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(54) Punching machine for blanking metal sheets

(57) The punching machine (1) for blanking metal sheets, comprises a base (2) carrying a divider (3) or locking device for locking and retaining a metal sheet (4) to be blanked, and a carriage (5) carrying at least one punch (8) movable between a rest position and a blanking position. The base (2) carries, for rotatably driving the divider (3), a motor (11) which is directly connected to the divider (3) itself.

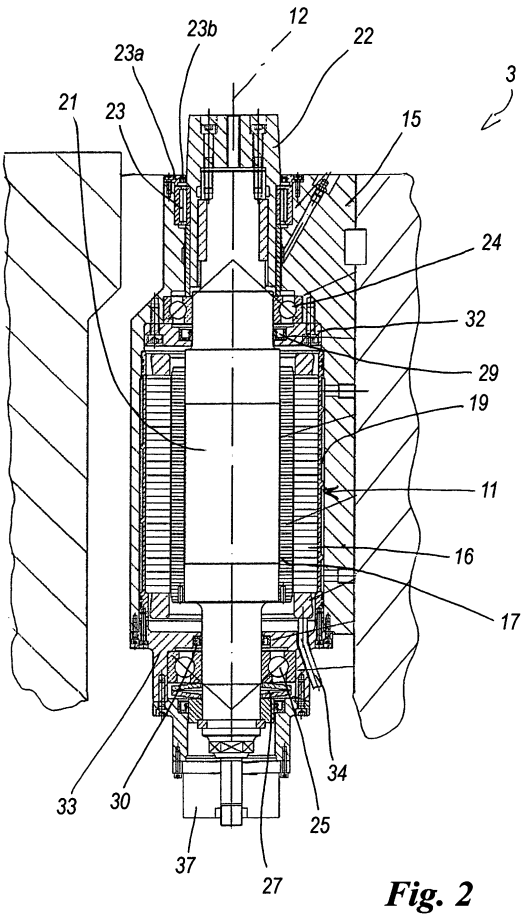

Fig. 2

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Description

[0001] The present invention relates to a punching machine for blanking metal sheets, in particular for blanking metal sheets for magnetic circuits (rotors or stators) of electrical machines, such as motors, transformers, etc.

[0002] In particular the punching machine of the invention is suitable for blanking metal sheets (typically in the shape of a disc or angular sector) of very large dimensions; for example such metal sheets can have a diameter of 1200 millimetres or more.

[0003] Punching machines are known machine tools by which slots of suitable shape and size can be die-cut from the interior or along the periphery of metal sheets of predetermined thickness which can be in the crude state or can originate from previous machining.

[0004] Such punching machines consist of a base and a carriage.

[0005] The base is fixed and is positioned on the floor surface.

[0006] On the base a locking device (usually known as a "divider") is positioned for retaining the metal sheet to be machined (of disc or angular sector profile) and rotating it about a vertical axis.

[0007] The carriage is movable relative to the base and carries a blanking device which die-cuts the slots in the metal sheet being machined.

[0008] This blanking device (known as a "die assembly") consists of a die (fixed part) and a punch (part movable towards and away from the die).

[0009] The die assembly (i.e. the die and punch) is interchangeable such that the machine can die-cut slots of different shape and size by simply replacing the die assembly by a suitable die assembly.

[0010] During operation the disc or angular sector shaped metal sheet to be machined is initially positioned on the base and is located on the divider; this operation can be manual, or be automated by a loading/discharge device.

[0011] The carriage position is then adjusted relative to the base.

[0012] The carriage can be moved linearly (horizontally), to modify the relative distance between the punch axis and the divider axis (hence relative to the centre of the disc or angular sector of the metal sheet being machined), in order to adapt the punching machine to the diameters of the discs (or angular sectors) to be machined.

[0013] The machine is then started and the slots are formed one after another automatically.

[0014] During operation the punch moves with to-and-fro (vertical) linear movement (reciprocating).

[0015] At each descent the punch forces a metal sheet portion (of disc or angular sector form) against the die to obtain a slot by die-cutting.

[0016] When the punch has die-cut a slot, the divider rotates to present to the punch a new and integral metal sheet portion which is to be blanked.

[0017] The divider rotates snapwise about the vertical axis, the slot being die-cut between one snap movement and the next.

[0018] The machine stops when the last slot required by the working cycle has been formed.

[0019] To operate the piston with linear movement and the divider with rotary movement the machine usually presents two motors, namely a motor translating the piston and a motor rotating the divider.

[0020] During operation, the divider is subjected to considerable acceleration during rotation because of the large number of punch strikes per minute (more than 600) and the large diameter of the metal sheets to be machined (more than 1200 millimetres).

[0021] At the same time the metal sheets have to be machined with high precision to form magnetic circuits with correct measurements and tolerances.

[0022] In the light of these requirements, punching machines of the indicated type traditionally present divider rotation drive devices of considerable dimensions connected mechanically to the blanking punch drive.

[0023] However because of the punching machine structure, the divider rotation drive device is displaced from the divider rotation shaft, the movement being transmitted to said shaft by a chain, belt or gear transmission.

[0024] The presence of belt, chain or other transmissions (mechanical transmissions) introduces angular positioning inaccuracies in the metal sheet during machining and causes considerable maintenance difficulties and delays.

[0025] Moreover because of the large dimensions of the divider drive device, the ability to adjust the carriage relative to the base is limited, so limiting those regions of the metal sheet which can be machined.

[0026] A further drawback is the need to change the transmissions (together with the die assembly) each time the type of slot to be made or its quantity is changed; in practice each different profile to be die-cut on the metal sheets requires the use of different transmissions (and different die assemblies), with consequent lengthy machine down-times.

[0027] The technical aim of the present invention is therefore to provide a punching machine for blanking metal sheets by which the stated technical drawbacks of the known art are eliminated.

[0028] Within the scope of this technical aim, an object of the invention is to provide a punching machine which is able to machine metal sheets with precision and is of simple and rapid maintenance.

[0029] Another object of the invention is to provide a punching machine which can be used to machine numerous different metal sheets (i.e. to machine metal sheets having a different outer profile and a different slot profile) in all their regions.

[0030] Another object is to provide a punching machine which can be easily, quickly and widely adjusted to adapt it to different types of slot to be formed.

[0031] The technical aim, together with these and other

objects, are attained according to the invention by providing a punching machine for blanking metal sheets in accordance with claim 1.

[0032] Other characteristics of the present invention are defined in the subsequent claims.

[0033] Further characteristics and advantages of the invention will be more apparent from the description of a preferred but non-exclusive embodiment of the punching machine of the invention, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figure 1 is a view of a punching machine for blanking metal sheets according to the invention;
Figure 2 is a section through a divider or locking device for a metal sheet to be machined according to the invention; and
Figure 3 is a schematic plan view of a metal sheet blanked by the punching machine of Figure 1.

[0034] With reference to said figures, these show a punching machine indicated overall by the reference numeral 1, for blanking metal sheets.

[0035] The punching machine 1 comprises a base 2 carrying a locking device or divider 3 for locking and retaining a metal sheet 4 to be blanked (typically of disc, angular sector or circular sector shape), and a carriage 5 slidable on the base 2.

[0036] The carriage 5 carries a die assembly 7, defined by a punch 8 cooperating with a die 9.

[0037] The punch 8 is movable as indicated by the arrow F1 (operated by a first motor) between a rest position (shown in the figure) and a blanking position in which it cuts the metal sheet 4.

[0038] The base 2 and the carriage 5 are movable relative to each other (as indicated by the arrow F2) to adjust the position in which the metal sheet 4 is blanked; the carriage 5 slides on guides (not shown) on the base 2.

[0039] For rotating the divider 3 the base 2 carries a second motor 11 which is directly connected to the divider 3. The axis of rotation of the motor 11 coincides with the axis of rotation of the divider 3 (axes 12).

[0040] Hence no gears or other mechanical transmission members are provided between the rotation motor 11 of the divider 3 and the divider 3 itself.

[0041] The divider 3 comprises a casing 15 housing in its interior the motor 11 and specifically the stator 16 and rotor 17 of the motor 11.

[0042] An annular chamber 19 is provided between the stator 17 and the casing 15 for circulating a cooling liquid (in the form of an aqueous solution) fed by an external unit for forcedly circulating and cooling the cooling liquid.

[0043] The rotor 17 is keyed onto a shaft 21 of vertical axis (coinciding with the axis 12) connected upperly (by screws) to a drive jig 22 of the metal sheet 4 to be machined; in other words the drive jig 22 retains and rotates the metal sheet 4 to be machined.

[0044] Advantageously the drive jig 22 has a frusto-conical longitudinal cross-section to provide a Morse cone connection.

[0045] To ensure rigidity, the top portion of the shaft 21 (to which the drive jig 22 is fixed) is guided by a cylindrical roller bearing 23 secured by a cover 23a.

[0046] To prevent undesirable infiltration of impurities and moisture, a rotating shaft gasket 23b is housed in the cover 23a.

[0047] Motion transmission between the motor 11 and divider 3 is direct.

[0048] The shaft 21 is supported by two grease-lubricated oblique ball bearings 24, 25 which can be re-lubricated from the outside of the casing 15.

[0049] The axial clearance can be set by cup springs 27.

[0050] The rotor 17 and stator 16 of the motor 11 are isolated from the bearings 24, 25 supporting the shaft 21 by rotary shaft gaskets 29, 30, to prevent the lubricating grease from reaching the electrical parts.

[0051] The gasket 29 relative to the upper bearing 24 is housed in a plate 32 the function of which is also to axially lock the outer ring of the bearing.

[0052] The gasket 30 relative to the lower bearing 25 is housed in the cover 33 closing the casing 15, which also supports the bearing 25 itself.

[0053] The electric cables powering the stator 16 of the motor 11 pass through a hole in the cover 33; this through hole is suitably sealed with insulating impermeable material to prevent entry of impurities and moisture.

[0054] The lower end of the shaft 21 presents a portion 36 projecting downwards from the cover 33 and connected to an electrical/electronic device 37 for measuring the angular position. The instrument has a hollow shaft, hence no intermediate connection element is used.

[0055] This ensures reliable correspondence between the measurement made and the effective angular movement of the shaft.

[0056] The upper end of the shaft extends upwards to obtain a suitable connection with the drive jig 22.

[0057] A controller is also provided (for example of PLC or CNC type) which controls the motor relative to the punch 7 and the motor relative to the divider 3. Via suitable actuators (not shown), the same controller also controls the adjustment of the first element 2 relative to the second element 5. The electrical/electronic measuring device 37 is also connected to the PLC or CNC.

[0058] The operation of the punching machine for blanking metal sheets of the invention is apparent from that described and illustrated, and is substantially as follows.

[0059] The metal sheet 4 to be machined is firstly deposited on the divider 3.

[0060] The position of the carriage 5 is then adjusted relative to the base 2 so that the punch 8, in its reciprocating movement, is able to die-cut the slots 39 in the metal sheet 4 in the desired position.

[0061] The punching machine 8 then effects a first blanking operation via the punch 8 which blanks the metal

sheet 4, then the divider 3 rotates through a predefined angle such that the next operation of the punch 8 forms a second slot 39 in the metal sheet 4 in the correct position; the machine operation continues until the metal sheet has been completely machined by being rotated through 360 degrees.

[0062] Specifically, the punch, driven with vertical movement, starts from its maximum vertical position (top dead centre; indicated hereinafter by the term TDC) and begins its descent towards the metal sheet.

[0063] After die-cutting the slot 39 when in its minimum vertical position (bottom dead centre; indicated hereinafter by the term BDC), the punch reverses its direction of movement and returns towards the TDC; on reaching this point it again reverses its direction of movement and again commences the punching cycle without stopping.

[0064] The punch hence moves with linear, reciprocating, continuous movement.

[0065] During the rise of the punch 8 and the subsequent descent step, the divider rotates the metal sheet (disc or angular sector shape) about the vertical axis by the predetermined amount.

[0066] The divider 3 halts just before the punch 8 die-cuts the slot 39, to then restart its movement immediately after this has been done in order to bring the metal sheet into the exact position for cutting the next slot 39.

[0067] The movement of the divider is hence of discontinuous (stepwise) rotary type.

[0068] The movement of the punch and of the divider take place simultaneously, the motions which characterize them being mutually synchronized.

[0069] The cycle terminates when the divider 3 has effected the predetermined number of snap movements (discontinuous rotations or divisions).

[0070] At this point the punch stops at its TDC and the now machined metal sheet (disc or angular sector shaped) can be removed.

[0071] Figure 2 shows a metal sheet blanked by a punching machine of the invention.

[0072] It has been found in practice that the punching machine for blanking metal sheets according to the invention is particularly advantageous because it ensures rigidity in a lateral direction (flexure) to obtain minimum deviation during shaft rotation, torsional rigidity to obtain maximum precision during shaft rotation, and shaft rotation start and stop control of purely electrical type.

[0073] Moreover the metal sheet to be machined by the punching machine is mounted directly on the shaft: as there are no intermediate elements, any angular movement of the shaft results in the same angular movement of the metal sheet (of disc or angular sector shape) being machined.

[0074] In addition, the angular position achieved by the shaft (and hence also by the metal sheet being machined) is verified and monitored by the electrical/electronic device mounted directly on the shaft; there are no intermediate connection elements between the shaft and the electrical/electronic device for angular measurement.

[0075] The invention ensures complete absence of slack between the shaft, the metal sheet to be machined and the electrical/electronic device measuring angular movement.

[0076] Moreover the complete absence of intermediate mechanical parts between the shaft and the metal sheet to be machined ensures that there are no parts subject to wear which can cause undesirable mechanical slack to develop with time, and that there is only a small number of mechanical components in movement; hence rotational speeds greater than those of an indirect drive can be obtained.

[0077] The punching machine has the capacity to adapt to different machining requirements in terms of the size of the metal sheet in which to make the slots.

[0078] This is ensured by the ability to move the carriage relative to the centre of rotation of the metal sheet when setting up the punching machine.

[0079] The punching machine has also the capacity to adapt to different machining requirements in terms of the number of slots to be made.

[0080] The divider is guaranteed able to effect the determined number of angular snap or discontinuous rotational movements (divisions) established by the user of the punching machine during its setting up.

[0081] The user can easily and quickly vary the number of slots to be made so minimizing machine downtimes when modifying the type of machining to effect on the disc (or angular sector).

[0082] Finally, the punching machine of the invention ensures precision in the angular positioning of the metal sheet, such as to respect the machining tolerances required for the finished product, without prejudice to synchronism between the punch which blanks the metal sheet and the angular movement of this latter; in the same manner the punching machine ensures rotary movement precision such as to respect the machining tolerances required by the finished product (absence of divider eccentric movement).

[0083] The punching machine for blanking metal sheets conceived in this manner is susceptible to numerous modifications and variants, all falling within the scope of the inventive concept; moreover all details can be replaced by technically equivalent elements.

[0084] In practice the materials used and the dimensions can be chosen at will according to requirements and to the state of the art.

Claims

1. A punching machine (1) for blanking metal sheets, comprising a base (2) carrying a divider (3) or locking device for locking and retaining a metal sheet (4) to be blanked, and a carriage (5) carrying at least one punch (8) movable between a rest position and a blanking position, **characterized in that** the base (2) carries, for rotatably driving the divider (3), a mo-

tor (11) which is directly connected to the divider (3) itself.

2. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** there are no mechanical transmission members provided between the motor (11) for rotatably driving the divider (3) and the divider (3) itself.

3. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** said punch cooperates with a die (9), where said die (9) and said punch (8) define a die assembly supported by said carriage (5).

4. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the base (2) and the carriage (5) are movable relative to each other to adjust the position in which to blank the metal sheet (4).

5. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the longitudinal axis of the motor (11) coincides with the axis of rotation of the divider (3).

6. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the divider (3) comprises a casing (15) internally housing the stator (16) and rotor (17) of the motor (11).

7. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** an annular chamber (19) is provided between the stator (16) and the casing (15) for circulating a cooling liquid.

8. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the rotor (17) is keyed onto a shaft (21) of substantially vertical axis connected upperly to a drive jig (22) for the metal sheet to be machined.

9. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the drive jig (22) presents a frusto-conical longitudinal cross-section to offer a Morse cone connection.

10. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the top portion of the shaft (21) is guided by a cylindrical roller bearing (23).

11. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the shaft (21) is supported by two oblique ball bearings (24, 25), the axial clearance being settable by cup springs (27).

12. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** the lower end of the shaft (21) presents a portion (36) projecting downwards from a closure cover (33) for the casing (15) and connected to an electrical/electronic device (37) for measuring its angular position.

13. A punching machine (1) as claimed in one or more of the preceding claims, **characterised by** comprising a controller preferably of PLC or CNC type for controlling said motor (11).

14. A punching machine (1) as claimed in one or more of the preceding claims, **characterised by** also comprising an operating motor for the punch (8), said punch operating motor being controlled by said controller.

15. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** said controller also controls the adjustment of the carriage (5) relative to the base (2) by means of suitable actuators.

16. A punching machine (1) as claimed in one or more of the preceding claims, **characterised in that** said electrical/electronic measuring device (37) is connected to said controller.

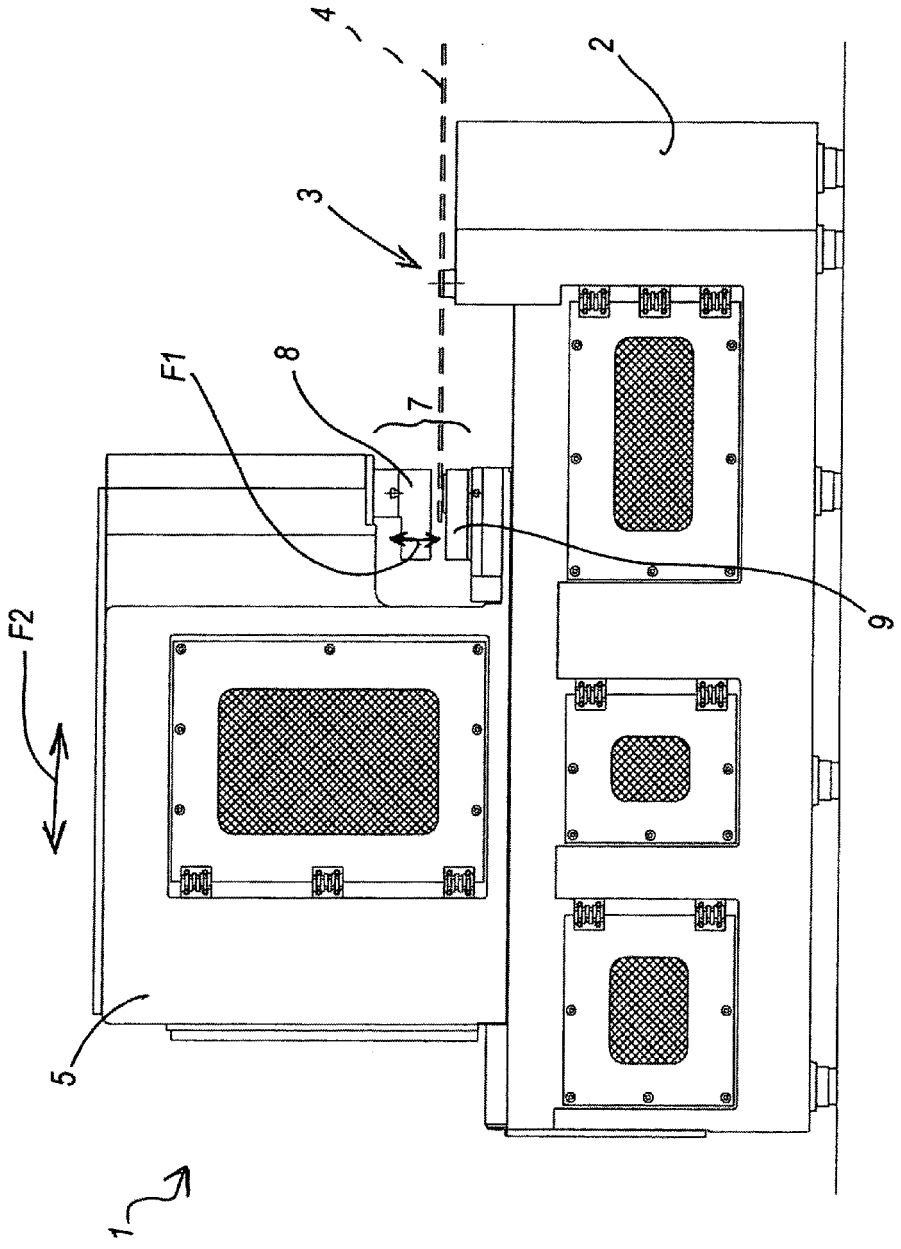

Fig. 1

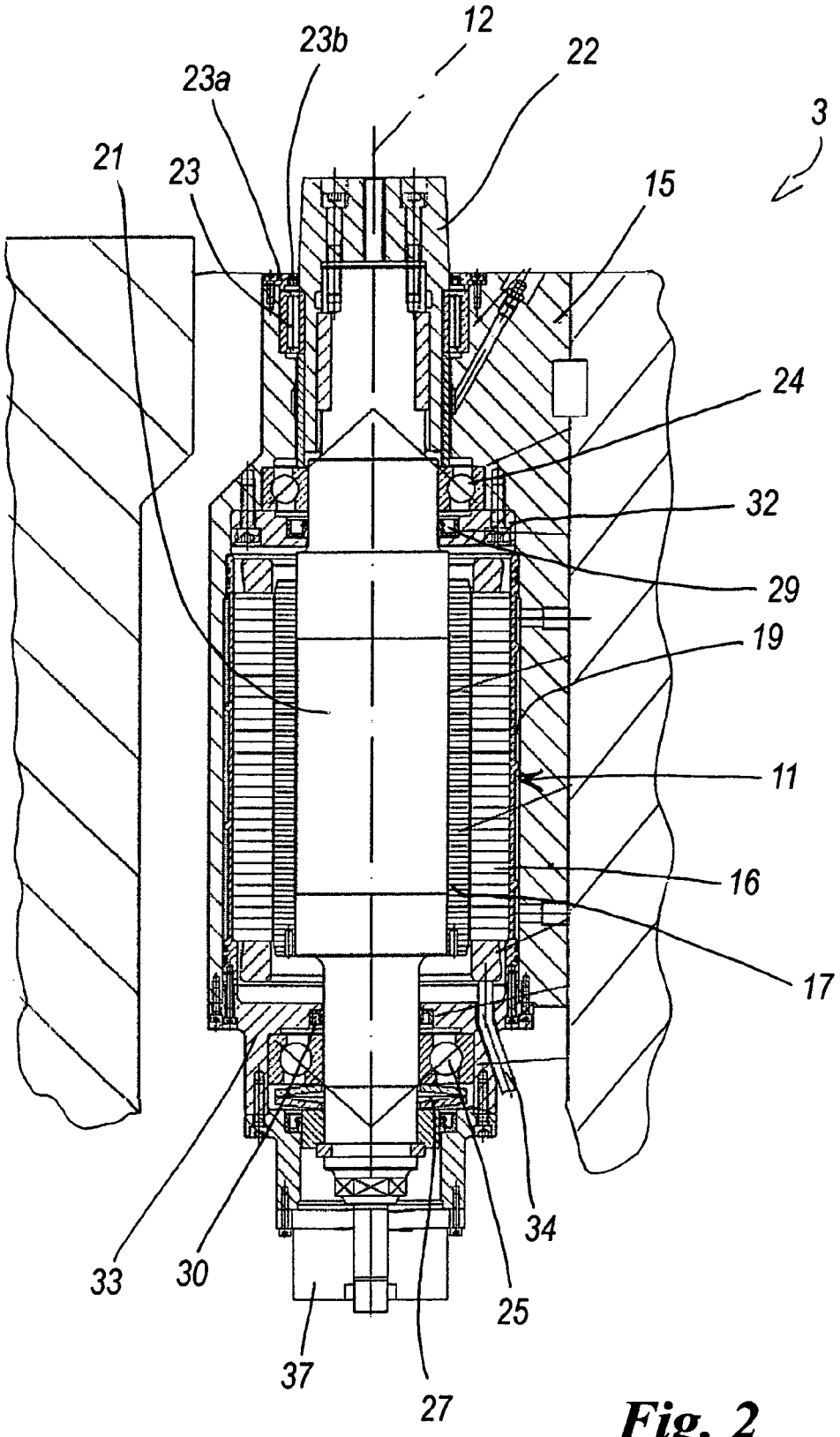

Fig. 2

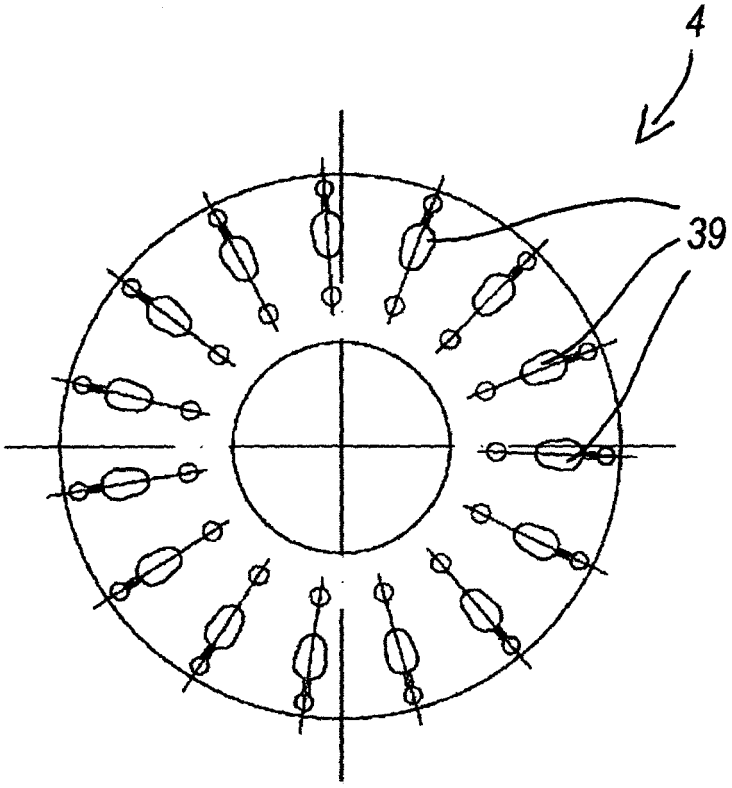

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
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TECHNICAL FIELDS SEARCHED (IPC)

B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 April 2008	Vinci, Vincenzo

CATEGORY OF CITED DOCUMENTS

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