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(54) **CUTTING HEAD FOR THE CUTTING OF SLABS**

(57) A cutting head (100) for the cutting of slabs comprises: a shaft (1) suitable for being connected to a driving system, a main body (2) connected to the shaft (1), disc cutting means (3) comprising a cutting disc (30); said disc cutting means (3) being movably mounted with respect to the main body (2) in such a way to tilt the cutting disc (30) with respect to a vertical plane, water jet cutting means (4) comprising a nozzle (40) connected to a duct for supplying high-pressure water; said water jet cutting means (4) being movably mounted relative to the main body (2) in order to raise, lower and tilt the nozzle (40) relative to the main body (2) independently of the movement of said disc cutting means (3).

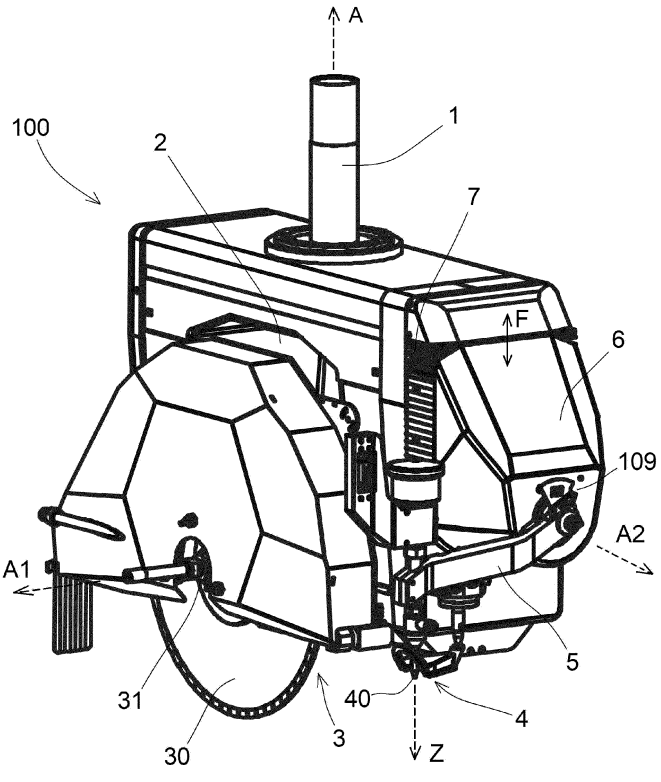

FIG. 1

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Description

[0001] The present invention relates to a cutting head for the cutting of slabs, particularly ceramic slabs, resin-based composite stone slabs, cement-based composite stone slabs, and slabs of stone material, such as marble and granite.

[0002] Cutting machines comprising a cutting head with a rotating diamond cutting disc and a water jet cutting system are known. The water jet cutting system comprises a high-pressure hydraulic duct in communication with a nozzle from which a mix of water and abrasive material is ejected at a very high pressure (3000-4000 bar) and directed onto the slab in such a way to cut the slab.

[0003] However, in the cutting heads of the prior art, the movements of the water jet cutting system are generally constrained to the movements of the cutting disc. As a result, such types of cutting heads are not versatile and do not allow to carry out all kinds of cutting operations with total freedom of movement.

[0004] EP2983879 describes a tool machine comprising a secondary beam connected to a rotating support. Supports are mounted on the secondary beam to support the tools, which can be disc cutting means and water jet cutting means. The support of the tools is mounted in such a way as to slide vertically so that the tool can move vertically along a vertical axis. The carriage is mounted in such a way as to slide horizontally on a horizontal guide of the secondary beam so that the tool can move horizontally along a horizontal axis. The tool support has a fork in which the tool body is pivoted, so that the tool can rotate around a horizontal axis of the fork. Thus, each tool mounted in the secondary beam has three levels of freedom: horizontal translation along the horizontal axis of the beam, vertical translation along the vertical axis of the support, and rotation around the horizontal axis of the fork.

[0005] The tool machine of EP2983879 is impaired by several drawbacks due to the arrangement of the tools and to the fact that the tools project from the beam and can slide horizontally on the beam.

[0006] The arrangement of the tools described in Fig. 10 of EP2983879 clearly shows that the cutting disc is not aligned with the water jet nozzle, that is, the axis of the nozzle does not lie on the same plane as the cutting disc. Even if the cutting disc and the water jet nozzle can be moved with various degrees of freedom, it is impossible to align the cutting disc with the water jet nozzle. In view of the above, with such a tool machine, the cutting disc and the water jet cannot work alternately during the same cutting operation. This is a severe inconvenience, as many machining processes require to work alternately with the cutting disc and the water jet during the same cutting operation.

[0007] Although the water jet nozzle shown in Fig. 10 of EP2983879 is fixed in rotation, i.e., not tiltable, evidently the water jet nozzle can be mounted on the fork that supports the motor of the cutting disc; in such a case, the nozzle would be tiltable, but the axis of rotation of the nozzle would not intersect the axis of rotation of the cutting disc, with the impossibility of making curved cuts during the same cutting operation.

[0008] In addition, the fact that the tools project from the beam and slide horizontally on the beam causes positioning errors, due to variation of the centers of gravity and of the weight of the tools along the beam. In fact, one must consider that the motor of a cutting disc has a considerable weight of about 80 kg. It is possible to correct such errors via software, but it is difficult to make such corrections on a plane. If the errors on the plane vary according to the variation of the position of the tools on the beam or according to the variation of the inclination of the cutting disc, the error correction calculation is impossible to manage, considering that such a correction should be continuous in order to avoid defects on the workpiece. Therefore, the horizontal translation of the tools along the beam is impractical in terms of accuracy.

[0009] The purpose of the present invention is to eliminate the drawbacks of the prior art by providing a cutting head provided with a cutting disc and water jet means for the cutting of slabs, wherein the disc cutting system is not constrained to the water jet cutting system.

[0010] Another purpose is to provide such a cutting head that allows for making a precise cutting and for alternately working with the cutting disc and the water jet means during the same cutting operation of the slab.

[0011] Still another purpose is to provide such a cutting head that is versatile and suitable for making different types of cuts on different types of slabs.

[0012] A further purpose is to provide such a cutting head that is easy to make and operate.

[0013] These purposes are achieved in accordance with the invention with the features of the appended independent claim 1.

[0014] Advantageous achievements of the invention appear from the dependent claims.

[0015] Additional features of the invention will appear clearer from the following detailed description, referring to a purely illustrative and therefore non-limiting form of its embodiment, illustrated in the appended drawings, wherein:

Fig. 1 is a perspective view of a cutting head according to the invention, wherein the water jet cutting means are in raised position;
Fig. 2 is a side view of the cutting head of Fig. 1;
Fig. 2A is a sectional view taken along the section plane A-A of Fig. 2;
Fig. 3 is a front view of the cutting head of Fig. 1;
Fig. 3A is a sectional view taken along the section plane A-A of Fig. 3;
Fig. 4 is a perspective view of a cutting head according to the invention, wherein the water jet cutting means are in lowered position;
Fig. 5 is a side view of the cutting head of Fig. 4;
Fig. 6 is a front view of the cutting head of Fig. 4;

Fig. 7 is a perspective view of a cutting head according to the invention, wherein the water jet cutting means are in tilted lowered position;
Fig. 8 is a side view of the cutting head of Fig. 7;
Fig. 9 is a front view of the cutting head of Fig. 7; and
Fig. 10 is a photograph of a workpiece cut with the cutting head according to the invention.

[0016] With the aid of the Figures, the cutting head according to the invention, which is denoted overall by the reference numeral 100, is described.

[0017] The cutting head (100) is used for the cutting of slabs that are normally positioned on a work surface under the cutting head (100).

[0018] The cutting head (100) comprises a shaft (1) suitable for being connected to a driving system of the cutting head. Such a driving system is of known type and therefore not illustrated. The driving system of the cutting head may provide for an overhead crane system with movement along three orthogonal axes, an anthropomorphic robot, or a six-axis robot. In any case, the shaft (1) has a vertical axis (A) and can rotate about its vertical axis (A).

[0019] The shaft (1) supports a main body (2) of the cutting head. Disc cutting means (3) and water jet cutting means (4) are movably mounted relative to the main body (2) in order to move and tilt according to the type of cutting to be done, independently of each other.

[0020] With reference to Fig. 2A, the disc cutting means (3) comprise a cutting disc (30) mounted on a hub (31) driven into rotation by an electric motor (32), causing a rotation of the disc (30) about an axis of rotation (A1) and cutting the slab. The cutting disc (30) has a thickness of 4-6 mm.

[0021] The assembly comprising the electric motor (32), the hub (31) and the cutting disc (30) has a considerable weight of about 60-90 kg. The assembly comprising the electric motor (32), the hub (31) and the cutting disc (30) has a center of gravity (B). The electric motor (32) is mounted in the main body (2) of the cutting head, so that the center of gravity (B) of the assembly comprising the electric motor (32), the hub (31) and the cutting disc (30) is positioned on the axis (A) of the shaft (1) that supports the main body (2) of the cutting head. Such an arrangement ensures the balance of the cutting head, avoiding the alignment errors of the cutting disc (30).

[0022] It should be noted that the disc cutting means (3) cannot translate horizontally relative to the main body (2) of the cutting head; therefore, the center of gravity (B) of the assembly comprising the electric motor (32), the hub (31) and the cutting disc (30) is always centered on the axis (A) of the shaft (1) that supports the main body (2) of the cutting head.

[0023] The axis of rotation (A1) of the cutting disc (30) can be tilted with respect to a vertical plane. For such a purpose, the hub (31) of the cutting disc is rotatably mounted on a support (8) (shown in Fig. 2A) mounted with possibility of being tilted with respect to the main body (2). In view of the above, the support (8) of the cutting disc can be tilted with respect to the main body (2), in such a way to tilt the cutting disc (30) with respect to a vertical position in order to make cuts on inclined planes with respect to the plane of the slab to be cut.

[0024] First adjustment means (9) (shown in Fig. 2A) are provided to adjust the inclination of the support (8) of the cutting disc with respect to the main body (2), thus adjusting an inclination of the cutting disc (30) with respect to a vertical plane in order to make oblique cuts. The first adjustment means (9) can be of manual type or of automatic type with an actuator for moving the support (8) of the cutting disc.

[0025] Going back to Fig. 1, the water jet cutting means (4) comprise a nozzle (40) connected to a duct for supplying a mix of high-pressure water and abrasive material used to cut the slabs. The nozzle (40) has an axis (Z) that identifies an ejection direction of the mix of water and abrasive material. The water jet ejected from the nozzle (40) makes a cut with thickness comprised between 0.6 and 0.7 mm.

[0026] Referring to Fig. 3, the nozzle (40) is arranged in the cutting head in an initial position in which the axis (Z) of the nozzle lies on the same plane as the cutting disc (30), when the cutting disc is arranged according to a vertical plane. In such a way, the cutting disc (30) and the water jet delivered from the nozzle (40) can alternately work during the same cutting operation, depending on the desired width of the cut.

[0027] In order to tilt the axis (Z) of the nozzle, the nozzle (40) is mounted on a lever (5) that is rotatably mounted on a support (6) of the nozzle in such a way to rotate around an axis of rotation (A2) orthogonal to the axis of rotation (A1) of the cutting disc, when the cutting disc lies on a vertical plane. The lever (5) is a lever of the second kind, pivoted in the support (6) of the nozzle.

[0028] Referring to Fig. 3A, the axis of rotation (A2) of the lever (5) intersects the vertical axis (A) of the shaft (1) that supports the main body (2) of the cutting head. Such an arrangement ensures the balance of the cutting head during the rotation of the lever (5) that supports the water jet nozzle.

[0029] Second adjustment means (109) are provided to adjust a rotation of the lever (5) around its axis of rotation (A2) in order to adjust the tilt of the nozzle (40) with respect to a vertical direction.

[0030] The second adjustment means (109) can be of manual type or of automatic type with an actuator for moving the lever (5). By way of example, such an actuator can be an electric motor connected to the lever (5) in order to drive said lever (5) into rotation.

[0031] The support (6) of the nozzle is mounted in such a way to translate vertically with respect to the main body (2). In such a way, the support (6) of the nozzle can be raised or lowered relative to the main body (2) in the direction of the arrows F (Fig. 1) in such a way to raise or lower the nozzle (40).

[0032] With reference to Fig. 3A, it should be noted

that when raising or lowering the support (6) of the nozzle, the axis of rotation (A2) of the lever (5) that supports the nozzle always intersects the vertical axis (A) of the shaft (1) that supports the body of the cutting head, thus ensuring the balance of the cutting head in order to avoid alignment errors.

[0033] It should be noted that the water jet cutting means (4) cannot translate horizontally relative to the main body (2) of the cutting head; therefore, the axis of rotation (A2) of the lever (5) that support the nozzle always intersects the vertical axis (A) of the shaft (1) that the body of the cutting head.

[0034] Third adjustment means are provided to adjust the raising and the lowering of the support (6) of the nozzle and consequently the raising and the lowering of the nozzle (40) relative to the main body (2). The third adjustment means can be of manual type or of automatic type with an actuator to move the support of the nozzle. By way of example, such an actuator can be a rack-and-pinion system or a linear actuator connected to the main body (2) and to the support (6) of the nozzle.

[0035] It should be noted that the water jet cutting means (4) are movably mounted relative to the main body (2) in order to raise, lower and tilt the nozzle (40) relative to the main body (2), regardless of the movement of the disc cutting means (3).

[0036] Referring to Fig. 2, for illustrative purposes, the support (6) of the nozzle may comprise a carriage (60) that is slidingly mounted in a vertical guide (20) of the main body (2).

[0037] A bellows cover (7) is connected to the support (6) of the nozzle and to the main body (2) so that, when the support (6) of the nozzle is moved, the bellows cover (7) is either extended or retracted, covering the vertical guide (20) of the main body.

[0038] It should be noted that the disc cutting means (3) and the water jet cutting means (4) cannot translate horizontally relative to the main body (2) of the cutting head. In view of the above, the center of gravity (B) of the assembly comprising the electric motor (32), the hub (31) and the cutting disc (30) is always balanced

[0039] Figs. 1-3 illustrate a situation in which the cutting disc (30) is in a vertical position and also the nozzle (40) is in a raised vertical position in which a lower end of the nozzle (40) is at a higher height than a lower end of the cutting disc. In such a situation, only the cutting disc (30) can be operated, and the nozzle (40) does not interfere with the working operation of the cutting disc (30).

[0040] Figs. 4-6 illustrate a situation in which the support (6) of the nozzle is lowered, so the nozzle (40) is in a lowered vertical position in which a lower end of the nozzle (40) is at the same height as a lower end of the cutting disc (30). The nozzle (40) is in an initial position in which the axis (Z) of the nozzle lies on the same plane as the cutting disc (30), so that the cutting disc (30) and the water jet delivered by the nozzle (40) can be alternately operated during the same cutting operation of a slab.

[0041] Figs. 7-9 illustrate a situation in which the support (6) of the nozzle is lowered and the lever (5) is rotated in the direction of the arrow (F1) (Fig. 9), so that the axis (Z) of the nozzle (40) is in a position that is inclined by an angle (α) relative to a vertical direction. Such a tilt of the axis (Z) of the nozzle (40) with respect to the plane of the cutting disc (30) can be obtained gradually during the cutting operation, enabling the making of cuts with particular curvatures, such as the workpiece illustrated in Fig. 10, which is obtained with the cutting head according to the invention.

Equivalent variations and modifications may be made to the present embodiment of the invention, within the reach of a person skilled in the art, and still falling within the scope of the invention as expressed by the appended claims.

Claims

1. Cutting head (100) for the cutting of slabs comprising:

   - a shaft (1) suitable for being connected to a driving system to move the cutting head (100); said shaft (1) having an axis (A),
   - a main body (2) connected to the shaft (1),
   - disc cutting means (3) comprising a cutting disc (30) driven into rotation around an axis of rotation (A1) by an electric motor (32); said disc cutting means (3) being movably mounted with respect to the main body (2) in order to tilt the cutting disc (30) relative to a vertical plane,
   - water jet cutting means (4) comprising a nozzle (40) connected to a duct for supplying a mix of water and abrasive material at a high pressure; said nozzle (40) having an axis (Z) identifying an ejecting direction of the mix of water and abrasive material;

   said water jet cutting means (4) being movably mounted with respect to the main body (2) in order to raise, lower and tilt the nozzle (40) with respect to said main body (2) independently of the movement of said disc cutting means (3),
   characterized in that
   said nozzle (40) can be positioned in an initial position wherein the axis (Z) of the nozzle lies on the same plane of the cutting disc (30), in such a way that the cutting disc (30) and the water jet ejected by the nozzle (40) can be alternately operated during the same cutting operation of a slab.

2. The cutting head (100) according to claim 1, wherein said disc cutting means (3) and said water jet cutting means (4) cannot translate horizontally with respect

to the main body (2) of the cutting head.

3. The cutting head (100) according to claim 1 or 2, wherein said cutting disc (30) is mounted on a hub (31) driven in rotation by an electric motor (32); the assembly comprising the electric motor (32), the hub (31) and the cutting disc (30) has a center of gravity (B); and the electric motor (32) is mounted in the main body (2) of the cutting head, so that the center of gravity (B) of the assembly comprising the electric motor (32), the hub (31) and the cutting disc (30) is positioned on the axis (A) of the shaft (1) that supports the main body (2) of the cutting head.

4. The cutting head (100) according to any one of the preceding claims, wherein said nozzle (40) of the water jet cutting means is mounted on a lever (5) pivoted to a support (6) mounted in such a way to make a vertical translation on said main body (2).

5. The cutting head (100) according to claim 4, wherein said lever (5) that supports the nozzle rotates around an axis of rotation (A2) orthogonal to the axis of rotation (A1) of the cutting disc (30), when the cutting disc is on a vertical plane.

6. The cutting head (100) according to claim 5, wherein the axis of rotation (A2) of the lever (5) intersects the vertical axis (A) of the shaft (1) that supports the main body (2) of the cutting head.

7. The cutting head (100) according to claim 5 or 6, comprising second adjustment means (109) suitable for adjusting a rotation of said lever (5) around its axis of rotation (A2) in order to adjust the tilt of the nozzle (40) with respect to a vertical direction.

8. The cutting head (100) according to claim 7, wherein said second adjustment means (109) are of automatic type with an actuator for moving the lever (5).

9. The cutting head (100) according to any one of claims 4 to 8, comprising third adjustment means to regulate the raising or lowering of the support (6) of the nozzle relative to the main body (2).

10. The cutting head (100) according to claim 9, wherein said third adjustment means are of automatic type with an actuator for moving the support (6) of the nozzle.

11. The cutting head (100) according to any one of claims 4 to 10, wherein the support (6) of the nozzle comprises a carriage (60) slidingly mounted in a vertical guide (20) of the main body (2).

12. The cutting head (100) according to any one of claims 4 to 11, comprising a bellows cover (7) connected to the support (6) of the nozzle and to the main body (2).

13. The cutting head (100) according to any one of the preceding claims, wherein said cutting disc (30) is mounted on a support (8) of the cutting disc mounted with possibility of being tilted with respect to said main body (2), and said cutting head (100) comprises first adjustment means (9) to adjust the tilt of the support of the cutting disc with respect to the main body (2).

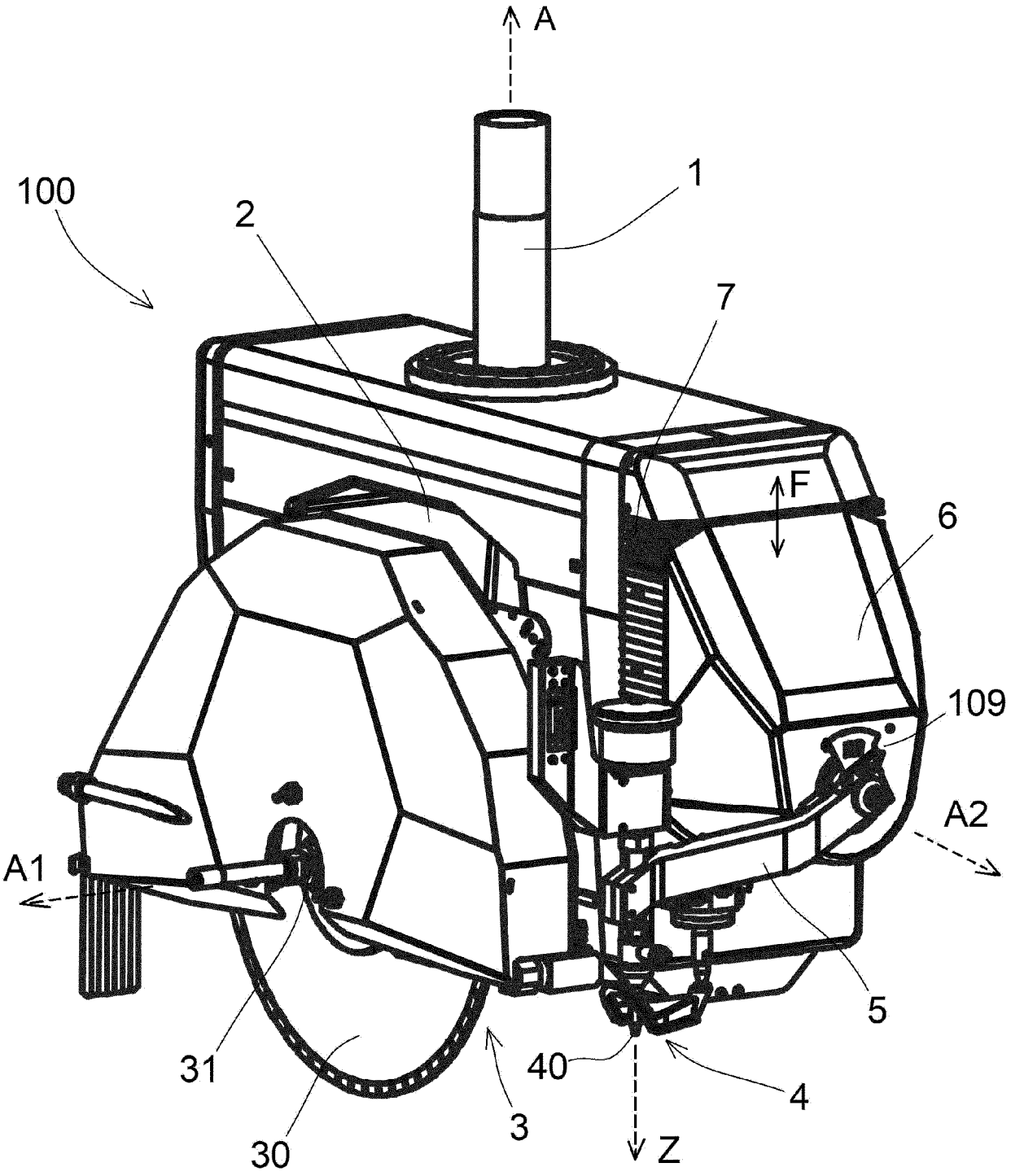

FIG. 1

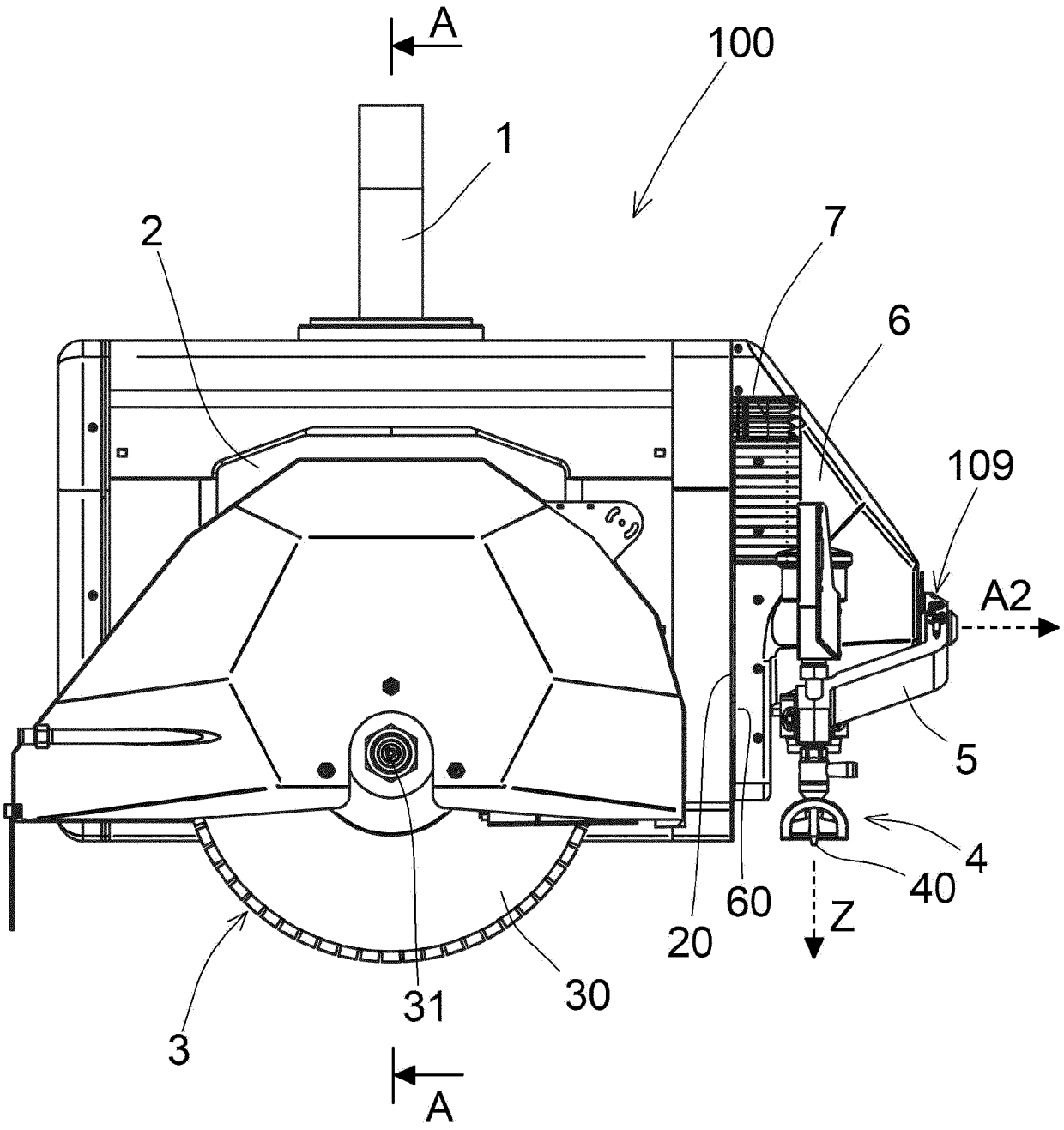

FIG. 2

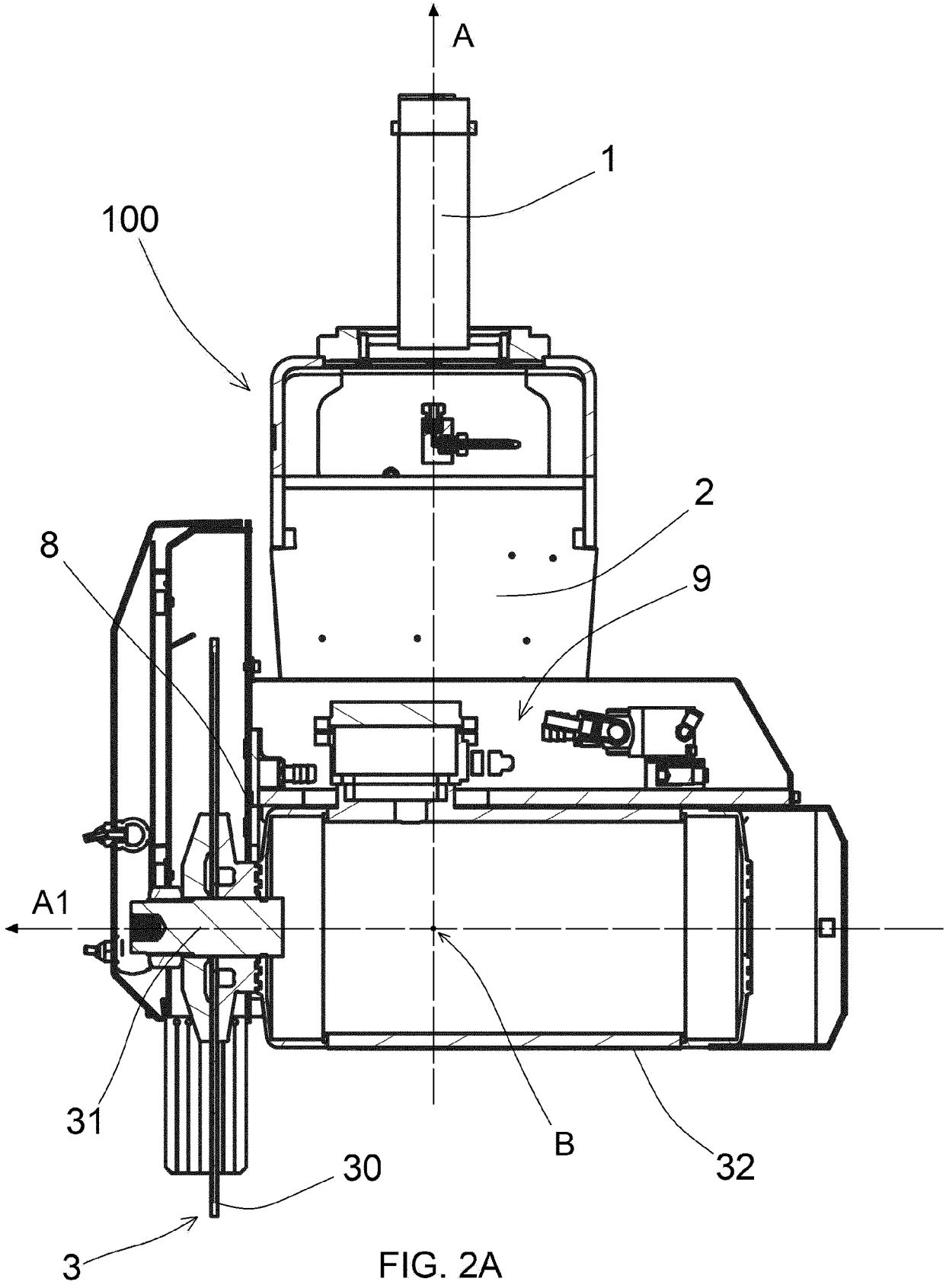

FIG. 2A

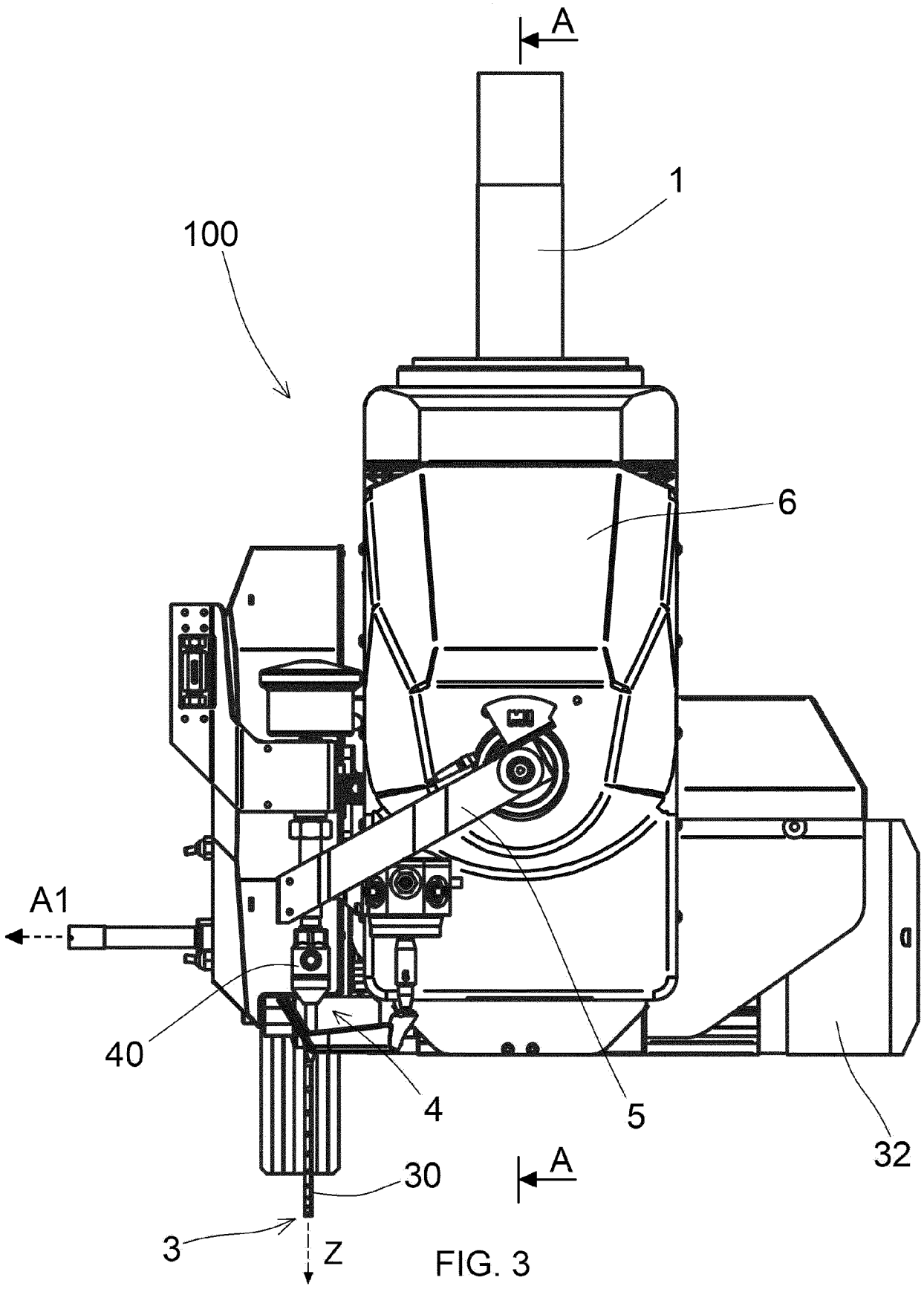

FIG. 3

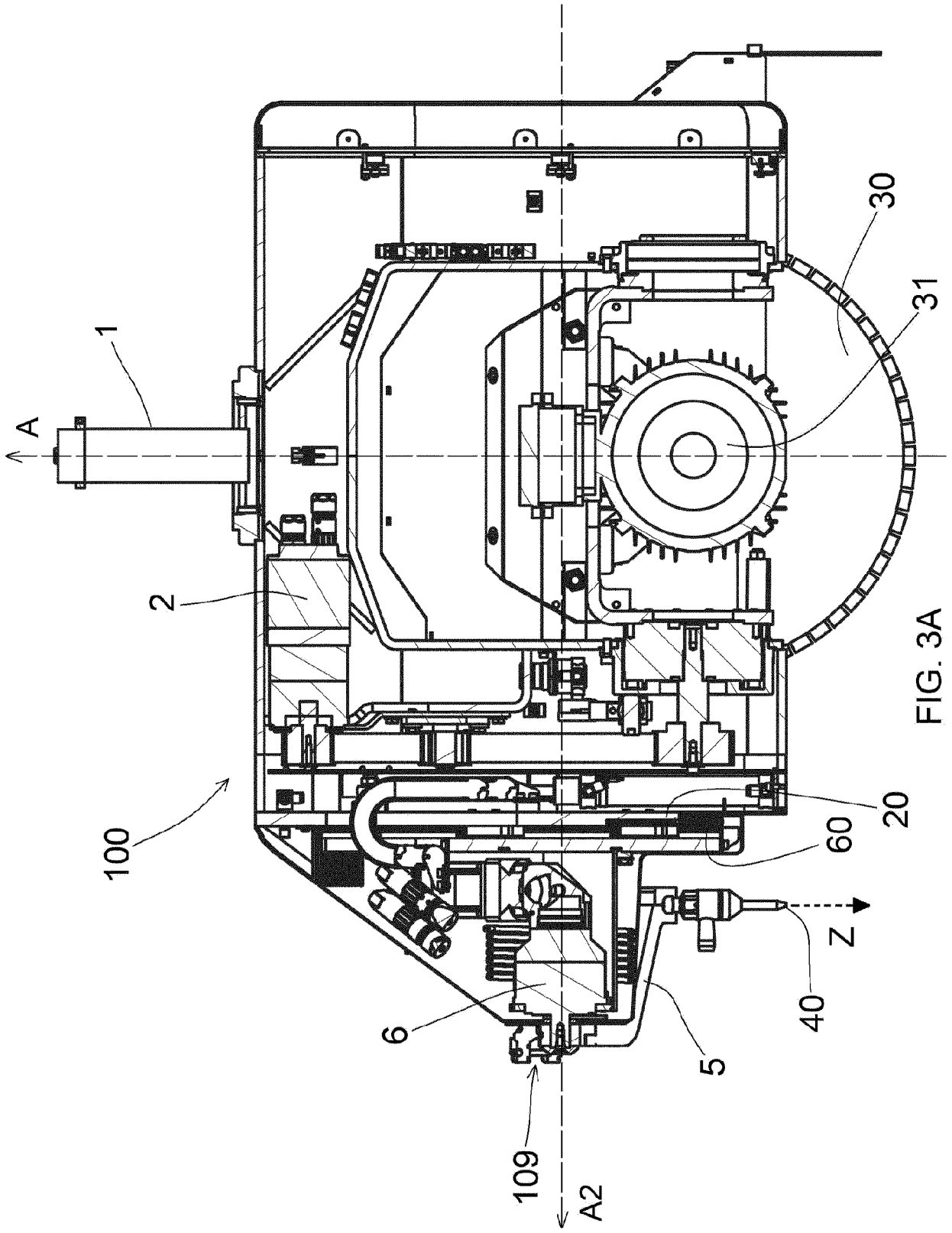

FIG. 3A

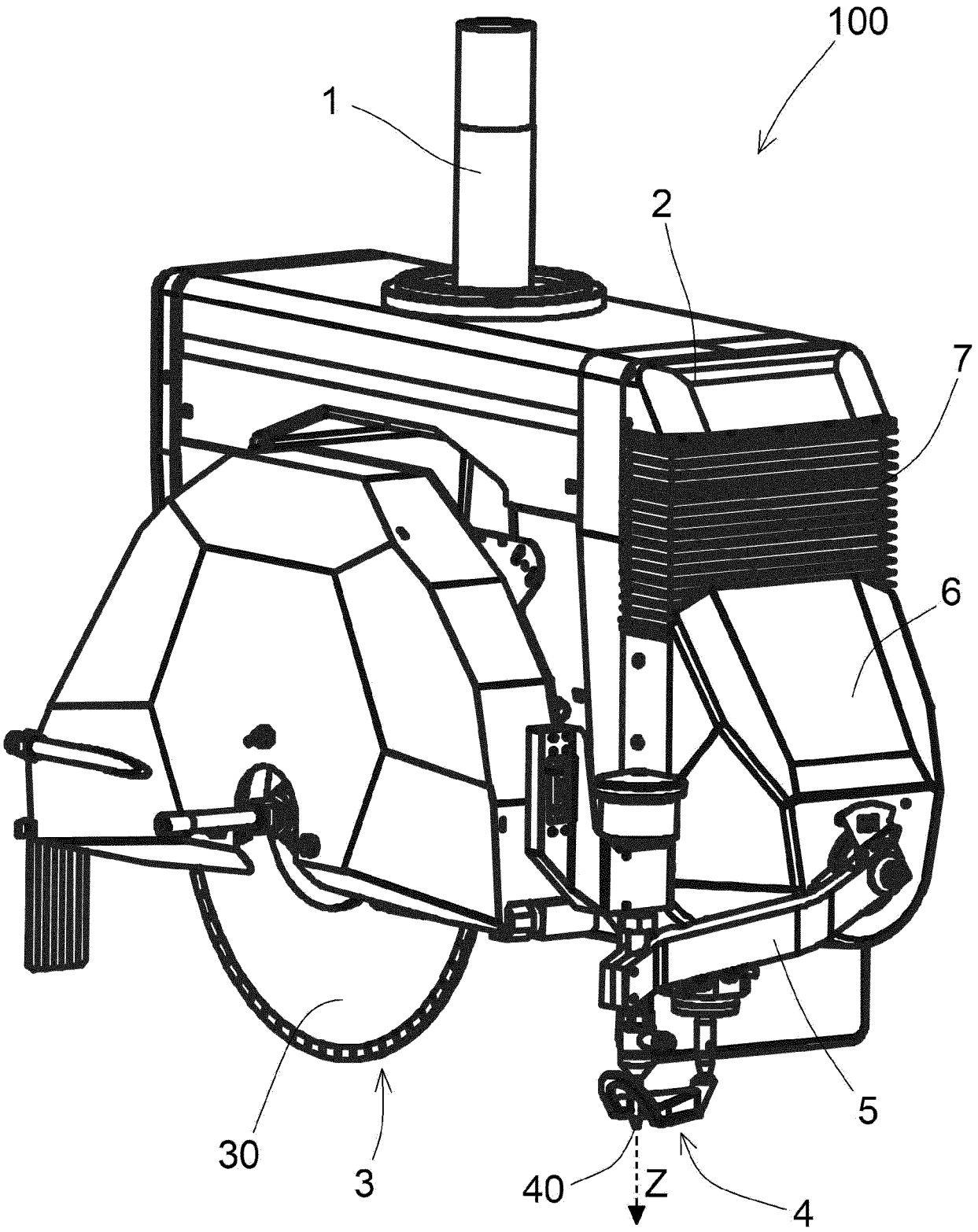

FIG. 4

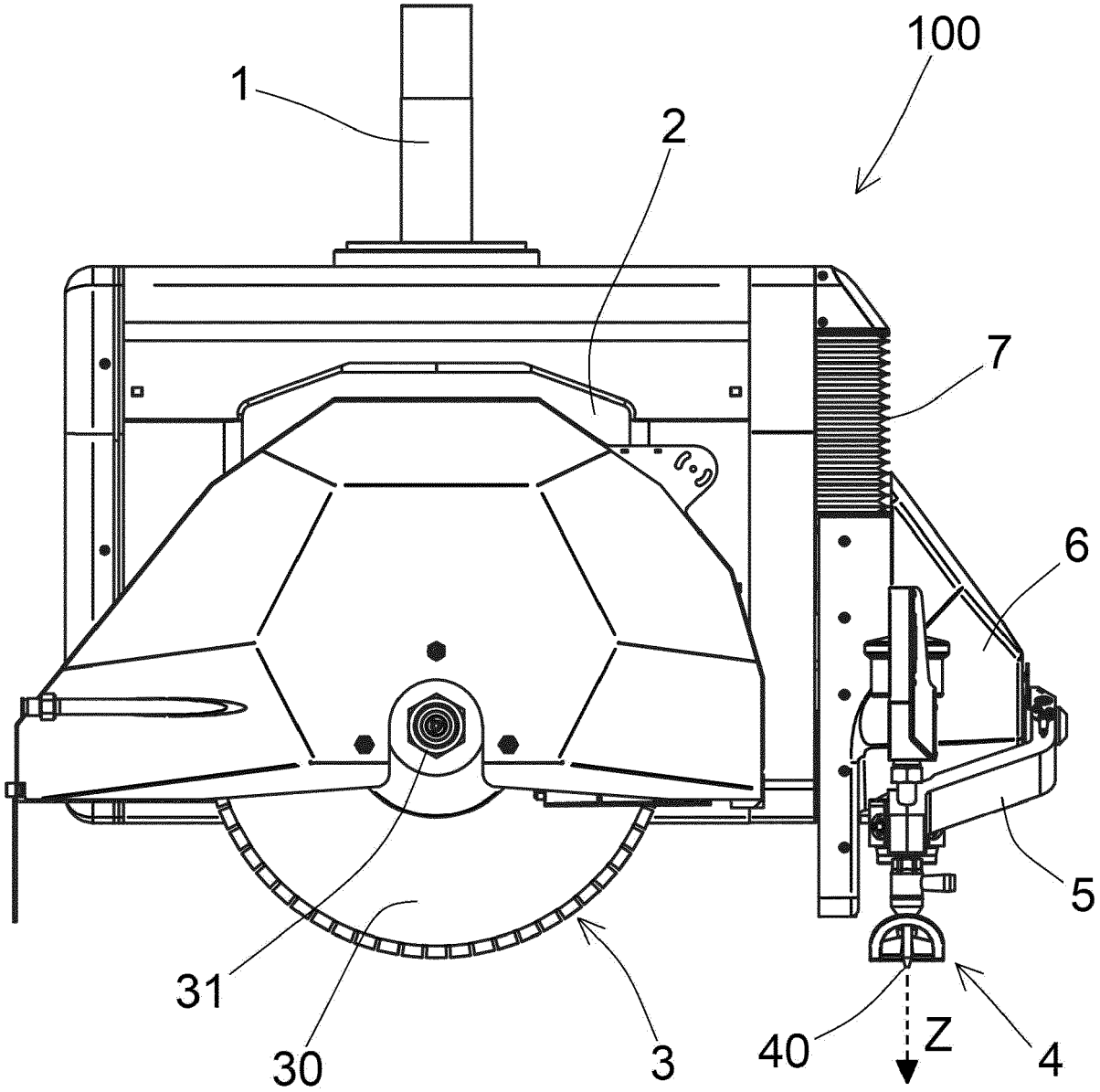

FIG. 5

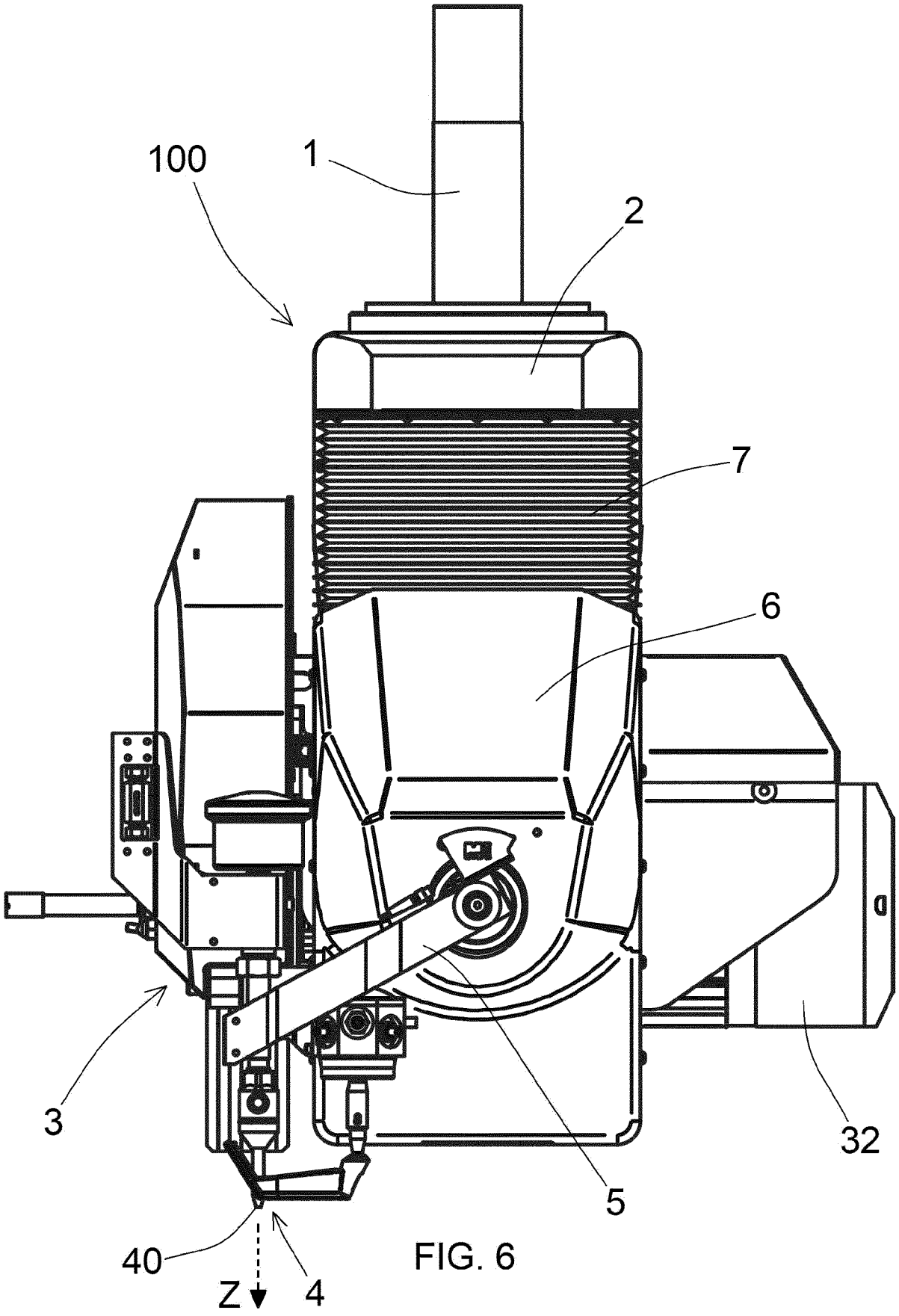

FIG. 6

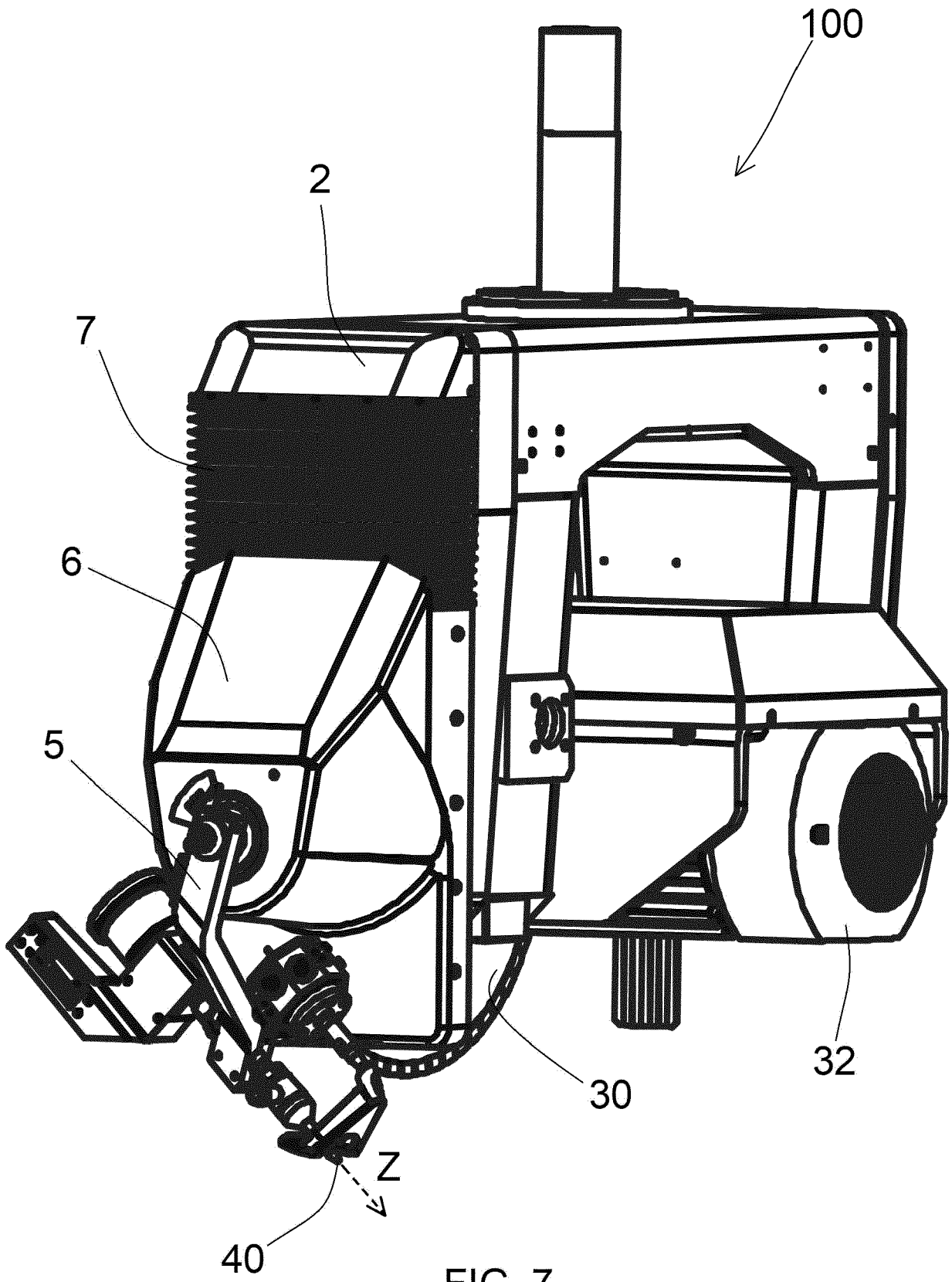

FIG. 7

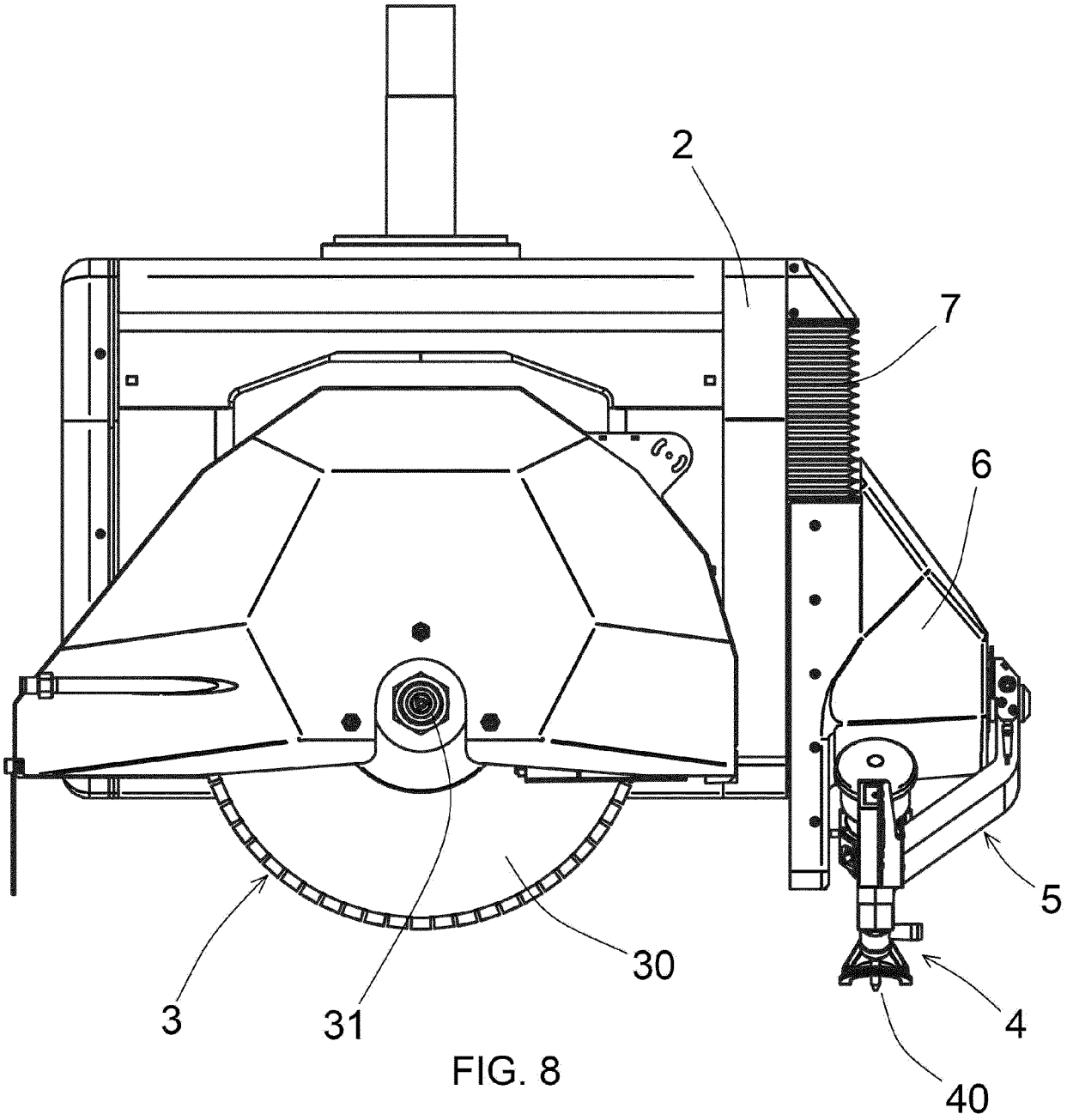

FIG. 8

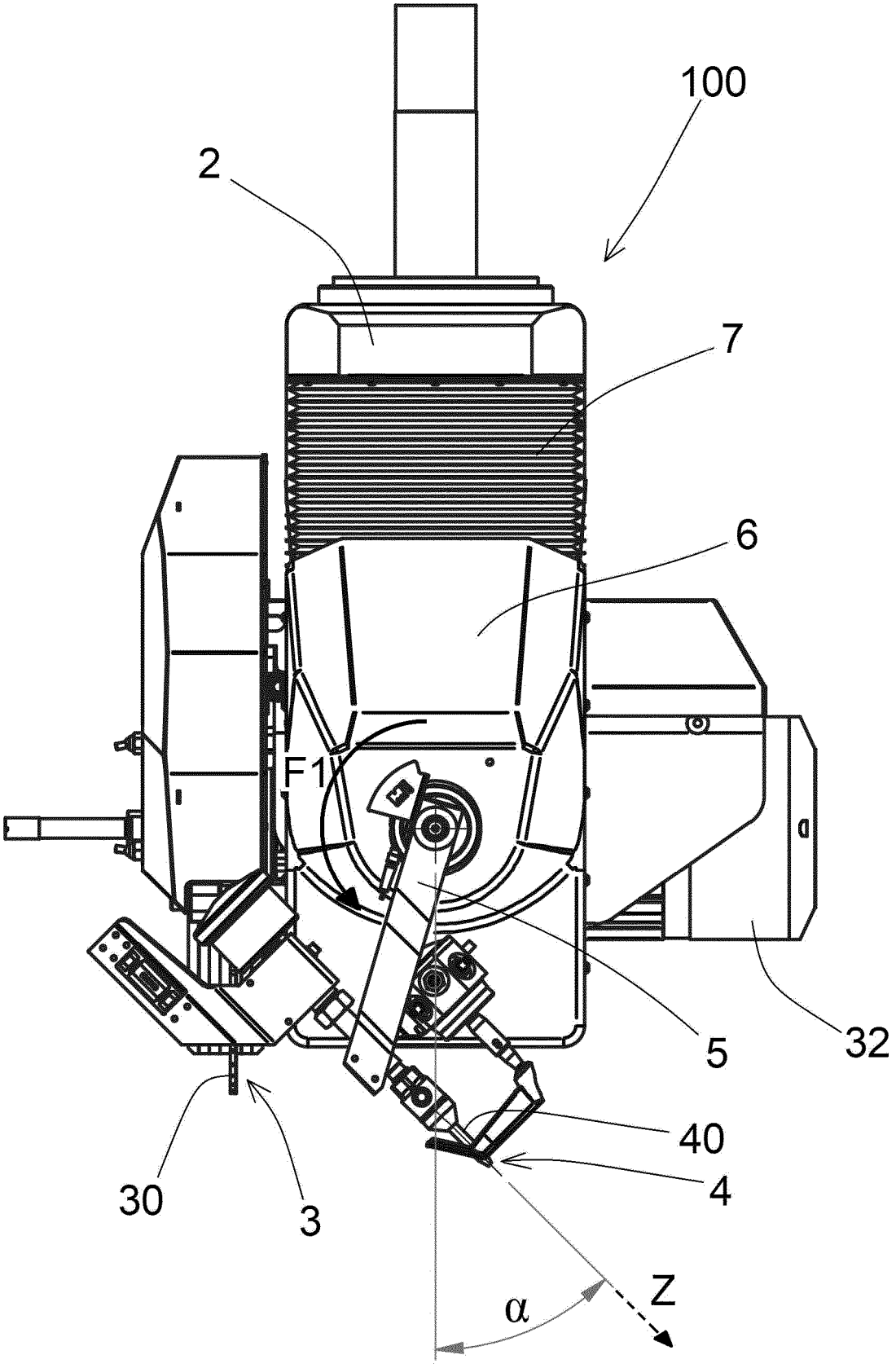

FIG. 9

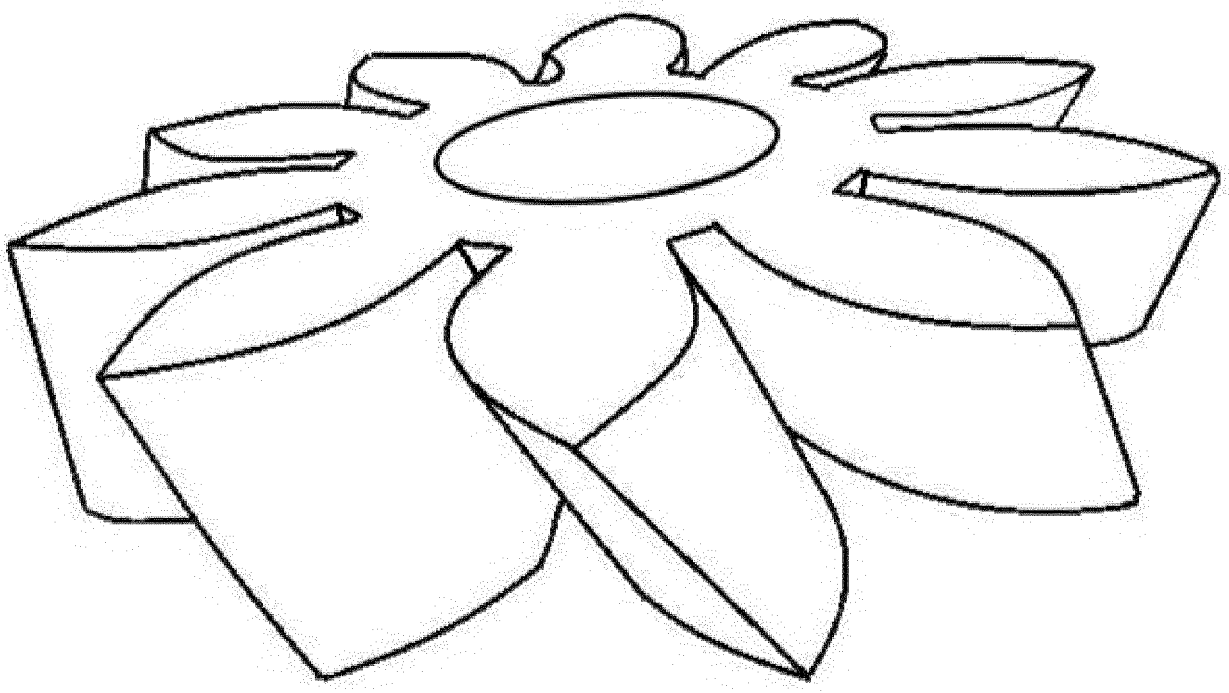

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 5742

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 983 879 B1 (DONATONI MACCH S R L [IT]) 26 April 2017 (2017-04-26)	1,4,5, 7-13	INV. B28D1/00
A	* paragraph [0029] - paragraph [0041] * * paragraph [0049] * * paragraph [0051] - paragraph [0060] * * figures 1,2,9,10 *	2,3,6	B28D1/04 B26F3/00
A	EP 3 909 732 A1 (CMS SPA [IT]) 17 November 2021 (2021-11-17) * the whole document * * in particular: * * paragraphs [0055], [0056] * * figures 6A,6B,8A,8B *	1-13	

TECHNICAL FIELDS SEARCHED (IPC)

B28D
B26F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18 March 2024	Rijks, Mark

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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18-03-2024

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