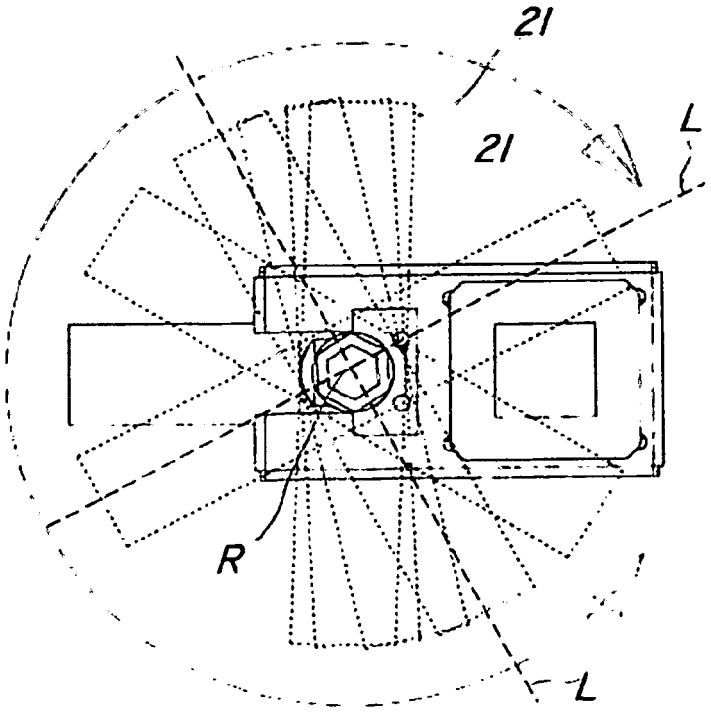

FIG. 14

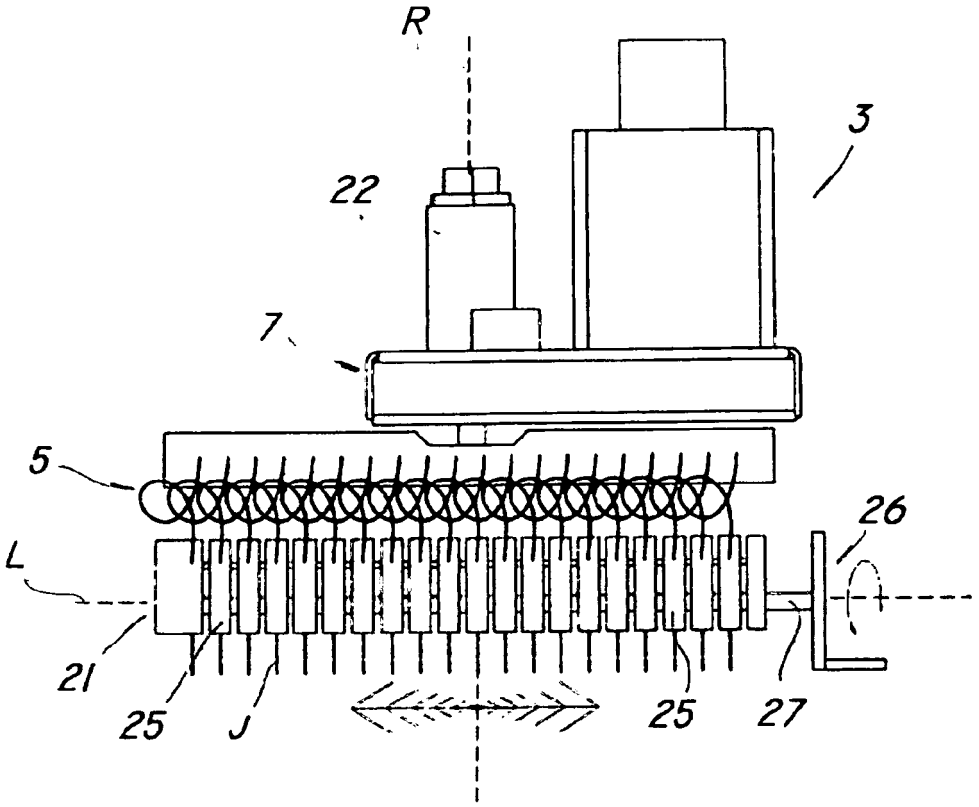

FIG. 15

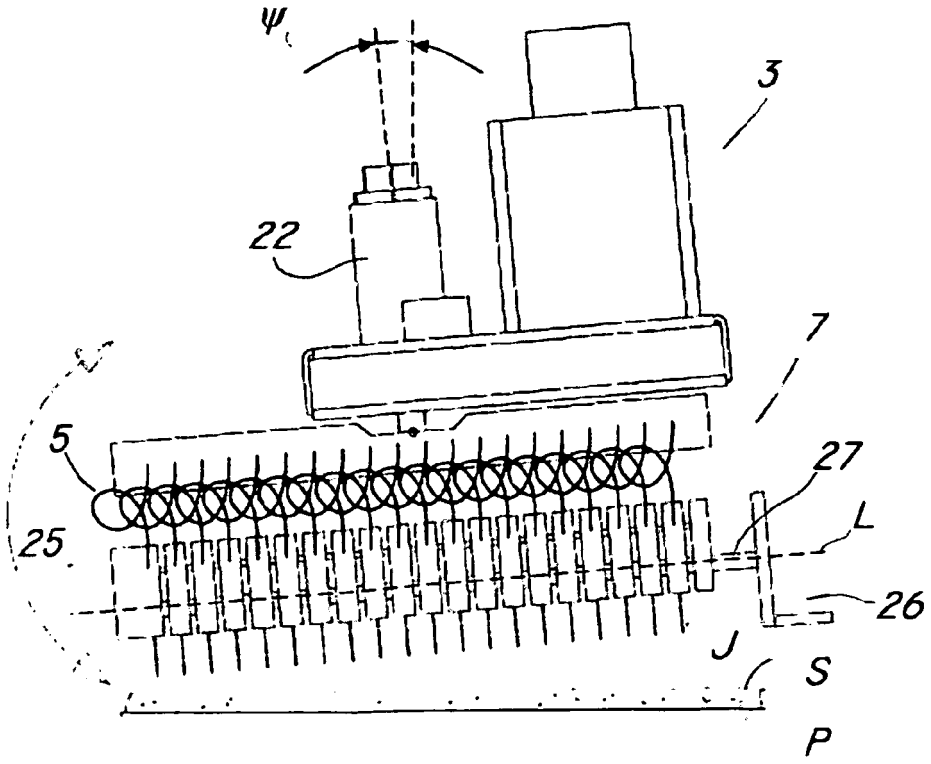

FIG. 16

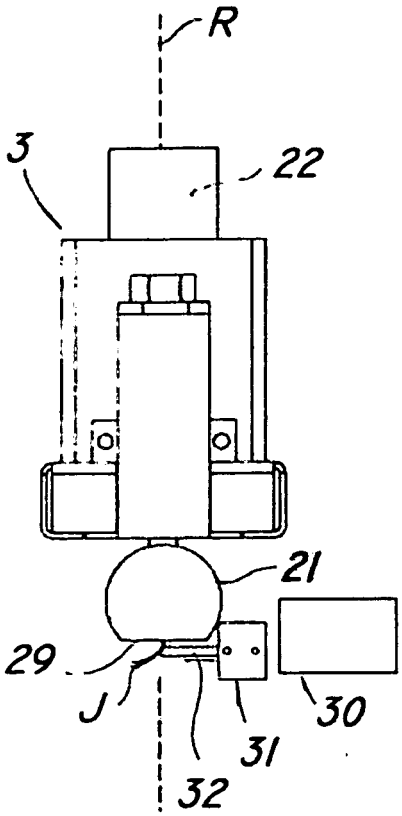

FIG. 17

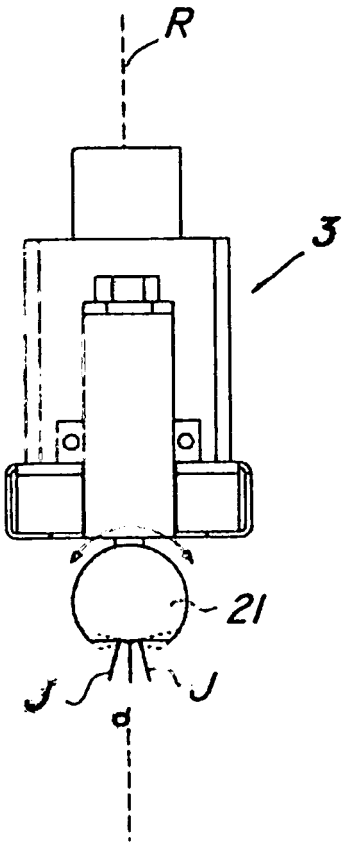

FIG. 18

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 October 2013	Chariot, David

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