

# NATIONAL PHYSICAL LABORATORY

## METROLOGY CENTRE

**Ref: MOY/SCMI/17 SPECIFICATION OF ACCURACY**  
**(Issue 5)**

**for**

### **A “MATRIX” INTERNAL DIAMETER MEASURING MACHINE**

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Type: A “Matrix” machine for measuring the diameters of the following types of gauges.

- (i) Internal plain diameters of the parallel and taper types.
- (ii) Internal screw thread diameters of the parallel type and of the taper type having threads square to the axis.
- (iii) External taper screw thread diameters of the “Taper Lock” and “Trilock” design, having threads square to the axis.

The measuring capacity of the machine is from 6 mm (¼ in) to 150 mm (6 in) in diameter.

Made by: Coventry Gauge and Tool Co. Ltd.

- Notes: (1) All measurements refer to the basic temperature of 20° C.  
(2) Where reference is made to hardness a minimum of 800 HV is required.

LIMITING VALUE OR  
MAXIMUM  
PERMISSIBLE ERROR

#### 1. GENERAL

- 1.1 The workmanship and finish shall be in conformity with a precision instrument of this class.
- 1.2 Each machine shall be marked with the maker’s name or trade mark and with an identification number.

#### 2. MAIN CASTING

- 2.1 The two vee grooves attached to the upper edges of the main casting, and the short transverse vee groove which supports the work-table shall be hardened and lapped.

#### 3. MEASURING CARRIAGE

- 3.1 The vee-groove and the flat attached to the under surface of the measuring carriage shall be hardened and lapped.
- 3.2 The balls shall be uniform and equal in diameter 0.0025 mm (0.0001 in)
- 3.3 When the measuring carriage is mounted on the main casting, it shall run freely and smoothly throughout its travel, also there shall be no wind in the measuring carriage as it is traversed. Wind, 1 minute of arc in 75 mm (3 in) travel of carriage.

4. **WORK-TABLE AND WORK-TABLE SUPPORT**

- |      |   |  |
|------|---|--|
| 4.1  | The balls which rest in the short transverse vee-groove, fitted to the main casting, shall be uniform and equal in diameter.  | 0.0025 mm (0.0001 in)                                |
| 4.2  | The bearing-flat fitted to the under surface of the work-table support shall be hardened and lapped.  |  |
| 4.3  | The above bearing (4.2) shall be flat.  | 0.0025 mm (0.0001 in)                                |
| 4.4  | The upper surface of the work-table shall be flat.  | 0.008 mm (0.0003 in)                                 |
| 4.5  | The upper surface of the work-table shall rotate in one plane.  | 0.005 mm (0.0002 in) at a radius of 75 mm (3 in)     |
| 4.6  | The upper surface of the work-table shall be set parallel with the travel of the measuring carriage and this parallelism shall be maintained for all positions of the transverse travel of the table. | 0.010 mm (0.0004 in) over the diameter of the table. |
| 4.7  | As the work-table is elevated throughout its range the level of the upper surface shall remain constant.  | 12 seconds of arc.                                   |
| 4.8  | The stops limiting the 180° rotation of the work-table shall be accurate.   | ±1 minute of arc.                                    |
| 4.9  | There shall be no play between the elevating shaft and its housing for all positions of elevation of the work-table.  |  |
| 4.10 | Any progressive error present in the elevating screw shall be of a uniform nature and shall not exceed  | 0.005 mm (0.0002 in) over its 50 mm (2 in) travel.   |
| 4.11 | Any periodic error in the elevating screw shall not exceed  | ±0.001 mm (±0.000 04 in)                             |

5. **MICROMETER**

Type: Non-rotating spindle, 0.5 mm pitch or 40 TPI micrometer screw. Rounded contact face. Thimble diameter not less than 65 mm (2 ½ in).

- |     |   |                         |
|-----|---|-------------------------|
| 5.1 | The micrometer head shall be marked with an identification number.  |                         |
| 5.2 | The micrometer screw shall run smoothly and evenly throughout its range and have an over-run of at least one revolution beyond each end of its 25 mm or 1 in travel.  |                         |
| 5.3 | (i) The graduations shall be cleanly cut on a non-reflecting surface and shall be uniform in thickness.   | 0.05 mm (0.002 in)      |
|     | (ii) The graduation lines shall preferably be blacked in.   |                         |
|     | (iii) It is recommended that the thickness of the graduation lines shall be approximately 1/5 <sup>th</sup> of the distance between the centres of adjacent lines with a minimum thickness of 0.10 mm (0.004 in). |                         |
| 5.4 | The measuring face shall be hard and well-finished.   |                         |
| 5.5 | Any backlash present in the micrometer screw shall not exceed   | 0.0025 mm (0.0001 in)   |
| 5.6 | The micrometer shall be capable of satisfactory repetition of reading.  | 0.0005 mm (0.000 02 in) |

5.7	Any progressive error present shall be of a uniform nature and shall not exceed	0.0025 mm (0.0001 in)
5.8	Any periodic error present shall not exceed	±0.0005 mm (0.000 02 in)
6.	<b><u>FIDUCIAL INDICATOR</u></b>	
6.1	The rounded contact face shall be hardened and well-finished.	
6.2	The magnification shall be adequate.	Approximately 400 times.
6.3	The working force shall not exceed	1N (4 ozf)
6.4	When clamped in position on the machine the indicator shall permit of repetition of reading.	0.0005 mm (0.000 02 in)
7.	<b><u>ABUTMENT FACE FOR THE INDICATOR AND FIXED STOP FOR THE MICROMETER</u></b>	
7.1	The working faces shall be hardened and lapped.	
7.2	The face of the fixed stop for the micrometer shall be flat.	0.0005 mm (0.000 02 in)
8.	<b><u>DISTANCE BARS FOR MEASURING CARRIAGE</u></b>	
8.1	The faces of the bars shall be hardened, lapped and flat.	0.0005 mm (0.000 02 in)
9.	<b><u>“GROOVED” AND “PLANE” END-PIECES FOR REFERENCE STANDARD</u></b>	
9.1	All working surfaces of the end-pieces shall be hardened.	
9.2	The contact faces shall be flat.	0.0003 mm (0.000 01 in)
9.3	The lower bearing surface shall be flat.	0.001 mm (0.000 04 in)
9.4	The lower bearing surface of the end-pieces shall be square with the contact faces.	
	Note: These bearing surfaces should be lapped in pairs, so that if the angle of one piece is plus, that of the other corresponding end-piece will be equally minus.	
	Under these conditions the error in squareness permitted is	0.005 mm (0.0002 in) over the depth of face.
9.5	The flanks of the vees shall be well finished and straight.	0.0008 mm (0.000 03 in)
9.6	The semi-angle of the vee shall agree with its nominal angle.	±4 minutes of arc.
9.7	The contact faces of the “grooved” end-pieces shall be parallel.	0.0025 mm (0.0001 in) overall.
9.8	The axis of the vee shall be parallel with the contact faces of the end-pieces.	0.0008 mm (0.000 03 in) over central 6 mm (¼ in) and 0.005 mm (0.0002 in) overall.
9.9	The vee shall be parallel to the lower bearing surface.	0.010 mm (0.0004 in)

- 9.10 For each pair of “grooved” end-pieces the height of the vee above the lower bearing surface shall be equal. 0.025 mm (0.001 in)

Notes Certification of this machine shall include: -

- (1) Values of “E<sub>0</sub>” and “E<sub>1</sub>” for the grooved end-pieces supplied. These values shall be given to the nearest 0.001 mm (0.000 05 in) and shall cover every pitch for which a stylus is provided.
- (2) The measured height of the vee groove above the lower bearing edge given to the nearest 0.0025 mm (0.0001 in).

#### 10. **BLOCK GAUGES FOR REFERENCE STANDARD**

- 10.1 The measuring faces of the block gauges shall be hard, flat and parallel. Inspection limits  
BS No. 888

- 10.2 Each pair of blocks shall be equal in length. 0.000 08 mm  
(0.000 003 in)

- 10.3 The block gauges shall be of nominal size to within: - Workshop limits  
BS No. 888

Note Certification of this machine shall include the measured size of each block gauge, given to the nearest 0.000 02 mm (0.000 001 in).

#### 11. **STYLUS**

- 11.1 The stylus points shall be well-finished and hardened.
- 11.2 Each stylus shall be identified with the TPI for which it is suitable.
- 11.3 The radii of the stylus points shall be as specified on NPL Sketch No. 672A dated October 1968.

#### 12. **STYLUS HOLDERS**

- 12.1 The length of the stylus holders from the abutment shoulder to the axis of the stylus hole (or the centre of the ball) shall be 57 mm (2 ¼ in). ±0.10 mm (±0.004 in)

#### 13. **WORK-HOLDERS** (when supplied)

- 13.1 The surfaces of the work-holders shall be hardened.
- 13.2 They shall be flat and parallel 0.005 mm (0.0002 in)

Note Certification of this machine shall include the measured height of each work-holder, given to the nearest 0.002 mm (0.0001 in).

14. **PERFORMANCE TEST**

14.1 The machine shall be used for measuring the following types of gauges, the sizes of which have been accurately determined by other means: -

The results obtained should agree with the known values to within: -

**Plain rings**

parallel  
tapered, up to 1 in 8

0.0015 mm (0.000 06 in)  
0.003 mm (0.000 12 in)

**Screwed rings**

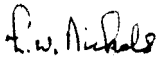
parallel  
tapered, up to 1 in 8, having threads square to axis.

0.004 mm (0.000 16 in)  
0.005 mm (0.000 20 in)

**Screwed plugs**

tapered, up 1 in 8  
("Taper lock" or "Trilock" design)  
having threads square to the axis.

0.005 mm (0.000 20 in)

(Signed)   
for Director

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