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None

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(54) Machine tool with plurality of tools

(57) The tool support unit (1), resting on machine frame (2) comprises a first tool-slide unit (3) formed of a first group of slides and a second tool-slide unit (3') formed of a second group of slides. A displacing axis provided to displace the first tool-slide unit (3) with respect to the machine frame (2) and a parallel displacing axis provided to displace the second tool-slide unit (3') with respect to the machine frame (2) coincide, thus forming a common displacing axis (U) in the form of a horizontally extending U-axis. The slides are displaced by guide means (2.1) and controllable motor-driven means (2.2). Each of the units comprises a centre slide (5) and an upper slide (6), the upper slides (6) carry the tool spindle units (7, 7'). The two tool-slide units (3, 3') are each provided with three pairwise arranged displacing axes (U, Y, W) and (U, V, R) running perpendicular to each other.

Fig.1

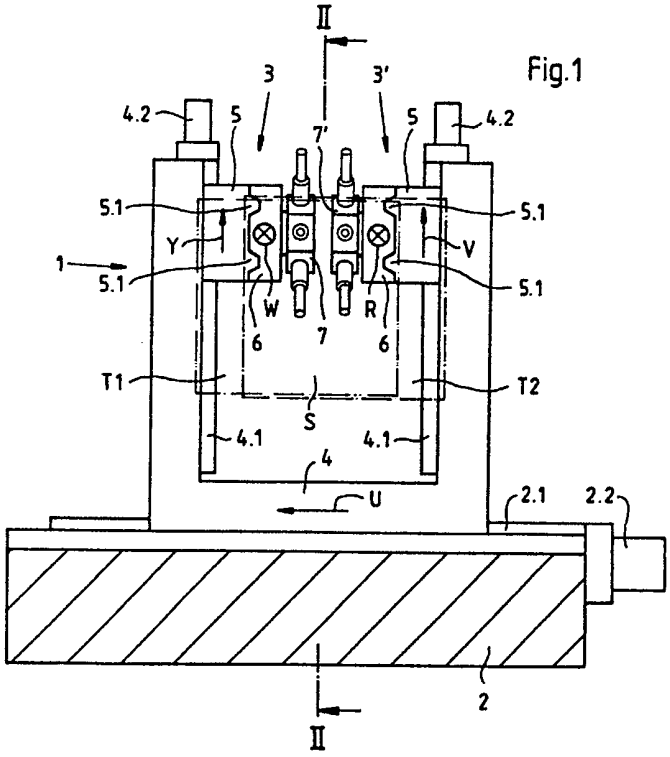

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Fig.1

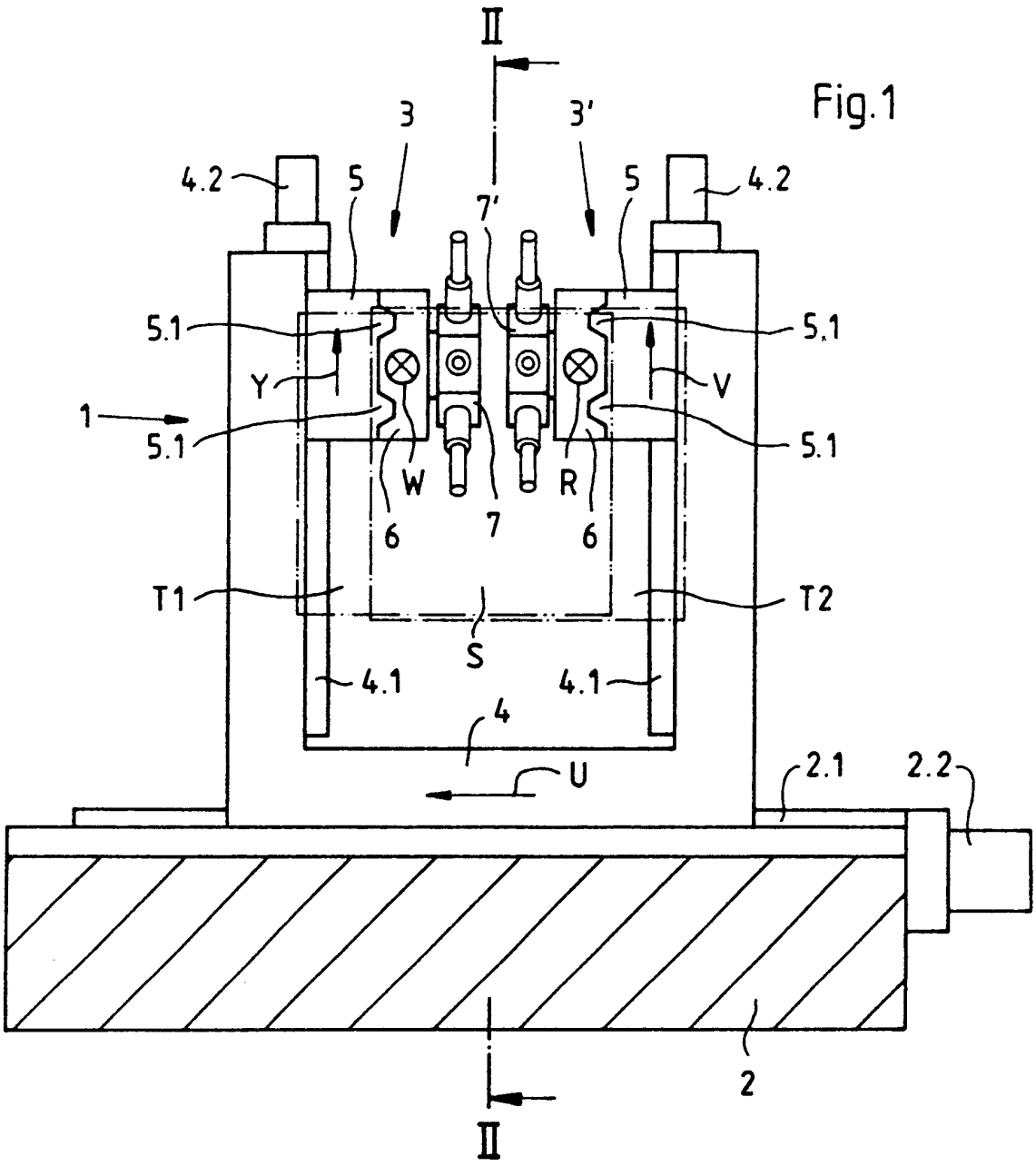
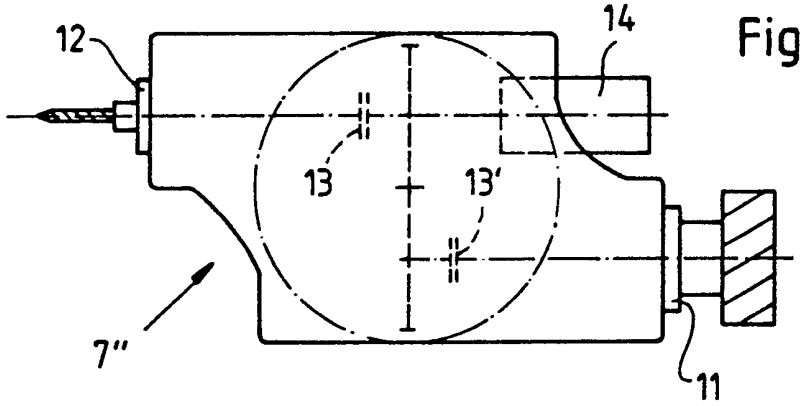

II
3
3'
4.2
5
7'
5
4.2
5.1
5.1
Y
V
1
5.1
5.1
W
R
6
7
6
T1
T2
S
4.1
4.1
4
U
2.1
2.2
2
II

Fig.3


12
14
13
13'
7''
11

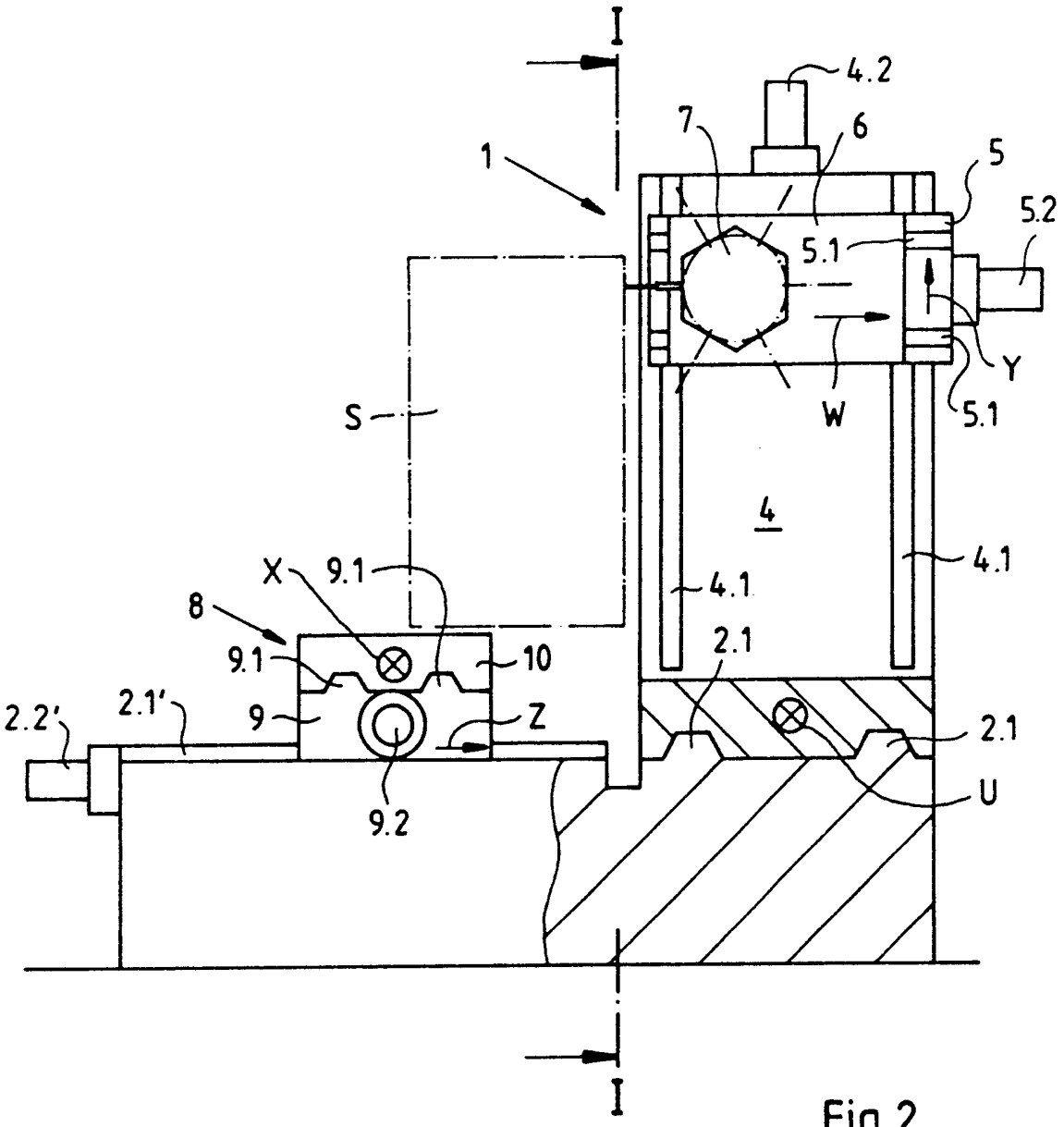


Fig.2

Cutting machine tool

The invention relates to a machine tool for cutting (machining) workpieces by means of a plurality of tools, said machine tool comprising a machine frame, a plurality of displacing axes, a plurality of slides movable along said displacing axes, a first group of slides forming a first tool-slide unit and at least a second group of slides forming a second tool-slide unit such that said first tool-slide unit and said second tool-slide unit can be moved with respect to the machine frame along displacing axes extending parallel to each other, and such that to a respective displacing axis provided at the said first tool-slide unit there is assigned a respective parallel displacing axis provided at said second tool-slide unit, comprising a respective controllable motor-driven means for each slide for moving the respective slide along a respective one of said displacing axes, comprising a first tool-spindle unit carried by said first tool-slide unit and a second tool-spindel unit carried by said second tool-slide unit, a respective tool-spindle unit being able to be moved along each displacing axis provided at the respective tool-slide unit, comprising a workpiece-support unit and a device for automatically changing a tool on a respective tool-spindle unit .

Machine tools having these features are known, for example, in the form of portal milling machines which - as is generally known - are designed as horizontal-plane milling machines, and thus for very specific machining operations. In as far as machining operations are effected by means of a plurality of tools, a first tool is in operation at a first longitudinal side of a workpiece while, at the same time, a second tool is in operation at a second longitudinal side of said workpiece, if necessary. A relatively large number of machining jobs consist in machining one and the same side of a workpiece by means of very different drilling and milling tools, whereby, most of the

time, it is also necessary to carry out machining operations in different x and y coordinates of an x y z coordinate system assigned to the workpiece, certain x and y coordinates requiring the use of a plurality of different tools. These requirements, however, lead to considerable non-productive periods, even if tools are changed by means of an automatic tool-changing device.

The invention provides a machine tool for cutting workpieces by means of a plurality of tools, said machine tool permitting a number of drilling and milling operations, with machining times being as short as possible. According to the invention this object is achieved by a machine tool as set forth in Claim 1.

The machine tool designed according to the invention makes it possible, in particular, to reduce the non-productive periods without raising the acceleration / deceleration values of the axial feed drives and without increasing the quick-motion velocity beyond the prior-art values so that the object is attained by using machine and control elements meeting corresponding to the well-tried prior art. Neither is it necessary to reduce the time required for automatic tool changing so that also known tool-changing systems may be used without questioning the desired result. An inventive machine tool permitting tool changing during the productive periods brings about great advantages. This possibility results from the fact that, for example, during the machining process tools may be changed on a second tool-spindle unit by means of a first tool-spindle unit, for this purpose said second tool-spindle unit being moved into a tool-changing position. Following the tool changing on the second tool-spindle unit positioning operations may be effected on said second tool-spindle unit at least to a certain extent, while said first tool-spindle unit is in machining operation.

Providing a respective tool-slide unit, according to the invention, with three pairwise arranged displacing axes

extending perpendicular with respect to each other proves advantageous in view of the attainable variety of machining possibilities, in particular in that machining operations may be effected both in horizontal and perpendicular working planes.

Moreover, alternatively to tool changing during the productive period by alternately using respective tool-spindle units, the conception of an inventive machine tool offers the advantages of a differently used machine tool having a multi-spindle head, said advantages bringing about to a reduction of the productive periods. For this purpose an inventive machine tool may be used such that a first and a second tool-spindle unit are simultaneously in machining operation. The possibility to change tools automatically even exceeds the advantages which may be realized by means of multi-spindle heads. The great versatility of use of a specimen embodiment of an inventive machine tool is obtained in that a respective tool-slide unit comprises an upper slide carrying a respective tool-spindle unit, a center slide guiding the upper slide, and a lower slide guiding said center slide, said lower slide being guided on the machine frame by guide means common to all tool-slide units.

The above-mentioned advantages brought about by the conception of an inventive machine become, to a large extent, visible in a specimen embodiment in which the tool-slide units feature a respective upper slide carrying a tool-spindle unit, a respective center slide guiding said upper slide, and a common lower slide guiding said center slide, said lower slide being guided on the machine frame by means of guide means.

According to a further advantageous specimen embodiment a respective tool-spindle unit for automatic tool changing on said tool-spindle unit is provided in the form of a turret. Thus, an additional tool-changing device is rendered unnecessary, without having to dispense with an adequate number of alternatively usable tools because, due to the design of a turret, the number

of tools made available by said turret is doubled, if two tool-slide units are each equipped with a turret provided for one and the same number of tools.

According to a further embodiment of the invention the turret is equipped with a low-frequency and high-frequency spindle, and, via a clutch, a respective one of said tool spindles is operatively connected to a common controllable main drive. This makes it possible - at least with special machining jobs - to further reduce the machining times by reducing the productive periods. Said special machining jobs are jobs which, in stages of the machining process, may be run at high such cutting speeds.

A further development of the invention provides that to a respective selected displacing axis provided on the tool-support unit there is assigned a parallel displacing axis provided at the workpiece-support unit, and to each slide being movable along said displacing axes there are assigned controllable motor-driven means for displacing said slides. In addition to the above-mentioned reduction in the machining times, such an embodiment of the inventive subject-matter makes it possible to reduce the machining times still further, which may have an influence on both the non-productive periods and the productive periods. Due to such a machine tool a tool-spindle unit and a workpiece-support unit may be moved simultaneously during positioning operations as well as during machining operations. By merely making use machine and control elements corresponding to the well-tried prior art a considerable reduction in the machining period can be reached, the utilization of such well-tried machine and control elements being made possible by changing relative speeds, instead of absolute speeds of slide displacements, between a workpiece and a tool-spindle unit.

Two embodiments of machine tool according to the invention are now described by way of example with reference to the accompanying drawings, in which:-

FIG.1 is a schematic sectional view of a tool support along line I-I in Fig.2;

FIG.2 is a schematic, partial section along line II-II in Fig.1, and

FIG.3 is a schematic view of a modified tool-sprindle unit.

Referring to Fig.1, a tool-support unit 1 featuring a plurality of displacing axes and a plurality of slides movable along said displacing axes is shown. The tool-support unit 1, resting on a machine frame 2, comprises a first tool-slide unit 3 formed by a first group of slides, and a second tool-support unit 3' formed by a second group of slides. In the specimen embodiment shown the first tool-slide unit 3 and the second tool-slide unit 3' have a common lower slide. A displacing axis provided to displace the first tool-slide unit 3 with respect to the machine frame 2 and a parallel displacing axis provided to displace the second tool-slide unit 3' with respect to the machine frame 2 coincide, thus forming a common displacing axis U in the form of a horizontally extending U-axis. For displacing the lower slide 4 common to both tool-slide units 3, 3' in direction of the U-axis U and opposite thereto, the machine frame is provided with guide means 2.1 and controllable motor-driven means 2.2 schematically illustrated in the form of a motor.

Furthermore, the first tool-slide unit 3 and the second tool-slide unit 3,' each of which is formed by a respective group of slides mentioned above, each comprises a center slide 5 guided by the lower slide 4 and each comprises an upper slide 6 guided by the respective center slide 5, said upper slide carrying a respective tool-spindle unit 7, 7' which, according to a further inventive embodiment, is designed as a turret in the specimen embodiment shown.

The respective center slide 5 and the respective upper slide 6 each can be moved along a further displacing axis. For this purpose there are provided for the two center slides 5 a displacing axis Y forming a Y-axis and a parallel displacing axis V forming a V-axis, and for the two upper slides 6 there are provided a displacing axis W forming a W-axis and a parallel displacing axis R forming a R-axis. The displacing axes Y and V for the center slides 5 are disposed perpendicularly to each other and the displacing axes W and R for the upper slides 6 are disposed so as to run perpendicular to the displacing axis U as well as to the displacing axes Y and V. Altogether there are thus provided for each of the two tool-slide units 3 and 3' three pairwise arranged displacing axes U, Y, W and U, V, R running perpendicular to each other.

For displacing the center slides 5 and the upper slides 6 along the displacing axes Y and V as well as W and R assigned thereto there are provided respective guide means 4.1 and 5.1 and respective controllable motor-driven means 4.2 and 5.2 schematically illustrated in the form of a respective motor (s. also Fig. 2).

Fig. 2 shows a further group of the above-mentioned slides forming a workpiece-support unit 8. Said workpiece-support unit 8 also rests on the machine frame 2 and includes a longitudinal slide 9 guided on said machine frame 2 and a cross slide 10 guided by said longitudinal guide. A particular embodiment of the inventive subject-matter provides a possibility to displace the longitudinal slide 9 with respect to the machine frame 2 along a horizontal displacing axis Z forming a Z-axis, said displacing axis Z running parallel to the displacing axes W and R provided at the tool-support unit 1, whereas the cross slide 10 can be displaced with respect to the longitudinal slide 9 along a horizontal displacing axis X forming an X-axis, said

displacing axis X running parallel to the displacing axis U provided at the tool-support unit 1.

Furthermore, in a particular embodiment of the inventive subject-matter, there are provided respective guide means 2.1' and 9.1 as well as acontrollable motor-driven means 2.2' and 9.2, schematically illustrated in the form of motors, for displacing the longitudinal slide 9 and the cross slide 10. On the whole, an inventive machine tool is designed to simultaneously move a tool-spindle unit 7, 7' and the workpiece-support unit 8 along respective displacing axes which are arranged such that to a respective selected displacing axis provided at the tool-support unit 1 there runs a parallel displacing axis provided at the workpiece-support unit 8, moving said displacing axes simultaneously by means of the controllable motor-driven means being assigned to a respective displacing axis or a respective slide described hereinabove.

In a specimen embodiment not illustrated in the drawing the two tool-slide units 3 and 3' can feature two separate lower slides, instead of one common lower slide, one and the same guide means 2.1 being provided as the common guide means for displacing said slides with respect to the machine frame 2, to each of the separate lower slides being however assigned separate controllable motor-driven means corresponding to the drive means 2.2 illustrated in the form of a motor and provided for the common lower slide 4.

Fig. 3 is an advantageous modification 7'' schematically showing a tool-spindle unit which is designed as a turret according to Figs. 1 and 2 and separated from a respective tool-slide unit 3, 3'. In an inventive embodiment - if provided with a turret, for example - said tool-spindle unit 7'' is equipped with two tools i.e. with a low-frequency spindle 11 and a high-frequency psindle 12 which, via a respective clutch 13, 13', are operatively connected to a controllable main drive 14.

It is understood that both the low-frequency spindle 11 and the high-frequency spindle 12 are designed so as to be adapted to the respective conventional spindle speeds ranging, in one case, in the area of up to approximately 10 000 revolutions per minute and, in the other case, in an area of up to approximately 40 000 revolutions per minute.

Precisely the possibility of such a design adaptation includes an important advantage of such a development of the inventive subject-matter compared to a conventional machine tool also provided with an automatic tool-changing device and designed to run certain machining jobs.

Furthermore, Figs. 1 and 2 show areas limited by dash - dot lines and covered by a respective tool-spindle unit 7, 7' when moving along the displacing axes provided for the tool-support unit 1. In Fig. 1, indicated by dash - double dot lines with respect to the first tool-slide unit 3 and by dash - dot lines with respect to the second tool-slide unit 3'- you may see how said areas extend along the displacing axes X and U and along the displacing axes Y and V, respectively. For the sake of clarity Fig. 1 shows the respective horizontal parts of the area-limiting lines as distinct lines, although horizontally extending parts of said area-limiting lines would coincide to some extent in Fig. 1, given an entirely symmetrical setup of the two tool-slide units 3 and 3'.

In Fig. 2 the width of a dash-dotted rectangular which would be the result of an entirely symmetrical setup of the two tool-slide units 3 and 3' shows how the above-mentioned areas extend along the displacing axes Z , W, and R, respectively.

A respective area which may be covered by means of a first and a second tool-spindle unit 7, 7', respectively, includes a first and a second subset T1, T2 of coordinates according to the

respective extensions set forth above, whereby, according to the invention, said two subsets T1, T2 are arranged in the space so as to form an intersection S representing a coordinate space due to the respective mutual arrangement of the two tool-slide units 3, 3'.

According to the specimen embodiment represented in Figs. 1 and 2 such a mutual arrangement of the two tool-slide units 3, 3' is provided for machining a workpiece at a certain side thereof so that a respective tool-spindle unit 7, 7' enters the coordinate space formed by the intersection S, when displacing said respective tool-spindle unit 7, 7'.

Besides, the slides (longitudinal slide 9 and cross slide 10) included in the workpiece-support unit 8 are arranged so as to be displaceable such that in a position in which a surface area of a workpiece surface of a workpiece mounted on the workpiece-support unit 8 is machined the coordinates of said surface area coincide with the coordinates of the above-mentioned intersection S .

Due to the fact that, according to the invention, the tool-slide units 3, 3' are each equipped with three pairwise arranged displacing axes extending parallel to each other, and due to the thus resulting possiblity to effect machining operations both in horizontal and perpendicular working planes, a respective tool-spindle unit 7, 7', when being displaced in a machining direction, may enter a coordinate space from the right as well as from above in the specimen embodiment shown (Fig. 2), said coordinate space forming a respective intersection.

It will of course be understood that the present invention has been described above purely by way of example, and modifications of detail can be made within the scope of the invention.

LIST OF REFERENCE NUMERALS

1	tool-support unit
2	machine frame
2.1, 2.1'	guide means
2.2, 2.2'	drive means
3, 3'	tool-slide unit
4	lower slide
4.1	guide means
4.2	drive means
5	center slide
5.1	guide means
5.2	drive means
6	upper slide
7, 7', 7''	tool-spindle unit
8	workpiece-support unit
9	longitudinal slide
9.1	guide means
9.2	drive means
10	cross slide
11	low-frequency spindle
12	high-frequency spindle
13, 13'	clutch

CLAIMS:

1. Machine tool for machining workpieces by means of a plurality of tools, comprising a machine frame, a plurality of slides movable along a plurality of displacing axes, a first group of said slides forming a first tool-slide unit, and at least a second group of said slides forming a second tool-slide unit such that said first tool-slide unit and said second tool-slide unit can be moved with respect to said machine frame along displacing axes running parallel to each other, and such that to a respective displacing axis provided at said first tool-slide unit there is assigned a parallel displacing axis provided at said second tool-slide unit, a respective controllable motor-driven means for each of said slides for moving a respective slide along a respective one of said displacing axes, a first tool-spindle unit carried by said first tool-slide unit, and a second tool-spindle unit carried by said second tool-slide unit, a respective tool-spindle unit being movable along each of the displacing axes provided at a respective tool-slide unit, a workpiece-support unit, and a device for automatic tool-changing on a respective tool-spindle unit, wherein the first and second tool-slide units each feature three pairwise arranged displacing axes running parallel to each other and wherein a first subset of co-ordinates which can be covered by said first tool-spindle unit, when being displaced by a means of said first tool-slide unit, and a second subset of co-ordinates which can be covered by said second tool-spindle unit, when being displaced by means of said second tool-slide unit, feature an intersection representing a co-ordinate space.

2. Machine tool according to claim 1, wherein a respective tool-slide unit features an upper slide carrying a respective tool-spindle unit, a centre slide guiding said upper slide, and a lower slide guiding said centre slide, said lower slide being guided on the machine frame by means of guide means common to said tool-slide units.

3. Machine tool according to claim 1, wherein the tool-slide units feature a respective upper slide carrying a tool-spindle unit, a respective centre slide guiding said upper slide, and a common lower slide guiding said centre slides, said lower slide being guided on the machine frame by means of guide means.

4. Machine tool according to claim 1, 2 or 3 wherein a respective tool-spindle unit is designed as a turret for automatic tool-changing on said tool-spindle unit.

5. Machine tool according to claim 4, wherein said turret is equipped with low-frequency and high-frequency spindles, and wherein, via a clutch, a respective one of said tool spindles is operatively connected to a common controllable main drive.

6. Machine tool according to claim 1, wherein to a respective selected displacing axis provided at said tool-support unit there is assigned a parallel displacing axis provided at said workpiece-support unit, and to each slide being movable along said displacing axes there are assigned controllable motor-driven means for displacing said slides.

7. A machine tool, substantially as hereinbefore described with reference to Figures 1 and 2, or Figures 1 and 2 as modified by Figure 3 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search report)

13

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(ii) Int Cl (Ed.5) B23B; B23C; B23Q

Search Examiner
R HOWE

Date of completion of Search
9 DECEMBER 93

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1-7

Categories of documents

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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Category	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

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