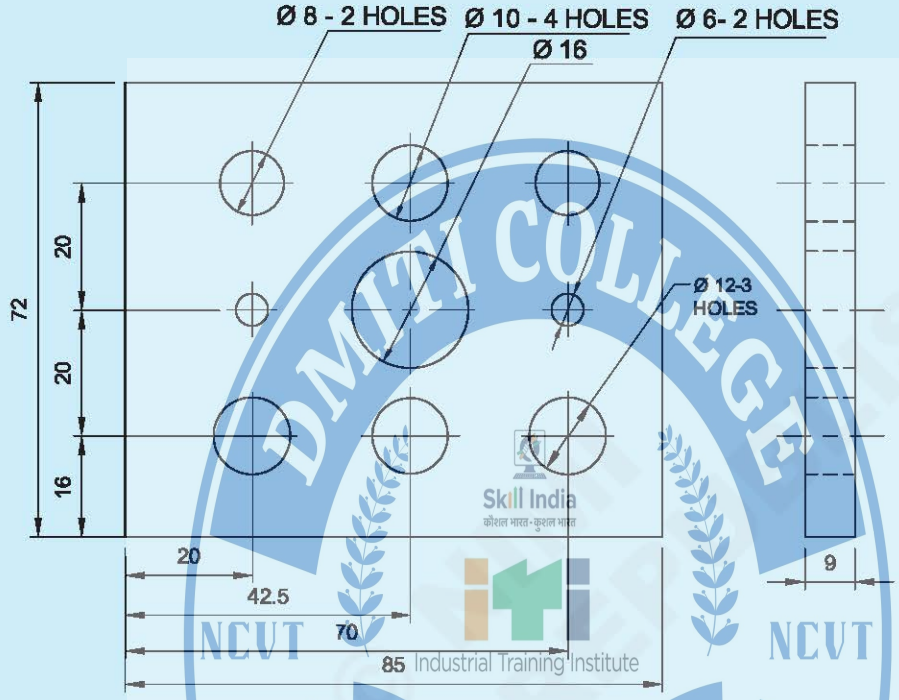
Mark off and drill through holes

Objectives: At the end of this exercise you shall be able to
- **mark drill holes as per drawing**
- **drill through holes using pillar drilling machine.**



Job Sequence

- Check the raw material for its size.
- File and finish to size 85 x 72 x 9 mm maintaining parallelism and perpendicularity.
- Mark drill holes as per drawing.
- Punch on drill hole centres using centre punch 90°
- Make centre drill in all drill hole centres.
- Fix Ø 6 mm drill and drill pilot holes in all centre drilled holes.
- Similarly fix Ø 8 mm, Ø 10 mm, Ø 12 mm, and 16mm drill in drilling machine and drill holes as per drawing.
- Finish de - burr in all the corners of the job.
- Check the size with vernier caliper.
- Apply a thin coat of oil and preserve it for evaluation.

1	75 ISF 10-90	-	Fe310	-	-	1.5.61
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE NTS	MARK OFF AND DRILL THROUGH HOLES				TOLERANCE : ± 0.04	TIME :
					CODE NO : FI20N1561E1	

Skill Sequence

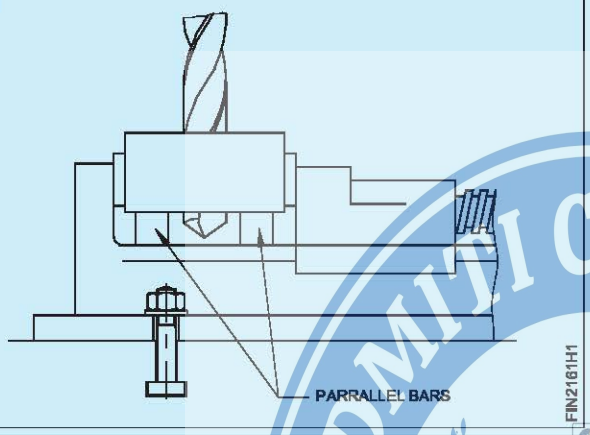
Drilling through holes

Objective: This shall help you to
- **drill through holes**

Punch the centre of the hole to be drilled by a centre punch.

Set the job in the machine vice securely by using two parallel bars to clear the drill (Fig 1)

Fig 1



Fix the drill chuck into the spindle of the drilling machine.

Fix centre drill and drill in all hole centres.

Fix Ø 6mm dia drill in the drill chuck for pilot hole.

Select the spindle speed by shifting the belt in the appropriate cone pulleys.

Drill all the holes first by Ø 6mm drill. This will serve as a pilot hole for Ø 8mm 10 mm, 12 mm and 16 mm dia drills.

Similarly, drill Ø 8mm hole, then drill 10 mm, 12 mm holes.

Remove the drill and drill chuck.

Fix Ø 16 mm taper shank drill in the drilling machine spindle.

Change the spindle speed to suit Ø 16 mm drill and drill the hole.

Caution: Do not remove chips with your bare hands - use brush.

Do not try to change the belt while the machine is running.

Ensure that the drill do not penetrate into the vice.

Fix securely the drill deep into the drill chuck. (Fig 2)

Since the web of large diameter drills are thicker, the dead centres of those drills do not sit in the centre punch marks. This can result in the shifting of the hole location. Thick dead centres can not penetrate into the material easily and will impose severe strain on the drill.

These problems can be overcome by drilling pilot holes initially. (Fig 3)

Fig 2

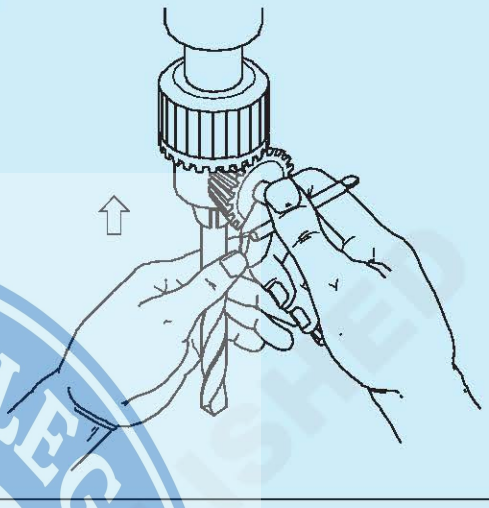
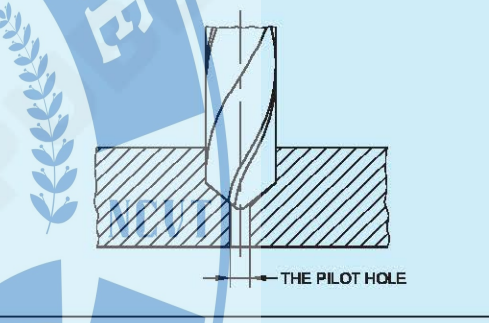


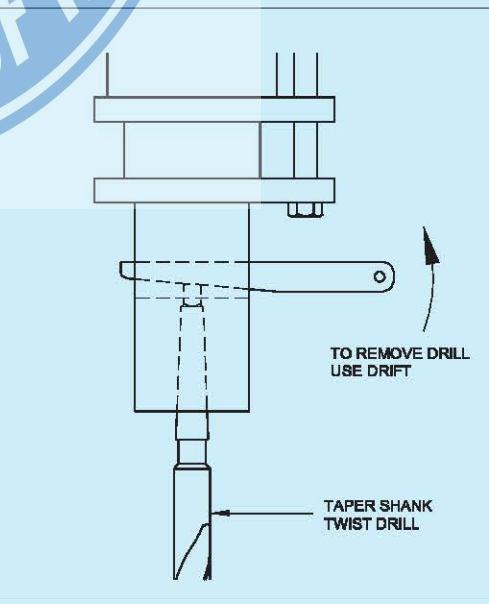
Fig 3



Use drift to remove the drill chuck and taper shank drill from drilling machine spindle (Fig 4)

Set the spindle speed according to the diameter of drills. For smaller diameter drill keep the spindle speed in higher R.P.M and for larger diameter of drill keep the spindle speed in lower R.P.M.

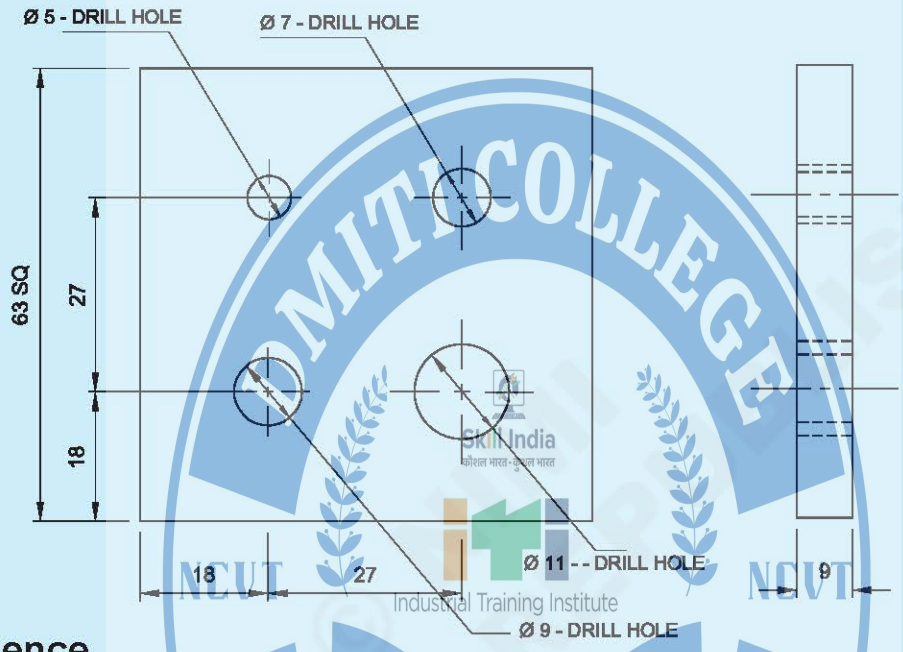
Fig 4



Drill on M.S Flat

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

- **mark drill hole centres**
- **hold the job in drilling machine table using machine vice**
- **set the spindle speed according to the diameter of drill**
- **drill through holes as per drawing**
- **finish and de-burr.**



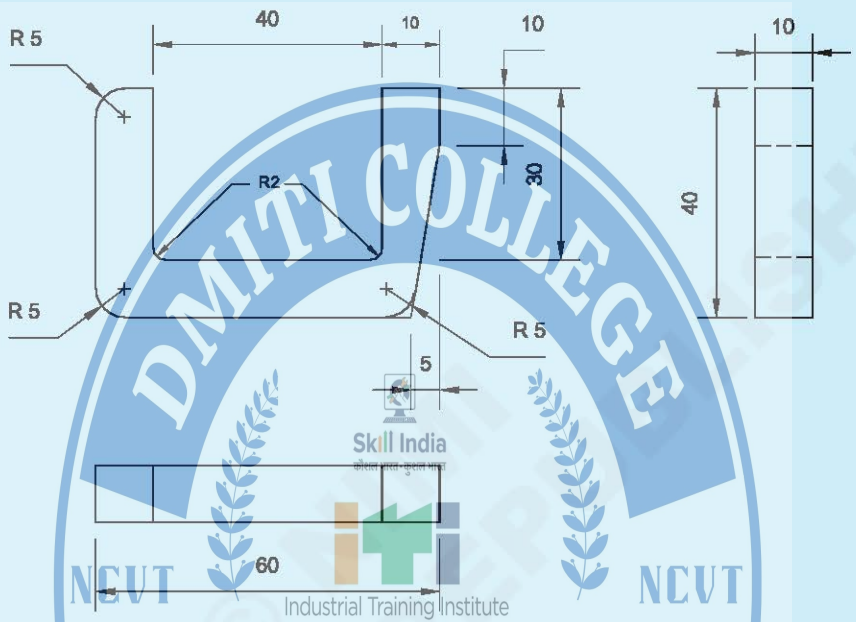
Job Sequence

- Check the raw material for its size.
- File surface to flatness.
- File right angle to squareness.
- File metal to size 63 x 63 x 9 mm maintaining parallelism and perpendicularity
- Check the flatness and squareness with try square and size with vernier caliper.
- Apply marking media, mark dimension lines as per drawing and punch the witness marks using dot punch.
- Punch on the drill holes centre using centre punch.
- Hold the job in drilling machine table using machine vice for drilling.
- Fix Ø 5 mm drill in drilling machine spindle through drill chuck.
- Set suitable spindle speed according to the size of drill.
- Drill Ø 5 mm through hole in job.
- Remove Ø 5 mm drill from drill chuck.
- Similarly, fix Ø 7, Ø 9 and Ø 11mm drill in drill chuck and drill through holes as per drawing.
- Check the size with vernier caliper.
- Finish and de - burr all the corners of the job.
- Apply a little oil on the job and preserve it for evaluation.

1	65 ISF 10-65	-	Fe310	-	-	1.5.62
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	DRILL ON M.S FLAT				TOLERANCE : ± 0.04	TIME :
					CODE NO : FI20N1562E1	

File radius and profile to suit gauge

Objectives: At the end of this exercise you shall be able to
- **file and mark as per job drawing**
- **file internal and external radius**
- **check the radius using radius gauge.**

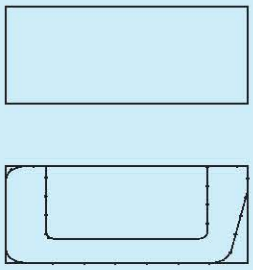


Job Sequence

- Check the raw material for its size.
- File metal to overall size 60x40x10 mm maintaining parallelism and perpendicularity and check flatness and squareness.
- Mark off all dimensions as per drawing.
- Mark the radius using divider and punch the identification marks. (Fig 1)
- Drill Ø 4mm to form internal radius 2 mm.
- Chain drill holes for parting off excess material from inside. (Hold the job rigidly, use a coolant and set correct RPM for drilling.)
- Hacksaw along the inner edges.
- Separate the excess material from inside using a web chisel and Ball pein hammer.
- File inside slot as per drawing.
- Hacksaw, file and finish angle and outside surfaces.
- File and finish external radius and check with the radius gauge.
- File and smooth finish all sides maintaining ±0.04 mm.

1	65 ISF 12 - 45	-	Fe310			1.5.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	FILE RADIUS AND PROFILE TO SUIT GAUGE				TOLERANCE : 0.04	TIME :
					CODE NO : FI20N1563E1	

Fig 1



FIN2163H1

- Apply a little oil on the job and preserve it for evaluation.

While chain drilling ensure 1 mm space between drilling holes and witness marks.

Skill Sequence

Parting off by chain drilling

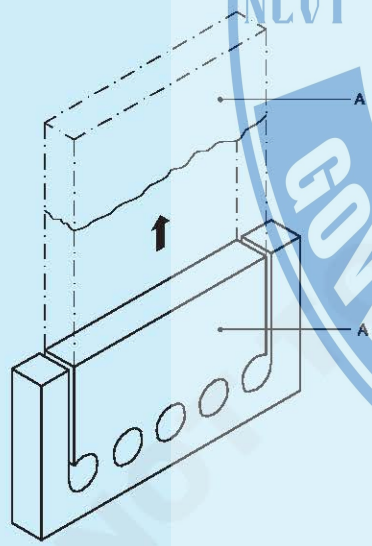
Objective: This shall help you to
- **part off metal by chain drilling.**

The shape of certain job features is such that metals are to be cut in places which are inaccessible for hacksawing by hand.

While there are many methods for doing this, the most common method adopted in bench fitting is to chain drill in such places, and hacksaw other sides, if possible.

After chain drilling and hacksawing the other sides, a chisel is used to part off the metal A. (Fig 1)

Fig 1



FIN2163J1

If the workpiece is not thick enough, parting with an ordinary flat chisel will cause distortion to the workpiece.

The best method is to use a PUNCHING CHISEL or WEB CHISEL to remove the metal web between the drilled holes.

The web chisel (punching chisel) has a double cutting edge, and this reduces the possibility of distortion to workpieces.

While cutting the web, the chisel is kept at an angle. (Fig 2)

Fig 2

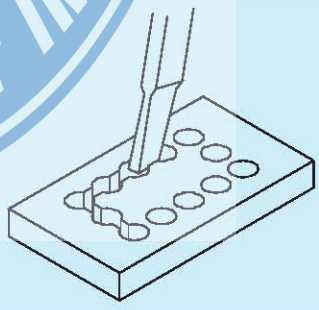
FIN2163J2

Remove only thin chips of equal thickness.

Thick workpieces need cutting with a web chisel from both sides.

While marking for chain drilling, place the location of drill centres in such a way that the web is not too thick. (Fig 3)

Fig 3



FIN2163J3

About 1 mm thick web is convenient for drilling and separating with a chisel.

If the web thickness is kept too small, a slight inaccuracy in drilling will draw the drill to the hole already drilled and cause damage to the drill.

For easier parting off, select suitable hole size to permit the chisel to enter and leave minimum material for filing.

Cutting with a web chisel will produce sharp cutting edges. Handle the workpieces carefully.

Filing radius (external)

Objective: This shall help you to
- **file external radius.**

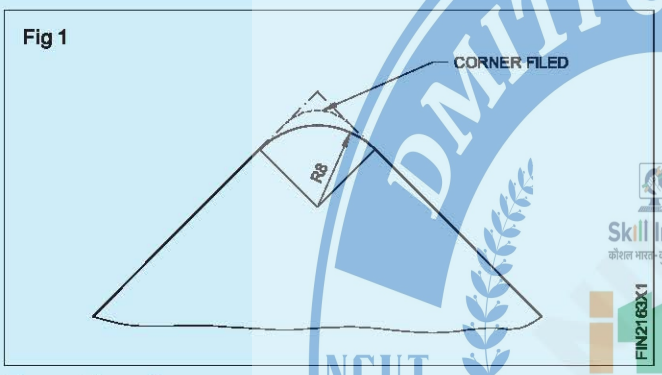
Filing radius is entirely a different technique, and needs considerable skill for filing accurately with a good finish.

In this type of filing, the file has to be held perfectly horizontal widthwise, and at the same time a rocking motion given lengthwise. The surface filed should not have any flat surface and should have a uniform curve. Radius filing of external surfaces is carried out in different steps.

Rough filing of corners

The corners are filed and brought closely to line using a bastard file. (Fig 1)

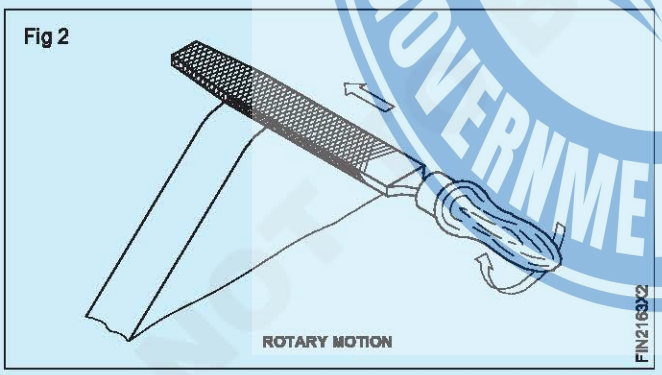
Fig 1



Rounding of corners

The flat surfaces are rounded and brought near about to finishing size, using a second cut file. In this, the file is moved forward across the curve with a turning motion (Fig 2)

Fig 2

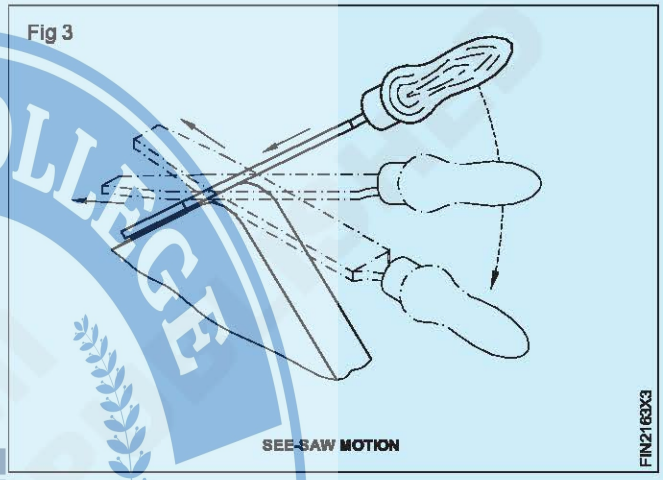


Check periodically with a radius gauge.

Final finishing of radius

For finishing steps, a smooth file is used. The file is given a see-saw motion along the curved line until the required radius is formed. (Fig 3)

Fig 3



While filing make sure

- to check the radius frequently with a radius gauge
- to use the broad surface to the job as datum for checking the size
- not to give excessive pressure while filing radius as the file is likely to slip.

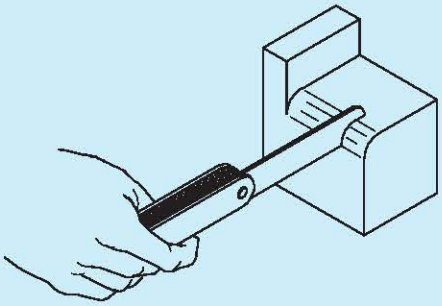
Checking the radius

Objective: This shall help you to
- **check the radius with a radius gauge.**

Before checking with a radius gauge ensure the radius gauge is perfectly clean. Remove burrs, if any, from the workpiece. Check and make sure the profile of the gauge is not damaged.

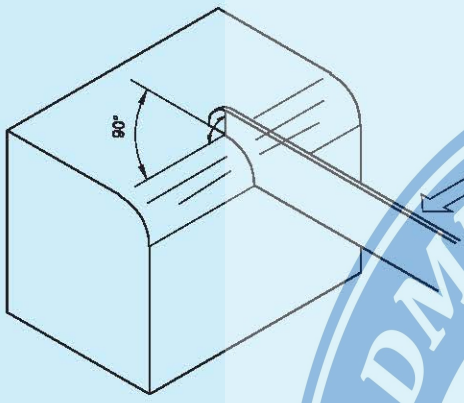
The radius gauge should be held perpendicular to the radius to be checked. (Fig 1 and 2)

Fig 1



FIN2163Y1

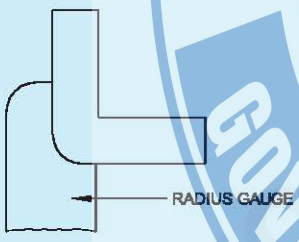
Fig 2



FIN2163Y2

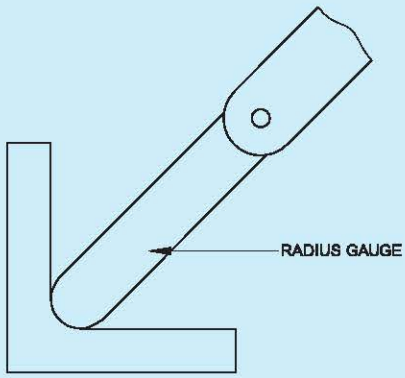
Observe the contact surfaces for any light passing through. Check against the background of light. The gauge should be moved along the filed length of the radius for checking. (Fig 3 and 4)

Fig 3



FI20N1163Y3

Fig 4

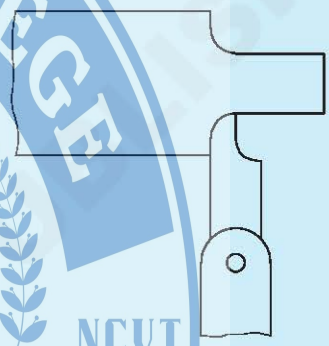


FI20N1163Y4

File and adjust the radius gradually according to the radius gauge.

The right radius is the one that matches correctly with the gauge. (Fig 5)

Fig 5

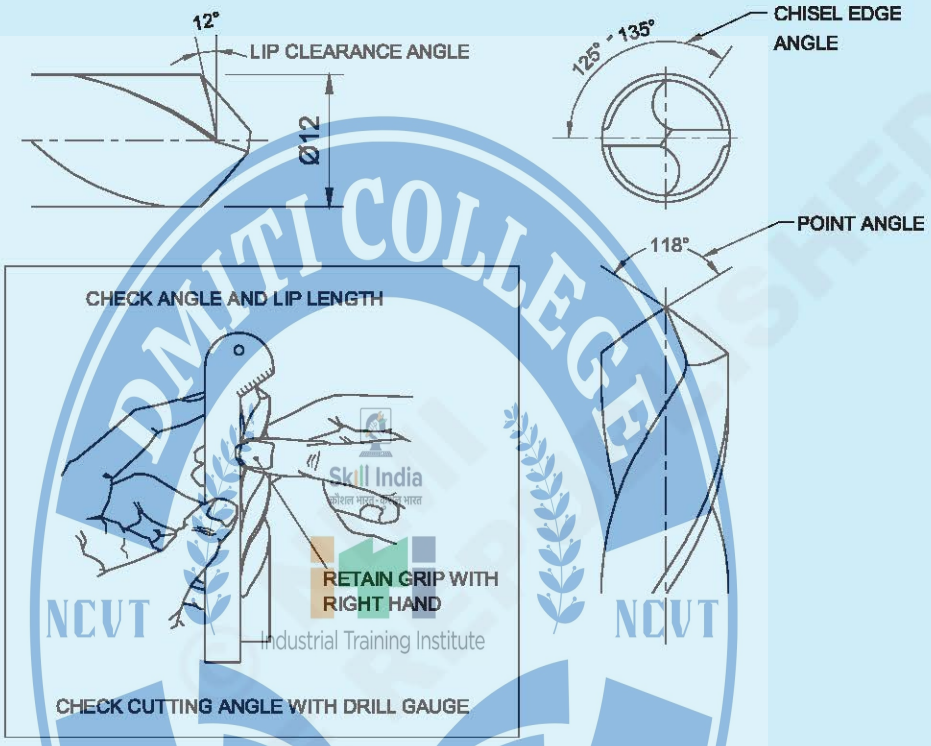


FIN2163Y5

After using the radius gauges, wipe them clean with a clean cloth and apply a light film of oil before storing.

Sharpening of drills

Objectives: At the end of this exercise you shall be able to
- **dress the grinding wheel**
- **sharpen the drill in pedestal grinder**
- **check the drill angle using drill gauge.**



Job Sequence

- Hold the blunt twist drill properly in both hands.
- Place the drill on tool rest.
- Touch the cutting edge of a twist drill in grinding wheel face maintaining 31° angle from grinding stone.
- Twist the drill slightly on wheel face and grind one cutting edge to the required angle to get 59°.
- Similarly, grind the other cutting edge to the required angle to get 59° maintaining the cutting edges length equal.

Swing the shank of the drill slightly downwards while grinding.

While sharpening drill, the cutting edges length and angles should be equal.

- Check the cutting angle and cutting edge length in drill grinding gauge.
- Switch off the grinding machine and clean properly.

Wear safety goggles while sharpening twist drills.

–	–	–	–	–	–	1.5.64
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	SHARPENING OF DRILLS				TOLERANCE : ± 30 mm	TIME :
					CODE NO : FI20N1564E1	

Skill Sequence

Off - Hand grinding with bench and pedestal grinders

Objectives: This shall help you to
- **identify the grinding machine and parts.**

Off - hand grinding is the operation of removing material which does not require great accuracy in size or shape. This is carried out by pressing the workpiece by hand against a grinding wheel.

Off - hand grinding is performed for rough grinding of jobs and resharpening wheel.

Scribers

Punches

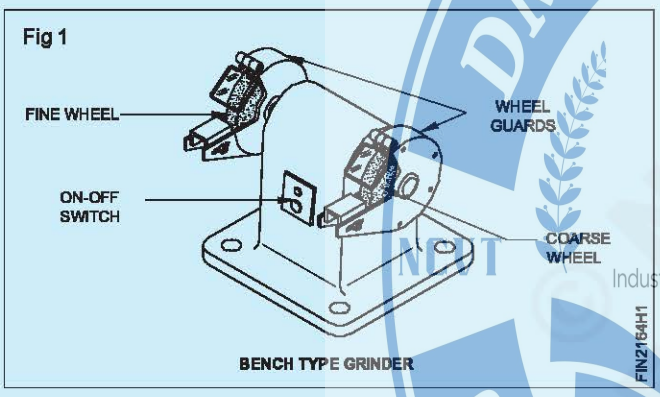
Chisels

Twist drills

Single point cutting tools etc.

Off - hand grinding is performed with a bench or pedestal grinder. (Fig 1 and 2)

Fig 1



Bench grinders

Bench grinders are fitted to a bench or table, and are useful for light duty work.

Pedestal grinders

Pedestal grinders are mounted on a base (pedestal), which is fastened to the floor. They are used for heavy duty work.

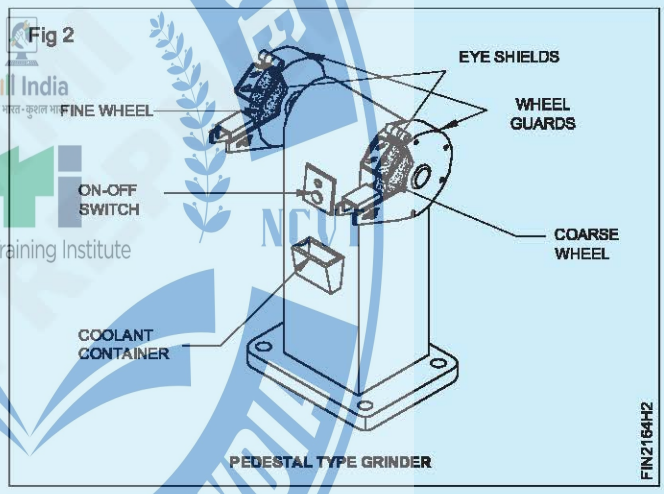
These grinders consist of an electric motor and two spindles for mounting grinding wheels. On one spindle a coarse - grained wheel is fitted, and on the other, a fine grained wheel. For safety, while working, wheel guards are provided. (Fig 1 and 2)

A coolant container is provided for frequent cooling of the work. (Fig 2)

Adjustable work - rests are provided for both wheels to support the work while grinding. These work - rests must be set very close to the wheels.

Extra eye - shields are also provided for the protection of the eyes. (Fig 2)

Fig 2



Re-sharpening a twist drill

Objective : This shall help you to
- **re-sharpen a twist drill.**

A twist drill can be successfully sharpened on a bench or pedestal grinder by adopting the following procedure.

Check that the surface of each wheel is running true and that the wheels are dressed clean.

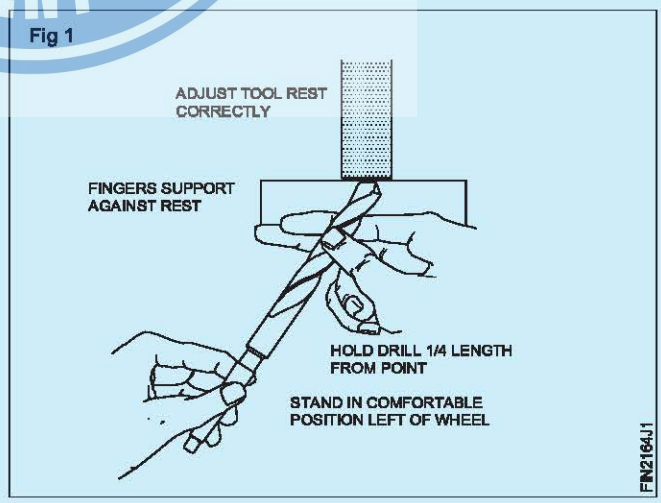
Ensure that the tool-rest are adjusted correctly and tightened.

Wear safety goggles.

Stand in a comfortable position in front of the machine.

Hold the drill at about one quarter of its length from the point, between the thumb and the first finger of the right hand. (Fig 1)

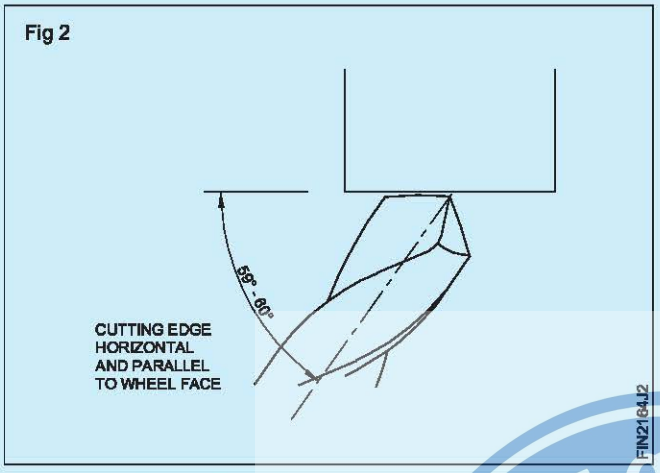
Fig 1



Keep both elbows against the side.

Position yourself in such a way that the drill makes an angle of 59° to 60° to the wheel face. (Fig 2)

Fig 2



Hold the drill level. Twist it until one cutting edge is horizontal and parallel to the wheel face.

Swing the shank of the drill slightly downwards and to the left with the left hand. The right hand is on the tool-rest.

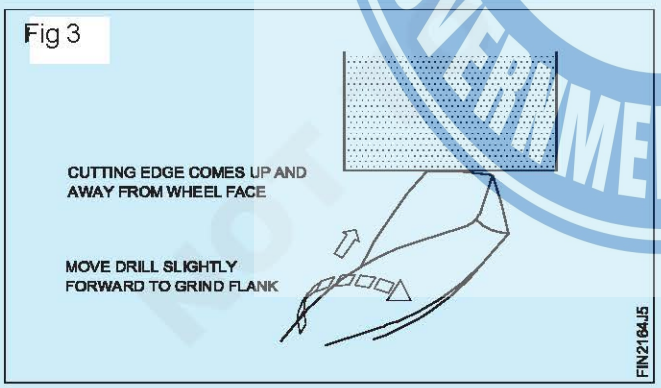
Watch the cutting edge against the wheel. Note that, as the shank, swings down, the cutting edge comes slightly upwards and away from the wheel face. (Fig 3)

Apply a slight forward motion to your hands.

This will bring the flank of the point against the wheel to produce a lip clearance.

Coordinate the three movements of swinging down, twisting clockwise and forward movement. These movements should not be heavy movements. If they are performed correctly, they will produce a cutting edge that has the correct lip clearance and cutting angle.

Fig 3



Practice these movements against a stationary wheel, using a new or correctly sharpened drill.

Notice how only a small movement is required to produce the required clearance.

Also note that, if the drill is twisted too far, the other cutting edge will swing down to contact the wheel face.

Proceed now to sharpen one edge, removing as little metal as possible.

Procedure to obtain equal angles

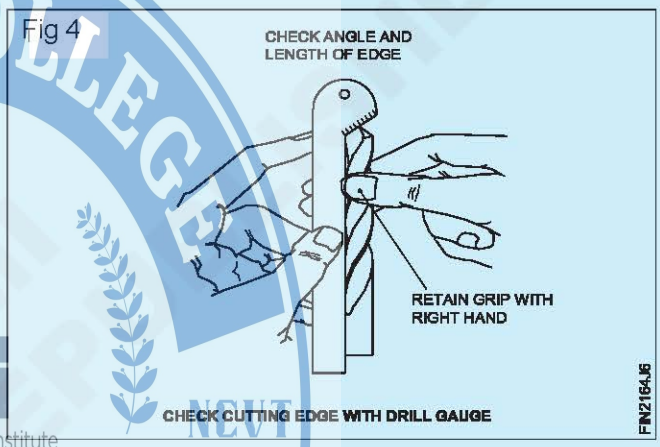
Move the drill back, clear of the wheel face.

Turn the drill over without moving the position. This presents the second edge to the wheel face at the same angle as the first cutting edge.

Proceed to sharpen the second cutting edge, using the same amount of drill movement as before. When these actions are carried but carefully, the drill will be sharpened with equal cutting angles. The lip clearance will be correct and equal.

Use a drill angle gauge to check that the cutting angle is correct (118° for mild steel), the cutting edges are of equal length and the lip clearances are equal and correct (about 12°). (Fig 4)

Fig 4



Lift the drill off the wheel face. Retain the grip on the drill with the right hand.

Make such inspection or checks as are necessary. Move the right hand back on-the tool-rest in the same position as before.

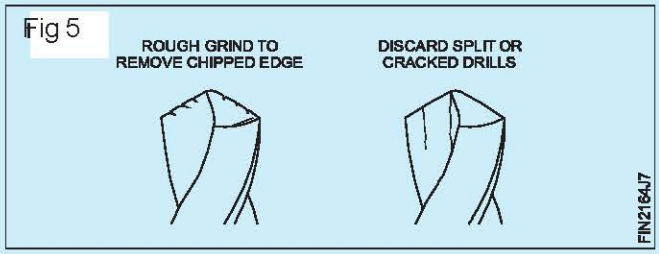
Hold the drill shank again in the left hand with the elbows against the side. The drill will locate back against the wheel face in the same position and at the same angle as before.

Points to be considered when sharpening drills

Grind as little as possible from the drill. Remove only enough to sharpen the cutting edges.

Rough down the drill point with a coarse grit wheel when the edges are badly chipped.(Fig 5)

Fig 5



Never re-sharpen a cracked or split drill.
Avoid overheating the drill.

Apply light pressure against the wheel face. Lift the edge clear of the wheel face frequently. This allows the air stream produced by the wheel to cool the drill point.

Cooling a drill rapidly by quenching in cold water may cause cracking of the cutting edge.

Re-sharpening of very small drills requires great skill. They require proportionally less movement to produce the cutting angles.

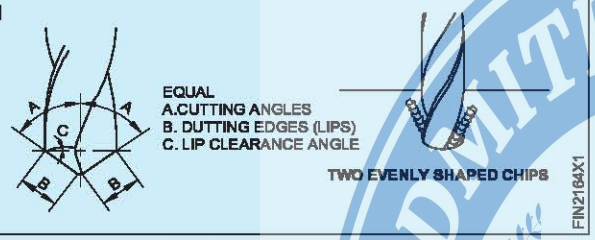
Testing a re-sharpened twist drill for its performance

Objective : This shall help you to
- **test the drill that has been re-sharpened by drilling a through hole.**

Set the spindle revolution of the drilling machine to give a cutting speed of 25 to 30 meters per minute. A drill that has been re-sharpened correctly will:

- Produce two evenly curled chips from its cutting edges (Fig 1)

Fig 1

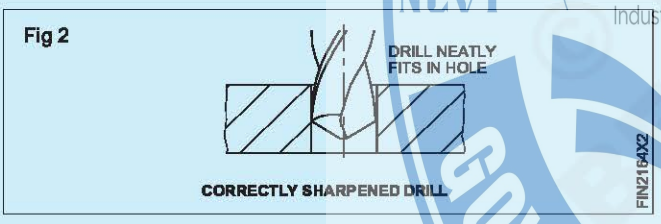


- Require only moderate pressure to feed it into the work.

When the hole has been drilled through, take the drill out of the machine and try it by inserting into the hole.

If the drill fits without any play it means that (Fig 2):

Fig 2



- The cutting edges and angles are equal
- The drill has produced a hole of the correct size.

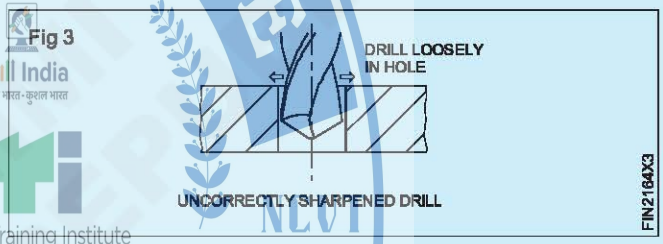
Any looseness of the drill in the hole means (Fig 3)

- The cutting edges are of uneven length
- The drill has produced an oversized hole.

A drill that has been ground with uneven or too great a lip clearance will

- Tend to chatter during starting
- Produce an out-of-round hole.

Fig 3



Safe working on off - hand grinders

Objective : This shall help you to
- **work safely on an off - hand grinder.**

How to work on an off - hand grinder?

While working on off - hand grinder, it is important to observe the following safety measures.

Before starting

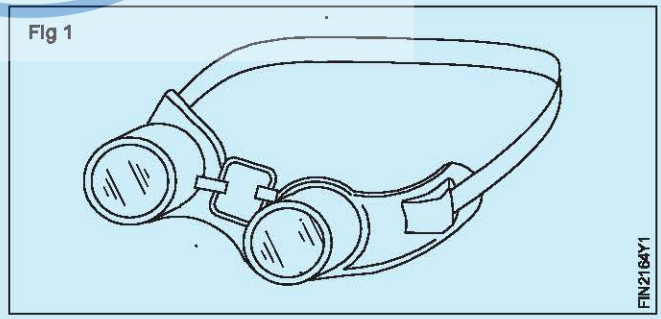
Make sure the grinding wheel guards are in place.

Wear safety goggles while grinding. (Fig 1)

Stand on one side of the machine while starting.

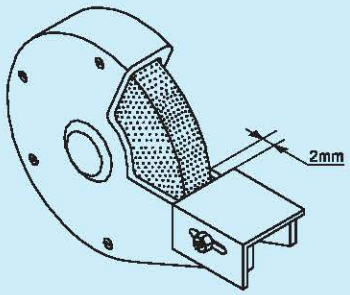
Adjust the tool - rest as close to the wheel as possible.

Fig 1



The maximum recommended gap is 2 mm. This will help to prevent the work from being caught between the tool rest and the wheel. (Fig 2)

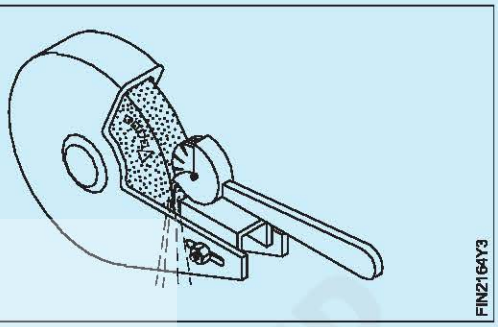
Fig 2



Do not work on grinding wheels which are loaded or glazed. Dress and true wheels whenever necessary. (Fig 3)

Caution: If any abnormal sound is noticed, stop the machine. Cracked or improperly balanced wheels are dangerous.

Fig 3



Dressing a grinding wheel

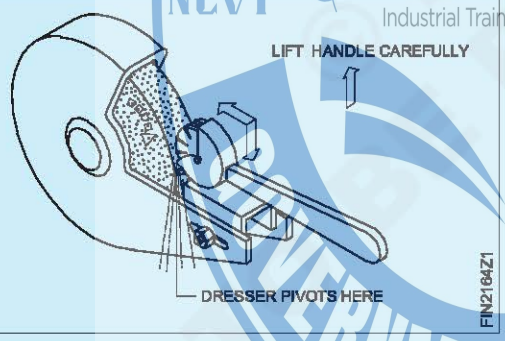
Objective : This shall help you to
- **dress a grinding wheel.**

When grinding wheels are loaded or glazed, they are rectified by dressing.

Dressing of pedestal grinder wheels is carried out by a star - wheel dresser.

For correct setting of the star - wheel dresser, the work - rest should be adjusted so that the dresser pivots get positioned between the wheel and the work - rest. (Fig 1)

Fig 1



Make the dresser come in contact with the wheel by slowly lifting the handle.

As the dresser star - wheel starts rotating, there can be a jerk. This can be overcome by pressure exerted on the work - rest.

Press the dresser firmly against the grinding wheel and move it across the face.

Do not run off the edge of the wheel while moving across.

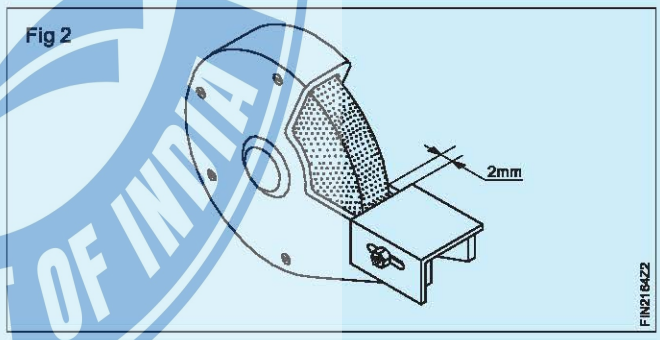
Do not release the downward pressure on the work - rest while lifting the handle.

Do not exert excessive pressure; it can crack the grinding wheel.

Move the dresser across the face of the grinding wheel until all the metal particles are removed, and the face is straight.

Adjust the work - rest as close to the grinding wheel as possible. (Fig 2)

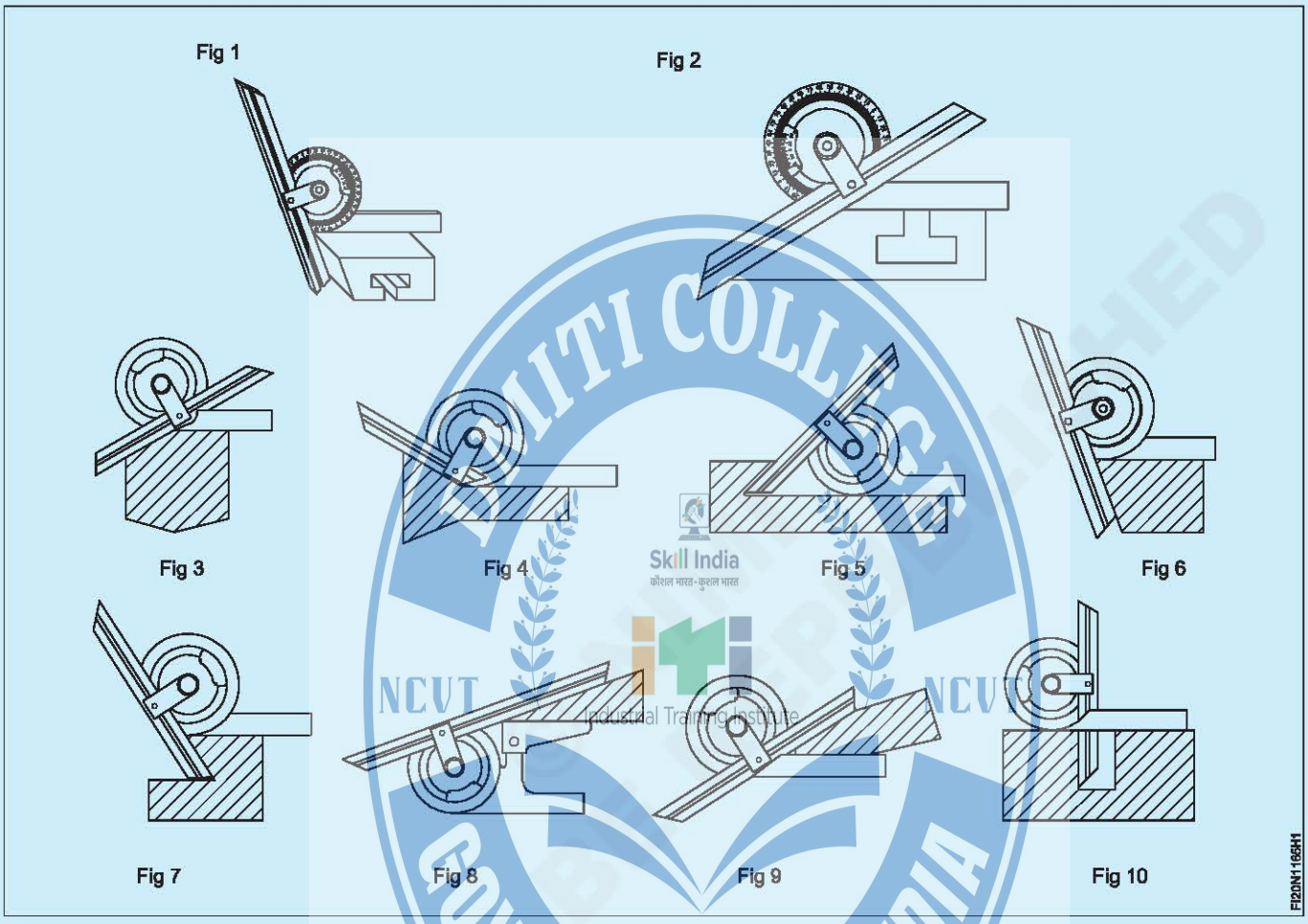
Fig 2



Wear safety goggles and gloves while dressing a grinding wheel. Stand on one side of the grinder while starting. Hold the dresser firmly while dressing. Do not put excessive pressure on the grinding wheels.

Practice use of angular measuring instrument

Objective: At the end of this exercise you shall be able to
- **measure the different acute angle and obtuse angle of components using vernier bevel protractor.**



Job Sequence

Note: Instructor shall arrange the different angular components for practicing with angular measuring instruments.

- Measure the different angle using vernier bevel protractor.
- Enter the angle in Table 1.

TABLE - 1

Component No.	Angle measured
1	
2	
3	
4	
5	

Component No.	Angle measured
6	
7	
8	
9	
10	

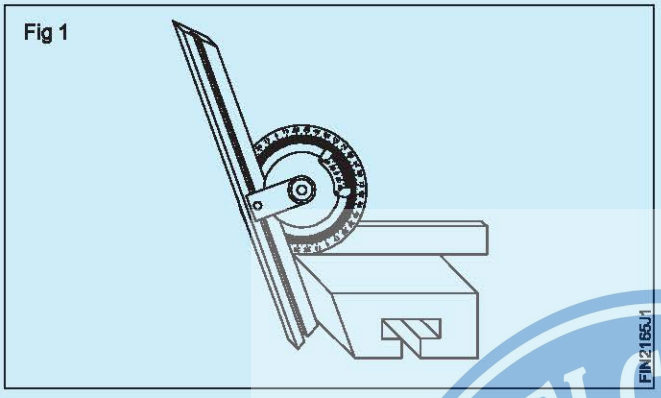
Get it checked by your instructor.

Reading of vernier bevel protractor

Objectives: This shall help you to
- **read vernier bevel protractor for acute angle setting**
- **read vernier bevel protractor for obtuse angle setting.**

For reading acute angle set up (Fig 1)

Fig 1



First read the number of whole degrees between zero of the main scale and zero of the vernier scale. (Fig 2)

Fig 2

Note the line on the vernier scale that exactly coincides with any one of the main scale divisions and determine its value in minutes.

To take the vernier scale reading, multiply the coinciding divisions with the least count.

Example: 10 x 5' = 50'

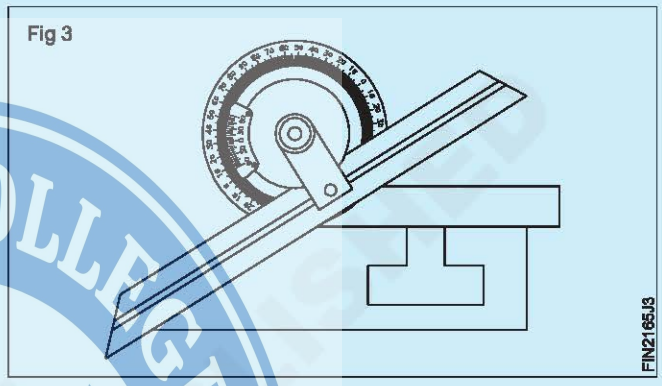
Total up both the readings to get the measurements = 41° 50'

If you read the main scale in an anticlockwise direction, read the vernier scale also in an anticlockwise direction from zero.

If you read the main scale in a clockwise direction, read the vernier scale also in a clockwise direction from zero.

For obtuse angle set up (Fig 3)

Fig 3



The vernier scale reading is taken on the left side as indicated by the arrow. (Fig 4) The reading value is subtracted from 180° to get the obtuse angle value.

Fig 4

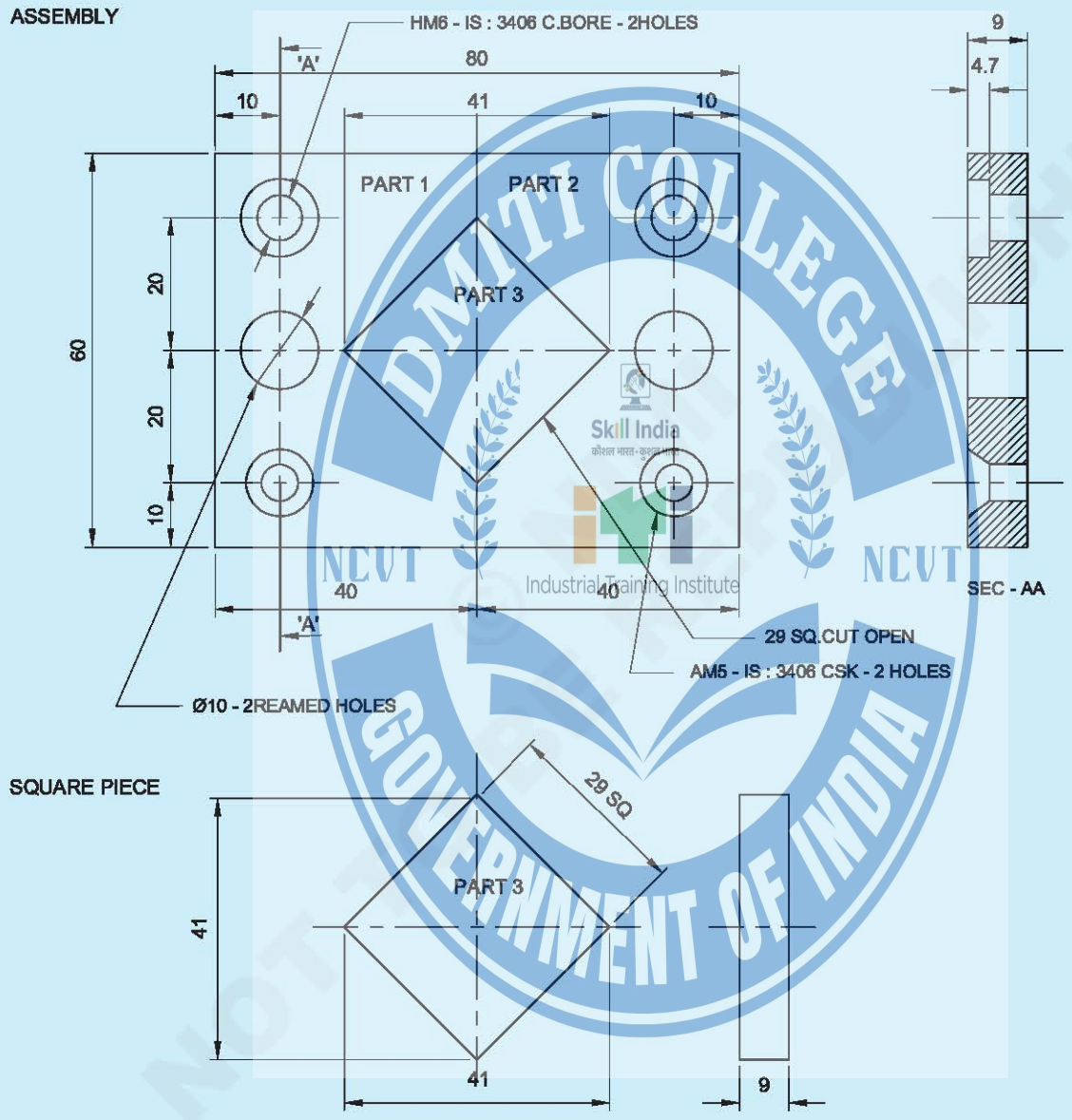
Reading 22°30'

Measurement

180° - 22°30' = 157°30'

Counter sink, counter bore and ream split fit (three piece fitting)

Objectives: At the end of this exercise you shall be able to
- **mark the lines as per job drawing**
- **drill, counter sink, counter bore and ream the holes as per drawing**
- **cut and remove excess metal in part 1 and 2**
- **file and finish to size and shape, make split fit as per drawing.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	45 ISF 10-45		Fe310		3	
1	65 ISF 10-45		Fe310		2	
1	65 ISF 10-45		Fe310		1	1.5.66

SCALE: 1:1	COUNTER SINK, COUNTER BORE, REAM SPLIT FIT (THREE PIECE FITTING)	TOLERANCE : ±0.04	TIME :
		CODE NO: FI20N1566E1	

Job Sequence

- Check the raw material for its size.
- File and finish to over all size of part 1 and 2 to 60 x 40 x 9 mm, part 3 to the size of 29 x 29 x 9mm maintaining parallelism and perpendicularity.
- Mark the hole centres and punch in part1 and 2 as per job drawing.
- Fix the job in drilling machine table with suitable clamps.
- Fix centre drill in drilling machine spindle through drill chuck and drill centre drilling in all drill holes centres.
- Fix Ø 5 mm drill in drill chuck and drill through holes as per drawing in all centre in drilled holes.
- Similarly, fix Ø 5.5, Ø 6.5 and Ø 9. 8 mm drill in drill chuck and drill through holes CSK, Counter bore and ream hole respectively.
- Fix counter sink tool in drilling machine and counter sink two holes to the required depth.
- Similarly, fix counter bore tool in drilling machine and counter bore two holes to the required depth.
- Ream in Ø 9.8 mm two drilled holes using Ø 10mm hand reamer with wrench.
- Hold part 1 in bench vice.
- Cut and remove excess metal by hacksawing.
- File to size and shape as per job drawing.
- Similarly, repeat the above process in part 2 and complete the job.

PART - 3

- Mark the dimension lines as per drawing and punch witness marks in part 3.
- Cut and remove excess metal by sawing and file to size and shape as per drawing.
- Match part 1, 2 ,3 and make three pieces as split fit.
- De - burr in all the surfaces and corners of the jobs.
- Apply oil and preserve it for evaluation.

Skill Sequence

Counter sink

Objective: This shall help you to

- **countersink holes of different sizes.**

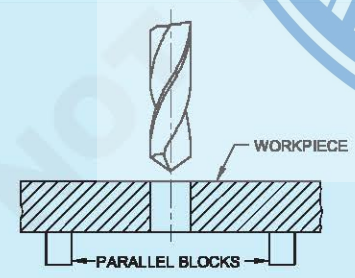
Selection of countersinks

Select the countersink tool according to the angle of the taper head of the screw. Use the table for countersink holes.

Fix the job in the machine vice (if necessary, use parallel blocks) and set it square.

Align the machine spindle with the drilled hole to be countersunk. (Fig 1)

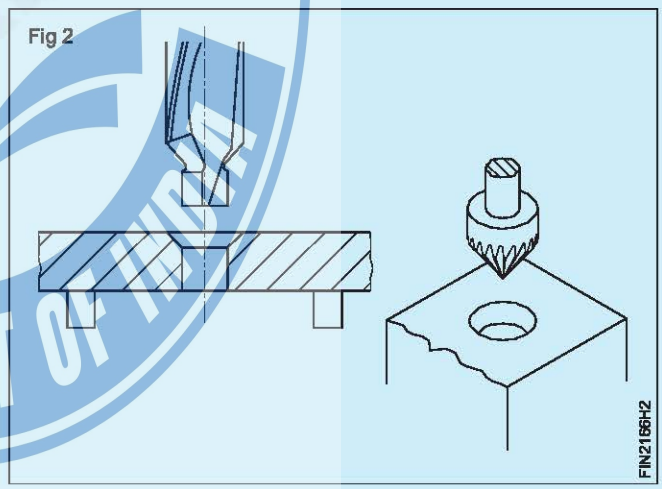
Fig 1



Remove the drill and fix the countersink tool on the machine without disturbing the alignment. (Fig 2)

Set the spindle speed of the drilling machine RPM. Use the formula

Fig 2



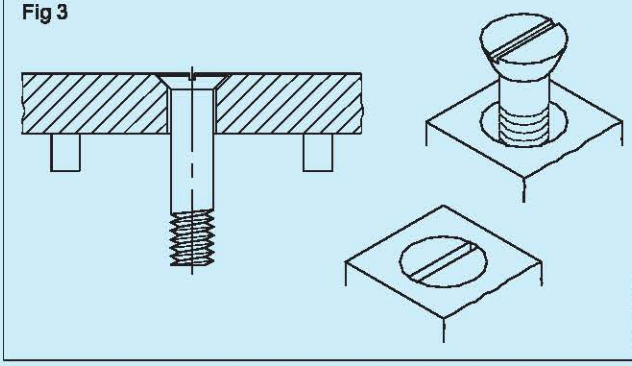
Substitute the recommended speed of the countersink.

(V = 1/3rd of the cutting speed for drilling)

Countersink hole to a depth equal to the head length of the screw head. (Fig 3)

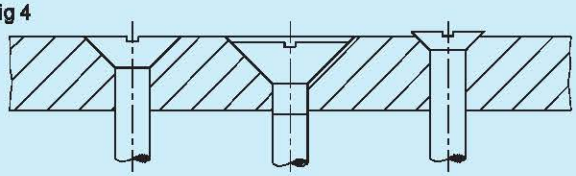
Check the countersink hole with a suitable countersink head screw for proper seating. (Fig 4)

Fig 3



FIN2166H3

Fig 4



FIN2166H4

Counterboring

Objective : This shall help you to

- **counterbore holes of different sizes concentric to the drilled holes.**

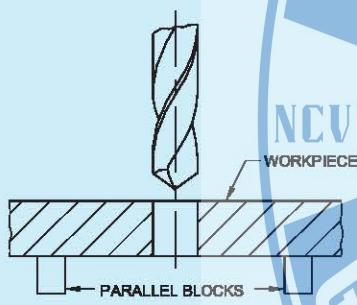
Selection of counterbore sizes

B.I.S. recommends different sizes of counterbores based on the sizes of the clearance holes.

Select the counterbore according to the screw size.

Fix the job in the machine vice, square to the axis of the machine spindle. Use parallel blocks. (Fig 1)

Fig 1



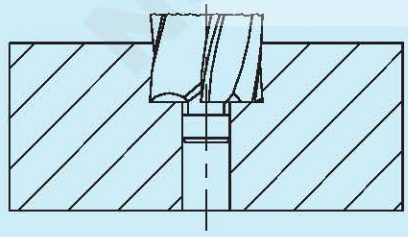
FIN2166J1

Set the location of the drilled hole position using the correct diameter drills.

Align the spindle axis with the drilled hole. For accurate work, drill and counterbore in one setting.

Mount and fix the counterbore tool on the drilling machine spindle. (Fig 2)

Fig 2



FIN2166J2

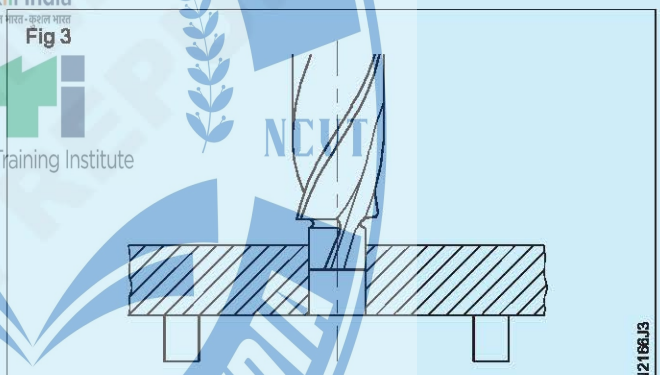
Set the spindle speed of the driling machine to the nearest calculated RPM. Use the formula

$$V = \frac{\pi \times d \times n}{1000}$$

(Consider the value of `V` as 1/3rd of the cuting speed for drilling)

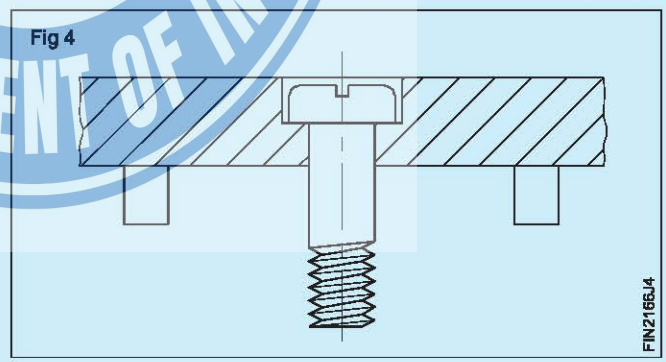
Counterbore the hole to a depth slightly more than the thickness of the screwhead (Figs 3 & 4)

Fig 3



FIN2166J3

Fig 4



FIN2166J4

Use the depth stop arrangement for controlling the depth of the counterbore hole.

Check the depth of the counterbored hole. (Use the correct screw for checking the depth and seating).

Reaming drilled holes using hand reamers

Objective: This shall help you to

- **ream through holes within limits and check reamed holes with cylindrical pins.**

Determining the drill size for reaming

Use the formula,

drill diameter = Reamed size - (under size + oversize)

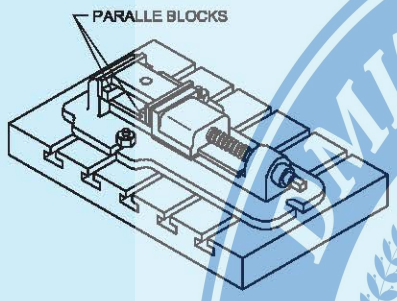
Refer to the table for the recommended under sizes in Related Theory on DRILL SIZES FOR REAMING.

Hand reaming

Drill holes for reaming as per the sizes determined.

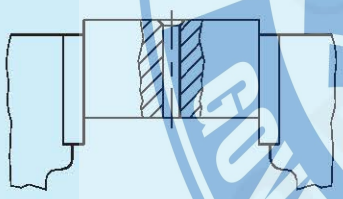
Place the work on parallels while setting on the machine vice. (Fig 1)

Fig 1



Chamfer the hole ends slightly. This removes burrs, and will also help to align the reamer vertically (Fig 2). Fix the work in the bench vice. Use vice clamps to protect the finished surfaces. Ensure that the job is horizontal.

Fig 2



Fix the tap wrench on the square end and place the reamer vertically in the hole. Check the alignment with a try square. Make corrections, if necessary. Turn the tap wrench in a clockwise direction applying a slight downward pressure at the same time (Fig 3). Apply pressure evenly at both ends of the tap wrench.

Apply cutting fluid.

Turn the tap wrench steadily and slowly, maintaining the downward pressure.

Do not turn in the reverse direction it will scratch the reamed hole. (Fig 4)

Fig 3

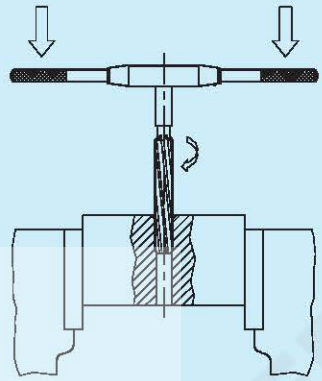
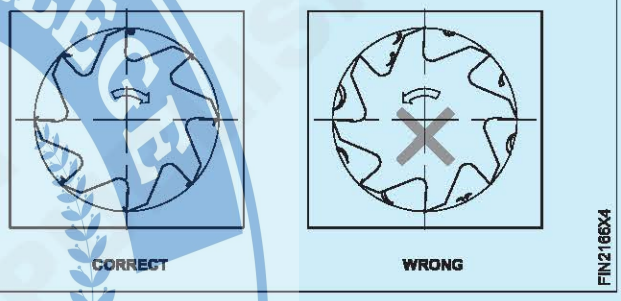


Fig 4



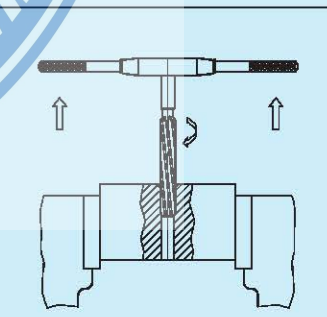
Ream the hole through. Ensure that the taper lead length of the reamer comes out well and clear from the bottom of the work. Do not allow the end of the reamer to strike on the vice.

Remove the reamer with an upward pull until the reamer is clear of the hole. (Fig 5)

Remove the burrs from the bottom of the reamed hole.

Clean the hole. Check the accuracy with the cylindrical pins supplied.

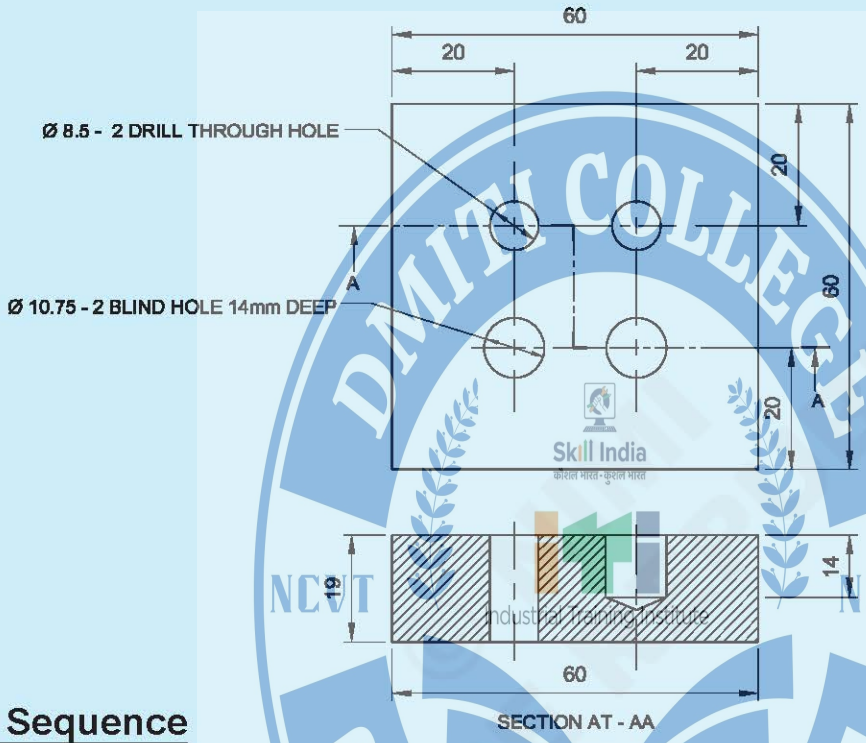
Fig 5



Drill through hole and blind holes

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

- **mark drill hole centres using vernier height gauge**
- **set the correct spindle speed in drilling machine**
- **drill through hole as per drawing**
- **set the depth bar to drill blind hole**
- **drill blind hole to the required depth size.**



Job Sequence

- Check the raw material size.
- File and finish the metal to size 60 x 60 x 19 mm maintaining parallelism and perpendicularity.
- Check the flatness and squareness with try square and size with vernier caliper.
- Apply marking media and mark drill holes centres using vernier height gauge as per drawing.
- Punch on drill holes centres using centre punch 90°
- Hold the job in drilling machine table.
- Make centre drill in drill holes centres.
- Fix Ø 6mm drill in drilling machine spindle through drill chuck and drill pilot holes for both through and blind holes.
- Fix Ø 8.5 mm drill and drill through hole as per drawing.
- Fix Ø 10.5 mm drill and drill blind hole to the required depth of 14 mm.
- De - burr in all the Corners of the job.
- Apply a thin coat of oil and preserve it for evaluation.

–	65 ISF 20 - 65	–	Fe310	–	–	1.5.67
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	DRILL THROUGH HOLE AND BLIND HOLES	TOLERANCE : ± 0.04	TIME :
		CODE NO : FI20N1567E1	

Skill sequence

Drilling blind holes

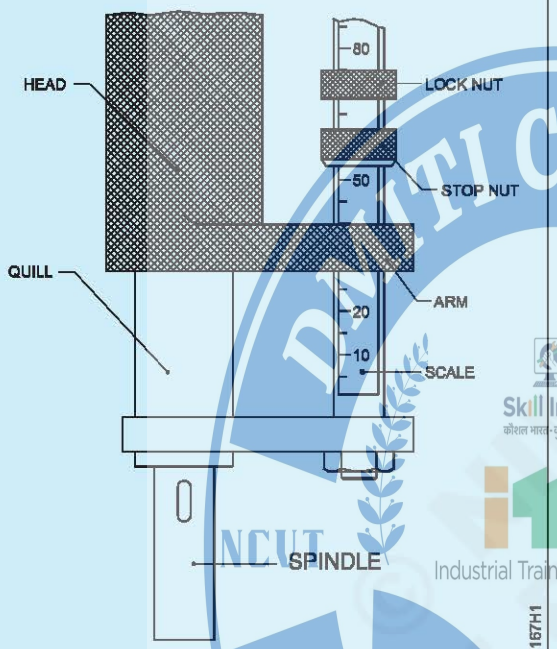
Objective: This shall help you to

- **drill blind holes to the required depth using the depth stops.**

Method of controlling depth of blind holes

While drilling blind holes, it is necessary to control the feed of the drill. Most machines are provided with a depth stop arrangement by which the downward movement of the spindle can be controlled. (Fig 1)

Fig 1



Most depth stop arrangements will have graduations by which the advancement of the spindle can be observed.

Generally the blind hole depth tolerances are given up to 0.5 mm accuracy.

Setting for drilling blind holes

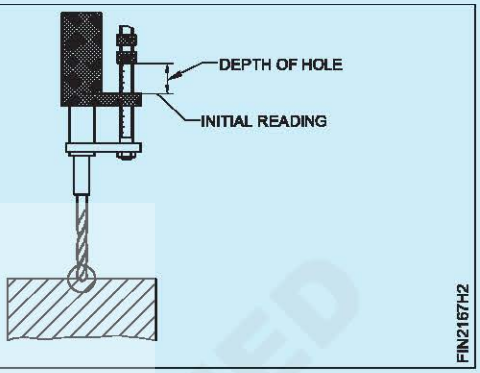
For blind hole - depth setting, first the work is held on the machine and the hole is located correctly.

The drill is started, and it drills until the full diameter is formed. Note down the initial reading at this point. (Fig 2)

Add the initial reading to the depth of the blind hole to be drilled.

Initial reading + Depth of hole = Setting.

Fig 2

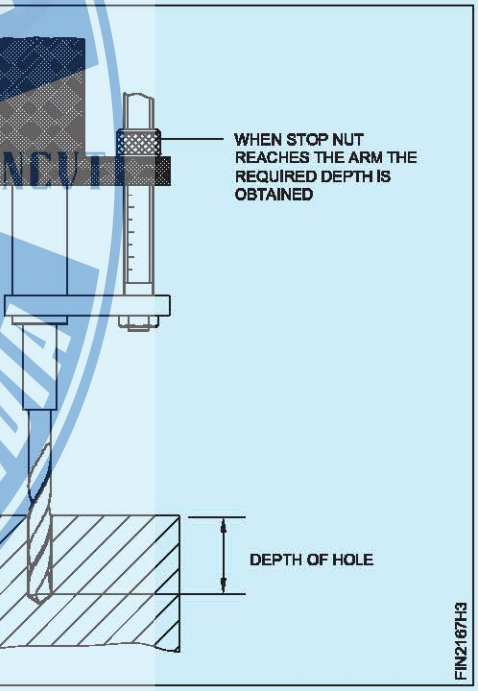


Adjust the stop next to the required setting, using the scale.

Tighten the lock nut to prevent the setting from being disturbed.

Start the machine and feed the drill. When the stop nut reaches the arm, the blind hole is drilled to the required depth. (Fig 3)

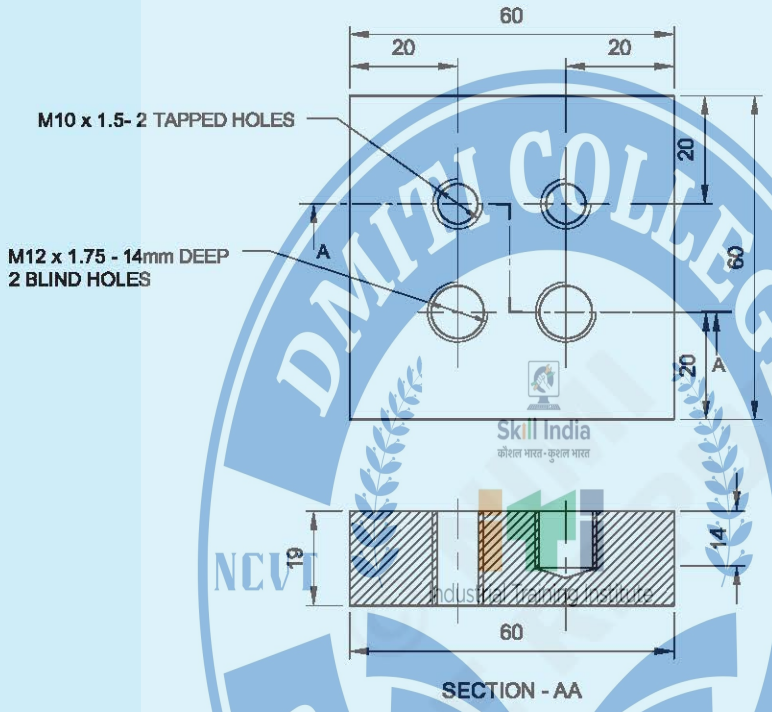
Fig 3



While drilling, release the drill frequently from the hole for the chips to be flushed out by the cutting fluid.

Form internal threads with taps to standard size (through holes and blind holes)

Objectives: At the end of this exercise you shall be able to
- **chamfer the holes for tapping**
- **fix the job in bench vice**
- **select the tap set**
- **cut internal threads in through and blind holes using hand tap and tap wrench.**



Job Sequence

Cut internal thread in through hole

- Use work piece of Ex.No 1.5.67 for this exercise.
- Fix the job in bench vice.
- Fix M 10 first tap in tap wrench and cut internal thread in through hole.
- Similarly, fix M 10 second tap and third tap in tap wrench one by one and cut the internal thread to form full thread.
- Repeat the above process to cut internal thread in other drilled through hole.

Cut internal thread in blind hole

- Remove metal chips if any from the blind hole by turning it upside down and slightly tapping it on a wooden surface.
- Fix the M 12 first tap in tap wrench.
- Screw a matching nut on the first tap to the required distance for 14 mm to act as a depth stop.

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
2		→ EX.NO.1.5.88	Fe310	–	–	–
1		EX.NO.1.5.67 ←	Fe310	–	–	1.5.68

SCALE 1:1	FORM INTERNAL THREADS WITH TAPS TO STANDARD SIZE (THROUGH HOLES AND BLIND HOLES)	TOLERANCE : ±0.04	TIME :
		CODE NO : FI20N1568E1	

- Cut internal thread in blind hole to the required depth 14 mm.
- Remove the metal chips, if any from the threaded blind hole.
- Similarly, fix M 12 second tap and third tap in tap wrench, one by one and cut the thread to form full thread.
- Clean the threaded hole without burrs.
- Repeat the above process to cut internal thread in other drilled blind hole.
- Check the threaded hole using the M10, and M12 matching bolts by screwing.
- Apply thin coat of oil and pressure it for evaluation.

Use cutting fluid while cutting the thread.

Internal threading of through holes using hand taps

Objectives: This shall help you to
- **determine the tap drill sizes for internal threading**
- **cut internal threads using hand taps.**

Determining the tap drill size

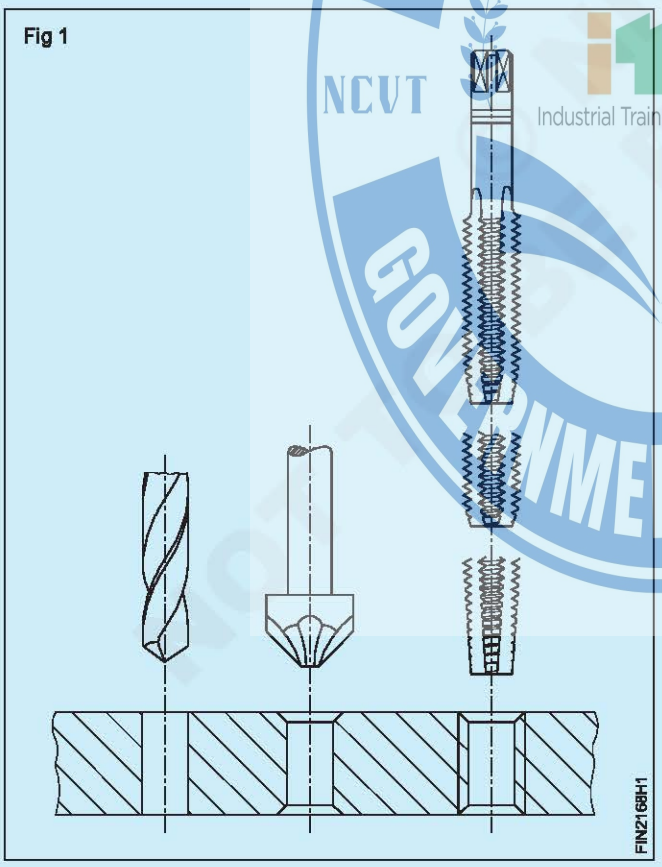
For cutting internal threads, it is necessary to determine the size of the hole (tap drill size). This can be calculated using the formula or can be chosen from the table of the tap drill sizes.

Procedure

Drill the hole to the required tap drill size.

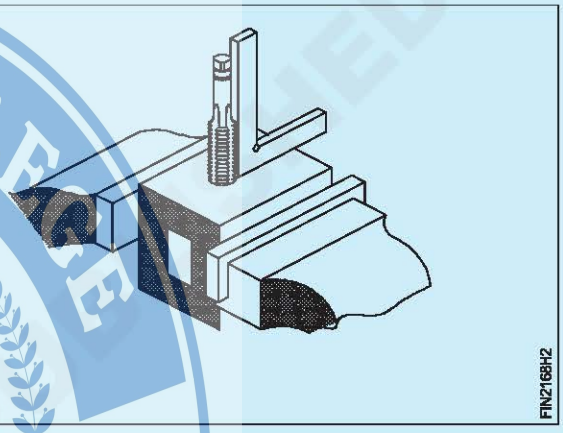
Do not forget to give the chamfer required for aligning and starting the tap. (Fig 1)

Fig 1



Hold the work firmly and horizontally in the vice. The top surface should be slightly above the level of the vice jaws. This will help in using a try square without any obstruction while aligning the tap (Fig 2).

Fig 2



Use soft jaws while holding the finished surface on the vice.

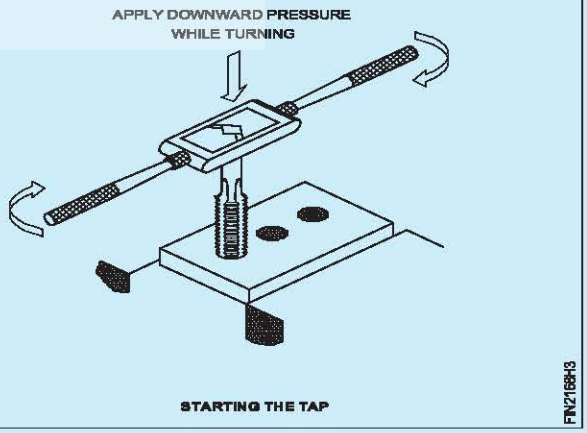
Fix the first tap (taper tap) in the wrench.

Too small a wrench will need a greater force to turn tap. Very large and heavy tap wrenches will not give the feel required to turn the tap slowly as it cuts.

Position the tap in the chamfered hole vertically by ensuring the wrench in a horizontal plane.

Exert steady downward pressure and turn the tap wrench slowly in a clockwise direction to start the thread. Hold the tap wrench close to the centre. (Fig 3)

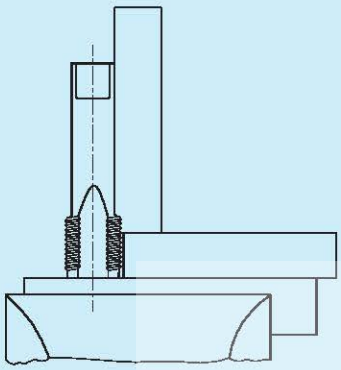
Fig 3



When you are sure of starting of the thread, remove the tap wrench without disturbing the tap alignment.

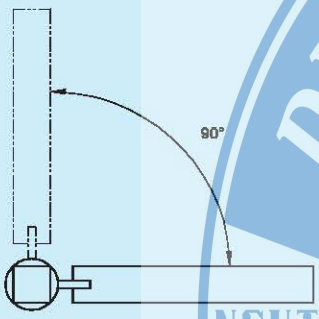
Check and make sure the tap is vertical. Use a small try square for help. (Fig 4)

Fig 4



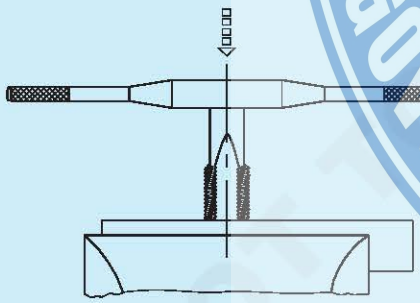
Place the try square in two positions, 90° to each other. (Fig 5)

Fig 5



Make corrections, if necessary. This is done by exerting slightly more pressure on the opposite side of the tap inclination. (Fig 6)

Fig 6



Never apply side pressure without giving a turning motion to the tap.

Check the tap alignment again with a try square.

Fit the tap wrench, and tighten without disturbing the tap alignment.

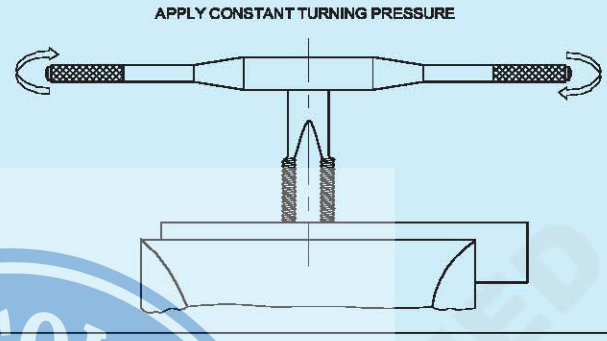
Make one or two turns and check the alignment.

The tap alignment should be corrected within the first few turns. Afterwards this cannot be done for the threads will break.

After the tap is positioned vertically, turn the wrench lightly by holding the ends of the wrench handles without exerting any downward pressure. (Fig 7)

While turning the wrench, the movement should be well balanced. Any extra pressure on one side will spoil the tap alignment and can also cause breakage of the tap.

Fig 7

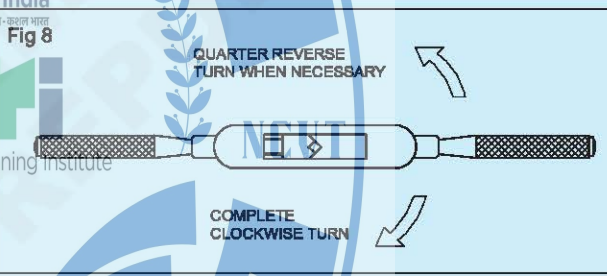


Continue cutting the thread. Turn backwards frequently, about quarter turn, to break the chip. (Fig 8) Stop and turn backwards also when some obstruction to movement is felt.

Use a cutting fluid while cutting the thread.

Cut the thread until the tap is fully inside the hole being threaded.

Fig 8



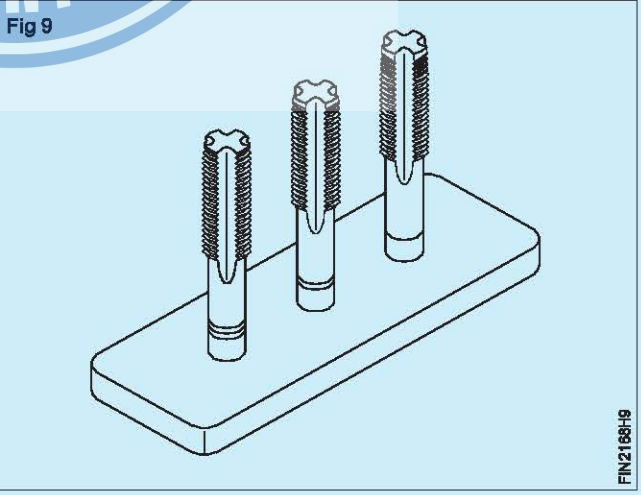
Finish and clean up using intermediate and plug tap. The intermediate and plug tap will not cut any thread if the tap has entered the hole fully.

Remove the chips from the work with a brush.

Check the threaded hole with a matching screw.

Clean the tap with a brush, and place it back on the stand (Fig 9)

Fig 9



Internal threading blind holes using hand taps

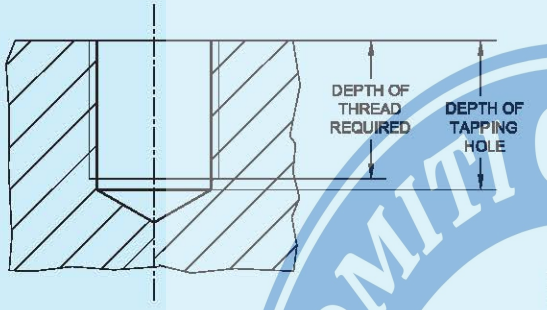
Objective: This shall help you to
- **cut internal threads using hand taps.**

Drilling a blind hole

Determine the tapping drill size using the table for tapping drill sizes.

Drill a blind hole using the depth stop arrangement. The depth of the tapping hole should be slightly more than the depth of the required thread. (Fig 1)

Fig 1



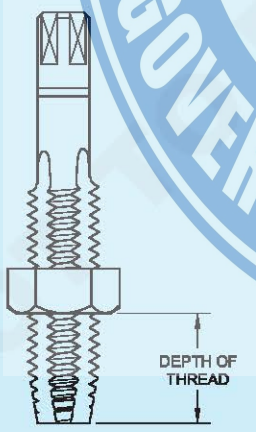
Procedure for threading

Remove metal chips, if any, from the blind hole by turning it upside down and slightly tapping it on a wooden surface.

Do not clear the chips by blowing as it can cause injury to your eyes.

Screw a matching nut on the first tap to act as a depth stop. (Fig 2)

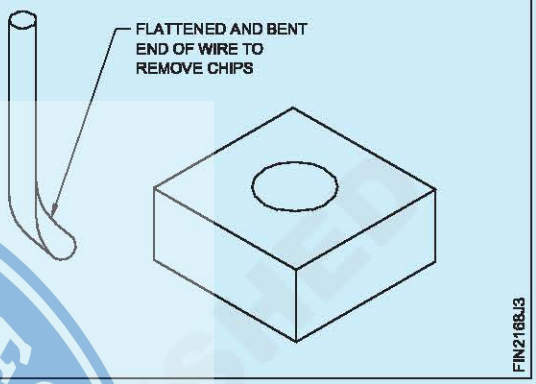
Fig 2



Thread the blind hole until the nut touches the plate surface.

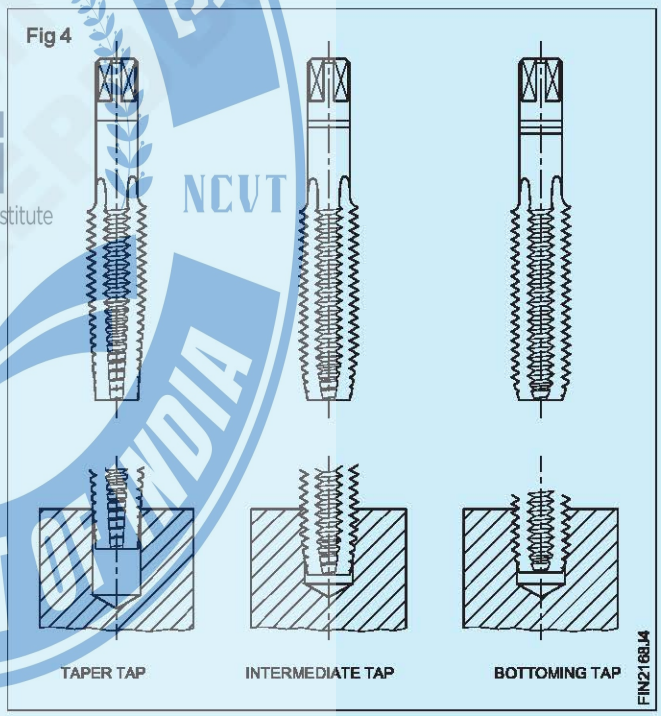
Remove the chips from the hole frequently, using a flattened and bend wire. (Fig 3)

Fig 3



Finish tapping the hole with intermediate and bottoming tap. Set the nut to control the depth of the thread. (Fig 4)

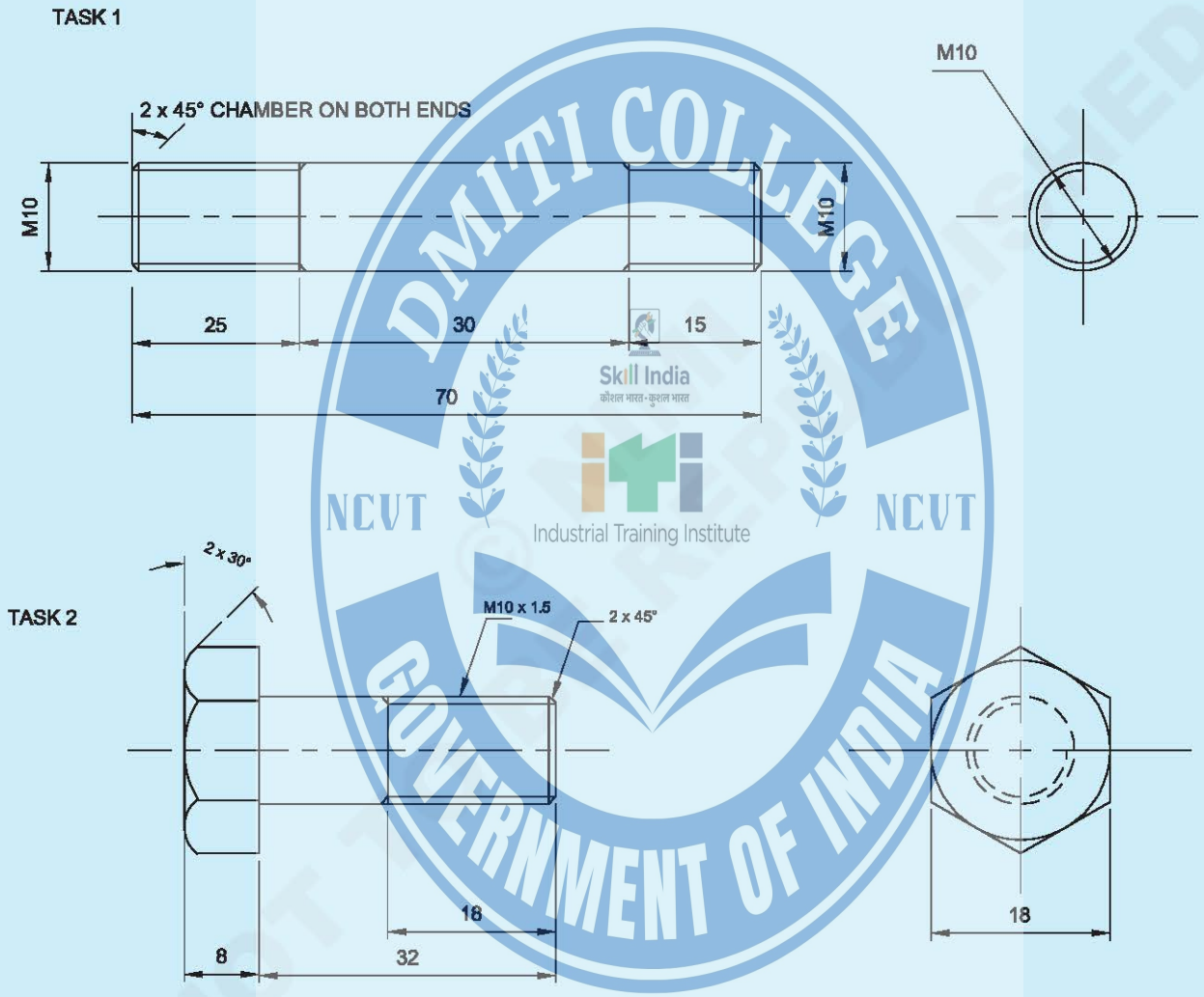
Fig 4



Prepare studs and bolt

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

- **file blank size to cut external thread for studs and bolts**
- **chamfer in both ends of studs and bolts**
- **mark the length required to cut external thread in studs and bolt**
- **cut external thread using die and die stock in studs and bolt**
- **check the external thread using screw pitch gauge and matching nuts.**



1	HEX A/F 18 - 45	→ 1.5.68	Fe310	–	2	1.5.69
1	Ø10 - 75	→ 1.5.68	Fe310	–	1	1.5.69
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PREPARE STUDS AND BOLT	TOLERANCE : ±0.04	TIME :
		CODE NO : FI20N1569E1	

Job Sequence

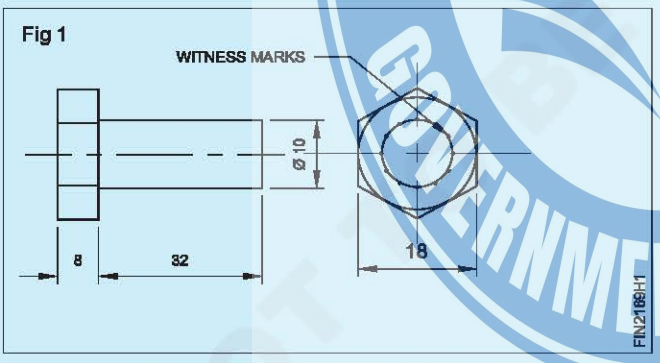
TASK 1: **Prepare stud**

- Check the raw material size.
- File the round rod ends to flatness and squareness maintaining size Ø 10 mm x 70 mm length.
- File round rod cylindrical profile to Ø 9.85 mm blank size to cut external thread as per drawing.
- File chamfer in both ends of the round rod to 2 mm x 45°
- Apply marking media on cylindrical surface of the job and mark the required length and punch witness marks to cut external thread as per drawing.
- Hold the cylindrical rod in bench vice to 90° with aluminium vice clamps and check the 90° with try square.
- Set M10 circular split die in die stock.
- Place the split die on the cylindrical round rod one end and cut external thread by rotating in clock wise and anti-clockwise direction to cut external thread.
- Apply pressure on the die stock evenly and turn in a clock wise direction to advance the die in stud blank and reverse the die for a short distance to break the chips.
- Following the above processes, cut the external thread upto the required length as per drawing.
- Clean the thread and check with suitable screw pitch gauge and matching nut.
- If the nut is not fitted with the external thread, increase the depth of cut gradually by adjusting the split die stock outer screws and deepen the cut of thread to correct pitch of thread and check with matching nut and screw pitch gauge.
- Similarly, repeat the thread cutting process in other end of cylindrical round rod to the required length and check with suitable screw pitch gauge and match with suitable nut.
- Clean the thread and ensure without burrs and apply little oil and preserve it for evaluation.

TASK 2: **Prepare bolt**

- Check the raw material for its size.
- turn hexagon rod ends to flatness and squareness maintaining size Ø 10 mm x 40 mm length in lathe
- Apply marking media and mark dimensions to prepare hexagonal head bolt blank as per job drawing.
- Punch witness marks using dot punch 60°. (Fig 1)

Fig 1



- Cut and remove excess metal by sawing.
- File hexagonal rod cylindrical blank size to Ø 9.9 mm x 18 mm length to cut external thread. (Fig 2)
- File chamfer in both ends of hexagon 2 mm x 45°
- Hold the Hexagonal head bolt in bench vice to 90°along with aluminium vice clamps.
- Set M10 split die in the die stock.
- Place the split die on the hexagonal head bolt round blank end with die stock and turn in clock wise direction and anti-clockwise direction to cut external thread. (Fig 3)

Fig 2

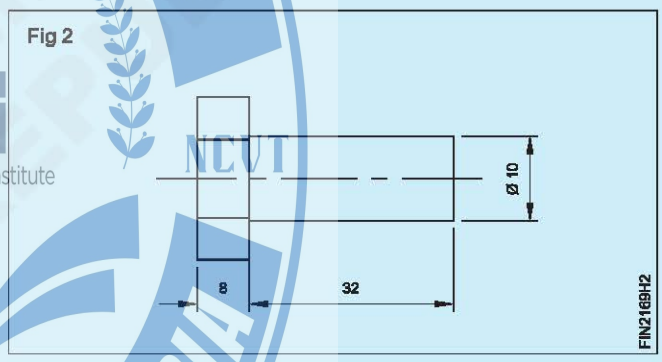
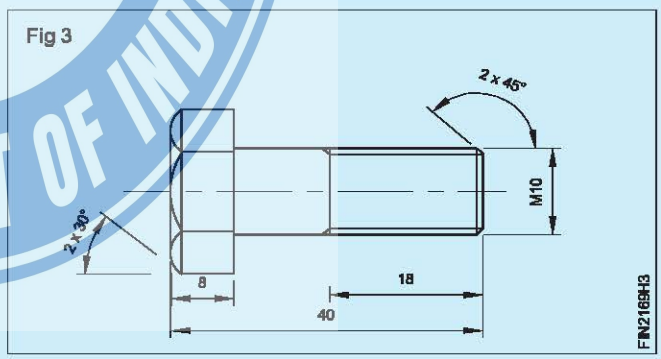


Fig 3



- Check the die to 90°, to the hexagonal head bolt blank while cutting external thread.
- Apply pressure on the die stock evenly and cut external thread as shown in job drawing.
- Check the thread with screw pitch gauge and matching nut.
- Clean the thread and apply oil and preserve it for evaluation.

Use a cutting lubricant while cutting thread

Skill Sequence

External threading using dies

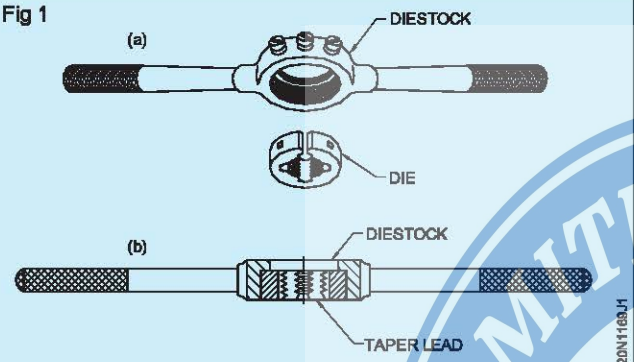
Objective: This shall help you to
- **Cut external threads using dies.**

Check blank size.

Blank size = Thread size - 0.1 x pitch of thread

Fix the die in the diestock and place the leading side of the die opposite to the step of the diestock. (Fig 1 & 2)

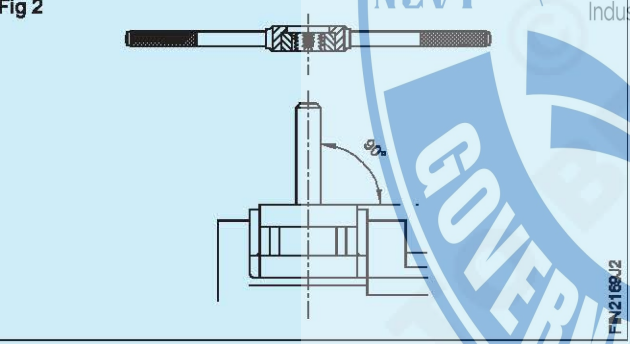
Fig 1



Use vice clamp for ensuring a good grip in the vice.

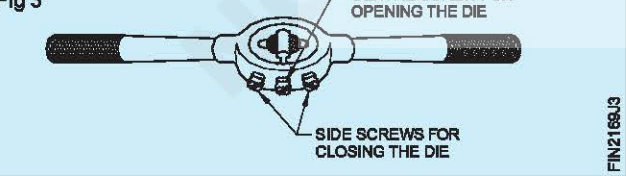
Project the blank above the vice - just the required thread length only.

Fig 2



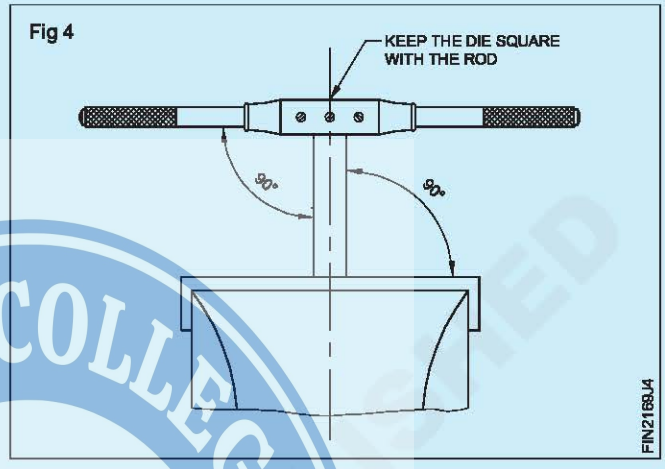
Place the leading side of the die on the chamfer of the work. (Fig 3)

Fig 3



Make sure that the die is fully open by tightening the centre screw of the diestock. (Fig 4)

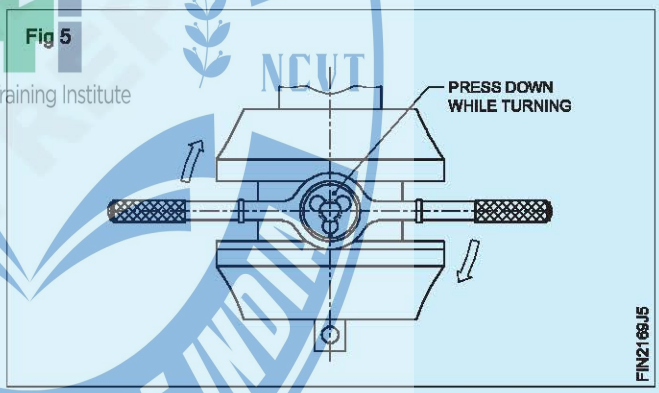
Fig 4



Start the die, square to the bolt centre line. (Fig 5)

Apply pressure on the diestock evenly and turn in a clockwise direction to advance the die on the bolt blank. (Fig 5)

Fig 5



Cut slowly and reverse the die for a short distance in order to break the chips.

Use a cutting lubricant

Increase the depth of the cut gradually by adjusting the outer screws.

Check the thread with a matching nut.

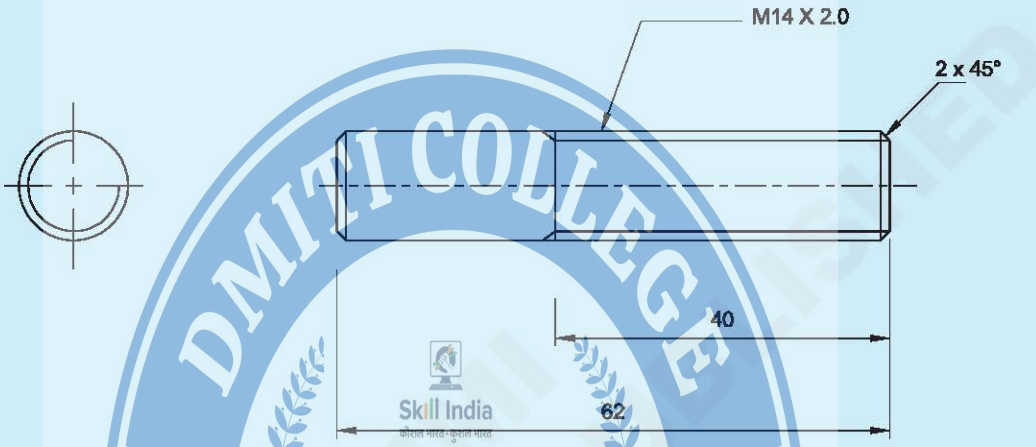
Repeat the cutting until the nut matches.

Too much depth of cut at one time will spoil the threads. It can also spoil the die.

Clean the die frequently to prevent the chips from clogging and spoiling the thread.

Form external threads with dies to standard size

Objectives: At the end of this exercise you shall be able to
- **file blank size in round rod to cut external thread**
- **cut M14 external thread using split die and die stock to the required length**
- **check the thread with screw pitch gauge and matching nut.**



Job Sequence

- Check the raw material for its size.
- File blank size to Ø 13.9 mm x 40 mm length as per drawing.
- File chamfer in both ends to 2 mm x 45°
- Hold the job at 90° in bench vice.
- Set M14 split die in die stock.
- Set the die on the blank end and press down evenly and turn in clockwise direction slowly to cut thread.
- Check the die 90° to the cylindrical rod.
- Apply pressure evenly on the die stock and turn in a clock wise direction to advance the die in cylindrical blank.
- Cut external thread slowly and reverse the die for short distance in order to break the chips.
- Increase depth of cut gradually by adjusting the screws and cut the thread to correct pitch of the thread.
- Check the thread with screw pitch gauge.
- Repeat the thread cutting process until the nut matches.
- Apply a little oil and preserve it for evaluation.

Use cutting lubricant while cutting thread

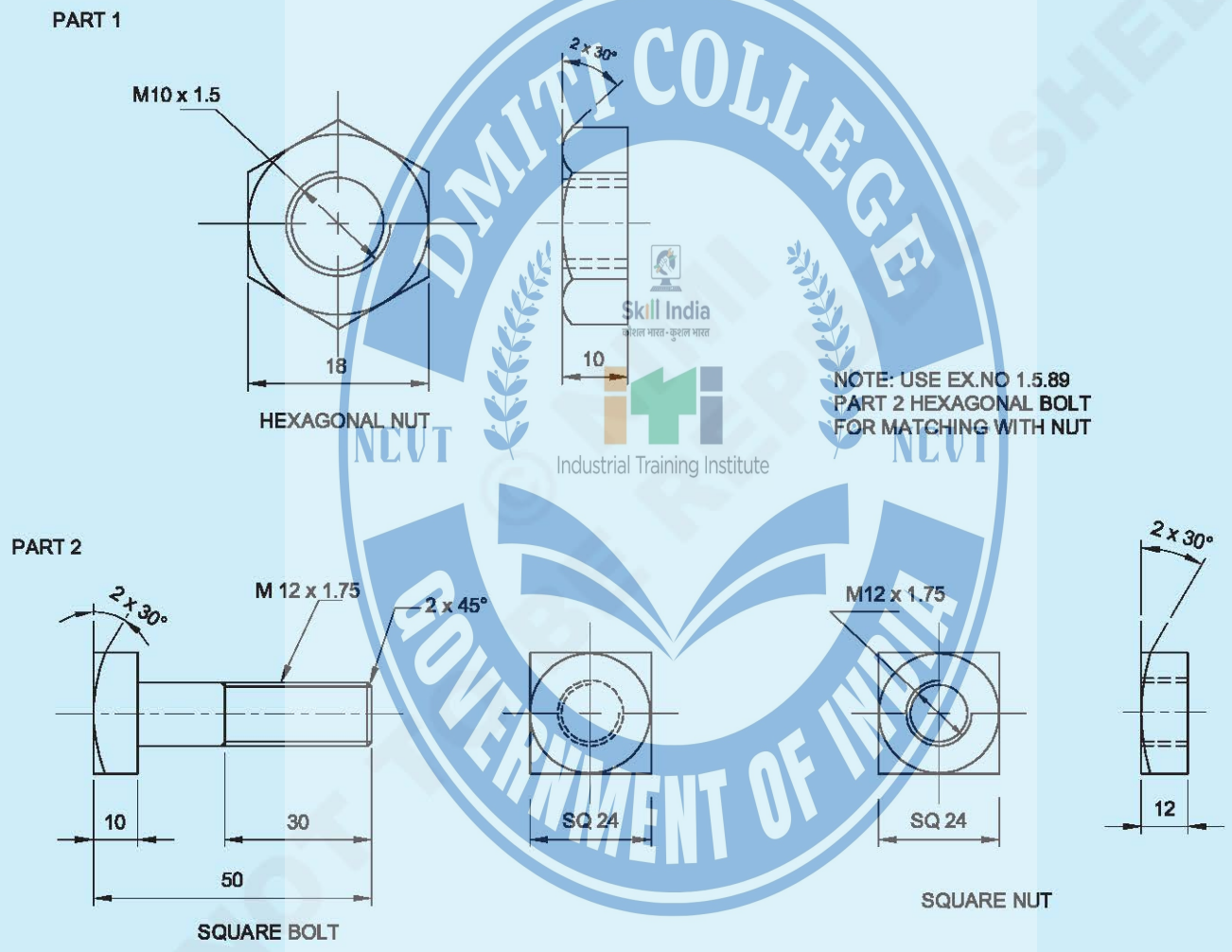
1	ISR Ø 14 - 65	–	Fe310	–	–	1.5.70
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FORM EXTERNAL THREADS WITH DIES TO STANDARD SIZE	TOLERANCE : ±0.04	TIME :
		CODE NO : FI20N1570E1	

Prepare nuts and match with bolts

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

- **cut and turn square rod to blank size to cut external threads**
- **file square bolt and nut to correct size and shape as per drawing**
- **determine tap drill sizes for hexagonal and square nut**
- **drill holes for tapping holes, to cut internal threads in hexagon and square nut**
- **cut external threads on square head bolt using die and die stock**
- **cut internal threads on hexagon and square nuts using tap and tap wrench**
- **match nuts with bolts.**



1	SQUARE 25 - 68 (BOLT & NUT)	–	Fe310	–	2	
1	HEX A/F 18 - 15 (NUT)	1.1.69 PART 2 (BOLT)	Fe310	–	1	1.5.71
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PREPARE NUTS AND MATCH WITH BOLTS	TOLERANCE : ±0.04	TIME :
		CODE NO : FI20N1571E1	

Job Sequence

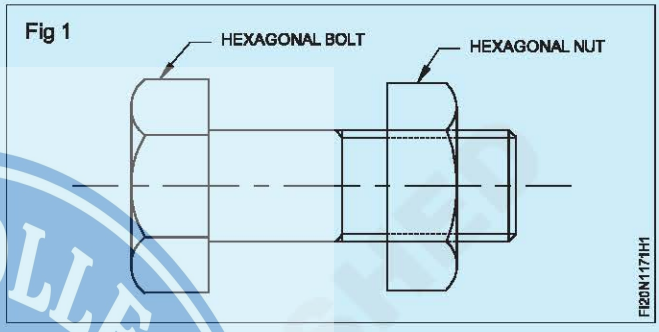
PART - 1 Hexagonal head bolt

Note: Use Ex:No 2.1.69 Task 2 hexagonal bolt for matching with hexagonal nut.

Hexagonal nut

- Check the raw material for its size
- File nut to size 10 mm thickness in 18 mm across flat hexagonal rod
- File chamfer in one end to 2 mm x 30°
- Determine tap drill size for M 10 tap.
- Mark centre of hole for tap drill size Ø 8.5 mm
- Punch on tap drill hole centre with centre punch 90°
- Make centre drill to locate hole centre
- Drill pilot hole Ø 5 mm in hexagonal nut
- Drill Ø 8.5 mm hole for M 10 tap.
- Chamfer both ends of drilled hole to 2 mm x 45°
- Hold the nut in bench vice parallel to vice jaws.
- Fix M10 first tap in tap wrench and cut internal thread as per drawing.
- Similarly, fix M10 second tap, third tap and cut and form the full thread.
- Check the threaded hole with screw pitch gauge and matching bolt.
- Clean the thread in bolt and nut.
- Match the nut with bolt as shown in Fig 1.

Fig 1



- Apply a little oil and preserve it for evaluation.

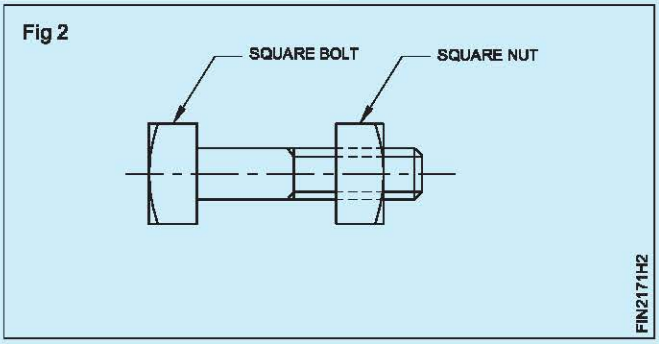
PART - 2 Square head bolt

- Cut the square rod to size 53mm.
- File square rod side 25 mm to side 24 mm and length 50 mm.
- Turn to size Ø 11.8 mm x 40 mm length as shown in Fig 2.
- File chamfer in blank end to 2 mm x 45° and head side 2 x 30°
- Hold the square head bolt blank in bench vice to 90°
- Fix M 12 split die in die stock.
- Set M 12 split die on square head bolt blank end and cut external thread.
- Repeat the thread cutting process untill the nut matches.
- Check the external thread using screw pitch gauge and matching nut.

Square Nut

- Check the raw material size 15mm.
- File nut to size 12 mm thickness in 25 mm side square rod.
- File chamfer in one end to 2 mm x 30°.
- Determine tap drill size for M 12 tap.
- Mark centre of hole for tapping hole.
- Punch on the tap drill hole centre with centre punch 90°
- Make centre drill to locate hole centre.
- Drill Ø 6 mm pilot hole in square nut
- Drill Ø 10.8 mm for tapiping hole.
- Chamfer both ends of drilled hole to 2 mm x 45°
- Hold the nut in bench vice parallel to vice jaws.
- Fix M 12 first tap in tap wrench and cut internal thread as per drawing.
- Similarly, fix M 12 second tap, third tap and cut and form full internal thread.
- Check the threaded hole with screw pitch gauge and matching bolt.
- Clean the thread in bolt and nut.
- Match the nut with bolt as shown in Fig 2.
- Apply a little oil and preserve it for evaluation.

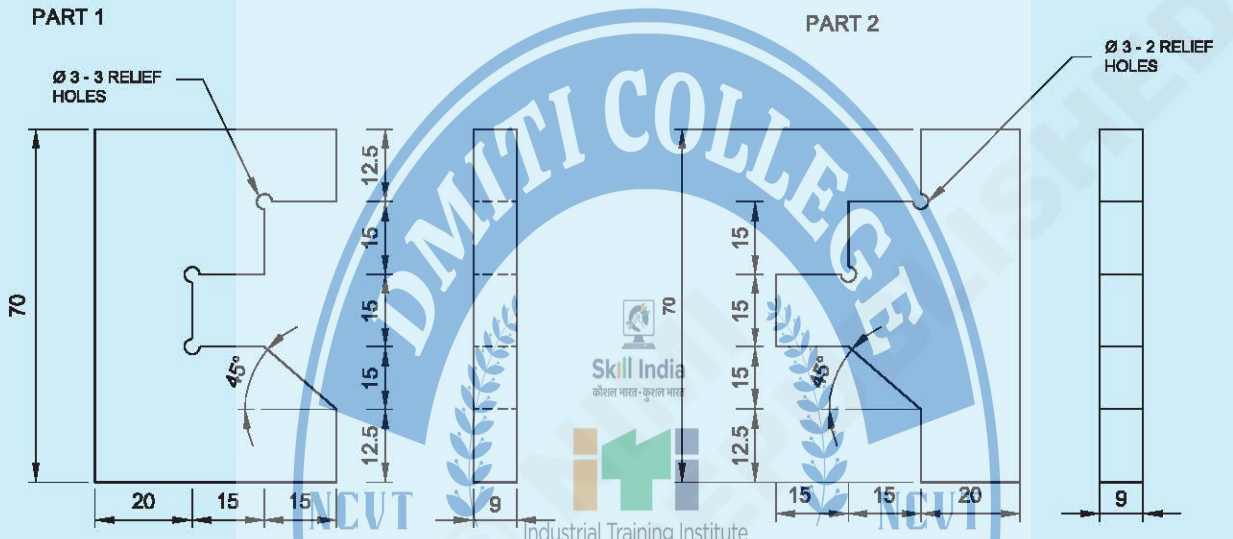
Fig 2



File and make step fit, angular fit, angle surfaces (bevel gauge accuracy 1 degree)

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

- **mark off lines using vernier height gauge**
- **file steps maintaining accuracy ± 0.04 mm**
- **mark 45° angle using vernier bevel protractor**
- **file angle maintaining 1°accuracy**
- **make step and angular fit, finish and de - burr.**

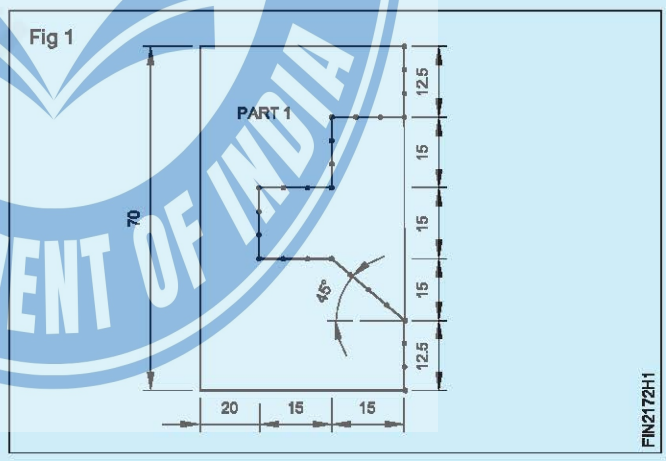


Job Sequence

PART - 1

- Check the raw material for its size.
- File and finish to size 70 x 50 x 9 mm maintaining parallelism and perpendicularity.
- Mark and punch in part '1' as shown in Fig - 1.
- Drill Ø 3 relief holes as shown in job drawing.
- Chain drill holes for parting off excess material from part '1' as shown in Fig 2.
- Cut and remove excess material using web chisel and ball pein hammer.

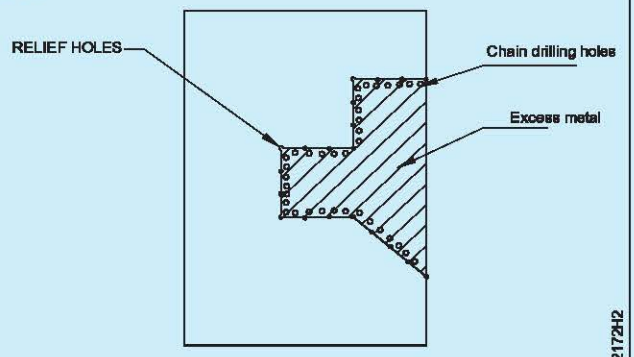
Fig 1



2	75 ISF 10 - 55	–	Fe310	–	1 & 2	1.5.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

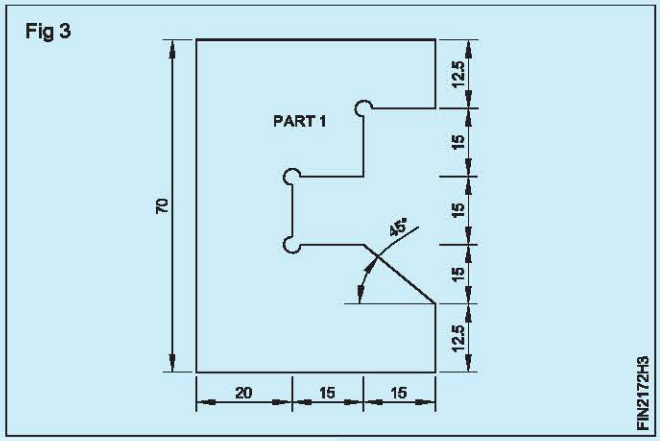
SCALE 1:1	FILE AND MAKE STEP FIT, ANGULAR FIT, ANGLE, SURFACES(BEVEL GAUGE ACCURACY 1 DEGREE)	TOLERANCE : ±0.04	TIME
		CODE NO : FI20N1572E1	

Fig 2



- File steps to size maintaining accuracy ± 0.04 mm and angle to 45° maintaining 1° accuracy using safe edge different grades of files as shown in Fig 3.

Fig 3

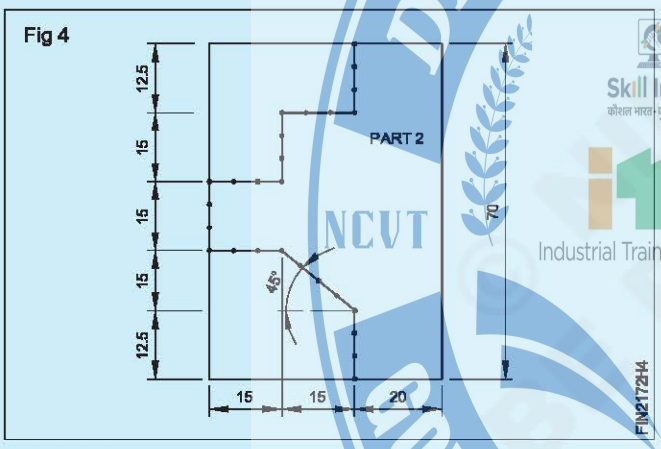


- Check the size with vernier caliper and angle with bevel gauge.

PART-2

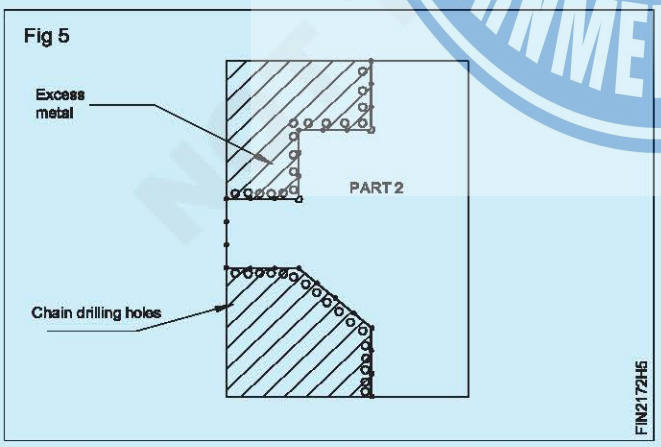
- File and finish to size 70 x 50 x 9 mm maintaining parallelism and perpendicularity.
- Mark and punch in part -2 as shown in Fig 4.

Fig 4



- Drill Ø 3 relief holes as shown in drawing.
- Chain drill holes for parting off excess material from part - 2 as shown in Fig 5.

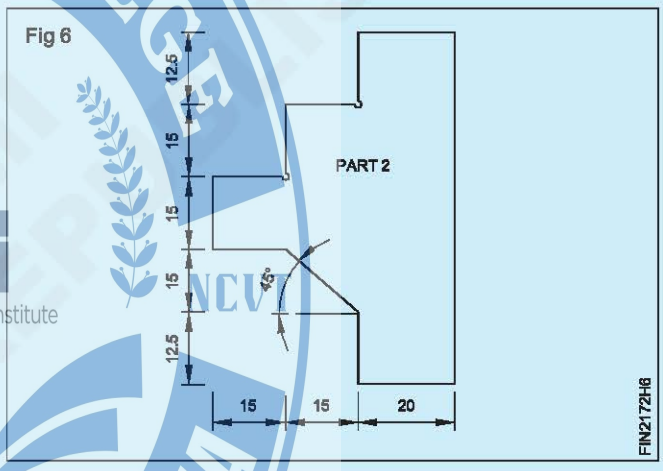
Fig 5



- Cut and remove excess material using web chisel and ball pein hammer.

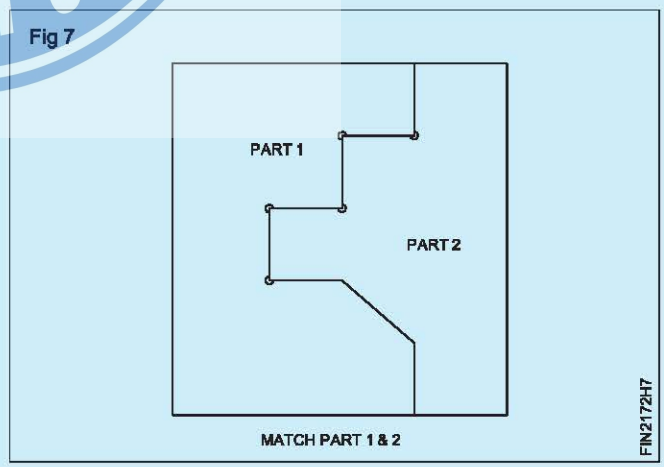
- File steps to size and angle to 45° using safe edge file different grades as shown Fig 6.

Fig 6



- Check the size with vernier caliper and angle with bevel gauge.
- Match part 1 and 2 as shown in Fig 7.
- Finish file on part 1, 2 and de - burr in all the surfaces.
- Apply a little oil and preserve it for evaluation.

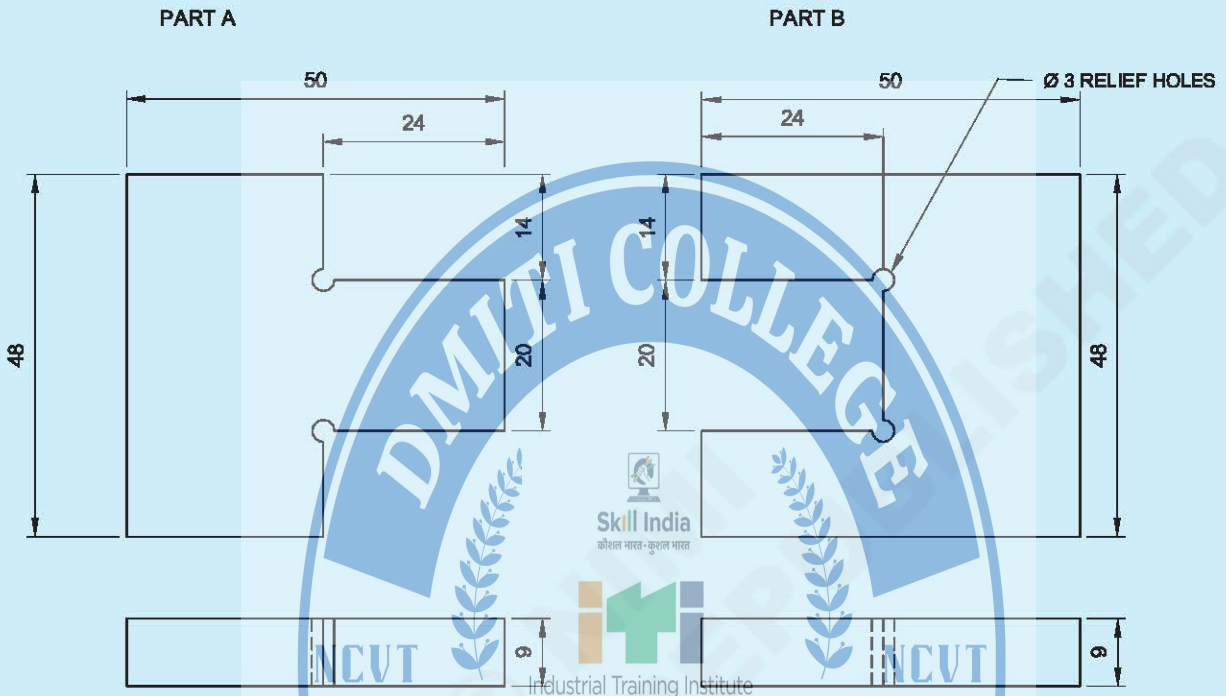
Fig 7



Make simple open and sliding fits

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

- **file flat surfaces to flat and parallel within an accuracy of ± 0.04 mm**
- **file and assemble the tongue and groove, and obtain the required class of fit.**

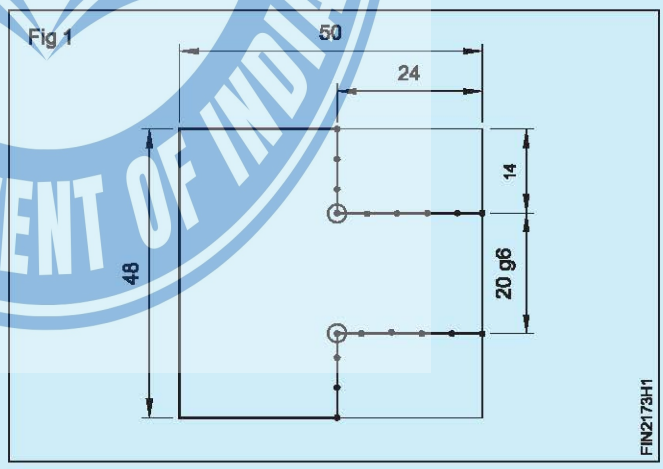


Job Sequence

Part - A

- Check the raw material for its size.
- File and finish to size 50 x 48 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media, mark as per job drawing and punch witness marks in part A as shown in Fig 1.
- Drill relief hole Ø 3 mm as per job drawing in part A.

Fig 1

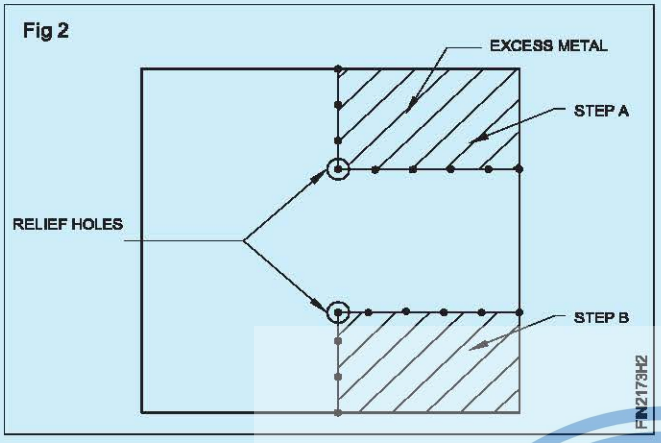


2	50 ISF 10 - 55	-	Fe310	-	A&B	1.5.73
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.

SCALE 1:1	MAKE SIMPLE OPEN AND SLIDING FITS	TOLERANCE : ± 0.04	TIME :
		CODE NO : FI20N1573E1	

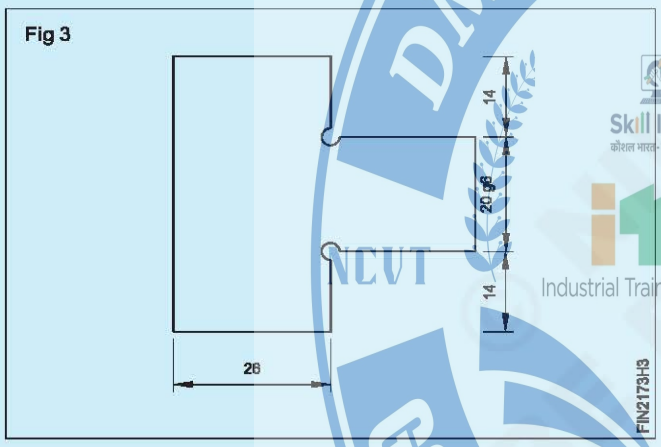
- Mark lines as shown in Fig 2 leaving the metal 1 mm away from the object line and cut and remove the excess metal by hacksawing.

Fig 2



- File part A as per drawing to size 14 mm x 24 mm with safe edge file and check the size with vernier caliper.
- Similarly cut and remove the excess metal and file step B to size and shape and check the size with vernier caliper as shown in Fig 3.

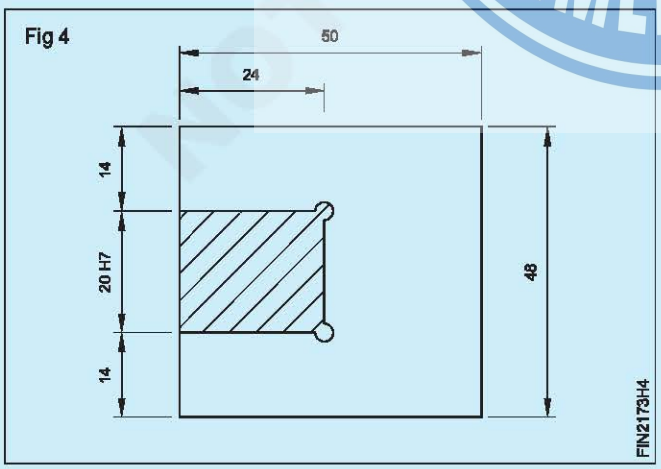
Fig 3



Part B

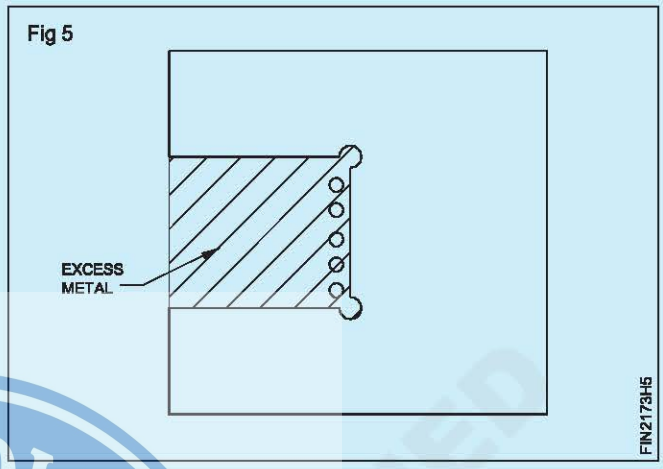
- File and finish to size 50 x 48 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media, mark and punch as shown in Fig 4.

Fig 4



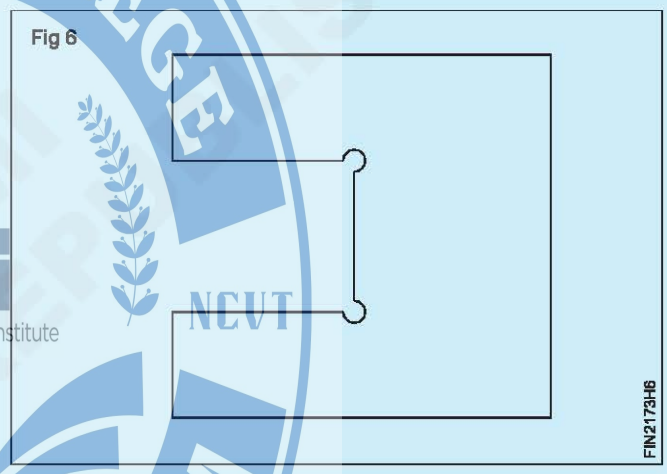
- Drill relief hole Ø 3 mm on part B
- Chain drill holes, chip, hacksaw and remove the excess metal as shown in Fig 5.

Fig 5



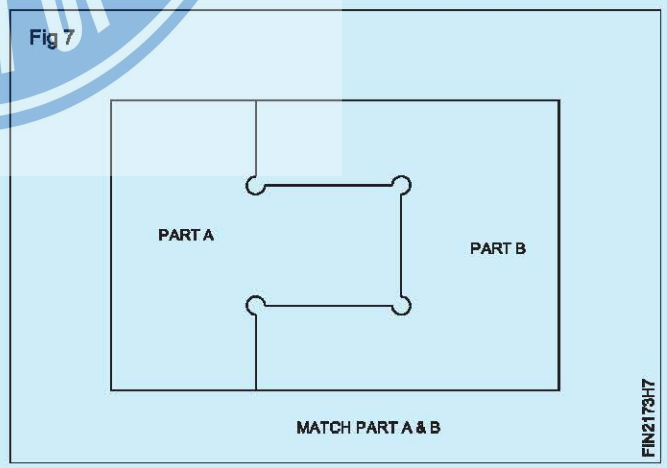
- File to size and shape maintaining the flatness and squareness as shown in Fig 6.

Fig 6



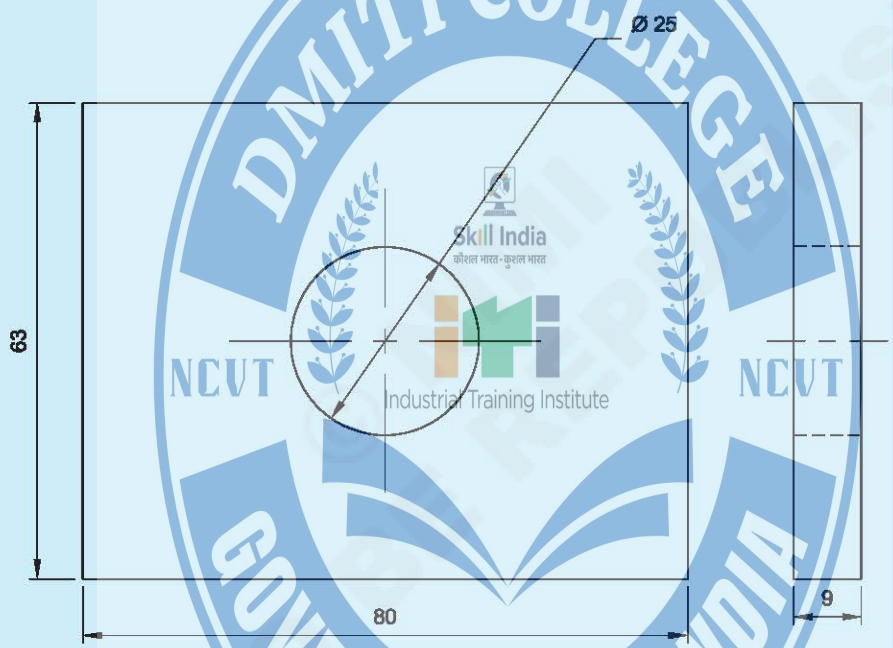
- Check the size with vernier caliper.
- Match part 'A' and 'B' as shown in Fig 7
- Finish de - burr in all the corners of the job.
- Apply a thin coat of oil and preserve it for evaluation.

Fig 7



Enlarge hole and increase internal dia

Objectives: At the end of this exercise you shall be able to
- **mark drill hole centre as per drawing**
- **drill centre drill and pilot hole**
- **enlarge the drilled holes to Ø 25 mm by filing.**

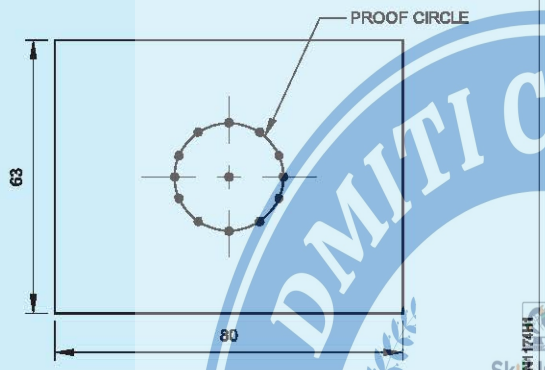


1	65 ISF 10 - 82	-	Fe310	-	-	1.5.74
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	ENLARGE HOLE AND INCREASE INTERNAL DIA				TOLERANCE : ±0.04	TIME :
					CODE NO : FI20N1574E1	

Job Sequence

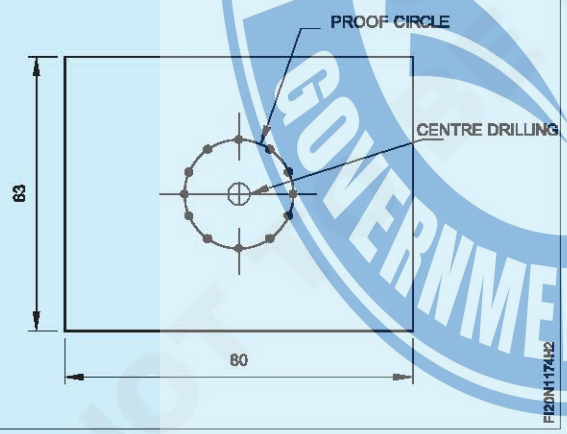
- Check the raw material for its size
- File and finish to size 80x63x9 mm and maintaining parallelism and perpendicularity.
- Apply marking media, mark off centre lines and locate the centre of drill hole as per drawing.
- Punch on the intersecting lines using prick punch 30°, set 12.5 mm in divider using steel rule and draw Ø 25 mm circle.
- Punch the Ø 25 mm circle using prick punch as shown in Fig 1.

Fig 1



- Fix the job on the drilling machine table.
- Fix centre drill in drill chuck and locate the drill hole in centre of the work piece. (Fig 2)

Fig 2



- Fix Ø 6 mm drill in drilling machine and drill pilot hole in the centre drilled hole. (Fig 3)
- set the drilling machine speed according to the diameter of drill.
- Similarly, fix Ø 10 mm, Ø 16 mm and Ø 20 mm drills in different diameters one by one in drilling machine and enlarge the previously drilled holes as shown in Fig 4.

Fig 3

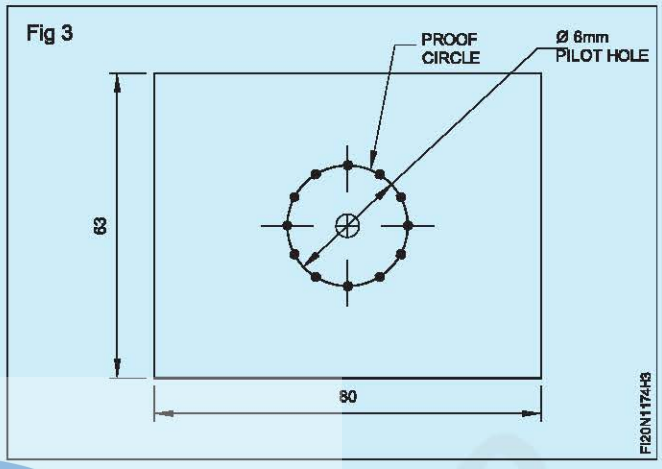
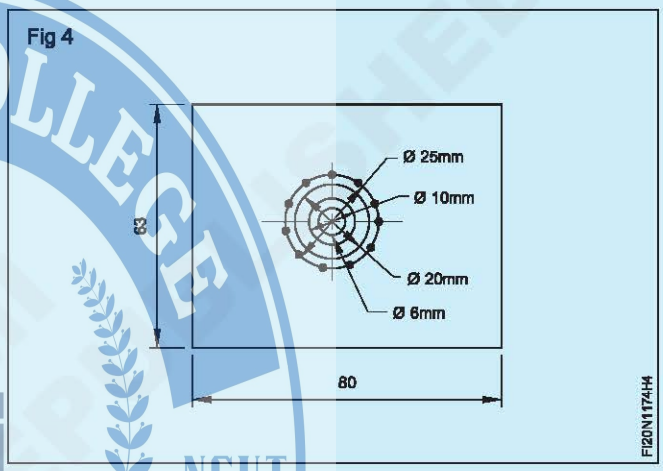
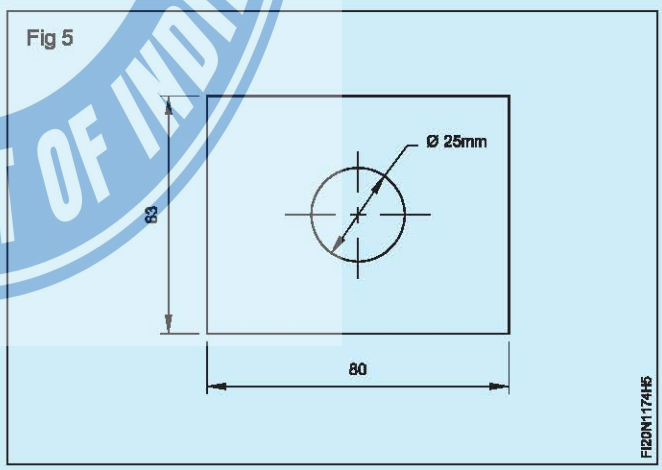


Fig 4



- Finally, enlarge the previously drilled hole to Ø 25 mm by filing as shown in Fig 5.
- Finish file on the job and de-burr in all the corners.
- Apply a thin coat of oil and preserve it for evaluation.

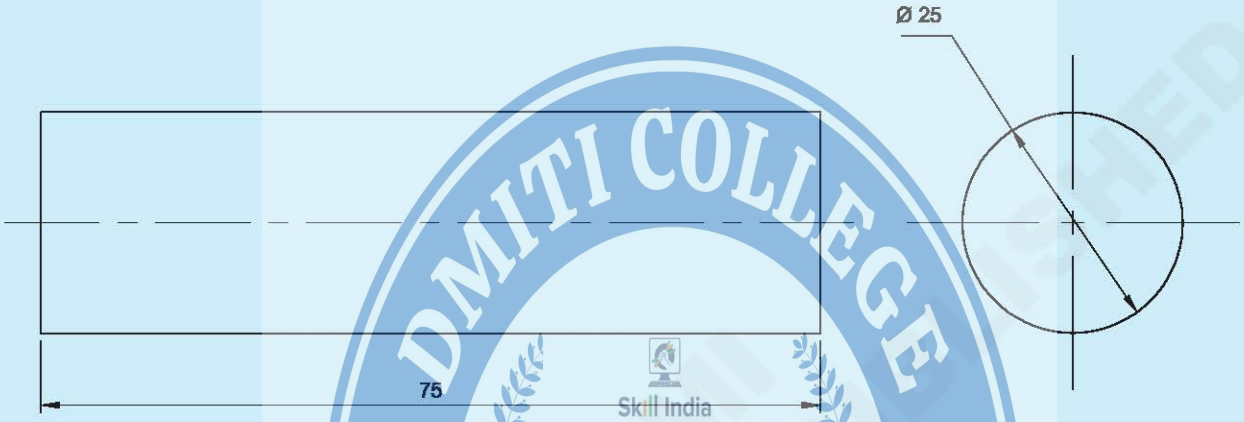
Fig 5



Use coolant while drilling

File cylindrical surfaces

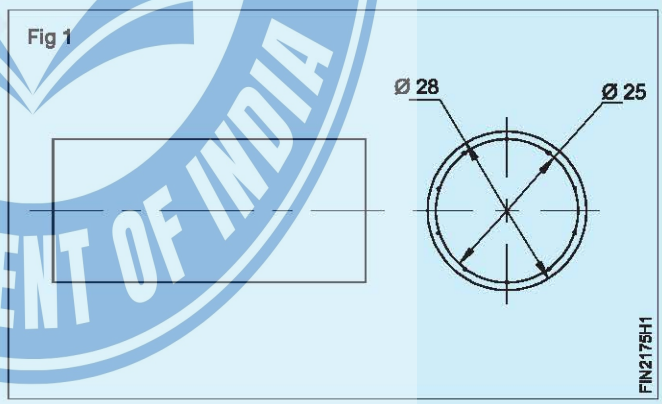
Objectives: At the end of this exercise you shall be able to
- **hold cylindrical rod in a bench vice**
- **file cylindrical surface an accuracy of ± 0.04 mm**
- **finish and de - burr.**



Job Sequence

- Check the raw material for its size
- File round rod both ends to flatness and squareness maintaining 75 mm length.
- Check the flatness squareness and parallelism.
- Apply marking media in both ends of round rod.
- Mark C/L of round rod. With reference to C/L mark the diameter Ø 25 mm on both ends using divider and steel rule to file cylindrical profile as shown in Fig 1.
- Punch witness marks on marked diameter.
- Hold the cylindrical rod in bench vice and file cylindrical profile to Ø 25 mm using flat file of different grades in see saw motion.
- Check the length and diameter of cylindrical rod with vernier caliper.
- Rotate the cylindrical rod and file circular profile to Ø 25 mm.
- Check the diameter with out side micrometer.
- Debur in both ends of round rod.
- Apply little oil and preserve it for evaluation.

Fig 1



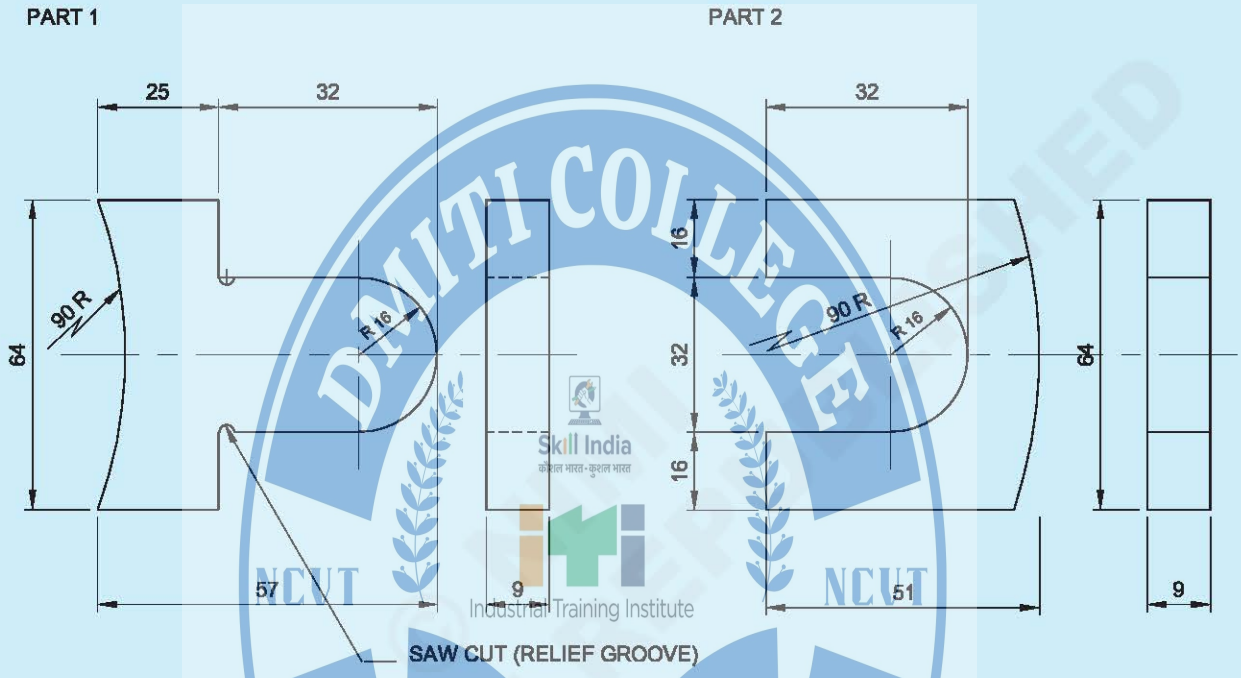
1	Ø28 - 80	–	Fe310	–	–	1.5.75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILE CYLINDRICAL SURFACES	TOLERANCE : ±0.04	TIME :
		CODE NO : FI20N1575E1	

Make open fitting of curved profiles

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

- **file surfaces to flat and parallel to an accuracy of ± 0.04 mm**
- **mark curved profiles as per drawing**
- **file radius and curved profiles to size and shape**
- **match open fitting of curved profile.**



Job Sequence

PART - 1

- Check the raw metal size using steel rule.
- File and finish to overall size 64 x 57 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media, mark in part 1 as per job drawing.
- Punch witness marks as shown in Fig 1
- Cut and remove the hatched portion of excess metal in one side and file to size and shape as shown in Fig 2.
- Check the size with vernier caliper.
- Similarly, cut and remove the hatched portion of excess metal on otherside and file to size and profile as shown in Fig 3.

1	65 ISF 10 - 55	–	Fe310	–	2	1.5.76
1	65 ISF 10 - 60	–	Fe310	–	1	1.5.76
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKE OPEN FITTING OF CURVED PROFILES	TOLERANCE : ±0.04	TIME :
		CODE NO : FI20N1576E1	

Fig 1

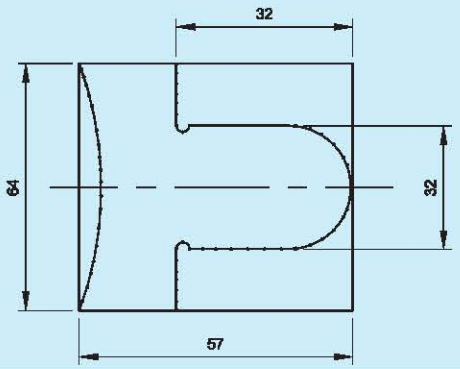


Fig 2

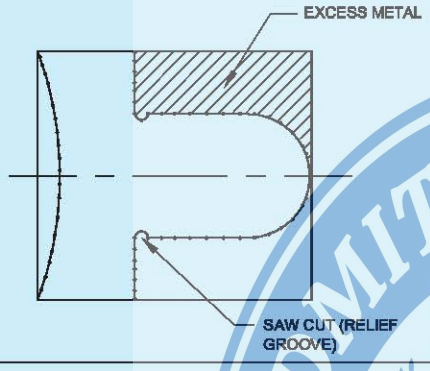
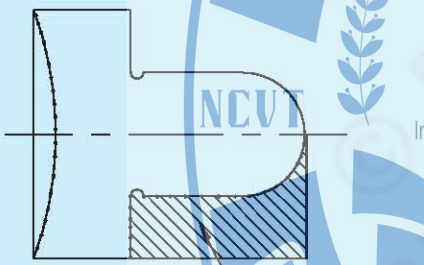


Fig 3



- Cut relief grooves by hacksaw.
- Cut and remove the hatched portion of excess metal on curvature side (fig 4) and file the curved profile to size and check the curved profile with template and check the sizes with vernier caliper as shown in Fig 5.

Fig 4

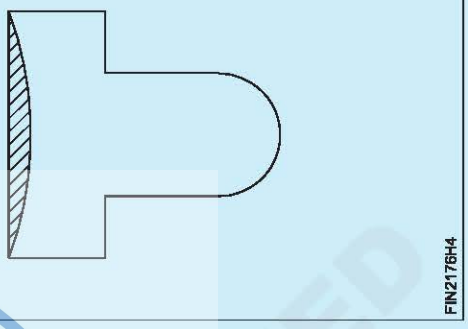
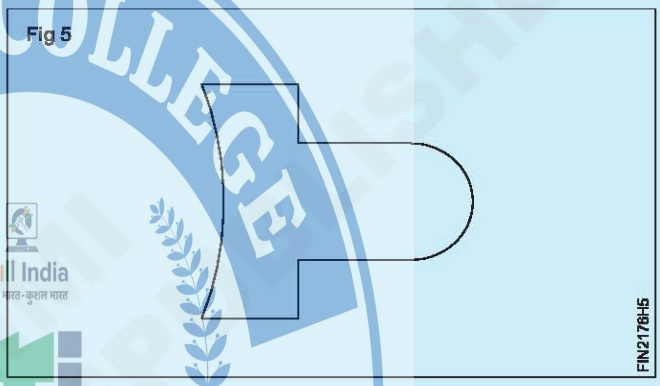


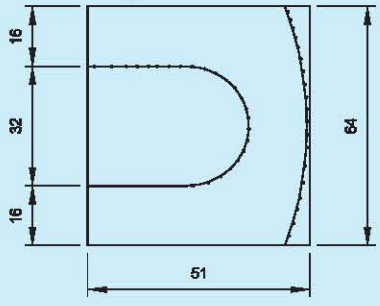
Fig 5



Part - 2

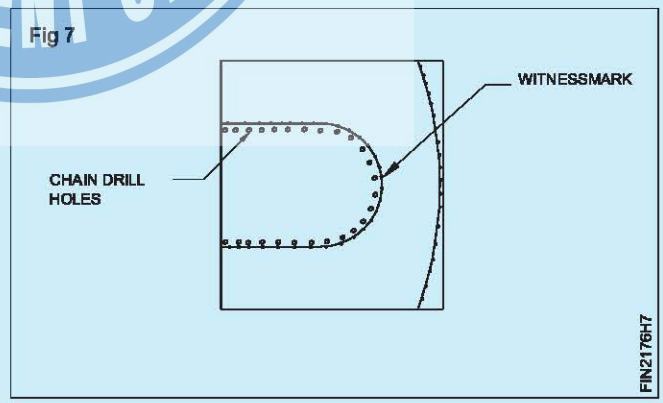
- Check the raw metal size using steel rub.
- File and finish to size 64 x 51 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media, mark as per job drawing.
- Punch witness marks in part 2 as shown in Fig 6.

Fig 6



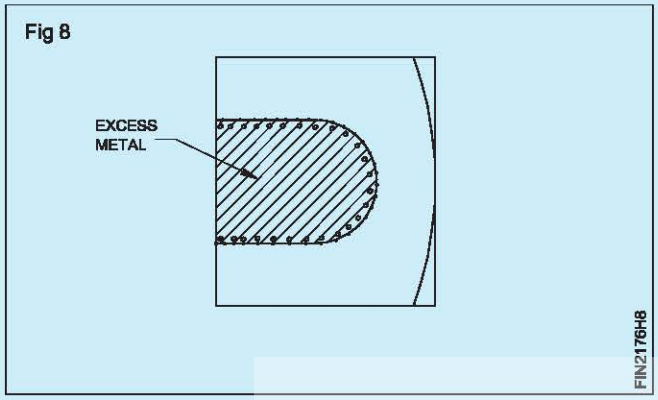
- Chain drill holes to remove excess metal as shown in Fig 7.

Fig 7



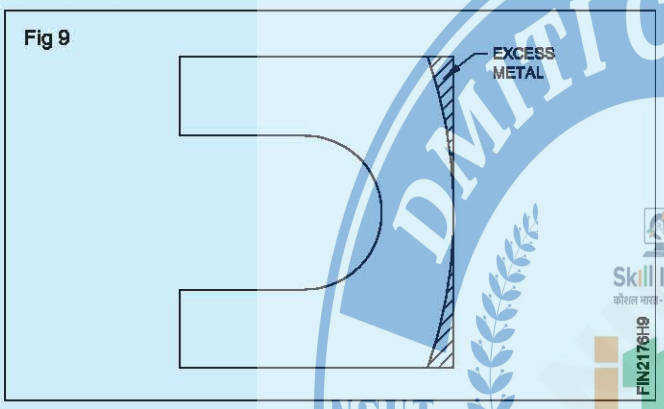
- Cut and remove the hatched portion of excess metal and file to size and shape as shown in Fig 8.

Fig 8



- Similarly, cut and remove the hatched portion of excess metal on curved profile side with hacksaw and file the profile to size and shape as shown in Fig 9.

Fig 9



- Check the curved profile with template and the size with vernier caliper as shown in Fig 10.
- Match part 1 and 2 as shown in Fig 11 & 12 in both sides.
- Finish file in part 1 and 2 and remove burrs in all the surfaces and corners.
- Apply a little oil and preserve it for evaluation.

Fig 10

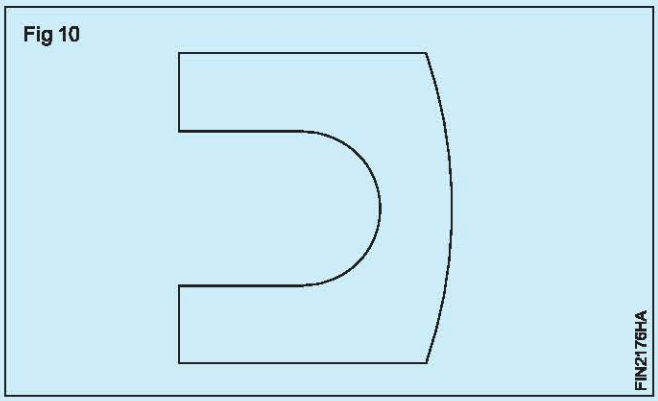


Fig 11

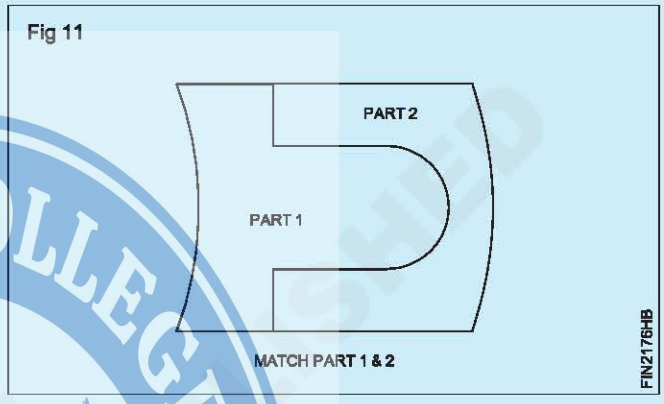
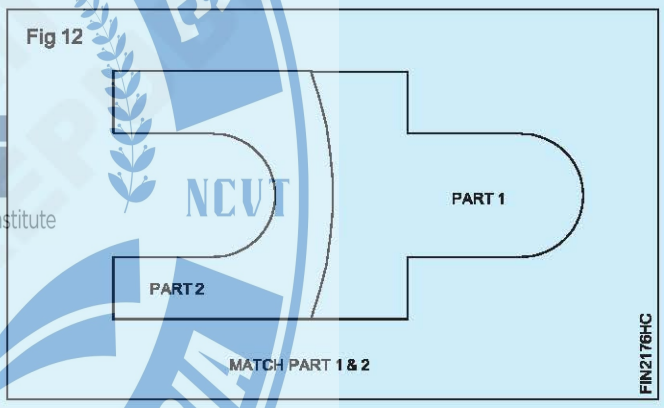


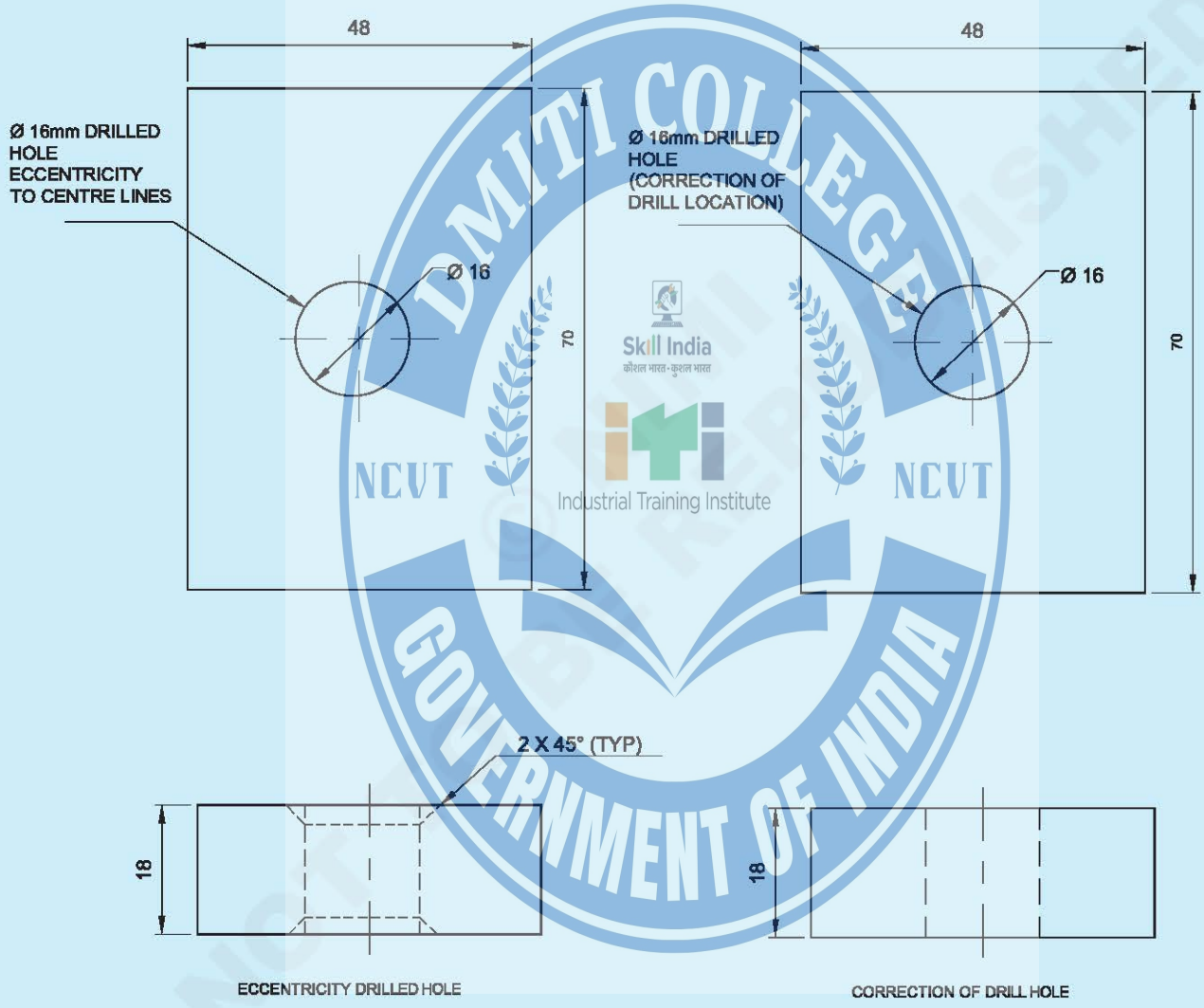
Fig 12



Correction of drill location by binding previously drilled hole

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

- **prepare round rod more than the hole size**
- **plug the hole as tight fit**
- **file the plugged surface on both sides flat and square**
- **mark the hole location concentricity to centre lines**
- **drill pilot and correct drill hole concentricity to the centre lines.**

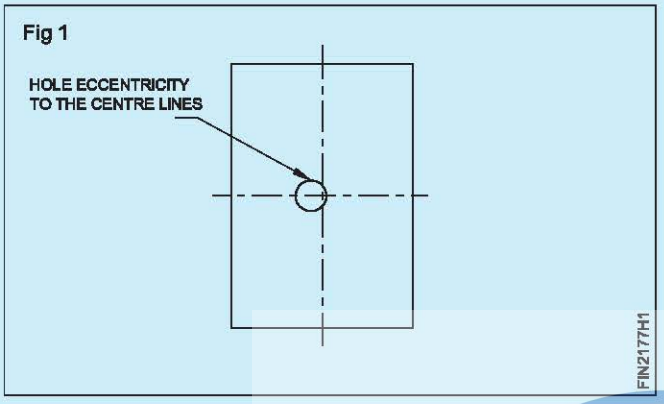


1	50 ISF 20 - 75	–	Fe310	–	1	1.5.77
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	CORRECTION OF DRILL LOCATION BY BINDING PREVIOUSLY DRILLED HOLE				TOLERANCE : ±0.04	TIME :
					CODE NO : FI20N1577E1	

Job Sequence

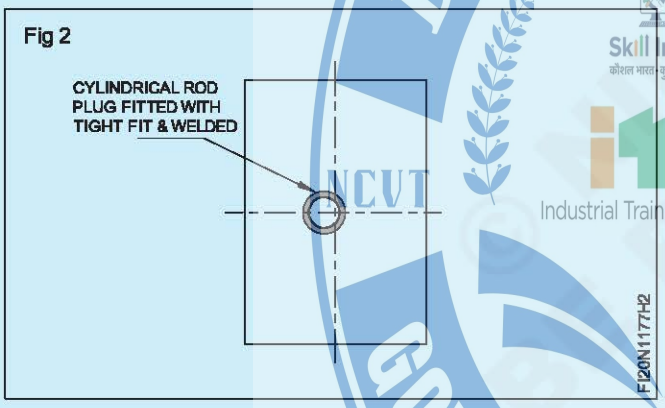
- Check the given material hole size Fig 1.

Fig 1



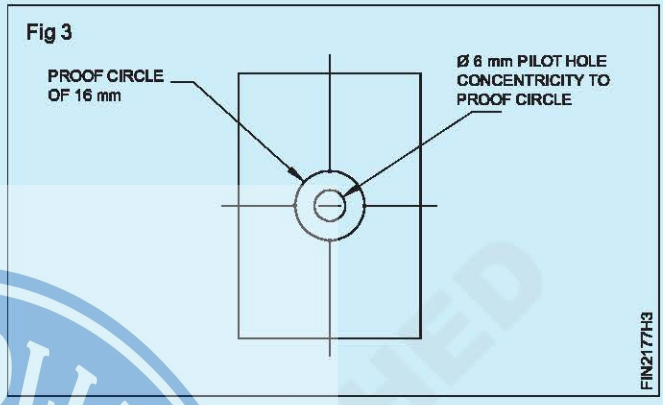
- Chamfer 2x45° at both ends of hole
- Prepare round rod more than 0.050 mm actual size of drilled hole (16.000 + 0.050 = 16.050 mm) and chamfer 2 x 45° at both ends of round rod
- Plug the hole as tight fit with prepared round rod using ball pein hammer (Fig 2)
- Weld both ends of plug fitted round rod

Fig 2



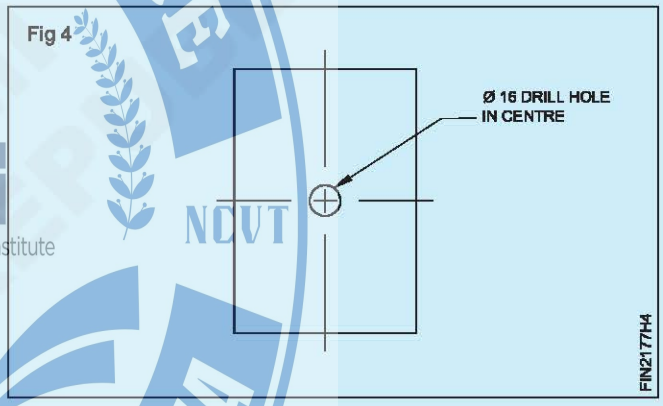
- File the plug surface on both sides to flat and square.
- Apply marking media on surface.
- Mark correct centre for drill hole with vernier height gauge (Fig 3)
- Punch on the drill hole centre mark with centre punch 90°.
- Fix centre drill in drill chuck and make centre drill hole.
- Fix Ø 6 mm drill and drill hole as a pilot hole (Fig 3).
- Similarly fix Ø 9 mm, Ø 13 mm drill and enlarge the previously drilled holes.

Fig 3



- Finally, fix Ø 16 mm drill and enlarge the previously drilled hole Fig 4.
- Finish file, de-burr, clean and check with vernier caliper.

Fig 4



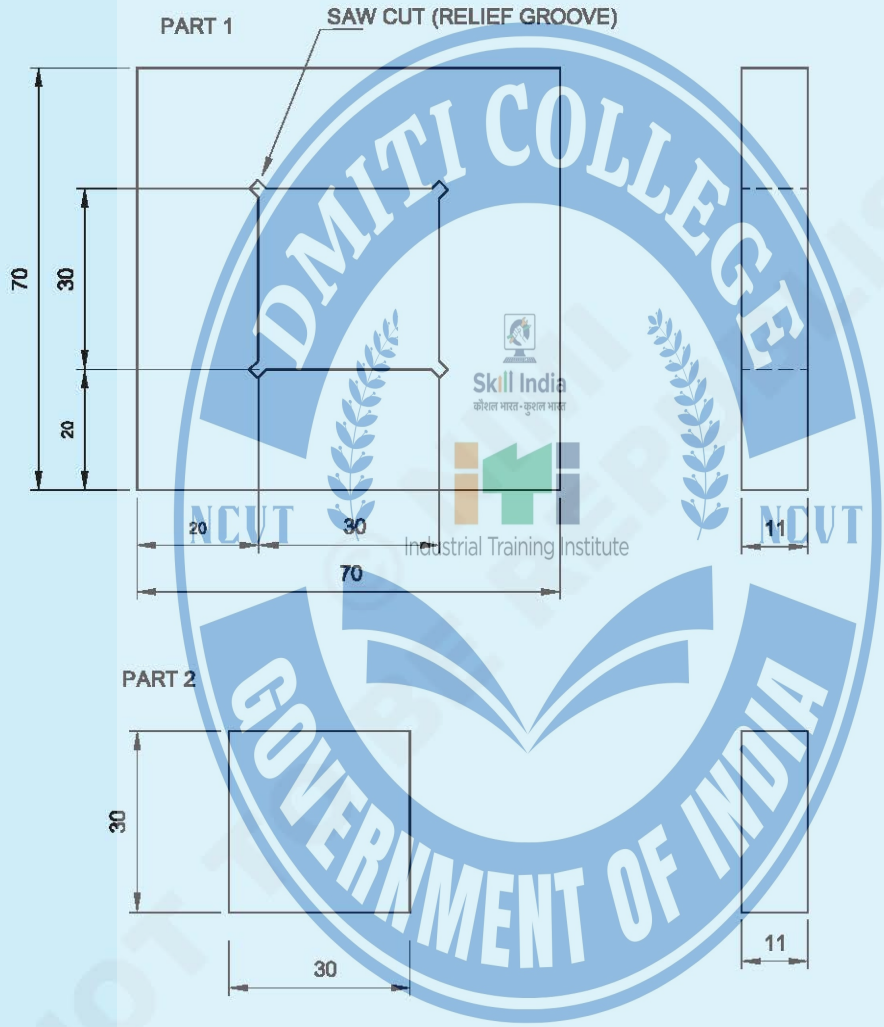
- Apply a little oil and preserve it for evaluation.

Incase of minor eccentricity to center lines follow the procedure given below

- Fix the work piece in machine vice
- Align the center with locating pin
- Fix the slot drill in drill chuck
- Slot drill it (now the center is in the location) with the same setting drill Ø 16 mm hole.

Make inside square fit

Objectives: At the end of this exercise you shall be able to
- **mark the dimension lines as per drawing**
- **chain drill, cut and remove excess metal by chipping**
- **file square slot maintaining ± 0.04 mm**
- **match square in square slot.**



1	35 ISF 12-35	–	Fe310	–	2	1.5.78
1	75 ISF 12-75	–	Fe310	–	1	1.5.78
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

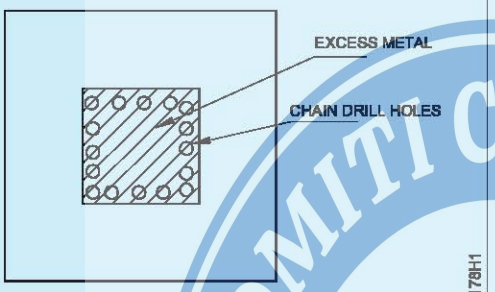
SCALE 1:1	MAKE INSIDE SQUARE FIT	TOLERANCE : ±0.04	TIME :
		CODE NO : FI20N1578E1	

Job Sequence

PART - 1

- Check the given raw material for its size.
- Rough and finish file on surfaces flat and square to over all size 70x70x11 mm maintaining accuracy ± 0.04mm.
- Mark off sizes in part 1 as per job drawing and punch witness marks.
- Hold part 1 in drilling machine table and drill chain drill holes to remove excess metal as shown in Fig 1.

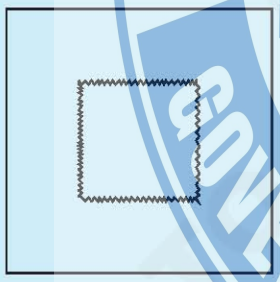
Fig 1



Pheriphery of the drill should not touch the witness marks

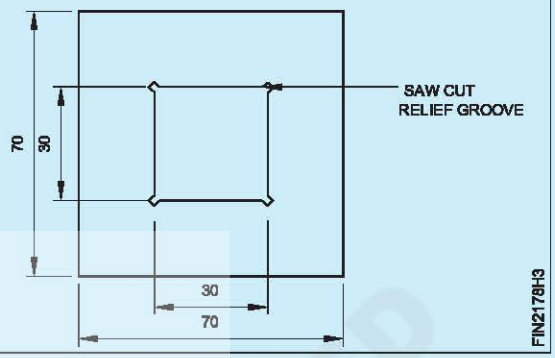
- Cut and remove the chain drilled hatched part using web chisel and ball pein hammer as shown in Fig 2.

Fig 2



- File the chipped portion to size and shape using safe edge file of different grades maintaining accuracy of ± 0.04 mm and check the size with vernier caliper.
- Cut relief grooves using hacksaw at four inside corners as shown in Fig 3.

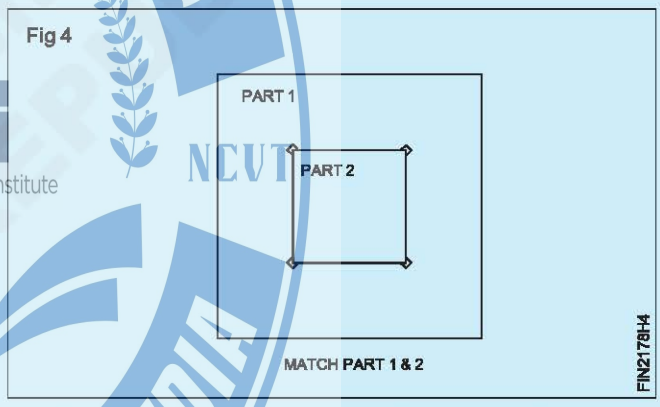
Fig 3



PART - 2

- File to size 30x30x11 mm maintaining accuracy ± 0.04 mm.
- Check the flatness and squareness with try square.
- Check the size with vernier caliper.
- Match part - 2 into part1 as shown in Fig 4.

Fig 4



- Finish file in part 1 and 2 with flat smooth file and de-burr in all the surfaces and corners of the job.
- Apply a little oil and preserve it for evaluation.