OPERATOR ADVANCE MACHINE TOOL

NSQF LEVEL - 4

1st Year

TRADE PRACTICAL

SECTOR : CAPITAL GOODS & MANUFACTURING

(As per revised syllabus July 2022 - 1200 Hrs)

कौशलं बलम्

Directorate General of Training

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

Nimi

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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Sector	**: Capital Goods & Manufacturing**
Duration	**: 2 Years**
Trade	**: Operator Advance Machine Tool - Trade Practical - 1st Year - NSQF Level - 4 (Revised 2022)**

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 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 Media Development Committee members of various stakeholders 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 **Operator Advance Machine Tool - Trade Practical** in **Capital Goods & Manufacturing** Sector. The NSQF Level - 4 (Revised 2022) 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 - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages 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

Director General of Training
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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 Federal Republic of Germany. The prime objective of this Institute is to develop and provide instructional materials for various trades as per the prescribed syllabus 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.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

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 organisation to bring out this IMP **(Trade Practical)** for the trade of **Operator Advance Machine Tool 1st Year - NSQF Level - 4 (Revised 2022)** under the **CG & M** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

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NIMI records its appreciation of 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 staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the two years course of the **Operator Advance Machine Tool** in **Capital Goods & Manufacturing** 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 - 4 (Revised 2022).

The manual is divided into Nine modules.

Module 1	Safety
Module 2	Basic Fitting
Module 3	Basic Maintenance Skills
Module 4	Basic Turning
Module 5	Basic Milling
Module 6	Grinding
Module 7	Advanced Machining Skills Turning
Module 8	Milling
Module 9	Inspection

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. 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 two years course of the **Operator Advance Machine Tool** in **Capital Goods & Manufacturing** Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade Theory. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation 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 at least 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

Sl.No.	Learning Outcome	Exercise No.
1	Plan and organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy following safety precautions. [Basic fitting operation – marking, Hack sawing, Chiseling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm] (Mapped NOS:CSC/N0304)	1.1.01 - 1.2.72
2	Plan & perform simple repair, maintenance of different machines and check for functionality. [Different Machines – Drill Machine, Power Saw and Bench Grinder] (Mapped NOS: NOS:CSC/N0901)	1.3.73 - 1.3.76
3	Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations. [Different cutting tool – V tool, side cutting, parting, thread cutting (both LH & RH), Appropriate accuracy:- ±0.06mm, Different turning operation – Plain, facing, drilling, boring (counter & stepped), grooving, Parallel Turning, Step Turning, parting, chamfering, U -cut, Reaming, knurling.] (Mapped NOS: NOS:CSC/N0110)	1.4.75 - 1.4.85
4	Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, face, angular, form, gang, straddle milling] (Mapped NOS: CSC/N0108)	1.5.86 - 1.5.91
5	Produce components of high accuracy by different operations using grinding. [Different operations – surface grinding, cylindrical grinding with an accuracy of ±0.01 mm] (Mapped NOS: CSC/N0109)	1.6.92 - 1.6.98
6	Set different components of machine & parameters to produce taper/angular components and ensure proper assembly of the components. [Different component of machine: Form tool, Compound slide, tail stock offset; Different machine parameters- Feed, speed, depth of cut.] (Mapped NOS: CSC/N0110)	1.7.99 - 1.7.103
7	Set the different machining parameters to produce screw & multi start threaded components applying method/ technique and test for proper assembly of the components.(Mapped NOS: CSC/N0110)	1.7.104 - 1.7.105
8	Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different components – Rack, Spur Gear, External Spline, bevel gear, Helical Gear, worm & work wheel.] (Mapped NOS: CSC/N0108)	1.8.106 - 1.8.113
9	Measure components using different instrument/ gauge and test machine tool accuracy. [Different instrument/ gaugesˆlimit gauges, Sine Bar, snip gauges, tool maker's microscope and profile projector; Simple Machines – Drill Machine,Power Saw and Lathe] (Mapped NOS: CSC/N0110)	1.9.114 - 1.9.119

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 260 Hrs; Professional Knowledge 50Hrs	Plan and organize the work to make job as per specification applying different types of ba sic fitting operation and check for dimensional accuracy fol lowing safety precautions. [Ba sic fitting operation – marking, Hack sawing, Chiseling, Fil ing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm] (Mapped NOS:CSC/ N0304)	1 Importance of trade training, List of tools & Machinery used in the trade. (2 hrs.) 2 Safety attitude development of the trainee by educating them to use Personal Protec tive Equipment (PPE). (2 hrs.) 3 First Aid Method and basic training. (2 hrs.) 4 Safe disposal of waste materials like cot ton waste, metal chips/ burrs etc. (1 hr.) 5 Hazard identification and avoidance. (1 hr.) 6 Identification of safety signs for Danger, Warning, caution & personal safety mes sage. (1 hr.) 7 Preventive measures for electrical acci dents & steps to be taken in such acci dents. (1 hr.) 8 Use of fire extinguishers. (2 hrs.)	All necessary guidance to be provided to the newcomers to become familiar with the working of Industrial Training Institute system including store's procedures. Soft skills, its importance and job area after completion of training. Importance of safety and general pre-cautions observed in the industry/ shop floor. Introduction of first aid. Operation of electrical mains and electrical safety. Introduction of PPEs. Response to emergencies e.g. power failure, fire, and system failure. Importance of housekeeping & good shop floor practices. Introduction to 5S concept & its ap-plication. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regu lations as applicable. Basic understanding on Hot work, confined space work and material handling equipment. (05 hrs)
		Basic Fitting 9 Preparation of filing. (2 hrs.) 10 Marking lines on the job surface for filing to the marked lines. (4 hrs.) 11 Gripping the job suitably in the vice jaw for filing (4 hrs) 12 Balancing of file, using rough file. (4 hrs.) 13 Measurement by using inside/ outside calipers and scale. (4 hrs.)	**Basic Fitting** Vice - purpose, types, description, size, construction method to use and maintenance. File - purpose, types, description, size and method to use. Use of file card, printing of file, convexity of file and proper filing technique. Rule - purpose, types, description and method to use. (05 hrs)
		14 Use of simple measuring instruments such as steel rule, Vernier caliper, Inside/Outside Micrometer. (4 hrs.) 15 Care and precaution to be observed in handling these instruments. (1 hr.) 16 Exercises on measurement of various geometrical shapes. (8 hrs.)	Divider - purpose, types, description and method to use. Scriber - purpose, types, description and method to use. Marking Block - purpose, types, descrip tion and method to use. Punch - pur pose, types, description and method to use. Micrometer - purpose, types, construc tion, calculation of least count, method to use and read, care and maintenance.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		17 Exercise on marking out according to simple blue prints, using steel rule, scriber, marking blocks & divider. (4 hrs.) 18 Scribing lines on chalked or coloured (blue) surfaces of the work piece. (2 hrs.) 19 Marking location of the position of holes & scribing circles using dividers. (2 hrs.) 20 Use of Dot and Center Punch for punching the lines, centers and circles. (3 hrs.) 21 Demo on filing operation, using rough file. (3 hrs.) 22 Exercise of filing flanges of a channel for balancing of file.(4 hrs.) 23 Filing flat surface and flange of a channel maintaining parallelism between them using outside caliper within + or - 0.5mm. (9 hrs.)	Vernier Caliper - purpose, construction, calculation of vernier constant, method to use & read, care and maintenance. (5 hrs.)
		24 Exercises on filing to develop control and Field layout the dimensional features of the work piece using vernier height gauge, engineering square, angle plate and surface plate. (5 hrs.) 25 Exercise on filing the adjoining sides Squareness with respect to one reference surface. Filing faces for maintaining flatness, squareness of adjacent side using try- square, parallelism between opposite sides and reducing thickness. (6 hrs.) 26 Filing with second cut file to prepare smooth surfaces. (4 hrs.) 27 Exercise on filing for maintaining dimensions within + or -0.1mm using vernier caliper. (8 hrs.)	Vernier height gauge - purpose, types, Construction, method to use and read, care and maintenance. Engineer's square - purpose, de scription and method to use. Surface Plate - purpose, description, method to use, care and mainte nance. Angle Plate - purpose, de scription and method to use.(04 hrs.)
		28 Marking of profiles - combination of straight lines, circles, arcs and angles using scale, divider height gauge, protractor, combination set etc. (3 hrs.) 29 Marking geometrical profiles on sheet metal and filing to mark lines. (3 hrs.) 30 Sharpening of marking tools, use of bench grinder for sharpening of scriber, centre punch, dot punch, divider etc. (1 hr.)	Combination set - purpose, descrip tion and method to use. Vernier bevel protractor - purpose, description, calculation of vernier con stant, method to read and use, care and maintenance. Bench Grinder - purpose, description, proce dure and precautions to be observed during grinding of marking tools, chis els and drill bits.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		31 Marking on the job piece for saw cuts. (1 hr.) 32 Gripping the job suitably in the vice jaws for hack sawing to dimensions. (1 hr.) 33 Hack sawing various metallic pieces (mild steel, aluminum, copper, brass, stainless steel etc.) of different thickness and cross sections, within + or - 0.5mm using hack saw blades of different pitches. (5 hrs.) 34 Hack sawing different lengths with hack saw frame in horizontal & vertical positions Sawing along the parallel marked lines within 0.5mm allowance for filing. (5 hrs.) 35 Hack sawing and filing steps and slots and open fitting of finished pieces. (4 hrs.)	Hack saw - purpose, types, descrip tion, method to use and precautions to be taken during hack sawing. Hack saw blade - purpose, types, de scription, select ON/ OFFappropriate grade, fixing of blade and precautions to be observed. (04 hrs.)
		36 Hammering practice on vertical hold round job. (5 hrs.) 37 Blind hammering practice. Stamping letters and numbers on M.S. plates. (5 hrs.) 38 Exercise on stamping to develop judgment, control on hand and feel. (3 hrs.) 39 Stamping practice on flat and round surfaces using flat, cross cut and round nose chisels for chipping edges and square to the faces and edges.(8 hrs.) 40 Checking with Try- square, use of cross peen hammer for stretching of metal strip. (4 hrs.)	Hammer - purpose, types, description, method to use and precautions to be observed. Bending of solid selections using fixtures. Letters and Numbers - purpose, description, method to use and precautions to be observed. Hollow Punch - purpose, description, method to use for preparations of gaskets and other packing materials. Pipe Fitting -material and types of pipes used in the trade.Method to cut, to thread and preparation of pipes for 'T' fitting elbow fitting, reducers etc. using unions. Method to fill ferrule. (04 hrs.)
		41 Preparation for drilling, marking out the position of holes and dot punching. (2 hrs.) 42 Deepening the points with centre punch. (2 hrs.) 43 Checking for centre distance. (1 hr.) 44 Drilling practice on sensitive drilling machine using different types of drills and drill holding devices. (6 hrs.) 45 Safety to be observed while working on drilling machine. (1 hr.) 46 Marking, chain drilling and filing to produce square, round and triangular openings on 6mm thick plate. (6 hrs.)	Drills - purpose, types, description, drill holding devices, method to use a drill with or without drill chuck (or collet) and precaution to be observed. Reamer -purpose, types, description, method to use, reaming allowance, coolant used and precautions to be observed during reaming. Drilling Machine with manual infeed, its purpose, types, description, drilling fixtures, method to drill and precautions to be observed during drilling. Procedure to be followed for counter sinking, counter boring, spot facing and reaming using bench drilling machine.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		47 Preparing inserts and fitting in these openings.(2 hrs.) 48 Drilling practice on varying thickness and different materials such as M.S., C.I., S.S., Cu, Brass, Nylon, Epoxy etc. (6 hrs.) 49 Drilling on sheet metal, precautions and safety to be observed. (3 hrs.) 50 Counter Sinking, counter boring, and spot facing operations using bench drilling machine. (3 hrs.) 51 Exercise on reaming with hand reamers and machine reamers. (2 hrs.) 52 Internal threading by hand using tap sets. (2 hrs.) 53 External threading by split die and finishing of thread by die nut. (2 hrs.) 54 Marking centre of a round bar with the help of 'V' block and clamp. (1 hr.) 55 Drilling and reaming of blind holes along the axis of round jobs. (3 hrs.) 56 Grinding of drills to specifications and checking of angles with gauges. (4 hrs.) 57 Grinding of chisels. (1 hr.)	Screw Threads - elements and forms screw threads single and multi-start thread, right and left hand thread. Taps and Tapping - purpose, types, description, precaution to be observed and method to use hand and machine taps during tapping. Types of coolant to be used. Calculation to drill size for tapping. Method to tap a blind hole, reasons for breakage of tap and method to remove broken tap. Construction and method to use tap wrench. Die and dieing purpose, types, description and method to use and precaution to be observed. Description of die stock, procedure and precautions to be observed during dieing. (8 hrs.)
		58 Measurement of shaft and hole diameters using outside and inside micrometer. (2 hrs.) 59 Filing round out of square bar within ± 0.1mm. Filing to an accuracy of ±0.1 mm., checking with an outside micrometer. (6 hrs.) 60 Preparation of plates for a gauge fitting. (3 hrs.) 61 Exercise on filing radius and angular filing using templates and gauges. (5 hrs.) 62 Filing templates and gauges for checking lathe tool angles. (5 hrs.) 63 Exercise on step and taper turning. (4 hrs.)	Defining and explanation of the elements of interchangeable system basis size, limits, tolerance, allowances. System of limits, fit and tolerances types of fit. Hole basis and shaft basis. Newal, British, I.S.I. B.S.I. systems, examples of fixing limit for various types of fit commonly met within the machine. (04 hrs.)
		64 Filing of various angle & clearances of lathe tool on square blanks. (6 hrs.) 65 Checking with templates & gauge already prepared. (2 hrs.)	Gauges & Template-purpose, types, description and method to use dial test indicator. Limit gauges - purpose, types, construction and method to use limit gauges. (07 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		66 Use of combination & round nose pliers to make different shapes profiles by bending wire to match the blue print to develop manipulative skills, hand control & eye judgment. (5hrs.) 67 Cold riveting. (3 hrs.) 68 Marking out location of holes for riveting. (2 hrs.) 69 Use of dolly and snap for forming rivet heads. (3 hrs.) 70 Lap and butt joint by cold riveting. (4 hrs.)	
		71 Cutting of sheet metal with chisel. Marking parallel clamp, 'C' clamp or micrometer stand using acquired skills. (8 hrs.) 72 Simple project work. (14 hrs.)	Sheet metal work-purpose, types, description and method to use snip & stake. Description and method to use hand shear. Rivets & riveting types & description of rivets. Method of lap & butt joint using dolly and snap. Cold & hot working of strips & pipesˆmethod of bending solid sections, using fixtures for different physical conditions. Use of cutters for pipes & method to bend in hot and cold condition using fixtures. (04 hrs.)
Professional Skill 25 Hrs; Professional Knowledge 05Hrs	Plan & perform simple repair, maintenance of different machines and check for functionality. [Different Machines – Drill Machine, Power Saw and Bench Grinder] (Mapped NOS: NOS:CSC/N0901)	**BASIC MAINTENANCE SKILLS** 73 Using hand tools such as screw driver, single end/double end spanners, box nut spanners, ratchet spanners, circlip, pliers, wrenches, pullers, extractors, drift. (6 hrs.) 74 Correct method to be used and care to be taken in using those tools. (9 hrs.) 75 Lubrication of different parts of machines. (4 hrs.) 76 Care and maintenance of machines. (6 hrs.)	**BASIC MAINTENANCE SKILLS** Screw drivers - purpose, types, description and method to use screw drivers. Spanners- purpose, types, description and method to use box, socket, tubular, hook spanner etc. Wrenches - purpose, types, description and method to use T socket, monkey, ratchet,pipe wrenches etc. Purpose, description, precautions to be observed and method to use drift, pullers and extractors. (05 hrs.)
Professional Skill 80Hrs; Professional Knowledge 15Hrs	Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations. [Different cutting tool – V tool, side cutting, parting, thread cutting (both LH & RH), Appropriate accuracy: - ±0.06mm, Different	**BASIC TURNING** 77 Safety precautions to be observed while handling machines. (3 hrs.) 78 Demonstration of change gear in the gearbox. (4 hrs.) 79 Practice of holding work piece and tool using different devices. (6 hrs.) 80 Exercises on plain, stepped, taper and form turning, knurling etc. (16 hrs.) 81 Exercises on drilling, reaming,	**TURNING** Types, construction features working principles, functions, use accessories and attachments of lathe machine. Driving mechanism – cone pulley, all geared headstock, quick-change gearbox and apron mechanism. Types, materials and angles of the lathe cutting tools. Purpose and method to perform various lathe operations. Using accessories and attachments.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
	turning operation – Plain, facing, drilling, boring (counter & stepped), grooving, Parallel Turning, Step Turning, parting, chamfering, U cut, Reaming, knurling.] (Mapped NOS: NOS:CSC/N0110)	boring, counter boring etc. (15 hrs.) 82 Screw thread cutting both internal and external of different types. (10 hrs.) 83 Exercise on eccentric turning. (6 hrs.) 84 Grinding of lathe tools. (2 hrs.) 85 Simple projects such as hollow punch, pulleys, gear blanks, simple coupling etc. (18 hrs.)	Determination and use of cutting speed, feed. Coolant and its applications. Lubrication system. (15 hrs.)
Professional Skill 80Hrs; Professional Knowledge 15Hrs	Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, face, angular, form, gang, straddle milling] (Mapped NOS: CSC/ N0108)	**BASIC MILLING** 86 Safety precautions in handling machine. (5 hrs.) 87 Demonstration of various parts of the milling machines. (10 hrs.) 88 Practice on different work and tool holding devices. (15 hrs.) 89 Exercises on: (30 hrs.) i) Parallel and angular milling. ii) Grooving using mills. iii) Milling square/hexagon using indexing head. iv) Use of slotting attachment for cutting key ways. v) Simple projects such as jaw, claw, 90 Oldham coupling, spline cutting etc. (10 hrs.) 91 Lubrication of different parts. Care &maintenance of machine. (10 hrs.)	**MILLING :** Construction features, working principles, types, functions. Use of accessories and attachment of milling machine. Types of milling cutters. Different method of holding work piece and cutters. Milling operations such as plain, step, angular milling, slot and groove cutting. Gear nomenclature definitions, symbols, explanation and gear cutting calculations. Explanation of cutting speed, feed and depth of cut. C oolant for different materials. Common fault, defects and their rectification. (15 hrs.)
Professional Skill 125Hrs; Professional Knowledge 28Hrs	Produce components of high accuracy by different operations using grinding. [Different operations – surface grinding, cylindrical grinding with an accuracy of ±0.01 mm] (Mapped NOS: CSC/N0109)	**GRINDING** 92 Safety precautions to be observed while using machine. (7hrs.) 93 Demonstration of various parts of the grinding machines. (13 hrs.) 94 Use of drive - both mechanical and hydraulic. (8 hrs.) 95 Grinding wheel specifications, mounting, balancing, truing and dressing of grinding wheels. (18 hrs.) 96 Lubrication of different parts and care & maintenance of grinding machine. (18 hrs.) 97 Practice on different work holding devices and grinding various jobs.(36 hrs.)	Types of machines- Constructional features, working principle, types, functions and use of surface and cylindrical grinding machine. Grinding wheels and their specifications - grit, grain, size, structure, bond, grades etc. Procedure to use grinding wheels for balancing and truing. Method to hold work and grind wheel. Method to perform various grinding operation selecting proper speed, Feed. Importance of coolant. Method to detect common faults, their rectification and preventive maintenance of grinding machine. Study of hydraulic system used on the machine. (28 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		98 Other machining process: (25 hrs.) • Shaping • Planning • Slotting • Hobbing • Broaching • Finish machining process like • Types • Coated Abrasives (Sandpaper, Emory Cloth) • Belt Grinders • Solid Belt • Mesh Belt (Hold Grinding Fluid via Surface Tension • Wire Brushing • Wire Provides Metal Cutting/ Burnishing Action • Wire (Metal) Acts as Abrasive • Honing (Interior of Holes) • Lapping (Flat Surfaces) • Polishing • Buffing • Electro-Polishing • Magnetic Float Polishing (Ceramic Ball Bearings) • Barrel Finishing • Abrasive Flow	
Professional Skill 60Hrs; Professional Knowledge 10Hrs	Set different components of machine & parameters to produce taper/ angular components and ensure proper assembly of the components. [Different component of machine: Form tool, Compound slide, tail stock offset; Different machine parameters- Feed, speed, depth of cut.] (Mapped NOS: CSC/N0110)	**ADVANCED MACHINING SKILLS TURNING** 99 Taper turning by using taper attachment. (10 hrs.) 100Taper turning by using a form tool. (10 hrs.) 101Internal and external taper turning and matching to mating parts. (10 hrs.) 102Eccentric turning practice. (15 hrs.) 103Boring and stepped boring, position boring. (15 hrs.)	**ADVANCED MACHINING SKILLS TURNING** Taper turning attachment and form tool. Care to be taken for boring, step boring and taper boring in a blind hole. Procedure and care to be taken eccentric turning. (10 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 40 Hrs; Professional Knowledge 8Hrs	Set the different machining parameters to produce screw & multi start threaded components applying method/ technique and test for proper assembly of the components. (Mapped NOS: CSC/ N0110)	104 Various Screw threads cutting to suit male and female threaded components. (25 hrs.) 105 Multi start threads cutting^2start. (15 hrs.)	Procedure for cutting various internal and external screw threads. Care to be taken during internal threading in a blind hole. (8 hrs.)
Professional Skill 130Hrs; Professional Knowledge 25Hrs	Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different components – Rack, Spur Gear, External Spline, bevel gear, Helical Gear, worm & work wheel.] (Mapped NOS: CSC N0108)	**MILLING** 106Gang milling - milling jobs of different shapes and dimensions by using gang-milling process. (15 hrs.) 107Milling hexagonal holes on a plate by attachment. Milling splines (external). (15 hrs.) 108Milling gears by both simple and differential indexing (15hrs.) 109Helical milling - milling helical groove on vertical milling machine by end mill cutter. (15 hrs.) 110Milling helical gears. (15 hrs.) 111Milling bevel gears. (15 hrs.) 112Milling a rack. (15 hrs.) 113Cutting worm and worm wheel on a milling. (25 hrs.)	**MILLING** Different types of milling operations. Indexing methods and its applications. Different types of gear & its application. Different cutters used in gear cutting operations and cutter nomenclature. Procedures for milling helical groove by a slab mill cutter on vertical milling machine. Care and precautions to be taken during milling. Procedure for milling helical gears, bevel gears, rack, worm and worm wheel. (25 hrs.)
Professional Skill 40Hrs; Professional Knowledge 8Hrs	Measure components using different instrument/ gauge and test machine tool accuracy. [Different instrument/ gauges^limit gauges, Sine Bar, snip gauges, tool maker's microscope and profile projector; Simple Machines – Drill Machine, Power Saw and Lathe] (Mapped NOS: CSC/N0110)	**INSPECTION** 114Familiarization with inspection and master gauge checking of finished product with limit gauges for their accuracy and usability. (2 hrs.) 115Use of Sine Bar, snip gauges along with standard balls and rollers for measurement of taper. (5 hrs.) 116Measuring with tool maker's microscope. (3 hrs.) 117Testing of gears for its measurements and accuracy. (5 hrs.) 118Use of digital profile projector. (5 hrs.)	**INSPECTION** Definition, description and use of worker's inspection and master gauge. Principle, construction and use of sine bar and sine center. Types and description of slip gauges, purpose, construction and method to use tool makers. Microscope and profile projector. (04 hrs.)
		119Geometrical accuracy test of machine as per test chart. (20 hrs.)	Defects and remedies of turning, milling and grinding. Defects such as: Taper, Chattering, Poor Surface finish, Parallelism. (04 hrs.)

Importance of trade training tools and machinery used in the trade

Objectives: At the end of this exercise you shall be able to
- **Importance of trade training**
- **Identifying the tools used in the section**
- **Identifying the machines used in the section.**

Job sequence

TASK 1: **Importance of trade training.**

- Education makes a person, to be better, whereas the training makes the person to be a better performer. Education and training is interlinked process for the better prospects of human development
- Technical trade training is mainly concerned for importing/ providing knowledge and skill improvement with specific objective and with precise targets
- The objective and the importance of the trade training also includes:
- To understand to appreciate and the importance of the trade for the concerned field of application for the benefit of industrial society and in turn for the development of the nation.
- To acquire the theoretical knowledge and to develop basic skills of practical work to perform the concerned work in a better way.
- To cultivate and to develop safe working habits in the works to be carried cut.
- To cultivate the reading to understand and to acquire the related information and developments.
- To improve the safe working method to maximise the productivity in the concerned field of works.
- To develop a sense of responsibility towards the working organisation/ institution/ society and sincerity towards the profession.
- To provide self confidence and to undertake the work and the challenging assignment in the respective trade.
- Technical training will also enable the transfer of technical skill acquired to other persons for the benefit of industries, society and the nation.

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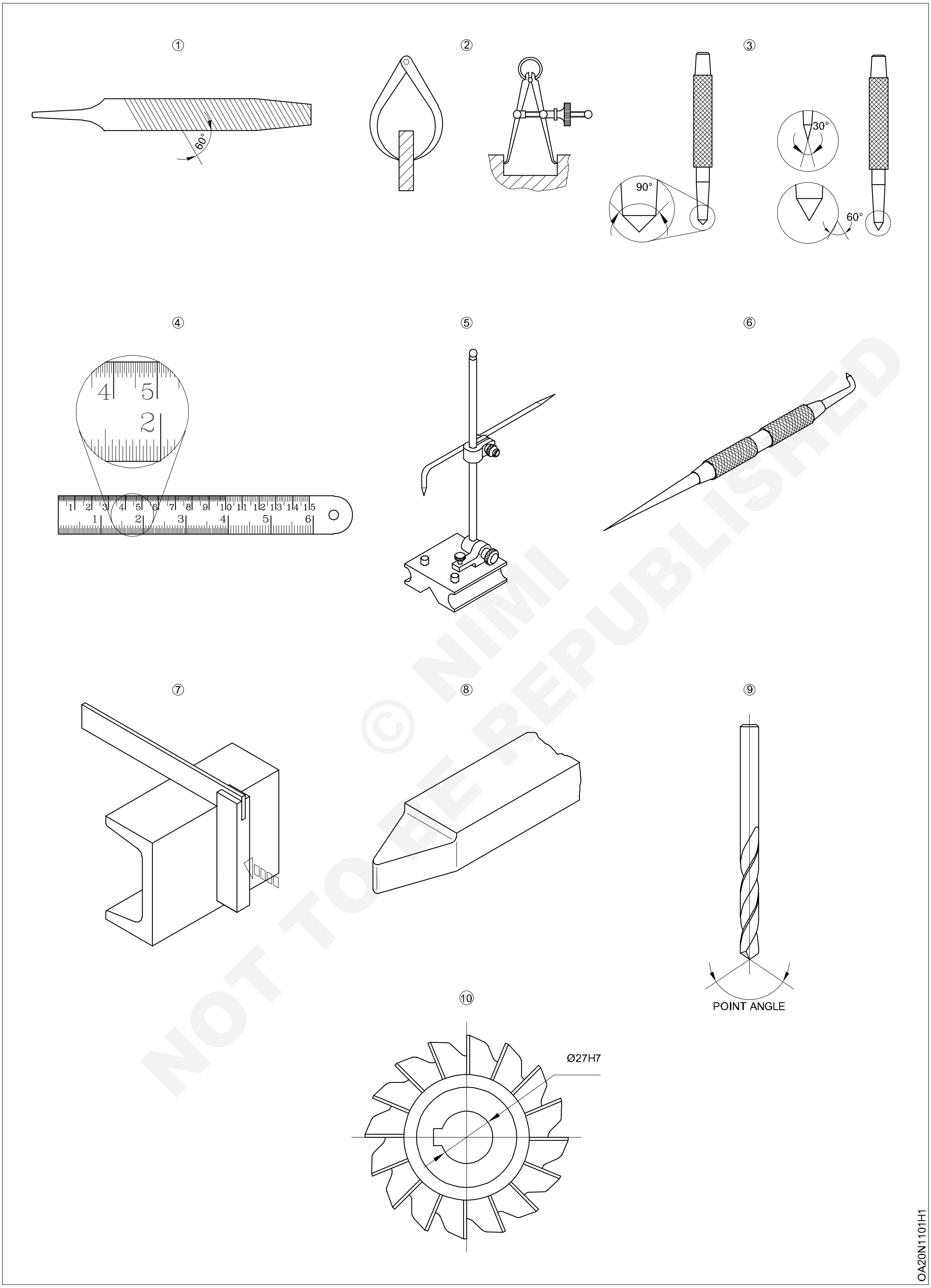
TASK 2: **Identification of tools.**

Instructor may display all the tools used in section and brief the used of tool. Ask the trainees to record in table 1

- Observe displayed tools in the section
- Identify the tools show in Fig 1 to Fig 10.
- Record the names and uses of the tool in table-1

TABLE - 1

Fig.No	Name of the tool	Uses
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		


①
60°
②
③
90°
30°
60°
④
4 5
2
⑤
⑥
⑦
⑧
⑨
POINT ANGLE
⑩
Ø27H7
OA20N1101H1

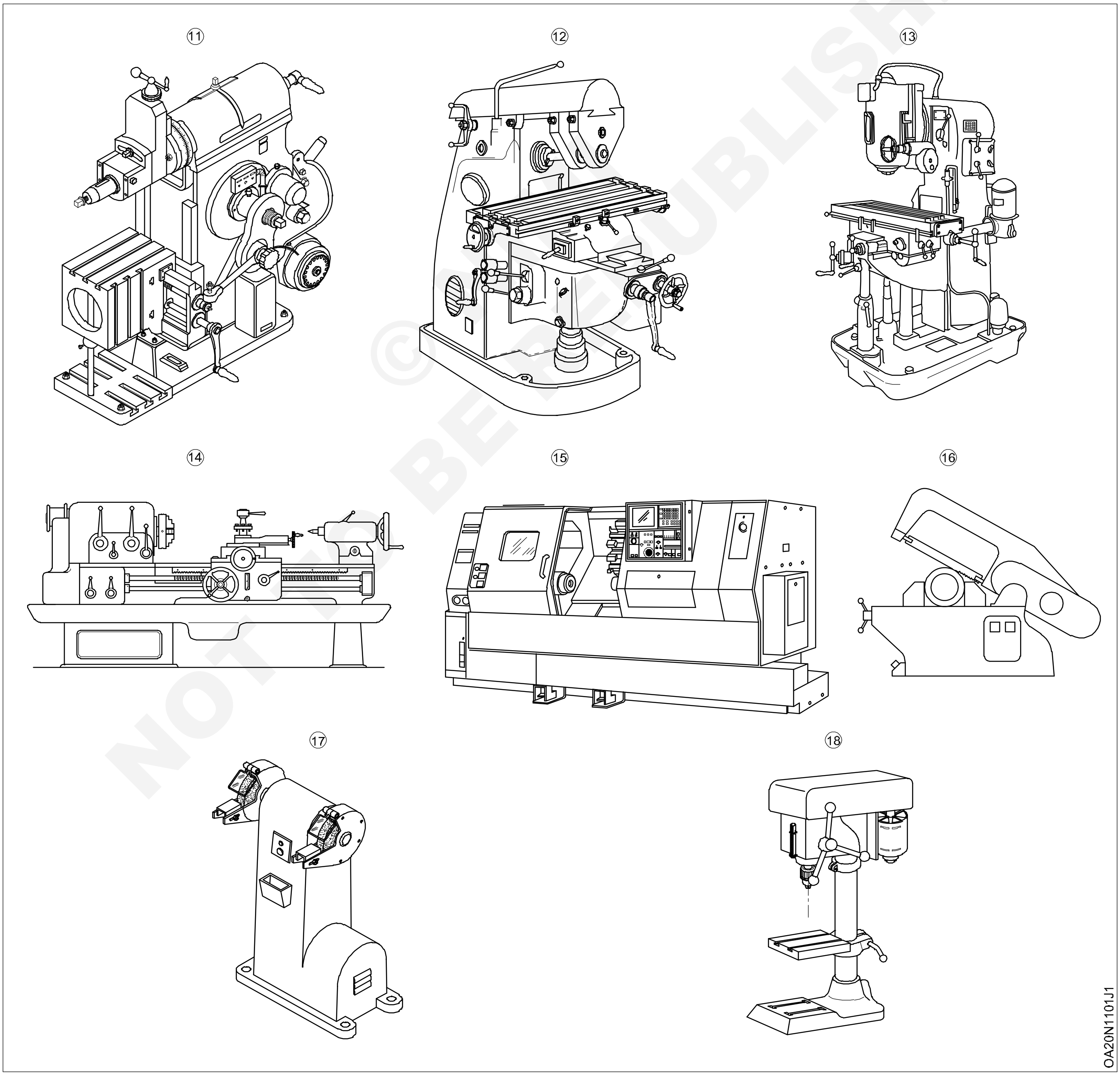
TASK 3: **Identification of machinery.**

IInstructor may show all the machines in the section and brief the purpose of machines. Ask the trainees to record in the table 2

- Identify the machines shown in Fig 11 to 18
- Record the name and purpose of the machines in Table - 2

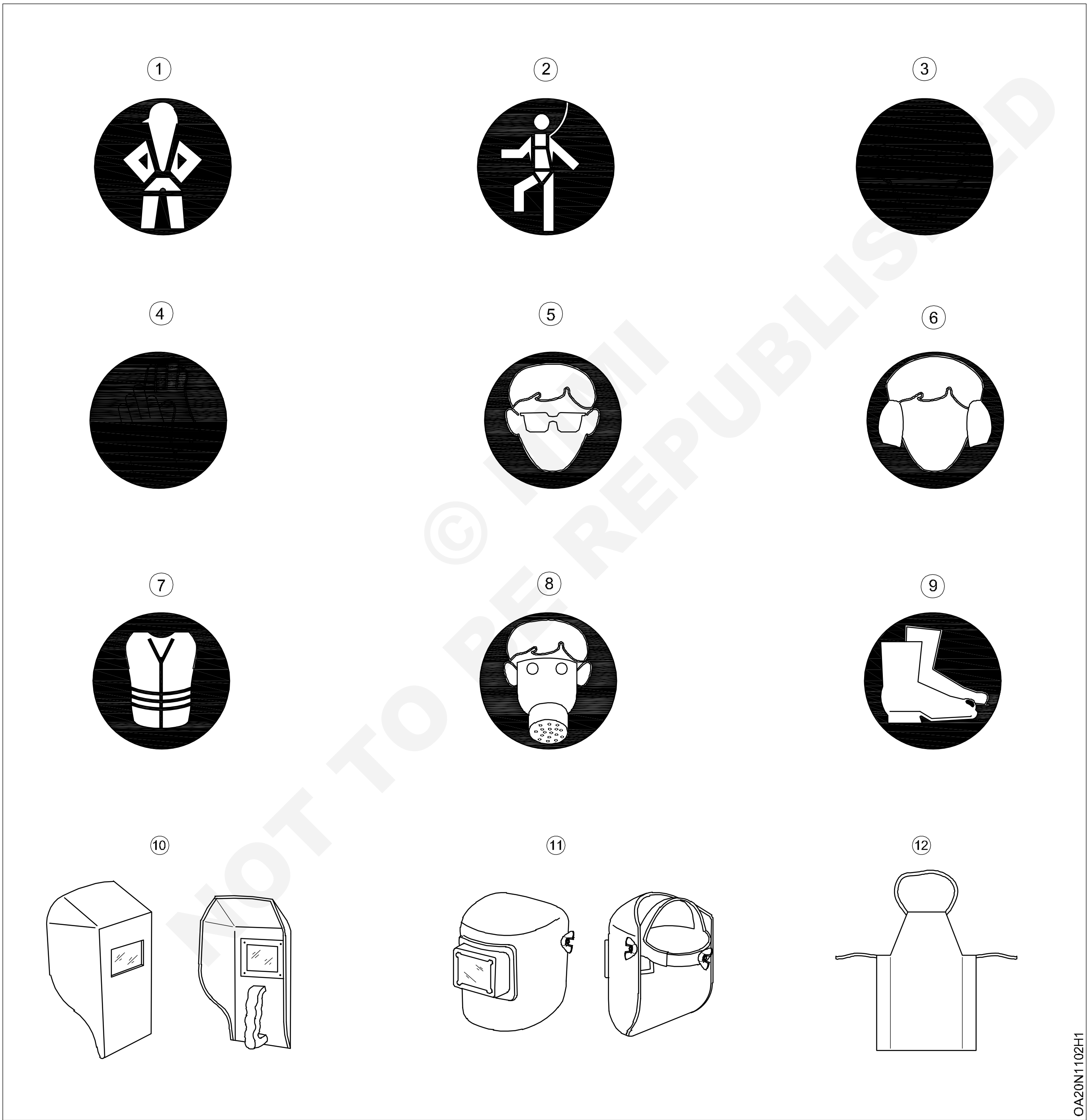
TABLE - 2

Fig.No	Name of the machine	Purpose
11		
12		
13		
14		
15		
16		
17		
18		



Safety attitude development of the trainee by educating them to use personal protective equipments (PPE)

Objectives: At the end of this exercise you shall be able to
- **identify personal protective equipments**
- **interpret the different types of personal protective equipments**
- **identify occupational hazards and the corresponding potential hazards.**



Job sequence

TASK 1: **Identification personal protective equipments.**

The instructor shall display the different types of personal protective equipments or charts and explain how to identify and select the PPE devices suitable for the work and the type of protection in the Table 1.

- Read and interpret the visuals of personal protective equipments on real devices or from the charts
- Identify and select personal protective equipments used for different types of protection
- Write the name of the PPE and the corresponding type of protection and the hazards in Table 1.
- Get it checked by yours instructor.

Table 1

Fig.No	Name of the PPE	Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

— — — — — — — —

TASK 2: **Identification of type of occupational hazards.**

Instructor may brief the various types of occupational hazards and their causes.

- Identify the occupational hazards and the corresponding situation with the potential harm and record it in table 2.
- Fill up get it checked by your instructor.

Table 2

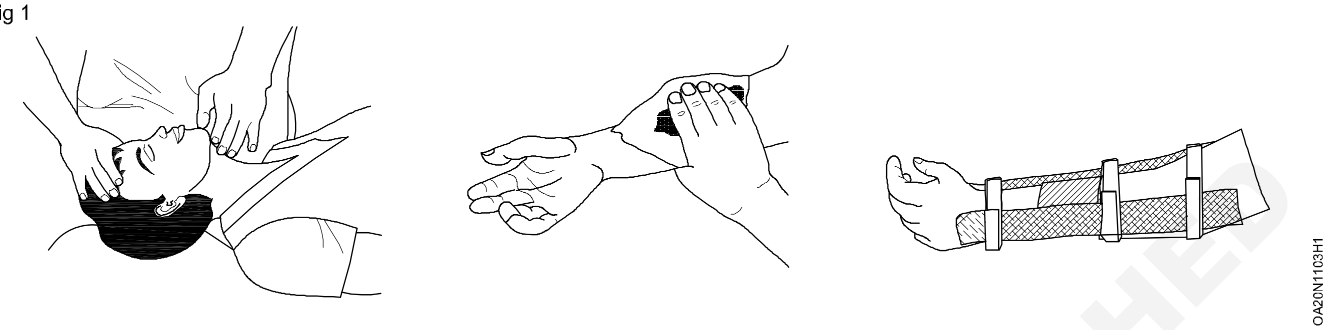
Si.No.	Source or potential harm	Type of occupational hazards
1	Noise	
2	Explosive	
3	Virus	
4	Sickness	
5	Smoking	
6	Non control device	
7	No earthling	
8	Poor house keeping	

— — — — — — — —

First aid method and basic training

Objectives: At the end of this exercise, you shall be able to
- **rescue breathing for an unconscious victim of difficult condition**
- **perform treatment for stopping of bleeding.**

Fig 1



Job sequence

Assumption - For easy manageability, Instructor may arrange the trainees in group and ask each group to perform one method of resuscitation.

TASK 1: **Prepare the victim to receive artificial respiration.**

1 Loosen the tight clothing which may interfere with the victim's breathing.

2 Remove any foreign materials or false teeth from his mouth and keep the victim's mouth open.

3 Bring the victim safely to the level ground, taking necessary safety measures.

4 Start artificial respiration immediately without delay. Do not waste too much time in loosening the clothes or trying to open the tightly closed mouth.

5 Avoid violent operations to prevent injury to the internal parts of the victim.

6 Send word for a doctor immediately.

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TASK 2: **Resuscitate the victim by Nelson's arm - Lift back pressure method.**

Nelson's arm-lift back pressure method must not be used in case there are injuries to the chest and belly.

1 Place the victim prone (that is face down) with his arms folded with the palms one over the other and the head resting on his cheek over the palms. Kneel on one or both knees near the victim's hand. Place your hands on the victim's back beyond the line of the armpits, with your fingers spread outwards and downwards, thumbs just touching each other as in Fig 1.

2 Gently rock forward keeping your arms straight until they are nearly vertical, and steadily pressing the victim's back as shown in Fig 2 to force the air out of the victim's lungs.

Fig 1

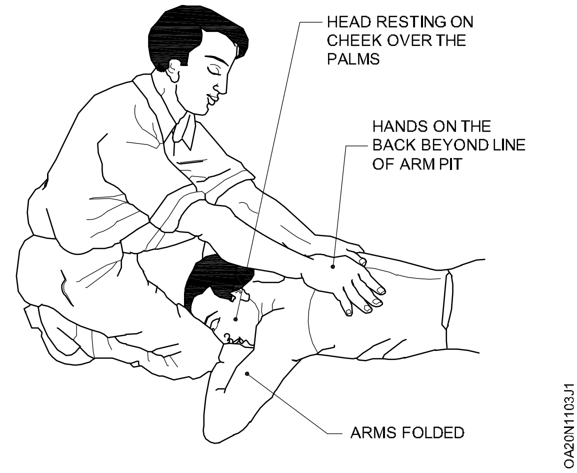
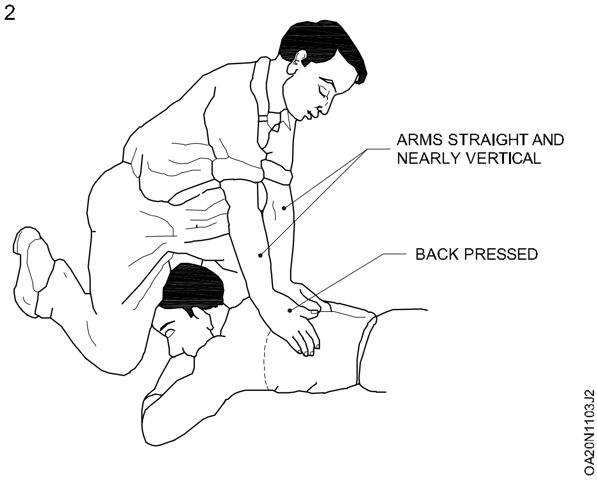


Fig 2

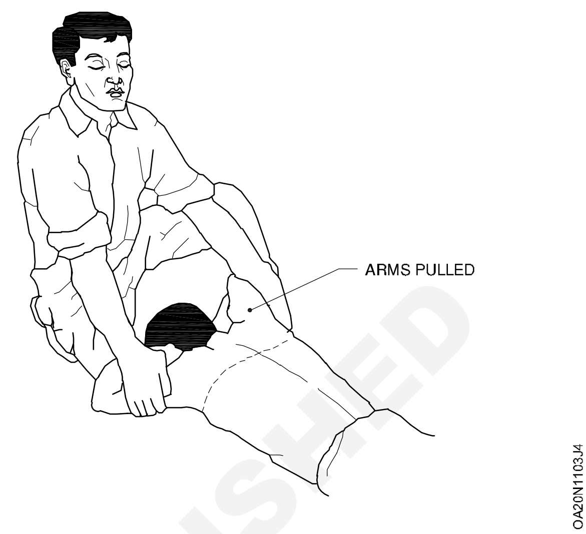


3 Synchronise the above movement of rocking backwards with your hands sliding downwards along the victim's arms, and grasp his upper arm just above the elbows as shown in Fig 3. Continue to rock backwards.

Fig 3

4 As you rock back, gently raise and pull the victim's arms towards you as shown in Fig 4 until you feel tension in his shoulders. To complete the cycle, lower the victim's arms and move your hands up to the initial position.

Fig 4



5 Continue artificial respiration till the victim begins to breathe naturally. Please note, in some cases, it may take hours.

6 When the victim revives, keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

7 Keep him in the lying down position and do not let him exert himself.

Do not give him any stimulant until he is fully conscious.

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TASK 3: **Resuscitate the victim by Schafer's method.**

Do not use this method in case of injuries to victim on the chest and belly.

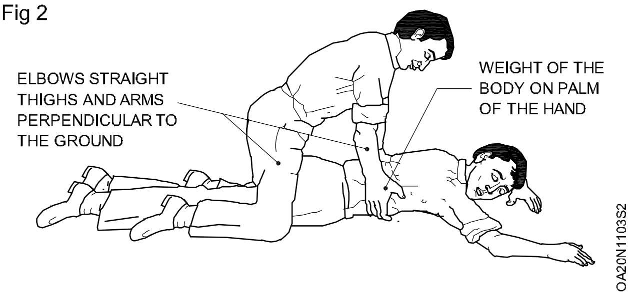
1 Lay the victim on his belly, one arm extended direct forward, the other arm bent at the elbow and with the face turned sideward and resting on the hand or forearm as shown in Fig 5.

Fig 1

2 Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned as in Fig 5.

3 With the arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the lower ribs of the victim to force the air out of the victim's lungs as shown in Fig 6.

Fig 2

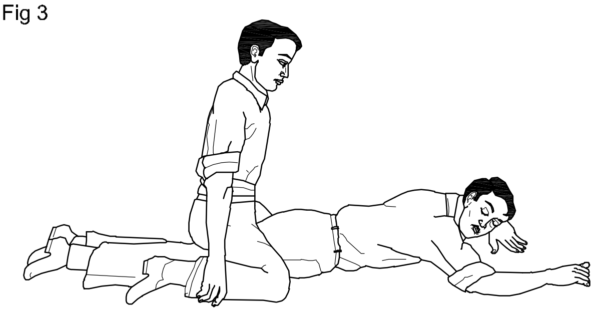


4 Now swing backward immediately removing all the pressure from the victim's body as shown in Fig 7, thereby, allowing the lungs to fill with air.

5 After two seconds, swing forward again and repeat the cycle twelve to fifteen times a minute.

6 Continue artificial respiration till the victim begins to breathe naturally.

Fig 3



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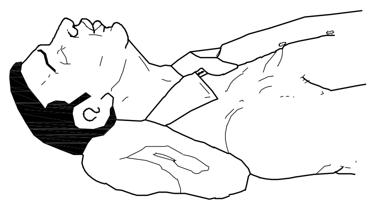
TASK 4: **Resuscitate the victim by mouth-to-mouth method.**

1 Lay the victim flat on his back and place a roll of clothing under his shoulders to ensure that his head is thrown well back. (Fig 8)

Fig 1

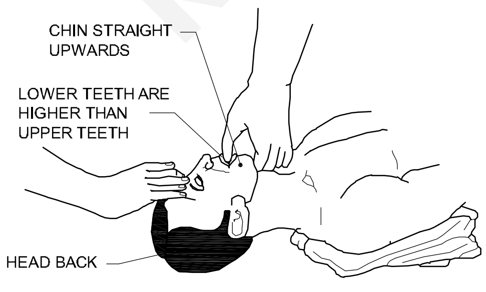


2 Tilt the victim's head back so that the chin points straight upward. (Fig 9)

Fig 2

3 Grasp the victim's jaw as shown in Fig 10, and raise it upward until the lower teeth are higher than the upper teeth; or place fingers on both sides of the jaw near the ear lobes and pull upward. Maintain the jaw position throughout the artificial respiration to prevent the tongue from blocking the air passage.

Fig 3



4 Take a deep breath and place your mouth over the victim's mouth as shown in Fig 11 making airtight contact. Pinch the victim's nose shut with the thumb and forefinger. If you dislike direct contact, place a porous cloth between your mouth and the victim's. For an infant, place your mouth over his mouth and nose.

Fig 4

5 Blow into the victim's mouth (gently in the case of an infant) until his chest rises. Remove your mouth and release the hold on the nose, to let him exhale, turning your head to hear the rushing out of air. The first 8 to 10 breathings should be as rapid as the victim responds, thereafter the rate should be slowed to about 12 times a minute (20 times for an infant).

If air cannot be blown in, check the position of the victim's head and jaw and recheck the mouth for obstructions, then try again more forcefully. If the chest still does not rise, turn the victim's face down and strike his back sharply to dislodge obstructions.

Sometimes air enters the victim's stomach as evidenced by a swelling stomach. Expel the air by gently pressing the stomach during the exhalation period.

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TASK 5: **Resuscitate the victim by Mouth-to-Nose method.**

Use this method when the victim's mouth will not open, or has a blockage you cannot clear.

1 Use the fingers of one hand to keep the victim's lips firmly shut, seal your lips around the victim's nostrils and breathe into him. Check to see if the victim's chest is rising and falling. (Fig 12)

2 Repeat this exercise at the rate of 10 - 15 times per minute till the victim responds.

3 Continue this exercise till the arrival of the doctor.

Fig 1

OA20N1103X1

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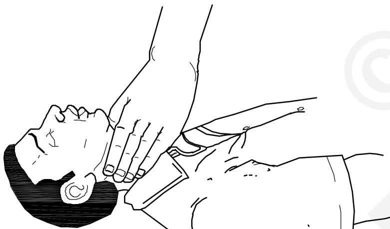
TASK 6: **Resuscitate a victim who is under cardiac arrest by (CPR) cardio pulmonary resuscitation.**

In cases where the heart has stopped beating, you must act immediately.

1 Check quickly whether the victim is under cardiac arrest.

Cardiac arrest could be ascertained by the absence of the cardiac pulse in the neck (Fig 13), blue colour around lips and widely dilated pupil of the eyes.

Fig 1

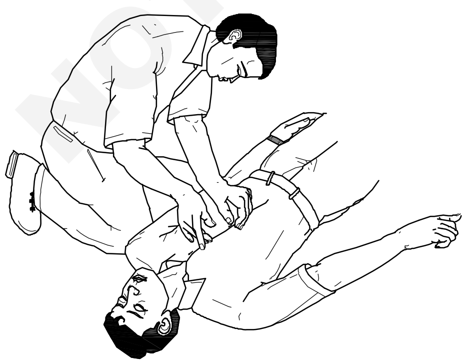


OA20N1103Y1

2 Lay the victim on his back on a firm surface.

3 Kneel alongside facing the chest and locate the lower part of the breastbone. (Fig 14)

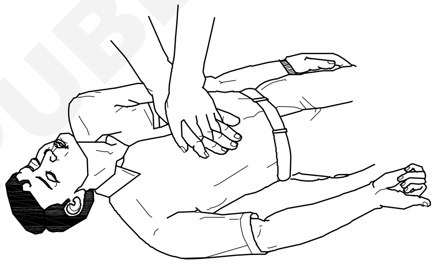
Fig 2



OA20N1103Y2

4 Place the palm of one hand on the centre of the lower part of the breastbone, keeping your fingers off the ribs. Cover the palm with your other hand and lock your fingers together as shown in Fig 15.

Fig 3



OA20N1103Y3

5 Keeping your arms straight, press sharply down on the lower part of the breastbone; then release the pressure. (Fig 16)

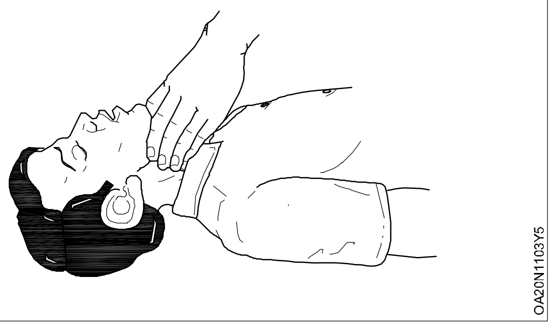
Fig 4

OA20N1103Y4

6 Repeat step 5, fifteen times at the rate of at least once per second.

7 Check the cardiac pulse. (Fig 17)

Fig 5



8 Move back to the victim's mouth to give two breaths (mouth-to-mouth resuscitation). (Fig 18)

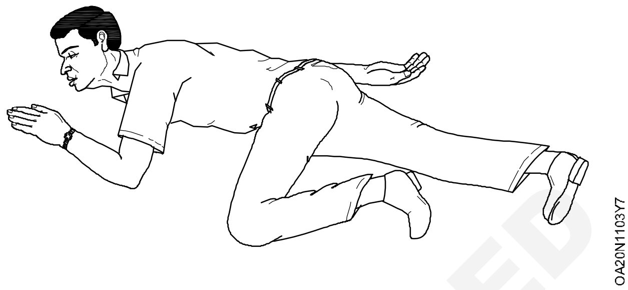
9 Continue with another 15 compressions of the heart followed by a further two breaths of mouth-to-mouth resuscitation, and so on, check the pulse at frequent intervals.

Fig 6

10 As soon as the heartbeat returns, stop the compressions immediately but continue with mouth-to-mouth resuscitation until natural breathing is fully restored.

11 Place the victim in the recovery position as shown in Fig 19. Keep him warm and get medical help quickly.

Fig 7



Other steps

1 Send word for a doctor immediately.

2 Keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

TASK 7: **Treatment for bleeding victim.**

1 Determine the location of the bleeding.

2 Elevate the injured area above the heart if possible.

3 Apply direct pressure to the bleeding area with sterile cloth.

4 Keep the pressure on for 5 seconds.

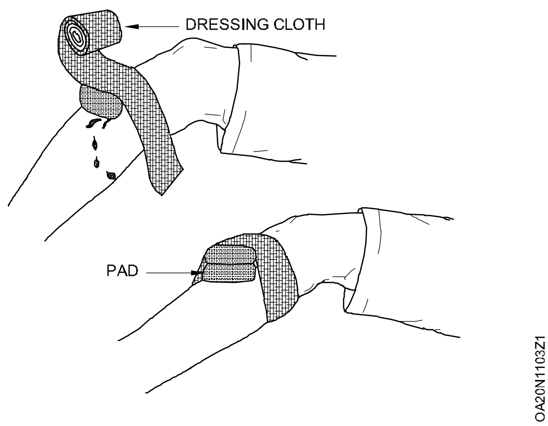
5 Check to see if the bleeding has stopped if not apply further pressure for 15 minutes.

6 Clean the wound.

7 Bandage the wound with pad of soft material. (Fig 20)

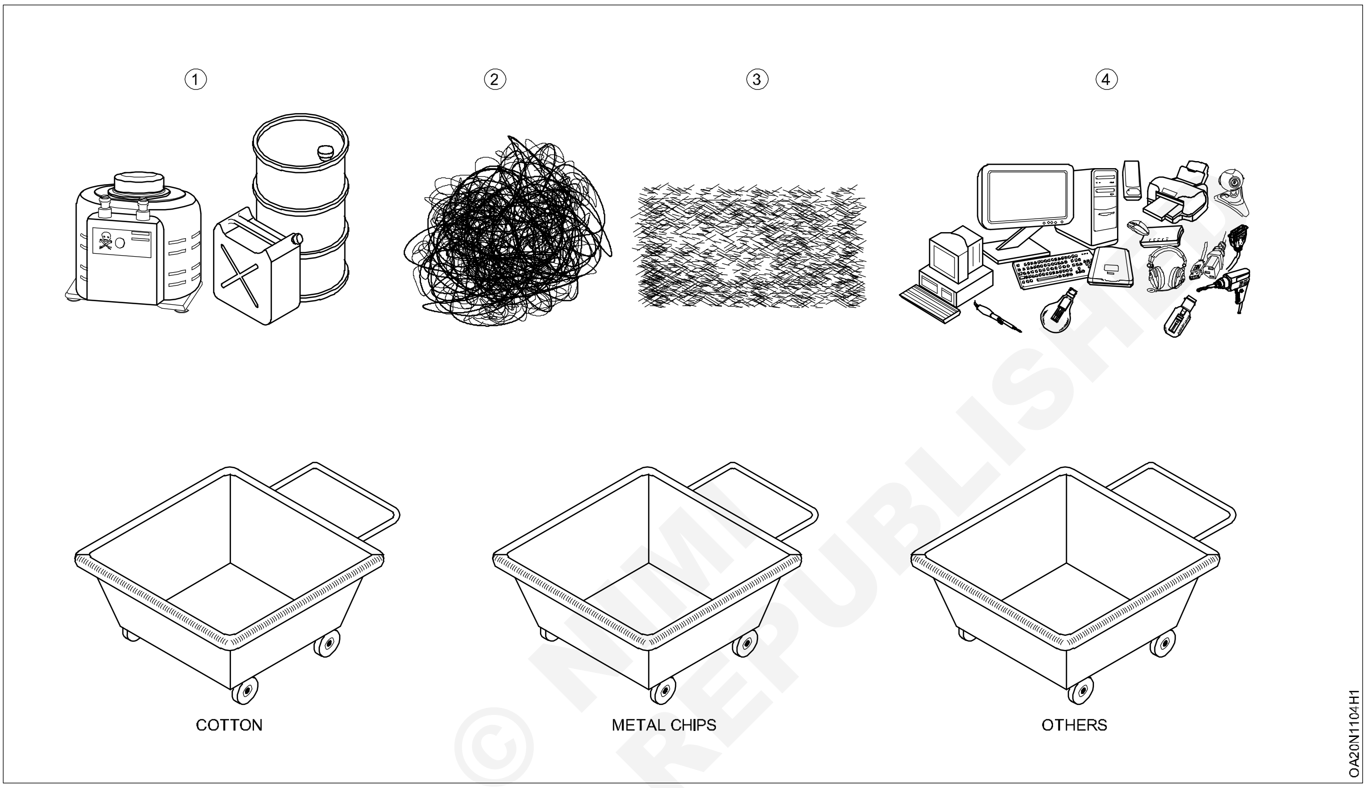
8 Advice victim to take treatment from doctor.

Fig 1



Safe disposal of waste materials like cotton waste, metal chips / burrs etc.

Objectives: At the end of this exercise you shall be able to
- **identify and segregate the waste material in workshop**
- **arrange the waste material in different bins.**



Job sequence

- Separate the cotton waste.
- Collect the chips by hand shovel with the help of brush.
- Clean the floor, if oil is spilled.

> **Do not handle the chip by bare hand**
>
> **There may be different metal chips. So separate the chip according to metal.**

- Separate the cotton waste material and store it in the bin provided to store the waste cotton material. (Fig.2)
- Similarly store the each category of metal chip in separate bins.

> **Each bin should have name of the material.**

- Identify the waste material given in Fig 1 to Fig 4 and fill in table 1

Table 1

Fig. No.	Name of the waste material
1	
2	
3	
4	

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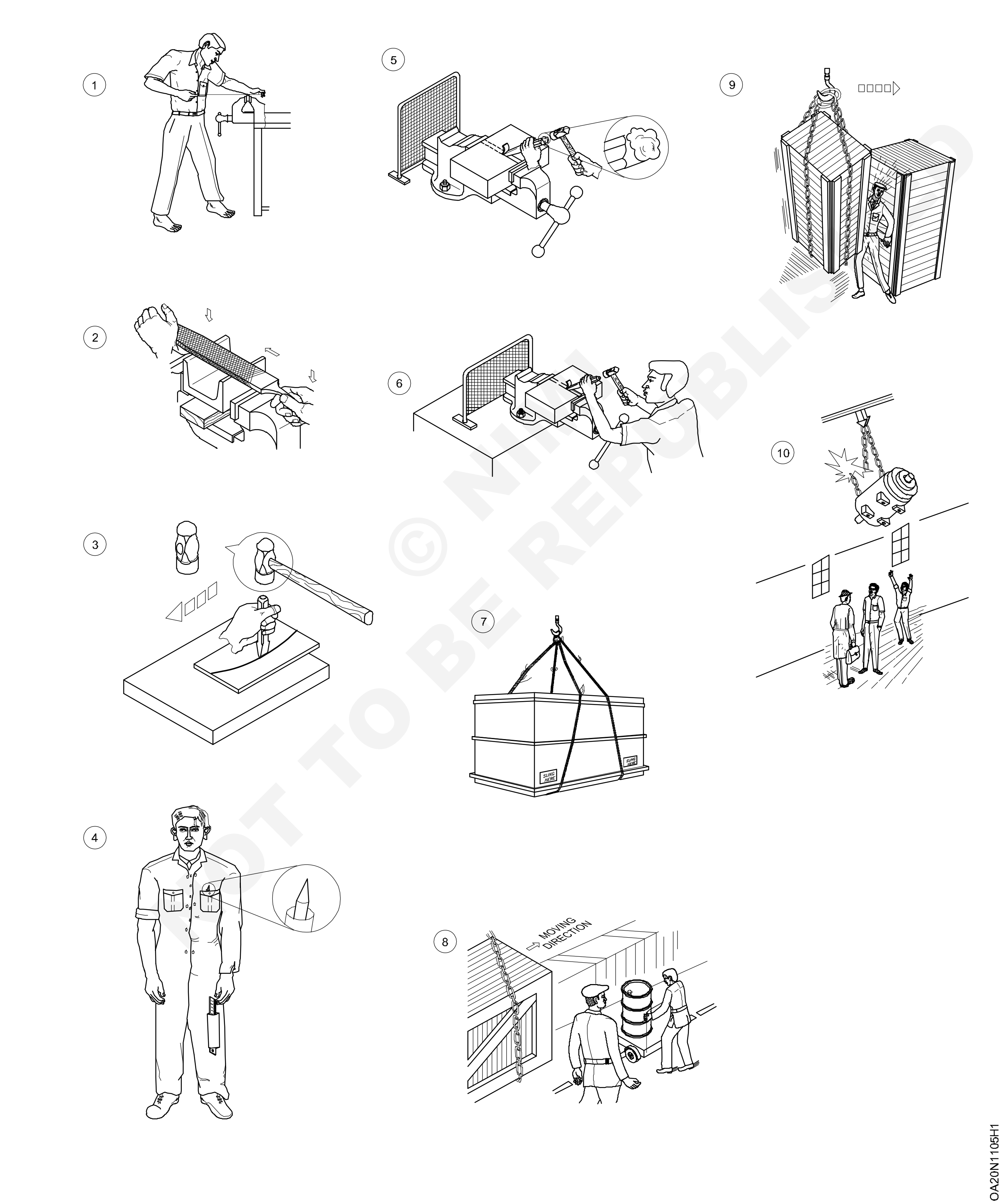
Hazard identification and avoidance

Objectives: At the end of this exercise you shall be able to
- **identify the occupational hazards**
- **suggest suitable methods to avoid occupational hazards.**



Job sequence

The instructor shall emphasise the importance of hazard identification and avoidance to the students and insist them to follow properly.

- Study the drawing of industrial hazards. Fig 1 to Fig 10
- Identify the type of hazards.
- Record the hazards avoidance in Table 1.
- Get it checked by your instructor

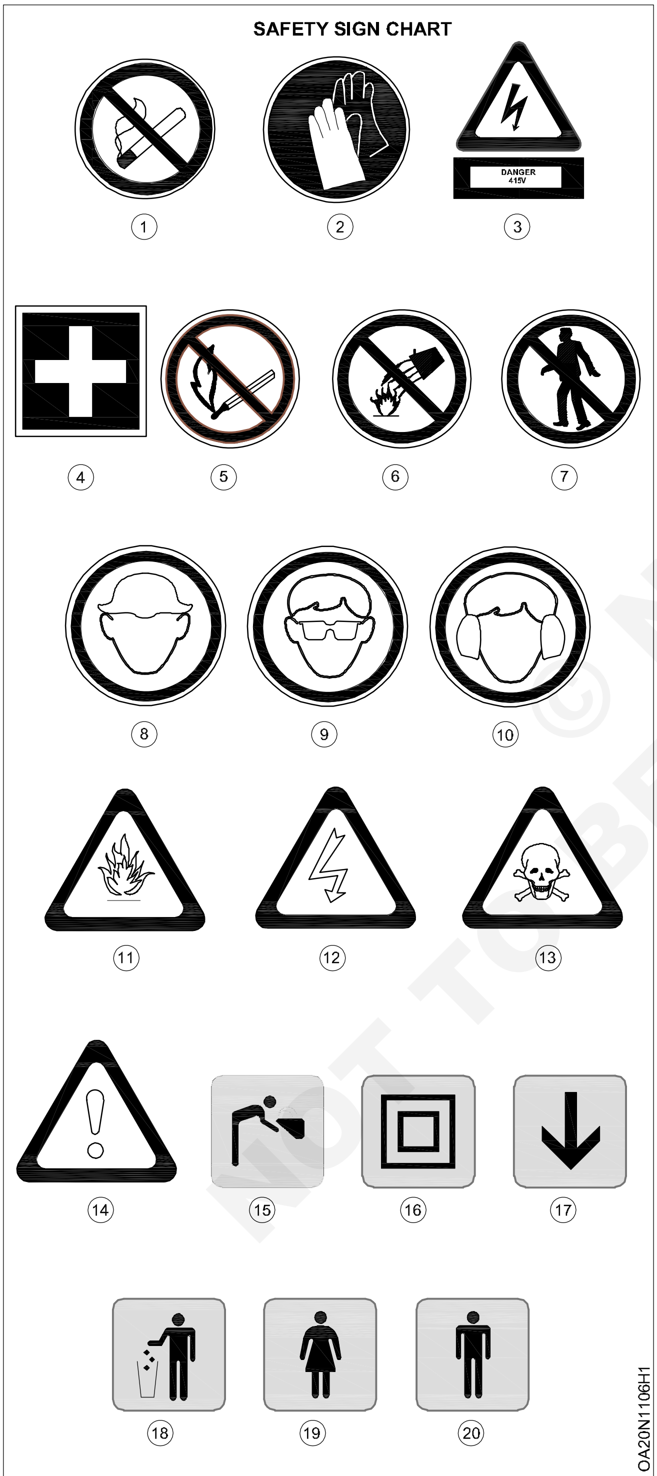
Table 1

Fig. No	Identification of hazards	Avoidance
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

— — — — — — — —

Identification of safety signs for Danger, Warning, Caution and personal safety message

Objectives: At the end of this exercise you shall be able to
- **identify the basic categories of safety signs**
- **record the meaning of safety signs in the table given.**



Job sequence

Instructor shall provide various safety signs, chart categories and explain their meaning, description. Ask the trainee to identify the sign and record in Table 1.

- Identify the safety sign from the chart.
- Record the name of the category in Table 1.
- Mention the meaning of description of the safety sign in Table 1.
- Get it checked by your instructor.

Table 1

Fig.No	Basic categories/Safetysign	Meaning description
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

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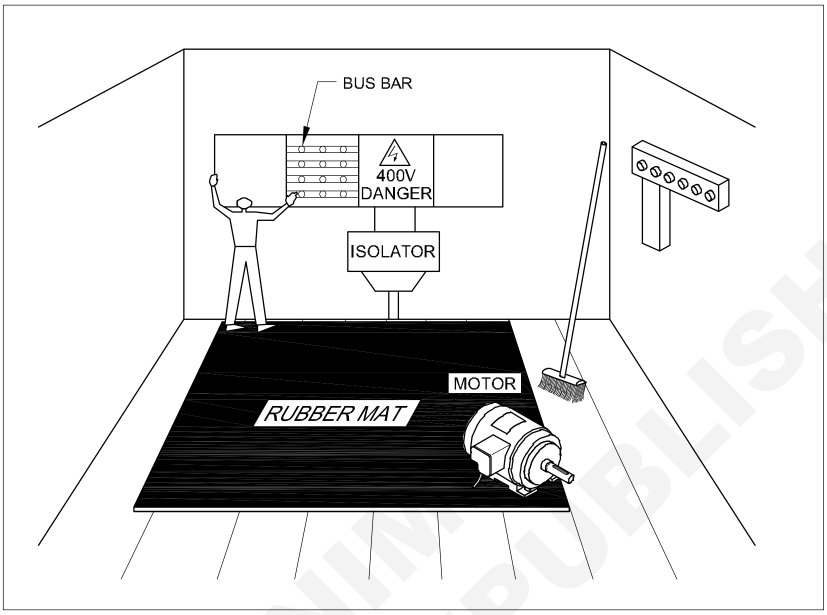
Preventive measures for electrical accidents and steps to be taken in such accidents

Objective: At the end of this exercise you shall be able to
- **rescue a person from live wire.**

Fig 1



Job sequence

Disconnecting a person (mock victim) from a live supply (simulated)

1 Observe the person (mock victim) receiving an electric shock. Interpret the situation quickly.

2 Remove the victim safely from the 'live' equipment by disconnecting the supply or using one of the items of insulating material.

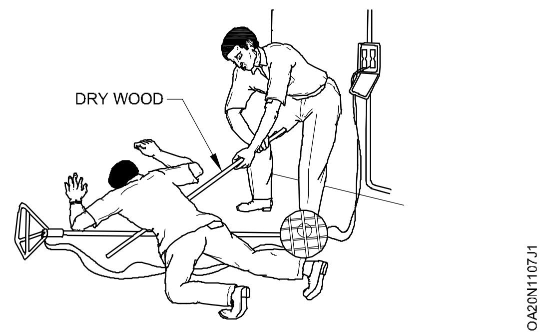
> **Do not run to switch off the supply that is far away.**
>
> **Do not touch the victim with bare hands until the circuit is made dead or the victim is moved away from the equipment.**
>
> **Push or pull the victim from the point of contact of the live equipment, without causing serious injury to the victim. (Fig.1)**

3 Move the victim physically to a nearby place.

4 Check for the victim's natural breathing and consciousness.

5 Take steps to apply respiratory resuscitation if the victim is unconscious and not breathing.

Fig 1



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Use of fire extinguishers

Objectives: At the end of this exercise you shall be able to
- **select the fire extinguisher according to the type of fire**
- **operate the fire extinguisher**
- **extinguish the fire.**

Fig 1

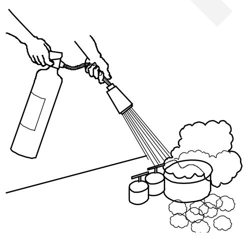
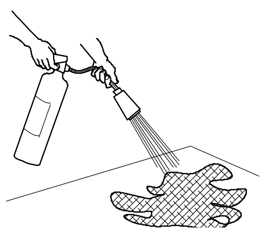
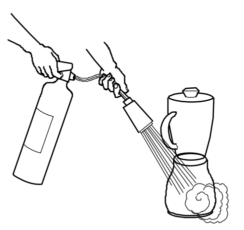
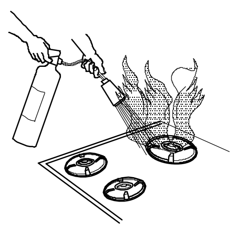
Job sequence

- Alert people surrounding by shouting fire, fire, fire when observe fire.
- Inform fire service or arrange to inform immediately.
- Open emergency exist and ask them to go away.
- Put "Off" electrical power supply.

Do not allow people to go nearer to the fire

- Analyze and identify the type of fire. Refer Table 1.

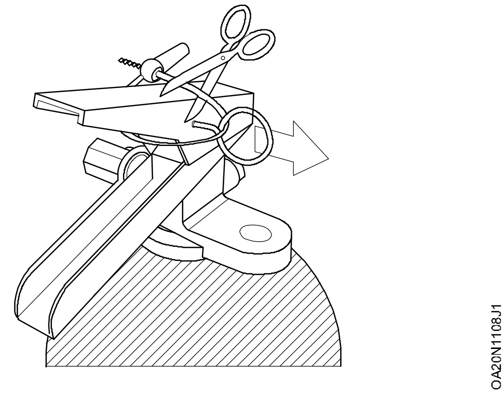
Table 1

Class 'A'	Class 'B'	Class 'C'	Class 'D'
			
Wood, paper, cloth, solid material	Oil based fire (grease, gasoline, oil) & liquefiable solids	Gas and liquefied gases equipment	Metals and electrical

Assume the fire is 'B' type (flammable liquefiable solids)

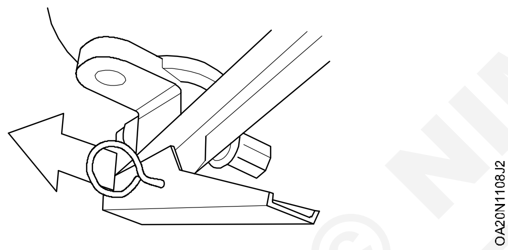
- Select CO_2 (carbon dioxide) fire extinguisher
- Locate and pick up CO_2 fire extinguisher. Check for its expiry date.
- Break the seal. Fig1

Fig 1



- Pull the safety pin from the handle (Fig 2) (Pin located at the top of the fire extinguisher) (Fig 2)

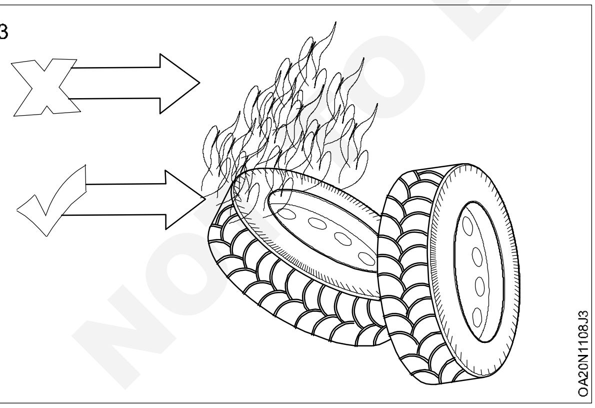
Fig 2



- Aim the extinguisher nozzle or hose at the base of the fire (this will remove the source of fuel fire) (Fig 3)

Keep yourself low

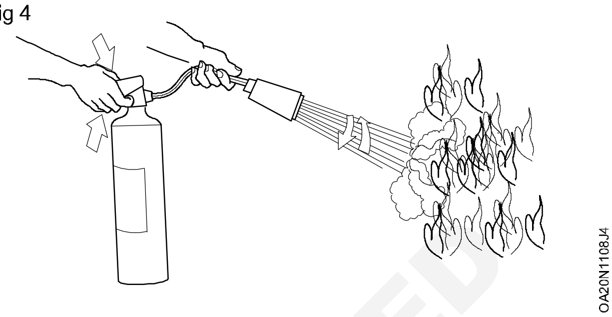
Fig 3



- Squeeze the handle lever slowly to discharge the agent (Fig 4)
- Sweep side to side approximately 15 cm over the fuel fire until the fire is put off. (Fig 4)

Fire extinguishers are manufactured for use from the distance.

Fig 4



Caution

- While putting off fire, the fire may flare up.
- Do not be panic so long as it is put off promptly
- If the fire doesn't respond well after you have used up the fire extinguisher move your self away from the fire point.
- Do not attempt to put out a fire where it is emitting toxic smoke, leave it to the professionals.
- Remember that your life is more important than property. So don't place yourself or others at risk.

In order to remember the simple operation of fire extinguisher

Remember

P.A.S.S. This will help to use fire extinguisher

P for pull

A for aim

S for squeeze

S for sweep

— — — — — — — —

Preparation of filing

Objectives: At the end of this lesson you shall be able to
- **select a file size**
- **choose a file shape**
- **pick the right tooth geometry**
- **Pressing the files**

Job sequence

- Select a file size: Large file are coarse and leave a rougher finish, but remove more stock.
- Smaller files are finel. They remove less stock but leaves a smoother finish. Hence based on the job select the right file.
- Choose a file shape: Use a flat file for general purpose work, a square file for enlarging rectangular hole, a round file for enlarging round holes. Use trianpular files on acute angles, and half round file to smoothe curved faces.
- Determine the degree of coarseness needed: A bastard cut file has the highest degree of coarseness, while a second cut file has a medium degree of coarseness. A smooth cut file in the least coarse option.
- Pick the right tooth geometry: fast removal of stock choose a double cut file for finishing use a simple cut file.
- Check the quality of file: Ensure the handle is intact and not loose. Look rust, which should be removed before using the file.
- Clean the file: Clean your file often while you are working as well.
- Apply check oil: This makes the file less likely to become clogged with pins in the future

Fig 1

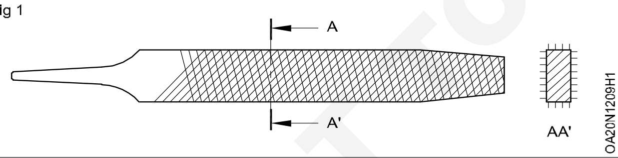


Fig 2

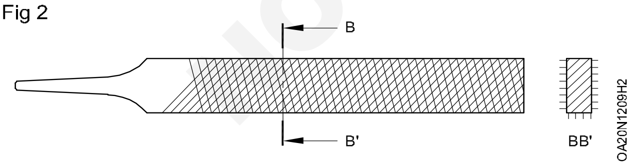


Fig 3

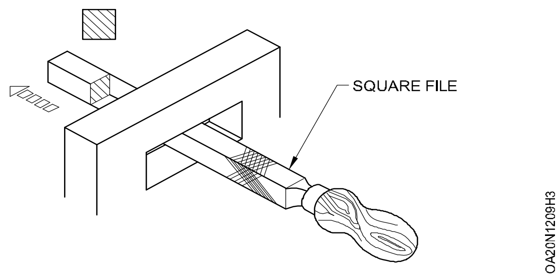


Fig 4

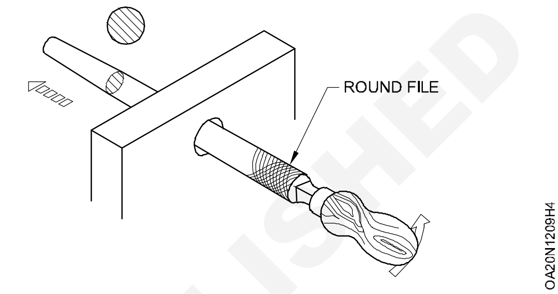


Fig 5

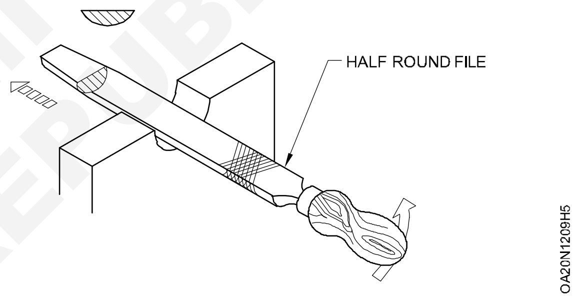


Fig 6

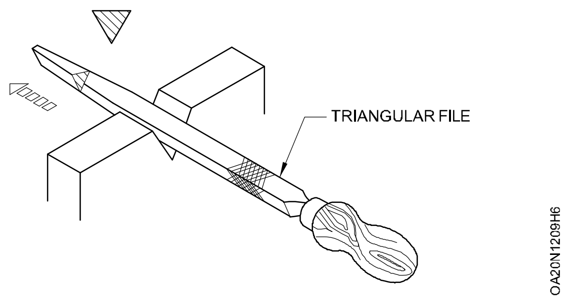
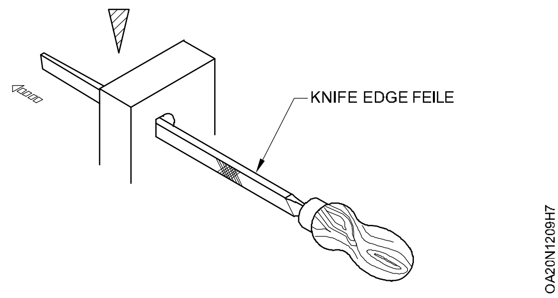


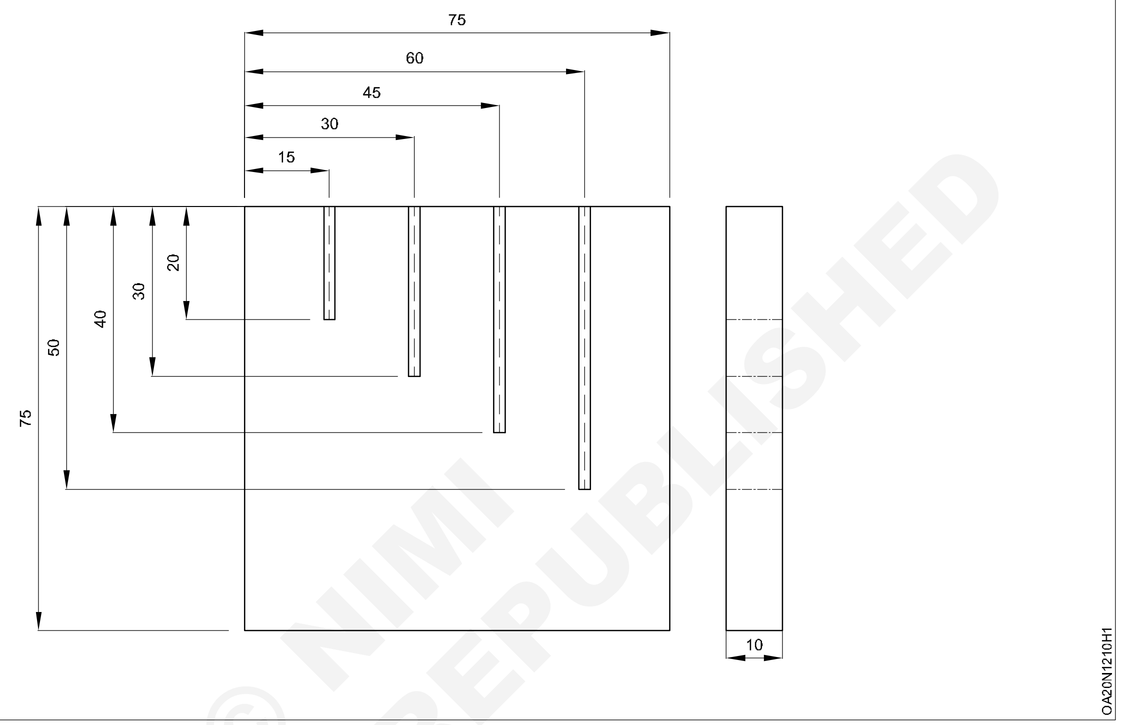
Fig 7



Marking lines on the job surface for filing to the marked line

Objectives: At the end of this lesson you shall be able to
- **mark out lines using jenny cliper**
- **punching the marked lines**

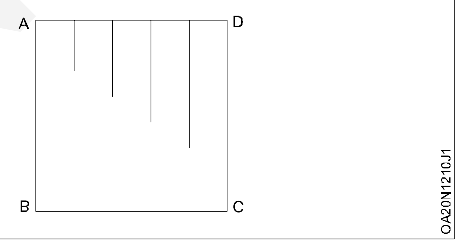
Fig 1



Job Sequence

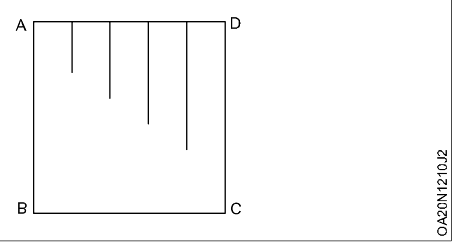
- Check the pre machined size of 75x75x10 mm using steel rule
- Apply marking media cellulose lacquer evenly on the surface of the job.
- Place the job in levelling plate
- Set the measurement 15mm in jenny caliper using steel rule
- Similarly set 30mm, 45mm and 60 mm and draw parallel lines to AB (Fig 1)

Fig 1



- Set 150 measurement 20mm in jenny caliper using steel rule
- Draw parallel line to side "AD" using jenny caliper
- Similarly set 30mm, 40mm and 50mm and draw parallel lines to side 'AD' as shown in Fig 2
- Punch witness mark on line using a dot punch and a ball pein hammer.

Fig 2



Skill sequence

Measuring with a steel rule

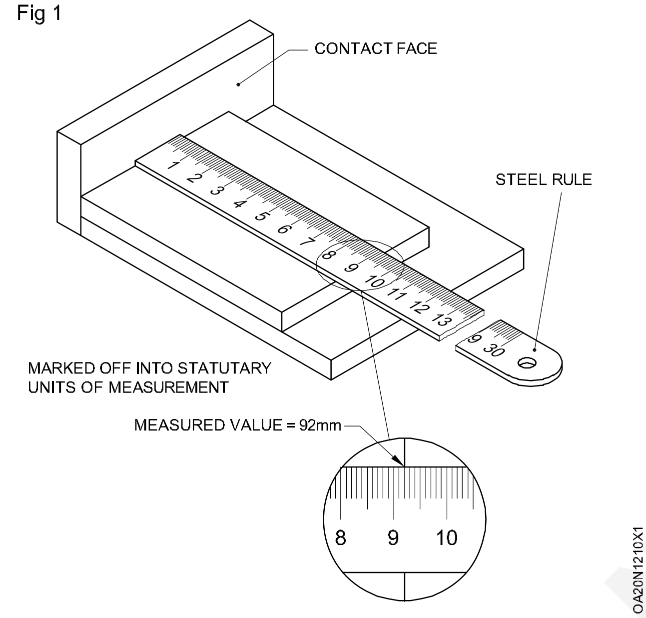
objective: This shall help you to

- **measure the length or a part of a length of objects**

Place the rule either directly on to the length to be measured or at right angel to the reference plane.

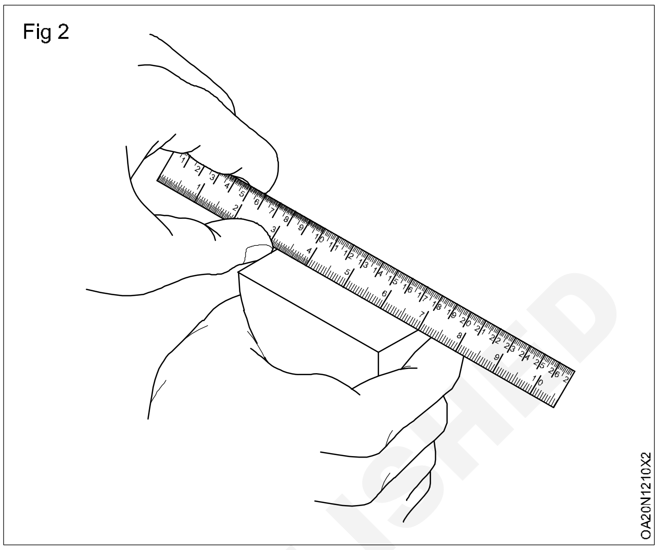
Use a contact face, if possible and read off measurements by looking at the steel rule directly (Fig 1)

Fig 1



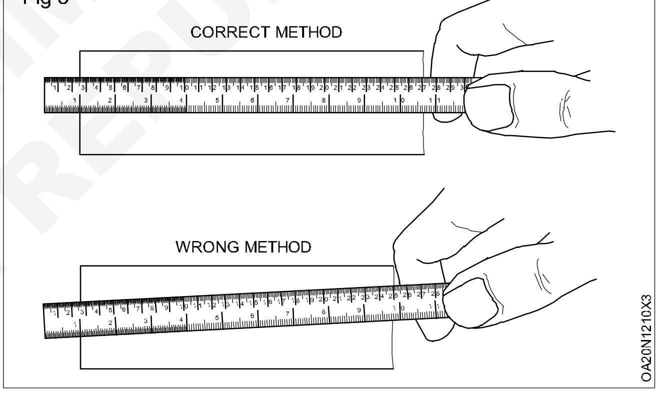
Measure with a rule starting off from the 1 cm line if the edge of the rule is worn out or damaged. (Fig 2)

Fig 2



The rule must be held parallel to the edge of the work as otherwise the measurement will not be correct. (Fig 3)

Fig 3



Marking lines parallel to the edge of the job

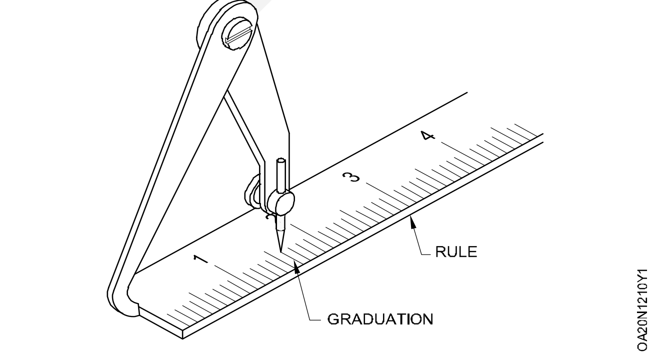
objective: This shall help you to

- **mark parallel lines using a jenny caliper**

Apply marking medium on the surface to be marked

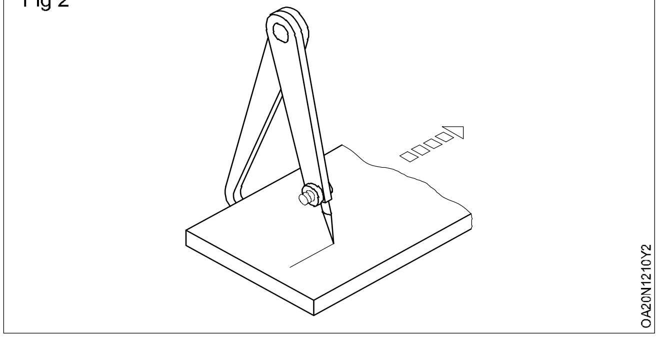
Set the jenny caliper to the size to be marked (i.e. dimension) with the help of a steel rule. (Fig 1)

Fig 1



Transfer the set dimension to the job. (Fig 2)

Fig 2



Incline slightly and move the jenny caliper with uniform speed and mark lines.

Make witness marks on the lines marked using a 60° prick punch. The witness marks should not be too close to one another.

Punching the marked line

Objective: This shall help you to

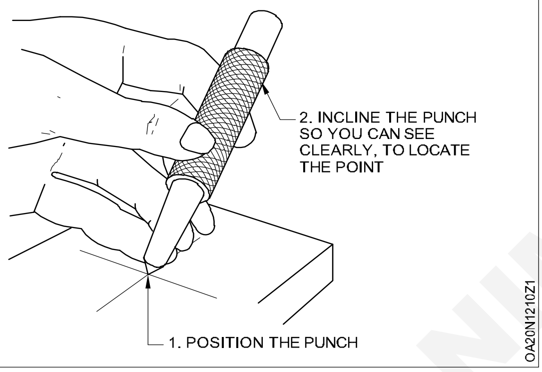
- **punch the line using prick punch**

Place the job on levelling plate, such that marked lines should be approximately perpendicular to the operator.

Hold the punch between the thumb and the first two fingers of the hand where possible, rest the little finger and the edge of your hand on the marked centre point as shown in Fig 1.

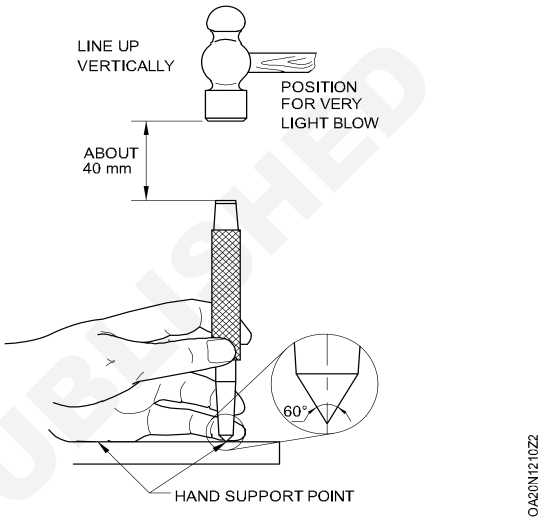
Bring up the dot punch in the vertical position and strike with a ball peen hammer on the head of the dot punch lightly.

Fig 1



Watch the point of the punch and strike its head with the ball pein hammer Fig.2 This dot punch marks prevent the wing compass leg from slipping while scribing curved lines from the centre point

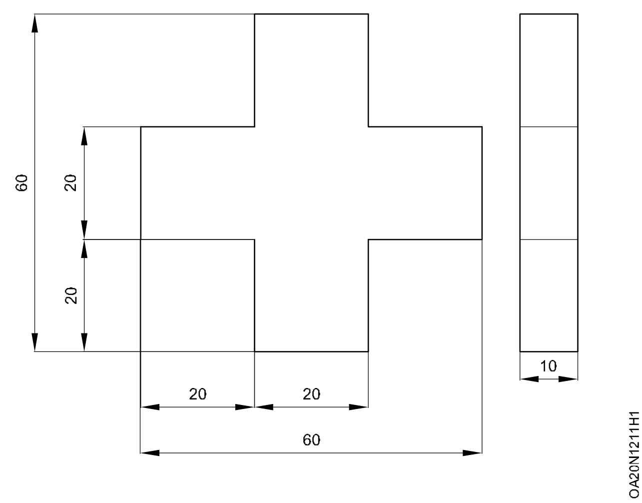
Fig 2



Gripping the jobe suitably in the vice jaw for filing

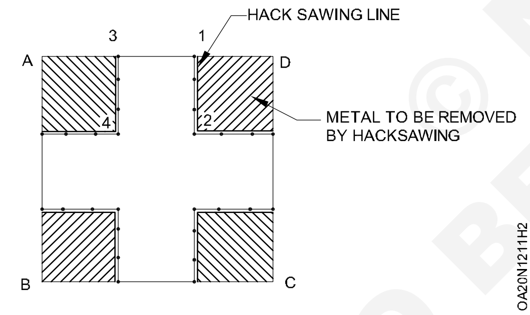
Objectives: At the end of this lesson you shall be able to
- **hold the job in bench vice**
- **cut along marked lines for filing**

Fig 1



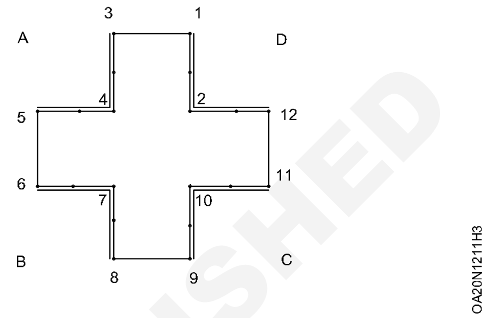
- Hold the job firmly in bench vice, keeping side "AD" parallel to vice jaws. (Fig 2)

Fig 2



- Start cutting on side "AD" cut the line 1 to 2 upto the marked length 20mm in right side. (Fig 3)

Fig 3

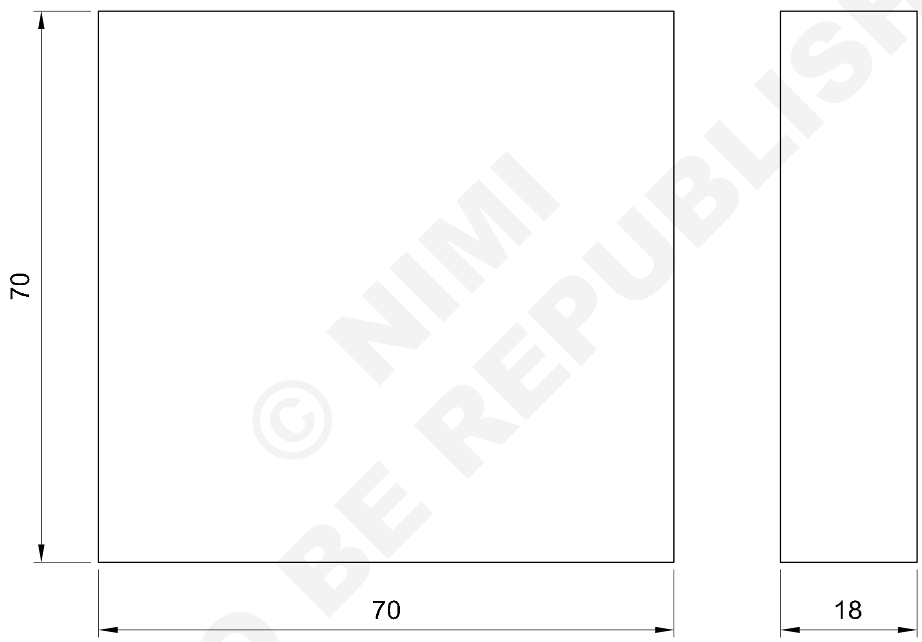


Ensure that half of the punch marks to be visible while sawing

- In the same setting, without changing the position of the joh cut the lnd 3 to 4 upto the marked length 20mm in left side as shown in Fig 3.
- Similarly, turn the job and cut the line 5 to 4, 6 to 7, 8 to 7, 9 to 10,11 to 10 and 12 to 2 as shown in fig 4.
- After sawing profile of the job shown in fig 5, check the size with steel rule.
- Set the job in the vice for holding 2 filing.

Balancing of file using rough file

Objectives: At the end of this lesson you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **file flat and square and maintain the sizes within± 0.5 mm**
- **check the flatness of filed job using straight edge try square blade**
- **check the squareness of the job with try square**



Job sequence

- Check the raw material size using steel rule.
- File 3 sides mutullay perpendicular to each other.
- Mark and file to size 70x70x18mm by maintaining the size ±0.5 mm
- Check the size with steel rule
- Check the squareness with try square and flat surface with straight edge/blade of try square.
- Clean and apply oil and preserve it for evaluation.

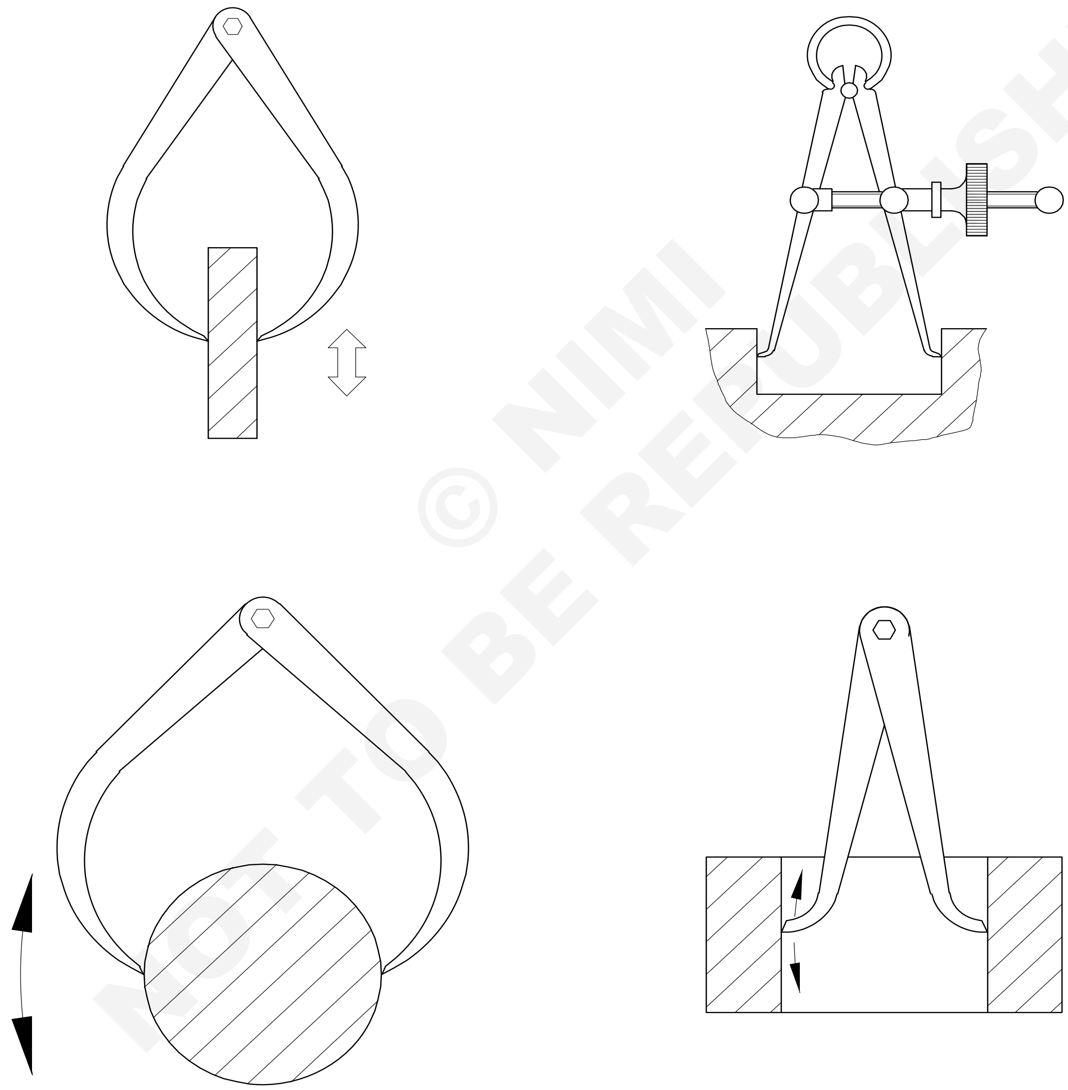
1	75 ISF 20-75	-	Fe310	-	-	1.2.12
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	FILING FLAT AND SQUARE	TOLERANCE :- ±0.5mm	TIME : 10Hrs
		CODE NO. OA20N1212E1	

Measurement by using inside/outside calipers and scale

Objectives: At the end of this lesson you shall be able to
- **check the dimension with a steel rule**
- **check the external dimensions with outside caliper**
- **check the inside dimensions with inside caliper**
- **check the depth of blind holes and slots with depth rule**

Note to the instructor: Provid e as much old exercise and models as possible to the trainees for acquiring measuring skills with simple measuring instruments



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE	MEASURING WITH SIMPLE MEASURING INSTRUMENTS			DEVIATIONS		TIME
				CODE NO. OA20N1213E1		

Skill sequence

Measuring with inside and outside calipers

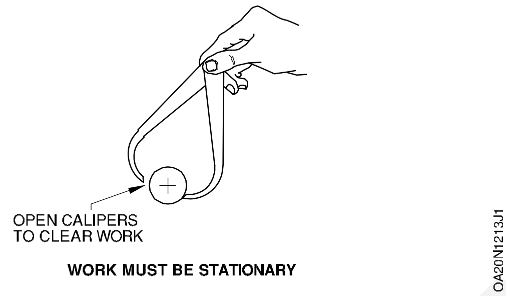
Objectives: This shall help you to
- **select the right capacity caliper for measurement**
- **set the sizes both in firm joint and spring calipers**
- **read the sizes by transferring them to a steel rule or other precision measuring devices as the case may be.**

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)

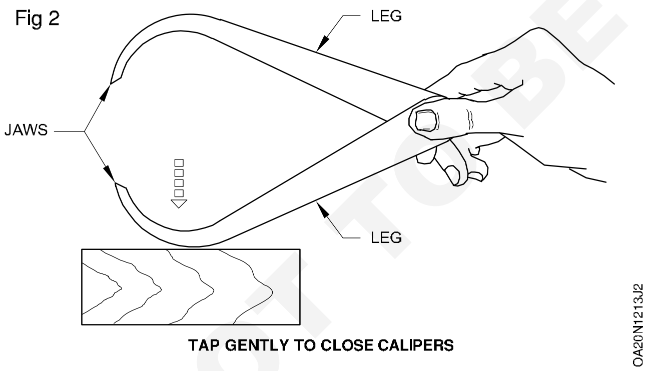
Fig 1



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 on a wooden piece until it just slips from the external diameter of the workpiece to give the right sense of 'feel'. (Fig 2)

Fig 2



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'.

In the case of spring outside calipers, adjust the screw nut so that the adjustment of the jaws just slips from the external diameter of the workpiece to give the right sense of feel. (Fig 3)

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 jaw firmly against the rule end. (Fig 4)

Fig 3

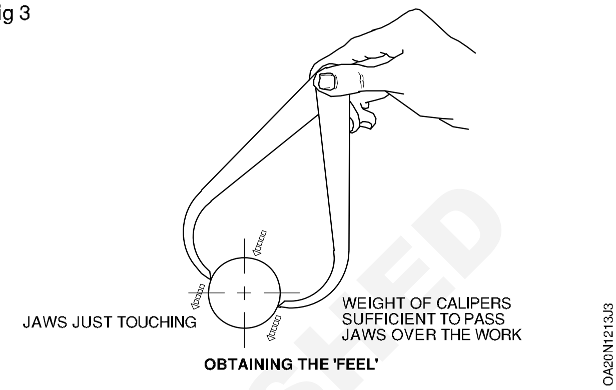
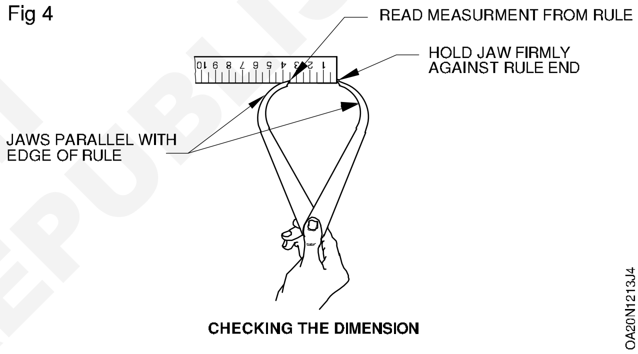


Fig 4



The point of one jaw must be placed over the graduation so that the point of the other jaw 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.

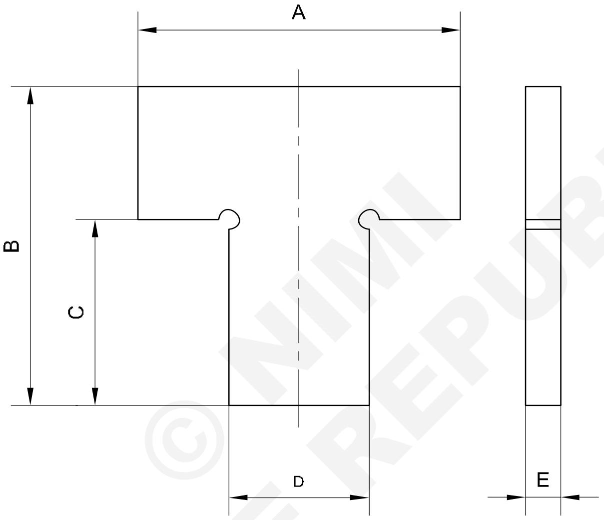
Inside caliper: Open out the jaws slightly less than the size to be measured.

Hold the caliper lightly in one hand with your thumb and first finger on the adjusting screws.

The point of one jaw should sit against the surface being measured. Support the weight of the caliper with the middle or third finger.

Use of simple measuring instruments

Objectives: At the end of this lesson you shall be able to
- **measure the components of length bread and width using steel rule**
- **measure the external dimensions of finished components of length, breadth and width using steel rule**
- **measure external and internal dimensions of cylindrical component using micrometer**



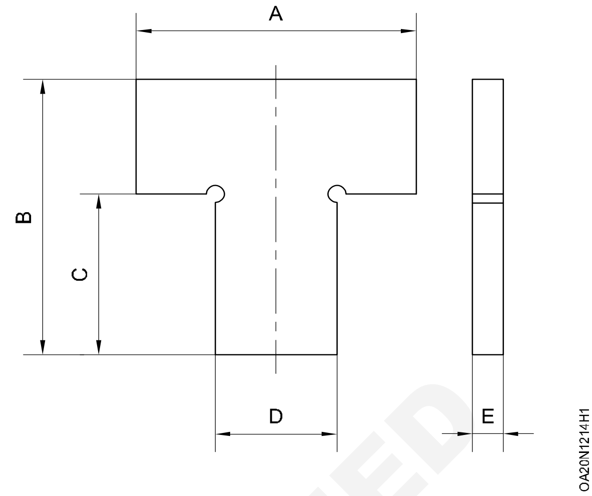
-						-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-

SCALE 1:1	MEASURING PRACTICE (VERNIER CALIPER AND MICROMETER)	DEVIATIONS ±0.02	-
		CODE NO. OA20N1214E1	

Job sequence

- Measure the dimensions A,B,C,D & E of finished components available in section with steel rule, vernier caliper and outside micrometer.
- Take three measurements of each dimension at various places and entee in the table.
- Calculate the average value
- Enter the average of measured value in the table

Fig 1



Dimension in mm	Values of measurement obtained				Measuring instrument
	1st	2nd	3rd	Average of 3 Values	
A					Steel rule
B					Steel rule
A					Vernier caliper
B					Vernier caliper
C					Vernier caliper
D					O.S micrometer
E					O.S. micrometer

- Measure with a rule starting off from the 1 cm line if the edge of the rule is worn out or damaged (Fig 2)
- The rule must be held parallel to the edge of the work as otherwise the measurement will not be correct. (Fig 3)

Fig 1

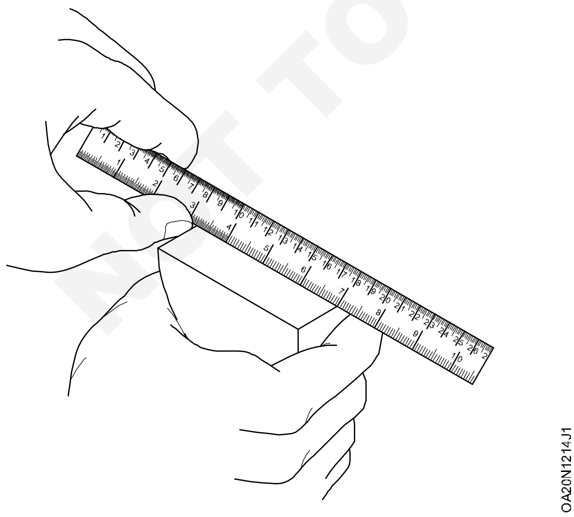
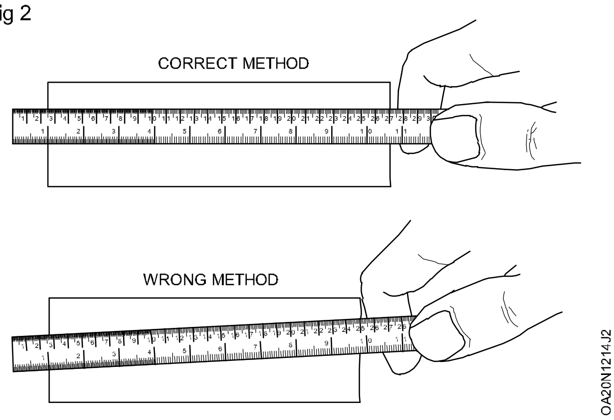


Fig 2



Skill sequence

Measuring the sizes with a vernier caliper

Objectives: This may help you to
- **check the condition of the vernier caliper**
- **measure the outside diameter**
- **measure the inside diameter of a bore**
- **measure the width of a tongue**
- **measure the length of a step**
- **measure the depth of a stepped bore.**

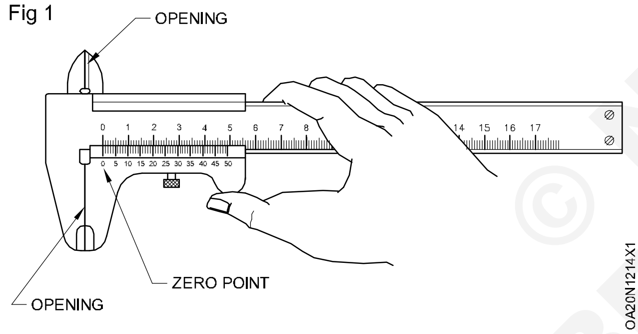
The sense of feeling is very important to judge the accuracy of the reading.

Checking the condition of the vernier caliper

Figs 1 indicate the general instructions for different applications of the universal vernier caliper.

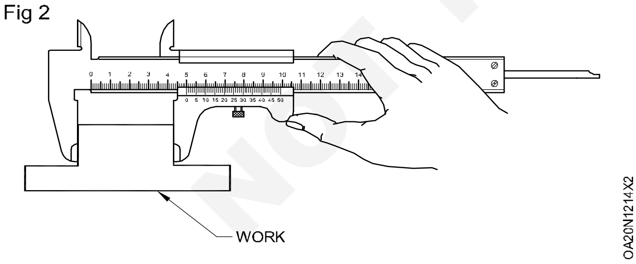
- Check the vernier caliper.
- Confirm looseness of the locking screw.
- Clean every part of the caliper with rags.
- Close the jaw and examine the opening through light.
- Check whether the zero points coincide. (Fig.1)

Fig 1



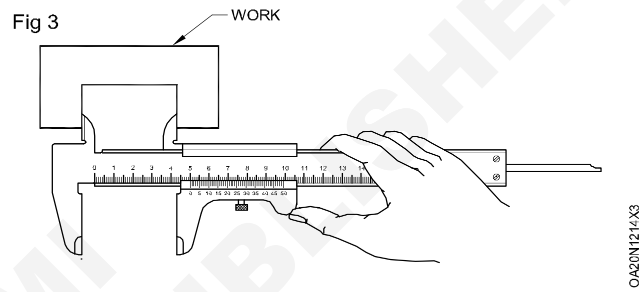
To measure the length of an object ,read the scale mark, keeping the work piece firmly held between the jaws so that the workpiece and the jaw faces establish a statisfactory contact. (Fig.2)

Fig 2



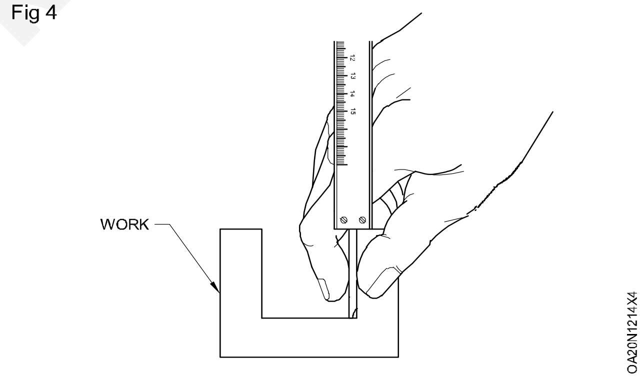
To measure the notch width of an object, fit the main scale nib correctly to the face of the object to be measured,hold it lightly with the fingers of the left hand and read the scale mark (minimum value) after moving the sliding unit so that it is contact with the other face of the notch. (Fig.3)

Fig 3



To measure the depth of a notch,fit the depth bar to the notch, hold it lightly with the fingers of the left hand, keep it upright and read the scale mark, while keeping the depth bar flush with the bottom of the notch and the depth reference surface in contact with the top of the notch.(Fig.4)

Fig 4



Measuring with micrometers

Objective: This shall help you to
- **measure with an outside micrometer.**

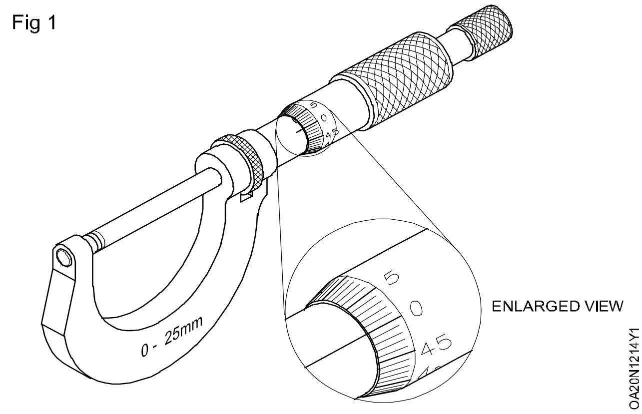
Observe the following aspects before takintg the measurements.

Clean the measuring faces of the micrometer and the surfaces of the work to be measured.

Check for the zero error.

In the case of a 0-25 mm outside micrometer, the zero of the thimble should coincide with the datum line. (Fig.1)

Fig 1

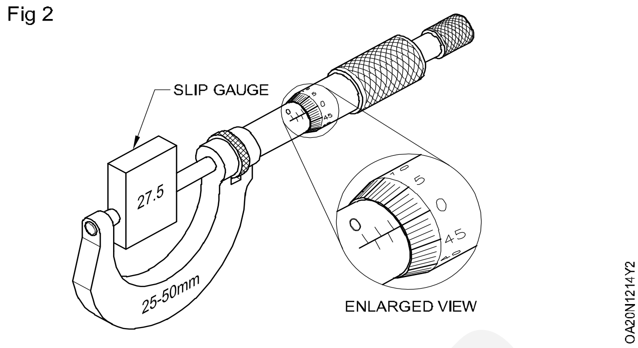


If they do not conincide, the instrument has an error.

The other sizes of the outside micrometer should be checked for errors with the help of standard gauges provided for this purpose.

If standard gauges are not available, slip gauges can be used. (Fig.2)

Fig 2



The slip gauge may be of any size above the minimum range of the micrometer.

The trainees are not expected to handle slip gauges now.

Use the instrument only after making the necessary correction.

Do not attempt to correct the errors, If any. The instructor will do it for you.

Steps required while taking measurements.

Holding of the micrometer for measuring depends on the workpiece.

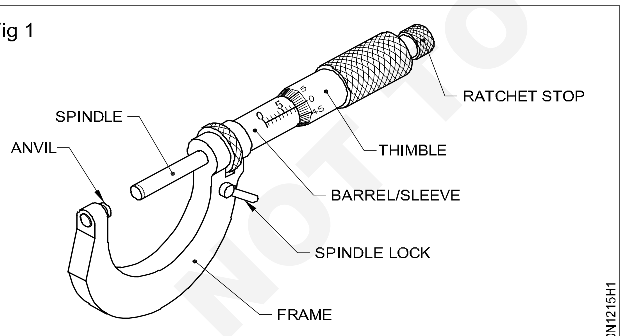
Care and precaution to be observed in handling these instruments

Objectives: At the end of this lesson you shall be able to
- **Handling measuring instruments with care and precaution**
- **Lubricate the instruments**
- **obtain recalibration assistance**

Job sequence

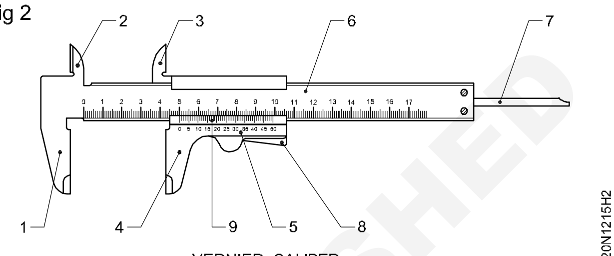
- Proper lubrication of measuring instruments will prevent damage due to corrosion and oxidation.
- Avoid spraying instruments with WD - 40 as it may leave a film that can alter the calibration of the instruments.
- Do not store precision instruments where they can jostle against one another in a draws.
- Keep measuring instruments stored in an area as far away as possible from vibration and movement.
- Prevent damage or miscalibration during use. including avoiding sudden shocks or rough treatment.
- Some instruments require recalibration to ensure they continue to function as designed.
- Screw the instruments tightly without exerting undue pressure to avoid any damage to the threads of the screw.
- Keep the eye directly over the division mark to avoid any error due to parallal.
- Note down each observation with correct significant figures and units.
- Rachet arrangement in micrometer must be utilised to avoid undue pressure on the wire as this may change the diameter.

Fig 1



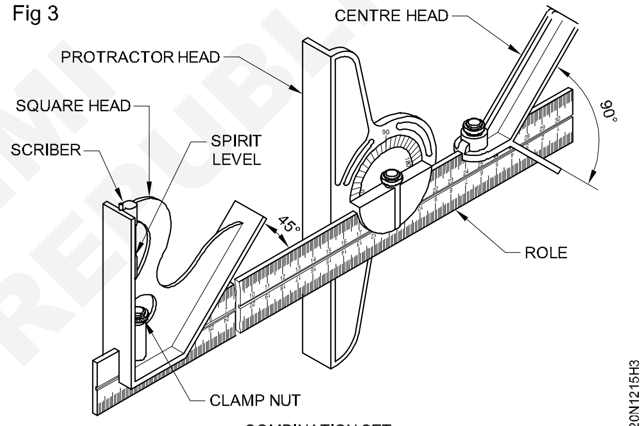
OUT SIDE MICROMETER

Fig 2



VERNIER CALIPER

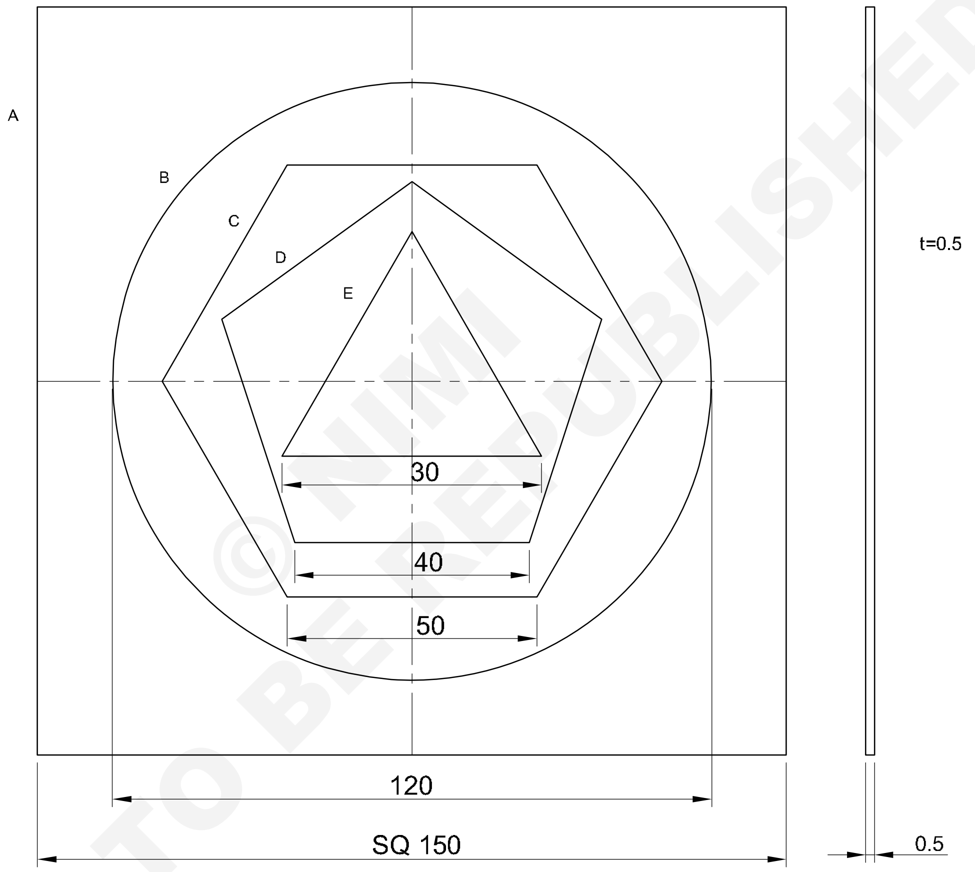
Fig 3



COMBINATION SET

Exercise on measurement of various geometrical shape

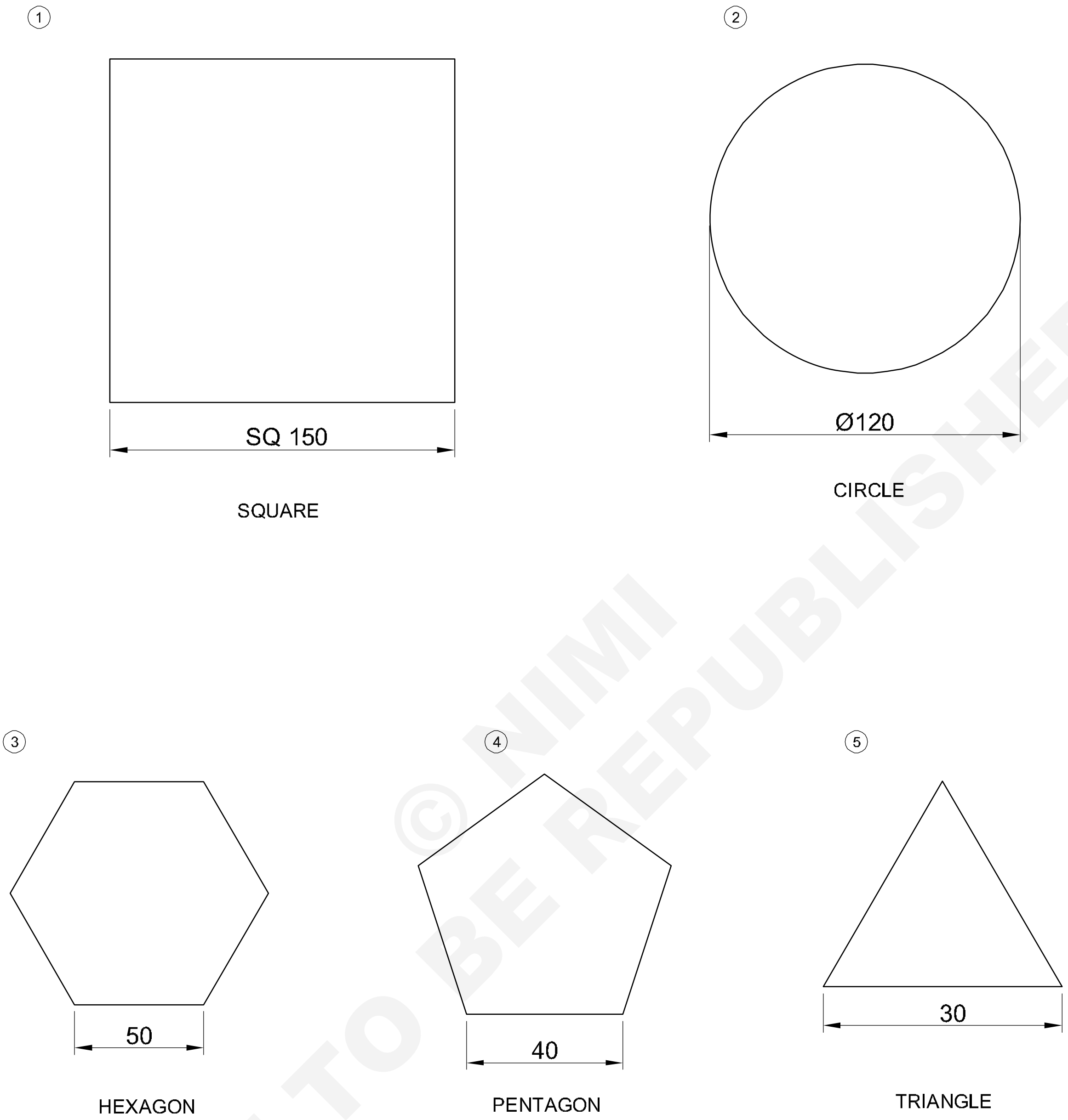
Objectives: At the end of this lesson you shall be able to
- **draw different types of geometrical shapes**
- **chip the different geometrical shapes by flat chisel**



A . SQUARE
B . CIRCLE
C . HEXAGON
D . PENTAGON
E . TRIANGLE

1	ISSH 160 x 160 x 0.5	-	G.I STEEL	-	-	1.2.16
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	DIFFERENT GEOMETRICAL SHAPES	TOLERANCE : ± 1mm	TIME
		CODE NO. OA20N1216E1	



1	ISSH 160 x 160 x 0.5	-	G.I STEEL	-	-	1.2.16
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	DIFFERENT GEOMETRICAL SHAPES				TOLERANCE : ± 1mm	TIME
					CODE NO. OA20N1216E2	

Job sequence

- Planish the sheet metal on a tinman's anvil using mallet.
- Check the sizes of the sheet 150x150x0.5 mm using a steel rule.
- Mark the centre line as shown in job drawing
- Punch the centre point using a prick punch 30° and a ball pein hammer.
- Mark a square of 150mm side using a steel rule, straight edge 'L' square and scriber
- Draw a circle of Ø 120mm from the same centre point using steel rule and divider.
- Mark a hexagon of 50mm side in the circle as shown in job drawing
- Mark a pentagon of 40mm side within the hexagon as shown in job drawing
- Mark and equilateral triangle of 30mm side within pentagon as shown in job drawing
- Place the sheet on anvil
- Cut the square 150mm side using flat chisel and ballpein hammer fig 1.
- Similarly, cut the other geometrical profiles. Circle (Fig 2) hexagon (Fig 3) pentagon (Fig 4) and triangle (Fig 5) using flat chisel and ball pein hammer
- Check the different geometrical profiles with steel rule and other measuring tools.

Skill sequence

Exercise on measurement of various geometrical shape

Objectives: At the end of this lesson you shall be able to
- **draw different types of geometrical shapes**
- **chip the different geometrical shapes by flat chisel**

Square

- Measure each sides of square using vernier caliper.
- Measure perpendicularity of adjacent side using my square
- Measure the diagnal of square
- If the side and diagnal are equal the given specimen is a square geometrical shape

Circle

- Measure the diameter of a circle at various points using vernier caliper
- If all the diameter are equal, the given specimen is a geometrical shape of circle.

Hexagon

- Measure the length of edges of hexagon.
- Check the parallelarity between opposite edges of hexagon using caliper.
- Measure the angle between adjacent sides of hexagon using level protector
- If all sides and equal and angle between sides are 120° then the given specimen is a geometrical shape of regular hexagon.

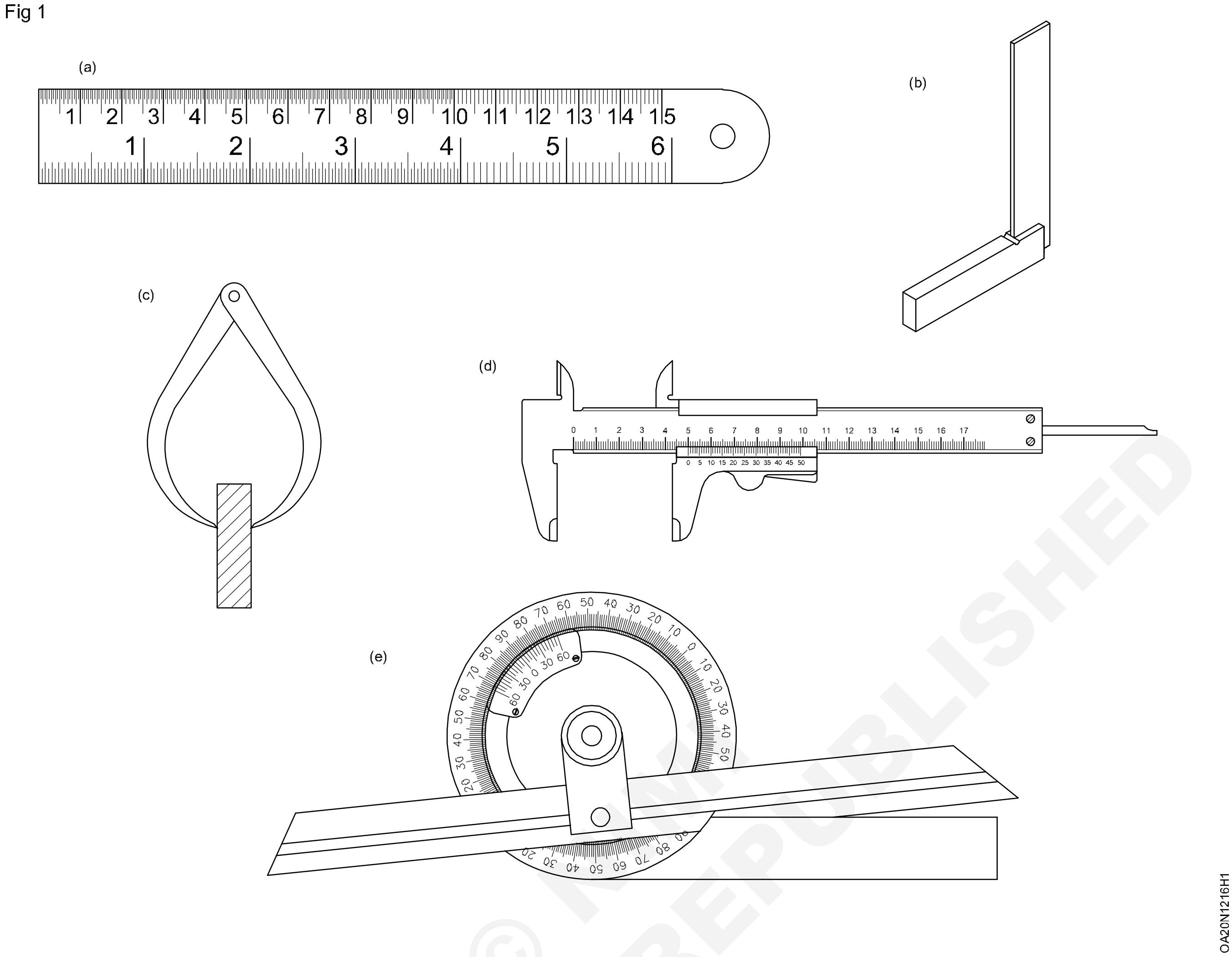
Pentagon

- Measure all the sides using steel rule
- Measure the angle between adjacent pices of specimen using level protector
- If the angle comes around 144° and sides are equal the given specimen is a geometrical shape of regular pentagon

Triangle

- Measure all the sides of speciman using vernier caliper.
- Measure the angle between adjacent sides of specimen using bevel protector
- If the side bevel are equal and the angle becomes 60° the given specimen is a geometrical shape of triangle

Fig 1



Exercise on marking out according to simple blue prints using steel rule, scriber, marking blocks & divider

Objectives: At the end of this lesson you shall be able to
- **mark drill holes and radius using divider**
- **mark angular lines using bevel protractor**
- **mark straight lines using marking block**

Fig 1

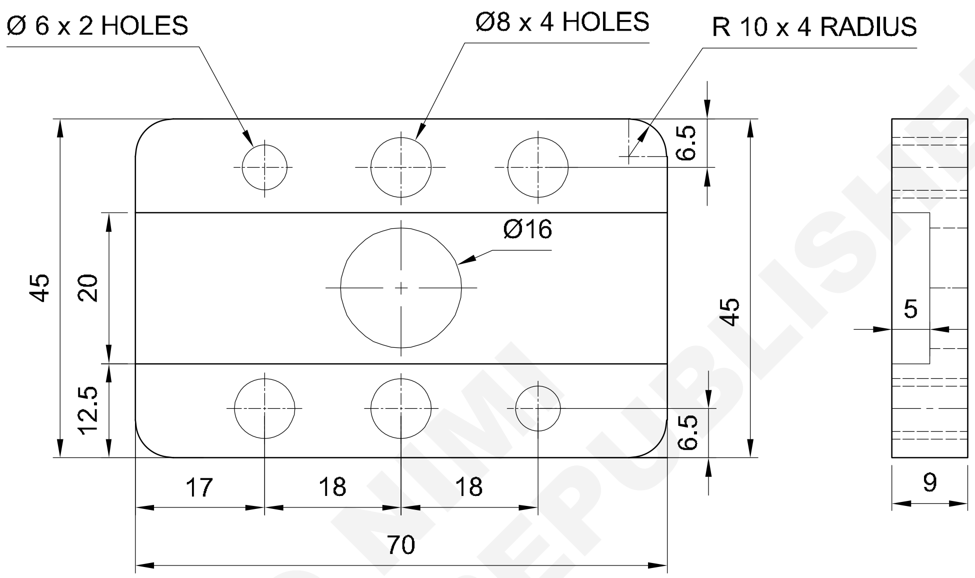
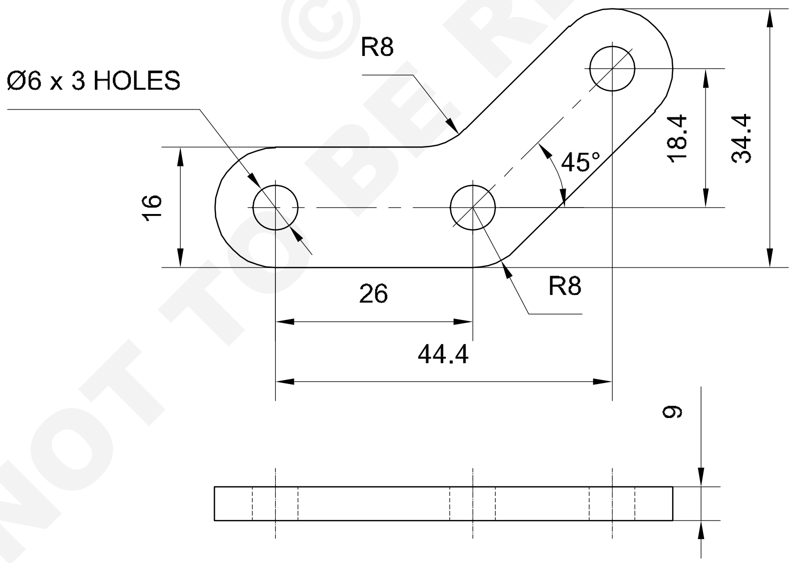


Fig 2



1	50 ISF 10-50	-	Fe 310	-	-	
2	50 ISF 10-75	-	Fe 310	-	-	1.2.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MARKING PRACTICE**	TOLERANCE : - ±0.5mm	TIME : 20Hrs
		CODE NO. OA20N1217E1	

Job sequence

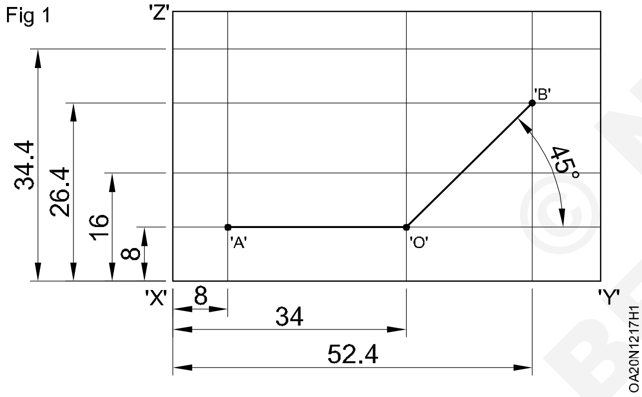
Figure: 1

- Check the raw material size using steel rule
- File raw metal to size 70x45x9mm and check with steel rule
- Apply marking media on the surface of the job
- Mark circular holes centre, radius and groove as per drawing using a jenny caliper
- Set the divider and draw circles Ø 6mm, Ø 8mm, and Ø16mm as per drawing
- Punch witness marks on marked line using a dot punch.
- Check the marking with steel rule

Figure: 2

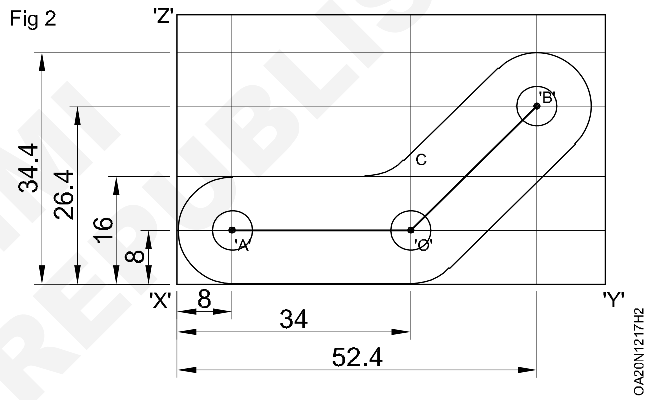
- Apply marking media on the another surface of the job.
- Mark 8mm, 16mm and 34.4mm lines using janny caliper with reference to 'xy'
- Mark 8mm, 34mm and 52.4 mm lines using jenny caliper with reference to 'xz' Fig 1.

Fig 1



- Mark 45° angular line at point 'o' using bevel protector as per drawing.
- Locate the intersecting point 'A', 'O' and 'B' using prick punch 30° Fig 2
- Set the radius 3 mm in divider and draw circles Ø 6mm 3 holes at point 'A', 'O' and 'B' as shown in Fig 2.
- Similarly, set the raidus 8 mm and draw half round as shown in Fig 2.
- Draw tangent line as shown in Fig 2.
- Draw external radius 8mm, from point 'C' with references to tangent lines
- Draw radius 8 mm at point 'o' to join tangent lines.
- Punch the witness marks on profile of the drawing.
- Check the marking with steel rule.

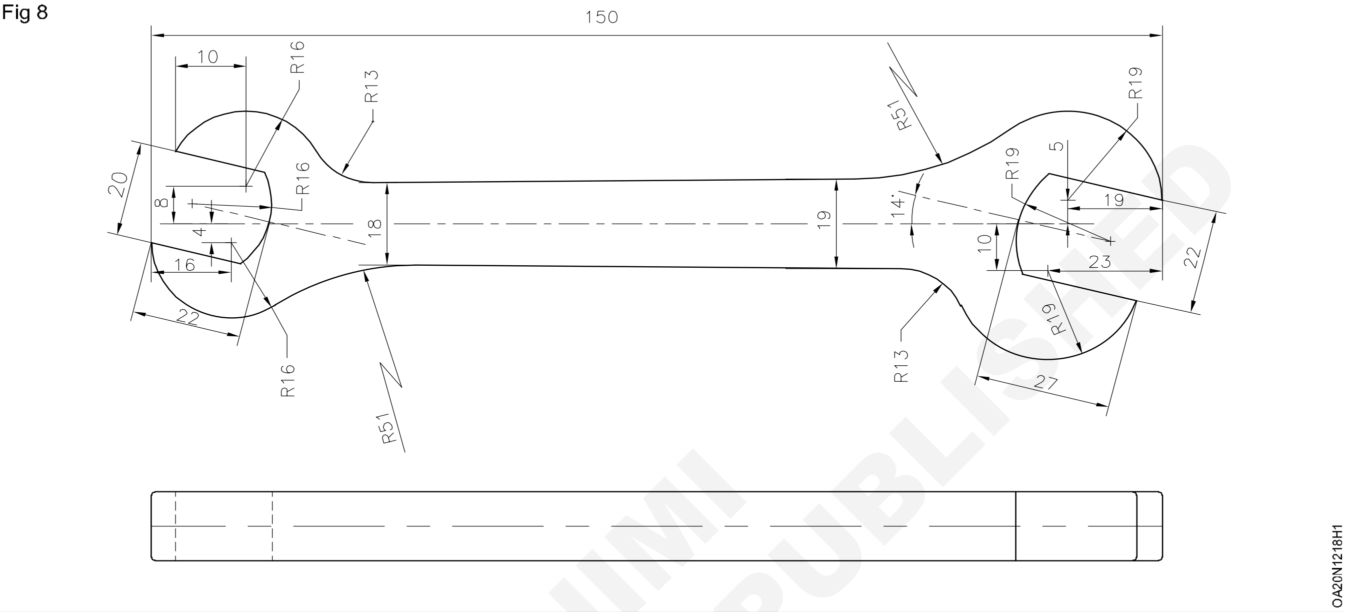
Fig 2



Scribing lines on chalked or coloured (blue) surface of the work piece

Objectives: At the end of this lesson you shall be able to
- **mark lines with scriber**
- **mark ample with bevel protractor**
- **Draw circles, access and tanpents with divider and scriber punch the profile**

Fig 8

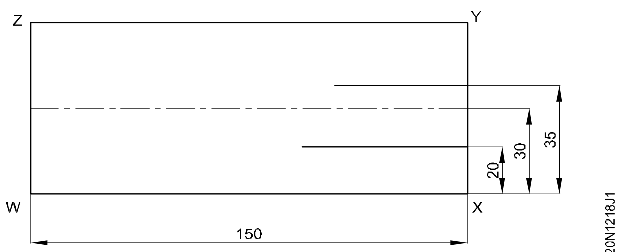


Job sequence

TASK 1: Spanner

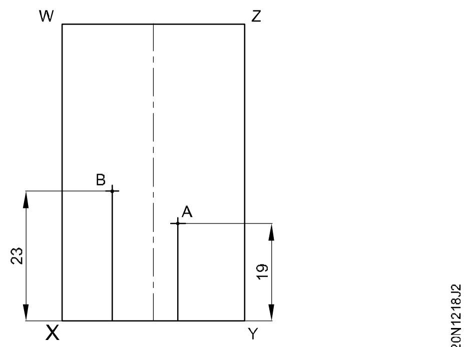
- Check the raw material size using steel rule
- File metal to size 150 x 64 x 9 mm.
- Apply marking media on the surface of the job
- Clean marking table marking block, angle plate and steel rule.
- Set the size 30 mm in marking block using steel rule.
- Place the job on marking table and support it with angle plate.
- Mark centre line datum 30mm with reference to side 'WX' Fig 1.
- Set the size 30+5 = 35 mm in marking block and scribe a line right side to 19mm length as shown in job drawing with reference to side 'WX' Fig 1.
- Similarly, set the size 30 -10 = 20 mm and scribe a line in right side to 23mm length as shown in job drawing with reference to side 'WX' Fig 1.
- Turn the job and support it with angle plate with reference to side 'XY' Fig 2.
- Set the size 19mm and scribe a line with reference to side 'XY' and mark point 'A' at the intersecting line. Fig 2

Fig 1



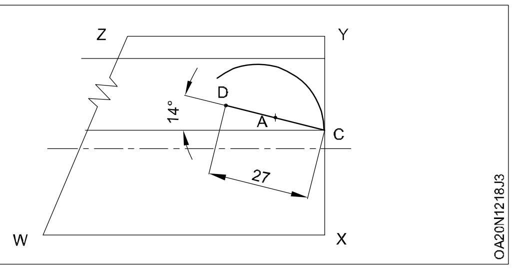
- Similarly, scribe a line to size 23 mm with reference to side 'XY' and mark point 'B' at the intersecting lines. (Fig 2)

Fig 2



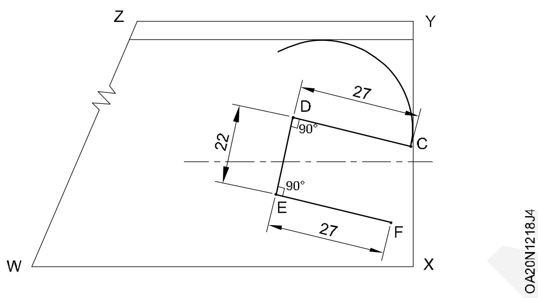
- Set the radius 19 mm and draw radius at point ‘A”
- Radius line intersect the object reference side ‘XY’ at point ‘C; Fig 3
- Mark 14” angle at point ‘C’ using bevel protractor and scribe a Angular line to the distance 27 mm and mark point ‘D’ Fig 3.

Fig 3



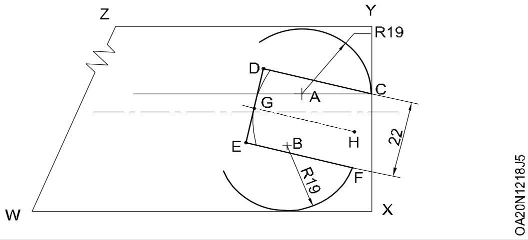
- Mark 90° angular line with reference to line ‘CD’ to the distance 22 mm and mark point ‘E; as shown in the job drawing. Fig 4.
- Similarly, mark 90° angular line with reference to line ‘DE’ to the distance 27 mm and mark point ‘F’ Fig 4.

Fig 4



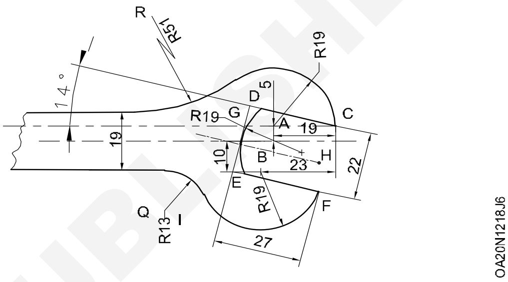
- Mark the centre line on line ‘DE’ and name it as ‘G’ Fig 5
- From point ‘G’ draw a perpendicular line to the length of 19 mm downward and mark it as “H’ Fig 5
- Draw radius of 19mm from the point ‘H’ in such a way that the arc should meet point ‘E’ and ‘D’ through centre point ‘G’ Fig 5.
- Set the radius 19 mm and draw an are at point ‘B’
- Radius line intersect the object reference side ‘XY’ at point ‘F’ Fig 5.

Fig 5



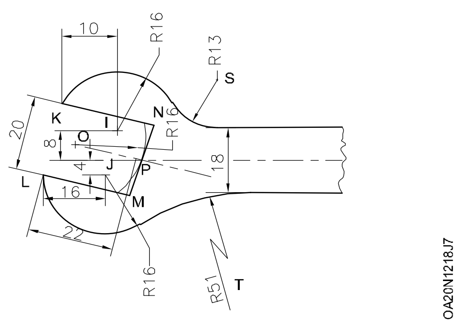
- Scribe a line 30 + 9.5 = 39.5 mm horizontal line with reference to side ‘WX’ Fig 6
- Similarly, scribe a line 30 - 9.5 = 20.5 mm horizontal line with reference to side ‘WX’ to mark the width of spanner in right end. Fig 6
- Join the spanner object lines by drawing a radius of 13 mm from point ‘Q’ in downward side and radius 51 mm from point ‘R’ in upward side and complete the spanner as shown in job drawing. Fig 6

Fig 6



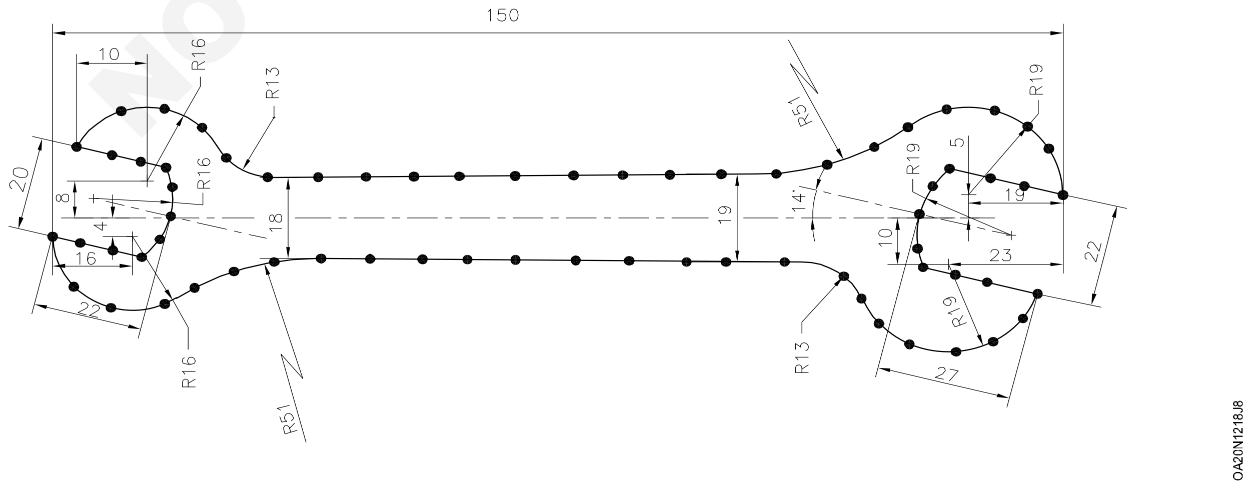
- Similarly, follow the above procedures to mark the left side end of the spanner from points I,J,K,L,M,N,O,P,S and T to complete the spanner profile marking. Fig 7

Fig 7



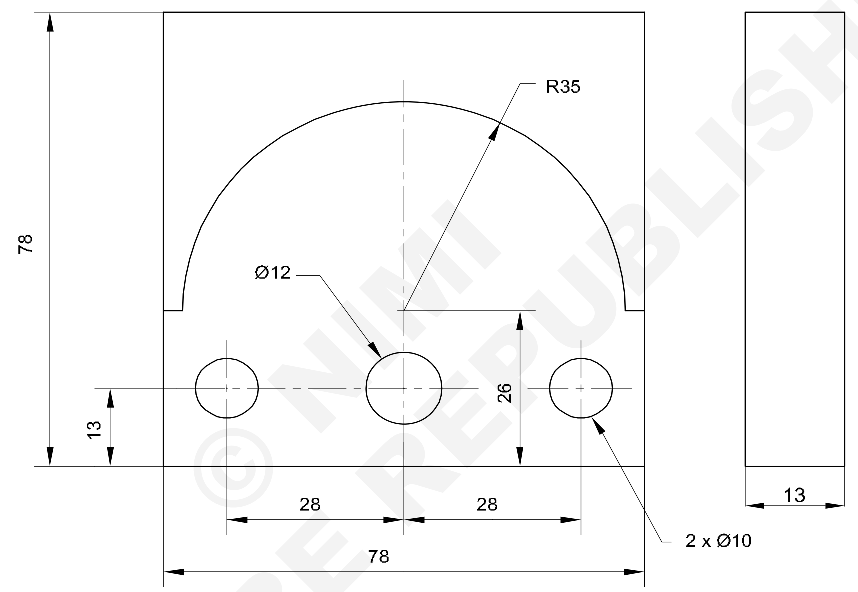
- Punch on the marked lines for prominent marks. (Fig 8)
- Check the size with steel rule.

Fig 8



Marking location of the position of holes and scribing circles using divider

Objectives: At the end of this lesson you shall be able to
- **mark parallel lines with jenny caliper**
- **mark angular lines with a prrotractor and scriber**
- **mark arcs, circles with divider and scriber**



MARKING CURVES & CIRCLES
(By Jenny caliper and divider)

1	80 ISF 10-80	-	FE 310	-	-	1.2.19
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

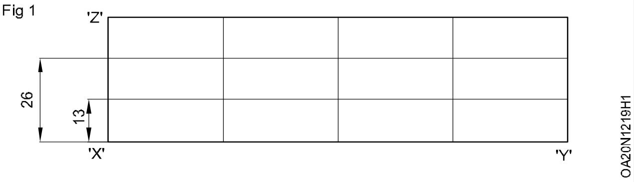
SCALE 1:1	**MARKING PRACTICE**	TOLERANCE : ±0.5mm	TIME : 5Hrs
		CODE NO. OA20N1219E1	

Job sequence

TASK 1: Marking curves & circles

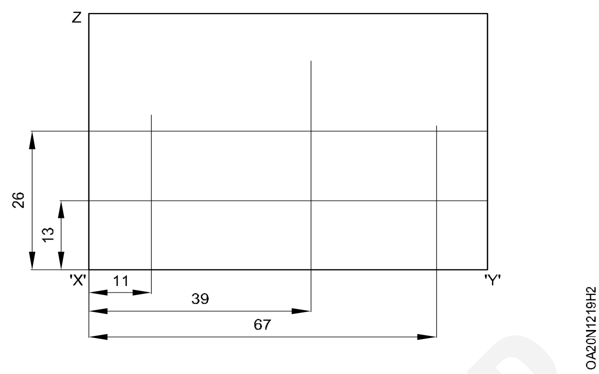
- Check the raw material size using steel rule
- File the raw material to size 78x78x9 mm
- Apply marking media cellulose lacquer on the surface of the job
- Set the dimension 13 mm in jenny caliper and draw parallel line as per drawing with reference to ‘xy’ Fig 1.
- Similarly, set the dimensions 26mm and draw parallel line Fig 1.

Fig 1



- Set the dimension 11mm in jenny caliper and draw parallel line as per drawing with reference to ‘xz’ Fig 2.
- Similarly, set the dimensions 39 mm, 67 mm and draw parallel lines. Fig 2

Fig 2



- Punch on the intersecting point of centre lines to draw circle and radius using prick punch 30°
- Set the radius 5 mm, 6 mm in divider and draw circles, as per drawing.
- Set the radius 35 mm and draw arc as per drawing.
- Punch witness marks on the circles and radius.
- Preserve it for evaluation.

Use of dot and center punch for punching the line, centres and circles

Objectives: At the end of this lesson you shall be able to
- **do punch mark by using center and dot punch**
- **made certain dimensional features of the layout permanent**

Job sequence

- In order to made certain dimensional features of the layout permanent we are using center and dot punch
- Keep the job on the levelled surface
- The marked lines should be vertical to the persue who is ready to do the punch marks.
- Hand drill will slip when drilling first starts. If a centre punch is used to make the point of drilling, stipping in unlikely to happen.
- Sheet metal in tobe cut along the line, to make it easier a dot punch in used to emphasis the line
- Hold the dot punch in between the thumb and the first two figure as phon in fig 1. and use ball pein hammer for hitting on the head of the punch
- While hammering the punch should not get slipping.
- Apply uniform pressure on the head of the prick punch by hammer to set unifom punch make continuously.
- The kurnld portion makes it easier to hold the punch when it is being used, as it can be gripped and prevents the holding hand slipping.

Fig 1

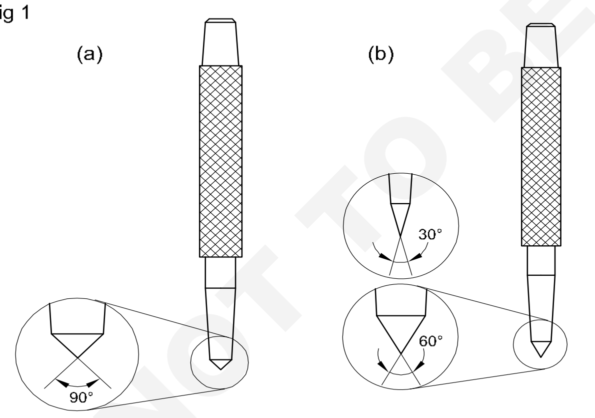


Fig 2

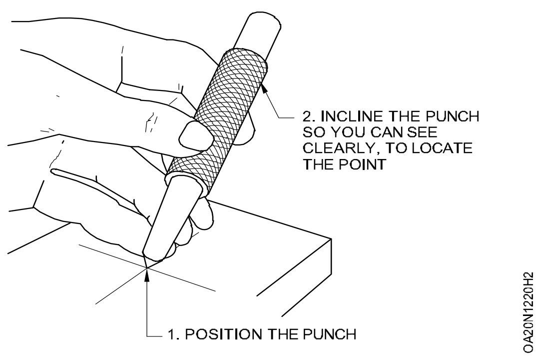


Fig 3

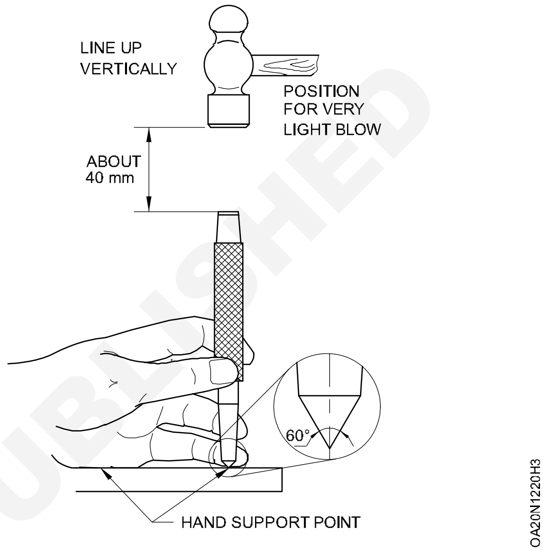
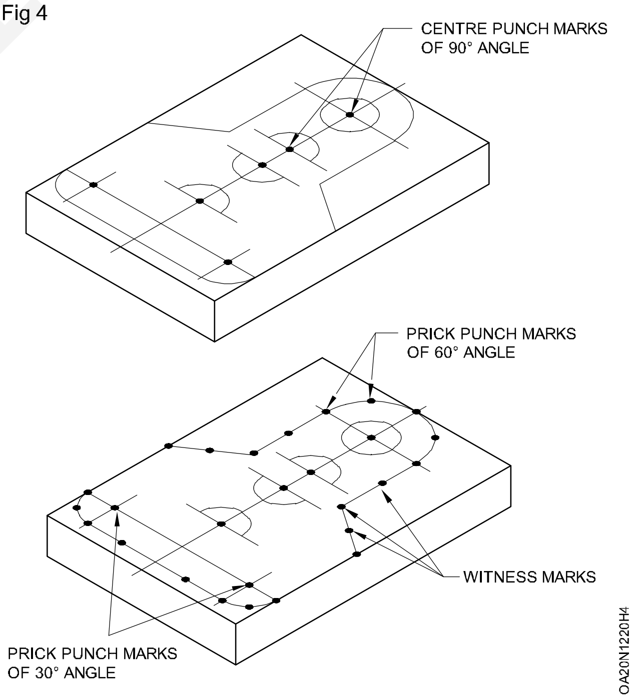
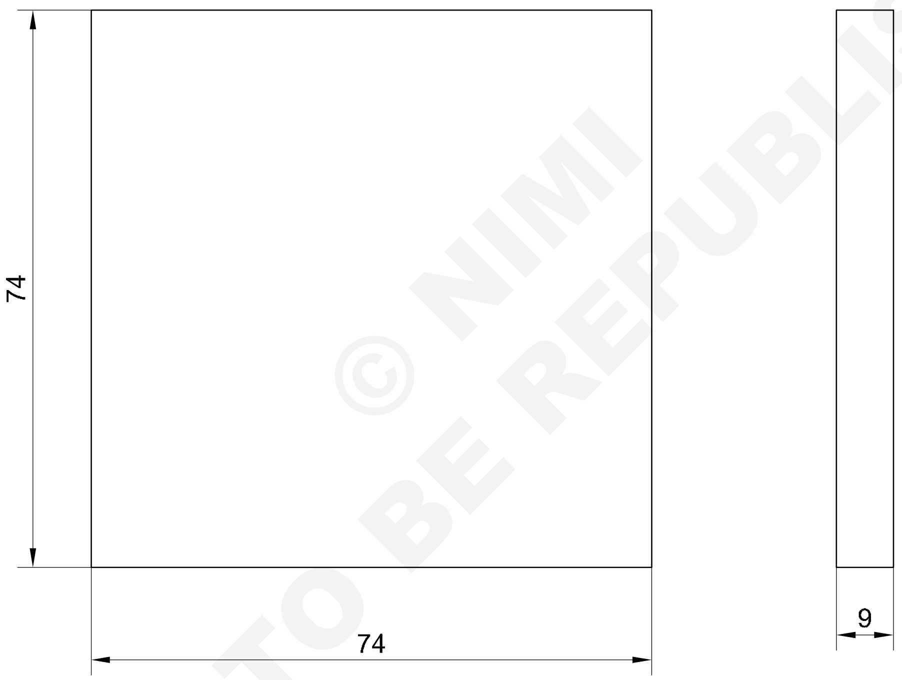


Fig 4



Demo on filing operation using rough file

Objectives: At the end of this lesson you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **file a flat surface**
- **check the flatness of filed job using straight edge/try square blade**
- **check the squarness of the job with trysquare**



1	75 ISF10 - 75	-	Fe310	-	-	1.2.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

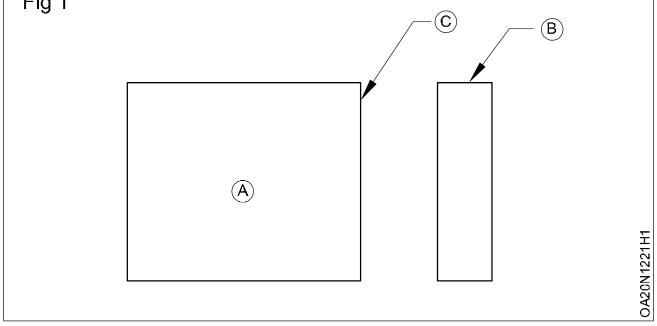
SCALE 1:1	DEMO ON FITTING OPERATION	TOLERANCE : ±0.5mm	TIME : 10Hrs
		CODE NO. OA20N1221E1	

Job sequence

- Check the raw material size using steel rule
- Remove the scaling by flat rough file
- File side (A) with flat bastard file (Fig 1)
- Check the flatness by blade of a try square
- File side (B) and maintain the squareness with respect to side (A)
- Check the squareness with a try square

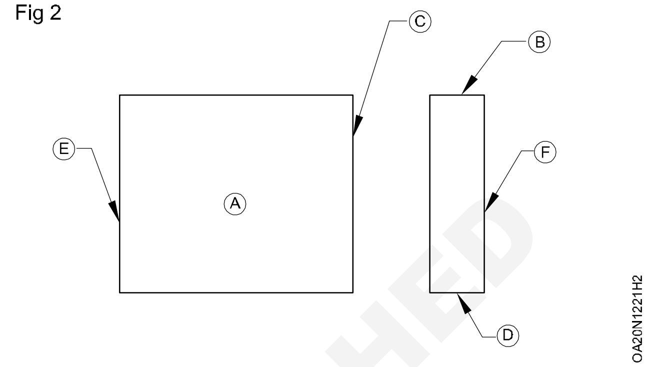
The side A,B and C are mutually perpendicular to each other (Fig 1)

Fig 1



- Set jenny caliper to 74mm using steel rule
- Draw parallel lines of 74 mm to side (B) and (C)
- Punch the marked line using dot punch and ball pein hammer
- Set and file sides (D) and (E) to 74 mm and maintain squareness to all other sides.
- Maintain (D) and (E) parallel to side (B) and (C) (Fig 2)

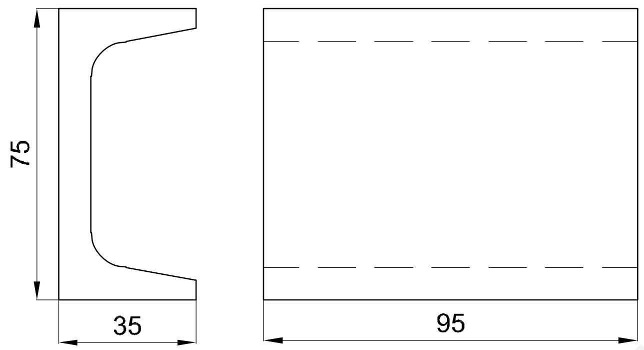
Fig 2



- Check the dimensions with a steel rule and squareness with a try square
- File surface (F) and maintain the thickness of 9 mm parallelism to side A.
- Remove sharp edges. Apply little amount of oil and preserve it for evaluation.

Exercise of filing flanges of a channel

Objectives: At the end of this lesson you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **file a flat surface with a flat bastard file**
- **check the flatness of the filed surface with a straight edge/blade of a try square**

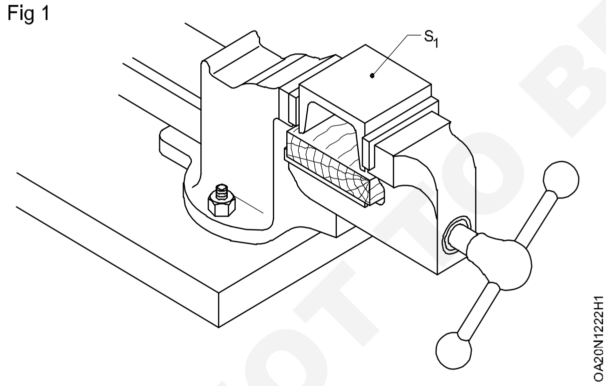


Job sequence

- Check the stock size with a steel rule
- Hold the job in bench vice, so that surface S1 comes on top (Fig 1)

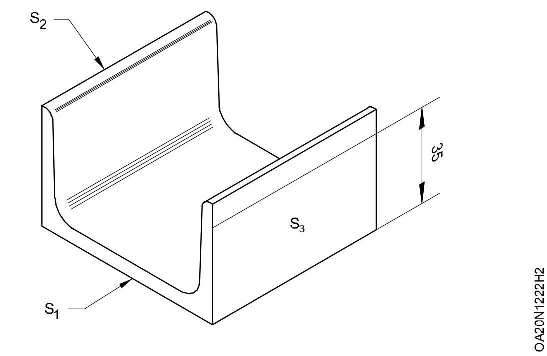
Apply only limited clamping force so that the ribs do not bend

Fig 1



- File the surface S1 with a flat bastard file
- Check the surface level with straight edge/blade of a try square.
- Mark 35 mm line on surface S2 and S3 parallel to S1 with a jenny caliper
- File the rib up to the marked line (Fig 2) and check the size with steel rule
- Check the surface level with the straight edge.

Fig 2



1	MC 75 - 95	-	Fe310	-	-	1.2.22
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	FILING CHANNEL PARALLEL	TOLERANCE : ±0.5mm	TIME : 5Hrs
		CODE NO. OA20N1222E1	

Skill sequence

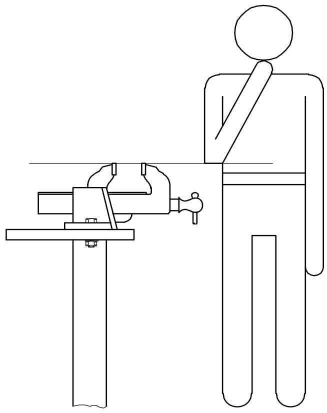
Filing flat surface

Objective: This shall be help you to

- **file flat**

Check the height of the bench vice. (Fig 1) If the height is more, Use a platform and if it is less, select and use another workbench.

Fig 1



OA20N1222J1

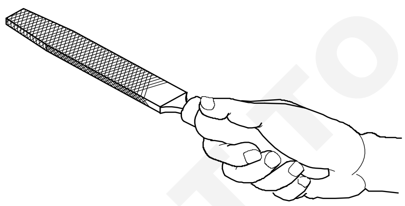
Hold the job in the bench vice with a projection of 5 to 10 mm from the top of the vice jaw.

Select flat files of various grades and length according to the

- size of the job
- quantity of metal to be removed
- material of the job

Check whether the handle of the file fitts tightly. Hold the handle of the file (Fig 2) and push the file forward using your right hand palm or left hand palm.

Fig 2

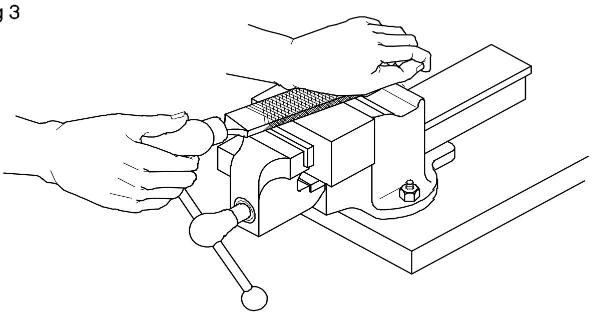


OA20N1222J2

Hold the tip of the file according to the quantity of the metal to be removed

For heavy filing. (Fig 3)

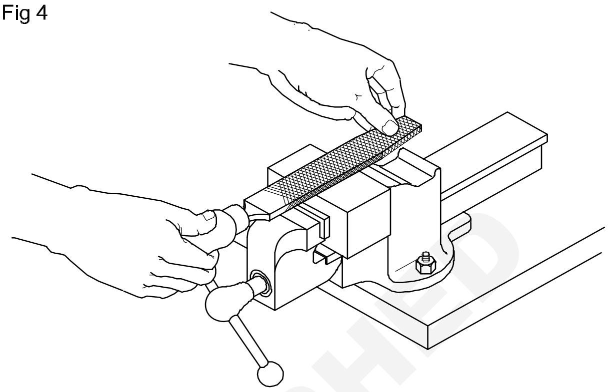
Fig 3



OA20N1222J3

For light filing. (Fig 4)

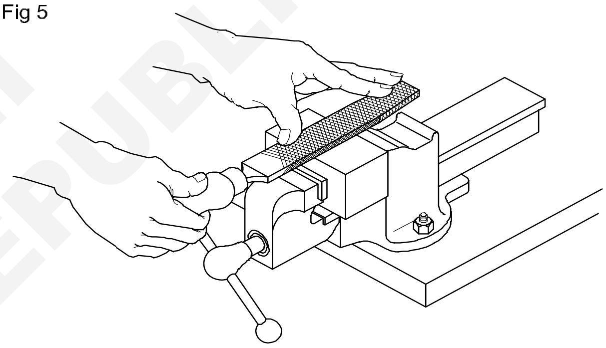
Fig 4



OA20N1222J4

For removing local uneveness. (Fig 5)

Fig 5



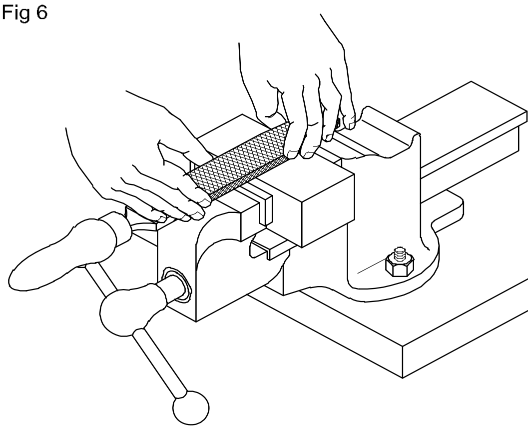
OA20N1222J5

For removing the local uneveness draw filing can also be done. (Fig 6) The same filing can also be don for fine finishing.

Start filing by punshing the file uniformly during the forward stroke and release the pressure during the return stroke.

Continue giving strokes. Balance the pressure of the file in such a way that the file always remains flat and straight over the surface to be filed.

Fig 6



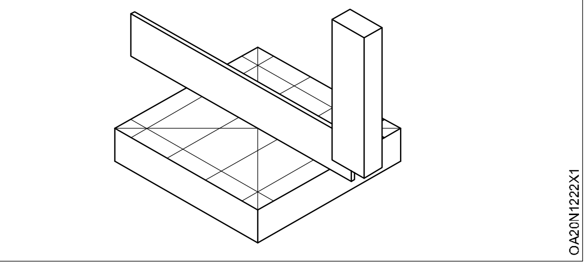
OA20N1222J6

Checking flatness and squareness

objectives: This shall help you to
- **check flatness**
- **check squareness.**

Checking flatness (Fig 1)

Fig 1



Use the blade of the try square as a straight edge for checking flatness.

Place the blade of the try square on the surface to be checked in all directions so as to cover the entire surface.

Do the checking facing the light. Light gap will indicate high and low spots.

Checking squareness: Consider the large finished surface as the reference surface. Ensure that the reference surface is filed perfectly and is free from burrs.

Butt and press the stock against the reference surface. (Fig 2)

Bring down slowly (Fig 3) and make the blade touch the second surface with which the squareness is to be checked.

Fig 2

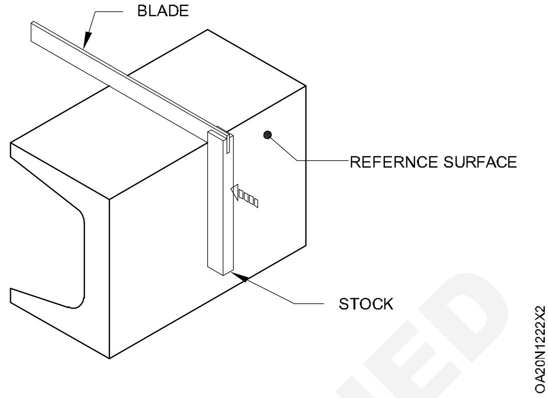
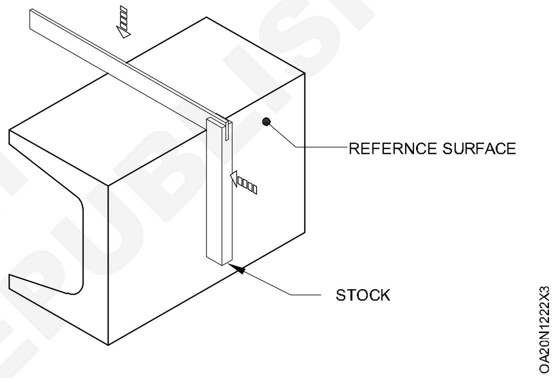
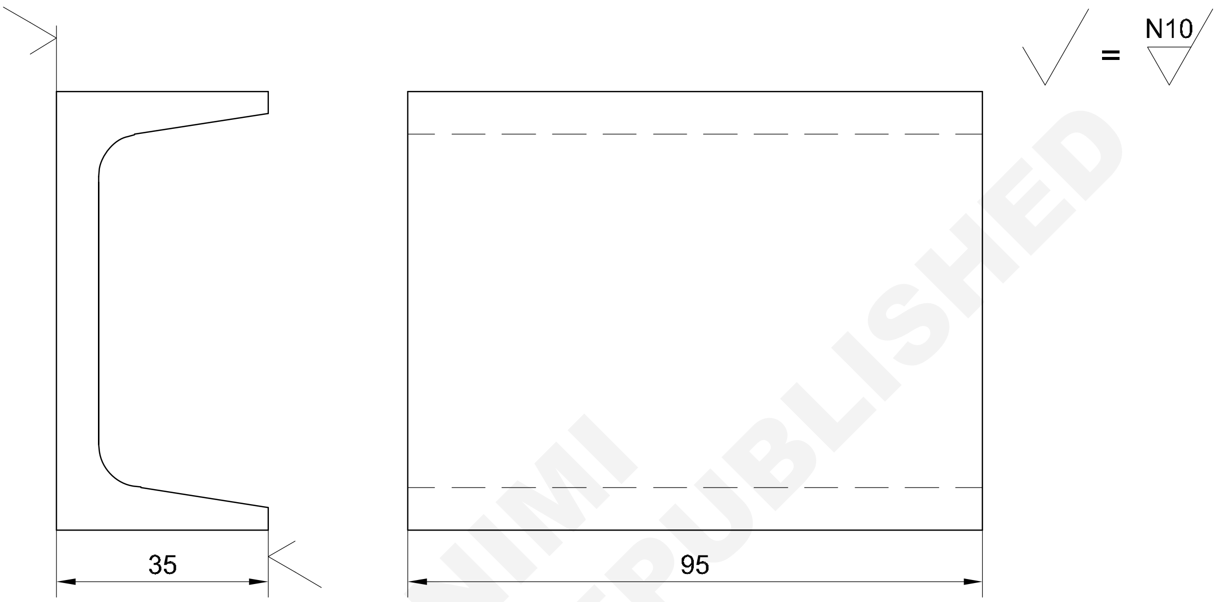


Fig 3



Filing flat surface and flange of a channel maintaining parallelism

Objectives : At the end of this exercise you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **file a flat surface with a flat bastard file**
- **Use a Jenny Caliper for marking**
- **Check the parallelism with an outside caliper.**



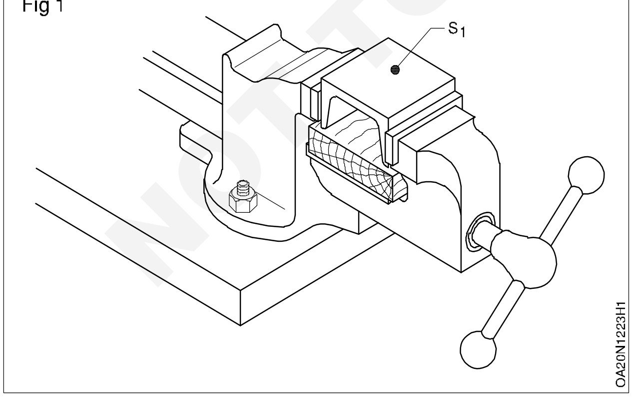
Job Sequence

- Check the stock size with a steel rule.
- Hold the job in bench vice, so that surface S1 comes on top.(Fig 1)

Apply only limited clamping force so that the ribs do not bend

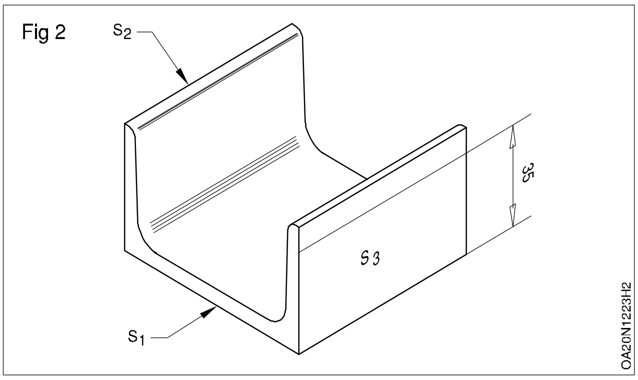
- File the surface S_1 with a flat bastard file.

Fig 1



- Check the surface level with straight edge/blade of a try square.
- Mark 35 mm line on surface S_2 and S_3 parallel to S_1 with a jenny caliper.
- File the rib up to the marked line (Fig 2) and check the size with steel rule.
- Check the surface level with the try square. (FIg 3)
- Check the parallelism with an outside caliper. (Fig 4)

Fig 2



1	BISLC 75 - 95	→ 1.2.04	--	--	--	-
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-

SCALE 1:1	FILING CHANNEL FLAT SURFACE	DEVIATIONS ±0.5	TIME -
		CODE NO. OA20N1223E1	

Fig 3

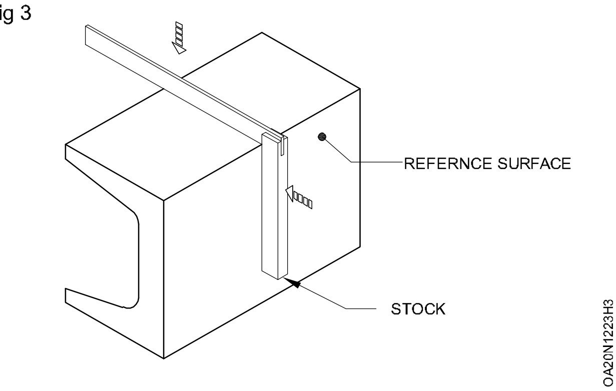
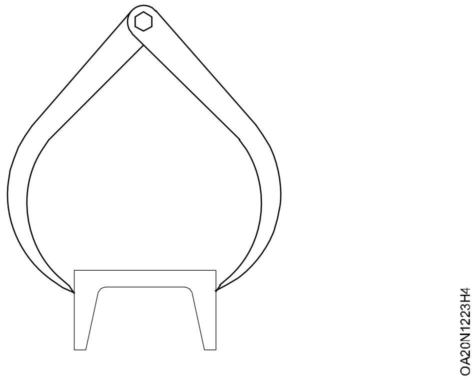


Fig 4



Measuring with outside calipers

Objective: This shall be help you to

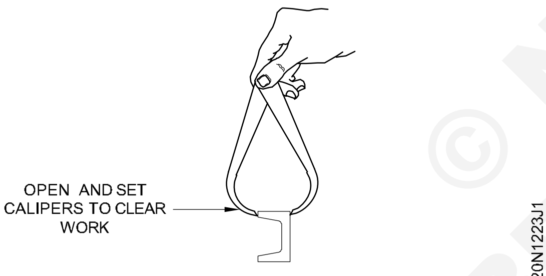
- **select the right capacity caliper for measurement**
- **set the sizes both in firm joint and spring calipers**
- **read the sizes by transferring them to a steel rule or other precision measuring devices as the case may be.**

Outside calipers: Select a caliper based on the dimension to be measured.

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

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

Fig 1

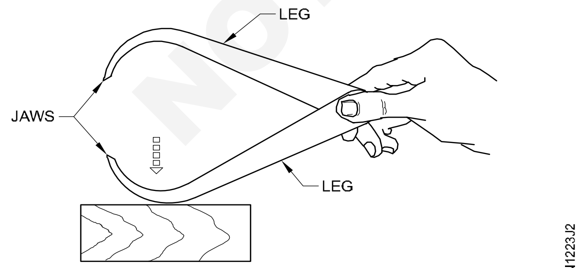


WORK MUST BE STATIONARY

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 on a wooden piece until it just slips from the external diameter of the workpiece to give the right sense of 'feel'. (Fig. 2)

Fig 2

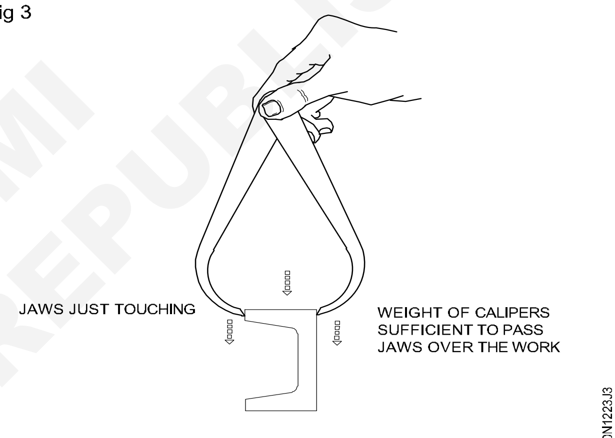


TAP GENTLY TO CLOSE CALIPERS

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'.

In the case of spring outside calipers, adjust the screw nut so that the adjustment of the jaws just slips from the external diameter of the workpiece to give the right sense of feel. (Fig.3)

Fig 3

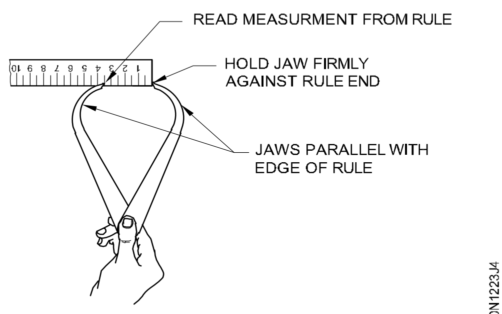


OBTAINING THE 'FEEL'

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 jaw firmly against the rule end. (Fig.4)

Fig 4



CHECKING THE DIMENSION

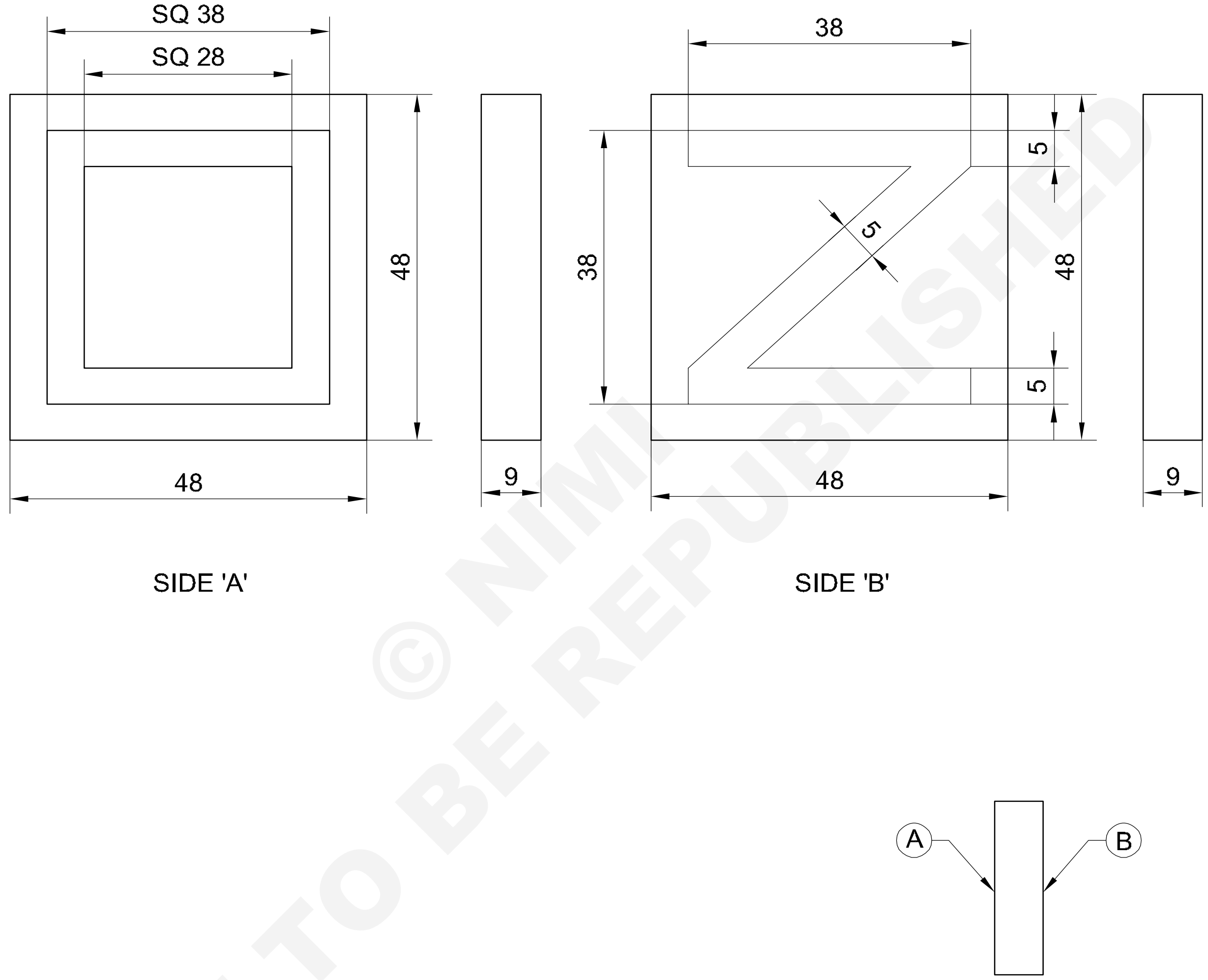
The point of one jaw must be placed over the graduation so that the point of the other jaw is parallel with the edge of the steel rule.

Record the reading to an accuracy of ±0.5mm.

Similarly take measurement at middle and at the end. If all the dimensions are equal then it is parallel.

Exercise on filing to develop control and field layout the dimensional feature

Objectives : At the end of this exercise you shall be able to
- **file and finish the flat to the required size**
- **mark lines using vernier height gauge and angle protractor**
- **punch the marked lines.**



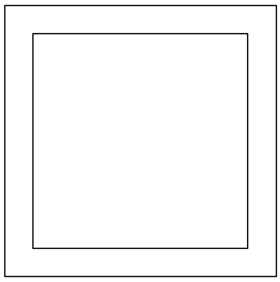
1	50 ISF 10-50	-	Fe310	-	-	1.2.24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MARKING WITH ODD LEG CALIPER AND STEEL RULE				TOLERANCE : ±0.5mm	TIME : 10Hrs
					CODE NO. OA20N1224E1	

Job Sequence

Mark on side A

- Check the raw material size using steel rule
- File 3 sides mutually perpendicular to each other.
- Mark and file to size 48x48x9 mm.
- Set 5 mm in vernier height gauge and draw parallel lines to all sides (Fig 1)

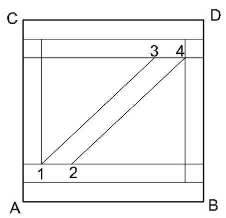
Fig 1



OA20N1224H1

- Similarly, set 10mm in vernier height gauge and draw parallel lines to all sides. (Fig 2) Punch on the marked line.

Fig 2

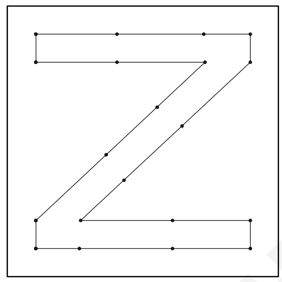


OA20N1224H2

Mark on side B

- Set 5 mm in vernier height gauge and draw parallel lines to side AB, CD, CA and DB Fig 2.
- Set 10 mm and draw parallel lines to side AB and CD.
- Mark 5 mm on line 1 and 2, 3 and 4 as shown in fig.3.

Fig 3



OA20N1224H3

- Join point 1 and 3, 2 and.4, and punch witness marks as shown in Fig 4 & Fig 5.
- Apply little oil and preserve it for validating the marking.

Skill Sequence

Marking with a vernier height gauge

Objective: This shall help you to
- **mark with a vernier height gauge.**

Check for free movements of the sliding unit.

Make sure that the workpiece has no burr and has been properly cleaned.

Workpiece necessiaties clamping to an angle plate. If thin, the application of the marking media should be light thin and even.

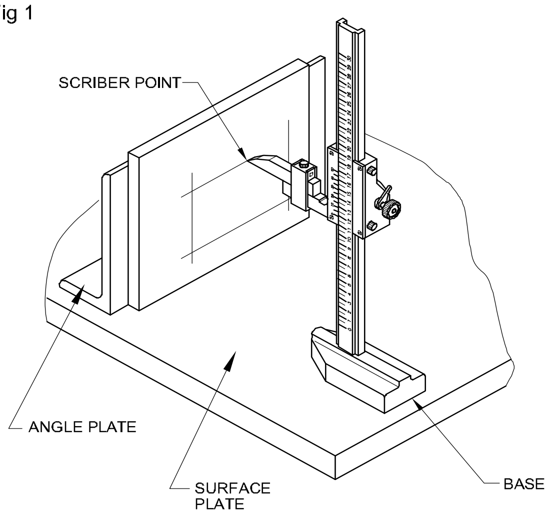
Keep the vernier height gauge base firmly on the suface plate.

Hold the scriber at an angle to the workpiece and pull the corner of the scriber across the work. (Fig.1)

> **Do not allow the base to lift.**
>
> **Do not apply too much pressure to peel off metal from the workpiece. This will avoid damage to the scriber point. Centre points can be located by scribing lines at right angles.**

Scribe first all lines of dimensions in one direction. Secondly scribe all the lines in another direction. (Fig 1).

Fig 1



OA20N1224J1

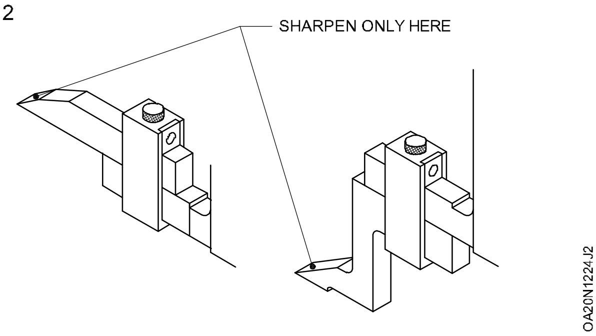
Place the work at 90° and scribe the lines to work. Job surfaces should be finished flat and smooth to avoid lifting during marking.

Precautions to get exact lines.

Ensure the scriber point is sharp always. Sharpen only the inclined surface of the scriber point. (Fig 2)

Frequent sharpening should be avoided. Ask the instructor to sharpen the scriber for you.

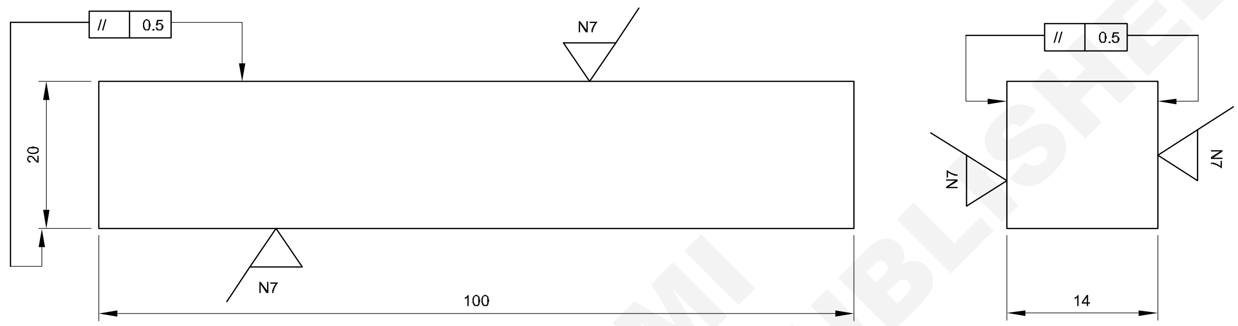
Fig 2



Exercise on filing the adjoining side squareres

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

- **file flat, parallel surfaces within an accuracy of ±0.5mm**
- **check dimensions with steel rule**
- **check parallelism with an outside caliper**
- **check right angle with try square.**



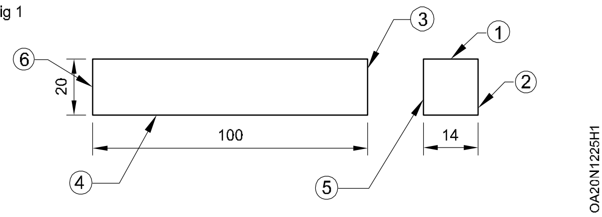
Job Sequence

- Remove burrs and check the size of the raw material.
- File diagonally (Fig.1) side 1 with a 350mm flat bastard file.
- Frequently check the flatness with a try square blade.
- File the same side with a flat second cut file and finish with a flat smooth file.
- File side 2, flat and at 90° to side 2 and side 1.
- File side 3, flat and at 90° to side 2 and side 1.
- Mark sizes as per drawing.
- File side 4 parallel to side 1. (use a caliper to check parallelism.
- File and finish side 5 parallel to side 2.
- File and finish side 6 parallel to side 3.
- Check the size with steel rule.

Remove the hard surface scale from the surface to be filed, using the edge of a flat bastard file.

- Clean, apply little oil and preserve it for evaluation.

Fig 1

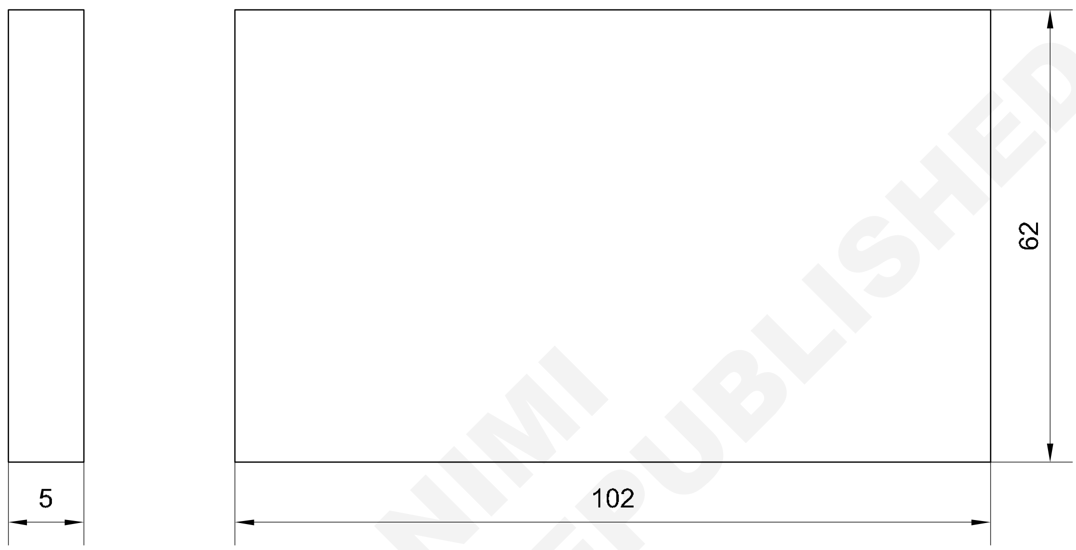


1	25 ISF 15-105	-	Fe310	-	-	1.2.25
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	FILING FLAT AND SQUARE (PARALLEL BLOCK)	TOLERANCE : ±0.5mm	TIME : 10Hrs
		CODE NO. OA20N1225E1	

Filing with second cut file to prepare smooth surface

Objectives: At the end of this exercise you shall be able to
- **file surfaces flat and square within ±0.5mm using flat bastard and second cut file**
- **clamp the workpiece in the bench vice**
- **punch witness marks on scribed lines with a dot punch**
- **check flatness and squareness using a try-square**
- **check thickness using an outside caliper.**



Job Sequence

- Remove burrs, if any using a flat second cut file and ensure the metal surface is free from oil or grease.
- Check the raw material for its size with a steel rule 300mm.
- Hold the workpiece in a 125mm jaw bench vice on its ends.
- Ensure the work is held horizontally.

Do not over-tighten the workpiece.

- File the top surface with a flat bastard file 250mm.
- Check flatness with a try-square.
- File to medium finish using a flat second cut file 250mm.
- Hold the workpiece to file the longer side.
- File and check flatness and squareness with previously finished surfaces using a try-square 150mm.
- File the adjacent shorter side flat and square to both the finished surface.
- Remove burrs and mark sizes as per job drawing, using a steel rule, try-square and scriber.
- File the other two sides flat and square, maintaining the dimensions.

Use soft jaws to protect the finish filed surface while holding the workpiece in the benchvice.

- File the other flat surface parallel and check the thickness using an outside caliper.

1	65 ISF 6 x 105		Fe310-O	–	–	1.2.26
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	FILING THIN METAL				TOLERANCE: ±0.5mm	TIME: 10hrs
					CODE NO. OA20N1226E1	

Cleaning files

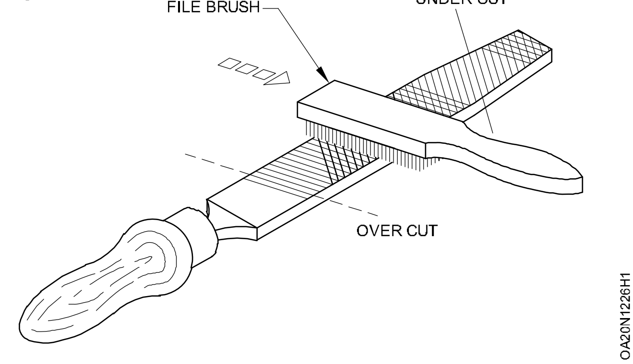
Objective: This shall help you to
- **clean files.**

Introduction

During filing, the metal chips (Filings) will clog between the teeth of the files. This is known as 'pinning' of files. Files which are pinned will produce scratches on the surface being filed, and also will not bite well.

Use a file brush to remove pinning of the files. (Fig.1)

Fig 1



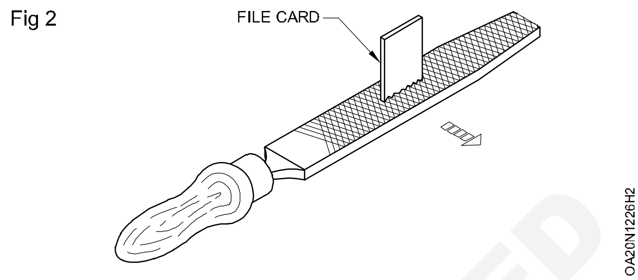
When filing a workpiece to a smooth finish more 'pinning' will take place because the pitch and depth of the the teeth are less.

Application of chalk on the face of the file will help reduce the penetration of the teeth and 'pinning'.

Pull the file brush along the direction of the overcut.

Take out the filings which do not come out easily by the file card by a brass or copper strip. (Fig.2)

Fig 2



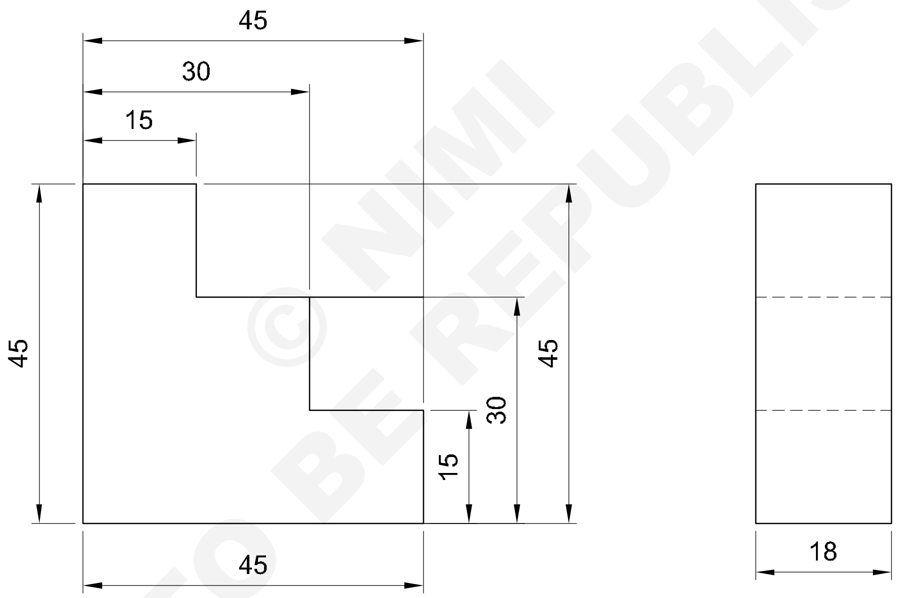
Use only soft metal strips (brass or copper) for cleaning new files.

The sharp cutting edges of the files will wear out quickly if a steel file card is used.

Clean the file frequently in order to remove the filings embedded in chalk powder.

Exercise on filing for maintaining dimension with in ±0.1mm using vernier caliper

Objectives : At the end of this exercise you shall be able to
- **mark steps with vernier height gauge**
- **cut metal by hacksawing**
- **file and finish steps to an accuracy of ±0.1mm.**



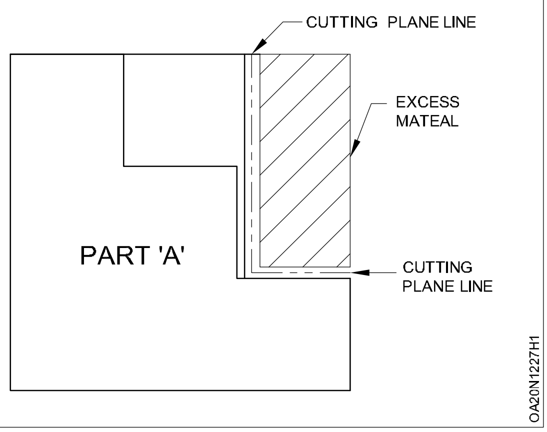
2	50 ISF 20 x 50	-	Fe310	-	1	1.2.27
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**STEP FILING AND MATCHING**	TOLERANCE : ±0.25mm	TIME : 15Hrs
		CODE NO. OA20N1227E1	

Job Sequence

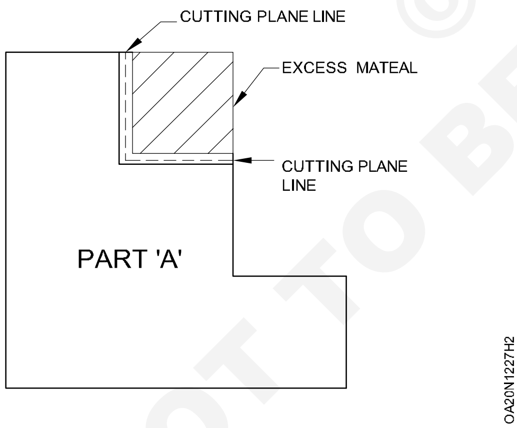
- Check the raw metal with steel rule.
- File and finish the raw metal to size 45x45x18 mm.
- Mark the steps with vernier height gauge as per drawing and punch witness marks.
- Cut and separate the excess material by sawing Fig 1

Fig 1



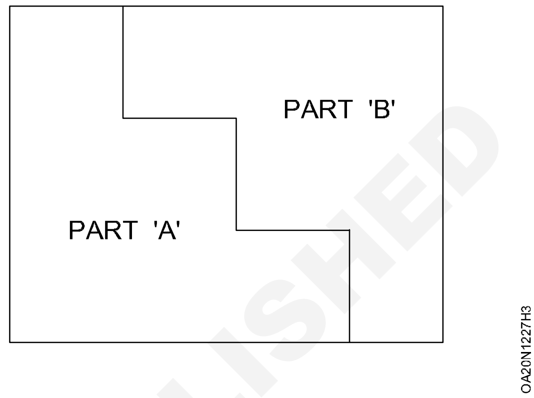
- File step with safe edge file using bastard, second cut and smooth grades.
- Measure the job sizes with vernier caliper maintaining the accuracy of ± 0.1 mm.
- Check the squareness with try square
- Similarly, cut and separate the excess material by sawing Fig 2

Fig 2



- File step with safe edge file using different grades
- Measure the job size with vernier caliper
- Check the squareness with try square
- Finish and de-burr the job
- Similarly, file and finish the another part 'B' and match with one another. Fig 3

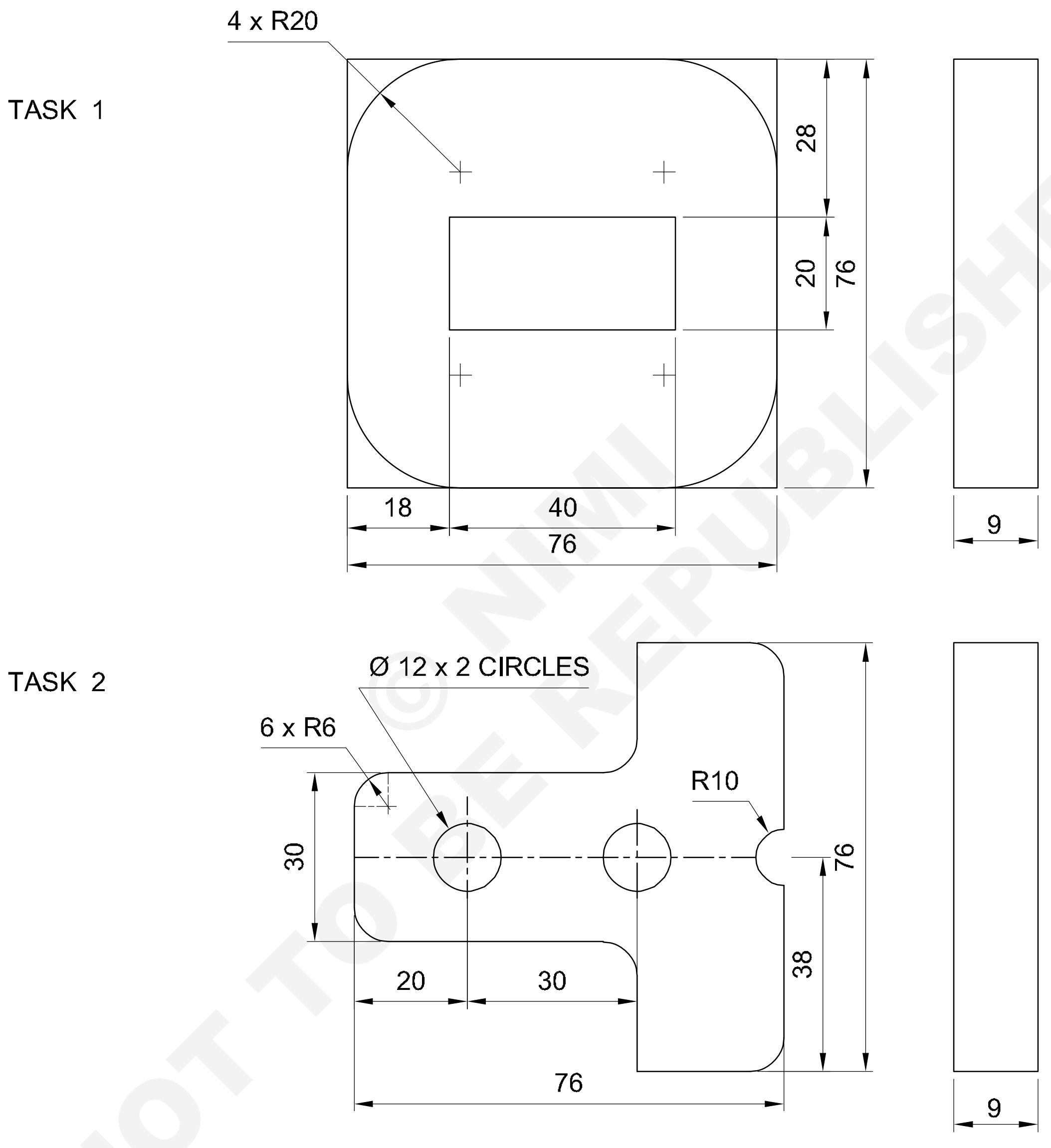
Fig 3



- Apply thin coat of oil and preserve it for evaluation.

Marking of profiles

Objectives: At the end of this exercise you shall be able to
- **mark parallel lines using scribing block**
- **mark arcs using dividers.**



1	80 ISF 10 - 80	-	Fe310	-	-	1.2.28
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

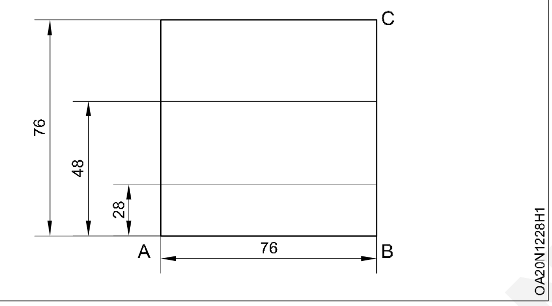
SCALE 1:1	MARKING STRAIGHT LINES & ARCS USING SCRIBING BLOCK & DIVIDERS	TOLERANCE : ±0. 5mm	TIME : 5Hrs
		CODE NO. OA20N1228E1	

Job Sequence

TASK 1: **Marking straight lines & arcs**

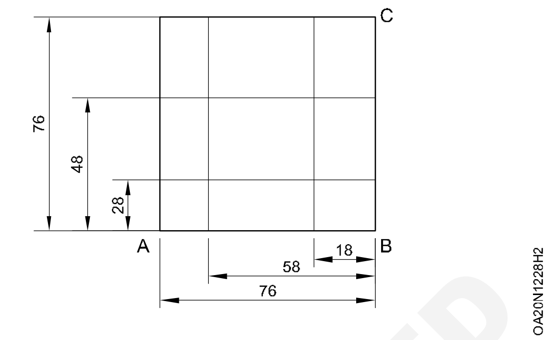
- Check the raw material size using steel rule.
- File three sides mutually perpendicular to each other.
- Mark and file to size of 76 x 76 x 9 mm
- Clean Marking Table, Angle plate, Vernier height gauge and Steel rule with soft cloth.
- Place height gauge, Angle plate and Steel rule on marking table.
- Support the Steel rule along with Angle plate.
- Set the dimension 28 mm in height gauge using Steel rule.
- Support the Job along with angle plate and scribe dimension line 28 mm in scribing block with reference to side 'AB' Fig 1

Fig 1



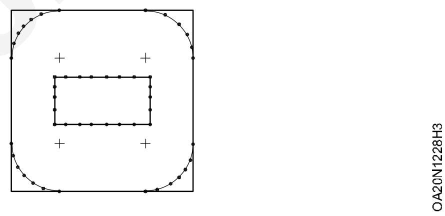
- Similarly, set 48 mm and scribe line with reference to side 'AB.
- Turn and place the Job with reference to side 'BC'.
- Set the size 18 mm and scribe line with reference to side 'BC' Fig 2.
- Similarly, set the size 58 mm and scribe line with reference to side 'BC'

Fig 2



- Set the size 20 mm and scribe line with reference to all over the four sides to draw radius.
- Punch on the four radius point with a 30° prick punch.
- Draw 20 mm radius using divider in four corners.
- Punch on the marked lines with equal intervals. (Fig 3)
- Preserve it for evaluation.

Fig 3



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TASK 2: **Marking straight lines, arcs & edges**

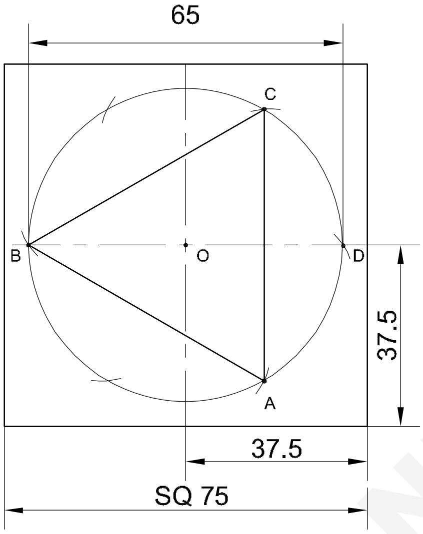
On other side of job, mark and punch TASK 2 as per drawing.

- Mark the centre line 38mm from reference surface AB.
- MArk 15mm above the centre line and 15mm below the centre line as per drawing.
- Mark 20mm and 30mm on the centre line draw reference surface AD.
- Mark radius R6 on the 6 place.
- Join radius lines as per drawing.
- Draw ∅ 12mm circle on the marked reference of 20mm and 30mm.
- Mark corner of the centre R10mm.
- Punch on the mark line by 60° dot punch.

Marking geometrical profiles on sheet metal chisel, snips

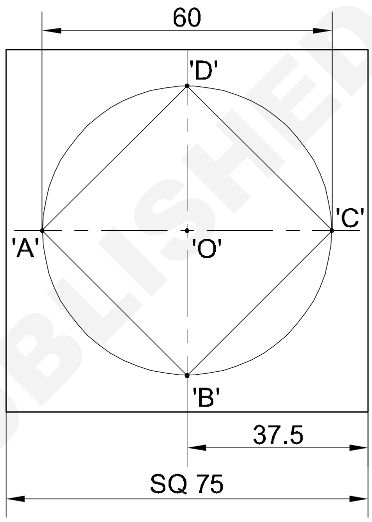
Objectives: At the end of this exercise you shall be able to
- **flatten a sheet using wooden mallet**
- **mark parallel lines, curved lines, circles and geometrical shapes**
- **cut sheet metal on straight lines using straight snips**
- **cut sheet metal on curved lines using curved snips**
- **cut sheet metal on various geometrical shapes.**

Task 1



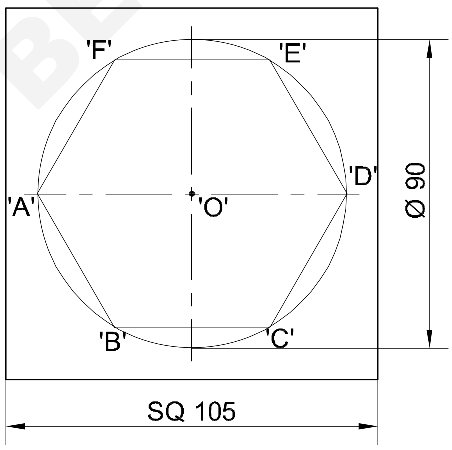
MARKING AND CUTTING TRIANGLE

Task 2



MARKING AND CUTTING SQUARE

Task 3



MARKING AND CUTTING HEXAGON

1	-	-	-	-	-	1.2.29
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MARKING VARIOUS GEOMETRICAL SHAPES IN G.I. SHEET	DEVIATIONS ±1mm	TIME
		CODE NO. OA20N1229E1	

Job Sequence

TASK 4: **Marking and cutting triangle**

Check the size of the sheet as per sketch using a steel rule.

Level the sheet on the bench stake using a mallet.

Punch the centre of the sheet by a prick punch.

Draw a ∅ 65mm circle using a divider on the sheet.

Punch a dot on the circumference of the circle by a prick punch.

Mark three arcs equal to the side of the equilateral triangle and join the arcs by lines.

Cut along the marked lines using chisel.

Check the triangle size with steel rule.

File all the edges of triangle with smooth file

TASK 5: **Marking and cutting square**

Check the size of sheet as per sketch using a steel rule.

Mark the centre lines.

Punch the centre of the sheet by a prick punch.

Draw a ∅ 60 mm circle using divider on the sheet at point 'O'.

Join points A,B,C,D and inscribe the square.

Cut along the marked lines using chisel.

File all the edges of square with smooth file.

Choose squareness with try square.

TASK 6: **Marking and cutting hexagon**

Check the size of the sheet as per sketch using a steel rule.

Level the sheet on a levelling plate.

Mark centre lines.

Punch at the centre of the sheet 'o'.

Draw ∅ 90mm circle.

Scribe arcs on the circumference, each arc being equal to the radius of the circle.

Join points A,B,C,D,E & Fand construct the hexagon.

Cut along the marked lines using chisel.

FIle all the edges of Hexagon with smooth file.

Measure the edges with steel rule.

Skill Sequence

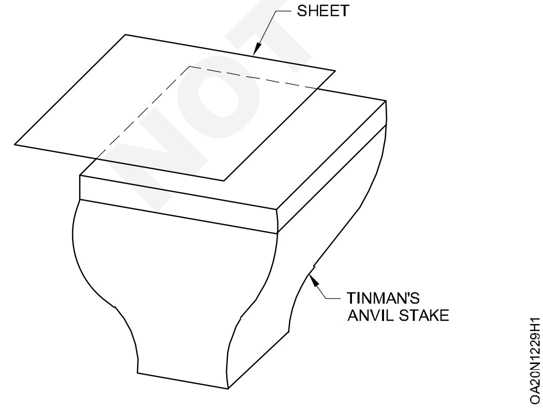
Flattening the sheet metal

Objective: This shall help you to
- **flatten the sheet metal of various sizes.**

Clean the tinman's anvil stake and the job.

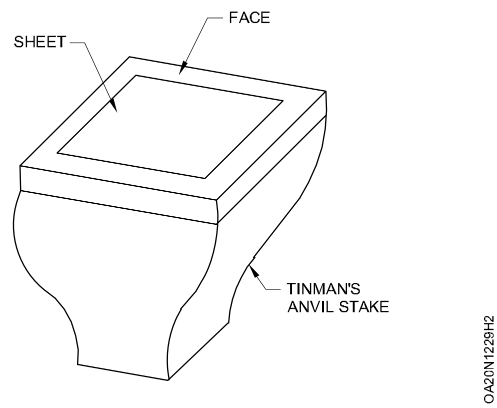
Place the job on the anvil stake top. (Fig 1)

Fig 1



If the size of the sheet metal is smaller than the face of the stake, place the sheet somewhere in the middle of the stakeface. (Fig 2)

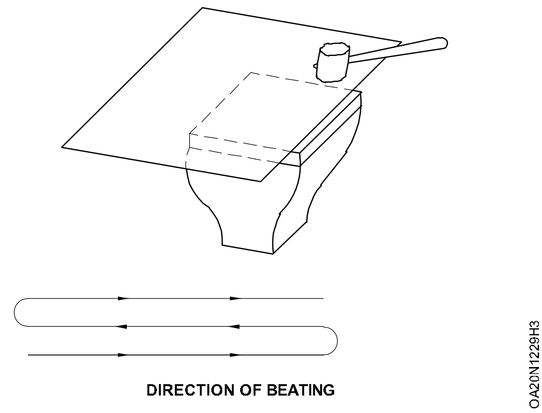
Fig 2



If the size of the sheet is bigger than the face of the stake, place the edge of the sheet at the center of the stake face.

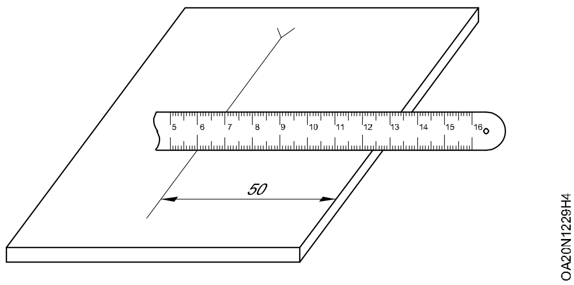
Strike the sheet with the mallet from front to back and back to front, till the entire surface of the sheet is flat. (Fig 3)

Fig 3



Check the flatness of the sheet metal with the edge of the steel rule. While checking the flatness, place the edge of the steel rule on the surface of the sheet and observe the gap between the steel rule edge and the surface of the sheet metal. (Fig 4)

Fig 4



If a gap is not observed, then the sheet is perfectly flat.

If a gap is observed, then the sheet is not flat at the points of the gap.

Flatten the surface at the points of the gap if a gap is observed

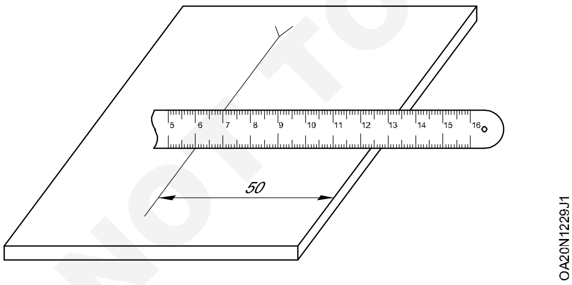
Measuring and marking the sheet metal

Objectives: This shall help you to
- **measure the linear dimensions of the sheet metal using a steel rule**
- **mark parallel lines using a steel rule, a straight edge and a scriber.**

Measuring

- Clean the edges of the steel rule using a waste cloth.
- Place the graduated edge of the steel rule on the workpiece such that the edge is perpendicular to the lines or the edges. (Fig 1)
- Coincide one line with a large graduated line (Centimeter lines) on the steel rule.
- Taking this as a reference dimension, note the dimension on the scale coinciding with the line/edge between which the distance is to be checked.

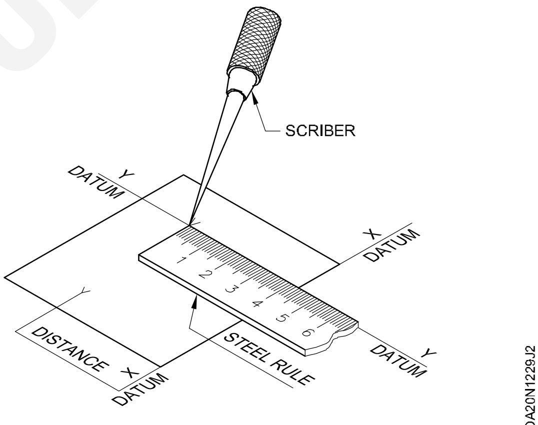
Fig 1



- Determine the distance between the two lines. For example, if 50 mm is the reference dimension and 100 mm is the dimension coinciding with the line between which the distance is to be checked, then 100-50 = 50 mm is the distance between the two lines.

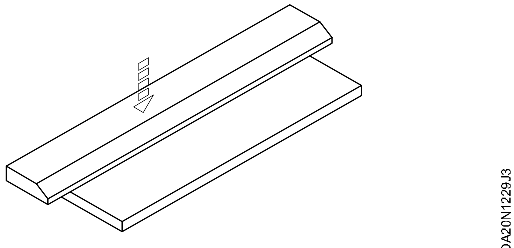
Mark a straight line on the sheet: Mark off two 'V' marks from the datum 'xx' at a distance as required for measurement, using a steel rule and a scriber. Datum 'xx' is at right angle to datum 'yy'. (Fig 2)

Fig 2



Set the straight edge in between the 'V' marks and press the straight edge with your fingers. (Fig 3)

Fig 3



While scribing lines, hold the scriber close to the straight edge as shown in Fig 4.

Incline the scriber at an angle of 45^0 approximately as shown in Fig 5 and scribe a line towards you along the edge of the straight edge.

Fig 4

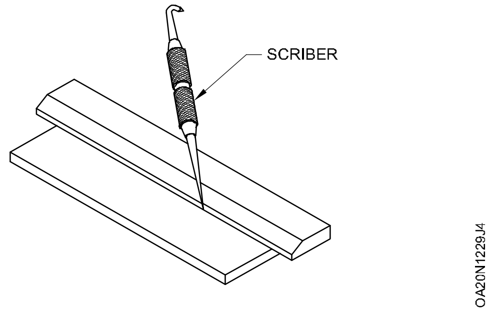
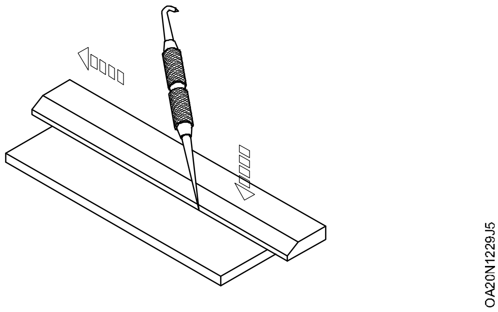


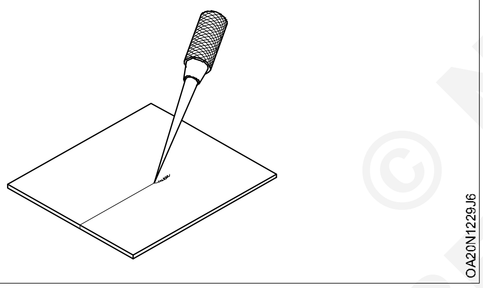
Fig 5



If the inclination is opposite from you, it will cause damage to the sheet and will remove the top layer of the metal.

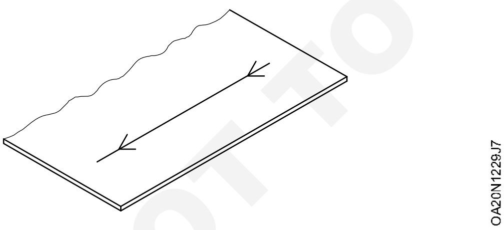
Don't apply excessive pressure while scribing lines using the scriber to avoid the removal of the metal. Fig 6.

Fig 6



The line AB is the parallel line to the datum xx. (Fig 7)

Fig 7



For economical marking

> **To avoid wastage, always scribe lines from left hand bottom corner as shown in Fig 8 but not as in Fig 9.**

Fig 8

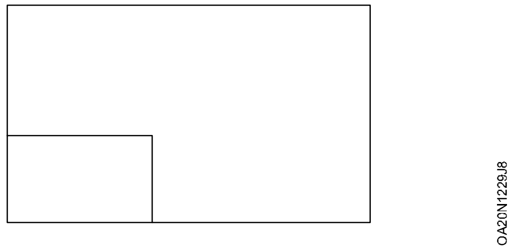
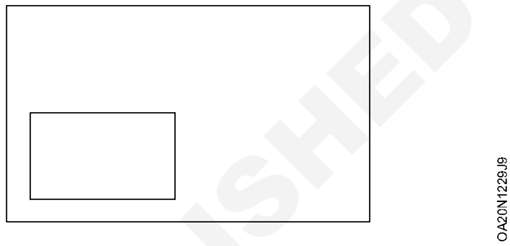
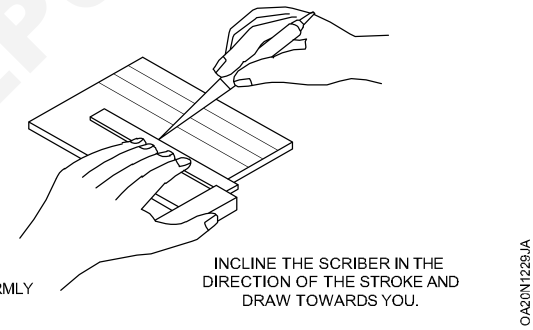


Fig 9



> **Draw parallel lines as in Fig 10 as per the dimensions shown in Job drawing. (Ref. Job sequence for Ex.No.1.3.42 Task 1.**

Fig 10



Marking with wing compass

Objectives : This shall help you to
- **set the required dimension on a wing compass**
- **draw circles and arcs with a wing compass.**

Wing compass

Verify that the legs of the compass are of the same length. (Fig 1)

> **If not, grind the leg and sharpen with an oilstone.**

Punch at the intersection of the marked lines. (Fig 2)

> **Only a small dot is needed to prevent the compass from slipping.**

For small lengths, loosen the wing nut and open the compass wider and then squeeze with your right hand to adjust and match the required length on the rule. (Fig 3)

Fig 1

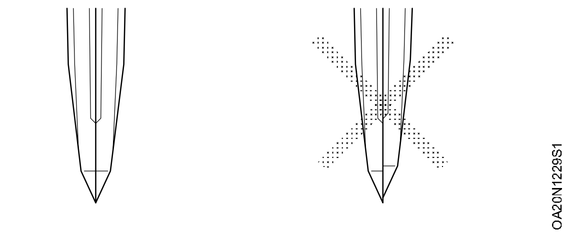


Fig 2

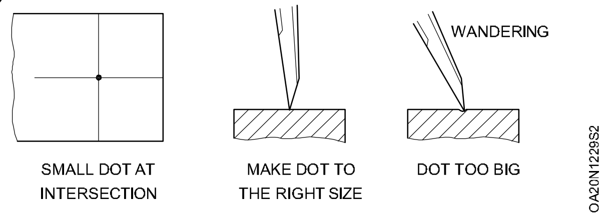
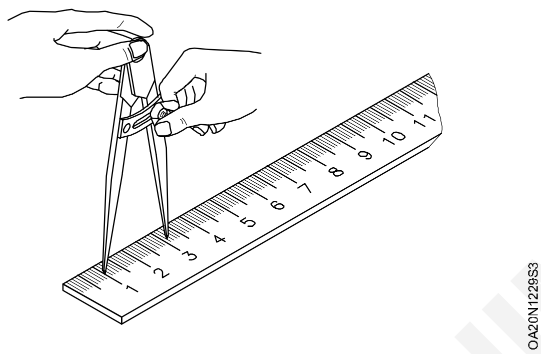


Fig 3



While adjusting the compass opening, use the middle of the rule and not the edge.

For larger lengths, place the rule on the worktable and adjust the compass opening, with both tips on the rule.

To close the legs fractionally, tap the outside of the leg lightly.

To open them fractionally, turn the compass upside down and tap the head lightly. (Fig 4)

After setting the dimensions, lock the legs with the wing nut and check the dimensions again.

Hold the compass head with the palm of your hand to prevent the compass point from slipping from the centre of the circle.

Do not press the wing nut.

Draw an upper half circle from the lower left to the right, using thumb pressure. (Fig 5)

Change the thumb position on the compass, and draw the rest of the circle from the lower left. (Fig 6)

When drawing, tilt the compass slightly in the direction of rotation.

Draw clearly the first time itself.

Fig 4

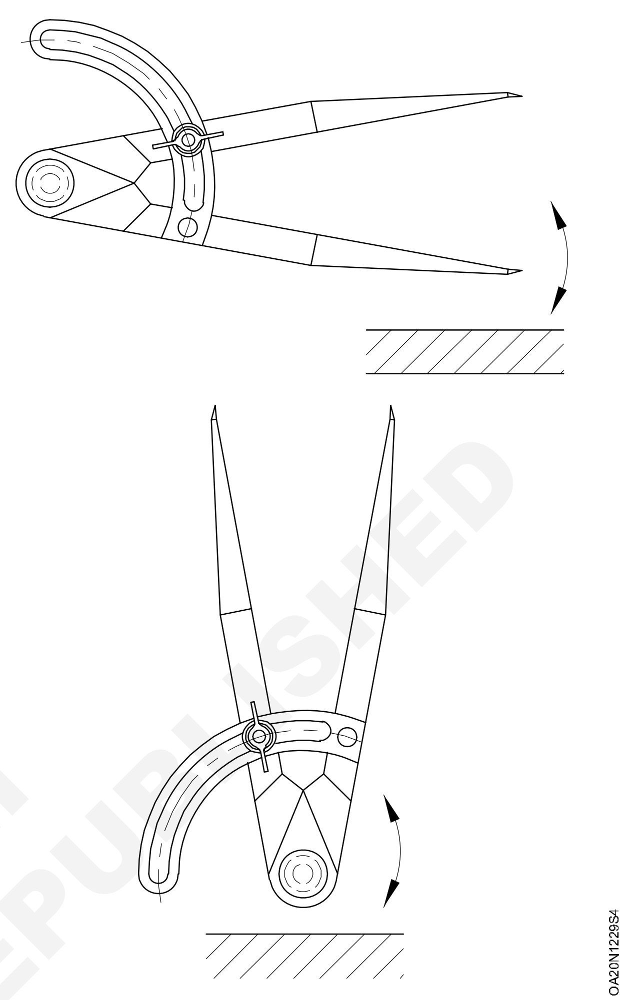


Fig 5

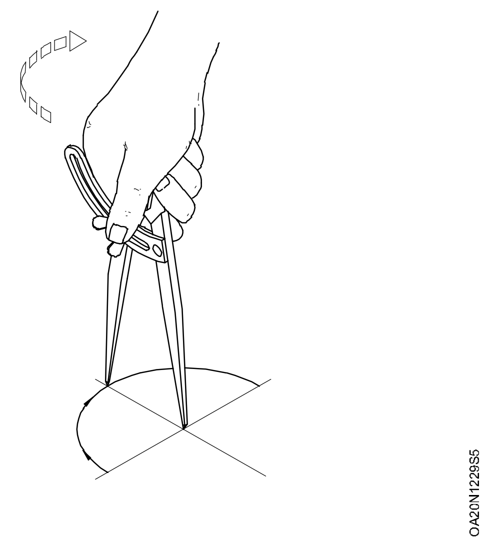
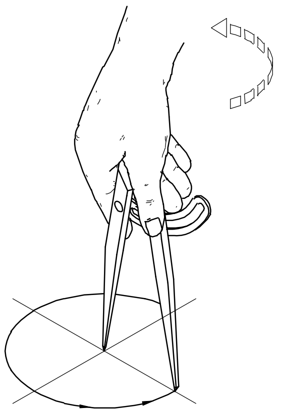


Fig 6



Mark curved lines

Objectives: This shall help you to
- **mark the centre line using a scriber and a steel rule**
- **punch a dot mark using a dot punch**
- **mark curved lines using a wing compass.**

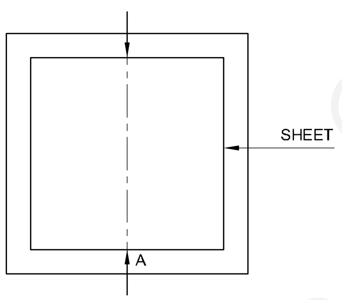
Clean the tinman's stake and the sheet metal surface.

Flatten the sheet metal using a wooden mallet.

Check the size of the sheet metal using a steel rule.

Mark 'V' at the centre of the workpiece on opposite sides and join it using a steel rule and a scriber. (Fig 1)

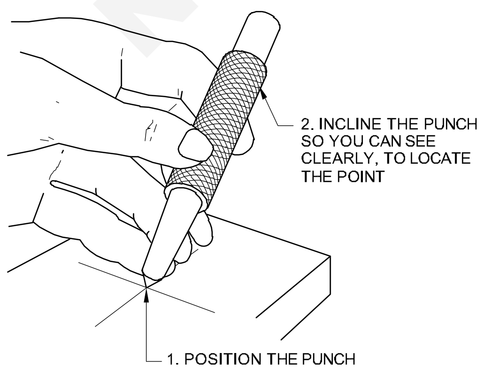
Fig 1



Mark the centre point on the centre line.

To punch the centre point use a dot punch. Place the sheet on the anvil stake. Hold the punch between the thumb and the first two fingers of the hand where possible, rest the little finger and the edge of your hand on the marked centre point as shown in Fig 2.

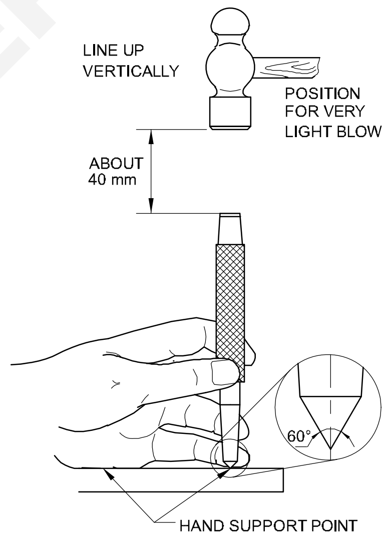
Fig 2



Bring up the dot punch in the vertical position and strike with a ball pein hammer on the head of the dot punch lightly.

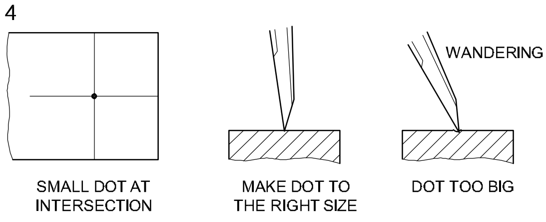
Watch the point of the punch and strike its head with the ball pein hammer Fig 3. This dot punch marks prevent the wing compass leg from slipping while scribing curved lines from the centre point.

Fig 3



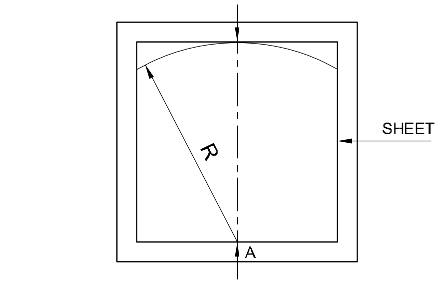
Only a small dot is needed to prevent the wing compass from slipping. If the dot is too big, compass leg will wander as shown in Fig 4.

Fig 4



Now set the wing compass to the required dimension. Set one leg of the wing compass at the centre point, and scribe a curved line (arc) by rotating the wing compass as shown in Fig 5.

Safety: While striking the head of the dot punch, the hammer face must be free of burrs and oil substances. The hammer head must be held tight on to the handle by wedge.

Fig 5


Marking triangle in a given circle

Objective : This shall help you to
- **draw a triangle inside a given circle.**

Draw the diameter BD of the circle. (Fig 1)

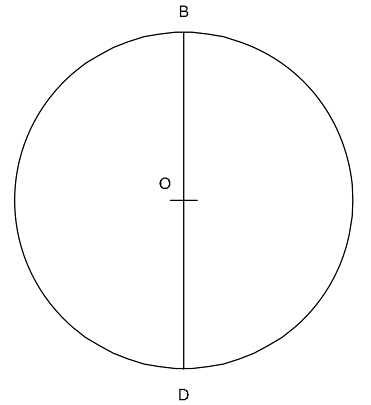
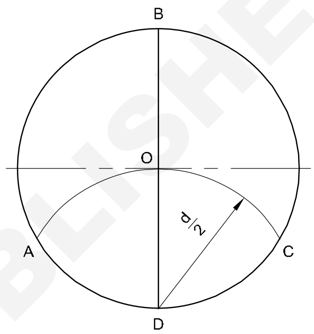
Fig 1


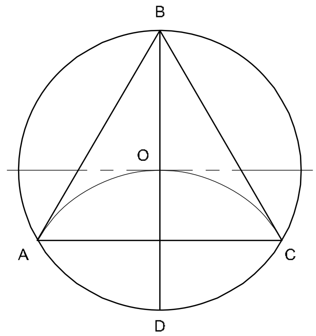
Fig 2


Draw an arc d/2 as radius and D as centre.

Let this arc intersect the circle at A and C. (Fig 2)

Join AB, BC, and AC to each other.

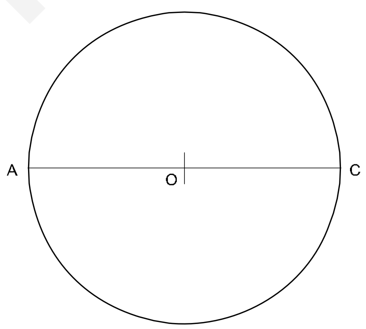
ABC is the triangle drawn inside the given circle. (Fig 3)

Fig 3


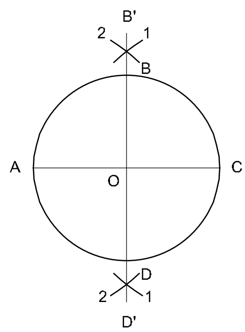
Marking square in a given circle

Objective : This shall help you to
- **inscribe a square in a given circle.**

Draw the diameter AC of the circle. (Fig 1)

Fig 1


Bisect AC. (Fig 2)

Fig 2


Draw two arcs 1 and 2 with A and C as centres on the top and bottom of the line AC. (Fig 3)

Let the arcs meet at B and D.

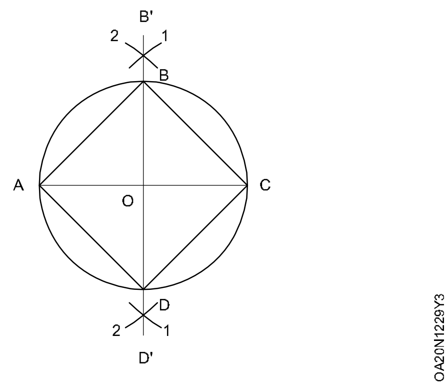
Join the points B and D

BD is the bisector of AC.

Join AB, BC, CD and DA to each other.

ABCD is the square drawn inside the given circle. (Fig 3)

Fig 3

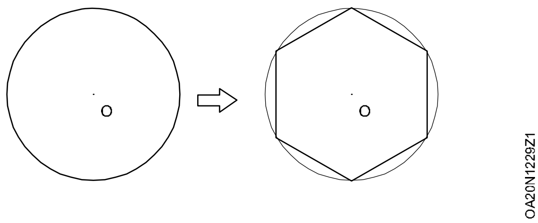


Marking a regular hexagon

Objective : This shall help you to
- **inscribe a regular hexagon in a circle.**

Inscribe a regular hexagon in a circle. (Fig 1)

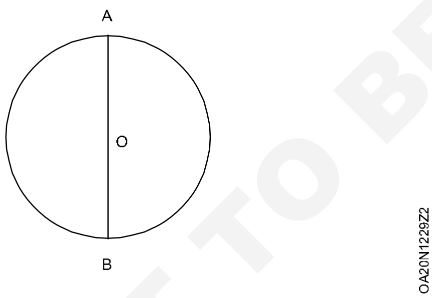
Fig 1



Draw the diameter vertically to the given circle whose centre is 'O'.

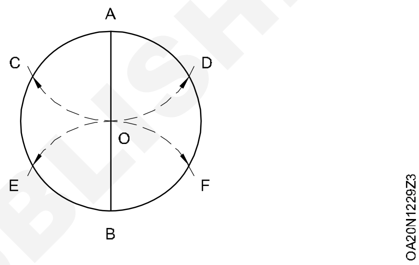
Let A and B be the intersecting points on the circumference. (Fig 2)

Fig 2



With AO as radius and A and B as centre, draw two arcs CD and EF respectively with the help of a compass. Let C,D,E,F be the intersecting points on the circumference. (Fig 3)

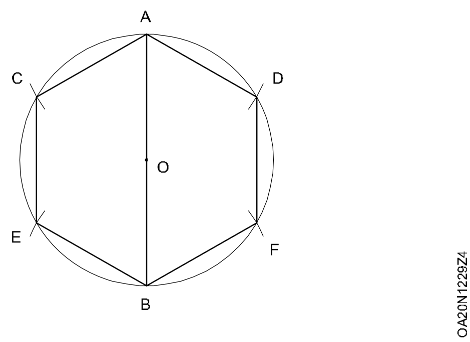
Fig 3



Connect points A,D,F,B,E and 'C' to each other. (Fig 4)

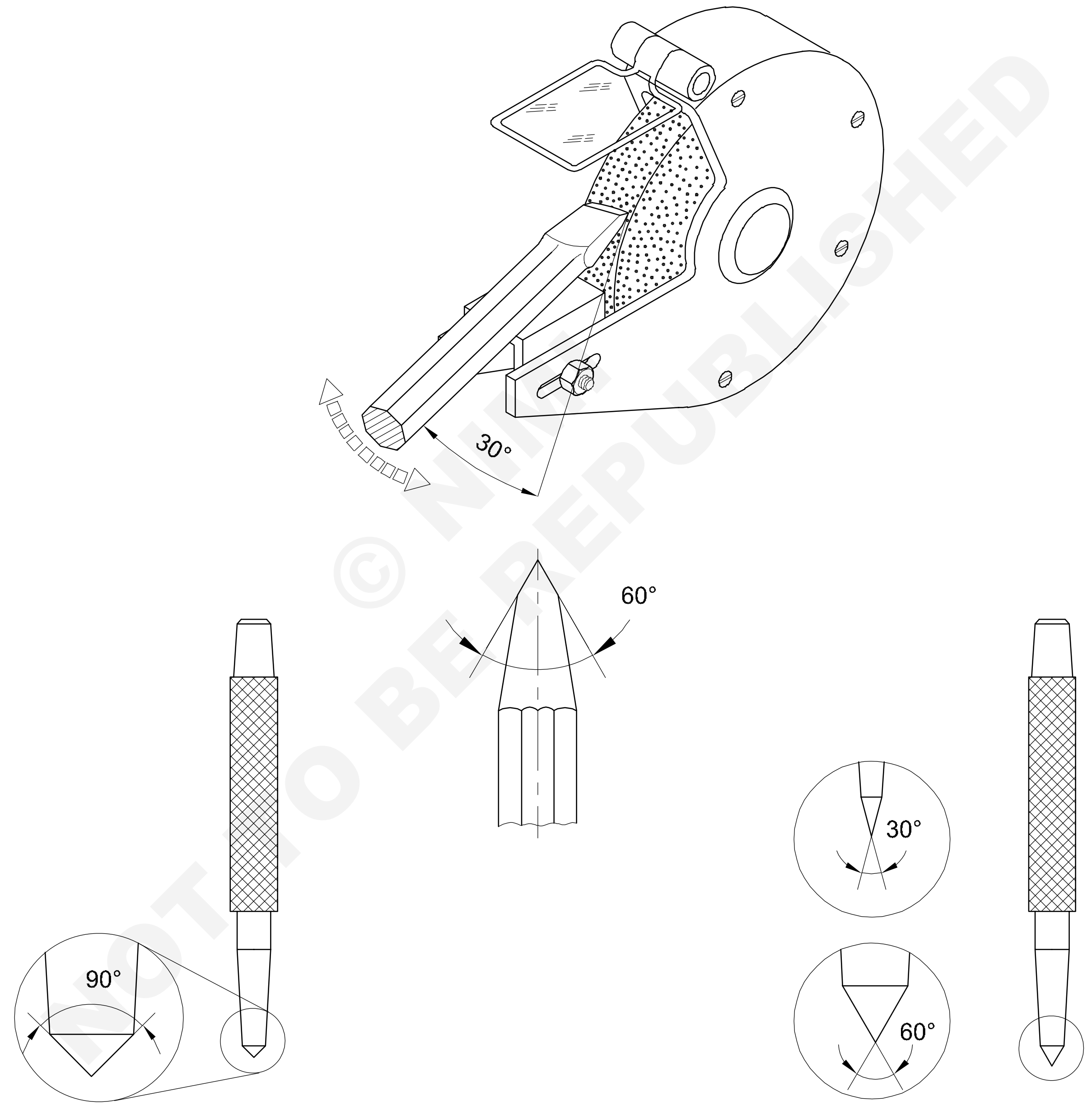
Now a regular hexagon is inscribed in the circle.

Fig 4



Sharpening of marking tools use of Bench grinder

Objectives: At the end of this exercise you shall be able to
- **re-sharpen the flat chisel when it becomes blunt using pedestal/bench grinder**
- **re-sharpen the centre punch when it becomes blunt**
- **re-sharpen the dot punch/prick punch when it becomes blunt**
- **operate safely the pedestal or bench grinding machine.**



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

SCALE	GRINDING FLAT CHISEL, CENTRE PUNCH & DOT PUNCH	DEVIATIONS	TIME
		CODE NO. OA20N1230E1	

The instructor can provide as much wornout chisel, and centre punch & dot punch as he can draw from section store and from other trades.

Skill sequence

Grinding of flat chisel

Objective: This shall help you to
- **grind a flat chisel when they become dull.**

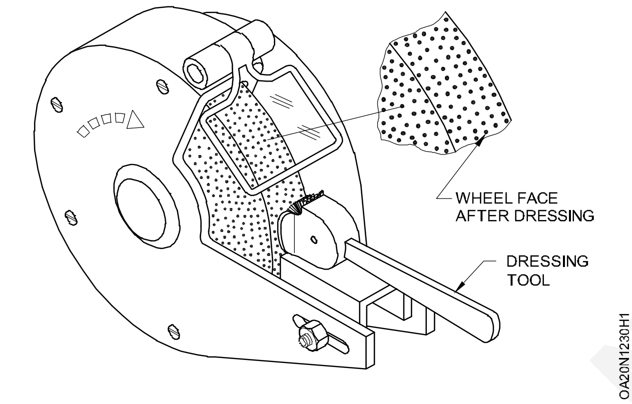
Before grinding: Check the grinding wheel by,

– sliding the finger tip across to detect glazing

(In case of glazing dress the wheel.) seek the help of the instructor. (Fig 1)

– visually check for cracks.

Fig 1



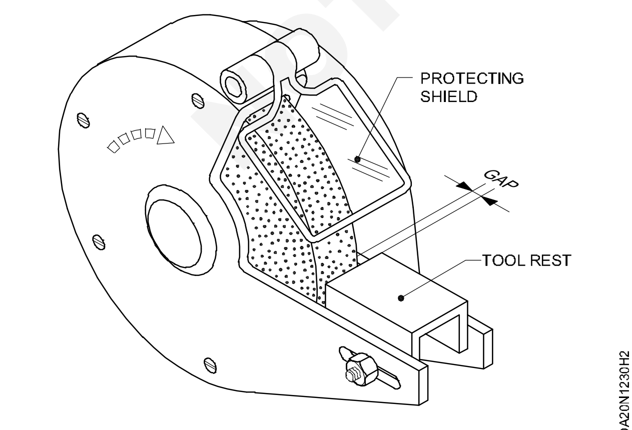
Switch on the grinder but stand by the side of the wheel for safety, and see whether the wheel runs 'true' and has no excessive vibration. In case of excessive vibration truing is necessary. Ask the instructor for advice.

Ensure that there is enough coolant in the container.

Protect your eyes with goggles or lower the protecting shield near the tool rest. (Fig 2)

Adjust the tool rest 2 mm closer to the wheel, if necessary. (Fig 2)

Fig 2

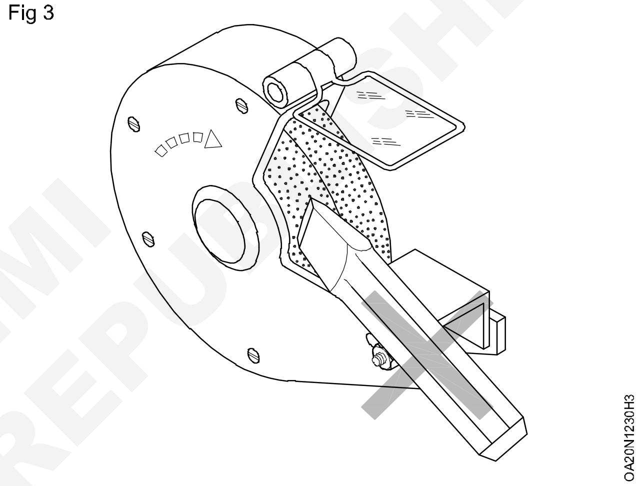


During grinding: Take a blunt chisel for re-grinding. Chisels will become blunt due to use. For efficient chipping, chisels are to be re-sharpened regularly.

Do not use cotton waste or other material for holding the chisel while grinding.

Use only the face of the wheel and not the sides (Fig 3)

Fig 3

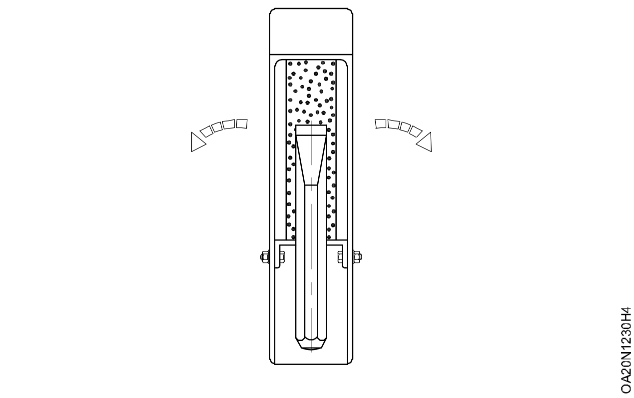


Switch on the grinder.

Hold the chisel edge parallel to the wheel surface; the body of the chisel must be at an angle of 30° in such a way as to get 60° wedge angle. (Fig 5)

Rest the body of the chisel on the tool rest (A) and allow the point to touch the wheel. (Figs 4 & 5)

Fig 4



Keep the pressure as minimum as possible to prevent excessive heating of the cutting edge, (avoid blue colour i.e. annealing effect).

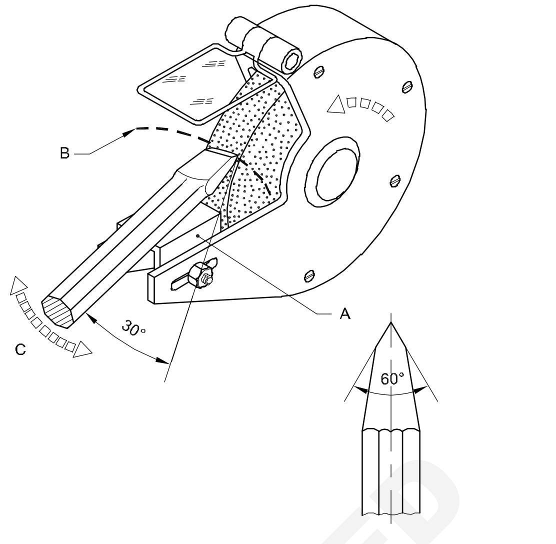
Rock the point on both sides in an arc to provide convexity at the cutting edge. (Fig 5) See the arrows 'C'.

Dip the chisel in the coolant as and when it is required so as to avoid overheating.

Repeat the grinding on the opposite side of the cutting edge.

Check the wedge angle with a bevel protractor.

Fig 5



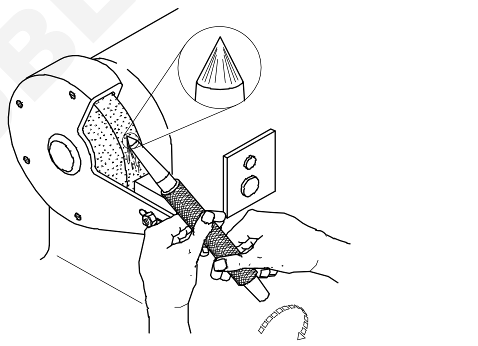
Sharpening a centre punch

Objective : This shall help you to

• sharpen worn out centre punch.

- For accurate layout work and hole locations it is important that the centre and prick punches are sharpened correctly.
- For grinding, hold the punch in a manner that the fingers of the left hand rest on the tool rest.(Fig.1)
- The head of the punch should be held by the right hand fingers tips.
- Position the punch at an angle - to obtain the required included angle.(90°for centre punch and 60° for prick punch)
- Grinding is always on the front of the wheel. Rotate the punch and exert even and continuous pressure while grinding.
- Do not overheat the point while grinding.
- Dip the point in the coolant frequently.

Fig 1



- Make sure that the tip of the centre punch point is in the centre.

Use googles to protect your eyes while grinding.

Sharpening a scriber

Objective: This shall help you to

• **sharpen a worn out scriber point.**

For drawing sine and accurate lines in layout work it is important to ensure that the scriber points are always maintained sharp.

If the scriber point is slightly blunt. It can be re-sharpened using an oilstone. (Fig.1)

When the point cannot be re-sharpened with an oilstone, it should be re-sharpened on a grinder.

Do not sharpen the scriber by grinding unless it is absolutely necessary.

Re-sharpening of the point should be done on the face of the grinding wheel.(Fig 2)

Fig 1

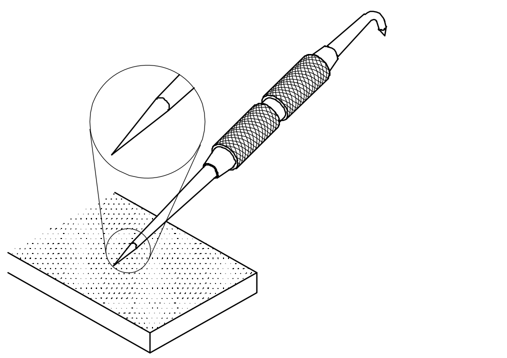
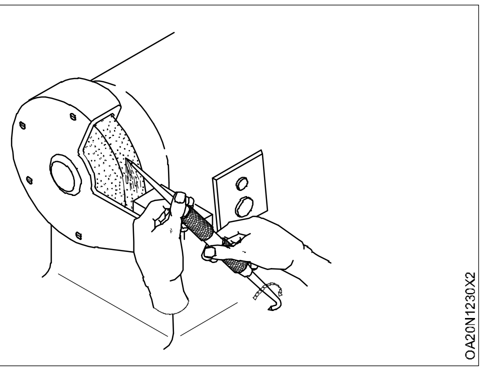


Fig 2



For grinding the point hold the scriber vertically on the grinding wheel face and rotate it with the fingers.

The point being small can get heated up very quickly quench the point often in the coolant.

After a few sharpening the diameter of the point will become larger and would need re-sharpening of the tapered portion.

The long tapered portion also can be reground and brought to the required shape and size.

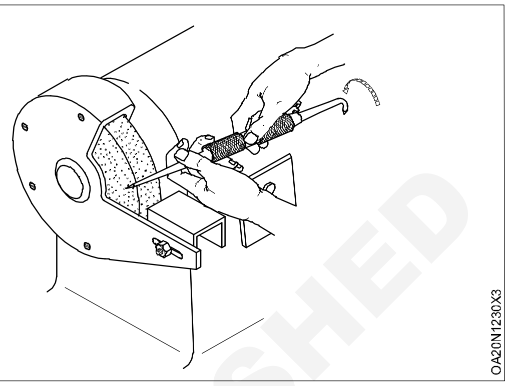
Sharpening a divider

The sharpening of scribes is adopted for sharpening on divider.

For this the scriber is placed horizontal on the face of the wheel and rotated by fingers. (Fig.3)

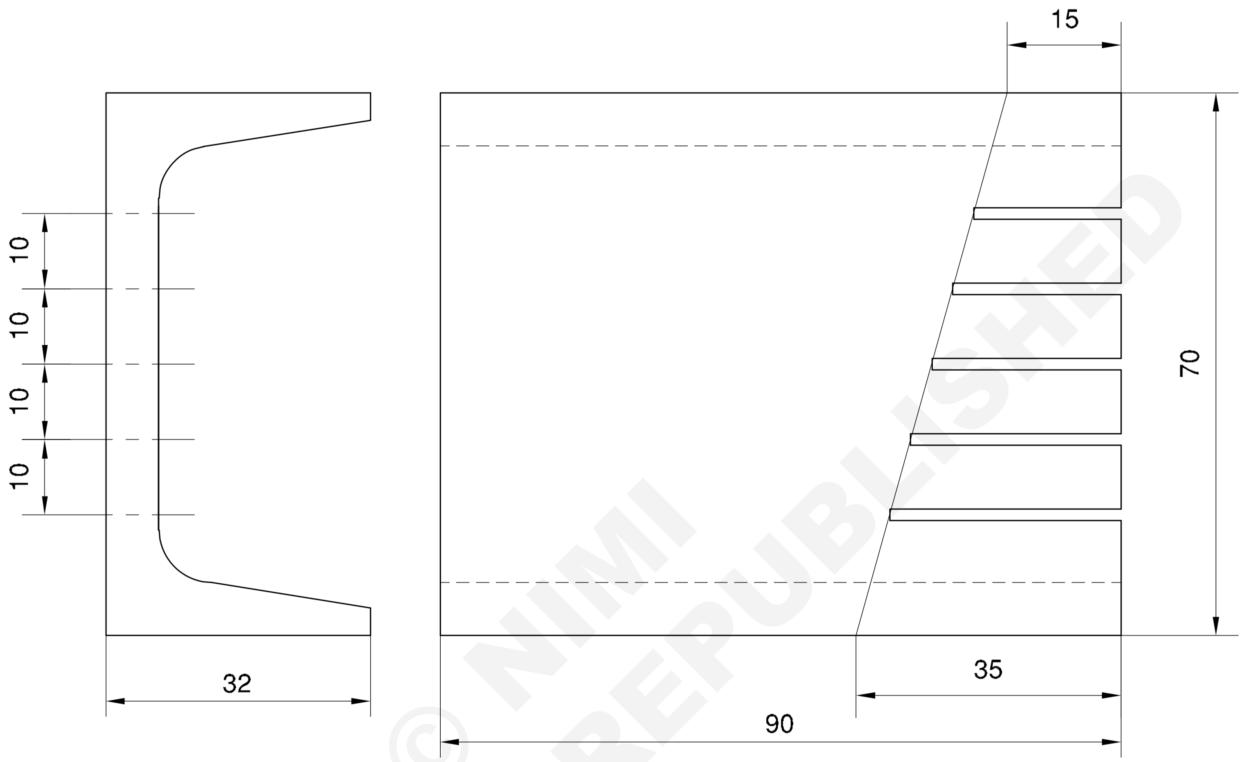
Be sure that the gap between the tool-rest and the wheel is correctly set before grinding.

Fig 3



Marking on the job piece for saw cuts

Objectives: At the end of this exercise you shall be able to
- **cut with a hacksaw**
- **saw along a straight line.**



Job sequence

- Check raw material to size.
- Apply marking media on the surface.
- Mark the required number of saw cut with a jenny caliper and steel rule.
- Punch the marked line.
- Hold the work piece firmly on the bench vice.
- Select the correct pitch blade (1.0 mm pitch)
- Fix the blade in the Hacksaw frame pointing teeth in the forward direction.
- Tighten the blade with required tension with the wing nut.
- File a notch at the point of cutting, to avoid slipping the blade.
- Start cutting with a slight downward pressure.
- Release the pressure in the return stroke.
- Use full length of the blade.

Caution: In case the blade brakes in half the way, do not use a new blade. Finish the cut with a used blade.

Don't tilt the frame while sawing.

1		1.2.04 ←	Fe310-O			-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	HACKSAWING ALONG A STRAIGHT LINE	DEVIATIONS ± 0.1	TIME
		CODE NO. OA20N1231E1	

Skill sequence

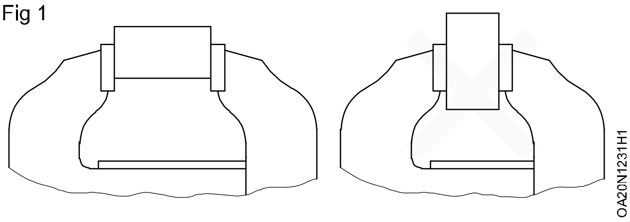
Sawing along a line

Objective: This shall help you to
- **use a hacksaw.**

Clamp the job to be cut according to the cross-section for sawing.

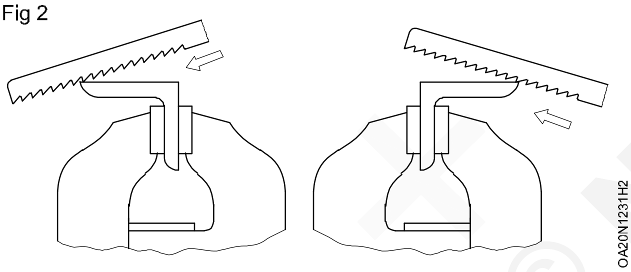
As far as possible hold the job in such a way that the flat or long side can be cut rather than the edge. (Fig 1)

Fig 1



In case the job has a profile (like steel angle), clamp the job so that sawing can be done towards the overhanging end. (Fig 2)

Fig 2



Clamp the job as long as possible on the vice and make sure that the marked sawing line is close to the side of the vice jaws in order to achieve maximum firmness.

Tighten the jaws firmly to avoid tilting and shifting of the job.

Whenever the section being cut shows chattering effect or vibration, the clamping needs improvement.

Select the correct pitch blade for cutting.

Shorter the cutting section is, siner the blade pitch. Make sure that atleast four teeth are cutting at a time.

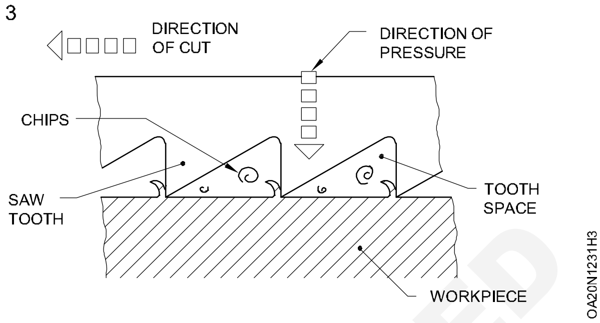
Harder the material siner the blade pitch should be.

Fix the blade in such away that the teeth are in the direction of cut. (Fig 3)

Tighten and tension the blade by hand using only the wing-nut.

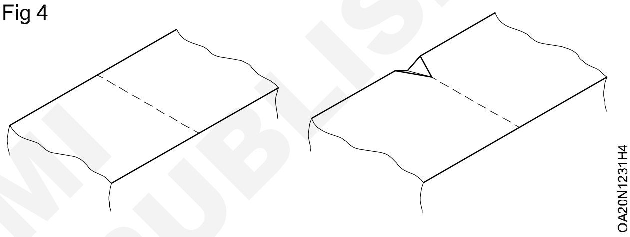
Caution
- **Insufficient blade tension - cut will not be straight**
- **Over tension - blade will break.**

Fig 3



File a notch at the starting point on smooth and hard jobs to avoid slipping of the hacksaw. (Fig 4)

Fig 4



Apply a little downward hand force as long as only a few teeth are cutting. Press down only during forward (cutting) stroke.

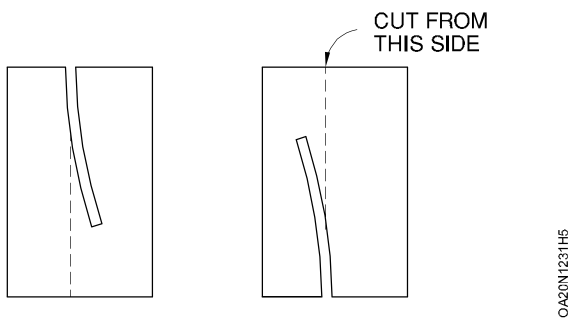
Use the full length of the blade in order to avoid early dulling of the teeth in the middle portion of the blade.

Move the blade strictly in line with the marked direction. Do not tilt the frame while sawing because bending of the blade can cause sudden breakage of the blade.

Resort to cutting from the opposite side in case the deviation from the marked line is excessive. (Fig 5)

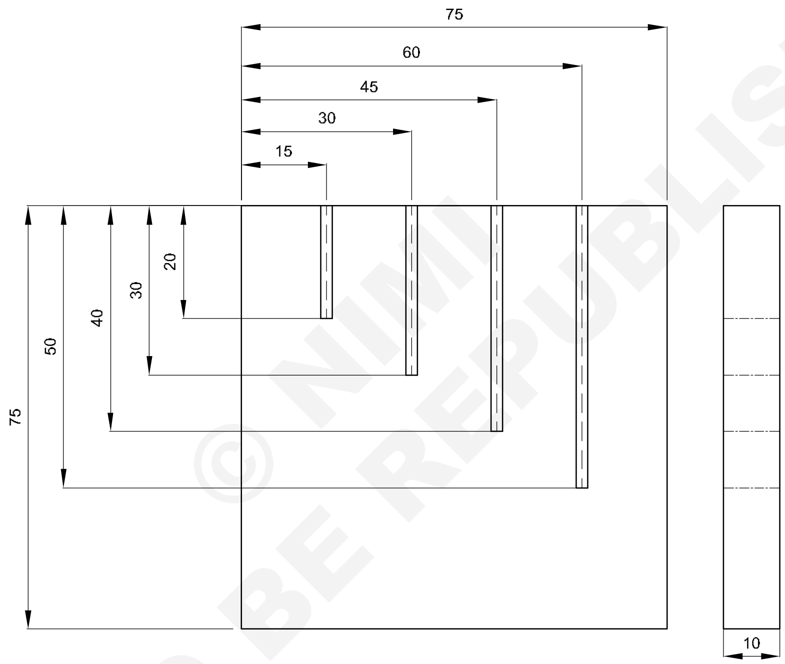
Slow down the cutting while completing the cut to avoid breakage of the blade and injury to yourself.

Fig 5



Cripping the job suitable in the vice jaws for hacksawing to dimension

Objectives: At the end of this exercise you shall be able to
- **mark out lines using jenny caliper**
- **hold the job in bench vice**
- **cut along markied lines.Job sequence**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	60 x ISF10 - 60	-	Fe310 PRE - MACHINED	-	-	-
1	75 ISF10 - 75	-	Fe310 PRE - MACHINED	-	-	-

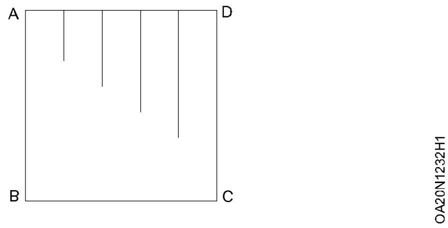
SCALE 1:1	**MARKING AND SAWING**	TOLERANCE : ±0.5mm	TIME : 10Hrs
		CODE NO. OA20N1232E1	

Job sequence

TASK 1 : **Marking and hacksawing**

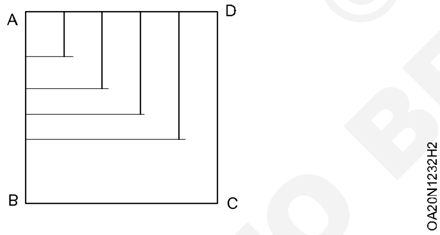
- Check the pre - machined size of 75x75x10 mm using steel rule.
- Apply marking media cellulose lacquer evenly on the surfaces of the job.
- Place the job in levelling plate.
- Set the measurement 15 mm in Jenny caliper using steel rule.
- Draw parallel line of 15 mm to the side “AB” with the help of Jenny Caliper as shown in Fig 1.
- Similarly, Set 30mm, 45mm and 60mm and draw Parallel lines to “AB” (Fig 1)

Fig 1



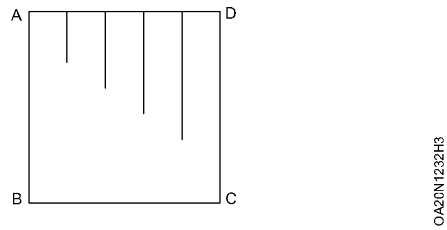
- Set the measurement 20 mm in jenny caliper using steel rule.
- Draw parallel line to side “AD” using Jenny caliper.
- Similarly, set 30 mm, 40 mm and 50 mm and draw parallel lines to side “AD” as shown in Fig 2.

Fig 2



- Punch witness mark on hacksawing lines using a dot punch and a ball pein hammer Fig 3.

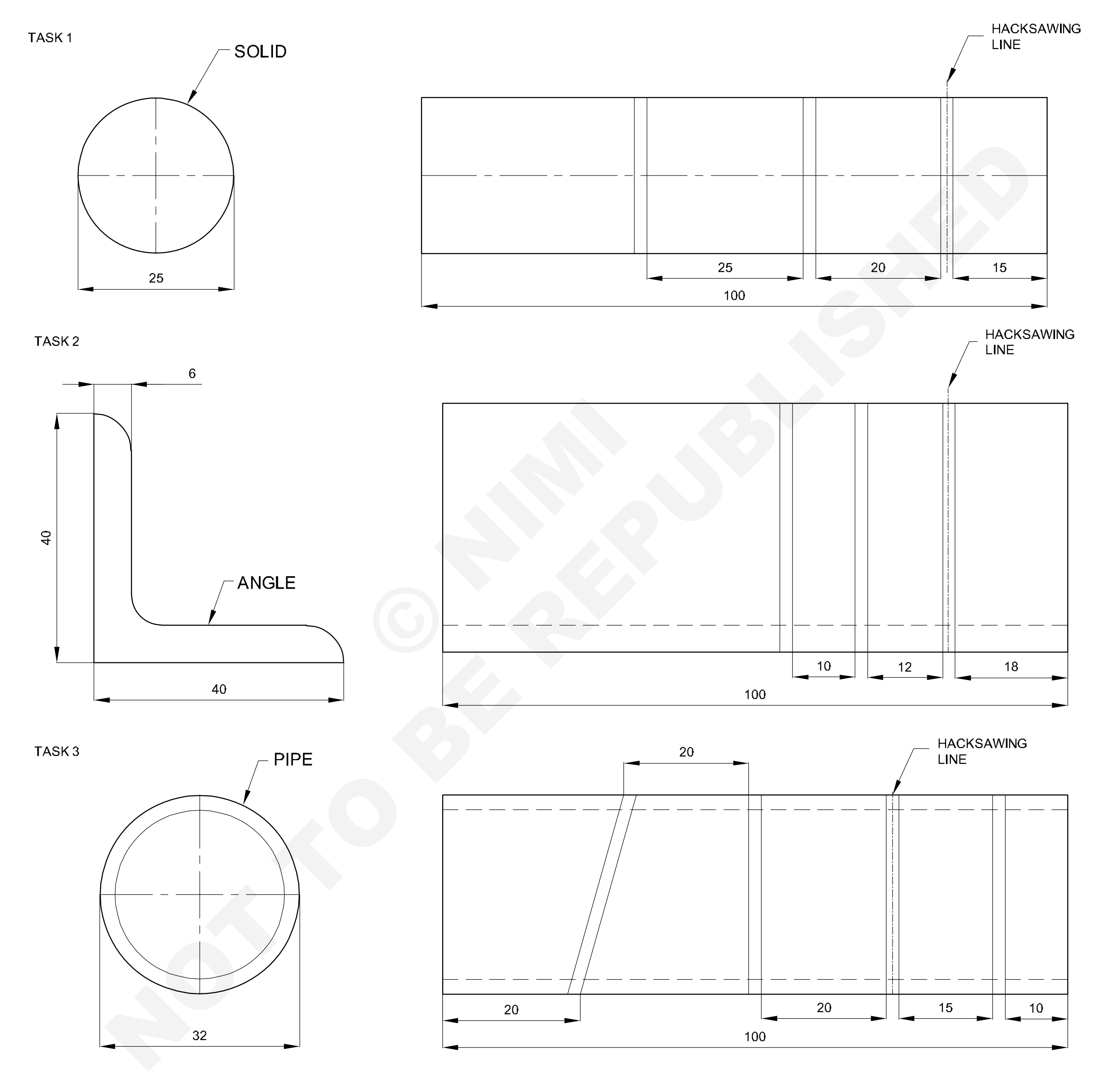
Fig 3



- Hold the job firmly in Bench vice, keeping side “AD” parallel to vice Jaws.
- Select 1mm pitch Hacksaw blade, fix the blade in hacksaw frame, pointing teeth in the forward direction.
- Tighten the blade to the required tension with the wing nut.
- File a notch at the point of hacksawing to avoid slippage of the blade.
- Start cutting with a slight downward pressure using Hacksaw.
- Saw along the lines up to punch marks.
- Apply pressure in the forward stroke.
- Release the pressure in the return stroke.
- Use full length of the blade while sawing
- Check the size with steel rule.

Hacksawing various metallic piece.

Objectives: At the end of this exercise you shall be able to
- **cut different thickness of metals**
- **cut sections of metals.**



1	ISR Ø25x100		Fe310	-	TASK - 1	1.2.33
1	ISA 40x40x6 - 100		Al310	-	TASK - 2	1.2.33
1	Ø32x3.2 - 100 IS:1161	-	Co310	-	TASK - 3	1.2.33
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**SAWING DIFFERENT TYPES OF METALS**	TOLERANCE : ±0.5mm	TIME : 10Hrs
		CODE NO. OA20N1233E1	

Job sequence

TASK 1: **Sawing on round rod**

- Check the raw material using steel rule.
- File the round to size Ø 25 x 100 mm.
- Remove the burrs from the edges.
- Apply marking media only where marking is required.
- Place the round rod on levelling plate.
- Use 'V' Block to support while marking the round rod.
- Punch witness marks on the sawing lines with dot punch
- Hold the Job in bench vice.
- Fix 1.8 mm pitch hacksaw blade in hacksaw frame.
- File a notch at the point of cutting to avoid slippage of the blade.
- Start cutting with a slight downward pressure on round rod using hacksaw.
- Cut on the hacks awing line giving proper pressure on forward and return stroke using full length of the blade.
- Cutting movement should be steady while sawing on round rod.
- While finishing the cut, slow down the pressure to avoid breakage of the blade and injury to yourself and others.
- Check the size of the round rod with steel rule.

Selection of hacksaw blade

- **For soft materials use 1.8 mm pitch blade while sawing.**
- **For hard materials use 1.4 mm pitch blade while sawing.**

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TASK 2: **Sawing on steel angle**

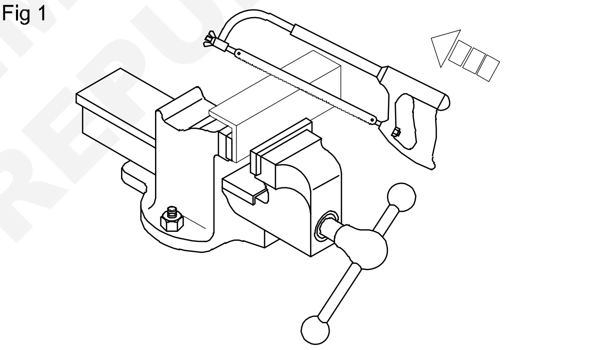
- Mark and punch the sawing lines.
- Hold the job in bench vice as shown in Figure.1
- Fix 1.8 mm coarse pitch blade in hacksaw frame.
- Cut along the sawing lines with hacksaw.
- Check the size of the angles with steel rule

Caution

Select correct pitch blade according to the shape and materials to be cut.

While sawing, two or more teeth of blade should be in contact on metal section.

Fig 1



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TASK 3: **Sawing on pipe**

- Mark and punch the sawing lines.
- Hold the job in bench vice as shown in figure.1
- Fix 1.0 mm pitch blade in hacksaw frame
- Cut along the sawing lines with hacksaw.
- Turn and change the position of the pipe while hack sawing

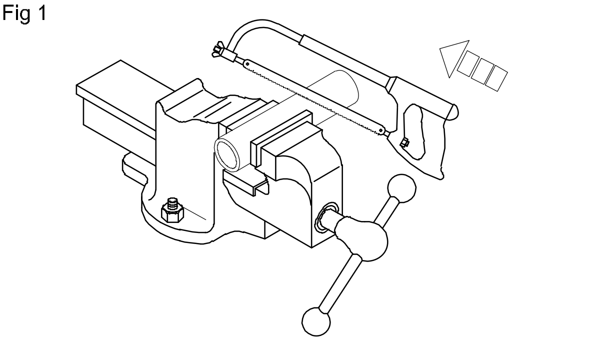
Caution

Avoid over tightening the pipe in the vice which causes deformation.

Do not cut too fast.

Cut very slow and reduce pressure while cutting through

Fig 1



Skill sequence

Hacksawing (holding-pitch selection)

Objectives: This shall help you to
- **select blades for different metal sections**
- **hold different sections of workpieces for hacksawing .**

Holding the workpiece

Position the metal to be cut according to the cross-section for hacksawing.

As far as possible the job is held so as to be cut on the flat side rather that the edge or the corner. This reduces the blade breakages. (Figs 1,2 and 3)

Fig 1

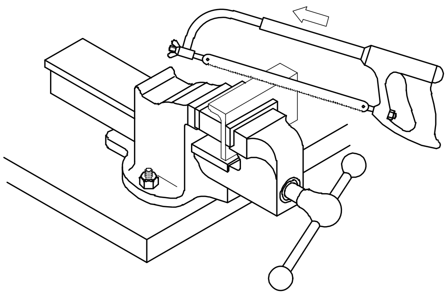


Fig 2

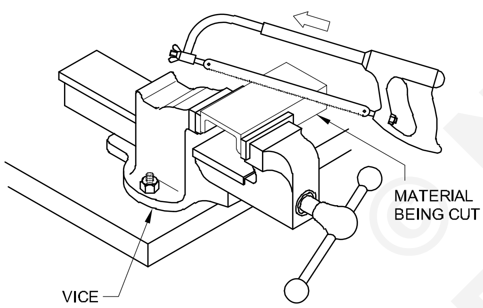
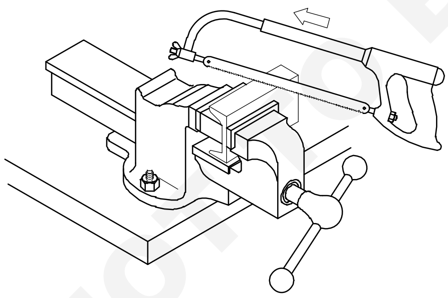


Fig 3

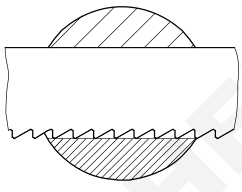


The selection of the blade depends on the shape and hardness of the material to be cut.

Pitch selection

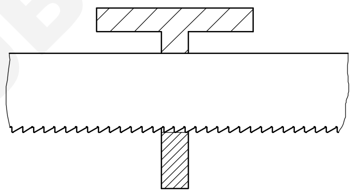
For soft materials such as bronze, brass, soft steel, cast iron, heavy angles etc. use a 1.8mm pitch blade. (Fig.4)

Fig 4



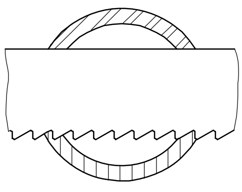
For tool steel, high carbon, high speed steel etc. use a 1.4mm pitch. For angle iron, brass tubing, copper, iron pipe etc. use a 1mm pitch blade. (Fig.5)

Fig 5



For conduit and other thin tubing, sheet metal work etc. use a 0.8mm pitch. (Fig.6)

Fig 6



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Hacksawing

Objectives: This shall help you to
- **fix hacksaw blades by maintaining correct tension and direction**
- **cut metal pieces with a hacksaw.**

Fixing of hacksaw blades

The teeth of the hacksaw blade should point in the direction of the cut and away from the handle. (Fig.1)

The blade should be held straight, and correctly tensioned before starting.

While starting the cut make a small notch. (Fig.2)

File 'V' notch using a triangular file.

The cutting movement should be steady and the full length of the blade should be used.

Fig 1

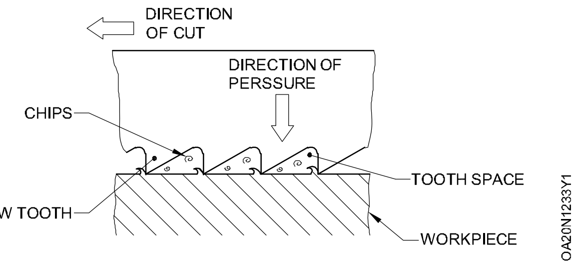
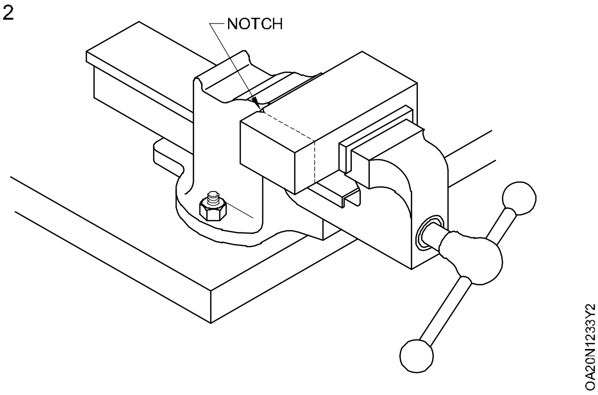
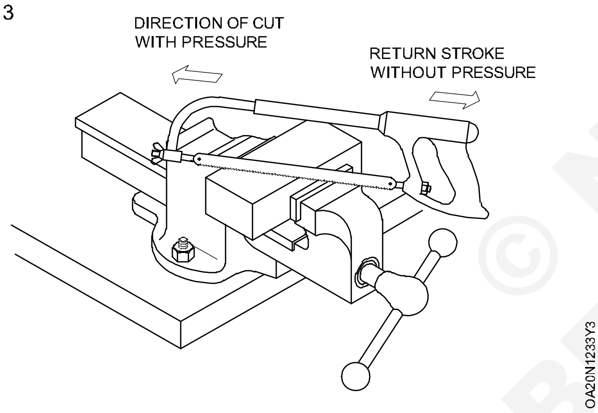


Fig 2



Apply pressure only during the forward stroke. (Fig.3)

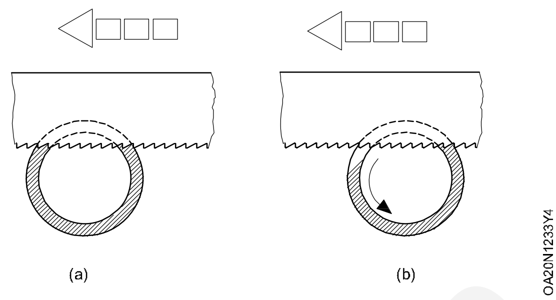
Fig 3



Atleast two to three teeth should be in contact with the work while cutting. Select a sine pitch blade for thin work. (Fig.4 & 5)

Turn and change the position of the pipe while hacksawing. (Fig.4 & 5)

Fig 4



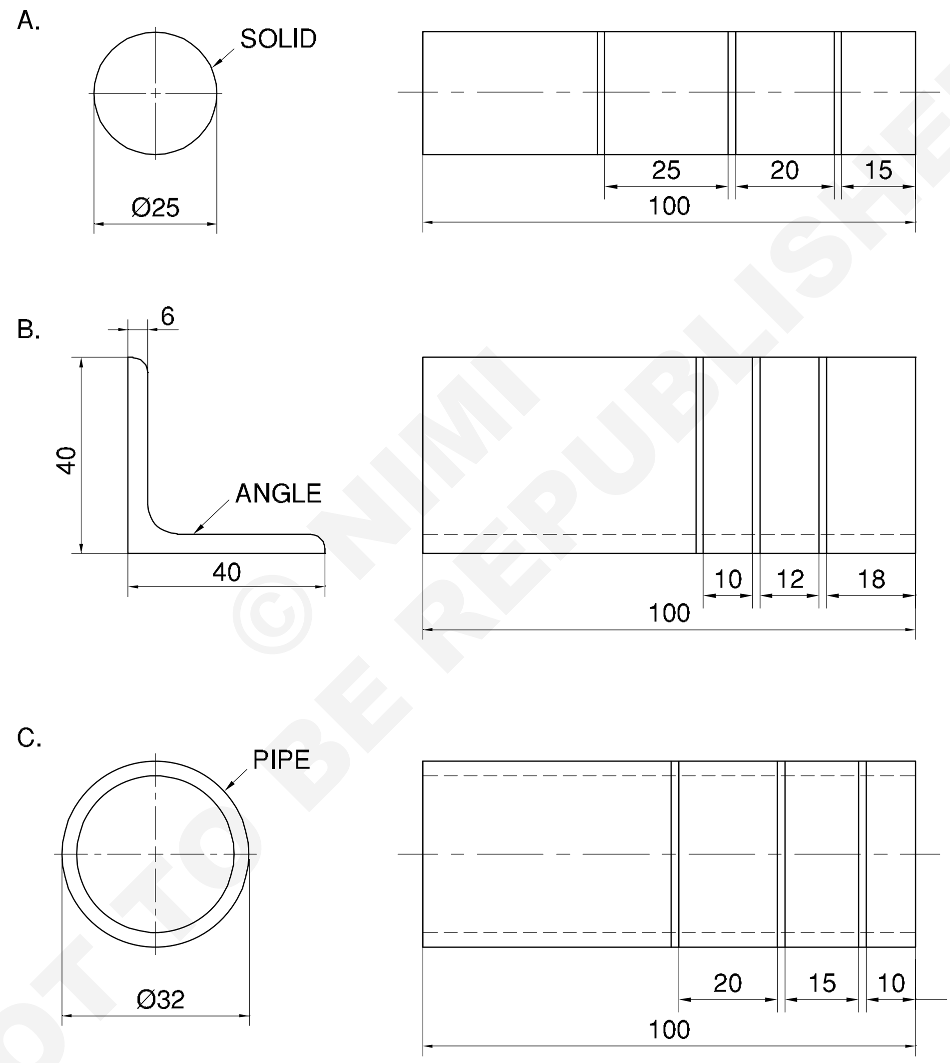
Normally, a coolant is not necessary while hacksawing by hand. However, to saw in heavy stock, intermittent coolant to be applied.

Do not move the blade too fast. While finishing a cut, slow down to avoid breakage of the blade and injury to yourself and others.

Hacksawing of different length of metals.

Objectives: At the end of this exercise you shall be able to
- **cut different thickness of metals.**
- **cut different sections of metals.**

Note to the Instructor: Provide MS. pipes, rods, angles and channels from scrap materials.



1	Ø32x3.2 - 100 IS:1161		Fe310-O			C
1	ISA 40x40x6 - 100		Fe310-O			B
1	Ø25 - 100		Fe310-O			A
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**HACK SAWING DIFFERENT THICKNESS OF METALS**	DEVIATIONS ± 0.5	TIME
		CODE NO. OA20N1234E1	

Job sequence

- Check the material to size.
- File and remove the burrs from the edges.
- Apply marking media only where marking is required.
- Mark the required cut by a scribing block and a steel rule.
- Secure the job in the vice.
- Select the correct pitch blade and fix the blade in the hacksaw frame.
- Select coarse pitch blade for solid metal and sine pitch blade for conduit tubes pipes and thin metal sections.
- Turn and change the position of pipe while sawing.

> **Caution:**
>
> **Avoid over tightening the pipe in the vice which cause deformation**
>
> **Do not cut too fast**
>
> **Cut very slow and reduce pressure while cutting through.**

Allowable deviations for dimensions without specified tolerances **IS:2102-1969**

Deviations for linear dimensions

Class of deviation													
	Above	0.5	3	6	30	120	315	1000	2000	4000	8000	12000	16000
	Upto and including	3	6	30	120	315	1000	2000	4000	8000	12000	16000	20000
Sine		± 0.05	± 0.05	± 0.1	± 0.15	± 0.2	± 0.3	± 0.5	± 0.8				
Medium		± 0.1	± 0.1	± 0.2	± 0.3	± 0.5	± 0.8	± 1.2	± 2	± 3	± 4	± 5	± 6
Coarse		–	± 0.2	± 0.5	± 0.8	± 1.2	± 2	± 3	± 4	± 5	± 6	± 7	± 8
Extra coarse		_	± 0.5	±1	± 1.5	± 2	± 3	± 4	± 6	± 8	± 10	± 12	± 12

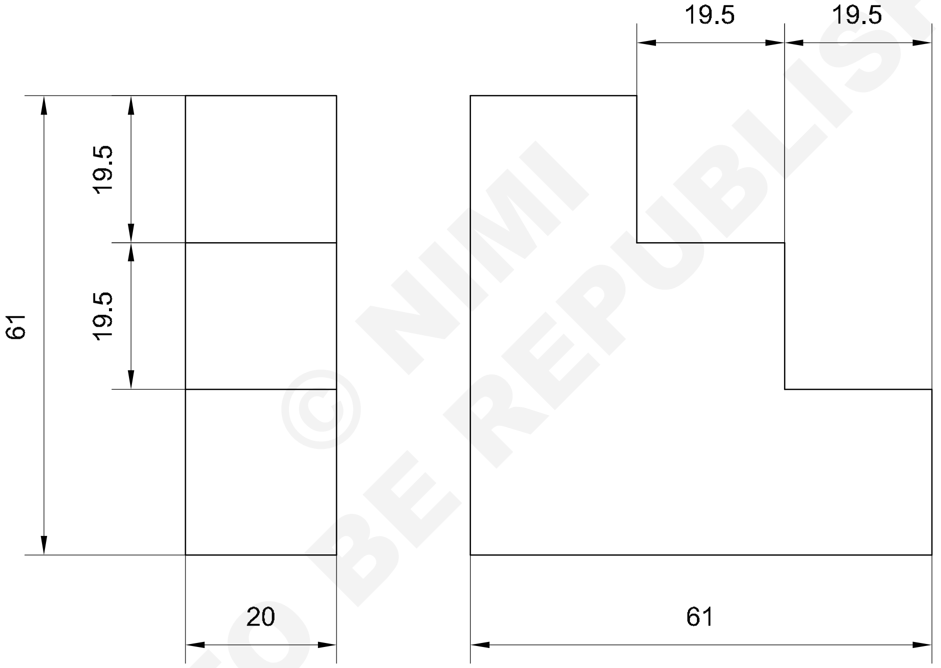
Deviations for angular dimensions

Δα = Angle Tolerance in angular units	Class of	Length (L) of shorter side of angle in mm				
		Above	–	10	50	120
		Upto and including	10	50	120	–
	Sine and medium	Δm (mm)	±0.1	±0.2	±0.6	±0.8
		Δα (deg. or min.)	±1°	±30°	±20°	±10°
Δm = Angle tolerance in linear units	Coarse	(mm)	±0.15	±0.3	±0.8	±1.2
		Δα (deg. or min.)	±1.5°	±50°	±25°	±15°
	Extra coarse	(mm)	±0.3	±0.8	±1.8	±2.4
		Δα (deg. or min.)	±3°±2°	±1°	±30	

Hacksawing and filling steps and slots and open fitting of finished pieces.

Objectives: At the end of this exercise you shall be able to
- **hold the job in a bench vice horizontally and file flat surface**
- **check the flatness and squareness of the job**
- **mark the dimensions as per drawing**
- **hacksaw and remove the unwanted material**

TASK : 1



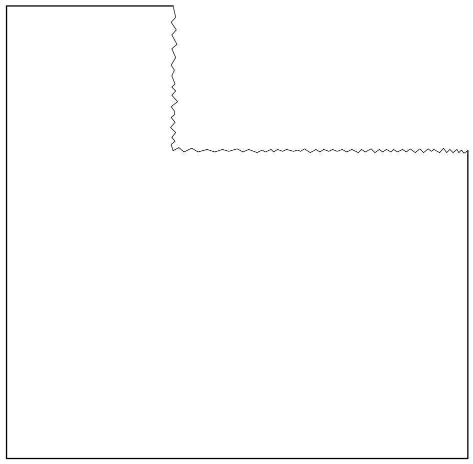
1	65 ISF 20 - 65	-	Fe 310			-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-

SCALE 1:1	STEP FILING	DEVIATIONS ±0.5	-
		CODE NO. OA20N1235E1	

Job sequence

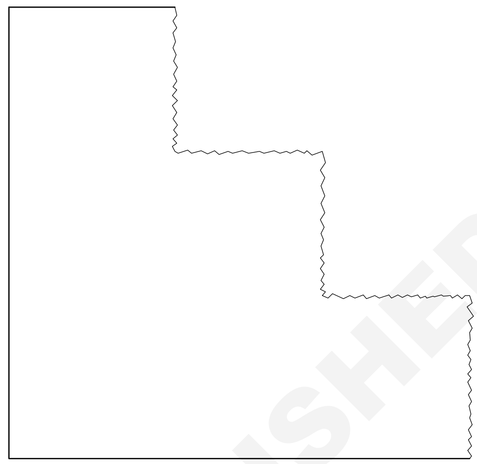
- Check the material size
- Fix the job securely in the bench vice.
- File and finish two sides to remove burrs and any visible waviness.
- Apply chalk powder and allow it to dry for marking.
- Mark and punch the job as per drawing using surface gauge and angle plate.

Fig 1



- Hacksaw along the marked lines and remove the unwanted material as per Fig.1 and Fig.2
- File and finish the job as per drawing.
- Check the dimensions with steel rule.

Fig 2



Skill sequence

Cleaning files

Objective: This shall help you to
- **clean files.**

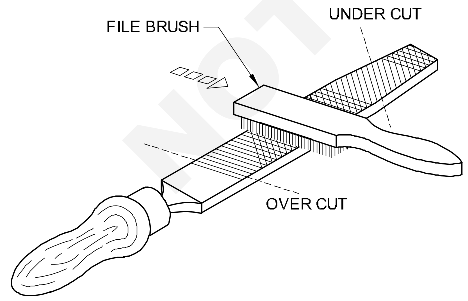
During filing the metal chips (filings) will clog between the teeth of the files. This is known as 'Pinning' of files. Files which are pinned will produced scratches on the surface being filed and also will not bite well.

Method of removing pinning

Pinning of the files is removed by using a file brush. (File card)

Pull the file brush along the direction of the overcut. (Fig.1)

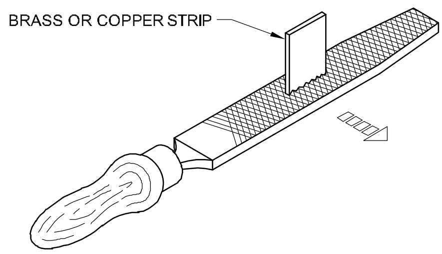
Fig 1



Filings which do not come out easily by the file card should be taken out with a brass or copper strip. (Fig. 2)

For new files, use only soft metal strips (Brass or Cop-per) for cleaning. The sharp cutting edges of the files will wear out quickly if a steel file card is used.

Fig 2

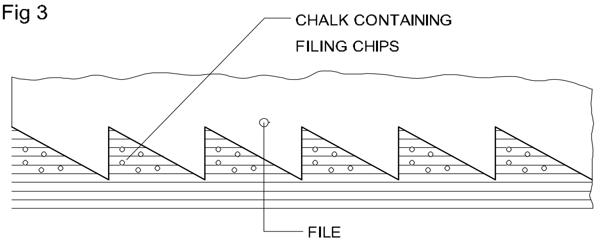


When filing a workpiece to a smooth finish more 'pinning' will take place because the pitch and depth of teeth are less.

Application of chalk on the face of the file will help reduce the penetration of the teeth and 'pinning'. (Fig. 3)

Clean the file frequently in order to remove the filings embedded in the chalk powder.

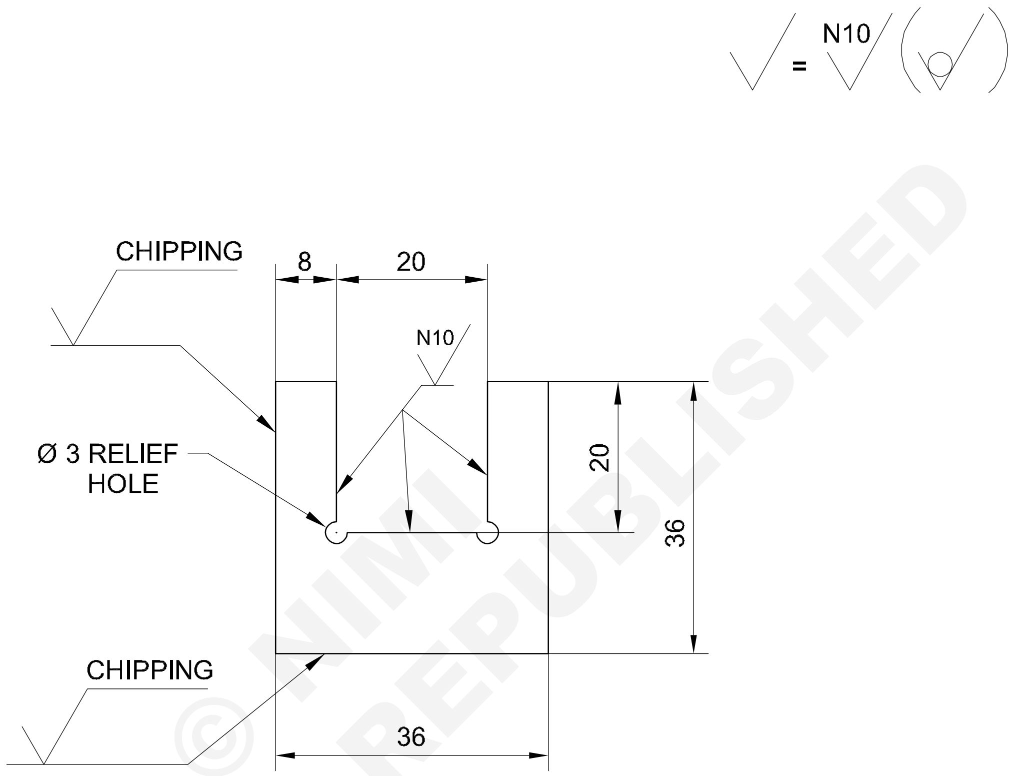
Fig 3



Slot filing

Objectives: At the end of this exercise you shall be able to
- **drill chain holes and removes unwanted portion of material by chipping**
- **file square slots and projections**
- **measure the width and depth of a slot using steel rule**
- **check the parallelism of surfaces of a slot with an inside caliper.**

TASK : 2

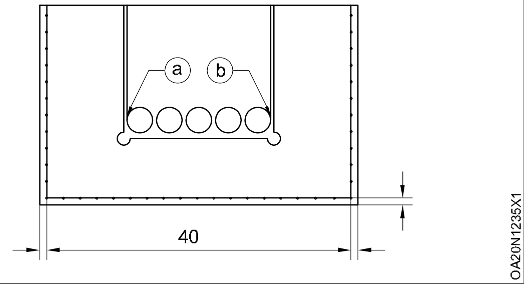


1	40 ISF 20 - 40	-	Fe310	1	4	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-
SCALE 1:1	SLOT FILING				DEVIATIONS ±0.5	-
					CODE NO. OA20N1235E2	

Job sequence

- Grind the flat chisel.
- Check the raw material size as per drawing.
- File two reference surfaces flat and square.
- Mark and punch the job as per drawing.
- Drill relief holes (Ø3) and chain holes (Fig. 1)
- Chip all the three sides.
- Cut along the lines at points a & b with a hacksaw. (Fig.1)
- Remove the web between the holes using a web chisel and part off the excess metal.

Fig 1



- File and finish the slot to size.
- Check the width and depth of the slot with a steel rule and check the parallelism of the sides with an inside caliper.

Skill sequence

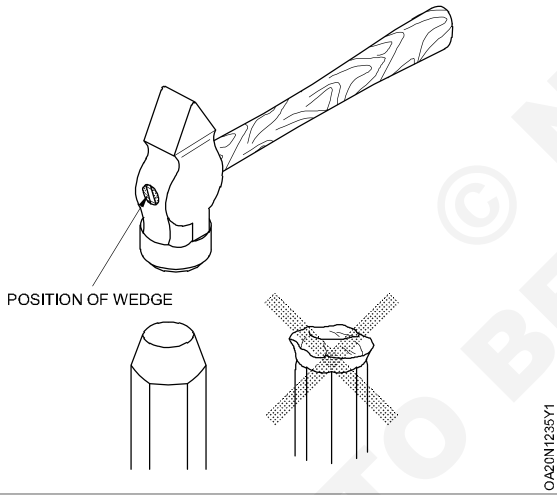
Chipping using flat chisel

Objective: This shall help you to
- **chip metal pieces.**

Before commecning chipping

Select a mushroom - free chisel and choose a hammer with a well secured handle (Fig.1)

Fig 1

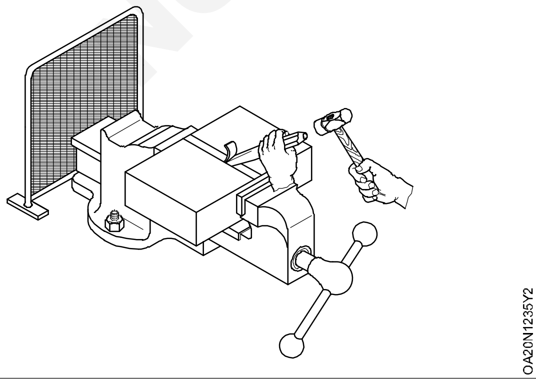


Wipe off oily substances, if any from the face

Wear safety googles.

Install the chip guard. (Fig.2)

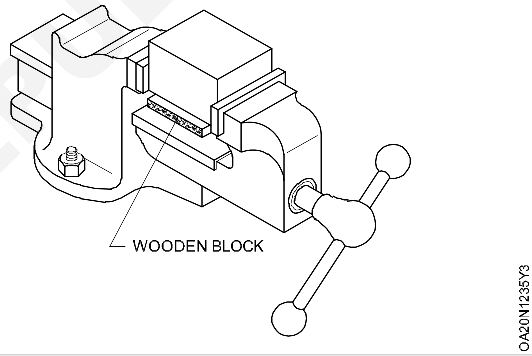
Fig 2



Chipping process

Hold the work in a vice. If necessary, support the work on a wooden block. (Fig.3)

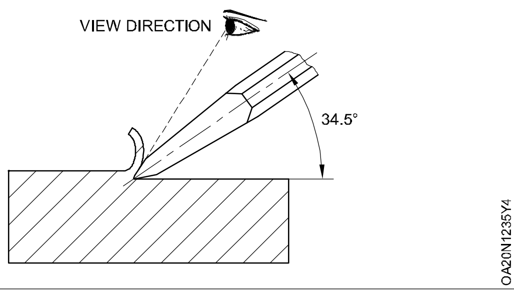
Fig 3



Position the chisel at an angle to cut the metal in uniform thickness. (Fig.4)

Hammer the head of the chisel by looking at the point of the chisel (Fig.4)

Fig 4



Hold the hammer at the end of the handle for maximum leverage. (Fig.5)

Stop chipping before the end of the surface; otherwise the edge of the job will break off. To prevent this, chip the end of the job from the opposite direction. (Figs 6A and B)

Fig 5

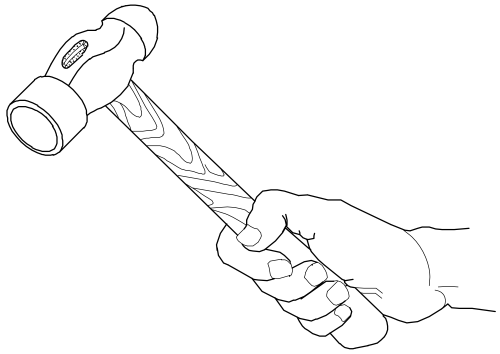
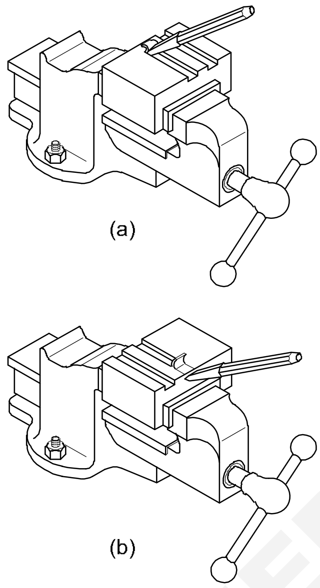


Fig 6

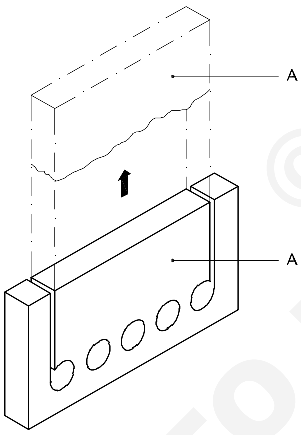


Parting off by chain drilling

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

To cut at places which are inaccessible for sawing, chain drilling can be done to part off metal. (Fig.1)

Fig 1



Select a suitable hole size to permit the chisel to enter and leave minimum material for filing.

Mark centres of holes in such a way that the distances between the peripheries of adjacent holes must be about 1 mm.

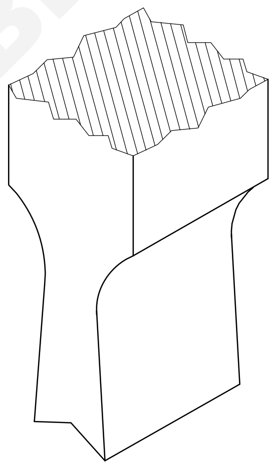
> **If the distance are more, a thicker web will be formed, and if it is small, a little inaccuracy in drilling will draw the drill into the hole already drilled and cause damage to the drill.**

Drill holes as per marking.

Grip the job in a bench vice and saw the two sides (Fig.1)

Select a web chisel (Fig.2) which has a double cutting edge and thus reduce the possibility of distortion to workpiece.

Fig 2

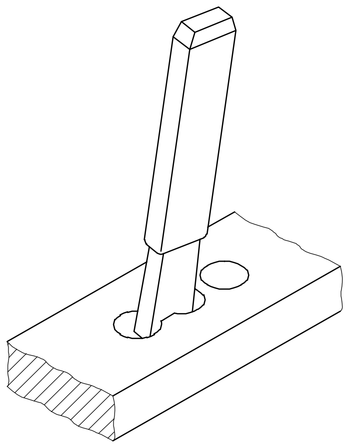


Keep the chisel on the web at an angle to the job (Fig.3)

Hammer and remove only thin chips of equal thickness.

Handle the job carefully after parting off because cutting with web chisels will produce sharp edges.

Fig 3

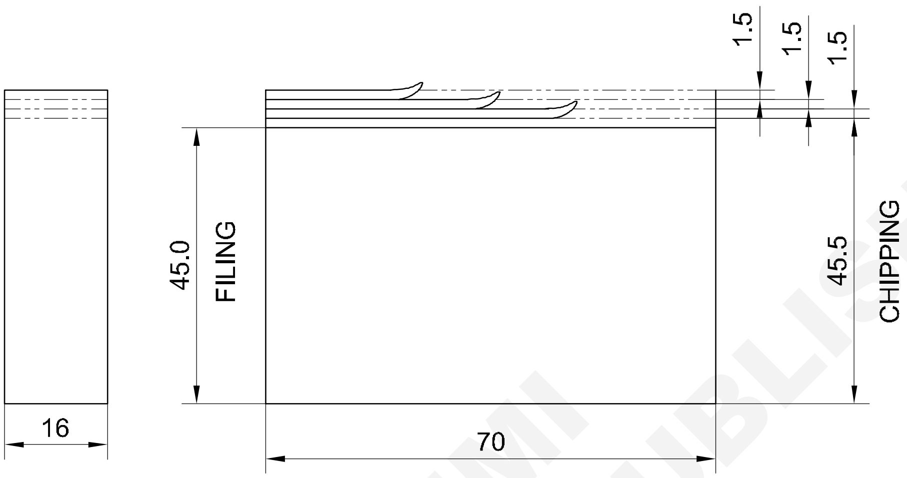


Hammering practice on vertical hold round job.

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

- **chip surfaces evenly using a flat chisel within ± 1mm by hammer.**

Note : Each trainee should practice chipping of 3 layers of 1.5 mm deep and then file it to 45 mm width



Job sequence

- Apply marketing media and mark the depth of metal to be removed by chipping. Punch the marked line with a dot punch.
- Hold the job firmly in the vice.

If necessary give a wooden support below the work piece so that the marked line should be above the vice jaw face.

- Select a flat chisel 20 mm width with a proper cutting edge.
- Select a ball pein hammer with required weight (450 gms)
- Hold the chisel at approximately 35° angle of inclination in chipping position.
- Hold the hammer at the end of the handle to get more leverage.

Caution: Chisel should be free of mushroom head.

Hammer handle should be securely fixed with eye hole with a wedge.

Use goggles while chipping.

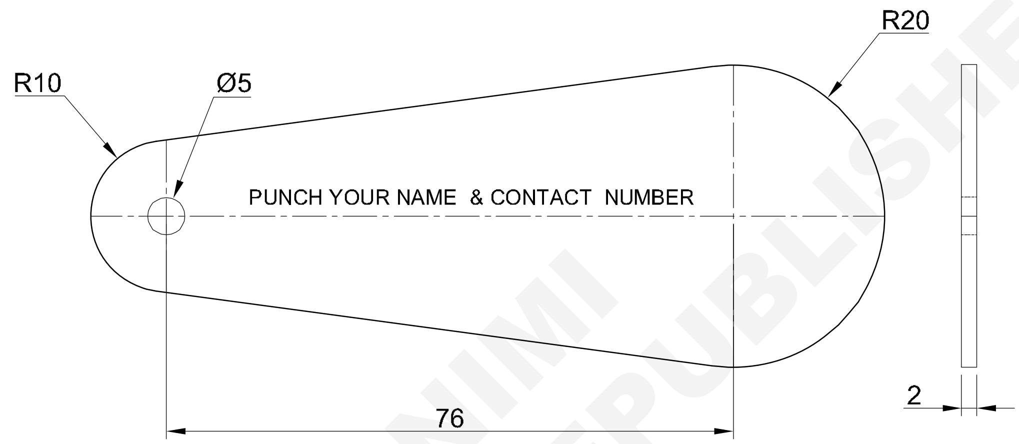
Use a chipping guard behind the vice to arrest the flying chips.

1	50 ISF 16 - 70	→ 1.1.11	Fe 310	--	--	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-

SCALE NTS	HAMERING PRACTICE WITH CHISEL	DEVIATIONS AS PER IS 2102 (m)	-
		CODE NO. OA20N1236E1	

Blind hammering practice stamping letters and numbers on M.S.Plates.

Objectives: At the end of this exercise you shall be able to
- **punch the letters and numbers.**



Job sequence

- Check the raw material size.
- Mark the line to punch the letters.
- Meawure the length.
- Select the size of the letters according to space.
- Count the letters of each line.
- Position the letter punch and hold vertical position hammer vertically above the punch.
- Practice letter and number punching.

1	SS 110 x45 x 2mm	-	STAINLESS STEEL	-	-	1.2.37
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**LETTER AND NUMBER PUNCHING PRACTICE ON KEY CHAIN TALLY**	TOLERANCE : NIL	TIME : 5Hrs
		CODE NO. OA20N1237E1	

Skill sequence

Stamping Letter Punch

Objective: This shall help you to
- **punch letters and numbers.**

Letter and number punches

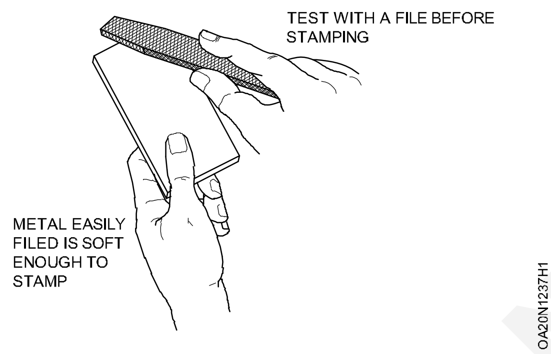
THese hardened and tempered steel punches are used to stamp identifying symbols,letters or numbers as required on the work.

They are obtainable with symbols ranging in size from 0.8mm to 13 mm.

They are kept in boxed sets.

Use a file on the work to be stamped to check the work is softer thant he punch. Any attempt to stamp hard material would damage the punch. Use an electric pencil or acid etching to mark hard materials.(Fig 1)

Fig 1



Each symbol must be made with a single blow. A second blow gives a distored second impression.

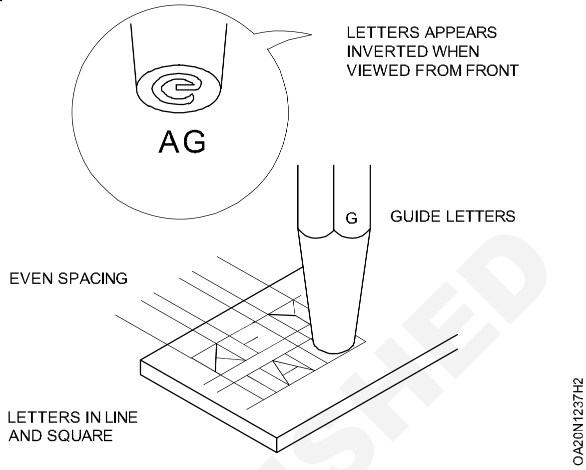
Letters such as **M** and **W** may require firmer blows to produce the same depth of impression such as letters **I** and **T** can make.

The depth of impression for a given blow varies with the softness of the material.

Use the punches in the following manner.

- Mark out the guidelines for the symbols.
- Check that you have the correct symbol.
- Position the punch so that the symbol will be in line, square, correctly spaced and the correct way up (Fig 2)

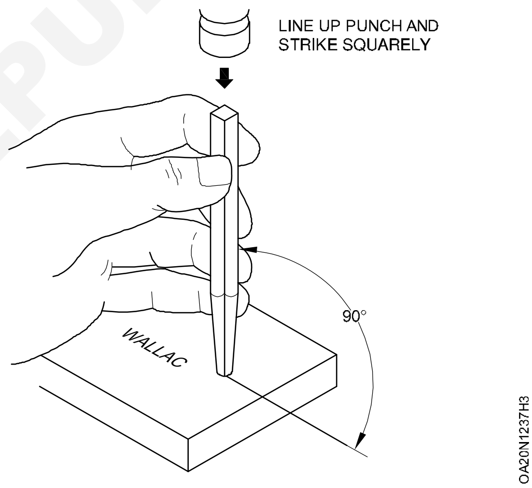
Fig 2



Hold the punch in a vertical position.(Fig 3)

Hold the hammer vertically above the punch.(Fig 3)

Fig 3



Watch the point of the punch.

Strike the punch squarely with one firm blow.

Exercise on stamping to develop judgement, control on hand and feet.

Objectives: At the end of this exercise you shall be able to
- **Handling of stamping with care.**

Job sequence

- Check the raw material size.
- Mark the line to punch the letters.
- Select the size of the letters according to space.
- Each symbol must be made with simple blow.
- A second blow gives a distorted second impression.
- Position the punch so that the symbol will be in line, correctly spaced and correct way up
- The hand which holding the punch should not be shivered.
- The holding pressure of punch is not enough to get clear stamping.

Fig 1

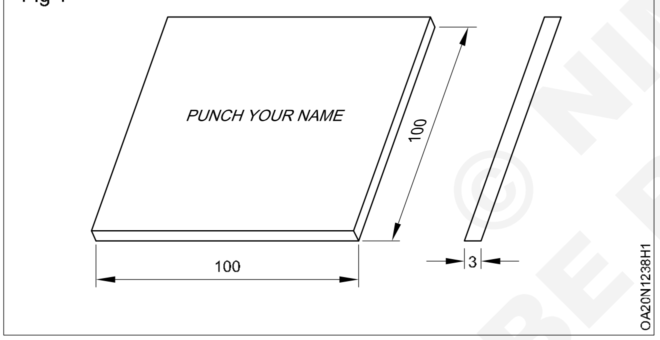


Fig 2

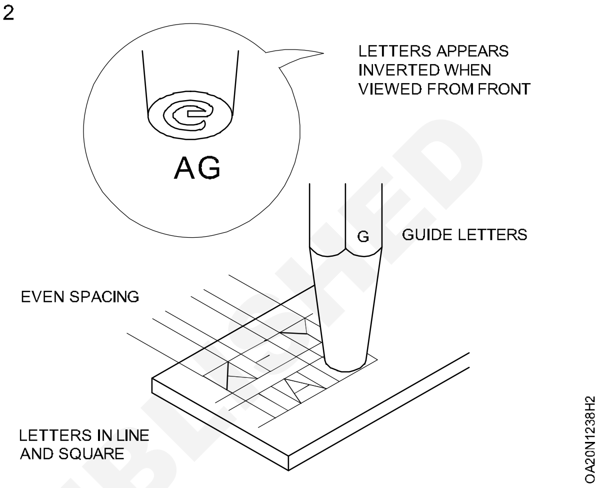
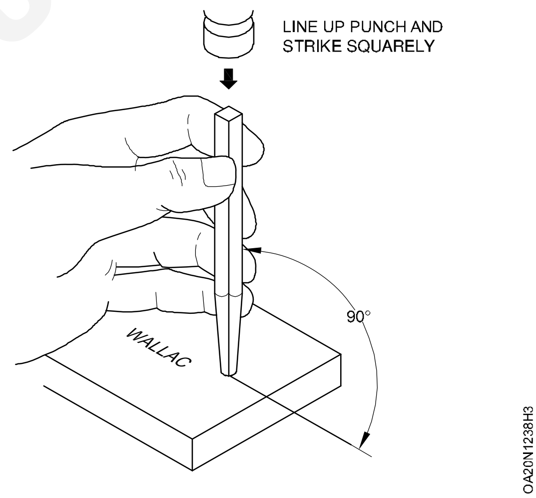


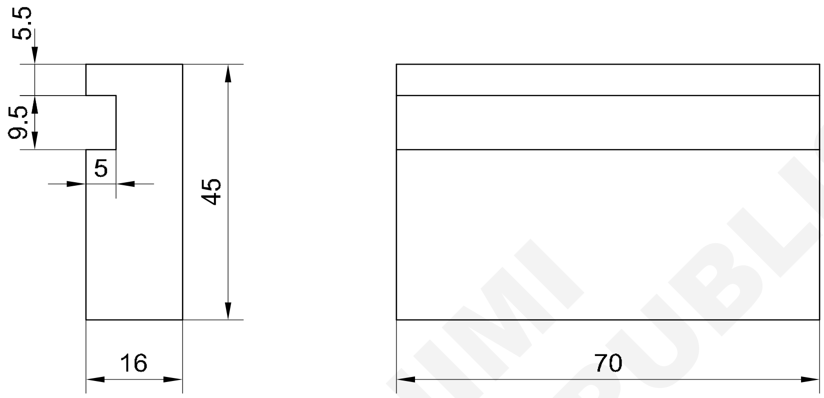
Fig 3



Stamping practice on flat and round surface using flat cross cut, and round nose chisel for chisel edge.

Objective: At the end of this exercise you shall be able to
- **chip grooves parallel with uniform depth using a cross cut chisel with in ± 1 mm.**

TASK : 1



Job sequence

- For chipping grooves and keyways, use cape / cross cut chisel.
- To get required depth of grooves 5 to 6 cuts may be required.
- While chipping ensure the chisel is moved in a straight line and pre-marked path.
- For cutting oil grooves select half round or round nose chisel.
- Mark the oil groove path on the bearing surface with specified width and punch the lines.

1	--	FP-1-07 → FP-1-09	Fe 310	--	--	08
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**CHIPPING GROOVES (By cross cut chisel)**	DEVIATIONS AS PER IS 2102 (m)	TIME 5h
		CODE NO. OA20N1239E1	

Skill sequence

Chipping grooves by cross cut chisel

Objective: This shall help you to
- **chip grooves or key ways.**

For chipping a flat surface (with a flat chisel) first make deep grooves with the help of a cape chisel, then the projecting portion between the grooves may be chipped with flat chisel.

Select a good chisel with out mushroom head.

A hammer with a proper handle.

Wear face shield.

Install safety guard.

Hold the work in the bench vice supported with a wooden block if necessary.

Hold the chisel with correct angle of inclination so that metal is cut with uniform thickness

Hold the hammer at the end of the handle.

Concentrate your eyesight on chisel point and beat on the head of chisel.

Chipping oil grooves (by round nose chisel)

Objective: At the end of this exercise you shall be able to
- **chip oil groove on flat bearing surface with uniform width using round nose chisel/half round nose chisel.**

TASK : 2

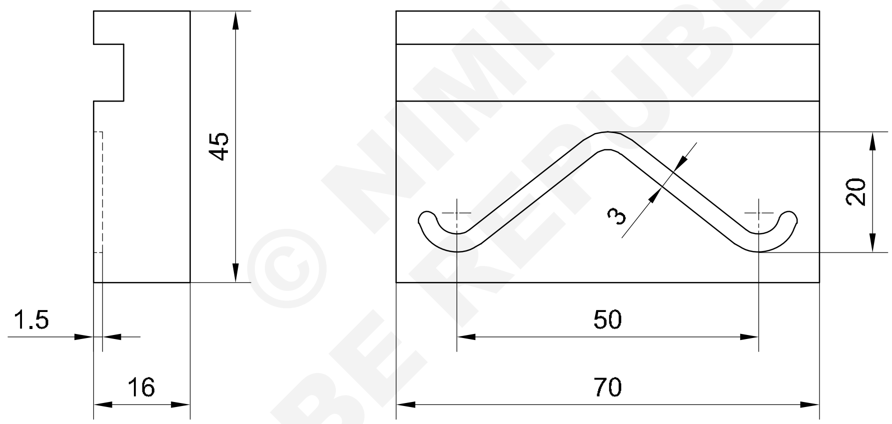
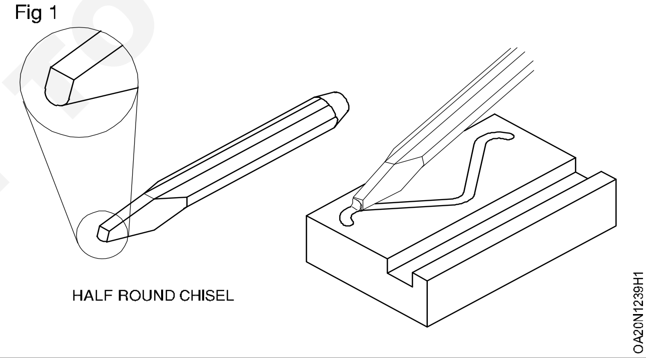


Fig 1

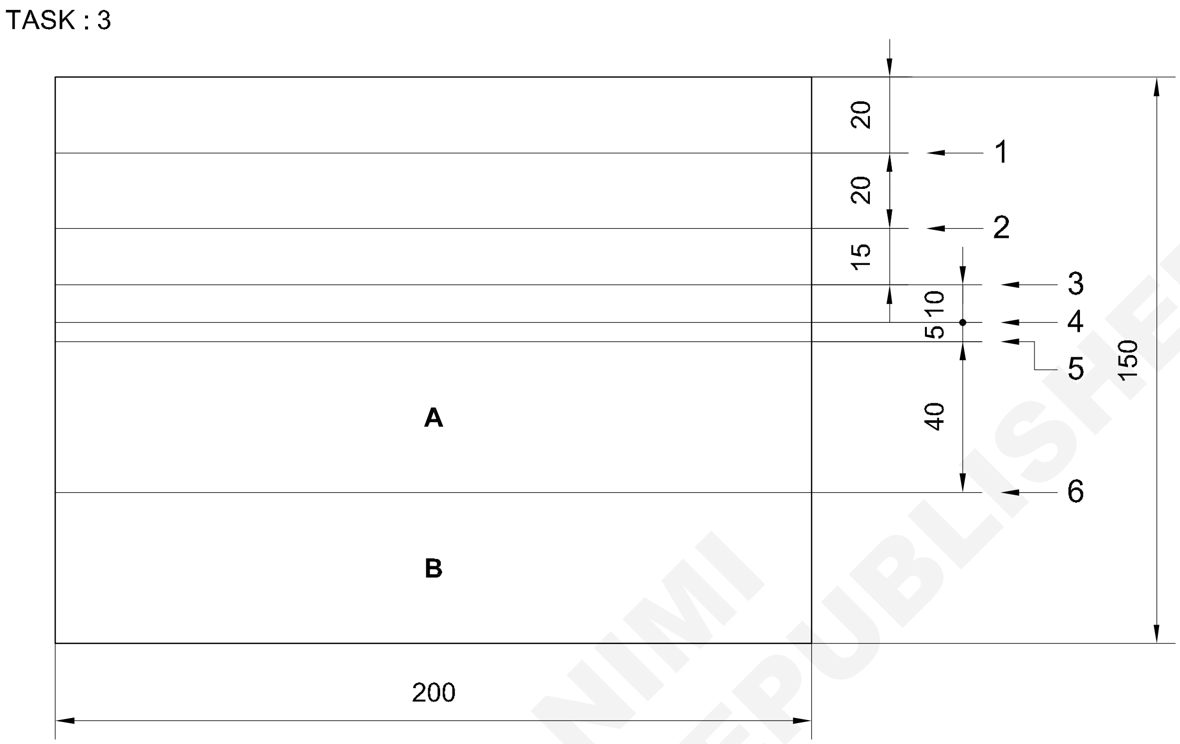


NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	--	FP-1-10 FP-1-08	--	--	--	09

SCALE NTS	**CHIPPING OIL GROOVES (By round nose chisel)**	DEVIATIONS AS PER IS 2102 (m)	TIME 3h
		CODE NO. OA20N1239E2	

Cutting sheet metal (by flat chisel)

Objectives: At the end of this exercise you shall be able to
- **cut sheet metal into different width, using flat chisel**
- **make yourself the vice-clamps/soft jaws required for your vice.**



Cut No.1 & 2 should be performed by placing the sheet on Anvil.

- Cut No.3,4 & 5 should be performed by holding the sheet on benchvice, such that the marked line is aligned with the top surface of jaw of vice, and cut the sheet by shearing force with flat chisel.
- Cut No.6 should again be performed by placing the sheet on Anvil.
- Piece A & B should be utilised for making vice clamps, to suit the vice jaws on which each trainee is working, with the guidance of the instructor.

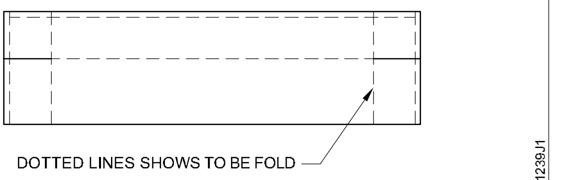
1	ISSH 150 x 1.6 - 200	-	G.I. SHEET	-	-	-
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-
SCALE 1:1	CUTTING SHEET METAL (BY FLAT CHISEL)				DEVIATIONS AS PER IS 2102 (m)	-
					CODE NO. OA20N1239E3	

Job sequence

- Check the stock size with a steel rule.
- Do the marking as per the dimensions given in the drawing with the help of a rule and scriber.
- Cut the 1st and 2nd mark by placing the sheet on anvil.
- Cut the 3rd, 4th & 5th mark by holding the sheet in benchvice.
- The 6th cut should be again made by placing the sheet on the anvil.

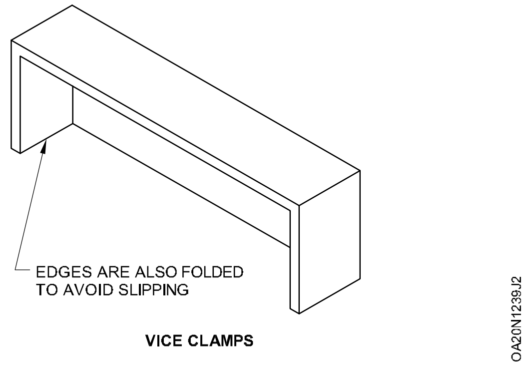
  File the sharp edges with a smooth file.
- Part A & B should be used for making vice clamp to suit the jaws of the vice you are using. (Refer Figs 1 & 2)

Fig 1



CUT BY CHISEL & FOLD AS PER THE Fig 2

Fig 2



VICE CLAMPS

For dimensions, consult your instructor.

Skill sequence

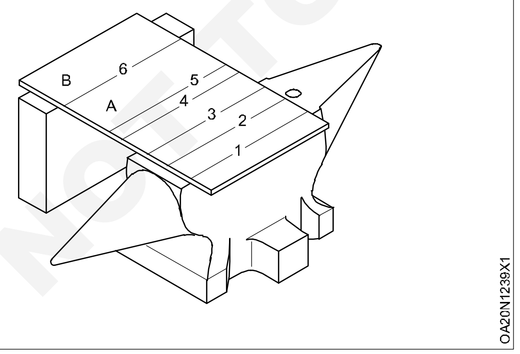
Cutting sheet metal (by using flat chisel)

Objectives: This shall help you to
- **cut sheet metals using flat chisel**
- **shear sheet metals using flat chisel and bench vice.**

Keep the job horizontal on the face of the anvil.

Give a support for the overhanging portion of the sheet if necessary. (Fig 1)

Fig 1



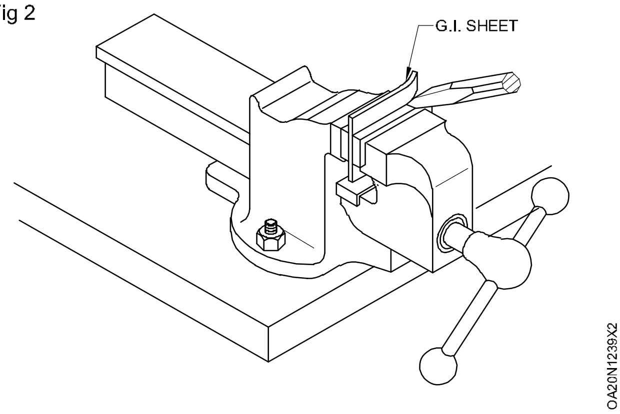
Take a flat chisel with sharp cutting edges.

Cut along the marked line (No.2 first) and later No.1 line can be cut conveniently.

Hold the sheet in between the vice jaws in such a way that the mark No.3 should be parallel and close with the vice jaw.

Cut and remove 3rd, 4th & 5th. Mark with the chisel with shearing action. (Fig 2)

Fig 2



Place the remaining portion of the sheet on the anvil and cut the 6th mark which forms part ‘A’ and ‘B’.

Checking with try square use of cross bean hammer for stretching of metal strip.

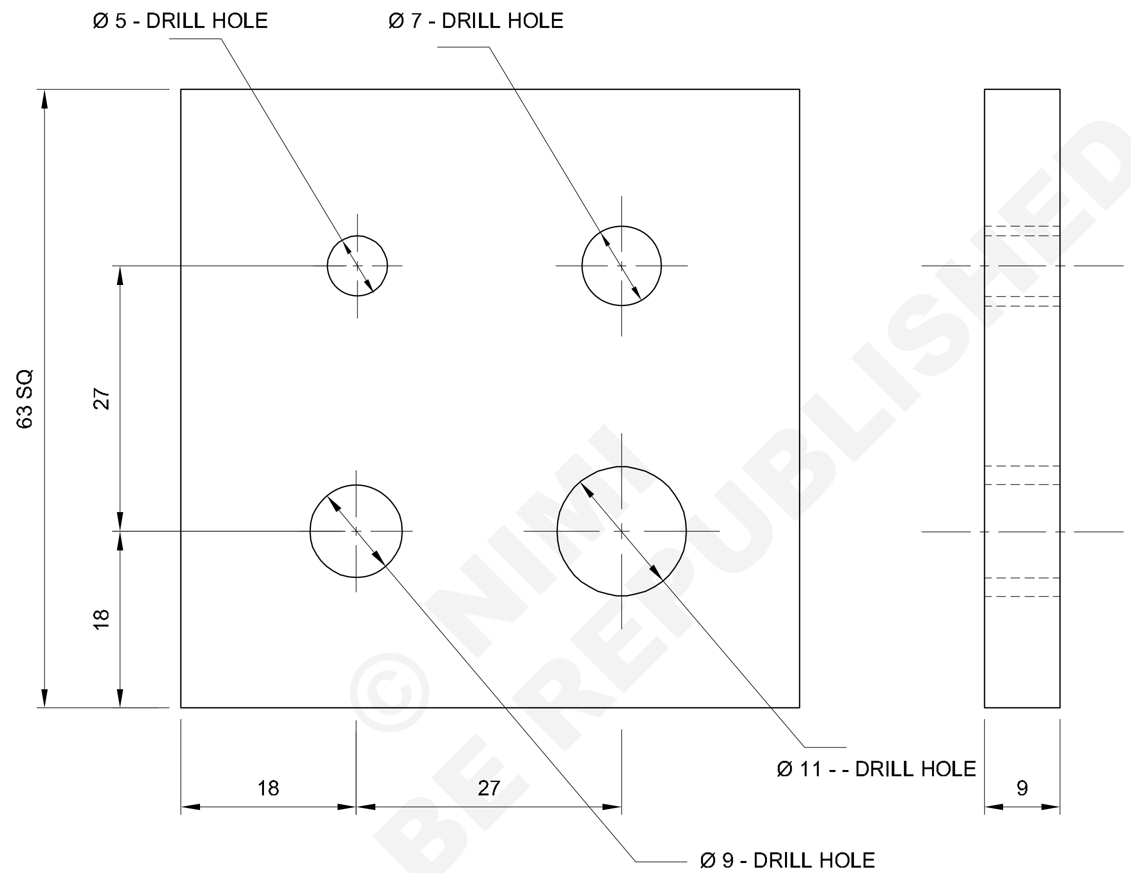
Objective: At the end of this exercise you shall be able to
- **checking with try square for square out of metal strip**
- **use of cross peen hammer for stretching of metal strip.**

Job sequence

- Check the dimensions of metal strup using steel rule.
- Deburr on the metal strip using file.
- heck the squareness using try square
- If square out, use hammer to strike out sheet to stretch the sheet further.
- Burr are to be removed and check with try square.
- Repeat the same till to get sine squareness achieved.

Preparation for drilling, marking out the position & holes and dot punching.

Objective: At the end of this exercise you shall be able to
- **mark drill hole centres**
- **hold the job in drilling machine table.**



Job sequence

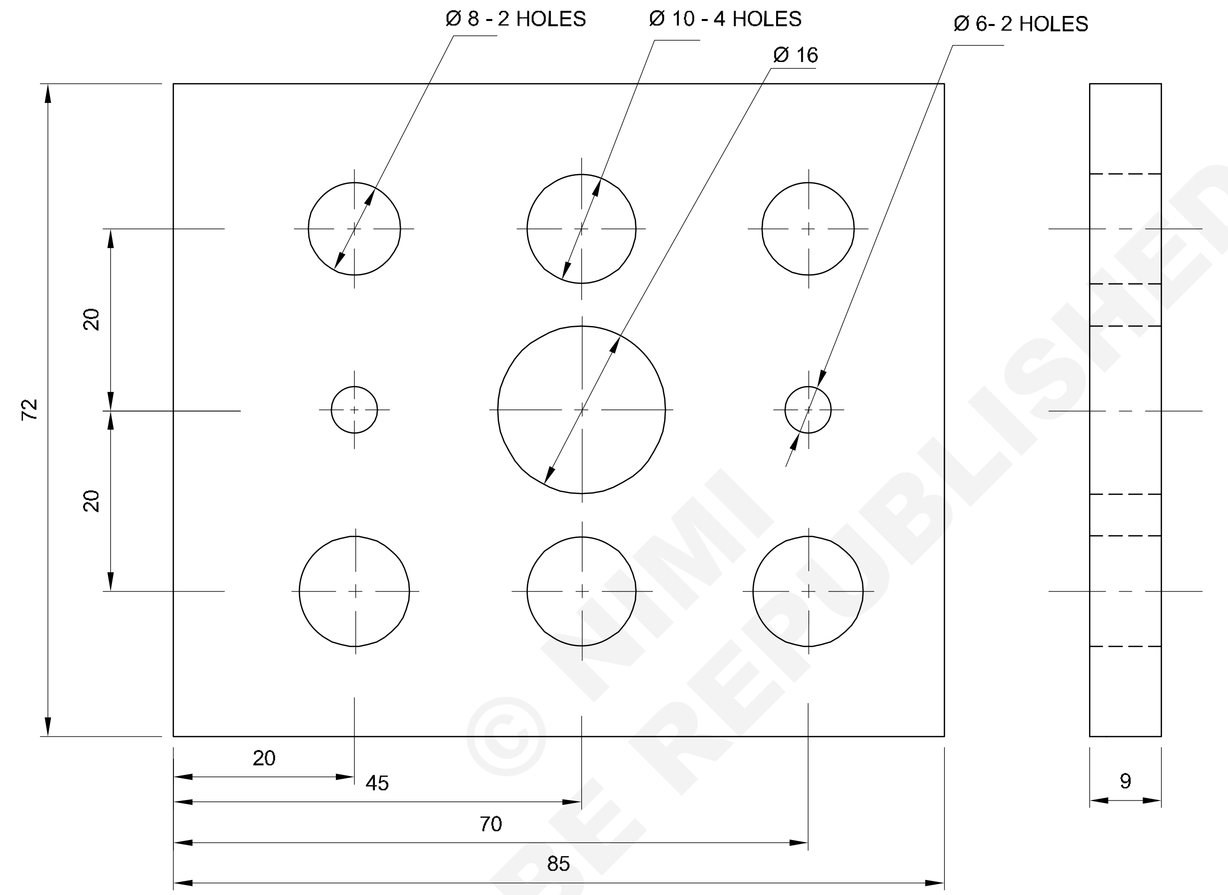
- Check the raw material for its size.
- File surface to flatness.
- File right angle to squareness.
- FIle metal to size 63x63x9 mm maintaining parallelism and perpendicularity.
- Check the flatness and squareness with try square and size with vernier caliper.
- Apply marking media, mark dimension lines as per drawing and punch the witness marks using dot punch.
- Hold the job in drilling machine table for drilling.

1	65 ISF 10-65	-	Fe310	-	-	1.2.41
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.

SCALE 1:1	MARKING OUT THE POSITION OF HOLES	TOLERANCE : ± 0.04	TIME : 1 Hr
		CODE NO : OA20N1241E1	

Deepening the points with centre punch.

Objective: 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	-	-	1.2.42
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 : OA20N1242E1	

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 dot punch 90°
- Make centre drill in all drill hole centres position with deepening the points with centre punch.
- 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

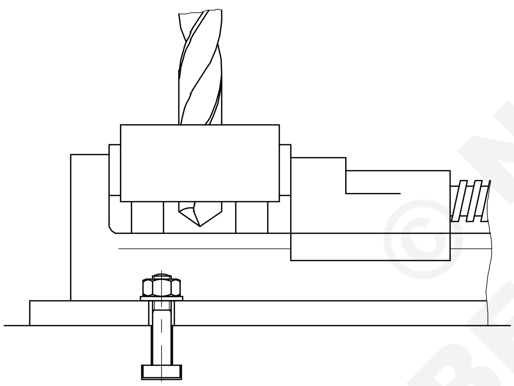
Drilling through holes

Objective: At the end of this exercise you shall be able to
- **drill holes as per drawing**
- **drill through pedestal drilling machine.**

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.

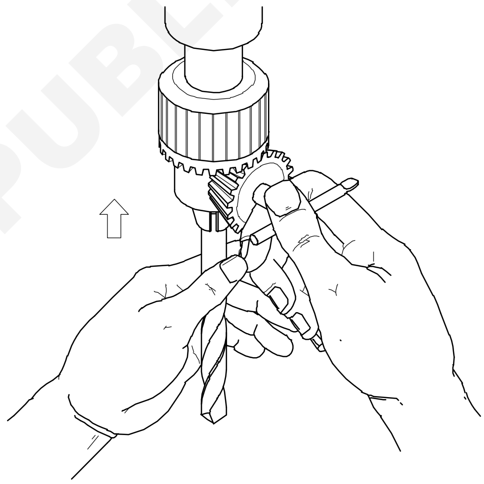
Caution: Do not remove chips with your bare hands - use brush.

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)

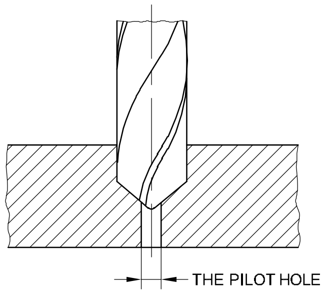
Fig 2



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



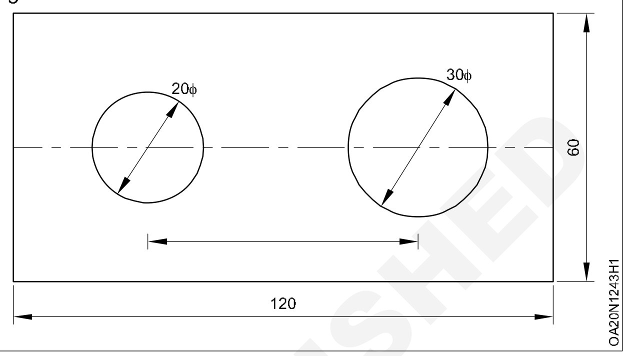
Checking for centre distance.

Objective: At the end of this exercise you shall be able to
- **checking the centre distance using vernier caliper.**

Job Sequence

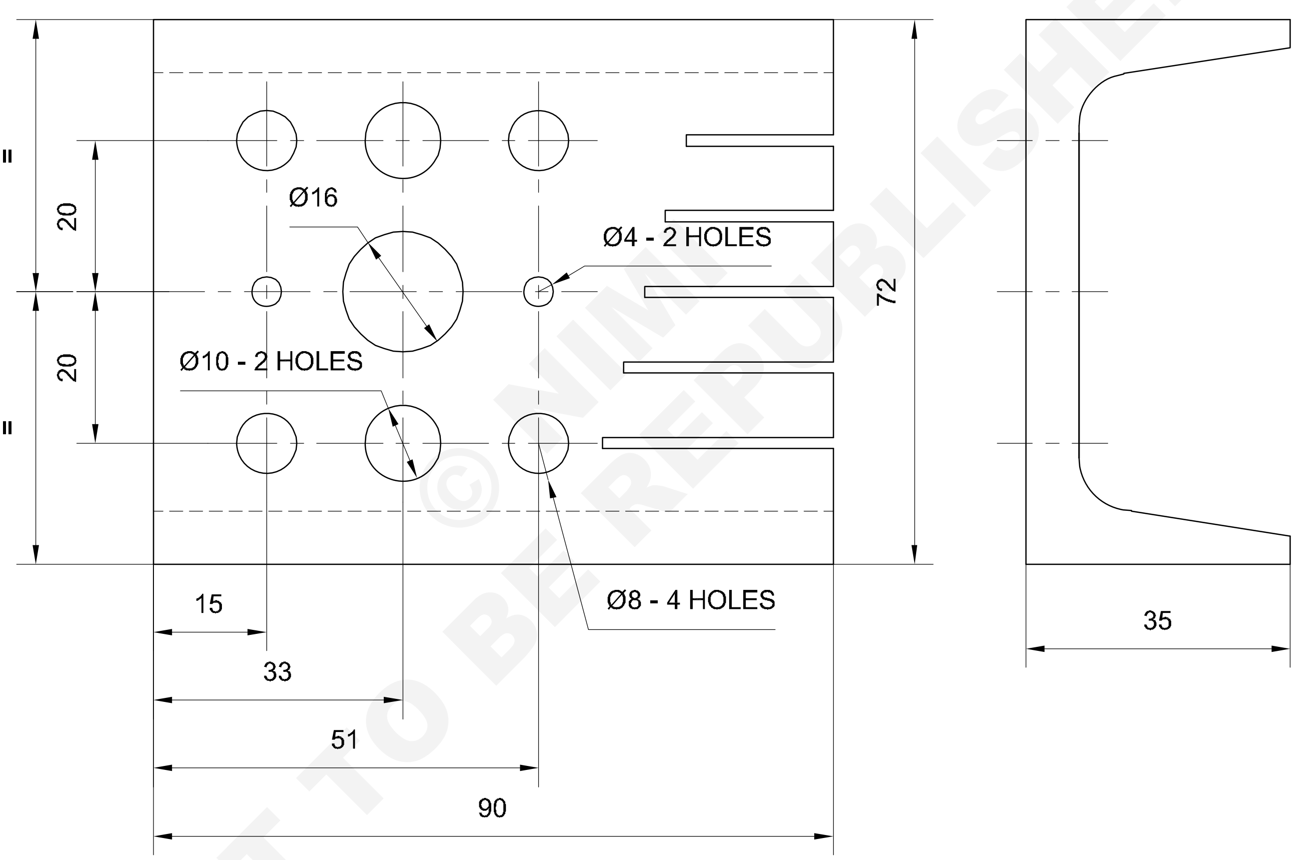
- Check the raw material using steel rule.
- Mark and punch the centre of holes using centre punch.
- Hold the job in bench vice.
- Mark two holes as per drawing.
- File the workpiece free from burns.
- Measure the diameter of two holes by vernier caliper.
- Measure the distance between two edges of the circle.
- Check the centre distance between two holes.
- Distance between two edges of holes and add two holes radius given the centre distance.

Fig 1



Drilling practice on sensitive drilling machine using different types of drills and drill holding devices.

Objectives: At the end of this exercise you shall be able to
- **mark off using scribing block**
- **drill through holes using pillar/bench drilling machine.**



1	BISLC 75 - 95	-	Fe310-O	-	-	1.2.44
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX NO.
SCALE 1:1	DRILLING THROUGH HOLES				TOLERANCE : ±0.1mm	TIME : 5 Hrs
					CODE NO. OA20N1244E1	

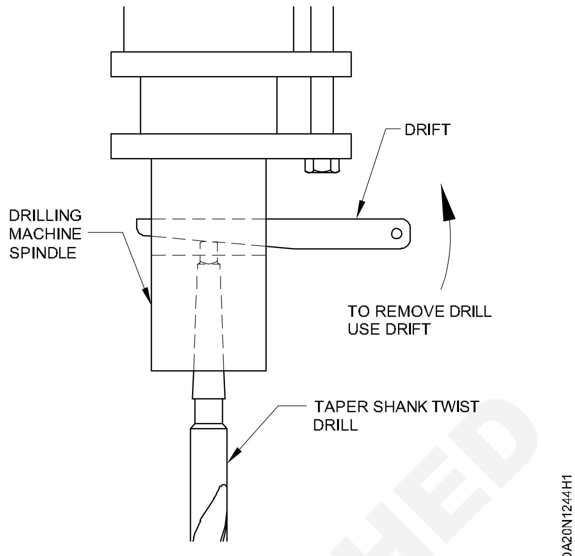
Job Sequence

- Check the raw material for its size.
- Apply marking media.
- Mark as per the drawing dimensions and punch the centre of holes with centre punch.
- Periphery of the big holes should be punched with prick punch 60°.
- Fix the job on the machine vice.
- Fix Ø 4mm drill in drill chuck
- Set the spindle speed for Ø 4 mm drill.
- Ø 4mm drill can be used as a pilot for all the holes.
- Fix Ø 8, Ø 10 and Ø 16 mm drill one by one and drill through holes as per job drawing.
- Use coolant while drilling

Caution: Use chuck key for tightening the drill in the drill chuck.

- Use drift to remove the taper shank drill from drilling machine spindle. (Fig 1)
- Do not hammer on drift to remove it out.

Fig 1



- Adjust the rpm of the spindle to suit the diameter of the drill. Ask your instructor.
- Finish the job and de-burr all corners.
- Apply thin coat of oil and preserve it for evaluation.

— — — — — — — — — — —

Skill Sequence

Drilling through holes

Objective: This shall help you to
- **drill holes of different diameter in a drilling machine.**

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)

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

Fix the 4 mm 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 4mm drill. This will serve as a pilot hole for 8 mm, 10 mm and 16 mm dia drills.

Drill Ø 8 mm.

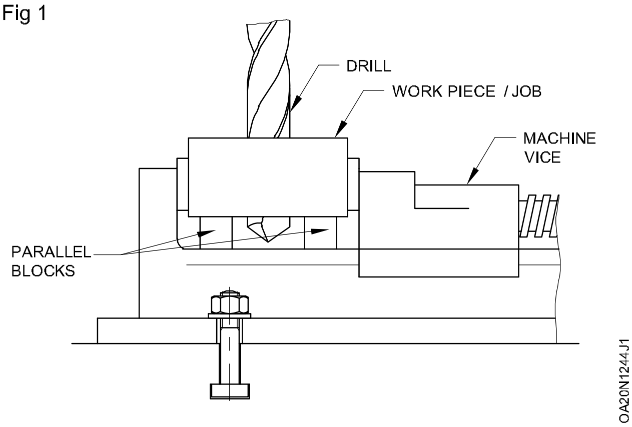
Drill Ø 10 mm hole.

Remove the drill and drill chuck.

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

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

Fig 1



Ensure that the drill do not penetrate into the vice.

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

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

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

Fig 2

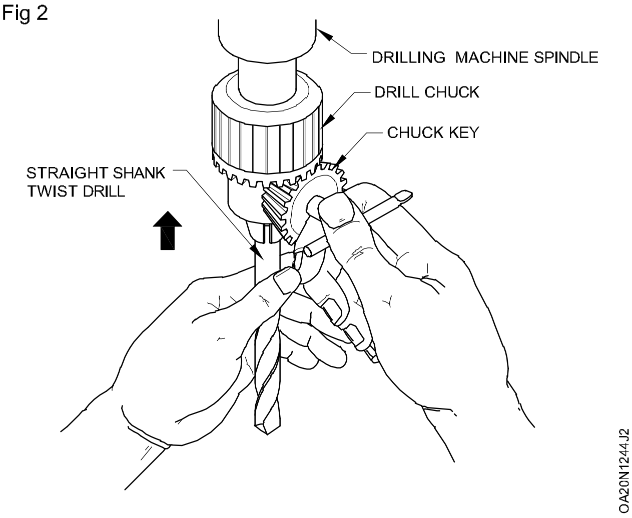
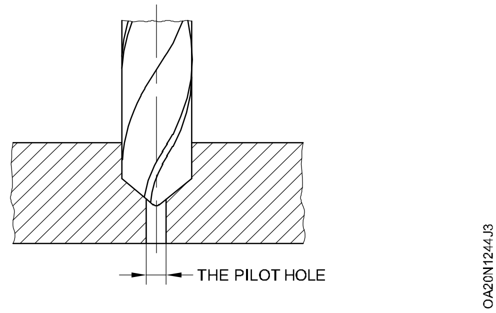

DRILLING MACHINE SPINDLE
DRILL CHUCK
CHUCK KEY
STRAIGHT SHANK
TWIST DRILL
OA20N1244J2

Fig 3


THE PILOT HOLE
OA20N1244J3

Safety to be observed while working on drilling machine.

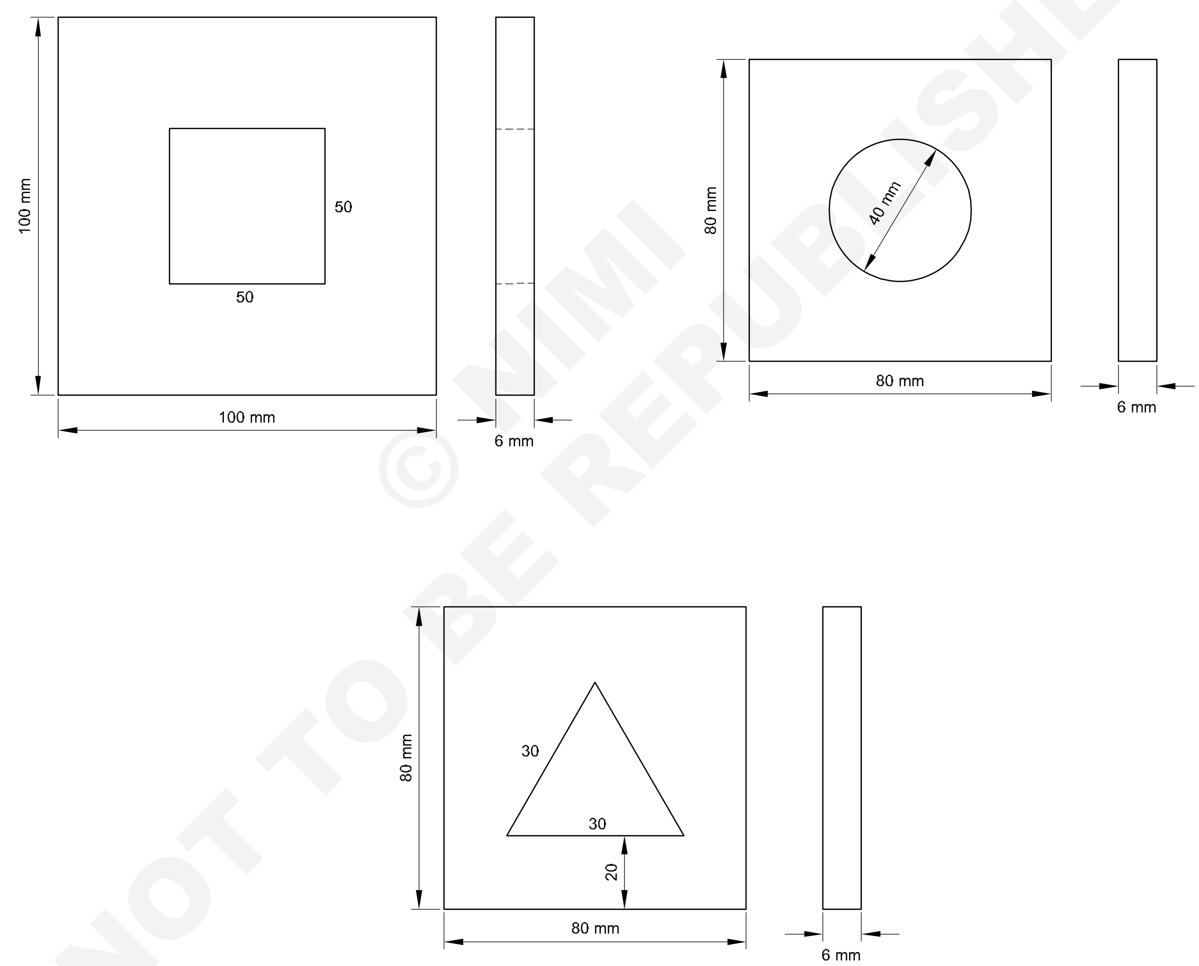
Objectives: At the end of this exercise you shall be able to
- **observe safety while working on drilling machine.**

Job Sequence

- The work should not be held by hand in any care.
- Proper work holding device should be used to hold the work.If the work in not held properly, the work tends to rotate along with the drill causing damage to the operator, the machine tool and the cutting tool.
- The shank of the drill should be cleaned before it is fitted into the spindle. The dirt on the shank may make the drill not to have a proper fit into the spindle. This will lead to breakage of drill
- The toper hole of the spindle should also be cleaned.
- The shank of the drill should conform with the spindle hole.
- Cutting speed and feed should be selected according to the prescribed range.
- Care should be taken to ensure whether the belt and gear are connected properly.
- Proper safety plates should be installed around rotative parts like belt drive and gears.
- The operator should wear safety goggles while operating the drilling machine.
- The machine should be disconnected from electric terminator when repair are undertaken.

Marking, chain drilling and filling to produce square,round and triangular openings on 6mm thick plate.

Objectives: At the end of this exercise you shall be able to
- **mark dimension on workpiece for dot punching**
- **centre punching for chain drilling operation**
- **removing unwanted part using chisel**
- **filing to the required shape.**



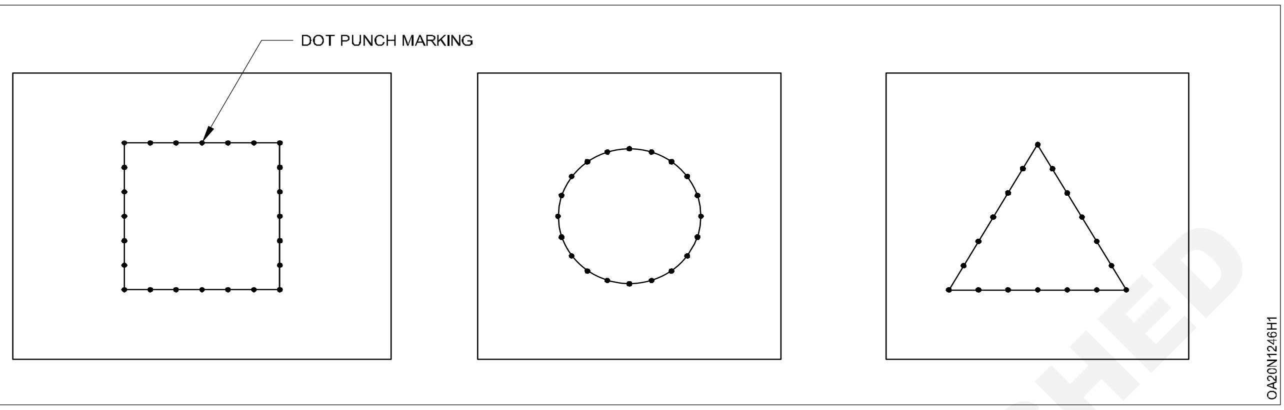
1	BISLC 75 - 95	-	Fe310-O	-	-	1.2.46
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX NO.

SCALE 1:1	**MARKING GEOMETRICAL SHAPES**	TOLERANCE : ±0.1mm	TIME : 5 Hrs
		CODE NO. OA20N1246E1	

Job Sequence

- Check the material size as per drawing.
- Remove burrs if any.
- Mark of all dimensions as per drawing for chain drilling
- Chain drill holes for parting of excess material.
- Separate the excess material from inside using a chisel.
- File inside slot as per drawing.
- File and smoots finish all sides as per size.

Fig 1



Skill Sequence

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

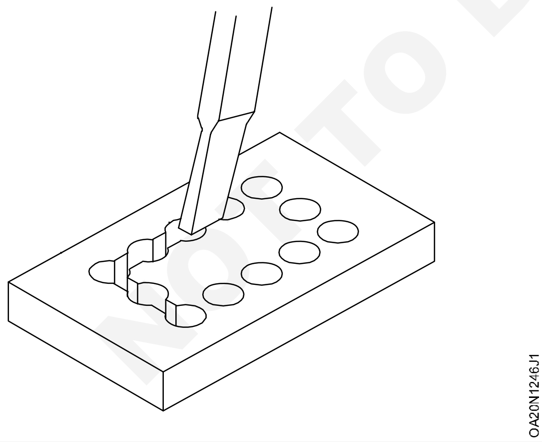
About 1mm thick web is convenient for drilling and separating with a chisel.

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

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

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

Fig 1

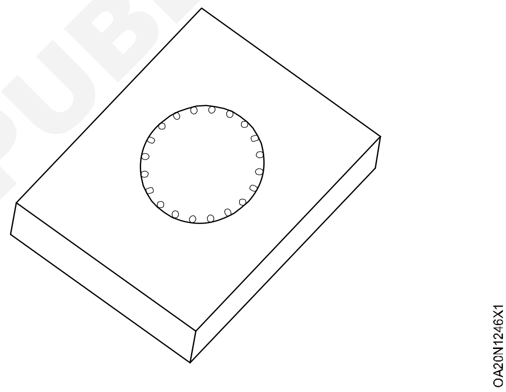


Using a divider draw an arc from the centre of circle mark the centre of drill hole using centre punch.Ensure the drill hole should not touch the dot circle mark keep the web thickness in the small, enable the part the material easily by chisel.

Cut the material using chisel.

Initially use flat file to remove the sharp cutting use half round file to finish the circular hole.

Fig 1



Draw equilateral triangle and punch the marked line by dot punch.

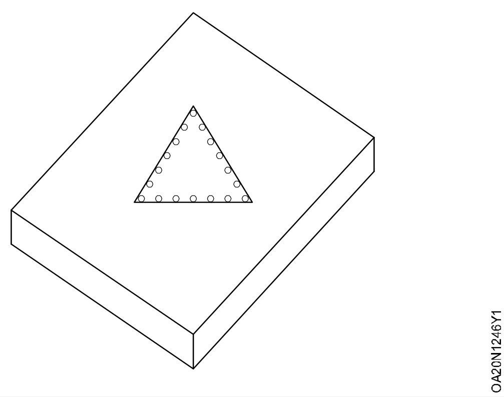
Mark the chain drill holes centre and deep punch in made to locate drill bit.

Drill hole should not touch the punched line but close to the line.

Using chisel cut the inner material and file the sharp edges.

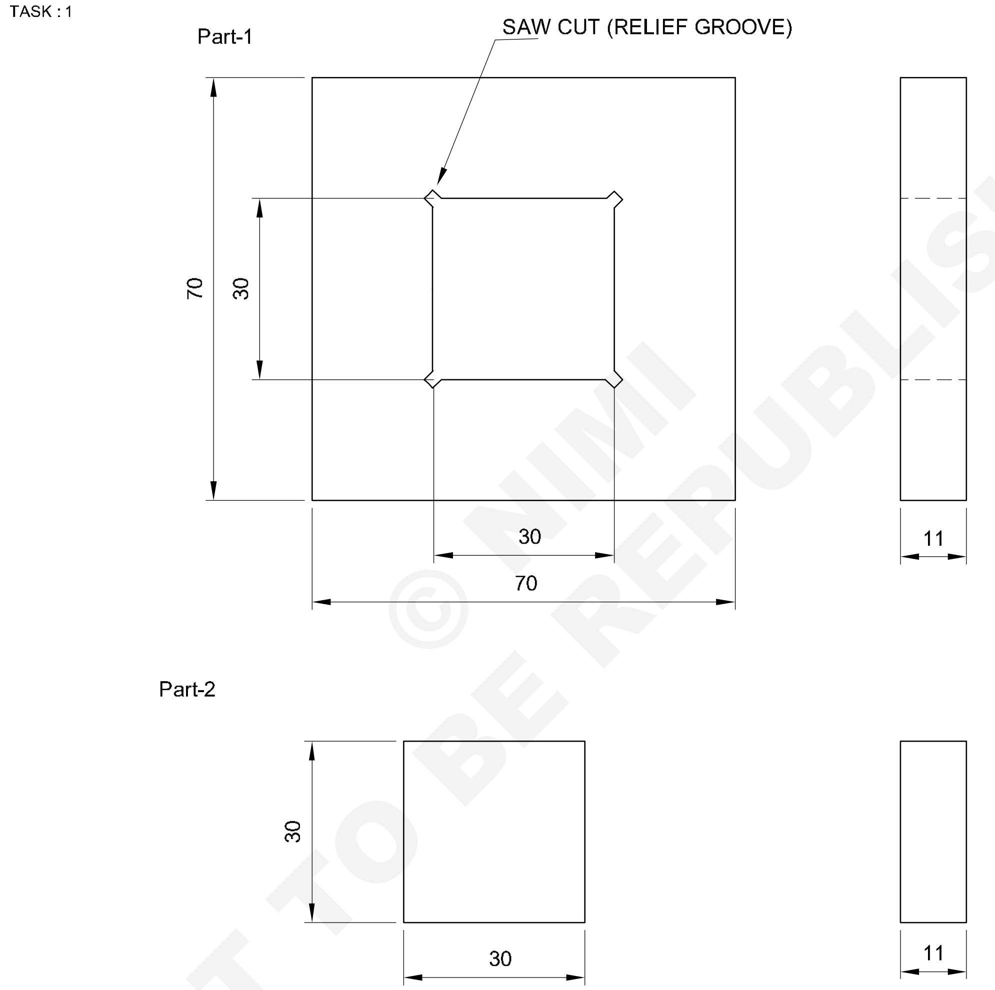
Finish the triangular slot using second cut (or) smooth file.

Fig 1



Preparing inserts and fitting in these opening

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



1	35 ISF 12- 35	–	Fe310	–	2	1.2.47
1	75 ISF 12 - 75	–	Fe310	–	1	1.2.47
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

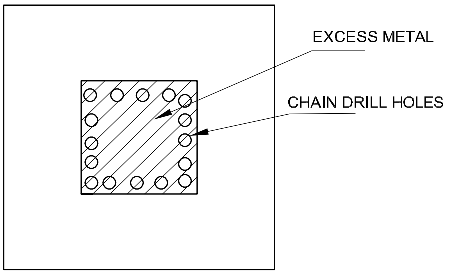
SCALE 1:1	MAKE INSIDE SQUARE FIT	TOLERANCE : ±0.04	TIME : 20 Hrs
		CODE NO : OA20N1247E1	

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

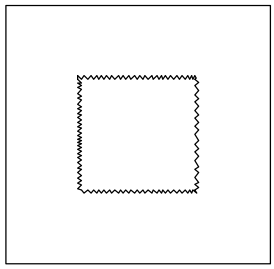


OA20N1247H1

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.

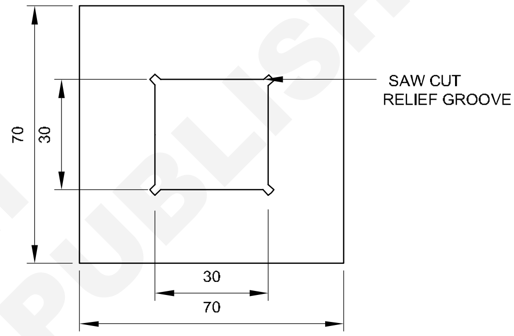
Fig 2



OA20N1247H2

- 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

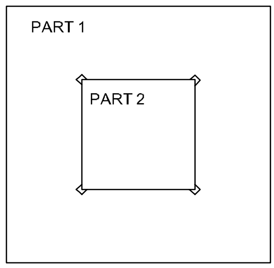


OA20N1247H3

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 deburr in all the surfaces and corners of the job.
- Apply a little oil and preserve it for evaluation.

Fig 1

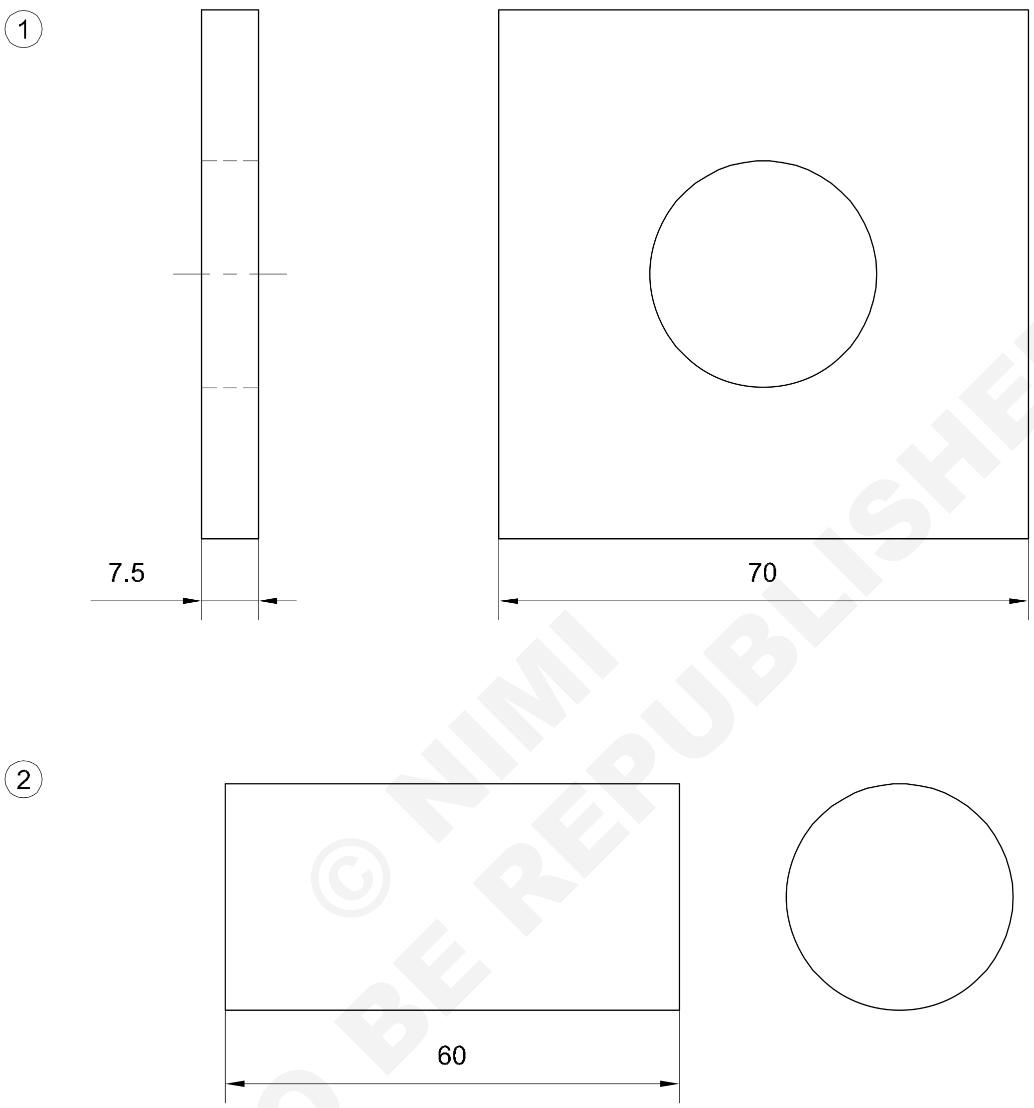


OA20N1247J1

Preparing circular insert in opening

Objectives: At the end of this exercise you will be able to
- **file and finish mating parts within ±0.04 mm using O/S micrometer**
- **file and finish mating parts having angular surfaces within ±1° accuracy using combination bevel protractor.**

TASK : 2



1	Ø32 - 65	→ FP - 1 - 21	Fe310-O	-	-	-
1	75 ISF 10 - 75	→ FP - 1 - 16	Fe310-O	-	-	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-

SCALE 1:1	FILING & FINISHING CIRCULAR HOLE & SHAFT	DEVIATIONS AS PER IS : 2102 (m)	-
		CODE NO. OA20N1247E2	

Job sequence

- File the surface and two adjacent edges at right angle to each other.
- Check the squareness.
- Refer the job drawing and do the marking as per the dimensions given. (Fig. 1)
- File the excess material and maintain the dimension. 70 mm with vernier caliper.
- Check the squareness with square head.
- To make the circular cut out, drill a 30 ∅ dia. drill hole in the center.

Fig 1

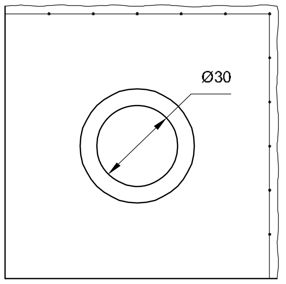
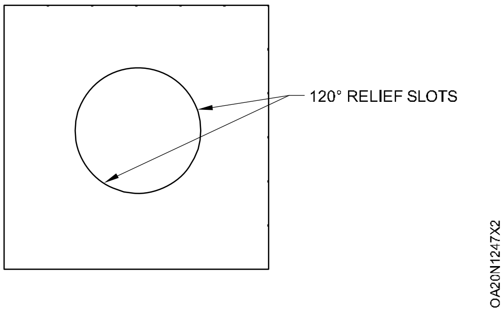


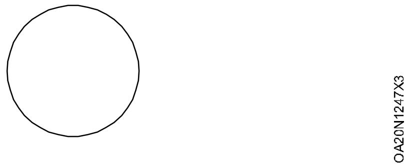
Fig 2



- At this stage make 3 relief slots in the corners by a blunt hacksaw blade. (Fig. 2)

- Finish the circular shape
- File the end of the given rod at right angle to the axis.
- Mark the circle as per the dimensions given in the drawing. (Fig. 3)

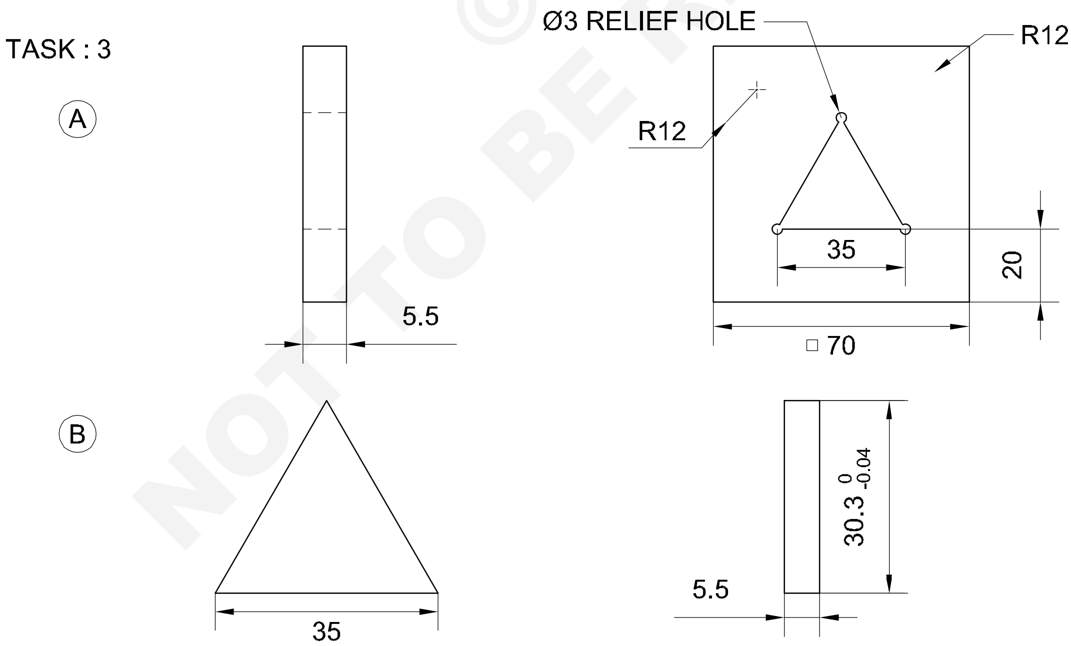
Fig 3



- File one side up to the marked line. Check the parallelism through out the length.
- File the adjacent side and check the angle (120°) by protractor head.
- Finally check the flat to flat dimension and other sizes and assemble in the circular slot.
- Place the female part on a wooden block. File and finish both surfaces with a smooth file and maintain the thickness.
- Remove the burrs from the edges.

Preparing triangular insert in this opening

Objectives: At the end of this exercise you will be able to
- **file and finish mating parts with angular surfaces with in ±0°10' using vernier bevel protractor**
- **file and finish external and internal radius surfaces and check with radius and fillet gauge**
- **drill relief holes.**



1	B	75 ISF 10 - 105	-	Fe310-O	-	A & B	17
NO.OFF		STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	TRIANGULAR FITTING WITH EXTERNAL & INTERNAL RADIUS					DEVIATIONS AS PER IS : 2102 (m)	TIME 20h
						CODE NO. OA20N1247E3	

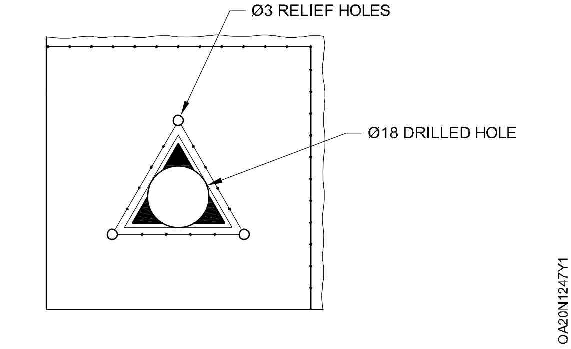
Job sequence

- Refer the drawing and mark as per the dimensions.

Part A

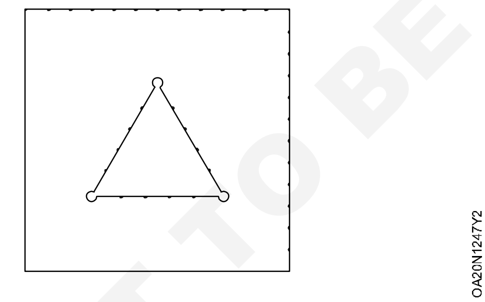
- File the excess material and finish the size to 70 mm square.
- Check the squareness.
- Drill 3 holes of 3 mm diameter as specified in the drawing as relief holes. (Fig 1)
- Drill a 18 mm dia hole exactly at the middle of the triangle as shown in the drawing.

Fig 1



- Cutoff the material from the corner with a hacksaw.
- File and finish the triangular hole and maintain the dimensions.
- File the external radius (convex) after cutting the metal roughly by an hacksaw.
- File and finish with a flat file. (Fig 2)

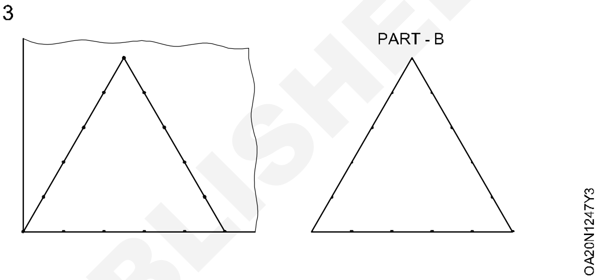
Fig 2



Part B

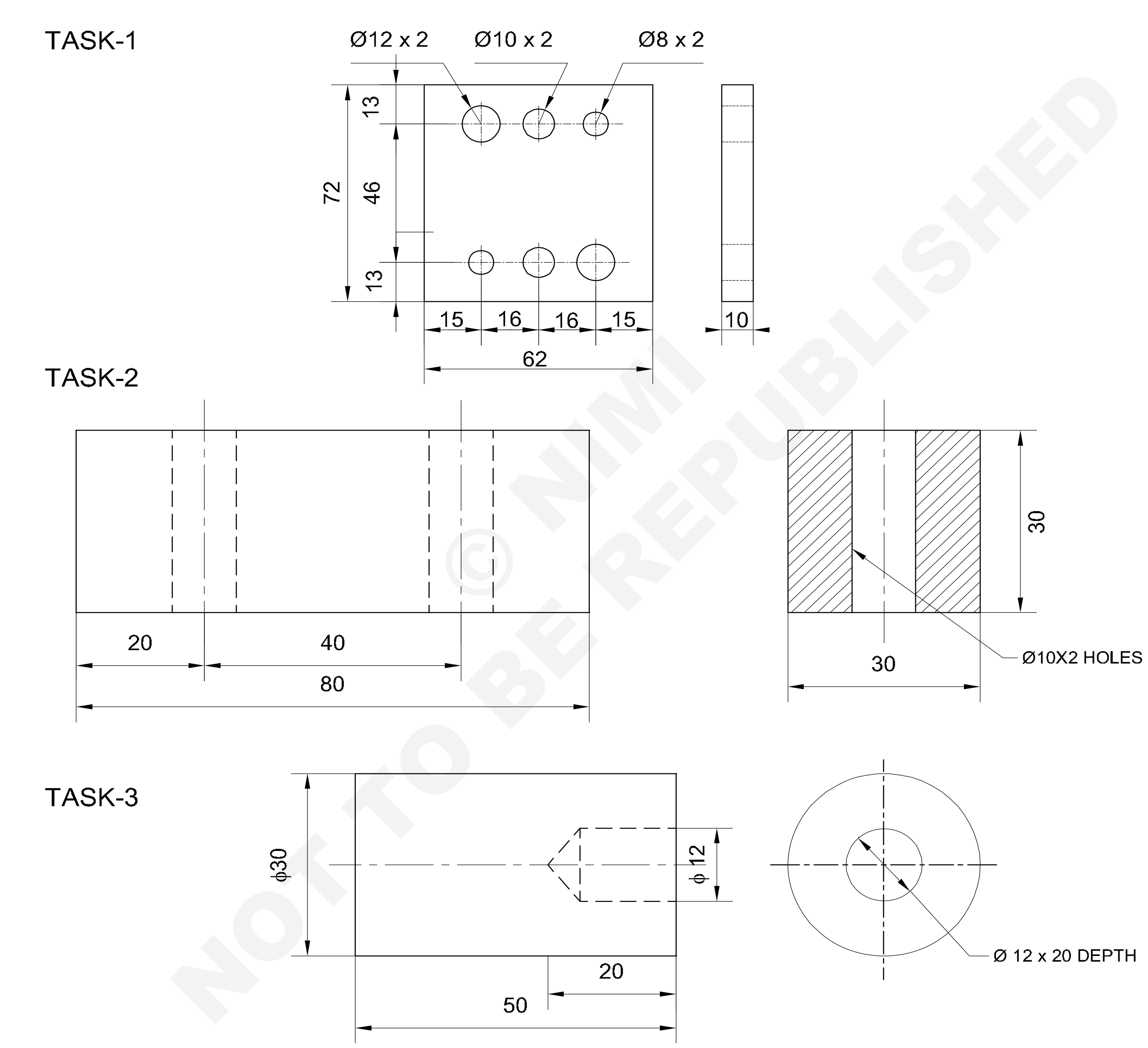
- Cut off excess material from part 'B' and file to the size. Maintain sharp corners
- Check the dimensions 30.30with a vernier caliper and angle 60° by vernier bevel protractor.
- Assemble the finished part 'B' with part 'A' by finish-filing.
- Place the assembled part on a wooden block and finish both surfaces with a smooth file to the given dimension. (5.5 mm)
- Separate part 'A' and 'B' and remove the burrs from the edges with a dead smooth file.

Fig 3



Drilling practice on varying thickness and different materials such as M.S, CI, S.S, Cu, Brass, Nylon, Epoxy etc.

Objectives : At the end of this exercise you shall be able to
- **mark the job as per drawing using surface gauge**
- **check the centre distance**
- **drill the different material.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	75ISF10x65		Fe 310			
1	SG 30X 80		Fe 310			
1	Ø30 x 50	-	-	-	-	1.2.48

SCALE 1:1	**DRILL ON FLAT, SQUARE BAR & ROUND BAR OF DIFFERENT MATERIAL**	DEVIATIONS ± 0.1	TIME : 15hrs
		CODE NO. OA20N1248E1	

Job sequence

TASK 1

- Check the raw material size.
- File the job and finish the job as per dimension.
- Apply the chalk powder and allow it do dry.
- Mark and punch the holes centres with a centre punch and draw circles as per drawing.
- Fix the vice on the drilling machine table.
- Fix the job in the vice for drilling.
- Fix the drill chuck into the machine spindle.
- Fix Ø8mm drill in the chuck rigidly.
- Set the spindle speed.
- Use a coolant and drill Ø8mm holes.
- In the same way continue drilling for the remaining holes.

Pilot hole drilling should be done for holes of Ø12 mm.

- Deburr the edges of the holes with drills 3 to 5mm bigger in size than the hole sizes.

— — — — — — —

TASK 2

- Check the raw material size.
- File the job if any burr is there.
- Apply the chalk powder and allow it to dry.
- Mark and punch the hole centres with a centre punch and draw circles as per drawing.
- Fix the vice on the drilling machine table.
- Fix the job in the vice for drilling.
- Fix the drill chuck into the machine spindle.
- Fix 10mm drill in the chuck rigidly.
- Set the spindle speed.
- Use a coolant and drill 10mm holes.
- In the same way continue drilling for the remaining holes.

Pilot hole drilling should be done for holes of Ø10 mm.

- Deburr the edges of the holes with drills 3 to 5mm bigger in size than the hole sizes.

— — — — — — —

TASK 3

- Check the raw material size.
- File the job in correct length.
- Mark and punch the holes centre with a centre punch.
- Draw the circle as per drawing.
- Fix the vice on the drilling machine table.
- Fix the job in the vice for drilling using 'Y' block
- Fix the drill chuck in to the machine spindle.
- Fix the 8mm drill in the chuck rigidly.
- Set the spindle speed.
- Set the depth using the depth bar in drilling M/C.
- Use coolant and drill pilot 8mm hole.
- Fix the 12mm drill in the chuck rigidly and set the spindle speed.
- Use coolant and drill 12mm hole length of 20mm.

— — — — — — —

Skill sequence

To set vice on the machine table in position

Objective: This shall help you to
- **align a machine vice on the table in position.**

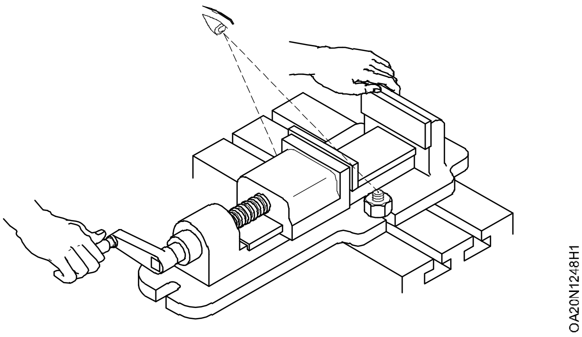
Clean the vice base and the machine table top, free from dust for seating.

Place the vice at the middle of the table with maximum support to avoid falling off of the vice. (Fig.1)

Position the 'T' bolts into the 'T' slot. (Fig.1) while shifting the vice towards the slots ensure that there is 1mm to 2mm clearance between the 'T' bolt and the vice slot to allow for adjustment.

Tighten all the bolts by hand.

Fig 1



Locating hole accurately by drilling centre hole

Objective: This shall help you to
- **drill centre holes with a drilling machine.**

Drilling centre holes by combination drills is an accurate method of locating the position of the holes (i.e within ±0.25mm). In drilling operations, this method will be specially helpful while drilling deeper holes and holes of fairly accurate locations. For doing centre drilling, proceed as follows.

Hold the combination centre drill in the drill chuck and check whether it 'runs true'. Adjust the spindle speed to suit the combination drill.

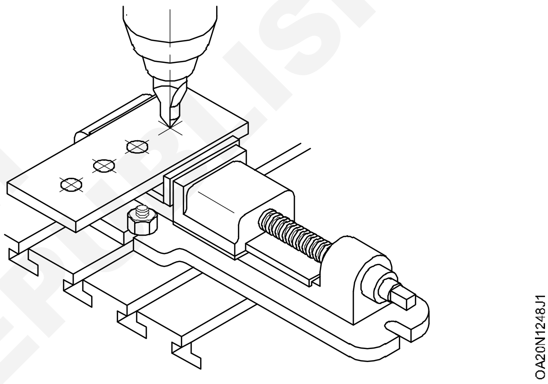
Adjust the job together with the vice and align with the centre punch mark.(Fig.1)

Drill a centre hole up to the depth of 3/4th of the counter sink. Do not apply undue pressure on the centre drill.

Apply sufficient quantity of cutting fluid.

Remove the centre drill, hold the twist drill of the required dia. check if it 'runs true'. start drilling the through hole.

Fig 1



Drilling on sheet metal, precaution and safety to be observed.

Objectives : At the end of this exercise you shall be able to
- **mark drill holes on sheet metal**
- **observing precaution and safety.**

Job sequence

- Check the dimensions of the work piece.
- Mark and punch centre point of drill holes using centre punch.
- Insert the drill bit in the portable drilling machine drill chuck and tight the same with chuck key.
- Place the sheet on the wooden board and tight with 'C' clamp as shown in Fig.
- Hold the drilling machine perpendicular to the metal sheet.
- Switch on the machine till completion of drill hole.
- Remove burrs with high dimension drill bit.
- Ensure earthing has been given on the portable electric machine.
- Less impression in given on the sheet otherwise drill may have on the sheet.
- Drilling to be done perpendicular to workpiece otherwise the hole may be oval shape.

Fig 1

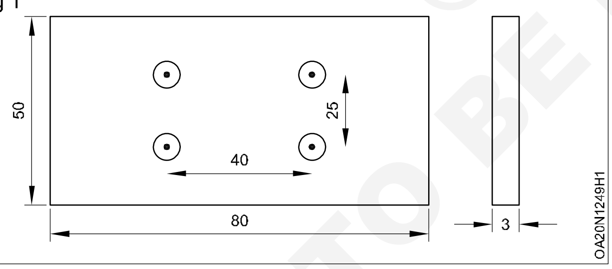


Fig 2

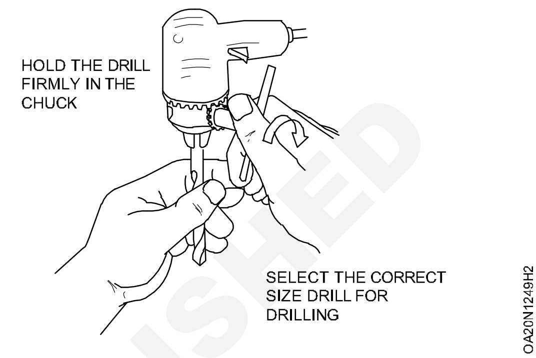


Fig 3

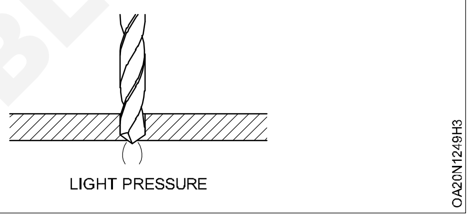
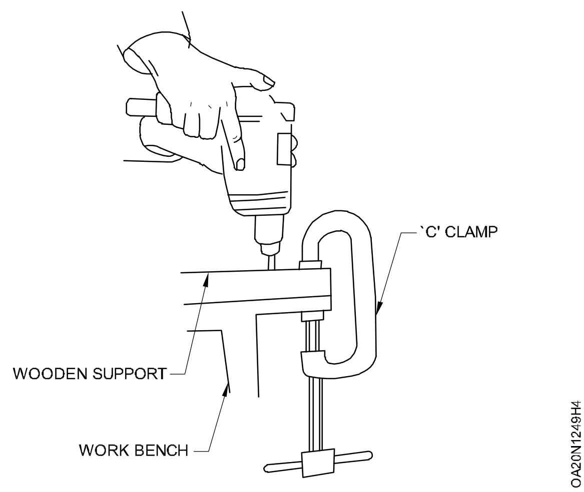
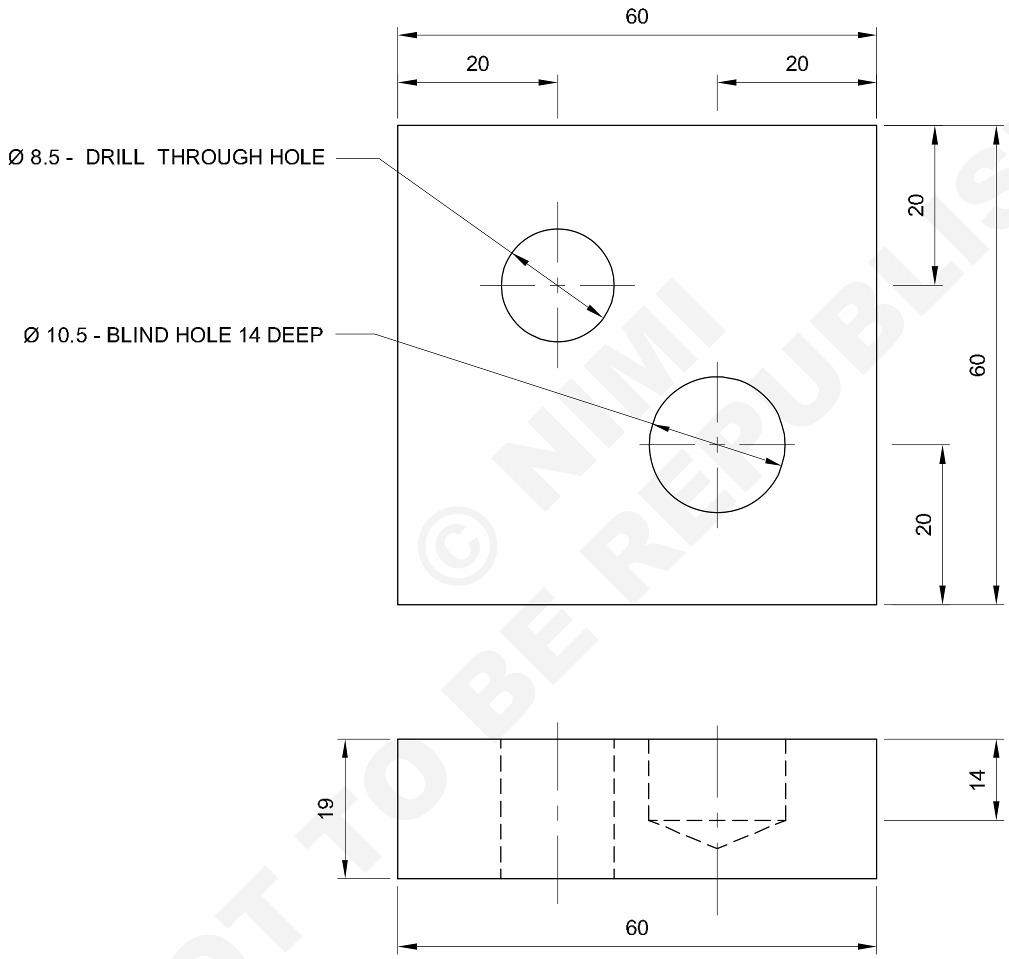


Fig 4



Counter sinking, counter boring and spot facing operations using bench drilling machine

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	–	–	1.2.50
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 : OA20N1250E1	

Job sequence

- Check the raw material for the correctness of the size.
- File and finish the metal to size 50 x 10 x 96 mm.
- Mark off and locate centres for the holes to be drilled.
- Fix the workpiece in the machine vice. The top surface of the workpiece should be square to the machine spindle axis.
- Drill through and blind holes. (⌀ 8.5 ⌀ 10.5 mm through holes, and Δα 14 mm blind holes)
- Locate centres and drill countersink and counter bore as per drawing without disturbing the setting.
- Repeat the same procedure for counter boring. Remove the sharp edges and burrs.

Ensure that the work is placed on parallel blocks and is clamped firmly in the machine vice.

Apply the cutting fluid continuously during drilling, counter boring and countersinking.

Skill sequence

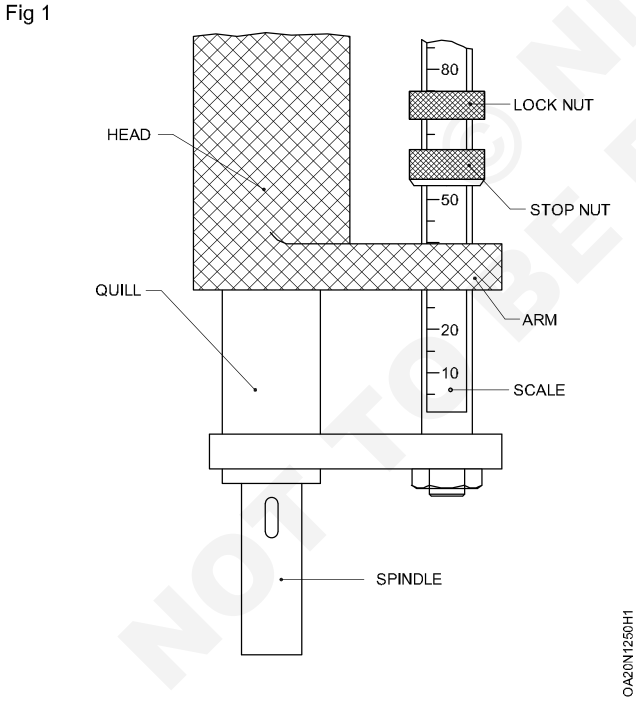
Drilling blind holes

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 arrangement will have graduations by which the advancement of the spindle can be observed.

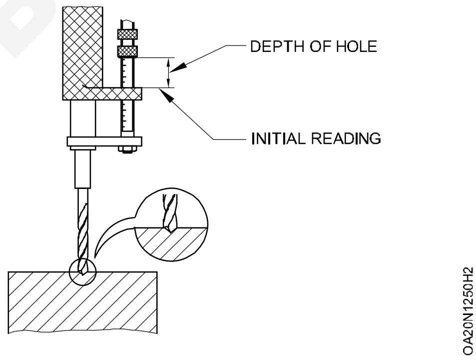
Generally the blind hole depth tolerances are given up to 5mm accuracy.

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 theis point. (Fig 2)

Fig 2



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

Initial reading + Depth of hole = Setting.

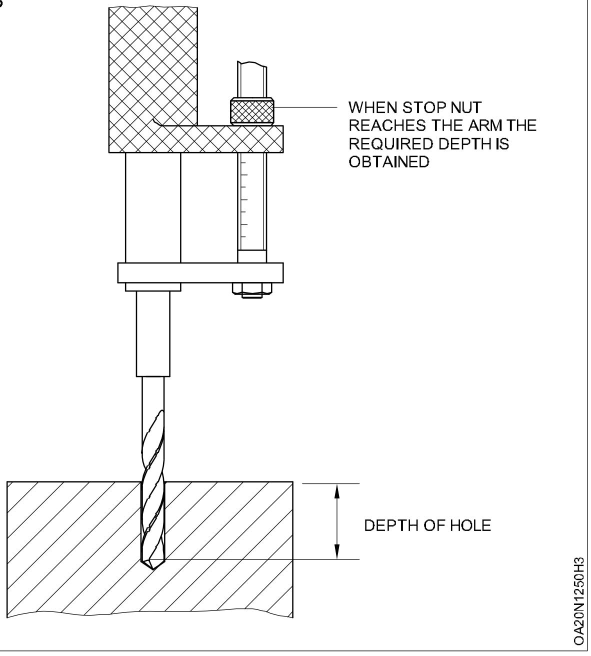
Adjust the stop next to the required setting, using the scale.

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

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

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

Fig 3



Counter sinking

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

Selection of countersinks

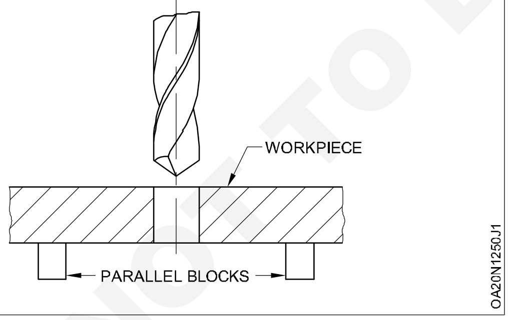
Select the countersink tool according to the angle of the taper head of the screw. Use the table for countersink holes.

Procedure

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)

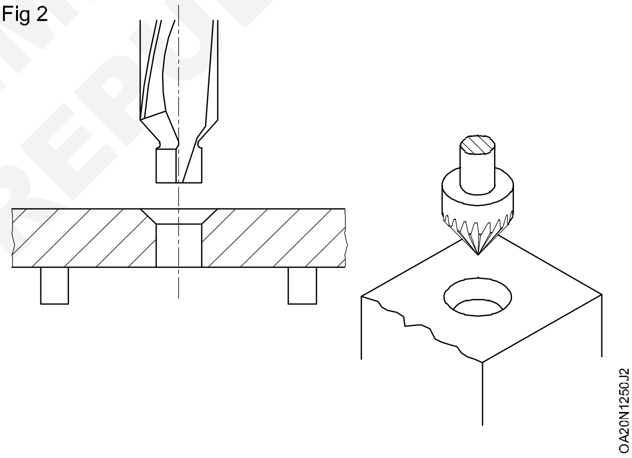
Set the spindle speed of the drilling machine to the nearest calculated RPM. Use the formula

$$V = \frac{\pi \times D \times N}{1000}$$

Substitute the recommended value of 'V and diameter of the countersink.

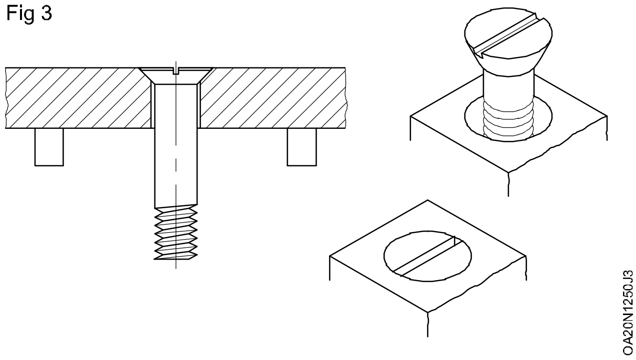
(V = 1/3rd of Drilling cutting speed)

Fig 2



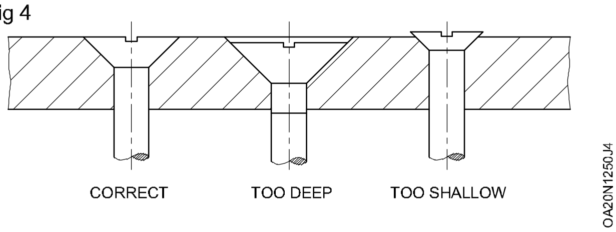
Countersink the hole to a depth equal to the head length of the screwhead. (Fig 3)

Fig 3



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

Fig 4



Counter boring

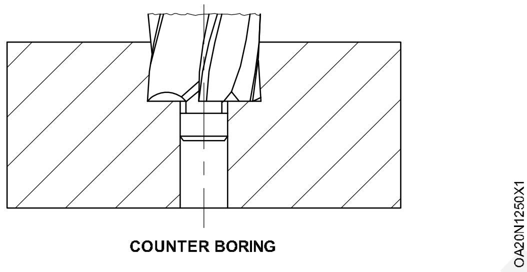
Objective : This shall help you to

- **counter bore holes of different size concentric to the drilled holes.**

Selection of counte bore sizes

B.I.S. Bureau of indian standards recommends different sizes of counter bores based on the sizes of the clearance holes. (Fig 1)

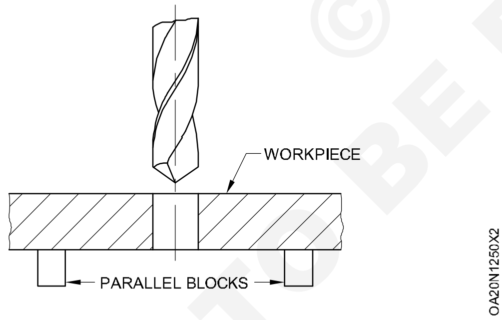
Fig 1



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 2)

Fig 2



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.

Mound and fix the counterbore tool on the drilling machine spindle. (Fig 3)

Consider the value of cutting speed as 1/3rd of the drilling cutting speed.

Counterbore the hole to a depth equal to the length of the screw head. (Fig 4)

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

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

Fig 3

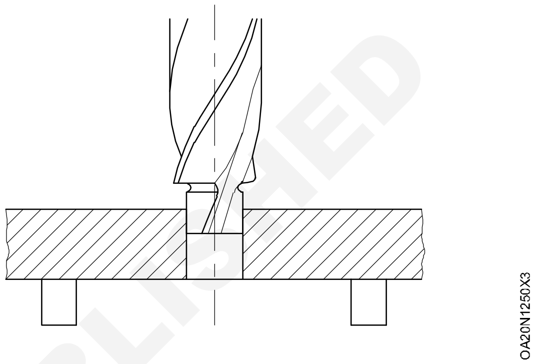
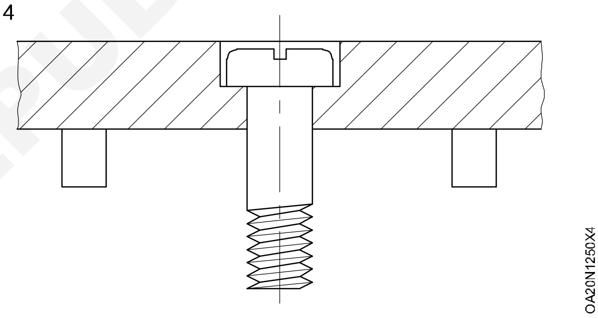


Fig 4



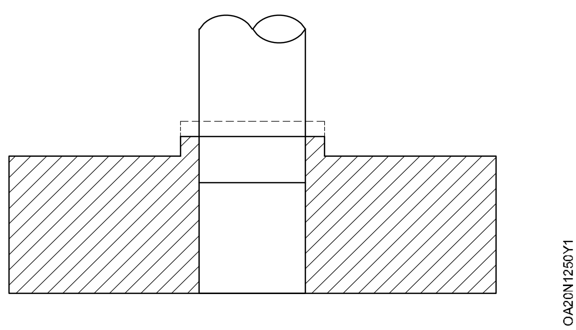
Spot Facing

Spot facing the hole to a depth equal to the length of the screw head.

Use the depth stop arrangement for controlling the depth of the spot facing hole.

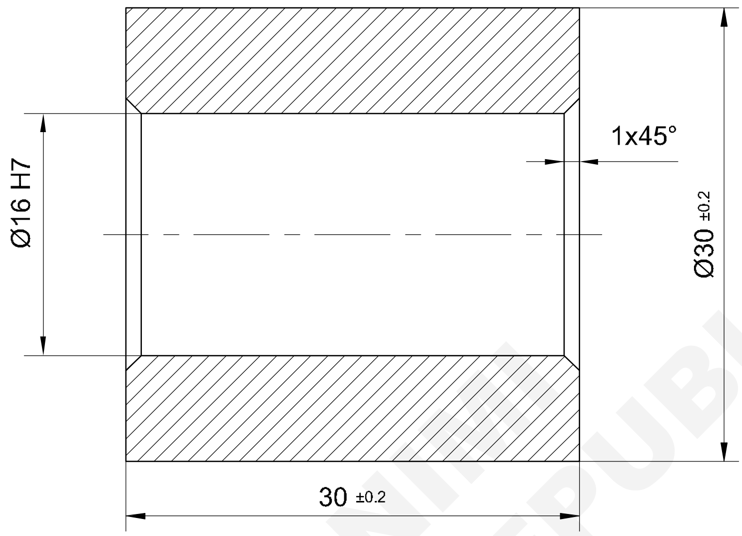
The main differences than the counterboring is the operation of smoothing and squaring the surface around and so as to provide a smoots seat for the head of screw.

Fig 1



Exercise on reaming with hand reamer and machine reamers

Objectives: At the end of this exercise you shall be able to
- **drill a hole to size leaving allowance for reaming**
- **Beam through hole with a hand reamer**
- **check the reamed hole by using a plus gauge**
- **enlarge the reamed hole by dia 0.1 using machine adjustable reamer.**



Job sequence

- Hold the job in a 4 jaw chuck and true it by holding it about 25mm outside the chuck.
- Face one end and turn ∅ 30 ± 0.2 mm to the maximum length.
- Reverse the job and reset it.
- Face the other end to 30 ± 0.2mm length.
- Turn the outside dia. 30 ± 0.2mm to the remaining length.
- Hold the centre drill in a drill chuck mounted on to the tailstock barrel, and centre drill the work.
- Drill through hole in the job with ∅ 15.75mm drill bit after drilling a pilot hole of ∅ 10mm.
- Chamfer the drilled hole 1 x 45 °.
- FIx the ∅ 16H7 hand reamer in the tailstock. Supporting with the dead centre.
- Ream the hole by using sufficient coolant.
- Give uniform hand feed while reaming.
- Check the hole with a 'Go' and 'No-Go' plug gauge.
- Enlarge the reamed hole using adjustable reamer to size of ∅ 16.1mm.
- Check the surface finish, comparing the roughness with the standard surface roughness set.

1	Ø32 - 35	–	Fe 310	–	–	1.2.51
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 2:1	**REAMING IN LATHE**	DEVIATIONS As specified	TIME 15hrs
		CODE NO. OA20N1251E1	

Skill sequence

Reaming a hole by a hand reamer on the lathe

Objectives : This shall help you to
- **set the machine for hand reaming**
- **set the reamer on a lathe**
- **ream a hole accurately with a hand reamer.**

The procedure sequence of hand reaming on a lathe is as follows.

Check the drilled hole to ensure that it has the required reaming allowance.

Choose the correct type and size of reamer.

Remove the tool-holder and tool post.

Fix up the tap wrench to the square end of the reamer. The tap wrench must be short enough to clear the lathe bed.

Move the tailstock back so that there is sufficient space for the reamer between the dead centre and the workpiece.

Place the reamer into the pre-drilled hole slightly with the shank supported by the tailstock dead centre. (Fig 1)

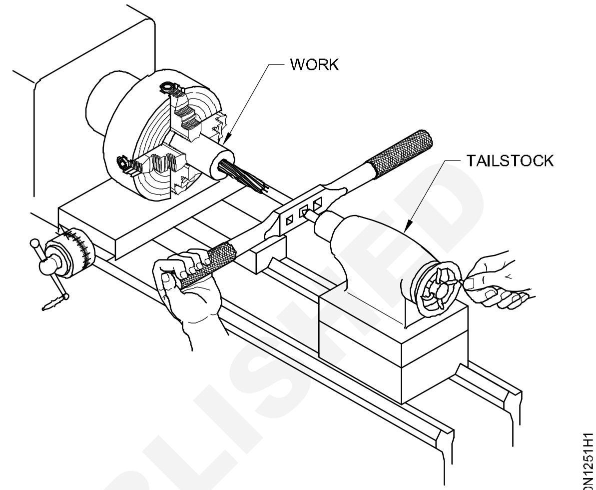
Apply cutting fluid to the reamer during reaming.

The job should not be rotated by power.

Now gently rotate the reamer clockwise with" the wrench by hand movement. (Fig 1)

When the hole is fully reamed, continue to rotate the reamer clockwise as you- pull it out of the hole.

Fig 1



USING A HAND REAMER IN A LATHE

Remove the reamer occasionally by turning it clockwise to clear of the chips from the flutes.

Never use a hand reamer under power.

Never turn the lathe spindle or reamer backward. This will damage the reamer blunting the cutting teeth of the reamer, and will also result in developing scratches on the reamed surface of the hole.

Method of checking the bore with a plain cylindrical plug gauge

Objectives : This shall help you to
- **select the plug gauge according to the bore limits**
- **check the low limit of the bore with the 'GO' end of the gauge**
- **check the high limit of the bore with the 'NO-GO' end of the gauge.**

Select a plug gauge of the correct size and tolerance for the hole being checked.

Clean both the ends of the gauge and the hole of the workpiece with a clean dry cloth.

Check both the ends of the gauge and the workpiece and ensure they are free from burrs in the bore.

Position the 'Go' end of the gauge squarely to the axis of the hole at the front and apply light pressure axially. (Fig 1)

If the hole is within limit, the gauge will enter easily.

Allow the plug to enter for the full length of the bore.

Check for the play between the plug gauge and the bore diameter.

If the plug does not go throughout the bore, it indicates that the bore is tapered.

The plug should not forced inside unless the bore is rectified.

Excessive play or looseness in any one direction indicates that the hole is elliptical.

Check with the 'No-Go' end of the gauge also, using the same procedure.

Hold the adjustable reamer with a morse socket in the tail stock and turn the tailstock wheel to advance the reamer into the hole.

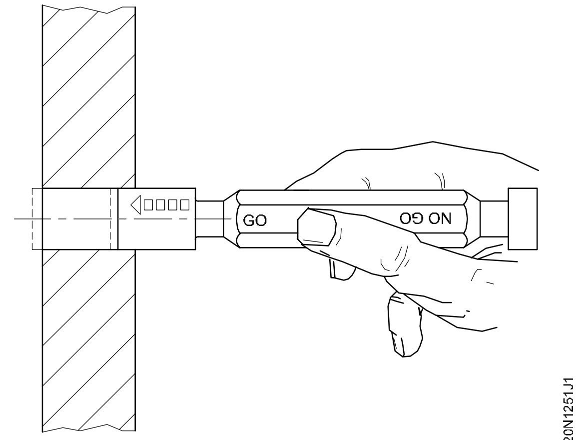
An entry of a 'No-Go' gauge into a hole beyond the chamfered length indicates an oversized hole, bell mouthed or tapered hole.

Do not force or twist a plug gauge in the hole. Forcing or twisting will cause excessive wear.

While checking, the plug gauge and workpiece must have the same temperature.

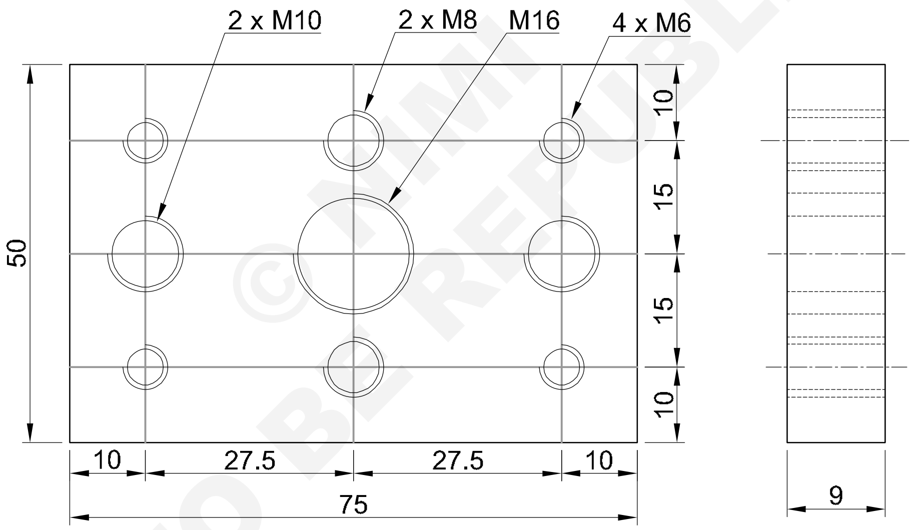
It is very important not to check the work which has warmed up during operation, with a cold plug gauge.

Fig 1



Internal threading by hand using tap sets

Objectives: At the end of this exercise you shall be able to
- **mark the tap holes with vernier height gauge**
- **determine the tap drill size**
- **drill tap drill hole on the job and chamfer it**
- **cut internal thread by hand tapping.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	60 ISF 10 x 78 mm	-	Fe310	-	-	1.2.52

SCALE 1:1	DRILLING AND TAPPING	TOLERANCE : ±0. 1mm	TIME : 10Hrs
		CODE NO. OA20N1252E1	

Job Sequence

- Check the raw metal and file to size 75x50x9 mm.
- Mark the hole centres for the tap drill holes with vernier height gauge.

Drilling

- Set the pillar drilling machine for drilling operation
- Set the job on the machine vice.
- Fix the centre drill in a drill chuck.
- Align centre drill in drawing machine and drill in all hole location.
- Fix Ø 5 mm drill in a drill chuck and drill all the centre drilled holes. (this sewes as pilot hole for larger diameter drills).
- Drill two holes Ø 6.8 mm for M 8 tap.
- Drill two holes Ø 8.5 mm for M 10 tap.
- Drill Ø 14 mm at the centre of the work for M16 tap.
- Fix the counter sink tool in a drilling machine and chamfer all the tap drill holes both sides to 1.0 mm depth.

Tapping

- Fix the Job in bench vice.
- Cut M6 internal thread using M6 hand tap and tap wrench.
- Similarly, cut internal threads using M8, M10 and M16 hand tap and tap wrench
- Finish and De - burr all the surfaces of the Job.
- Clean all the threads without burrs.
- Apply a little oil and preserve the job for evaluation

Locating hole accurately by drilling centre drill

Objective: This shall help you to
- **drill centre holes with a drilling machine.**

Drilling centre holes by combination drills is an accurate method of locating the position of the holes (i.e. within ± 0.025mm). In drilling operations, this method will be specially helpful while drilling deeper holes, and holes of fairly accurate locations. For doing centre drilling, proceed as follows.

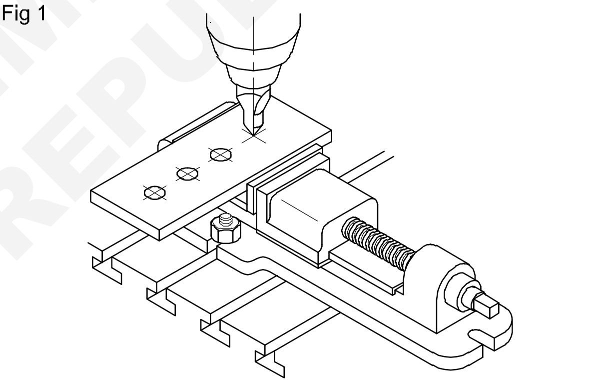
Hold the combination centre drill in the drill chuck and check whether it 'runs true'. Adjust the spindle speed to suit the combination drill.

Adjust the job together with the vice and align with the centre punch mark. (Fig.1)

Drill a centre hole up to the depth of 3/4th of the counter sink. Do not apply undue pressure on the centre drill.

Apply sufficient quantity of cutting fluid.

Fig 1



Remove the centre drill. Drill hole with the required diameter twist drill. Check if it 'runs true'. Start drilling the through hole.

Tapping through holes

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

Determine the tap drill size either using the formula or the table.

Drill the hole to the required tap drill size. [An undersized hole will lead to breakage of the tap].

Chamfer the end of the drilled hole for easy aligning and starting of the tap. (Fig 1)

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

Fig 1

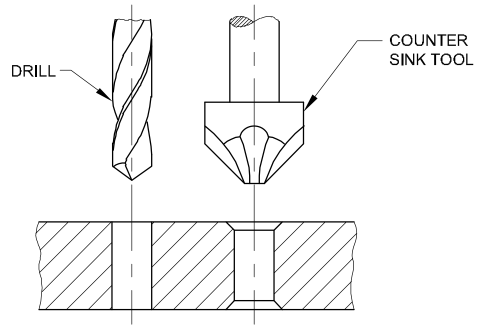
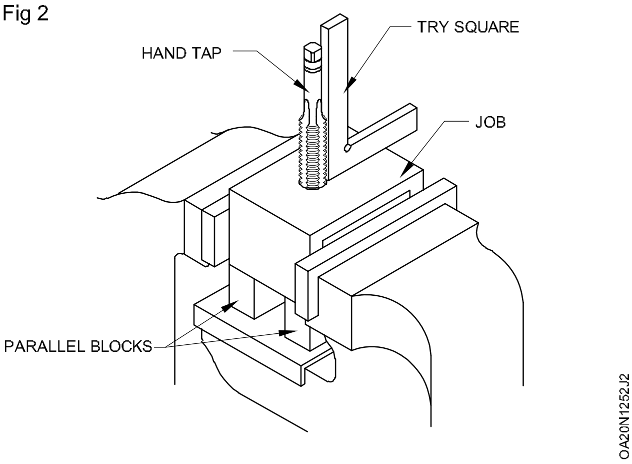


Fig 2

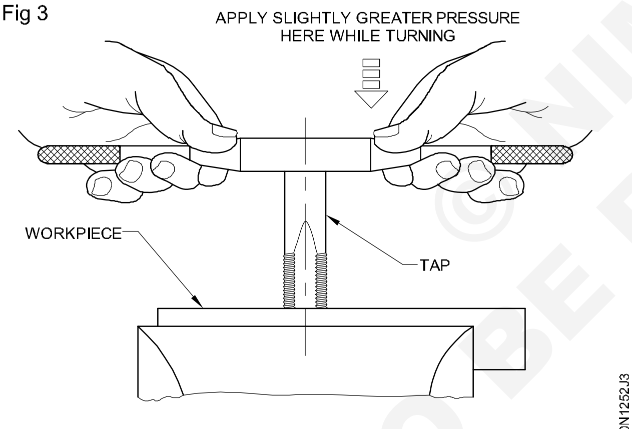


Fix the first tap (taper tap) in the correct size tap wrench. Too small a wrench will need a greater force to turn the tap. Very large and heavy wrenches will not give the 'feel' required to turn the tap as it cuts and may lead to breakage of the tap.

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

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

Fig 3



SQUARING UP THE TAP

Remove the wrench from the tap when you are sure of starting the thread without disturbing the setting.

Check and make sure that the tap is vertical by using a try square in two positions at 90° to each other. (Figs 4 & 5)

Fig 4

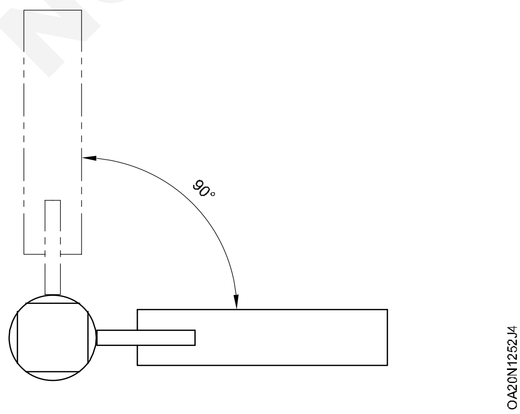
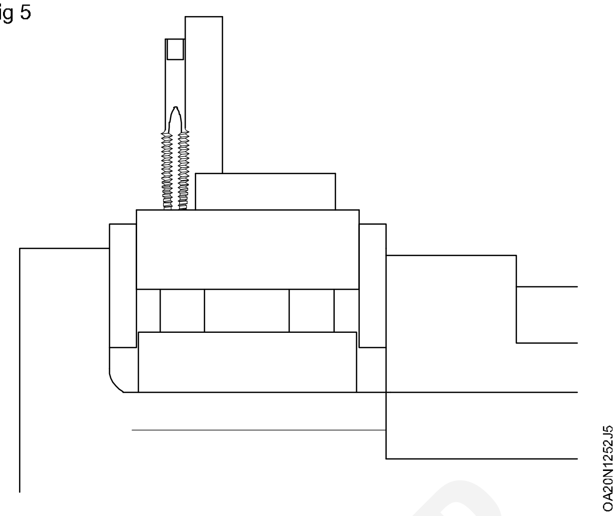


Fig 5



Make correction if necessary by exerting slightly more pressure on the opposite side of the tap inclination.

Check the tap alignment again. The tap alignment should be corrected within the first few turns. If it is tried afterwards there is a chance of breaking of the tap.

Turn the wrench lightly by holding at the ends without exerting any downward pressure after the tap is positioned vertically. The wrench pressure exerted by the hands should be well balanced. Any extra pressure on one side will spoil the tap alignment and can also cause breakage of the tap. (Fig 6).

Continue cutting the thread. Turn backwards frequently about quarter turn, to break the chips. (Fig 7)

Stop and turn backwards when any obstruction to the movements is felt.

Use a cutting fluid while cutting the thread to minimise friction and heat.

Cut the thread until the hole is totally threaded.

Cut the thread until the hole is totally threaded.

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

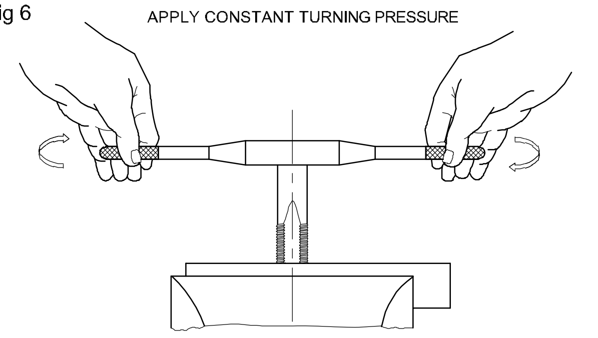
Remove the chips from the work and clean the tap with a brush.

Make sure that the dia of the hole to be tapped is correct for the given size of the tap.

Turn backwards to break the chip after every quarter turn.

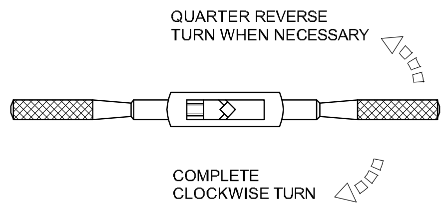
Select the length of wrench suitable to the size of the tap. Overlength of wrench may cause the breakage of tap.

Fig 6



THREAD FORMING BY TAP

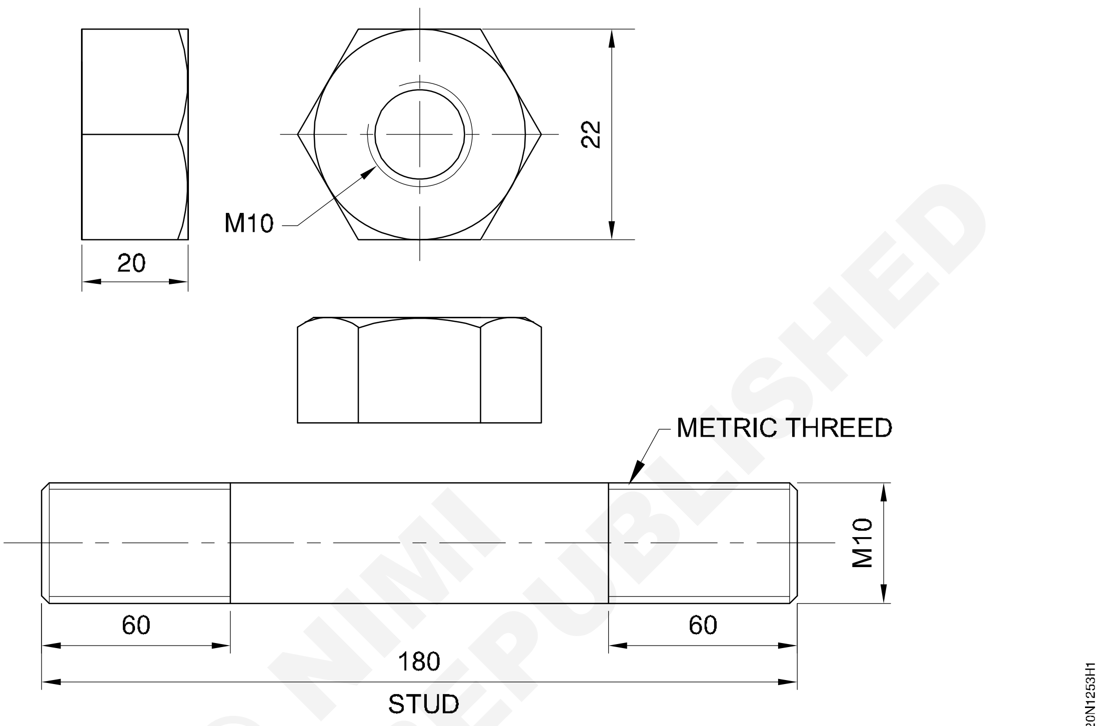
Fig 7



External threading by split die and finishing of thread by die nut

Objective: At the end of this exercise you will be able to
- **drill and cut internal threads using hand taps.**

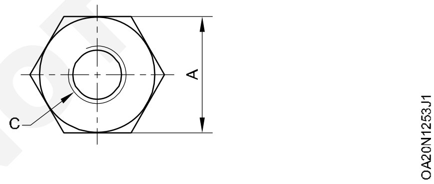
Fig 1



Job sequence

- Cut the hexagonal rod to the required length.
- File the ends at right angle to the axis.
- Chamfer both the ends at an angle of 30°.
- Mark the centre and drill the required hole for tapping. (Fig 1)

Fig 1



Ensure that the drill hole is made through the axis of the hexagonal rod.

- Tap the hole with a set of M10 tap.

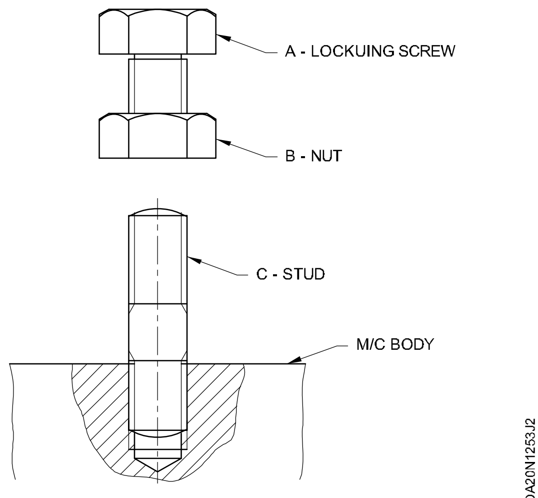
Cut external thread using split dia on

- Screw in the given hexagonal bolt to the tapped hole.

How to use

Tightening a stud / Fixing the stud to the machine body

Fig 2



- Insert the nut 'B' over the stud C as shown in the Fig 2.
- Tight the nut 'B' by a spanner while tightening, the locking screw 'A' must be in unlocked state.

To remove a stud from machine body

- First tight the nut 'B' by a spanner in the stud 'C'.
- Tight the locking screw 'A' in the nut until it touches the stud end.

- Hold the locking screw ‘A’ with a spanner firmly.
- Now use another spanner on nut 'B', loosen the nut 'B' which will remove the stud from the machine body. (care should be taken to hold the screw 'A' firmly).

Caution: Use correct size double ended spanner to avoid damage to the corners of the nut and head of the locking screw.

Skill sequence

External threading using split dies

Objective: This shall help you to
- **cut external thread using split dies.**

Select a correct size and circular rod as blank and chamfer the ends.

Blank size = Thread size - 0.1pitch of the thread

Grip the blank in the vice using a false jaw, projecting the blank above the vice jaws 5 mm more than the required length of thread.

Fix the die in the diestock. The leading side of the die must be opposite to the step of the die stock. (Fig 1 and 2)

Fig 1

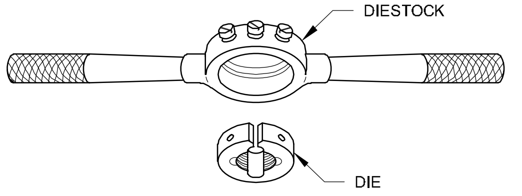
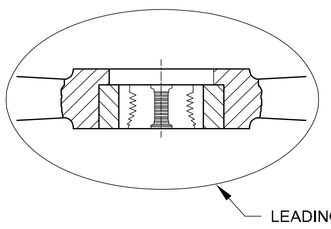
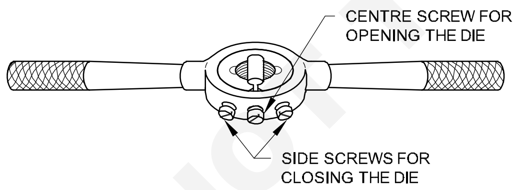


Fig 2



Open the die fully by tightening the centre screw of the die stock. (Fig 3)

Fig 3



Place the leading side of the die on the chamfer of the job. (Fig 2)

Start the die, square to the bolt centre line. (Figs 4 and 5)

Turn in the clockwise direction to advance the die on the blank, with even pressure on both ends of the die stock.

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

Use a cutting fluid

Clean the die frequently with a brush to prevent the chips from clogging and also from spoiling the thread.

Reverse and remove the die after the full height is reached.

Increase the depth of the cut gradually by loosening the centre screw and tightening the side screws.

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

Check the fit of threads with a matching nut.

Tighten the side screws and repeat the cutting, until the standard nut matches without undue ‘play’ between the threads.

Fig 4

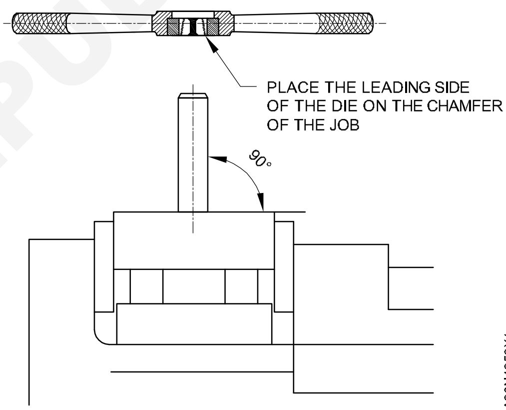
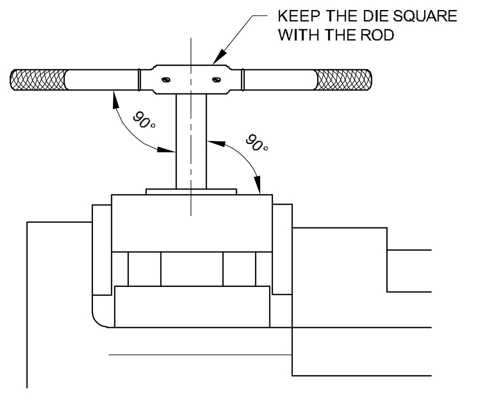
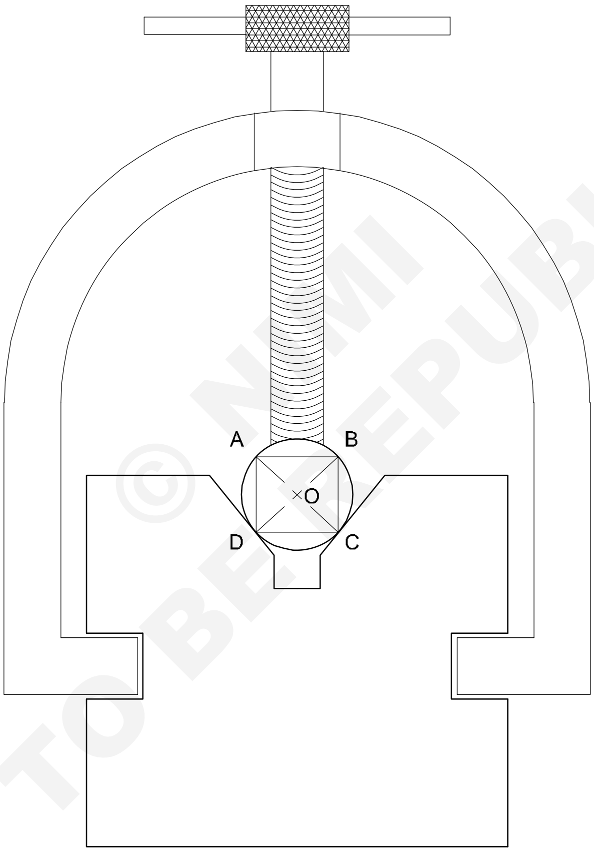


Fig 5



Marking centre of a round bar with the help of 'V' block and clamp

Objectives: At the end of this exercise you shall be able to
- **select appropriate sizes of 'V' block to hold round bar**
- **find the centre of round bar using 'V' block and marking block.**



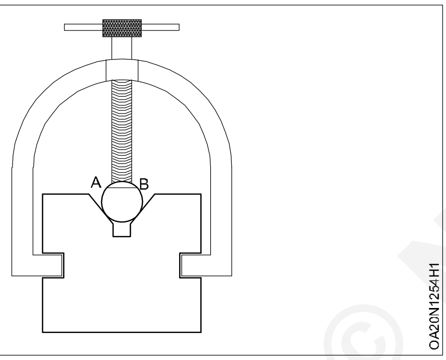
1	Ø50-50	-	Fe310	-	-	1.2.54
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MARKING CENTER OF A ROUND BAR	TOLERANCE : - ±0.5mm	TIME : 5Hrs
		CODE NO. OA20N1254E1	

Job Sequence

- File the faces of round bar
- Apply marking media on a face of round bar
- Clean marking table, 'V' block, marking block and steel rule
- Place ‘V’ block, marking block and steel rule on marking table.
- Set the round bar on ‘V’ block and clamp it with ‘U’ clamp.
- Place the marking block scriber on top of the round bar and read measurement in steel rule.
- Measure the height of round bar using steel rule
- Set the measurement in marking block using steel rule lesser than 10mm from the top of the round bar reading.
- Scribe line 'AB' on face of round bar using marking block as shown in Fig 1.

Fig 1



- Loosen the 'U' clamp
- Rotate and set the job to 90° using try square and Tighten the 'U' clamp and scribe line BC (Fig 2).
- Repeat the same procedure to scribe lines CD and AD fig 3.

Fig 2

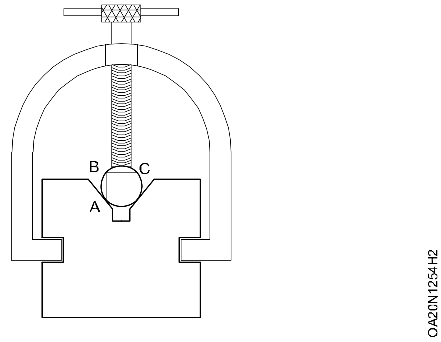
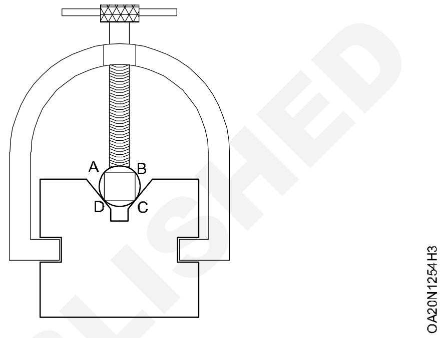
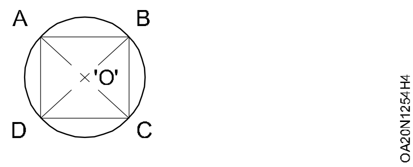


Fig 3



- Loosen the 'U' clamp and take out the round bar outside and keep it on marking table.
- Join the coordinate points ‘AC’ and ‘BD’ using steel rule and scriber fig 4.

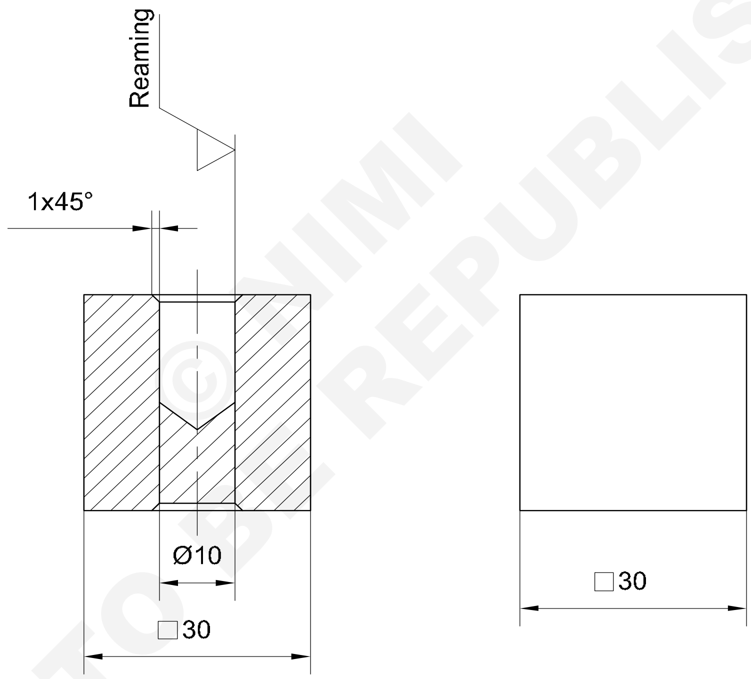
Fig 4



- Punch on the intersecting point 'O' using centre punch 90°.
- Point 'O' is the centre of round bar.
- Preserve it for evaluation.

Drilling and reaming a blind holes along the axis of round jobs

Objectives: At the end of this exercise you will be able to
- **drill and ream a blind hole using machine reamer in drilling machine**
- **use a floating chuck for reaming.**



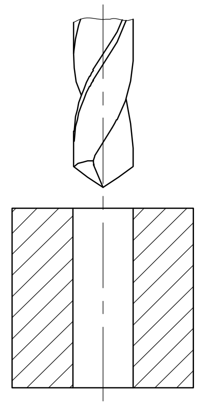
1	-	FP-1-26 FP-1-14 PART B	Fe310-O	-	-	20
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	DRILLING AND REAMING OF BLIND HOLES	DEVIATIONS AS PER IS : 2102 (m)	TIME 2h
		CODE NO. OA20N1255E1	

Job sequence

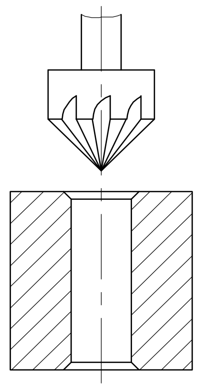
- Mark the center point in the given material.
- Register a deep punch mark for drilling.
- Find out the reaming allowance for 10 mm reamer .
- Fix the material in the machine vice rigidly.
- Drill the hole. (9.8 mm) dia. (Fig 1)

Fig 1



- Chamfer the hole end with a countersink (Fig 2) to guide the reamer concentrically.

Fig 2



- Hold the machine reamer directly in the spindle. (Fig 3)

Caution: Don't disturb the job setting for the above 3 operations.

- Select the spindle speed for reaming (1/3 to 1/2 the rate of cutting speed of drilling).
- Rate of feed should be 2 to 3 times lesser than of those used for drilling of the same dia.

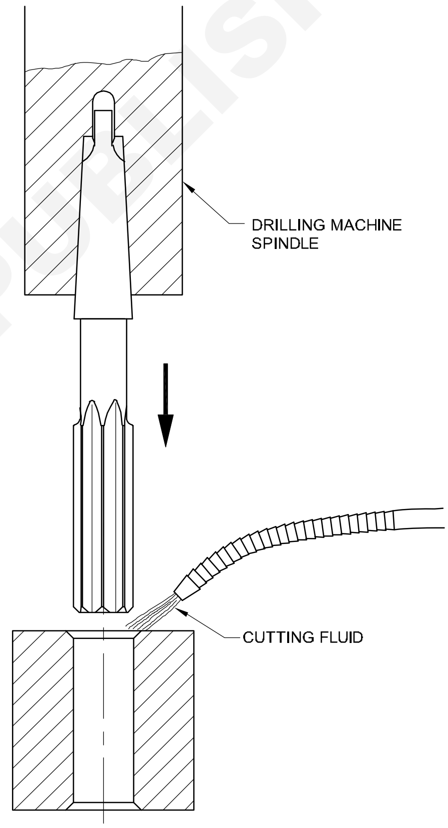
Caution: Too low feed may glaze the hole, and too high may tends to reduce the accuracy of hole and quality of the surface finish.

The amount of feed may vary for different job materials.

- Provide cutting fluid for smooth cutting.
- Switch on the machine and start the operation.
- Once the reamer has passed through the hole withdraw the reamer from the hole while the spindle is rotating.

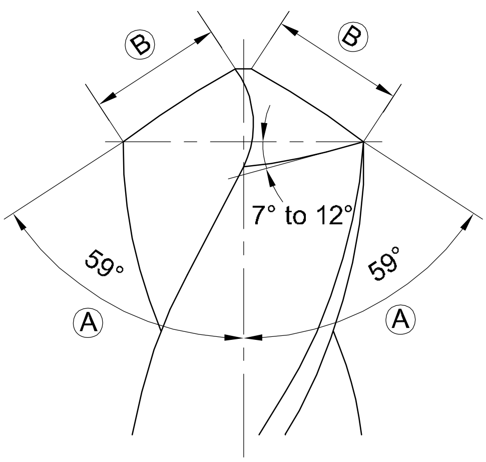
Caution: Never reverse the machine spindle to withdraw the reamer from the hole.

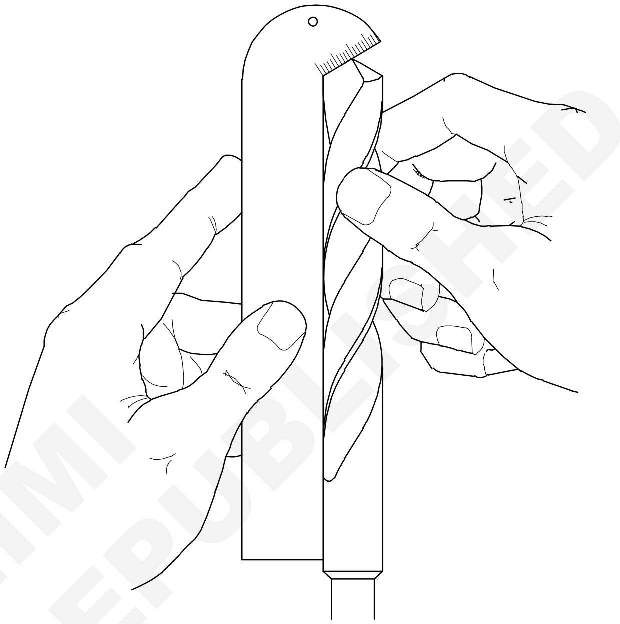
Fig 3



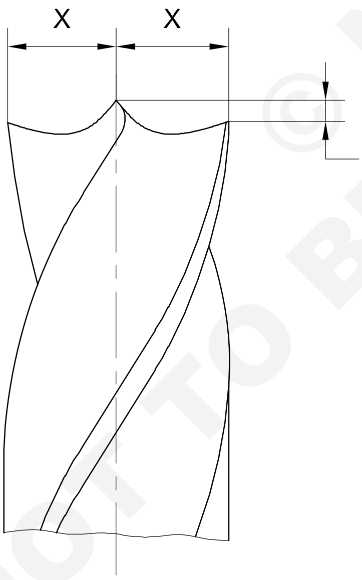
Grinding of drills to specification and checking of angles with gauges

Objectives: At the end of this exercise you will be able to
- **re-sharpen the twist-drill point to 118°, when it becomes blunt**
- **check the drill point with drill grinding gauge for the accuracy of grinding operation**
- **alter the standard drill point for drilling sheet metal.**





CHECKING LIP LENGTH AND ANGLE



DRILL POINT FOR DRILLING SHEET METAL

Note to the instructor

1 Please provide old worn out drills from section stores for grinding of standard 118° point.

2 Please demonstrate grinding drill point for sheet metal drilling and give skill information sheet to each trainee.

Stock size : Old wornout drill from section stores.

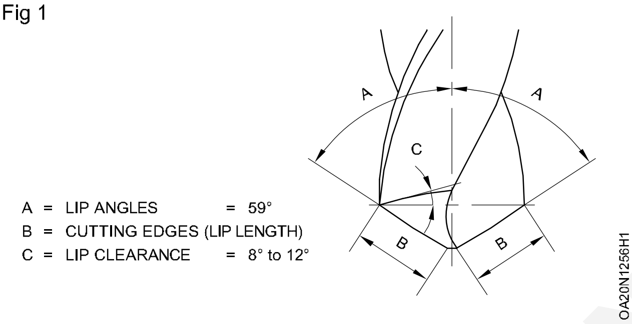
-	-	-	-	-	-	19
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	DRILL GRINDING (118° POINT ANGLE) AND DRILL GRINDING FOR SHEET METAL DRILLING	TIME 5h
		CODE NO. OA20N1256E1

Job sequence

- For general purpose drilling of steel the point of the twist drill is ground with an angle of 118°.
- Select a bench grinder fixed with a dressed silicon carbide grinding wheel.
- Use the face of the wheel for grinding the drill.
- Follow the safety procedures of working in a bench grinder.
- Wear safety goggles.
- Grind both lips with equal length and equal lip clearance of approximately 12°.
- Maintain the lip angle 59° either side from the axis of the drill.
- Check the angle with a drill grinding gauge and ensure the angle. (Fig 1)

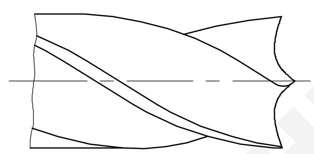
Fig 1



Caution: Don't cool HSS drill in water allow to cool in air only.

- For drilling sheet metal drill with usual point angle is not suitable.
- Grind the end of the drill flat and square with the axis.
- Leaving the web, grind the 2 lips with a slight radius as shown in the Fig 2.
- Sharpen the web like a point to penetrate in to the sheet metal.

Fig 2



POINT OF A DRILL FOR DRILLING SHEET METAL

Skill sequence

Sharpening of drills

Objective: This shall help you to
- **sharpen drills on an off hand grinder.**

A drill will loose the sharpness of its cutting edges due to continuous use, and improper use of drills will also spoil the cutting edges.

Spoiled or blunt cutting edges of the drills must be sharpened on a grinder.

Check the grinding wheel for loading, glazing, trueness and cracks. Call your instructor for advice. Dress and true the wheel if necessary.

Protect your eyes either with goggles or by lowering the eye protecting shield near the tool rest and adjust the tool rest 2 mm closer to the wheel, if necessary.

Switch on the grinder.

Hold the shank of the drill lightly between the thumb and the forefinger, and with the other hand hold the portion near the point. (Fig 1)

The hand near the point of the drill should be pivoted lightly on the tool rest at 'x' for easy manipulation. (Fig 2)

Fig 1

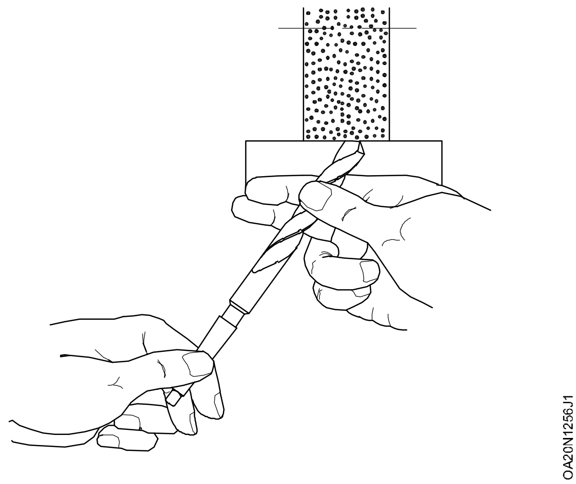
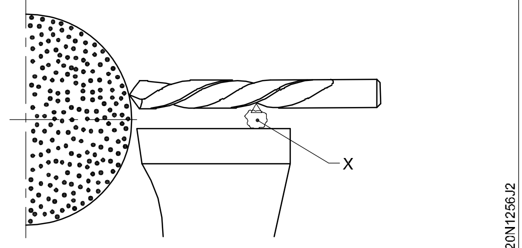


Fig 2



Hold the drill level (Fig 1) and turn it to 59° to the face of the wheel and swing the drill slightly downward and towards left. (Figs 3 & 4)

Rotate the drill to the right by turning it between the thumb and the forefinger. (Fig 4)

Fig 3

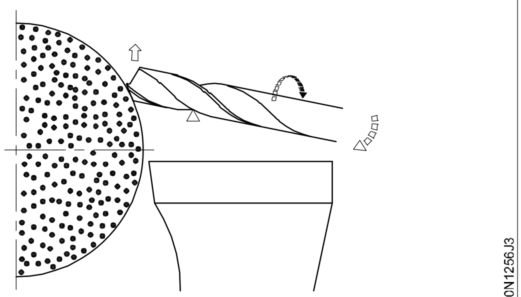
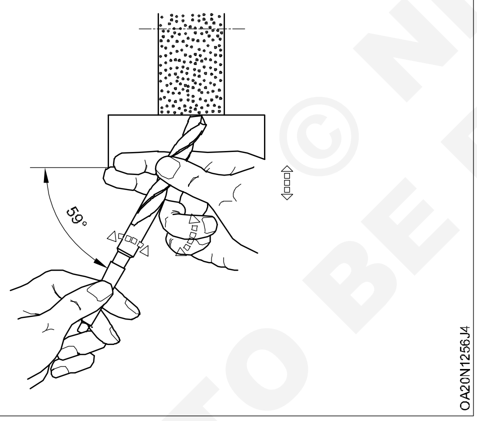


Fig 4



This turning movement is not necessary for smaller dia. drills.

While swinging down, apply a slight forward motion. This will help to form the clearance angle.

While swinging and turning the drill make sure you do not grind the other cutting edge.

All movements of the drill in angular turning, swinging and forward movements, should be well coordinated. They should result in one smooth movement to produce a uniformly finished surface.

Repeat the process to re-sharpen the other cutting edge.

Check both the cutting edges with a drill angle gauge, for correctness of the lip angle and equality of the lip lengths. (Figs 5 and 6)

Check the lip clearance angle in Fig 5 visually. The angle should be between 7° to 12°.

Fig 5

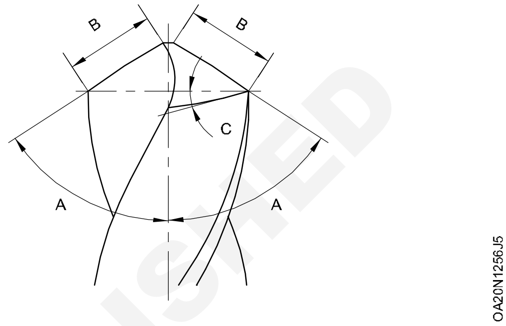
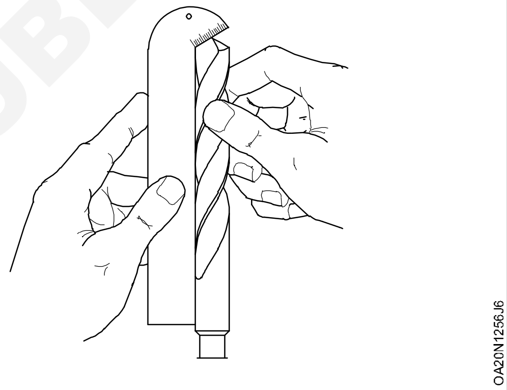


Fig 6



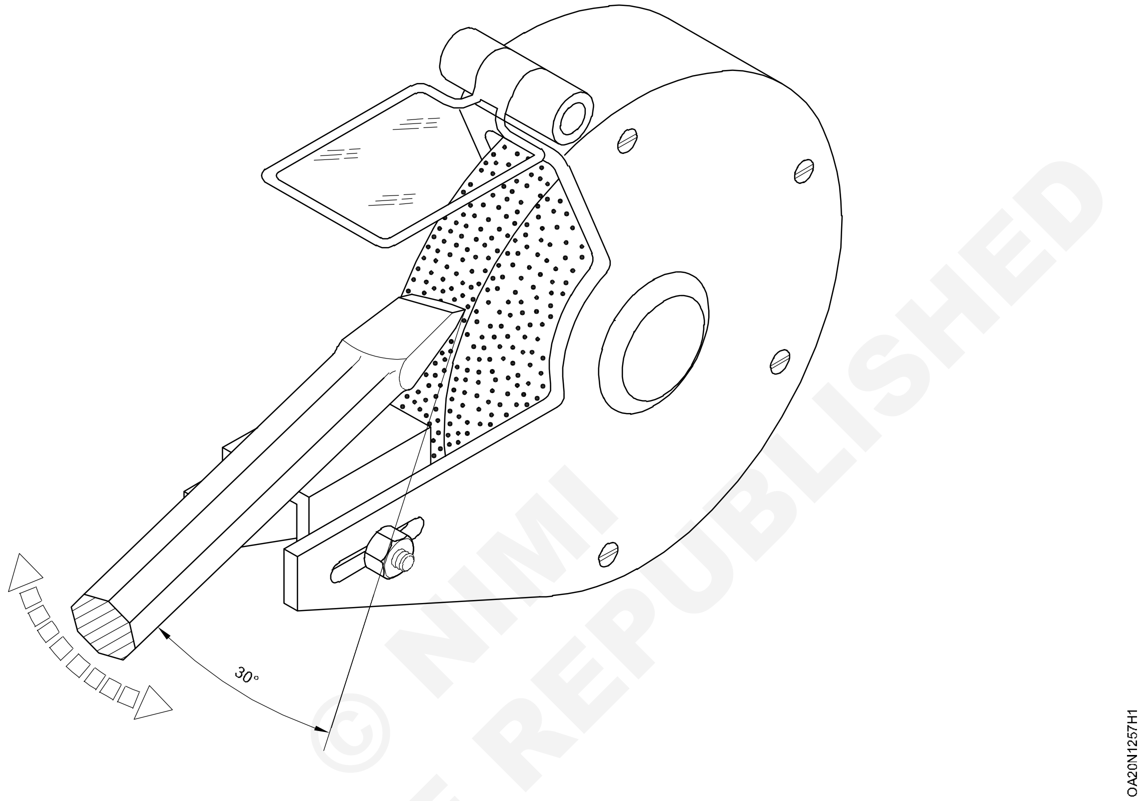
When you are satisfied correct equal angle and equal lip length. Drill a hole in a scrap metal. Before drilling confirm correct drill speed (r.p.m.) use cutting fluid.

Verify the condition of the hole while drilling. Did the drill chatter? If chattering happened, this could be caused by too much lip clearance. If the hole is over size by more than 0.12 to 0.25 mm then check for uneven lip lengths / uneven lip angles.

Grinding of chisels

Objectives: At the end of this exercise you shall be able to
- **re-sharpen the flat chisel using pedestal/bench grinder**
- **operate safely the pedestal or bench grinding machine.**

Fig 1



Skill Sequence

Grinding of flat chisel

Objective: This shall help you to
- **grind a flat chisel when they become blunt.**

Before grinding: Check the grinding wheel by,

– sliding the finger tip across the grinding wheel to detect glazing

– (In case of glazing, dress the wheel.) For dressing use silicon carbide sticks and seek the help of the instructor. (Fig 1)

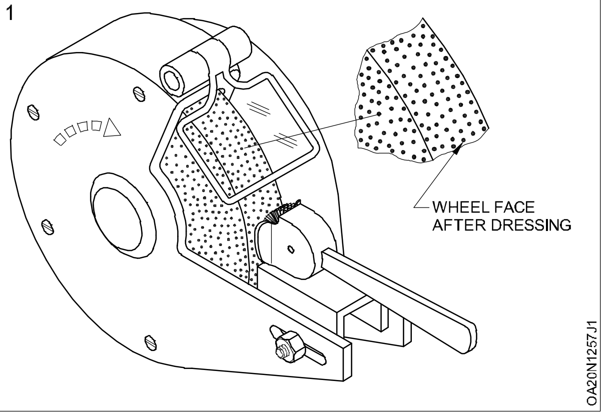
– visually check for cracks.

Switch on the grinder, stand by the side of the wheel for safety, and see whether the wheel runs 'true' and has no excessive vibration. In case of excessive vibration, truing is necessary. Ask the instructor for advice.

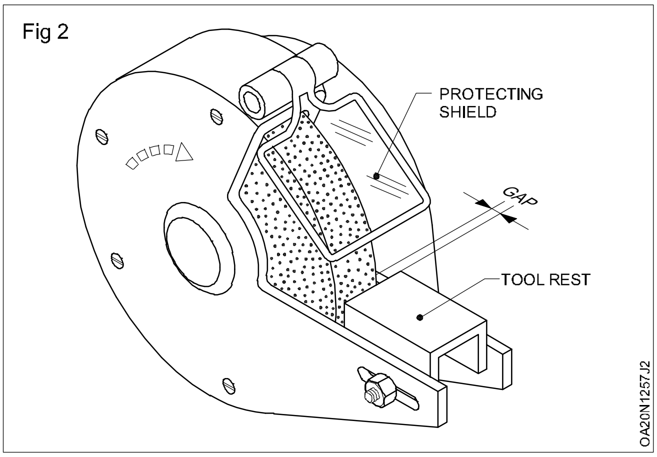
Ensure that there is enough coolant in the container.

Protect your eyes with goggles or lower the protecting shield near the tool rest. (Fig 2)

Fig 1



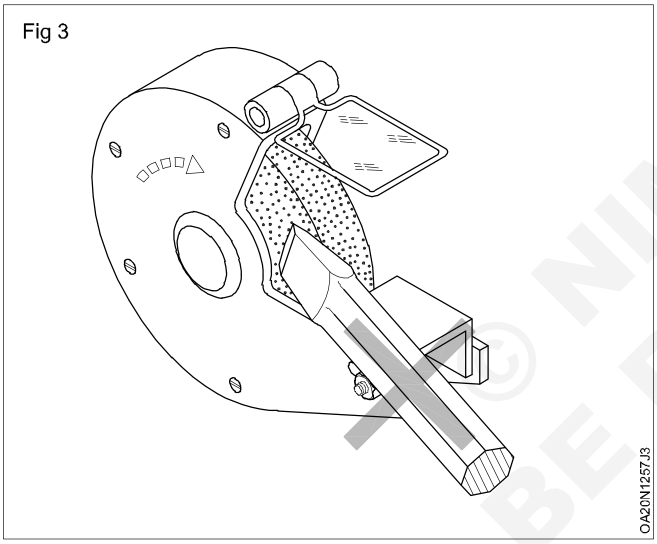
Adjust the tool rest 2 mm closer to the wheel, if necessary. (Fig 2)



During grinding: Take a blunt chisel for re-grinding. Chisels will become blunt due to use. For efficient chipping, chisels are to be re-sharpened regularly.

Do not use cotton waste or other material for holding the chisel while grinding.

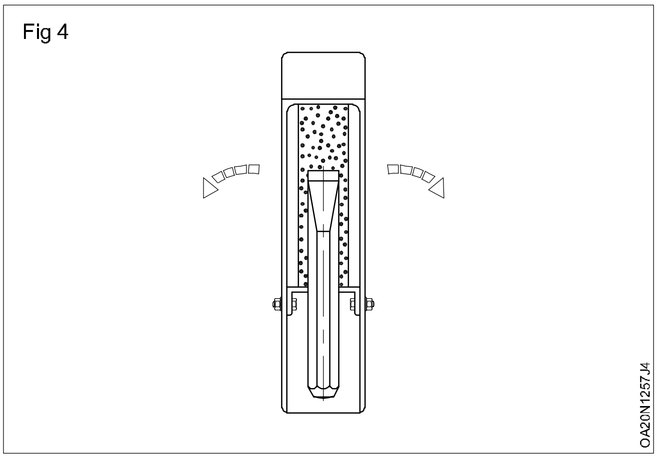
Use only the face of the wheel and not the sides (Fig 3)



Switch on the grinder.

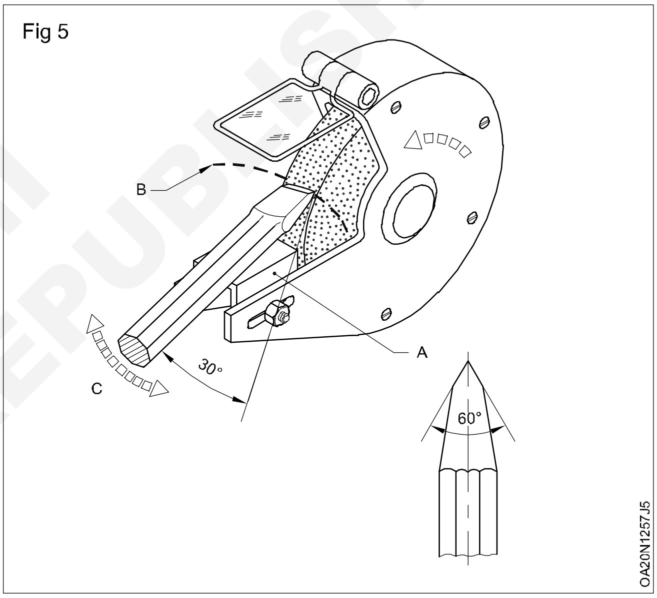
Hold the chisel edge parallel to the wheel surface; the body of the chisel must be at an angle of 30° in such a way as to get 60° wedge angle. (Fig 5)

Rest the body of the chisel on the tool rest (A) (Fig.5) and allow the point to touch the wheel. (Figs 4 & 5)



Keep the pressure as minimum as possible to prevent excessive heating of the cutting edge, (avoid blue colour i.e. annealing effect).

Rock the point on both sides in an arc to provide convexity at the cutting edge. (Fig 5) See the arrows 'C'.



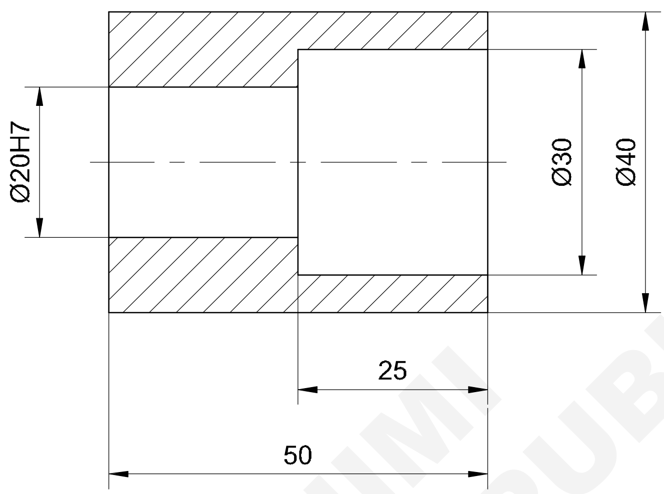
Dip the chisel in the coolant as and when it is required so as to avoid overheating.

Repeat the grinding on the opposite side of the cutting edge.

Check the wedge angle with a bevel protractor.

Measurement of shaft and hole diameters using outside and inside micrometer

Objectives: At the end of this exercise you shall be able to
- **bore using a boring bar within an accuracy of ±0.08mm**
- **maintain a square face at a step bored hole; ream the hole to ∅20 H7**
- **check the bore size with a inside micrometer.**



Job sequence

- Check the raw material size, and deburr.
- Hold the job in a 4 jaw chuck protruding about 40mm outside, and true the job.
- Set the speed according to the diameter; face and centre drill.
- Turn the outside diameter to ∅ 40.5 mm to a maximum length.
- Drill pilot holes starting from ∅ 8mm up to ∅ 19mm through.
- Bore hole to ∅ 19.75 mm through with a boring bar with a bit and countersink the bore for reaming.
- Set the spindle speed for reaming and carry out reaming ∅ 20H7 to full length. Check with a plug gauge.
- Finish turn the outside diameter 40.5mm to ∅ 40 mm.
- Reverse the job and hold on ∅ 40 mm in a 4 jaw chuck and true it.
- Face and maintain 50 mm total length.
- Finish bore ∅ 30mm × 25mm length and measure with a inside micrometer. Chamfer bore 0.5 × 45°
- Finish turn OD to ∅ 40 mm.
- Break the sharp edges.

1	Ø45 - 55	–	Fe310	–	–	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1 : 1	MEASUREMENT OF SHAFT AND HOLE DIAMETERS	TOLERANCE ±0.08 Unless otherwise stated	-
		CODE NO. OA20N1258E1	

Precision measuring instruments - outside metric micrometer

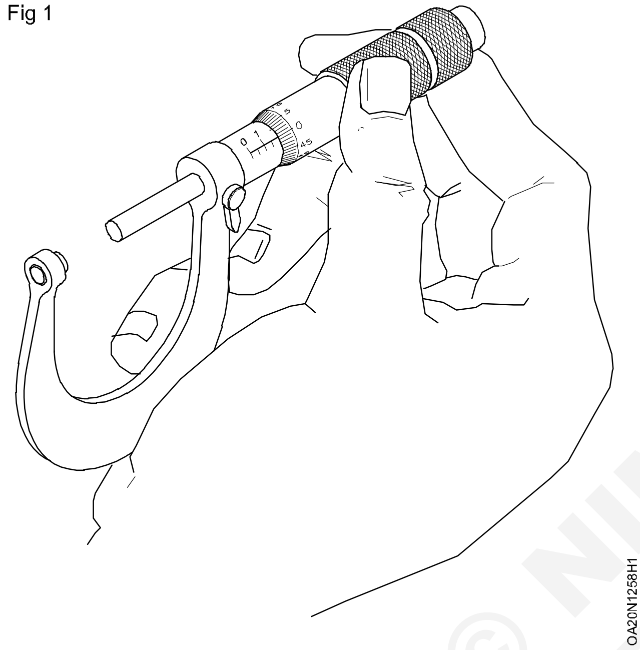
Objectives : This shall help you to
- **hold the micrometer for measurement**
- **set the micrometer on work for measurement**
- **read the measurement.**

Holding the micrometer for measurement

The micrometer may be held either in one hand or both the hands.

Holding in one hand (Fig 1)

Fig 1



Hold the outside micrometer in your right hand, keeping the graduations on the main scale towards you.

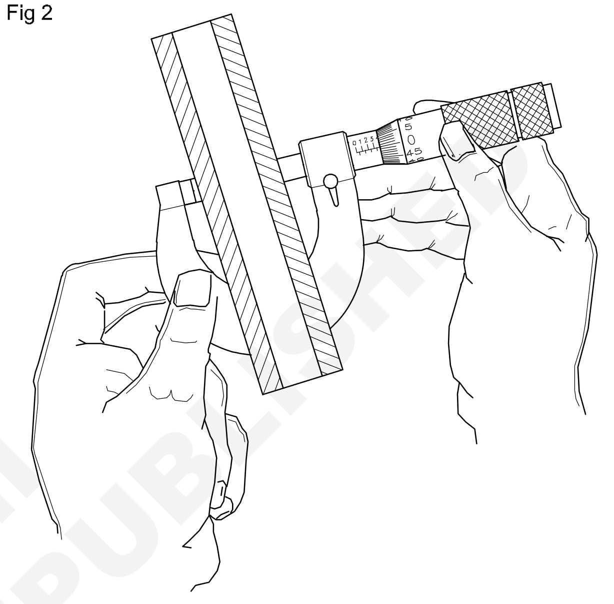
Support the frame on the lower centre of your palm. Use your little or third finger ta hold the frame in the palm.

Place the middle finger behind the frame to support it.

Keep the first finger and thumb free to adjust the knurled thimble.

Holding by both the hands (Fig 2)

Fig 2



Sometimes, it may be more convenient to hold the micrometer with both the hands.

Support the frame between the fingers and the thumb of your left hand.

Use the thumb and finger of your right hand to adjust the thimble.

Measuring holes and slots using telescopic gauges

Objective : This shall help you to
- **check holes and slots using a telescopic gauge.**

Measure the approximate size of the hole or slot with a steel rule.

Select a suitable range of a telescopic gauge.Press the moving leg gently and place it inside the hole. (Fig 1)

Release the pressure and allow both the legs to touch on the wall of the hole.

Keep the inside micrometer perpendicular to the diameter of the hole.

Move the gauge slightly inside the hole and get the correct 'feel'.

Check the diameter again and confirm the reading.

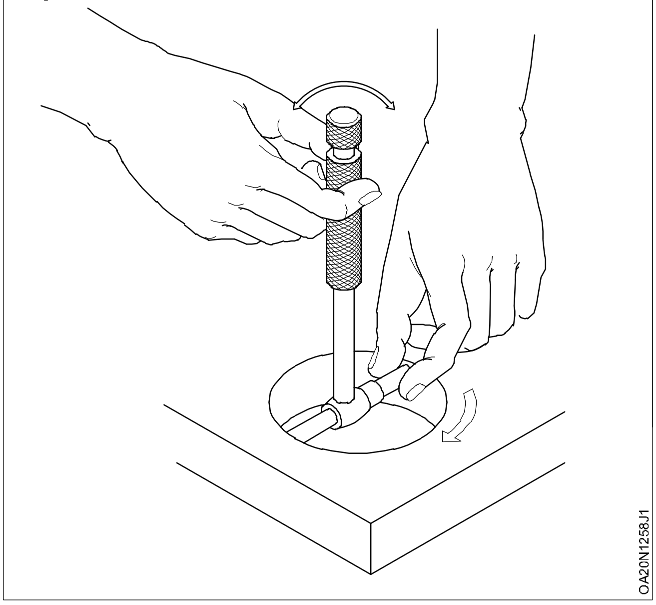


Fig 1

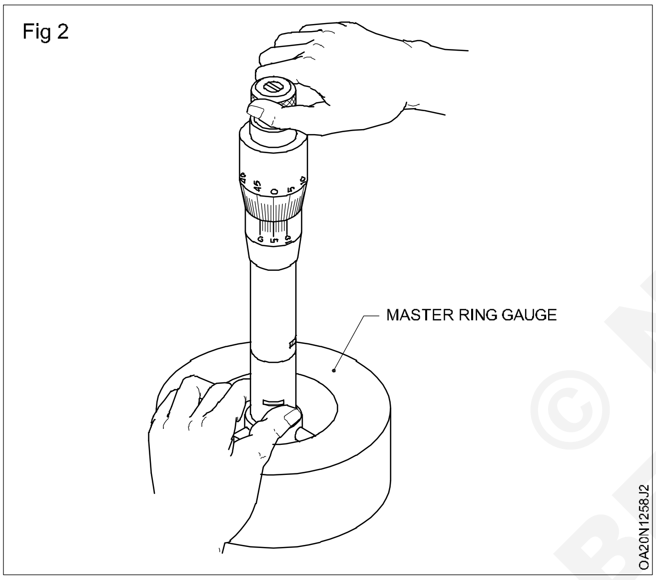


Fig 2

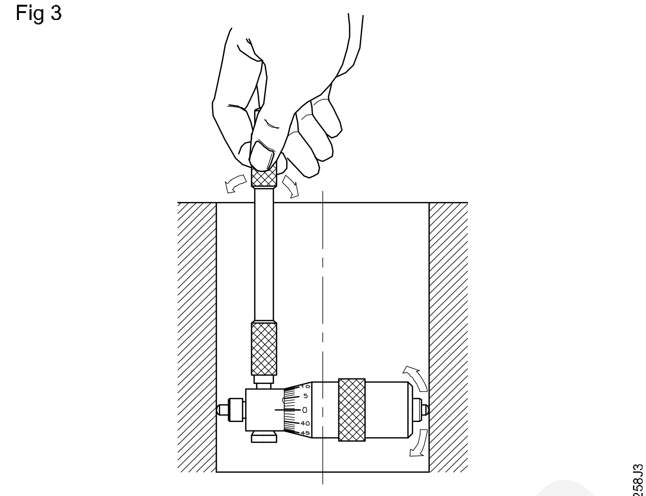
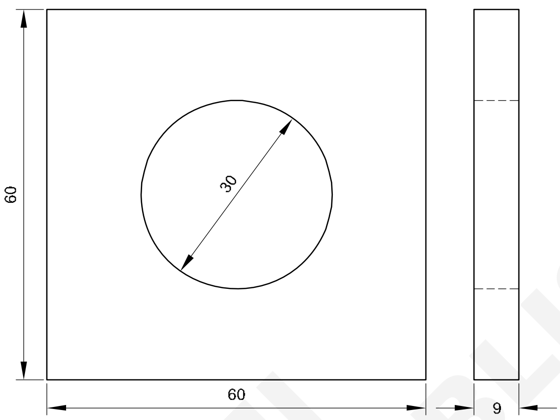


Fig 3

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

Filing round out of square bar within 0.1mm. Filing to an accuracy of ± 0.1mm, checking with an outside micrometer.

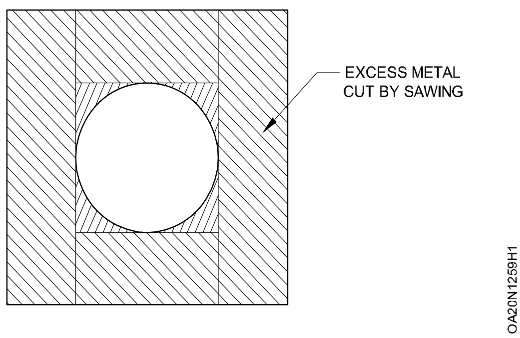
Objectives: At the end of this exercise you shall be able to
- **mark the circle in the square plate**
- **cut the excess material using hacksaw**
- **file the plate with accuracy of ± 0.1mm.**



Job sequence

- Check the raw metal size using steel rule.
- Mark the circle in centre of square plate.
- Dot punch on the marked line.
- Cut and remove, excess metal by sawing.
- File the excess material using rough file.
- File convex circular part using second cut file.
- The flat surface are rounded and brought rear about to finishing size.
- Check the circle frequently with a template.
- Do not give excessive pressure while filing curved part of circle as the file may likely to slip.
- Finish to the required size.
- Measure the diameter of circular plate using outside micrometer.
- Apply a little oil and pressure it for evaluation.

Fig 1

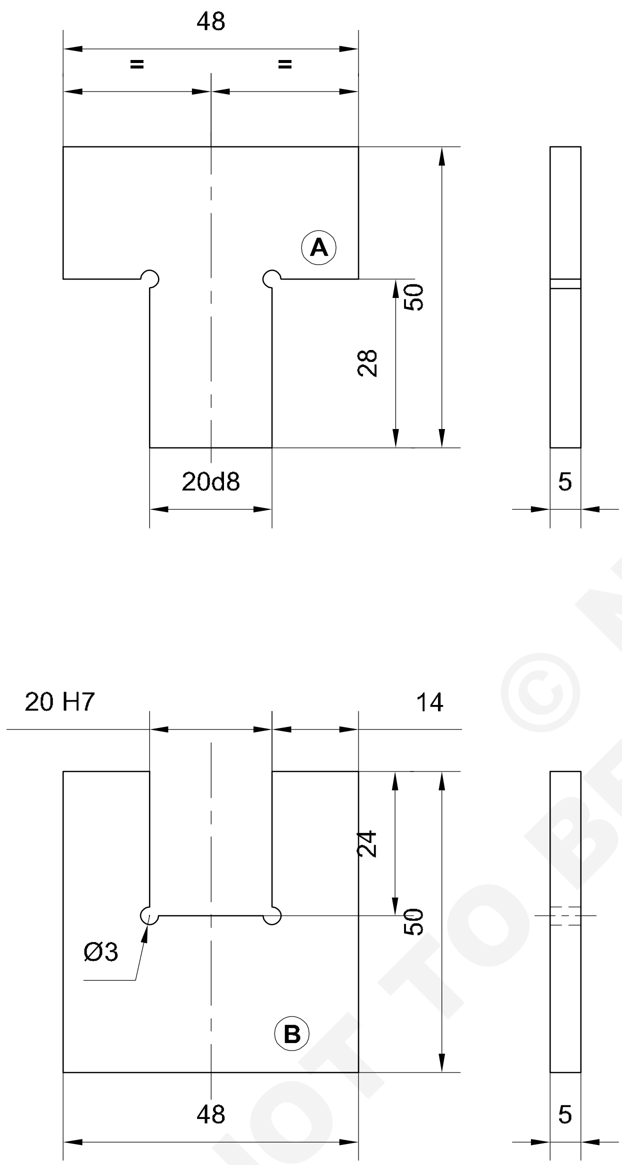


1	80 ISF 10 - 80	-	Fe310	-	-	1.2.59
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	FILING ROUND IN SQUARE BAR	TOLERANCE : ±0. 5mm	TIME : 5Hrs
		CODE NO. OA20N1259E1	

Preparation of plates for a gauge fitting.

Objectives: At the end of this exercise you shall be able to
- **file and assemble part A and B with the required fit.**



Job sequence

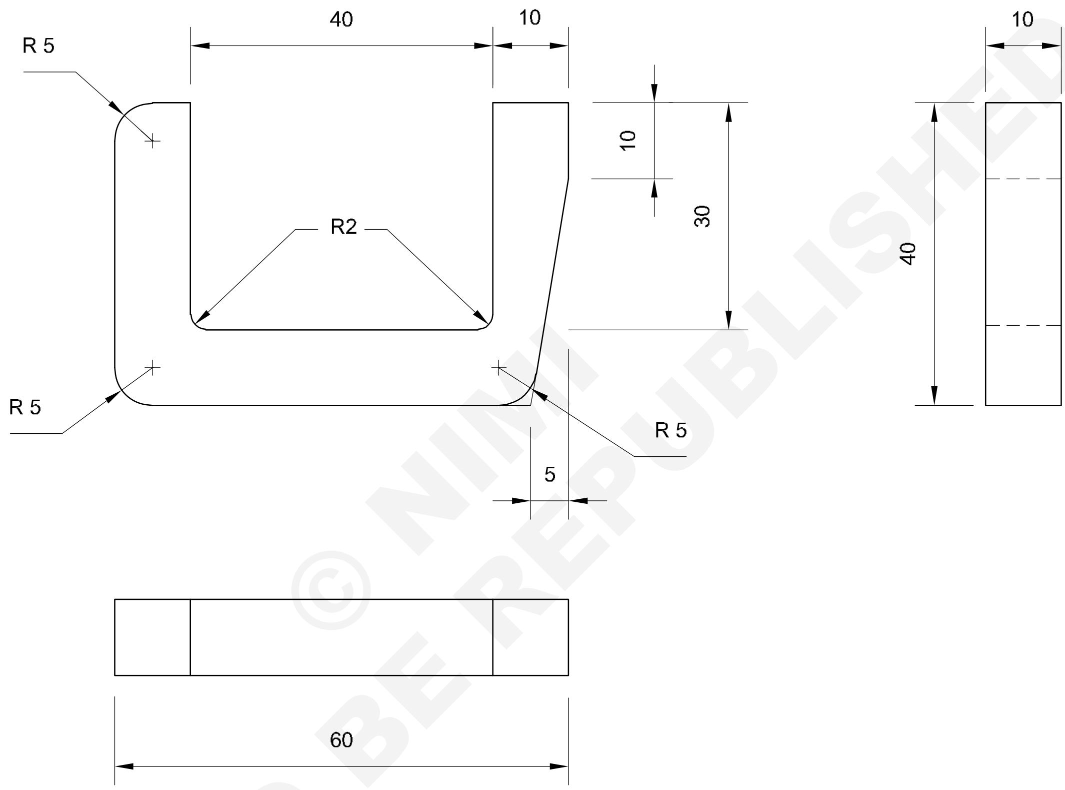
- Check the given raw material for its size by measurement.
- Rough and finish the surface flat to size 5 x 48x 105 mm, maintaining surfaces at right angles within the specified accuracy.
- Mark of sizes of both parts using the same reference surfaces.
- Hacksaw and part off the pieces.
- Drill relief holes 3mm on both the pieces.
- Hacksaw the extra metals, If any.
- File and finish the tongue (male piece A) to dimensions, and remove all sharp corners.
- Ensure that the tongue width 20 is symmertrical with respect to the centre line.
- File and finish female part B - the groove width
  20 } + 0.060 maintaining equality with
  - 0.000 respect to the centre line.
- Assemble part A to B using the tongue as gauge to finish part B
- Check the assembly for the required class of fit.

1	50 ISF 6-110	-	Fe310	-	-	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-

SCALE 1:1	GUAGE FITTING	DEVIATIONS ±0.6	-
		CODE NO: OA20N1260E1	

Exercise on filing radius and angular filing using templates and gauges

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.**

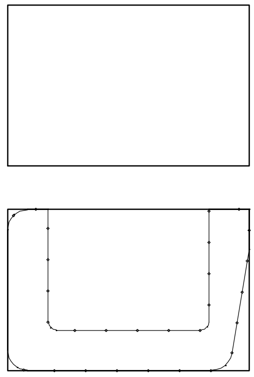


1	65 ISF 12 - 45	-	Fe310			1.2.61
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	FILE RADIUS AND PROFILE TO SUIT GAUGE				TOLERANCE : 0.04	TIME : 13 Hrs
					CODE NO : OA20N1261E1	

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.

Fig 1



- File and smooth finish all sides maintaining ±0.04 mm.
- 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.

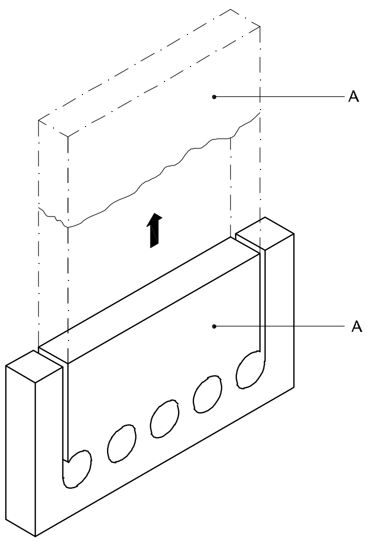
While cutting the web, the chisel is kept at an angle. (Fig 2)

Remove only thin chips of equal thickness.

Thick workpieces need cutting with a web chisel from both sides

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

Fig 1

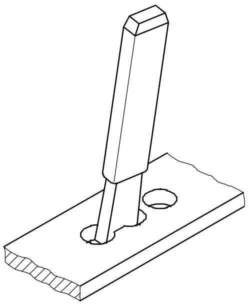


About 1 mm thick web is convenient for drilling and separating with a chisel.

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

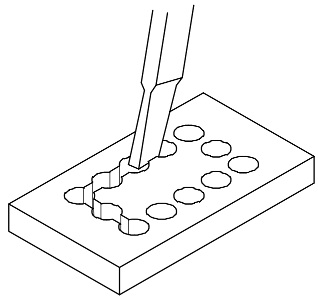
For easier parting off, select suitable hole size to permit the chisel to enter and leave minimum material for filing.

Fig 2



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

Fig 3



Filing radius (external)

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

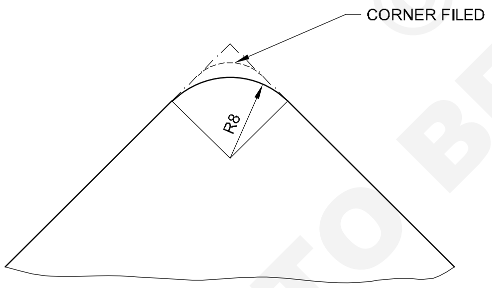
Filing radius is entirely a different technique, and needs considerable skill for filing accurately with a good finish.

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

Rough filing of corners

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

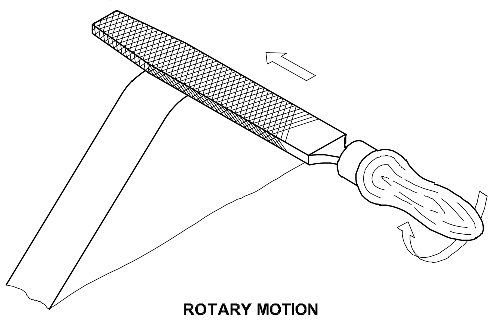
Fig 1



Rounding of corners

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

Fig 2

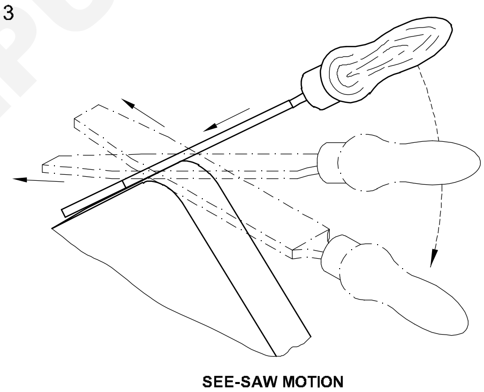


Check periodically with a radius gauge.

Final finishing of radius

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

Fig 3



While filing make sure

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

Checking the radius

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

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

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

Fig 1

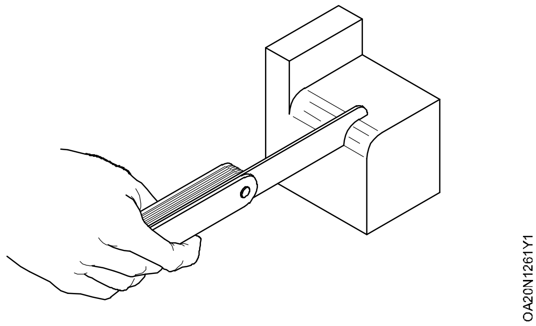
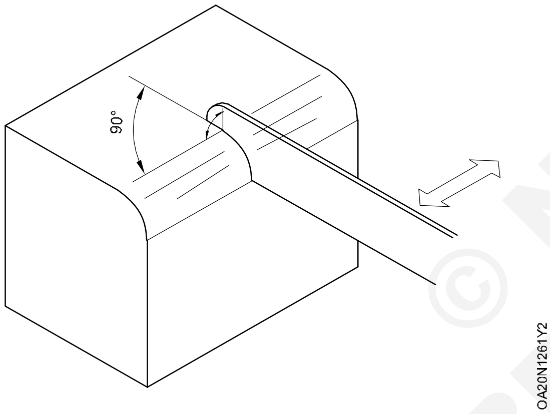


Fig 2



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

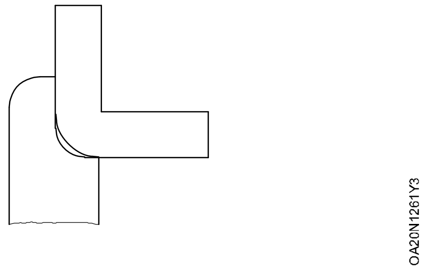
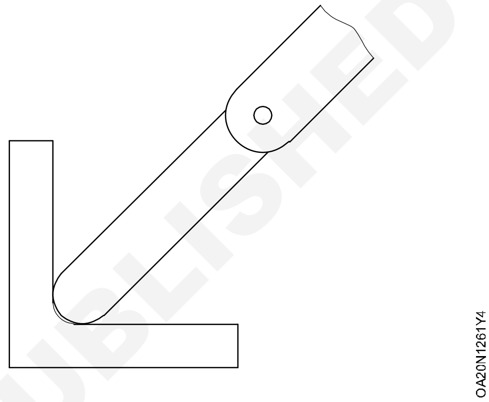
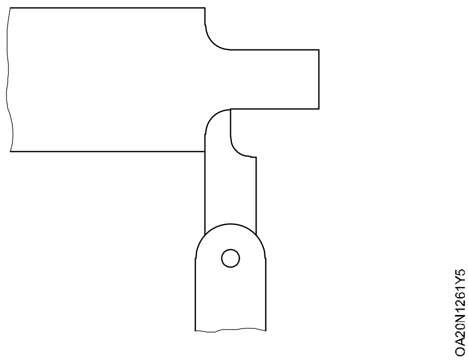


Fig 4



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

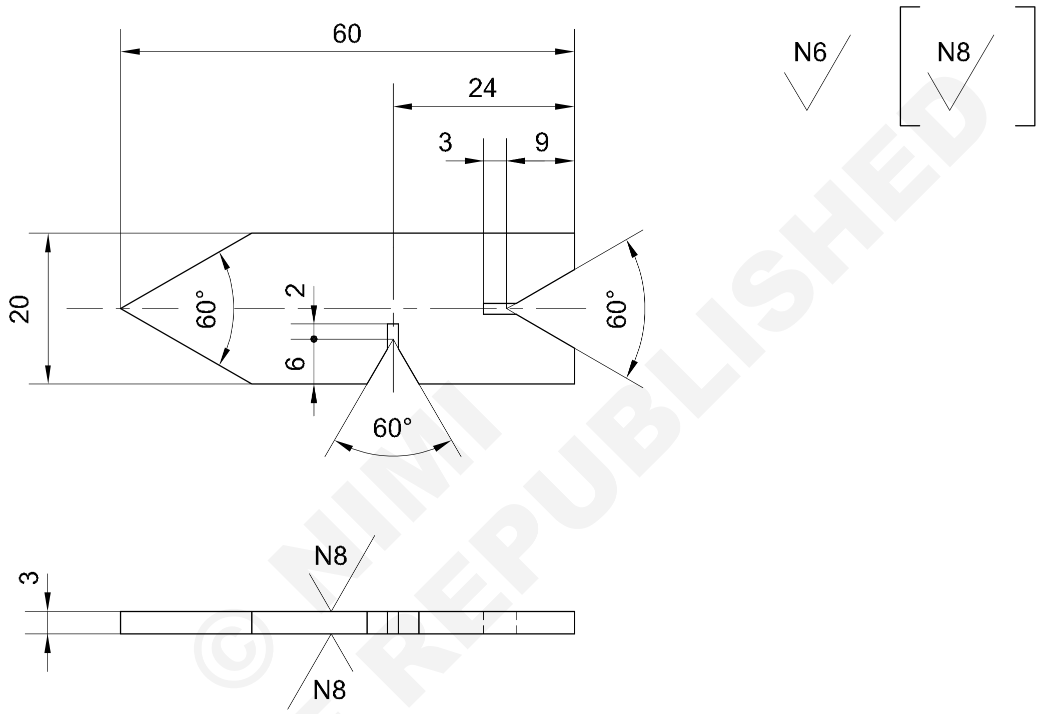
Fig 5



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

FIling templates and gauge for checking lathe tool angles

Objectives: At the end of this exercise you shall be able to
- **file surfaces flat and parallel within ± 0.02 mm**
- **mark dimensions on workpiece using a vernier height gauge**
- **mark angles on workpiece using a vernier bevel protractor**
- **check parallelism of the workpiece with a dial indicator.**



Job sequence

- Remove burrs and check the raw material size.
- FIle the large surface with a 200 mm flat second cut file. (Hold the sheet on the wooden block.)
- File two adjacent edges - flat and square.
- Mark dimensions as per drawing.
- Hacksaw and remove the excess material.
- Cut slots and finish slots with knife edge files.
- File and finish the remaining surfaces (60mm) to size and check the size.
- FIle and finish external and internal 60° angles to size and check with vernier bevel protractor
- FIle and finish thickness to 3mm, by fixing work on the wooden block.

Care should be taken to maintain the correct length

1	25 ISF 4 - 63	-	Fe310	1	-	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	-

SCALE 1:1	CENTRE GAUGE	DEVIATIONS LINEAR ±0.04 ANGULAR 5'	-
		CODE NO. OA20N1262E1	

Exercise on step and taper turning

Objectives: At the end of this exercise you shall be able to
- **turn the component as per drawing**
- **setting of taper turning attachment to turn taper**
- **check the taper using sine bar.**

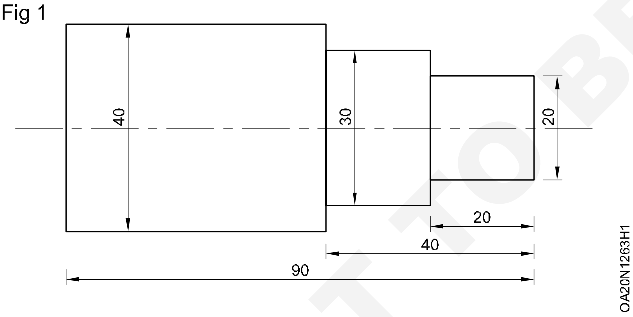
Job sequence

- Hold the jobs in a four jaws chuck, true and face one side.
- Reverse the job, true and maintain length C hold about 35mm inside the chuck.
- Reduce the diameter 30.5 mm upto length of 40mm
- By using a knife remove 0.5mm dia and turn upto 40mm
- By using a thick knife for maintain the diameter o 20mm for a length of 20mm
- Reverse the job, by holding on 30 dia, true the job and jinish of 40 mm for the remaining length with the help of a side knife tool.

Points to remeber

- Choose the rpm depending upon the diameter.
- Set the tool properly.
- Check the steps by using a steel rule. Use sufficient coolant.
- Remove burrs by filing.

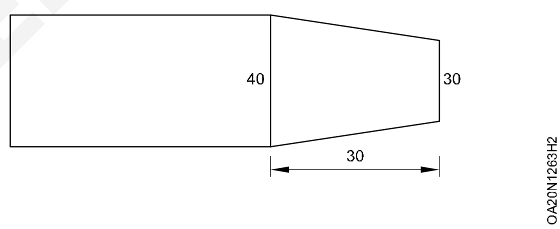
Fig 1



Task A

- Set the job in four jaw chuck projecting outside the chuck.
- True it by universal surface gauge.
- Set the carbide tip tool to the correct centre
- Set the spindle speed as per the cutting speed chart.
- Face one end.
- Turn dia d, and chuck by using vernier micrometer.
- Set the taper turning attachment to turn a taper of 1’26’16”
- Turn taper and checl tje dimensions as per drawing
- FIle on taper end by using safe edge file.
- Remove the job and check taper using sine bar.

Fig 2



Skill Sequence

Producing taper by using taper turning attachment

Objective: This shall help you to
- **set the taper turning attachment to the required angle**
- **produce taper by using a taper turning attachment.**

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.

Tighten 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.

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 the work surface.

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

Use the binding 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 metal chips.

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

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

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

Switch on the lathe.

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

Set the depth of the roughing cut.

Machine the work as with plain turning.

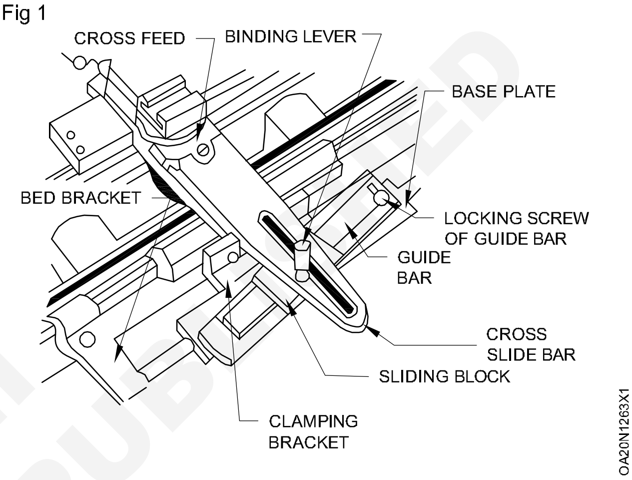
Remove the play by moving the cutting tool 12 mm beyond the right hand end of the work at the beginning of each cut.

Check the taper for fit.

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

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

Fig 1



Skill Sequence

Checking tapers

Objective: This shall help you to

- **check the taper using sine bar**
- **check the taper using ring gauges/taper plug gauges.**

Select suitable size sine bar and clean.

Calculate the height of slip gauges required for checking the angle.

Select minimum number of slip gauges to check required angle.

De-burr and clean the job.

Clean and "Wiring" slip gauges together.

Position the job on the sine bar but against plate on surface plate as shown in Fig 1.

Keep the tapered job on the top of the sine bar and with a reference diameter but against the angle plate.

Ensure that the sine bar angle plate and job are parallel to each other.

Position dial indicator on surface plate.

place the styles to one end of workpiece taper.

Slide stylus across width of taper to check the highest point.

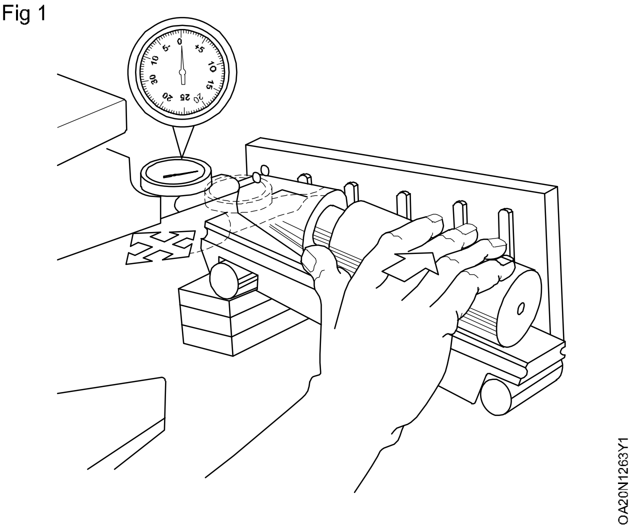
Set the indicator dial to zero position.

Check for zero reading at other and of taper.

Note amount of error.

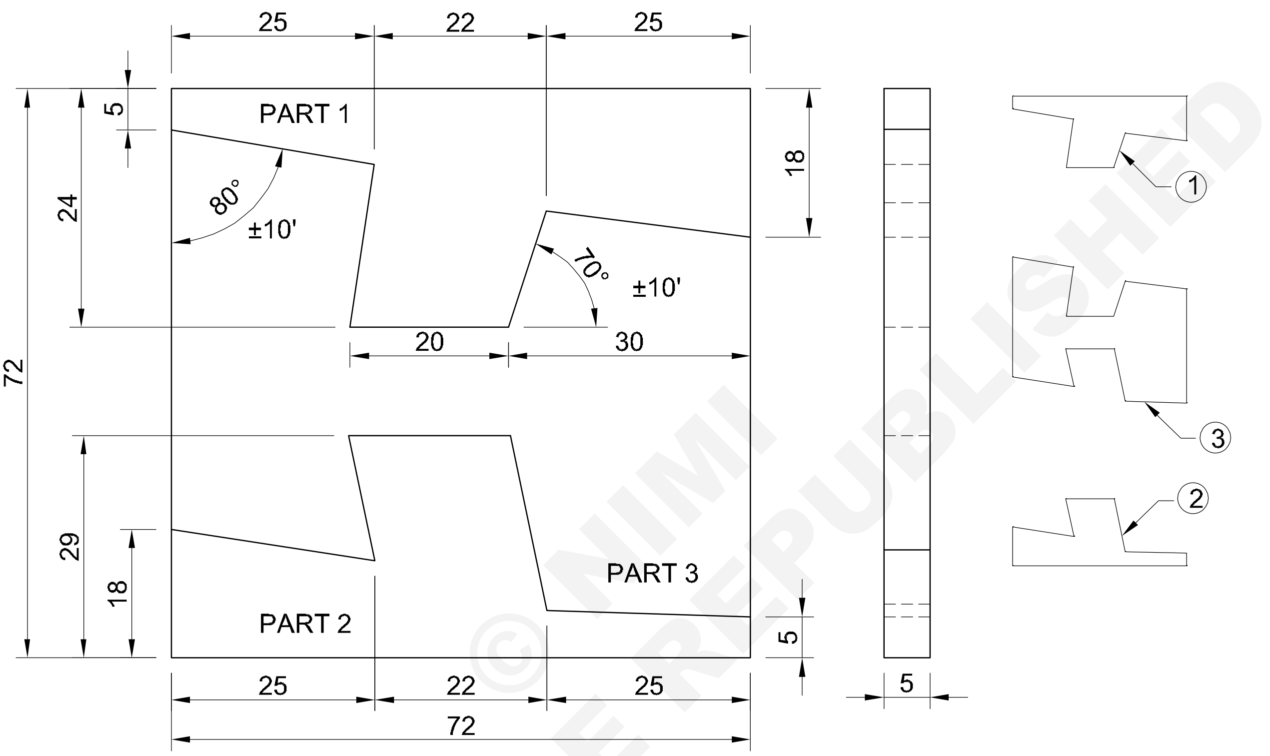
If angle is correct, a zero reading should be obtained at both ends of taper

Fig 1



FIling of various angle & clearance of lathe tool on square blank

Objectives: At the end of this exercise you shall be able to
- **mark angular otlines of part 1,2,3 with an accuracy of ± 10’ accuracy**
- **file part 1,2 & 3 maintaining the accuracy of ± 0.02 for fitting**
- **assemble the part 1,2 & 3**
- **finish and de-burr.**



Job sequence

- Check the raw material for its size.
- File surface and right angle and mark off part 1,2 & 3 with vernier height guage and vernier bevel protracor
- Punch on the marked lines.
- Remove excess materials by hacksawing & chain drilling.
- File part 1,2 & 3 with an linear accuracy of ± 0.02 mm and angular of ± 10’ .
- Check the linear dimensions with vernier caliper and angular by vernier bevel protractor.
- Fit part 1,2 & 3 simultaneously and finish.
- Apply little oil for preservation and evaluation

Do not mark angular dimension/angle by scale/set square while marking.

Do not make a force fit.

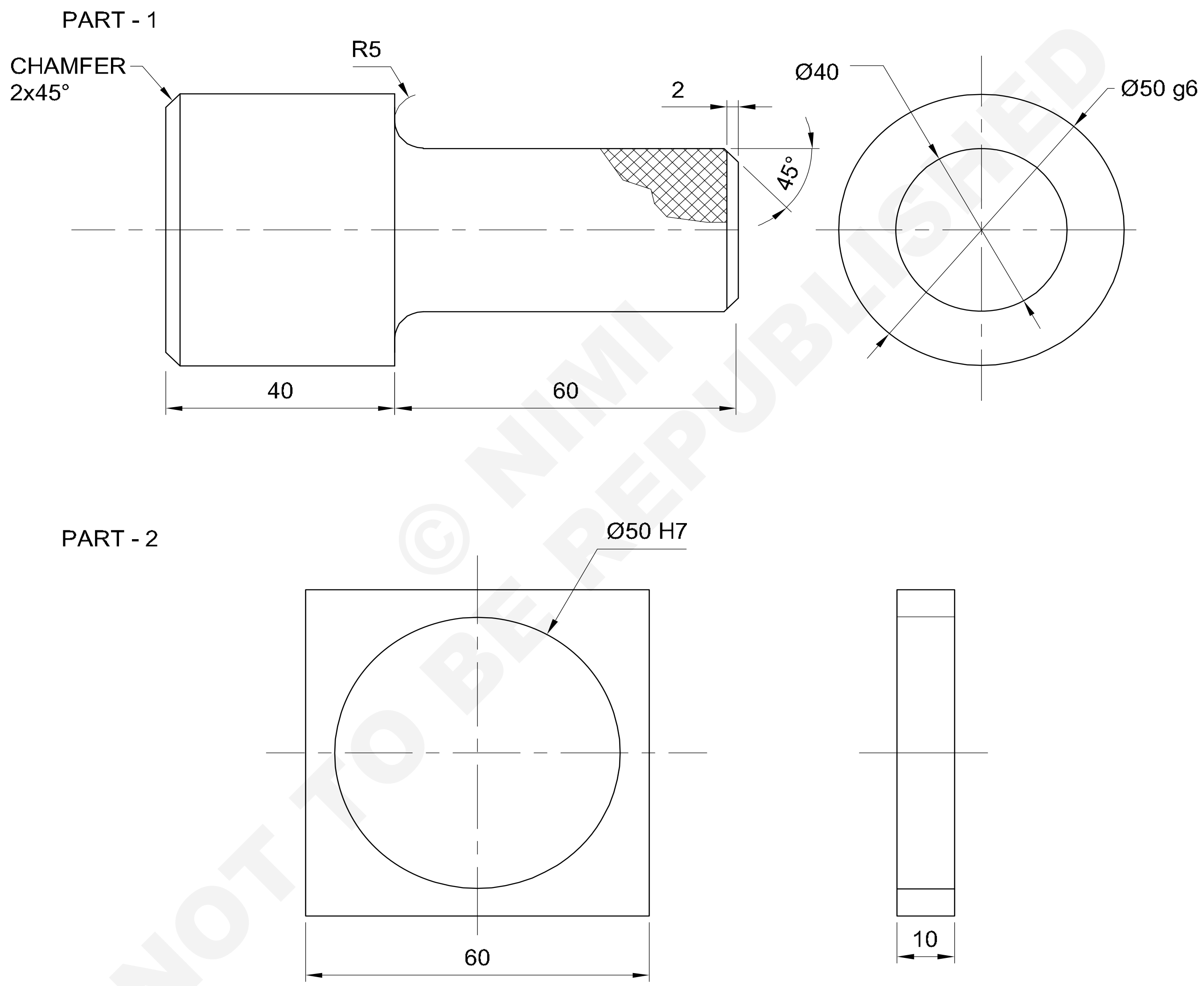
1	65 ISF 6 -75		Fe310		3	
1	35 ISF 6 - 75		Fe310		2	
1	35 ISF 6 - 75		Fe310		1	1.2.64
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1.1	FILE AND FIT ANGULAR MATTING SURFACE WITHIN AN ACCURACY OF ± 0.02 mm & 10 MINUTES ANGULAR FITTING	TOLERANCE : ±0.02	TIME: 25 Hrs
		CODE NO: OA20N1264E1	

Checking with templates & gauge already prepared

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

- **turn the shaft as per dimensions in part 1**
- **drill the hole dia 49.50 mm on part 2**
- **ream cylindrical bore to ∅ 50**
- **scrape on cylinder bore**
- **check the scrapped bore with plug gauge.**



1	65 ISF 12 - 65	-	Fe310	–	2	1.2.65
1	Ø56 - 105	-	Fe310	–	1	1.2.65
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	SCRAPPING CYLINDRICAL BORE AND TO MAKE A FIT	TOLERANCE : ±0.02mm	TIME: 15Hrs
		CODE NO: OA20N1265E1	

Job sequence

Part: 1

- Cut the raw material to its size.
- Turn the shaft as per dimension in lathe.
- Turn shouldering and knuri in the shaft job as per the drawing.
- Finish the shaft within the dimensions.
- (Part - 1 making correct size ∅ 50 g6 as a master gauge for checking scraped hole)

Part: 2

- Mark location of centre.
- Drill pilot hole and enlarge, the drilled hole to ∅ 49 mm.
- Ream the drilled hole ∅ 50 using adjustable reamer.
- Apply precision blue on cylindrical surface of a ∅ 50 mm plug gauge.
- Insert and rotate plug gauge in a hole smoothly to find high spots.
- Hold the job on bench vice.
- Scrap high spots with by using half round scraper.

Assembling Technique:

- Clean the scraped surface with soft cloth.
- Fit the master test piece to the scraped hole and rotate smoothly for testing.
- FIt the shaft into the cylindrical hole as per drawing and rotate it freely.
- Apply a little oil and preserve it for evaluation.

Skill Sequence

Scraping curved surface

Objective: This shall help you to

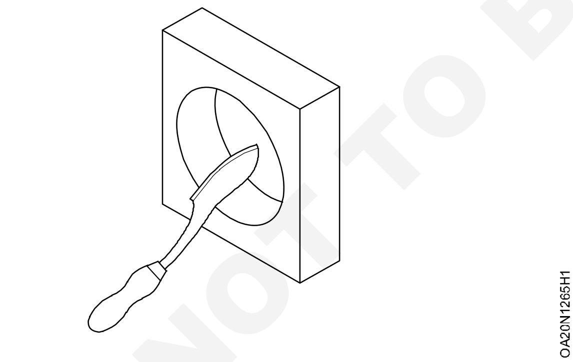
- **scraping and testing of curved surface.**

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 i n such a way as to facilities 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 line 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

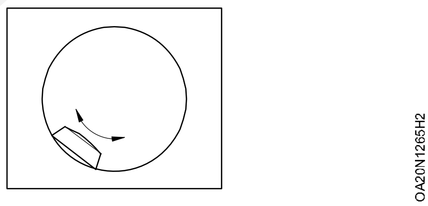
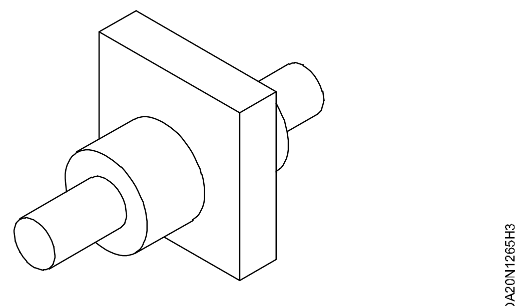


Fig 3



After each pass, change the direction of cutting. This ensures a uniform surface.

> **Apply a thin coating of prussion blue on the master bar to locate the high spots**

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

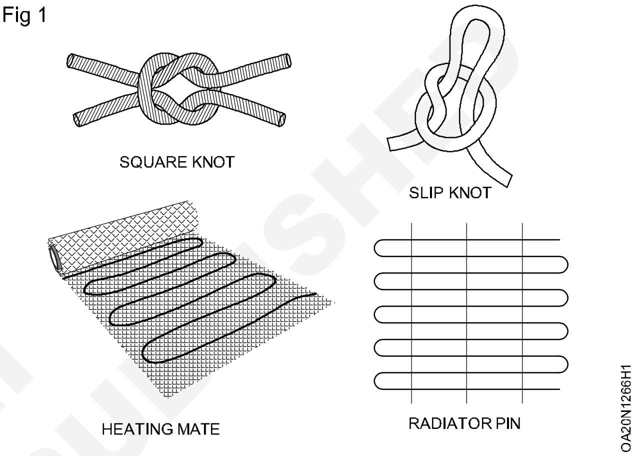
Use of combination & round nose plier to make different shape / profile by bending wire to make the blue print to develop manipulation skills, hand control & eye judgement

Objectives: At the end of this exercise you shall be able to
- **practice combination and nose plier for bending wire to make different shape make wire loop using nose plier**

Job sequence

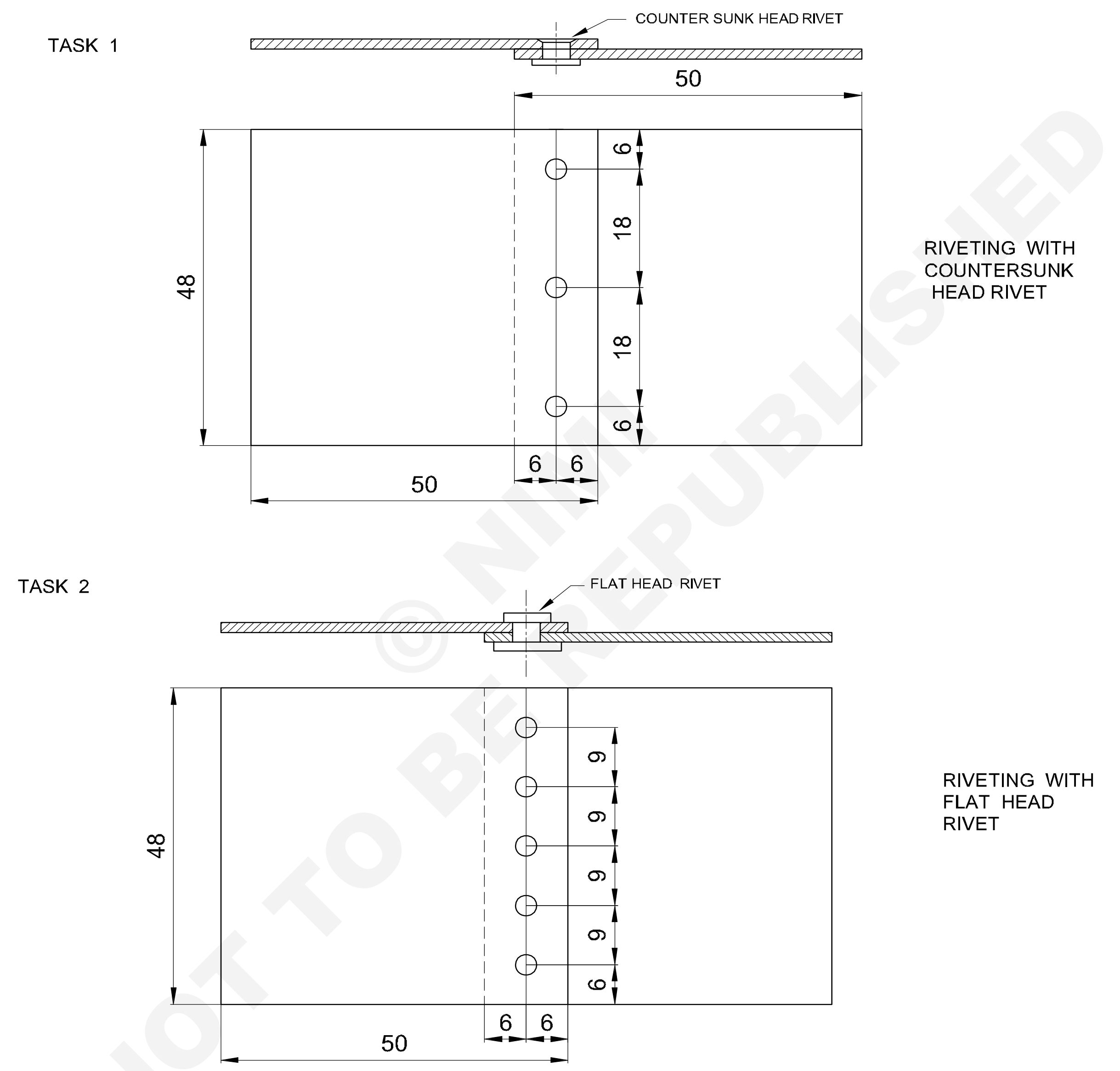
- Take low tension 10 SWG wire.
- Clean the wire free from dirt and oil.
- Cut the required length of wire using combination plier.
- Fold the wire using nose plier zigzag design to make heating mat.
- Cut the wire in to two required length.
- Fold and lock the wire using combination and nose plier to make square knot as shown in Fig 1
- Cut the wire to the required length fold and loop the wire as shown in figure to make slip knot.
- Cut the cutting to the required length and make it an radiator mesh used in refrigerator.

Fig 1



Cold Riveting

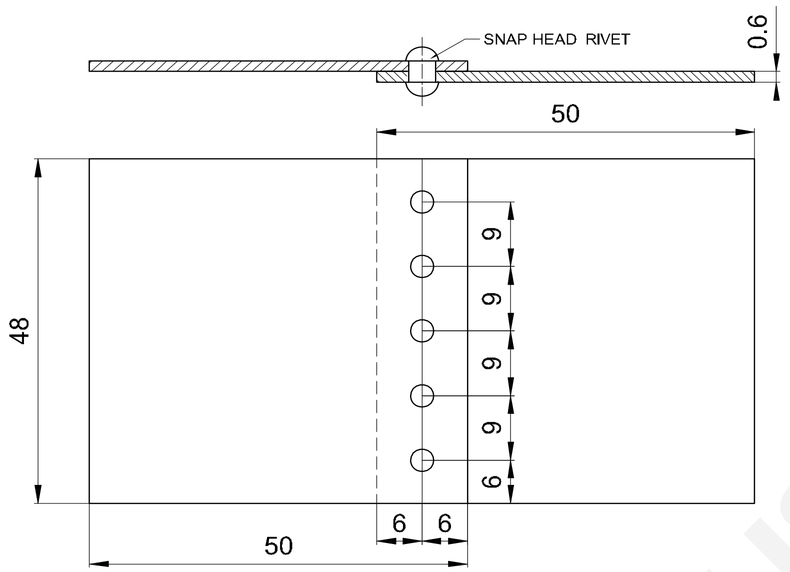
Objectives: At the end of this exercise you shall be able to
- **mark and drill hole for riveting as per drawing**
- **rivet counter sunk head rivet, head rivet, snap head rivet and pan head rivets.**



2	ISSH 50 x 48x 1.2	–	G.I SHEET	–	TASK 2	1.2.67
2	ISSH 50 x 48x 1.2	–	G.I SHEET	–	TASK 1	1.2.67
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

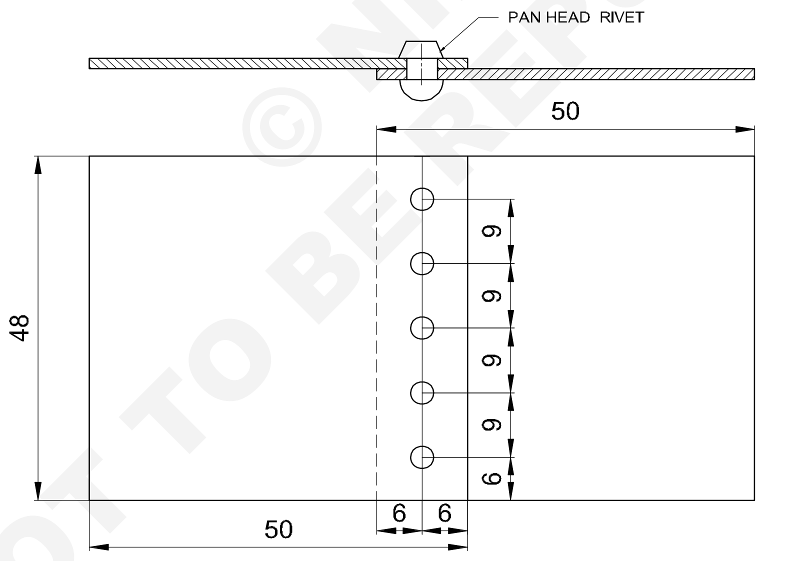
SCALE 1:1	**RIVETING WITH TYPES OF RIVETS** (COUNTER SUNK HEAD AND FLAT HEAD RIVETS)	DEVIATIONS ±0.5mm	TIME: 5Hrs
		CODE NO. OA20N1267E1	

TASK 3



RIVETING WITH SNAP HEAD RIVET

TASK 4



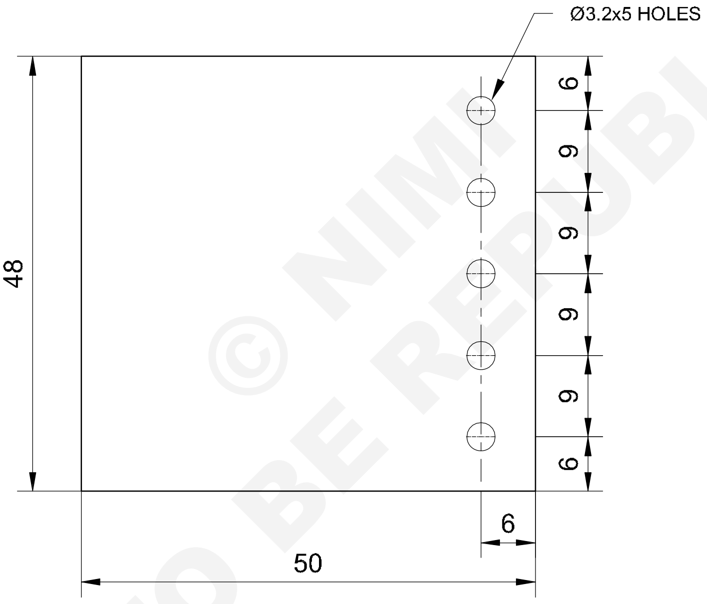
RIVETING WITH PAN HEAD RIVET

2	ISSH 50 x 48x 1.2	–	G.I SHEET	–	TASK 4	1.2.67
2	ISSH 50 x 48x 1.2	–	G.I SHEET	–	TASK 3	1.2.67
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**RIVETING WITH MANY TYPERS OF RIVETS**	DEVIATIONS ±0.5	TIME:
	(SNAP HEAD AND PAN HEAD RIVETS)	CODE NO. OA20N1267E2	

Marking out location of holes for riveting

Objectives: At the end of this exercise you shall be able to
- **mark the drill holes as per drawing**
- **clamp and drill holes in sheetmetal for riveting using electric portable drilling machine.**



2	ISSH 50 x 48 x1.2	–	G.I SHEET	–	–	1.2.68
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	DRILL FOR RIVETING	DEVIATIONS ±0.5mm	TIME: 1Hrs
		CODE NO. OA20N1268E1	

Job sequence

- Check the size of sheet 48 x 50 mm using a steel rule.
- Flattern the sheet on dressing plate using mallet.
- Layout the spacing for drill holes and mark the centre points of drill holes using a centre punch and a ball pein hammer.
- Hold the sheet firmly using ‘C’ clamp.
- Drill ∅ 3.2mm through holes as per drawing.
- De-burr the holes with larger sized drill by rotating it on the drilled holes by hand.

Skill Sequence

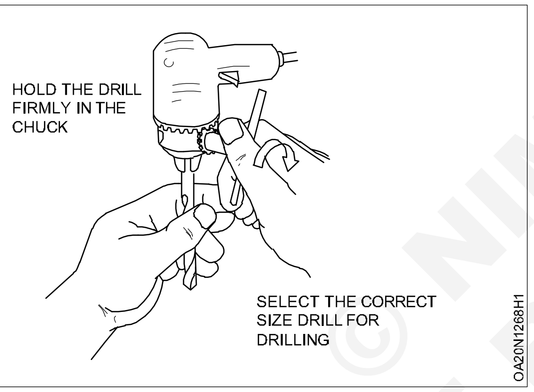
Drilling on sheetmetal by power operated portable drilling machine

Objective: This shall help you to
- **drill correct size hole on sheetmetal by operating power operated portable drilling machine properly.**

Punch the marked centre points of the holes to be drilled lightly using a centre punch and a ball pein hammer.

Insert a straight shank, drill bit in the drill chuck of the portable drilling machine and lighten with the chuck key.(Fig 1)

Fig 1



Before inserting the drill in the drill chuck of the power operated portable drilling machine, be sure that the switch is off and earthing is provided.

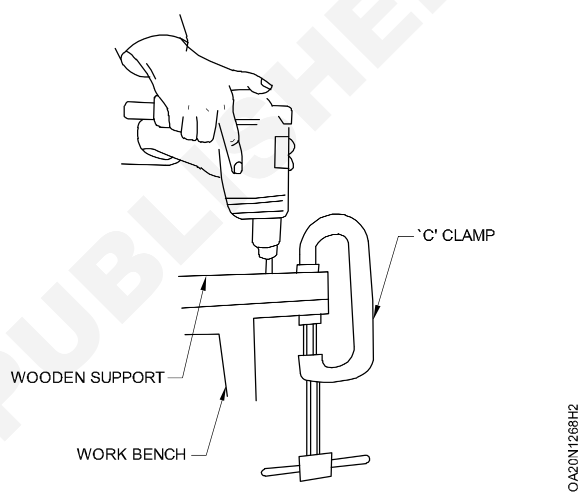
Place the workpiece on a suitable wooden support and clamp with the help of a ‘C’ clamp. (Fig 2)

Hold the portable drilling machine in one hand and grasp the gun with fore finger and thumb of the other hand, such that the drill is perpendicular to the surface of the metal to be drilled. (Fig 2).

Switch ‘ON’ the trigger switch with second finger.

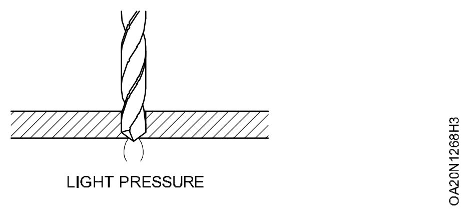
Apply pressure on the drilling machine till hole is drilled.

Fig 2



While drilling by electric operated portable drilling machine on a sheet metal, light pressure should be applied otherwise. the drill will get struck to the workpiece. (Fig 3)

Fig 3



Switch off the drilling machine after the drilling is completed.

De-burr the holes by larger sized drill by rotating it on the drilled hole by hand.

Use of dolly and snap for forming rivet head

Objective: This shall help you to
- **make proper use of the dolly, rivet set and rivet snap to perform correct riveting**
- **form the rivet head in round shape, by applying the hammer blows properly by the ball pein hammer**
- **rivet snap head rivet to make the riveted joint tight without damaging the base metal.**

Ensure that all the rivet holes are drilled on one sheet and only one hole for the centre rivet is drilled on another sheet.

Ensure that the drilled holes are deburred and the sheets are flat.

Hold vice dolly rigidly in the bench vice.

Place the sheet having all holes drilled over the other, align the drilled hole and coincide the marked lines for lap with the edges.

Insert the rivet in the centre hole and place the rivet head on the vice dolly, to avoid deformation, while hammering. (Fig 1 & 2)

Fig 1

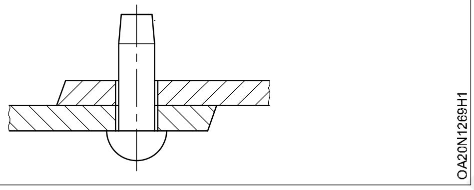
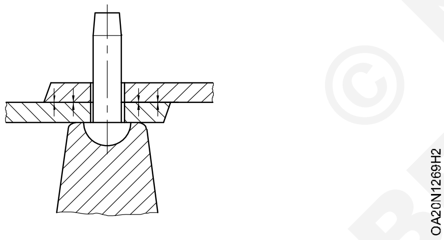


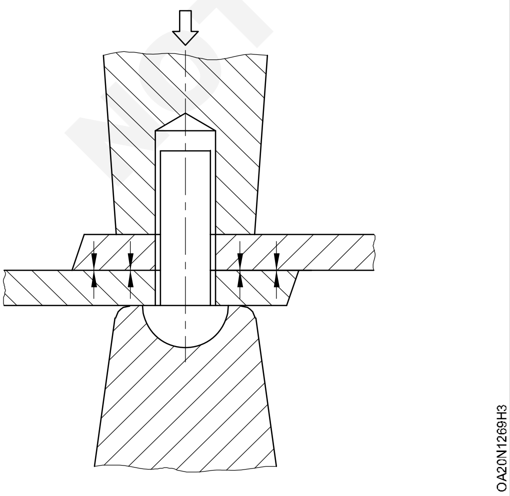
Fig 2



Place the deep hole of the rivet set over the shank of the rivet. (Fig 3)

Strike the rivet set with a ball pein hammer to bring the sheets closer, to set the joint firmly for riveting. (Fig 3)

Fig 3



Remove the rivet set over the shank of the rivet.

Form the rivet head roughly by hammering it down initially and then rounding the head using a ball pein hammer. (Fig 4 & 5)

Fig 4

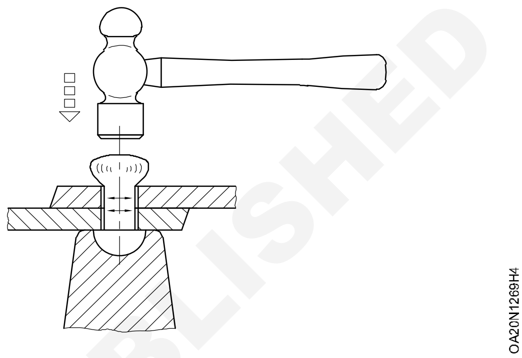
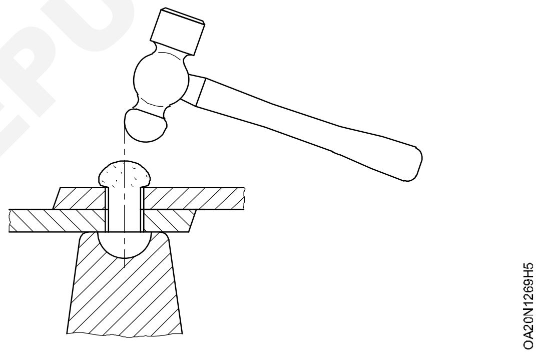
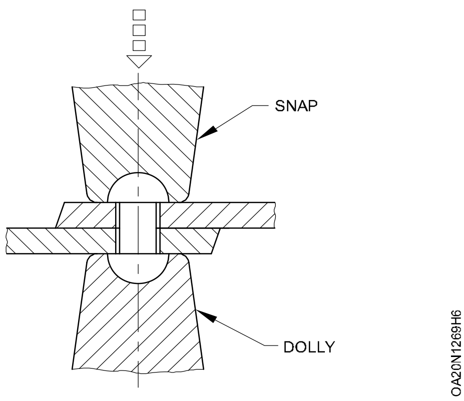


Fig 5



Place the rivet snap over the rounded head of the rivet and strike with a hammer over it to form and finish the rivet head using a ball pein hammer. (Fig 6)

Fig 6



Skill Sequence

Layout the spacing for rivet holes to make a single riveted lap joint

Objectives: This shall help you to

- **calculate the distance of the lap, the distance between centre of first rivet and edges and the distance of pitch as per BIS standard**
- **layout the spacing for rivet holes to make a single riveted lap joint.**

Ensure the edges of the workpieces to be joined are free of burr and straight.

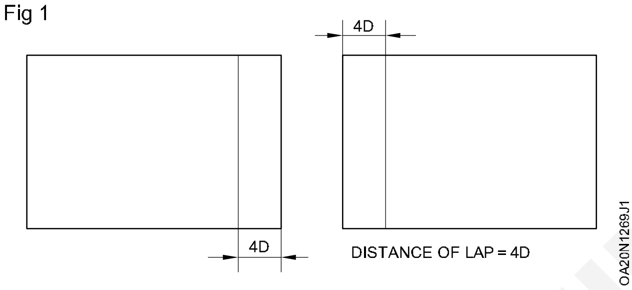
Calculate the distance of the lap.

Distance of the lap = 4 x Dia of the rivet (D)

Diameter of the rivet = 2.5 or 3times from the known thickness, calculate the dia of the rivet, and calculate the distance of the lap.

Mark the line of distance of the lap parallel to the edge, on both workpieces using a scriber and a steel rule. (Fig 1)

Fig 1



Calculate distance of the rivet line from the edge of the sheet.

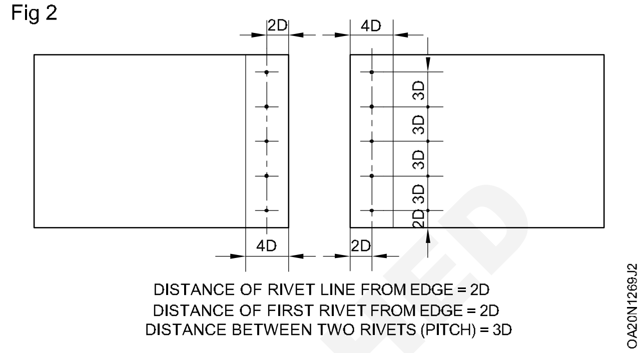
Distance of the rivet line from the edge = 2 x the diameter of the rivet (D)

Mark the rivet lines parallel to the edge, on both workpieces (Fig 2).

Calculate the distance of the first rivets from the side edge.

Distance of the first rivet from the edge = 2 x dia of rivet (D)

Fig 2



Mark the distance of the first rivets from the side edges on the rivet line, on both the workpieces using a divider.

Calculate the distance between two rivets i.e. pitch.

Pitch = 3 x the dia of rivet (D)

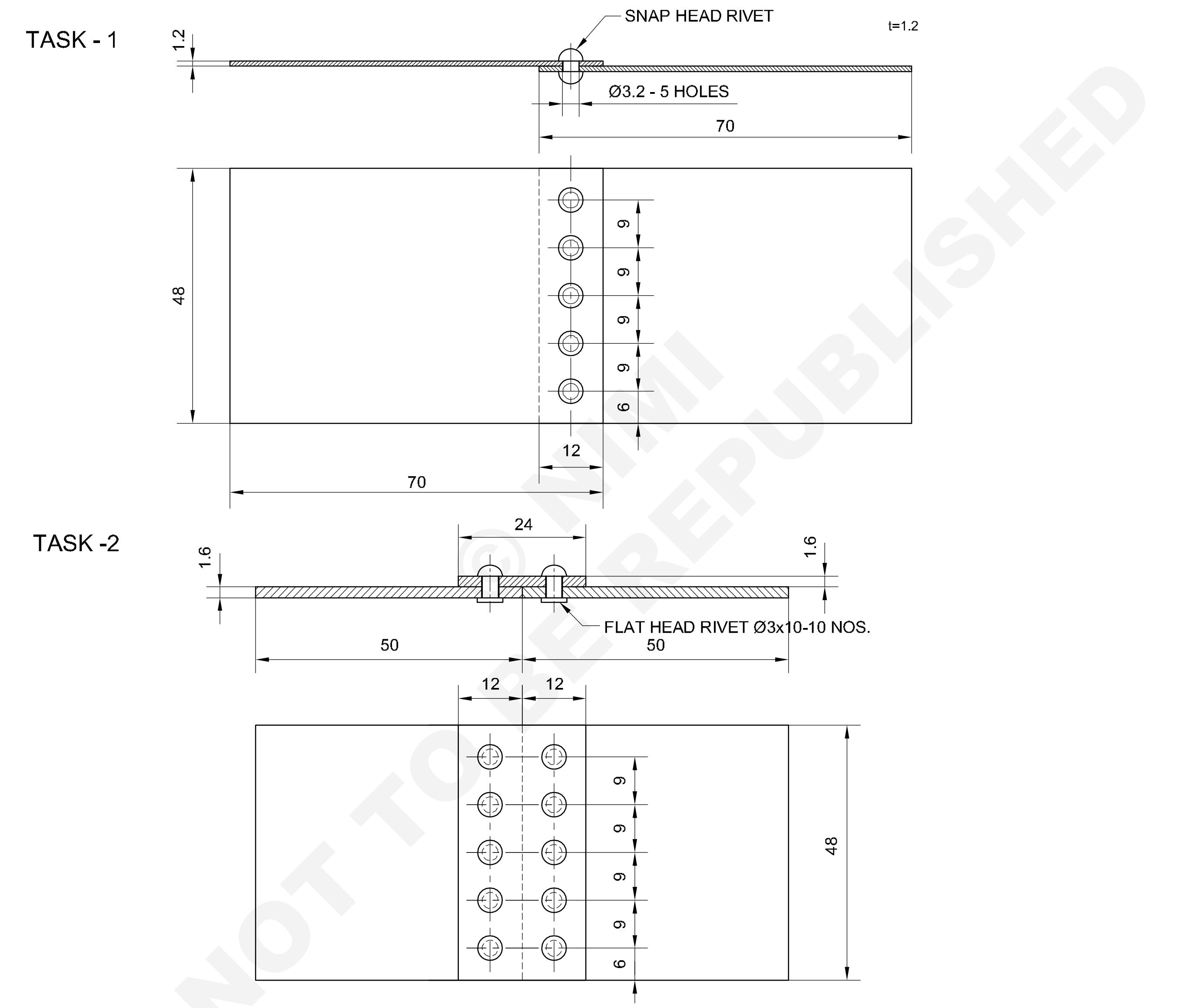
Mark the pitch of the rivets on the rivet lines, on both workpieces (Fig 2) using a divider.

Punch on the centre points of the reivets using a centre punch and a ball pein hammer.

Lap and butt joint by cold riveting

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

- **layout the spacing for rivet holes to make single riveted lap & butt joint**
- **punch the correct size holes using a solid punch**
- **rivet the snap head rivets with the help of rivet set, a rivet snap, a dolly using ball pein hammer, to make single riveted lap and butt joint.**
- **form the rivet heads of snap head and flat head rivets.**



10	IS: 2155 - Ø3 - 6	--	M.S. FLAT HEAD RIVET	--	--	-
1	ISSH 100 x 50 x1.6	--	MILD STEEL SHEET	--	--	-
5	IS:2155 - Ø3 - 5	--	M.S. SNAP HEAD RIVET	--	--	-
1	ISSH 140 x 48 x1.2	--	MILD STEEL SHEET	--	--	1.2.70
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

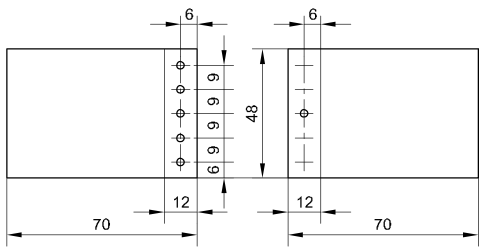
SCALE 1:1	**SINGLE RIVETED LAP JOINT & SINGLE STRAP SINGLE RIVETED JOINT**	DEVIATIONS ±0.5mm	TIME :
		CODE NO. OA20N1270E1	

Job Sequence

TASK 1: **Single riveted lap joint**

- Cut and check the given raw material to the size 140 x 48 mm using a steel rule.
- Flatten the sheet on the dressing plate by a mallet.
- Deburr the edges using a flat smooth file.
- Mark the centre line of length 140 mm and cut the sheet into two pieces of size 70 x 48 using straight snips.
- Layout the spacing for rivet holes to make single riveted lap joint using a scriber and a steel rule on both pieces of the sheet, and mark the centre points of rivet holes using a centre punch and a setting hammer. (Fig 1 & 2 of Skill sequence)
- Punch and make ϕ 3.2 holes on all centre points on one piece of the sheet and one central hole on another piece of sheet using a solid punch (Fig.1)

Fig 1



- Deburr the holes with larger sized drill rotating it on drilled holes, by hand. (Fig 2)
- Place the piece of sheet having all holes punched above another, such that the overlapped edges of the sheets coincide with the marked lines.
- Insert 3 mm dia snap head rivet in the centre hole. (Fig.3)
- Form the rivet head, with the help of the rivet snap and dolly using ball pein hammer.

Fig 2

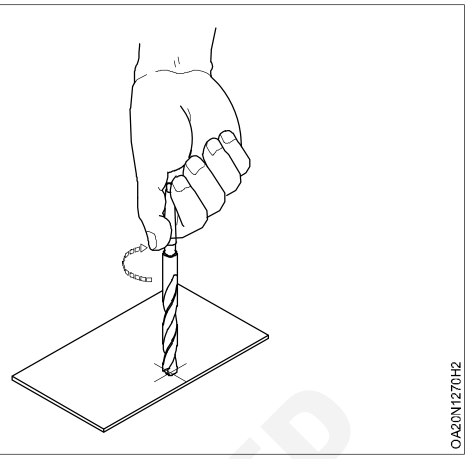
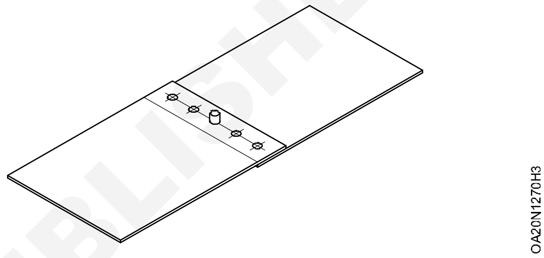


Fig 3



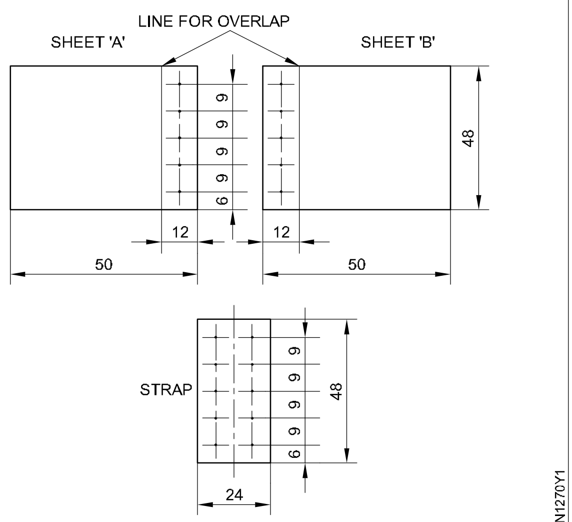
- Punch the remaining four holes on the bottom piece of the sheet, through the holes, already punched on the upper piece of the sheet.
- Deburr the holes with the larger sized drill, rotating it on the punched holes, by hand.
- Insert the rivets in alternate holes and form the rivet heads, one by one to make a single riveted lap joint, with the help of a rivet set, rivet snap, a dolly and a ball pein hammer.

— — — — — — — — —

TASK 2: **Single strap single row riveted butt joint**

- Cut the given material into three pieces, two to sizes of 50 x 48mm and the third piece of size 24 x 48 mm using a straight snip and check the size using a steel rule. (Fig.1)
- Flatten the sheet on the dressing plate by a mallet.
- Deburr the edges using a flat smooth file.
- Layout the spacing for rivet holes to make single strap single riveted butt joint using a scriber, a divider and a steel rule on the pieces of sheets. (Fig.1)
- Mark the centre point for the rivet holes using a centre punch and a ball pein hammer.
- Drill ϕ 3.2 mm holes at all the points on the strap and the centre holes on the two workpieces to be joined.
- Deburr the holes with larger sized drill by rotating it on the drilled holes by hand.

Fig 1

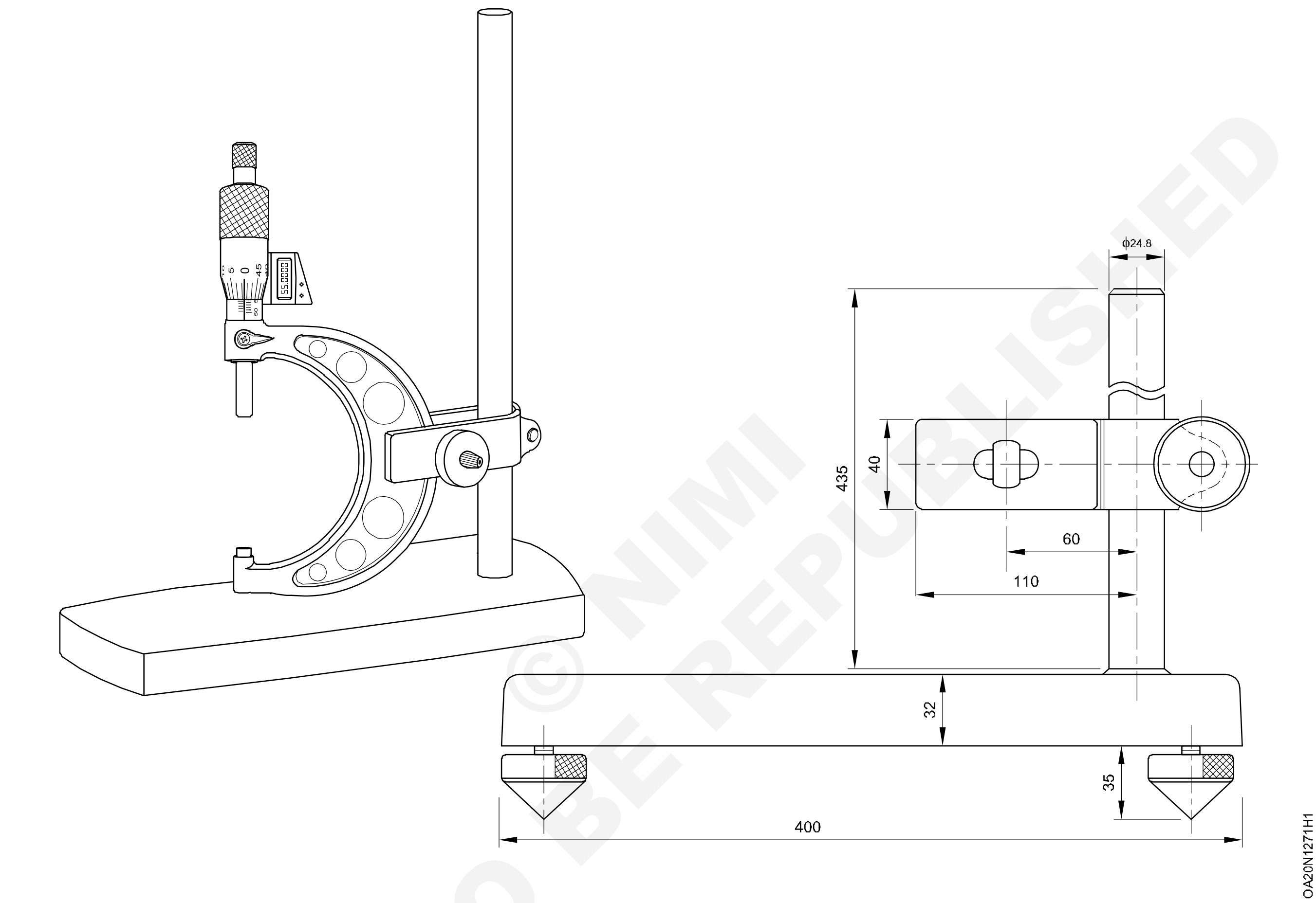


LAYOUT OF RIVET SPACING

Cutting of Sheet metal with chisel marking parallel clamp,'C' clamp or micrometer stand using acquired skills.

Objectives: At the end of this exercise you shall be able to
- **marking,cuttingshet metal to prefere micrometer stand using previous skills.**

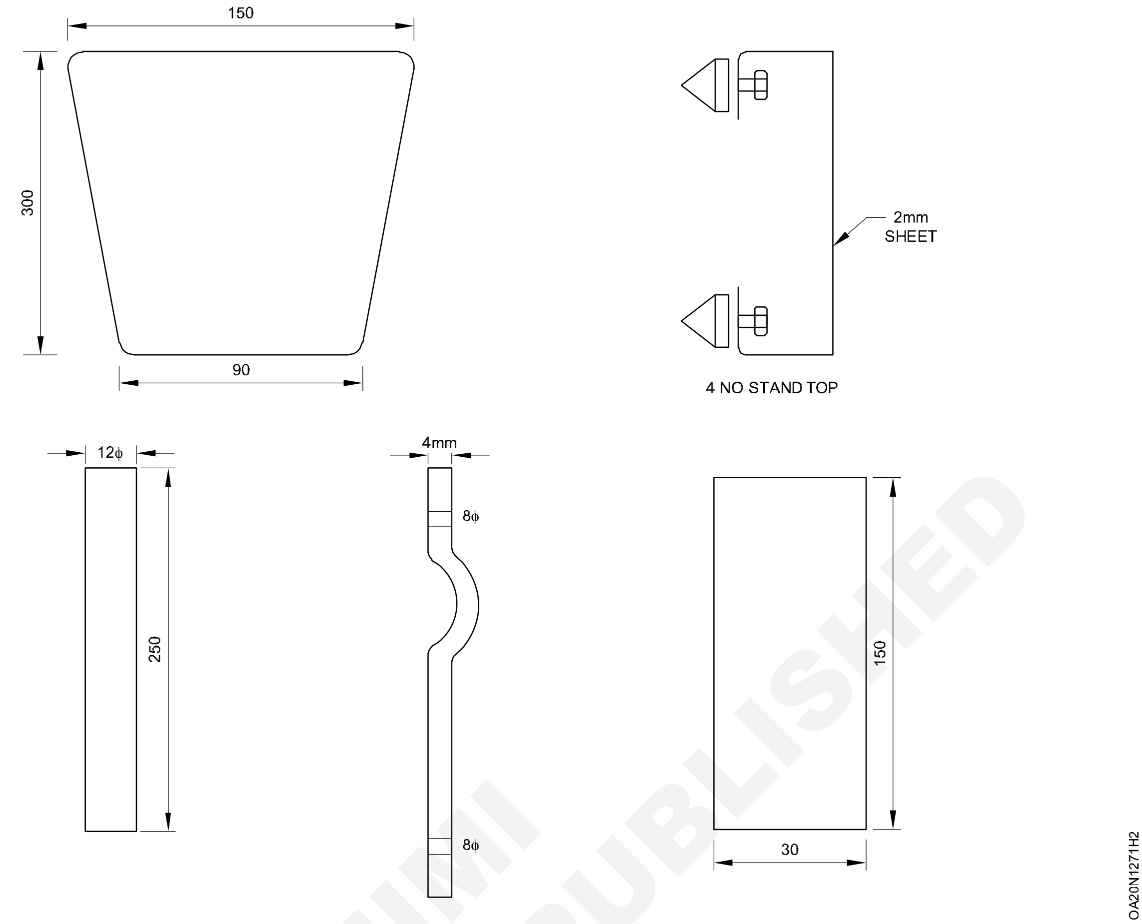
Fig 1



Job Sequence

- Measure the dimensions of sheet using steel rule.
- Move as per the drawing given.
- Cut the sheet as per drawing with cutting allowance.
- Clean the burrs using hand file.
- Cut the 12 ∅ pipe to the length of 250mm, clean with emey sheet.
- Cut and file 4mm as per drawing.
- Bend the plate on the anvil to accomodate the plate on the pipe.
- Bending the sheet wherever required.
- Make holes as per drawing.
- Werd the bottom of 12 ∅ pipe on the sheet.
- Assemble are the parts together.
- Paint the assembly for fitting micrometer.

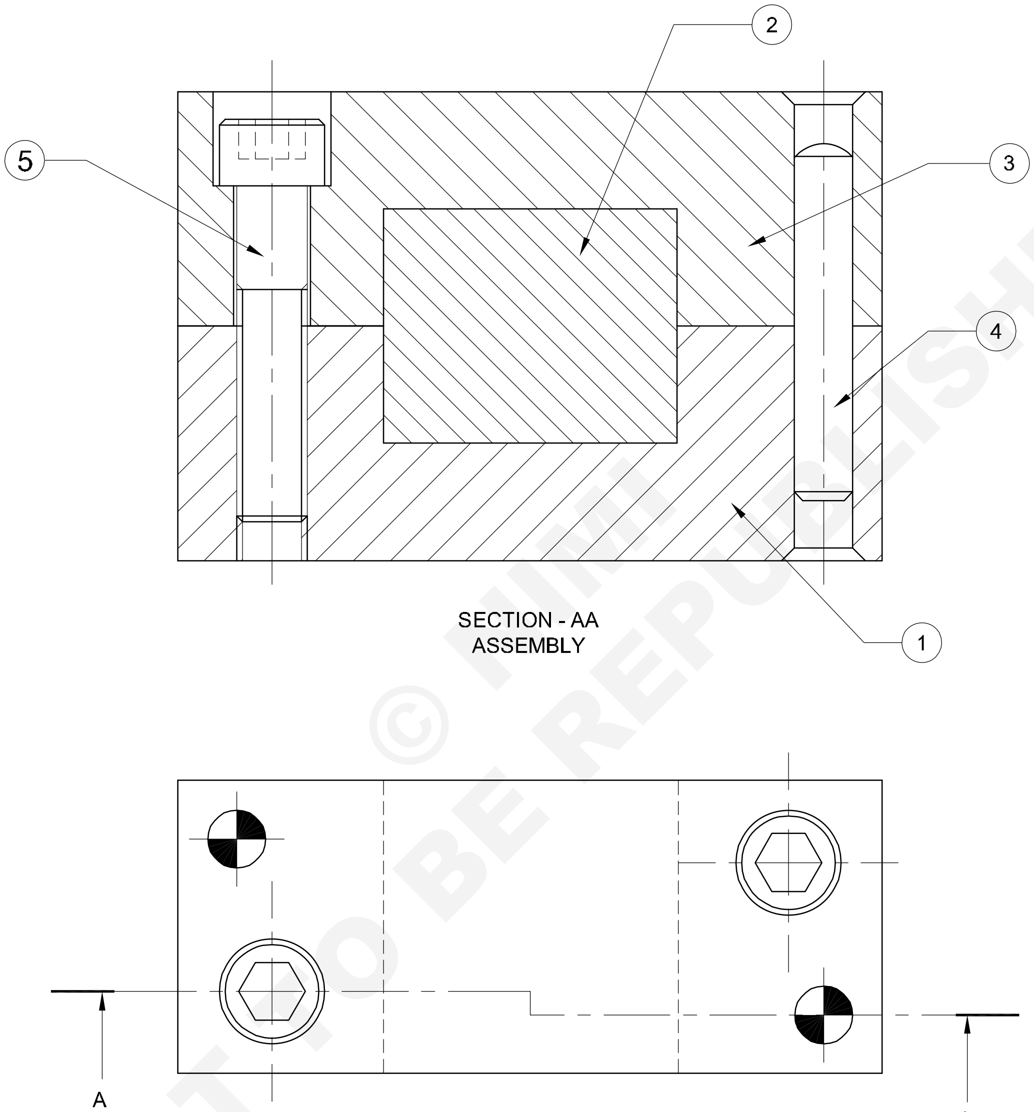
Fig 2



150
300
90
2mm
SHEET
4 NO STAND TOP
12ϕ
250
4mm
8ϕ
8ϕ
150
30
OA20N1271H2

Simple Project work.

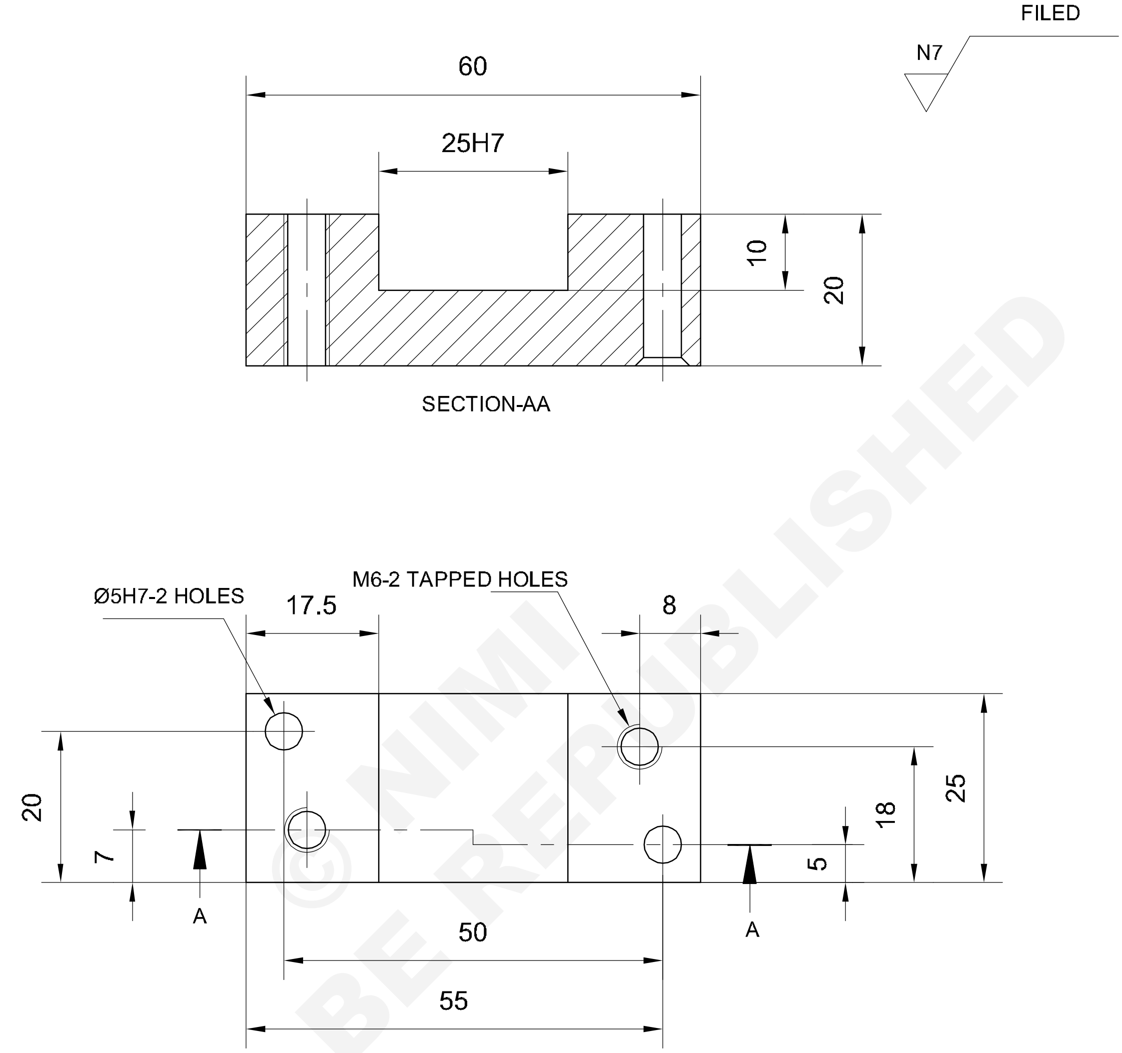
Objectives: At the end of this exercise you shall be able to
- **prepare and assemble the assembly fit using dowet pins and ap screws.**



2	M6x30	CAP SCREW	Fe310	-	PART-5	1.2.72
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	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	ASSEMBLE SIMPLE FITTING USING DOWEL PINS AND CAP SCREW ASSEMBLY USING TORQUE WRENCH	DEVIATIONS ±0.04mm	TIME 25Hrs
		CODE NO. OA20N1272E1	

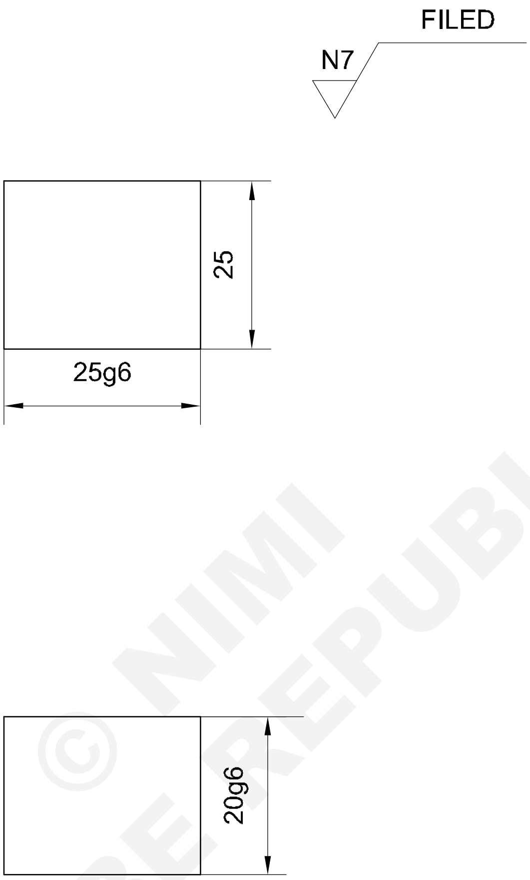
PART-1 BASE PLATE



-	-	-	-	-	-	1.2.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	BASE PLATE	DEVIATIONS	TIME
		CODE NO: OA20N1272E2	

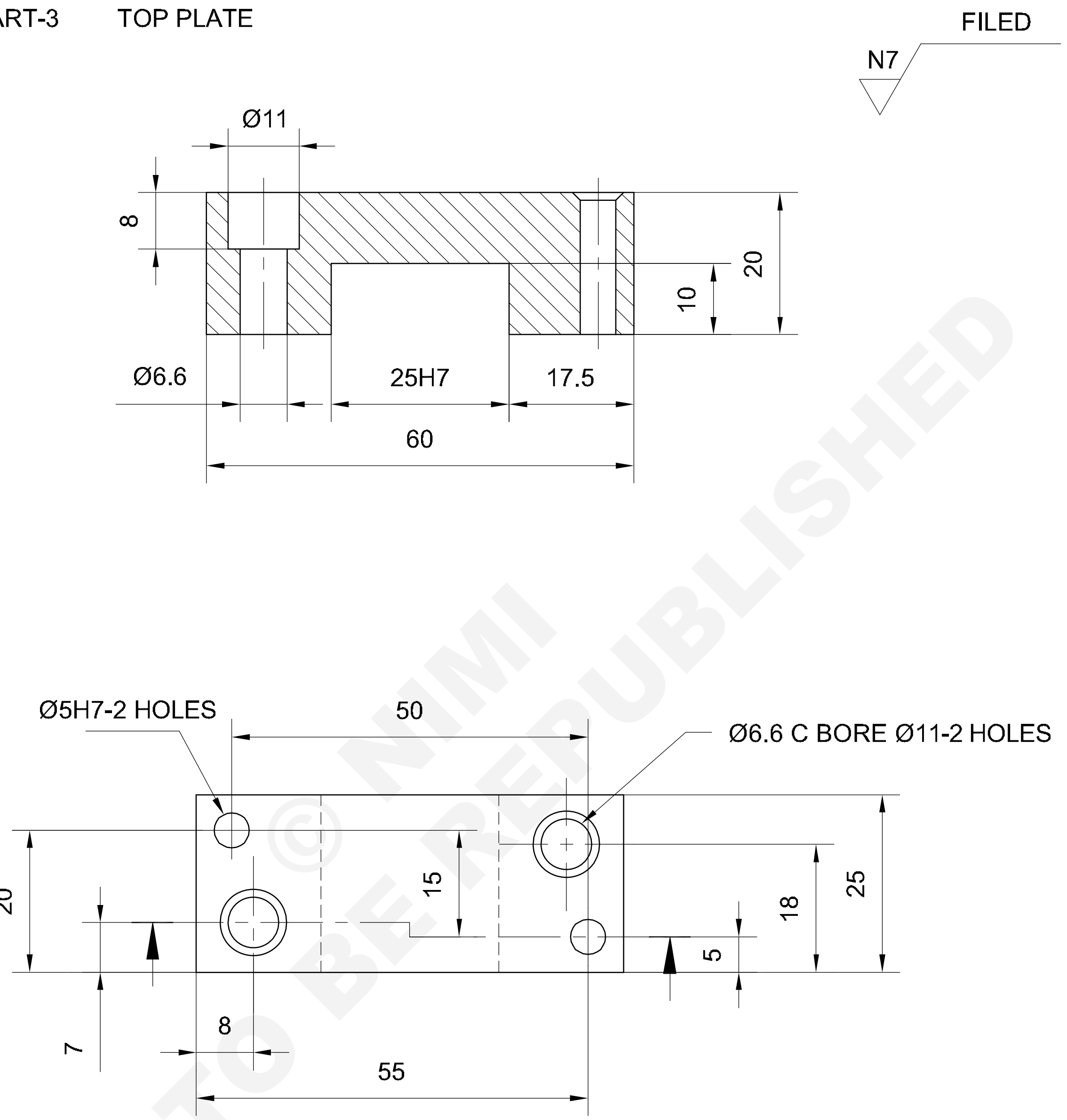
PART-2 MIDDLE PLATE



-	-	-	-	-	-	1.2.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MIDDLE PLATE	DEVIATIONS	TIME
		CODE NO: OA20N1272E3	

PART-3 TOP PLATE



-	-	-	-	-	-	1.2.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	TOP PLATE	DEVIATIONS	TIME
		CODE NO: OA20N1272E4	

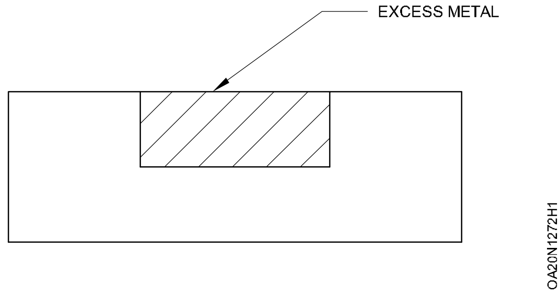
Job Sequence

- Check the raw materials size.
- File part 1,2 and 3 to over all size maintaining parallelism and perpendicularily.
- 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

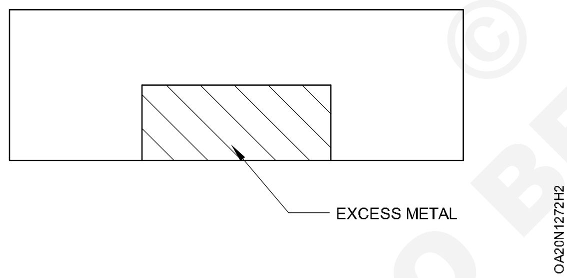
- Chain drill, cut and remove the excess metal and file to size and shape as shown Fig 1.

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 squaremess.
- 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 without 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

Objective: 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.

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.

Drive the dowel keeping pin punch dia 5/8 ovet the radius of the end of the dowel such that the chamfered end of the dower into position 2 as shown in Fig 4.

Drive the dowel in about 10mm into positon 2 as shown in Fig 5.

Tighten the socket head screw such that there is no gap exists as shown in Fig 6.

Removal of the dowel

Removal of the dowel should be in the same direction as driving.

Fig 1

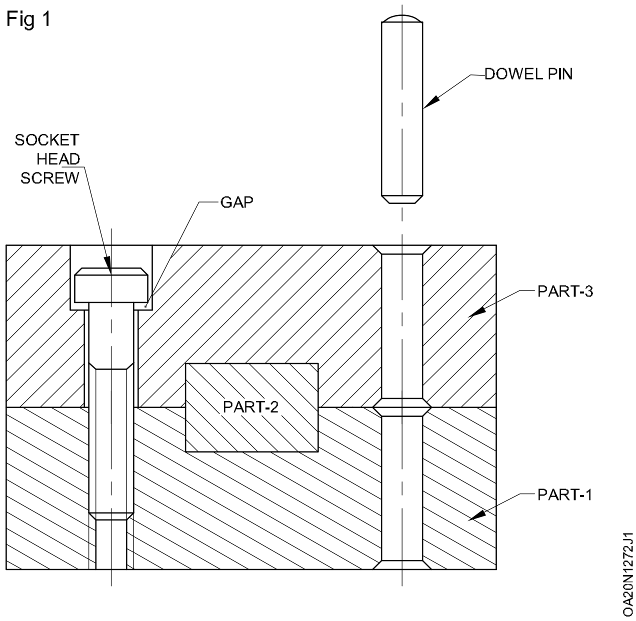


Fig 2

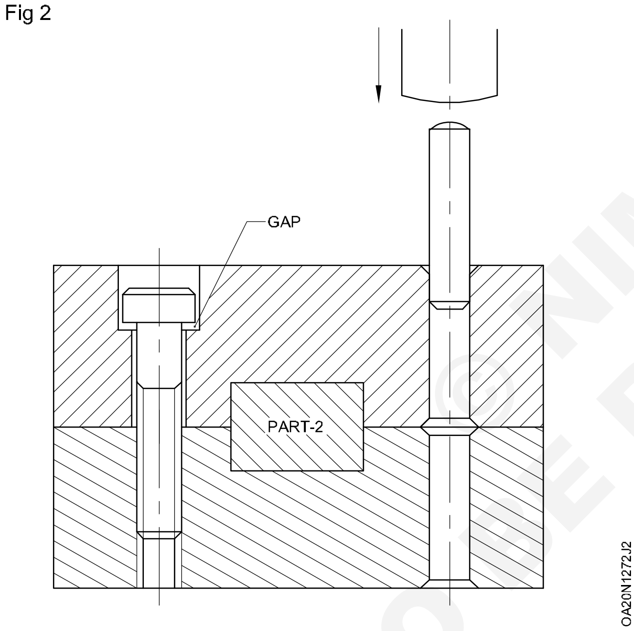


Fig 3

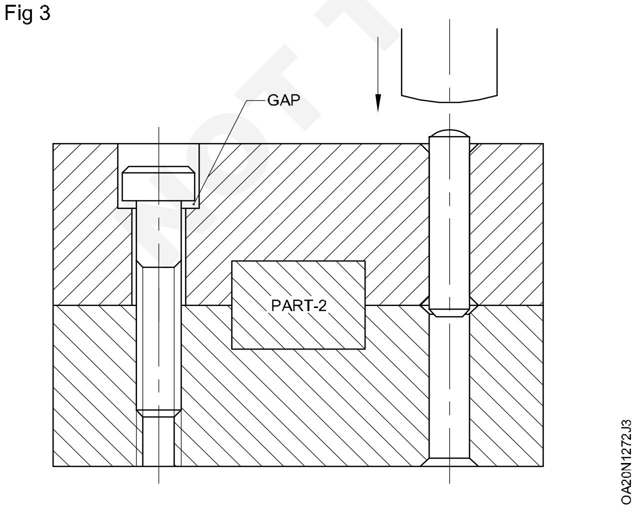


Fig 4

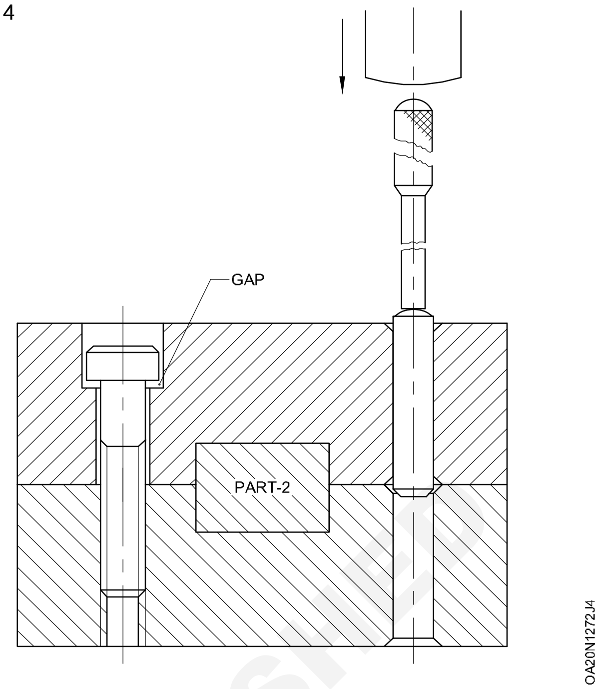


Fig 5

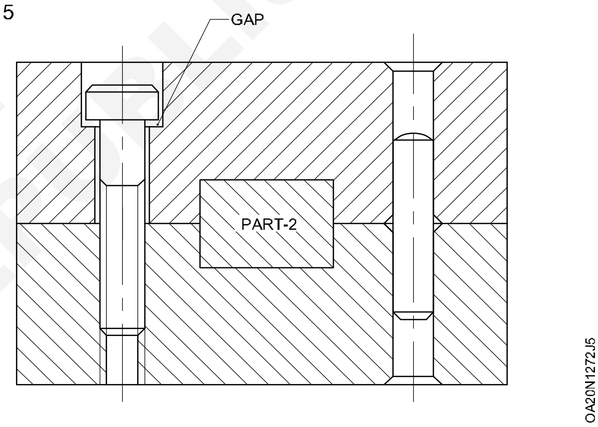
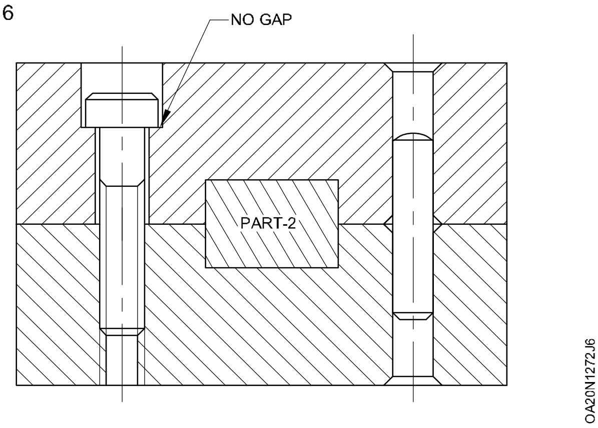


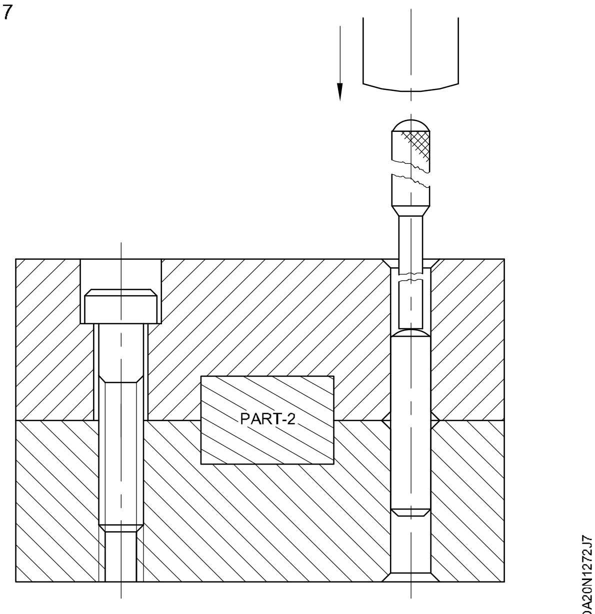
Fig 6



Insert pin punch into the reamed hole such that it sits over the radius end of the dowel as shown in Fig 7.

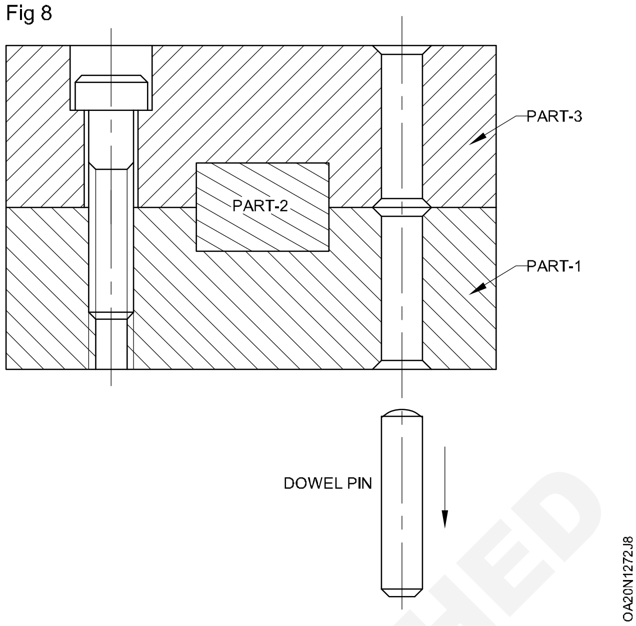
Knock the dowel cut using the hammer as shown in Fig 8.

Fig 7



PART-2
OA20N1272J7

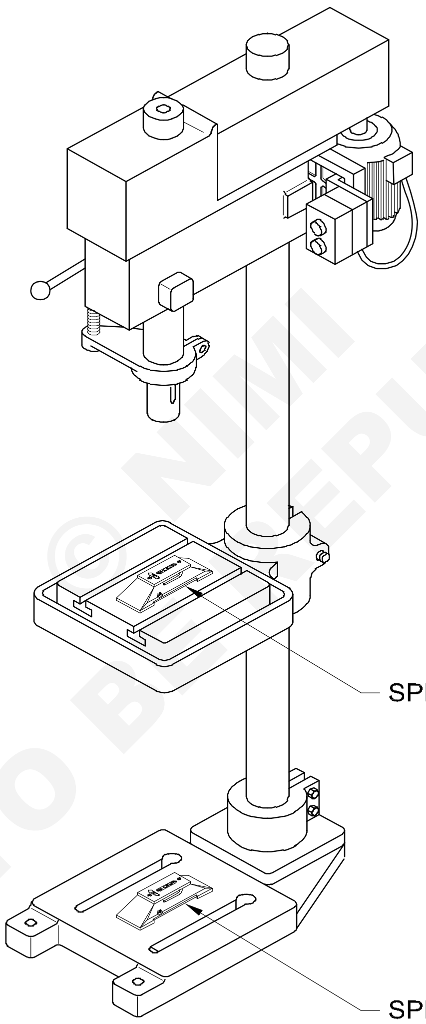
Fig 8



PART-3
PART-2
PART-1
DOWEL PIN
OA20N1272J8

Using hand tools such as screw drilling, spanner, puller etc allignment and levelling of machine

Objectives: At the end of this lesson you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **file a flat surface with a flat bastard file**
- **check the flatness of the filed surface with a straight edge/blade of a try square**



1	-	-	-	-	-	4.4.195
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	INSPECTION OF MACHINE TOOLS SUCH AS ALIGNMENT,LEVELLING	DEVIATIONS	TIME: 10 Hrs
		CODE NO. OA20N1373E1	

Job sequence

- Lock the table of the pillar drilling machine in mid - position.
- Level the machine using a precision spirit level and a straight edge.
- Check the flatness of the table surface and the base plate of the machine.
- Check the run out of the internal taper of the spindle using a dial test indicator and test mandrel.
- Check the straightness of the pillar in two different planes.
- Check the squareness of the table surface in two different planes.

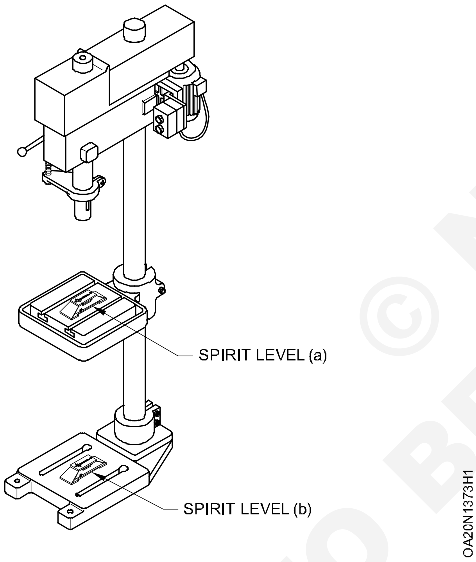
Skill sequence

Geometrical test for pillar type drilling machine

Objective: This shall help you to
- **carry out the preventive maintenance of drill machine.**

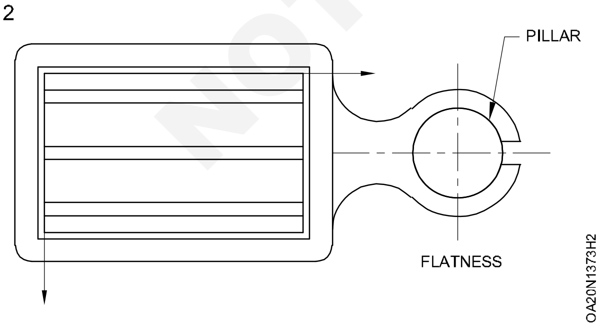
Levelling of the machine at two different positions (a) and (b) should be done before conducting the geometrical test. The permissible deviation is 0.03 per 300 mm. (Fig 1)

Fig 1



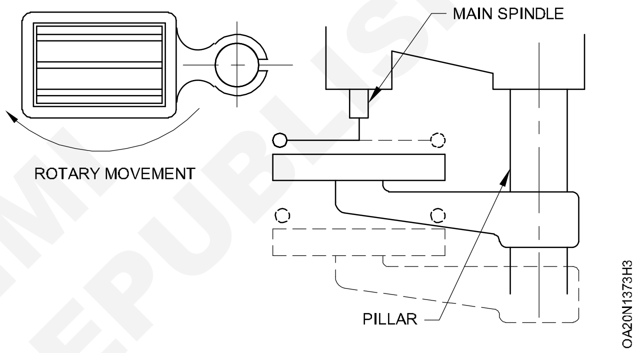
Check the flatness of the work table surface and the base plate if it is machined. (Fig 2)

Fig 2



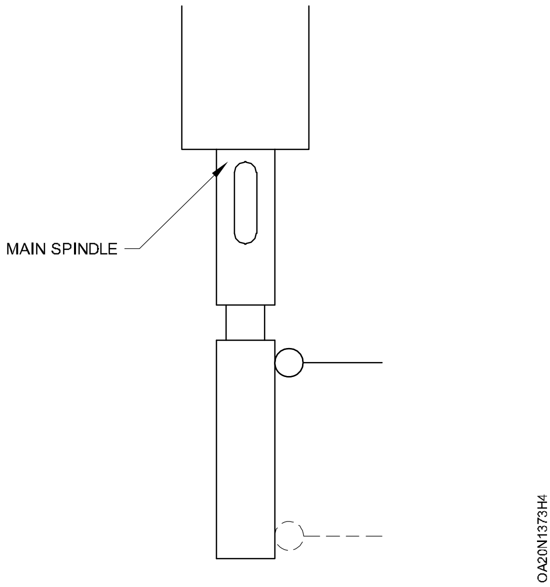
Check the camming of the rotating table, if the machine is provided with rotary movement. (Fig 3)

Fig 3



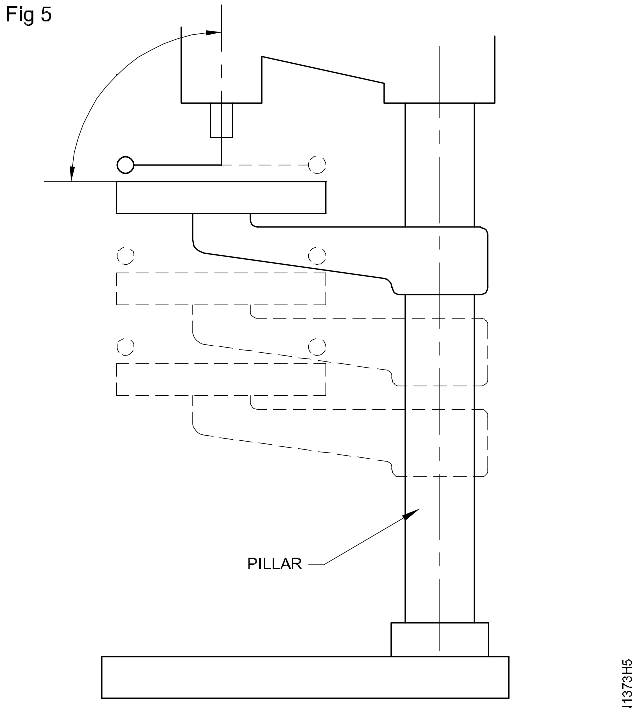
Check the run out of the spindle internal taper at two positions.(Fig 4)

Fig 4



Check the straightness of the pillar and squareness of the spindle axis to the table surface (Fig 5) in two different planes.

Fig 5



STRAGHTNESS

Fig 6

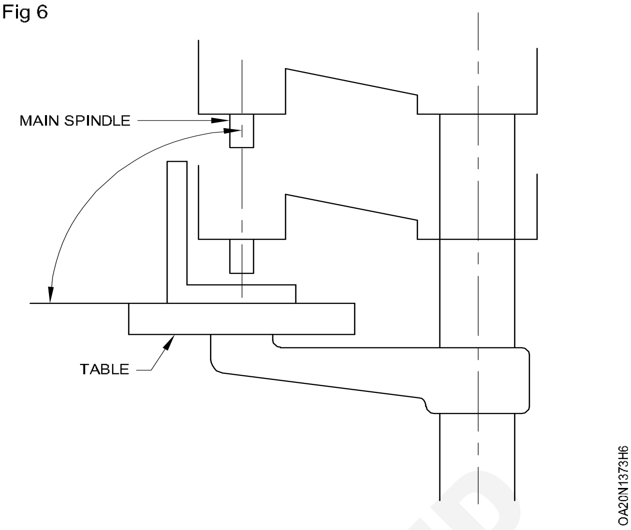
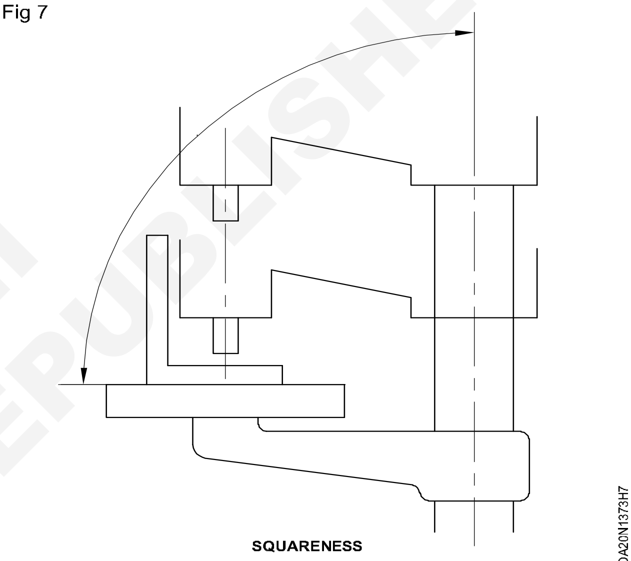


Fig 7



SQUARENESS

Check the squareness of the table surface to the vertical movement of the spindle housing in two planes. (Fig 6)

Check the squareness of the table surface to the vertical movement of the spindle head of machines having an elevated spindle head. (Fig 7)

Lubricating the parts

Apply lubrication oil in main spindle, cam of rotating table, gear box and pillar. Daily by using a oil can with oil.

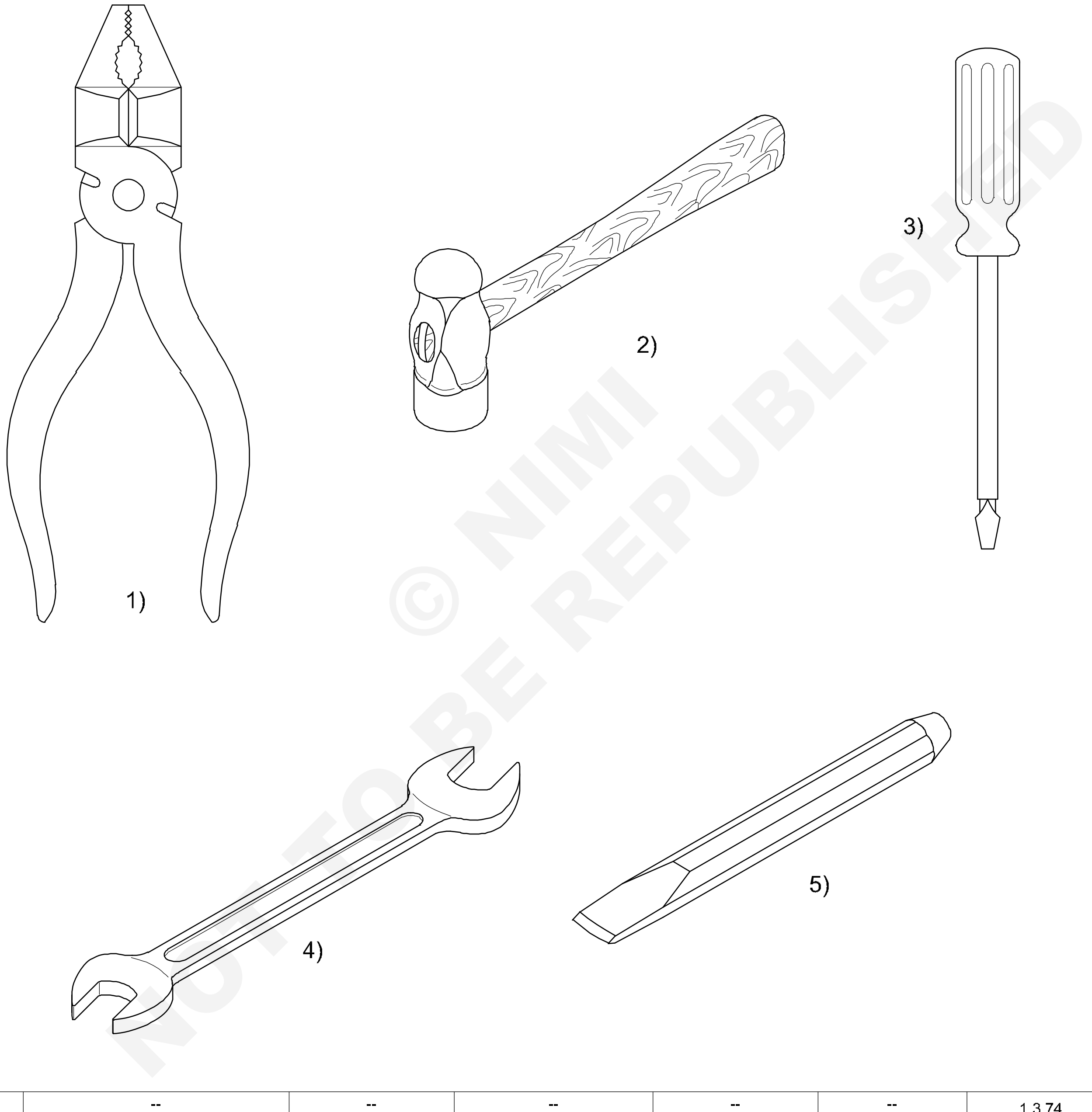
Inspect the following items and tick in the appropriate column and list the remedial measures for the defective items.

Items to be checked	Good working/Satisfactory	Defective	Remedial measures carried out
Level of the machine			
Belt and its tension			
Bearing sound			
Exposed gears			
Working in all the speeds			
Working in all feeds			
Lubrication system			
Coolant system			
Spindle & its travel			
Arm & its movement			
Electrical controls			
Safety gaurds			

Correct method to be used and care to be taken in using hand tools

Objectives: At the end of this lesson you shall be able to
- **adopt correct method of using hand tools**
- **care tobe taken in using hand tools**

TASK : 1



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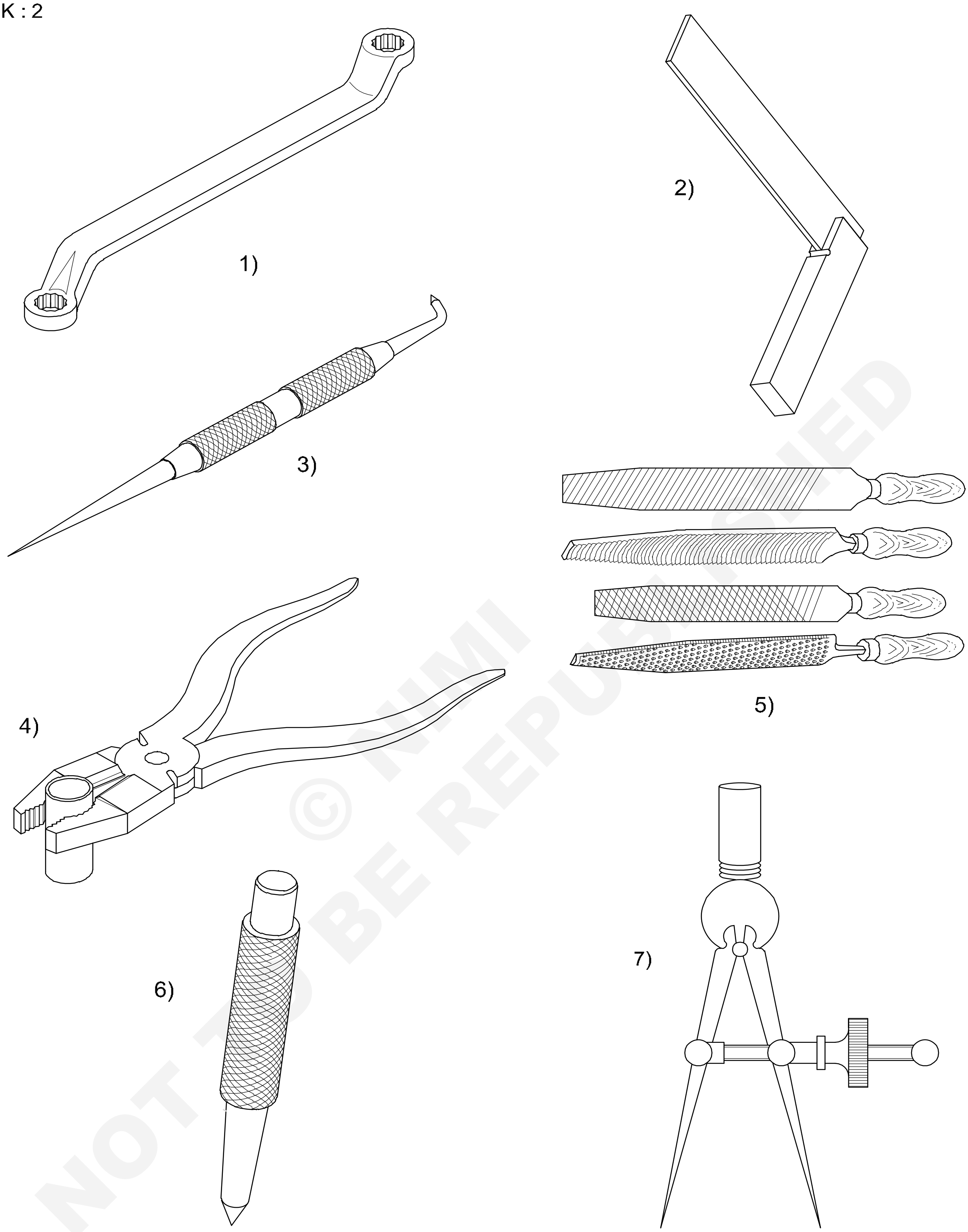
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	**IDENTIFICATION OF TOOLS AND EQUIPMENTS (HAND TOOLS)**	DEVIATIONS	TIME
		CODE NO. OA20N1374E1	

TASK : 2



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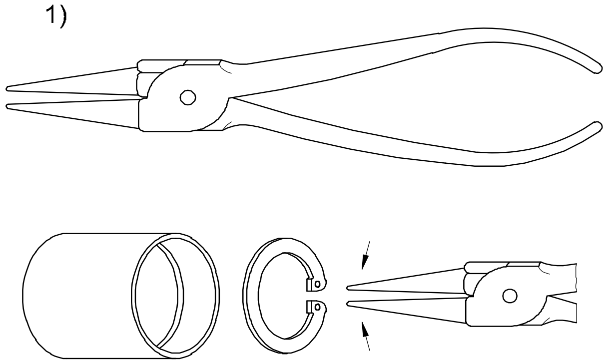
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

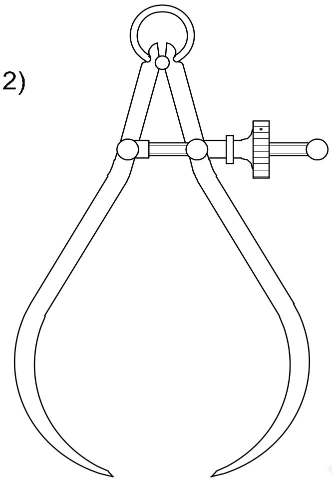
SCALE	**IDENTIFICATION OF TOOLS AND EQUIPMENTS (FITTING TOOLS)**	DEVIATIONS	TIME
		CODE NO. OA20N1374E2	

TASK : 3

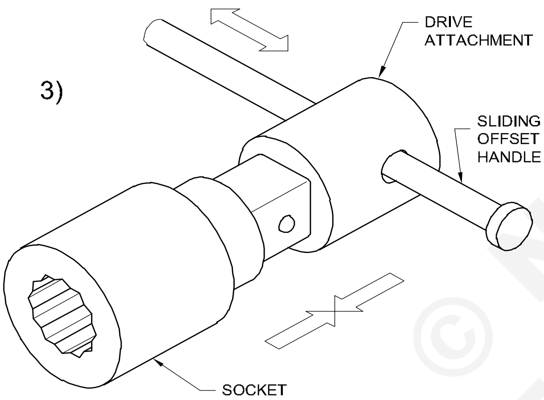
1)



2)



3)



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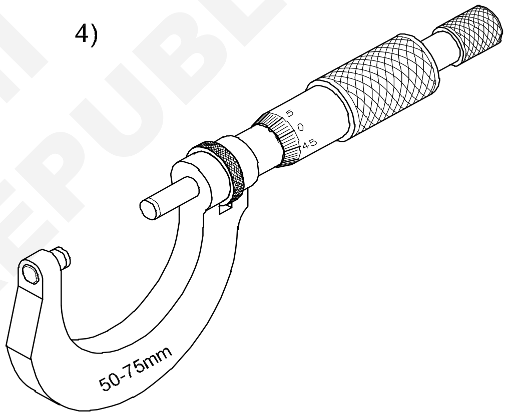

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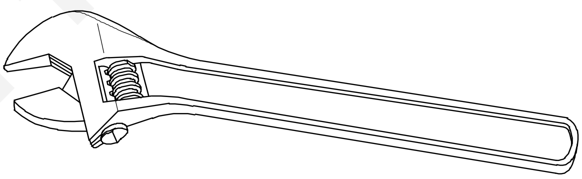

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
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SCALE	IDENTIFICATION OF TOOLS AND EQUIPMENTS (MEASURING TOOLS)	DEVIATIONS	TIME
		CODE NO. OA20N1374E3	

Job sequence

- identify the hand tools.
- clean the tooth befor using.
- select the right tools suitable the job.
- Remembers correct usage of tools for example files cut on the push stroke even apply preserve on the push stroke the could crusing the tile teeth.
- Do not use it for very heavy work
- keep it in its place after use.
- Record the name and use of tools in table

Table

Sl.No	Type of tool	Name of tool	Use of tool

Fig 1

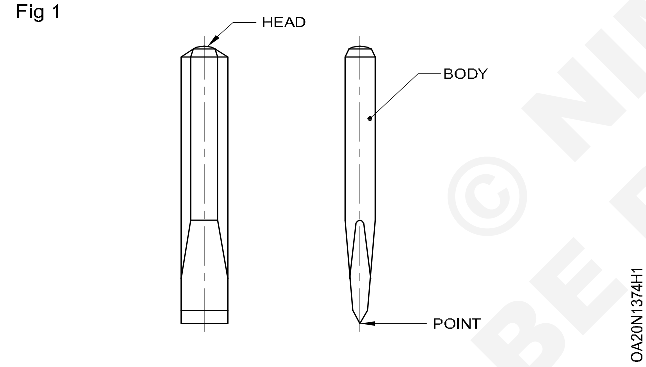
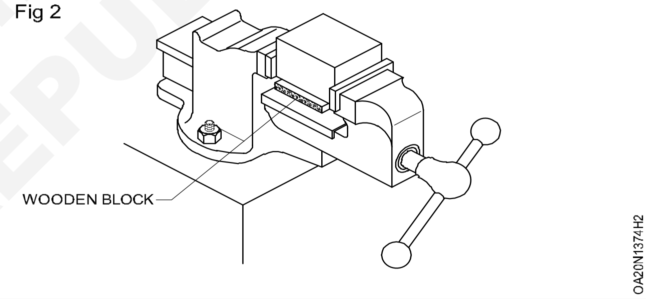


Fig 2



Lubrication of different parts of machine

Objectives: At the end of this lesson you shall be able to
- **smooth functioning of sliding and moving parts**
- **Reduction of friction and consequent wear**
- **Prevention of rust formation on precise parts**

Job sequence

- identify the machine parts need to be lubricated Fig 1,2,3
- general lubrication parts namely:
  - Mechanism of hydraulic system couvade ways of sliding parts rotating shafts
  - gear box,
  - feed box
  - Speed champing mechanism
  - Bearing
- Tabulate the name of part to be lubricated daily, monthly and half yearly.
- Type of lubrication method applied to each parts.
- Usuage of suitable lubrication for specific purpose.

Table - 1

Daily lubrication points

Sl.No	Name of part	Specification of oil

Table - 2

Monthly lubrication points

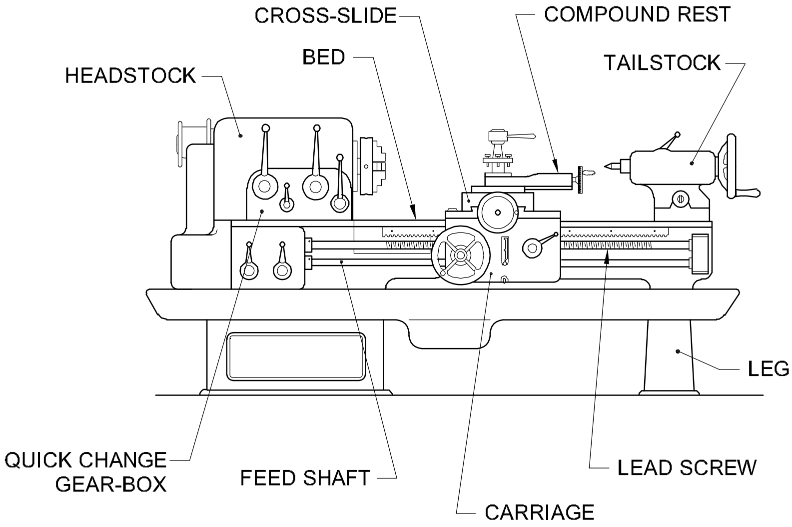
Sl.No	Name of part	Specification of oil

Table - 3

Half yearly lubrication points

Sl.No	Name of part	Specification of oil

Fig 1



CENTRE LATHE - MAJOR PARTS

Fig 2

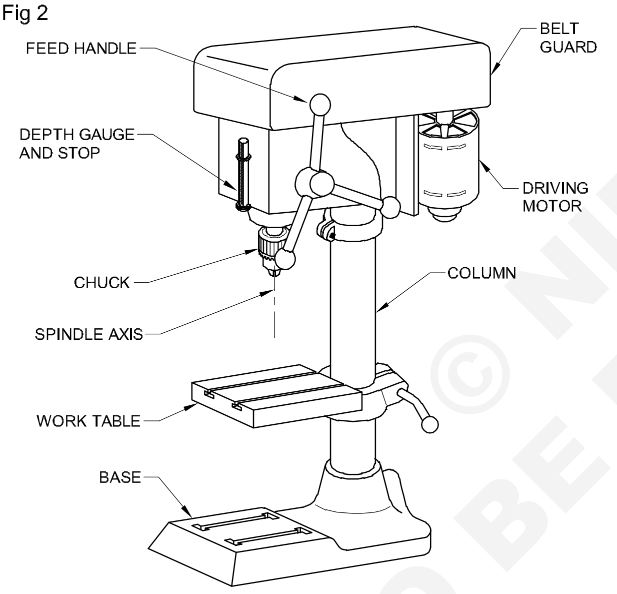
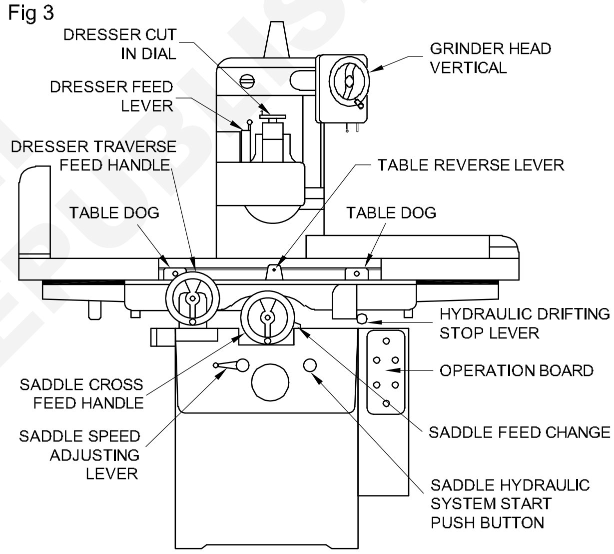


Fig 3



Care and maintenance of machines

Objectives: At the end of this lesson you shall be able to
- **ensure the machine tools instruments and accessories in good working conditions**

Job sequence

- Maintenance are to be carried out for each machine on daily maintenance weekly maintenance preventing maintence and break done maintenance.
- Clean all the parts of the machine cut
- Lubricating the movable parts parts with greas and as per requrements.
- To correct the machine for to make it operate accurately.
- To look at whether the coolant supply are woring properly
- To remove the burn cleanly
- The space parts and internal parts of the machine tool should be cleaned.
- Grinding wheels and tool and cutter grinder should be dressed.
- The work of these machines should be adjusted properly.
- The careen and electrical connection should be checked
- The felt chain etc are checked and adjusted.
- Parts like gear clutter and leavings are checked for their proper functioning
- In order to avoid sudden breakdown of machine tooth and major parts a complete maintenance is carried out.
- In order to bring back the machine to its original condition some minor or major repair are needed to be done

Safety precaution to be observe while handling machines

Objectives: At the end of this exercise you shall be able to
- **observe safety precaution while handling.**

Job Sequence

- Ensure that the lubricating system is functioning.
- Check the power feed lever are in neutral position.
- Check safety gaurds present in rotating part of machine.
- Switch of machine before any adjustment on the lathe.
- Never try to stop a rotating cjuck with your hand.
- Don't leave chuck key in the chuck, remove after use.
- Never remove chips with your bare hand.
- Don't put surface gauge on measuring instrument on the slider run way.
- Use file for removing burn.

Fig 1

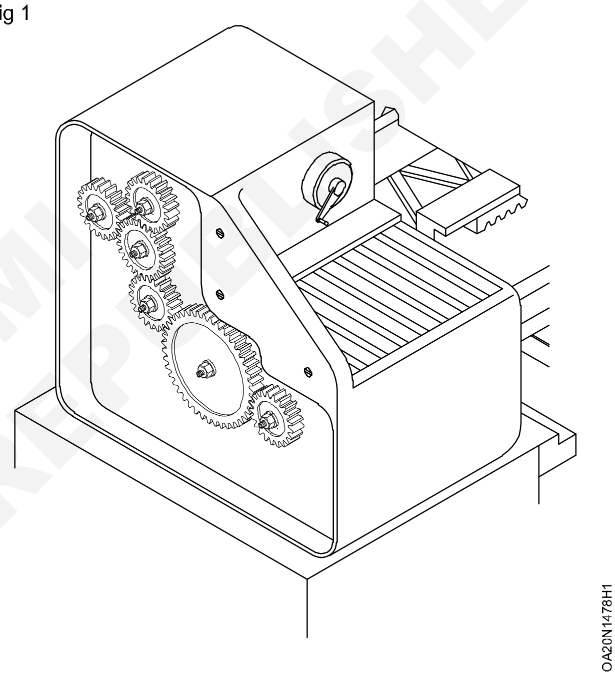
Demonstration of change gear in the gear box

Objectives: At the end of this exercise you shall be able to
- **observe safety precaution while handling**
- **changing of wornout gear.**

Job Sequence

- Cables and electrical connection to the lathe should be disconnected.
- Remove the safety device of gear box.
- Inspect the gear and meching with other gear.
- Find the wornout gear in the gear box assembly.
- Fix the gear changing lever in neutral position.
- Rotate the spindle, chuck the power transfer from one fear to other.
- Find out the looking system of worn out gear.
- Remove the key of gear set of worn out gear without disturbing the other gear set.
- Replace the wornout gear with new one without changing module and no of teeth of gear.
- Assembled the gear train in the same order of dismantling.
- Now rotate the spindle check the gear meshing and power transfer.
- Fix the safety devices of gear box.
- Connect the electric power supply.
- Check the speed ratio at all levels using lever changing.
- Ensure the power transmission and meshing of all gears in assembly.

Fig 1



Practice of holding workpiece and tool using different devices

Objectives: At the end of this exercise you shall be able to
- **practice of job turning using various work building devices.**

Job Sequence

TASK 1: **Chuck 4 Jaws**

- Open all the fout jaws to give clearance to the workpiece.
- Hold the workpiece upto the chuck face.
- Set the scribe of the surface gauge over the lathe bed.
- Rotate the chuck by hand and check the running of guide circle with surface gauge printer.
- Tighten each jaw slightly in turn, after necessary adjustment, of the two sets of opposite jaws are made.
- Recheck the guide circle with surface gauge.
- Reallign the jaws, if required.
- Tighten the jaws fully.

Fig 1

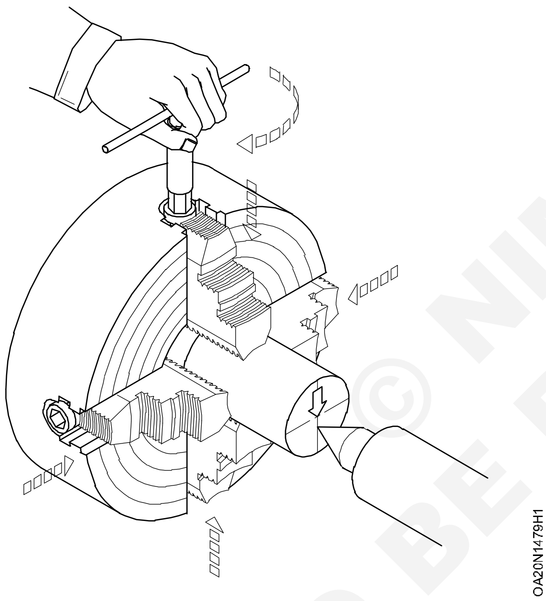
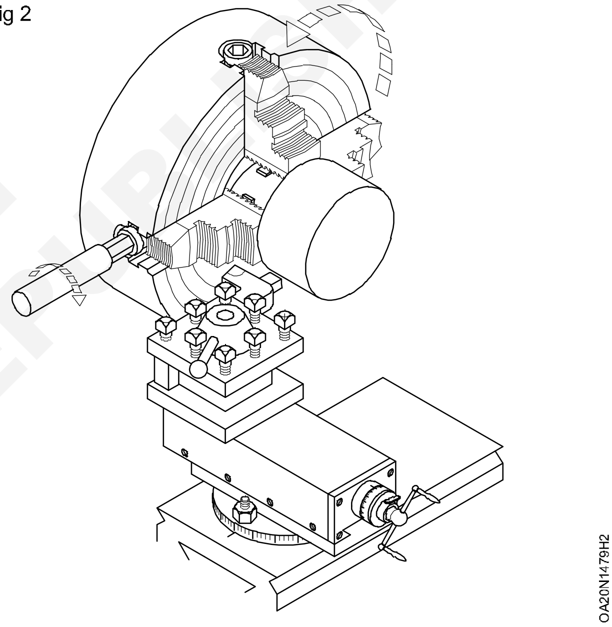


Fig 2



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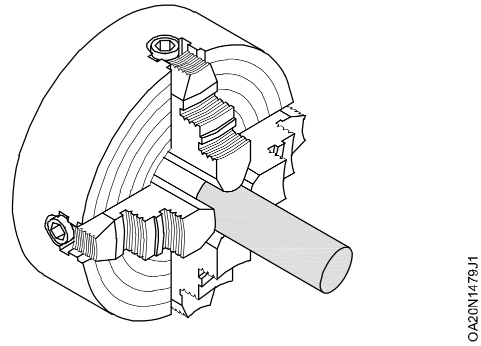
TASK 2: **Three jaw chuck**

- Clean the chuck body with cotton wash.
- Open the jaws sufficient, enough to insert the work.
- Place the wok inside the chuck keeping sufficient portion outside the chuck for turning.
- Tighten the jaws enongh to grip the work.
- Place the surface gauge on the bed ways close to the chuck.
- Adjust the pointer to make its tip move close to the top side position of the work with a minimum gap.
- Rotate the chuck by hand and observe the gap between the pointer and work surface.
- Repeat until the gap its the same.
- Run the machine to make the tip to touch the work and feel.
- If the feel of contacting the pointer tip in uniform it indicator, that the work its trued.

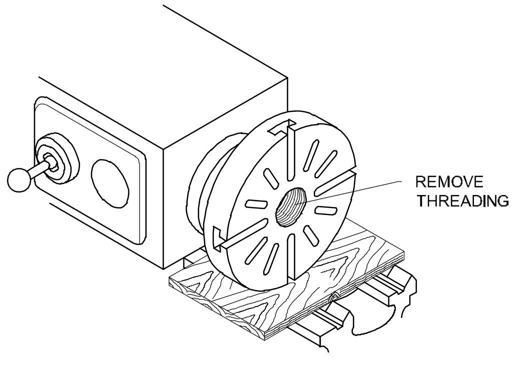
Fig 1



TASK 3: **Face plate**

- Switch off the motor.
- Place wooden board on the lathe bed, to prevent damage to sideways.
- Remove the three jaw chuck already assembled in the spindle.
- Ensure that the correct face plate for the lathe and for the job in hand before attempt to mount the face plate.
- Clean the mating part of the face plate, the dirt on these surface could result in runout of true.
- Turn the spindle by hand until the key on the spindle nose lines up with the keyway in the face plate.
- Ensure the face plate mounted for its trueness for mounting the workpiece.

Fig 1



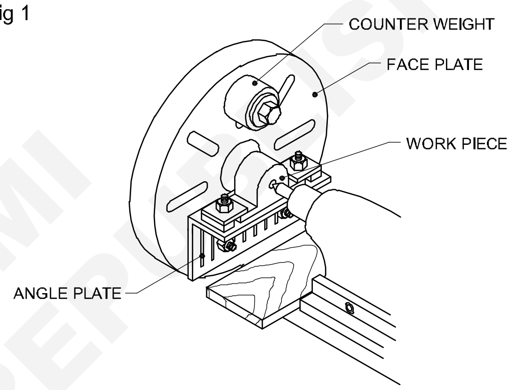
BOARD TO PROTECT SLIDEWAYS

— — — — — — —

TASK 4: **Angle plate**

- Clamp the angle plate to position approximate to the spindle axis.
- Mount the workpiece on the angle plate.
- Adjust the workpiece centre to spindle axis.
- Tighten the clamping bolts and nuts of angle plate and workpiece.
- Locate and position the counter weight above the workpiece in the slot of face plate is balanced by increasing or decreasing the weight of the counter weight to set the correct position.
- Tighten all the clamping bolts and nuts rigidly before operating the lathe.

Fig 1



WORK HELD ON AN ANGLE PLATE

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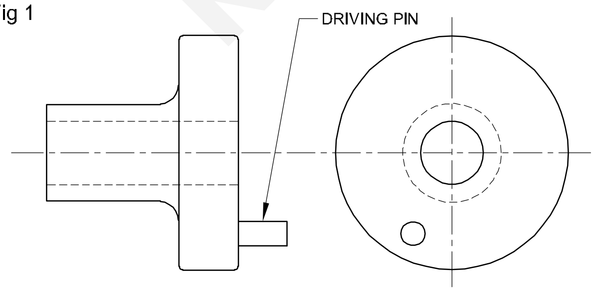
TASK 5: **Driving plate**

- Check for the true running of the live centre.
- Chuck the alignment of the live centre and dead centre of the lathe with a test bar and dial indicator.
- Mount a driving to the spindle nose.
- Mount the mandrel with the workpiece in between centre, and carefully adjust the force on the centre.
- Very light cuts should only be taken on a work of a layer diameter mounted on a small mandrel.

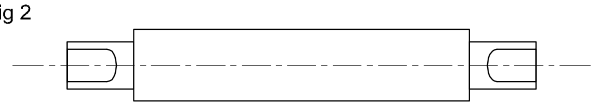
Fig 1



DRIVING PLATE

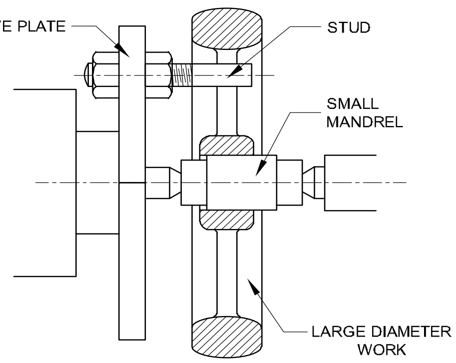
- If portible drive the workpiece, directly from the drive plate by mean of suitable stud. This wil prevent the work from slipping.

Fig 2



PLAIN MANDREL

Fig 3

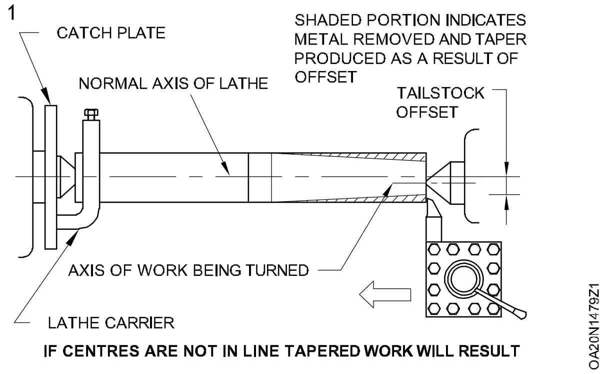


WORK DRIVEN DIRECTLY BY DRIVE PLATE

TASK 6: **Catus plate**

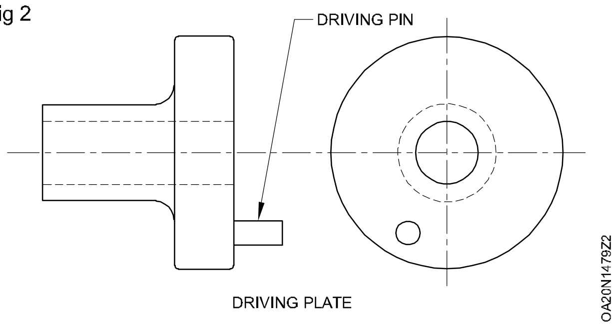
- When a workpiece in held between centres catus plate is used.
- A long bar is used for taper turning catch plate is used to hold the job through lathe carrier.

Fig 1



- It prevents from sliping when job held between centre.

Fig 2



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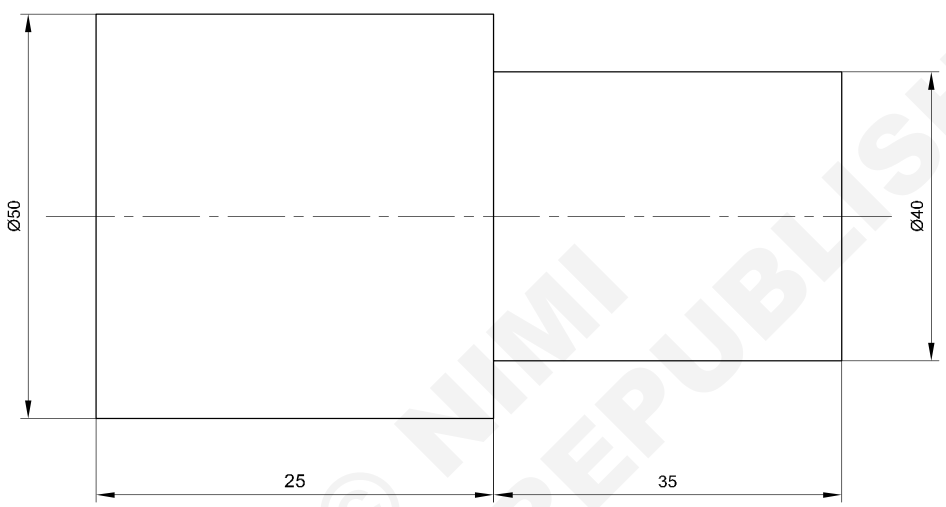
Exercise on plain, steped, taper and form turning, knurling etc

Objectives: At the end of this exercise you shall be able to
- **parallel turn the work by hand feed method with various depth of cuts**
- **turn step to the required diameter and length.**

TASK 1: **Perform parallel turning and step turning operation**

TASK: 1



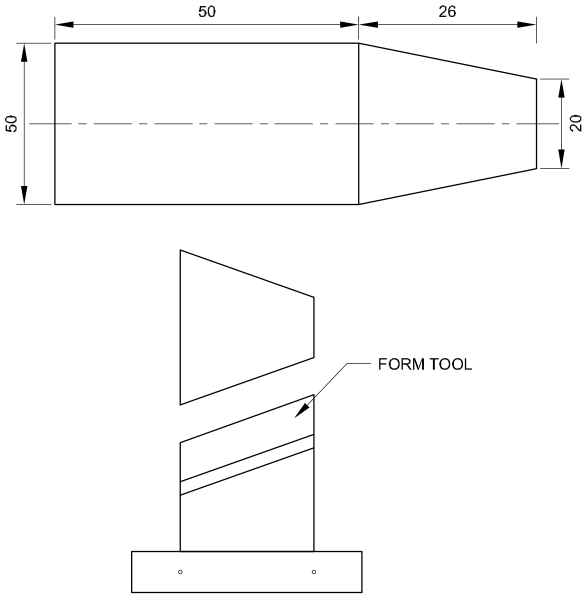
		→ EX.NO.1.3.51				
1		EX.NO.1.3.45 ←	Fe310	-	-	1.4.80
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**PERFORM PARALLEL TURNING AND STEP TURNING OPERATION**	DEVIATIONS ± 0.1 mm	TIME :
		CODE NO. OA20N1480E1	

TASK 2: **Taper turning by form tool**

- **Grind form tool for taper turning**

TASK: 2

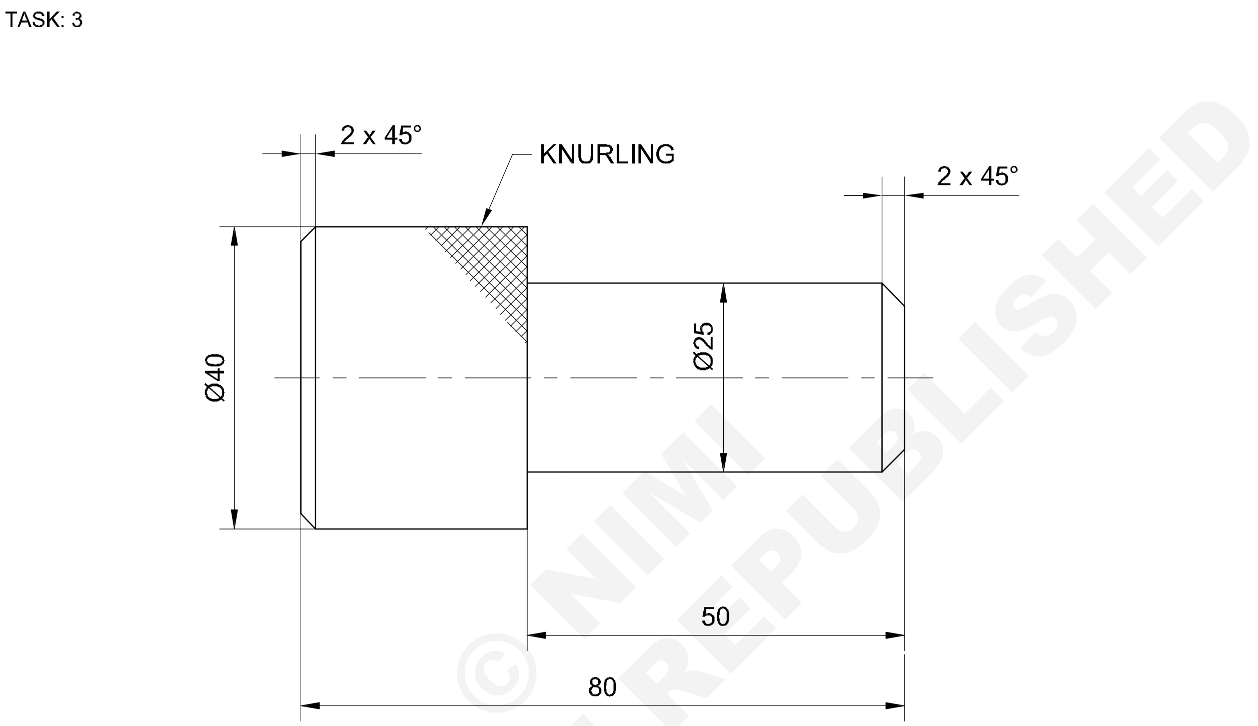


		EX.NO.1.3.51				
1		EX.NO.1.3.45	Fe310	-	-	1.4.80
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**TAPER TURNING BY FORM TOOL**	DEVIATIONS ± 0.1 mm	TIME :
		CODE NO. OA20N1480E2	

TASK 3: **Knurl the job**

- Hold the job in lathe chuck.
- Set a knurling tool in the tool post.
- Knurl on the cylindrical surface.



1	Ø45 - 85	–	Fe 310	–	–	1.4.80
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. OA20N1480E3	

Job Sequence

- Check the raw material size.
- Hold the job in a 4 jaw chuck and true it by keeping about 40mm over hanging outside the chuck.
- Set the tool to the correct centre height.
- Select and set the spindle RPM.
- Face one side and turn parallel the outer diameter to 60mm for the maximum possible length.
- Reverse the job and hold it.
- Face the other end to total length of 60mm.
- Turn step for size of ∅ 40 x 35mm length.
- Remove the sharp corners.
- Check the dimensions by using vernier caliper.
- Apply thin film of oil and pressure it for evealution.
- Chuck the given material to the draining size.
- Hold 40mm inside the chuck and true.
- Grind the from tool to the requiring angle 30°.
- Hold the tool in the tool post.
- Check the centre height and centre the tool to the lathe centre.
- Form the taper to the required length using form tool by mean of the on slide.
- Less feed is givenas entire cutting edge will be in contact with the workpiece.

Then method in limited to turn short length of taper. The length of the taper is shorter than the cutting edge

- Check the raw material size.
- Hold the material securely in a 3 jaw chuck projecting 50mm 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 80mm.
- Turn the job ∅ 25x50 with a side knife tool.

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.

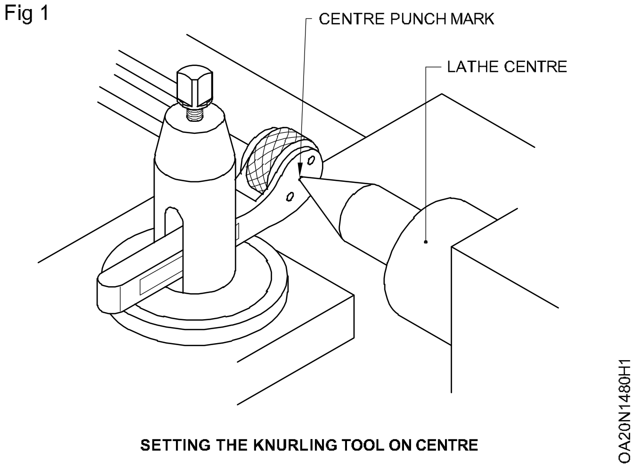
Reduce the diameter of the portion to be knurled depending upon the grade of knurl and material of the job. Reduce 0.1 mm for fine knurling, 0.2 mm for medium knurling and 0.3 mm for coarse knurling approximately.

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)

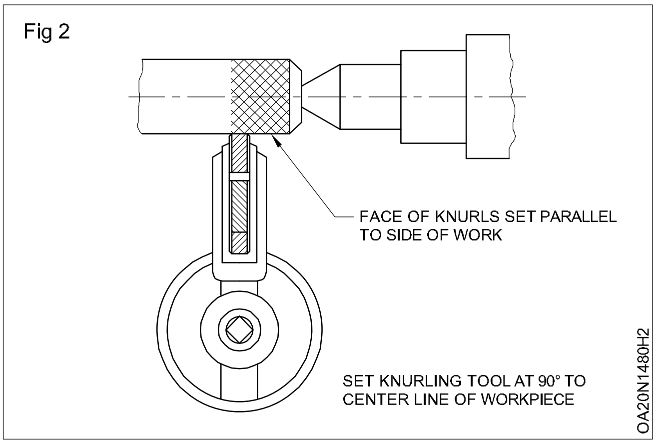
Set the machine for a low speed, preferably 1/3 to 1/4 of the turning speed. Mark off the length to be knurled.

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

Fig 1

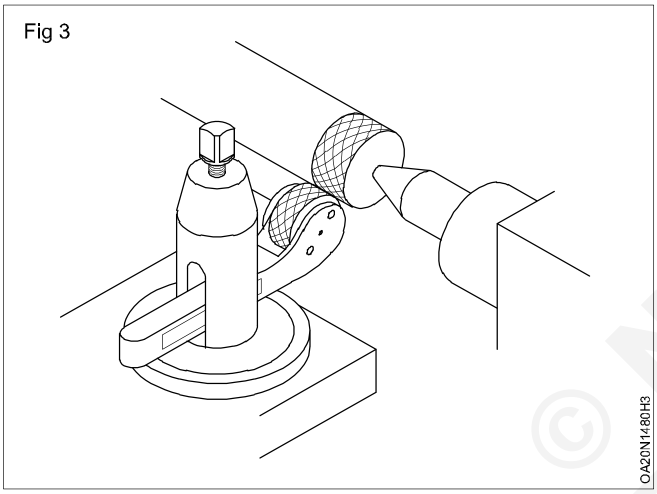


SETTING THE KNURLING TOOL ON CENTRE



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)



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.

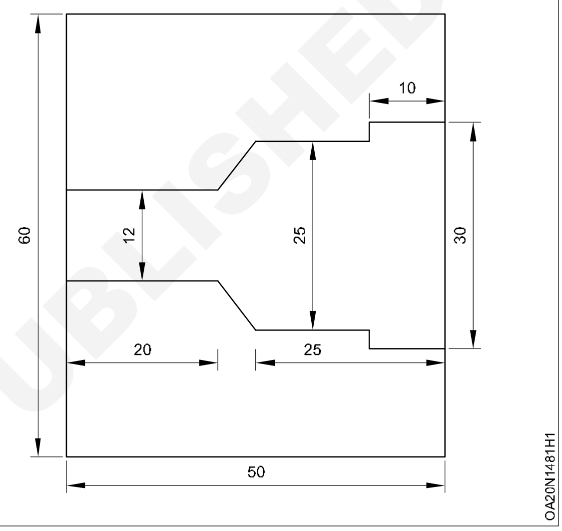
Exercise on drilling, reaming, boring counter boring etc

Objectives: At the end of this exercise you shall be able to
- **practice on drilling, reaming in a lathe**
- **practice on counter reaming in a lathe**
- **measuring internal diameter using vernier**

Job sequence

- Hold the job in a 4 jaw chuck and true it.
- Face one end and centre drill the job
- Drill the job with a Ø 11.75 mm drill through out
- Fix a Ø 20mm drill in te tail stove spindle
- Feed the Ø 20 mm drill to 25 mm length with the help of the graduated collar of the tailstock.
- Set the boring bar in the tool past to the centre height and bore the drill hole toØ 25 Ø to 25mm
- Check the bane size with a vernier caliper
- File the Ø 12 size reamer in the tailstock supporting with the dead centre.
- Ream the hole by using sufficient coolant. fine uniform feed while reaming
- Check the hole with a 'Go' and 'logo' plug gauge.
- Fix the Ø 30 mm drill bit in the hailstock drill the job 25mm Ø hole side to the depth of 10mm as a counter loaring.
- Deburr the edges
- Check the loan with vernier caliper.

Fig 1



Skill sequence

Reaming a hole by a hand reamer on the lathe

Objectives: This shall help you to
- **set the machine for hand reaming**
- **set the reamer on a lathe**
- **ream a hole accurately with a hand reamer**

The procedural sequence of hand reaming on a lathe is as follows.

Check the drilled hole to ensure that it has the required reaming allowance

Choose the correct type and size of reamer.

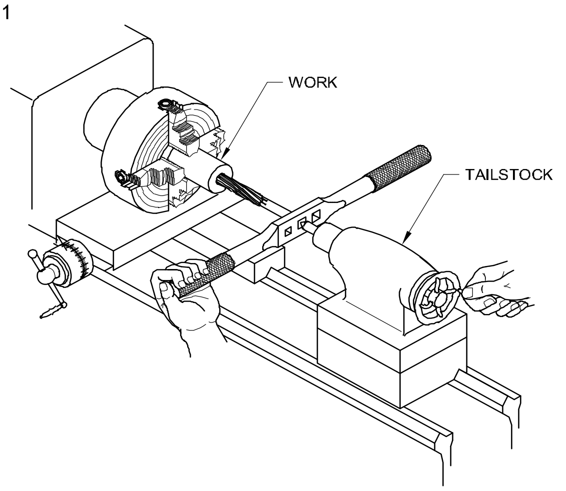
Remove the tool holder and tool post.

Fix up the tap wrench to the square end of the reamer. The tap wrench must be short enough to clear the lathe be

Move the tailstock back so that there is sufficient space for the reamer between the dead centre and the workpiece.

Place the reamer into the pre drilled hole slightty with the shank supported by the tailstock dead centre. (Fig 1)

Fig 1



USING A HAND REAMER IN A LATHE

Apply cutting fluid to the reamer during reaming.

The job should not be rotated by power.

Now gently rotate the reamer colckwise with “the wrench as you turn the tailstock hand wheel to support and advance the reamer into the hole. (Fig 1)

An adjustable wrench can also be used to rotate the reamer instead of the tap wrench.

When the holes is fully reamed, continue to rotate the reamer clockwise as you pull it out of the hole.

Remove the reamer occasionally by turning it clockwise to clear of the chips from the flutes.

Never use a hand reamer under power.

Never turn the lathe spindle or reamer backward. This will damage the reamer blunting the cutting teeth of the reamer, and will also result in developing scratches on the reamed surface of the hole.

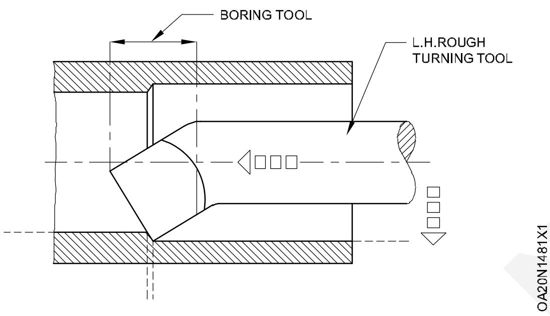
Remove any burrs from the edge of the hole with a scraper.

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)

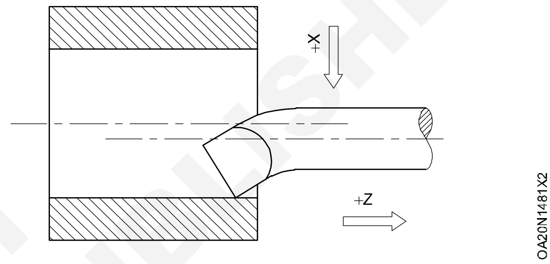
Fig 1



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

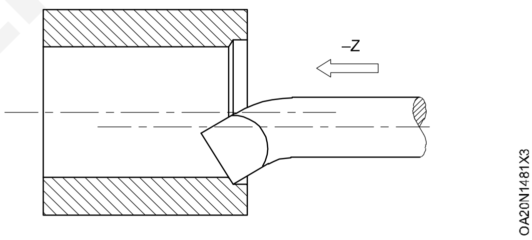
- Mount the workpiece in a four jaw chuck. True the face of the work and the outer diameter.
- Set the lathe to the proper spindle speed for boring.
- Mount the boring tool on the tool post of the compound rest.
- Fix the boring tool, level and parallel to the centre line of the lathe
- Grip the boring tools as short as possible to reduce chatter.
- Use the largest diameter boring tool which can be accommodated in the drilled hole. (Approximately 2/3 size of the bore)
- Set the cutting edge of the cutting tool just slightly above the centre line, since there is a tendency for the thool 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 anti clockwise until the cutting tool touches the inside surface of the hole. (Fig 2)

Fig 2



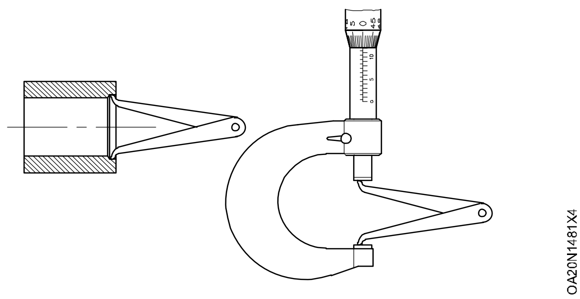
- Tak a light trial cut about 0.2 mm deep and about 8 mm long at the right hand end of the work. (Fig 3)

Fig 3



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

Fig 4



- 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 lenght. (Fig 5)

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

Fig 5

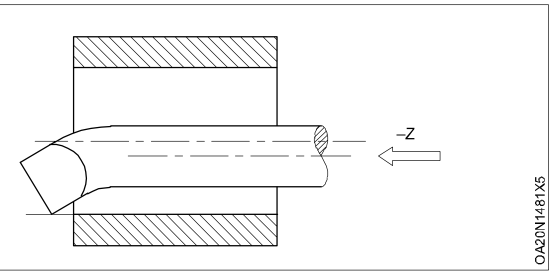
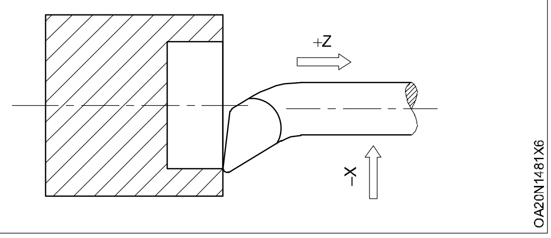


Fig 6



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.

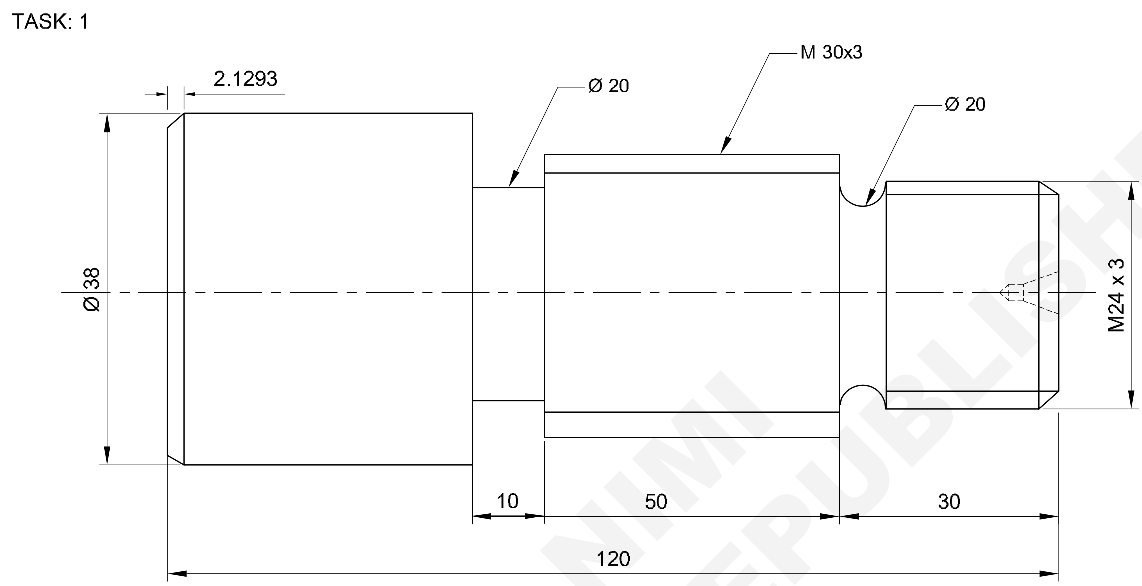
To avoid bell mouth, repeat the same cut

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

Remove the sharp corners.

Screw thread cutting both internal and external of different types

Objectives: At the end of this exercise you shall be able to
- **form undercut on work held chuck to centre**
- **cut metric 'V' threads on external**
- **cut internal thread**
- **check the profile using pitch gauge metric**

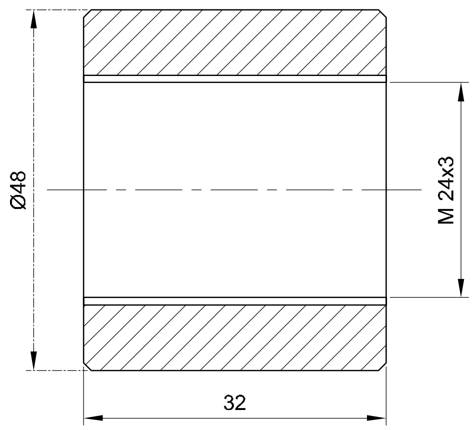


Job Sequence

- Check raw material size.
- Hold the job in a 4 jaw chuck keeping 60mm outside and face the one end.
- Turn Ø 38mm to a maximum length.
- Chamfer 2 x 45° as per drawing.
- Reverse and hold the job in the chuck and true it.
- Face the end maintain total length 120mm.
- Centre drill the job and support the job with centre.
- Turn Ø 30mm to 80mm length.
- Turn Ø 24mm to 30mm length.
- Undercut Ø 20 mm x 10 mm length.
- Form radius R2 on Ø20mm.
- Set the machine to 3mm pitch and the spindle speed levers to 1/3rd of the roughing speed.
- Set the 60° threading tool with the help and the centre gauge.
- Cut threads M24 x 3, M30 x 3.
- Check the threads with the help of a screw pitch gauge.

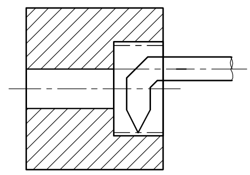
1	Ø 40 - 125	–	Fe 310	–	–	1.4.82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
	SCREW THREAD CUTTING (EXTERNAL METRIC)				TIME :	
					CODE NO.	OA20N1482E1

TASK: 2



TASK 2: **Cutting internal thread**

- Check the raw material size.
- Hold the work in a four jaw chuck about 10mm inside the chuck and true it.
- Face the one end.
- Rough and finish turn the outer dia 48 mm to possible length.
- Chamfer 2 x 45° on the outer edge.
- Drill and bore the hole to the core dia of the thread.
- Fix the internal threading tool in a post and set it with the centre gauge.
- Set the machine to 3 mm pitch and the spindle speed levers to 1/3rd of the roughing speed.
- Touch the tool tip to the bore surface and set the cross feed graduated collar to zero.
- Rough and finish M24 x 3 by giving successive cuts ensuring the correctness of the pitch by checking with a pitch gauge.
- Reverse and hold the work on Ø 48 mm and chuck its run out.
- Face the end of work and maintain a total length of 32mm.
- Chamfer 1 x 45° on the outer edge.

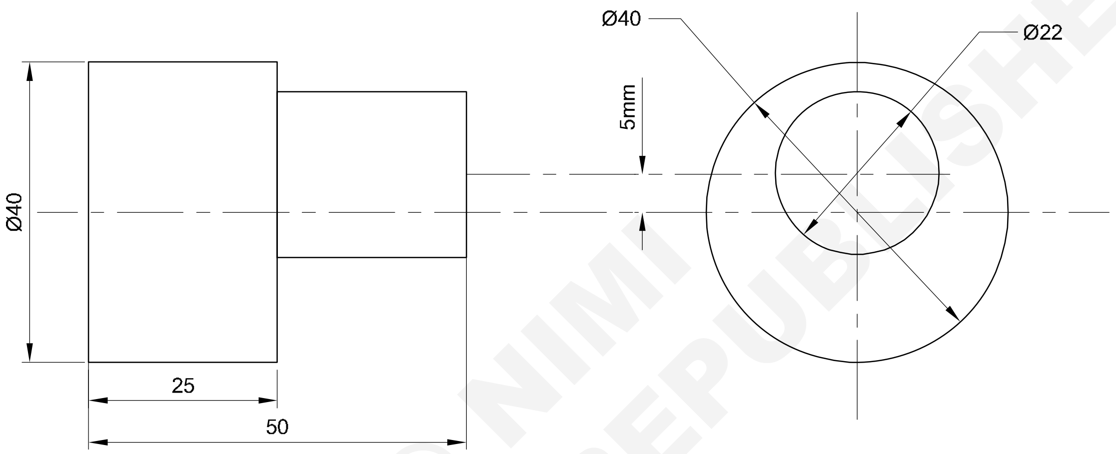


1	Ø50-35	–	Fe 310	–	TASK-1	1.4.82
1	SQ 16-100	–	Forged HSS Tool	–	TASK-2	1.4.82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1 : 1	**SCREW THREAD INTERNAL (METRIC) AND THREADINGTOOL GRINDING**	TOLERANCE	TIME
		CODE NO. OA20N1482E2	

Exercise on eccentric turning

Objectives: At the end of this exercise you shall be able to
- **mark eccentricity**
- **set the job for eccentric turning in a 4 jaw chuck and turn**
- **methods of turning eccentric jobs**
- **uses of eccentric job**



Job sequence

- Check the raw material
- Hold the job with about 30mm projection from the jaw face and true the workpiece.
- Face the work piece with minimum stock removal.
- Turn Ø 40 mm to a maximum length.
- Reverse the job hold and true it and face the end to maintain a total length of 50 mm and remove the job
- Mark the centre line and eccentric centre line according to the drawing with the help of making tools.
- Punch both centre lines.
- Draw a guide circle 22 mm with the eccentric centre as the centre point.
- Punch the intersecting 4 points.
- Hold the job in a 4 jaw independent chuck on the turn diameter by keeping 30mm outside the chuck.
- True the concentric guide circle.
- Turn eccentric diameter 22 mm to length of 25 mm.

1	Ø 45-55mm	–	Fe 310	–	–	1.4.83
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
	SIMPLE ECCENTRIC TURNING (WITH Ø 22m AND THROW/OFFSET OF 5mm)				DEVIATIONS : ±0.02 mm	TIME:
					CODE NO. OA20N1483E1	

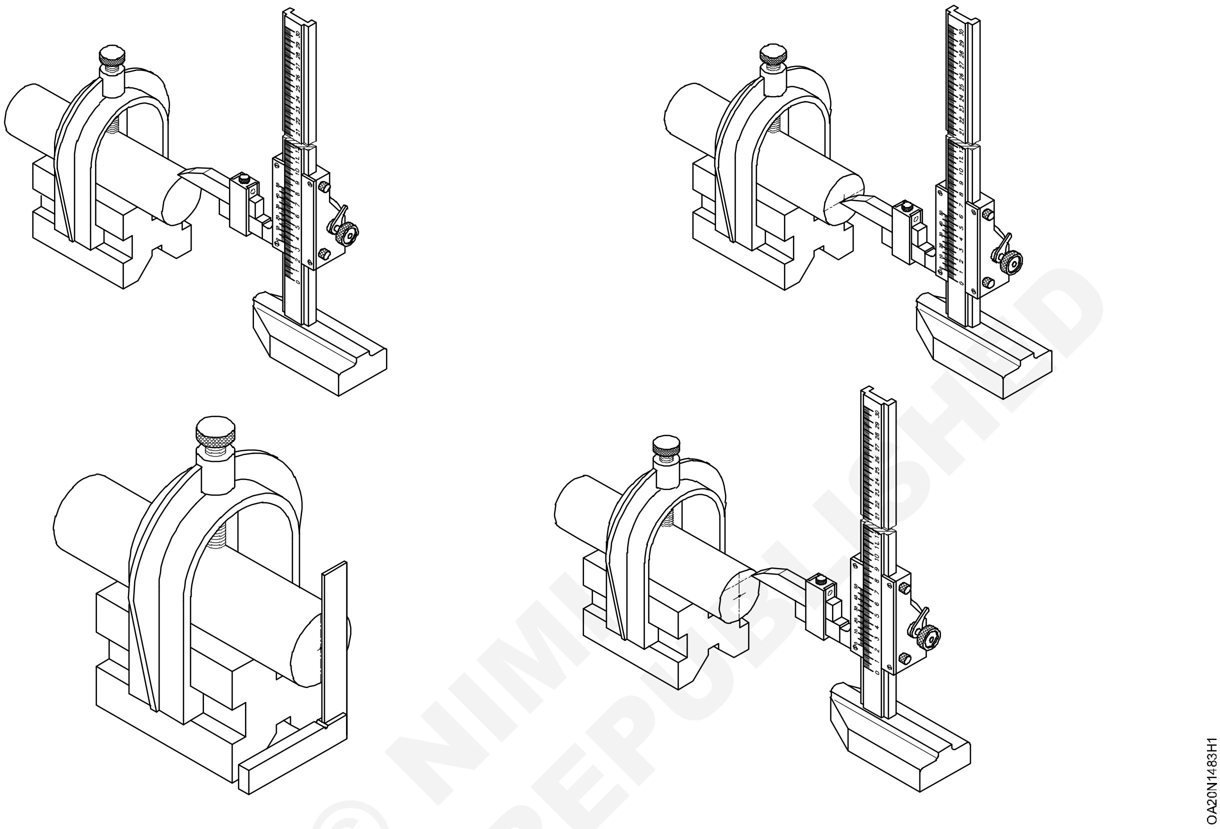
Skill sequence

Use of marking vernier height gauge and V block

Objective: This shall hlep you to

- **mark concentric and eccentric centre lines of a job using vernier height gauge**

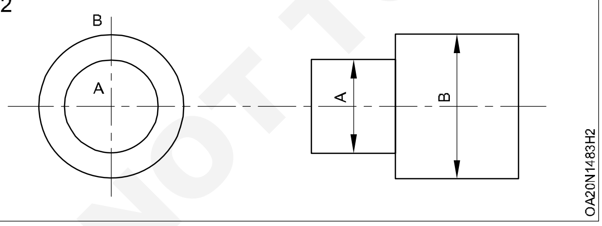
Fig 1



Concentricity

When different diameters are turned in the same axis, it is said to be concentric turning. Figure 1 shows the two diameters A & B lie on the same axis having the same centre of rotation. If such jobs are tested with a dial test indicator and V block the dial test indicator shows a constant reading.

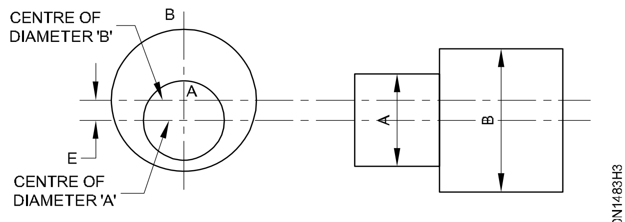
Fig 2



Eccentricity

When different diameters are turned on different axes, it is said to be eccentric turning. The figure shows that the diameter A & B lie on different centres and have a different centre of rotations. The distance E between the centre of rotation is the amount of 'offset' or 'eccentricity' it the diameter 'A' is tested with the dial test indicator by supporting the diameter 'B' in the 'V' block, the dial test indicator reads twice the reading of 'E'. The different in the maximum readings of the dial test indictor is called 'throw' (i.e) throw = E (Fig 2)

Fig 3



ECCENTRIC DIAMETERS (EACH DIAMETER HAS A DIFFERENT CENTRE)

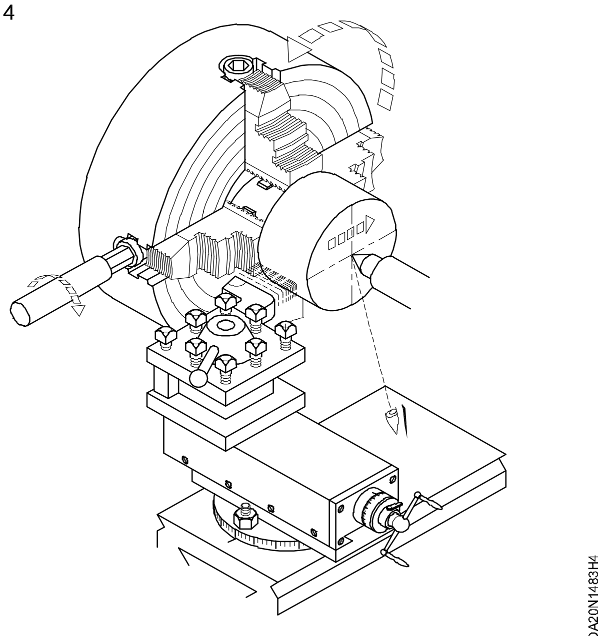
Method of identifying ecentricity

The eccentricity of a turned job is tested with the help of a dial test indictor. It is possible to test the offset of the turned job when the job is being held on a 4 jaw chuck.

Figures 3 shows the method of using the dial test indicator for testing the trueness. If the diameters are eccentric, the dial test indicator gives different readings which amount to '2E'. Thus, eccentricity 'E' may be obtained from the two readings. (Fig 3)

The other method of testing eccentricity is using a 'V' block and dial test indicator. In this method, one of the diameters of the eccentric turning is supported in the 'V' block and the reading of the other diameter is obtained with the help of the dial test indicator. The difference in the readings gives the throw '2E'. Thus eccentricity 'E' may be determined by this method.

Fig 4



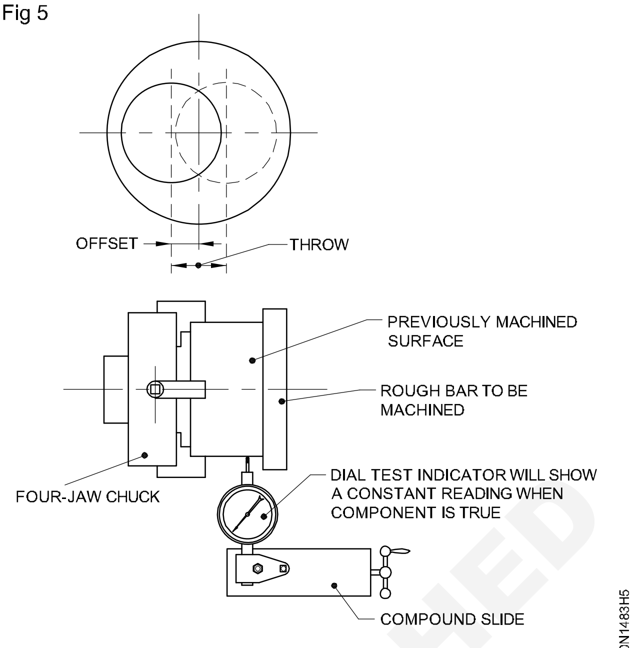
Method of eccentric turning

External eccentric turning as well as internal eccentric boring may be accurately carried out on a centre lathe. The figure shows the external eccentric and internal eccentric jobs.

It is possible to turn the eccentric turning with the help of a 4 jaw chuck as well as using a lathe carrier and centres, holding the work between centres.

When 4 jaw chuck is used, a guide circle of the eccentric axis is essential for truing the eccentric axis. This requirement may be met by the marking process prior to the eccentric turning with the help of this circle, the 'Offset' may be easily made by using a surface gauge. Thus the eccentric axis is located for external eccentric turning and eccentric boring. (Fig 4)

Fig 5



TRUING-UP WITH THE DIAL TEST INDICATOR

Eccentric turning by using a lathe carrier and centres is done with the help of accurate marking before using these accessories, the 'offset' has to be marked with the help of marking tools. Both the concentric and the offset centres have to be centre drilled by using these centre holes, it is possible to turn eccentric turning on the job.

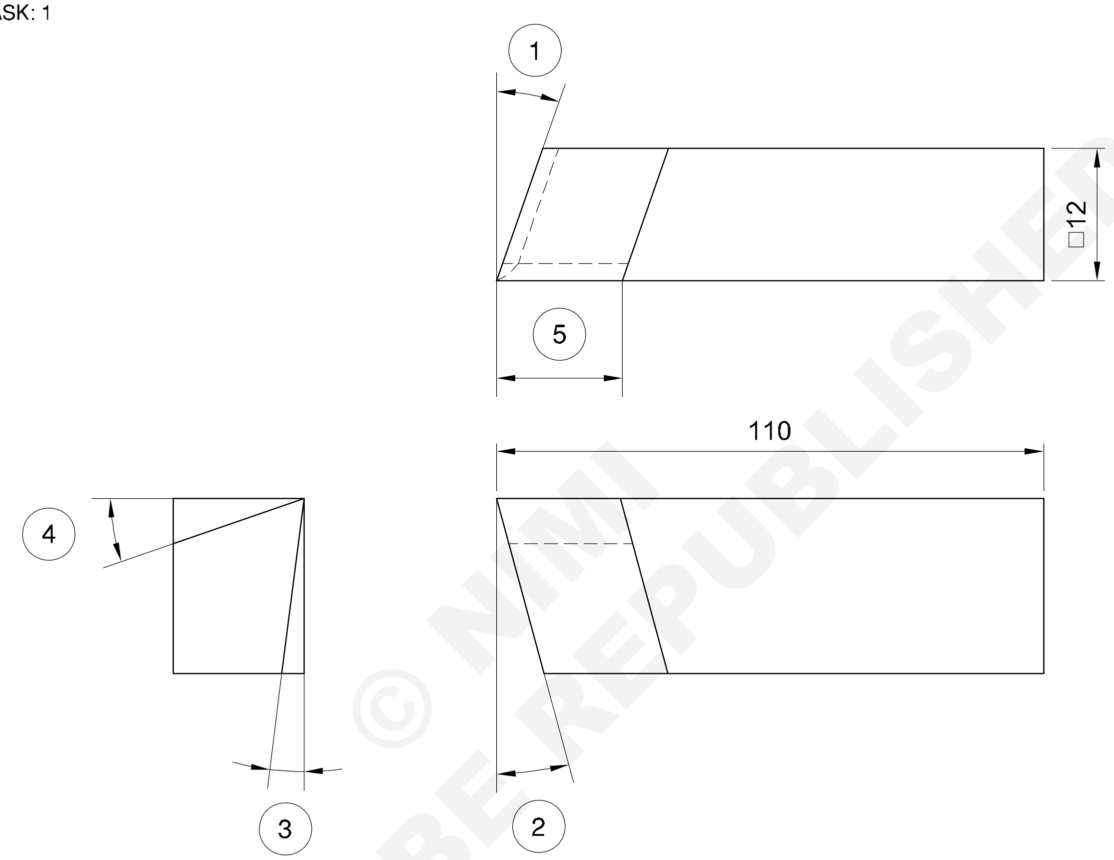
Use of eccentric turned jobs

Eccentric turned jobs are largely used in automobile industry to convert rotary motion into reciprocating motion. An eccentric turned job is used in crankshafts. It is used in power press, guillotine machines, and press brakes. It is also generally used in automatic controls.

Grinding of lathe tools

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

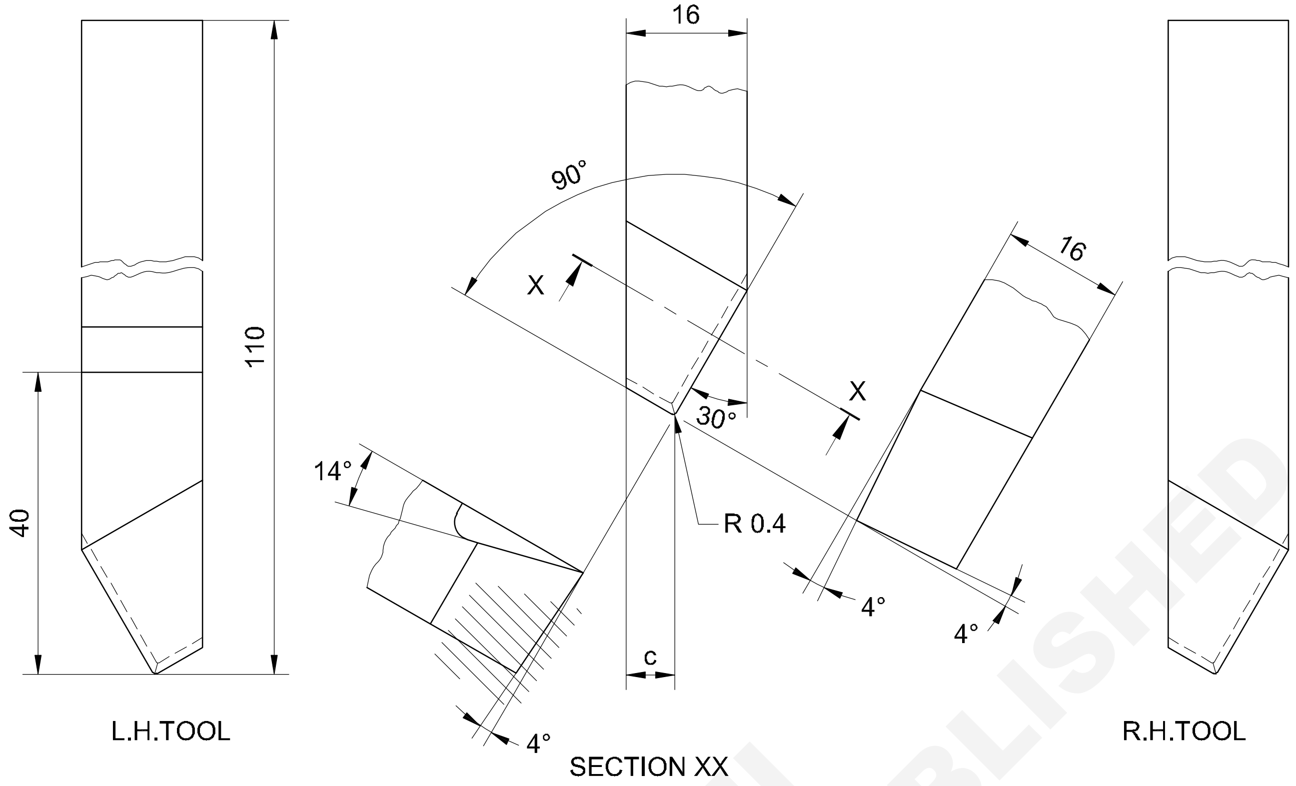
TASK: 1



1	□ 12 - 110		Fe310-O			-
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**PROJECT : SIDE CUTTING TOOL**	DEVIATIONS	-
		CODE NO. OA20N1484E1	

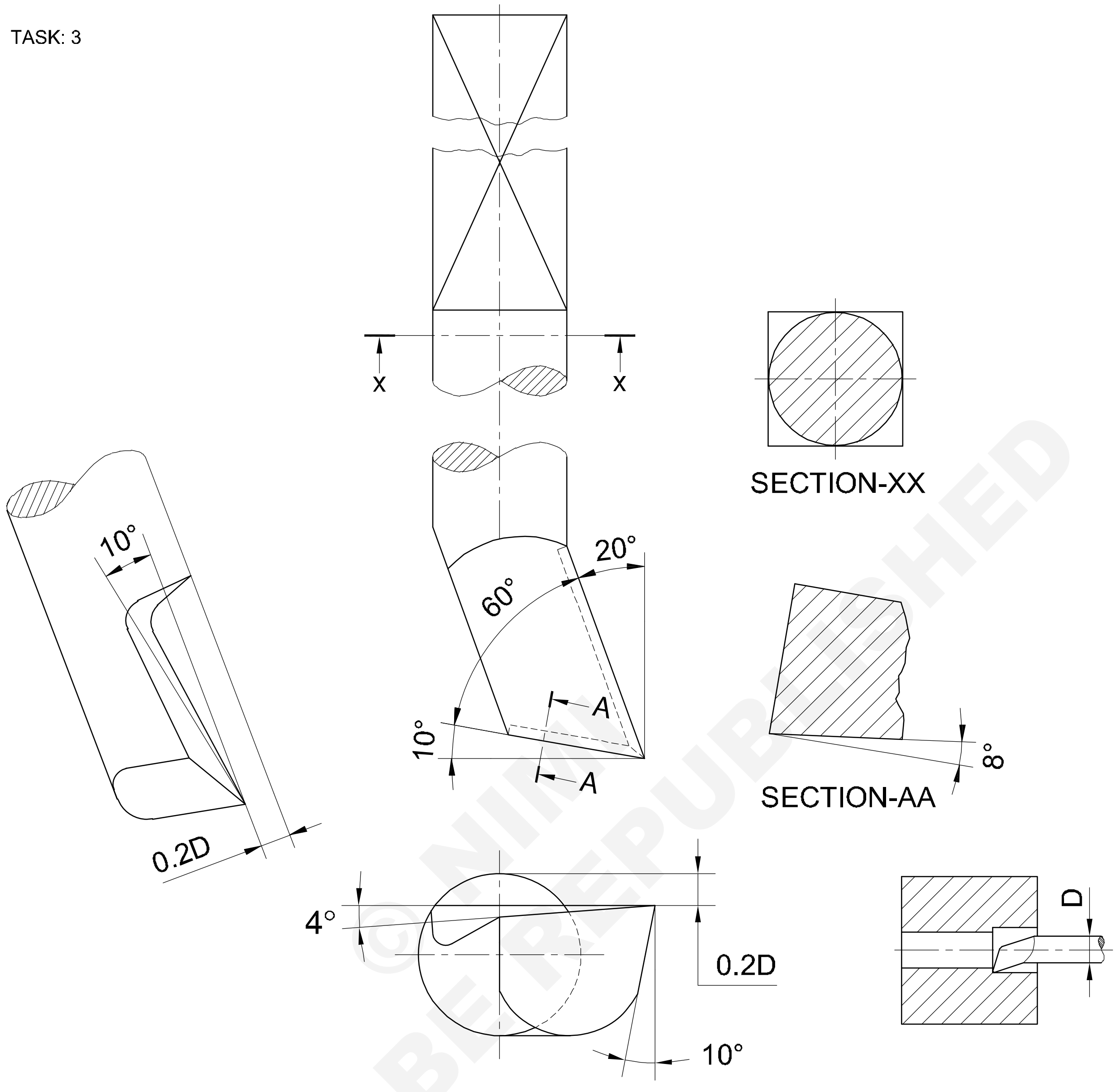
TASK: 2



1	SQ16 - 110	–	Fe310	–	–	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**PROJECT : GRINDING A STRAIGHT TURNING TOOL**	TOLERANCE	-
		CODE NO. OA20N1484E2	

TASK: 3



1	SQ16 - 100	–	Forged H. S. S Tool	–	–	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PROJECT : BORING AND FACING TOOL	TOLERANCE	-
		CODE NO. OA20N1484E3	

TASK 1: Grinding of lathe tools

- 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

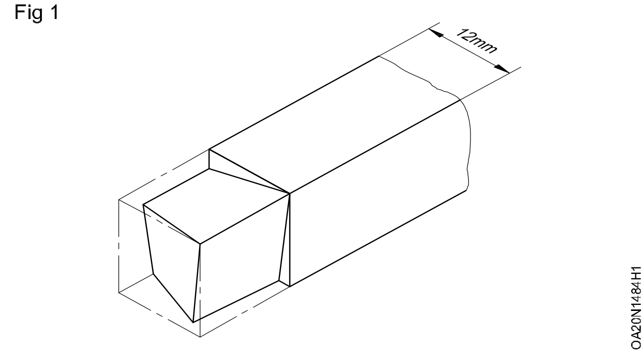
Skill sequence

Grinding a side cutting tool for machining steel

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

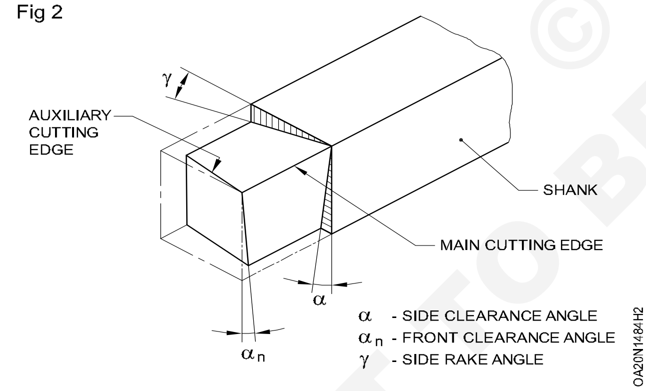
The side cutting tool to be used on steel is illustrated in Fig 1. The right hand portion illustrates the tool blank in dotted lines before grinding, and the ground tool by thick lines. (Fig 1)

Fig 1



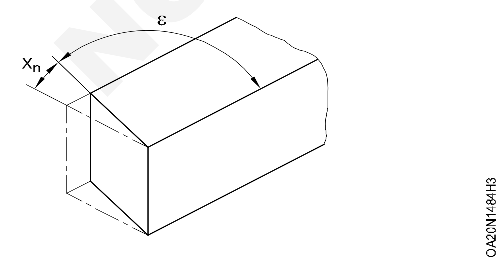
The side cutting is in line with the blank edge and the end cutting edge is inclined at an angle of 25°. The side rake angel is 14°. The front and side clearances are ground 6°. The length of the side cutting edge is maintained equal to the size of the square cross-section of the tool blank, i.e. 12mm, 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.

Fig 2



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

Fig 3



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

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

Fig 4

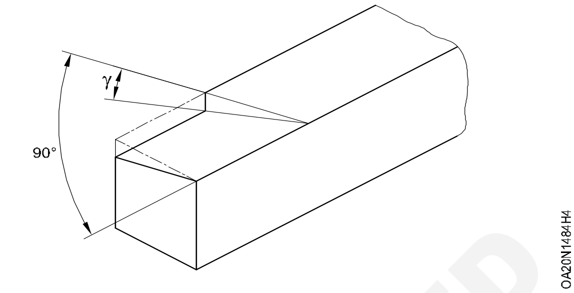
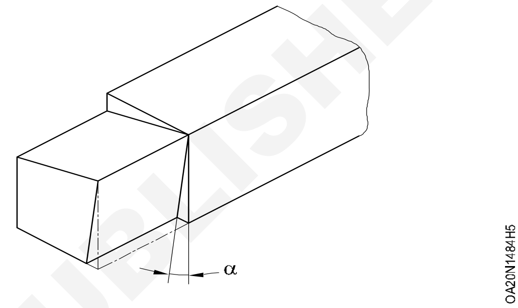
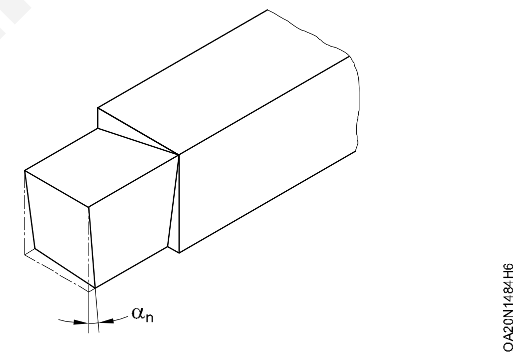


Fig 5



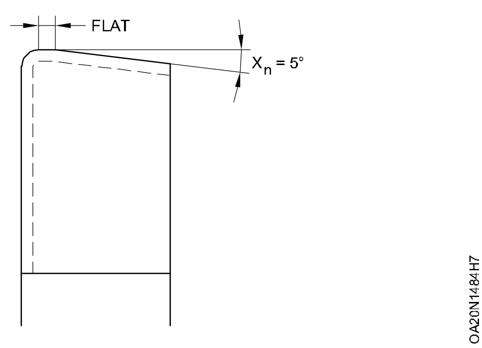
Grind the front clearance angle of 6°. Angle ∅ (Fig 6)

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.

Fig 7



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TASK 2: Grinding of lathe tools

- 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 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 an oilstone.
- The top rake (back rake) angle should be kept at 0°.

— — — — — — —

TASK 3: Grinding of lathe tools

- Prepare the pedestal grinder for grinding a boring and facing tool.
- Grind a front clearance angle of 8° and an end cutting angle of 10°.
- Grind a side clearance angle of 10° and a side cutting-edge angle of 20°.
- Grind a top rake angle of 10° and a side rake angle of 4°.
- Maintain a nose radius of 0.3 to 0.5 mm.
- Deburr with an oilstone and check with a tool angle gauge/protractor.

Points to Remember

- Avoid burning of tools.
- Make sure the cutting edge is visible/always, while grinding.
- Make use of the entire width of the grinding wheel i.e. don't grind in one particular place.

Grind a secondary clearance angle of 16° if necessary.

Simple projects such as hollow punch, pulleys, gear blanks, simple coupling

Objectives: At the end of this exercise you shall be able to
- **Do project models such as follow punch, pulley, gear blank, simple coupling**

Job sequence

- Check the dimension of material available in the lab suitable for making project model.
- Do the project an shown in figure applying your knowledge gained in the previous exercise
- Disown with you instructor to compelete the job.
- Apply oil and preserve it for evaluation.

Fig 1

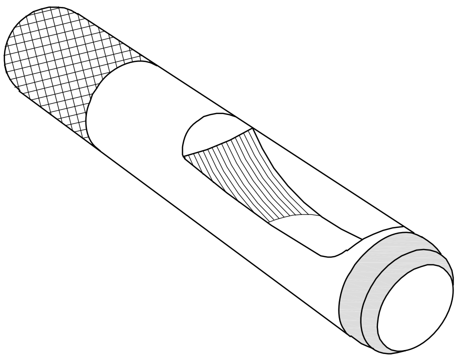


Fig 2

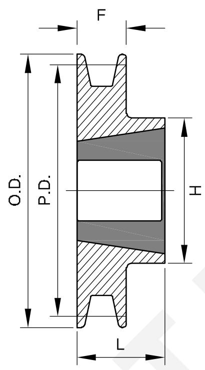


Fig 3

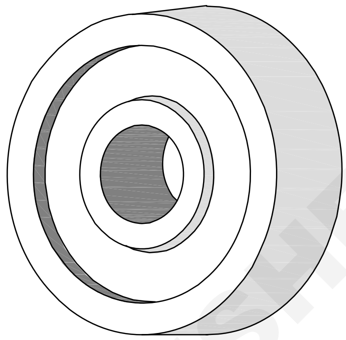


Fig 4

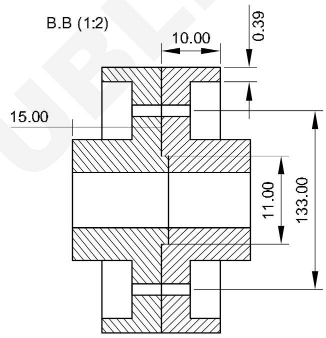
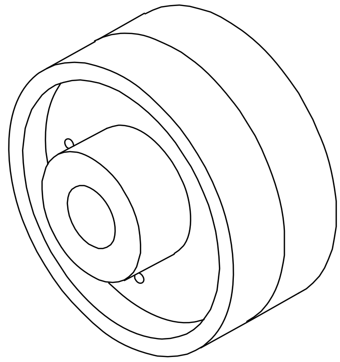


Fig 5



Safety precautions in handling machine

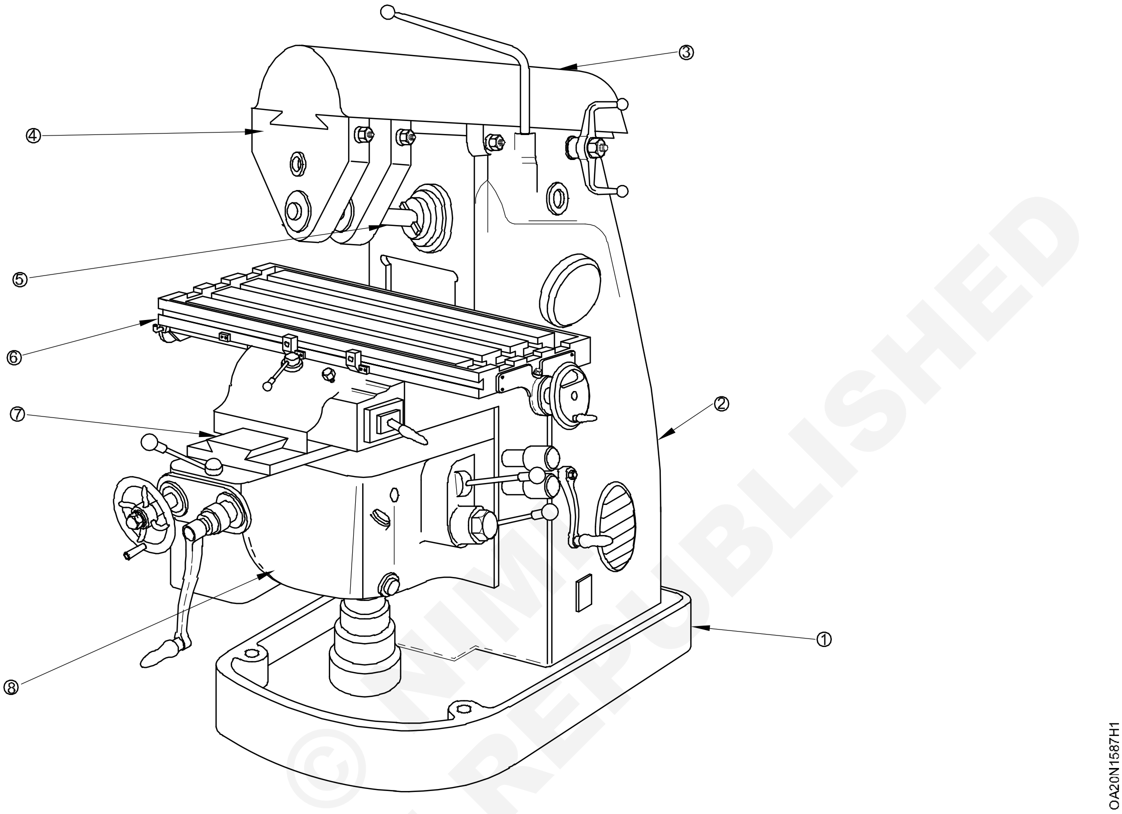
Objectives: At the end of this exercise you shall be able to
- **observe safety precautions while working in milling machine**

- Work must be clamped securely in a vise and vise clamped tightly to the table, or, work must be clamped securely to the table.
- Do not take climb milling cuts on the shop's mills unless instructed to do so.
- Make sure cutter is rotating in the proper direction before cutting material.
- Before running machine the spindle should be rotated by hand to make sure it is clear for cutting.
- Make sure the power is off before changing cutters.
- Always use the proper cutting fluid for the material being cut.
- Never run the machine faster than the correct cutting speed.
- Make sure that the machine is fully stopped before taking any measurements.
- Always use cutters which are sharp and in good condition.
- Don't place anything on the milling machine table such as wrenches, hammers, or tools.
- Always stay at the machine while it is running.
- Don't place anything on the milling machine table such as wrenches, hammers, or tools.
- Always stay at the machine while it is running.
- Don't take too heavy a cut or use too rapid a feed.
- Remove the collet tightening wrench immediately after using it.
- If at all feasible rig a guard or shield to prevent chips from hitting other people.
- Use the milling machine spindle brake to stop the spindle after the power has been turned off.
- Before cleaning the mill remove cutting tools from the spindle to avoid cutting yourself.

Safety precautions in handling machine

Objectives: At the end of this exercise you shall be able to
- **observe safety precautions while working in milling machine**

Fig 1



Job sequence

- Identifiy the machine parts.
- Move the slides manually
- Set the different spindle speed.
- Practice on mounting of different arbor.
- Practice on automatic feed and rapid movement

Table 1

Sl.No	Name of the parts	Type of movement
1		
2		
3		
4		
5		
6		
7		
8		

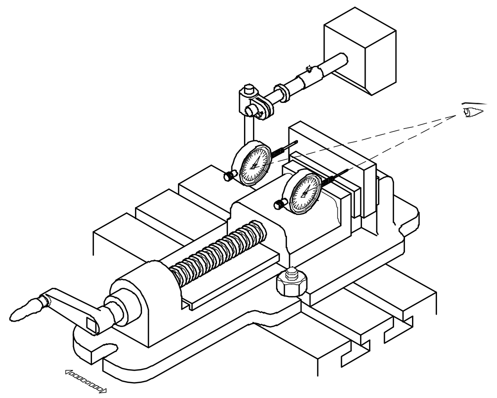
Practice on different work and tool holding devices

Objectives: At the end of this exercise you shall be able to
- **align a machine vice on the table of the milling machine**
- **fix the workpiece in machine vice**

TASK 1: Practice on different work and tool holding devices

Fig 1

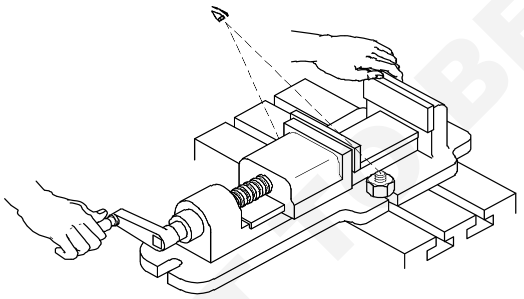
TASK: 1



Clean the vice base and the machine table top, free from dust for seating.

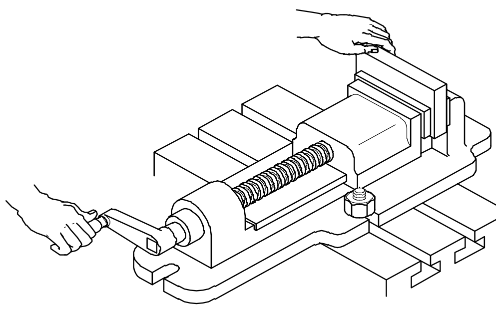
- Place the vice at the middle of the table with maximum support to avoid falling off of the vice. (Fig 1)
- Position the 'T' bolts into the 'T' slot. (Fig 1) while shifting the vice towards the slots ensure that there is 1 mm to 2 mm clearance between the 'T' bolt and the vice slot to allow for adjustment.

Fig 1



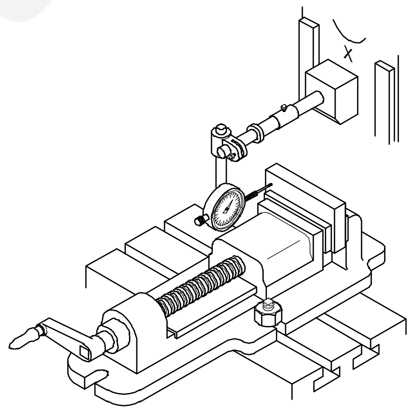
- Tighten all the 'T' bolt nuts by hand.
- Clamp the parallel block in the vice. (Fig 2) Set the vice such that the jaws are at right angle to the direction of cut.

Fig 2



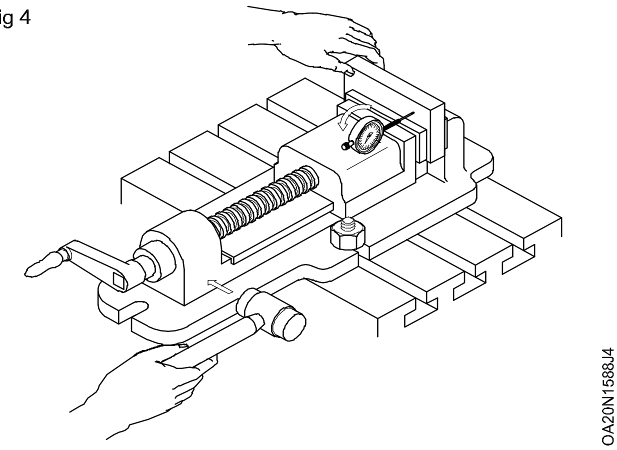
- Position the dial indicator with the magnetic base firmly on the reference surface (X) (Fig 3)

Fig 3



- Engage the dial indicator stylus on one end of the parallel. (Fig 3) Ensure that the dial indicator and stand do not foul anywhere.
- Adjust the position of the dial pressure and set the reading to zero on one end of the parallel.
- Move the table so that the dial indicator is at the other end of the parallel. (Fig 4) observe the pointer movement.
- If the pointer deviates from zero, adjust the vice by gentle tapping in the direction as needed. (Fig 4) Ensure that the plunger is not lifted while tapping.
- Repeat the step until the dial indicator reads zero along the length.
- Tighten the vice clamping nuts without disturbing the setting.

Fig 4

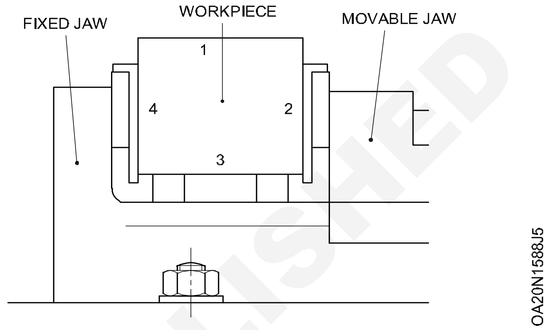


- Check the alignment after clamping. and adjust it necessary

Lubricate the vice screw and the slide ways

- Place one of the larger surfaces of the workpiece on the parallel to prevent its downward movement while machine.
- Ensure that the workpiece is projecting the vice jaws. by about 3 to 5 mm more than the total depth of cut. This avoids resetting of the job now and then also it prevents the vice jaws, tools and workpiece from damage.
- Place a rod of diameter 6 to 15 mm between the middle of the unfinished side and the movable jaw. This gives line contact between the job and prevents lifting off the workpiece. (Fig 5)
- Tighten the workpiece.
- Tap the workpiece gently with a soft hammer for seating on the parallel. Ensure that the parallel block does not shake.

Fig 5



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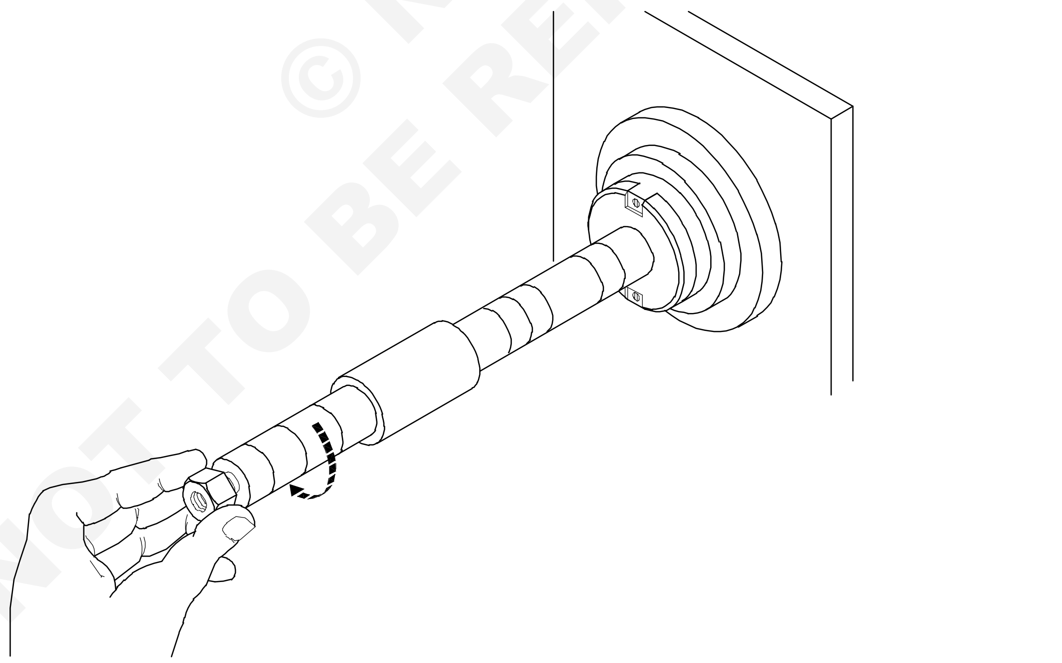
TASK 2: Set arbor on the spindle of milling machine

Fig 1

TASK 2



- Set the lowesst available spindle speed to avoid free rotation of the spindle nose
- Ensure that the machine is switched off, Consult your instructor.
- Select the arbor with correct diameter and taper to suit the machine spindle nose.
- Clean the internal thread and taper portion of the arbor, (Fig 1)
- Clean the spindle nose of the machine. (Fig 2)
- For cleaning, use soft cloth free from dust, chips etc. to avoid scratches on the surface.

Fig 1

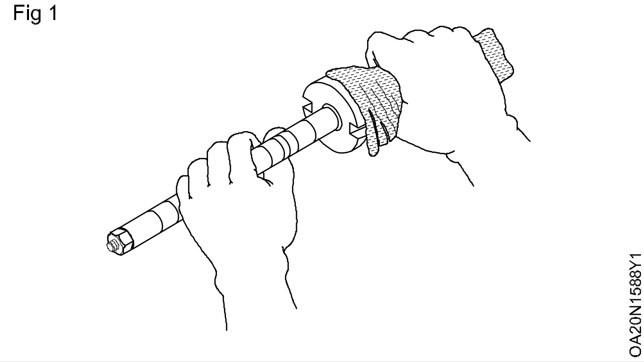
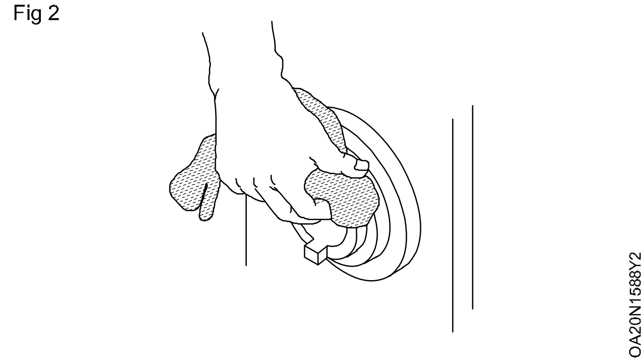
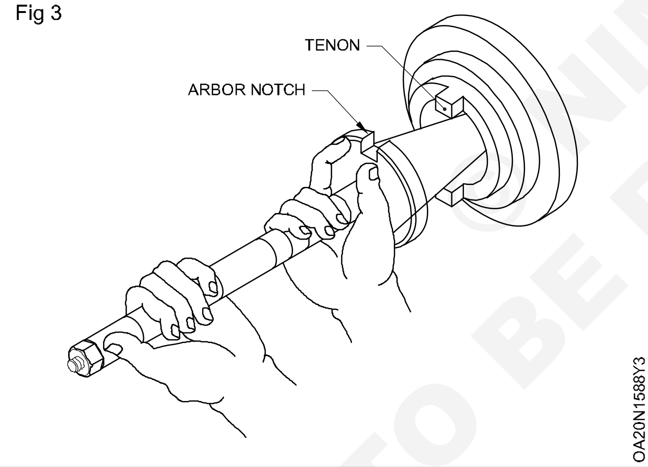


Fig 2



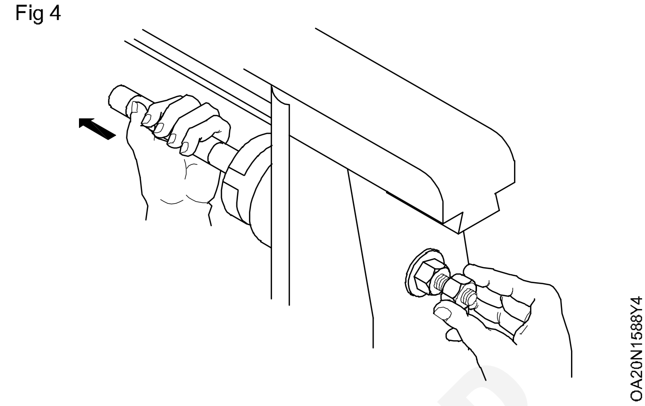
- Hold the arbor and ensure that the arbor notches fit on to the nose of the tenon to get the drive (Fig 3)

Fig 3



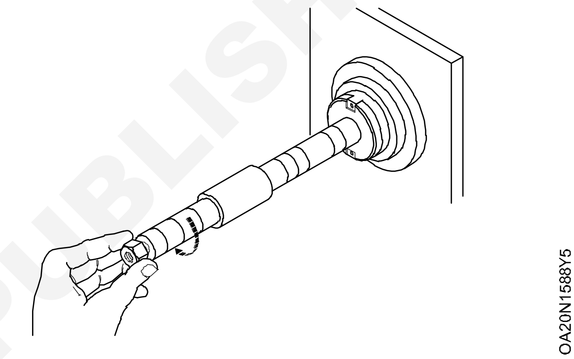
- Tighten the draw- bar from the rear side of the spindle and secure the arbor into machine by tightening the lock nut (Fig 4)

Fig 4



- Unscrew and remove the not from the arbor end by rotating it in the clockwise direction. (Fig 5)

Fig 5



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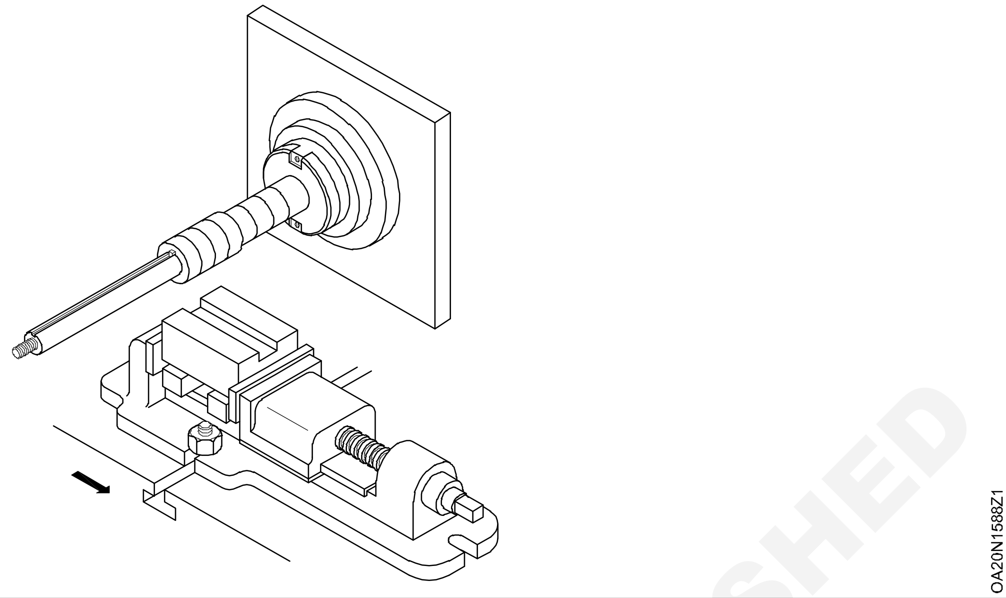
TASK 3: Set the cutter on arbor

- Remove the spacers and bearing bushes and clean them. (Fig 1)

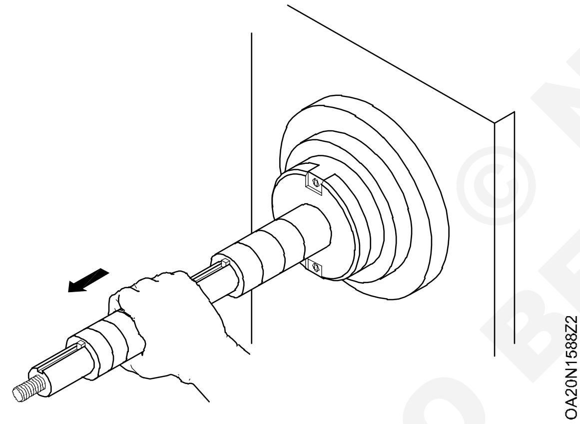
Fig 1

TASK 3



- Insert enough spacers on to the arbor so that the last spacer extends over the rear edge of the workpiece. This will enable you to fix the cutter in the middle of the workpiece for milling. (Fig 2)

Fig 2



- Clean the side and face the cutter and the bore of the cutter.
- Select the key to suit the cutter keyway.
- Place the cutter on the arbor such that the direction of rotation of the cutter is in the opposite direction of the job feed for up milling at the initial stage. Depending upon the condition of the machine, down milling may be performed at a later stage of practice. (Fig 3)

Fig 3

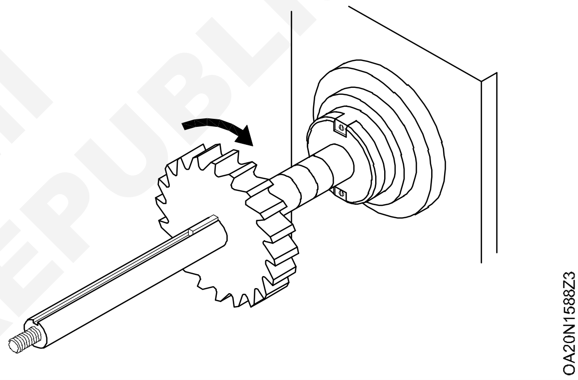
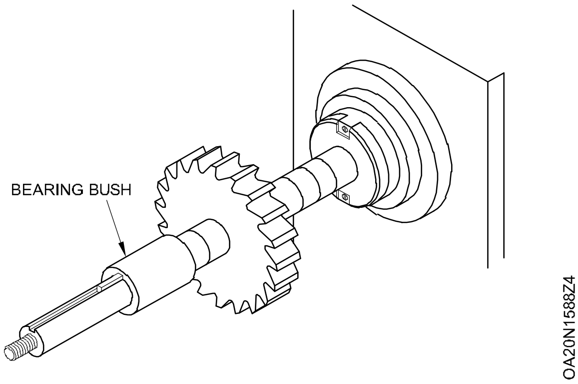


Fig 4



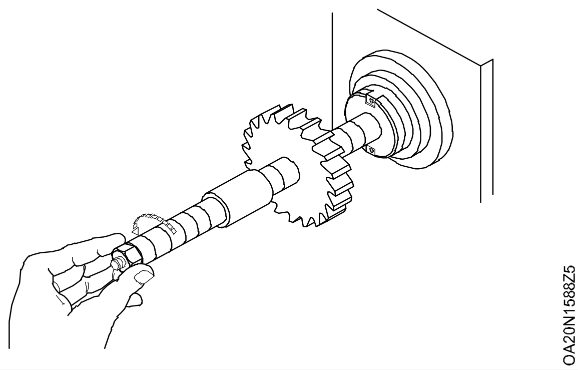
Ensure that the key is placed into the keyway, and milling cutter.

Slide the bearing bust on to the arbor. (Fig 4)

Slide on more spacers until one or two threads on the arbor screw are covered so that the speacers are pressed while tightening. If not, the cutter may not be tightened sufficiently.

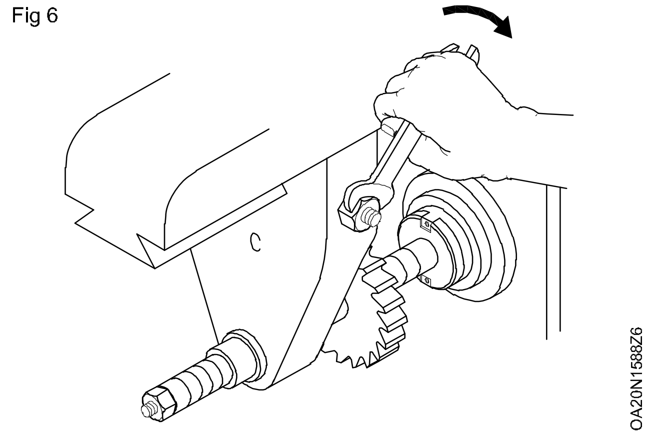
Tighten the arbor nut by hand. (Fig 5)

Fig 5



Carefully slide tha arbor support. (Fig 6)

Fig 6

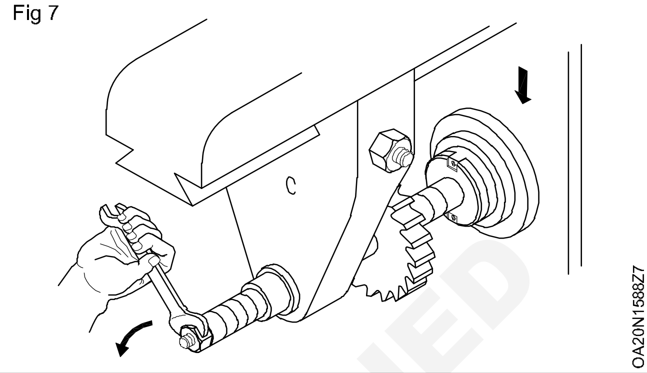


Ensure that the bearing bush extends equally on both sides of the arbor for uniform support.

Tighten the arbor nut and switch on the machine and check visually that the cutter runs true. (Fig 7)

The milling machine, like all machine tools, should be cleaned after each work period. A medium width paint brush may be used to remove the accumulated chips.

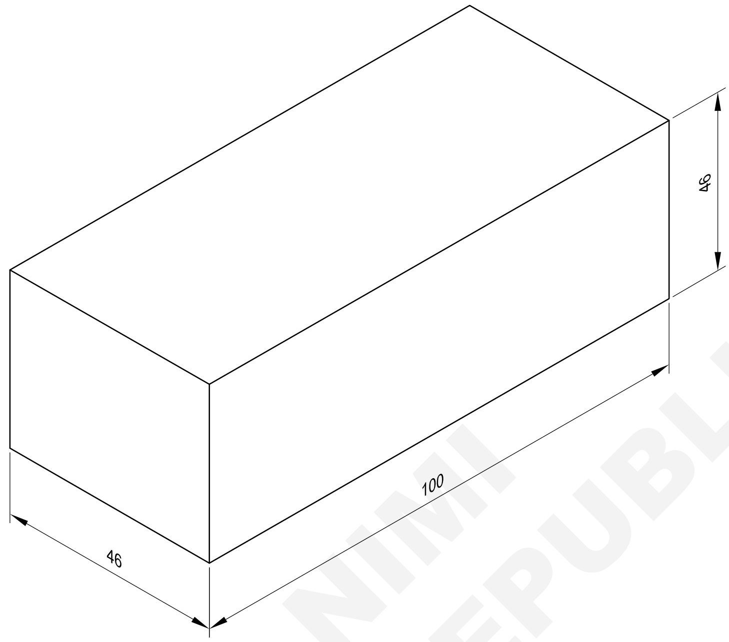
Fig 7



Practice on different work and tool holding devices

Objectives: At the end of this exercise you shall be able to
- **set the workpiece on a horizontal milling machine**
- **mill six faces perpendicular to each other**
- **maintain the size of the workpiece**

TASK - 1



Job sequence

- Clamp the machine vice securely on the machine table and align jaw parallel to the coloumn.
- Fasten the cutter in the machine.
- Set the required RPM.
- Place surface 'C' on the parallel block, clamp the job. Ensure that the parallel block dose not move.
- Mill surface 'A' flat. (Fig 1)
- Keep surface 'A' against the fixed jaw and surface D on the parallel block.
- In the middle of the surface C, a round rod is kept between the job and the movable jaw for line contact to avoid lifting of the job. This roller enables for maintaining squareness of the surfaces A & B (Fig 2)
- Mill surface 'B' at right angle to surface 'A' (Fig 2)
- Keep the surface 'A' on the parallel blocks and butt the surface B to the fixed jaw.
- Place a round rod in between movable jaw and surface D.

1	-	⟶ 1.4.69	Fe310	-	-	1.5.89
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	SEQUENCE OF MILLING SIX FACES OF A SOLID BLOCK	DEVIATIONS ± 0.1	TIME : 8hrs
		CODE NO. OA20N1589E1	

Fig 1

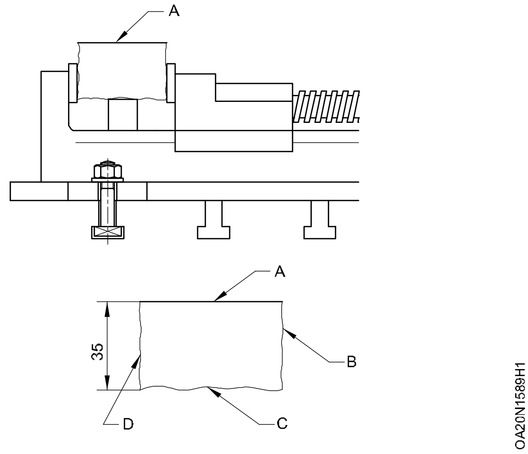
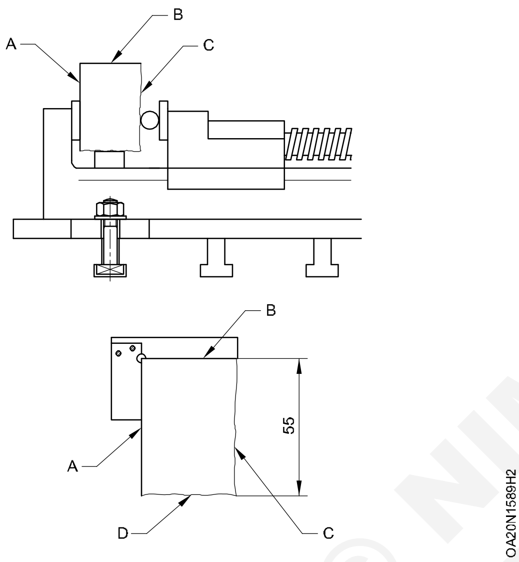
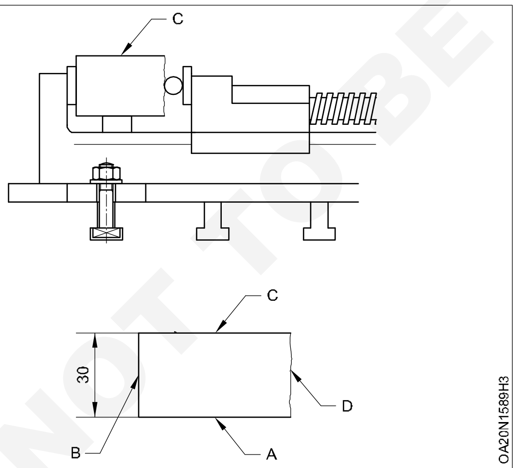


Fig 2



- Mill surface C maintaining the size of 46 mm (Fig 3).

Fig 3



- Keep surface C on the parallel blocks.
- Set the work projecting it atleast 10mm from the sides of the vice
- Mill surface 'D' maintaining a size of 46 mm (Fig 4)
- Keep surface 'C' on the parallel blocks (Fig 5)

Fig 4

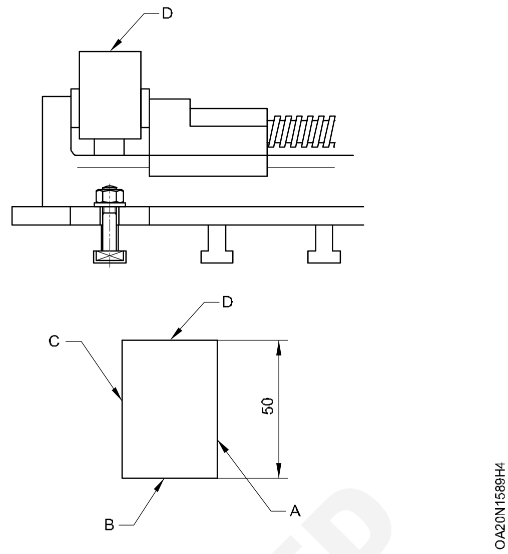
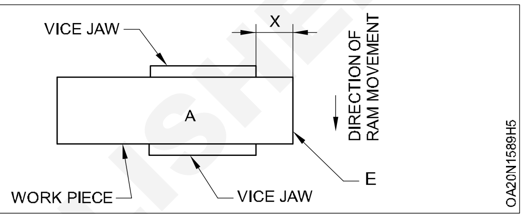
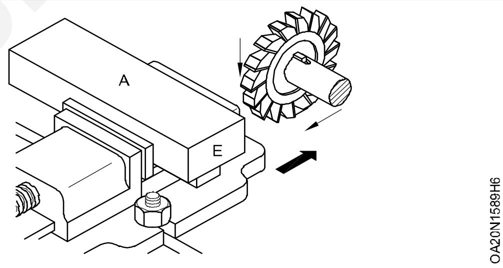


Fig 5



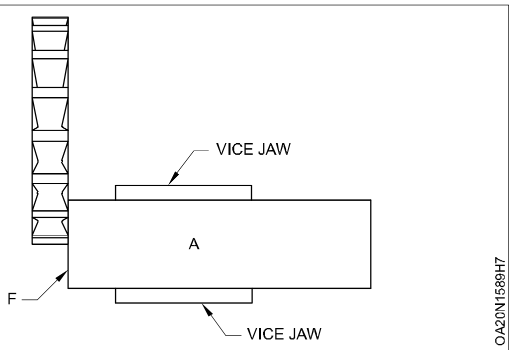
- Set side and face milling cutter and mill the surface 'E' (Fig 6)

Fig 6



- Set the RPM for side and face cutter.
- Mill the 'F' side by the side and face cutter and maintain the size (Fig 7)
- Deburr the job and check all the dimensions.

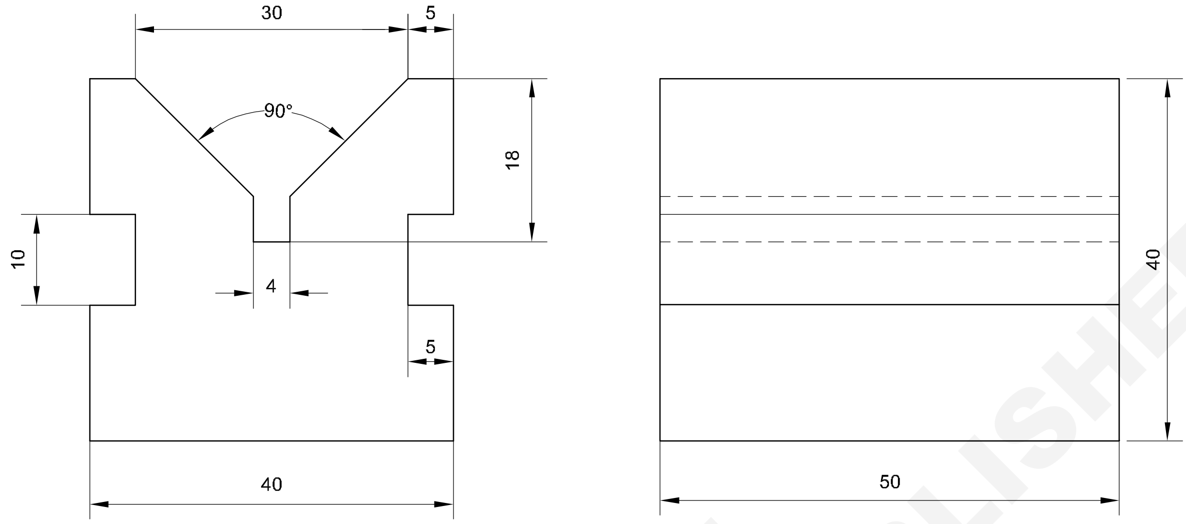
Fig 7



Angular milling

Objectives: At the end of this exercise you shall be able to
- **mill slot using sitting saw**
- **mill ‘V’ groove by 90° double angle cutter**
- **mill slot with side and face milling cutter**
- **check the dimension with vernier caliper.**

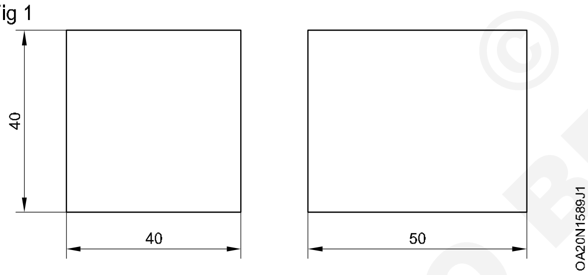
TASK - 2



Job Sequence

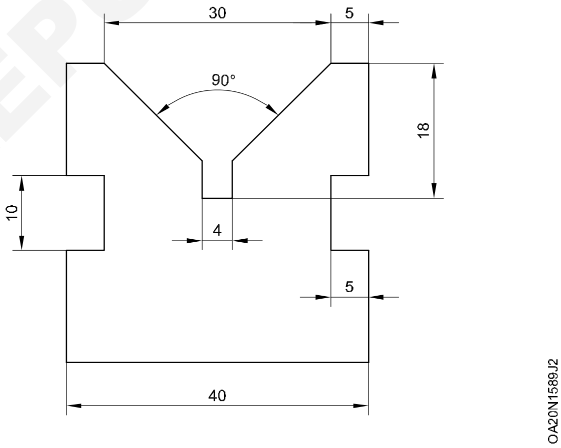
- Check the premachined block flat and square, to size 50 x 40 x 40mm. (Fig 1)

Fig 1



- Mark and punch the job as per drawing. (Fig 2)
- Set the slitting saw 4mm width.
- Hold the job on machine vice.

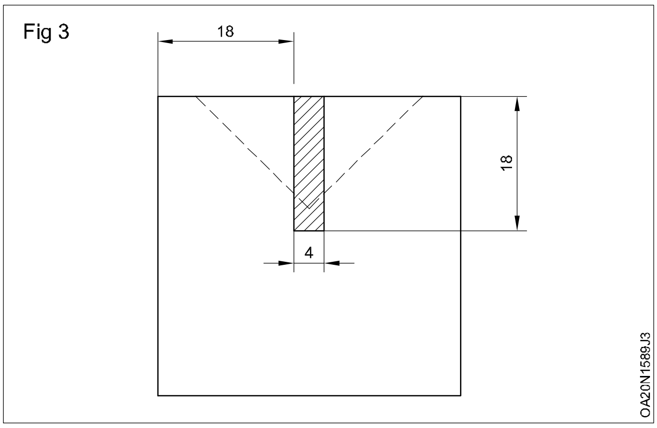
Fig 2



1	ISSQ 50-60	1.4.68 ←	Fe310	-	-	1.5.89
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	V - BLOCK			DEVIATIONS ± 0.02MM	TIME : 8hrs	
				CODE NO. OA20N1589E2		

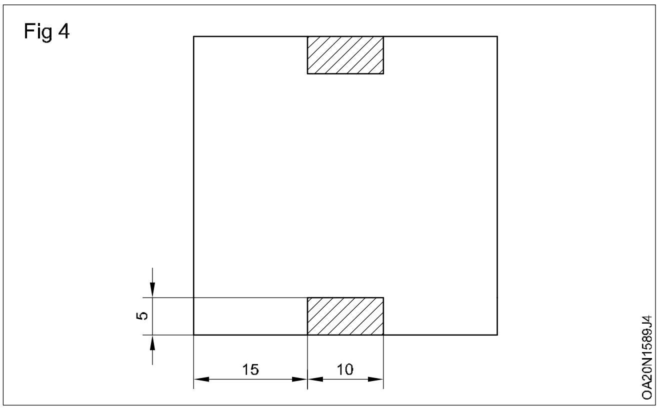
- Mill the slot maintaining dimensions 18,18 and 4 mm. (Fig 3)

Fig 3



- Machine angular surface using 45 double angle cutter both the sides.
- Cut slot (shaded portion) maintaining dimensions 15,10 and 5 mm on both sides (Fig 4) using 10mm width side face cutter.

Fig 4



- Check the angular dimensions using vernier bevel protractor.
- Check the dimensions with vernier caliper
- Remove the burrs.

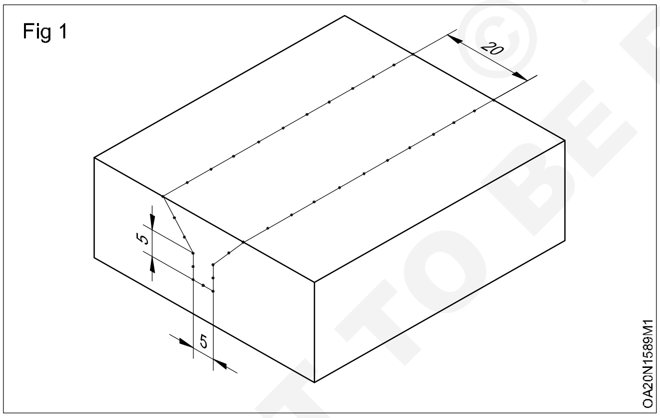
Skill sequence

Mill angular surface on horizontal milling machine

Objective: This shall help you to
- mill an angular surface on a horizontal milling machine

Mark the workpiece as per drawing. Punch witness marks on the lines. (Fig 1)

Fig 1



Mount a plain machine vice on a horizontal milling machine such that the vice jaws remain parallel to the column.

Select pair of parallel blocks which will lift the workpiece, bringing the top surface of the workpiece above the vice jaws.

Clamp the workpiece in the machine vice.

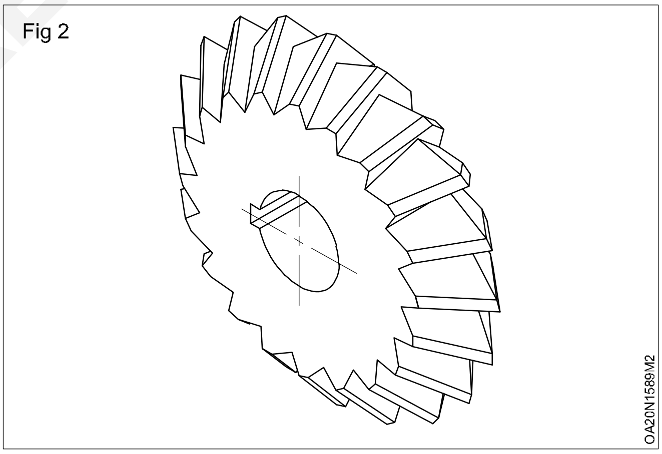
Select an angular milling cutter.

Selection of the angular milling cutter depends upon the angle to be milled.

There are 90°, 60° equal angle cutters. And 45°,30° single side angle cutters.

Here select 90°equal angle cutters. (Fig 2) The cutter thickness should be more than the width of the 'V' groove.

Fig 2



Ensure that the cutter is sharp and undamaged.

Select and mount the long arbor on the horizontal milling machine spindle.

Mount an equal angle cutter of 90° on the long arbor. (Fig 3)

Calculate the r.p.m for the given material and cutter. Set the nearest lower speed and feed available on the machine.

Use hand feed in vertical, longitudinal and cross directions to position the workpiece such that the cutter is close to the top surface of workpiece. (Fig 4)

Fig 3

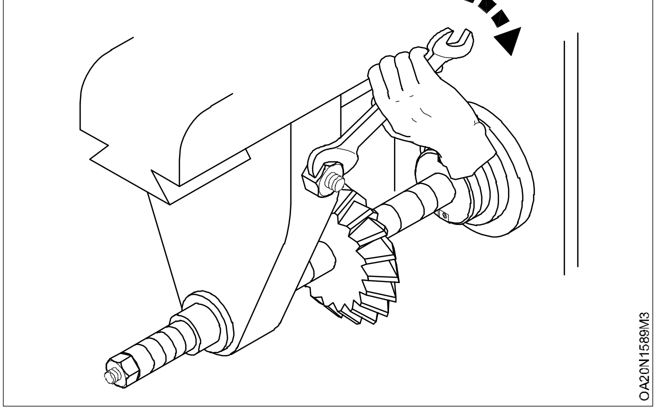
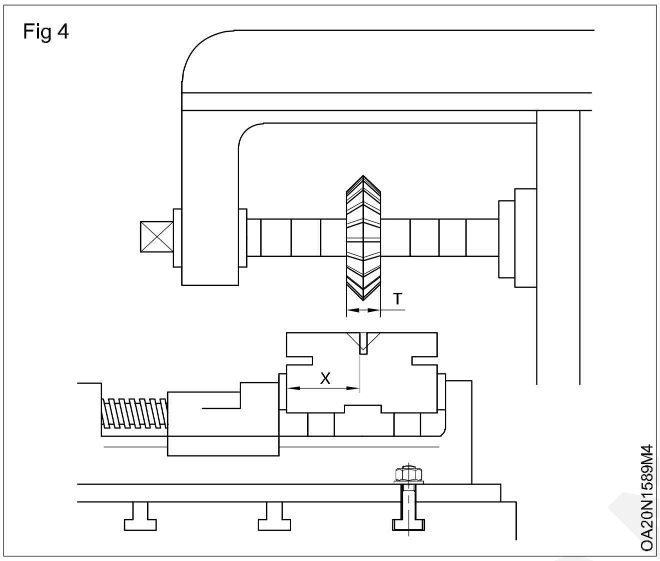


Fig 4



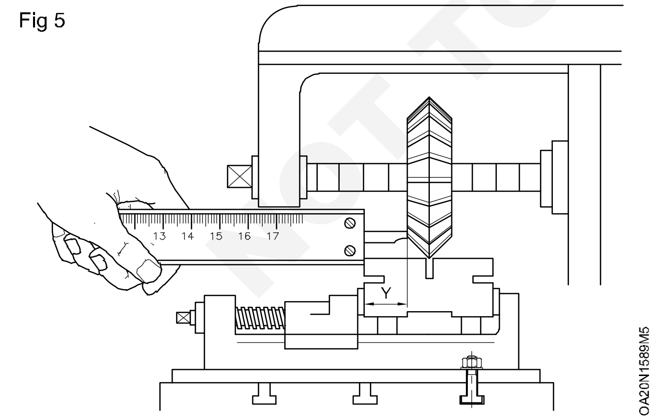
Measure the thickness of the cutter (T).

Find out the centre distance of the 'V' groove from the edge[X].

Now Y = X - T/2.

Set the Y distance on the depth gauge or vernier caliper. (Fig 5)

Fig 5

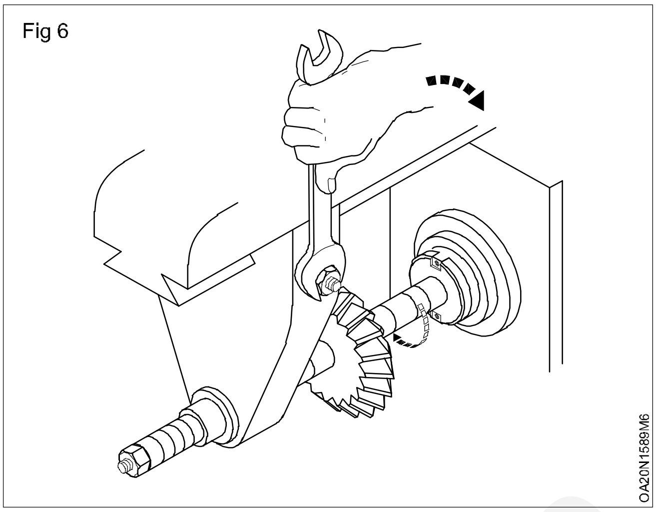


Use the cross - hand feed and adjust the workpiece such that the cutter surface and the workpiece edge are at [Y] distance.

Ensure the dimension with a vernier caliper depth gauge.

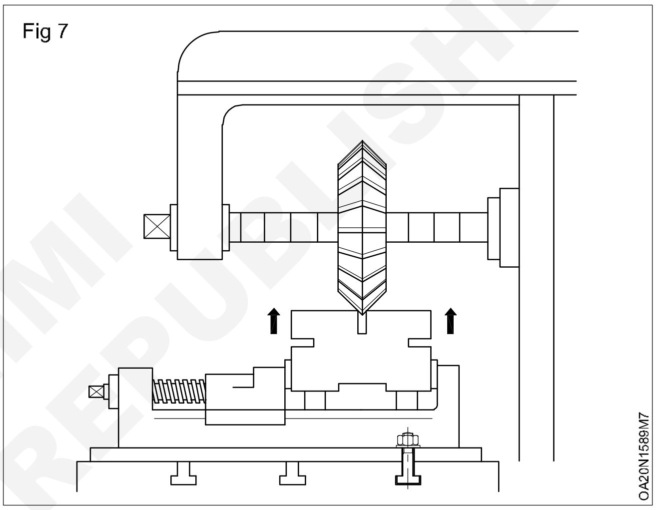
Set the spindle to clockwise direction. (Fig 6)

Fig 6



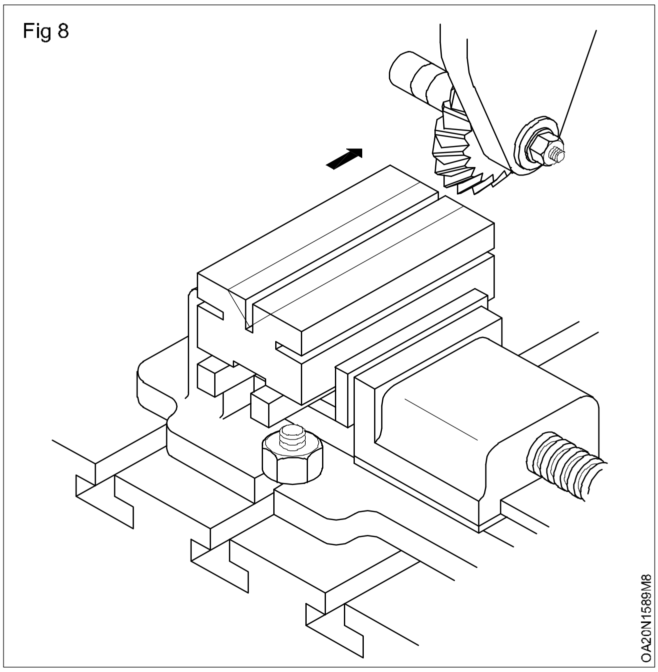
Set the datum at the top surface using tissue paper. (Fig 7)

Fig 7



Move the table to the left hand side to clear the cutter and workpiece. (Fig 8)

Fig 8



Unlock the vertical slide.

Set the depth of cut of 2 mm by vertical hand feed.

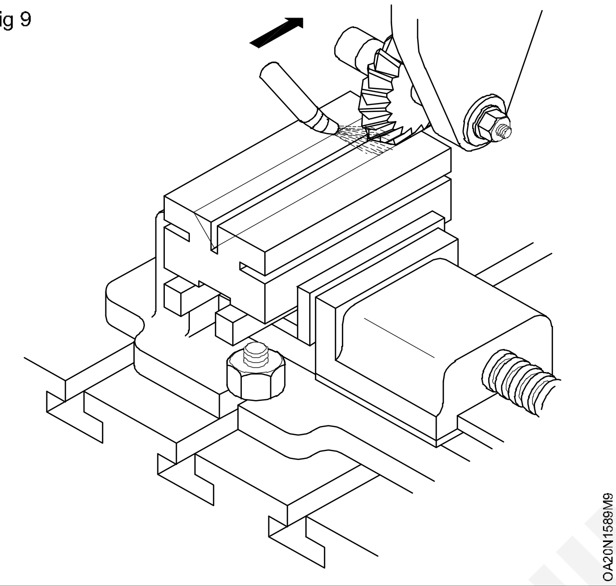
Lock the vertical slide.

Adjust the coolant nozzle and start the coolant pump.

Start the machine spindle.

Move the table to the right hand side slowly and mill the groove by rotating the longitudinal hand wheel manually. (Fig 9)

Fig 9

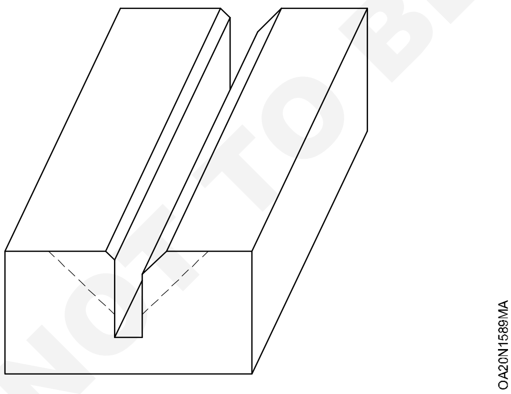


Stop the spindle.

Move the table to the left hand side to clear the cutter from the workpiece.

Check the position of the 'V' groove layout for any error. (Fig 10)

Fig 10

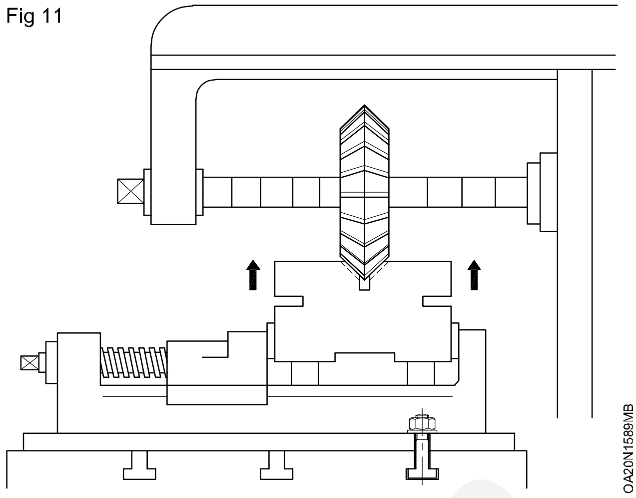


Adjust the cross -side to correct the error.

Lock the cross - slide.

Unlock the vertical slide and set final depth by rotating the vertical slide manually. (Fig 11)

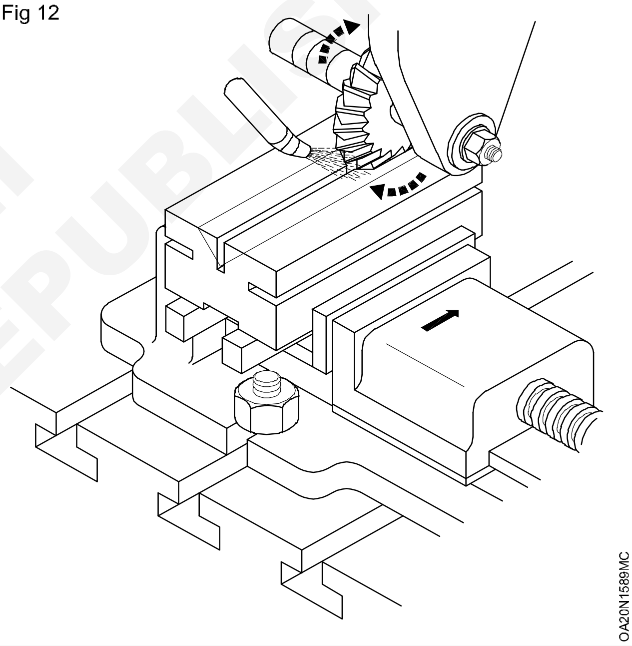
Fig 11



Lock the vertical slide.

Start the machine spindle and mill the 'V' groove. (Fig 12)

Fig 12



Apply automatic feed if your machine permits. If not, apply manual feed.

Stop the machine spindle.

De - clamp and deburr the sharp edges at the milled surface.

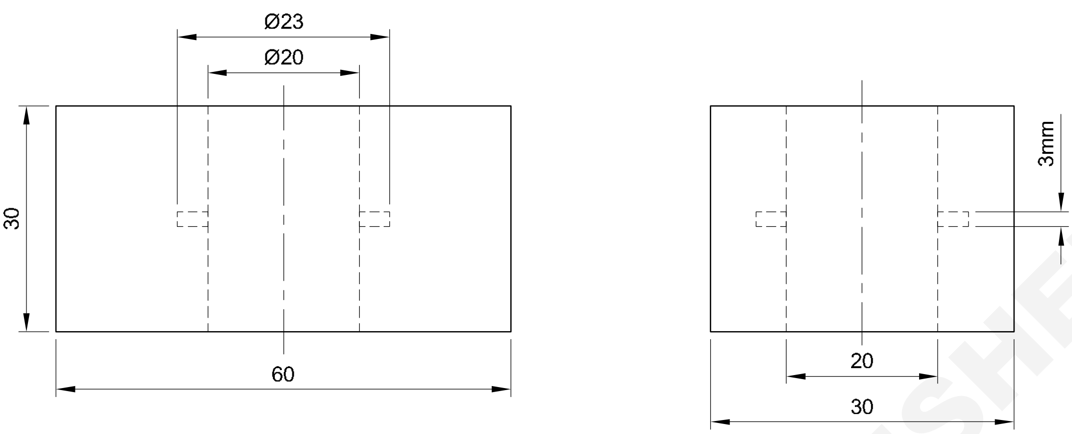
Check the 'V' groove for the following parameters.

- Central position
- Depth of groove

Be thoroughly familiar with the placement of the stop lever.

Grooving using mills (II)

Objectives: At the end of this exercise you shall be able to
- **set the boring head on vertical milling machine**
- **true the Job to centre**
- **machine the internal groove.**



Job Sequence

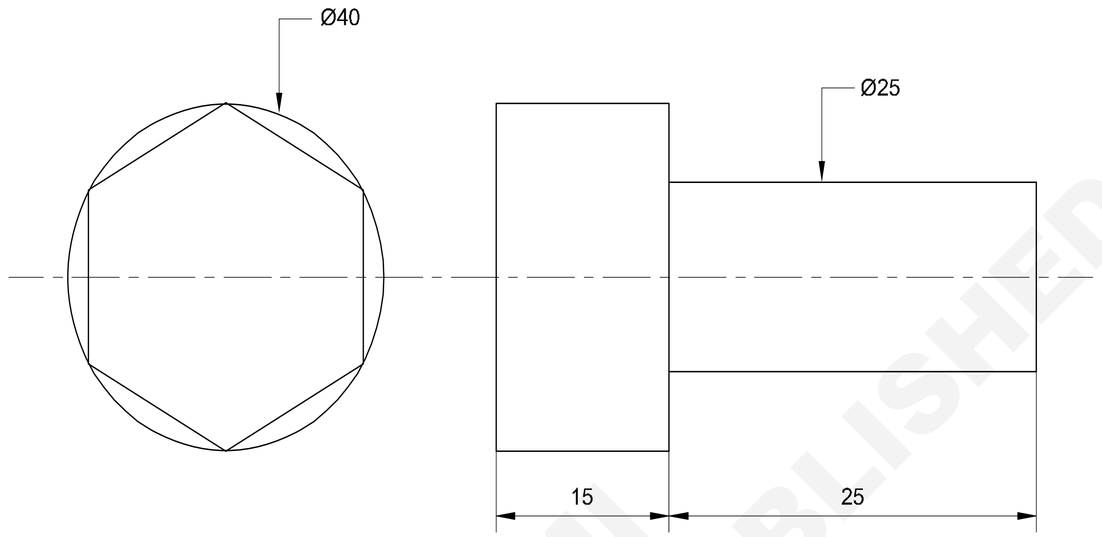
- Check the Raw material size.
- Mill to the size of 60 x 30 x 20 mm.
- Mark and punch the centre position.
- Clamp the work piece on the vertical milling machine.
- Align the centre of the circle with the axis of the spindle.
- Lock the longitudinal and cross feed movement.
- Set the collet adoptor.
- Set the spindle speed.
- Hold the centre drill and drill the location.
- Drill the pilot holes.
- Finish the drill ϕ 20 mm.
- Set the boring head with boring tool.
- Set the spindle speed.
- Off set the boring head and machine the internal groove to required depth.
- Deburr the groove.
- Check the groove depth with inside caliper.

If boring head is not available. Use boring bar with collet.

1	65x35x25MM		Fe310			1.5.89
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MAKE INTERNAL GROOVING USING MILLING MACHINE WITH AN ACCURACY ±0.02MM				DEVIATIONS ±0.2	TIME 15Hrs
					CODE NO. OA20N1589E3	

Milling hexagon using indexing head (III)

Objectives: At the end of this exercise you shall be able to
- **mount the index head on the table and align it parallel to the column face**
- **hold the job in the three jaw - chuck and true to face**
- **set the index head for direct indexing**
- **mill the hexagon on the job by direct indexing to an accuracy of ± 0.02 mm**
- **check the distance across the flats of the hexagon using a vernier caliper**



1	Ø40x45mm	-	PRE MACHINED	-	-	1.5.89
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

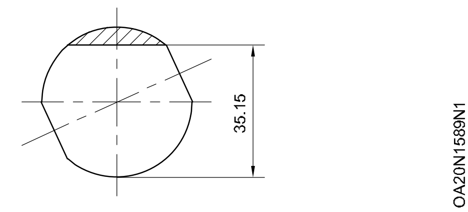
SCALE 1:1	**MAKE HEXAGONAL JOB BY SIMPLE INDEXING METHOD WITH AN ACCURACY ±0.02MM**	DEVIATIONS ±0.02mm	TIME 9hrs
		CODE NO. OA20N1589E4	

Job Sequence

Clean the table and dividing head free from dirt and burrs and align the dividing head on the vertical milling machine table.

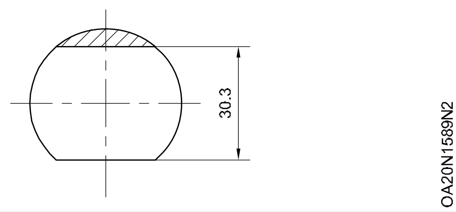
- Set the dividing head for direct indexing.
- Hold the job on f 30 in a three-jaw chuck of the dividing head.
- Support the end with the tailstock.
- Set the index plate to zero position.
- Mount the f 18 mm end mill.
- Set the r.p.m. closer to 300.
- Set the datum at the highest point on the dia meter. (40)
- Mill the surface flat maintaining the dimension 37.32. (Fig 1)

Fig 1



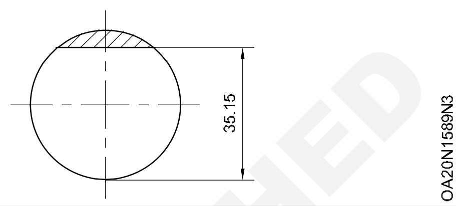
- Index the job by 180°.
- Mill the surface flat maintaining the dimension 34.64 (Fig 2)

Fig 2



- Index the job by 60°.
- Mill the surface flat maintaining the size 37.32. (Fig 3)

Fig 3



- Index the job by 180°
- Mill the flat surface maintaining the size 34,64.
- Repeat the above procedure and complete the hexagon.
- Deburr, check and confirm the dimensions of the hexagon.

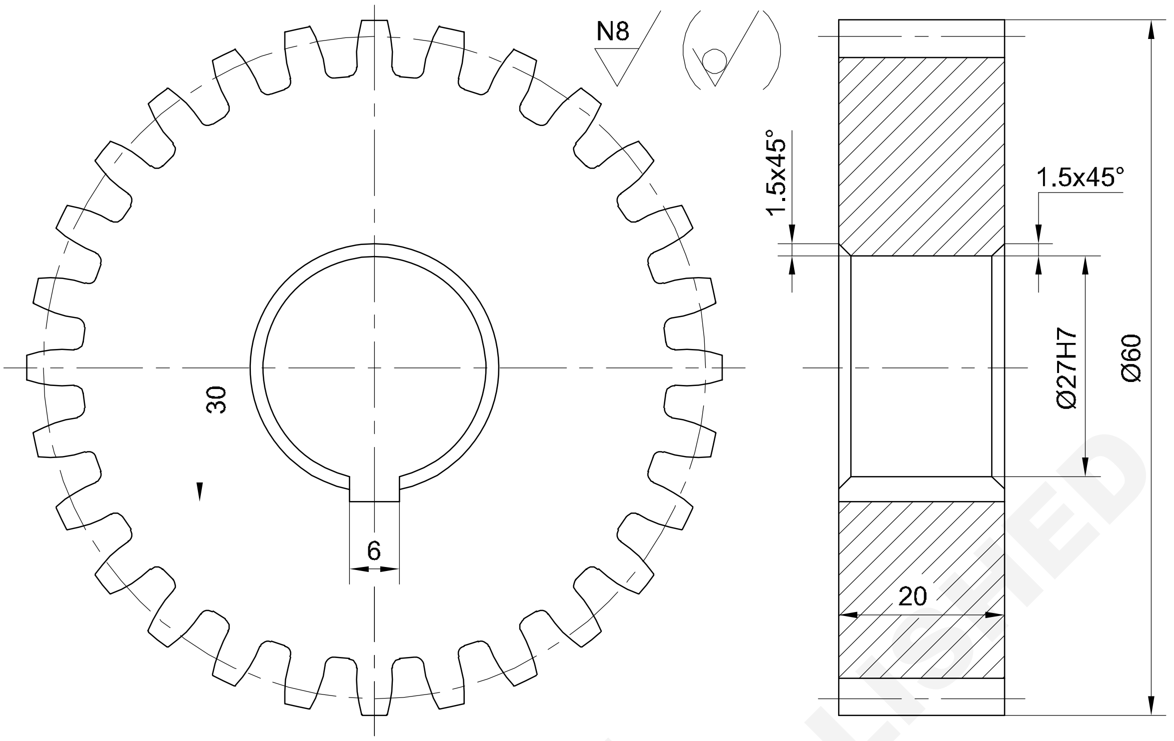
Use of slotting attachment for cutting key way (IV)

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

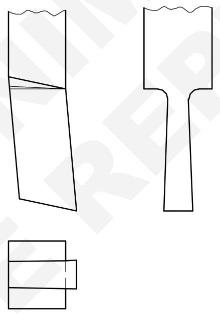
- **set the workpiece for slotting keyway using slotting attachment on milling machine**
- **grind and set the tool for kayway slotting**
- **slot the keyway as per dimension.**

Job Sequence

- Check the size of the workpiece
- Check the outside, inside and the thickness of the spur gear
- Mark the centre lines and keyway.
- Clamp the keyway (slotting) tool.
- Clamp the workpiece approximately at the centre of the slotting table and align it.
- Set the length and position of the stroke
- Slot the keyways 6x3mm to the given accuracy.
- Deburr the job.
- Check the dimensions using a vernier caliper.
- Grind the slotting tool to suit the key way.



TOOLS TO BE USED



GROOVING / PARTING TOOL

1	ISR 100×25	1.5.89 ←	Fe 310			1.5.89
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**SLOTTING KEYWAYS**	DEVIATIONS ±0.04MM	TIME 10hrs
		CODE NO. OA20N1589E5	

Skill Sequence

Aligning slotting tool for slotting

Objective: This shall help you to
• set the slotting tool in the tool box of the slotting attachment and align the slotting tool.

Mount the slotting attachment on a universal milling machine (Trainer shall assist the trainees).

Select the required tool.

Clean the tool box.

Insert the tool in the tool clamps till it touches the tool stopper.

Butt the tool to one side of the clamp.

Use packing pieces between the clamp and the tool, if necessary, to align the tool in line with the locking bolt.

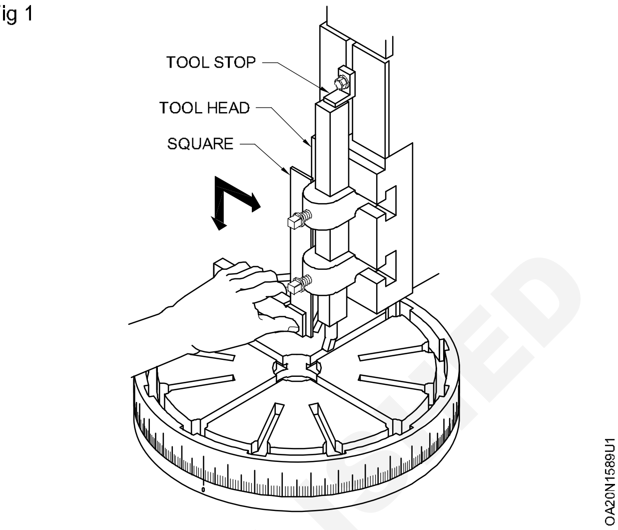
Align the tool in vertical position to eye judgment and finger tighten the tool by locking bolts.

Project the tool sufficiently to ensure that the tool box is not fouling with the top of the work.

Using a square head/try square, set the shank perpendicular to the face of the rotary table. (Fig.1)

Use soft hammer for tapping the tool while aligning with the try square.

Fig 1



Tighten the bolts fully.

For tool bits, use a tool-holder and follow the steps stated above.

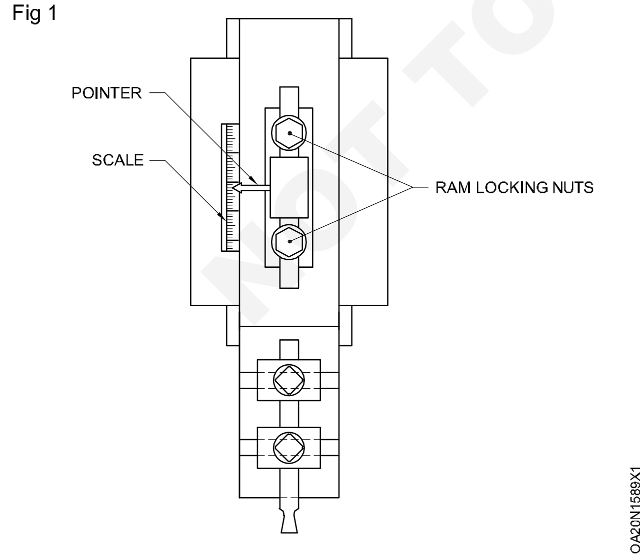
Setting the length of stroke and position of ram

Objectives: This shall help you to
- **set the length of stroke**
- **set the position of the ram.**

Ensure that the machines is switched off.

Bring the ram to its extreme upward position to read the existing length of stroke, by rotating the fly wheel by hand. (Fig 1)

Fig 1



Determining the length of stroke (Figs 2&3)

The length of stroke should be 25 to 30mm more than the height of the surface to be machined.

This is ensure complete removal of material over the whole length of the job surface, and

To provide sufficient clearance and time to complete the feeding of the tool before the next cut is taken on the down stroke.

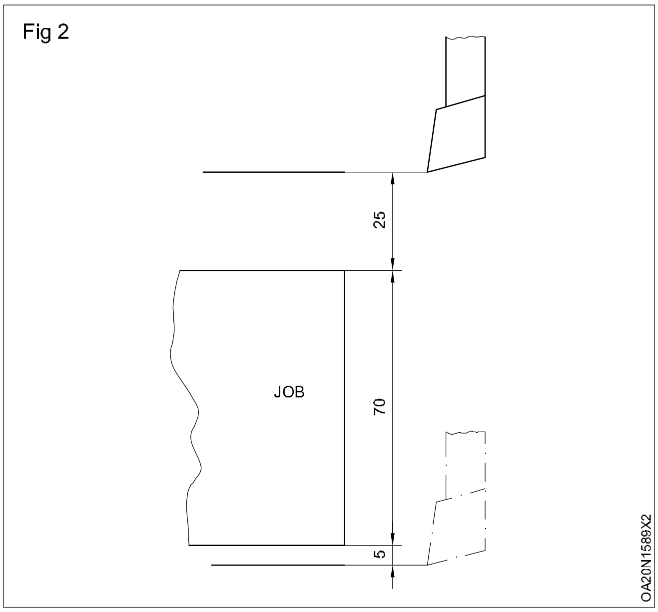
Length of stroke = Length of job+25 to 30mm clearance.

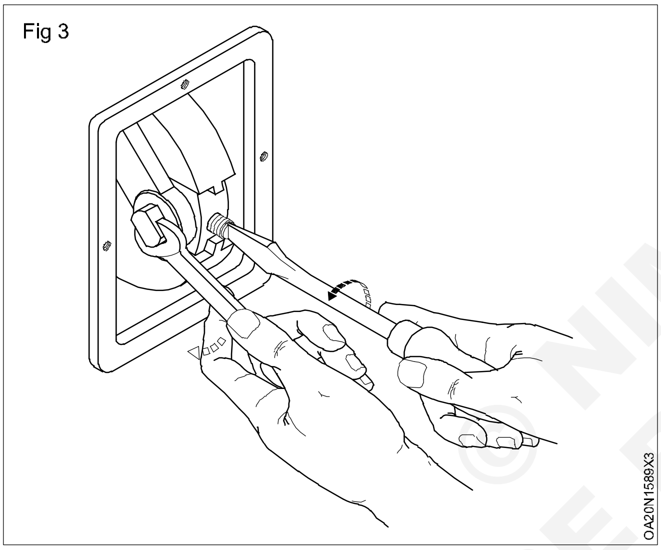
Eg. Length of stroke = 70+30=100mm.(Fig 2)

Loosen the crank pin lock-nut which is at the end of the connecting link.

Rotate the stroke setting screw shaft using a box spanner, in clockwise direction till the pointer indicates the required stroke length (100mm). (Fig 3)

Tighten the crank pin lock - nut.





Positioning the RAM (Fig 4)

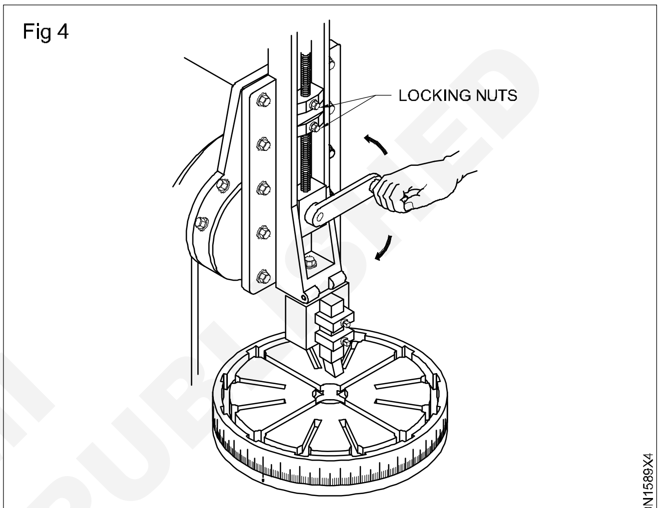
Bring the ram to its lowest position by rotating the fly wheel by hand to know the position of the tool at its lowest point.

Loosen the ram lock-nuts.

Rotate the ram positioning screw shaft in clockwise or anticlockwise direction till the tool reaches a position 5mm below the job bottom surface.

Tighten the ram lock-nuts.

Rotate the flywheel by hand to ensure the correct setting of the length of stroke and position of the ram.



POSITIONING RAM FOR SETTING STROKE

Slotting an internal keyway

Objectives: This shall help you to
- **lay out the job for slotting an internal keyway**
- **slot an internal keyway.**

Mark the centre line, width and depth of the keyway as per the drawing.

Select parallel of suitable thickness and place on the table.

Mount the work on the parallels, and by eyesight, align the bore of the job to the centre bore of the table.

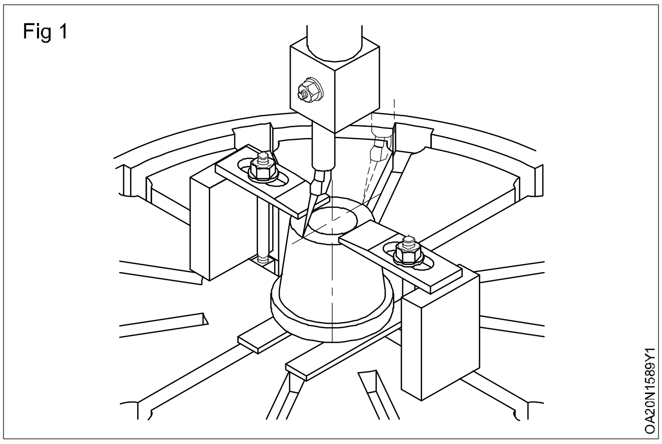
Clamp the job using clamps, bolts and nuts.

Select and mount the keyway roughing tool.

Ensure that the width of the tool edge is less than the width of the keyway.

Attach a sticky pin pointer to the tool.

Align the centre line of the job to the pointer by using longitudinal, cross and rotary feeds. (Fig 1)



Lock the rotary feed.

Set the tool edge parallel to the depth line of the keyway.

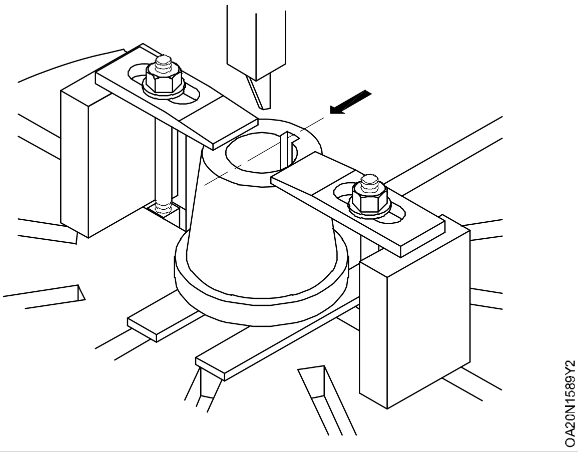
Bring the tool edge 0.5mm above the job surface by rotating the fly wheel by hand .

Adjust the stroke length, position of the ram and the ram speed.

Ensure that the cutting point is 10 mm above the table when the ram is at its lowest position.

Set the position of the job so that the tool lies at the centre of the bore by eyesight by adjusting the longitudinal and cross-feed. (Fig 2)

Fig 2

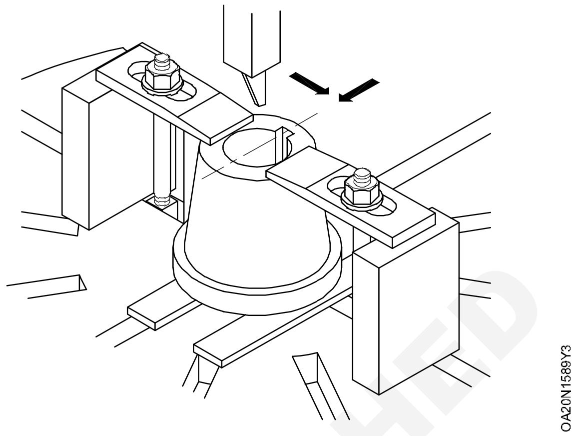


Switch on the machine.

Give a depth of cut about 1 mm and rough-machine the keyway leaving 0.5 mm for the finish cut.

Use the cross-feed for slotting the width and longitudinal feed for depth. (Fig 3)

Fig 3



Set and align the keyway finishing tool in the holder.

Slot and finish the keyway to the given dimensions.

De-clamp the job.

Check the dimensions of the keyway.

Simple projects such as jaw, law (V)

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

• Do projects model of jaw, claw using milling machine applying your knowledge

- Check the dimensions of material available in the lab suitable for making jaw and claw
- Do the projects as shown in figure applying your knowledge labed on your previous exercise skill
- Discuss with your instructor to complete the job
- Apply oil and preserve it for evaluation

Fig 1

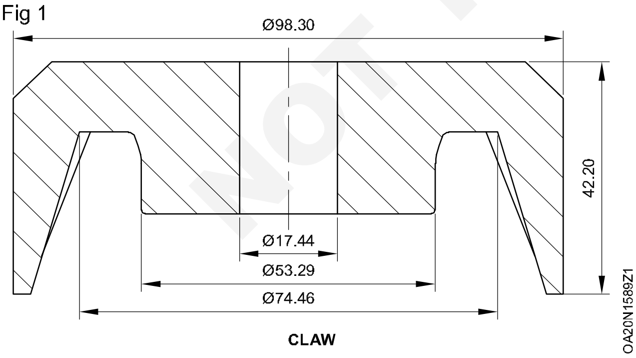
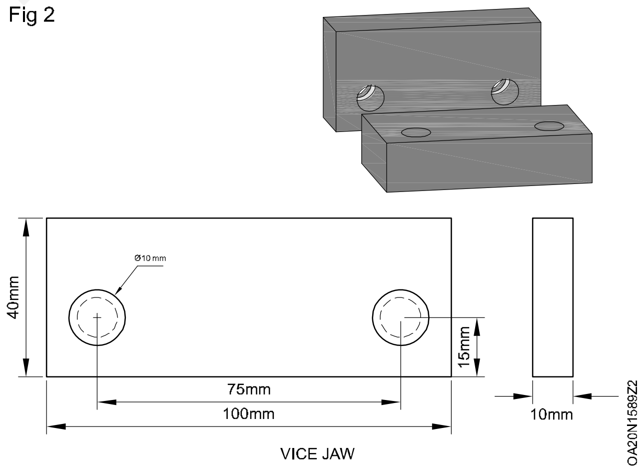


Fig 2



Oldham coupling, spline cutting etc

Objectives: At the end of this exercise you shall be able to
- **practice the oldham coupling machine**
- **practice spline cutting of shaft**

PROCEDURE

TASK1: Oldham coupling spline cutting

- Check the dimensions of the workpiece
- Take of cylindrical workpiece is 3.6 D turn tv get 3.5 D by lathe machine
- Cut the material to the length of 1.7 D
- Facing two sides and maintain the length of 1.6 D
- Turning the workpiece to the length of D and achieve the OD as 2D.
- Boring the material to get the internal diameter as 'D'
- Make key through slotting machine (on stabtting attachment with milling machine)
- Hold the workpiece 3.5 D face as top side in the milling machine vise
- Make the work a line passing through centre of workpiece and parallel to the table
- Using face milling cutter make slot width of 0.5 D and depth of 0.3 D.
- Deburr the workpiece
- Prepare same componant, same material as two pieces.

Fig 1

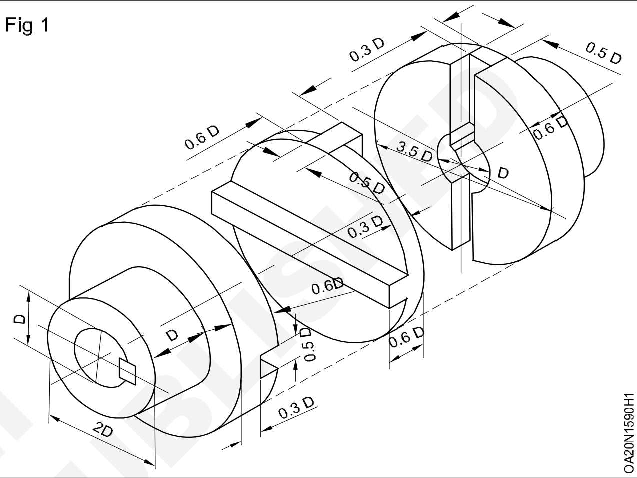
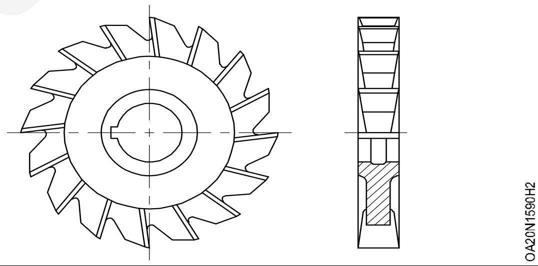


Fig 2



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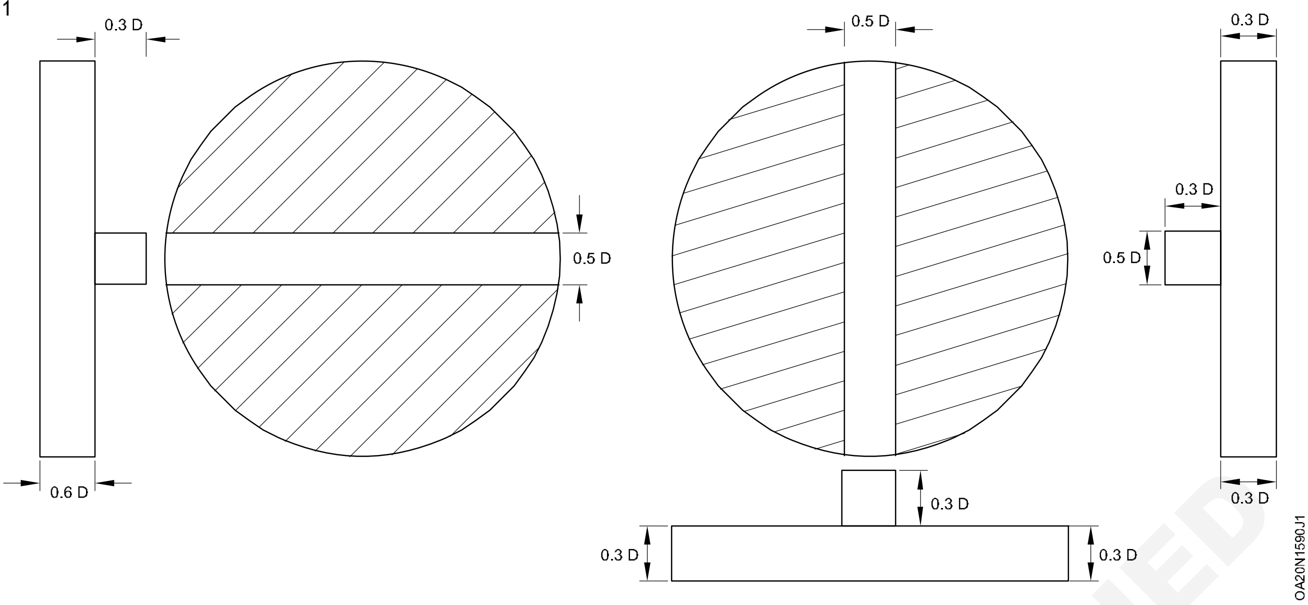
TASK2:

- Prepare the workpiece od as 3.5 and length as u.9.D
- Hold the workpiece in the millingvse and mill tohe shacked part as shown in fig by suitable milling cutter
- Reverse the workpiece and the milling process to be done perpendicular to the previous extructed part.
- Deburr the workpiece
- Assemble and test the oldham coupling

Fig 1



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TASK 3: Spline cutter

- Turn the given workpiece blank to required diameter in lathe
- Fix the blank between two centres using carrier plate
- Set the spline milling cutter on the machine spindle and select the suitable speed.
- The cutter in centered accurately with spline blank.
- Range the table vertically up untill blank touches the cutter.
- According to index calculation. Set the dividing head.

Direct indexing

No of splines = 6

For 24 division circle pin locatd at 24/6 =4 div.

For 30 division circle pin located at 30/6 = 5 div

For 36 division circle pin located at 36/6 = 6 div.

- Then indexing for next 4/5/6 Div for next spline cutting
- This is continued till all the spline teeth are cut.

Fig 1

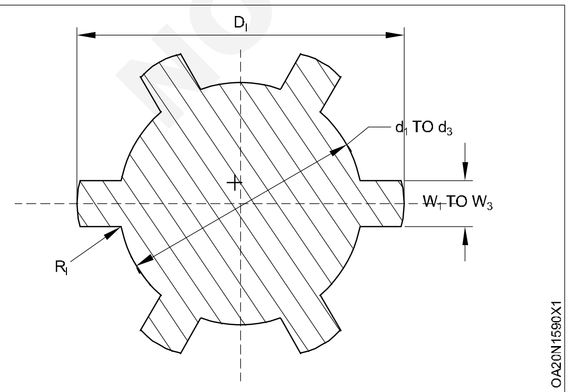


Fig 2

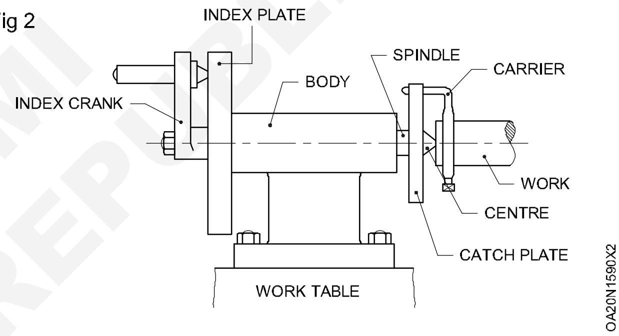
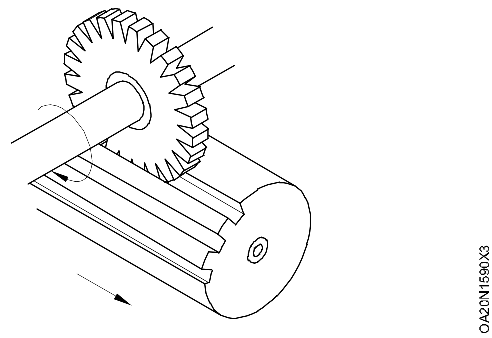


Fig 3



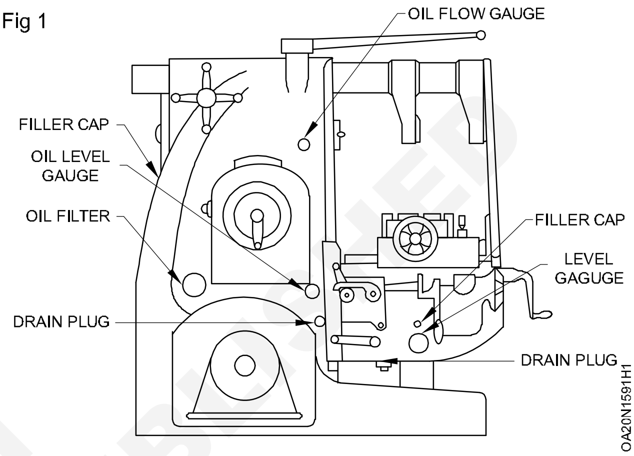
Lubrication of different parts, maintenance of machine

Objectives: At the end of this exercise you shall be able to
- **practice lubrication of different parts of milling machine**
- **maintenance of machine free from break down**

Job sequence

- Check the level of the oil in column, saddle, knee etc.
- Clean the area surrounding the filler cap refone open it, to prevent entrance of chip, grit and dirt.
- Add sufficient quantity of clean oil in order to maintain the oil land.
- Check the operation of the oil pumps
- Locate clean and fill all oil holes and pockets which require hand oiling.
- Replace all screw plugs which were removed in the oiling process
- Clean and lubricate all flat and round sliding surfaces which are not automatically oiled.
- Clean and lubricate the sliding surfaces on the overarm before changing its position in the coloumn.
- Clean and oil all exposed screws, such as the elevating screw for the knee, if they are not oiled automatically.

Fig 1



Safety precaution to be observe while using machine.

Objectives: At the end of this exercise you shall be able to
- **Observe safety precaution while using grinding machine.**

Job Sequence

- Always wear safety glasses as this machine may send shavings in all direction.
- If you have a long hair you should keep it tied back, so that it does not get caught in the machine
- Never strike the wheel against the material.
- Make sure that the gauard is in place over the grinding wheel.
- Make sure the work piece in securely fastened in place
- Make sure the magnetic table is clean before placing material on it.
- Ensure that the grinder has a start / stop button with in easy reach of the operator.
- Follow manufacture's instructions for mounting grinding wheel.
- Keep face of the wheel evenly dressed.
- Ensure that the wheel grand covers atleast one half of the grinding wheel.
- Check that the magnetic chuck has been turned on by trying to remove work from the chuck
- Run on new grinding wheel for about one minute before ensafing the wheel into the work
- Turnoff coolant before stopping the wheel to avoid creating an out - of - balance condition.
- Keep the working surface clear of scraps, tools and meterials.
- Keep the floor around the grinder clean and free of oil and greace.
- Use of appropriate ventilation exhaust system to reduce inhalation of dust, debris, and coolant mists.
- Follow lockout procedures when performing maintenance work.

Demonstration of various parts of the grinding machines.

Objectives: At the end of this exercise you shall be able to
- **movement of the slides manual and automatic**
- **run the machine in difference speed of half**
- **put on and off the machine.**

Job Sequence

- Identify the machine parts and its sliding movements.
- Move the slide manually and get it families .
- Set the different speed of wheel.
- Practice on mounting jobs on table.
- Practice on automatic feed and rapid movement.

Table

Si.No	Name of the parts	Type of Movement
1		
2		
3		
4		
5		
6		
7		

Use of drive – both mechanical and hydraulic.

Objectives: At the end of this exercise you shall be able to
- **Practice surface grinding machine using manual (mechanical drive) and hydraulic system.**

Job Sequence

- The receprocating table and carbo slide movements are hydraulically operated and for mechanical drive hand operation is provided.
- The column and wheel head are roughed and lowered through a screw and nut from a hand wheel.
- The can be applied by hydraulic power units manually operated hand wheel.
- Proper feed has to be given for mechanical as well as hydraulic machines for smooth machining on its job.
- Use work holding device properly to fix the job firmly to avoid any slipcase of job while working.

Fig 1

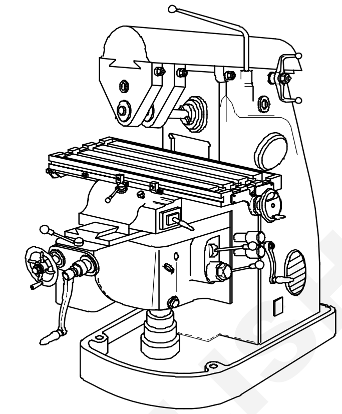
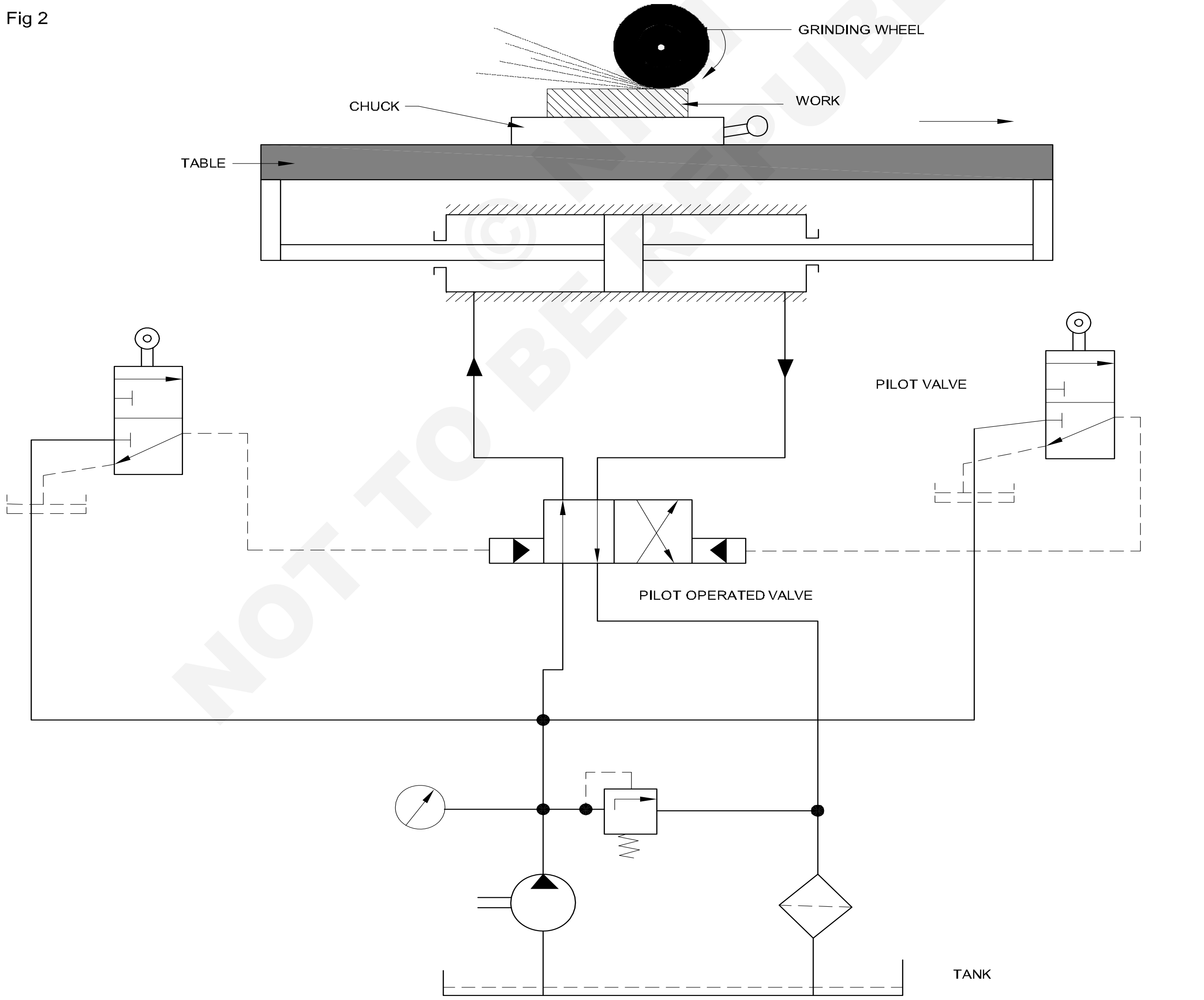


Fig 2



HYDRAULIC CIRCUIT FOR SURFACE GRINDER

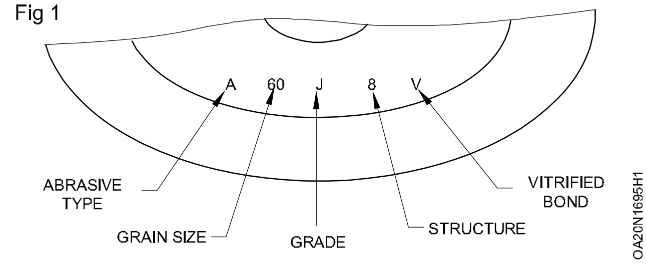
Grinding Wheel specifications mounting balancing, truing and dressing of grinding wheel.

Objectives: At the end of this exercise you shall be able to
- **Practice of mounting grinding wheel.**
- **Balancing and ****** of grinding wheel.**
- **Dressing of grinding wheel.**

Job Sequence

Specification of grinding wheel

Fig 1



First symbol: Type of Abrasive

A-Fused Aluminum Oxide.

Second symbol: Unit size

Warm :	4	36	46
Medium:	60	100	120
Fine:	240	500	

Third symbol: Grade of hardness

A to g one softer

H to p one more medium grace

R to z are hoarder

Forth symbol : structure

The spacing of the abrasive **** in the wheel is indicated by numbers

1 is a dense structure

8 is a more medium structure

15 is an open structure.

Fifth symber : bond

v- verified

B- Retinoid

R – rubber

E – shellac

M- Metol

Mounting the grinding wheel

- check the wheel visually for any crack or damage on the surface (Fig 1)
- check that the wheel is not cracked by tapping at four about 90° apart with Plastic handle of a screw drive (Fig 2)

Fig 2

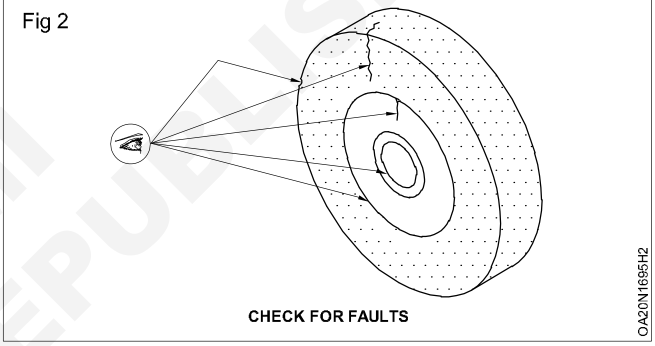
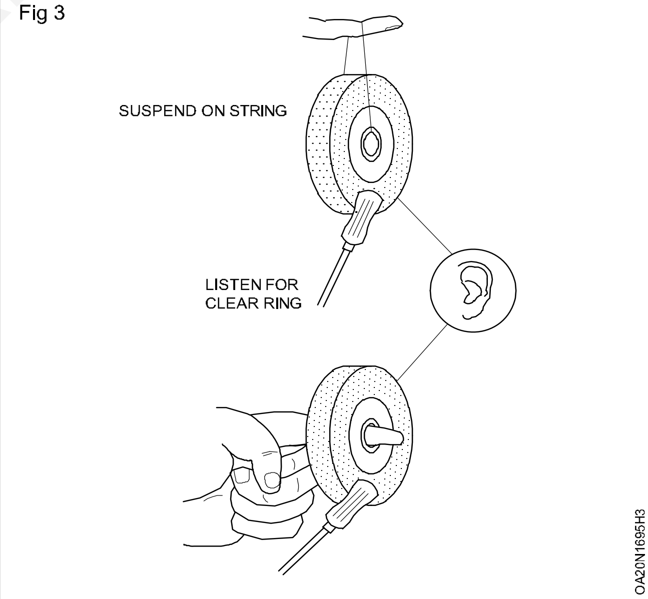


Fig 3



- mounting the clamp in grinding wheel (Fig3)
- Make sure that labels are struck on both sides of the grinding wheel.
- Do not insert the grinding wheel into the flange with excessive force
- Insert the outer flange without damaging the inner flange.

- Make sure that the installing holds of bolts are rightly placed.
- After mounting flame in the grinding wheel than balanced by balancing stem.
- Holding the grinding wheel firmly with both hands insert it into the spindle without bumping (Fig4)

Fig 4

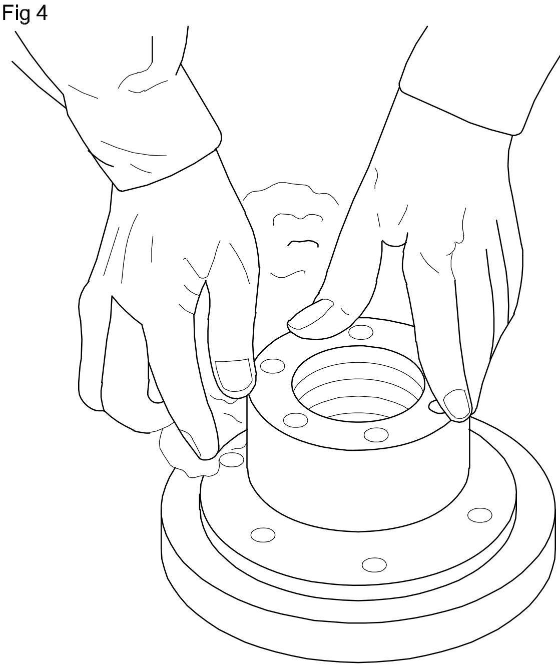
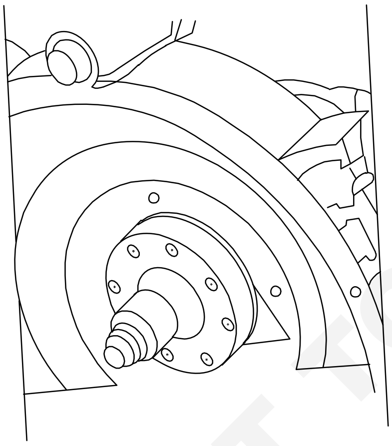


Fig 5



Balancing a grinding wheel

Remove the balance weight Fig 5

Clean the internal and external corner

place the wheel unit on the spindle nose and tighten locknut.

Replace the wheel gauard

Dress the wheel on the periphery (Fig 6)

place the levelling plate on the balancing stand (Fig7)

Tighten the nut on the mandrel (fig 8a)

Raise the protection guards (Fig 8b)

Place the wheel to be balanced on the top of the protection slides and lower gently on to the balancing stand(Fig 8c)

Visually ensure that the balancing mandrel in at input angle to the balancing ways (Fig 9a)

Allow the wheel to reassure slowly by its own momentum until stationary.

Place chance mark at the bottom to indicate a heavy point(fig 9b)

Turn the wheel 90° to the heavy point and diametrically opposite (Fig 9 c & d)

Repeat until assembly remain static (Fig10)

Remount the assembly on to the wheel head replace the gauard and redress the wheel before putting it into further operation.

Fig 6

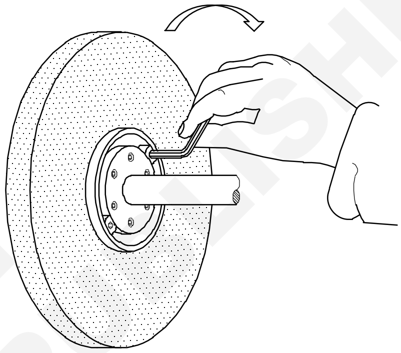


Fig 7

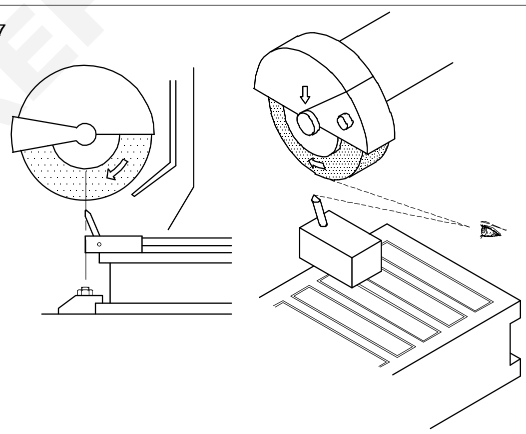
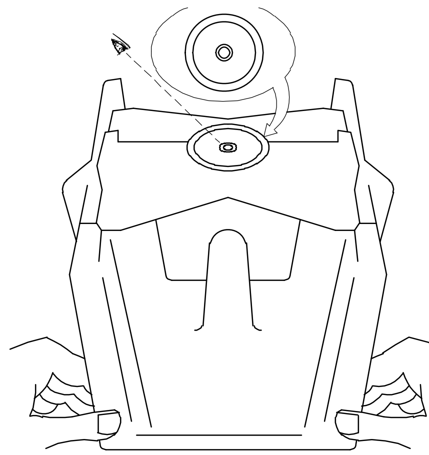
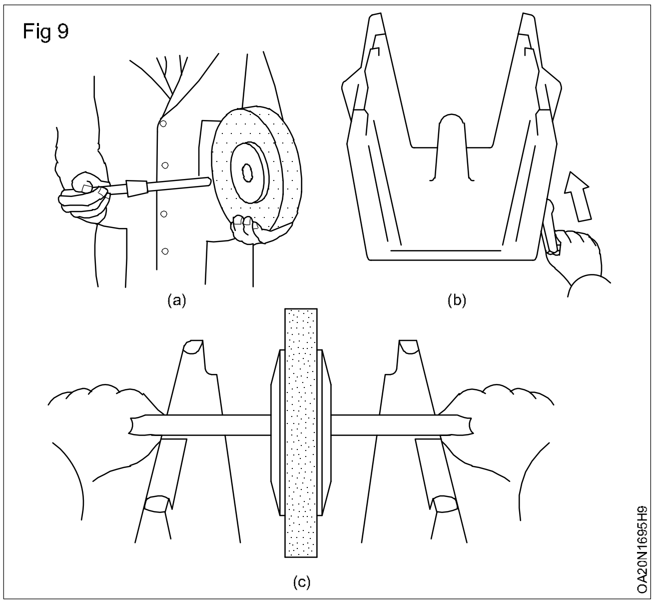
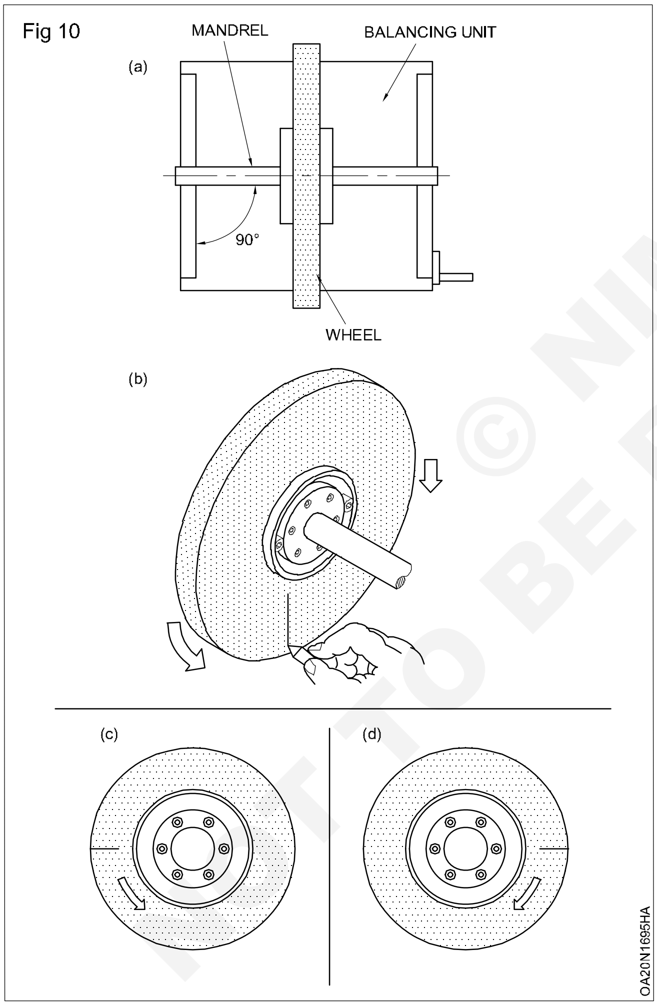
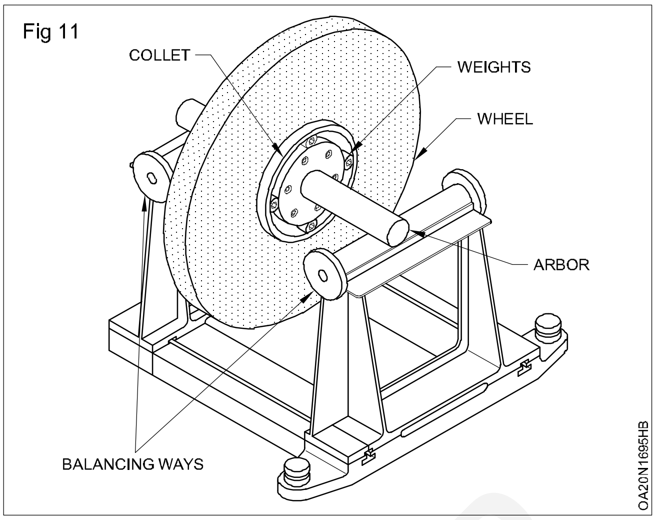


Fig 8









Truing and dressing

This is done for removing any high spots on the face of the wheel with a diamond dresses.(Fig11)

The point of the diamond should be effect about 12mm grinding wheel center line with reference to the direction of rotation of grinding wheel.(Fig 12)

Make sure that the diamond clears the wheel than start the grinder.

Lower the wheel until it touches the diamond move the diamond slowly across the face of the wheel.

Take light cuts (0.02mm) until the wheel it clean sharp and in running true.

Take a finish parts with 0.01mm across the face of the grinding wheel (Fig 13&14)

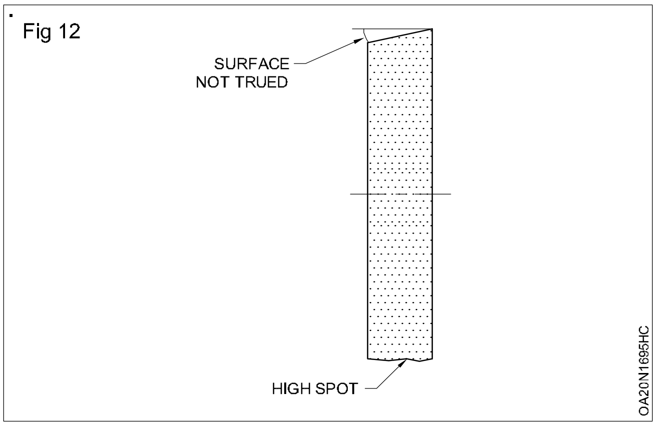


Fig 13

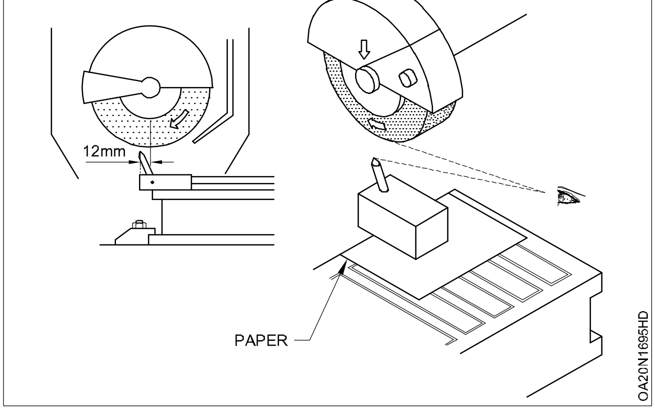


Fig 15

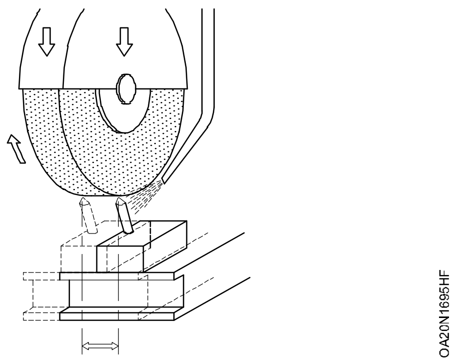
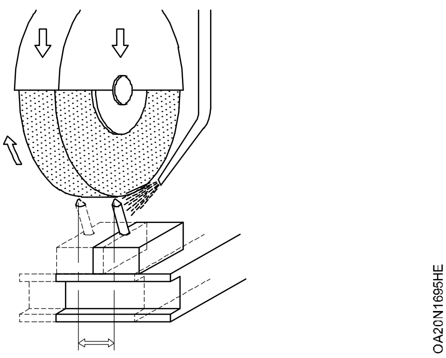


Fig 14



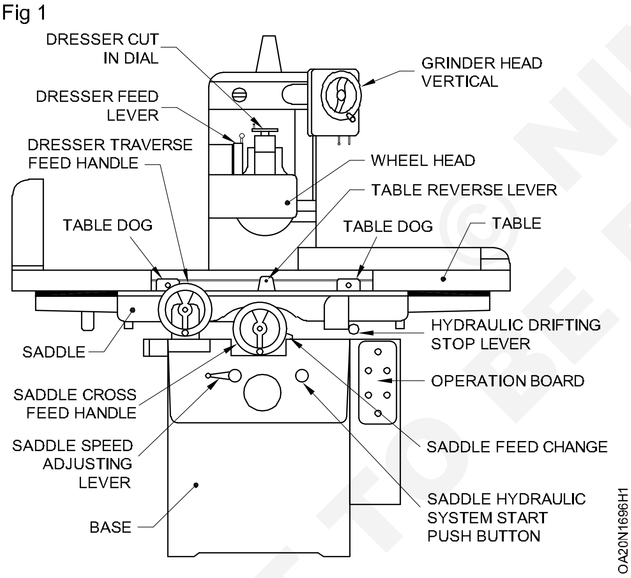
Lubrication of different parts and care maintenance of grinding machine.

Objectives: At the end of this exercise you shall be able to
- **identify the parts of machine to be lubricated.**
- **maintenance of machine about daily and weekly.**

Job Sequence

- Check the level of oil in column knee etc.
- Clean the area surrounding the filler cap before open it to present entrance of grinding particles, dirt etc.
- Add oil in order to maintain the oil level.
- Check operation of the oil bump.
- Locate clean and fill and oil hole and pockets which require hand oiling.
- Replace all screw plugs which were removed in the oiling progress.
- Clean and lubricate the sliding surface in the column.

Fig 1



Always clean the grinding work from all parts of the grinder.

For important joint part of the machine tool anti rust oil should be applied.

Daily maintenance

Cleaning & oiling.

Oil level in lubrication pump

Check the motor & spidle for any under noise.

Monthly maintenance

Check oil level in magnet slide.

Cleaning of vertical slide by removing front and rear cover.

Grind the magnet surface (very light cut) greasing of spindle.

Practice on different work holding devices. and grinding various job.

Objectives: At the end of this exercise you shall be able to
- **practice on work holding devices for grinders.**

Job Sequence

Work holding on cylindrical grinder

- Clean the work table slots with a slot cleaner.
- Dressing the cylindrical grinding wheel.
- Work piece is held between centers and is rotated on its axis
- If the work piece in long slender and its supported by work rest
- The work table is moved slowly by giving minimum depth of cut to get smooth finishing.

Work holding on the surface grinder

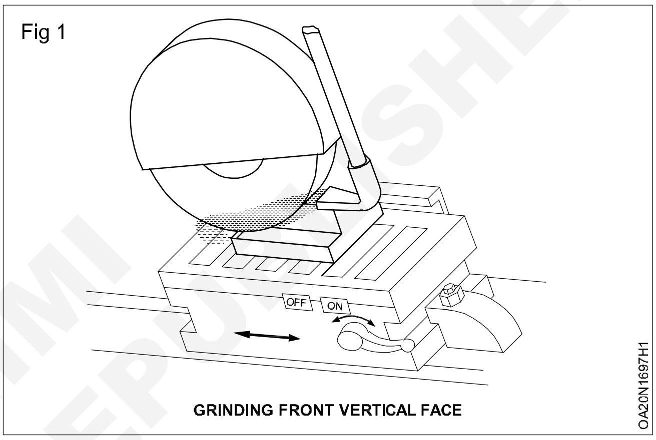
Work holder on the surface grinder are angle plate, vice, magnetic chuck, special fixture, indeying head etc.

Work holding on table, angle plate, vice and fixture, you know well these are used in milling.

Magnetic chuck

- Magnetic chuck are most commonly used work holding device for work piece, made up of ferrous materials.
- The work piece are attracted by magnetic forces and hence they are kept rest against the grinding.
- While clamping out by demagnetting the work piece can be taken out.
- Currently surface grinder have magnetic chuck incorporated In their design as the permanent table.

Fig 1



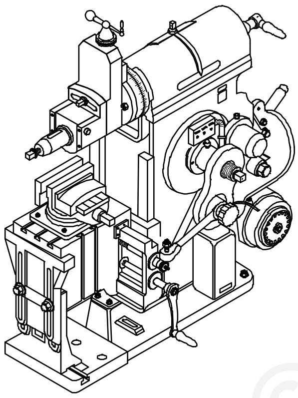
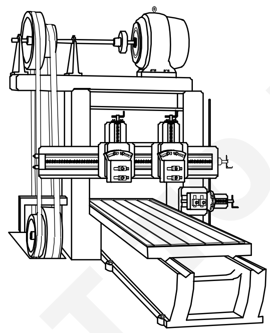
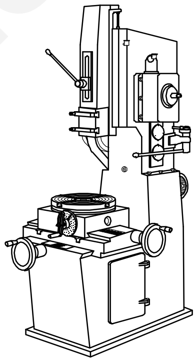
Other machining process.

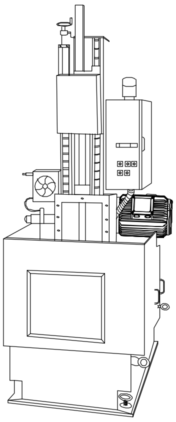
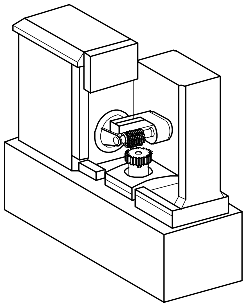
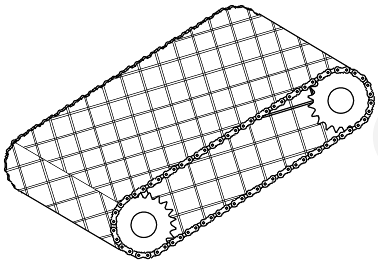
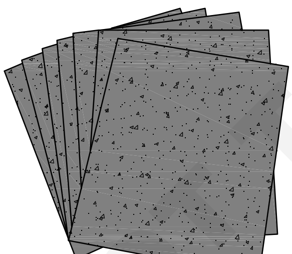
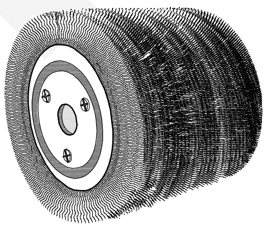
Objectives: At the end of this exercise you shall be able to
- **familiar all the machining process by visiting industrial sector.**
- **tabulate the machining process and their function.**

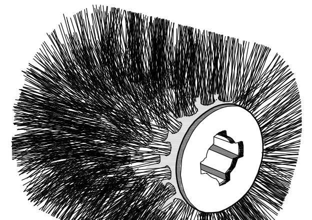
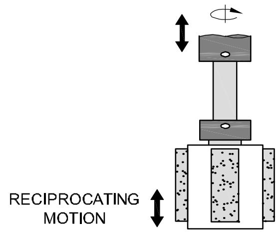
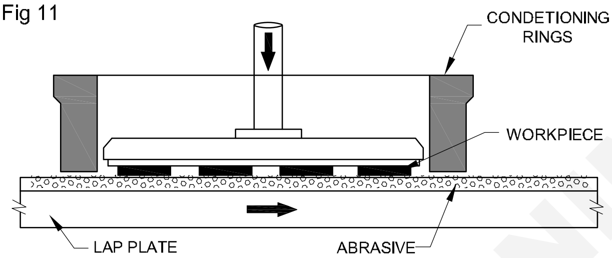
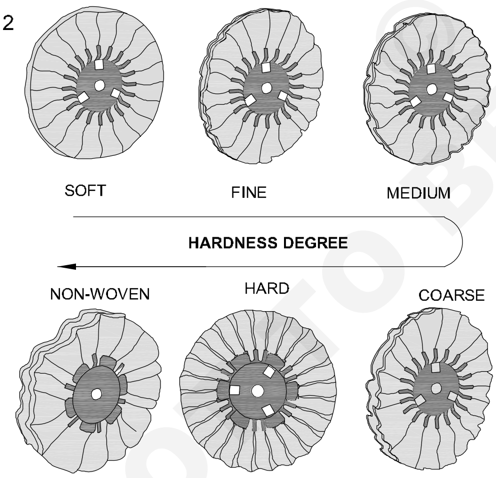
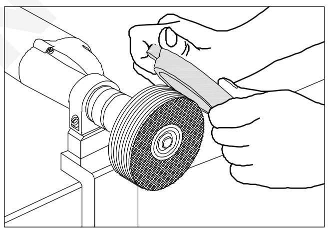
Job Sequence

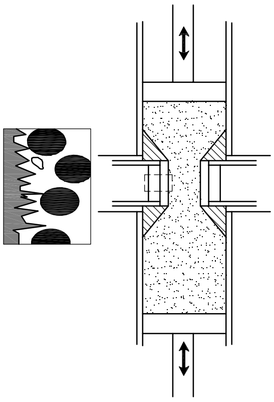
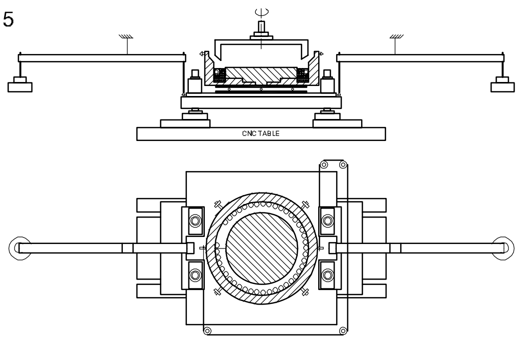
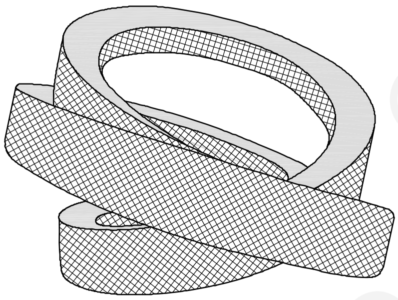
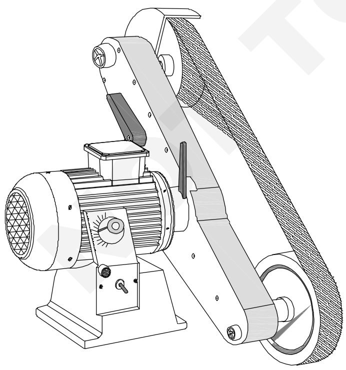
- Trainees visit the industrial sector and knowhow the machining process.

Instructors are asked to arrange industrial visit to know the machining process physically and instruct the trainees tabulate all the process and their function.

Machines / Accessories	Name of the machine / accessories	Application
Fig 1  OA20N1698T1	Shaping machine	Shaper is used to generate flat surfaces by means of a single print tod.
Fig 2  OA20N1698T2	Planning machine	Planner are used primary to produce horizontal, vertical and inclined flat surfaces that are too large to be accommodated on shapers.
Fig 3  OA20N1698T3	Slotting machine	slotters are used to cut slots, splines,keyways etc.

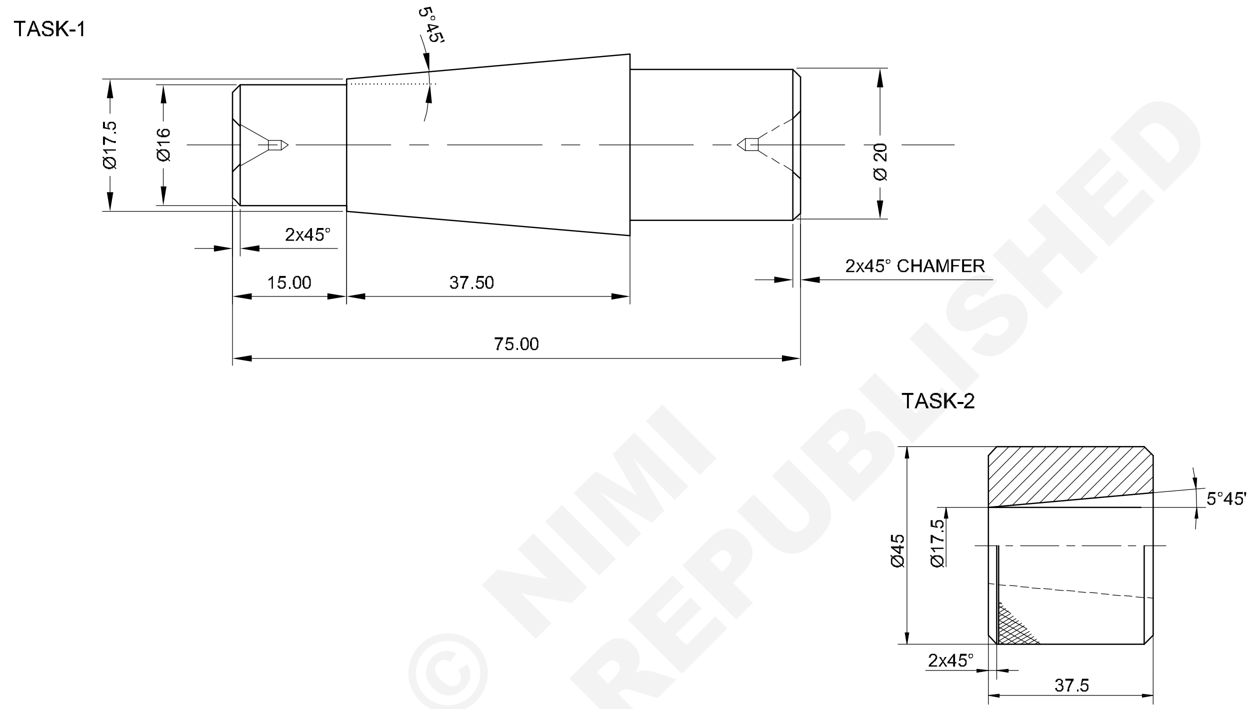
Machines / Accessories	Name of the machine / accessories	Application
Fig 4 	Broaching machine	Broaching is a process of machining a surface with a special tool called a broach
Fig 5 	Hobbling machine	The most accurate way of cutting spur and helical gear by the hobbing process
Fig 6 	Mesh belt	Primarily used for the filtration, draining and drying of various continuous products.
Fig 7 	Sand paper	To remove material from surface, to make them smoother.
Fig 8 	Wire brush provides metal cutting	Rust and oxide removal, surface preparation and surface finishing.

Machines / Accessories	Name of the machine / accessories	Application
Fig 9 	Wire act as abrasive	Cleaning rust and removing paint.
Fig 10 	Honing process	As a method for finishing and polishing.
Fig 11 	Lapping	Lapping is a low speed, low pressure abrading operation to get extreme accuracy.
Fig 12 	Buffing	Buffing is a final operation to improve the polish of a metal.
Fig 13 	Polishing	Polishing is generally done after grinding with a solid abrasive wheel and is followed by buffing.

Machines / Accessories	Name of the machine / accessories	Application
Fig 14 	Abrasive flow machining	To remove burrs, polish surface and even remove materials.
Fig 15 	Magnetic float polishing	For efficient finishing of advanced ceramics.
Fig 16 	Solid belt	To transmit mechanical power efficiently.
Fig 17 	Belt grinders	For grinding and shaping metal parts.

Taper turning by using taper attachment

Objective: At the end of this exercise you shall be able to
- **produce taper (male and female) by taper turning attachment method.**



1	Ø30 -87L	–	Fe 310	–	TASK-1	
1	Ø50 - 40L	–	Fe 310	–	TASK-2	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.1.7.99

SCALE 1 : 1	MALE AND FEMALE TAPER TURNING (BY TAPER TURNING ATTCHMENT & TAIL STOCK OFFSET METHOD)	Devietion ±0.02	TIME :22 hrs
		CODE NO. OA20N1799E1	

Job Sequence

TASK 1: **External taper by using taper turning attachment**

- Check the raw material size.
- Hold the material in 4 jaw chuck and true it.
- Face one end and make centre drill.
- Turn ∅ 20 to a length of 22.5 mm.
- Chamfer the end to 1 x 45°.
- Reverse the work & clamp in the jaw.
- Ensure that the total length remains 75 mm.
- Make a centre drill to hold the job between centres.
- Turn a step ∅ 16 mm to a length of 15 mm.
- Set the angle 5° 45” to turn external taper by taper turning attachment method.
- Turn the taper as per drawing.

Safety

- Remove the sharp corners
- Use coolant while centre drilling and taper turning

— — — — — — — —

TASK 2: **Internal taper by taper turning attachment**

- 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 ∅ 10 mm.
- Enlarge the hole to ∅ 16 mm by drilling.
- Chamfer 2 x 45°.
- 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 2 x 45°.
- Set the taper turning attachment 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 with task - 1

Safety precautions

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

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Skill Sequence

Lathe operation - Taper turning

Objectives: This shall help you to
- **state the principle of taper turning by the tailstock offset method**
- **identify the parts involved while taper turning by the tailstock offset method**
- **calculate the amount of offset according to the expression of taper.**

Principle of taper turning by the tailstock offset method

The job is held at an angle to the lathe axis, equal to half the included angle of the taper, and the tool is fed parallel to the axis.

As the job is held at an angle, it is possible to hold the work in between centres only as shown in the figure (1). The parts involved during turning, the taper by the offsetting tailstock are:

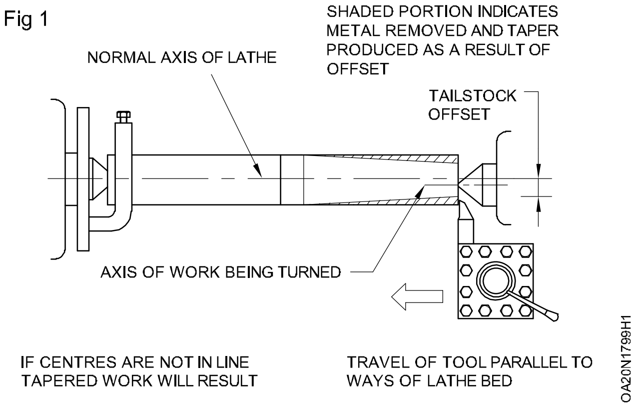
- Live centre and dead centre.
- Tailstock assembly of body and base.
- Driving plate/catch plate.
- Lathe carrier.

The centres used should preferably be ball centres to avoid distortion or damage to the centre - drilled holes of the job. To avoid more load and wear and tear on centres, the tailstock will not be usually offset more than 1/50th of the length of the workpiece.

Calculation of the amount of offset

If the taper is expressed by giving the big dia. (D) the small dia. (d) the length of taper (l), then

Fig 1



$$\text{offset} = \frac{(D-d)\times L}{2l}$$

where L = total length of job, l length of taper

Example

The big diameter of a tapered job (D) = 30 mm.

The small diameter of the tapered job (d) = 26 mm.

The length of taper portion (l) = 100 mm.

Total length of job (L) = 200 mm.

$$\text{offset} = \frac{(D-d)\times L}{2l}$$

$$= \frac{(30-26)\times 200}{2\times 100}$$

$$= \frac{4\times 200}{2\times 100}$$

= 4 mm

If the taper is expressed in TPF then the amount of offset

$$= \frac{TPF \times L}{2}$$

Where TPF is given in inches

L = total length of job.

If taper is expressed as a ratio then the amount of offset

$$= \frac{\text{ratio}\times L}{2}$$

If taper is expressed by included angle i.e. 2θ.

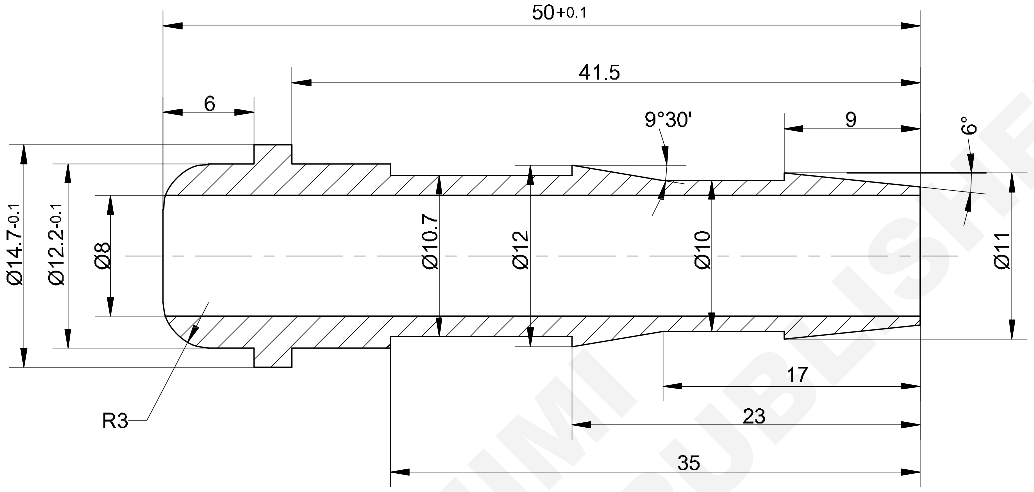
offset = L x tan θ

where L = total length

θ = 1/2 included angle in degrees.

Taper turning by using a form tool

Objective: At the end of this exercise you shall be able to
- **grind form tool for taper turning**
- **turn taper using form tool.**



1	Ø25 - 55	–	Fe310	–	TASK-1	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.1.7.100
SCALE 1 : 1	TAPER TURNING BY FORM TOOL				TOLERANCE Degree ±30 ±0.01 Unless otherwise stated	TIME : 20hrs
					CODE NO. OA20N17100E1	

Job Sequence

TASK 1: **Taper turning by form tool**

- Check the given material for the dimension.
- Hold the job 50mm projecting outside the chuck and true it.
- Face the one end and make centre drill.
- Drill ∅ 8mm through hole.
- Turn ∅14.7 mm for a length of 50mm.
- Turn the ∅12.2 mm for a length of 41.5mm from the face.
- Form a step of ∅ 10.7mm for 12mm width leaving a 23mm distance from the face to 35mm.
- Form an under cut to ∅ 10.7 for 8mm width leaving a distance of 9mm from the face to 17mm.
- Step turn ∅ 11mm for 9mm length from face.
- Grind with special form tools to the degree of 9°30’ and 6°.
- Set from tool 9°30’ perpendicular to the work axis to form taper by plunging.
- Set the machine to 1/3 of rpm for form turning.
- Feed the tool perpendicular to the axis of the work and form taper.

Ensure slow, steady and continuous feeding

- Set the form tool 6° perpendicular to the work.
- Form the 6°.
- Remove the job and hold the work on ∅12.2mm.
- Face the work and maintain the length.
- Turn ∅ 12.2 mm for a length 6mm.
- Form radius R3 at the end.
- Deburr and complete work.

— — — — — — — —

Skill Sequence

Measuring with vernier bevel protractor

Objectives: This shall help you to
- **check the various angles of the machined parts up to an accuracy of ±5 minutes**
- **check the straightness of the machined surface with reference to the other vertical surface.**

The vernier scale is duplicated to read either side of the ‘zero’ graduation of the main scale. If you read the main scale in the clockwise direction, continue reading the vernier scale also in a clockwise direction. Always make sure that the vernier scale reading is added to the main scale.

Method of using clockwise reading

Set the angular surface of the workpiece between the blade and the face of the base and lock the blade and inner disc firmly with the locking device.

The position of the vernier scale with reference to the main scale is shown in Figure 1.

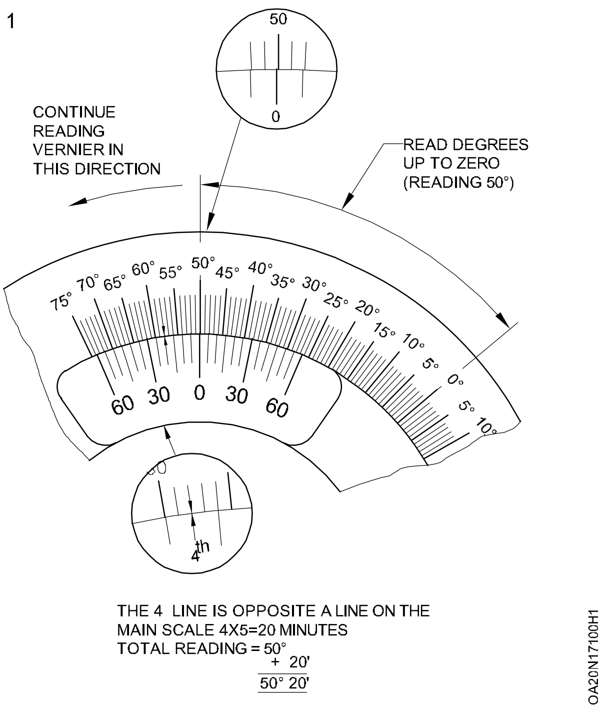
Read the degrees of the main scale up to the graduation ‘0’ of the vernier scale i.e. 50°.

Continue reading on the appropriate vernier scale (towards the left hand side). Note the number of lines in the vernier scale the coincide with a division of the main scale. (i.e. 4th division of the vernier scale is coinciding with one of the main scale division line)

As the least count is 5’ multiply this number by 5. (i.e 4 x 5’ = 20’)

Add this result to the main scale reading of 50° i.e. 50° + 20’ = 50°, 20’.

Fig 1



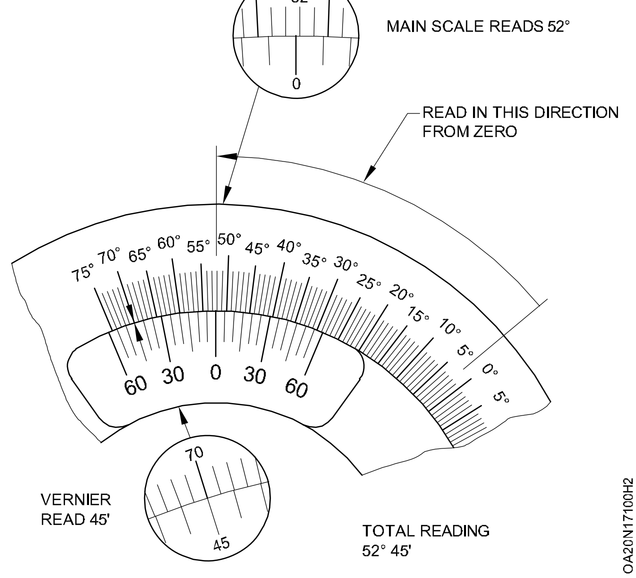
Similarly the reading for figure 2 may be obtained as 52°, 45’. (Fig 2)

Method of checking the straightness with reference to the vertical surface

Set the blade and base firmly on the machined surface.

Lock the blade and base in position with the help of the locking device.

Fig 2



Read the vernier scale with reference to the main scale.

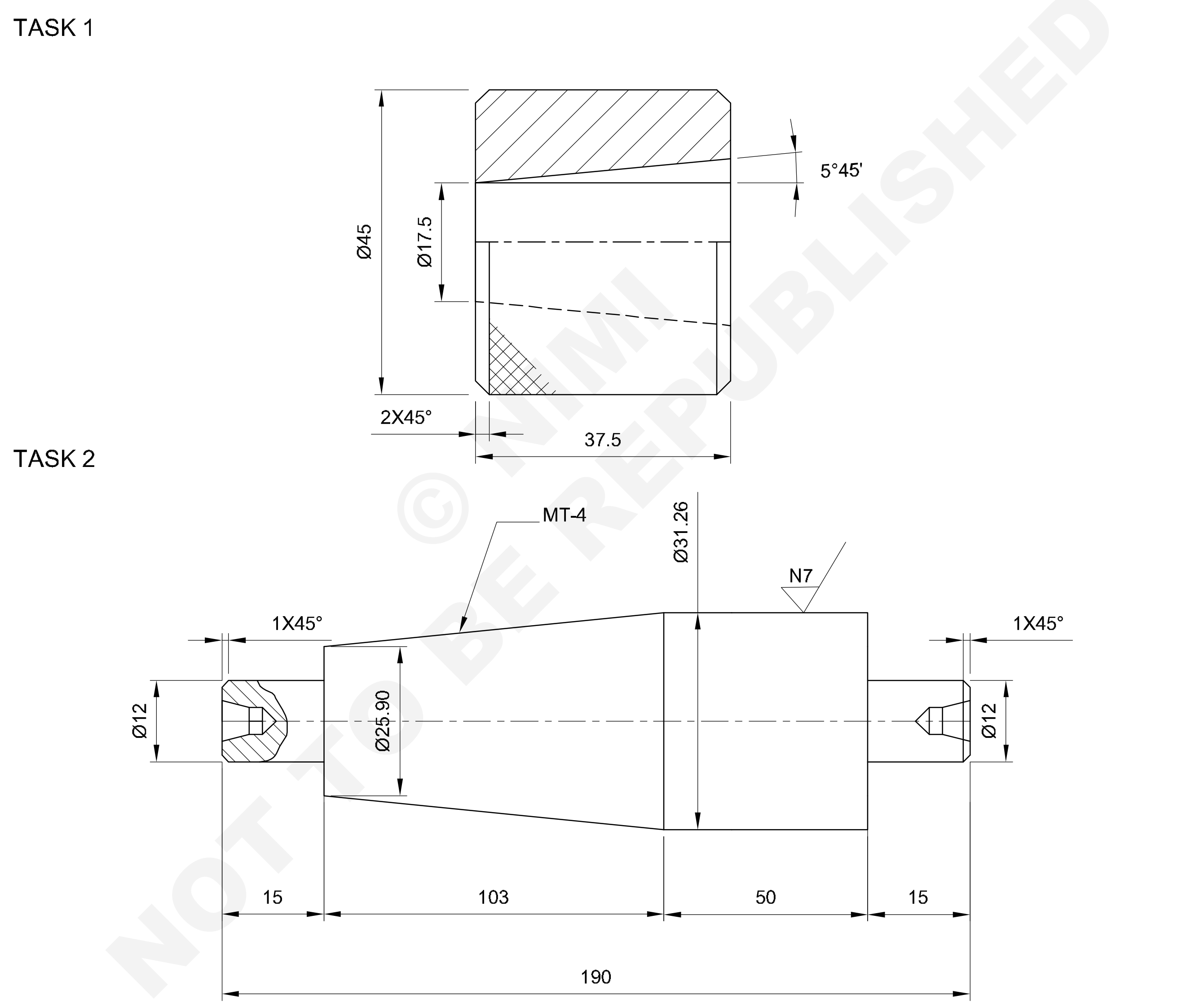
If the ‘0’ graduation of the vernier scale and 90° of the main scale coincide, the machined faces are at right angles, i.e. 90°.

If the ‘0’ graduation of the vernier scale does not coincide, read the appropriate vernier scale and find the error in degrees and minutes.

The error shows the deviation of surface from the straightness.

Internal and external taper turning and matching to mating part

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.**



1	Ø50 - 45		Fe 310		TASK 1	1.7.101
1	Ø36 - 200	–	Fe 310	–	TASK 2	1.7.101
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	TURN TAPER (INTERNAL AND EXTERNAL)	TOLERANCE : ± 0.04mm	TIME 10h
		CODE NO. OA20N17101E1	

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.

— — — — — — — —

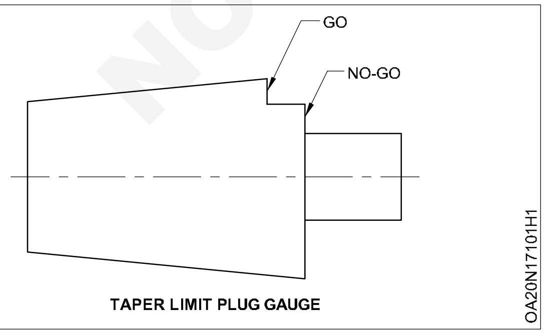
Skill Sequence

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)

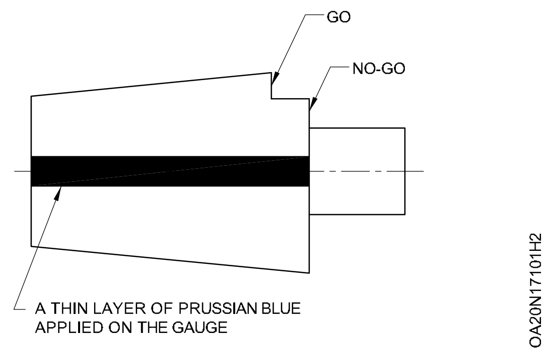
Fig 1



Clean the tapered bore.

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

Fig 2

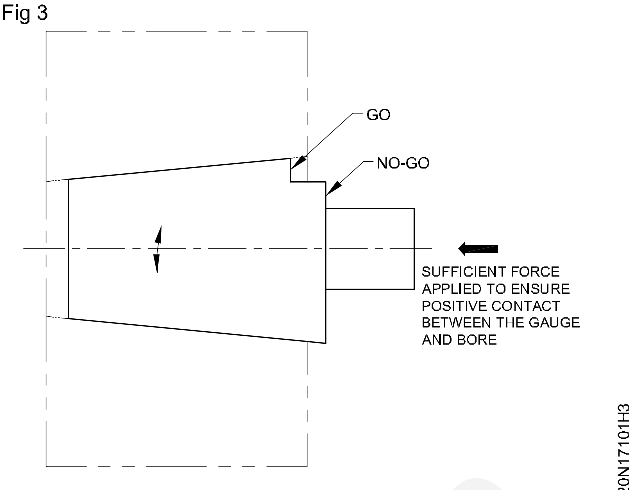


Assemble the taper plug gauge inside the tapered bore carefully with sufficient force to ensure positive contact between the gauge and the bore, and give one quarter twist to the plug gauge.

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.

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.

Fig 1

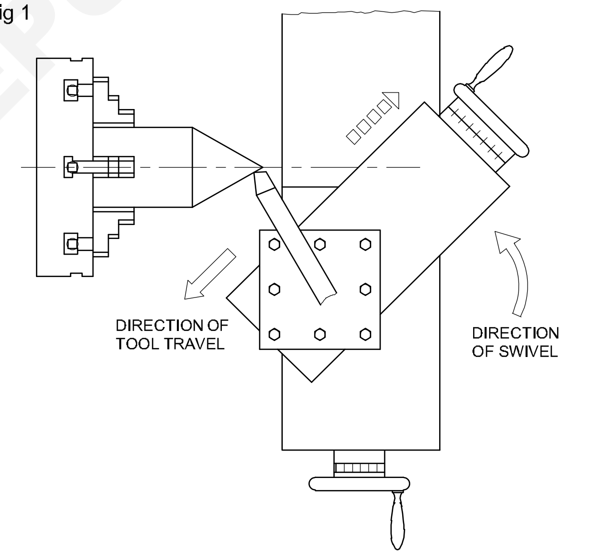
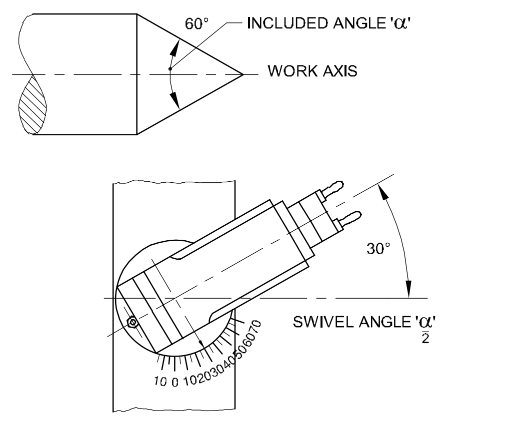
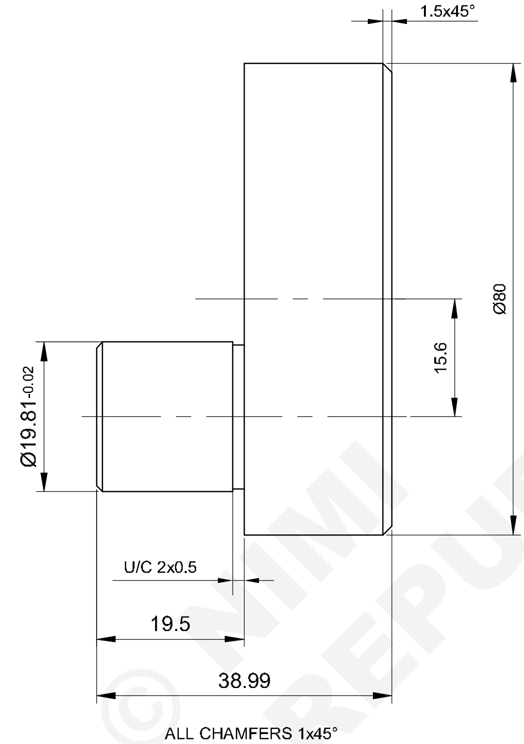


Fig 2



Eccentric turning practice

Objective: At the end of this exercise you shall be able to
- **mark the eccentric centre and circle**
- **true the eccentric dia (external)**
- **learn eccentric turning.**



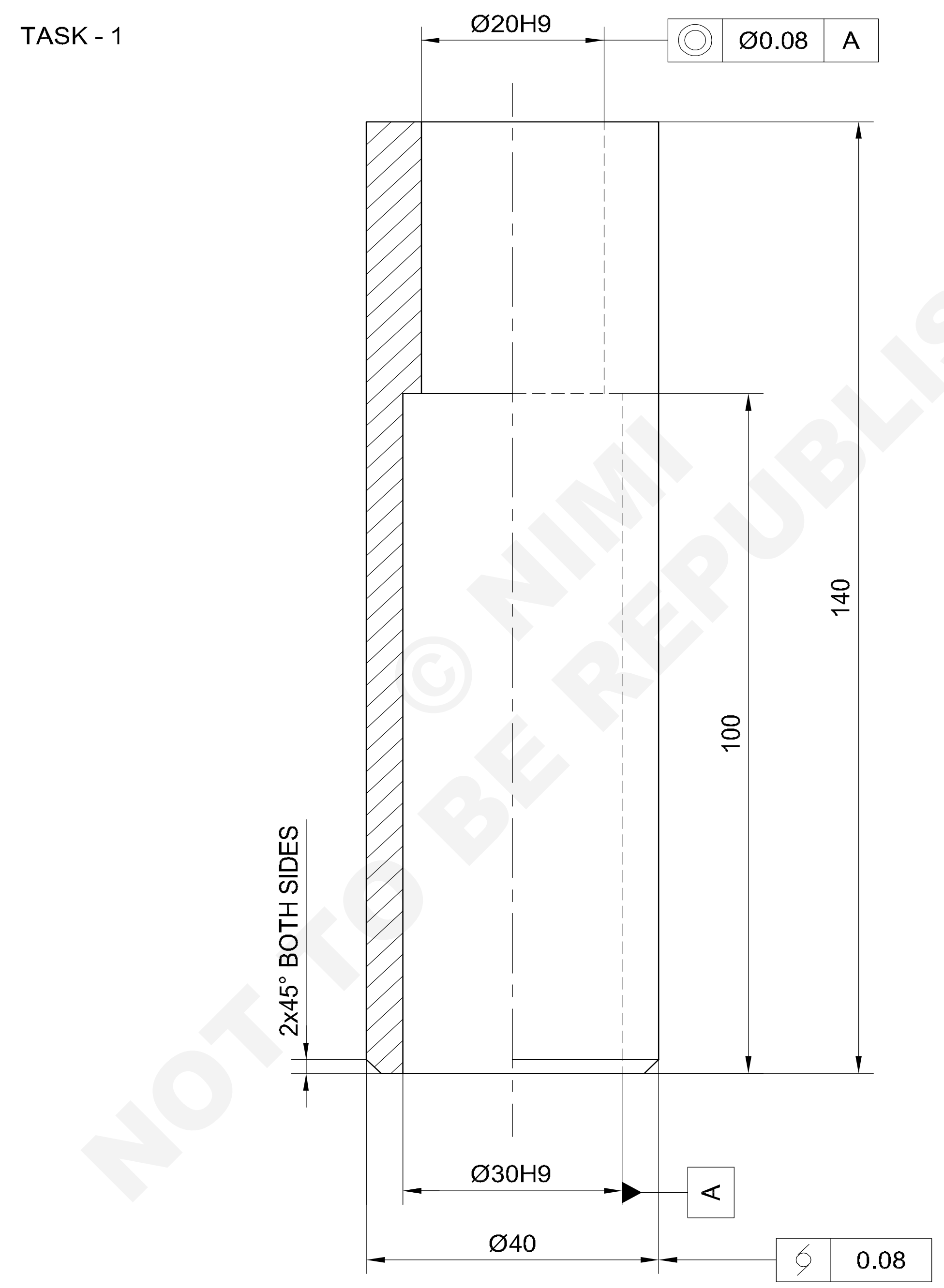
Job Sequence

- Check the raw material size.
- Hold the material in a 4 Jaw independent chuck and true it.
- Face the one end.
- Turn ∅80mm to a maximum length.
- Chamfer 1 x 45°.
- Reverse the job hold and true it.
- Face the job maintain total length 50mm.
- Turn ∅80mm to remaining length.
- Remove the job from the chuck.
- Mark the centre line and eccentric centre line according to the drawing with the help of marking tools.
- Punch both the centre lines.
- Draw a guide circle of ∅26mm with the eccentric centre as the centre point.
- Punch the intersecting 4 points.
- Hold the job in a 4 jaw independent chuck on the turned diameter.
- True the concentric circle.
- Open one jaw and tighten the opposite jaw so that the centre of the work moves.
- Repeat the operation till the eccentric centre comes in line with the lathe center.
- Check & true eccentric circle with the help of the surface gauge.
- Turn eccentric dia 25.4 mm to a length of 25 mm.
- Chamfer 1 x 45°.
- Under cut 2 x 0.5mm and deburr by a smooth file.

1	Ø85 - 55	–	Fe 310	–	–	102
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.1.7.102
SCALE 1 : 1	PERFORM ECCENTRIC TURNING				TOLERANCE ±0.06 Unless otherwise stated	TIME :15hrs
					CODE NO. OA20N17102E1	

Boring and stepped boring, position boring

Objectives: At the end of this exercise you shall be able to
- **bore deep holes within close limits**
- **check the bore dia using inside micrometer.**

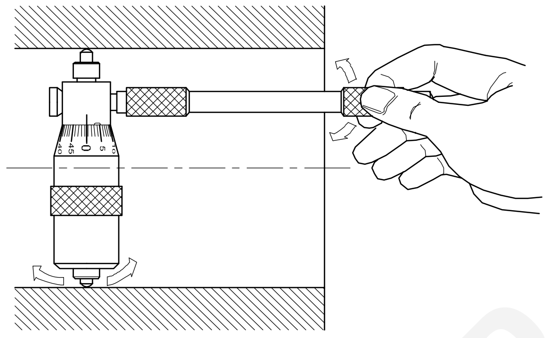


1	Ø45 - 150	-	Fe 310 - O	-	-	1.7.103
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	BORING AND STEPPED BORING			DEVIATIONS IS:2102 (M)	TIME 15h	CODE NO. OA20N17103E1

Job Sequence

- Check the raw material size.
- Hold the job in three jaw self centring chuck. Projecting 110 mm outside the chuck.
- Face the end.
- Turn to Ø 40 mm for a maximum possible length.
- Reverse the job & face to maintain a length of 140 mm.
- Centre drill the end.
- Turn to dia 40 mm for a remaining length.
- Drilling step by step (first pilot drill of Ø 10 mm, Ø 16 mm & Ø 22 mm) for full length.
- Set the broing tool & bore to dia 20 H_9 through hole.
- Check the hole by using inside micrometer.
- Step bore to Ø 30 H_9 for a length of 100 mm (By giving several rough cuts & finally by finish cut)
- Check the stepped bore using inside micrometer.
- Deburr sharp corners if any. (Fig 1)

Fig 1

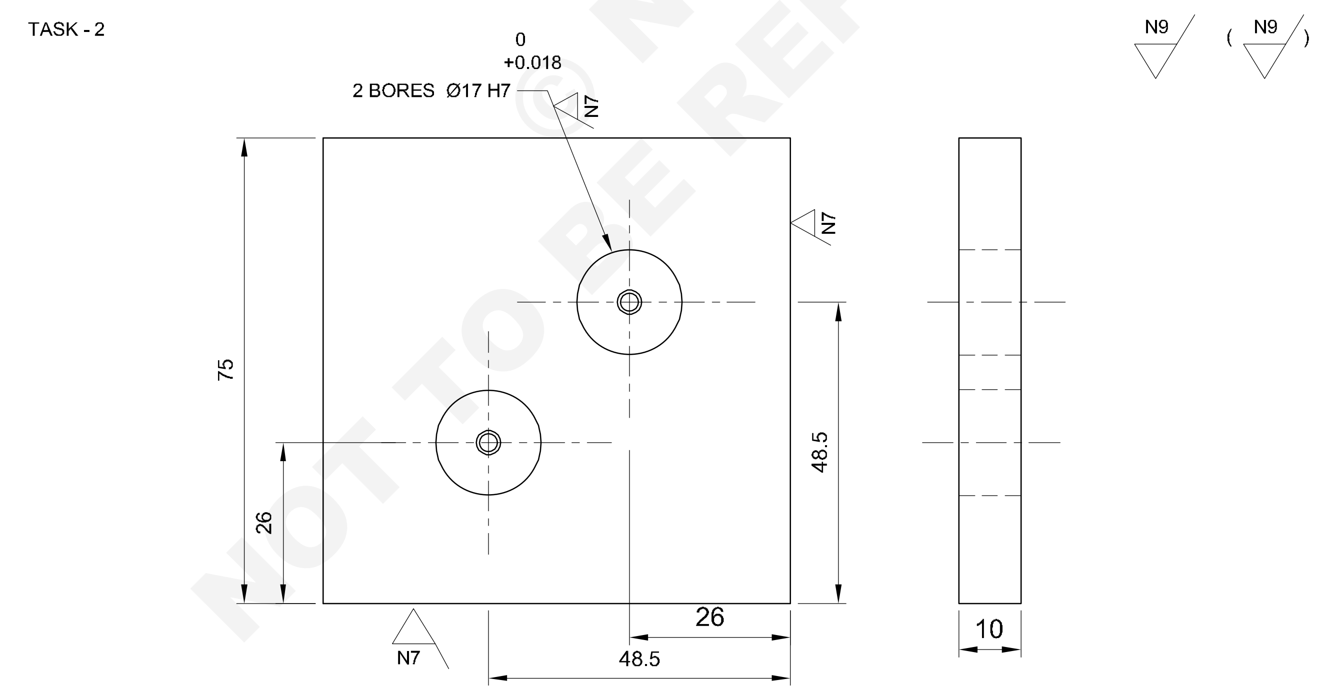


USING AN EXTENDED HANDLE WHEN MEASURING A DEEP BORE

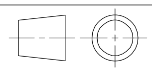
— — — — — — — — —

Position boring using tool makers button

Objectives: At the end of this exercise you shall be able to
- **make use of tool maker's button**
- **set and mark bore offsets**
- **set on four jaw to bore offset bores.**



1	80ISF 12x80	-	Fe 310	-	-	1.7.103
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	POSITION BORING (USING TOOL MAKER'S BUTTON	TOLERANCE.	TIME: 10HOURS
		CODE NO. OA20N17103E2	

Job Sequence

- Check raw material and deburr.
- In 4 jaw chuck make blank of 10 x 75 x 75. (Fig 1&2)

Fig 1

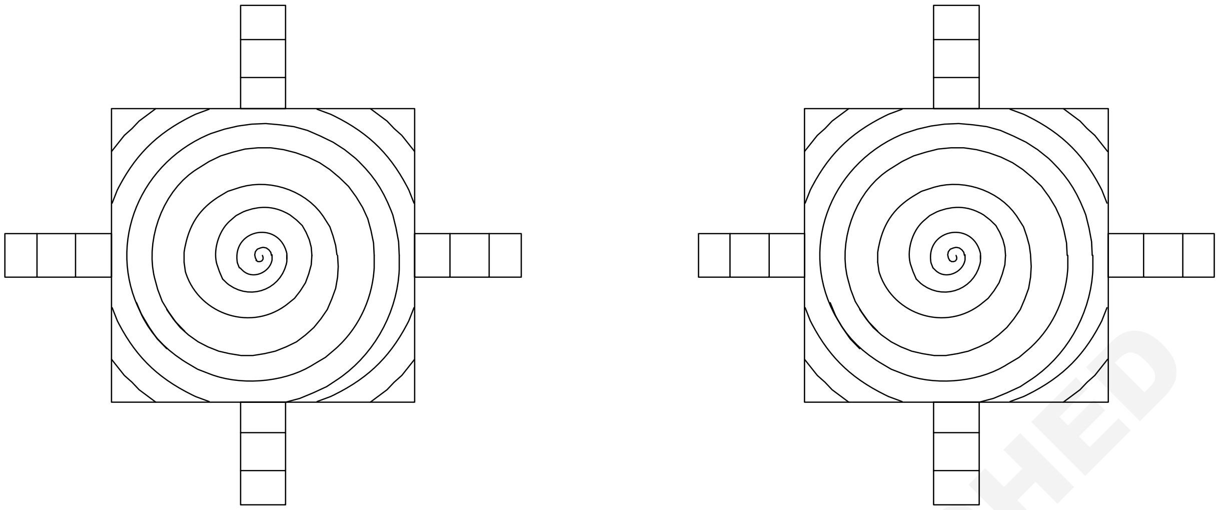
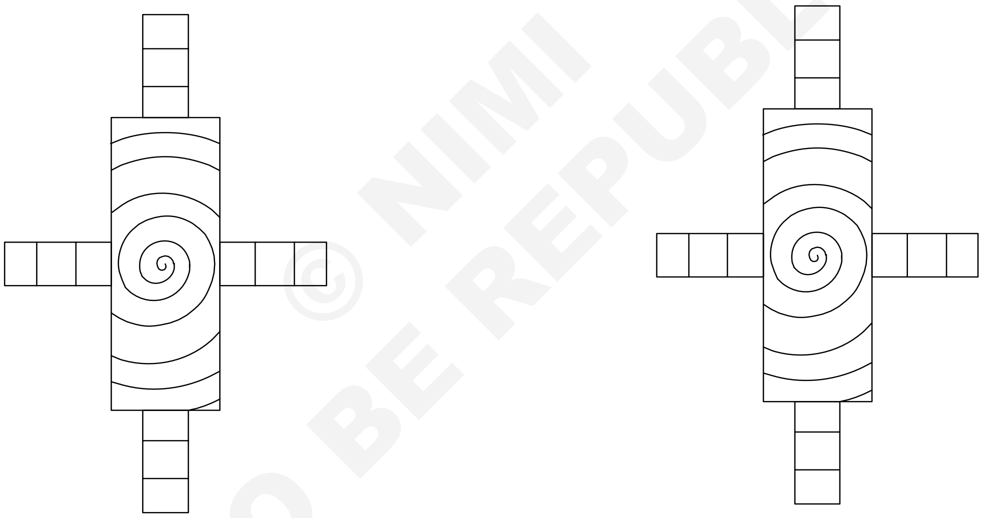


Fig 2



- Mark two centre points of 26, 48.5 two points as per drawing. (Fig 3)
- Drill to Tap to suit 4 BA.
- Drill to Tap to suit 4 BA.
- Fix tool maker's button Ø 10.
- Set the centre to 25.88, 48.5 co-ordinate. (Fig 4)
- Fix job in 4 jaw chuck and tool maker's button Ø 10 to lathe axis.
- After aligning remove tool maker's button. (Fig 5)
- Drill and bore to dia Ø 17 $H_7^{+0.018}$
- Remove job and fix tool maker's button in the other centre.
- But the job against angle block build slips 26 - 5 = 21 mm, adjust the roller against slip. Set the

Fig 3

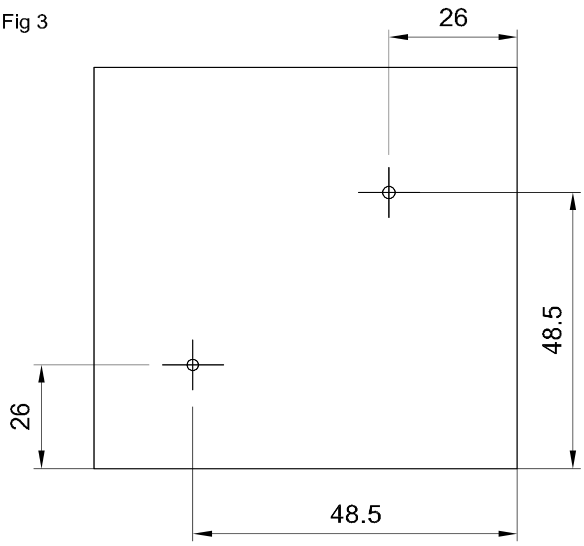
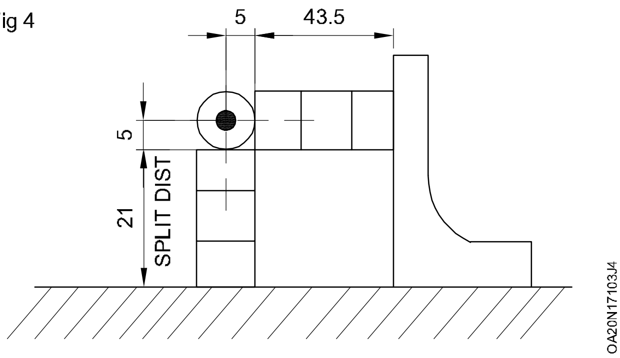


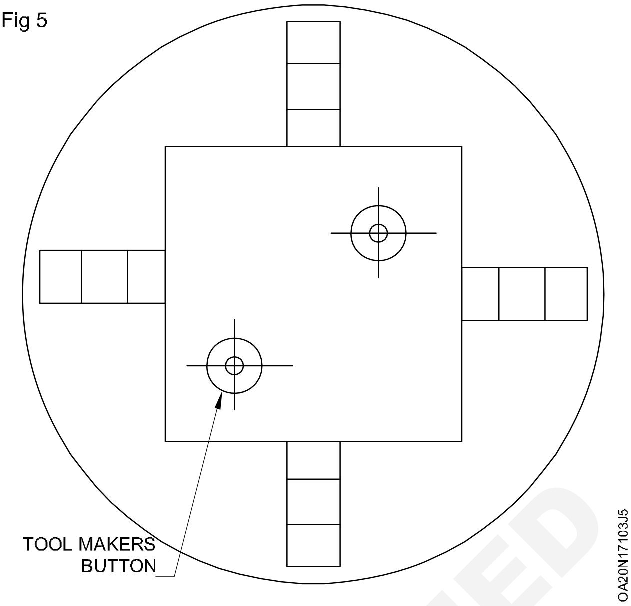
Fig 4



dial test indicator 0' on surface plate and raise height to 26 + 5 = 31 mm and compare with slips. Then check and correct the tool maker's button to 26 of co-ordinate centre. Similarly the distance 48.5 is set.

- Fix job in 4 jaw chuck and align tool maker's button to axis of lathe.
- Remove tool maker's button.
- Drill and bore to dia 17 $H_7^{+0.018}$
- Remove job and deburr.

Fig 5



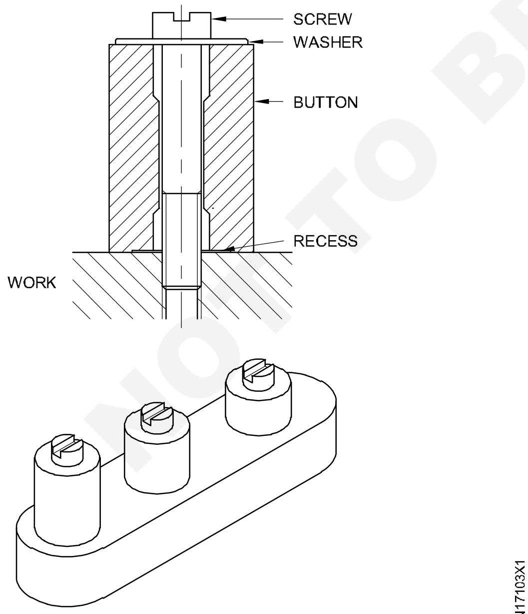
Skill Sequence

Checking the eccentric

Objectives: At the end of this exercise you shall be able to
- **setting job for eccentric boring using tool maker's buuton.**

- Mark the eccentricity with 'V' block & Vernier height gauge.
- Punch the centre marked & drill Ø 8 mm. (Fig 1)

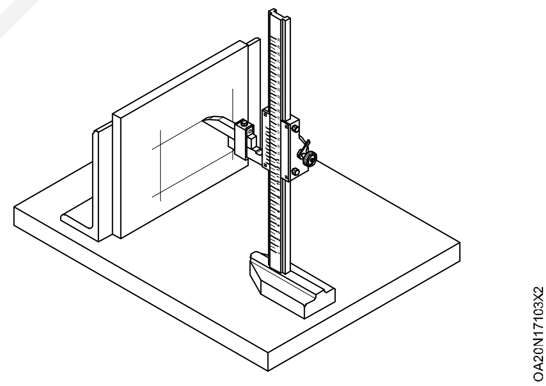
Fig 1



TOOL MAKERS BUTTONS

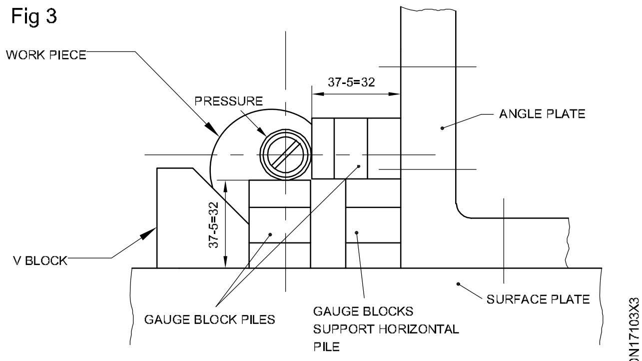
- Tap M10 threaded hole. (Fig 2)
- Fit a tool maker's button over this threaded hole. (Do not tighten fully)

Fig 2



- Adjust the botton position by building up by slip gauge block. (Fig 3)

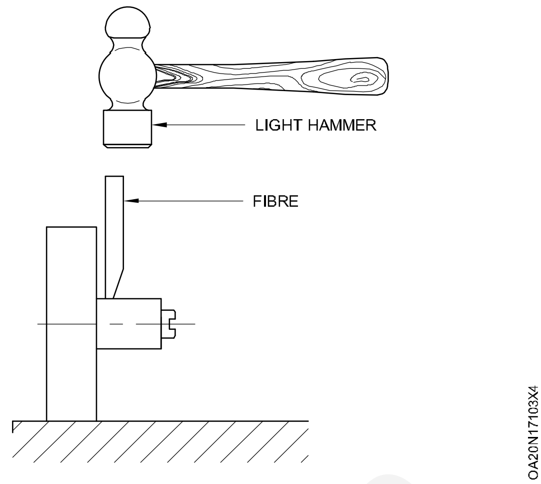
Fig 3



SETTING THE BUTTON

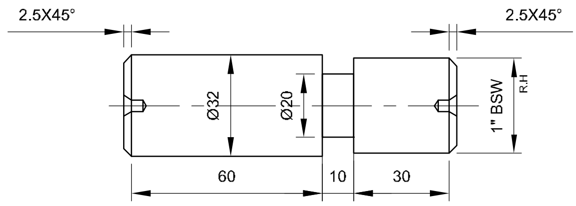
- While positioning the button, tap gently as shown in figure. (Fig 4)
- After the button positioned as per the required dimension tighten the screw fully.
- Finally mount the work in four jaw chuck & true it by using dial test indicator.

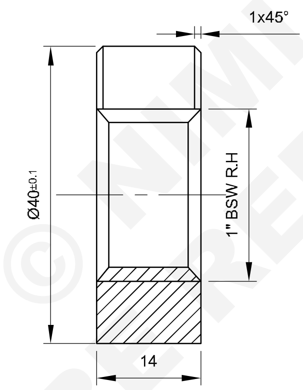
Fig 4



Various screw thread cutting to suit male and female threaded components.

Objectives : At the end of this exercise you shall be able to.
- **clean both the internal & external thread**
- **rotate the internal thread into external thread**
- **check the thread for correct profile fitting.**





Job sequence

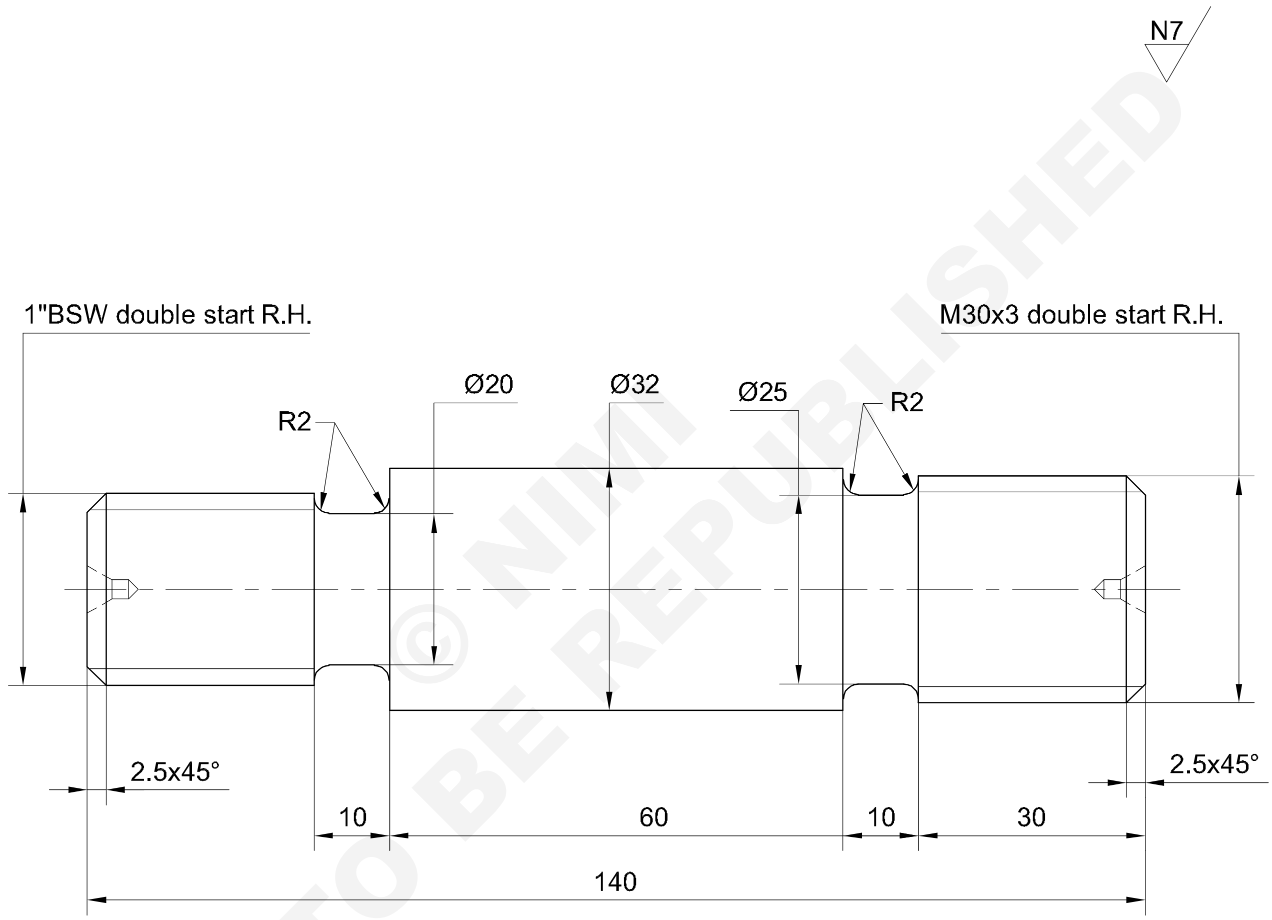
- Clean external internal 1” BSW threaded job and check thread profile.
- Check and select 7/8” BSW RH external and internal component.
- Fit the R.H internal component rotate clockwise direction to external component.
- Clean the external and internal 7/8” threaded job.
- Check threads profile.
- Check and select 7/8” BSW L.H external and internal component.
- Fit the L.H internal component rotate anti clockwise direction to external component.

1	Ø50x20	→ EX.NO.1.3.59	Fe 310IS:1977	-	-	
1	Ø36x105	→ EX.NO.1.3.58	Fe 310IS:1977	-	-	1.7.104
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MALE AND FEMALE THREADED COMPONENTS	DEVIATION ±0.06mm	TIME 3hrs
		CODE NO. OA20N17104E1	

Multi start threads cutting

Objectives: At the end of this exercise you shall be able to
- **plain turn within close limits**
- **step turn within close limits**
- **cut R.H. double start metric threads**
- **cut R.H. double start BSW threads.**



1	Ø36 - 145		Fe 310 - O			1.7.105
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**THREAD CUTTING** (EXTERNAL)	DEVIATIONS IS:2102 (M)	TIME 10h
		CODE NO. OA20N17105E1	

Job sequence

- Hold the job in a four-jaw chuck and face both the ends to maintain a total length of 140 mm.
- Centre drill at the ends and hold the job between centres using a driving plate having slots milled at 180° and a bent tail carrier.
- Turn the outer dia. 32mm to full length and chamfer the ends.
- Form the radius groove Ø25 x 10 mm at 30 mm distance from the end.
- Arrange the gear train to cut 6 mm lead threads on the job.
- Cut the first start threads to half the depth.
- Remove and refix the job, setting the bent tail of the dog carrier in the opposite slot of the face- plate.
- Cut the 2nd start threads to full depth by giving successive cuts.
- Reset the work for completing the 1st start threads to full depth.
- Cut the first start threads to full depth by giving successive cuts.
- Reverse the job and turn the step Ø 1" for 30 mm length and form the radius groove Ø 20 x 10 mm.
- Arrange the gear train to cut 1/4" lead threads.
- Cut 1st and 2nd start threads as done before.

Skill sequence

Double start thread by thread chasing dial

Objective: At the end of this exercise you shall be able to
- **cut multi-start threads using thread chasing dials.**

This may be used to produce 2, 4 and 8 starts mostly with odd numbered leads such as 1,3,5,7 etc. or fractional leads such as 1/1.5.

The steps for cutting double start threads of 1/7" pitch on a lathe having 4 TPI lead screw are as follows.

Set the lathe for cutting a screw thread of the given lead.

Mount the workpiece.

Engage the carriage half nut on a numbered line on the thread chasing dial.

Make the first cut of the first start threads and return the cutting tool to the starting position of the threads.

Set the cross-slide graduated collar to zero.

Engage the carriage half nut on an unnumbered line on the thread chasing dial and take the first cut of the second start threads.

Engagement of the half nut at this position automatically centres the cutting tool half way between the path of the first start threads.

Give the same depth of cut for both the starts alternatively till the full depth is reached.

Multiple thread by face - plate method

Objective: This shall help you to
- **cut multistart threads by the face-plate method.**

This method may be used only if the face–plate slots are accurately machined. (Fig 1)

If, for example, a double start Vee form thread having 12 threads per inch and a 1/6" lead is required, the procedure is as follows.

Set up the lathe for thread cutting.

Set the gearbox levers for 6 threads per inch.

If a change gear train has to be arranged, determine the change gears using the formula

Lead of workpiece   Driver

Lead of lead screw   Driven

Calculate the depth of the thread to be cut for 12 threads per inch.

Face–plate with slots

The slots numbered as 1, 2, 3 and 4 are to be used for cutting the double start threads.

Cut the first start threads to within 0.010" inch of the required depth. The depth of cut is given by the top slide.

Make a note of the graduation on the top slide graduated collar, and without moving the cross-slide handle, withdraw the cutting tool from the workpiece by the top slide hand wheel rotation.

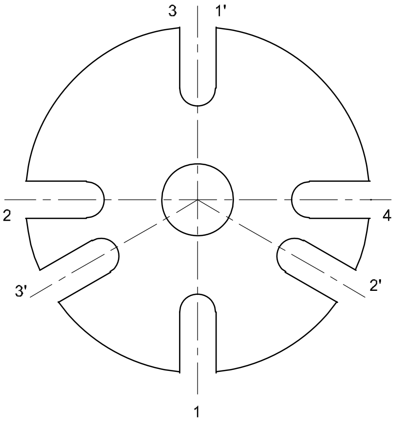


Fig 1

1,2,3 AND 4 FOR TWO AND FOUR START THREADS AND 1',2' AND 3' FOR THREE START THREAD.

FACE PLATE WITH SLOTS

Stop the lathe and bring the carriage to the starting position.

With the driving attachment still fitted to the workpiece, remove the workpiece from the lathe, turn it through 180° and set it back in the lathe with the driving attachment fitted in the opposite slot in the drive-plate.

Start the lathe and engage the half nut.

Feed the compound slide towards the workpiece for the depth of cut until the cutting tool just contacts the workpiece surface.

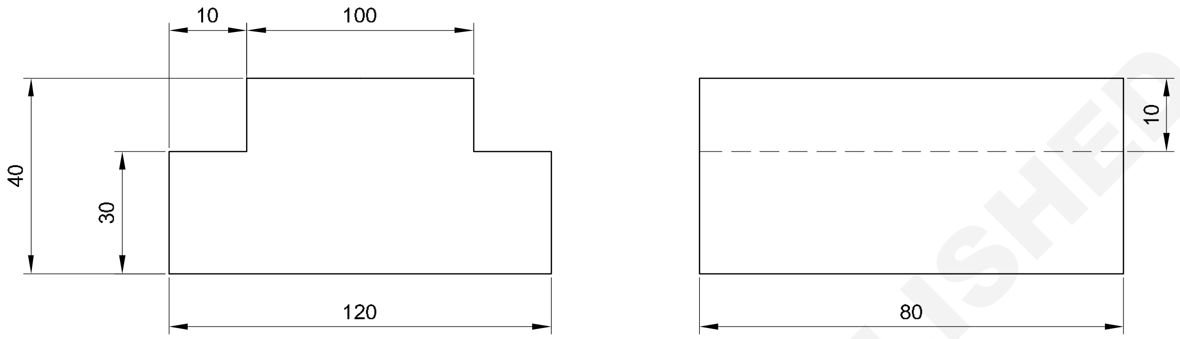
Using the compound rest for successive depths, cut the second start thread to the calculated depth.

Without moving the setting of the crossslide and top slide remove the workpiece and turn it through 180° as before and reset in the lathe.

Give the finishing cut on the first start threads.

Gang milling - milling jobs of different shapes and dimensions by using gang milling process

Objective: At the end of this exercise you shall be able to
- **layout the job as per the drawing with a vernier height gauge**
- **set the job on the vice for gang milling**
- **mount the cuffers for gang milling.**

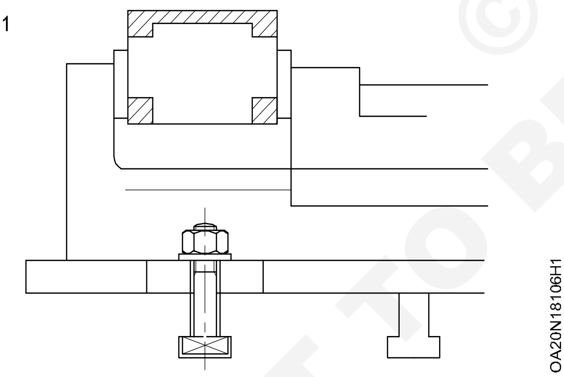


Job Sequence

Mount machine vice perpendicular to the column on a horizontal milling machine.

Mark the job as per drawing. Put witness mark on the lines (Fig 1)

Fig 1



Ensure that the workpiece projects sufficiently above the vice jaw to avoid damage to the vice jaw and resetting of the workpiece.

Select the suitable form and diameters of milling cutter having the same bore diameter.

Select and mount the long arbor on the horizontal milling machine.

Keeping in view the drawing and dimensions, hold the cutter on the machine.

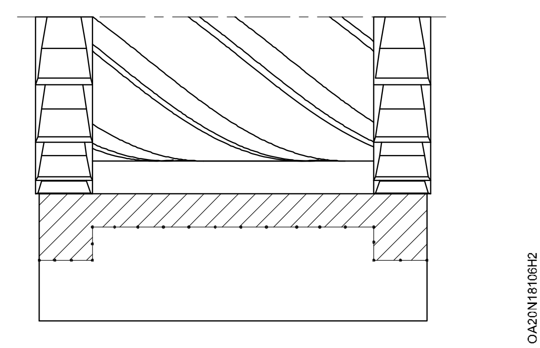
Calculate the speed and feed for gang milling.

Consider the average diameter for calculating the c.p.m

Set a lower range of r.p.m for gang milling.

Set the daturn to the reference sides for the vertical and cross- slides (Fig 2)

Fig 2



1	125 x 45 x 85	–	Fe 310	–	–	1.8.106
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	GANG MILLING OPERATION WITH AN ACCURACY ± 0.02 mm				TOLERANCE ± 0.02 mm	TIME:
					CODE NO. OA20N18106E1	

Lock the cross slides. Clear the workpiece from the cutters by moving the longitudinal side to the left side.

Apply 2 to 3mm depth of cut using the vertical slide. Start the spindle and the coolant pump.

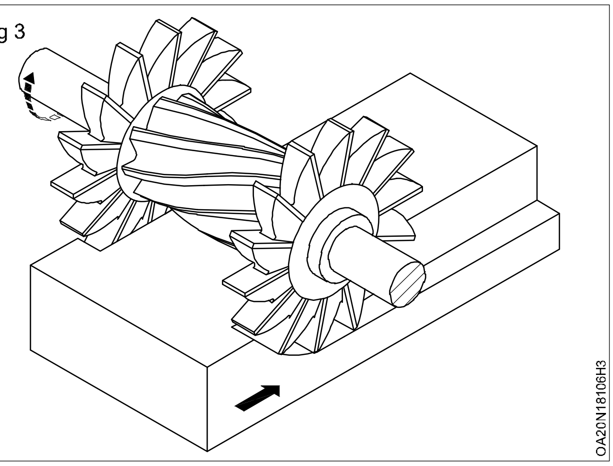
Move the longitudinal slide to bring the workpiece in contact with the cutter. Feed the workpiece slowly (Fig 3).

Use manual feed to avoid any jerks on the machine or cutter .See to it that sufficient coolant flows on the cutter to avoid plunting of the cutting edges.

After completion of the cut, stop the spindle.

Rewind the longitudinal slide to its original position .Apply another rough cut between 3 to 4 mm and complete roughing of the profile.By applying **0**.5 to 0.8mm depth of cut finish the profile.

Fig 3



For the finishing cut, use automatic feed to get a better surface finish at the profile.

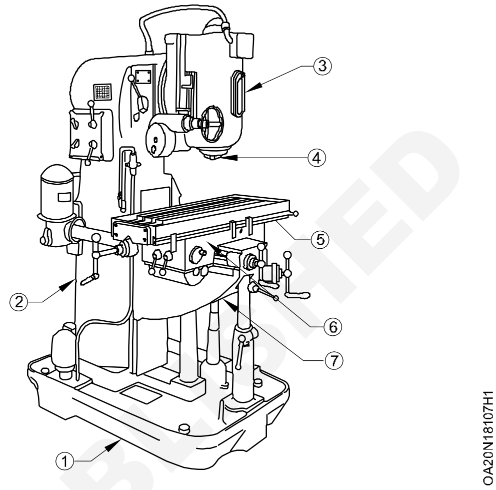
Milling hexagonal holes on a plate by attachment milling splines (external)

Objective: At the end of this exercise you shall be able to
- **making hexagonal holes by milling process.**

Job Sequence

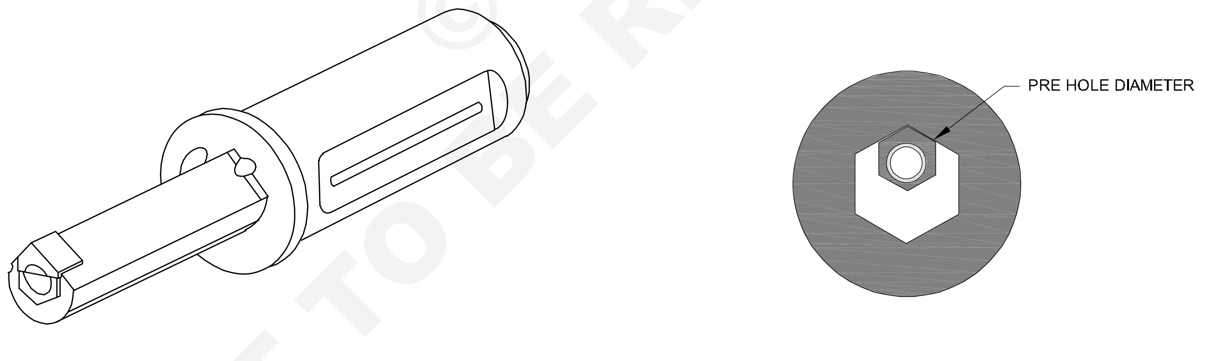
- Check the row material size
- Mark and punch the centre position of workpiece
- Clamp the work piece on the vertical milling machine.
- Align the centre of circle with the axis of spindle
- Lock the longitudinal and cross feed movement
- Set the spindle speed
- Hold the centre drill and drill the location
- Drill the pilot hole
- Finish the drill with hole diameter using relation hexagon thickness x 1.020
- Set the boring head with insert for hexagon.
- Set the spindle speed
- After few minute we get the hexagonal hole with required hexagonal size

Fig 1



- Various insert size available to execute various hexagonal size
- Absolute ascentricity is maintained by using internal hexagonal hole insert

Fig 2



Milling gear by both simple and differential indexing

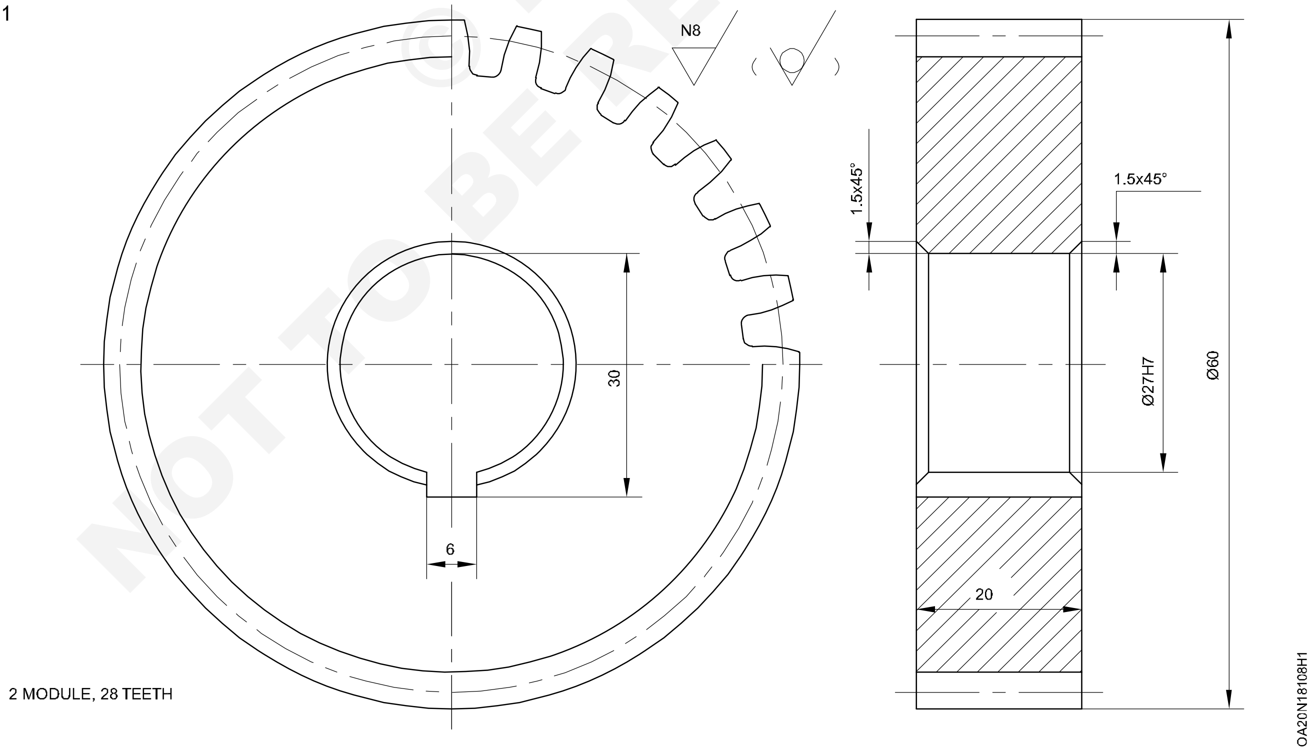
Objective: At the end of this exercise you shall be able to

- **mount and align the universal index head on a plainmilling mathing**
- **set index head for simple indexing**
- **cut the gear on the gear blank**
- **check the chordal addendum with a vernier tools caliper.**

Job Sequence

- Turn the given C1 blank to required diameter in lathe.
- Drill a hole in the blank of diameter equal to mandrel size.
- Fix the blank between two centre of the dividing head using mandrel.
- Set the milling cutter on the machine spindle and select the suitable speed.
- The cutter is centered accurately with the gear blank.
- Raise the table vertically up until blank touches the cutter.
- For giving depth of cut, the table is raised till the periphery of the gear blank just touches the cutter.
- The micrometer dial of vertical feed screw in set by zero in the position.
- Then the table is raised further to give the required depth of art.
- According to index calculation set the dividing head.
- More the index arm on the index plate according to the calculated number of holes.
- Switch on the spindle and feed the blank against the rotating cutter by reciprocating the table.
- Then the gear blank is indexed for the next tooth space.
- Then is continued till all the gear teeth an cut.

Fig 1



Skill Sequence

Calculation of external diameter & depth of cut

Objective: This shall help you to

- **making hexagonal holes by milling process.No. of teeth (z) = 28**

module (m) = 2 mm

external dia of blank = (z+2) m

= (28+2)2

= 60 mm

Depth of cut = 2.25 x m

= 2.25 x 2

= 4.5 mm

Indexing

crank rotation = $\frac{40}{z} = \frac{40}{28}$

$= 1\frac{12}{28}$

Brown and sharpe index plate

Plate 1	15-16-17-18-19-20
Plate 2	21-23-27-29-31-33
Plate 3	37-39-41-43-47-49

Simplify in accordance with the holes available in the 3 plates (choose from plate 1 to plate 2).

$1\frac{12}{28} = 1\frac{3}{7} = 1\frac{3x3}{7x3}$

$= 1\frac{9}{21}$ (plates 2)

One complete turn of the index crank and lock the pin in a 9 hole of 21 hole circle.

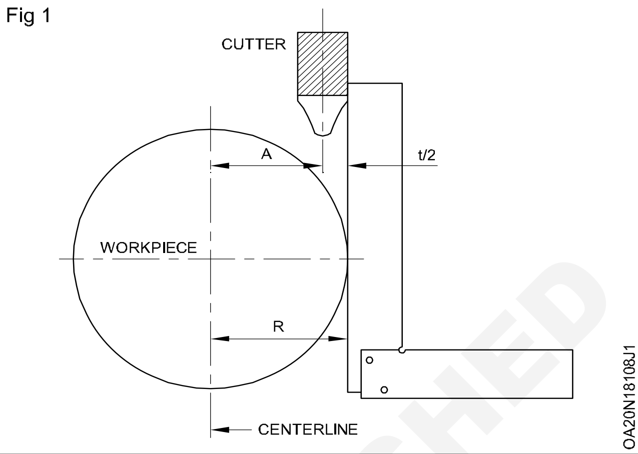
Centralize the cutter

Centralize the gear blank with respect to the cutter centre using a try square and cross feed screw as shown in Fig calculation A using relation A= R – $\frac{t}{2}$

Where R is the Radius of blank and T in the thickness of cutter

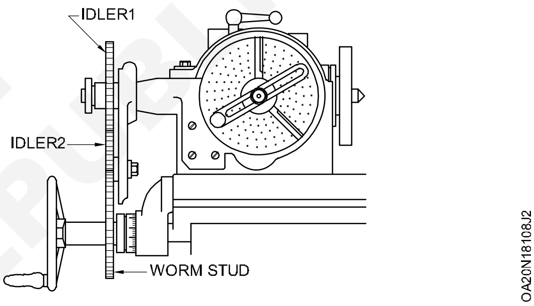
By moving the cutter to a distance of A you can centralize the cutter with blank.

Fig 1



Index for a combination of full and part turn of the index crank

Fig 2



One turn of the index crank will cause the worm to make one complete turn. This causes the worm wheel to advance one tooth. As there are forty teeth in the worm wheel, an advance of one tooth is equivalent to rotating the worm wheel one – fortieth (1/40) of a turn. If the index crank is given forty turns, the worm wheel will make one complete revolution.

The worm wheel is attached to the main spindle. When the index crank is given forty turns, the worm wheel, with the spindle attached, will make one complete revolution. If it were necessary to have the spindle revolve a half (1/2) turn, or to divide the rotary motion of the spindle into two divisions, it can be seen that only twenty turns of the crank would be required for each division.

Let us assume again that the spindle is required to make two half turns, or two divisions. In this case, the crank would be given twenty turns for each of the divisions. What happened was this : when two divisions of the spindle were required, the number of teeth in the worm wheel, which is forty, was divided by the number of divisions required.

$\frac{40}{2} = 20$

The rule, then is to divide the number forty by the number of divisions required.

The formula is written in this form:

The number of turns of the crank = 40/number of divisions required

If the number of turns of the crank is represented by the letter “N” and the number of divisions is represented by the letter “D” the rule can be written as follow:

$$N = \frac{40}{D}$$

Frequently, the number of divisions required does not divide equally into the number forty as, for example, six divisions

$$N = \frac{40}{6} \quad , 6\frac{4}{6}$$

Six complete turn of the index crank and four-sixths (4/6) of a turn are required.

It is for the purpose of calculating partial turns of the index crank rapidly and accurately that the index plate is provided. The fractional part of the turn should first be reduced to two-thirds (2/3). The next step is to find on the index plate a circle of holes that is divisible by three. There are several circles of holes on the index plate that are divisible by three such as twenty-four, thirty or thirty-nine holes.

Assuming that the twenty-four-hole circle is selected, we know that two-thirds of twenty-four is sixteen (2/3 of 24 = 16). Therefore, sixteen holes in the twenty-four hole circle is sixteen twenty-fourths (16/24) or two-thirds (2/3).

Indexing for six divisions then would be six complete turns of the index crank and sixteen holes in the twenty-four-hole circle.

Select plate1 if the Brown and Sharpe dividing head is used

SETTING THE SECTOR ARMS

1 Select a circle of holes that is divisible by three. As a twenty-four hole circle was used in a preceding problem, use this circle of holes.

2 Set the index pin so that it is opposite the hole marked 24 in the twenty-four hole circle. adjust the index crank so the index pin is aligned with a hole.

3 Place the index pin in a hole in the 24 hole circle.

4 Move the sector around so that the beveled edge of one arm is on the left-hand side of the pin (Fig).

5 Count off to the right (starting with the hole next to the pin) sixteen holes in the circle.

6 Loosen the set screw, and set the second arm of the sector so that the sixteen holes lie in the larger space between the arms.

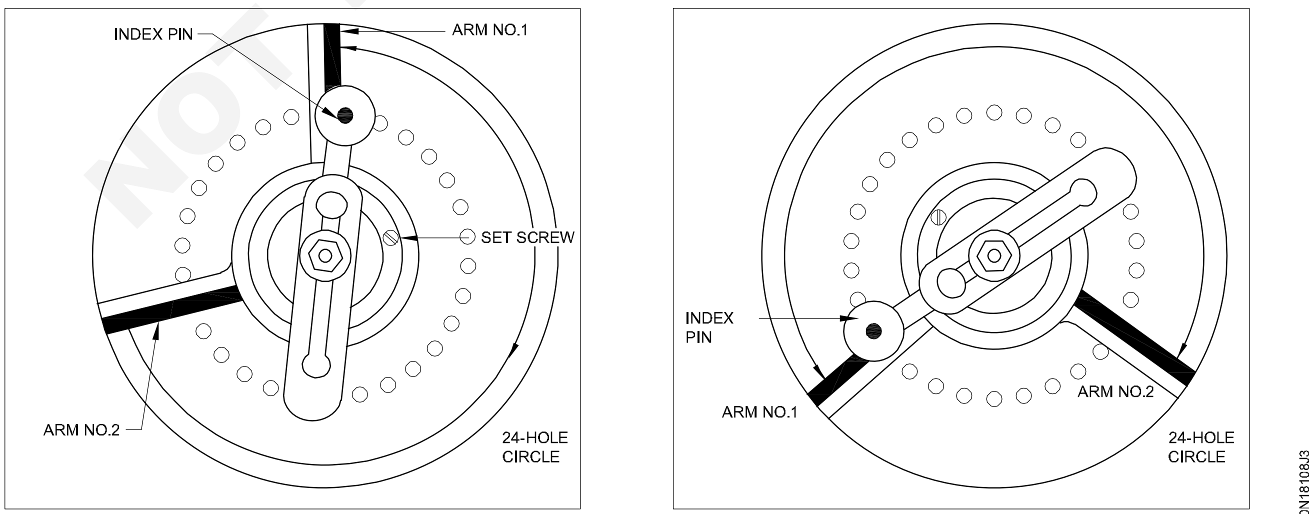
7 Tighten the set screw so that the sector arms retain their relative positions.

8 Check the setting of the sector arms.

CAUTION: There must be sixteen open holes between the sector arms. The hole which the pin occupies does not count (Fig). The purpose of the sector arms is to do away with counting the holes for each setting, thereby saving time and avoiding errors.

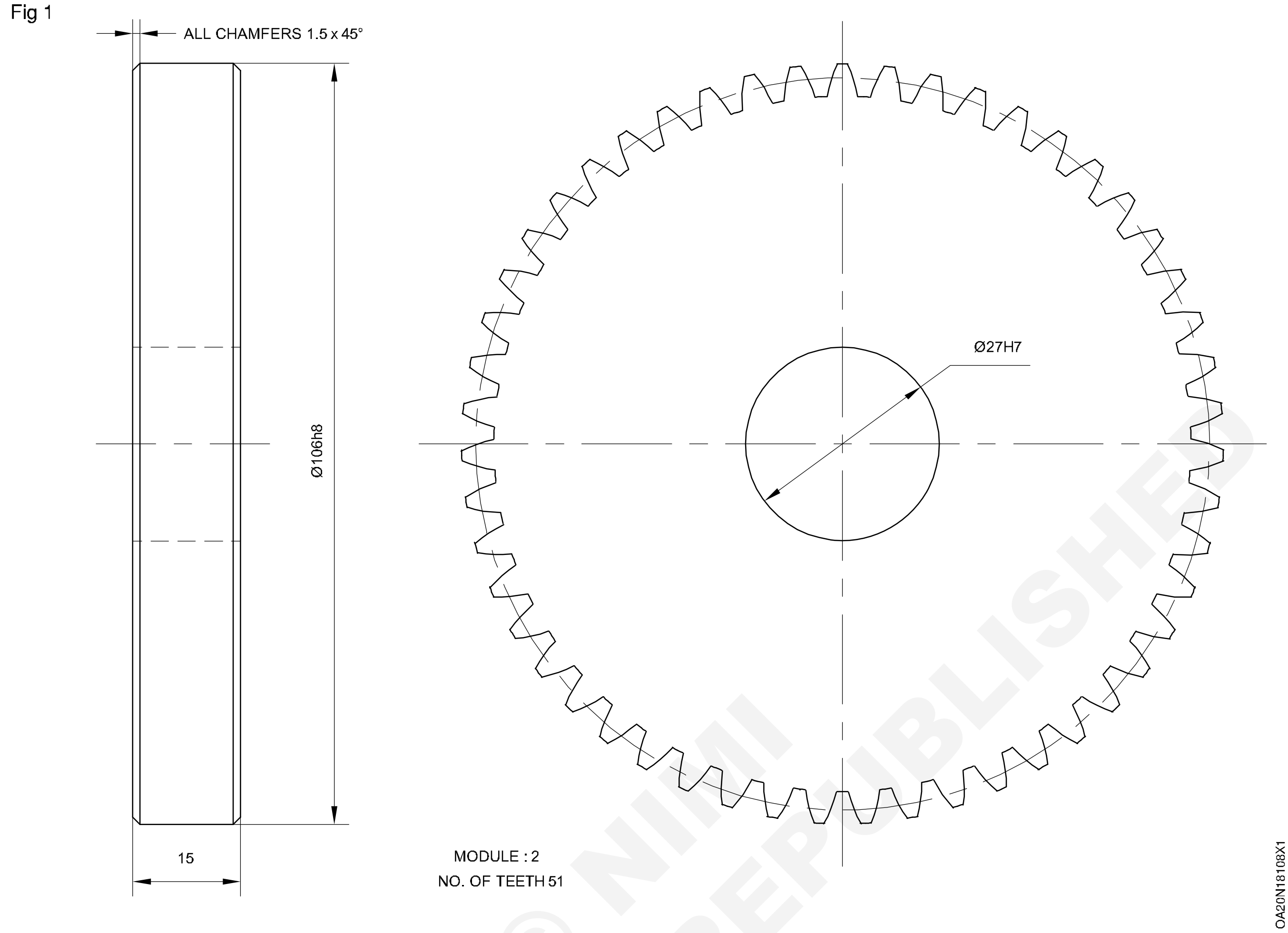
9 Withdraw the index pin. Index for the next division by giving the index crank six complete turns and sixteen holes in the twenty-four hole circle.

Fig 3



10 Insert the index pin in the hole of the new position and lock the spindle.

Fig 1



11 Revolve the sector arms to the right for the next setting by placing the finger on arm No. 1 and moving it around to touch the pin in its new position (Fig).

CAUTION: If arm No. 2 is used to revolve the sector, there is a possibility of spreading the sector arms by allowing arm No. 1 to strike the index pin. If the arms are accidentally spread enough to include another hole in the circle the indexing is incorrect.

Task 2 : **Differential index**

Calculation of External dia & Depth of cut

OD= m (z+2)

= 2 (51+2)

= 2 x 53

= 106 mm

Depth of cut = 2.25 x m

= 2.25 x 2

= 4.5 mm

For differential indexing gear are to inserted in gear arm of universal indexing

gear ratio = $A - N \frac{40}{A}$

Where A is assumed teeth , A = 48

$= (48 - 51)\ \frac{40}{48}$

$= -3 \times \frac{40}{48}$

$= \frac{-3 \times 24}{1 \times 24} \times \frac{40}{48}$

$= \frac{-72}{24} \times \frac{40}{48}$

Multiflication factor may be in according with available gear

Driver gear 72, 40

Diver gear 24, 48

(A – N) is negative one idler gear is used .

Index crank movement = $\frac{40}{A} = \frac{40}{48} = \frac{10}{12} = \frac{5}{6}$

Plate 1, 6x3, 18 holes available

therefore $\frac{5x3}{6x3} = \frac{15}{18}$

crank should more 15 holes in 18

Circle measure gear width and depth using gear tooth vernier refer Job sequence and Skill sequence exercise spur gear simple indexing.

Fig 2

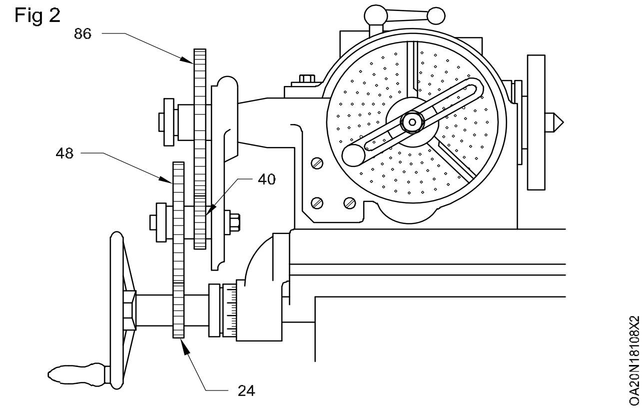
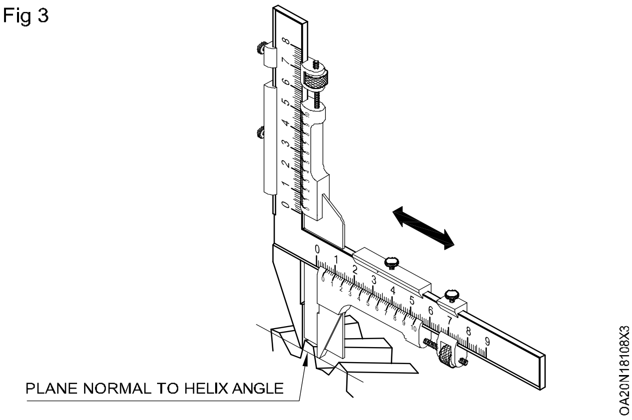
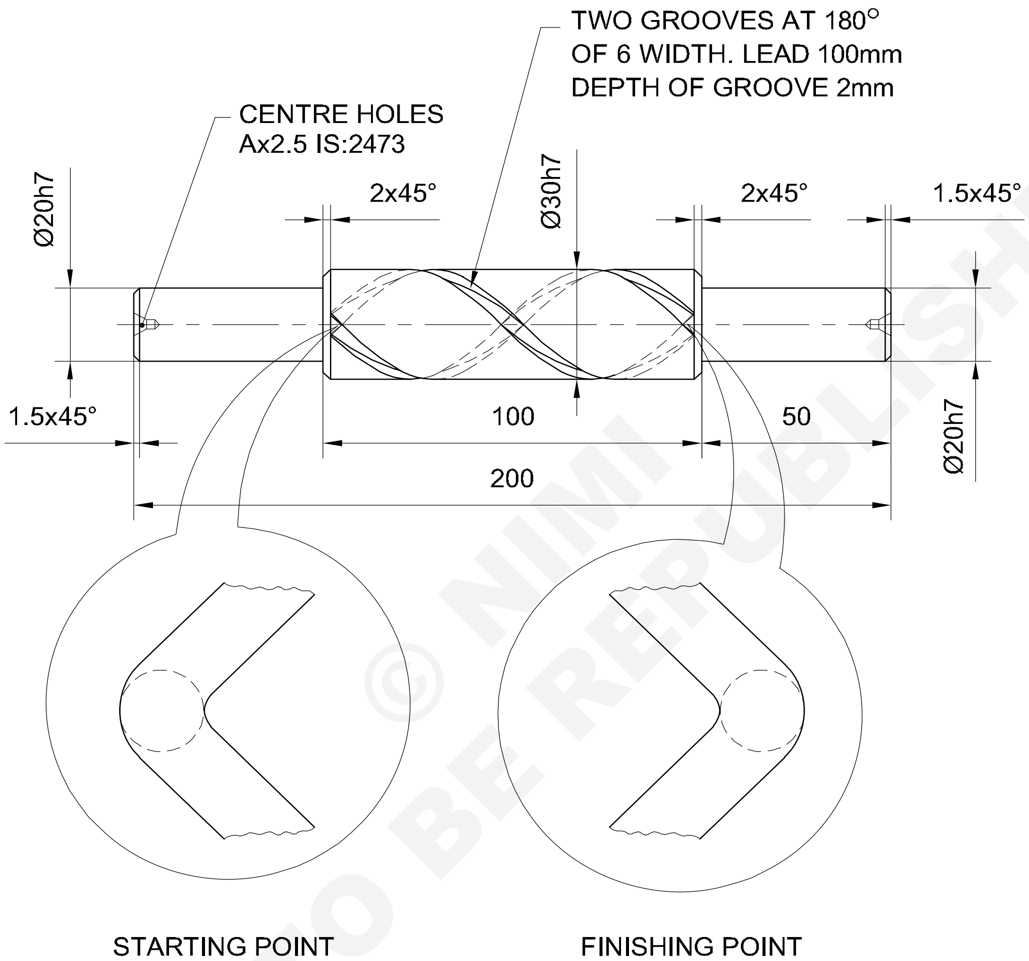


Fig 3



Helical Milling – Milling helical groove on vertical milling machine by end mill cutter.

Objective: At the end of this exercise you shall be able to
- **prepare vertical milling for milling helical groove**
- **mill helical groove on the job using end mill cutter.**



1	-	-	TU-2-13 ←	-	-	1.8.109
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MILLING HELICAL GROOVE USING ENDMILL / SLOT DRILL**	DEVIATIONS ±0.06	TIME 5Hrs
		CODE NO. OA20N18109E1	

Job Sequence

Turn the given CI blank to the required diameter in a lathe

Mount the job between centre and fix the job in the driving bracket

Align the end mill to the centre of job. Adjust the table position at the starting point.

Arrange a gear brain for 100 mm lead of helix and for right hand helix.

$$\text{gear ration} = \frac{\text{Machine lead}}{\text{Job lead}}$$

machine lead = 40 X pitch

= 40 X 5 = 200

Job lead = 100 (given)

$$\text{gear train} = \frac{200}{100} = \frac{20}{10}$$

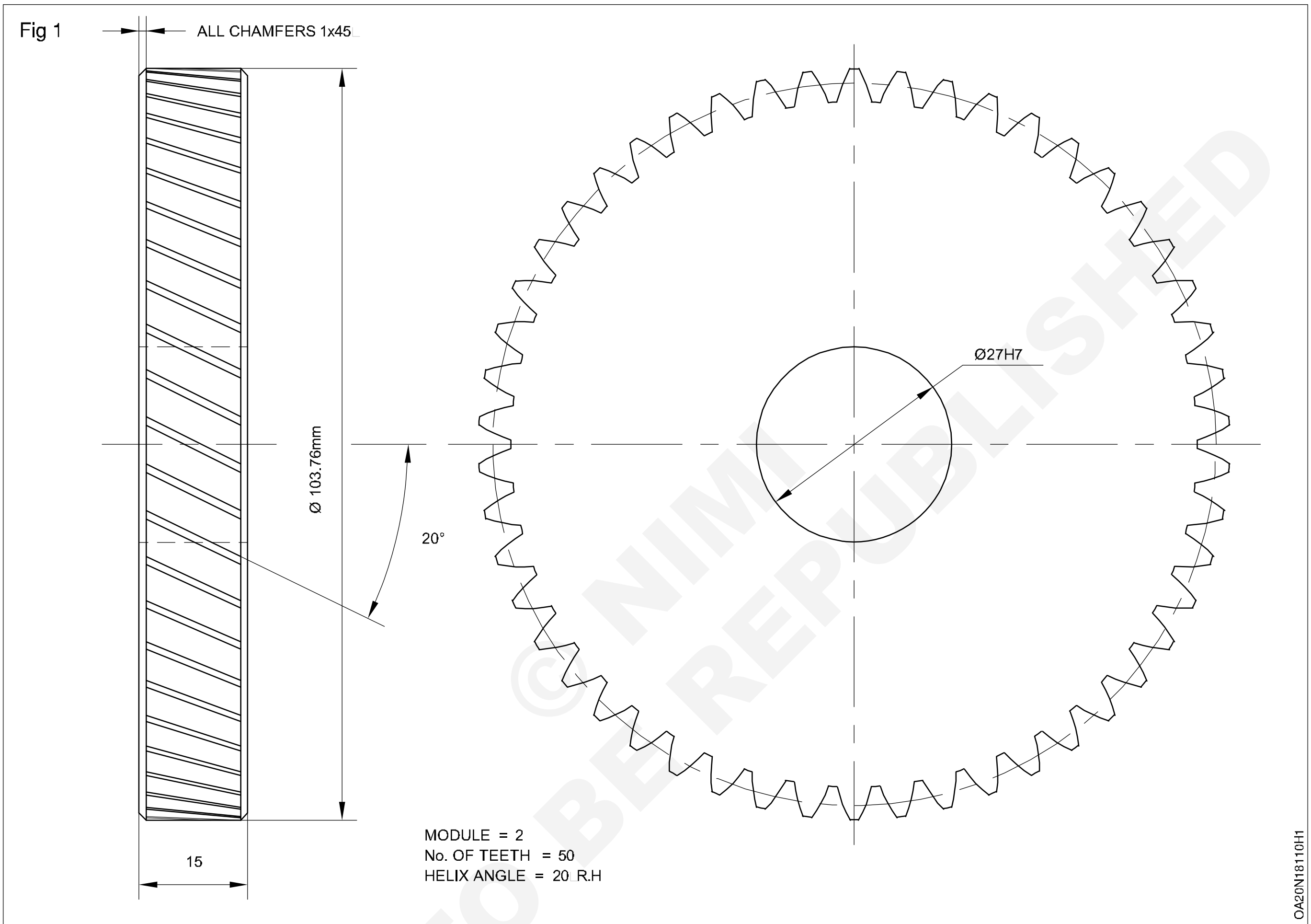
$$= \frac{2x24}{1x24} \times \frac{10x3}{10x3}$$

$$= \frac{48}{24} \times \frac{30}{30}$$

- There is no need to swivel the table for the helix angle.
- Back stopper pin is disengaged from the index plate.
- Set the spindle speed to suit the 6mm dia end mill.
- Start the machine spindle. Apply depth of cut 2mm gradually.
- Feed the wrone piece slowly by turing the index crank of the index head. No need for index hole pin positioning.
- Mill the right hand helical groove upto the finishing point.
- Adding one ideler in the gear train for milling left hand helix.
- Same procedure followed as for right hand helix grooving.
- Stop the machine spindle, remove the job and deburr helical groove using smooth flat file.

Milling helical gears

Objective: At the end of this exercise you shall be able to
- **set the universal dividing head for helical gear milling using compound gear train**
- **swivel table according to the helix angle**
- **mill the helical teeth to the desired depth.**



Job Sequence

- Turn the given CI blank to required diameter in lathe.
- Drill a hole in the blank of diameter equal to mandrel size.
- Fix the blank between two centre of the dividing head using mandrel.
- Set the milling cutter on the machine spindle and select the suitable speed.
- The cutter is centred accurately with the gear blank.
- Raise the table vertically up until blank touched the cutter.
- For giving depth of cut the table is raised till the periphay of the gear blank just touched the cutter.
- The micrometer dial of vertical feed screw is set to zero in the position.
- Then table is raised further to give the required depth of cut.
- According to index calculation set the dividing head and also set the compound gear train as per gear ratio.
- Move the index arm on the index plate according to the calculated number of holes.
- Switch on the spindle and feed the blank, against the rotating cutter by reciprocating the table.
- Switch the table to 20° for input hand helix.
- Then the gear blank is indexed for next tooth space.
- This is continued till all the gear teeth are cut.

Skill Sequence

Indexing after helical gear cutting

Objective: This shall help you to

- **calculate for crank rotation cutting teeth**

calculation of helical blank

module = 2

no. of teeth Z = 50

Helix angle = 20° RH.

Normal module nm = m x cos θ

= 2 x 0.9396

= 1.8792

OD = pd + 2nm

$$pd = \frac{Z\,X\,nm}{\cos\theta} = \frac{50 \times 1.8792}{0.9396}$$

= 100mm

OD = (100 + 2 x 1.8792) = 103.7584 mm

Teeth depth = 2.25 x nm

= 2.25 x 1.8792 = 4.2282 mm’

$$\text{Gear ration} = \frac{\text{Machine lead}}{\text{Job lead}}$$

Machine lead = 40 x pitcle of the lead screw.

Assume pitch = 5nm.

= 40 x 5 = 200 mm

$$\text{Job lead} = \tan\beta = \frac{\pi d}{l}$$

$$l = \frac{\pi d}{\tan\beta}$$

$$= \frac{3.142 \times 100}{\tan 20°} = 863.4L$$

Job lead = 860 (nearest rounded off)

$$\text{Gear ration} = \frac{\text{Machine lead}}{\text{Job lead}}$$

$$= \frac{200}{860} = \frac{20}{86} = \frac{1x20}{2x43}$$

$$= \frac{1x24}{2x24} \times \frac{20x2}{43x2}$$

$$= \frac{24}{48} \times \frac{40}{86}$$

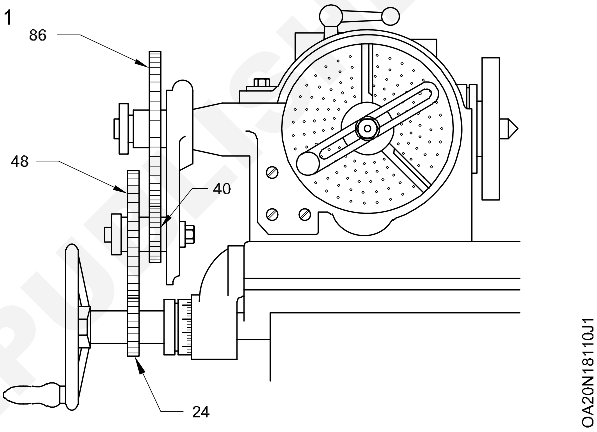
The gear 24,40 are driver gear and 48,86 are driver gear

$$\text{Indexing crank rotation} = \frac{40}{z} = \frac{40}{50}$$

$$= \frac{4x4}{4x5} = \frac{16}{20}$$

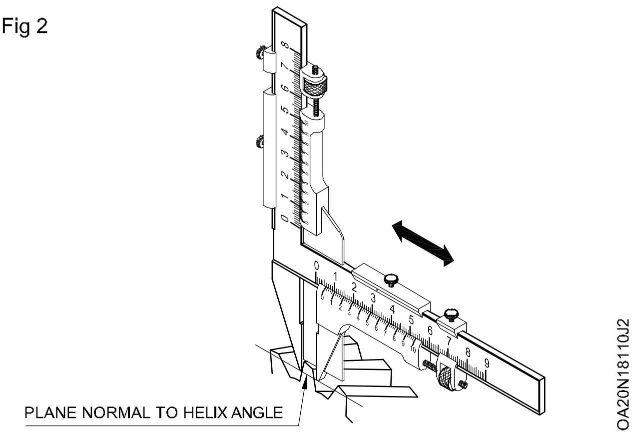
Therefore . The index crank should be moved it holes in 20 hole circle for 1 teeth cutting.

Fig 1



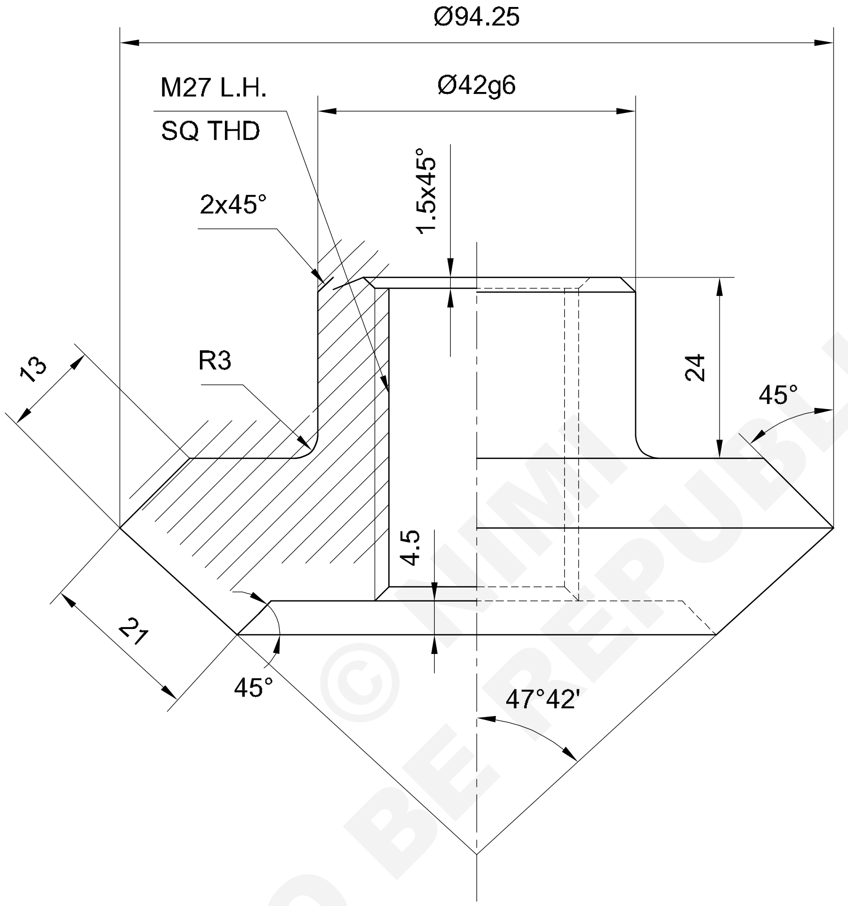
Measure gear teeth width and depth using gear teeth vernier.

Fig 2



Milling bevel gears

Objective: At the end of this exercise you shall be able to
- **calculate the essential data for milling teeth on bevel gear**
- **set dividing head as per requirement**
- **cut the bevel gear teeth step by step.**



MODULE	- 3	OUTSIDE DIAMETER	- 94.25
PRESSURE ANGLE	- 20°	CONE DISTANCE	- 63.64
NUMBER OF TEETH	- 30	FACE WIDTH	- 21.00
ANGLE OF SHAFT	- 90°	FACE ANGLE	- 47°42'
PITCH CONE ANGLE	- 45°	ROOT ANGLE	- 41°38'
PITCH DIAMETER	- 90	CUTTER NUMBER	- 3

1	-	1.8.111 ←	-	-	-	1.8.111
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MILLING TEETH ON BEVEL GEAR (STRAIGHT TOOTH)**	DEVIATIONS ±0.05	TIME 10h
		CODE NO. OA20N18111E1	

Job Sequence

- Turn the given C.I blank to required size in lathe.
- Fix the blank in a M-T shank mandrel and the mandrel into the spindle of the index head.
- Tilt the spindle of the dividing head to 41'38' (Fig 1) root angle of bevel gear.
- Select and set the bevel gear cutter 3, Module 3 and mount it on the arbor.
- Centralise the job with respect to the cutter. Lock the cross feed and set graduated collar at 'O' when the cutter touches at the larger end of bevel gear (Fig 1)
- Apply a depth of cut 4mm and rough out all the teeths.
- Set the depth of cut at the large and to 6.75mm. Lock the vertical feed.
- According to the index calculuation & set the dividing head.
- Move the index arm on the index plate according to the calculated number of holes (one complete trank rotation and 11 holes in 33 hole circle).
- Mill the IST tooth space.
- Mill the second tooth space after rotation of crank pin $1\frac{11}{33}$
- Check the form and measure thickness at both end of the tooth by gear tooth vernier caliper.
- Determine the excess material at layer end to be trimmed of by offset methods.
- Repeat the step and mill all the teeth .
- Correct and mill all the 30 teeth.

Skill Sequence

Indexing for bevel gear

Objective: This shall help you to

- **calculate for crank rotation for cutting bevel teeth**

Calculation of Indexing

$$\text{Crank rotation} = \frac{40}{z} = \frac{40}{30}$$

$$= 1\frac{1}{3} = 1\frac{1\text{x}11}{3\text{x}11}$$

$$= 1\frac{11}{33}$$

Crank are complete rotation and 11 holes in 33 hole circle.

Selection of cutter

Bevel gear cutters have a curve of cutting edge is right for the larger end of the tooth, but they are thinner than spur gear cutters because they pan through the space at the smaller end of the tooth (Fig 2)

Bevel gear cutter is not selected for the number of teeth in the bevel gear.

Rule

Number of teeth for which to select the cutter for bevel

$$\text{gear} = \frac{\text{Number of tooth on bevel gear}}{\text{cosine of pitch angle}}$$

This number will be always more than the actual number of teeth on the bevel gear to be cut

$$\frac{N}{\cos 45} = \frac{30}{0.707} = 42.$$

Select cutter number from chart of required module/Dp based on 42 teeth

Set the index head for indexing refer skill sequence spur gear cutting.

IST offset (Trimming) (Fig 3)

$$\text{IST offset} = \frac{C - F}{C} \text{ X } \sin\frac{90°}{N}$$

where C = Cone distance

F = Face width

N = Number of teeth on bevel gear

IST angular movement of the gear blank = $\frac{90°}{N}$.

Off set the table to the amount calculated. Then the side of the tooth of the smaller end.

Fig 1

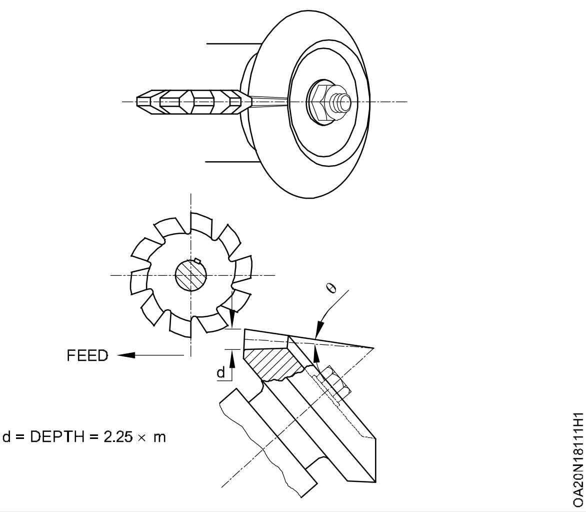


Fig 2

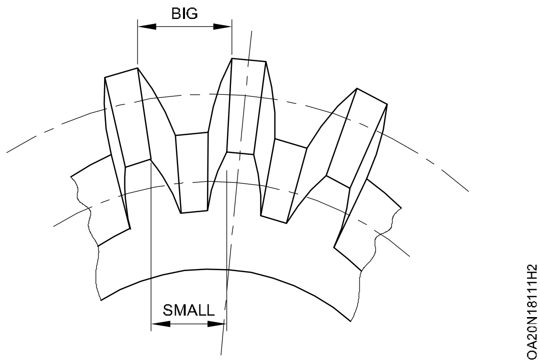
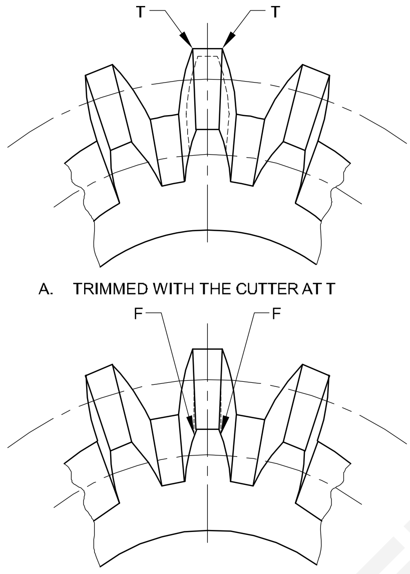

BIG
SMALL
OA20N18111H2

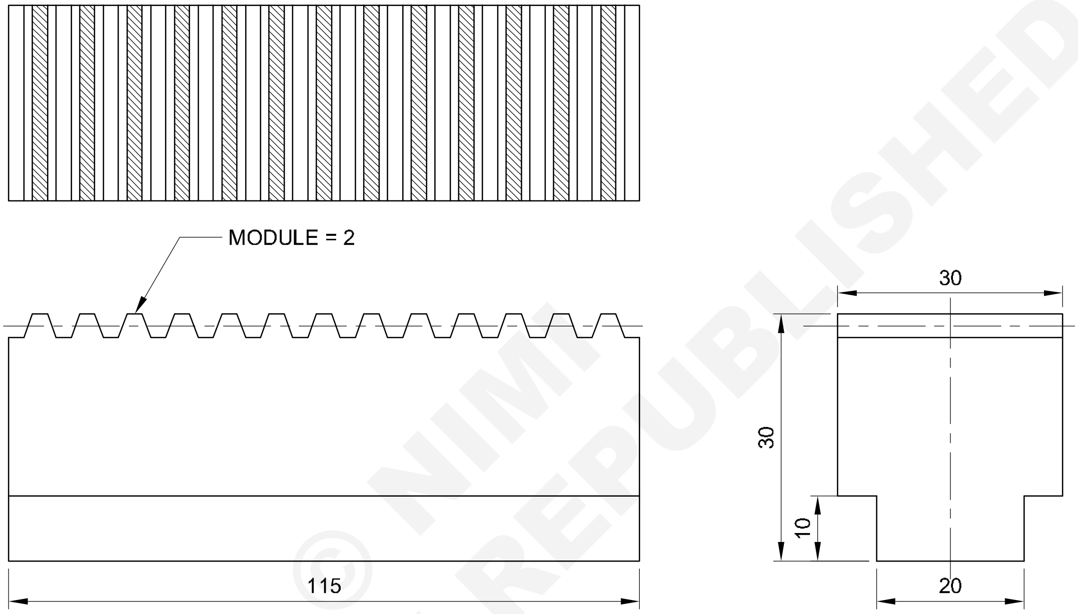
Fig 3


T
T
A. TRIMMED WITH THE CUTTER AT T
F
F
B. FILED TO CORRECT CURVE AT T
OA20N18111H3

Milling a rack

Objective: At the end of this exercise you shall be able to
- **mill the rack blank as per drawing**
- **calculate the rack proportions**
- **set the cutter in the arbor**
- **prepare the milling machine for linear indexing**
- **mill the rack using linear indexing.**

TASK - 1



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	ISSQ 32-120	-	Fe310	-	-	1.8.112

SCALE 1:1	MAKE STRAIGTH TEETH RACK USING MILLING MACHINE WITH AN ACCURACY ±0.05MM	DEVIATIONS ±0.2	TIME 10Hrs
		CODE NO. OA20N18112E1	

Job Sequence

- Calculate the required rack proportions for a 2 module straight tooth rack.

  whole depth = 2.25 x m

  = 2.25 x 2 = 4.5 mm

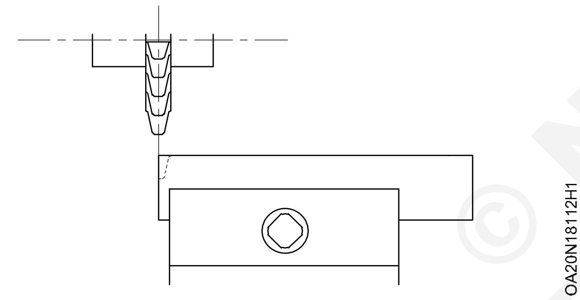
  Linear pitch = x m

  = 3.14 x 2

  = 6.28 mm.

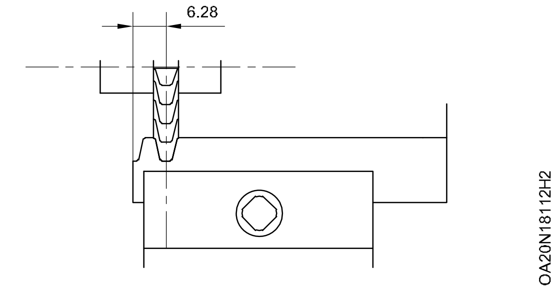
- Mill the rack blank to the given dimension as per the drawing.
- Clean the machine table and mount the machine vice keeping the jaws perpendicular to the machine column.
- Align it with dial test indicator.
- Clamp the job such that it projects 10 mm above the jaw surface.
- Mount the 2 module rack cutter at the middle of the arbor.
- Bring the job under the cutter such that the centre of the cutter form is aligned to the edge of the job. (Fig 1)

Fig 1



- Eliminate the backlash, adjust the graduated collar of the cross – slide and the elevating screw to zero.
- Start the machine and mill the initial portion of the rack to a depth of 4.50 mm in two steps; 3 mm for the roughing cut and 1.5 mm for the finishing cut.
- Clear off the job from the cutter and stop the machine.
- Slide the job using a cross – slide to a pitch distance of 6.28 mm and reset the collar again to zero. (Fig 2)

Fig 2

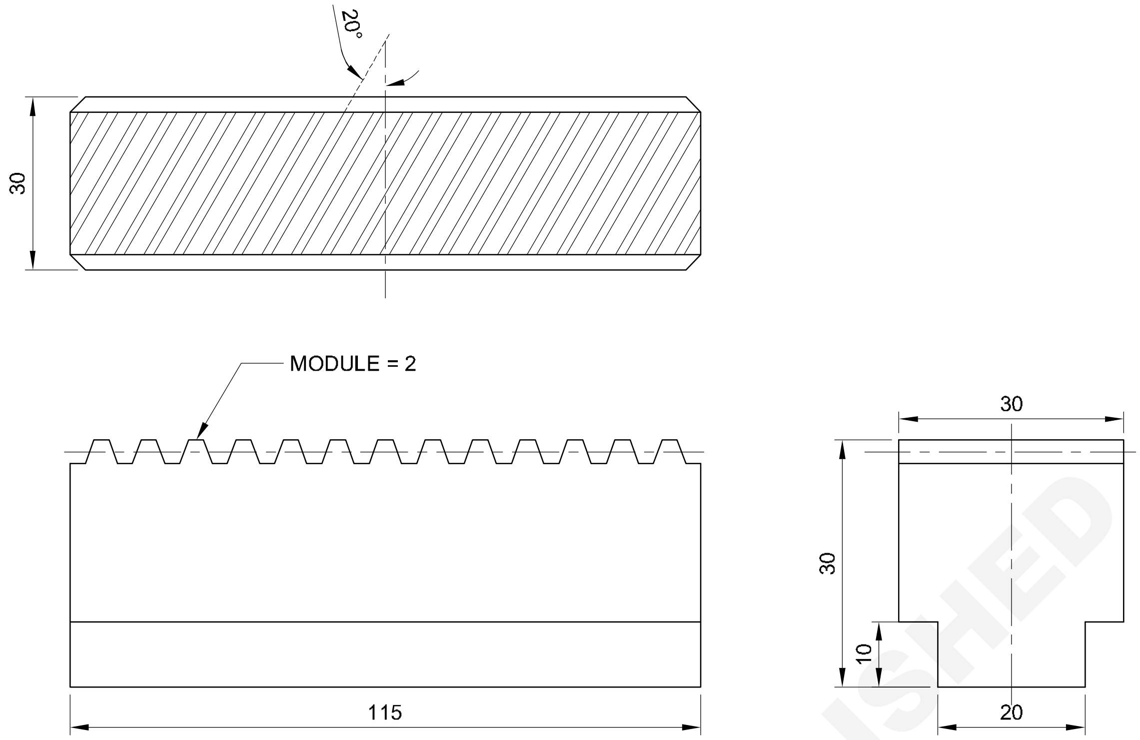


- Start the machine and mill the next tooth.
- Repeat the above sequence and mill the remaining rack teeth over the entire length of the job.

Rack milling using rack milling attachment

- Calculate the required rack proportions of a 2 module of straight tooth rack.
- Mount the machine vice parallel to column face and mount the job.
- Mount the rack cutting attachment.
- Prepare the milling machine for linear indexing with driver 72 teeth (index head spindle), driven 24 teeth (lead screw) and 20 hole circle plate.
- Mount the cutter number 1 on to the spindle of the rack cutting attachment.
- Position the job under the cutter for the first tooth space cutting. (The direction of table movement will depend on the number of idlers for the same rotation of crank).
- Give the depth of cut to 4.5 mm.
- Mill the first tooth space.
- Index for the next tooth space.
- Index the crank movement = 16 full turns and 15 hole in a 20 hole circle plate.
- Cut the second tooth space.
- Check the thickness of the tooth 3.14 mm, using a gear tooth vernier caliper.
- Repeat the process and finish the rack.

TASK - 2



Job sequence

Rack cutting

- Calculate the required rack proportions for a 2 module helical tooth rack.

  Whole depth = nm X 2.25 (nm – normal module)

  nm = m x cos α (module = m)
  =2 x cos 15°
  = 2 x 0.9659 = 1.93

Whole depth

= 1.93 x 2.25

= 4.34 mm

Linear pitch

=π x nm

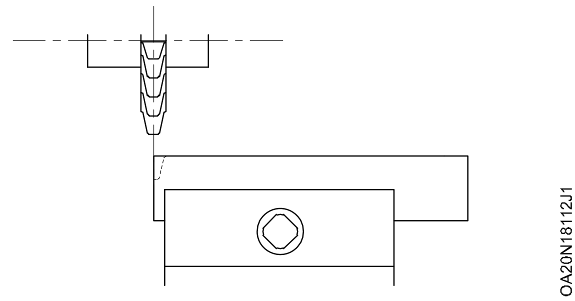
= 3.14 x 1.93 = 6mm

1	ISSQ 32-120	-	Fe310	-	-	1.8.112
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKE HELICAL TEETH RACK USING MILLING MACHINE WITH AN ACCURACY ±0.05MM ONE STRAIGHT RACK	DEVIATIONS ±0.2	TIME 10Hrs
		CODE NO. OA20N18112E2	

- Clean the machine table and mount the swivel machine vice keeping the jaws perpendicular to the machine column.
- Align it with dial test indicator.
- Swivel the vice 15° with respect to column.
- Clamp the job such that it projects 10mm above the jaw surface.
- Mount the 2 module rack cutter at the middle of the arbor.
- Bring the job under the cutter such that the centre of the cutter form is aligned to the edge of the job. (Fig 1)

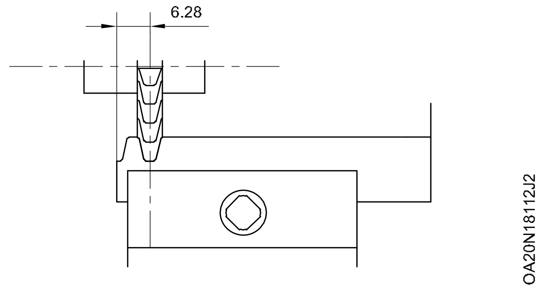
Fig 1



- Eliminate the backlash, adjust the graduated collar of the cross-slide and the elevating screw to zero.
- Start the machine and mill the initial portion of the rack to a depth of 4.34 mm in two steps; 3mm for the roughing cut and 1.34 mm for the finishing cut.

- Clear off the job from the cutter and stop the machine.
- Slide the job using a cross-slide to a pitch distance of 6.00 mm and reset the collar again to zero. (Fig 2)
- Start the machine and mill the next tooth.
- Repeat the above sequence and mill the remaining rack teeth over the entire length of the job.

Fig 2



Skill Sequence

Cutting rack teeth on universal milling machine using graduated dial

objective: This shall help you to

- **prepare machine for rack milling and cut rack teeth using graduated collar of cross-feed traverse.**

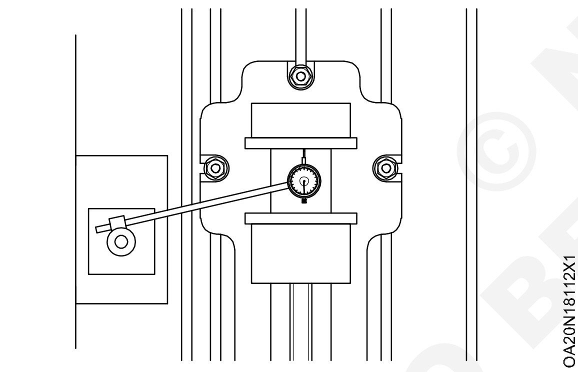
If length of rack to be cut is short (i.e. less than the max. travel of cross feed) it can be done on normal horizontal milling machine.

If it is more than the max. traverse of cross feed traverse it should be done using a rack milling attachment.

Mill rack on horizontal milling machine

Clamp the vice on the table in such a way that its jaws are parallel to the spindle axis, and align the fixed jaw with D.T.I. (Fig 1)

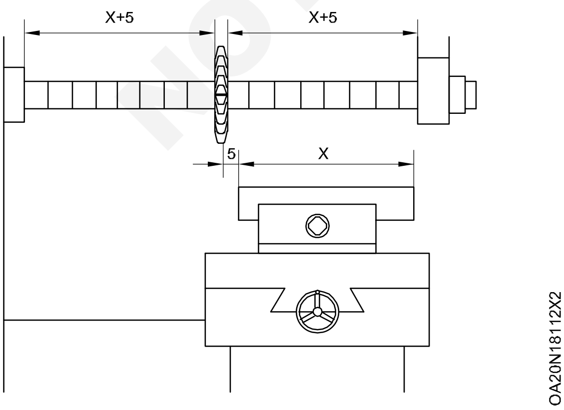
Fig 1



Take the table far away from the column.

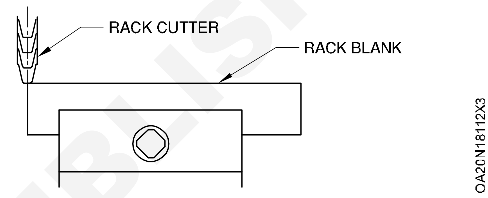
Mount the rack cutter (cutter No. 1) in the arbor in such a way that there is a 5 to 10 mm. gap between the job and the cutter. (Fig 2)

Fig 2



Set the datum (ie'O') on graduated dials of the vertical traverse and cross traverse, when the cutter is touching the job on the top and at the edge. (Fig 3)

Fig 3



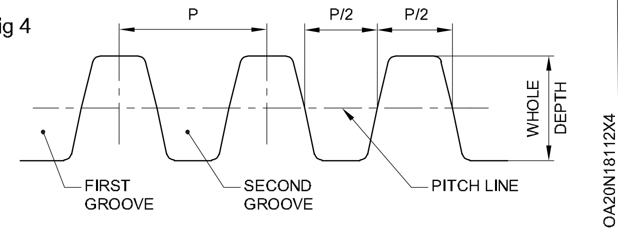
Apply depth of cut raising the knee.

Total depth of cut = 2.25 x m.

Cut a groove by feeding the job against the cutter horizontally as per pitch and depth. (Fig 4)

Move the cross-slide using a graduated dial by a distance, P = π X module, towards the column and cut the next groove.

Fig 4



Deburr the tooth and measure the tooth thickness on the pitch line using a gear tooth caliper.

Thickness = 1.5708 x m

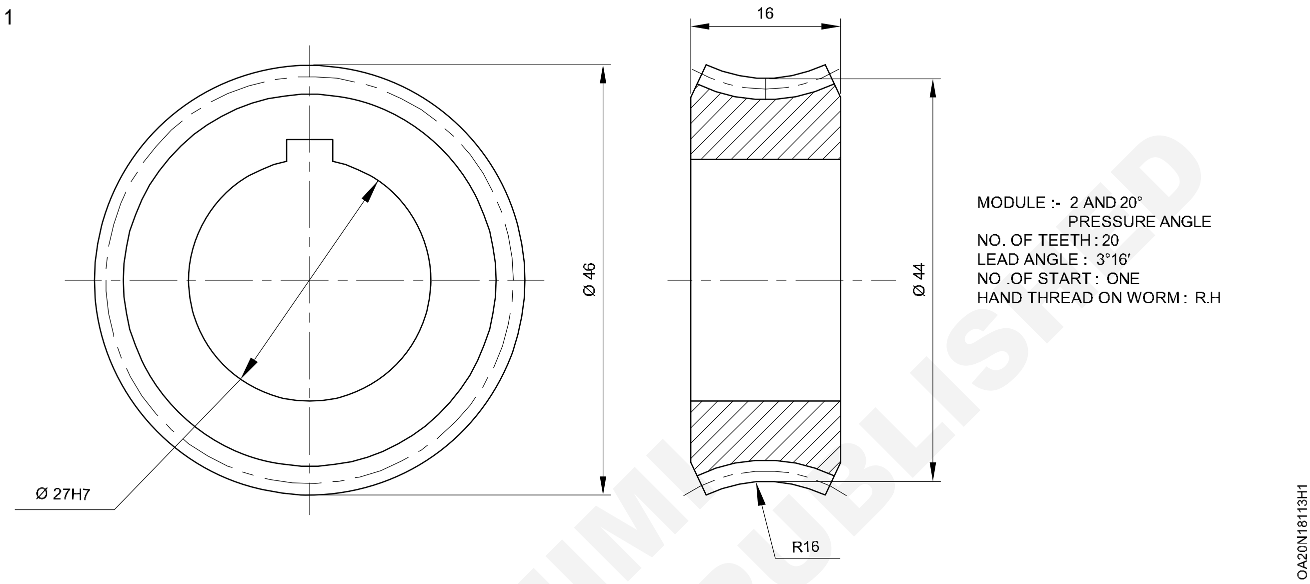
Make necessary correction in the depth of cut, if necessary.

Cut the remaining teeth.

Cutting worm and worm wheel on a milling

Objective: At the end of this exercise you shall be able to
- **mount a worm wheel blank on the mandrel between centre**
- **select the cutter suitable to the worm wheel**
- **mill worm teeth to the exact form.**

Fig 1

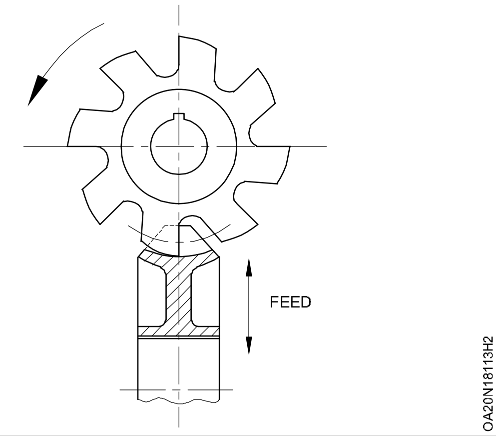


Job sequence

- Check the size of the blank-outside dia 46 mm throat area 44 mm and throat radium 16 mm.
- Fix the blank between two centre of the dividing head using mandrel.
- Mount a job between centre using a mandral
- Check run cut.
- Mount cutter no 6 of 2 module on the arbor.
- The cutter is centred accurately with the gear blank.
- Raise the table vertically up until blank touched the cutter.
- Swivel the table to 3'16' (3 '16') for right hand helix.
- According to index calculation set the dividing hand.

  Crank rotation = $\frac{40}{z} = \frac{40}{20} = 2.$
- Set the indexing head for indexing so teeth crank rotate 2 full turn.
- Switer on the spindle and feed the blank against the rotating cutter without moving the table horizontally (Fig 1)
- Only down movement, above not for table movement (linear)
- Mill one tooth space to a depth of 4.5 mm by playing the job gradually by using vertical feed.
- Then the gear blank in indexed for next tooth space.
- This is continued till all the gear teeth are cut deburr and finish the job.

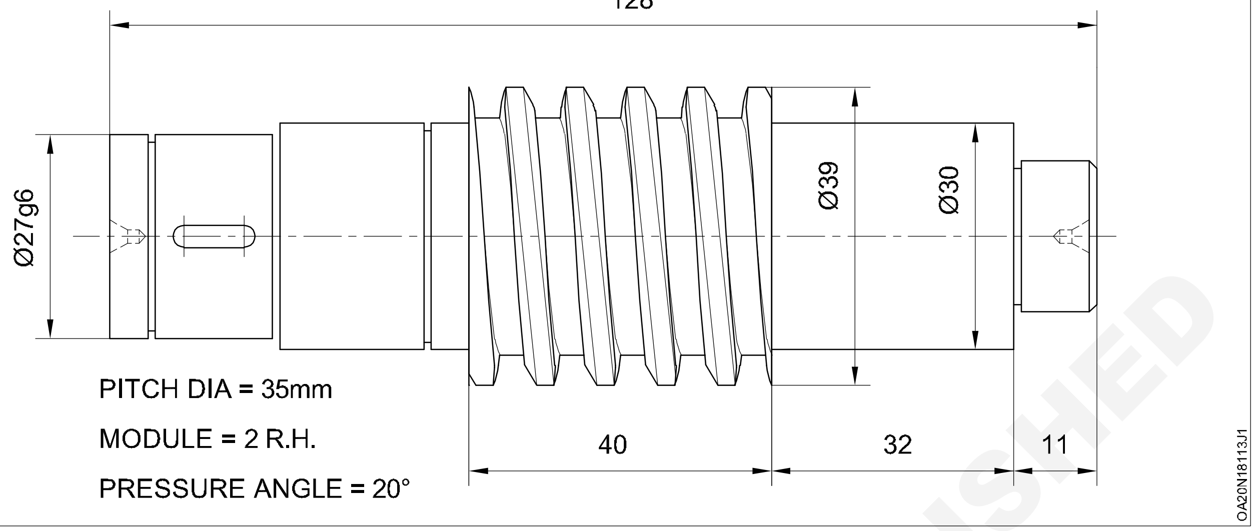
Fig 2



Cutting of worm on a milling

Objective: At the end of this exercise you shall be able to
- **arrange and set the dividing head using gear train for a required lead**
- **cut worm to the desired depth and lead.**

Fig 1



Job sequence

- Check the dia of worm blank dia 89 mm.
- Mount the job in between centre and align it.
- Centralize the job with respect to cutter.
- Mount the universal milling attachment into the spindle of a universal milling machine.
- Set the universal index head the table of the machine.
- Disengage the worm shaft from wheel of the index head by shifting the eccentric bush.
- This is essential to mill worm thread with short lead.
- Arrange gear train as per calculation.

$$\frac{\text{lead of machine}}{\text{lead of worm}} = \frac{5}{6.25}$$

$$= \frac{40}{100} \times \frac{64}{32}$$

- Set driver gears are 40,64 and driver gear and 100,32 in the gear train.
- Select and mount a gear cutter 2 module cutter no. 1 on the spindle of the attachment.
- Swivel the table or attachment of the machine to 3'15' for right hand helix.
- Give a depth of cut 4.5 mm by vertical feed.
- Feed the job longitudinally slowly gently and mill the worm thread.
- Debur the teeth with a smooth file.
- Check the thickness of the tooth by vernier gear tooth caliper

Familiarization with inspection and master gauge checking of finished product with limit gauges for their accuracy and usability.

Objective: At the end of this exercise you shall be able to
- **familiarize with inspection gauges**
- **importance of master gauge**
- **handling of limit gauge.**

Job Sequence

- To familiarize with inspection you know the following gauges.

  Standard gauges

  Limit gauges

  Indicating gauges

  Combination gauges

  Workshop gauges

  Inspection gauges

  Master gauge (or) Reference gauge

  Dimension meauring gauge

  Plug gauge and pin gauge

  Snap gauge

  Ring gauge

Limit gauges

- This gauge is used to measure a component by two limits one is high and another is low two gauges are go-gauge and no-go gauge.
- In production line for holes measurements we can not measure each parts with master gauge we use limit gauges for accuracy and time consuming.
- When inserting go gauge of limit gauge into a hole, go side entern and not go side not entern the dimension of hole is acceptable.
- These limits gauge can meaure more parts easily in the production line.
- The out side diameter of parts can be measured easily by snap gauge.
- Periodically the limit gauges are inspected by master gauge for dimenstional accuracy with in the tolerance.
- Hence master gauge is a reference gauge which measure all other gauges.
- Examples of master gauge one slip gauge dial vernier and dial micrometer etc.
- The limit gauges are deviated from their tolerance due to more usage of gauges and wear and tear due to rubbing of components. These gauges are replaced by inspection of master gauge.

Fig 1

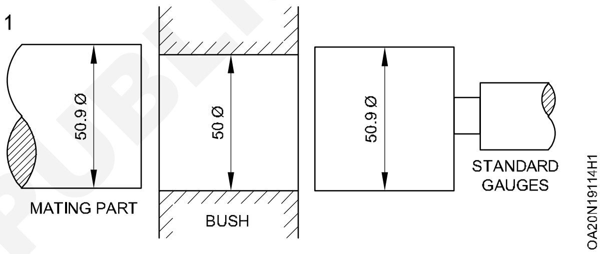


Fig 2

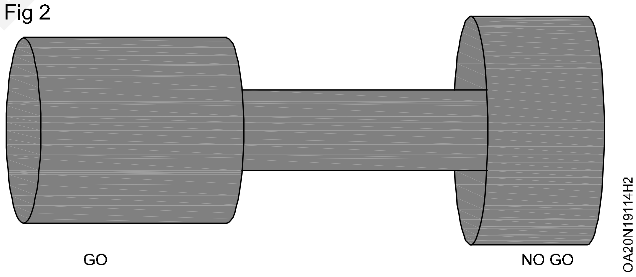


Fig 3

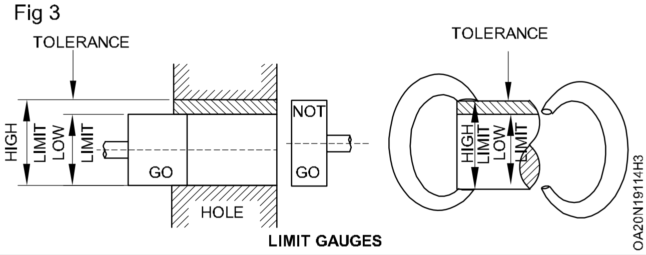
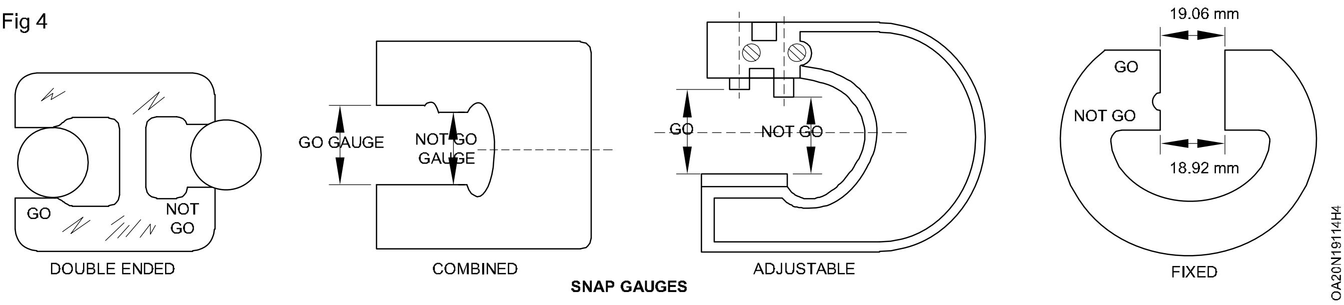


Fig 4



Use of sine bar, snip gauge along with standard balls and rollers for measurement of taper.

Objective: At the end of this exercise you shall be able to
- **set the required angle using slip gauges**
- **measure the taper angle of the given specimen using sine bar and slip gauges.**

Job Sequence

- The sine bar is made to rest on surface with rollers.
- Place the component on sine bar and lock it in position.
- Lift one end of the roller of sine bar and place a pack of slip gauge under the roller.
- Height of slip gauge should be selected such that the top surface of component is parallel to the surface plate.
- Calculate the inclination using relation $\theta = \text{Sin}^{-1}\frac{h}{l}$

  Where l is the Length of sine bar, and h is the height of slip gauge.
- Now to verify angle, bring the height gauge near the work piece and make the tip of dial indicator touch the dia of taper at one end make the dial reading as zero.
- Now dial indicator is moved parallel to the workpiece to the other end.
- If no deflection is observed in the indicator the angle is correct.

Skill Sequence

Determining taper using sine bar and slip gauges.

Objective: At the end of this exercise you shall be able to
- **determine correctness of a known angle**
- **calculate the height of slip gauges to a known angle.**

Sine bars provide a simple means of checking angles to a high degree of accuracy of not less than the one minute upto 45°

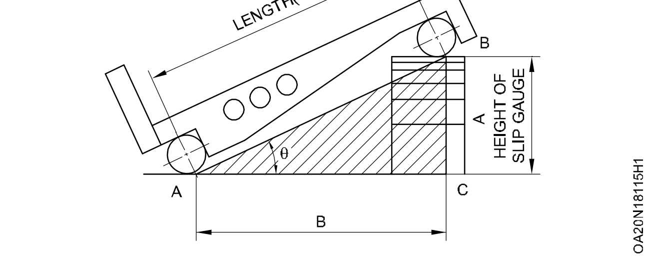
The use of a sine bar is based on trigonometric function. The sine bar forms the hypotenuse of the triangle and the slip gauges the opposite side.(Fig 1)

Checking the correctness of a known angle

For this purpose first choose the correct slip gauge combination for the angle to be checked.

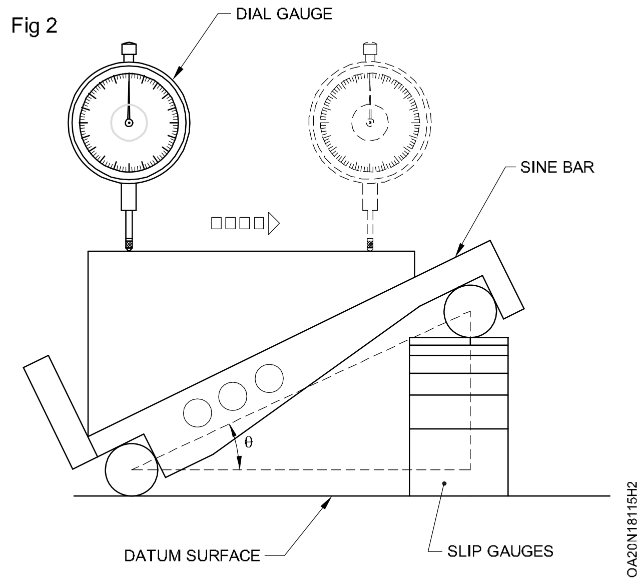
The component to be checked should be mounted on the sine bar aftr placing the selected slip gauges under the rollar. (Fig 1)

Fig 1



A dial test indicator is mounted on a suitable stand or vernier height gauge (Fig 2). The dial test indicator is then set in first position as in the figure and the dial is set to zero.

Fig 2

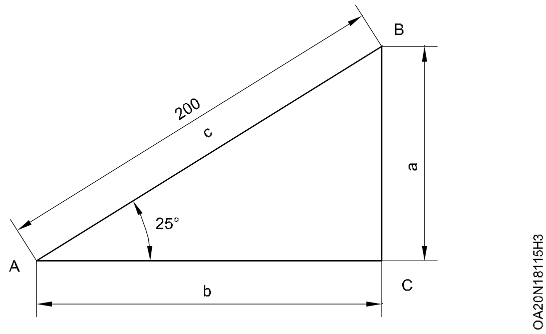


Move the dial to the other end of the component (second position). If there is any difference then the angle is incorrect. The height of the slip gauge pack can be adjusted until the dial test indicator reads zero on both ends. The actual angle can then be calculated and the deviation, if any,will be the error.

Method of calculating the slip gauge height

(Fig 3)

Fig 3



Example 1

To determine the height of slip gauges for an angle of 25° using a sine bar of 200mm long.

$$\sin\theta = \frac{a}{c}$$

θ = 25°

a = C Sine θ

= 200 x 0.4226

a = 84.52 mm

The height of the slip gauge required is 84.52 mm.

The value of sine θ can be obtained from mathematical tables. (Natural trigonometrical functions)

Tables are also available with readily worked out sine bar constants for standard sine bar lengths.

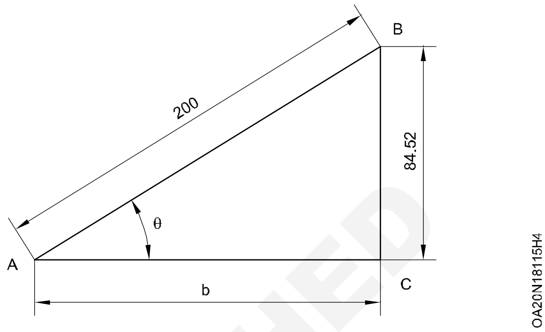
Calculating the angle for tapered components

Example 2

The height of the slip gauge used is 84.52 mm. The length of the sine bar used is 200 mm.

What will be the angle of the component ? (Fig 4)

Fig 4



The angle whose sine value is 0.4226 is 25°. Hence the angle of tapered component is 25°.

$$\sin\theta = \frac{a}{c}$$

$$= \frac{84.52}{200}$$

$$\sin\theta = 0.4226$$

Measuring with tool maker's microscope.

Objective: At the end of this exercise you shall be able to
- **determine the various thread parameter using a tool maker's microscope.**

Job Sequence

- Set the threaded workpiece on the work table.
- Switch on the tool maker microscope.
- Focus the light on the workpiece.
- Using eyepiece lens align the workpiece with reference to the conquire of the lens.
- The mirror is adjusted to see the object clearly.
- Using sliding knots move the table at various points.
- Record the reading where the coincidence of cross wire with the objects measured part
- Move transverse and longitudinal direction for recording the dimension.
- All the reading are tabulated and find out the each dimension of thread.

Table - 1

S.No	Micrometer reading (MR)								
	1	2	3	4	5	6	7	8	9
1									
2									

Major diameter of bolt = MR1 ~ MR4

Minor diamter of bolt = MR2 ~ MR3

Pitch diameter of bolt = MR1 ~ MR3

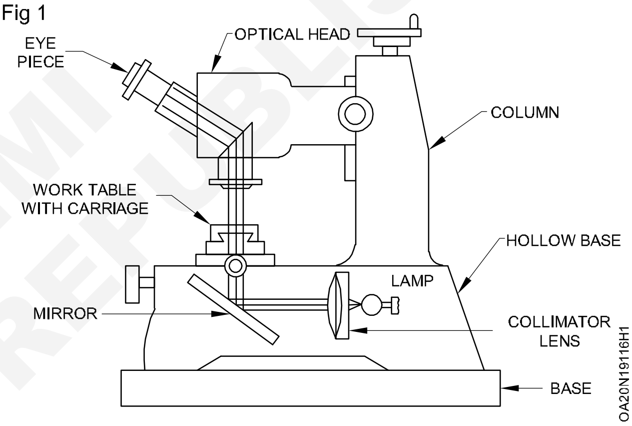
Depth of thread = MR1 ~ MR2

Pitch of thread = MR5 ~ MR6

Angle of thread = MR8 ~ MR9

Flank angle $= \dfrac{MR8 \sim MR9}{2}$

Fig 1



Testing of gears for its measurements and accuracy.

Objective: At the end of this exercise you shall be able to
- **measure the gear tooth profile for the given spur gear using vernier gear tooth caliper.**

Job Sequence

- The given gear caliper is held own the gear.
- Slide is moved down so that it touch the top of the gear tooth.
- The jaws are made to have contact with the toothe on either side by adjusting the knots.
- Note down the reading on horizontal scale.
- Note down the reading on vertical scale.
- The above procedure is repeated for three times and readings are noted.
- The verical scale given the dimension for depth of gear.
- The horizontal scale given the dimension for thickness of spur gear (width)

Table - 1 Tooth thickness (Horizontal scale)

Si.No	MSR	VSR	VSKXLL	TR= MSR + (VSRXLL)

Table - 2 Depth of gear

Si.No	MSR	VSR	VSKXLL	TR= MSR + (VSRXLL)

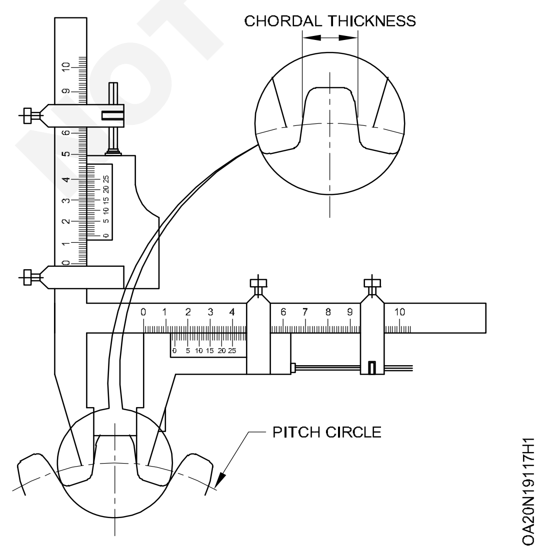
Chardel thickness of gear W = NM Sin (90/N) theoritical

Where N = Number of teeth on the gear

M = Module of gear in mm

Differences in the actual dimension (Horizontal scale) and theoritical thickness given the error in mm.

Fig 1



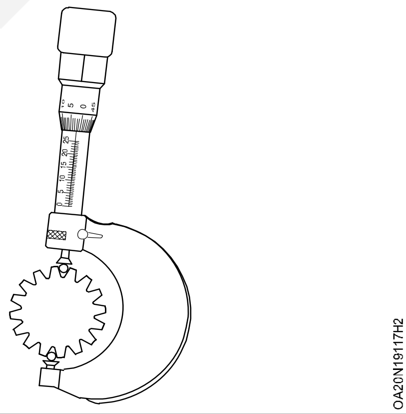
Size inspection by ball with micrometer

- The traditional method of inspection a gear for correct size is the measurement over pins or balls with a micrometer.
- Place two balls over the gear as shown in fig
- Measure across the ball using micrometer.
- Using relation we can find out the measurement over ball assuming pressure angle as 20°

$$\text{Even teeth } m = \frac{z\, m \cos\alpha}{\cos\beta} + d_p$$

$$\text{Odd teeth } m = \frac{z\, m \cos\alpha}{\cos\beta} \cos\frac{90°}{Z} + d_p$$

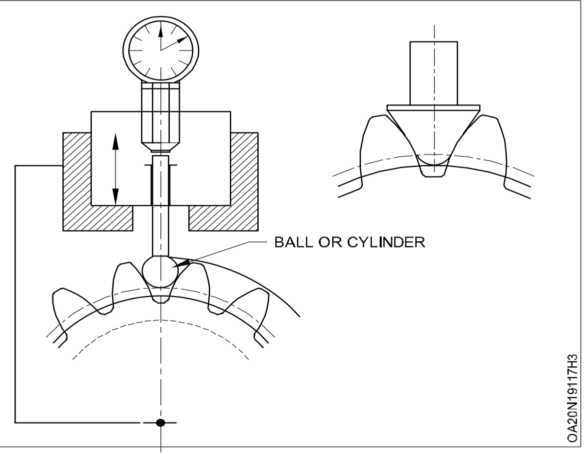
Fig 2



Runout Inspection

- Runout of a gear can be measured with a dial indicator over a pin or ball placed in successive tooth spaces.
- It in the variation of the distance between a surface of revolution and a datum surface.
- Then inspection is used to correct backlash and minimum variation of rotary motor.
- The measurement set up is as shown in figure.

Fig 3



Use of digital profile projector

Objective: At the end of this exercise you shall be able to
- **know the importance of digital profile projector**
- **usage of profile projector.**

Job Sequence

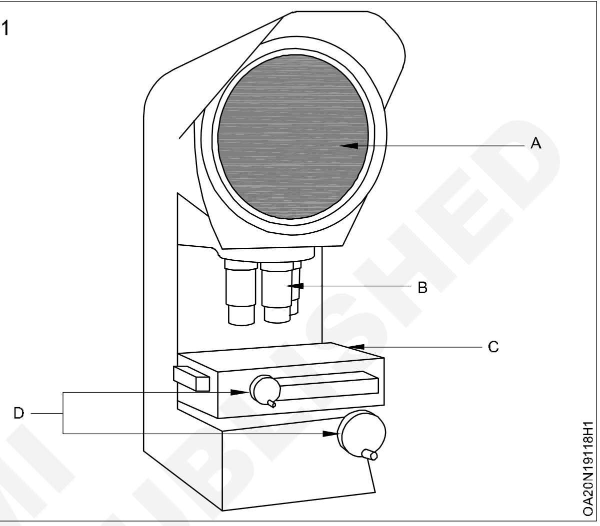
Instructors are asked to arrange industrial visit to enable the trainees to know the operating procedure for digital profile projector by the industry personal.

- Profile in the shape of the gear tooth curve and in measured from the root to the tip of the gear tooth.
- The typical projector illuminator from below and projector the shadow of the measuring object placed through a projection lens on to a projection screen.
- A grid that can be rotated 360° so the x-y axis of the screen can be aligned with a straight edge of the specimen to examine lineup with grid on the screen.
- Profile projector can reveal inspections such as burrs, scratches,indentations or undesirable chambers which micrometer cannot reveal.
- If measures objects in 2D-space measure length and width simulteneously.
- It reduce the inspection time.

A - Projection screen

B - Projection lens

Fig 1

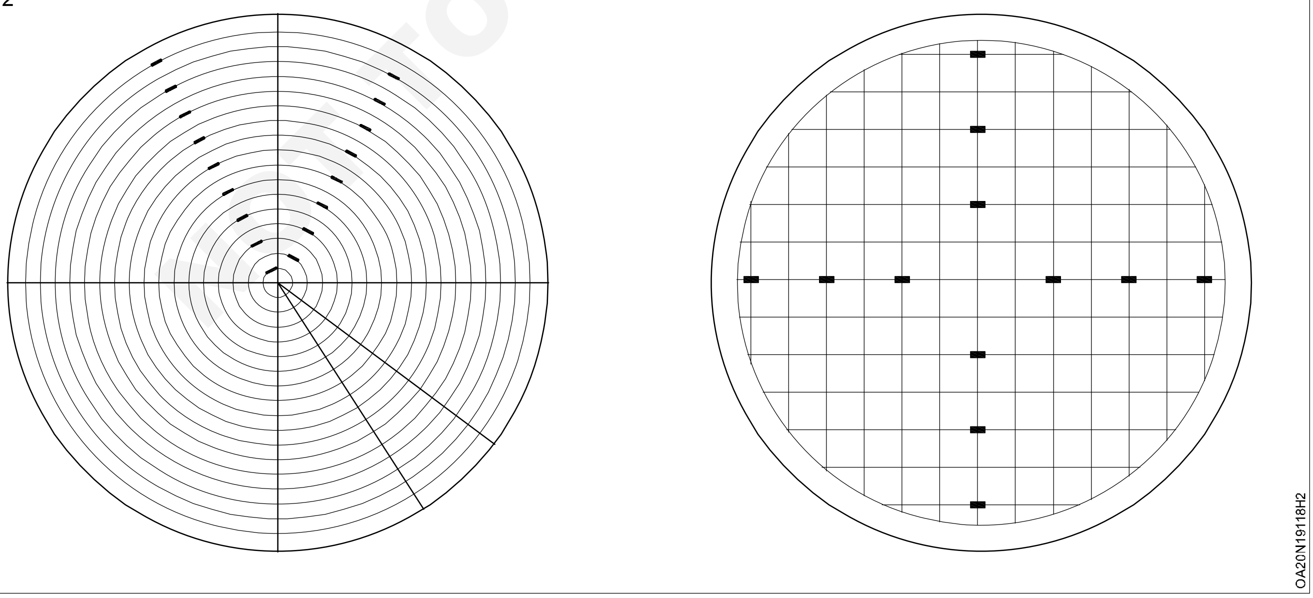


C - Movable stage

D - Stage movement handles (x and y handle)

- Place the object on the shpae.
- A scale is applied to the image projected enlarged on the screen to measure the dimension.
- A profile projectors computerized calculation function given various measurement results such as width,diameter and angle etc by moving the stage.

Fig 2



Geometrical accuracy test of machine as per test chart

Objective: At the end of this exercise you shall be able to
- **understand the geometrical accuracy test procedure as per norm.**

Job Sequence

- The object of geometrical test, measuring instruments, the method adopted for testing are tabulated/furnished by IS1878 (Part 1).
- The test for each part are carried out and find the deviation with in tabulation or not.
- The practical test are also to be carried as per norm given and the deviation are with in the range given.

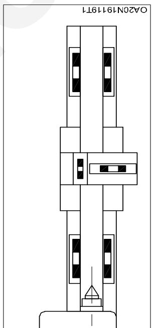
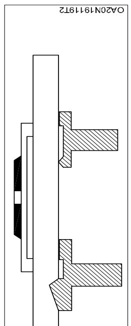
TEST CHART FOR GENERAL PURPOSE PARALLEL LATHES -LATHES WITH SWING OVER BED UP TO 800 mm

Type.. Customer ....

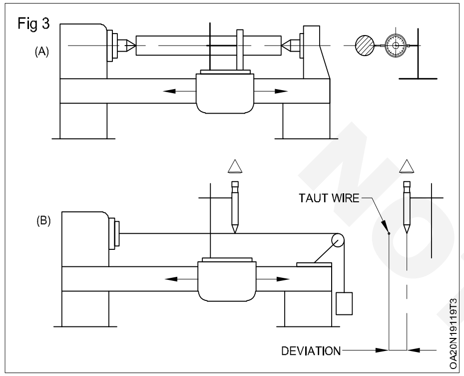
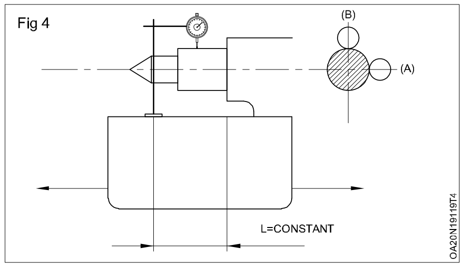
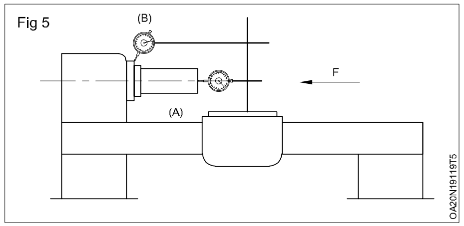
I'vlachine No...................................Order No.. Date...........Inspector ....

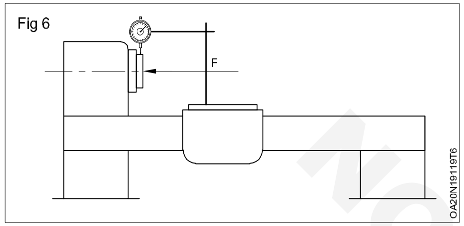
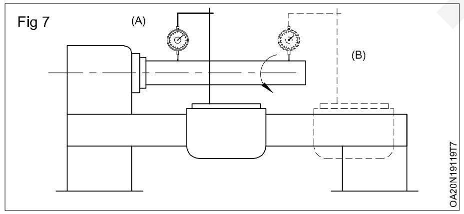
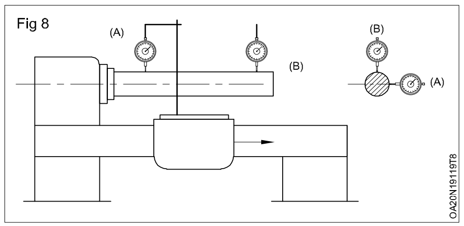
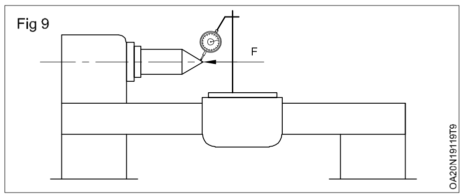
I Geometrical Tests

All dimensions in millimetres,

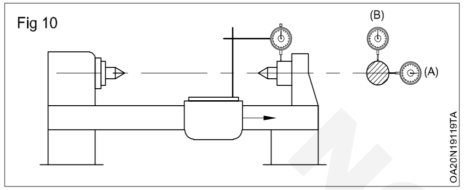
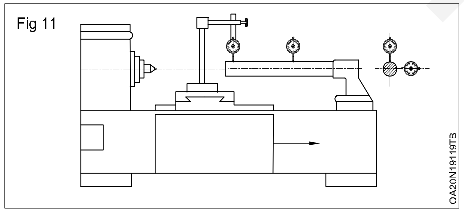
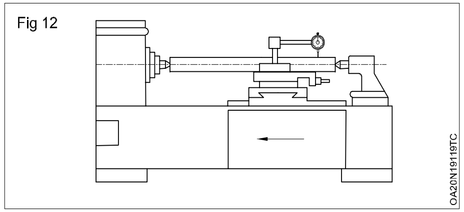
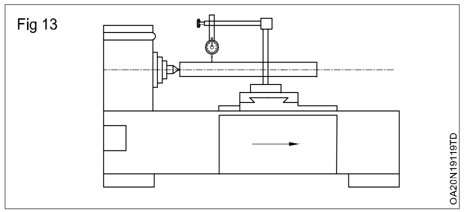
Sl No.	Figure	Object	Measuring Instruments	Reference to IS 2063 : 1988 and/ or Instructions for Testing	Permissible Deviations
1	 Fig 1 a)	Verification of levelling of slidcways a) Lo111titudina 1 direction: Straightness ofslideways in the vcriicai piane	Precision ieveis,straight edge,optical or other methods	**a) 3.11, 3.21, 5.212.21** and **5.2i2.22** Make the measurement at a number of positions equally spaced along the length of the btd The levels may be placed on ihe transverse siide. When the slideways are not horizontal use a straight-edge as	DC< 500 0·0i (convex) v .... 500 < DC 1 000 0·02 (convex) Local tolerance : 0.007 5 for any length of 250 (*see* Annex **A**) DC > i 000 for each I000 increase in distance between centres beyond **1000,** add to the corres- ponding preceding
	 Fig 2 b)	b)Transverse direction: lirlPw::tyQ shall be in the same plane	Precision levels	mentioned in **S.212.21,** Fig. 12 **b) 5.412.7** P1".I P ".i 1PuP1 tr".In"-IuP.r'- 'IPIy nn the slideways and take measure-ments at a number of positions equally spaced along the length of the s!ideways The variation of level measured at any position shaii not exceed	tolerance: 0·01 Localtolerance: 0·015 for any length of 500 *(see* AnnexA) Variation of level: 0-04/1 000

B - CARRIAGE

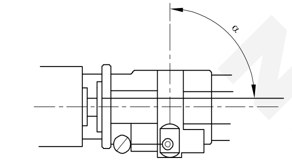
2		Checking of straightness of carriage movement in a horizontal plane or, possibly. in a plane defined by the axis of the centres and the tool point	a) For DC< I 500Dial gauge and mandrel between centres or straightedge b) Whateverthe value of DC, taut wire and microscope or optical methods	a) **5.232.3** (a) or **5.232.1**Touch the front generatrix of the mandrel (instead of the mandrel, a straightedge with parallel faces may be used)Length of mandrel between centres shall be as nearly as possible equal to the value of DC b) **5.212.3** and **5.232.3** (b)The deviation of straightness of carriage movement shall, other than in exceptional cases, be concave relative to the axis of the centres NOTE - Whenever test (b) is carried out, test ta) is not necessary	DC< 500 0·015 500 < DC < 1 0000·02 DC > **1000**For each **1 000** increase in distance between centres beyond **I** 000, add to the corresponding preceding tolerance 0·005Maximum pennis- sible deviation 0·03
3		Checking of parallelism of Tailstock movement to carriage movements: a) in the horizontal plane; b) in the vertical plane	Dial gauge	**5.422.5** With the tailstock as close as possible to the carriage take the readings when both are moved together; keep the tailstock sleeve locked so that the dial gauge fixed on the carriage always touches the same point	DC< I 500 (a) anrl (b) 0·03 Local tolerance: 0·02 for any length of 500 DC > 1 500 (a) and (b) 0·04 Local tolerance: 0·03 for any length of 500
C - HEAD STOCK SPINDLE					
4		a) Measurement of periodic axial slip b) Measurement of caroming of face plate re ting surface	Dial gauge and possibly a special device	**5.62, 5.621.2, 5.622.2** and **5.632** If necessary the value of axial force *F**, to be applied for the tests (a) and (b), shall be specified by the manufacturer	a) 0-01 b) 0·02 including periodic axial slip

5	Fig 6 	Measurement of runout of spindle nose centring sleeve Measurement of	Dial gauge Dial gauge	**5.612.2** and **5.621.2** If necessary, the value of force *F** to be applied shall be specified by the manufacturer In the case of a tapered spindle nose fix the dial gauge perpendicular to the generating line of the taper	0·01
6	Fig 7 	run- out of axis of centre: a) near the spindle nose of the housing b) at a distance from the spindle nose equal to Da/2 or not more than 300	and **test** mandrel	**5.612.3**	a) 0·01 b) 0·02 for a measuring length of 300
7	Fig 8 	Checking of parallel- ism of spindle axis **to** carriage longitudinal move ment on a length equal to Da/2 or a maximum equal to 300 a) in the horizontal plane b) in the vertical plane	Dial gauge and test mandrel	**5.412.1** and **5.422.3**	a) 0·15/300 free end of mandrel front wards b) 0·02/300 free end of mandrel **upwards**
8	Fig 9 	Measurement of runout of head- stock centre	Dial gauge	**5.612.2** and **5.621.2** The dial gauge being placed perpendicularly to the taper surface of the head centre, and tolerance being given in a plane perpendicular to the spindle axis, divide the readings observed by cos Jt,oc being the semi-cone angle of the ta per. If necessary, th value of force *F** to be applied shall be specified by t h e manufacturer	0·015

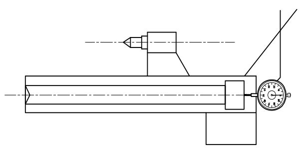
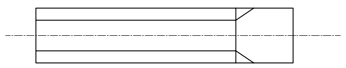
D - TAILSTOCK

9	Fig 10	Checking of parallelism of the axis of the outside of tailstock sleeve to carriage movement: a) in the horizontal plane b) in the vertical plane	Dial gauge	**5.422.3** After the tailstock sleeve has been sufficiently extended, it shall be locked as under normal wurking conditions of the taper	a) 0·015/100 free end of the sleeve frontwards b) 0·02/100 free end of the sleeve upwards
10	Fig 11	Checking of parallelism of taper bore of sleeve to carriage movement on a length equal to Da/4 or a maximum equal to 500 mm a) in the horizontal plane **b) in** the vertical plane	Dial gauge and test mandrel	**5.422.3** Lock the tailstock sleeve as under normal working conditions	a) 0·03/300 free end of the mandrel frontwards b) 0·03/300 free end of the mandrel upwards
E - CENTRES					
11	Fig 12	Checking of difference in height between headstock and tailstock centres	Dial gauge and test mandrel	**5.422.3** Touch the top generatrix of the mandrel. Take readings at the extremities of the test mandrel with the tailstock and tailstock sleeve locked as under normal working conditions	0·04 Tailstock centre higher than headstock centre
F - UPPER SLIDE					
12	Fig 13	Checking of parallelism of the longitudinal movement of the upper slide to the spindle axis	Dial gauge and test mandrel	**5.422.3** Make the measurement in the vertical plane (after setting up the upper slide parallt:l with the spindle axis in the horizontal plane), only in the working position of the upper slide	0·04/300

G - CROSS SLIDE

13	 Fig 14	Measurement of squareness of the transverse movement of the cross slide to the spindle axis	Dial gauge and flat disk or straight edge	3.22 and 5.522.3	0·02/300Direction of deviation IX;;.,, 900

H - LEAD SCREW

14	 Fig 15	Measurement of periodic axial slip due to caroming of each thrust bearing	Dial gauge	**5.622.1** and **5.622.2** This operation may be deleted if practical test No. 3 is carried out	0·015
15	 Fig 16	Checking of the cun:ulative pitch error generated by the lead screw	Dial gauge length bars, etc	**6.1** and **6.2** Length bars will be used associated with a dial gauge so as to compare the carriage travel to the number of corresponding revolutions of the spindle. However, a record of the lead screw accuracy (over a specified length and checked along four generators shifted 90° forward) should be satisfactory. NOTES 1 By agreement between the manufacturer and the user on the measuring method and the values of permissible deviation, total error may be checked over 300mm 2 This test is to be carried out only if a certified lead screw is required by the customer	i) DC< 2000 0·04 For any measured length of 300 ii) DC> 2000 For each 1000 increase in distancebetween centres beyond 2 000, add to the corresponding preceding tolerance: 0·005 Maximum permissible deviation:0.005 iii) 0·015 for any measured length of 60

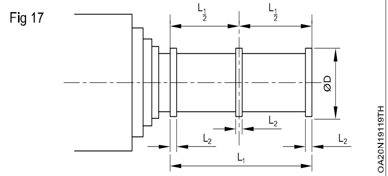
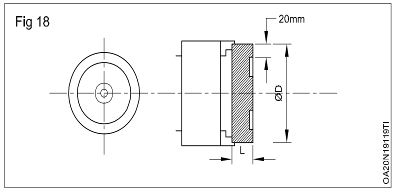
TEST CHART FOR GENERAL PURPOSE PARALLEL LATHES -LATHES WITH SWING OVER BED UP TO 800 mm

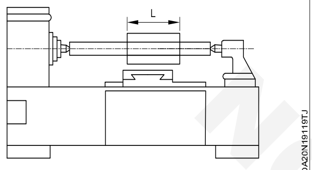
Type... Customer .... I'vlachine No..................................Order No.. Date...........Inspector ....

II Practical Tests

All dimensions in millimetres,

G - CROSS SLIDE

Sl No.	Figure	Nature of Test	Cutting Condition	Checks to beApplied	Measuring Instruments	Ref to **IS 2063 : 1988 and/or Instructions for Testing**	Permissible Deviations	Actual .. Error
1	Fig 17 	Machining of cylindrical test pieces held in a chuck (the cylindrical test pifce mav be inserted in the ta per bore of the spindle) ***D Da/8*** **/1** = 0·5 *Da* 1_1 *max*= 300 *l, max*= 20 *Material* : Test pieces shall be made of free cutting steel or cast iron	Machining of three diameters on a cylinder with a single point tool. It may be two diameters if/ ,< 50	a) *Circularity-* Variation in diameter at the location end of the test piece for atleast four readings b) *Consistency of machined diameters(bands)* Variation betweenmachined diameters at either end of the test piece measured in a single axial plane. Any taper shall be such thatthe major dia is near the headstock	Roundness measuring instrument and micrometer	3.1, 3.22 4.1 and 4.2	a) 0·02 b) 0·04 per $/_1$ = **300** The difference between adjacent bands (except when these are only two) shall not exceed 75percent of the measured difference between the outside bands	
2	Fig 18 	Machining of **2** cylindrical test piece held in a chuck *D* > 0·5 *D.* Lmax =Da/8 *1viaterial:*Testpieces shall be made of free cutting steel or cast iron	Facing of flat surfaces perpendicular to **the**spindle (facing only two or three surfaces,one of which is central)	*Surface flatness* Deviation of flatness should only be allowed in a concave direction	Straight edge and slip gauges	3.1, 3.22 4.1 and 4.2	0·025 for a diameter of 300	

3	Fig 19  	Threading of a cylindrical piece* L = 300mm	The start of the screw thread is taken from any point on the lead screw. Diameter a.nd pitch should be as close as possi- ble to · those of the lead screw	Cumulative pitch error over **-300**	Special instruments of tested precision	**3.1, 3.22, 4.14.2, 6.1** and **6.2** The screw thread shall be clean without flats or waviness NOTE-This test is to be carried out only if specifi- cally required by the custo- mer	DC< 2 **000**a) 0·04 forany measuredlength of 300 DC > 2 000For each 1 000 increase in distance between centres beyond 2000, add to the corresponding preceding tolerance:0·005 Maximum permissible deviation 0·05b) 0·015 for any measured length of 60	