FITTER

NSQF LEVEL - 5

2nd Semester

TRADE PRACTICAL

SECTOR: Production & Manufacturing

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

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P. B. No.3142, CTI Campus, Guindy Industrial Estate,
Guindy, Chennai - 600 032.
Phone : 044 - 2250 0248, 2250 0657, 2250 2421
Fax : 91 - 44 - 2250 0791
email : chennai-nimi@nic.in, nimi_bsnl@dataone.in
Website: www.nimi.gov.in

FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai has now come up with instructional material to suit the revised curriculum for **Fitter 2nd Semester Trade Practical NSQF Level - 5 in Production & Manufacturing Sector under Semester Pattern.** The NSQF Level - 5 Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 5 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 5 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

RAJESH AGGARWAL
Director General/ Addl. Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

R. P. DHINGRA
EXECUTIVE DIRECTOR

Chennai - 600 032

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Practical)** for the trade of **Fitter** under Production & Manufacturing Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. M. Sampath	_	Training officer (Retd.) CTI, Chennai-32.
Shri. M. Sangarapandian	_	Training officer (Retd.) CTI, Chennai - 32
Shri. K. Kesavan	_	Asst. App. Advisor Junior (Retd) DET, Tamilnadu
Shri. C.C. Subramanian	_	Training officer (Retd.) Balamandir PHM ITI, Chennai - 17
Shri. A. Stephen	_	Instructor, St. John's ITI Manapparai Trichy District - 621 307
Shri. K.B. Shivaramu	_	Junior Training officer Government ITI, Mysore - 570007
Shri. D.C. Nataraja	_	Junior Training officer Government ITI, Mysore - 570007
Shri. Milind Rasu	_	Instructor, Government ITI Aliganj, Lucknow
Shri. K. Srinivasa Rao	_	Joint Director, Co-ordinator, NIMI, Chennai - 32
Shri. G. Michael Johny	_	Assistant Manager, Co-ordinator, NIMI, Chennai - 32

NIMI records its appreciation for the Data Entry, CAD, DTP operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks the invaluable efforts rendered by all other NIMI staff who have contributed towards the development of this Instructional Material.

NIMI is also grateful to everyone who has directly or indirectly helped in developing this Instructional Material.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in practical workshop . It consists of a series of practical exercises to be completed by the trainees during the Second Semester Course of the Fitter Trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 5 syllabus are covered.

The manual is divided into five modules. The distribution of time for the practical in the five modules are given below.

Module 1	**Drilling**	150 Hrs
Module 2	**Fitting assembly**	150 Hrs
Module 3	**Turning**	125 Hrs
Module 4	**Basic Maintenance**	75 Hrs
Module 5	**Project work**	50 Hrs
	Total	550 Hrs

The skill training in the shop floor is planned through a series of practical exercises centred around some practical object. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the Second Semester Course of the Fitter Trade. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 5 syllabus on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade Theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indications about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not for the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Produce components by different operations and check accuracy using appropriate measuring instrument. [Different Operations-Drilling, reaming, taping, dieing., Appropriate measuring instruments - Vernier, screw gauge, micrometer.]**
- **Make different fit of components for assembling as per required tolerance observing principle of interchargeability and check for functionality. [Different fit-sliding, angular, step fit, 'T' fit, square fit and profile fit., Required tolerance; ± 0.04 mm, angular tolerace: 30 min]**
- **Produce components involving different operations on lathe observing standard procedure and check for accuracy. [Different operations - Facing, plain turning, step turning, parting, chamfering, shoulder turn, grooving, knurling, boring, taper turning, threading (external 'V' only.]**
- **Plan & perform simple rapair, overhauling of different machines and check for functionality. [Different machines - Drill machine, power saw, bench grinder and lathe.]**

SYLLABUS

Second Semester **Duration: Six Month**

Week No.	Ref. Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
27	Produce componentsby different operations and check accuracy using appropriate measuring instruments.[Different Operations-Drilling, Reaming, Taping, Dieing; Appropriate Measuring Instrument – Vernier, Screw Gauge, Micrometer]	61 Mark off and drill through holes. (5 hrs.) 62 Drill on M.S. flat. (1 hrs.) 63 File radius and profile to suit gauge (13 hrs.) 64 Sharpening of Drills.(1 hrs.) 65 Practice use of angular measuring instrument. (5 hrs.)	Drill- material, types, (Taper shank, straight shank) parts and sizes. Drill angle-cutting angle for different materials, cutting speed feed. R.P.M. for different materials. Drill holding devicesmaterial, construction and their uses.
28	-do-	66 Counter sink, counter bore and ream split fit (three piece fitting). (5 hrs.) 67 Drill through hole and blind holes. (2 hrs.) 68 Form internal threads with taps to standard size (through holes and blind holes).(3 hrs.) 69 Prepare studs and bolt.(15 hrs.)	Counter sink, counter bore and spot facing-tools and nomenclature, Reamermaterial, types (Hand and machine reamer), kinds, parts and their uses, determining hole size (or reaming), Reaming procedure. Screw threads: terminology, parts, types and their uses. Screw pitch gauge: material parts and uses. Taps British standard (B.S.W., B.S.F., B.A. & B.S.P.) and metric / BIS (course and fine) material, parts (shank body, flute, cutting edge).
29	-do-	70 Form external threads with dies to standard size. (10 hrs.) 71 Prepare nuts and match with bolts.(15 hrs.)	Tap wrench: material, parts, types (solid &adjustable types) and their uses removal of broken tap, studs (tap stud extractor). Dies: British standard, metric and BIS standard, material, parts, types, Method of using dies. Die stock: material, parts and uses.

30	-do-	72 File and make Step fit, angular fit, angle, surfaces (Bevel gauge accuracy 1 degree).(15 hrs.) 73 Make simple open and sliding fits. (10 hrs.)	Drill troubles: causes and remedy. Equality of lips, correct clearance, dead centre, length of lips. Drill kinds: Fraction, metric, letters and numbers, grinding of drill.
31	-do-	74 Enlarge hole and increase internal dia. (2 hrs.) 75 File cylindrical surfaces.(5 hrs.) 76 Make open fitting of curved profiles.(18 hrs.)	Grinding wheel: Abrasive, grade structures, bond, specification, use, mounting and dressing. Selection of grinding wheels. Bench grinder parts and use. Radius/fillet gauge, feeler gauge, hole gauge, and their uses, care and maintenance.
32	-do-	77 Correction of drill location by binding previously drilled hole.(5 hrs.) 78 Make inside square fit. (20 hrs.)	Pig Iron: types of pig Iron, properties and uses. Cast Iron: types, properties and uses.
33	Make different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. [Different Fit – Sliding, Angular, Step fit, 'T' fit, Square fit and Profile fit; Required tolerance: ±0.04 mm, angular tolerance: 30 min.]	79 Make sliding „T. fit.(2 hrs.)	Interchangeability: Necessity in Engg, field definition, BIS. Definition, types of limit, terminology of limits and fits-basic size, actual size, deviation, high and low limit, zero line, tolerance zone Different standard systems of fits and limits. British standard system, BIS system
34	-do-	80 File fit- combined, open angular and sliding sides. (10 hrs.) 81 File internal angles 30minutes accuracy open, angular fit.(15 hrs.)	Method of expressing tolerance as per BIS Fits: Definition, types, description of each with sketch. Vernier height gauge: material construction, parts, graduations (English & Metric) uses, care and maintenance.
35-36	-do-	82 Make sliding fit with angles other than 90°.(25 hrs.)	Wrought iron- : properties and uses. Steel: plain carbon steels, types, properties and uses. Non-ferrous metals (copper, aluminum, tin, lead, zinc) properties and uses.

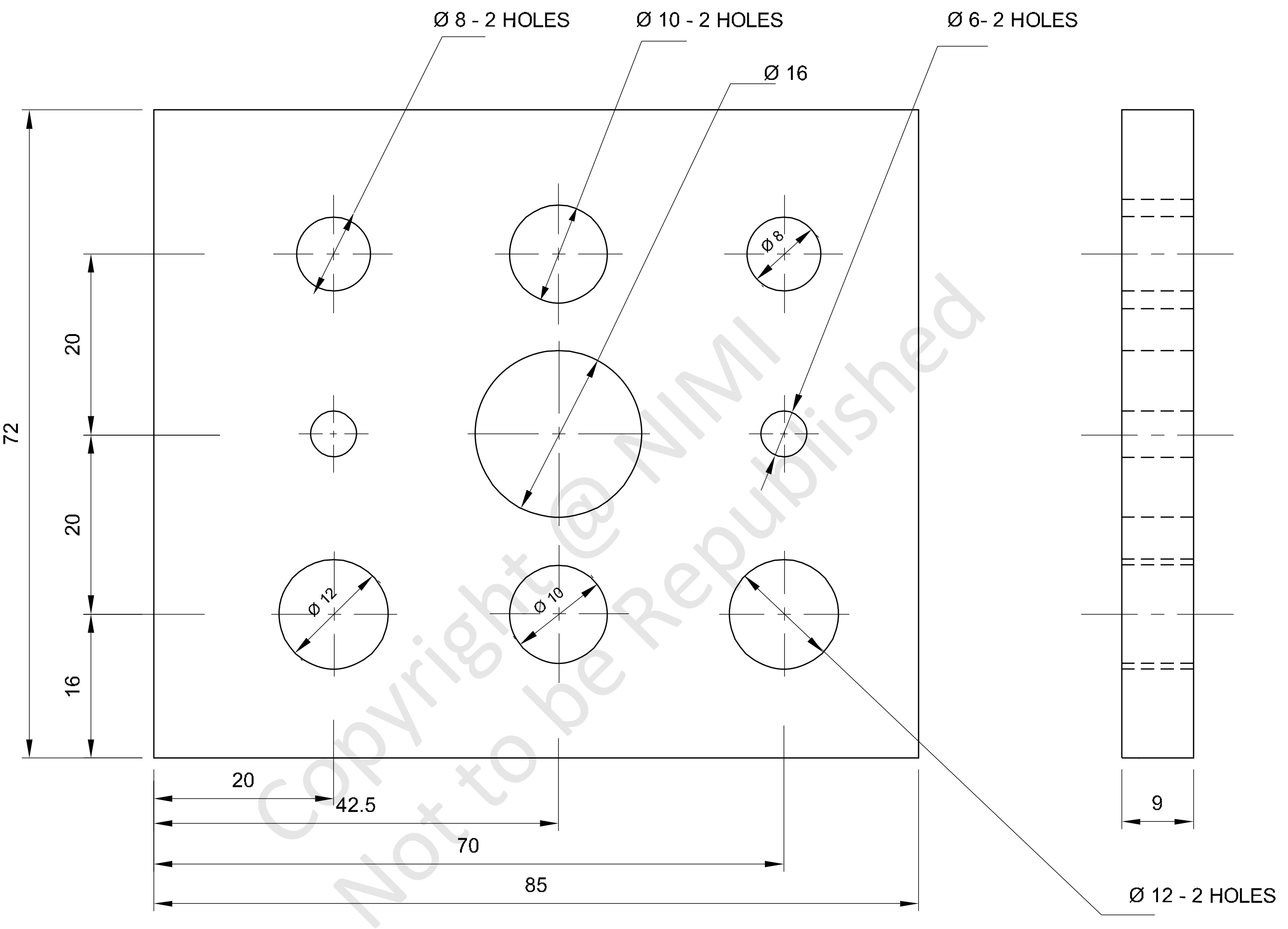
37	-do-	83 Scrap on flat surfaces, curved surfaces and parallel surfaces and test. (5 hrs.) 84 Make & assemble, sliding flats, plain surfaces. (15 hrs.) 85 Check for blue math of bearing surfaces - both flat and curved surfaces by with worth method.(5hrs.)	Simple scraper- circular, flat, half round, triangular and hook scraper and their uses. Blue matching of scraped surfaces (flat and curved bearing surfaces)
38	-do-	86 File and fit combined radius and angular surface (accuracy ± 0.5 mm), angular and radius fit. (18 hrs.) 87 Locate accurate holes & make accurate hole for stud fit.(2 hrs.) 88 Fasten mechanical components / sub-assemblies together using screws, bolts and collars using hand tools. (5 hrs.)	Vernier micrometer, material, parts, graduation, use, care and intenance. Calibration of measuring instruments. Introduction to mechanical fasteners and its uses. Screw thread micrometer: Construction, graduation and use.
39	-do-	89 Make sliding fits assembly with parallel and angular mating surface. (± 0.04 mm) (25 hrs.)	Dial test indicator, construction, parts, material, graduation, Method of use, care and maintenance. Digital dial indicator. Comparators- measurement of quality in the cylinder bores.
40	Produce components involving different operations on lathe observing standard procedure and check for accuracy. [Different Operations – facing, plain turning, step turning, parting, chamfering, shoulder turn, grooving, knurling, boring, taper turning, threading (external 'V' only)]	90 Lathe operations- 91 True job on four jaw chuck using knife tool.(5 hrs.) 92 Face both the ends for holding between centers. (9 hrs.) 93 Using roughing tool parallel turn ± 0.1 mm. (10 hrs.) 94 Measure the diameter using outside caliper and steel rule.(1hrs.)	Safely precautions to be observed while working on a lathe, Lathe specifications, and constructional features. Lathe main parts descriptions- bed, head stock, carriage, tail stock, feeding and thread cutting mechanisms. Holding of job between centers, works with catch plate, dog, simple description of a facing and roughing tool and their applications.
41	-do-	95 Holding job in three jaw chuck.(2 hrs.) 96 Perform the facing, plain turn, step turn, parting, deburr, chamfercorner, round the ends, and use form tools. (11 hrs.)	Lathe cutting tools- Nomenclature ofsingle point & multipoint cutting tools, Tool selection based on different requirements and necessity of correct grinding, solid and tipped, throw away

		97 Shoulder turn: square, filleted, beveled undercut shoulder, turning-filleted under cut, square beveled. (11 hrs.) 98 Sharpening of -Single point Tools. (1 hrs.)	type tools, cutting speed and feed and comparison for H.S.S., carbide tools. Use of coolants and lubricants.
42	-do-	99 Cut grooves- square, round,V. groove. (10 hrs.) 100 Make a mandrel-turn diameter to sizes. (5 hrs.) 101 Knurl the job.(1 hrs.) 102 Bore holes –spot face, pilot drill, enlarge hole using boring tools. (9 hrs.)	Chucks and chucking the independent four-jaw chuck. Reversible features of jaws, the back plate, Method of clearing the thread of the chuck-mounting and dismounting, chucks, chucking true, face plate, drilling - method of holding drills in the tail stock, Boring tools and enlargement of holes.
43	-do-	103 Make a bush step bore-cut recess, turn hole diameter to sizes.(5 hrs.) 104 Turn taper (internal and external). (10 hrs.) 105 Turn taper pins. (5 hrs.) 106 Turn standard tapers to suit with gauge.(5 hrs.)	General turning operations- parallel or straight, turning. Stepped turning, grooving, and shape of tools for the above operations. Appropriate method of holding the tool on tool post or tool rest, Knurling: - tools description, grade, uses, speed and feed, coolant for knurling, speed, feed calculation. Taper – definition, use and method of expressing tapers. Standard tapers-taper, calculations morse taper.
44	-do-	107 Practice threading using taps, dies on lathe by hand. (2 hrs.) 108 Make external „V. thread.(8 hrs.) 109 Prepare a nut and match with the bolt.(15 hrs.)	Screw thread definition – uses and application. Square, worm, buttress, acme (non standard-screw threads), Principle of cutting screw thread in centre lathe –principle of chasing the screw thread – use of centre gauge,setting tool for cutting internal and external threads, use of screw pitch gauge for checking the screw thread.
45-46	Plan & perform simple repair, overhauling of different machines and check for functionality. [Different Machines – Drill Machine, Power Saw, Bench Grinder and Lathe]	110 Simple repair work: Simple assembly of machine parts from blue prints. (15 hrs.) 111 Rectify possible assembly faults during assembly.(19 hrs.) 112 Perform the routine maintenance with check list (10 hrs.) 113 Monitor machine as per routine checklist (3 hrs.) 114 Read pressure gauge, temperature gauge, oil level (1 hrs.) 115 Set pressure in pneumatic system (2 hrs.)	**Maintenance** -Total productive maintenance -Autonomous maintenance -Routine maintenance -Maintenance schedule -Retrieval of data from machine manuals Preventive maintenance-objective and function of Preventive maintenance, section inspection. Visual and detailed, lubrication survey, system of symbol and colour coding. Revision, simple estimation of materials, use of handbooks and reference table. Possible causes for assembly failures and remedies.

47	-do-	116 Assemble simple fitting using dowel pins and tap screw assembly using torque wrench. (25 hrs.)	Assembling techniques such as aligning, bending, fixing, mechanical jointing, threaded jointing, sealing, and torquing.Dowel pins: material, construction, types, accuracy and uses.
48-49		**In-plant training / Project work** 1 Pipe Fixture 2 Adjustable Clamp 3 Hermaphrodite/ Inside Caliper 4 Chuck Key	
50-51		**Revision**	
52		**Examination**	

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 pedestal drilling machine.**



1	75 ISF 10-90	-	Fe310	-	-	2.1.61
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 : 5 Hrs
					CODE NO : FIN2161E1	

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 file and de - burr in all the surfaces of the job.
- Check the size with vernier caliper.
- Apply a thin coat of oil and preserve it for evaluation.

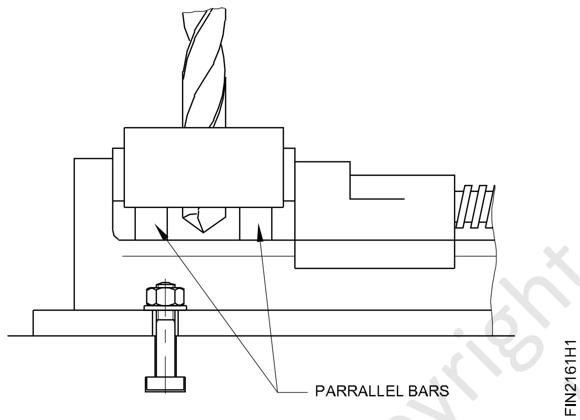
Skill Sequence

Drilling 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.

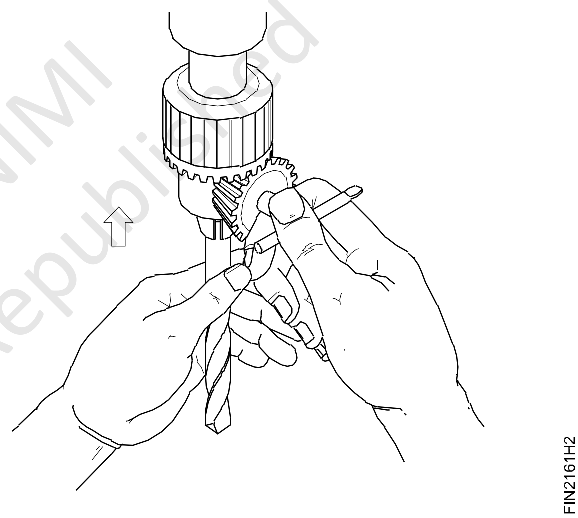
Caution: Do not remove chips with your bare hands - use brush.

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)

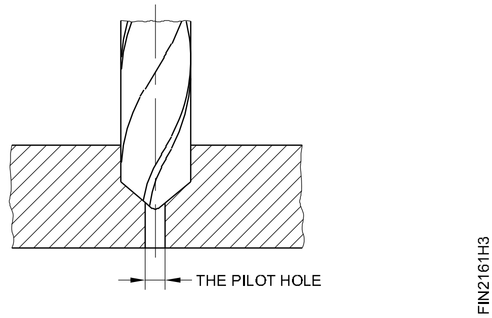
Fig 2



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)

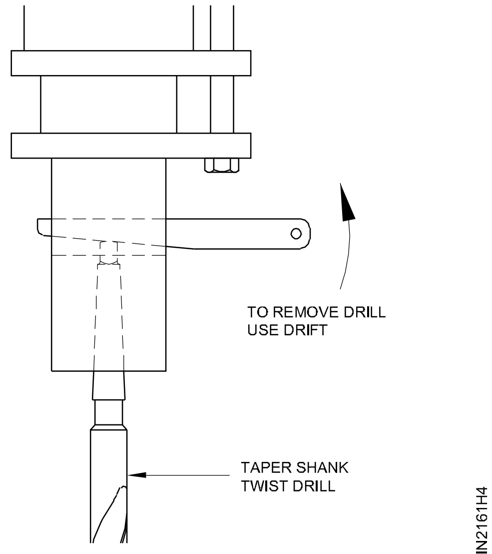
Fig 3



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



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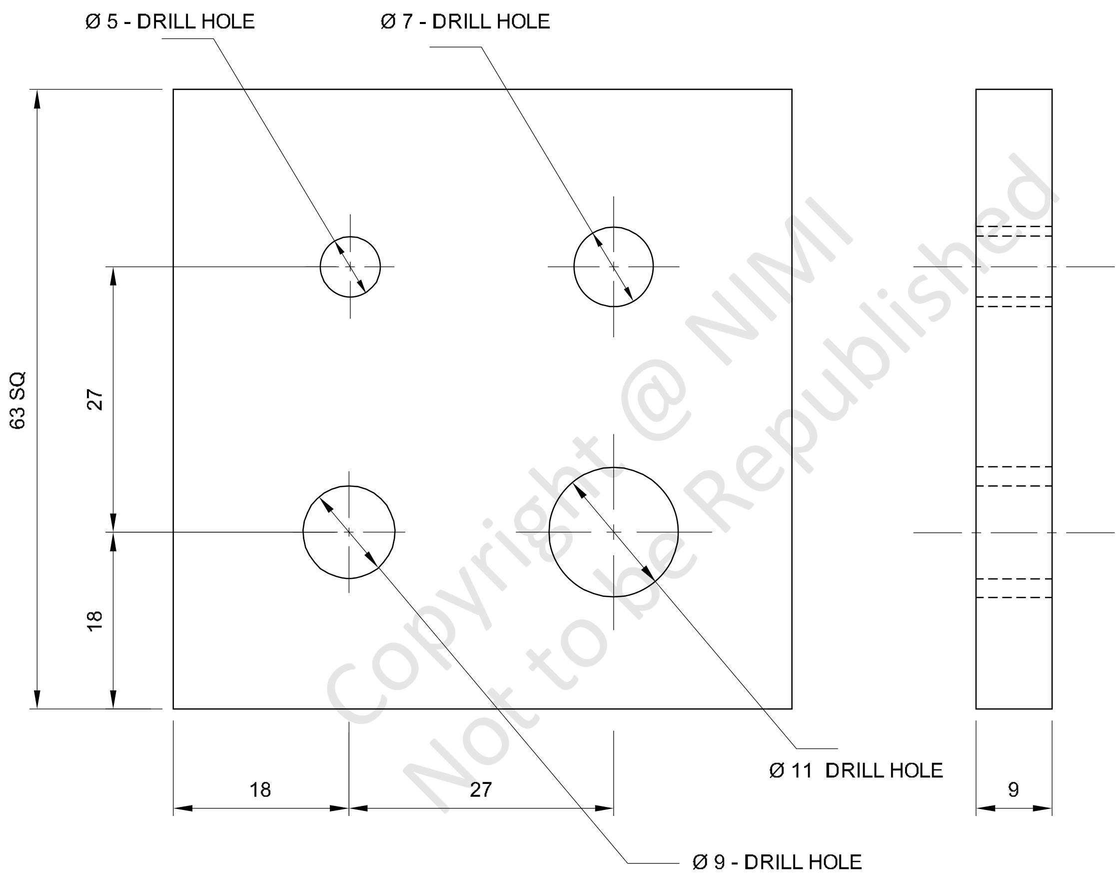
Drill on M.S Flat

Objectives: At the end of this exercise you shall be able to
- **mark drill hole centres**
- **hold the job in drilling machine table**
- **set the spindle speed according to the diameter of drill**
- **drill through holes as per drawing**
- **finish and de-burr.**



1	65 ISF 10-65	-	Fe310	-	-	2.1.62
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 : 1 Hr
					CODE NO : FIN2162E1	

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 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.

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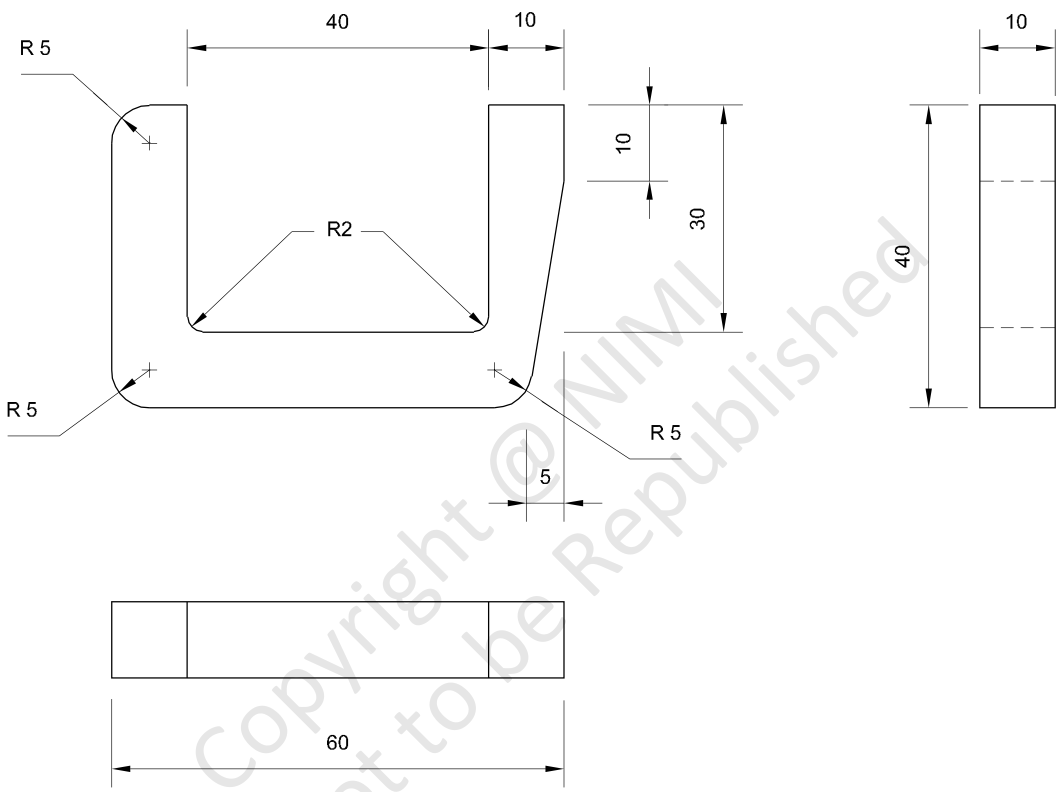
File radius and profile to suit gauge

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.**

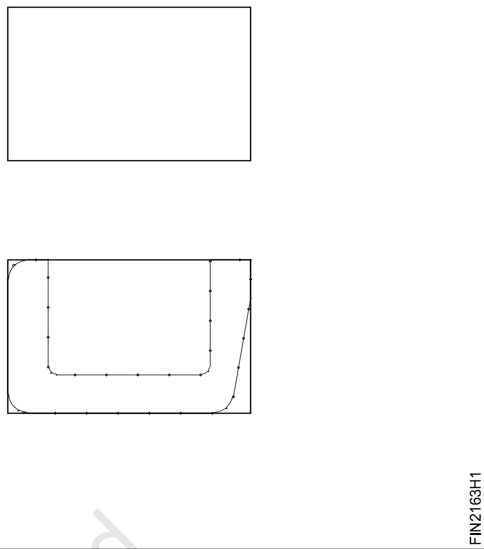


1	65 ISF 12 - 45	-	Fe310			2.1.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	FILE RADIUS AND PROFILE TO SUIT GAUGE				TOLERANCE : 0.04	TIME : 13 Hrs
					CODE NO : FIN2163E1	

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.
- 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 webchisel 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.

Fig 1



- 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)

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)

Remove only thin chips of equal thickness.

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

Fig 1

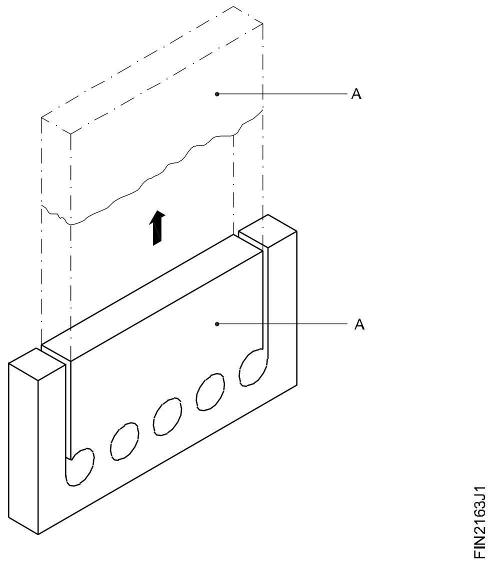
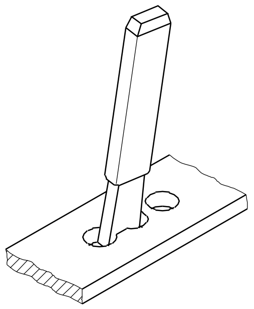


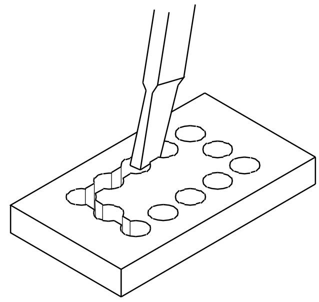
Fig 2



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

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

Fig 3



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.**

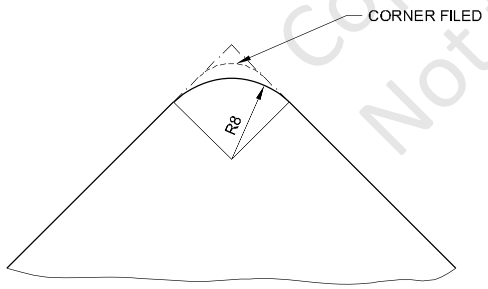
Filing radius is entirely a different technique, and needs considerable skill for filing accurately with a good finish.

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)

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 2

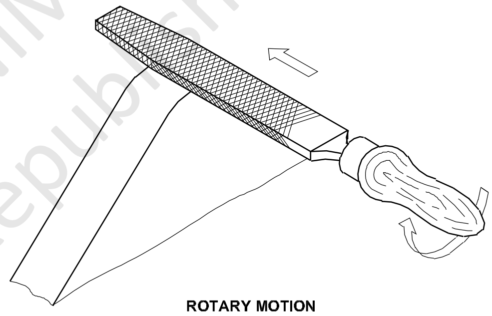
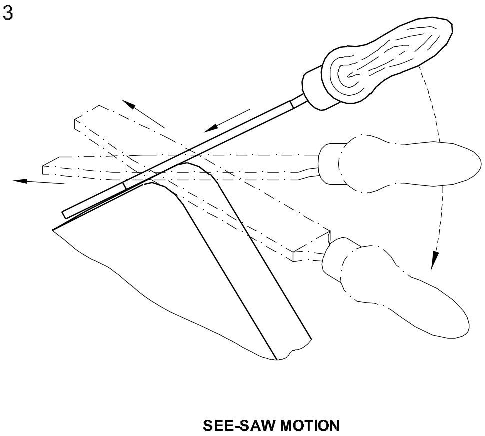


Fig 3



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

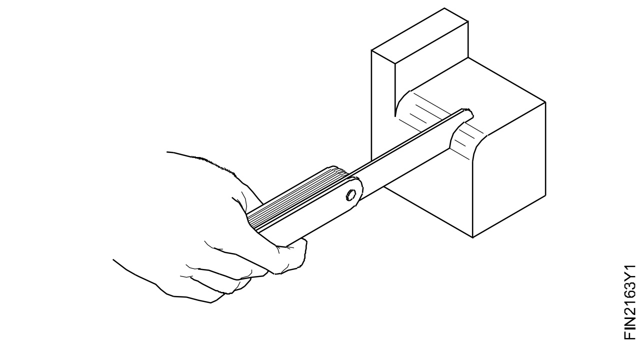
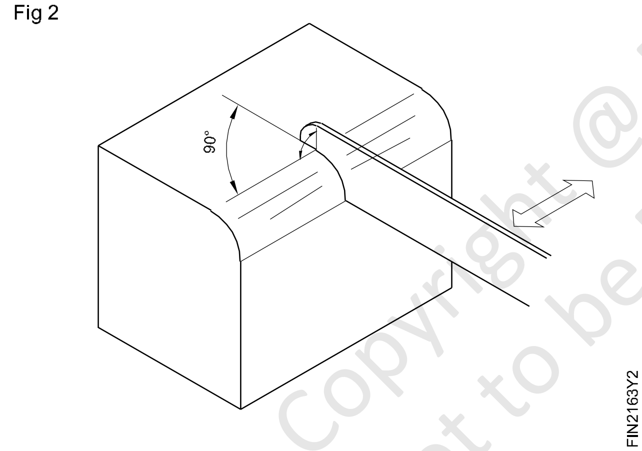


Fig 2



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)

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

Fig 3

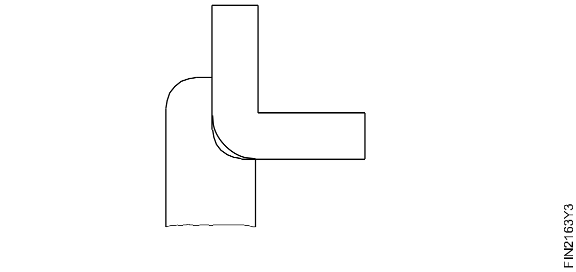
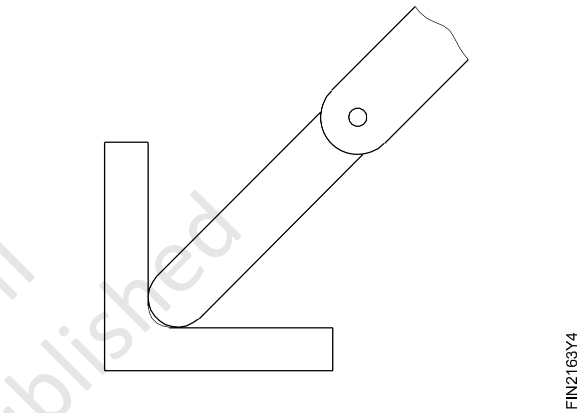
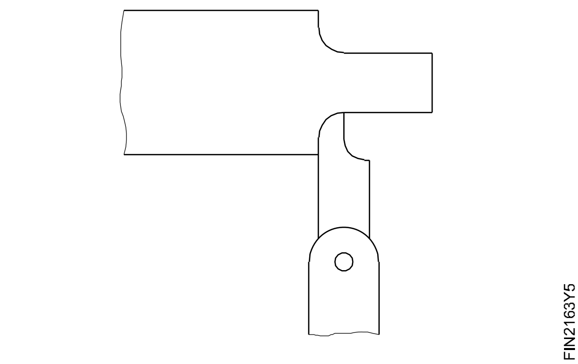


Fig 4



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

Fig 5

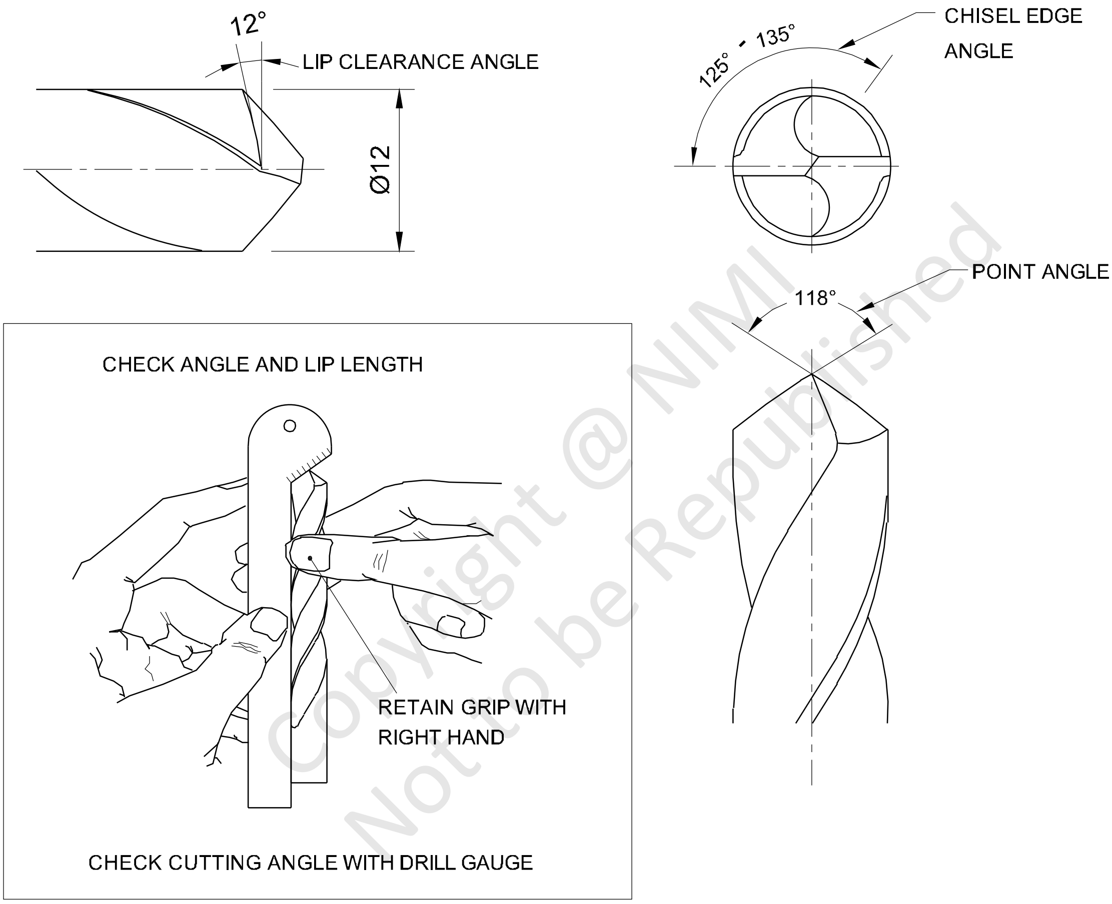


After using the radius gauges, wipe them clean with a clean cloth and apply a light film of oil before storing.

— — — — — — — —

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.**



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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	SHARPENING OF DRILLS				TOLERANCE : ± 30 minutes	TIME : 1 Hr
					CODE NO : FIN2164E1	

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 sharpenning 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.

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.

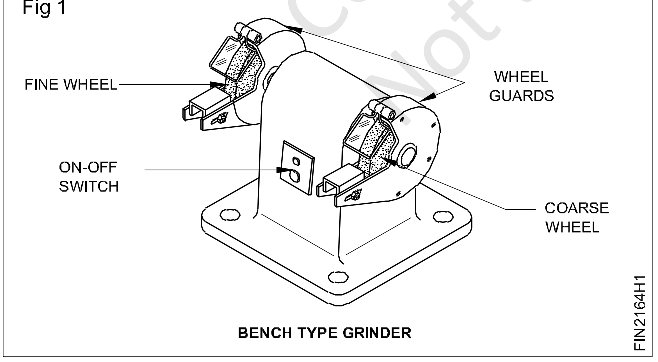
Off - hand grinding is performed for rough grinding of jobs and resharpening wheel.

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 TYPE GRINDER

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.

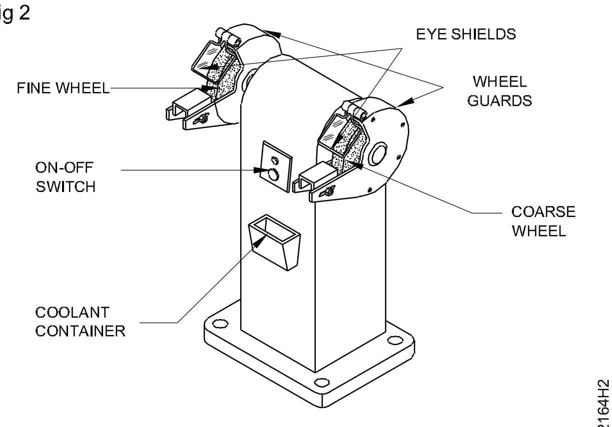
These grinders consist of an electric motor and two spindles for mounting grinding wheels. On one spindle a coarse - grained wheel is fitted, and on the other, a fine grained wheel. For safety, while working, wheel guards are provided. (Fig 1 and 2)

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



PEDESTAL TYPE GRINDER

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 preocedure.

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

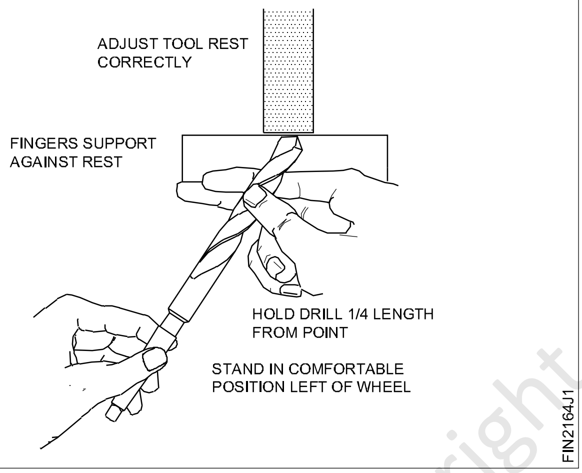
Ensure that the tool-rest are adjusted correctly and tightened.

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)

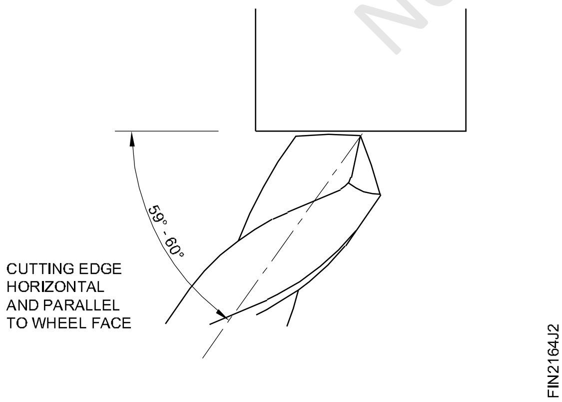
Fig 1



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. (Fig 3)

Swing the shank of the drill slightly downwards and to the left with the left hand. The right hand is on the tool-rest. (Fig 4)

Fig 3

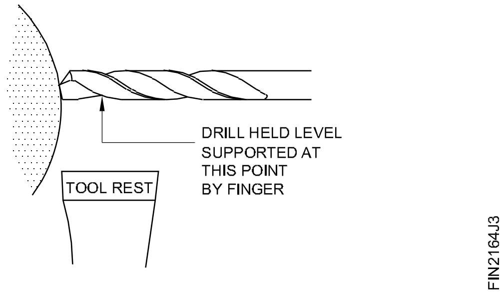
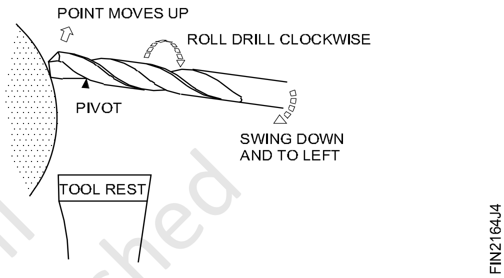
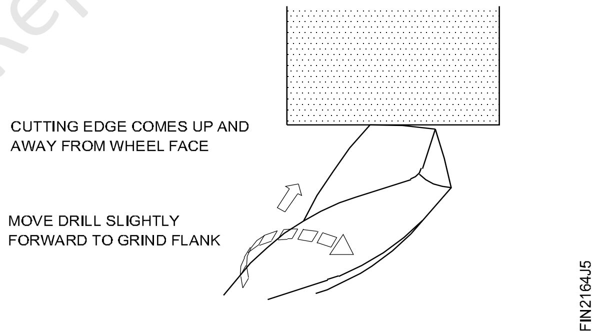


Fig 4



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 5)

Fig 5



Apply a slight foward 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.

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

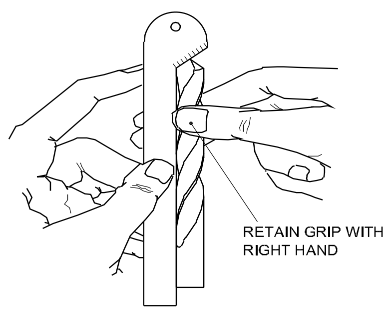
Move the drill back, clear of the wheel face.

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 6)

Fig 6



CHECK CUTTING EDGE WITH DRILL GAUGE

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.

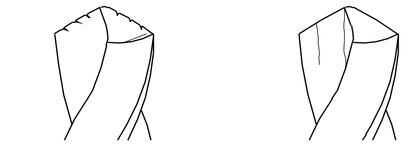
Hold the drill shank again in the left hand with the elbows against the side. The drill will locate back against the wheel face in the same position and at the same angle as before.

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 7)

Fig 7



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.(Fig 8)

Fig 8

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

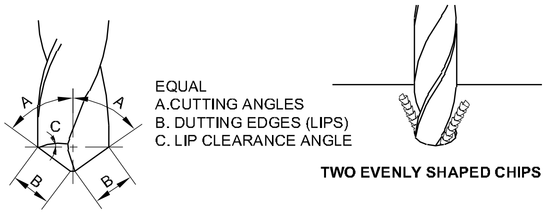
Objective : This shall help you to

- **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

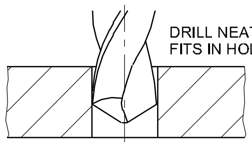


- Require only moderate pressure to feed it into the work.

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



CORRECTLY SHARPENED DRILL

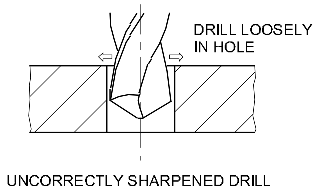
- the cutting edges and angles are equal
- the drill has produced a hole of the correct size.

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

Fig 3



- tend to chatter during starting
- produce an out-of-round hole.

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?

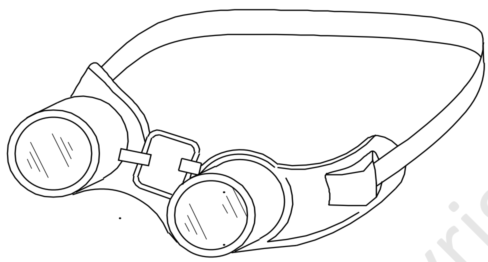
While working on off - hand grinder, it is important to observe the following safety measures.

Before starting

Make sure the grinding wheel guards are in place.

Wear safety goggles while grinding. (Fig 1)

Fig 1



Stand on one side of the machine while starting.

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

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)

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

Fig 2

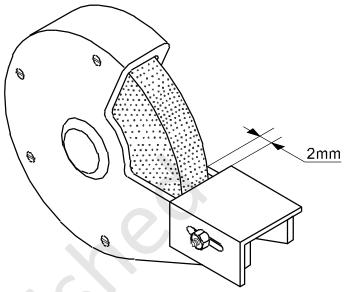
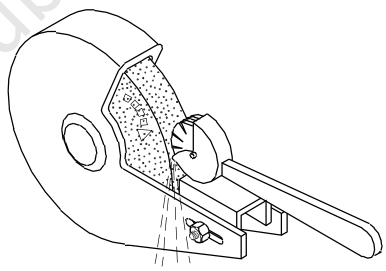


Fig 3



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

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.

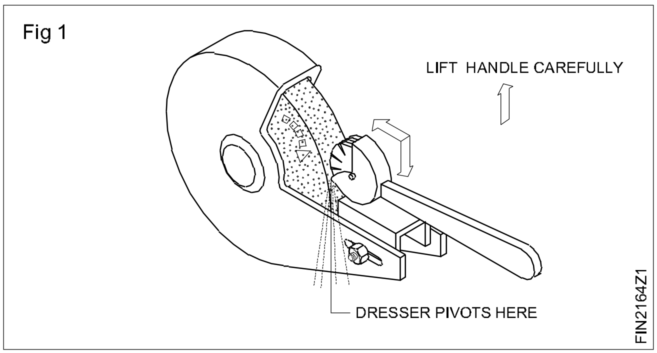
Dressing of pedestal grinder wheels is carried out by a star - wheel dresser.

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)

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.



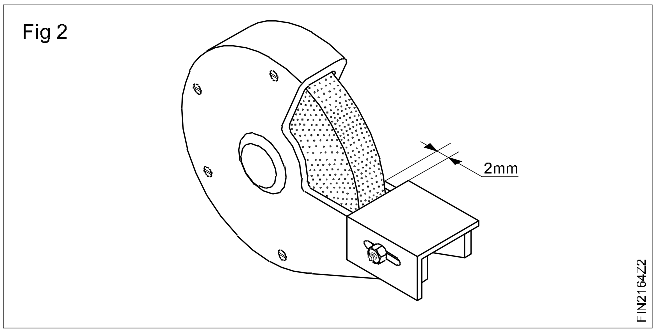
Do not run off the edge of the wheel while moving across.

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.

Read just the work - rest as close to the grinding wheel as possible. (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.

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Practice use of angular measuring instrument

Objectives: 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.**

Fig 1

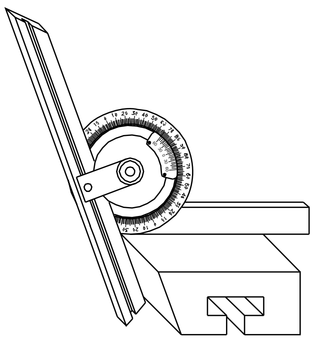
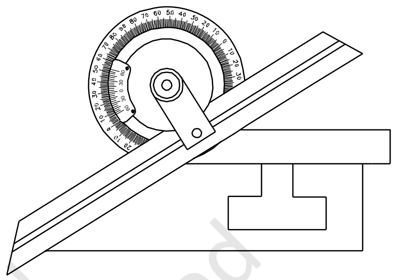


Fig 2



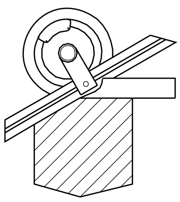


Fig 3

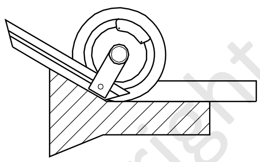


Fig 4

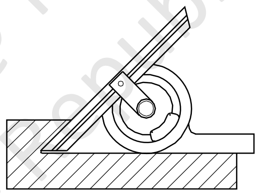


Fig 5

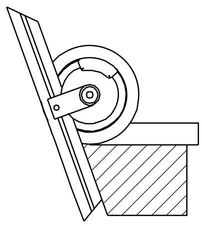


Fig 6

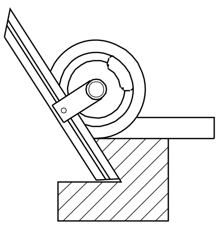


Fig 7

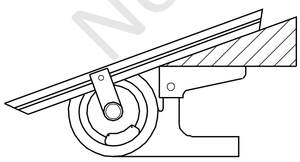


Fig 8

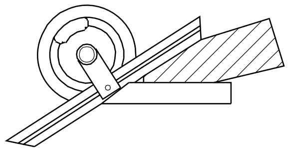


Fig 9

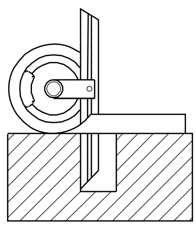


Fig 10

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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PRACTICE USE OF ANGULAR MEASURING INSTRUMENT	TOLERANCE : ± 30 minutes	TIME : 5 Hrs
		CODE NO : FIN2165E1	

Job Sequence

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

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

TABLE - 1

Part Number	Angle measured
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Get it checked by your instructor.

Skill Sequence

Vernier bevel protractor

Objective: This shall help you to
- **identify the parts of a universal bevel protractor.**

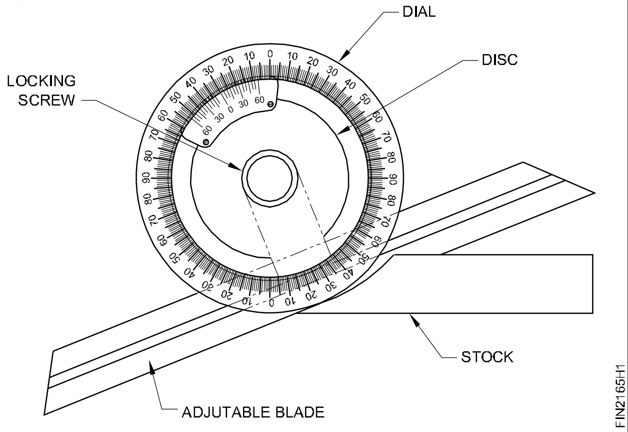
The vernier bevel protractor is a precision instrument meant for measuring angles precisely to an accuracy of 5 minutes. (5')

Parts of a vernier bevel protractor

The following are the parts of a vernier bevel protractor, (Fig 1)

Stock, Disc, Dial, Blade Locking screws.

Fig 1

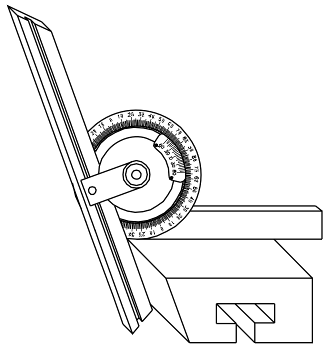


Reading of vernier bevel protractor

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)

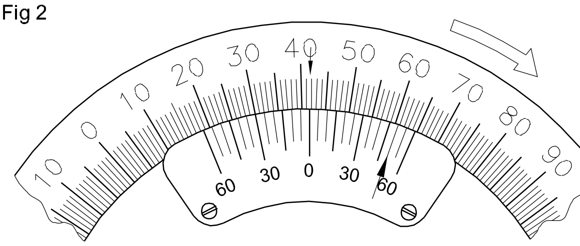
Fig 1



FIN2165J1

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

Fig 2



FIN2165J2

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)

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.

Reading 22°30’

Measurement

180° - 22°30’ = 157°30’

Fig 3

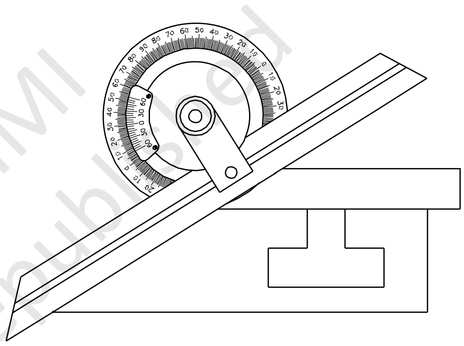


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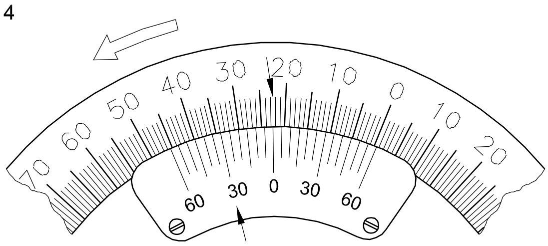
Fig 4



FIN2165J4

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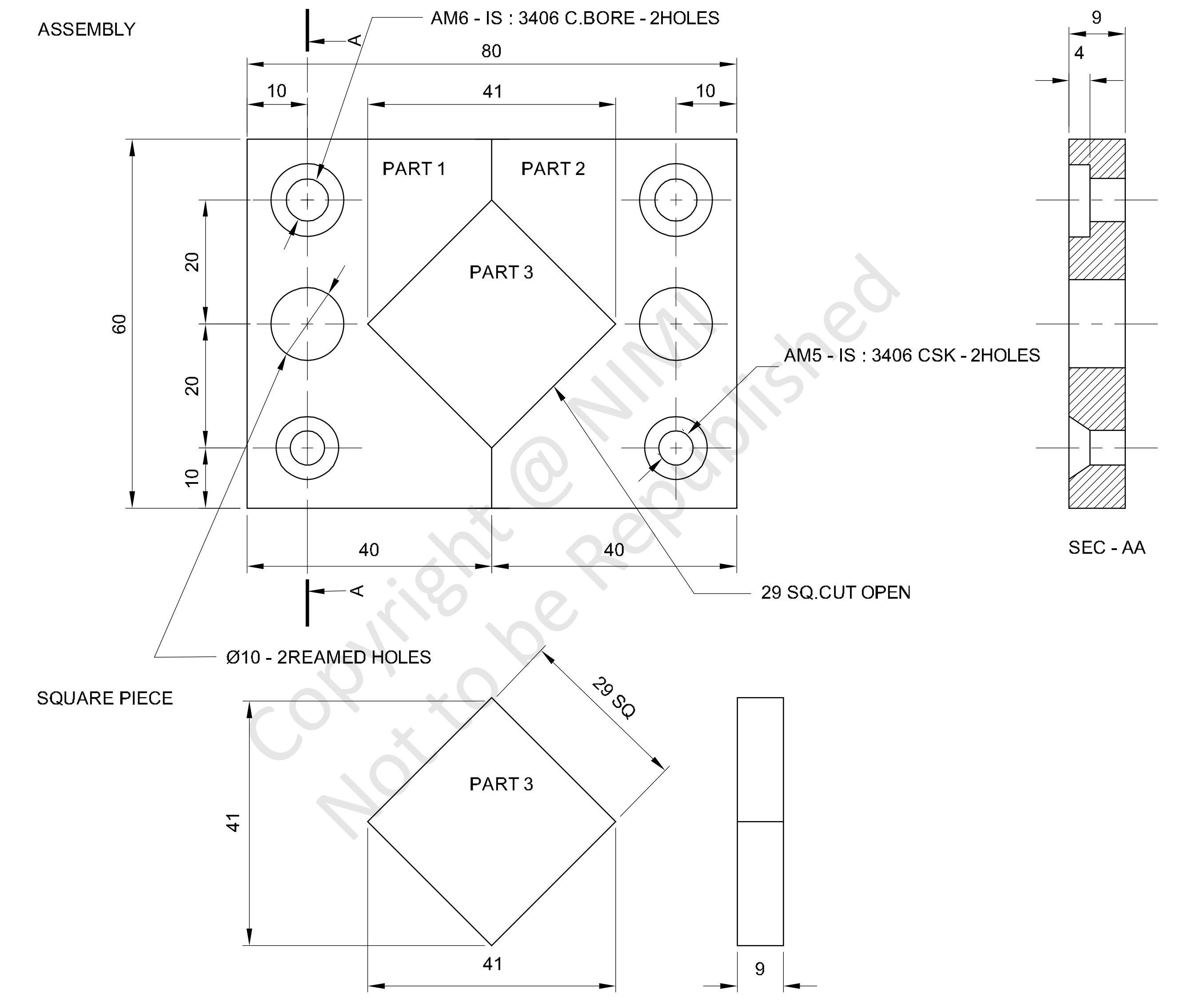
Counter sink, counter bore and ream split fit (three piece fitting)

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.**



1	35 ISF 10-35		Fe310		3	
1	65 ISF 10-45		Fe310		2	
1	65 ISF 10-45		Fe310		1	2.1.66
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE: 1:1	COUNTER SINK, COUNTER BORE, REAM SPLIT FIT (THREE PIECE FITTING)	TOLERANCE : ±0.04	TIME : 5Hrs
		CODE NO: FIN2166E1	

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 9 mm 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 6 mm drill in drill chuck and drill through holes as per drawing in all centre in drilled holes.
- Similarly, fix Ø 9.8 mm drill in drill chuck and drill through holes in ream hole locations.
- 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 10 mm 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

Objectives: This shall help you to
- **countersink holes of different sizes.**

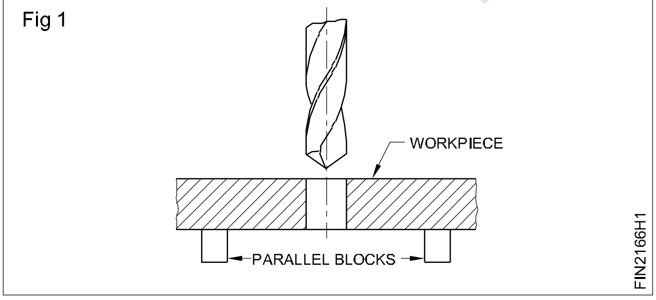
Selection of countersinks

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)

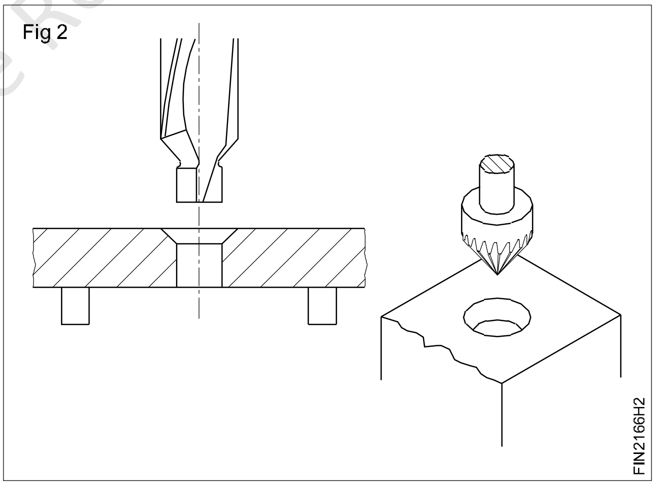
Fig 1



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 screwhead. (Fig 3)

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

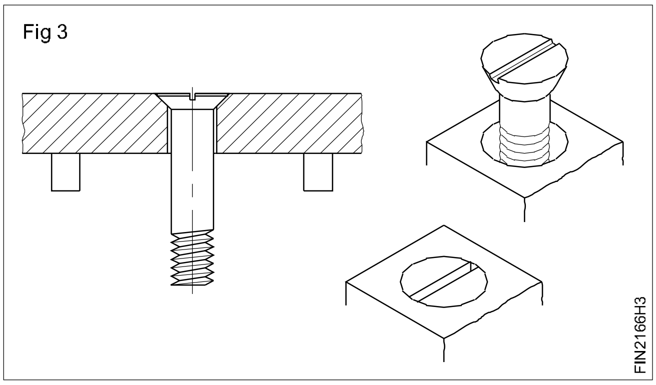


Fig 3

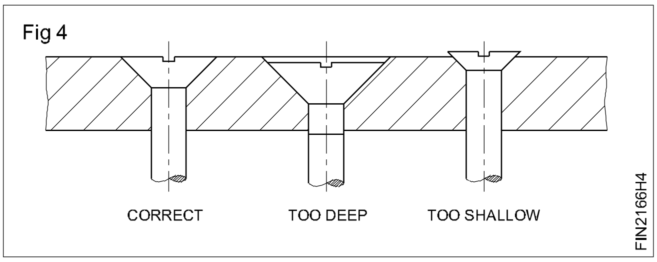


Fig 4

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)

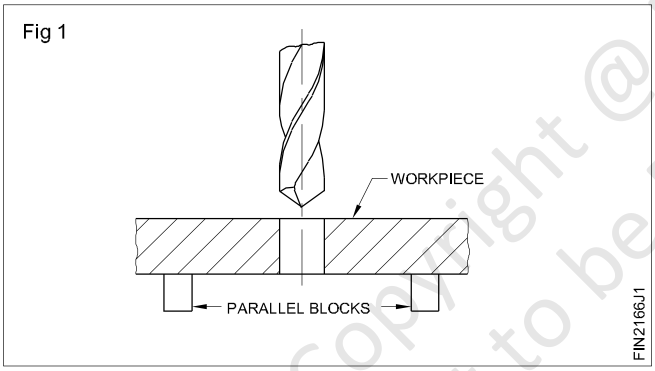


Fig 1

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)

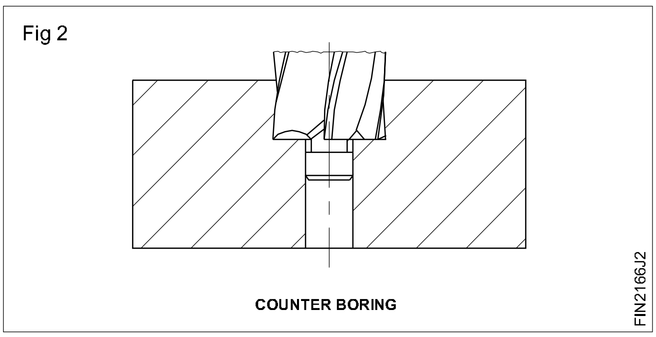


Fig 2

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

$$V = \frac{\pi \text{ x } d \text{ x } n}{1000}$$

(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)

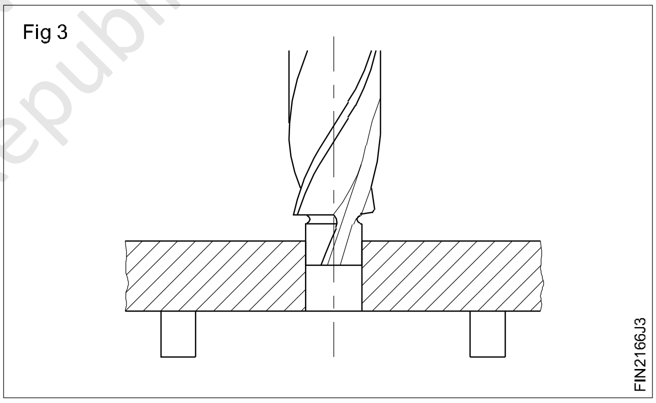


Fig 3

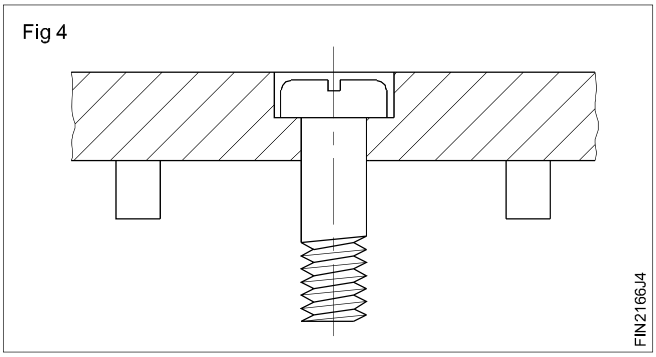


Fig 4

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 hole size. (undersize + oversize)

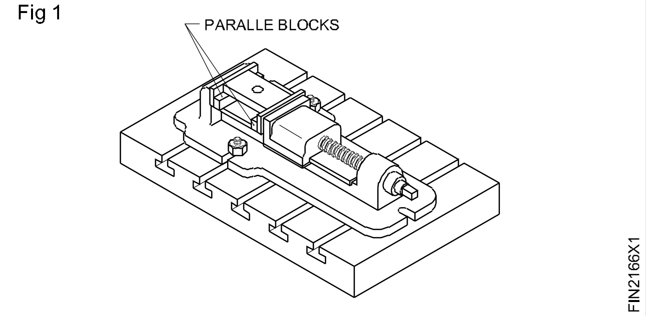
Refer to the table for the recommended undersizes in Related Theory on DRILL SIZES FOR REAMING.

Hand reaming

Drill holes for reaming as per the sizes determined.

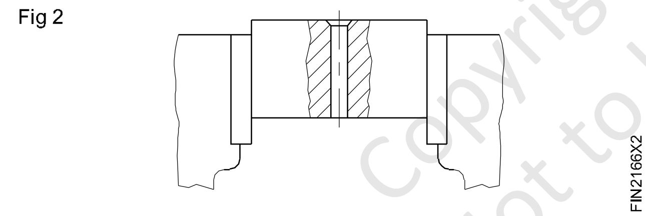
Place the work on parallels while setting on the machine vice. (Fig 1)

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

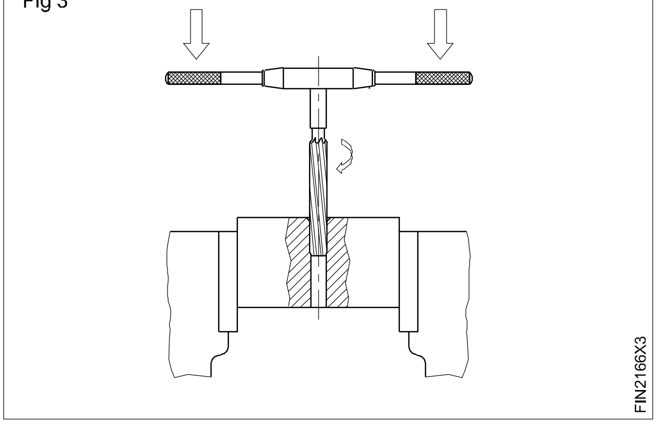


Fix the tap wrench on the square end and place the reamer vertically in the hole. Check the alignment with a try square. Make corrections, if necessary.Turn the tap wrench in a clockwise direction applying a slight downward pressure at the same time (Fig 3). Apply pressure evenly at both ends of the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

Apply cutting fluid.

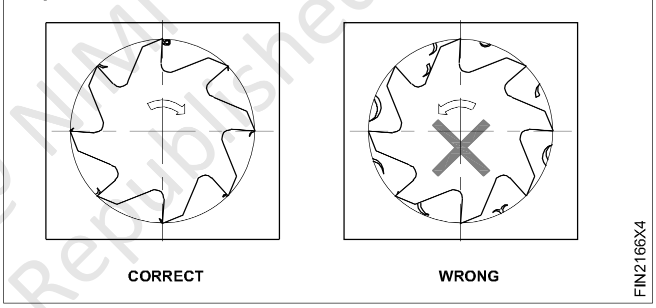
Turn the tap wrench steadily and slowly, maintaining the downward pressure.

Fig 3



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

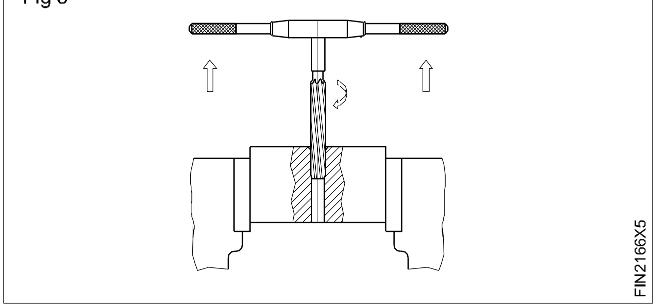
Fig 4



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)

Fig 5



Remove the burrs from the bottom of the reamed hole.

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

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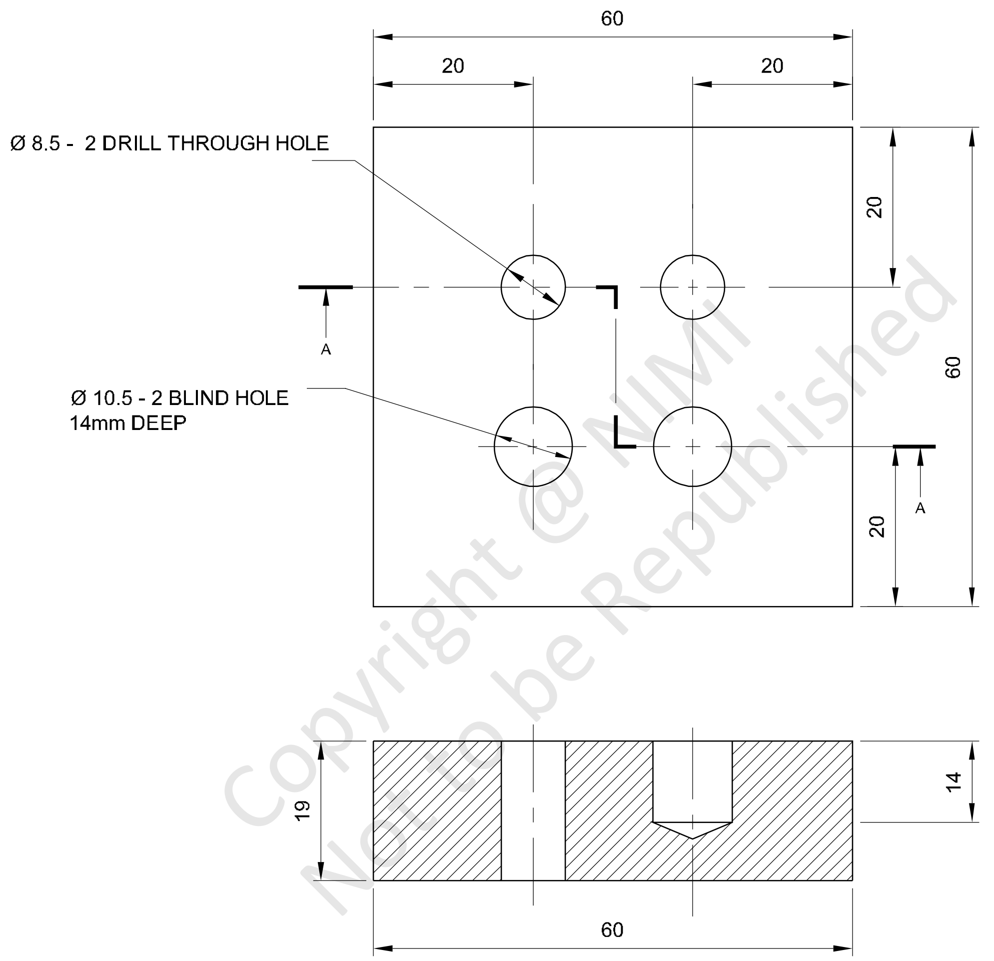
Drill through hole and blind holes

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.**



–	65 ISF 20 - 65	–	Fe310	–	–	2.1.67
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 : 2 Hrs
		CODE NO : FIN2167E1	

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.
- File and de - burr in all the surfaces of the job.
- Apply a thin coat of oil and preserve it for evaluation.

Skill sequence

Drilling blind holes

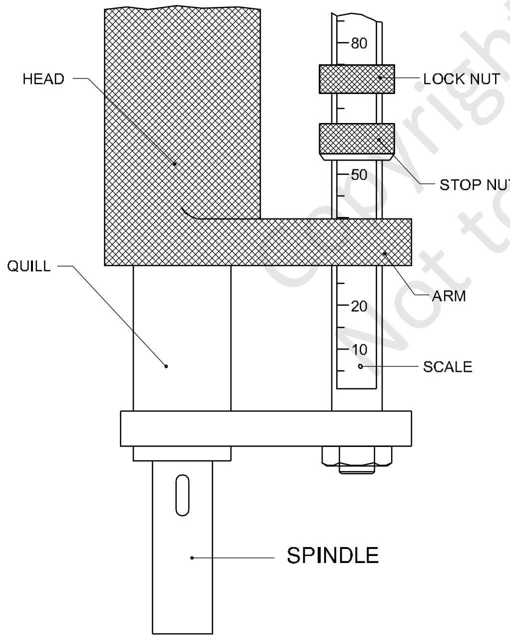
Objective: This shall help you to

- **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.

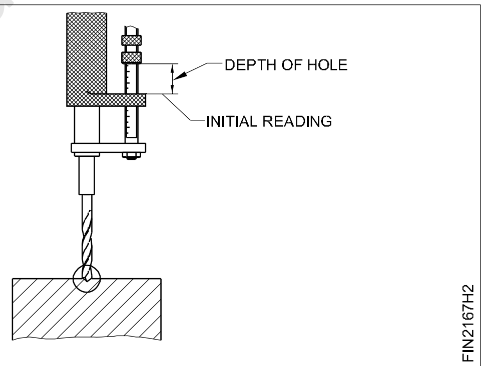
Generally the blind hole depth tolerances are given up to 0.5 mm accuracy.

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)

Fig 2



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

Initial reading + Depth of hole = Setting.

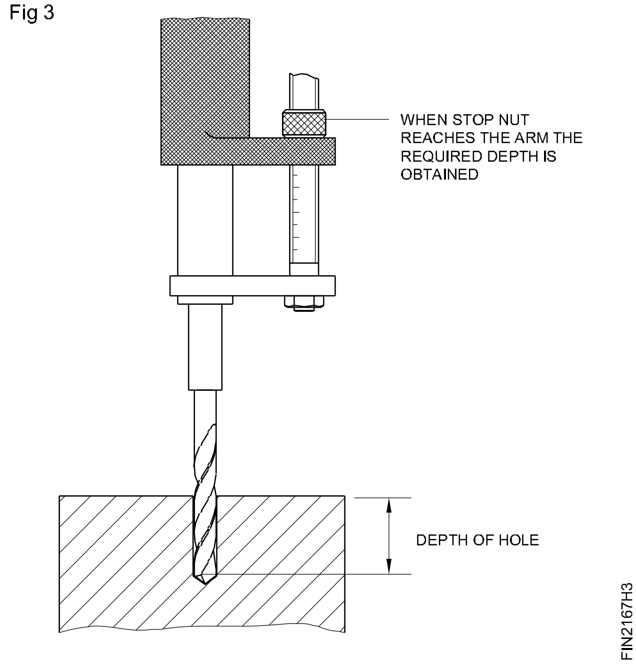
Adust the stop next to the required setting, using the scale.

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)

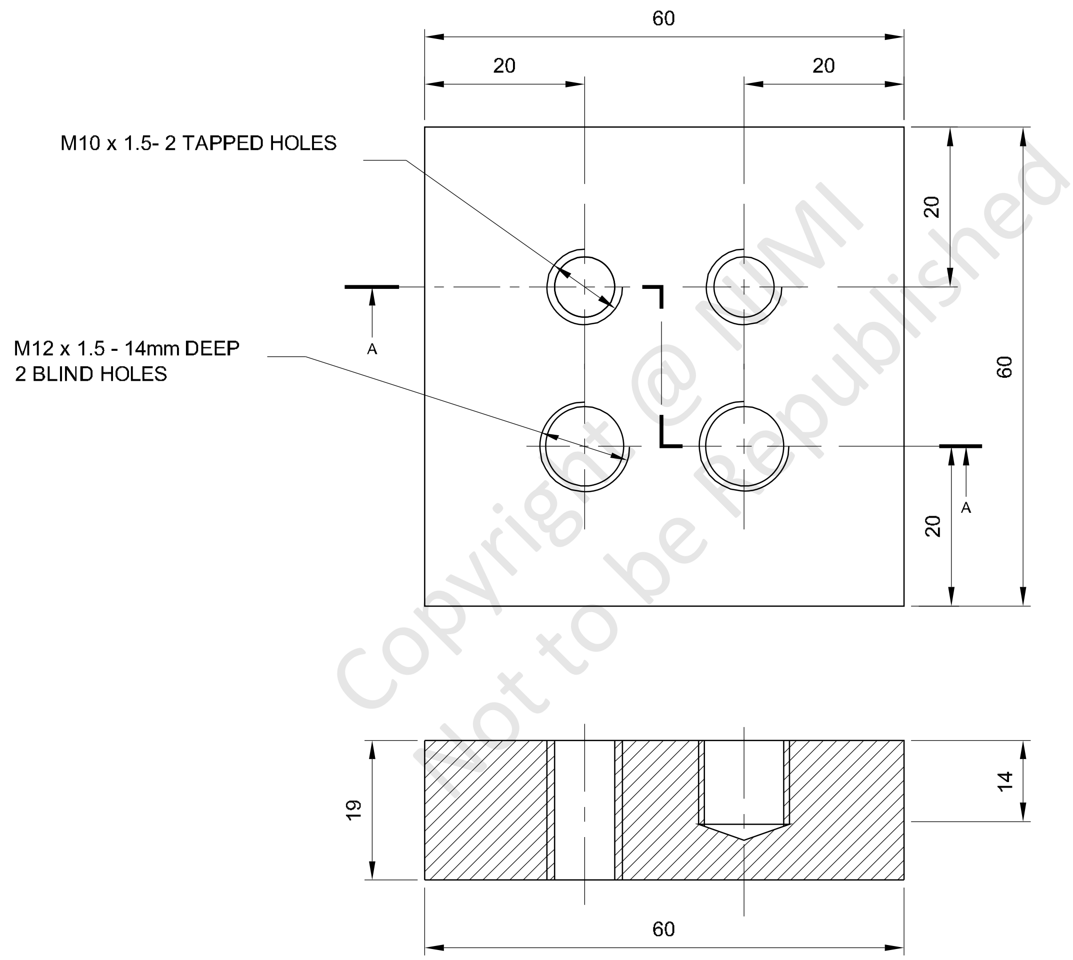
While drilling, release the drill frequently from the hole for the chips to be flushed out by the cutting fluid.

Fig 3


WHEN STOP NUT REACHES THE ARM THE REQUIRED DEPTH IS OBTAINED
DEPTH OF HOLE
FIN2167H3

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.**



1		EX.NO.2.1.67	Fe310	–	–	2.1.68
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	FORM INTERNAL THREADS WITH TAPS TO STANDARD SIZE (THROUGH HOLES AND BLIND HOLES)	TOLERANCE : ±0.04	TIME : 3 Hrs
		CODE NO : FIN2168E1	

Job Sequence

Cut internal thread in through hole

- Use Ex.No 2.1.67 for this excercise.
- 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.
- 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

Objective: 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)

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).

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

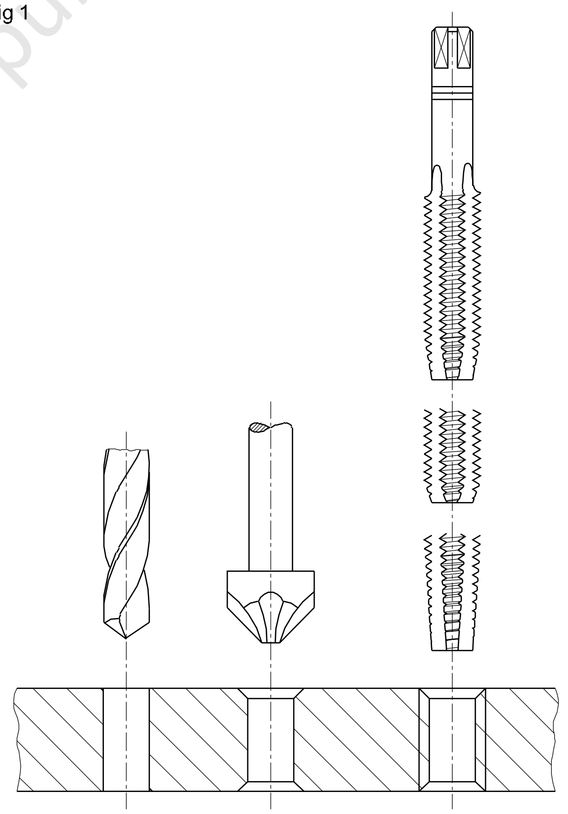
Fix the first tap (taper tap) in the wrench.

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 1



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 2

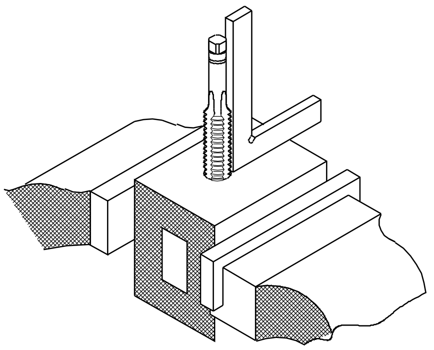
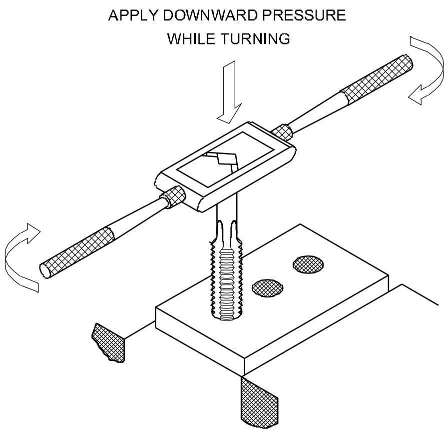


Fig 3



STARTING THE TAP

Fig 4

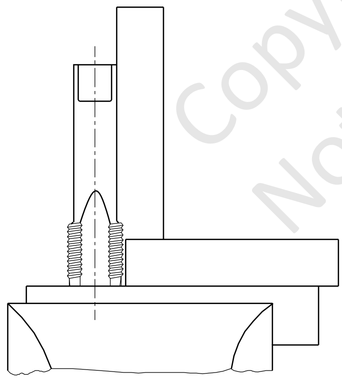
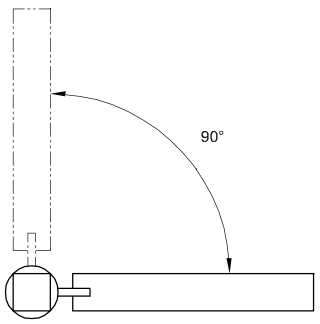
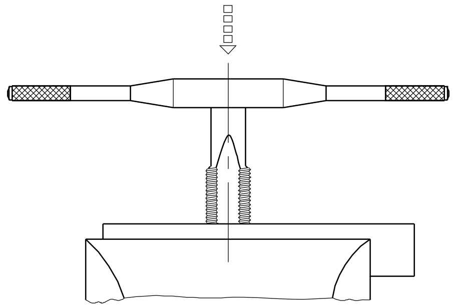


Fig 5



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

Fig 6



SQUARING UP THE TAP

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

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

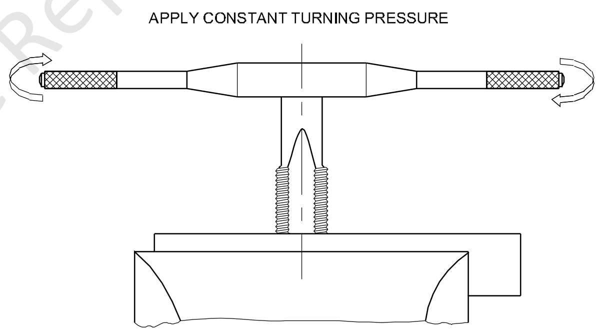
Check the tap alignment again with a try square.

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.

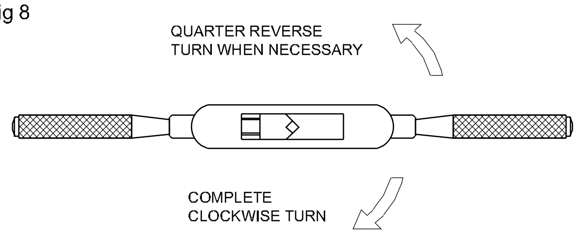
Fig 7



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 8



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.

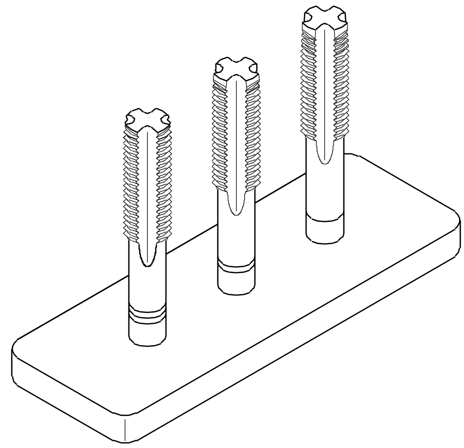
Finish and clean up using intermediate and plug tap. The intermediate and plug tap will not cut any thread if the tap has entered the hole fully.

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



FIN2168H9

Internal threading blind holes using hand taps

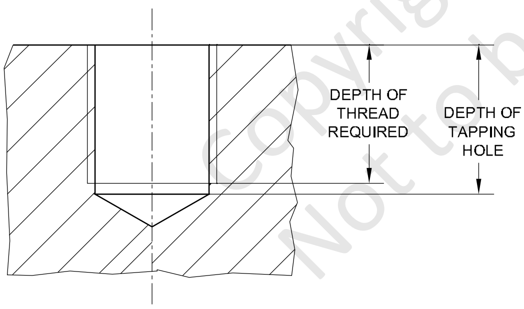
Objective: This shall help you to
- **cut internal threads using hand taps.**

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



FIN2168J1

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.

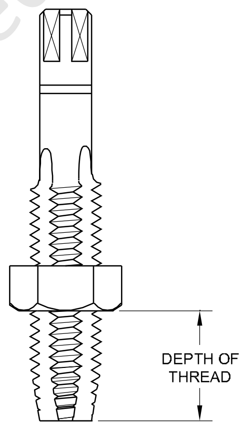
Do not clear the chips by blowing as it can cause injury to your eyes.

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

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

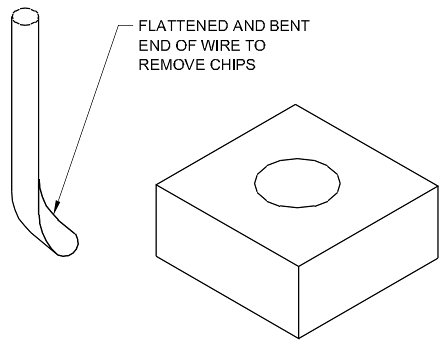
Remove the chips from the hole frequently, using a flattened and bend wire. (Fig 3)

Fig 2



FIN2168J2

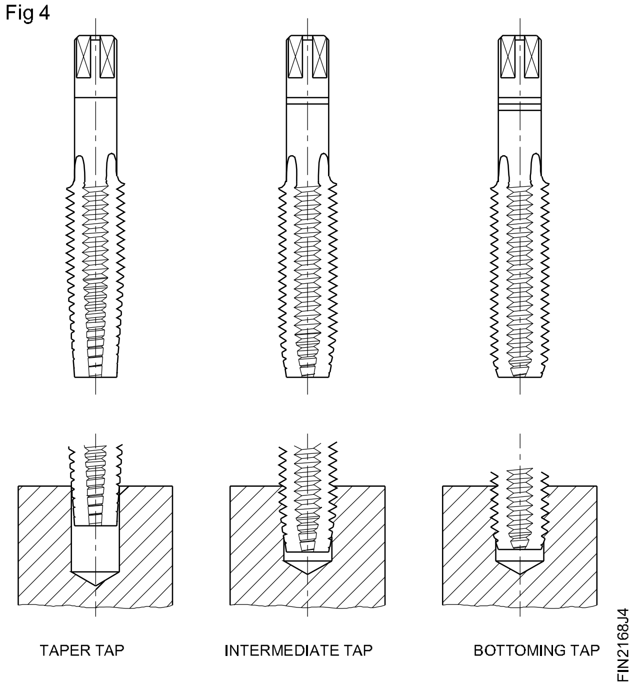
Fig 3



FIN2168J3

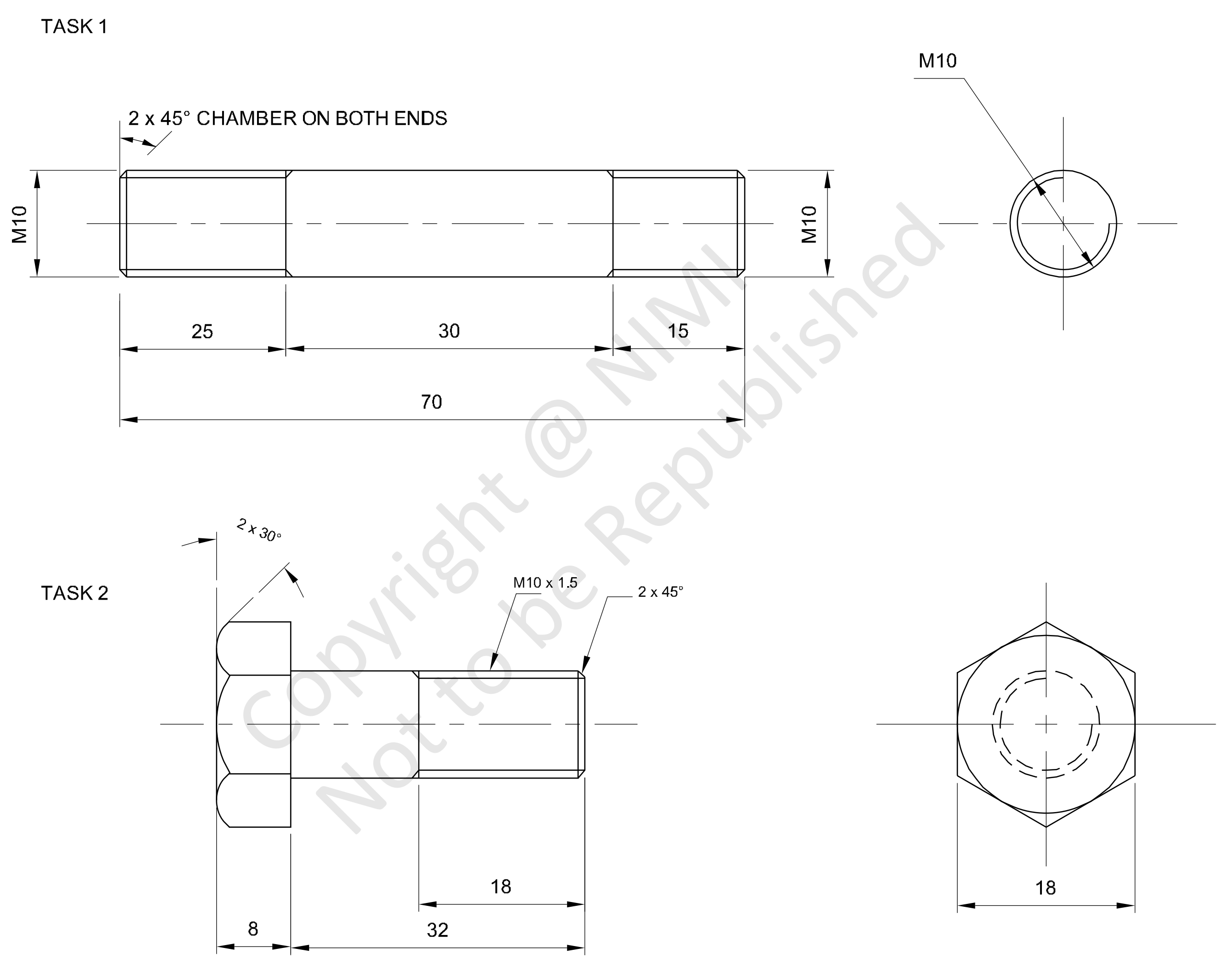
Finish tapping the hole with intermediate and bottoming tap. Set the nut to control the depth of the thread. (Fig 4)

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	–	Fe310	–	2	2.1.69
1	Ø10 - 75	–	Fe310	–	1	2.1.69
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PREPARE STUDS AND BOLT	TOLERANCE : ±0.04	TIME : 15 Hrs
		CODE NO : FIN2169E1	

Job Sequence

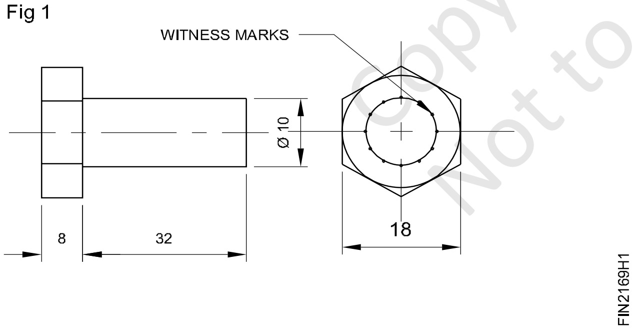
TASK 1: **Prepare stud**

- 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 9.9 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 without burrs and apply little oil and preserve it for evaluation.

TASK 2: **Prepare bolt**

- Check the raw material for its size.
- File the hexagon rod ends to flatness and squareness maintaining size Ø 10 mm x 40 mm length
- 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

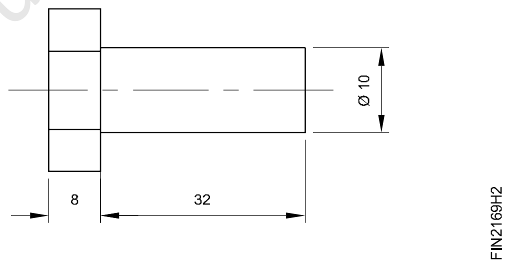
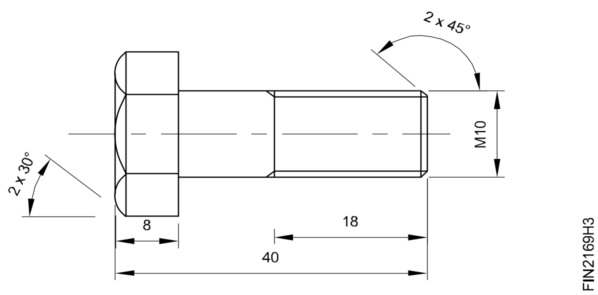


Fig 3



- 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

<u>**Skill Sequence**</u>

External threading using dies

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

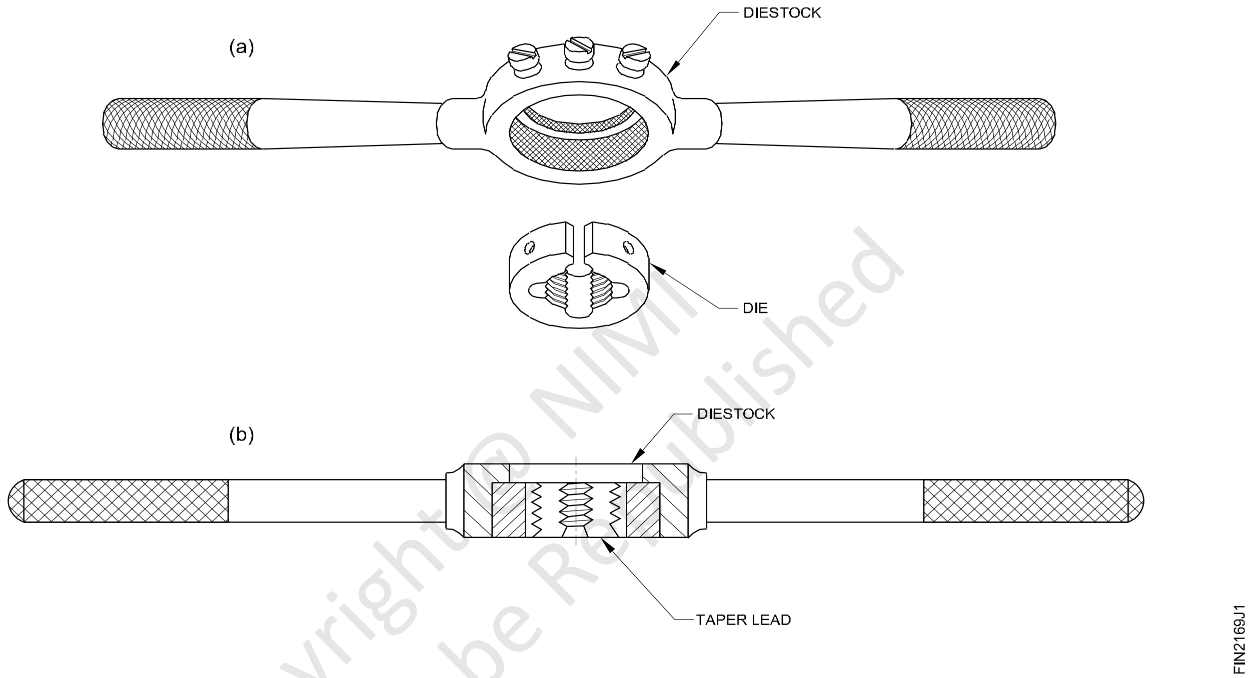
Check blank size.

Blank size = Thread size - 0.1 x pitch of thread

PROCEDURE

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.**

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

Fig 3

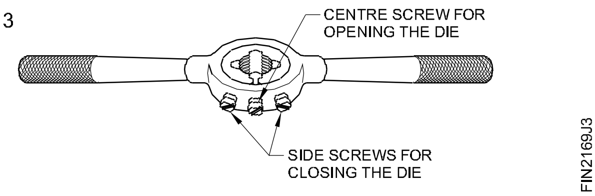
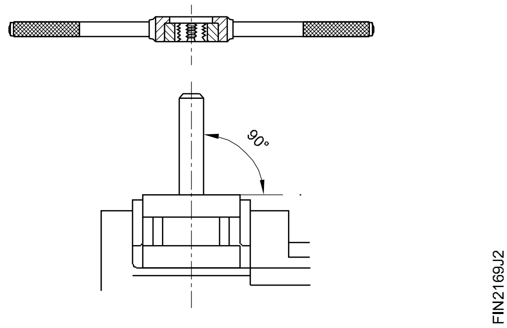
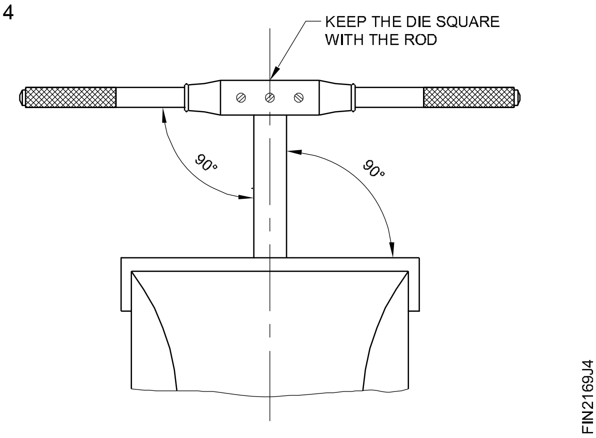


Fig 2



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)

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

Use a cutting lubricant

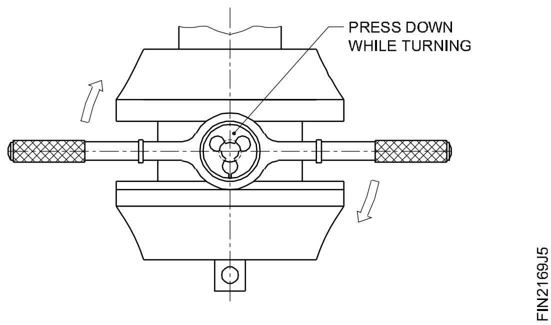
Increase the depth of the cut gradually by adjusting the outer screws.

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.**

Fig 5



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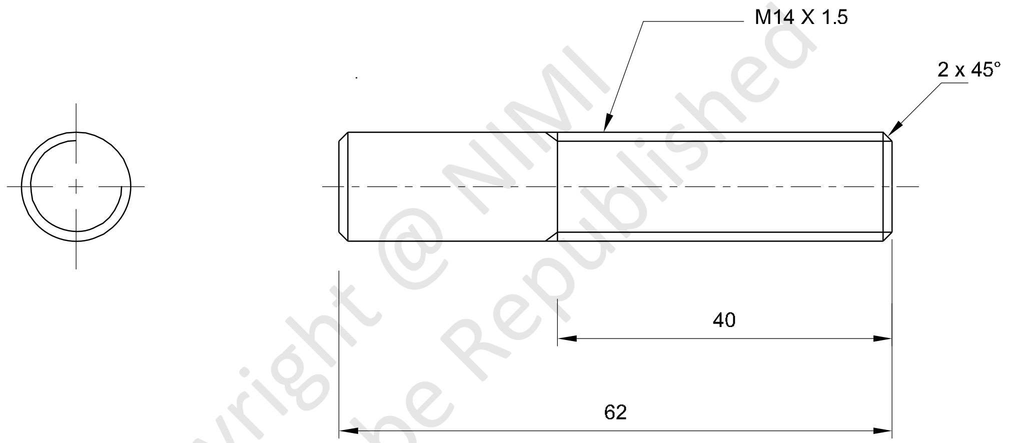
Form external threads with dies to standard size

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.**



1	ISR Ø 14 - 65	–	Fe310	–	–	2.1.70
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 : 10 Hrs
		CODE NO : FIN2170E1	

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

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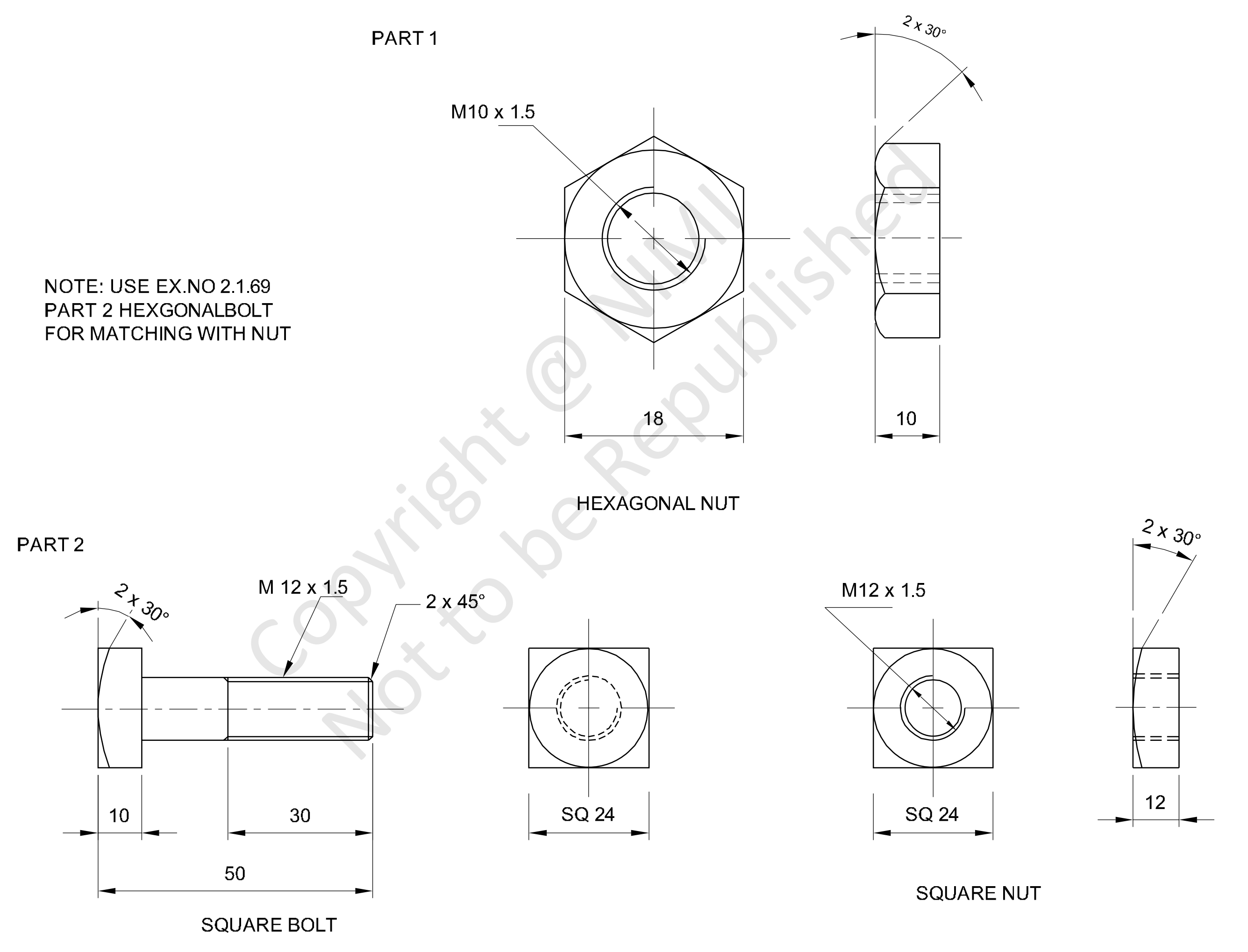
Prepare nuts and match with bolts

Objectives: At the end of this exercise you shall be able to
- **cut and file 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	2.1.71
1	HEX A/F 18 - 15 (NUT)	2.1.69 PART 2 (BOLT)	Fe310	–	1	2.1.71
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 : 15 Hrs
		CODE NO : FIN2171E1	

Job Sequence

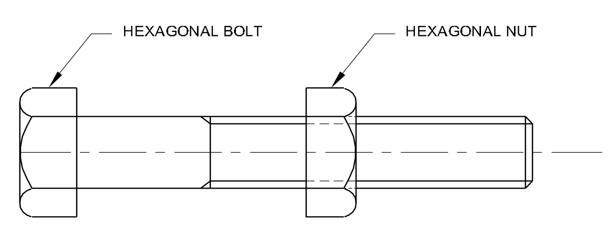
PART - 1 Hexagonal head bolt

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.

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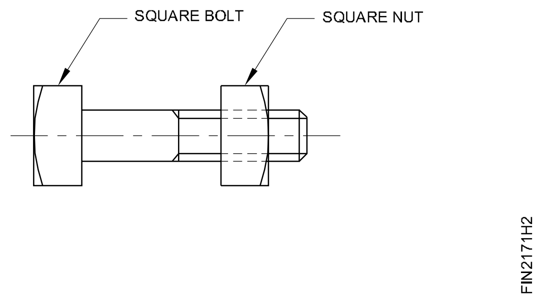
PART - 2 Square head bolt

- Cut the square rod to size 53mm.
- File square rod side 25 mm to side 24 mm and length 50 mm.
- File to size Ø 11.9 mm x 50 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 10.5 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



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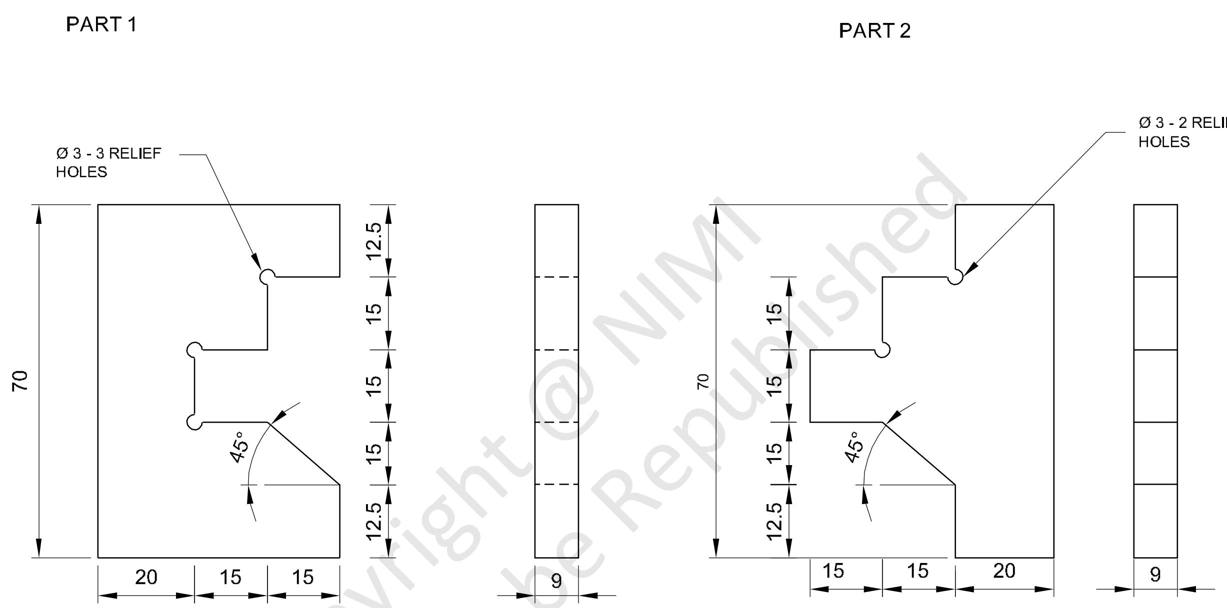
File and make step fit, angular fit, angle, surfaces (bevel gauge accuracy 1 degree)

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.**



2	75 ISF 10 - 55	–	Fe310	–	1 & 2	2.1.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

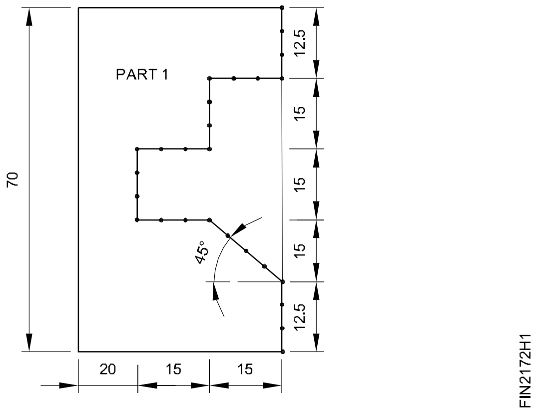
SCALE 1:1	FILE AND MAKE STEP FIT, ANGULAR FIT, ANGLE, SURFACES(BEVEL GAUGE ACCURACY 1 DEGREE)	TOLERANCE : ±0.04	TIME : 15 Hrs
		CODE NO : FIN2172E1	

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.

Fig 1



- Drill Ø 3 relief holes as shown 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.
- 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 2

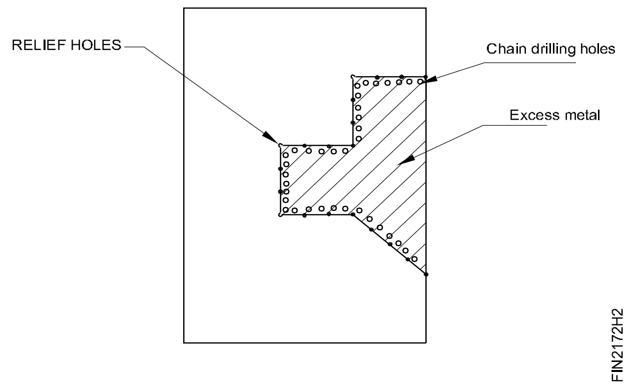
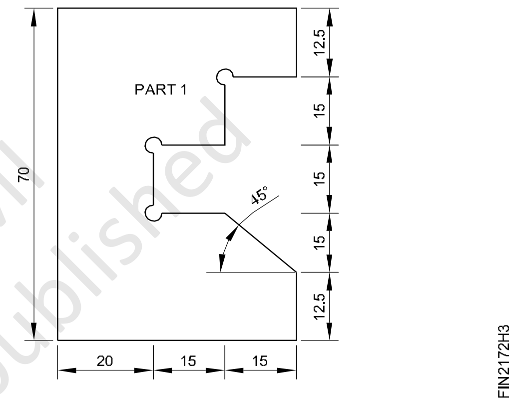


Fig 3



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

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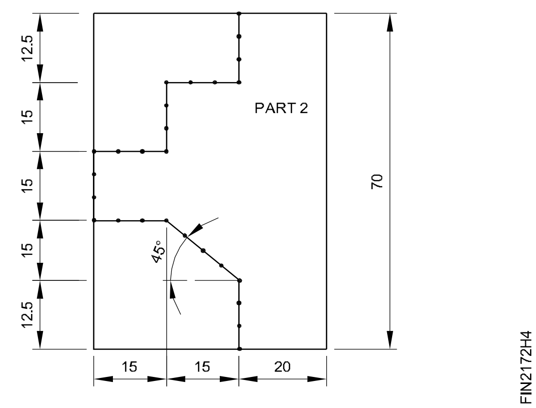
PART- 2

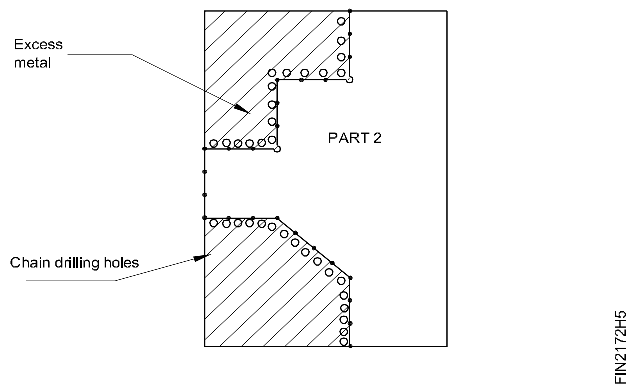
- File and finish to size 70 x 50 x 9 mm maintaining parallelism and perpendicularity.
- Mark and punch in part -2 as shown in Fig 4.

Fig 4

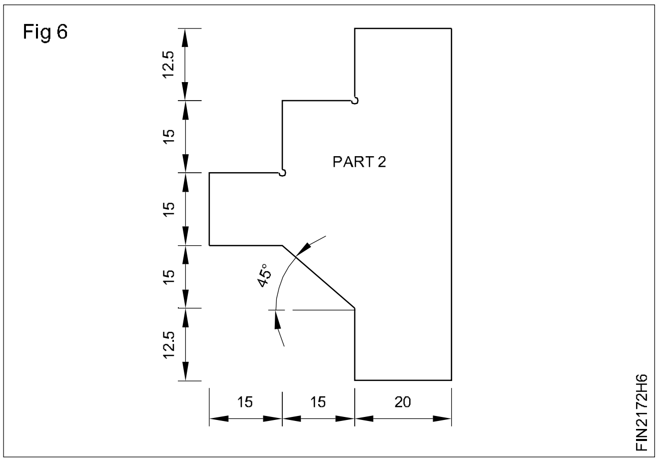


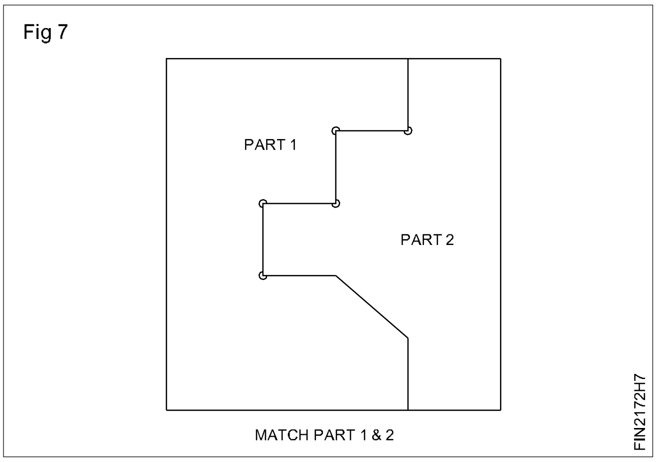
- Drill Ø 3 relief holes as shown in drawing.
- Chain drill holes for parting off excess material from part - 2 as shown in Fig 5.

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.
- 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.

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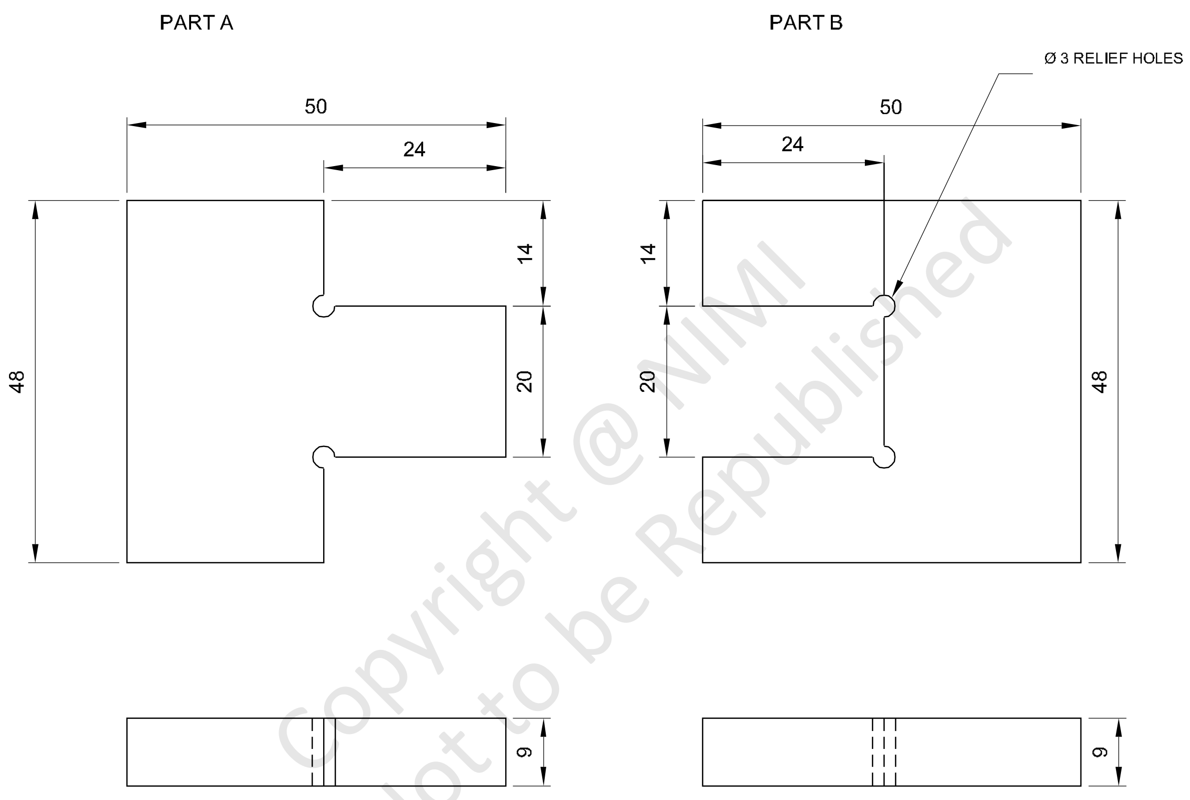
Make simple open and sliding fits

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.**



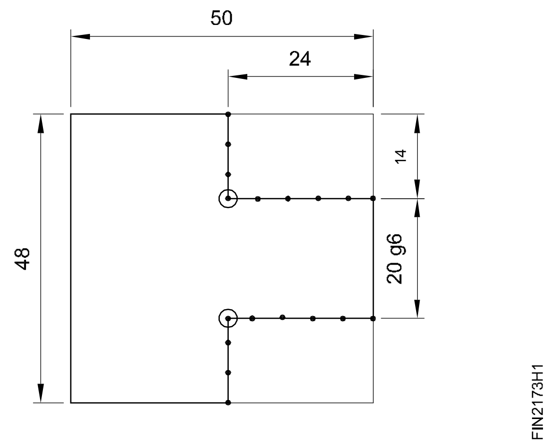
2	50 ISF 10 - 55	-	Fe310	-	A&B	2.1.73
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	MAKE SIMPLE OPEN AND SLIDING FITS				TOLERANCE : ± 0.04	TIME : 10 Hrs
					CODE NO : FIN2173E1	

Job Sequence

Part - A

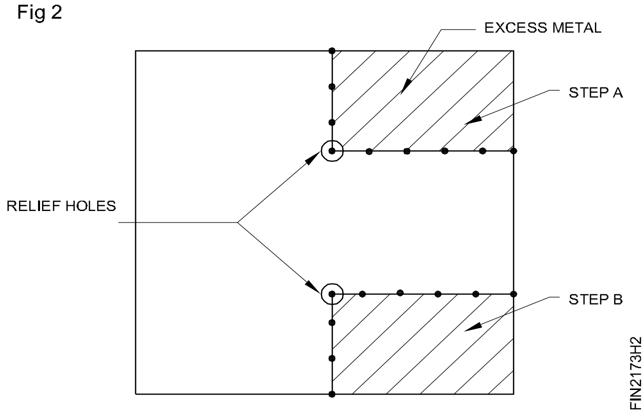
- Check the raw material for its size.
- File and finish to size 50 x 48 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media, mark as per job drawing and punch witness marks in part A as shown in Fig 1.

Fig 1



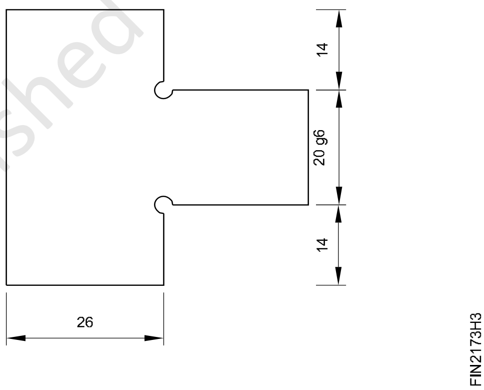
- Drill relief hole Ø 3 mm as per job drawing in part A.
- Mark lines as shown in Fig 2 leaving the metal 1 mm away from the object line and cut and remove the excess metal by hacksawing.
- File part A as per drawing to size 14 mm x 24 mm with safe edge file and check the size with vernier caliper.

Fig 2



- 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.

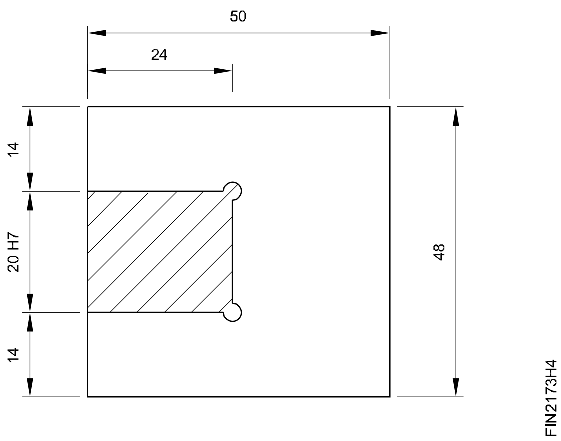
Fig 3



Part B

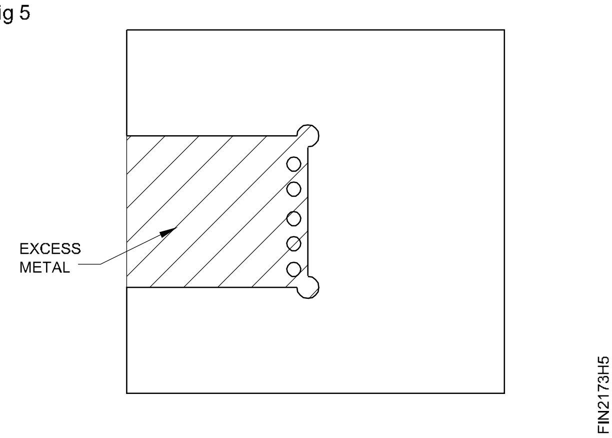
- File and finish to size 50 x 48 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media, mark and punch as shown in Fig 4.

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

Fig 6

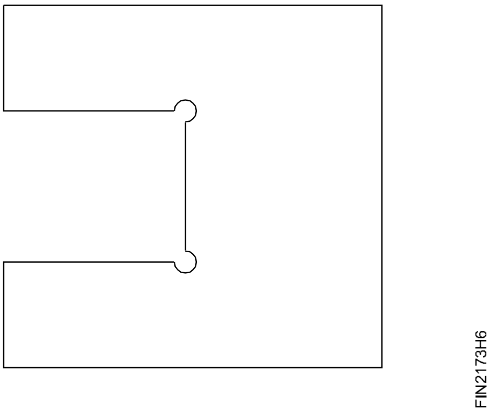
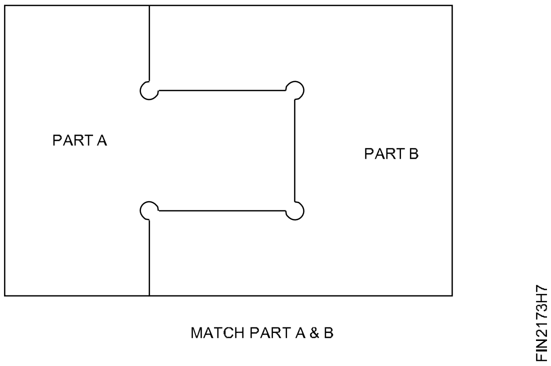
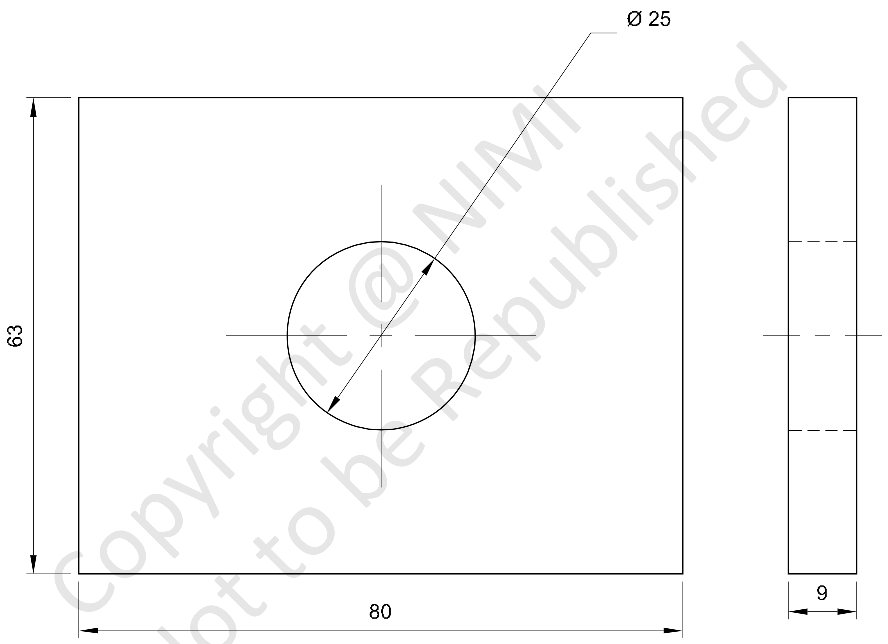


Fig 7



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.**

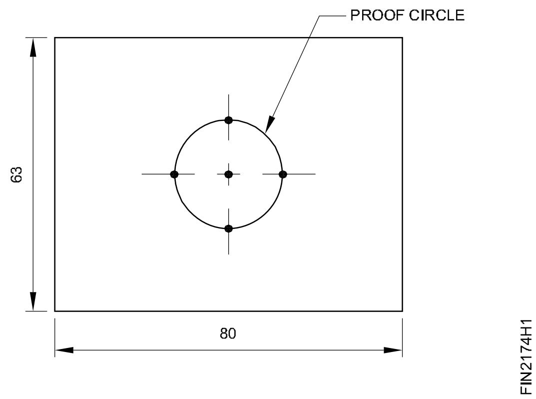


1	65 ISF 10 - 82	-	Fe310	-	-	2.1.74
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	ENLARGE HOLE AND INCREASE INTERNAL DIA				TOLERANCE : ± 0.04	TIME : 2 Hrs
					CODE NO : FIN2174E1	

Job Sequence

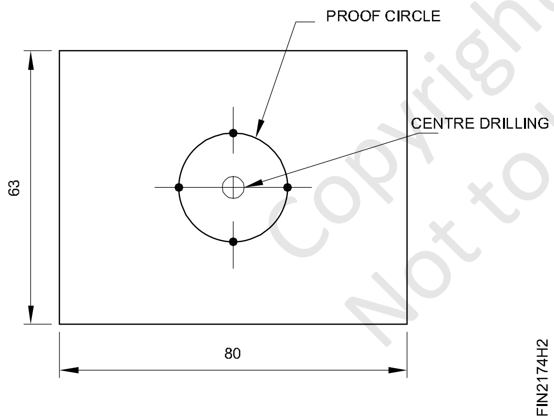
- Check the raw material for its size
- File and finish to size 80x63x9 mm and maintaining parallelism and perpendicularity.
- Apply marking media, mark off centre lines and locate the centre of drill hole as per drawing.
- Punch on the intersecting lines using prick punch 30°, set 12.5 mm in divider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

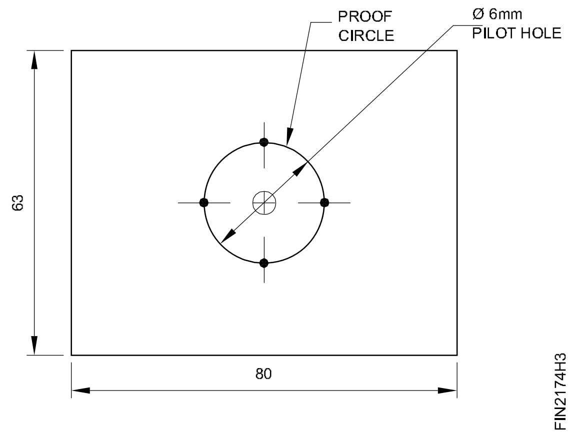
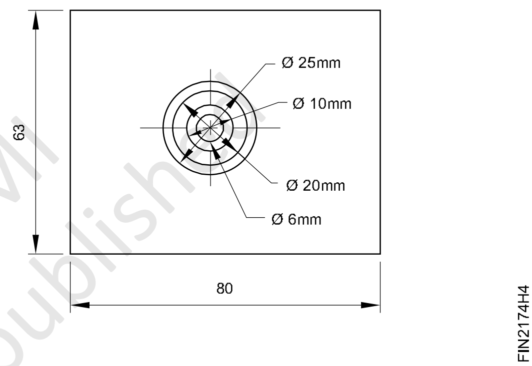
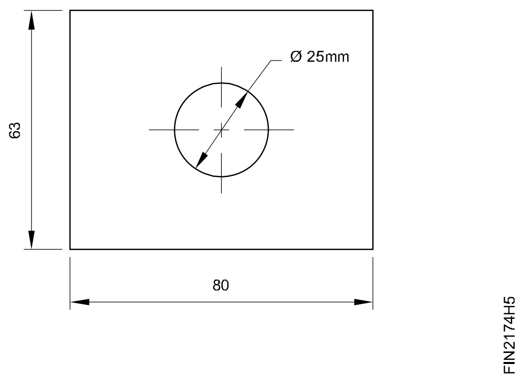


Fig 4



- Finally, enlarge the previously drilled hole to Ø 25 mm as shown in Fig 5.

Fig 5

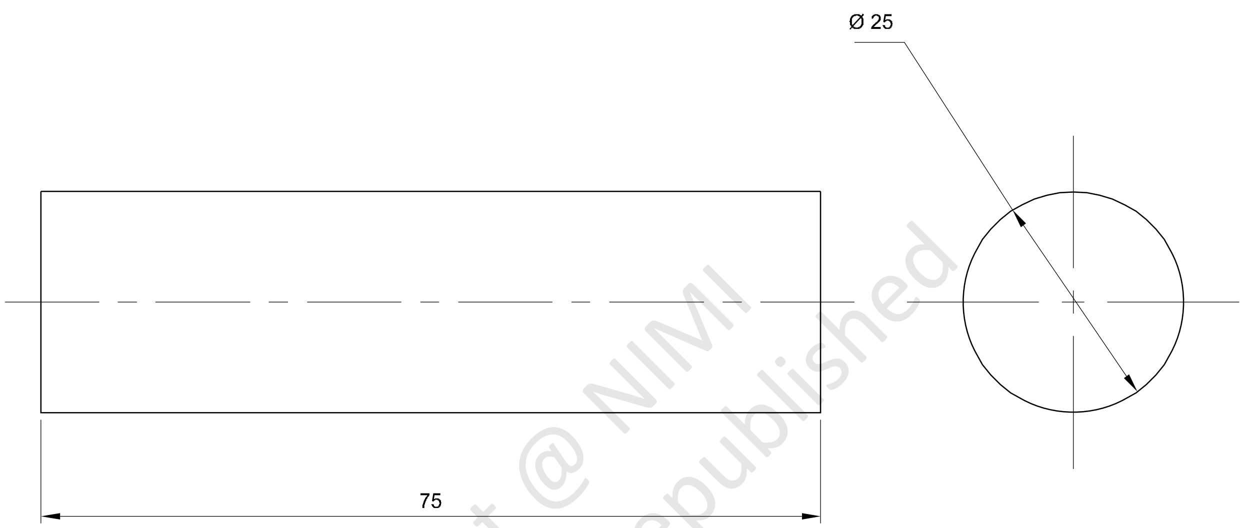


- Finish file on the job and de-burr in all the surfaces.
- Apply a thin coat of oil and preserve it for evaluation.

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 maintaining ± 0.04 mm in diameter**
- **finish and de - burr.**

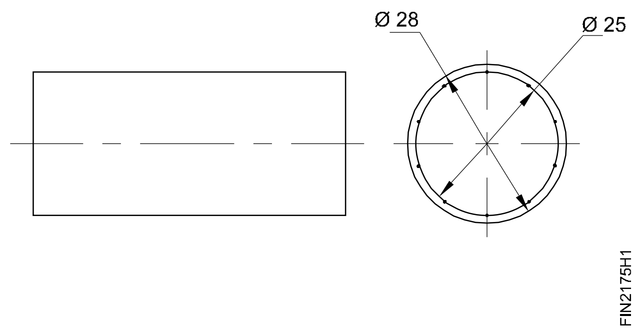


1	Ø28 - 80	–	Fe310	–	–	2.1.75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILE CYLINDRICAL SURFACES				TOLERANCE : ±0.04	TIME : 5 Hrs
					CODE NO : FIN2175E1	

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 and squareness with try square.
- Apply marking media in both ends of round rod.
- 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.

Fig 1



- 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.

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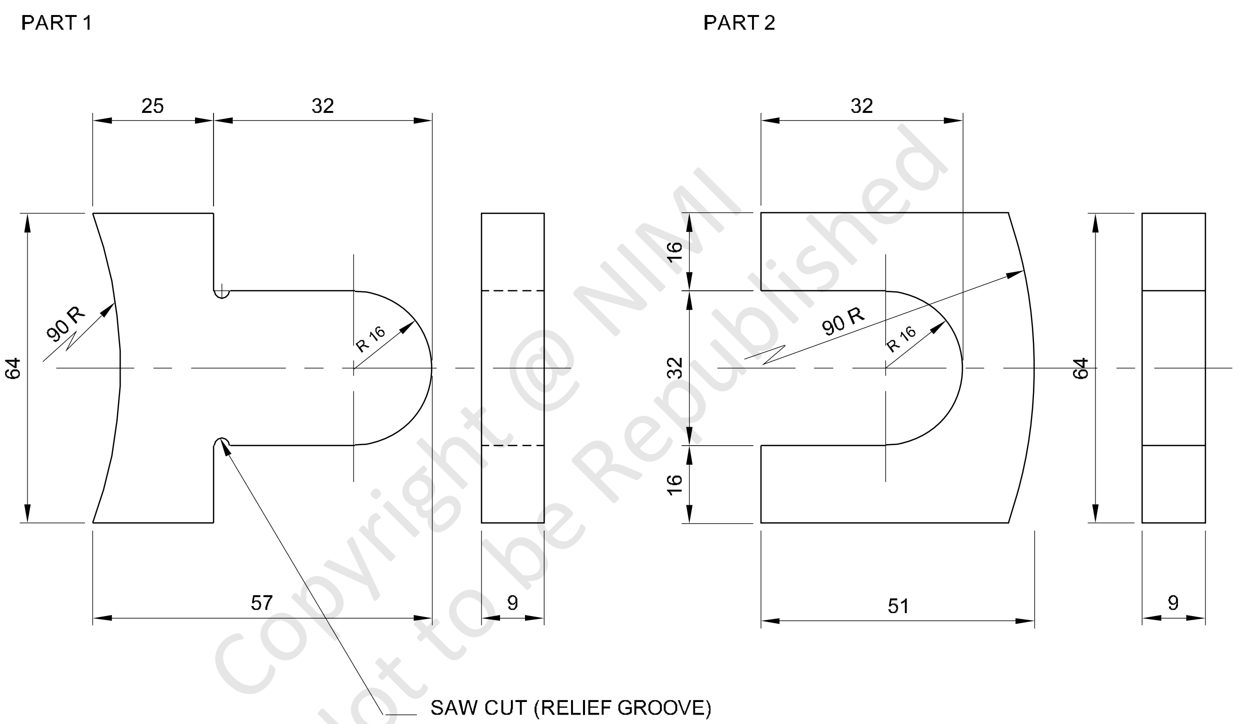
Make open fitting of curved profiles

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.**



1	65 ISF 10 - 55	–	Fe310	–	2	2.1.76
1	65 ISF 10 - 60	–	Fe310	–	1	2.1.76
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 : 18 Hrs
		CODE NO : FIN2176E1	

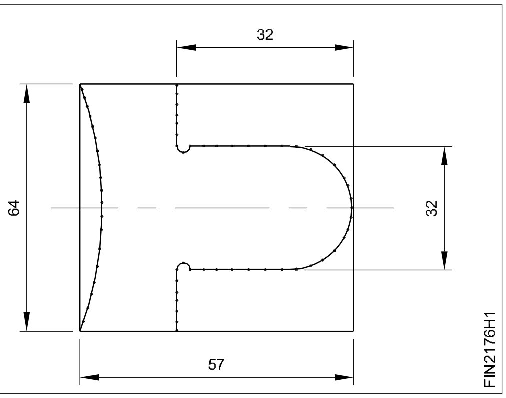
Job Sequence

- Check the raw matel size using steel rule.

PART - 1

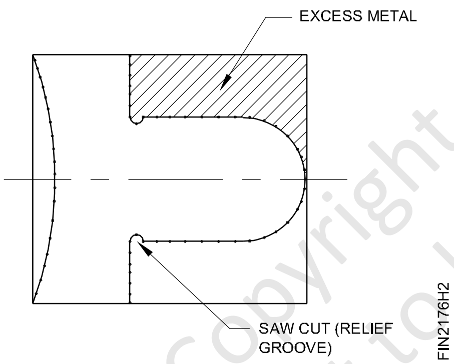
- File and finish to overall size 64 x 57 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media, mark in part 1 as per job drawing.
- Punch witness marks as shown in Fig 1

Fig 1



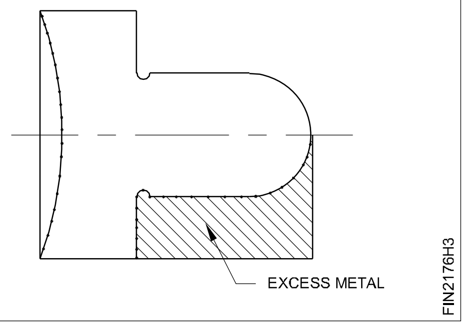
- Cut and remove the hatched portion of excess metal in one side and file to size and shape as shown in Fig 2.

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.

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

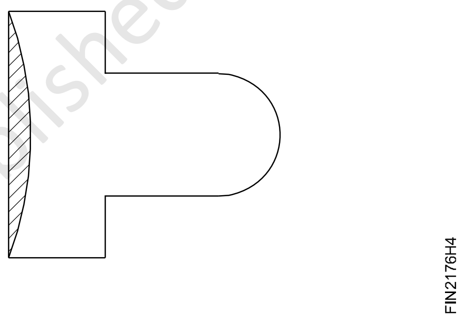
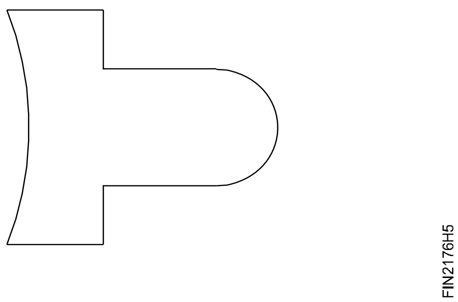


Fig 5



Part - 2

- 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.
- Chain drill holes to remove excess metal as shown in Fig 7.
- Cut and remove the hatched portion of excess metal and file to size and shape as shown in Fig 8.

Fig 6

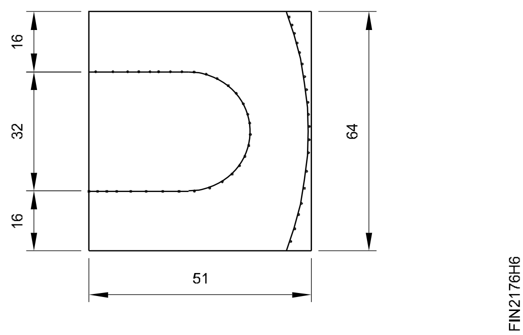


Fig 7

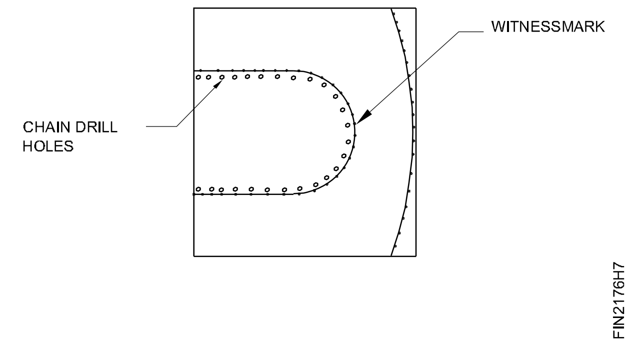
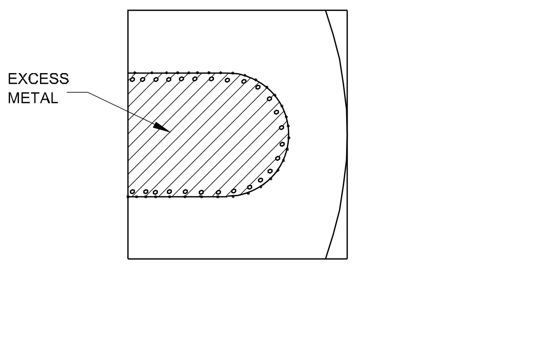
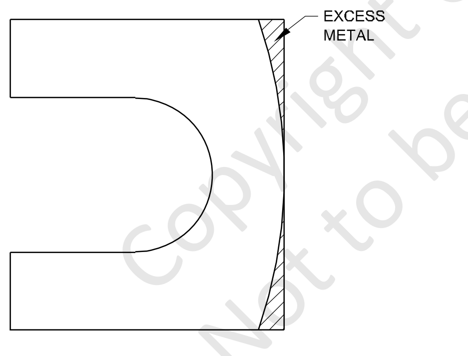


Fig 8



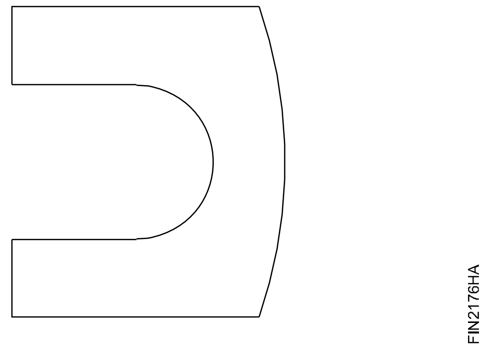
- Similarly, cut and remove the hatched portion of excess metal on curved profile side with hacksaw and file the profile to size and shape as shown in Fig 9.

Fig 9



- Check the curved profile with template and the size with vernier caliper as shown in Fig 10.

Fig 10



- Match part 1 and 2 as shown in Fig 11 & 12 in both sides.

Fig 11

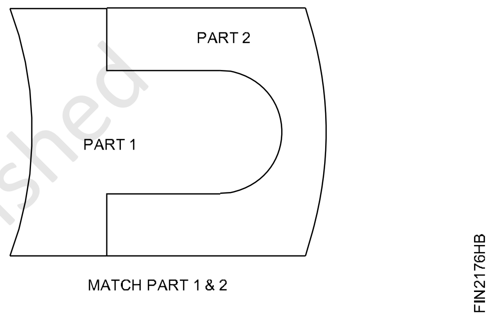
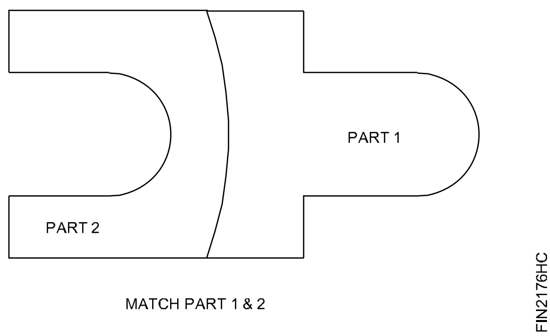


Fig 12



- 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.

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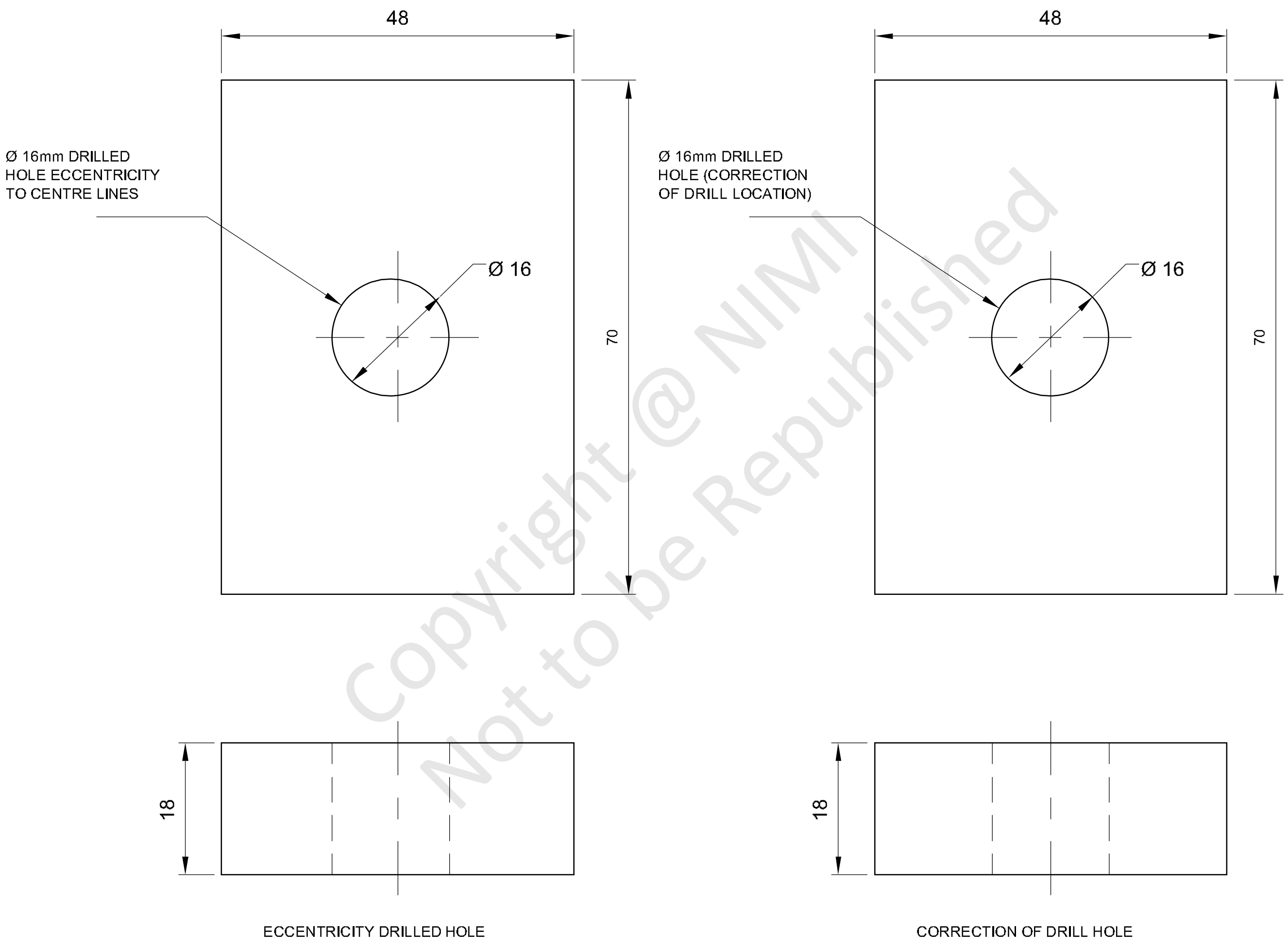
Correction of drill location by binding previously drilled hole

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.**



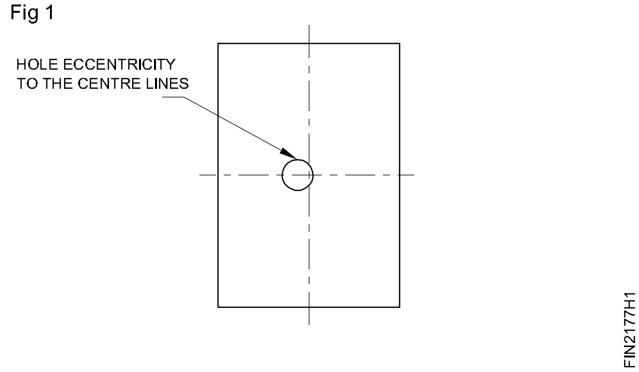
1	50 ISF 20 - 75	–	Fe310	–	1	2.1.77
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	CORRECTION OF DRILL LOCATION BY BINDING PREVIOUSLY DRILLED HOLE	TOLERANCE : ±0.04	TIME : 5 Hrs
		CODE NO : FIN2177E1	

Job Sequence

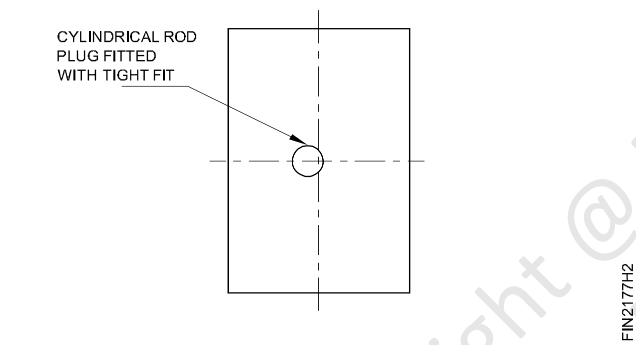
- Check the given material hole size Fig 1.

Fig 1



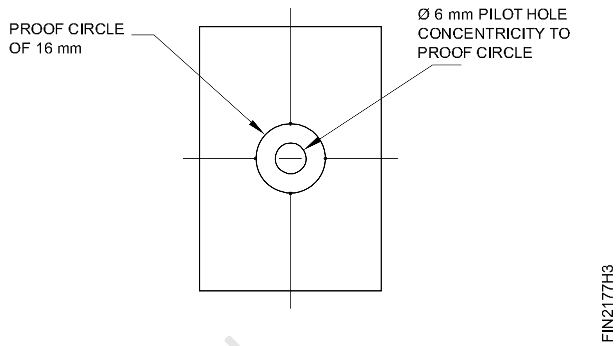
- Prepare round rod more than 0.050 mm actual size of drilled hole (16.000 + 0.050 = 16.050 mm)
- Plug the hole as tight fit with prepared round rod using ball pein hammer (Fig 2)

Fig 2



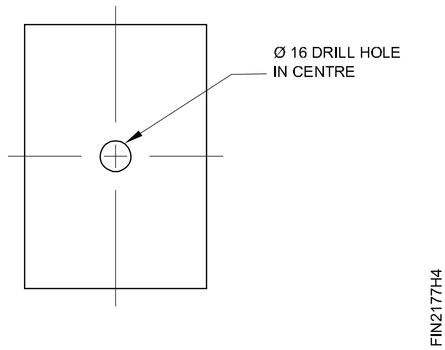
- File the plug surface on both sides to flat and square.
- Apply marking media on surface.
- Mark correct centre for drill hole with vernier height gauge (Fig 3)
- Punch on the drill hole centre mark with centre punch 90°.
- Fix centre drill in drill chuck and make centre drill hole.
- Fix Ø 6 mm drill 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.

Fig 4

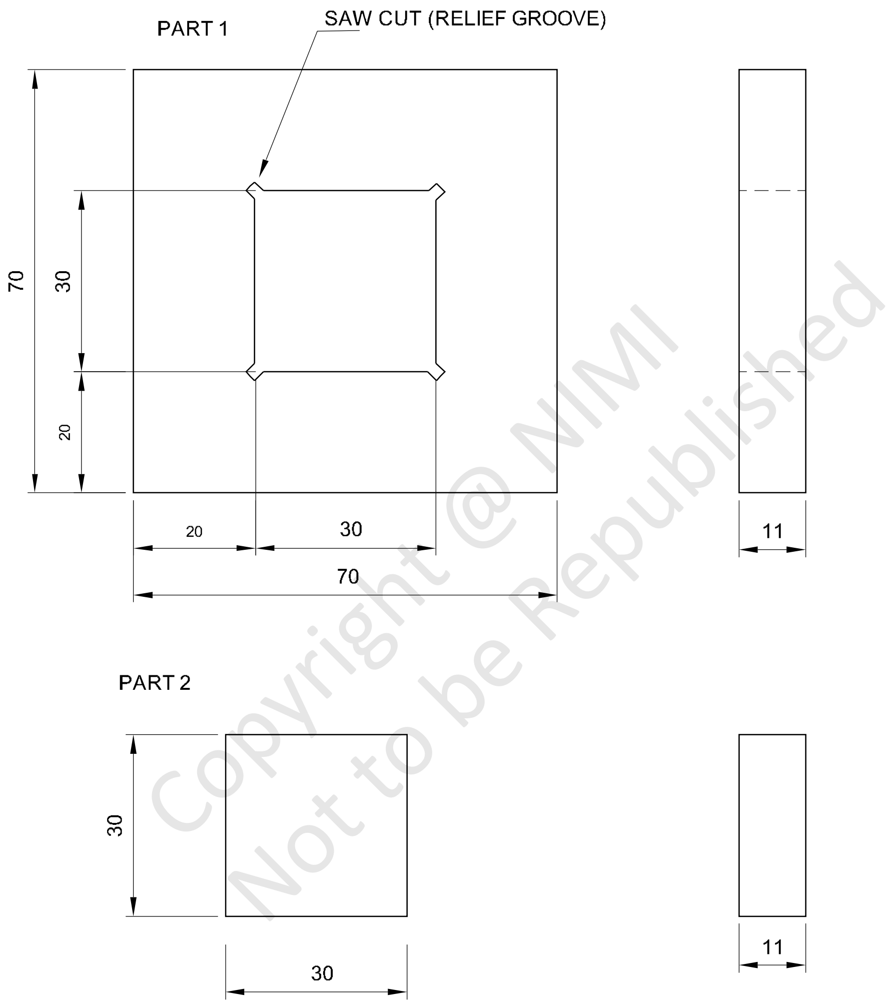


- Finish file, de-burr, clean and check with vernier caliper.
- Apply a little oil and preserve it for evaluation.

— — — — — — —

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	2.1.78
1	75 ISF 12 - 75	–	Fe310	–	1	2.1.78
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

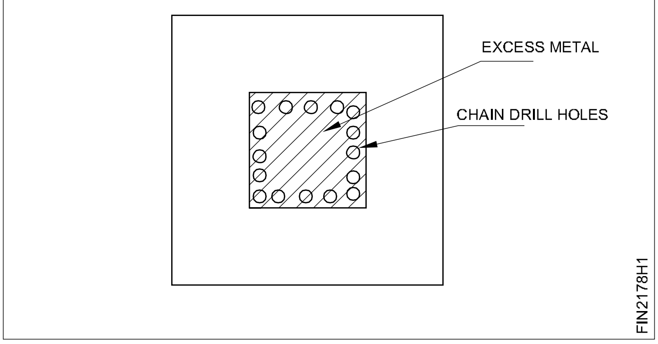
SCALE 1:1	MAKE INSIDE SQUARE FIT	TOLERANCE : ±0.04	TIME : 20 Hrs
		CODE NO : FIN2177E1	

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.

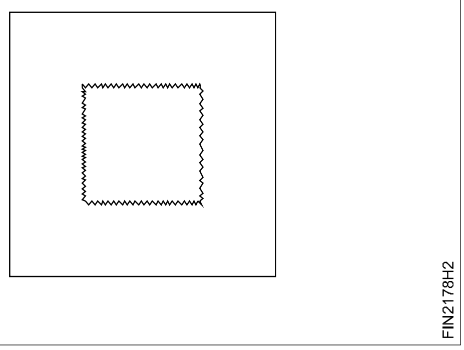
Fig 1



Pheriphery of the drill should not touch the witness marks

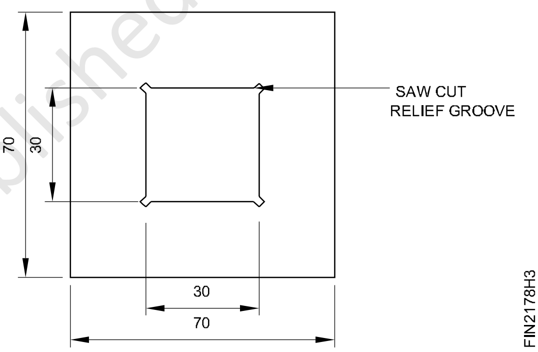
- Cut and remove the chain drilled hatched part using web chisel and ball pein hammer as shown in Fig 2.

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



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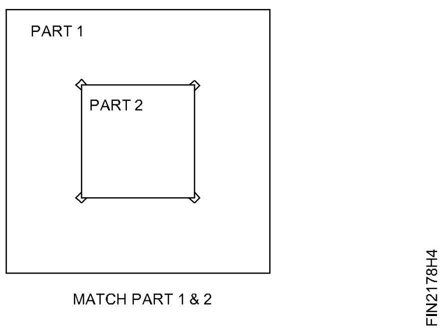
PART - 2

- 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.
- 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.

Fig 4



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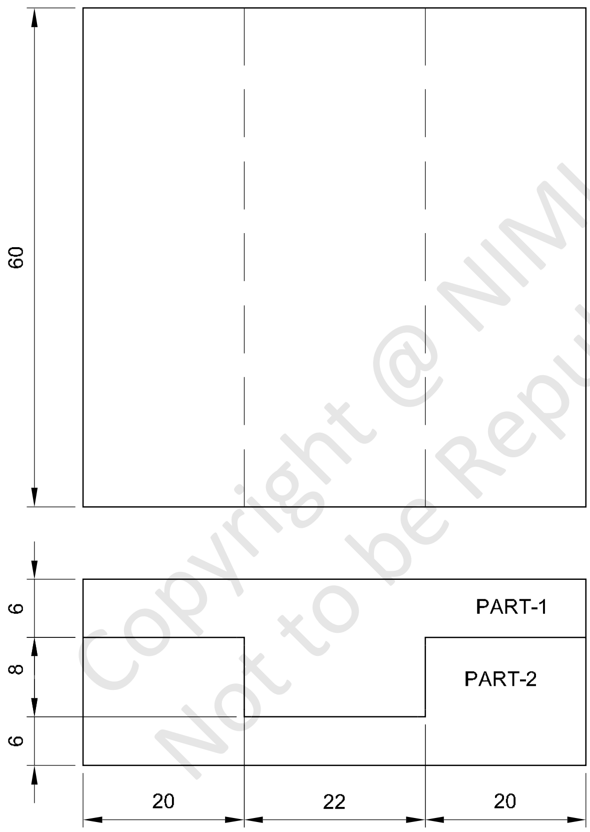
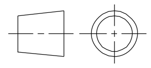
Make sliding 'T' fit

Objectives: At the end of this exercise you shall be able to
- **file flat surfaces to flat and square maintaining accuracy ± 0.04 mm**
- **mark dimension lines as per drawing**
- **file to size, shape and make sliding fit.**



2	65ISF15-65	-	Fe 310	-	-	2-2-79
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MAKE SLIDING 'T' FIT**	TOLERANCE ±0.04mm	TIME: 25 HOURS
		CODE NO. FIN2279E1	

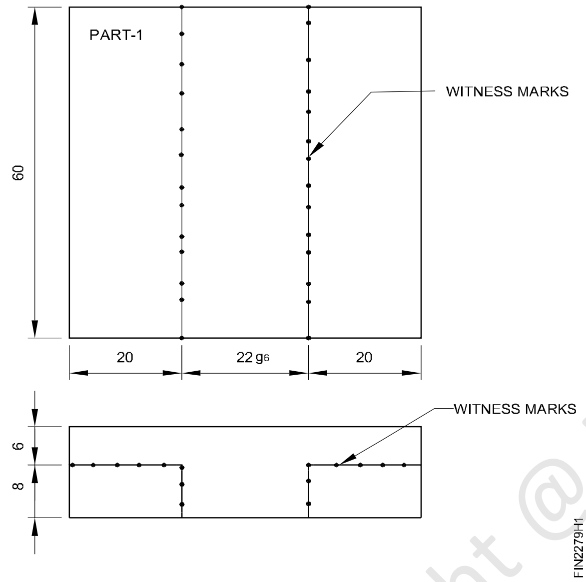
Job Sequence

- Check the raw matal size using steel rule.

PART - 1

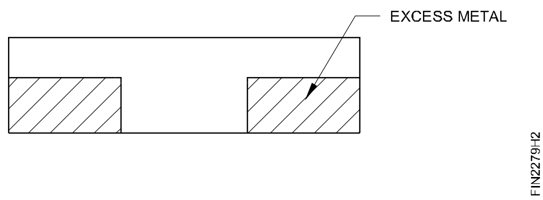
- File and finish to overall size of 62x60x14 mm maintaining parallelism and perpendicularity and to the accuracy of ± 0.04 mm.
- Check the size with vernier caliper.
- Apply marking media, mark as per drawing and punch witness marks as shown in Fig 1.

Fig 1



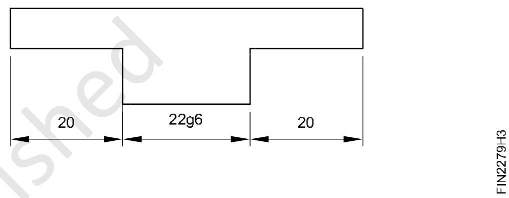
- Hacksaw and remove the hatched portion of excess metal in one side of the job as shown in Fig 2.

Fig 2



- File the cut portion to size and shape maintaining flatness and squareness to the accuracy of ± 0.04mm.
- Similarly, cut and remove the excess metal in other side, file and check the size with vernier aliper as shown in Fig 3.

Fig 3



PART - 2

- File and finish to size 62x60x14 mm maintaining parallelism and perpendicularity to the accuracy of ± 0.04 mm
- Apply marking media, mark and punch the dimension lines as shown in Fig 4.
- Hacksaw chip and remove the hatched portion of excess metal as shown in Fig 5.
- File to size and shape maintaining flatness and squareness as shown in Fig 6.
- Match part 1 and 2 and slide it as shown in Fig 7.
- Finish file part 1 and 2 and de-burr all the surfaces and corners of the job.
- Apply a little oil and preserve it for evalluation.

Fig 4

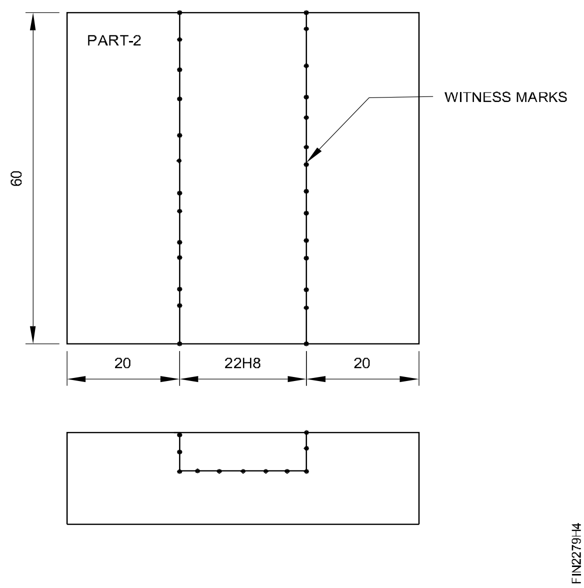


Fig 5

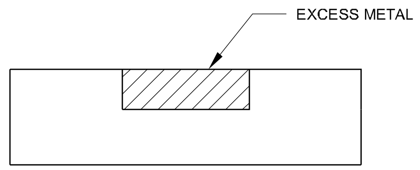


Fig 6

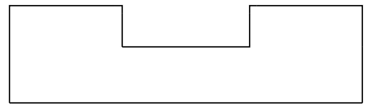
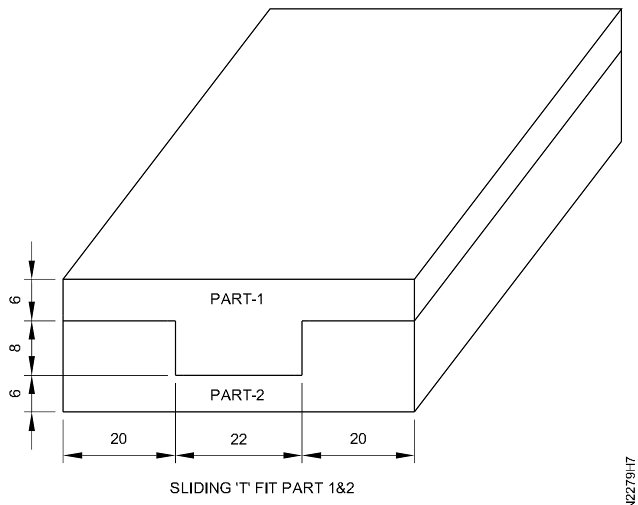


Fig 7



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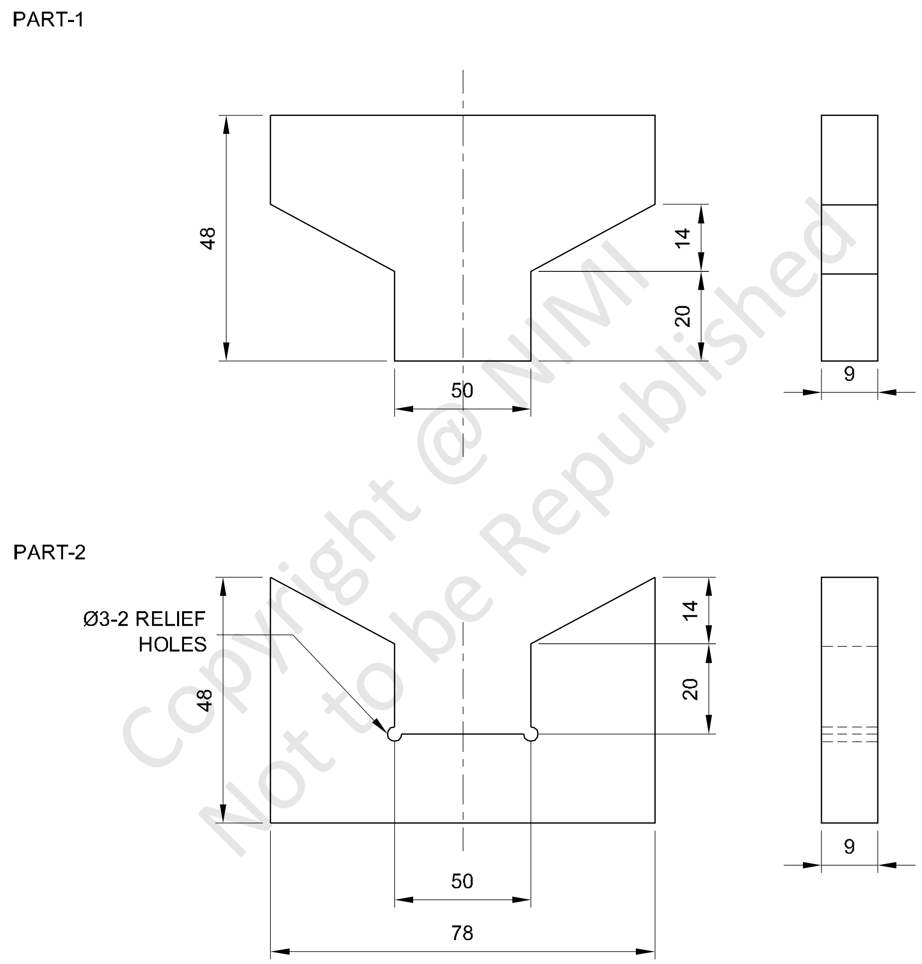
File fit - combined, open angular and sliding sides

Objectives: At the end of this exercise you shall be able to
- **file surfaces flat and square to the accuracy of ± 0.04 mm**
- **mark dimension lines as per drawing**
- **file flat and angular surfaces as per drawing**
- **measure the angle using vernier bevel protractor**
- **fit combined open, angular sliding sides, finish and de-burr.**



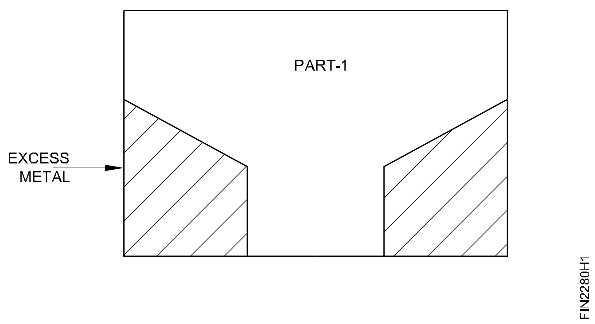
2	50ISF10-80	-	Fe 310	-	1&2	2-2-80
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FILE FIT-COMBINED ,OPEN ANGULAR AND SLIDING SIDES**	TOLERANCE LINEAR ±0.04mm ANGLE ±30 minutes	TIME: 10 HOURS
		CODE NO. FIN2280E1	

Job Sequence

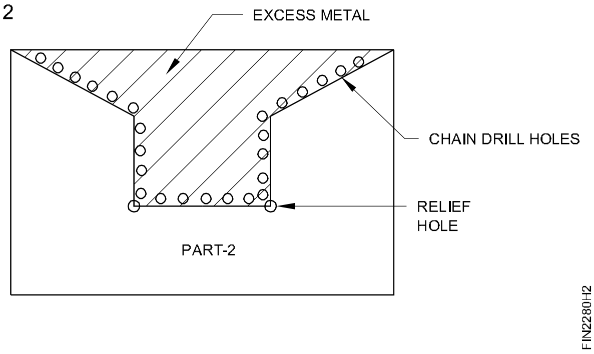
- Check the raw matal for its size.
- File part 1 and 2 to over all size 78 x 48 x 9 mm maintaining parallelism and perpendicularity.
- Check the size with vernier caliper.
- Apply marking media and mark dimension lines on part 1 and 2 as per job drawing.
- Punch witness marks on part 1 and 2.
- Hacksaw and remove the excess metal in part 1 and file to size and shape maintaining accuracy ± 0.04 mm and angle 30 minutes as shown in Fig 1.

Fig 1



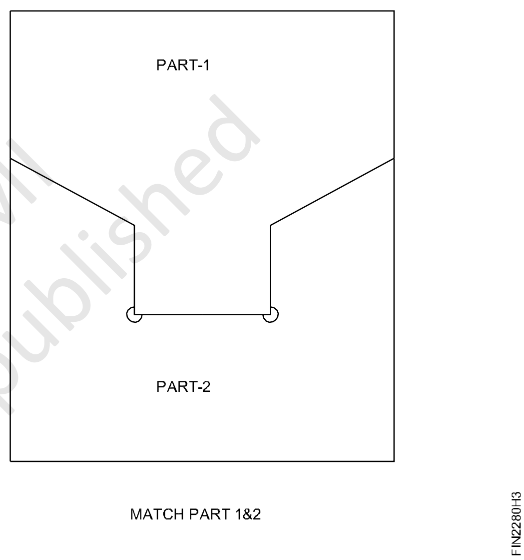
- Drill Ø 3 mm relief hole in part 'B'
- Chain drill, chip, remove the excess metal in part 'B' and file to size and shape as shown in Fig 2.
- Check the size with vernier caliper and angles with vernier bevel protector.
- Finish file on part 1 and 2 and de-burr in all corners.

Fig 2



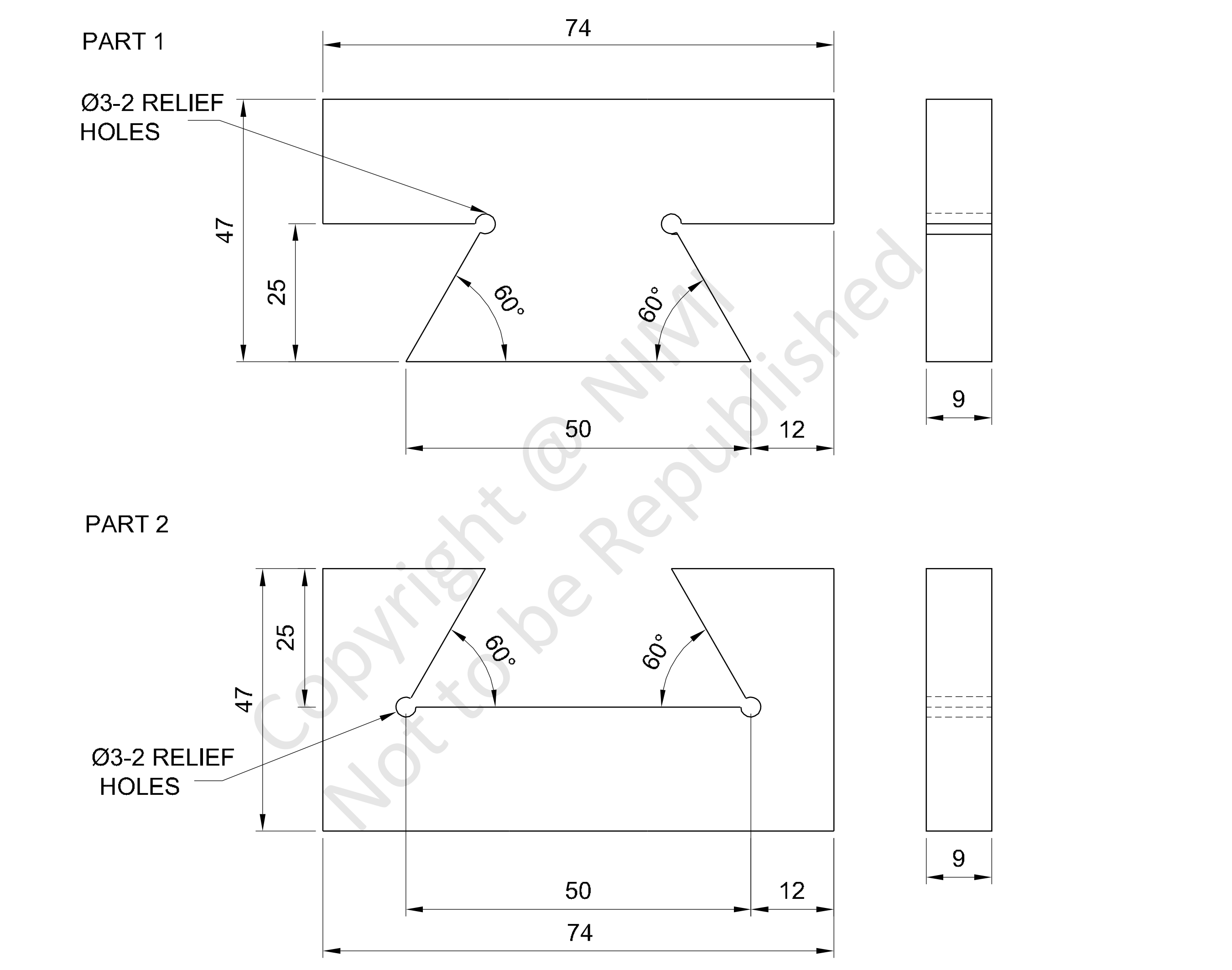
- Match part 1 and 2 as shown Fig 3.
- Apply a little oil and perserve it for evaluation.

Fig 3



File internal angles 30 minutes accuracy open, angular fit

Objectives: At the end of this exercise you shall be able to
- **file surfaces parallel and square within an accuracy of ± 0.04 mm**
- **mark dimension and angular lines as per drawing**
- **file flat and angular surfaces as per drawing**
- **check the angle using vernier bevel protector to an accuracy of 30 minutes**
- **fit angular surfaces as per drawing, finish and de-burr.**



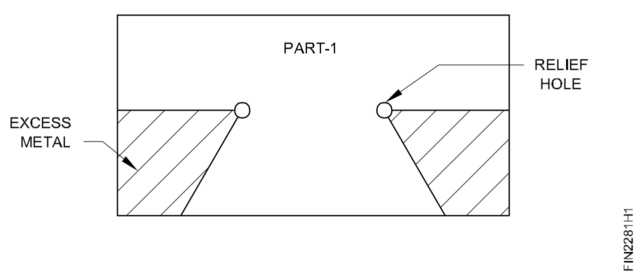
2	50ISF10 - 80	–	Fe310	–	1&2	2.2.81
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	FILE INTERNAL ANGLES 30 MINUTES ACCURACY OPEN , ANGULAR FIT	TOLERANCE LINEAR ±0.04 mm ANGLE ±30	TIME: 15Hrs
		CODE NO: FIN2281E1	

Job Sequence

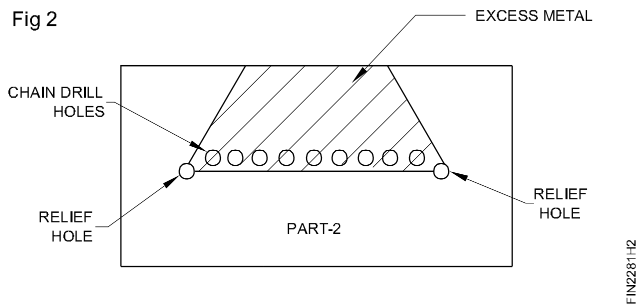
- Check the raw material size.
- File part 1 and 2 to over all size 74 x 47 x 9 mm maintaining flat and squareness.
- Apply marking media on the surface and mark dimension lines on part 1 and 2 as per job drawing.
- Punch witness marks on part 1 and 2.
- Drill Ø 3 mm relief holes in part 1 and 2.
- Hacksaw and remove the excess metal in part 1 and file the cut portion to size and shape maintaining the accuracy ± 0.04 mm and angles 30 minutes as shown in Fig 1.

Fig 1



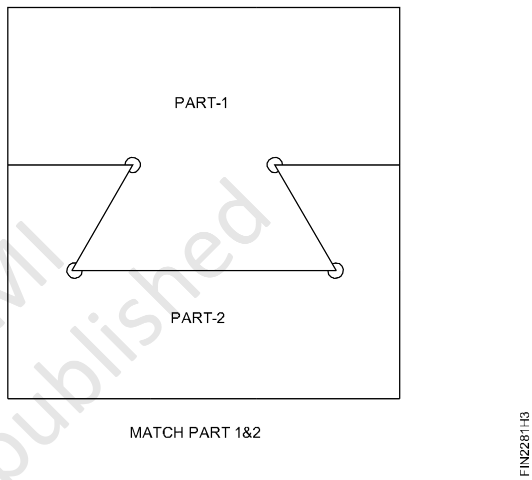
- Chain drill, chip, hacksaw and remove the excess metal in part 2 and file to size and shape as shown in Fig 2.
- Check the size with vernier caliper and angles with vernier bevel protector.

Fig 2



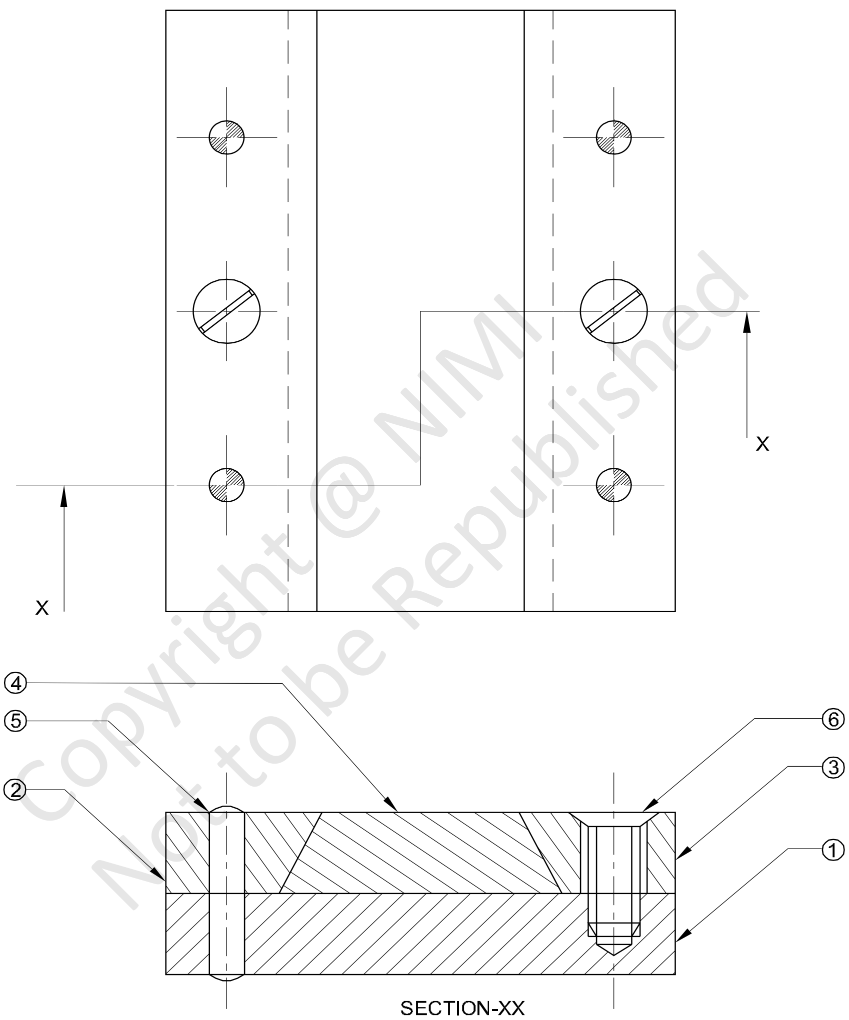
- Match part 1 and 2 as shown in Fig 3.
- Apply a little oil and preserve it for evaluation.

Fig 3



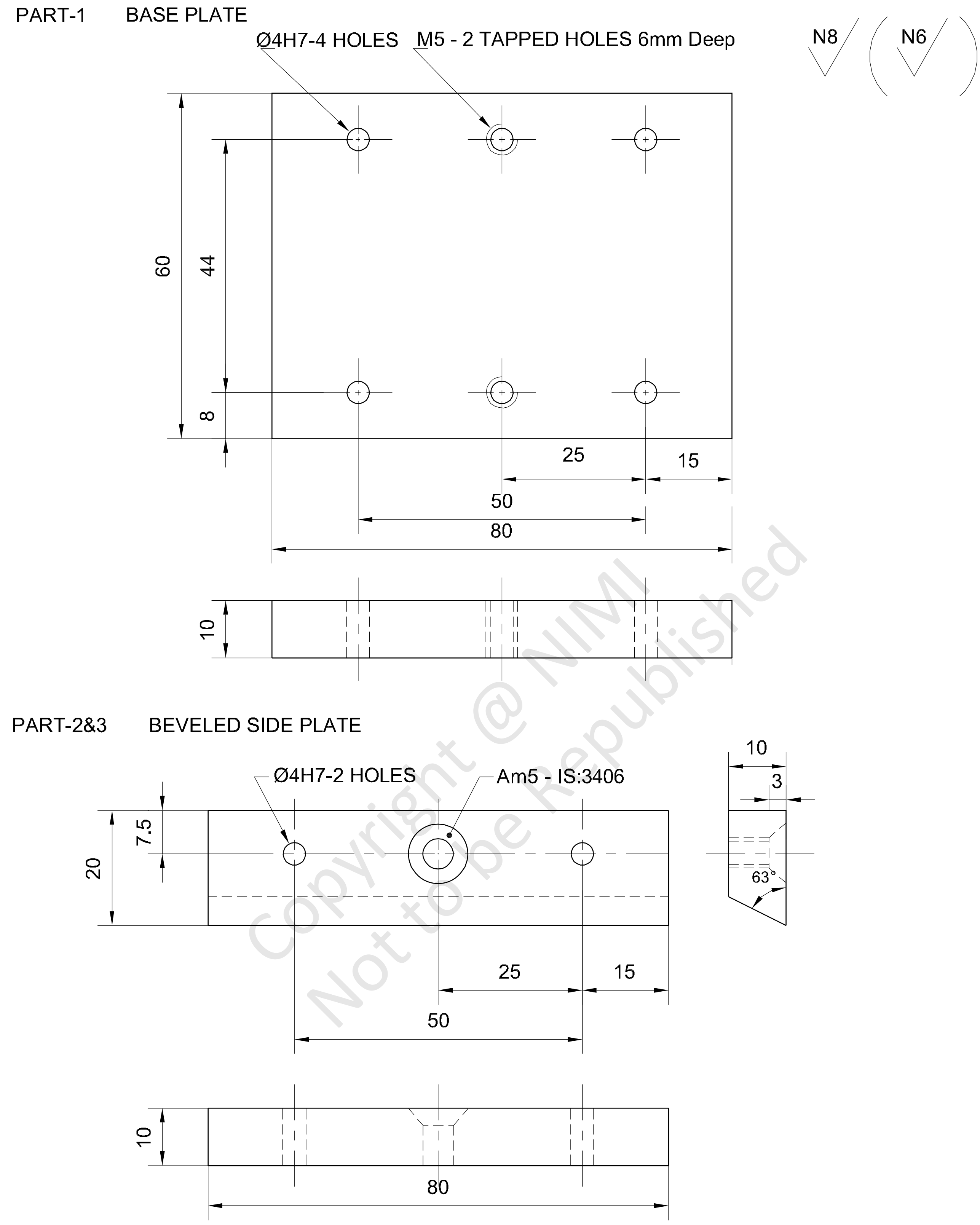
Make sliding fit with angles other than 90°

Objectives: At the end of this exercise you shall be able to
- **file and finish flat and angular surfaces within an accuracy of ± 0.04 mm and ± 30 minutes**
- **mark and drill holes as per drawing**
- **cut internal thread to assemble countersink screws**
- **prepare and assemble components using screws and dowel pins**
- **assemble components to achieve sliding fit with angular mating surfaces.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
2	AM5-15IS:1365	CSK SCREW	30CB		6	
4	4H8x20IS:2393	CYLINDRICAL PIN	40CB		5	
1	35ISF12-85	SLIDING PLATE	Fe310		4	
2	25ISF12-85	BEVELED SIDE PLATE	Fe310		2&3	
1	65ISF12-85	BASE PLATE	Fe310	–	1	2.2.82

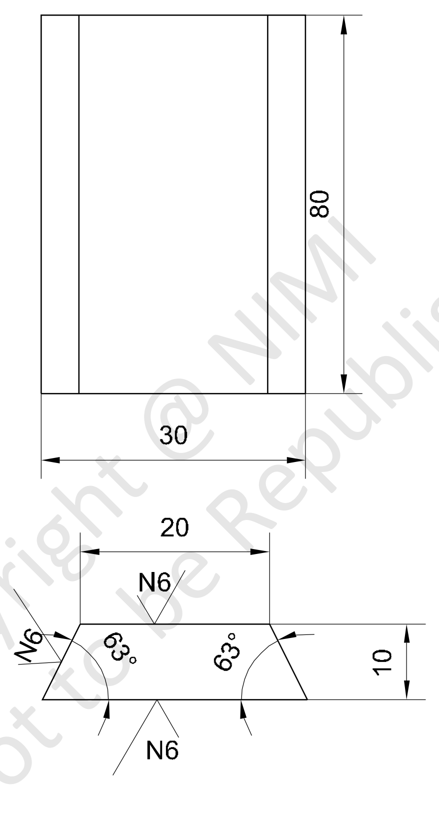
SCALE NTS	MAKE SLIDING FIT WITH ANGLES OTHER THAN 90°	TOLERANCE ±0.04 mm	TIME: 25Hrs
		CODE NO: FIN2282E1	



-	-	-	-	-	-	2.2.82
NO.OFF	STOCK SIZE	DESCRIPTION	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	BASE PLATE & BEVELED SIDE PLATES	DEVIATIONS	TIME
		CODE NO. FIN2282E2	

PART-4 SLIDING PLATE



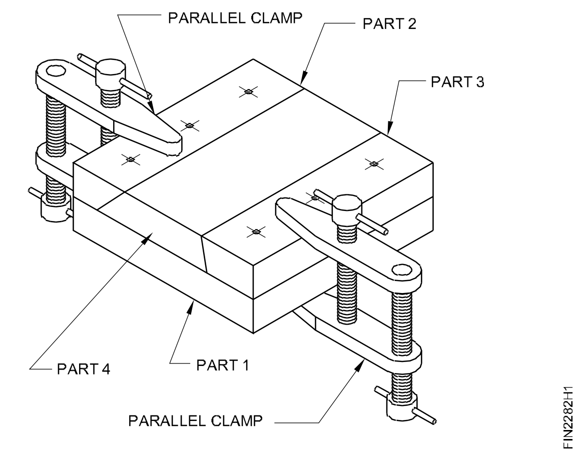
-	-	-	-	-	-	2.2.82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	SLIDING PLATE	DEVIATIONS	TIME
		CODE NO. FIN2282E3	

Job Sequence

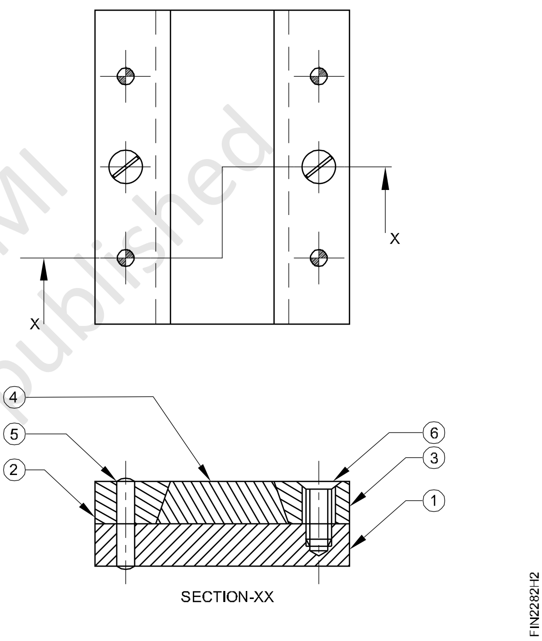
- Check the raw material for its size.
- File the material of part 1, 2, 3 and 4 to over all sizes maintaining the accuracy of ± 0.04 mm.
- Apply marking media on part 1, 2, 3 and 4 surfaces and mark lines as per drawing.
- Punch witness marks.
- Hacksaw and file in part 2, 3 and 4 and file to size and shape as per job drawings.
- Assemble and clamp part 1,2,3 and 4 together in drilling machine table with parallel clamps as shown in Fig 1.

Fig 1



- Fix Ø 3.8 mm drill in drilling machine spindle through drill chuck and drill through hole.
- Fix Ø 4 mm hand reamer in tap wrench and ream the drilled hole to fix Ø 4 mm dowel pin without disturbing the assembly setting.
- Clean the reamed hole and insert Ø 4 mm dowel pin.
- Similarly, drill other dowel pin holes one by one and ream the drilled hole one by one and fix the dowel pins without disturbing the assembly.
- Fix Ø 4.2 mm drill in drilling machine spindle through drill chuck and drill holes for cutting internal thread to fix counter sink screws in assembly without disturbing the setting.
- Seperate the assembly parts 1,2,3 and 4 and chamfer the tapping holes both ends in part 1 using countersink tool.
- Drill free hole Ø 5.5 mm for CSK screw in part 2 and 3.
- Counter sink the drilled holes to seat the counter sink head screws in part 2 and 3.
- Hold the part 1 in bench vice.
- Cut internal thread using M5 hand tap and tap wrench.
- Clean the threads with out burrs.
- Cut and file in part 2, 3 and 4 to size and shape as per job drawing and check the size with vernier caliper and angles with vernier bevel protractor.
- Assemble part 1,2,3 and 4 as per job drawing along with dowel pins and counter sink screws.
- Fit and slide part 4 in the assembly as shown in Fig 2.

Fig 2

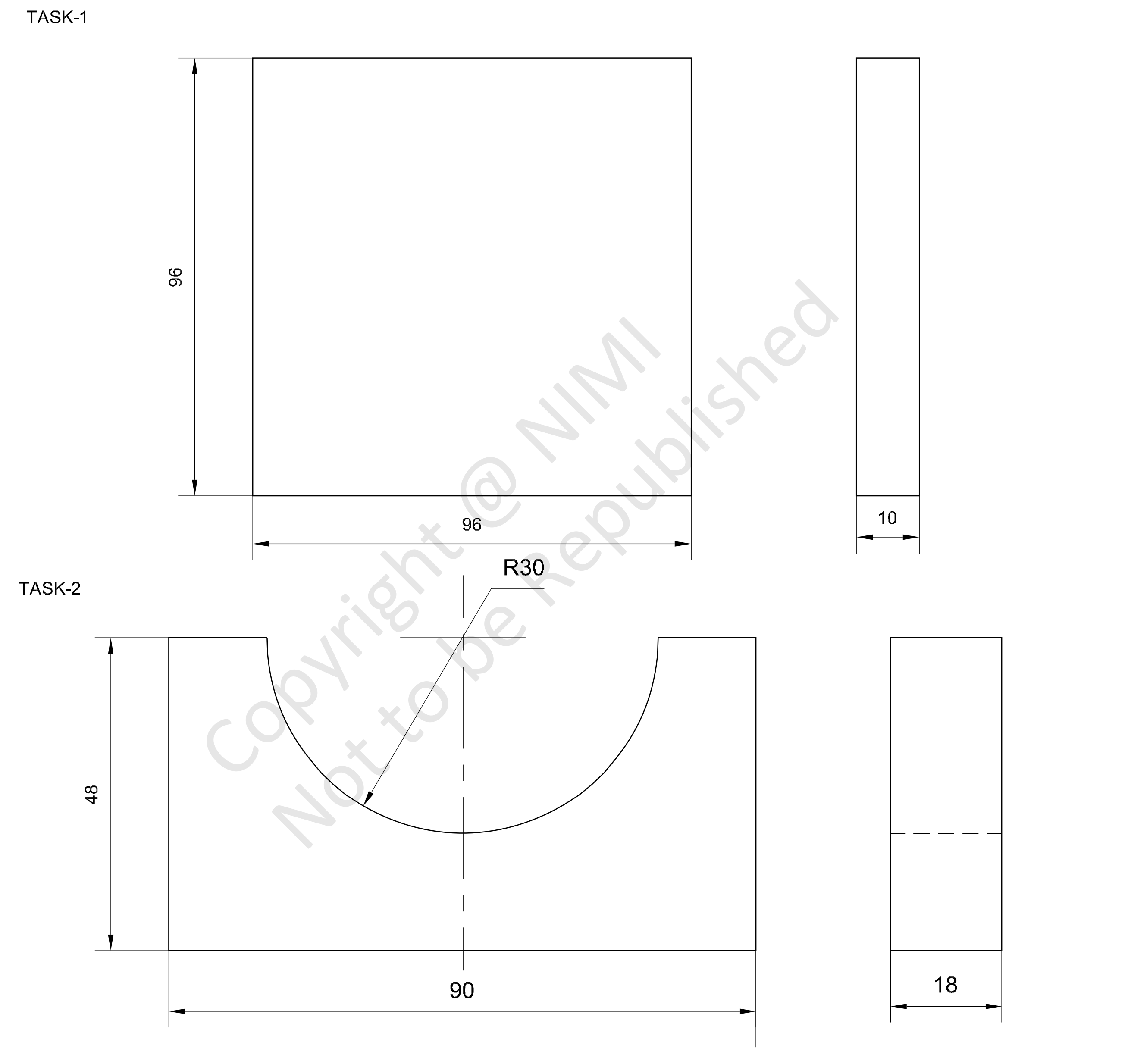


- Disassemble all the parts from assembly.
- Finish file on part 1,2,3 and 4 and remove burrs in all the corners of the job.
- Re-assemble all the parts together as per job drawing.
- Apply a little oil and preserve it for evaluation.

— — — — — — — —

Scrap on flat surfaces, curved surfaces and parallel surfaces and test

Objectives: At the end of this exercise you shall be able to
- **file surfaces flat and square to the accuracy of ± 0.04 mm**
- **find high spots on flat and curved surfaces using prussion blue**
- **scrap on flat, curved surfaces and test.**



1	100ISF12-100		Fe310	-	TASK-1	2.2.83
1	100ISF20-50	-	Fe310	-	TASK-2	2.2.83
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

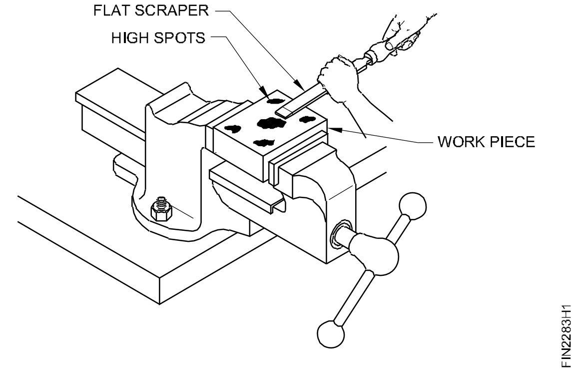
SCALE NTS	SCRAP ON FLAT SURFACES , CURVED SURFACES AND PARALLEL SURFACES AND TEST	TOLERANCE ±0.04 mm	TIME 5Hrs
		CODE NO. FIN2283E1	

Job Sequence

TASK 1: **Scraping on flat surface**

- Check the raw material for its size.
- File metal to size 96x96x10 mm maintaining flatness and squareness.
- Check the size with vernier caliper.
- Clean the surface plate with soft cloth.
- Apply prussion blue evenly on the surface plate.
- Place the job on surface plate and move slightly forward and backward
- Take the job from surface plate and notice the blue spotted marks on the flat surface.
- Hold the job in bench vice
- Scrap and remove the high spots on the flat surface of the job using flat scraper Fig1.
- Wipe off the scraped surface with soft cloth to remove burrs.
- Again, place the scraped surface on prussion blue applied surface and move forward and backward and notice the high spot marks.

Fig 1



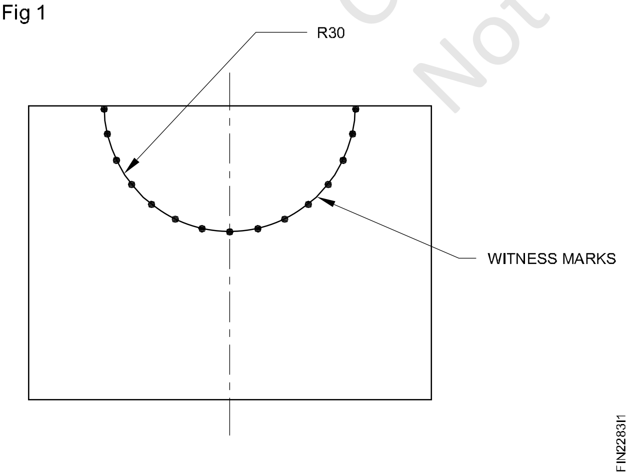
- Repeat the scraping process untill the prussion blue spotted marks spread over the entire surface of the job.
- Wipe off the scraped surface with soft cloth.
- Apply thin coat of oil and pressure it for evaluation.

— — — — — — — —

TASK 2: **Scraping on curved surface**

- Check the raw material for its size.
- File metal to size 90x48x18 mm maintaining flatness and squareness.
- Check the size with vernier caliper.
- Apply marking media, mark and punch as shown in Fig 1.

Fig 1



- Chain drill holes remove excess material as shown in Fig 2.
- Cut and remove the hatched portion of chain drilled holes excess metal using web chisel and ball pein hammer as shown in Fig 3.

Fig 2

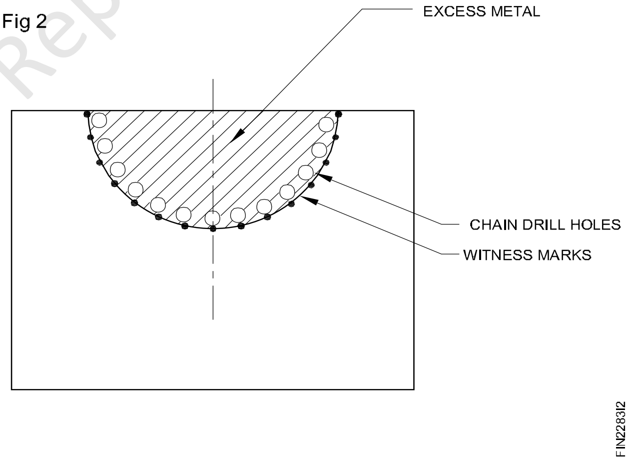
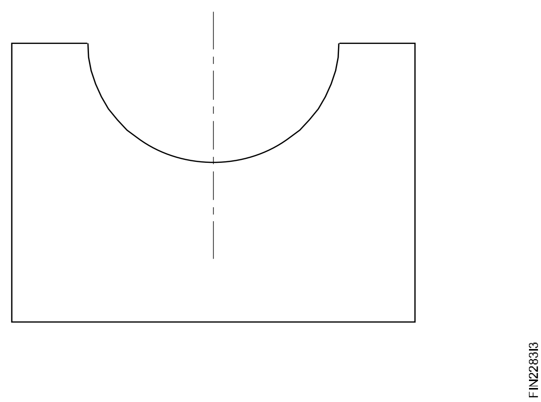


Fig 3



- File curved surface with half round file and check the curved profile with template.
- Hold the round test bar in bench vice along with aluminium vice clamps.
- Apply thin coat of prussion blue on the one end of cylindrical surface of test bar.
- Place the curved surface of the job on prussion blue applied test bar and rotate back and forth.
- Notice the blue spotted marks on curved surface.
- Hold the job in bench vice.
- Scrap and remove the high spots on the curved profile surface using half round scraper.
- Wipe off the scraped surface with soft cloth to remove burrs.
- Again, apply prussion blue on the test bar and place the curved scrapped surface on test bar and rotate back and forth.
- Repeat the scrapping process untill the prussion blue spotted marks spread over the entire curved surface of the job.
- Wipe off the scraped surface with soft cloth.
- Apply thin coat of oil and presserve it for evaluation.

Skill sequence

Scraping curved surfaces

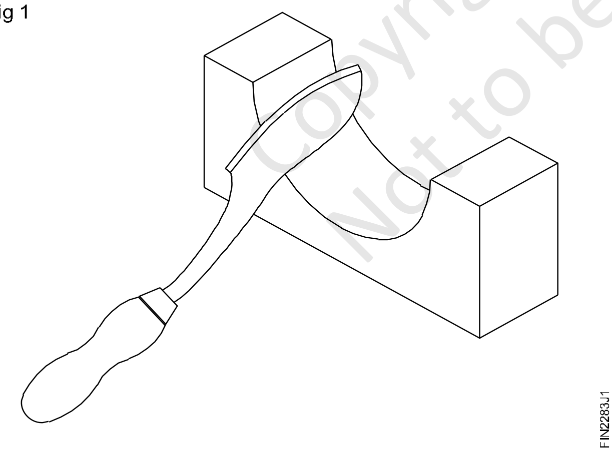
Objectives: This shall help you to
- **scrap and test curved surfaces.**

A half round scraper is the most suitable scraper for scraping curved surfaces. This method of scraping differs from that of flat scraping.

Method

For scraping curved surfaces the handle is held by hand in such a way as to facilitate the movement of the scraper in the required direction. (Fig 1)

Fig 1



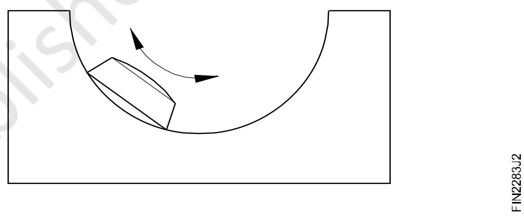
Pressure is exerted with the other hand on the shank for cutting.

Rough scraping will need excessive pressure with longer strokes.

For fine scraping, pressure is reduced and the stroke length also becomes shorter.

Cutting action takes place both on forward and return strokes. (Fig 2)

Fig 2



During the forward movement one cutting edge acts, and on the return stroke, the other cutting edge acts.

After each pass, change the direction of cutting. This ensures a uniform surface. (Figs 3 & 4)

Fig 3

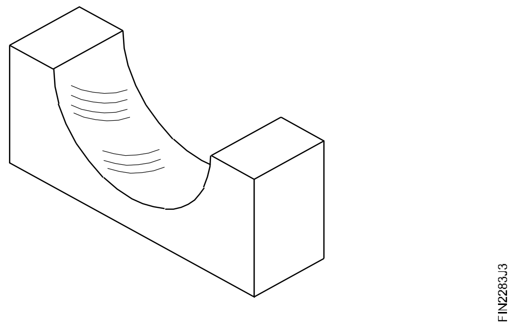
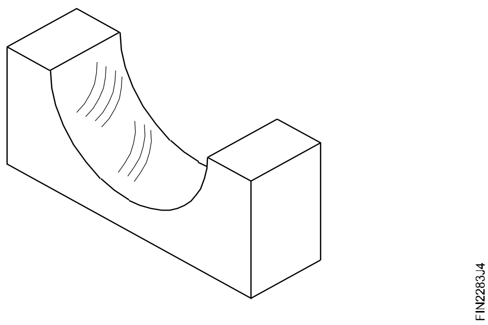


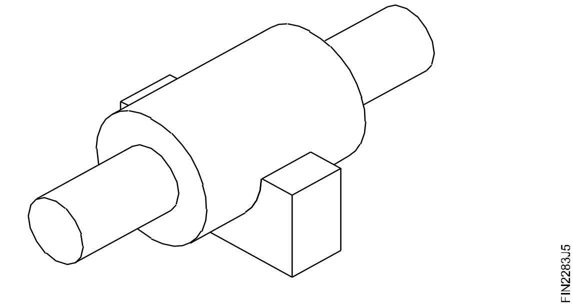
Fig 4



Use a master bar to check the correctness of the surface being scraped. (Fig 5)

Apply a thin coating of Prussion blue on the master bar to locate the high spots.

Fig 5



Sharpening a flat scraper

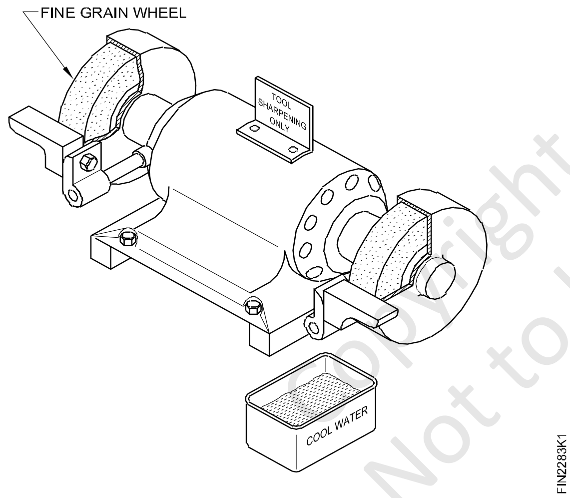
Objectives: This shall help you to
- **sharpen a flat scraper by grinding and honing.**

Flat scrapers are sharpened by grinding the cutting edge and honing both faces.

To avoid overheating while grinding, use wet wheel grinding or ensure that there is a cooling arrangement for the pedestal/bench grinder.

Select a grinding wheel with fine grain. (Fig 1)

Fig 1

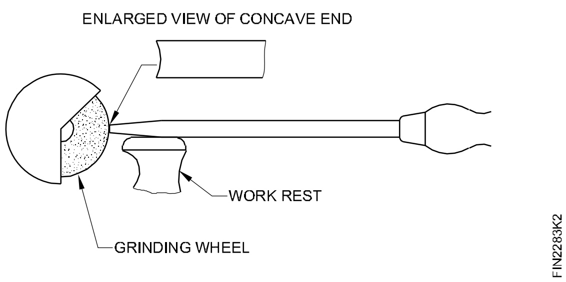


Soft grade aluminium oxide grinding wheel with large diameter gives best results.

Check for gap between the work-rest and the grinding wheel, and adjust, if neessary.

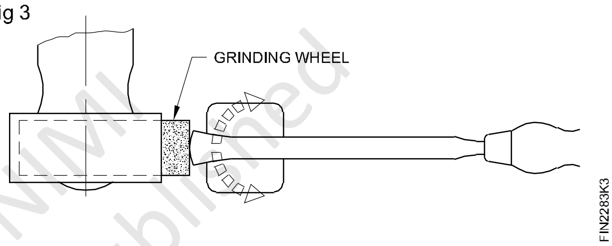
For grinding the cutting edges, hold the scraper horizontal and flat on the tool rest. (Fig 2)

Fig 2



Move the scraper in an arc to provide a slightly concave surface on the cutting edge. (Fig 3)

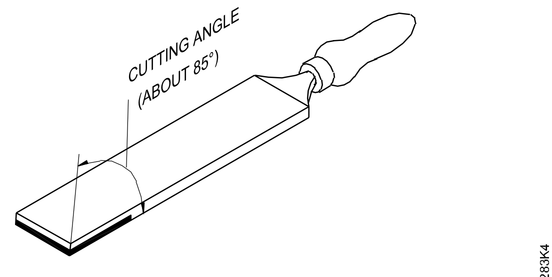
Fig 3



If the scraper is carbide-tipped use silicon carbide or diamond wheels. (Fig 4)

The cutting edges sharpened by grinding should be honed. Honing removes grinding marks and provides keen cutting edges.

Fig 4



Use a fine grade aluminium oxide oilstone for honing.

While honing use a lubricant.

Mix light mineral oil with kerosene for preparing the lubricant.

Hone the faces first with a movement as shown in Fig 5.

Then hone the cutting end by placing the scraper in an upright position on the oilstone with a rocking movement. (Figs 6 and 7)

What should be the cutting angle? It should be

- for rough scraping - 60^o
- for final scraping - 90^o.

Fig 5

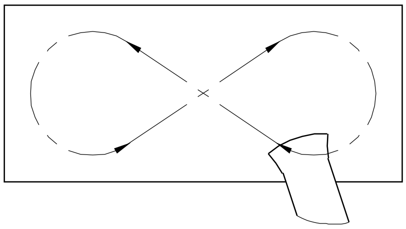


Fig 6

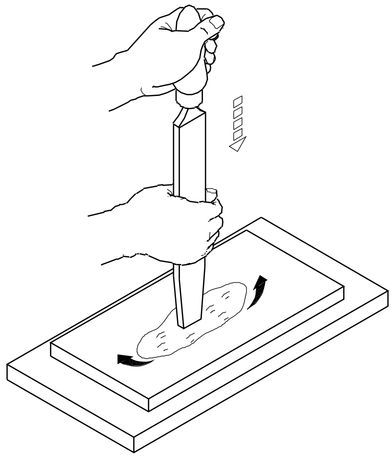
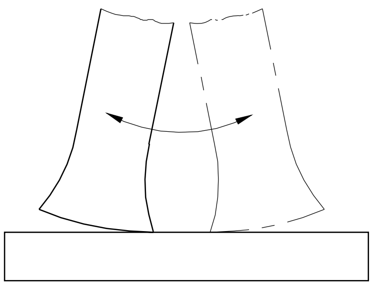


Fig 7



Sharpening half round scrapers

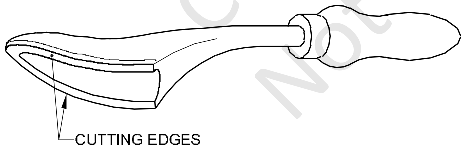
Objectives: This shall help you to
- **sharpen a half round scraper.**

Scrapers are usually re-sharpened on oilstones. When cutting edges are badly damaged, they are ground on pedestal grinders.

Sharpening half round scrapers

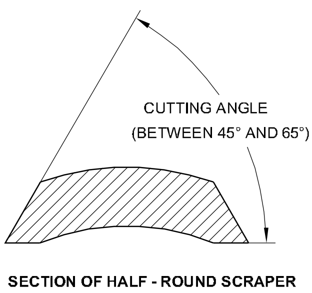
Half round scrapers have two cutting edges on the rounded back. (Fig 1)

Fig 1



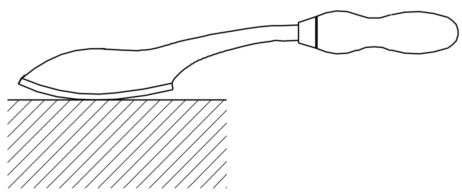
The cutting edges are formed by the bottom surface, and the flat surfaces are ground on the rounded back of the scraper. (Fig 2)

Fig 2



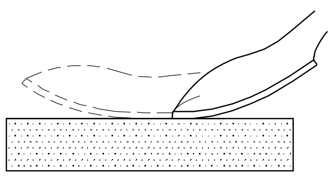
Grind the bottom surfaces with a slight curve. This helps the cutting edges to make point contact on the surfaces being scraped. (Fig 3)

Fig 3



Rub the bottom surface with a rocking motion on the olistone for re-sharpening. (Fig 4)

Fig 4

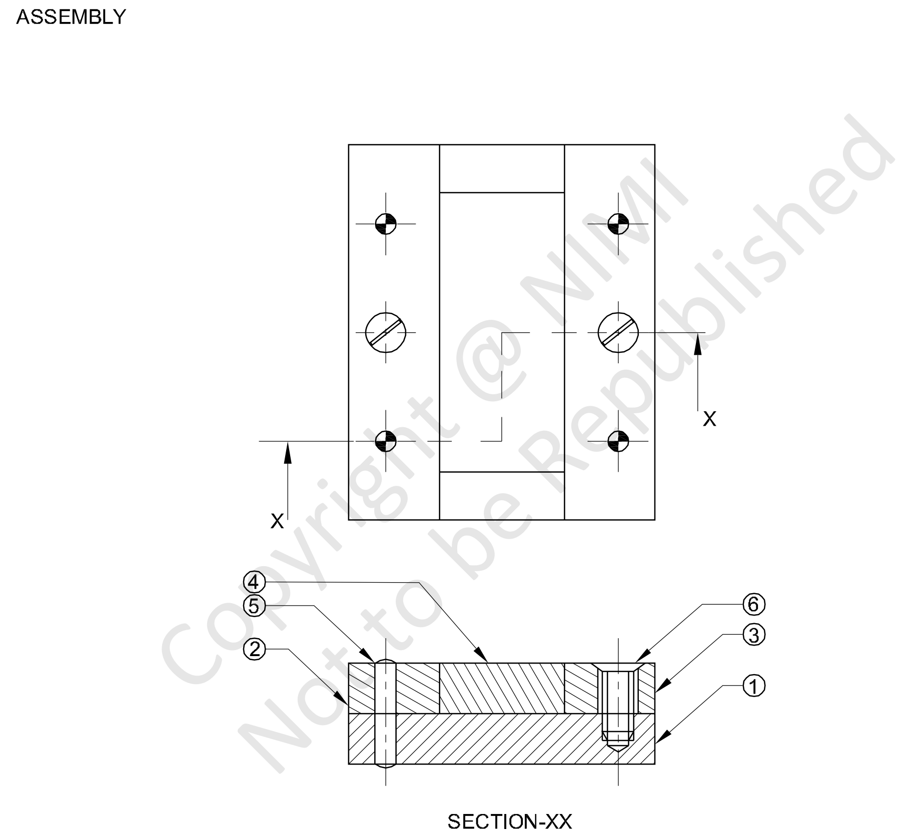


When the cutting edge is blunt it can be re-sharpened by grinding the bottom surface.

As far as possible avoid grinding of the edges. (Flat surface ground on the rounded back.)

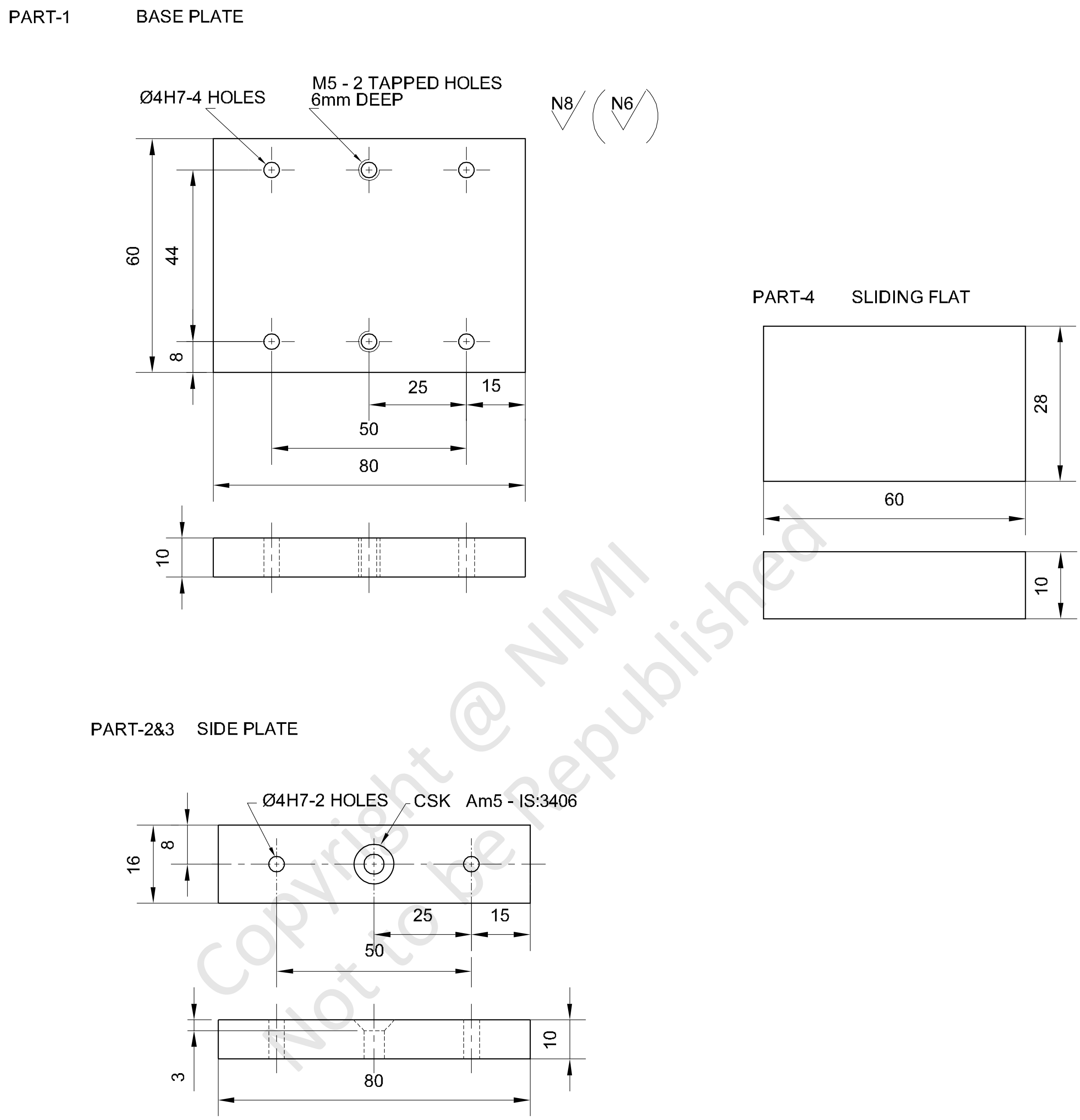
Make and assemble, sliding flats, plain surfaces

Objectives: At the end of this exercise you shall be able to
- **file surfaces to flat and square to the accuracy of ± 0.04 mm**
- **mark dimension lines as per drawing**
- **prepare all the parts as per drawing**
- **drill dowel pin holes, counter sink screw holes**
- **assemble and slide flat in plain surfaces.**



2	M5-16	COUNTER SUNK SCREW	-	-	6	-
4	Ø4-20	DOWEL PIN	-	-	5	-
1	65 ISF 12-32	SLIDING FLAT	Fe310	-	4	-
2	20 ISF 12-85	SIDE PLATE	Fe310	-	2&3	-
1	65 ISF 12-85	BASE PLATE	Fe310	-	1	2.2.84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MAKE & ASSEMBLE, SLIDING FLATS, PLAIN SURFACES	TOLERANCE ±0.04 mm	TIME 15Hrs
		CODE NO. FIN2284E1	



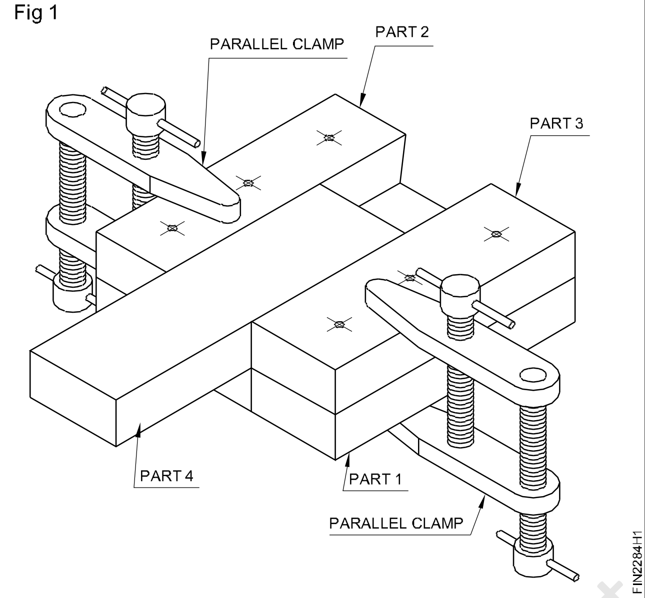
-	-	-	-	-	-	2.2.84
NO.OFF	STOCK SIZE	DESCRIPTION	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BASE PLATE, SIDE PLATES & SLIDING FLAT	DEVIATIONS	TIME
		CODE NO. FIN2284E2	

Job Sequence

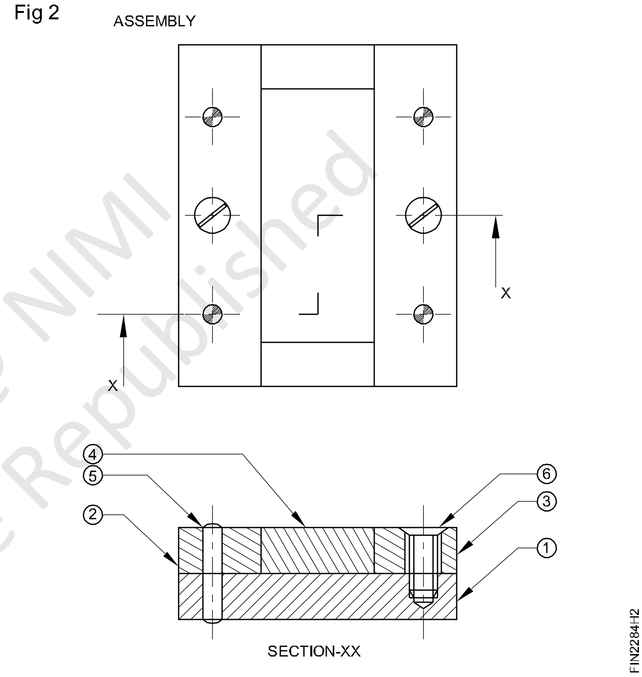
- Check the raw material for its size.
- File job for part 1,2 3 and 4 to size and shape as per drawing.
- Apply marking media on part 2 and 3 and mark to locate the dowel pin holes, countersink screw holes as per drawing.
- Assemble and clamp part 1,2 3 and 4 together in drilling machine table with parallel clamps as shown in Fig 1.

Fig 1



- Fix Ø 3.8 mm drill in drilling machine spindle through drill chuck and drill through hole.
- Fix Ø 4 mm hand reamer in tap wrench and ream the drilled hole to fix Ø 4 mm dowel pin without disturbing the assembly setting.
- Clean the reamed hole and insert Ø 4 mm dowel pin.
- Similarly, drill holes for other 3 dowel pin holes one by one and ream the drilled holes one by one and fix the dowel pins without disturbing the assembly.
- Fix Ø 4.2 mm drill in drilling machine spindle through drill chuck and drill holes for tap drill holes for fixing counter sink screws in assembly without disturbing the setting.
- Seperate the assembly parts 1,2 3,4 and chamfer the tapping holes both ends in part 1 using countersink tool.
- Hold part 1 in bench vice.
- Drill free hole Ø 5.5 for countersink screw on part 2and 3 and countersink the hole to seat ountersink head screw .
- Cut internal thread using M5 hand tap and tap wrench.
- Clean the thread without burrs
- Assemble part 1, 2,3 and 4 as per job drawing along with dowel pins and countersink screws.
- Fit and slide part 4 in the assembly as shown in Fig 2.

Fig 2



- Disassemble all the parts from assembly.
- Finish file on the surface of part 1,2,3,4 and remove burrs in the corners of the job.
- Re-assemble all the parts together as per job drawing.
- Apply thin film of oil and preserve it for evaluation.

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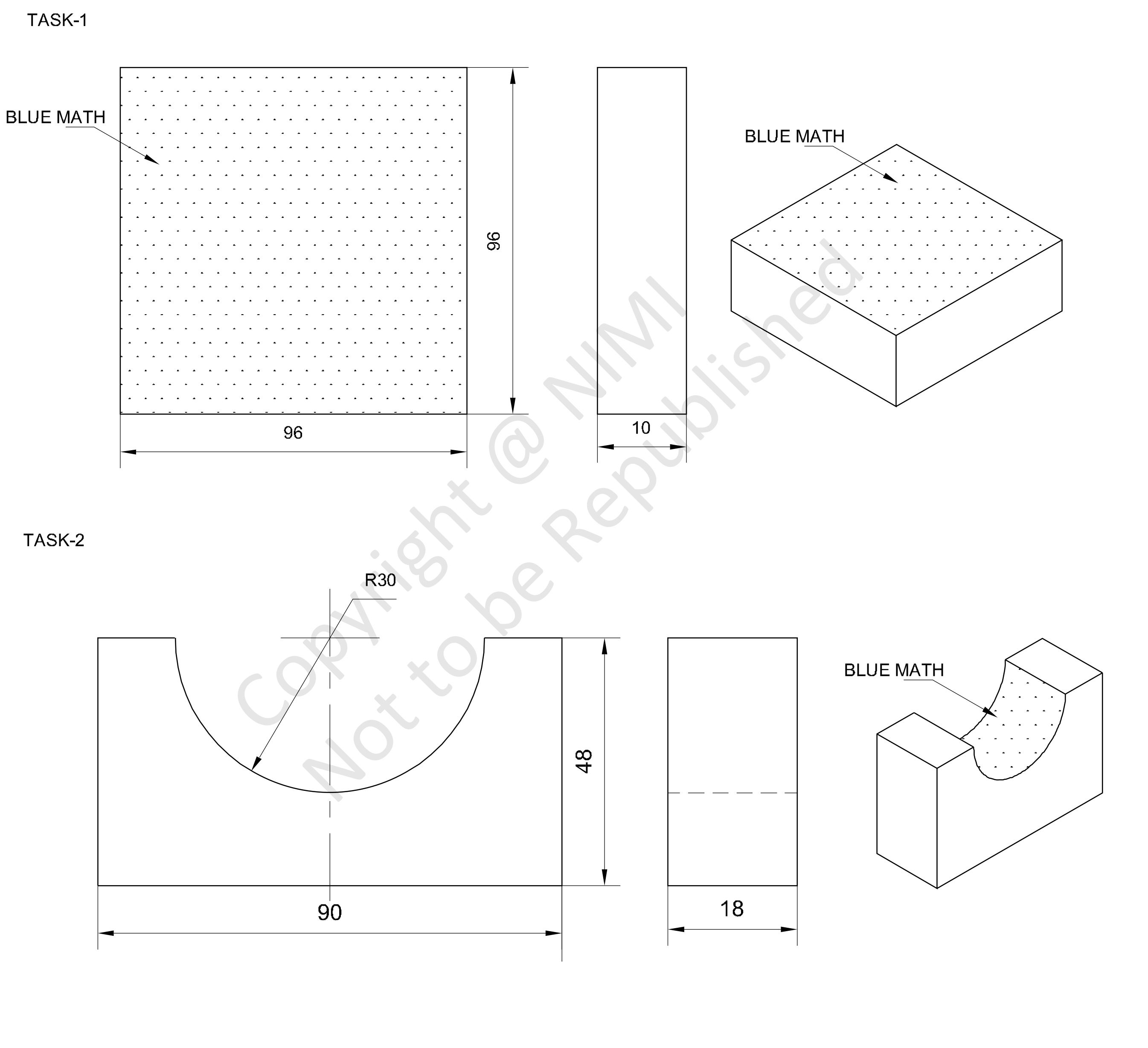
Check for blue math of bearing surfaces - both flat and curved surfaces by whitworth method

Objectives: At the end of this exercise you shall be able to
- **apply prussion blue on surface plate and cylindrical test bar**
- **check the blue math of high spots on flat surface using surface plate**
- **check the blue math of high spots on curved surface using test bar.**



1	-	EX NO: 2.2.83	-	-	TASK-1	2.2.85
1	-	EX NO: 2.2.83	-	-	TASK-2	2.2.85
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	CHECK FOR BLUE MATH OF BEARING SURFACES-BOTH FLAT AND CURVED SURFACES BY WHIT WORTH METHOD				TOLERANCE ±0.04 mm	TIME 5Hrs
					CODE NO. FIN2285E1	

Job Sequence

TASK 1: **Checking blue math on flat surface**

- Use exercise no:2-2-83 Task 1 job for this exercise.
- Clean the surface plate with soft cloth.
- Apply prussion blue evenly on the surface plate.
- Place the job on the surface plate
- Move slightly forward and backward and notice the blue math spreaded over entire the flat surface.

— — — — — — — —

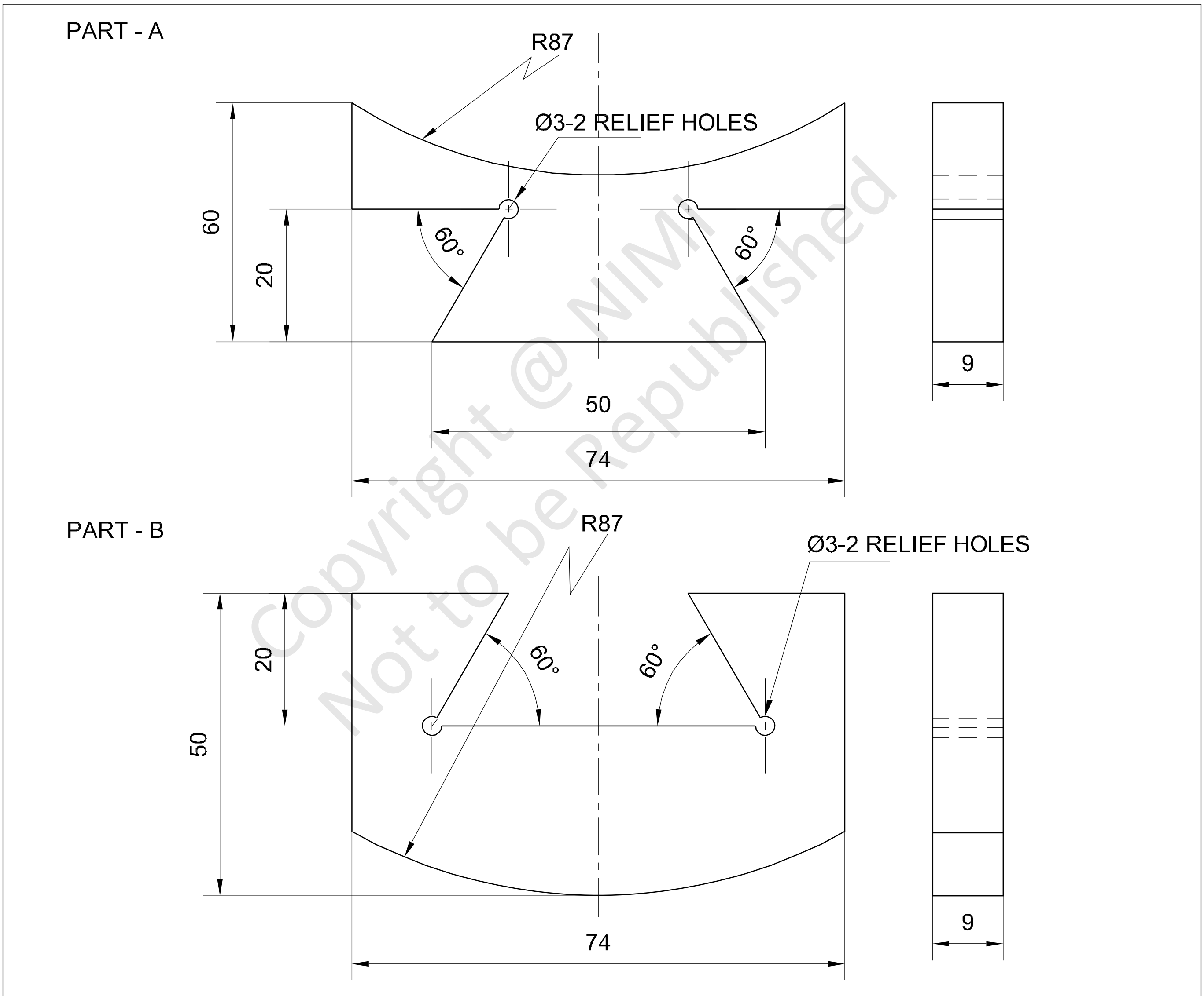
TASK 2: **Checking blue math on curved surface**

- Use exercise no: 2-2-83 Task 2 job exercise.
- Clean the cylindrical test bar with soft cloth.
- Hold the test bar in bench vice along with aluminium vice clamp.
- Apply prussion blue evenly on the curvature of the test bar.
- Place the curved surface of the job on test bar and rotate slightly on back and forth.
- Notice the blue math spreaded over the entire curved surface.

— — — — — — — —

File and fit combined radius and angular surface (accuracy ± 0.5 mm) angular and radius fit

Objectives: At the end of this exercise you shall be able to
- **file flat and parallel surface to an accuracy of ± 0.04 mm**
- **mark dimension lines as per drawing**
- **chain drill, chip to remove excess material**
- **file dovefail and curved profile as per drawing and check the angles with vernier bevel protractor and curved surface with template**
- **fit combined radius and angular surface.**



1	75 ISF 10 - 55	-	Fe310	-	B	2.2.86
1	75 ISF 10 - 65	-	Fe310	-	A	2.2.86
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1 :1	FILE AND FIT COMBINED RADIUS AND ANGULAR SURFACE (ACCURACY±0.5mm), ANGULAR AND RADIUS FIT	TOLERANCE ±0.04mm ANGLE 30 MINUTES	TIME 18Hrs
		CODE NO FIN2286E1	

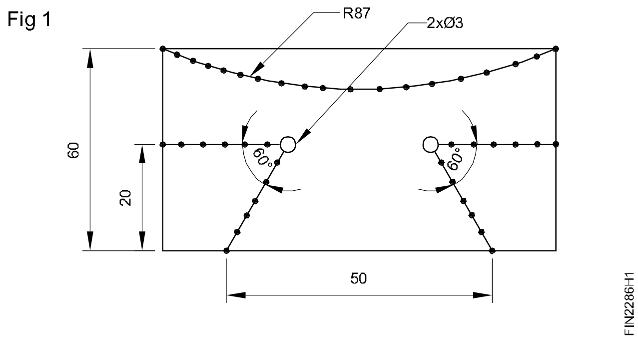
Job Sequence

- Check the raw matel size using steel rule.

PART A

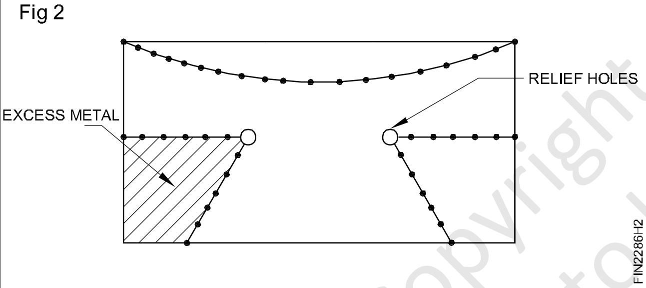
- File and finish to overall size of 74x60x9 mm maintaining parallelism, perpendicularity and to the accuracy of ± 0.04 mm
- Check the size with vernier caliper.
- Apply marking media, mark as per drawing and punch witness marks as shown in Fig 1.

Fig 1



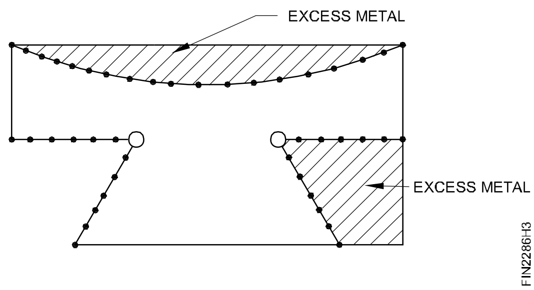
- Drill relief holes Ø 3 mm as shown Fig 2.
- Hacksaw and remove the hatched portion of excess metal in one side as shown in Fig 2.

Fig 2



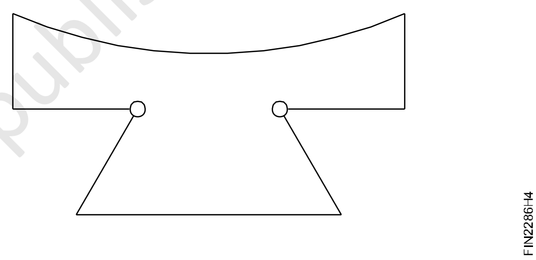
- File to size maintaining accuracy of ± 0.04 mm for linear dimension and 30 minutes accuracy for angular dimesion.
- Check the size with vernier caliper and angle with vernier bevel protector.
- Similarly, cut and remove excess metal in other side and file to size and shape as shown in Fig 3.

Fig 3



- Cut and remove the excess metal in curvature side and file curved profile to size and shape as shown in Fig 4.
- Check the curved profile with template.

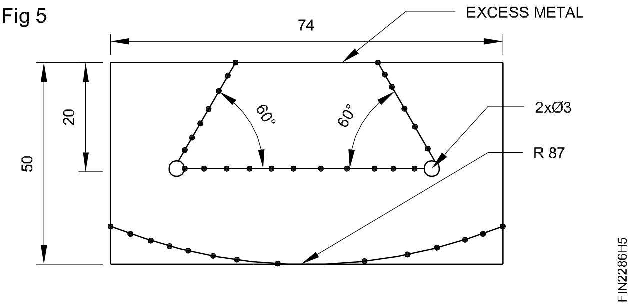
Fig 4



PART B

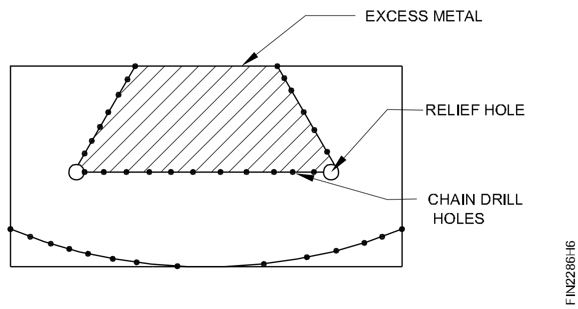
- File and finish to overall size of 74x50x9 mm maintaining parallelism and perpendicularity and to the accuracy of ± 0.04 mm.
- Check the size with vernier caliper.
- Apply marking media, mark as per drawing and punch witness marks as shown in Fig 5.

Fig 5



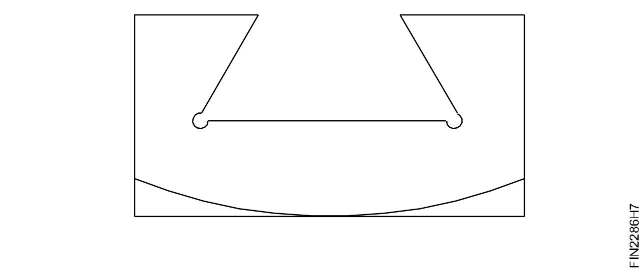
- Drill relief holes Ø 3 mm and drill chain drill holes to remove excess metal as shown Fig 6.

Fig 6



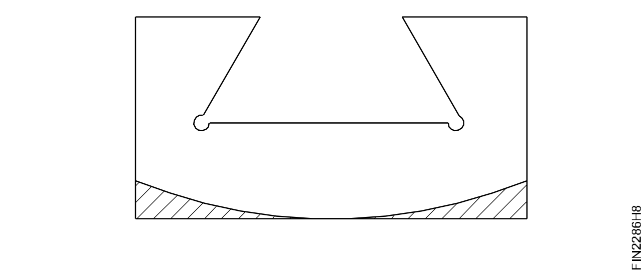
- Hacksaw, chip and remove the hatched portion of excess metal and File the chipped portion to size and shape as shown in Fig 7.

Fig 7



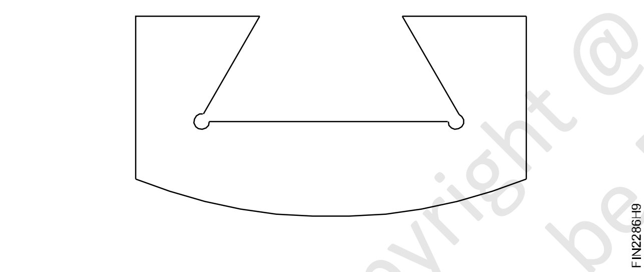
- Hacksaw and remove the hatched portion of excess metal on curved surface shown in Fig 8.

Fig 8



- File the curved portion to size and shape as shown in Fig 9.

Fig 9



- Check the curved profile with template.
- Match part A and B as shown in Fig 10 and 11
- Finish file in part A,B and remove the burrs in all the corners.

Fig 10

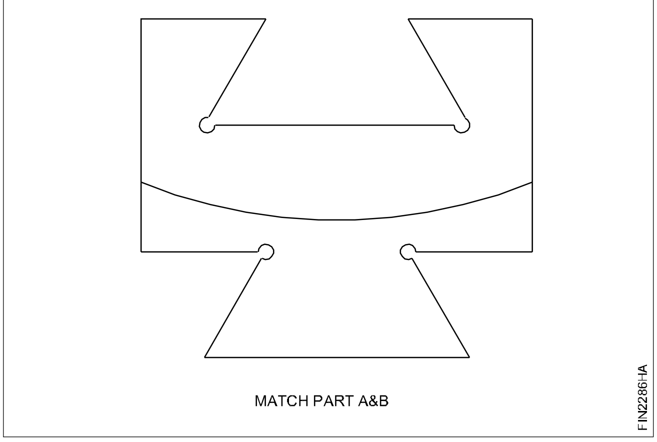
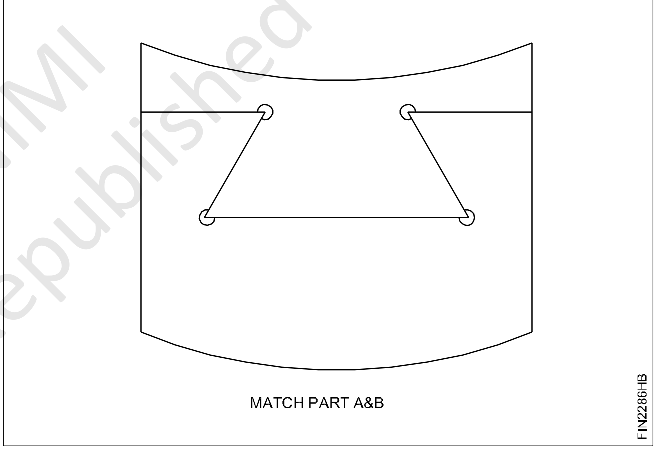


Fig 11



- Apply a little oil and preserve it for evaluation

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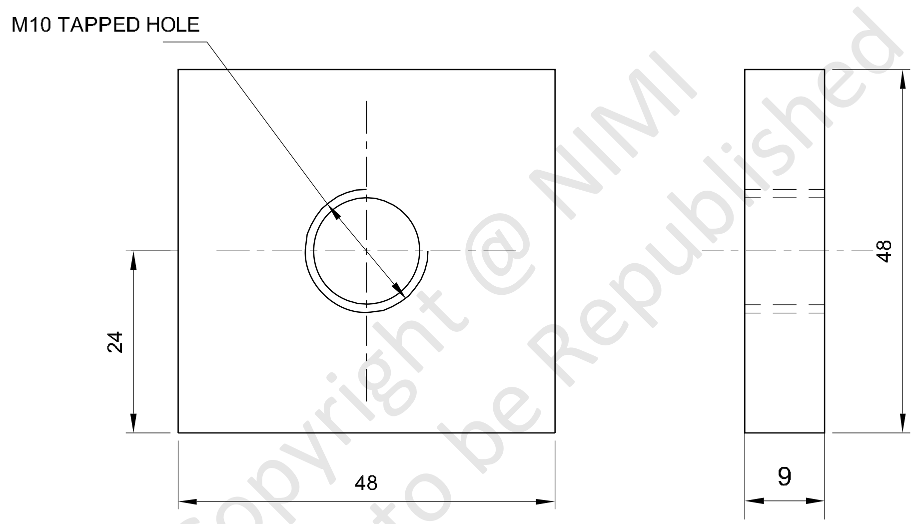
Locate accurate holes and make accurate hole for stud fit

Objectives: At the end of this exercise you shall be able to
- **file surfaces flat and square**
- **determine tap drill size for tapping hole and drill the hole**
- **cut M10 internal thread using tap with wrench**
- **fit stud in the threaded hole.**



NOTE: USE EX NO: 2.1.69 STUD FOR FIT

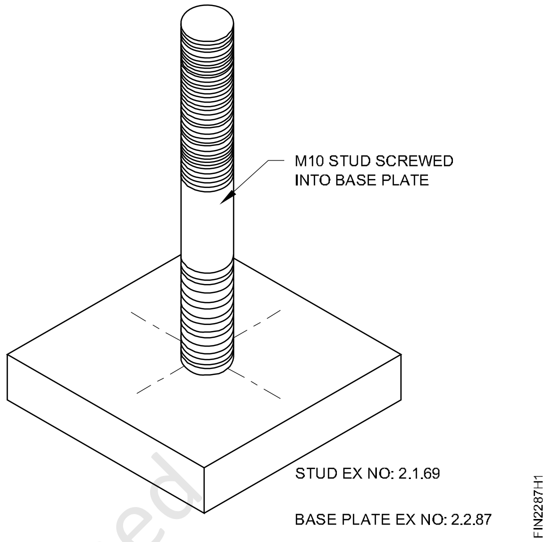
1	50 ISF 10 - 50	-	Fe310	-	-	2.2.87
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1 :1	LOCATE ACCURATE HOLES & MAKE ACCURATE HOLE FOR STUD FIT	TOLERANCE ±0.04mm	TIME 2Hrs
		CODE NO. FIN2287E1	

Job Sequence

- Check the raw material for its size.
- File metal to size 48x48x9 mm maintaining flatness and squareness.
- Check the size with vernier caliper.
- Mark drill hole at the centre of the job as per drawing.
- Determine the tap drill size for M10 tap.
- Hold job in bench vice
- Fix centre drill in drill chuck and drill centre drilling to locate the drill hole centre.
- Similarly, fix Ø 6 mm drill and drill pilot hole.
- Fix Ø 8.5 mm drill and drill through hole for tapping.
- Chamfer on both ends of the drilled hole using countersink tool.
- Hold the job in bench vice.
- Cut M10 internal thread using hand tap and tap wrench.
- Clean the thread to remove the burrs.
- Check the thread with screw pitch gauge.
- Fit stud in the threaded hole Fig 1.
- Apply a little oil and preserve it for evaluation

Fig 1



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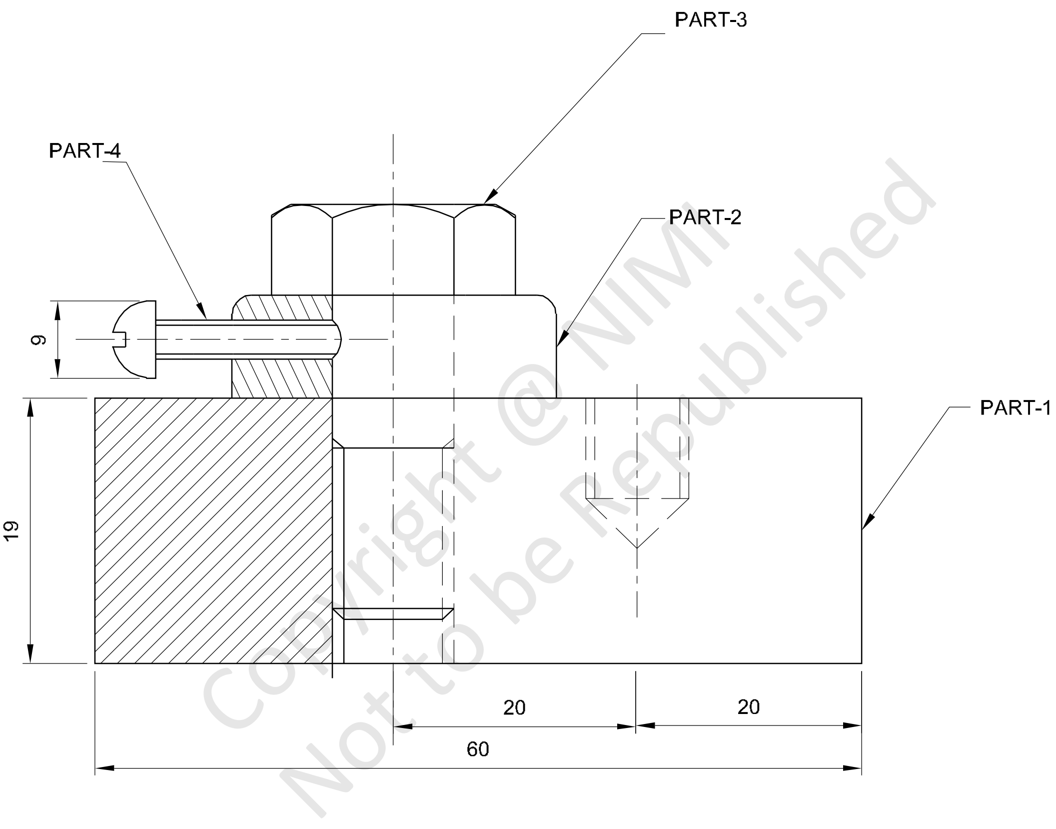
Fasten mechanical components/sub-assemblies together using screws, bolts and collars using hand tools

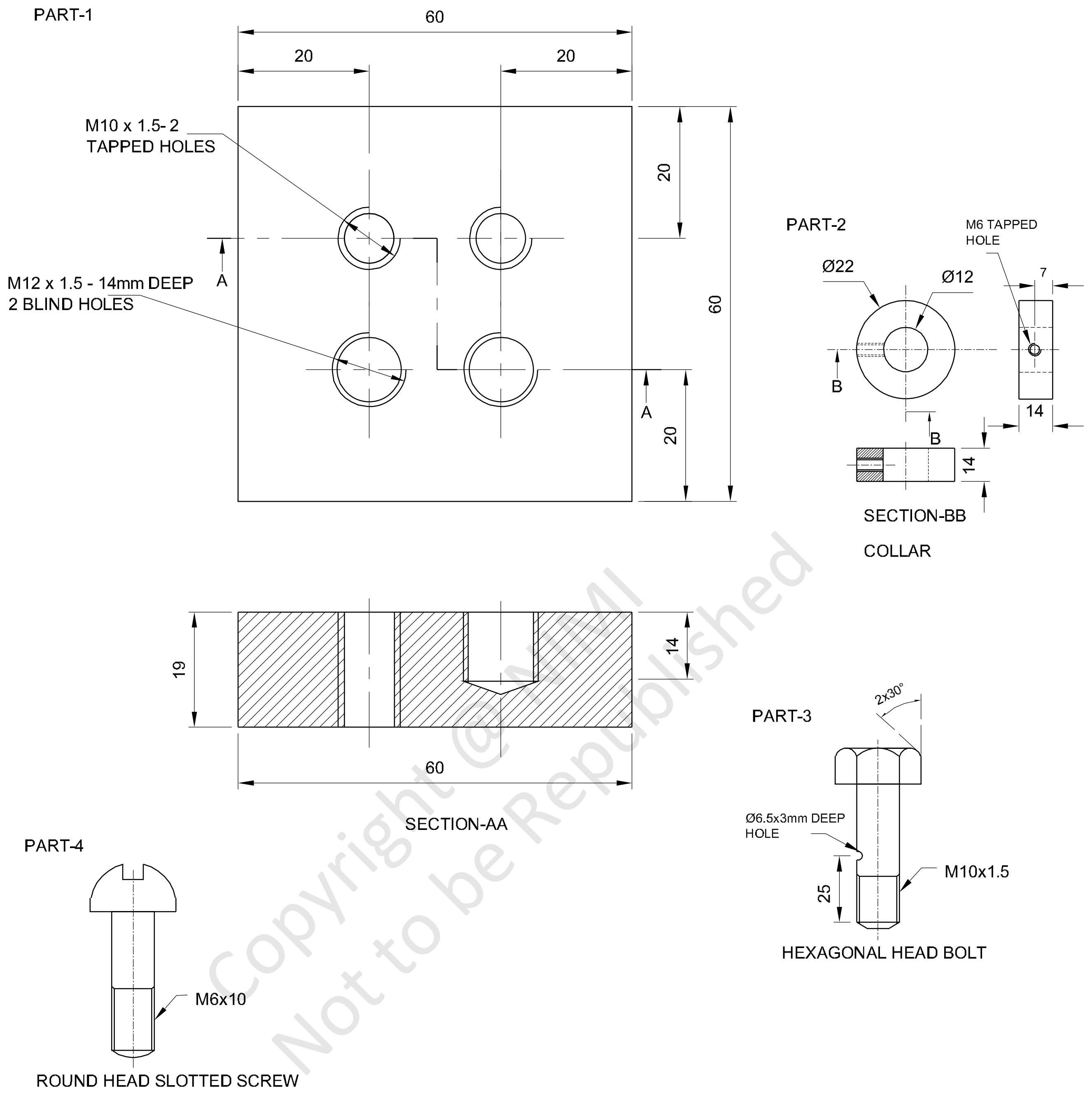
Objectives: At the end of this exercise you shall be able to
- **file surface flat and square**
- **mark drill holes as per drawing**
- **cut M6 internal thread using hand tap and tap wrench**
- **assemble together all the parts as per drawing.**



SUB-ASSEMBLY

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	ROUND HEAD SLOTTED SCREW M6x10	-	Fe310	-	4	2.2.88
1	-	EX NO 2.1.69 PART-2	Fe310	-	3	2.2.88
1	25 ISF15-25	-	Fe310	-	2	2.2.88
1	-	EX NO 2.1.68	Fe310	-	1	2.2.88

SCALE 1 :1	FASTEN MECHANICAL COMPONENTS/SUB-ASSEMBLIES TOGETHER USING SCREWS,BOLTS AND COLLARS USING HAND TOOLS	TOLERANCE ±0.04mm	TIME 5Hrs
		CODE NO. FIN2288E1	



-	–	–	–	–	–	2.2.88
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	SUB-ASSEMBLE MECHANICAL COMPONENTS BOLT,COLLAR,SCREW				TOLERANCE :	TIME :
					CODE NO : FIN2288E2	

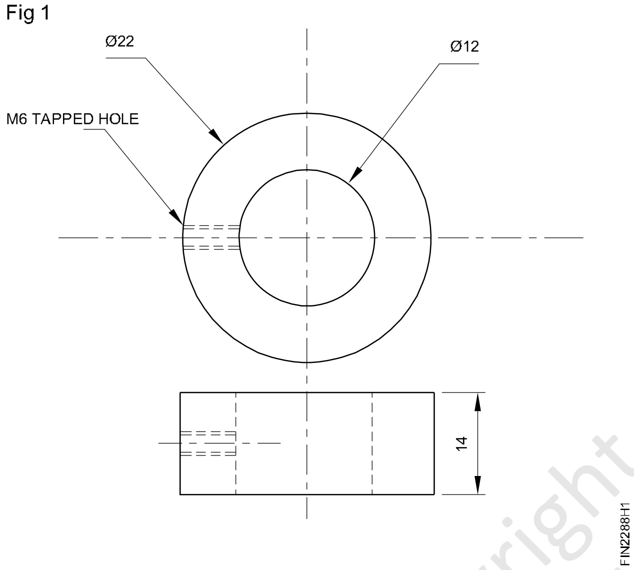
Job Sequence

- Use Ex: No 2.1.68 for part 1 and Ex.No 2.1.69 part 2 for part 3.

Prepare collar: (Part 2)

- Check the raw material size.
- File flatness and squareness
- Mark in collar as per job drawing and punch the hole centre and the outer circumference of collar.
- Drill the centre of hole Ø 10.5 mm and counter sink the drilled hole both sides.
- Hold the job in bench vice and file the circumference of collar to Ø 22 mm and thickness 14 mm.Fig 1

Fig 1

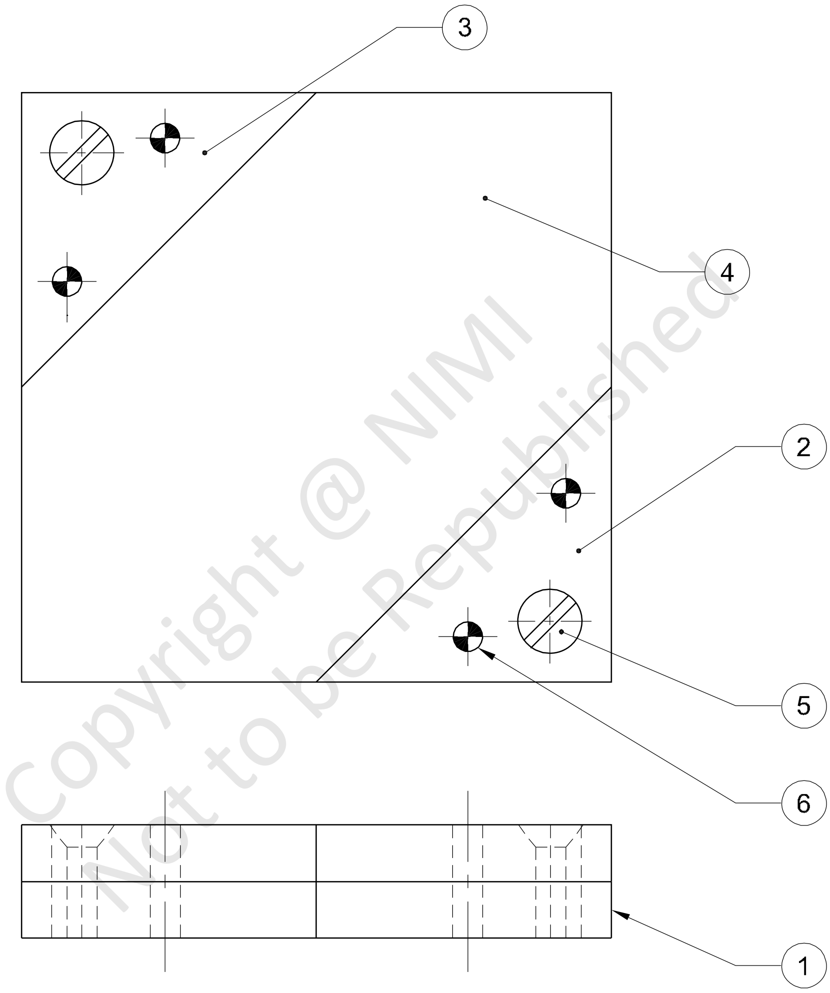


- Check the size with vernier caliper.
- Clean the parts 1,2 and 3.
- Assemble the parts 1 and 2 using hexagonal bolt and tighen the bolt using suitable double ended spanner/ ring spanner.
- Mark the tap drill hole centre on middle of the collar as shown in job drawing
- Set the assembly in drilling machine table using suitable clamping device.
- Make drill hole collar Ø 5.2 mm for M6 tap and drill upto the depth of 3 mm in hexagonal bolt as shown in job drawing.
- Seperate the parts 1,2, and 3.
- Fix counter sink tool in drilling machine and chamfer the Ø 5.2 mm drilled hole.
- Hold the collar in bench vice
- Cut M6 internal thread using hand tap and tap wrench.
- Enlarge the Ø 5.2 mm already drilled hole to Ø 6 mm x 3 mm depth in the hexagonal bolt.
- Re-assemble the parts 1,2 and 3 and tighten the hexagon bolt using suitable double ended spanner / ring spanner.
- Screw the round head slotted screw in collar as shown job drawing and make it tight using suitable screw driver and complete the sub-assemblies.
- Apply thin coat of oil and preserve it for evaluation.

Make sliding fits assembly with parallel and angular mating surface

Objectives: At the end of this exercise you shall be able to
- **file surface flat and parallel to the accuracy of ± 0.04 mm**
- **mark dimension lines as per drawing**
- **file and prepare all the parts for assembly**
- **drill holes for dowel pins and countersink screws**
- **assemble components using dowel pins and counter sink screws**
- **fit and slide the angular mating surface, finish and de-burr.**

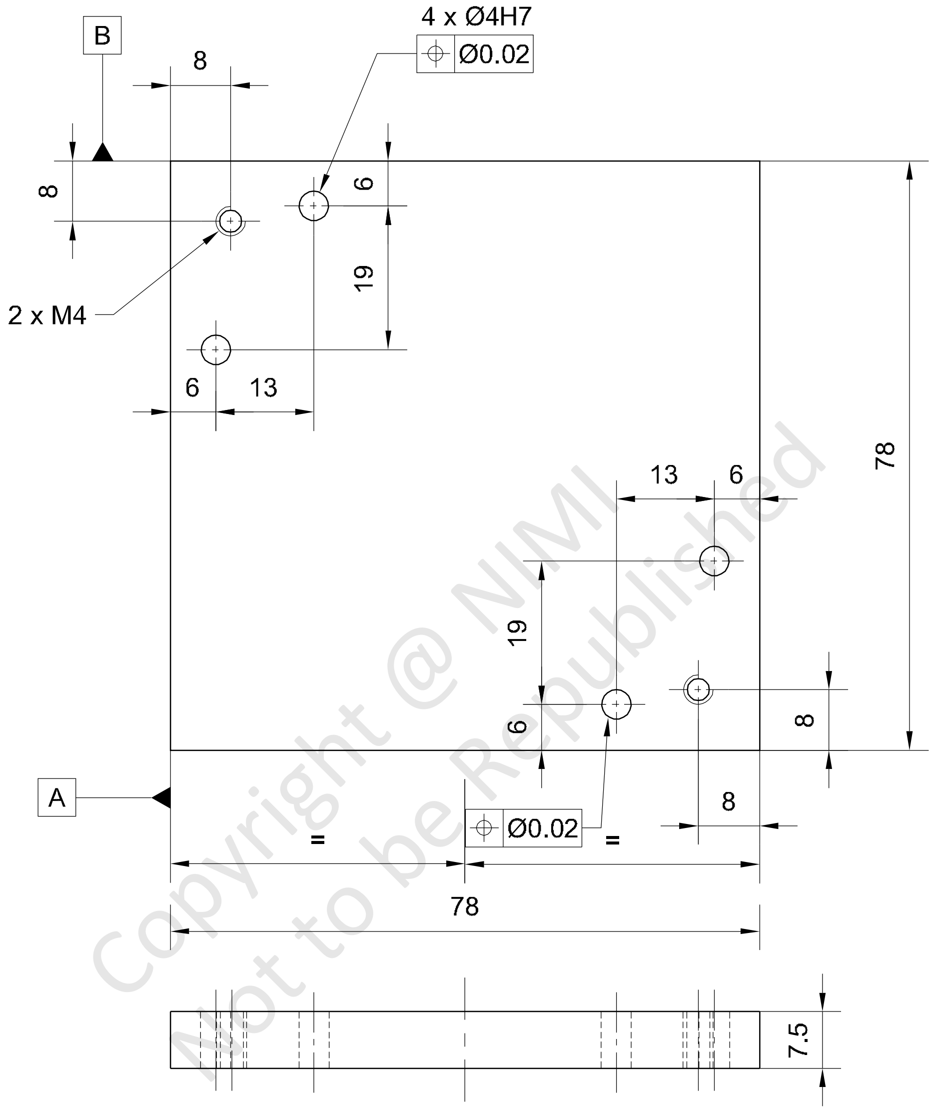
ASSEMBLY



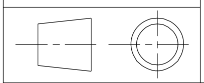
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
4	4h8 x 14 IS:2393	CYLINDRICAL PIN	Std	-	6	-
2	AM4 x 14 IS:1365	CSK HEAD SCREW	Std	-	5	-
1	80ISF8 - 80	-	Fe310	-	4	-
2	40ISF8 - 42	-	Fe310	-	2&3	-
1	80ISF8 - 80	-	Fe310	-	1	2.2.89

SCALE 1:1	MAKE SLIDING FITS ASSEMBLY WITH PARALLEL AND ANGULAR MATING SURFACE.(±0.04mm)	DEVIATIONS: ±0.04mm	TIME 25h
		CODE NO. FIN2289E1	

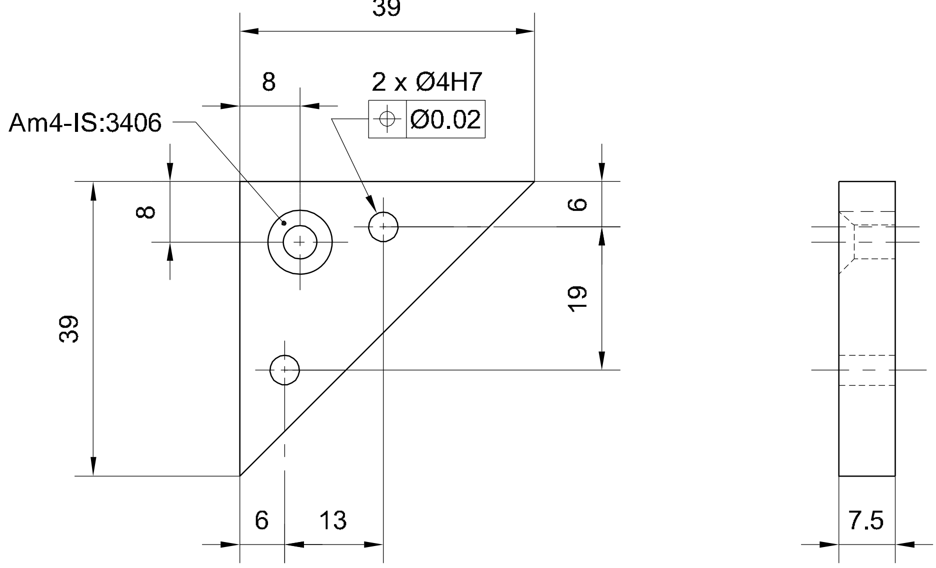
PART-1 BASE PLATE



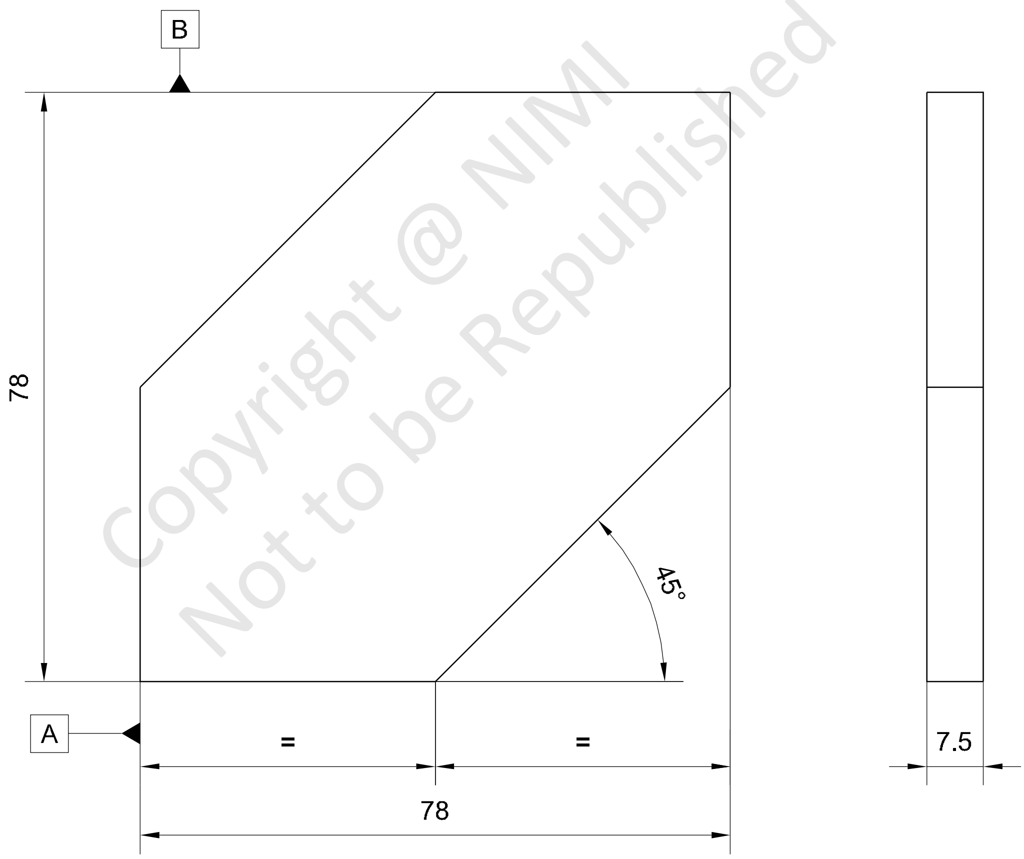
-	-	-	-	-	-	-
-	-	-	-	-	-	2.2.89
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	BASE PLATE	TOLERANCE	TIME
		CODE NO. FIN2289E2	

PART-2&3 SIDE PLATES



PART-4 SLIDING PLATE



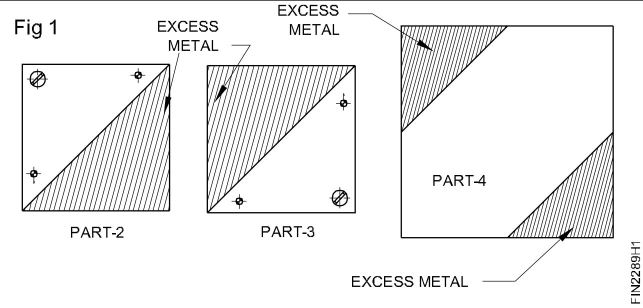
-	-	-	-	-	-	-
-	-	-	-	-	-	2.2.89
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	SLIDE PLATES AND SLIDING PLATE	TOLERANCE	TIME
		CODE NO. FIN2289E3	

Job Sequence

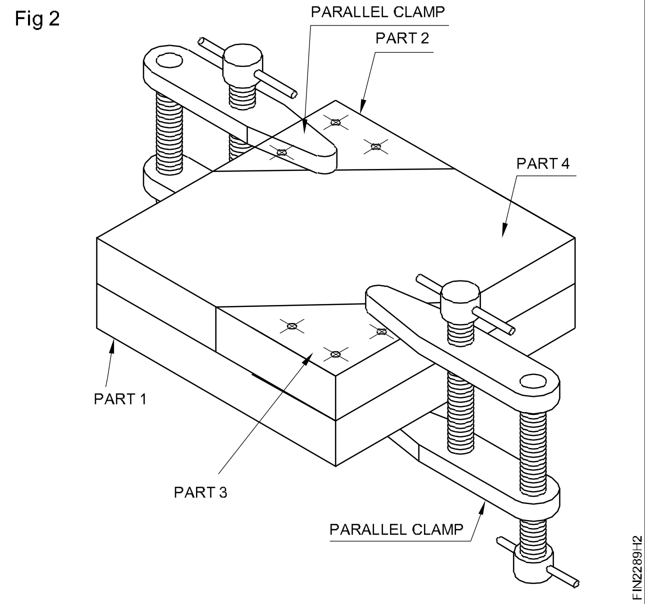
- Check the raw material for its size.
- File the materials for part 1,2,3 and 4 to overall sizes maintaining the accuracy ± 0.04 mm.
- apply marking media on part 2,3 and 4 and mark linear dimensional lines with vernier height gauge and angular lines with vernier bevel protector.
- Punch witness marks on part 2,3 and 4.
- Punch on drill hole marks for dowel pins and counter sink screws assembly using centre punch.
- Cut and remove the excess metal from part 2,3,4 and file to size and shape as per job drawing and check the size with vernier caliper and angles with vernier bevel protractor. (Fig 1)

Fig 1



- Assemble and clamp part 1,2 and 3 together in a drilling machine table with parallel clamps as shown in Fig 2.
- Fix Ø 3.8 mm drill in drilling machine spindle through drill chuck and drill through holes for dowel pin assembly.
- Fix Ø 4 mm hand reamer with tap wrench and ream the drilled hole to fix Ø 4 mm dowel pins without disturbing the assembly setting.
- Clean the reamed hole with soft cloth and insert Ø 4 mm dowel pin.

Fig 2



- Similarly, drill for other dowel pin holes one by one and ream drilled holes to fix Ø 4 mm, 3 dowel pins, one by one without disturbing the assembly setting.
- Determine tap drill size for M4 internal thread
- Fix Ø 3.5 mm drill in drilling machine spindle through drill chuck and drill tap drill two holes as shown in job drawing.
- Seperate the assembly part 1,2,3 and 4.
- Fix counter sink tool in drilling machine and chamfer in both ends of drilled holes to cut internal thread in part 1.
- Hold the part 1 in bench vice and cut internal thread using M4 tap and tap wrench.
- Fix counter sink tool and counter sink the drilled holes in part 2 and 3 to seat the counter sink head screws.
- Finish file on part 1,2,3, 4 and remove burrs in all corners of the job and assemble the parts all together using dowel pins,counter sink screws as shown in job drawing.
- Apply a thin coat of oil and preserve it for evaluation.

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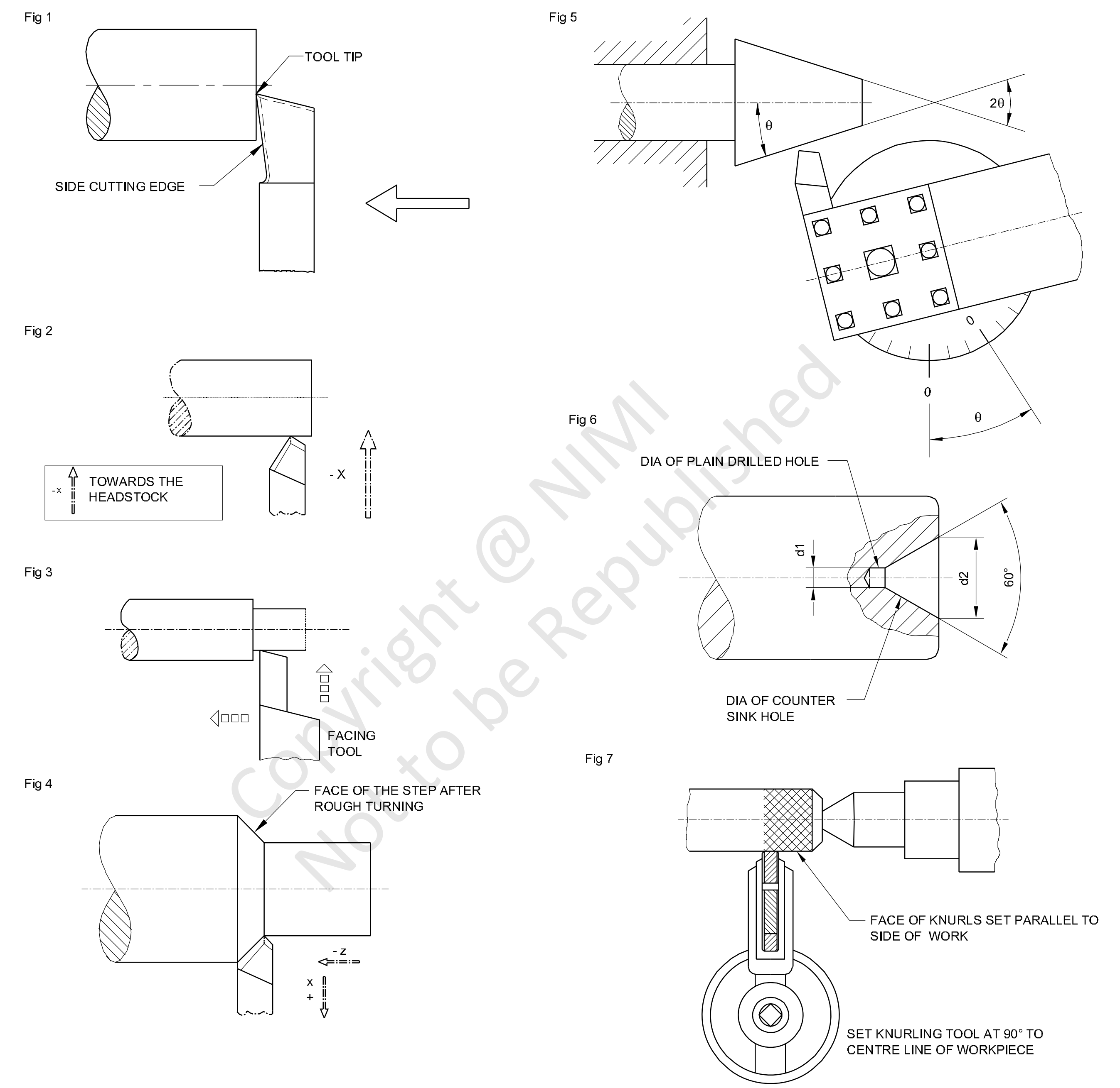
Lathe operations

Objective: At the end of this exercise you shall be able to
- **record the different lathe operations in table 1.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
–	–	–	–	–	–	2.3.90

SCALE : NTS	LATHE OPERATIONS	TIME
		TOLERANCE
		CODE NO. FIN2390E1

Note: Instructor shall demonstrate to the trainees regarding the different lathe operation performed in lathe.

Record the lathe operations in Table 1

TABLE 1

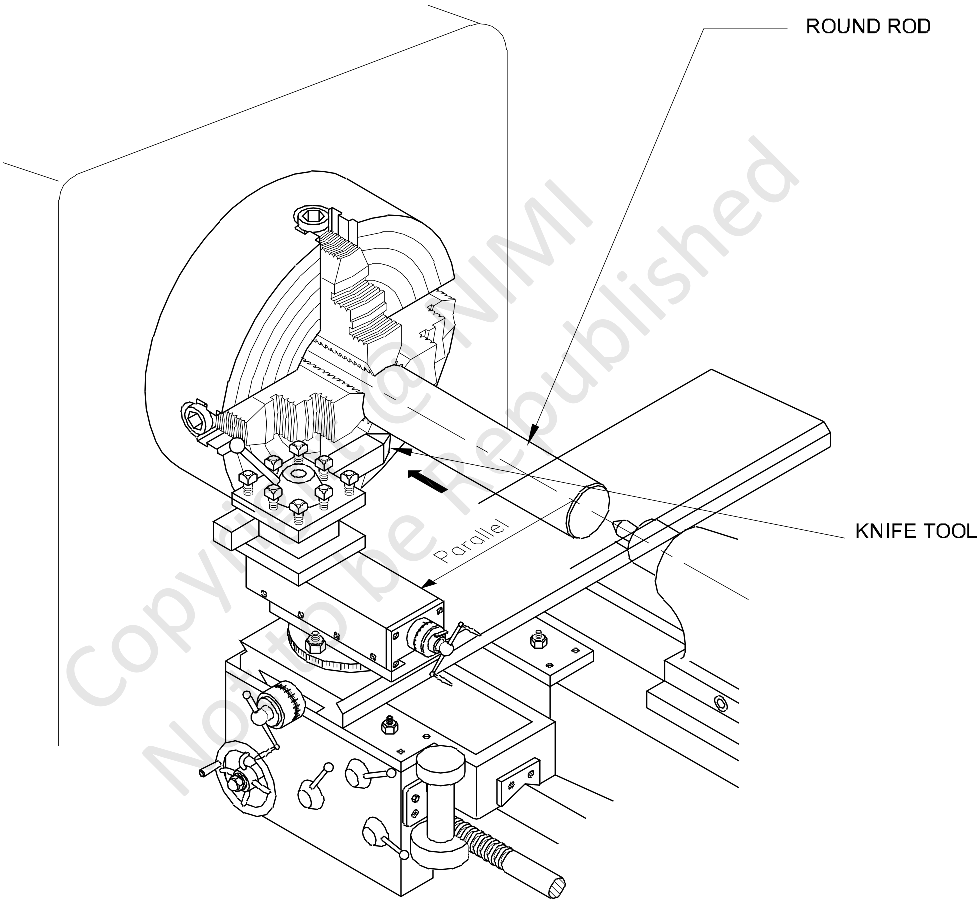
Fig.No.	Name of the operation
1	
2	
3	
4	
5	
6	
7	

Get it verified by your instructor.

— — — — — — —

True job on four jaw chuck using knife tool

Objectives: At the end of this exercise you shall be able to
- **set the round rod/job in four jaw chuck**
- **true the round rod/job using knife tool.**



1	Ø50-100	–	Fe310	–	–	2.3.91
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE :NTS	TRUE JOB ON FOUR JAW CHUCK USING KNIFE TOOL	TIME : 5 hrs
		TOLERANCE : ±0.04mm
		CODE NO. FIN2391E1

Job Sequence

- Open one jaw by chuck key.
- Turn the chuck and open the opposite jaw
- Open all jour jaws approximately more than job diameter
- Keep the job inside the jaws
- Make jaws close and hold the job
- Check the job trueness by knife tool.
- Tighten all the jaws.
- Check the truness of the job by rotating the chuck in neutral position using knife tool.
- Knife tool should touch the job evenly.
- Check once again for the true running of the job.

Skill Sequence

Truing work in a four jaw chuck with the help of a surface gauge

Objective: This shall help you to

- **true a round rod in a four jaw independent chuck with the help of a surface gauge.**

If truing is not done before turning, the following will be the results.

Uneven load on the cutting tool.

For the same depth more metal will be removed from the out of centre portion.

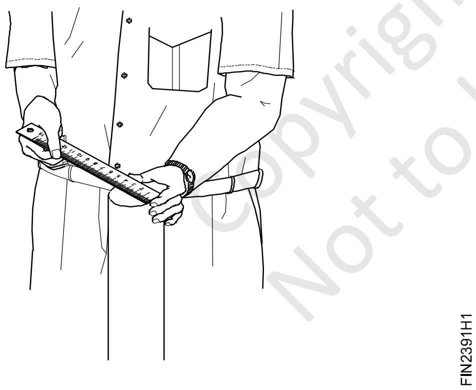
Surface turned may not be cylindrical.

During truing

Keep the main spindle in a neutral position.

Measure the job diameter with an outside caliper or with a steel rule. (Fig 1)

Fig 1



Position the four jaws of the independent chuck, equidistant from the centre. The distance between the inner face of the opposite jaws is equal to the diameter of the work. (Fig 2)

Open the adjacent jaws sufficiently enough to insert the work. (Fig 3)

Place the work inside the chuck, keeping sufficient portion outside the chuck for turning, and tighten the two adjacent jaws, enough to grip the work.

Fix the knife tool on the bed-ways close to the chuck.

Adjust the tool to make its tip move close to the top or side portion of the work with a minimum gap.

Fig 2

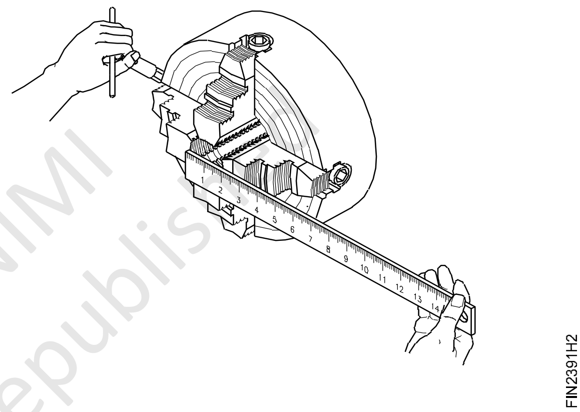
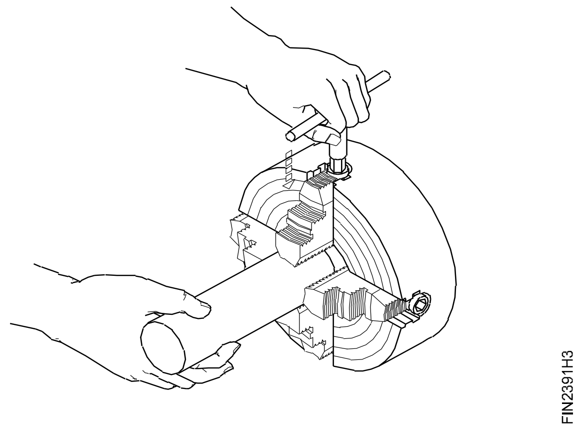
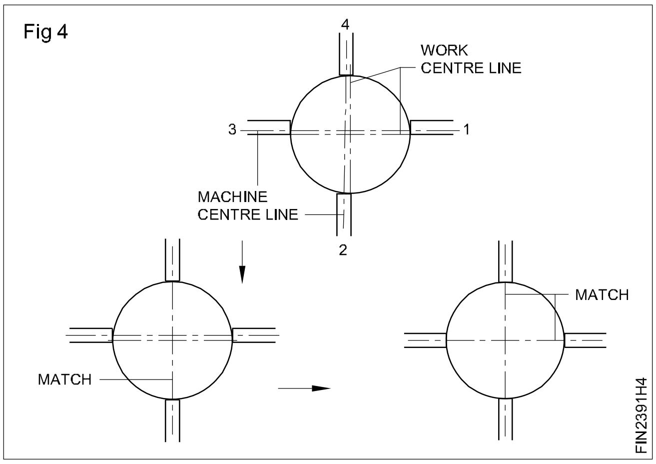


Fig 3

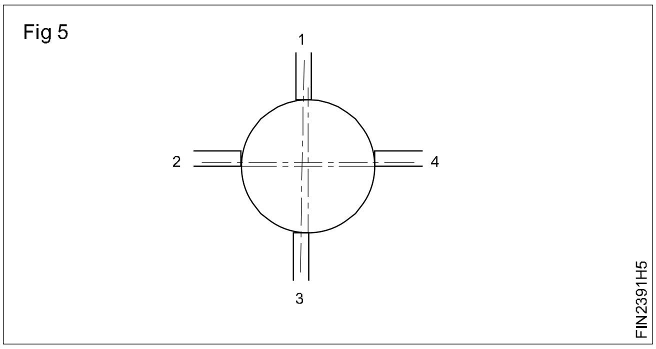


Rotate the chuck by hand and observe the gap between the tool and work surface for the position of the two opposite jaws.

Open the jaw slightly where the gap is more, and tighten the opposite jaw. (Fig 4).



Repeat until the gap is the same. (Fig 5)



Repeat the above sequences for the other set of opposite jaws.

Bring the tool point tip closer to the work surface.

Rotate the chuck by hand and observe the gap.

Engage the spindle levers at about 250 rpm and run the machine.

Touch the tool point on the job.

If the line on the job is uniform tighten the jaw.

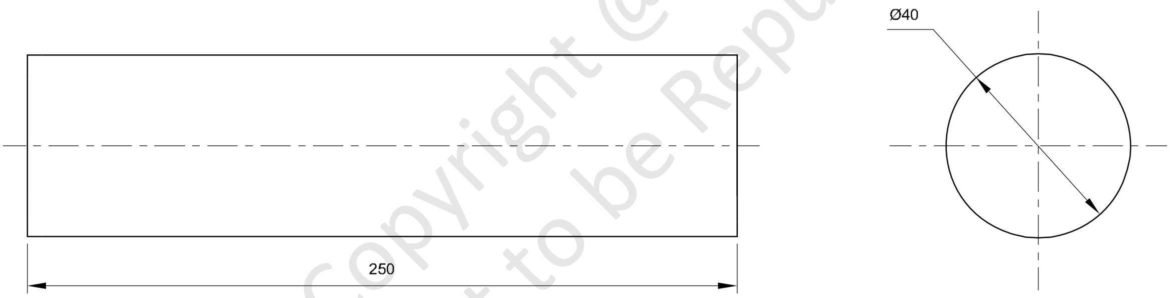
Repeat till a uniform line is formed.

Finally, tighten the opposite jaws with the same amount of pressure.

Check once again for the true running of the work.

Face both the ends for holding between centres

Objectives: At the end of this exercise you shall be able to
- **set the job on a four jaw chuck**
- **set the tool on the tool post**
- **face the job**
- **measure the length with vernier caliper.**



1	Ø40 X 260	–	Fe310	–	–	2.3.92
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	FACE BOTH THE ENDS FOR HOLDING BETWEEN CENTERS	DEVIATIONS : ± 0.04mm	TIME : 9Hrs
		CODE NO. FIN2392E1	

Job Sequence

- Check the raw material for its size.
- Hold the job in a four-jaw independent chuck with 25 mm overhang and true it.
- Set the R.H. facing tool in the tool post.
- Set the R.P.M.
- Face one end of the work.
- Mark the job 250mm long and punch witness marks on the circumference.
- Reverse the job, clamp it in the chuck and true it again.
- Set the spindle speed closer to 318 revolution per minute.
- Face the length up to the half punch mark level and maintain 250 mm long.
- deburr and check the job.

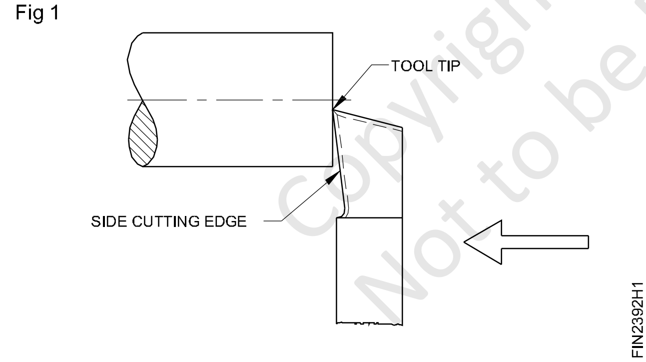
Skill Sequence

Finish-facing the work with a right hand facing tool

Objective: This shall help you to
- **finish-facing the work using a right hand facing tool.**

When more metal is to be removed on the face of work, we prefer to do rough facing by an L.H. facing tool or a L.H. roughing tool, feeding the tool from the periphery of the work towards the centre. Finish-facing is done to get a better surface finish on the face of the work by removing the rough facing. The normal R.H. facing tool, having its cutting edge straight, may be kept slightly inclined to the face of the work during facing. A tool, having its cutting edge itself ground at an angle, may be used. (Fig.1)

Fig 1



The procedure of the finish-facing the work with such a tool is given in sequence below.

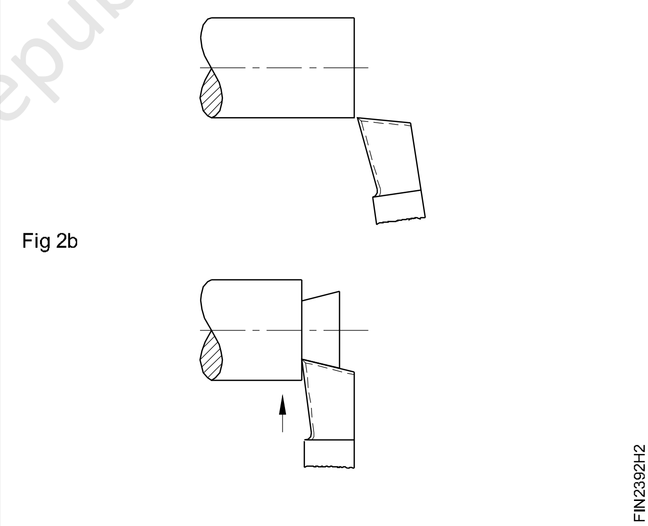
Hold the tool in the tool post to the correct centre height with its axis at right angles to the axis of the work and with a minimum overhang.

Set the machine to about 500 rpm. (Calculate the spindle speed by choosing the recommended cutting speed for finish-facing and the mean diameter of the work).

Start the machine and touch the tool point to the work-face by moving cross slide and carriage movement. Move the tool away from the work (Fig 2a) and set the top slide graduated collar to zero, eliminating backlash. Lock the carriage.

Feed the tool about 0.5 mm by the top slide.

Feed the tool towards the centre of the work by the cross-slide till the tool point crosses the centre. (Fig. 2b) Move back the tool to the starting position (Fig. 2a).



Advance the tool by a further 0.5 mm inside the work by the top slide.

Engage the power feed (set at 0.05 mm/rev.) and allow the tool to travel towards the centre of the work, removing the metal.

Repeat the sequence until the required amount of material is removed.

Observe the finish obtained.

— — — — — — —

Using roughing tool parallel turn ± 0.1 mm

Objectives: At the end of this exercise you shall be able to
- **hold the work in lathe chuck**
- **grind RH turning tool**
- **set the turning tool in tool post**
- **set the machine spindle speed for turning**
- **parallel turn the work by hand feed method with various depths of cuts.**

Job sequence

- Hold the work in four jaw chuck.
- Grind and fix RH turning tool and turn ∅36 to maximum length of job with the R.P.M. close to 318.
- Check the diameter by using vernier caliper
- Chamfer the end 3×45° and deburr.
- Reverse the job and hold in four jaw chuck.
- Turn the remaining length to ∅36 mm by parallel turning.
- Chamfer the end and deburr.

1	EX.NO.2.3.92	—	Fe310	—	—	2.3.93
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE :NTS	USING ROUGHING TOOL PARALLEL TURN ± 0.1mm.				DEVIATIONS : ± 0.1mm	TIME : 10Hrs
					CODE NO. FIN2393E1	

Skill Sequence

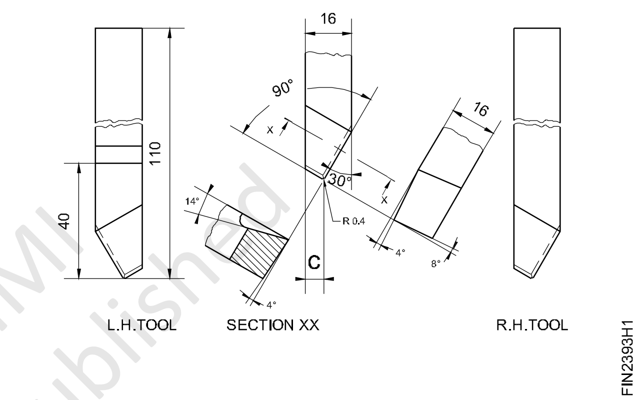
Rough turning tool grinding

Objective: This shall help you to

- **grind rough turning tool with various angle.**

- Rotate the wheel by hand and observe for free rotation.
- Check the grinding wheels for true running.
- Wear goggles.
- Dress the wheels by a wheel dresser.
- Adjust the tool-rest to maintain a minimum gap from the wheel face to a minimum of 2 to 3 mm.
- Hold and apply the side flank of the tool to the front face of the grinding wheel at 30° to horizontal.
- Move the tool left to right and vice versa to grind the side cutting edge angle to cover 2/3rd width of the tool.
- Grind a side clearance angle of 8°, the bottom of the edge touching the wheel first.
- Rough grind the end cutting edge angle of 30° and the front clearance angle of 5° simultaneously.
- Hold the top flank of the tool against the wheel face inclined at 14°, the rear the side contacting the wheel first, and grind the side rake angle of 14°.
- Ensure that the ground portion is parallel to the side cutting edge.
- Finish grind all the faces on the finishing wheel.
- Grind a nose radius of approximately R. 0.4 mm.
- Check the angles with a tool angle gauge and template.
- Lap the cutting edge with a oilstone.
- The top rake (back rake) angle should be kept at 0°.

Fig 1



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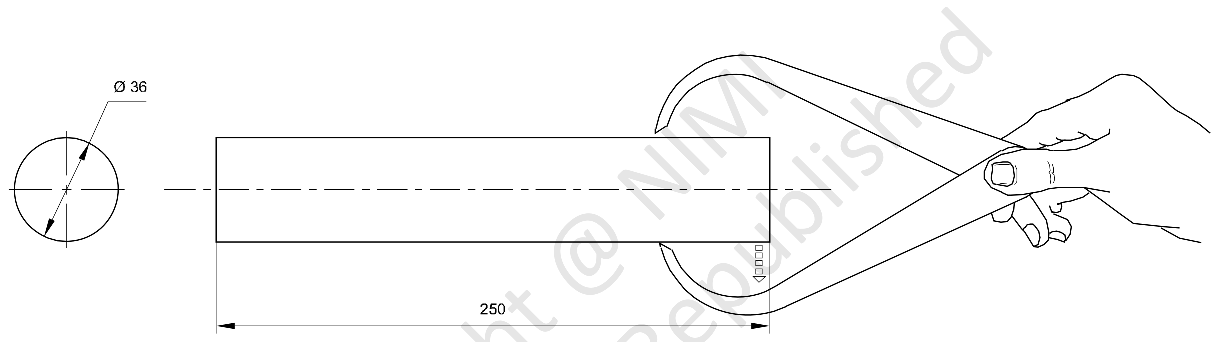
Measure the diameter using outside caliper and steel rule

Objectives: At the end of this exercise you shall be able to
- **check the diameter using outside caliper**
- **measure diameter with steel rule.**



1	–	EX.NO:2.3.93	Fe310	–	–	2.3.94
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	MEASURE THE DIAMETER USING OUTSIDE CALIPER AND STEEL RULE					TOLERENCE: ±0.5mm
						TIME: I HOUR
						CODE NO: FIN2394E1

Job Sequence

- Hold the out side caliper
- Open the caliper legs approximately more than job diameter
- Adjust the outside caliper leg to touch the diameter of the job.
- Adjust the caliper legs to just touch outer diameter of the job.
- Repeat the same procedure in different position of the job
- Measure the diameter by using steel rule.

Skill Sequence

Measuring with outside calipers

Objectives: This shall help you to
- **select the right capacity caliper for measurement**
- **set the sizes both in firm joint and spring calipers**
- **read the sizes by transferring them to a steel rule or other precision measuring devices as the case may be.**

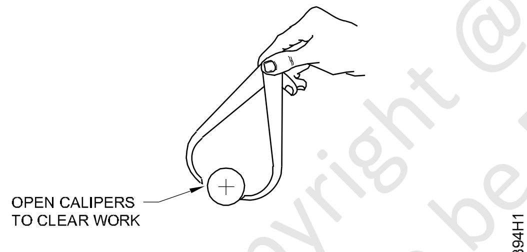
Outside calipers

Select a caliper based on the diameter to be measured.

A 150 mm capacity outside caliper is able to measure sizes from 0-150 mm.

Open out the jaws of the calipers until they pass clearly over the diameter to be measured. The work must be stationary when measuring the sizes. (Fig 1)

Fig 1

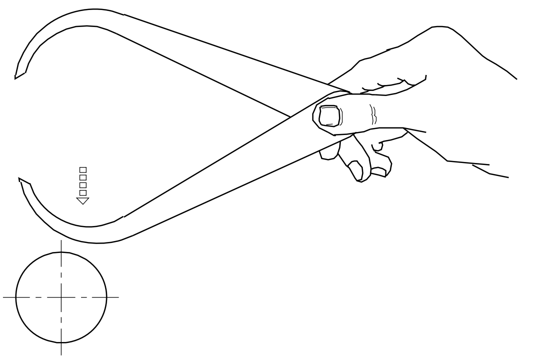


WORK MUST BE STATIONARY

Place one point of the leg over the workpiece and get the sense of feel of the other point of the leg.

If there is clearance on the other point of the leg, gently tap the back of one leg of the firm joint calipers so that it just slips from the external diameter of the workpiece to give the right sense of `feel'. (Fig 2)

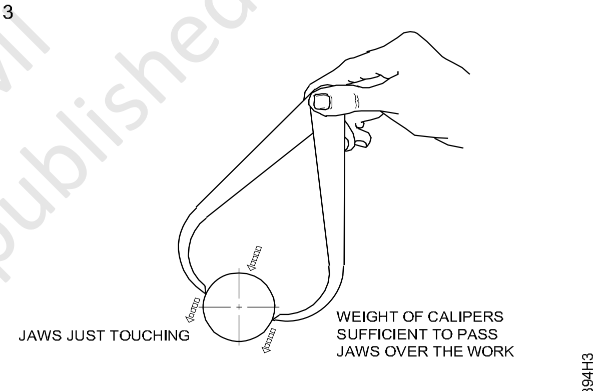
Fig 2



TAP GENTLY TO CLOSE CALIPERS

Because the accuracy of reading the sizes depends mainly upon the sense of feel of the user, high care should be exercised to get the correct feel. (Fig 3)

Fig 3



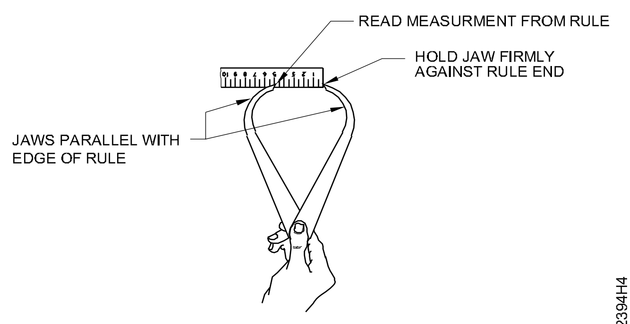
OBTAINING THE 'FEEL'

In the case of spring outside calipers, adjust the screw nut so that the adjustment of the caliper just slips from the external diameter of the workpiece to give the right sense of feel.

When you have adjusted the outside caliper for the correct 'feel' transfer the measurement to a steel rule or any other precision measuring instrument as the case may be.

Keep the graduated steel rule on a flat surface and hold the point of one leg firmly against the rule end. (Fig 4)

Fig 4



CHECKING THE DIMENSION

The point of one leg must be placed over the graduation so that the point of the other leg is parallel with the edge of the steel rule.

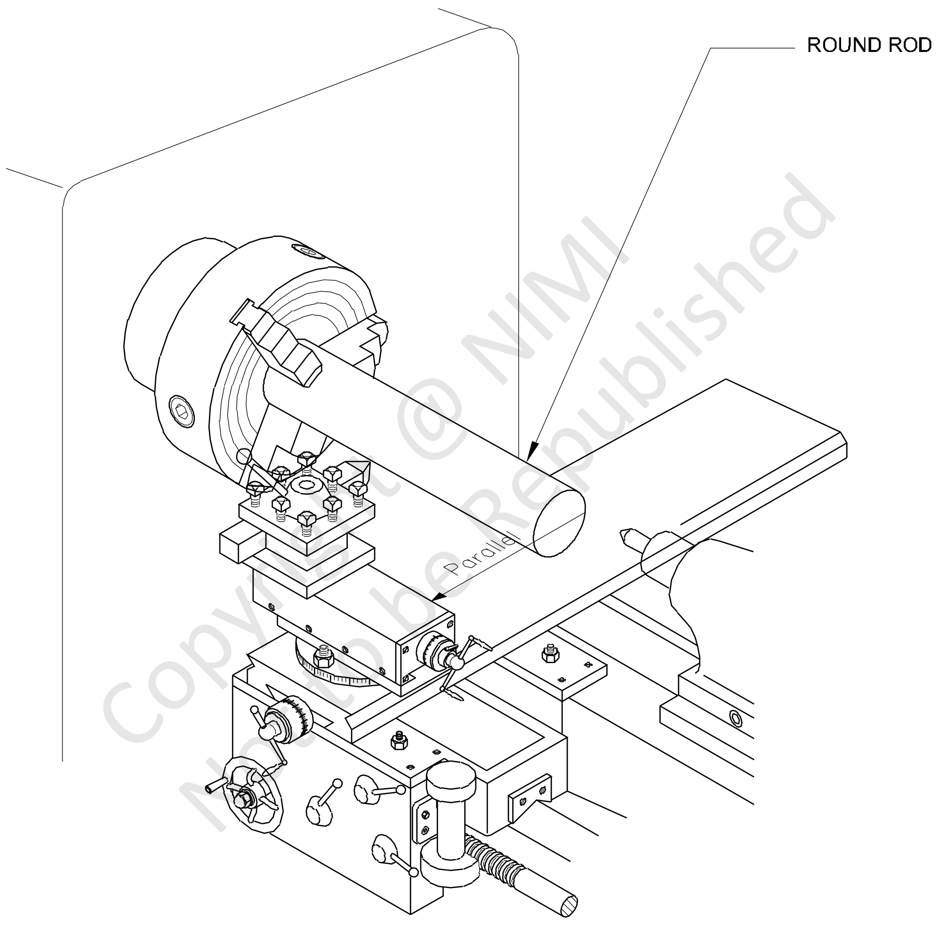
Record the reading to an accuracy of ± 0.5 mm.

In the case of precision measurements, transfer the measurements over an inside micrometer or vernier caliper. This measurement will give an accuracy of ± 0.01 or ± 0.02 mm. Here, the sense of feel of the user is very important in deciding the reading.

— — — — — — —

Holding job in three jaw chuck

Objective: At the end of this exercise you shall be able to
- **hold the job in three jaw chuck.**



1	–	EX.NO:2.3.94	Fe310	–	–	2.3.95
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE :NTS	HOLDING JOB IN THREE JAW CHUCK	TIME : 2 Hrs
		TOLERANCE : ±0.04mm
		CODE NO. FIN2395E1

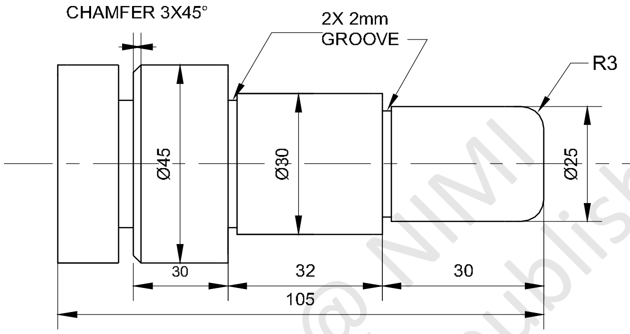
Job Sequence

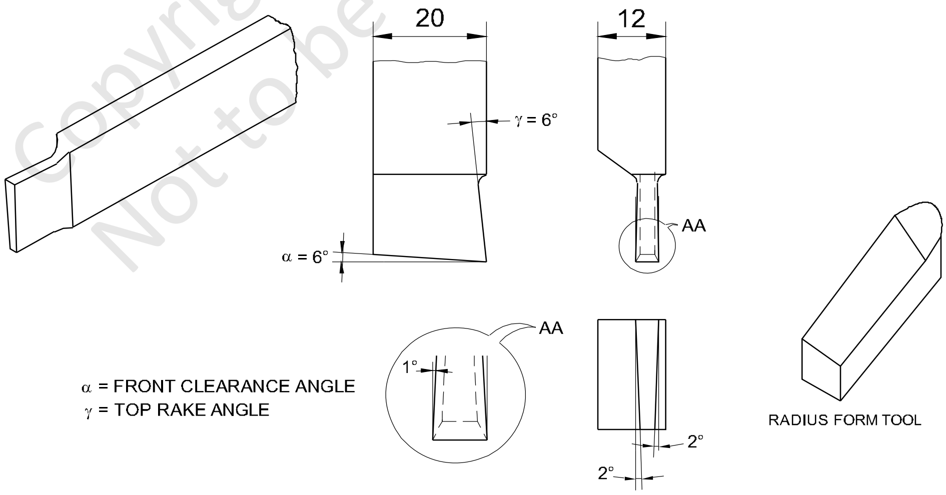
- Check the raw material size.
- Open the jaws by chuck key
- Open the jaws approximately more than job diameter
- Keep the job in the chuck with overhang of 75 mm
- Tighten the jaws as required
- Check the trueness of the job

— — — — — — —

Perform the facing, plain turn, step turn, parting, deburr, chamfer corner, round the ends, and use form tools

Objectives: At the end of this exercise you shall be able to
- **hold the work in three jaw chuck**
- **face the end and plain turning**
- **step turn job ± 0.1 using power feed and a knife tool**
- **form turning using form tool**
- **parting off using parting tool**
- **grind parting tool and make under cut to the required size.**





1	Ø50-105	–	Fe 310-O	–	–	2.3.96
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	PERFORM THE FACING ,PLAIN TURN, STEP TURN,PARTING,DEBURR, CHAMFER CORNER, ROUND THE ENDS AND USE FORM TOOLS	TOLERANCE ±0.04mm	TIME 11Hrs
		CODE NO. FIN2396E1	

Job Sequence

- Check the raw material for its size.
- Hold the job in a 3 jaw chuck keeping about 75mm outside the chuck.
- Set the tool to the correct centre height.
- Select and set the correct spindle R.P.M.
- Face one side first and turn the the outer diameter to ∅ 45mm for the maximum possible length.
- Turn ∅ 30 mm x 32 mm length as shown in job drawing.
- Turn ∅ 25 mm x 30 mm length.
- Set the under cut tool, radius tool, to the correct centre height and hold it rigidly.
- Form a square groove 2 mm depth x 2 mm width at 30 mm and 62mm from the end face.
- Form a radius 3 mm at ∅ 25mm x width 30 mm at the end face.
- Reverse and hold the job at ∅ 30mm x width 32mm inside the three jaw chuck keeping about 40mm length outside the chuck and true the job.
- Turn ∅ 45mm x 40mm length.
- Set the 2mm width parting tool to the correct centre height
- Part the job using plunge cut method at ∅ 45 mm x width 8mm from the end face.
- Face the other end to a total length of 92mm.
- Set the chamfering tool to the correct centre height.
- Chamfer the ∅ 45mm corner to 3x45°.
- Remove the sharp edge.
- Check the dimensions.

Skill Sequence

Turning steps of different diameters

Objective: This shall help you to
- **turn steps of different diameters for definite length on a shaft.**

When the width of step to be turned is more than the width of the tool, it is turned by using a R.H. knife-edge tool.

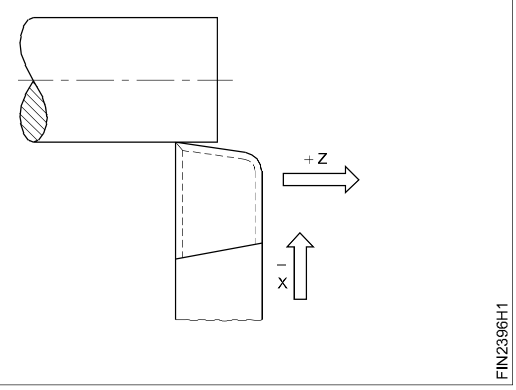
Hold the previously turned shaft in three jaw chuck and true it at both ends (near the chuck and overhanging end).

Hold the RH Knife-edge tool in the tool post with its cutting edge at centre height and at right angle.

Set the machine to 300 r.p.m.

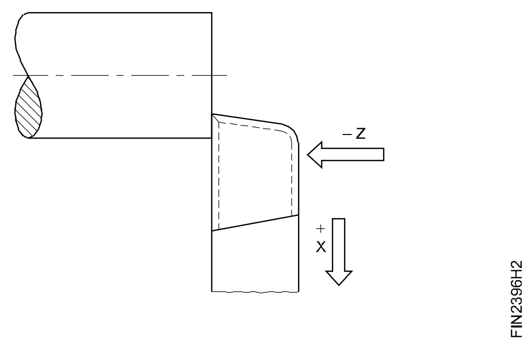
Start the machine and touch the tool tip on the surface of work to set the cross-slide graduated collar to zero with the backlash eliminated. (Fig.1)

Fig 1



Withdraw the tool from work and make the cutting edge contact the face of the work to set the top slide graduated collar to zero with a backlash eliminated. (Fig.2)

Fig 2



Position the tool tip near the edge of the work. (Fig.3)

Give a depth of cut to turn steps progressively. (Fig.4)

Advance the tool axially to the required length by rotating the top slide hand wheel.

(The rotation of the top slide hand wheel should be continuous and uniform till the required length is reached).

Restrict the depth of cut to a maximum of 3 mm for each cut.

Repeat the depth of cuts till the required diameter is reached.

Keep the carriage in the locked position.

Fig 3

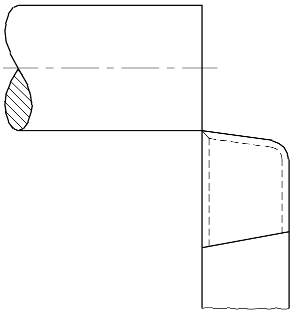
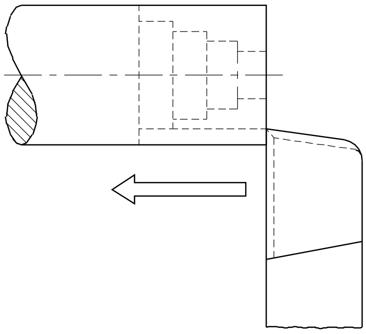


Fig 4



Corner forming tool

Objective: This shall help you to
- **grind the corner forming tool.**

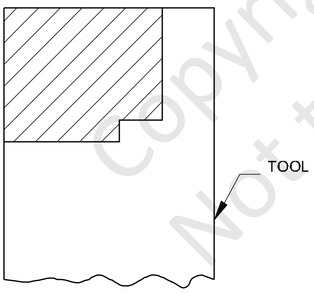
Procedure for grinding corner forming tool (for external operation).

Set the pedestal grinder for tool grinding.

Wear goggles.

Dress rough wheel, grind the tool approximately to a depth of 10.00 mm, maintaining a wall thickness of 3 to 4 mm. (Fig 1)

Fig 1



Prepare a template out of M.S. sheet to check positional accuracy. (Fig.2)

Now dress smoother wheel to form 2R at the corner.

Carborundum dresser is used to form corner radius.

Check the dressed wheel with template.

Grind 4°- 6° front clearance angle at the front and 3°- 4° side clearance. (Fig.3)

Remove the step and form 2R and check with template.

Deburr with oil stone.

No rake angle is given.

Fig 2

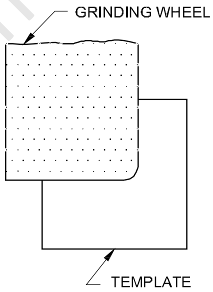
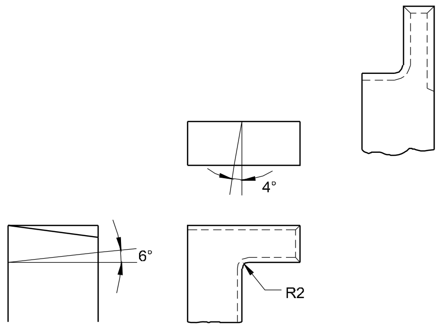


Fig 3



Parting off operation

Objective: This shall help you to
- **set the parting off tool in the machine to the correct centre height**
- **follow the correct procedure while parting off**
- **observe certain precautions while parting off.**

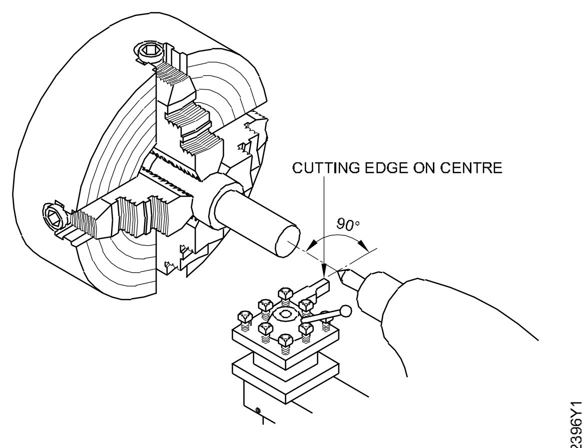
Parting off operation

Parting off or cutting off is the operation of severing a finished part from the rough or finished stock.

Setting of parting tool

Set the parting tool exactly on the centre with as little back rake as possible. (Fig 1)

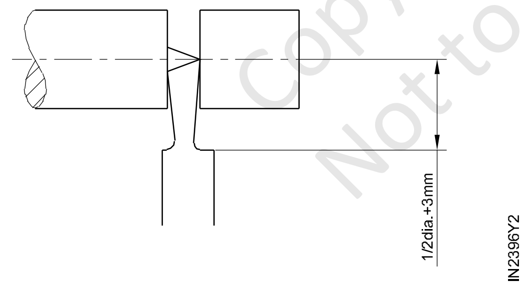
Fig 1



CORRECT CUTTING EDGE POSITION

Adjust the parting off tool so that it extends one half the diameter of the work plus about 3mm for clearance from the tool-holder (Fig 2)

Fig 2



If the cutting tool is too high, it will not cut through the work piece. If it is too low, the work may be bent and the cutting tool damaged.

Procedure

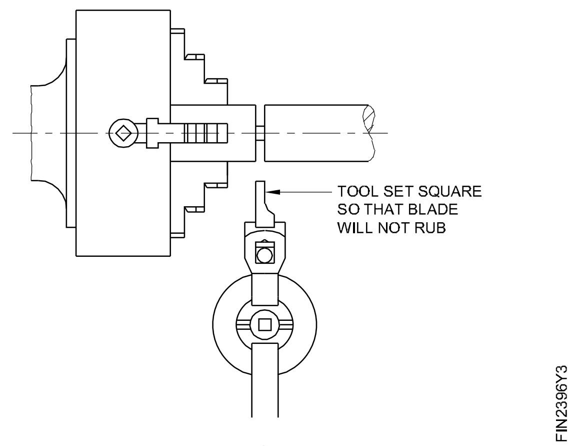
Select the correct type of tool for a specified job.

Hold the work with the minimum overhang in a chuck.

Set the tool square with the work so that it does not rub against the sides of the groove, as it is fed into the work (Fig 3)

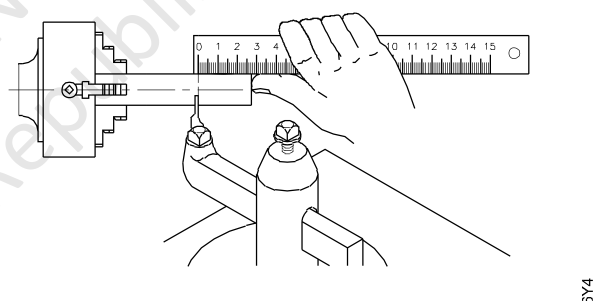
Set the spindle speed to half the speed for turning.

Fig 3



Move the carriage so that the right hand side of the blade is at the point where the work is to be cut off. (Fig 4)

Fig 4



PARTING TOOL POSITIONED TO CUT OFF
A DEFINITE LENGTH OF WORKPIECE

Start the lathe and feed the tool steadily into the work using the cross-slide handle.

Continue to feed the tool into the work until the part is severed.

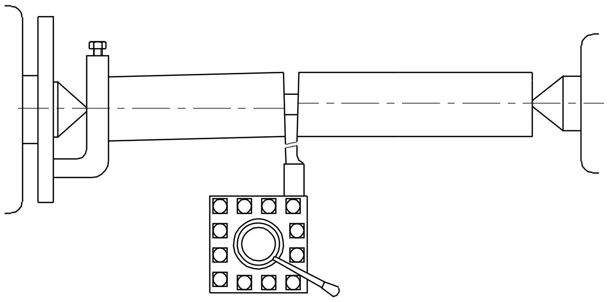
Precautions

The work should protrude from the chuck jaws, sufficiently enough to permit the cut to be made as close as possible to the chuck jaws.

The work must always be held securely in a chuck or a collet.

If the workpiece is held between centres, it may bend or break and fly out of the lathe during parting off. (Fig 5)

Fig 5

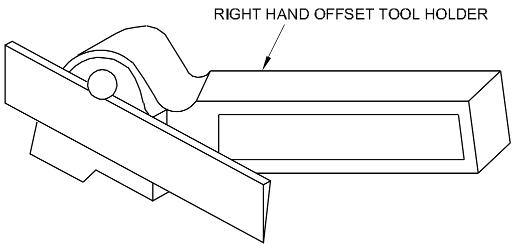


INCORRECT METHOD OF PARTING

FIN2396Y5

Use a right hand offset tool-holder (Fig 6)

Fig 6



INSERTED-BLADE TYPE PARTING TOOL

FIN2396Y6

A work having more than one diameter should be gripped on the large diameter while parting.

> **Intermittent feed tends to dull the tool's cutting edge.**

Heavy feed causes jamming and tool breakage.

Use sufficient coolant on steel. Brass and cast iron should be cut off dry.

Make sure the saddle is locked during the entire operation.

Reduce the rate of feed, when the work is almost cut off.

While parting off long work, it should be supported with the tailstock centre.

If the machine is in good condition, the automatic cross feed may be used.

When the tool has penetrated to about the depth of its width, withdraw it and move it sideways with the compound slide and feed again.

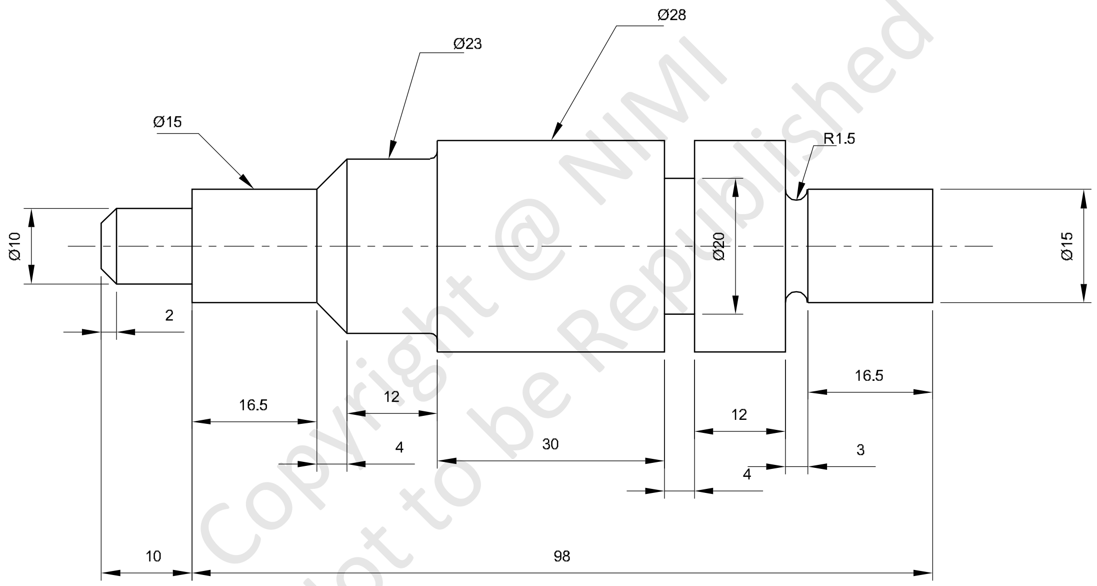
The above operation should be repeated frequently to minimise the tendency of the tool to dig in and cause trouble.

When the parting off operation is almost completed, hold the workpiece by hand to prevent it from falling, so that damage can be avoided.

— — — — — — —

Shoulder turn : Square , filleted, beveled under cut shoulder, turning-filleted under cut, square beveled

Objectives: At the end of this exercise you shall be able to
- **set and true the job in a 3-jaw chuck**
- **face, plain and step turn the work by hand tool to an accuracy of ± 0.1 mm**
- **form square filleted under cut**
- **set and true the job to the run out accuracy of 0.1 mm**
- **turn square filleted shoulder**
- **turn bevel shoulder.**



1	Ø 30-120	—	Fe310	—	—	2.3.97
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	SHOULDER TURN: SQUARE, FILLETED, BEVELED UNDER CUT SHOULDER, TURNING- FILLETED UNDER CUT,SQUARE BEVELED	DEVIATIONS LINEAR ± 0.04mm ANGULAR ± 30'	TIME 11Hrs
		CODE NO. FIN2397E1	

Job Sequence

- Check the raw material size.
- Hold the job in three jaw chuck with minimum overhang.
- Set the R.H. facing tool rigidly to the correct centre height with a minimum overhang.
- Set the machine to the predetermined R.P.M.
- Lock the carriage and face one end.
- Set the R.H. turning tool in the tool post rigidly.
- Turn the job to ∅ 28 mm to the maximum possible length.
- Step turn ∅ 15 mm to a length of 19.5 mm.
- Check the dimensions with a vernier caliper.
- Do filleted under cut R1.5x1.5 depth
- Make under cut of 4mm with and 4mm depth.
- Reverse the job and hold it on the finished surface.
- Face the job to 108 mm length.
- Check the length with a vernier caliper.
- Turn the job to ∅ 23 mm to the 16 mm length.
- Step turn ∅ 15 mm to a length of 26.5 mm.
- Bevel the ∅ 23 mm step to an angle of 4x45°.
- Turn ∅ 10 mm x 10 mm length
- Chamfer the ∅ 10 mm step to an angle of 2X30°
- Remove burrs from the job.
- Check the angle with a vernier bevel protractor.
- Check the dimensions with a vernier caliper.

Skill Sequence

Form an undercut shoulder at the junction of two diameters

Objectives: This shall help you to
- **set the undercutting tool in the tool post**
- **set the tool at the required position**
- **perform undercut operations**
- **check the undercut width and depth with a vernier caliper.**

The end of a section to be threaded is mostly undercut to provide a channel into which the threading tool may run. It allows the mating part to sit squarely against it. When the diameter is to be finished to size by grinding, a channel is generally cut against the shoulder to provide a clearance for the grinding wheel, thus ensuring a square corner.

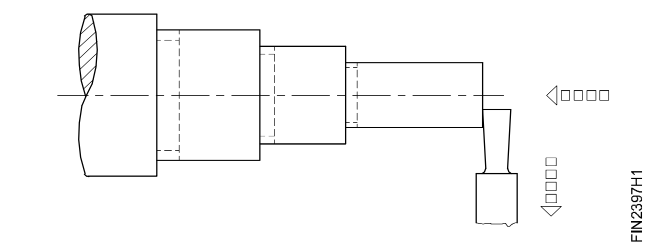
To form an undercut shoulder at the junction, the following procedure is to be followed.

Select a suitable tool bit or grind one to the shape and size required.

Set correct spindle speed, and start the machine.

Rotate the carriage handle until the tool almost touches the face of the work. (Fig.1)

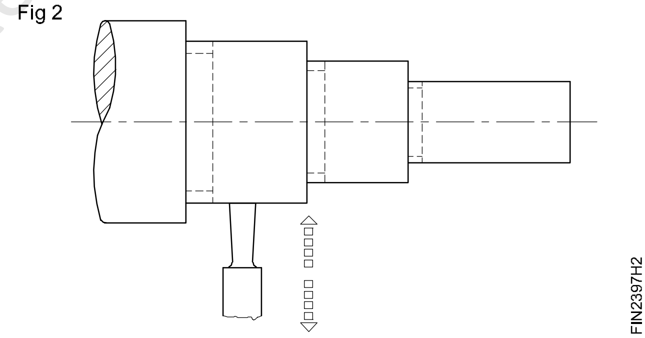
Fig 1



Lock the saddle in this position.

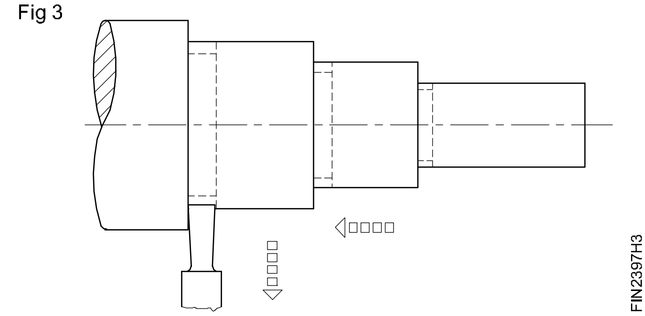
Rotate the cross-slide handle and touch the work surface lightly with the front cutting edge of the tool. Set the cross-slide graduated collar to zero. (Fig.2)

Fig 2



Rotate the top slide handle until the tool marks the shoulder lightly. (Fig 3)

Fig 3



Note the reading on the graduated collar of the top slide feed screw, and set the reading to zero.

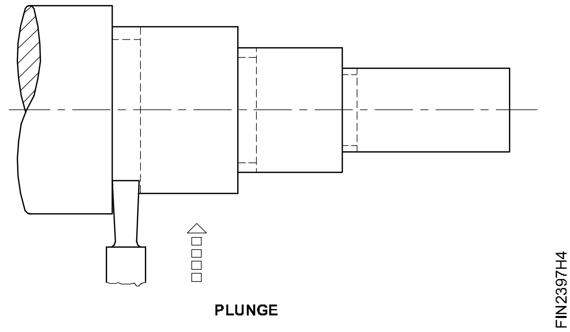
Apply cutting fluid

Feed the tool slowly and evenly into the work to the required depth using cross-slide handle (Fig 4)

Stop the lathe and check the undercut for its dimensions.

Remove sharp corners, if any.

Fig 4



Machining various shoulders

Objective: This shall help you to
- **machining various shoulders.**

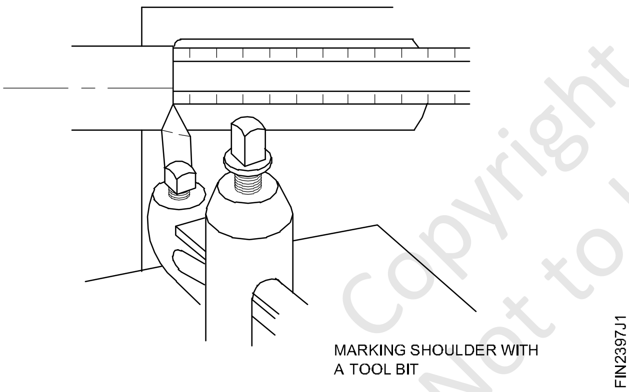
Machining a square shoulder

Face the end of the work to provide a reference surface point from which to take measurements.

Lay out the position of the shoulder by one of the following methods.

Cut a light groove with the point of a sharp tool bit around the circumference of the work to mark the required length. (Fig 1)

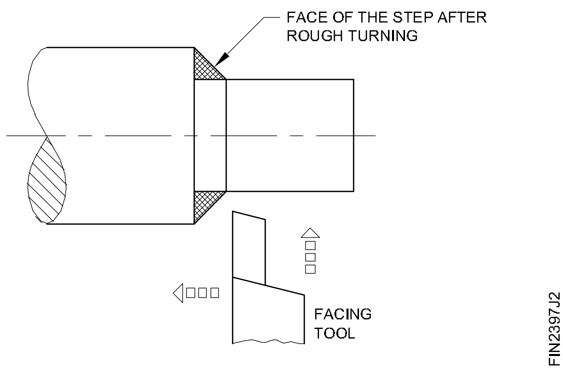
Fig 1



Rough and finish turn the diameter to within about 1 mm of the required length.

Mount a facing tool bit in the tool-holder and set it to centre. (Fig 2)

Fig 2



Make sure that the tool bit is set up with the point close to the work, and with a slight space along the side cutting edge.

Apply chalk or lay out dye to the small diameter, as close to the shoulder as possible.

Before starting the lathe, the tool bit should be brought fairly close to the diameter, by using a piece of paper or thin stock between the tool bit point and the work diameter.

Start the lathe and bring the facing tool in until it just removes the chalk or the layout dye.

Note the reading on the graduated collar of the cross-slide screw.

Bring the tool bit towards the shoulder with the carriage hand wheel until a cut is started.

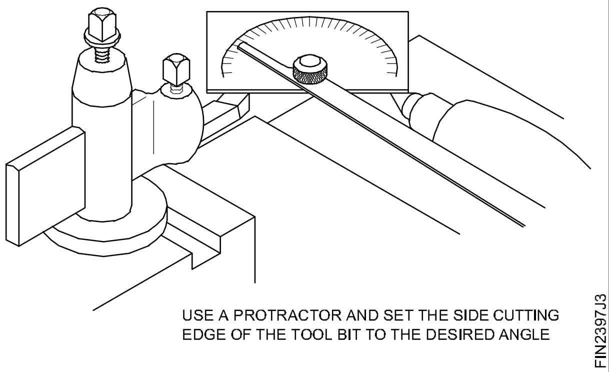
Face the shoulder by turning the cross-slide handle anti-clockwise, thus cutting from the centre to the outside.

For successive cuts, return the cross-slide screw to the same graduated collar setting. Repeat the above procedure until the shoulder is machined to the correct length.

Machining a bevelled shoulder (Fig 3)

Lay out the position of the shoulder along the length of the workpiece, and set the tool as shown in Fig 3.

Fig 3



Rough and finish turn the small diameter to size.

Mount a side cutting tool in the tool-holder and set it to centre.

Apply chalk or layout dye to the small diameter as close as possible to the shoulder location.

Bring the point of the tool bit in until it just removes the chalk or layout dye.

Turn the carriage hand wheel by hand to feed the cutting tool slowly into the shoulder.

Apply a cutting fluid to assist the cutting action and to produce a good surface finish.

Machine the bevelled shoulder until it is to the required size.

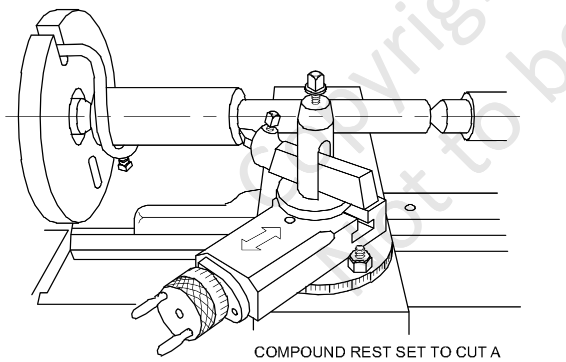
If the size of the shoulder is large, and chatter occurs when cutting with the side of the tool bit, it may be necessary to cut the bevelled shoulder using the compound rest.

Set the compound rest to the desired angle. (Fig 4)

Adjust the tool bit so that only the point will cut.

Apply a cutting fluid to assist cutting action. Progressively machine the bevel. Always cut outwards and start each cut near the outermost edge of the face of the shoulder. Be careful not to damage the small diameter when preparing to make each new cut. At the start of the final cut, bring the point of the tool bit in, until it just removes the chalk or layout dye at the innermost edge of the original shoulder face.

Fig 4



COMPOUND REST SET TO CUT A BEVELLED SHOULDER

FIN2397J4

Machining a filleted shoulder (Fig 5)

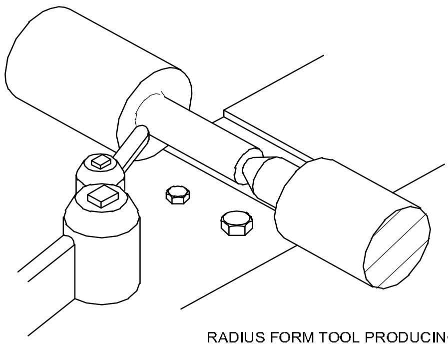
Lay out or mark the location of the shoulder on the workpiece.

When laying out for a filleted shoulder make allowance for the radius to be cut. If a filleted shoulder has a 4 mm radius and is 60 mm from the end of the workpiece, the layout should be 56 mm from the end. This would leave material for cutting the radius.

Rough and finish turn the small diameter to size.

Mount a radius tool in the holder and set it to centre. Check the tool bit with a radius gauge to be sure that it has the correct radius.

Fig 5



RADIUS FORM TOOL PRODUCING A FILLETED SHOULDER

FIN2397J5

Apply a layout dye or chalk to the small diameter as close as possible to the shoulder location.

Set the lathe spindle speed to approximately one half of the turning speed.

Start the lathe and bring the tool bit in until it just removes the layout dye or chalk.

Note the reading on the graduated collar of the cross-slide screw.

Retract the cutting tool by turning the cross-slide handle anticlockwise one half turn.

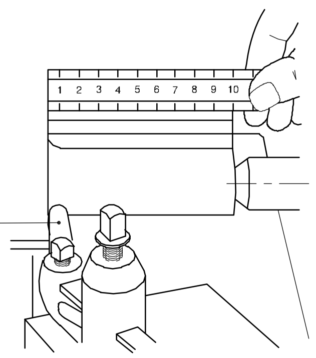
Turn the cross-slide handle clockwise until it is within approximately 1 mm of the original collar setting. The point of the round nose tool bit should now be about 1 mm away from the work diameter. This prevents the cutting tool from undercutting while roughing out the filleted corner.

Turn the carriage hand wheel slowly to start the radius tool cutting the filleted shoulder. If chattering occurs while machining the filleted corner, reduce the lathe speed and apply a cutting fluid to improve the finish of the fillet. (Fig 5)

Continue turning the carriage hand wheel slowly and carefully until the length of the shoulder is correct.

When stopping the lathe to measure the shoulder distance, do not move the cutting tool setting by withdrawing it from the diameter. (Fig 6)

Fig 6



MEASURING THE SHOULDER DISTANCE

FIN2397J6

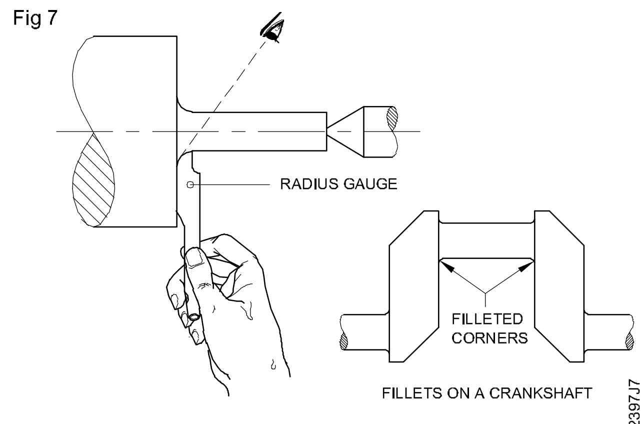
Turn the carriage hand wheel to move the cutting tool away from the shoulder slightly.

Turn the cross-slide handle anticlockwise about 1 mm back to the original collar setting.

Finish the filleted corner by carefully advancing the radius tool bit with the carriage hand wheel.

If the radius is too large for a form tool bit, or too much chattering occurs, cut the fillet in steps, using the largest radius tool that does not cause chattering. Check the accuracy of the fillet with a radius gauge. (Fig 7)

Fig 7



CHECK ACCURACY OF FILLET WITH A RADIUS GAUGE

Machining an undercut shoulder

Lay out the position of the undercut shoulder along the length of the workpiece.

Rough and finish turn the small diameter to size.

Mount the undercut tool in the tool-holder and set it to the centre.

Apply chalk or layout dye to the small diameter as close as possible to the undercut shoulder location and also on the face of the larger diameter.

Set the lathe spindle to approximately one half of the turning speed.

Bring the point of the tool bit in until it just removes the chalk or layout dye on the face and set the top slide graduated collar to zero.

Apply a cutting fluid to assist the cutting action and produce a good surface finish.

Retract the cutting tool by turning the cross-slide handle anticlockwise.

Repeat the above procedure until the undercut shoulder is machined to the correct depth.

Bring the tool tip clear off the large diameter face and advance the tool axially by 1 division of the top slide.

Feed the tool into the work from the edge of the larger diameter face, till it just removes the chalk mark applied on the small diameter.

Note the cross-slide graduated collar reading and advance the tool into the work to the number of divisions required according to the depth.

Ensure that the tool cutting edge is parallel to the work axis.

Ensure that the carriage is locked during the undercutting operation.

Apply a cutting fluid to assist the cutting action and to produce a good surface finish.

Retract the cutting tool by turning the cross-slide handle anticlockwise.

Repeat the above procedure until the undercut shoulder is machined to the correct depth.

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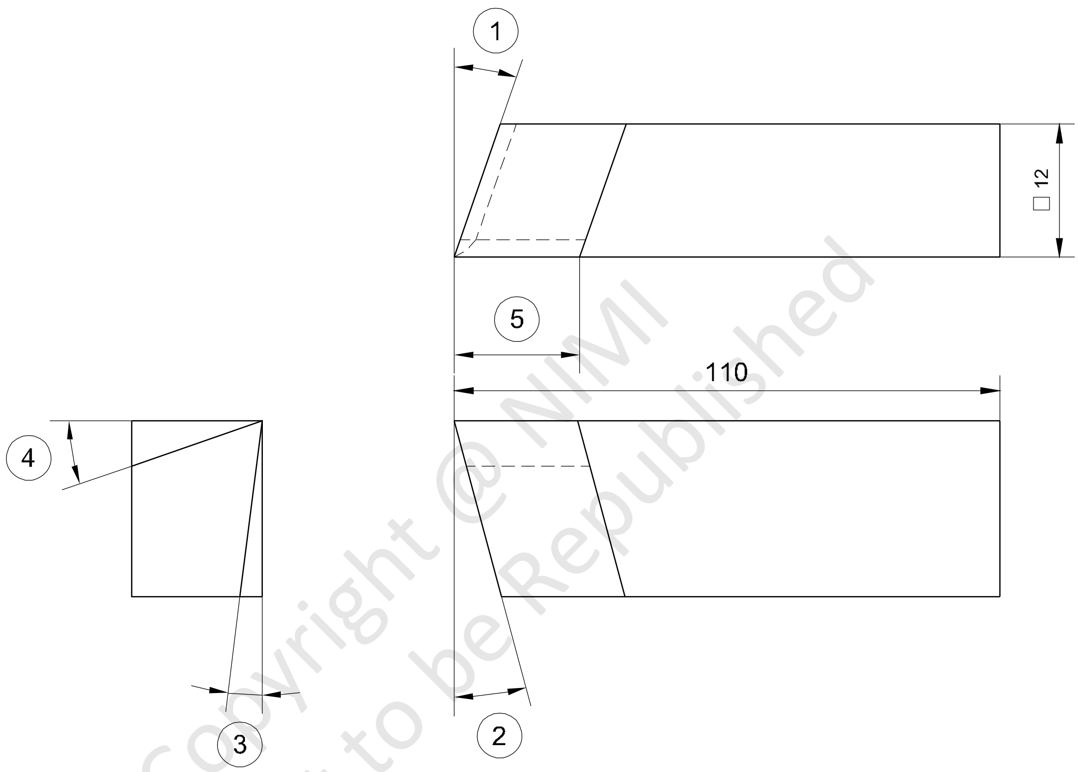
Sharpening of - single point tools

Objective: At the end of this exercise you shall be able to
- **grind side cutting tool for machining steel.**



1 End cutting edge angle - 25°
2 Front clearance angle - 6°
3 Side rake angle - 6°
4 Side rake angle - 14°
5 Cutting edge - equal to tool thickness

1	SQ12 - 110	–	Fe310	–	–	2.3.98
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SHARPENING OF - SINGLE POINT TOOLS	TOLERANCE :±30'	TIME 1Hr
		CODE NO. FIN2398E1	

Job Sequence

- Before starting wear safety goggles.
- Check the gap between the wheel and the tool rest, and maintain the gap 2 to 3 mm.

Damages or any corrections needed should be brought to the notice of the instructor.

- Hold the blank against the wheel to grind the end cutting edge angle 20° to 25° and the front clearance angle between 6° to 8° - simultaneously.
- Grind the side of the tool - for giving 6° to 8° side clearance. The side length should be equal to the width of the tool blank.
- Grind the top of the tool for a side rake angle of 12° to 15°.
- Finish grind all angles and clearances - on a smooth wheel.
- Grind a nose radius of approximately 0.5 mm R.

The ground surfaces should be without steps and should have a uniform smooth finish.

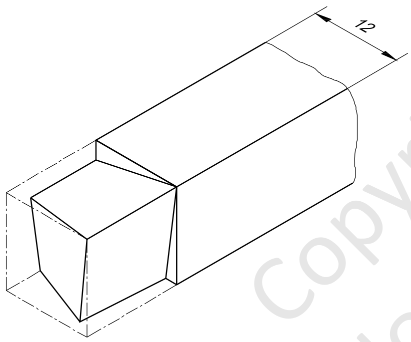
Skill Sequence

Grinding a side cutting tool for machining steel

Objective : This shall help you to
- **grind a right hand side cutting tool to machine steel.**

The side cutting tool to be used on steel is illustrated in Figure 1. The right hand portion illustrates the tool blank in dotted lines before grinding, and the ground tool by thick lines. (Fig 1)

Fig 1



The side cutting edge is in line with the blank edge and the end cutting edge is inclined at an angle of 25°. The side rake angle is 14°. The front and side clearances are ground 6°. The length of the side cutting edge is maintained equal to the size of the square cross-section of the tool blank, i.e. 12 mm. Fig 2 shows the shaded portion to be removed by grinding the tool blank to get the ground tool. The procedure in sequence is as follows.

Grind the end cutting edge angle 25°. Angle 'x_n' (Fig 3)

Fig 2

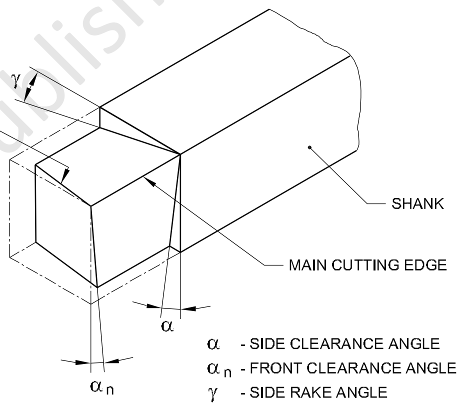
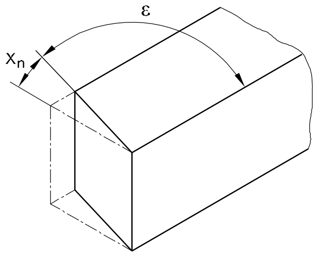
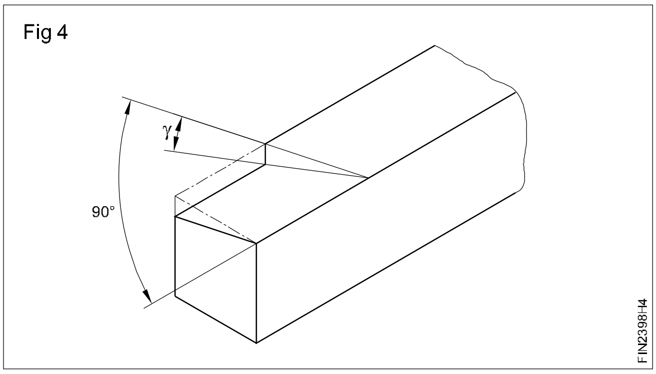


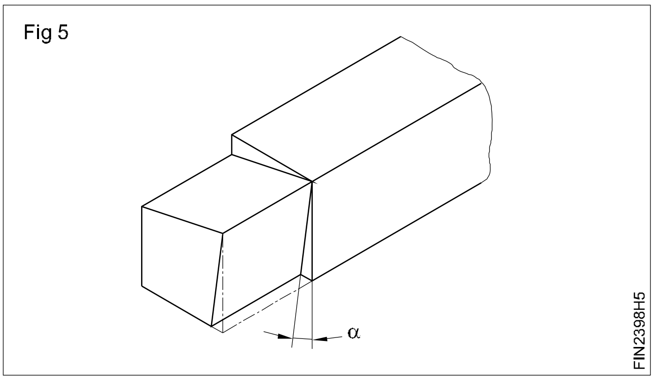
Fig 3



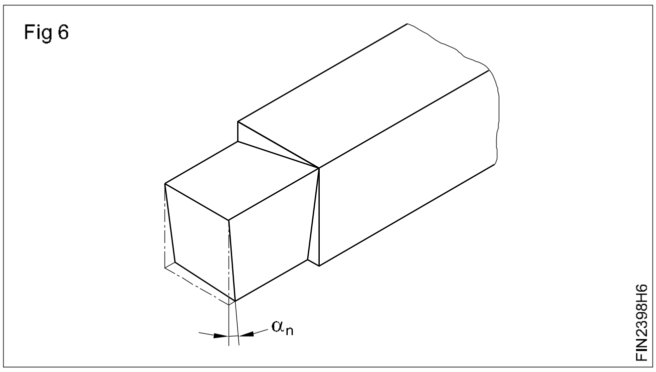
Grind the side rake angle of 14°. Angle 'r'. (Fig 4)



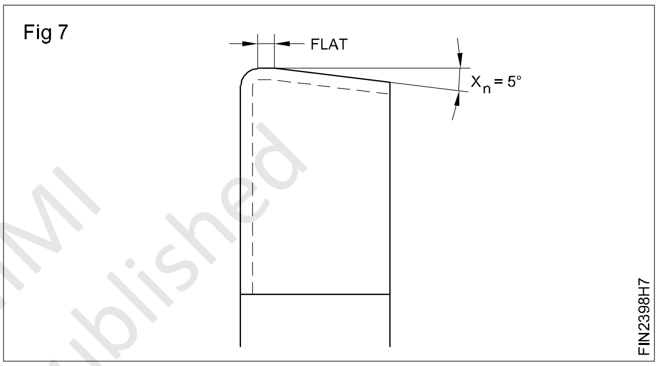
Grind the side clearance angle of 6°. Angle ∅ (Fig 5)



Grind the front clearance angle of 6°. Angle ∅ (Fig 6)



Grind and provide a nose radius of R 0.4 to R 0.6 mm at the point of tool. Grind a flat for a short length of 0.2 to 0.3 mm as shown in Fig 7. For the sake of clarity the figure is magnified.



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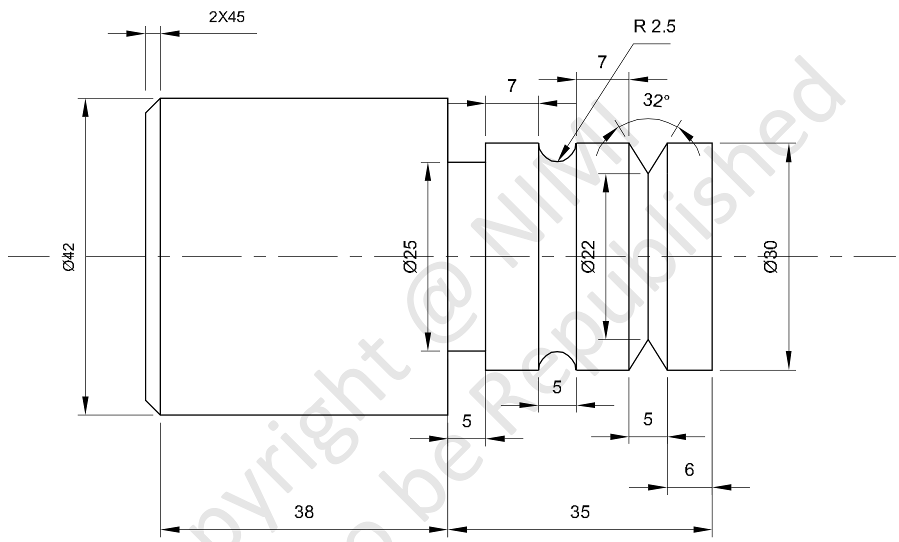
Cut grooves - square, round 'V' groove

Objectives: At the end of this exercise you shall be able to
- **hold the job in lathe chuck**
- **set the turning tool**
- **set the machine spindle speed**
- **parallel turn the work piece by hand feed**
- **set the tool for groove turning -'V' tool, radius tool and square tool.**



1	Ø50-80	—	Fe310	—	—	2.3.99
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	CUT GROOVES - SQUARE, ROUND, 'V' GROOVE					TOLERENCE: ±0.04mm
						TIME: I0 Hrs
						CODE NO : FIN2399E1

Job Sequence

- Check the raw material for its size.
- Hold the job in 3 jaw chuck keeping about 50mm outside the chuck
- Set the tool to the correct centre height.
- Select and set the correct spindle R.P.M.
- Face one side first and turn the outer diameter to ∅ 42mm for the maximum possible length.
- Turn ∅ 30 mm x 35 mm length.
- Set the under cut tool, radius tool, 'V' groove tool to the correct centre height and hold it rigidly.
- From a square groove 2.5 mm depth x 5mm width at 30 mm from the end face.
- From a radius groove 2.5 mm depth x 5mm width at 18 mm from the end face.
- Plunge the 'V' groove tool to form a 'V' groove 5mm width at 6mm from the end face.
- Reverse and hold the job.
- Face the other end to a total length of 75mm.
- Turn ∅ 42 mm x 40 mm length
- Remove the sharp edge
- Check the dimensions.

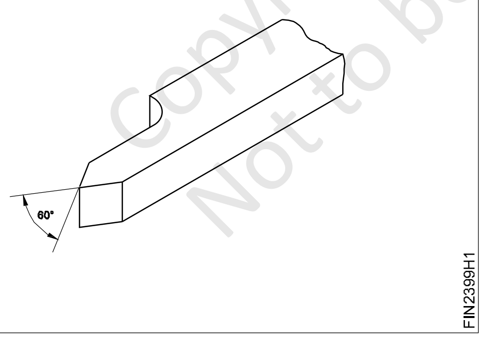
Skill Sequence

Objective: This shall help you to
- **grind 60° 'V' tool.**

1 Grind the tool to the given angle of 60°

- Mount the tool and set centre height properly
- Set the speed, lock the carriage
- Move the cross slide and plunge the tool to the required size.
- Check the depth of the 'V' groove. (Fig 1)

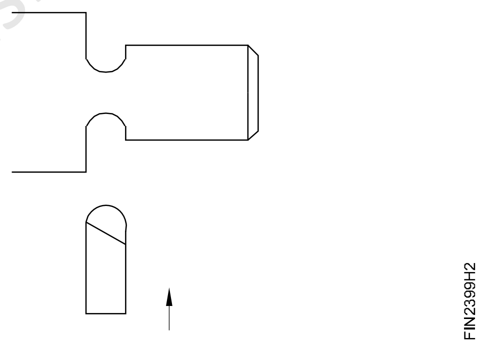
Fig 1



2 Grind the tool 4 mm radius

- Mount the tool and set centre height properly
- Set the speed, lock the carriage
- Move the cross slide and plunge the tool to the required size. (Fig 2)

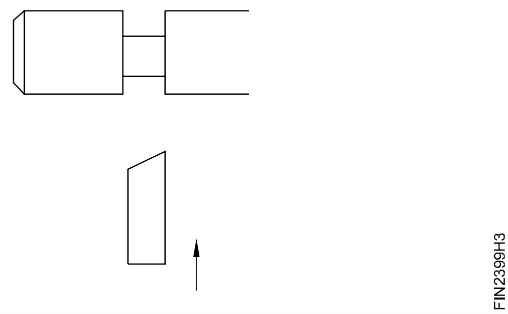
Fig 2



3 Grind the tool to thte required width of 4 mm

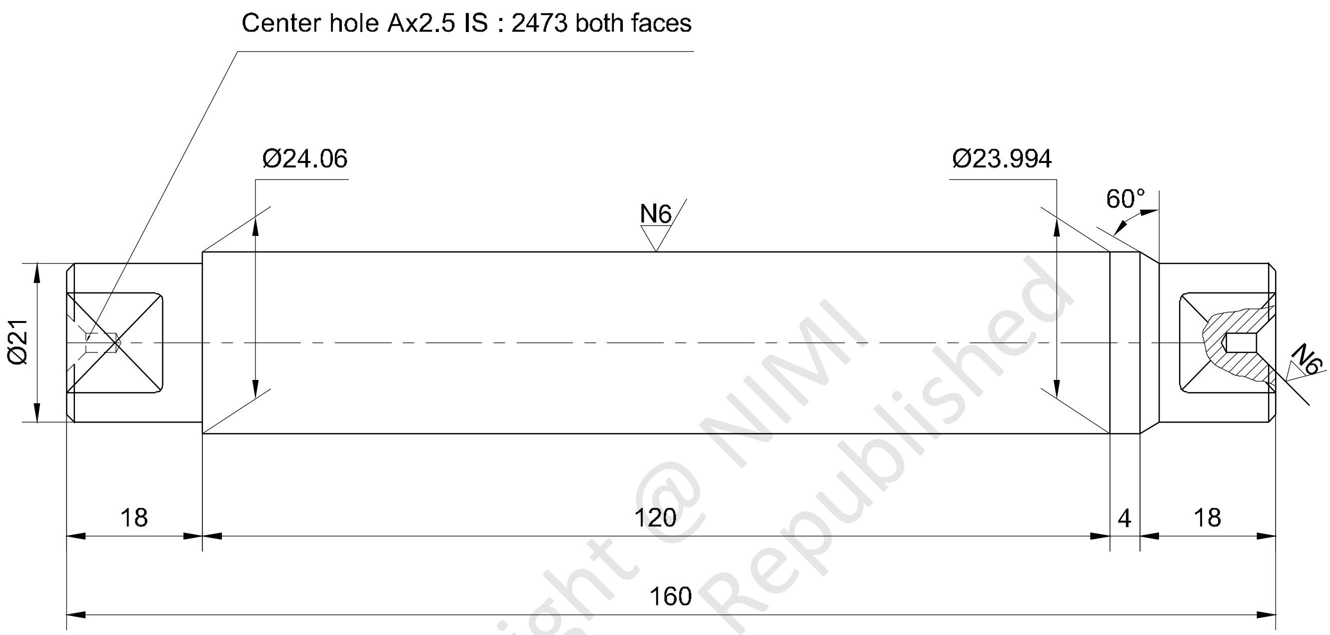
- Mount the tool and set centre height properly.
- Set the speed, lock the carriage.
- Move the cross slide and plunge the tool to the required size. (Fig 3)

Fig 3



Make a mandrel - turn diameter to sizes

Objectives: At the end of this exercise you shall be able to
- **mount the driving plate on spindle nose of lathe spindle**
- **protect the centre hole by crowning**
- **turn the mandrel with an accuracy of ±0.1 mm**
- **turn with carbide tipped tool.**



1	Ø25 - 170	–	15Ni16Cr5	–	–	2.3.100
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1 : 1	MAKE A MANDREL - TURN DIAMETER TO SIZES	TOLERANCE : ±0.04	TIME : 5Hrs
		CODE NO. FIN23100E1	

Job Sequence

- Check the size of the raw material.
- Hold the job in a 4 jaw chuck and true it.
- Set the spindle R.P.M. and face one end.
- Centre drill with the help of the tailstock and drill chuck.
- Reverse and true the job.
- Face to length 160 mm and centre drill.
- Crown centre holes using the special centre drill.
- Dismount the 4 jaw chuck from the lathe spindle and mount the driving plate on the spindle nose.
- Clamp the job on a suitable lathe carrier and support the work between centres.
- Set the spindle r.p.m. and rough turn diameter to 24.16 mm. to maximum possible length
- Turn step ∅ 21 for 18 mm length and chamfer 2 x 45°.
- Reverse the job and turn ∅ 21 mm for 18 mm length and chamfer 2x45°.
- Set the form tool to 60° and turn taper on step dia. as shown in the sketch.
- Check the size with an outside micrometer.
- Set the taper turning attachment for the small taper.
- Adjust in such a way that ∅ 24 mm diameter at the centre of the mandrel is achieved.

Skill Sequence

Turning work held on a plain mandrel

Objectives: This shall help you to
- **mount the work on a mandrel**
- **machine the work held on a mandrel.**

It may sometimes be necessary to machine external surfaces of a cylindrical work accurately in relation to a hole that has been previously bored in the centre of the work. In such cases the work is mounted on a mandrel and machined.

Work has to be mounted on a mandrel before holding on a lathe for machining. The following sequence is to be followed for mounting work on a mandrel.

Select the correct size of the mandrel to suit the hole of the workpiece.

Clean and apply a light film of oil or soft grease on the diameter of the mandrel.

Remove the burrs from the edge of the hole in the workpiece.

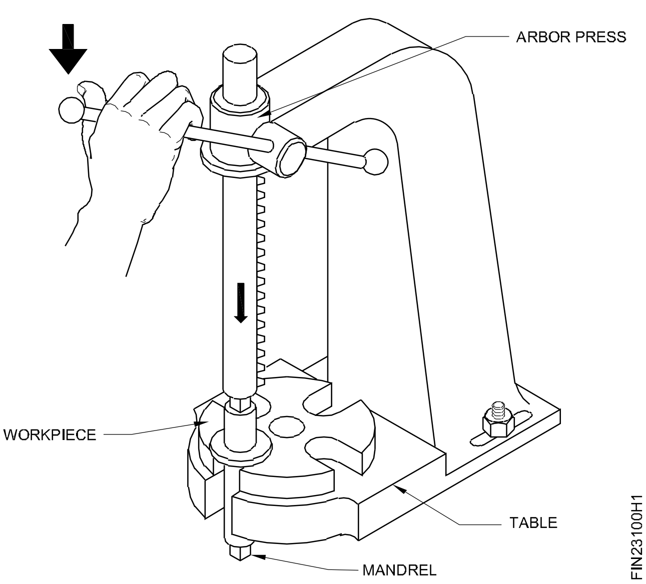
Clean and lubricate the hole in the workpiece to prevent seizing or scoring when the mandrel is pressed into or out of the work.

Insert the small end of the mandrel squarely into the hole by hand. It should enter the hole approximately about 25 mm and should square itself.

Note: The larger end of the mandrel has the size stamped on it.

If an arbor press is available, place the work on the arbor press table, preferably with the machined surface downwards. (Fig 1)

Fig 1

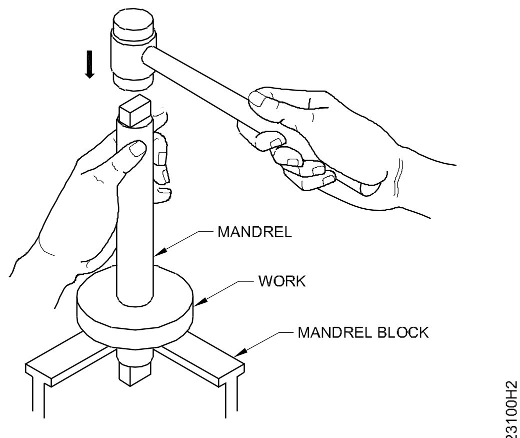


Press the mandrel firmly, but not too tightly, into the workpiece.

If the mandrel is forced into the work tightly, it may distort, damage the bore of the workpiece, and sometimes break the workpiece.

If an arbor press is not available, use a lead hammer to drive the mandrel into the hole by light hammering. (Fig 2)

Fig 2



USING A HAMMER TO MOUNT WORK ON A MANDREL

Note: The workpiece is pressed on a solid plain mandrel, and is held in position approximately at the centre of the mandrel length only by friction. Take all cuts towards the large diameter end of the mandrel and avoid taking heavy cuts.

Mount a suitable lathe carrier on the large diameter end.

Check for the true running of the live centre.

Check the alignment of the live centre and the dead centre of the lathe with a test bar and dial indicator.

Clean the lathe centres and the centre holes of the mandrel thoroughly.

Mount a catch plate or driving plate to the spindle nose.

Mount the mandrel with the workpiece in between centres, and carefully adjust the force on the centres.

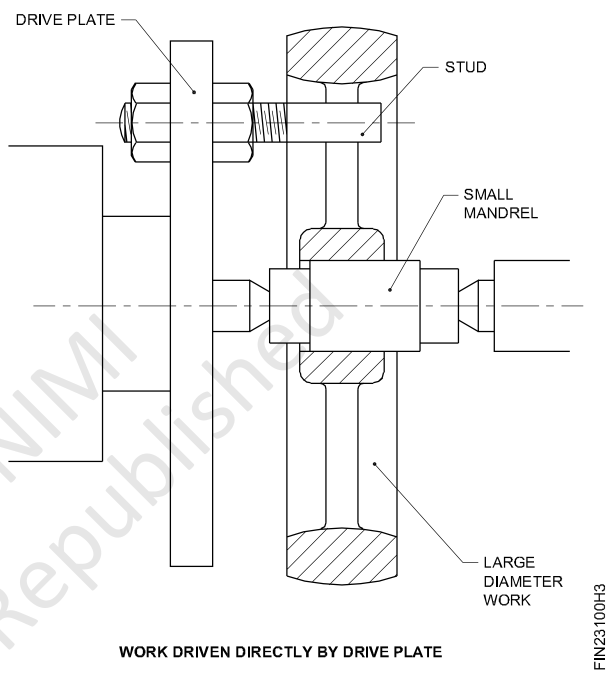
Avoid overhang of the tailstock spindle.

To prevent the work getting forced off from the mandrel, avoid taking cuts from the larger diameter end towards the smaller.

Very light cuts should only be taken on a work of a larger diameter mounted on a small mandrel.

If possible, drive the workpiece directly from the drive plate by means of a suitable stud. This will prevent the work from slipping. (Fig 3)

Fig 3

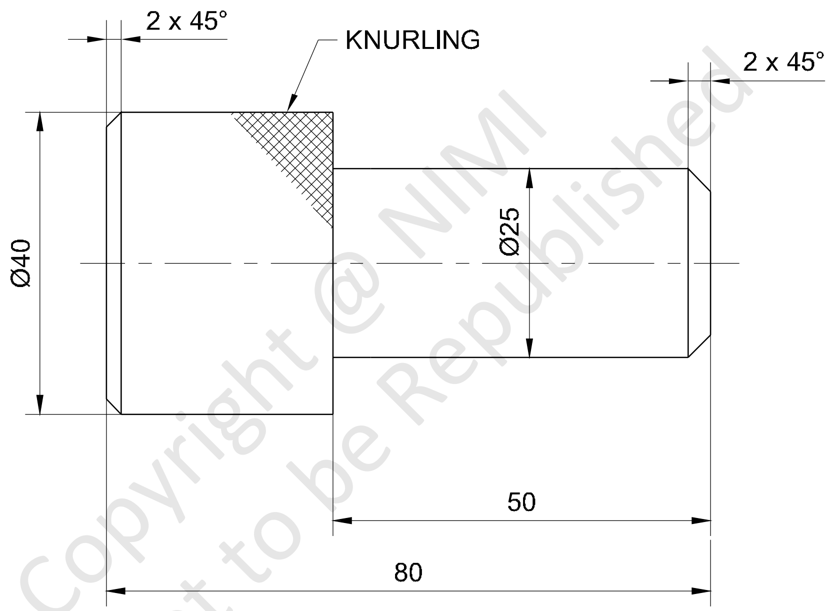


WORK DRIVEN DIRECTLY BY DRIVE PLATE

— — — — — — —

Knurl the job

Objectives: At the end of this exercise you shall be able to
- **hold the job in lathe chuck**
- **set a knurling tool in the tool post**
- **knurl on the cylindrical surface.**



1	Ø45 - 85	–	Fe 310	–	–	2.3.101
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	KNURL THE JOB	TOLERANCE : ± 0.04mm	TIME : 1h
		CODE NO. FIN23101E1	

Job Sequence

- Check the raw material size
- Hold the material securely in a 3 jaw chuck projecting 50 mm outside the chuck.
- Face the one end.
- Turn the job to ∅ 40-0.2 for more than the required for knurling
- Hold the diamond knurling tool securely and set it to the centre height.
- Select the suitable speed for the knurling operation.
- Knurl the surface till a diamond shape is formed
- Chamfer 2x45° at the end.
- Reverse and hold the job in the chuck and true the job.
- Face the end and maintain the length of 80 mm.
- Turn the job ∅ 25 x 50 with a side knife tool. (Use a vernier caliper for measuring dimensions.)
- Chamfer to 2x45° at the end with a 45° chamfering tool.
- Deburr all sharp edges.

Remember

- Avoid overhanging of the tool.
- Use aluminium pieces for packing, to avoid marks on the knurled surface.

Safety precautions

- Never operate a lever when the machine is in motion.
- Do not keep any tools on the moving parts of the machine.
- Use a suitable coolant.

Skill Sequence

Knurling on lathe

Objectives: This shall help to you

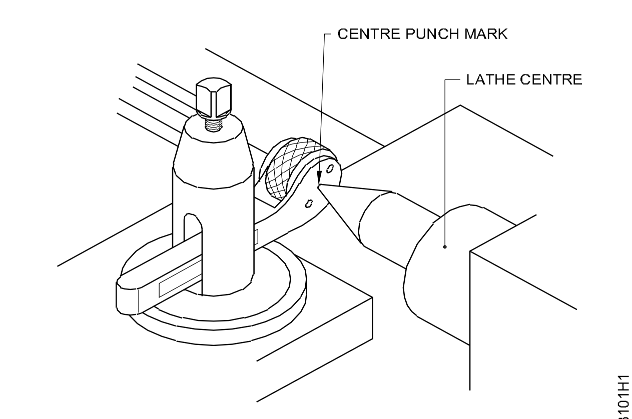
- **prepare the work for knurling**
- **set the speed for knurling**
- **set the knurling tool in the tool post**
- **knurl the job using the required grade of knurl.**

For better grip and for a good appearance on cylindrical surfaces, a portion of the component is knurled. The procedure of knurling, in sequence, is as follows.

Reduce the diameter of the portion to be knurled depending upon the grade of knurl and material of the job. Reduce 0.1 mm for fine knurling, 0.2 mm for medium knurling and 0.3 mm for coarse knurling approximately.

Support the job knurling tool in the post with the centre of the floating head at the same height as the lathe centre point. (Fig 1)

Fig 1

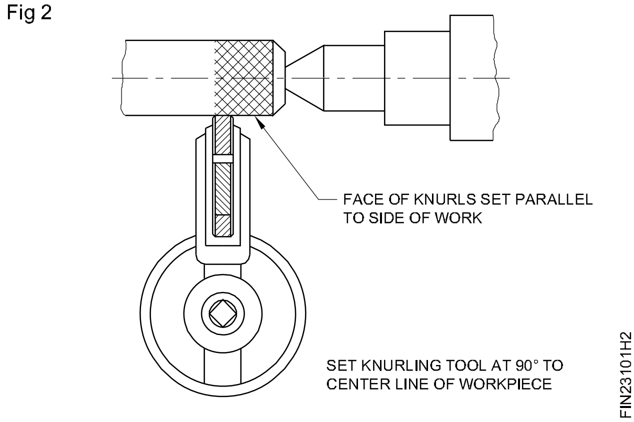


SETTING THE KNURLING TOOL ON CENTRE

Set the machine for a low speed, preferably 1/3 to 1/4 of the turning speed. Mark off the length to be knurled.

Adjust the knurling tool so that it is at right angles to the axis of the work; tighten it firmly. (Fig 2)

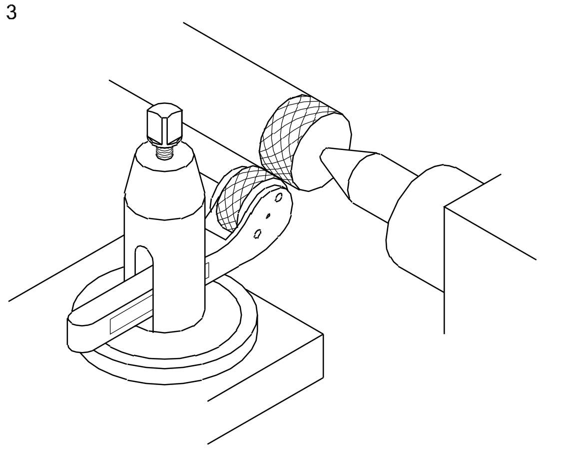
Fig 2



Feed the knurl and make the pair of knurls to contact the work periphery by the cross-slide hand wheel.

Move the carriage until about the face of the knurling roll overlaps the end of the workpiece which helps to produce a true pattern.(Fig 3)

Fig 3



Start the lathe and feed the knurling tool into the work by the cross-slide.

Stop the lathe and reset the knurling tool, if necessary.

Feeding the knurl into the workpiece, before it is rotated, may damage the knurl.

Move the knurling tool longitudinally with a uniform movement by the carriage hand wheel up to the required length of the work to be knurled.

Give the depth by the cross-slide without drawing the tool back. Feed the knurling tool to the other end.

Until the correct pattern is obtained, do not withdraw the knurling tool back.

Ample coolant is to be applied to the workpiece being knurled. This washes away any metal particles, and provides lubrication for the knurling rolls.

Use a fine feed for knurling hard metals and a coarse feed for knurling soft metals.

Clean the knurl with a brush for subsequent cuts.

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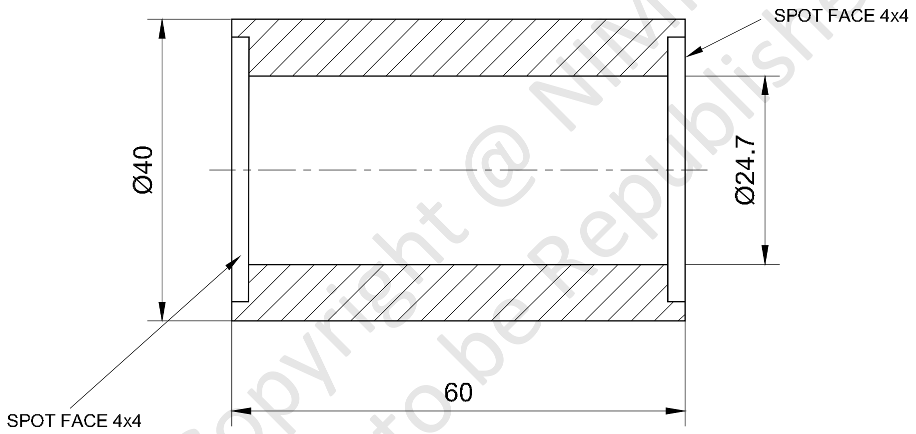
Bore holes - spot face, pilot drill, enlarge hole using boring tools

Objectives: At the end of this exercise you shall be able to
- **drill through hole**
- **bore a hole to an accuracy of ± 0.04 mm with boring tool**
- **measure the bore by using a vernier caliper**
- **re-shapen a twist drill**
- **check the twist drill for its performance**
- **spot face the end of bored hole.**



1	Ø45 - 65	–	Fe 310	–	–	2.3.102
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	BORE HOLES - SPOT FACE, PILOT DRILL, ENLARGE HOLE USING BORING TOOLS.	TOLERANCE : ± 0.04mm	TIME : 9h
		CODE NO. FIN23102E1	

Job Sequence

- Check the raw material for its size.
- Hold the job in a 4 jaw chuck and true it, keeping about 45mm outside the chuck.
- Set the facing tool to the correct centre height.
- Select and set the correct spindle speed, for facing.
- Face one side first, and turn the outer diameter to ∅40 mm for the maximum possible length.
- Centre drill.
- Select the required size of drills including the pilot drill.
- Hold the drill in the tailstock spindle with the help of suitable sleeves after cleaning.
- Select the spindle speed for drilling the pilot hole of 12mm dia.
- Bring the tailstock to a convenient position for drilling, and lock the tailstock on the bed.
- Run the lathe and advance the drill, so that it does the drilling opeartion on the job held in the chuck.
- Use coolant while drilling and advance the drill slowly.
- Enlarge ∅12 mm hole to ∅20 mm hole by drilling at a reduced spindle speed.
- Set the boring tool in the tool post to the centre height and bore the drilled hole to ∅24.7 mm through.
- Check the bore with vernier caliper.
- Make spot face 4x4 mm by boring tool
- After completion of drilling throughout the job reverse and true the job; face to the required length as per drawing, and turn outer dia ∅40mm.
- Make spot face by boring tool 4x4 mm

Safety precautions

- Select proper spindle speeds as per size and operation.
- Use pilot drill while drilling more than 20mm drill size.
- Feed the drill slowly while drilling.
- Use coolant while drilling.

Skill Sequence

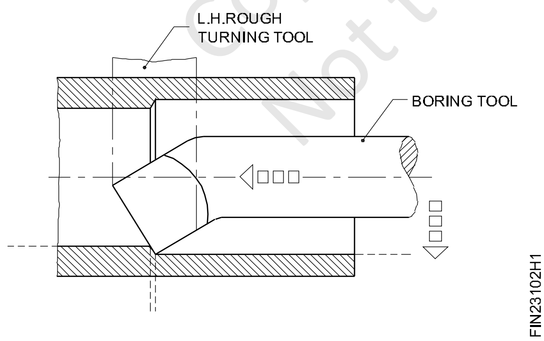
Boring a drilled hole

Objectives: This shall help you to

- **set the boring tool in the tool post**
- **bore the drilled hole to the required size**
- **check the hole with the help of a vernier caliper.**

Boring is an internal operation of enlarging a hole with the help of a single point cutting tool. (Fig.1)

Fig 1



To bore the hole the following procedure is to be followed.

Mount the workpiece in a four jaw chuck. True the face of the work and the outer diameter.

Set the lathe to the proper spindle speed for boring.

Mount the boring tool on the tool post of the compound rest.

Fix the boring tool, level and parallel to the centre line of the lathe.

Grip the boring tool as short as possible to reduce chatter.

Use the largest diameter boring tool which can be accommodated in the drilled hole. (Approximately 2/3rd size of the bore)

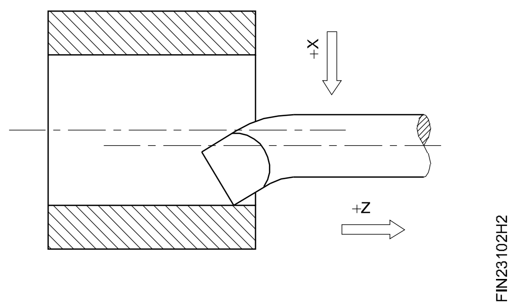
Set the cutting edge of the cutting tool just slightly above the centre line, since there is tendency for the tool to spring downwards when cutting.

Choose a proper feed for rough boring.

The speed for boring is the same as that for turning and is calculated for the diameter of the bore.

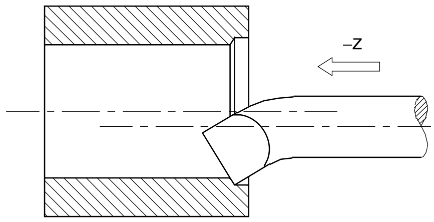
Start the machine and turn the cross-slide handle anticlockwise until the cutting tool touches the inside surface of the hole. (Fig.2)

Fig 2



Take a light trail cut about 0.2 mm deep and about 8 mm long at the right hand end of the work. (Fig.3)

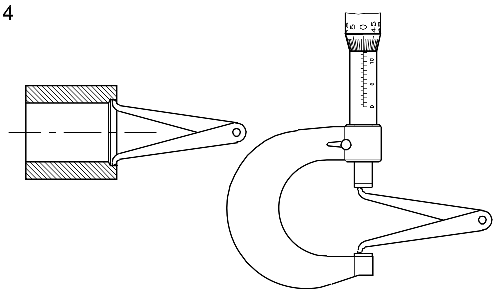
Fig 3



FIN23102H3

Stop the machine and measure the diameter using a telescopic gauge or inside caliper. (Fig.4)

Fig 4



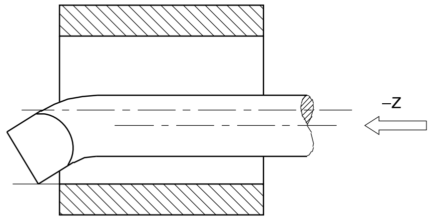
FIN23102H4

Calculate the amount of material to be removed from the hole for the roughing cut.

Leave about 0.5 mm undersize for a finish cut.

Take a roughing cut for the required length. (Fig.5)

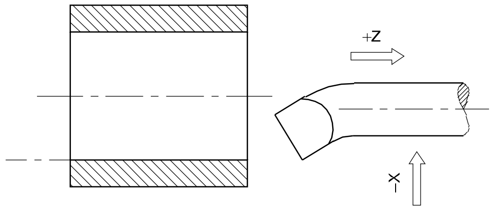
Fig 5



FIN23102H5

Keep the machine and move the carriage to the right until the boring tool clears the hole. (Fig.6)

Fig 6



FIN23102H6

Set a fine feed of about 0.1 mm for the finish cut.

Set the cutting tool for the required depth to get the finished bore size.

Use the cross-slide graduated collar.

Finish the boring operation and measure with a vernier caliper.

To avoid bell mouth, repeat the same cut.

Several cuts taken without adjusting the depth of cut would correct bell mounting.

Remove the sharp corners.

Inside calliper & outside micrometer used for bore measurement

Objective: This shall help you to

- **take the measurement of a bored hole with an inside caliper, transfer it to an outside micrometer and read the measurement.**

Bores are checked for their dimensional accuracy by using:

- Inside micrometers.
- Universal vernier calipers.
- Inside calipers and outside micrometers (transfer measurement).
- Telescopic gauges and outside micrometers (transfer measurement).

The first two methods give direct reading whereas the 3rd and 4th are by transfer measurement.

For checking the bore diameters using inside calipers and outside micrometers the following sequence is to be followed.

Select the inside caliper according to the size of the bore to be measured.

Select an outside micrometer of suitable range for the size of the hole.

Open the legs of the inside caliper approximately permitting its entrance into the hole.

Position one leg in contact with the bottom of the bore.

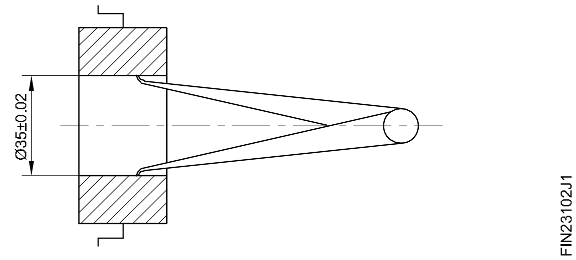
Keeping this as the fulcrum, oscillate the other leg in the bore.

Adjust the distance between the legs by gentle tapping to increase or to decrease so as to enable the leg to enter.

Rock the inside caliper with respect to the axis of the work so as to make the leg of the inside caliper contact the bore top surface. (Fig 1)

If the 'feel' is hard, reduce the distance between the leg tips and if the feel is less or if there is no feel, increase the distance between the leg tips slightly.

Fig 1



Check once again and repeat till you get the correct feel.

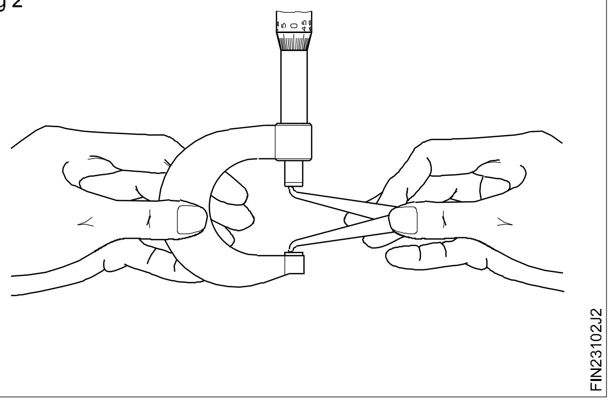
Ensure that the position of the legs is not disturbed, once the correct feel is obtained.

Hold the outside micrometer in one hand, and the spindle away from the anvil face, a little more than the distance between the two legs of the inside caliper.

Hold the inside caliper with the other hand, contacting the tip of one leg with the anvil face of the micrometer.

Oscillate the other leg and rotate the thimble of the outside micrometer to contact the tip of the oscillating leg of the inside caliper. (Fig.2)

Fig 2



Ensure you get the same 'feel' as before.

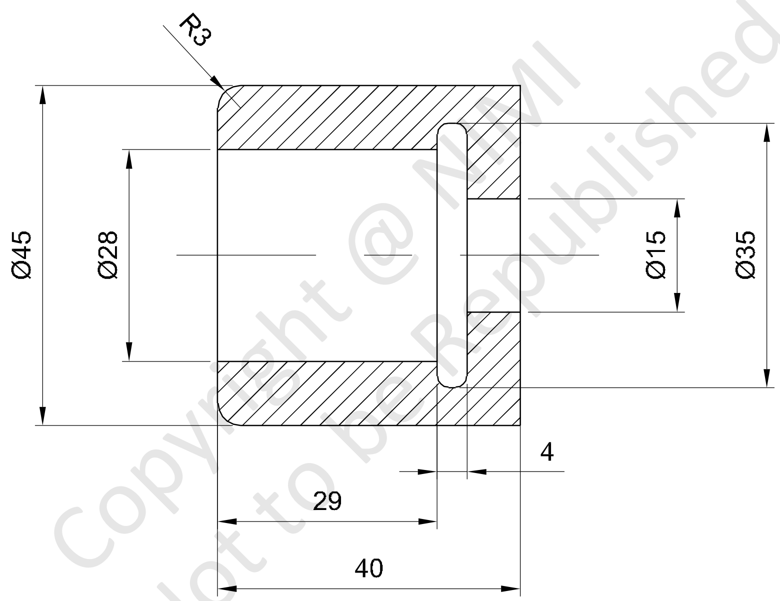
Note the readings on the barrel and thimble of the outside micrometer, and determine the size of the measurement.

The accuracy depends on the skill. Practice to get the correct feel for the measurement.

— — — — — — — —

Make a bush step bore-cut recess, turn hole diameter to sizes

Objectives: At the end of this exercise you shall be able to
- **grind recessing tools**
- **perform step boring**
- **form an internal recess**
- **check the diameter of the recess by a transfer caliper.**



1	Ø50 - 45	–	Fe 310	–	–	2.3.103
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKE A BUSH STEP BORE - CUT RECESS, TURN HOLE DIAMETER TO SIZES.	TOLERANCE : ± 0.04mm	TIME : 5h
		CODE NO. FIN23103E1	

Job Sequence

- Hold the job in a 4 jaw chuck and true.
- Face the end and centre drill.
- Drill ∅10 mm hole through and enlarge to ∅ 14 mm by drilling
- Bore through hole to ∅ 15 mm
- Finish turn the outer dia.to size ∅ 45 mm for possible lenght
- Reverse the job, hold on ∅ 45 mm and true
- Face to maintain the total length of 40 mm.
- Bore ∅ 28 mm to 33 mm length, set the recessing tool
- Form recess 4 mm width as per drawing and R2 ∅ 35 mm.
- Perform R3 on a ∅ 45 at one edge, with a 3R radius tool
- Deburr all the sharp edges and check with the precision instruments.

Points to remember

- Hand feed should be uniform to obtain good surface finish; work with a round nose tool.
- Set the radius tool properly to avoid chattering marks.
- Limit the speed for internal recessing i.e, 1/3rd of the drilling R.P.M.
- Lock the carriage while recessing operation is done, to avoid vibration.
- Use a transfer caliper to measure ∅ 35 mm.
- Check the radius with a radius gauge.

Skill Sequence

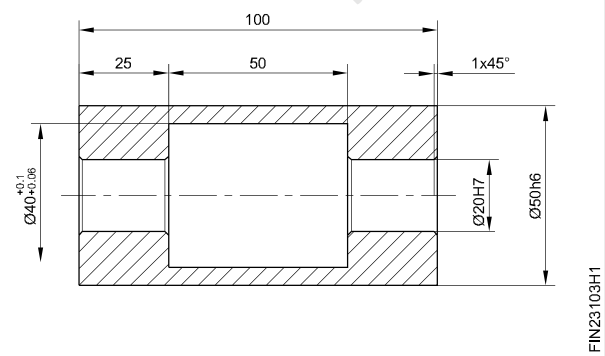
Internal recessing to a size broader than the width of the tool

Objectives : This shall help you to
- **grind an internal recessing tool maintaining a definite width of 4 mm**
- **cut an internal recess of a given diameter for the required width.**

At times, it may be necessary to form the recess for sufficient length for the same diameter. This is necessary to

- Reduce the weight of the bush
- Have contact surfaces with the shaft only at both ends of the bush
- Have parallelism in the bore diameter at both ends. (Fig 1)

Fig 1



A recessing tool is to be ground to a definite width 'w', say 4 mm. The relief given is 2° on both sides. The front clearance is about 12° and the front edge is ground to 45° of the secondary clearance, avoiding the bottom of the tool fouling with the bore diameter. The front cutting edge, 'with a primary clearance of 12°, is kept to about 1/5th of the height 'h' in order to have a maximum portion, ground to the secondary clearance. The cutting edge is ground parallel to the axis. A small back rake of about 6° is ground on top of the cutting edge.(Figs 2 and 3)

Fig 2

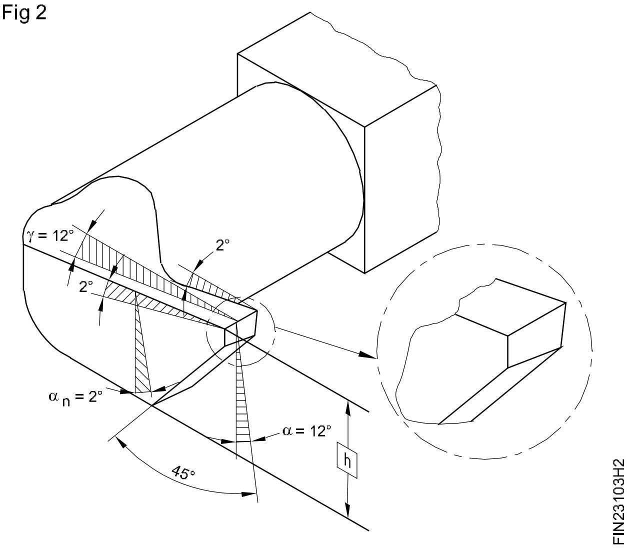
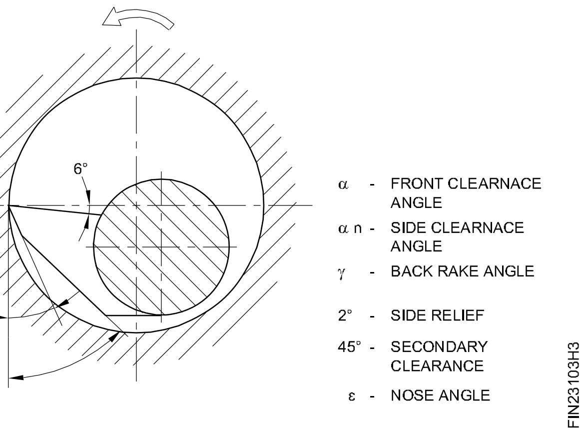


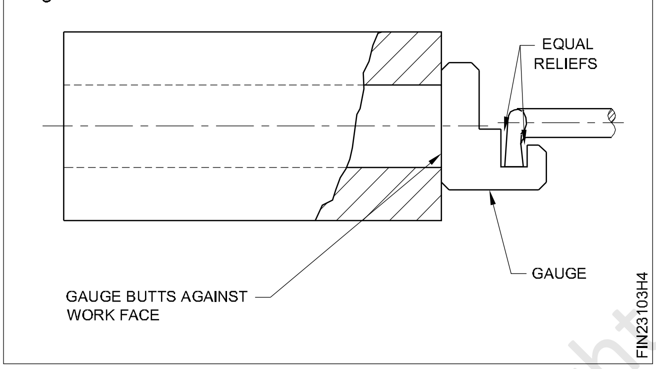
Fig 3



The procedure in sequence is as follows.

Hold and clamp the tool in the tool post to have the cutting edge to exact centre height and parallel to the axis of the work. Use the tool setting gauge as shown in Fig 4.

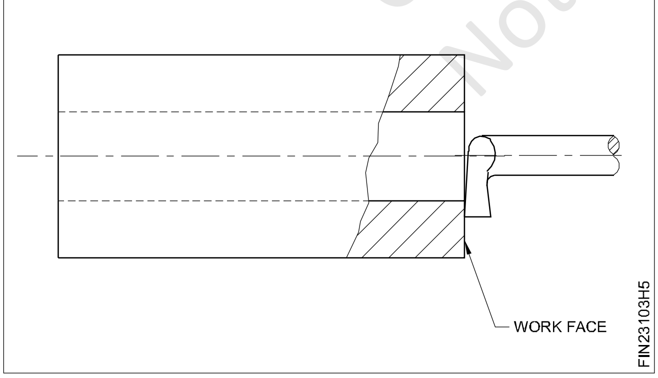
Fig 4



Keep a minimum overhang of the tool.

Touch the leftside of the cutting edge so as to just contact the work face. (Fig 5)

Fig 5



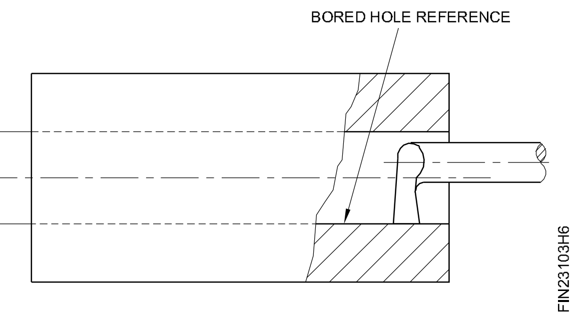
Set the top slide graduated collar to zero with the backlash eliminated.

Set the machine to about 250 r.p.m.

The spindle speed depends upon the material and diameter of the bush.

Lock the carriage and withdraw the tool from the face, and touch the bore diameter with the front cutting edge of the tool. (Fig 6)

Fig 6



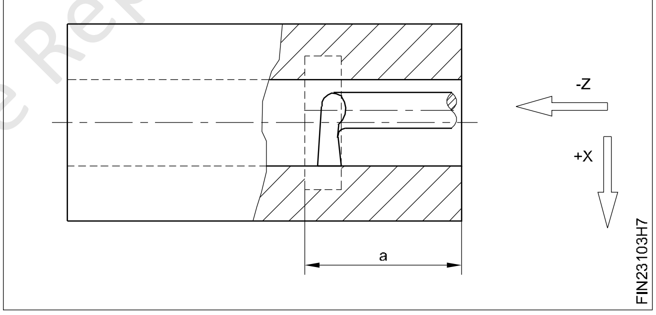
Set the cross-feed graduated collar to zero with the backlash eliminated.

Release the cutting edge from the bore diameter, and position the left side of the cutting edge of the tool at the start of the bore.

The top slide graduated collar reads the previously marked zero setting with the backlash eliminated.

Advance the tool inside the bore till the left side tip of the cutting edge is at a distance equal to the width of the cutting edge + the distance from the front face to the starting position of the recess. (Fig 7)

Fig 7



Example

In the example shown, it is equal to 4 mm +25 mm = 29mm. (Tool cutting edge width ground for 4 mm width).

Rotate the cross-slide hand wheel in the anticlockwise direction till the tool cutting edge touches the bore.

Ensure the graduated collar zero is in line with the fixed mark in this position.

Continue rotating the cross-slide hand wheel in the anticlockwise direction to make the tool advance deep,and form the recess.

Continuous, uniform, and slow feeding is necessary.

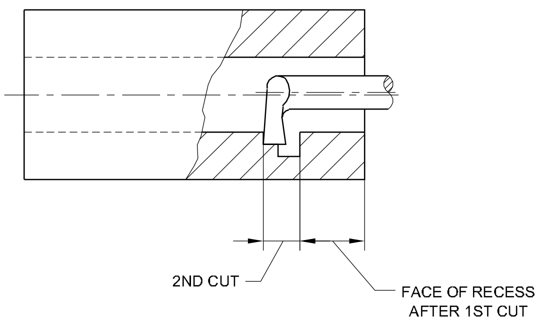
In the example given, the advancement of the tool is 10mm.

Note the cross-feed graduated collar reading in this position.

Rotate the cross-slide hand wheel in the clockwise direction till the tool cutting edge is released from the recess.

Advance the tool axially by the top slide movement for about 3/4th width of the tool. (Fig 8)

Fig 8



FIN23103H8

Rotate the cross-slide hand wheel till the tool tip reaches the same depth (10 mm in the example).

Repeat the steps till the required length of the recess (50mm) is reached.

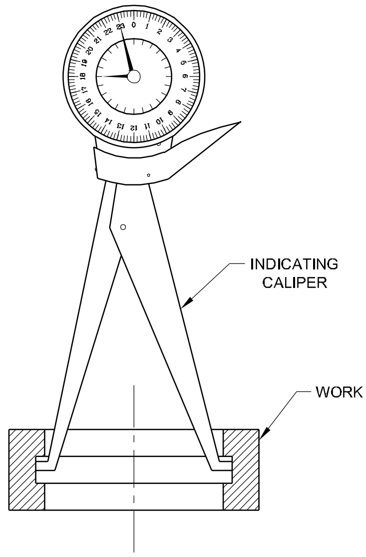
Rotate the top slide graduated collar in the anticlockwise direction, continuously and uniformly to clean the recess till the right hand end of the cutting edge just touches the face at the start of the recess.

Withdraw the tool from the recess and the bore.

Check the diameter of the recess with the indicating caliper. (Fig 9)

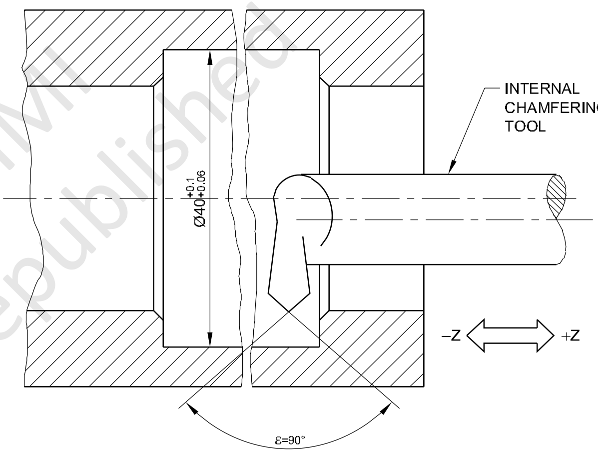
Clamp the internal chamfering tool and chamfer the edges of the recess to remove the burrs. (Fig 10)

Fig 9



FIN23103H9

Fig 10



FIN23103HA

Form a recess

Objectives: This shall help you to
- **set the recessing tool in the tool post**
- **set the tool at the required position**
- **perform different types of recesses**
- **check the recess using an inside caliper.**

Recessing

Recessing is the process of cutting an annular channel inside the bored hole.

To perform recessing, the following procedure is to be followed.

Select an internal recessing tool of the correct width.

Check that the tool or boring bar will clear the work of the bore.

Mount the tool on the tool post.

Align the face of the tool to the wall of the bore.

Calculate the distance from the face to the edge of the groove farthest from the end face.

Turn the top slide handle back to ensure that the slide can move the required distance.

Touch the tool edge to the face of the workpiece using the top slide handle.

The tool may be made to contact the feeler gauge held between the edge of the tool and the face of the workpiece.

Set the compound slide graduated collar to zero.

Turn the cross-slide handle so that the front of the tool just clears the wall of the bore.

Turn the top slide handle to position the tool at the calculated distance into the bore.

If a feeler gauge has been used in the above procedure, allow for the thickness of the gauge when calculating the distance to move the top slide.

Turn the cross-slide hand wheel in an anticlockwise direction to advance the tool and touch the wall of the bore.

Note the cross-feed graduated collar reading.

Rotate the cross-slide hand wheel in the same direction to make the tool to remove the metal from the bore to form the recess.

Feed the tool slowly and continuously till the calculated division of the cross-slide reaches the zero mark.

Reverse the direction of rotation of the cross-slide hand wheel and make the cutting edge clear the diameter of the bore.

Retreat the tool by moving the saddle towards the tailstock.

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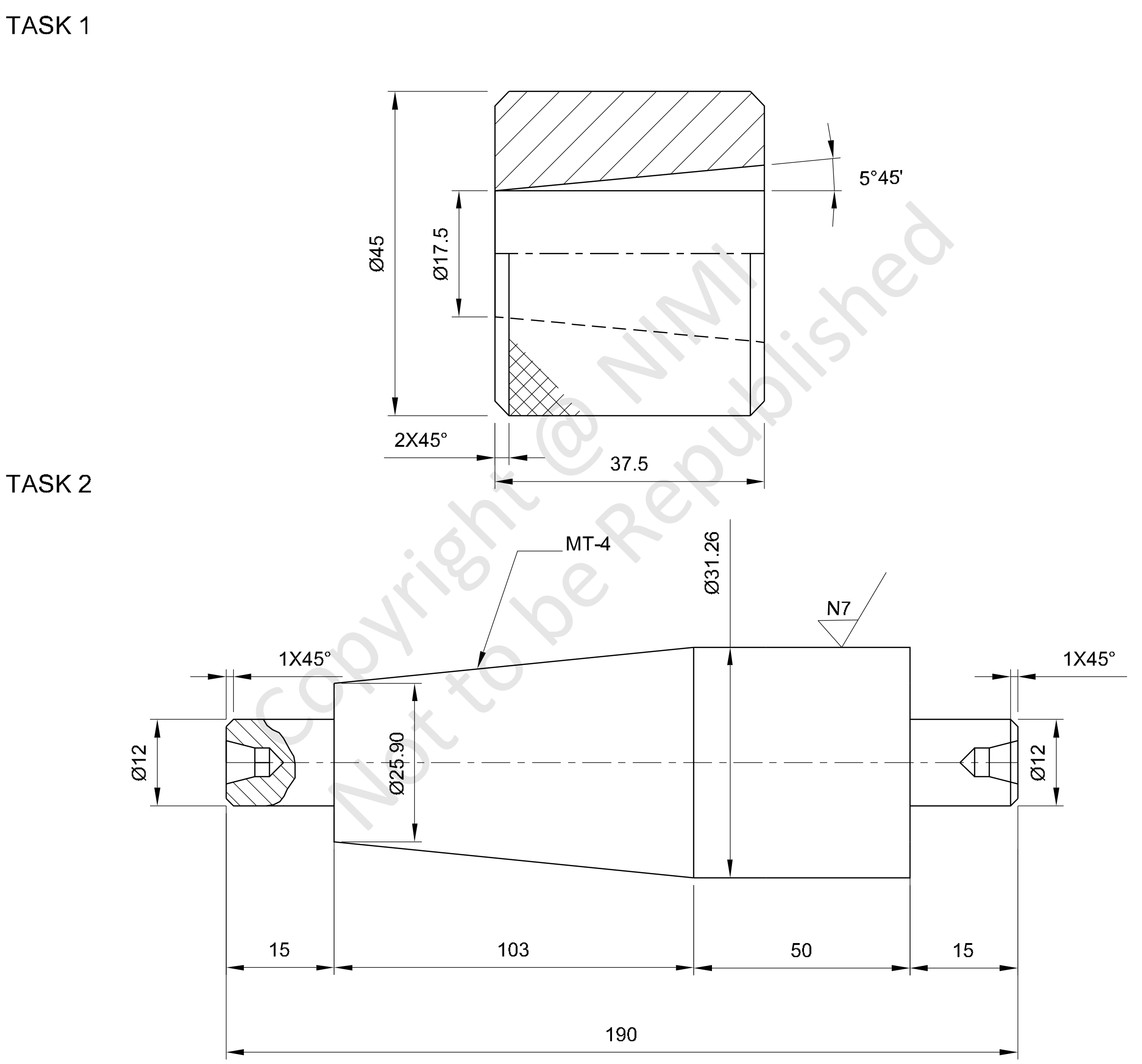
Turn taper (internal and external)

Objectives: At the end of this exercise you shall be able to
- **hold the work in between centres**
- **knurl the surface**
- **produce taper bore by compound slide**
- **set the compound rest to the specified angle**
- **turn the external taper by the compound rest method**
- **check the taper with a vernier bevel protector.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	Ø50 - 45		Fe 310		TASK 1	2.3.104
1	Ø36 - 200	–	Fe 310	–	TASK 2	2.3.104

SCALE 1:1	TURN TAPER (INTERNAL AND EXTERNAL)	TOLERANCE : ± 0.04mm	TIME 10h
		CODE NO. FIN23104E1	

Job Sequence

TASK 1: **Taper turning internal**

- Hold the job in a 4 jaw chuck and true it.
- Set the tool to correct centre height.
- Face one end of the job.
- Turn ∅ 44.75 mm to a length of 45 mm.
- Set the knurling tool (diamond cut) to correct centre height.
- Knurl the job to a length of 40 mm.
- Drill pilot hole ∅ 16 mm by drilling
- Chamfer 2x45°.
- Set the parting tool to centre height and cut off to a length of 40 mm.
- Hold the knurled job and face the ends to maintain a length of 37.5 mm.
- Chamfer the end to 2x45°.
- Set the compound rest to the 5° 45' with the help of a vernier bevel protractor.
- Set the boring tool, to the correct centre height.
- Turn taper as per drawing.
- Match the taper.

Safety precautions

- Remove all sharp comers.
- Use slow speed while knurling.
- Use plenty of coolant while drilling, taper turning and knurling.

— — — — — — —

TASK 2: **Taper turning external**

- Check the raw material size.
- Hold the job in between centres.
- Turn the step ⌀12 x 15 mm long at the taper end.
- Turn MT4 taper by attachment method
- Reverse and refix between centres.
- Turn the step ⌀12 x 15 mm long from the other end of job.
- Calculate the setting angle of the compound rest using the formula
- Swivel the compound rest slide to the above angle using a vernier bevel protractor.
- Turn the taper by using the top slide feed and maintain the major dia. to 31.26 mm. minor dia to 25.90 mm and length to 103 mm.
- Check the size of the job with a vernier bevel protractor and vernier caliper.

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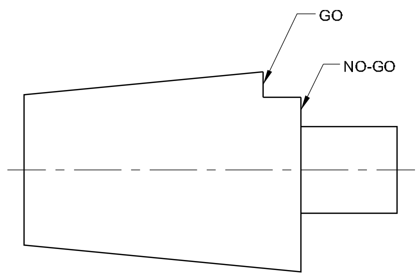
Skill Sequence

Checking a tapered bore using a taper limit plug gauges

Objective: This shall help to you
- **check the internal taper with taper plug gauge.**

A taper limit plug gauge ensures the accuracy of the angle and the linear dimensions of the taper bore. (Fig 1)

Fig 1

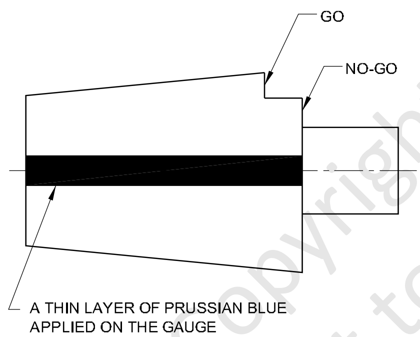


TAPER LIMIT PLUG GAUGE

Clean the tapered bore.

Apply a thin layer of prussion blue on the traper limit plug gauge along its length. (Fig 2)

Fig 2

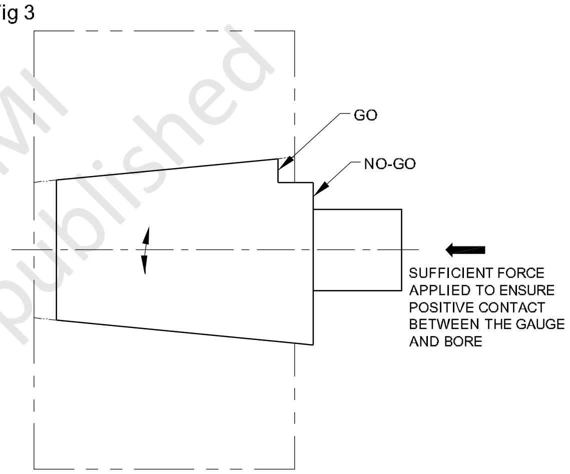


Assemble the taper plug gauge inside the tapered bore carefully with sufficient force to ensure positive contact between the gauge and the bore, and give one quarter twist to the plug gauge.

Carefully remove the taper limit plug gauge and check if the prussion blue is rubbed off uniformly, atleast to about 75% of its area. This ensures the accuracy of the angle required.

Then once again insert the taper plug gauge inside the taper bore and check, if the big dia, end of the bore falls within the 'Go' and 'No-Go' limits marked on the gauge, this ensures the dimensional accuracy of this tapered bore. (Fig 3)

Fig 3



LINEAR DIMENSIONS OF THE BORE WITHIN LIMITS

Turning taper by compound slide swivelling

Objectives: This shall help you to
- **turn the taper using a compund slide**
- **check the taper with a vernier bevel protractor.**

One of the methods of turning taper is by swivelling the compound slide and feeding the tool at an angle to the axis of the work by hand feed. (Fig 1)

Set and true the job turned to the bigger diameter of taper.

Set the machine to the required rpm.

Loosen the top slide clamping nuts.

Swivel the top slide to half the included angle of the taper as shown in Fig.2.

Ensure that equal pressure is exerted by the spanner for both the nuts.

Fix the turning tool in the tool post to the correct centre height.

Keep a minimum overhang of the tool.

Set the top slide to the rearmost position.

Position the saddle such that the tool is able to cover the full length of the taper to be turned.

Ensure that the top slide does not travel beyond the edge of the base.

Fig 1

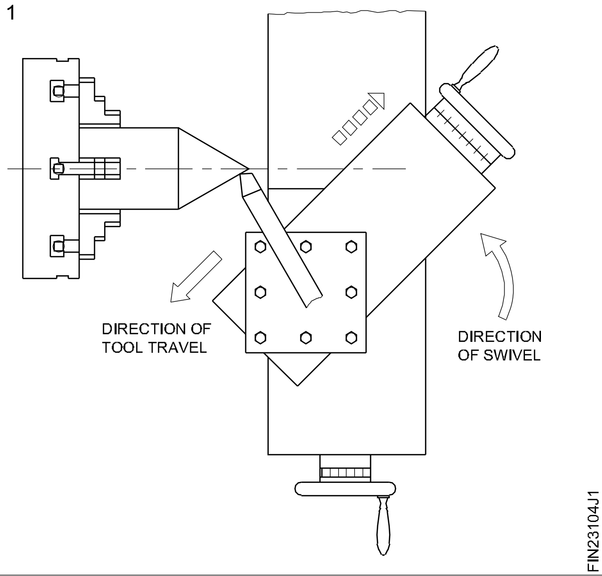
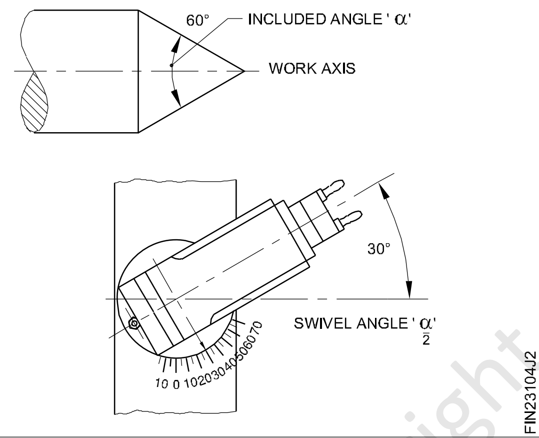


Fig 2



Lock the carriage in position.

Touch the tool to the work - surface during running and set the cross-slide graduated collar to zero.

Bring the tool to clear off the work by the top slide hand wheel movement.

Give a depth of cut by the cross-slide and feed the tool by the top slide hand wheel till the tool clears from the work.

Feeding by the top slide must be uniform and continuous.

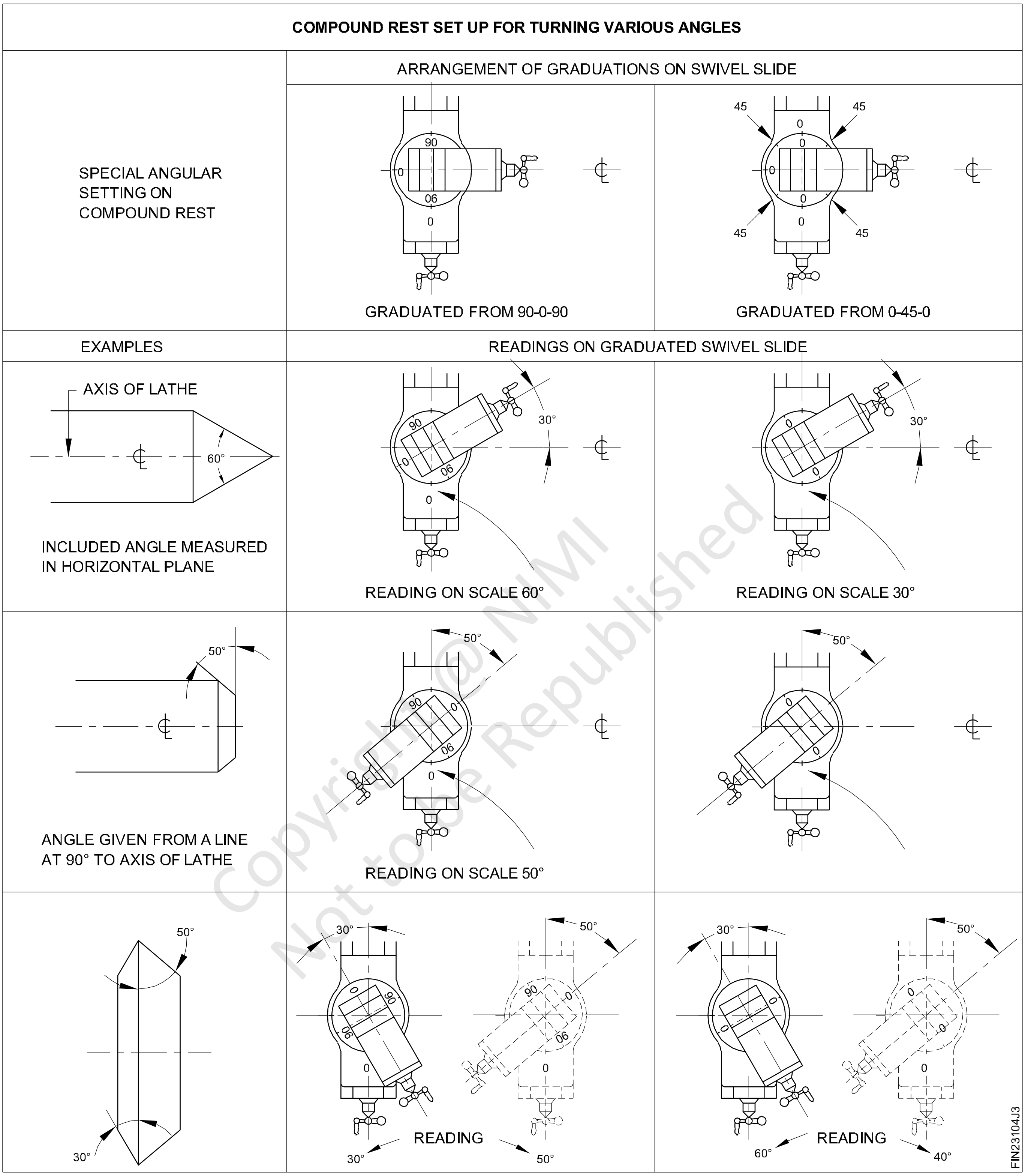
Give successive cuts by the cross-slide and feed the top slide each time.

Check the angle of the turned job with a vernier bevel protractor.

Adjust the swivel if there is any difference.

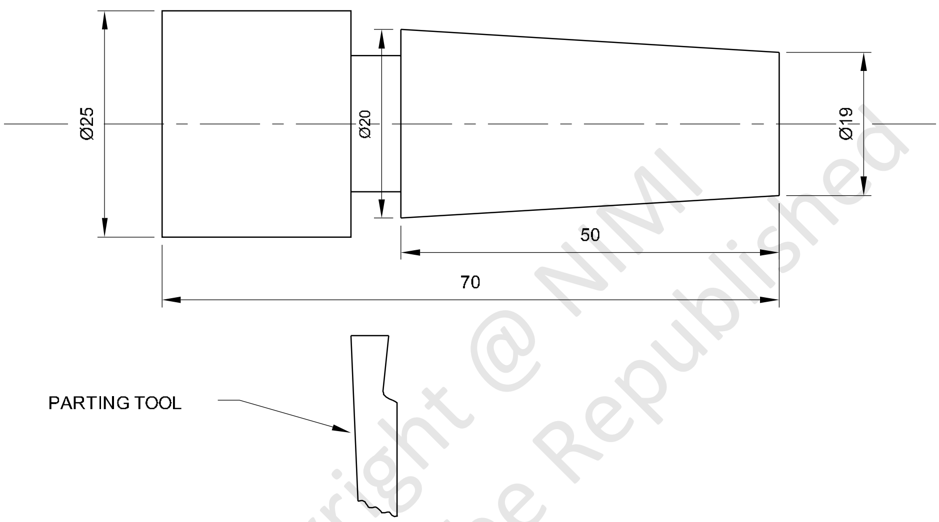
Continue the taper turning and finish the taper.

Compound rest setup for turning various angles



Turn taper pins

Objectives: At the end of this exercise you shall be able to
- **set the job on a four jaw chuck**
- **set the tool in the tool post**
- **set the taper turning attachment to the required angle**
- **turn the job in diameter 1:50 taper ratio.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	Ø25 - 75	–	Fe 310	–	–	2.3.105

SCALE 1:1	TURN TAPER PINS	TOLERANCE : ± 0.04mm	TIME : 5Hrs
		CODE NO. TU1215E1	

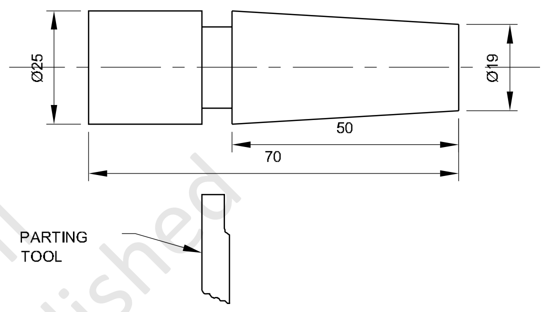
Job Sequence

- Check the raw material size.
- Set the job on a four jaw chuck.
- True the job
- Turn the job ∅ 20 mm up to the length of 55 mm
- Set the tapper turning attachment
- Turn the diameter taper ration of 1:50
- Check the diameter of both end as ∅ 20 and ∅ 19
- Set the parting tool
- Feed the cut and remove the length of 50 mm.

Skill Sequence

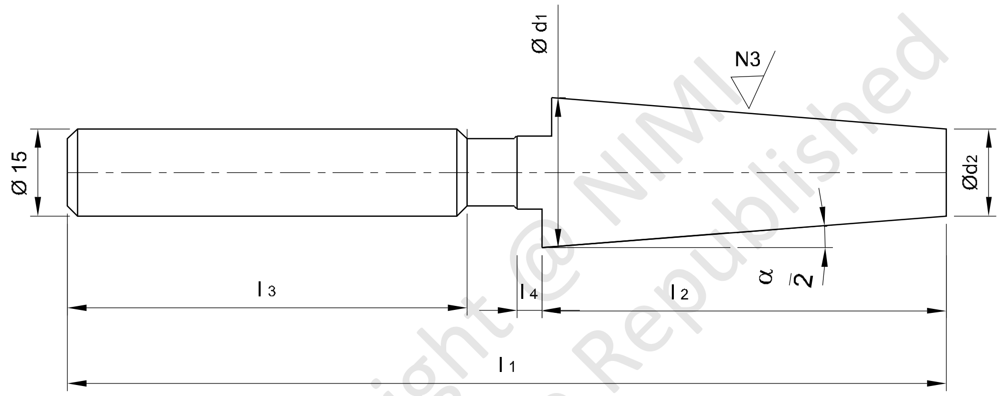
Do not part off component before check the diameter of both end and length of 50 mm. (Fig 1)

Fig 1



Turn standard tapers to suit with gauge

Objectives: At the end of this exercise you shall be able to
- **set the job on a four jaw chuck**
- **set taper turning attachment to turn taper**
- **set the tool in the tool post**
- **turn standard taper MT3**
- **check the taper with gauge.**



DESIGNATION OF TAPER	d_1 js5	d_2	l_1	l_2 js8	l_3	l_4	Z ±0.05	$\frac{\alpha}{2}$	AT_D µm
MT3	23.825	17.5	176	81	80	5	1.0	1°26'16"	+5.1

CONE ANGLE TOLERANCE(AT_D) IS AT_4 GRADE OVER LENGTH 'l_2' AS PER IS 7615-1975 SYSTEM OF CORE TOLERANCE

1	Ø25 - 180	–	Fe 310	–	–	2.3.106
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	TURN STANDARD TAPERS TO SUIT WITH GAUGE	TOLERANCE ± 0.04mm	TIME 5Hrs
		CODE NO. FIN23106E1	

Job Sequence

- Set the job in four jaw chuck projecting [(l_1 - l_2 + 10 mm)] outside the chuck.
- True it by universal surface gauge.
- Set the carbide tip tool to the correct centre height for facing with offset facing tool.
- Set offset side cutting tool for turning.
- Set the spindle speed as per the cutting speed chart.
- Face the one end.
- Turn dia 15mm for a length equal to (l_1 - l_2).
- Form grooving, after leaving l_3 from the end and maintain dia d_2.
- Chamfer the two ends of ∅ d_2 to 1x45°.
- Reverse the job and hold turned dia d_2 by giving aluminium/copper sheet as a packing.
- True the job by using suface gauge.
- Face the end to maintain a length of l_1 .
- Turn dia d1 and check by using vernier micrometer.
- Set the taper turning attachment to turn a taper of 1°26'16".
- Turn taper MT3 and check the dimensions as per the drawing by using vernier micrometer and vernier bevel protractor.
- Check the taper with gauge.

Skill Sequence

Producing taper by using taper turning attachment

Objectives: this shall help you to
- **set the taper turning attachment to the required angle**
- **produce taper by using a taper turning attachement.**

A taper turning attachment provides a quick and accurate means of turning tapers.

The following procedure is to be followed during turning taper using a taper turning attachment.

Check for backlash between the guide bar and the sliding block, and adjust, if necessary.

Clean and oil the guide bar.

Loosen the locking screws, then swivel the guide bar to the required angle.

Tightern the locking screws.

Adjust the base plate until the ends of the guide bar are equidistant from the cross-slide extension.

Set up the cutting tool on exact centre.

Any error will result in an incorrect taper

Mount the workpiece on the chuck or between centres.

Adjust the carriage until the cutting tool is approximately opposite to the centre of the tapered section.

Lock the clamping bracket to the lathe bed to secure the taper turning attachment in this position.

When using a plain taper turning attachment, follow the steps given below at this stage.

Adjust the top slide so that it is parallel with the cross-slide, i.e at 90° to the work.

Set up the cutting tool for the correct position.

Wear safety goggles.

Set the required r.p.m

Feed the cutting tool in until it is about 6 mm from work surface.

Remove the locking screws which connect the cross-slide and the cross -slide nut.

Use the blinding lever to connect the cross-slide extension and sliding block.

Insert a suitable plug in the hole on the top of the cross slide to protect the cross-slide screw from dirt and chips.

The compound slide must now be used to feed the cutting tool into the work.

Move the carriage to the right until the cutting tool is 12 mm away from the right hand end of the workpiece.

This removes any play in the moving parts of the taper turning attachment.

Switch on the lathe.

Take a light cut of about 2 mm long and check the end taper for size.

Set the depth of the roughing cut.

Machine the work as with plain turning.

Remove the play by moving the cutting tool 12 mm beyond the right hand end of the work at the beginning of each cut.

Check the taper for fit.

Readjust the taper turning attachment, if necessary a light cut and recheck the taper.

Finish the taper to size and fit it to the taper gauge.

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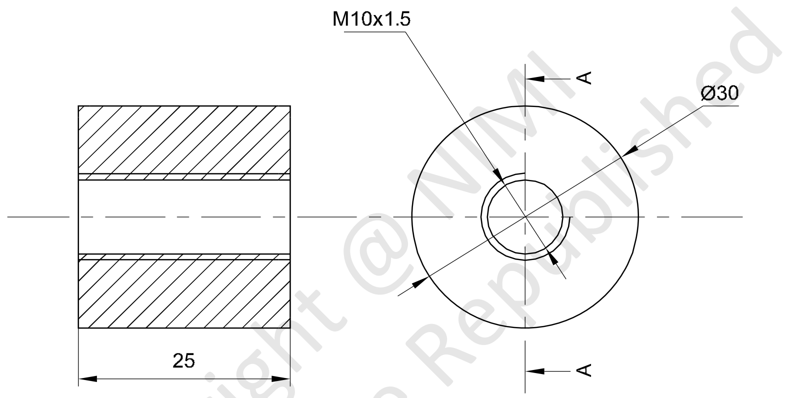
Practice threading using taps, dies on lathe by hand

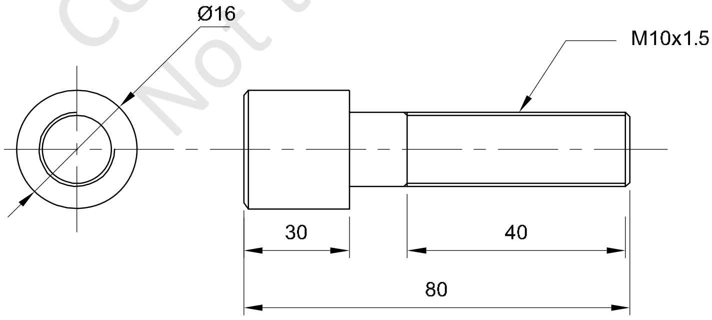
Objectives: At the end of this exercise you shall be able to
- **set the job in a three jaw chuck**
- **drill through hole**
- **cut internal thread in a lathe using tap and tap wrench**
- **set the pre machined round rod with three jaw chuck**
- **cut external thread in a lathe using die and die stock.**

TASK 1



SECTION -A A

TASK 2



1	Ø16 - 85	–	PRE-MACHINED ROUND ROD	–	TASK 2	2.3.107
1	Ø30 - 30	–	PRE-MACHINED ROUND ROD	–	TASK 1	2.3.107
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PRACTICE THREADING USING TAPS,DIES ON LATHE BY HAND	TOLERANCE : ± 0.04mm	TIME : 2h
		CODE NO. FIN23107E1	

Job Sequence

TASK 1:

- Check the raw material size.
- Hold the job in a 3 jaw chuck
- Centre drill and drill ∅ 8.2 mm for M10
- Chamfer the drilled hole on both sides.
- Fix the tap wrench to the square end of first tap
- Place the first tap taper lead in hole and support other end with tail stock dead centre.
- Form thread by first tap, second tap and third tap one by one by hand rotate clock wise slowly and half rotation to release chips till you get the full formation of internal thread.
- Apply oil and clean burrs
- Check the thread hole by M10 bolt.

— — — — — — —

TASK 2:

- Check the raw material for its size.
- Hold the job in a 3 jaw chuck
- Turn the job for blank size of ∅ 9.85 mm to 50 mm length
- Chamfer the end of the job.
- Hold the die parallel to job face.
- Rotate the die for a thread forward and for half thread backward with appropriate push to cut thread and remove chips.
- Increase the depth of cut gradually and cut thread to match M10 nut by adjusting the screws provided in the die stock.
- Check the thread with the matching round nut (Task 1).
- Clean the threads without burrs.
- Apply a little oil and preserve it for evaluation.

Note: The tap wrench and die stock handle must be short enough to ensure to rotate on lathe bed.

— — — — — — —

Skill sequence

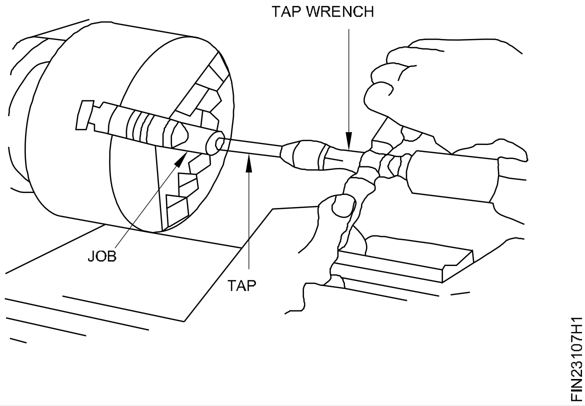
Objective: This shall help you to

- **cut internal and external thread in lathe using tap and die.**

TASK 1:

Cutting internal thread using tap and tap wrench in lathe. (Fig 1)

FIG 1



TASK 2:

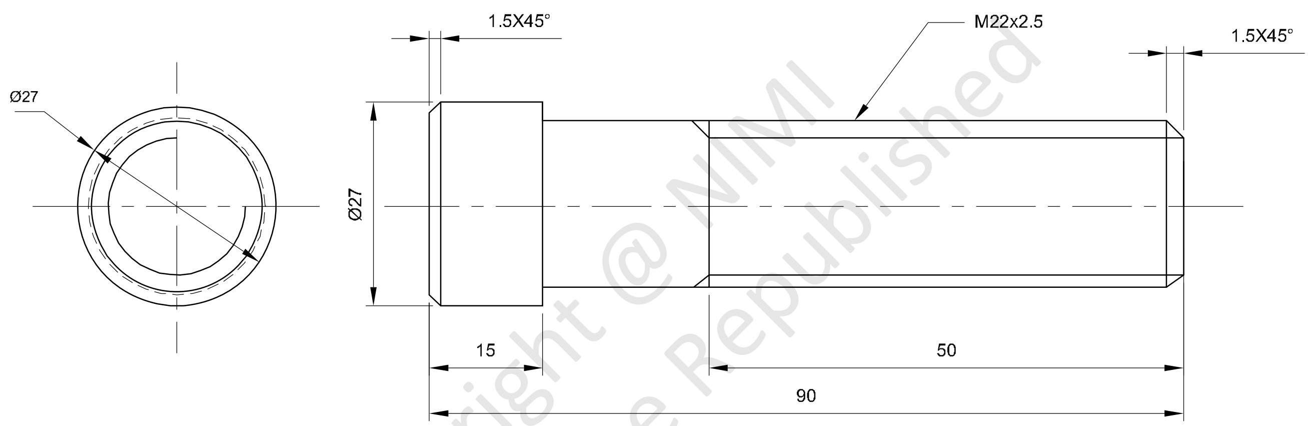
Cutting external thread using die and die stock in lathe. (Fig 2)

Fig 2

— — — — — — —

Make external ‘V’ thread

Objectives: At the end of this exercise you shall be able to
- **hold the job in lathe machine**
- **turn and chamfer as per drawing**
- **grind threading tool to cut metric thread on lathe**
- **cut metric thread on lathe by single point tool**
- **check the metric thread using thread ring gauge.**



1	Ø30 - 100	–	Fe 310	–	–	2.3.108
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MAKE EXTERNAL 'V' THREAD			TOLERANCE : ± 0.04mm		TIME : 8Hrs
				CODE NO. FIN23108E1		

Job Sequence

- Check the raw material size.
- Hold the job in the chuck with 40 mm overhang and true it.
- Face end and turn to ∅ 27 mm to maximum length possible.
- Chamfer 1.5×45° at the end.
- Reverse and hold the job in the chuck with 75 mm overhang, face and centre drill.
- Chamfer 1.5×45° at the end.
- Turn the job to ∅ 22 mm to length of 75 mm.
- Chamfer 1 x 45° at the end.
- Set the metric 'V' threading tool in the tool post and with the help of centre gauge, set threading tool perpendicular to the axis.
- Set the machine for 2.5 mm pitch to cut right hand thread.
- Set across slide graduation collar to size.
- Cut right hand metric 'V' thread, giving depth of cut by the cross slide for successive cuts.
- Withdraw the tool at the end of each cut by the cross slide. Again advance to zero before giving depth of cut by the cross slide.
- Rough and finish the thread and check with a thread ring gauge.

Skill Sequence

Chamfering on lathe

Objective: This shall help you to
• **chamfer the end to required size.**

Grind the tool to the given angle usually 45°.

Mount the tool and set centre height properly.

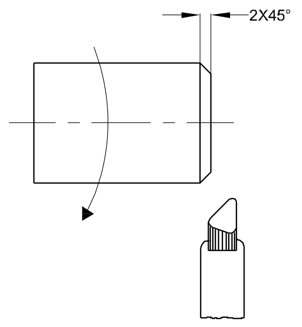
Set the speed, lock the carriage.

Move cross slide and plunge the tool to the required size.

Check the length of chamfer by vernier caliper.

> **If the protruding length is greater, support with centre.**
>
> **Make sure the tool is perpendicular to the lathe axis.**

Fig 1



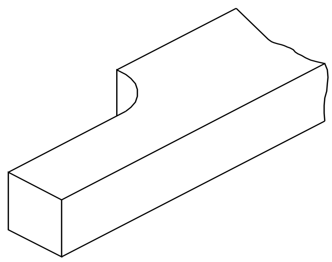
Grinding 60° threading tool

Objective: This shall help you to
• **grind 60° threading tool.**

Set the pedestal grinder for tool grinding.

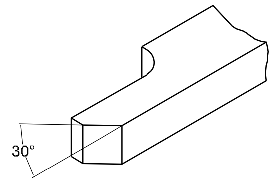
Remove excess material on right hand side of the tool to length equal to thickness of tool and width being half of the thickness of tool on rough grinding wheel. (Fig.1)

Fig 1



Hold the tool at an angle of 60° to the face of the wheel, grind 30° on left hand side of the tool. (Fig.2)

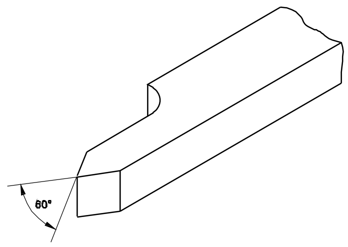
Fig 2



FIN23108J2

Repeat the above procedure on the right side of the tool to get an included angle of 60° on the tool. (Fig.3)

Fig 3



FIN23108J3

Grind 6° to 8° side clearance angle on each side of the tool.

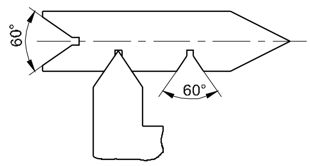
Grind 4° to 6° front clearance angle.

Finish all slides by using smooth grinding wheel.

Do not Grind Rake Angle

Check the tool by centre gauge, there light should not pass through gauge and cutting edge of the tool. (Fig.4)

Fig 4



FIN23108J4

Cutting point is curved to 0.14 × pitch by carefully grinding in smooth wheel.

Finally Lap the tool by applying oil stone on cutting edges.

Safety precautions

Ensure grinding wheels are properly guarded.

Keep 2 mm gap between tool rest and grinding wheel face.

Ensure cutting edge is visible to the operator while grinding.

Do not give too much pressure on the wheel face.

Frequently cool the tool in coolant.

Cutting 'V' thread by plunge cut method

Objective: This shall help you to

- **cut 'V' thread using a single point tool on a lathe by the plunge cut method.**

Thread has coarse and fine pitches according to their usage. Standard fine pitch threads, both external and internal, are generally cut by using taps and dies. When they are produced in large quantities, different methods are adopted on different machine tools. However, at times, it may be necessary to cut threads by a single point tool on a centre lathe.

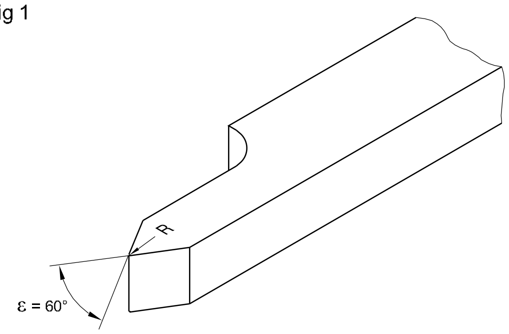
The plunge cut method of threading by a single point tool is done by plunging the tool into the work to produce the thread form. The tip of the tool, as well as, the two flanks of the tool will remove metal during thread cutting and hence the load on the tool will be more. As the possibility of obtaining a good finish on the thread is limited, this method is applicable to fine pitch thread cutting.

The following is the procedural sequence in cutting the 'V' thread by the plunge cut.

Grind a 'V' thread tool for the required thread angle. (Fig.1)

Ensure that the thread angle ground is symmetrical with respect to the axis of the tool.

Fig 1



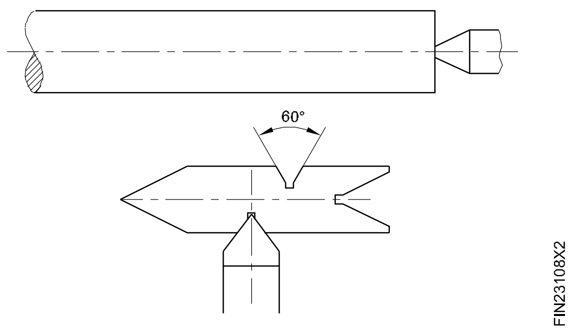
FIN23108X1

Arrange the change gear train and set the quick change gearbox levers for the required pitch and hand of thread.

Clamp the tool in the tool-post and set the tool to centre height.

Set the tool perpendicular to the lathe axis by using centre gauge. (Fig.2)

Fig 2



Ensure that the top slide is set at 0°, and slackness is removed by gib adjustment.

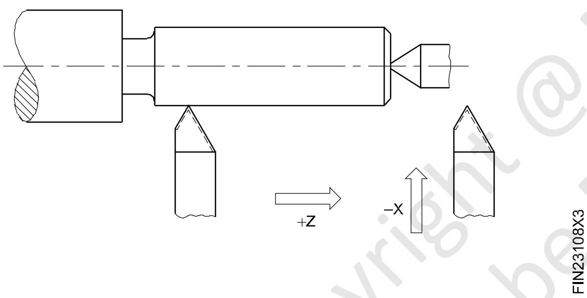
Set the machine to about 1/3rd of the rough turning r.p.m.

Start the machine and touch the tip to work. (Fig.3) set the cross-slide and the compound slide graduated collars to zero, eliminating backlash.

Bring the tool to the starting point and engage the half nut.

Allow the tool to take the trial cut, the depth being given 0.05 mm divisions of the cross-slide graduated collar.

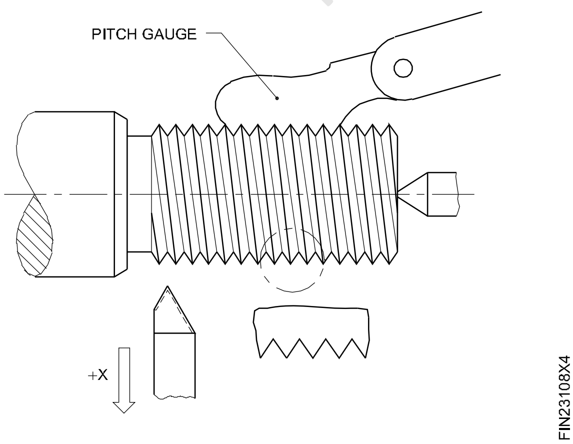
Fig 3



Withdraw the tool at the end of the cut and stop the machine. (Fig.4)

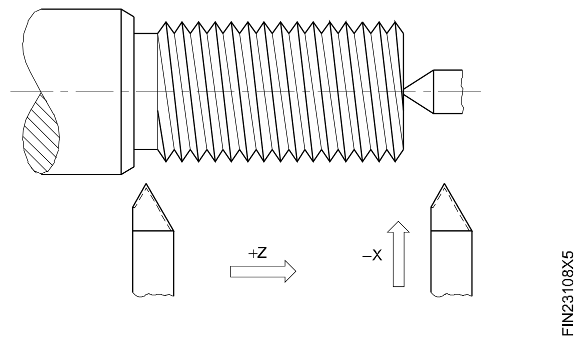
Check with the screw pitch gauge to confirm the gear box setting. (Fig.4)

Fig 4



Reverse the machine to bring the carriage to the starting point. (Fig.5)

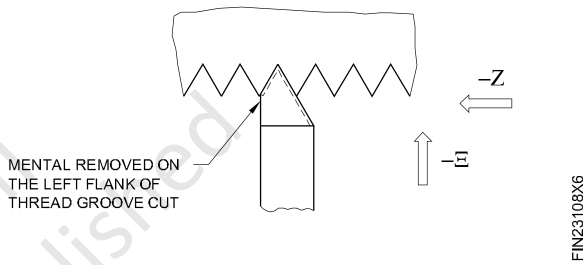
Fig 5



Give successive cuts.

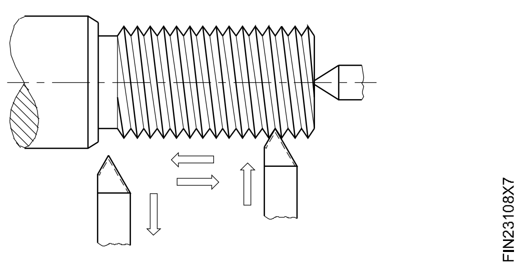
For every 3 depths of cuts by the cross-slide, give one axial cut by feeding the tool axially by half division of the compound slide. This relieves the load on the tool. (Fig.6)

Fig 6



Continue the sequence till the thread profile is formed. (Fig.7)

Fig 7

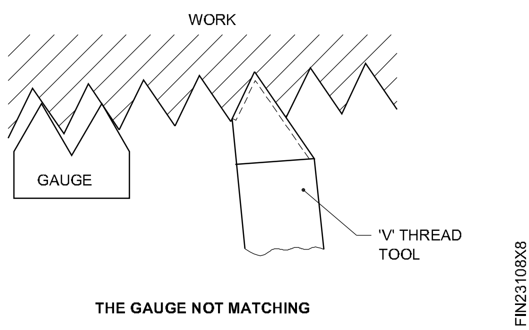


Check with the screw pitch gauge for the thread form.

Match the mating component to ensure the class of fit.

If the tool is not set square to the axis of the work, the gauge will not match with the thread. (Fig. 8)

Fig 8



In the plunge cut method of thread cutting with a single point tool on a lathe, the accuracy of the thread is greatly influenced by:

- The correctness of the tool profile.
- The accuracy with which the tool is set square to the axis of the work.
- The number of plunge cuts (depth of cut) given
- The relative number of side cuts (preferably on both flanks) given.

Effect of grinding positive back rake angle of 'V' thread tool and threads cut. (Figs 9 & 10)

Fig 9

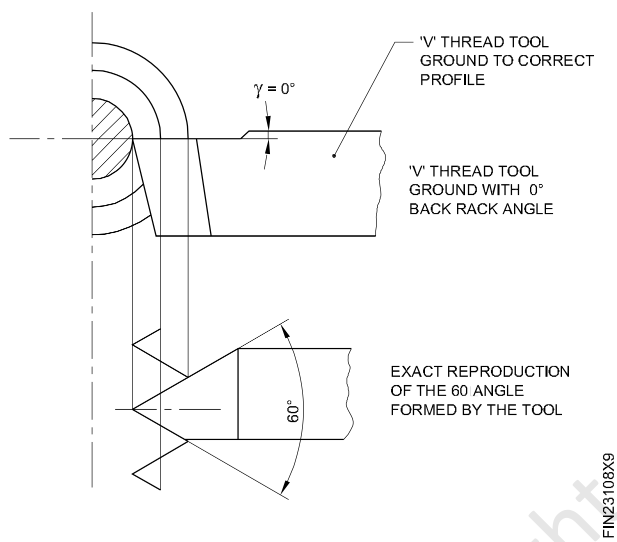
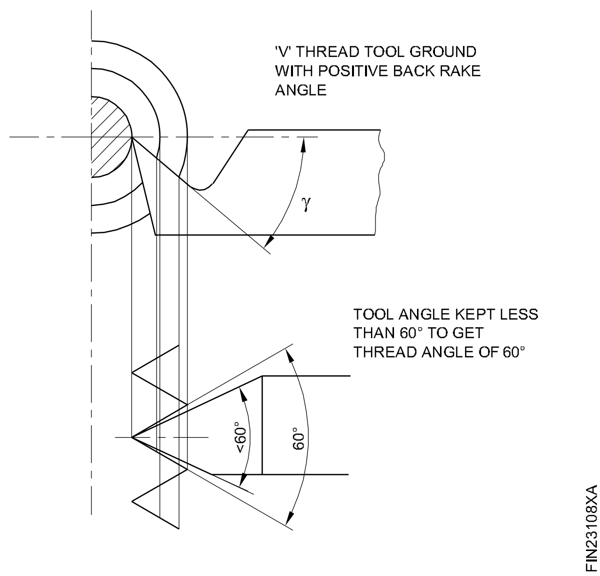
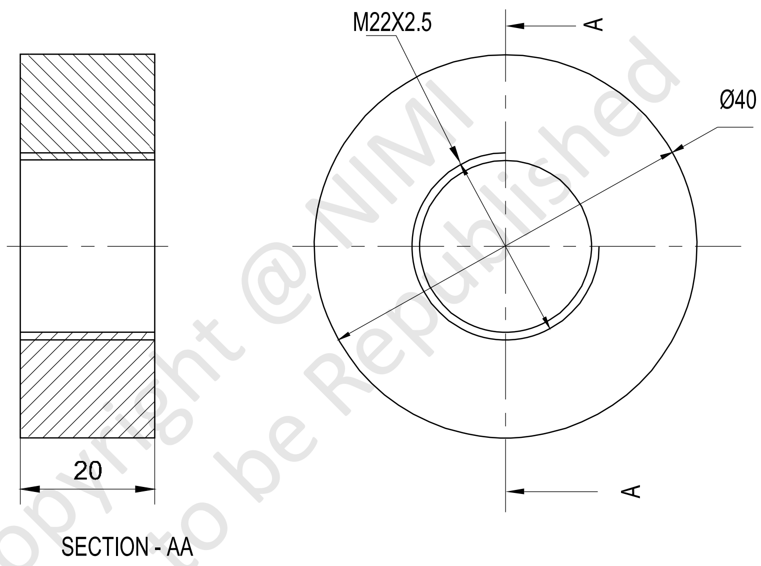


Fig 10



Prepare a nut and match with the bolt

Objectives: At the end of this exercise you shall be able to
- **cut internal 'V' thread by single point threading tool**
- **check the metric thread using thread plug gauge**
- **match the nut and bolt.**



1	Ø45 - 25	–	Fe310	–	–	2.3.109
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PREPARE A NUT AND MATCH WITH THE BOLT	ACCURACY ±0.04mm	TIME 15Hrs
		CODE NO. FIN23109E1	

Job Sequence

- Check the given material for its size by steel rule.
- Hold the work in a three jaw chuck about 10 mm inside the chuck.
- Turn the outer dia to 40 mm to possible length.
- Chamfer the edge 1x45° by chamfering tool.
- Centre drill, and drill a pilot of ∅ 10 mm through hole.
- Enlarge the drilled hole dia 10 mm ∅ 18 mm by drilling.
- Bore the drilled hole to the core (root) diameter of the thread i.e. 19.2 mm.
- Set the machine to cut 2.5 mm pitch internal thread.
- Cut the internal thread.
- Check the thread with screw pitch gauge.
- Check the thread with external thread mating parts Ex. 2.3.107
- Reverse and hold the work on ∅ 40 mm and true it.
- Face the end of the work, and maintain a total length of 20 mm.
- Chamfer 1x45° on the outer edge.
- Remove the sharp edges and have a final check.

Skill Sequence

Cutting an internal thread

Objective: This shall help you to

- **cut an internal thread on a centre lathe.**

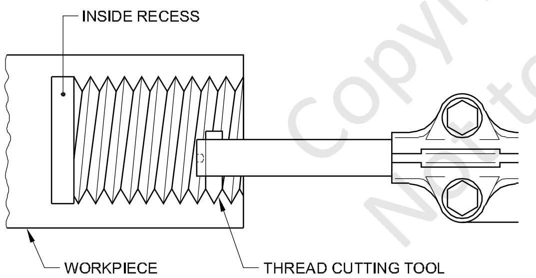
Mount the job on four jaw chuck / three jaw chuck/ collet.

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 2×45°.

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

Set the gear box levers to the required pitch.

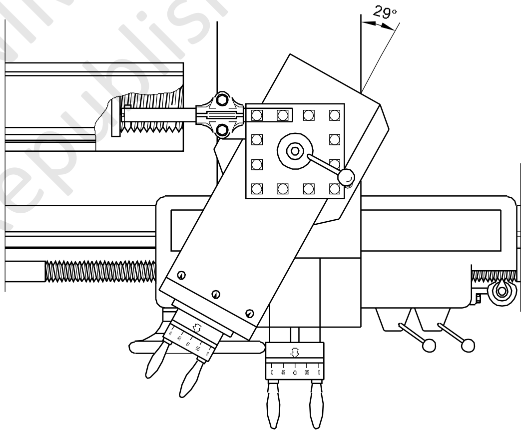
Fix the correctly ground threading tool in a boring bar.

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.

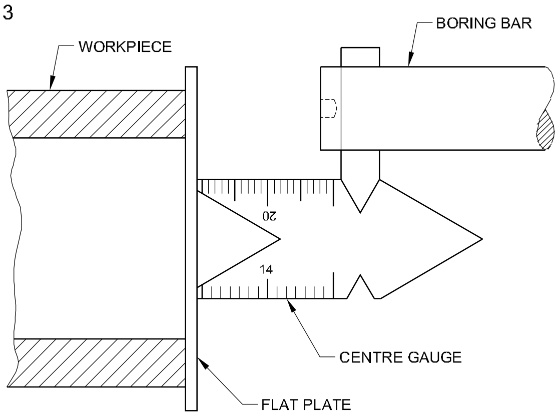
Mark the boring bar to indicate the required depth of entry into the bore.

Fig 2



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

Fig 3



ALIGNING THE CUTTING TOOL WITH A CENTRE GAUGE

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 compound 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 chuck 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.

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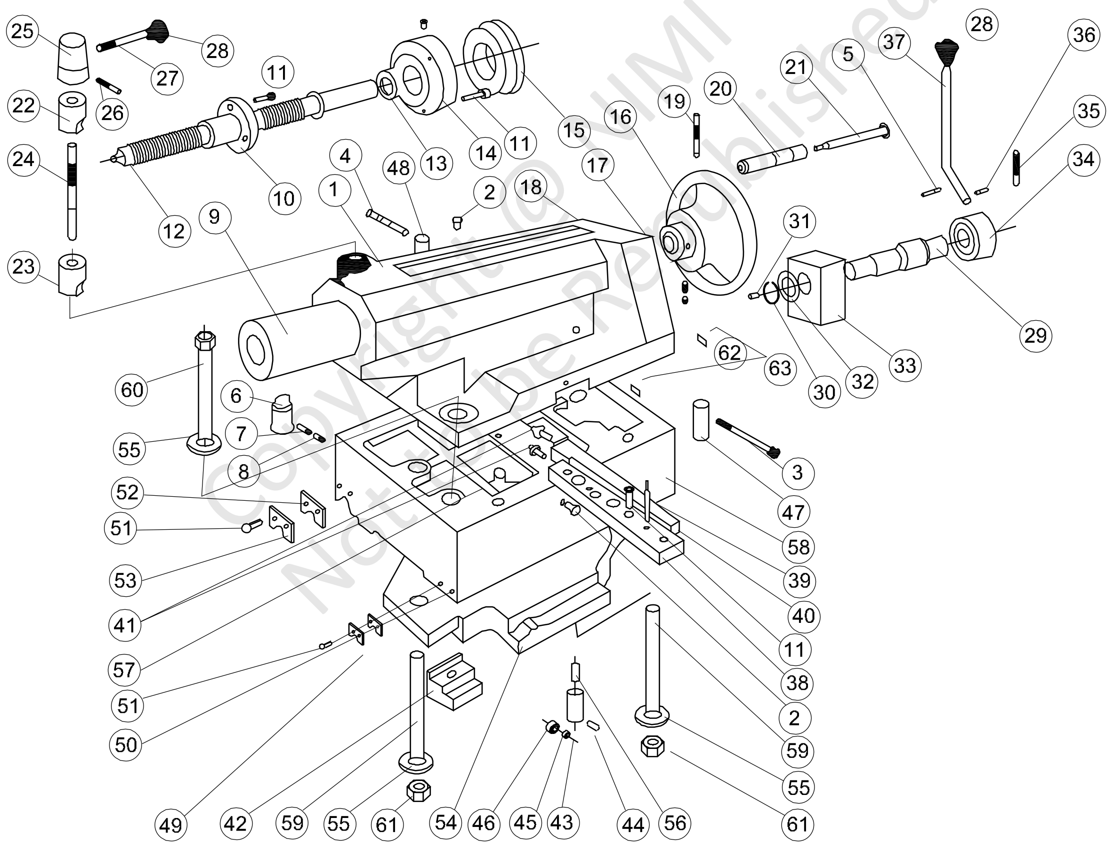
Simple repair work - simple assembly of machine parts from blue prints

Objectives: At the end of this exercise you shall be able to
- **identify the defects in tail stock assembly**
- **dismantle the tail stock assembly**
- **identify the defective/worn out parts**
- **prepare the defective parts**
- **assemble in the tail stock**
- **check the tail stock performance.**

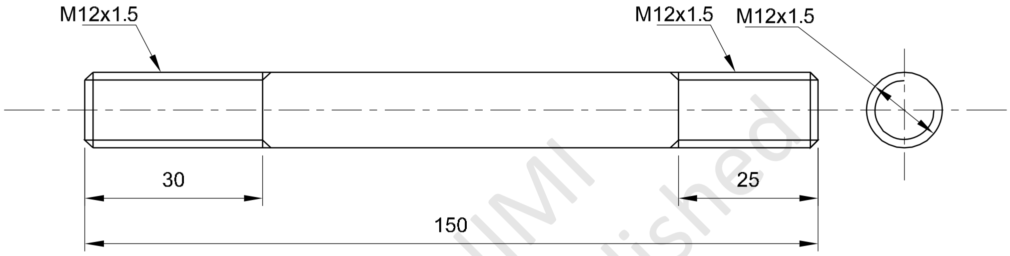
TASK-1 DISMANTLE THE TAIL STOCK AND KEEP THE PARTS IN A SEPARATELY AND IDENTIFY THE DAMAGED WORNOUT PARTS



1	Ø14-155	SCREW ROD	Fe310	TAIL STOCK REPAIR WORK	24	2.4.110
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**SIMPLE REPAIR WORK:SIMPLE ASSEMBLY OF MACHINE PARTS FROM BLUE PRINTS**	DEVIATIONS ±0.04 mm	TIME 15Hrs
		CODE NO. FIN24110E1	

TASK-2 PREPARE A NEW SCREW ROD INSTEAD OF WORNOUT SCREW ROD



-	-	–	-	–	24	2.4.110
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**SIMPLE REPAIR WORK:SIMPLE ASSEMBLY OF MACHINE PARTS FROM BLUE PRINTS**	DEVIATIONS	TIME
		CODE NO. FIN24110E2	

Job Sequence

Identification of defects in a tail stock

- Identify defect in a tail stock.
- Rotate the tail stock hand wheel for moving the spindle.
- Lock the spindle using the locking lever.
- Rotate the tail stock hand wheel and check the spindle movements and locking position. If the spindle is not locked properly it will move.
- Hence, it is known as screw rod spindle lock is not working properly.
- Dismantle the spindle locking unit from the tail stock.
- Prepare the new screw rod instead of defective screw rod.
- Assemble the prepared screw rod instead of wornout screw rod.
- Check the tail stock performance and lock the spindle in the proper position.

Tailstock

Group Assembly Drawing

No. On DRG	Qty / Group	Description	Size
1	1	Tailstock	
2	6	Oil nipple	C8
3	1	Hex. Soc. hd. cap. screw	M8 x 100
4	1	Hex. Soc. hd. cap. screw	M8 x 60
5	1	Cyl.pin	10 x 50
6	1	Key	
7	1	Grub Scr. 'G'	M8 x 16
8	1	Grub Scr. 'A'	M8 x 10
9	1	Sleeve	
	1	Sleeve (with tenon slot)	
10	1	Nut	
11	10	Hex. Soc. hd. cap. screw	M8 x 25
12	1	Screw	
13	1	Th. ball bearing (51205)	25/47 x 15
14	1	Flange	
15	1	Graduated collar	
16	1	Hand wheel	
17	3	Compression spring	
18	3	Steel Ball Class V	5/16" class V
19	1	Taper pin	6 x 60
20	1	Handle	
21	1	Handle rod	
22	1	Clamp piece	
23	1	Clamp piece	
24	1	Screw rod	
25	1	Cap	
26	1	Taper pin	6 x 50
27	1	Handle rod	
28	2	Knob	
29	1	Eccentric shaft	
30	1	External circlip	A 30
31	1	Cyl. plug	6
32	1	Spacer	
33	1	Clamp nut	

No. On DRG	Qty / Group	Description	Size
34	1	Cap	
35	1	Taper pin	6 x 80
36	1	Taper pin	4 x 30
37	1	Handle rod	
38	1	Tenon	
39	2	Int. Thrd. taper pin	8 x 50
40	1	Gib	
41	2	Spec. screw	
42	1	Clamp piece	
43	3	Bearing holder	
	3	Hex. soc. grub screw	M6 x 10
44	3	Spec. pin	
45	3	Needle roller bearing DL-810	8/14 x 10
46	3	Bearing bush	
47	1	Shaft	
48	1	Shaft	
49	2	Wiper	
50	2	Plate	
51	8	Slotted ch. hd. scr. 'A'	M6 x 18
52	2	Wiper	
53	2	Plate	
54	1	Clamp plate	
55	3	Spec. washer	
56	3	Compression spring	
57	3	Spec. grub screw	
58	1	Tailstock base (For NH22)	
	1	Tailstock base (For NH26)	
	1	Tailstock base (For NH32)	M20 x 130
59	2	Stud 'B' (For NH22)	
	2	Stud 'B' (For NH26)	M20 x 170
	2	Spec stud (For NH 32)	
60	1	Hex. bolt (For NH22)	M20 x 140
	1	Hex. bolt (For NH26)	M20 x 180
	1	Hex. bolt (For NH32)	M20 x 220
61	2	Sef locking nut	0, 8d x M20

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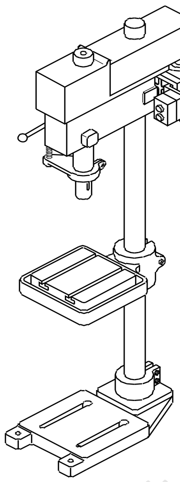
Rectify possible assembly faults during assembly

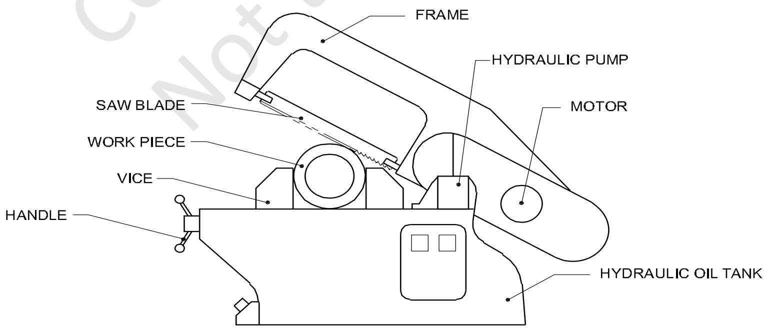
Objectives: At the end of this exercise you shall be able to
- **dismantle the spindle and spindle pulley from drilling head**
- **clean and inspect the parts for worn out and damage**
- **assemble the spindle and spindle pulley**
- **test the spindle and spindle pulley for proper function**
- **rectify the hydraulic faults in powersaw**
- **dismantle and assemble the wornout grinding wheel**
- **dismantle and assemble the gib from the cross slide of lathe.**

TASK-1



DRILL MACHINE(PEDESTAL)

TASK-2

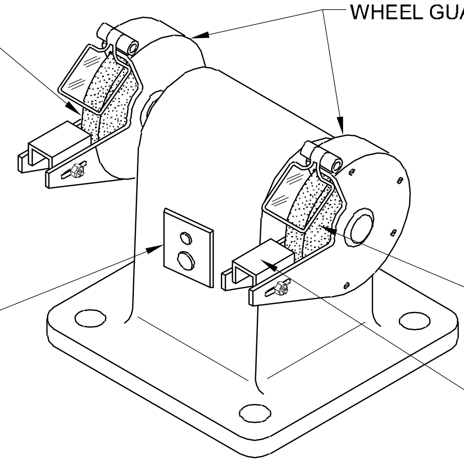


POWER SAW

-	-	-	-	-	-	2.4.114
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

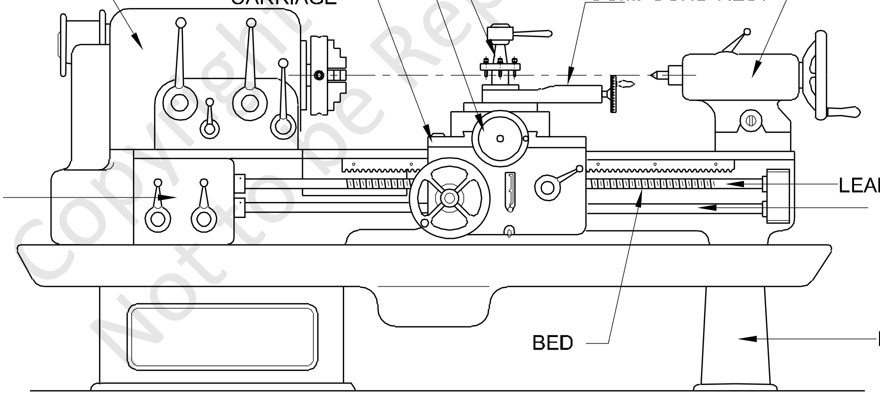
SCALE NTS	RECTIFY POSSIBLE ASSEMBLY FAULTS DURING ASSEMBLY	DEVIATIONS	TIME 19Hrs
		CODE NO. FIN24111E1	

TASK-3



BENCH GRINDER

TASK-4



LATHE

-	-	-	-	-	-	2.4.111
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	RECTIFY POSSIBLE ASSEMBLY FAULTS DURING ASSEMBLY	DEVIATIONS	TIME
		CODE NO. FIN24111E2	

Job Sequence

TASK 1: **Dismantle and assembly of spindle and pulley of drilling machine**

- Remove the drill chuck and arbor (Part no 20 & 19) from the spindle
- Switch off the machine and remove the belt guard.
- Remove the 'V' belt (Part no 1) from the pulley.

Removal of spindle pulley and Hub assembly

- Loosen the nuts (Part no 2) from the spindle hub (Part no 4).
- Remove the stepped 'V" pulley (part no 3) from the spindle hub.
- Remove the feather key (part no 5).
- Remove the internal circlips (part no 6) from spacer (part no 8).
- Remove the external circlip (part no 9) from the end of spindle hub (part no 4).
- Remove the spindle hub and bearings (part no 7) from spacer.

Use aluminium or copper rod to avoid damage of hub and bearings.

Removal of spindle sleeve

- Remove the pinion with shaft from the machine.
- Straighten the toothed washer (part no 11).
- Loosen and remove the nut (part no 10) from spindle (part no 17).
- Remove the toothed washer from the spindle.
- Remove the bearings (part no 12 from the spindle sleeve (part no 14)
- Remove the O - Ring (part no 13).
- Remove the spindle sleeve (part no 14).
- Remove the spindle (part no 17) from the spindle sleeve.
- Remove the thrust bearing (part no 15) from spindle using hydraulic press.
- Clean all the dismantled parts and dry it.

Keep all the disassembled parts in a separate tray in proper order while dismantling.

Identification of worn out and damaged parts

- Check all dismantled parts of spindle and pulley, thoroughly and list out the damaged, worn out parts and fill up the table given.

Table

Sl.No.	Name of the parts	Remarks
1		
2		
3		

- Replace the worn out and damaged parts and assemble the spindle and pulley.
- Assemble all the parts of the spindle and pulley in the reverse order and apply, grease, oil at necessary parts.

Care should be taken while fixing new bearings and the circlips.

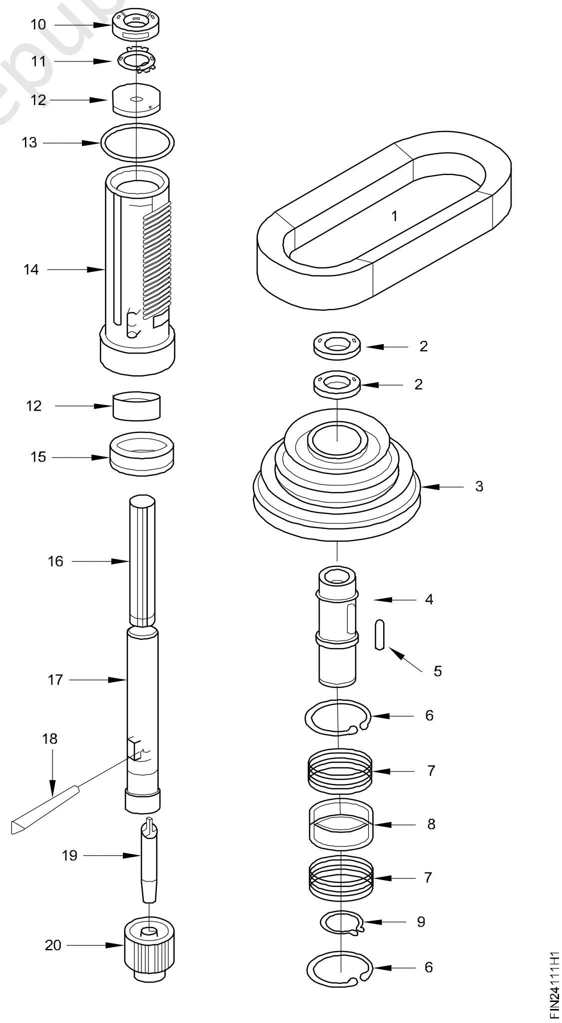
- Fix the 'V' belt and adjust to proper tension.
- Mount the belt guard.

Test run the machine

- Switch on the power supply.
- Check the run out of the spindle by using lever type dial test indicator with magnetic stand.
- Run the machine at slow, medium and high speed atleaset 5 minutes.
- Listen if any abnormal noise hearing from spindle assembly.
- Check if any noise generating in the spindle assembly if so rectify the fault and run the machine without noise.

Parts of spindle and pulley

Fig 1



Parts

1 'V' Belt

2 Nut

3 Spindle pulley

4 Spindle hub (Internal splines)

5 Feather key

6 Internal circlip

7 Bearing

8 Spacer for bearing

9 External circlip

10 Nut

11 Washer

12 Bearing

13 O-Ring

14 Spindle sleeve

15 Thrust bearing

16 Splines on spindle

17 Spindle

18 Wedge slot

19 Chuck arbor

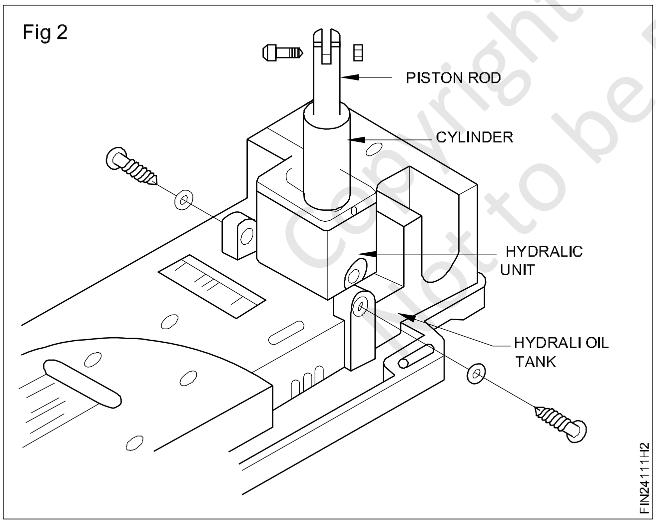
20 Drill chuck

— — — — — — —

TASK 2: **Rectification of hydraulic fault in power saw**

- Switch off the machine and remove the belt guards.
- Support the arm properly.
- Drain the hydraulic oil and keep it safely.
- Remove the connecting pin/circlip/split pin and loosen the fasteners in the hudraulic unit.
- Disconnect the oil lines and remove the hydraulic unit from the m/c.
- Dismantle the hydraulic unit and keep it in a separate tray Fig 2.

Fig 2



- Clean all the parts and dry it.
- Inspect oil flow part with compressed air.
- Inspect the oil seal/ 'o' rings/filter control valves/ valve seat.
- Replace / repair the worn out/damaged parts.

Assemble the hydraulic unit in the reverse manner of dismatling.

- Fix unit to the machine.
- Check the condition of drained oil if condaminated fill as per manufacturers recommended grade oil.
- Connect the oil lines & drive system and remove the arm support.
- Trail run the machine and observe the performance.
- Check any leakage in the oil line, if found arrest them.
- Adjust the control valve and verify to arm lifting & descending performance.
- Fix the belt guards.

— — — — — — —

TASK 3: **Dismantling and assembling of a worn out grinding wheel**

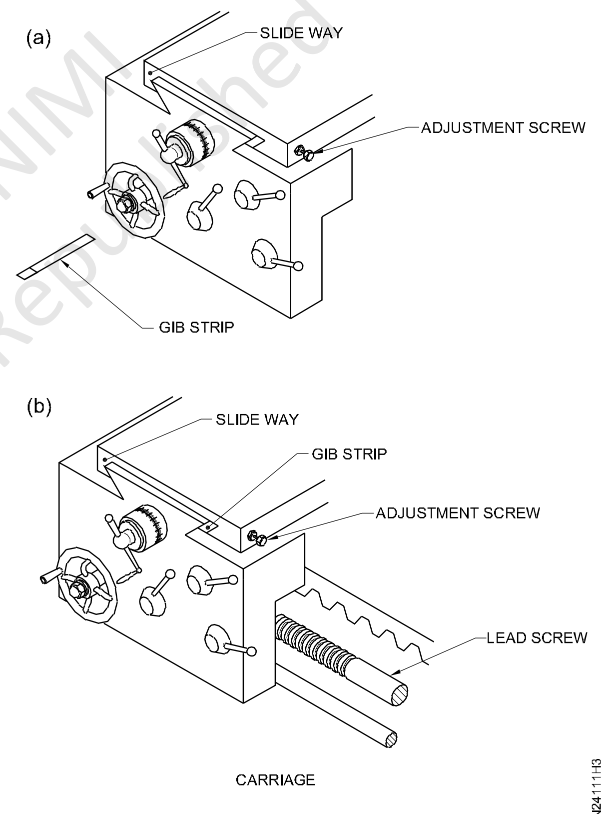
- Switch-off the electrical power supply.
- Dismount the safety glass bracket.
- Remove the grinding wheel covers.
- Unscrew the nuts from the spindle of the grinding wheel.
- Remove the tool rest.
- Remove the grinding wheels from the spindle.
- Remove the belts from the motor pulley.
- Disengage the grinding wheel head unit from the main body.
- Dismantle the wheel spindle from the wheel head.
- Extract the ball bearings from the housings/spindle.
- Clean the ball bearings and other parts.
- Inspect the bearings and other parts.
- Replace the bearings, if necessary.
- Change the belts, if damaged.
- Lubricate the bearings and other parts.
- Assemble the parts in the reverse sequential order.
- Replace the grinding wheels, if necessary.
- Check the smooth running of the bench grinder.

— — — — — — —

TASK 4: **Dismantling and assembling of gib from the cross slide of a lathe**

- Remove the adjusting screws from the dovetail slide.
- Dismantle the gib from the cross slide.
- Clean the slide surfaces.
- Check and inspect all the parts.
- Damaged parts of gib strip and adjustment screws should be replaced.
- Lubricate the slide ways.
- Assemble the gib and check the gib seating.
- If you find any defects, rectify it.
- Check adjusting screws thread.
- Lubricate the slide ways of gib strip.
- Assemble slide way, gip strip with saddle.
- Tighten the adjusting screws to give the correct freedom required in the assembly.
- Lock the movement of the adjusting screw by the check - nut.
- Check the slide ways smooth movement without any shake.
- If taper gib is provided in the assembly, properly position the gib by end screws.

Fig 3



— — — — — — —

Skill Sequence

Fit a new grinding wheel -Task 3

Objectives: This shall help you to
- **fit a new grinding wheel in pedestal grinding machine.**

Switch off the power supply to the machine

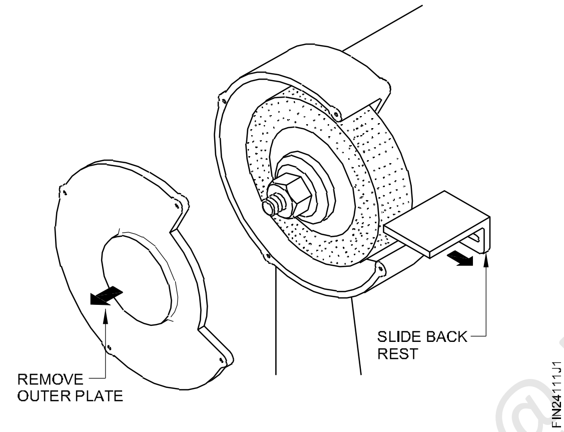
Clean the machine and remove any loose metal or abrasive particles.

Loosen the work rest clamp and remove the rest Fig 1.

Remvoe the outer plate of the whell guard Fig 1.

The wheel clamping nut is now accessible.

Fig 1

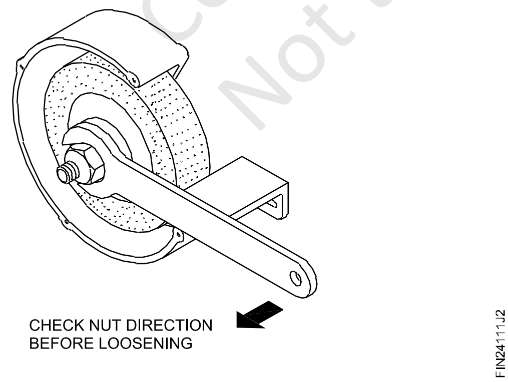


Check the nut direction before loosening.

Loosen the nut using a spanner of the correct size Fig 2.

Remember that when facing the front of the machine, the spindle on the left has a left-hand thread. Turn the nut clockwise to loosen it.

Fig 2



Remove the nut and the outer flange Fig 3.

A light blow with a soft hammer may be needed to free it from the wheel.

Remove the worn out wheel from the spindle and place it in the scrap bin.

Check that the markings on the old wheel are the same as those on the new wheel Fig 4.

Fig 3

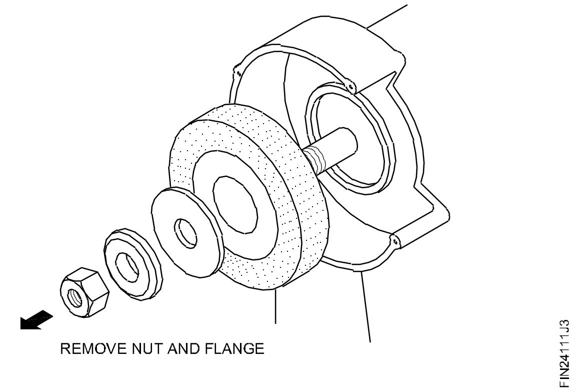
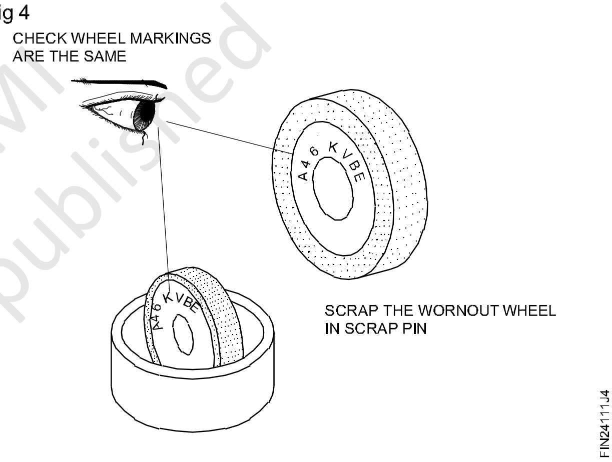
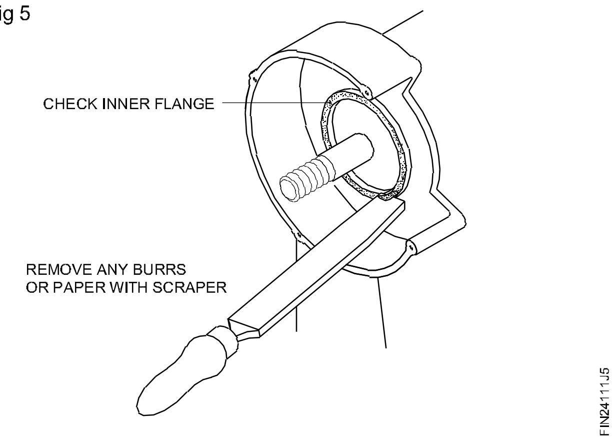


Fig 4



Remove any paper, washer that has adhered to the flange Fig 5.

Fig 5

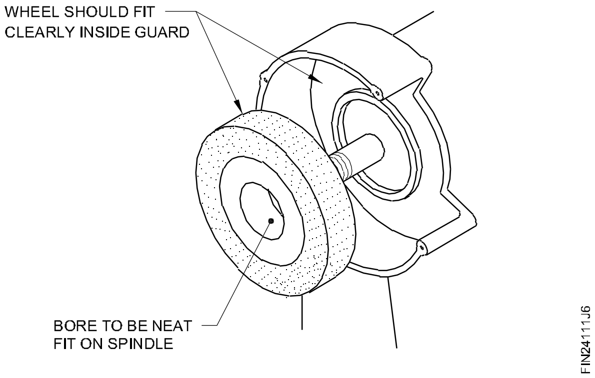


Clean the flange, spindle, thread and inside the guard.

Check that both the paper washers are intact in the new wheel.

Try the new wheel on the spindle Fig 6.

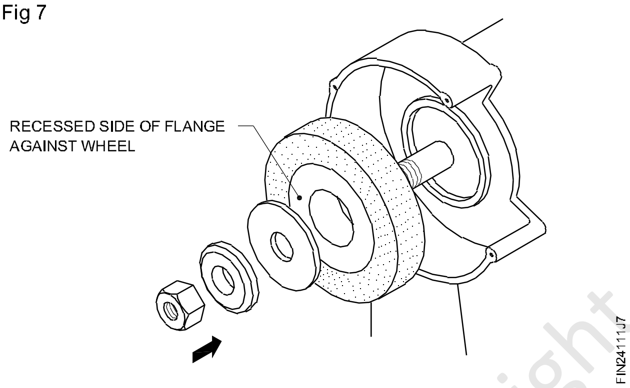
Fig 6



Scrape the lead bush to abtain a correct fit. The outer diameter of the new wheel should fit neatly inside the wheel guard, but with adquate clearance.

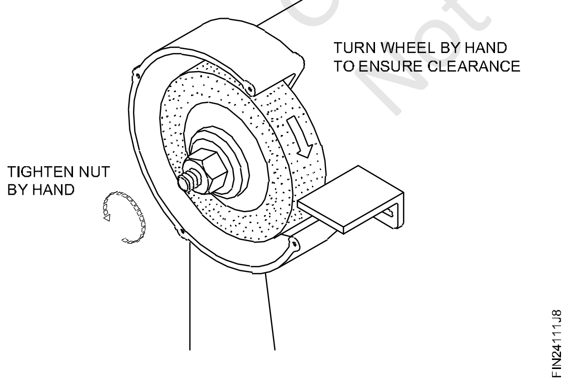
Push the wheel carefully against the driving flange and place the outer flange in position Fig 7.

Fig 7



Screw up the clamping nut by hand, firmly enough to hold the wheel in position Fig 8.

Fig 8

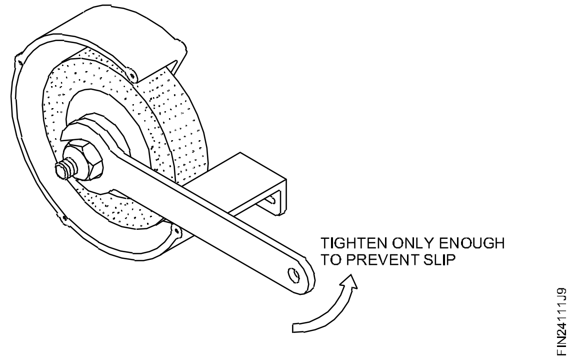


Turn the spindle and wheel a complete revolution.

Ensure that the wheel is running true, by rotating hand and it is clear of the inner part of the guard.

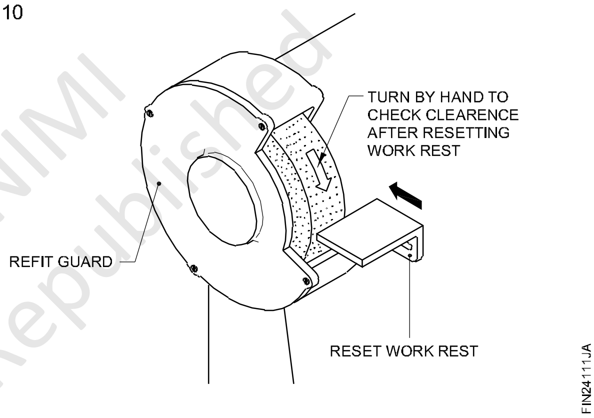
Tighten the nut sufficiently enough to ensure that the flanges will drive the wheel without slipping Fig 9.

Fig 9



Refit the outer plate of the wheel guard Fig 10.

Fig 10



Reset the work rest as close to the wheel face as possible.

Tighten the work rest clamp firmly.

Rotate the wheel again by hand ensure that the wheel runs freely and true.

(Switch on the power supply and start the machine).

Allow the wheel to operate for one minute at full operating speed.

The machine is now ready for grinding operations.

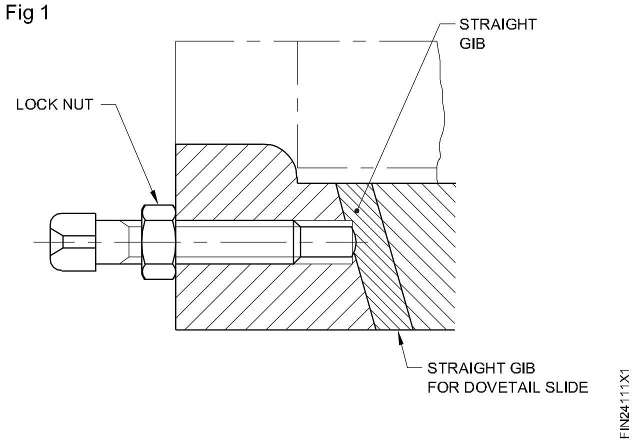
Adjust the gib strip - Task 4

Objective: This shall help you to

- **adjust and align the gib strip in a lathe.**

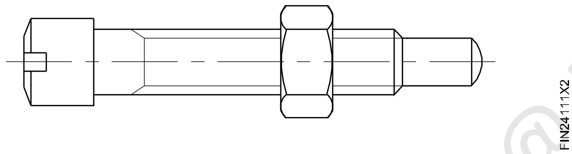
Loosen the lock-nuts. (Fig 1)

Fig 1



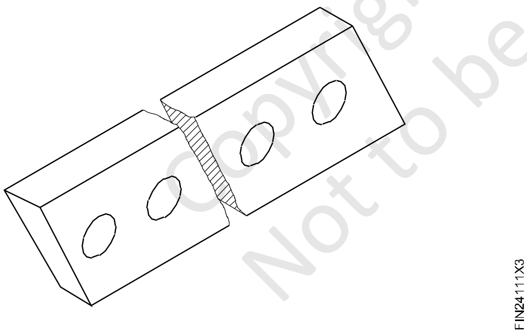
Remove the set screws. (Fig 2)

Fig 2



Pull the gib out. (Fig 3)

Fig 3



Clean all the parts.

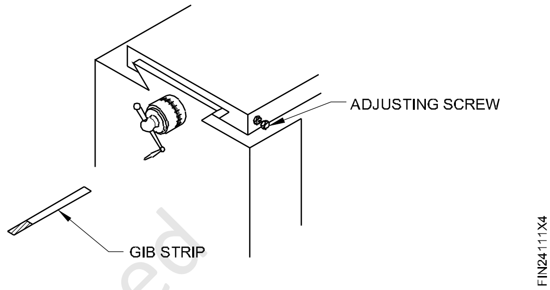
Check the straightness of the gib using Prussian blue.

Scrape the gib to get even surface to prevent stick-slip motion of the cross-slide.

Lubricate all the parts.

Assemble the gib into the dovetail slide and position it. (Fig 4)

Fig 4



Adjust the screws and eliminate the clearance between the slides for getting the correct freedom required in the assembly.

Lock the movement of the adjusting screws by the check-nut.

Hold the gib in correct position firmly while locking with check-nuts.

Check the function of the cross-slide.

— — — — — — —

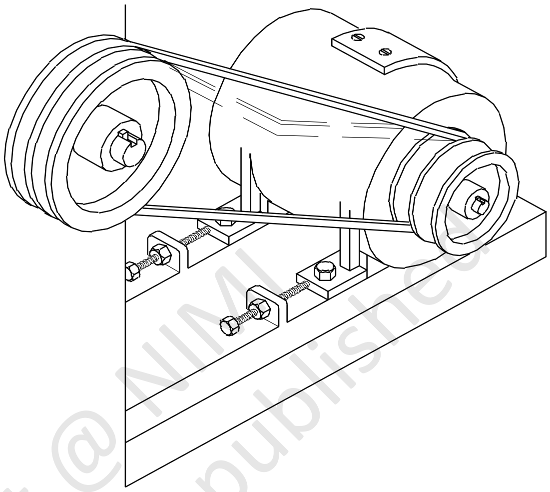
Perform the routine maintenance with check list

Objectives: At the end of this exercise you shall be able to
- **perform the routine maintenance with check list**
- **rectify the defective items found.**

TASK-1

Job sequence

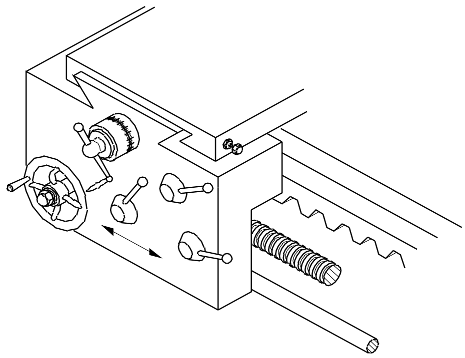
- **Check the tension of the belt and adjust**



TASK-2

TASK 2: **Check the movement of the carriage of the lathe**

- Run the machine on different spindle speeds and check the speed.
- Engage the power feed and check the longitudinal and transverse feed movements.
- Check the function of clutches by operating the clutch lever.

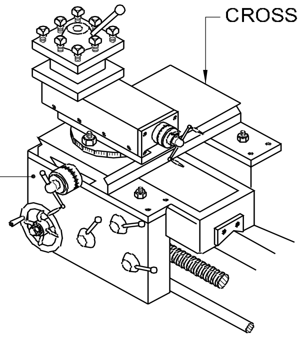


-	-	-	-	-	-	2.4.112
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PERFORM THE ROUTINE MAINTENANCE WITH CHECK LIST	DEVIATIONS	TIME 10Hrs
		CODE NO. FIN24112E1	

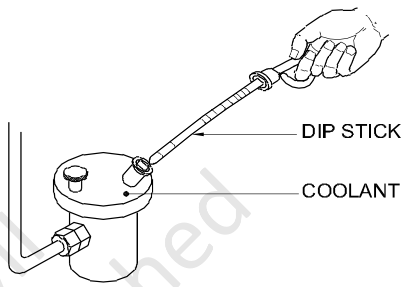
TASK-3

- **Check the movement of the cross-slide and the compound slide.**



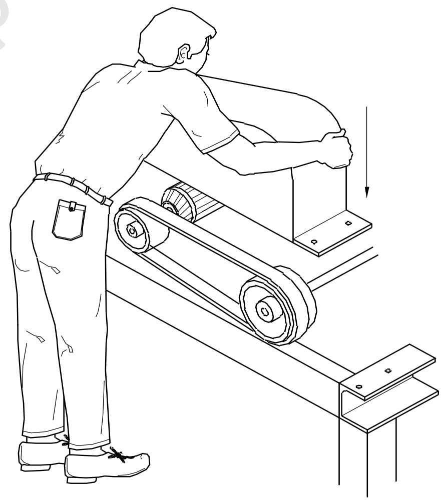
TASK-4

- **Check the oil level and the functioning of the lubricating pump.**
- Check the coolant level and the functioning of the coolant pump.



TASK-5

- **Check the safety guards and ensure that they are in postion.**



-	-	-	-	-	-	2.4.112
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PERFORM THE ROUTINE MAINTENANCE WITH CHECK LIST	DEVIATIONS	TIME
		CODE NO. FIN24112E2	

Inspect the following check list items of centre lathe and tick it in appropriate column.

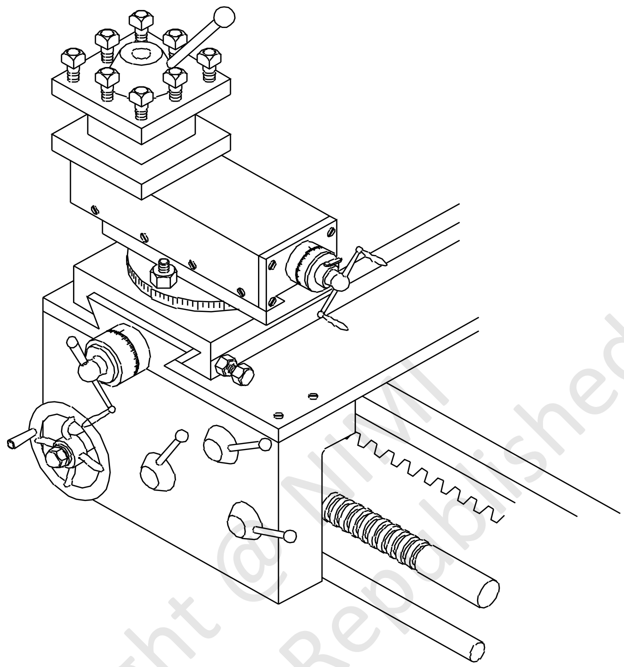
Table

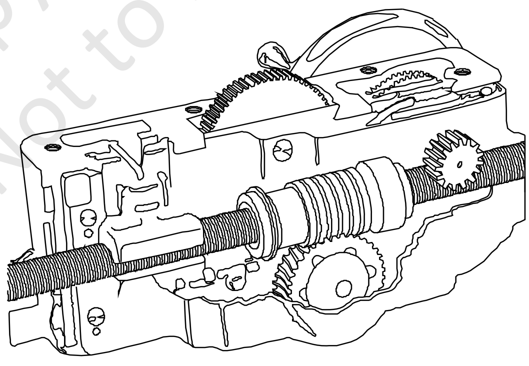
Items to be checked	Good working/Satisfactory	Defective	Remedial measures to be carried out
Belt and its tension			
Bearing sound			
Driving clutch and brake			
Exposed gears			
Working in all the speeds			
Working in all feeds			
Lubrication system			
Coolant system			
Carriage & its travel			
Cross-slide & its movement			
Compound slide & its travel			
Tailstock's parrallel movement			
Electrical controls			
Safety gaurds			

— — — — — — —

Monitor machine as per routine check list

Objectives: At the end of this exercise you shall be able to
- **inspect the lathe parts**
- **applying lubrication to lathe parts**
- **operate and check the movements of the machine parts, before machining.**





APRON UNIT

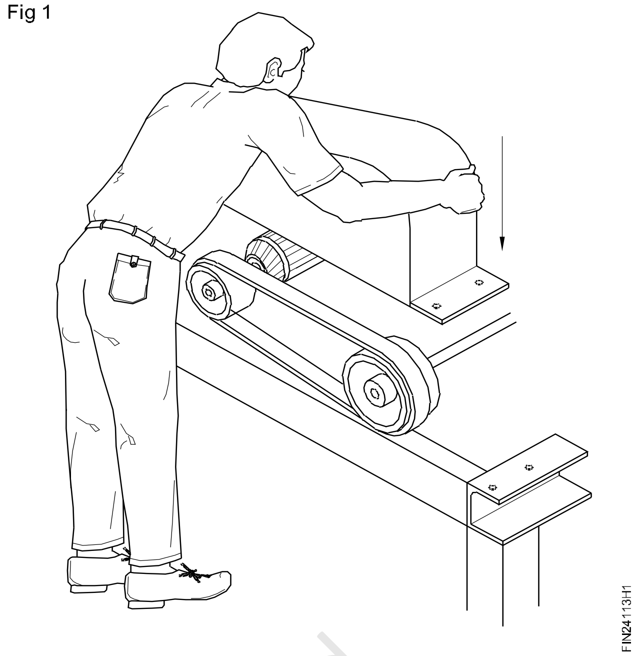
-	-	-	-	-	-	2.4.113
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MONITOR MACHINE AS PER ROUTINE CHECK LIST	DEVIATIONS	TIME 3Hrs
		CODE NO. FIN24113E1	

Job Sequence

- Clean the machine.
- Check the safety guards (Fig 1) and ensure that they are in position.
- Check the tension of belt.
- Check the free movement of carriage, tailstock of the lathe.
- Run the machine on different spindle speeds and check.
- Engage the power feed and check the longitudinal and transverse feed movements.
- Check the function of clutches by operating the clutch lever.
- Check the movement of cross slide and the compound slide.
- Check the oil level and functioning of the lubrication.
- Check the coolant and the functioning of the coolant pump.
- Check the exposed gears are fitted proerly switch ON and check the running condition of machine before machining.

Fig 1



Routine check list of lathe

Table

Items to be checked	Description	Remarks
Belt and its tension		
Bearing sound		
Driving clutch and brake		
Exposed gears		
Working in all the speeds		
Working in all feeds		
Lubrication system		
Coolant system		
Carriage & its travel		
Cross-slide & its movement		
Compound slide & its travel		
Tailstock's parrallel movement		
Safety gaurds		
Adjustment screw		
Quick change gear box		
Feed selector		

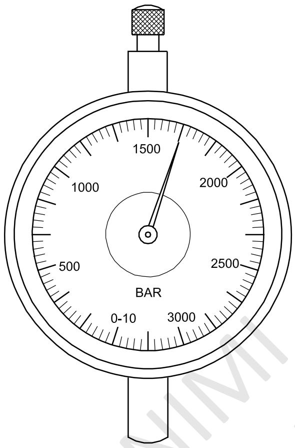
— — — — — — —

Read pressure gauge, temperature gauge, oil level

Objectives: At the end of this exercise you shall be able to
- **read pressure gauge**
- **read temperature gauge**
- **check the oil level.**

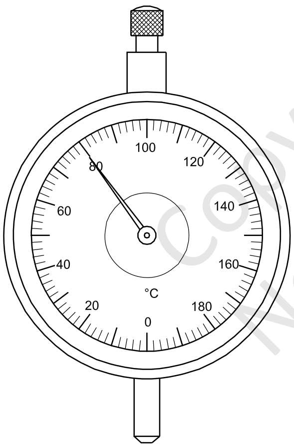
TASK-1

PRESSURE GAUGE

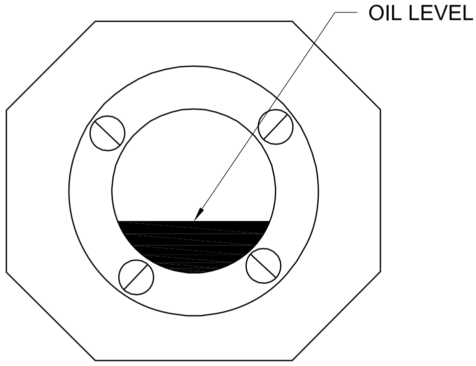


TEMPERATURE GAUGE

TASK-2



TASK-3



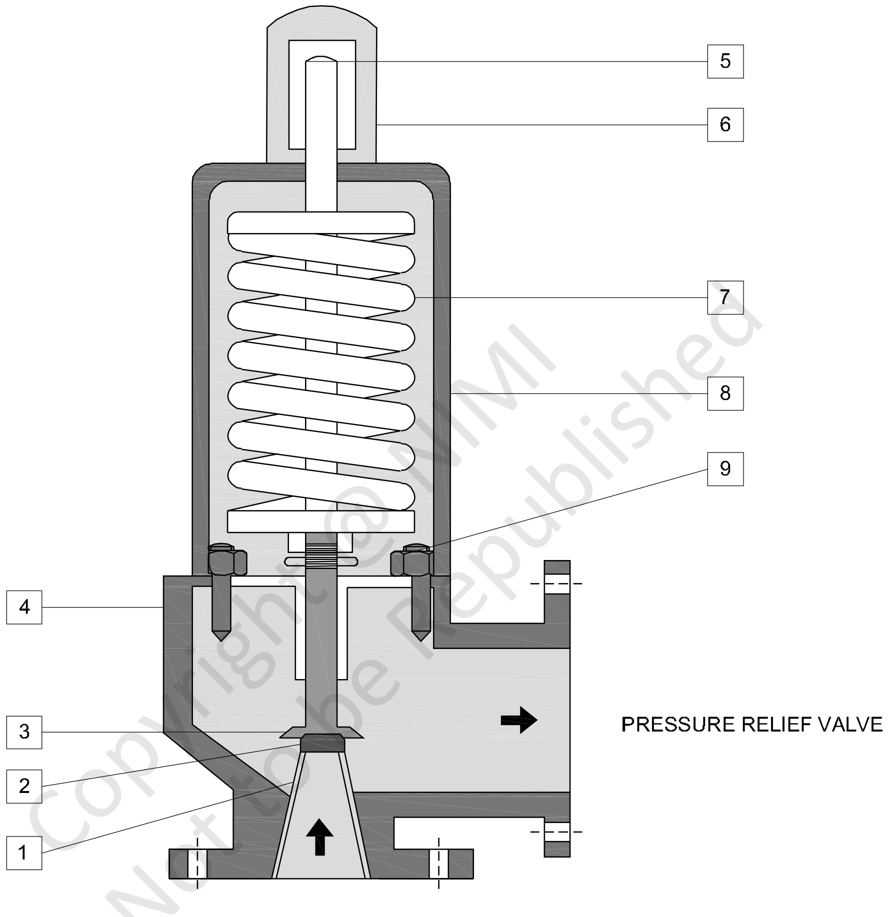
Note: Instructor shall demanstrate to the trainees regarding, reading of pressure gauge, temperature gauge and oil level.

-	-	-	-	-	-	2.4.114
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	READ PRESSURE GAUGE, TEMPERATURE GAUGE,OIL LEVEL	DEVIATIONS	TIME 1Hr
		CODE NO. FIN24113E1	

Set pressure in pneumatic system

Objectives: At the end of this exercise you shall be able to
- **set the pressure relief valve**
- **check the function of relief valve.**



1-INLET NOZZLE
2-VALVE SEAT
3-SEAT HOLDER
4-VALVE BODY
5-SET PRESSURE ADJUSTING SCREW
6-CAP
7-SPRING
8-BONNET
9-SEAL

-	-	-	-	-	-	2.4.115
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	SET PRESSURE IN PNEUMATIC SYSTEM				DEVIATIONS	TIME 2Hrs
					CODE NO. FIN24115E1	

Job Sequence

- Switch on the compressor
- Read the pressure gauge in the compressor tank.
- Close the outlet line.
- Check the relief valve function according to the working pressure system
- It not functioning properly, do the following.
- Open the cap
- Adjust the set screw No.5 in the Fig.
- Adjust the set screw according to the required pressure.
- Check the function of the pneumatic system

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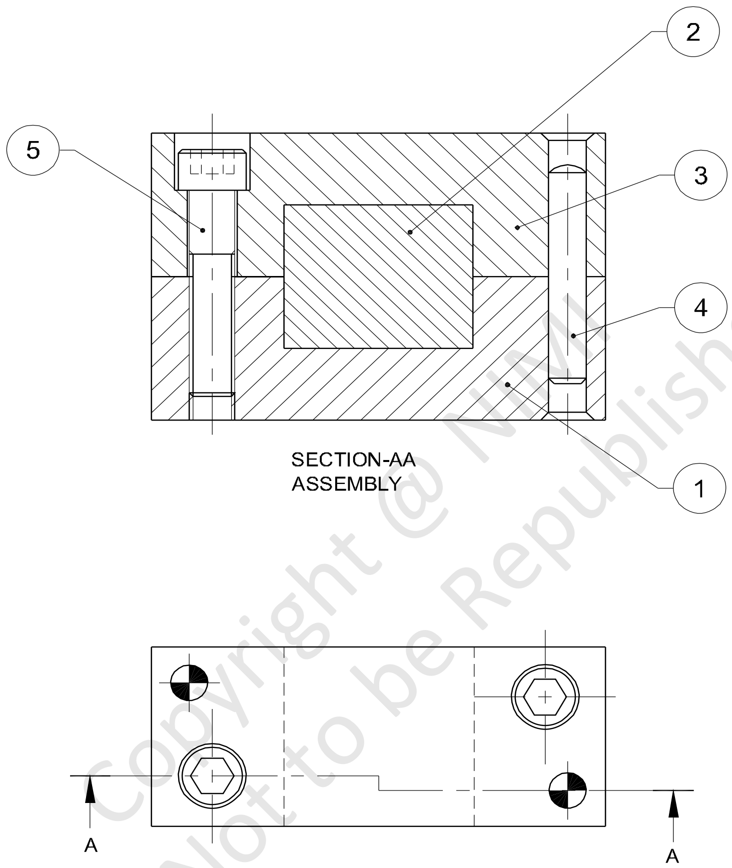
Assemble simple fitting using dowel pins and cap screw assembly using torque wrench

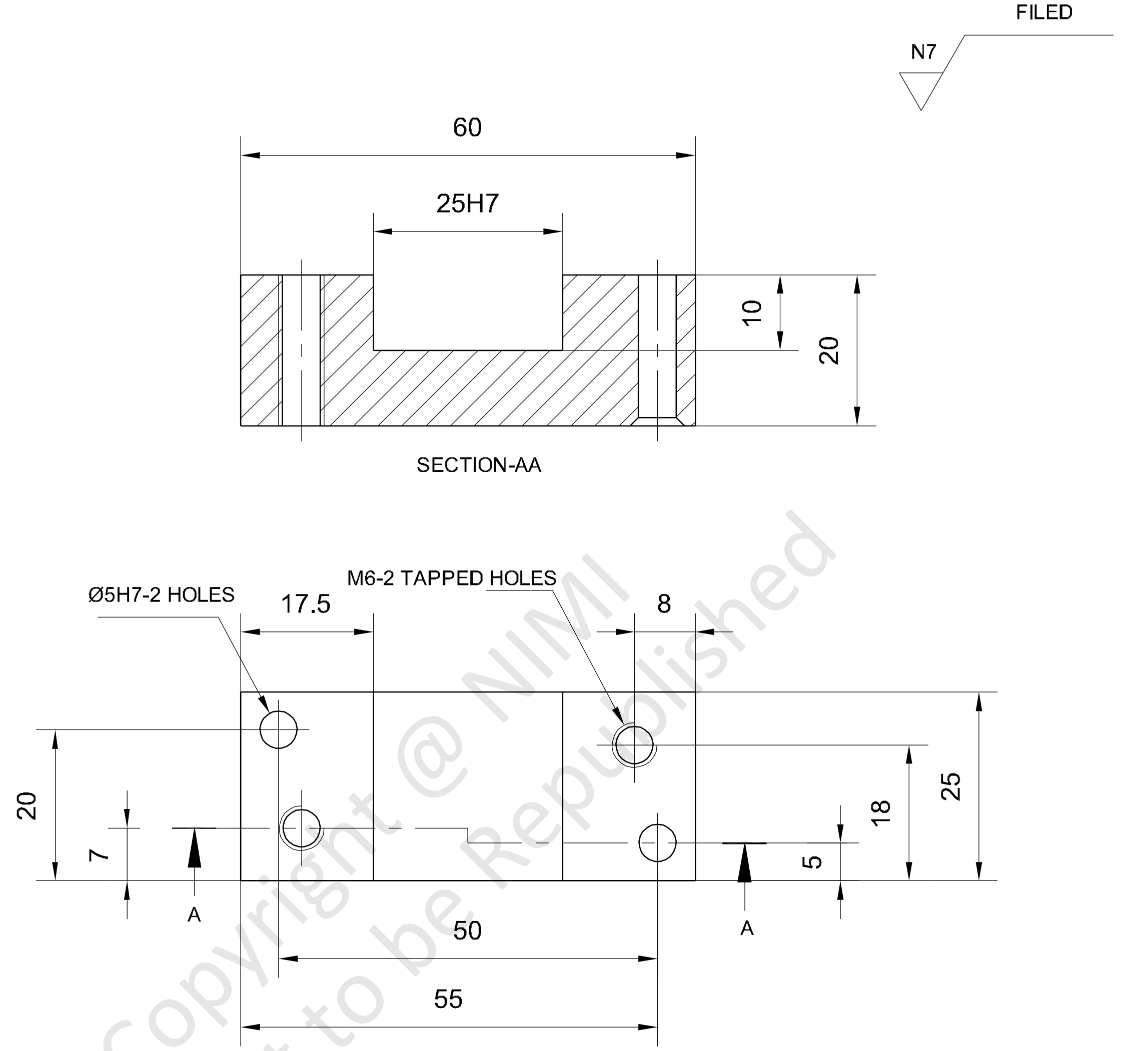
Objectives : At the end of this exercise you shall be able to
- **prepare and assemble the assembly fit using dowel pins and cap screws.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
2	M6x30	CAP SCREW	Fe310	-	PART-5	2.4.116
2	Ø5x30	DOWEL PIN	Fe310	-	PART-4	
1	65 ISF 30 - 25	-	Fe310	-	PART-3	
1	SQUARE 28-30	-	Fe310	-	PART-2	
1	65 ISF 30 - 25	-	Fe310	-	PART-1	

SCALE 1:1	ASSEMBLE SIMPLE FITTING USING DOWEL PINS AND CAP SCREW ASSEMBLY USING TORQUE WRENCH	DEVIATIONS ±0.04mm	TIME 25Hrs
		CODE NO. FIN24116E1	

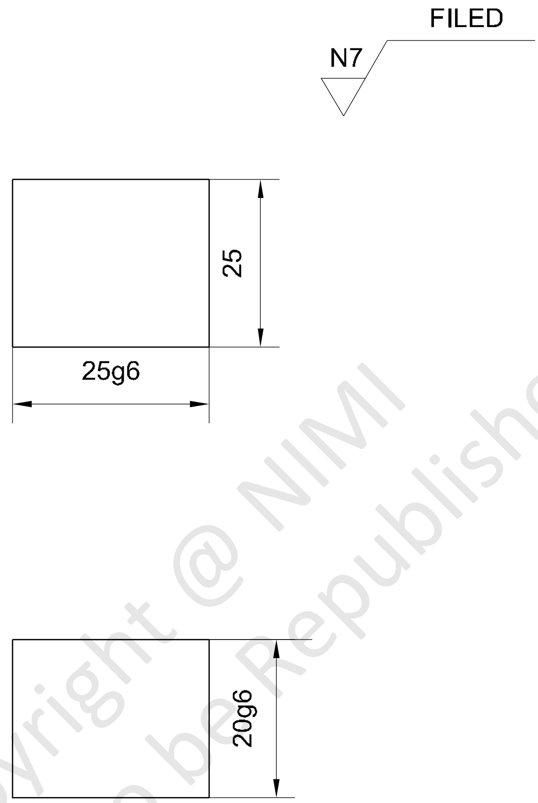
PART-1 BASE PLATE



-	-	-	-	-	-	1.2.116
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

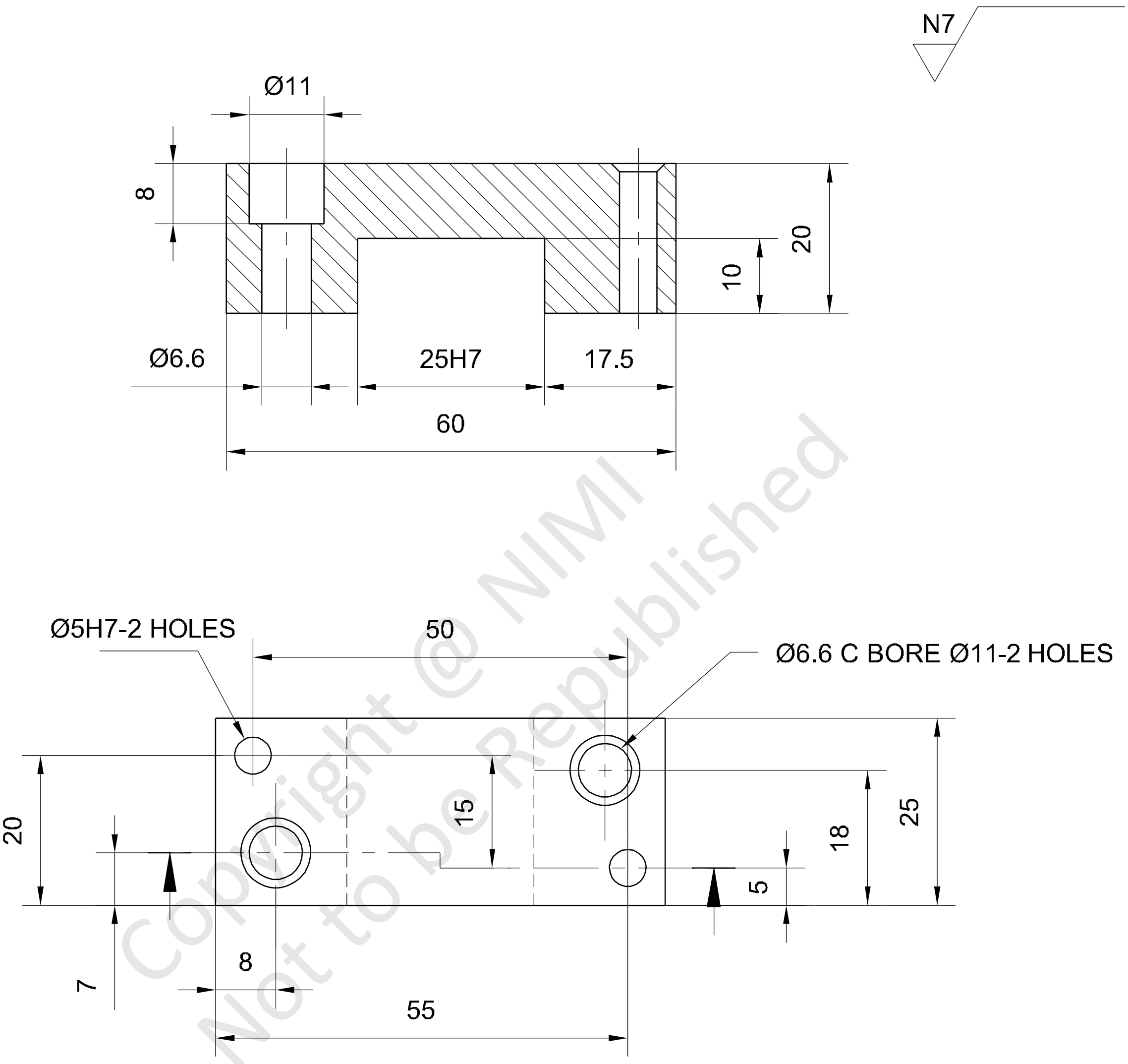
SCALE 1:1	BASE PLATE	DEVIATIONS	TIME
		CODE NO.FIN24116E2	

PART-2 MIDDLE PLATE



-	-	-	-	-	-	2.4.116
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MIDDLE PLATE				DEVIATIONS	TIME
					CODE NO.FIN24116E3	

PART-3 TOP PLATE



-	-	-	-	-	-	2.4.116
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	TOP PLATE				DEVIATIONS	TIME
					CODE NO. FIN24116E4	

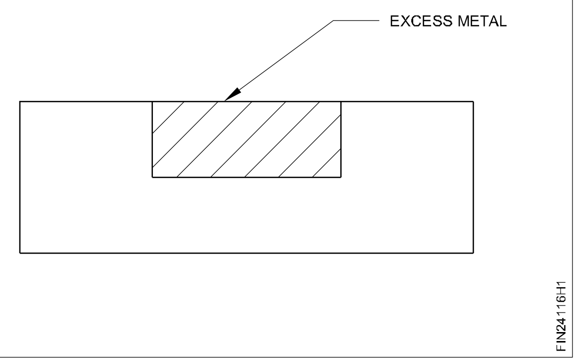
Job Sequence

- Check the raw materials size
- File part 1, 2 and 3 to over all size maintaining parallelism and perpendicularity.
- Check the faltness and squareness with try square and dimensions with vernier caliper.
- Apply marking media on part 1 and 3 and mark the dimensional lines as per drawing.
- Punch witness mark and drill hole marks

Part 1 & 2

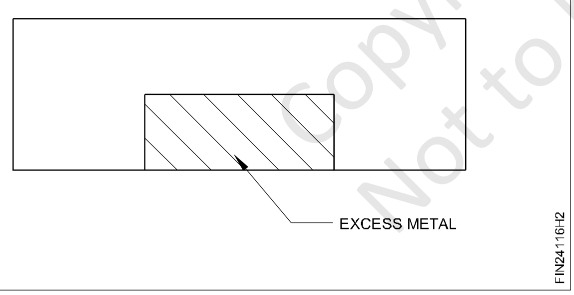
- Chain drill, cut and remove the excess metal and file to size and shape as shown Fig 1.

Fig 1



- Similarly, chain drill, cut and remove the excess metal in part 3 and file to size and shape as shown in Fig 2.

Fig 2



- Fit, part 2 in part 1 and 3 maintaining tolerance ± 0.04mm.
- Assemble, part 1, 2 and 3 all together and clamp it using parallel clamps maintaining squareness.
- Hold the assembly setting in drilling machine table along with suitable fixtures.
- Drill, counter sink and ream the hole as per drawing and fix ∅ 5mm dowel pin without disturbing the assembly setting.
- Similarly, drill, counter sink and ream the other dowel pin hole without disturbing the assembly setting and fix other ∅ 5mm dowel pin.
- Drill holes for tapping in part 1 and 3 withsout disturbing the assembly setting.
- Separate the assembly setting, drill ∅ 6.6mm through hole and ∅ 11mm counter bore to the depth of 8mm in part 3 to enter the cap head screws as shown in job drawing.
- Hold part 1 in bench vice and cut M6 internal thread in two holes to fix cap head screws.
- Clean the threads without burrs.
- Finish file in part 1, 2, 3 and de-burr in all corners of the job.
- Re-assemble part 1 and 3 along with dowel pins and cap screws.
- Fit, part 2 in part 1 and 3 opening slot.
- Apply a little oil and preserve it for evaluation.

Skill Sequence

Fixing of dowel

Objectives: This shall help you to
- **fix dowel pins**
- **remove dowel pins.**

Keep position 1 and position 2 as shown in Fig 1.

Tighten the socket head screw such that there is a gap of one pitch of the socket head screw as shown in Fig 1.

Drive the dowel using a hammer such that about 5 mm of the chamfer side of the dowel enters into the reamed hole as shown in Fig 2.

Fig 1

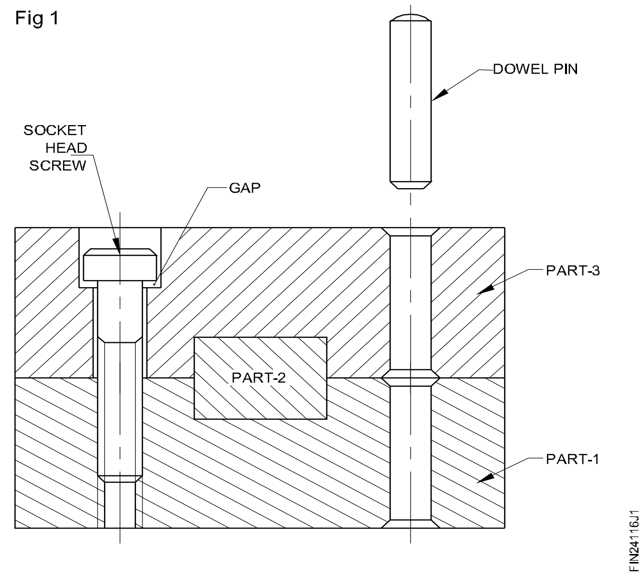
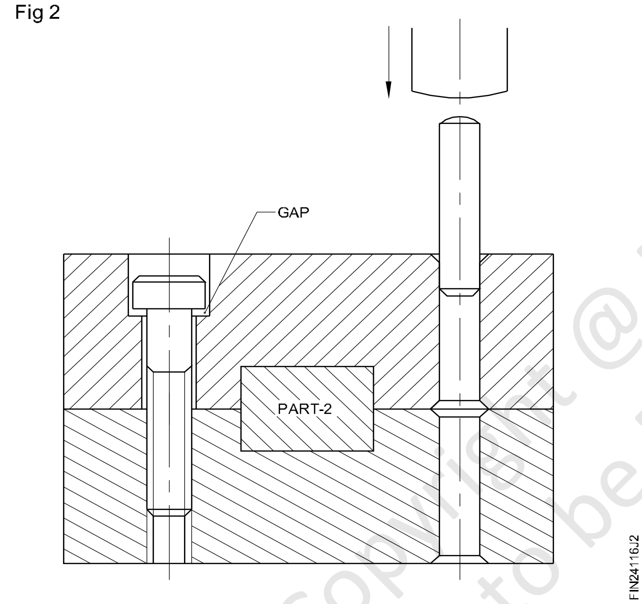


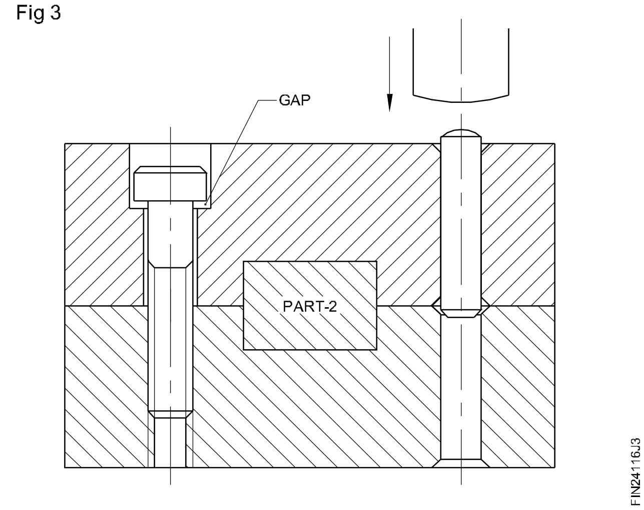
Fig 2



Check for the perpendicularity.

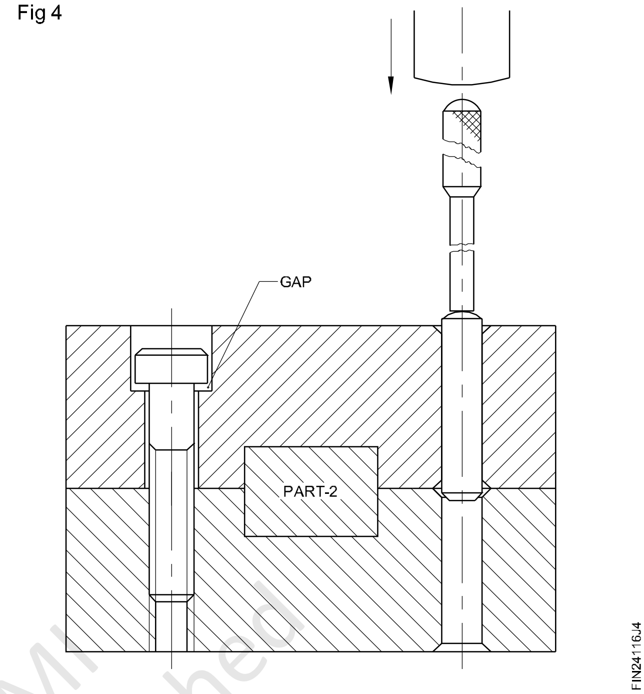
Drive the dowel into the reamed hole such that chamfered end of the dowel enters fully into the position 1 as shown in Fig 3.

Fig 3



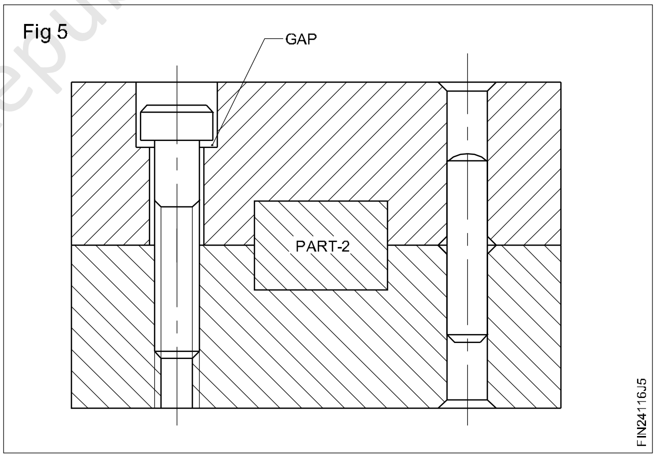
Drive the dowel keeping pin punch dia 5.8 over the radius of the end of the dowel such that the chamfered end of the dowel into position 2 as shown in Fig 4.

Fig 4



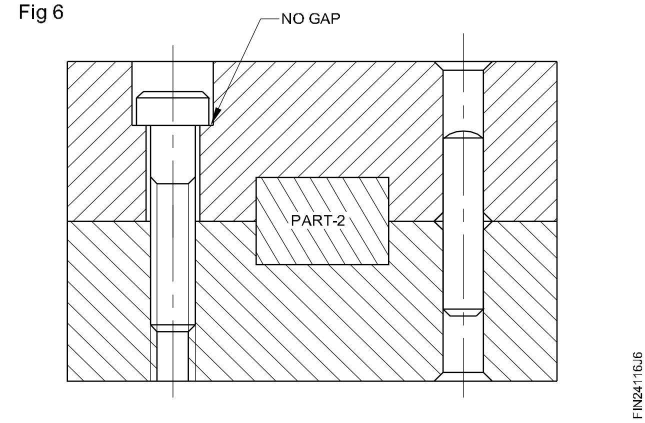
Drive the dowel in about 10 mm into position 2 as shown in Fig 5.

Fig 5



Tighten the socket head screw such that there is no gap exists as shown in Fig 6.

Fig 6

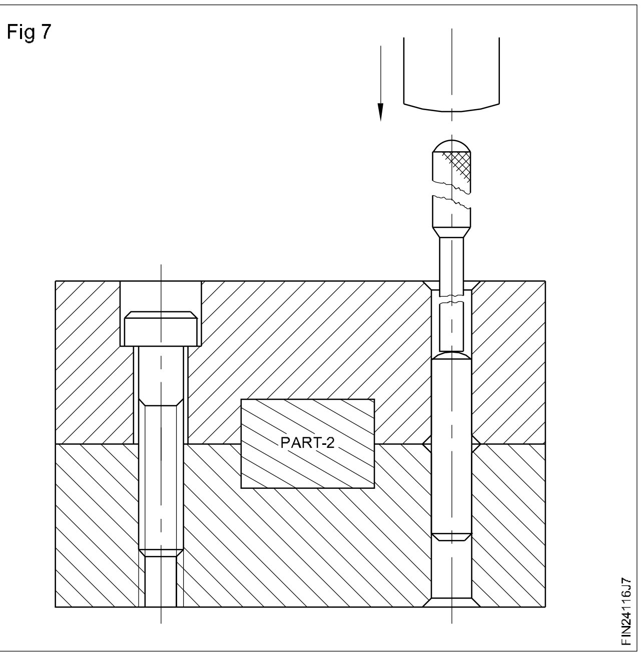


Removal of the dowel

Removal of the dowel should be in the same direction as driving.

Insert pin punch into the reamed hole such that it sits over the radius end of the dowel as shown in Fig 7.

Fig 7



Knock the dowel out using the hammer as shown in Fig 8.

Fig 8