DIESEL MECHANIC

MINING QUALIFICATIONS AUTHORITY

CODE: MMI

USE MEASURING INSTRUMENTS

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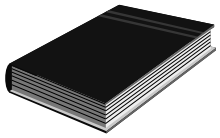
TRG 9

INDEX

The following elements are contained in this learning guide:

SOURCE REFERENCES



Instrument manuals.

OBJECTIVE

You will be learning towards the outcome “Use measuring instruments”. Whilst learning towards the outcome you will be required to achieve the following:

- Use the various measuring instruments to measure and mark off work pieces.

On completion of this module, the learner must be able to:

- Select the correct instruments to measure a selection of test pieces to within specified accuracy limits.
- Use a surface gauge to mark off a keyway on a shaft.

During this process you must adhere to certain specified requirements as listed in the Module.

ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you are able to achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- A practical test will be set at the end of the module and must be completed without using references.
- The learner will be given twelve test pieces and must select the correct measuring instrument to measure each test piece to the accuracy specified for each.
- The learner will also be required to mark off a keyway on a shaft using a surface gauge. The dimensions must be correct to within ±0.25 mm.
- There must be no damage to instruments or equipment.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM

MMI

USE MEASURING INSTRUMENTS

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
1. Use measuring instruments to measure the dimensions of objects.	• Improper or careless handling of measuring instruments can lead to damaged instruments.	• Always handle measuring instruments, especially precision instruments, correctly and with great care. • Wipe instruments clean after use and store in their appropriate packing cases in a safe place.

NOTE: Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of learner: _____

Signature of Training Officer: _____

Date: _____

1. INTRODUCTION

ITEM / TASK: Accuracy of measuring instruments.

DESCRIPTION:

A. Measuring instruments can be precision or semi-accurate instruments.

- A **precision instrument** is one, which measures to an accuracy of between 0.01 mm to 0.05 mm.
- A **semi-accurate instrument** is a measuring instrument that is used to transfer sizes or where the reading is not directly obtained.

See Table 1 for more information regarding the accuracy of the various instruments that will be dealt with in this module.

TABLE 1: MEASURING INSTRUMENTS

INSTRUMENT	READING	GRADUATION	ACCURACY
Plain outside micrometer	Direct	0.01mm	± 0.01mm
Plain inside micrometer	Direct	0.01mm	± 0.01mm
Plain depth micrometer	Direct	0.01mm	± 0.01mm
Telescopic gauge	Transfer	Nil	See note
Vernier callipers (Two types)	Direct	0.02mm / 0.05mm	± 0.02mm / ± 0.05mm
Outside & inside callipers	Transfer	Nil	See note
Steel rule	Direct	0.50mm	± 0.50mm
Thread angle gauge	Direct	Comparison	Actual
Thread pitch gauge	Direct	Comparison	Actual
Combination square	Direct	Degrees	± 1°
Universal bevel protractor	Transfer	Nil	See note
Vernier protractor	Direct	Degrees	5 minutes
Feeler gauge	Direct	0.01mm	± 0.03mm
Radius gauge	Direct	Comparison	Actual
Engineers square	Direct	Comparison	Actual

NB. Accuracy depends on the measuring instrument used to transfer the size.

ITEM / TASK: Care of measuring instruments.

DESCRIPTION:

A. All measuring instruments should be handled carefully.
B. Extra care must be taken with all measuring instruments.
C. Exposure to heat, even that caused by excessive handling, can result in inaccurate readings being obtained.
D. Measuring instruments should never be placed or stored where they are likely to be damaged and should always be kept in their cases when they are not in use.
E. When they are to be stored for a long period of time they should be wiped with a clean oil-soaked cloth before being stored.
F. Only the correct tools and spanners must be used when adjustments or repairs are made to measuring instruments and these should only be done by a competent person.

2. THE ENGINEER`S SQUARE

ITEM / TASK: Design features.

DESCRIPTION:

A. The engineer's square was known as a "try square" and this latter name really describes its function. The square is applied to a workpiece to "try" it for squareness.
B. The square has a blade and a stock, both of which are hardened and tempered. All of the faces are precision ground. See Fig 1.

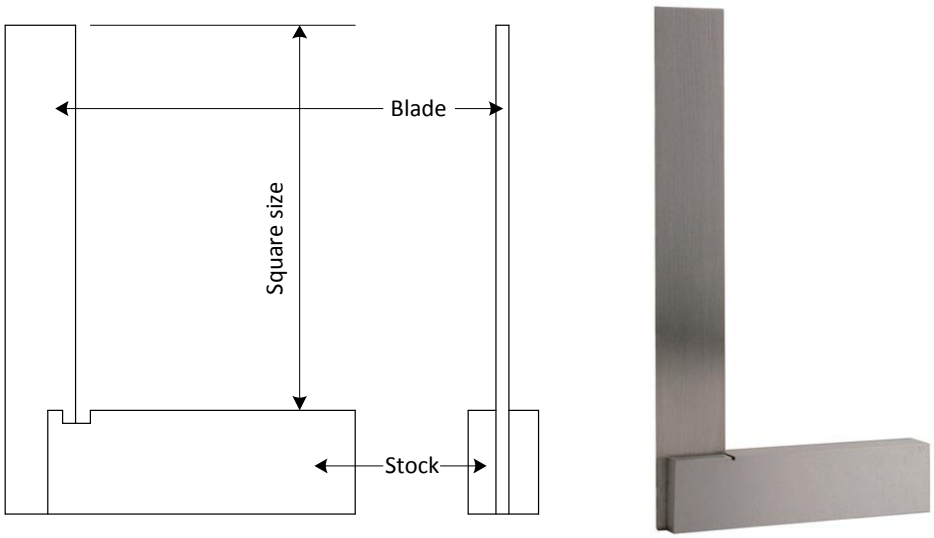


FIG 1.

ITEM / TASK: Use of the engineer's square.

DESCRIPTION:

A. Do the following to check the square for squareness if there is any doubt about the condition of the instrument:

- Place the stock of the square against the edge of the marking off table or marking off plate and scribe a line as shown for position (a) of Fig 2.

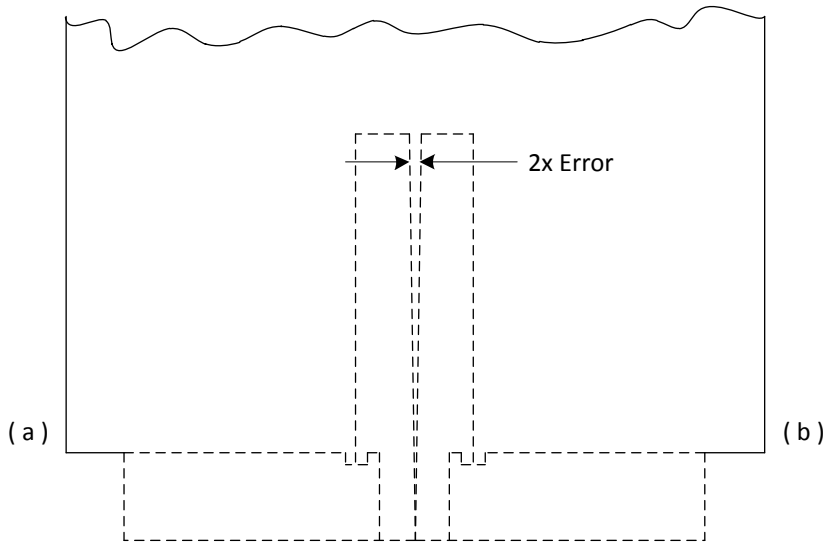


FIG 2.

- Reposition the square as shown for position (b) of Fig 2 and scribe a second line.
- If the lines do not coincide the square is faulty.

Note:

This method is quite accurate as the error is doubled on the marking table. To make precise checks, more complicated equipment is required.

B. An engineer's square is used in the following way: (See Fig 3 on the next page)

- Wipe the contact areas of the square i.e. the stock and the blade, and the surfaces of the workpiece and table before measuring for squareness or marking off.
- Place the stock of the square against the adjacent side of the side to be checked for squareness as shown in Figure 3(a).
- Slide the square down until the blade touches the top of the side to be checked as shown in Figure 3(b) and hold it up to the light.
- If light is visible between the blade and the side at points (A) or (B) in Figure 3, then the workpiece is not square.

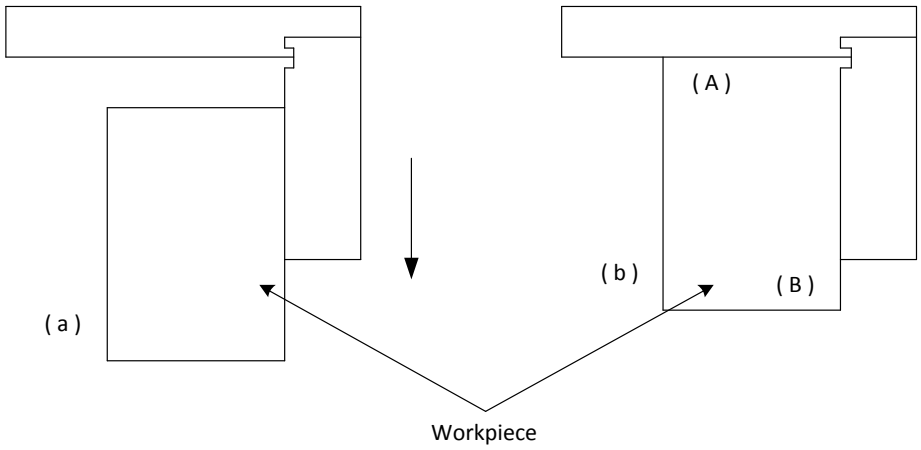


FIG 3.

C. The following method is an alternate way to use the square to check the squareness of a workpiece. Refer to Fig 4.
   - Place the workpiece on a surface plate. (Fig 4)
   - Place the square on the surface plate, slide it up close to the workpiece and measure the gap at position (a) with a feeler gauge as shown in Fig 4.
   - Hold the square firmly in position and try the same blade at position (b) as shown in Fig 4.
   - If the fit is the same, the workpiece is square. If the fit is not the same, the amount of error can be determined by trying different blades until one is found to fit.

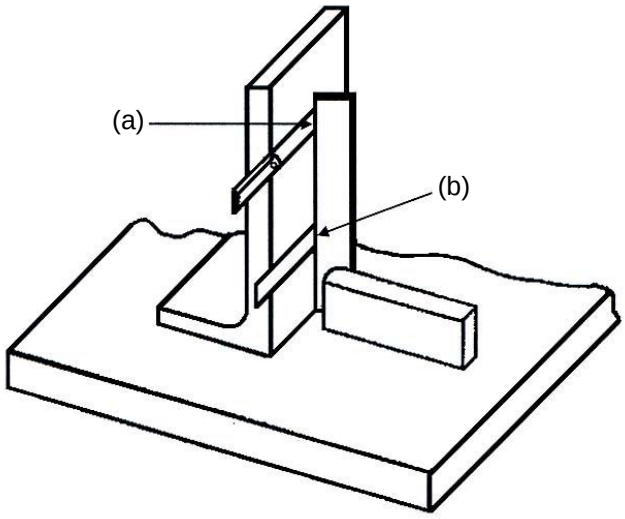


FIG 4.

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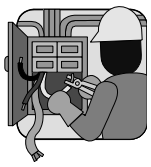


PRACTICE

The engineer's square is used frequently in your work.

You must practice checking the squareness of different work pieces **and** determine the "error of squareness" of the Engineers square.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

3. THE STEEL RULE

ITEM / TASK: Design.

DESCRIPTION:

A. Steel rules come in various lengths and widths, the most common being the 150 mm and 300 mm lengths.
B. They are usually graduated in centimetres (cm), millimetres (mm) and half millimetres as shown in Fig 5.

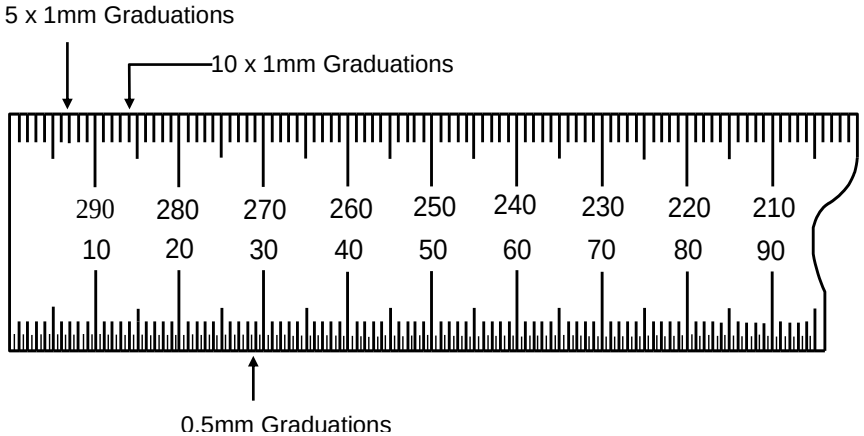


Fig 5.

ITEM / TASK: Using a steel rule.

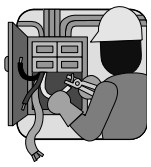
DESCRIPTION:

A. The steel rule is the most commonly used measuring instrument in the workshop, and is used for most general measurements and marking off that do not require accuracy greater than 0.5 mm.
B. When measuring dimensions up to 1 metre it is usual to express them in millimetres, e.g. 0.3 metre is usually expressed as 300 mm.

Note:

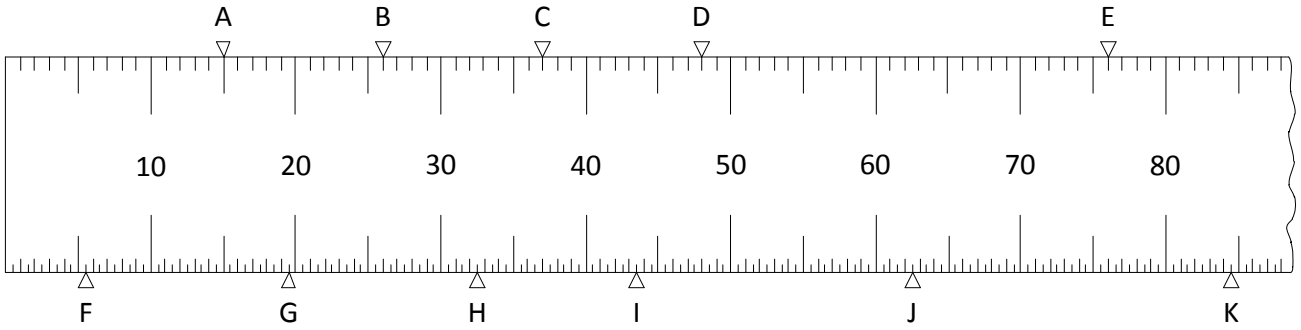
Steel rules are often abused. Remember to take care of it to ensure a long life for the instrument.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Fill in the sizes indicated by arrows on the rule in the figure below.



A	:		B	:	
C	:		D	:	
E	:		F	:	
G	:		H	:	
I	:		J	:	
K	:				

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

4. INSIDE AND OUTSIDE CALLIPERS

ITEM / TASK: Introduction.

DESCRIPTION:

Inside and outside callipers are used together with a steel rule to measure the dimensions of objects or to set inside and outside dimensions respectively.

ITEM / TASK: Construction.

DESCRIPTION:

A. The general construction of callipers can be seen in Figs 6 to 13.
   - Callipers are either spring-jointed or firm-jointed as shown in Fig 6.
   - Spring-joint callipers range in size from 75 mm to 300 mm.
   - Firm-joint callipers range in size from 75 mm to 900 mm.

B. The size range indicates the maximum dimensions that can be measured with the two types.

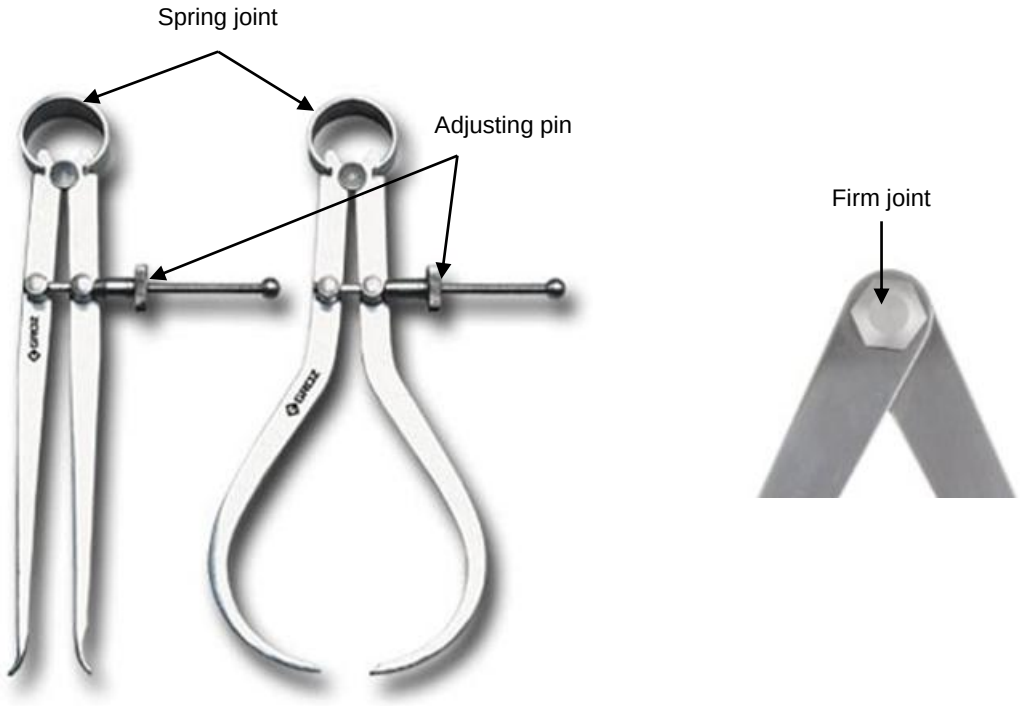


FIG 6.

ITEM / TASK: Measuring with an outside calliper.

DESCRIPTION:

A. Measuring an object.

- Open the calliper until it fits around the object to be measured.
- Close the legs. Set and move the calliper until you get a "feel" of the measurement.

N.B:

The "feel" is the slight resistance felt when the moving leg of the calliper passes over the apex of the diameter you are measuring. See Fig 7.

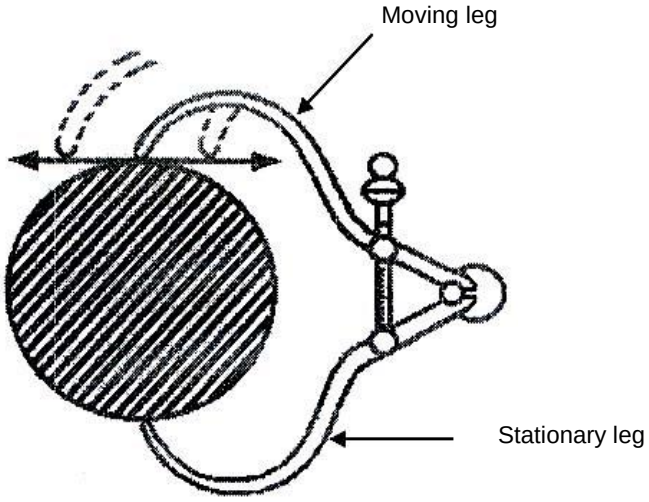
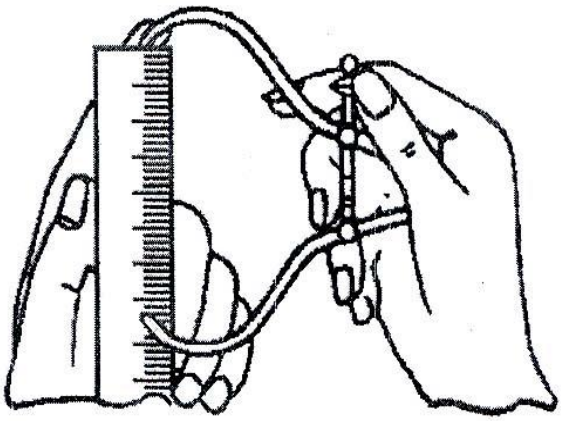


FIG 7.

- Remove the calliper and measure the size on a steel rule as in Fig 8.
- Take and check reading.



Measure the size against the rule

FIG 8.

B. Setting an outside calliper.

- Hold one leg against the end of the rule and adjust the other leg with the adjusting nut. (Fig 9)
- Support the calliper at the end of the rule.

The legs of a firm-joint calliper may be adjusted (opened or closed) by tapping one of the legs against a firm surface.

Note:

Never tap a calliper on the points**.**

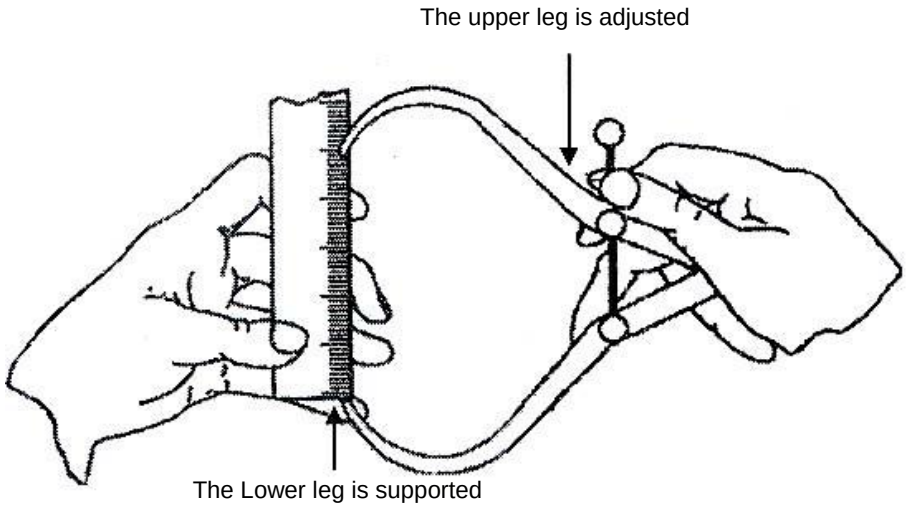


FIG 9.

ITEM / TASK: Measuring with an inside calliper.

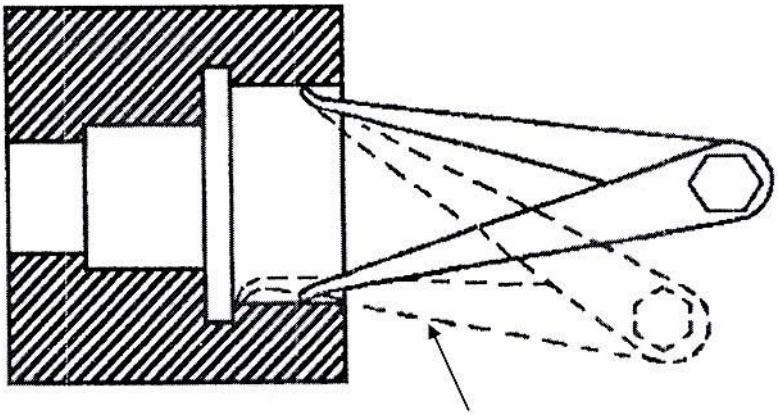
DESCRIPTION:

A. Measure an object with an inside calliper.

- Hold the calliper at the joint in one of your hands and close it sufficiently to enter the bore, which has to be measured.
- Place the calliper into the bore.
- Rock the callipers sideways and up and down (Fig 10 on the next page), while adjusting it until you get a "feel" of the size.

NB:

The "feel" is the slight resistance felt when the moving leg of the callipers passes through the apex of the bore diameter you are measuring. The mass of the callipers is usually sufficient to overcome the resistance.



Getting the “feel” of the size

FIG 10.

- Hold a rule against the stock and along the blade of the Engineers square and read the size set on the calliper as shown in Fig 11.

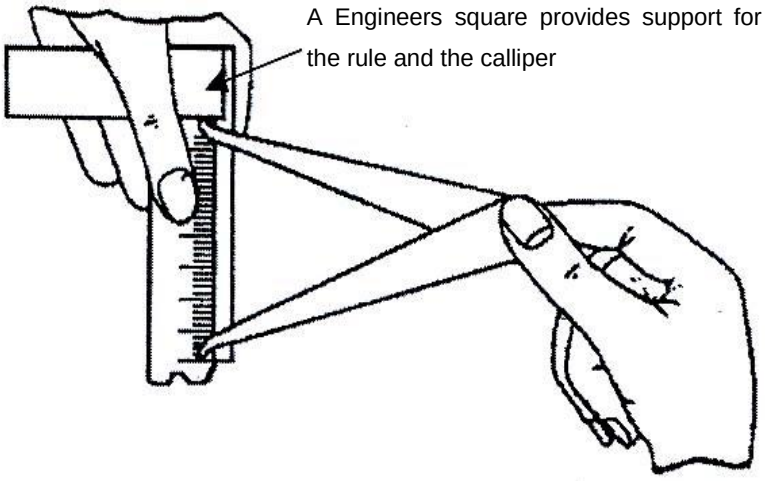


FIG 11.

Note:

The legs of a firm jointed inside calliper may be adjusted by tapping one of the legs against a solid object (Fig 12 on the next page), until the correct size is obtained. **Remember not to tap against the points of the calliper.**

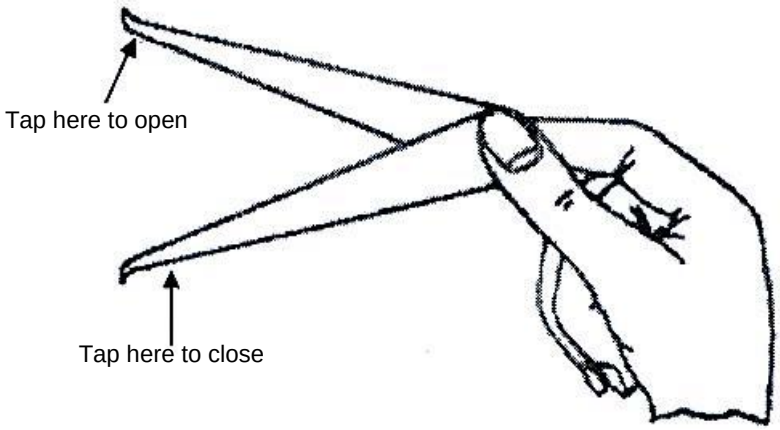


FIG 12.

B. Setting an inside calliper.

- Hold the steel rule square and the leg of the calliper against a flat surface.
- Set the calliper by turning the adjusting nut until the top leg reaches the required dimension. (Fig 13)

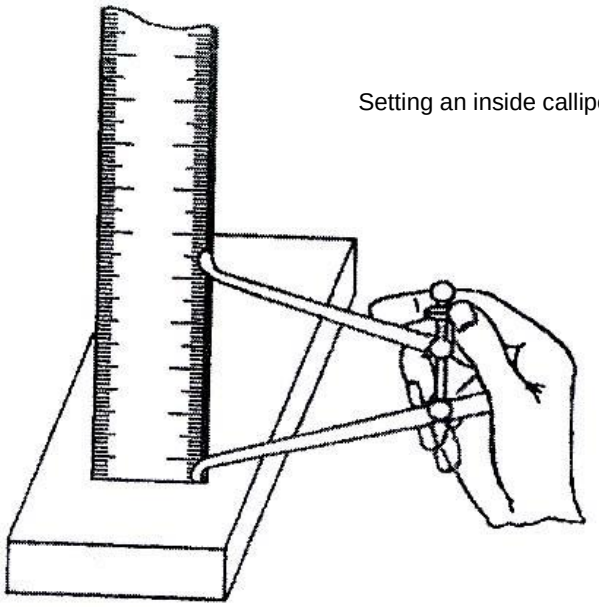


FIG 13.

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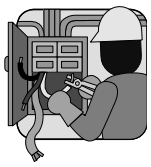


PRACTICE

To set callipers correctly and to measure accurately with them, it is essential that you obtain a “feel" for the instruments. This can only be done by practising.

Practice using both outside and inside spring-jointed and firm-jointed callipers by setting each one to the sizes indicated by arrows on the rule in the figure in the previous Practice on page 13.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

5. THE VERNIER CALLIPER

ITEM / TASK: Uses for vernier callipers.

DESCRIPTION:

Vernier callipers are used to obtain quick and accurate inside, outside and depth measurements.

ITEM / TASK: Construction of a vernier calliper.

DESCRIPTION:

A. The various parts of the vernier calliper are shown in Fig 14.

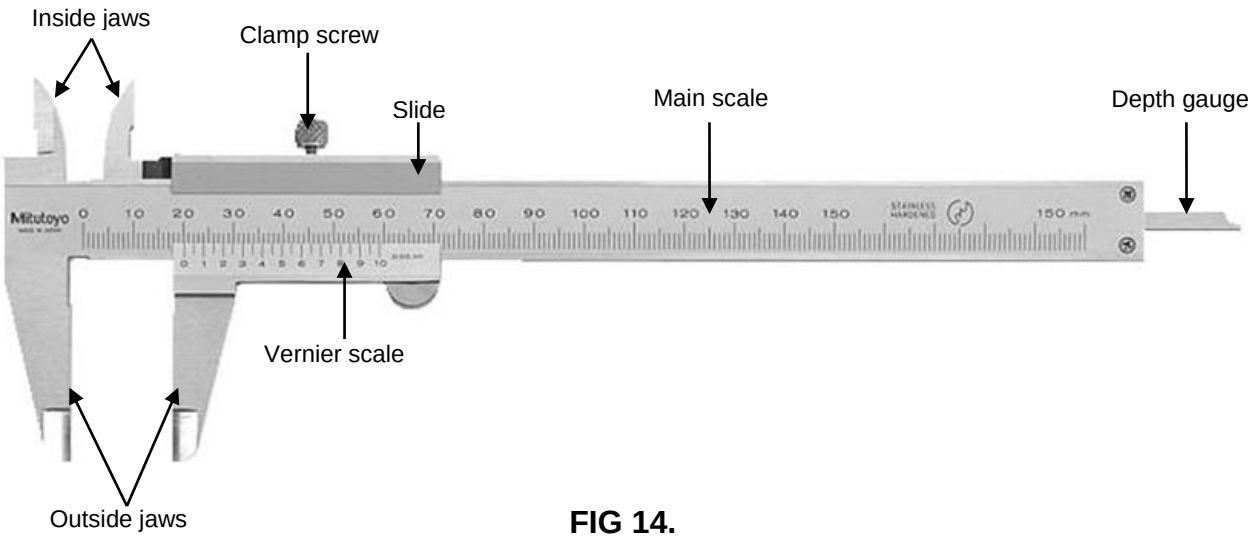


FIG 14.

B. Vernier callipers are available in different sizes, typically from 150mm to 1 000mm.

C. They are graduated in millimetre divisions and can measure accurately to 0.02mm or 0.05mm depending upon the type of vernier scale used.

- When the main scale is graduated in 1.00 mm division and the vernier scale is graduated in twenty equal divisions the vernier calliper can measure to within ±0.05mm, i.e. one-twentieth of a millimetre.
- When the main scale is graduated in 1.00 mm division and the vernier scale is graduated in fifty equal divisions the vernier calliper can measure to within ±0.02mm, i.e. one-fiftieth of a millimetre.

Fig 14 shows a vernier that can measure to within ±0.05mm.

ITEM / TASK: Reading a vernier calliper.

DESCRIPTION:

A. Two readings are taken when reading a vernier calliper, namely a **main scale** reading and a **vernier scale** reading. Refer to Fig 15. Note that the numbers on the main scale replicate 10 mm intervals.

B. Note that the vernier scale is graduated in twenty divisions. Therefore each division is equal to 0.05 mm.

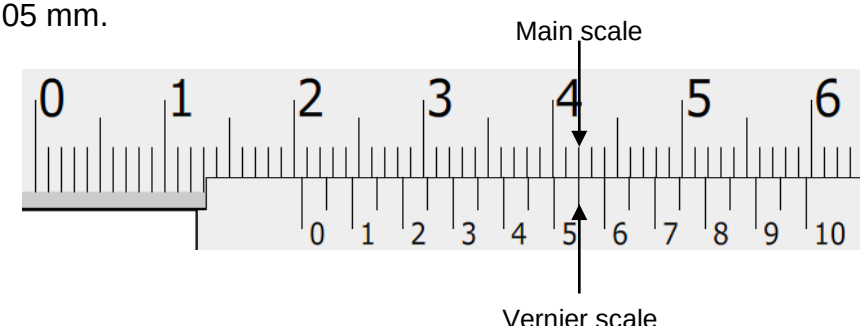


FIG 15.

C. Take the reading as follows:

- Note where the 0-line of the vernier scale is positioned in relation to the main scale graduations. Record the whole number of the main scale. In Fig15 this is equal to 20mm.
- Now find the point on the main scale where a graduation line coincides exactly with a graduation line on the vernier scale.

In Fig 15, the line between 5 and 6 on the vernier scale coincides with 42 on the main scale. Take the reading on the vernier scale. Note that it is between 5 and 6.

The dimension is thus:
20.0 mm (Main scale) + 0.55 mm (Vernier scale) = 20.55 mm

- Considerable practice and skill are needed to distinguish accurately where the vernier and main scale graduations coincide. The vernier calliper must be viewed squarely to avoid parallax error.

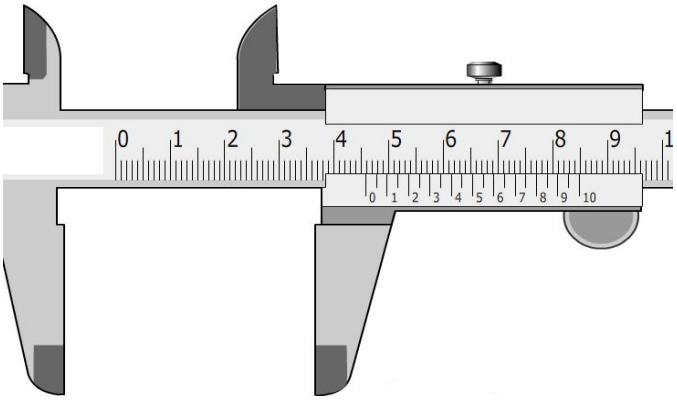
DO THE SELF TEST ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.

SELF TEST 1

Read the dimensions shown in the figures below and write them down in their respective spaces provided.

(Main scale : 1 = 10mm, 2 = 20mm etc)

a.

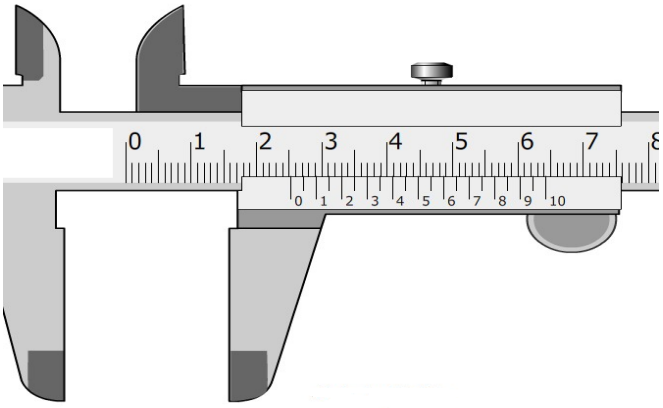


Main Scale : _____

Vernier Scale : _____

Reading : _____

b.

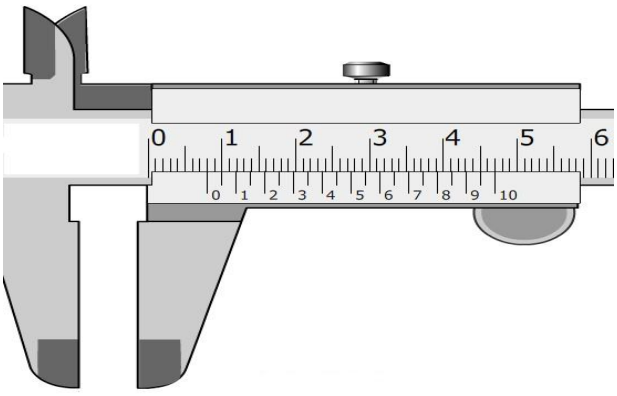


Main Scale : _____

Vernier Scale : _____

Reading : _____

c.

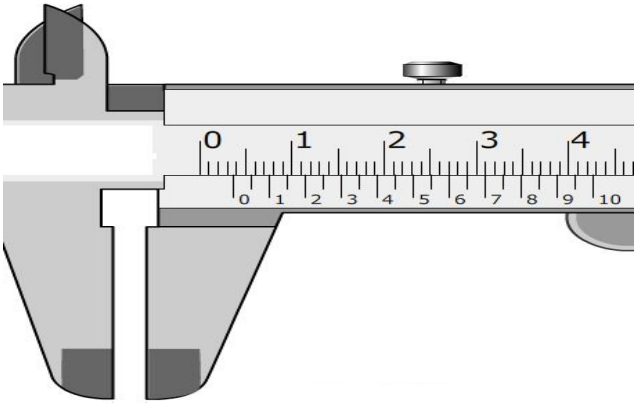


Main Scale : _____

Vernier Scale : _____

Reading : _____

d.



Main Scale : _____

Vernier Scale : _____

Reading : _____

ANSWERS

	a	b	c	d
Main scale	45	25	8	3
Vernier scale	0.75	0.25	0.05	0.65
Reading in mm	**45.75**	**25.25**	**8.05**	**3.65**

Are your answers correct?

If they are, well done! If not, find out why you are wrong and practise until you answer all the questions correctly.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	**TRAINING OFFICER**
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: Measure with a vernier calliper.

DESCRIPTION:

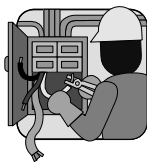
The procedure for using an inside or an outside calliper to measure a workpiece is basically the same.

- Clean all the dust and dirt from the surfaces of the vernier calliper with a clean cloth.
- Apply clean oil to all moving parts. Dry surfaces do not move freely and can result in the surface of the vernier becoming scratched.
- Open the outside jaws so that they can fit over the object to be measured. If an inside dimension has to be measured, the inside jaws must be closed sufficiently to fit inside the object.
- Make sure that the instrument is square on and central to the object being measured.
- Tighten the clamp screw.
- Remove the instrument and read the size.
- Take reading.

Note:

In some cases it is possible to read the instrument while it is in position.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practice measuring inside and outside dimensions of given test pieces with a vernier calliper. Measurements must be correct to within the accuracy of the instrument used, i.e. ±0.02 mm or ±0.05 mm, depending on how the vernier calliper is graduated.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

6. THE COMBINATION SET

ITEM / TASK: Uses for a combination set.

DESCRIPTION:

The **combination set** is a versatile instrument used to measure various dimensions of workpieces and to mark off the different objects. It is so named because it consists of a combination of four main parts –

- a rule,
- a centre head,
- a protractor, and
- a square head with a scriber attachment.

ITEM / TASK: Construction of a combination set.

DESCRIPTION:

Fig 16 shows the construction of a combination set.

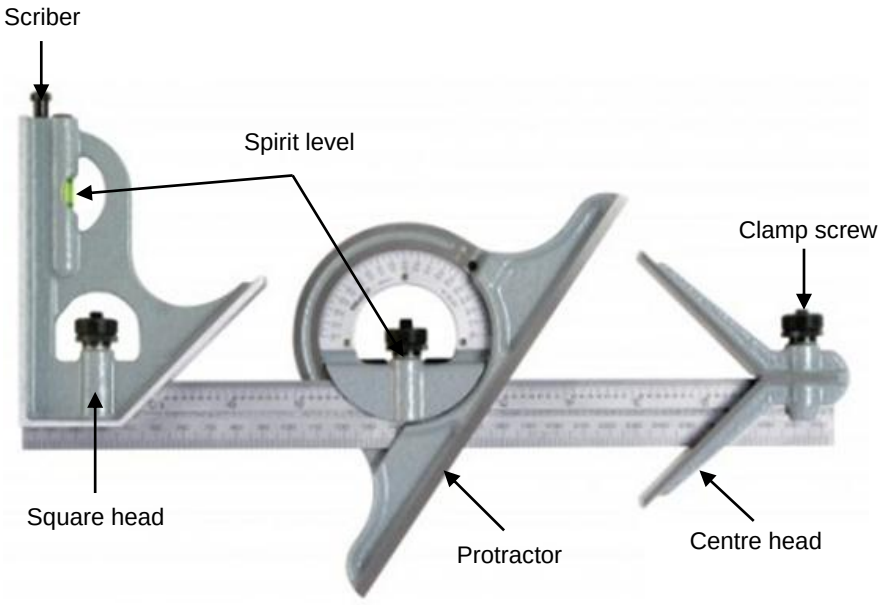


FIG 16.

- **The rule** is calibrated and used in the same way as an ordinary steel rule. It has a groove in the middle on one side, which enables it to be used with the other parts of the set.
- **The centre head** is used to find the centre of a round object. It has a clamp, which enables it to be clamped to the rule.

- **The protractor** is used for measuring and marking off angles. When clamped to the rule (Fig 16), it can move 50° to one side and 80° to the other, i.e. a total of 130°. It is also equipped with a spirit level.

- **The square head** can be used with the rule, to measure depths and elevations (heights). It is not suitable to be used as a precision or engineer's square, but it can be used to mark off 45° and 90° angles.

ITEM / TASK: Use a combination set.

DESCRIPTION:

A. Use the **centre head** to find the centre of a round object. See Fig 17.

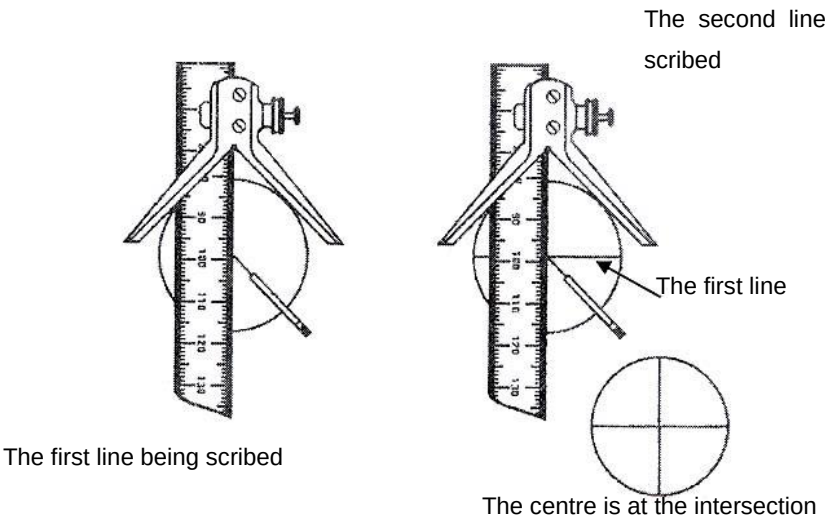


FIG 17.

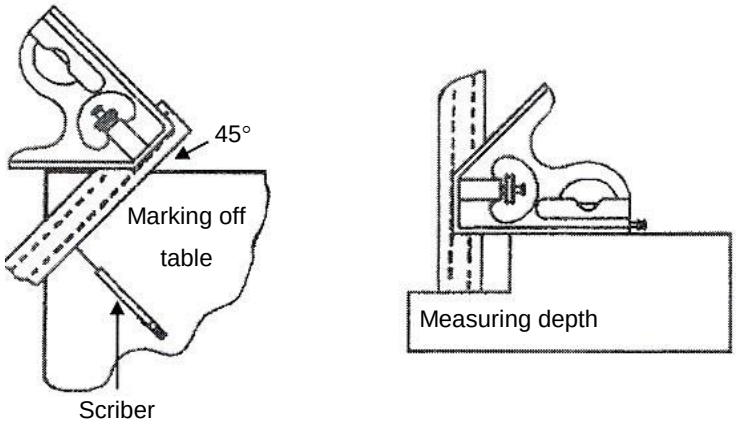
- Slide the rule into the centre head until it protrudes about 10 mm at the rear.
- Tighten the clamp screw and check if the rule is secured to the centre head.
- Make sure there are no burrs on the periphery of the round workpiece (bar of disc).
- Apply marking blue onto the surface that has to be marked.
- Slide the centre head over the circular workpiece.
- Mark a line on the blue surface with a scriber.
- Turn the shaft or disc 90° and scribe another line.

Note:

The centre of the round bar or disc will be where the lines intersect.

- Loosen the clamp screw and remove the rule.

B. Use the **square head** to measure the depth of a step in a workpiece, and to measure or mark off an angle of 45°. See Fig 18.



(a) (b)

FIG 18.

- Slide the rule into the square head to a position that will suit the application it is going to be used for.
- Tighten the clamp screw and check to see if the rule is secured.
- As a first task, mark off a 45° angle on one of the corners of the marking-off table as shown in Fig 18 (a).
- To measure the step in a given test piece, place the square head on the top surface of the workpiece, loosen the clamp screw and adjust the rule to touch the bottom of the step as shown in Fig 18 (b).
- Tighten the clamp screw, remove the combination set and read the depth of the step on the rule.
- Loosen the clamp screw and remove the rule.

C. Use the **protractor** to measure angles between faces on a test piece. See Fig 19.

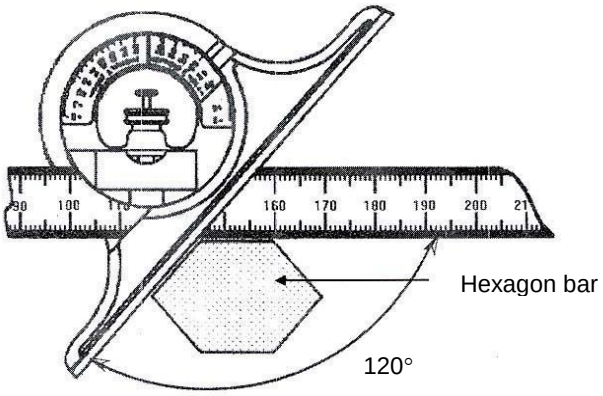


FIG 19.

- Slide the rule into the protractor. The rule should protrude for about half of its length.
- Tighten the clamp screw and make certain the rule is secured.
- Loosen the clamp on the protractor.
- Place the protractor and rule on two adjacent sides of a given hexagon bar and adjust the angle until the rule and protractor seat properly.
- Tighten the clamp screw and read the angle on the protractor scale.
- Loosen the clamp on the protractor and rule and reassemble the combination set.

7. BEVELS

ITEM / TASK: Use of bevels.

DESCRIPTION:

Bevels are handy instruments for setting, measuring and transferring angles. Fig 20 shows three types of bevels.

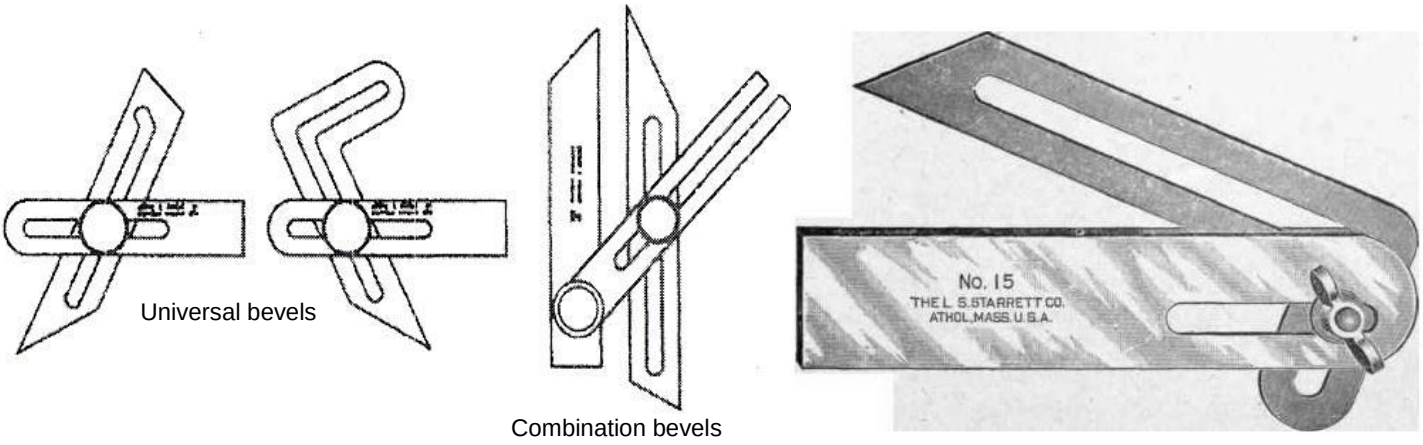


FIG 20.

Fig 21 shows a number of typical uses for bevels. A combination set must be used to set or read the angles.

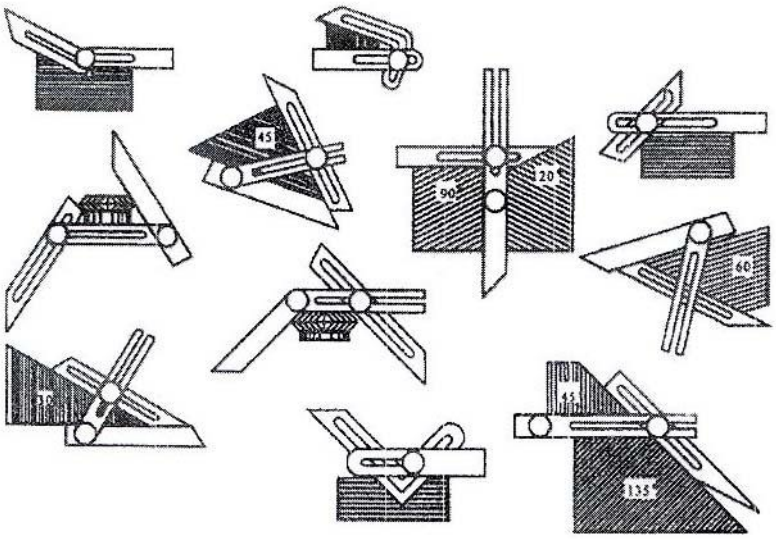
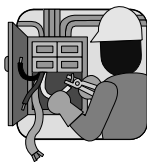


FIG 21.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise using a combination set in all its various assembled combinations, as well as all the different bevels, until you are competent. Ask your Training Officer to assist you if you have any problems.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

8. MICROMETERS

ITEM / TASK: Introduction.

DESCRIPTION:

There are three types of micrometers, namely:

- outside micrometers,
- inside micrometers, and
- depth micrometers.

Each type and its application will be discussed below.

ITEM / TASK: The outside micrometer.

DESCRIPTION:

A. Uses.

- An outside micrometer is used to measure accurately the outside diameters and dimensions of objects and workpieces.
- It is accurate to within 0.01 mm. However, if it has a vernier scale it can measure to within 0.001 mm.
- Outside micrometers used for measuring diameters of 300 mm and larger, have a suggested accuracy of 0.02 mm.

B. Construction. See Fig 22.

FIG 22.

- **The anvil** face is glass hard and optically flat and is hardened to prevent wear.
- **The spindle** is also hardened, and its threads are ground to provide accurate measurement.
- **The locknut** is knurled for gripping and it is effective at any position of the spindle.
- **The barrel** is clearly marked off and is adjustable for zero settings.
- **The thimble** is clearly calibrated and is also knurled for easy handling.
- **The ratchet** is used to ensure even pressure when measurements are taken and to prevent over-tightening.
- **The measuring surfaces** are part of the anvil and the spindle.
- **The frame** is made of hardened steel and is sturdy.

C. Calibration of a micrometer. Refer to Fig 23.

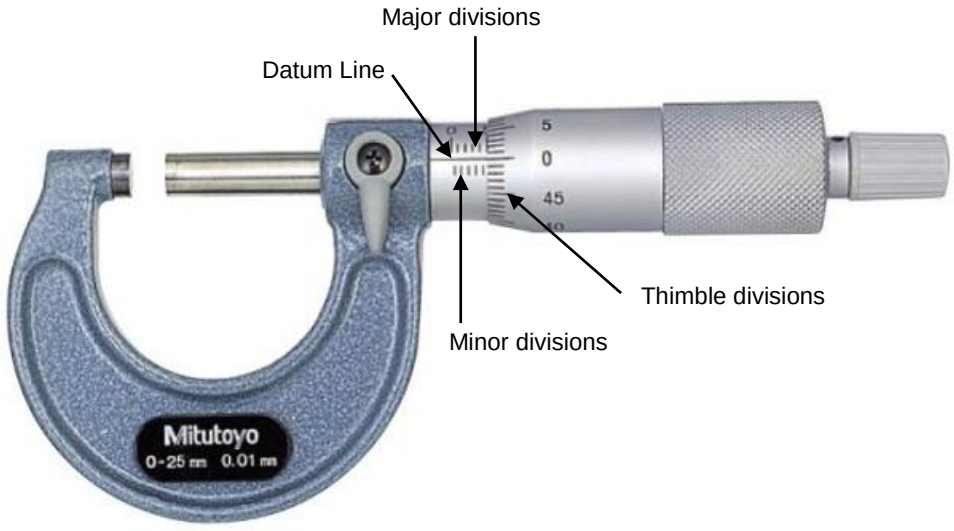


FIG 23.

N.B.

The following notes are applicable to metric micrometers that are graduated in hundredths of a millimetre. (0.01mm)

- The thread has a pitch of 0.5mm. Therefore two revolutions of the thimble will move the spindle 1.0mm.

- The datum line on the barrel has two sets of graduations of 1mm divisions. Usually the graduations below the line are staggered to give 0.5mm readings when read in conjunction with the graduations above the line.
- However, this system of marking may be reversed.
- The 1.0mm divisions are often called "major divisions" and the 0.5mm are known as "minor divisions".
- The circumference of the thimble is divided into 50 equal divisions along its bevelled edge, commonly called thimble divisions.
- Each small division is equal to 0.01 mm and the graduations are marked at every five units, e.g. 5, 10, 15 and so on.

D. Reading a micrometer.

The instrument is read as follows:

- Read the whole numbers of the "major divisions" i.e. the 1.0mm markings on the barrel.
- Note whether there is a 0.5mm division on the "minor division" scale visible between the thimble and the last whole millimetre division.
- Read the number of 0.01mm divisions on the thimble. That is the reading in line with the barrel datum line.
- Add all of the above readings to obtain the actual size.

Major divisions	=	9.00mm
Minor divisions There is one additional 0.5mm division.	=	0.50mm
Thimble divisions The datum line coincides with 48 on the thimble division.	=	0.48mm
Reading	=	9.98mm

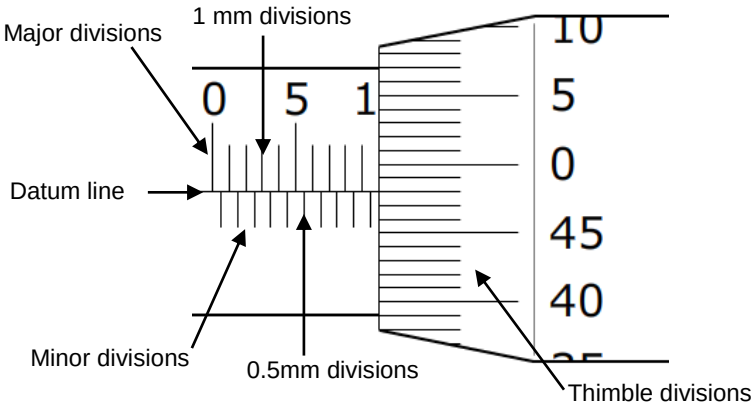


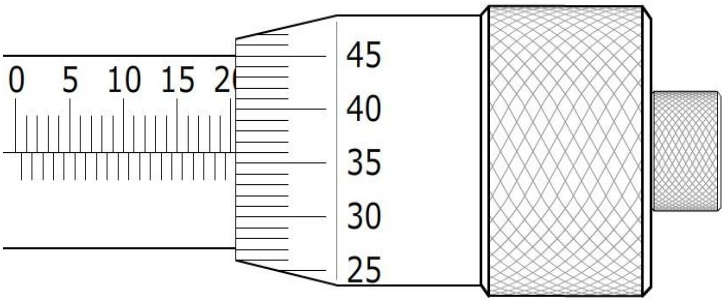
FIG 24.

DO THE SELF-TEST ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.

SELF TEST 2

Read the dimensions shown in the figures below and write them down in their respective spaces provided.

a.



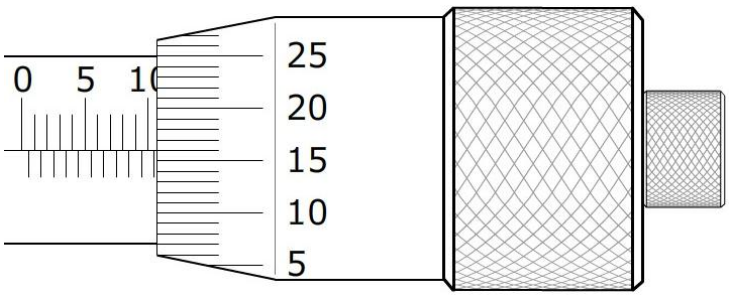
Major divisions : _____

Minor divisions : _____

Thimble divisions : _____

Reading : _____

b.



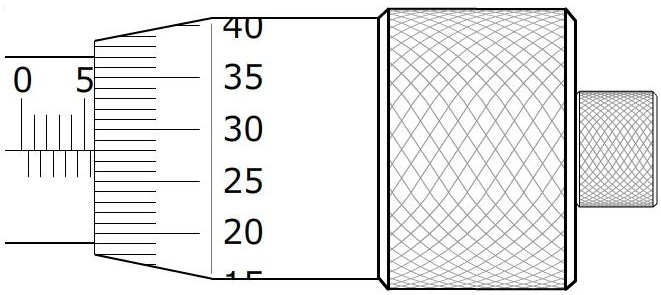
Major divisions : _____

Minor divisions : _____

Thimble divisions : _____

Reading : _____

c.



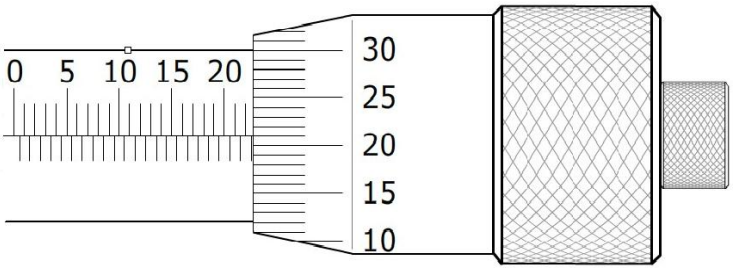
Major divisions : _____

Minor divisions : _____

Thimble divisions : _____

Reading : _____

d.



Major divisions : _____

Minor divisions : _____

Thimble divisions : _____

Reading : _____

ANSWERS

	a	b	c	d
Major divisions	20.00	10.00	5.00	22.00
Minor divisions	NIL	0.50	0.50	0.50
Thimble divisions	0.36	0.16	0.28	0.21
Reading in mm	**20.36**	**10.66**	**5.78**	**22.71**

Are your answers correct?

If they are, well done! If not, find out why you are wrong and practise until you answer all the questions correctly.

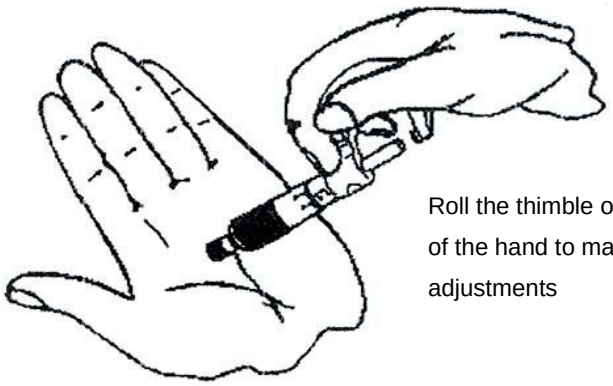
Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	**TRAINING OFFICER**
DATE :	DATE :
SIGNATURE :	SIGNATURE :

E. Measure with an outside micrometer.

- Clean the faces of the anvil, the spindle and the job to be measured with a clean cloth.
- Open the micrometer wide enough to pass over the workpiece to be measured.
- When it is necessary to open or close the micrometer considerably, the thimble should be rolled in the palm of the hands as shown in Fig 25.

Do not twist or swing the micrometer to open or close it.



Roll the thimble on the palm of the hand to make large adjustments

FIG 25.

- Place the micrometer over the object (workpiece) to be measured so that the anvil face touches the surface of the object.
- Turn the ratchet until the spindle touches the opposite side of the job. See Fig 26.
- Hold the micrometer square to the workpiece.
- Read the micrometer as explained in Section D above.
- Make a check measurement. The two readings should be the same.

The measurement is taken squarely to the item being measured

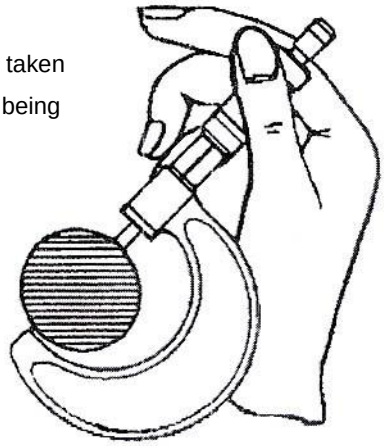


FIG 26.

Points to remember when using a micrometer.

a. Excess force must never be used when turning the thimble to obtain face contact.
b. Use the ratchet to obtain an even pressure.
c. The micrometer should be checked regularly to ensure that it is accurate, usually at the beginning of the shift or every time the micrometer is used. This is done by measuring the length of a test piece. See Fig 27.

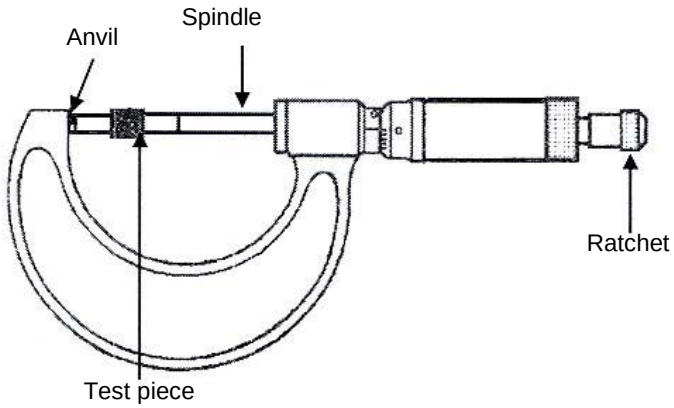


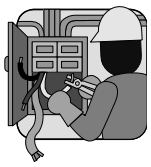
FIG 27.

- The test piece length is known, and it is usually equal to the smallest possible setting of the micrometer.
- With a 0-25 mm outside micrometer the thimble is turned until the spindle face touches the anvil face, the reading should then be zero if the instrument is accurate. A test piece is therefore not necessary.

NB :

The test piece must be held between the anvil and the spindle of the micrometer as shown in Fig 27. The thimble is then turned until both the anvil and the spindle touch the test piece. The zero marks on the barrel and thimble will line up if the micrometer has been set accurately.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise using an outside micrometer to measure the dimensions of different sized test pieces.

Ask your Training Officer or another skilled person to check your readings.

Remember that you must be able to measure to within an accuracy of 0.01 mm, if the test piece is less than 300 mm in diameter.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: The inside micrometer.

DESCRIPTION:

A. Uses for the inside micrometer:

- This instrument is used to measure internal bores and dimensions accurately.
- It is accurate to within 0.01 mm. However, if it has a vernier scale it can measure to within 0.001 mm.
- Inside micrometers are available in sets with various ranges and can measure dimensions up to 1 metre.

B. Construction. See Fig 28.

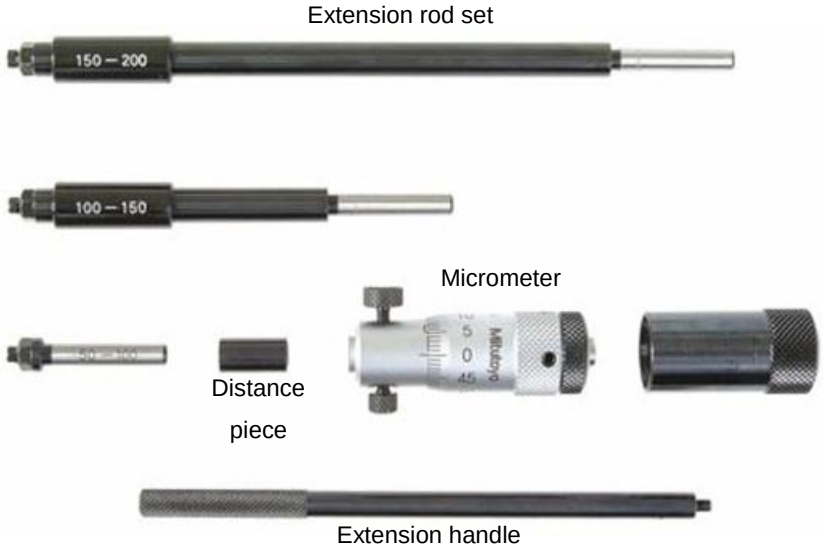


FIG 28.

- All the component parts that make up a 50 mm to 220 mm inside micrometer are shown in Fig 28.
- The extension rods and thimble have radiused anvils, which are hardened to resist wear. The anvils of the extension rods are threaded and can be adjusted with the correct spanner.
- The thimble and sleeve (barrel) are similar in construction to those of the outside micrometer.
- The extension handle is used when measuring small deep bores.

Fig 29 is an illustration of an assembled inside micrometer.

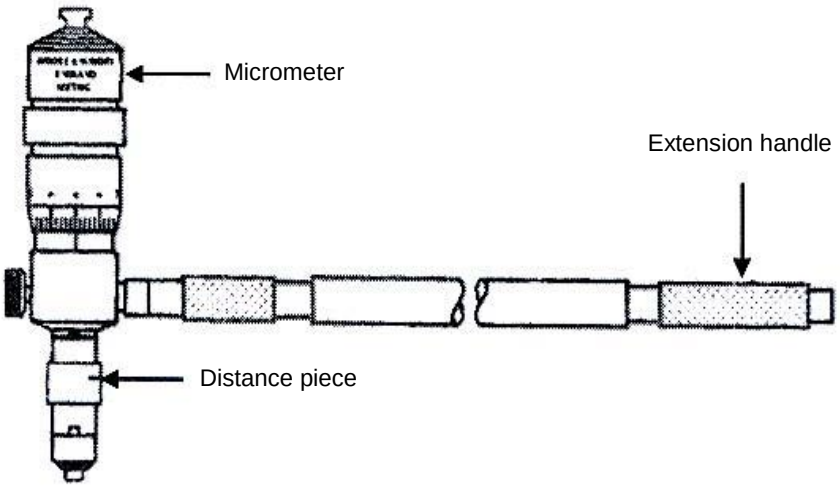


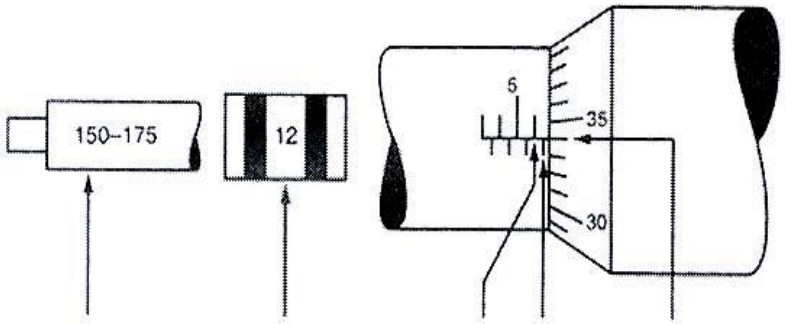
FIG 29.

C. Reading an inside micrometer.

- Read the major divisions first, then read the minor divisions and finally the thimble divisions.
- The actual dimension is the sum of these three readings.
- If you are uncertain of this method refer to the previous Section D on page 35, and repeat the self-test if necessary.

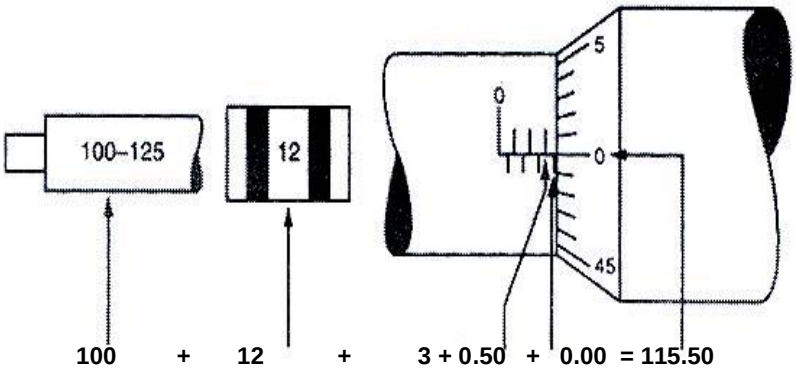
Examples:

a.



150 + 12 + 6 + 0.50 + 0.34 = 168.84

b.



100 + 12 + 3 + 0.50 + 0.00 = 115.50

D. Measure with an inside micrometer.

- Clean the joining faces of the extension rods, the distance piece and the micrometer head before assembling them.
- Choose the right extension rod so that it will fit inside the workpiece to be measured.
- Hold the micrometer squarely across the bore in the dead centre position. Move the top of the micrometer from side to side and in and out. (Fig 30)

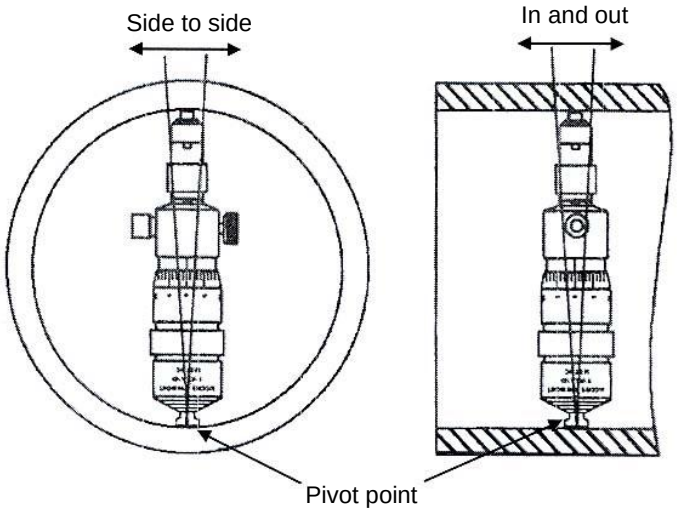


FIG 30.

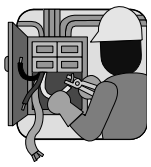
- Adjust the thimble whilst making these movements until side-play cannot be felt and there is only a slight drag on the in and out movement.

NB:

Force must never be used because it will damage the instrument.

- Remove the micrometer and read the size.
- Take a check reading. The two readings should be the same.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise using an inside micrometer until you are able to measure the inside dimensions of different workpieces accurately.

Remember you must be able to measure within an accuracy of 0.01 mm.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: The depth micrometer.

DESCRIPTION:

A. Uses for the depth micrometer.

- The depth micrometer is used to measure accurately the depth of steps, slots and holes.
- It is accurate to within 0.01 mm. However, if it has a vernier scale it can measure to within 0.001 mm.

B. Construction.

- The various parts of the depth micrometer are shown in Fig 31.
- The rods are interchangeable, and the selected rod is held firmly in position against a positive face by the thimble cap, which can be easily unscrewed.

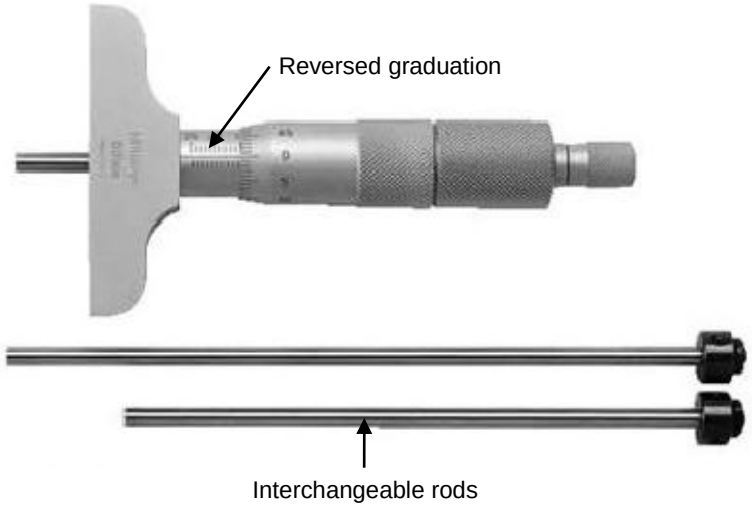
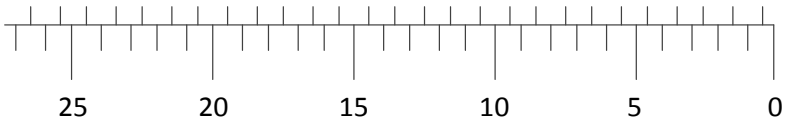


FIG 31.

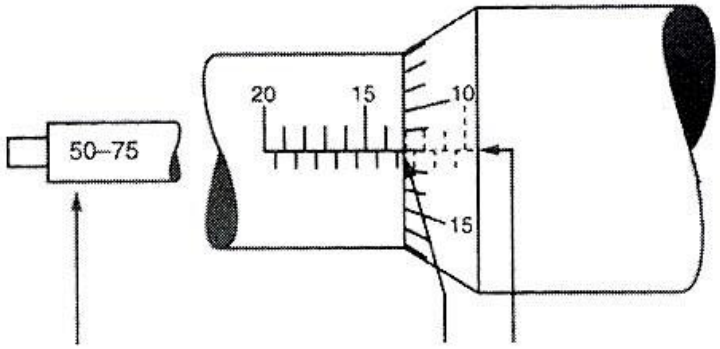
C. Reading a depth micrometer.

- This instrument is read in the same manner as described for inside and outside micrometers.
- However, it should be noted that the datum line is graduated from right to left as shown below.



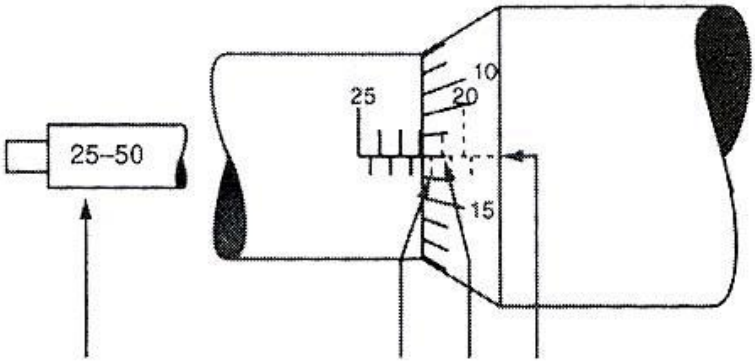
Examples:

a.



50 + 13 + 0.12 = 63.12

b.



25 + 0.5 + 21 + 0.13 = 46.63

D. Measure with a depth micrometer.

- Clean the instrument and the rods, particularly the faces.
- Estimate the depth to the measured. If necessary measure it with a rule.
- Fit he correct sized rod to the instrument. For example, if the hole is approximately 35 mm deep fit the 25-50 mm rod.
- Place the rod in the hole (or against the step or the slot) that has to be measured.
- Press the base firmly against the top surface, using your thumb and another finger.
- Screw the thimble down with the other hand, until the base of the rod touches the bottom of the hole or the bottom surface of the step or slot. (See Fig 32 on the next page) Resistance is noticeable when contact is made if the micrometer is not equipped with a ratchet.

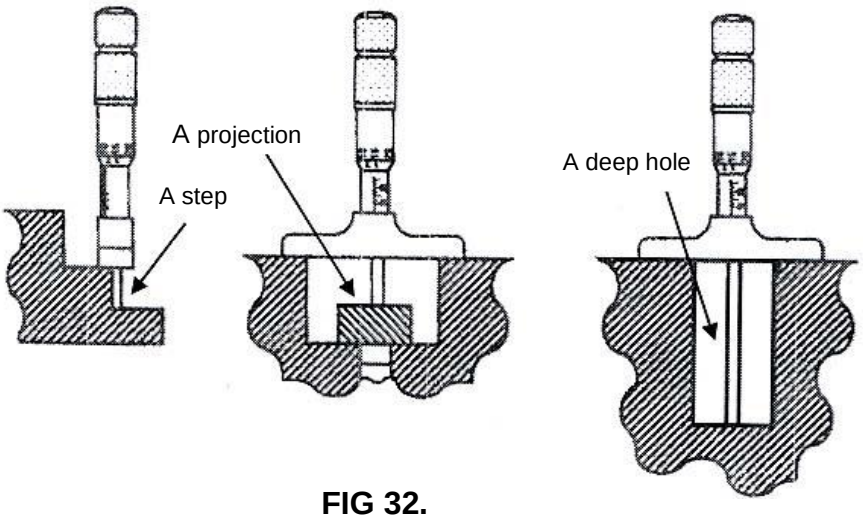
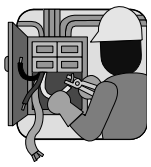


FIG 32.

- Remove the micrometer and read the depth.
- Take a check reading.

The zero setting must be corrected, if necessary. It should only be done by a competent person.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise using a depth micrometer to measure depths of holes, steps and slots.

You must be able to measure to within as accuracy of 0.01 mm.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

9. THE TELESCOPIC GAUGE

ITEM / TASK: Introduction.

DESCRIPTION:

A. This instrument is used in conjunction with an outside micrometer to measure bore dimensions accurately, or alternatively it can be used on its own as a comparator.

B. After the size of a bore has been measured with the telescopic gauge the size must be transferred to an outside micrometer to obtain the reading.

C. Telescopic gauges are supplied in sets and each gauge in the set has a fixed measuring range. Fig 33 shows a typical set of telescopic gauges that can measure from 13 mm to 330 mm. The size of the gauge increases as the measuring range increases. The gauges are accurate to within 0.02 mm.

FIG33.

ITEM / TASK: Construction of a telescopic gauge.

DESCRIPTION:

The various parts of a telescopic gauge are shown in Fig 34.

The telescopic leg is locked in position by tightening the knurled lock screw.

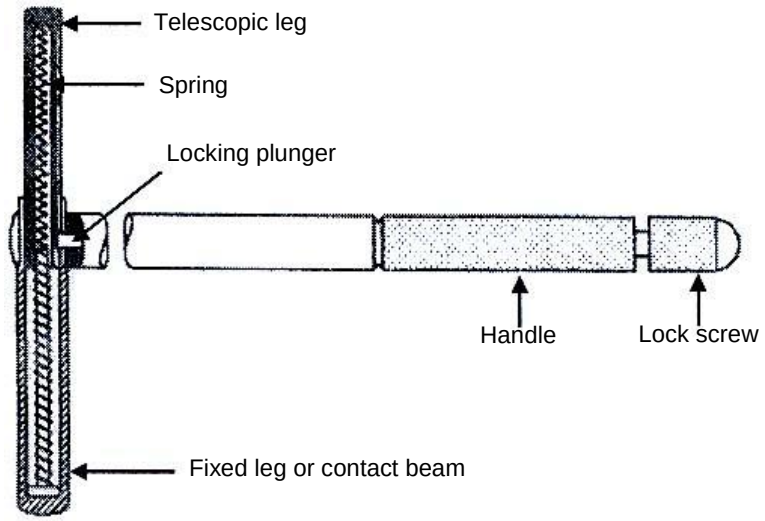


FIG 34.

ITEM / TASK: Measure with a telescopic gauge.

DESCRIPTION:

A. Loosen the lock screw and compress the telescopic leg.

B. Insert the gauge into the bore.

C. Position the gauge exactly in “dead centre" and hold it square across the bore. (Fig 35)

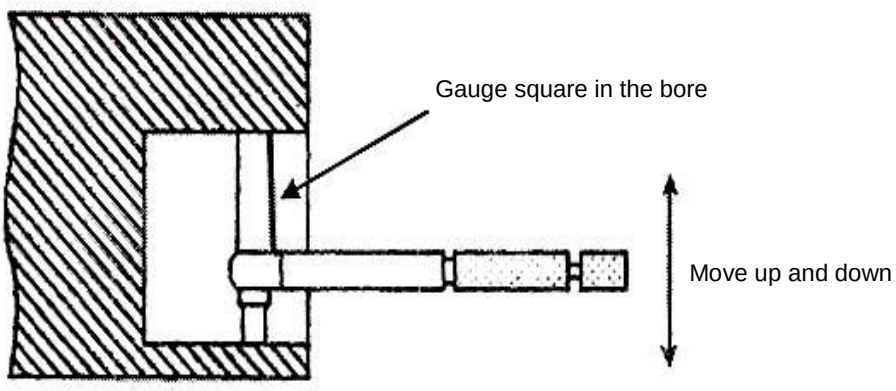
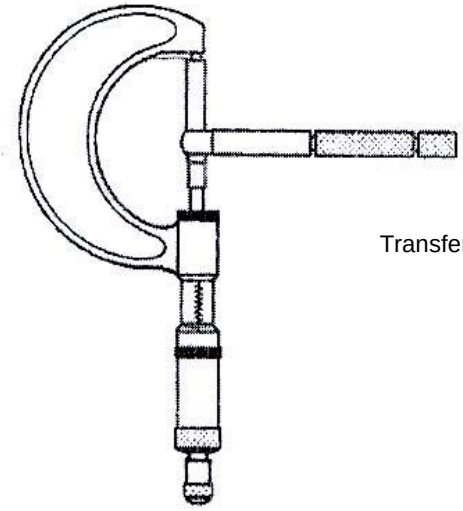


FIG 35.

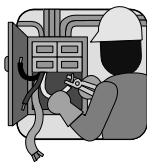
D. Tighten the lock screw and at the same time move the handle up and down to feel the contact between the bore surfaces and the gauge ends. A good "feel" is obtained when the mass of the handle is sufficient to move the gauge past the point of contact. (You must practise getting the feel of a good fit).
E. Remove the gauge and obtain the dimensions by using an outside micrometer as described previously. (Fig 36)
F. Take and check reading.



Transferring the size to the micrometer

FIG 36.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Use a telescopic gauge and outside micrometer to measure the inside diameters of at least four different bores. Remember you should be able to obtain measurements to within an accuracy of 0.02 mm.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

10. THE FEELER GAUGE

ITEM / TASK: Uses for a feeler gauge.

DESCRIPTION:

A feeler gauge is used for measuring narrow slots and gaps, checking small gaps and clearances, and checking the straightness and flatness of parts.

ITEM / TASK: Construction of a feeler gauge.

DESCRIPTION:

A. A feeler gauge is made of tempered steel and is normally in leaf form. Feel gauges are generally about 10 mm wide and from 75 mm to 300 mm long.
B. Each blade has its thickness marked (etched) on it. The thickness of the blades varies, depending on the type and make of instrument and because each blade in a set has a different thickness. Typically, the blades increase in thickness by 0.01 mm and 0.05 mm. See Fig 37.

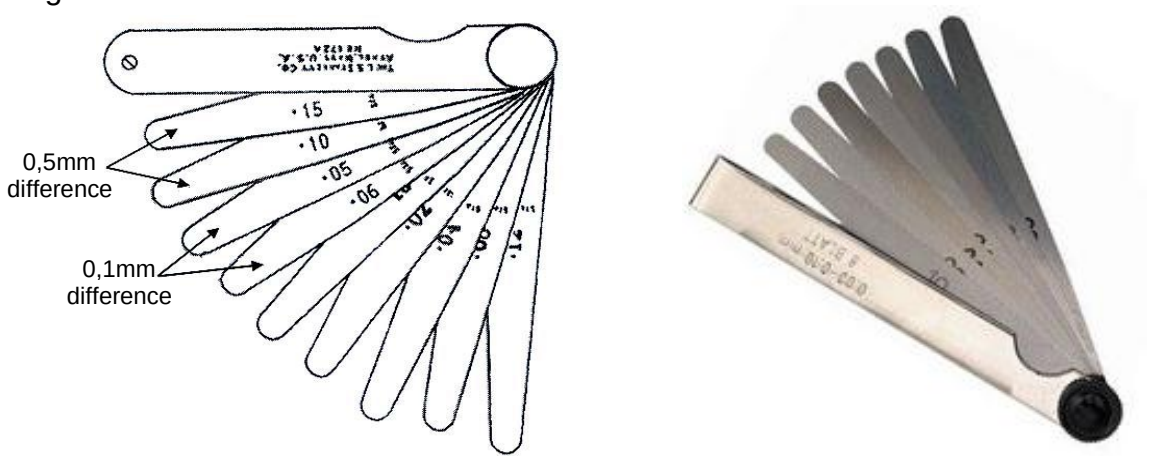


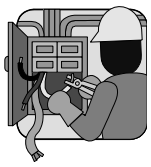
FIG 37.

ITEM / TASK: Measure with a feeler gauge.

DESCRIPTION:

A. A feeler gauge must be treated and cared for as if it is precision instrument.
B. To use it, place a blade in the gap to be measured and "feel" whether it fits correctly.
C. When the fit "feels" correct then the number marked on the blade is the size of the gap.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise using the feeler gauge to measure gaps.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

11. THE THREAD ANGLE GAUGE

ITEM / TASK: Uses for the thread angle gauge.

DESCRIPTION:

A. A thread angle gauge is used to check angles when grinding screw cutting tools, and to set the screw cutting tool square to the workpiece.

B. The thread angle gauge is also commonly referred to as a screw cutting gauge.

ITEM / TASK: Construction of a thread angle gauge.

DESCRIPTION:

The gauge usually has four different "V" form thread angle cut outs, which are each marked with its degrees of angle. (Fig 38) They are given below.

- 60° Metric (SI) System International.
- 55° British Standard Whitworth or British Standard Fine (BSW or BSF).
- 47 ½° British Association (BA).
- 14 ½° Acme.

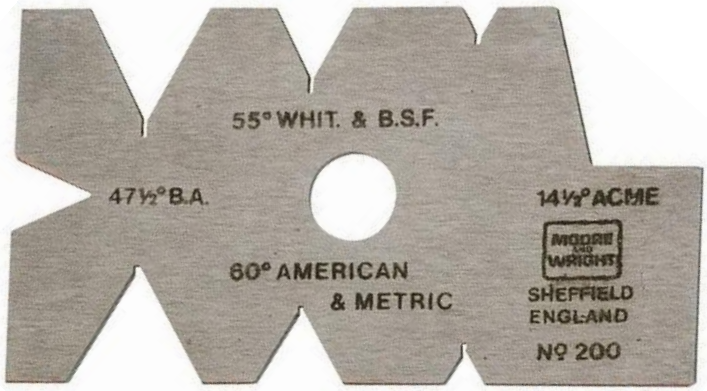


FIG 38.

ITEM / TASK: Measure with a thread angle gauge.

DESCRIPTION:

It is a simple instrument to use. The tool to be measured is tried in all the cut outs of the gauge until one is found that fits. See Fig 39 below for an example of how to use the gauge.

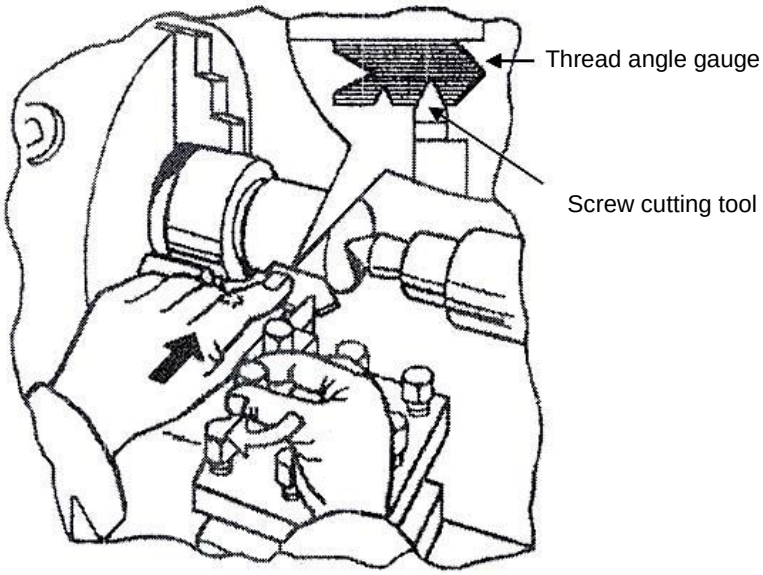


FIG 39.

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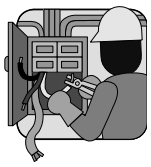


PRACTICE

Practise measuring angles of various tools with a thread angle gauge.

Later in module MTG you will learn to use the gauge to grind tool bits and later still in module MTF, turners will use this gauge to check tool angles and to set screw cutting tools square to the job.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

12. THE THREAD PITCH GAUGE

ITEM / TASK: Uses for the thread pitch gauge.

DESCRIPTION:

A thread pitch gauge is used:

- to check the pitch of a thread when screw cutting, and
- to measure the pitch and angle of a thread so that it can be identified.

ITEM / TASK: Construction of a thread pitch gauge.

DESCRIPTION:

A. Thread pitch gauges are obtainable for all basic "V" form threads.
B. They are available in sets, and the thread standards are clearly marked on the side cover of the gauge.
C. The pitch is also marked on each blade and in some cases the diameter of the thread is also given.

A typical thread pitch gauge is shown in Fig 40 below.

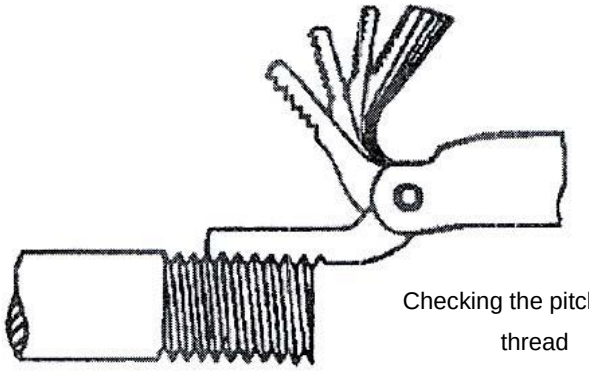
FIG 40.

ITEM / TASK: Measure with a thread pitch gauge.

DESCRIPTION:

A thread pitch gauge is quite simple to use as shown in Fig 41.

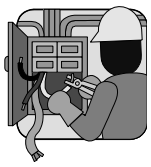
The blade, which fits correctly into the pitch, indicates the thread pitch of the screw or bolt.



Checking the pitch of the thread

FIG 41.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise measuring the threads of different sized bolts. You will use this instrument in module TS, which is concerned with identifying threads.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

13. THE RADIUS GAUGE

ITEM / TASK: Uses for the radius gauge.

DESCRIPTION:

The radius gauge is used

- as a gauge to measure the radius of a component, and
- as a template when grinding a round nose tool.

ITEM / TASK: Construction of a radius gauge.

DESCRIPTION:

A radius gauge may have a concave and / or convex shape, and these are usually known as male and female radii respectively. See Fig 42.

The numbers on the blades indicate the radius size in millimetres.

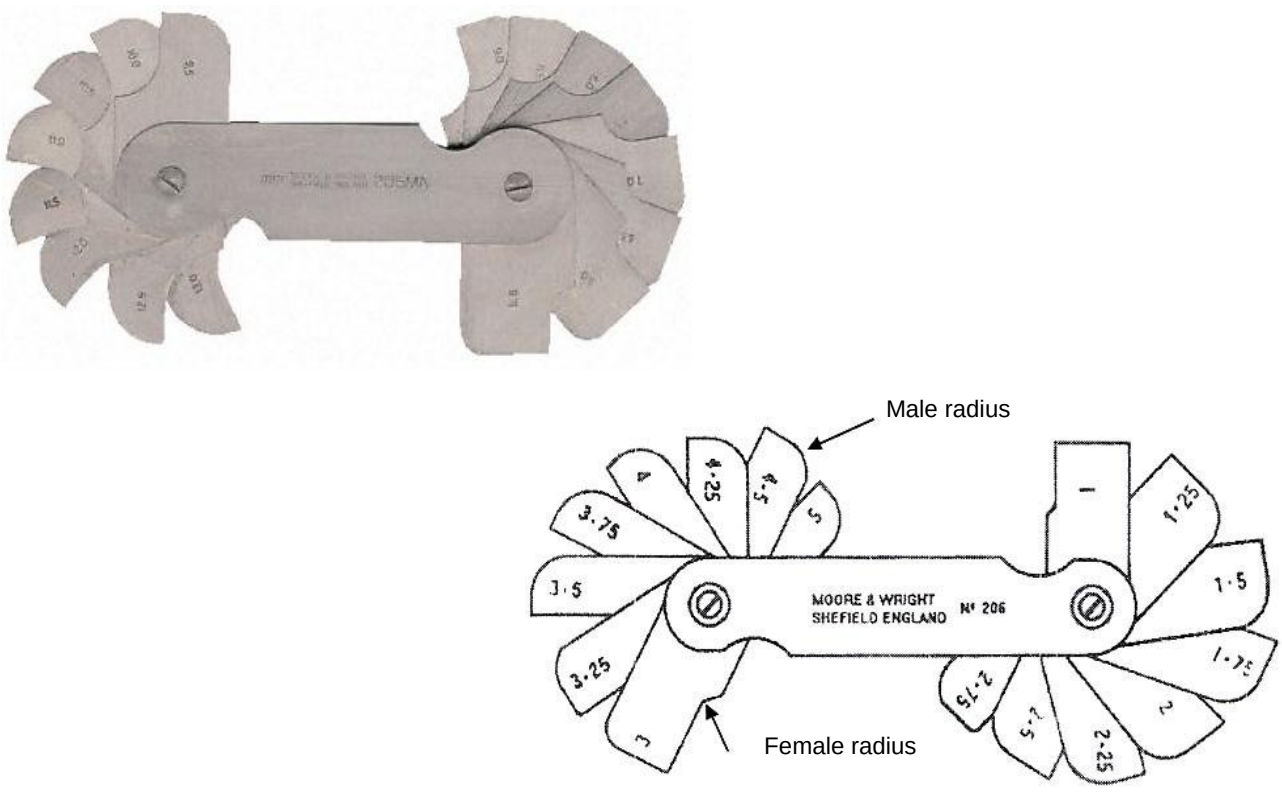


FIG 42.

ITEM / TASK: Measure with a radius gauge.

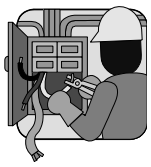
DESCRIPTION:

A. The radius gauge is placed against the object to be measured or ground. The actual size is when the curves coincide.
B. When a **male radius** has to be cut on a lathe to suit a female radius, a blade 0.25 mm **larger** than the required radius should be used as a gauge.
C. When a **female radius** has to be cut on a lathe to suit a male radius, a blade 0.25 mm **smaller** than the required radius should be used as a gauge.

Note:
The differences explained in B and C above is made to ensure that the shoulders of the components will meet flush.

The radius gauge, like all other instruments, must be treated with care.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise measuring a number of male and female radii of given test pieces until you are able to do the measurements correctly.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

14. THE UNIVERSAL SURFACE GAUGE

ITEM / TASK: Uses for the universal surface gauge.

DESCRIPTION:

The universal surface gauge is also known as a "scribing block". It is used for:

- scribing lines parallel to a datum surface such as a marking-off table,
- checking parallelism, and
- setting up workpieces in a lathe.

ITEM / TASK: Construction of a universal surface gauge.

DESCRIPTION:

Fig 43 shows a typical surface gauge with all its component parts. It is adjustable through a wide range, and the sensitive or fine adjustment is smooth but firm.

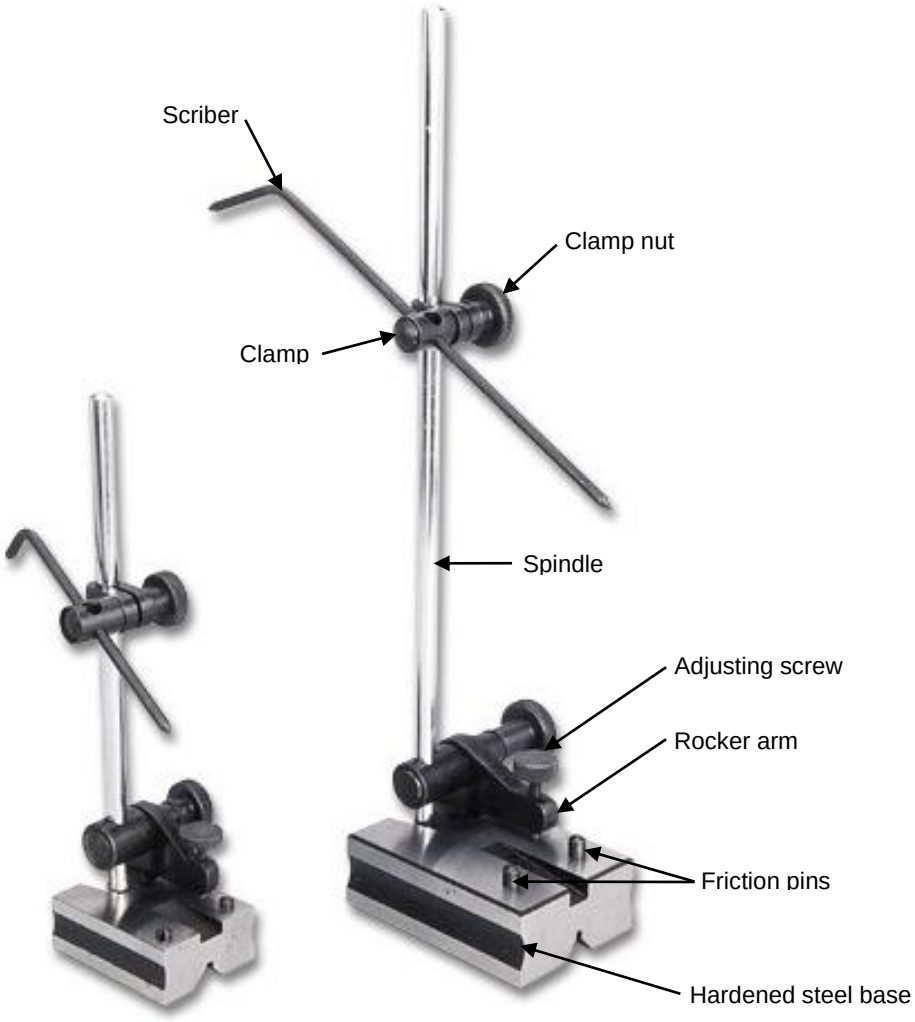


FIG 43.

ITEM / TASK: Uses for a surface gauge.

DESCRIPTION:

A. Fig 44 below shows some of the typical applications of a surface gauge.

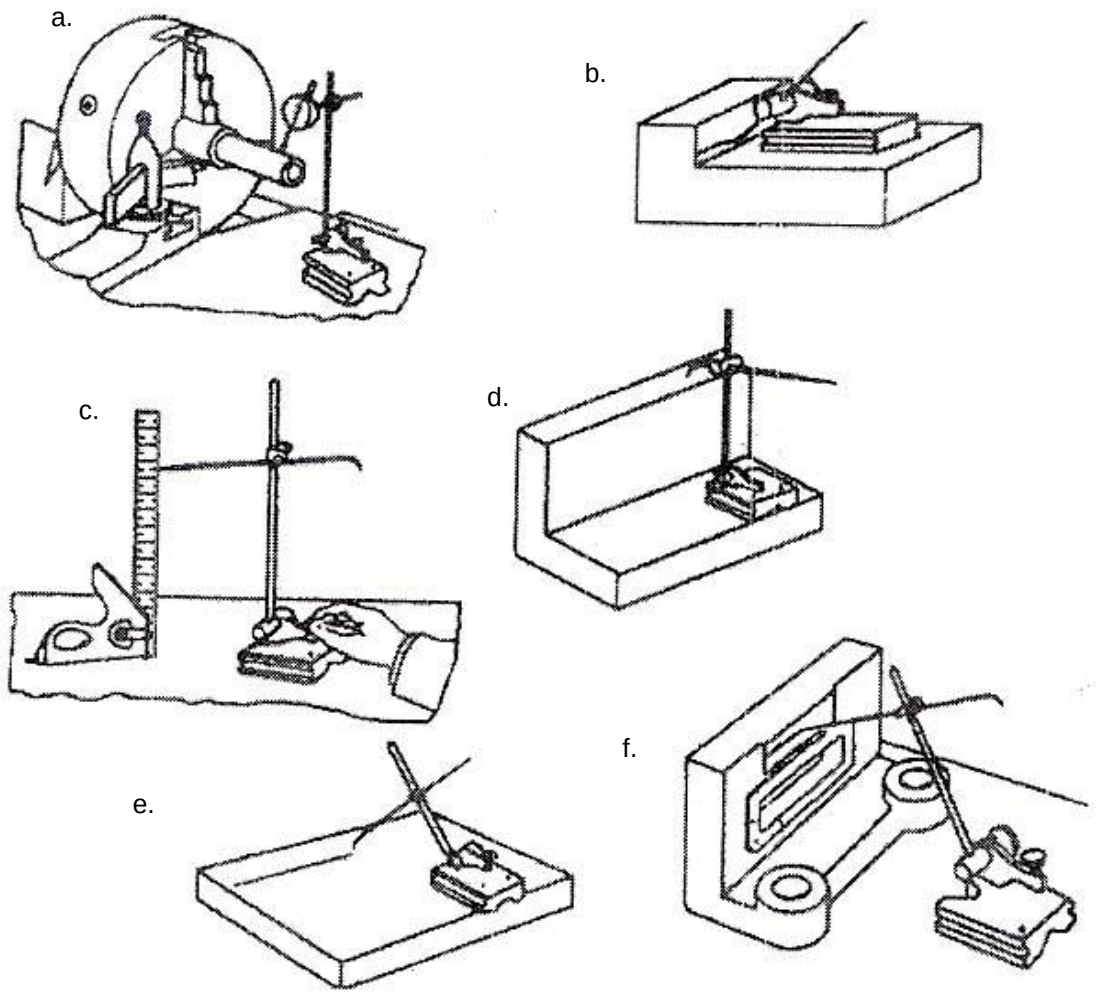


FIG 44.

a. As a dial gauge stand for accurate setting up on a lathe. The scriber can be used instead of the dial gauge for the initial setting up.
b. Scribing a line parallel to a surface.
c. Setting a height to a combination square and rule.
d. Checking a surface for parallelism.
e. Using the friction pins to scribe a line parallel to an edge.
f. Marking off a casting for machining.

See the next page for a practical example on using a surface gauge.

B. Practical example of using a surface gauge –

Marking off a keyway.

- Place the shaft in two v-blocks on the marking-off table. (Fig 45)

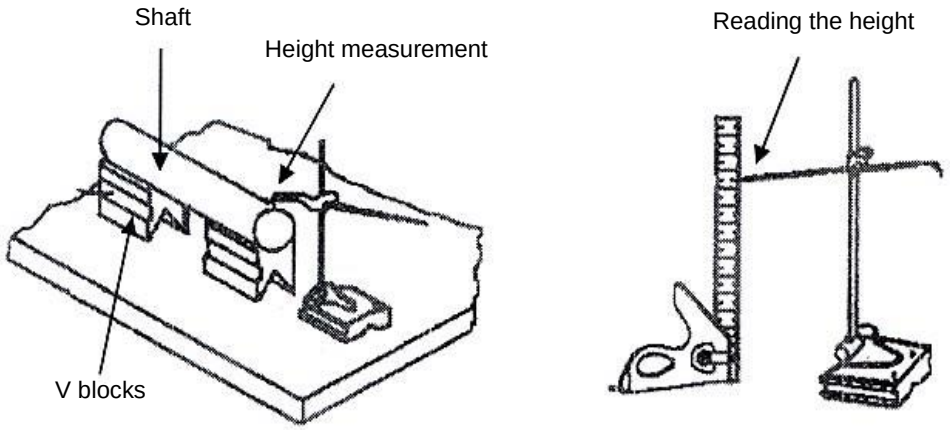


FIG 45.

- Spray the end and one side of the shaft with marking blue.
- Measure the height to the top of the shaft, and read it against the rule as shown in Figure 45.
- Deduct half the shaft diameter from this height and set the surface gauge to this new height as shown in Fig 46.

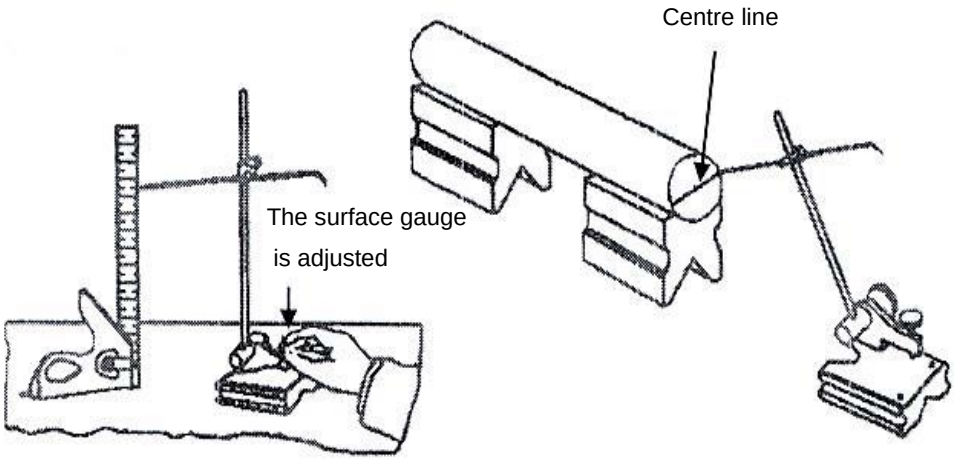


FIG 46.

- Scribe a line on the sprayed end of the shaft (Fig 46), turn the shaft through 180° in the v-blocks and scribe another line.
- If there are two lines you must split the difference and scribe a third line in the centre of these lines.

- Adjust the scriber up by half the width of the keyway and scribe a line on the end and the side of the shaft.
- Adjust the scriber down by the full width of the keyway and repeat the above step. You will now have a pattern as shown in Fig 47.
- Mark the depth of the keyway off on one of the lines on the end of the shaft. Turn the shaft through 90° and set the centre line vertical with a try square. (Fig 48)

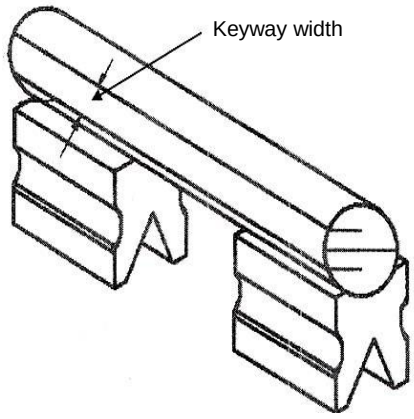


FIG 47.

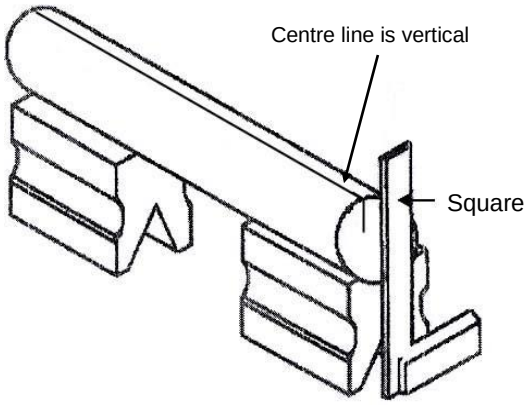


FIG 48.

- Adjust the surface gauge to the mark indicating the depth of the keyway and scribe a line to cut the width lines of the keyway. (Fig 49)

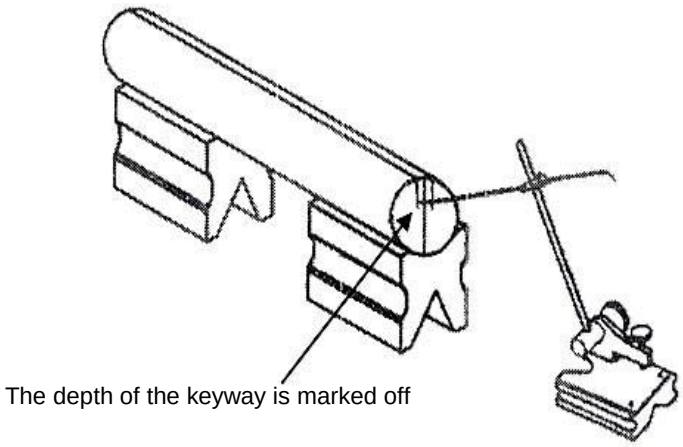
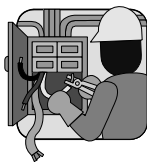


FIG 49.

The marking off of the keyway is now complete.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practise marking off a keyway on a shaft using a universal surface gauge, a combination square and rule.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

15. THE VERNIER HEIGHT GAUGE

ITEM / TASK: Uses for the vernier height gauge.

DESCRIPTION:

A vernier height gauge is used to mark off workpieces.

ITEM / TASK: Construction of a vernier height gauge.

DESCRIPTION:

A. See Fig 50 for the construction of a vernier height gauge.
   It consists of:
   - a heavy base,
   - a graduated beam, and
   - a slide with vernier scales which holds the scriber and clamp for fine adjustments.

B. It is very similar to a big vernier calliper except that the heavy base allows that the gauge stands upright with the slide that can move up and down.

C. The vernier height gauge scriber is usually provided with a carbide point, which is ground to a sharp point. Since the height of this sharp point must correspond with the reading on the vernier it is assured that lines drawn with the scriber are absolutely accurate.

D. Vernier height gauges are available in various sizes.

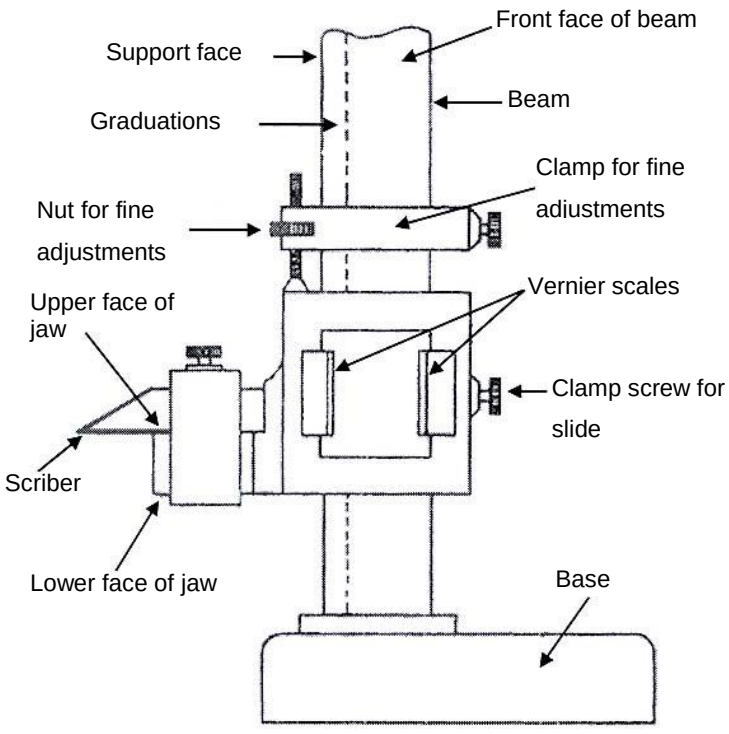


FIG 50.

ITEM / TASK: How to use a vernier height gauge.

DESCRIPTION:

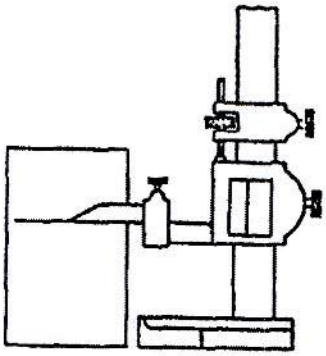
A. A vernier height gauge is a precise measuring and marking off instrument and must be handled with care to ensure that it remains accurate.

Note:

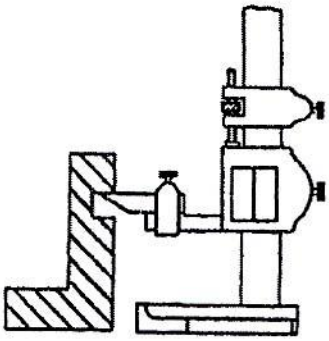
It must not be used where a scribing block can be used.

B. Ensure that the vernier height gauge is always free of oil, rust and dust. Always keep the instrument in its container in a safe place.
C. The vernier height gauge is used as follows:
    - Move the sliding scale near to the required height measurement on the graduated beam.
    - Use the fine adjustment of the sliding scale until the accurate height is obtained.
    - Tighten the clamping screw on the fine adjustment and make sure that the required height is correct.
    - Move the vernier height gauge closer to the workpiece and scribe the required line.
    - The same method can be used when measurements have to be transferred from one workpiece to another.

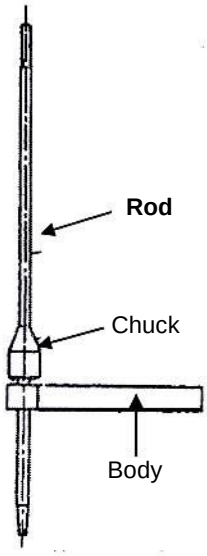
Figure 51 on the next page illustrates the different ways in which the vernier height gauge can be used.



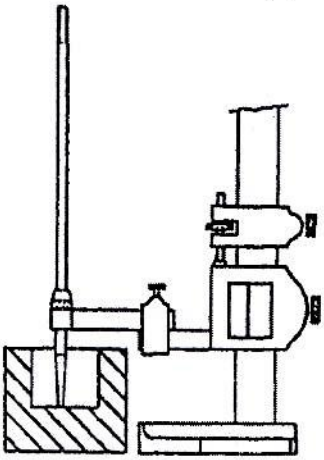
Scribing a line



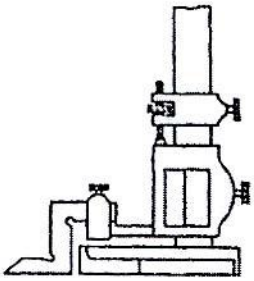
Taking measurements in a slot

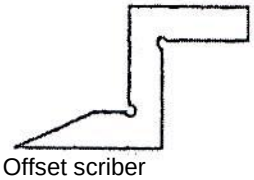


Depth gauge attachment



Using a depth gauge attachment





Offset scriber

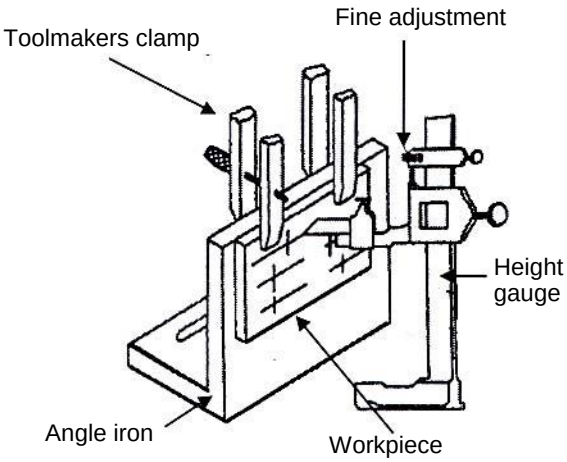


FIG 51.

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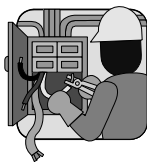


PRACTICE

In order to use the vernier height gauge correctly, it is important that you use the instrument often in all the applications shown in the notes.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

16. THE DIAL TEST INDICATOR

ITEM / TASK: Applications of the dial test indicator.

DESCRIPTION:

Dial test indicators have many uses in precision engineering such as:

- checking the parallelism and concentricity of shafts,
- setting up workpieces prior to marking off or machining.

ITEM / TASK: Use the dial test indicator.

DESCRIPTION:

A. The most commonly used type of dial test indicator operates by means of a rack and pinion movement as shown in Fig 52.

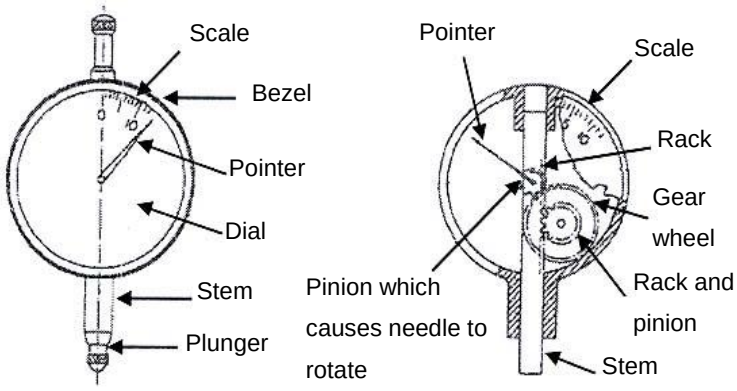


FIG 52.

B. The dial test indicator is a precision instrument, by means of which variations in the measurements and movements of a workpiece may be visually checked. The amount of variation is registered on a dial in 0.01 mm or 0.1 mm quantities.

   The big reading scale is divided in 0.01 mm and the small reading scale is divided in millimetres. (Fig 53 on the next page)

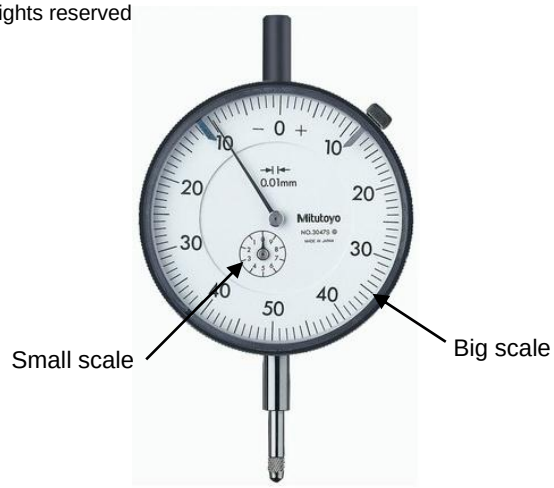


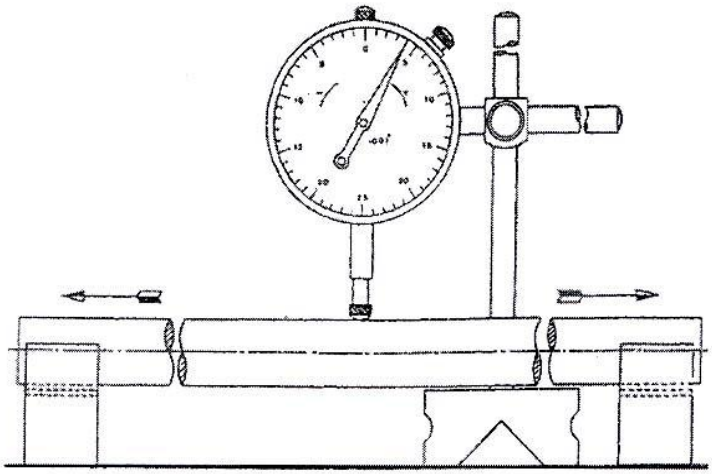
FIG 53.

C. When the pointer on the big reading scale moves through 360º positive or negative, the pointer on the small reading scale moves one millimetre positive or negative.
D. When the plunger of the dial test indicator is pushed upward (towards the instrument), the pointer moves in a positive direction. When the plunger is moved outward (away from the instrument), the pointer moves in a negative direction. (See Fig 52)

ITEM / TASK: Applications for dial test indicators.

DESCRIPTION:

A. Checking the parallelism of shafts. (Fig 54)



Checking the parallelism of a shaft

FIG 54.

- Support the shaft on V-blocks on a clean marking off table, taking care that the shaft does not sag.
- Set the plunger of the dial test indicator over the centre of the shaft.

- Ensure that there is sufficient pressure on the plunger so that any variation in the parallelism will be registered on the dial.
- Move the dial test indicator along the centre of the shaft.
- Note any variation, which may be registered.
- Alternatively, the shaft may be supported between centres in a lathe and the dial test indicator clamped in the tool post and then moved by turning the longitudinal feed hand wheel on the lathe.

B. Checking the concentricity of a shaft.

A magnetic base is a useful accessory for doing this check and can be used as shown in Fig 55.

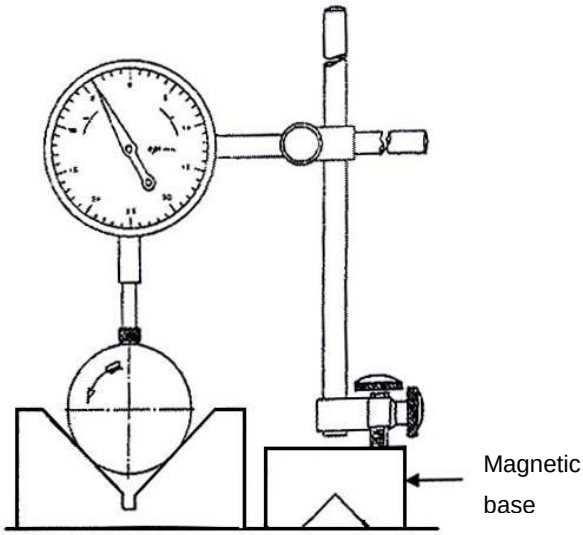


FIG 55.

- Support the shaft on V-blocks on a clean marking-off table.
- Set the plunger of the dial test indicator over the centre of the shaft.
- Ensure that there is sufficient pressure on the plunger so that any variation in the concentricity of the shaft will be registered on the dial.
- Ensure that the shaft does not sag.
- Rotate the shaft slowly by hand, noting movement, if any, of the pointer.
- Movement of the pointer indicates variation in the roundness of the shaft or possibly a bent shaft.

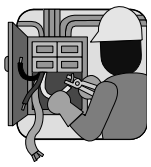
ITEM / TASK: Care of the dial test indicator.

DESCRIPTION:

The dial test indicator is a sensitive precision instrument that must be well cared for.

- Ensure that the instrument is free from oil, rust dirt and grit.
- Before using the instrument, clean all surfaces to be checked as well as the instrument.
- Always handle the instrument gently. Sometime even slight bumps can damage it.
- Store the instrument in its appropriate packing case.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

In order to use the dial test indicator correctly, it is important that you use the instrument often in all the applications shown in the notes.

Ask your Training Officer to sign you off when you have completed the task correctly and achieved the required standards.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

REMEMBER ALWAYS WORK SAFE

Once you have passed the entire self tests and practices, you are now at liberty to request a Formative Assessment from your Assessor.