

**Setting-up and Operating of Horizontal or Vertical Milling Machines –
Course: Techniques for Machining of Material. Instruction Examples
for Practical Vocational Training**

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Setting-up and Operating of Horizontal or Vertical Milling Machines – Course: Techniques for Machining of Material. Instruction Examples for Practical Vocational Training

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Introduction

The present booklet contains 4 selected instruction examples which are intended to help practising and consolidating knowledge and skills acquired in the setting-up and operation of milling machines.

In order to facilitate the preparation and execution of the work, the necessary materials, working, measuring and testing tools and accessories are stated for each instruction example. For the instruction examples 2 and 3 the steel is specified according to the value of its tensile strength in the unit “Megapascal” (MPa).

We also recommend knowledge required in addition to knowledge of setting-up and operation of milling machines, which should be repeated before starting with the work.

Explanations to the working drawings are given before the specification of the technological sequence.

The specified sequence of operations for the individual instruction examples gives the steps necessary for the production of the relevant workpiece. This sequence of operations should be strictly observed if good quality is to be achieved.

For the instruction examples 2 and 3 a working drawing is attached showing the required shapes and dimensions of the work-pieces. The admissible deviations for sizes with no indication of tolerances may be taken from the table below.

Nominal size	Admissible deviation in mm
0.5 – 6	± 0.1
6 – 30	± 0.2
30 – 120	± 0.3
120 – 315	± 0.5

The admissible surface roughness Rz is given in μm (0.001 mm).

Instruction example 1.1.: Operation of the control elements

This example serves to practise the operation of the control elements of a horizontal milling machine and to understand their functions.

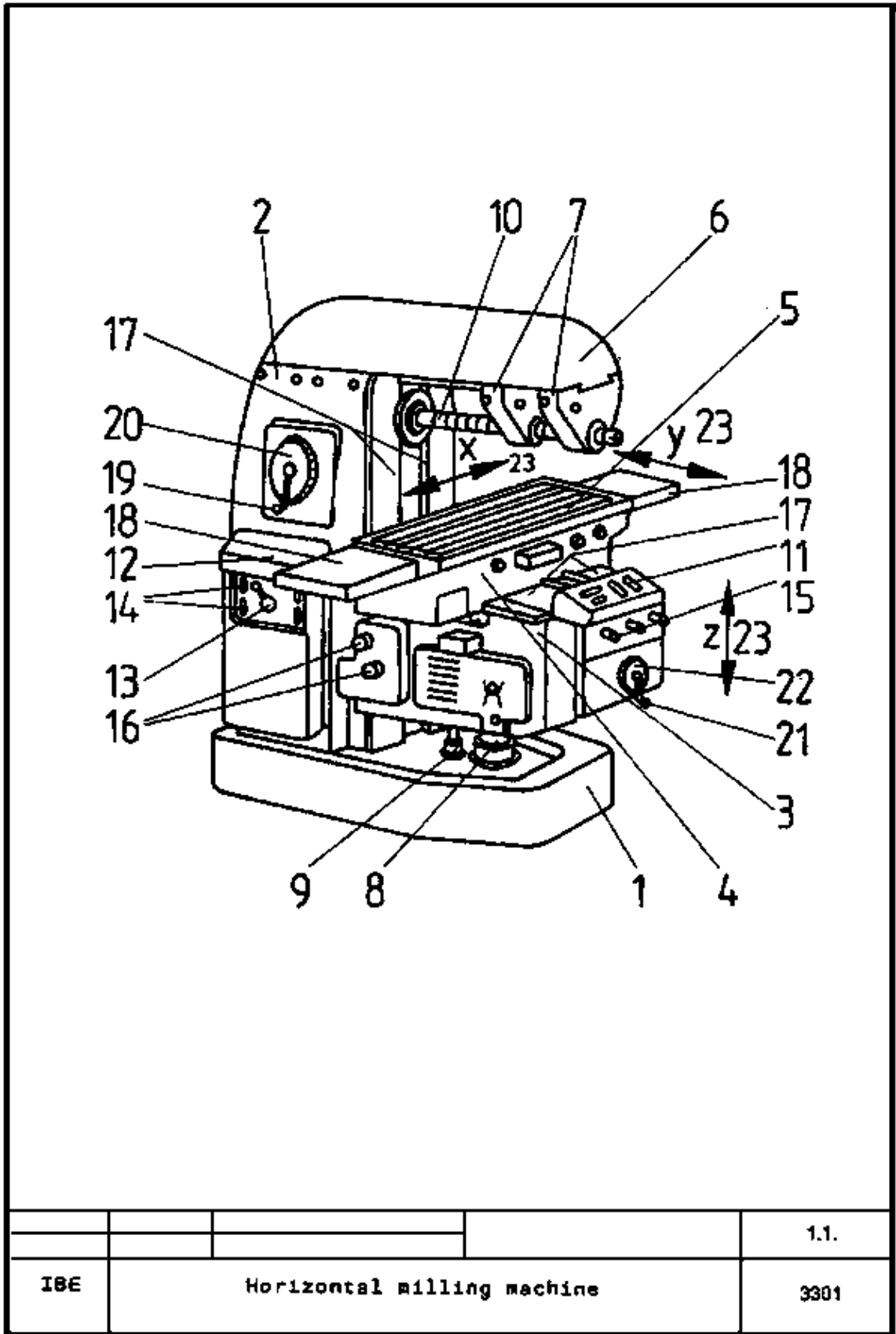
Required previous knowledge

Reading of drawings, design and operating principle of the horizontal milling machine, use and field of application of the milling machine, labour safety regulations.

Explanations to the working drawing

The attached working drawing shows the design of the horizontal milling machine. The individual parts are numbered. In the sequence of operations the number (s) of the control element to be operated is (are) given in brackets.

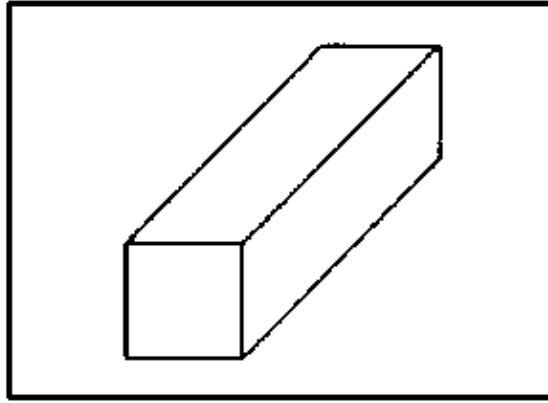
Sequence of operations	Remarks
1. Familiarization with the milling machine – selection of speed (19, 20)	Study the construction and control elements of the milling machine – practise the actuation of the speed selection lever. Operate the lever only when the milling spindle is stopped!
2. Selection of feed (21)	Read the table to determine the feed rate.
3. Operation of the knee (3, 15, 16)	Vertical direction of motion, up and down (Z direction). Vertical motion may be operated manually by the crank handle (moving into position) and mechanically by feed and rapid motion.
4. Operation of the saddle (14, 15, 16)	Horizontal direction of motion on the knee (Y direction). Horizontal motion may be operated manually by the crank handle (moving into position) and mechanically by feed and rapid motion.
5. Operation of the machine table (milling table) (5, 15)	Longitudinal direction of motion in X direction. Longitudinal motion may be operated manually by the crank handle and mechanically by feed and rapid motion. Electro–mechanical stops are used to set and limit the milling travel and the power return travel of the milling table after the milling operation.
6. Operation of the control panel (11, 12)	Familiarization with the functions of the symbols. Location of the main switch and of the circuit breakers and emergency switches. Speed and feed selector switches. Function of the table rise and fall mechanism. Up–cut and down–cut milling. Coolant switch. Operation of rapid motion, feed motion and creep feed motion. Oil lubrication (centralized lubrication, oil level inspection) .
7. Switching the machine ON and OFF (13)	Main switch, emergency switch and control buttons of the main control panel. Check for serviceability prior to putting into operation. On completion of the work order or when leaving the machine, switch off the main switch! Repeat and practise the operation of the milling machine.



Horizontal milling machine

Instruction example 1.2.: Selection of the working tools

The example of a strip to be machined serves to practise the selection of suitable working tools.



Material

St 60 (structural steel with a tensile strength of 600 MPa)

Dimensions

150 x 42 x 38

Machine tool

Vertical milling machine

Working tools

Face milling cutter, cutter arbor (short), machine vice, sliding blocks, clamping screws, spanner, hammer, flat file.

Measuring and testing tools

Vernier caliper

Accessories

Chip brush, hand broom, cleaning rag, parallel pieces, T-slot cleaner

Required previous knowledge

Reading of drawings, types and application of clamping tools and accessories

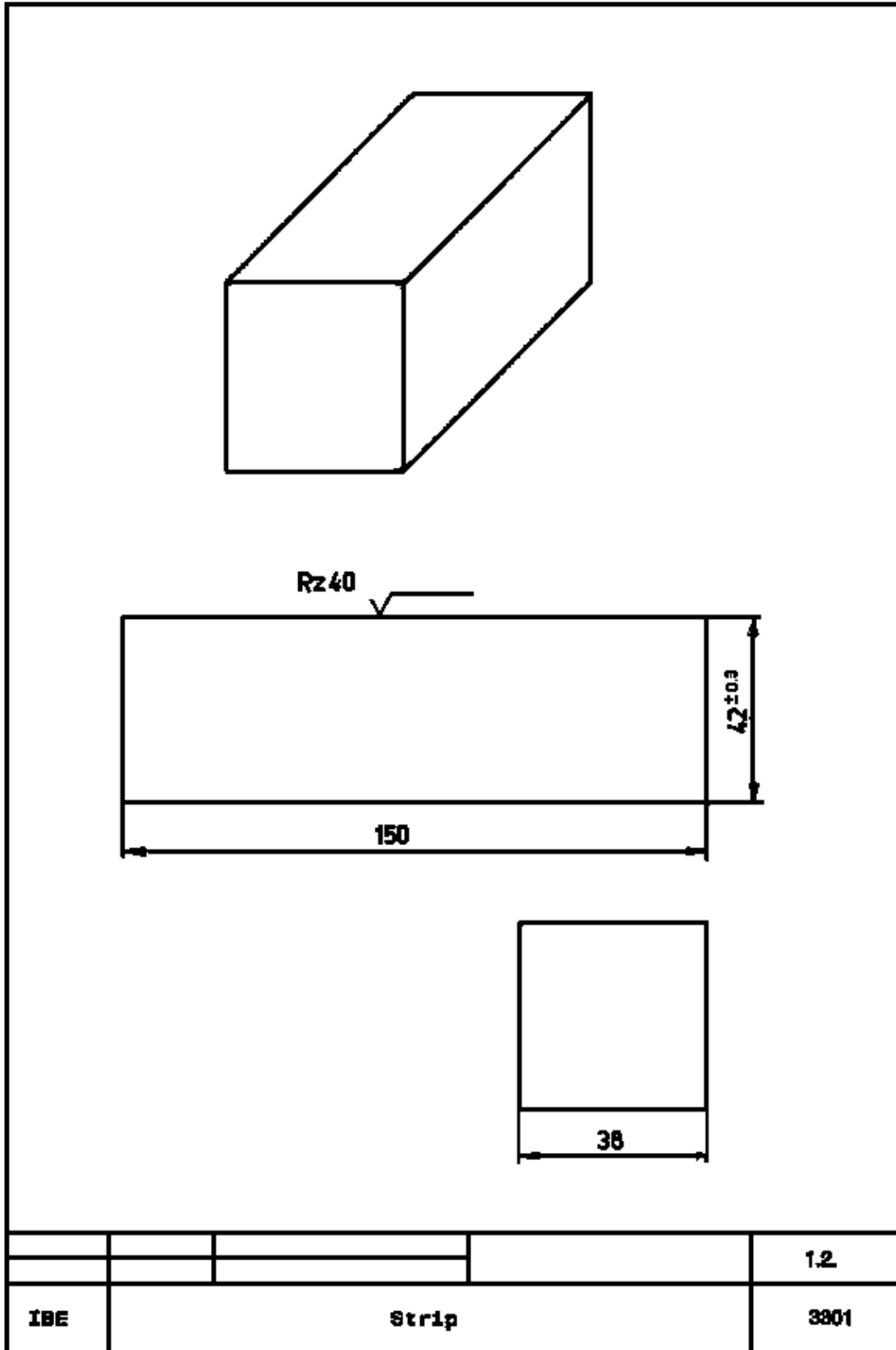
Explanations to the working drawing

Rz 40 : Average roughness of the surface machined = 40 μm (0.04 mm)

Size 40 \pm 0.3 : Range of tolerance 39.70 – 40.30 admissible

Sequence of operations	Remarks
1. Inspection of blank sizes	Compare with the details on the accompanying documents.
2. Functional test and lubrication of the milling machine	Lubricate and check oil level as per lubrication chart of the milling machine
3. Clamping the machine vice on the machine table	Locate the machine vice by means of sliding blocks.
4. Selection of milling cutter face milling cutter – (dia. 80 x 40 x 32)	Because of material of workpiece (steel), milling cutters of super high-speed steel or carbide can be used.
	Pay attention to cleanliness when clamping!

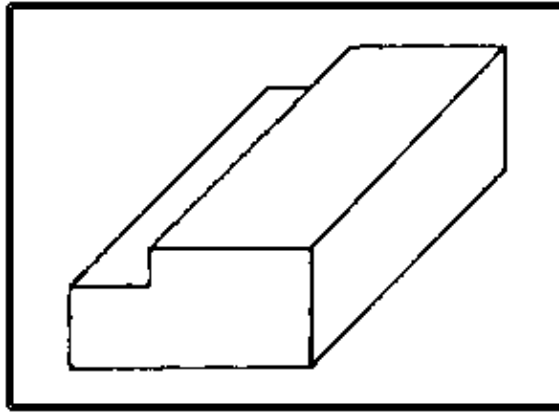
5. Clamping of cutter and mounting of cutter arbor in milling spindle	
6. Clamping of workpiece in machine vice and hammering onto clamping support (parallel pieces)	The workpiece is to be clamped in the vice as deep as possible (safe clamping). In case of small machining allowance a support (e.g. of aluminium) is to be used for hammering to protect the surface from damage by hammer blows.
7. Setting of cutting values for face milling (speed and feed rates)	Values to be taken from tables/standards or to be calculated.
8. Moving the workpiece in machining position (setting the knee, saddle and machine table)	Move knee, saddle and machine table into working position by rapid motion.
9. Scratching (starting cut) of rotating cutter on the workpiece surface and setting of required depth of cut	Machining of steel by a milling cutter of super high-speed steel necessitates the use of coolant.
10. Milling of the first side of the workpiece, inspection of accuracy to size and surface finish	After machining the table is returned in rapid motion with the table rise and fall mechanism in operation.
11. Deburring, cleaning and storing the workpiece on the workbench and machining of the remaining workpieces	Constant checking of the size 42 mm and of surface roughness and correction, if necessary.



Strip

Instruction example 1.3.: Clamping and aligning of workpiece and tool

The example of the production of a strip terminal serves to practise clamping and aligning of workpiece and tool.



Material

GGL 25 (grey cast iron, unalloyed, tensile strength 250 MPa)

Dimensions

500 × 120 × 60

Machine tool

Vertical milling machine

Working tools

Offset holding clamps, clamping screws, spanner, sliding blocks, pressure jaws, locators, face cutter (carbide tipped), cutter arbor (short), flat file.

Measuring and testing tools

Vernier caliper, depth gauge, micrometer depth gauge

Accessories

Chip brush, hand broom, cleaning rag, T-slot cleaner, parallel pieces.

Required previous knowledge

Reading of drawings, measuring and testing, types and application of clamping tools and accessories.

Explanations to the working drawing

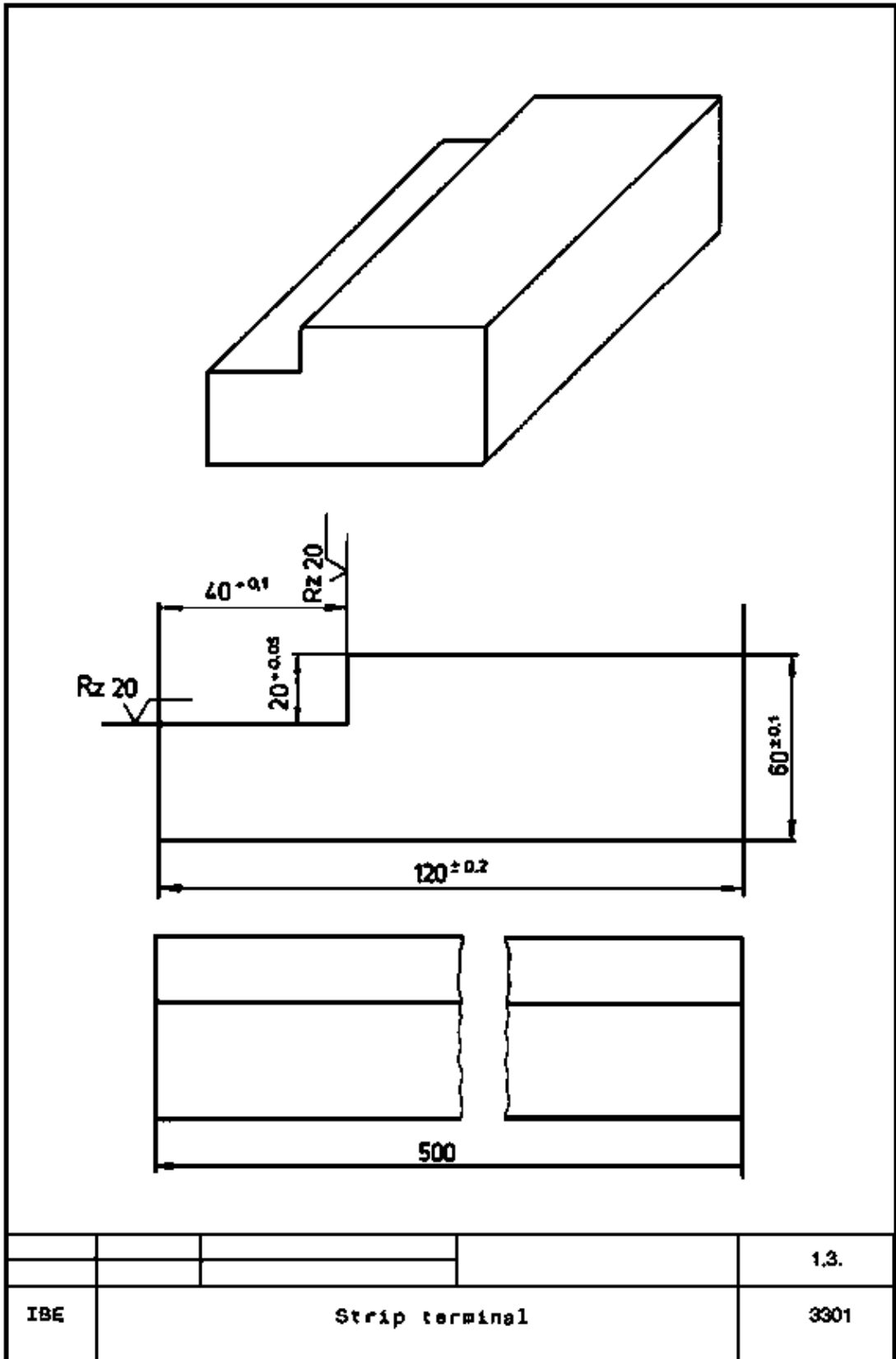
Rz 20 : Average roughness of the surface machined – 20µm (0.02 mm)

size 20^{+0.05} : Range of tolerance 19.95 – 20.05 mm permissible

size 40^{+0.1} : Range of tolerance 40.00 – 40.10 mm permissible

Sequence of operations	Remarks
1. Inspection of dimensions	Compare with the details on the accompanying documents.
2. Functional test and lubrication of the milling machine	Lubricate and check oil level as per lubrication chart.
3. Selection of holding clamps, clamping screws, sliding blocks, pressure jaws and locators	Locate the workpiece by location against sliding blocks by means of pressure jaws and locators. Fix the workpiece preferably by using offset holding clamps.

4. Clamping of workpiece on machine table, checking for good contact and support (location)	Pay attention to cleanliness of contact and supporting faces of workpiece!
5. Clamping of face cutter on short arbor (dia. 32) and mounting of cutter arbor in milling spindle	Pay attention to cleanliness when clamping the cutter on the cutter arbor and the cutter arbor in the milling spindle, otherwise there will be radial or axial runout.
6. Setting of cutting values (speed rate n and feed rate v)	<p>Values to be taken from table or to be calculated.</p> $n = \frac{v \cdot 1000}{d \cdot \pi} \text{ (r.p.m.)}$ <p>$v_f = sz \cdot z \cdot n$ (mm/min) sz = feed per cutting edge of cutter (mm) z = number of cutting edges of cutter $\pi = 3.14$ For workshop use the approximate formula is recommended:</p> $n = \frac{v \cdot 320}{d}$
7. Scratching (starting cut) and milling (roughing) of the shoulder, dimensional inspection and milling of the shoulder to final size ($40^{+0.1} \times 20^{+0.05}$)	Prior to dimensional inspection deburring by the flat file might be necessary.
8. Dimensional and surface inspection	Labour safety note: Never use compressed air for cleaning the machine table – risk of eye injury!



Strip terminal

Instruction example 1.4.: Maintenance and servicing of the milling machine

This serves to practise maintenance and servicing on a horizontal milling machine.

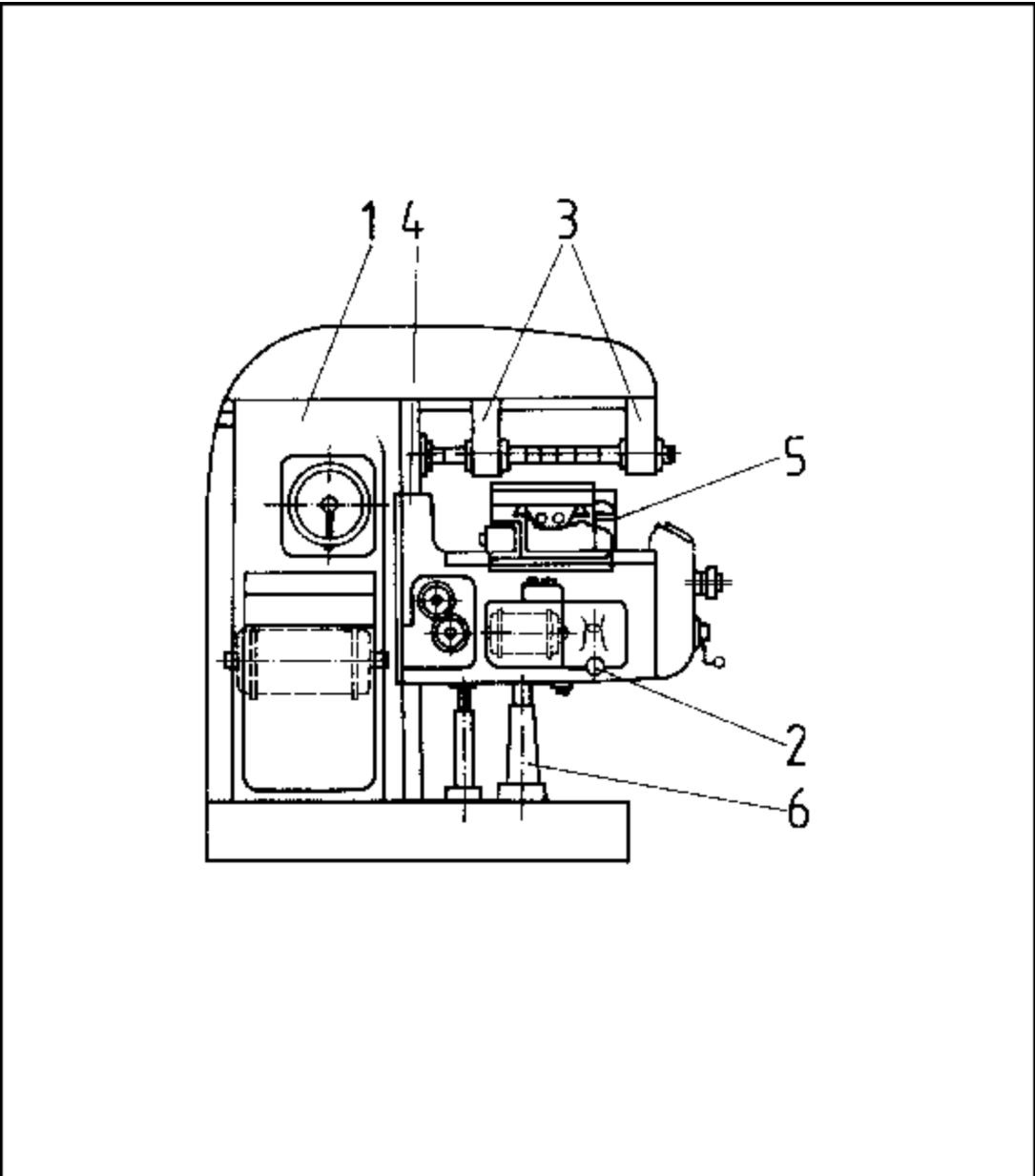
Required previous knowledge

Properties of lubricants and process materials (lubrication chart of the relevant machine), reading of drawings, reading of the instruction manual of the relevant milling machine, labour safety and fire protection regulations when handling lubricants and process materials

Explanations to the working drawing

The drawing shows the following lubricating points: 1 bubble glass (speed gear), 2 sight glass (feed gear), 3 sight glasses (counter bearings), 4 lubricating point (saddle and machine table), 6 lubricating point (screw, screw nut)

Sequence of operations (Kind of servicing/maintenance work)	Remarks (Cycle/interval)
1. Cleaning of guideways	daily
2. Inspection of oil level (sight glasses)	daily
3. Lubrication as per lubrication chart	as per instructions on lubrication chart
4. Oil renewal	semi-annually/annually
5. Inspection and, if necessary, refilling of coolant tank	weekly
6. Thorough cleaning of the machine	weekly
7. Inspection of slackness of bearings	annually
8. Inspection of electrics (contactors, limit switches, cable connections)	every three months
9. Inspection of lubrication pump	semi-annually
10. Coolant renewal	semi-annually



				1.4.
IBE	Lubricating points of the horizontal milling machine			3301

Lubricating points of the horizontal milling machine

