International Standard 3655

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Acceptance conditions for vertical turning and boring lathes with one or two columns and a single fixed or movable table — General introduction and testing of the accuracy

Conditions de réception des tours verticaux à un ou deux montants, à un seul plateau fixe ou déplaçable — Introduction générale et contrôle de la précision

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3655 was prepared by Technical Committee ISO/TC 39, *Machine tools.*

This second edition cancels and replaces the first edition, published in two parts (ISO 3655/0-1976 and ISO 3655/1-1986), of which it constitutes a minor revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Acceptance conditions for vertical turning and boring lathes with one or two columns and a single fixed or movable table — General introduction and testing of the accuracy

1 Scope and field of application

This International Standard defines machining operations on vertical turning and boring lathes with one or two columns and a single fixed or movable table. It defines and summarizes the different types of machines and establishes a glossary for the various types of machine tool. It indicates, with reference to ISO 230/1, both geometrical and practical tests for such vertical lathes, and gives the corresponding permissible deviations for general purpose use machines of normal accuracy.

NOTE — In addition to terms used in the three official ISO languages (English, French and Russian), this International Standard gives the equivalent terms in German, Italian and Swedish; these have been included at the request of Technical Committee ISO/TC 39 and are published under the responsibility of the member bodies for Germany F.R. (DIN), Italy (UNI) and Sweden (SIS). However, only the terms given in the official languages can be considered as ISO terms.

It deals only with the verification of accuracy of the machine. It does not apply to the running of the machine (vibrations, abnormal noises, stick-slip motion of components, etc.) or to machine characteristics (speeds, feeds, etc.), which should generally be checked before testing accuracy.

2 References

ISO 230/1, *Machine tools — Acceptance code for machine tools — Part 1: Geometric accuracy of the machine operating under no load or finishing conditions.*

ISO 841, *Numerical control of machines — Axis and motion nomenclature.*

ISO 1101, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings.*

3 Definitions of the machining operations carried out on these machines

3.1 Turning operations

Turning consists of machining of internal or external, cylindrical or conical or other revolving surfaces by means of one or more single point cutting tools.

3.2 Facing operations

A vertical turning and boring lathe can also be used for machining flat surfaces, perpendicular to the axis of rotation of the table. This operation is called facing.

3.3 Threading operations

Threads of given pitches are machined on external or internal cylindrical surfaces by means of special thread form cutting tools.

3.4 Scroll cutting operations

Scroll (Archimedian spiral) cutting is the machining of spiral grooves in a surface perpendicular to the axis of rotation of the table.

4 Definition and description of the various types

The common characteristic of all vertical turning and boring lathes is that they have at least one circular table which revolves on a fixed or movable base. The axis of rotation of the table is vertical and the horizontal surface is used as a location face for workpiece location fixtures.

These machines fall into two categories characterized by type, i.e.:

- vertical turning and boring lathes with a single column;
- vertical turning and boring lathes with two columns.

In addition, in the machines of the first category or "single column lathes", there are machines with:

- fixed column and fixed table;
- fixed column and movable table;
- movable column and fixed table.

Machines of the second category or "lathes with two columns" can be sub-divided into:

- machines with fixed columns and fixed table;
- machines with movable columns and fixed table;
- machines with fixed columns and movable table.

4.1 Vertical lathes with a single column (see 7.1)

This configuration relates to machines of small to medium capacity having a table diameter of between 630 and 2 500 mm (25 and 100 in) for machines with a fixed table, and of between 1 600 and 10 000 mm (63 and 400 in) for machines with a movable table or column.

4.1.1 Base, table, table support, column

For single column machines the table is supported by a base to which the column is rigidly attached. In certain cases the base and column are integral. In the case of machines with a movable table the world "bed" can be substituted for the word "base".

The table support consists of the base of the machine including the table drive and gear-box.

The table axis and the column slideways are located in parallel vertical planes.

4.1.2 Rail, side head and rams

The rail is an element the main slideways of which are perpendicular to the column slideways. It can be either fixed or movable. If the rail is fixed, it is rigidly connected to the column or in certain cases integral with the column; if movable, it slides along the vertical slideways of the column which are parallel to the table axis.

The rail has horizontal slideways on which either one or two railheads move.

These railheads carry a ram or a slide with vertical or inclined movement and on which a toolholder or turret is mounted.

In certain cases, the machine may have an additional head called a side head. This head is mounted at the side of the table and is guided by vertical slideways which are parallel to the rail vertical movement. It has a ram fitted with a toolholder or turret and has horizontal or inclined movement.

4.1.3 Cutting and feed movements

The cutting movement is generated by the table.

The machine can be fitted with the following feed movements:

- horizontal movement of the railhead or heads along the rail;
- vertical or inclined movement of the railhead ram or rams;
- vertical movement of the side head;
- horizontal or inclined movement of the side head ram.

These movements also generally have a "rapid traverse".

The vertical movement of the rail and, where applicable, the table or column movement on the bed, are only positioning movements and not feed movements.

4.2 Vertical lathes with two columns (see 7.2)

This configuration relates to machines with a large capacity having a table diameter of greater than 1 800 or 2 000 mm (72 or 80 in).

For this type of machine the table is supported by the base, which is rigidly attached to the right- and left-hand columns.

At their upper end the columns are connected by a solid member called the bridge. The upper part of the machine can have a front cover for aesthetic reasons.

4.2.1 Rail, railheads and rams

Vertical turning and boring lathes having two columns, with the exception of specially adapted machines, always have a rail which can be moved vertically.

The rail has horizontal slideways on which one or two railheads move.

The railheads carry a ram or slide with vertical or inclined movement, and on which a toolholder or turret is mounted.

In the case of a rail with two railheads, these are called the right- and left-hand railheads with respect to an operator standing in front of the machine.

In certain cases the machine can have a side head placed on the right-hand column and guided by vertical slideways parallel to the rail vertical movement. The side head ram may have horizontal or inclined movement. The side head may be fitted with a toolholder or turret.

4.2.2 Cutting and feed movements

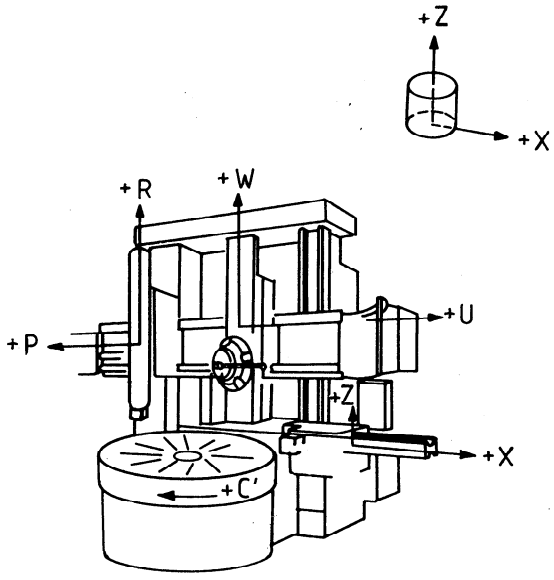
The cutting movement is generated by the table. The machine may have the following feed movements:

- horizontal movement of the two railheads along the rail;
- vertical or inclined movement of the railhead ram or slide;
- horizontal or inclined movement of the side head ram;
- vertical movement of the side head.

The movements are also generally capable of "rapid traverse".

The vertical movement of the rail and, where applicable, the movement of the column on the base, are only positioning movements and are not feed movements.

4.3 Designation of axes



5 Preliminary remarks

5.1 In this International Standard, all dimensions and tolerances are expressed in millimetres and inches.

5.2 To apply this International Standard, reference should be made to ISO 230/1, especially for installation of the machine before testing, warming up of spindles and other moving parts, description of measuring methods and recommended accuracy of testing equipment.

5.3 The sequence in which the geometrical tests are given is related to the sub-assemblies of the machine and this in no way defines the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be applied in any order.

5.4 When inspecting a machine, it is not always necessary to carry out all the tests given in this International Standard. It is up to the user to choose, in agreement with the manufacturer, those relating to the properties which are of interest to him, but these tests are to be clearly stated when ordering a machine.

5.5 The practical tests shall be made with finishing cuts and not with roughing cuts which are liable to generate appreciable cutting forces.

5.6 When establishing the tolerance for a measuring range different from that given in this International Standard (see 2.311 in ISO 230/1) it should be borne in mind that the minimum tolerance value is 0,005 mm (0.000 2 in) for geometrical and practical tests.

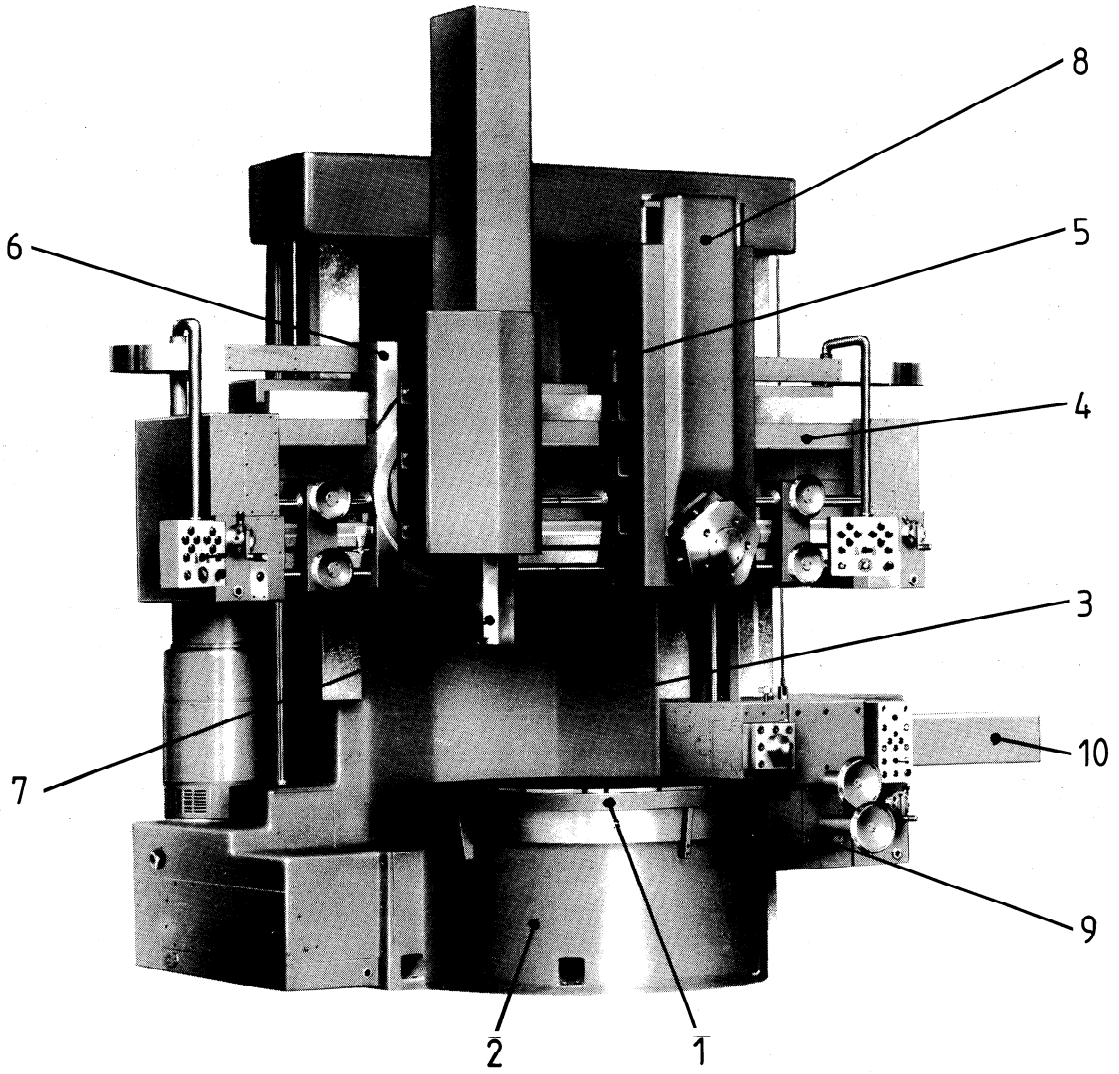
5.7 For table or movable column machines, tests shall be carried out setting the column as near as possible to the axis of rotation of the table.

6 Diagrams

For reasons of simplicity, diagrams in this International Standard illustrate only typical designs of machines.

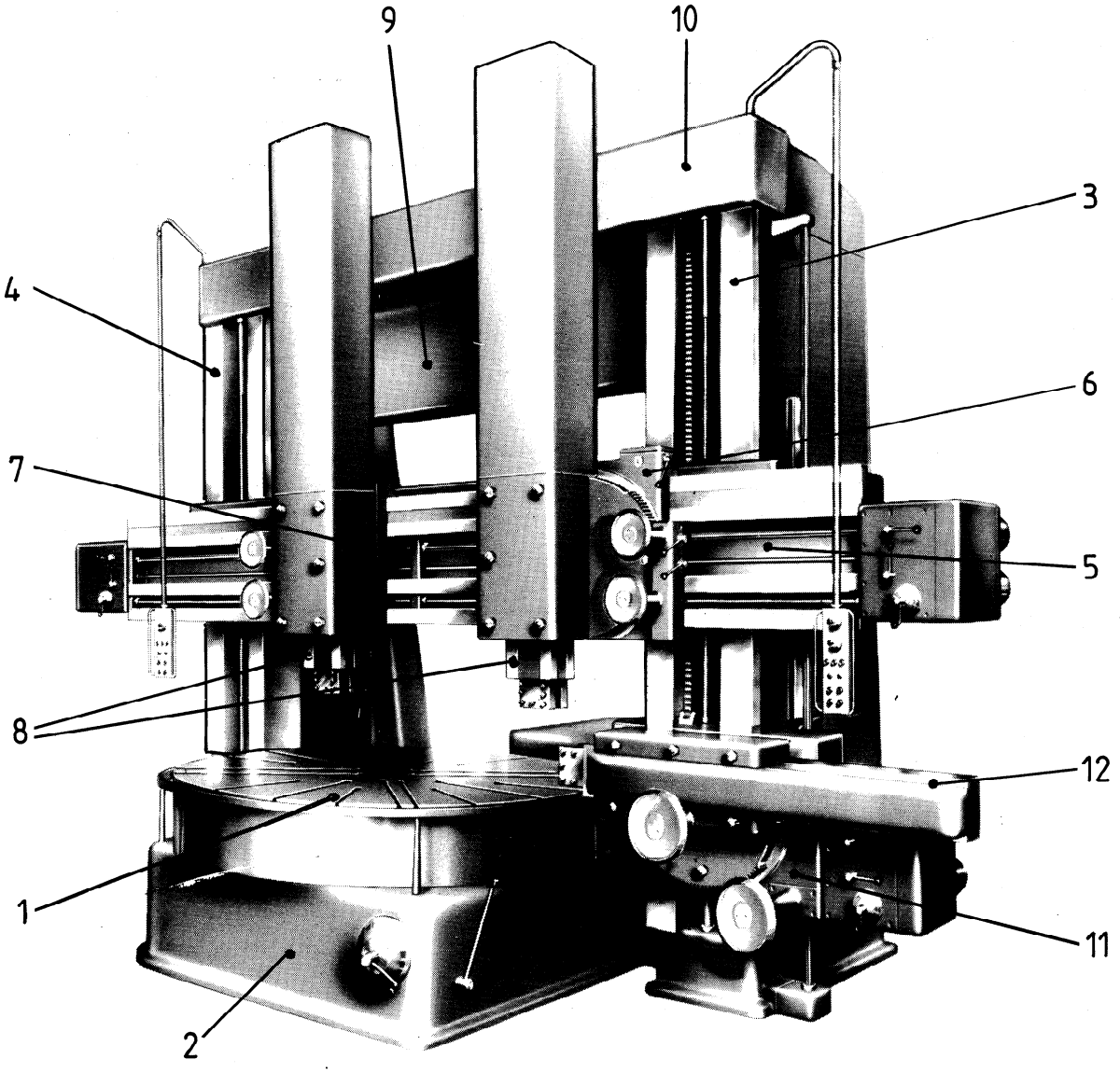
7 Nomenclature

7.1 Vertical lathe with a single column



Reference	Designation					
	English	French	Russian	German	Italian	Swedish
1	Table	Plateau	планшаиба	Planscheibe	Tavola	Bord
2	Base	Socle	основание	Untersatz	Basamento	Bädd
3	Column	Montant	стойка	Ständer	Montante	Pelare
4	Rail	Traverse	поперечина	Querbalken	Traversa mobile	Tvärbalk
5	Turret railhead	Chariot de tourelle	вертикальный суппорт правый (с револьверной головкой	Revolversupport	Slitta orizzontale del carrello destro di traversa (a torretta)	Revolversupport
6	Railhead	Chariot de traverse	вертикальный суппорт левый (с ползуном)	Meisselschieber-Support	Slitta orizzontale del carrello sinistro di traversa	Mejselslidsupport
7	Railhead ram	Coulant du chariot de traverse	ползун	Meisselschieber	Slitta verticale	Mejselslid
8	Turret slide	Coulisse de tourelle	ползун правого суппорта (с ревильверной головкой)	Revolverschieber	Slitta verticale con torretta	Revolverslid
9	Side head	Chariot latéral	боковой суппорт	Seiten-Support	Slitta verticale del carrello di montante	Sidosupport
10	Side head ram	Coulant du chariot latéral	ползун бокового суппорта	Seitensupport-Schieber	Slitta orizzontale	Sidosupportslid

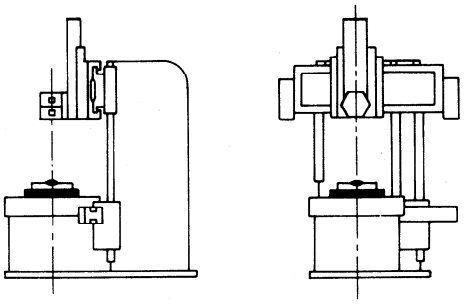
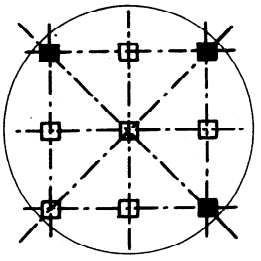
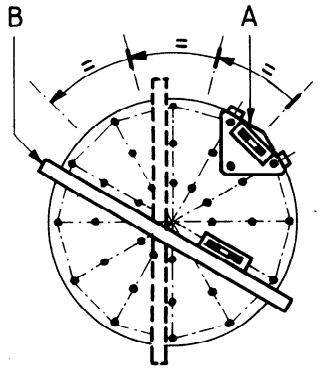
7.2 Vertical lathe with two columns



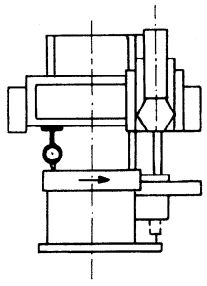
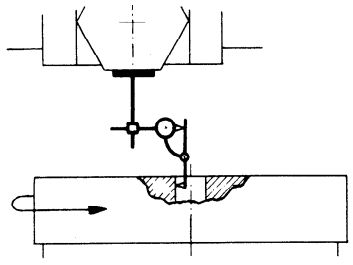
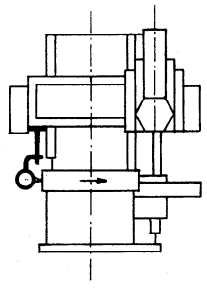
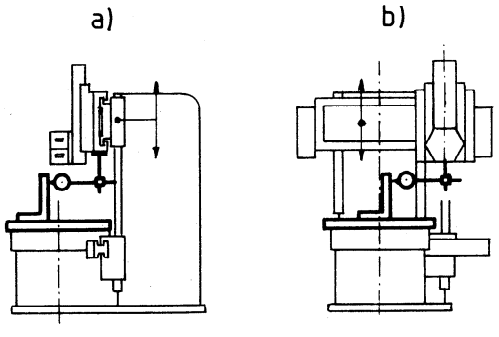
Reference	Designation					
	English	French	Russian	German	Italian	Swedish
1	Table	Plateau	планшаиба	Planscheibe	Tavola	Bord
2	Base	Socle	основание	Untersatz	Basamento	Bädd
3	Right-hand column	Montant droit	правая стойка	Ständer rechts	Montante destro	Pelare, höger
4	Left-hand column	Montant gauche	левая стойка	Ständer links	Montante sinistro	Pelare, vänster
5	Rail	Traverse	поперечина (траверса)	Querbalken	Traversa mobile	Tvärbalk
6	Railhead, right-hand	Chariot droit de traverse	правый суппорт	Querbalken-Support rechts	Slitta orizzontale del carrello destro di traversa	Tvärbalksupport, höger
7	Railhead, left-hand	Chariot gauche de traverse	левый суппорт	Querbalken-Support links	Slitta orizzontale del carrello sinistro di traversa	Tvärbalksupport, vänster
8	Railhead ram (either right or left)	Coulant du chariot de traverse (droit ou gauche)	ползун (правый или левый)	Meisselschieber (rechts oder links)	Slitta verticale	Mejselslid, höger eller vänster
9	Bridge	Entretoise	перекладина	Traverse	Traversa fissal	Travers
10	Front cover	Fronton	передний кожух	Abdeckung	Frontone di copertura	Skydd
11	Side head	Chariot latéral	боковой суппорт	Seiten-Support	Slitta verticale del carrello du montante	Sidosupport
12	Side head ram	Coulant du chariot latéral	ползун бокового суппорта	Seitensupport-Schieber	Slitta orizzontale	Sidosupportslid

8 Acceptance conditions and permissible deviations

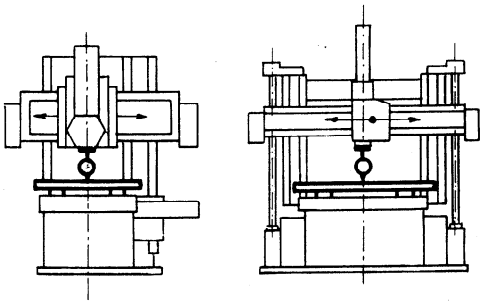
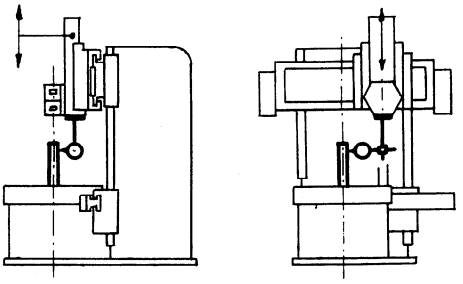
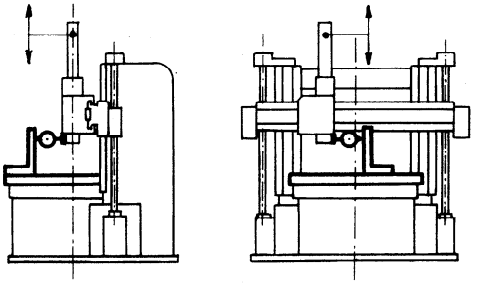
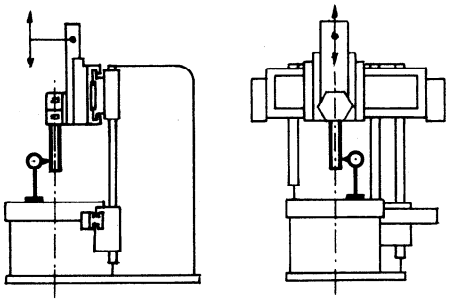
8.1 Geometrical tests

No.	Diagram	Object
G0		**A — Table** Levelling
G1	a)  **Alternative** b)  	Verification of flatness of the table surface

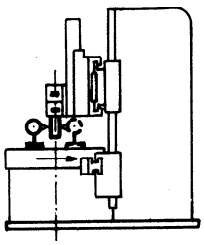
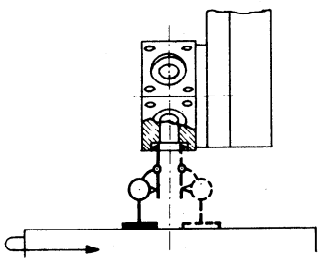
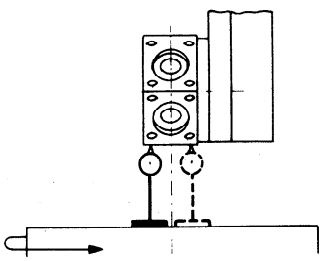
Permissible deviation		Measuring instruments	Observations and references to the ISO 230/1 test code
mm	in		
0,06/1 000	0.002 5/40	Straightedge and precision level	Clause 3.11 NOTE — For table dimensions greater than 1 000 mm (40 in) the number of positions for the level is to be agreed between the manufacturer and user.
0,03	0.001 2	Straightedge and gauge blocks or precision level	a) Clause 5.322 Alternative b) Clause 5.323 **Alternative test** (Checking with the aid of level) 1) Circular checking The level shall be placed on a support **A** having three bearing points on the table periphery. The support shall be moved to positions equally spaced along the table periphery. 2) Radial checking The level shall be placed on the table and along a diametrical direction with the aid of a straightedge **B**. The level shall be moved at positions equally spaced along the straightedge. The procedure shall be repeated moving the straightedge according to the successive positions occupied by the support **A**. Subject to agreement between manufacturer and user, it is permissible to carry out diametrical checking only.
for any measuring diameter up to			
1 000	40		
flat to concave			
For each 1 000 mm (40 in) increase in diameter add to the tolerance			
0,01	0.000 4		
Local tolerance			
0,01	0.000 4		
over any measuring length of			
300	12		

No.	Diagram	Object
G2		Measurement of camming of the table surface when rotating.
G3		Measurement of run-out of the table bore;
		or
		Measurement of run-out of the external cylindrical surface of the table (in the case of a table not having a central bore).
G4		**B — Rail and railhead** Checking of squareness of the vertical slideways of the column to the table surface: a) in a plane perpendicular to the rail; b) in a plane parallel to the rail.

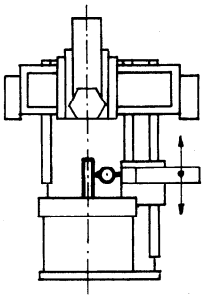
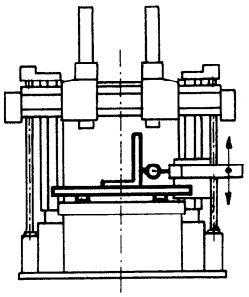
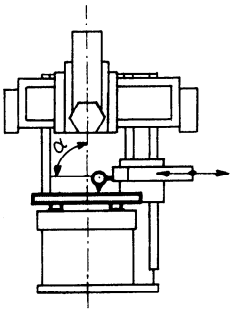
Permissible deviation		Measuring instruments	Observations and references to the ISO 230/1 test code
mm	in		
0,02	0.000 8	Dial gauge	Clause 5.632 The dial gauge shall be placed on a fixed part of the machine and shall be placed as near as possible to the table periphery and approximately 180° from the position occupied by the tool when the table was machined. Rail, railhead and slide locked in position.
for a table diameter of:			
1 000	40		
For each 1 000 mm (40 in) increase in diameter add to the tolerance:			
0,01	0.000 4		
0,02	0.000 8	Dial gauge	Clauses 5.611.4 and 5.612.2 The dial gauge shall be placed approximately 180° from the position occupied by the tool when the table was machined. Rail, railhead and slide locked in position. The dial gauge shall also be placed on a fixed part of the machine.
for a table diameter of:			
1 000	40		
For each 1 000 mm (40 in) increase in table diameter add to the tolerance:			
0,01	0.000 4		
a) 0,06/1 000 b) 0,04/1 000	a) 0.002 5/40 b) 0.001 6/40	Straightedge, square and dial gauge	Clause 5.522.2 Railhead and slide locked in position. The rail shall be locked on its column or columns before each measurement. The checking shall be carried out moving the rail successively in the upper position, mid-travel, and in the lower position.

No.	Diagram	Object
G5		Checking of parallelism of the movement of the railhead or railheads to the table surface.
G6	a) b) 	Checking of parallelism of the toolhead slide or slides movement to the axis of rotation of the table: a) in a plane perpendicular to the rail; b) in a plane parallel to the rail; or Checking of squareness of the toolhead slide or slides movement to the table surface: a) in a plane perpendicular to the rail; b) in a plane parallel to the rail.
	a) b) 	
G7	a) b) 	**C — Turret** Checking of parallelism of the tools housing axes to the slide movement: a) in a plane perpendicular to the rail; b) in a plane parallel to the rail.

Permissible deviation		Measuring instruments	Observations and references to the ISO 230/1 test code
mm	in		
a) without a height-correcting device: 0,03	0.001 2 for a 1 000 mm (40 in) travel b) with a height-correcting device: 0,02	0.000 8 for a 1 000 mm (40 in) travel	Straightedge, gauge blocks and dial gauge	Clause 5.422.22 — Rail and slide locked in position. — Checking shall be made by applying the dial gauge stylus on a straightedge laid parallel to the table surface.
a) 0,015 b) 0,01	a) 0.000 6 b) 0.000 4 for a measuring length of: 300	12	Test mandrel and dial gauge	Clause 5.422.3 Rail and railhead locked in position.
			Straightedge, square and dial gauge	Clause 5.512.2 Rail and railheads locked in position.
a) 0,03 b) 0,02	a) 0.001 2 b) 0.000 8 for a measuring length of: 300	12	Test mandrel and gauge	Clause 5.422 These operations shall be repeated for each of the tool housings.

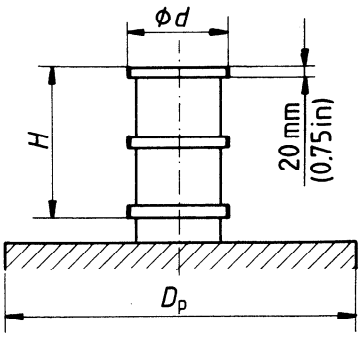
No.	Diagram	Object
G8		Checking of coaxiality between the axes of the tool housing and the axis of rotation of the table.
G9		Checking of coaxiality between the axes of the centring surfaces of the tool holders and the axis of rotation of the table.
G10		Checking of squareness of the faces of turret with the axis of rotation of the table.

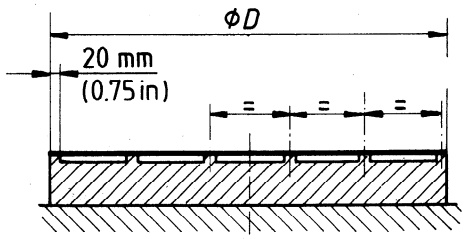
Permissible deviation		Measuring instruments	Observations and references to the ISO 230/1 test code
mm	in		
0,025*	0.001*	Test mandrel and dial gauge	Clause 5.442 — A mandrel of a 300 mm (12 in) maximum length shall be inserted in one of the tool housings. — A dial gauge shall be fixed on the table; rotate the table and adjust the position of the mandrel until the deviations shown on the dial gauge are at a minimum. — Repeat the operation by placing the dial gauge stylus at several different heights. — Repeat the same operations for each of the tool housings. * The value of permissible deviation is equal to half of the readings of the dial gauge.
0,025*	0.001*	Dial gauge	Clause 5.442 — A dial gauge shall be fixed on the table and shall touch the inside of the centring housing of the tool holders. — The table shall be rotated. — This same operation shall be repeated for each of the housings of the turret. * The value of permissible deviation is equal to half of the total readings of the dial gauge.
0,02/300	0.000 8/12	Dial gauge	Clause 5.512.1 — A dial gauge shall be fixed on the table and shall touch the face of turret located opposite. — The table shall be rotated and dial gauge shall be moved to touch the face of turret on the largest possible diameter. — This same operation shall be repeated for each of the faces of the turret.

No.	Diagram	Object
G11		**D — Side head** Checking of parallelism of the side head movement to the axis of rotation of the table; or Checking of squareness of the side head movement to the table surface.
		
G12		Checking of parallelism of the side head ram movement to the table surface.

Permissible deviation		Measuring instruments	Observations and references to the ISO 230/1 test code
mm	in		
0,01 over a measuring length of: 300	0.000 4 12	Test mandrel and dial gauge	Clause 5.422.3
0,01 over a measuring length of: 300	0.000 4 12	Straightedge, square and dial gauge	Clause 5.522.2 The square shall be placed on a straightedge laid parallel to the table surface.
0,02 over a measuring length of: 300 Direction of deviation: $\alpha \geqslant 90°$	0.000 8 12	Straightedge and dial gauge	Clause 5.422.22 The side head shall be locked in position. Checking shall be carried out by placing the dial gauge stylus onto a straightedge laid parallel to the table surface.

8.2 Practical tests

<table>
<tr><th>No.</th><th>Diagram</th><th>Nature of test</th><th>Cutting conditions</th><th>Checks to be applied</th></tr>
<tr><td>P1</td><td rowspan="2"> 

H = 3/4 of the tool holder travel [max. = 1 000 mm (40 in)]
$d = \frac{H}{2}$
Material: cast iron</td><td rowspan="2">Machining on a cylinder of three bearing surfaces of a 20 mm (0.75 in) maximum length</td><td rowspan="2">With a tool mounted on a railhead</td><td>Circularity (clause 14.3 of ISO 1101)</td></tr>
<tr><td>Cylindricity (clause 14.4 of ISO 1101)</td></tr>
<tr><td>P2</td><td rowspan="2">With a tool mounted on the side head (to be carried out only if there is sufficient ram travel)</td><td>Circularity (clause 14.3 of ISO 1101)</td></tr>
<tr><td>Cylindricity (clause 14.4 of ISO 1101)</td></tr>
<tr><td>P3</td><td> 

<table>
<tr><th>Table diameter, D_p [1]</th><th>D [1]</th></tr>
<tr><td>For $D_p \leq$ 1 000 (40)</td><td>500 (20)</td></tr>
<tr><td>(40) 1 000 < $D_p \leq$ 3 000 (120)</td><td>1 000 (40)</td></tr>
<tr><td>(120) 3 000 < D_p</td><td>1 500 (60)</td></tr>
</table>
Material: cast iron</td><td>Machining on a circular block of three concentric bands of 20 mm (0.75 in) maximum width</td><td>With a tool mounted on a railhead</td><td>Flatness (clause 14.2 of ISO 1101)</td></tr>
</table>

1) Dimensions in millimetres (inches in parentheses).

Permissible deviation			Measuring instruments	Observations and references to the ISO 230/1 test code
Table diameter, D_p [1]	mm	in		
For $D_p \leqslant 1\,000$ (40)	0,005	0.000 2	Precision instruments	Clauses 4.1 and 4.2
(40) $1\,000 < D_p \leqslant 3\,000$ (120)	0,01	0.000 4		
(120) $3\,000 < D_p$	0,015	0.000 6		
For $H = 300$ (12)	0,01	0.000 4		
For $D_p \leqslant 1\,000$ (40)	0,005	0.000 2		
(40) $1\,000 < D_p \leqslant 3\,000$ (120)	0,01	0.000 4		
(120) $3\,000 < D_p$	0,015	0.000 6		
For $H = 300$ (12)	0,01	0.000 4		
a) with a height-correcting device:			Straightedge and gauge blocks or level	Clauses 4.1 and 4.2 The respective dimensioning of the three bands shall be determined in relation to the diameter of the test piece and shall be equally spaced.
For $D_p \leqslant 1\,000$ (40)	0,01	0.000 4		
(40) $1\,000 < D_p \leqslant 3\,000$ (120)	0,02	0.000 8		
(120) $3\,000 < D_p$	0,03	0.001 2		
b) without a height-correcting device:				
For $D_p \leqslant 1\,000$ (40)	0,02	0.000 8		
(40) $1\,000 < D_p \leqslant 3\,000$ (120)	0,03	0.001 2		
(120) $3\,000 < D_p$	0,04	0.001 6		

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