FACULTY OF ENGINEERING

DESIGN AND PRODUCTION ENGINEERING DEPARTMENT

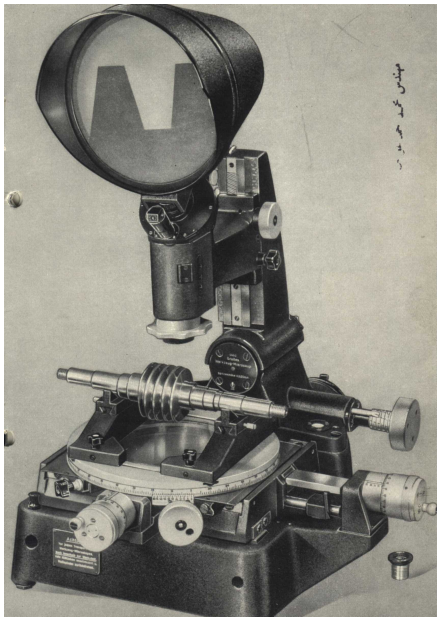
MEASURING INSTRUMENTS

3 rd Year Production

Report On:

(8)

Microscopes



Metrology laboratory

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Class No:	***Signature***
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2008/2009

MICROSCOPES

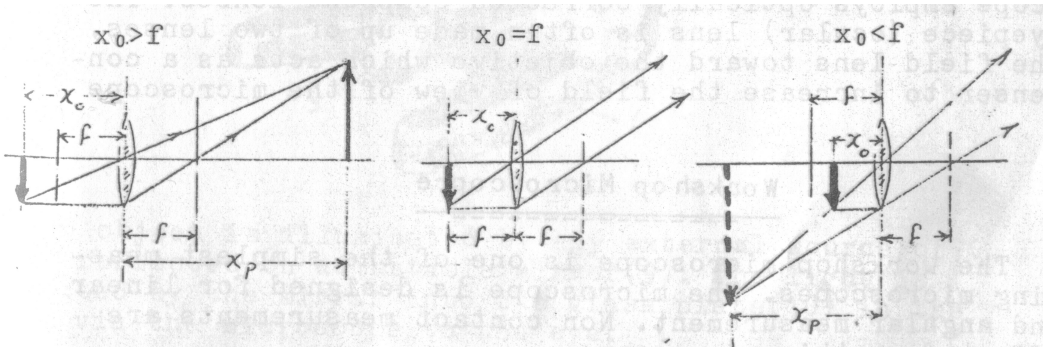
Introduction

Optical instruments have a decided advantage with respect to the accuracy of measurement over mechanical instruments; since higher degree of magnification can be attained. There is no friction or wear that affect the accuracy of measurement.

Principles of optical magnification

The simplest optical magnifier consists of a single convex lens, of a focal length (f), mounted in circular frame for protection.

If an object is brought near to the lens ($x_o > f$), the image is larger and farther away. When the object is brought into focal plane ($x_o = f$), rays from the lens became parallel and no image is formed. By bringing the object still near to the lens ($x_o < f$), a virtual, upright, image is formed.



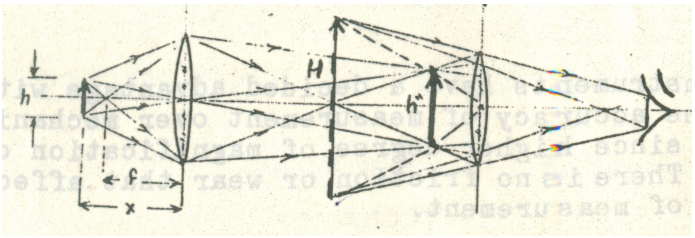
The optical magnification of single convex lens can be expressed as:

$$M = f / (f - x_o)$$

Where (x_o) is the distance between the object and the lens.

Principle of microscope

In order to obtain a higher magnification, it is necessary to employ a pair of lenses, each of which is a compound lens made of two or more lenses built up and located relative to one another so as to act as a single lens. This is the principle of the compound microscope as shown in the figure.



The microscope consists of double convex lenses. The small object (h) is located at a distance from the objective lens slightly greater than the focal length of this lens (x > f). The objective length forms an inverted image (h") at greater distance from it, this image is proportionally greater than the object (h). The image is viewed by the eye of the observer through the ocular lens which has a larger focal length than the objective. The ocular forms an enlarged image (H).

Instead of simple convex lenses, the modern microscope employs optically corrected compound lenses. The eyepiece (ocular) lens is often made up of two lenses, the field lens toward the objective which acts as a condenser to increase the field of view of the microscope.

Workshop Microscope

The workshop microscope is one of the simplest measuring microscopes. The microscope is, designed for linear and angular measurement. Non contact measurements are affected on this microscope.

The microscope consists of a cast-iron base of U-shape (1) in which a column (2) is secured. The instrument is provided with a bracket (3) moves along the column (2) and can be locked at any required height by means of the locking screw (4). The stage (5) rest on the upper surface of the bracket. This stage (table) can be rotates through 360^{o} and the angular rotation can be read by fixed vernier to a scale value of 5'. Two micrometers screw, enable the table to slide in the X and Y directions. A microscope head is mounted on a supporting arm (6), which slides along the column and can be locked at any height by a start knob screw (7). The microscope head can be fine adjusted by means of a rack and pinion (8).

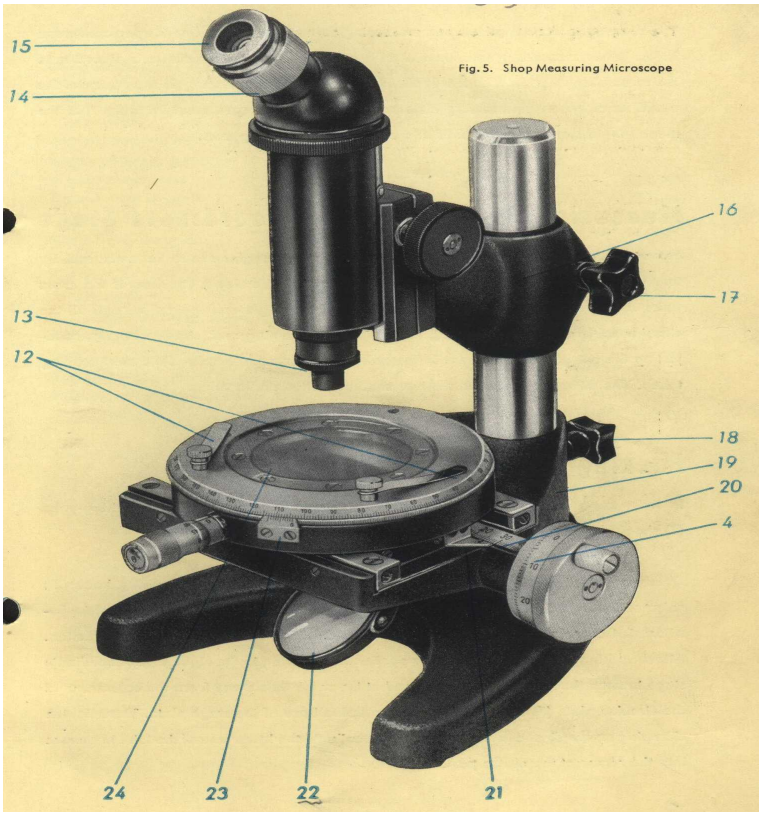
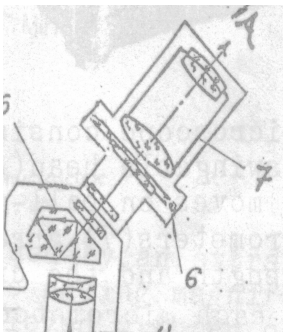


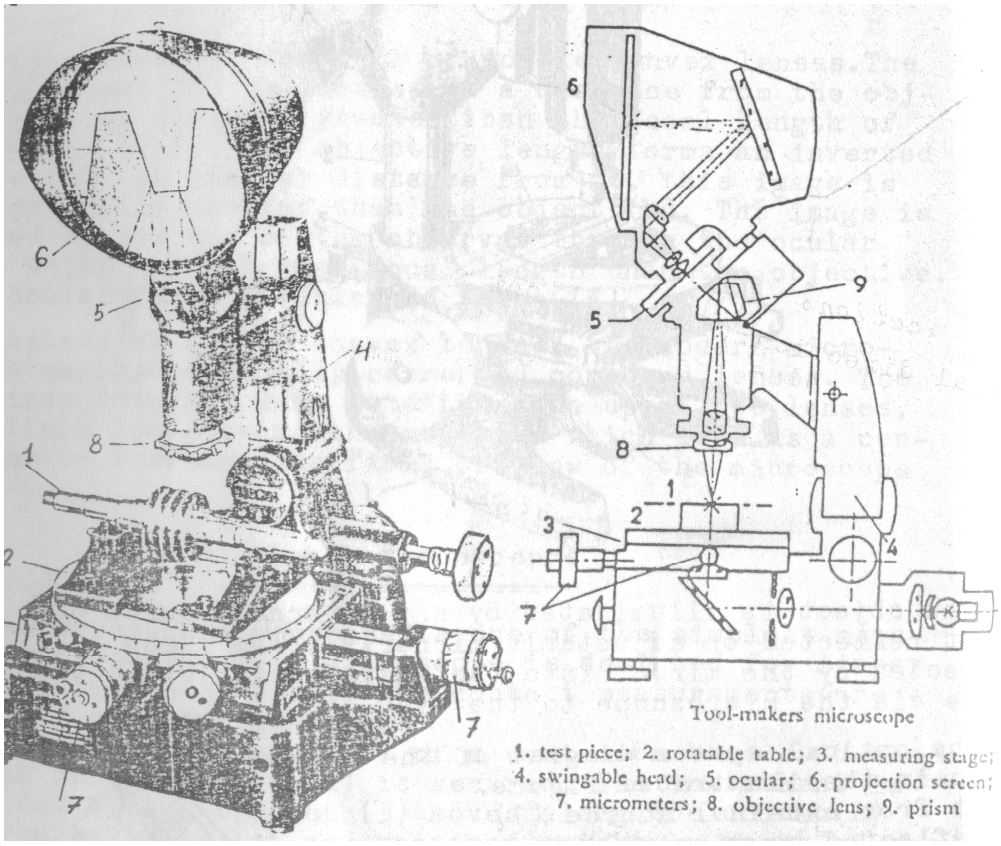
Fig. 5. Shop Measuring Microscope

The optical system diagram of the workshop diagram is shown in the illustrated figure. Wight from external source (1) is reflected by mirror (2) to the object glass (3) to the object be reassured. The object's shadow contour is projected by objective (4) on to the plane of ocular gratitude (6) via prism (5). The objective image and the gratitude are observed through eyepiece (7).



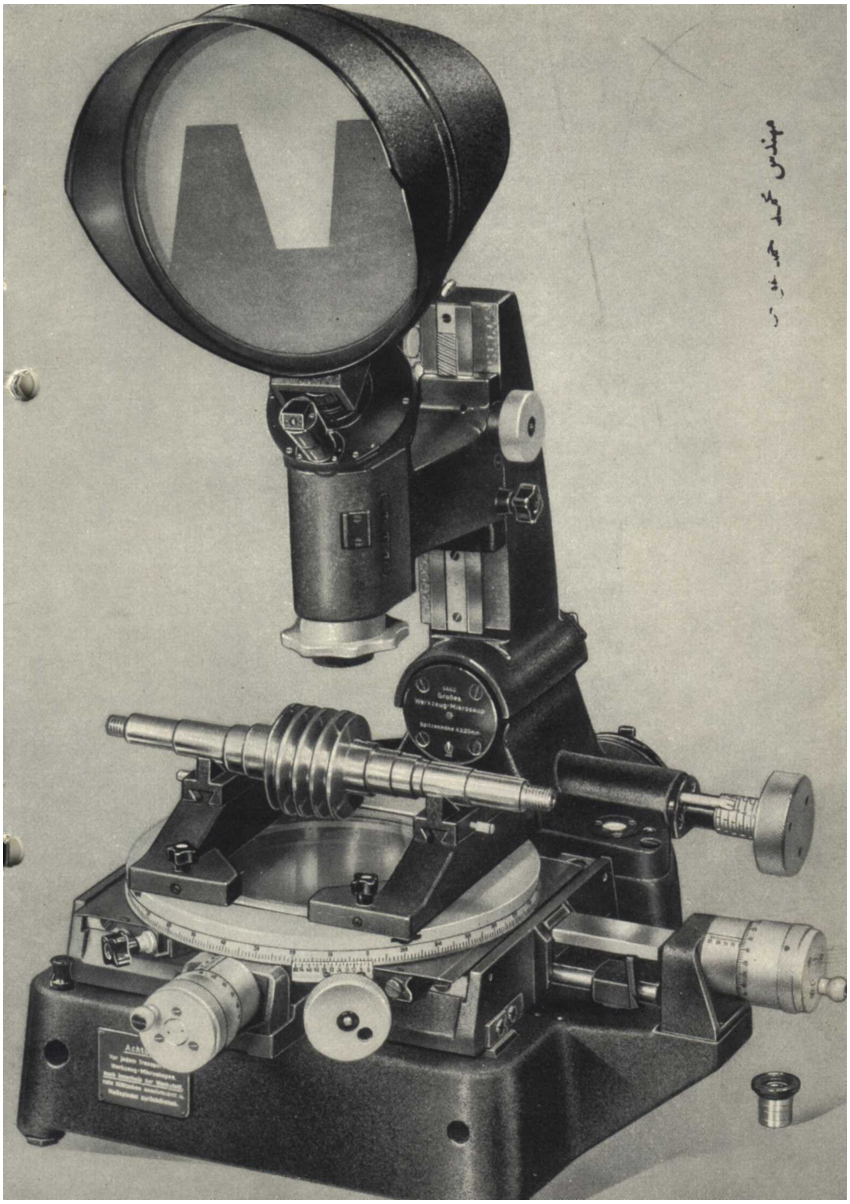
Toolmaker's Microscope

The tool-maker's microscope is an optical measuring machine equipped for external and internal length measurement as well as measurements on screw threads, profiles, curvatures and angles. For these purpose, the microscope is provided with several measuring attachments such as center stage for mounting cylindrical components evolving and angle measuring ocular, double image ocular optical fee let and a projection screen for contour comparison and measurement.



Tool-makers microscope

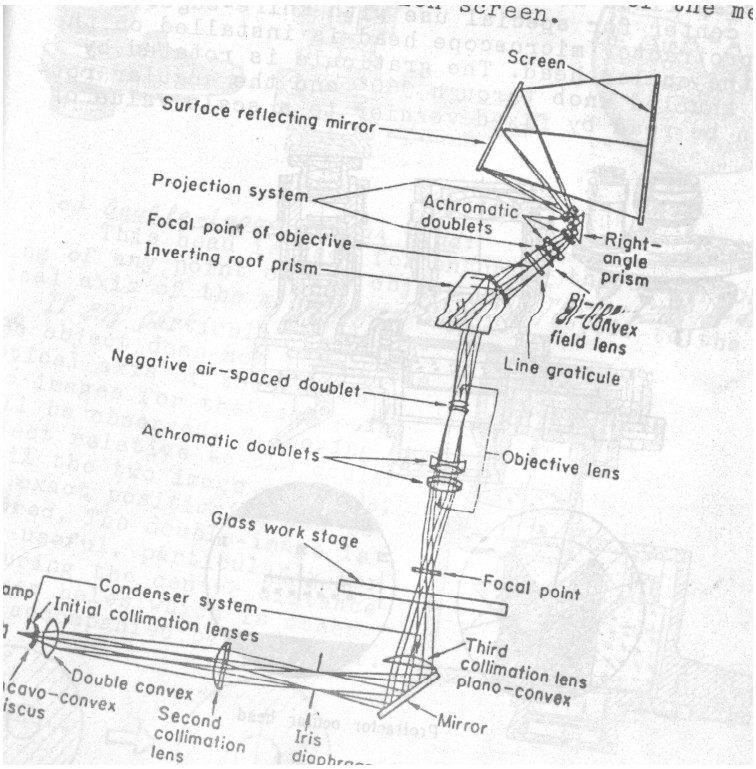
1. test piece; 2. rotatable table; 3. measuring stage; 4. swingable head; 5. ocular; 6. projection screen; 7. micrometers; 8. objective lens; 9. prism



The microscope consists mainly of a rigid stand on which a swing able head (4) is mounted. The measuring stage (3) moves on ball-guide ways by actuating two measuring micrometers (7) arranged perpendicular to each other in the length and the cross-directions. The measuring range of each micrometer is 25 mm and the measuring capacity can be increased using slip gauges. A rotatable table (2) is provided over the stage, on which the work

piece can be fixed either directly or between centers. This table can be rotate through 360^{o} and the angular rotation can be read by a fixed vernier to a scale value of 3'.

The component being measured (1) is illuminated by the through light method. A parallel beam light illuminates the lower side of the work piece which is then received by the objective lens (8) in its way to a prism (9) that deflects the light rays in the directions of the measuring ocular and the projection screen.



Incident illumination can be provided by an extra attachment. Exchangeable objective lenses having magnifications 1X, 1.5X, 3X, and 5X can be achieved with an ocular of 10X. The direction of illumination can be tilted with respect to the work piece by tilting the measuring head and the whole optical system.

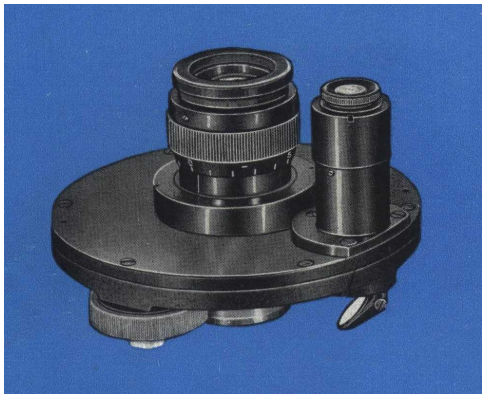
Types of Ocular Heads:

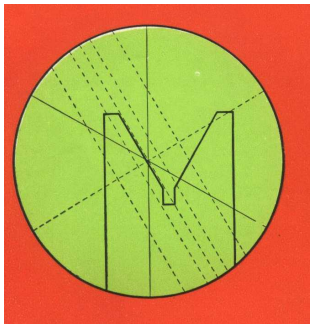
The principal types of ocular heads used for tool-maker's microscopes are the Protractor (Goniometer) ocular head, Template (Dial-template) ocular head, Double-image (Coincidence) ocular head. All these heads have a magnification of 10X.

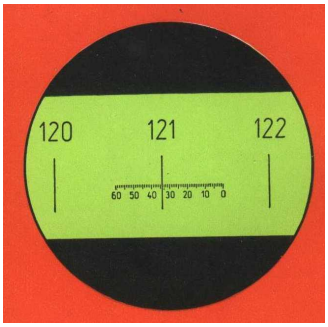
(a) Protractor Ocular Head:

The eyepiece field of view contains an unbroken crosshair (60° angle), a dotted crosshair and four parallel broken lines at fixed distance (0.3 & 0.9 mm) from the center for special use with knife-edges.

A protractor microscope head is installed on the side of the ocular head. The graticule is rotated by means of knurled knob through 360° and the angular rotation can be read by fixed vernier to a scale value of 1'.

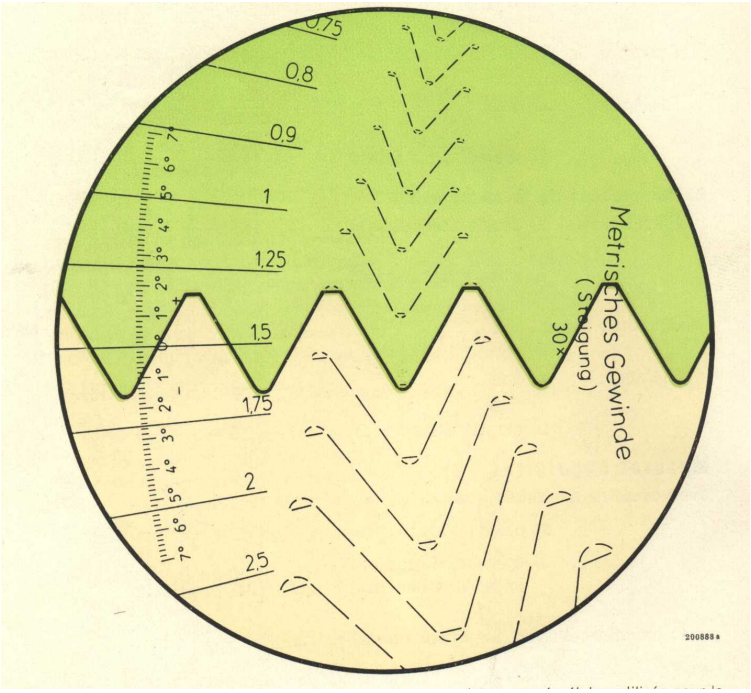






(b) Template Ocular Head:

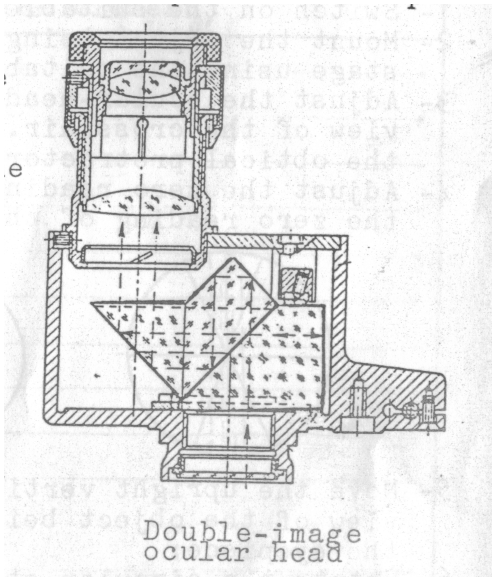
The eyepiece contains the most standard contours and templates for testing and measuring Metric and Whit-worth (including test of thread angle). It is also provided with two double angles (30° and 60°) to test threads, cutting tools and hobs. The template eyepiece may contained circular arcs of different radii (0.1 mm to 80 mm). Gear tooth forms can be checked by another template according to DIN standard.



(c) Double-Image Ocular Head:

This head is used for ensuring the exact positioning of any point on the object with respect to the optical axis of the microscope.

If any particular point on the object does not lie on the optical axis of the system, two images for the same point will be observed. By moving the object relative to the ocular until the two image coincide, the exact positioning can be ensured. The double-image is very useful, particularly for measuring the centre distance between holes which is otherwise accompanied by big error.



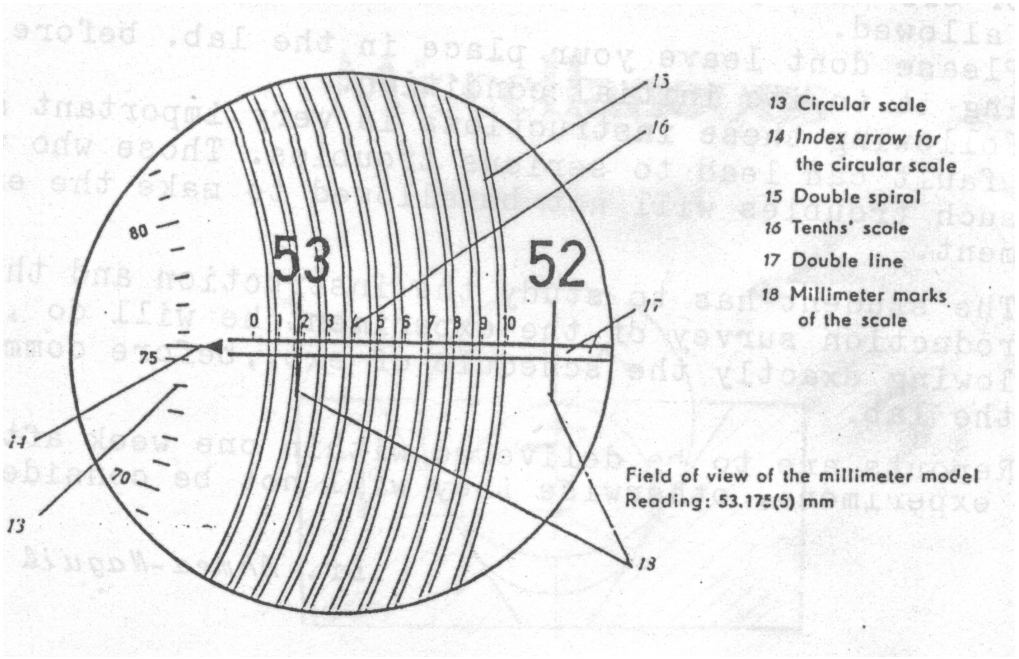
Double-image ocular head

Reading spiral microscope

The determination of the measured value described under b) above is generally preferred, because this enables computation to be done in round figures. The sequence of readings is given in detail on page 8. There are two templates in the Spiral Microscopes eyepiece:

1. The rotatable template, axis of which is outside the field of view, with:
   (a) The hundredths circular scale (13) to indicate hundredths and thousandths of a millimeter, or to indicate thousandths and ten-thousandths of an inch in the model with the circular scale divided into 50 parts:
   (b) The double Archimedean spiral (15), turning with the circular scale, the double turns of which have a spiral pitch and whose apparent size is 0.1 mm, or 0.005 in. in the inch model;
2. the fixed template with
   (a) the thick double line (17), within which the scale graduation bracketed by a double line of the spiral (15) is read:
   (b) the tenths' scale (16) graduated from 0 to 10, for reading tenths of a millimeter or the inch scale, graduated from 0 to 50, for reading 0.005 Ma.

   The index arrow (14) for the circular scale.


13 Circular scale
14 Index arrow for the circular scale
15 Double spiral
16 Tenths' scale
17 Double line
18 Millimeter marks of the scale
53
52
80
75
70
0 1 2 3 4 5 6 7 8 9 10
15
16
17
14
13
13
Field of view of the millimeter model
Reading: 53.175(5) mm

Precautions:

The following Procedure should be applied for the microscope before carrying measurements:

1. Switch on the suitable illuminating source of light;
2. Mount the object being measured on the microscope stage using the suitable attachment;
3. Adjust the ocular-head eyepiece for clear and sharp view of the crosshair. Also, adjust the eyepiece of the optical protractor;
4. Adjust the zero reading of the swinging upright, and the zero reading of the optical protractor;
5. Move the upright vertically until a clear and sharp view of the object being measured is reach through the eyepiece;
6. Rotate the circular stage carrying the object until the line of measurement of the object is aligned with one of the microscope measuring axis;
7. read the initial reading of the micrometer, then move the stage by turning the micrometer until the final position of the object is achieved. Read the micrometer and calculate the different between the initial and final readings to obtain the required dimension.

THE EXPERIMENT

Main objective:

To study the construction, the specifications and the fields of usage of measuring microscopes.

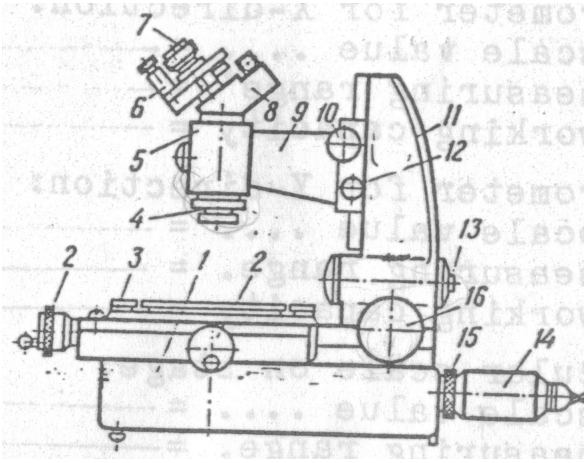
Apparatus:

1. Different types of measuring microscopes:
    i. Tool-marker's microscope;
    ii. Tool-room microscope;
    iii. Workshop microscope.
2. Microscope accessories:
    i. Objectives;
    ii. Projection attachment;
    iii. Ocular heads;
    iv. Incident-light illuminator;
    v. Work piece Attachments.
3. Objects to be measured.

Objective:

Study the construction and the basic elements of the Tool-maker's microscope. Show by means of arrows the direction of motion of the moving elements.

Construction



Basic elements

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Specifications	
Micrometer for X- direction	
Scale value	=
Measuring range	=
Working capacity	=
Micrometer for X- direction	
Scale value	=
Measuring range	=
Working capacity	=
Circular scale of stage	
Scale value	=
Working capacity	=
Tilting scale of upright	
Scale value	=
Working capacity	=
Angular scale of protractor ocular head	
Scale value	=
Working capacity	=
Diameter of circular stage	=
Fields of Usage	

Objective: Show by means of neat sketches the different methods of holding the object being measured on the microscope stage.

Objective: measure the dimension of the given product using the tool makers's microscope.

Sketch of the product

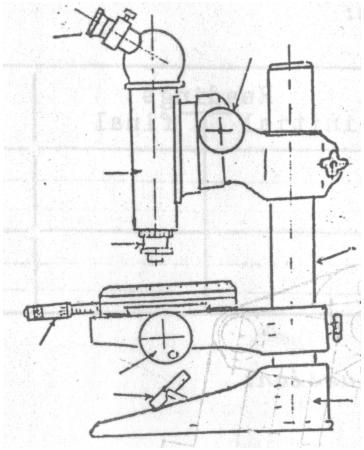
Reading & results

Discussion

Objective:

Study the construction and the basic elements, the specifications and the uses of the workshop microscope.

Construction & basic elements



Specifications

Micrometer for X- direction Scale value Measuring range Working capacity	
Micrometer for X- direction Scale value Measuring range Working capacity	
Circular scale of stage Scale value Working capacity	
Diameter of stage	
Uses	

Objective: measure the outer diameter of the given coin using both the workshop and tool makers microscope. Compare the results.

Microscope Type	Readings		Dimensions
	Initial	Final	(mm)
Workshop			
Tool Maker			

Comparisons & discussions

Conclusions