MACHINIST

NSQF LEVEL - 4

1st Year

TRADE PRACTICAL

SECTOR : CAPITAL GOODS AND MANUFACTURING

(As per revised syllabus July 2022 - 1200 Hrs)

Directorate General of Training

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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

Sector : **Capital Goods & Manufacturing**

Duration : **2 - Years**

Trade : **Machinist 1st Year - Trade Practical - 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 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, an autonomous body under Ministry of Skill Development & Entrepreneurship is entrusted with developing producing and disseminating Instructional Media Packages (IMPs) required for ITIs and other related institutions.

The institute has now come up with instructional material to suit the revised curriculum for **Machinist 1st Year - Trade Practical NSQF Level - 4 (Revised 2022)** in **Capital Goods & Manufacturing Sector under Annual Pattern.** The NSQF Level - 4 (Revised 2022) Trade Theory 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 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

Addl. Secretary / Director General of Training
Ministry of Skill Development & Entrepreneruship
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 Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

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

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

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

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

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

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

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

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 organisations to bring out this Instructional Material **(Trade Practical)** for the trade of **Machinist 1st Year NSQF Level - 4 - (Revised 2022)** under **Capital Goods & Manufacturing** Sector for ITIs.

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

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

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

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the 1st Year Course of Machinist 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 syllabus are covered. The manual is divided into Seven modules.

Module 1	Safety
Module 2	Basic fitting
Module 3	Turning
Module 4	Slotting
Module 5	Milling
Module 6	Advanced turning
Module 7	Grinding

The skill training in the shop floor is planned through a series of practical exercises centered 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 Course of the Machinist Trade. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 5 syllabus on Trade Practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

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

It will be preferable to teach/learn 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	Ref.Ex.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, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]	1.1.01 -1.2.24
2	Produce components by different operations and check accuracy using appropriate measuring instruments. [Different Operations - Drilling, Reaming, Tapping, Dieing; Appropriate Measuring Instrument - Vernier, Screw Gauge, Micrometre] (NOS not available)	1.2.25 - 1.2.35
3	Make different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. [Different Fit - Sliding, 'T' fitand Square fit; Required tolerance: ±0.2 mm, angular tolerance: 1 degree. (NOS not available)	1.2.36 - 1.2.38
4	Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks: 3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal] (NOS not available)	1.3.39 - 1.3-41
5	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.] (NOS not available)	1.3.42 - 1.3.50
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.] (NOS not available)	1.3.51- 1.3.54
7	Set the different machining parameters to produce metric-v threaded components applying method/ technique and test for proper assembly of the components.(NOS not available)	1.3.55 1.3.57
8	Set the different machining parameters and cutting tool to prepare job by performing different slotting operation. [Different machining parameters - feed, speed and depth of cut. Different slotting operations -concave & convex surface, internal key ways, profiling, making internal sprocket with an accuracy of +/- 0.04 mm] (NOS not available)	1.4.58 -1.4.61
9	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] (NOS not available)	1.4.62 -1.5.83
10	Set the different machining parameters to produce square & "V" threaded components applying method/ technique and test for proper assembly of the components. (NOS not available)	1.6.84 -1.6.92
11	Produce components of high accuracy by different operations using grinding. [Different operations - surface grinding, cylindrical grinding with an accuracy of+/- 0.01 mm} (NOS not available)	1.7.93 -1.7.110

SYLLABUS FOR MACHINIST

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 100 Hrs.; Professional Knowledge 20Hrs.	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, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm] (NOS not available)	1 Importance of trade training, List of tools & Machinery used in the trade.(02hr.) 2 Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (05hrs.) 3 First Aid Method and basic training.(03hrs.) 4 Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (02hrs.) 5 Hazard identification and avoidance. (02hrs.) 6 Identification of safety signs for Danger, Warning, caution & personal safety message.(02 hrs.) 7 Preventive measures for electrical accidents & steps to be taken in such accidents.(03hrs.) 8 Use of fire extinguishers.(04hrs.) 9 Practice and understand precautions to be followed while working in fitting jobs. (02hrs.) 10 Safe use of tools and equipments used in the trade. (02 hr)	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 precautions 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 application. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable. Basic understanding on Hot work, confined space work and material handling equipment. (04 hrs.)
		11 Study the drawing to plan the job/ work. Identification of tools &equipments as per desired specifications for marking, filing& sawing. (03hrs.) 12 Familiarisation of bench vice. (02 hr) 13 Filing- Flat and square (Rough finish). (06 hrs.) 14 Marking with scriber and steel rule.(03hrs.) 15 Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule. (06hrs.)	Linear measurements- its units, steel rule dividers, callipers - types and uses, Punch - types and uses. Uses of different types of hammers. Description, use and care of marking off table. (03hrs.)
		16 Marking out lines, gripping suitably in vice jaws, hack sawing to given dimensions. (05hrs.) 17 Sawing different types of metals of different sections. (06hrs.)	Bench vice construction, types, uses, care & maintenance, vice clamps, hacksaw frames and blades, specification, description, types and their uses, method of using hacksaws.

		18 Marking practice with dividers, odd leg callipers, scriber and steel rule (circles, arc, parallel lines). (06hrs.)	Files- elements, types, specification and their uses. Methods of filing. Care and maintenance of files. Measuring standards (English, Metric Units) (04 hrs.)
		19 Grinding, centre punch, dot punch, chisel and scriber.(07hrs.) 20 Marking, filing, filing square and check using try-square. (10 hrs.)1.	Pedestal grinding machine: Use, care and safety aspect. Marking off and layout tools, scribing block, care & maintenance. Try square, ordinary depth gauge, Care & maintenance of cold chisels-materials, types, cutting angles. Combination set- its components, uses and cares. (05 hrs)
		21 Marking according to drawing for locating, position of holes, scribing lines on chalked surfaces with marking tools. (04hrs.) 22 Finding centre of round bar with the help of 'V' block and marking block. (04hrs.) 23 Prepare mushroom head and round bar and bending metal plate by hammering. (05hrs.) 24 Marking using scale, surface gauge and angle plate. (06 hrs.)	Marking media, Prussian blue, red lead, chalk and their special application, description. Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel block, description, types, uses, accuracy, care and maintenance. (04 hrs.)
Professional Skill 39 Hrs; Professional Knowledge 08 Hrs.	Produce components by different operations and check accuracy using appropriate measuring instruments. [Different Operations - Drilling, Reaming, Tapping, Dieing; Appropriate Measuring Instrument - Vernier, Screw Gauge, Micrometre] (NOS not available)	25 Chipping flat surfaces along a marked line. (07hrs.) 26 Make a square from a round job by chipping upto 20mm length. (3 hrs) 27 Slot straight and angular chipping. (2 hrs) 28 Mark off and drill through holes. (03hrs.) 29 Drill and tap on M.S. flat. (02hrs.) 30 Cutting external thread on M.S. rod using Die.(03hrs.) 31 Punch letter and number (letter punch and number punch). (03hrs.) 32 Counter sinking, counter boring and reaming with accuracy +/- 0.04 mm.(05 hrs.) 33 Drill blind holes with an accuracy 0.04 mm.(02 hrs.) 34 Form internal threads with taps to standard size (blind holes).(03 hrs.) 35 Prepare studs and bolt.(06hrs.)	Drill, Tap,Die-types & application. Determination of tap drill size. Basic terminology related to screw thread. Reamer- material, types (Hand and machine reamer), parts and their uses, determining hole size for reaming, Reaming procedure. Vernier height gauge: construction, graduations, vernier setting & reading. Care and maintenance of Vernier height Gauge. (04 hrs.) Drilling machines-types &their application, construction of Pillar & Radial drilling machine. Countersunk, counter bore and spot facing-tools and nomenclature. Cutting Speed, feed, depth of cut and Drilling time calculations. (04 hrs.)
Professional Skill 90 Hrs.; Professional Knowledge 12 Hrs.	Make different fit of components for assembling as per required tolerance observing principle of interchangeability and	36 Make Male & Female 'T' fitting with an accuracy +/- 0.2 mm and 1 degree. (25hrs.) 37 Make male female square fit with accuracy +/- 0.1 mm. (25hrs.)	Interchangeability: Necessity in Engg., field, Limit- Definition, types, terminology of limits and fits-basic size, actual size, deviation, high and low limit, zero-line, tolerance zone, allowances. Different standard

	check for functionality. [Different Fit - Sliding, 'T' fitand Square fit; Required tolerance: ±0.2 mm, angular tolerance: 1 degree.] (NOS not available)	38 Make Male & Female Hexagon fitting with accuracy +/- 0.06 mm. (40 hrs.)	systems of fits and limits. (British standard system & BIS system) (06 hrs) Vernier calliper-its parts, principle, reading, uses & care. Outside micrometre- its parts, principle, reading, uses, Reading of Vernier Micrometre), care & maintenance. Dial test indicator-its parts, types, construction and uses. (06 hrs.)
Professional Skill 20 Hrs.; Professional Knowledge 05 Hrs.	Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks: 3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal] (NOS not available)	39 Identify & function of different parts of lathe. Practice on operation of lathe (dry/idle run). (07 hrs.) 40 Setting lathe on different speed and feed.(04 hrs.) 41 Dismantling, assembling & truing of 3-jaw & 4-jaw chucks. (09hrs.)	Getting to know the lathe with its main components, lever positions and various lubrication points as well. Definition of machine & machine tool and its classification. History and gradual development of lathe. Introduction to lathe- its types. Centre lathe construction, detail function of parts, specification. Safety points to be observed while working on a lathe. (05 hrs.)
Professional Skill 112 Hrs.; Professional Knowledge 16 Hrs.	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.] (NOS not available)	42 Grinding of R.H. and L.H. tools, V- tool, parting tool, Round nose tool. (15 hrs.) 43 Checking of angles with angle gauge/ bevel protractor. (02 hrs.) 44 Grinding of "V" tools for threading of Metric 60-degree threads. (08 hrs.)	Lathe cutting tool-different types, material, shapes and different angles (clearance, rake etc.) and their effects, specification of lathe tools, grinding process of tools. Types of chips, chip breaker. Tool life, factors affecting tool life. (04 hrs.)
		45 Perform facing operation to correct length. (05 hrs.) 46 Centre drilling and drilling operation to required size. (05 hrs.) 47 Perform parallel turning and step turning operation. (12 hrs.)	Driving mechanism, speed and feed mechanism of Lathe. (03 hrs)
		48 Perform drilling, boring and undercut operation, parting, grooving, chamfering practice, Blinding hole Boring. (55 hrs.) 49 Measurement with steel rule and outside calliper with an accuracy of ± 0.5 mm. (02 hrs.)	Concept of Orthogonal and Oblique Cutting. Chucks & different types of job holding devices on lathe and advantages of each type. Mounting and dismounting of chucks. Vernier Bevel Protractor - parts, reading and uses. (06hrs)
		50 Perform different Knurling operation in lathe with accuracy of ± 0.5 mm (8 hrs.)	Lathe operations-facing, turning, parting-off, grooving, chamfering, boring etc. Knurling-types, grade & its necessity. (03 hrs)

Professional Skill 45 Hrs.; Professional Knowledge 06 Hrs.	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.] (NOS not available)	51 Make taper turning by form tool with an accuracy of 1 degree. (05 hrs.) 52 Make taper turning by compound slide swivelling with an accuracy of ± 30 minute (15 hrs.)	Taper - different methods of expressing tapers, different standard tapers. Method of taper turning, important dimensions of taper. Taper turning by swiveling compound slide, its calculation. (03 hrs.)
		53 Make taper by off-setting tailstock with an accuracy of ± 30 minute. (20hrs.) 54 Checking taper by Vernier Bevel Protractor and sine bar & slip gauge. (05 hrs.)	Calculations of taper turning by off-setting tail stock. Sine Bar - description & uses. Slip gauge -description and uses. (03 hrs.)
Professional Skill 40 Hrs.; Professional Knowledge 07 Hrs.	Set the different machining parameters to produce metric-v threaded components applying method/ technique and test for proper assembly of the components. (NOS not available)	55. Cutting V thread (external) in a lathe and check with Screw Pitch Gauge. (18 hrs.) 56. Cutting V thread (internal) in a lathe and check with Screw Pith Gauge. (19 hrs.) 57. Fitting of male & female threaded components. (03 hrs.)	Different thread forms, their related dimensions and calculations of screw cutting in a lathe (Metric thread on English lathe and English thread on Metric lathe). Measurement of threads by three wire methods. Use of Screw Pitch Gauge. (07hrs.)
Professional Skill 71 Hrs.; Professional Knowledge 15 Hrs.	Set the different machining parameters and cutting tool to prepare job by performing different slotting operation. [Different machining parameters - feed, speed and depth of cut. Different slotting operations -concave & convex surface, internal key ways, profiling, making internal sprocket with an accuracy of +/- 0.04 mm] (NOS not available)	58. Identification of slotting machine parts & its construction, use of rotary table. (10 hrs.) 59. Practice on slotting key ways on pulley with accuracy +/- 0.04 mm (15 hrs.) 60. Slotting a double ended spanner with accuracy +/- 0.1 mm. (25 hrs.) 61. Cutting internal spline on slotting machine with accuracy +/-0.04 mm. (21 hrs.)	Slotter- Classification, principle, construction, Safety precaution. Introduction and their indexing process on a Slotter by its Rotary table graduations. Driving mechanisms, quick return motion and speed ratio. Safety points to be observed while working on a Slotter. (06 hrs.) Job holding devices-vice, clamps, V-block, parallel block etc. Slotting tools- types, tool angles. (04 hrs) Spline - types and uses. Coolant & lubricant - Introduction, types, properties, application & applying methods. (05hrs)
Professional Skill 138 Hrs.; Professional Knowledge 25 Hrs.	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]	62. Identification of milling machine. (02 hrs.) 63. Demonstrate working principle of Milling Machine. (04hrs.) 64. Set vice & job on the table of Milling Machine. (04 hrs.) 65. Set arbor on the spindle of milling machine. (06hrs.) 66. Set the cutter on arbour. (04 hrs.) 67. Safety points to be observed while working on a milling machine. (02 hrs.)	Milling Machine: Introduction, types, parts, construction and specification. Driving and feed mechanism of Milling Machine. (04 hrs)

	(NOS not available	68. Demonstrate Up Milling and Down Milling Process. (05hrs.) 69. Sequence of milling six faces of a solid block. (08 hrs.) 70. Check the accuracy with the help of try-square and vernier height gauge. (02hrs.) 71. Perform Step milling using side and face cutter checking with depth micrometer. (05hrs.) 72. Perform slot milling using side and face cutter. (05hrs.)	Different types of milling cutters & their use. Cutter nomenclature. (03 hrs)
		73. Make "V" Block using Horizontal Milling Machine with accuracy +/ -0.02 mm. (20hrs.)	Different milling operations - plain, face, angular, form, slot, gang and straddle milling etc. Up and down milling. (03 hrs)
		74. Make concave surfaces with an accuracy +/-0.02 mm. (03 hrs.) 75. Make convex surfaces with an accuracy +/-0.02 mm. (03 hrs.) 76. Straddle milling operation with an accuracy +/-0.02 mm. (07 hrs.) 77. Gang milling operation with an accuracy +/-0.02 mm. (07hrs.)	Different types of milling attachments and their uses. (03 hrs)
		78. Make Dovetail fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm. (12hrs.)	**Jigs and Fixtures-** Introduction, principle, types, use, advantages & disadvantages. (03 hrs)
		79. Make T-Slot fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm. (18hrs.)	Properties of metals general idea of physical, mechanical properties of metals, colour, weight, hardness toughness, malleability, ductility their effect on machinability. Heat Treatment - Introduction, necessity, types, Purposes, different methods of Heat Treatment. Heat Treatment of Plain Carbon Steel. (05 hrs)
		80. Demonstrate indexing head. (04hrs.) 81. Set and align indexing head with reference to job on milling machine.(04hrs.) 82. Make square job by direct/ simple indexing method with an accuracy +/-0.02 mm. (05hrs.) 83. Make hexagonal job by simple indexing method with an accuracy +/-0.02 mm. (08hrs.)	Indexing-introduction & types. Indexing head-types &constructional details, function of indexing plates and the sector arms. Calculation for direct and simple indexing. (04 hrs)
Professional Skill 60 Hrs.; Professional Knowledge 13 Hrs.	Set the different machining parameters to produce square & "V" threaded components applying method/ technique and test for	84. Checking of alignment of lathe centres and their adjustments. (03 hrs.) 85. Turning practice-between centres on mandrel (gear blank) with an accuracy +/-30 minute. (07hrs.)	Turning of taper by taper turning attachment - advantages and dis-advantages, taper calculations. Mandrel, Lathe centres, Lathe dog, catch plate/Driving plate, Face plate, Rests, their types & uses. (04 hrs)

	proper assembly of the components. (NOS not available)	86. Taper turning by swivelling the cross slide. (03 hrs.)	
		87. Make square thread (external) on a lathe with an accuracy +/-0.02 mm. (10hrs.) 88. Make square thread (internal) on a lathe with an accuracy +/-0.02 mm. (14hrs.) 89. Check with thread gauge - grinding of tool & setting in correct position. (04hrs.) 90. Fitting of male & Female Square threaded components. (02hrs.) 91. Make multi-start V thread on lathe with Screw Pitch gauge.(10 hrs.) 92. Perform eccentric turning with an accuracy +/-0.02mm. (07hrs..)	Terms relating screw thread major/ minor diameter, pitch and lead of the screw, depth of thread. Simple gear train and compound gear train change gears for fractional pitches. Square thread and its form and calculation of depth, core dia, pitch dia. Difference between single and multi-start threads- their uses, merits and demerits. (9 hrs.)
Professional Skill 125 Hrs.; Professional Knowledge 35 Hrs.	Produce components of high accuracy by different operations using grinding. [Different operations - surface grinding, cylindrical grinding with an accuracy of+/- 0.01 mm] (NOS not available)	93. Identification of different types of grinding machine. (02 hrs.) 94. Wheel balancing & truing. (06 hrs.) 95. Dressing of grinding wheel. (02 hrs.) 96. Grinding of block (six sides) by surface grinding machine with an accuracy of +/- 0.01 mm. (15 hrs.)	**Grinding -** Introduction, grinding wheel- abrasive, types, bond, grade, grid, structure, standard marking system of grinding wheel, selection of the grinding wheel. (06 hrs.)
		97. Grinding of step block by surface grinding machine with an accuracy of +/- 0.01 mm. (10hrs.) 98. Grinding of slot block by surface grinding machine with an accuracy of +/- 0.01 mm. (08hrs.)	Dressing, types of dresser. Glazing and Loading of wheels - its causes and remedies. Roughness values and their symbols. Explain the importance and necessity of quality. (06 hrs.)
		99. Set and perform angular grinding using universal vice/ sign vice to standard angle. (05 hrs.) 100. Make slide fit with an accuracy ± 0.01mm (male female) (05hrs.) 101. Perform form grinding (05 hrs.) 102. Make dovetail fitting with an accuracy ± 0.01mm (male & female) (08 hrs.)	**Surface Grinder -** Types, Parts, construction, use, methods of surface grinding, specification & safety. (06 hrs.)
		Cylindrical grinding: 103. External parallel cylindrical grinding (Both holding in chuck/ collet and in between centers. (10 hrs.) 104. Plunge grinding (08hrs.)	**Cylindrical grinder:** Introduction, parts, construction, types, specification, safety, different methods of cylindrical grinding. (06 hrs.)

		105. Perform straight bore grinding (05hrs.) 106. Perform step bore grinding (05hrs.) 107. Internal taper bore grinding (05hrs.) 108. Make male female fitting with an accuracy of +/- 0.01 mm (08hrs.)	Cutting speed, feed, depth of cut, machining time calculation. (06 hrs.)
		109. External step cylindrical grinding with an accuracy of +/- 0.01 mm (10hrs.) 110. External taper Cylindrical grinding with an accuracy of +/- 0.01 mm. (08hrs.)	Wet grinding and dry grinding, various types of grinding wheels and their application, grinding defects and remedies. (05 hrs.)

Importance of trade training, list of tools and machinery used in the trade

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

- **identify the tools and equipments used in Machinist section**
- **record the names of tools, do's and don't of each tool**
- **record the names of the industries where the Machinists are employed.**

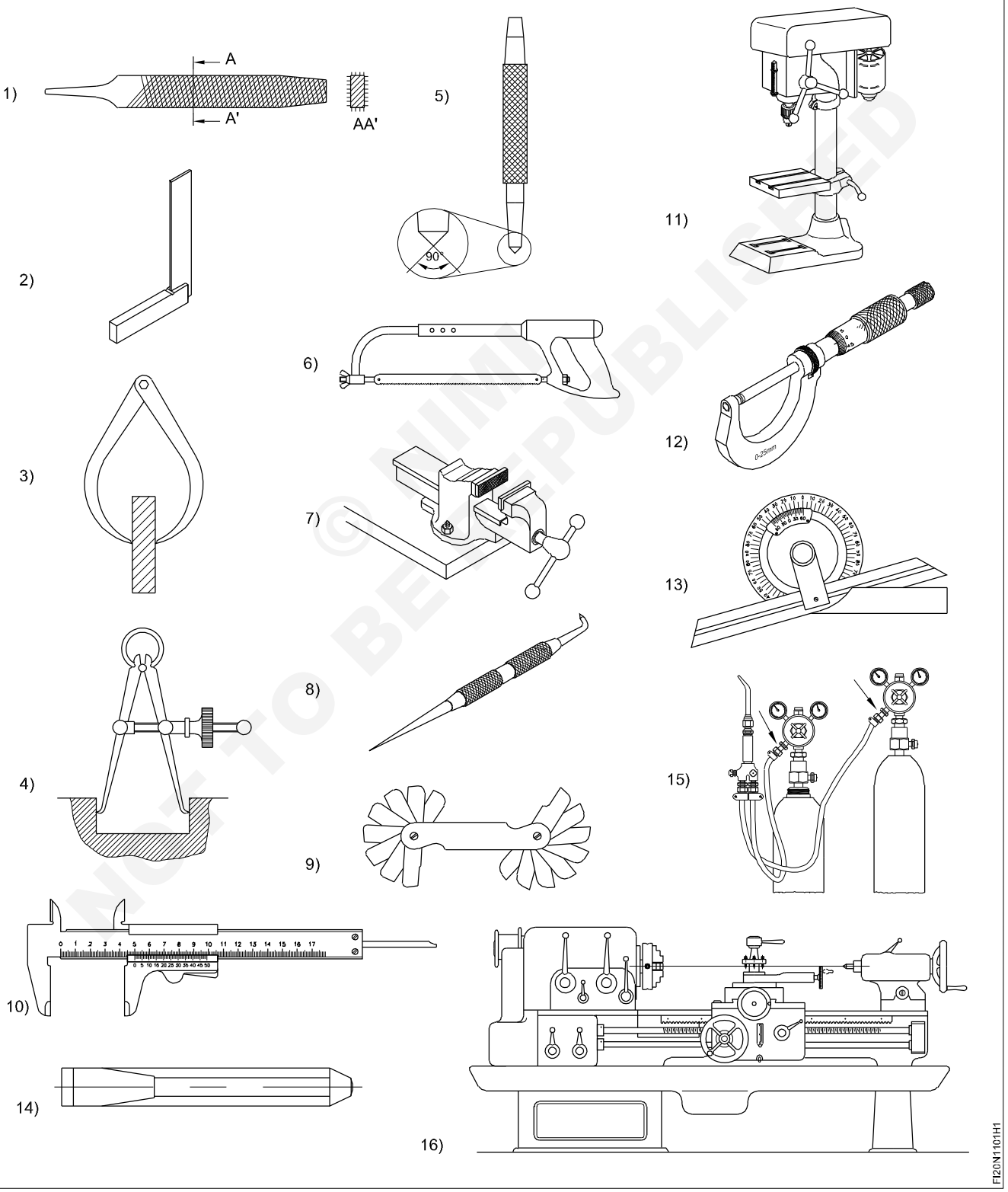


Fig 17

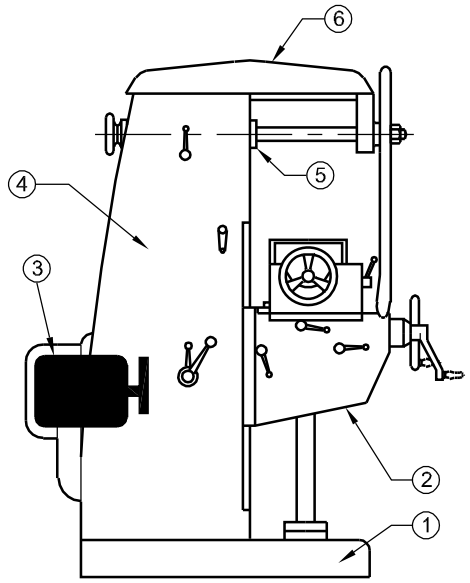


Fig 18

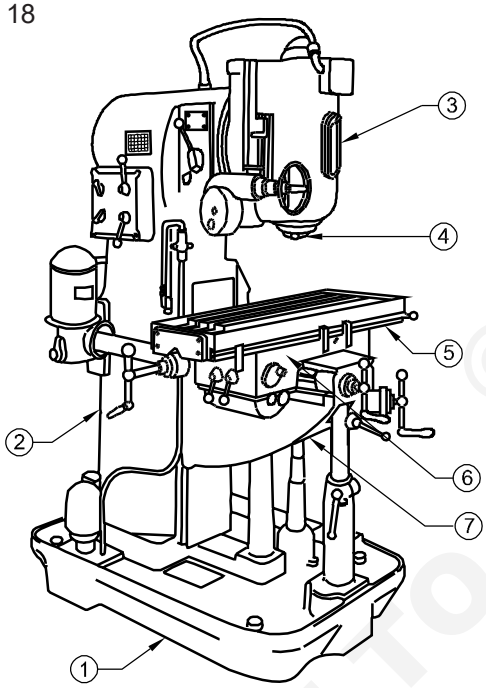
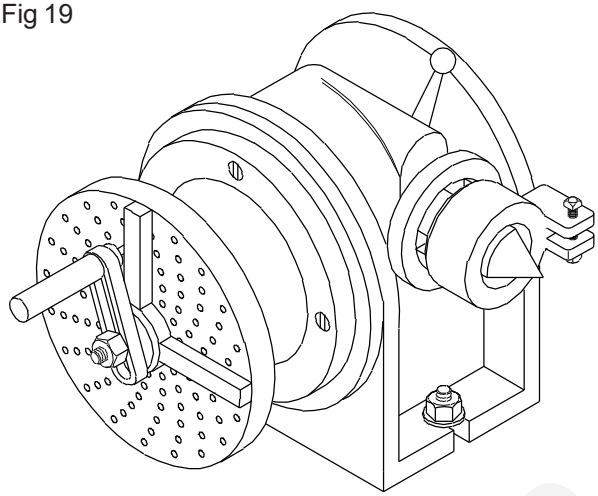


Fig 19



Job Sequence

Instructor shall display all the tools and equipments in the section and brief their names, uses and the safety point to be observed for each tool and equipment.

- Trainees will note down all the displayed tools names, uses and the precaution to be observed while working with each tool.
- Record it in Table 1.
- Get it checked by the instructor.

Table 1

Sl.No	Name of tool/equipment	Uses	Precaution to be observed (Do's and Don't)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			

Instructor shall brief the role of a Machinist in industries. Emphasis more on the assembly shop by providing the names of the private and public sector industries, where the Machinists are largely employed. Ask the trainees to note down the names of the industries.

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

Objectives: At the end of this exercise, you shall be able to
- **identify personal protective devices**
- **interpret the different types of personal protective devices.**

Fig 1

Job Sequence

- Read and interpret the visuals of personal protective equipment on real devices or from the charts.
- Identify and select personal protective equipment used for different types of protection.
- Write the name of the PPE and the corresponding type of protection and the hazards in table 1.

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 ask the trainees to note down the hazards and type of protection in the Table 1.

The instructor shall demonstrate how to wear and remove the all the PPE's.

Ask the trainees to practice it.

TASK 1:

Table 1

S.No.	Name of the PPE	Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			

Get it checked by your instructor.

— — — — — — — —

First aid method and basic training

Objectives: At the end of this exercise, you shall be able to
- **provide first aid for chocking, wound, burn, bites and sting on human.**
- **take care a person with, eye injury, nose bleeding, diabetes, heat exhaustion by first aid treatment**
- **give first aid treatment to person with heat stroke.**

Job Sequence

TASK 1: **Chocking**

1 Severe choking: back blows and abdominal thrusts as shown in Fig 1.

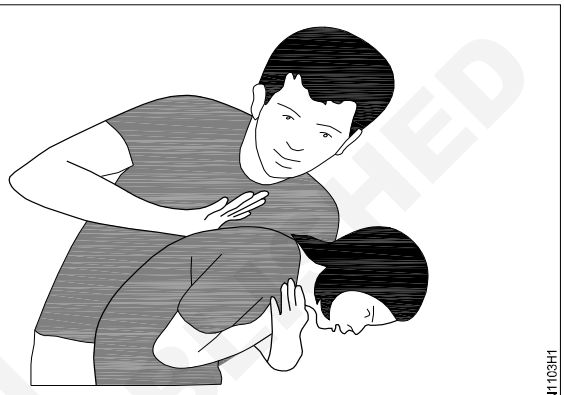
2 Stand behind them and slightly to one side. Support their chest with 1 hand. ...

3 Give up to 5 sharp blows between their shoulder blades with the heel of your hand. ...

4 Check if the blockage has cleared.

5 If not, give up to 5 abdominal thrusts.

Fig 1



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TASK 2: **Wound (Fig 2 to 3)**

1 The first step in care of a wound is to stop the bleeding.

2 Locate the source of the bleeding.

3 Wash your hands and, when possible, wear gloves or use a barrier between you and the wound.

4 Remove any loose debris.

5 Apply direct pressure on wound (FIg 1)

Fig 1

6 Dress the wound with cotton bandage (Fig 2)

Fig 2

— — — — — — — — —

TASK 3: **Burns (Fig 1 to 3)**

Treating minor burns

1 Cool the burn.

2 Remove rings or other tight items from the burned area.

3 Don't break blisters.

4 Apply lotion.

5 Bandage the burn.

6 If needed, take a nonprescription pain reliever, such as ibuprofen (Advil, Motrin IB, others), naproxen sodium (Aleve) or acetaminophen (Tylenol, others).

Fig 1

Fig 2

Fig 3

TASK 4: **Bites and Stings (Fig 1 to 3)**

1 Stop the wound from bleeding by applying direct pressure with a clean, dry cloth.

2 Wash the wound. ...

3 Apply an antibacterial ointment to the wound. ...

4 Put on a dry, sterile bandage.

5 If the bite is on the neck, head, face, hand, fingers, or feet, call Doctor right away

Fig 1

Fig 2

Fig 3

TASK 5: **Eye injury (Fig 1 & 2)**

1 Ask patient to look up.

2 Draw lower eyelid down. If object visible, remove with corner of moist cloth.

3 If not visible, pull upper lid down.

Fig 1

4 If unsuccessful, wash eye with sterile saline or clean water.

5 If still unsuccessful, cover injured eye only and seek medical aid.

Fig 2

TASK 6: **Nose Bleedings (Fig 1 & 2)**

1 Make a patient to sit straight and bend forward the head portion only(This will reduce blood pressure in the Veins of your nose)

2 Ask the patient to breathe out from the nose.

3 Pinch the nose to take out the blood in the nose.

Fig 1

4 To prevent re-bleeding, don't pick or blow your nose and don't bend down for several hours.

5 If re-bleeding occurs, go through these steps again.

Fig 2

TASK 7: **Diabetes (Low blood sugar) (Fig 1 & 2)**

1 Follow the basic first aid plan to assess the casualty.

2 Give high-energy foods or sugar.

3 Only give food if the casualty is conscious.

Fig 1

4 If medical aid is delayed give sugar every 15 minutes.

5 The casualty will recover quickly if low blood sugar level is the cause.

Fig 2

TASK 8: **Heat Exhaustion (Fig 1 to 2)**

Fig 1

Fig 2

Heat Exhaustion

1 Rest in a cool place. Getting into an air-conditioned building is best, but at the very least, find a shady spot or sit in front of a fan.

2 Drink cool fluids. Stick to water or sports drinks.

3 Try cooling measures.

4 Loosen clothing.

— — — — — — — — —

TASK 9: **Heat Stroke**

1 Put the person in a cool tub of water or a cool shower.

2 Spray the person with a garden hose.

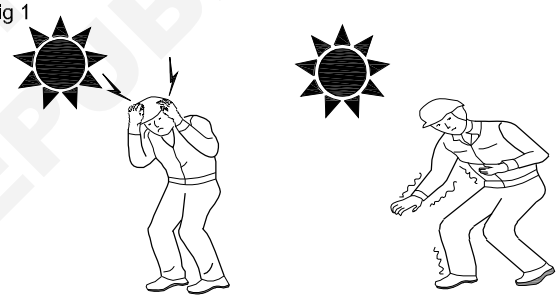
3 Sponge the person with cool water.

4 Fan the person while misting with cool water.

5 Place ice packs or cool wet towels on the neck and armpits.

6 Cover the person with cool damp sheets.

Fig 1



— — — — — — — — —

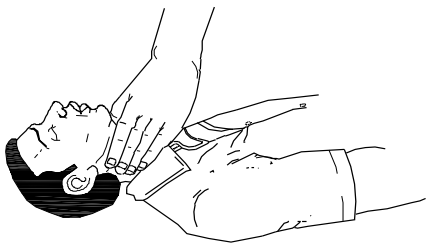
TASK 10: **Resuscitate a victim who is under cardiac arrest by (CPR) cardio pulmonary resuscitation**

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 1), blue colour around lips and widely dilated pupil of the eyes.

Fig 1



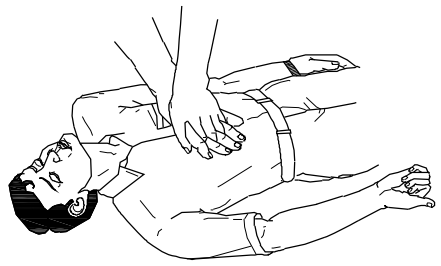
2 Lay the victim on his back on a firm surface.

3 Kneel alongside facing the chest and locate the lower part of the breastbone. (Fig 2)

Fig 2

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 3.

Fig 3



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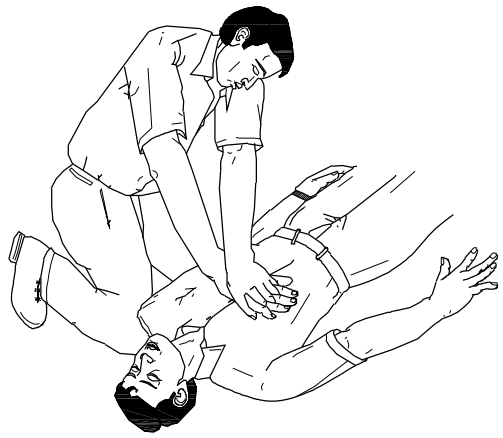
5 Keeping your arms straight, press sharply down on the lower part of the breastbone; then release the pressure. (Fig 4)

Fig 4



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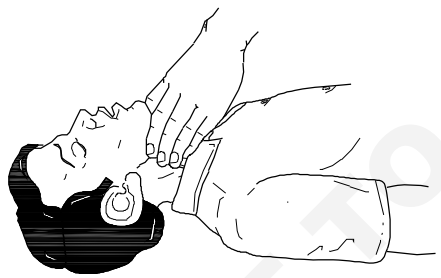
6 Repeat step above, fifteen times at the rate of atleast once per second.

7 Check the cardiac pulse. (Fig 5)

Fig 5



FIN1103JH

8 Move back to the victim's mouth to give two breaths (mouth-to-mouth resuscitation). (Fig 6)

Fig 6

FIN1103JI

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.

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 7. Keep him warm and get medical help quickly.

Fig 7

FIN1103JJ

Other steps

12 Send word for a doctor immediately.

13 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.

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.**

Fig 1

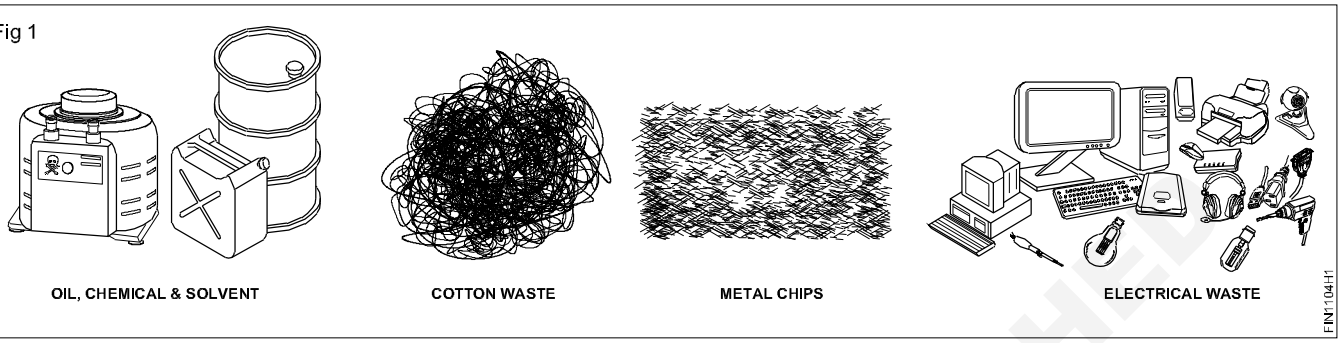
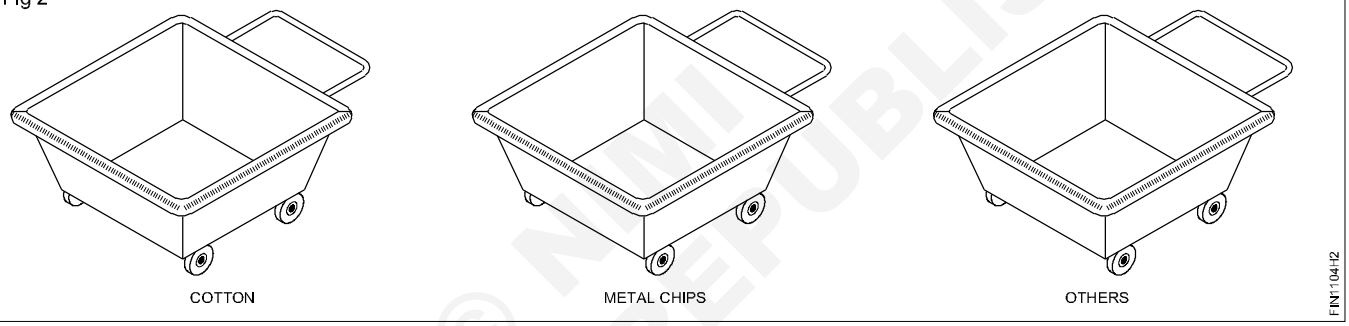


Fig 2



Job Sequence

- Separate the cotton waste.
- Collect the chips by hand shovel with the help of brush. (Fig.2).
- 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 material given in fig 1 and fill in table 1

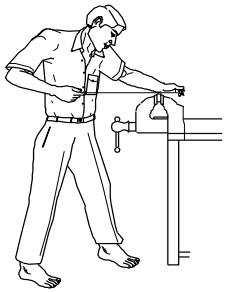
Table1

S. No.	Name of the material
1	
2	
3	
4	
5	

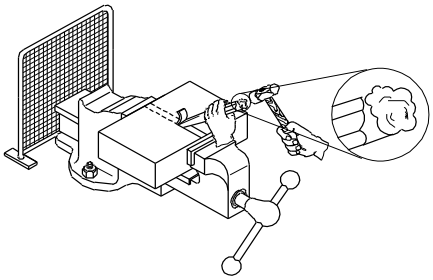
Hazard identification and avoidance

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

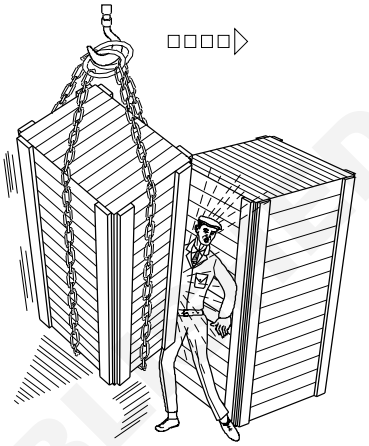
Fig 1



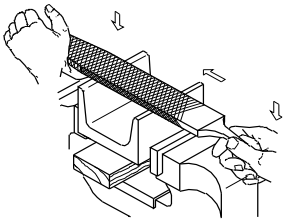
1 WORKING BARE FOOT IN SHOP FLOOR



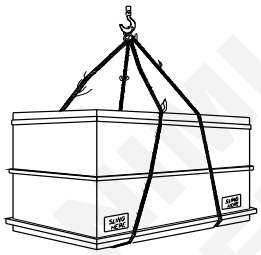
5 CHIPPING METAL SURFACE WITH MUSHROOM HEAD CHISEL



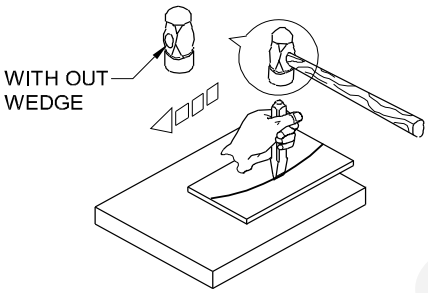
8 LIFTING A LOAD WHILE PEOPLE WORKING NEARBY



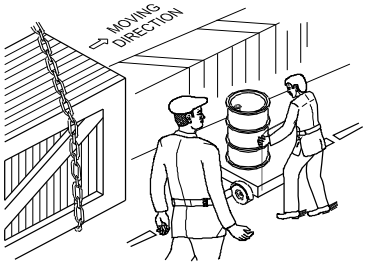
2 USING FILE WITHOUT HANDLE



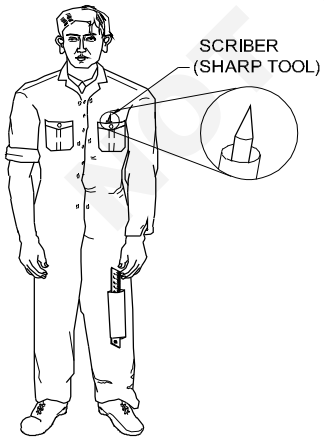
6 LIFTING LOAD WITH DAMAGED SLINGS



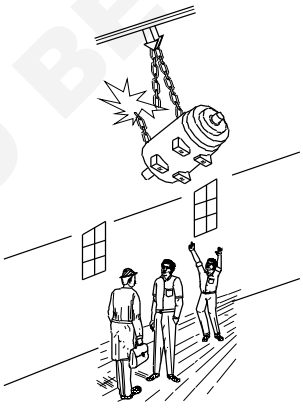
3 STRIKING ON CHISEL HEAD WITH BALL PEIN HAMMER WITHOUT WEDGE



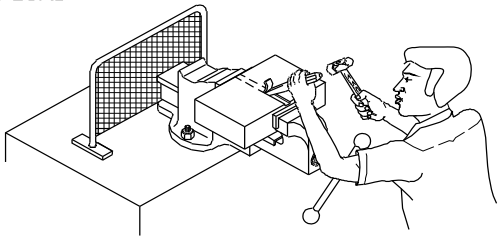
9 NO OBSTACLE WHILE MOVING THE LOAD



4 KEEPING SCRIBER SHARP EDGE OPEN IN POCKET



7 STANDING BELOW A SUSPENDED LOAD



10 CHIPPING ON METAL SURFACE WITHOUT SAFETY GOGGLES

FI20N1105H1

Job Sequence

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

- Study the drawing of industrial hazards.
- Identify the type of hazards.
- Name the hazards against their names.
- Record the hazards and avoidance in Table 1.

Table 1

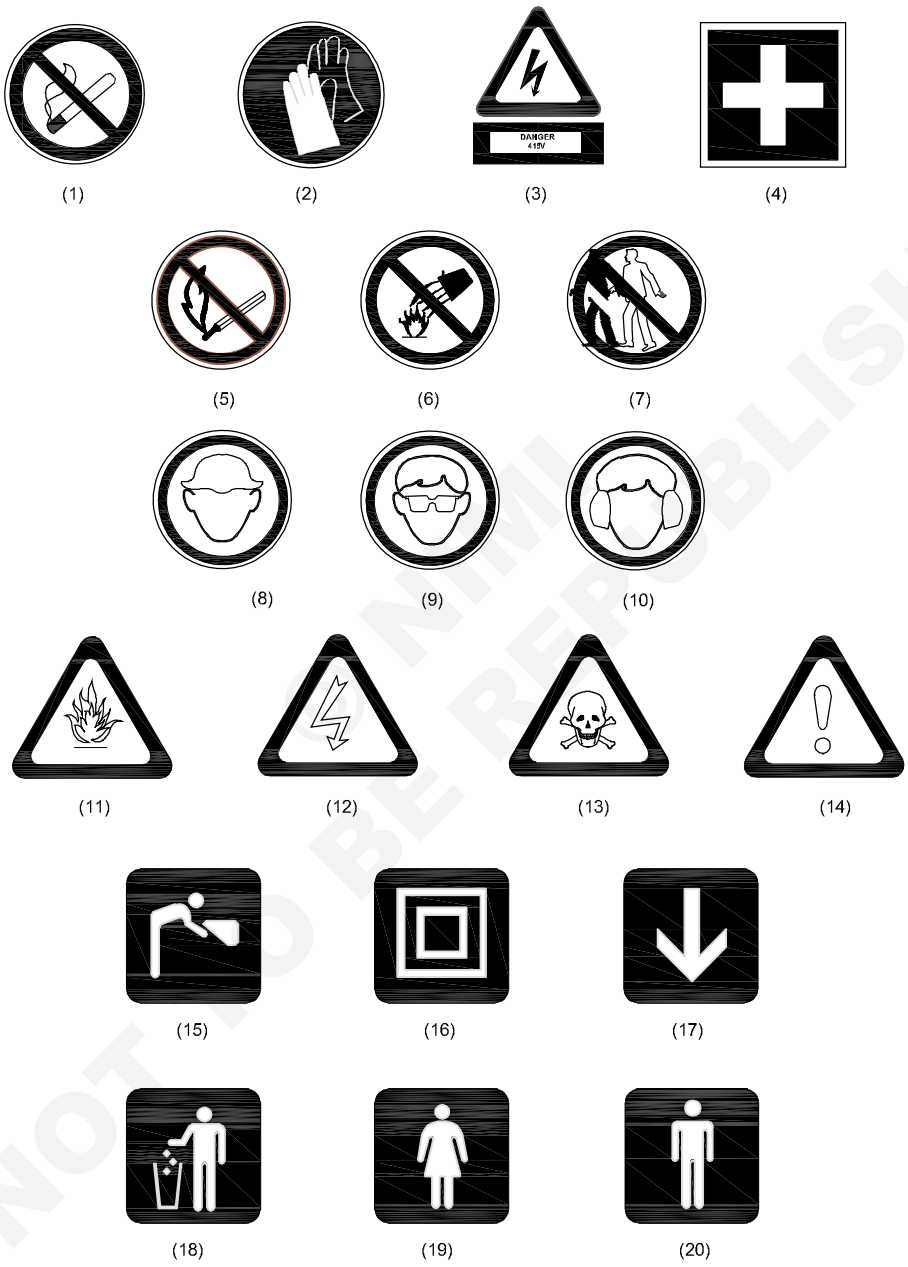
S. No.	Identification of hazards	Avoidance
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Get it checked by your instructor

Safety sign 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 sign**
- **record the meaning of safety sign in the table given.**

Fig 1



FI20N1106H1

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 description of the safety sign in Table 1.

Table 1

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

- Get it checked by your instructor.

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

Objectives: At the end of this exercise you shall be able to
- **adopt preventive measures to avoid electrical accidents**
- **take care of a person with electrical accident.**

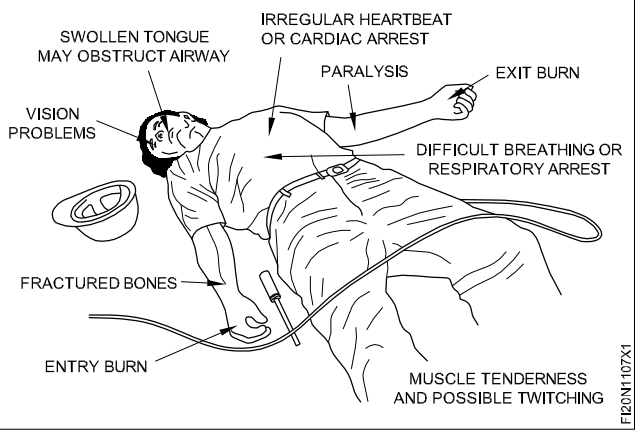
Note: The instructor shall arrange suitable electrical Safety poster/chart/slogan appropriate to this exercise

Preventive measures for electrical accidents

- Never touch any electrical apparatus /machinery with wet hands or while standing in water.
- If you get a tingle or shock when touching any electrical item, a sink, tub, or other wet area, turn off the power at the main panel and immediately call an electrician.
- Don't use damaged or broken cords/ wires or plug in anything with a missing prong.
- When unplugging, don't pull the cord; pull it by the plug.
- Don't overload sockets; use a power extension board with a safety switch.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Avoid for water or chemical spills on or near electrical equipment. Wear rubber shoes in wet areas.
- Cover unused outlets and keep metal objects away from outlets. you should always take extra care to ensure that you do not come into contact with the exposed live wires as this runs the risk of shock and burns.
- Put a notice nearby to the appliance to inform others of the danger and to ensure that it is protected until you are able to schedule repairs.
- Use safe work practices every time electrical equipment is used.
- All electrical installations regardless of whether at home or in the workplace, must be grounded, which is otherwise known as earthing to track down any excess electricity, the most effective route to return to the ground without posing any safety risks.
- It is safe to work on the electrical equipment that is plugged in with only dry hand and wear non-conductive gloves and insulated-soles shoes.
- Disconnect the device from the source in the period of service or maintenance of the device.
- Disconnect the power source before servicing or repairing electrical equipment.
- All electrical cords should have sufficient insulation to prevent direct contact with wires.
- In a laboratory/workshop it is particularly important to check all cords before each use, since corrosive chemicals or solvents may erode the insulation.
- Damaged cords should be repaired or taken out of service immediately, especially in wet environments such as cold rooms and near water baths.
- Keep away from the energized or loaded circuits Arcing, sparking, or smoking from the equipment
- If the device interacts with water or other liquid chemicals, equipment must be shut off power at the main switch or circuit breaker and unplugged.
- If any individual comes in contact with a live electric line, do not touch the individual or equipment / source/ cord; disconnect the power source from the circuit breaker or pull out the plug using a leather belt.
- always stay at least ten feet away from the overhead power lines, carry highest voltage, which means that should anyone come into contact with them, there is a significant risk of not only electrocution but also severe burns.

First Aid for Accidental Electric Shock Victims (Fig 1)

Fig 1



- Ensure that you are taking sufficient safety precaution to protect yourself before going to help the other person met with accidental electric shock.
- Talk to the person and ask loudly, "Are you OK?"; make him feel comfortable.

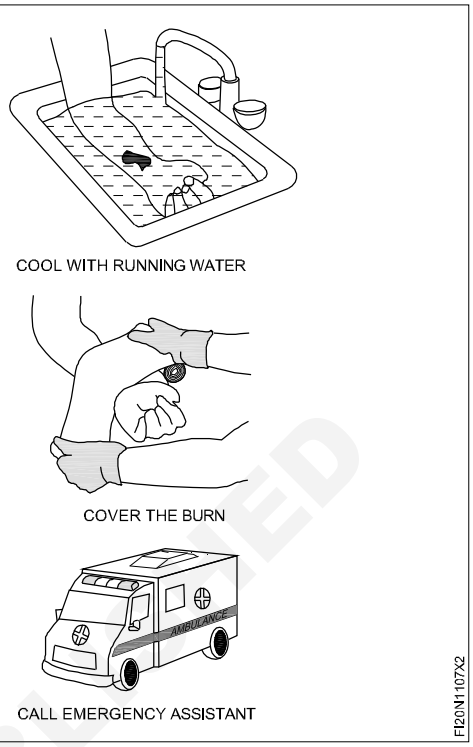
- Check for ventilation and airways; clear obstruction and provide fresh air flow.
- Check for signs of normal breathing; observe breathing.
- If not breathing normally, begin CPR
- Unplug the appliance or turn off the power at the control panel.
- If you can't turn off the power, use a dry wooden piece, like a broom handle, dry rope or dry clothing, to separate the victim from the electrical contact / power source.
- Do not try to move the victim touching a high voltage wire; Call for emergency help/immediate superior for assistance.
- Unconscious victims should be placed on their side to allow drainage of fluids; Keep the victim lying and observe for the symptoms shown in Fig.1
- Do not move the victim if there is a suspicion of neck or spine injuries call for the ambulance service.
- If the victim is not breathing, apply mouth-to-mouth resuscitation. If the victim has no pulse, begin cardiopulmonary resuscitation (CPR). Then cover the victim with a blanket to maintain body heat, keep the victim's head low and get medical attention.

First Aid for Accidental Electrical Burn Victims

Electrical burns vary in severity depending upon the following conditions

- how long the victim is in contact with the electric current;
- the strength of the current flow;
- the type of current AC or DC; and
- the direction of the current takes through the body.
- Observe the person, if the person is conscious and there are no signs of shock (such as being cold, clammy, pale and having a rapid pulse)
- Do not apply grease or oil to the burn.
- Cover the burn with a dry, sterile dressing.
- There may be more than one area burned.
- If the person has electrical burn, check for shock and follow the outlined points shown in Fig.2

Fig 2



- Keep the victim from getting chilled; Seek medical attention as soon as possible.

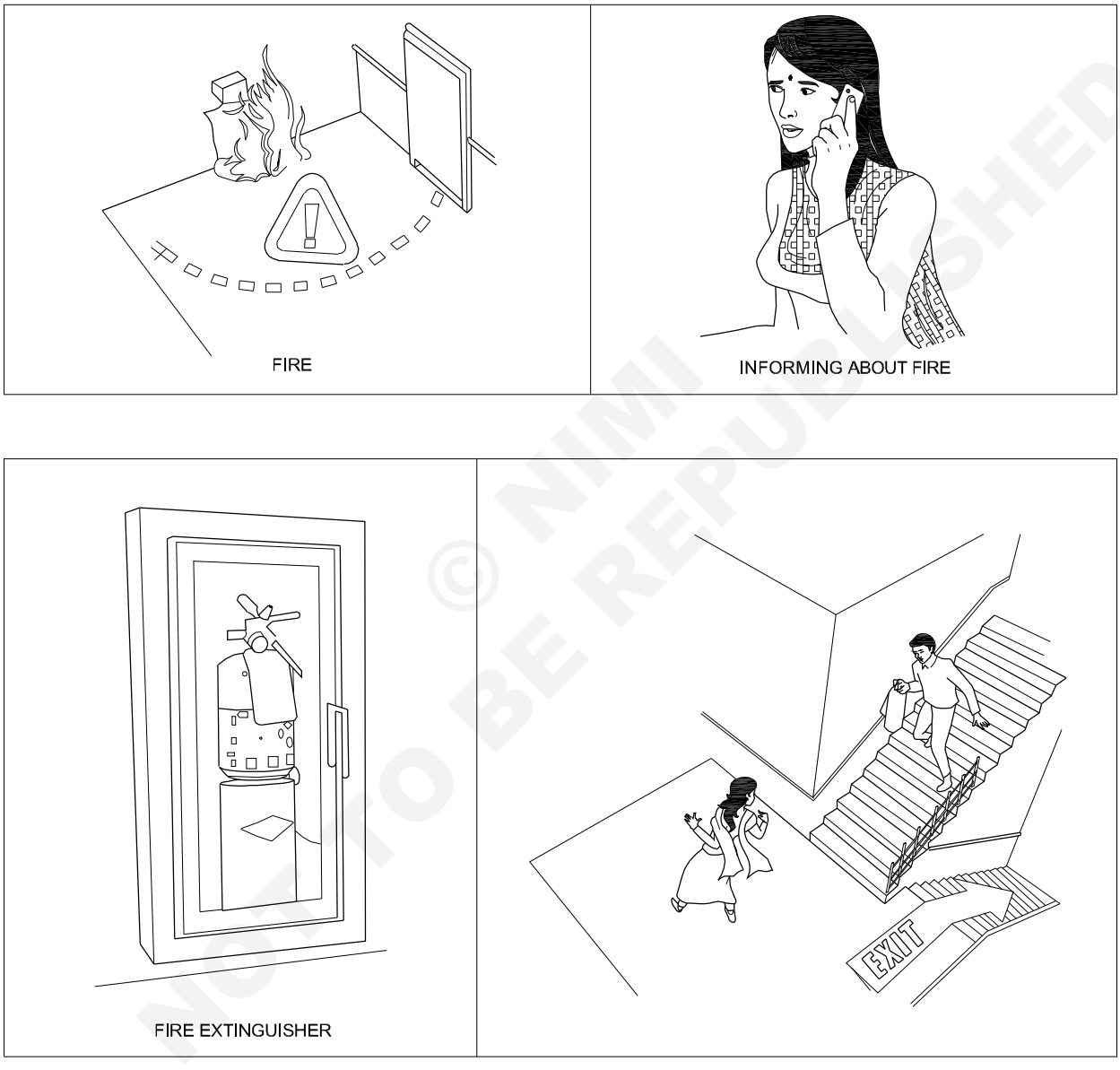
Accidental Electrical Fire

- Keep flammable materials away: Electrical appliances or outlets that come into contact with flammable materials that may trigger a fire.
- Inspect electrical wiring: Have your electric wiring checked to prevent electrical fires. Wiring does not last forever, so it is a good idea to have your wiring checked
- Be wary of certain appliances: If an appliance blows a fuse, trips a circuit, or sparks while being used, unplug the appliance immediately, and check to see if it needs to behave it repaired or replaced.
- Check Switches or outlets that are hot to touch and/or emit an acid odour; Inspect and repair outlets and switches.
- In case of electrical fire, use only CO_2 type of Fire extinguisher.

Uses 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



FI20N1108H1

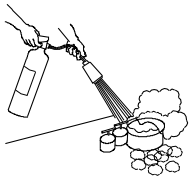
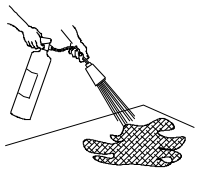
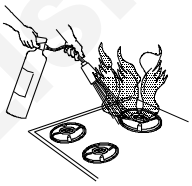
Job Sequence

Extinguishing fire

- Alert people surrounding by shouting fire, fire, fire.
- Inform fire service or arrange to inform immediately.
- Open emergency exist and ask them to go away.
- Analyze and identify the type of fire. Refer Table1.

All fire extinguisher are labelled to indicate which class of fire they are designed to combat.

Table1

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

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.

Stand back: Face the fire and keep your back to the exit stay between six and eight feet away from flame.

Operator: Operate the fire extinguisher

Most of the fire extinguisher operator the same basic way stand six to eight feet away from the fire and remember to PASS - PULL - AIM - SQUEEZE - SWEEP.

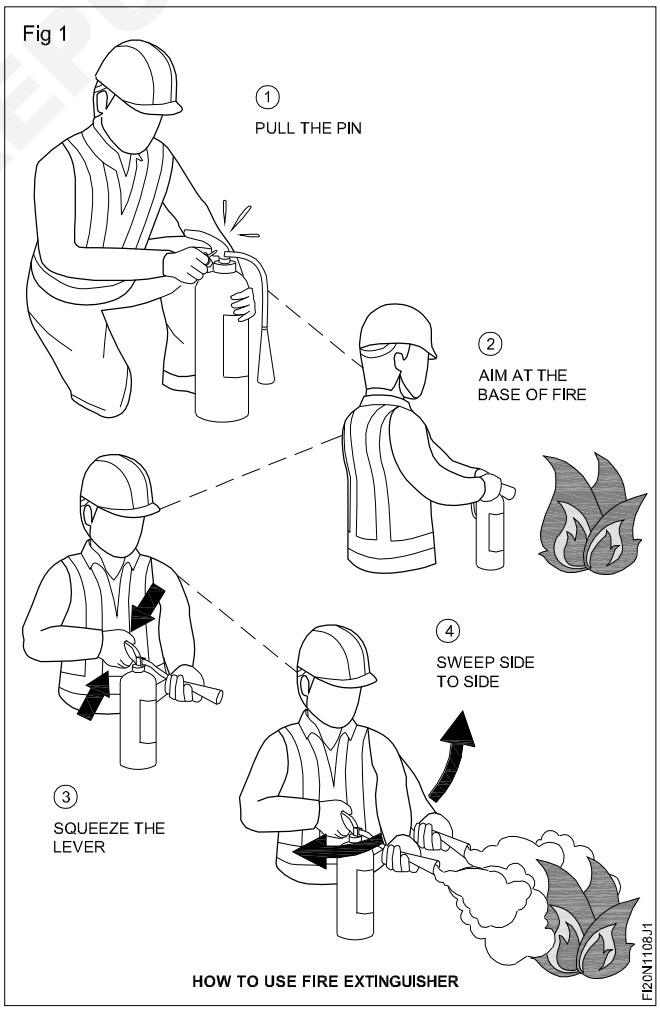
PULL the pin: This will allow you to discharge the extinguisher. (Fig 1)

AIM at the base of fire: If you aim at the flames (Which is freuquently the temptation). The extinguishing agent will fly right through and do no good. (Fig 2)

Squeeze the top handle or lever: This depress a button that releases the pressurised extinguishing agent in the extinguisher. (Fig 3)

Sweep from side to side until the fire is completely put off. Start using the extinguisher from distance away. Then move forward. Once the fire is put off keep on eye on the area incase re-ignite. (Fig 4)

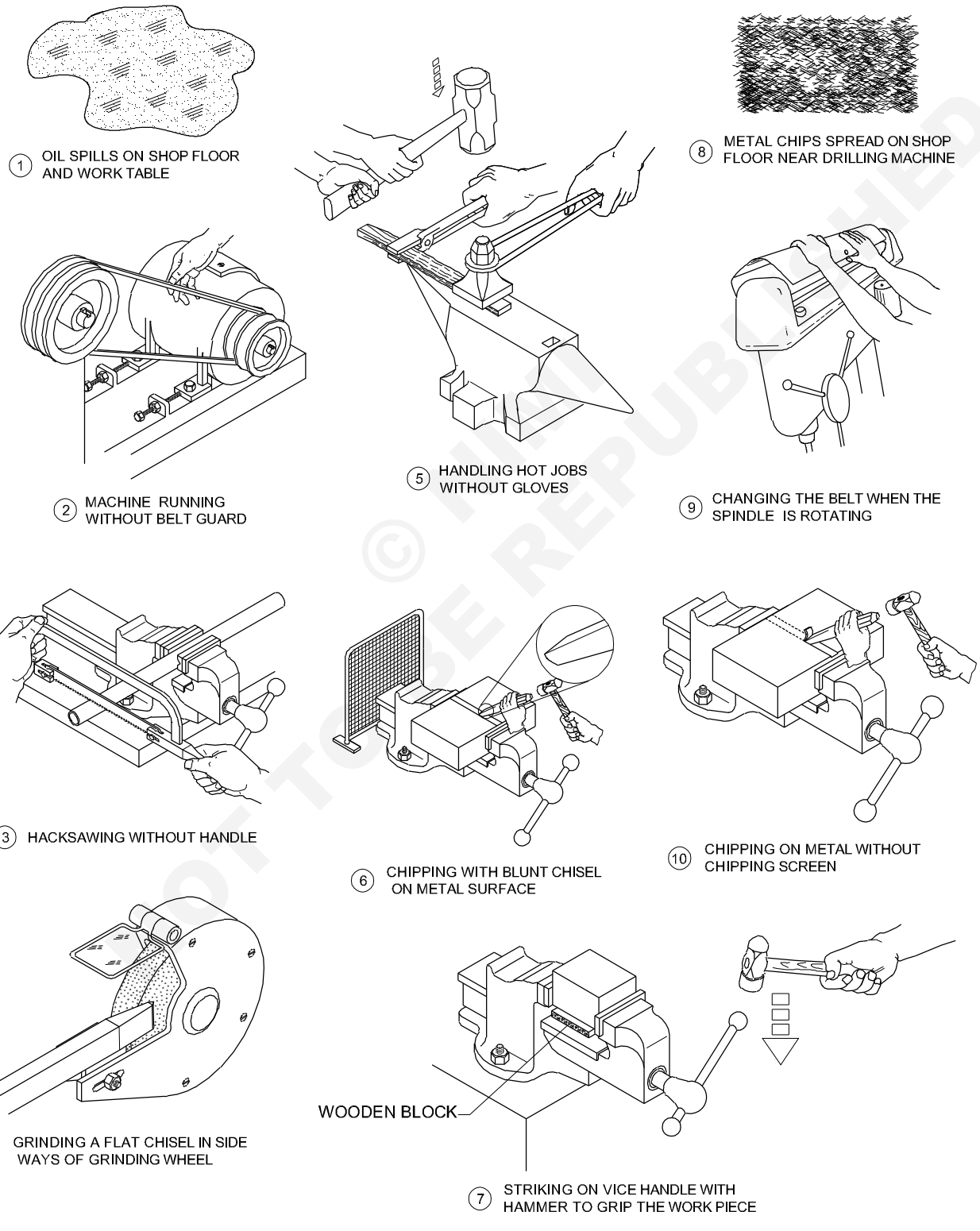
Fig 1



Practice and understand precautions to be followed while working in fitting jobs

Objective: At the end of this exercise, you shall be able to
- **record the precaution to be followed while working in fitting jobs.**

Fig 1



Job Sequence

The instructor shall guide and demonstrate the students to practice and understand precautions to be followed while working in fitting jobs.

- Record the precautions to be followed while working in fitting job in Table 1

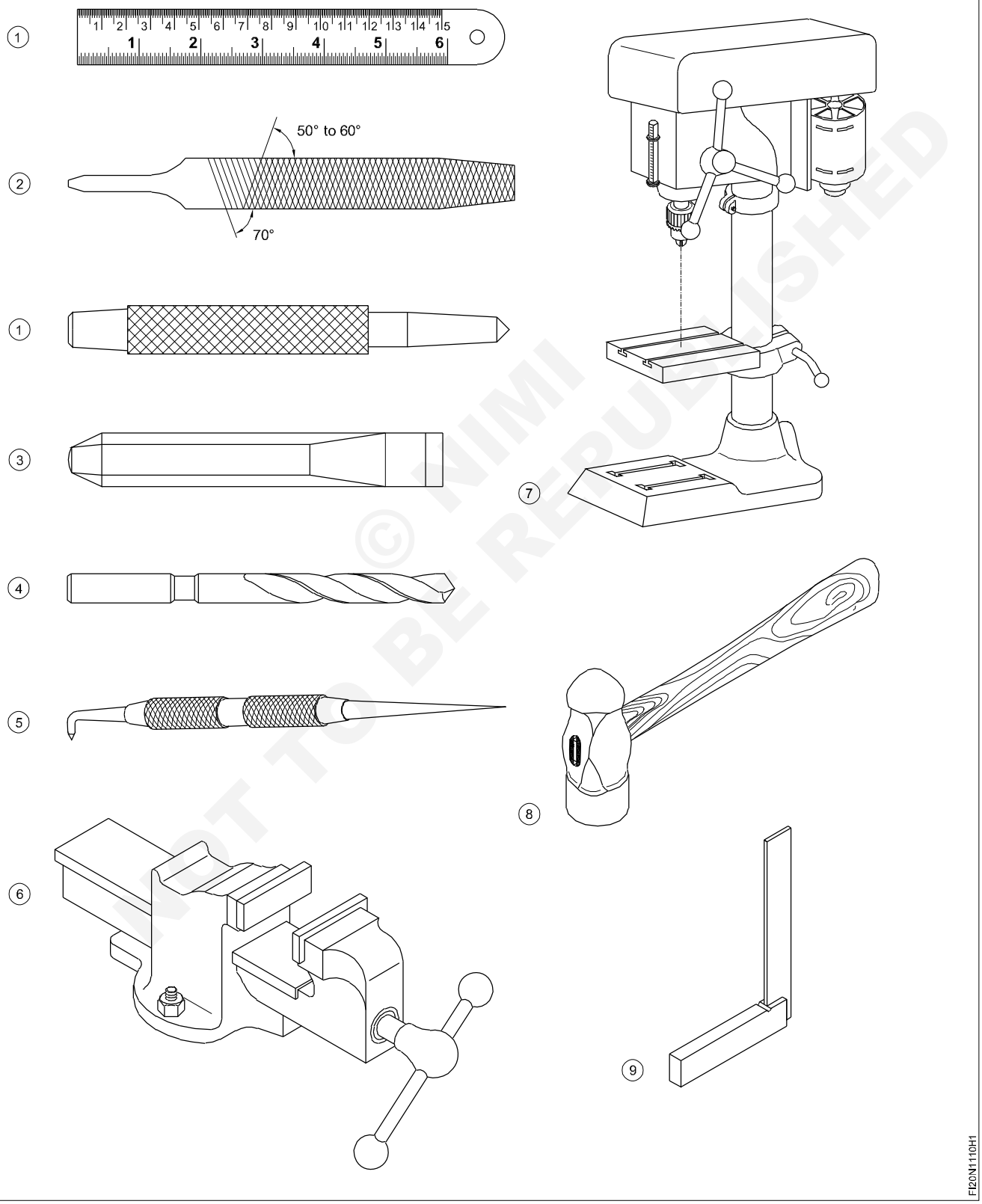
Table 1

Fig. No.	Description	Record precautions to be followed while working in fitting job
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Fill up and get it checked by your instructor.

Safe use of tools and equipments used in the trade

Objective: At the end of this exercise, you shall be able to
- **record the safety points while using the Machinist trade tool and equipments.**



Job Sequence

The instructor shall emphasise the students about the safe use of tools and equipmments used in trade and guide them to record the safety points

- Record the precautions to be followed while working in fitting job in Table 1

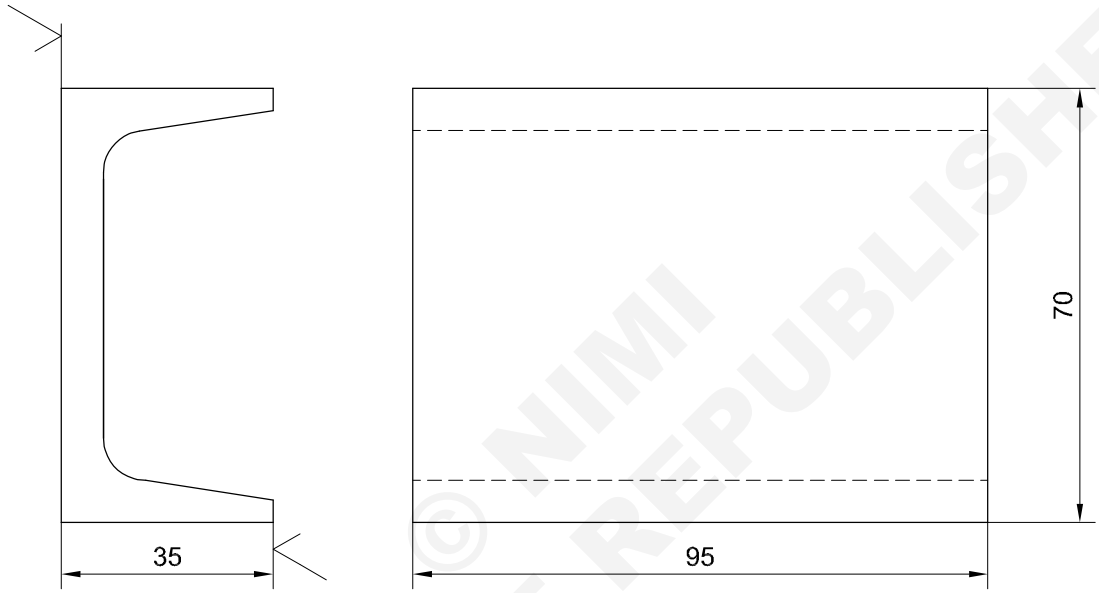
Table 1

Fig. No.	Description	Record precautions to be followed while working in fitting job
1		
2		
3		
4		
5		
6		
7		
8		
9		

- Fill up and get it checked by your instructor.

Study the drawing to plan the job/ work Identification of tools and equipments as per desired specifications for marking, filing and sawing

Objectives : At the end of this exercise you shall be able to
- **read the drawing and understand**
- **identify the marking tools, cutting tools and sawing tools**
- **to mark and cut as per drawing and to follow safety precautions.**



Job Sequence

- Study the given job drawing
- Plan the tools and marking tools required
- Make availability of steel rule, jennycaliper, try square and scriber
- Punch hammer, and regular files required for filing the job

Required files

- Flat rough file - 300mm
- Flat bastard file - 250mm, flat second cut files - 250 mm file card

Required sawing tools

- Hacksaw blade and adjustable hacksaw frame.

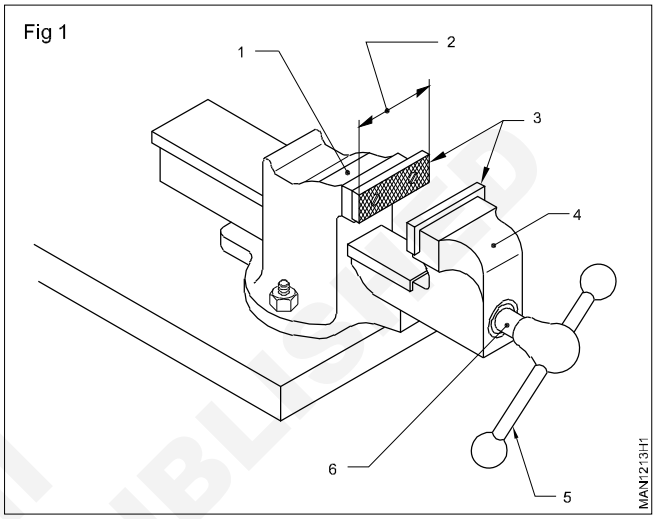
1	ISLC 75x40 - 100	-	DRAWING	-	-	1.2.11
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**STUDY THE DRAWING TO PLAN THE JOB/WORK FOR MARKING,FILING AND SAWING**				DEVIATIONS ±0.5	TIME:
					CODE NO. MAN1211E1	

Familiarisation of bench vice

Objective : At the end of this exercise you shall be able to
- **name the parts of bench vice**

Job Sequence

The instructor may give demo to the trainees. Explain the parts of bench vice and how to hold the job and ask the trainees to write each parts name in the table.



- Observe the each part in Fig 1.
- Record the bench vice part name in the Table -1

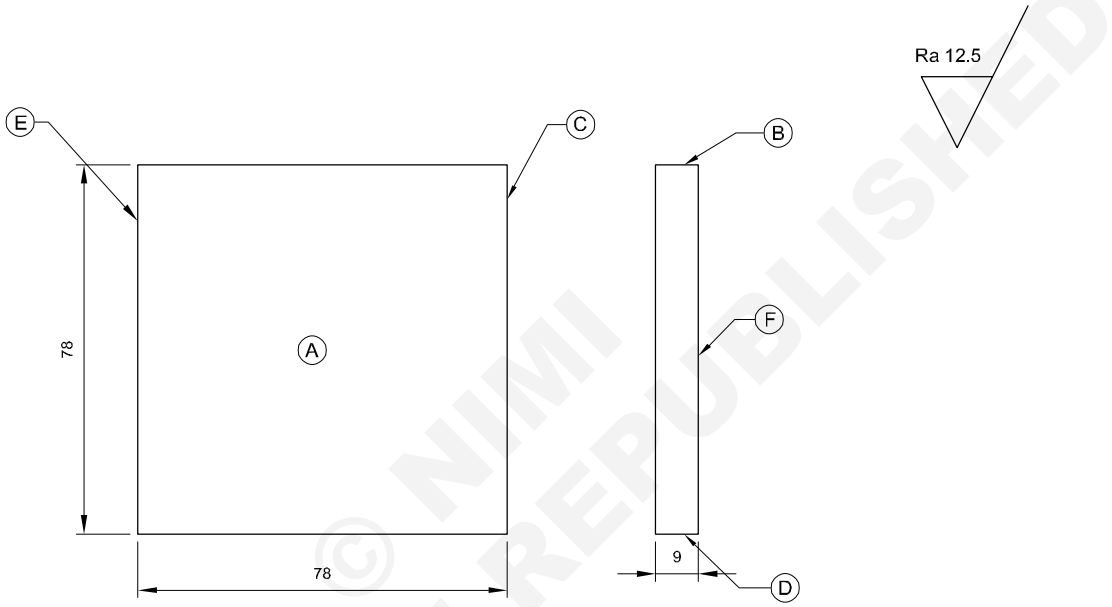
Table - 1

Part.No	Name of the part
1	
2	
3	
4	
5	
6	

- Get it checked by your instructor

Filing flat and square (Rough finish)

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**
- **check the flatness of filed job using straight edge/try square blade**
- **check the squarness of the job with try square.**



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)

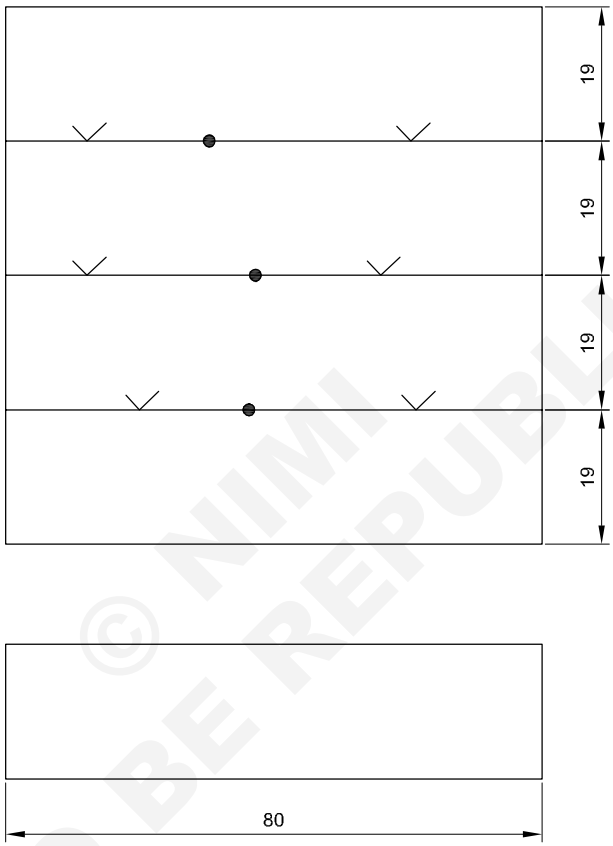
- Set Jenny caliper to 74 mm using steel rule
- Draw parallel lines of 74 mm to side (B) and (C)
- Punch the marked line using dot punch and ball pein hammer
- Set and file sides (D) and (E) to 74mm and maintain squareness to all other sides.
- Maintain (D) and (E) parallel to side (B) and (C) (Fig.2)
- Check the dimensions with a steel rule and squareness with a try square
- File surface (F) and maintain the thickness of 9mm parallelism to side A.
- Remove sharp edges. Apply little amount of oil and preserve it for evaluation.

1	80 ISF 10-80	→ EX.NO.1.2.14	Fe310	-	-	1.2.13
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	FITTING FLAT AND SQUARE (ROUGH FINISH)	TOLERANCE :	TIME :
		CODE NO.MA20N1213E1	

Marking with scriber and steel rule

Objectives: At the end of this exercise you shall be able to
- **filing squareness and flatness**
- **marking with scriber and steel rule.**



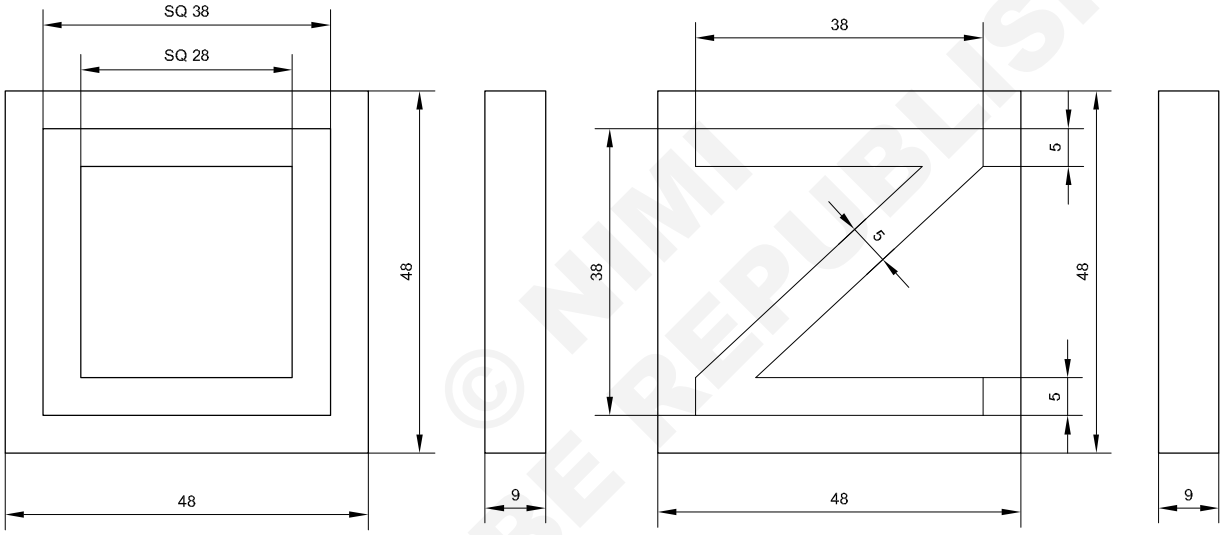
Job Sequence

- Check the raw material size
- File to flatness and squareness for size of 80x80x10mm
- Apply marking media
- Keep the job on the marking table
- Mark 20mm,40mm and 60mm from one edge using steel rule and scriber.
- Mark two arrow on the above dimensions
- Join the two arrows for full length of job by using steel rule and scriber
- After scribing four lines handover the job for evaluation.

1	-	EX.NO.1.2.13 ←	Fe310	-	-	1.2.14
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	MARKING WITH SCRIBER AND STEEL RULE				TOLERANCE :±0.5mm	TIME :
					CODE NO.MA20N1214E1	

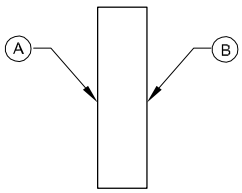
Filing practice, surface filing, marking of straight and parallel lines with odd leg caliper and steel rule

Objectives : At the end of this exercise you shall be able to
- **file and finish the flat to the required size**
- **mark lines using odd leg caliper**
- **punch the marked lines.**



SIDE 'A'

SIDE 'B'



NOTE: USE SAME MATERIAL FOR BOTH THE MARKINGS (SIDE A&B)

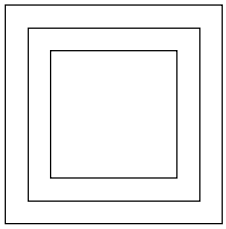
1	50 ISF 10-50	-	Fe310	-	-	1.2.15
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**FILING PRACTICE,SURFACE FILING MARKING OF STRAIGHT AND PARALLEL LINES WITH ODD LEG CALIPERS AND STEEL RULE**				TOLERANCE :	TIME :
					CODE NO. MAN1216E1	

Job Sequence

Mark on side A

- Check the raw material size using steel rule
- File three sides mutually perpendicular to each other.
- Mark and file to size 48x48x9 mm.
- Mark on side (A) with two square as per dimensions using odd leg caliper and steel rule.(Fig.1)

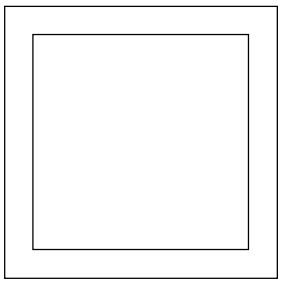
Fig 1



MAN1216H1

- Set 5 mm in odd leg caliper and draw parallel lines to all sides (Fig 2)

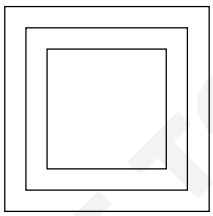
Fig 2



MAN1216H2

- Similarly, set 10 mm in odd leg caliper and draw parallel lines to all sides. (Fig 3) Punch on the marked line.

Fig 3

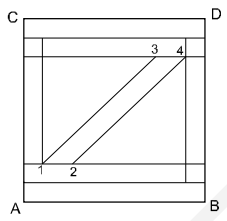


MAN1216H3

Mark on side B

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

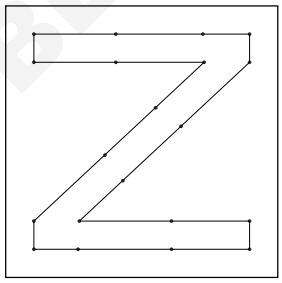
Fig 4



MAN1216H4

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

Fig 5

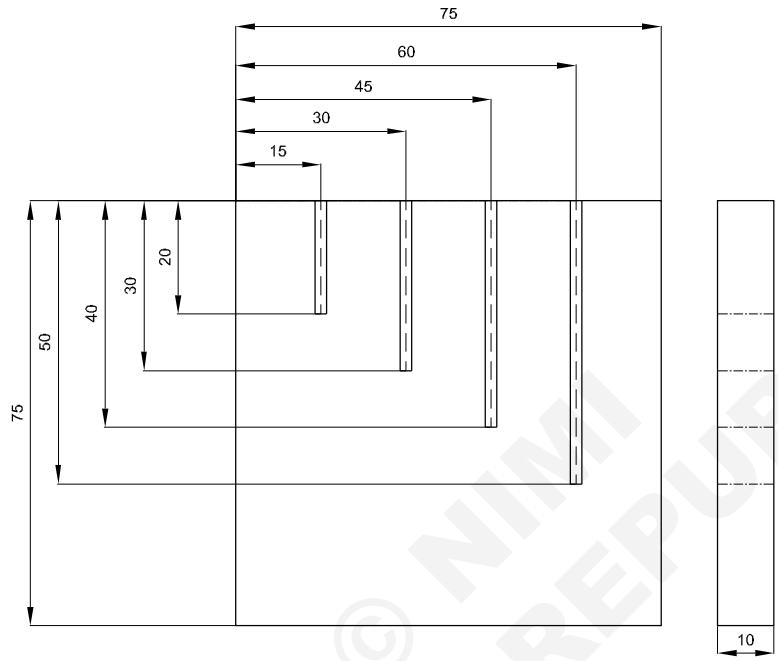


MAN1216H5

Marking out lines, gripping suitably in vice jaws, hack sawing to given dimensions

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 marked lines.**

TASK -1



TASK -2

1	60 x ISF10 - 60	-	Fe310 PRE - MACHINED	-	TASK - 2	1.2.16
1	75 ISF10 - 75	-	Fe310 PRE - MACHINED	-	TASK - 1	1.2.16
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MARKING OUT LINES,GRIPPNG SUITABLY IN VICE JAWS,HACK SAWING TO GIVEN DIMENSIONS**	TOLERANCE : ±0.5mm	TIME :
		CODE NO. MA20N1216E1	

Job Sequence

TASK 1: **Marking and hacksawing**

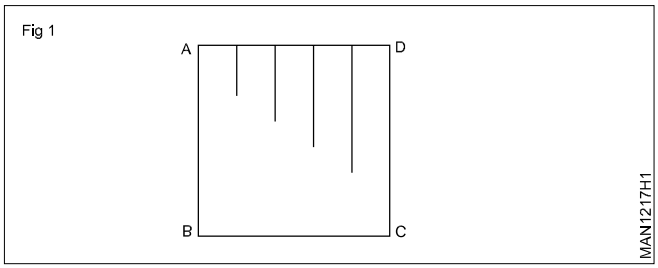
1 Check the pre - machined size of 75x75x10 mm using steel rule.

2 Apply marking media cellulose lacquer evenly on the surface of the Job.

3 Place the job in levelling plate.

4 Set the measurement 15 mm in Jenny caliper using steel rule.

5 Draw parallel line of 15 mm to the side "AB" with the help of Jenny caliper as shown in Fig 1.



6 Similarly, Set 30 mm, 45 mm and 60 mm and draw Parallel lines to "AB". (Fig 1).

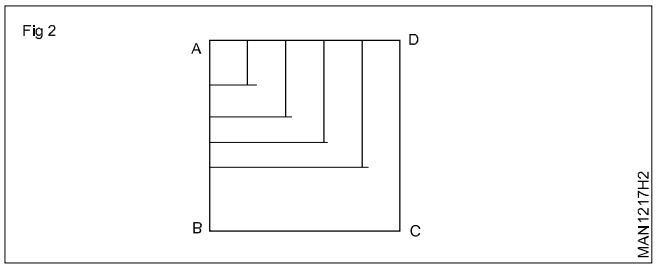
7 Set the measurement 20 mm in jenny caliper using steel rule.

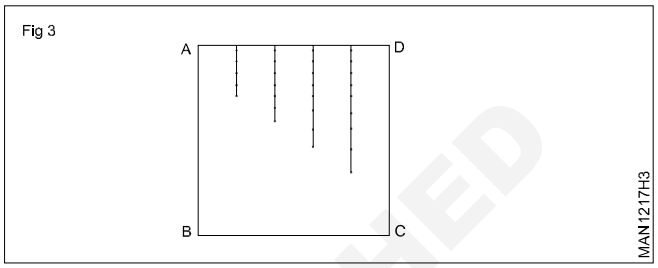
8 Draw parallel line to side "AD" using Jenny caliper.

9 Similarly, set 30 mm, 40 mm and 50 mm and draw parallel lines to side "AD" as shown in Fig 2.

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

11 Hold the Job firmly in Bench vice, keeping side "AD" parallel to vice Jaws.





12 Select 1 mm pitch Hacksaw blade, fix the blade in hack saw frame, pointing teeth in the forward direction.

13 Tighten the blade to the required tension with the wing nut.

14 File a notch at the point of hacksawing to avoid slippage of the blade.

15 Start cutting with a slight downward pressure using Hacksaw.

16 Saw along the lines up to punch marks.

17 Apply pressure in the forward stroke.

18 Release the pressure in the return stroke.

19 Use full length of the blade while sawing.

20 Check the size with steel rule.

TASK 2: **Marking and hacksaw cutting**

1 Check the pre-machined size of 60x60x10mm using steel rule.

2 Apply marking media cellulose lacquer evenly on the surface of the Job.

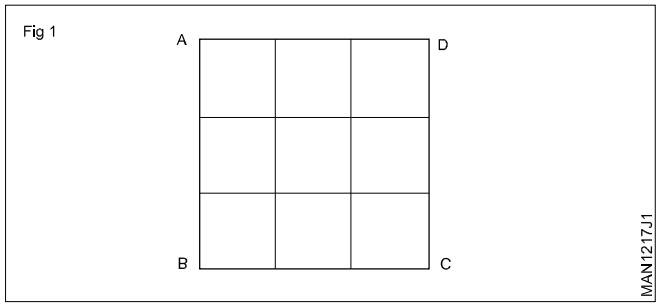
3 Place the job on levelling plate.

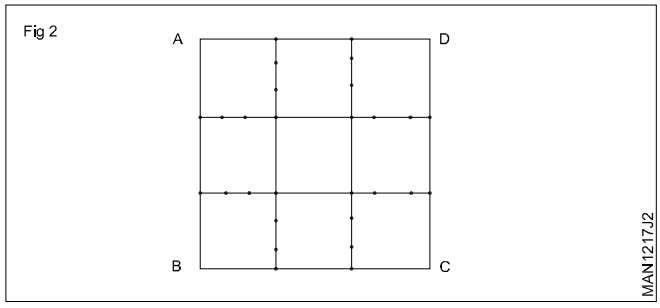
4 Set the measurement 20 mm in Jenny caliper using steel rule.

5 Draw parallel line of 20 mm to the side "AB" using jenny caliper (Fig 1).

6 Similarly, with the same setting of the dimension 20 mm in Jenny caliper, draw parallel lines to "BC", "CD", and "AD". As shown in Fig 1.

7 Punch witness marks on the profile of Job using a dot punch and a Ball pein hammer as shown in Fig 2.

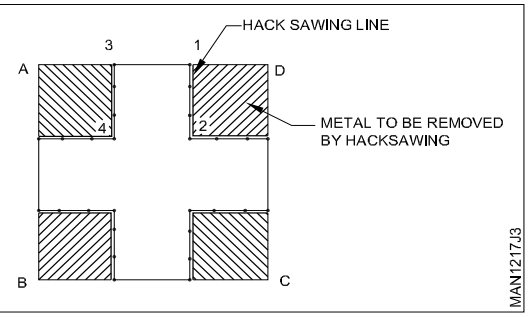




8 Hold the Job firmly in Bench vice, keeping side "AD" parallel to vice Jaws. (Fig 3)

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

Fig 3



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

10 In the same setting, without changing the position of the job cut the line 3 to 4 upto the marked length 20mm in left side as shown in Fig 3.

11 Similarly, turn the job and cut the line 5 to 4, 6 to 7, 8 to7, 9 to 10, 11 to 10 and 12 to 2 as shown in Fig 4.

12 After sawing profile of the Job shown in fig 5, check the size with steel rule.

Fig 4

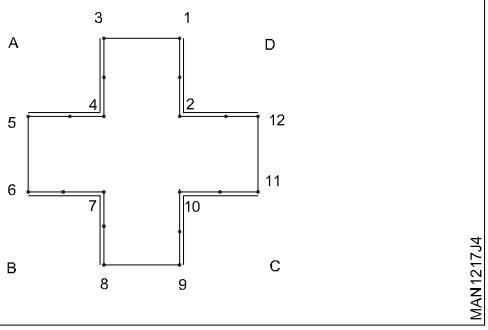
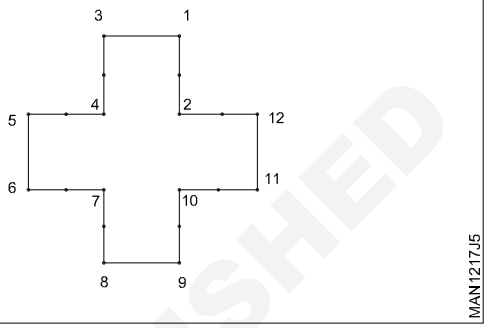


Fig 5



Skill Sequence

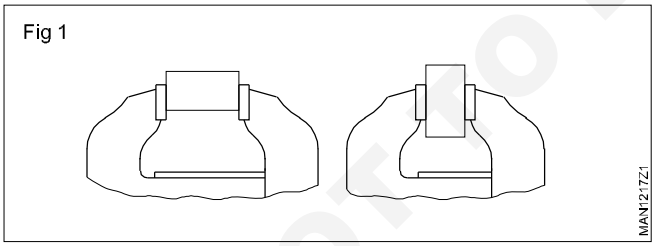
Sawing along a line

Objective: This shall help you to
- **cut along a straight line by hacksaw.**

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

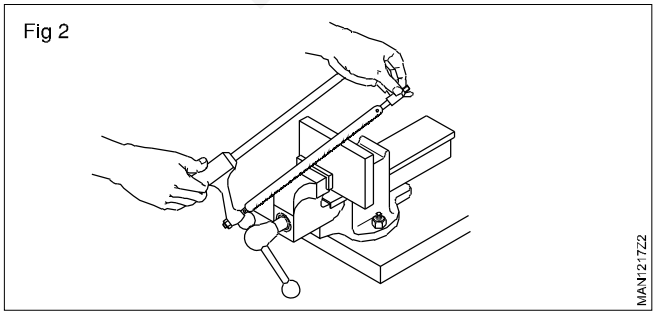
As far as possible hold the job in such a way that the flat or long side can be cut rather than the edge. (Fig 1)

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, finer the blade pitch. Make sure that atleast four teeth are cutting at a time.

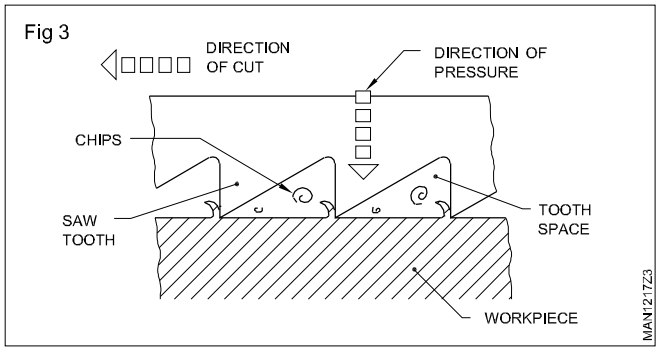
Harder the material finer the blade pitch should be.

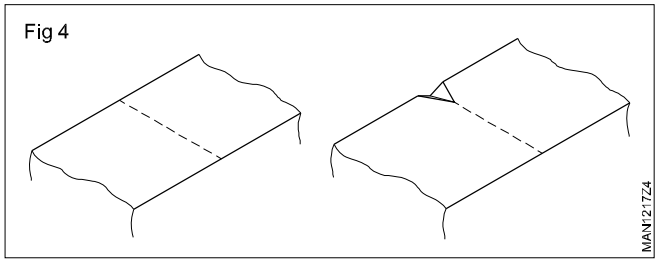
Fix the blade in such away that the teeth are in the direction of cut. (Fig 3)

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.

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

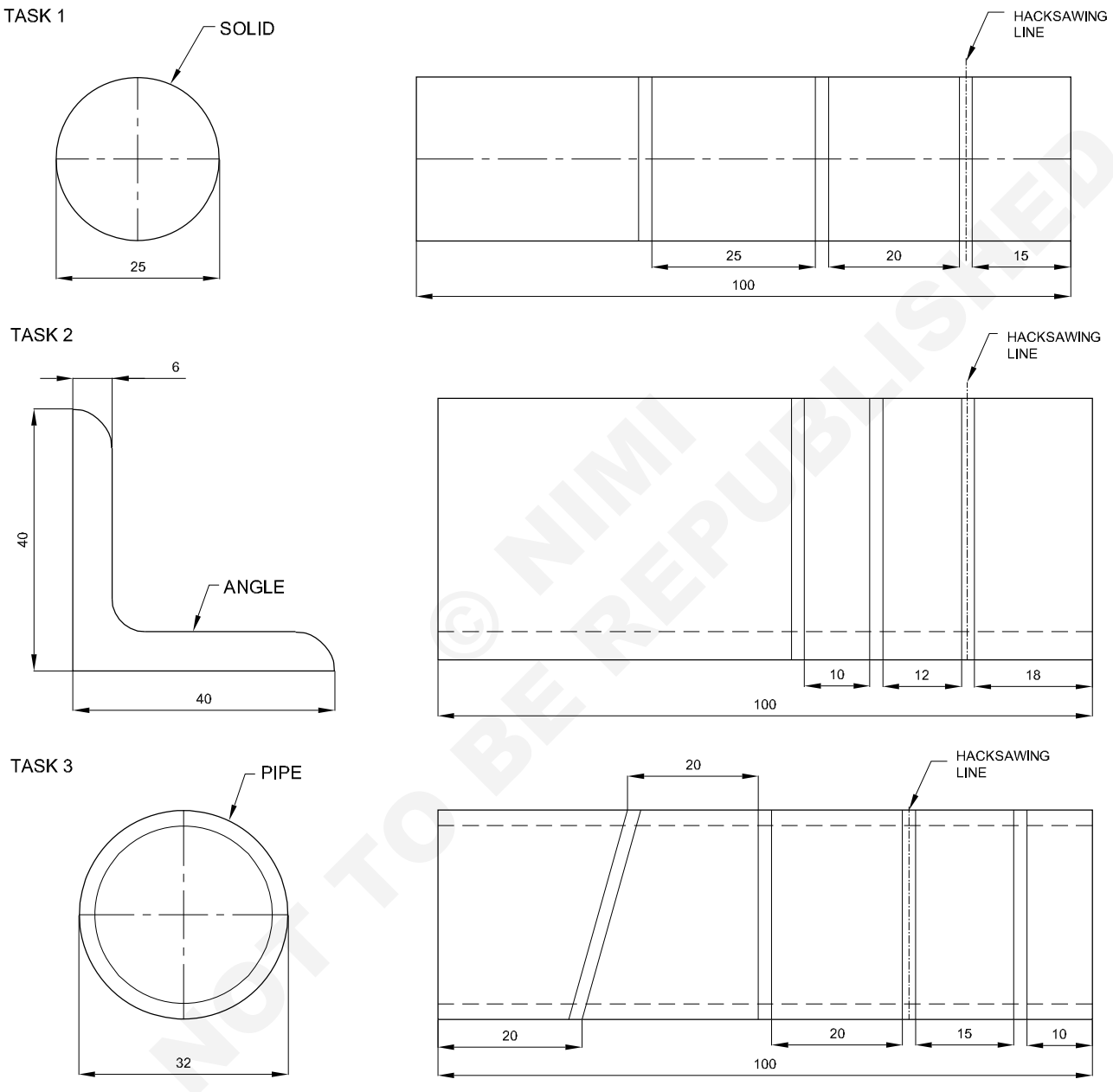
Move the blade strictly in line with the marked direction. Do not tilt the frame while sawing because bending to the blade can cause sudden breakage of the blade.

Resort to cutting from the opposite side in case the deviation from the marked line is excessive.

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

Sawing different types of metals of different sections

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	1.2.17
1	ISA 40x40x6 - 100		Al310	-	TASK - 2	1.2.17
1	Ø32x3.2 - 100 IS:1161	-	Co310	-	TASK - 3	1.2.17
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:
		CODE NO. MA20N1217E1	

Job Sequence

TASK 1: **Sawing on round rod**

1 Check the raw material using steel rule.

2 File the round to size Ø 25 x 100 mm.

3 Remove the burrs from the edges.

4 Apply marking media only where marking is required.

5 Place the round rod on levelling plate.

6 Use 'V' Block to support while marking the round rod.

7 Punch witness marks on the sawing lines with dot punch

8 Hold the Job in bench vice.

9 Fix 1.8 mm pitch hacksaw blade in hacksaw frame.

10 File a notch at the point of cutting to avoid slippage of the blade.

11 Start cutting with a slight downward pressure on round rod using hacksaw.

12 Cut on the hacks awing line giving proper pressure on forward and return stroke using full length of the blade.

13 Cutting movement should be steady while sawing on round rod.

14 While finishing the cut, slow down the pressure to avoid breakage of the blade and injury to yourself and others.

15 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.**

TASK 2: **Sawing on steel angle**

1 Mark and punch the sawing lines.

2 Hold the job in bench vice as shown in Figure.1

3 Fix 1.8 mm coarse pitch blade in hacksaw frame.

4 Cut along the sawing lines with hacksaw.

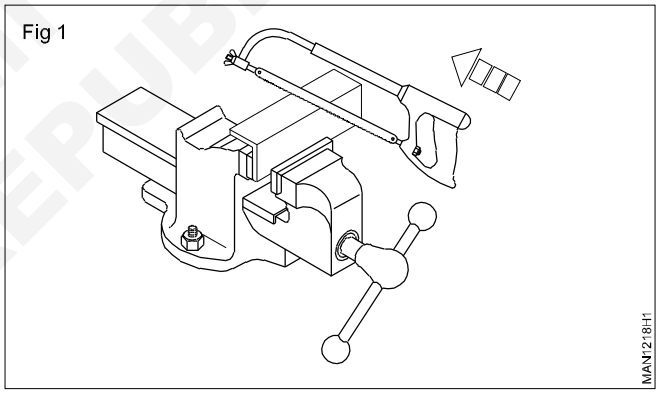
5 Check the size of the angles with steel rule.

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



TASK 3: **Sawing on pipe**

1 Mark and punch the sawing lines.

2 Hold the job in bench vice as shown in Fig 1.

3 Fix 1.0 mm pitch blade in hacksaw frame

4 Cut along the sawing lines with hacksaw.

5 Turn and change the position of the pipe while hack sawing.

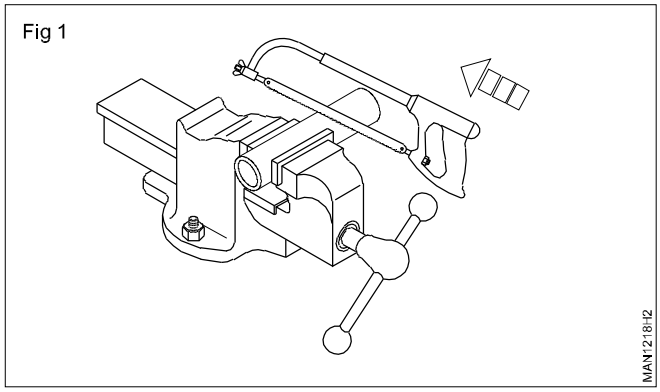
Caution

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

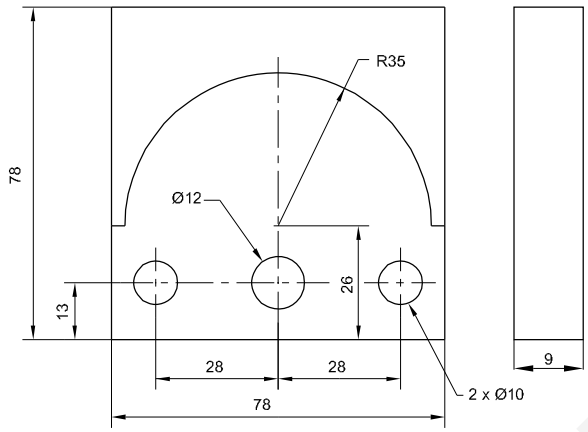
Fig 1



Marking practice with dividers, odd leg calipers, scriber and steel rule (circles, arc, parallel lines)

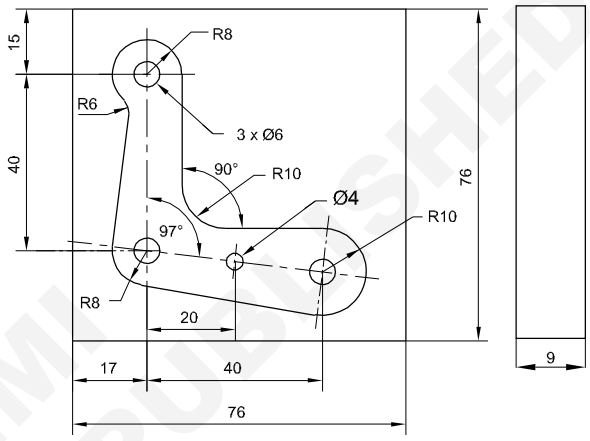
Objectives : At the end of this exercise you shall be able to
- **mark parallel lines with jenny caliper**
- **mark angular lines with a protractor and scriber**
- **mark arcs, circles and tangents with divider and scriber.**

TASK 1



MARKING CURVES & CIRCLES (By Jenny caliper and divider)

TASK 2



MARKING TANGENTS & ARCS

Job Sequence

TASK1: **Marking curves and circles**

1 Check the raw material size using steel rule

2 File the raw material to size 78x78x9 mm

3 Apply marking media cellulose lacquer on the surface of the Job.

4 Set the dimension 13 mm in Jenny caliper and draw parallel line as per drawing with reference to 'xy. (Fig 1)

5 Similarly, set the dimensions 26mm and draw parallel line (Fig 1)

6 Set the dimension 11 mm in Jenny caliper and draw parallel line as per drawing with reference to 'xz'. (Fig 2)

7 Similarly, set the dimensions 39 mm, 67 mm and draw parallel lines. (Fig 2)

8 Punch on the intersecting point of centre lines to draw circle and radius using prick punch 30°

9 Set the radius 5mm, 6mm in divider and draw circles, as per drawing.

10 Set the radius 35 mm and draw arc as per drawing.

11 Punch witness marks on the circles and radius.

12 Preserve it for evaluation.

2	80 ISF 10-80	-	FE 310	-	-	
1	80 ISF 10-80	-	FE 310	-	-	1.2.18
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MARKING PRACTICE WITH DIVIDERS,ODD LEG CALIPERS,SCRIBER AND STEEL RULE (CIRCLES,ARC,PARALLEL LINES)**	TOLERANCE : ±0.5mm	TIME :
		CODE NO. MA20N1218E1	

Fig 1

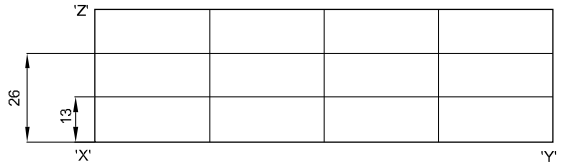
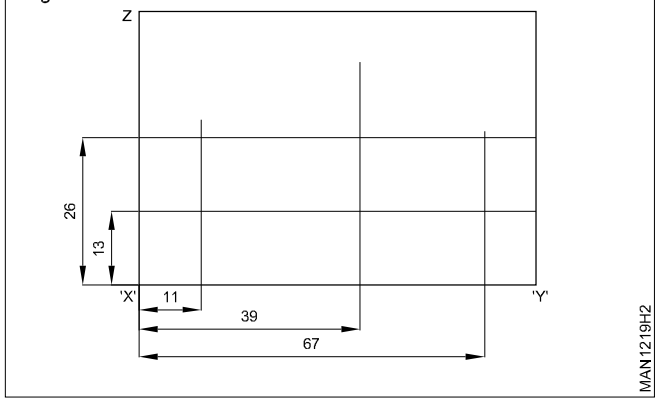


Fig 2



TASK 2: **Marking tangents and arcs**

Step 1

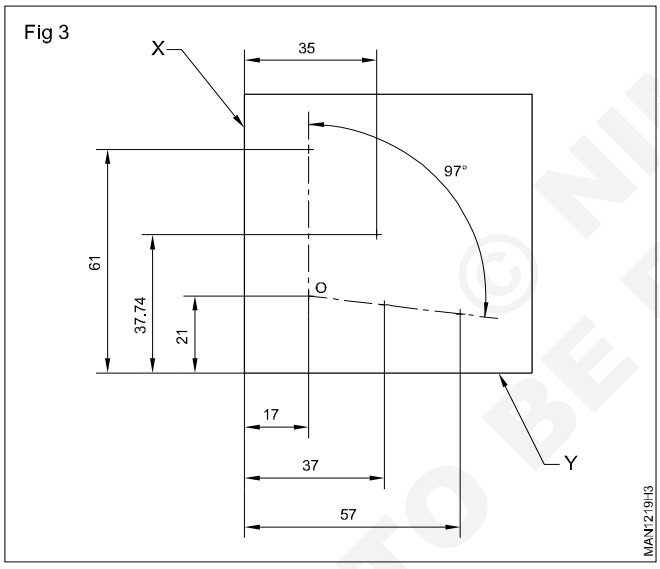
1 Check the material for its size and its squareness

2 Apply marking media on one face of the job.

Step 2

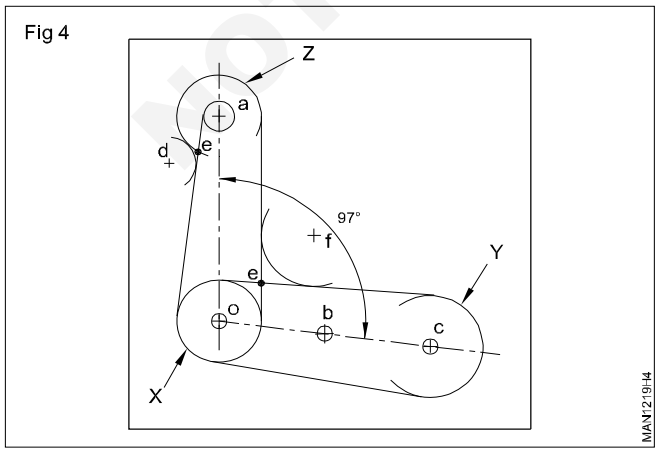
1 Draw parallel lineof 17mm from side x (Fig 3).

Fig 3



2 Mark 21mm and 61mm from side y on the marked parallel line (Fig 3).

Fig 4



3 Set 97° on the bevel protractor

4 Mark 97° line through point 'O' and set the centres of other two circle

5 Punch centre marks on all four circles

Step 3

1 Draw Ø6 mm circle at 'a','o','c' and Ø4 mm circle at 'b'.

2 Draw tangent lines to join x,y and z as shown in (Fig 4)

Step 4

1 Draw an arc, R8 mm from the centre ‘a’ and ‘o’

2 Draw an arc, R10 mm from the centre ‘c’.

3 Draw the tangent lines from the arc drawn, the inter section of the tangent (e) is the centre for joining the tangent with arc.

4 Draw R10 mm arc from the centre at point ‘f’ as shown in Fig.4.

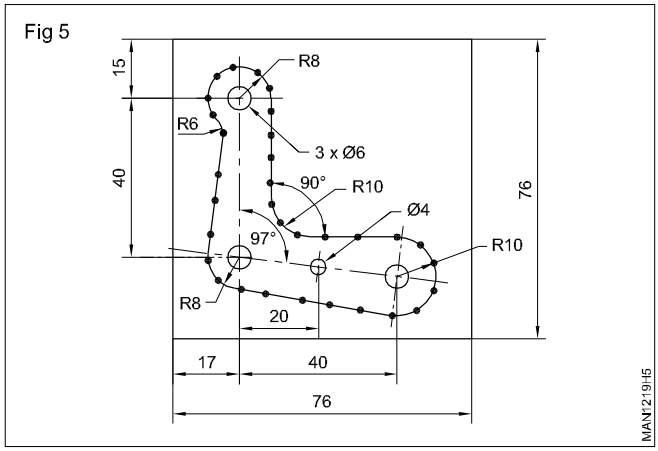
5 Similarly, draw R6 mm arc at point ‘d’

Step 5

1 Punch on the marked lines with equal intervals. (Fig 5).

2 Preserve the job for evaluation.

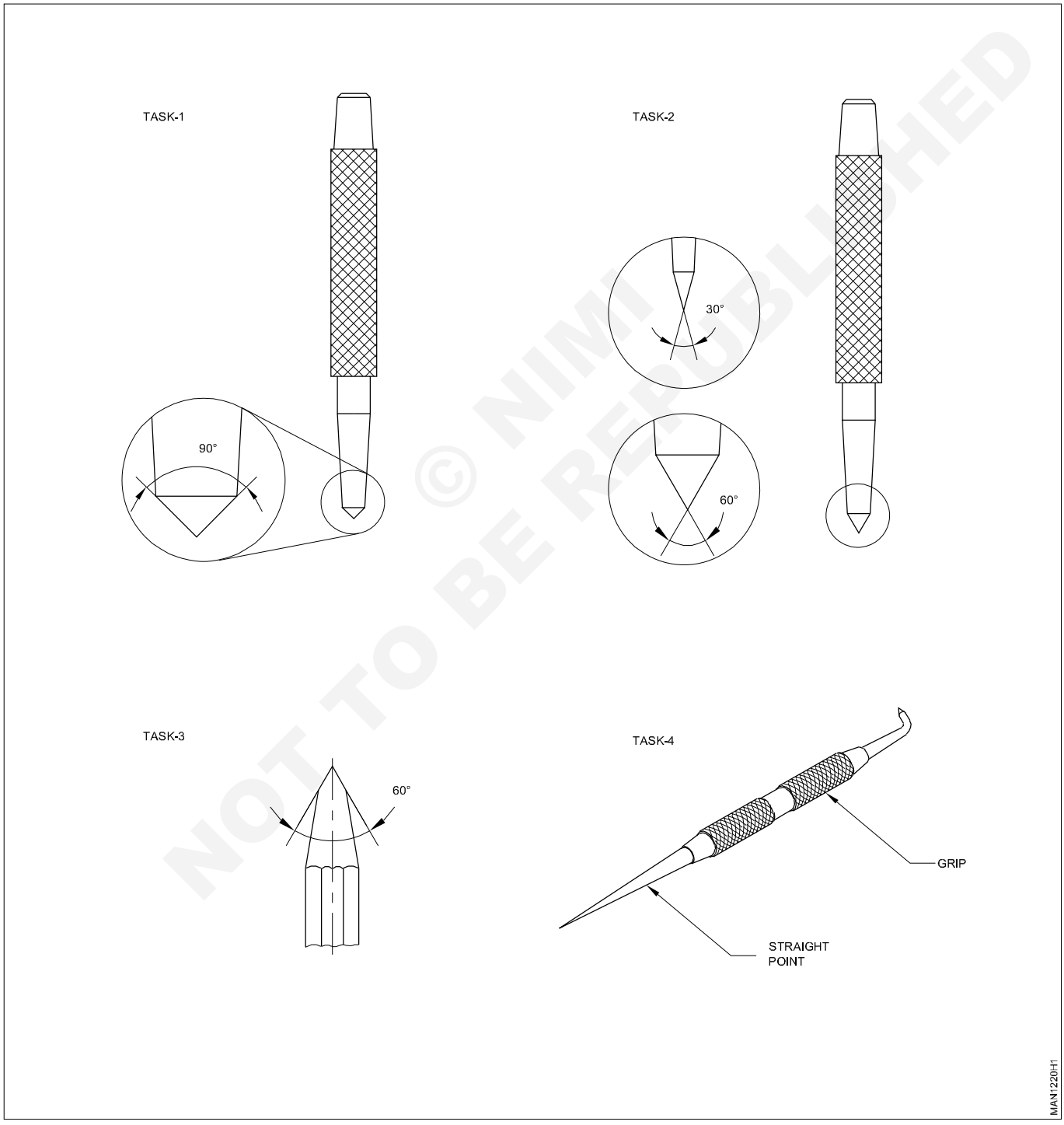
Fig 5



Grinding, center punch, dot punch, chisel and scriber

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**
- **re-sharpen the chisel**
- **re-sharpen scriber**
- **operate safely the pedestal or bench grinding machine.**



Job Sequence

TASK 1 & 2 : **Grinding centre punch and dot punch**

1 Check the grinding wheel usually for any cracks.

2 Adjust the tool rest so that there is a gap of 2 to 3mm between the grinding wheel and the tool rest

3 Hold the punch in a manner that the fingers of the left hand rest on the tool rest.

4 The head of the punch should be held by right hand finger tips

5 Position the punch at an angle to obtain the required included angle

6 90° for the centre punch and 60°for the dot punch.

7 Check for the angle by using bevel protractor

— — — — — — — —

TASK 3 : **Grinding chisel**

1 Check the grinding wheel visually for any cracks

2 Adjust the tool rest so that there is a gap of 2 to 3mm between the grinding wheel and the tool rest

3 Hold the chisel parallel to the wheel surface

4 Turn the chisel for 30° one side and 30° otherside

5 Rest the body of the chisel on the tool rest

6 Allow the point to touch the wheel

7 Keep minimum pressure on the chisel body while grinding

8 Grind for slight convexity (Crown) on the face of the chisel

9 Check the point angle with a bevel protector

— — — — — — — —

TASK 4 : **Grinding Scriber**

1 Hold the scriber vertical on the grinding wheel face and rotate it with the finger

2 Quench the point frequently in the coolant

3 Sharp the scriber to an angle of 150

4 Finish the scriber to the required sharp point.

Skill Sequence

Grinding of flat chisel

Objective : This shall be help you to

- **grind a flat chisel centre punch and dot punches when they become dull.**

Before grinding

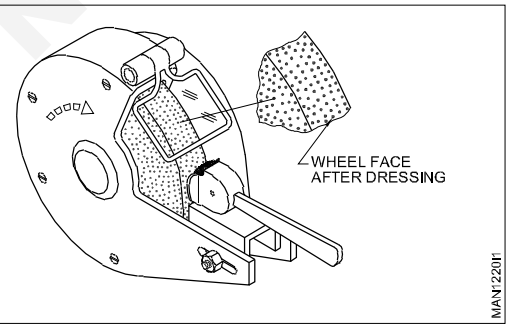
Check the grinding wheel by,

- Sliding the finger tip across the grinding wheel to detect glazing

  (In case the 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 turning is necessary. Ask the instructor for advice.

Ensure that there is enough coolant in the container.

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

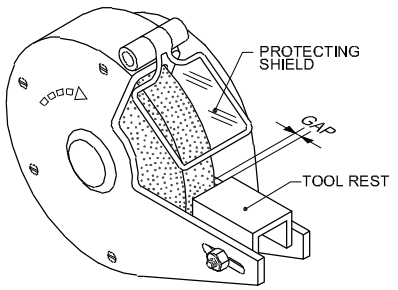
Adjust the tool rest 2mm closer to the wheel, if necessary. (Fig 2)

During grinding

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

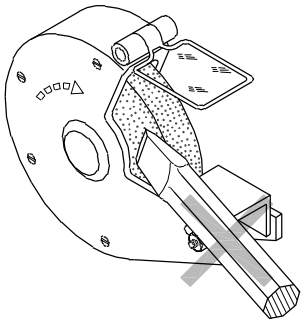
Do not use cotton waste or other material for holding the chisel while grinding

Fig 2



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. (Fig 4 &5).

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

Fig 4

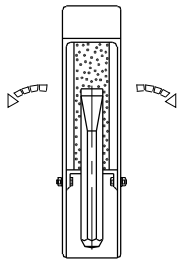
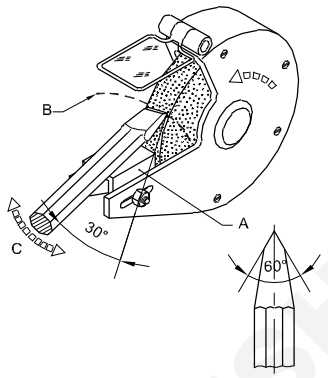


Fig 5



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

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.

Sharpening a centre punch

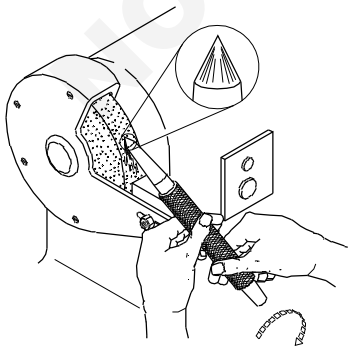
Objective : This shall help you to

• 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)

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.

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

Use googles to protect your eyes while grinding.

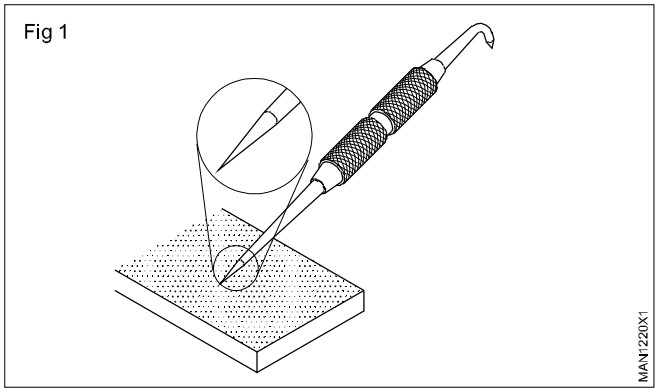
Sharpening a scriber

Objective: This shall help you to
- **sharpen a worn out scriber point.**

For drawing fine 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)

Fig 1

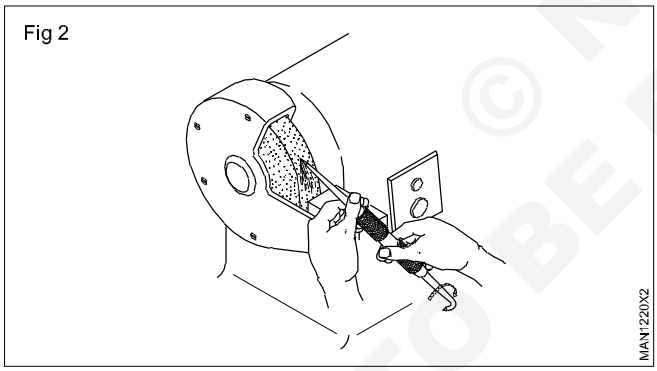


When the point cannot be re-sharpened with an oilstone, it should be re-sharpened on a grinder.

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 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.

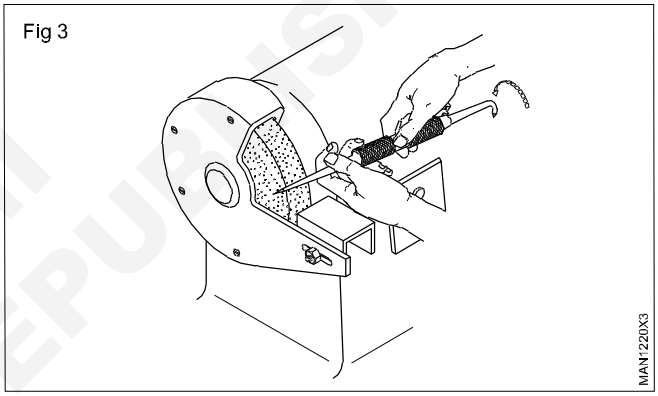
After a few sharpening the diameter of the point will become larger and would need re-sharpening of the tapered portion.

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

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

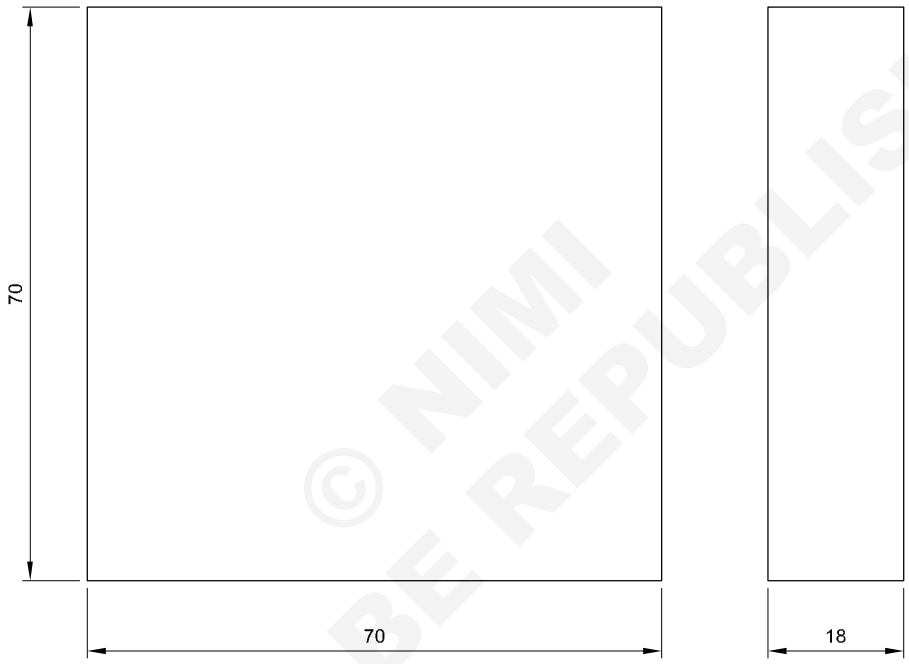
Be sure that the gap between the tool-rest and the wheel is correctly set before grinding.

Fig 3



Marking, filing, filing square and check using Try - square

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



Job Sequence

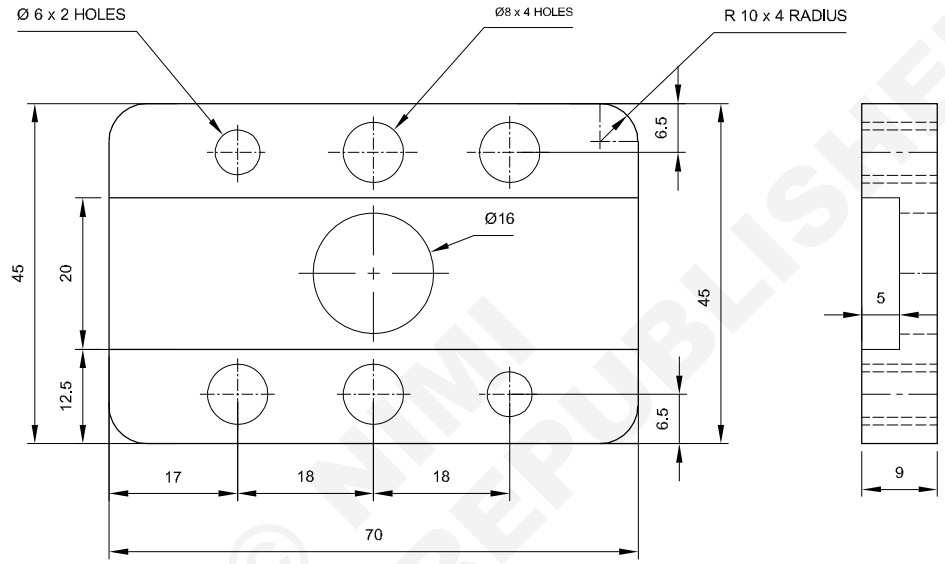
- Check the raw material size using steel rule.
- File three sides mutually perpendicular to each other.
- Mark and file to size 70x70x18mm by maintaining the size ±0.5mm.
- Check the size with steel rule
- Check the squareness with try square and flat surface with straight edge/blade of try square.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

1	75 ISF 20-75	EX.NO.1.2.25 →	Fe310	-	-	1.2.20
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**MARKING,FILING,FILING SQUARE AND CHECK USING TRY-SQUARE**				TOLERANCE :- ±0.5mm	TIME :
					CODE NO. MA20N1220E1	

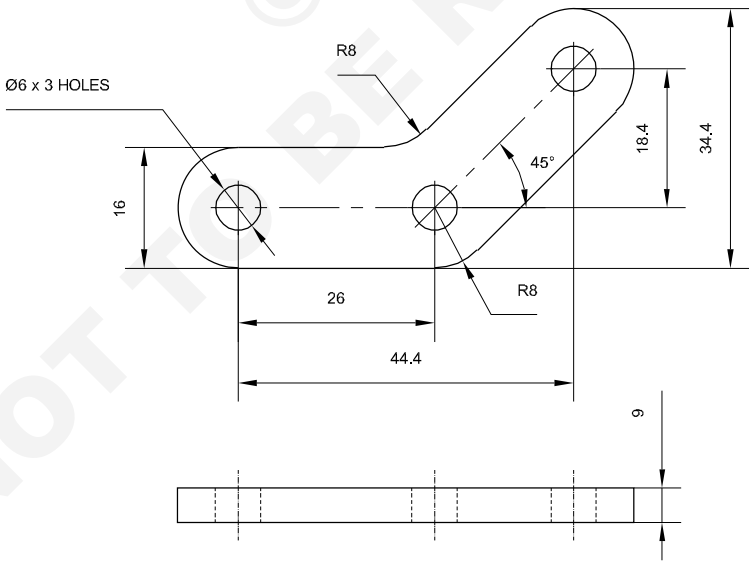
Marking according to drawing for locating, position of holes, scribing lines on chalked surfaces with marking tools

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

TASK-1



TASK-2



1	50 ISF 10-50	-	Fe 310	-	TASK-1	
2	50 ISF 10-75	-	Fe 310	-	TASK-2	1.2.21
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MARKING ACCORDING TO DRAWING FOR LOCATING,POSITION OF HOLES,SCRIBING LINES ON CHALKED SURFACES WITH MARKING TOOLS**	TOLERANCE : - ±0.5mm	TIME :
		CODE NO. MA20N1221E1	

PROCEDURE

TASK 1: **Marking as per drawing 1**

1 Check the raw material size using steel rule

2 File raw material to size 70 x 45 x 9mm and check with steel rule.

3 Apply marking media on the surface of the job.

4 Mark circular holes centre, radius and groove as per drawing using a Jenny caliper.

5 Set the radius of 5 mm in divider and draw circles ∅ 6 mm, ∅ 8 mm, and ∅ 16 mm as per drawing.

6 Punch witness marks on marked line using a dot punch.

7 Check the marking with steel rule.

— — — — — — — —

TASK 2: **Marking as per drawing 1**

1 Apply marking media on the another surface of the job.

2 Mark 8mm, 16mm, 26.4 mm and 34.4 mm lines using Jenny caliper with reference to ‘xy’.

3 Mark 8mm, 34 mm and 52.4 mm lines using Jenny caliper with reference to ‘xz’. (Fig 1).

4 Mark 45° angular line at point 'o' using Bevel Protector as per drawing.

5 Locate the intersecting point 'A',' O' and 'B' using prick punch 30°. (Fig 2)

6 Set the radius 3 mm in divider and draw circles Ø 6mm 3 holes at point 'A','O' and 'B'.

7 Similarly, set the raidus 8 mm and draw half round as shown in Fig 2

8 Draw tangent line as shown in Fig 2.

9 Draw external radius 8mm, from point ‘C’ with references to tangent lines.

10 Draw radius 8 mm at point ‘o’ to join tangent lines.

11 Punch the witness marks on profile of the drawing.

12 Check the marking with steel rule.

Fig 1

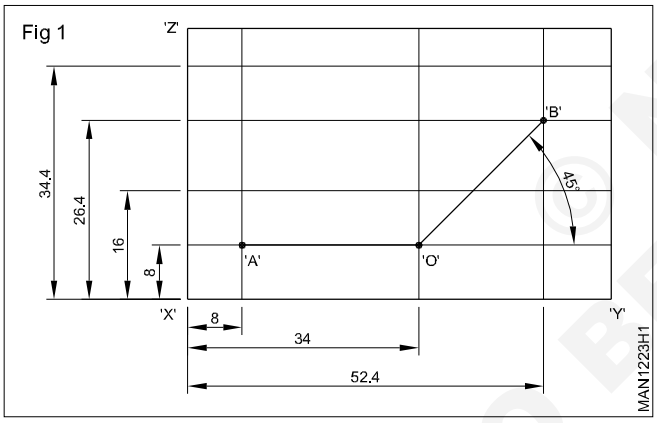
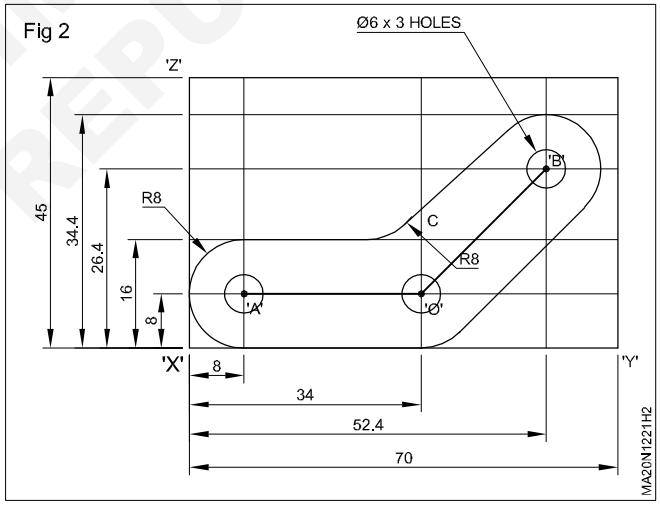


Fig 2



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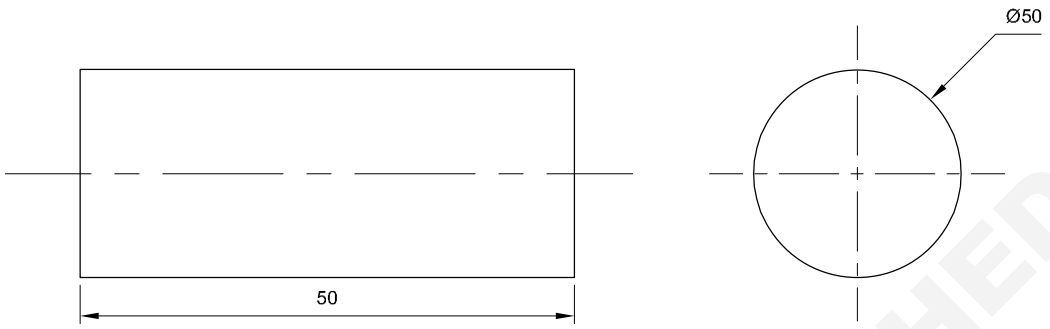
Finding center of round bar with the help of 'V' block and marking block

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.**



Job Sequence

- File the faces of round bar
- Apply marking media on a face of round bar
- Clean the 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 the 'V' block and clamp it with an '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 the face of round bar using marking block as shown in (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.
- 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.
- Punch on the intersecting point 'O' using centre punch 90°.
- Point 'O' is the centre of round bar.
- Preserve it for evaluation.

Fig 1

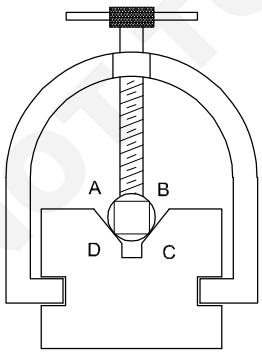
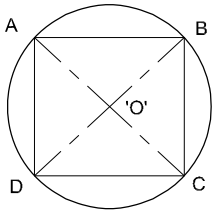


Fig 2



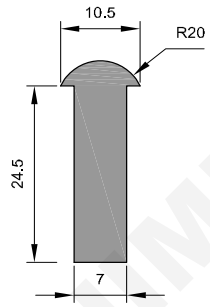
1	ISR Ø50-50	-	Fe310	-	-	1.2.22
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FINDING CENTER OF ROUND BAR WITH THE HELP OF 'V' BLOCK AND MARKING BLOCK**	TOLERANCE : - ±0.5mm	TIME :
		CODE NO. MA20N1222E1	

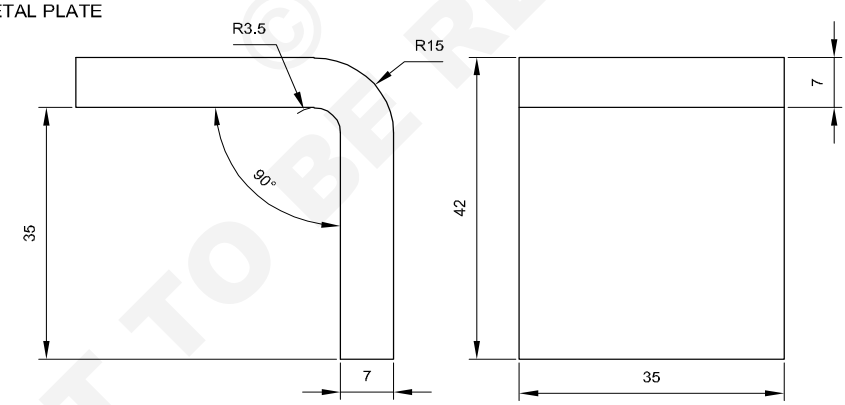
Prepare mushroom head on round bar and bending metal plate by hammering

Objectives : At the end of this exercise you shall be able to
- **form mushroom head on a round bar by hammering**
- **bend the M.S plate to an angle of 90° by using bench vice and ball pein hammer.**

TASK-1 MAKING OF MUSHROOM HEAD



TASK-2 BENDING OF METAL PLATE



ALL DIMENSIONS ARE IN MM

1	ISR Ø7x60	-	Fe310	-	-	
1	100ISF10-140	-	Fe310	-	-	1.2.23
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**PREPARE MUSHROOM HEAD AND ROUND BAR AND BENDING OF METAL PLATE BY HAMMERING**	TOLERANCE : - ±0.5mm	TIME:
		CODE NO. MA20N1223E1	

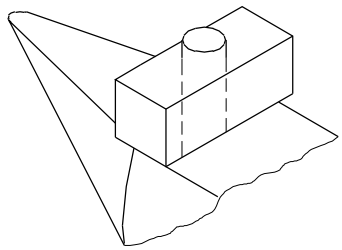
Job Sequence

TASK 1: **Making of mushroom head on round bar by hammering**

1 Check the raw material for the correct size.

2 Insert the round rod into the the M.S Block as show in the (Fig 1) and place it on the anvil, such that the rod is projecting 7mm above

Fig 1



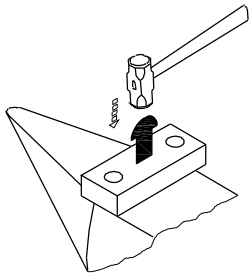
MAN1225H1

3 Hammer it on the projection of the round rod above the M.S block so as to form mushroom head. (Fig 2). Use the ball been hammer

4 Continue the hammering till we get the required shape of mushroom head

5 (Note : Instructor shall provide a suitable template)

Fig 2

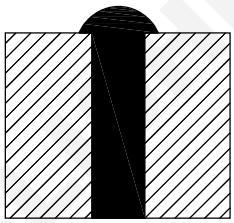


MAN1225H2

6 Fill the burrs (if any) to have even shape and correct dimension (Fig.3)

7 Check the mushroom head with a template.

Fig 3



MAN1225H3

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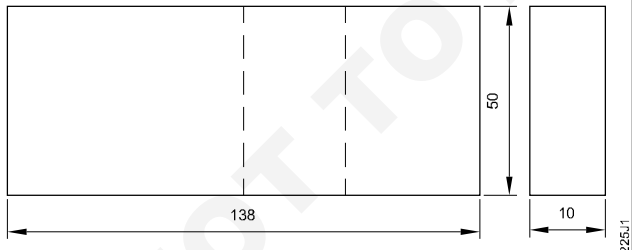
TASK 2: **Bending of metal plate**

1 Calculate the bending allowance for 90° (1/4 of the circumference)

2 Determine the overall size of the job required.

3 File the given raw material stock to overall size. (Fig 1).

Fig 1

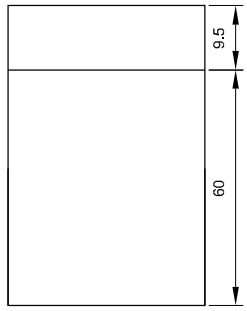


MAN1225J1

4 Mark and punch the centre line of the job (Fig.2)

5 Hold the job in a bench vice such that marking line is 2.5 mm above the vice jaw

Fig 2

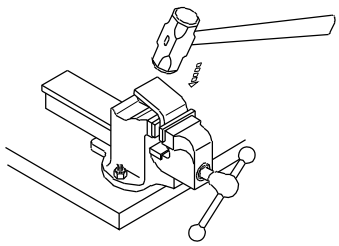


MAN1225J2

6 Strike at the edges of the plate as shown in Fig 3 by using as sledge hammer.

7 Check the angle of bend and the radius

Fig 3



MAN1225J3

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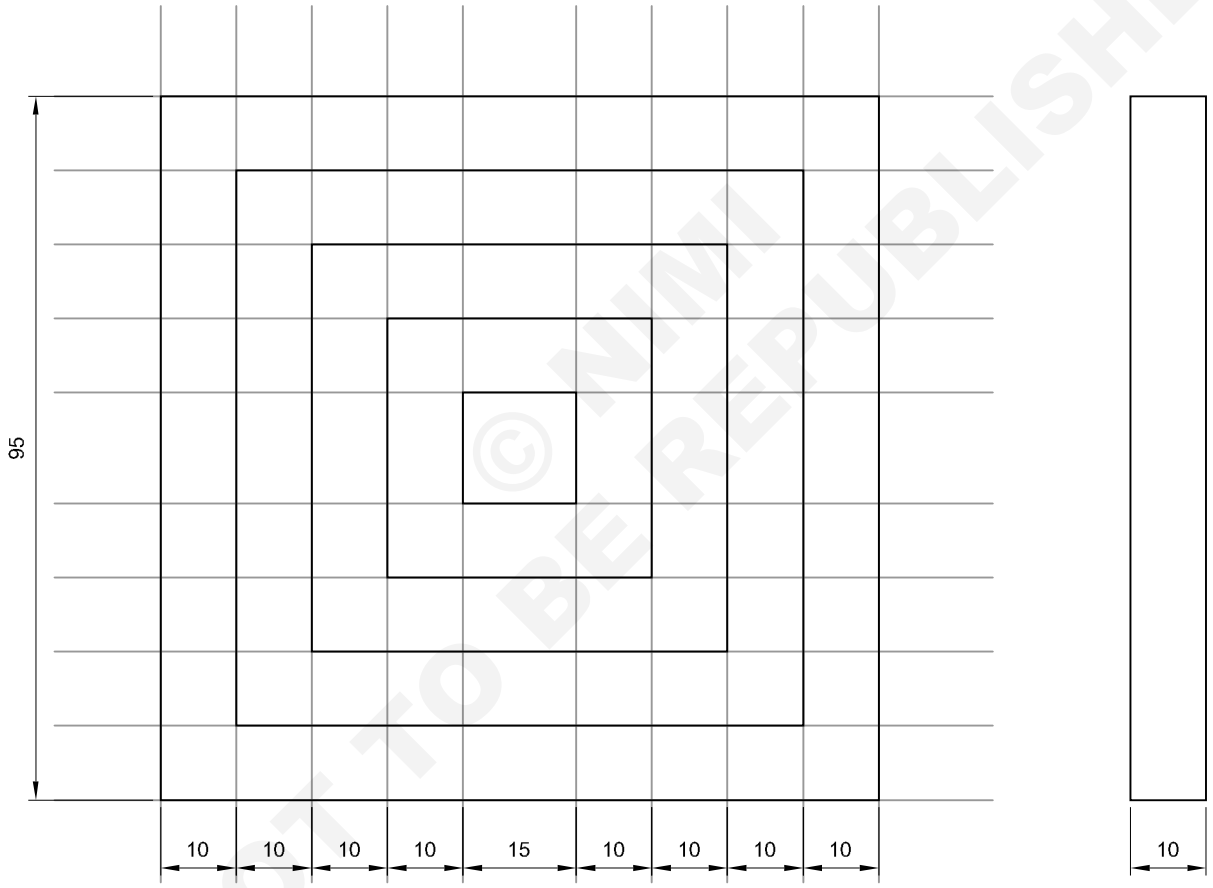
Marking using scale, surface gauge and angle plate

Objectives : At the end of this exercise you shall be able to
- **filing flatness and squareness**
- **apply marking media**
- **scribe parallel lines using surface gauge, angle plate and steel rule.**



1	100 ISF10-100	-	Fe310	-	-	1.2.24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MARKING USING SCALE,SURFACE GAUGE AND ANGLE PLATE**	TOLERANCE	TIME:
		CODE NO. MA20N1224E1	

Job Sequence

1 Check the raw material for is size

2 Remove burrs if any

3 File for flatness and squareness for size 95x95x10

4 Apply marking media

5 Keep the job on the surface table with the support of angle plate

6 Prepare the surface gauge

7 Mark the lines from the base of distance of 10, 20, 30, 40, 55, 65, 75, 85mm

8 Use the steel rule for setting dimension

9 Hold the job by left hand and move two surface in right hand while marking.

10 Turn the job 90° and mark the lines as per the above dimension

11 Darken the lines by using scriber and steel rule to form square of 15, 35, 55, 75mm as per drawing

12 Submit for evaluation

Skill Sequence

Marking parallel line using surface gauge

Objective : This shall help you to
- **mark parallel lines using a surface gauge.**

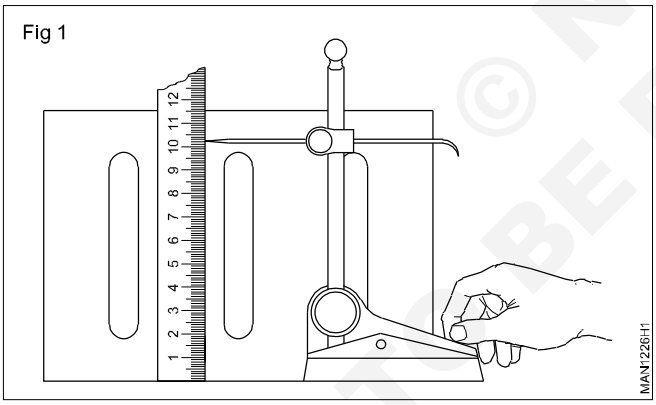
Check the free movement of the scriber and other sliding units.

Clean the base of the surface gauge.

Keep the base firmly on the surface plate.

Rest the steel rule against the angle plate and set the scriber to the size to be marked.(Fig 1)

Fig 1



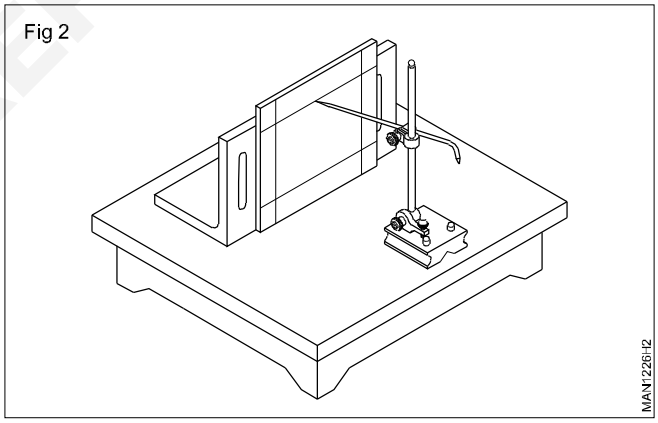
Make sure that the job has no burrs and has been properly cleaned.

Apply a thin and even coating of the marking media.

Butt the job against the angle plate.

Hold the job in one hand and move the scriber point touching the surface across the work and mark. (Fig 2)

Fig 2

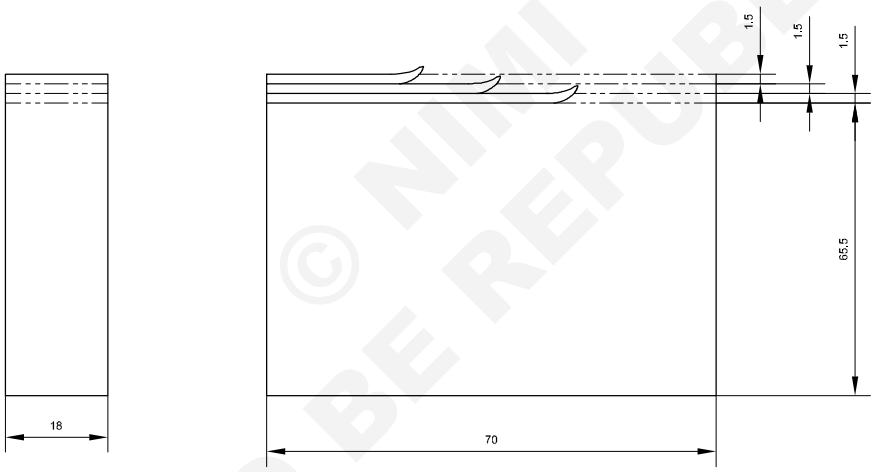


Chipping flat surfaces along a marked line

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

- **chip surface evenly using a flat chiesel within ± 1mm.**

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



1	50 ISF 18 - 70	EX.NO: 1.2.20 ←	Fe 310	–	--	1.2.25
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	CHIPPING FLAT SURFACES	DEVIATIONS AS PER IS 2102 (m)	TIME :
		CODE NO. MA20N1225E1	

Job sequence

- Apply marking media and the 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 20mm with a proper cutting edge.
- Select a ball pein hammer with required weight (450gms)
- 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.

Skill sequence

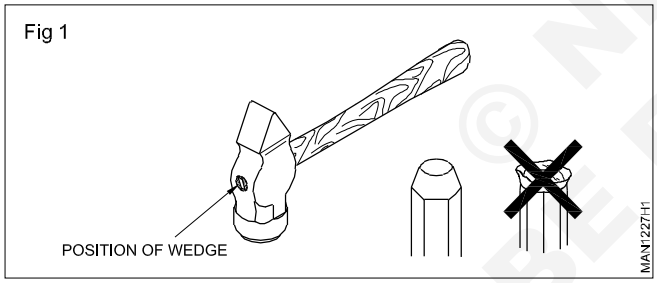
Chipping using flat chisel

Objective : This shall help you to

• chip metal pieces.

Before commencing chipping : Select a mushroom free chisel and choose a hammer with a well secured handle.(Fig 1)

Fig 1

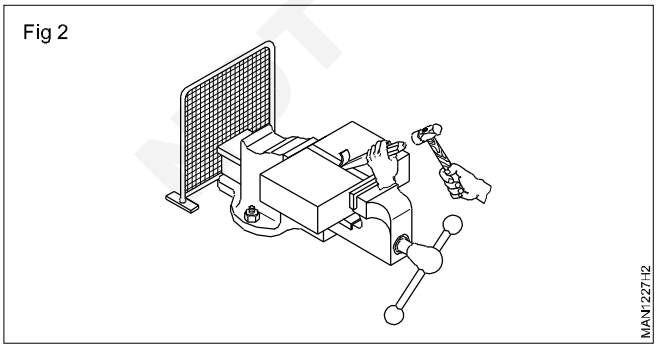


Wipe off oily substances, If any, from the face of the hammer.

Wear safety googles

Install the chipping screen. (Fig 2)

Fig 2



Chipping process: Hold the work in a vice. If necessary, support the work on a wooden block. (Fig3)

Position the chisel at an angle 34.5° to cut the metal in uniform thickness.(Fig.4)

Fig 3

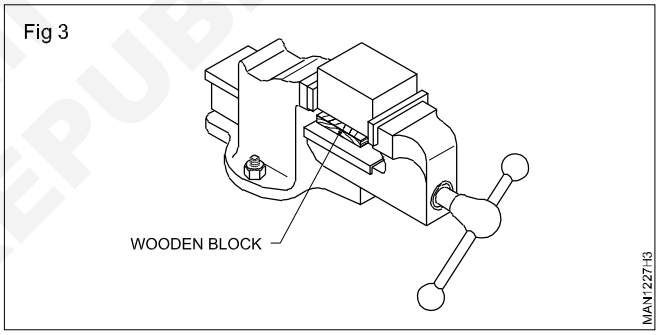
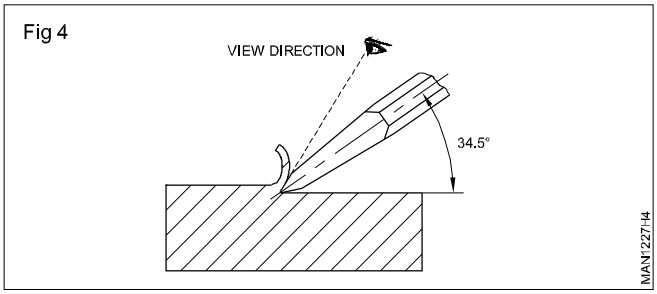
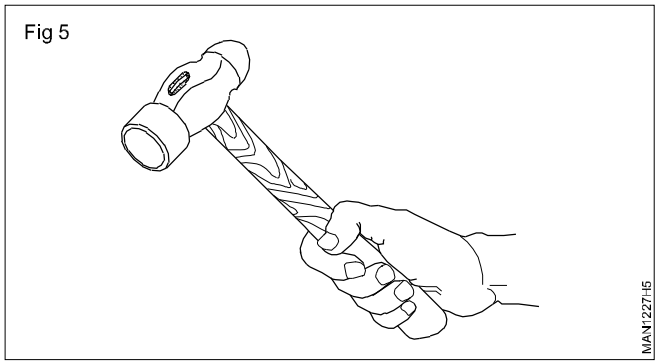


Fig 4



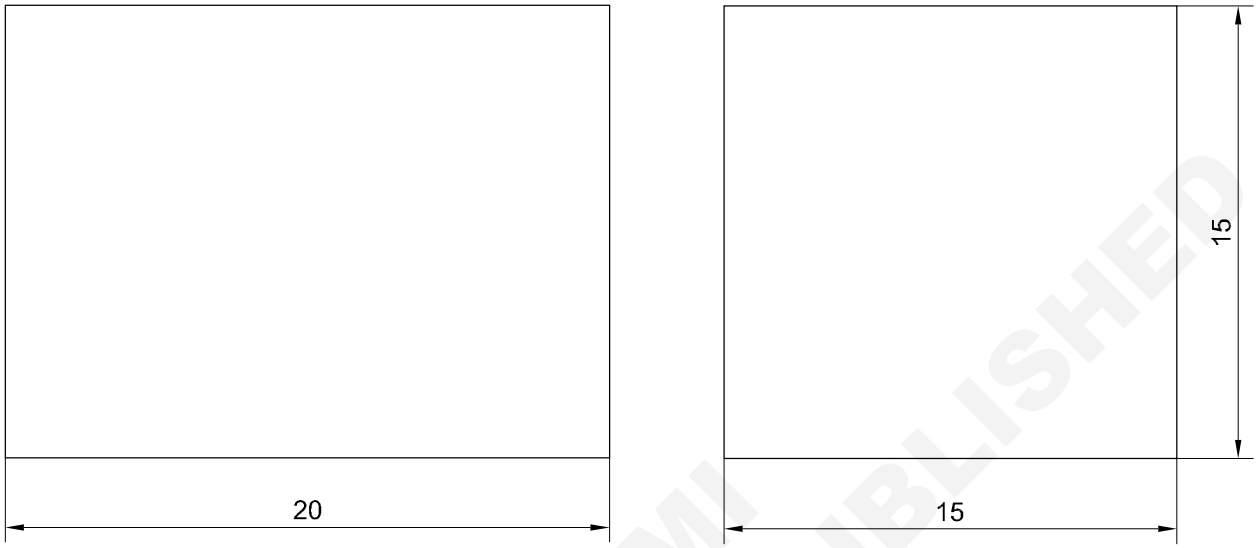
Hold the hammer at the end of the handle for maximum leverage.(Fig 5)

Fig 5



Make a square from a round job by chipping upto 20mm length

Objective: At the end of this exercise you shall be able to
- **to make a square job from a round rod.**



ALL DIMENSIONS ARE IN MM

Job sequence

- Check the size of metal
- Remove the burrs if any in the stock
- Apply marking media on both the faces
- Set the job in V-block and U clamp it.
- Find the centre using the jenny caliper and punch the centre.
- Keep the job on the surface plate
- Use the scribing block and steel rule and mark the lines as per the drawing size .
- Turn the job 90° using try square.
- Mark the lines as per the drawing
- Punch the square shape using prick punch and hammer both the faces
- Remove the job from the 'V' block and hold it in the bench vice.
- Select the chisel for chipping
- Hold the chisel in left hand and hammer it with right hand
- Remove excess metal from the job by chipping upto the punched marks.
- Remove all the burrs.

Safety

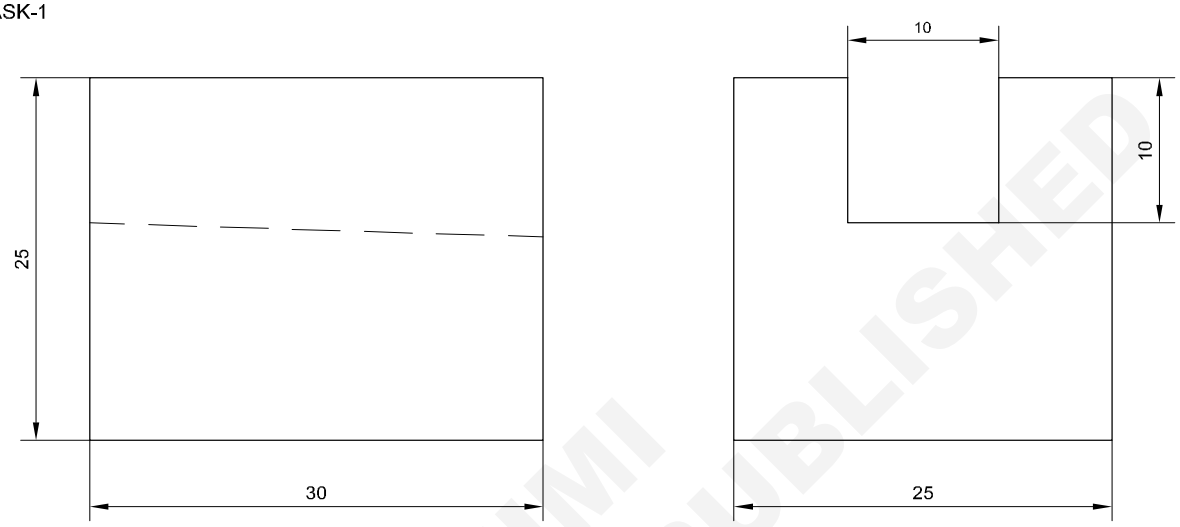
- Do not use mushroom head chisel.
- Place /use the chip guard while chipping.

1	ISR 25x20	-	Fe 310	--	–	1.2.26
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 4:1	**MAKE A SQUARE FROM A ROUND JOB BY CHIPPING UPTO 20 mm LENGTH**				DEVIATIONS ±0.25mm	TIME:
					CODE NO. MA20N1226E1	

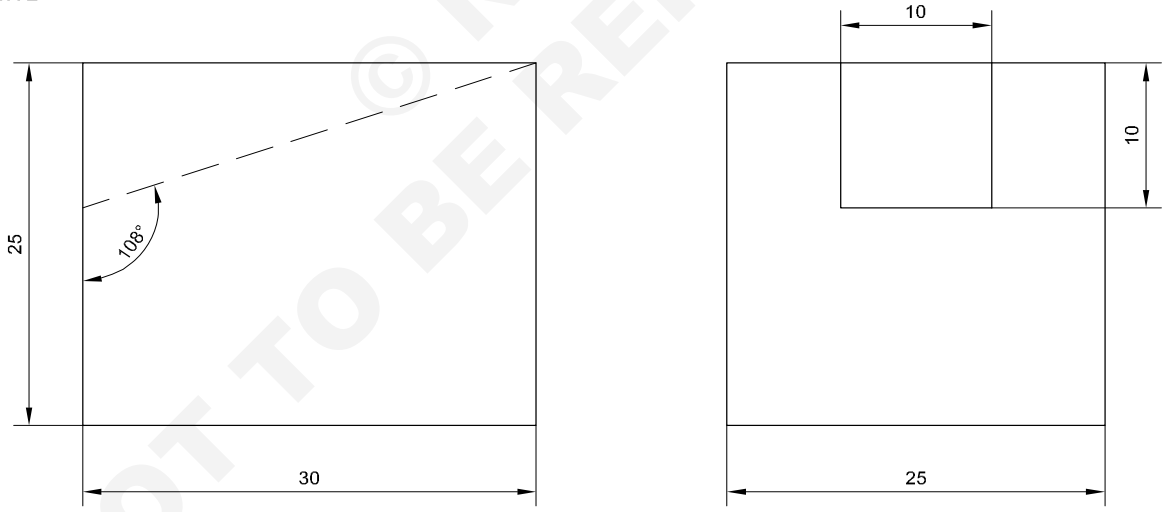
Slot, straight and angular chipping

Objectives : At the end of this exercise you shall be able to
- **select the chisel suitable for straight slot chipping**
- **select the chisel suitable for angular slot chipping**

TASK-1



TASK-2



ALL DIMENSIONS ARE IN mm

2	25 ISF - 30	-	Fe 310	--	--	1.2.27
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 2:1	**SLOT,STRAIGHT AND ANGULAR CHIPPING**				DEVIATIONS ±0.25mm	TIME:
					CODE NO. MA20N1227E1	

Job sequence

TASK 1 : **Chipping straight slot**

- Check material for its size
- Remove the burrs if any
- Apply marking media
- Mark the slot using scribing block and steel rule.
- Punch the slot in both the sides by using prick punch and hammer.
- Hold the job firmly on the vice
- Support the job with wooden block while chipping
- Select the cross cut chisel for chipping slots
- Chip the slot upto required depth as per the drawing.
- Remove the burrs and finish the job
- Check the width and depth using steel rule

— — — — — — — —

TASK 2 : **Chipping angular slot**

- Check the raw material for its size.
- Remove the burrs if any
- Apply marking media
- Mark the angular slot for 108°
- Punch on both faces and side
- Hold the job angularly
- Select the corss cut chisel for chipping angular slot
- Chip the angular slot as per marking
- Check the angle using bevel protractor.
- Remove the burrs and finish the job.

Safety

- Chisel should be free from mushroom head
- Hammer handle should be securely fixed with eyehole with a wedge
- Wear goggles while chipping
- Use chipping guard behind the vice to arrest the flying chips.

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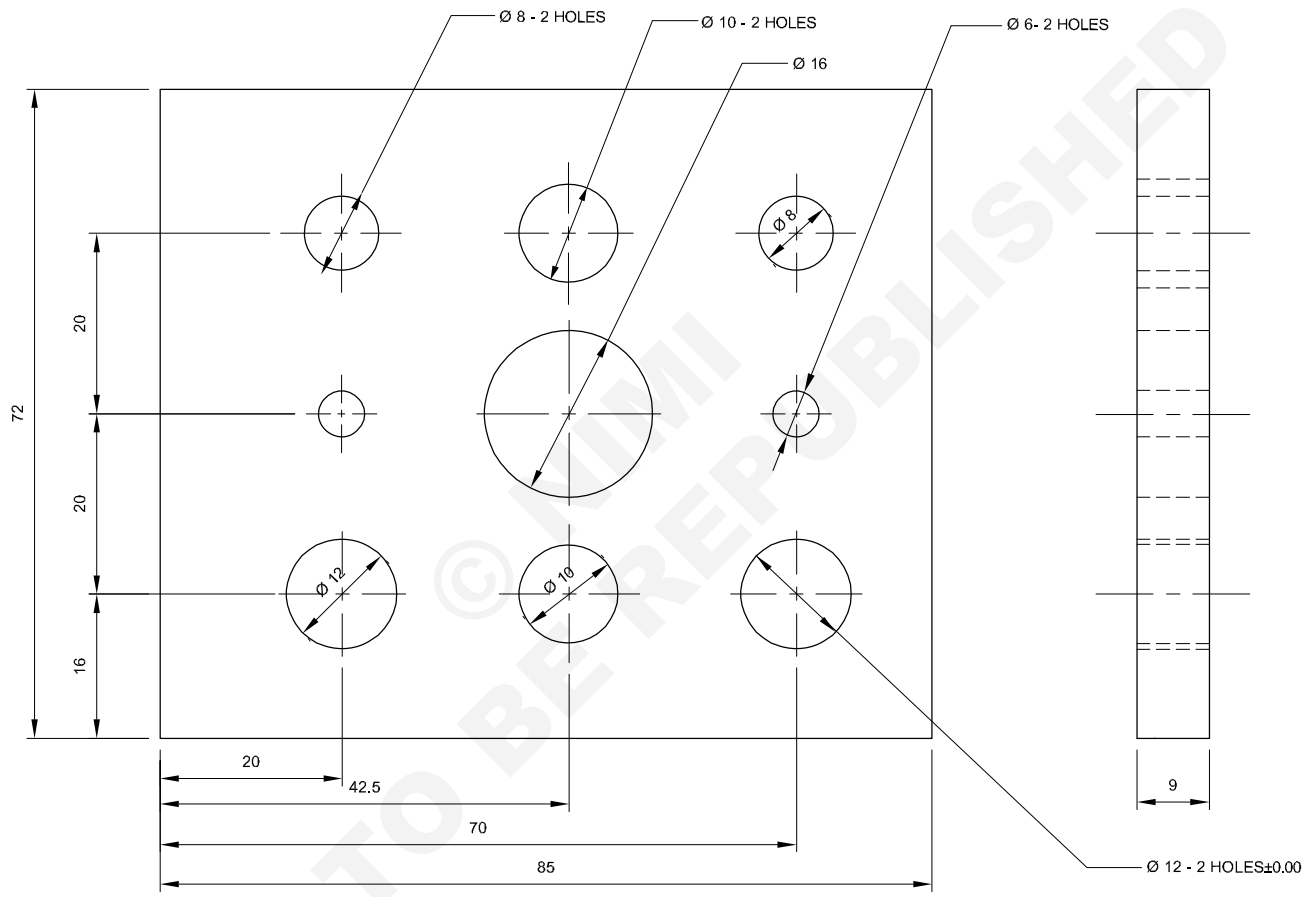
Mark off and drill through holes

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



Job sequence

- Check the raw material for its size.
- File and finish to size 85 x 72 x 9mm maintaining parallelism and perpendicularity.
- Mark drill holes as per drawing
- Punch on drill hole centres using centre punch 90°
- Make centre drill in all drill hole centres.
- Fix ϕ 6mm drill and drill pilot holes in all centre drilled holes.

1	75 ISF 10-90	-	Fe310	-	-	1.2.28
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE NTS	MARK OFF AND DRILL THROUGH HOLES				TOLERANCE : ± 0.04 mm	TIME :
					CODE NO : MA20N1228E1	

- Similarly fix ϕ8mm, ϕ10 mm, ϕ12mm, and ϕ16mm 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

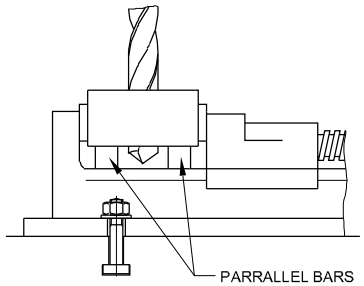
Drilling through holes

Objectives : This shall help you to
- **fix the job in vice**
- **make the drilling**

Punch the centre of the holes 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 centre

Fix ϕ 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 ϕ 6mm drill. This will serve as a pilot hole for ϕ 8mm 10mm 12mm and 16mm dia drills.

Similarly, drill ϕ 8mm 10mm,12mm holes.

Remove the drill and drill chuck.

Fix ϕ16mm taper shank drill in the drilling machine spindle.

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

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

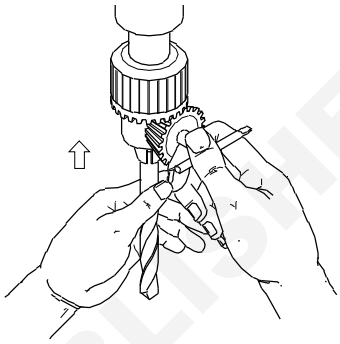
Do not try to change the belt while the machine is running.

Ensure that the drill do not penetrate into the vice.

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

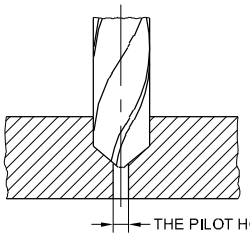
Since the web of large diameter drills are thicker, the dead centres of those drills do not sit in the centre punch marks. This can result in the shifting of the hole location. Thick dead centre can not penetrate into the material easily and will impose severe strain on the drill.

Fig 2



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

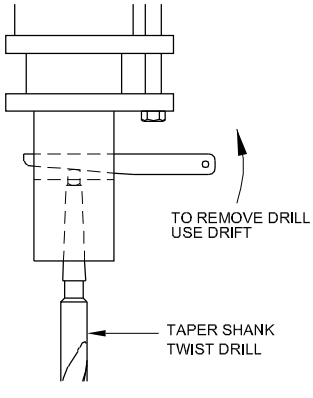
Fig 3



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

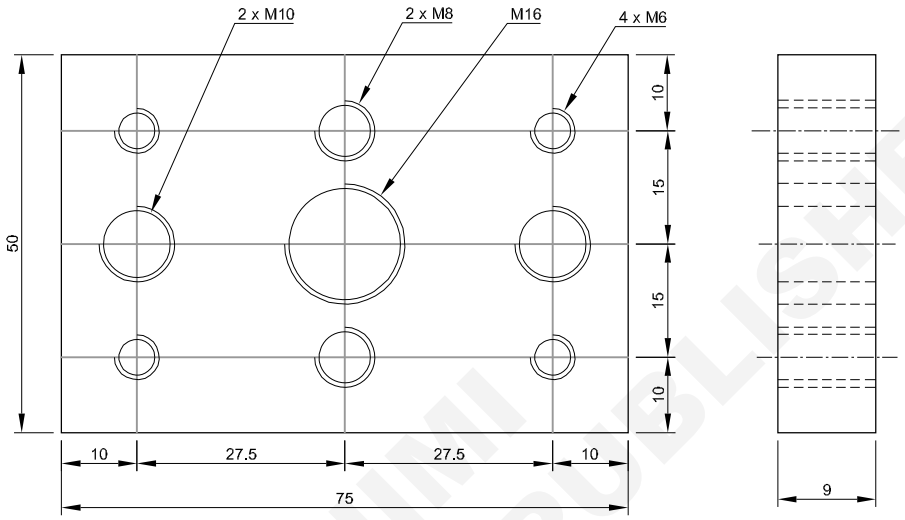
Set the spindle speed according to the diameter of drills. For smaller diameter drill keep the spindle speed in higher R.P.M and for larger diameter of drill keep the spindle speed in lower R.P.M

Fig 4



Drill and tap on M.S.flat

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.**



Job Sequence

- Check the raw material 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 serve 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

1	60 ISF 10 x 78 mm	-	Fe310	-	-	1.2.29
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	DRILL AND TAP ON M.S.FLAT	TOLERANCE : ±0. 1mm	TIME :
		CODE NO.MA20N1229E1	

Skill sequence

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.

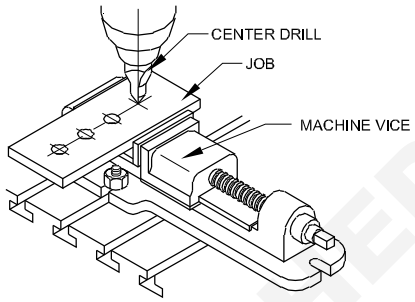
Adjust the job together with the vice and align with the centre punch mark. (Fig.1)

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.

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

Fig 1



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Tapping through holes

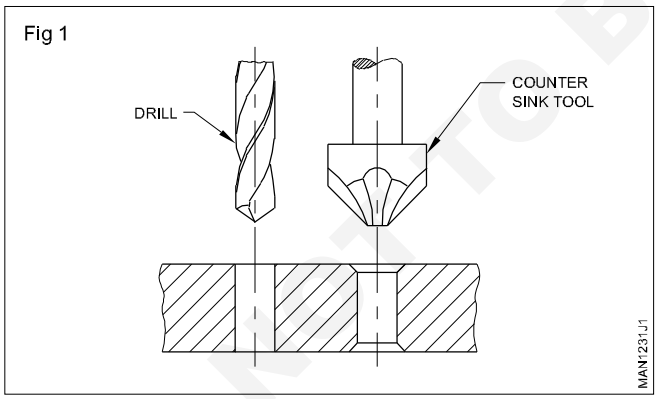
Objective: This shall help you to
- **cut internal threads using hand taps.**

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)

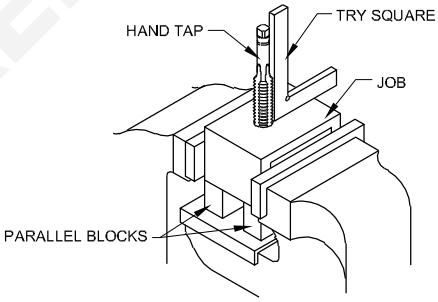
Fig 1



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)

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.

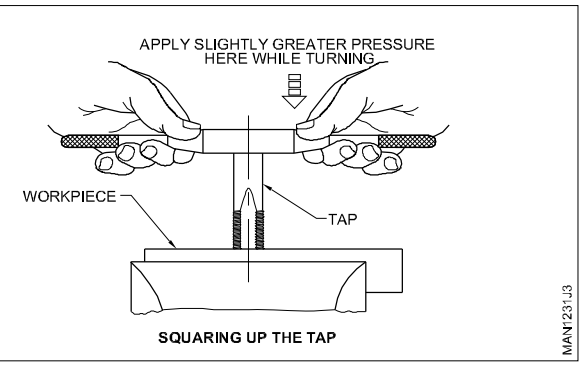
Fig 2



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



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

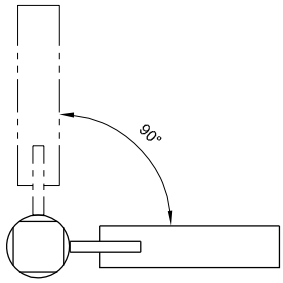
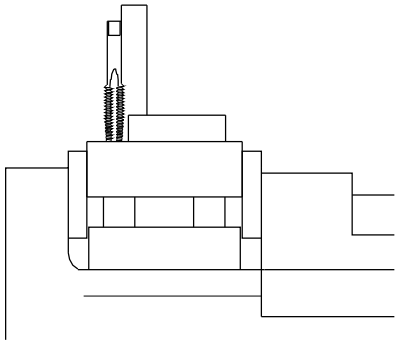


Fig 5



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)

Fig 6

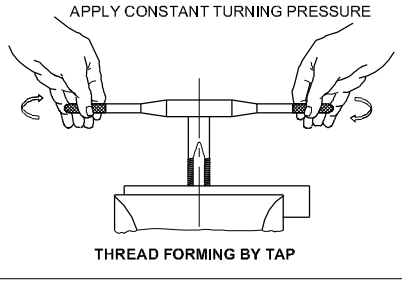
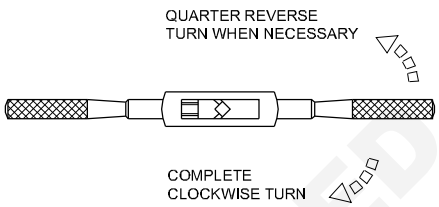


Fig 7



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

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

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.

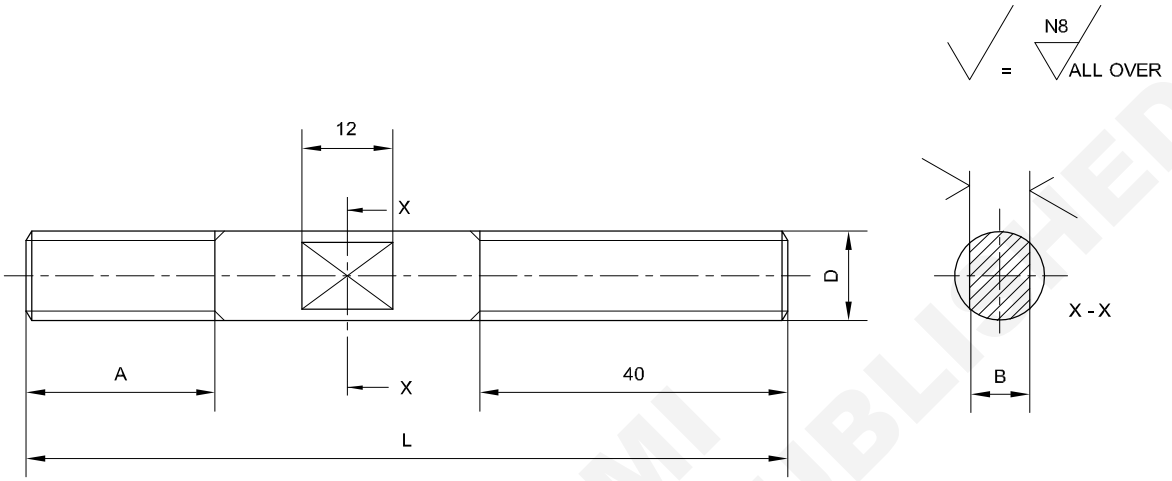
Make sure that the dia of the hole to be tapped is correct for the given size of the tap.

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.

Cutting external thread on M.S rod using die

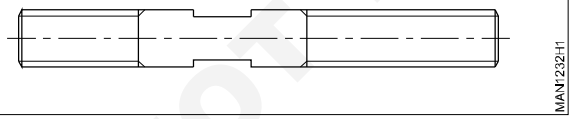
Objectives : At the end of this exercise you shall be able to
- **cut external thread with a hand die**
- **grind chamfer on the ends of stud on a bench grinder**
- **check the external threads fit with a standard nut.**



Job sequence

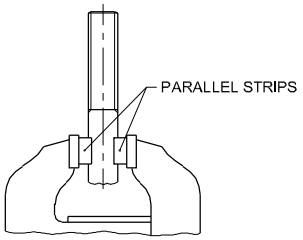
- Cut the bright bar allotted to you by your instructor as per the lengths specified in the drawing.
- Check the diameter of the bar.
- Square up the ends of the bar by filing
- Chamfer the ends using a pedastral grinder.
- File and finish both portions (flat) to size (Fig.1)
- Hold the job in the bench vice (Fig.2)
- Cut the thread with a die set on one side
- Reverse the job and hold
- Cut threads on the opposite side and checks the threads with a standard nut.

Fig 1



1	Ø 10x100		Fe310			1.2.30
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**CUTTING EXTERNAL THREAD ON M.S.ROD USING DIE**				DEVIATIONS ±0.5 mm	TIME:
					CODE NO. MA20N1230E1	

Fig 2



MAN1232H2

SL.NO	D - Normal size	L	A	B
1	M10	100	12	08
2	-Do-	130		
3	M12	100	14	12
4	-Do-	100		
5	M16	130	18	14
6	-Do-	150		

Skill sequence

External threading using dies

Objective : This shall help you to
• cut external threads using dies.

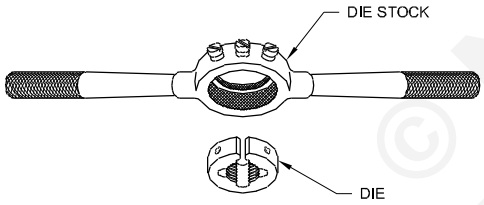
Select a correct size and circular rod as blank and chamfer the ends.

Blank size= Thread size-0.1% pitch of the thread

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

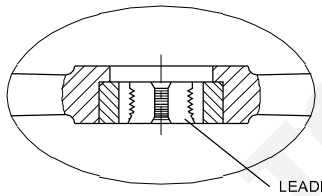
Fix the die in the diestock. The leading side of the die must be opposite to the step of the die stock. (Figs 1& 2)

Fig 1



MAN1232J1

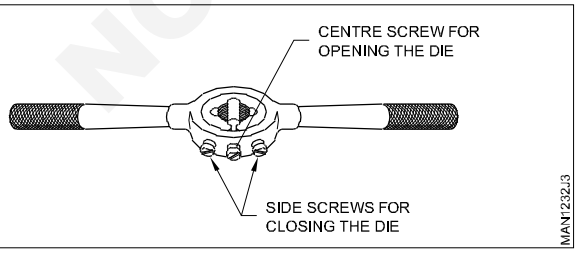
Fig 2



MAN1232J2

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

Fig 3

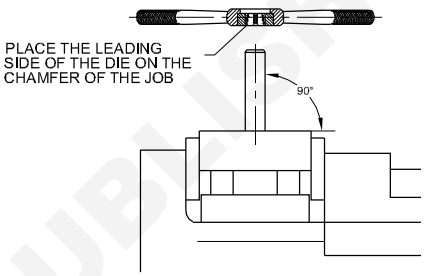


MAN1232J3

Place the leading side of the die on the chamfer of the job.

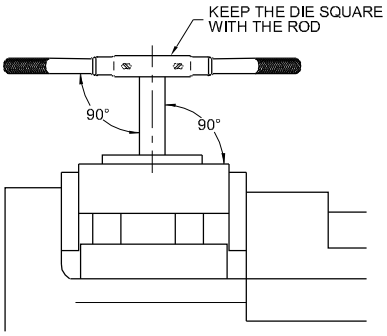
Start the dyeing, square to the bolt centre line. (Figs 4 & 5) turn in the clockwise direction to advance the die on the blank with even pressure on both ends of the die stock.

Fig 4



MAN1232J4

Fig 5



MAN1232J5

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

Use a cutting lubricant.

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 reached.

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

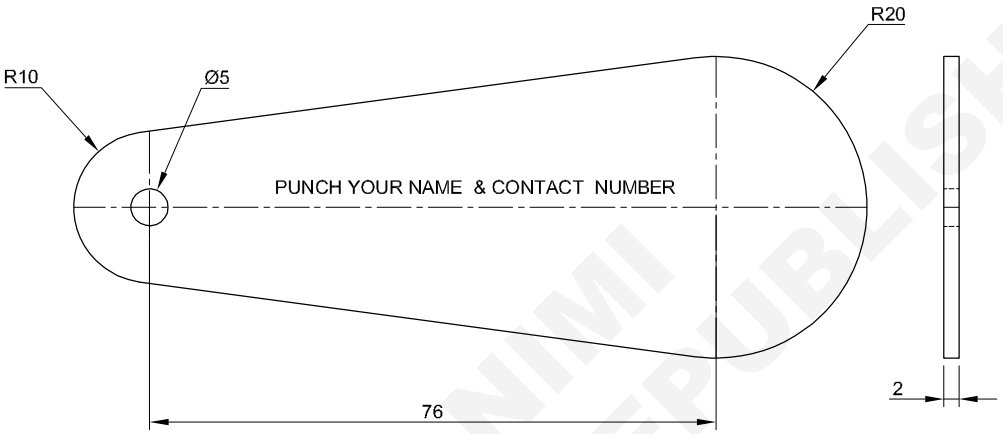
Too much depth of cut at one time will spoil the threads it can also spoils the die.

Check the fit of threads with a matching nut.

Tighten the side screw by hand and repeat the cutting until the standard nut matches with the external and without undue 'play' between the threads.

Punch letter and number (letter punch and number punch)

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



Job sequence

- Check the raw material size
- Mark and cut as per the drawing
- File and finish to shape and dimension
- Drill ϕ 5mm hole as shown in the figure
- Punch your name and the contact number
- Deburr and polish it.

1	SS 110 x45 x 2mm	-	STAINLESS STEEL	-	-	1.2.31
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**PUNCH LETTER AND NUMBER (LETTER PUNCH AND NUMBER PUNCH)**				TOLERANCE : ±0.5 mm	TIME :
					CODE NO. MA20N1231E1	

Skill sequence

Make letters and numbers

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

Letter and number punches

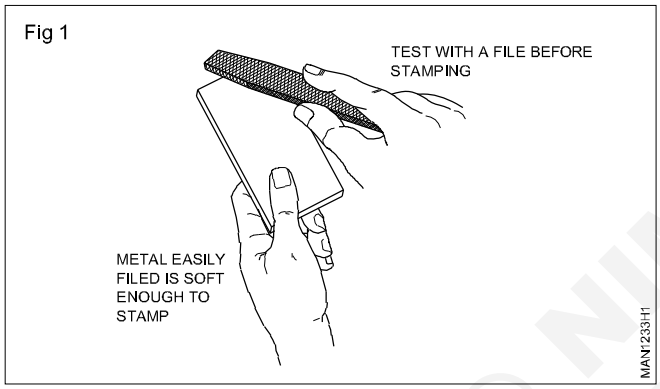
These hardened and tempered steel punches are used to stamp identifying symbols, letters or numbers as required on the work.

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

They are kept in boxed sets.

Use a file on the work to be stamped to check the work is softer than the 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 distorted 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.

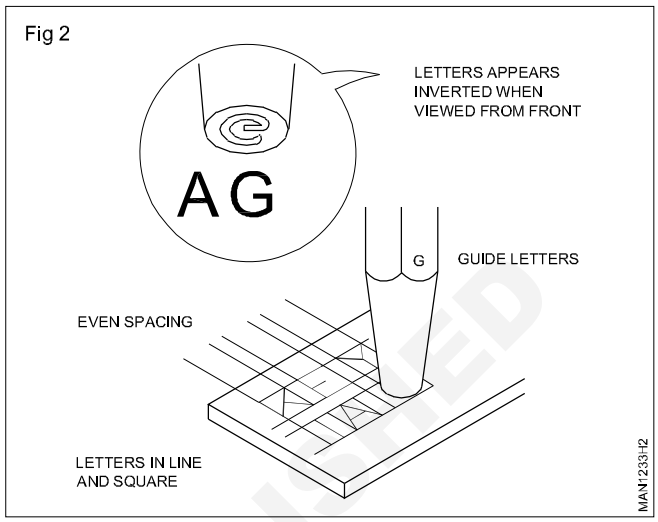
The depth of impression for a given blow varies with the softness of the material.

Practice on different metals.

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)

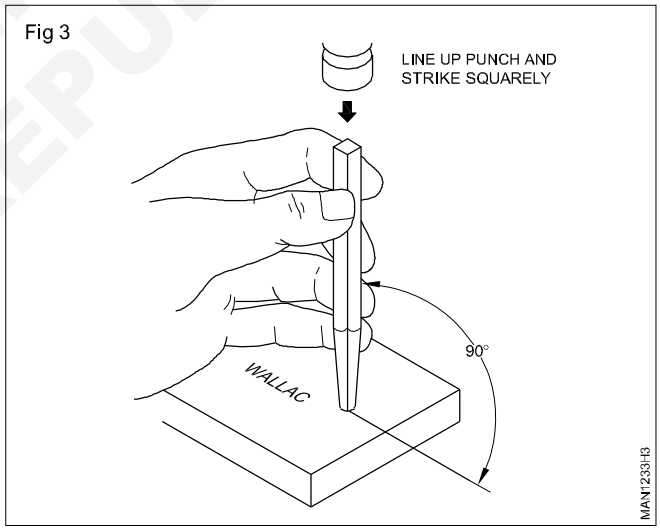
Fig 2



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

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

Fig 3



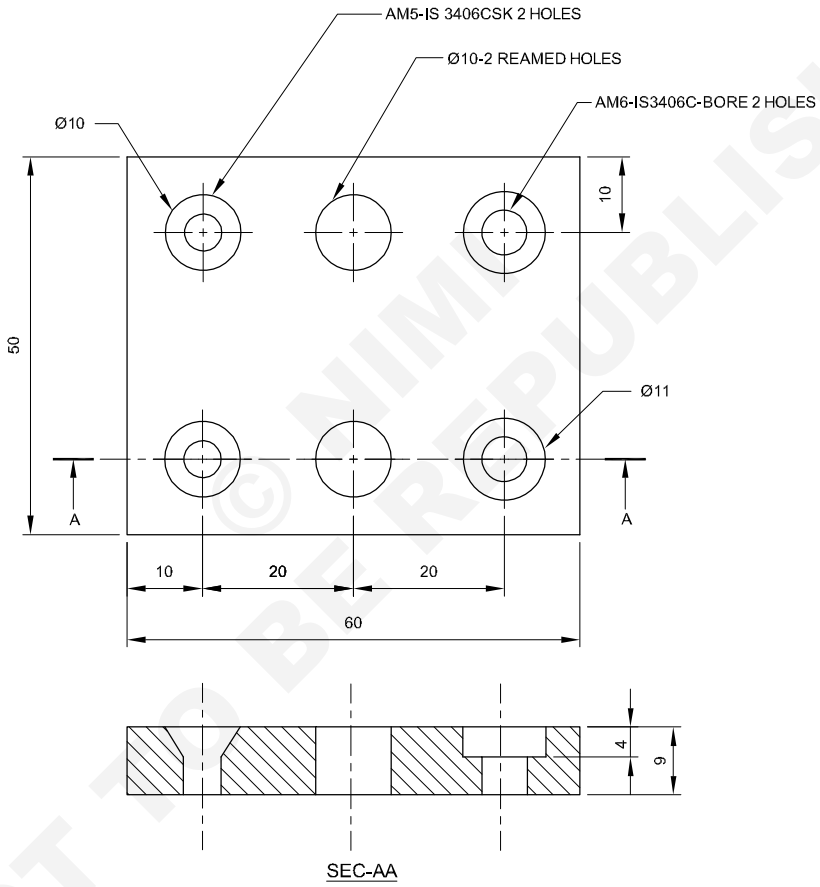
Watch the point of the punch.

Strike the punch squarely with one firm blow.

Counter sinking, counter boring and reaming with accuracy ± 0.04 mm

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

- **mark the lines as per job drawing**
- **drill counter sink, counter bore and ream the holes as per drawing**
- **file and finish to size and shape as per drawing.**



1	55 ISF 10 - 65	-	Fe310	-	-	1.2.32
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	COUNTER SINKING,COUNTER BORING AND REAMING WITH ACCURACY ±0.04 mm	TOLERANCE ±0.04 mm	TIME :
		CODE NO. MA20N1232E1	

Job Sequence

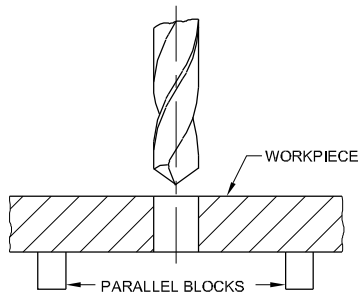
TASK 1: **Selection of counterbore sizes**

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

Select the counterbore according to the screw size.

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

Fig 1

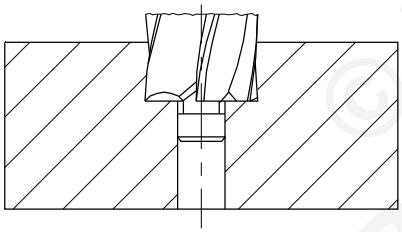


Set the location of the drilled hole position using the correct diameter drills.

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

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

Fig 2



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

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

(consider the value of 'V' as 1/3rd of the cutting speed for drilling)

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

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

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

Fig 3

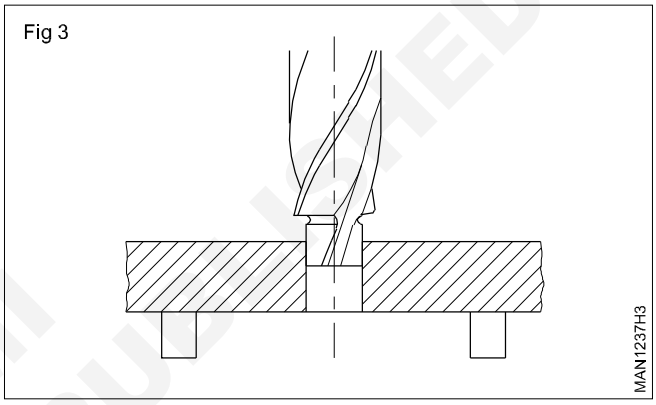
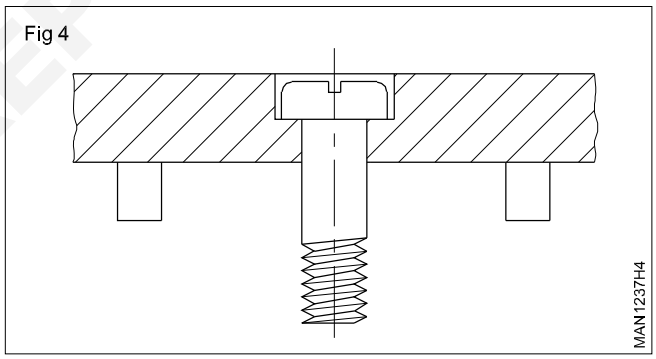


Fig 4



TASK 2 : Determine the drill size for reaming

Use the formula,

drill diameter = (reamed hole size) - (undersize + oversize)

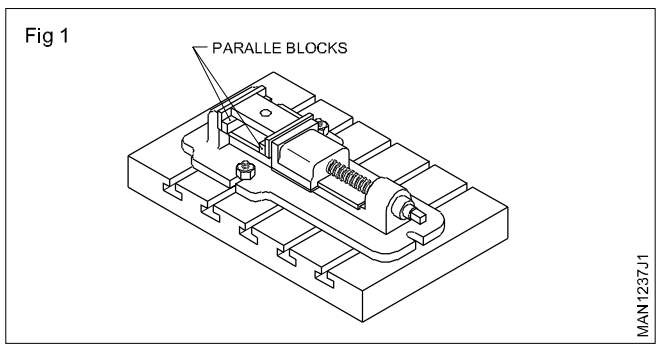
Refer to the table for the recommended undersizes in related theory on Drill sizes for reaming.

Hand reaming

Drill holes for reaming as per the sizes determined.

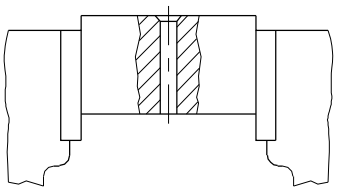
Place the work on parallel while setting on the machine vice. (Fig 1)

Fig 1



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

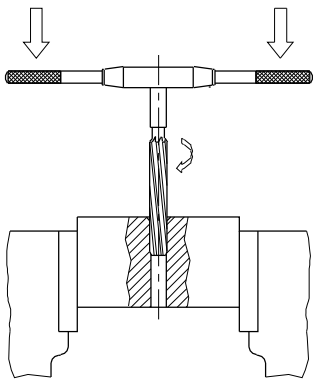
Fig 2



MAN1237J2

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

Fig 3



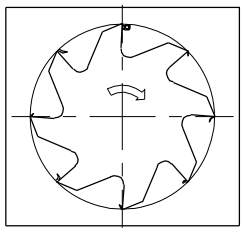
MAN1237J3

Apply cutting fluid.

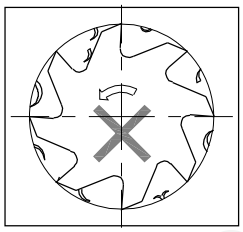
Turn the tap wrench steadily and slowly, maintaining the downward pressure.

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

Fig 4



CORRECT



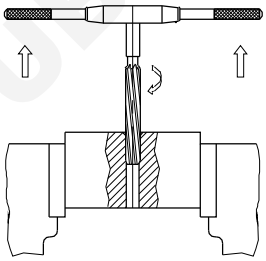
WRONG

MAN1237J4

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

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

Fig 5



MAN1237J5

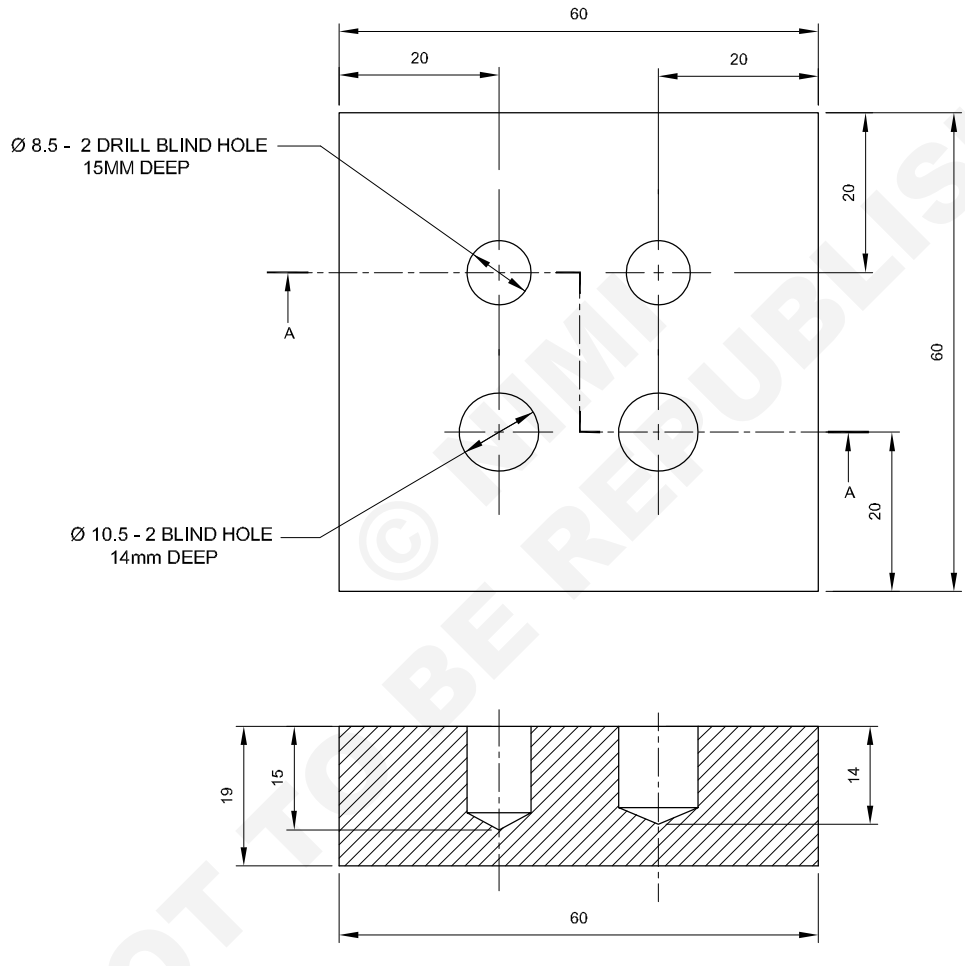
Remove the burrs from the bottom of the reamed hole.

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

Drill blind holes with an accuracy 0.04mm

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.**



SECTION VIEW AT 'AA'

–	65 ISF 20 - 65	→ EX.NO.1.2.34	Fe310	–	–	1.2.33
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**DRILL BLIND HOLES WITH AN ACCURACY 0.04mm**				TOLERANCE : ± 0.04 mm	TIME :
					CODE NO : MA20N1233E1	

Job sequence

- Check the raw material size
- File and finishthe metal size 60 x 60 x 19mm maintaining parallelism and perpendicularity
- Check the flatness and squareness with try square and size with vernier calliper.
- Apply marking media and mark drill hole, centres using veriner height gauge as per drawing.
- Punch on drill hole centres using centre punch 90°
- Hold the job in drilling machine table.
- Make centre drill in dirll hole centres.
- Fix φ 6mm drill in drilling machine spindle through drill chuck and drill pilot holes for both through and blilnd holes.
- Fix ø 8.5mm drill and drill blind hole as per drawing to required depth of 15mm
- Fix ø 10.5mm drill and drill blind hole to the required depth of 14mm.
- File and de- burr in all the surfaces of the job
- Apply a thin coat of oil and preserve it for evaluation.

Skill sequence

Drilling blind holes

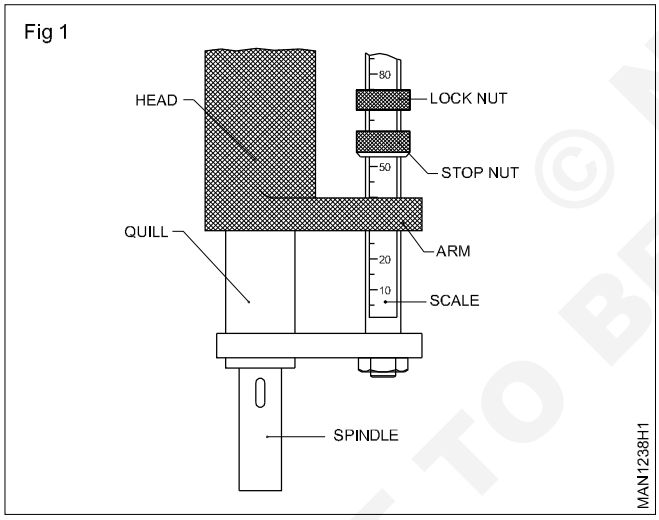
Objective : This shall be help you to

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

Method of controlling depth of blind holes

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

Fig 1



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

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

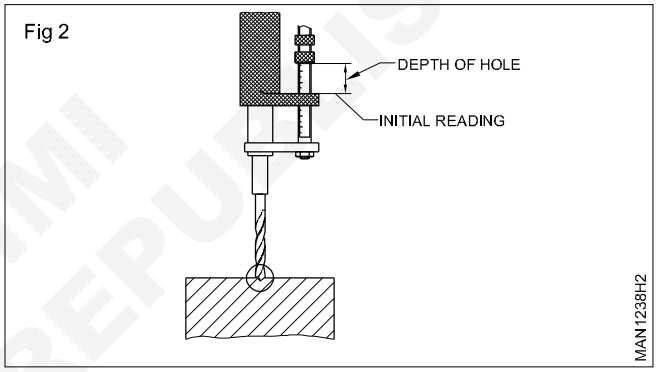
The drill is started, and the hole is located correctly.

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

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

Initial reading + Depth of hole = Setting.

Fig 2



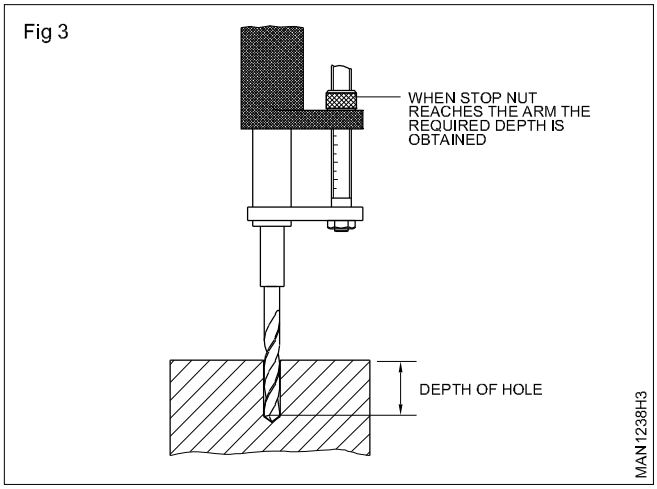
Adjust the stop next to the required setting, using the scale.

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

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)

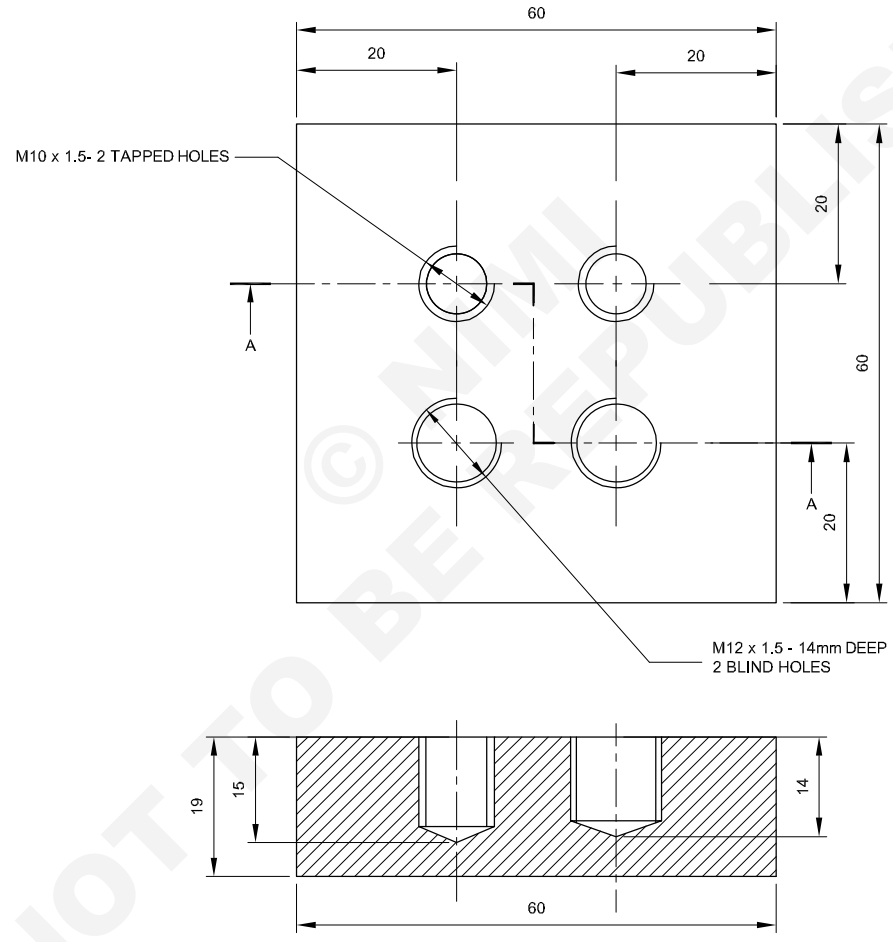
While drilling, release the drill frequently from the hole for the chips to be flushed out by the cutting fluid.

Fig 3



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

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



SECTION VIEW AT 'AA'

1	60ISF 20-60	EX.NO:1.2.33 ←	Fe310	–	–	1.2.34
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FORM INTERNAL THREADS WITH TAPS TO STANDARD SIZE (BLIND HOLE)**				TOLERANCE : ±0.04	TIME :
					CODE NO : MA20N1234E1	

Job sequence

Cut internal thread in blind hole M10

- Use finished job 09 Ex.No.1.2.33 for this excercise.
- Fix the job in bench vice.
- Fix M 10 first tap in tap wrench and cut internal thread to required depth of 15mm
- Similarly, fix M10 second tap and third tap in tap wrench one by one and cut the internal thread to form full thread.
- Repeat the above process to cut internal thread in other drilled blind hole

Cut internal thread in blind hole M12

- Remove metal chips if any from the blind hole by turning it upside down and slightly tapping it on a wooden surface.
- Fix the M12 first tap in tap wrench.
- Screw a matching nut on the first tap to the required distance for 14 mm to act a depth stop.
- Cut internal thread in blind hole to the required depth 14mm.
- Remove the metal chips, if any from the threaded blind hole.
- Similarly ,fix M12 second tap and third tap in tap wrench one by one and cut the thread to form full thread.
- Clean the threaded hole without burrs.
- Repeat the above process to cut internal thread in other drilled blind hole.
- Check the threaded hole using the M10, and M12 matching bolts by screwing.
- Apply thin coat of oil and preserve it for evaluation.

Use cutting fluid while cutting the thread

— — — — — — — —

Internal threading of through holes using hand taps

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

Determine the tap drill size

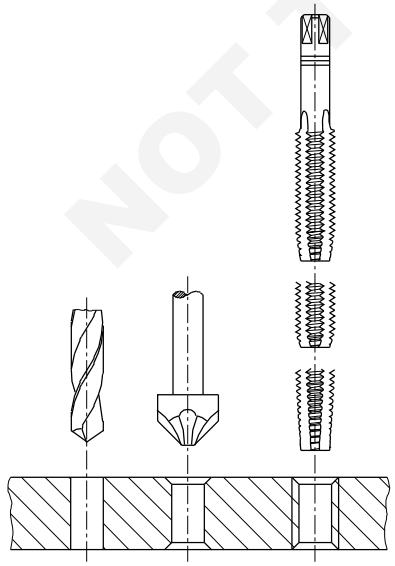
For cutting internal thread it is necesssary to determine the size of the hole (tap drill size). This can be calculated using the formula or can be chosen from the table of the tap drill sizes.

Procedure

Drill the hole to the required tap drill size.

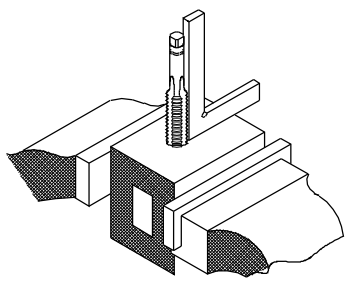
Do not forget to give the chamfer required for aligning and starting the tap. (Fig 1)

Fig 1



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

Fig 2



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

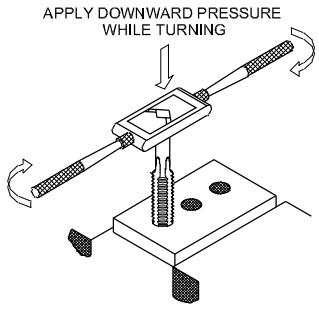
Fix the first tap (taper tap) in the wrench.

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

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

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

Fig 3



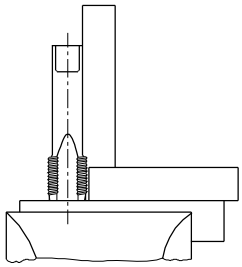
STARTING THE TAP

MAN1239H3

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

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

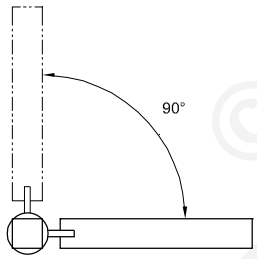
Fig 4



MAN1239H4

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

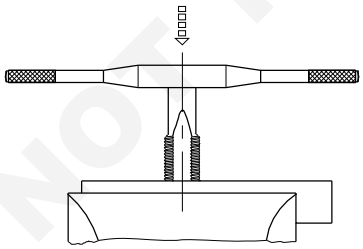
Fig 5



MAN1239H5

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

Fig 6



SQUARING UP THE TAP

MAN1239H6

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

Check the tap alignment again with a try square.

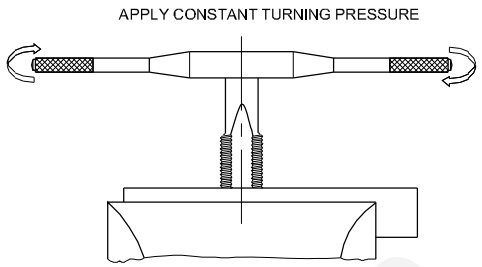
Fit the tap wrench and tighten without distributing the tap alignment.

Make one or two turns and check the alignment

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

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

Fig 7



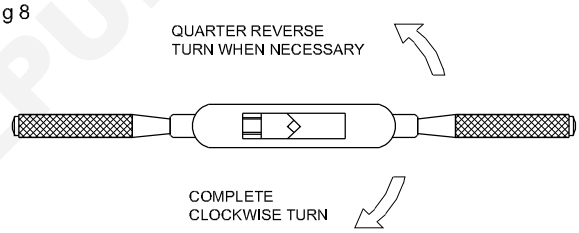
MAN1239H7

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

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

Use a cutting fluid while cutting the thread.

Fig 8



MAN1239H8

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

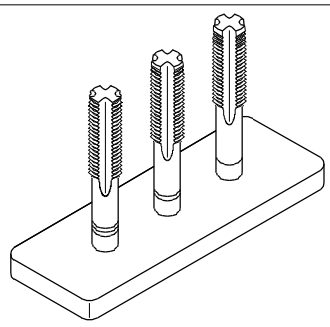
Finish and clean up using intermediate and plug tap. The intermediate and plug tap will not cut any thread if the tap has entered the hole fully.

Remove the chips from the work with a brush.

Check the threaded hole with a matching screw.

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

Fig 9



MAN1239H9

Internal threading of blind holes using hand taps

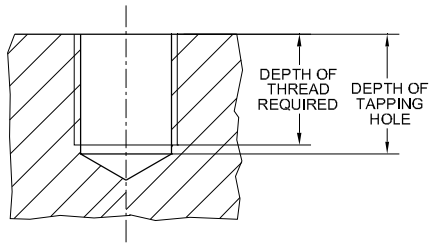
Objective : This shall help you to
- **cut internal threads using hand taps.**

Drilling a blind hole.

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

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

Fig 1



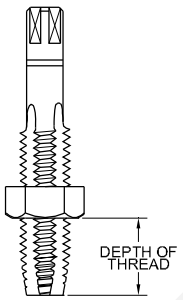
Procedure for threading

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

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

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

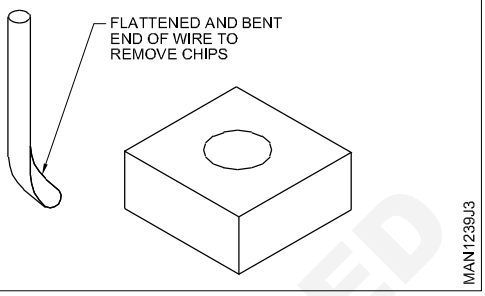
Fig 2



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

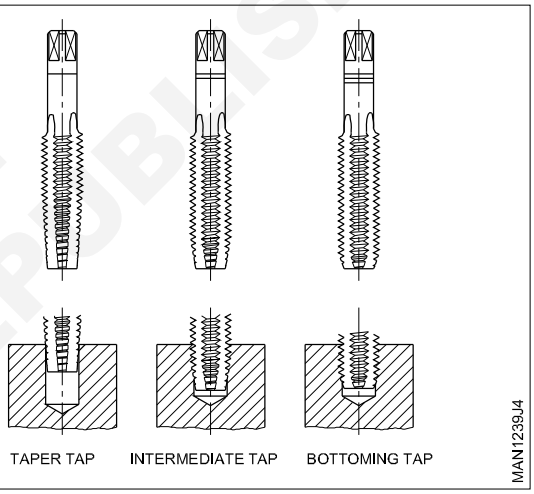
Remove the chips from the hole frequently, using a flattened and bend wire. (Fig 3)

Fig 3



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

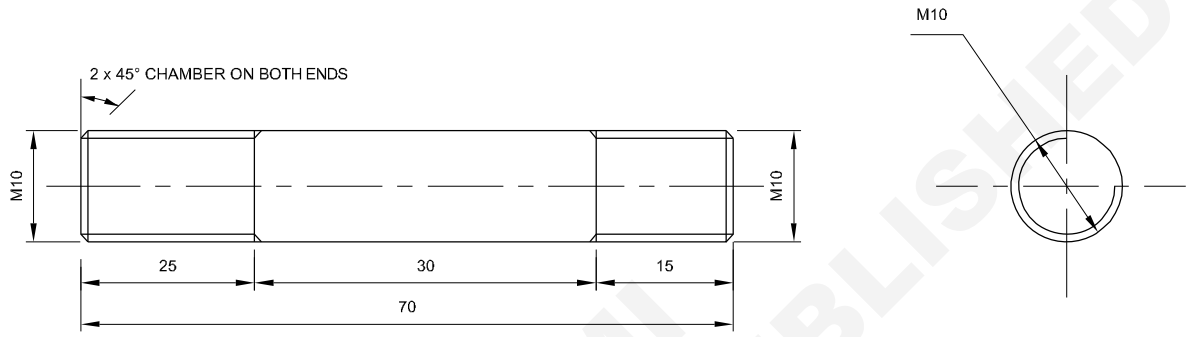
Fig 4



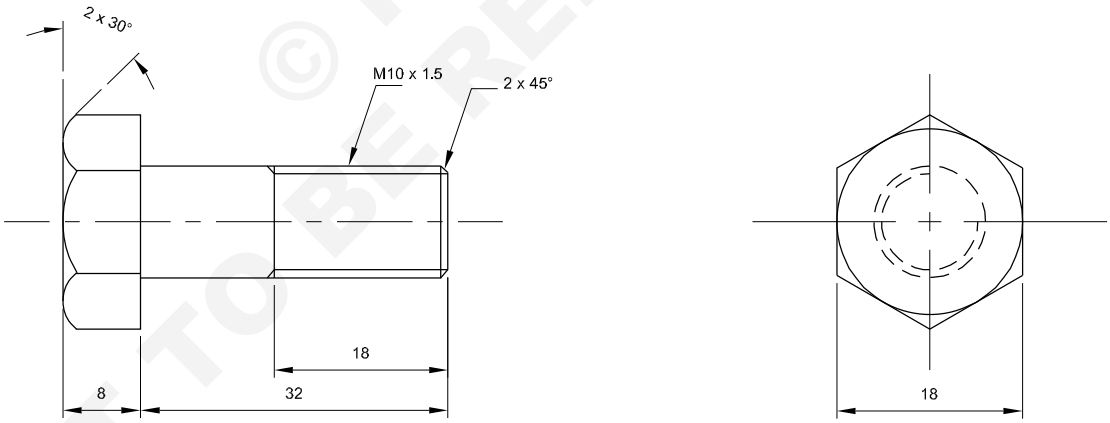
Prepare studs and bolt

Objectives : At the end of this exercise you shall be able to
- **file blank size to cut external thread for studs and bolts**
- **chamfer in both ends of studs and bolts**
- **mark the length required to cut external thread in studs and bolts**
- **cut external threads using die and die stock in studs and bolts**
- **check the external thread using screw pitch gauge and matching nuts.**

TASK 1



TASK 2



1	HEX A/F 18 - 45	–	Fe310	–	-	1.2.35
1	Ø10 - 75	–	Fe310	–	-	1.2.35
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS		**PREPARE STUDS AND BOLT**			TOLERANCE : ±0.04	TIME :
					CODE NO : MA20N1235E1	

Job sequence

TASK 1 **: Prepare stud.**

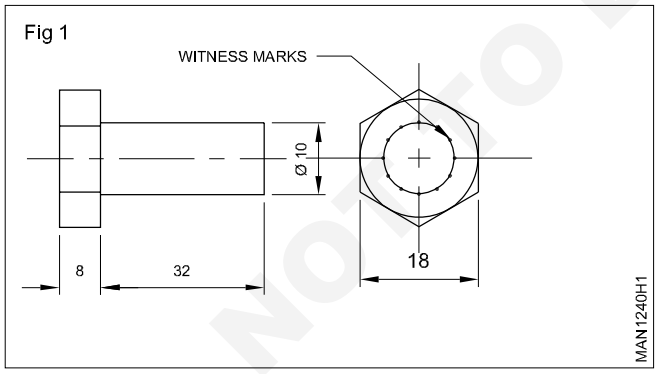
- Check the raw material size.
- File the round rod ends to flatness and squareness maintaning size ø 10mm x 70mm length.
- File round rod cylindrical profile to ø 9.9mm blank size to cut external thread as per drawing.
- File chamfer in both ends of the round rod to 2mm x 45°.
- Apply marking media on cylindrical surface of the job and mark the required length and punch witness marks to cut external thread as per drawing
- Hold the cylinerical rod in bench vice to 90° with aluminium vice clamps and check the 90° with try square.
- Set M10 circular split die in die stock.
- Place the split die on the cylindrical round rod one end and cut external thread by rotating in clock wise and anti-clockwise direction to cut external thread.
- Apply pressure on the die stock evenly and turn in a clock wise direction to advance the die in stud blank and reverse the die for a short distance to break the chips.
- Following the above processes, cut the external thread upto the required length as per drawing.
- Clean the thread and check with suitable screw pitch gauge and matching nut.
- If the nut is not fited with the external thread, increase the depth of cut gradually by adjusting the split die stock outer screw and deepen the cut of thread to correct pitch of thread and check with matching nut and screw pitch gauge.
- Similarly, repeat the thread cutting process in other end of cylinderical round rod to the required length and check with suitable screw pitch gauge and match with suitable nut.
- Clean the thread without burrs and apply little oil and preserve it for evaluation.

— — — — — — — — —

TASK 2 : **Prepare bolt.**

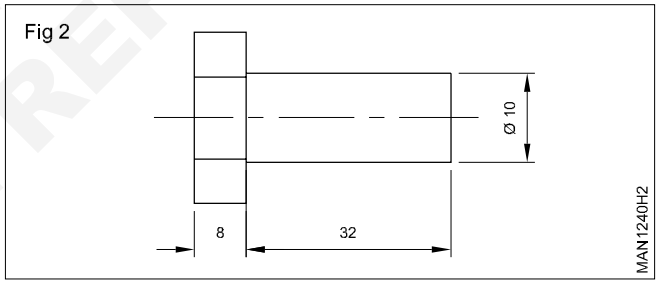
- Check the raw material for its size.
- File the hexagon rod ends to flatness and squareness maintaining size 10mm x 40mm length
- Apply marking media and mark dimensions to prepare hexagonal head bolt blank as per job drawing.
- Punch witness marks using dot punch 60° (Fig 1)

Fig 1



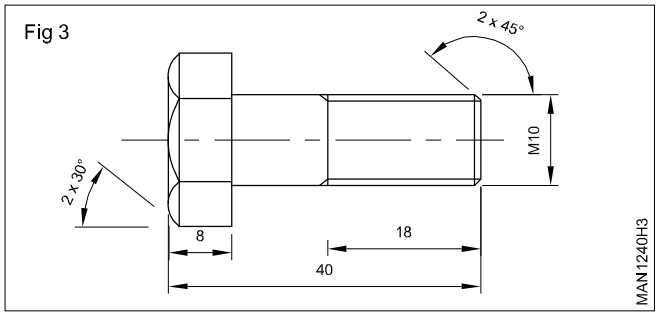
- Cut and remove excess metal by sawing.
- File hexagonal rod cylindrical blanks size to ø 9.9 mm x 18mm length to cut external thread. (Fig2)
- File chamfer in both ends of hexagon 2mm x 45°
- Hold the hexagonal head bolt in bench vice to 90° along with aluminium vice clamps.

Fig 2



- Set M10 split die in the die stock.
- Place the split die on the hexagonal head bolt round blank end with die stock and turn in clock wise direction and anti- clockwise direction to cut external thread. (Fig 3)

Fig 3



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

Use a cutting lubricant while cutting thread

— — — — — — — —

Skill sequence

External threading using dies

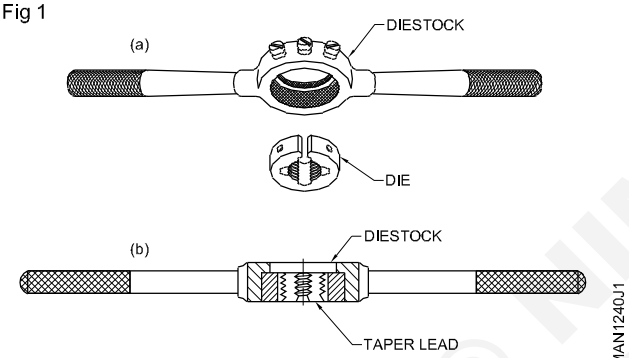
Objective : This shall help you to
- **cut external threads using dies**

Check blank size

Blank size = Thread size - (0.1 xpitch thread)

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

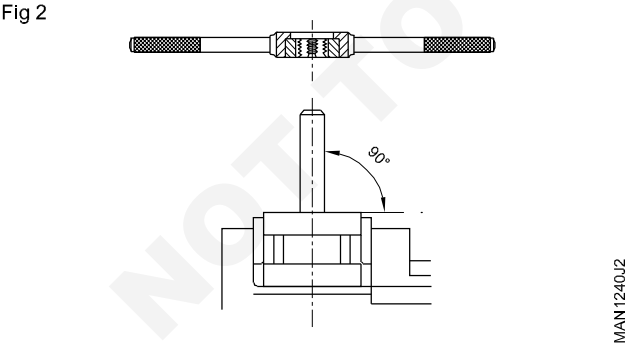
Fig 1



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

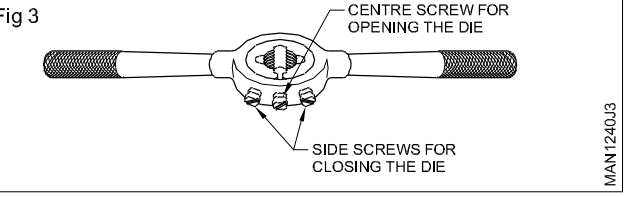
Project the blank above the vice - just for the required thread length only.

Fig 2



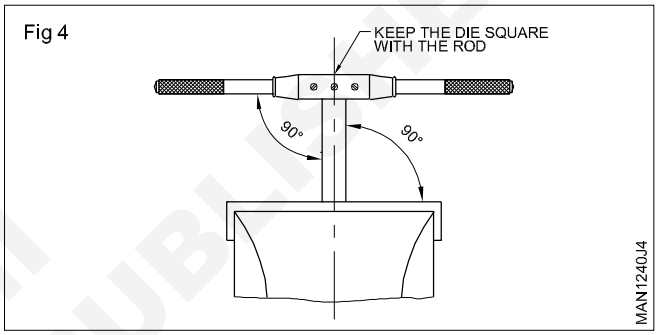
Place the leading side of the die on the chamfer the work. (Fig 3)

Fig 3



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

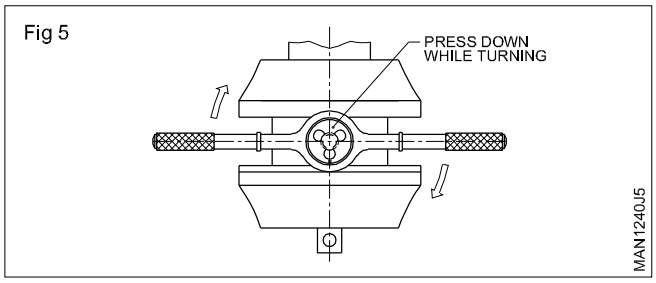
Fig 4



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

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

Fig 5



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

Use cutting lubricant

Increase the depth of the cut graudually by adjusting the outer screws

Check the thread with a matching nut.

Repeat the cutting untill the nut matches.

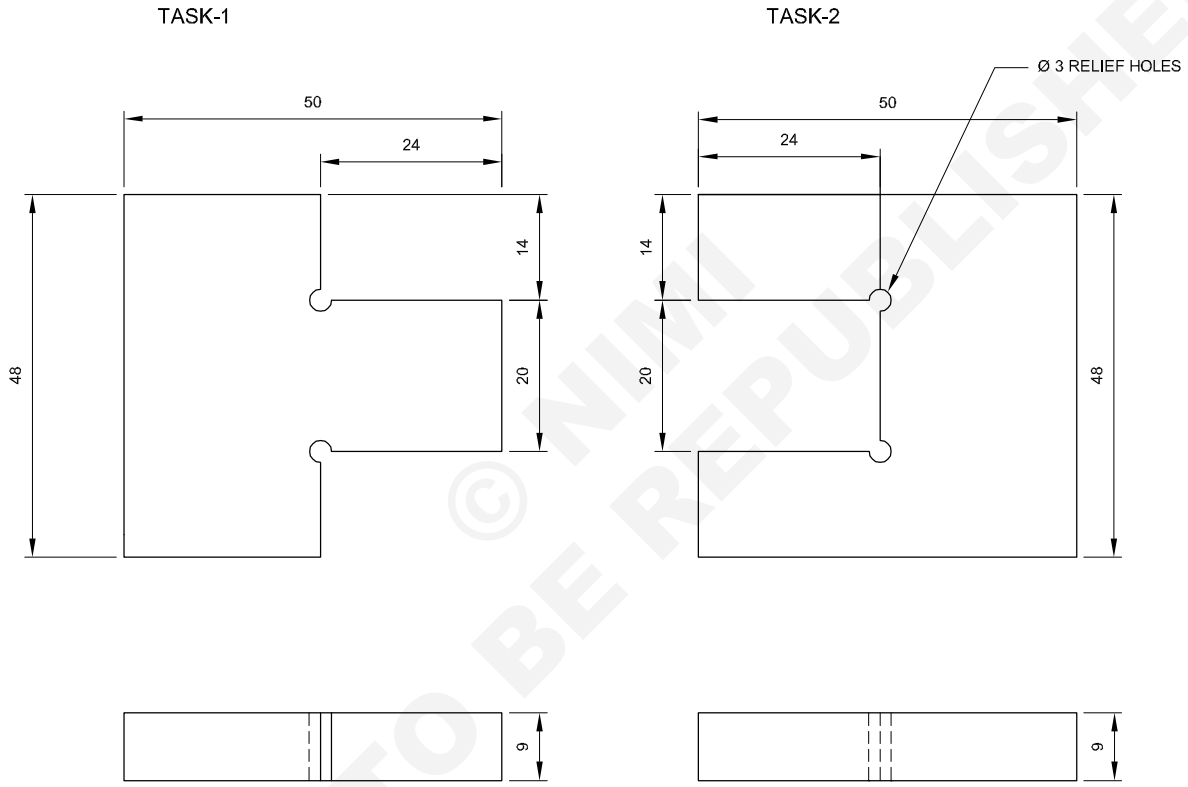
Too much depth of cut at one time will spoil the threads. It can also spoil the die.

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

Make male & female 'T' fitting with an accuracy ± 0.2mm and 1 degree

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

- **file flat surface to flat and parallel within an accuracy of ± 0.02 mm**
- **file and assemble the T fitting and obtain the required class of fit.**



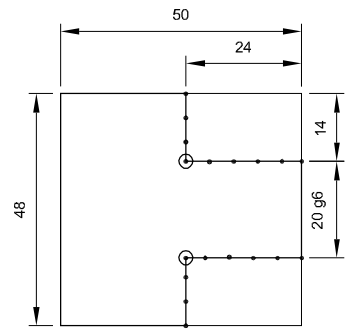
2	50 ISF 10 - 55	-	Fe310	-	A&B	1.2.36
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	**MAKE MALE & FEMALE 'T' FITTING WITH AN ACCURACY ±0.2 mm AND 1 DEGREE**				TOLERANCE : ± 0.2 mm	TIME :
					CODE NO : MA20N1236E1	

Job sequence

TASK 1: **Male part.**

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

Fig 1

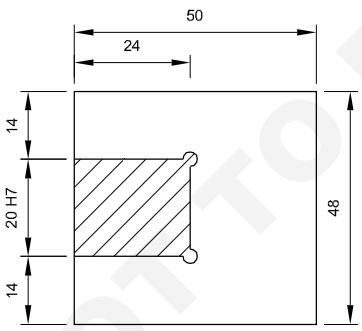


- Drill relief hole ϕ 3mm as per job drawing in part A.
- Mark lines as shown in Fig 2 leaving the metal 1mm away from the object line and cut and remove the excess metal by hack sawing.
- File part A as per drawing to size 14mm x 24mm with safe edge file and check the size with vernier caliper.

TASK 2: **Female part.**

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

Fig 4



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

Fig 5

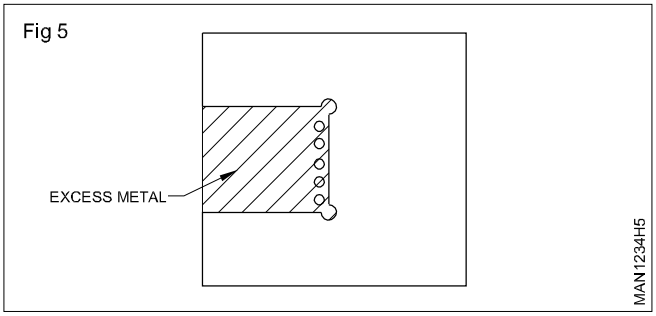
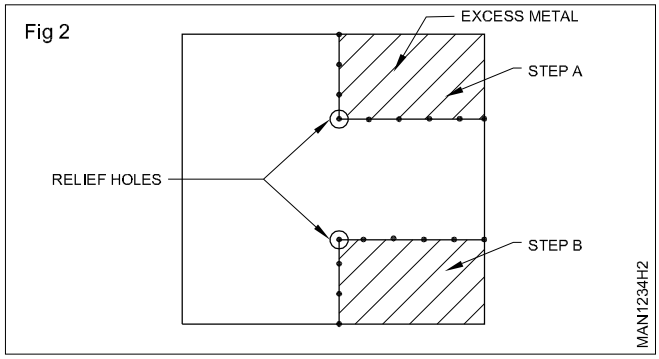
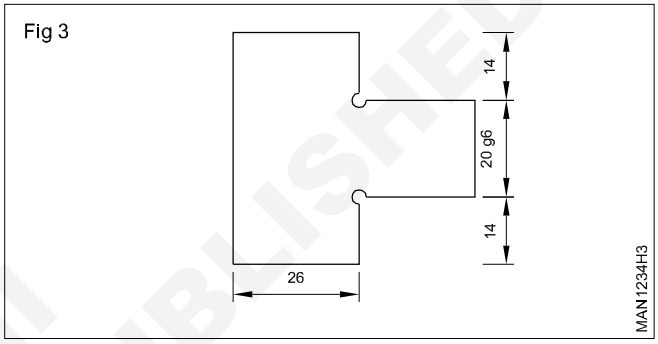


Fig 2



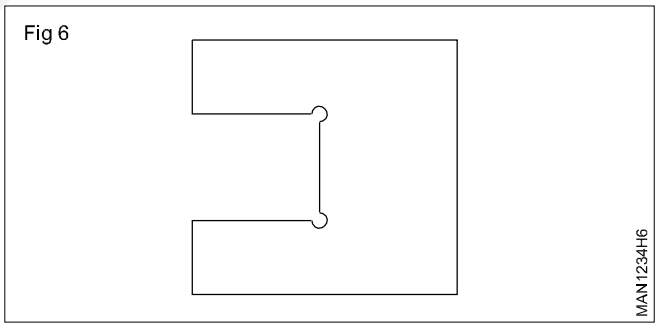
- Similarly cut and remove the excess metal and file step B to size and shape and check the size with veriner caliper as shown in Fig3.

Fig 3



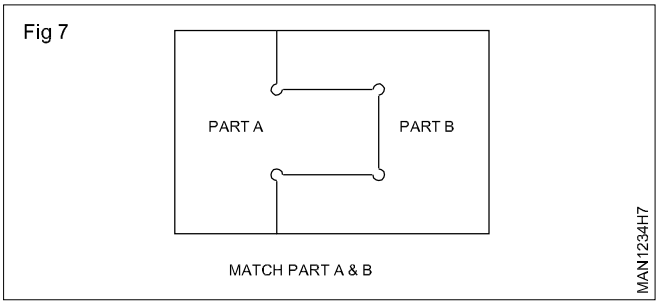
- File to size and shape maintaining the flatness and squareness as shown in Fig 6.

Fig 6



- Check the size with vernier caliper.
- Match part 'A' and 'B' as shown in Fig 7.

Fig 7



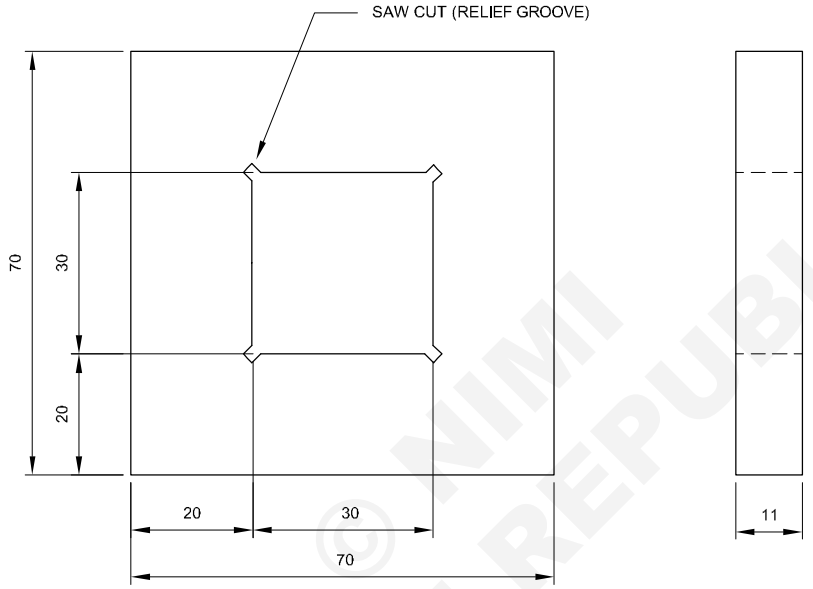
- Finish the filing and de- burr in all the surface of the job.
- Apply a thin coat of oil and preserve it for evaluation

Make male and female square fit with accuracy ± 0.1mm

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

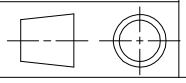
- **mark the dimension lines as per drawing**
- **chain drill, cut and remove excess metal by chipping**
- **file square slot maintaining ± 0.1 mm**
- **match square in square slot.**

TASK-1



TASK-2

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	35 ISF 12- 35	–	Fe310	–	-	
1	75 ISF 12 - 75	–	Fe310	–	-	1.2.37

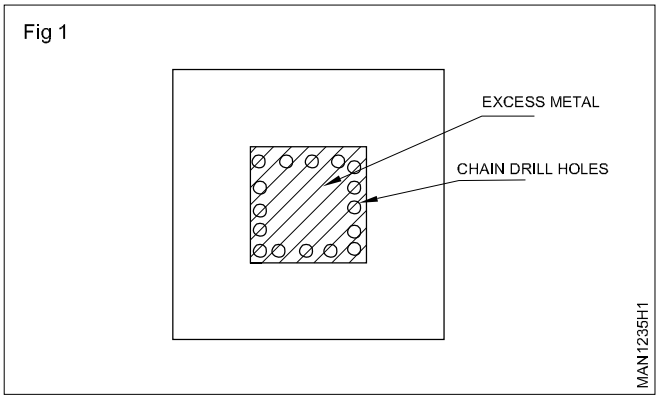
SCALE NTS	MAKE MALE FEMALE SQUARE FIT WITH ACCURACY ±0.1 mm	TOLERANCE : ±0.01 mm	TIME :
		CODE NO : MA20N1237E1	

Job sequence

TASK 1: **Marking and chain drilling.**

- Check the given raw material for its size.
- Rough and finish file on surface flat and square to overall size 70 x70 x11 mm maintaining accuracy ± 0.01mm.
- 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 .

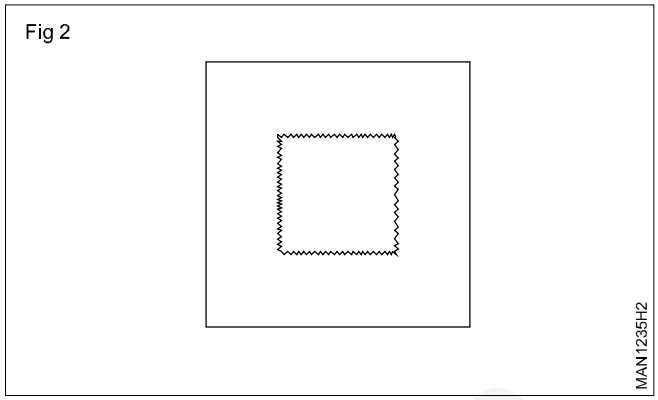
Fig 1



Periphery of the drill should not touch the witness marks

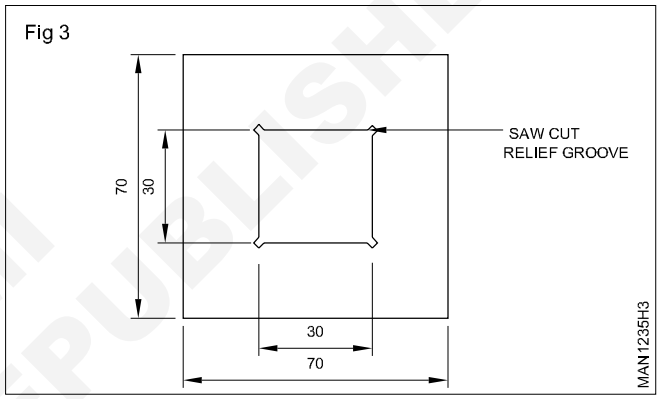
- Cut and remove the chain drilled hatched part using web chisel and ball pein hammer as shown in Fig 2.
- File the chipped portion to size and shape using safe edge file of different grades maintaining accuracy of ± 0.04mm and check the size with veriner caliper.

Fig 2



- Cut relief grooves using hacksaw at four inside corners as shown in Fig 3.

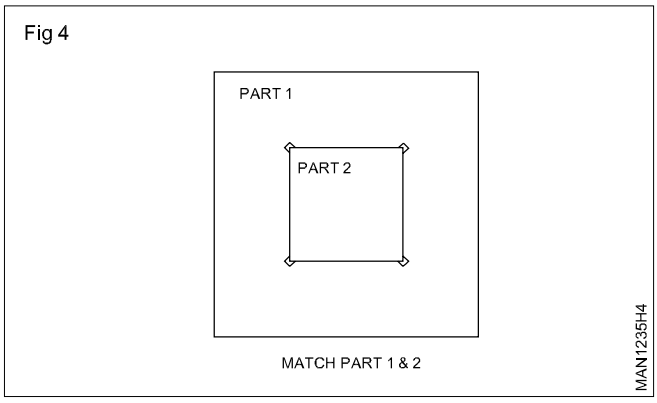
Fig 3



TASK 2: **Filling the square and fitting.**

- File to size 30 x 30 x 11mm maintaining accuracy **±** 0.04mm.
- Check the flatness and squareness with try square.
- Check the size with vernier caliper.
- Match part - 2 into part 1 as shown in Fig 4.
- Finish file in part 1 and 2 with flat smooth file and de burr in all the surface and corners of the job.
- Apply a little oil and preserve it for evaluation.

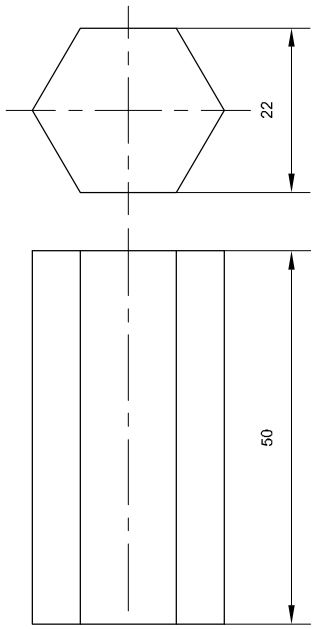
Fig 4



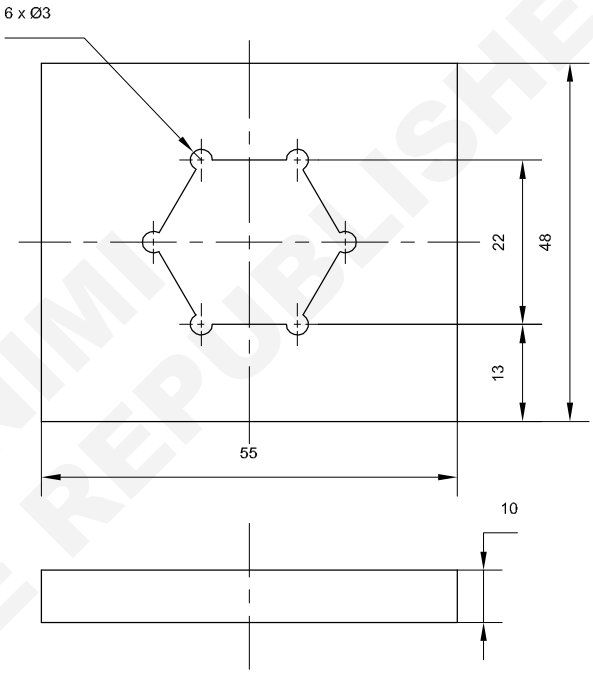
Make male and female Hexagon fitting with accuracy ± 0.06mm

Objectives : At the end of this exercise you shall be able to
- **prepare the part 'B' by filing and finish to the required size and shape**
- **prepare the part 'A' by filing and finish to the required size and shape**
- **fit part 'A' and 'B'.**

PART-A



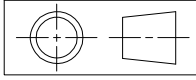
PART-B



Job Sequence

- File surface flat and parallel to an accuracy of ± 0.06mm
- File and finish angular surface to an accuracy of ±10'
- Mark sizes with vernier height gauge
- Drill relief holes
- Chip flat surface
- File angular and parallel surfaces to an accuracy of ± 0.06mm
- Check parallelism of filed surface with a try square
- File and fit male and female
- Check the angle of the external taper of tapered components using bevel protractor

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	50 ISF 10 - 58	-	Fe310	-	-	
1	Ø28 - 53	-	Fe310	-	-	1.2.38

SCALE NTS	MAKE MALE & FEMALE HEXAGON FITTING WITH ACCURACY ±0.06 mm	TOLERANCE ±0.06 mm	TIME :
		CODE NO. MA20N1238E1	

Identify and function of different parts of lathe. Practice on operation of lathe (Dry /Idle run)

Objectives: At the end of this exercise you shall be able to
- **identify the main parts of lathe**
- **function of the parts of lathe**
- **operate the lathe on idle /dry run.**

Job sequence

TASK 1: **Write the name and function of the main parts.**

Identify the main parts of the marked in Fig 1 & 2.

- Record in Table 1.

Fig 1

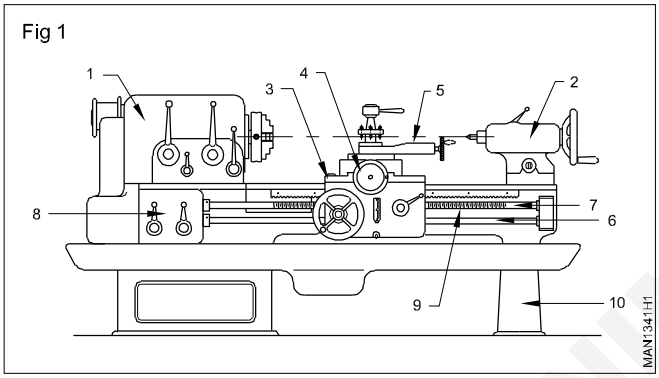


Table 1

Fig No	Part name	Function
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

TASK 2: **Write the name of the lathe parts.**

- Identify the function of lathe parts marked in Fig 2.
- Record in Table 2.

Fig 2

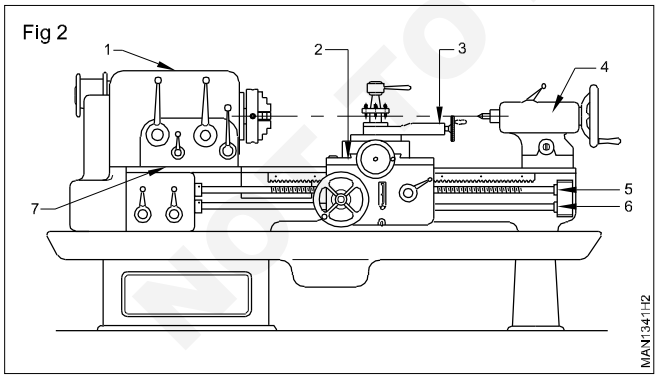


Table 2

Fig No	Part name	Operation
1		
2		
3		
4		
5		
6		
7		

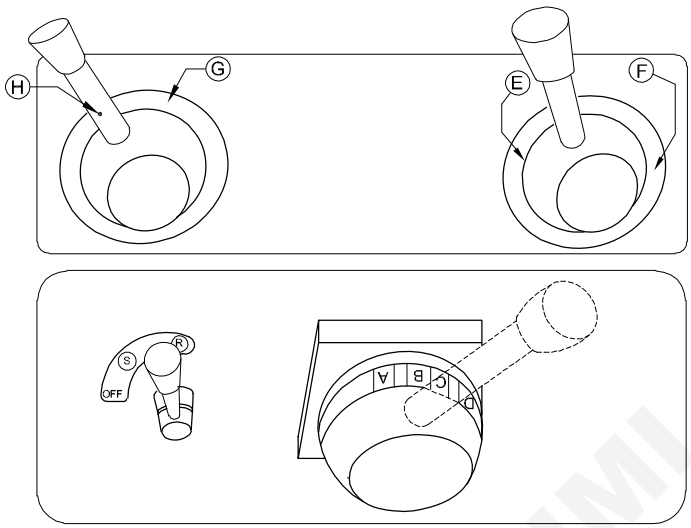
TASK 3: **Idle/dry run at the lathe.**

- Instructor may train the trainees to operate the lathe on idle

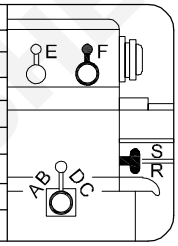
Setting lathe on different speed and feed

Objectives: At the end of this exercise you shall be able to
- **identify the speed on the lathe**
- **select the speed and feed**
- **tabulate the speed in the given table for the task 1.**

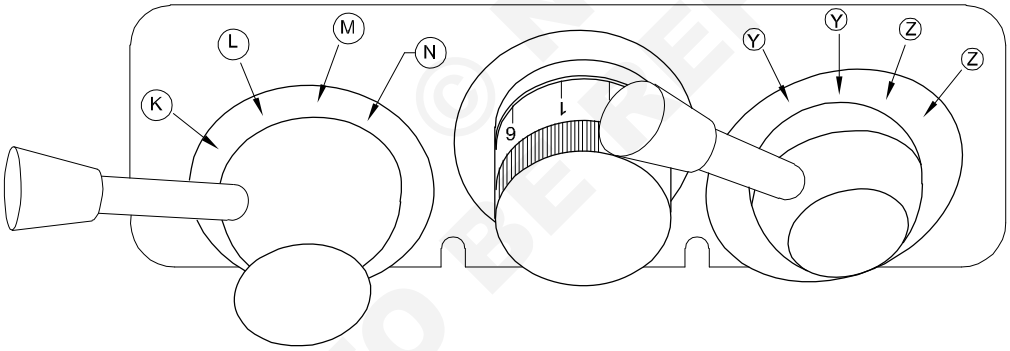
TASK. 1

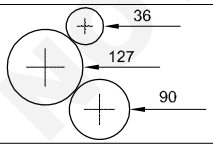
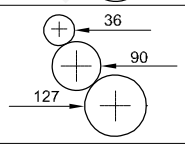
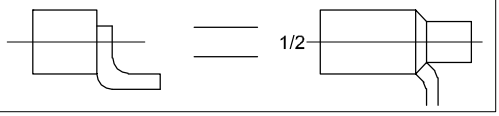


n/min		E	F
D	R	1600	250
C	R	1150	200
D	S	800	140
B	R	740	115
C	S	580	90
A	R	450	71
B	S	360	60
A	S	228	38



TASK. 2



			G			F		H
			K	L	M	K	L	M
	Z	6	0.07	0.13	0.27	0.53	1.07	2.13
		2	0.08	0.16	0.32	0.64	1.27	2.54
		3	0.09	0.18	0.36	0.71	1.42	2.84
		5	0.11	0.23	0.46	0.91	1.82	3.66
		4	0.12	0.25	0.5	0.99	1.98	3.96
	Z	6	0.05	0.1	0.2	0.4	0.8	1.6
		2	0.06	0.11	0.23	0.45	0.9	1.8
		3	0.07	0.13	0.25	0.5	1.0	2.0
		5	0.08	0.16	0.32	0.65	1.3	2.6
		4	0.09	0.18	0.35	0.7	1.4	2.8
								

MA20N1340H1

Job sequence

TASK 1: **Selection of speed.**

- Observe the speed chart in the machine.
- Change the right side lever in (E)
- After that change the bottom side lever in (B)
- Then change the another bottom lever (D)
- Switch on the machine the speed is 1600 rpm.
- Again and again change different lever at the chart method an take different speed.
- Identify speed change lever position A,B,C,D & E,FS,R.
- Record in table 1.
- Get it verified by your instructor.

Note : According to the machines available in your institute prepare the speed chart for the practice of the trainees.

Table 1

M/Min		E	F
A	S		38
B	S		
C	S	580	
D	S		
A	R		71
B	R		
C	R		
D	R	1600	

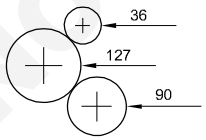
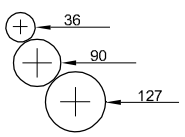
— — — — — — — — —

TASK 2 : **Selection of feed.**

- Observe feed chart in the machine.
- Change the top left side lever (G)
- Change the bottom left side lever (K)
- Change the bottom right side lever (Z)
- After number change shaft rotate the number (6)
- Switch ON the machine and engage carriage feed lever and get feed rate 0.07mm/rev.
- Again and again change different lever on chart method and take different feed.
- Identify the feed change lever position Y,G,H & K,L,M
- identify the feed in different set of change gears
- Record in table 2.
- Get it verified by your instructor.

Note : According to machine available in your institute prepare the feed chart for practice the trainees.

Table 2

			G			F	H	
			K	L	M	K	L	M
	Z	2	0.16					
		3				0.71		
		4						3.96
		5				0.46		
		6	0.07					
	Z	2		0.11				
		3				0.5		
		4	0.09					
		5					1.3	
		6			0.2			

Dismantling , assembling and truing of 3 jaw and 4 jaw chucks

Objectives: At the end of this exercise you shall be able to
- **dismantling 3 jaw self centring chuck of lathe**
- **dismantling 4 jaw independent chuck of lathe**
- **method of assembling of 3 jaw and 4 jaw chuck**

Job sequence

TASK 1**: Dismantling and assembling of 3 and 4 jaw chuck.**

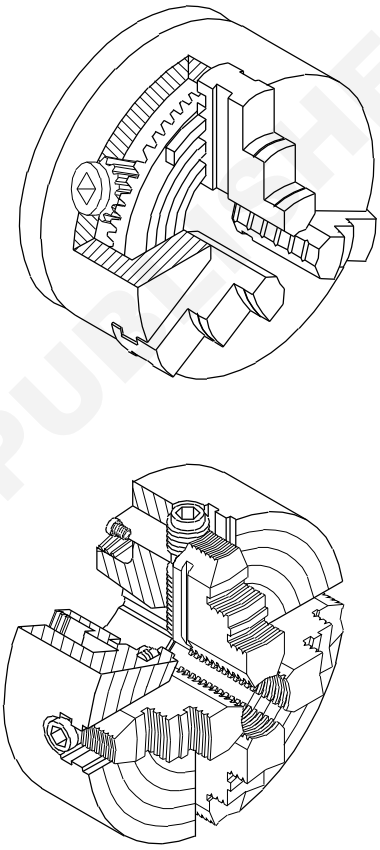
Three jaw chucks

- Clean the chuck body with cotton waste.
- Rotating any one of the pinion in anticlockwise direction with the chuck key
- Remove all the three jaws one after another by rotating.
- Remove the back plate by unscrewing the screw bolts.
- Separate the pinions by removing curved keys.
- Remove scroll disc from the chuck body.
- Clean all the parts with kerosene oil.
- Lubricating the sliding surface with grease.
- Reassemble all the parts in the reverse sequence.
- Mount the chuck on the machine spindle.
- Take a trail run of the chuck and check the function.

Four jaw chucks

- Clean the chuck body with cotton waste.
- Check the function of the chuck.
- Remove all the four jaws individually by rotating the screws in anticlockwise direction by a chuck key.
- Remove the fork pins by unscrewing the locking screws. Remove the driving screws.
- Repair or replace the worn out parts.
- Clean all the parts with kerosene oil.
- Lubricating all the moving surfaces with grease.

Fig 1



- Re-assemble all the parts in reverse sequence.
- Mount the chuck on the machine spindle.
- Take a trail run of the chuck and check its function.

— — — — — — — —

Skill sequence

Dismantling and assembling of lathe chuck

Objectives : This shall help you to
- **dismantle a lathe chuck**
- **lubricant and re-assemble the lathe chuck.**

3 Jaw self centering chuck

Clean the chuck body with cotton waste.

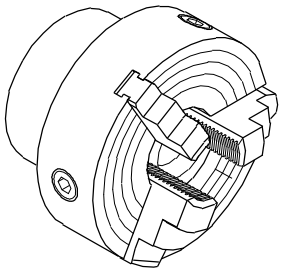
Inspect the function of the chuck.

Remove all the three jaws, one after another by rotating any one of the pinions in anticlockwise direction with the chuck key.

Remove the back plate by unscrewing the screws/bolts and separate the pinions by removing curved keys.

Remove scroll disc from the chuck body.

Fig 1



3 JAW SELF-CENTRING CHUCK

MAN:343J1

Use proper allen key, screwdriver, soft hammer, copper drift etc to avoid damage of the parts.

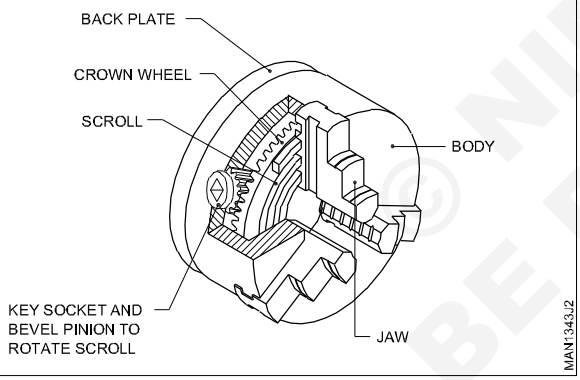
Repair or replace the broken /worn out parts, if any.

Clean all the parts with kerosene oil and wipe off with a banyan cloth.

Lubricant the sliding /moving surfaces with servo gem No. 2 grease.

Reassemble all the parts in the reverse sequence.

Fig 2



MAN:343J2

All the 3 jaws both Forward set and reverse set are marked as 1,2,3 which must be fitted serially, one by one into the slots provided for the particular jaws.

Take a trial run of the chuck and check its function.

4 Jaw independent chuck

Clean the chuck's body with cotton waste.

Check the function of the chuck.

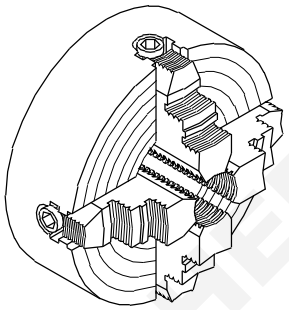
Remove all the four jaws individually by rotating the screws in anticlockwise direction by a chuck key.

Remove the fork pins (4 Nos) by unscrewing the locking screws.

Remove the driving screws. (4 Nos)

Use soft hammer copper drift proper allen keys/ spanners to avoid damage of the parts.

Fig 3



4 JAW INDEPENDENT CHUCK

MAN:343J3

Repair or replace the broken /worn out parts,if any.

Clean all the parts with kerosene oil.

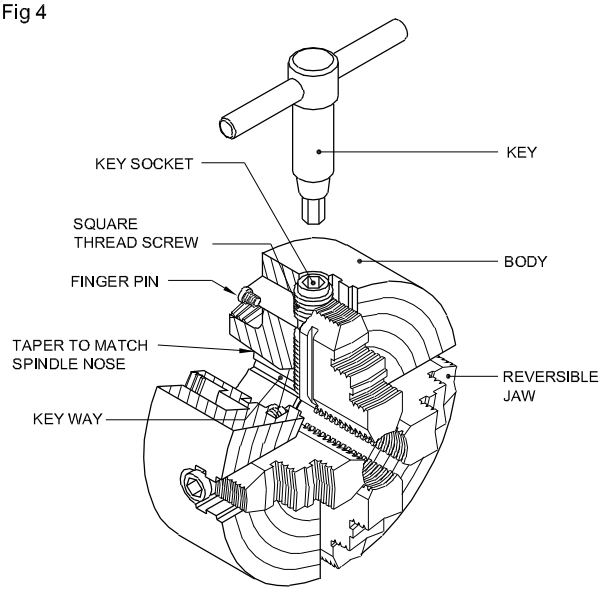
Wipe off all the parts with banyan cloth.

Lubricate all the sliding/moving surface with servo gem No.2 grease.

Reassemble all the parts in reverse sequence.

Take a trial run of the chucks and check its function.

Fig 4



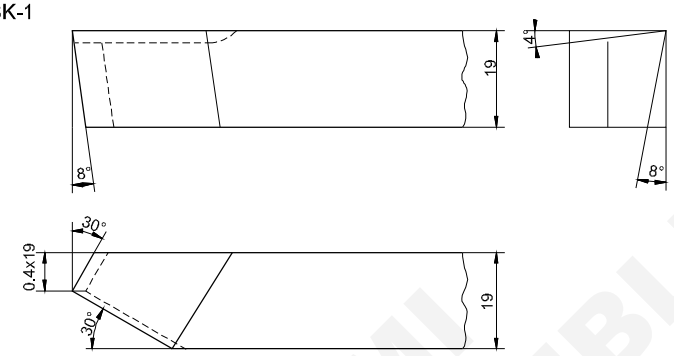
MAN:343J4

Grinding of R.H. and L.H tools V-tool parting tool, round nose tool

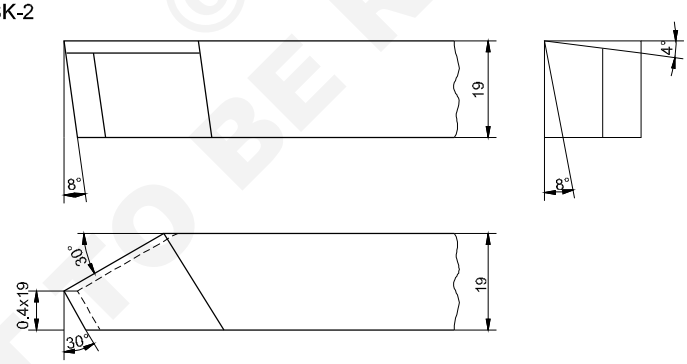
Objectives : At the end of this exercise you shall be able to

- **grind R.H. and L.H. tool**
- **grind 'V' tool**
- **grind round nose tool**
- **grind parting tool**
- **check the angles with a protractor.**

TASK-1

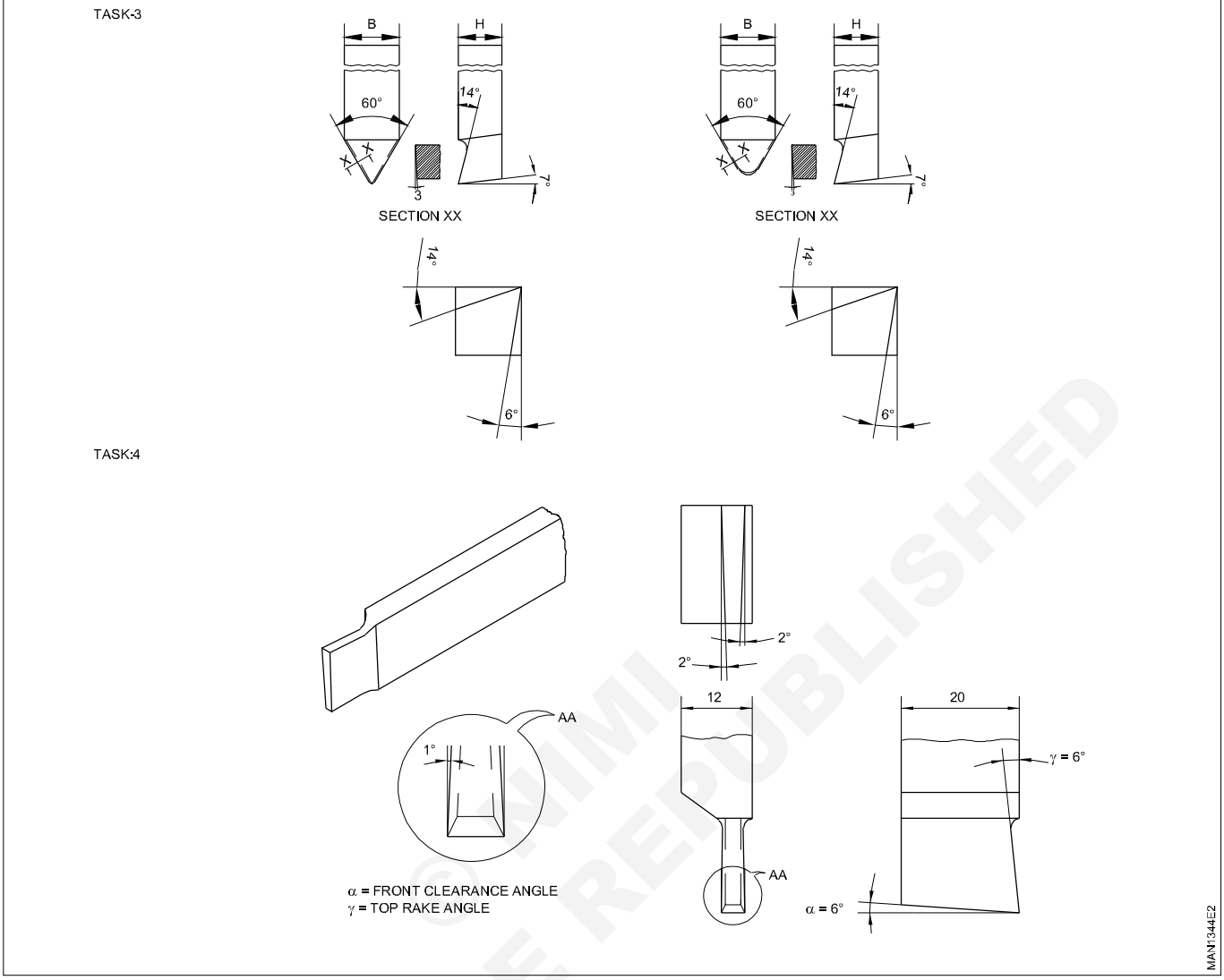


TASK-2



1	20ISF-12-150	–	1	Fe 310	-	
1	SQ 12-110	–	1	Fe 310	-	1.3.42
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX NO.

SCALE NTS	**GRINDING OF R.H. AND L.H.TOOLS,V.TOOL PARTING TOOL,ROUND NOSE TOOL**	DEVIATIONS ± 1°	TIME :
		CODE NO. MA20N1342E1	



Job sequence

TASK 1: **Grinding R.H and L.H 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 4° 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 4°.
- To prepare L.H tool follow the same procedure.

TASK 2 : **Grinding 'V' tools.**

- Set the pedestal grinder for tool grinding and make sure it is safe to start.
- Remove excess material on right hand side of the tool to length equal to the thickness of tool and width.
- Adjust the tool rest to maintain a minimum gap from the wheel face of 2 to 3 mm.
- Wear the goggles, start the wheel, hold the tool firm at an angle of approximately 60º to the face of the wheel, grind the left hand side of tool.
- Repeat the above procedure for right hand side to get the included angle of 60º .
- Grind the top rake angle, back rake angle of 14º
- Grind the front clearance angle of 7º, the bottom of the edge touching the wheel first.
- Lap the cutting edge with an oilstone.

Precautions:

- Wear goggle
- Avoid burning of tool by using suitable coolant.

— — — — — — — — —

TASK 3: **Grinding side cutting tool.**

- 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 instructor.

- Hold the blank against the wheel to grind the end cutting edge angle 20° to 25° and the front clearance angle between 6º to 8º - 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 R 0.5 mm.

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

— — — — — — — —

TASK 4: **Grinding parting tool.**

- Set the pedestal grinder for tool grinding.
- Remove excess of material on right hand side of the tool to length equal to the thickness of tool and width.
- Grind Half of the thickness of tool on rough grinding wheel.
- Grind 6° to 8° front clearance angle.
- Hold the tool at an angle of 55° to the face of the wheel.
- Grind 27 1/2° on left hand side of the tool.
- Repeat the above procedure on the right side of the tool to get an included angle of 55° on the tool.
- Grind 2° to 4° side clearance angle on each side of the tool.
- Finish all sides by using smooth grinding wheel. Check the tool by centre gauge; there should not be any light passing through gauge and cutting edges of the tool.
- Cutting point is carefully ground in a smooth wheel.
- Finally lap the tool by applying oil stone on cutting edges.

Remember

- Avoid burning of the tool.
- The cutting edge should be visible during grinding.

— — — — — — — — —

Skill sequence

Grinding a side cutting tool for machining steel

Objective : This shall help you to

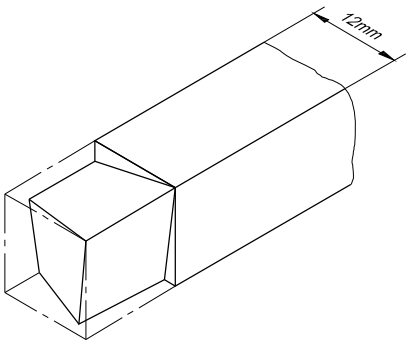
- **grind a right hand side cutting tool to machine steel.**

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)

The side cutting edge is in line with the blank edge and the end cutting edge is inclined at an angle of 25°. The side rake angle is 14°. The front and side clearances are ground 6°. The length of the side cutting edge is maintained

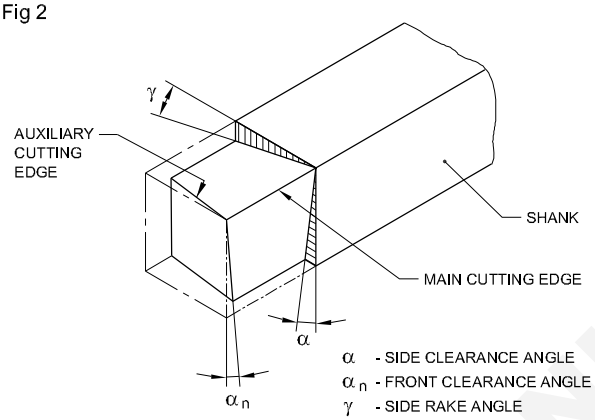
equal to the size of the square cross-section of the tool blank, i.e. 12 mm. Fig 2 shows the shaded portion to be removed by grinding the tool blank to get the ground tool. The procedure in sequence is as follows.

Fig 1



MANI344-I1

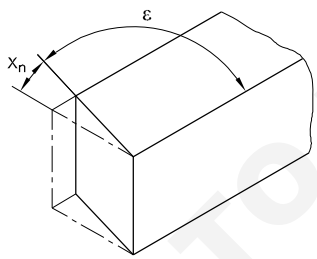
Fig 2



MANI344-I2

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

Fig 3



MANI344-I3

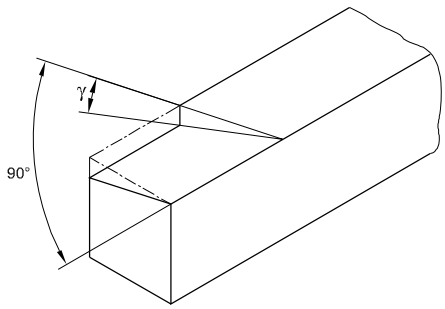
Grind the side rake angle of 14°. Angle. (Fig 4)

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

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

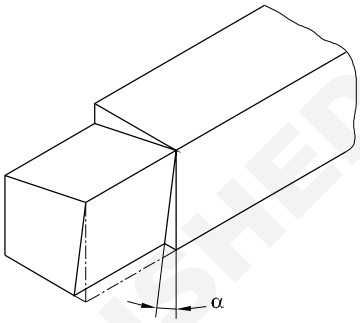
Grind and provide a nose radius of R 0.4 to R 0.6 mm at the point of tool. Grind a flat for a short length of 0.2 to 0.3 mm as shown in Fig 7. For the sake of clarity the figure is magnified.

Fig 4



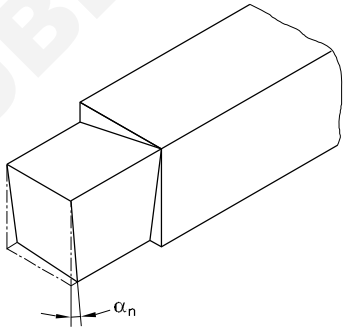
MANI344-I4

Fig 5



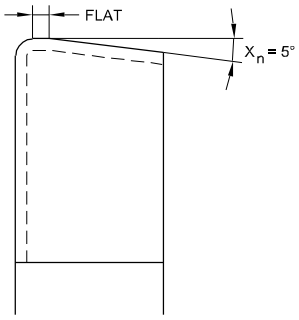
MANI344-I5

Fig 6



MANI344-I6

Fig 7

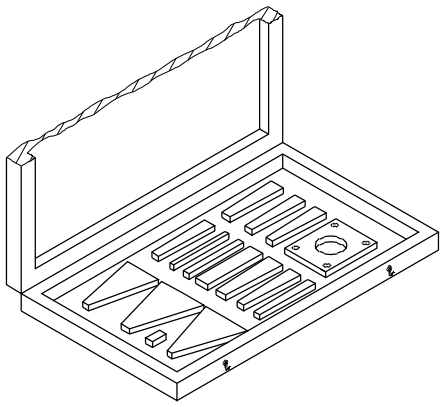


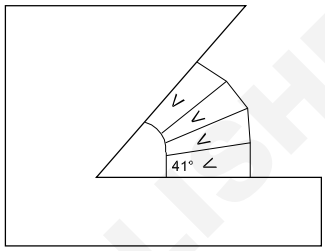
MANI344-I7

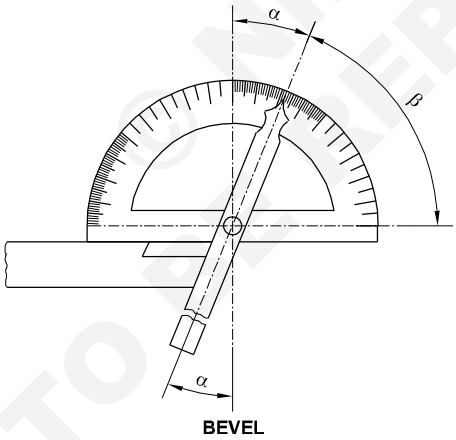
Checking of angles with angle gauge and bevel protractor

Objectives : At the end of this exercise you shall be able to
- **build up different angles using angle gauge**
- **measure angle of a different components using bevel protractor.**

NOTE: Instructor shall provide different type of work pieces for measurement of angles and give the angle to build up angle gauge.







BEVEL

MAN1345H1

Job sequence

Instructor shall demonstrate on angle measurement using angle gauge and bevel protractor

- Trainees should be able to build different angles using angle gauges
- Trainees should measure the angle of work piece provided by the instructor and record it in table 1.

Note: The instructor may check the build up angle of angle gauge and evaluate

Table - 1

Component	Angle
1	
2	
3	
4	
5	

Skill sequence

Building up a combination

Objective: This shall help you to
- **build up angle using angle gauge.**

To build up a size of 27° 9' 9" (Fig 1)

Gauge required

1st series	-	27° 0' 0"
2nd series	-	0° 9' 0"
3rd series	-	0° 0' 6"
Additional		
Block	-	0° 0' 3"
		27° 9' 9"

Fig 1

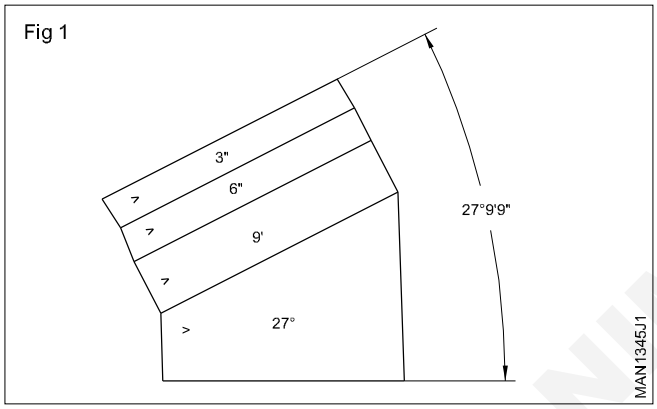
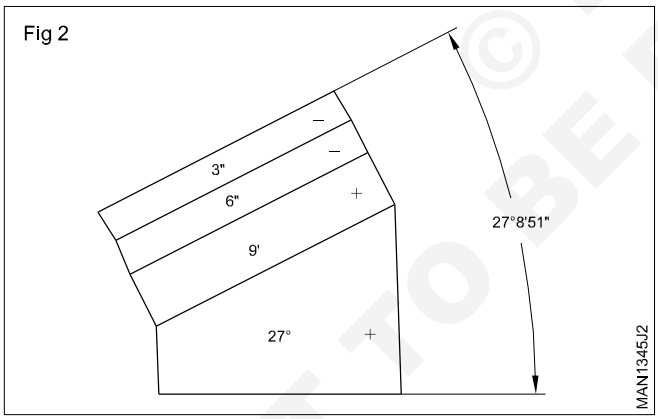


Fig 2



To obtain an angle of 27°-8'-51" the same gauges may be used, but they must be wrung together as shown in Fig 2.

Work out the

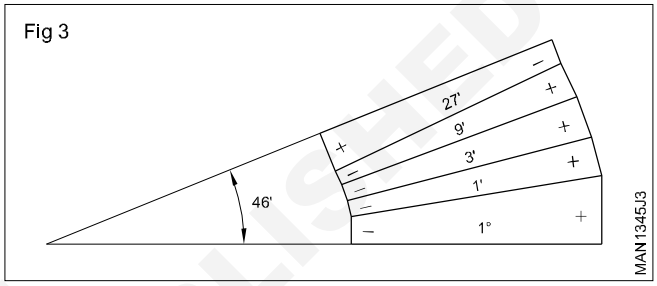
Gauges required for	27° 8' 51"	
1st series	27° 0' 0"	
2nd series	0° 9' 0"	To be added
3rd series	0° 0' 6"	To be subtracted
4th series	0° 0' 3"	From the sum of the 1st and 2nd series as these two are positioned in the opposite way.

If the angle includes minutes, and is greater than 40 minutes, increase the angle by 1° and subtract the number of minutes necessary to obtain the required minute.

This is because the total minutes available with the pieces in the series is 40' only.

To obtain 46' the build up will be as shown in Fig 3.

Fig 3



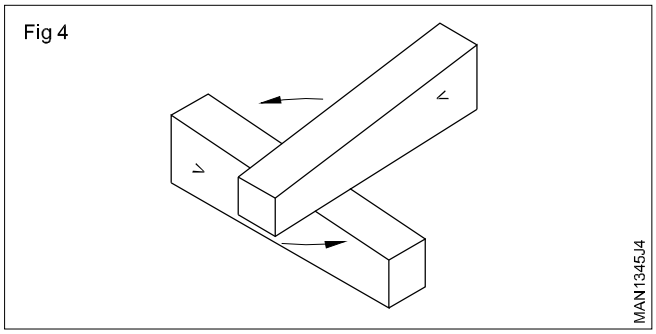
Handling and wringing

Gloves of cotton fabric or chamois leather must be worn to prevent corrosion.

Before the gauges are wrung together the faces should be wiped clean using soft muslin cloth or chamois leather.

The wringing of the angle gauges should be carried as shown in Fig 4.

Fig 4

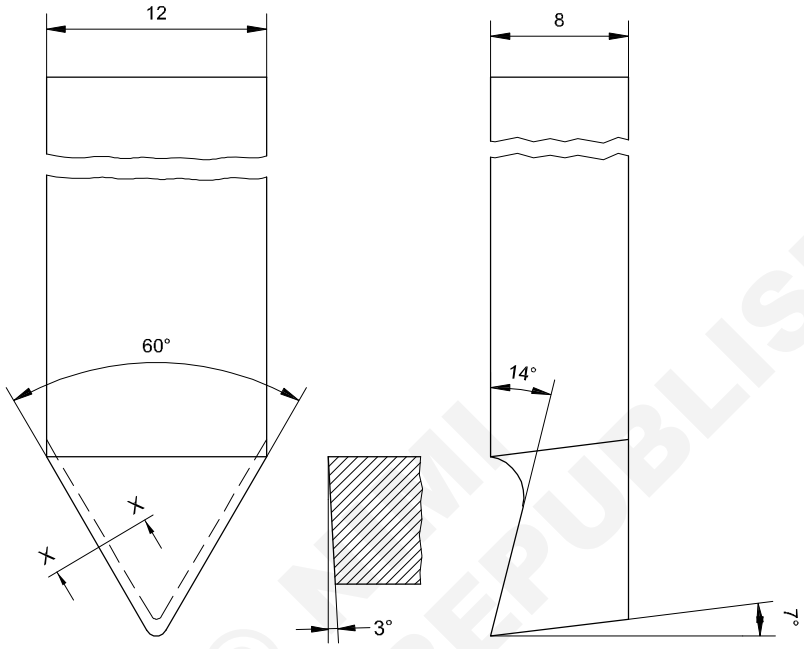


After use, clean the gauges thoroughly with a soft cloth and white spirit.

Apply vaseline lightly and store the gauges in a box.

Grinding of 'V' tools for threading of metric 60 degree threads

Objective : At the end of this exercise you shall be able to
- **grinding 'V' threading tool (metric).**



SECTION XX

Job sequence

- Remove the excess material on the right hand side to the required width and length by using a rough grinding wheel.
- Grind Half of the thickness of tool on rough grinding wheel.
- Grind 4° to 8° front clearance angle.
- Hold the tool at an angle 30° to the face of the wheel.
- Grind 30° on left hand side of the tool.
- Repeat the above procedure on the right side of the tool to get an included angle of 60° on the tool.
- Grind 3° to 5° side clearance angle on each side of the tool.
- Finish all sides by using smooth grinding wheel.
- Check the tool by centre gauge; there should not be any light passing through gauge and cutting edges of the tool.
- Cutting point is carefully ground in smooth wheel.
- Finally lap the tool by applying oilstone on cutting edges.

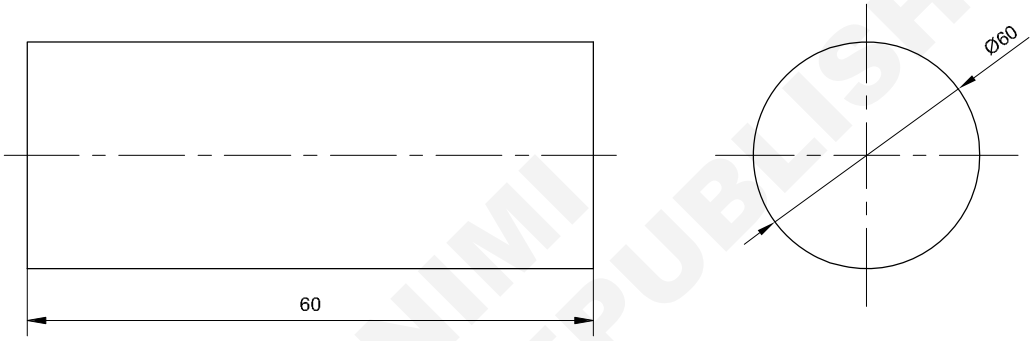
Remember

- Avoid burning of the tool.
- The cutting edge should be visible during grinding.

1	12x8x150 H.S.S BIT	-	Fe 310	-	-	1.3.44
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	GRINDING OF 'V' TOOLS FOR THREADING OF METRIC 60 DEGREE THREADS				DEVIATIONS ± 1°	TIME:
					CODE NO. MA20N1344E1	

Perform facing operation to correct length

Objectives : At the end of this exercise you shall be able to
- **grind the facing tool**
- **true the work piece on a 4 jaw chuck**
- **set the tool to the correct centre height**
- **face the work piece with an accuracy of ±0.1mm.**



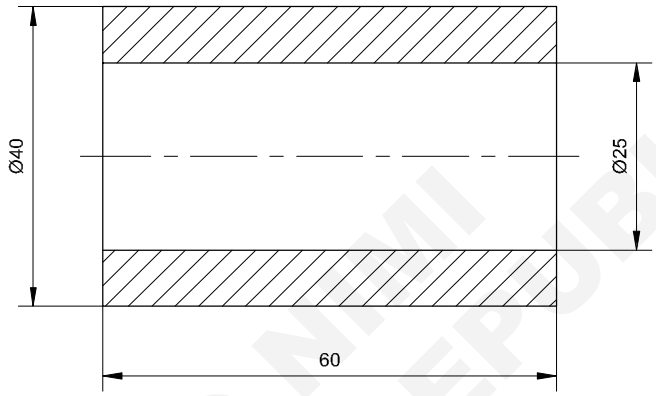
Job sequence

- Check the raw material for size.
- Hold the job in a four jaw chuck about out side.
- Face one end and reduce the length 5mm
- Reverse the job and reset it.
- Face the other end to a reduce length of 5mm.
- Check the dimension with a steel rule and out side caliper.
- Deburr the workpiece.

1	ISR Ø60x70	→ EX NO.1.3.47	Fe 310	-	-	1.3.45
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**PERFORM FACING OPERATION TO CORRECT LENGTH**				DEVIATIONS ±0.1 mm	TIME:
					CODE NO. MA20N1345E1	

Centre drilling and drilling operation to a required size

Objectives : At the end of this exercise you shall be able to
- **set the job on a four jaw chuck**
- **set the tool to the correct centre height**
- **centre drill on a job**
- **drill through hole.**



Job sequence

- Check the raw material size.
- Hold the job in a four jaw independent chuck with 40mm overhang and true it.
- Set the right hand facing tool in the tool post.
- Face one end of the work.
- Fix the drill chuck in the tailstock spindle and fix the centre drill of size A2x6.3 IS : 2473.
- Centre drill the work.
- Turn the outer dia 40 mm to the length 35mm.
- Drill through hole in the job with ø 10mm drill bit after centre drilling.
- Drill through hole in the job with ø 25 mm drill bit after drilling 10mm.
- Chamfer the drilled hole 1x45^{o} .
- Reverse the job and reset it.
- Face the other end maintain to 60mm length.
- Turn the outer dia 40mm to length 25mm.

1	Ø45 - 65	-	Fe 310	-	-	1.3.46
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	CENTRE DRILLING AND DRILLING OPERATION TO REQUIRED SIZE	DEVIATIONS	TIME:
		CODE NO. MA20N1346E1	

Skill sequence

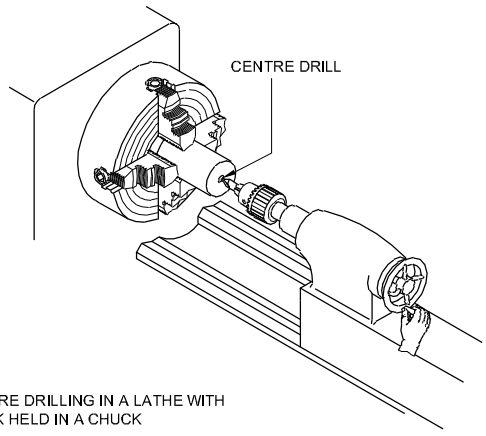
Centre drilling on lathe

Objective : This shall help you to
- **centre drill a work held in a chuck.**

Round work pieces can be quickly and accurately centre-drilled without the necessity of centre punch marks.

The procedure to centre drill a work held in a chuck is given below in sequence. (Fig 1)

Fig 1



CENTRE DRILLING IN A LATHE WITH WORK HELD IN A CHUCK

Hold the work in a four jaw chuck about 50 mm outside and true.

Finish face the work with a facing tool.

Ensure no 'pip' is left out in the centre and the face is at right angles to the axis.

Mount the drill chuck in the tailstock spindle.

Remove dirt on the taper shank of the chuck and the tailstock spindle taper bore.

Mount a suitable centre drill securely in the drill chuck.

Set the spindle speed about 1000 r.p.m.

Slide the tailstock over the bed until the centre drill is close to the work face.

Lock the tailstock in this position.

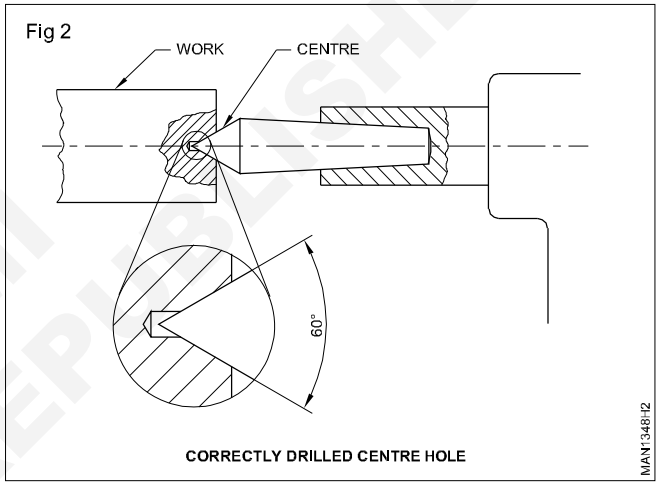
Start the machine and slowly feed the centre drill into the work by rotating the tailstock hand wheel.

Withdraw the drill frequently from the work piece to clean the chips and to apply the cutting fluid.

Continue drilling until about three fourths of the tapered portion of the centre drill has entered the work. (Fig 2)

Ensure that uniform continuous pressure is applied during feeding and no extra force is given.

Fig 2

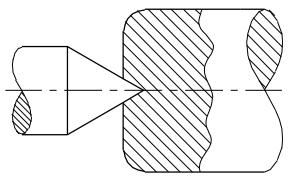


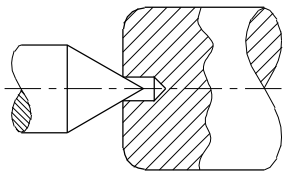
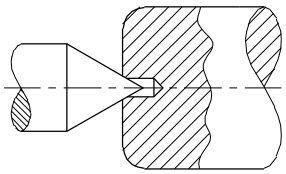
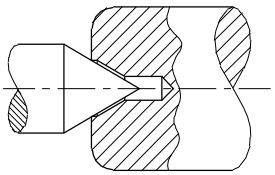
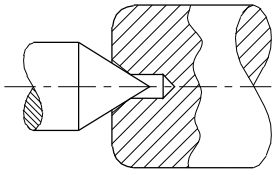
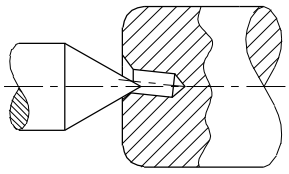
CORRECTLY DRILLED CENTRE HOLE

After drilling to the correct depth, withdraw the tailstock spindle.

Note: **When the diameter of the work is more than 150 mm with the same amount outside the chuck, and when irregular work is held in the chuck, running the machine at 1000 r.p.m. for centre drilling will cause undue load to the spindle. Avoid this method of centre drilling.**

Common errors in centre drilling

Condition of centre hole	Errors	How to avoid and correct the errors
	No clearance for point of centre. Centre hole incomplete. Insufficient bearing surface for lathe centre.	Drill pilot hole. Countersink pilot hole at 60°. Drill centre hole with a centre drill.

	No bearing surface for. lathe centre	Countersink mouth of hole at 60°
	Insufficient bearing surface for lathe centres.	Countersink deeper
	Hole drilled too deep with centre drill. Poor bearing surface.	Face end if the job will allow it. Ream the mouth with a centre reamer.
	Poor bearing surface. Wrong angle.	Countersink hole with a 60° centre drill.
	Centre hole drilled at angle to the axis of work.	Align work squarely when drilling the centre hole. Face end and re-centre.

Rectifying a damaged centre-drilled hole

Objective : This shall help you to
- **correct a damaged centre hole previously centre- drilled.**

When components are disassembled for repairs, the centre-drilled holes in the shafts often get damaged due to many reasons. Unless the damaged centre holes are rectified, the shaft will not run true when held between centres or between chuck and centre.

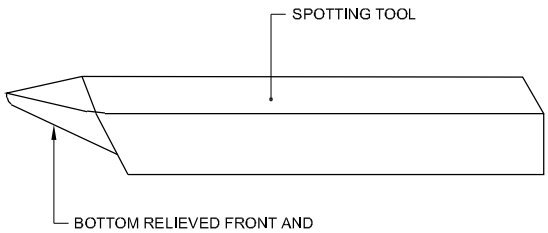
Centre holes may be rectified by any of the following methods.

1. With a spotting tool.
2. With a boring tool held in top slide and swivelled at 30°.
3. With a special countersink.

With a spotting tool

Hold the shaft in a four jaw chuck and true by using a dial test indicator.

Fig 1



Grind a 60° spotting tool with sufficient side and front clearance to prevent it from rubbing in the centre hole.(Fig.1)

Fix and clamp the tool straight in the tool post or fix it in a tool-holder and clamp the tool -holder in the tool post.

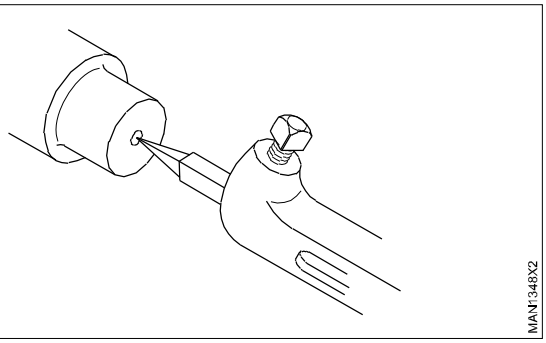
The tool tip must be on the centre line with the axis of the work.

Set the machine to the required r.p.m. depending upon the material and the diameter of the work.

Start the machine and slowly feed the tool bit into the centre hole with the carriage hand wheel.

With the cross-slide hand wheel, gradually feed the tool outwards to make contact with the damaged centre hole countersink portion. (Fig 2)

Fig 2



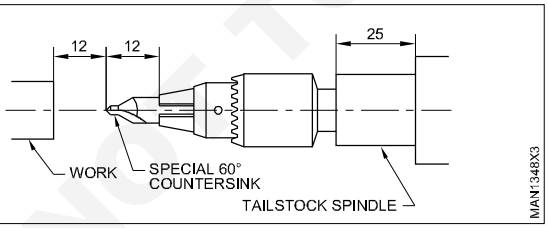
Continue feeding till the damaged centre hole runs true for its full length.

Finally finish the countersink portion of the centre hole using the 60° countersink drill held in the drill chuck mounted in tailstock.

With a special countersink

Better and quick results can be achieved by using a special countersink. This special countersink is nothing but a centre drill with a broken point but whose 60° angular portion is undamaged. A flat parallel with one cutting face is ground across the end of the centre drill so that only one lip or cutting edge remains. (Fig 3)

Fig 3



The sequence is as follows.

Mount the workpiece in a four jaw chuck and true it with the dial indicator.

Mount the drill chuck in the tailstock spindle.

Ensure that the tailstock spindle is aligned with the headstock spindle.

Insert the centering tool in the drill chuck with not more than 12 mm protruding.

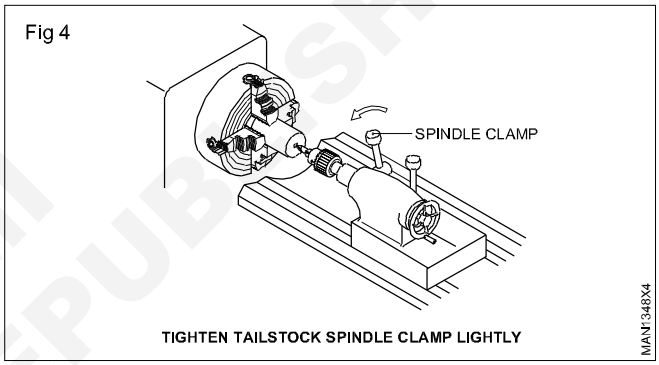
Set and position the tailstock spindle with a minimum overhang.

Slide the tailstock towards the workpiece and lock the tailstock in position.

Start the lathe and allow the work to rotate.

Tighten the tailstock spindle clamp until a slight drag is felt when turning the tailstock hand wheel. (Fig 4)

Fig 4

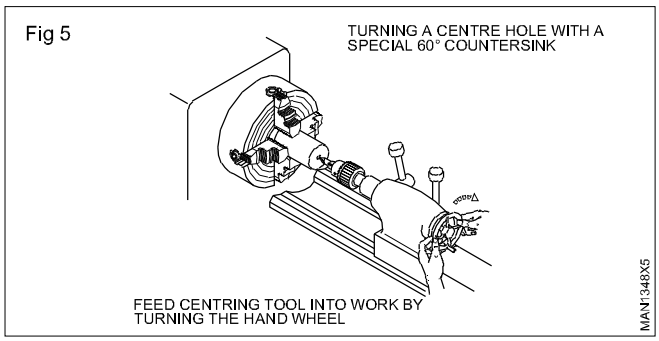


This prevents the tailstock spindle from deflecting.

Apply the cutting fluid, and slowly bring the centering tool into the damaged centre.

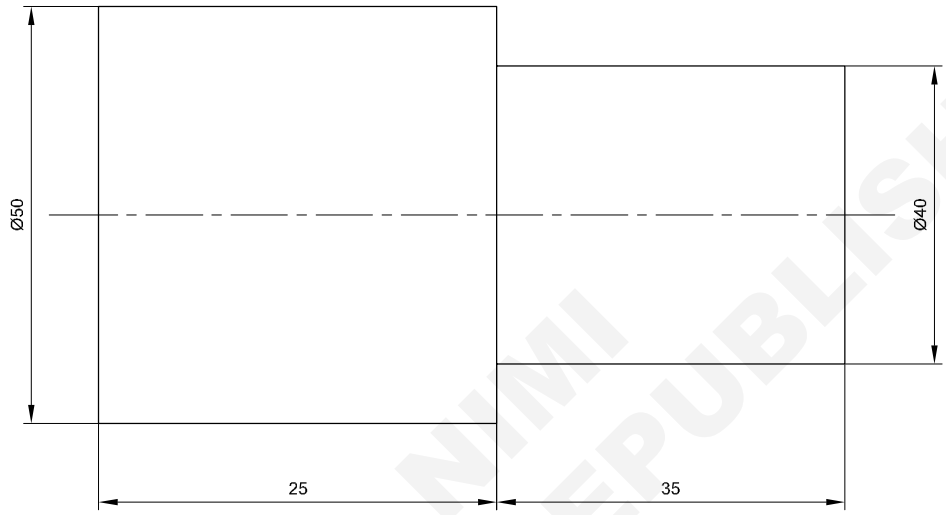
Continue feeding the centering tool until the centre hole runs true. (Fig 5)

Fig 5



Perform parallel turning and step turning operation

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.**



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 hole it
- Face the other end to total length of 60mm
- Turn step for size of ø 40 x 35mm length
- Remove the sharp corners
- Check the dimensions by using vernier caliper
- Apply thin film of oil and pressure it for evaluation.

		→ EX.NO.1.3.51				
1		EX.NO.1.3.45 ←	Fe310	-	-	1.3.47
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. MA20N1347E1	

Skill sequence

Step turning by using R.H Knife tool

Objective: This shall help you to

- **turn steps of different diameters for definite lengths on a shaft.**

When the width of the step turned does not permit plunge cuts to form the steps, they are turned by using a R.H knife tool, feeding the tool axially for the length of the step. By using a knife tool a square shoulder is also formed at each junction of the steps.

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

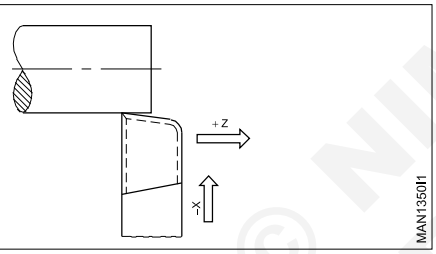
Ensure that the face is running true since the length measurement are taken from it as a reference.

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

Set the machine spindle speed to 300 RPM.

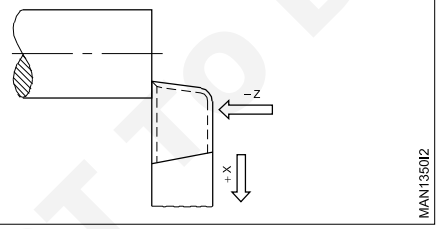
Start the machine and touch the tool tip to the work to set the cross-slide graduated collar to zero, with the backlash eliminated.(Fig 1)

Fig 1



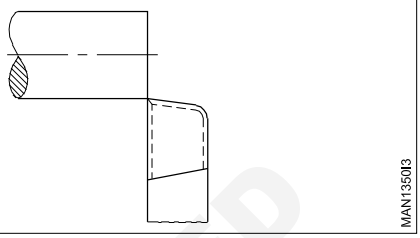
Withdraw the tool from the work and make the cutting edge contact the wrok face to set the top slide graduated collar to zero with the backlash eliminated.(Fig 2)

Fig 2



Position the tool to have the tip at the edge of the work (Fig.3)

Fig 3



Give the depth of cut by the cross-slide for the next smaller step to the shaft diameter.(Fig 4)

Advance the tool axially by rotating the top slide hand wheel to the required length, read by the graduated divisions of the graduated collar of the tool slide.

Ensure that the top slide is at zero setting with the base.

The rotation of the top slide hand wheel should be continuous and uniform till the required movement for the length of the step is attained.

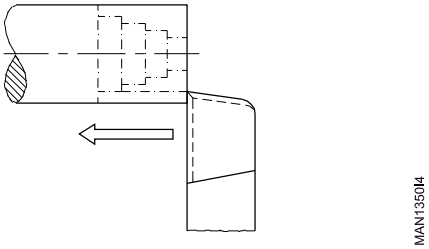
Restrict the depth of cut to a maximum of 3mm for each cut as only hand feed is given.

Repeat by further depth od cut, if needed to finish the first step.

Keep the carriage in a locked position.

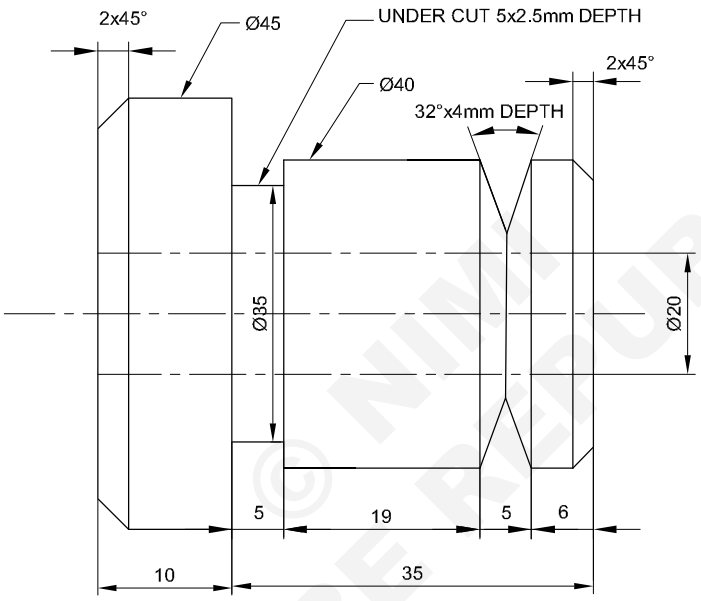
Measure the diameter and length of each step to confirm the dimensional accuracy.

Fig 4



Perform drilling, boring and undercut operation, parting, grooving, chamfering practice

Objectives: At the end of this exercise you shall be able to
- **drilling and boring**
- **undercut on shoulder**
- **chamfer the edge at an angle of 45°**
- **form 'V' groove**
- **setting parting tool and parting operation.**



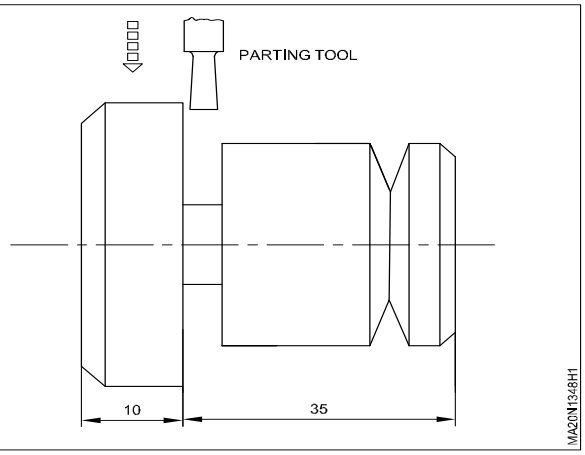
Job sequence

- Hold the completed job in 3 -jaw chuck by keeping about 55mm to overhang
- Set the centre drill,on the tailstock using drill chuck
- Make the center drill to required depth.
- Remove the centre drill insert the ø 8mm drill for pilot hole.
- Drill ø 15mm through hole.
- Set the boring tool t o correct centre height
- Bore ø 20mm giving different cuts.
- Prepare the grooving tool for 32°.
- Hold the grooving tool at the correct centre height and rigidly
- Form the 'V' groove to a width of 5mm and the depth of 4mm
- Set the chamfering tool at correct centre height.
- Chamfer the end to 2x45°

1	ISR Ø50x55		Fe310	-	-	1.3.48
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	PERFORM DRILLING,BORING AND UNDERCUT OPERTAION,PARTING GROOVING, CHAMFERING PRACTICE				DEVIATIONS ± 0.06mm	TIME :
					CODE NO. MA20N1348E1	

- Set the 3mm width parting tool at correct centre height (Fig-1).
- Select and set correct spindle speed for parting operation
- Part the job using plunger cut method at 47mm from the end.
- Reverse the job and hold to face the other end to the length of 45mm
- Chamfer the end to 2x45°
- Deburr the job and apply oil for preserving.

Fig 1



Form an undercut shoulder at the junction of two diameters

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

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

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

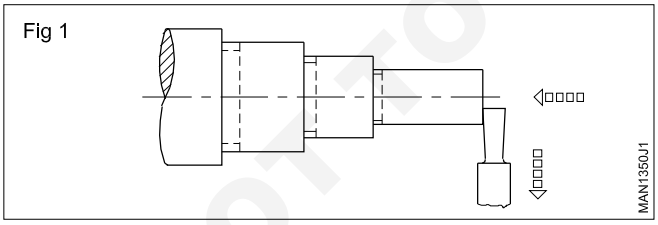
Select a suitable tool bit or grind one to the shape and size required.

Mount the tool bit in the tool - holder.

Set the correct spindle speed, and start the machine.

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

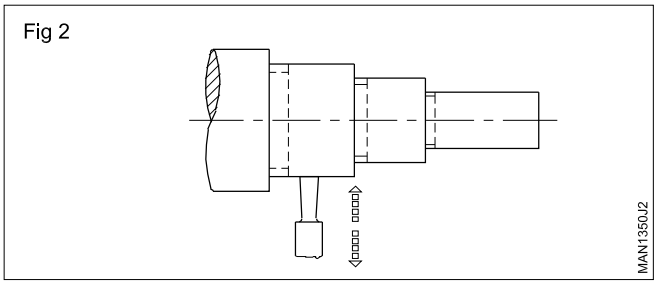
Fig 1



Lock the saddle in this position.

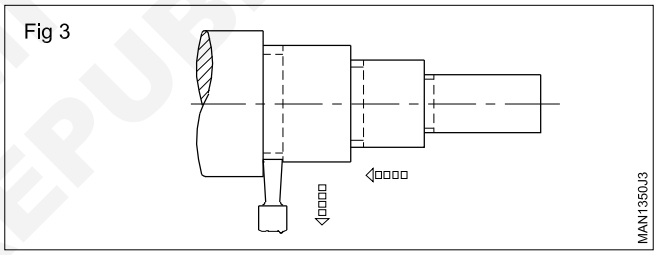
Rotate the cross slide handle and touch the work surface lightly with the front cutting edge of the tool. Set the cross slide graduted collar to zero.(Fig.2)

Fig 2



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

Fig 3

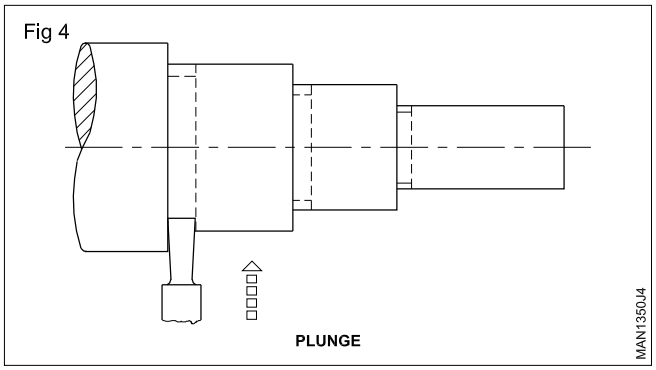


Note the reading on the graduated collar of the top slide feed screw and set the reading to zero.

Apply cutting fluid.

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

Fig 4



Widthdraw the tool from the undercut when the required depth is reached.

Stop the lathe and check the undercut for its dimensions.

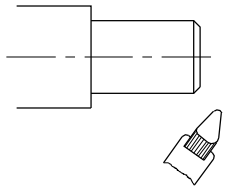
Remove sharp corners if any.

Chamfering on a lathe

Objective: This shall help you to
- **chamfer the end 45°**

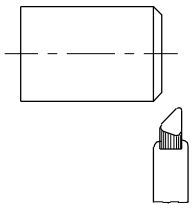
- Chamfering is an operation of bevelling the edge of a work piece
- Set the tool in any one of the ways shown in Fig.1,2 & 3 in the tool post to correct centre height.
- Plunge the tool and form the chamfer to the size specified.

Fig 1



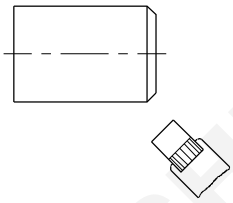
MAN1350X1

Fig 2



MAN1350X2

Fig 3



MAN1350X3

Skill sequence

Parting off operation

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

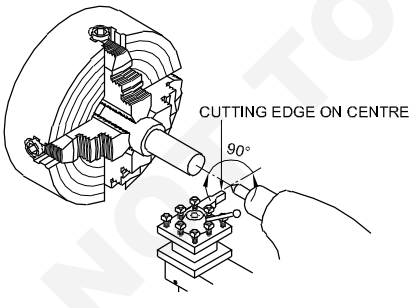
Parting off operation

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

Setting of parting tool

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

Fig 1



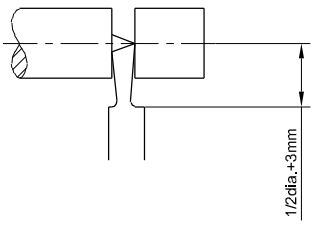
CORRECT CUTTING EDGE POSITION

MAN1350Y1

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

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

Fig 2



MAN1350Y2

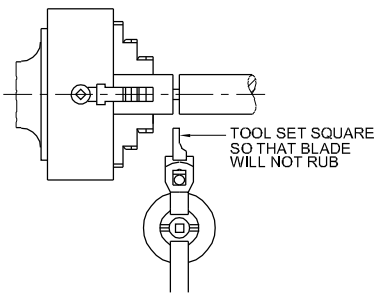
Procedure

Select the correct type of tool for a specified job.

Hold the work with the minimum overhang in a chuck.

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

Fig 3

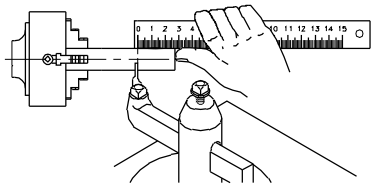


MAN1350Y3

Set the spindle speed to half the speed for turning.

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

Fig 4



PARTING TOOL POSITIONED TO CUT OFF
A DEFINITE LENGTH OF WORKPIECE

MAN1350Y4

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

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

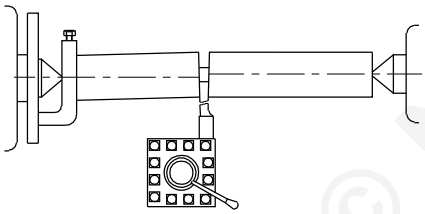
Precautions

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

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

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

Fig 5

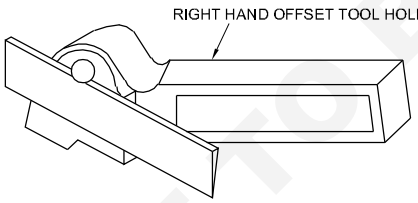


INCORRECT METHOD OF PARTING

MAN1350Y5

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

Fig 6



INSERTED-BLADE TYPE PARTING TOOL

MAN1350Y6

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

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

Heavy feed causes jamming and tool breakage.

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

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

Heavy feed causes jamming and tool breakage.

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

Make sure the saddle is locked during the entire operation.

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

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

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

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

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

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

Measurement with steel rule and outside caliper with an accuracy of ± 0.5 mm

Objectives : At the end of this exercise you shall be able to
- **select the right capacity caliper for measurement**
- **set the size in caliper**
- **read the sizes by transferring them to a steel rule.**

NOTE: Instructor shall provide different diameters for measurement.

Job sequence

- Measure the given jobs with help of outside caliper and with steel rule.
- Record in Table 1.
- Get it verified by the instructor.

Fig 1

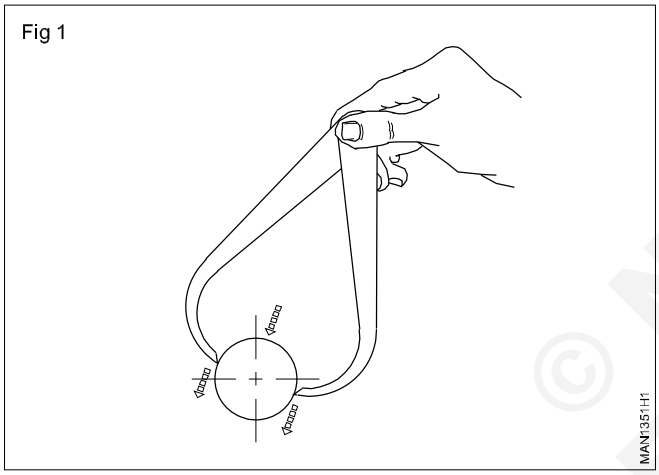


Fig 2

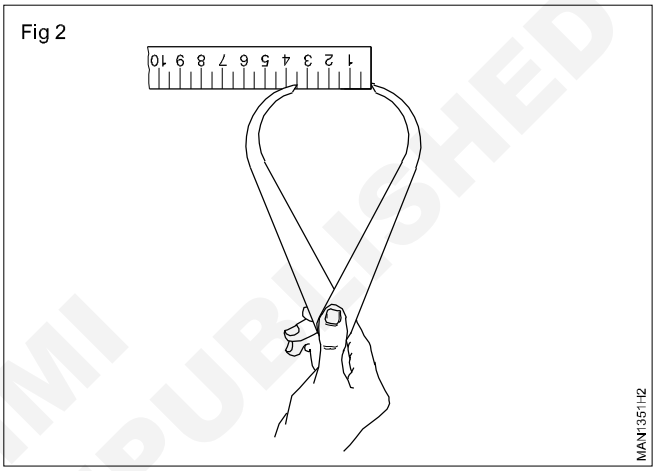


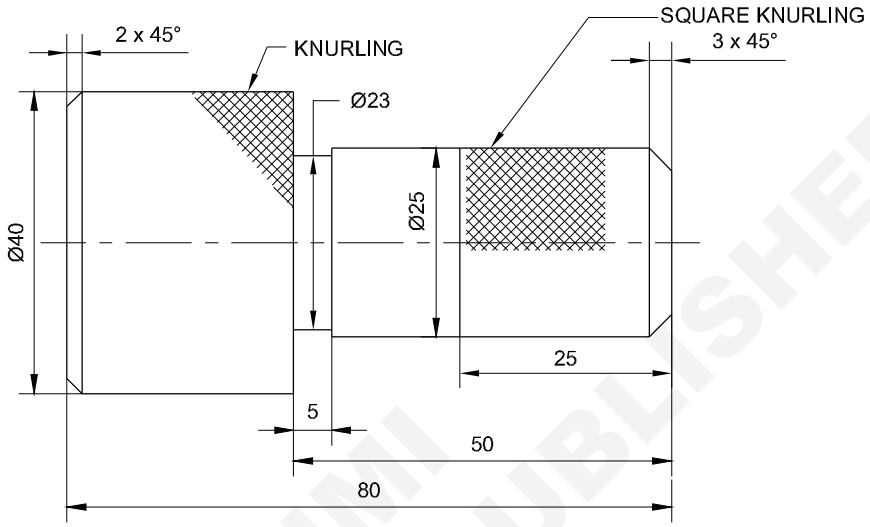
Table 1

Si.No.	Measurement job size		Remarks
	Dia	Length/Width	
1			
2			
3			
4			
5			

Perform different knurling operation in lathe with accuracy of ± 0.5mm

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

- **mount a 4 jaw chuck**
- **true the job in the 4 jaw chuck with a surface gauge**
- **turn the component as per drawing and maintain the dimensions within ± 0.5mm**
- **Knurl the different types.**



Job sequence

- Check the raw material size.
- Hold the material securely in a 4 jaw chuck projecting 50 mm outside the chuck.
- True the job with a surface gauge and face the end.
- Turn the job to ø 40.00 - 0.5 for more than the required length 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 2 x 45° at the end.
- Reverse and hold the job in the chuck and true the job.
- Face the end and maintain the length of 80 mm.
- Turn the job to ø 25 x 50 with a side knife tool. (Use a vernier caliper for measuring dimensions.)
- Turn the job to ø 25 - 0.5 for 25mm length from the faced end.
- Knurl the surface till a square shape is formed.
- Chamfer to 3 x 45° at the end with a 45° chamfering tool.
- Undercut and maintain Ø23 and groove with a 5 mm width grooving tool.
- Deburr all sharp edges.

Remember

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

Safety precautions

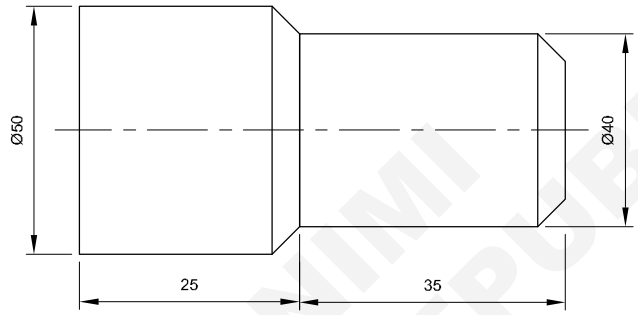
- Never operate a lever when the machine is in motion.
- Do not keep any tools on the moving parts of the machine.
- Use a suitable coolant.

1	Ø45 - 85	-	Fe 310	-	-	1.3.50
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PERFORM DIFFERENT KNURLING OPERATION IN LATHE WITH ACCURACY ± 0.5mm	TOLERANCE ± 0.2 on dia and length	TIME :
		CODE NO. MA20N1350E1	

Make taper turning by form tool with an accuracy of 1degree

Objectives : At the end of this exercise you shall be able to
- **grind form tool for taper turning**
- **turn taper using form tool**



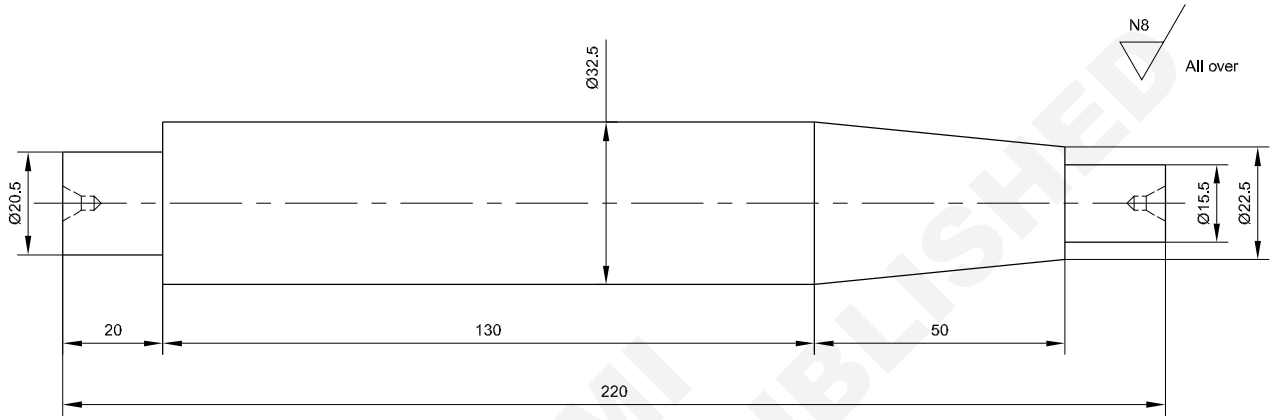
Job sequence

- Check the given material to the drawing size.
- Hold ϕ 50 mm inside the chuck and true
- Face the one end and make centre drill
- Turn ϕ 40 to ϕ 35 mm to the length of 35 mm
- Grind the form tool to the requiring angle30°
- 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 as to make 25mm smaller dia by means of the cross slide
- Form the taper in ϕ 50 coinside to the ϕ 35 as shown in figure
- Lock the carriage and feet through cross slide

1		EX.NO.1.3.47 ←	Fe 310	-	-	1.3.51
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS		MAKE TAPER TURNING BY FORM TOOL			TOLERANCE : ± 0.3mm	TIME :
					CODE NO. MA20N1351E1	

Make taper turning by compound slide swiveling with an accuracy of ±30 minutes

Objectives: At the end of thi s exercise you shall be able to
- **swivel the compound rest for taper turning**
- **turn the taper by compound rest method**
- **measure the taper with a vernier bevel protractor**
- **measure the dimension with vernier caliper.**



Job sequence

- Check the raw material size.
- Hold the job in a four jaw chuck with 25mm overhanging and true it.
- Set the R.H. turning tool in the tool post.
- Face one end of the work.
- Fix the drill chuck in the tail stock spindle and fix the centre drill of size A3. 15x 8.00 IS6708.
- Centre drill the work.
- Dismount the four jaw chuck.
- Mount between centres in lathe
- Hold the job in between centres.
- Turn the step ϕ 15.5 mm X 20 mm long at the taper end.
- Reverse the job and refix between centres.
- Turn the step ϕ 20.5 X 20mm long from the other end of job.
- Turn the step ø 32.5 X130mm long from the other end of the job.
- Calculate the setting angle of the compound reset using the formula.

$$\text{Tan}\,\theta = \frac{D-d}{2\,x\,L} \quad \frac{32.5 - 22.5}{2 \times 50} = \frac{10}{100} = \text{Tan}\,\theta = 0.100 = 7°$$

$\text{Tan}\,\theta = 5.71 = 6°$

- Swivel the compound rest slide to the above angle using a Vernier protractor.
- Turn the taper by using the top slide feed and maintain major dia to 32.5mm minor dia to 22.5mm and length to 50mm.
- Measure the dimension of job with vernier caliper.
- Check the taper of the job with vernier bevel protractor.

1	ISR 36 - 225	-	Fe 310-O			1.3.52
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX.NO.
SCALE NTS	MAKE TAPER TURNING BY COMPOUND SLIDE SWIVELLING WITH AN ACCURACY OF ± 30 MINUTE				DEVIATIONS ± 0.1	TIME :
					CODE NO. MA20N1352E1	

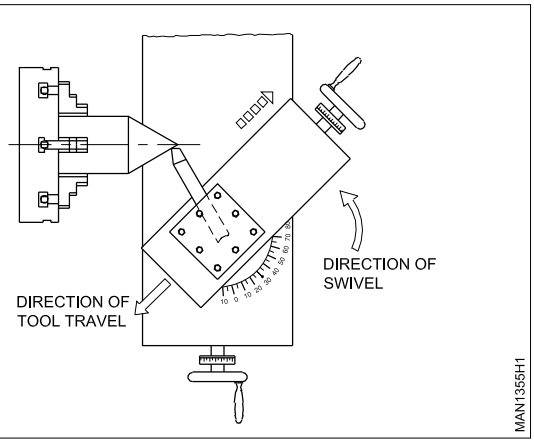
Skill sequence

Turning taper by compound slide swivelling

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

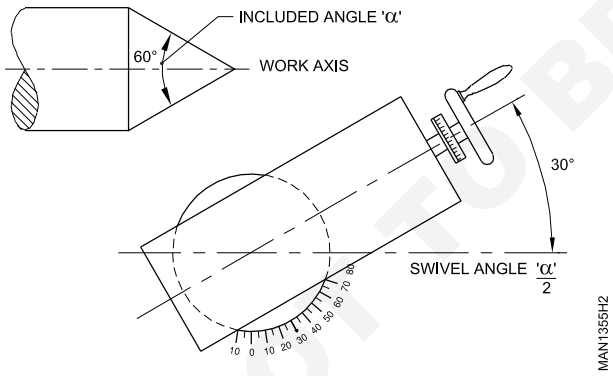
- One of the methods of turning taper is by swivelling a compound slide and feeding the tool at an angle to the axis of the work by hand. (Fig 1)

Fig 1



- Set and true the job turned to the bigger diameter of the taper.
- Set the machine spindle speed to the required r.p.m
- Loosen the top slide clamping nuts.
- Swivel the top slide to half the included angle of the taper, as in the Fig. 2.

Fig 2



- Tighten the clamping nuts firmly

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

- Fix the turning tool in the tool post to the correct centre height.
- Keep a minimum overhanging 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.

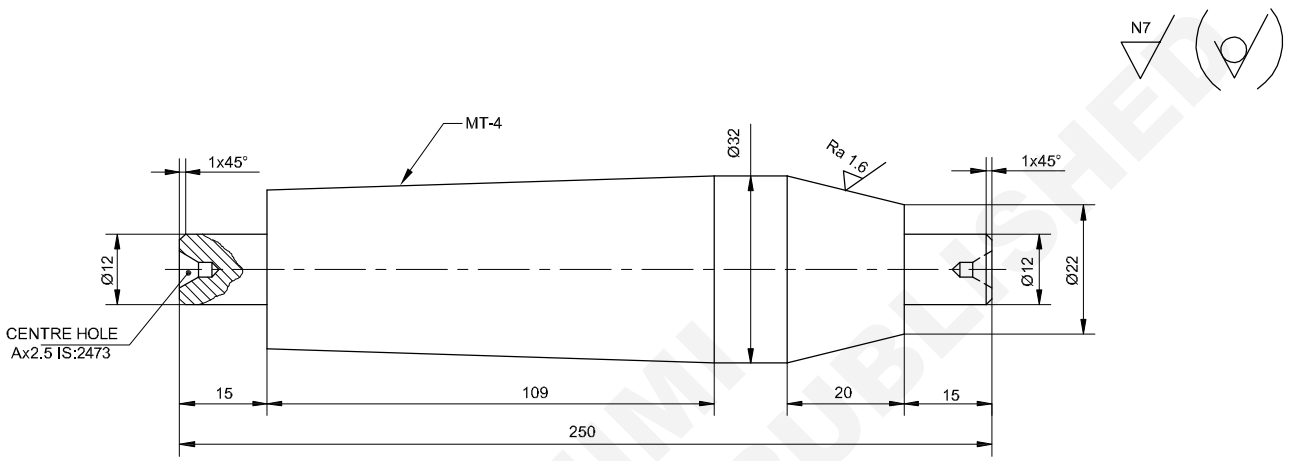
Give successive cuts by the cross - slide and feed by the top slide every time.

- Check the angle of the turned job with a verier bevel protractor.
- Adjust the swive, if there is a difference.
- Continue the taper turning and finish the taper.
- After completion of the job check the angle with vernier bevel protractor.

Make taper by off setting tailstock with an accuracy of ± 30 minute

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

- **hold the work in between centres**
- **grind and set RH turning tool**
- **turn the steps to the given dimension**
- **set the tail stock to the specified angle by off setting the centre**
- **turn the external taper by the tail stock offset method**
- **check the taper with a vernier bevel protractor.**



Job sequence

- Check the raw material size.
- Hold the job in between centres.
- Turn the step ø 12 X15 mm long at the taper end.
- Calculating the setting angle tail stock offset using formula

$$\text{Offset} = \frac{(D-d)\times 124}{2\times l}$$

D – Bigdia, d – small dia L – Length of job

l – length of taper

$$= \frac{(32-2)\,124}{2\times 109}$$

$$= \frac{1240}{218}$$

$$= 5-7\text{mm}$$

- Reverse and refix between centres.
- Turn the step ø 12x15 mm long from the other end of job.
- Calculate the setting angle of the compound rest using the formula

$$\text{Tan}\varnothing = \frac{D-d}{2\times l}$$

$$= \frac{32-22}{2\times 20} = \frac{10}{40} = 0.250$$

$$\text{Tan}\varnothing = 14°2'10"$$

- 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 32 mm. Minor dia to 22 mm and length to 20 mm.
- Check the size of the job size with a vernier bevel protractor and vernier caliper.

1	Ø35 - 260L	–	Fe 310	–	-	1.3.53
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**MAKE TAPER BY OFF-SETTING TAILSTOCK WITH AN ACCURACY OF ± 30 MINUTES**				DEVIATIONS : ±0.1 mm	TIME :
					CODE NO. MA20N1353E1	

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 1/50 th of the length of the work piece.

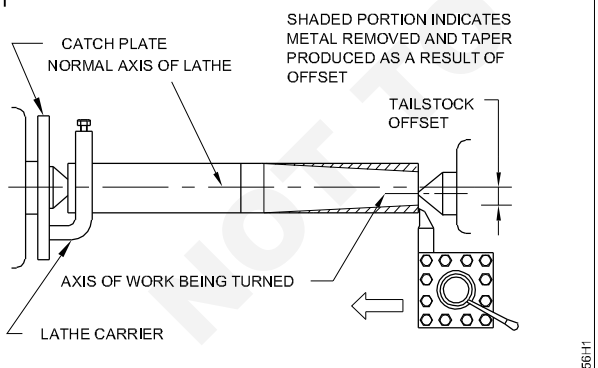
Calculation of the amount of offset.

If the taper is expressed by giving the big dia. (D) the small dia. (d) the length of taper (l), then

$$\text{Offset} = \frac{(D-d)\times L}{2l}$$

Where L = total length of job.

Fig 1



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 job (l) = 100mm

Total length of job (L) = 200 mm.

$$\text{Offset} = \frac{(D-d)\ x\ L}{2l}$$

$$= \frac{(30-26)\times 200}{2\times 100}$$

$$= \frac{4\times 200}{2\times 100}$$

$$= 4\text{mm}$$

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.2

Offset = L X tan θ

Where L = total length

= 1/2 included angle in degrees.

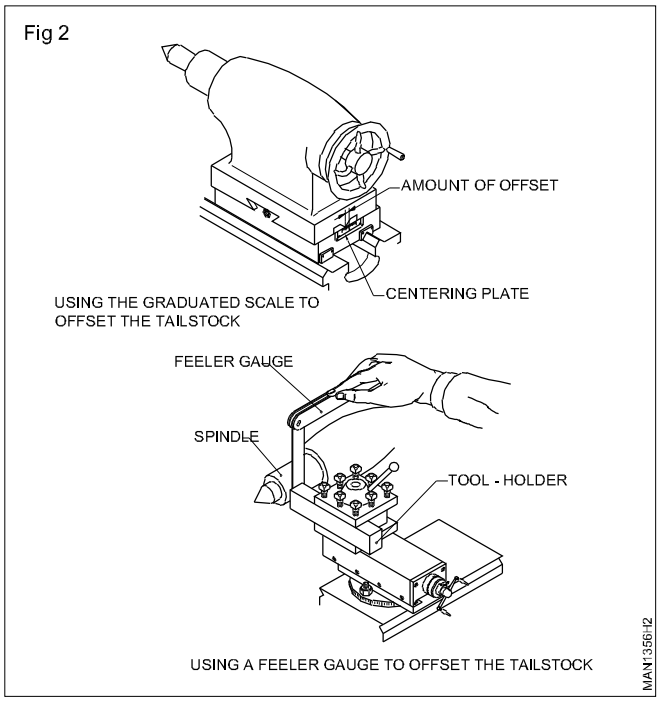
Different methods of offsetting the tailstock (Fig 2)

Setting offset with the help of the inside measuring jaws of a vernier caliper to the required mm, if direct graduation is not provided on the base of the tailstock.

Using a dial test indicator.

Using a cross- slide graduated collar and feeler gauge.

Fig 2



Checking taper by vernier bevel protractor and sine bar with slip gauge

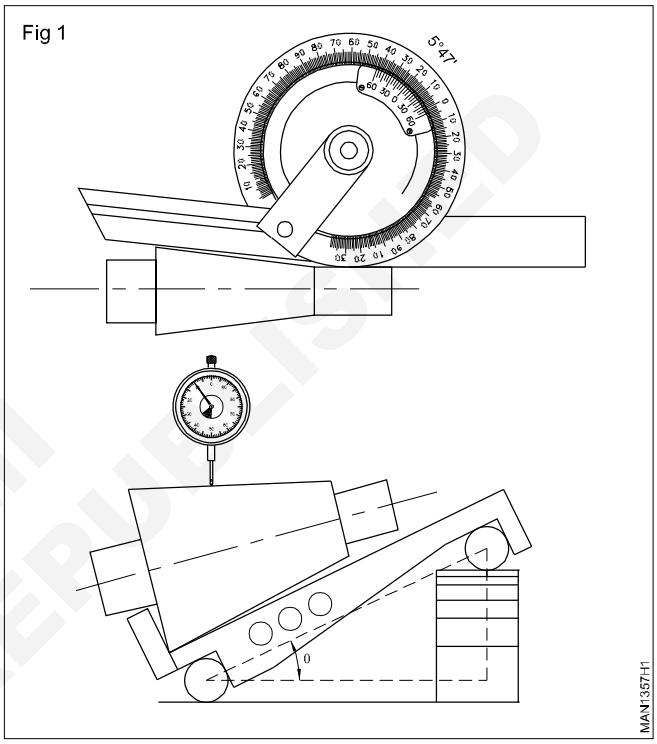
Objectives: At the end of this exercise you shall be able to
- **check the angle of the machined parts upto an accuracy of ± 5 minutes.**

Job Sequence

TASK 1: **Check the taper by bevel protractor.**

- Set the angular surface of the workpiece between the bevel protractor blade and the face of the base (Fig 1).
- Lock the blade and inner disc firmly with the locking device.
- Note the position of the vernier scale with reference to the main scale.
- Read the degrees of the main scale at the graduation '0' of the vernier scale.
- Note the number of lines in the vernier scale that coincides with a division of the main scale.
- Add this result to the main scale reading + least count 5' multiply number of division of the vernier scale coincidence.

Fig 1

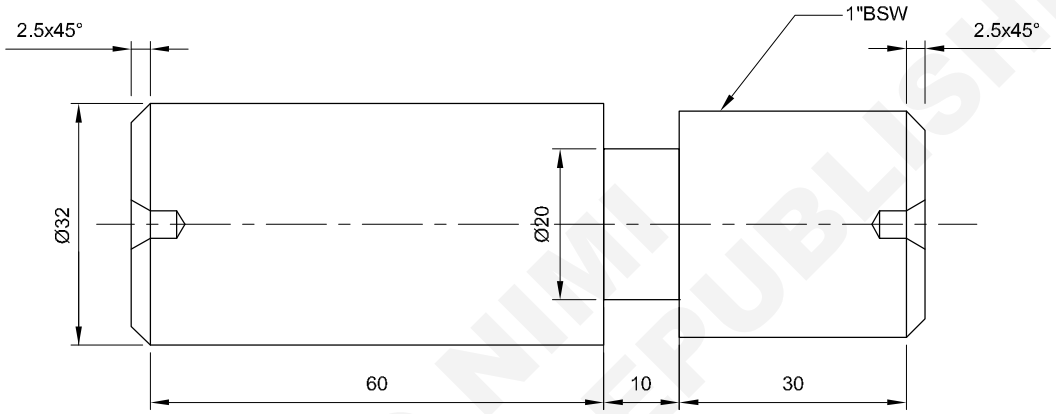


TASK 2: **Check the taper by sine bar slip gauges**

- Set the 200mm sine bar on the surface plate.
- Mount the taper component on the sine bar after placing the selected slip gauges under one roller with the other roller resting on the datum surface.
- Mount the dial test indicator with a suitable stand or vernier height gauge.
- Set dial test indicator at one end and ensure the dial in zero position.
- Move the dial indicator to the other end of the component.
- If the dial indicator reads zero at both ends the setting is ok.
- If there is any difference than the angle set is incorrect. The height of slip gauge has to be adjusted till dial reads zero at both ends.

Cutting V thread (external) in a lathe and check with screw pitch gauge

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.B.S V thread (external).**



Job sequence

- Hold the job in a four jaw chuck and face both the ends to maintain a total length of 100mm
- Centre drill at both the ends and hold the job between centres using catch plate having slots milled at 180° and a bent tail carrier.
- Turn the outer dia 32mm to full length and chamfer the ends.
- Turn the job ø 1" for 30 mm length
- Arrange the gear train to cut 1" BSW threads on the job
- Cut RH threads.
- Check with screw pitch gauge

Follow the recommended cutting speed & feed for the job

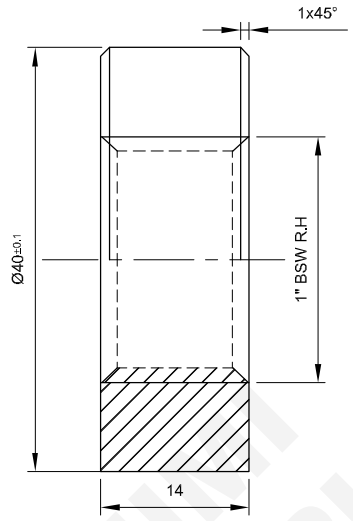
Use coolant to cool the tool & washout chips

1	Ø36 - 105	→ EX.NO.1.3.57	Fe 310IS:1977	–	-	1.3.55
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1 : 1	CUTTING V THREAD (EXTERNAL) IN A LATHE AND CHECK WITH SCREW PITCH GAUGE	DEVIATION ±0.06mm	TIME :
		CODE NO. MA20N1355E1	

Cutting V thread (Internal) in a lathe and check with screw pitch gauge

Objectives : At the end of this exercise you shall be able to
- **bore the drill to the core diameter**
- **fixing of internal threading tool**
- **checking with external thread.**



Job sequence

- Part A and PART B
- Check the given raw material for its size by rough measurement
- Hold the work in a four jaw chuck about 10mm inside the chuck and true it.
- Face the end centre drill and support with centre.
- Rough and finish turn the outer dia. 40mm to possible length.
- Chamfer the edge 1x45°
- Drill a pilot hole ø 10 mm through and enlarge it to ø 18mm by drilling.
- Bore the drilled hole to a core dia of part A 22.8mm and part B18.6mm
- Chamfer the bore 2x45°mm.
- Fix the internal threading tool in a tool-post and set it with the centre gauge.

Ensure a minimum overhanging of the tool.

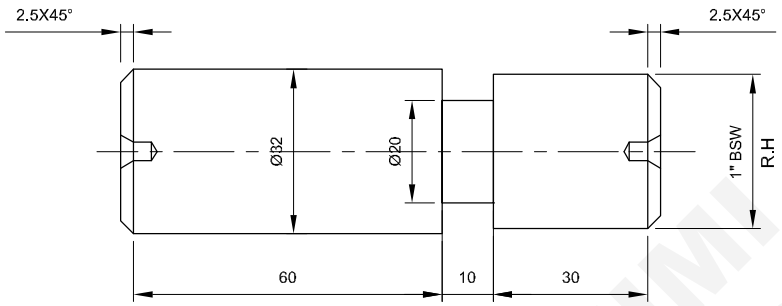
- Set the machine to 8 TPI mm pitch and the spindle speed levers to 1/3rd of the roughing speed.
- Touch the tool tip to the bore surface, and set the cross-feed graduated collar to zero.
- Rough and finish thread 1" RH and LH BSW thread by giving successive cuts, ensuring the correctness of the pitch by checking with a pitch gauge.
- Check with the external thread mating part for the correctness of fit.
- Reverse and hold the work on ø 40mm and true.
- Face the end of the work, and maintain a total length of 14 mm.
- Rough and finish turn ø 40mm for the remaining length.
- Chamfer 1x45° on the outer edge and 2x45° on the threaded bore.
- Remove the sharp edges and have a final check.

1	Ø50x20	→ EX.NO.1.3.57	Fe 310IS:1977	–	-	1.3.56
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	CUTTING V THREAD (INTERNAL) IN A LATHE AND CHECKING WITH SCREW PITCH GAUGE				DEVIATION ±0.06mm	TIME :
					CODE NO. MA20N1356E1	

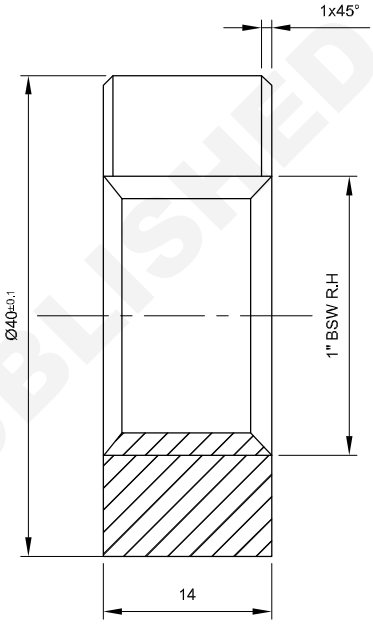
Fitting of male and female threaded components

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.**

PART : 1



PART : 2



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	-	EX.NO.1.3.56 ←	Fe 310IS:1977	-	2	
1	-	EX.NO.1.3.55 ←	Fe 310IS:1977	-	1	1.3.57
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

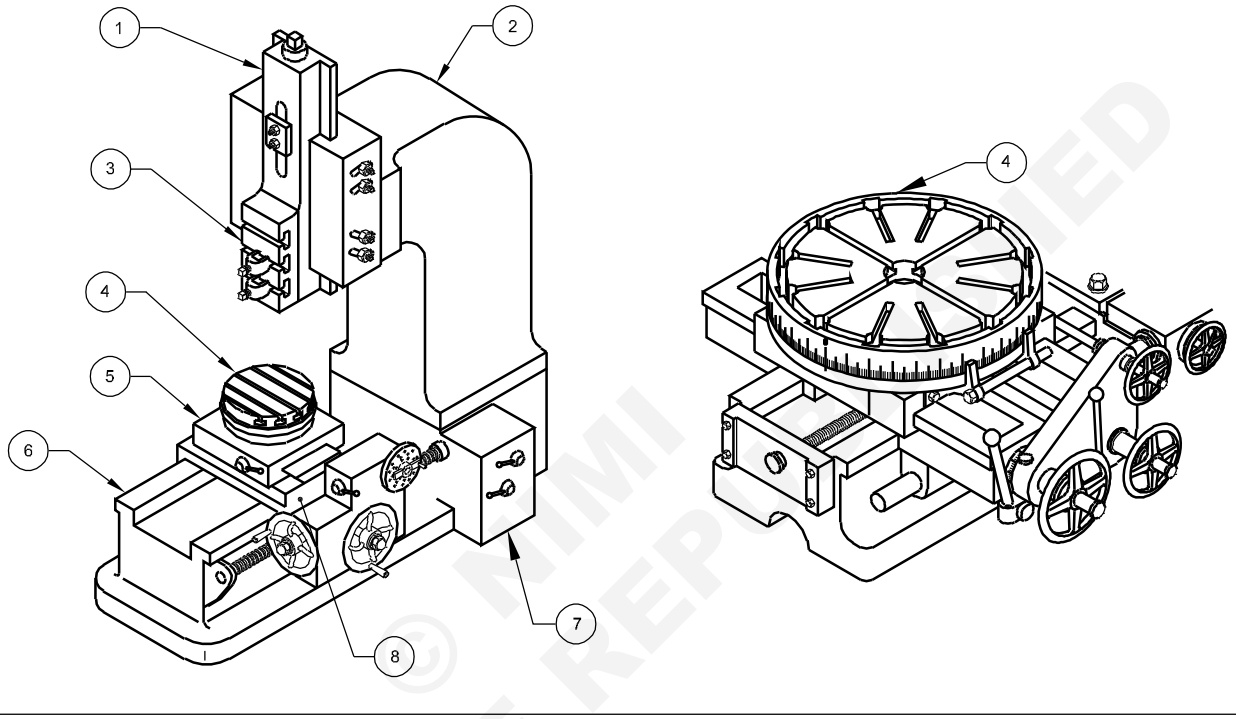
SCALE NTS	**FITTING OF MALE AND FEMALE THREADED COMPONENTS**	DEVIATION ±0.06mm	TIME :
		CODE NO. MA20N1357E1	

Identification of slotting machine parts & its construction, use of rotary table

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

- **identify and write the name of parts of the slotting machine**
- **know the construction of slotting machine**
- **know the use of rotary table.**

Fig 1



Job Sequence

Instructor shall brief the name of the parts and construction of slotting machine, and the use of rotary table. Ask the trainees to record the part names in the table 1

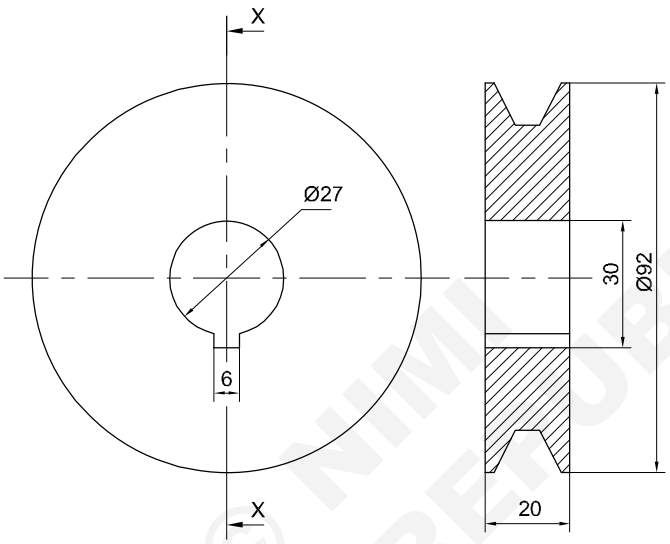
- Trainees will note down all the part's name in the table 1.
- Practice on manual movement of rotary table in different position.
- Practice on starting and stopping of the slotting machine.
- Get it checked by your instructor

Table 1

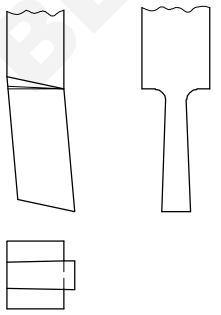
Sl.No	Name of the parts	Uses
1		
2		
3		
4		
5		
6		
7		
8		

Practice on slotting key ways on pulley with accuracy ± 0.04mm

Objectives: At the end of this exercise you shall be able to
- **face and centre drill the pulley**
- **mark the keyway**
- **hold the pulley on slotting machine**
- **set the tool on the machine**
- **slot the keyway as per dimension.**



TOOLS TO BE USED



GROOVING / PARTING TOOL

1	ISR Ø100x25		Fe 310			1.4.59
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**PRACTICE ON SLOTTING KEYWAYS ON PULLEY WITH ACCURACY ±0.04mm**				DEVIATIONS ±0.04 mm	TIME:
					CODE NO. MA20N1459E1	

Job Sequence

- Check the raw material
- Hold the job on 4 jaw chuck with 5 mm over hang
- Set the facing tool and face one end of the job.
- Fix the drill chuck in the tail stock spindle and fix the centre drill
- Centre drill the work
- Drill pilot holes starting from 8mm up to 25 mm
- Set the boring tool and bore hole 27mm
- Reverse and refix the job and true it
- Face the other end to maintain 20 mm width
- Remove the job and fix in mandrel
- Turn the job to 92mm diameter
- Remove the job
- Check the outside, inside and the thickness of the pulley.
- Mark the centre lines and keyway.
- Clamp the keyway (slotting) tool.
- Clamp the pulley 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.

Skill Sequence

Aligning slotting tool for slotting

Objective: This shall help you to
• set the slotting tool in the tool box of the slotting machine and align the slotting tool.

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.

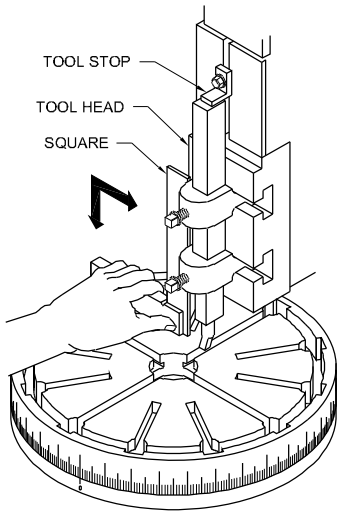
Using a square head/try square, set the shank perpendicular to the face of the rotary table. (Fig.1)

Use soft hammer for tapping the tool while aligning with the try square.

Tighten the bolts fully.

For tool bits, use a tool-holder and follow the steps stated above.

Fig 1



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)

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.

Fig 1

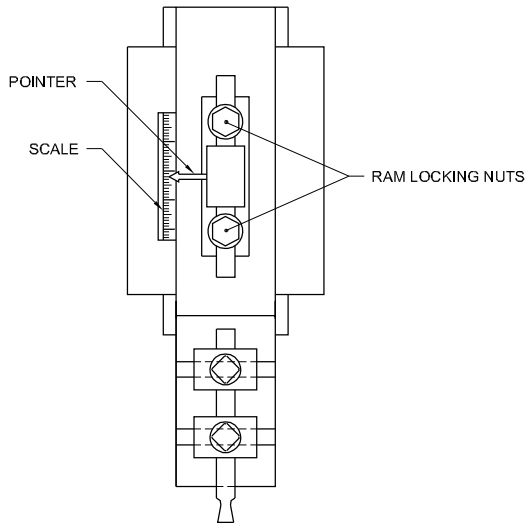
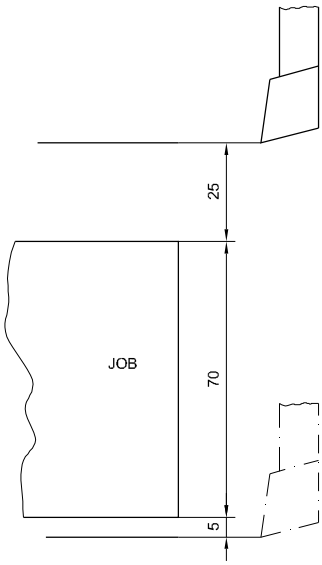


Fig 2



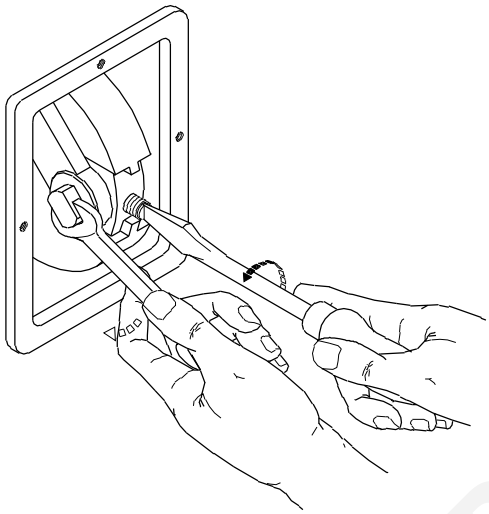
Eg. Length of stroke = 70+30=100mm.(Fig.2)

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.

Fig 3



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.

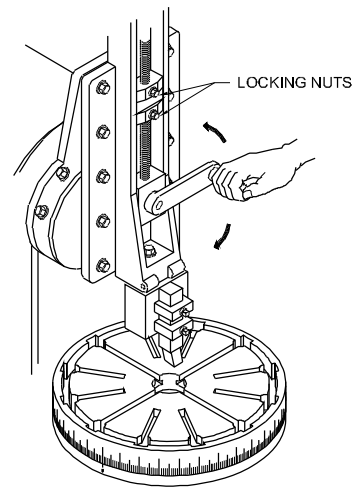
Loosen the ram lock-nuts.

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.

Fig 4



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.

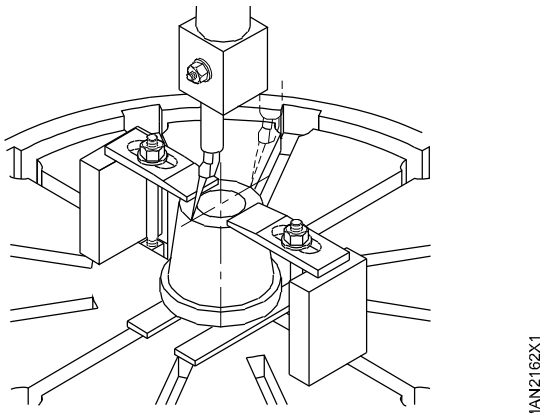
Select and mount the keyway roughing tool.

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)

Fig 1



MAN2162X1

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 .

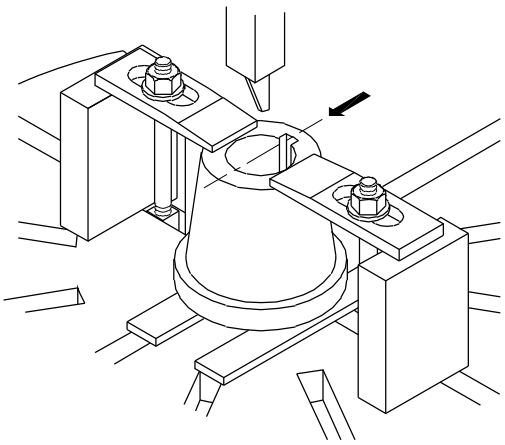
Adjust the stroke length, position of the ram and the ram speed.

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)

Switch on the machine.

Fig 2



MAN2162X2

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)

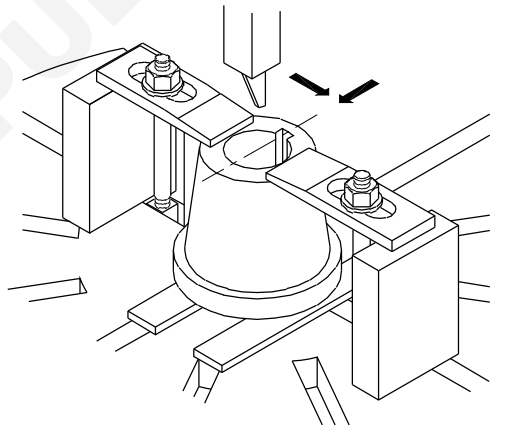
Set and align the keyway finishing tool in the holder.

Slot and finish the keyway to the given dimensions.

De-clamp the job.

Check the dimensions of the keyway.

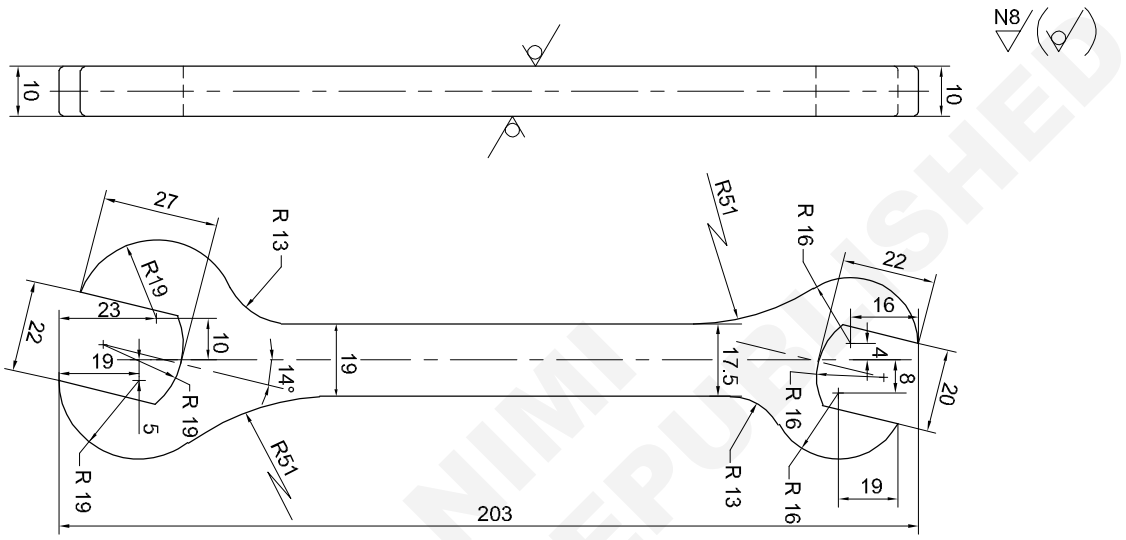
Fig 3



MAN2162X3

Slotting a double-ended spanner with accuracy ± 0.1mm

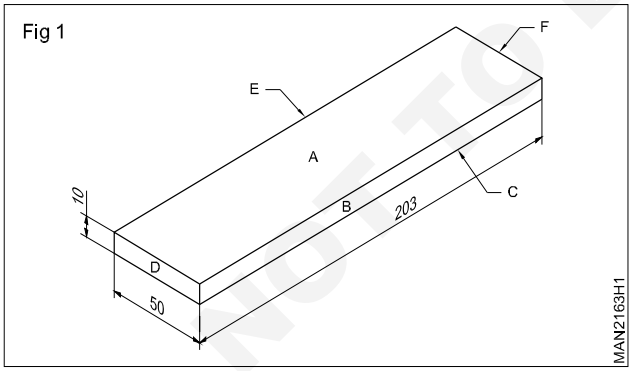
Objectives: At the end of this exercise you shall be able to
- **mark and punch the outline of the job as per drawing with a template**
- **chain drill for removing excess material**
- **slot concave and convex faces to an accuracy of ±0.1mm**
- **slot rectangular opening to an accuracy of ±0.1mm**
- **slot rectangular opening to an accuracy of ±0.1mm.**



Job Sequence

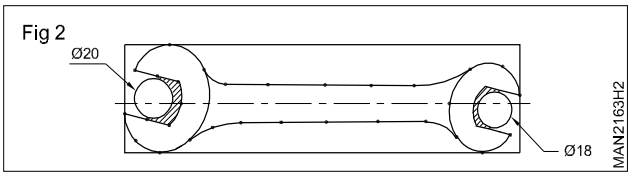
- Check the raw material for its size.
- Slot the edges B D E F to square with each other. Provide enough material along the length and breadth for further slotting. (Fig 1)

Fig 1



- Mark the job using a template.
- Mark the positions for holes.
- Drill the holes ø20 and ø18.
- Align the holes with the rotary table axis and slot the internal radius. (Fig 2)

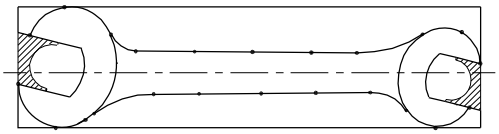
Fig 2



- Slot the shaded portion.
- Align the marking with the movement of the Table. Slot side of the opening. Repeat the procedure for the side opening.
- Check the width for 22 mm.
- Repeat the procedure for opening on the opposite side.
- Check width for 20. (Fig 3)

1	65 ISF 10-205		Fe 310			1.4.60
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**SLOTTING A DOUBLE - ENDED SPANNER WITH ACCURACY ±0.1MM**				DEVIATIONS ±0.1 mm	TIME :
					CODE NO. MA20N1460E1	

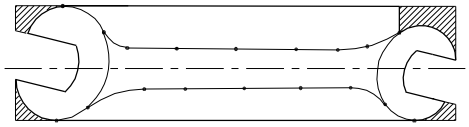
Fig 3



MAN2163H3

- Align the marking of the external profile with the axis of the rotary table.
- Slot the external profile using circular feed. Repeat the procedure for the external profile at the other end. (Fig 4)

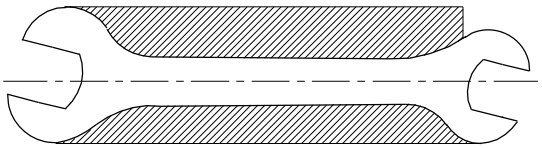
Fig 4



MAN2163H4

- Saw the shaded portion keeping 1 mm allowance for slotting.
- Align the marking with the movement of the table.
- Slot the taper profile at one side. Repeat the procedure for the taper profile at the other side.
- Slot the round corners using a form tool. (Fig 5)

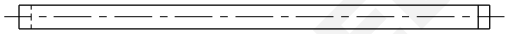
Fig 5



MAN2163H5

- Deburr the corners for smoothness. (Fig 6)
- Check the various dimensions of spanners using different instruments.

Fig 6



MAN2163H6

Skill Sequence

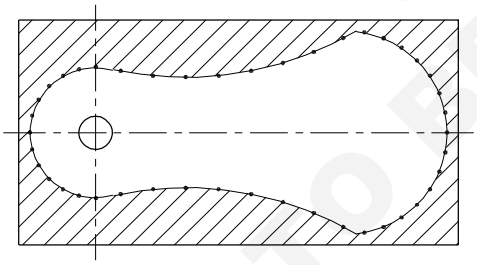
Slotting irregular contour / profile

Objectives: This shall help you to
- **lay out irregular contour/profile on the job**
- **slot the irregular contour/profile.**

Lay out the job as per the drawing. (Fig 1)

Mount the job at the centre of the table using parallels, clamps, T- bolts and nuts.

Fig 1



MAN2163J1

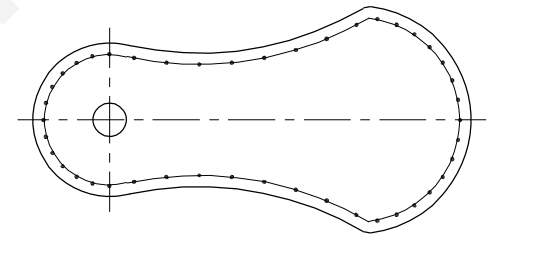
Ensure that the clamps and parallels are not fouling, while slotting a particular curve.

Set and align the tool in the tool-holder.

Rough machine the contour leaving 0.5mm for the finish cut, using longitudinal, cross and rotary feeds(Fig 2) Attach a sticky pointer/pin on the tool edge.

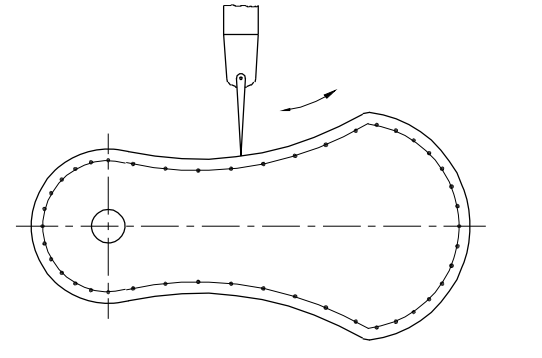
True the contour to the pointer by using rotary, longitudinal and cross feeds. (Fig 3)

Fig 2



MAN2163J2

Fig 3



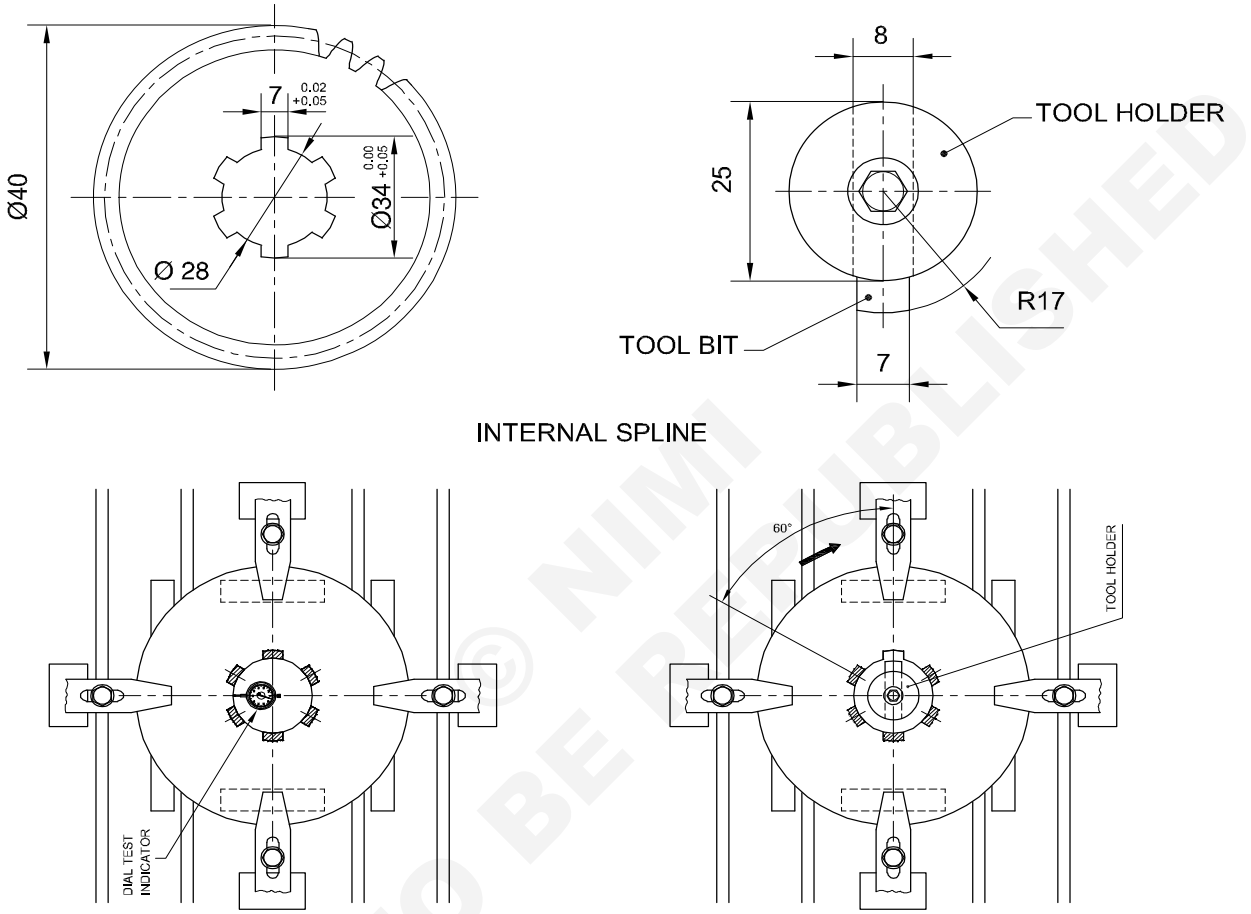
MAN2163J3

Machine the contour by taking finish cut, using rotary feed.

Repeat for completing other contours.

Cutting internal spline on slotting machine with accuracy ± 0.04mm

Objectives: At the end of this exercise you shall be able to
- **grind tool for internal spline**
- **mount and align the job on a circuit table using job holding devices**
- **slot internal spline**
- **repeat the procedure for the remaining spline.**



Job Sequence

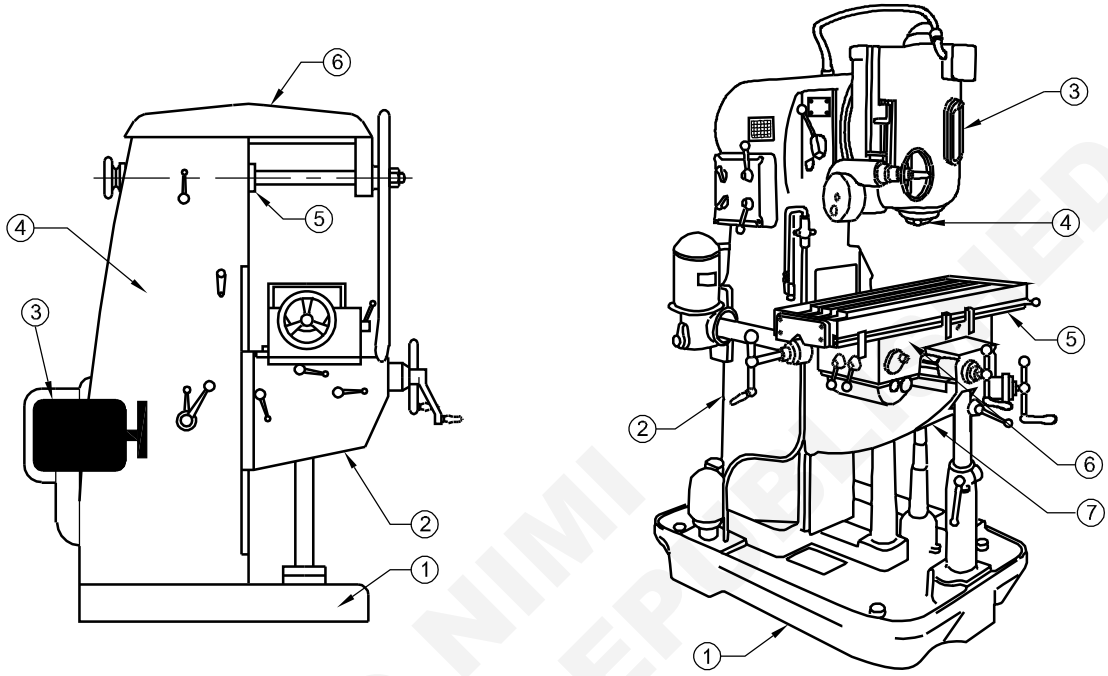
- Check the bore diameter ø28mm of the blank.
- Layout outside circle ø34mm and splines of width 7mm on the face of the blank.
- Hold the job on the rotary table using parallels, clamps and bolts.
- Align the centre with respect to the rotary table using a dial test indicator.
- Align the tool with respect to the job.
- Slot internal spline to a width 7mm and depth 3mm.
- Check the dimensions of the spline.
- Index the table through 60° and slot the next spline.
- Repeat the same procedure for the remaining splines.

1	Ø45x10	-	Fe310	-	-	1.4.61
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**CUTTING INTERNAL SPLINE ON SLOTTING MACHINE WITH ACCURACY ±0.04MM**				DEVIATIONS ±0.04 mm	TIME :
					CODE NO. MA20N1461E1	

Identification of milling machine

Objective: At the end of this exercise you shall be able to
- **identify and record the type of milling machine**
- **identify the parts of milling machine**
- **record the parts name in table.**

Fig 1



Job Sequence

Instructor shall show the horizontal and vertical milling machines. Brief the each part of milling machines, ask the trainees to till the parts name in Table - 1 for horizontal milling machine and Table - 2 for vertical milling machine.

- Trainees to note down the part names of both milling machines

Table 1- Horizontal milling machine

Sl. No.	Name of the parts
1	
2	
3	
4	
5	
6	

- Record the parts name in Table - 1 for horizontal and Table 2 for vertical milling machine.

Table 2- Vertical milling machine

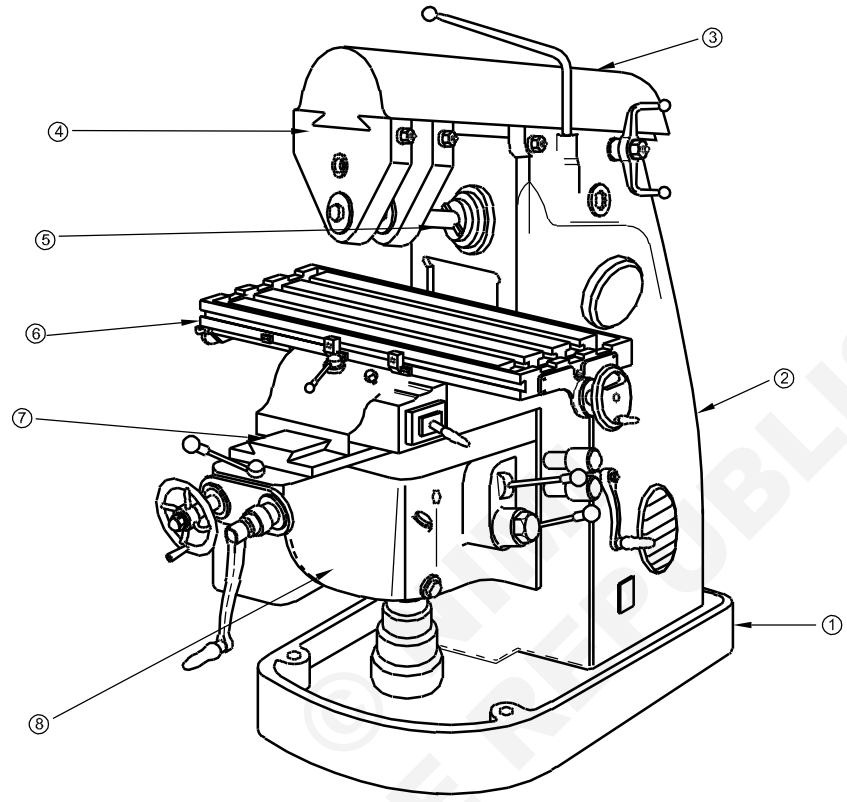
Sl. No.	Name of the parts
1	
2	
3	
4	
5	
6	

- Get it checked by instructor.

Demonstrate working principle of milling machine

Objectives: At the end of this exercise you shall be able to
- **movement of the slides manual and automatic**
- **run the machine in different spindle speed**
- **put ON and OFF the machine.**

Fig 1



Job Sequence

- Identify 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.

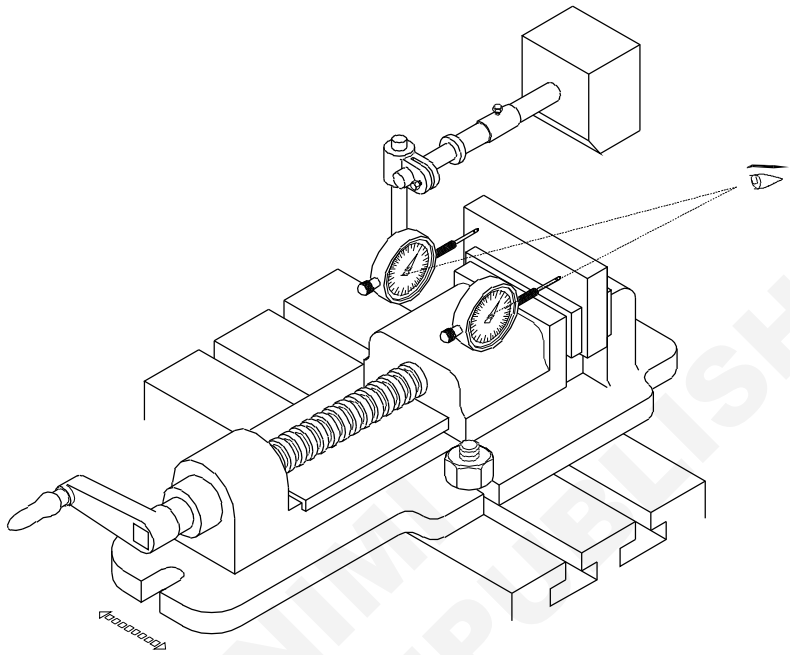
Table 1

Sl.No	Name of the parts	Type of movement
1		
2		
3		
4		
5		
6		
7		
8		

Set vice & job on the table of milling machine

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.**

Fig 1



MAN2268H1

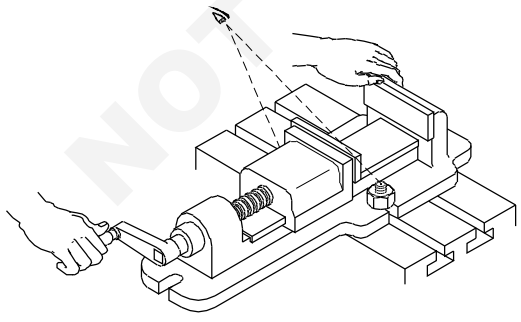
Job Sequence

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

Fig 1

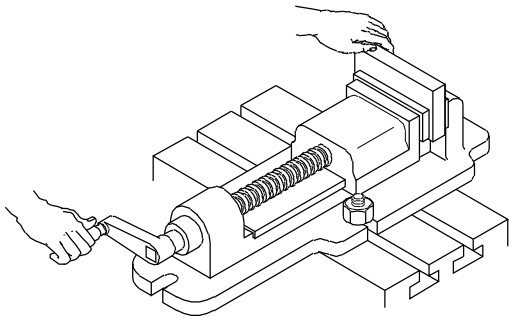


MAN2268J1

adjustment.

Tighten all the 'T' bolt nuts by hand.

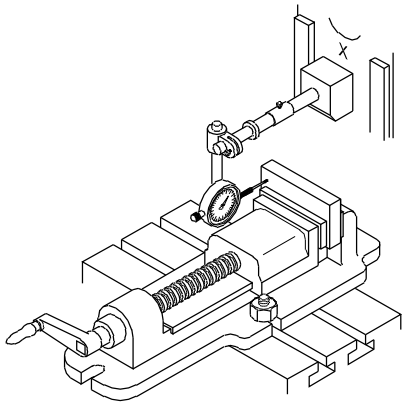
Fig 2



MAN2268J2

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 3



MAN2268J3

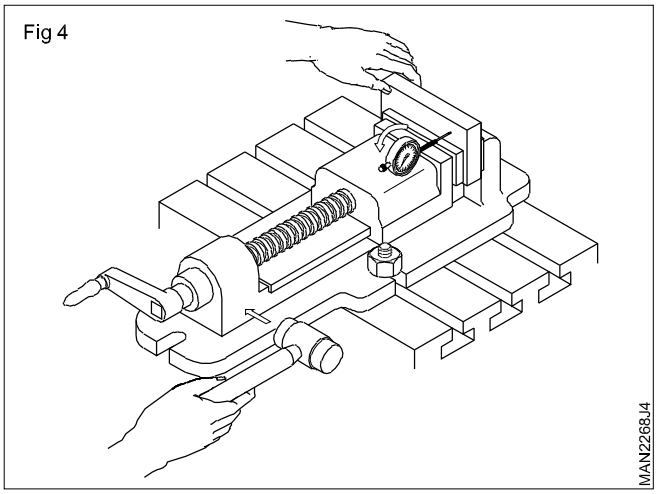
Position the dial indicator with the magnetic base firmly on the reference surface (X). (Fig 3).
Engage the dial indicator stylus on one end of the parallel. (Fig 3) Ensure that the dial indicator and stand do not foul anywhere.

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

Fig 4



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.

Check the alignment after clamping, and adjust, if necessary.

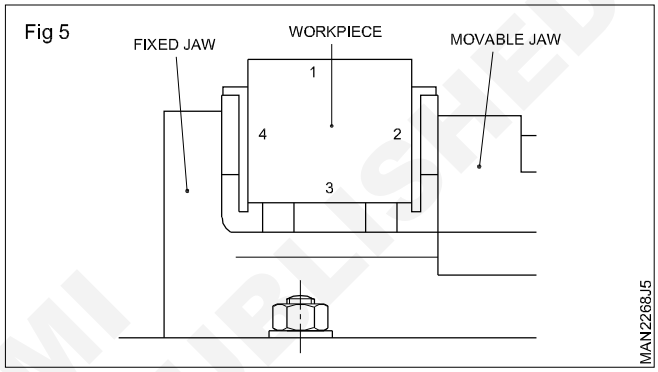
Lubricate the vice screw and the slide ways.

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 15mm between the middle of

Fig 5



the unfinished side and the movable jaw. This gives line contact between the job and prevents lifting off the workpiece. (Fig 5).

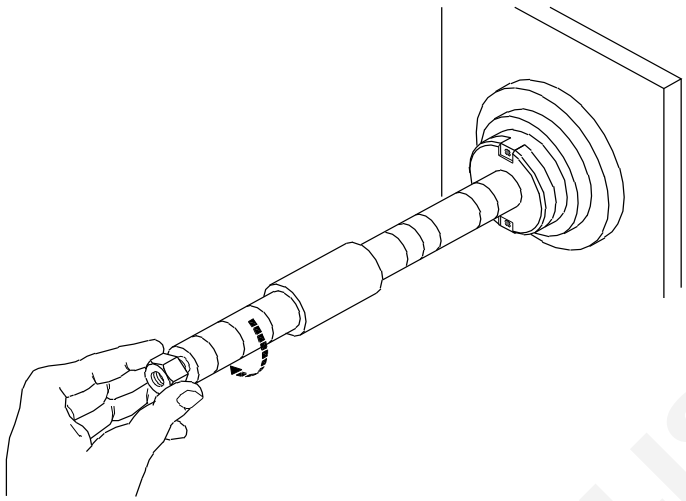
Tighten the workpiece.

Tap the workpiece gently with a soft hammer for seating on the parallel. Ensure that the parallel block does not shake.

Set arbor on the spindle of milling machine

Objective: At the end of this exercise you shall be able to
• mount arbor on the machine spindle of milling machine.

Fig 1



MAN2269H1

Job Sequence

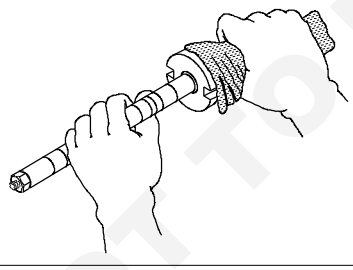
Set the lowest available spindle speed to avoid free rotation of the spindle nose.

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)

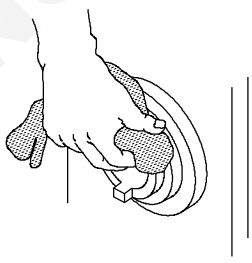
Fig 1



MAN2269J1

Clean the spindle nose of the machine. (Fig 2)

Fig 2

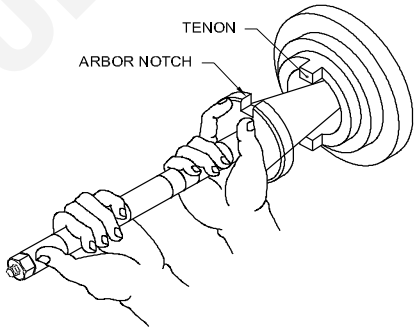


MAN2269J2

For cleaning, use soft cloth free from dust, chips etc. to avoid scratches on the surface.

Hold the arbor and ensure that the arbor notches fit on to the nose of the tenon to get the drive. (Fig 3)

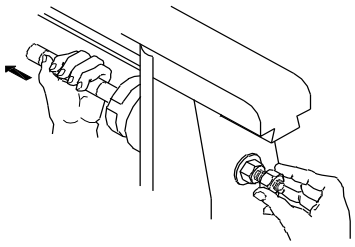
Fig 3



MAN2269J3

Tighten the draw - bar from the rear side of the spindle and secure the arbor into machine by tightening the lock - nut. (Fig 4)

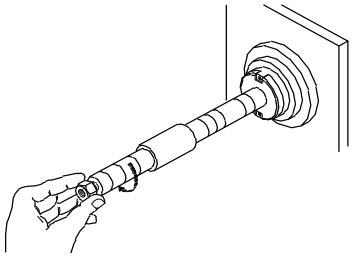
Fig 4



MAN2269J4

Unscrew and remove the nut from the arbor end by rotating it in the clockwise direction. (Fig 5)

Fig 5



MAN2269J5

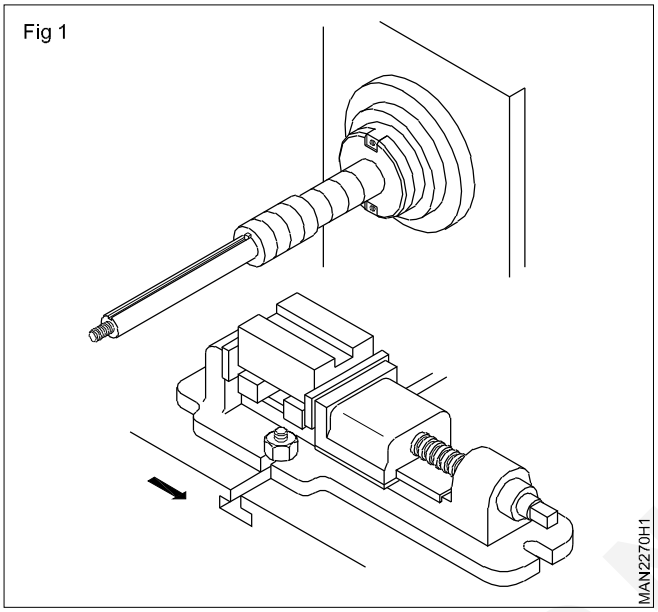
Set the cutter on arbor

Objective: At the end of this exercise you shall be able to
• mount and position the cutter on milling machine arbor.

Job Sequence

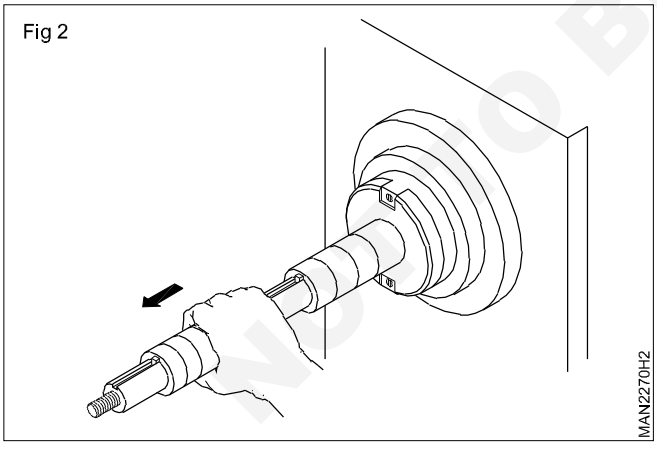
Remove the spacers and bearing bushes and clean them. (Fig 1)

Fig 1



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

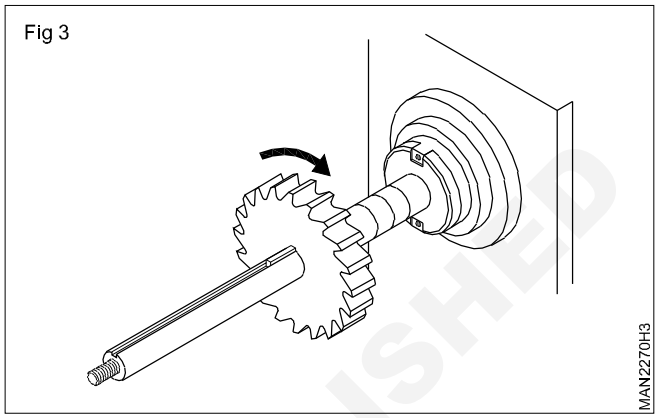


Clean the side and face the cutter and the bore of the - cutter.

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)

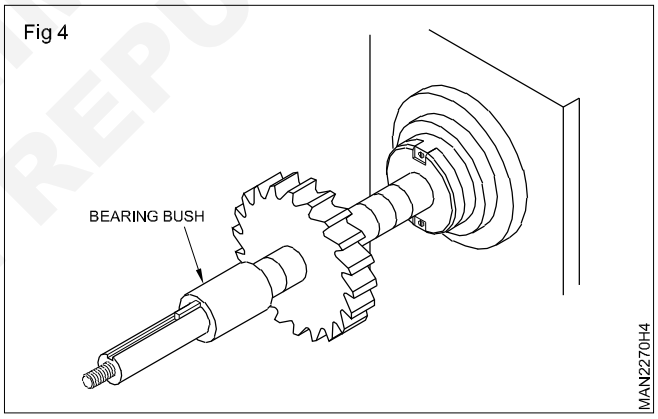
Fig 3



Ensure that the key is placed into the keyway, and milling cutter.

Slide the bearing bush on to the arbor. (Fig 4)

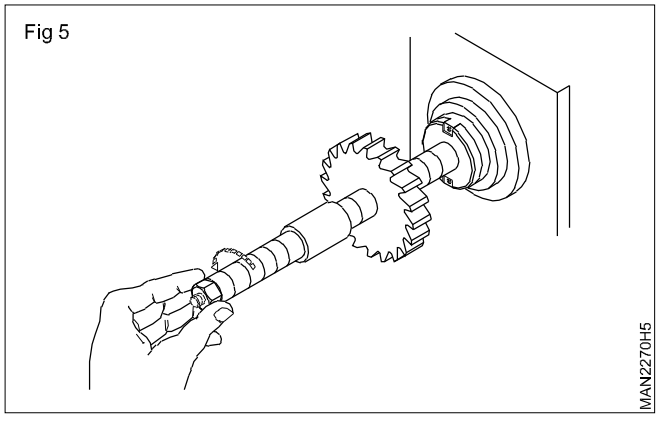
Fig 4



Slide on more spacers until one or two threads on the arbor screw are covered so that the spacers are pressed while tightening.If not, the cutter may not be tightened sufficiently.

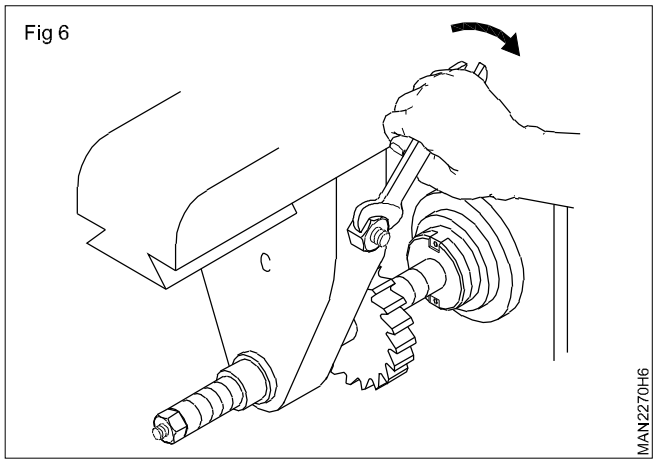
Tighten the arbor nut by hand. (Fig 5)

Fig 5



Carefully slide the arbor support. (Fig 6)

Fig 6

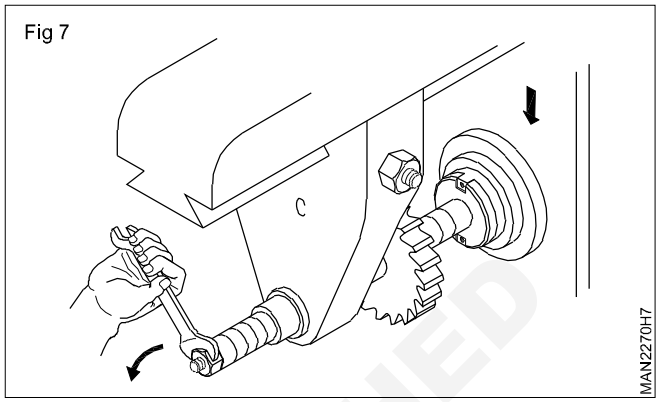


Ensure that the bearing bush extends equally on both sides of the arbor for uniform support.

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



Safety points to be observed while working on a milling machine

Objective: At the end of this exercise you shall be able to
• **adopt the safe procedures while working on milling machine.**

Do not use this machine unless a instructor has instructed you in its safe use and operation and has given permission.

- Safety glasses must be worn at all times in work areas.
- Appropriate footwear with substantial uppers must be worn.
- Rings and jewellery must not be worn
- Long and loose hair must be contained.
- Close fitting/protective clothing must be worn.
- Gloves must not be worn when using this machine
- Use a cutter guard wherever possible.
- Do not take any measurement while the machine is in running condition i.e stop the machine first and then take measurement.
- Use proper feeds and depth of cuts avoid heavier feeds and cuts.
- Before taking any cut ensure that the job is properly clamped.
- Clean the cutter or workpiece while the machine is in still position.
- Do not use machine table as storage space for spanners, mallets and other tools. These tools may fall down and injure the workmen when the machine table is moving.
- While using cutting fluid or lubricant directly from the machine, make sure that the flow pipe outlet is well clear of the milling cutter.
- Do not fix a heavier job than recommended for the machine.
- Check the job for proper clamping.
- Use a piece of cloth for protection of the cutter and your hands when handling the milling cutter.
- Do not be distracted or talk to others while operating the machine.
- Only remove chips using gentle air blasting or chip brushes.
- Be aware of cutting tools.
- Never reach any where over around or near any rotating cutters.

Demonstrate up milling and down milling process

Objectives: At the end of this exercise you shall be able to
- **set the cutter on the arbor and decide the direction of rotation**
- **set the job correctly on the vice**
- **mill the surface by up milling**
- **mill the surface by down milling.**

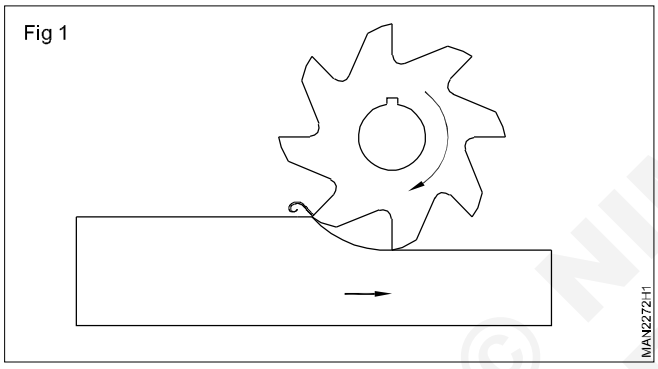
Job Sequence

The two operating procedures are distinguished by the directions in which the teeth of the cutter and the feed of the workpiece move.

TASK 1: **Up-cut milling**

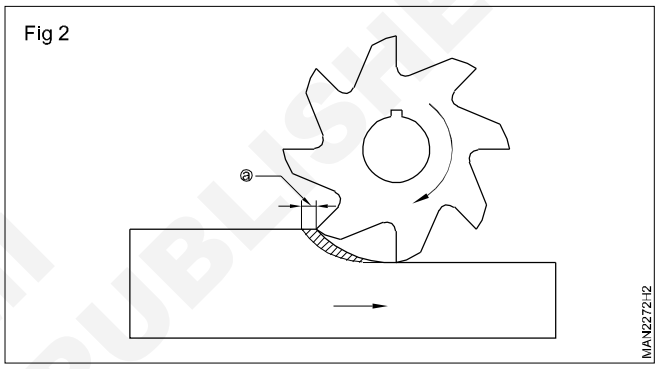
The most commonly used method of feeding is to bring the work against the direction of rotation of the cutter. (Fig.1) This is otherwise known as convention milling. This is the most commonly used method.

Fig 1



In up-milling the removal of chip by each cutting edge starts at the thinnest part of the chip (a) and progresses to the thickest part. (Fig 2) The cutting edge slides in the material before it starts to cut. This scraping causes a good deal of heat and wear on the cutter. As the cutter teeth emerge from the material, the accumulated cutting forces are suddenly released.

Fig 2

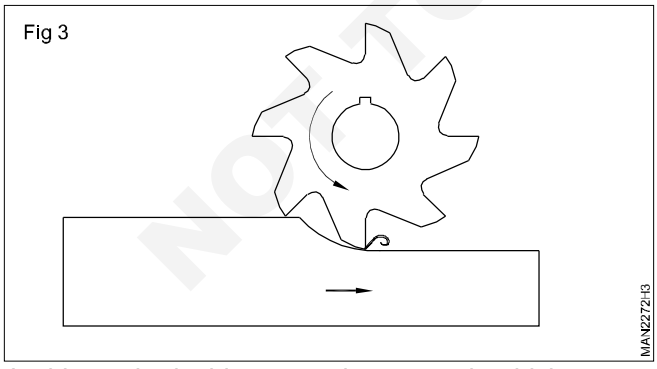


The cutter and workpiece suddenly spring apart, the machine chatters, and the material surface is flawed by ripples. The spindle for the milling is tensioned in the direction of the feed. The forces involved are taken up by the flank of the thread in contact.

TASK 2: **Down-cut milling**

In down-milling or climb-milling the feed moves in the same direction as the rotation of the cutter. (Fig 3)

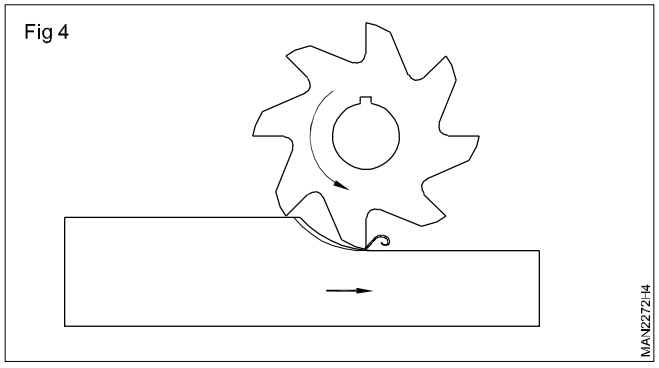
Fig 3



In this method, chip removal starts at the thickest part. The cutter cuts into the material straightway and does not slide. (Fig 4) As a result less heat is developed and there is less wear on the cutter.

In this method, the workpiece is pressed down on the work table by the cutting pressure and thus prevents the workpiece from lifting. (Fig.5) This is an advantage, especially when milling long workpieces.

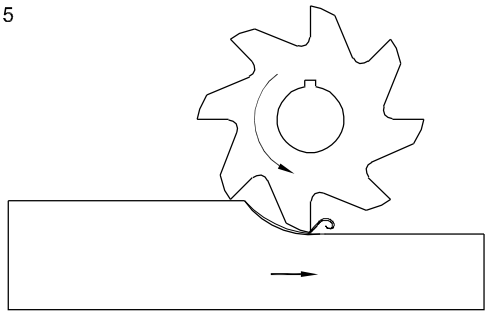
Fig 4



Because in climb-milling the cutter is pulling the workpiece, it should only be carried out on a machine having a 'backlash eliminator'. This is because the backlash eliminator takes up any clearance in the feed drive mechanism and prevents the cutter from being pulled along.

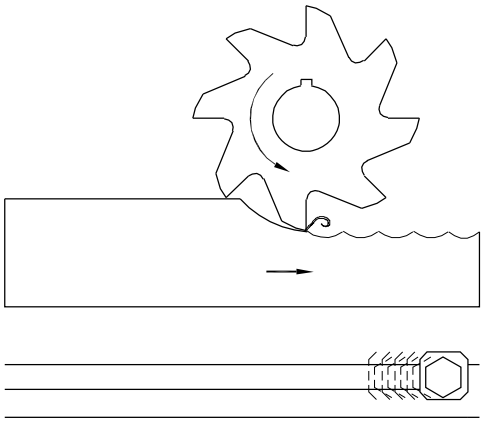
If down-milling is tried on a machine without a backlash eliminator, the workpiece will move along in a series of jerks (Fig 6), resulting in very poor finish and even breakage of the cutter.

Fig 5



MAN2272H5

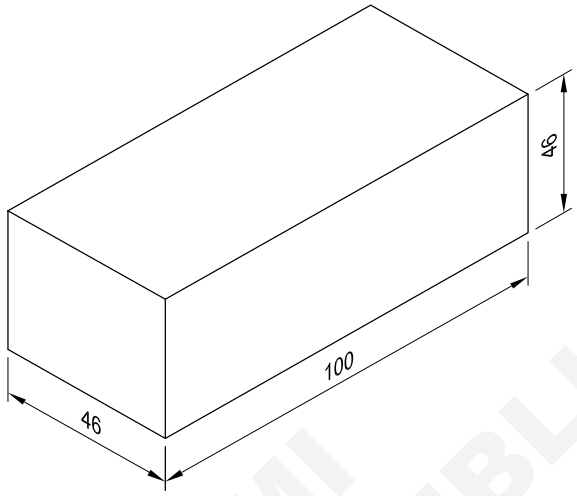
Fig 6



MAN2272H6

Sequence of milling six faces of a solid block

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.**



Job Sequence

- Clamp the machine vice securely on the machine table and align jaw parallel to the column.
- 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)

Fig 1

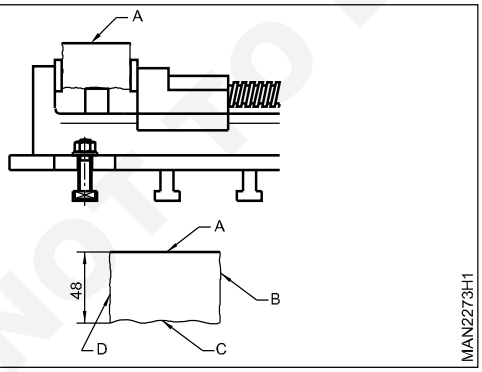
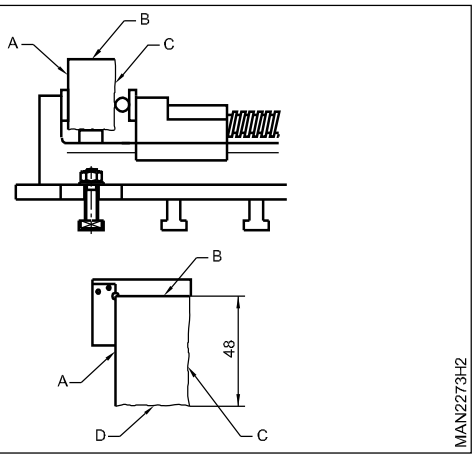


Fig 2

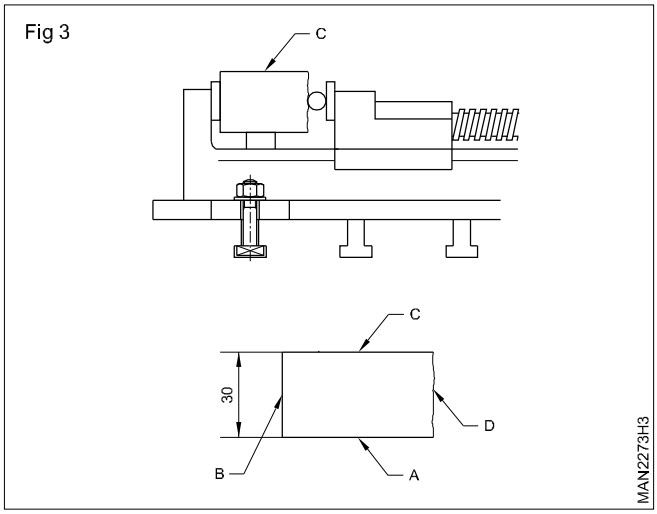


1	ISSQ50X105	→ EX NO.1.5.72	Fe310	-	-	1.5.69
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**SEQUENCE OF MILLING SIX FACES OF A SOLID BLOCK**	DEVIATIONS ± 0.1	TIME :
		CODE NO. MA20N1569E1	

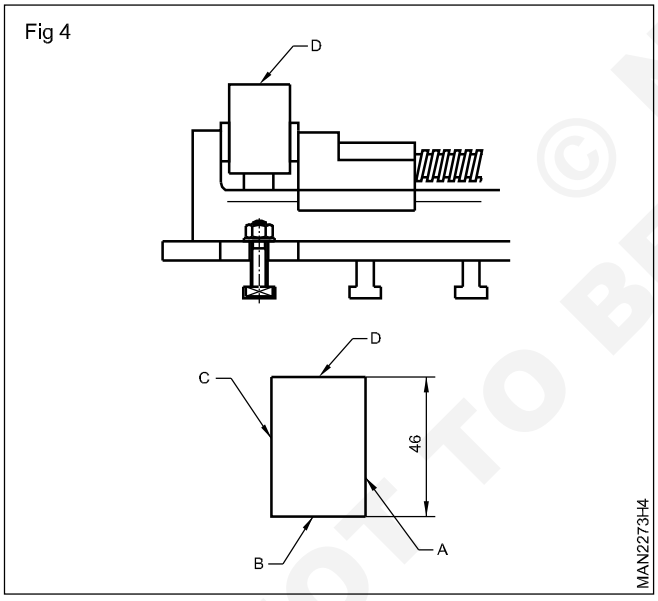
- Keep the surface ‘A’ on the parallel blocks and butt the surface B to the fixed jaw.
- Place a round rod in between movable jaw and surface D.
- Mill surface C maintaining the size of 46mm (Fig 3).

Fig 3



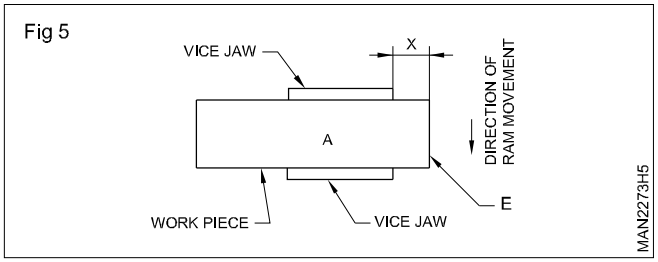
- Keep surface C on the parallel blocks.
- Set the work, projecting it atleast 10mm from the sides of the vice.
- Mill surface ‘D’ maintaining a size of 46 mm (Fig 4)

Fig 4



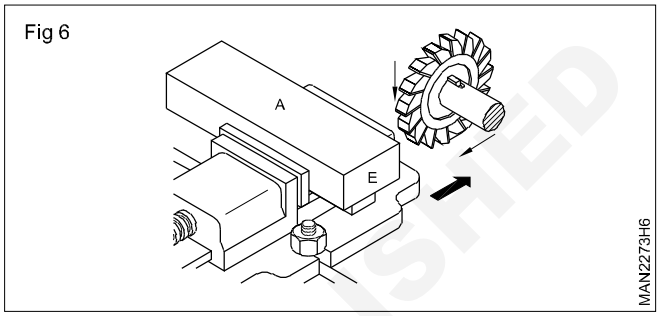
- Keep surface ‘C’ on the parallel blocks (Fig 5)

Fig 5



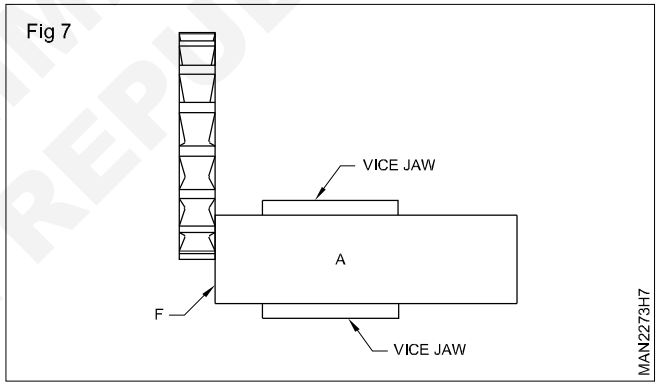
- Set side and face milling cutter and mill the surface ‘E’ (Fig 6)
- Set the RPM for side and face cutter.

Fig 6



- Mill the ‘F’ side by the side and face cutter and maintain the size (Fig 7)

Fig 7



- Deburr the job and check all the dimensions.

Check the accuracy with the help of try square and vernier height gauge

Objectives: At the end of this exercise you shall be able to
- **check the flatness with try square**
- **check the squareness with try square**
- **check the height with the vernier height gauge.**

Job Sequence

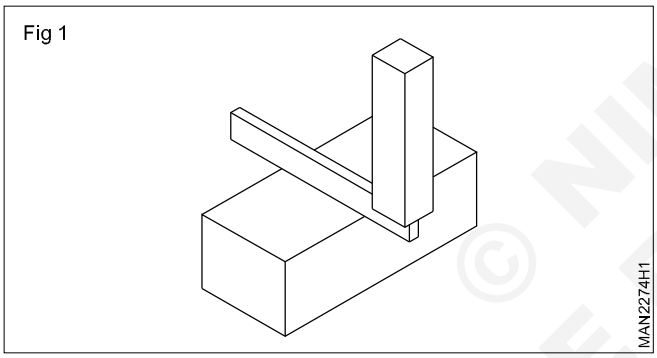
TASK 1: **Checking flatness with try square**

During the initial stages of filing the evenness of the surface can be visually observed to a reasonable degree of perfection from the surface texture of diagonal filing.

To ensure perfection, the surface should be checked with a straight edge. To do this, the blade of a try square can serve as a straight edge.

Flatness should be checked in all directions so as to cover the entire surface. Light gap will indicate high and low spots. (Fig 1)

Fig 1



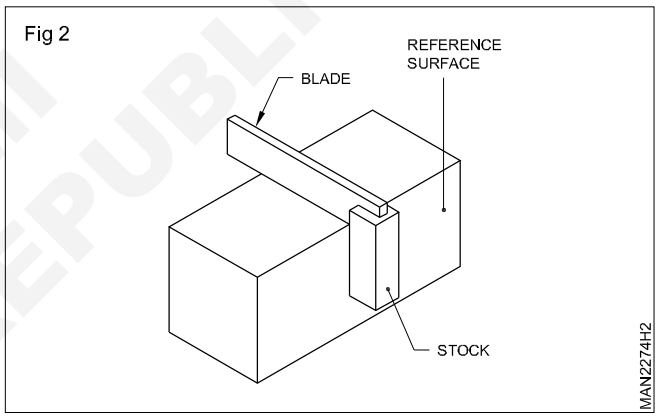
Checking squareness

While checking for squareness, the large finished surface is taken as a reference surface. (Fig 2)

Ensure that the reference surface is finished perfectly before filing other surfaces.

Burrs, if any, should removed before checking with a try square.

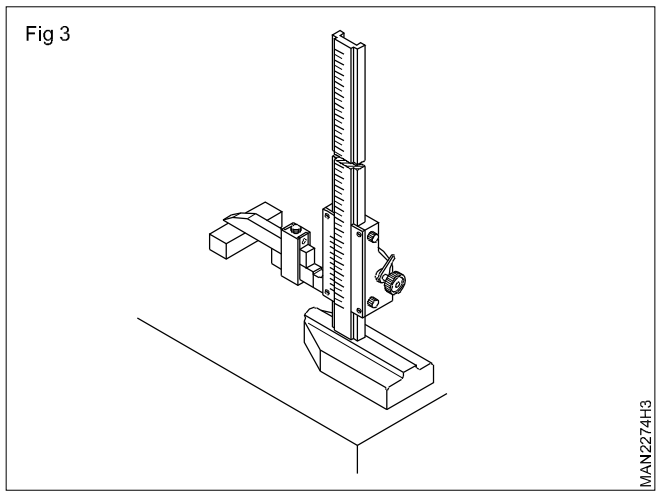
Fig 2



TASK 2: **Check the accuracy with the help of vernier height gauge**

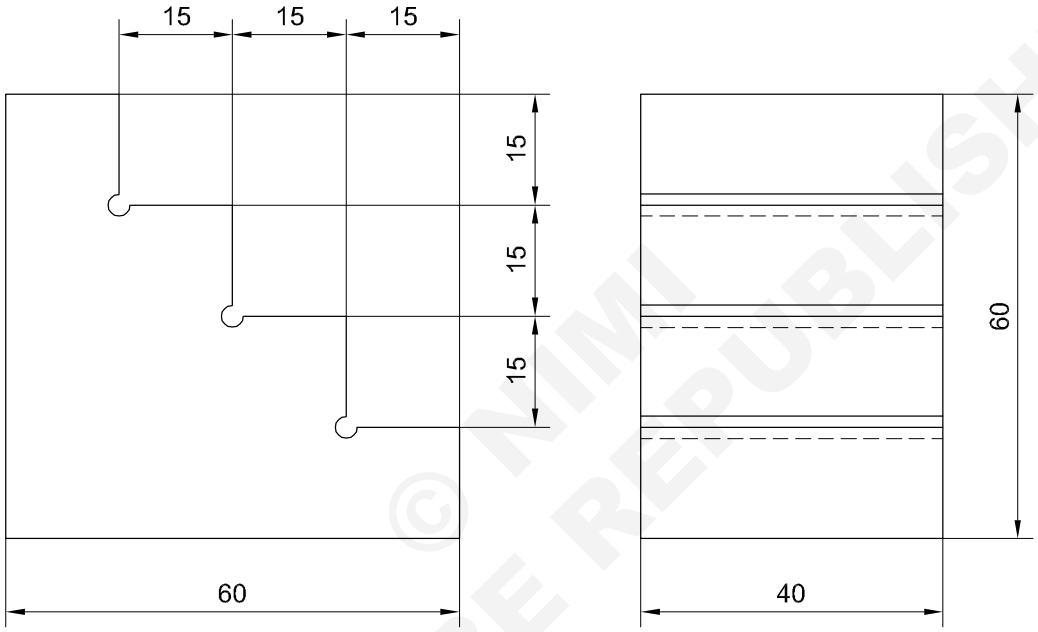
- Keep the job on the surface table
- Set the vernier height gauge on the surface table
- Zero set the instrument using the offset scribes
- Zero setting of the instrument is at a level above the datum surface for using the straight scriber.
- Check the height of the job to a accuracy of ± 0.02mm.

Fig 3



Perform step milling using side and face cutter checking with depth micrometer

Objectives: At the end of this exercise you shall be able to
- **lay out the job as per drawing with a vernier height gauge**
- **set the job in the machine vice for machining**
- **mount a side and face cutter on the arbor**
- **mill steps on the job**
- **check the dimensions of the steps using a depth micrometer.**



Job Sequence

- Check the dimensions of the block. (Deburr, if necessary)
- Mark the steps on the block (steps) as per the dimensions and punch witness marks.
- Align the machine vice with reference to the column using dial indicator.
- Mount a Ø32 mm long arbor and a side and face milling cutter of Ø125x16x32mm bore for the horizontal milling machine.
- Set the r.p.m. of the cutter near to 50.
- Clamp the job in the machine vice to mill all the steps in one setting.
- Align the cutter and the job for milling the step.
- Mill the steps in sequence and check with a depth micro meter.

Mill the relief groove before grinding for grinding purpose.

- Drill relief hold Ø3 mm at the junction of steps.

1	60X60X40	→ EX NO.1.7.97	CI BLOCK	-	-	1.5.71
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	PERFORM STEP MILLING USING SIDE AND FACE CUTTER CHECKING WITH DEPTH MICROMETER				DEVIATIONS ± 0.1 mm	TIME :
					CODE NO. MA20N1571E1	

Skill Sequence

Mill steps on plain milling machine

Objective: This shall help you to
- **mill steps on plain milling machine.**

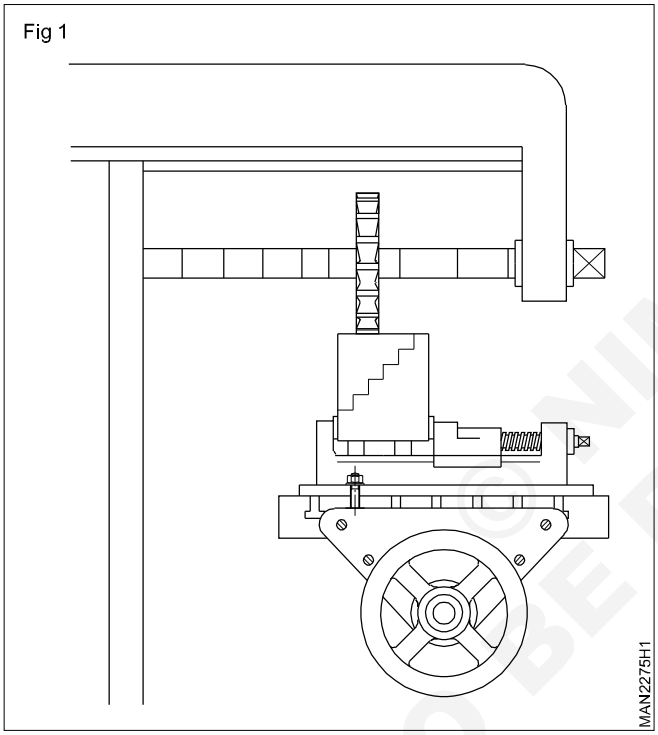
Align and mount the plain machine vice on the machine such that the vice jaws are parallel to the column.

Mark the job as per drawing and punch witness marks.

Hold the job in the machine vice.

Clamp the job in the machine vice such that all the steps can be machined in one setting. (Fig 1) If the job cannot be accommodated on the plain milling machine, step mill on the vertical milling machine.

Fig 1



Mount the long arbor and the side and face milling cutter.

Ensure that (D - S)/2 is 5 to 6 mm more than the maximum depth to be machined.

D = diameter of the cutter

S = outside diameter of the spacers

The gap of 5 to 6 mm is provided to avoid fouling of the spacers with the job while machining. (Fig 2)

Set the machine for up-milling.

Calculate and select suitable r.p.m. for the cutter.

Stick tissue paper (T) on the side face of the job. (Fig 3)

Raise the vertical slide such that the upper surface of the job is 10 to 15 mm above the cutter.

Move the table and bring the tissue paper side of the job parallel to the side of the cutter with a gap of 5 to 6 mm. (Fig 4)

Fig 2

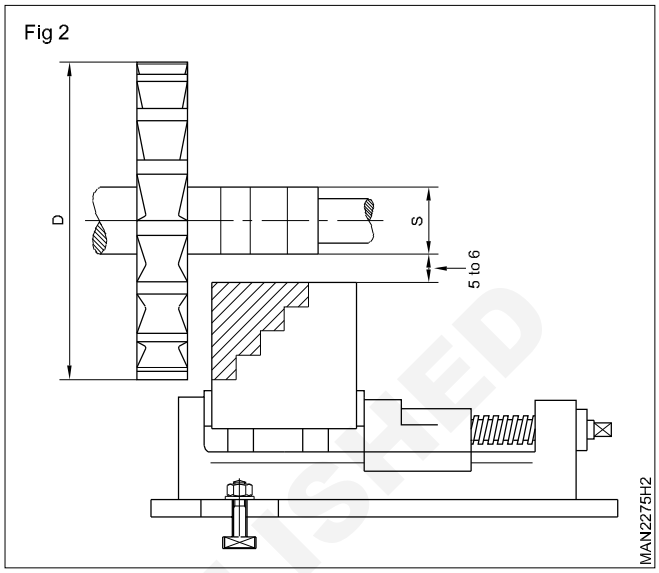


Fig 3

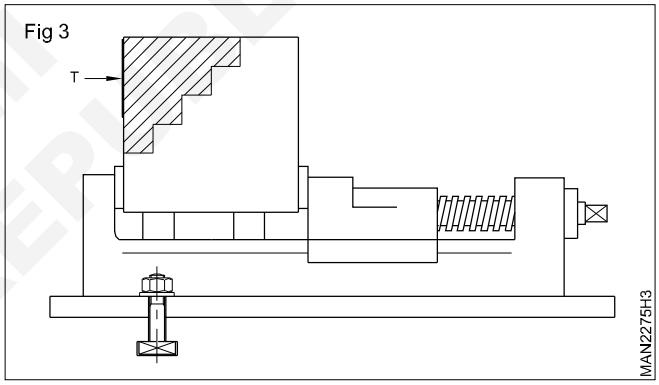
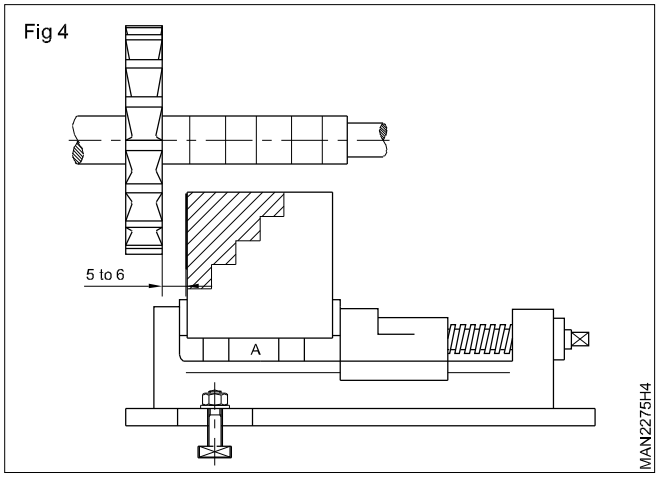


Fig 4



Start the spindle.

Move the cross-slide slowly till the tissue paper is just displaced from its position.

Stop the machine as soon as the tissue paper slips.

Lock the cross-slide.

Adjust the graduated scale to zero of the cross-slide.

This is the datum in one axis for milling the steps horizontally.

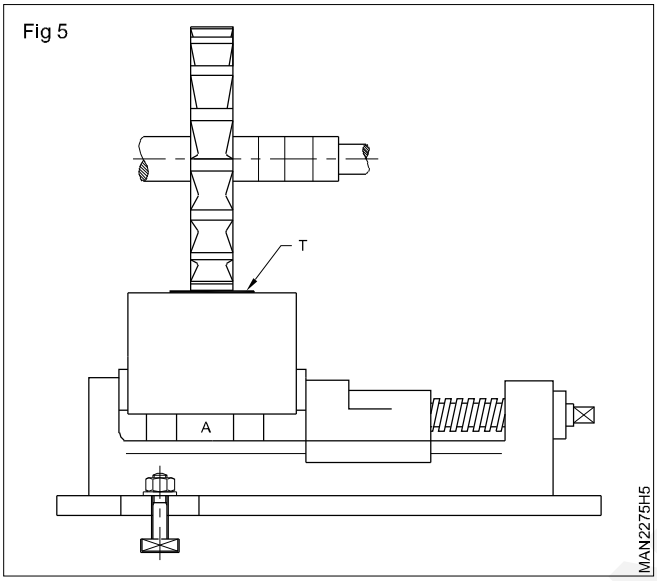
Stick the tissue paper on the top surface of the job.

Clear the workpiece from the cutter and set the cutter 10-15 mm above the top surface of the job.

Start the machine.

Raise the workpiece slowly and manually till the job just touches the cutting edges and the tissue paper slips away by the rotation of the cutter. (Fig 5)

Fig 5



Stop the machine as soon as the tissue paper slips.

Adjust the graduated scale to zero of the vertical slide.

This is the datum in another axis for milling the steps vertically.

Unlock the vertical slide.

Clear the job from the cutter.

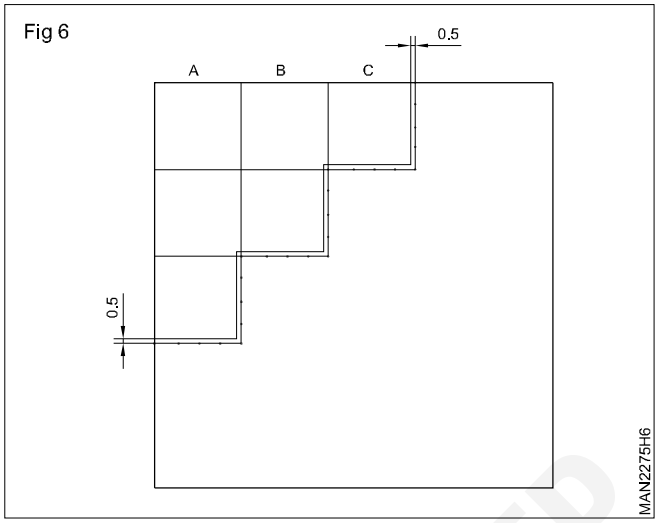
Take care that the datum, set for both the axes, is not disturbed.

Set the coolant nozzle towards the cutter.

Depending upon the condition of the machine, rough milling is possible by using a heavy feed, with a depth of cut from 5 to 10 mm and a low cutting speed. Rough milling is done to remove surplus material in the shortest time. Consult the instructor when and if necessary.

Rough mill the steps a,b,c in that order. (Fig 6)

Fig 6



Leave 0.5 mm allowance of material on both the axes for the final finish.

While machining observe for abnormal noise, vibration of job or cutter and bad surface finish. If you are in doubt stop the machine and check that the

- job is tightened firmly, without any shake
- cutter is tightened securely without play
- cutter teeth are not blunt.

Ensure defect-free machining condition, restart the machine and complete the rough milling operation.

Clear the job from the cutter and deburr the job.

Measure the job and confirm that that 0.5 material is left for final finishing.

Set the machine and complete the steps to the final dimension and finish to a smooth surface by automatic feed.

A fine finish is achieved by relatively high cutting speed and fine feed - check the dimension after completion of each step - consult the instructor.

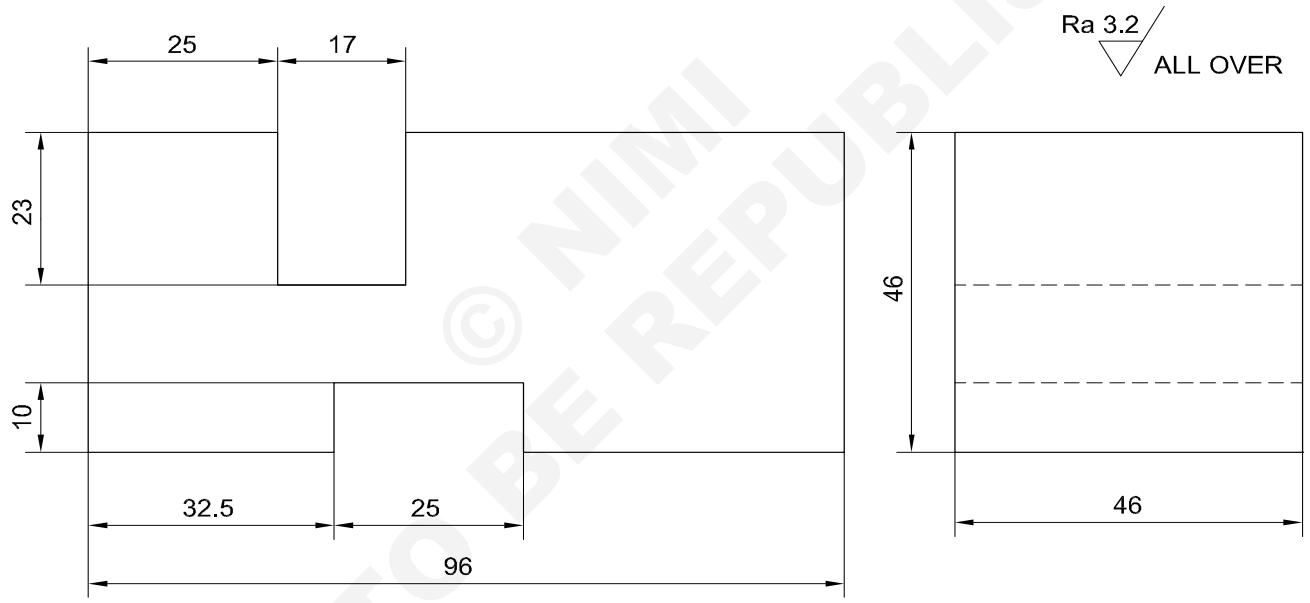
Stop the machine and deburr the job.

Remove the job and measure for its size.

Stop the machine before attempting to make adjustments or measurements.

Perform slot milling using side and face cutter

Objectives: At the end of this exercise you shall be able to
- **set the job in the machine vice for machining**
- **align the job with respect to the cutter**
- **mill the slot to an accuracy of ± 0.04 mm**
- **check the width of the slot using a vernier caliper**
- **check the depth of the slot using a vernier depth gauge.**

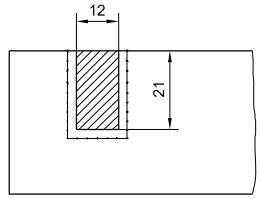


1	-	EX NO.1.5.69 ←	CI BLOCK	-	-	1.5.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	PERFORM SLOT MILLING USING SIDE AND FACE CUTTER				DEVIATIONS ± 0.04 mm	TIME :
					CODE NO. MA20N1572E1	

Job Sequence

- Check the dimensions of the block, 100 x 50 x 50mm.
- Machine the block to the dimension of 96 x 46 x 46mm.
- Mark the groove as per drawing and punch witness marks.
- Hold the job on the machine vice using parallel blocks.
- Mount the side face milling cutter ∅100 x 12 x 27 mm bore at the centre of the arbor and set the spindle speed to 100 r.p.m.
- Align the workpiece with reference to the cutter.
- Mill the slot in the middle of the job giving a depth of cut of 4 mm up to a depth of 21 mm. (Fig 1)

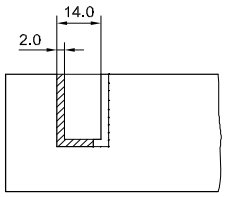
Fig 1



MAN2276H1

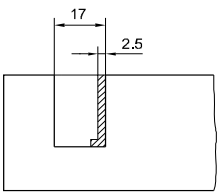
- Offset the job towards the column by 2.0 mm (Fig 2) and mill the width to 14.0 mm (Fig 2). Offset the job away from the column by 5 mm and mill the slot to 17 mm. (Fig 3)
- Check the size of the slot.

Fig 2



MA20N1572H2

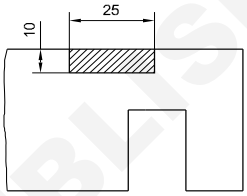
Fig 3



MAN2276H3

- Reset the job and mill a slot of 25 x 10 on the opposite side. (Fig 4)
- Deburr and measure.

Fig 4



MAN2276H4

Skill Sequence

Mill a slot by side and face milling cutter

Objective: This shall help you to
- **mill a slot by a side and face milling cutter.**

Deburr and clean the workpiece.

Mark the job as per drawing and punch witness marks on the lines.

Mount the plain machine vice on the plain milling machine such that the vice jaws are parallel to the column.

Select the cutter size.

The width of the cutter should be less than the width of the slot required.

Calculate the diameter of the cutter approximately, using the following thumb rule.

Select the nearest higher diameter available.

Dia. of cutter/2 = (depth of slot + bore dia./2 + 20) x 2.

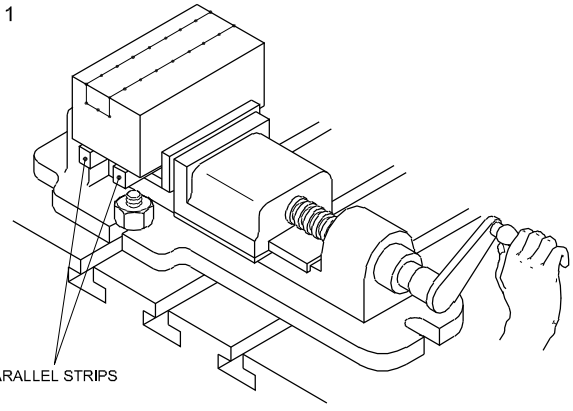
Mount the long arbor and the side and face milling cutter on the machine.

Ensure that the cutter is mounted at the middle of the arbor to facilitate the free traverse of the cross-slide.

Clamp the job with its marked surface on the top, between the vice jaws firmly.

Keep the job on the pair of parallels in such a way that the top surface of the job is above the top surface of the jaws by 4 to 5 mm. (Fig 1)

Fig 1



MAN2276J1

Calculate the r.p.m. for the selected dia. of the side and face cutter.

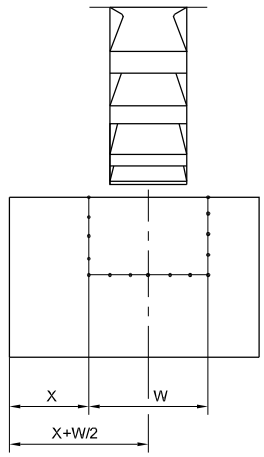
Calculate the feed per minute of the longitudinal traverse.

Set the r.p.m. and feed.

Stick tissue paper to the reference sides of the workpiece and set the datum for the cross and vertical slides.

Set the cutter at the middle of the slot to (X+W/2) mm taking reference from the side datum (cross-slide). (Fig 2) W is width of the slot.

Fig 2



Set the depth of cut taking reference from the top surface of the job.

Be sure that whenever the depth of cut is taken, the cutter is away from the job.

Keep 0.4 to 0.5 mm on both the sides and depth of the slot for final finish.

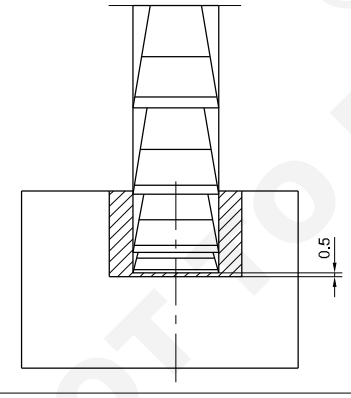
Lock the vertical and cross-slides. Adjust the coolant nozzle point on the cutter.

Start the machine and the coolant pump.

Move the longitudinal slide manually towards the cutter such that the workpiece comes in contact with the cutter gently. Sudden contact may damage the workpiece and the cutter may break.

Mill the depth at the middle of the slot leaving 0.4 to 0.5mm for final finish. (Fig 3)

Fig 3



Move the cutter to the left to a distance of X + 0.5 mm and mill the side of slot. (Fig 4)

Ensure that the datum is again set whenever the cutter is changed or the job disturbed.

Move the cutter to the right to a distance of (X+W) = 0.5mm and mill the right side of the slot. (Fig 5)

Follow the above procedure and mill the slot to size. (Fig 6)

Deburr the job.

Check the slot for dimension.

Fig 4

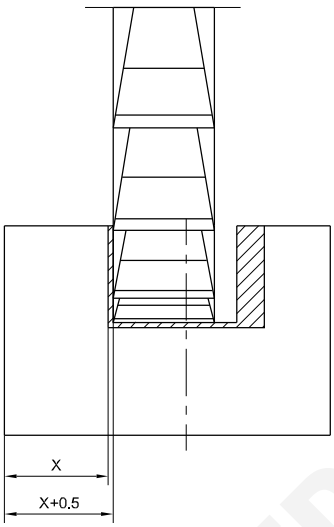


Fig 5

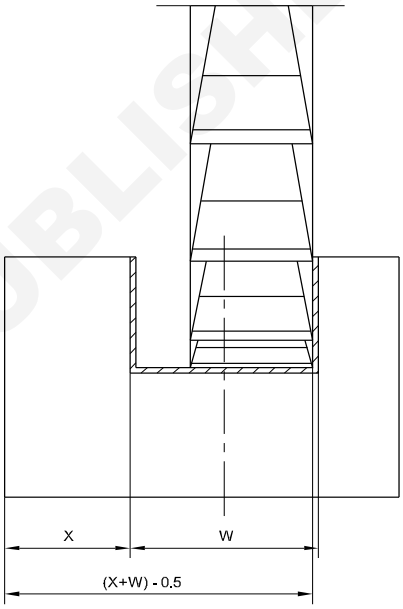
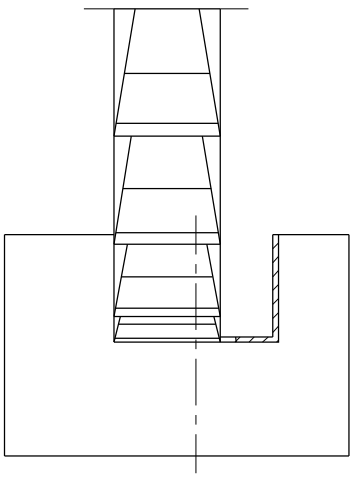


Fig 6

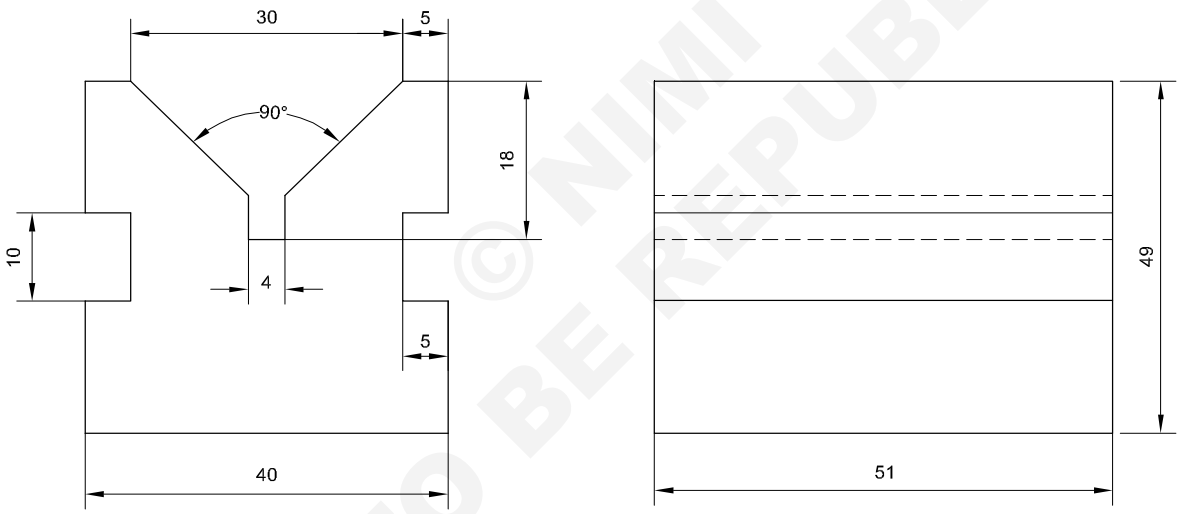


Be sure the holding device is mounted solidly to the table and the work is held firmly. Spring or vibration can cause thin cutters, like the slitting saw, to jam and chatter.

Make 'V' Block using horizontal milling machine with accuracy ±0.02mm

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

- **mark and punch as per drawing**
- **set slitting saw cutter**
- **set 90° double angle milling cutter on arbor**
- **cut angular surface to an accuracy of ± 10 minutes**
- **check angle using vernier bevel protractor**
- **check dimensions using vernier caliper**
- **cut slots with an accuracy of ± 0.02mm.**



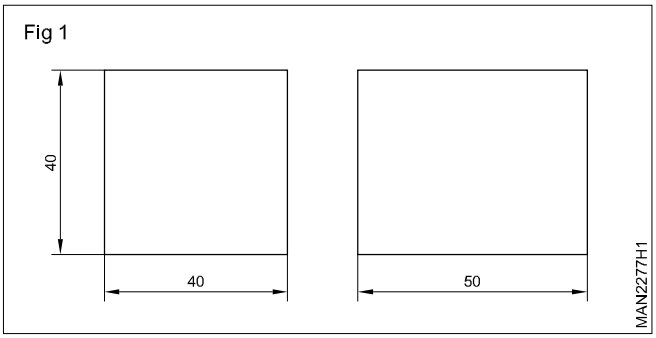
1	ISSQ 50-60	EX NO.1.7.99	Fe310	-	-	1.5.73
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKE 'V' USING HORIZONTAL MILLING MACHINE WITH ACCURACY ±0.02MM	DEVIATIONS ± 0.02 mm	TIME :
		CODE NO. MA20N1573E1	

Job Sequence

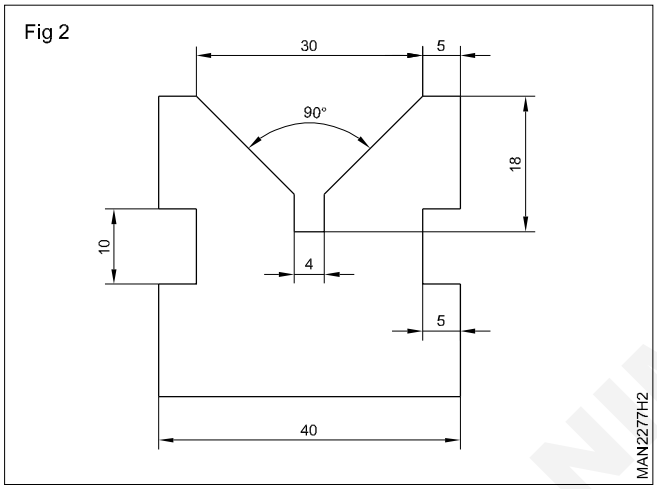
- Machine the block flat and square, to size 50+40+40mm (Fig 1)

Fig 1



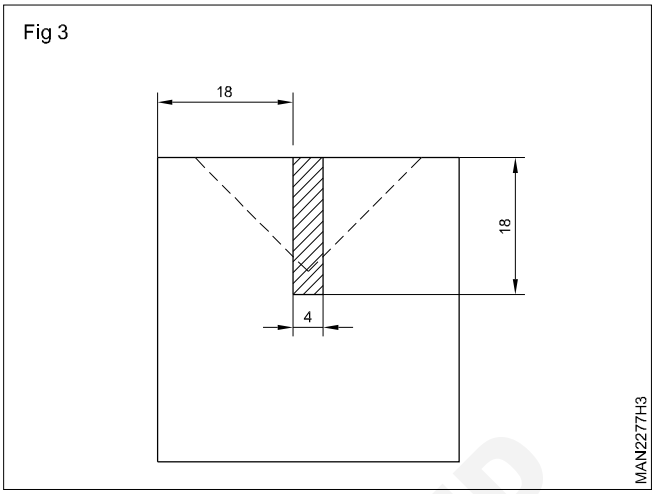
- Mark and punch the job as per drawing (Fig 2)

Fig 2



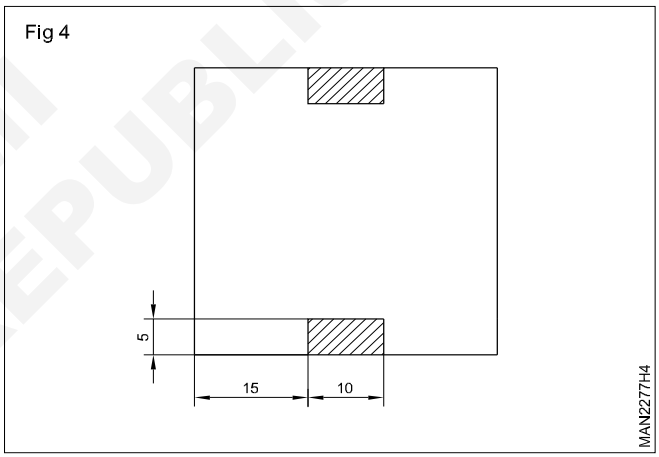
- Set the slitting saw 4mm width
- Hold the job on machine vice
- Mill the slot maintaining dimensions 18,18 and 4mm. (Fig 3)
- Machine angular surface using 45 double angle cutter both the sides.

Fig 3



- Cut slot (shaded portion) maintaining dimensions 15,10 and 5 mm on both sides (Fig 4) using 10mm width side face cutter.
- Check the angular dimensions using vernier bevel protractor.

Fig 4



- Check the dimensions with vernier caliper
- Remove the burrs

Skill Sequence

Mill narrow groove by using slitting saw

Objective: This shall help you to
- **mill a narrow groove by using a slitting saw.**

Mark the job as per drawing to mill a narrow groove.

Mount a plain machine vice on a plain milling machine such that the jaws are parallel to the column.

Set a pair of parallel blocks in such a way that the top surface of the job is 5 to 6 mm above the top surface of the jaws.This will help to measure the dimensions of the slot from the sides using a vernier caliper.

Clamp the workpiece in the machine vice.

Select the slitting saw.

The thickness of the slitting saw should be equal to the width of the groove.

The diameter must be sufficiently large so that the desired depth can be achieved.

Check that the slitting saw is sharp and undamaged.

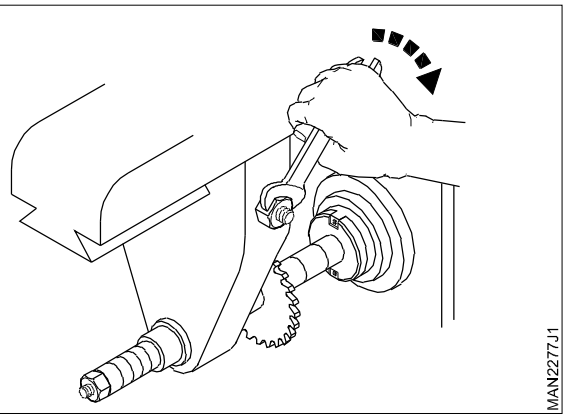
A blunt or damages slitting saw may create excessive vibration and may result in the breakage of the slitting saw.

Select the arbor having the same diameter as the bore of the slitting saw.

Mount the long arbor on the plain milling machine.

Mount the slitting saw on the centre of the arbor.(Fig 1)

Fig 1



Do not insert the key between the arbor and slitting saw, if the slitting saw is less than 4mm thick.

The use of a key may result in the breakage of the slitting saw if it gets jammed into the cut during cutting.

Select the cutting speed, the feed for the slitting saw considering the material the saw is made of .

Calculate the r.p.m., and the feed/min.

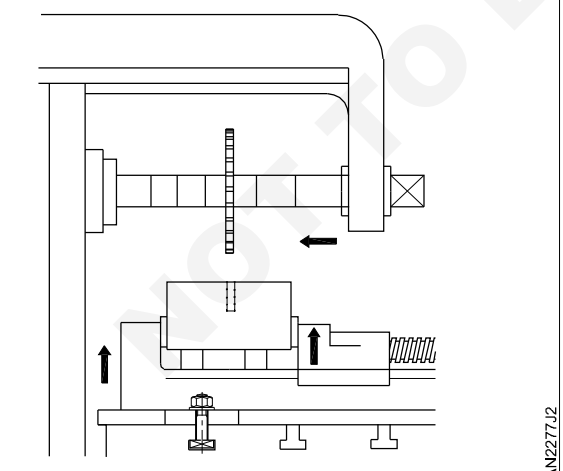
Set the r.p.m. cutter rotation and table feed.

If a higher r.p.m. is set the cutting edges may get blunt, and if a lower r.p.m. is set the cutting time will be more.

Set the nearest lower speed and feed available if the machine does not have the exact values.

By using a hand traverse of the vertical, cross and longitudinal, position the work such that the slitting saw is close to the top of the work. (Fig 2)

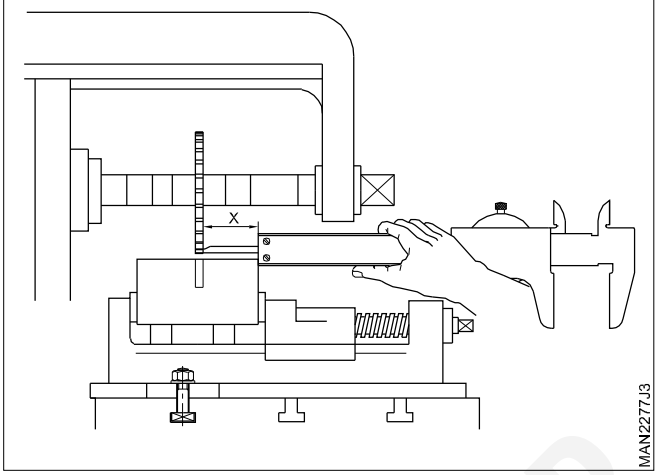
Fig 2



Set the workpiece under the slitting saw such that the distance (x) is as indicated in the drawing.(Fig 3)

For this, move the cross-slide manually. Check 'x' distance with a vernier depth gauge.

Fig 3



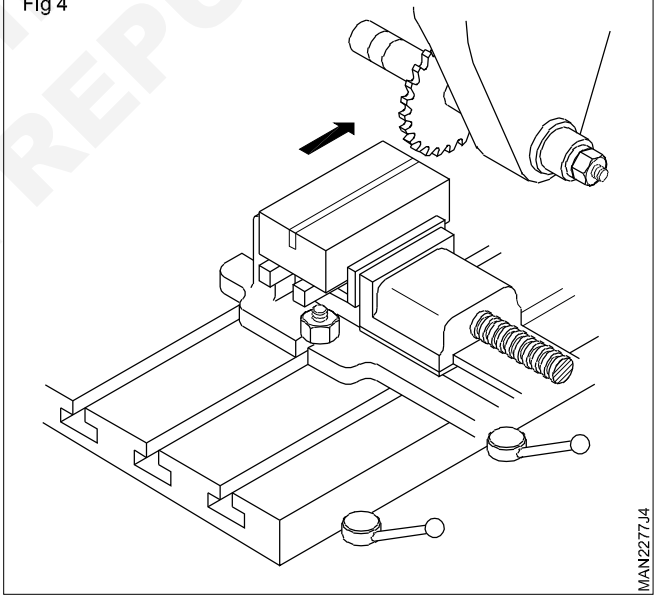
Ensure that the spindle is disengaged. This will ensure that the spindle will not rotate accidentally.

Lock the cross - slide.

Stick tissue paper on the top surface of the workpiece and set the datum for the vertical slide.

Move the longitudinal slide so as to clear the cutter from the workpiece. (Fig 4)

Fig 4



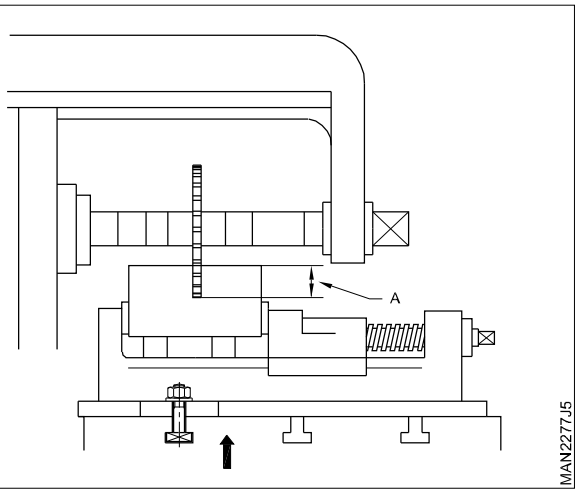
By moving the vertical slide upward, apply a depth of cut. (Fig 5)

Lock the vertical slide.

If the depth of the groove is more by 3 to 4 times than that of the thickness of the cutter (width of the groove), then the total depth of the groove should not be achieved in the first attempt. It should be completed with 2 to 3 passes.

Set the nozzle of the coolant pipe and start the coolant pump.

Fig 5



Start the spindle.

Mill the groove.

Observe the following points during grooving.

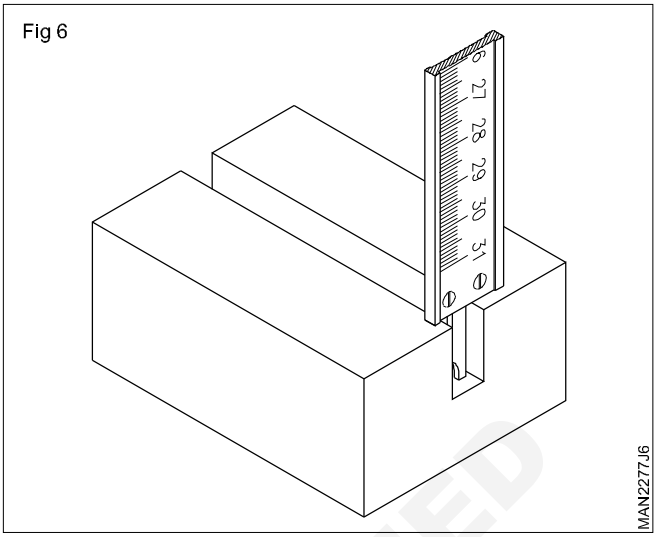
Apply only manual longitudinal feed. This facilitates withdrawing the workpiece from the cutter if it jams into the cut during cutting.

Ensure that there is no abnormal noise in the machine during cutting.

If abnormal noise is generated:

- reduce the r.p.m and feed
- check the sharpness of the cutter
- Check the build up edge is generated in the teeth of the slitting saw.

Fig 6



Move the table to its initial position. Check the dimension (depth) by a vernier caliper. (Fig 6)

If required, take further cuts till the required depth is achieved.

Deburr and remove the workpiece.

Keep the floor around the machine clear of chips and wipe off spilled cutting fluid immediately. Use sawdust, sweeping or special oil absorbing compound on slippery floors.

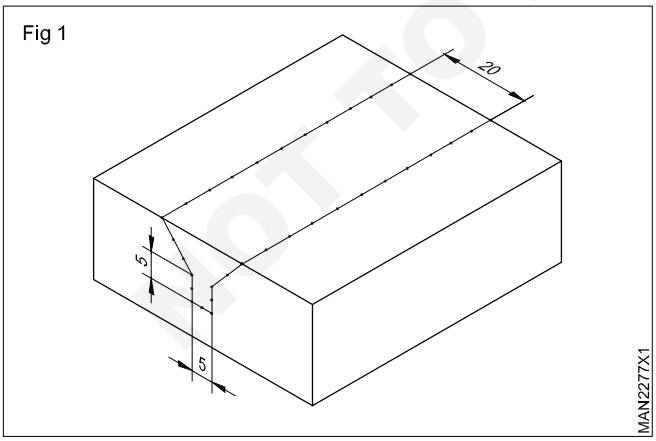
Mill angular surface on horizontal milling machine

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.

Ensure that the cutter is sharp and undamaged.

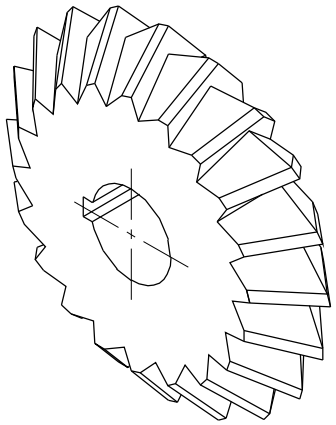
Select and mount the long arbor on the horizontal milling machine spindle.

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.

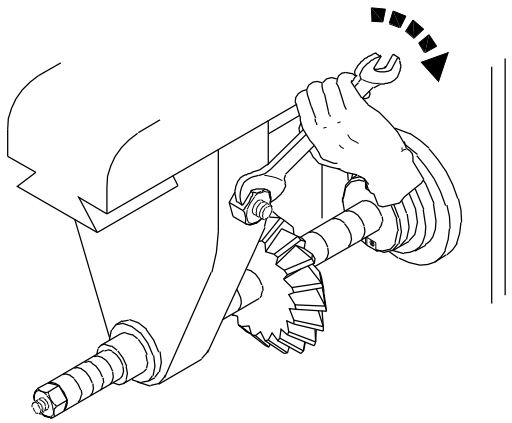
Use hand feed in vertical, longitudinal and cross directions to position the workpiece such that the cutter is close to the top surface of workpiece. (Fig 4)

Fig 2



MAN2277X2

Fig 3



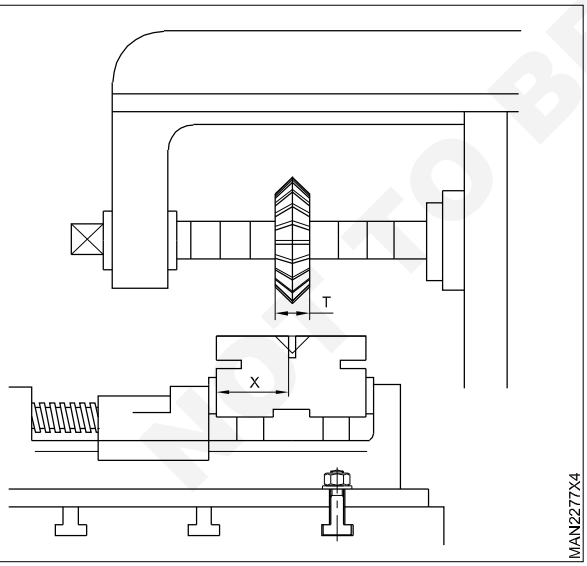
MAN2277X3

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.

Fig 4



MAN2277X4

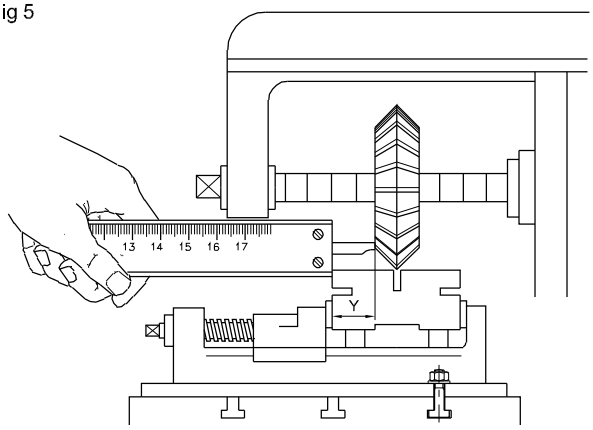
Set the Y distance on the depth gauge or vernier caliper. (Fig 5)

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.

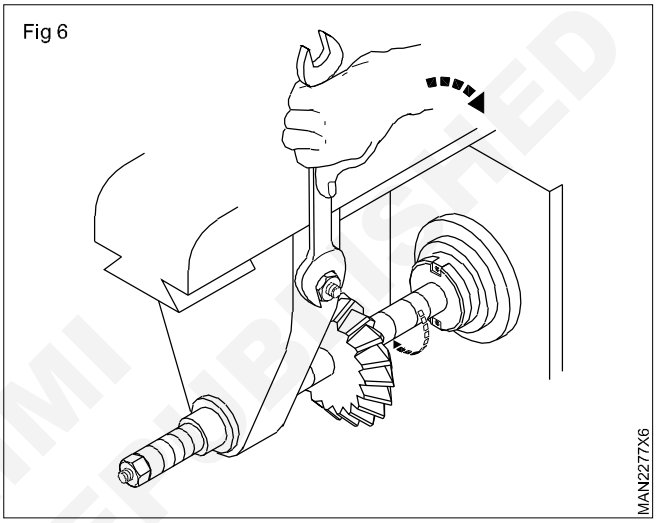
Set the spindle to clockwise direction. (Fig 6)

Fig 5



MAN2277X5

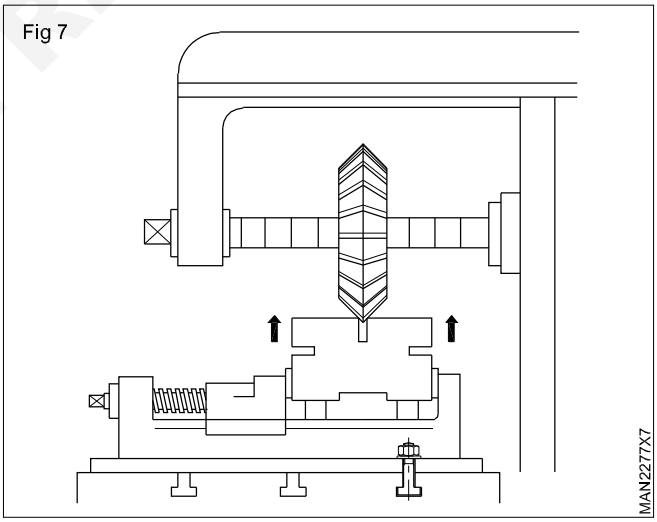
Fig 6



MAN2277X6

Set the datum at the top surface using tissue paper. (Fig.7)

Fig 7



MAN2277X7

Move the table to the left hand side to clear the cutter and workpiece. (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 8

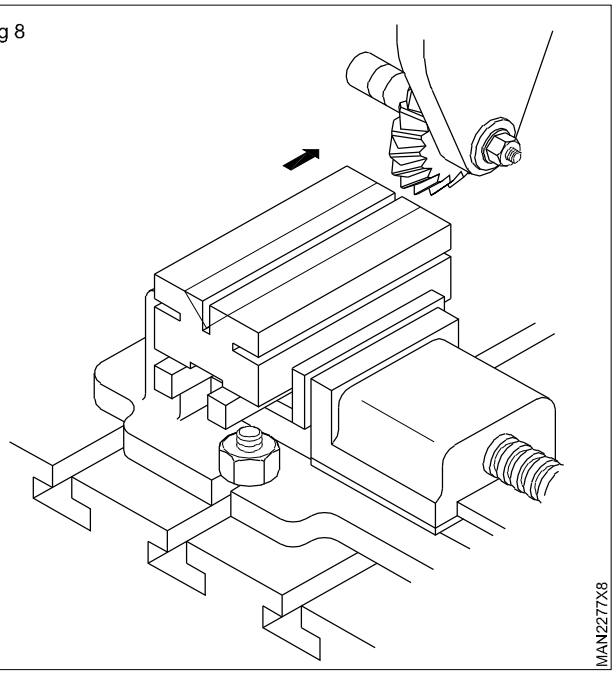
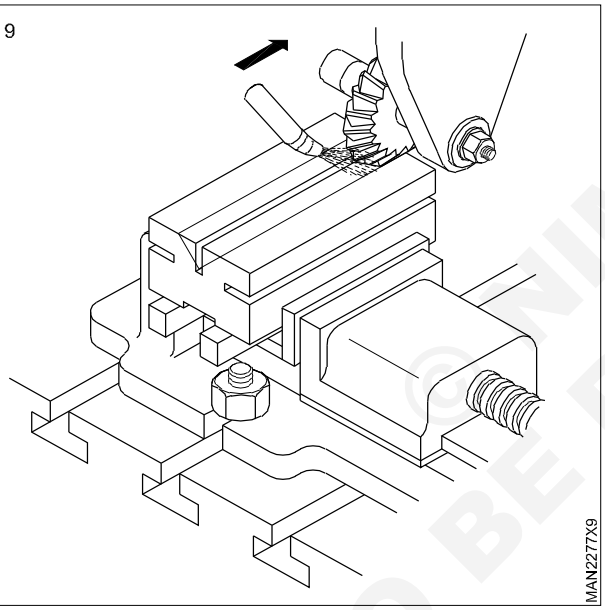


Fig 9

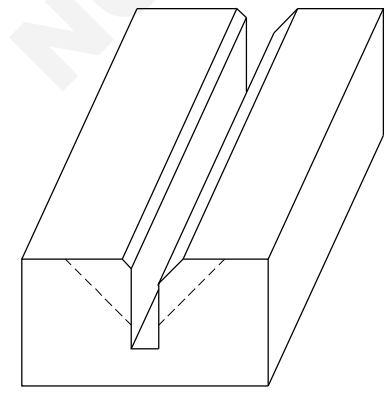


Stop the spindle.

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

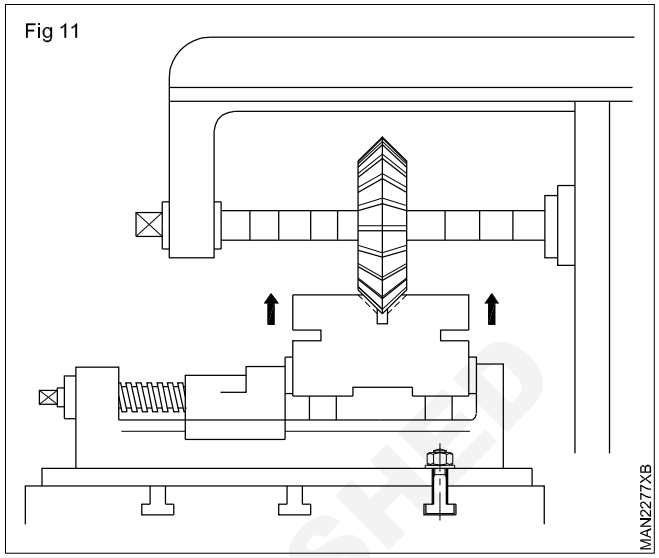


Adjust the cross -side to correct the error.

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)

Apply automatic feed if your machine permits. If not, apply manual feed.

Stop the machine spindle.

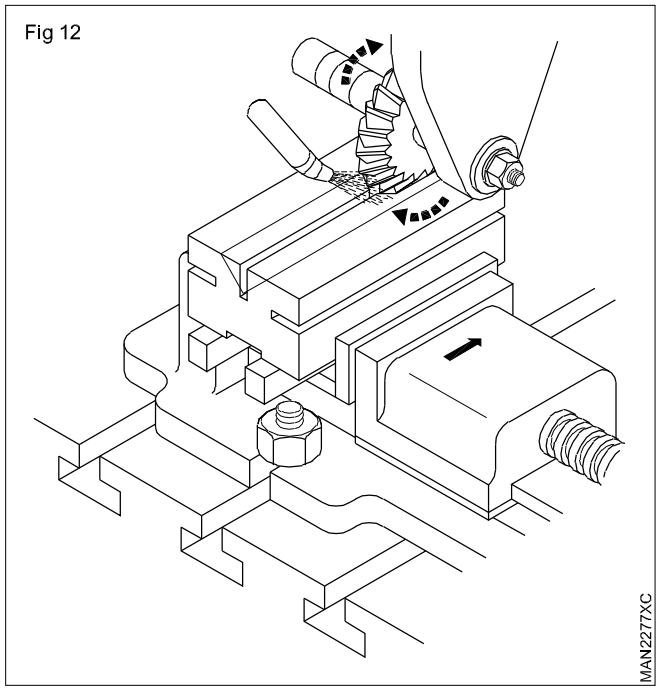
De - clamp and deburr the sharp edges at the milled surface.

Check the 'V' groove for the following parameters.

– Central position

– Depth of groove

Fig 12

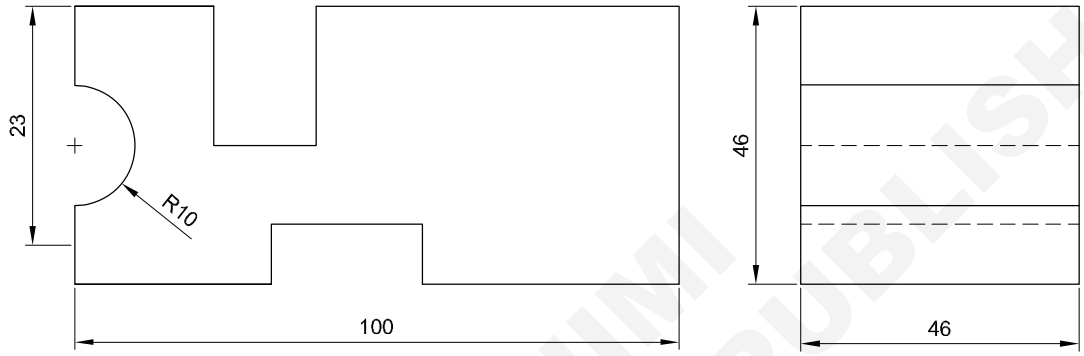


Be thoroughly familiar with the placement of the stop lever.

Make concave surfaces with an accuracy ± 0.02mm

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

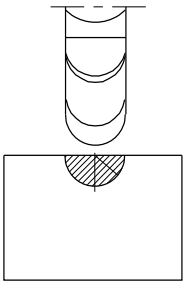
- **layout the job as per the drawing using a vernier height gauge and spring divider**
- **align the job with respect to the cutter**
- **mill a concave surface and check the concave surface using a radius gauge.**



Job Sequence

- Check the dimensions of the job.
- Lay out the job for concave milling as per drawing.
- Hold the job in the vice for milling the concave surface.
- Mount the convex milling cutter of Ø90 x 10R x 27mm bore on the arbor and set the spindle speed to 60 r.p.m.
- Align the job such that the cutter width is symmetrical with the centre line of the concave marking, and mill the concave surface. (Fig 1)
- Deburr the job and measure by a radius gauge.

Fig 1



1	–	EX NO.1.5.72 ←	–	–		1.5.74
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**MAKE CONCAVE SURFACES WITH AN ACCURACY ± 0.02 mm**				TOLERANCE ± 0.02 mm	TIME:
					CODE NO. MA20N1574E1	

Skill Sequence

Mill a form concave surface on plain milling

Objective: This shall help you to
- **mill a concave surface on plain milling machine.**

Mark the job as per drawing and put witness marks.

Mount a plain machine vice at the middle of the table on the milling machine such that the jaws are perpendicular to the column.

Hold the workpiece in the vice on a pair of parallel blocks such that the profile marking is 10 to 15 mm above the vice jaw surface.

Select a convex milling cutter which suits the form of the workpiece.

Ensure that the cutter is sharp and undamaged.

Calculate the r.p.m. feed per minute and set on the machine.

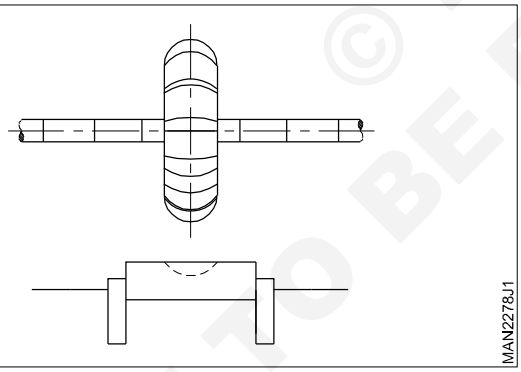
Mount the selected cutter on the arbor of the plain milling machine.

Set the nearest lower r.p.m. for form cutters.

If a higher r.p.m. is set chatter marks may appear on the cut surface.

Bring the job to the central position with respect to the centre. This is to be done visually, and be confirmed after cutting a shallow cut. (Fig 1)

Fig 1



If any error is found adjust the work suitably.

Clear the job from the cutter to do 'up-milling'. The job is to be fed against the cutter rotation. In form milling, if the surface in contact is more, more cutting force is required. In down-milling the cutter may tend to slip over the job.

Lock the cross-slide.

Apply 1 mm depth of cut and lock the vertical slide.

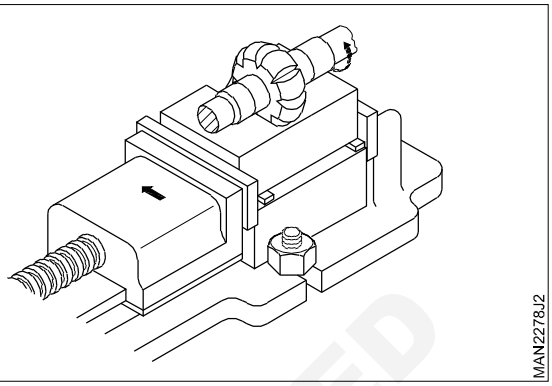
Set the coolant nozzle and start the coolant pump.

Start the spindle.

Feed the job against the cutter rotation by rotating the longitudinal slide. (Fig 2)

Stop the machine.

Fig 2



After completion of the first cut, return the workpiece to its original position. Confirm the form whether if it is in the centre as per the marking. If it is not do the necessary adjustment by moving the cross- slide and lock the cross slide.

Unlock the vertical slide.

Apply 4 to 5 mm depth of cut for rough milling.

Start the spindle.

Rough out the form by feeding the longitudinal slide against the rotation of the cutter.

Stop the spindle.

Clear the job from the cutter.

Unlock the vertical slide.

Apply the necessary depth of cut.

Reset the feed at a low rate of [0.02 to 0.03 mm/tooth] for finishing the profile.

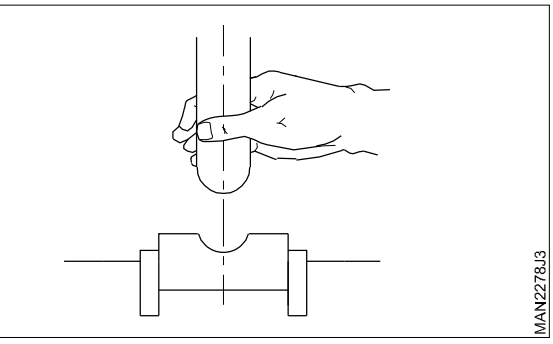
Start the spindle.

Bring the job near to the cutter longitudinally and set the automatic feed.

After completion of the cut, disengage the auto-feed and stop the machine, deburr and check the form of the profile using a gauge. (Fig 3)

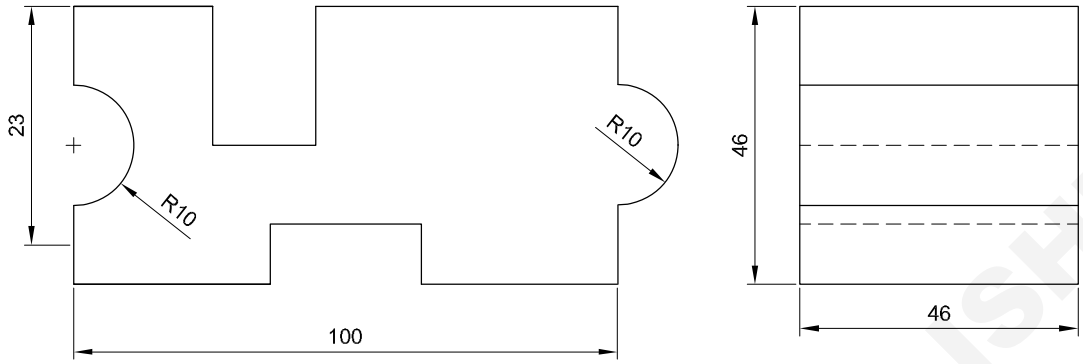
De-clamp the job.

Fig 3



Make convex surfaces with an accuracy ± 0.02mm

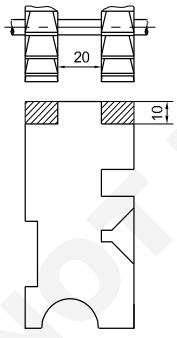
Objectives: At the end of this exercise you shall be able to
- **layout the job as per the drawing using a vernier height gauge and spring dividers**
- **align the job with respect to the cutter**
- **mill a convex surface and check the convex surface using a radius gauge.**



Job Sequence

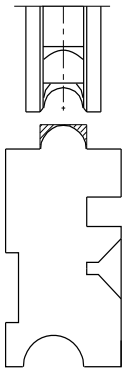
- Set and hold the job for convex milling.
- Mount two side and face milling cutters of the same size ø100 x 15 x 27 mm bore with a spacer of 20mm in between for straddle milling. Set the speed to 90 r.p.m.
- Align the job with reference to the cutter and mill the job by straddle milling to a depth of 10 mm in two passes of 5 mm each. (Fig 1)

Fig 1



- Replace the cutter with a concave milling cutter ø90 x 10R x 27 mm bore and set the speed at 60 r.p.m.
- Align the job with reference to the cutter and mill the convex surface. (Fig 2)
- Deburr the job and measure by a radius gauge.

Fig 2



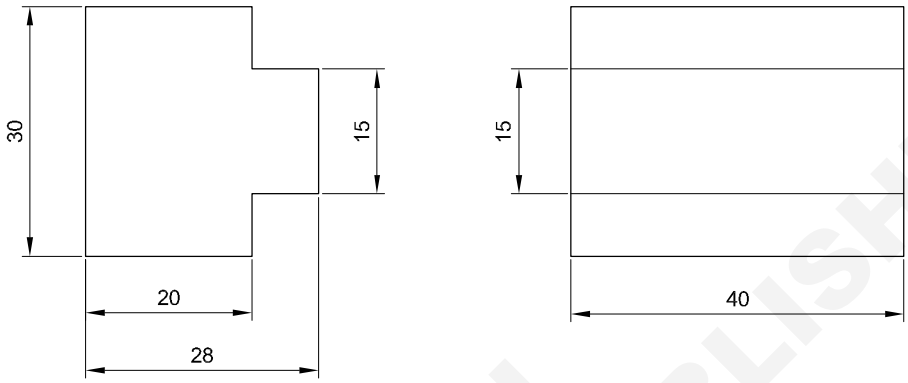
1	–	1.5.74 ←	–	–		1.5.75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKE CONVEX SURFACES WITH AN ACCURACY ± 0.02MM	TOLERANCE ± 0.02	TIME:
		CODE NO. MA20N1575E1	

Straddle milling operation with an accuracy ± 0.02mm

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

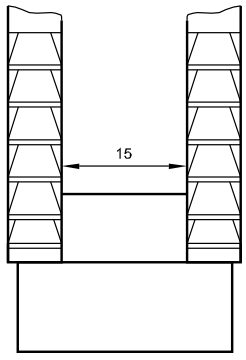
- **layout the job as per the drawing with a vernier height gauge**
- **set the job on the vice for straddle milling**
- **mount two sides and face milling cutters on the arbor for straddle milling**
- **straddle-mill the job to an accuracy ± 0.02mm**
- **check the size and the steps with a vernier caliper and vernier depth gauge.**



Job Sequence

- Check the dimensions of the block. (Job)
- Blocking up as per drawing.
- Mark the dimensions as per drawing and punch witness marks.
- Hold the job on a machine vice such that the job will be 10mm above the vice jaw.
- Mount two side and face cutters of size Ø100x 12x 32mm bore for straddle milling with a spacer of 15 mm size.
- Set the r.p.m. closer to 70.
- Align the job with reference to the cutter.
- Mill in two stages (Fig 1) by giving a depth of cut of 4mm each.
- Deburr and measure the dimensions.

Fig 1



1	45X35X30	–	Fe310	–		1.5.76
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	STRADDLE MILLING OPERATION WITH AN ACCURACY ±0.02MM	TOLERANCE ± 0.02	TIME :
		CODE NO. MA20N1576E1	

Skill Sequence

Mount cutter for straddle milling and straddle mill

Objective: This shall help you to

- **mount a cutter for a straddle milling.**

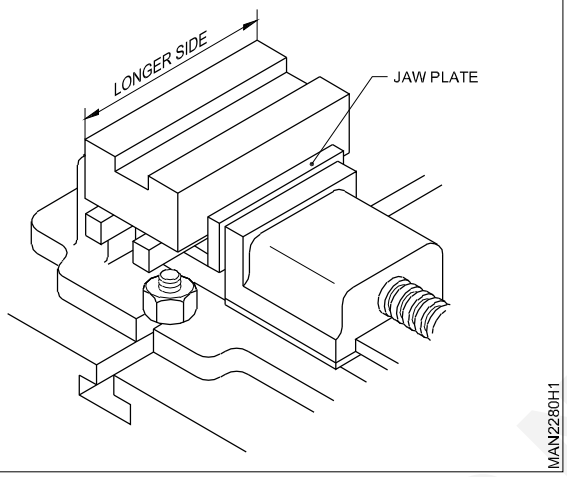
Set up the plain machine vice on the machine table

Hold the job in the machine vice.

Ensure that burrs are removed from the job by using a smooth flat file before holding.

While holding the job. ensure that the longer side of the job is always kept parallel to the jaw plates irrespective of the position of the slots to be milled. This gives maximum grip to the workpiece. (Fig 1)

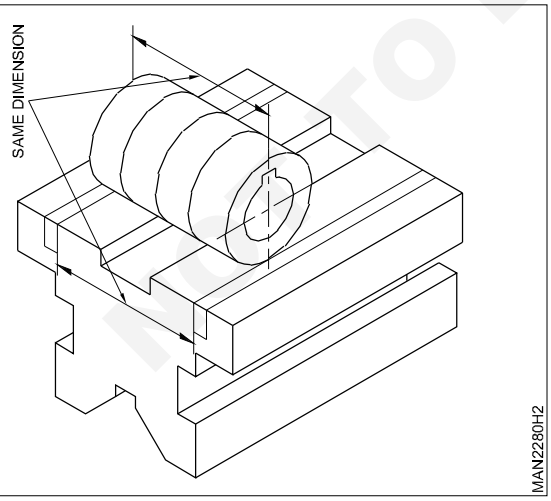
Fig 1



Select spacing collars to make up the dimension between the inner edges of the slots to be cut.

In the case of plain side and face cutters, the length of the collar shall be equal to the distance between the inner edges of the slots. (Fig 2)

Fig 2



In the case of staggered tooth side and face cutters calculate the length of space considering the tooth offset.(Fig 3)

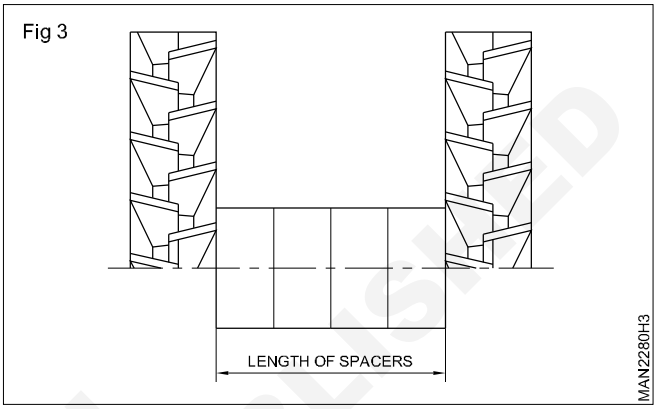
Fix the long arbor in the machine spindle.

Mount the cutters on the arbor with spacers in between.

Ensure that both the cutters are of the same type and dimension and have a right hand helix.

Be sure to insert key into both the cutters.

Fig 3

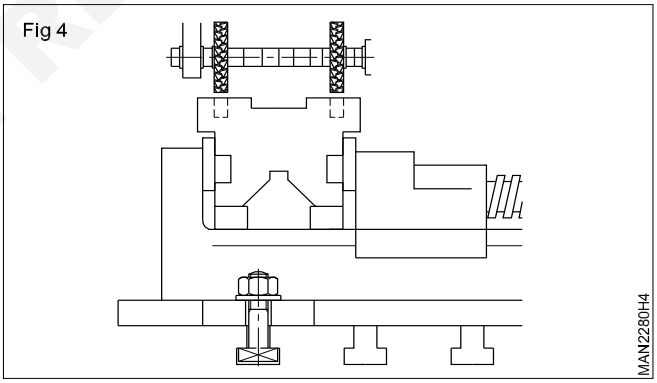


Calculate the r.p.m and set the spindle speed.

Set to the nearest lower speed available if the machine does not have the exact value.

Position the cutters in line with the slots to be cut by adjusting the table. (Fig 4)

Fig 4



Start the spindle.

Raise the work table until the cutters just touch the top surface of the workpiece. Confirm visually that the cut is exactly in line within the slots; if it is not in line, adjust the table. (Fig 5)

Set the vertical scale to zero.

Move the table to bring the cutters clear of the workpiece.

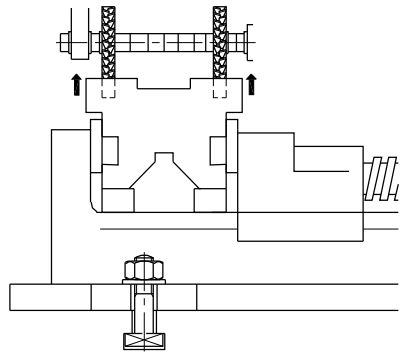
Stop the spindle.

Set the longitudinal feed stops so that the cutters will clear each end of the workpiece. (Fig 6)

Set the depth of cut using vertical hand feed.

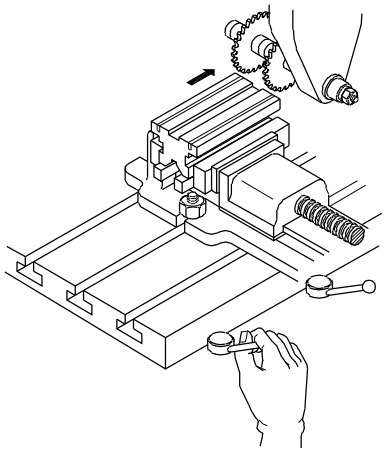
Lock the vertical slide.

Fig 5



MAN2280H5

Fig 6



MAN2280H6

Position the coolant pipe and guard.

Start the spindle.

Put on the safety goggles.

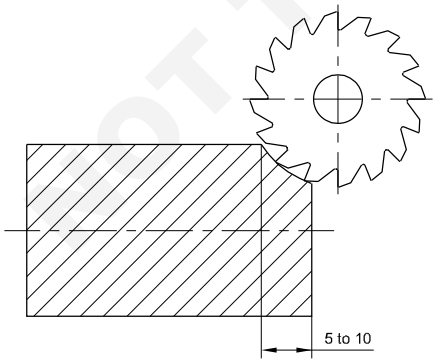
Calculate the correct feed.

Select the nearest lower feed available if the machine does not have the exact value.

Engage the coolant pump.

Mill the slot and feed the table up to 5 to 10mm. (Fig 7)

Fig 7



MAN2280H7

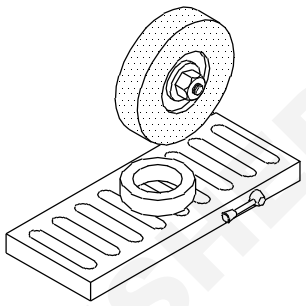
Stop the spindle and move the table longitudinally back to the initial position.

Deburr the edges and measure the distance between the slots by a vernier caliper.

Ensure that the dimension is correct.

- If not check the length of the space between the cutters.
- Replace the spacers of correct size. If spacers of the correct size are not available grind the face of the spacer. (Fig.8)

Fig 8



MAN2280H8

Start the machine and mill the slots.

Stop the spindle when the automatic table feed stops.

Clear away the chips from the slot.

Return the table to the initial position.

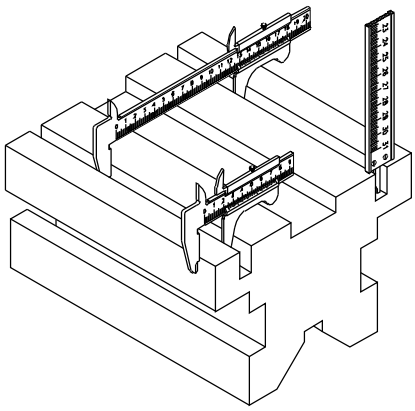
Check the depth and take further cuts until the required depth is accomplished.

Remove the burrs from the edges of the slots.

Check the workpiece dimensions with the help of a vernier caliper. (Fig 9)

Avoid close proximity to the rotating cutter always. Otherwise you may injure yourself.

Fig 9

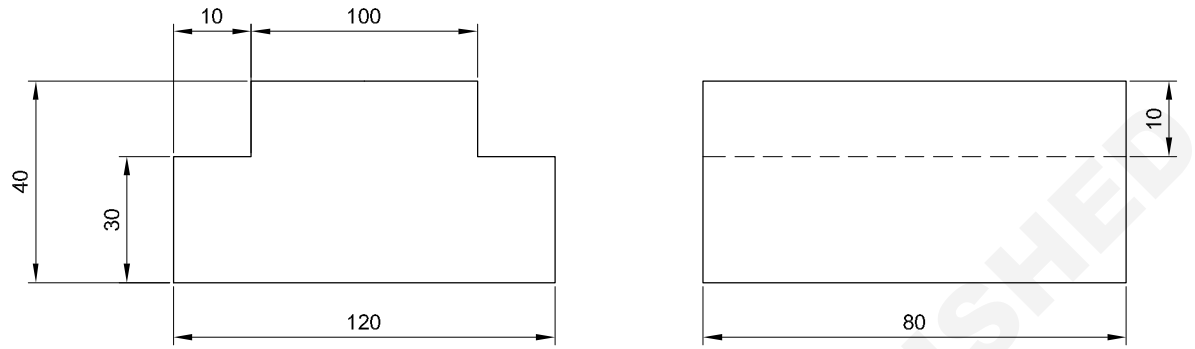


MAN2280H9

Gang milling operation with an accuracy ± 0.02mm

Objectives: 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 cutters for gang milling.**

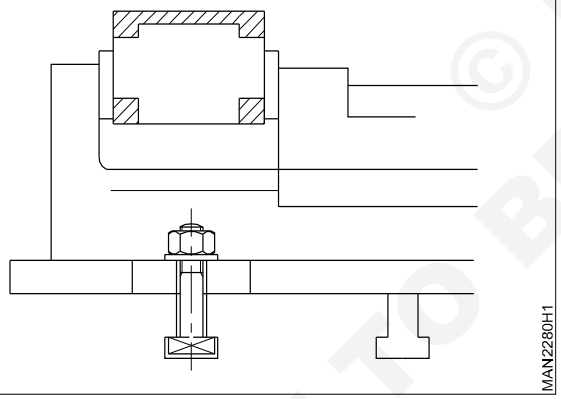


Job Sequence

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.

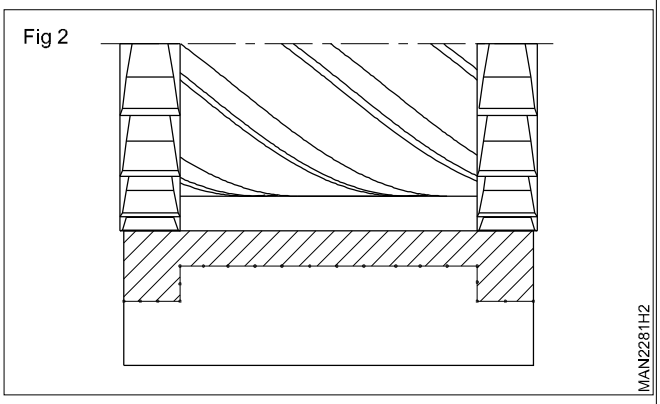
Calculate the speed and feed for gang milling.

Consider the average diameter for calculating the r.p.m.

Set a lower range of r.p.m. for gang milling.

Set the datum to the reference sides for the vertical and cross-slides. (Fig 2)

Fig 2



1	125 x 45 x 85	–	Fe 310	–	–	1.5.77
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. MA20N1577E1	

Lock the cross-slides. Clear the workpiece from the cutters by moving the longitudinal side to the left side.

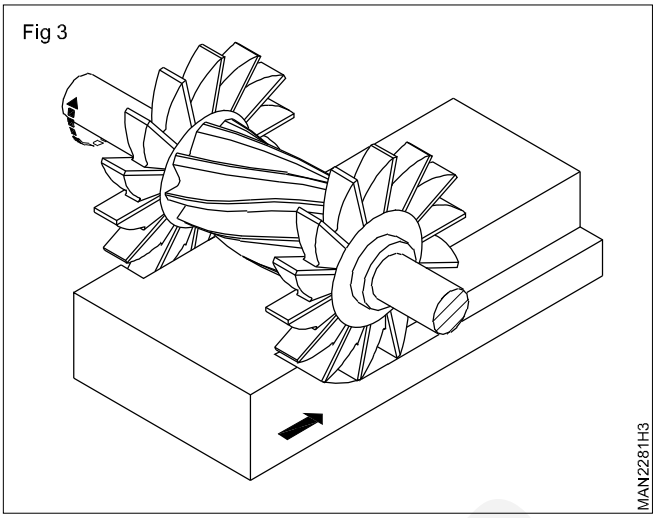
Apply 2 to 3 mm depth of cut using the vertical slide. Start the spindle and the coolant pump.

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 blunting 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 0.8 mm depth of cut finish the profile.

Fig 3

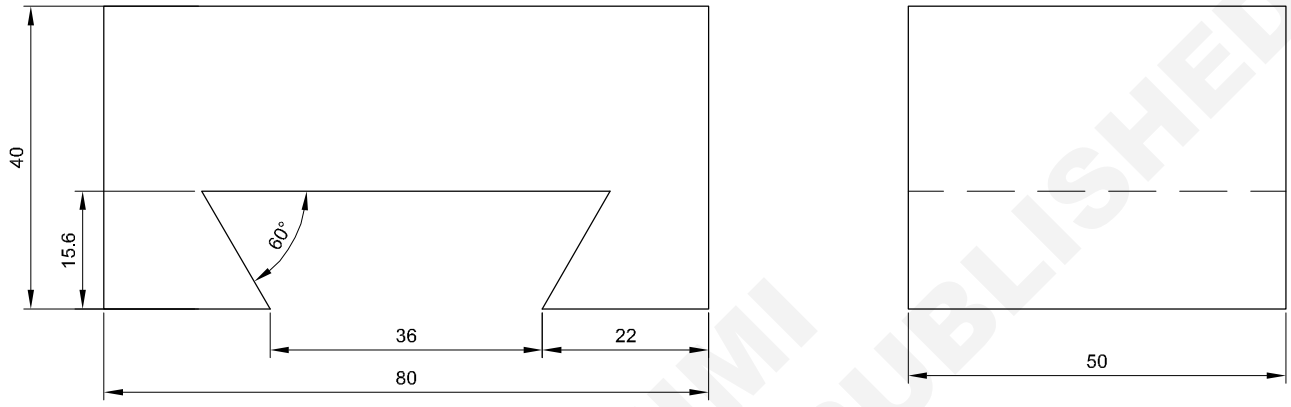


For the finishing cut, use automatic feed to get a better surface finish at the profile.

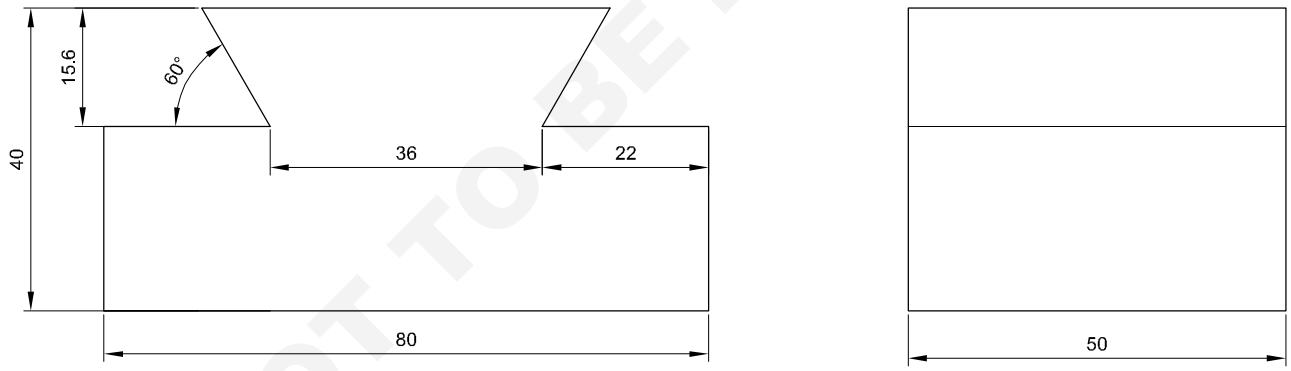
Make dovetail fitting (male & female) on milling machine with an accuracy ± 0.02mm

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

- **lay out the job as per the drawing using vernier height gauge and vernier bevel protractor**
- **mount and align the job with respect to the cutter**
- **mill the internal and external dovetails to an accuracy of ± 0.02 mm**
- **check the dimensions of the internal and external dovetails using rollers and assemble it.**



PART - A (FEMALE)



PART - B (MALE)

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
2	90 x 60 x 60	-	CAST IRON	-	B	
1	90 x 60 x 60	-	CAST IRON	-	A	1.5.78

SCALE 1:1	MAKE DOVETIAL FITTING (MALE & FEMALE) ON MILLING MACHINE WITH AN ACCURACY ±0.02 mm	DEVIATIONS ±0.02 mm	TIME:
		CODE NO. MA20N1578E1	

Job Sequence (Part 'A')

- Mark the dovetail as per drawing
- Calculate the r.p.m for the selected cutter and set it.
- Set a end mill cutter with collet chuck on vertical machine spindle.
- Set the workpiece on the machine vice.
- Set the datum on the top surface of the block using tissue paper.
- Cut the slot 36 x 15.6mm between the dovetail marking.
- Set the dovetail cutter for clockwise direction on vertical milling machine by changing end mill cutter.
- Set the datum on the bottom surface of the slot using tissue paper
- Set the vertical surface also by touching the edge of the dovetail cutter 60° x 25 mm shank dia.
- Cut first side and then another side cut of the dovetail with dovetail cutter.
- Check the size of details with rollers and vernier caliper.

Job Sequence (Part 'B')

- Mark the dovetail as per drawing.
- Calculate the r.p.m for the selected cutter and set it.
- Set the end mill cutter on vertical milling machine spindle.
- Set the block on the vice of vertical milling machine.
- Touch the vertical surfaces of the block by end mill cutter and cut shoulders 13x15.6mm both side of the block.
- Set the dovetail cutter for clockwise direction on vertical milling machine changing end mill cutter.
- Set the datum on the surface of the block using tissue paper.
- Set the vertical surface by touching the edge of the dovetail cutter 60° x 25 mm cut first side dovetail then another side of the dovetail upto punch line.
- Check the dovetail by rollers method.
- Fit the job with female part of the dovetail (Part- A).

Skill Sequence

Mount dovetail cutter and mill external and internal dovetail on vertical milling

Objective: This shall help you to
- **mill internal and external dovetail.**

Internal dovetail

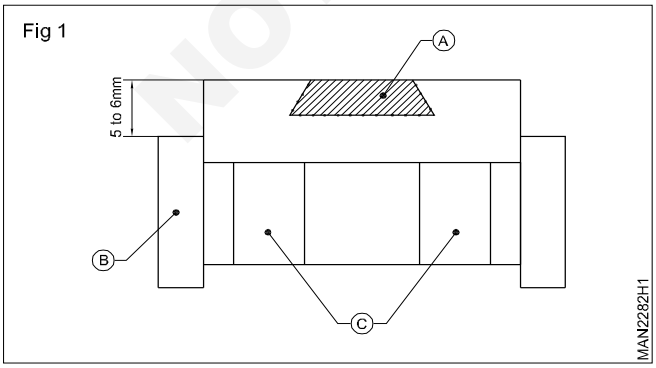
Mark the job as per drawing and put witness marks.

Mount the machine vice such that the vice jaws are perpendicular to the column.

If the length of the job is more than the width of the vice jaws, mount the vice such that the jaws are parallel to the column. And if the length of the job is smaller than the width of the vice jaws mount the machine vice such that the jaws are perpendicular to the column.

Hold the job in the machine vice on the pair of parallel blocks (C) such that the bottom surface remains 5 to 6 mm above the vice jaws (B). (Fig 1)

Fig 1



Mill the central slot by the end mill cutter.

Select the dovetail cutter to suit the dovetail groove dimensions.

Mount the collet chuck on the vertical milling machine.

Hold the dovetail cutter in the collet chuck and tighten it using a hook spanner.

Ensure that the cutter is sharp and not damaged.
Ensure that the cutter is not gripped overhung.

Calculate the r.p.m. for selected cutter and set it.

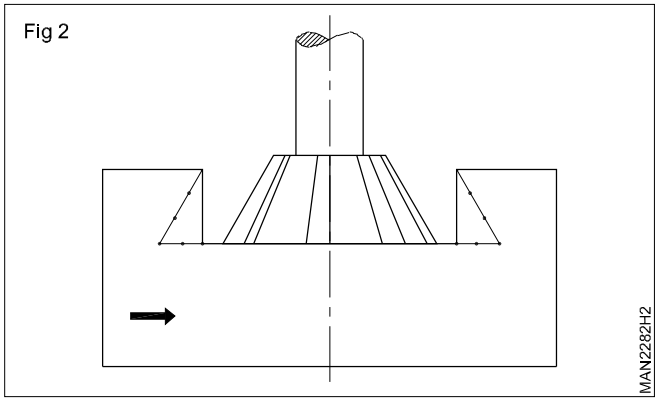
Calculate the feed per minute to the selected cutter, and set to the nearest lower feed available.

Set the cutter for clockwise rotation.

Position the workpiece so that the cutter is over the previously milled slot.

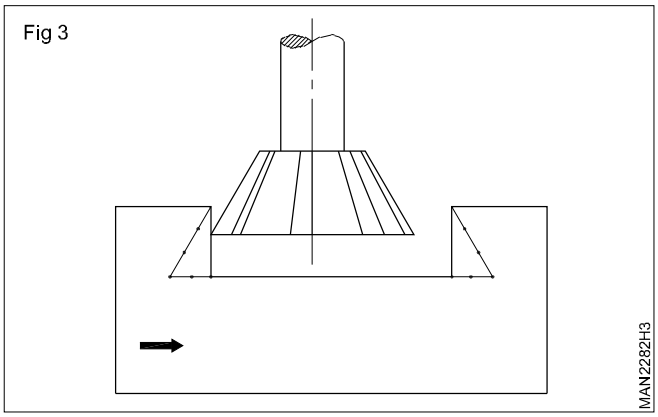
Set the datum on the bottom surface of the slot (Fig 2) using tissue paper.

Fig 2



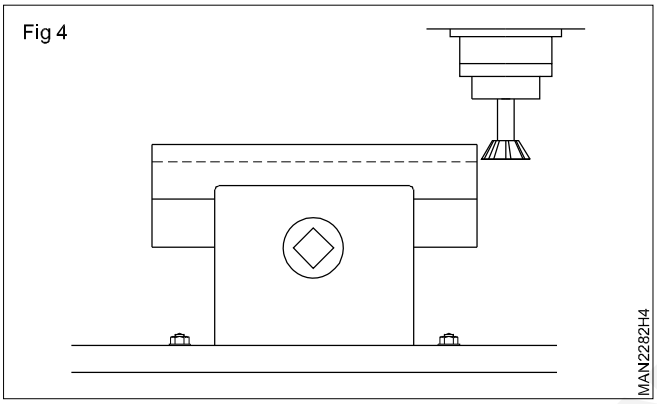
Set the datum at the vertical face of the slot by touching the edge of the dovetail cutter. (Fig 3)

Fig 3



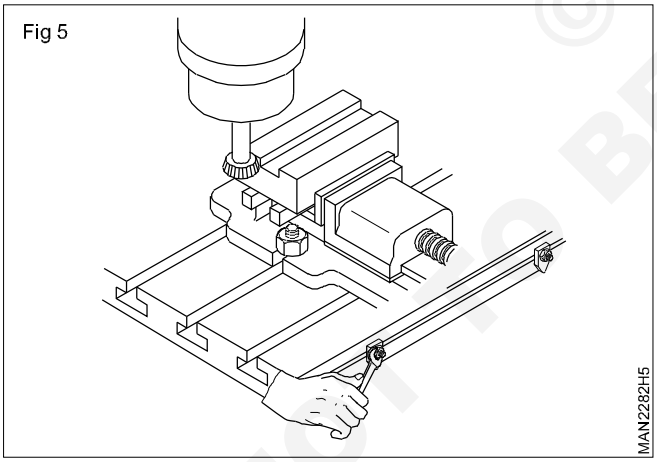
Clear the workpiece from the cutter by moving the longitudinal slide. (Fig 4)

Fig 4



Set the longitudinal feed stops so that the cutter will clear each end of the workpiece. (Fig 5)

Fig 5



Unlock the cross-slide.

Use the hand cross-feed and set the depth of cut for the first roughing cut of about 1to 5 mm. (Fig 6)

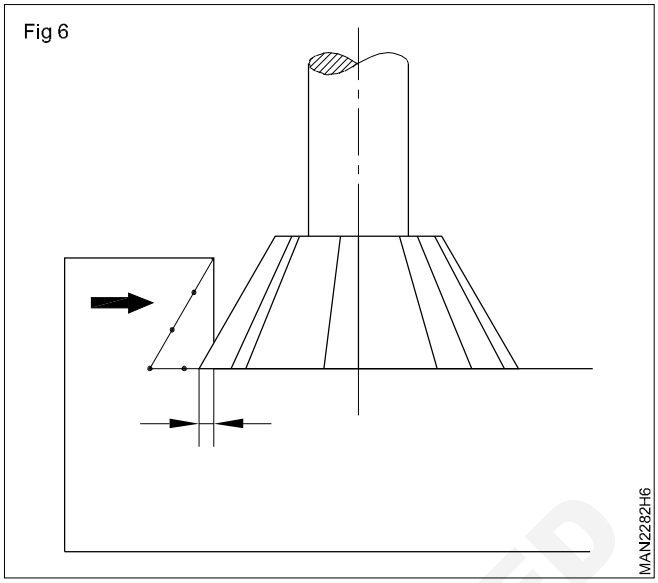
Lock the cross-slide.

If the depth to be milled is more than 5 mm then rough out the dovetail in two passes.

Adjust the coolant nozzle directing it towards the cutting edges.

Start the spindle and coolant pump.

Fig 6

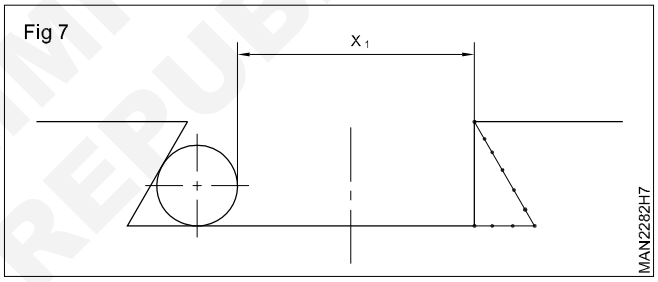


Engage the longitudinal feed and mill the dovetail. When the feed stops, stop the spindle. Return the table to the starting position.

Calculate the roller dimensions using 6 mm rollers.

Check the dimension (X_1) by vernier calipers and roller. (Fig 7)

Fig 7



Find out the difference between the actual dimension and the calculated dimension.

Unlock the cross slide.

Adjust the cross slide so as to get the calculated dimension.

Lock the cross slide.

Start the spindle.

Move the longitudinal slide manually and mill the dovetail.

Stop the spindle.

Bring the workpiece to its original position.

Check the roller dimensions (X1) and confirm.

Mill the opposite dovetail following the required steps.

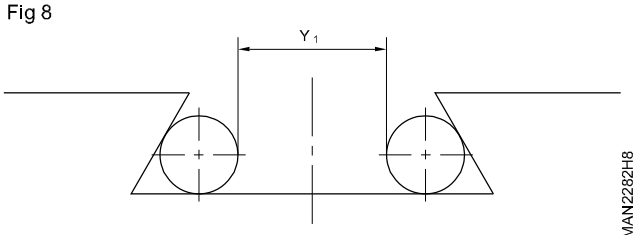
Ensure that the feed is from the opposite side of the previous one to adopt up-milling.

Check (Y_1) dimension by using a 6 mm dia. roller and vernier caliper. (Fig 8)

External dovetail

Mark the job as per the drawing and put witness marks on it.

Fig 8



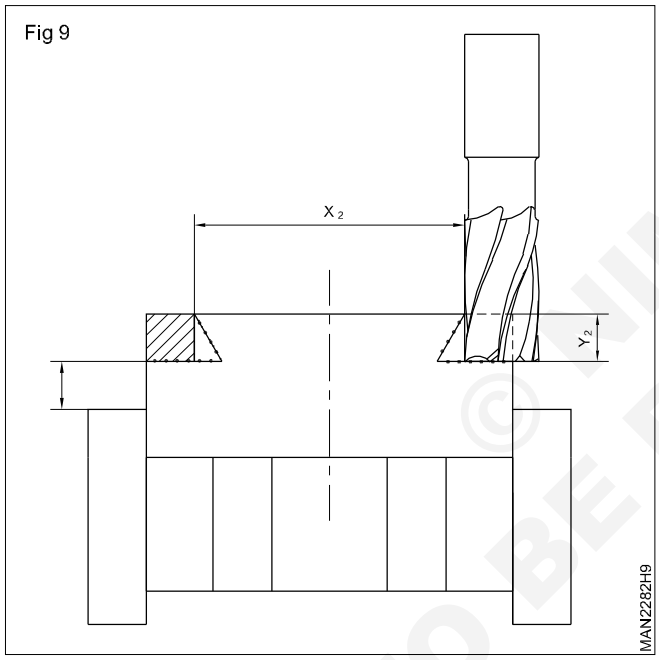
Mount the plain milling vice on the vertical milling such that the vice jaws are perpendicular to the column.

Hold the job in the vice on a pair of parallel blocks. The bottom surface of the dovetail marking should remain 5 to 6 mm above the vice jaws.

Mount the collet chuck on the vertical milling machine.

Mill the hatched portion using an end mill cutter by maintaining X_2 and Y_2 dimension to suit the dovetail groove dimensions. (Fig 9)

Fig 9



Mount the dovetail cutter in the collet chuck and tighten.

Calculate and set the r.p.m. and feed for the dovetail cutter.

Set the datum at the bottom surface of the step and the vertical face of the step, using tissue paper.

Take the workpiece to the left side to clear from the cutter.

Apply a depth of cut (0.2 to 0.3 mm) depending upon the material to be rough cut by rotating the cross-slide.

Lock the cross-slide.

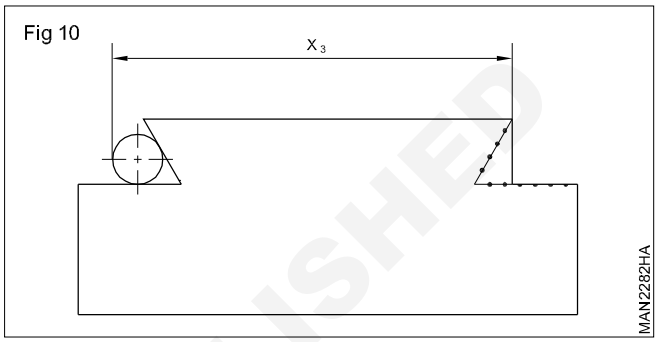
Move the longitudinal slide slowly towards the rotating cutter and rough cut the dovetail on one side.

Stop the spindle.

Calculate the roller dimension X3 and check it with a vernier caliper.

Use a 6 or 8 mm dia. roller. (Fig 10)

Fig 10



Adjust the cross-slide to get the correct calculated dimension.

Start the spindle.

Move the longitudinal slide towards the cutter and finish the dovetail.

Check X_3 dimension by using ∅6 or ∅8 roller.

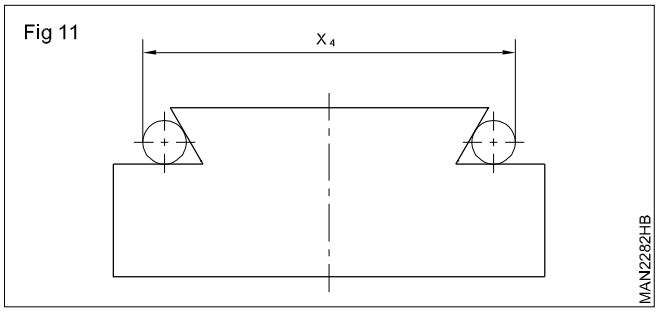
Calculate X_4 dimension using a ∅6 or ∅8 roller.

Mill the opposite dovetail following the necessary steps.

Check X_4 dimension by using ∅6 or ∅8 dia. roller. (Fig 11)

Deburr and remove the job.

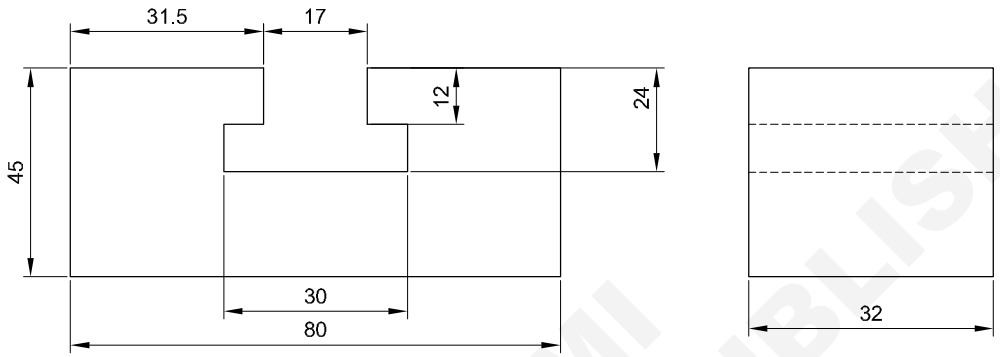
Fig 11



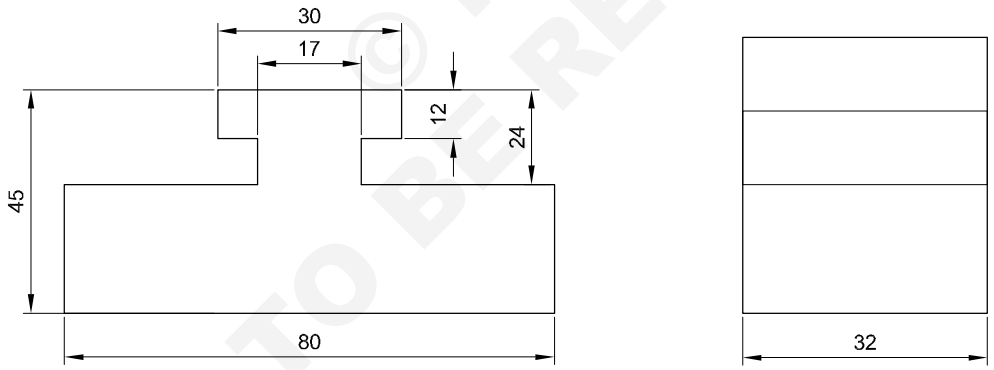
Make T-slot fitting (male & female) on milling machine with on accuracy ± 0.02mm

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

- **layout male and female 'T' slot using vernier height gauge**
- **mill female 'T' slot on vertical milling machine**
- **mill male 'T' slot**
- **match part 'A' with part 'B'.**



PART - A (FEMALE)



PART - B (MALE)

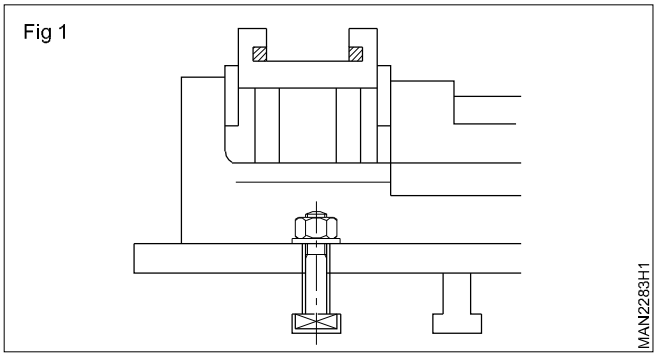
1	ISSQ 50x90x50	-	Fe310	-	B	
1	ISSQ 50x90x50	-	Fe310	-	A	1.5.79
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 2:1	**MAKE 'T' SLOT FITTING (MALE & FEMALE) ON MILLING MACHINE WITH AN ACCURACY ±0.02MM**	DEVIATIONS ± 0.02mm	TIME :
		CODE NO. MA20N1579E1	

Job Sequence (Part 'A')

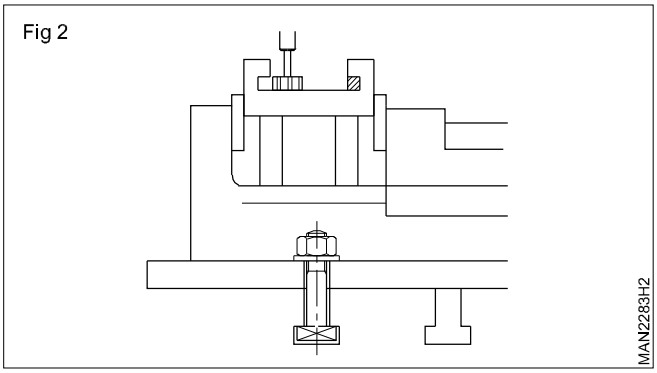
- Mark the 'T' slot as per the drawing.
- Mount and align the vice on the vertical milling machine.
- Hold the job in the vice supported with parallel blocks. (Fig 1)

Fig 1



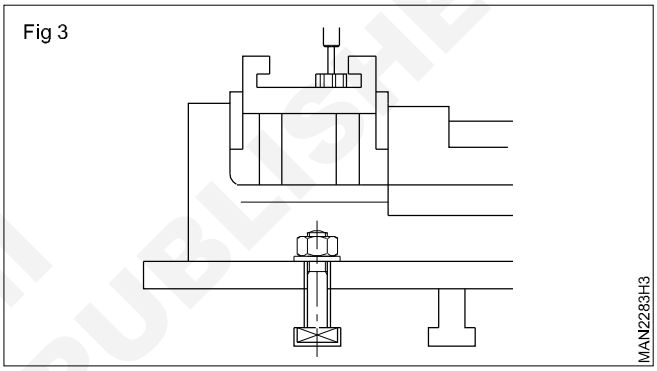
- Mount the 'T' slot cutter Ø25 x12 mm on the machine with an adapter and collets.
- Align the job for 'T' slot milling with respect to the cutter. (Fig 2)
- Set the spindle nearest to 275 r.p.m.
- Mill the 'T' slot on the left side to size. (Fig 2)
- Deburr and check the size.

Fig 2



- Mill the 'T' slot on the right side to size. (Fig 3)
- Deburr and check the dimensions of the 'T' slot with a telescopic gauge and a 25 to 50 mm outside micrometer.

Fig 3



Job Sequence (Part 'B')

- Mark the 'T' as per drawing
- Mount and align the vice on the horizontal milling machine.
- Hold the job in the vice supported with parallel blocks.
- Cut the both side of the block by side and face milling cutter on horizontal milling machine.
- Mount a 'T' slot cutter of Ø25 x 12 mm into the vertical milling machine spindle
- Set the r.p.m near to 275
- Mill the 'T' on the vertical milling machine check the dimension of the 'T' slot with vernier caliper and out side micrometer.
- Fitting the job with the female part of part A.

Mill a 'T' slot on vertical milling machine

Objective: This shall help you to
- **mill a 'T' slot on a vertical milling machine.**

Mark the workpiece as per drawing. Remove burrs if any.

Mount the plain machine vice on the table with its jaws parallel to the column.

Keep the workpiece on a pair of parallel blocks such that the workpiece is above the jaws of the vice.

Clamp the workpiece.

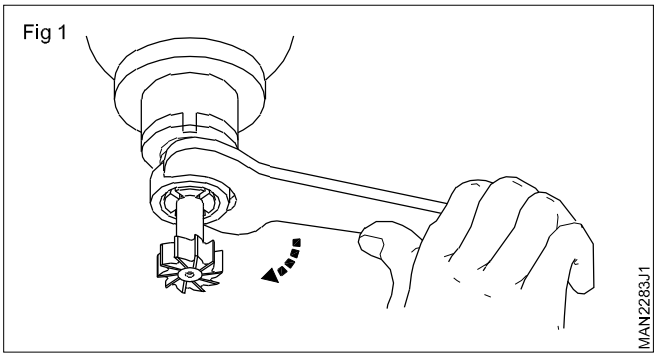
Mill the slot as per the given dimension.

Select a 'T' slot cutter to match the 'T' slot dimensions to be cut.

Check if the cutter is sharp and undamaged.

Select a collet of the same size as that of the cutter shank and set the cutter in the chuck. (Fig 1)

Fig 1



Start the spindle for a while to ensure that the cutter is running true and in the correct direction, and stop the spindle.

Set the datum for the top and side using tissue paper. (Figs 2 and 3)

Fig 2

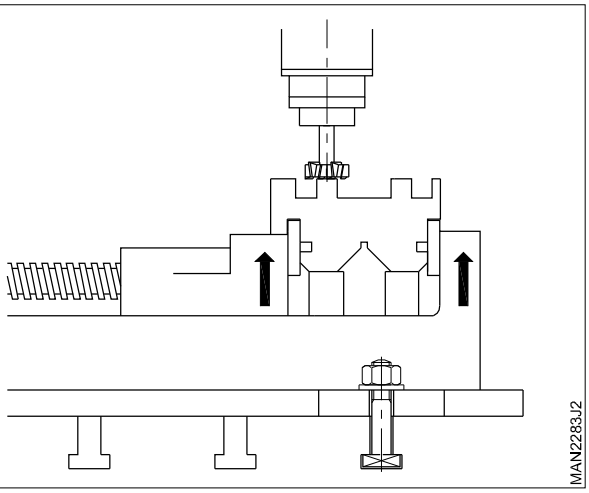
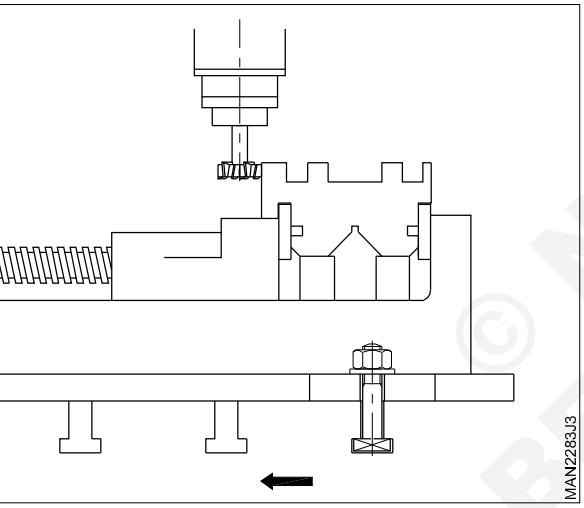


Fig 3



Set the spindle speed and table feed.

Move the table to clear the cutter from the workpiece by using the hand cross-feed after fixing the datum.

Position the table to correct dimension (L+D/2), using hand cross-feed, so that the cutter is into the centre of the 'T' slot. (Fig 4)

Lock the cross-slide.

Use a vertical slide and raise the table to bring the cutter to correct depth of the 'T' slot.

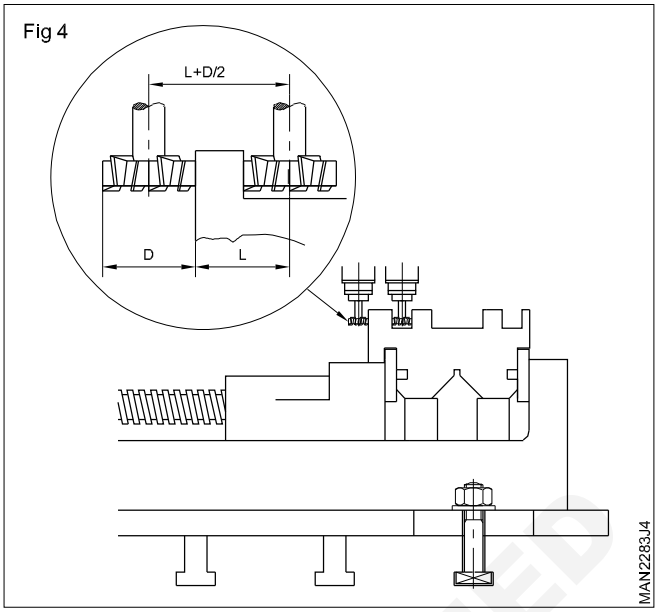
Lock the vertical slide.

Set the longitudinal feed stops so that the cutter will clear both ends of the workpiece.

Start the spindle.

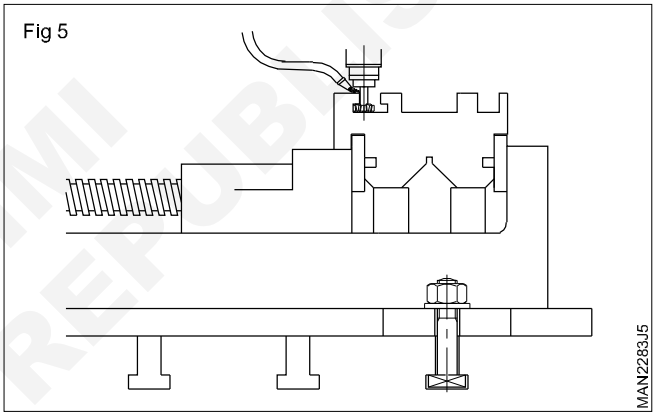
Ensure that the guard is in position and safety goggles are put on. This is required for personal safety.

Fig 4



Use longitudinal hand feed and move the table slowly until the cutter begins to cut the workpiece. (Fig 5)

Fig 5



Ensure that the table movement is gentle and smooth to avoid damage to the cutter.

Start the coolant.

Engage the longitudinal feed and mill the slot.

Ensure that the chips collecting in the slot are carried away by the flow of the coolant while the slot is being cut. In 'T' slot milling blocked chips may cause breakage of the cutter.

Stop the spindle when the feed stops.

Clear away the chips.

Deburr the slot.

Clear the slot and check the dimension.

Repeat the process, if more than one slot are to be milled.

Put all the oily rags, used to wipe the machine, in a metal container that can be closed tightly.

Demonstrate indexing head

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

- **identify the different types of indexing**
- **identify the parts of a universal indexing head.**

Fig 1

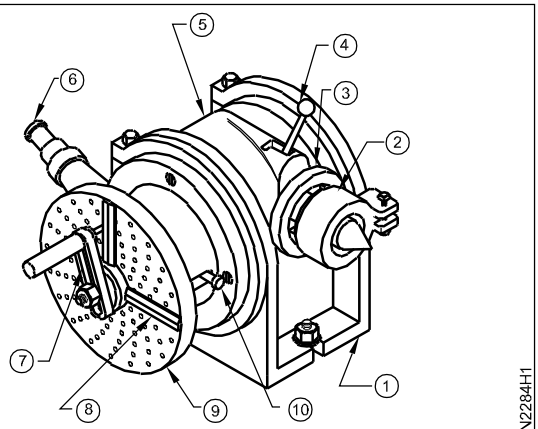


Fig 2

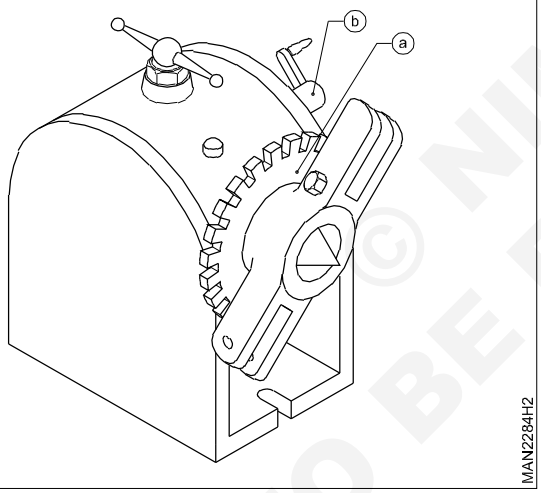
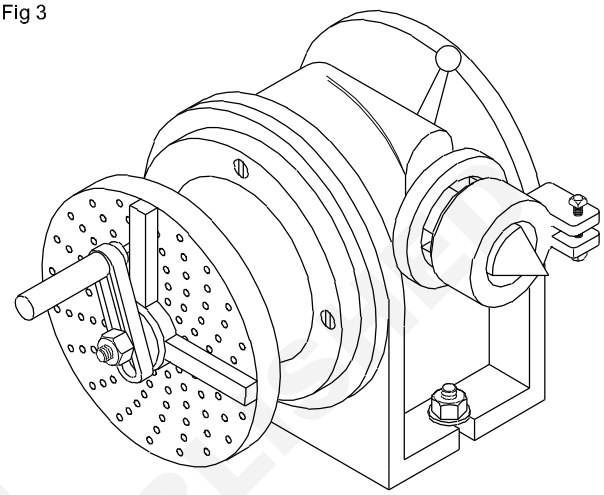


Fig 3



Job Sequence

- Mount the indexing head on the machines and demonstrate.
- Indentify the parts of indexing head and write it in the table.

Table 1

Sl.No	Name of parts
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Set and align indexing head with reference to job on milling machine

Objectives: At the end of this exercise you shall be able to
- **mount and align the dividing head**
- **set the dividing head for direct indexing.**

Job Sequence

A dividing head is used to hold workpieces that must be machined with accurate division on the circumference.

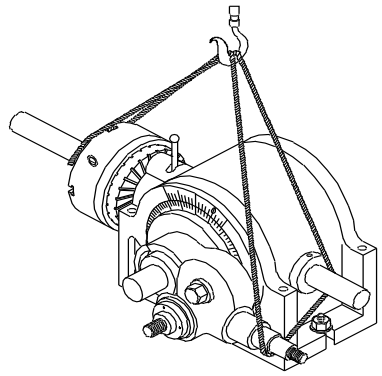
The universal dividing head is the type most commonly used.

Clean the table top and Tee slots thoroughly.

Insert a rod of suitable length through the head spindle to protrude 75 to 100 mm at each end and tighten the chuck on the bar.

Sling the head with a strong rope. (Fig 1)

Fig 1



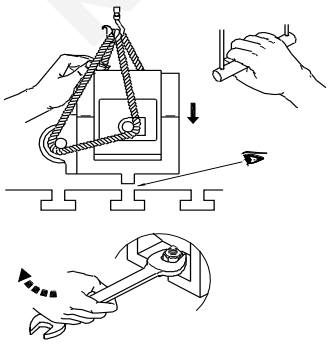
Lift the indexing head with help of crane and position it on the milling machine table.

The rope should be free from wear. The crank hook should be at the centre of the head to balance the head. Stand clear when lifting to avoid any injury to you in case of an accident.

Clean the base of the dividing head.

Lower the head gently and engage the ten on in the table slot and tighten the securing bolt. (Fig 2)

Fig 2



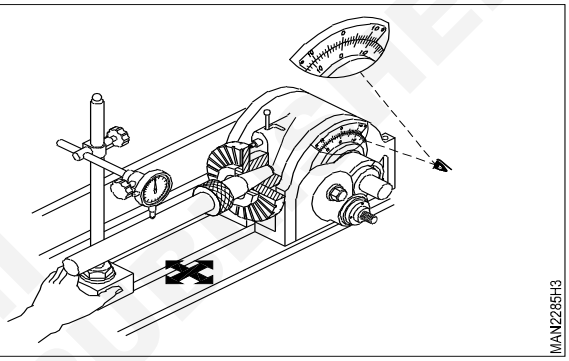
Keep your hands clear of the bottom of the dividing head when lowering the head.

Setting head horizontal

'Zero' the index scale.

Insert the tapered shank test-bar in the spindle, making sure both are clean. (Fig 3)

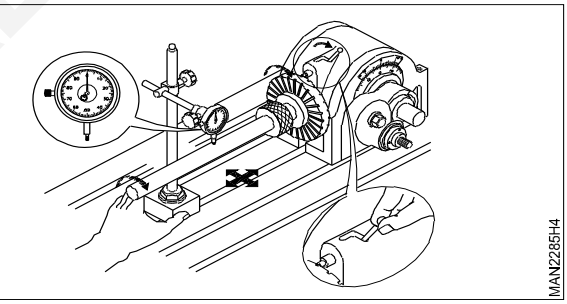
Fig 3



Disengage the worm from the worm-wheel for rapid indexing.

Set the dial indicator as shown in Fig 4.

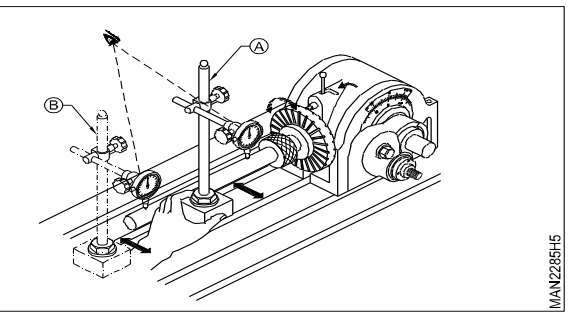
Fig 4



Rotate the head manually to ensure the bar is running true.

Take a reading with the dial indicator as near the spindle nose as possible. (Fig 5)-A

Fig 5



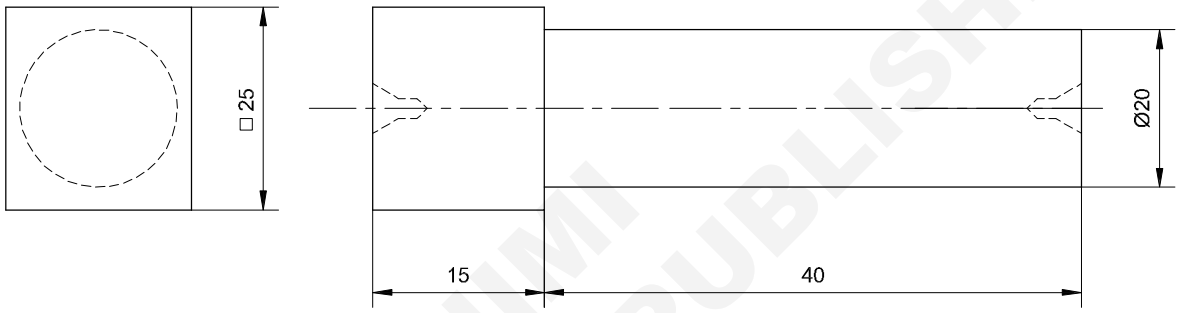
Take the reading at the opposite end of the bar. (Fig 5)-B Note any variation.

In case of any variation, remove the dial indicator and slightly loosen the locking nuts at the back of the head.

Tap lightly with a soft hammer in the required direction and check again.

Make square job by direct/ simple indexing method with an accuracy ± 0.02mm

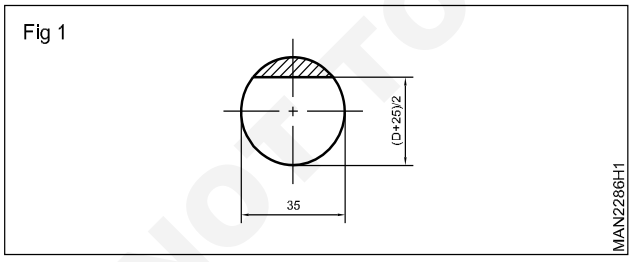
Objectives: At the end of this exercise you shall be able to
- **mount the index head on the table and align it parallel to the column face**
- **hold the job in the three-jaw chuck and true to face**
- **set the index head for direct indexing**
- **mill the square on the job by direct indexing to an accuracy of ± 0.02 mm**
- **check the distance across the flats of the square using a vernier caliper.**



Job Sequence

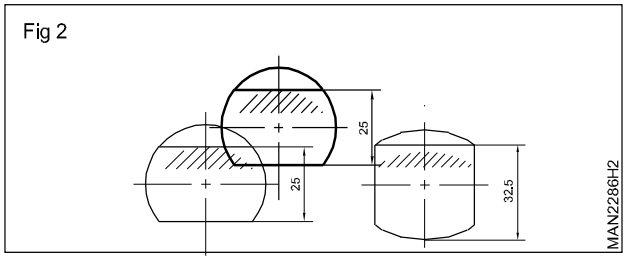
- Clean the table and dividing head free from dirt (and) burrs and align the dividing head on the vertical milling machine table.
- Set the dividing head for direct indexing.
- Hold the job on Ø25 in a three-jaw chuck of the dividing head.

Fig 1



- Support the end with the tail stock.
- Set the index plate to zero position.
- Mount the ∅18 mm end mill.
- Set the r.p.m. closer to 300.
- Set the datum at the highest point on the diameter.
- Mill the surface flat maintaining the dimension 30.0mm.
- Index the job by 180°.
- Mill the flat surface maintaining the size to 25 mm.
- Index the job by 90°.

Fig 2

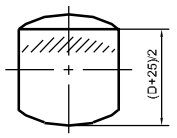


1	Ø35x60mm	-	PRE MACHINED	-	-	1.5.82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MAKE SQUARE JOB BY DIRECT/SIMPLE INDEXING METHOD WITH AN ACCURACY ±0.02MM**	DEVIATIONS ±0.02mm	TIME:
		CODE NO. MA20N1582E1	

- Mill the flat surface maintaining the size to 30.0mm (Fig 3)
- Index the job by 180°.
- Mill the flat surface maintaining the size to 25 mm.
- Deburr, check and confirm the dimensions of the square.

Fig 3



MAN2286H3

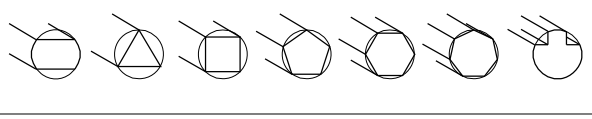
Skill Sequence

Milling square and hexagon

Objective: This shall help you to
- **mill flats on shafts.**

Some shapes of slots are shown in Fig 1 which are normally done by direct indexing.

Fig 1



MAN2286J1

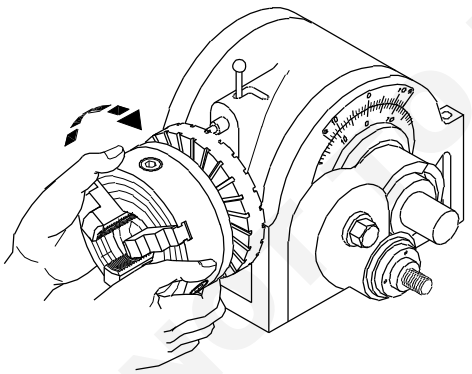
Mount and align the index head on the vertical milling machine.

Ensure that the index head is mounted at the extreme left side on the machine table to facilitate easy approach for cutting.

Set the index head for direct indexing.

Mount a three-jaw chuck on the index head. (Fig 2)

Fig 2



MAN2286J2

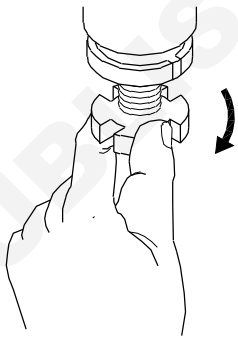
Hold the job in the three-jaw chuck at the index head and lock it.

The portion to be milled should be 10 to 20 mm away from the face of the chuck jaw to avoid damage to the cutter and the chuck.

Select a suitable diameter of an end mill cutter or shell end mill cutter to cut the entire surface in one pass.

Mount the collet chuck and end mill cutter or stub arbor with a shell end mill cutter on the spindle nose of the machine. (Fig 3)

Fig 3



MAN2286J3

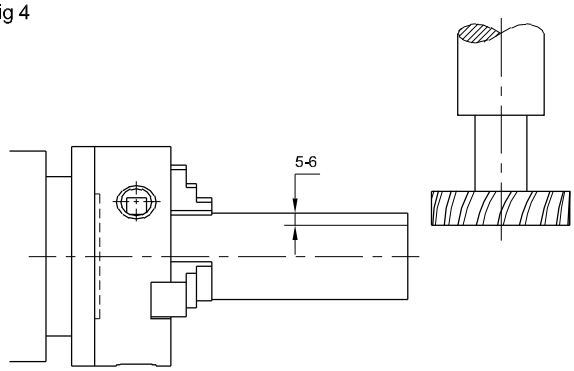
Calculate and set the r.p.m. and feed per minute for the above selected diameter of the cutter.

Set a lower range of speed and feed to avoid metal cutting problems.

Engage the locking pin into the index plate and note the number on the plate.

Bring the workpiece in line with the cutter by moving the cross-slide. Raise the top surface of the job 5 to 6 mm above the face of the cutter. (Fig 4)

Fig 4



MAN2286J4

Start the spindle.

Move the longitudinal slide towards the cutter till the cutter just touches the end face of the workpiece.

Stop the spindle.

Set the datum for the longitudinal slide.

Clear the cutter by moving the cross-slide.

Move the longitudinal slide to the required length of the square to be milled, and lock it.

Lower the vertical slide to clear the cutter.

Start the spindle.

Bring the workpiece under the cutter by moving the cross-slide.

Raise the vertical slide slowly manually. As soon as the cutter touches the top surface of the workpiece, stop the spindle.

Clear the workpiece from the cutter by moving the cross-slide.

Set the graduated dial to zero at the vertical slide.

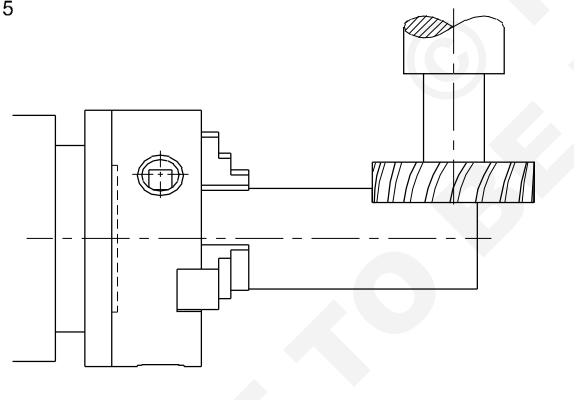
Apply a 0.5 mm depth of cut and lock the vertical slide.

Set the coolant nozzle.

Start the spindle and the coolant pump.

Move the cross-slide and mill the first side by hand feed. (Fig 5)

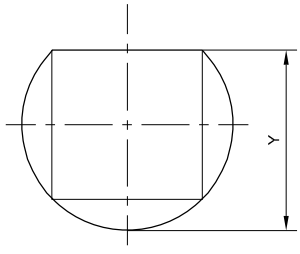
Fig 5



Stop the spindle.

Bring the workpiece to the original position. Check the Y-dimension with an outside micrometer. (Fig 6)

Fig 6



Unlock the vertical slide and apply a depth of cut equal to the difference in dimension Y and the measured dimension, and lock.

Start the spindle.

Move the cross-slide and mill the first side of the square.

Stop the spindle.

Bring the workpiece to its original position.

Remove the locking pin of the index plate.

Unlock the index head spindle.

Index the work by 180°.

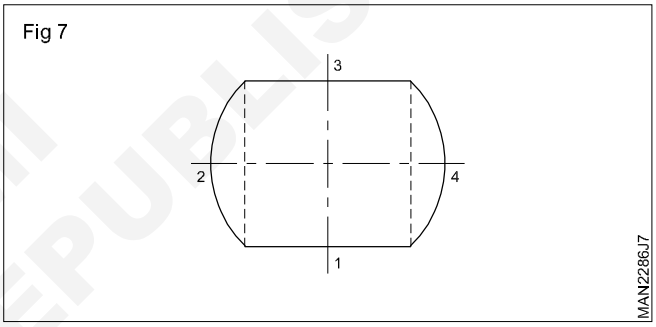
Insert the locking pin in the hole at the index plate (12 holes). Lock the index head spindle.

Start the spindle.

Move the cross-slide manually and feed it slowly. (Reduce the depth of cut if it is more)

Complete the milling of the opposite side (side 3). (Fig 7)

Fig 7



Stop the spindle.

Bring the workpiece to its original position and check flat to flat.

Unlock the index head and index the workpiece by 90° (6 holes).

Insert the index pin into the hole of the index plate and lock the index head.

Start the spindle.

Move the cross-slide and feed it manually, and complete the milling of the 2nd side.

Repeat the above procedure to mill the 4th side.

Check the job for size.

For milling a hexagon the same procedure is adopted and the sides are milled as numbered in (Fig 8).

To determine the depth of cut use the following formula.

The depth of cut(d) is $\frac{C-F}{2}$ (Fig 7)

If the 30 hole circle is used, the division is as shown in (Fig 9).

The hexagon is shown in the centre with a dotted line. To index from one side to the adjacent side, the crank is rotated to

Fig 8

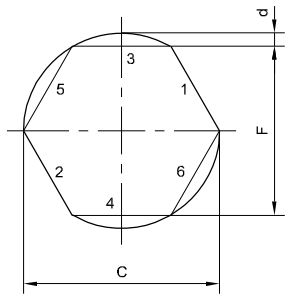
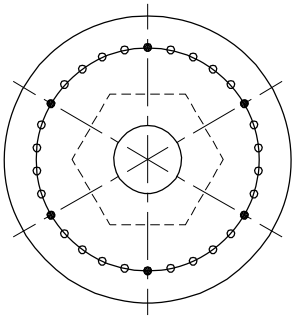


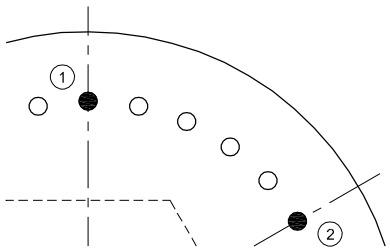
Fig 9



$$\frac{30\,(\text{number of holes})}{6\,(\text{number of divisions})} = 5 \text{ holes}$$

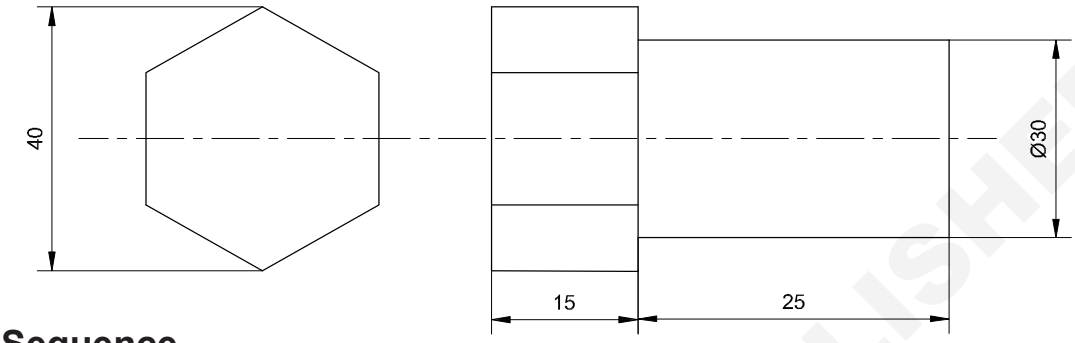
That means that you place the pin of the crank into the fifth hole and pass over 4 holes. (Fig 10)

Fig 10



Make hexagonal job by simple indexing method with an accuracy ± 0.02mm

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.**

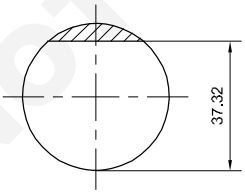


Job Sequence

Clean the table and dividing head free from dirt and burrs and align the dividing head on the vertical milling machine table.

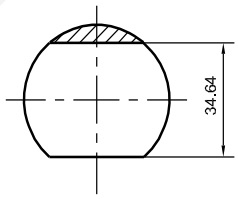
- Set the dividing head for direct indexing.
- Hold the job on ∅30 in a three-jaw chuck of the dividing head.
- Support the end with the tailstock.
- Set the index plate to zero position.
- Mount the ∅18 mm end mill.
- Set the r.p.m. closer to 300.
- Set the datum at the highest point on the dia meter. (40)
- Mill the surface flat maintaining the dimension 37.32. (Fig 1)

Fig 1



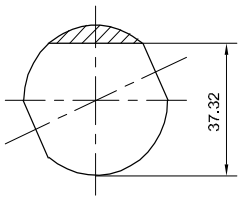
- Index the job by 180°.
- Mill the surface flat maintaining the dimension 34.64. (Fig 2)

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.

1	Ø40x45mm	-	PRE MACHINED	-	-	1.5.83
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:
		CODE NO. MA20N1583E1	

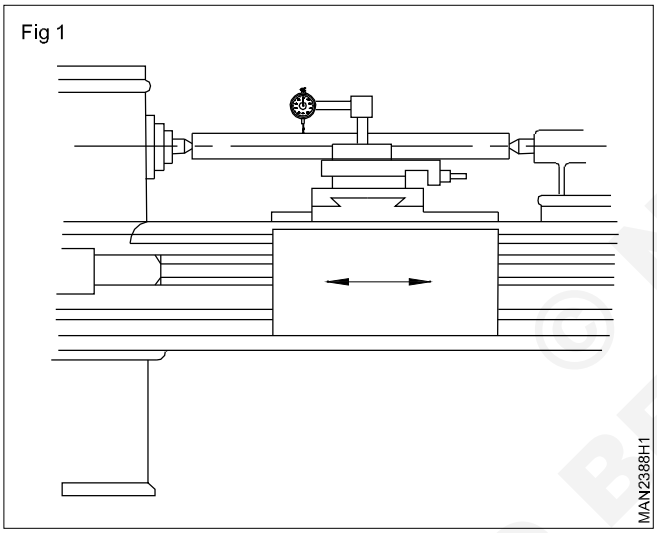
Checking of alignment of lathe centres and their adjustments

Objectives: At the end of this exercise you shall be able to
• mount the test bar in lathe between centres
• set the dial test indicator
• check the centre alignment using test bar with dial test indicator.

Job Sequence

- Clean the centres of the lathe ane the centres drilled holes in the test bar.
- Mount the test for required tighten the between centres and tighten the tail stock spindle space clamp.
- Mount a dial indicator in the tool post or on the lathe carriage.
- The contact point should be on the space centre of the bar and the indicator plunger should be in a Vertical position.

Fig 1

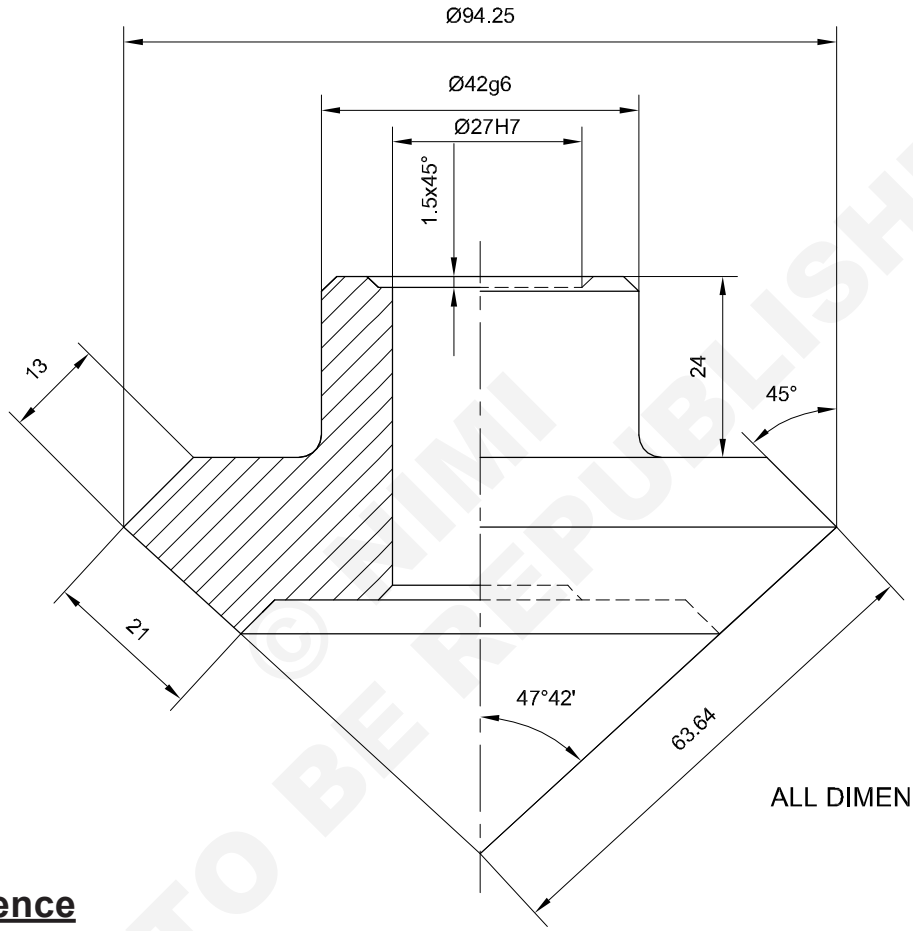


- Adjust the cross slide so that the indicator needle registers about are half of a revolution on the dia. at the tail stock end.
- Move the carriage to the left by hand until the indicator registers on the diameter at the handstock end.
- Note the indicator reading.
- If the readings are not the same
- Move the carriage until the indicator again registers on the tailstock end diameters.
- Loosen the tailstock clamp nut.
- Using the tailstock adjusting screw.
- Move the tailstock in the proper direction.
- The amount of movement should equal the difference between the indicators readings.
- Tighten the loose adjusting screw to lock the upper part of the tailstock in place.
- Tighten the tailstock clamp nut and recheck to make sure that the test bar still fits snugly between centres.
- Repeat these steps until the indicator readings at the two ends are the same.

Turning practice-between centres on mandrel (gear blank) with an accuracy ± 30 minutes

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

- **mount the work on mandrel (Mandral)**
- **swivel compound rest required angle**
- **turn bevel gear blank.**



ALL DIMENSIONS ARE IN mm

Job Sequence

- Check the blank size.
- Mount the work on a mandrel.
- Set the mandrel in between centres.
- Grind and set the tool in the tool post.
- Swivel the compound rest to an angle of 47° 42' degrees.
- Turn the taper to have a face width of 21mm
- Again swivel the compound rest to angle 45° degrees.
- Hold the job on the mandrel
- Turn the taper to have a width of 13 mm.
- Check angle with vernier bevel protractor.

1	IS - Ø100 x 60	-	Fe 310	-	-	1.6.85
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	TURNING PRACTICE - BETWEEN CENTRES ON MANDREL (BEVEL GEAR BLANK)	±30 DEVIATIONS ±0.05 Unless otherwise stated	TIME :
		CODE NO. MA20N1685E1	

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'**
- **check the straightness of the machined surface with reference to the other vertical surface.**

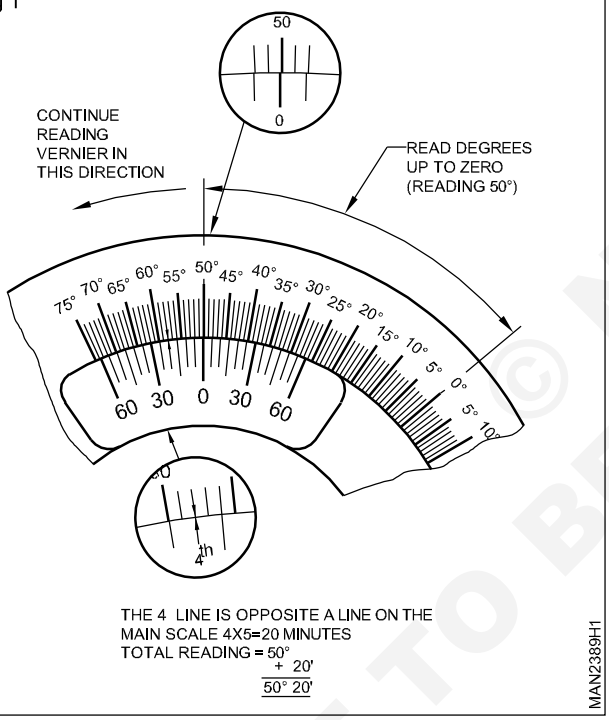
The vernier scale is duplicated to read either side of the zero graduation of the main scale. If you read the main scale in the clockwise direction. Continue reading the vernier scale also in a clockwise direction. Always make sure that the vernier scale reading is added to the main scale.

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 discfrmly with the locking device.

The position of the vernier scale with reference to the main scale is shown in Figure 1.

Fig 1



Read the degrees of the main scale up to the graduation 0 of the vernier scale i.e. 50°.

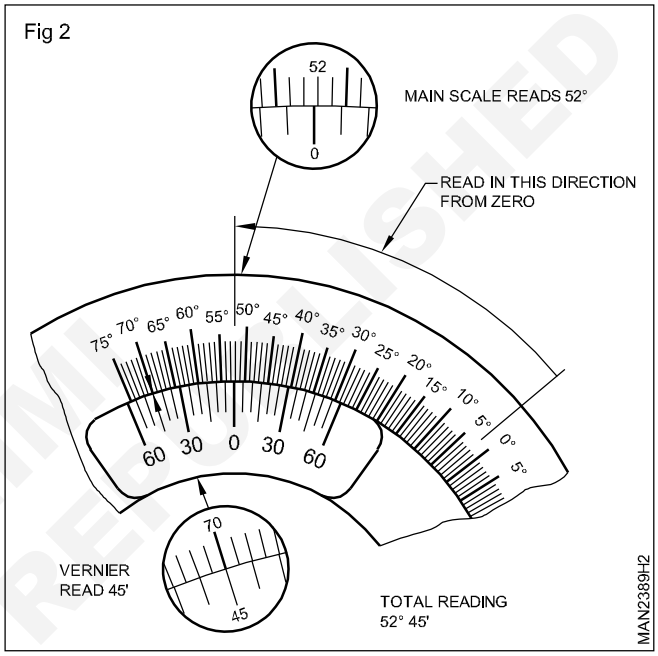
Continue reading on the appropriate vernier scale (towards the left hand side). Note teh number of lines in the vernier scale the coincide with a division of the main scale. (i.e. 4 th division of the vernier scale is coinciding with one of the main scale division line)

As the least count is 5' multiply this number by 5. (i.e 4 5 - 20')

Add this result to the main scale reading of 50° i.e 50° + 20 -50° 20'.

Similarly the reading for figure 2 may be obtained as 52° 45'. (Fig 2)

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.

Read the vernier scale with reference to the main scale.

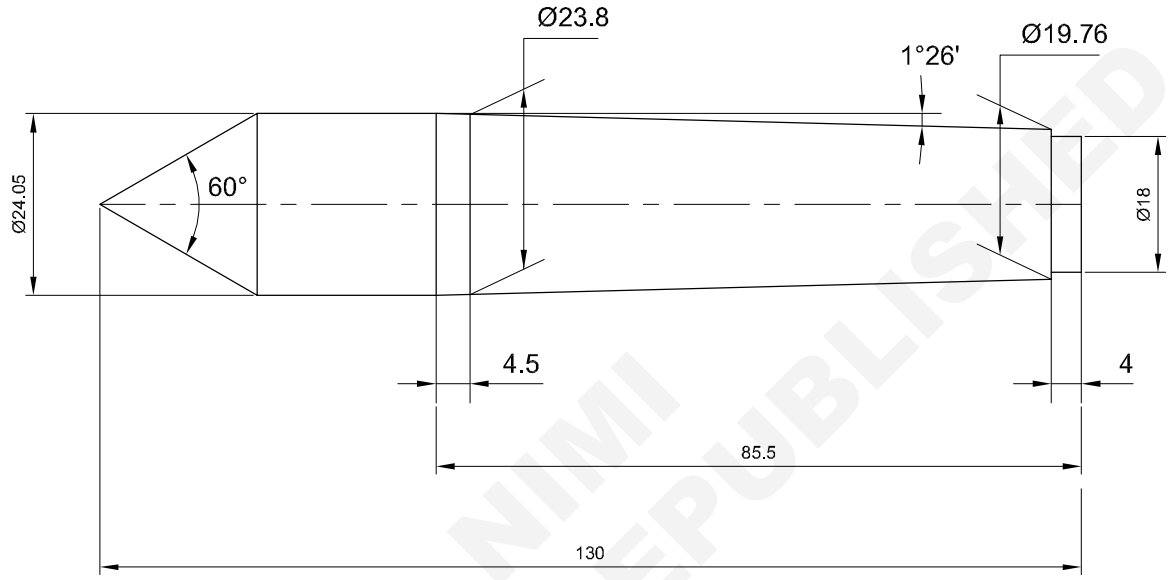
If the '0' graduation of the vernier scale and 90° of th main scale coincide, the machined faces are at right angles, i.e. 90°

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.

Taper turning by swiveling the cross - slide (Taper turning attachments)

Objectives: At the end of this exercise you shall be able to
- **set the compound rest to the specific angle**
- **turn taper using the compound slide method within an accuracy ±30'**
- **turn the external taper by the compound rest method.**



Job Sequence

- Check the size of the raw material.
- Hold the job in a four jaw chuck and true it.
- Set the required tools in a four way tool post.
- Face one end and centre drill.
- Reverse the job, face the other end to maintain a total length of 130 mm and centre drill.
- Hold the job in a four jaw chuck and true it.
- Support the job on the tailstock keeping 115 mm from the chuck face, and true.
- Turn a diameter 24.05 mm to the maximum possible length and check with a micrometer.
- Position the turning tool and turn step dia. to 18 mm.
- Form radius at the edge of 18 mm.
- Set the taper turning attachment for the required amount of taper 1° 26'.
- Confirm the graduations on the bracket of the taper turning attachment whether for half included angle of the taper or full, and then set it.
- Taper turn, engaging the power feed for a short length and maintaining a smooth surface.
- Adjust the setting, if needed, to get proper matching.
- Complete the taper turning to suit the gauge up to the gauge plane.
- Dismount the chuck from the spindle nose and fix the spindle sleeve to the nose bore.
- Insert the job in the sleeve and set the machine r.p.m.
- Swivel the compound slide to 30° away from you.
- Rough and finish turn taper to get a 60° included angle.

1	Ø32-145mm	–	Fe310	–	–	1.6.86
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1 : 1	TAPER TURNING BY SWIVELLING THE CROSS SLIDE (TAPER TURNING ATTACHMENT)	TOLERANCE Degree ±30 ±0.04 Unless otherwise stated	TIME:
		CODE NO. MA20N1686E1	

Skill Sequence

Producing taper by using taper turning attachment

Objectives: This shall help you to
- **set the taper turning attachment to the required angle**
- **produce taper by using a taper turning 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 in correct taper

Mount the work piece on the chuck or between centres.

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

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

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

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

Set up the cutting tool for the correct position.

Wear safety goggles.

Set the required r.p.m.

Feed the cutting tool in until it is about 6 mm from 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 used 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 end of the work piece.

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

Switch on the lathe.

Take a light cut about 2 mm 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.

Turning taper by compound slide swivelling

Objectives: This shall help you to
- **set and swivel the top slide of the compound rest to the required taper angle**
- **set the tool in the tool post**
- **turn the taper**
- **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 the machine to the required rpm.

Loosen the top slide clamping nuts.

Swivel the top slide to half the included angle of the taper away or towards the operator as required.

Tighten the clamping nuts firmly. (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.

Fig 1

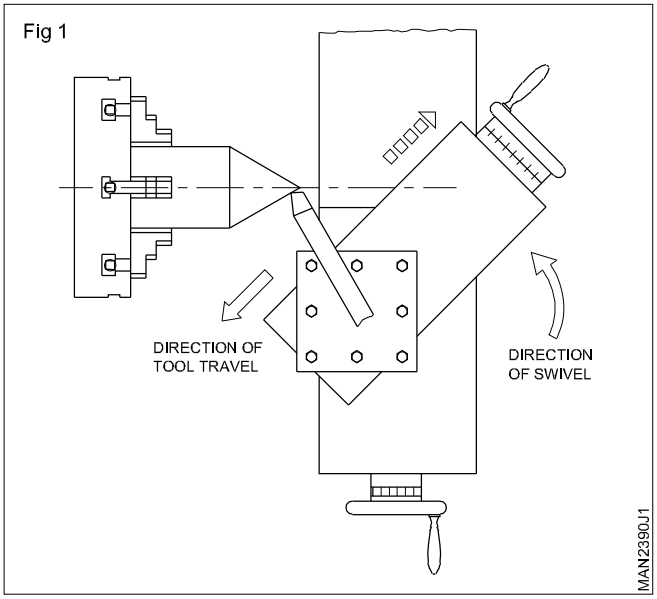
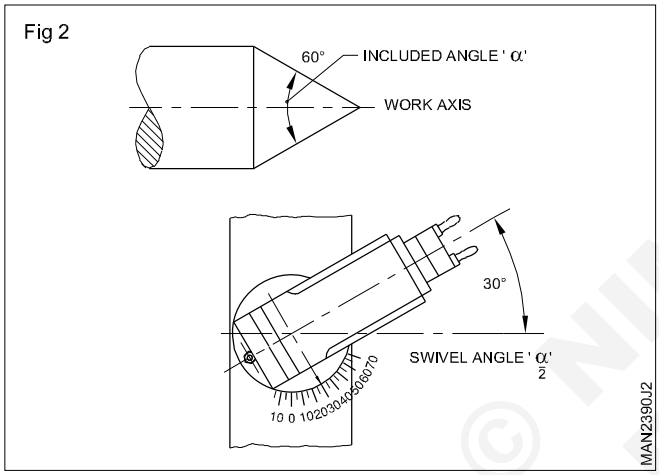


Fig 2



Position the top slide to cover the length of the taper turning.

As far as possible ensure that the top slide does not go 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 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 continous.

Compound rest setup for turning various angles

Give successive cuts by the cross - slide, feeding by the top slide each time.

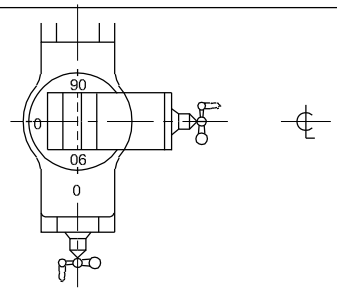
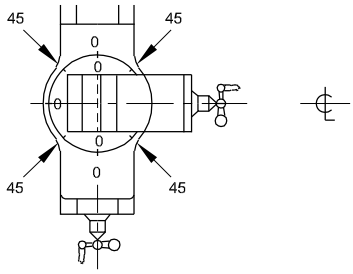
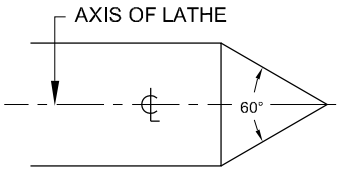
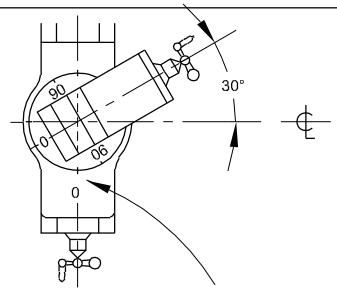
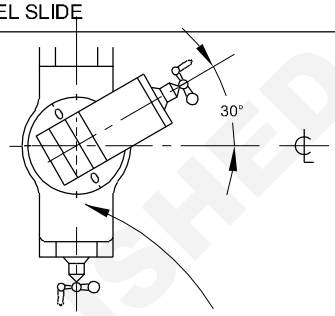
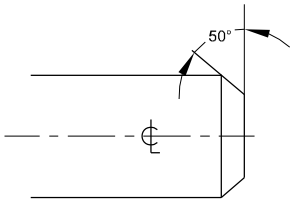
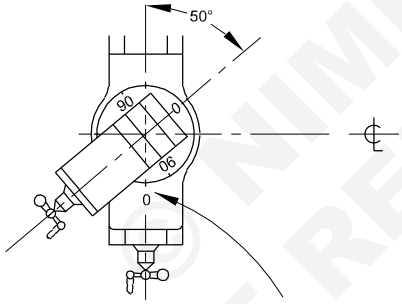
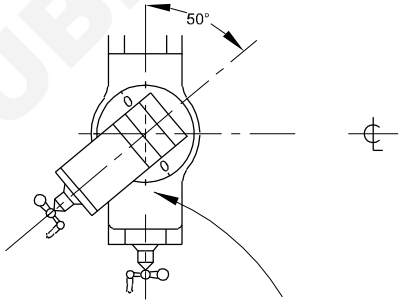
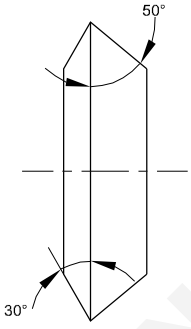
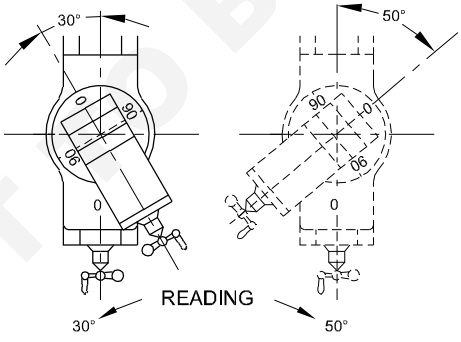
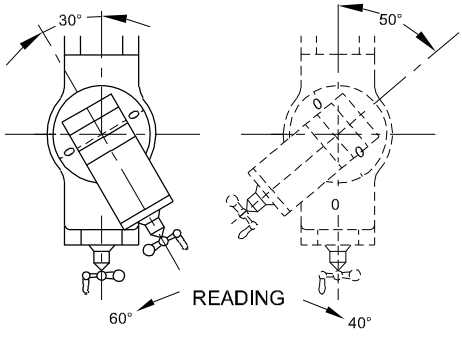
Check the angle of the turned job with a vernier bevel protractor.

Adjust the swivel if there is any difference.

Continue the taper turning and finish the taper.

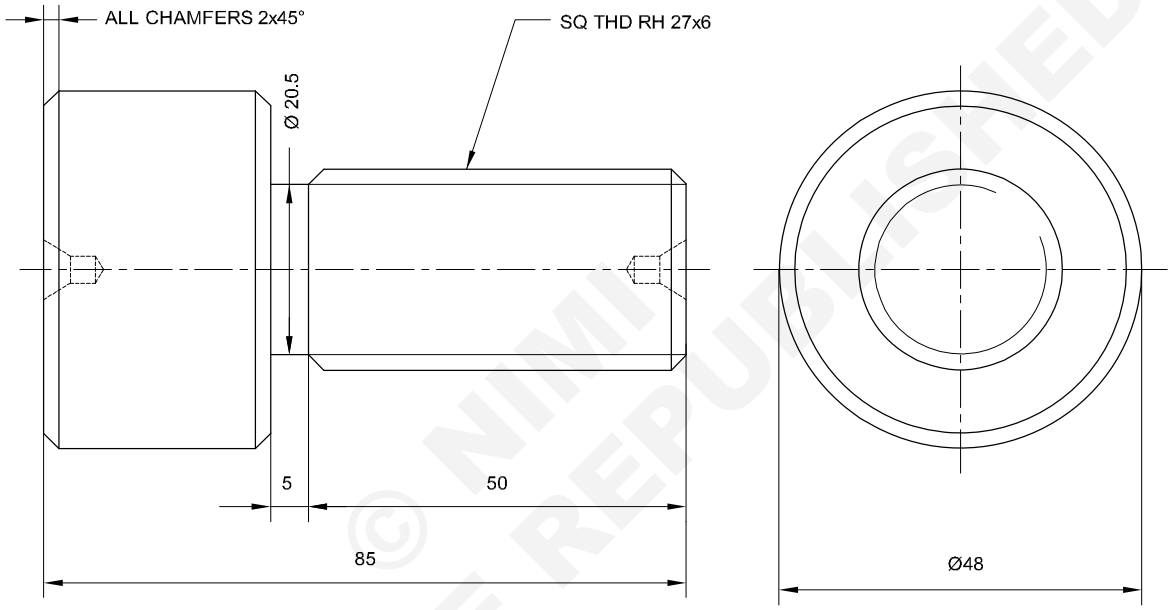
Compound rest setup for turning various angle is given in table 1.

Table 1

	ARRANGEMENT OF GRADUATIONS ON SWIVEL SLIDE	
SPECIAL ANGULAR SETTING ON COMPOUND REST	 GRADUATED FROM 90-0-90	 GRADUATED FROM 0-45-0
EXAMPLES	READINGS ON GRADUATED SWIVEL SLIDE	
 INCLUDED ANGLE MEASURED IN HORIZONTAL PLANE	 READING ON SCALE 60°	 READING ON SCALE 30°
 ANGLE GIVEN FROM A LINE AT 90° TO AXIS OF LATHE	 READING ON SCALE 50°	
	 READING	 READING

Make square thread (external) on a lathe with an accuracy ±0.02mm

Objectives: At the end of this exercise you shall be able to
- **turn step to an accuracy of ±0.02 mm**
- **cut right hand external square thread.**



Job Sequence

- Hold the job in a four jaw chuck, true and face both ends and maintain on total length of 85mm by plain turning.
- Centre drilling on both ends
- Remove the four jaw chuck and mount a driving plate
- Insert the head stock centre with the spindle sleeve and the tail stock centre also.
- Hold the job in a suitable carrier in between centres.
- Turn 48mm to a length of 30mm.
- Turn 27mm to another side maintaining length 55mm.
- Finish chamfer 2x45° at the both end of 48mm dia. And also chamfer at the end of 27 by V cutting tool.
- Set the spindle speed about ¼ th of normal turning.
- Cut rough up to ¾th depth and full width by taking successive cuts up to complete thread form.
- Deburr and check using square thread gauge.

1	ISRO 50-90	-	Fe 310	-	-	1.6.87
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**MAKE SQUARE THREAD(EXTERNAL) ON A LATHE WITH AN ACCURACY ±0.02mm**				DEVIATIONS ±0.02 mm	TIME :
					CODE NO. MA20N1687E1	

Skill Sequence

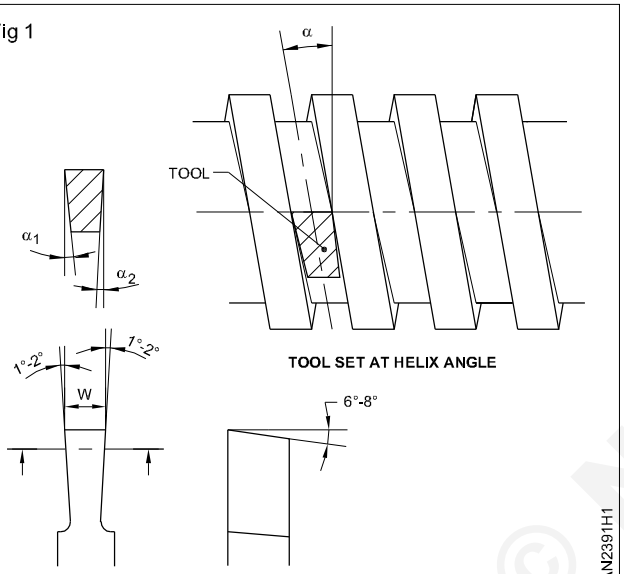
Grind an external threading tool

Objective: This shall help you to
- **grind an external square threading tool.**

Determine width and angles required for grinding the external square threading tool.

The side clearance of the square threading tool is of prime importance to prevent the tool from interfering or rubbing against the vertical flank of the thread. As rule, the forward side clearance angle (a1) is determined by adding 1° to the helix angle of the thread and trailing side clearance angle is obtained by subtracting 1° from the helix angle. (Fig 1)

Fig 1



α_1=1° + Helix angle of thread

and

α_2= Helix angle of thread -1° where, helix angle (α)

$$= \frac{\text{Lead of thread}}{\pi \text{ x cord dia. of thread}}$$

The width of the nose of the square threading tool should be equal to half of the pitch of the square thread to be cut.

W=0.5xp

Grind the front flank of the tool too get the front clearance angle 6° to 8°. (Fig 2)

Grind the forward side flank of the tool to obtain side relief angle 1°- 2° and forward side clearance angle α1. (Fig 3)

Fig 2

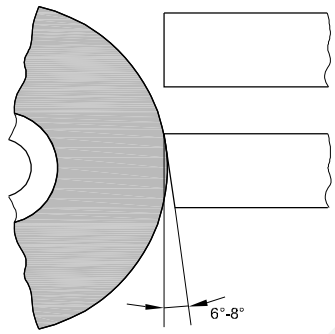
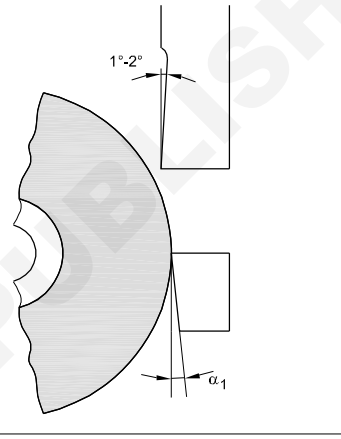


Fig 3



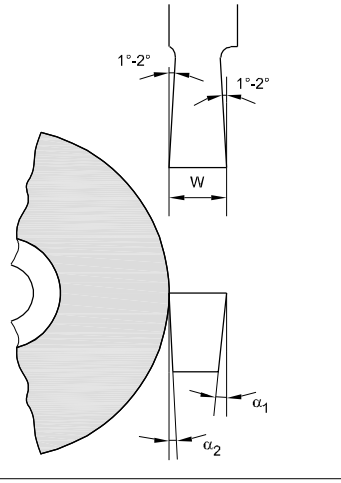
α_1= α + (to 2°)

Grind the trailing side flank of the tool to maintain the side relief angle 1°-2°, trailing side clearance angle

α_2(α_2=2–1°) and the width w(ω=0.5xπ) (Fig.4)

Deburr and check the width of the angles using a vernier caliper and bevel protractor.

Fig 4



Square thread

Objective: This shall help you to
- **cut a square thread.**

Check the diameter of the portion to be threaded as indicated in the drawing.

Chamfer the edge of the job to 2 x 45°

Set up the gearbox to cut the required pitch of thread, and hand of thread.

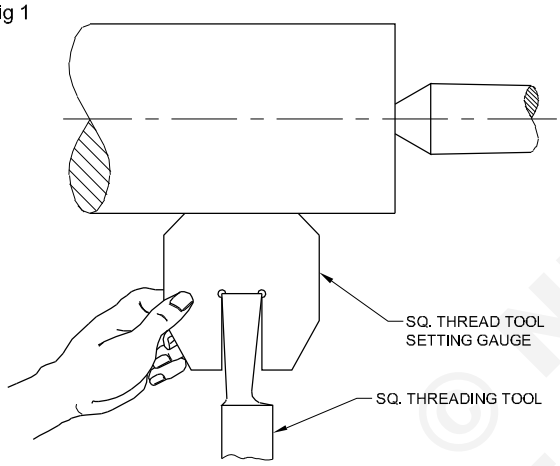
Set the square threading (roughing) tool in the tool post with its height to the centre height of the lathe.

Set the tool square to the axis of the with the square thread gauge. (Figs 1 and 2)

Care is to be taken to prevent overhanging of tool from the holder to avoid chatter.

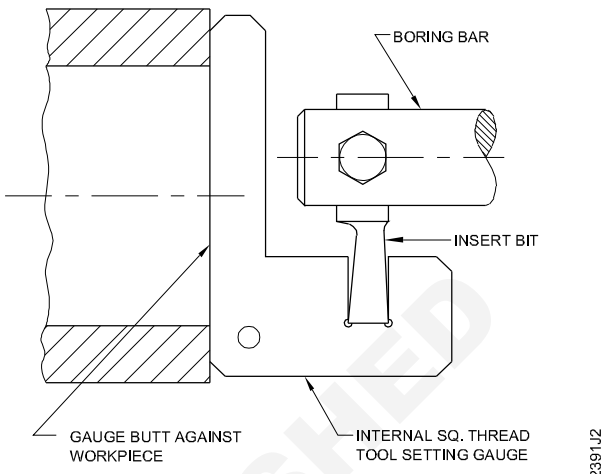
Set the spindle speed about 1/4th of the normal turning.

Fig 1



TOOL SETTING FOR
CUTTING EXTERNAL SQUARE THREAD

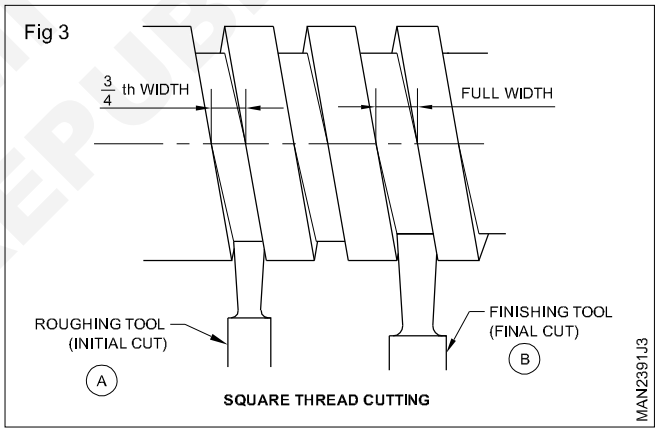
Fig 2



TOOL SETTING FOR CUTTING INTERNAL SQ. THREAD

Cut the square thread, by repeated successive depth of cuts to reach 3/4th width and depth of thread. (Fig 3)

Fig 3



SQUARE THREAD CUTTING

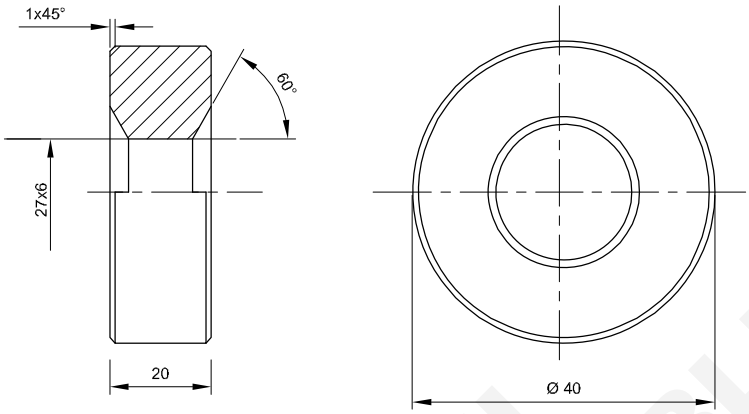
Set the finishing square thread tool for finishing cuts.

Cut the square thread to full depth and full width by taking successive cuts to complete the required thread form.

Deburr and check the square thread using a square thread gauge.

Make square thread (internal) on a lathe with an accuracy ± 0.02mm

Objectives: At the end of this exercise you shall be able to
- **grind internal square threading tool**
- **cut internal square thread by the plunge cut method**
- **match square threads**
- **knurl the surface with medium knurl.**



Job Sequence

- Check the size of the raw material.
- Hold the job in 4 jaw chuck keeping 10mm outside the chuck and true the job with a surface gauge.
- Set the facing tool and face one end of the job.
- Set the R.H. turning tool and turn Ø40x20mm length.
- Centre drill, drill pilot hole 8mm and enlarge to 20mm hole by drilling.
- Set the boring tool and bore the drilled hole to core diameter 21mm.
- Set the chamfering tool and form internal chamfer 1 x 60°.
- Set the internal square threading tool, the cutting edge parallel to the axis.
- Arrange change gears for 6mm pitch.
- Cut internal square thread SQ 27X6 and match with the male piece.
- Reverse and true the job.
- Face and maintain 20mm.
- Form internal chamfer 1 X 60°.
- Form external chamfer 1 x 45°.
- Hold the job keeping 10mm outside the jaws, such that two jaws grip the work on its face and two jaws grip on the periphery.
- Set the line perpendicular to the lathe axis with the help of a surface gauge align the job, if required.
- Set the facing tool to form a flat surface up to the half of centre punch mark.
- Approximate feeding to the tool will be 2.6 mm maximum.
- Reset the job in a 4 jaw chuck keeping the opposite side of the flat surface outside the jaws.
- While setting, keep the flat surface of the job butt against the parallel block, and remove the parallel block after fixing the job.
- Check the sizes with a precision measuring instrument and the thread with the mating part for the fit.

1	Ø 45-25mm	-	Fe 310	-	-	1.6.88
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKE SQUARE THREAD (INTERNAL) ON A LATHE WITH AN ACCURACY ±0.02mm	TOLERANCE ±0.02mm	TIME:
		CODE NO. MA20N1688E1	

Capital Goods & Manufacturing — Exercise 1.6.89
Machinist - Advanced Turning

Check with thread gauge - Grinding of tool and setting in correct position

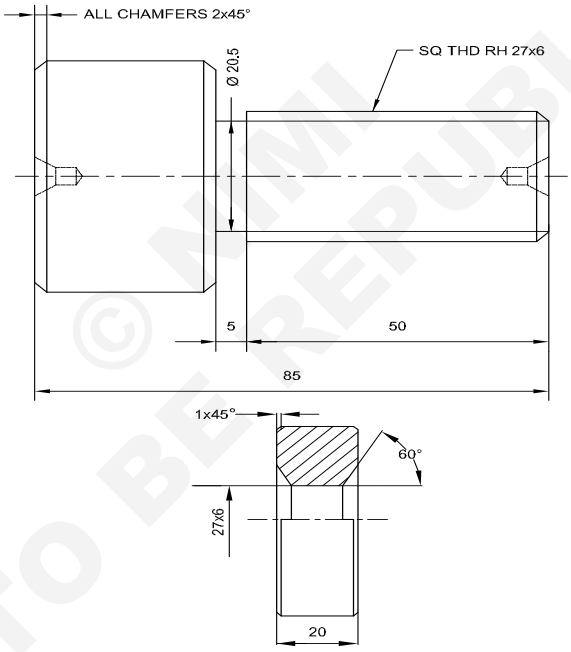
Tool grinding tool setting and checking is already given in the previous exercise 1.6.87 & 1.6.88

Note : Adjust the tool height depending upon the type of top holder used

Capital Goods & Manufacturing — Exercise 1.6.90
Machinist - Advanced Turning

Fitting of Male and Female square threaded components

Objectives: At the end of this exercise you shall be able to
- **check the thread profile and depth**
- **adjust thread profile dimensions**
- **assemble male and female thread.**



Job Sequence

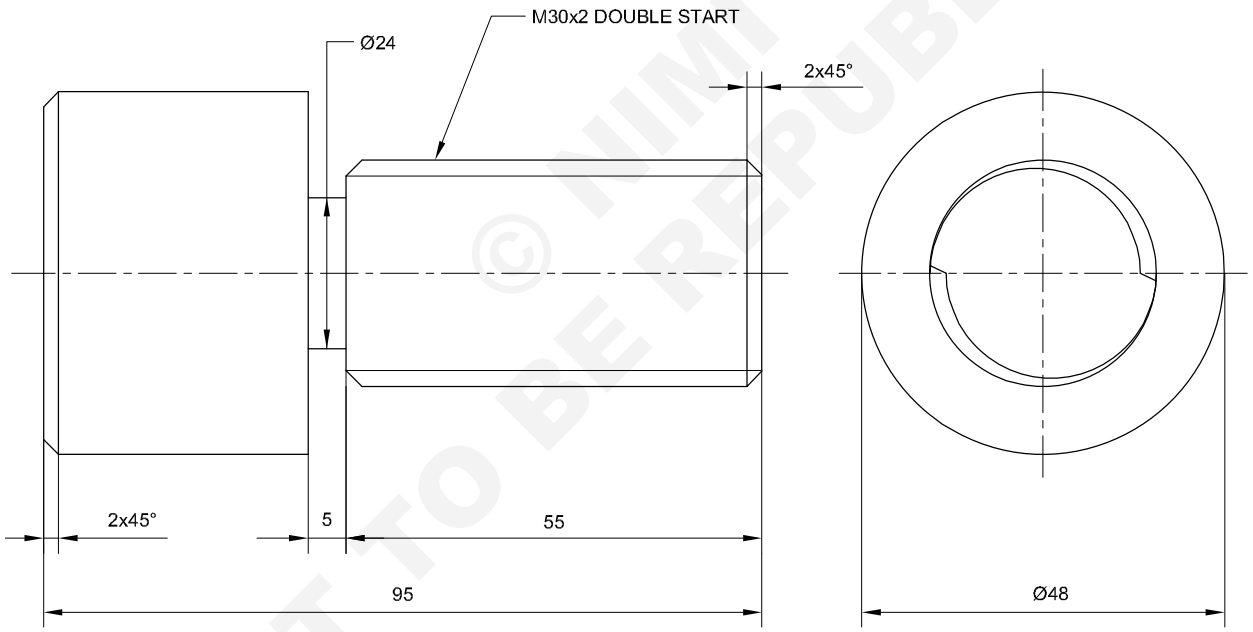
- Clean male and female square Threaded component.
- Check the Thread dimension, pitch and thread profile using Vernier caliper and Screw Pitch Gauge
- Assemble by screwing in 27x 6 female square thread into the external in27x 6 square threaded component
- Tighten the two component (male and female)

1	ISRO 50-90	-	Fe 310	-	-	1.6.90
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	FITTING OF MALE AND FEMALE SQUARE THREADED COMPONENTS				DEVIATIONS ±0.05 mm	TIME :
					CODE NO. MA20N1689E1	

Make multi-start 'V' thread on lathe with screw pitch gauge

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

- **grind 'V' tool as per drawing**
- **set the turning tool 'V'**
- **set the machine spindle speed for turning**
- **parallel turn the work by hand feed method with various depths of cuts**
- **turn step to an accuracy of ± 0.05 mm**
- **measure the dia. of the job with micrometer**
- **grind chamfering tool as per drawing**
- **set chamfering tool and chamfer the job as per drawing**
- **cut multi - start 'V' thread by thread chasing dial**
- **cut multi start thread by face plate method.**



1	ISRO 50-100	-	Fe 310	-	-	1.6.91
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKE MULTI START 'V' THREAD ONLINE WITH SCREW PITCH GAUGE	DEVIATIONS ±0.05 mm	TIME :
		CODE NO. MA20N1691E1	

Job Sequence

- Check the raw material for its size.
- Hold and true the job in a four-jaw chuck so that the job is projected to about 60mm length out of the jaws.
- Face the end of the job.
- Turn the outside diameter to ø48mm over the projected length.
- Chamfer the sharp corner of the end.
- Reverse and reset the job in the chuck so that the job is projected about 65 mm out of the jaws.
- Face the end of the job to 95 mm length.
- Turn the outside diameter to ø30x60mm length.
- Turn the undercut to 5x3 mm.
- Chamfer the sharp corner of the end.
- Set the angle of the compound rest to zero.
- Set the graduated dial of the compound rest to zero, without any backlash.
- Set the external V- threading tool in the tool post using a centre gauge.
- Set the quick change gearbox to first start of the thread to 4mm pitch.
- Cut the external V- threads of 4mm pitch to full depth by successive cuts.
- Move the compound slide longitudinally equal to 2mm referring to the graduated dial, for the second start of the threads.
- Cut the second start of the external V-threads of 4mm pitch to full depth by successive cuts.
- Deburr the sharp corners.
- Check the dimensions.

Skill Sequence

Resetting of 'V' thread cutting tool

Objective: This shall be able to
- **reset the threading tool which has been re-sharpened by grinding.**

A thread is formed by taking a number of successive cuts and it may become necessary sometimes to remove the tool and re-sharpen it as it may get blunt or the point may break. The tool has to be fixed and set in a tool post in such a way that it follows the same thread groove previously formed.

The resetting of the cutting tool is necessary when

– the workpiece has moved
(shifted in the mounting accessory)

– the tool-holder has moved
(shifted) in the tool post

– the tool has been removed and re-sharpened

– the workpiece has to be reset.

Listed below are the steps to be followed in resetting the cutting tool.

Check that the lathe is correctly set up for cutting the thread of the required pitch.

With the cutting tool mounted, but cleared off the workpiece, start the lathe and engage the lead screw with the carriage half nut.

When the tip of the cutting tool is in line with one of the thread grooves, stop the lathe.

Do not disengage the half-nut.

Carefully position the tip of the cutting tool in the groove with its trailing edge in contact with the trailing edge of the thread.

The tool must be moved to this position by operating the cross-slide and the compound slide hand wheels.

Set the graduated collars of the slides to zero.

Wind the cutting tool out of the groove and move the carriage to the right to clear the end of the workpiece by reversing the lathe.

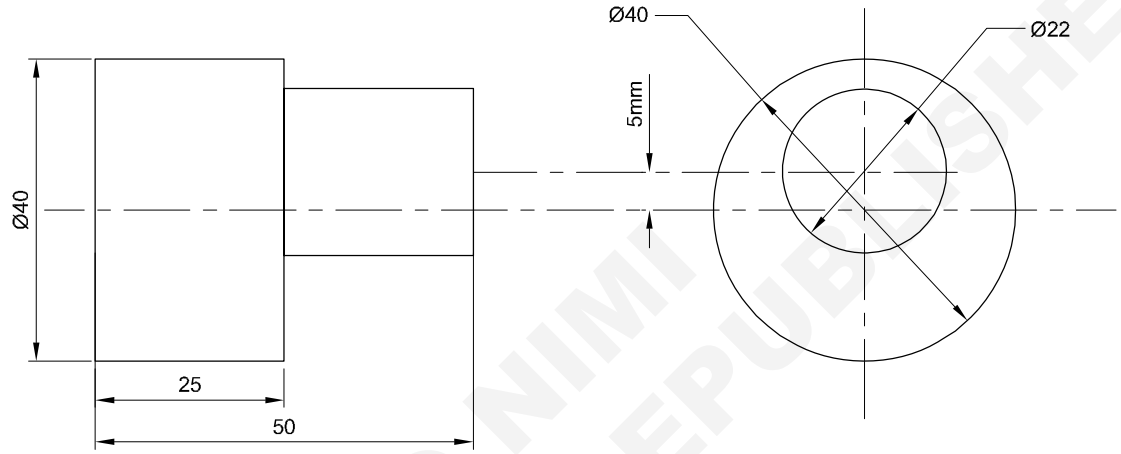
Advance the tool by rotating the cross-slide hand wheel, and bring it to zero position.

Start the machine to allow the tool to grace the thread groove formed previously to confirm the setting is proper.

If found satisfactory, take successive cuts to finish the thread.

Perform eccentric turning with an accuracy ±0.02mm

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 work piece.
- Face the work piece with minimum stock removal.
- Turn ø40mm to a maximum length.
- Reverse the job hold and true it and face the end to maintain a total length of 50mm 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 22mm 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 22mm to length of 25mm.

1	Ø 45-55mm	–	Fe 310	–	–	1.6.92
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. MA20N1692E1	

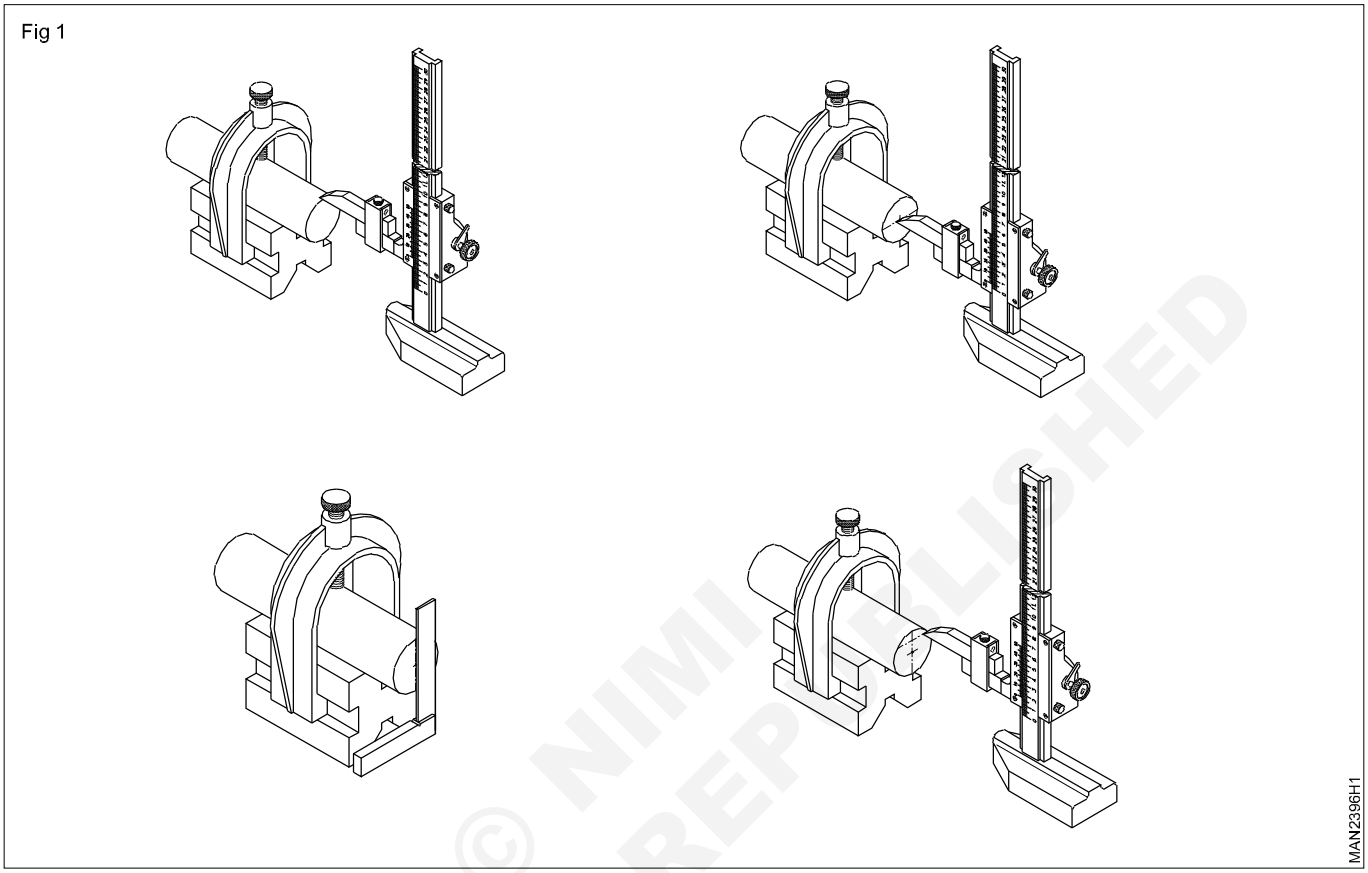
Skill Sequence

Use of marking vernier height gauge and 'V' block

Objective: This shall help you to

- **mark concentric and eccentric centre lines of a job using vernier height gauge.**

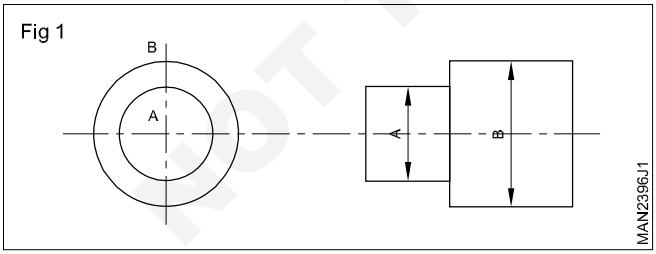
Fig 1



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.

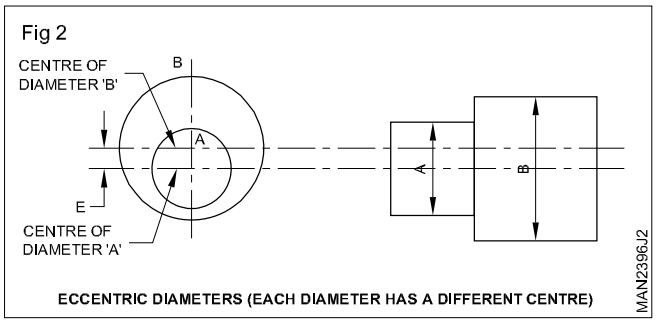
Fig 1



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'. If 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 2



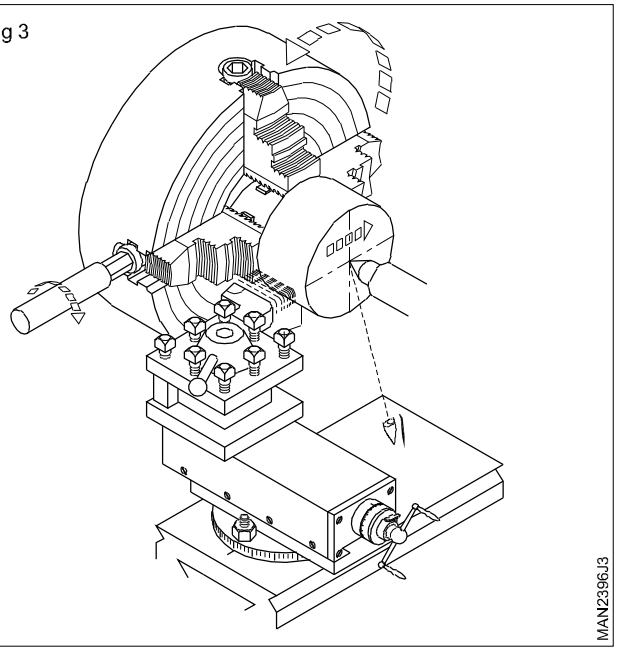
ECCENTRIC DIAMETERS (EACH DIAMETER HAS A DIFFERENT CENTRE)

Method of identifying eccentricity

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)

Fig 3



MAN2396J3

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.

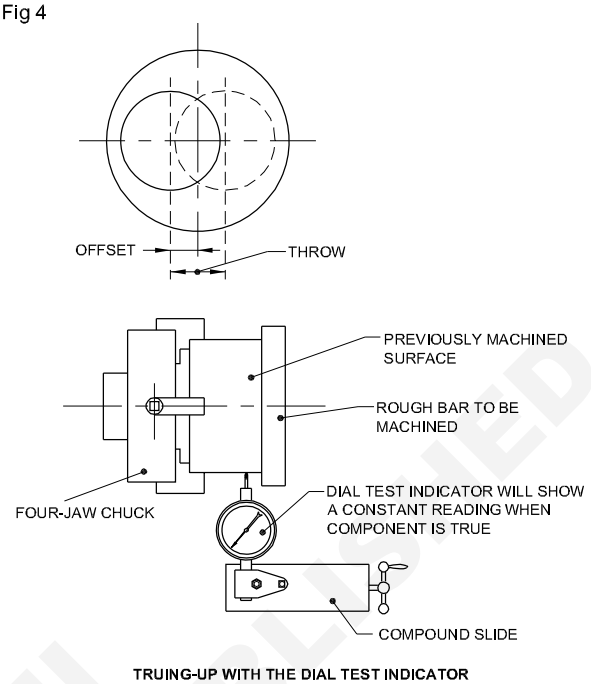
Method of eccentric turning

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 a 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 4



TRUING-UP WITH THE DIAL TEST INDICATOR

MAN2396J4

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. Bothe 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.

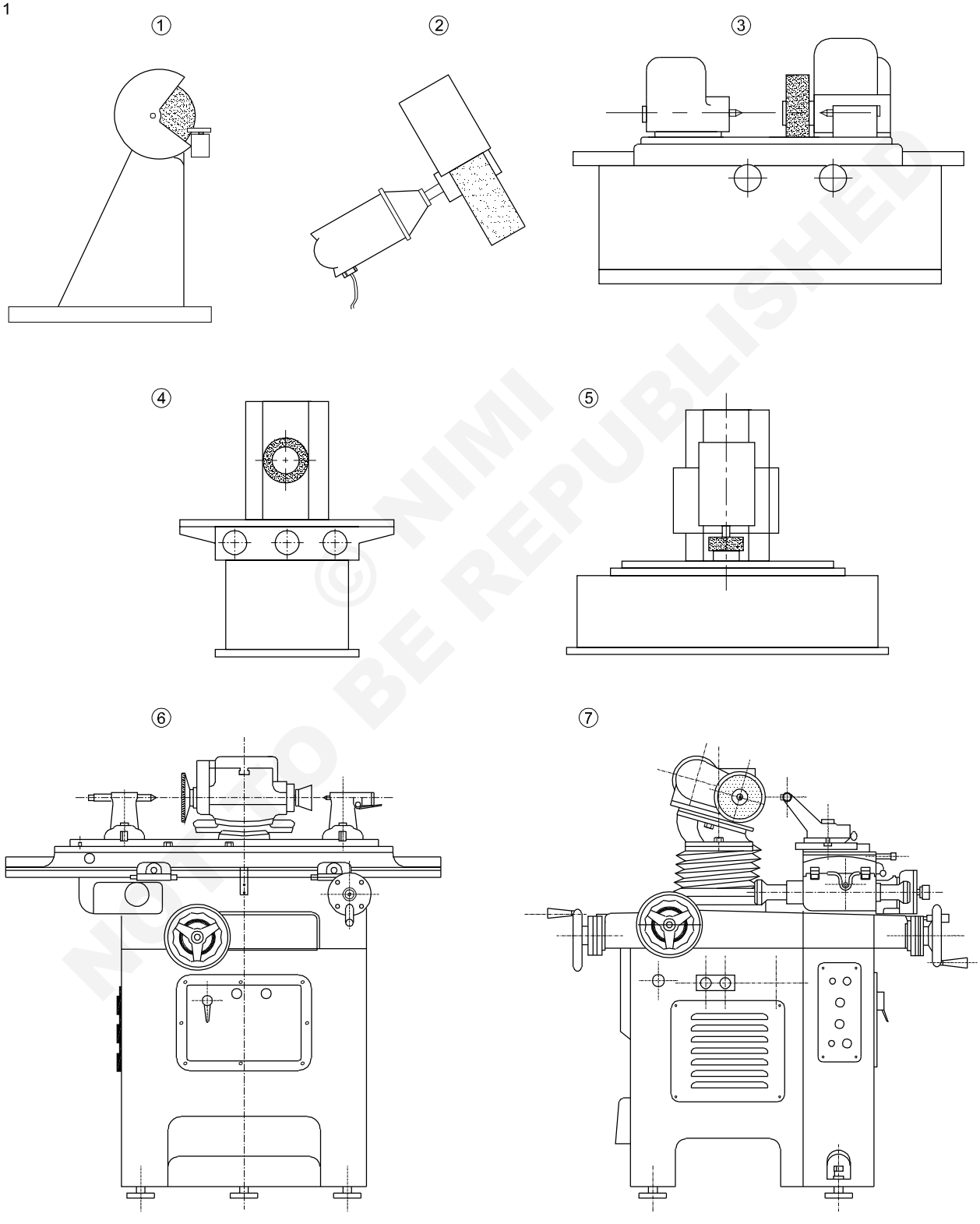
Use of eccentric turned jobs

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.

Identification of different types of grinding machines

Objectives: At the end of this exercise you shall be able to
- **identify the different types of grinding machines**
- **state the use according to the purpose of grinding operation.**

Fig 1



Job Sequence

Instructor should arrange to visit the difference types of grinding machines available in the ITI

- Trainees will note down the types of grinding machines in the ITI.
- Record it in table -1
- Get it checked by the instructor.

Table 1

No.	Name of the machines	Remarks
1		
2		
3		
4		
5		
6		
7		

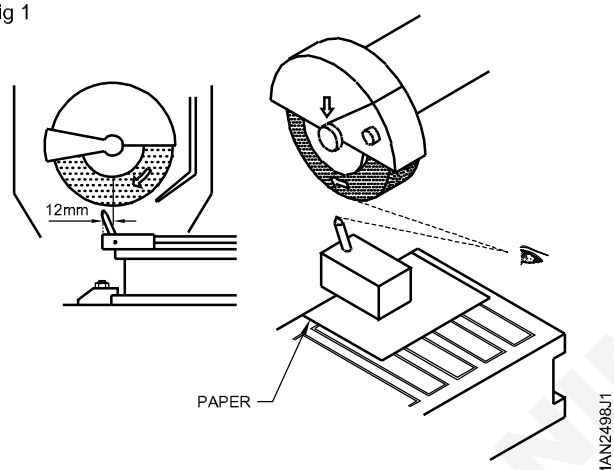
Wheel balancing & truing

Objectives: At the end of this exercise you shall be able to
- **truing the grinding wheel**
- **balancing the grinding wheel.**

TASK 1: **True the grinding wheel**

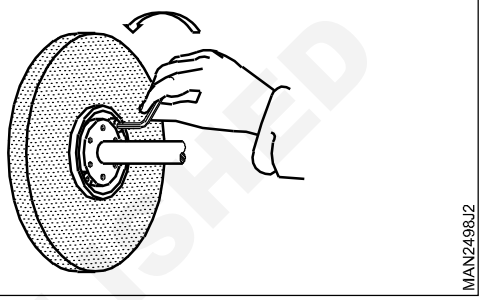
- Clean the grinding machine table
- Select and hold the dresser in proper holder
- Mount the holder with dresser in grinding machine table (Fig.1)

Fig 1



- Start the wheel head and allow it to run, for the machine to attain normal working temperature.
- Dress the wheel on the periphery (Fig.2)

Fig 2



Dress the sides if the wheel diameter exceeds 250mm. Apply a small in feed of the diamond until eccentricity of the wheel is removed.

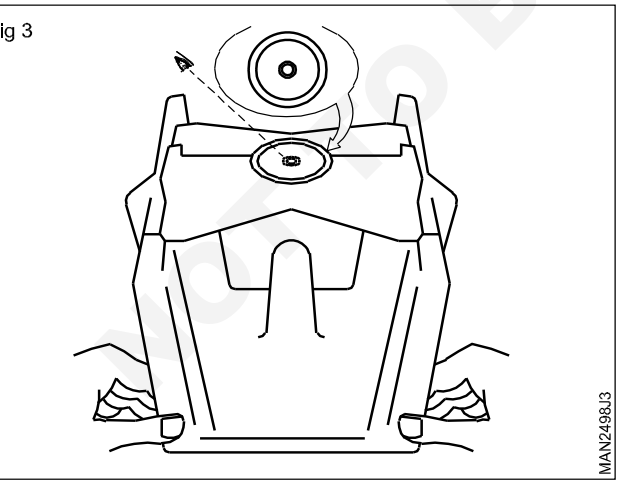
- Stop the machine.

TASK 2: **Balancing a grinding wheel**

Mount the Wheel on the machine.

Remove the balance weight. (Fig 3)

Fig 3



Clean the internal and external cones

Place the wheel unit on the spindle nose, and tighten the lock-nut

Replace the Wheel guard

Remove the Wheel guard and lock-nut

Screw on the collet Extractor and remove the wheel assembly.

Use both hands when removing the wheel assembly. Take care not to knock on any machine part to prevent any damage to the wheel.

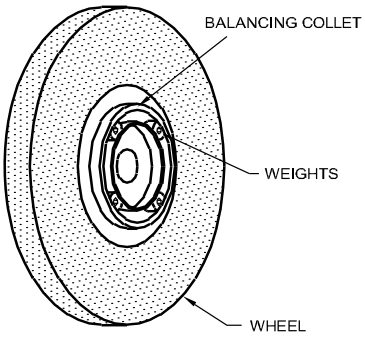
Preparing the balancing unit

Lower the protection guards

Place the levelling plate on the balancing stand. (Fig 4)

Adjust the unit, using two knurled Screws on the base until the bubble in the levelling plate is concentric with the circle engraved on the glass.

Fig 4

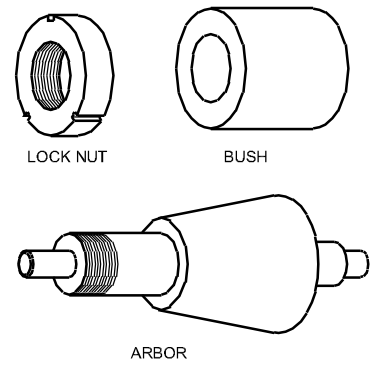


GRINDING WHEEL MOUNTED ON A BALANCING COLLET

Positioning Wheel on unit

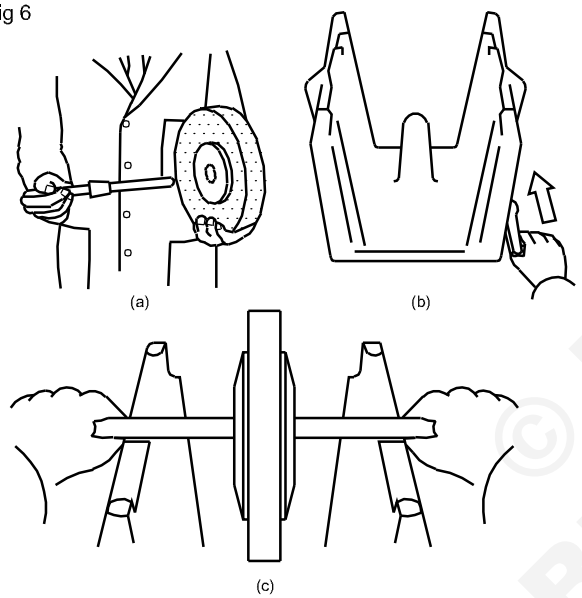
Clean the bore of the unit (Fig.5) and the balancing Mandrel, then mount the Wheel assembly on the mandrel. (Fig.6)

Fig 5



BALANCING ARBOR COMPONENTS

Fig 6



Tighten the nut on the mandrel. (Fig.7a)

Raise the protection guards.(Fig.7b)

Place the wheel to be balanced on the top of the protection slides and lower gently on to the balancing stand.(Fig.7c)

(ii) Balancing the wheel

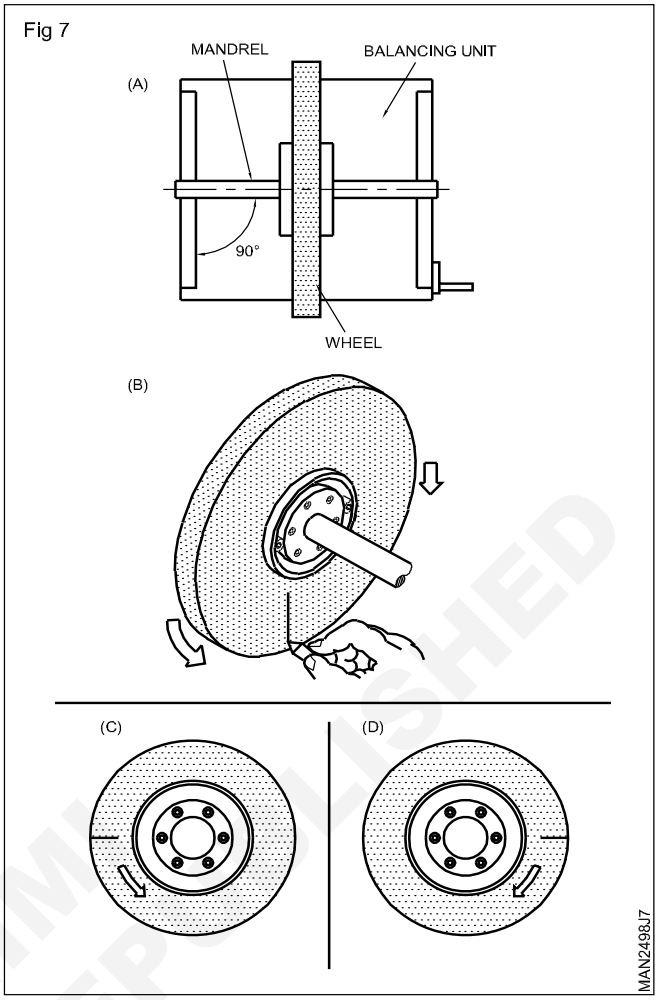
Visually ensure that the balancing mandrel is at right angles to balancing ways. (Fig 8a)

Allow the wheel to revolve slowly, by its own momentum until stationary.

Place a chalk mark at the bottom to indicate a heavy point. (Fig 8b)

Turn the wheel 90° to the heavy point, and diametrically opposite. (Fig 8c&d)

Fig 7

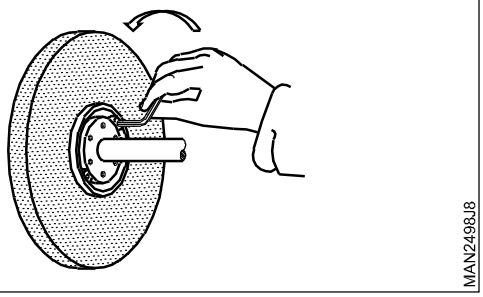


If the wheel finds the heavy points quickly, the balancing weights could be moved approximately 180°. (This indicates that the wheel is considerably out of balance). Move the weights equally towards the lighter side, approximately 3 mm at a time. Fig 8)

Repeat until the assembly remains static in any position.

Remount the assembly on the wheel head, replace the guard and re-dress the wheel before putting it into further operation.

Fig 8

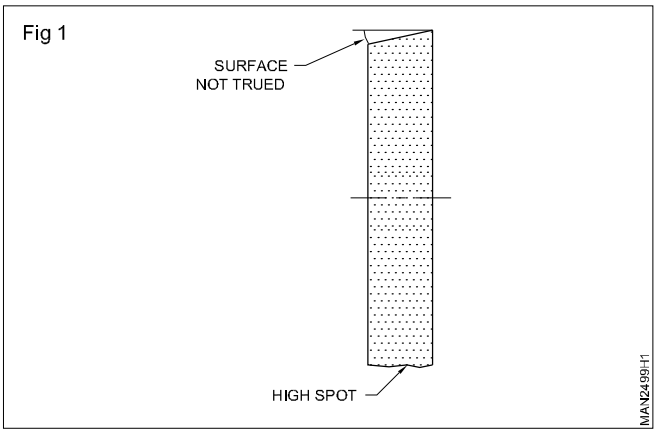


Dressing of grinding wheel

Objectives: At the end of this exercise you shall be able to
- **set the grinding wheel**
- **mount the holder with dresser.**

This operation is done after mounting the grinding wheel for removing any high spots on the face of the wheel with a diamond dresser. (Fig 1).

Fig 1



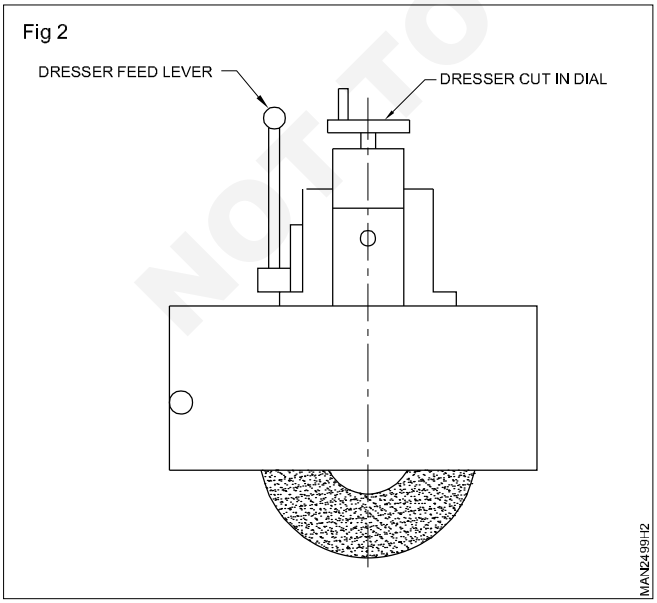
The high spots are removed for uniform contact of the wheel over the job. Otherwise only the high spots on the wheel will contact the surface resulting in poor surface finish.

Dressing is the operation of removing dull grains and metal particles from the cutting surface of a grinding wheel. This operation exposes sharp cutting edges of the abrasive grains to make the wheel cut better.

They are two method of dressing a grinding wheel for the surface grinder.

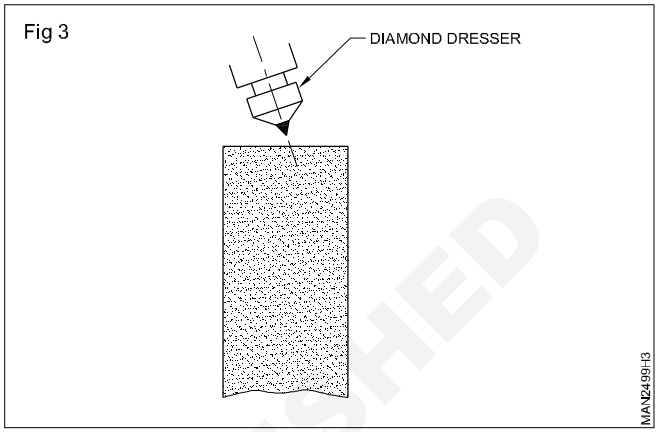
- Dressing of grinding wheel by grinding head dresser. (Fig.2)

Fig 2



- Dressing of grinding wheel by attached to holder. (Fig.3)

Fig 3



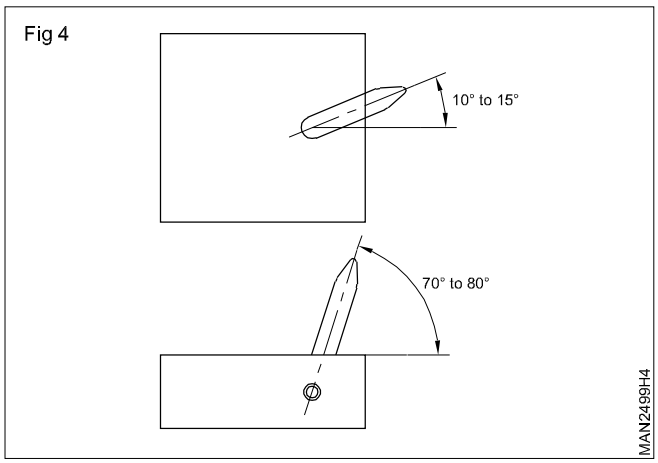
Dressing grinding wheel by grinding head dresser

- Start the motors for the grinding spindle and coolant.
- Open the cover of the grinding wheel, and shift the dresser to the centre of the grinding wheel as shown in Fig 2 by pulling the dresser feed lever to the front side.
- Turn the dresser cut in dial gently to let the dresser tip touch the perimeter of the grinding wheel.
- Restore the dresser feed lever to the original position and shut the cover of the grinding wheel.
- Set the depth of cut in the dresser by means of the dresser dial and carry out the dressing by operating the dresser feed lever. (The depth of cut for dressing is 0.015-0.025mm at a time, and the dresser feed speed is 250-500mm/min in case of the finish).

Dressing of grinding wheel by dresser attached to holder

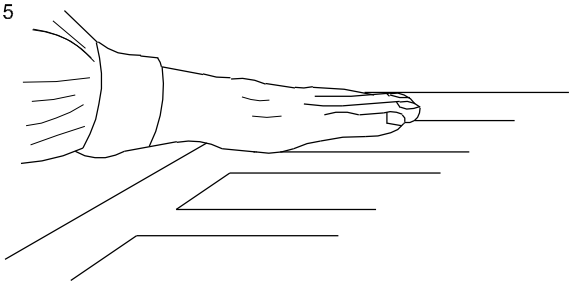
Keep the dresser on the base as shown in Fig.4. This position helps to prevent chattering and the tendency to drag in during the dressing operation.

Fig 4



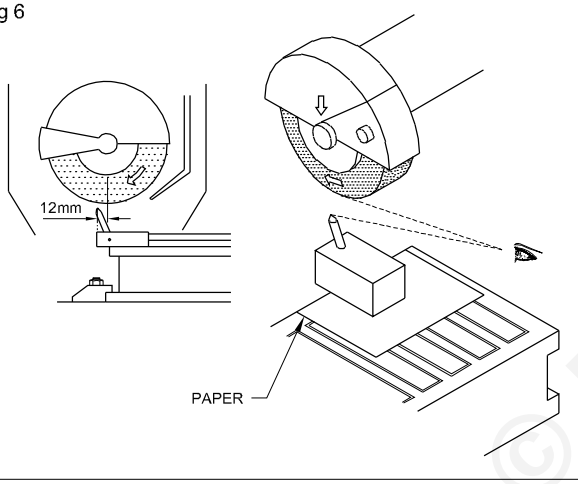
Clean the magnetic chuck thoroughly with a cloth and then (Fig 5) feel for any dirt with your palm. Remove it if any.

Fig 5



Place the diamond on the last two magnetic poles on the left hand end of the magnetic chuck Paper should be placed between the diamond holder and the chuck is prevent scratching the chuck surface when removing the diamond holder. (Fig.6)

Fig 6



The point of the diamond should be offset about 12mm from the grinding wheel centre line with reference to the direction of rotation of grinding wheel (Fig.6)

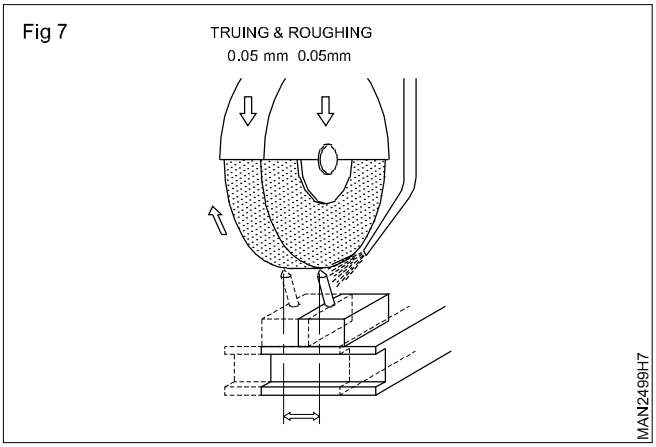
Make sure that the diamond clears the wheel, then start the grinder.

Lower the wheel until it touches the diamond.

Move the diamond slowly across the face of the wheel (Fig.7)

Take light cuts (0.02mm) until the wheel is clean, sharp and is running true.

Fig 7



Take a finish pass with 0.01mm across the face of the grinding wheel. (Fig 8&9)

Fig 8

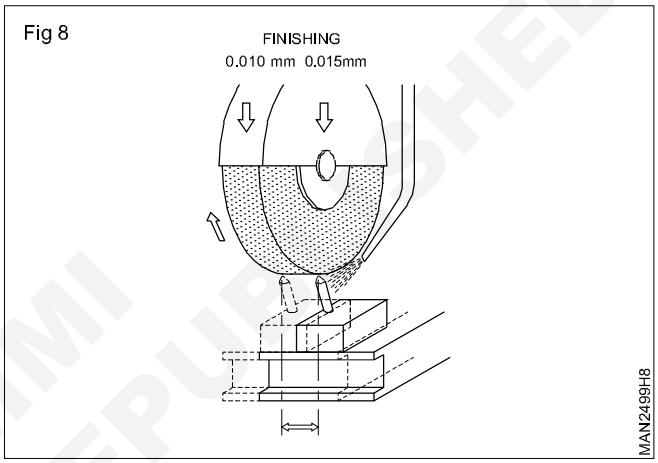
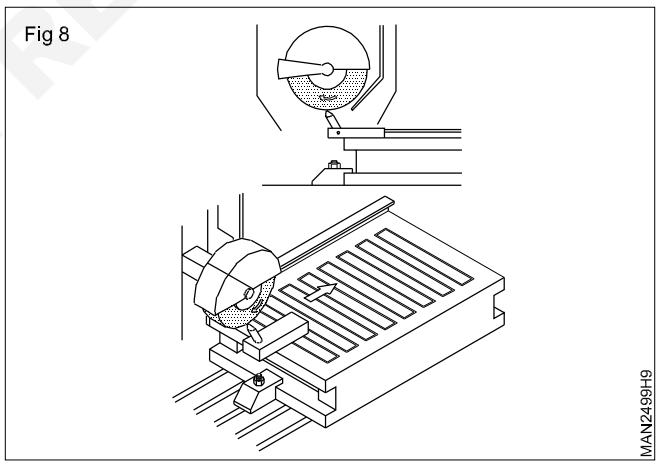
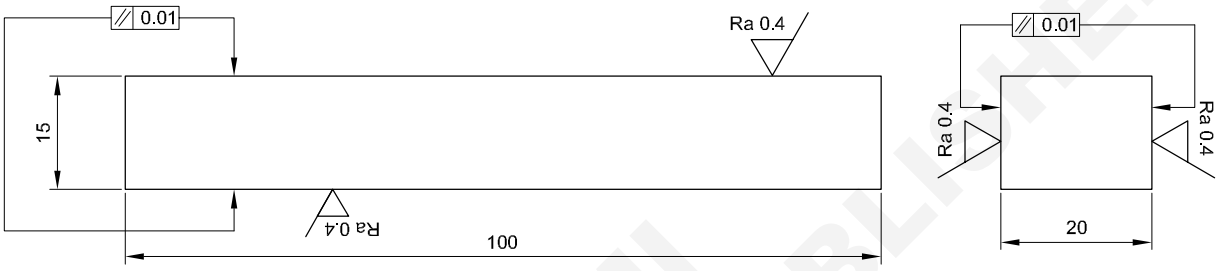


Fig 8



Grinding of block (six sides) by surface grinding machine with an accuracy of +/- 0.01mm

Objectives: At the end of this exercise you shall be able to
- **grind parallel surface to an accuracy +/-0.01**
- **prepare the surface grinding machine for grinding operation.**



Job Sequence

- Machine the jobs and determine the grinding allowance for each surface to be ground.
- Prepare the surface grinding machine for grinding.
- Rough grind both the opposite sides of the pieces and maintain to 15.04mm thick.
- Dress the wheel for finish grinding.
- Finish grind the pieces 15.00 thick to an accuracy of ±0.01mm. Measure the size with a 0-25 outside micrometer.
- Set the job with the angle plate (150x150) by 2 'C' clamps of 100mm size for grinding adjacent surfaces at 90°.
- Rough grind the adjacent sides individually leaving half of the grinding allowance for the opposite surfaces to 20.03mm thick.
- Mount the job on the magnetic chuck keeping down the surfaces already ground and rough grind the opposite surfaces of 20.03mm thick.
- Finish grind and bring the thickness to 20.00 to an accuracy of ± 0.01mm.
- Remove the parallels from the magnetic chuck.
- Clean thoroughly and deburr with a fine abrasive stone.
- Measure the width and thickness for dimensional accuracy with an outside micrometer.
- Also check for parallelism with an outside micrometer on the four corners on each piece.
- Demagnetize the block.

-	20x105x25	-	CI	-	-	1.7.96
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	GRINDING OF BLOCK (SIX SIDES) BY SURFAE GRINDING MACHINE WITH AN ACCURACY OF +/- 0.01 mm	TOLERANCE = ±0.01mm TIME:
		CODE NO. MA20N1796E1

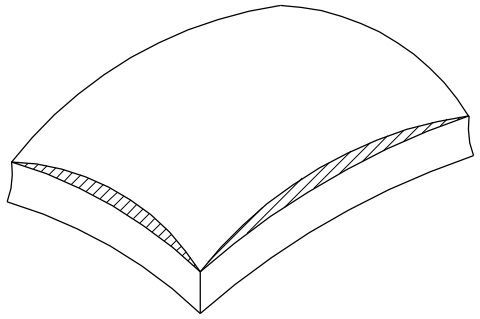
Skill Sequence

Grinding parallel surfaces

Objective: This shall help you to
- **grind parallel surfaces to an accuracy of ± 0.01.**

Always assume that the workpiece is distorted in one or more planes. (Fig 1) For this reason a true reference face must first be produced.

Fig 1

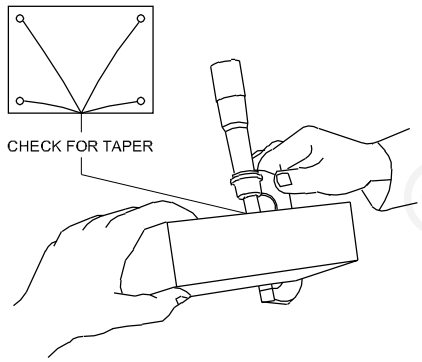


MAN24100I1

Check the flatness with a straight edge and locate the lowest spot by visual examination.

Check the parallelism using an outside micrometer and mark the high spot. (Fig 2)

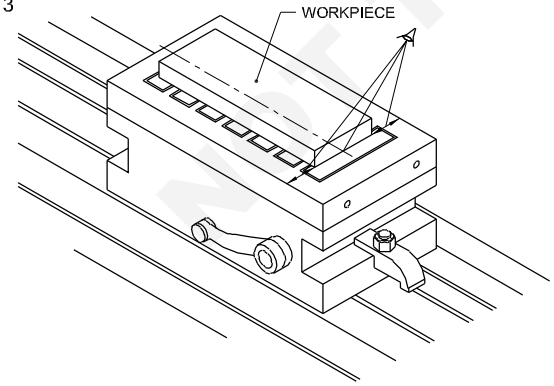
Fig 2



MAN24100I2

Clean the work table surface and the bottom of the magnetic chuck. (Fig 3)

Fig 3

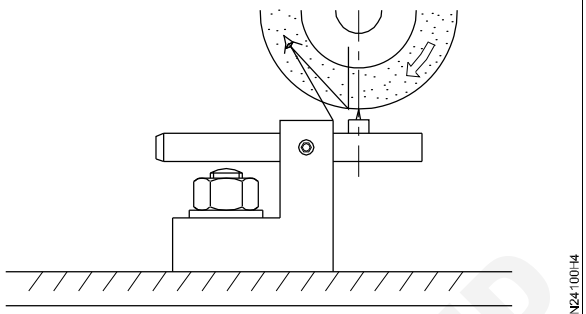


MAN24100I3

Place, align and clamp securely the magnetic chuck over the work table.

Dress the grinding wheel for rough grinding. (Fig 4) (Seek the help of your instructor)

Fig 4

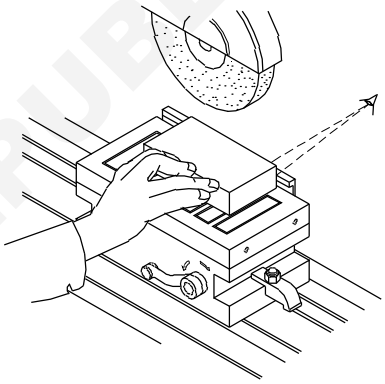


MAN24100I4

Clean the abrasive particles spread over the magnetic chuck and table.

Mount the workpiece on the magnetic chuck, (Fig 5) resting the lengthier surface with the side stopper plate of the magnetic chuck.

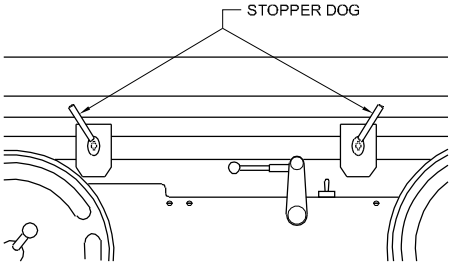
Fig 5



MAN24100I5

Set the table traverse-stopper dog considering the (Fig 6) approach length and over travel. Also set for the clearance of the job width.

Fig 6



MAN24100I6

Set the feed rate of the table to 10 to 15 m/mm.

Hand-feed the wheel head down, and watch the narrowing of the gap. Stop at 0.25 mm gap approximately.

Clear the job from the grinding wheel.

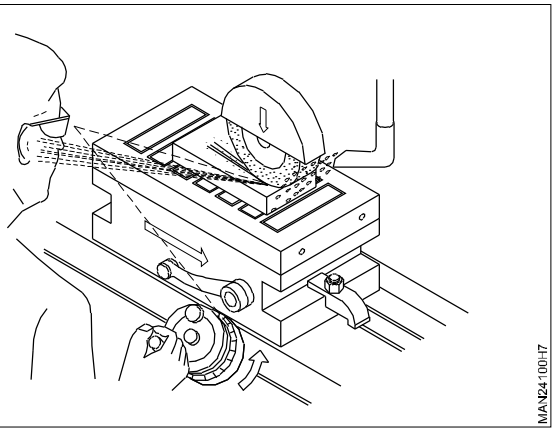
Switch on the grinding wheel spindle.

Engage the longitudinal power traverse using the fine feed mechanism and 'pick up spark' at the high spot.

Cross-traverse the workpiece to clear the wheel.

Start the coolant pump and direct the stream of the coolant between the wheel and the workpiece. (Fig 7)

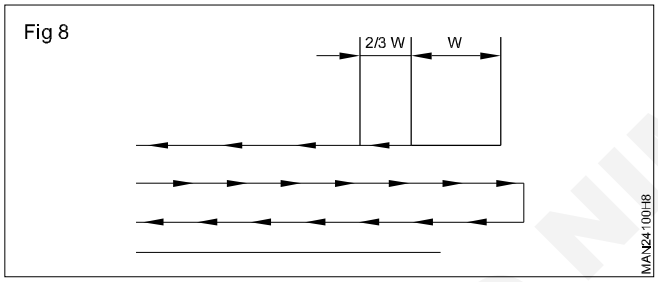
Fig 7



This will reduce the heat of the job, and the ground particles will be washed away.

Apply a 0.03 mm depth of cut by the fine feed mechanism when the workpiece clears the grinding wheel after each cut. (Fig 8)

Fig 8



Keep your hands away from the revolving wheel at all times to avoid injuries to yourself.

Repeat rough grinding till the grinding allowance for that side is ground away.

Cross-traverse the workpiece to clear the wheel.

Re-dress the grinding wheel for finish grinding. (Seek the help of your instructor). Clean the table and workpiece thoroughly.

Engage the longitudinal travel feed.

Apply 0.012 mm cut and finish grind the workpiece allowing the wheel to 'spark out'.

Always apply the depth of cut at the end of the stroke.

Stop all traverses and turn off the coolant. Position the workpiece away from the wheel.

Remove the workpiece from the magnetic chuck. While so doing see that no scratches are formed on the magnetic chuck. (Consult your instructor)

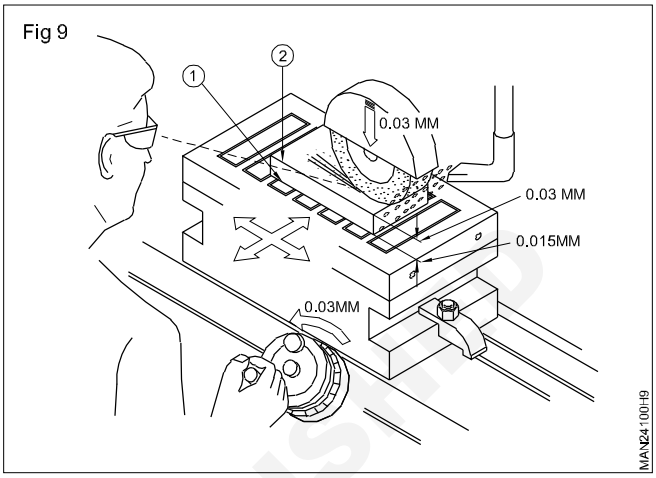
Remove the sharp edges of the workpiece by using a fine abrasive stick or stone.

Check the ground face with a straight edge and the thickness with an outside micrometer. This will be the reference surface for grinding the other surfaces.

Dress the grinding wheel for rough grinding.

Clean the magnetic chuck face and mount the ground surface of the workpiece over the face of the magnetic chuck. (Fig 9)

Fig 9



Set table traverse stops.

Clean up the face by removing minimum material.

Remove the workpiece, deburr and clean it.

Determine the stock of material to be removed with an outside micrometer.

Check parallelism with an outside micrometer and determine the amount of taper if any. (To correct taper ask your instructor for advice)

Remount the workpiece in the same position and continue rough grinding, leaving an allowance of 0.012 mm for finish grinding.

Remove the workpiece and dress the wheel for finish grinding.

Remount the workpiece and give a depth of cut of 0.005 mm and grind the surface.

Remove the workpiece from the magnetic chuck.

Thoroughly clean the workpiece and the surface of the chuck.

Measure the thickness and parallelism and decide the remaining allowance.

Remount the workpiece and apply another 0.005 mm depth of cut and finish grind.

Using the graduated dial of the wheel head, down feed for grinding the remaining allowance.

Allow the wheel to spark out.

Remove the workpiece and clean thoroughly. Check the thickness, parallelism and flatness of the surface texture.

Preparing surface grinding machine for grinding

Objective: This shall help you to
- **prepare the surface grinding machine for grinding operations.**

Preparing wheel spindle

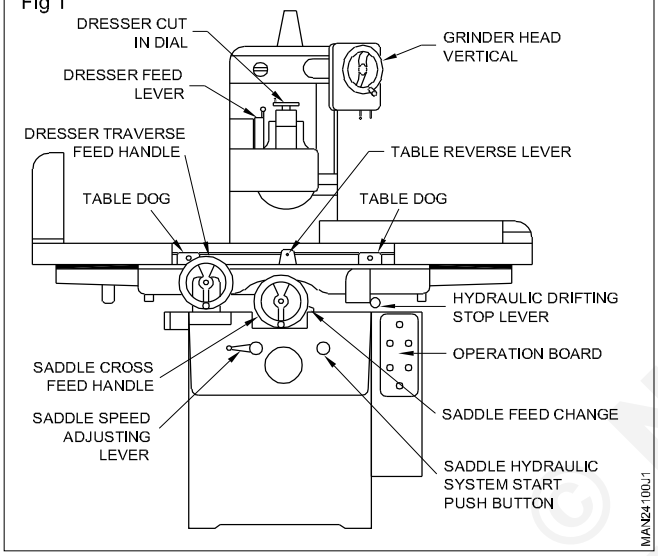
It is very essential to check the different controls of the machine before actually starting the grinding operation. This will help the preparation of the machine for work. Check the following before the grinding operation.

Checking and oiling before start

Supply oil to all the lubricating points.(Consult your instructor)

Check that the button on the operation board is at the stop position. (Fig 1)

Fig 1



Check that the clutch of the table traverse feed handle is cut.

Check that the table dog is fixed.

Manual feed of table

Set the table reverse lever at the neutral position (Fig.1) Engage the clutch of the table traverse feed handle.

Move the table to the right and left by turning the handle clockwise and anticlockwise respectively.

Manual and automatic feed of saddle

Move the saddle forward by turning the saddle cross-feed handle clockwise. (Fig 1)

Move the saddle backward by turning the saddle cross-feed handle anticlockwise.

Set in the automatic feed by turning the saddle feed change lever upward and downward. (Fig 2) (when the lever is pushed up or down, the saddle moves forward or backward respectively)

Raise and lower the grinding wheel.

Disengage the fine feed knob. (Fig 3)

Fig 2

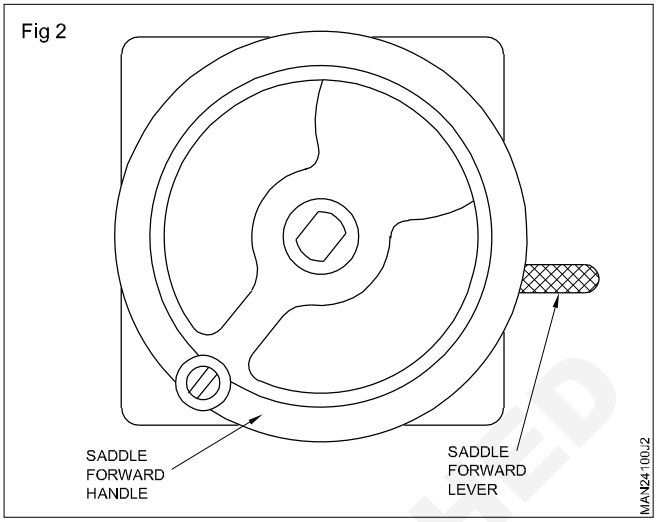
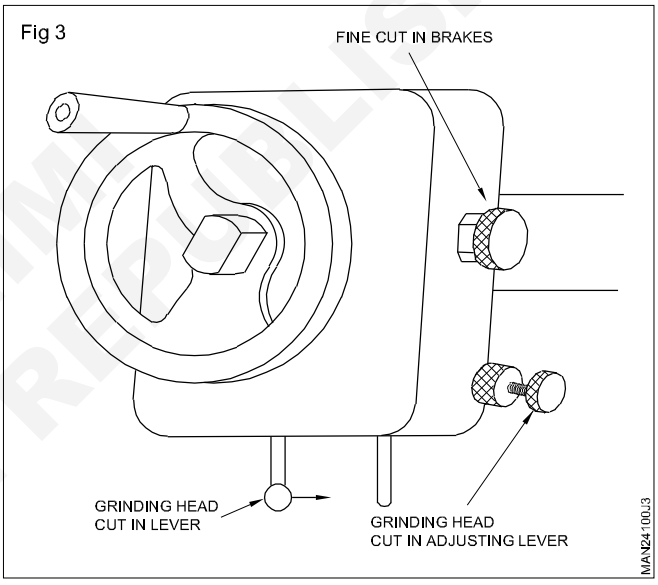


Fig 3



Turn the grinding wheel elevation handle anticlockwise to lower the grinding wheel. (Fig 1)

Turn the grinding wheel elevation handle clockwise to raise the grinding wheel.

Hydraulic operation of table

Pull the table traverse feed handle to the front side to disengage the clutch.

Push the hydraulic driving push-button to drive the table hydraulically. (Fig 1)

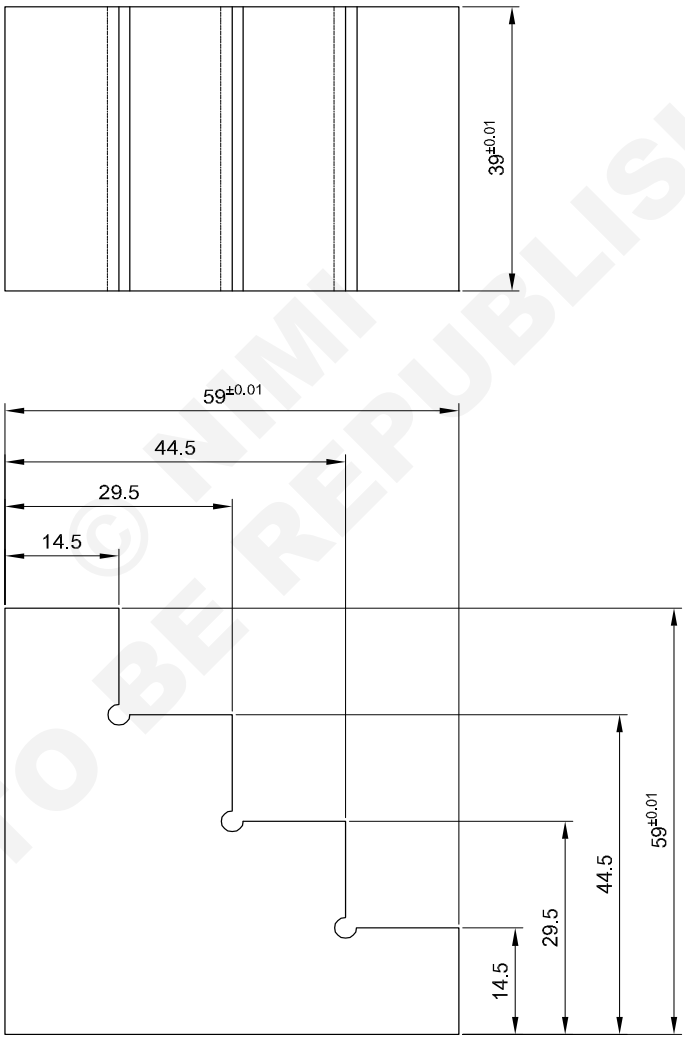
Adjust the table speed by the use of the table speed adjusting lever. (When the lever is pushed up, the table speed is increased. The speed is decreased by lowering the lever and the hydraulic drive is stopped at the lowest position of the lever)

Stop the hydraulic drive by pushing or pulling the hydraulic drive stop lever. (The table is stopped at the right end position)

Grinding of step block by surface grinding machine with an accuracy ± 0.01mm

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

- **mount the grinding wheel**
- **set the job on the magnetic chuck**
- **align the job on the magnetic chuck using dial test indicator**
- **grind stepped surfaces flat and square**
- **check the dimensions by an out side micro meter.**

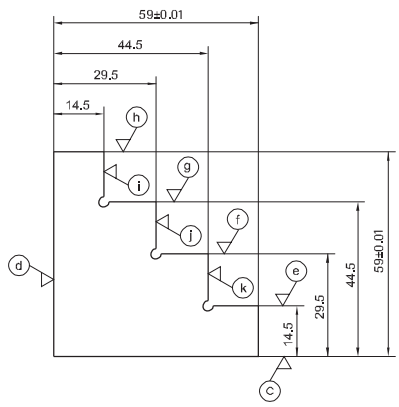


1	-	EX NO.1.5.71 ←	CI BLOCK	-	1	1.7.97
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX.NO.
SCALE 1:1	**STEP GRINDING**				DEVIATIONS ±0.01 mm	TIME:
					CODE NO. MA20N1797E1	

Job Sequence

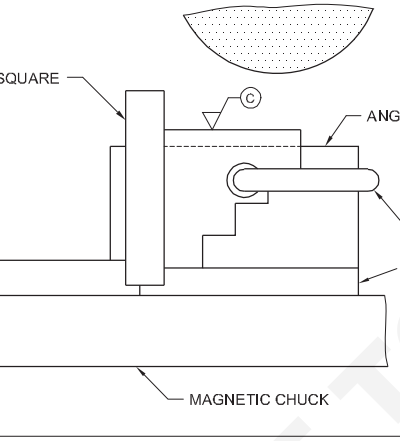
- Study the job drawing, measure the job and determine the grinding allowance on each surface and step to be ground. (Fig 1)

Fig 1



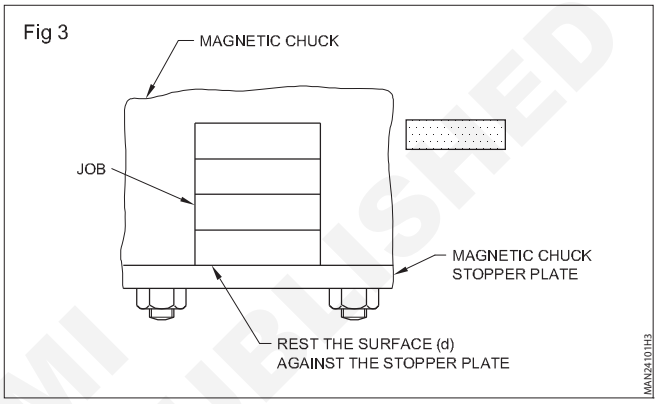
- Prepare the machine, the magnetic chuck and grinding wheel for the surface grinding operation.
- Rough and finish grind the surfaces (a) and (b) to parallel and maintain the size to 39 ± 0.01 mm removing half of the grinding allowance.
- Set the job on the angle plate (150 x 100 mm) with a 100 mm ‘C’ as shown in Fig 2.

Fig 2



- Ensure that the surface (c) is 1 to 2 mm above the top surface of the angle plate.
- Do not seat the job tight on the parallel, after aligning with the try square.
- Rough and finish grind the surface ‘C’ removing half of the grinding allowance.
- Repeat the above steps for grinding the surface (d).
- Rough and finish grind the surface (d) removing half of the grinding allowance.
- Mount the surface (C) on a magnetic chuck,and align the surface (d) against the stopper plate. (Fig 3)

Fig 3

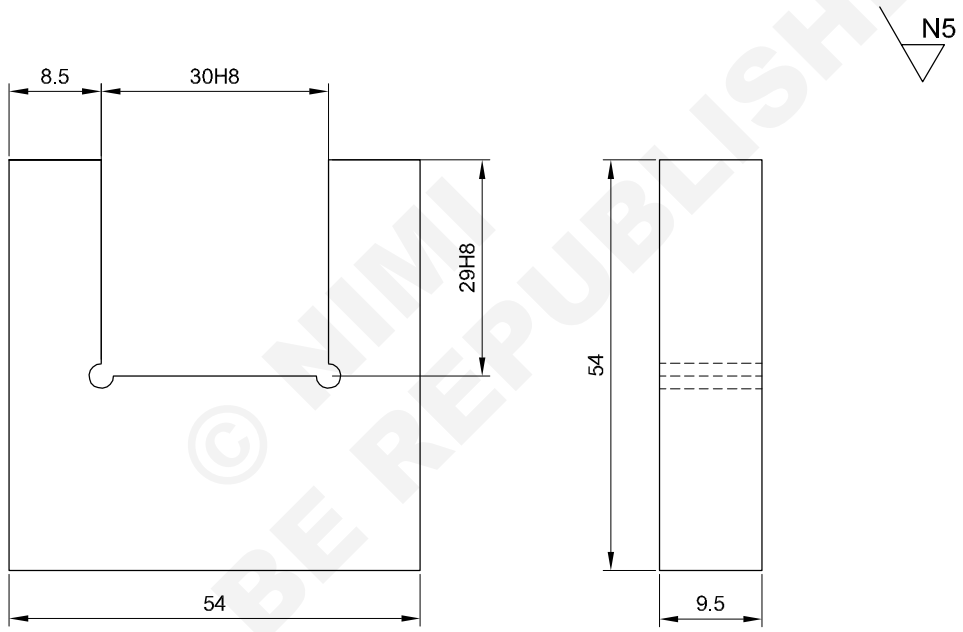


- Rough and finish grind the step (e) to 14.50 mm. Check with a depth micrometer.
- Rough and finish grind the step (f) to 29.50 ((f) - (e) = 15.00). Check with a depth micrometer.
- Rough and finish grind the step (g) to 44.50, (g) - (f) = 15.00). Check with a depth micrometer.
- Rough and finish grind the surface (h) to 59 ± 0.01 (h) - (g) = 15.00). Check with depth micrometer.
- Mount the surface (d) on a magnetic chuck,and align the surface (c) against the stopper plate. (Fig 2)
- Rough and finish grind steps (i) to (2) to the dimensions as per the dimensions given in the drawing.
- Check the steps with a depth micrometer at every stage.
- Deburr all the edges.

Grinding of slot block surface grinding machine with an accuracy of ± 0.01mm

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

- **grind the slot to an accuracy of ± 0.01 mm**
- **mount the job on magnetic chuck.**



1	56x56X10mm	-	Fe310	-	-	1.7.98
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	GRINDING OF SLOT BLOCK BY SURFACE GRINDING MACHINE WITH AN ACCURACY OF +/- 0.01 mm	TOLERANCE ±0.01mm	TIME :
		CODE NO. MA20N1798E1	

Job Sequence

- Prepare the machine and dress the grinding wheel for grinding parallel surfaces.
- Mount the job on the magnetic chuck. Rough and finish grind the surfaces parallel, to maintain the thickness to 9.5mm.
- Deburr the edges.
- Rough and finish grind the width to 54mm using an angle plate and 'C' clamps with suitable parallels.
- In the same setting, rough and finish grind the 54x9.5mm surface at 90° and remove half of the grinding allowance on the length of 54 mm.
- Dress the grinding wheel for the grinding slot.
- Mount the plain vice on the magnetic chuck and align its fixed jaw parallel to the grinding wheel axis.
- Hold the job in the vice such that the bottom of the slot is 2mm above the top surface of the vice jaws.
- Rough and finish grind the top surfaces of the slot to maintain the length to 54.00mm.
- Measure the bottom of the slot with a depth micrometer and decide the grinding allowance.
- Rough and finish grind the bottom of the slot to maintain the depth to 29.00mm using face of the grinding wheel. Check the depth with a depth with a depth micrometer.
- Rough and finish grind the shoulder to 8.50mm using the rear side of the grinding wheel.
- Grind only half of the grinding allowance.
- Check the size, 8.5mm, with an outside micrometer.
- Rough and finish grind the other shoulder until the width of the slot becomes 30.00.
- Check the slot for its centricity with an outside micrometer and the width by a snap gauge, (Consult your instructor)
- Remove the job, deburr the edges, and demagnetize.

Skill sequence

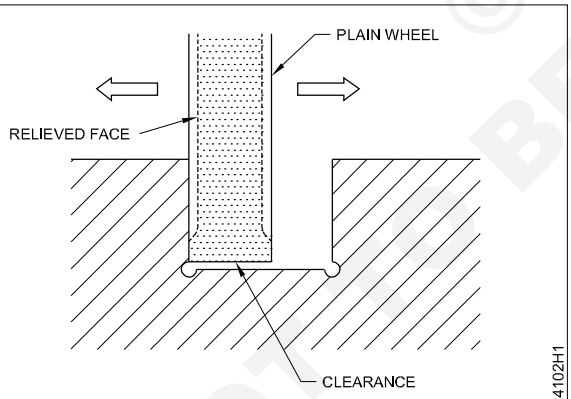
Grinding a slot to an accuracy of ±0.01mm

Objective: This shall help you to

- **grind a slot to an accuracy of ±0.01mm.**

Select and mount the grinding wheel such that the face width of the wheel is less than the width of the slot to be ground.(Fig 1)

Fig 1



GRINDING VERTICAL FACES

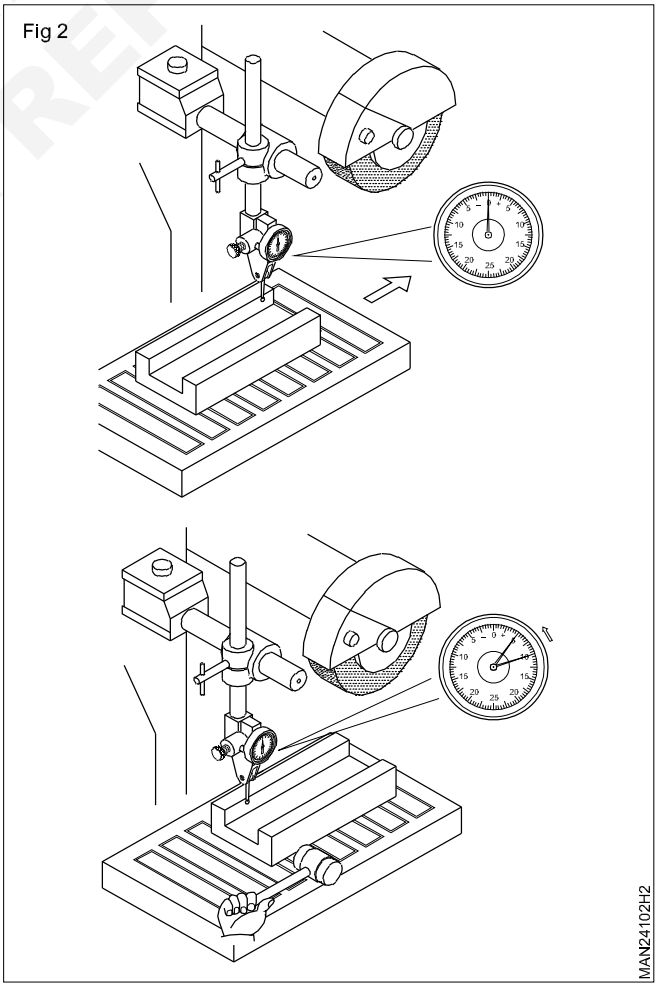
Dress the wheel for the faces, clean up and relieve both sides of the wheel if a straight wheel is used.

Mount the workpiece on to the magnetic chuck directly if it is of a sufficiently large size.

If the job is small in nature, take the support of an angle plate.

Align the workpiece accurately in the correct plane and secure. (Fig 2) (Consult your instructor)

Fig 2



Set the table traverse stops in position.

Position the wheel approximately 0.4mm above the horizontal face of the slot and switch on the wheel.

Engage the table traverse and feed wheel in until it just touches the horizontal surface.

Keep the wheel clear of the vertical faces.

Clean up the whole horizontal surface by the table traverse and careful cross-feed operation. (Consult your instructor)

Stop the wheel and clear it from the work and determine the amount of material to be removed.

Reposition the wheel into the slot, start up the wheel and engage the traverse.

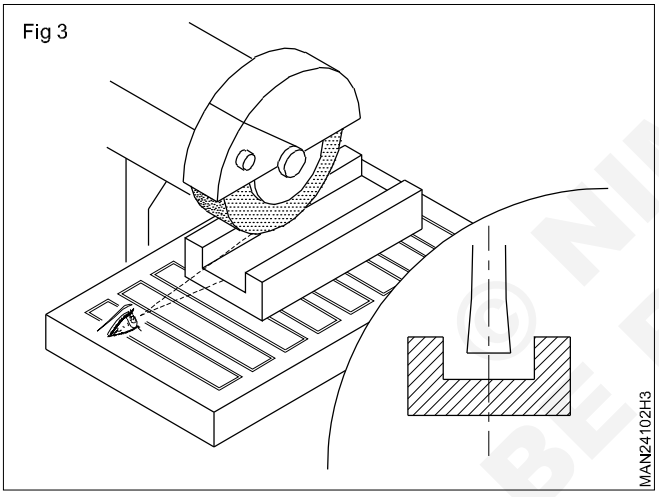
Feed in the wheel and grind the whole surface with 0.04mm accuracy.

Keep the wheel clear of the horizontal face.

Determine the material to be removed on the vertical faces.

Position the wheel and touch the vertical face of the job with the wheel. (Fig 3)

Fig 3

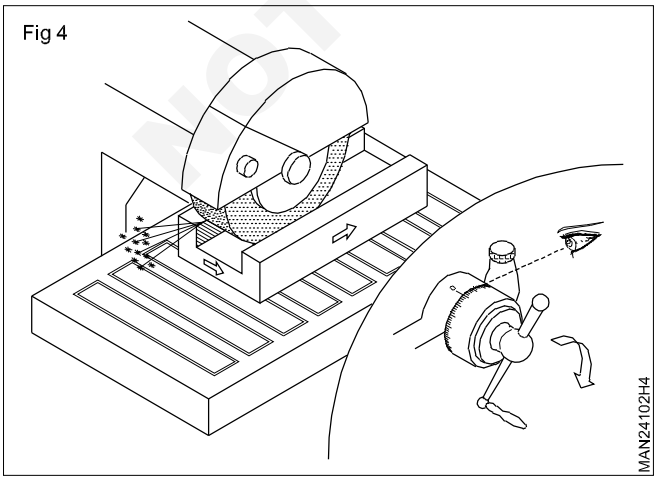


Keep the wheel away from the job.

Set the depth of cut.

Feed the Wheel down and grind the vertical face down up to the corner (recessed). (Fig 4)

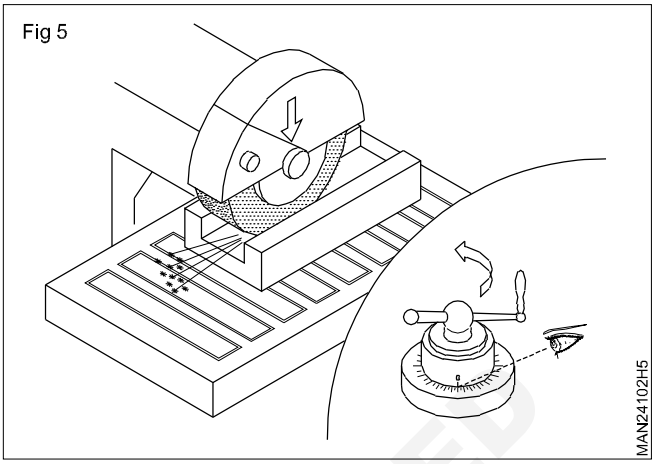
Fig 4



Keep the wheel away from the slot.

Position the wheel and touch the other vertical face of the job with the wheel. (Fig 5)

Fig 5



Keep the wheel away from the job and set the depth of cut.

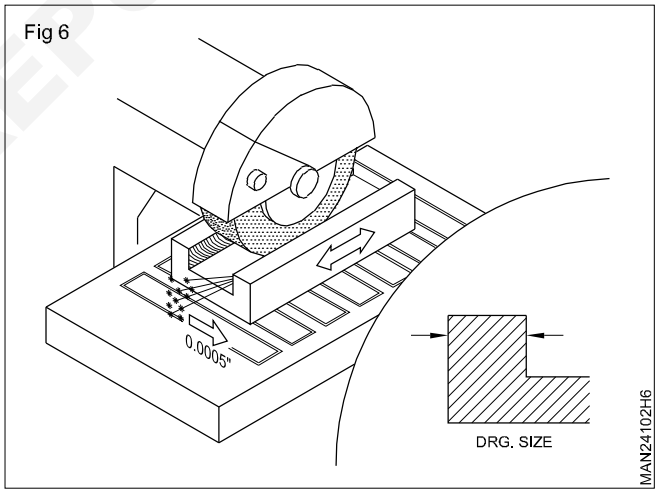
Down-feed the wheel and grind the vertical face down up to the space corner. (Fig 6)

Stop the job away from the grinding wheel.

Deburr and clear the ground surfaces.

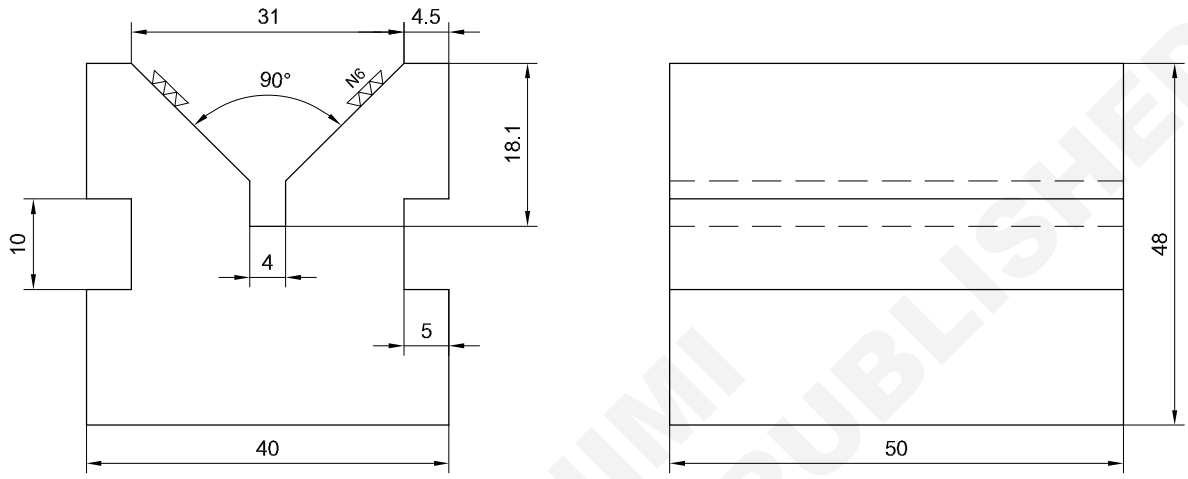
Check the slot for its dimension with a vernier caliper and depth micrometer.

Fig 6



Set and perform angular grinding using universal vice/sine vice to standard angle

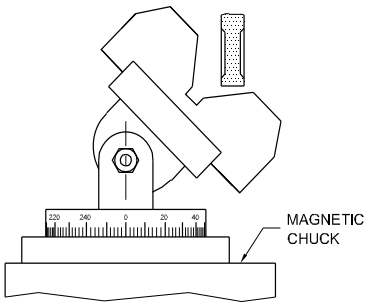
Objectives: At the end of this exercise you shall be able to
- **mount the grinding wheel**
- **set the universal vice on the magnetic chuck**
- **hold the job & grind the angular surface.**



Job Sequence

- Study the drawing. Observe the surface to be ground and determine the grinding allowance for each surface by measuring.
- Prepare the machine dress the grinding wheel for grinding angular surface.
- Mount the suitable universal vice on the magnetic chuck and align its fixed jaw parallel to the grinding wheel axis by using the dial test indicator.
- Ensure that all the swivel base graduations coincide with the O degree dead mark before aligning
- Hold the job in the vice and tilt the vice to 45° (Fig1)
- Rough and finish grind the surface, (a) using the face of the grinding wheel. Record the amount of materials removed by noting down the divisions on the graduated dial of the wheel head.

Fig 1



- Remove the same amount of material from the surface (b) using the front side of the grinding wheel by manual cross-feeding in the same setting.
- Remove the job. Deburr and demagnetise the job.

1	-	1.5.73 ←	-	-	-	1.7.99
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	SET AND PERFORM ANGULAR GRINDING USING UNIVERSAL VICE / SINE VICE TO STANDARD ANGLE	TOLERANCE ±0.01mm	TIME:
		CODE NO. MA20N1799E1	

Skill Sequence

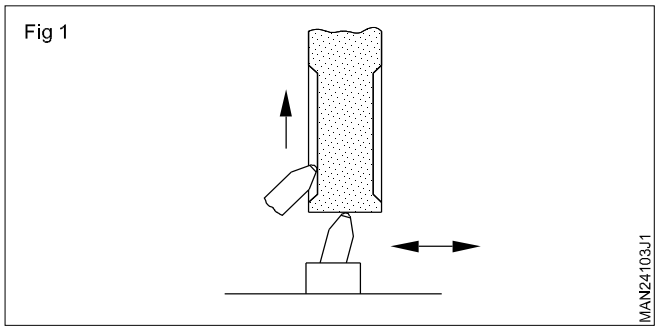
Grinding angular surface using universal vice

Objective: This shall help you to

- **grind angular surfaces using a universal vice.**

Dress the grinding wheel on the sides for relief and on the face for trueness. (Fig 1)

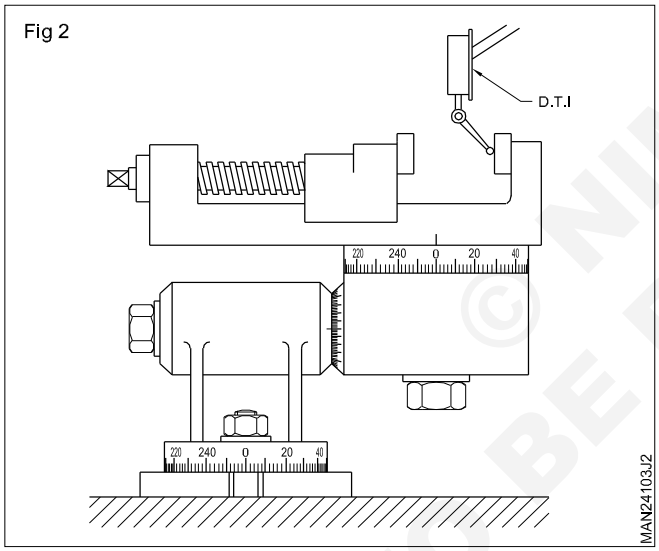
Fig 1



Clean the machine table and mount the universal vice.

Align the fixed jaws of the vice perpendicular to the axis of the spindle. (Fig 2)

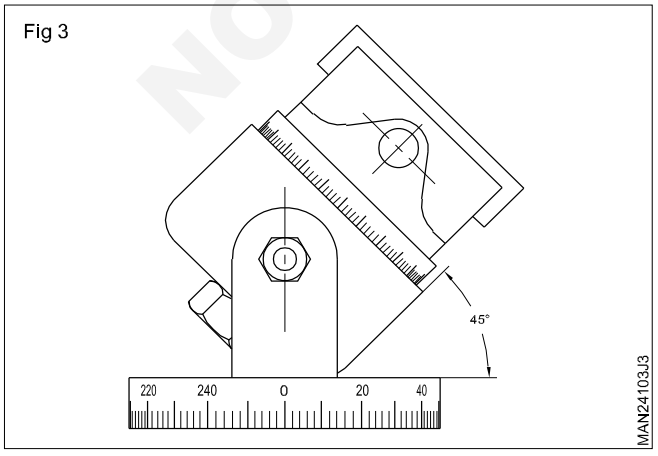
Fig 2



Ensure that the swivel base graduation coincides with 'O' degree dead mark before aligning.

Tilt the vice to 45° with reference to the graduated plate at the bottom of the vice. (Fig 3)

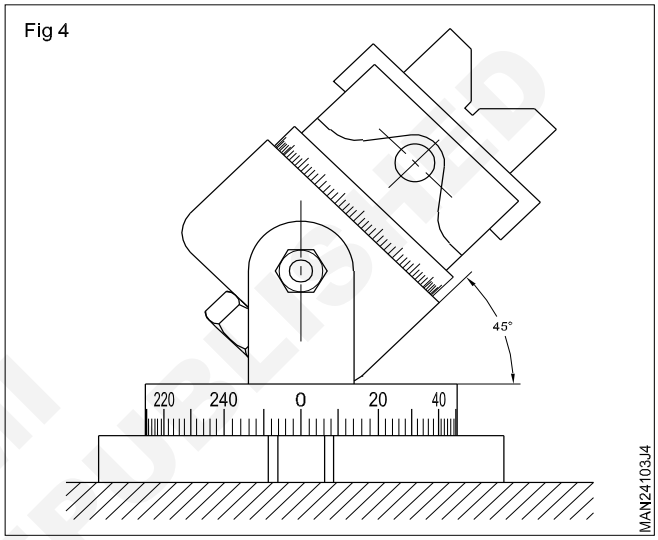
Fig 3



Clean the job and measure it to determine the grinding allowance. (Ask your instructor for help in determining the allowance)

Hold the job in the vice such that the horizontal surface to be ground is aligned parallel to the surface of the table using a dial test indicator. (Fig 4)

Fig 4



Position the stop dogs for longitudinal traverse.

Start the wheel and lower the wheel head until the wheel just sparks the high spot of the job.

Start the table travelling automatically and feed the entire length of the job and clear off the job from the wheel.

Engage the vertical depth for rough and finish cut as predetermined, and feed from the cross-feed manually. (Fig 5a)

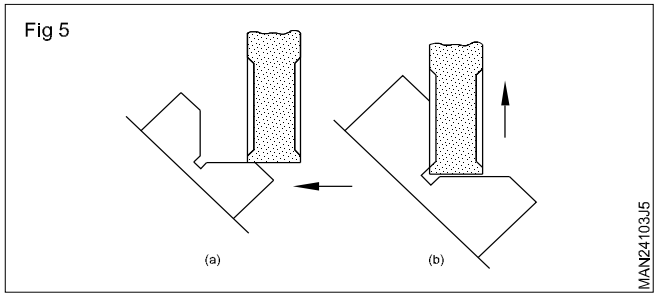
Grind the longitudinal surface up to the corner relief.

Remove only that much of material pre-determined as grinding allowance, and record the amount of material removed.

Raise the wheel head to 0.20mm and without releasing the wheel, plunge the wheel little by little against the vertical surface of the job to be ground to the depth equal to the horizontal surface.

Raise the wheel gradually to finish grind the vertical surface. (Fig 5b)

Fig 5

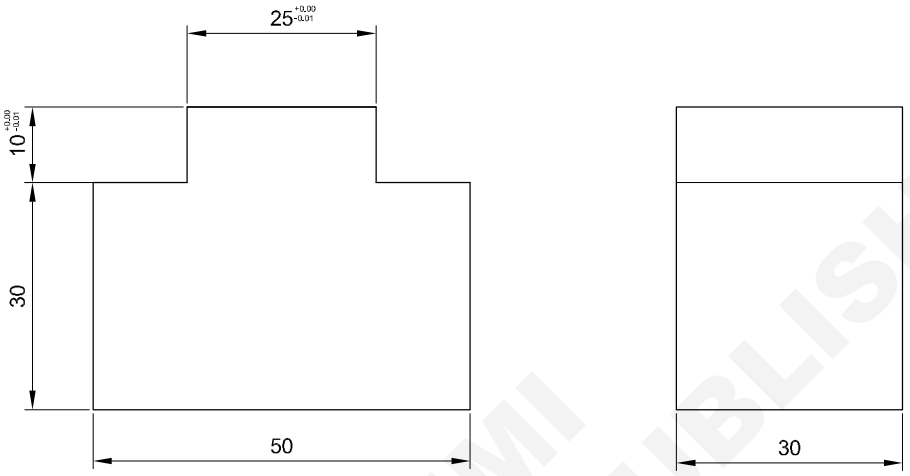


Make slide fit with an accuracy ± 0.01mm (Male & Female)

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

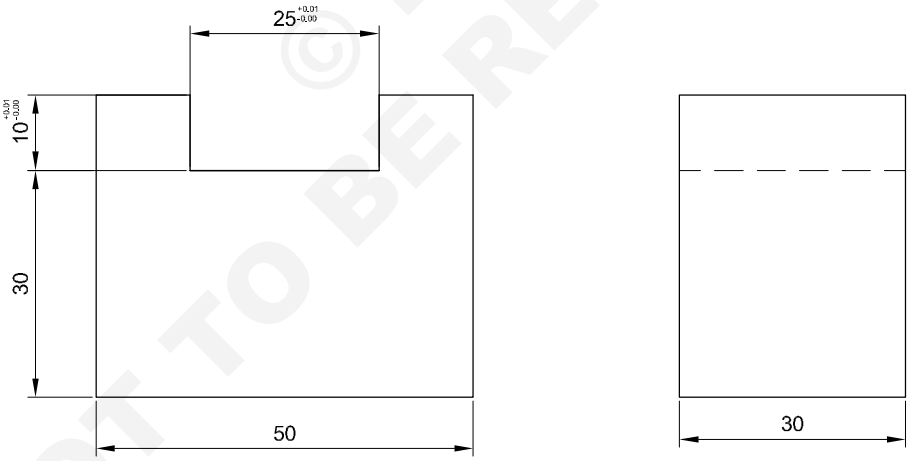
- **set the grinding wheel**
- **mount the job**
- **grind the male & female part as per drawing with an accuracy of ± 0.01.**

TASK-1



MALE PART

TASK-2



FEMALE PART

2	50x40x30	PRE MACHINED	Fe310	-	-	1.7.100
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MAKE SLIDE FIT WITH AN ACCURACY ±0.01mm (MALE FEMALE)**	TOLERANCE ±0.01mm	TIME :
		CODE NO. MA20N17100E1	

Job Sequence

TASK 1: **Male part grinding**

- Clean the work piece
- Check the work piece to determine the grinding allowance
- Select the machine tool and dress the grinding wheel
- Clean the machine table
- Set the magnetic chuck and align by using Dial Test Indicator
- Set and align the work piece
- Start the machine and touch down the wheel and then finish grind the job
- Stop the machine
- Remove the job and check measurement by measuring instrument

TASK 2: **Female part grinding**

- Clean the work piece
- Check the work piece to determine grinding allowance
- Select the suitable grinding wheel and dress the grinding wheel
- Clean the machine table
- Clean the magnetic chuck
- Set and align the work piece
- Start the machine and touch down the wheel and then finish grind the job
- Stop the machine
- Check matting part (slide level)
- Remove the job and clean the job
- Measure and check the dimension
- Matting and slide the job.

Skill Sequence

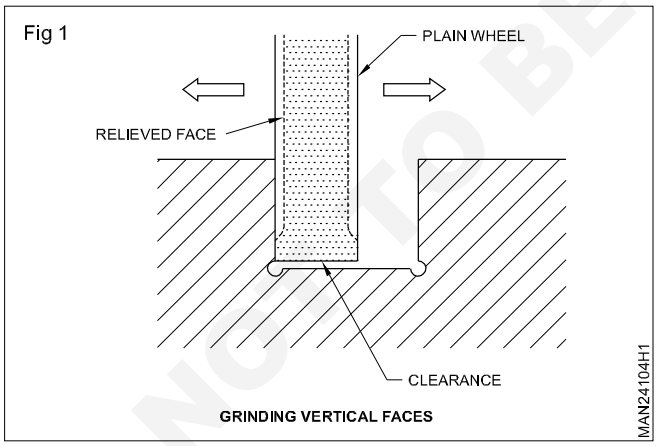
Grinding a slot to an accuracy of ± 0.01 mm

Objective: This shall help you to

- **grind a slot to an accuracy of ± 0.01 mm.**

Select and mount the grinding wheel such that the face width of the wheel is less than the width of the slot to be ground (Fig.1)

Fig 1



GRINDING VERTICAL FACES

Dress the wheel on the faces, clean up and relieve both sides of the wheel if a straight wheel is used.

Mount the workpiece on the magnetic chuck directly if it is sufficiently large size.

If the job is small in nature, take the support of an angle plate.

Align the workpiece accurately in the correct plane and secure. (Fig.2)

Set the table traverse stops in position.

Position the wheel approximately 0.4mm above the horizontal face of the slot and switch on the wheel.

Engage the table traverse and feed the wheel in, until it just touches the horizontal surface.

Keep the wheel clear of the vertical faces.

Clean up the whole horizontal surface by the table traverse and careful cross-feed operation. (consult your instructor)

Stop the wheel and clear it from the work and determine the amount of material to be removed.

Reposition the wheel into the slot, start up the wheel and engage the traverse.

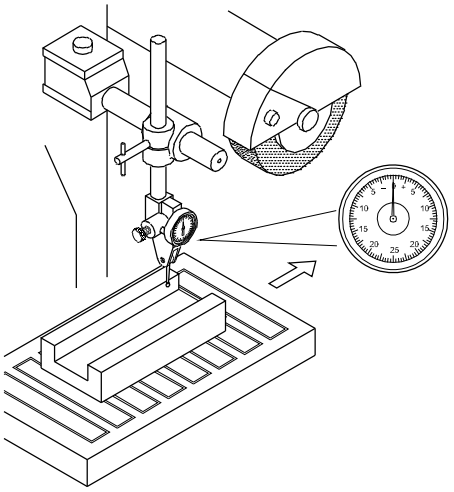
Feed in the wheel and grind the whole surface with 0.04mm accuracy.

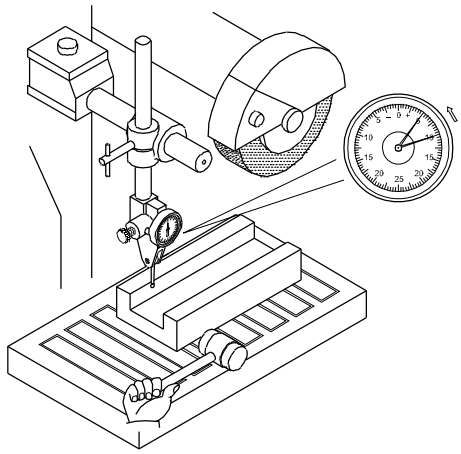
Keep the wheel clear of the horizontal face.

Determine the material to be removed on the vertical faces.

Position the wheel and touch the vertical face of the job with the wheel. (Fig. 3)

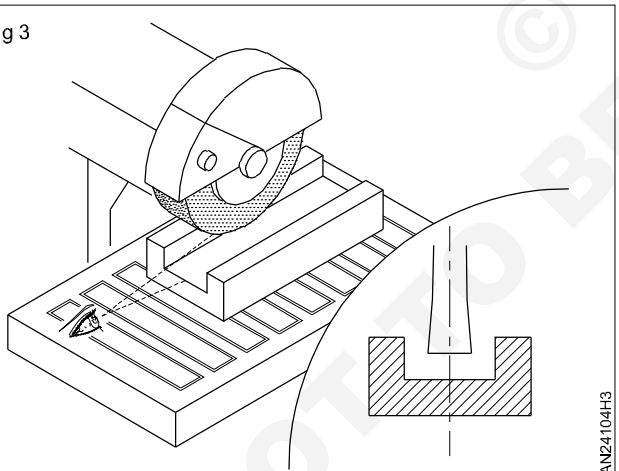
Fig 2





MAN24104H2

Fig 3



MAN24104H3

Keep the wheel away from the job.

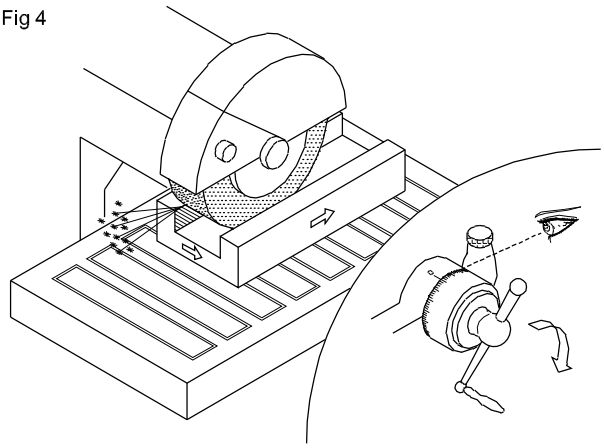
Set the depth cut.

Feed the wheel down and grind the vertical face down up to the corner (recessed). (Fig. 4)

Keep the wheel away from the slot.

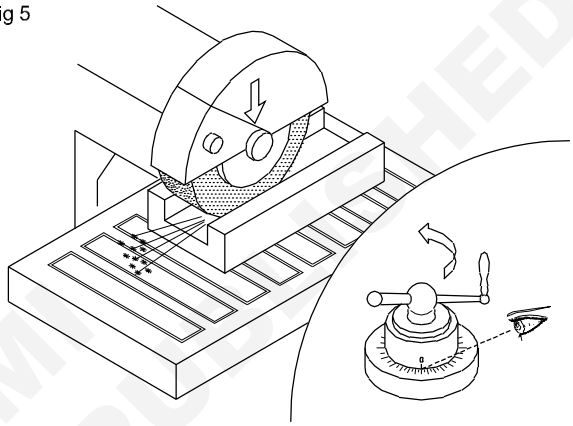
Position the wheel and touch the other vertical face of the job with the wheel. (Fig. 5)

Fig 4



MAN24104H4

Fig 5



MAN24104H5

Keep the wheel away from the job and set the depth of cut.

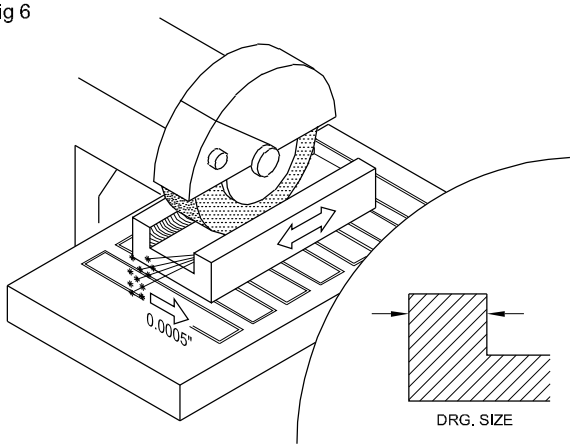
Down-feed the wheel and grind the vertical face down to the corner. (Fig. 6)

Stop the job away from the grinding wheel.

Deburr and clear the ground surfaces.

Check the slot for its dimension with a vernier caliper and depth micrometer.

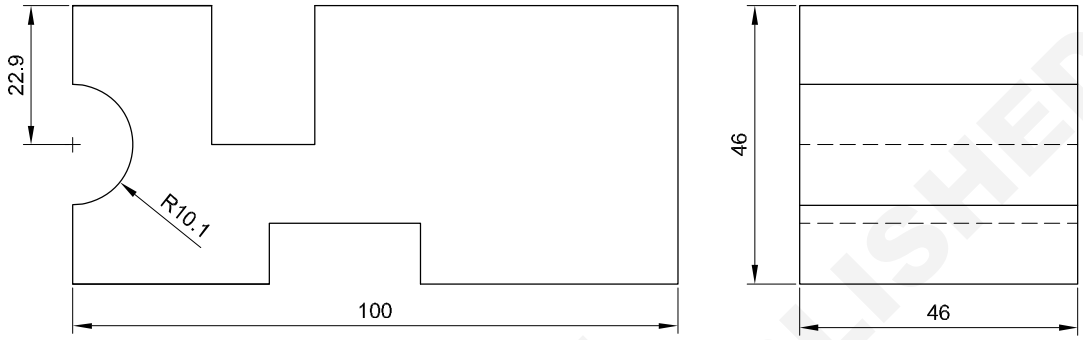
Fig 6



MAN24104H6

Perform form grinding

Objectives: At the end of this exercise you shall be able to
- **select and set the grinding wheel**
- **mount the job on magnetic chuck**
- **grind the concave surface.**



CONCAVE SURFACE

Job Sequence

TASK 1

Concave surface grinding

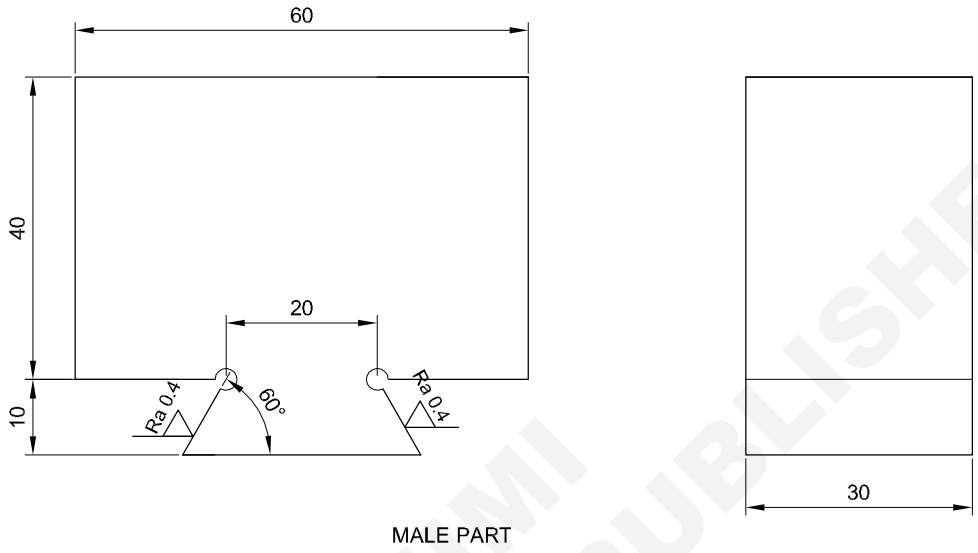
- Clean the work piece.
- Check the work piece to determine grinding allowance.
- Select the machine tool and dress the grinding wheel.
- Clean the machine table and magnetic chuck.
- Set the magnetic chuck and align by using Dial Test Indicator.
- Set and align the work piece.
- Start the machine and touch down the wheel and then finish grind the job.
- Stop the machine and check the measurement.
- Set the radius attachment on magnetic chuck and form the wheel in according to radius.
- Remove the attachment after completing the job.
- Set the job and align with form wheel.
- Finish the form grinding to required depth.
- Stop the machine and check machine by radius gauge.
- Clean the job.
- Clean the job.

1	-	1.5.74 ←	-	-	-	1.7.101
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**PERFORM FORM GRINDING**				TOLERANCE ±0.01mm	TIME:
					CODE NO. MA20N17101E1	

Make dovetail fitting with an accuracy ± 0.01mm (Male & Female)

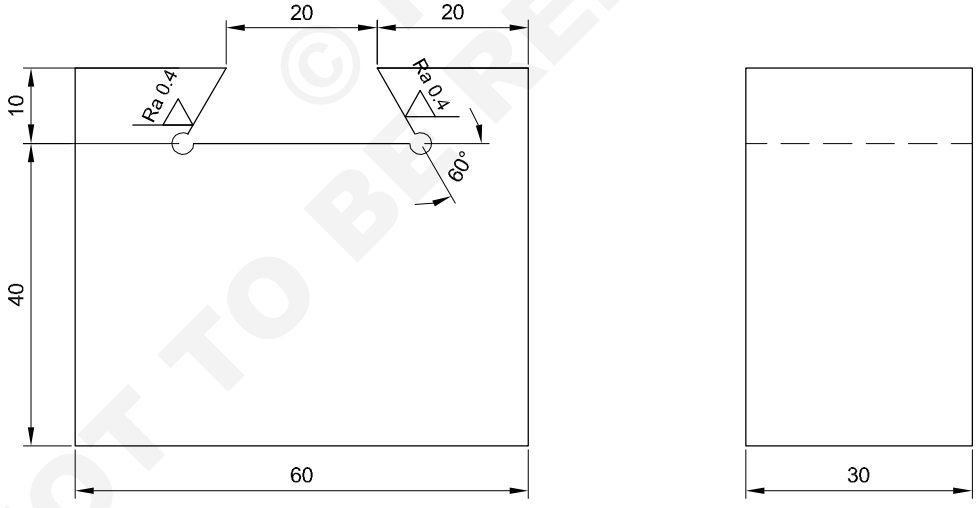
Objectives: At the end of this exercise you shall be able to
- **select and set the grinding wheel**
- **mount the job on magnetic chuck.**

TASK-1



MALE PART

TASK-2



FEMALE PART

RELIEF HOLE Ø3 MM

2	65x55mm	-	Fe310	-	-	1.7.102
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MAKE DOVETAIL FITTING WITH AN ACCURACY ±0.01mm (MALE & FEMALE)**	TOLERANCE ±0.01mm	TIME :
		CODE NO. MA20N17102E1	

Job Sequence

TASK 1**: Grinding male part**

- Prepare the job in milling as per drawing leaving the grinding allowance.
- Fix the vice on table of surface grinder.
- Set the job on vice using parallel block.
- Fix press the wheel to 30° on the spindle.
- Grind the dovetail 60° on both side.
- Check the dimension and angles with the use of vernier caliper and vernier bevel protractor.
- Remove the job and deburr.

TASK 2: **Female part**

- Make the female dovetail on milling machine.
- Finish dovetail surface using fine oil stone.
- Match the job with the male part.

Job Sequence

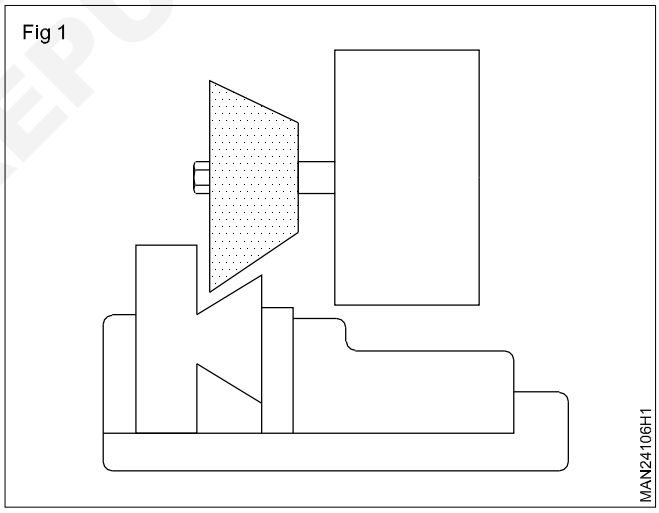
TASK 1: **Grinding female part**

- Prepare the job in milling as per drawing leaving the grinding allowance.
- Study the drawing and ascertain the surface to be ground.
- Fix the vice on the table of vertical surface grinder.
- Dress the grinding wheel in required shape.
- Set the job on vice using parallel block.
- Grind the dovetail 60° on both side.
- Check the depth with a depth micrometer.
- Remove the job deburr all the edges with a fine abrasive stone.

TASK 2: **Male part**

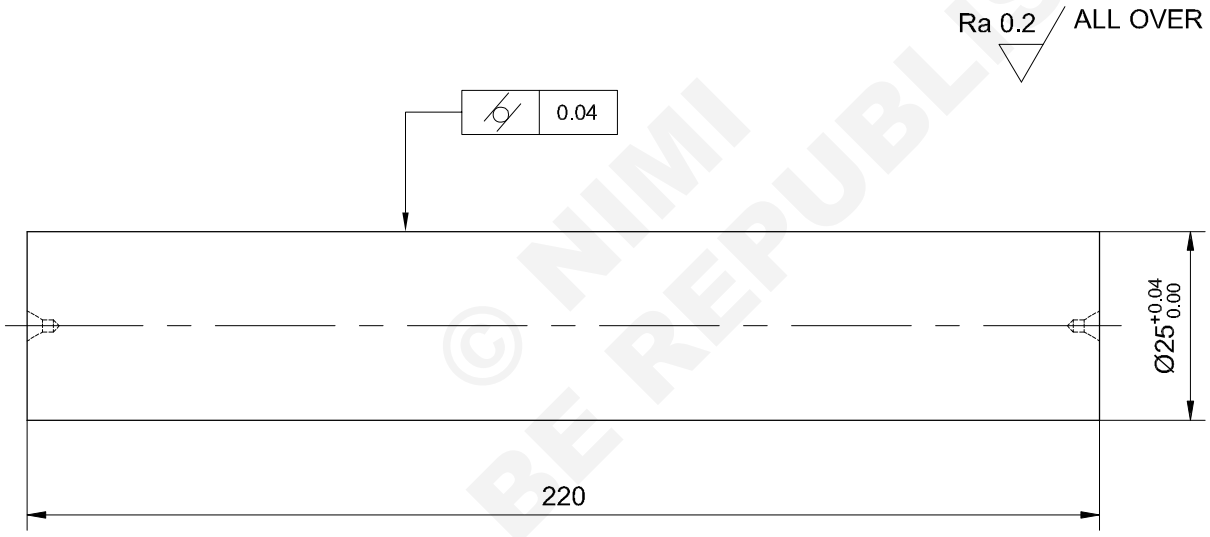
- Prepare the job in milling as per drawing leaving the grinding allowance.
- Study the drawing and as certain the surface to be ground.
- Fix the vice on the table in vertical surface grinder.
- Dress the grinding wheel in required shape.
- Set the job on vice using parallel block.
- Grind the dovetail 60° on both
- Check the depth with a depth micrometer.
- Remove the job deburr all the edges with a fine abrasive stone.
- Grinding wheel setting against the job is shown in Fig 1.

Fig 1



External parallel cylindrical grinding (Both holding in chuck/collet and in between centres)

Objectives: At the end of this exercise you shall be able to
- **select and set the grinding wheel**
- **mount the job**
- **check the parallelism with dial test indicator.**



1	Ø26x220	–	Fe310	–	–	1.7.103
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	EXTERNAL PARALLEL CYLINDRICAL GRINDING (BOTH HOLDING IN CHUCK / COLLET AND IN BETWEEN CENTERS)	DEVIATIONS ±0.04 mm	TIME:
		CODE NO. MA20N17103E1	

Job Sequence

- Prepare the cylindrical grinding machine for operation.
- Study the drawing and measure the grinding allowance for given job.
- Dress the grinding wheel make sure that the abrasive particles are removed uniformly.
- Mount the job in between centres.
- Set the length of stroke using reversing dogs.

Fix the safety guard in proper place.

- Put on the grinding wheel.
- Start the work table traverse.
- Bring the grinding wheel forward to engage the workpiece by operating the cross feed hand wheel on the machine.

Wear goggles at all times while using a grinding machine.

- Take a moderate cut (0.04mm) measure the workpiece diameter and the work is parallel after the first traverse.
- Continue traverse and give depth of cut at the end of each traverse until the job is within 0.05-0.10mm of the required final size.
- Reserve the position of the job in the centres.

Use a soft metal spacer to protect the job.

- Grind the end of the job previously covered by the carrier to the same size as the other end of the job.
- Dress the grinding wheel.
- Grind the work piece to the finished size Ø25mm like roughing cycle.
- Remove the job from centres.
- Remove burrs of the job using fine abrasive stone.
- Measure the diameter of the job used by 0-25mm outside micrometer.
- Check the cylindrical of the job.

Skill Sequence

Cylindrical grinding

Objectives: At the end of this exercise you shall be able to
- **cylindrical grinding**
- **checking of parallelism**
- **measurement by micrometer.**

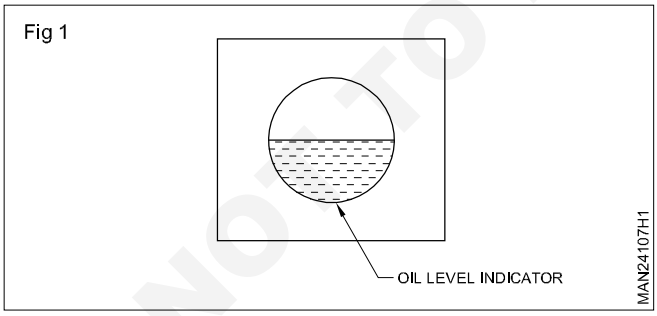
Prepare the cylindrical grinding machine for grinding

Throughly clean the machine with banian cloth.

Don't use cotton waste for cleaning the grinding machine.

Check the oil level in the workhead and wheel head (Fig.1)

Fig 1



If it is below the recommended oil level inform to the instructor. (Fig 2)

Apply oil in all oil points use oil gun.

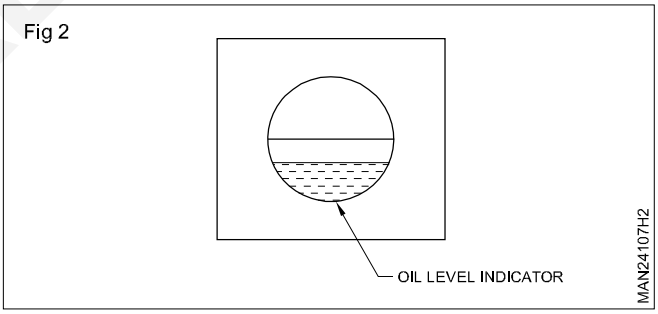
(IOC SAE 30/40)

Apply grease in all grease points with grease gun (servo gem No.2)

Ensure that the work head and wheel head are set to zero position.

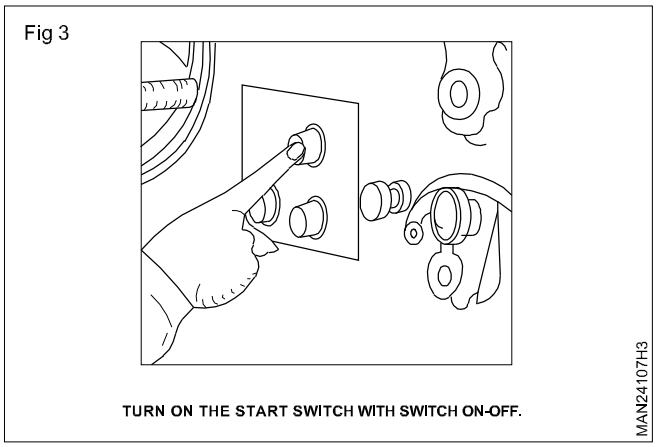
Check the wheel guards are in proper position.

Fig 2



Start the hydraulic motor by pressing the hydraulic motor switch (Fig 3)

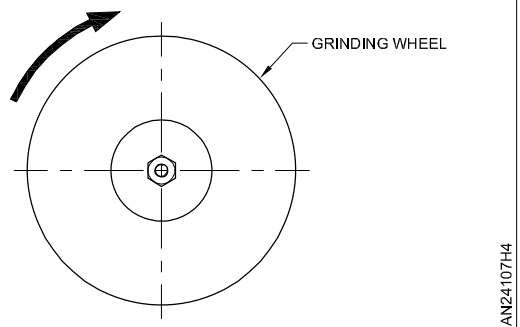
Fig 3



Check the oil pressure gauge.

Start the grinding wheel and check the direction of rotation. (Fig 4) by viewing the direction of arrow provided on the wheel guard.

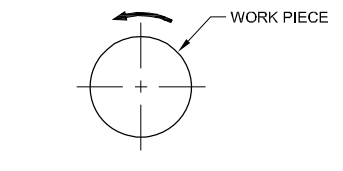
Fig 4



Workhead

Start the work head spindle by pressing the work head motor switch. (Fig 5)

Fig 5



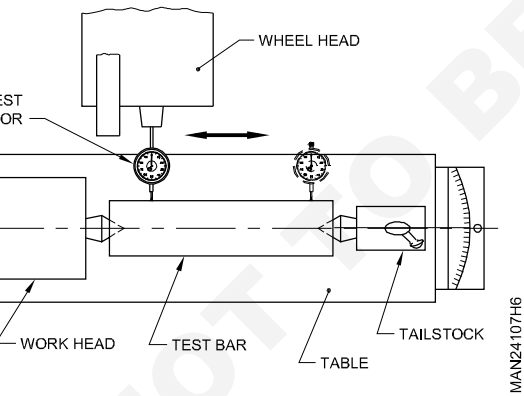
Check for the job rotation.

Align the work table perpendicular to the wheel head

Clean the wheel head of front side.

Hold the dial test indicator with magnetic base on wheel head slide. (Fig 6)

Fig 6



Fix the test bar in between centres.

Set the work head wheel head and table at zero degree.

Touch the dial on job and giving light pressure as shown in figures.

Move the table from work head to tailstock.

Check the dial reading zero.

Incase variation of reading ±10 divisions.

Loose the table top Allen screws and adjust slightly side screw.

Check the dial reading at zero so that the work head centre and tail stock centre at same line.

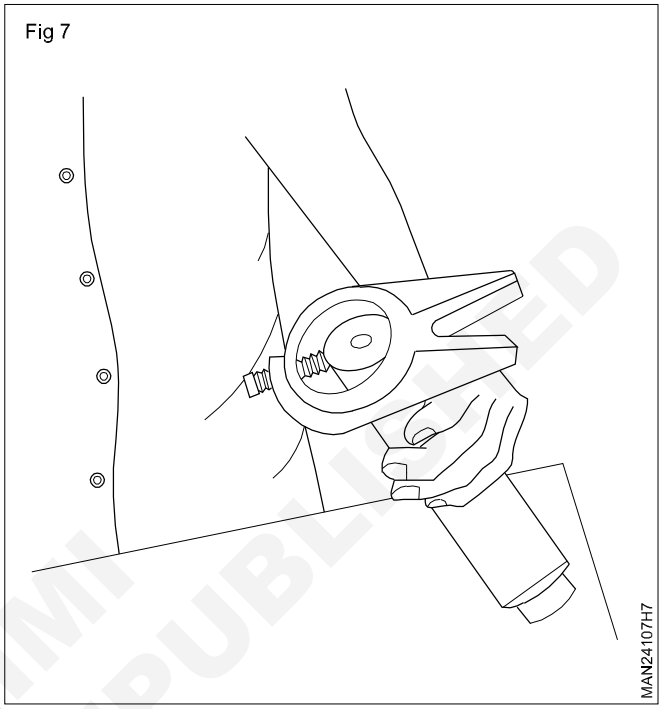
The table at zero degree aligning is correct position.

Set the job in between centres

Select a dog corresponding to the work diameter.

Fit a dog at right angles to the end of the work. (Fig 7)

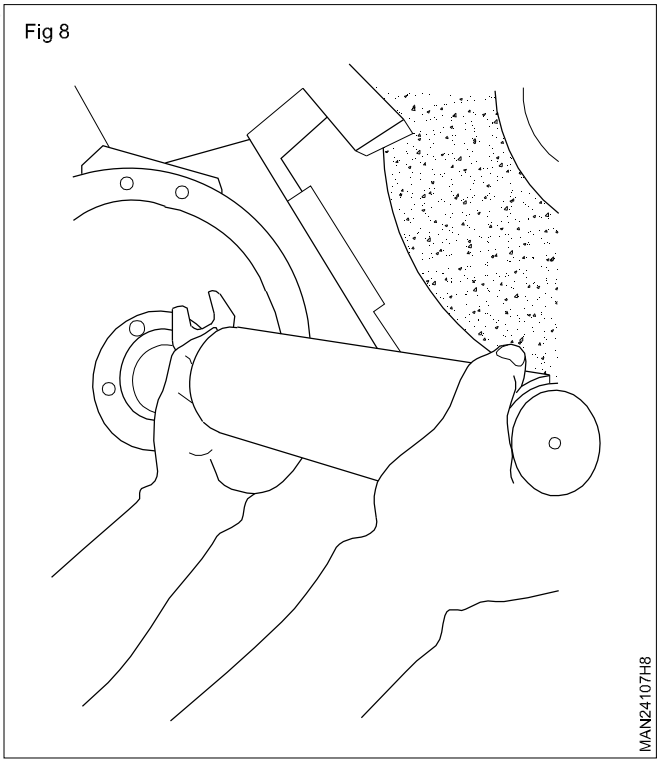
Fig 7



Too long bolt on a dog may become loose in the course of grinding.

Hold the work securely in both hands and fit the centre hole carefully to the centre on the work head side. (Fig.8)

Fig 8



Hold the work with the left hand as illustrated while holding the work to prevent the centre hole coming out.

As illustrated support the work with the left hand and fit the centre to the centre hole by operating the lever of the tailstock with the right hand. (Fig.9)

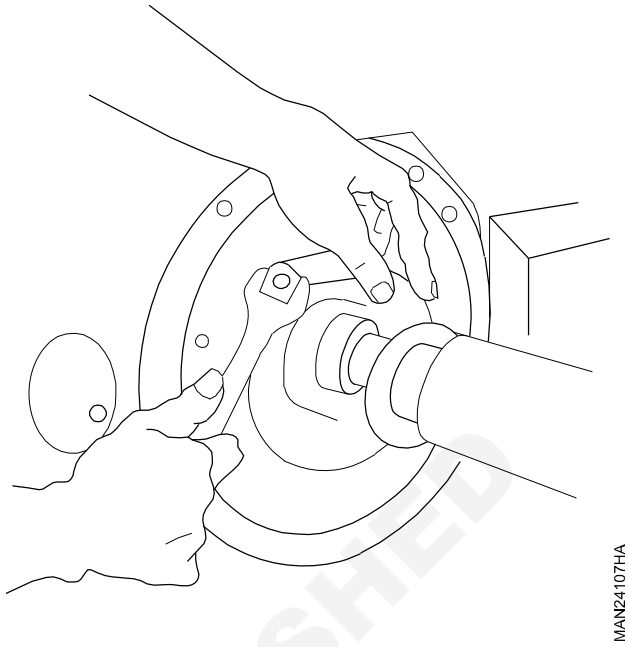
Fig 9

Before support the job in between tailstock centre gap is 5mm should be maintained. (Fig.9)

Where the tailstock centre has a nut for adjusting nut so as to allow the work to be turned lightly by the fingers.

Where the tailstock centre has a nut for adjusting nut so as to allow the work to be turned lightly pin in accordance with the dog with the dog leg length. (Fig 10)

Fig 10



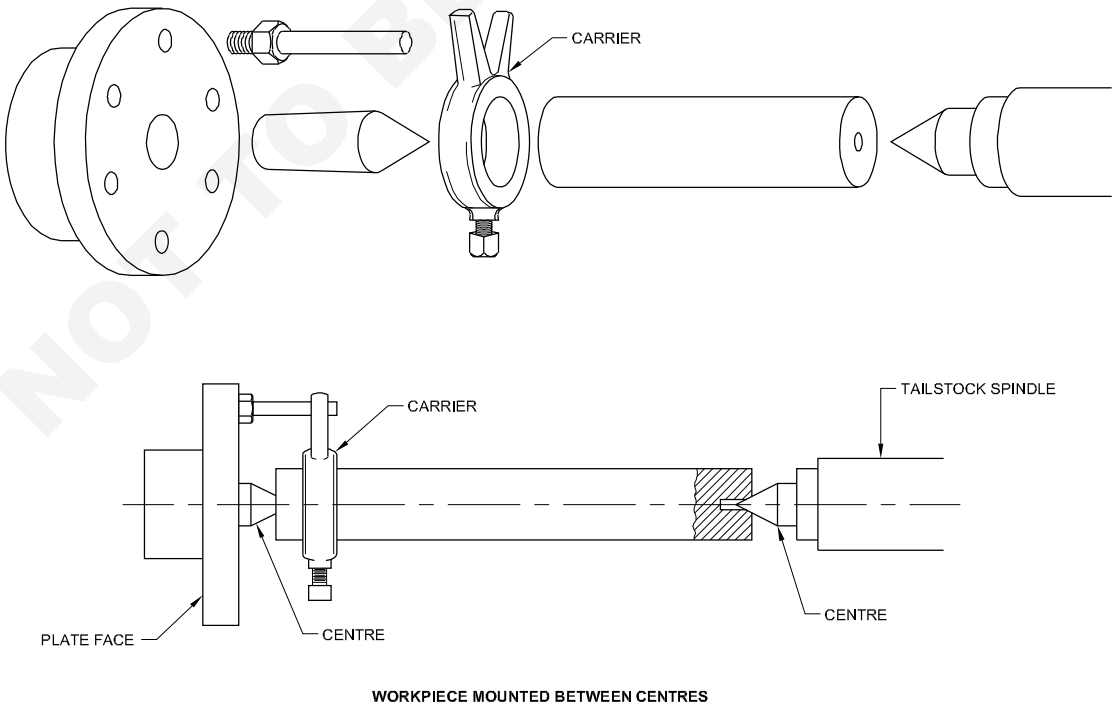
So the workpiece mounted in between centres. (Fig 11)

Adjustment of taper

When the work has been tapered beyond expectation loosen the four fasteners. Allen screw of the upper table, set the dial gauge at zero and then a mind the swivelling of the table with the adjusting screw as illustrated. (Fig.12)

When the diameter at the side of the work head is larger than the other turn the table clockwise and when the diameter at the tailstock side is too large turn in counter clockwise.

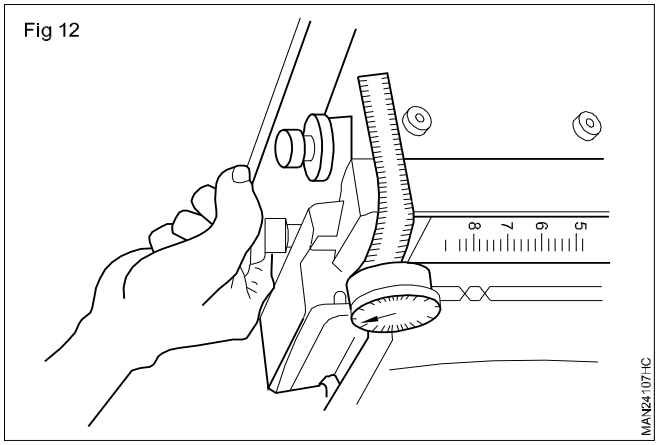
Fig 11



WORKPIECE MOUNTED BETWEEN CENTRES

As for table tilting give the specified conversion value to the dial gauge according to the length and the difference in size of the work. (Fig 12)

Fig 12



Fix the upper table do trial grinding to repeat adjustments for obtaining the given taper.

When the given taper has been obtained, do rough grinding leaving a finish margin of 0.02 -0.05mm in the outer diameter.

To finish grind

Determine the numbers of work revolution so as to make the peripheral speed of the work 12-15m/min.

Adjust the table speed so as to be fed at about (1/8-1 10) of the wheel thickness per work revolution.

If necessary do finish dressing.

Make the depth of cut from 0.0025mm to 0.01mm per stroke, while measuring from time to time as grinding by making the depth of cut by graduations.

In the final stages the depth of the cut shall not be made, but reciprocate the table 2-3 times to do spark out.

Back the wheel spindle stock and do fine chamfering with an oil-stone.

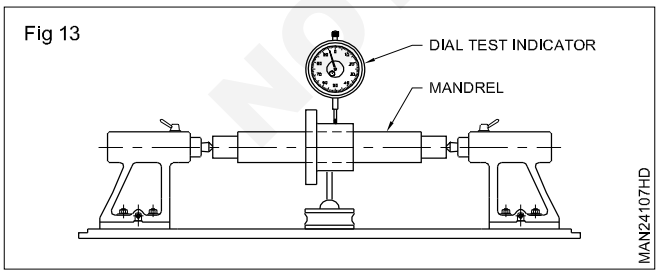
Measure the size of the work when it stops fully.

Parallelism checking ref. (Fig 13)

Clean the surface plate without any dust and oil.

Fix the tailstock centres on surface plate.

Fig 13



Hold the dial in magnetic base.

Keep it on the surface plate.

Hold the job in between centres.

Touch the job and give the pressure on the dial and set zero.

Move the dial traversely.

Check the reading for variation.

Incase of variation on job go for regrinding.

Recheck the job for parallelism.

Rotate the job by hand and check for cylindrical.

If the error is repeated and it is within the permissible limit then the same may be accepted as finished job.

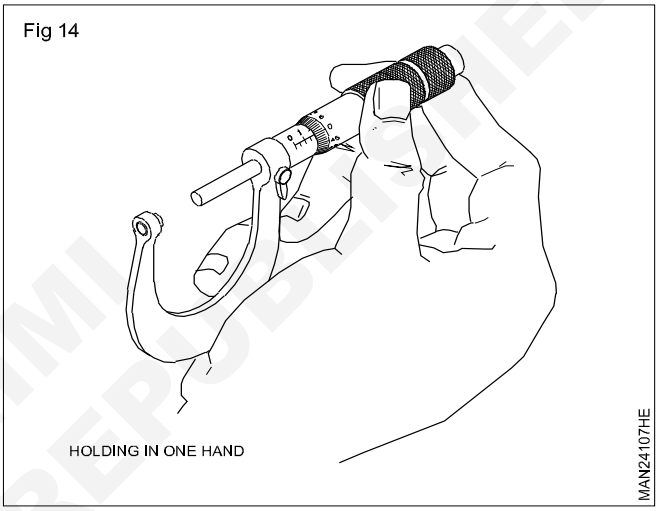
Holding the micrometer for measurement

The micrometer may be held either in one hand or both the hands.

Holding in one hand (Fig 14)

Hold the outside micrometer in your right hand, keeping the graduations on the main scale towards you.

Fig 14



Support the frame on the lower centre of your palm. Use your little or third finger to hold the frame in the palm.

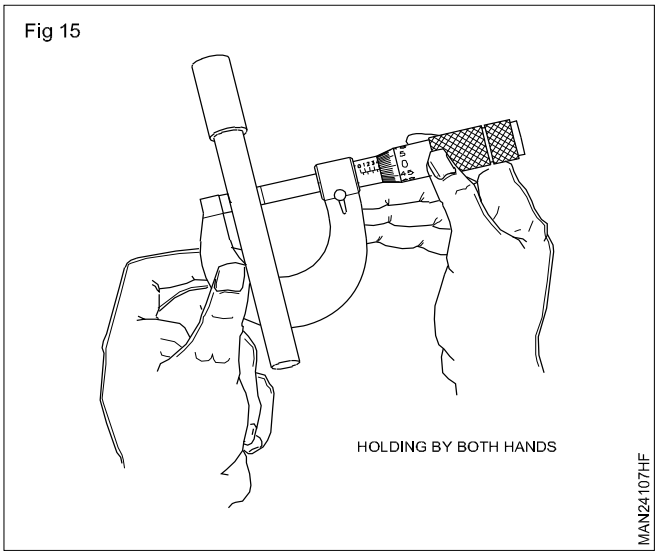
Palm the middle finger behind the frame to support it.

Keep the first finger thumb free to adjust the knurled thimble.

Holding by both the hands. (Fig 15)

Sometimes, it may be more convenient to hold the micrometer with both the hands.

Fig 15



Support the frame between the fingers and the thumb of your left hand .

Use the thumb finger of your right hand to adjust the thimble.

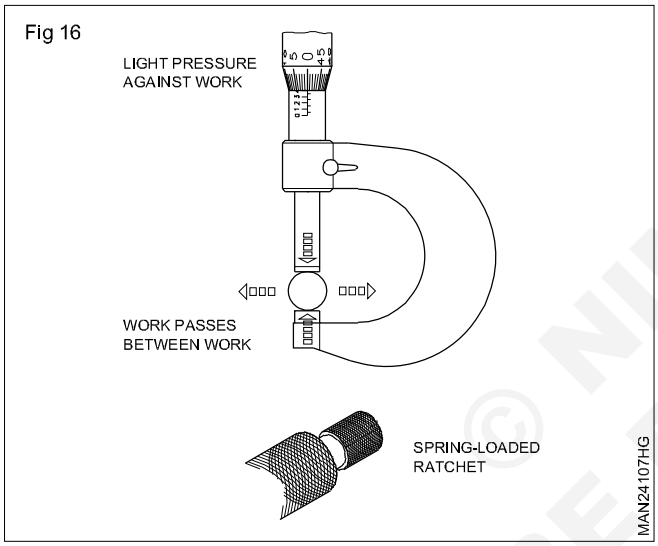
Set the micrometer on the workpiece for measurements.

High skill is needed for obtaining accurate measurement with the outside micrometer. A wrong setting of the micrometer over the workpiece may cause

- inaccurate reading
- excessive strain on the screw thread
- distortion in the frame.

Fig.15 shown the adjustment of the spindle and anvil over the workpiece. As you adjust the workpiece between the spindle and the anvil you should feel a light pressure or resistance against the workpiece surface. Use the spring-loaded ratchet stop to ascertain the feel. (Fig 16)

Fig 16



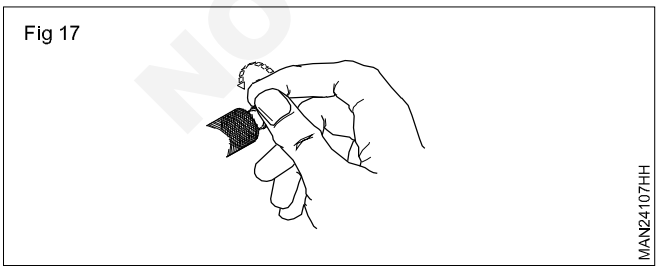
Measuring outside diameter using outside micrometer

While using only one hand.

Close the anvil and spindle until you feel them just touching the work.

Move the work slightly between the spindle and the anvil or pass the micrometer over the workpiece by moving your wrist. (Fig 17)

Fig 17

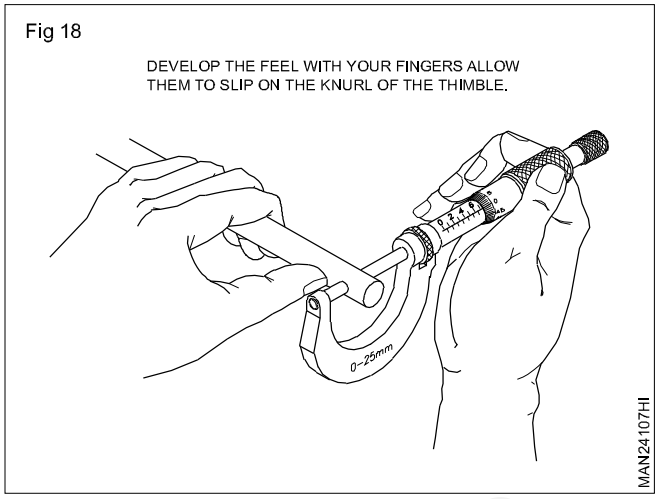


Make further adjustments of the thimble as required until you obtain the right 'Feel' (Fig 18)

When satisfied with the feel remove the fingers from the thimble.

Turn the micrometer towards you.

Fig 18



Read the measurement.

Method of reading the micrometer 0-25 range.

Look at the reading the which has been taken from the workpiece.

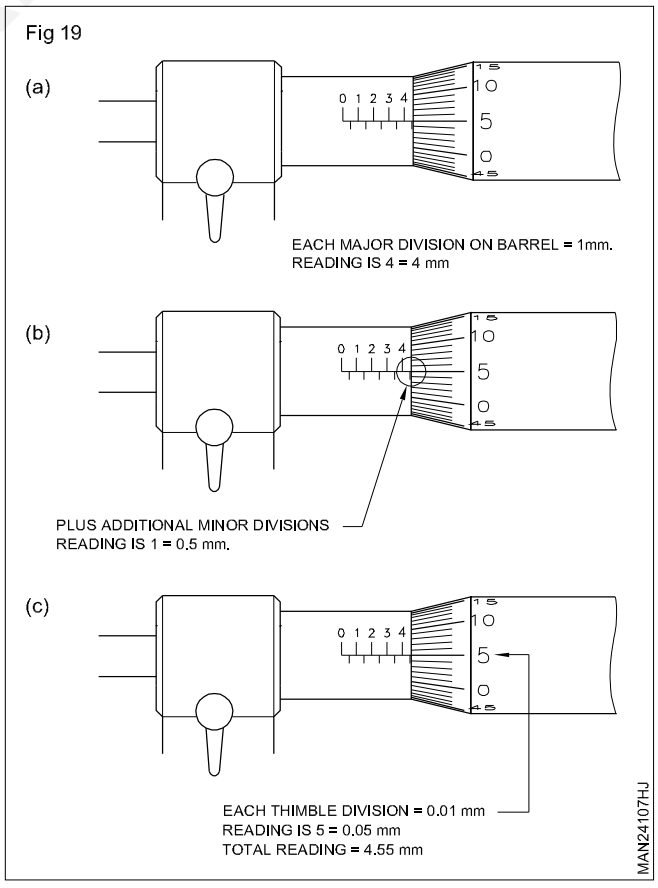
Read on the barrel scale the number of whole millimetres that are completely visible from the bevel edge of the thimble.Fig 19a shows 4 divisions = 4mm.

Add any half millimetres that are completely visible from the bevel edge of the thimble. (Fig 19a)

Fig (19b) shows 1 division =0.5mm.

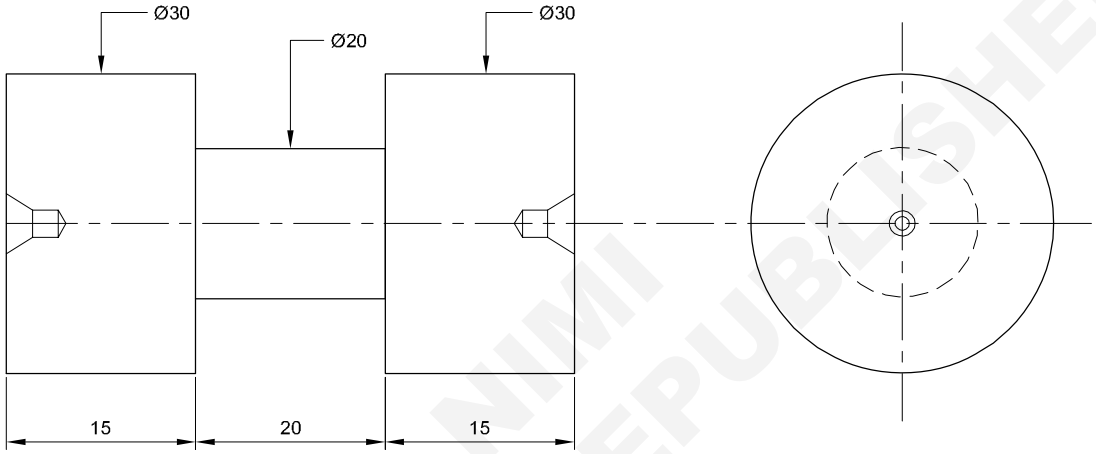
Add the thimble reading to the main scale reading which has already been taken. Fig 19c shows the 5 th division of the thimble scale is coinciding with the index line. So thimble reading =5x0.01=0.05mm. (Fig 19c)

Fig 19



Plunge Grinding

Objectives: At the end of this exercise you shall be able to
- **mount the grinding wheel on the cylindrical grinding machine**
- **hold the job between centres in eccentric position**
- **grind the job to the required dimension and accuracy.**



Job Sequence

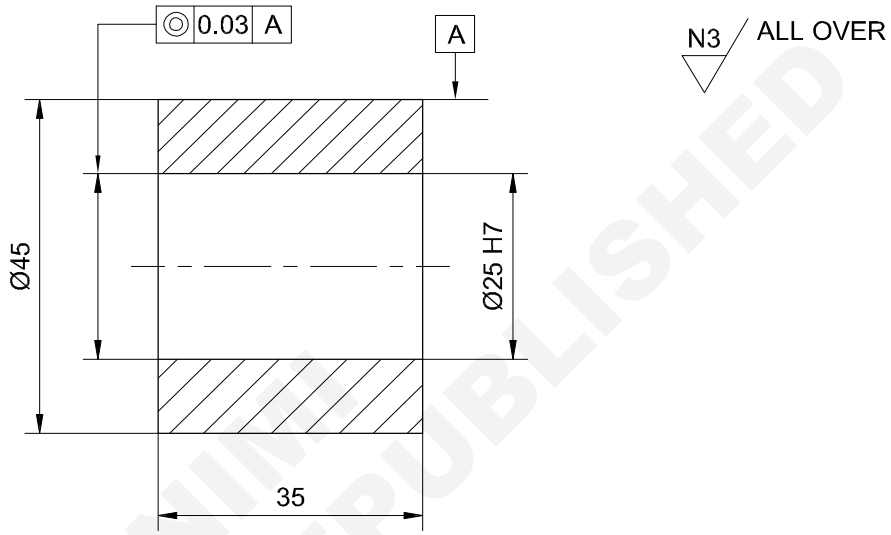
- Clean the machine completely.
- Determine the grinding allowance.
- Select the suitable grinding wheel.
- Balance the grinding wheel.
- Mount the wheel on the cylindrical grinding machine.
- Dress the grinding wheel.
- Hold the job between centres.
- Set the longitudinal position and tighten the longitudinal traverse.
- Start the grinding wheel and the job rotation.
- Work rotates in a fixed position as the wheel feeds.
- Grind the job to an accuracy of 0.01mm.
- Move the wheel away from the job and stop the movement of the wheel and the job.
- Check the dimensions with a micrometer.
- And then follow the above procedure for next plunge grinding operation.

1	Ø40x55mm	-	Fe310	–	–	1.7.104
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	PLUNGE GRINDING				DEVIATIONS ±0.04 mm	TIME :
					CODE NO. MA20N17104E1	

Perform straight bore grinding

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

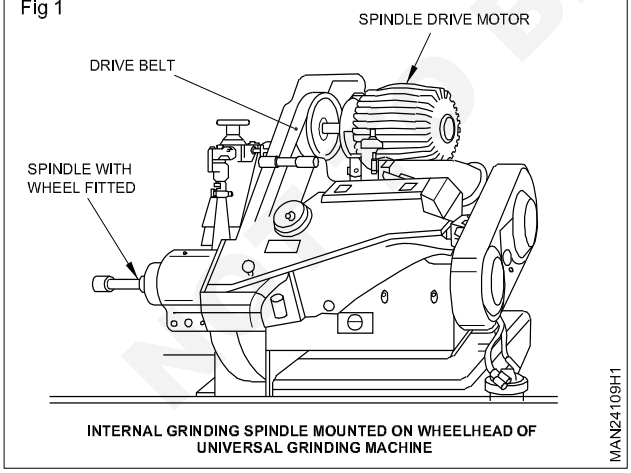
- **mount the internal grinding attachment**
- **mount the grinding wheel and dress the wheel by diamond dresser**
- **set the job in four jaw chuck by using dial test indicator**
- **grind the plain bore with an accuracy of ± 0.04**
- **measure the bore diameter by using telescopic gauge.**



Job Sequence

- Turn the part as per drawing with required grinding allowance.
- Prepare the machine for internal grinding. (Fig.1)

Fig 1



INTERNAL GRINDING SPINDLE MOUNTED ON WHEELHEAD OF UNIVERSAL GRINDING MACHINE

- Fit the spindle and mount spindle.
- Dress the wheel with a diamond tipped dressing tool.
- Measure the bore diameter of the workpiece to check the grinding allowance.
- Determine the work and wheel surface speeds and set the machine accordingly.
- Mount the workpiece in a chuck.
- True the workpiece used by dial test indicator.
- Set the length of stroke using reversing dogs.

Make sure that the traverse setting do not cause the wheel to contact any internal shoulder in the workpiece and that the wheel does not leave the workpiece surface completely at the end of the traverse strokes.

- Put on your goggles.
- Start the grinding wheel.

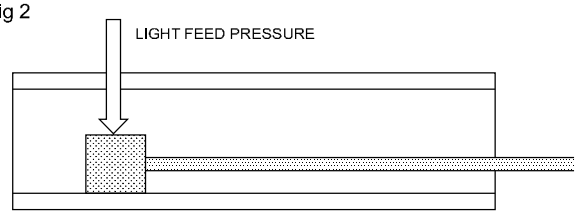
1	Ø50x40mm	-	Fe310	–	–	1.7.105
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PERFORM STRAIGHT BORE GRINDING	DEVIATIONS as per IS : 2102(F)	TIME :
		CODE NO. MA20N17105E1	

- Start the head stock spindle drive.
- Check that the directions of rotation of the wheel and workpiece are opposed.
- Grind the Ø 25 x 35mm bore.
- Start coolant supply and table traverse if necessary.
- Run the grinding wheel to the workpiece by hand and advance the wheel against the bore taking a light cut.
- When cut is complete measure the bore and reset the feed.
- Make repeated cuts until close to the desired size.
- Dress the wheel again for finish grinding.
- Check the bore size, parallism and make the final cuts.
- Remove burred edges.
- Measure the base by using telescopic gauge bore.

Mounting the spindle (Fig.2)

Fig 2



LONG SPINDLE REQUIRES LIGHT FEED PRESSURE TO AVOID FLEXING

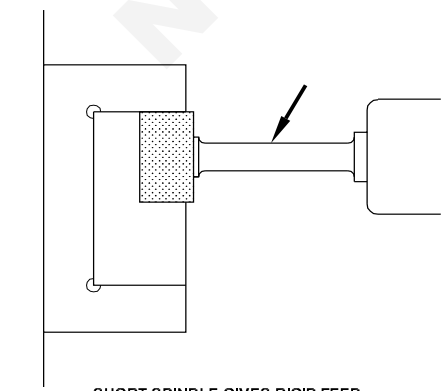
MAN24109H2

For setting up the internal grinding spindle of a universal grinding machine, the general procedure is as follows:

- Position the internal grinding attachment, including the spindle on the wheel head and fix securely. Refer to the operators handbook for the particular machine.
- Mount the drive belt between the internal grinding drive motor and the pulley on the internal grinding attachment and adjust to proper tension.
- If a machine motor selector control is provided turn it to the 'internal' position.
- Disengage the power operated cross - feed.
- Replace any guards removed to set the attachment in place.

The dimensions of the workpiece (Fig.3)

Fig 3



SHORT SPINDLE GIVES RIGID FEED

MAN24109H3

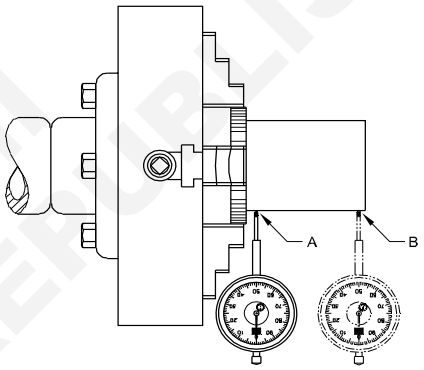
The spindle chosen should be as rigid as possible. Where a long workpiece is to be ground the spindle will be correspondingly long and thus subject to flexing under load. If care is not taken this flexing will cause chatter of the wheel with resultant marking of the bore surface. It will also produce a bore of uneven diameter.

Warning

Due to the nature of the operation a wheel guard is not used during internal grinding operations. The workpiece serves as a guard during actual grinding, but remember that the unguarded wheel is a definite safety hazard when not within a workpiece. Keep your hands away from the moving wheel and wear close fitting clothing. If a guard is available on the machine to the wheel when not actually grinding, make sure this set in place after the wheel is retracted from the workpiece.

Set the job in four jaw chuck using dial test indicator. (Fig. 4)

Fig 4



WORK MUST BE TRUED IN THE FOUR-JAW CHUCK
SO THAT THE INDICATOR READINGS AT A & B ARE THE SAME.

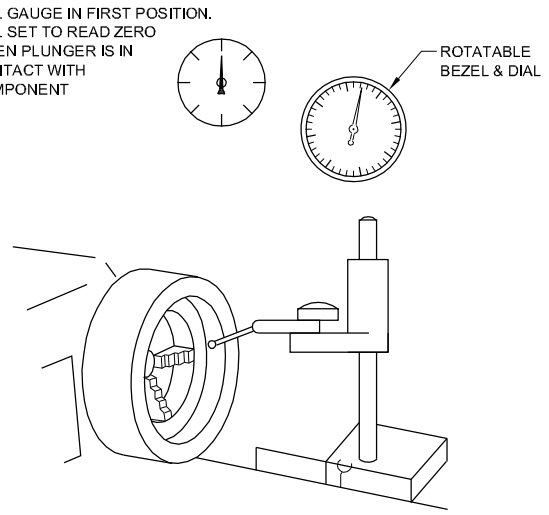
MAN24109H4

- Hold the job in a four jaw chuck.
- Mount the dial stand on machine table.
- Fix the dial and touch on the job.
- Move the dial and rotate the job.
- Check the trueness of the job with the indicator at zero position.
- Incase of difference in reading adjust the jaw and rotate the chuck.
- The dial moving at A and B are the same reading at zero.

Grinding a parallel bore (Figs 5&6)

- Set up the machine for internal grinding
- Fit the spindle and mount the wheel.
- Dress the wheel with a diamond tipped dressing tool.
- Measure the diameter of the workpiece to check the grinding allowance.

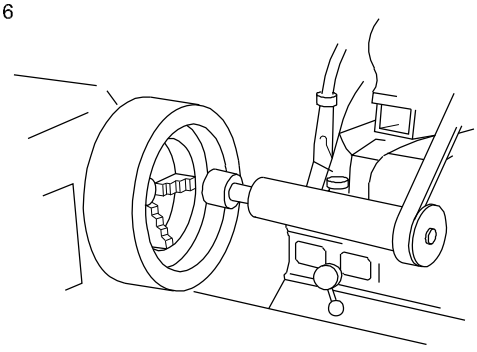
Fig 5



GRINDING A PARALLEL BORE IN A CHUCK MOUNTED WORKPIECE

MAN24109H5

Fig 6



GRINDING A PARALLEL BORE IN A CHUCK MOUNTED WORKPIECE

MAN24109H6

- Determine the work and wheel surface speeds and set the machine accordingly.
- Mount the workpiece in a chuck or other suitable support on the machine headstock.
- True the workpiece in the head stock and align the headstock to the work table.
- If table traverse is necessary, adjust the machine by setting the table reversing dogs.

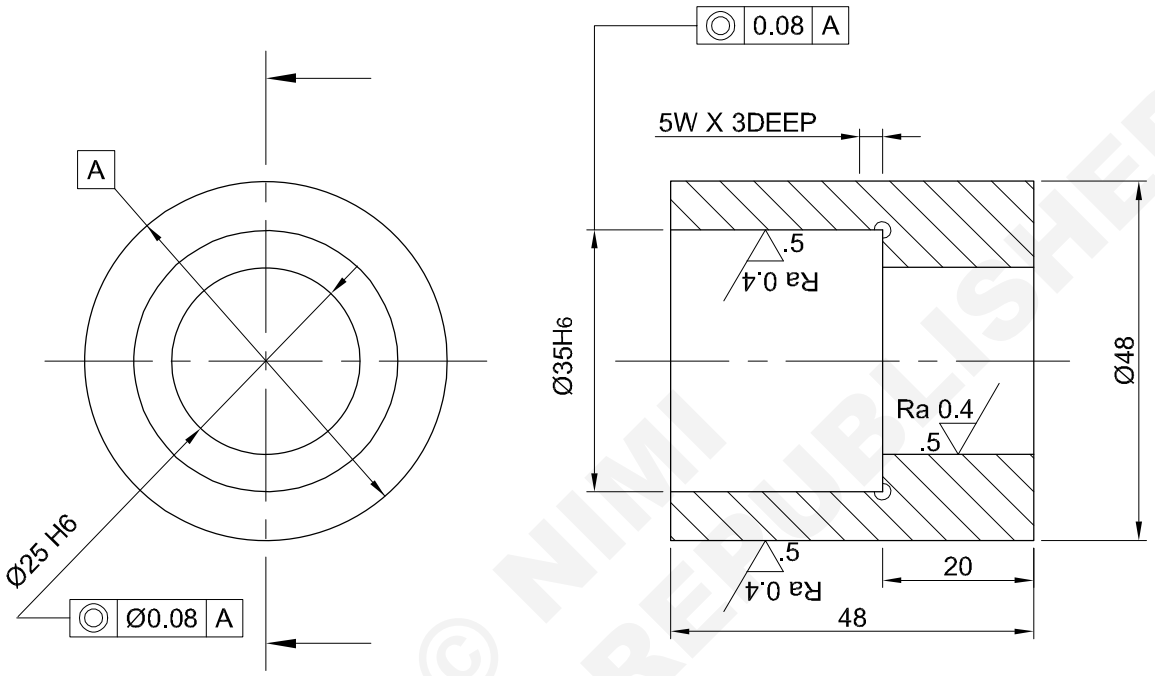
Caution

Make sure that the traverse settings do not cause the wheel to contact any internal shoulder in the workpiece and that the wheel does not leave the workpiece surface completely at the end of the traverse strokes.

- Put on your goggles.
- Start the grinding wheel
- Start the headstock spindle drive
- Check that the directions of rotation of the wheel and workpiece are opposite.
- Start coolant supply and table traverse if necessary.
- Run the grinding wheel to the workpiece by hand and advance the wheel against the bore, taking a light cut.

Perform step bore grinding

Objectives: At the end of this exercise you shall be able to
- **set the machine for grinding internal surfaces**
- **set workpiece and adjustment of table traverse length**
- **grind the internal bore maintaining concentricity within close limit.**



GEN. DEVIATION IS AS PER IS 2102 (F)
3 TO 6 = ± 0.05
6 TO 30 = ± 0.10
30 TO 120 = ± 0.15

Job Sequence

- Study the drawing, turn the job as per drawing and maintain the size with grinding allowance.
- Ascertain the grinding allowance.
- Mount the quill head and fix the appropriate grinding wheel.
- Mount the workpiece in the 3 jaw chuck.
- Check the concentricity by DTI.
- Adjust the coolant.
- Set stoppers to adjust the table traverse length accurately.
- Rough and finish grind the bore Ø35 H6.
- Check the finish part by inside micrometer.
- Rough and finish grind the bore Ø25 H6.
- Check the finish part by inside micrometer.
- Check the concentricity using DTI.

1	Ø50x50mm	-	Fe310	-	-	1.7.106
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**PERFORM STEP BORE GRINDING**				DEVIATIONS : ± 0.04 mm	TIME :
					CODE NO. MA20N17106E1	

Skill Sequence

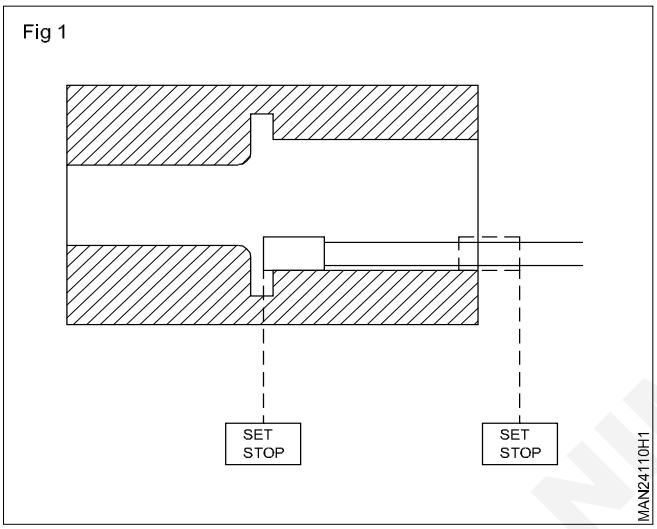
Grinding a bore and shoulder

Objective: This shall help you to
- **grind the bore and shoulder.**

General information

For this particular requirement two procedures are adopted. Initially the bore is ground to size as covered in previous chapter, and then a procedure is used to grind the face of the shoulder. In work of this nature an undercut may not be required in the finished workpiece and the undercut shown in the following illustrations is used purely as an aid to the grinding process. (Fig 1)

Fig 1



1 Measure workpiece

Check diameter and depth of bore.

2 Mount workpiece

3 Mount spindle and wheel

Select a recessed type wheel, ensuring that the head at the securing screw will seat below the face of the grinding wheel.

4 Dress wheel for roughing out

Apply slight angular relief to the front face of wheel.

5 Set table traverse stops

6 Clean up the bore

7 Measure bore size and parallelism

8 Rough grind bore to within 0.25mm of finished size.

9 Dress wheel for finish grinding

10 Finish grind bore

Note final index reading

11 Measure bore

Safety: Before attempting to measure the bore. Switch OFF the job rotation and grinding wheel rotation completely.

12 Check wheel diameter

The wheel diameter must be of a size that will grind the face flat. In the example shown, the wheel diameter must not be greater than bore radius plus the central hole radius, or less than bore radius minus the central hole radius.

13 Dress the front face of wheel

- Apply slight angular relief.
- Slightly relieve wheel diameter, leaving approximately 3.2 mm and at front.

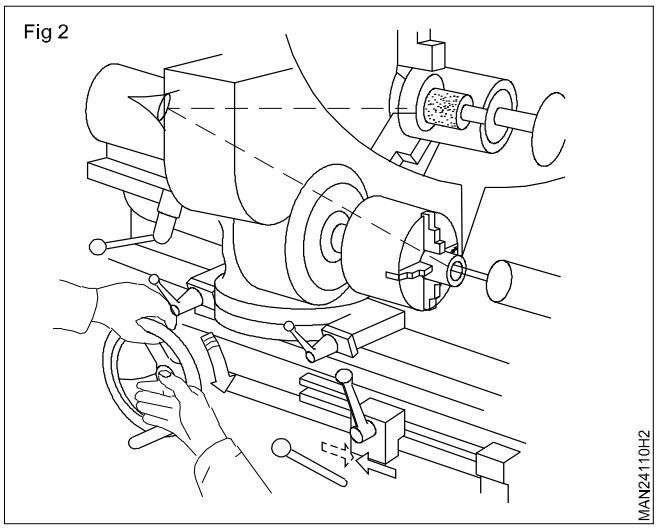
14 Grind shoulder face

- Start workhead
- Working to the indeed index, position the wheel to clear the finished bore diameter by approximately 0.02 mm.
- Hand traverse table, to position the wheel inside the bore and just clear of shoulder face.

The line previously marked upon the spindle will give indication of distance between wheel and face.

- Traverse table very slowly until sparks or sound indicate the wheel is grinding the face.
- With the left hand holding the traverse wheel to act as a brake, gently tap the handle with the right hand to advance the workpiece on to the wheel. (Fig 2)

Fig 2



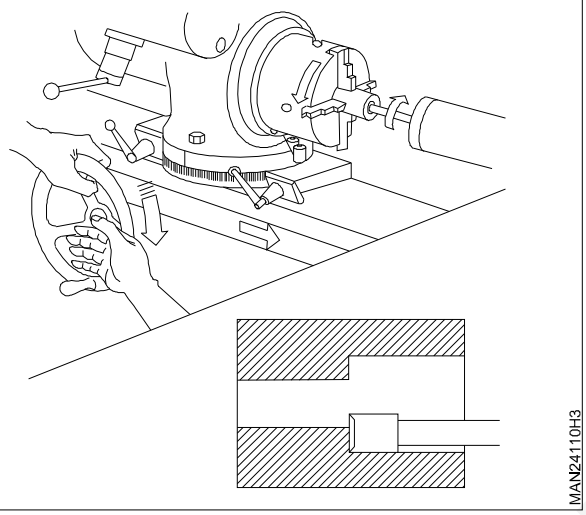
Very small movement is necessary. Take extreme care in applying feed, as too heavy cut will tend to make the spindle whip, causing the wheel to bite into the finished bore.

- Clear workpiece from wheel and visually check face has fully cleaned up. Take further cuts until a satisfactory condition is achieved. Allow wheel to “spark out”.

- Re-dress the front face of wheel.
- Position wheel in bore.
- Adjust infeed index to bring the wheel within 0.002mm of the bore diameter.
- Traverse table until contact is made and apply feed as in Fig 3.

If a reasonably square corner is required, it will be necessary to re-dress the wheel face frequently as the corner of the wheel tends to break down.

Fig 3



- Clear workpiece from wheel, stop workhead.

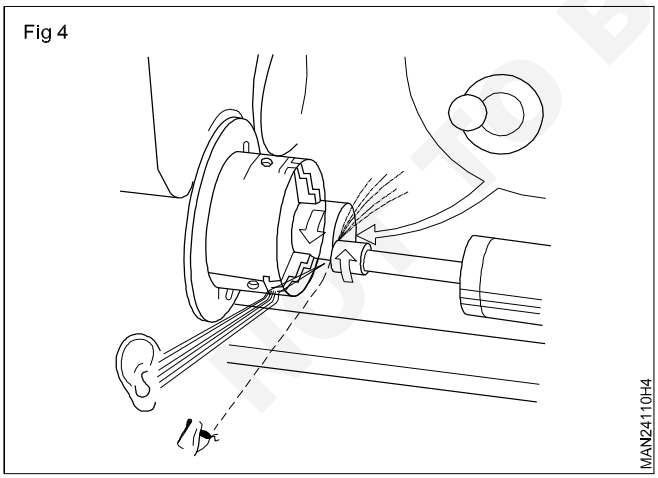
15 Remove sharp corners

16 Check depth

17 Remove workpiece from machine

Grinding a face (Fig 4)

Fig 4



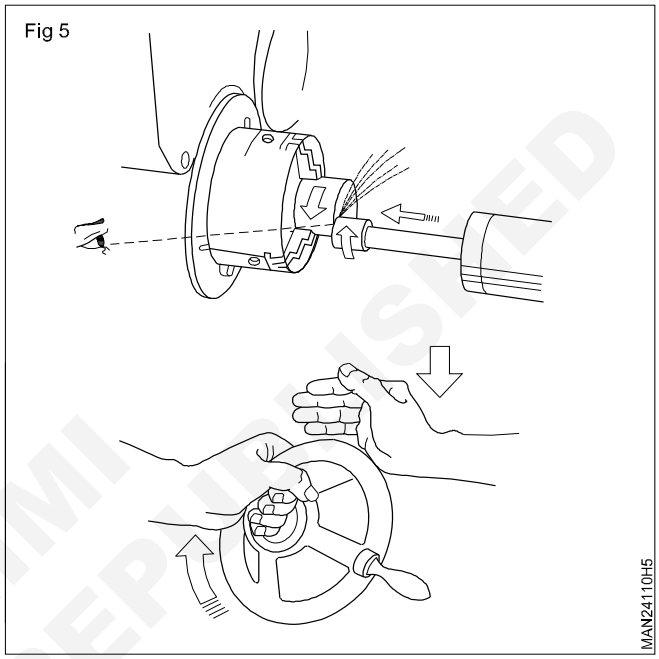
This type of operation is generally carried out to ensure that the face of the workpiece is square to the axis of the bore.

Basically the procedure is similar to that for grinding a shoulder, and is a secondary operation following the grinding of the bore.

- Finish grind bore
- Mount spindle and grinding wheel
  - Select and mount short robust spindle.
  - Select and mount a recessed wheel of diameter larger than the width of face to be ground. Ensure the head of the securing screw is below the wheel face.
- Dress the wheel

  Apply slight angular relief to the front face.
- Grind the face (Fig 5)

Fig 5



- Start workhead.
- Use hand traverse, to position the wheel square to and just clear of the face to be ground.
- Traverse table slowly, until the wheel lightly contacts the face.

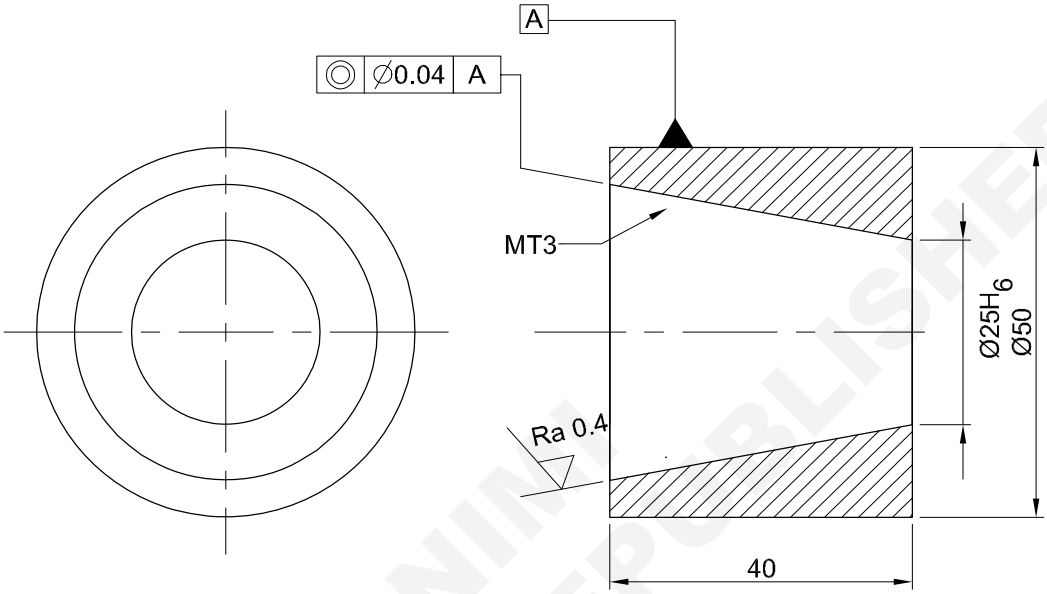
Safety

Safety glasses must be wear.

- With the left hand holding the traverse wheel to act as a brake, gently tap the handle with the right hand to advance the workpiece on to the wheel. (Fig 5)
- Very small movement is required. Extreme care should be taken in applying cuts, as too heavy cut will tend to make the spindle whip. Allow wheel to spark out.
- Clear workpiece from wheel and visually check face has fully cleaned up.
- Re-dress face of wheel as necessary.
- Take further cuts as necessary, until a satisfactory condition is achieved.
- Clear workpiece from wheel, stop workhead.
- Check surface texture and flatness of face.
- Remove sharp corners.
- Remove workpiece from machine.

Internal taper bore grinding

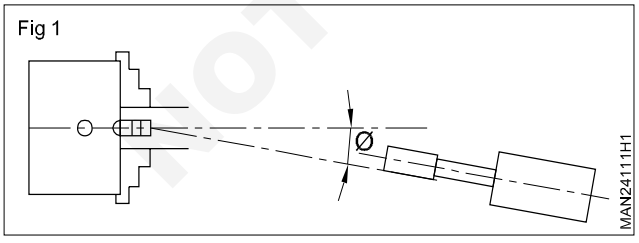
Objectives: At the end of this exercise you shall be able to
- **grind the taper bore upto close limit to H6**
- **check the taper using taper plug gauge.**



Job Sequence

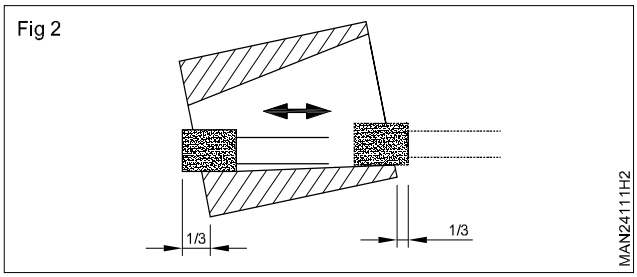
- Study the drawing, turn the job as per drawing and maintain the size with grinding allowance.
- Ascertain the grinding allowance.
- Clamp the job in 3 jaw chuck .
- Mount the internal grinding wheel in spindle.
- Dress the wheel.
- Swivel the work head to the MT3 taper angle (θ) as shown in Fig 1.

Fig 1



- Set the stopper for required stroke length.
- Rough and finish grind ID taper as shown in Fig 2.
- Check the taper using the taper plug gauge.

Fig 2



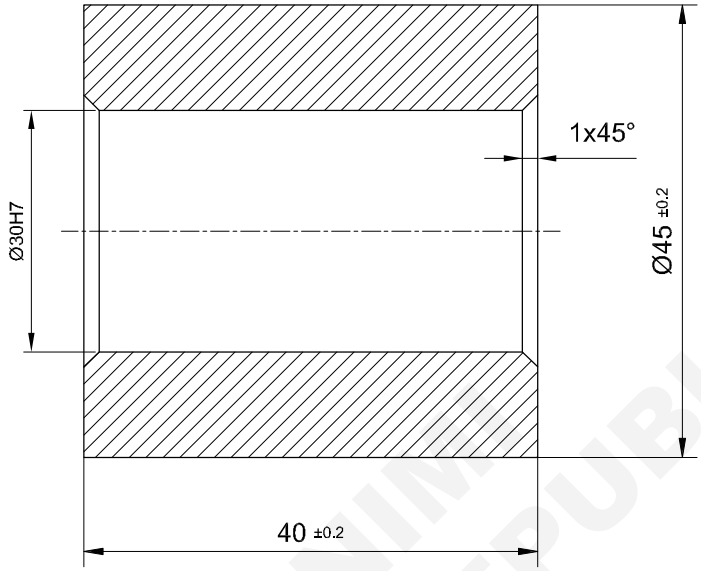
1	Ø50x40mm	-	Fe310	-	-	1.7.107
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	INTERNAL TAPER BORE GRINDING	DEVIATIONS : ± 0.04 mm	TIME :
		CODE NO. MA20N17107E1	

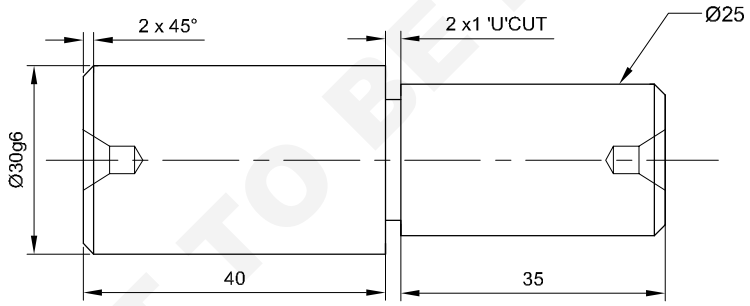
Make male and female fitting with an accuracy of ± 0.01mm

Objectives: At the end of this exercise you shall be able to
- **set the grinding wheel**
- **mount the job**
- **grind the male and female part.**

TASK-1



TASK-2



1	Ø45x29.5x40mm	–	Fe 310- PREMACHINED	–	1	1.7.108
1	Ø30.5x75mm	–	Fe 310- PREMACHINED	–	2	–
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MAKE MALE FEMALE FITTING WITH AN ACCURACY OF ±0.01mm**	TOLERANCE ±0.01mm	TIME:
		CODE NO. MA20N17108E1	

Job Sequence

TASK 1

- Prepare the machine for internal grinding and measure the grinding allowance.
- Fit the internal grinding spindle and mount on wheel head.
- Dress the wheel with a diamond dresser.
- Measure the existing bore diameter of the job to know the grinding allowance.
- Mount the job in a chuck.
- True the workpiece.
- Set the length of stroke.
- Put on your goggles.
- Start the grinding wheel for rotation.

TASK 2

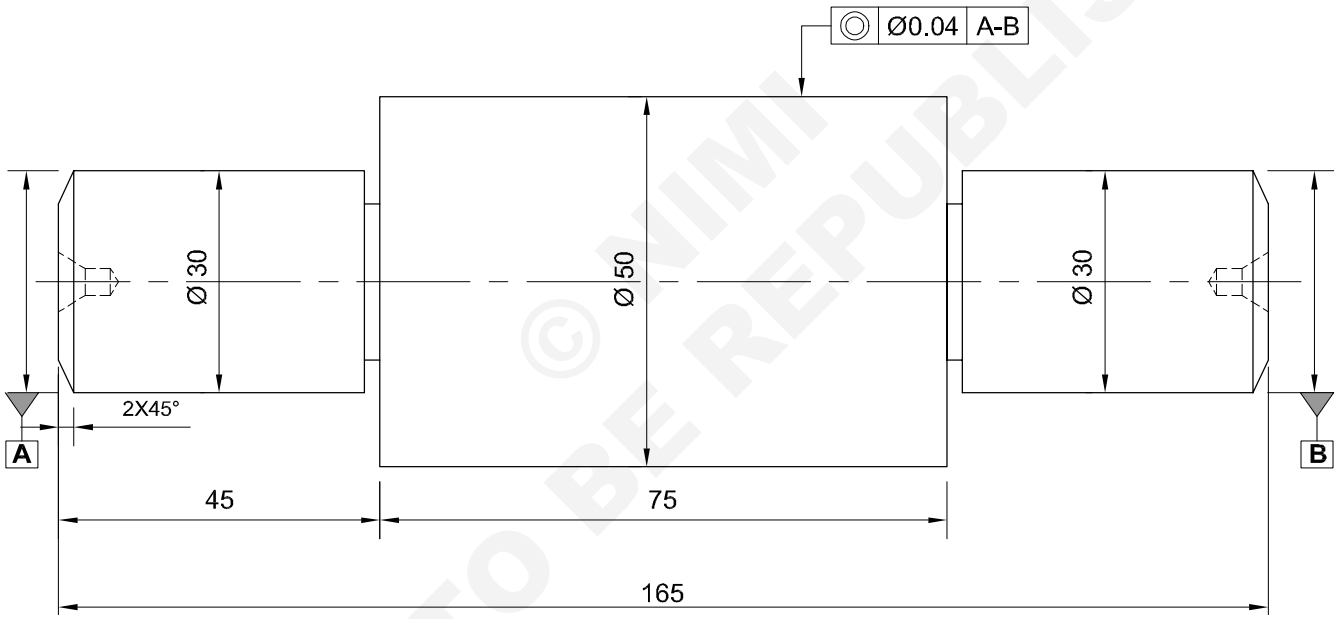
- Prepare the machine for external cylindrical grinding.
- Study the drawing and measure the grinding allowance.
- Set the workhead, wheel head and table at 0^{o}.
- Dress the grinding wheel for rough grinding.
- Hold the job with suitable dog carrier.
- Mount the job in between centres.
- Rough and finish grind the go end surface removing half of the grinding allowance.
- Engage the work head spindle drive.
- Take the grinding wheel inside the bore with rotation of job and wheel manually till grinding wheel touches the job make few setting.
- Start the coolant supply.
- Make repeated cuts until close to the desired size.
- Dress the wheel for finish grinding.
- Grind the bore diameter to 30.47mm.
- Check the bore size using by telescopic gauge.
- Remove the job from the chuck.
- Remove burred edges.
- Check the diameter of the job using outside micrometer to ascertain the grinding allowance.
- Finish the surface and maintain the diameter to Ø30g6 on 40 mm long side.
- Fit the female part.

Use a soft metal spacer if necessary to protect the job.

- Check the diameter of the workpiece.
- Remove burred edges.
- Remove the workpiece from the centres.

External step cylindrical grinding with an accuracy of ± 0.01mm

Objectives: At the end of this exercise you shall be able to
- **grind by the traverse feed method with an accuracy ±0.01mm**
- **dress the grinding wheel**
- **grind steps with shoulder and chamfer**
- **check and measure the dimension with an outside vernier micrometer**
- **check the concentricity of the job.**



1	Ø55x170mm	-	Fe310	-	-	1.7.109
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	EXTERNAL STEP CYLINDRICAL GRINDING WITH AN ACCURACY OF ±0.01mm	DEVIATIONS : ±0.01 mm	TIME :
		CODE NO. MA20N17109E1	

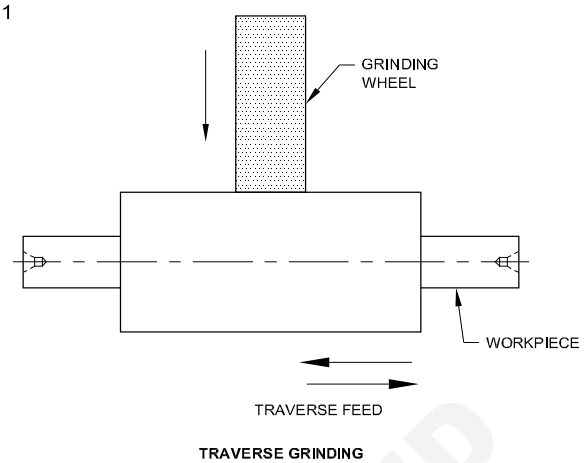
Job Sequence

- Study the drawing, turn the job as per drawing and maintain the size with grinding allowance.
- Ascertain the grinding allowance.
- Check the grinding wheel is rotating in correct direction.
- Set the work head, wheel head and table at 0º.
- Dress the wheel.
- Mount the workpiece in between centres with carrier.
- Start the machine for grinding wheel rotating.
- Move the grinding wheel back about 50 mm from the workpiece to allow the wheel to clear the carrier.

This will prevent accidental contact between the wheel and the carrier.

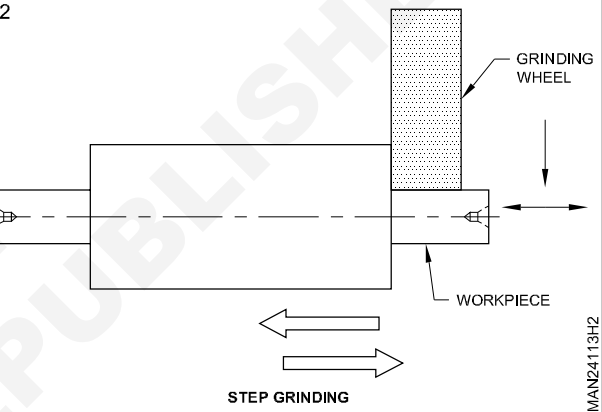
- Set the length of stroke.
- Move the table automatically in traverse feed. (Fig 1)
- Rough finish to grind the step ∅50 x 75 mm long.
- Feed the work traversely.
- Grind the step ∅30 x 45 mm long rough and finish grinding at both ends one after other. (Fig 2)
- Remove the job from the centres and dog carrier.
- Measure and check the job using by outside vernier-micrometer (25-50 mm).
- Check the concentricity of job using Dial Test Indicator.

Fig 1



TRAVERSE GRINDING

Fig 2



STEP GRINDING

Keep your hands away from the revolving wheel at all times to avoid injuries to yourself.

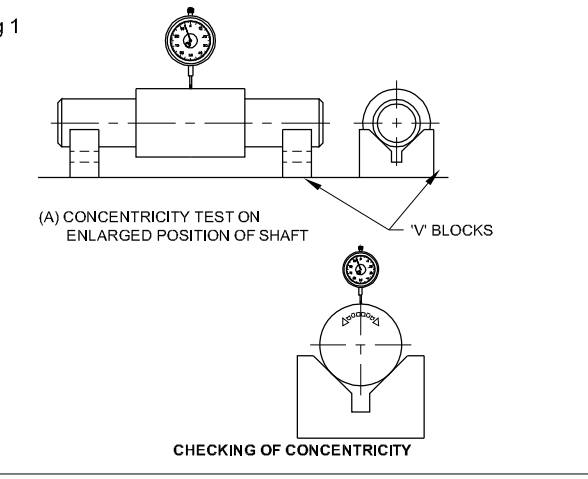
Skill Sequence

Checking the concentricity of job

Objective: This shall help you to
- **check the concentricity of the cylindrical job using 'V' block and DTI.**

- Mount the job in 'V' blocks.
- Touch the dial plunger on job.
- Rotate the job for concentricity test.
- See the reading of dial.
- Measure the reading position of Dial Test Indicator for concentricity.

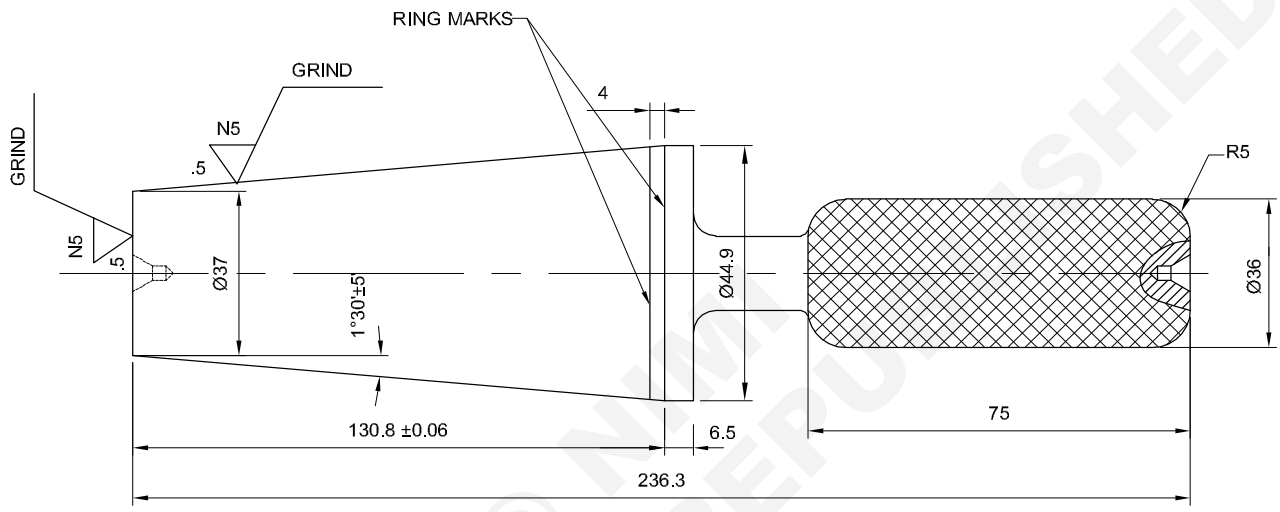
Fig 1



CHECKING OF CONCENTRICITY

External taper cylindrical grinding with an accuracy of ± 0.01mm

Objectives: At the end of this exercise you shall be able to
- **hold the job in chuck**
- **set the table according to taper angle**
- **set cutting speed, feed and depth of cut**
- **rough grind & finish grind the workpiece within accuracy**
- **check the taper by using standard gauge.**



Job Sequence

- Determine the grinding allowance.
- Balance the grinding wheel.
- Mount the wheel on the cylindrical grinding machine.
- Dress the grinding wheel.
- Hold the job in between centres.
- Tilt the table of 1°30' to grind.
- Set the table traverse dog to grind 130.8 mm length on the taper end.
- Start the grinding wheel and the job for rotation.
- Bring the wheel to the job and allow it to touch.
- Grind the job (giving required feed) to an accuracy of ± 5 minutes.
- Move the wheel away from the job and stop the movement of the wheel and job.
- Check the taper angle with a vernier bevel protractor.

1	Ø45x236.3mm		Fe310			1.7.110
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**EXTERNAL TAPER CYLINDRICAL GRINDING WITH AN ACCURAY OF ±0.01mm**				DEVIATIONS : ±0.01 mm	TIME :
					CODE NO. MA20N17110E1	