

Machine tool

The invention relates to a machine tool according to the preamble of Patent Claim 1.

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Document EP1002621A1 shows a similarly constructed machine tool. The swivel motion of the swivel arm is in this machine produced by a spindle drive and a lever mechanism.

Starting from this prior art, the object of the invention is to propose a machine tool which is of simpler construction and allows more rapid swivel motions of the swivel arm than the known machine.

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This object is achieved according to the invention by the features defined in the characterizing part of Patent Claim 1.

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By virtue of the design according to the invention, the machine tool requires for the swivel motion of the swivel arm fewer moving parts and allows more rapid swivel motions than the known machine.

20 Particular embodiments of the invention are described in the dependent patent claims.

Another aspect of the invention relates to a swivel arm for a machine tool according to Claim 6 and achieves the die object of damping vibrations of the swivel arm which are caused, for instance, by the tool spindle disposed on its end.

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Illustrative embodiments of the invention are explained below with reference to the attached drawings, wherein:

Figure 1 shows a perspective view of a machine tool according to the invention;

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Figure 2 shows a similar view to Figure 1 with X-Y protective walls and a tool-holding chain magazine, and

Figure 3 shows a sectional view of the mounting and of the drive mechanism of the swivel arm.

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Figure 1 shows in a perspective view an illustrative embodiment of the machine tool according to the invention. This is particularly suitable for the machining of blade wheels for turbines, so-called "bladed discs", also referred to as "blisks". On a machine bed 10 is arranged a first horizontal linear guide 1 and, at right angles thereto, a second horizontal linear guide 2. On the first linear guide 1, a workpiece clamping fixture 3 is arranged such that it is horizontally movable and is swivelable about a horizontal swivel axis 4. For the horizontal motion of the workpiece clamping fixture 3 on the first linear guide 1, a ball screw, for instance, is provided. Alternatively, the horizontal motion can be executed by means of a linear motor. Moreover, the workpiece clamping fixture 3 is rotatable about a rotation axis 5 oriented at right angles to its swivel axis 4. Disc-shaped blanks for blade wheels are supplied lying flat, for instance on pallets. The arrangement and design of the workpiece clamping fixture 3 allows these blanks to be clamped without being tilted, which is particularly advantageous in the case of large and heavy blanks.

On the second linear guide 2, a swivel arm 6 is arranged such that it is horizontally movable and is swivelable about a horizontal swivel axis 7, on the free end of which swivel arm is arranged a tool spindle 8. The horizontal motions of the swivel arm 6 on the second linear guide 2 are preferably executed by a linear motor. The axis 9 of the tool spindle is oriented parallel to the swivel axis 7. The machine tool according to the invention is thus a five-axis machine having the translatory axes X, Y and Z and the rotatory axes A and B. A particularity is here that, for a pure displacement of the tool along the Y-axis, a combined circular motion of the tool spindle 8 and linear motion of the swivel axis 7 along the linear guide 2 is necessary. A particular advantage of this construction consists in the fact that the centre of gravity of the entire unit which is movable on the second linear guide 2 is located vertically only a little above the second linear guide 2 and moves only a little upwards when the tool spindle 8 is transported into its uppermost position. This in contrast to machine tools of different construction, such as, for instance, the machine according to EP1509360, in which a tool spindle is likewise disposed on a swivel arm, wherein, however, the swivel arm is raised, together with its swivel drive, along a vertical linear guide in order to bring the tool spindle into an upper position. A high centre of gravity promotes the occurrence of undesirable vibrations. The direct driving of the swivel arm 6 by a torque motor disposed on the swivel axis 7 allows rapid and precise motions of the tool spindle 8.

Figure 2 shows the same machine as Figure 1, yet with additional sub-assemblies, of which two are described in greater detail below. Two X-Y protective covers 11 and 12

separate the working space from the other regions of the machine tool, in particular the linear guides 1 and 2, in order to keep chips, and also coolant and lubricant, in the working space. These X-Y protective covers can be of known construction, having a driving plate 13 and plate fins operatively connected thereto, for instance as described in
5 EP19861324A1. In the machine according to the invention, having the swivel arm 6, the problem now exists that that part of the tool spindle 8 which passes through the driving plate 13, with the swiveling of the swivel arm 6, inevitably in the driving plate 13 executes a rotary motion. Therefore the tool spindle 8 cannot be connected directly to the driving plate 8, but rather with the interposition of a pivot bearing 14.

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A further sub-assembly, which is visible in Figure 2, is a tool-holding chain magazine 15, which is of angular or arcuate configuration and is configured such that a limb 16 ends with an at least approximately horizontally oriented end in the top of the work region, and a limb 17 ends with an at least approximately vertically oriented end in a region, facing
15 away from the working area, behind the first linear guide. In the end region of the limb 16 is arranged a tool changer 18, which is reachable by the tool spindle 8 along a short path. The end region of the limb 17 is configured for the loading and emptying of the tool-holding chain store 15 and is easily reachable by an operator.

20 Figure 3 shows in a sectioned view a detail of the mounting of the swivel arm 6. The latter is driven in the present example by means of an external-rotor torque motor. A torque motor stator denoted by 19 has a stator part 20 connected in a rotationally secure manner thereto. A torque motor rotor 21 is additionally supported on the stator part 20 by an oil-lubricated slide bearing 22. The slide bearing 22 has, by virtue of its oil film, a
25 vibration-damping effect (squeeze film damping).

Reference symbol list

X	X-axis
Y	Y-axis
Z	Z-axis
A	A-axis
B	B-axis
1	first linear guide
2	second linear guide
3	workpiece clamping fixture
4	swivel axis, tool clamping fixture
5	rotation axis
6	swivel arm
7	swivel axis, swivel arm
8	tool spindle
9	axis of the tool spindle
10	machine bed
11	X-Y protective cover
12	Z protective cover
13	driving plate
14	pivot bearing
15	tool-holding chain magazine
16	horizontal limb
17	vertical limb
18	tool changer
19	torque motor stator
20	stator part
21	torque motor rotor
22	slide bearing

Patent claims

1. Machine tool containing a machine bed (10) having a first horizontal linear guide (1) and a second horizontal linear guide (2) arranged at right angles to the first linear guide (1), wherein on the first linear guide (1) is arranged, in an axially displaceable manner, a workpiece clamping fixture (3), which is swivelable about a swivel axis (4) oriented parallel to the second linear guide (2) and is rotatable about a rotation axis (5) oriented at right angles to the swivel axis (4), wherein on the second linear guide (2) a swivel arm (6) is axially displaceable, the swivel axis (7) of which is arranged parallel to the first linear guide (1) and which on its free end bears a tool spindle (8), the axis (9) of which is oriented parallel to the first linear guide (1), characterized in that the swivel arm (6) is swivelable by means of a torque motor disposed on its swivel axis (7).
2. Machine tool according to Claim 1, characterized in that, for the axial displacement of the workpiece clamping fixture (3) on the first linear guide (1) and/or the axial displacement of the swivel arm (6) on the second linear guide (2), a linear motor is present.
3. Machine tool according to one of the preceding claims, characterized in that, for the swivel motion and the rotary motion of the workpiece clamping fixture (3), a torque motor is respectively present.
4. Machine tool according to one of the preceding claims, characterized in that parallel to the second linear guide (2), on the side facing towards the workpiece clamping fixture (3), is arranged an X-Y protective cover (11) having a driving plate (13) in which is accommodated a pivot bearing (14) surrounding the tool-side end of the tool spindle (8).
5. Machine tool according to one of the preceding claims, characterized in that parallel to the second linear guide (2), on the side facing towards the workpiece clamping fixture (3), is arranged an angular or arcuate tool-holding chain magazine (15) having an approximately horizontally arranged limb (16) and an approximately vertically arranged limb (17), and in that at the free end of the approximately horizontal limb (16) is arranged a tool changer (18).

6. Swivel arm (6) for a machine tool, which is swivelable about a swivel axis (7) and bears on its free end a tool spindle (8), characterized in that the swivel arm (6) is directly drivable by means of a torque motor (19, 20, 21), and a slide bearing (22) acting between the stator (20) and the rotor (21) is arranged with oil damping.

7. Swivel arm (6) according to Claim 6, characterized in that the torque motor (19, 20, 21) has an external rotor (21) and an internal stator (19, 20).