Metrology Laboratory
Department of Mechanical Engineering

Experiment No. 1B

MICROMETER CALIBRATION

Aim:

- To study various types of micrometers.
- To calibrate the given micrometers, using slip gauge as standard.
- To study use of combination set.

Apparatus:

- Set of Micrometers
- Set of Slip gauges
- Combination set

Theory:

A micrometer is a device used widely in mechanical engineering and machining for precision measurement, along with other metrological instruments such as dial calipers and vernier calipers. Micrometer screw-gauge is used for measuring accurately the diameter of a thin wire or the thickness of a sheet of metal. It consists of a U-shaped frame, fitted with a screwed spindle which is attached to a thimble, as shown in Fig. 1.

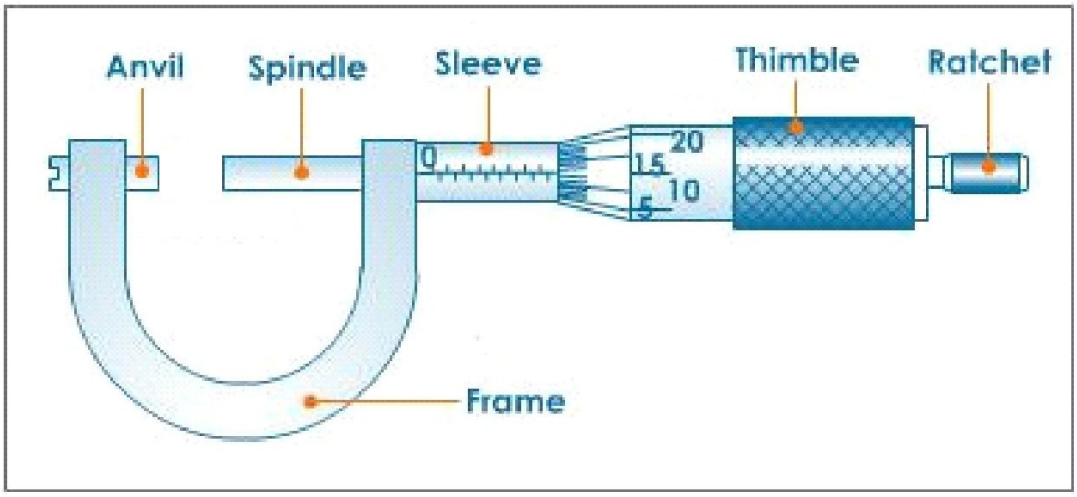

Fig. 1 Screw gauge

Micrometers use the principle of a screw to amplify small distances that are too small to measure directly into large rotations of the screw that are big enough to read from a scale. The accuracy of a micrometer derives from the accuracy of the threadform that is at its heart. The basic operating principles of a micrometer are as follows:

The amount of rotation of an accurately made screw can be directly and precisely correlated to a certain amount of axial movement (and vice versa), through the constant known as the screw's pitch (for single start screw thread). A screw's pitch is the distance it moves forward or backward axially with one complete turn. The screw has a known pitch such as 0.5 mm. Hence in this case, for one revolution of the screw the spindle moves axially by 0.5 mm. This movement of the spindle is shown on an engraved linear millimeter scale on the sleeve. On the thimble there is a circular scale which is divided into 50 or 100 equal parts.

When the anvil and spindle end are brought in contact, the edge of the circular scale should be at the zero of the sleeve (linear scale) and the zero of the circular scale should be opposite to the datum line of the sleeve. If the zero is not coinciding with the datum line, there will be a positive or negative zero error as shown in Fig. 2.

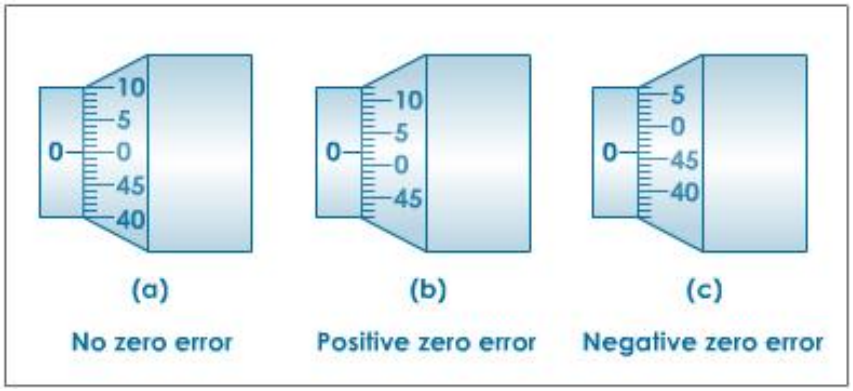

Fig. 2 Zero error in case of screw gauge

The least count of the micrometer screw can be calculated using the formula given below:

Least count =Pitch/ Number of divisions on the circular scale =0.5 mm/50 =0.01 mm

- As an example, to determine the diameter of a wire, the wire is to be placed between the anvil and spindle end, and the thimble is rotated till the wire is firmly held between the anvil and the spindle. The ratchet is provided to avoid excessive pressure on the wire. It prevents the spindle from further movement. The diameter of the wire could be determined from the reading as shown in Figure 3.

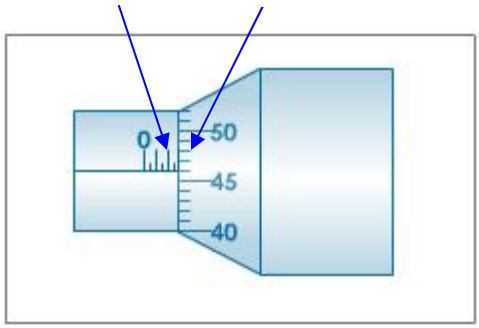

Fig. 3 Linear and circular scales of screw gauge

- Reading = Linear scale reading + (coinciding cicular scale * Least count)
  = 2.5 mm+ (46*0.01) = 2.96 mm (for Figure 3)

Accuracy of the measured reading is the degree of veracity while precision is the degree of reproducibility. The analogy may be used to explain the difference between accuracy and precision is the target comparison. In this analogy, repeated measurements are compared to arrows that are shot at a target as shown in Figure 4. Accuracy describes the closeness of arrows to the bullseye at the target center. Arrows that strike closer to the bullseye are considered more accurate. The closer a system's measurements to the accepted value, the more accurate the system is considered to be.

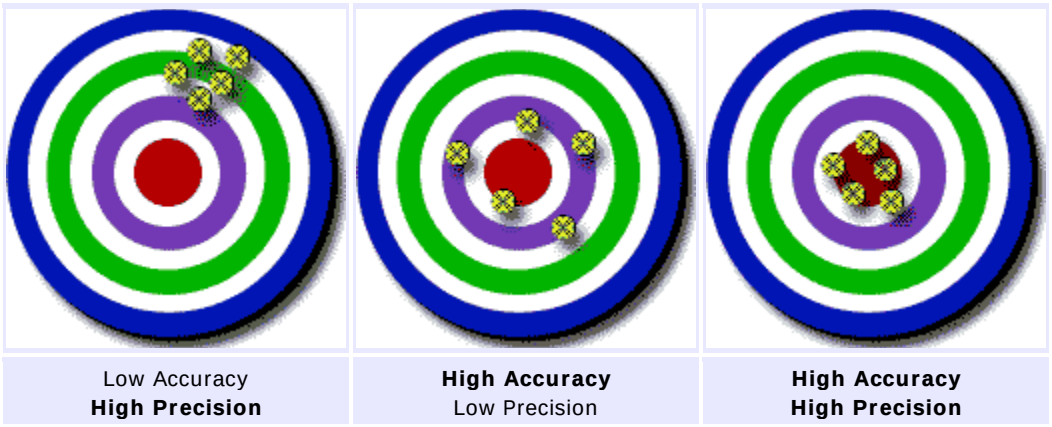

Fig. 4 Difference between accuracy and precision

Gauge block or slip gauge is a precision ground and lapped length measuring standard. It is used as a reference for the setting of measuring equipment used in machine shops, such as micrometers, sine bars, and dial indicators (when used in calibration or inspection role).

These gauges consists of a set of steel blocks, each of which has one pair of opposite faces lapped flat and parallel accurately to a few millionths of an inch. They are used to check the accuracy of workshop and similar gauges, which in use arc subjected to

wearing action; slip gauges should never be used as ordinary measuring gauges, but as reference or master standards. They arc generally employed in connection with comparator instruments when workshop gauges have to be checked.

The slip gauges are supplied in sets, the number in each set varying according to the purpose in view. The most widely employed set consists of 81 gauges of differing thickness made up as fallows:

- Nine pieces with range of 0.1 001 to 0.1009 in. in steps of 0.0001 in.
- Forty-nine pieces with a range of 0.101 to 0.149 in. in steps of 0.001 in.
- Nineteen pieces with a range of 0.05 to 0.95 in. in steps of 0.05 in.
- Four pieces of parallel width, 1 in, 2 in, 3 in, and 4 in. respectively.

Metric unit sets of 103 pieces are made up as follows:

- Forty-nine pieces with a range of 1.01 to 1.09 mm. in steps of 0.01 mm.
- Forty-nine pieces with a range of 0.50 to 24.50 mm. In steps of 0.50 mm.
- Four pieces of25, 50, 75, and 100 mm respectively.
- One extra piece of 1.005 mm.

Smaller sets of 76, 56, 48, and 31 pieces are also supplied in the metric sizes, and sets of 49, 41, 35 and 28 in English sizes.

Before using these gauges they should be wiped with a piece of soft linen cloth. If the presence of any grease is suspected, or in the case of new gauges having a protective coating, the surface should be wiped over with a piece of soft linen moistened with benzole or petrol. The removal of any grease including that from the fingers is important since; otherwise, dirt may be picked up more easily. In a dustless atmosphere however, a trace of grease on the surface assists in obtaining a satisfactory wringing action.

Fingering of slip gauges should be avoided as much as possible since it tends to promote tarnishing and thermal expansion effects. A change of only in temperature causes a length change of about 1 /1, 00, 000 in. per inch thickness of gauge.

It is important for fine precision measurements to use slip gauges in a room thermo-statistically controlled at 20^0 C and to allow, the work and the gauges sufficient time to attain this temperature if taken into heat-regulated room. Gauges after use should be wiped off carefully at once and returned to their storage case, closing the lid of the latter as soon as possible.

Wringing is the process of sliding two blocks together so that their faces lightly bond. When combined with a very light film of oil, this action excludes any air from the gap between the two blocks. The alignment of the ultra-smooth surfaces in this manner permits molecular attraction to occur between the blocks, and forms a very strong bond between the blocks along with no discernible alteration to the stack’s overall dimensions.

- The recommended procedure for wringing a pair of slip gauges together is as follows and shown in the Fig. 5.
- First clean the surfaces as desired previously, and then place one gauge centrally across the other gauge at right angles to form a symmetrical cross. Finally rotate the upper gauge over the lower one to its final coincident position. This method results in appreciably less rubbing action than the upper gauge is slid lengthwise over the lower one.

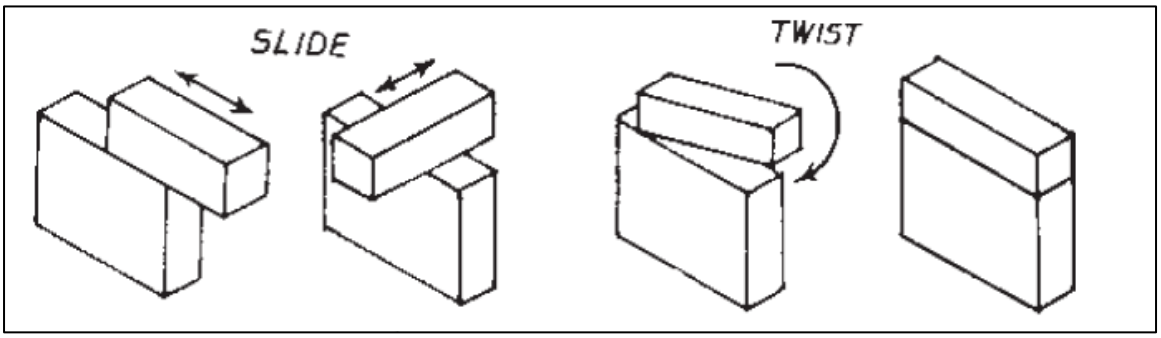

Fig. 5 Wringing of slip gauges

Procedure:

For calibration of micrometers

1. Check the range of measurement of the micrometer.
2. Note down zero error of the micrometer, if any.
3. Select a number of slip gauge combinations.
4. Measure each slip gauge combination with the micrometer and note down micrometer reading (M) and slip gauge combination length (G) in tabular form.
5. Plot a calibration chart for the micrometer taking M on the X-axis and (M-G) on the Y-axis.
6. Repeat the steps l-5 for other micrometers.

Precautions:

! While making slip gauge combination, do the wringing correctly, so that no foreign particles are entrapped.
! While taking micrometer reading, care should be taken to clamp the spindle in position, before taking it away from the block, as due to friction the Spindle will rotate and give a wrong reading.
! Turn the spindle always in the clockwise direction to avoid backlash error.

Observations & Result:

Micrometer Details	Sl. No. of reading	Slip Gauge reading (G)	Micrometer Reading (M)	Error (M-G)
Range: No.: Make: Zero error:	1 2 3			

Discussion:

Sources of measurement errors

Questions:

1. Discuss functions and principle of ratchet drive in case of a micrometer.
2. Why does zero error occur in a micrometer?
3. Differentiate among terms accuracy, precision, sensitivity, & readability.
4. When is an instrument required to be calibrated?
5. What is the use of calibration chart?
6. What do you mean by Protector Slip Gauge?
7. What is wringing? How is it done?
8. Sketch the type of anvil required for measuring the thickness of a paper, chip thickness?