

Centre for Basic, Thermal and Length Metrology
National Physical Laboratory

MOY/SCMI/9

**SPECIFICATION OF ACCURACY FOR A
SCREW DIAMETER MEASURING MACHINE**

Floating micrometer machine for measuring diameters of external screws (with and without radial measuring attachment). Capacity: 0 to 50 mm (0 to 2 in.) in diameter; 0 to 100 mm (0 to 4 in.) in diameter. Capacity: over 100 mm (4 in.) in diameter.

Note: Specifications previously numbered 9 (Issue 6) and 12 (Issue 4) have been reviewed and combined to form this specification.

FOREWORD

In the 1940s and 1950s, NPL was involved in drafting a special series of Specifications of Accuracy that covered a wide range of precision measuring apparatus. This series has been built on first hand experience gained in the design and construction of prototype measuring equipment at NPL and in the design and calibration of measuring equipment of British and foreign manufacture. Each specification in the series originally conformed to a general pattern and was allocated a permanent serial number which, in addition to its title, serves as its identity.

The MOY/SCMI (Metrology/Specification Certification Measuring Instruments) standards are complementary to the Standards issued by the British Standards Institute (BSI). The majority relate to measurement equipment of a proprietary kind designed either at NPL or by British manufacturers which, in the ordinary way, would not fall within BSI's terms of reference. In some cases, in which the equipment is of a more general nature, the Specification has provided a useful basis for formulating a British Standard. The specifications are to enable manufacturers to base their inspection on mutually agreed specifications of accuracy both in workmanship and performance.

MOY/SCMI/9 has been updated as part of a project financed by the DTI (MPU 8/61.3) concerned with Good Practice Guides and Equipment Specifications.

SCOPE

Floating micrometer machine for measuring diameters of external screws. Capacity: 0 to 50 mm (0 to 2 in.) in diameter; 0 to 100 mm (0 to 4 in.) in diameter. Capacity: over 100 mm (4 in.) in diameter. With / without radial measuring attachment.



Figure 1 Floating carriage machine fitted with electronic readout

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1 GENERAL

- 1.1 The general workmanship and finish shall be in keeping with a precision instrument of this class.
- 1.2 The instrument shall be marked:
- (i) With an identification number (to ensure correct assembly all the machine castings should bear this common identification number).
 - (ii) With the maker's name or trade mark.
 - (iii) "Based on NPL Design".
- 1.3 The vee-grooves and bearing flats shall be smooth and free from blowholes.
- 1.4 The balls shall be of uniform diameter to within **0.002 5 mm**.
- 1.5 Cones provided on the underside of the intermediate slide shall be hardened and be a satisfactory fit in the vee-grooves.
- 1.6 The measuring carriage and intermediate slide shall move smoothly and be stable in all positions.
- 1.7 The capacity of the machine shall cover its nominal measuring range.
- 1.8 The "feel" of the micrometer shall be smooth and uniform over its measuring range.
- 1.9 The micrometer spindle shall have an over-run of at least one revolution at each end of its nominal range. Any backlash present in the screw shall not exceed **0.002 5 mm**.

The following two clauses apply to floating micrometer machine for measuring diameters of external screws. Capacity: over 100 mm (4 in.) in diameter.

- 1.10 The castings shall be sufficiently robust to accommodate heavy gauges of the maximum diameter.
- 1.11 If the machine is supported on more than three feet, it shall be tested and used on a flat surface plate. Under these conditions there shall be no noticeable "rock".

2 CENTRES

- 2.1 The centre points shall have a hardness of approximately **700 HV**, when tested in accordance with BS EN ISO 6507-1:1998.
- 2.2 The centre rods shall be straight, parallel and equal in diameter to within **0.005 mm** for machines up to 100 mm capacity and to within **0.008 mm** for machines with over 100 mm capacity.
- 2.3 Each centre point shall be concentric with its rod (**0.01 mm TIR**).
- 2.4 The two centre rods shall be co-axial (Refer to 5.3).

3 FIDUCIAL INDICATOR

- 3.1 When the indicator shank is clamped in the measuring carriage, its action shall be free from “stickiness”.
- 3.2 The indicator pointer shall be clear of the casing when the face of the measuring plunger is depressed to its limit.
- 3.3 The pointer shall have free movement of at least 5 mm on either side of the fiducial mark.
- 3.4 The force required to operate the indicator shall be between **2 and 5 N**.
- 3.5 The magnification of the indicator shall be not less than **150 times**.
- 3.6 The indicator bearing shank shall be straight and uniform in diameter to within **0.005 mm**.
- 3.7 The measuring face shall have a hardness of not less than **800 HV**, when tested in accordance with BS EN ISO 6507-1:1998.
- 3.8 The measuring face shall be lapped flat to within **0.000 5 mm**.
- 3.9 The measuring face shall be square to the bearing shank to within **0.001 mm** over the diameter of the face.

4 MICROMETER

Note: The micrometer spindle should preferably be of the non-rotating type

- 4.1 The measuring face shall have a minimum hardness of **800 HV** when tested in accordance with BS EN ISO 6507-1:1998.
- 4.2 The measuring face shall be lapped, well finished and flat to within **0.000 5 mm**.
- 4.3 If the micrometer has a rotating spindle, the measuring face and spindle axis shall be square to within **0.000 8 mm** over the diameter of the face. The measuring face and micrometer bearing axis shall also be square to the same accuracy; alternatively, if not square, the angular position of the sleeve shall be located against the machine casting to ensure the required parallelism between the measuring faces (see para 5.2).
- 4.4 The bearing shank of the micrometer shall be straight and uniform in diameter to within **0.005 mm**.

The following clauses apply to micrometers without electronic readout

- 4.5 The graduation lines on the thimble and barrel shall be clearly cut and uniform in thickness to within **0.05 mm**.
Note: The graduation lines shall preferably be blacked in
- 4.6 It is recommended that the thickness of the graduation lines shall be approximately 20% of the distance between the centres of adjacent lines. The minimum thickness shall be **0.10 mm**.

5 ALIGNMENT OF MEASURING FACES

- 5.1 The axes of the micrometer and fiducial indicator shall be collinear to within **0.5 mm**.
- 5.2 The measuring faces of the micrometer and fiducial indicator shall be parallel for all relative positions to within **0.002 5 mm**.
- 5.3 The measuring faces shall, in the mean, be parallel with the common axis of the centres for all positions of the measuring carriage and slide along the ways to within **0.002 5 mm** over the diameter of the face.
- 5.4 The measuring axis of the machine shall be at the same height as the line of centres to within **0.5 mm**.

6 CALIBRATION OF MICROMETER SCREW

- 6.1 When making a series of repeated settings, the readings shall fall within the range **0.000 5 mm**.
- 6.2 Any progressive error present shall be of a uniform nature and shall not exceed **0.003 mm over 25 mm**.
- 6.3 Any periodic error present shall not exceed **± 0.000 5 mm**.

CLAUSES 7-9 ARE ADDITIONAL REQUIREMENTS WHEN THE MACHINE IS FITTED WITH AN ATTACHMENT FOR MAKING RADIAL MEASUREMENTS

7 GENERAL

- 7.1 The capacity of the machine when fitted with the attachment shall cover its nominal measuring range.
- 7.2 The abutment contact shall have a hardness of not less than **800 HV**, when tested in accordance with BS EN ISO 6507-1:1998.
- 7.3 The abutment contact shall be securely fixed in its housing.

8 ALIGNMENT OF MICROMETER FACE

- 8.1 The measuring face shall be parallel with the common axis of the centres to within **0.002 5 mm over the diameter of the face**.

9 PARALLELISM OF WAYS WITH LINES OF CENTRES (IN PLAN)

- 9.1 Radial micrometer readings made on an accurately centred, parallel mandrel held between the machine centres should vary by no more than the limits given in Table 1 as the slide is moved along the full length of the ways of the machine.

Table 1

Machine capacity	Tolerance on variation of radial micrometer reading	
	For any 50 mm of travel	Overall
0 to 100 mm	0.002 5 mm	0.005 mm
above 100 mm	0.002 5 mm	0.008 mm

- 9.2 Radial micrometer readings shall be made on two accurately centred, parallel mandrels. One shall be approximately 50 mm long, and the other approximating to the maximum length the centres will accommodate.

The recorded difference between the radial readings shall agree with the true difference between the radii of the mandrels to within **0.004 mm** for machines up to 100 mm and to within **0.008 mm** for machines above 100 mm.

10 DIAGRAMS

Figure 2 shows a diagram of the machine. The gauge to be measured is mounted between a pair of centres carried on a base (A) which has two vee-grooves machined in its upper surface parallel to the line of the centres. These vee-grooves form runways for a saddle (B), having on one side two projecting conical pegs (C) which rest in one of the grooves. The other end of the saddle rests on a steel ball placed in the other vee-groove. A micrometer carriage (D), with a vee-groove and a flat on its underside, can move freely on steel balls resting in two vee-grooves cut in the upper surface of the saddle in a direction at right angles to the line of centres. This micrometer carriage is provided on one side with a micrometer head graduated to either 0.002 mm or 0.0001 in and capable of being read to 0.0005 mm or 0.00002 in, and on the other side with an adjustable anvil associated with a sensitive indicator. The common axis of the micrometer and anvil is at the same height as the line of centres. The shank of one of the conical pegs (C) is made eccentric, so that by turning it in its hole, it is possible to adjust the axis of the micrometer square with the line of centres. After making this setting, the position of the peg can be maintained by a clamping screw. Taken as a whole, the machine is a development of the bench

micrometer, having a free motion at right angles to the line of centres, and capable also of being traversed along the bed of the machine so as to measure at any desired position along a screw gauge mounted between the centres. The cylinders used with the machine during the measurements of the pitch diameter are suspended by threads from light rods (E) fixed to the micrometer carriage. In order to eliminate entirely the personal element as regards the "feel" of the micrometer, and also to obtain a control on the measuring force, the adjustable anvil is fitted with a fiducial indicator (F) which operates under a force of about 250 grammes wt (8 oz wt), or less if desired. The machine described, which was designed at NPL, is obtainable commercially in sizes to accommodate gauges up to 250 mm (10 in) or so in diameter.

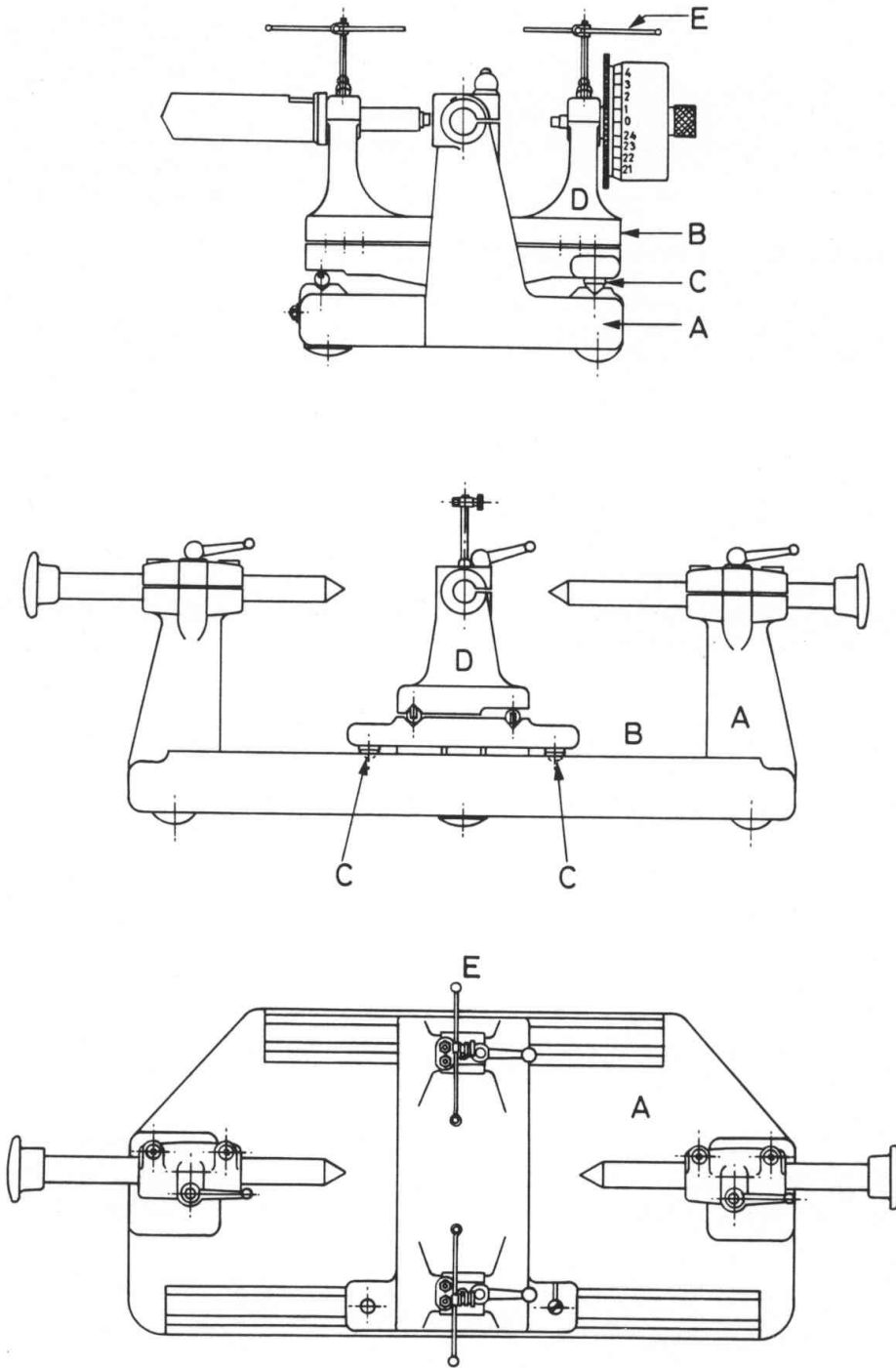


Figure 2 Floating micrometer machine for measuring pitch diameter and minor diameter of screw plug gauges

11 UNCERTAINTIES

- 11.1 It will normally be necessary to consider the uncertainty of measurement when ascertaining compliance (or non-compliance) with this specification. UKAS document M3003 '*Uncertainty and confidence in measurement*' gives guidance in Appendix J.

12 REPORTING OF COMPLIANCE

- 12.1 Certain clauses in any specifications are necessary to support manufacture and assembly but may be difficult or unnecessary to check in subsequent checks for compliance with this specification. In certain cases checking a feature may require disassembly of the item, which may be undesirable. Although it is not essential that all clauses be checked on subsequent verification, it is important that those clauses omitted do not detract from the metrological value of the test. Where applicable, a performance check should always be carried out as this may allow indirect verification of those parameters that are not easily measured individually without disassembly.
- 12.2 When making statements of compliance or non-compliance, it is recommended that this specification and the relevant clauses within it be unambiguously identified in the calibration certificate or test report.

Example wording for a set of angle gauges follows.

This set of angle gauges has been examined for compliance with the accuracy requirements of clauses 2 and 3 of NPL Specification of Accuracy MOY/SCMI/18 (Issue 5), a copy of which is attached to this certificate.

For free measurement advice and information on other specifications in this series call the NPL Help line on 020 8943 6880

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This machine and its use are described in *Notes on Applied Science No.1 Gauging and Measuring Screw Threads* HMSO 1958 (Third Edition) published by NPL.

The standard reference temperature for industrial length measurements is defined in ISO 1:1975 *Standard reference temperature for industrial length measurements*.

Micrometer heads are covered by British Standard 1734:1951.

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