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(54) **Title**: QUICK ATTACHMENT ARRANGEMENT FOR A MOTION AXIS MODULE OF A CNC STATION

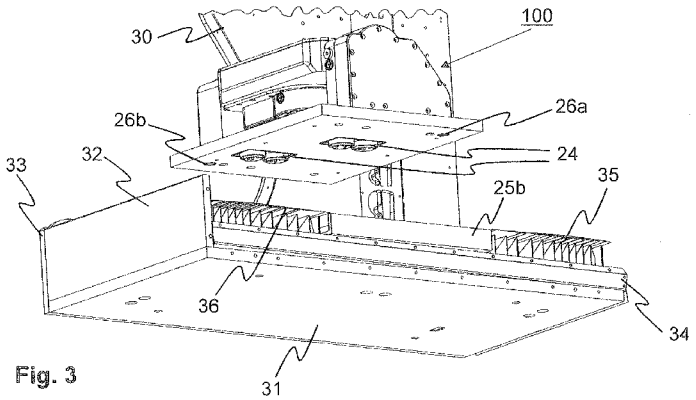

Fig. 3

(57) **Abstract**: The invention relates to a mechanical and electrical quick attachment system for a motion axis module (100) to be utilised in the machining station of a CNC machine tool, where the normal user of the machine alters the number of machining axes in the CNC machine tool by changing the quick-attached motion axis module (100) in the machining station for another on the work table (20) of the machine tool (30).

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Quick attachment arrangement for a motion axis module of a CNC station

The invention relates to a quick attachment arrangement for a motion axis module to be utilised in a CNC machine tool, where the number of machining axes in the CNC machine tool is altered by changing in the CNC machine tool the quick-attached motion axis module to a base plate of the work table of the CNC machine tool, whereby a CNC machine tool with three, four, five or six axes is obtained.

Prior art

Figure 5 shows a conventional numerically controlled control solution of a numerically controlled machine tool complex 50. The user of the machine tool programs and/or controls the machine tool mainly via a control unit 51. The control unit 51 comprises an operation panel and a display device for giving machining instructions to the machine tool 56. The operation of the machine tool 56 is controlled with an operation control unit 52, which comprises two operational parts: a motion control unit and a machine control unit, which is also called an adaption part.

The motion control unit forms motion control signals 561a needed in the machine tool 56 during the machining. With the motion control signals the motion control unit controls servo motors 561 belonging to the machine tool 56 via a servo amplifier 55. The motion control unit also deciphers feedback signals 561b received from the servo motors 561 of the machine tool 56.

The motion control unit shown in Figure 5 can however not give commands to various auxiliary devices belonging to the machine tool 56, but a machine control unit belonging to the operation control unit 52 is used for giving these commands. The machine control unit and the motion control unit are in continuous interaction with each other while the machine tool is operational.

The machine control unit functions as an interface between the inputs and outputs of the control unit 51 and the machine tool 56, see reference 53. For example all the push-buttons, switches and warning lights, which are needed when using the machine tool 56, are controlled via the machine control unit.

The machine tool 56 may also include a control panel 54 of the machine tool, which control panel may have various function controls and signal lights, by using which some functions of the machine tool 56 may be monitored and/or controlled.

In the control system for the machine tool according to Figure 5, all the servo motors 561 controlling the machining devices are attached to the work table attached to the frame of the machine tool 56. The servo motors 561 can be used to control both the machining tool and the work table holding and/or moving the piece to be machined.

Several machining axes can be utilised in the machine tool 56. It depends on the number of machining axes and the machine tool 56, what kind of pieces can be manufactured with it. On the other hand, it depends on the ability of the control of the machine tool, how many machining axes and/or shafts belonging to the machine it can be used to control. In order to be able to use the machine tool in a diverse manner, the machine tool must have a sufficient number of controllable machining axes.

The machining axes of the machine tool are usually named according to the ISO standard, in order to know in which direction the movement is at any time. The machining axes can be named as follows.

The basic linear axes are the **X**, **Y** and **Z** axes, which are perpendicular to each other. The **Z** axis is usually in the direction of the shaft, which is used to machine the piece. Rotational movements occurring around the linear axes **X**, **Y** and **Z** are described with other axes as follows. The axis **A** rotates around the **X** axis. The axis **B** rotates around the second linear axis **Y**. The axis **C** rotates around the **Z** axis in the direction of the shaft being machined.

The movements of said axes and shafts can be controlled for example with servo motors. In known solutions the servo motors are installed in a fixed manner to the frame or work table of the machine tool. The control signals of the servo motors are generated in the motion control unit. A servo amplifier 55 amplifies the control signals, so that they can achieve the desired movement in the machining object. Generally the servo amplifiers are situated in an electric installation space of the machine tool. The servo motors and the servo amplifiers are connected to each other with fixed cabling. Thus changing the number of machining axes in the machine tool also requires cabling work, before the work can be started. Changing

the cabling takes time. Therefore machine tools are very commonly equipped with more machining axes than what is required in the machining of simple pieces.

In order to speed up the starting and finishing of the machining of different pieces in the machine tool, some machine tool systems utilise two or more parallel work tables, of which one at a time is moved into the machining station of the machine tool.

Patent application publication US 2009/0110505 describes a machine tool, into the machining station of which work tables can be changed, to which the pieces to be machined are attached. The described work tables are however a fixed part of the machine tool, and they do not have motors or other actuators associated with moving the work tables. When a piece on one work table is machined, a completed piece on another work table can be exchanged for a new preform, which has not been machined. When the previous piece to be machined is completed, the work tables always change places as controlled by the machine tool.

Machine tool solutions are also known, where two or more machining axes utilised in the machine tool are arranged to function as a part of the work table.

For example in application publication US 2006/0242818 shows a CNC machine with five axes and a work table utilised therein. The described work table includes means for turning/moving the piece on the work table in relation to two axes **C** and **Z**. The work table described in the publication is however a fixed part of the described CNC machine, and changing the work table requires changing the technical structure of the machine.

Application publication WO 2005/018875 shows a machine tool, where the movements of three machining axes **X**, **Y** and **C** needed in the machining are achieved in the machining table of the machine tool. The work table of the machine tool described in the publication is however permanently attached to the frame of the machine tool.

Publication US 2006/0089089 shows a large three-axis work table arrangement of a heavy machining centre, which is installed in the frame of the machining centre in a fixed manner. As a problem with the work table described in the publication has been presented the size and weight of the work table, which according to the

publication cannot be decreased to such a degree that the solution could be utilised in small machining centres. The publication presents an improvement where the work table can be made lighter by attaching the work table by one side to the frame structure of the machining centre. With this arrangement some of the devices controlling the position of the work table can be installed inside the frame structure of the machining centre, whereby the machining table itself thus becomes smaller and lighter.

Publication WO 2006/031265 shows a mechanical adaptation unit to be connected to the work table of a machining centre, which unit is installed between the work table and the part keeping hold of the piece to be machined. By using the adaptation unit presented in the publication, the same part keeping hold of the work piece can be used in machining centres of different brands. The described adaptation unit is attached with a bolt joint in a fixed manner to the work table of the machining centre by its lower surface. Hydraulic, pneumatic or electric feeds going via the adaptation unit to the part keeping hold of the work piece are each separately connected via connectors in the sides of the adaptation unit according to the reference. In order for the part keeping hold of the work piece to function in the planned manner, the connections must be made in one defined manner. Thus the use of the adaptation unit described in the reference always requires a professional acquainted with connections to make said connections.

There is therefore a need for a machine tool solution, where a normal user of the machine can quickly and simply change the machining properties of the machine tool, or more precisely the number of machining axes.

Summary of the invention

It is an object of the invention to provide a new machine tool arrangement, by using which the number of machining axes of the machine tool needed for machining can quickly be changed according to need.

The objects of the invention are attained with a motion axis module of the machine tool, which can be quickly installed in the machine tool with the aid of mechanical controls in the base plate of the work table of the machine tool. The quick-attached motion axis module advantageously comprises servo or step motors needed for moving the piece to be machined and amplifiers of the motors as well as encoders identifying the motion station. Signal cablings going to and from the

amplifiers and encoders are arranged to be connected with fixed connectors in the motion axis module from jacks in the base plate. Also the electricity feed needed for the actuators of the motion axis module and/or the connections needed for the pneumatics are handled using corresponding plug-jack combinations. Changing a motion axis module according to the invention for another does thus not need to comprise changing the cablings in the motion axis module or work table, but all the necessary cable connections are in connection with installing the new motion axis module also connected at the same time from the motion axis module via the machining table to the control unit of the machine tool.

It is an advantage of the invention that the number of machining axes in the machine tool can be changed simply by changing the motion axis module of the machine tool. The machine tool can be acquired as a version, where the machine tool has the functional properties that are needed at the time of the purchase and a readiness for simple changing of the motion axis module without technical changes. The functional properties of the machine tool can later be updated by acquiring a motion axis module according to the invention, which supports new functionalities.

It is further an advantage of the invention that after the installation of the motion axis module no further additional procedures or additional installations are needed for bringing the machine tool into working condition.

It is further an advantage of the invention that when installing the motion axis module to the work table, all the electrical and pressurised air-underpressure connections between the motion axis module and the control system of the machine tool are connected, when the motion axis module is mechanically locked into the work table.

A machining arrangement according to the invention, which comprises a work table of the machine tool with a base plate and a motion axis module, which have quick attachment means for connecting the motion axis module to the base plate of the work table, is characterised in that the quick attachment means comprise
– attaching pins in the base plates and attaching notches in the motion axis module for realising a mechanical quick attachment and
– electrical connectors in the base plate and electrical plugs in the motion axis module, which electrical connectors and electrical plugs are arranged to connect the motion axis module electrically to the electrical control system of the machine

tool, when the motion axis module is mechanically attached to the base plate of the work table.

The motion axis module according to the invention is characterised in that the motion axis module comprises quick attachment means for connecting the motion axis module at the same time both mechanically and electrically to the base plate of the work table of a multi-axis machine tool, which quick attachment means comprise

– mechanical quick attachment means, which comprise at least two attaching notches on the lower surface of the attaching plate of the motion axis module, and

– electrical quick attachment means, which comprise one or more electrical plugs on the lower surface of the attaching plate of the motion axis module.

The work table of the machine tool according to the invention is characterised in that the base plate of the work table comprises

– at least two attaching pins for aligning and attaching the motion axis module in a mechanical manner and

– electrical connectors, which are arranged to connect the electrical actuators of the motion axis module to the electrical control system of the machine tool, when the motion axis module is mechanically connected to the base plate.

Some advantageous embodiments of the invention are presented in the dependent claims.

The basic idea of the invention is the following: A motion axis module according to the invention, which can be connected to the base plate of a numerically controlled machine tool, can alternatively comprise either zero, one, two or three axes utilised in the machining. In all the above-mentioned cases the mechanical dimensions of the motion axis module according to the invention, which dimensions are important for the attaching, are the same and they are based on the internal standards of the product family of the CNC machine in question. Also the mechanical guide/connection means used in attaching the motion axis module to the work table are the same in all cases. Further the connectors and plugs used in electrically connecting the motion axis module and the machine tool to each other are in all above-mentioned cases the same. Further the connectors and plugs used in pneumatically connecting the motion axis module and the machine tool to each other are in all above-mentioned cases the same. Also the position of all above-mentioned plugs in the motion axis module and the position of all the

connectors in the base plate of the work table of the machine tool is unchanged in all above-mentioned cases. The electrical plugs and pneumatic connections in the motion axis module are connected to counterparts, the connectors, in the base plate of the work table of the machine tool, when the motion axis module is installed into place in the base plate of the work table using mechanical connecting means.

The number of machining axes determines such structural properties of the motion axis module as for example the number of motors and their placement. The amplifier needed by each motor installed in the motion axis module can advantageously also be installed in the motion axis module.

With the above-described structural arrangements the number of machining axes in the machine tool can quickly be changed by detaching the previous motion axis module from the quick attachments of the work table and by attaching a new motion axis module, the machining properties of which differ from the previous work module, to the work table of the machine tool.

In the following, the invention will be described in detail. In the description, reference is made to the appended drawings, in which

Figure 1 shows the functional main parts of a motion axis module according to the invention as an exemplary exploded view,

Figure 2 shows as an example the motion axis module of Figure 1 seen from the side when it is ready to be installed in a work table according to the invention,

Figure 3 shows as an example the motion axis module shown in Figure 2 and the machining table seen from below,

Figure 4 shows as an example the motion axis module shown in Figure 2 as attached to the work table and

Figure 5 shows as an example a machine tool arrangement according to prior art.

The embodiments in the following description are given as examples only, and someone skilled in the art may carry out the basic idea of the invention also in some other way than what is described in the description. Though the description may refer to a certain embodiment or embodiments in several places, this does not mean that the reference would be directed towards only one described embodiment or that the described characteristic would be usable only in one described embodiment. The individual characteristics of two or more embodiments may be combined and new embodiments of the invention may thus be provided.

Figure 5 is described in connection with the description of prior art.

Figure 1 shows as an exploded view a motion axis module 100 according to the invention, which can be attached to a work table according to the invention of a numerically controlled machine tool.

In the description of an exemplary embodiment in Figure 1, a servo motor is shown as a motor to be utilised in the motion axis module, and suitable electrical components to be utilised in the control thereof. It is clear to someone skilled in the art that for example a step motor with the auxiliary devices associated therewith can be used instead of the servo motor. A harmonic gear has been shown in the exemplary embodiment of Figure 1 as the gear to be utilised in the motion axis module. It is clear to someone skilled in the art that a planet or worm gear can also be utilised in the motion axis module without deviating from the inventive idea.

Figure 1 shows the functional main parts of the motion axis module 100 according to the invention. The motion axis module 100 comprises an attaching plate 18, where the other components of the motion axis module 100 are advantageously attached. The attaching plate 18 also comprises means, with which the motion axis module 100 according to the invention is attached to the work table of the machine tool according to the invention.

In Figure 1 reference 7 shows a left axle stand used for supporting the **A** axis of a rotary table 12 belonging to the motion axis module 100. The axle stand 7 is in Figure 1 attached to the left edge of the attaching plate 18. The axle stand 7 has an axle hole 7a, wherein the left axle stub (not shown in Figure 1) in the rotary table 12 is arranged to be installed. Sensors 16, which are used to indicate the position of the rotary table 12 in relation to the **A** axis, are arranged to be installed

into a hollow (not shown in Figure 1) made in the axle stand 7. The left axle stand 7 is advantageously closed with a lid 15.

References 5 and 6 show axle stand components of a right axle stand used for supporting the **A** axis of a rotary table 12 belonging to the motion axis module 100. The opposite surfaces of the axle stand components 5 and 6, which form the right axle stand, have been machined so that a hollow 19 is formed between them, when the axle stand components 5 and 6 have been attached against each other.

The axle stand component 5 has an axle hole 5a, wherein the right axle stub 12a in the rotary table 12 is arranged to be installed.

In said hollow 19 formed between the axle stand components has been placed a harmonic gear 2b (the first harmonic gear), the first end of which is arranged to be attached to the axle stub 12a of the rotary table. Also the motor 3b (the first servo motor) rotating the **A** axis and advantageously also the thereto connected encoder 9b identifying the motion position of the servo motor 3b are in the hollow forming between the axle stand components 5 and 6. In the hollow 19 there is advantageously also space for the servo amplifier 8b of the servo motor 3b of the **A** axis.

The rotating motion of the axle of the servo motor 3b is conveyed with a cogged belt 10 (the first cogged belt) to the second end of the harmonic gear 2b. A hollow 6a has been machined for the cogged belt 10 in the surface of the axle stand component 6, which is away from the rotary table.

The right axle stand is advantageously closed with a lid 14 connected to the axle stand component 6.

The rotary table 12 of the motion axis module 100 advantageously has a rectangular shape. In Figure 1 there are in the left and right end of the rotary table 12 axle stubs, with which the rotary table 12 is arranged to be connected in a rotating manner to the left and right axle stand. The rotary table 12 can be rotated supported on the axle stubs in the direction of the **A** axis of the machine tool. Only the right axle stub 12a of the rotary table 12 is shown in Figure 1.

A circular cavity 12b has been machined in the upper surface of the rotary table 12. In the middle of the circular cavity 12b there is an axle hole 12d, where the

axle 1a of a rotary plate 1 needed for rotating the **C** axis is arranged to be installed. A seal 4b and a bearing 4c are advantageously also installed in the cavity 12b. The seal 4b, bearing 4c and rotary plate 1 and the thereto belonging axle 1a are arranged to be installed in the circular cavity 12b so that the axle 1a of the rotary plate 1 extends through the axle hole 12d to the first end of the second harmonic gear 2a.

A hollow 12c has advantageously also been machined through the upper surface of the rotary table 12, where the servo motor 3a (the second servo motor) to be used in rotating the **C** axis is arranged to be installed.

The above-mentioned components are from above the rotary table 12 locked into place by the steel plate 4 of the rotary table. In the steel plate 4 there is in the middle a round opening 4a for the rotary plate 1. The steel plate 4 can advantageously be attached to the rotary table 12 for example with screws.

The lower surface of the rotary table 12 is machined so that the components which move the piece being machined in the direction of the **C** axis and their protective covers can fit in the hollow (not shown in Figure 1) formed in the lower surface of the rotary table 12.

These components comprise among others a second servo motor 3a rotating the **C** axis, which servo motor is installed partly also in the hole 12c penetrating the rotary table 12. They also comprise an encoder 9a identifying the motion position of the second servo motor 3a and advantageously also a servo amplifier 8a (the second servo amplifier) of the second servo motor 3a. The rotating movement of the axle of the second servo motor 3a is arranged to be conveyed with a cogged belt 11 (the second cogged belt) to the second end of the second harmonic gear 2a of the **C** axis. The second harmonic gear 2a is arranged to be connected by its first end to the axle 1a of the rotary plate 1.

All the above-mentioned components utilised in the operation of the **C** axis are closed into a hollow in the lower surface of the rotary table 12 with the lid 17 of the casing of the **C** axis.

In one advantageous embodiment of the invention the amplifiers and/or electrical controls of the motors are situated in the control centre of the machining centre. In this embodiment the connection of the motors to the amplifiers and/or the control

circuits is arranged to connect via the quick connectors, when the motion axis module is connected mechanically to the base plate of the work table.

Figure 1 does for the sake of the clarity of Figure 1 not show the cabling arrangements of the motion axis module 100. The motion axis module according to the invention also comprises plugs/quick connectors (reference 23 in Figure 2) attached in the lower surface of the attaching plate and utilised in the connecting of the cablings and the pneumatics. The plugs are advantageously connected via the axle stands 5, 6 and 7 of the motion axis module 100 to the electric components of the motion axis module 100 according to the invention.

Figure 2 shows an assembled motion axis module 100 according to the invention and a base plate 20 of a work table according to the invention, whereon the motion axis module 100 according to the invention can be installed. Figure 2 does not show attaching means, with which the actual piece to be machined is attached either to the rotary plate 1 of the rotary table 12 or to some other attaching means installed on the attaching plate 18. It is clear to someone skilled in the art that the attaching of the piece to be machined can be done with several different means and in several different manners.

The rotary table 12, which is supported in a rotating manner to the motion axis module 100 with the aid of the axle stands 5, 6 and 7, can be rotated/tilted in relation to the **A** axis. The driving force for tilting the rotary table 12 is obtained from the first servo motor 3b.

The rotary plate 1 on the upper surface of the rotary table 12 can be turned in relation to the **C** axis. The driving force needed for the turning is obtained from the second servo motor 3a.

With the above-mentioned means, two machining axes can be realised in the motion axis module 100 according to the invention.

The base plate 20 of the machine tool according to the invention advantageously comprises a support plate 21, side controls 25a and 25b, attaching pins 22a and 22b and quick connectors 23. The exemplary quick connectors 23 in Figure 2 may advantageously comprise one or more low current connectors, high current connectors and pneumatic connectors. The same base plate 20 according to the invention can be utilised with all motion axis modules according to the invention.

The installation position for the motion axis module 100 to be connected to the base plate 20 is advantageously determined with two or more attaching pins 22a and 22b in the base plate 20 of the work table.

Figure 3 shows diagonally from below a part of the frame of the machine tool 30, the motion axis module 100 according to the invention, a part of the side control 25a of the base plate 20 and solid support structures 21, 32, 33 and 34 of the machining table.

Figure 3 shows components on the lower surface of the attaching plate 18 belonging to the motion axis module 100. References 26a and 26b show notches, wherein the attaching pins 22a and 22b are arranged to be installed. Reference 24 shows four exemplary plugs/quick connectors on the lower surface of the attaching plate 18 belonging to the motion axis module 100, which plugs/quick connectors are arranged to connect to connectors 23 in the machining table 20, when the motion axis module 100 is installed into place using the attaching notches 26a and 26b and the attaching pins 22a and 22b. The plugs 24 advantageously comprise one or more low current plugs, high current plugs or plugs/quick connectors providing a pneumatic connection. It is clear to someone skilled in the art that the number and placement of the plugs/quick connectors 24 and connectors 23 in the base plate 20 can also be some other than the solution presented in Figure 3.

The base plate 20 according to the invention can advantageously be attached to the frame of the machine tool, so that the base plate 20 of the work table can be moved in a controlled manner in the direction of the **Y** axis, as is shown in Figure 4. When the motion axis module 100 according to the invention shown in Figure 2 is connected to the base plate 20 of a work table according to the invention, which base plate is installed in the solid support structures 31–34 of the machine tool 30 according to Figure 3, a three-axis machining station is provided, where the **Y**, **A** and **C** axes can be utilised according to Figure 2 and 4.

If it is desired to change the number of machining axes in the machine tool from what it is in Figures 2, 3 and 4, then another motion axis module is connected to the base plate 20 of the work table according to the invention, which has a number of machining axes which differs from the one in Figure 2. When the motion axis

module is connected to the base plate 20, the number of utilised machining axes can for example be zero, one, two or three.

In the example of Figure 4 the motion axis module 100 according to the invention is attached both mechanically and electrically to the base plate 20 of the work table of the machine tool. The work table according to the invention can be moved in the direction of the **Y** axis. The base plate 20 according to the invention is attached to a means (not shown in Figure 4), which provides a linear movement in the direction of the **Y** axis. The linear movement on the direction of the **Y** axis can advantageously be provided for example with a shaft, a cogged belt or some other known device providing a linear movement.

In order to recover machining fluid and machining residues the machining station advantageously comprises two folding protective lids 35 and 36. When the base plate 20 according to the invention is moved in the direction of the **Y** axis, one of the protective lids 35 or 36 stretches and the other one contracts. The mechanical structure of the protective lids 35 and 36 is such that in whichever point in the direction of the **Y** axis the base plate 20 of the work table is, the protective lids 35 and 36 protect the inner parts of the machine tool. It is clear to someone skilled in the art that the structure of the protective lids 35 and 36 can be some other than the structure shown in Figures 3 and 4.

All the above-mentioned controls of the different machining axes and movements of the machining shaft of the numerically controlled machine tool can be realised as controlled by computer program commands, which computer program commands are executed in a suitable general or special-purpose processor, which is advantageously a part of the numerically controlled machine tool. The computer program commands can also be stored in a computer-readable media, such as a data disk or a memory, from where the processor of the machine tool can retrieve said computer program commands and execute them. The references to computer-readable media can for example also contain special components, such as programmable USB Flash memories, logic arrays (FPLA), application-specific integrated circuits (ASIC) and signal processors (DSP).

Some advantageous embodiments of the device according to the invention have been described above. The invention is not limited to the solutions described above, but the inventive idea can be applied in numerous ways within the scope of the claims.

Claims

1. A multi-axis machining arrangement for a numerically controlled machine tool (30), which comprises
– a base plate (20) of a work table, which base plate is configured to move in the direction of the **Y** axis of the machining station
– a motion axis module (100) attached to the base plate (20) of the work table, which motion axis module comprises at least one of the means, which are configured to
– turn a piece to be machined, which is attached to the motion axis module, in the direction of the **A** axis of the machining station
– turn a piece to be machined, which is attached to the motion axis module, in the direction of the **C** axis of the machining station, and
– means for attaching the piece to be machined to the motion axis module (100),
characterised in that the motion axis module (100) is attached with quick attachment means (22a, 22b, 23, 24, 26a, 26b) to the base plate (20) of the work table, which quick attachment means comprise
– attaching pins (22a, 22b) in the base plate (20) and attaching notches (26a, 26b) in the motion axis module (100) for realising a mechanical quick attachment and
– electrical connectors (23) in the base plate (20) and electrical plugs (24) in the motion axis module (100), which electrical connectors and electrical plugs are arranged to connect the motion axis module electrically to an electrical control system of the machine tool, when the motion axis module is mechanically attached to the base plate (20) of the work table.

2. The machining arrangement according to claim 1, **characterised** in that the electrical plugs (24) of the motion axis module (100) comprise both low current and high current plugs.

3. The machining arrangement according to claim 2, **characterised** in that the motion axis module (100) and the base plate (20) of the motion axis module (100) also comprise pneumatic connectors.

4. A motion axis module (100) of a multi-axis, numerically controlled machine tool (30), which comprises at least one of the means, which are configured to
– turn a piece to be machined, which is attached to the motion axis module, in the direction of the **A** axis of the machining station

– turn a piece to be machined, which is attached to the motion axis module, in the direction of the **C** axis of the machining station, and

– means for attaching the piece to be machined to the motion axis module (100), **characterised** in that the motion axis module (100) comprises quick attachment means (24, 26a, 26b) for connecting the motion axis module at the same time mechanically and electrically to the base plate (20) of the work table of the multi-axis machine tool (30), which quick attachment means comprise

– mechanical quick attachment means, which comprise at least two attaching notches (26a, 26b) on the lower surface of an attaching plate (18) of the motion axis module (100), and

– electrical quick attachment means, which comprise one or more electrical plugs (24) on the lower surface of the attaching plate (18) of the motion axis module (100).

5. The motion axis module according to claim 4, **characterised** in that the electrical plugs (24) of the motion axis module (100) comprise both low current and high current plugs.

6. The motion axis module according to claim 4, **characterised** in that the quick attachment means of the motion axis module (100) also comprise pneumatic connectors on the lower surface of the attaching plate (18).

7. The motion axis module according to claim 4, **characterised** in that the means for turning the piece to be machined, which is attached to the motion axis module, in the direction of the **A** axis of the machine tool comprise

– a right (5, 6) and a left (7) axle stand

– a rotary table (12) installed on the axle stands to be turnable in the direction of the **A** axis

– a first gear (2b), a first amplifier (8b) and an encoder (9b) and first motor (3b) electrically connected thereto installed in the axle stand (5, 6) and

– a first cogged belt (10) for conveying the rotating movement achieved with the first motor (8b) to the first gear (2b), which is configured to turn the rotary table (12) in the direction of the **A** axis.

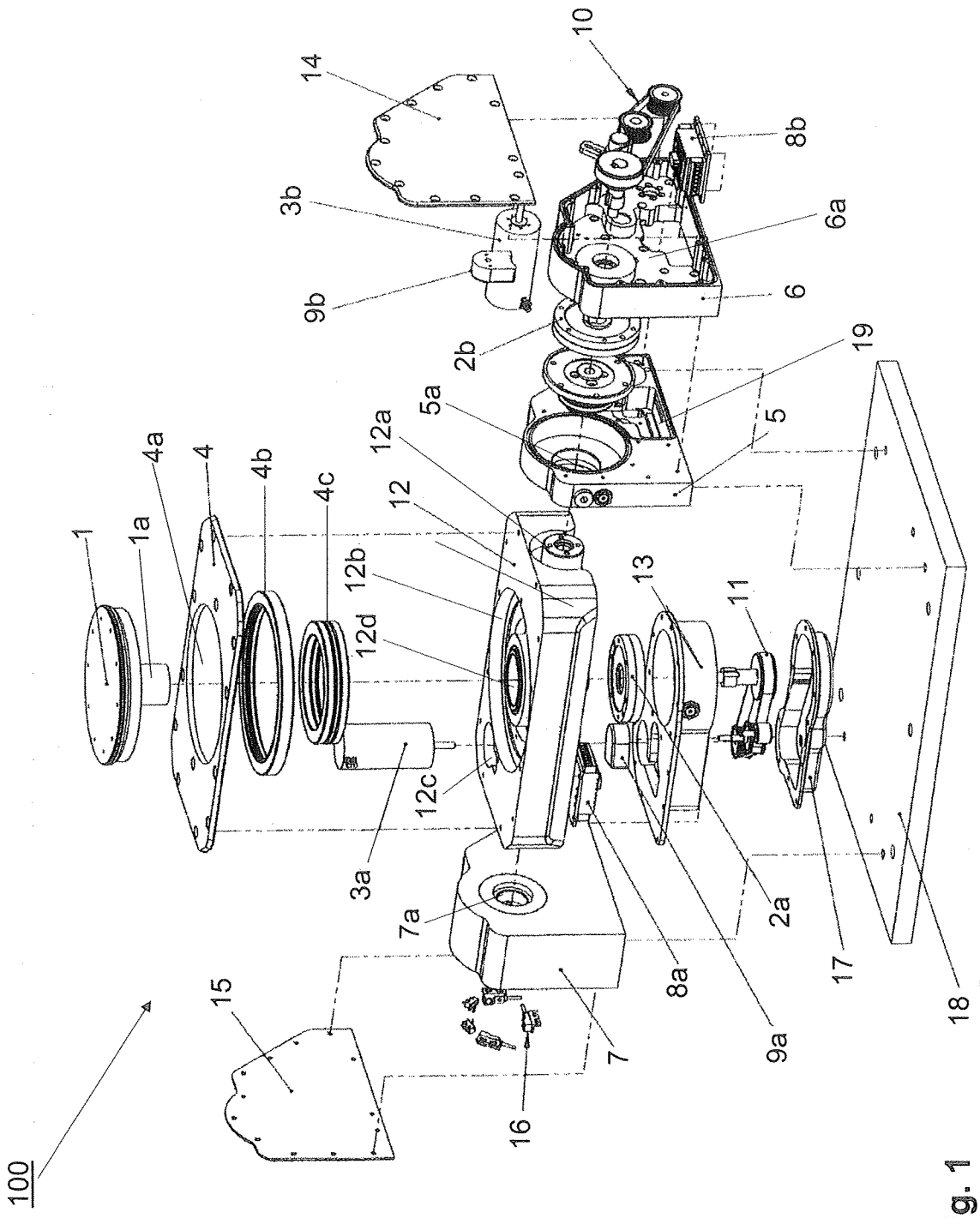
8. The motion axis module according to claim 4, **characterised** in that the means for turning the piece to be machined, which is attached to the motion axis module, in the direction of the **C** axis of the machine tool comprise a hollow in the lower surface of the rotary table (12), in which hollow has been installed

– a second gear (2a)
– a second amplifier (8a) and a second motor (3a) and a thereto electrically connected encoder (9a) and
– a second cogged belt (11) for conveying the rotating movement achieved with the second motor (8a) to the second harmonic gear (2a), which is configured to turn the rotary plate (1) belonging to the rotary table (12) in the direction of the **C** axis.

9. The motion axis module according to claim 4, **characterised** in that the motor (3a) is a servo motor or a step motor and that the gear (2a) is a harmonic gear, a planet gear or a worm gear.

10. A work table of a numerically controlled machine tool (30), which comprises a base plate (20) configured to be moved in the direction of the **Y** axis of the machine tool, which base plate comprises a support plate (21) for mechanically attaching a motion axis module (100) to the base plate (20), **characterised** in that the base plate (20) comprises
– at least two attaching pins (22a, 22b) for aligning and attaching the motion axis module (100) in a mechanical manner and
– electrical connectors (23), which are configured to connect electrical actuators of the motion axis module (100) to an electrical control system of the machine tool (30), when the motion axis module is mechanically connected to the base plate (20).

11. The work table of a machine tool according to claim 10, **characterised** in that the base plate (20) of the work table also comprises pneumatic quick connectors.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1a
4a
4
4b
4c
12
12a
12b
12d
12c
3a
7a
15
16
7
8a
9a
2a
13
11
17
18
5a
5
19
2b
9b
3b
14
10
8b
6a
6

Fig. 1

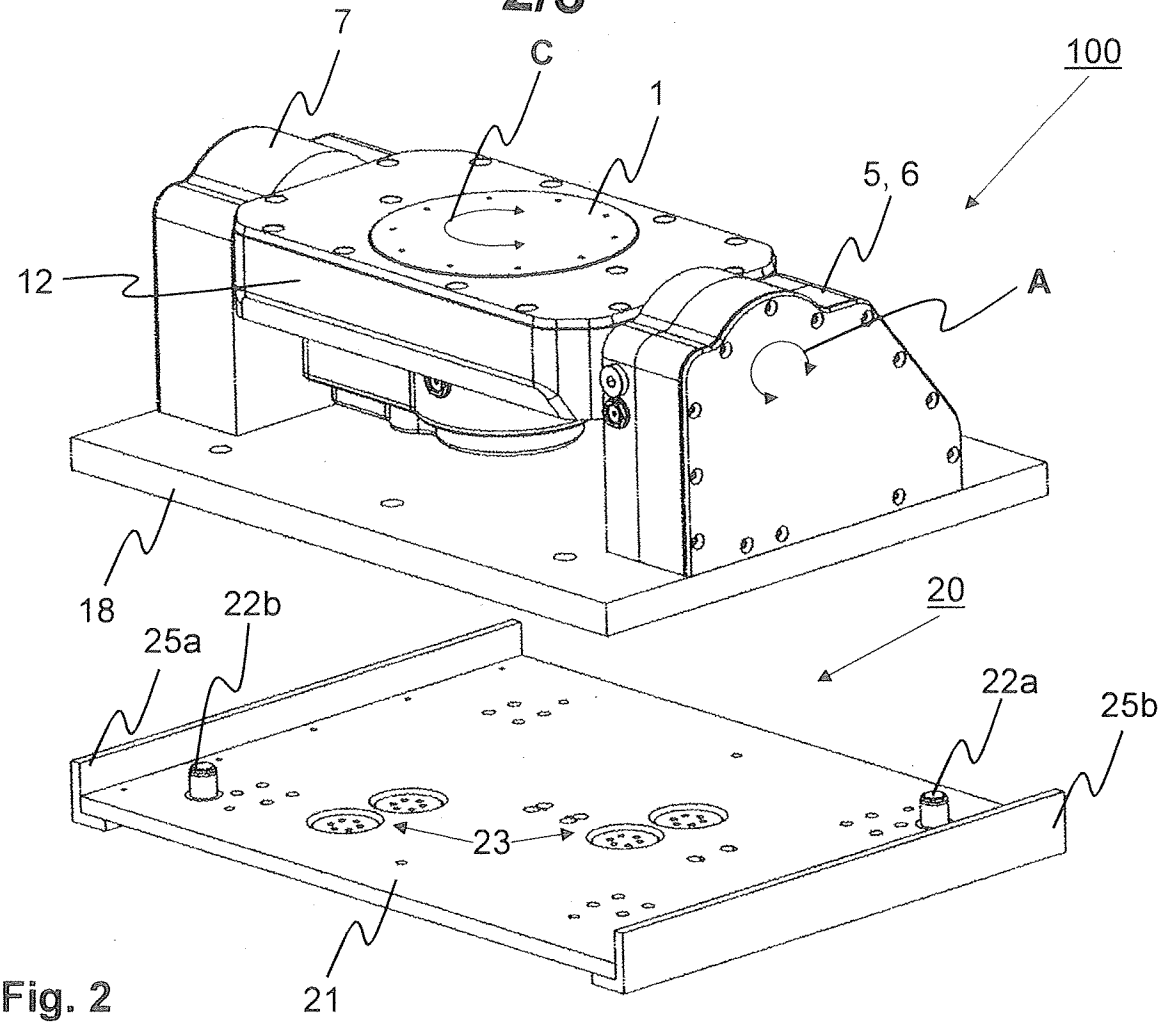
7
C
1
100
5, 6
12
A
18
20
22b
25a
22a
25b
23
21

Fig. 2

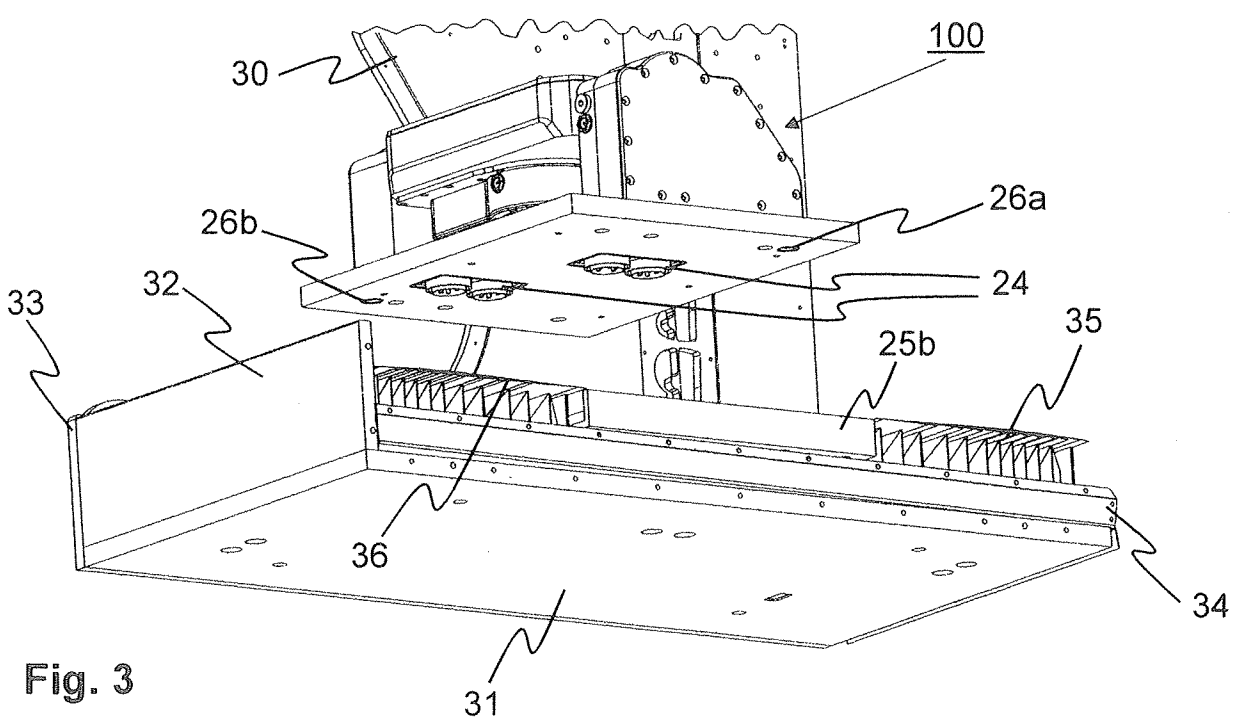
100
30
26b
26a
32
24
33
35
25b
36
34
31

Fig. 3

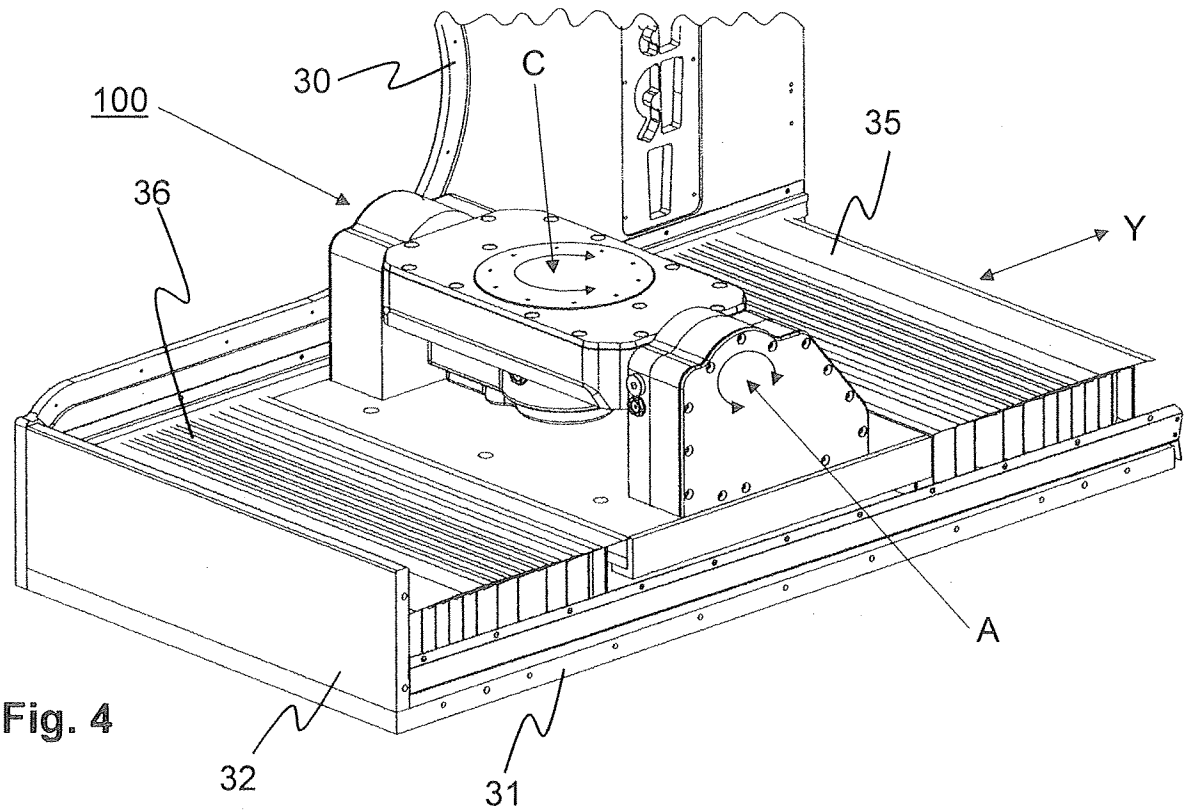

Fig. 4

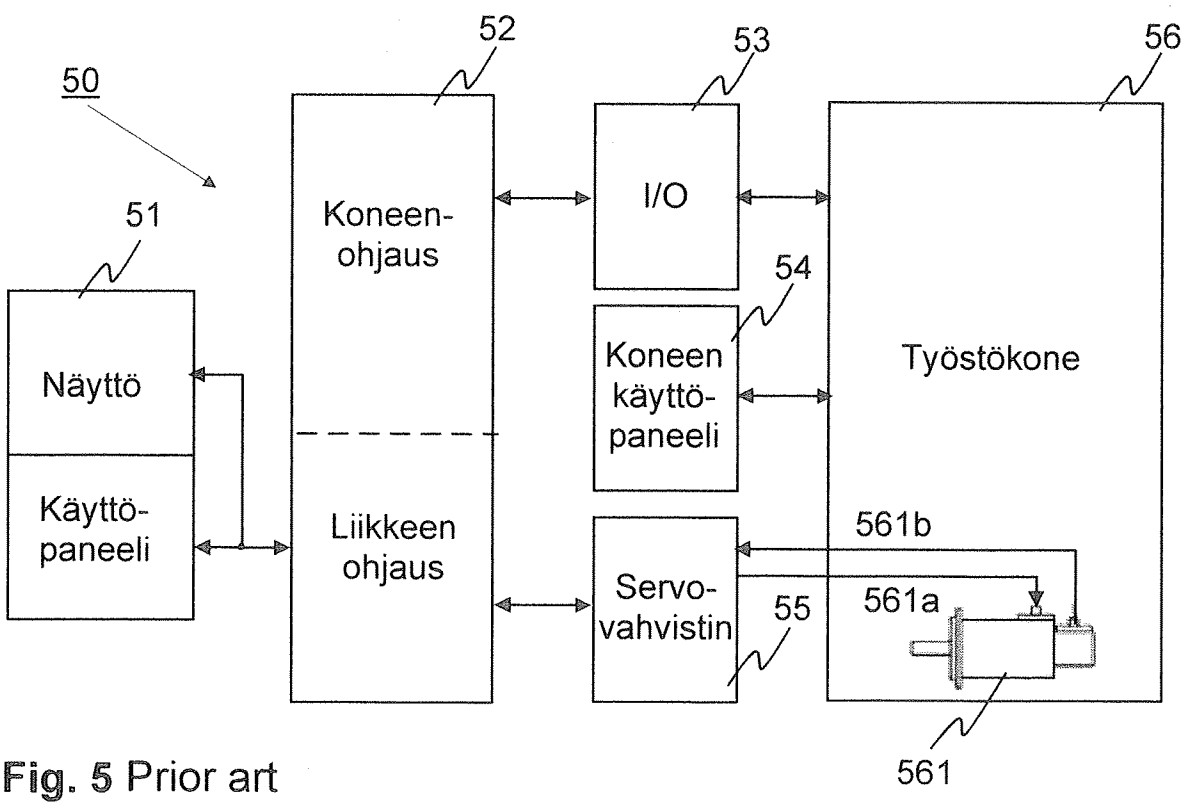

Fig. 5 Prior art

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2011/050672

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B23Q, B25J

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

FI, SE, NO, DK

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

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5239160 A (SAKURA SHUNJI et al.) 24 August 1993 (24.08.1993) abstract; column 3, lines 11-68; column 4, lines 1-68; column 5, lines 1-41; column 7, lines 62-65; claim 1; figures 1-5	1-11
Y	WO 2006031265 A1 (DELPHI TECH INC et al.) 23 March 2006 (23.03.2006) The whole document, especially pages 3-5; figures 1-3	1-11
A	US 2004146369 A1 (KATO HEIZABURO) 29 July 2004 (29.07.2004)	1-11
A	US 2006089089 A1 (KATO HEIZABURO et al.) 27 April 2006 (27.04.2006)	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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

"E" earlier application or patent but published on or after the international filing date

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 December 2011 (21.12.2011)	28 December 2011 (28.12.2011)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2011/050672

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 5239160 A	24/08/1993	JP 4100689 A	02/04/1992
WO 2006031265 A1	23/03/2006	None	
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		TW I230640B B	11/04/2005
		KR 20040035578 A	29/04/2004
		EP 1413390 A1	28/04/2004
		DE 60304793T T2	03/05/2007
		CN 1500589 A	02/06/2004
		JP 2004160642 A	10/06/2004
US 2006089089 A1	27/04/2006	CN 1759983 A	19/04/2006
		KR 20060052163 A	19/05/2006
		EP 1647355 A1	19/04/2006
		DE 602005002517T T2	26/06/2008
		TW I270435B B	11/01/2007
		JP 2006110682 A	27/04/2006

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2011/050672

CLASSIFICATION OF SUBJECT MATTER

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B23Q 1/54 (2006.01)
B23Q 7/02 (2006.01)
B23Q 1/72 (2006.01)
B23Q 37/00 (2006.01)