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(54) ENGRAVING DEVICE FOR RELATIVELY FRAGILE MATERIAL SLABS AND ENGRAVING METHOD THEREOF

(57) A device (1) for engraving slabs (L) of relatively fragile material, such as ceramic or glass, adapted for use in combination with a multiaxial machine tool having a working head (2) placed above a substantially horizontal support surface (P), wherein the head (2) comprises a fork (3) movable along three Cartesian axes (X, Y, Z) and rotatable around a vertical axis (Z) and adapted to support a working unit (4). The device (1) comprises a movable member (8) operatively associable to the fork (3) and having at its lower end a rolling tool (9) with a substantially horizontal rotation axis ($\mathbf{R_2}$), configured to engrave a slab (L) resting on the support surface (P) along a predetermined engraving path. A method for engraving slabs (L) of relatively fragile material, such as ceramic and glass, using the device (1).

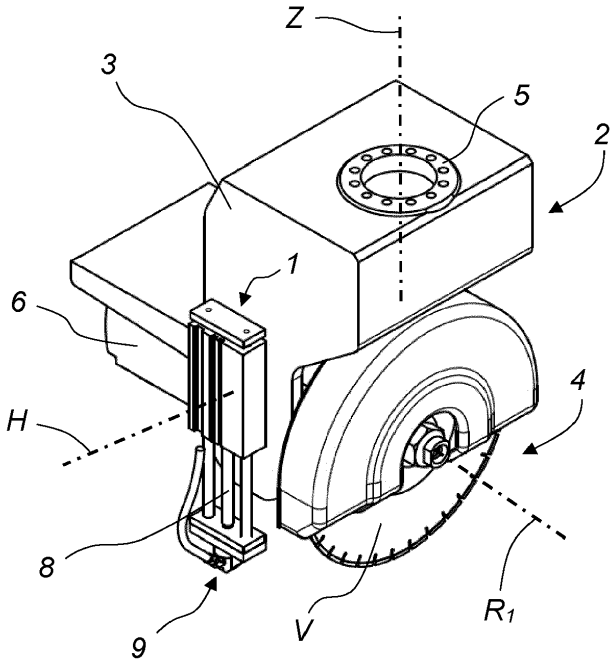

FIG. 1

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Description

Technical field

[0001] The present invention generally finds application in the technical field of processing slabs of relatively fragile material and particularly relates to a device for engraving ceramic or glass slabs, suitable for use in combination with a multiaxial machine tool having a working head.

[0002] The invention also relates to a method for engraving slabs of relatively fragile material using the aforementioned device.

Background art

[0003] It is long known in the field of processing slabs of relatively fragile materials, such as ceramic or glass to use devices for engraving or pre-cutting the upper surface of the slab.

[0004] Generally, these devices have a handle suitable for being gripped by an operator and at the end thereof a high hardness tool is mounted, suitable for being pressed against the slab and moved along its surface to engrave this latter.

[0005] Hence, the processing of the slab using this device and any further handling, loading, unloading and/or transfer of the products under processing from one working area to another is carried out manually.

[0006] In the field of processing slabs, it is also known the use of machine tools comprising a portal structure designed to delimit a working area and at least one horizontal beam on which a head for processing the slabs is slidingly mounted.

[0007] Usually, in the cutting processing of slabs of stone material, the machine tool comprises a carriage sliding on the main beam and a cutting head movable above the slab with an electrospindle to which a disk-shaped tool for cutting the slab is rotatably associated.

[0008] The machine tool can be equipped with automatic devices for handling the slabs, loading/unloading and/or transferring the products being processed from one area to another to allow automatic processing.

[0009] Furthermore, the cutting head is configured to be coupled to other types of tools, e.g., a chamfering tool with an appropriately shaped grinding wheel.

[0010] Nonetheless, a drawback of this solution is that the machine tool can be used for processing slabs in stone material, such as marble or granite, but not for processing slabs of relatively fragile material such as ceramic or glass.

[0011] Hence, the processing of slabs made of different materials requires having two different machine tools, one for stone materials and one for relatively fragile materials, with a consequent increase in operating costs.

[0012] In an attempt to at least partially obviate this drawback, machine tools have been developed for the automatic engraving of slabs of relatively fragile material adapted to be used in combination with machine tools for slabs of stone material in order to allow processing of both glass and stone slabs.

[0013] This combination is carried out by means of portal machine tools comprising a pair of side-by-side carriages sliding on the main beam and respectively provided with a cutting head for slabs in stone material and a device for engraving slabs of relatively fragile material.

[0014] Nonetheless, this solution has a greater constructive complexity which results in significant increase in manufacturing and operating costs of the machine tool.

[0015] Therefore, the is a need to conceive and make available a device for engraving or pre-cutting slabs of relatively fragile material, such as ceramic or glass, suitable for use in combination with a multiaxial machine tool having a working head equipped with a disk-like tool for cutting stone materials.

Technical problem

[0016] In view of the prior art, the technical problem addressed by the present invention consists in engraving slabs of relatively fragile material with a machine tool normally used for cutting stone materials thus limiting the construction and management costs of the machine as a whole.

Disclosure of the invention

[0017] The object of the present invention is to solve the aforementioned problem by providing a device for engraving slabs of relatively fragile material that is highly efficient and relatively cost effective.

[0018] A particular object of the present invention is to provide a device of the above-described type that is suitable for use in combination with a multiaxial machine tool for cutting stone materials, such as marble and granite.

[0019] A further particular object of the present invention is to provide a device of the above-described type that makes the engraving processing of the slabs particularly quick and simple.

[0020] Another object of the present invention is to provide a device of the above-described type that allows a slab to be engraved automatically and by pure rolling along a predetermined path.

[0021] A further object of the present invention is to provide a device of the above-described type that allows to adjust the engraving pressure of the slab and to engrave it uniformly along the entire engraving path.

[0022] Another object of the present invention is to provide a device and a method of the above-described type that do not require particular skills from an operator assigned to its management.

[0023] A further object of the present invention is to provide a device of the above-described type that allows to adjust the incision thickness of the slab.

[0024] Another object of the present invention is to provide a device and a method of the above-described type

that allow slabs of relatively fragile material to be processed at a high speed.

[0025] A further object of the present invention is to provide a device of the above-described type that allows dry engraving of slabs of relatively fragile material.

[0026] These and other objects, as more clearly explained hereafter, are fulfilled by a device for engraving slabs of relatively fragile material, such as ceramic or glass, adapted for use in combination with a multiaxial machine tool having a working head placed above a substantially horizontal support surface, as defined in claim 1.

[0027] The head comprises a fork movable along three Cartesian axes which is rotatable around a vertical axis and adapted to support at least one work unit, and the device comprises a movable member operably associable with the fork of the machine tool and which has at its lower end a rolling tool with a substantially horizontal rotation axis, configured to engrave by rolling a slab resting on the support surface along a predetermined engraving path.

[0028] Furthermore, the rolling tool comprises an adapter designed to be anchored to the lower end of the movable member and a wheel idly pivoted on the adapter.

[0029] The adapter is anchored to the lower end of the movable member in a floating manner, with freedom of rotation around a second substantially vertical axis of the movable member in such a manner to engrave the material being processed along the predetermined path while the fork is two-dimensionally moved along said horizontal Cartesian axes.

[0030] Advantageously, the device comprises actuator means acting on the adapter to push the wheel downwards along a substantially vertical direction and vary the engraving pressure of the wheel.

[0031] Thanks to this combination of features a slab of relatively fragile material can be engraved, while simplifying the processing and making the engraving operations particularly quick.

[0032] The invention also relates to an engraving method using the aforementioned device, as defined in claim 13.

[0033] Advantageous embodiments of the invention are obtained as defined in the dependent claims.

Brief description of the drawings

[0034] Further features and advantages of the invention will become more apparent in the light of the detailed description of a preferred, non-exclusive embodiment of a device for engraving plates of relatively fragile material described as a non-limiting example with the help of the annexed drawings, in which:

FIGS. 1 and **2** are perspective views of a working head of a multiaxial machine tool provided with the device according to the invention, in a first and second operating positions respectively;

FIGS. 3 and **4** are side views of the working head of Fig. 1 and Fig. 2 respectively;

FIG. 5 is a perspective view of the device of Fig. 1 in a first embodiment;

FIGS. 6 and **7** are an enlarged front view and an enlarged side view of the device of Fig. 5 respectively;

FIG. 8 is a perspective view of the device of Fig. 1 in a second embodiment;

FIGS. 9 and **10** are an enlarged front view and an enlarged side view of the device of Fig. 8 respectively.

Detailed description of a preferred exemplary embodiment

[0035] Particularly referring to the figures, a device is shown, generally designated by numeral **1,** for engraving slabs **L** of relatively fragile material, such as ceramic or glass.

[0036] The device **1** is adapted for use in combination with a multiaxial machine tool, not shown in the figures, for example of the portal type, which comprises a substantially horizontal main beam movable along first longitudinal guide means anchored to the ground.

[0037] The machine comprises a working head **2** slidingly mounted on the main beam and placed above a substantially horizontal support surface **P.**

[0038] The machine tool with its working head **2** can be used to cut or shape slabs in stone materials, such as marble, stone, granite, stone, cement or ceramic conglomerates, following cutting paths controlled by the PLC unit of the machine.

[0039] In detail, head **2** comprises a fork **3** movable along three Cartesian axes **X, Y, Z** integral with the support surface **P** and rotatable around a first vertical axis **Z** and adapted to support at least one working unit **4** for cutting stone slabs.

[0040] For this purpose, the fork **3** can comprise a flange **5** which can be coupled to rotation means, not shown in the figures, configured to impart to the working unit **4** a rotation around the **Z** axis to vary its cutting direction.

[0041] The working unit **4** comprises at least one electrospindle **6** provided with a disk-shaped tool **V** for cutting the slabs of stone material and coupled to the fork **3** in such a manner to rotate around a first rotation axis $\mathbf{R_1}$ which is substantially horizontal and perpendicular to the vertical axis **Z,** as better depicted in **FIGS. 1** and **2.**

[0042] Conveniently, the electrospindle **6** can be rotatably mounted on the fork **3** so that it can be tilted around an inclination axis **H** which is also horizontal and perpendicular to the first rotation axis $\mathbf{R_1}$.

[0043] Thus, the electrospindle **6,** and therefore the tool **V** of the working unit **4,** il tiltable with respect to the support surface **P** to allow the performance of inclined cuts or material removal machining, such as contouring and/or chamfering.

[0044] In some embodiments, not shown in the drawings, the working unit **4** can be equipped with further cutting means other than the disk-shaped tool, for example with high-pressure water jets or with drilling bits, also tiltable unitary with the electrospindle around the inclination axis **H.**

[0045] Optionally, the fork **3** can also be combined with a manipulator device of the suction cup type for handling the slabs on the support surface **P.**

[0046] Moreover, the support surface **P** of the machine tool for the slabs to be processed may have a fixed or movable supporting surface.

[0047] In one embodiment of the machine tool, not shown in the figures, head **2** can be mounted on the main beam and the support surface **P** for the slabs may have a surface that is rotatable around a vertical axis to facilitate the orientation of the product being processed with respect to the working head **2** and to the engraving device **1.**

[0048] According to the invention, the slab **L** of relatively fragile material is arranged on the support surface **P** to have a substantially flat upper surface L_A of the slab facing upwards and facing the working head **2,** a lower surface L_B resting to the support surface **P,** and a thickness **s** of predetermined and substantially constant sizes.

[0049] Advantageously, the device **1** comprises a movable member **8** operatively associable to the fork **3** and having at its lower end a rolling tool **9** with a second substantially horizontal axis of rotation R_2, configured to engrave by rolling a slab **L** resting on the support surface **P** along a predetermined engraving path.

[0050] In this way, during the movement of the head **2** along a predetermined path, the rolling tool **9** is free to rotate due to the contact with the upper surface L_A of the slab **L** to engrave an incision line.

[0051] Thus, by means of a single working head **2** equipped with the device **1** it is possible to process both the normal slabs of stone material and slabs **L** of relatively fragile material without replacing the head **2** or move processing to another machine tool.

[0052] Similarly, by means of the working head **2** in combination with the device **1** it will be possible to carry out a greater number of working operations on the same slab **L** of relatively fragile material, such as, for example, a first abrasion operation of a ceramic slab **L** by means of the disk-shaped tool **V** and a second engraving operation by means of the rolling tool **9,** as well as the subsequent breaking by tensioning along the engraving path.

[0053] It is apparent that the combination of the device **1** and the working head **2** makes the machine tool extremely versatile.

[0054] Conveniently, the movable member **8** protrudes laterally from the fork **3** so as to selectively extend downwards, along a vertical direction or a second vertical axis **W,** and without interfering with the working unit **4.**

[0055] Hence, the movable member **8** can move between an inoperative position in which the rolling tool **9** does not interact with the slab **L,** as shown in **FIGS. 2** and **4,** and an operating position in which the tool **9** is in contact with the slab **L,** as shown in **FIGS. 1** and **3.**

[0056] Suitably, the movable member **8** is coupled to actuator means **10** adapted to promote movement thereof towards the slab L and/or along the vertical direction **W and** selected from the group comprising pneumatic or hydraulic actuators, worm screw, pinion and rack, linear motors or similar systems.

[0057] These actuator means **10** comprise a fixed part positioned on a side plate **12** of the fork **3** and a movable part provided by the member **8.**

[0058] In the embodiment illustrated in the figures, the actuator means **10** comprise a pneumatic cylinder having a fixed part or jacket **11** anchored to the side plate **12** and a movable part comprising a stem, wherein in the fixed part **11** there is a provided a pressure chamber, not visible in the figures, in which a piston, also not visible in the figures, integral with the member **8** slides.

[0059] Preferably, the actuator means **10** are associated with guide means **13** to accurately guide the movable member **8** in its vertical movement.

[0060] In one embodiment, the guide means **13** comprise a pair of cylindrical or prismatic guides **13', 13"** adapted to keep the movable member **8** perpendicular to the support surface **P** during its vertical movement and during the rotation of the rolling tool **9.**

[0061] In a preferred embodiment, the rolling tool **9** comprises an adapter **14** which is anchorable to the lower end of the movable member **8** and a wheel **15** idly pivoted on the adapter **14** and rotatable around the second rotation axis R_2.

[0062] In use, the member **8** acts on the adapter **14** to push the wheel **15** downwards along the substantially vertical direction **W** in such a manner to vary and adjust the engraving pressure of the wheel **15** as well as the engraving thickness of the slab **L** to engrave the latter uniformly and along a predetermined path.

[0063] Preferably, the adapter **14** may be provided with a fitting **16** connected to a supply pipe **17** of a lubricating or refrigerant fluid in order to reduce the frictional forces and the rolling resistance of the wheel **15.**

[0064] In the embodiment illustrated in **FIGS. 1-7,** the adapter **14** is integral with the lower end of the movable member **8** to engrave the relatively fragile material being processed along the predetermined path while the fork **3** is moved along the Cartesian axes **X, Y** and rotated around the first vertical axis **Z.**

[0065] In one mode of use of the device **1,** it will be sufficient to integrally rotate the fork **3** of the machine tool to trace predetermined and not straight engraving paths.

[0066] Preferably, as shown in **FIGS. 8-10,** the adapter **14** is anchored to the lower end of the movable member **8** in a floating manner, i.e., with freedom of rotation around the substantially vertical axis **W** during the dragging with respect to the material being processed along the predetermined path while the fork **3** is moved only along the Cartesian axes **X, Y.**

[0067] In such a manner, the substantially horizontal

axis R_2 of the wheel **15** does not intersect the second vertical axis **W** and is offset with respect to the latter by a predetermined distance **d,** as better illustrated in **FIG. 10.**

[0068] As better illustrated in the figures, the wheel **15** is hinged on the adapter **14** with minimal friction and has a substantially circular peripheral cutting edge.

[0069] The peripheral cutting edge can be made of a material selected from the group comprising tungsten carbide, titanium carbide, tantalum carbide, industrial diamond, or a combination thereof.

[0070] First sensor means are also provided, not shown in the figures, for detecting and controlling the pressure exerted by the movable member **8** on the wheel **15** and therefore the incision force on the relatively fragile material being processed.

[0071] The first sensor means can comprise an adjustable pressure switch associated with the actuator means **10.**

[0072] In the embodiment illustrated in the figures, the pressure switch can be interposed between the pressure chamber of the pneumatic cylinder and a source of pressurized fluid.

[0073] Conveniently, the device **1** can be provided with second sensor means, not shown in the figures, for detecting the position of the movable member **8** with respect to the upper surface L_A of the slab **L.**

[0074] Advantageously, the adjustable pressure switch and the second sensor means are associated with an electronic control unit adapted to vary the engraving pressure of the wheel **15** as a function of the relatively fragile material being processed and the thickness **s** of the slab **L** to be engraved or pre-cut.

[0075] Further, it will be sufficient to exert a manual or automatic tensioning of the material to be processed along the predetermined engraving path in order to carry out the final cut.

[0076] According to a further aspect of the invention, it is provided a method for engraving slabs **L** of relative fragile material, such as ceramic and glass, by means of a device **1** of the above-described type.

[0077] The method according to the invention comprises the following steps:

- positioning a slab **L** of relatively fragile material to be processed on the support surface **P;**
- connecting the movable member **8** to pressure adjustment means;
- anchoring to the lower end of the movable member **8** an adapter **14** in a floating manner, with freedom of rotation around a second substantially vertical axis **W** of the movable member **8;**
- providing a wheel **15** idly pivoted on the adapter **14;**
- moving the movable member **8** downwards in order to bring the rolling tool **9** into contact with the material to be engraved;
- actuating the pressure adjustment means to exert on the wheel **15** a predetermined engraving force as a function of the material and thickness of the material to be engraved;
- two-dimensionally moving the head **2** and the fork **3** so as to make an incision along the predetermined path by rolling the wheel **15;**
- tensioning the material along the engraving path to carry out the final cut of the material being processed.

[0078] It is apparent from the foregoing, that the engraving device **1** and the related engraving method achieve the intended purposes and in particular allow to simplify the processing and the engraving operations particularly quick.

[0079] The device and the method according to the invention are susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept expressed in the appended claims.

[0080] Although the device and the method have been described with particular reference to the attached figures, the reference numbers used in the description and in the claims are used for the sake of a better intelligibility of the invention and shall not be intended to limit the claimed scope in any manner.

[0081] Reference here to "an embodiment" or "the embodiment" or "some embodiment" indicates that a particular feature, structure or element described is included in at least one embodiment of the inventive subject matter.

[0082] Furthermore, the particular features, structures or elements can be combined together in any suitable manner to provide one or more embodiments.

Industrial applicability

[0083] The present invention might find application in industry, because it can be realized on an industrial scale by industries belonging to the field of processing relatively fragile materials.

Claims

1. A device **(1)** for engraving slabs **(L)** of relatively fragile material, such as ceramic or glass, adapted for use in combination with a multiaxial machine tool having a working head **(2)** placed above a substantially horizontal support surface **(P);**

wherein said head **(2)** comprises a fork **(3)** movable along three Cartesian axes **(X, Y, Z)** and rotatable around a first vertical axis **(Z)** for supporting at least one working unit **(4);**
wherein said device **(1)** comprises a movable member **(8)** operatively associable to said fork **(3)** and having at the lower end thereof a rolling tool **(9)** with a substantially horizontal rotation axis (R_2), configured to engrave by rolling a slab **(L)** resting on said support surface **(P)** along a

predetermined engraving path;
characterized in that said rolling tool **(9)** comprises an adapter **(14)** adapted to be anchored to the lower end of said movable member **(8)** and a small wheel **(15)** idly pivoted on said adapter **(14),** said adapter **(14)** being anchored at the lower end of said movable member **(8)** in a floating manner, with freedom of rotation around a second substantially vertical axis **(W)** of said movable member **(8)** so as to engrave the material being processed along the predetermined path while said fork **(3)** is moved two-dimensionally along said horizontal Cartesian axes **(X, Y).**

2. Device as claimed in claim 1, wherein said movable member **(8)** projects laterally from said fork **(3)** so as to extend downwards without interfering with said working unit **(4).**

3. Device as claimed in claim 1, wherein said wheel **(15)** is pivoted on said adapter **(14)** with minimum friction and has a substantially circular peripheral cutting edge.

4. Device as claimed in claim 3, wherein at least said peripheral cutting edge is made of a material selected from the group comprising tungsten carbide, titanium carbide, tantalum carbide, industrial diamond or a combination thereof.

5. Device as claimed in claim 1, wherein said adapter **(14)** is integral with the lower end of said movable member **(8)** so as to engrave the material being processed along the predetermined path while said fork **(3)** is moved along the two horizontal Cartesian axes **(X, Y)** and rotated around the third vertical Cartesian axis **(Z).**

6. Device as claimed in claim 1, wherein the substantially horizontal axis (R_2) of said wheel **(15)** is offset with respect to said second vertical axis **(W)** of said movable member **(8)** by a predetermined distance **(d).**

7. Device as claimed in claim 1, wherein first sensor means are provided for detecting and controlling the pressure exerted by said movable member **(8)** on said wheel **(15)** and therefore of the incision force on the material being processed.

8. Device as claimed in claim 1, wherein said movable member **(8)** is coupled to actuator means **(10)** adapted to promote its movement towards the slab **(L)** and selected from the group comprising pneumatic or hydraulic systems, worm screw, pinion and rack, linear motors or similar systems, said actuator means **(10)** having a fixed part positioned on a side plate **(12)** of said fork **(3).**

9. Device as claimed in claim 8, **characterized in that** it comprises guide means **(13)** associated with said actuator means **(10)** for precisely guiding said movable member **(8)** along said vertical direction.

10. Device as claimed in claim 7, wherein said first sensor means comprise an adjustable pressure switch associated with said actuator means **(10).**

11. Device as claimed in claim 10, wherein said adjustable pressure switch is associated with an electronic control unit adapted to vary the engraving pressure of said wheel **(15)** as a function of the material and thickness (s) of the material to be engraved.

12. Device as claimed in claim 1, wherein said working unit **(4)** comprises at least one electrospindle **(6)** provided with a disk-shaped tool **(V)** for cutting stone materials.

13. A method for engraving slabs **(L)** of relatively fragile material, such as ceramic and glass, by means of the device **(1)** according to one or more of the preceding claims, which method comprises the following steps:

- positioning a slab **(L)** of relatively fragile material to be processed on said support surface **(P);**
- connecting said movable member **(8)** to pressure adjustment means;
- anchoring to the lower end of said movable member **(8)** an adapter **(14)** in a floating manner, with freedom of rotation around a second substantially vertical axis **(W)** of said movable member **(8);**
- providing a wheel **(15)** idly pivoted on said adapter **(14);**
- moving said movable member **(8)** downwards in order to bring said rolling tool **(9)** into contact with the material to be engraved;
- activating the pressure adjustment means to exert on said wheel **(15)** a predetermined engraving force as a function of the material and thickness of the material to be engraved;
- two-dimensional movement of said head **(2)** and said fork **(3)** so as to make an incision along the predetermined path by rolling said wheel **(15);**
- tensioning the material along the engraving path in order to carry out the final cut of the material being processed.

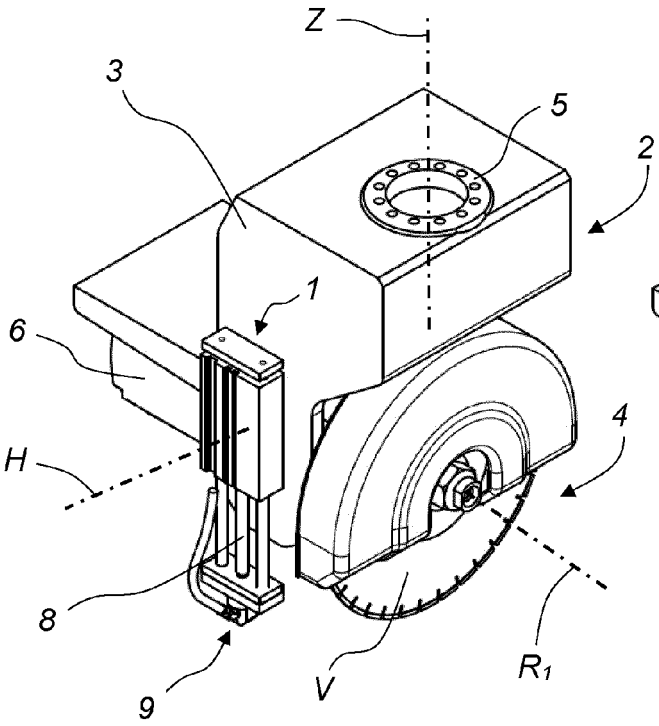

FIG. 1

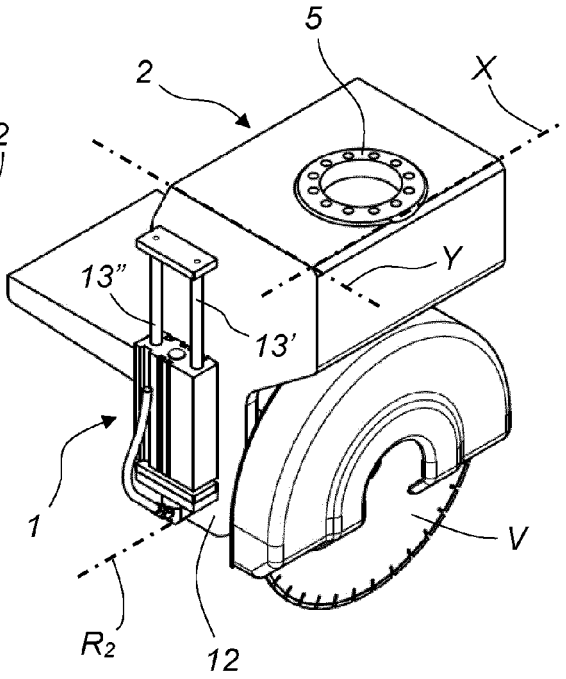

FIG. 2

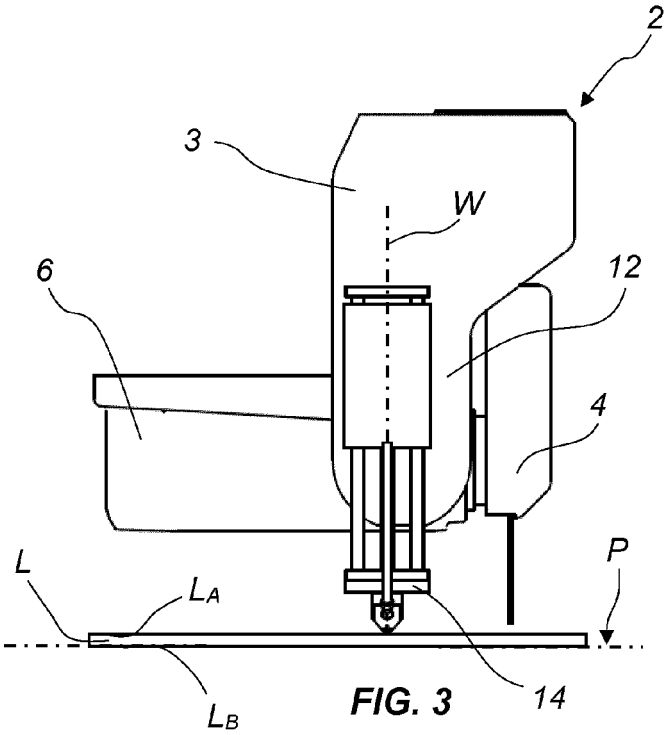

FIG. 3

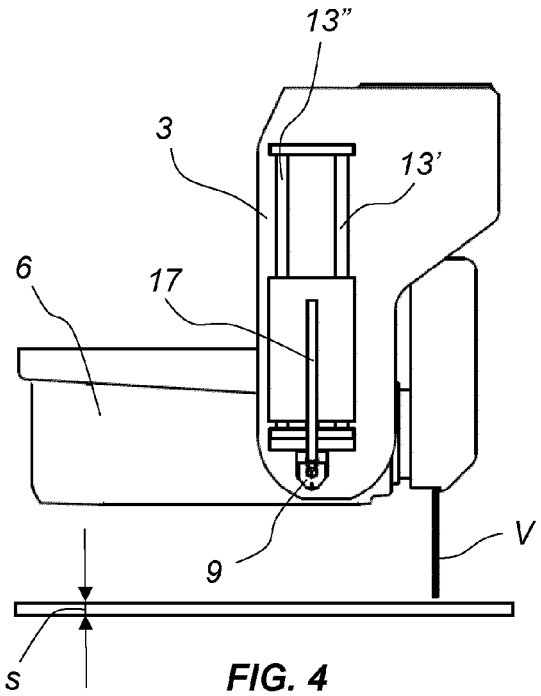

FIG. 4

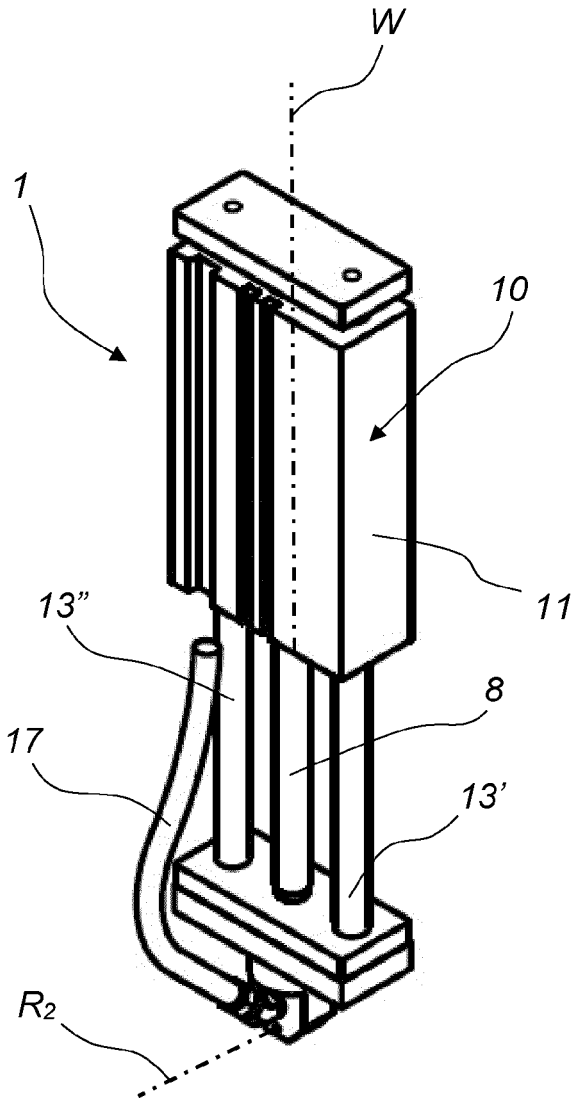

FIG. 5

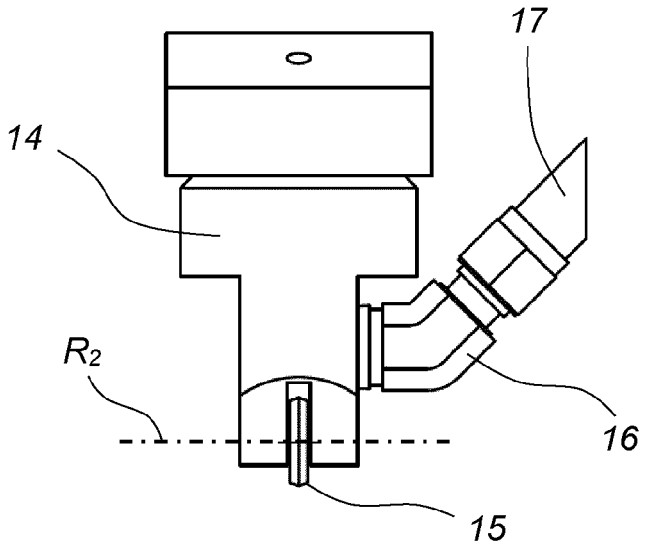

FIG. 6

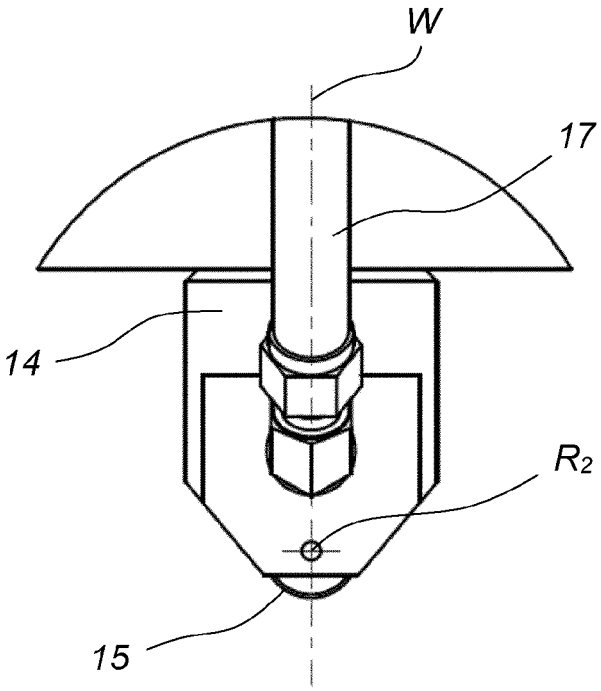

FIG. 7

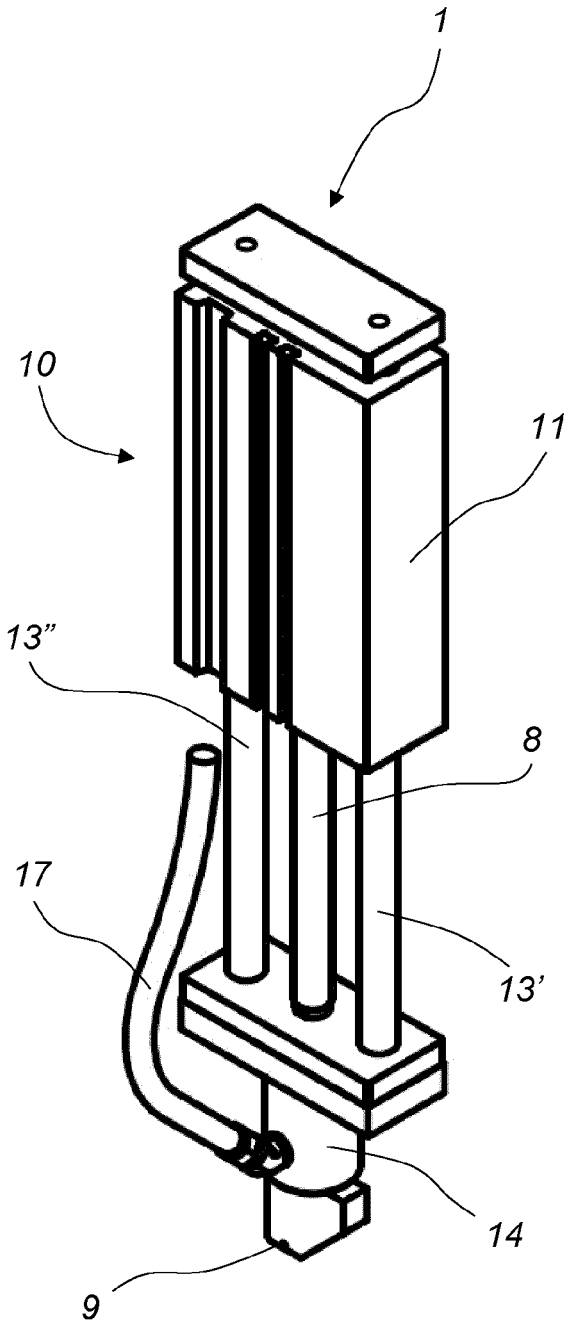

FIG. 8

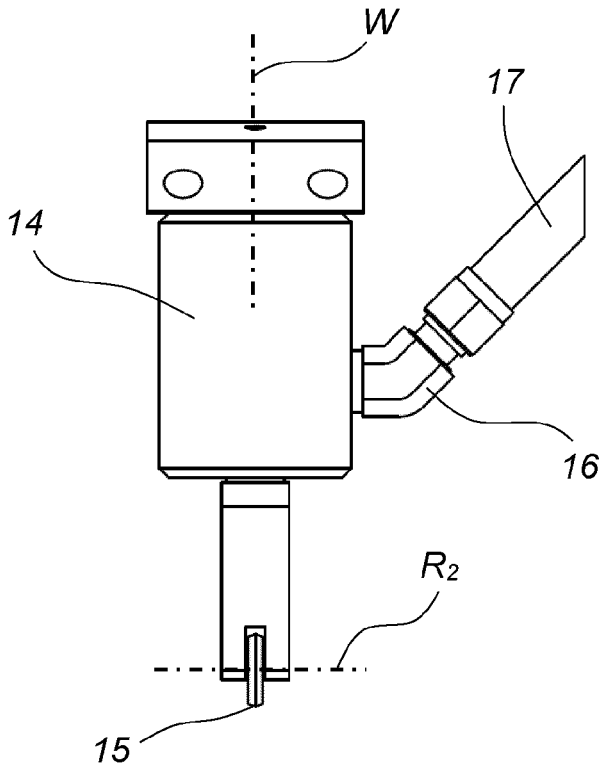

FIG. 9

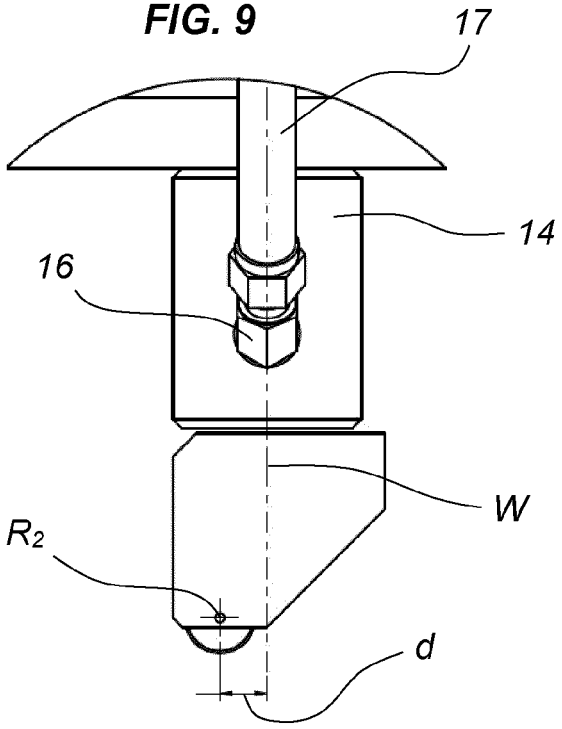

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 7564

DOCUMENTS CONSIDERED TO BE RELEVANT

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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	25 November 2022	Chariot, David

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X : particularly relevant if taken alone
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