

Different types of micrometer, outside/inside and sources of error

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

- **identify and name the different types of micrometers other than regular micrometers**
- **state the specific use of each micrometer.**

In addition to regular micrometers, there are several other types of micrometers, with the same fundamental principle, but specifically designed to meet the various special applications, such as external, internal, depth measurement etc.

Types of micrometers other than regular

Screw thread micrometer

Tube micrometer

Digital micrometer

Depth micrometer

Flange micrometer

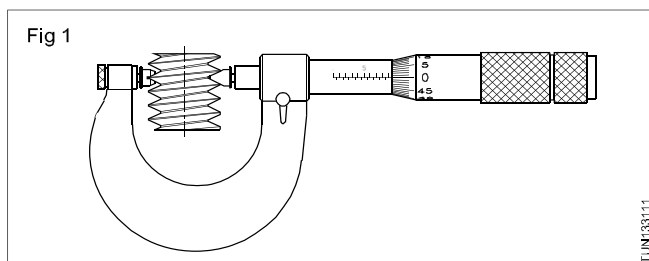
Ball micrometer

Stick micrometer

External micrometer with interchangeable anvils

Keyway depth micrometer

Screw thread micrometer (Fig 1)



A screw thread micrometer is similar to an outside micrometer except that the spindle is pointed to fit between 60° V threads, and the anvil is shaped to fit over 60° V thread. It is used to measure the pitch diameter of the thread. Screw thread micrometers are available in many sizes depending on the pitch of the thread to be measured.

Tube micrometer (Fig 2)

A tube micrometer is specially designed to measure the thickness of the material of piping, tubing and other parts of similar shapes.

Digital micrometer

This type of micrometer has got a dial on the frame of the micrometer and an illuminated screen below it. The dial pointer has an internal connection with the micrometer screw for measuring. The graduations on the sleeve and thimble are the same as on a regular micrometer. This micrometer is used to measure the dimensions similar to those measured by the outside micrometers, and the reading can be noted. (Fig 3)

Fig 2

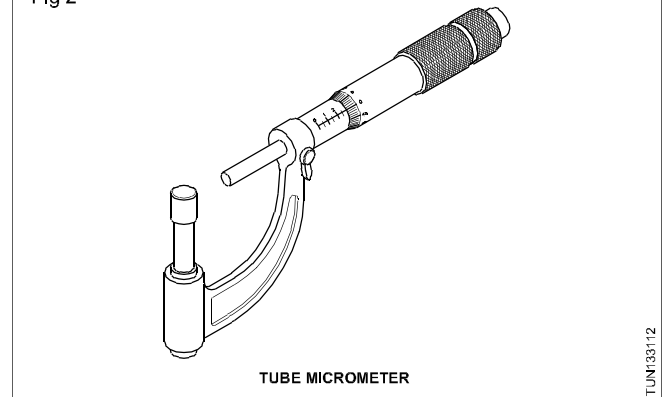
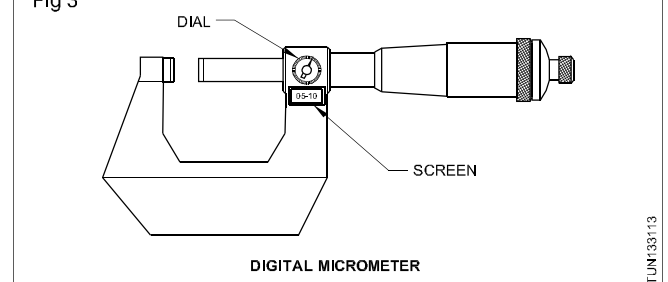


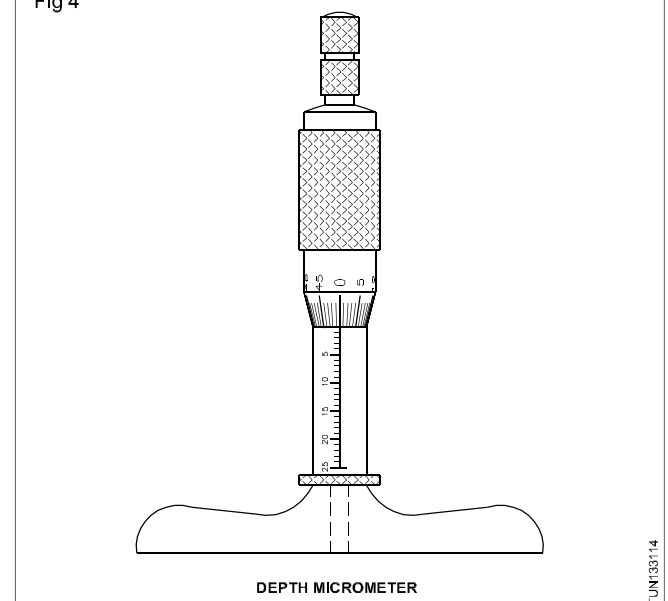
Fig 3



The advantage of this micrometer is, the readings are seen on the screen or the dial directly, without any difficulty. We need not look on the sleeve or the thimble scale coincidence. This avoids errors in reading and saves time. A layman can also read the measurement directly.

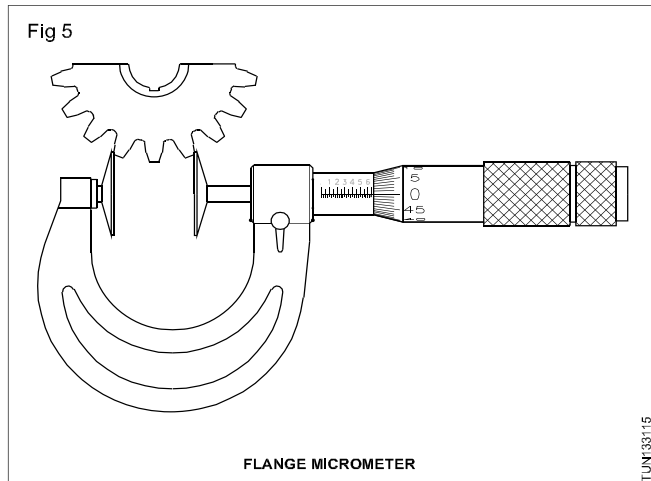
Depth micrometer (Fig 4)

Fig 4



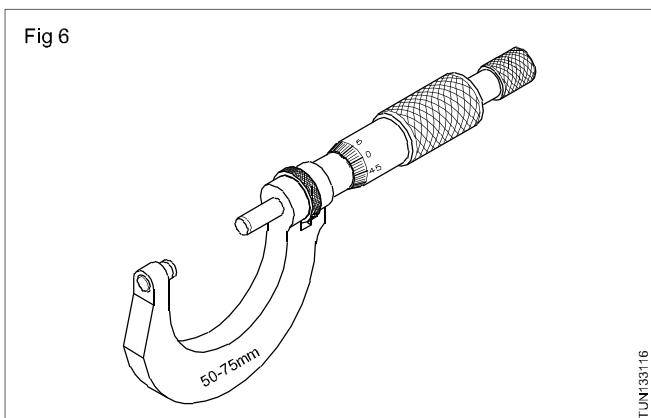
A depth micrometer is designed to measure accurately the depth of grooves, bores, counterbores, recesses and holes. The graduations are read in the same manner as is done in the case of regular micrometers. Larger ranges of depth can be measured by inserting an extension rod through the top of the micrometer. The graduations are in the reversed direction to those of an o/s micrometer.

Flange micrometer (Fig 5)



A flange micrometer is similar to a regular micrometer and is equipped with two flanges in the place of the anvil and spindle. This is used to measure chordal thickness of the gear teeth and the thickness of the fins of an engine and the collar thickness of the job.

Ball micrometer (Fig 6)



In this form of micrometer, hemispherical balls are fitted at the anvil and spindle. Measurement is similar to that in a regular micrometer. It is used to measure a sphere where the point of contact comes in between.

Stick micrometer

Stick micrometers are designed for the measurement of longer internal lengths.

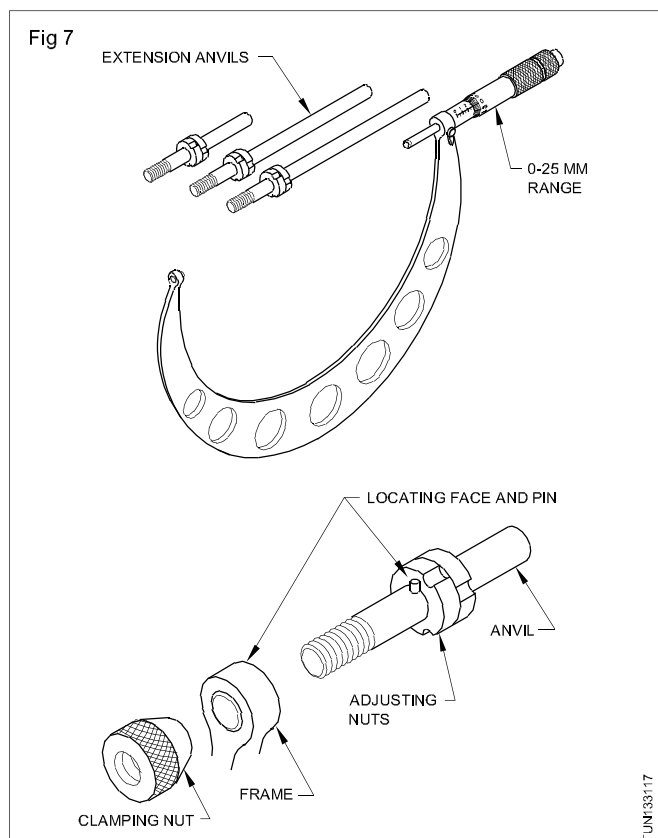
This comprises of:

- a 150 mm or 300 mm micrometer unit, fitted with a micrometer of 25 mm range and having rounded terminal faces
- a series of extension rods, which together with the micrometer unit, permits a continuous range of measurement up to the maximum length required.

Secured joints are used for joining the end piece, extension rod and the measuring unit. The screw unit generally has threads of 0.5 mm pitch. The extension rod is generally hollow and has a minimum external diameter of 14 mm.

In this type of micrometer, there should be sufficient play between the external and internal threads of the joint to permit the abutment forces of the various parts of the micrometer to butt together solidly.

External micrometer with interchangeable anvils (Fig 7)



It is nothing but an external micrometer. The advantage in this micrometer is the range of the micrometer can be increased by merely changing the different anvils.

A set of replaceable anvils is supplied in a box and the size of the anvil is marked on each anvil. Depending upon the size of the job, the anvil size can be changed, and reading can be taken. Thus it is an economy micrometer, i.e. in one micrometer itself, long ranges can be accommodated. To fix the anvils to the frame, a guide is provided and locked by a nut.

Keyway depth micrometer

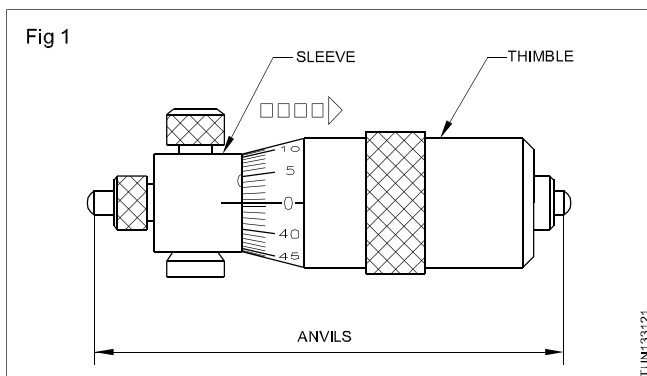
It is similar to a depth micrometer except that the frame has 120° inclined butting surfaces to rest on the circumference on a cylindrical job. It is used for measuring depth of keyways on a cylindrical shaft. While measuring the depth of the keyway, first take the measurement on a cylindrical job opposite to the keyway; then take the measurement of the keyway depth, subtract the initial measurement from the final measurement to know the exact depth of the keyway.

Inside micrometer - metric

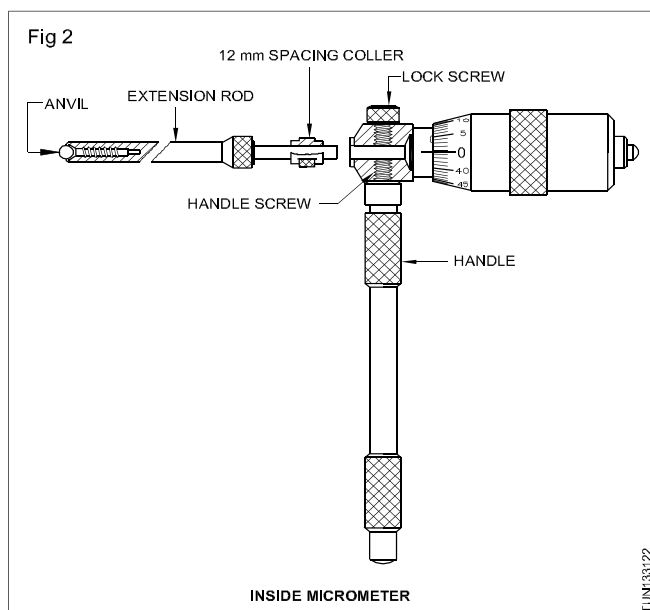
Objectives : At the end of this lesson you shall be able to

- name the parts of an inside micrometer
- determine the reading of the bore or hole
- determine the reading with a spacing collar & extension rods
- determine the distance between internal parallel surfaces.

The inside micrometer is similar to an ordinary outside micrometer but without the 'U' frame. (Fig 1) The measurement is taken over the contact points. As the thimble opens or closes, the contact points get opened or closed. The inside micrometer consists of a sleeve, thimble, anvils, a spacing collar and extension rods. It is also equipped with a handle to measure deep bores. The least count of the instrument is also 0.01 mm



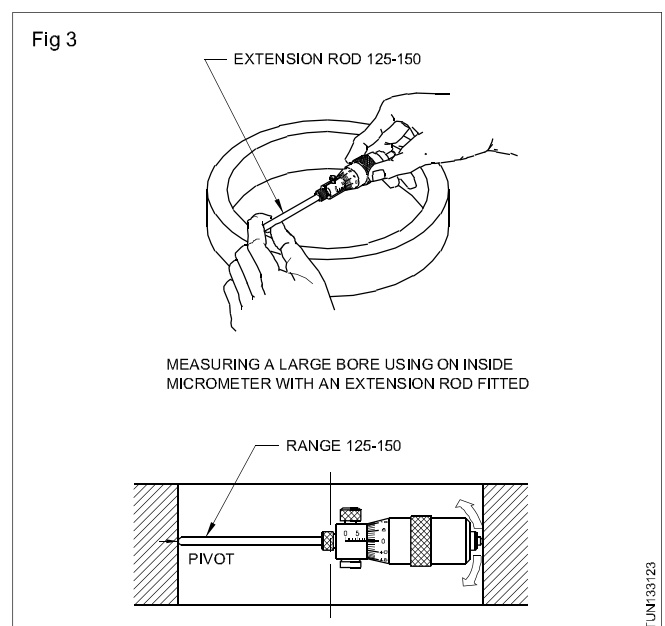
The inside micrometer is equipped with a 12mm spacing collar and 4 extension rods for measuring holes of ranges. 50-75mm, 75-100 mm, 100-125mm and 125-150mm. The sleeve is marked with the main scale and the thimble with the thimble scale. The barrel has a limited adjustment of 13mm. when the inside micrometer is closed (when zero of thimble coincides with the zero of the barrel), it is capable of reading the minimum dimension of 25mm. In addition to this, it is possible to read up to 38mm with the thimble opening to the extreme right. In order to read further higher ranges, a standard spacing collar of 12mm width is to be added. This facilitates the micrometer to read a minimum range of 50mm (Fig 2).



Similarly, each extension rod has to be used without the collar for measuring a minimum range up to 13mm variation and with the collar for a maximum range of measurements. a clamping screw is also provided to clamp the extension rod firmly.

Determining the size of a bore or hole

Fig 3 shows an inside micrometer with a spacing collar and extension rod of 125-150mm range. The size of the bore is 125mm + 12mm + barrel reading + thimble reading which is equal to $125 + 12 + 1.5 + 0.00 = 138.50\text{mm}$.



Determining the distance between internal parallel surfaces

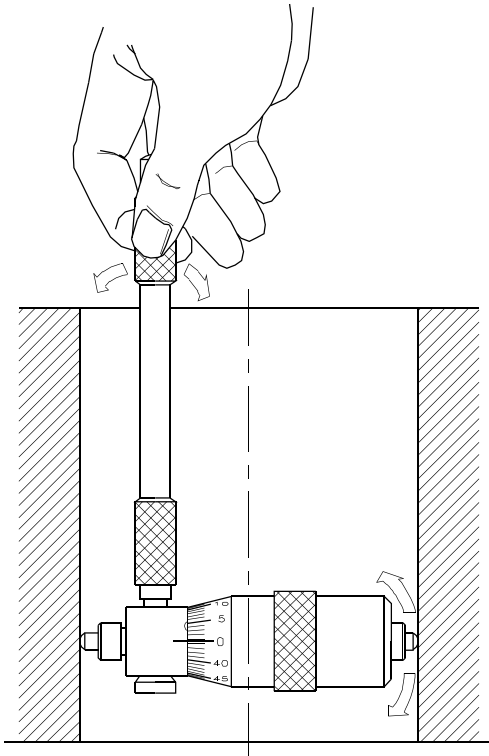
While checking parallelism between two surfaces of a deep bore, a handle must be used along with the inside micrometer. The figure shows the inside micrometer with a handle. In order to ascertain the parallelism., a minimum of two readings has to be taken, i.e. one at the top surface of the bore. If there is no difference in the two readings, we may take it for granted that the surfaces are perfectly parallel. Any variation in the reading shows the bore has an error between the two surfaces. (Fig 4)

Three point internal micrometer (Fig 5)

A three-point internal micrometer is used for a direct measurement of an internal diameter accurately and efficiently. It is also used to measure the diameter of a deep hole, the end of a blind hole, internal recess etc.

The instrument is checked for its zero error with a master ring gauge. (Fig 6)

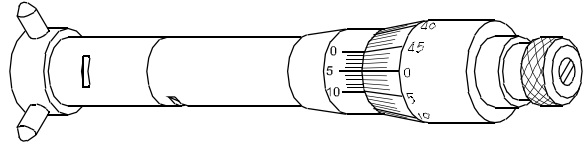
Fig 4



USING AN EXTENDED HANDLE WHEN MEASURING THE BORE OF A SLEEVE BEARING

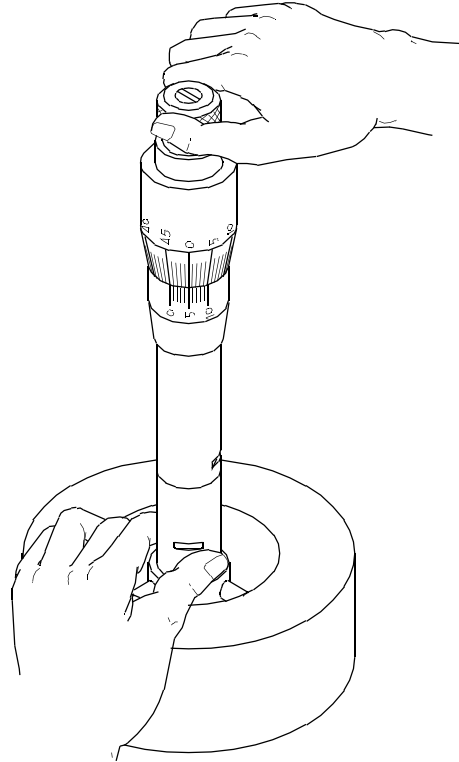
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Fig 5



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Fig 6



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Three-point internal micrometer

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

- state the uses of a three-point internal micrometer
- identify the parts of a three-point micrometer
- state the features of a three-point micrometer.

The three-point internal micrometer (Fig 1) is useful for :

- measuring the diameters of through and blind holes
- checking cylindricity and roundness of bores.

The commonly used three-point internal micrometers have a least count of .005mm

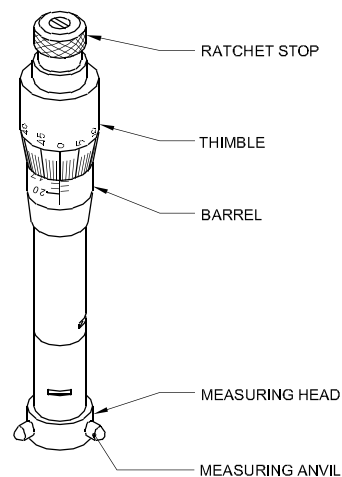
Parts

- The measuring head (consisting of three measuring anvils)
- Ratchet stop
- Thimble
- Barrel

This micrometer has a cone spindle which advances when the thimble is rotated clockwise. The movement of the cone spindle makes the measuring anvils to move forward

and backward uniformly. The three measuring anvils facilitate self-alignment of the instrument within the bore.

Fig 1

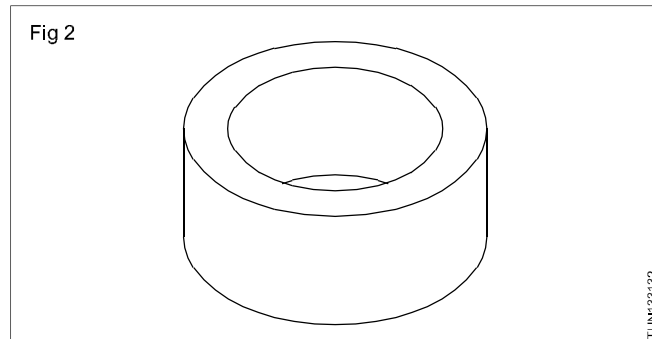


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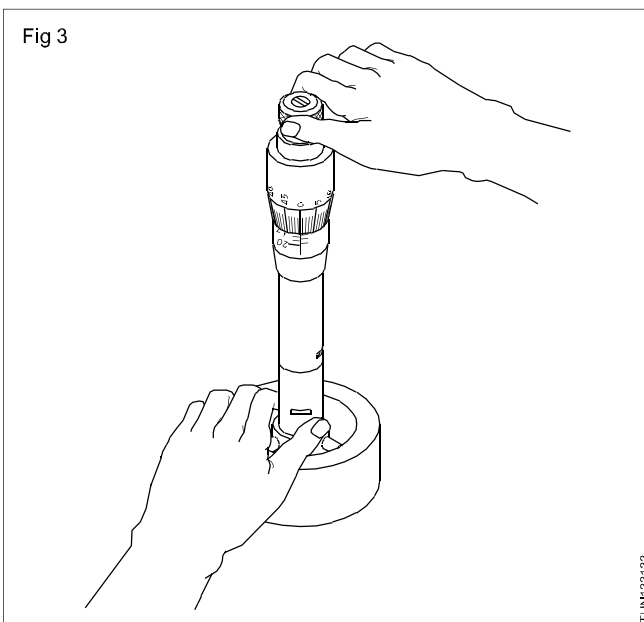
Three-point internal micrometers are available in sets. Each set consists of 3 or 4 micrometers. The measuring range of each of them will be 10mm.

The ratchet stop permits uniform pressure between the anvils and the work surfaces being measured.

These micrometers are provided with one or more zero setting rings. (Fig 2)



Before taking measurement, the zero setting has to be checked using the setting ring. (Fig 3)

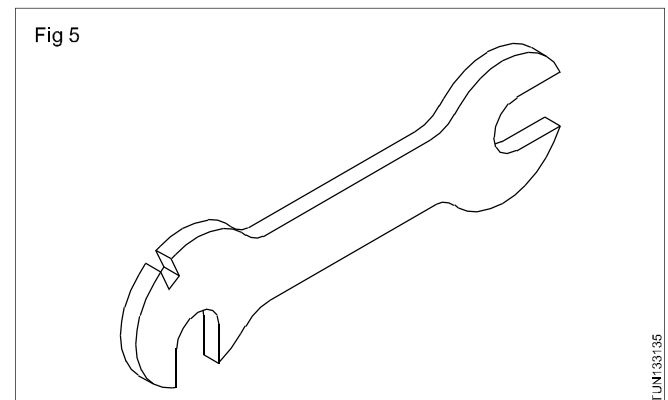
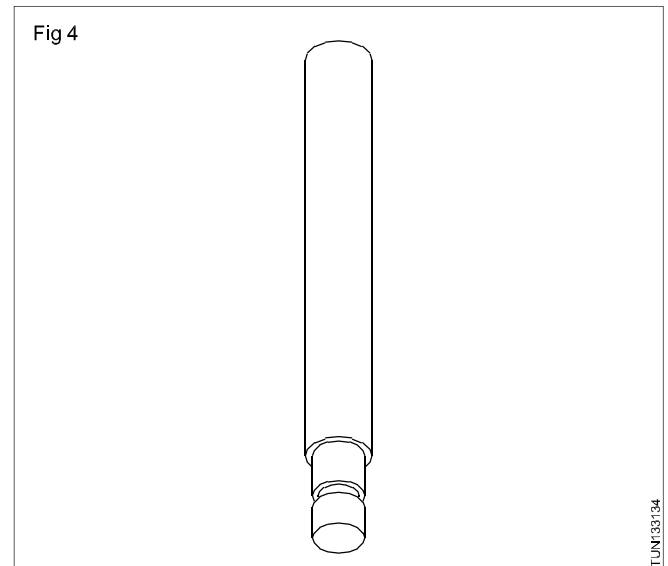


The position of the anvil can be reset by loosening the barrel using a screw driver provided for this purpose.

Depending on the depth of the bore the length of the micrometer can be varied using the extension rod. (Fig 4) A set of spanners is provided for assembling and disassembling the extension rod. (Fig 5)

The instruments are available in various sizes and forms for measuring different sizes.

They are also available in analogue or digital readouts.



Sources of measuring errors

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

- state what is meant by measuring errors
- name the different types of measuring errors
- identify each of the measuring errors.

Measuring errors occur each time when we measure a workpiece. We must, therefore, always allow for a certain inaccuracy when we measure a workpiece. The degree of this inaccuracy depends on the skill of the person measuring it and the inaccuracy of the measuring instrument.

Measuring errors can be grouped as follows.

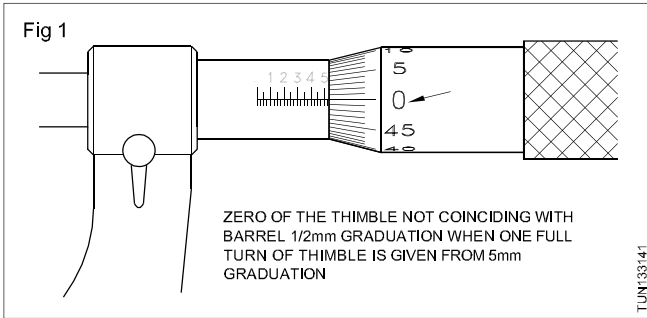
- Systematic errors
- Random errors
- Geometrical errors
- Contact errors
- Gauge and instrument errors
- Elastic deformation
- Parallel errors
- Observation errors
- Cosine errors
- Temperature errors

Systematic errors

Measuring errors which are due to the measuring instrument are known as systematic errors. The systematic errors can be subdivided into:

- known systematic errors
- unknown systematic errors.

The known systematic errors are those which always influence the measuring result to the same extent and in the same direction (+ or -); for example, a subdividing error for a scale as shown here. The value to be read off here can then be corrected. (Fig 1)



The unknown systematic errors give different values in different directions (+ and -) in different measurements. An example of this type of error is errors due to friction changes in the measuring instrument.

The result of all the unknown systematic errors is referred to as the degree of inaccuracy of the measuring device.

Random or accidental errors

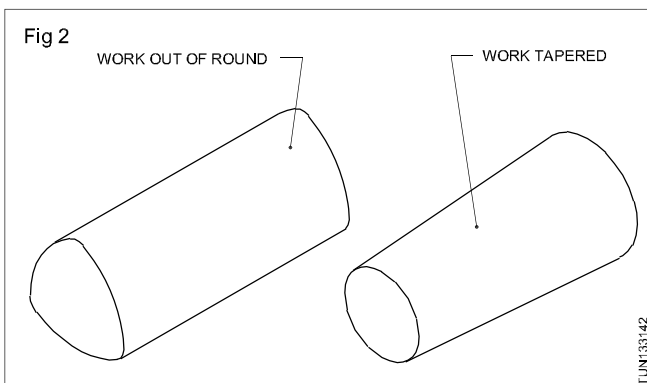
Random errors are caused by external conditions, such as differences in temperature, air humidity, dirt and vibrations and also the human factor such as viewing errors and fatigue.

Geometric errors

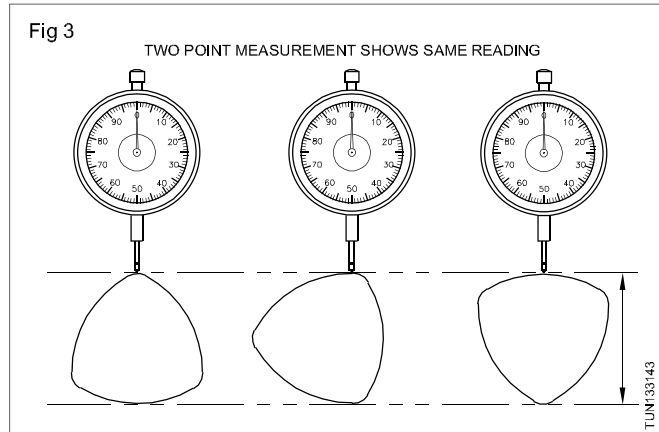
Geometric errors can be subdivided into:

- macro-geometrical errors
- micro-geometrical errors.

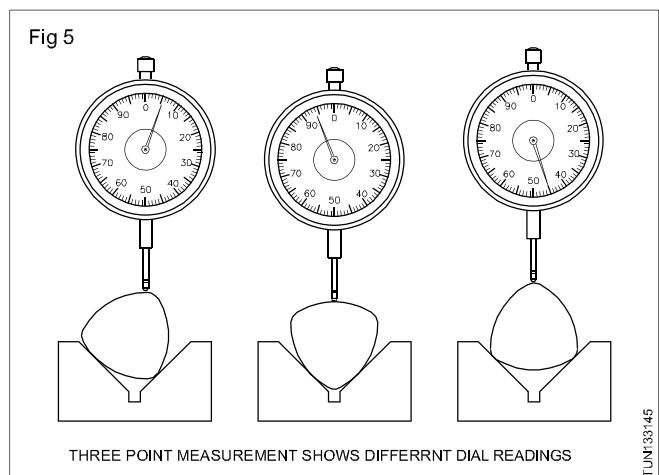
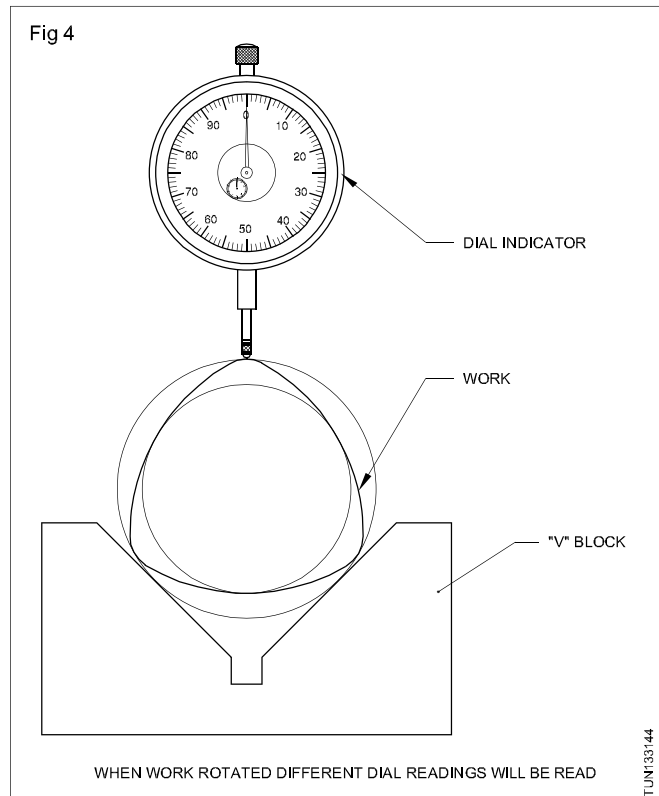
Macro-geometrical errors occur when the workpiece measured does not correspond to the theoretical form indicated in the drawing. For example, when a cylinder is tapered or out of round as shown in Fig 2, it results in a macro-geometrical error.



This type of error cannot be detected with the two point measurement as shown in Fig 3.

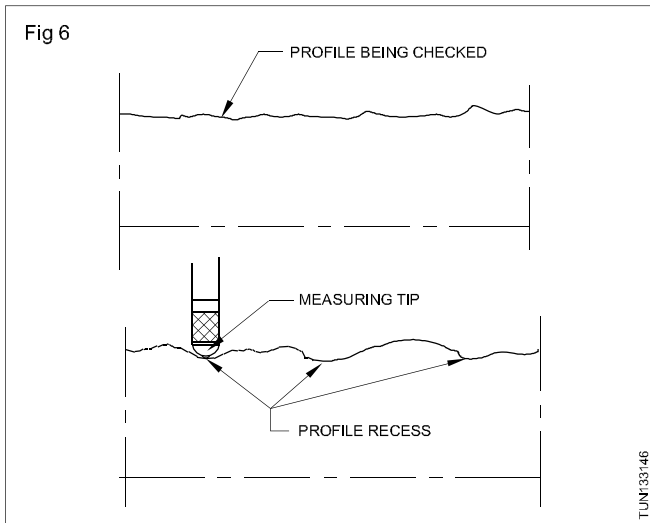


By placing the shaft on a 'V' block (three point measurement), this defect can be immediately noticed. (Figs 4 and 5)



This error can also occur when measuring holes.

Micro-geometrical errors are due to surface roughness. In the case of a surface with considerable profile depth, the measuring tip could drop down in a profile recess, thereby giving a faulty reading. (Fig 6)

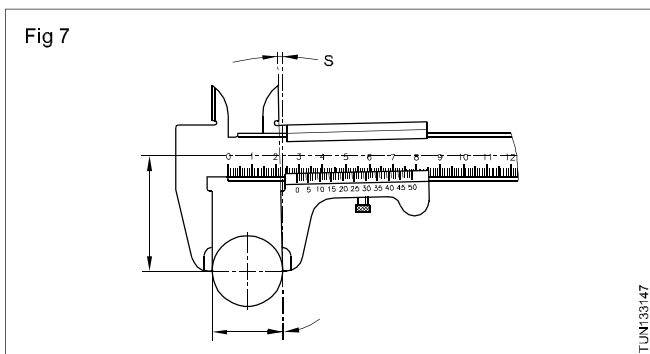


Contact errors

Impurities between the measuring tip and the workpiece being measured can often cause measuring errors. In order to eliminate the contact errors (considered quite serious), always keep the measuring instruments clean.

Gauge and instrument errors

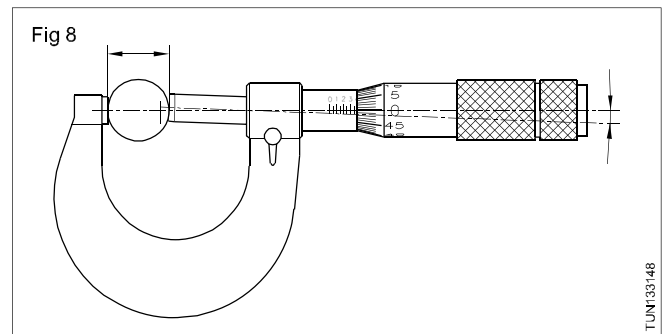
In the case of the vernier caliper, the measurement is parallel but not in line with the scale. (See the distance 's' on the illustration). A play between the movable jaw and the main scale can, in this case, produce an error which could have a considerable effect on the result. (Fig 7)



In the case of a micrometer an angular error is negligible but a parallel error will occur. Other errors that come under this heading are errors due to changes in friction, and backlash in measuring instruments. (Fig 8)

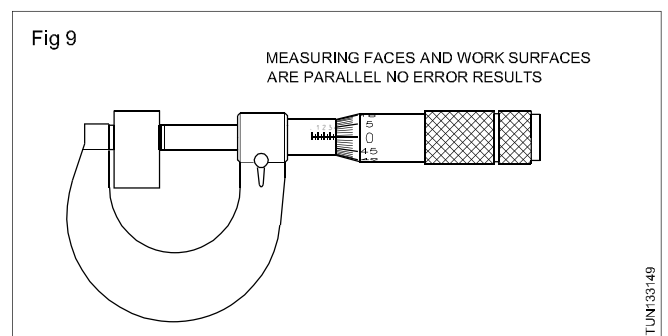
Elastic deformation

In order to keep the elastic deformation within reasonable limits, the indicator stands, measuring clamps and measuring fixtures must be robustly constructed. By using a small and constant measuring force, this error can also be brought to a minimum. Eg. the ratchet drive provided in micrometers.



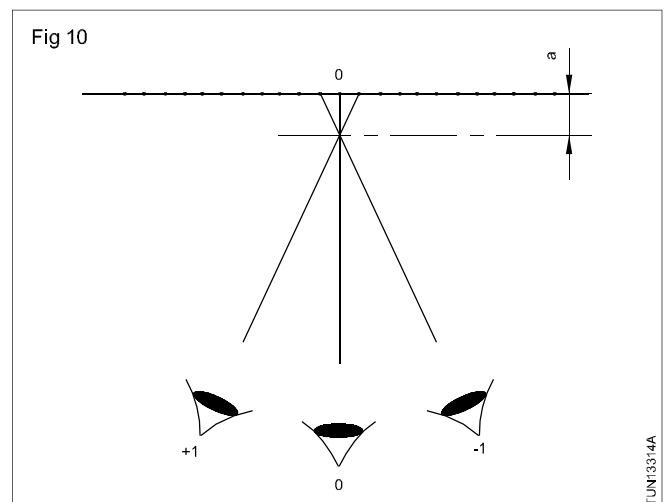
Parallel errors (Fig 9)

If measurement is being carried out between two flat measuring surfaces, these must be parallel to each other. If the measuring workpiece surfaces are not parallel to each other, parallel errors will result. By using a spherical measuring tip against a flat surface to be measured, parallel errors can be avoided.



Observation errors (Fig 10)

Parallax errors occur in connection with the reading of scales and instruments with dial indicators. The error depends on the fact that the pointer has a certain distance 'a' from the scale. If viewed from one side instead of from straight ahead as you should do, the pointer appears to show a larger or smaller reading.



Temperature errors

The change in temperature can cause major measuring errors. For this reason 20°C has been set as the reference temperature for measurements.

Cosine errors (Fig 11)

A cosine error occurs when the plunger/lever of the measuring instrument is not parallel with the workpiece being measured.

It may be noted that the movement of the dial indicator hand depends on the movement of the plunger or lever.

An inclination of the plunger, as shown in the figure, would need additional movement of the plunger for a distance. X is the deviation of the component perpendicular to the surface of the work, and naturally the dial indicator will show a reading of X_a . (X_a is the plunger movement.)

Fig 11

