Vernier micrometer, screw thread micrometer, graduation & reading

Objectives: At the end of this lesson you shall be able to
- **state the graduations of a vernier micrometer (metric)**
- **read a vernier micrometer**

Vernier micrometer

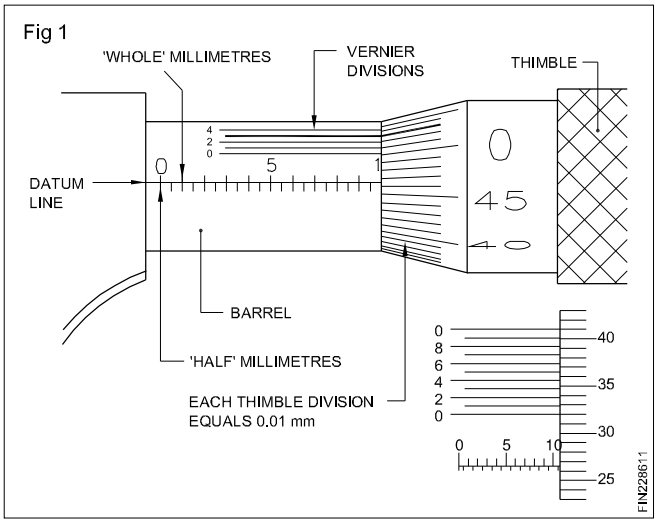
Ordinary metric micrometers can measure only to an accuracy of ±.01mm.

For taking more accurate measurements, vernier micrometers are useful. Vernier micrometers can measure to an accuracy of ±.001 mm.

Construction and graduation

Vernier micrometers are very similar to ordinary micrometers in construction. The difference is in the graduation. These micrometers have additional, equally spaced graduations (vernier graduations) given above the datum line. There are ten such vernier graduation lines marked parallel above the datum line. (Fig 1) The space between these 10 lines is equal to 9 divisions in the thimble. (Fig 1)

Fig 1



The value of 10 vernier divisions is

.0 1 mm X 9

=.09 mm.

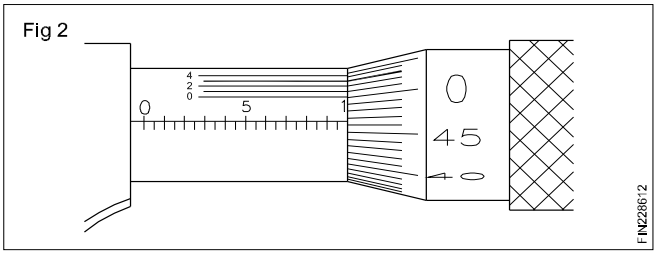
The value of a vernier division

$$\frac{0.09}{10} = .009\text{mm}$$

The least count = 1 thimble division – 1 Vernier division
= 0.01 – 0.009mm = .001 mm

Reading a vernier micrometer (Fig 2)

Fig 2



Example

After measuring, read the full mm divisions visible on the barrel.

full divisions in mm. 9 mm

Note the half divisions, if any, visible on the barrel.

1 half division

Read the thimble divisions below the datum line. (Fig 2)

46 divisions

Note the vernier division coinciding with the thimble division.

3rd division

Add up all the readings together

Calcuation

The range of micrometer is 0 to 25 mm

A Full mm division visible before the thimble edge = 1.00 x 9 = 9.00 mm

B Half mm division visible after the full mm divsion on barrel. = 0.5 x 1 = 0.50 mm

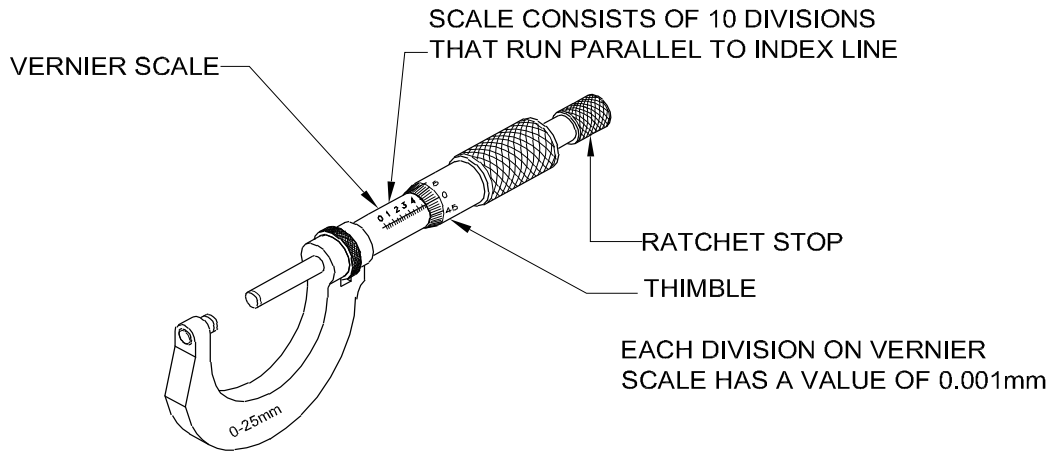
C Thimble division below the index line = 46 X 0.01 = 0.46 mm

D Vernier division coinsiding with thimble division = 3 X 0.001 = 0.003 mm

Reading = 9.963 mm

Vernier micrometers are made of invar steel. (Fig 3)

Fig 3



Care and maintenance

- Clean the circumference of the spindle and both measuring faces with dry linen cloth regularly before use.
- Clean and apply thin layer of oil on the spindle and measurring faces after the use.
- Care should be taken while handling the micrometer and not to drop on floor.
- Recalibrate the vernier micrometer if it is accidently droped.
- Store vernier micrometer in a ventilated place with low humidity and ideally at room temperature.
- Ensure that there is a gap between measuring faces, when it is not in use.

Calibration of measuring instrument

Objectives: At the end of this lesson you shall be able to
- **state the importance of calibration**
- **state calibration and its procedure.**

Why calibration is important ?

The accuracy of all measuring devices degrade over time. This is typically caused by normal wear and tear. However, changes in accuracy can also be caused by electric or mechanical shock or a hazardous manufacturing environment in which it is being used, it may degrade very quickly or over a long period of time. The bottom line is that, calibration improves the accuracy of the measuring device. Accurate measuring devices improve product quality.

When should you calibrate your measuring device?

A measuring device should be calibrated:

- According to recommendation of the manufacturer.
- After any mechanical or electrical shock.
- Periodically (annually, quarterly, monthly).

What is calibration

Calibration is defined as a scientific and systematic method of identifying deviations (error) in a instrument by comparing with a master, having higher accuracy and rational traceability.

It is also referred as checking the integrity of an instrument, alternately ascertaining whether the instrument is fit enough to be used for measurement.

The instrument calibration is carried out as per (ISS) Indian Standard Specification published by the Bureau of Indian standards (BIS), which also gives the permissble error, that can be allowed in the relavant standard for each instrument.

Calibration is mandatory in most of the global quality standards and is covered under a special clause called measuring system analysis (MSA) for automobile industry standard ISO/TS 16949. Calibration should be carried out by an accredited laboratory or by following relevant documents of the certifying agency, NABL India (National Accreditation Board for calibration testing laboratries, the accrediting body in our country.

A part from following the standard specification for calibration of an instrument, the environmental condition of the lab is critical with respect to temperature, humidity, vibrations proper lighting, magnetic interference etc., which are specified in IS:199 or the NABL document, essential criteria for the calibration lab, which should adopt the

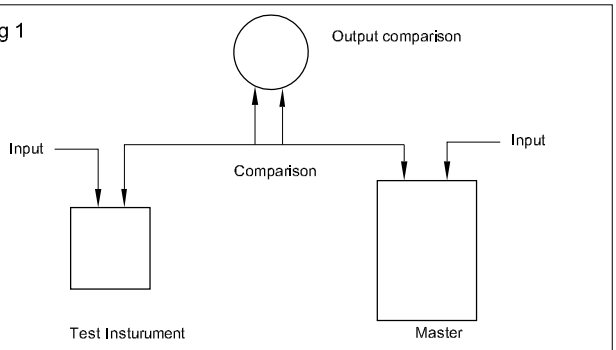
quality system standard (QSS) as per ISO/IEC/170235 - 2015. The vital factor in calibration of an instrument is the frequency of calibration, which is determined based on the importance & criticality of the measurement process.

A good calibrated instrument will maintain both precision & accuracy, the essential requirement of any measuring system

Calibration of your measuring instruments has two objectives. It checks the accuracy of the instrument and it determines the traceability of the measurement. In practice, calibration also includes repair of the device if it is out of calibration. A report is provided by the calibration expert, which shows the error in measurements with the measuring device before and after the calibration.

To explain how calibration is performed we can use an external micrometer as an example. Here, accuracy of the scale is the main parameter for calibration. In addition, these instruments are also calibrated for zero error in the fully closed position and flatness and parallelism of the measuring surfaces. For the calibration of the scale, a calibrated slip gauge is used. A calibrated optical flat is used to check the flatness and parallelism.

Fig 1



CALIBRATOR - Schematically Explained
Input = Same-both to TMI & Master
Output = deviation of error

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Mechanical fasteners

Objectives: At the end of this lesson you shall be able to

- **define mechanical fasteners**
- **classification of fasteners**
- **state the application of various fasteners & their uses.**

Definition

A mechanical fastener is a device that mechanically joins two (or) more components together easily and also can be dismantled without damaging any components using hand tools (or) power tools.

Classification

According to the need and usage they are classified into three categories.

- Temporary (or) removable fasteners
- Semi permanent fasteners
- Permanent fasteners

Temporary (or) removable fasteners

- The fasteners like bolts, nuts, screws, studs etc., enable us to join two (or) more components easily and also can be dismantled without damaging any component using hand tools (or) power tools.
- The most common types of male fasteners used in industry are hexagonal head, square head, flat (or) counters sunk head, round head, socket head (or) allen head, button head and socket set screws etc.
- The most common types of female fasteners (ie nuts) used in industry are regular hexagonal nut, square nut, round nut and nylon ring elastic stop nuts etc.

Uses

These types of fasteners are used for assembling two (or) more components together to make a sub-assembly (or) to make a full assembly.

Semi permanent fasteners

The fasteners like rivets are used to hold the plates (or) steel sections firmly. The rivets are placed through the pre drilled appropriate holes in parts to be joined (or) assembled.By using rivet sets, the tail part of the shank is formed into the head closing the hole.

The plates are held between the heads on cooling. Rivet is a cylindrical rod either carbon steel (or) wrought iron (or) non-ferrous metal. It consists of a head and shank tapering at the end facilitating easy placement in the rivet holes. During dismantling the rivets may be drilled to remove the plates already joined together without spoiling them. This process is a permanent as well as a semi-permanent in nature. According to the head type the rivets are called snap head, pan head, countersunk head, flat head etc.

Uses

Rivets are used in ship building, bridge girders, structural towers, goods wagons, boilers and heavy pressure vessels industry and also for small scale applications too.

Permanent fasteners

Arc welding, gas welding and brazing are the operations used in industry during permanent fastening of components and structures. Once the arc welding, gas welding and brazings has been done, the components (or) the structures cannot be separated without damage, hence these type of fastening is called permanent fastening.

Uses

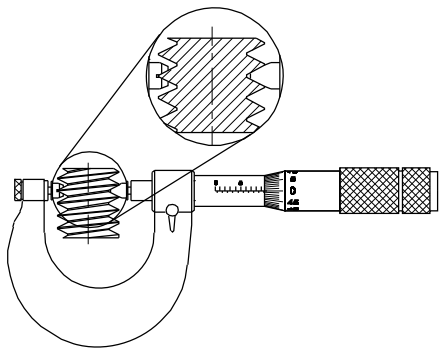
To hold steel plates (or) structures together like goods wagon building, ship building, bridge structures assembling etc. Sometimes before doing welding the components (or) the parts hold together with temporary fasteners like bolts, nuts, screws, rivets etc.

Screw thread micrometer - Thread measurement (effective diameter) using screw thread micrometer

Objectives: At the end of this lesson you shall be able to
- **state the features of a screw thread micrometer**
- **state the features of the three-wire system of measurement with the help of tables**
- **select the best wire with the help of tables for using in the three-wire method.**

The Screw thread micrometer: This micrometer (Fig 1) is used to measure the effective diameter of the screw threads. This dimension is important, because the area of the thread flanks in the vicinity of the pitch line is where the greatest transmission of force occurs between mating threads.

Fig 1



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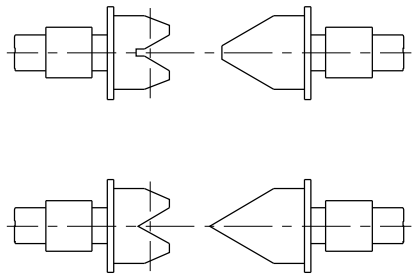
This is very similar to the ordinary micrometer in construction but has facilities to change the anvils.

The anvils are replaceable and are changed according to the profile and pitch of the different systems of threads. (Figs 2 & 3)

Fig 2



INTERCHANGEABLE ANVILS

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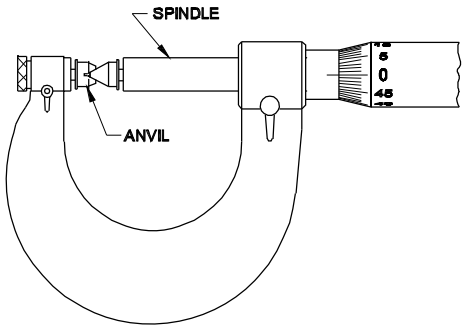
Fig 3



SPINDLE AND ANVIL OF MICROMETER AT ZERO SETTING

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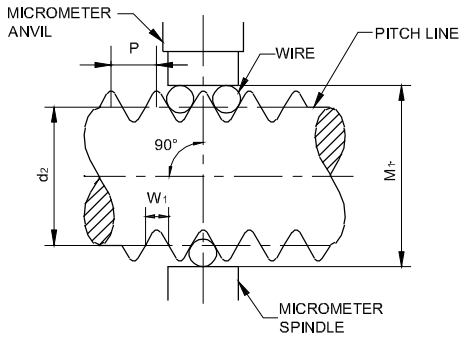
The three-wire method: This method uses three wires of the same diameter for checking the effective diameter and the flank form. The wires are finished with a high degree of accuracy.

The size of the wires used depends on the pitch of the thread to be measured.

For measuring the effective diameter, three wires are suitable placed between the threads. (Fig 4)

Fig 4



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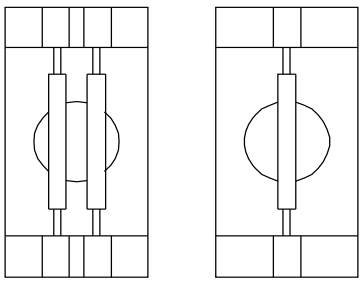
The measuring wires are fitted in wire-holders which are supplied in pairs. One holder has provisions to fix one wire and the other for two wires. (Fig 5)

Fig 5



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While measuring the screw thread, the holder with the one wire is placed on the spindle of the micrometer and the other holder with two wires is fixed on the anvil. (Fig 6)

Selection of 'best wire' (Fig 7)**:** The best wire is the one which, when placed in the thread groove, will make contact at the nearest to the effective diameter. The selection of the wire is based on the type of thread and pitch to be measured. The selection of the wire can be calculated and determined but readymade charts are available from which the selection can be made.

Fig 6

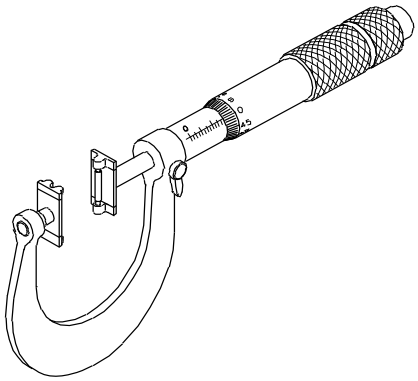

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Fig 7

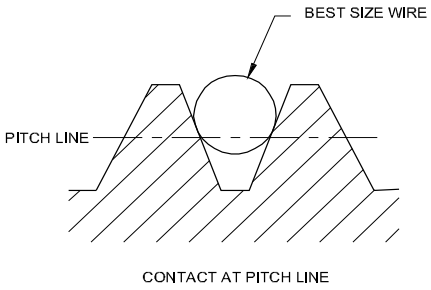

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Table 1

Measurement with measuring wires. Metric threads with coarse pitch (M)

Thread designation	Pitch P (mm)	Basic measurement mean d_2 (mm)	Measuring wire dia. W_1 (mm)	Dimension over wire M_1 (mm)
M1	0.25	0.838	0.15	1.072
M 1.2	0.25	1.038	0.15	1.272
M 1.4	0.3	1.205	0.17	1.456
M 1.6	0.35	1.373	0.2	1.671
M 1.8	0.35	1.573	0.2	1.870
M 2	0.4	1.740	0.22	2.055
M 2.2	0.45	1.908	0.25	2.270
M 2.5	0.45	2.208	0.25	2.569
M 3	0.5	2.675	0.3	3.143
M 3.5	0.6	3.110	0.35	3.642
M 4	0.7	3.545	0.4	4.140
M 4.5	0.75	4.013	0.45	4.715
M 5	0.8	4.480	0.45	5.139
M 6	1	5.350	0.6	6.285
M 8	1.25	7.188	0.7	8.207
M 10	1.5	9.026	0.85	10.279
M 12	1.75	10.863	1.0	12.350
M 14	2	12.701	1.15	14.421
M 16	2	14.701	1.15	16.420
M 18	2.5	16.376	1.45	18.464
M 20	2.5	18.376	1.45	20.563
M 22	2.5	20.376	1.45	22.563
M 24	3	22.051	1.75	24.706
M 27	3	25.051	1.75	27.705
M 30	3.5	27.727	2.05	30.848

Table 2

Measurement with measuring wires. Metric threads with fine pitch (M)

Thread designation	Basic measurement d_2 (mm)	Measuring wire dia.mean W_1 (mm)	Dimension over wire M_1 (mm)
M 1 x 0.2	0.870	0.12	1.057
M 1.2 x 0.2	1.070	0.12	1.257
M 1.6 x 0.2	1.470	0.12	1.557
M 2 x 0.25	1.838	0.15	2.072
M 2.5 x 0.35	2.273	0.2	2.570
M 3 x 0.35	2.773	0.2	3.070
M 4 x 0.5	3.675	0.3	4.142
M 5 x 0.5	4.675	0.3	5.142
M 6 x 0.75	5.513	0.45	6.214
M 8 x 1	7.350	0.6	8.285
M 10 x 1.25	9.188	0.7	10.207
M 12 x 1.25	11.188	0.7	12.206
M 14 x 1.5	13.026	0.85	14.278
M 16 x 1.5	15.026	0.85	16.278
M 18 x 1.5	17.026	0.85	18.277
M 20 x 1.5	19.026	0.85	20.277
M 22 x 1.5	21.026	0.85	22.277
M 24 x 2	22.701	1.15	24.420
M 27 x 2	25.701	1.15	27.420
M 30 x 2	28.701	1.15	30.419

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