Machining center with two main spindle units

The invention provides a machining center having a first main spindle unit and also a second main spindle unit with a ram shaft attached to a vertical machining center. A machining center 1 comprises a rotary table 20 that moves in the direction of an X-axis on a bed 10, and a cross rail 40 supported by a column 30 and moving in the direction of a Z-axis. A first main spindle unit 60 is attached to a saddle 50 supported by the cross rail and moving in the direction of a Y-axis. The first main spindle unit 60 is equipped with a first main spindle 70 that rotates around a B-axis. A second main spindle unit 100 disposed between the first main spindle unit 60 and the saddle 50 is equipped with a ram shaft 110 that moves in the direction of a W-axis and a turning head or a milling head that is replaceably attached to the leading end of the ram shaft.
Description

BACKGROUND OF THE INVENTION

Field of the invention

[0001] The present invention relates to a machining center comprising, in addition to a first main spindle, a second main spindle having a long protruding length for providing turning and milling processes to inner bore portions and the like of a work.

Description of the related art


SUMMARY OF THE INVENTION

[0005] The object of the present invention is to provide a machining center having in addition to a first main spindle a second main spindle especially capable of performing a long boring process.

[0006] In order to achieve the above object, the machining center of the present invention comprises, as basic means, a vertical machining center having a table disposed horizontally and a processing unit disposed perpendicularly, wherein the processing unit comprises a first main spindle unit, and a second main spindle unit having an axis of movement that is parallel to the axis of movement of the first main spindle unit.

[0007] Further, the vertical machining center is a gate-type machining center comprising a rotary table disposed on a bed, a means for moving a rotary table in an X-axis direction, a pair of columns disposed vertically on both sides of a bed, a cross rail supported by the column, a means for moving the cross rail in a Z-axis direction, a saddle supported by the cross rail and having a processing unit, and a means for moving the saddle in a Y-axis direction; or the vertical machining center is a column-type machining center comprising a rotary table disposed on a bed, a saddle moving on the table in an X-axis direction, a column moving on the saddle in a Y-axis direction, and a processing unit moving on a front side of the column in a Z-axis direction.

[0008] Moreover, the first main spindle unit comprises a first processing head disposed rotatably around a B-axis orthogonal to a Z-axis and a rotating mechanism that rotates the first processing head around the B-axis, and the second main spindle unit is disposed in a space formed between the rotating mechanism of the first processing head and the saddle; and the second main spindle unit comprises a ram shaft controlled to move in a W-axis direction parallel to a Z-axis, a ram head attached to a lower end portion of the ram shaft, and a turning head and a milling head replaceably attached to the ram head.

[0009] Even further, the ram head comprises a hydraulic clamp unit that replaceably supports the turning head or the milling head, and the second main spindle unit comprises a motor disposed on an upper portion of the ram shaft, a driving shaft for transmitting the driving force of the motor, a means for transmitting the rotary force of the driving shaft via a transmission mechanism to an output shaft disposed on a lower end of the ram shaft, and a clutch disposed on a leading end of the output shaft.

[0010] Moreover, the milling head comprises an input shaft connected to a chuck of the ram shaft, a power transmission mechanism for orthogonally converting the driving force of the input shaft and transmitting the same to a spindle, and a milling tool attached to the spindle.

[0011] As described, the machining center according to the present invention has a first main spindle unit that rotates around a B-axis and a second main spindle unit having a ram shaft which are disposed on a common saddle. Thus, when processing a bore at a deep area of the work, the saddle can be lowered to directly above the work on a Z-axis and then processing can be performed with a shortest possible projection length of the ram shaft, so that the processing effect can be improved.

[0012] Furthermore, since the ram shaft can be arranged between the B-shaft driving mechanism and the saddle, efficient use of space can be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a perspective view of the machining center to which the present invention is applied; FIG. 2 is a front view of the machining center to which the present invention is applied; FIG. 3 is an explanatory view showing the arrangement of a second main spindle unit; FIG. 4 is an explanatory view showing an example in which a turning head is attached to the second main spindle unit; FIG. 5 is an explanatory view showing the turning
process performed by the second main spindle unit; FIG. 6 is an explanatory view showing an example in which a milling head is attached to the second main spindle unit; FIG. 7 is an explanatory view showing the milling processes performed by the second main spindle unit; and FIG. 8 is a perspective view of another machining center to which the present invention is applied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] FIG. 1 is a perspective view showing the external appearance of a machining center to which the present invention is applied, and FIG. 2 is a front view thereof.

[0015] The machining center shown as a whole by reference number 1 is a so-called gate-type machining center including a rotary table 20 disposed on a bed 10, wherein the table is controlled to move along an X-axis. A pair of columns 30 is disposed vertically on both sides of the bed 10, and a cross rail 40 capable of moving arbitrarily along a Z-axis by a linear guide is disposed between the columns 30. The cross rail 40 is controlled to move by a servomotor 42 in the direction of the Z-axis via a ball screw or the like.

[0016] A saddle 50 is disposed to move arbitrarily along a Y-axis on the cross rail 40 by a linear guide. The saddle 50 is controlled to move in the direction of the Y-axis by a servomotor 52 and a ball screw. A first main spindle unit 60 is disposed on the saddle 50. A first main spindle 70 is disposed on the first main spindle unit 60, capable of being rotated arbitrarily around a B-axis. A tool T1 is disposed on the first main spindle 70. The tool T1 to be attached to the first main spindle 70 is either a turning tool or a milling tool, which is used to provide necessary turning processes or milling processes and the like to a work K1, which is fixed on the table 20. A second main spindle unit 100 is disposed on a rear side of the first main spindle unit 60 on the saddle 50.

[0017] The second main spindle unit 100 comprises a ram shaft 110, and the ram shaft 110 is controlled to move along a W-axis parallel to the Z-axis by a servomotor 120 and a ball screw. FIG. 3 is an explanatory view showing the details of the second main spindle unit 100.

[0018] The second main spindle unit 100 has a plurality of linear guide blocks 106 fixed to the side having a head unit 105, and slidably supports the ram shaft 110. The plurality of linear guide blocks 106 is disposed above and below the head unit 105 at a distance therefrom, designed to maintain sufficient rigidity even when the ram shaft 110 is arranged at a protruded position.

[0019] The ram shaft 110 is controlled to move in the direction of the W-axis by a servomotor 120 and via a ball spring.

[0020] The second main spindle unit 100 can be disposed using the space existing between the saddle 50 and the first main spindle unit 60 comprising the mechanism to drive the first main spindle 70 around the B-axis, so there is no need to prepare any excessive space.

[0022] FIG. 4 is an explanatory view showing the outline of the arrangement of the second main spindle unit 100.

[0023] The servomotor 120 attached to the head unit 105 moves the ram shaft 110 in the direction of the W-axis via a drive system such as a ball spring.

[0024] A ram head 130 is attached to the upper end of the ram shaft 110.

[0025] The ram head 130 comprises a hydraulic clamp unit 140 and a gear transmission mechanism 160. During the turning process, a turning head 200 is attached to the turning head 130. A turning tool T2 is attached to the turning head 200, which is fixed to the ram shaft 110 via the hydraulic clamp unit 140 of the ram head 130.

[0026] The hydraulic clamp unit 140 has a piston 140 operated via hydraulic pressure, which supports the turning head 200 using a taper shank 205.

[0027] FIG. 5 shows a case in which the second main spindle unit 100 is used to subject a work K1 to a bore turning process.

[0028] The second main spindle unit 100 can subject deep areas of the work K1 to turning process by projecting the ram shaft 110.

[0029] According to the machining center of the present invention, after lowering the cross rail and the saddle 50 along the Z-axis to approximate the upper surface of the work K1, the ram shaft 110 is projected along the W-axis so as to subject deep areas of the work K1 to a turning process efficiently.

[0030] FIG. 6 illustrates a state in which a milling head 300 is attached to the ram head 130 at the leading end of the ram shaft.

[0031] The milling head 300 is supported by the hydraulic clamp unit 140 of the ram head 130 using a shank 305. This supporting mechanism is similar to how the turning head 200 is supported.

[0032] The second main spindle unit 100 has a milling motor 150 disposed at an upper portion of the ram shaft 110, and drives the gear transmission mechanism 160 disposed on the side of the ram head 130 via the driving shaft 152. The gear transmission mechanism 160 comprises a pair of mesh gears 162 and 164, and drives an output shaft 166.

[0033] A clutch 170 is disposed at the leading end of the drive shaft 166, which is connected to an input shaft 310 disposed on the side of the milling head 300. The milling head 300 comprises a pair of mesh gears 312 and 314 and a bevel gear 320, and drives a spindle 330 disposed in a direction orthogonal to the input shaft 310. A mill tool T3 is attached to the spindle 330.

[0034] As described, since the driving mechanism of the milling head of the present invention has its driving system arranged at a position offset from the axis line of the hydraulic clamp unit, the milling head can be effec-
ment, the present invention is applied to a gate-
head unit 550 capable of sliding arbitrarily in a Z-
On the front side of the column 540 is disposed
[0040] a head unit 550 capable of sliding arbitrarily in a Z-
referring number 500 has a rotary table 520 disposed
[0039] The machining center illustrated as a whole by
[0038] FIG. 8 illustrates an example in which the
[0037] According to the above-described embodiment,
the present invention is applied to a gate-type ma-
chining center, but the present invention can also be ap-
plied to other types of machining centers.
[0036] FIG. 7 shows a case in which the ram shaft 110
equipped with the milling head 300 which is an angle
head is extended so as to provide a milling process using
a mill tool T3 to a deep portion of the work K1.
[0035] Furthermore, since the driving motor of the mill
tool can be disposed at the upper portion of the ram shaft,
the structure thereof can be simplified.

Claims

1. A vertical machining center having a table disposed
equihorizontally and a processing unit disposed perpen-
dicularly, wherein
the processing unit comprises a first main spindle
unit, and a second main spindle unit having an axis
of movement that is parallel to the axis of movement
of the first main spindle unit.

2. The machining center according to claim 1, wherein
the vertical machining center is a gate-type machin-
ing center comprising:
a rotary table disposed on a bed;
a means for moving a rotary table in an X-axis
direction within a horizontal plane;
a pair of columns disposed vertically on both sides of a bed;
a cross rail supported by the column;
a means for moving the cross rail in a perpen-
dicularly Z-axis direction;
a saddle supported by the cross rail and having a
processing unit; and
a means for moving the saddle in a Y-axis di-
rection orthogonal to the X-axis within a horizon-
tal plane.

3. The machining center according to claim 1, wherein
the vertical machining center is a column-type ma-
chining center comprising:
a rotary table disposed on a bed;
a saddle moving on the table in an X-axis direc-
tion within a horizontal plane;
a column moving on the saddle in a Y-axis di-
rection orthogonal to the X-axis within a horizon-
tal plane; and
a processing unit moving on a front side of the
column in a perpendicular Z-axis direction.

4. The machining center according to claim 1, wherein
the first main spindle unit comprises a first process-
ing head disposed rotatably around a B-axis ortho-
gonal to a Z-axis and a rotating mechanism that ro-
tates the first processing head around the B-axis;
and
the second main spindle unit is arranged in a space
formed between the rotating mechanism of the first
processing head and the saddle.

5. The machining center according to claim 1, wherein
the second main spindle unit comprises a ram shaft
controlled to move in a W-axis direction parallel to a
Z-axis, a ram head attached to a lower end portion of
the ram shaft, and a turning head and a milling
head replaceably attached to the ram head.

6. A vertical machining center having a table disposed
horizontally and a processing unit disposed perpen-
dicularly, wherein
the processing unit comprises a first main spindle
unit, and a second main spindle unit having an axis
of movement that is parallel to the axis of movement
of the first main spindle unit;
the second main spindle unit comprises a ram shaft
controlled to move in a W-axis direction parallel to a
Z-axis, a ram head attached to a lower end portion of
the ram shaft, and a turning head and a milling
head replaceably attached to the ram head;
and
the ram head comprises a hydraulic clamp unit that
replaceably supports the turning head or the milling
head.

7. The machining center according to claim 6, wherein
the second main spindle unit comprises:
a motor disposed on an upper portion of the ram
shaft; a driving shaft for transmitting the driving force of the motor; a means for transmitting the rotary force of the driving shaft via a transmission mechanism to an output shaft disposed on a lower end of the ram shaft; and a clutch disposed on a leading end of the output shaft.

8. The machining center according to claim 6, wherein the milling head comprises:

an input shaft connected to a clutch of the ram shaft; a power transmission mechanism for orthogonally converting the driving force of the input shaft and transmitting the same to a spindle; and a milling tool attached to the spindle.
Fig. 2
Fig. 5
### DOCUMENTS CONSIDERED TO BE RELEVANT

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**The present search report has been drawn up for all claims**

**Place of search**

Munich

**Date of completion of the search**

17 March 2008

**Examiner**

Lasa Goñi, Andoni
### CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- [ ] Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

- [ ] No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

### LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

- [ ] All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

- [ ] As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

- [ ] Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

- [ ] None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

- [ ] The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).
The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-3

Vertical machining center according to claim 1, with a rotary table and different configurations of the machine axes.
Problem solved: alternative configuration of the machine axes for a relative movement of workpiece and spindle in X, Y and Z direction.
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2. claim: 4

Vertical machining center according to claim 1, wherein the second main spindle unit is arranged in a space formed between the first processing head and the saddle.
Problem solved: no need to prepare excessive space (see p. 6, lines 15-19)
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3. claims: 5-8

Vertical machining center according to claim 1, wherein the second spindle unit comprises a ram shaft movable in a W-axis and a ram head attached to it.
Problem solved: alternative configuration of the second spindle unit.
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REFERENCES CITED IN THE DESCRIPTION

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