INTERNATIONAL STANDARD ISO 3070/II

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

Test conditions for boring and milling machines with horizontal spindle — Testing of the accuracy — Part II : Floor type machines

Conditions d'essai des machines à aléser et à fraiser à broche horizontale — Contrôle de la précision — Partie II : Machines à montant mobile - à taque

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

International Standard ISO 3070/II was developed by Technical Committee ISO/TC 39, *Machine tools,* and was circulated to the member bodies in March 1977.

It has been approved by the member bodies of the following countries :

Australia	Italy	Sweden
Belgium	Korea, Rep. of	Switzerland
Brazil	Mexico	Turkey
France	Poland	United Kingdom
Germany	Romania	U.S.A.
Hungary	South Africa, Rep. of	Yugoslavia
India	Spain	

No member body expressed disapproval of the document.

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Test conditions for boring and milling machines with horizontal spindle — Testing of the accuracy — Part II : Floor type machines

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies, with reference to ISO/R 230, both geometrical and practical tests on general purpose and normal accuracy boring and milling machines with horizontal spindle — floor type machines — and the corresponding permissible deviations which apply.

These machines can be provided with spindle heads of different types corresponding in most cases to figures :

4 (spindle head with milling spindle and boring spindle)

5 (spindle head with sliding boring spindle and with facing head)

6 (spindle head with ram or milling arm)

of Part 0 : "General introduction" of ISO 3070.

It must be made clear that this International Standard concerns machines which have both a transverse movement of the column on the bed, a vertical movement of the spindle head, an axial movement of the boring spindle and possibly a feed movement of the radial facing slide in the facing head. They can be provided with a floor supporting workpieces but this device is not taken into consideration in this International Standard.

Some machines also have an intermediate saddle having slideways between bed and column to achieve additional longitudinal feed movement of the column parallel with the spindle axis.

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

2 PRELIMINARY REMARKS

2.1 In this International Standard, deviations and ranges are expressed in millimetres and in inches.

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

2.3 Users of this International Standard are reminded that a movement is said to be longitudinal when it is parallel to the axis of the machine spindle and is said to be transversal when it is in the perpendicular direction.

2.4 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.

2.5 When inspecting a machine, it is not always possible or 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 tests relating to the properties which are of interest to him, but these tests are to be clearly stated when ordering a machine.

2.6 Practical tests should be made with finishing cuts.

2.7 When establishing the tolerance for a measuring range different from that given in this International Standard (see clause 2.311 in ISO/R 230) it should be taken into consideration that the minimum value of tolerance is 0,002 5 mm (0,000 1 in) for both geometrical and practical tests.

3 REFERENCES

ISO/R 230, *Machine tool test code.*

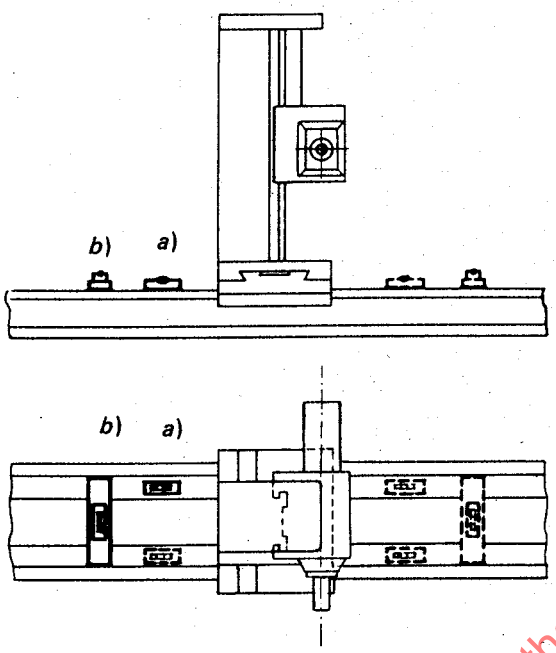
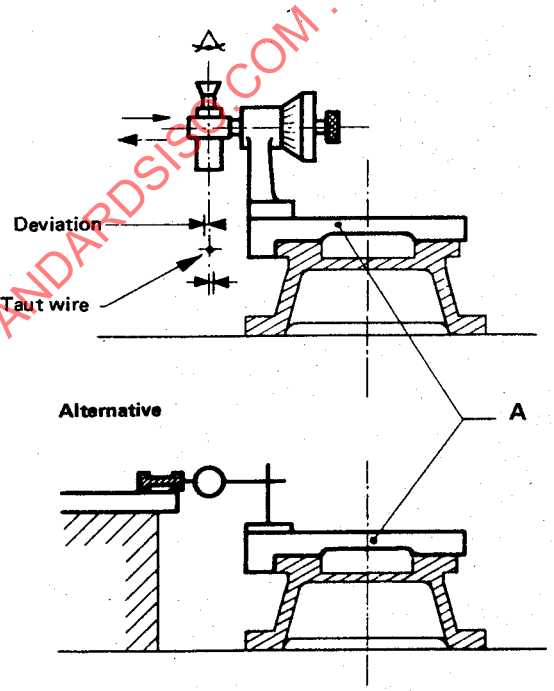
ISO 841, *Numerical control of machines — Axis and motion nomenclature.*

ISO 3070/0, *Test conditions for boring and milling machines with horizontal spindle — Testing of the accuracy — Part 0 : General introduction.*

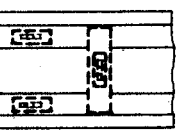
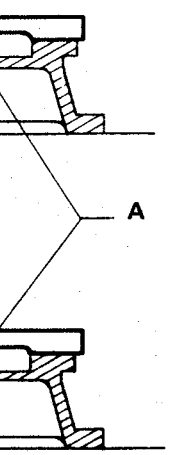
ISO 3070/I, *Test conditions for boring and milling machines with horizontal spindle — Testing of the accuracy — Part I : Table type machines* (and its addendum : *Complementary geometrical tests and practical test to be specified in the case of rotary table machines*).

4 TEST CONDITIONS AND PERMISSIBLE DEVIATIONS

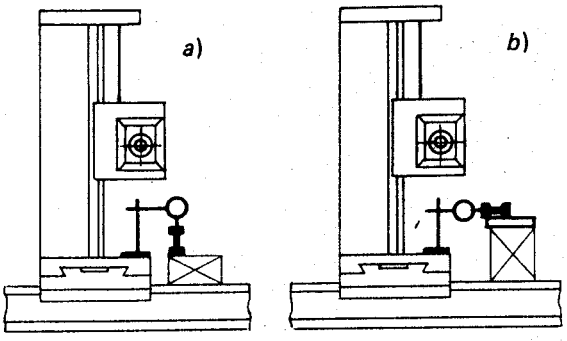
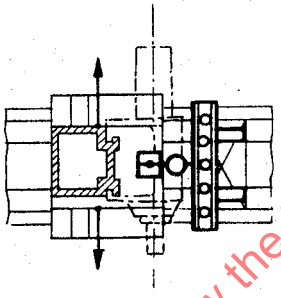
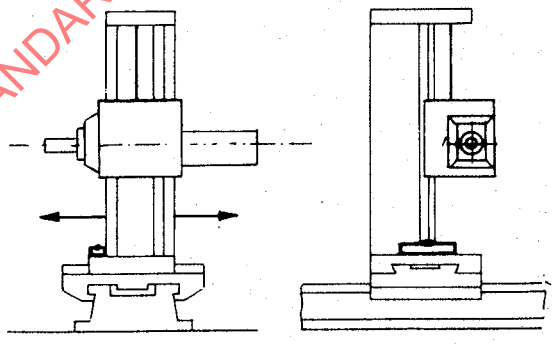
4.1 Geometrical tests

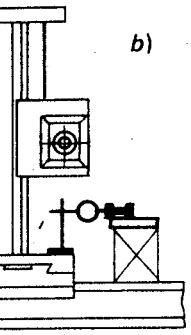
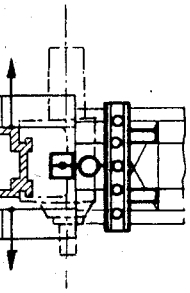
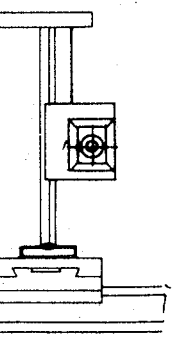
No.	Diagram	Object	
G 1		**A – BED** Verification of levelling of slideways : *a*) Checking of bed lengthwise : – straightness of slideways in the vertical plane;	*a*)
		b) Checking of bed crosswise : – slideways should be in the same plane.	*b*)
G 2		Checking of straightness of the slideways in a horizontal plane.	

and h

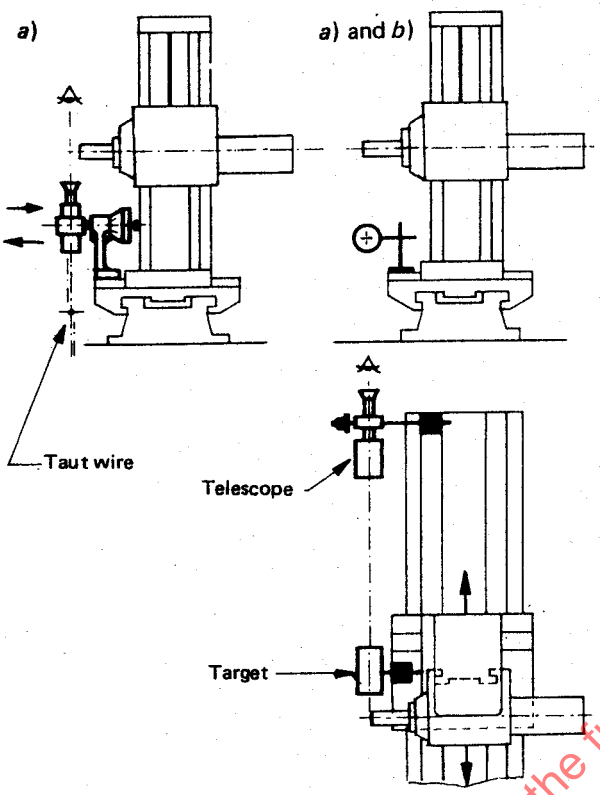
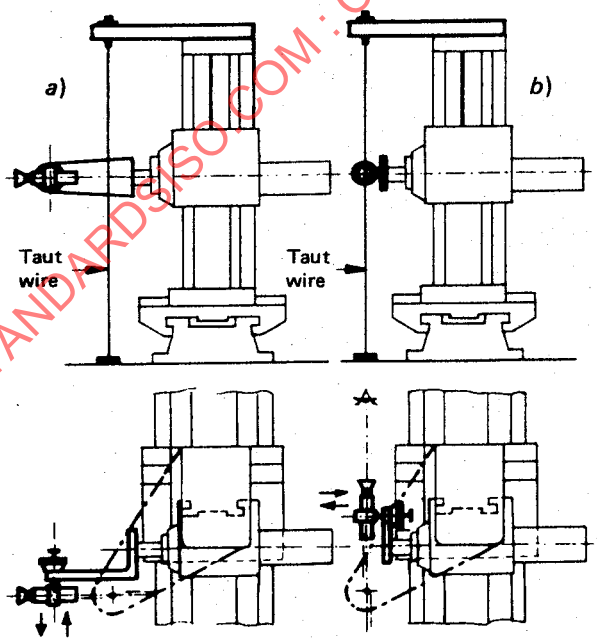
	Object	Permissible deviation	
		mm	in
	**A – BED** Verification of levelling of slideways : *a*) Checking of bed lengthwise : – straightness of slideways in the vertical plane;	*a*) 0,02 up to 1000 For each 1000 mm (40 in) increase in length add to the preceding tolerance : 0,01 Local tolerance : 0,006 over any measuring length of 300 Maximum permissible deviation : 0,05 up to 10000 0,08 above 10000	*a*) 0.0008 up to 40 0.0004 0.00025 over any measuring length of 12 0.002 up to 400 0.0032 above 400
	*b*) Checking of bed crosswise : – slideways should be in the same plane.	*b*) Variation of level : 0,02/1000	0.0008/40
	Checking of straightness of the slideways in a horizontal plane.	0,02 up to 1000 For each 1000 mm (40 in) increase in length add to the preceding tolerance : 0,005 Local tolerance : 0,006 over any measuring length of 300 Maximum permissible deviation : 0,05 up to 10000 0,08 above 10000	0.0008 up to 40 0.0002 0.00025 over any measuring length of 12 0.002 up to 400 0.0032 above 400

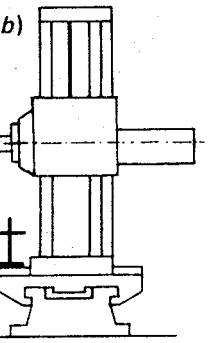
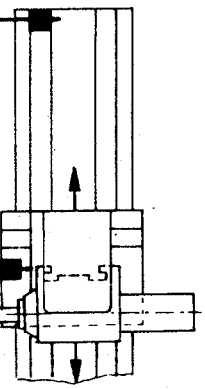
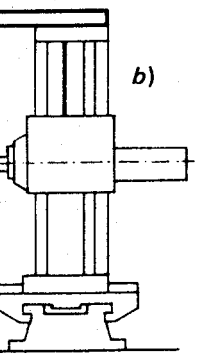
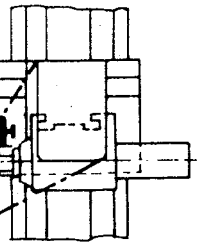
Permissible deviation		Measuring instruments	Observations and references to the test code ISO/R 230
mm	in		
0,02 to 1000	*a*) 0.0008 up to 40	Precision level, optical or other methods	*a*) Clauses 3.11, 3.21 and 5.212.21 or 5.212.22 – Measurements shall be made at a number of positions equally spaced along the length of the bed. – The column shall be placed in the middle of its traverse on the table saddle with the table saddle placed in the middle of the bed.
1000 mm (40 in) increase in length add to the lerance :			
0,01	0.0004		
Local tolerance :			
0,006	0.00025		
over any measuring length of			
300	12		
Maximum permissible deviation :			
0,05 to 10000	0.002 up to 400		
0,08 ve 10000	0.0032 above 400		
Variation of level :		Precision level and support	*b*) Clause 5.412.7 A level shall be placed transversely and measurements taken at a number of positions equally spaced along the length of the bed. The variation of level at any position shall not exceed the permissible deviation.
02/1000	0.0008/40		
0,02 to 1000	0.0008 up to 40	Microscope and taut wire or other optical methods	Clauses 5.212.3 or 5.212.22 or 5.232.1 The microscope or the dial gauge shall be fixed on a support A of a suitable form such that it can slide in the slideways and shall sight or touch, in the horizontal plane, the taut wire or a straightedge laid parallel to the slideways. The taut wire or the straightedge shall be placed on a fixed part, independent of or integral with the machine and as near as possible to the slideways to be checked.
00 mm (40 in) increase in length add to the preceding			
0,005	0.0002		
Local tolerance :			
0,006	0.00025		
over any measuring length of			
300	12		
Maximum permissible deviation :		Dial gauge, straightedge and supports	
0,05 to 10000	0.002 up to 400		
0,08 ve 10000	0.0032 above 400		

No.	Diagram	Object
G 3	  	**B – COLUMN SADDLE** (In the case of columns provided with a saddle for movement of the column parallel to the spindle axis) Checking of the slideways between saddle and column : – straightness of movement of the column on the saddle. 1) **Longitudinal verification** (along the W axis) : *a*) in a vertical plane; *b*) in a horizontal plane. 2) **Transverse verification** (along the X axis) : – slideways should be in the same plane.

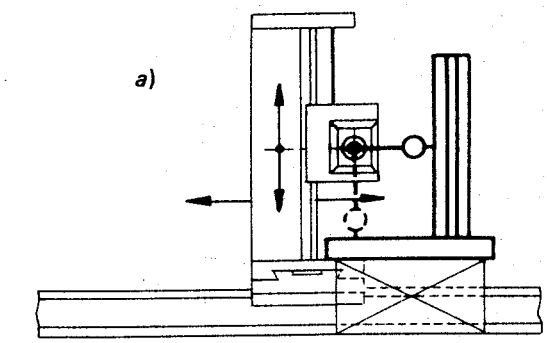
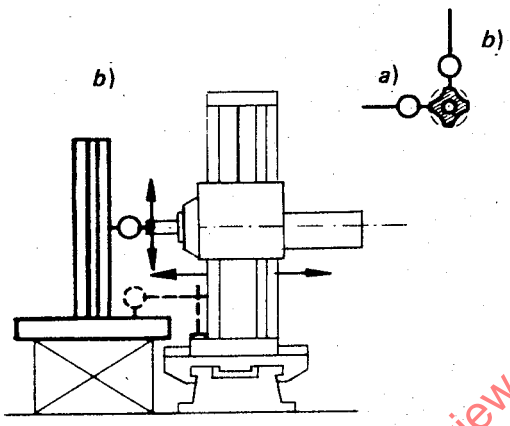
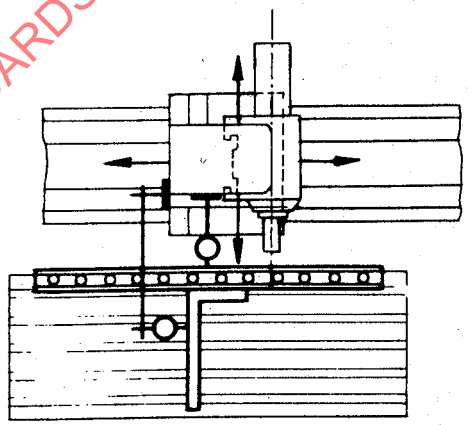
	Object	Permissible deviation	
		mm	in
	B – COLUMN SADDLE (In the case of columns provided with a saddle for movement of the column parallel to the spindle axis) Checking of the slideways between saddle and column : – straightness of movement of the column on the saddle.		
b) 	1) **Longitudinal verification** (along the W axis) : *a*) in a vertical plane; *b*) in a horizontal plane.	For *a*) and *b*) 0,02 up to 1000 0,03 above 1000 Local tolerance : 0,006 over any measuring length of 300	0.0008 up to 40 0.0012 above 40 0.00025 12
			
	2) **Transverse verification** (along the X axis) : – slideways should be in the same plane.	Variation of level : 0,02/1000	0.0008/40

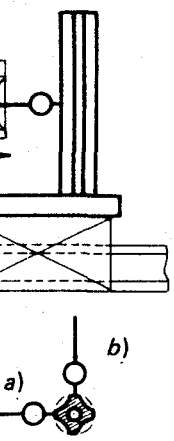
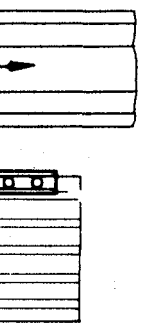
Permissible deviation		Measuring instruments	Observations and references to the test code ISO/R 230
mm	in		
For *a*) and *b*)		Dial gauge, straightedge and supports or optical methods	Clauses 5.232.1 or 5.212.22 The dial gauge shall be fixed on the column base such that it can slide against the functional part of a straightedge laid parallel to the saddle slideways. For checking *b*), the straightedge is laid horizontally and flat and for checking *a*), the straightedge is laid vertically on edge. The straightedge shall be placed on a fixed part, independent of or integral with the machine and as near as possible to the slideways to be checked.
0,02	0.0008		
to 1000	up to 40		
0,03	0.0012		
ove 1000	above 40		
Local tolerance :			
0,006	0.00025		
over any measuring length of			
300	12		
Variation of level :		Precision level	Clause 5.412.7 A level shall be placed transversely on the column base and measurements taken at a number of positions equally spaced along the length of the column. The variation of level measured at any position shall not exceed the permissible deviation.
02/1000	0.0008/40		

No.	Diagram	Object	
G 4		**C – COLUMN** Checking of straightness of the movement of the column lengthwise on the bed : *a*) in the horizontal plane; *b*) in the vertical plane.	For ea precedi
G 5		Checking of straightness of the vertical movement of the spindle head on the column : *a*) in the vertical plane coaxial with the spindle axis; *b*) in a vertical plane perpendicular to the spindle axis.	For eac toleranc f

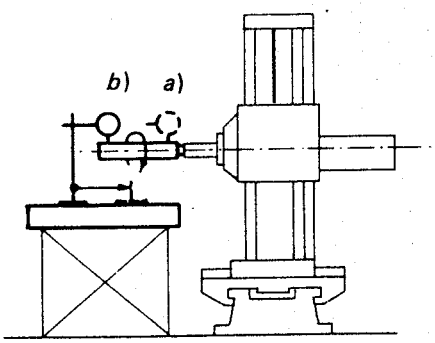
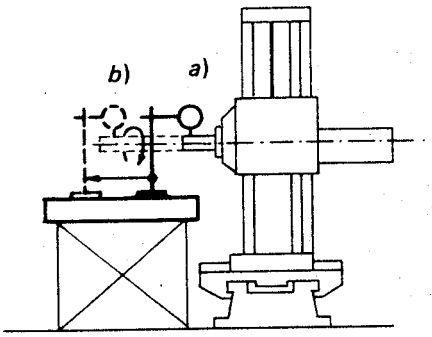
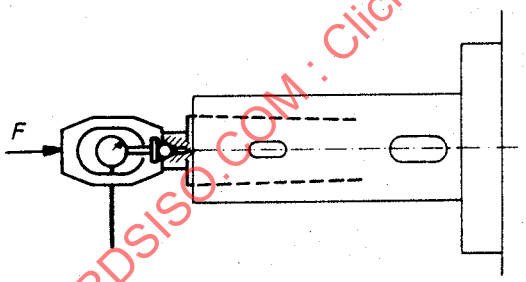
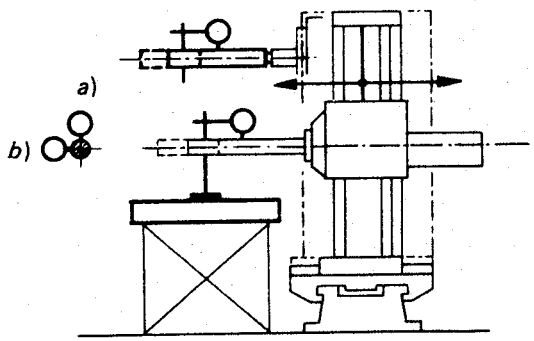
	Object	Permissible deviation	
		mm	in
 	**C – COLUMN** Checking of straightness of the movement of the column lengthwise on the bed : *a*) in the horizontal plane; *b*) in the vertical plane.	For *a*) and *b*) 0,04 up to 1000 For each 1000 mm (40 in) increase in length, add to the preceding tolerance : 0,005 Maximum permissible deviation : 0,12	 0.0016 up to 40 0.0002 0.005
 	Checking of straightness of the vertical movement of the spindle head on the column : *a*) in the vertical plane coaxial with the spindle axis; *b*) in a vertical plane perpendicular to the spindle axis.	For *a*) and *b*) 0,02 up to 1000 For each 1000 mm (40 in) increase in length add to the preceding tolerance : 0,01 for machines having travel ⩽ 4000 mm (160 in) and : 0,02 for machines having travel > 4000 mm (160 in)	 0.0008 up to 40 0.0004 0.0008

Permissible deviation		Measuring instruments	Observations and references to the test code ISO/R 230
mm	in		
For *a*) and *b*)		Optical methods or microscope and taut wire	Clauses 5.212.22 or 5.212.3-5.232.2 For checking *b*) the telescope may be fixed on the machine or may be independent of the machine.
0,04	0.0016		
to 1000	up to 40		
1000 mm (40 in) increase in length, add to the olerance :			
0,005	0.0002		
Maximum permissible deviation :			
0,12	0.005		
For *a*) and *b*)		Microscope and taut wire or optical methods	Clauses 5.212.3-5.232.2 or 5.212.22 Carry out the test with saddle locked and possibly column base locked in mid-travel. Lock the spindle head when taking measurements. If the spindle can be locked, the alignment telescope can be mounted on it. If the spindle cannot be locked, the alignment telescope shall be placed on the spindle head of the machine. The taut wire shall be tightened between fixed parts independent of or integral with the machine.
0,02	0.0008		
to 1000	up to 40		
00 mm (40 in) increase in length add to the preceding			
0,01	0.0004		
achines having travel ⩽ 4000 mm (160 in) and :			
0,02	0.0008		
machines having travel > 4000 mm (160 in)			

No.	Diagram	Object	
G 6		Checking of squareness of the vertical movement of the spindle head : *a*) to the transverse movement of the column (axis X) in a vertical plane perpendicular to the spindle axis;	*a*)
		*b*) to the longitudinal movement of the column (axis W) in the vertical plane coaxial with the spindle axis.	*b*)
G 7		Checking of squareness of the longitudinal (axis W) and transverse (axis X) movements of the column (if there is a column saddle).	

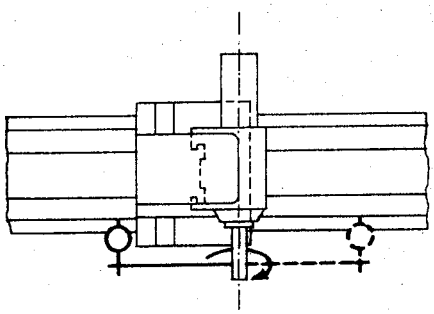
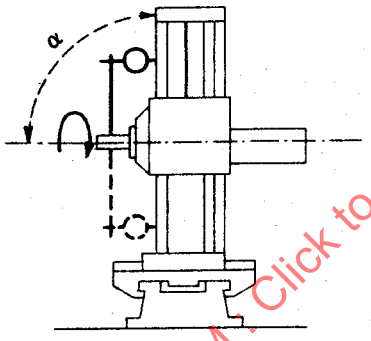
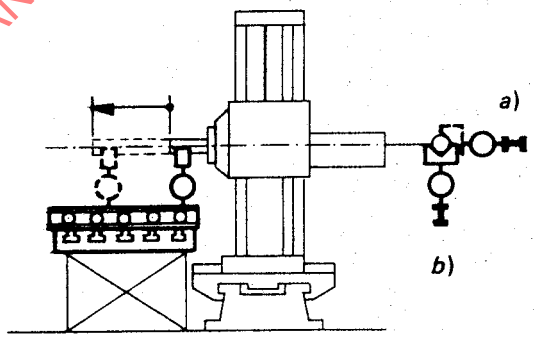
	Object	Permissible deviation	
		mm	in
	Checking of squareness of the vertical movement of the spindle head : *a*) to the transverse movement of the column (axis X) in a vertical plane perpendicular to the spindle axis;	*a*) 0,03/1000	*a*) 0.0012/40
	b) to the longitudinal movement of the column (axis W) in the vertical plane coaxial with the spindle axis.	*b*) 0,03/1000	*b*) 0.0012/40
	Checking of squareness of the longitudinal (axis W) and transverse (axis X) movements of the column (if there is a column saddle).	0,03/1000	0.0012/40

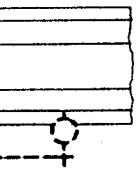
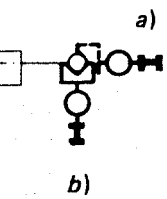
Permissible deviation			Measuring instruments	Observations and references to the test code ISO/R 230
mm		in		
,03/1000	*a*)	0.0012/40	Dial gauge, surface plate and square or optical methods	Clauses 5.522.4 or 5.212.22 For *a*) : place a surface plate on a support independent of the machine and as near as possible to the machine. The surface plate face shall be adjusted parallel to the transverse (axis X) movement of the column. For *b*) : the surface plate face shall be adjusted parallel to the longitudinal (axis W) movement of the column. Lock the column on the table saddle and lock the column saddle on the bed when taking measurements. Set a cylindrical square on the surface plate adjusted as indicated above. Lock the spindle head when taking measurements (spindle retracted). If the spindle can be locked, then the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine. NOTE – Operation G 6 *b*) is to be carried out only on machines provided with a longitudinal (axis W) movement of the column.
,03/1000	*b*)	0.0012/40		
,03/1000		0.0012/40	Dial gauge and straightedge and square or optical methods	Clauses 5.522.4 and 5.212.22 Spindle head locked in mid-travel. The straightedge shall be set and fixed parallel to the transverse movement of the column and with the square against the straightedge. The saddle shall then be locked on the bed. The longitudinal movement of the column shall then be checked.

No.	Diagram	Object	
G 8		**D – BORING SPINDLE** Measurement of run-out of the internal taper of the boring spindle : *a*) at the mouth of taper; *b*) at a distance of 300 mm (12 in) from the spindle nose.	*a*) *b*) *a*) *b*)
G 9		Measurement of run-out of the boring spindle : *a*) spindle retracted; *b*) spindle extended 300 mm (12 in) (sliding spindle)	*a*) *b*) *a*) *b*)
G 10		Measurement of periodic axial slip of the boring spindle (spindle retracted).	
G 11	Alternative 	Checking of parallelism of the boring spindle axis to the longitudinal movement of the column (axis W) on the slideways between column and saddle (if there is a column saddle) : *a*) in the vertical plane; *b*) in the horizontal plane.	*a*) *b*)

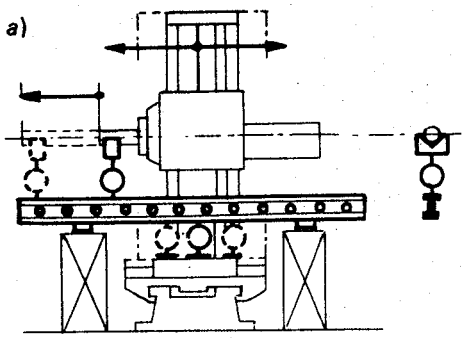
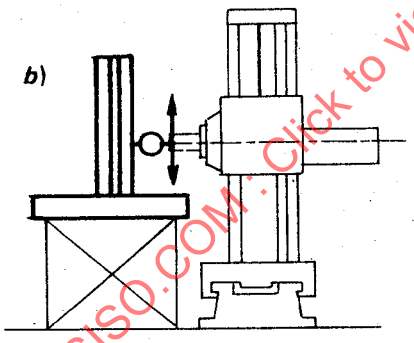
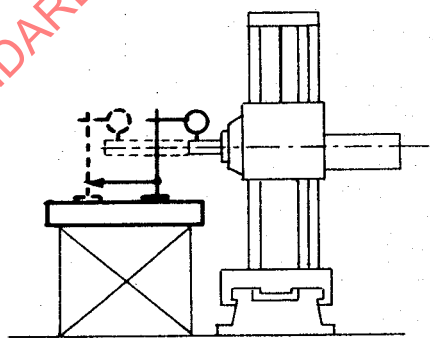
	Object	Permissible deviation	
		mm	in
	D – BORING SPINDLE		
	Measurement of run-out of the internal taper of the boring spindle :	For $D^* \leqslant 125$	For $D^* \leqslant 5$
	a) at the mouth of taper;	*a*) 0,01	*a*) 0.0004
		b) 0,02	*b*) 0.0008
		For $D^* > 125$	For $D^* > 5$
	b) at a distance of 300 mm (12 in) from the spindle nose.	*a*) 0,015	*a*) 0.0006
		b) 0,03	*b*) 0.0012
	Measurement of run-out of the boring spindle :	For $D^* \leqslant 125$	For $D^* \leqslant 5$
	a) spindle retracted;	*a*) 0,01	*a*) 0.0004
		b) 0,02	*b*) 0.0008
		For $D^* > 125$	For $D^* > 5$
	b) spindle extended 300 mm (12 in) (sliding spindle)	*a*) 0,015	*a*) 0.0006
		b) 0,03	*b*) 0.0012
	Measurement of periodic axial slip of the boring spindle (spindle retracted).	For $D^* \leqslant 125$ 0,010 For $D^* > 125$ 0,015	For $D^* \leqslant 5$ 0.0004 For $D^* > 5$ 0.0006
	Checking of parallelism of the boring spindle axis to the longitudinal movement of the column (axis W) on the slideways between column and saddle (if there is a column saddle) :		
	a) in the vertical plane;	*a*) 0,02 for a measuring length of 300	*a*) 0.0008 for a measuring length of 12
	b) in the horizontal plane.	*b*) 0,02 for a measuring length of 300	*b*) 0.0008 for a measuring length of 12

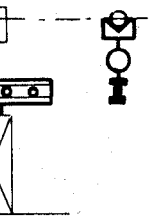
Permissible deviation			Measuring instruments	Observations and references to the test code ISO/R 230
mm		in		
For $D^* \leqslant 125$		For $D^* \leqslant 5$	Dial gauge, test mandrel and surface plate	Clause 5.612.3 Carry out measurements with the spindle retracted (sliding spindle). * D = diameter of boring spindle.
0,01	*a*)	0.0004		
0,02	*b*)	0.0008		
For $D^* > 125$		For $D^* > 5$		
0,015	*a*)	0.0006		
0,03	*b*)	0.0012		
For $D^* \leqslant 125$		For $D^* \leqslant 5$	Dial gauge and surface plate	Clause 5.612.2 * D = diameter of boring spindle.
0,01	*a*)	0.0004		
0,02	*b*)	0.0008		
For $D^* > 125$		For $D^* > 5$		
0,015	*a*)	0.0006		
0,03	*b*)	0.0012		
For $D^* \leqslant 125$		For $D^* \leqslant 5$	Dial gauge	Clauses 5.622.1 and 5.622.2 Carry out this test with the spindle retracted (sliding spindle). The existence, value and the direction of application of the force F should be stated by the manufacturer. * D = diameter of boring spindle.
0,010		0.0004		
For $D^* > 125$		For $D^* > 5$		
0,015		0.0006		
0,02	*a*)	0.0008	Dial gauge and, possibly, test mandrel, and surface plate	Clauses 5.412.1 and 5.422.3 Spindle head locked in mid-travel, column saddle locked in mid-position on the bed. The measurement shall be carried out according to the possibilities, either touching directly the external part of the boring spindle, or with the aid of a test mandrel mounted in the spindle nose (alternative).
for a measuring length of				
300		12		
0,02	*b*)	0.0008		
for a measuring length of				
300		12		

No.	Diagram	Object	
G 12		Checking of squareness of the boring spindle axis to the bed slideways.	
G 13		Checking of squareness of the boring spindle axis to the column ways.	
G 14		Checking of straightness of the boring spindle movement (sliding spindle) : *a*) in a horizontal plane; *b*) in a vertical plane.	*a*) *b*)

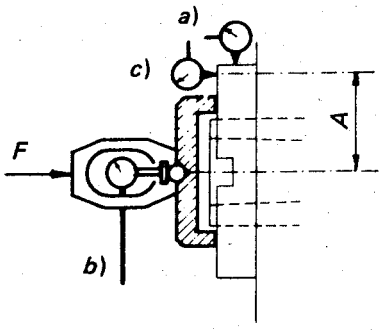
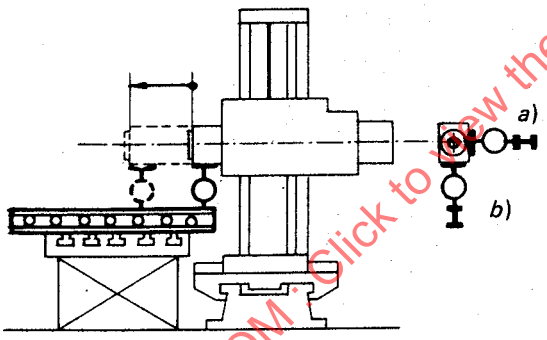
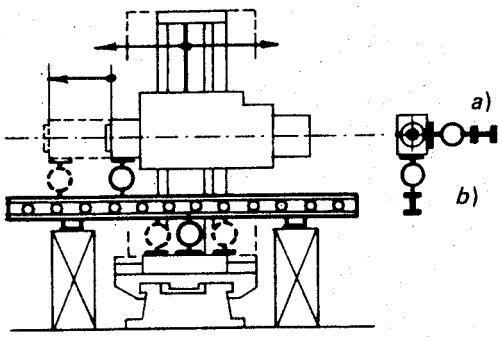
	Object	Permissible deviation	
		mm	in
	Checking of squareness of the boring spindle axis to the bed slideways.	0,03/1000*	0.0012/40*
	Checking of squareness of the boring spindle axis to the column ways.	0,03/1000* with $\alpha \leqslant 90°$	0.0012/40* with $\alpha \leqslant 90°$
 a) b)	Checking of straightness of the boring spindle movement (sliding spindle) : *a*) in a horizontal plane; *b*) in a vertical plane.	*a*) 0,02 for a measuring length of 300 *b*) 0,02 for a measuring length of 300	*a*) 0.0008 for a measuring length of 12 *b*) 0.0008 for a measuring length of 12

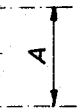
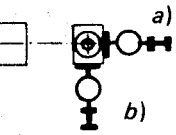
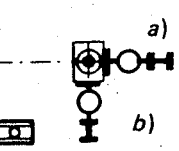
Permissible deviation		Measuring instruments	Observations and references to the test code ISO/R 230
mm	in		
0,03/1000*	0.0012/40*	Dial gauge and possibly straightedge	Clauses 5.512.1, 5.512.42 and 5.442 Column locked on the table, saddle locked in mid-position on the bed, spindle head locked in low position on the column, spindle and possibly ram retracted. For large machines for which sizes have a great importance the measuring reference shall be related to a plane parallel to the bed slideways. * Distance between the two points touched.
0,03/1000* with $\alpha \leqslant 90^\circ$	0.0012/40* with $\alpha \leqslant 90^\circ$	Dial gauge and possibly straightedge	Clauses 5.512.1, 5.512.42 and 5.442 Spindle head locked in mid-travel on the column, spindle retracted. For spindle heads provided with a ram, the checking shall be carried out with the ram retracted. For large machines for which sizes have a great importance the measuring reference shall be related to a plane parallel to the column ways. * Distance between the two points touched.
0,02 *a)* for a measuring length of 300 0,02 *b)* for a measuring length of 300	0.0008 for a measuring length of 12 0.0008 for a measuring length of 12	Straightedge and dial gauge	Clause 5.232.1 Spindle head locked. The straightedge shall be set parallel to the sliding spindle movement; then touch the functional surface of the straightedge with the stylus of a dial gauge fixed on the spindle nose. Repeat the same operations in the two planes : horizontal and vertical. In the case of a machine having a ram, it shall be maintained locked, in the retracted position.

No.	Diagram	Object	
G 15	a) 	Measurement of deflection of the spindle in its sliding movement (axis Z) : *a*) [in the case of columns provided with a saddle for longitudinal movement (axis W)] in relation to a reference plane parallel to the plane of movement of the column on the saddle;	For a diamet
	b)  	*b*) [in the case of columns placed directly on the bed] in relation to a reference plane perpendicular to the vertical movement of the spindle head on the column.	For a diamet For a diamet NOTE diamete

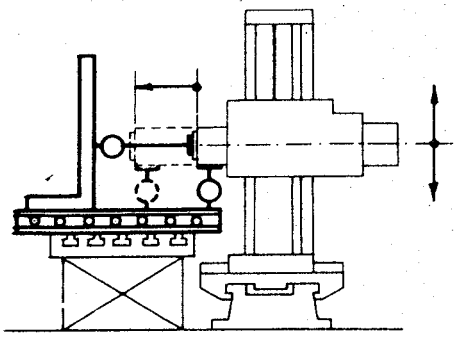
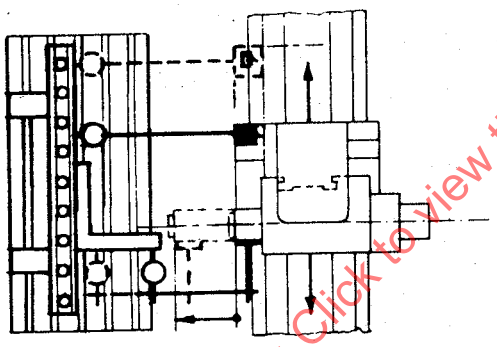
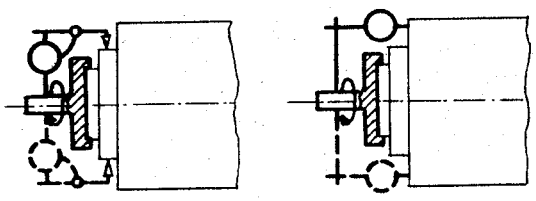
	Object	Permissible deviation	
		mm	in
	Measurement of deflection of the spindle in its sliding movement (axis Z) : *a*) [in the case of columns provided with a saddle for longitudinal movement (axis W)] in relation to a reference plane parallel to the plane of movement of the column on the saddle;	For an extension of the spindle equal to twice the spindle diameter : + 0,015 For an extension of the spindle equal to 4 times the spindle diameter : ± 0,02 For an extension of the spindle equal to 6 times the spindle diameter : − 0,06 NOTE – The extension of the spindle is limited to 6 times the spindle diameter and must not exceed 900 mm (36 in).	+ 0.0006 ± 0.0008 − 0.0024
	b) [in the case of columns placed directly on the bed] in relation to a reference plane perpendicular to the vertical movement of the spindle head on the column.		

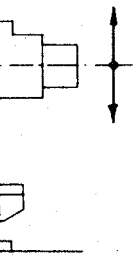
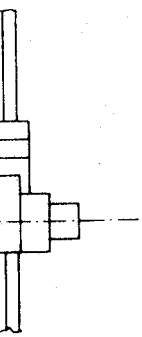
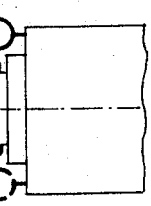
Permissible deviation		Measuring instruments	Observations and references to the test code ISO/R 230
mm	in		
			a) Align the straightedge in a horizontal plane parallel to the movement of the column on the saddle.
tension of the spindle equal to twice the spindle			
+ 0,015	+ 0.0006		
tension of the spindle equal to 4 times the spindle		Straightedge, gauge blocks and dial gauge	
± 0,02	± 0.0008		
tension of the spindle equal to 6 times the spindle			*b*) Align the straightedge so that the vertical plane of a square laid on this straightedge is parallel to the guiding surface of the column ways and then, with the spindle retracted, incline the straightedge so that the upper part of the vertical side of the straightedge leans towards the column with an inclination of 0,006/300 mm (0.00024/12 in).
− 0,06	− 0.0024		
e extension of the spindle is limited to 6 times the spindle l must not exceed 900 mm (36 in).			NOTE — For *a*) and *b*), the measurements shall be carried out at positions corresponding to 2, 4 and 6 times the spindle diameter.

No.	Diagram	Object	
G 16		**E – MILLING SPINDLE** *a*) Measurement of run-out of the milling spindle; *b*) Measurement of periodic axial slip; *c*) Measurement of camming of the face of the spindle nose (including periodic axial slip).	*a*) *b*) *c*) *a*) *b*) *c*)
G 17		**F – RAM** Checking of straightness of the ram movement : *a*) in a horizontal plane; *b*) in a vertical plane.	*a*) *b*)
G 18		Checking of parallelism of the ram movement (axis Z) to the longitudinal movement of the column (axis W) : *a*) in a horizontal plane; *b*) in a vertical plane.	

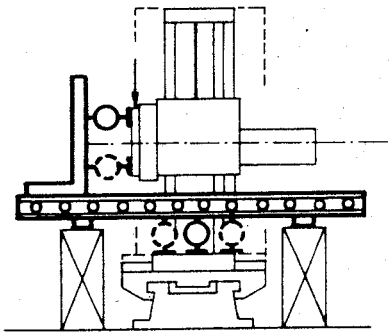
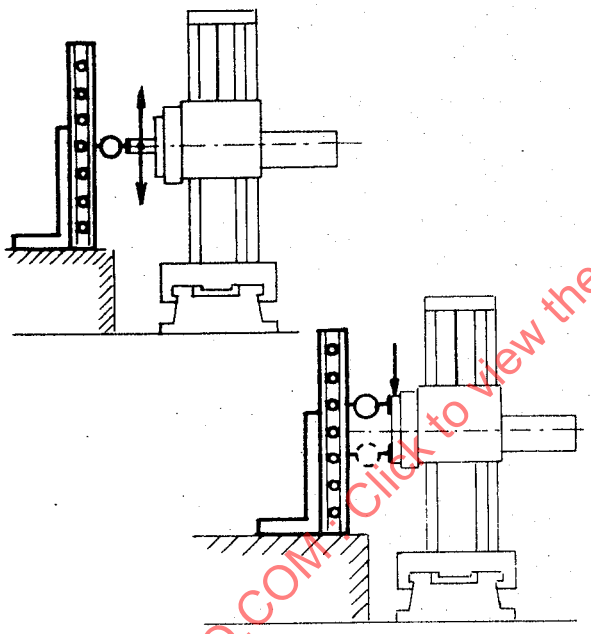
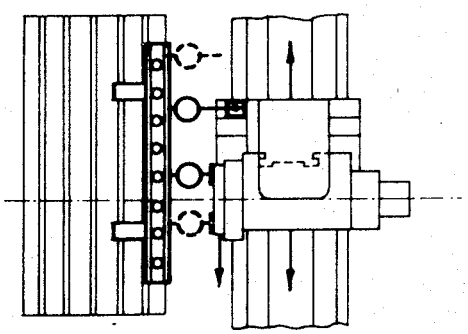
	Object	Permissible deviation	
		mm	in
	**E – MILLING SPINDLE**	For $D^* \leqslant 125$	For $D^* \leqslant 5$
	a) Measurement of run-out of the milling spindle;	*a*) 0,01	*a*) 0.0004
	b) Measurement of periodic axial slip;	*b*) 0,01	*b*) 0.0004
	c) Measurement of camming of the face of the spindle nose (including periodic axial slip).	*c*) 0,02	*c*) 0.0008
		For $D^* > 125$	For $D^* > 5$
		a) 0,015	*a*) 0.0006
		b) 0,015	*b*) 0.0006
		c) 0,03	*c*) 0.0012
	**F – RAM**		
	Checking of straightness of the ram movement :		
	a) in a horizontal plane;	*a*) 0,02 for a measuring length of 500	*a*) 0.0008 for a measuring length of 20
	b) in a vertical plane.	*b*) 0,02 for a measuring length of 500	*b*) 0.0008 for a measuring length of 20
	Checking of parallelism of the ram movement (axis Z) to the longitudinal movement of the column (axis W) :		
	a) in a horizontal plane;	For *a*) and *b*) 0,03 for a measuring length of 500	0.0012 for a measuring length of 20
	b) in a vertical plane.		

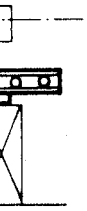
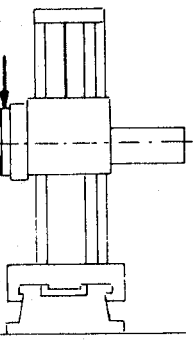
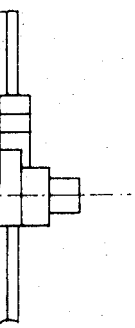
Permissible deviation			Measuring instruments	Observations and references to the test code ISO/R 230
mm		in		
$D^* \leqslant 125$		For $D^* \leqslant 5$	Dial gauge	*a*) Clause 5.612.2 *b*) Clauses 5.622.1 and 5.622.2 The existence, value and direction of application of the force F shall be stated by the manufacturer. *c*) Clause 5.632 The distance A of dial gauge *c*) from the spindle axis shall be as large as possible. • D = diameter of boring spindle.
0,01	*a*)	0.0004		
0,01	*b*)	0.0004		
0,02	*c*)	0.0008		
$D^* > 125$		For $D^* > 5$		
0,015	*a*)	0.0006		
0,015	*b*)	0.0006		
0,03	*c*)	0.0012		
			Straightedge and dial gauge	Clause 5.232.1 Spindle head locked. Boring spindle retracted. Set the straightedge parallel to the ram movement; then touch the functional surface of the straightedge with the stylus of a dial gauge fixed at the end of the ram. Repeat the same operations in the two planes : horizontal and vertical.
0,02	*a*)	0.0008		
for a measuring length of				
500		20		
0,02	*b*)	0.0008		
for a measuring length of				
500		20		
			Straightedge and dial gauge	Clause 5.422.5 A straightedge shall be set parallel to the longitudinal movement of the column (axis W) and then the column locked in the middle of its travel on its saddle. The ram movement shall then be checked with respect to the straightedge.
For *a*) and *b*)				
0,03		0.0012		
for a measuring length of				
500		20		

No.	Diagram	Object	
G 19		Checking of squareness of the longitudinal movement of the ram (axis Z) to the vertical movement of the spindle head on the column ways.	
G 20		Checking of squareness of the ram longitudinal movement (axis Z) to the ram transverse movement (axis X) on the bed slideways.	
G 21	a) b) 	*a*) Checking of concentricity of the milling spindle and of the front centring of tools or accessories on the ram; *b*) Checking of squareness of the support surface of tools or accessories to the rotation axis of the milling surface.	*a*) *b*)

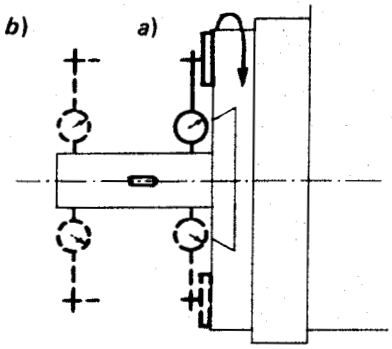
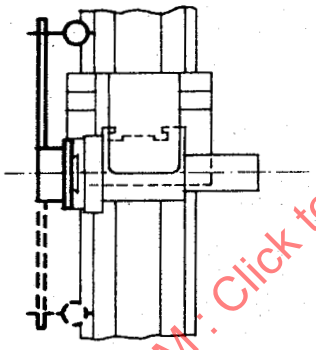
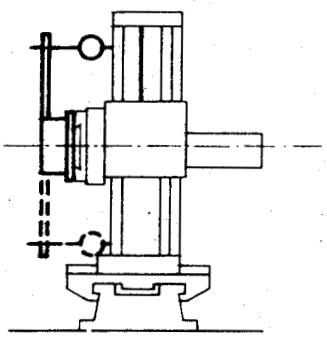
	Object	Permissible deviation	
		mm	in
	Checking of squareness of the longitudinal movement of the ram (axis Z) to the vertical movement of the spindle head on the column ways.	0,03/500	0.0012/20
	Checking of squareness of the ram longitudinal movement (axis Z) to the ram transverse movement (axis X) on the bed slideways.	0,05/1000	0.0020/40
	*a*) Checking of concentricity of the milling spindle and of the front centring of tools or accessories on the ram; *b*) Checking of squareness of the support surface of tools or accessories to the rotation axis of the milling surface.	*a*) 0,02 *b*) 0,02/500	*a*) 0.0008 *b*) 0.0008/20

Permissible deviation		Measuring instruments	Observations and references to the test code ISO/R 230
mm	in		
03/500	0.0012/20	Straightedge, square and dial gauge or optical methods	Clause 5.522.4 Place a straightedge on a table set parallel to the longitudinal movement of the ram (axis Z) in a vertical plane and place a square on the straightedge. *Alternative* : The surface plate used in test G 6 may be used for carrying out this test.
5/1000	0.0020/40	Straightedge, square and dial gauge or optical methods	Clause 5.522.4 Place a straightedge on the table set parallel to the movement of the column on the bed (axis X) and place a square against the straightedge.
0,02	*a*) 0.0008	Dial gauge	*a*) Clause 5.422
2/500	*b*) 0.0008/20		*b*) Clause 5.512.42 NOTE — This operation is valid only if there is a circular locating surface on the ram.

No.	Diagram	Object
		**G – INTEGRAL FACING HEAD** **– radial facing slide –** Checking of squareness of the radial facing slide movement (axis U) to the longitudinal movement of the column (axis W);
G 22		or (if there is no column saddle) : Checking of parallelism of the radial facing slide movement (axis U) to the vertical movement of the spindle head.
G 23		Checking of parallelism (in the horizontal plane) of the radial facing slide movement to the transverse movement of the column on the bed (axis X).

	Object	Permissible deviation	
		mm	in
	**G – INTEGRAL FACING HEAD** **– radial facing slide –** Checking of squareness of the radial facing slide movement (axis U) to the longitudinal movement of the column (axis W);	0,025/300	0.001/12
	or (if there is no column saddle) : Checking of parallelism of the radial facing slide movement (axis U) to the vertical movement of the spindle head.	0,025 for a measuring length of 300	0.001 for a measuring length of 12
	Checking of parallelism (in the horizontal plane) of the radial facing slide movement to the transverse movement of the column on the bed (axis X).	0,025 for a measuring length of 300	0.001 for a measuring length of 12

Permissible deviation		Measuring instruments	Observations and references to the test code ISO/R 230
mm	in		
0,025/300	0.001/12	Straightedge, square and dial gauge	Clauses 5.522.2 and 5.422.5 A straightedge or a surface plate shall be set parallel to the longitudinal movement of the column (axis W) or, where there is no such movement, parallel to the vertical movement of the spindle head. The column shall then be locked in the middle of its travel on its saddle. Place a square on the straightedge or on the surface plate. Then, check the radial facing slide movement. Repeat the same operation after rotation of the facing head by 180°. NOTE — The surface plate used in test G 6 may be used for carrying out this test.
0,025 for a measuring length of 300	0.001 12		
0,025 for a measuring length of 300	0.001 12	Straightedge and dial gauge	Clause 5.422.5 Set a straightedge on the table parallel to the transverse movement of the column on the bed (axis X). Then check the radial facing slide movement with respect to the straightedge. Repeat the same operation after rotation of the facing head by 180°.

No.	Diagram	Object	
G 24		Checking of coaxiality of the boring spindle axis and of the facing head axis (in the case of independent movements of the boring spindle and of the facing head). *a*) at the mouth of spindle housing; *b*) at a distance from the spindle housing face equal to 300 mm (12 in).	*a*) *b*) *a*) *b*)
G 25		Checking of squareness of the facing head axis to the bed slideways.	
G 26		Checking of squareness of the facing head axis to the column ways.	