TOOL MAKERS MICROSCOPE

The large Tool Maker's Microscope (TMM) essentially consists of the cast base, the main lighting unit, the upright with carrying arm and the sighting microscope. The rigid cast base is resting on three foots screws by means of which the equipment can be leveled with reference to the build-in box level. The base carries the co-ordinate measuring table, consists of two measuring slides; one each for directions X and Y and a rotary circular table provided with the glass plate (Fig.1). The slides are running on precision balls in hardened guide ways warranting reliable travel. Two micrometer screws each of them measuring range of 0 to 25 mm permit the measuring table to be displaced in the directions X and Y. The range of movements of the carriage can be widened up to 150 mm in the X direction and up to 50mm in the Y direction with the use of gage blocks.

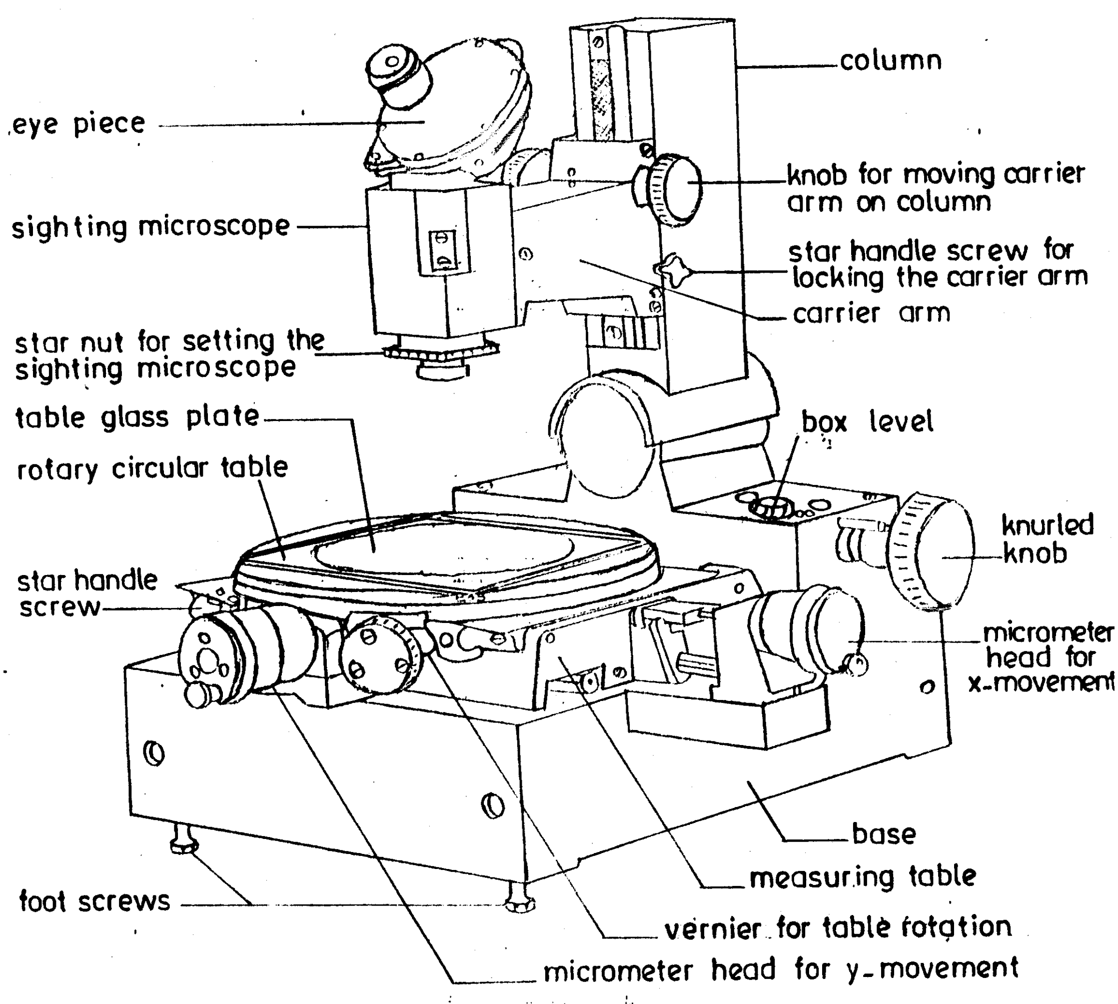


Fig. 1 Tool Makers Microscope

The rotary table has been provided with 360 degrees graduation and with a three minute vernier. The rotary motion is initiated by activation of knurled knob and locked with star handle screw. Slots in the rotary table serve for fastening different accessories and completing elements.

The sighting microscope has been fastened with a carrier arm to column. The carrier arm can be adjusted in height by means of a rack and locked with star handle screw. Thread measuring according to the shadow image permits the column to be tilted in X direction to either side about an axis on centre plane level. The corresponding swivel can be adjusted with a knurled knob with a graduation cellar. The main lighting unit has been arranged in the rear of the cast base and equipped with projection lamp where rays are directed via stationary mounted mirror through table glass plate into the sighting microscope.

Measuring principle

The work piece to be checked is arranged in the path of the rays of the lighting equipment. It produces a shadow image, which is viewed with the microscope eyepiece having either a suitable mark for aiming at the next points of the objects or in case of often occurring profiles. e.g. Threads or rounding – standard line pattern for comparison with the shadow image of the text object is projected to a ground glass screen. The text object is shifted or turned on the measuring in addition to the comparison of shapes.

The addition to this method (shadow image method), measuring operations are also possible by use of the axial reaction method, which can be recommended especially for thread measuring. This involves approached measuring knife edges and measurement in axial section of thread according to definition. This method permits higher precision than shadow image method for special measuring operations.

Applications

The large tool maker's microscope is suitable for the following fields of applications;

Length measurement in cartesian and polar co-ordinates.
Angle measurements of tools; threading tools punches and gauges, templates etc.
Thread measurements i.e., profile major and minor diameters, height of lead, thread angle, profile position with respect to the thread axis and the shape of thread. (rounding, flattering, straightness of flanks)
Comparison between centres and drawn patterns and drawing of projected profiles.

Single point lathe tool angle measurements

The various tool angles as per machine reference system (American System of Tool Nomenclature-ASA) are as follows;

Back rake angle (γ_y) is the angle between the tool face and the y_m axis and is measured in y_m - z_m Plane (Fig.2). Side rake angle (γ_x) is the angle between the tool face and the

x_m axis measured in x_m - z_m plane. End relief angle (α_y) is the angle between the end flank and the z_m axis measured in y_m - z_m plane. Side relief angle (α_x) is the angle between the side flank of the tool and the z_m axis and is measured in x_m - z_m plane. End cutting edge angle (φ_e) is the angle between the trailing edge of the tool and the x_m axis and is measured in x_m - y_m plane. Side cutting edge angle (φ_s) is the angle between the side cutting edge of the tool and the y_m axis and is measured in the x_m - y_m plane.

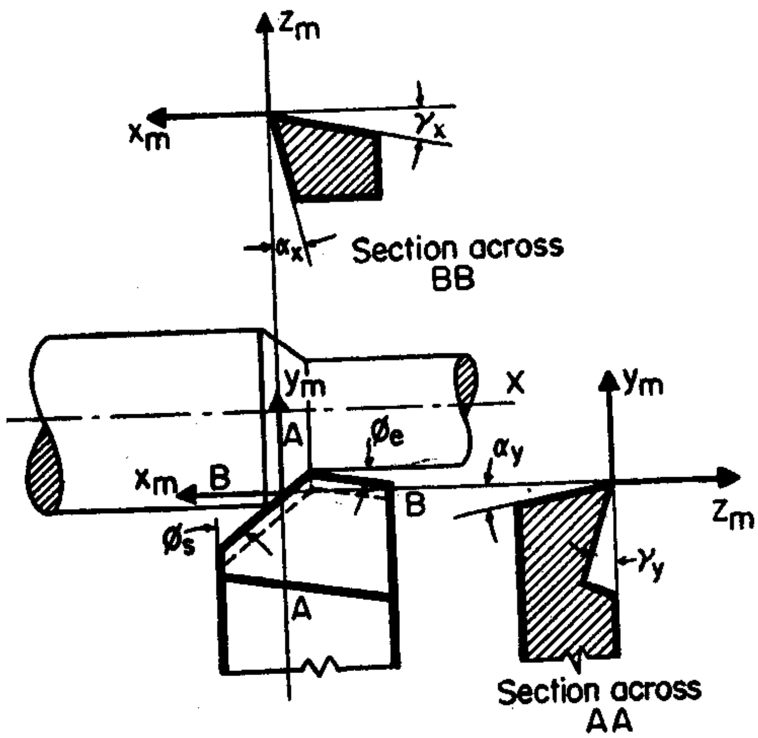
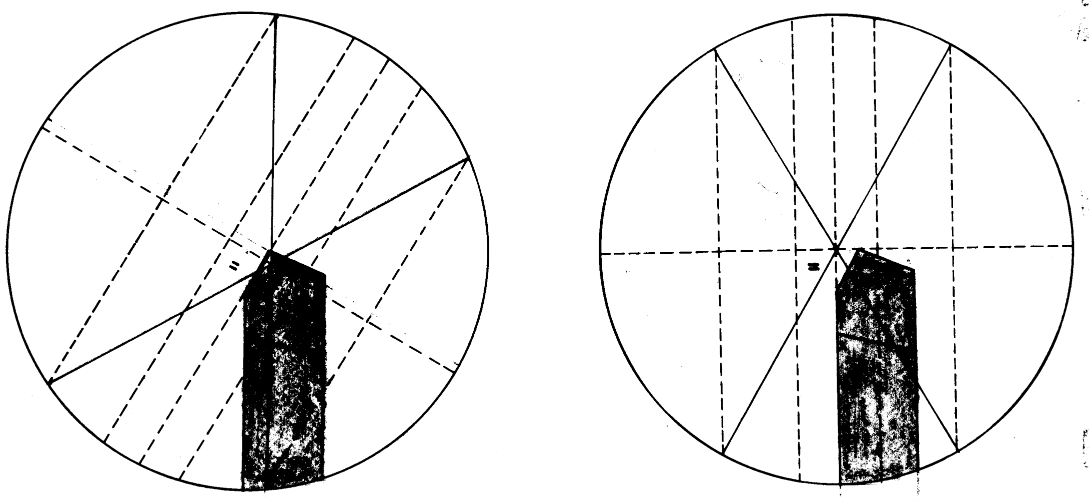


Fig.2 Orientation of face and flank surfaces with respect to machine reference system (American System of Tool Nomenclature)

Procedure of measurement with TMM

Place the tool bit on the glass stage so as to obtain a clear image on which angular measurements are done. Focus the microscope to get a real image super imposed on the graticule pattern of the eyepiece. Tilt the graticule pattern so as to align the shank edge with the reference hair line. Read microscope angle scale. Tilt the angle so as to bring the cutting edge of the tool to align with the reference hairline. If necessary X, Y movements may be made to retain the edge in the field of view. A typical field of vision before and after adjustment is shown in Fig. 3.



(a) before adjustment (b) after adjustment

Fig. 3 Field of vision of sighting microscope of TMM

Different Nomenclature systems for face and flank orientations

The commonly used nomenclature systems for face and flank orientations are American System of Tool Nomenclature (ASA system-which follows machine reference system), Orthogonal Rake System (ORS- which follows tool reference system) and Normal Rake System (NRS- which also follows tool reference system). The different angles and their plane of measurement are depicted in Fig. 4. A comparison of the various systems and their interrelations are given in Table1.The graphical method of conversion between ASA and orthogonal system is explained in Fig. 5. The common wear patterns on tool flank and crater surface is shown in Fig. 6.

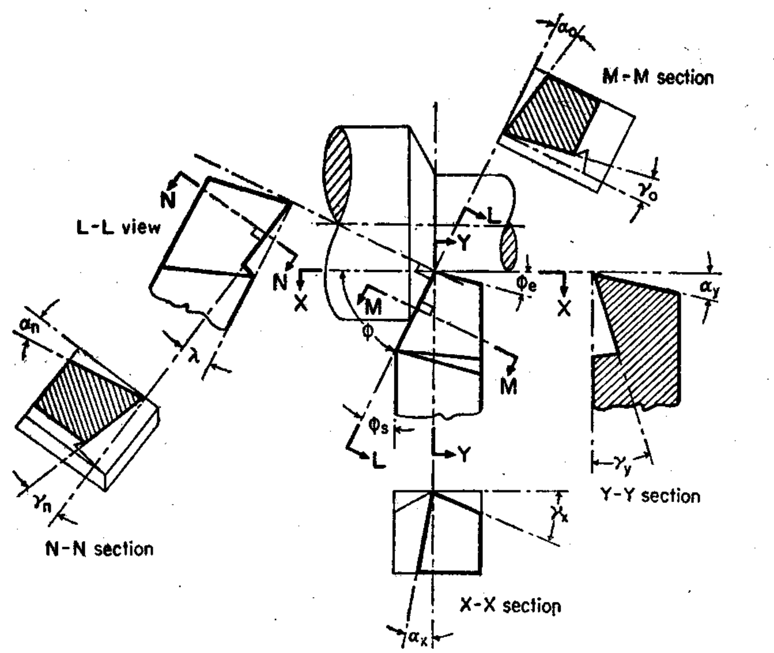


Fig. 4 ASA system, ORS and NRS

The shape of a tool may be specified in a special sequence (tool signature) as given

1. American system

$\gamma_y - \gamma_x - \alpha_y - \alpha_x - \varphi_e - \varphi_s - r$ (ASA)

2. Orthogonal rake system

$\lambda - \gamma_o - \alpha_o - \alpha_{o'} - \varphi_e - \varphi - r$ (ORS)

3. Normal rake system

$\lambda - \gamma_n - \alpha_n - \alpha_{n'} - \varphi_e - \varphi - r$ (NRS)

where, φ is the plan approach angle (principal cutting edge angle)- complimentary to φ_s

Table 1. The summary of different systems of tool nomenclautre

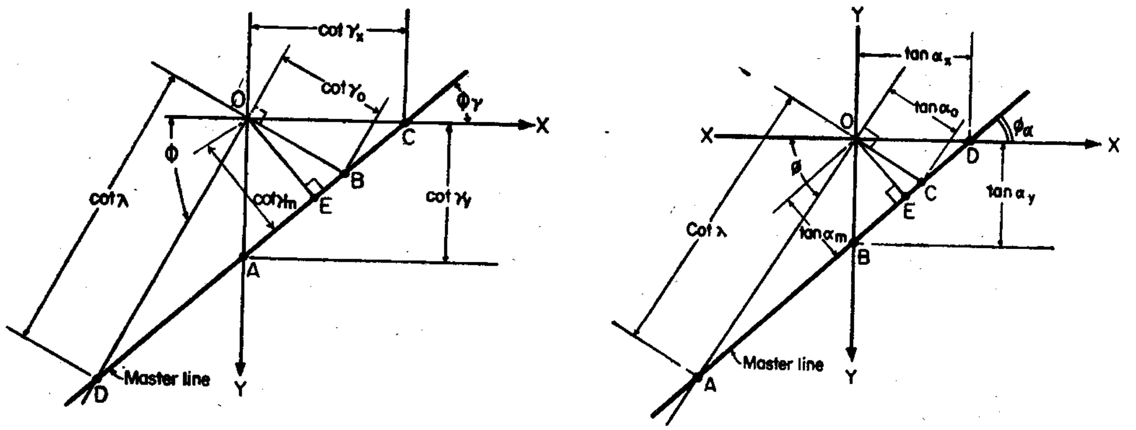
Item	Machine reference system: American	Tool reference system: Orthogonal	Tool reference system: Normal
1. Location of cutting edges	φ_s , φ_e	φ , φ_e	φ , φ_e
2. Orientation of face	γ_y , γ_x	γ_o , λ	γ_n , λ
3. Orientation of principal flank	α_y , α_x	α_o	α_n
4. Orientation of auxiliary flank	-	$\alpha_{o'}$	$\alpha_{n'}$
5. Nose radius	R	R	r

Interrelation between different systems

$$\begin{bmatrix} \tan\lambda \\ \tan\gamma_o \end{bmatrix} = \begin{bmatrix} \sin\varphi & -\cos\varphi \\ \cos\varphi & \sin\varphi \end{bmatrix} \begin{bmatrix} \tan\gamma_y \\ \tan\gamma_x \end{bmatrix} \qquad \begin{bmatrix} \tan\gamma_y \\ \tan\gamma_x \end{bmatrix} = \begin{bmatrix} \sin\varphi & \cos\varphi \\ -\cos\varphi & \sin\varphi \end{bmatrix} \begin{bmatrix} \tan\lambda \\ \tan\gamma_o \end{bmatrix}$$

$$\begin{bmatrix} Cot\alpha_x \\ Cot\alpha_y \end{bmatrix} = \begin{bmatrix} \sin\varphi & -\cos\varphi \\ \cos\varphi & \sin\varphi \end{bmatrix} \begin{bmatrix} \cot\alpha_o \\ \tan\alpha\lambda \end{bmatrix} \qquad \begin{bmatrix} Cot\alpha_o \\ \tan\lambda \end{bmatrix} = \begin{bmatrix} \sin\varphi & \cos\varphi \\ -\cos\varphi & \sin\varphi \end{bmatrix} \begin{bmatrix} \cot\alpha_x \\ \cot\alpha_y \end{bmatrix}$$

$$\tan\gamma_n = \tan\gamma_o Cos\lambda \qquad \tan\alpha_n = \frac{\tan\alpha_o}{\cos\lambda}$$



(a) For rake angles (b) For clearance angles

Fig. 5 Method of master line (graphical method)

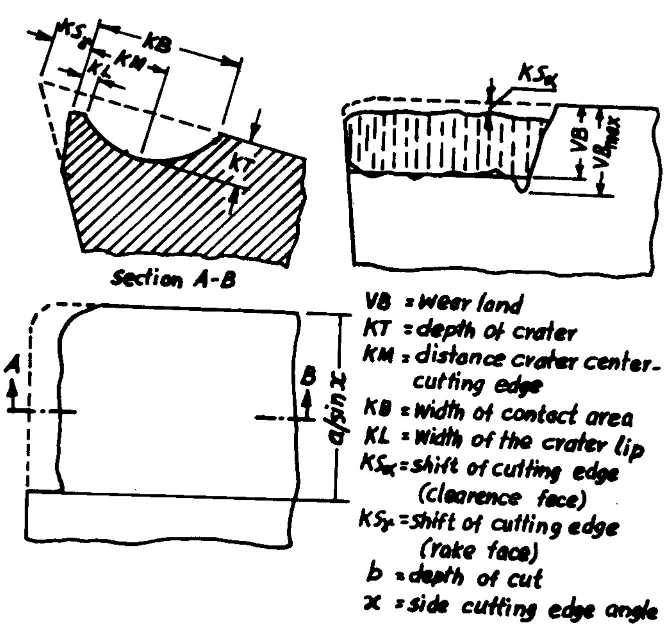


Fig. 6 Tool wear pattern on flank and creator

Ref: Amitabha Bhattacharyya, Metal Cutting, Theory and Pratice

Prepared by: Dr. V. George & Dr. Jose Mathew