

Universal Machine Tool

The invention relates to a universal machine tool provided with a workpiece slide for the workpieces to be machined, said workpiece slide being movable on a machine bed by means of a motor, and with a machining unit movable along a plurality of axes by means of a motor and including a motor-driven work spindle for receiving the machining tools.

In such a universal milling, drilling and boring machine, known, for example, from the EP 0 664 176 B1, the work spindle is disposed in a swivelling milling head which is turnable about a locating face vertical to a face wall of a support housing on said face wall inclined by 45° with respect to the vertical plane. The support housing is disposed on the face of a travelling stand so as to be vertically movable, said travelling stand being mounted on guiding rails in the rear end of a machine bed so as to be movable by means of a motor. On the front part of the machine bed, a table slide comprising a workpiece table is disposed so as to be horizontally movable. With a thus arranged machine tool, complex milling, drilling and threading operations may be carried out on a plurality of sides of a workpiece in a single clamping position. However, no turning operations including a rotary main cutting motion by the workpiece can be carried out with such a machine.

Turning machines provided with tool revolvers into which smaller boring or milling heads may be inserted are also known. In these, however, the moving capabilities and the cutting performance of the milling heads are limited, and driving those machines is relatively complicated. The range of applications of such milling and drilling heads in turning machines is therefore limited.

It is the object of the invention to provide a universal machine tool of the above mentioned type which, in addition to milling and drilling operations with a high cutting performance, also enables turning operations for an complete automatic machining of workpieces in one clamping position.

According to the invention, said object is solved by providing the workpiece slide with at least one turnable workpiece accommodation and an associated rotary drive by which the workpiece accommodation can be driven for carrying out turning operations on the workpiece to be processed.

The universal machine tool according to the invention provides the possibility to carry out turning operations including a rotary main cutting motion by the workpiece in addition to milling, drilling and threading operations including a rotary main cutting motion by the tool. In this way, an effective, automatic complete machining of workpieces of even complicated shapes may be effected without any complicated re-clamping of the workpieces between a turning and a milling or drilling machine. By avoiding the re-clamping of the workpieces, a higher machining accuracy is obtainable. Another important advantage of the machine tool of the invention is that the travelling paths of a work spindle provided for milling and drilling may also be used for the feeding and supply motions for turning operations, whereby the complexity of the construction and control technology may be decreased. Aside from the milling technology, the turning technology may

also be covered by one control with the same user interface, the advantage of the machine concept being usable also for turning operations.

Efficacious embodiments of the invention are indicated in the sub-claims.

The workpiece accommodation may, for example, be formed as a horizontal rotary spindle including workpiece clamping means. In a particularly robust and stiff embodiment, the rotary spindle is, for example, borne in a spindle head integrally formed with the workpiece slide. The rotary spindle may, however, also be disposed in a separate spindle head which can be mounted on a workpiece slide if required. Said arrangement enables a simple retrofit or detachment of the rotary spindle for possibly changing machining tasks.

In addition to or instead of the horizontal rotary spindle, the workpiece slide may also include a horizontal workpiece table which is turnable about a vertical axis and includes an integrated rotary drive as a workpiece accommodation. With a machine tool provided with such a workpiece slide, milling and turning operations can be carried out in one clamping position even on larger or bulky workpieces. Thus, the range of applications of the machine tool can be widened, and machining accuracy may be enhanced.

The workpiece accommodation may, for example, be driven by a ring-shaped driving motor comprising a stator ring fixed, for example, to a console of the workpiece slide and a rotor ring fixed to the turn table in a particularly compact embodiment. The driving motor may, for example, be a collectorless ring-shaped torque motor enabling a direct drive with high dynamics and exact positioning without an additional gearing or coupling. The workpiece accommodation may, with such little spatial requirements and weight, not only be driven with high dynamics for carrying out turning opera-

tions, but may also be positioned in arbitrary angular positions to carry out, for example, special milling or drilling operations.

In another advantageous embodiment of the invention, a workpiece exchanger insertable into the work spindle is provided. Since the work spindle can carry out all the movements required for a workpiece exchange at the rotary spindle, no separate driving motors or travelling elements are necessary in this case. The workpiece exchanger may, for example, be a workpiece gripper provided with a plurality of gripper arms by which the finished workpieces are transported from the rotary spindle to a workpiece deposit. The rotary spindle may also be supplied with new workpieces via the workpiece gripper. A rod feeding magazine may also be provided by which the turning spindle is supplied with rod-shaped material.

In a simple and efficacious embodiment, the workpiece gripper is operable via an internal coolant supply in the work spindle. In this way, additional operation devices may be omitted.

Efficaciously, an automatically operable three or more jaw chuck is disposed on the rotary spindle. The rotary spindle, however, may also be provided with an internal clamping cone for receiving different power jaw chucks.

Further particularities and advantages of the invention will become obvious from the following description of advantageous embodiments with reference to the drawing, in which:

Fig. 1 is a schematic side view of an universal machine tool for milling, drilling and turning operations;

Fig. 2 is a schematic, partially cross sectional side view of the universal machine tool shown in Fig. 1 comprising a rod feeding magazine and a protective cabin;

Fig. 3 is a partially cross sectional perspective view of a workpiece slide comprising a turn table; and

Fig. 4 shows the workpiece slide illustrated in Fig. 3 including a clamped workpiece and turning tools for explaining the turning operations in the universal machine tool according to the invention.

The universal machine tool schematically shown in Fig. 1 comprises a machine bed 1 on which a workpiece slide 2 is disposed so as to be movable along a Y-axis in the direction of the double arrow 3 by means of a motor. The workpiece slide 2 comprises a spindle head 4 in which a horizontal rotary spindle 5 rotary-driven by means of a driving motor (not shown) and including an automatically operable three jaw chuck 6 as a clamping means for clamping workpieces is rotatably borne. The rotary spindle 5 may, however, also be provided with other workpiece clamping means and/or an internal clamping cone for receiving different power jaw chucks or the like.

On the rear part of the machine bed 1, guiding rails 7 and 8 extending vertically with respect to the drawing plane are mounted, on which guiding rails 7 and 8 a travelling stand 9 is guided so as to be horizontally movable along an X-axis via a motor-driven threaded spindle 10. On the front side of the travelling stand 9, a support housing 11 is disposed so as to be vertically movable up and down along a Z-axis in the direction of the double arrow 12. On a face wall 13 of the carrier housing 11 inclined by 45° with respect to the vertical plane and extending obliquely downward, a swivelling milling head 14 including a work spindle 15 turnable by means of a motor is mounted as a machining unit so as to be turnable about a swivelling axis 16 which is perpendicular to the face wall 13. The work spindle 15 is borne within the swivelling milling head 14 in an angle of 45° with respect to

the swivelling axis 16. By a corresponding rotation of the swivelling milling head 14 about the swivelling axis 16, the work spindle 15 can thus be turned from a vertical machining position indicated by solid lines to a horizontal machining position indicated by broken lines. At the end of the machine bed 1 a chip conveyer 17 is disposed for removing the chips produced during the machining process.

Aside from the tools for, for example, milling, drilling, boring or threading operations, the tools for turning operations may also be inserted into the work spindle 15. Said tools may be disposed in corresponding clamps or tool accommodations which are deposited in a tool magazine (not shown) and can be inserted into the work spindle by means of an appropriate tool exchanger. For carrying out turning operations on a workpiece clamped to the rotary spindle 5, for example, a tool carrier for indexable inserts can be inserted into the work spindle. The rotary main cutting motion is then generated by the motor-driven rotary spindle 5. The feeding motion along the Y-axis is effected by moving the workpiece slide 2 with the rotary spindle arranged thereon while the feeding motions along the X- and Z-axes are effected by moving the travelling stand 9 and the support housing 11. By a controlled movement along the individual travelling and turning axes, also complex turning motions may thus be carried out with high precision. Above that, the common tools for milling, drilling, boring and threading processes or the like can also be inserted into the work spindle 15. Therefore, all other types of machining, such as milling, drilling, boring, reaming and threading can also be carried out on the workpieces clamped to the turning spindle 5 before or after the turning operations. Thus, complete machining without any complicated re-clamping between different types of machines is enabled.

However, a workpiece exchanger 18 schematically shown in Fig. 1 for exchanging the workpieces clamped to the rotary spindle 5 may also be insertable into the work spindle 15. The insertion of the workpiece exchanger 18 into the work spindle 15 may be effected by an automatic tool exchanger (not shown), the workpiece exchanger 18 being deposited in a tool magazine (also not shown) during the machining process. The workpiece exchanger may, for example, be a workpiece gripper provided with a plurality of gripping arms 19 insertable into the work spindle 15 via a clamping cone. The operation of the gripping arms 19 may be effected via the internal coolant supply of the work spindle 15 in an efficacious embodiment. Since a relatively high pressure of, for example, 40 bar, is generally available via the coolant supply of the machine tool, no additional power supply is required for the operation of the gripping arms 19.

With the tool gripper movable by means of the work spindle 15, the finished workpieces can be detached from the rotary spindle and transported to a workpiece deposit. The rotary spindle may also supplied with new workpieces via the workpiece gripper. It is also possible to provide a rod feeding magazine by which an appropriate rod material is transported to the rotary spindle.

In the further embodiment of the universal machine tool according to the invention shown in Fig. 2 a per se known rod feeding magazine 18 is disposed in front of the machine bed 1. With this rod magazine 18, rod shaped workpieces may be transported to a rotary shaft 5 formed as a hollow shaft and clamped by the three jaw chuck 6. In Fig. 2, a protective cabin 10 usually enclosing the machine tool is shown as well.

In Fig. 3, another workpiece slide 20 is shown which can be used instead of the workpiece slide 2 illustrated in Figs. 1 and 2. This workpiece slide 20 comprises a console 21

on which a horizontal turn table 22 is borne via a ring bearing 23 so as to be rotatable about a vertical axis. In a ring space 24 vertical to the rotational axis of the workpiece table 22 within the console 21, a driving motor 21 is disposed which comprises an inner stator ring 26 fixedly connected to the console 21 on the inner wall of the ring space 24 and an outer rotor ring 27 fixed to the bottom side of the workpiece table. On the bottom side of the turn table 22 and concentric to its rotational axis a tappet 28 protruding downwards is fixed, about which a slip ring 29 and a shaft encoder 30 are arranged. The driving motor 25 may, for example, be a collectorless ring-shaped torque motor enabling, in addition to high dynamics for carrying out turning operations, an exact positioning for carrying out milling and drilling operations in different angular positions even without a coupling or gearing.

The clamping of the turn table or the rotary spindle for carrying out a milling process on a workpiece which is not rotationally driven may be effected by the motor or a separate clamping means which can be activated if required. Above that, one or more flyweight sensors, by which an unacceptable flyweight can be detected and by which the machine tool can be turned off, may be disposed on the turn table or the rotary spindle.

Fig. 4 shows an embodiment for turning operations in a machine tool according to the invention comprising a workpiece slide 20 according to Fig. 2. On the turn table 22, a table 31 to be machined is clamped upside down. With the aid of turning tools 32, 33 and 34 which can be inserted into the work spindle 15 shown in Fig. 1 different turning operations may be carried out with a corresponding drive of the turn table 22. For example, turning operations on the inner and outer side of the turn table may be carried out with the

turning tools 32 and 34, and recessing works may be effected by the turning tool 33.

The invention is not limited to the embodiments described in detail and shown in the drawings. The turning spindle may, for example, be disposed in a separate spindle head which is, for example, detachably mounted on a table slide. The workpiece slide may additionally comprise a rotary spindle turnable about a horizontal axis as well as a workpiece table turnable about a vertical axis.

Claims



1. Universal machine tool comprising
a workpiece table (2; 20) for the workpieces to be machined which is movable on a machine bed (1) by means of a motor and
a machining unit (14) movable about a plurality of axes by means of a motor and comprising a motor-driven work spindle (15) for receiving the machining tools,
characterised in that
the workpiece slide (2; 20) comprises at least one rotatable workpiece accommodation (5; 22) and an associated rotary drive (25) by which the workpiece accommodation (5; 22) can be driven for carrying out turning operations on the workpiece to be machined.
2. Universal machine tool according to claim 1, characterised in that the workpiece accommodation (5; 22) is arranged so as to be turnable about a vertical or horizontal axis.
3. Universal machine tool according to claim 1 or 2, characterised in that the workpiece accommodation is formed as a rotary spindle (5) including a clamping arrangement (6).
4. Universal machine tool according to claim 3, characterised in that the rotary spindle (5) is provided with an automatically operable three jaw chuck (6) and/or an inner clamping cone as clamping means.

5. Universal machine tool according to claim 3 or 4, characterised in that a rod feeding magazine (18) is allocated to the rotary spindle (5).



6. Universal machine tool according to claim 1 or 2, characterised in that the workpiece accommodation is formed as a horizontal turn table (22).
7. Universal machine tool according to one of the claims 1 to 6, characterised in that the rotary drive (25) is a ring-shaped driving motor comprising a stator ring (26) fixed to a console (21) of the workpiece slide (20) and a rotor ring (27) fixed to the workpiece accommodation (22).
8. Universal machine tool according to claim 7, characterised in that the driving motor (25) is a collectorless torque motor.
9. Universal machine tool according to one of the claims 1 to 8, characterised in that a tool exchanger (18, 19) for supplying workpieces to the workpiece accommodation (5; 22) and/or for removing the workpieces is insertable into the work spindle (15).
10. Universal machine tool according to claim 9, characterised in that the workpiece exchanger is a workpiece gripper (18) provided with a plurality of gripping arms (19).

11. Universal machine tool according to claim 9 or 10, characterised in that the workpiece exchanger (18, 19) is operable by means of an internal coolant supply of the work spindle (15).

