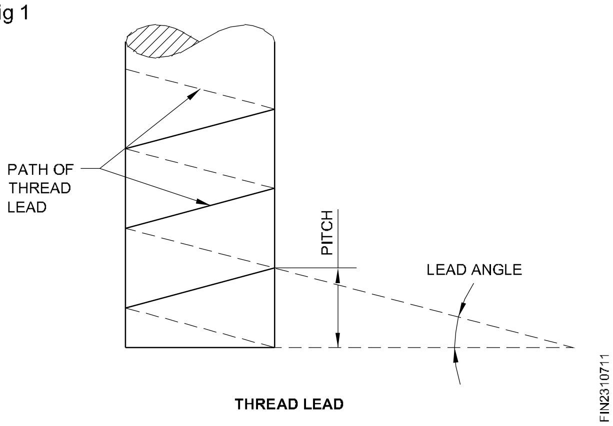
Screw thread

Objectives: At the end of this lesson you shall be able to
- **define screw thread**
- **state the use of screw thread.**

Definition

Thread is a ridge of uniform cross-section which follows the path of a helix around the cylinder or cone, either externally or internally. (Fig 1)

Fig 1



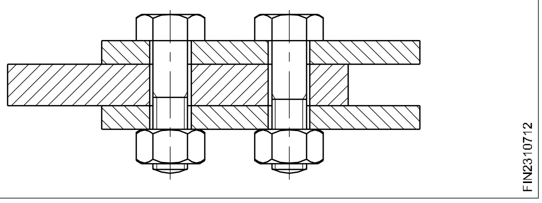
Helix is a type of curve generated by a point which is moving at a uniform speed around the cylinder or cone and at the same time, moves at a uniform speed parallel to the axis. (Fig 1)

Uses of Screw threads

Screw threads are used

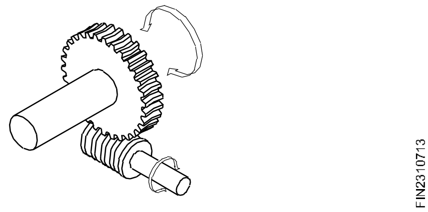
- As fasteners to hold together and dismantle components when needed. (Fig 2)

Fig 2



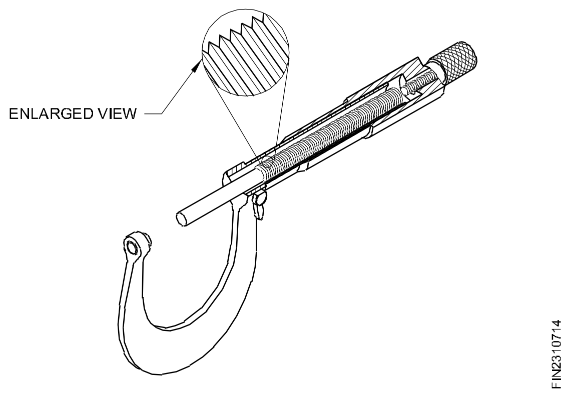
- To transmit motion on machines from one unit to another. (Fig 3)

Fig 3



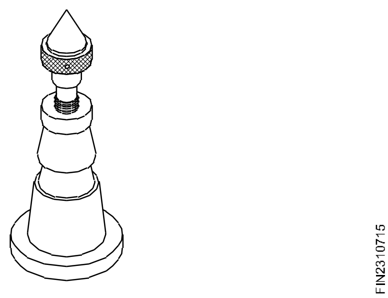
- To make accurate measurements. (Fig 4)

Fig 4



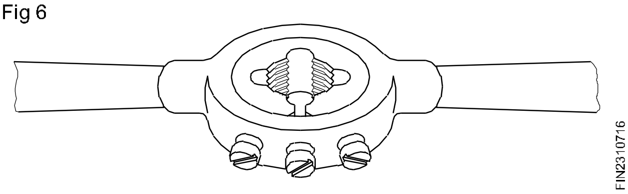
- To apply pressure. (Fig 5)

Fig 5



- To make adjustments. (Fig 6)

Fig 6



Square, worm, buttress and acme threads

Objectives: At the end of this lesson you shall be able to
- **identify square thread and specify its uses**
- **state the relationship between the pitch and the other elements of square threads**
- **identify the modified square thread and its applications**
- **identify the different forms of trapezoidal threads and their uses**
- **state the relationship between the pitch and the other elements of all the different forms of trapezoidal threads.**

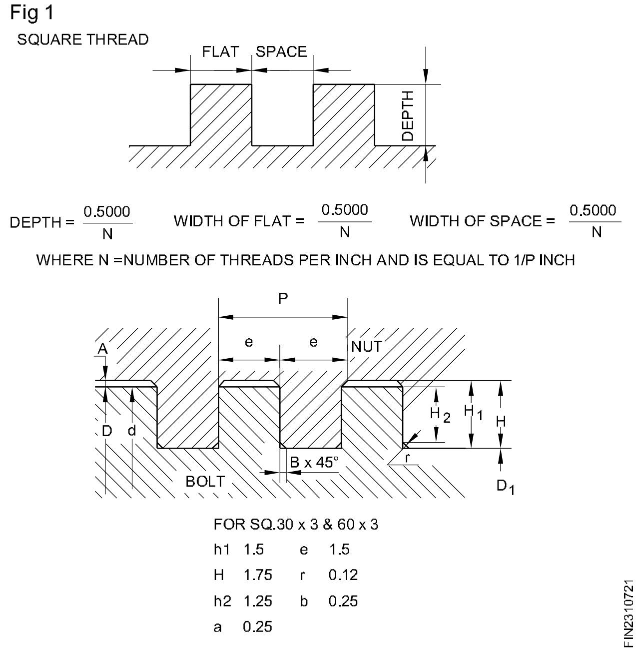
Square and trapezoidal threads

Square and trapezoidal threads have more cross-sectional area than ‘V’ threads. They are more suitable to transmit motion or power than ‘V’ threads. They are not used for fastening purposes.

Square thread

In this thread the flanks are perpendicular to the axis of the thread. The relationship between the pitch and the other elements is shown in Fig 1.

Fig 1



Square threads are used for transmitting motion or power. Eg. screw jack, vice handles, cross-slide and compound slide, activating screwed shafts.

Designation

A square thread of nominal dia. 60mm and pitch 9mm shall be designated as Sq. 60 x 9 IS: 4694-1968. The dimensions a, b, e, p, H_1, h_1, h_2 & d_1 are changed as per thread series (fine, normal & coarse).

Modified square thread

Modified square threads are similar to ordinary square threads except for the depth of the thread. The depth of thread is less than half pitch of the thread. The depth varies according to the application. The crest of the thread is chamfered at both ends to 45° to avoid the formation of burrs. These threads are used where quick motion is required.

Trapezoidal threads

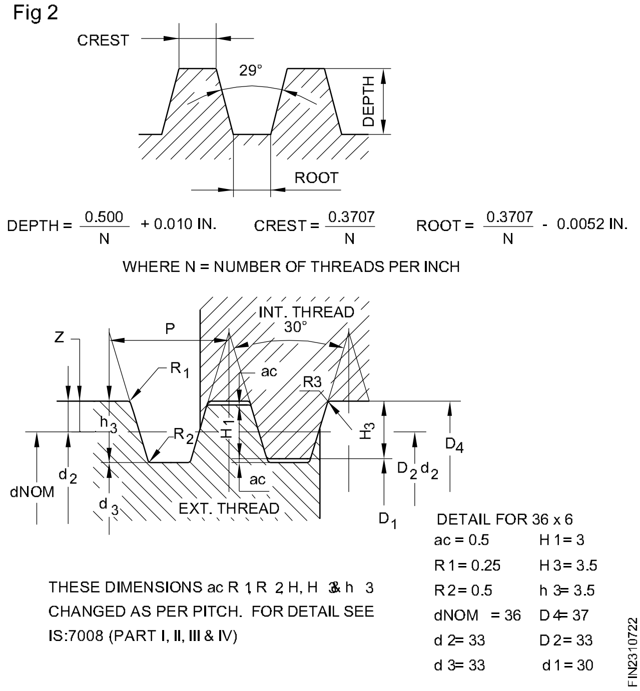
These threads have a profile which is neither square nor ‘V’ thread form and have a form of trapezoid. They are used to transmit motion or power. The different forms of trapezoidal threads are:

- Acme thread
- Buttress thread
- Saw-tooth thread
- Worm thread.

Acme thread (Fig 2)

This thread is a modification of the square thread. It has an included angle of 29°. It is preferred for many jobs because it is fairly easy to machine.

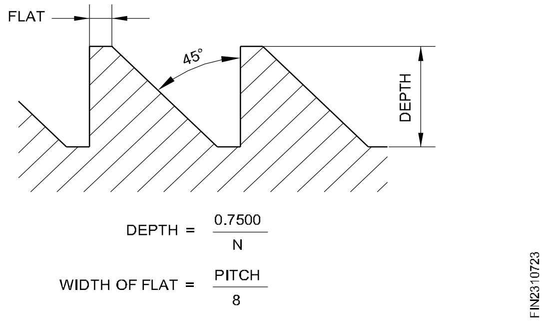
Fig 2



Acme threads are used in lathe lead screws. This form of thread enables the easy engagement of the half nut. The metric acme thread has an included angle of 30°. The relationship between the pitch and the various elements is shown in the figure.

Buttress thread (Fig 3)

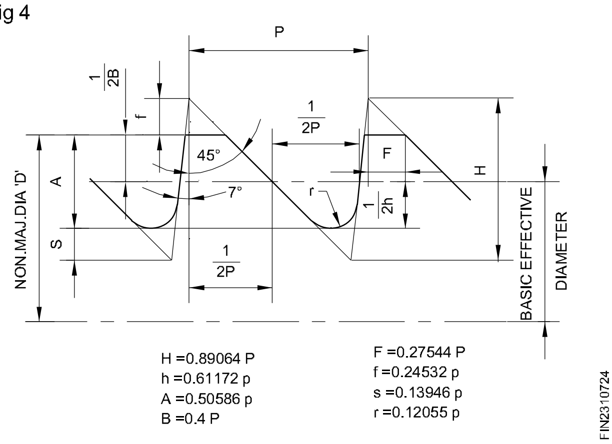
Fig 3



In buttress thread one flank is perpendicular to the axis of the thread and the other flank is at 45°. These threads are used on the parts where pressure acts at one flank of the thread during transmission. Figure 3 shows the various elements of a buttress thread. These threads are used in power press, carpentry vices, gun breeches, ratchets etc.

Buttress thread as per B.I.S. (Fig 4)

Fig 4



This is a modified form of the buttress thread. Figure 4 shows the various elements of the buttress thread. The bearing flank is inclined by 7° as per B.I.S. and the other flank has a 45° inclination.

Saw-tooth thread as per B.I.S. 4696

This is a modified form of buttress thread. In this thread, the flank taking the load is inclined at an angle of 3°, whereas the other flank is inclined at 30°. The basic profile of the thread illustrates this phenomenon. (Fig 5) The proportionate values of the dimensions with respect to the pitch are shown in Figs 6 and 7.

Fig 5

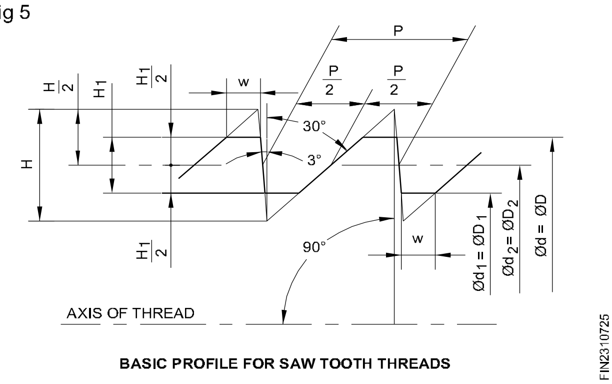


Fig 6

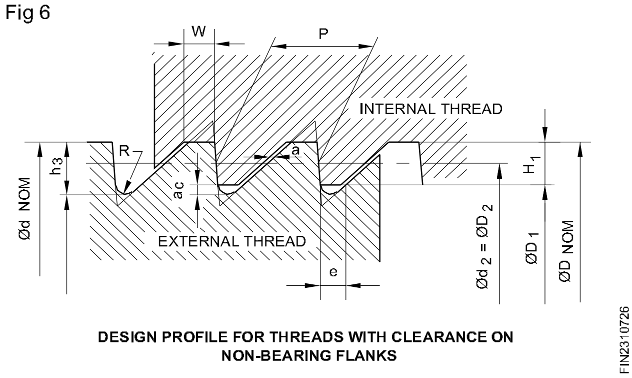
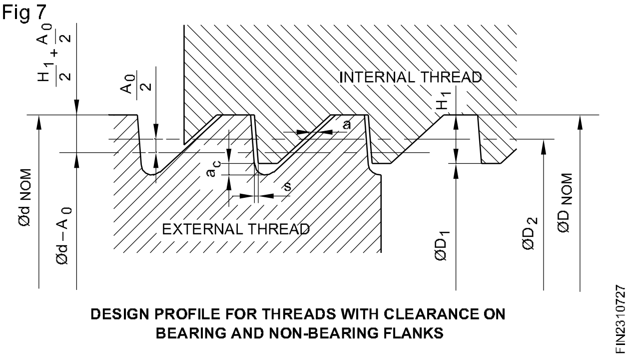


Fig 7



The equations associated with the dimensions indicated in the two figures (Figs 6 and 7) are given below.

$H_1 = 0.75\ P$

$h_3 = H_1 + a_c = 0.867\ 77\ P$

$a = 0.1\ \overline{P}$ (axial play)

$a_c = 0.117\ 77\ P$

$W = 0.263\ 84\ P$

$e = 0.263\ 84\ P - 0.1$ Ö $P = W - a$

$R = 0.124\ 27\ P$

$D_1 = d - 2\ H_1 = d - 1.5\ P$

$d_3 = d - 2\ h_3$

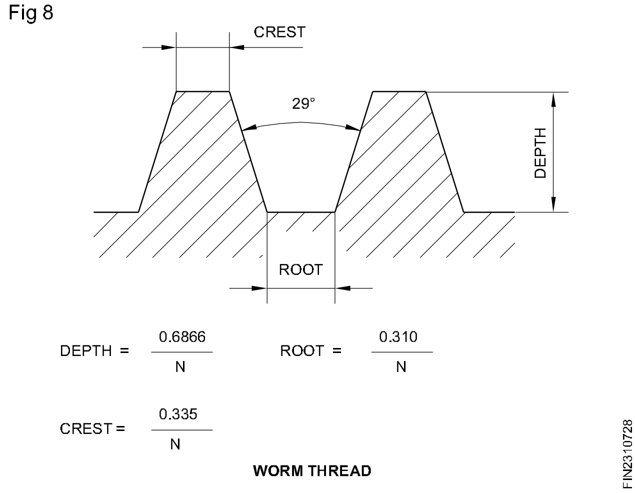
$d_2 = D_2 = d - 0.75\ P$

$S = 0.314\ 99\ A_o$, where A_o = basic deviation (= upper deviation) for external thread in the pitch diameter.

Worm thread

This is similar to acme thread in shape but the depth of thread is more than that of acme thread. This thread is cut on the worm shaft which engages with the worm wheel. Figure 8 shows the elements of a worm thread.

Fig 8



WORM THREAD

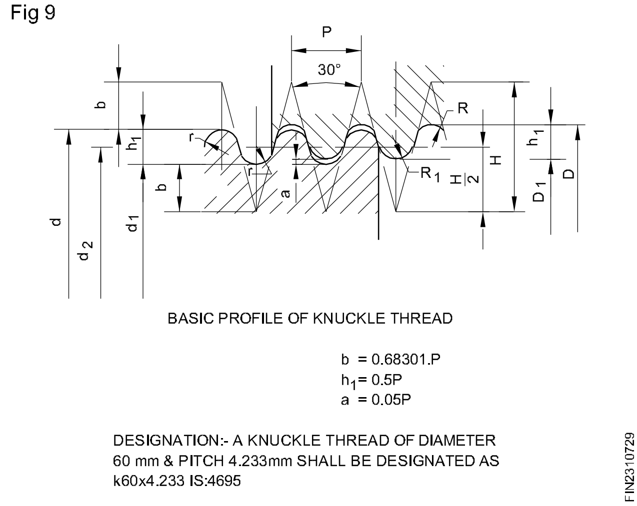
The worm wheel and worm shaft are used in places where motion is to be transmitted between shafts at right angles. It also gives a high rate of speed reduction. The worm wheel is generally cut by diametral pitch (D.P) or module pitch cutters. Diametral pitch (D.P) is the ratio between the number of teeth to the pitch diameter (P.D.) of the gear. Module is the ratio between the pitch diameter of the gear and the number of teeth of the gear.

The linear pitch of the worm thread must be equal to the circular pitch of the worm gear. When the worm gear is of D.P. then the linear pitch of the worm thread in mesh is equal to p/DP. When the worm gear is of module teeth, then the linear pitch of the worm thread is equal to module x p. In some of the lathes, a chart illustrates the position of levers of the quick change gearbox together with the change gear connections for cutting D.P. or module worm threads.

Knuckle threads

The shape of the knuckle thread is not trapezoidal but it has a rounded shape. It has limited application. The figure shows the form of knuckle thread. It is not sensitive against damage as it is rounded. It is used for valve spindles, railway carriage couplings, hose connections etc. (Fig 9)

Fig 9



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Principle of cutting screw thread in centre lathe

Objectives: At the end of this lesson you shall be able to
- **state the principle of thread cutting by a single point tool**
- **list the parts involved in the thread cutting mechanism and state their functions**
- **derive formula for change gear calculation.**

Principle of thread cutting

The principle of thread cutting involves producing a uniform helical groove on a cylindrical or conical surface by rotating the job at a constant speed, and moving the tool longitudinally at a rate equal to the pitch of the thread, per revolution of the job.

The cutting tool moves with the lathe carriage by the engagement of a half nut with the lead screw. The shape of the thread profile on the work is the same as that of the tool ground. The direction of rotation of the lead screw determines the hand of the thread being cut.

Parts involved in thread cutting

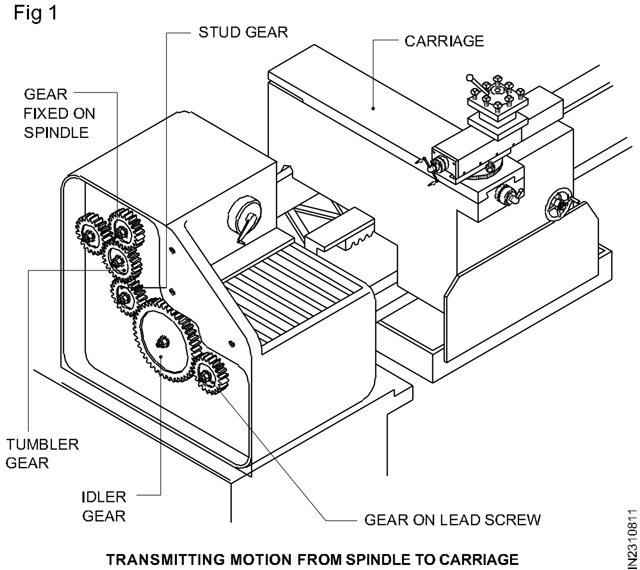
Figures 1 & 2 illustrate how the drive is transmitted from the spindle to the lead screw through a change gear arrangement. From the lead screw the motion is transmitted to the carriage by engaging the half nut with the lead screw.

Derivation of the formula for change gears

Example

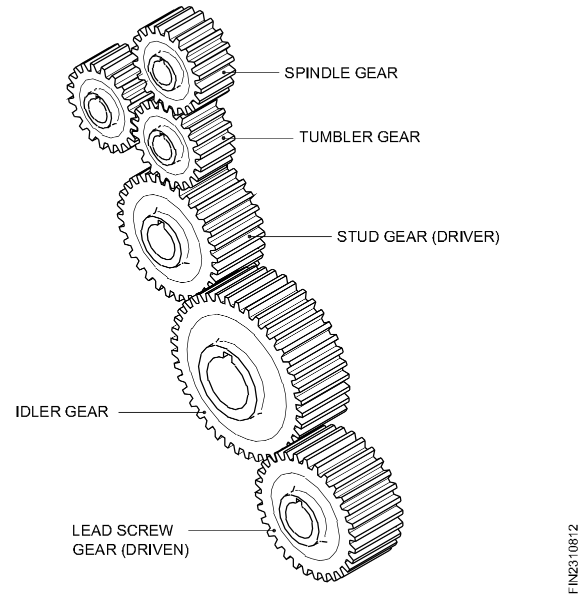
CASE 1 : To cut 4 mm pitch (lead) thread on the job in a lathe having a lead screw of 4 mm pitch.

Fig 1



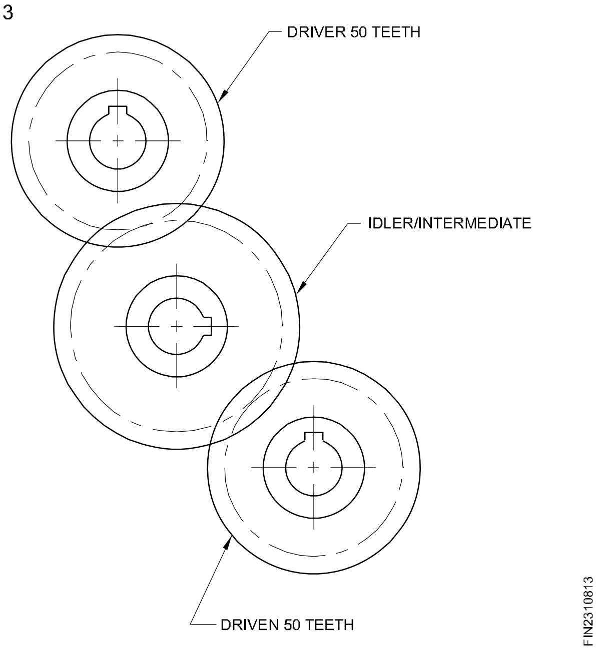
TRANSMITTING MOTION FROM SPINDLE TO CARRIAGE

Fig 2



When the job rotates once, the lead screw should make one revolution to move the tool by 4 mm. Hence, if the stud gear (Driver) has a 50 teeth wheel, the lead screw should be fixed with a gear of 50 teeth (Driven) to get the same number of revolutions as the spindle. (Fig 3)

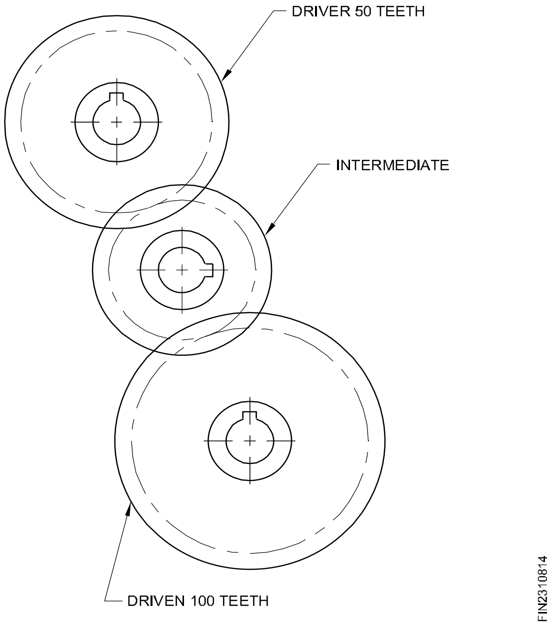
Fig 3



CASE 2 : To cut 2 mm pitch threads instead of 4 mm in the same lathe.

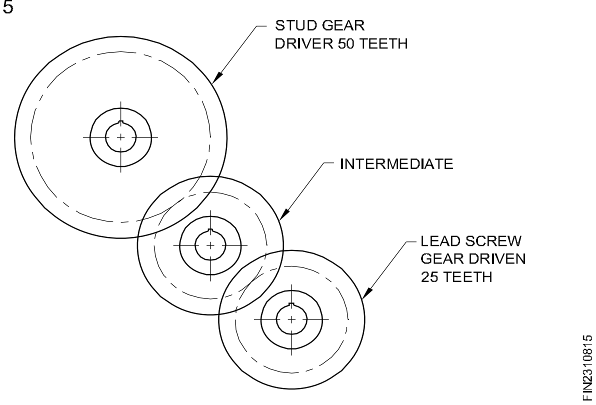
When the job makes one rotation, the lead screw should rotate 1/2 revolution so that the lead screw rotation is slower. Therefore, the driven wheel (lead screw gear) should be of 100 teeth if the driver (stud gear) is of 50 teeth. (Fig 4)

Fig 4



CASE 3 : If we have to cut a 8 mm pitch thread on a job, with a 4mm lead screw pitch, the tool should move 8 mm per revolution of the job. The lead screw should rotate 2 revolutions when the job makes one rotation, making the L S to run twice as fast as the spindle. So the driven wheel (lead screw gear) should be of 25 teeth if the driver wheel is of 50 teeth. (Fig 5)

Fig 5



Let us compare the above three examples.

Examples :	Case 1	Case 2	Case 3
Pitch(Lead) of job	4	2	8
Pitch(Lead) of L.S	4	4	4
Driver	50	50	50
Driven	50	100	25

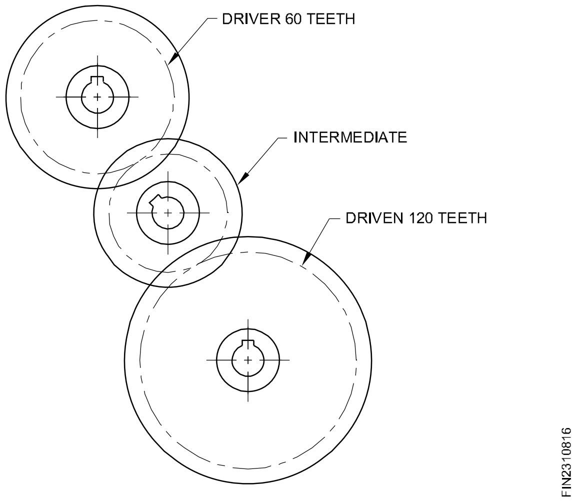
Stating the above in a formula,

$$\text{The gear ratio} = \frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead of work}}{\text{Lead of lead screw}}$$

Solved examples

1 Find the change gears required to cut a 3 mm pitch on a job in a lathe, having a lead screw of 6 mm pitch. (Fig 6)

Fig 6



Ratio = Driver = Lead of work

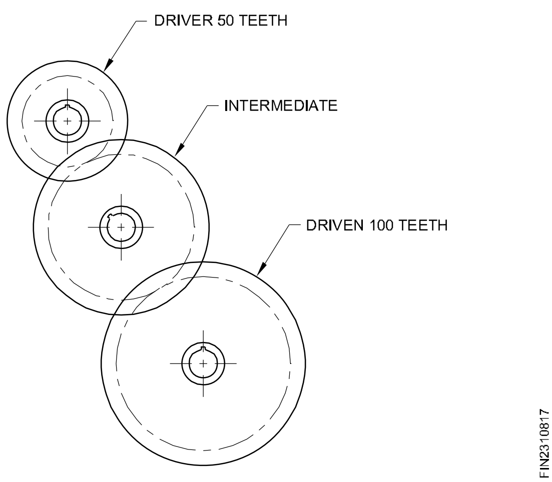
$$\text{The gear ratio} = \frac{3}{6} = \frac{3 \times 20}{6 \times 20} = \frac{60}{120}$$

Driver = 60 teeth

Driven = 120 teeth

2 Find the change gears required to cut a 2.5 mm pitch in a lathe, having a lead screw of 5 mm pitch. (Fig 7)

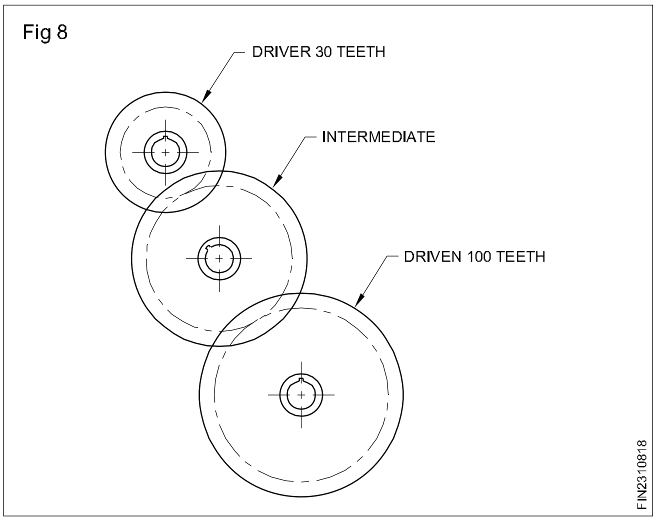
Fig 7



$$\text{Ratio} = \frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead of work}}{\text{Lead of lead Screw}}$$

$$= \frac{2.5}{5} = \frac{2.5 \times 20}{5 \times 20}$$

$$= \frac{50\ \text{(Driver)}}{100\ \text{(Driven)}}$$



3 Calculate the gears required to cut a 1.5 mm pitch in a lathe having a lead screw of 5 mm pitch. (Fig 8)

$$\text{Ratio} = \frac{\text{Driver}}{\text{Driven}} = \frac{\text{Lead of work}}{\text{Lead of lead Screw}}$$

$$= \frac{1.5}{5} = \frac{3}{10} = \frac{3 \times 10}{10 \times 10}$$

$$= \frac{30\ \text{(Driver)}}{100\ \text{(Driven)}}$$

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Principle of chasing screw thread

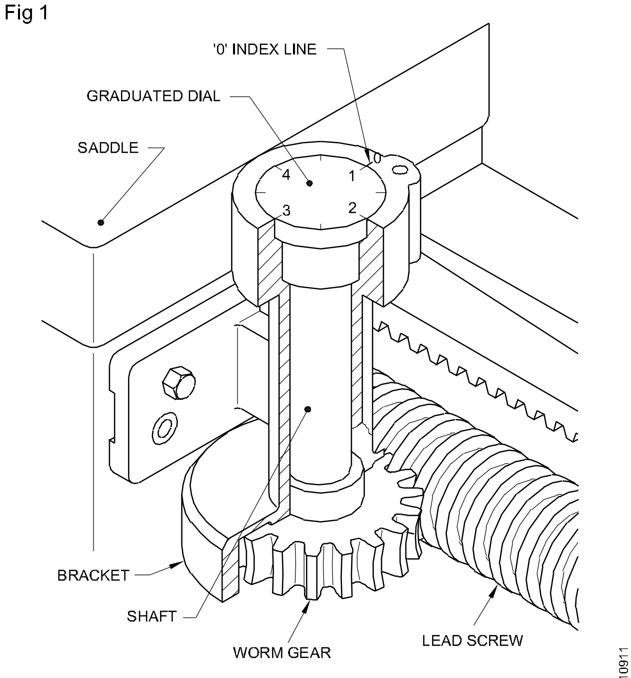
Objectives: At the end of this lesson you shall be able to
- **state the necessity of a thread chasing dial**
- **state the constructional details of a British thread chasing dial**
- **state the functional features of a British thread chasing dial.**

Thread chasing dial

To catch the thread quickly and to save manual labour, use of a chasing dial is very common during thread cutting by a single point cutting tool. A thread chasing dial is an accessory.

Constructional details (Fig 1)

Fig 1



THREAD CHASING DIAL MECHANISM

The figure shows constructional details of a British thread chasing dial. It consists of a vertical shaft with a worm wheel made out of brass or bronze, attached to the shaft at the bottom. On the top, it has a graduated dial. The shaft is carried on a bracket in bearing (bush) which is fixed to the carriage. The worm wheel can be brought into an engaged or disengaged position with the lead screw as needed. When the lead screw rotates it drives the worm wheel which causes the dial to rotate. The movement of the dial is with reference to the fixed mark ('O' index line).

The face of the dial is usually graduated into eight (8) divisions, having 4 numbered main divisions and 4 unnumbered subdivisions in between.

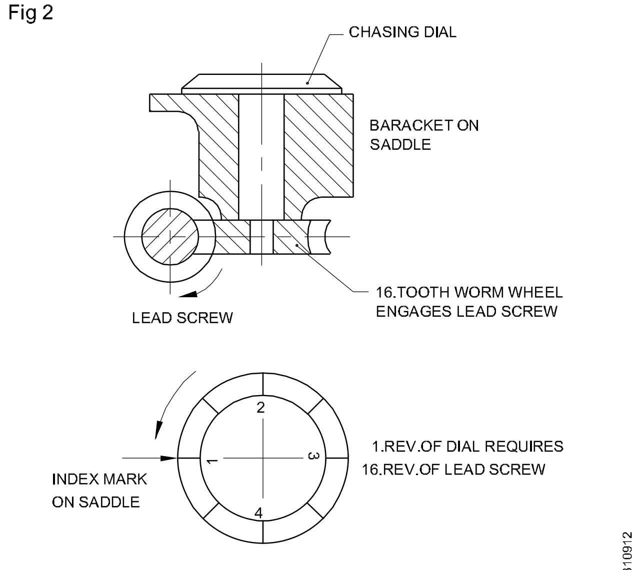
The number of teeth on the worm gear is the product of the number of threads per inch on the lead screw and the number of numbered divisions on the dial.

Each numbered division represents 1 inch travel of the carriage.

Let the worm wheel have 16 teeth, and the lead screw 4 TPI. The number of numbered graduations and unnumbered graduations are 4 each.

The half nut can be engaged 8 times for one revolution of the graduated dial. The movement of the carriage for one complete revolution of the dial is 4". (Fig 2) Since the dial is having totally 8 graduations marked, each graduation represents 1/2" travel of the carriage.

Fig 2



PLAN VIEW OF DIAL

The chart given here shows the positions at which the half nut is to be engaged when cutting different threads per inch, when a British thread chasing dial with the above data is fitted to the lathe.

THREAD CHASING DIAL CHART

Threads per inch to be cut	Dial graduation at which the half nut can be engaged to catch the thread	Reading on the dial illustrated
Threads which are a multiple of the number of threads per inch of the lead screw.	Engage at any position the half nut meshes.	Use of dial unnecessary.

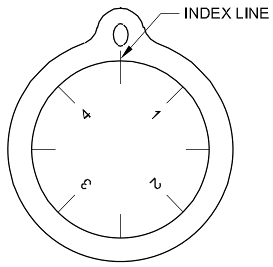
Example T.P.I. to be cut - 8

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I to be cut}} = \frac{4}{8} = \frac{1}{2}$$

Predetermined travel $= 1 \times \frac{1''}{4} = \frac{1''}{4}$

The predetermined travel of 1/4" is represented by the dial position in the exact middle between any numbered division and adjacent un-numbered division. The half nut engagement can be done at any position at which it can be engaged (ie. 16 positions).

Referring to the dial is not necessary.

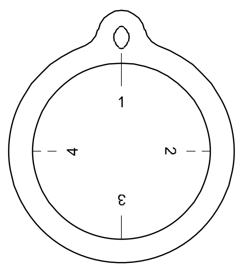
Even number of threads	Engage at any graduation on the dial. 8 positions 1 1 1/2 2 2 1/2 3 3 1/2 4 4 1/2	

Example T.P.I. to be cut - 6

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I to be cut}} = \frac{4}{6} = \frac{2}{3}$$

Predetermined travel $= 2 \times \frac{1''}{4} = \frac{1''}{2}$

The predetermined travel of 1/2" is represented by dial movement from any numbered division to the next adjacent unnumbered division. The half nut can be engaged when any numbered or unnumbered graduation coincides with the zero line (8 positions).

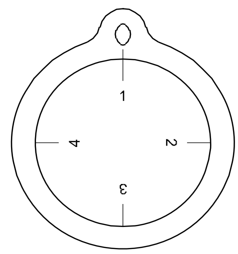
Odd number of threads	Engage at any main division. 4 positions 1 2 3 4	

Example T.P.I. to be cut - 5

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{5} = \frac{4}{5}$$

Predetermined travel $= 4 \times \frac{1''}{4} = 1''$

The predetermined travel of 1" is represented by the dial movement from any numbered division to the next numbered division or from any unnumbered division to the next unnumbered division. Therefore, if the first cut is taken when a numbered division of the dial coincides with zero, then the half nut engagement for successive cuts can be done when any numbered division coincides with the zero mark. If the first cut is taken when an unnumbered division coincides with the zero, then the half nut for successive cuts, is engaged when any unnumbered division coincides with the zero. (4 positions)

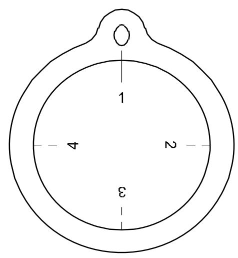
Half fractional number of threads	Engage at every other main division. 2 positions	1 & 3 or 2 & 4	

Example T.P.I. to be cut - 3 1/2

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{3\ 1/2} = \frac{8}{7}$$

Predetermined travel $= 8 \times \frac{1"}{4} = 2"$

The half nut can be engaged only at opposite numbered or unnumbered graduations (2 positions).

Quarter fractional number of threads	Engage at the same main division. 1 position	1 or 2 or 3 or 4	

Example T.P.I. to be cut - 2 3/4

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{2\ 3/4} = \frac{16}{11}$$

Predetermined travel $= 16 \times \frac{1"}{4} = 4"$

The half nut can be engaged to catch the thread only when the same numbered or unnumbered graduated line, at which the first cut is taken, coincides with the zero line (1 position only).

Example T.P.I. to be cut - 1 3/8

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{1\ 3/8} = \frac{32}{11}$$

Predetermined travel $= 16 \times \frac{1"}{4} = 4"$

The half nut engaged for the first cut should remain at the engaged position till thread cutting is completed and the machine is reversed as it takes a long time to cover the predetermined travel arrived at by calculation.

Example T.P.I. to be cut - 1 3/8

$$\frac{DR}{DN} = \frac{\text{T.P.I. on lead screw}}{\text{T.P.I. to be cut}} = \frac{4}{1\ 3/8} = \frac{32}{11}$$

Predetermined travel $= 32 \times \frac{1"}{4} = 8"$

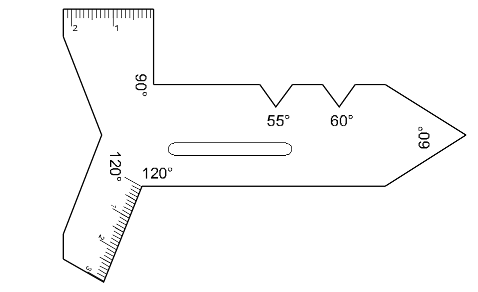
The half nut engaged for the first cut should remain at the engaged position till thread cutting is completed and the machine is reversed as it takes a long time to cover the predetermined travel arrived at by calculation.

Centre gauge

Objectives: At the end of this lesson you shall be able to
- **define centre gauge**
- **write the uses of centre gauge.**

Centre gauge: (Fig 1)

Fig 1



Centre gauges and fish tail gauges are gauges used in lathe work for checking the angles when grinding the profiles of single point screw cutting tool bits and centers. In the image, the gauge on the left is called a fishtail gauge or centre gauge, and the one on the right is another style of center gauge.

These gauges are most commonly used when hand grinding threading tool bits on a bench grinder, although they may be used with tool and cutter grinders.

When the tool bit has been ground to the correct angle, they may then be used to set the tool perpendicular to the workpiece.

They can incorporate a range of sizes and types on the one gauge, the two most common being metric or UNS at 60^0, and BSW at 55^0. Gauges also exist for the acme thread form.

Tool setting - external thread

Objectives: At the end of this lesson you shall be able to
- **tool setting to cut external thread by half angle method.**

Check the diameter of the workpiece to be threaded by referring to the drawing.

To provide thread clearance, it is good practice to turn the diameter of the workpiece undersize depending upon the requried.

Set the lathe spindle speed to about one fourth of the turning speed.

Set the gerarbox according to the pitch of thread to be cut.

Swivl the compound slide to 90° from the horizontal position to bring it in line with the cross-slide.

Swivel to the right 1° less than the half included angle of the thread it is a right hand thread. (Fig 1)

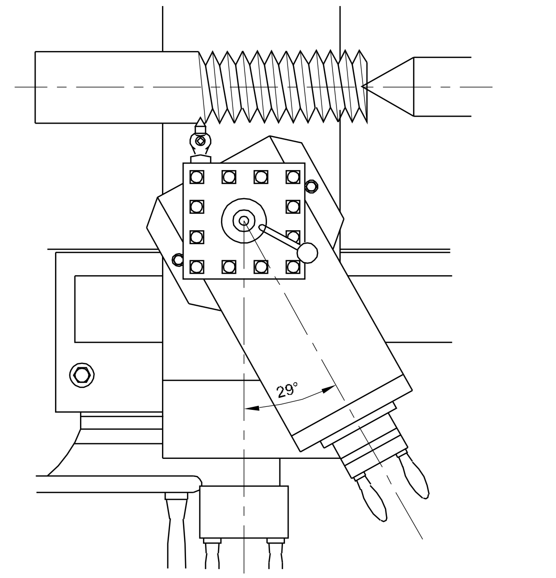
The angle to which the compound rest is set affects the cutting action of the cutting tool by producing a shearing action on the trailing edge of the tool. THis produces a smooth cut.

Set the tool in the tool post with a minimum overhand perpendicular to the axis and also set with a centre gauge. (Fig 2)

Mark out the length of the workpiece to be threaded.

Chamfer the end of the workpiece surface with the leading edge of the cutting tool to a depth, just greater than the minor diameter of the thread to be cut.

Fig 1



COMPOUND REST SET AT 29° TO THE RIGHT TO CUT A 60° INCLUDED ANGLE RIGHT HAND THREAD

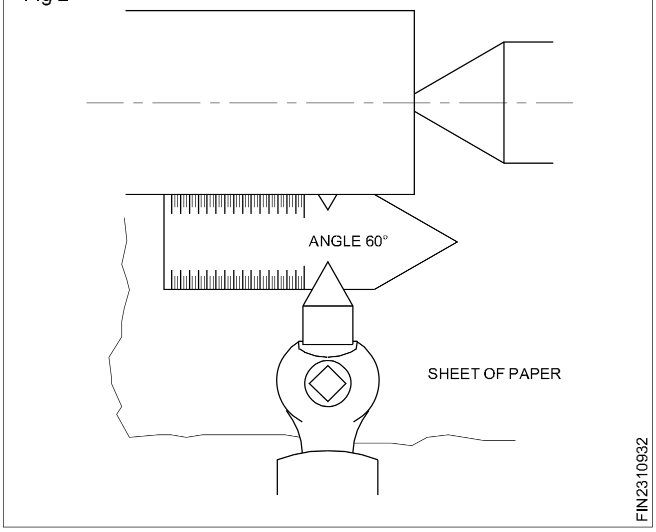
Advance the cutting tool to the work surface by operating the cross-slide hand wheel.

When the tip of the tool just touches the work surface, stop further advancement and set the cross-slide and compound slide graduated collars to zero.

Move the carriage to the right until the end of the tool clears the work.

Feed the tool in about 0.1 mm using the top slide hand wheel.

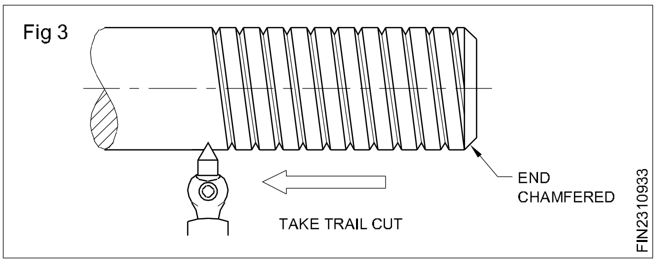
Fig 2



Engage the half nut referring to be chasing dial.

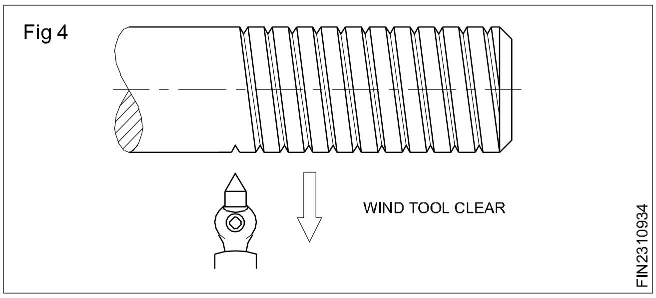
Take a trial cut along the workpiece to be threaded. (Fig 3)

Fig 3



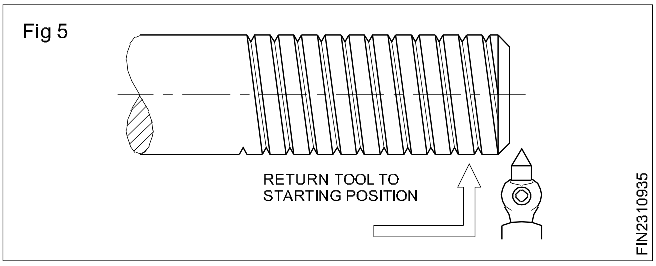
At the end of the trial cut, withdraw the tool immediately, winding it clear off the workpiece by operating the crossslide hand wheel and simultaneously reversing the machine. (Fig 4)

Fig 4



Allow the carriage to move to the right till it is cleared from the end of the work, and stop the machine. (Fig 5)

Fig 5



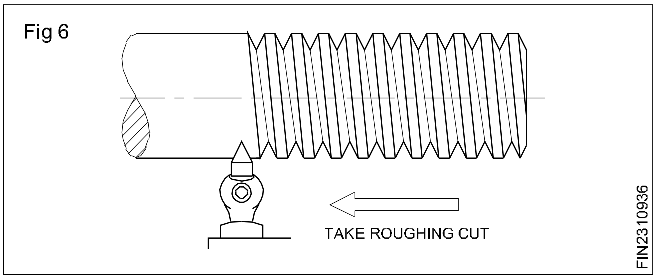
Check the thread formation with a pitch gauge.

Advance the tool by the cross-slide hand wheel toll zero postion.

Give depth of cut with the top slide handle.

Start the machine and allow the tool to cut the thread. (Fig 6)

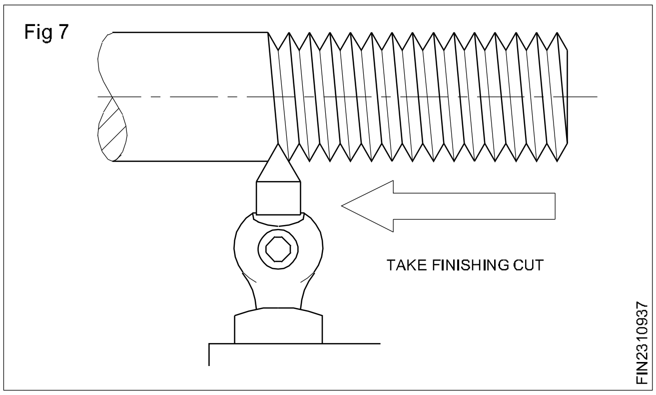
Fig 6



Use plenty of coolant during theading.

Repeat the steps till the required depth is reached. (Fig 7)

Fig 7



Note: At the end of each cut, the tool is withdrawn from the work by the cross-slide hand wheel and the carriage is brought to the starting point. The cross-slide hand wheel is brought to zero position and a depth of cut is given by the top slide.

Cutting an internal thread

Objectives: At the end of this lesson you shall be able to
- **tool setting to cut an internal thread.**

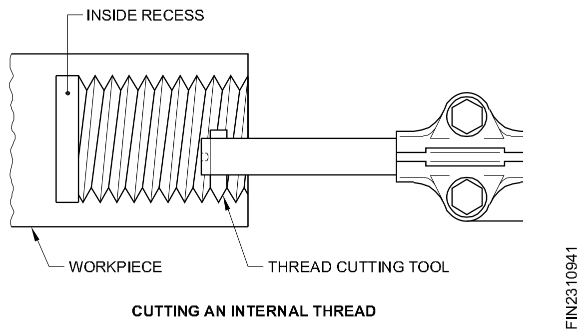
Mount the job on four jaw chick/three jaw chuck/ collect.

Drill and bore the job to the core diameter of the thread to required length/through hole.

For a blind hole, cut a recess at the end of the bore enough to permit the cutting tool to clear thread.

The recess must be larger than the major diameter of the thread. (Fig 1)

Fig 1

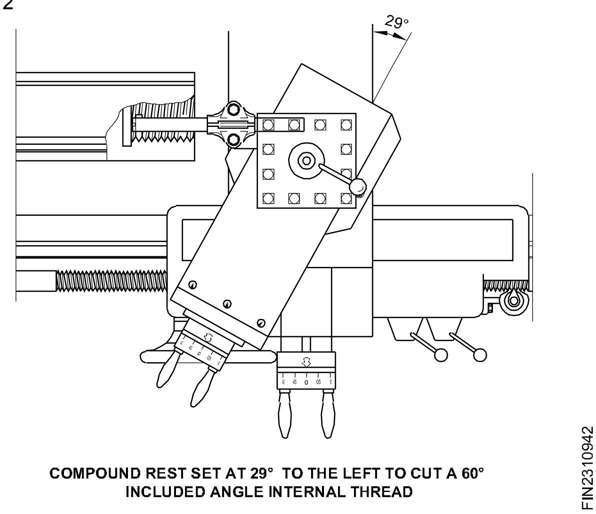


CUTTING AN INTERNAL THREAD

Chamfer the front end to 2x45°.

Set the compount rest at 29° to cut 60° included angle as shown in Fig 2.

Fig 2



COMPOUND REST SET AT 29° TO THE LEFT TO CUT A 60° INCLUDED ANGLE INTERNAL THREAD

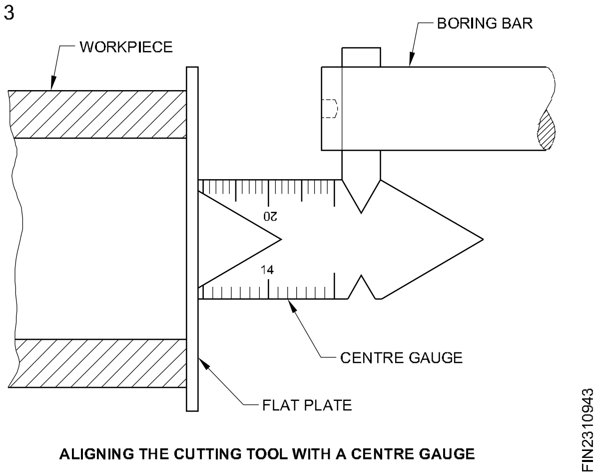
Set the gear box levers to the required pitch.

Fix the correctly ground threading tool in a boring bar.

Fix the boring bar parallel to the lathe centre line and set the point of the cutting tool to lie on the centre.

Align the cutting tool with a help of centre gauge as shown in Fig 3.

Fig 3



ALIGNING THE CUTTING TOOL WITH A CENTRE GAUGE

Mark the boring bar to indicate the required depth to entry into the bore.

Ensure that the boring bar does not foul anywhere on the job.

Reverse the cross slide until the tool point just touches the bore.

Set the cross-slide and compount slide graduated collars to zero.

Withdraw the cutting tool from the bore.

Set the spindle speed to 1/3 of the calculated r.p.m.

Start the machine.

Adjust the depth of cut to 0.1 mm.

Engage the half nut.

At the end of the cut, simultaneously reverse the chunk and clear the tool just away from the thread.

Ensure that the tool should not touch the thread in both side of the bore.

When cutting tool comes out of the bore stop the machine.

Give the depth of cut and run the machine in forward direction. Similarly finish the thread until final depth is achieved.

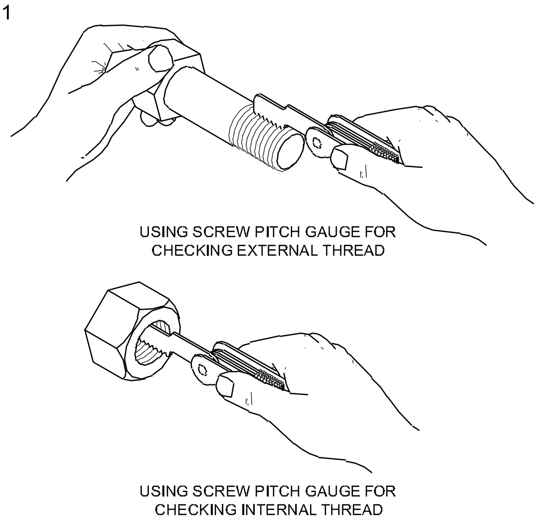
Check the finished thread with a thread plug gauge or a threaded bolt.

Screw pitch gauge (Refer Related theory ex.no. 2.1.68-69)

Objectives: At the end of this lesson you shall be able to
- **state the purpose of a screw pitch gauge**
- **state the features of a screw pitch gauge.**

For obtaining accurate results while using the screw pitch gauge, the full length of the blade should be placed on the threads. (Fig 1)

Fig 1



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