

FITTER

NSQF LEVEL - 4

2nd Year

TRADE PRACTICAL

SECTOR : CAPITAL GOODS & 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 : Fitter - Trade Practical - 2nd Year - NSQF Level - 4 (Revised 2022)

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FOREWORD

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

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Fitter - Trade Practical - 2nd Year - NSQF Level - 4 (Revised 2022) in CG & M Sector under Annual Pattern**. The NSQF Level - 4 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

Atul Kumar Tiwari, I.A.S
Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

February 2023
New Delhi - 110 001

PREFACE

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

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

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

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

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

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

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

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

Chennai - 600 032

EXECUTIVE DIRECTOR

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP (**Trade Practical**) for the trade of **Fitter 2nd Year - NSQF Level - 4 (Revised 2022)** under the **CG & M** Sector for ITIs.

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

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

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

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the two years course of the **Fitter in Capital Goods & Manufacturing** trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF Level - 4 (Revised 2022)

This manual is divided into Eight modules. The Eight modules are given below

Module 1	Assembly - 1
Module 2	Gauges
Module 3	Pipes and Pipe Fittings
Module 4	Drill jig
Module 5	Repairing Technique
Module 6	Hydraulics and Pneumatics
Module 7	Preventive Maintenance
Module 8	Erection and Testing

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the two years course of the **Fitter in Capital Goods & Manufacturing** Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade Theory. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptual capabilities for performing the skills.

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

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

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

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LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl.No.	Learning Outcome	Exercise No.
1	Make & assemble components of different mating surfaces as per required tolerance by different surface finishing operations using different fastening components, tools and check functionality. [Different Mating Surfaces – Dovetail fitting, Radius fitting, Combined fitting; Different surface finishing operations – Scraping, Lapping and Honing; Different fastening components – Dowel pins, screws, bolts, keys and cotters; Different fastening tools-hand operated & power tools, Required tolerance - $\pm 0.02\text{mm}$, angular tolerance ± 10 min.] (Mapped NOS: CSC/N0304)	2.1.115 - 2.1.138
2	Make different gauges by using standard tools & equipment and checks for specified accuracy. [Different Gauges – Snap gauge, Gap gauge; Specified Accuracy - $\pm 0.02\text{mm}$] (Mapped NOS:CSC/N0304)	2.2.139 - 2.2.148
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5	Plan, dismantle, repair and assemble different damaged mechanical components used for power transmission & check functionality. [Different Damage Mechanical Components – Pulley, Gear, Keys, Jibs and Shafts.] (Mapped NOS:CSC/N0304)	2.5.159 - 2.5.170
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SYLLABUS FOR FITTER

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 255Hrs; Professional Knowledge 70Hrs	Make & assemble components of different mating surfaces as per required tolerance by different surface finishing operations using different fastening components, tools and check functionality. [Different Mating Surfaces – Dovetail fitting, Radius fitting, Combined fitting; Different surface finishing operations – Scraping, Lapping and Honing; Different fastening components – Dowel pins, screws, bolts, keys and cotters; Different fastening tools-hand operated & power tools, Required tolerance - $\pm 0.02\text{mm}$, angular tolerance ± 10 min.] (Mapped NOS: CSC/N0304)	115. Make 'H' fitting. (13 hrs.) 116. Power tools: Practice operation of power tool for fastening. (5 hrs.) 117. Tightening of bolt/ screw with specified torque. (2 hrs.) 118. Selection of right tool as for Tightening or loosening of screw/bolt as per accessibility. (1 hr.)	Screws: material, designation, specifications, Property classes (e.g. 9.8 on screw head), Tools for tightening/ loosening of screw or bolts, Torque wrench, screw joint calculation uses. Power tools: its constructional features, uses & maintenance. (06 hrs.)
		119. Assembly sliding for using keys, dowel pin and screw, ± 0.02 mm accuracy on plain surface and testing of sliding fitting job. (13 hrs.) 120. File & fit angular mating surface within an accuracy of ± 0.02 mm & 10 minutes angular fitting. (12 hrs.)	Locking device: Nuts- types (lock nut castle nut, slotted nuts, swam nut, grooved nut) Description and use. Various types of keys, allowable clearances & tapers, types, uses of key pullers. (06 hrs.)
		121. Drill through and blind holes at an angle using swivel table of drilling machine. (09 hrs.) 122. Precision drilling, reaming and tapping and Test- Job. (12 hrs.)	Special files: types (pillar, Dread naught, Barrow, warding) description & their uses. (07 hrs.)
		123. Make Dovetailed fitting and radius fitting. (18hrs.)	Templates and Radius/fillet gauge, feeler gauge, hole gauge, and their uses, care and maintenance. (05 hrs.)
		124. File and fit, combined fit with straight, angular surface with ± 0.02 mm accuracy and check adherence to specification and quality standards using equipment like Vernier-calipers, micrometres etc. (18 hrs.)	Slip gauge: Necessity of using, classification & accuracy, set of blocks (English and Metric). Details of slip gauge. Metric sets 46: 103: 112. Wringing and building up of slip gauge and care and maintenance. (06 hrs.)
		125. Drilling and reaming, small dia. holes to accuracy & correct location for fitting. (4 hrs.) 126. Perform drilling using 'V' block and a clamp. (1 hrs.) 127. Make male and female fitting parts, drill and ream holes not less than 12.7 mm. (18 hrs.)	Application of slip gauges for measuring, Sine Bar-Principle, application & specification. Procedure to check adherence to specification and quality standards. (05 hrs.)
		128. Make Sliding Diamond fitting. (22 hrs.) 129. Lap flat surfaces using lapping plate. (5 hrs.) 27. Filing flat, square, and parallel to an accuracy of 0.5mm. (07 hrs.)	Lapping: Application of lapping, material for lapping tools, lapping abrasives, charging of lapping tool. Surface finish importance, equipment for testing-terms relation to surface finish. Equipment for

			tasting surfaces quality – dimensional tolerances of surface finish. (06 hrs.)
		130. Prepare Stepped keyed fitting and test job. (16 hrs.) 131. Lapping holes and cylindrical surfaces. (5 hrs.)	Honing: Application of honing, material for honing, tools shapes, grades, honing abrasives. Frosting- its aim and the methods of performance. (05 hrs.)
		132. Dovetail and Dowel pin assembly. (16 hrs.) 133. Scrape cylindrical bore. (5 hrs.)	Metallurgical and metal working processes such as Heat treatment, various heat treatment methods - normalizing, annealing, hardening and tempering, purpose of each method, tempering colour chart. (06 hrs.)
		134. Scrapping cylindrical bore and to make a fit-(12 hrs.) 135. Scrapping cylindrical taper bore and check taper angle with sine bar. (08 hrs.)	Annealing and normalizing, Case hardening and carburising and its methods, process of carburising (solid, liquid and gas). (07 hrs.)
		136. Make a cotter jib assembly. (20 hrs.)	Tapers on keys and cotters permissible by various standards. (06 hrs.)
		137. Hand reams and fit taper pin. (12 hrs.) 138. Drilling and reaming holes in correct location, fitting dowel pins, stud, and bolts. (08 hrs.)	The various coatings used to protect metals, protection coat by heat and electrical deposit treatments. Treatments to provide a pleasing finish such as chromium silver plating, nickel plating and galvanizing. (05hrs.)
Professional Skill 113Hrs; Professional Knowledge 30Hrs	Make different gauges by using standard tools & equipment and checks for specified accuracy. [Different Gauges – Snap gauge, Gap gauge; Specified Accuracy - $\pm 0.02 \text{ mm}$] (M a p p e d NOS:CSC/N0304)	139. Making a snap gauge for checking a dia. of $10 \pm$ 140. Scrape external angular mating surface and check angle with sine bar. (15 hrs.) 141. Scrape on internal surface and check. (10 hrs.) 142. Practice in dovetail fitting assembly and dowel pins and cap screws assembly. (16 hrs.) 143. Industrial visit. (5 hrs.) 144. Preparation of gap gauges. (12 hrs.) 145. Perform lapping of gauges (hand lapping only) (10 hrs.)	Gauges and types of gauge commonly used in gauging finished product-Method of selective assembly 'Go' system of gauges, hole plug basis of standardization. (06 hrs.) Bearing-Introduction, classification (Journal and Thrust), Description of each, ball bearing: Single row, double row, description of each, and advantages of double row. (06 hrs.) Roller and needle bearings: Types of roller bearing. Description & use of each. Method of fitting ball and roller bearings (06 hrs.) Bearing metals – types, composition and uses. Synthetic materials for bearing: The plastic laminate materials, their

			properties and uses in bearings such as phenolic, Teflon polyamide (nylon). (06hrs.)
		146. Preparation of drill gauges. (10 hrs.) 147. File and fit straight and angular surfaces internally. (13 hrs.) 148. Identify different ferrous metals by spark test (2 hrs.)	The importance of keeping the work free from rust and corrosion. (06 hrs.)
Professional Skill 62 Hrs.; Professional Knowledge 18Hrs	Apply a range of skills to execute pipe joints, dismantle and assemble valves & fittings with pipes and test for leakages.[Range of skills – Cutting, Threading, Flaring, Bending and Joining] (Mapped NOS:CSC/N0304)	149. Flaring of pipes and pipe joints. (02 hrs.) 150. Cutting & Threading of pipe length. (3 hrs.) 151. Fitting of pipes as per sketch observing conditions used for pipe work. (10 hrs.) 152. Bending of pipes- cold and hot. (06 hrs.)	Pipes and pipe fitting- commonly used pipes. Pipe schedule and standard sizes. Pipe bending methods. Use of bending fixture, pipe threads-Std. Pipe threads Die and Tap, pipe vices. (06 hrs.)
		153. Dismantling & assembling – globe valves, sluice valves, stop cocks, seat valves and non-return valve. (20 hrs.)	Use of tools such as pipe cutters, pipe wrenches, pipe dies, and tap, pipe bending machine etc. (06 hrs.)
		154. Fit & assemble pipes, valves and test for leakage & functionality of valves. (18 hrs.) 155. Visual inspection for visual defects e.g. dents, surface finish. (1 hr.) 156. Measuring, checking and recording in control chart. (2 hrs.)	Standard pipefitting- Methods of fitting or replacing the above fitting, repairs and erection on rainwater drainage pipes and household taps and pipe work. Inspection & Quality control -Basic SPC -Visual Inspection. (06 hrs.)
Professional Skill 24 Hrs.; Professional Knowledge 06 Hrs.	Make drill jig & produce components on drill machine by using jigs and check for correctness. (M a p p e d NOS:CSC/N0304)	157. Make a simple drilling jig. (20 hrs.) 158. Use simple jigs and fixtures for drilling. (04 hrs.)	Drilling jig-constructural features, types and uses. Fixtures- Constructural features, types and uses. (06 hrs.)
Professional Skill 152Hrs. Professional Knowledge 43 Hrs.	Plan, dismantle, repair and assemble different damaged mechanical components used for power transmission & check functionality. [Different Damage Mechanical Components – Pulley, Gear, Keys, Jibs and Shafts.] (M a p p e d NOS:CSC/N0304)	159. Marking out for angular outlines, filing and fitting the inserts into gaps. (06 hrs.) 160. Exercises on finished material such as aluminium/ brass/ copper / stainless steel, marking out, cutting to size, drilling, tapping etc. without damage to surface of finished articles. (09 hrs.)	Aluminum and its alloys. Uses, advantages and disadvantages, weight and strength as compared with steel. Non-ferrous metals such as brass, phosphor bronze, gunmetal, copper, aluminum etc. Their composition and purposes, where and why used, advantages for specific purposes, surface wearing properties of bronze and brass. (04 hrs.)

		161. Making an adjustable spanner: - Marking out as per Blueprint, drilling, cutting, straight and curve filing, threading, cutting slot and cutting internal threads with taps. (16 hrs.)	Power transmission elements. The object of belts, their sizes and specifications, materials of which the belts are made, selection of the type of belts with the consideration of weather, load and tension methods of joining leather belts. (04 hrs.)
		162. Dismantling and mounting of pulleys. (12 hrs.) 163. Making & replacing damaged keys. (12 hrs.) 164. Dismounting, repairing damaged gears and mounting and check for workability. (16 hrs.) 165. Repair & replacement of belts and check for workability. (12 hrs.)	Vee belts and their advantages and disadvantages, use of commercial belts, dressing and resin creep and slipping, calculation. Power transmissions- coupling types-flange coupling, -Hooks coupling-universal coupling and their different uses. Pulleys-types-solid, split and 'V' belt pulleys, standard calculation for determining size crowning of faces-loose and fast pulleys-jockey pulley. Types of drives-open and cross belt drives. The geometrical explanation of the belt drivers at an angle. Clutch: Type, positive clutch (straight tooth type, angular tooth type). Chains, wire ropes and clutches for power transmission. Their types and brief description. (15 hrs.)
		166. Making of template/gauge to check involute profile. (17 hrs.)	Power transmission –by gears, most common form spur gear, set names of some essential parts of the set-The pitch circles, Diametral pitch, velocity ratio of a gear set. (05 hrs.)
		167. Repair of broken gear tooth by stud and repair broken gear teeth by dovetail. (17 hrs.)	Helical gear, herring bone gears, bevel gearing, spiral bevel gearing, hypoid gearing, pinion and rack, worm gearing, velocity ratio of worm gearing. Repair of gear teeth by building up and dovetail method. (05 hrs.)
		168. Make hexagonal slide fitting. (16 hrs.) 169. Prepare different types of documentation as per industrial need by different methods of recording information. (04 hrs.)	Method of fixing geared wheels for various purpose drives. General cause of the wear and tear of the toothed wheels and their remedies, method of fitting spiral gears, helical gears, bevel gears, worm and worm wheels in relation to required drive. Care and maintenance of gears. (05 hrs.)

		170. Marking out on the round sections for geometrical shaped fittings such as spline with 3 or 4 teeth. Finishing and fitting to size, checking up the faces for universality. (15 hrs.)	Fluid power, Pneumatics, Hydraulics, and their comparison, Overview of a pneumatic system, Boyle's law. Overview of an industrial hydraulic system, Applications, Pascal's Law. (05 hrs.)
Professional Skill 21Hrs; Professional Knowledge 07Hrs	Identify, dismantle, replace and assemble different pneumatics and hydraulic components. [Different components – Compressor, Pressure Gauge, Filter Regulator Lubricator, Valves and Actuators.]	171. Identify pneumatic components – Compressor, pressure gauge, Filter-Regulator-Lubricator (FRL) unit, and Different types of valves and actuators. (2 hrs.) 172. Dismantle, replace, and assemble FRL unit. (5 hrs.) 173. Demonstrate knowledge of safety procedures in pneumatic systems and personal Protective Equipment (PPE). (2 hrs.) 174. Identify the parts of a pneumatic cylinder.(1 hrs.) 175. Dismantle and assemble a pneumatic cylinder.(6 hrs.) 176. Construct a circuit for the direction & speed control of a small-bore single-acting (s/a) pneumatic cylinder. (5 hrs.)	Compressed air generation and conditioning, Air compressors, Pressure regulation, Dryers, Air receiver, Conductors and fittings, FRL unit, Applications of pneumatics, Hazards & safety precautions in pneumatic systems. Pneumatic actuators:- Types, Basic operation, Force, Stroke length, Single-acting and double-acting cylinders. (07 hrs.)
Professional Skill 20Hrs; Professional Knowledge 07Hrs	Construct circuit of pneumatics and hydraulic observing standard operating procedure & safety aspect.	177. Construct a control circuit for the control of a d/a pneumatic cylinder with momentary input signals. (4 hrs.) 178. Construct a circuit for the direct & indirect control of a d/a pneumatic cylinder with a single & double solenoid valve. (08 hrs.) 179. Dismantling & assembling of solenoid valves. (08hrs.)	Pneumatic valves:- Classification, Symbols of pneumatic components, 3/2-way valves (NO & NC types) (manually-actuated & pneumatically-actuated) & 5/2-way valves, Check valves, Flow control valves, One-way flow control valve Pneumatic valves: Roller valve, Shuttle valve, Two-pressure valve Electro-pneumatics: Introduction, 3/2-way single solenoid valve, 5/2-way single solenoid valve, 5/2-way double solenoid valve, Control components -Pushbuttons (NO & NC type) and Electromagnetic relay unit, Logic controls. (07 hrs.)
Professional Skill 20Hrs; Professional Knowledge 07Hrs	Identify, dismantle, replace and assemble different pneumatics and hydraulic components. [Different components – Compressor, Pressure Gauge, Filter Regulator Lubricator, Valves and Actuators.]	180. Demonstrate knowledge of safety procedures in hydraulic systems (Demo by video) (04 hrs.) 181. Identify hydraulic components – Pumps, Reservoir, Fluids, Pressure relief valve (PRV), Filters, different types of valves, actuators, and hoses (04 hrs.) 182. Inspect fluid levels, service reservoirs, clean/replace filters (04 hrs.) 183. Inspect hose for twist, kinks, and minimum bend radius, Inspect hose/ tube fittings (04 hrs.)	- Symbols of hydraulic components, Hydraulic oils – function, properties, and types, Contamination in oils and its control - Hydraulic Filters – types, constructional features, and their typical installation locations, cavitation, Hazards & safety precautions in hydraulic systems - Hydraulic reservoir & accessories, Pumps, Classification – Gear/vane/piston types, Pressure relief valves – Direct acting and pilot-operated types

		184. Identify internal parts of hydraulic cylinders, pumps/motors (04 hrs.)	- Pipes, tubing, Hoses and fittings – Constructional details, Minimum bend radius, routing tips for hoses. (07 hrs.)
Professional Skill 18 hrs.; Professional Knowledge 05Hrs	Construct circuit of pneumatics and hydraulics observing standard operating procedure & safety aspect.	185. Construct a circuit for the control of a s/a hydraulic cylinder using a 3/2-way valve (Weight loaded d/a cylinder may be used as a s/a cylinder), 4/2- & 4/3-way valves. (8 hrs.) 186. Maintenance, troubleshooting, and safety aspects of pneumatic and hydraulic systems (The practical for this component may demonstrated by video). (10 hrs.)	- Hydraulic cylinders –Types - Hydraulic motors –Types - Hydraulic valves: Classification, Directional Control valves – 2/2- and 3/2-way valves - Hydraulic valves: 4/2- and 4/3-way valves, Centre positions of 4/3-way valves - Hydraulic valves: Check pneumatic and hydraulic systems (The practical for this component may demonstrated by video). (10 hrs.) valves and Pilot-operated check valves, Load holding function - Flow control valves: Types, Speed control methods – meter-in and meter-out - Preventive maintenance & troubleshooting of pneumatic & hydraulic systems, System malfunctions due to contamination, leakage, friction, improper mountings, cavitation, and proper sampling of hydraulic oils. (05 hrs.)
Professional Skill 80Hrs; Professional Knowledge 23Hrs	Plan & perform basic day to day preventive maintenance, repairing and check functionality. [Simple Machines – Drill Machine, Power Saw and Lathe] (Mapped NOS:CSC/N0304)	187. Dismantle, overhauling & assemble cross-slide & hand-slide of lathe carriage. (20 hrs.) 188. Simple repair of machinery: - Making of packing gaskets. (04 hrs.) 189. Check washers, gasket, clutch, keys, jibs, cotter, Circlip, etc. and replace/repair if needed. (04 hrs.) 190. Use hollow punches, extractor, drifts, various types of hammers and spanners, etc. for repair work. (16 hrs.) 191. Dismantling, assembling of different types of bearing and check for functionality. (20 hrs.) 192. Perform routine check of machine and do replenish as per requirement. (15 hrs.)	Importance of Technical English terms used in industry –(in simple definition only) Technical forms, process charts, activity logs, in required formats of industry, estimation, cycle time, productivity reports, job cards. (05 hrs.) Method of lubrication-gravity feed, force (pressure) feed, splash lubrication. Cutting lubricants and coolants: Soluble off soaps, sud-paraffin, soda water, common lubricating oils and their commercial names, selection of lubricants. Washers-Types and calculation of washer sizes. The making of joints and fitting packing. (18 hrs.)

Professional Skill 75 Hrs; Professional Knowledge 16Hrs	Plan, erect simple machine and test machine tool accuracy. [Simple Machines – Drill Machine, Power Saw and Lathe]	193. Inspection of Machine tools such as alignment, levelling. (10 hrs.) 194. Accuracy testing of Machine tools such as geometrical parameters. (15 hrs.)	Lubrication and lubricants- purpose of using different types, description and uses of each type. Method of lubrication. A good lubricant, viscosity of the lubricant, Main property of lubricant. How a film of oil is formed in journal Bearings. (04 hrs.)
		195. Practicing, making various knots, correct loading of slings, correct and safe removal of parts. (5 hrs.) 196. Erect simple machines. (45 hrs.)	Foundation bolt: types (Lewis cotter bolt) description of each erection tools, pulley block, crowbar, spirit level, Plumb bob, wire rope, manila rope, wooden block. The use of lifting appliances, extractor presses and their use. Practical method of obtaining mechanical advantage. The slings and handling of heavy machinery, special precautions in the removal and replacement of heavy parts. (12 hrs.)

Scan the QR Code to view the video for these exercise

Module 1 - Ex.No. 2.1.115 to 2.1.138



File & fit angular mating surface within an accuracy of ± 0.02 mm & 10 minutes angular fitting

Ex.No.2.1.120



Drill through and blind holes at an angle using swivel table of drilling machine

Ex.No.2.1.121



Make dovetailed fitting and radius fitting

Ex.No.2.1.123



Prepare stepped keyed fitting and test job

Ex.No.2.1.130



Scrape cylindrical bore

Ex.No.2.1.133



Drilling and reaming holes in correct location, fitting dowel pins, stud and bolts

Ex.No.2.1.138

Module 2 - Ex.No. 2.2.139 to 2.2.148



Making a snap gauge for checking a dia. of 10 ± 0.02 mm

Ex.No.2.2.139



File and fit straight and angular surfaces internally

Ex.No.2.2.147

Scan the QR Code to view the video for these exercise

Module 3 - Ex.No. 2.3.149 to 2.3.156



Flaring of pipes and pipe joints

Ex.No.2.3.149



Fitting of pipes as per sketch observing conditions used for pipe work

Ex.No.2.3.151



Bending of pipes - cold and hot

Ex.No.2.3.152



Fit & assemble pipes, valves and test for leakage & functionality of valves

Ex.No.2.3.154

Module 4 - Ex.No. 2.4.157 to 2.4.158



Make a simple drilling jig

Ex.No.2.4.157



Marking out for angular outlines, filing and fitting the inserts into gaps

Ex.No.2.5.159



Marking out for angular outlines, filing and fitting the inserts into gaps

Ex.No.2.5.160



Making an adjustable spanner

Ex.No.2.5.161



Dismantling and mounting of pulleys

Ex.No.2.5.162



Repairing damaged gears

Ex.No.2.5.164



Geometrical shaped fittings

Ex.No.2.5.170

Module 7 - Ex.No. 2.7.187 to 2.7.192



Dismantle, overhauling & assemble cross slide & hand slide of lathe carriage

Ex.No.2.7.187



Simple repair of machinery
Making of packing gaskets

Ex.No.2.7.188

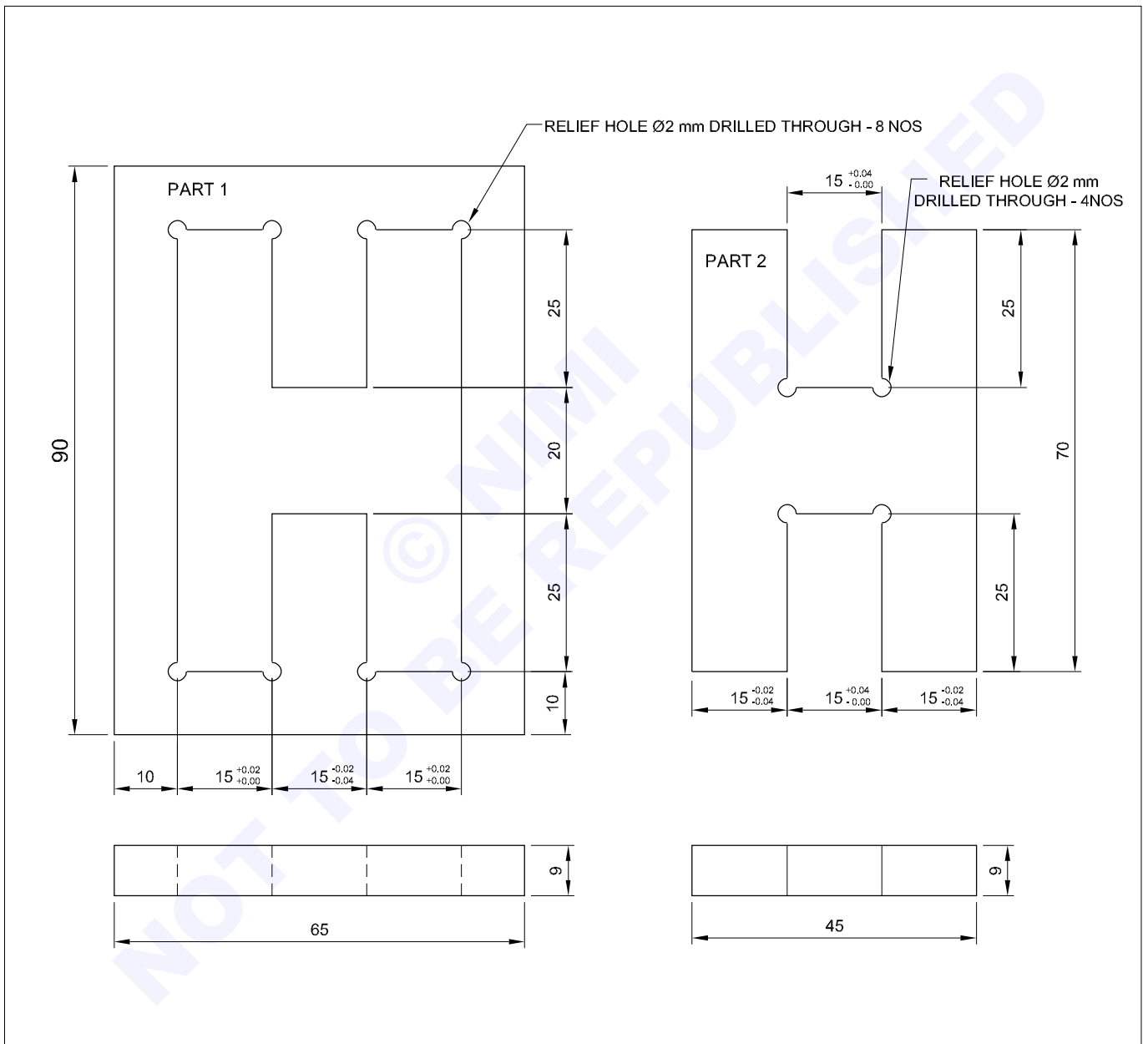


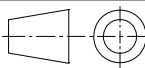
Use hollow punches, extractor, drifts, various types of hammer and spanners etc for repair work

Ex.No.2.7.190

Make - H - Fitting

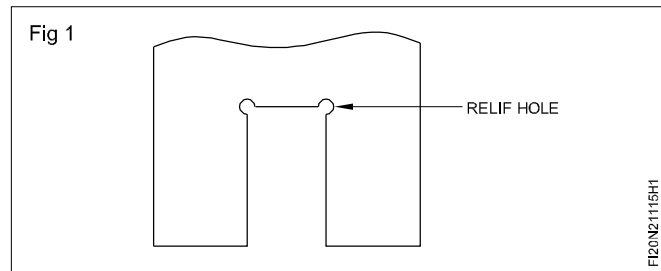
- Objectives:** At the end of this exercise you shall be able to
- file flat, square and parallel to an accuracy of $\pm 0.02\text{mm}$
 - drilling, chain drilling and relief holes
 - file profile to the given dimensions
 - assemble part 1 and 2 as per drawing
 - finish and de-burr.



1	100 ISF 10 - 70	-	Fe310	-	1	2.1.115
1	50 ISF 10 - 75	-	Fe310	-	2	2.1.115
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1					TOLERANCE : ± 0.02 TIME: 13 Hrs	
 <p style="text-align: center;">MAKE H - FITTING</p>					CODE NO. FI20N21115E1	

Job Sequence

- Check the size of raw material using steel rule for part 1 and 2.
- File surface and right angle on both part 1 and 2 and check by using try square.
- Apply marking media on part 1 and 2.
- Mark off part 1 and 2 as per given drawing dimensions, using 300 mm vernier height gauge.
- Punch witness marks on required lines, by using 60° Dot punch.
- Punch relief holes using centre punch.
- Make relief drill hole $\varnothing 2$ at corners on part 1 and 2. (Fig 1)
- Remove unwanted material by chain drilling, Hacksawing and chipping.

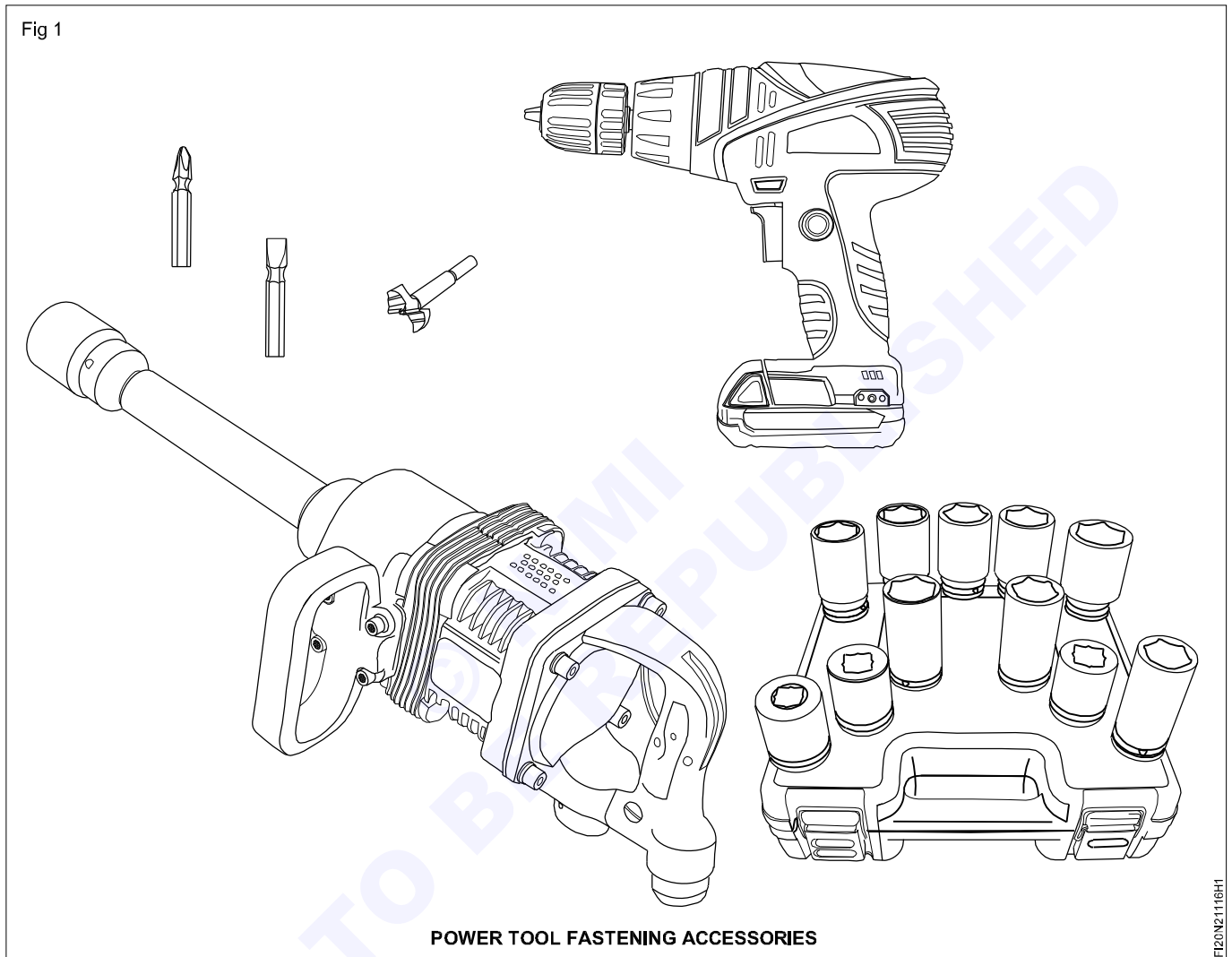


- File to size part 1 as per dimensions and measure the size by using outside micrometer/ vernier caliper.
- Finish part 1 and check the dimension using vernier caliper.
- Similarly finish part 2.
- Assemble part 1 and 2 and check for the slide fit.
- Apply thin coat of oil and preserve it for evaluation.
- Clean the work area and arrange the tools in order.

Power tools: Practice operation of power tool for fastening

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

- identify various power tools
- practice the operation of power tools for fastening.



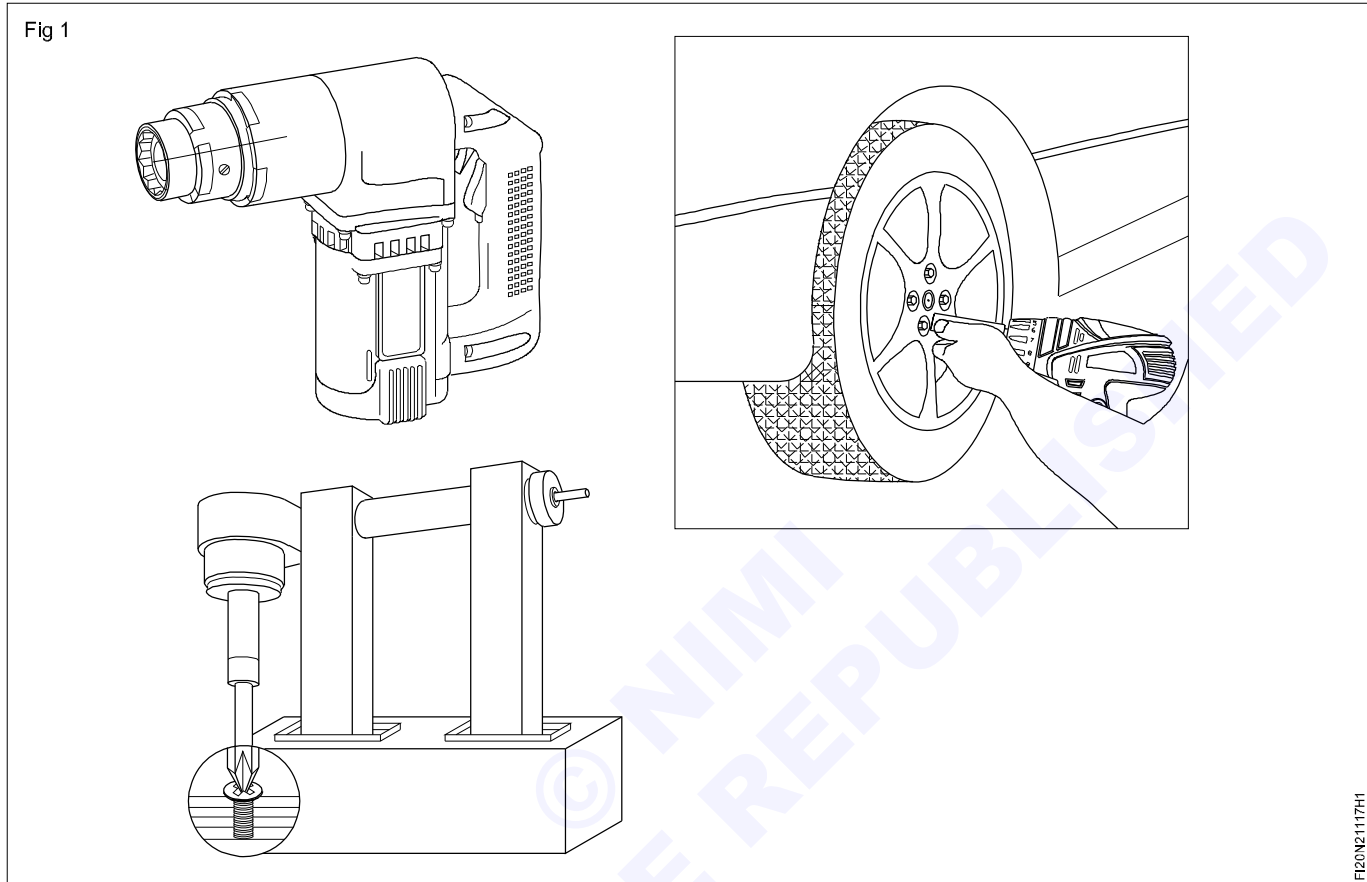
Job Sequence

- Identify the power tools.
- Follow the work operations required for the use of hand and power tools.
- Identify the source and access of power supply to power tools.
- Select the proper safety equipments such as safety goggles, hand gloves, boots, apron etc. and wear them.
- Check the tools for serviceability and safety and if there is any faults, report the same to the concerned authority.
- Select and use the equipment to hold and support the power tools.
- Choose the sequence of operations to produce the desired outcome from power tools.
- Select the tool required for operation and fix it, according to need.
- Power tools should be cleaned and stored safely in appropriate location according to standard workshop procedure and manufacturer recommendations.
- Fasten the nut and bolt.
- Clean the power tool and keep it in safe place.
- Keep work area neat and clean.

Tightening of bolt/screw with specified torque

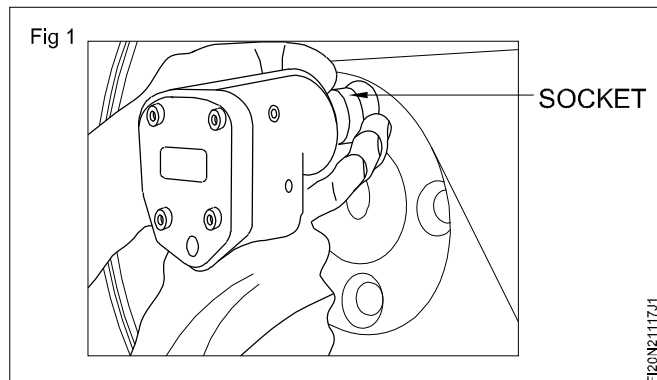
Objective: At the end of this exercise you shall be able to

- tighten the bolt/screw with specified torque.



Job Sequence

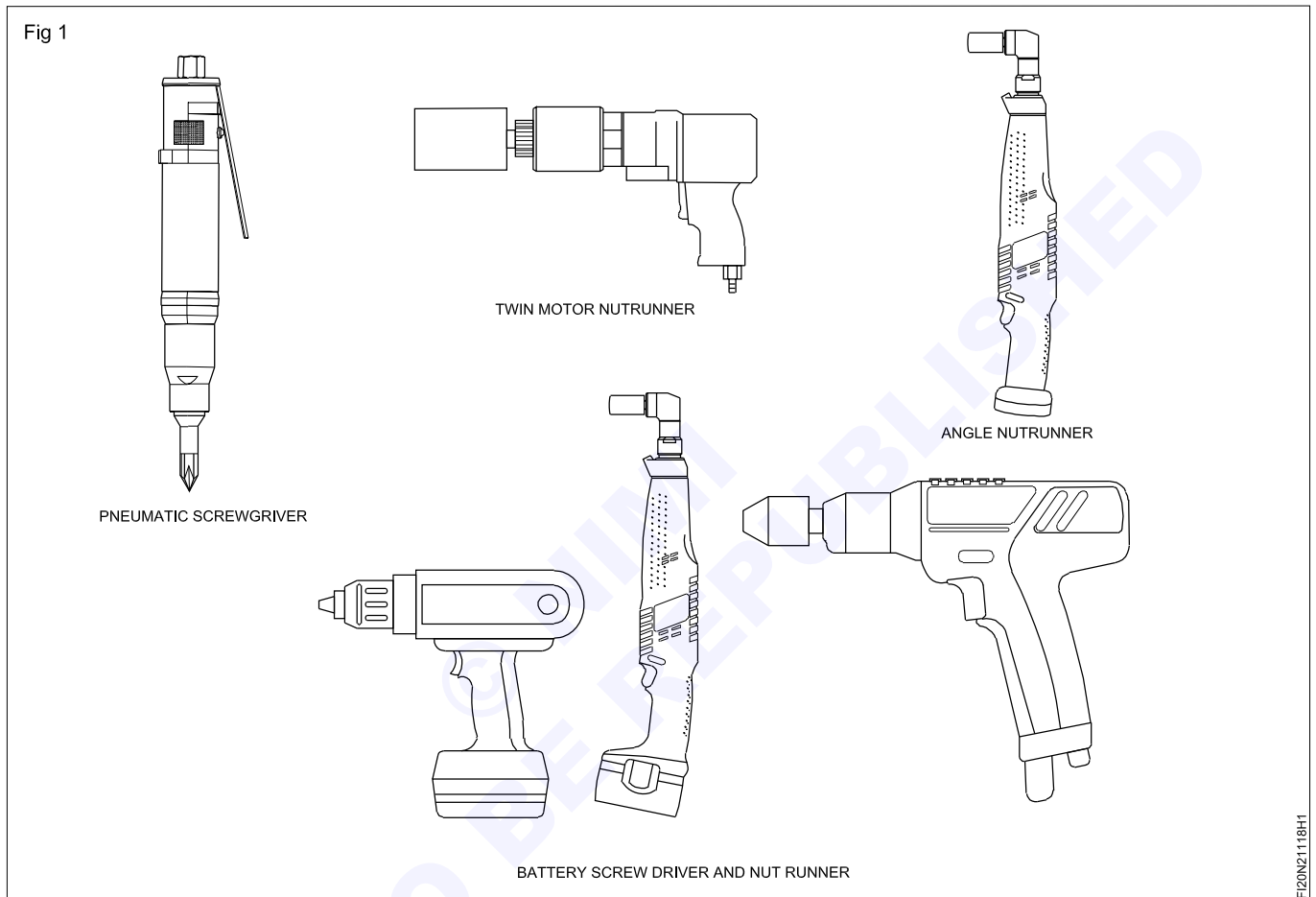
- Select a proper power tool for fastening.
- Select an impact wrench power tool operated by compressed air for tightening and loosening nuts.
- Check the air impact wrench is connected to the air lines.
- Select correct size of socket which can withstand sudden impact force. (Select six point impact socket).
- Fit the socket on the air impact wrench. (Fig 1).
- Set the direction of spin forward or backward with the help of wrench lever.
- Set the torque by turning the valve to increase or decrease.
- Insert the impact socket on the wheel leg nut.
- Trigger the switch of the impact wrench to loosen and remove the nut.



Selection of right tool as for tightening or loosening of screw/bolt as per accessibility

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

- record the tools required for the following applications
- select right tool for tightening and loosening of screw/bolt.



Note:

Instructor should display the required power tools and demonstrate the trainees for tightening and loosening of screw/bolt.

Ask the trainees to write the tool name for application in the Table 1.

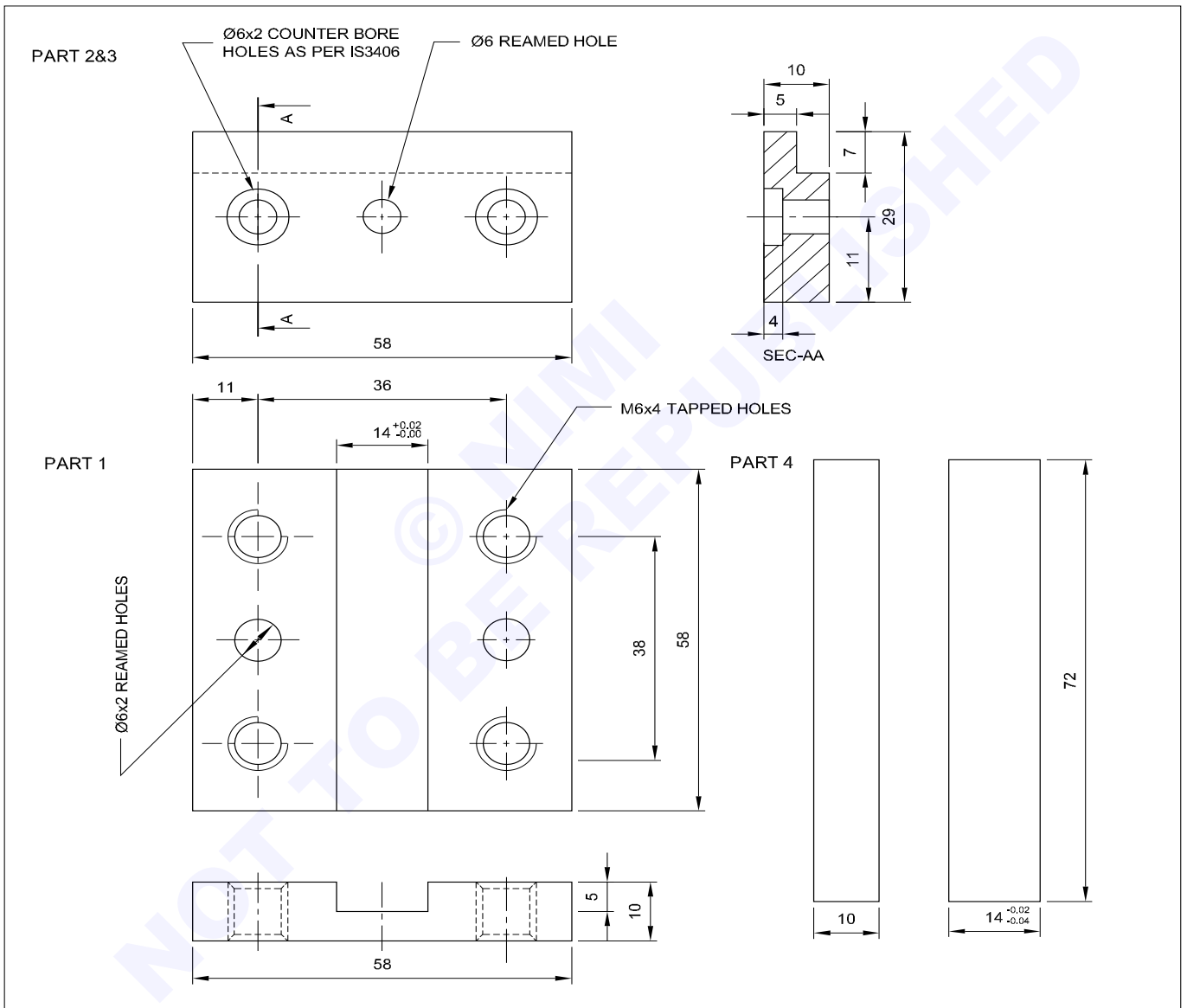
Table - 1

Applications	Tools required
Loosening and tightening of large dimension bolts during maintenance. High torques with moderate accuracy requirements.	
Assembly of machines screws where speed and handiness are important. Medium accuracy.	
Small screw assembly at low torque and medium high accuracy.	
Assembly of machine screws at low torque and medium to high accuracy.	
Assembly of machine screws and nuts where accuracy requirements are high. Bolts with limited accessibility.	
Assembly of machine screws where in the tightening process the torque and/ or angle must be monitored for quality control and certification.	
Application where the counting of properly tightened screws in a joint is essential for product quality control.	
Assembly where in the tightening process control to a high level of accuracy is necessary.	
Applications where articulated arms are used to support the reaction torque for multiple spindle tightening and for automatic systems.	
For maximum mobility and where the air hose or electric cable would limit access or pose a safety risk from a jammed cable	

Assembly sliding for using keys, dowel pin and screw, ± 0.02 mm accuracy on plain surface and testing of sliding fitting job

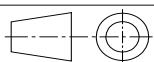
Objectives: At the end of this exercise you shall be able to

- mark dimensions with vernier height gauge
- file part 1,2,3,4, to size
- drill, ream and tap at correct location
- counter bore to the required depth
- assemble part 1,2,3,4 with dowel pins and cheese head screws.



2	Ø6-20	DOWEL PIN	FE310	-	6	2.1.119
4	M6-20	CHEESE HD SCREW	FE310	-	5	2.1.119
1	75 ISF 12-16	KEY	FE310	-	4	2.1.119
2	65 ISF 12-35	TOP PLATES	FE310	-	2&3	2.1.119
1	65 ISF 12-65	BASE PLATE	FE310	-	1	2.1.119
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1



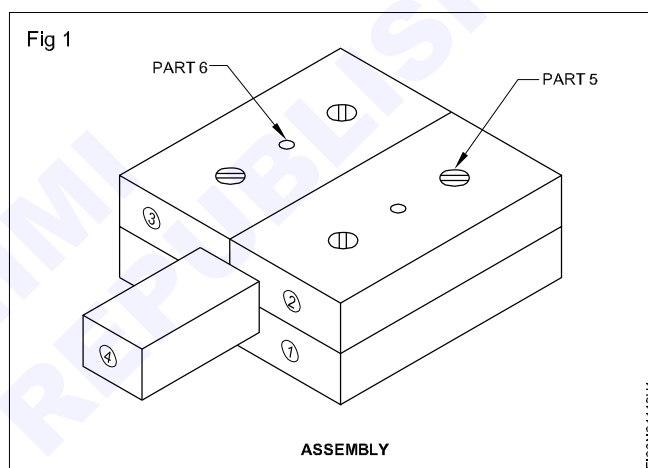
ASSEMBLY SLIDING FOR USING KEYS, DOWEL PIN AND SCREW, ± 0.02 mm ACCURACY ON PLAIN SURFACE AND TESTING OF SLIDING FITTING JOB

TOLERANCE : ±0.02mm TIME: 13 Hrs

CODE NO: FI20N21119E1

Job Sequence

- Check the raw materials for its size.
- File the parts 1,2,3 and 4 to its overall sizes maintaining accuracy ± 0.02 mm with flatness and squareness.
- Mark the dimension and location of holes as per drawing on part 1,2 and 3 by using Vernier height gauge.
- Punch witness marks.
- Punch on the location of holes on parts 1,2, and 3 using centre punch.
- File to size and shape in part 2 and 3 maintaining accuracy ± 0.02 mm with flatness and squareness.
- Set all four pieces together and clamp them with parallel clamps and check the squareness by using try square.
- Hold all the pieces together along with clamps on a drilling machine table and centre drill on part 2, and 3 in all hole locations.
- Remove the centre drill from the drill chuck and fix $\varnothing 5.8$ mm twist drill and drill through hole on part 2 to fix dowel pin without disturbing the position of job.
- Ream the drilled hole with $\varnothing 6$ mm hand reamer with tap wrench without disturbing the position of the job.
- Clean the reamed hole and fix $\varnothing 6$ mm dowel pin in the assembly.
- Similarly, drill other drill hole, ream and fix dowel pin in part 3 without disturbing the assembly.
- Fix $\varnothing 5$ mm twist drill and drill through hole on part 1 and 2 in assembly without disturbing the job to cut M6 internal thread in part 1 to fix cheese head screw.
- Similarly, drill $\varnothing 5$ mm other drill through holes in part 1, 2 and 3 without disturbing the job to cut M6 internal thread in part 1.
- Disassemble the setting and separate the part 1, 2, 3 and 4 of job pieces.
- Fix counter bore tool in drilling machine spindle and counter bore in part 2 and 3 to fix M6 cheese head screw.
- Fix counter sink tool and chamfer both ends of internal thread cutting holes $1\text{mm} \times 45^\circ$ in part 1.
- Hold the part 1 in bench vice and cut M6 internal thread in all four holes.
- Clean the threads without burrs.
- Finish file on all the parts and de-burr in all the corners of the jobs.
- Assemble all the parts 1,2,3 and 4 as shown in job drawing. (Fig 1)
- Apply thin coat of oil and preserve it for evaluation.



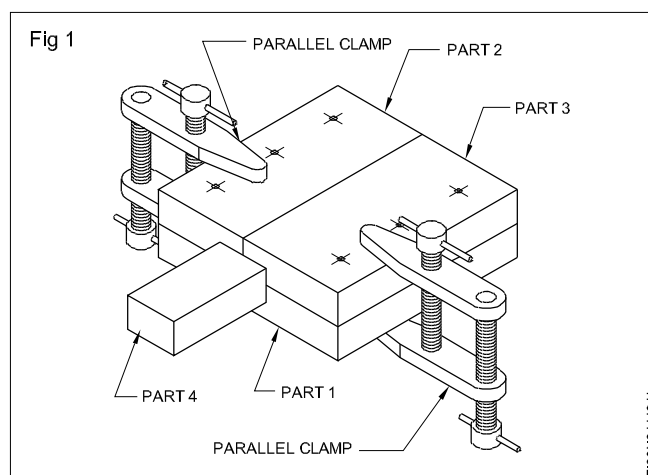
Skill Sequence

Assembly

Objective: This shall help you to

- assemble the parts together for drilling process to avoid mis-alignment of job setting.

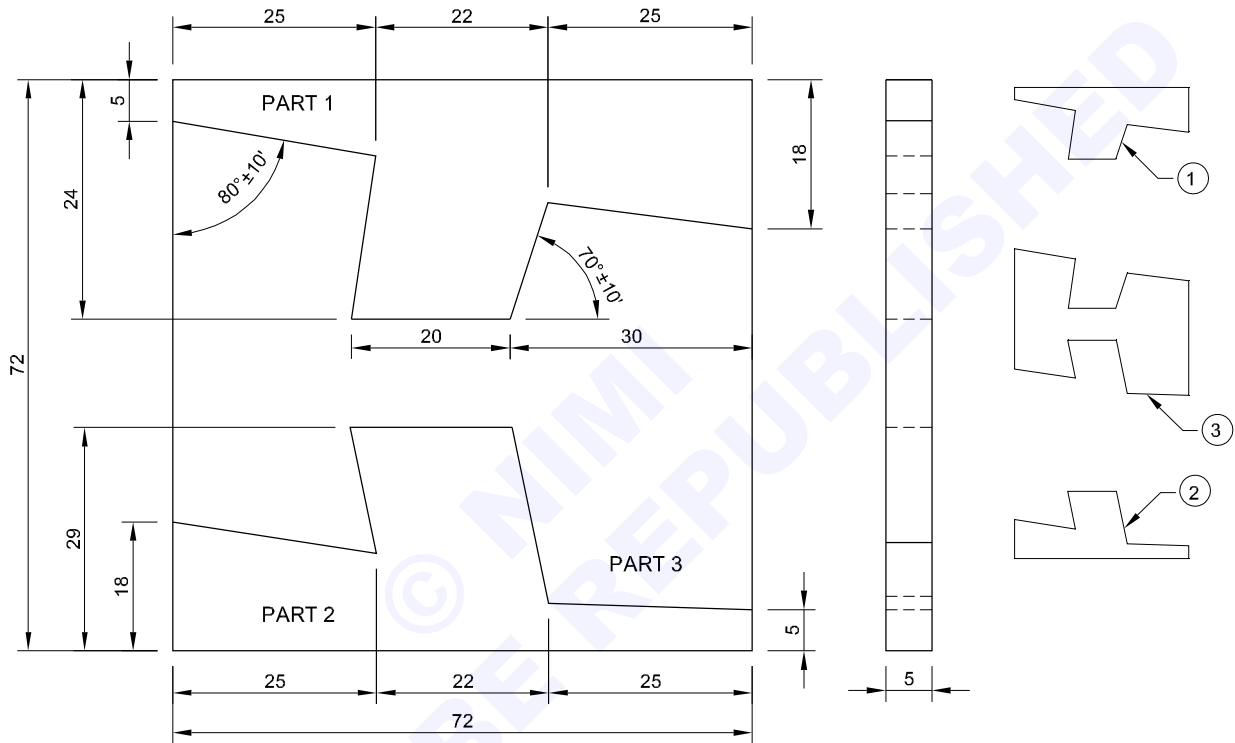
- keep two parallel blocks on a surface plate
- keep part 1 over the parallel block horizontally
- position part 2 on top of left side of part 1 and check the squareness of part 1 & 2 by using try square and clamp it by using parallel clamp
- simultaneously position part 3 on top of right side of part 1, check the squareness, by using try square, insert the part 4 in between gap and then clamp it by using parallel clamps.



File & fit angular mating surface within an accuracy of ± 0.02 mm & 10 minutes angular fitting


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

- mark angular outlines of part 1,2,3 with an accuracy of $\pm 10'$ accuracy
- file part 1,2,& 3 maintaining the accuracy of ± 0.02 for fitting
- assemble the part 1,2 & 3.
- finish and de-burr.



Job Sequence

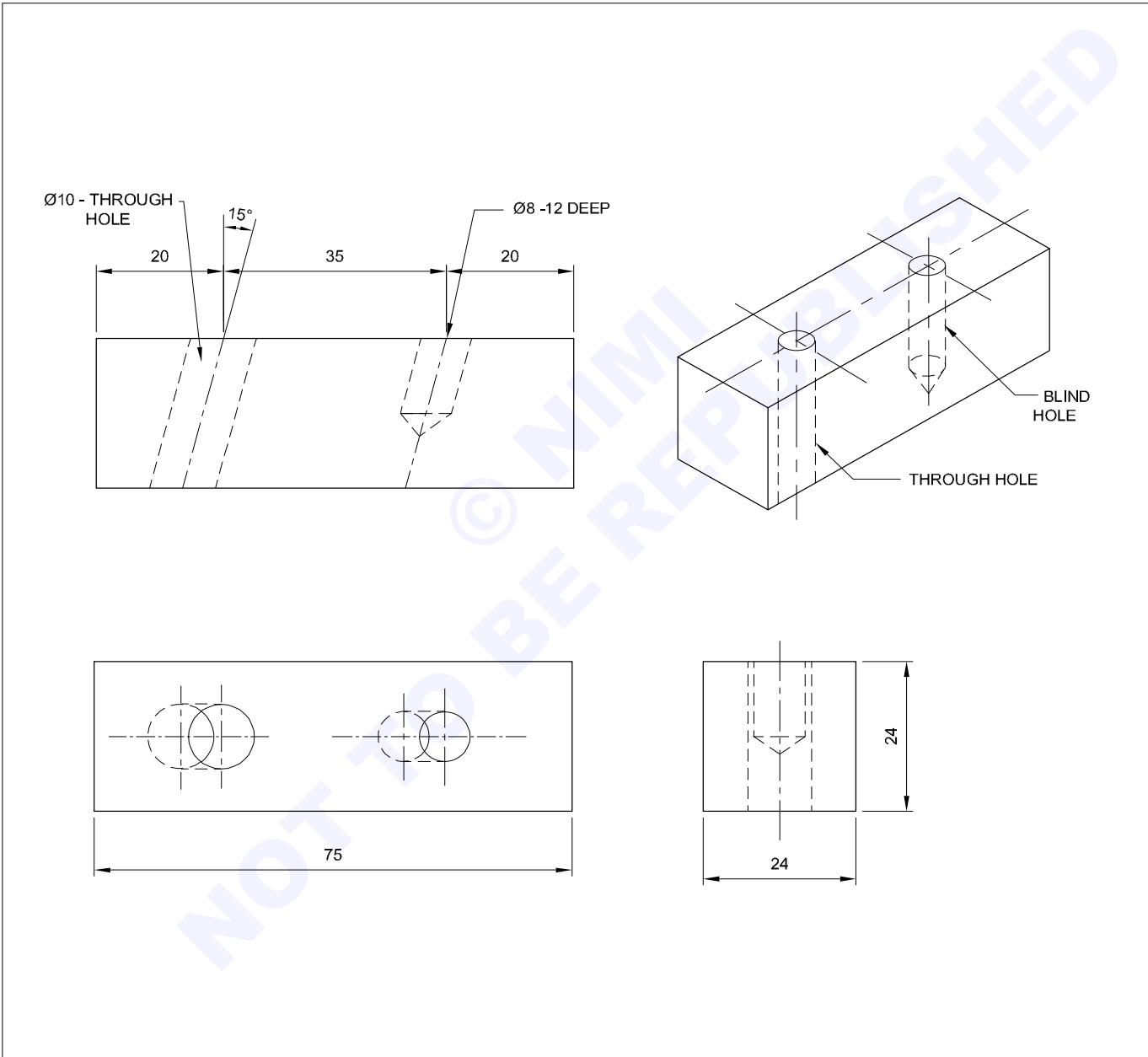
- Check the raw material for its size.
 - File surface and right angle and mark off part 1,2 & 3 with vernier height guage and vernier bevel protractor.
 - Punch on the marked lines.
 - Remove excess materials by hacksawing & chain drilling.
 - File part 1, 2 & 3 with an linear accuracy of ± 0.02 mm and angular of $\pm 10'$
 - Check the linear dimensions with vernier caliper and angular by vernier bevel protractor.
 - Fit part 1, 2 & 3 simultaneously and finish.
 - Apply little oil for preservation and evaluation.
- **Do not mark angular dimension/angle by scale/set square while marking.**
 - **Do not make a force fit**

1	65 ISF 6-75		Fe310		3	
1	35 ISF 6-75		Fe310		2	
1	30 ISF 6-75		Fe310		1	2.1.120
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1		FILE AND FIT ANGULAR MATTING SURFACE WITHIN AN ACCURACY OF ± 0.02 mm & 10 MINUTES ANGULAR FITTING			TOLERANCE : ± 0.02 mm	TIME: 12 Hrs
					CODE NO: F120N21120E1	

Drill through and blind holes at an angle using swivel table of drilling machine

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

- file surface and right angle and check with try square
- file to size maintaining accuracy $\pm 0.02\text{mm}$
- align the job for angular drilling
- drill angular through hole
- drill angular blind hole.



1	SQ 25-80	-	Fe310	-	1	2.1.121
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1	DRILL THROUGH AND BLIND HOLES AT AN ANGLE USING SWIVEL TABLE OF DRILLING MACHINE				TOLERANCE : $\pm 0.02\text{mm}$	TIME: 9 Hrs
					CODE NO: FI20N21121E1	

Job Sequence

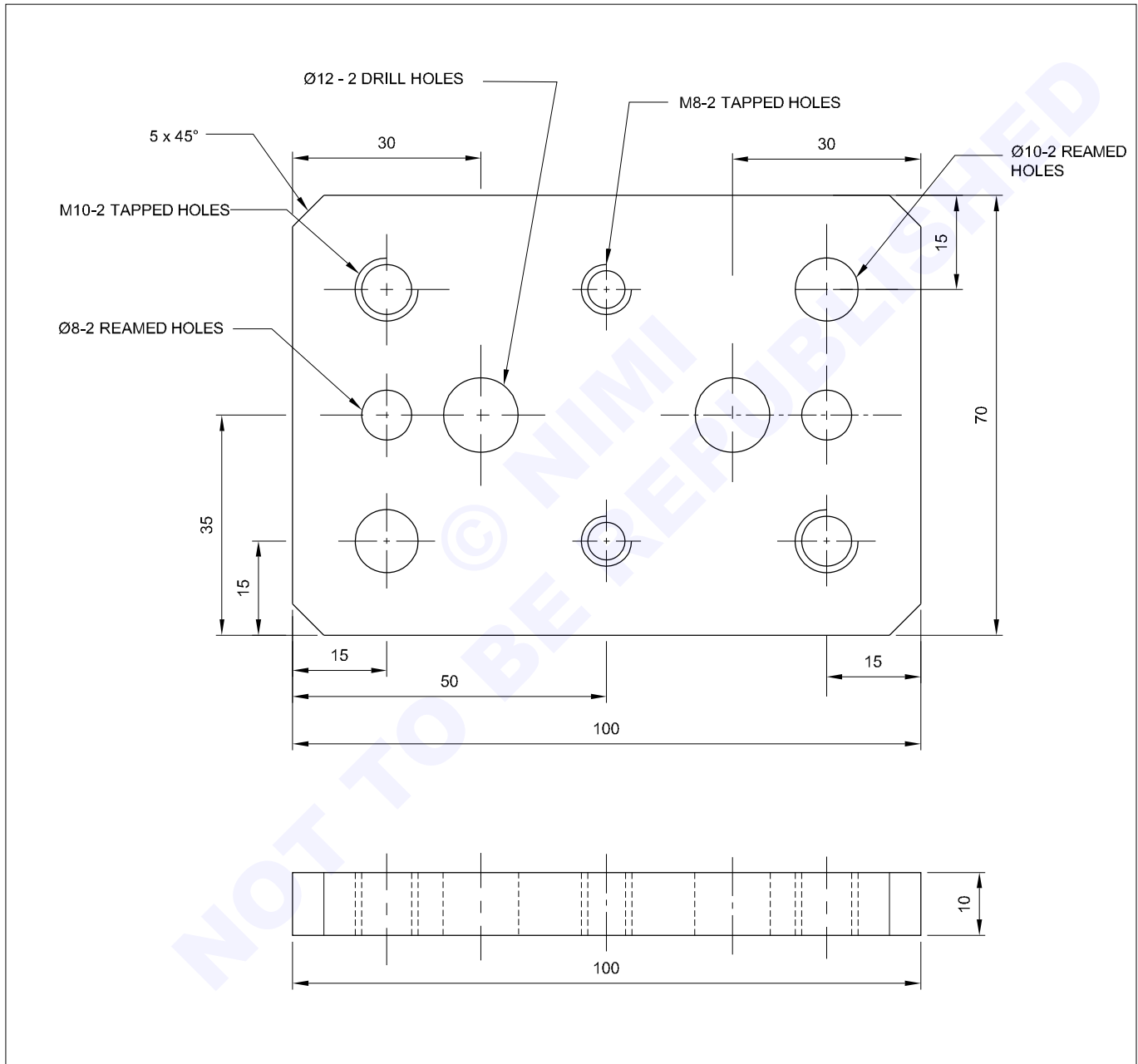
- Check the raw material for its size.
- Mark the required size and cut by hacksawing.
- File to size 75x24x24mm and check with vernier caliper.
- Mark the given dimension for drilling location as per size by using vernier height gauge.
- Punch on correct locations of drills
- Hold the work piece in the machine horizontally by keeping the parallel blocks under the work piece to avoid drill bit tip touch the metal base of machine vice.
- Check with spirit level.
- Clamp the machine vice to the drilling machine universal table.
- Lock and arrest the table rotation in 'z' axis.
- Tilt the drilling machine table at an angle of 15°, lock it, and drill hole to the required depth.
- Align the spindle centre and hole location using locating pin.
- Centre drill the hole, till it reaches the formation of cone.
- Drill a $\varnothing 8$ mm to a depth of 12 mm as shown in drawing using depth bar.
- Align the spindle centre to another hole location.
- Centre drill the hole slowly feed the centre drill till it reaches the formation of cone.
- Drill a $\varnothing 10$ mm to full depth.
- Deburr and clean the job.
- Apply thin layer of oil and preserve it for evaluation.

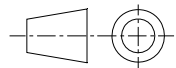
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Precision drilling, reaming and tapping and test - job

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

- file and finish the job to the over all size.
- chamfer all the corners
- drill, ream & tap at specified location
- check using plug gauge & thread plug gauge
- finish and deburr.



1	75 ISF 12 - 105	-	Fe310	-	-	2.1.122
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1		PRECISION DRILLING,REAMING AND TAPPING AND TEST- JOB			TOLERANCE : ±0.02 mm	TIME: 12 Hrs
					CODE NO: FI20N21122E1	

Job Sequence

- Check the raw materials for its size.
- File the raw material to its overall dimension 100 x 70 x 10 mm.
- Mark the dimensional lines for location of holes as per drawing.
- Punch the centre punch marks on the location of holes and witness mark on the object line.
- Hold the work piece on a drilling machine table with machine vice.
- Keep the parallel blocks under the work piece in machine vice.
- Hold the centre drill in drilling machine spindle through drill chuck and drill centre drill holes on all the holes punched locations.
- Set the drilling machine spindle speed according to the diameter of drill and material.
- Remove the centre drill and fix $\varnothing 7.8$ mm drill through holes as per drawing.
- Set the spindle speed, fix drills $\varnothing 8.5$ mm, $\varnothing 7.0$ mm, $\varnothing 9.8$ mm, $\varnothing 12$ mm drill through holes as per drawing.
- Hold the counter sink tool and chamfer all the drilled holes on both sides of job 2 mm x 45° .
- Ream $\varnothing 8$ mm holes using hand reamer.
- Check the reamed holes using suitable cylindrical plain plug gauge.
- Cut M8 and M10 internal threads using hand tap and tap wrench.
- Clean the burrs in the threaded holes.
- Check the threaded holes using thread plug gauge.
- File the chamfer portion 5mm X 45° angle using flat file (using bastard and smooth grade of files).
- Check the chamfer angle with vernier bevel protractor to an angular accuracy $\pm 5'$.
- Finish and remove burrs on all surfaces and corners of the job.
- Apply a little oil and preserve it for evaluation.

Skill Sequence

Reaming drilled holes using hand reamers

Objective: This shall help you to

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

Determining the drill size for reaming

Use the formula,

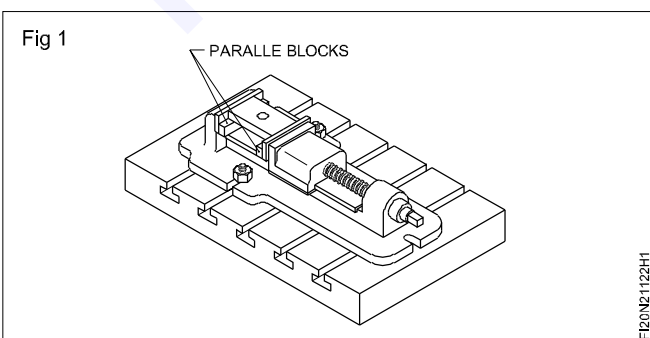
drill diameter = reamed hole size - (undersize + oversize)

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

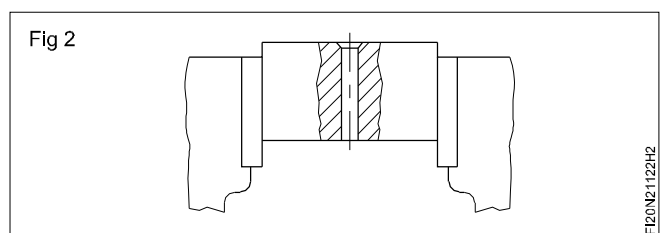
Hand reaming

Drill holes for reaming as per the sizes determined.

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



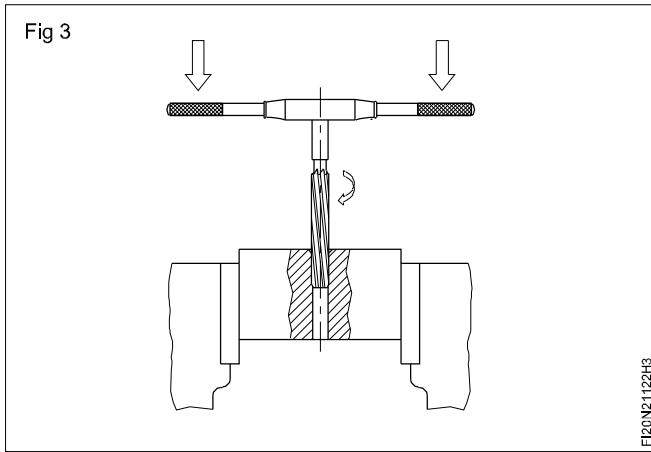
Chamfer the hole ends slightly. This removes burrs, and will also help to align the reamer vertically (Fig 2). Fix the work in the bench vice. Use vice clamps to protect the finished surfaces. Ensure that the job is horizontal. (Fig 2)



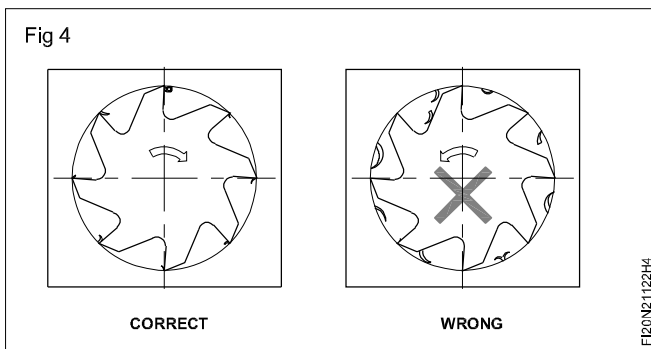
Fix the tap wrench on the square end and place the reamer vertically in the hole. Check the alignment with a try square. Make corrections, if necessary. Turn the tap wrench in a clockwise direction applying a slight downward pressure at the same time (Fig 3). Apply pressure evenly at both ends of the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

Apply cutting fluid.

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



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

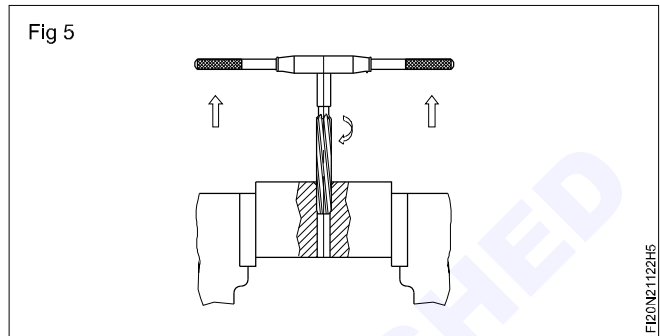


Ream the hole through. Ensure that the taper lead length of the reamer comes out well and clear from the bottom of the work. Do not allow the end of the reamer to strike on the vice.

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

Remove the burrs from the bottom of the reamed hole.

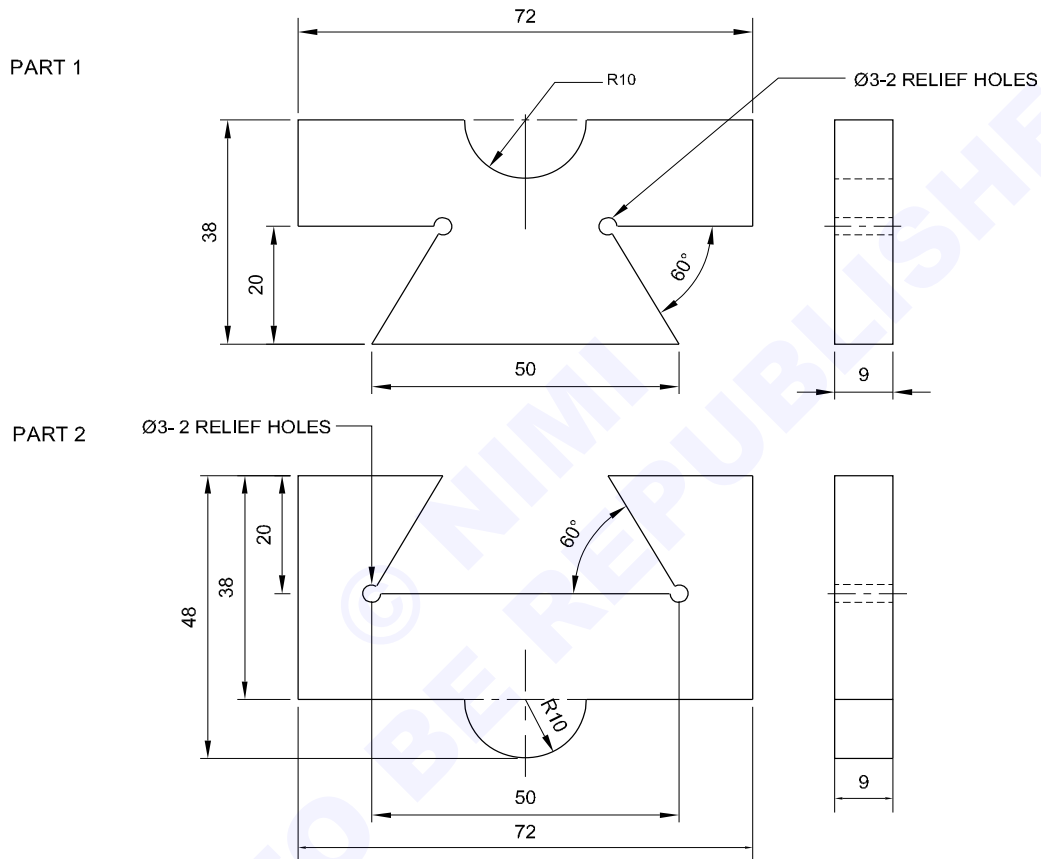
Clean the hole. Check the accuracy with the cylindrical pins supplied.



Make dovetailed fitting and radius fitting

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

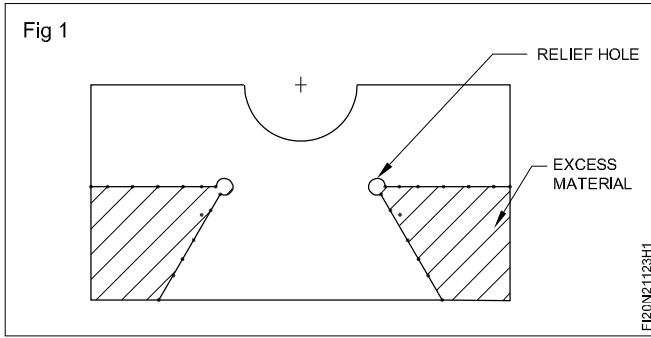
- file and finish to overall size on part 1 and 2
- mark off dimensions and radius by divider
- remove excess material by chain drilling on part 2
- fix male and female parts and assemble
- finish and deburr.



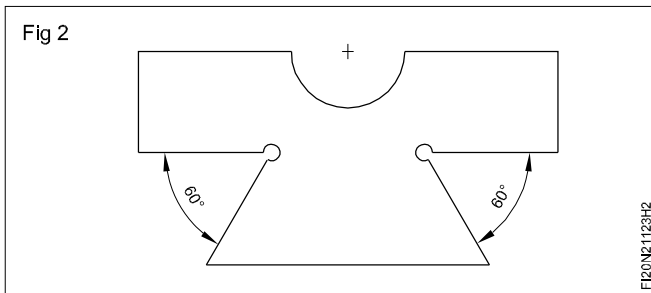
Job Sequence

- Check the raw material for its size.
 - File and finish part 1 and 2 for the over all dimensions.
 - Mark off lines part 1 and 2 with a vernier height gauge.
 - Punch on witness marks and relief hole marks.
 - Drill relief holes of $\varnothing 3$ mm in both the parts 1 & 2 and also chain drill in part 2.
- Part - 1**
- Hacksaw on sides of dovetail of Part 1 to remove excess metal as shown in Fig 1.

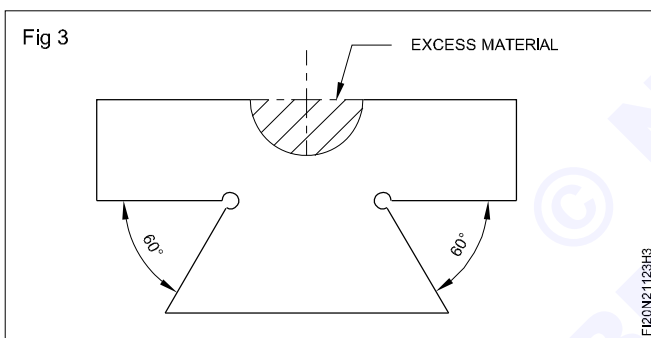
1	75 ISF 10 - 50	-	Fe310	-	2	2.1.123
1	75 ISF 10 - 40	-	Fe310	-	1	2.1.123
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1					TOLERANCE : ± 0.02 mm	
<p>MAKE DOVETAILED FITTING AND RADIUS FITTING</p>					TIME: 18 Hrs	
					CODE NO: FI20N21123E1	



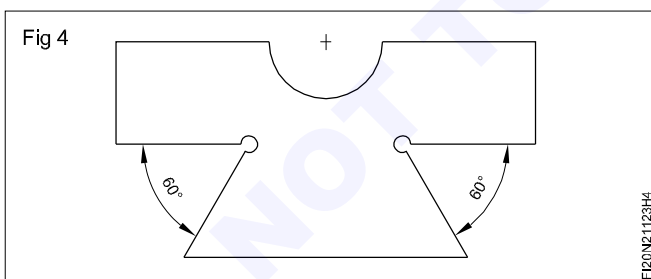
- File and check the size with vernier caliper and angle with vernier bevel protractor as shown in Fig 2.



- Similarly, hacksaw on the other side of round profile, remove excess metal to size and shape as shown in Fig 3.

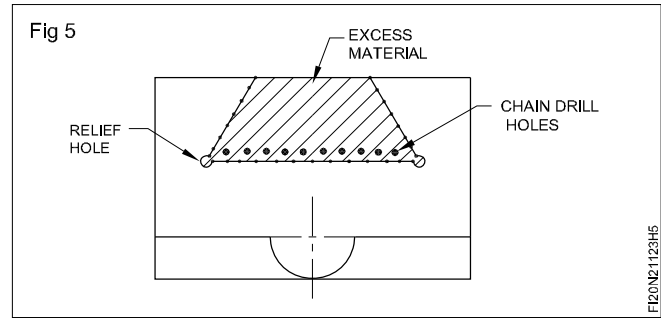


- Remove excess metal using bastard, second cut and smooth file. File half round profile using half round file and check the profile with radius gauge Fig 4.

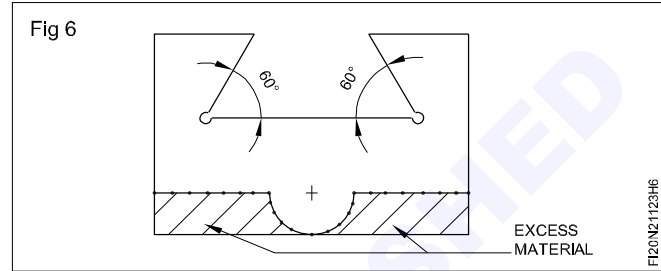


Part - 2

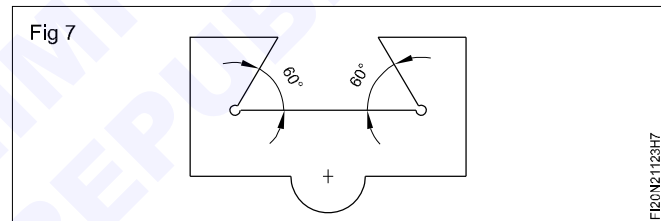
- Hacksaw on sides of dovetail to remove excess metal as shown in Fig 5.
- Chain drill and cut off along the chain drilled holes using web chisel and ball pein hammer and remove as shown in Fig 5.



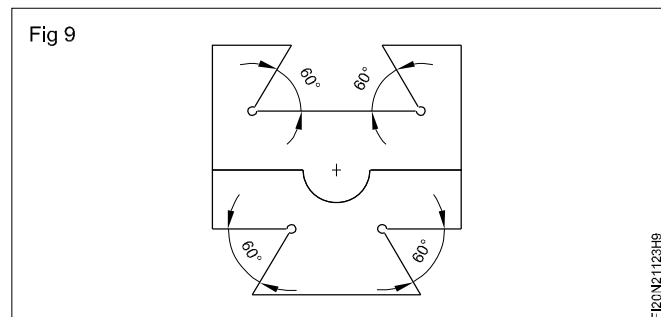
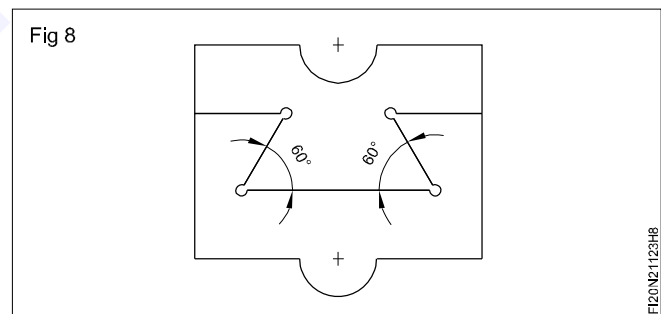
- File the internal dovetail of Part -2 to size and angle and check the size with vernier caliper and angle with vernier bevel protractor Fig 6



- Hacksaw and remove the excess metal and file the half round profile to size and check it with radius gauge Fig 7.



- Match part 1 and 2 to fit both dovetail and half round profile as shown in Fig 8 and Fig 9.

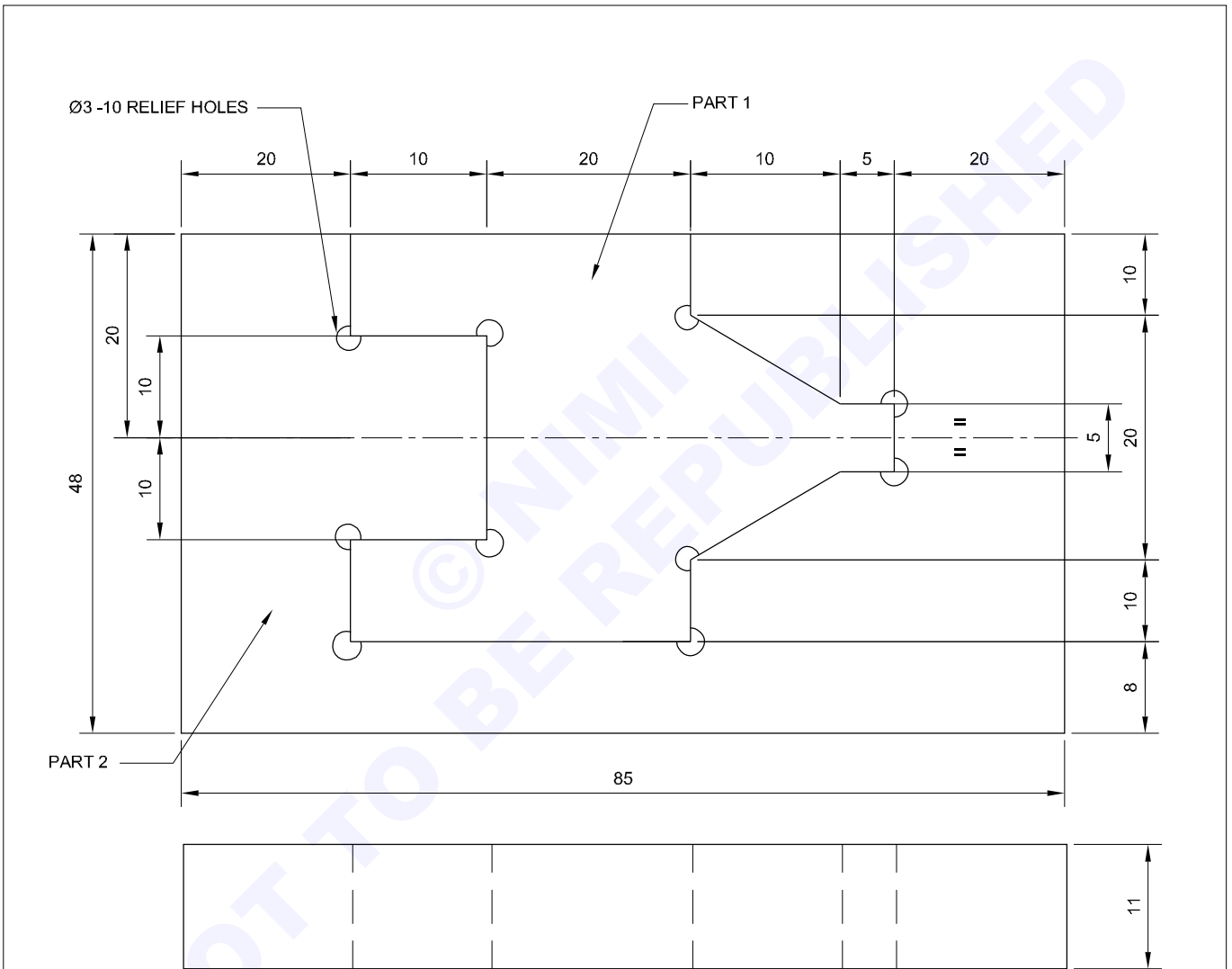


- Separate part 1 and 2, file and finish, de-burr all the corners of the job.
- Apply thin coat of oil and preserve it for evaluation.

File and fit, combined fit with straight, angular surface with ± 0.02 mm accuracy

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

- file flat and square to accuracy of ± 0.02 mm
- mark dimensions with a vernier height gauge
- drill relief holes
- fit part 1 & 2 maintaining and accuracy of ± 0.02 mm.

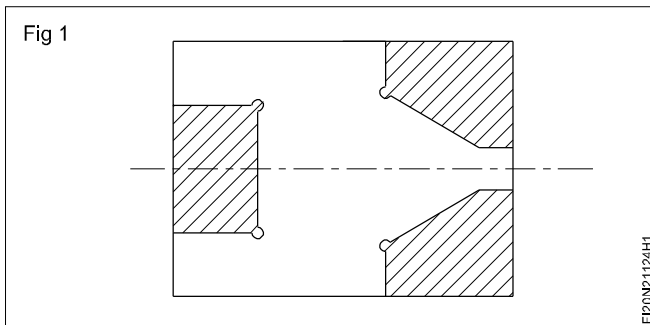


1	50 ISF 12 - 90		Fe310	-	2	2.1.124
1	50 ISF 12 - 45		Fe310	-	1	2.1.124
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS		FILE AND FIT, COMBINED FIT WITH STRAIGHT, ANGULAR SURFACE WITH ± 0.02 mm ACCURACY			TOLERANCE : ± 0.02 mm	TIME : 18 Hrs
					CODE NO: FI20N21124E1	

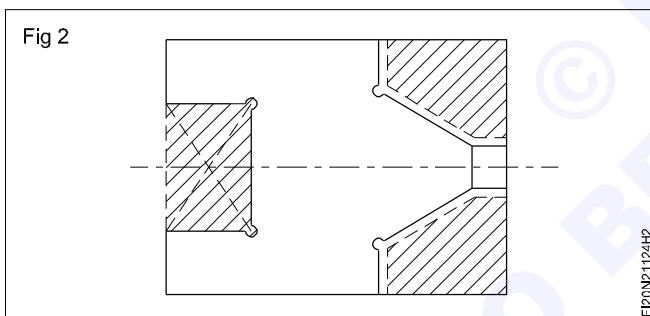
Job Sequence

- Check the raw material for its size.
- File and finish part 1 & 2 for the overall dimensions.
- Check the size with vernier caliper.
- Mark off dimensional lines in part 1 & 2 with a vernier height gauge.
- Punch on witness marks and relief hole markds.
- Chain drill and drill relief holes of $\varnothing 3$ mm in part 1 & 2 as shown in Fig 1 to 4.

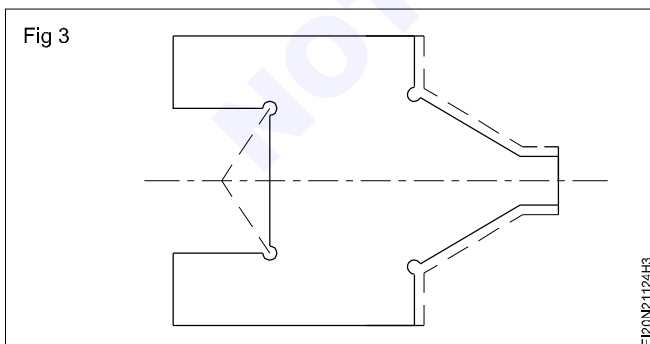
Part 1



- Hacksaw on one portion of part 1 to remove excess metal and file to size and shape maintaining accuracy of ± 0.02 mm Fig 2.
- Check the size with vernier caliper.

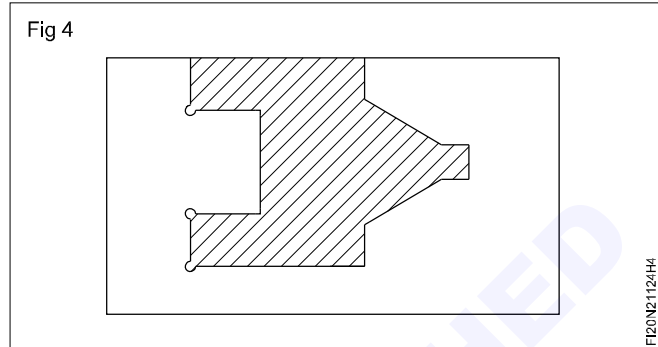


- Similarly, hacksaw on other two portion of part 1 to remove excess metal and file to shape to an accuracy of ± 0.02 mm Fig 3.

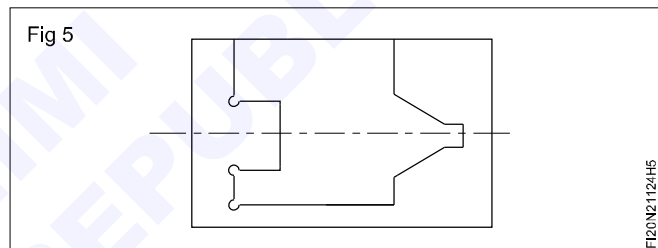


Part 2

- Chain drill and drill relief holes $\varnothing 3$ mm as shown in Fig 4.
- Hacksaw, chip and remove the excess material as shown in Fig 4.



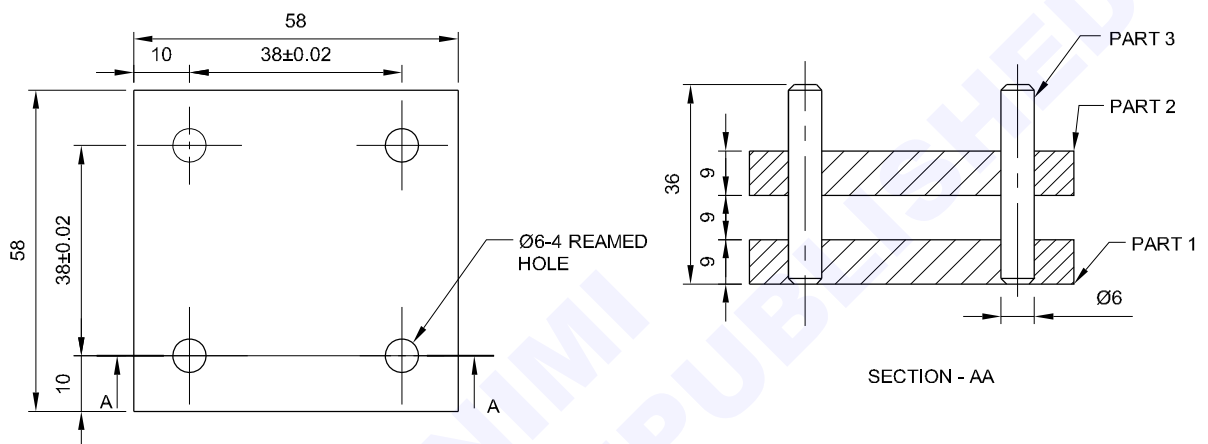
- File to size to shape maintaining accuracy of ± 0.02 mm.
- Check the size with vernier caliper.



- Finish file part 1 and deburr in all corners of the job.
- Fit part 1 and 2 as shown in job drawing.
- Apply thin coat of oil and preserve it for evaluation.
- Clean and arrange the tools in order.

Drilling and reaming small dia. holes to accuracy & correct location for fitting

- Objectives:** At the end of this exercise you shall be able to
- file surfaces flat and parallel to an accuracy of ± 0.02 mm
 - mark off dimensions with a vernier height gauge
 - measure dimensions with a vernier caliper
 - drill through holes as per drawing
 - ream the holes and assemble with dowel pins.



Job Sequence

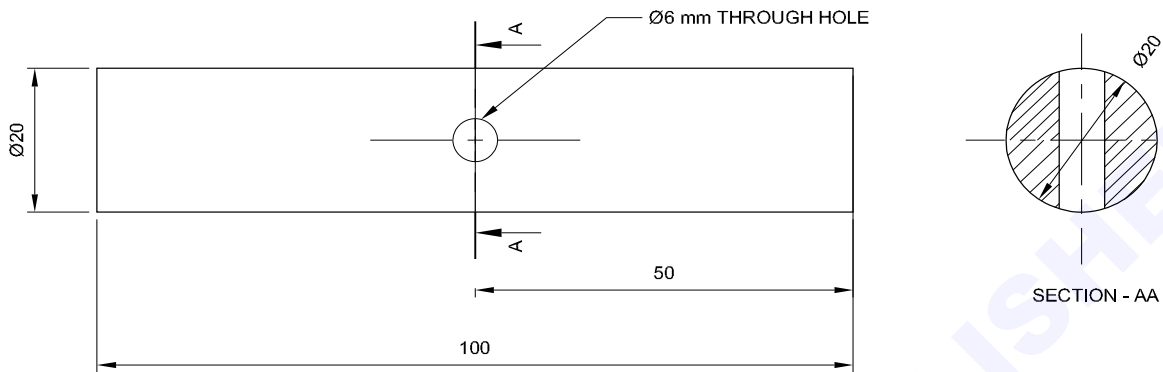
- Check the raw material for its size.
- File one flat surface and two adjacent sides at right angles to each other on both pieces.
- Apply marking media on the surfaces of the job.
- Mark the dimensions and the hole location with a vernier height gauge.
- Punch the witness mark using dot punch.
- Punch the hole location using centre punch.
- Remove excess material by hacksawing and file to size 58x58x9mm on both the pieces.
- Measure the dimensions with a vernier caliper
- Clamp both pieces together on the drilling machine vice and keeping parallel blocks under the job.
- (Use parallel clamps for holding both jobs)
- Using a centre drill locate the hole position and drill up to 1mm depth.
- Without changing the position of the job remove the centre drill and fix a Ø 5.8 mm drill and drill a through hole.
- Similarly drill the other three holes.
- Remove the job from the drilling machine and ream the holes using Ø 6 mm hand reamer by holding in a vice.
- Fix the 4 dowel pins in reamed holes.
- Check the squareness of dowel pins & correct location.
- Apply little oil and preserve it for evaluation.

4	Ø6 - 36	DOWEL PIN	AS PER IS 6689	-	3	2.1.125
2	65 ISF 10 - 60	MATCH PLATE	Fe310	-	1 & 2	2.1.125
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1					TOLERANCE : ± 0.02 mm	
<p>DRILLING AND REAMING SMALLER DIA. HOLES TO ACCURACY & CORRECT LOCATION FOR FITTING</p>					TIME: 4Hrs	
					CODE NO: FI20N21125E1	

Perform drilling using 'V' Block and a clamp

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

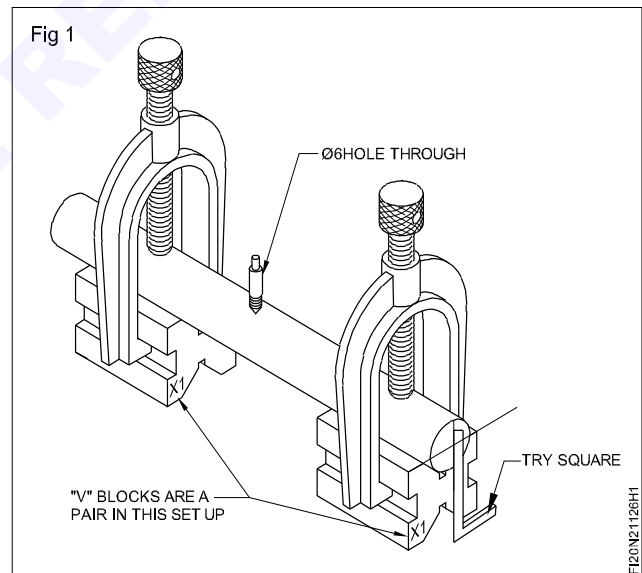
- set cylindrical job on 'V' block
- drill on cylindrical job.



Job Sequence

- Place two 'V' blocks on the marking table.
- Keep the pre machined cylindrical job on 'V' block.
- Insert 'U' clamps in the 'V' block and clamp it.
- Mark the centre line at both periphery and face using vernier height gauge.
- Punch the location of hole as per drawing.
- Align the centre line on face of round rod perpendicular to the drilling machine table surface.
- Clamp the job rigidly.
- Set the proper Rpm.
- Using centre drill locate the hole position and drill up to 1mm depths
- Drill Ø 6 mm to through hole.
- Loosen the 'U' clamp and remove the job from 'V' block.

Use two 'V' blocks and clamp to support long round rods rigidly while marking. (Fig -1)



1	Ø20 - 100	-	Fe310	-	1	2.1.126
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1					TOLERANCE : ±0.02 mm	
					TIME: 1Hr	
					CODE NO: FI20N21126E1	

Make male and female fitting parts, drill and ream holes

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

- file and finish the job to the over all dimensions
- mark and punch all dimensions
- drill and ream the hole
- file and finish Part 1 and part 2 and match it.

PART - 1

Ø3-6 RELIEF HOLES
Ø13 REAMED HOLE

23, 11.5, 10, 58, 9.5, 8, 23, 31, 58, 5

PART - 2

Ø3-4 RELIEF HOLES
R11.5

23, 10, 58, 8, 9.5, 23, 31, 58, 5

2	60 ISF 6 - 60	-	Fe310	-	PART 1 & 2	2.1.127
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MAKE MALE AND FEMALE FITTING PARTS				TOLERANCE : ±0.02 mm	TIME: 18 Hrs
					CODE NO. FI20N21127E1	

Job Sequence

- Check the raw materials for its size.

Part 1

- File Part 1 to overall size 58 x 58 x 5 mm and check the sizes with Vernier caliper
- Check flatness and squareness with try square.
- Apply marking media and make lines as per drawing
- Punch witness marks and drill hole marks.
- Drill relief holes in drilling machine
- Drill \varnothing 12.7 mm through hole for reaming.
- Ream \varnothing 13 mm hole with reamer.
- Cut and remove excess materials and file the profile of the job maintaining necessary accuracy of ± 0.02 mm.

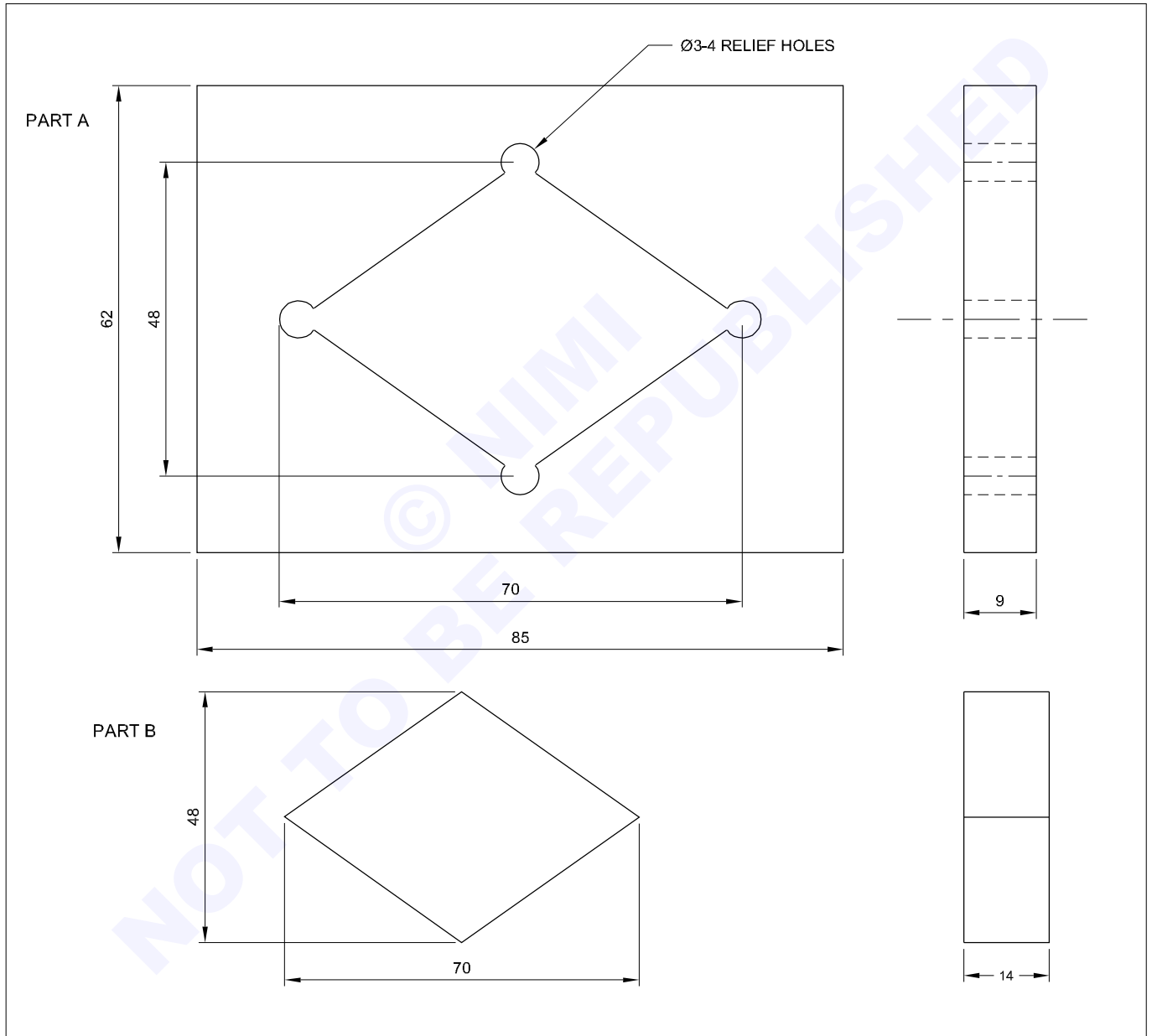
- Check the size with the vernier caliper.
- Check the radius with radius gauge.
- Check the 9.5 mm slots using with vernier caliper.
- Finish all the surfaces and de burr, corners of the job.


Part 2

- Similarly repeat the above job sequence for part 2 and file the profile of the job.
- Remove unwanted material by chain drilling, hacksawing and chipping.
- Match part 1 and part 2 as per job drawing
- Apply thin oil and preserve it for evaluation.

Make sliding diamond fitting

- Objectives:** At the end of this exercise you shall be able to
- file flat surfaces and parallel to an accuracy of ± 0.02 mm
 - file angular surfaces to an accuracy of $\pm 15'$
 - relief drill hole of $\varnothing 3$ mm
 - chain drill hole and remove excess metal
 - file to size and match as per drawing
 - finish and deburr.



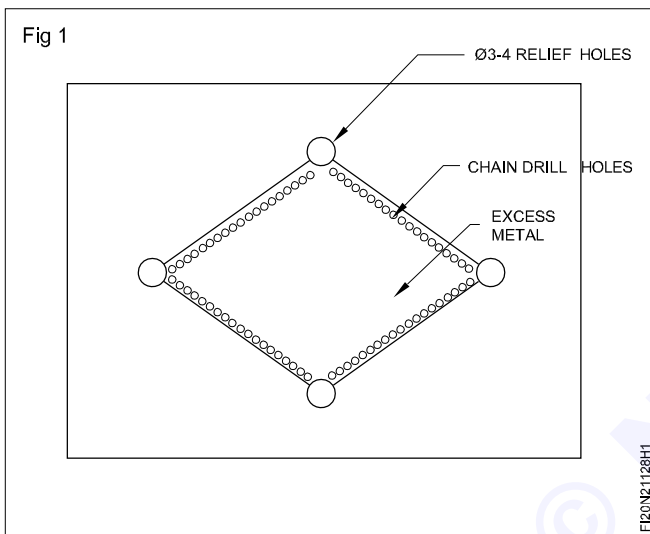
1	50 ISF 16-75	-	Fe310	-	B	2.1.128
1	65 ISF 10-90	-	Fe310	-	A	2.1.128
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE: NTS					TOLERANCE : ± 0.02 mm	
<p align="center">MAKE SLIDING DIAMOND FITTING</p> 					TIME 22 Hrs	
					CODE NO. F120N21128E1	

Job Sequence

- Check the raw material for its size.
- File and finish part A and part B for the over all size maintaining parallelism and perpendicularity.
- Mark of part A and part B with a vernier height gauge as per drawing.
- Punch witness marks and relief hole marks.
- Drill relief holes of $\varnothing 3\text{mm}$ in part A.
- Chain drill hole in part A.

Part A

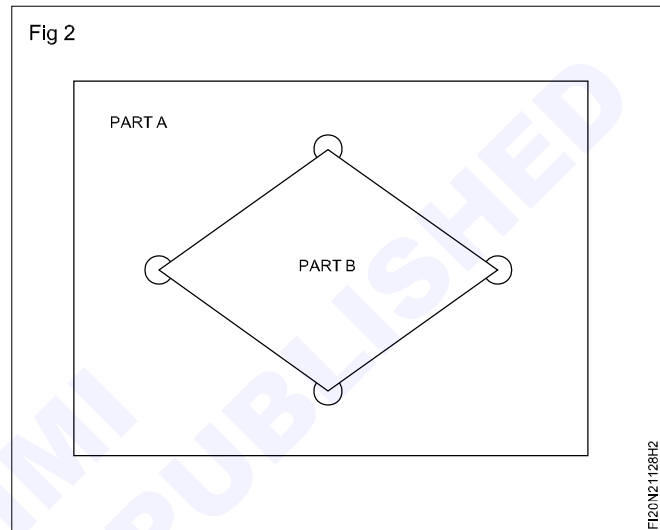
- Chip and remove excess metal in part A as shown in Fig 1.



- File part A to size and shape as per drawing.
- Check the size with vernier caliper and angles with vernier level protractor.

Part B

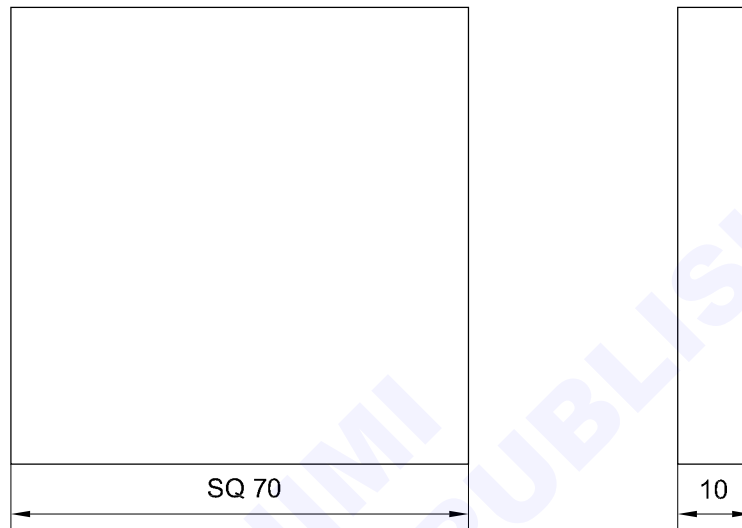
- File part B to size and shape as per drawing.
- Match part A and B as shown in Fig 2.
- Finish part A and B and remove burrs in all corners.
- Apply a thin coat of oil and preserve it for evaluation..



Lap flat surfaces using lapping plate

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

- lap the surface using lapping plate
- smear the lapping medium
- check the surface quality with surface roughness standard set.



Job Sequence

- Check the raw material size.
- Cut the material as per size given in the drawing.
- Mark the job as per dimension given in the drawing.
- Punch on the marked line and cut the unwanted materials.
- File and finish to the size.
- Place the lapping plate on the bench vice.

- Hold the job tightly and lap the surface.
- Checking the flatness by applying prussian blue method.
- Finish the job accurately.

Precautions:

- Always keep the lap moist.
- While lapping use the entire surface of the lapping plate.
- Do not give any excessive pressure.
- Check the surface roughness by comparing with standard set of roughness sample.

Make sure the lapping plate not shacking.

- Position the job on the lapping plate.
- Apply lapping medium.

1	75 ISF 12 x 75	-	Fe310	-	-	2.1.129
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1		LAP FLAT SURFACES USING LAPPING PLATE			TOLERANCE: ±0.02 mm	TIME: 5hrs
					CODE NO. FIN20N21129E1	

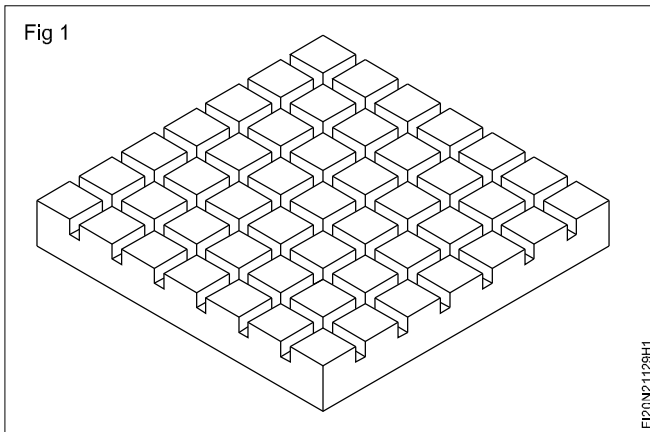
Skill Sequence

Lapping flat surfaces

Objective: This shall help you to

- lap flat surfaces using a lapping plate.

For lapping flat surfaces, a rigid cast iron plate - machined perfectly flat with grooves cut on it (Fig 1) can be used as a lapping plate.

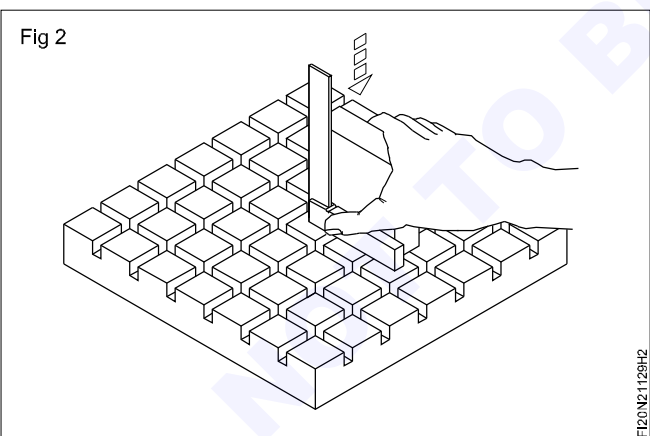


This lapping plate should be kept flat without any rocking on the workbench.

Aluminium oxide may be used as a lapping medium as the workpiece is unhardened steel.

Smear the lapping medium on the plate and charge that surface.

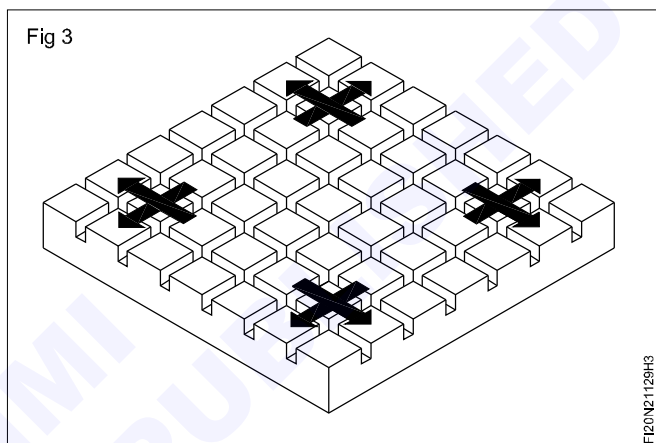
The section of the workpiece being very thin, use a machined and ground cast iron block to butt against the workpiece while lapping. This will assist to keep the workpiece perpendicular while lapping. (Fig 2)



The method of holding the workpiece should be such that it moves along the lapping plate without any tilting or rocking.

Apply downward pressure with finger tips while moving the work.

Use the entire surface of the lapping plate while lapping (Fig 3) to avoid wear on the plate in different small areas.



Do not dwell in one place while lapping.

The lapped surface can be identified by the dull surface. Lapping should be continued until the entire surface being lapped has a dull appearance.

When the entire surface is lapped, clean the surface with kerosene and inspect the workpiece.

The surface texture of the surface being lapped should show a dull appearance.

Prepare stepped keyed fitting and test job

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

- file surfaces to flat and square to an accuracy of ± 0.02 mm
- mark dimension lines as per drawing using vernier height gauge
- prepare hub, shaft and stepped key as per drawing
- fit as per drawing
- finish and de-burr.

NOTE:

12 H7 - 12 $\begin{matrix} +0.02 \\ -0.00 \end{matrix}$

8 h7 - 8 $\begin{matrix} +0.015 \\ +0.00 \end{matrix}$

12 g6 - 12 $\begin{matrix} -0.006 \\ -0.017 \end{matrix}$

8 g6 - 8 $\begin{matrix} -0.005 \\ -0.015 \end{matrix}$

1	Ø50 - 50	HUB	Fe310		1	2.1.130
1	Ø28 - 50	SHAFT	Fe310		2	2.1.130
1	16 ISF 10-50	STEPPED KEY	Fe310	-	3	2.1.130
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

PREPARE STEPPED KEYED FITTING AND TEST JOB

TOLERANCE : ± 0.02 mm TIME : 16Hrs

CODE NO: FI20N21130E1

Job Sequence

- Check the raw material using steel rule.
- File and prepare part 1, 2 and 3 for the over all size maintaining parallelism and perpendicularity.
- Mark off part 1, 2 and 3 with vernier height gauge as per drawing.
- Punch witness marks.

Part 1

- Hold the job in four jaw chuck in lathe.
- Turn face turning on ends.
- Turn $\varnothing 46 \times 45$ mm length.
- Chamfer the outer end of the job 2 mm x 45° .
- Centre drill to locate the centre of the job.
- Fix $\varnothing 6$ mm twist drill in tail stock through drill chuck and drill pilot hole.
- Drill and bore $\varnothing 25^{+0.02}$ mm through hole.
- Chamfer the $\varnothing 25$ mm hole end to 2 mm x 45° .
- Reverse the job and hold it in lathe chuck.
- Plain turn the job to $\varnothing 46$ mm.
- Face turn the other end and also maintain the length as per drawing.
- Chamfer outer and inner end of the job to 2 mm into 45° as per drawing.
- Mark and file keyway in part 1 as shown in drawing.
- Check the keyway size using vernier caliper.

Part 2

- Hold the job in four jaw chuck in lathe.
- Turn face turning on ends.
- Chamfer the end to 2 mm x 45° .
- Plain turn the job of $\varnothing 25^{-0.02}_{-0.01}$ mm to the maximum length.
- Reverse the job and hold it in lathe chuck.
- Face turn the other end of the job keeping the required length as per drawing.
- Chamfer the end to 2 mm x 45° .
- Mark and file the key way on shaft as per drawing dimension.
- Check the key way size with vernier caliper.

Part 3

- Mark the dimensional lines and punch witness marks in part 3 as per drawing.
- Hacksaw and remove the excess metal and file it to size and shape as per drawing.
- Finish file and remove burrs in all the corners of the stepped key.
- Assemble part 1 and 2 together and fit stepped key into the keyway slot as shown in drawing.
- Apply a little oil and preserve it for evaluation.

Lapping holes and cylindrical surfaces

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

- lap hole (internal)
- lap shaft (external)
- change the abrasive compound on laps
- check the hole size with three point internal micrometer
- check the shaft with vernier micrometer
- match shaft and hole together.

PART - 1

Ø25 H7

SQ48

11

LAPPING ON HOLE

PART - 2

Ø 25g6

60

LAPPING ON CYLINDRICAL SURFACE

NOTE:

25 H7 - 25 ^{+0.021}/_{+0.000}

25 g6 - 25 ^{-0.007}/_{-0.020}

1	Ø28-65	-	Fe310,BRIGHT BAR	-	2	2.1.131
1	50 ISF 12-50	-	Fe310	-	1	2.1.131
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1

LAPPING HOLES AND CYLINDRICAL SURFACES

TOLERANCE : ±0.02 mm

TIME: 5 Hrs

CODE NO: FI20N21131E1

29

Job Sequence

- Prepare the bore in part 1 as per drawing.
- Hold the job in bench vice.
- Select a adjustable cylindrical lap for lapping hole
- Charge the abrasive compound (lapping compound) on cylindrical lap
- Insert the adjustable cylindrical lap in a cylindrical hole.
- Rotate the lap forward key pushing inside hole giving a clock wise movement.

Never remove the lap while lapping.

- While removing the lap from the job, hold and rotate it in clock wise direction and take out.
- Clean the lapping hole with kerosene and wipe with soft cloth.
- Check the hole size using three point internal micrometer.

- Lapping external cylindrical surface (shaft) manual process.
- Prepare the shaft as per drawing.
- Hold the job in bench vice/lathe.
- Select a adjustable ring lap.
- Charge the abrasive compound in adjustable ring lap.
- Insert the abrasive ring lap on cylindrical surface.
- Rotate and slide the ring lap forward and backward along the cylindrical surface.
- Apply light pressure while lapping.
- Clean the lapped cylindrical surface with kerosene and wipe with soft cloth.
- Check the shaft size using vernier micrometer.
- Match shaft with hole.
- Apply thin coat of oil and preserve it for evaluation.

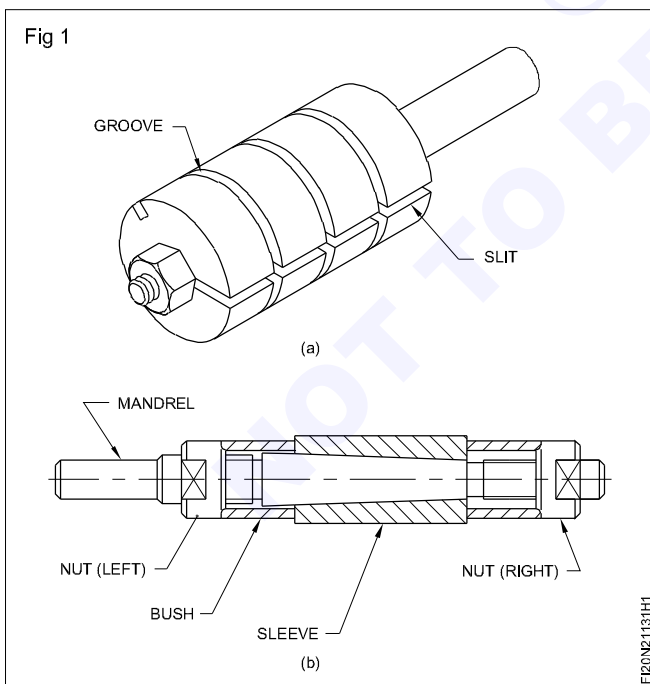
Skill Sequence

Lapping holes and cylindrical surfaces

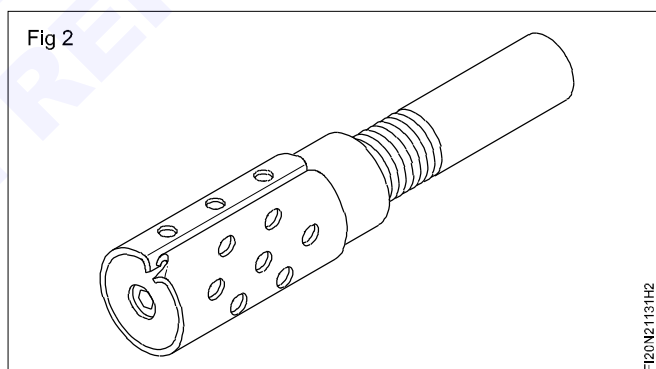
Objective: This shall help you to

- lap on internal and external cylindrical surfaces.

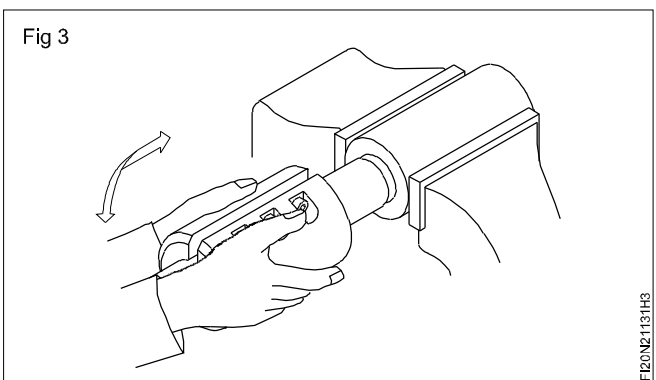
Solid or adjustable types of laps are used for lapping internal cylindrical surfaces/holes (Fig.1). Adjustable lap have interchangeable sleeves made of copper.



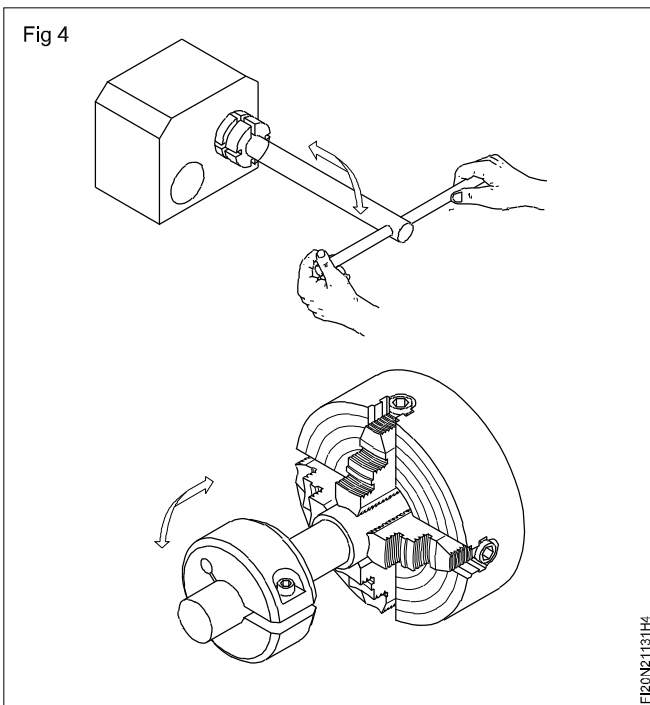
Laps are sometimes provided with holes which can hold the lapping compound (Fig.2).



Ring lapping can be done manually Fig 3 or by holding the work on the lathe while the split ring is moved over the cylindrical surface.

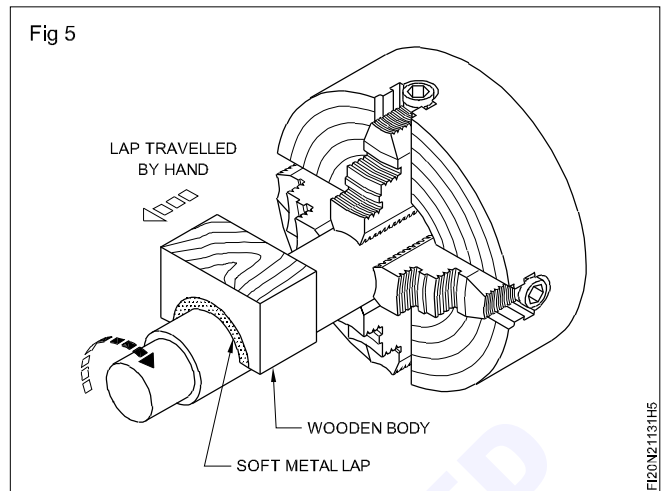


The lap should not be removed from the hole while lapping, and should travel the full length of the bore Fig 4.



While lapping, the ring lap should slide forward and backward along the workpiece - rotating the lap at the same time in alternate directions.

For lapping large diameters, special laps can be prepared and used Fig 5.



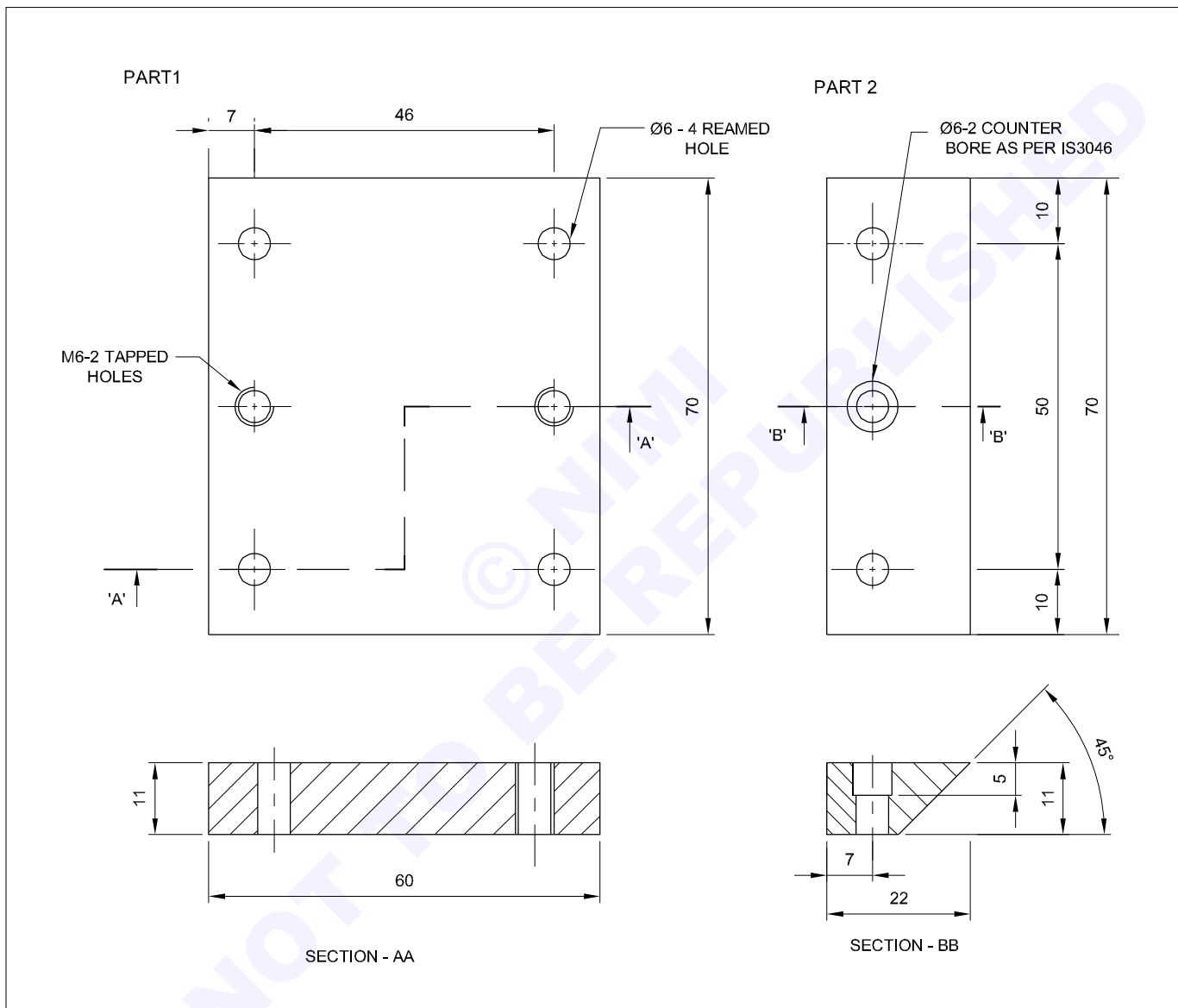
Precautions to observed while lapping:

- Do not dwell in the same place while lapping.
- Keep the lap moist always.
- Do not add fresh abrasive during lapping; recharge if necessary.
- Do not apply excessive pressure while lapping.

Dovetail and dowel pin assembly

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

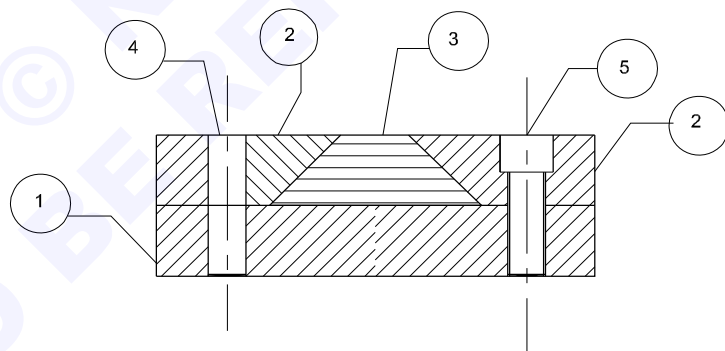
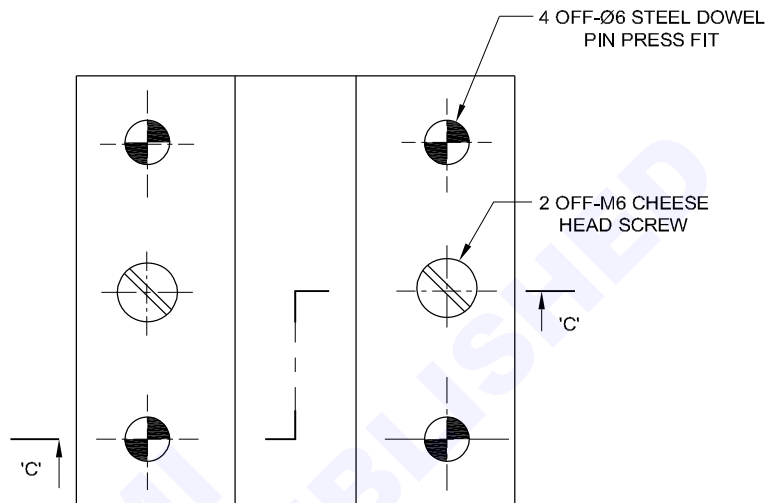
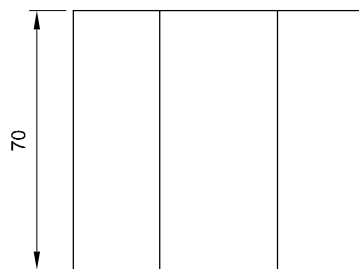
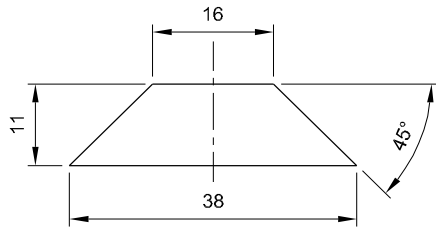
- file part 1,2,3 to size
- drill, ream & tap at correct location
- counter bore to required depth
- assemble Part 1,2 3 with dowel pins and cheese head screws.



2	M6 X 16 mm LENGTH	CHEESE HEAD SCREW	-	-	5	2.1.132
4	Ø6 - 22	DOWEL	-	-	4	2.1.132
1	75 ISF12 - 40	SLIDE	Fe310	-	3	2.1.132
2	75 ISF 12 - 30	TOP PLATE	Fe310	-	2	2.1.132
1	65 ISF 12 - 75	BASE PLATE	Fe310	-	1	2.1.132
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	DOVETAIL AND DOWEL PIN ASSEMBLY	TOLERANCE : ±0.02mm	TIME : 16 Hrs
		CODE NO: FI20N21132E1	

PART 3



SECTION - CC

ASSEMBLY

-	-	-	-	-	-	2.1.132
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE :1:1	DOVETAIL AND DOWEL PIN ASSEMBLY				TOLERANCE :	TIME:
					CODE NO: FI20N21132E2	

Job Sequence

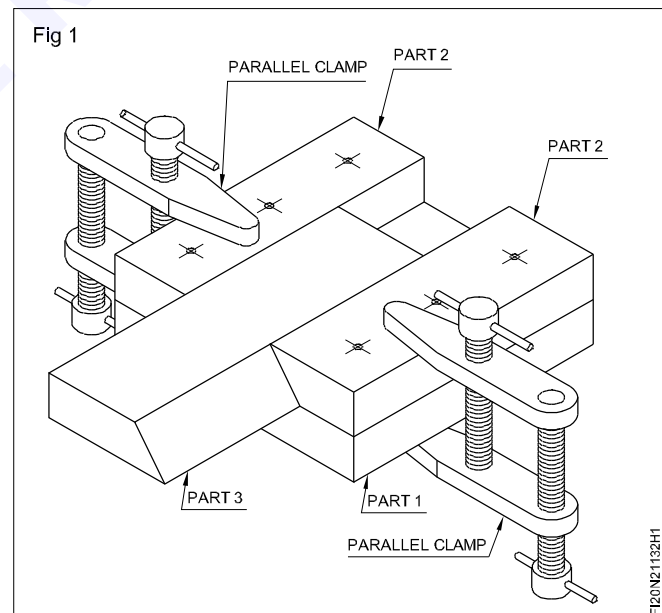
- Check the raw material for its size.
- File part 1,2, and 3 for its overall dimensions
- Mark the dimensions and location of holes as per drawing on part 1 and 2 by using vernier height gauge.
- Centre punch on the location of holes in part 1 & 2 and punch the witness marks.
- File part 2 and 3 to the required angle and check it with vernier bevel protractor to an accuracy ± 10 minute.
- Set all four pieces together and clamp them with parallel jaw clamps and check the squareness by using try square.
- Hold all four pieces together with clamps on a drilling machine table.
- Centre drill on part – 2 in both the pieces.
- Remove the centre drill from the drill chuck and fix $\varnothing 5.8$ mm drill in drilling machine and drill through hole.
- Ream $\varnothing 6$ mm in the drilled hole without disturbing the position of job.
- Fix $\varnothing 6$ mm dowel pin in the reamed hole.
- Similarly, drill, ream and fix $\varnothing 6$ mm other three dowel pins as shown in job drawing.
- Fix $\varnothing 5$ mm drill in drilling machine spindle and drill two through holes in the place of cheese head screws assembly to cut M6 internal thread.
- Disassemble and separate all the parts.
- Fix counter bore tool and counter bore to the required depth in part 2 to fix cheese head screws.
- Fix counter sink tool and chamfer in both ends of part 1 for tapping hole to cut internal thread.
- Hold part 1 in bench vice and cut M6 internal thread to fix cheese head screws.
- Clean the threads without burrs.
- Finish file in all the parts and de-burr in all corners of the job.
- Reassemble all the parts as shown in job drawing and slide part 3 in the dovetail slot.
- Apply a little oil and preserve it for evaluation.

Skill Sequence

Objective: This shall help you to

- **assemble the parts for positioning and drilling.**

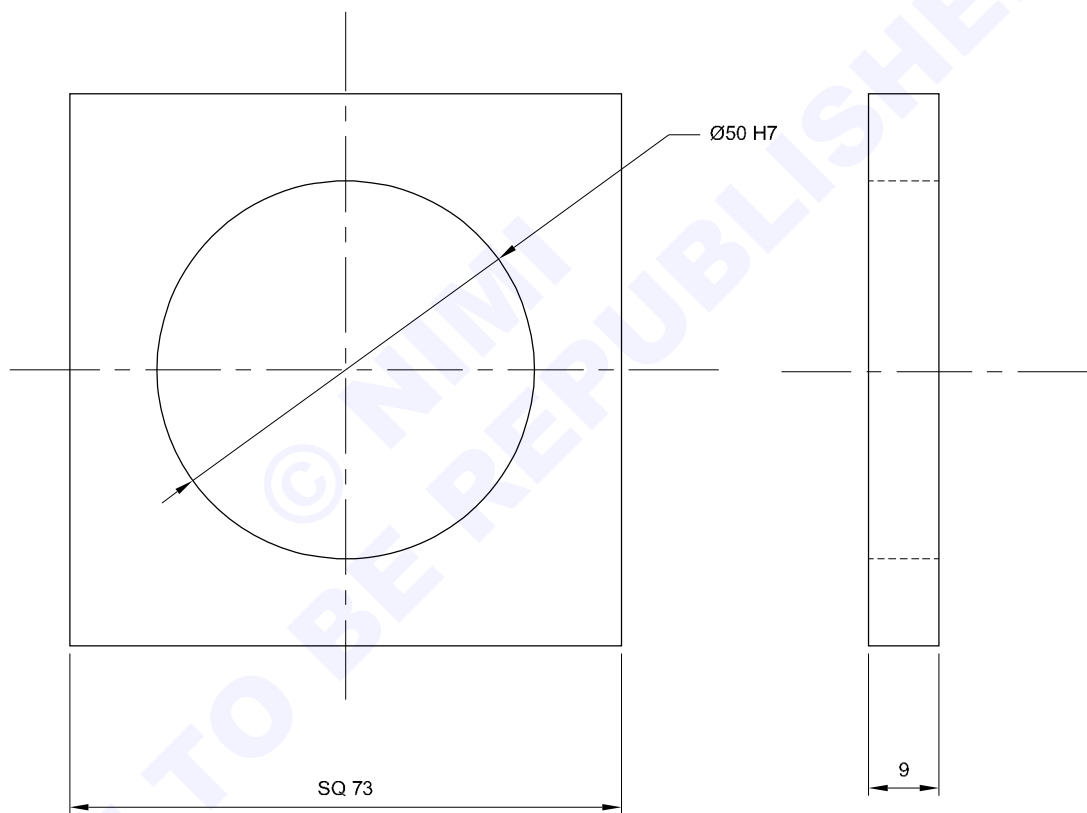
- Assembling technique by using clamps (Fig: 1)
- Clamp all the parts together using parallel clamps.
- Check the squareness of assembly using try square.
- Hold the assembly in drilling machine table without disturbing the setting.



Scrape cylindrical bore

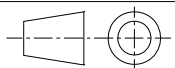
Objectives: At the end of this exercise you shall be able to

- locate and drill pilot hole
- enlarge the pilot hole to size
- ream the hole and find high spots
- scrape and test the cylindrical hole.



NOTE:

50 H7 - 50 $\begin{matrix} +0.025 \\ +0.000 \end{matrix}$

1	75 ISF 10 x 75mm	→ 2.1.134	Fe310	-	1	2.1.133
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1	SCRAPE CYLINDRICAL BORE				TOLERANCE : ±0.02mm	TIME: 5Hrs
					CODE NO: FI20N21133E1	

Job Sequence

- Cut the raw material to its size.
- File to size 73 x 73 x 9 mm and check with vernier caliper.
- Check the flatness and squareness with try square.
- Mark and punch the centre.
- Drill the pilot hole \varnothing 6 mm
- Enlarge a hole \varnothing 12, \varnothing 25, \varnothing 40 and \varnothing 49 in sequence.
- Ream the hole \varnothing 50 mm using reamer.
- Hold the \varnothing 50 mm cylindrical test bar in a bench vice
- Apply prussian blue on cylindrical surface of a test bar \varnothing 50 mm
- Insert the reamed hole on cylindrical surface turn clock wise and anti clock wise direction and move it to find high spots.
- Hold the job in bench vice
- Scrape high spots by using half round scraper.
- Clean the scraped surface with soft cloth.
- Check the bore by using three point internal micrometer.
- Check the scraped hole by inside micrometer.
- Again insert the scraped hole on prussian blue applied cylindrical surface of test bar and check for uniform spreading of prussian blue on cylindrical surface of scraped hole.
- Apply thin oil and preserve it for evaluation.

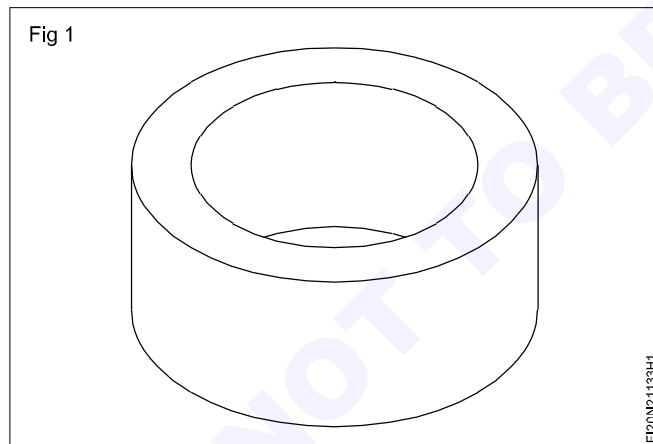
Skill Sequence

Measure diameter using three point internal micro meter

Objectives: This shall help you to

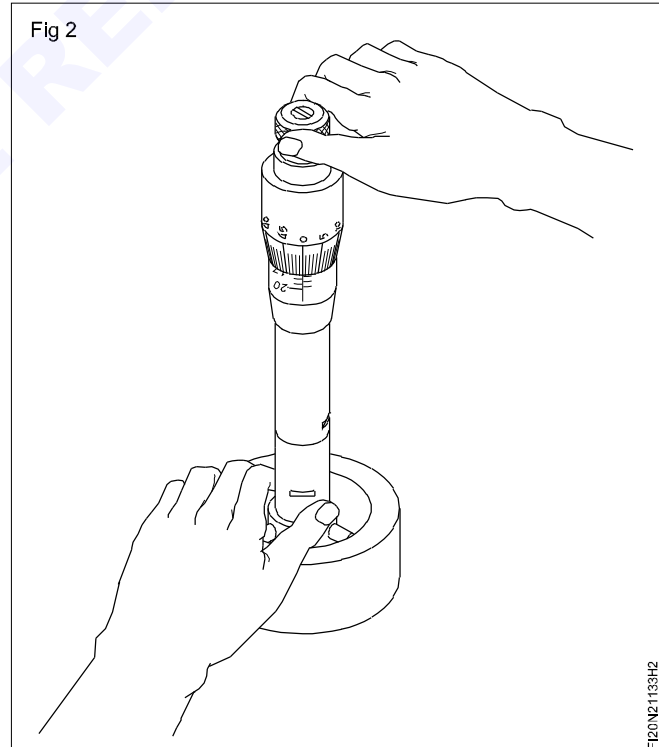
- **skill information is required for 3 point micrometer**
- **measure diameter of through holes**
- **check cylindricity and roundness of bore using three point internal micrometer.**

- Select the correct size of three point internal micro meter.
- Select the proper zero setting ring Fig 1.



Before taking the measurements.

- Set the zero in three point internal micrometer using zero setting ring Fig 2.
- Check the measurement of job bore size using three point internal micrometer.



Scrapping cylindrical bore and to make a fit

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

- turn the shaft as per dimensions in Part 1
- drill the hole dia 49.50 mm on part 2
- ream cylindrical bore to $\text{Ø} 50$
- scrape on cylinder bore
- check the scrapped bore with plug gauge.

PART - 1

CHAMFER 2x45°

R5

2

40

60

Ø40

Ø50 g6

45°

PART - 2

Ø50 H7

SQ 73

9

NOTE:

50 H7 - 50 $\begin{matrix} +0.025 \\ +0.000 \end{matrix}$

50 g6 - 50 $\begin{matrix} -0.010 \\ -0.025 \end{matrix}$

1	-	2.1.133 ←	Fe310	-	2	2.1.134
1	Ø56 - 105		Fe310	-	1	2.1.134
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1					TOLERANCE : ±0.02mm	
SCRAPPING CYLINDRICAL BORE AND TO MAKE A FIT					TIME: 12 Hrs	
					CODE NO: FI20N21134E1	

Job Sequence

Part: 1

- Cut the raw material to its size.
- Turn the shaft as per dimension in lathe.
- Turn shouldering and knurl in the shaft job as per the drawing.
- Finish the shaft within the dimensions.
- (Part – 1 making correct size \varnothing 50 g6 as a master gauge for checking scraped hole)

Skill Sequence

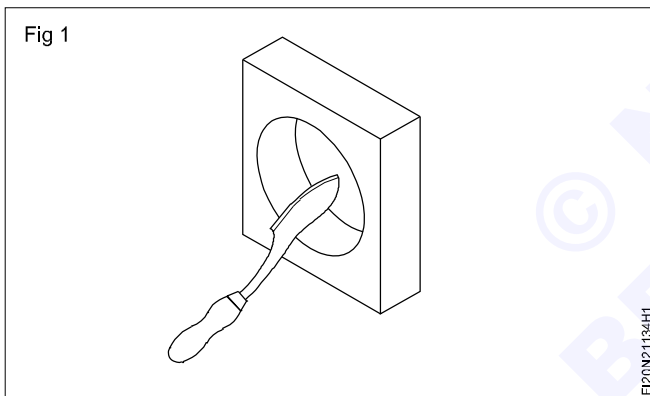
Objective: This shall help you to

- **scraping and testing of curved surface.**

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

Method

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



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

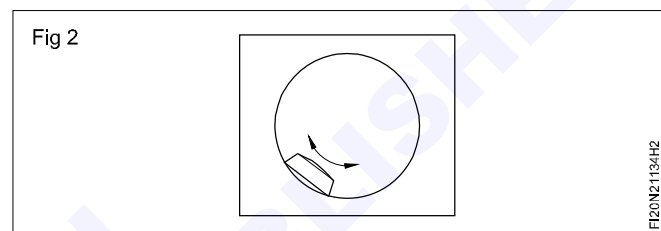
Rough scraping will need excessive pressure with longer strokes.

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

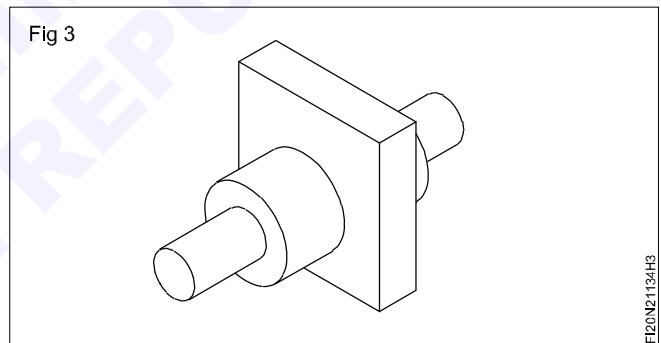
Cutting action takes place both on forward and return strokes Fig 2.

Part: 2

- Use Ex No 133 workpiece as part 2
- Clean the scraped surface with soft cloth
- Fit the master test piece into the scraped hole and rotate smoothly for testing.
- Note that the master piece should rotate freely.
- Apply a little oil and preserve it for evaluation.



After each pass, change the direction of cutting. This ensures a uniform surface.



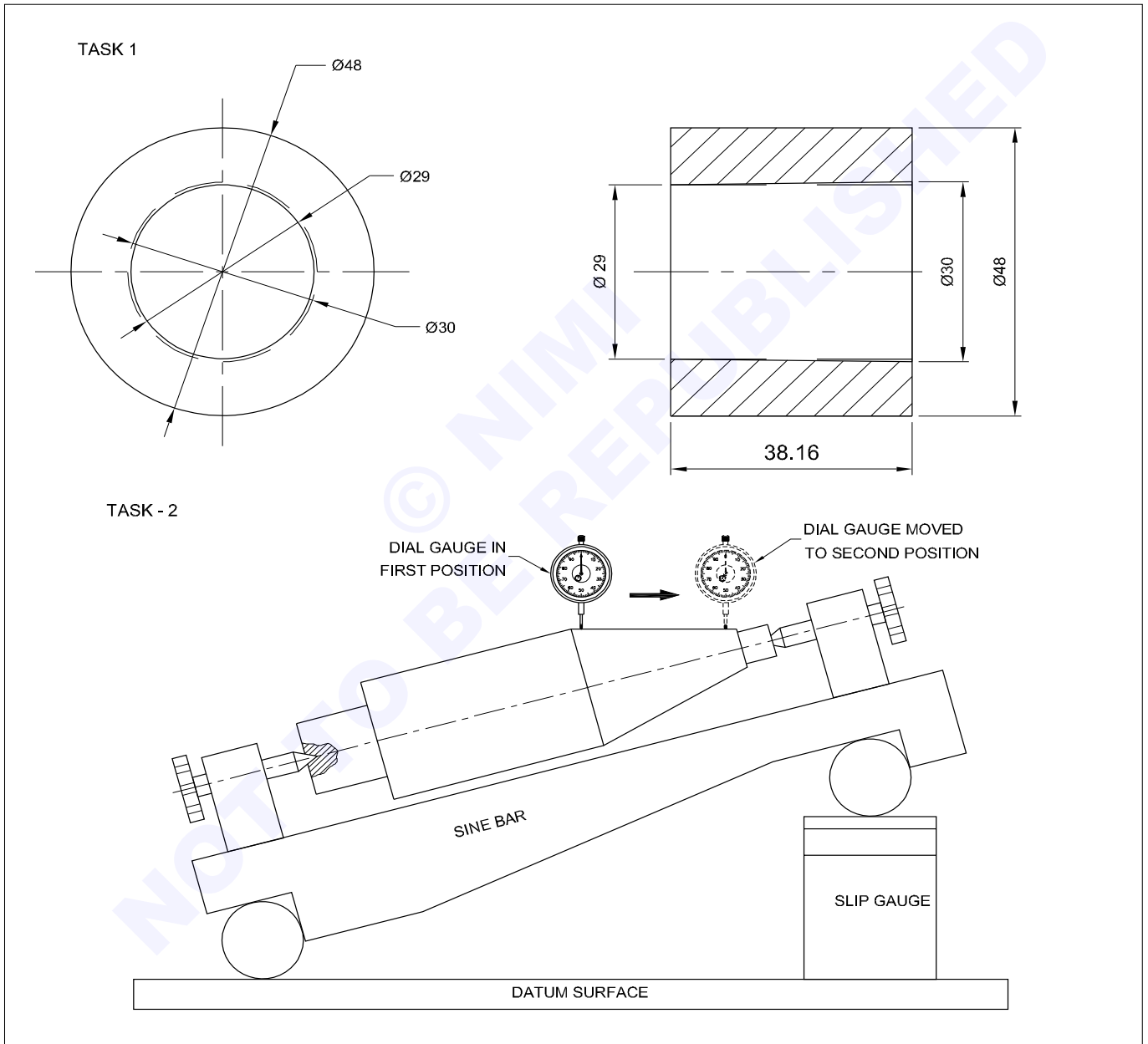
Apply a thin coating of prussion blue on the master bar to locate the high spots.

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

Scrapping cylindrical taper bore and check taper angle with sine bar

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

- turn a round as per drawing
- drill centre hole of $\varnothing 28$ mm and turn - taper turn $1^{\circ}30'$ steep to the major diameter $\varnothing 30$
- scrap taper bore using half round scraper
- hold taper plug gauge in sine bar
- build up slip gauge to the required height
- set dial test indicator to check parallelism
- calculate the taper angle using sine bar and slip gauge.



1	$\varnothing 50 - 45$	-	Fe310	-	TASK 1	2.1.135
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1					TOLERANCE : $\pm 0.02\text{mm}$	
<p align="center">SCRAPPING CYLINDRICAL TAPER BORE AND CHECK TAPER ANGLE WITH SINE BAR</p>					TIME: 8 Hrs	
					CODE NO: FI20N21135E1	

Job Sequence

TASK 1: Scraping in cylindrical taper bore

- Cut the raw material to its size.
- Turn the round rod to overall dimension in a lathe.
- Centre drill at the centre of the round rod.
- Drill a through hole up to $\varnothing 28$ mm.
- Set the tool in tool post.
- Turn the compound slide to an angle of $1:30'$ maintaining major diameter $\varnothing 30$ mm to turn taper.

TASK 2: Check taper angle with sine bar

- Select a suitable sine bar and clean it
- Hold taper plug gauge in a sine bar.
- Select the suitable slip gauge according to taper.
- Build up the slip gauges under the sine bar rollers by wringing method
- Check the parallelism of taper with dial test indicator.
- If DTI's pointer stand still in zero position at both ends of the taper plug gauge, then there is no taper. Instead of that pointer move either direction and shows plus (or) minus reading means errors are there,
- Select the correct slip gauges and keep under the sine bar rollers and correct the parallelism of taper.
- Sine bar length size is hypotenuse.
- Slip gauge height is opposite side
- Marking table serves as adjacent side.

Principle of sine bar is based on trigonometry

Skill Sequence

Use of sine bar and slip gauge

Objectives: This shall help you to

- state the principal of the sine bar
- specify the sizes of sine bars
- state the features of sine bars
- state the different uses of sine bars.

A sine bar is a precision measuring instrument for checking and setting of angles Fig 1

The principal of a sine bar is based on the trigonometrical function.

In a right angled triangles the function known as Sine of the angles is the relationship existing between the opposite side to the angle and the hypotenuse Fig 2.

- Apply prussian blue on taper plug gauge
- Insert and rotate the taper plug gauge to find high spots.
- Scrape and remove high spots using half round scraper.
- Again insert (prussian blue applied) taper plug gauge in the taper hole and rotate. Ensure the uniform spreading of prussian blue around taper bore.
- Fit/match taper plug gauge in the taper hole.
- Apply little oil and preserve it for validation.

$$\text{Sine } \theta = \frac{\text{Opposite side}}{\text{Hypotenuse}}$$

$$\text{Sine } \theta = \frac{\text{Height of the slipgauge}}{\text{Length of the sinebar}}$$

Skill Information

Calculate the angle of taper of plug gauge, slip gauge pack height is 17.36 mm and length of the sine bar is 100 mm

Solution:

Height of slip gauge = 17.36 mm

Length of sine bar = 100 mm

$$\text{Angle of taper plug gauge} = \frac{17.36}{100} = 0.1736$$

$$\sin \theta = 0.1736$$

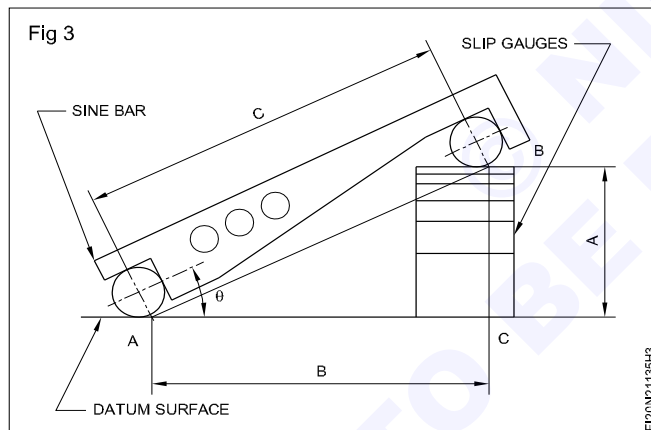
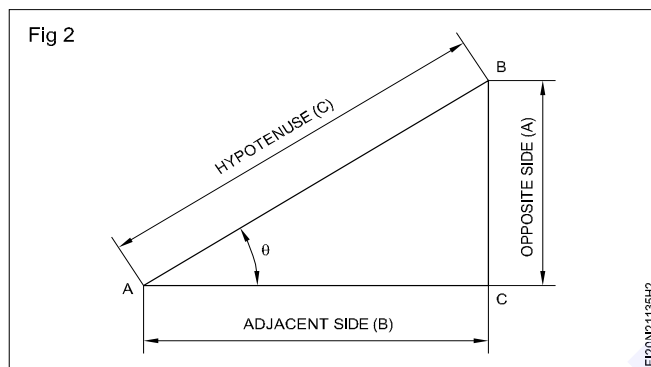
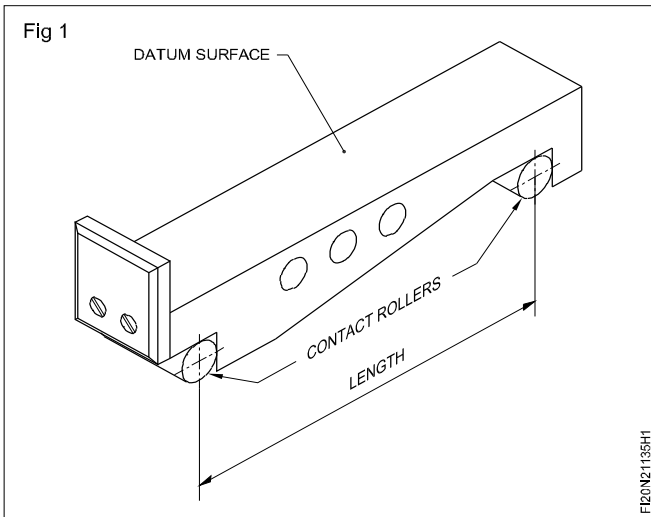
$$\therefore \theta = 10^\circ$$

$$\therefore \text{Angle of taper plug} = 10^\circ$$

It may be noted that for setting the sine bar to different angles, slip gaugs are used

A surface plate or making table provides the datum surface for the set up.

The sine bar, the slip gauges and the datum surface upon which they are set form a right angles triangle Fig 3. The sine bar forms the hypotenuse (c) and the slip gauge stack forms the side opposite.



$$\text{Sine of the angle } \theta = \frac{\text{Opposite side}}{\text{Hypotenuse}}$$

$$\text{Sine } \theta = \frac{a}{c}$$

Features is a rectangular bar made of stabilized chromium steel.

The surfaces are accurately finished by grinding and lapping.

Two precision rollers of the same diameter are mounted on either end of the bar. The centre line of the rollers is parallel to the top face of the sine bar.

There are holes drilled across the bar. This helps in reducing the weight and also it facilitates clamping of sine bar on angle plate.

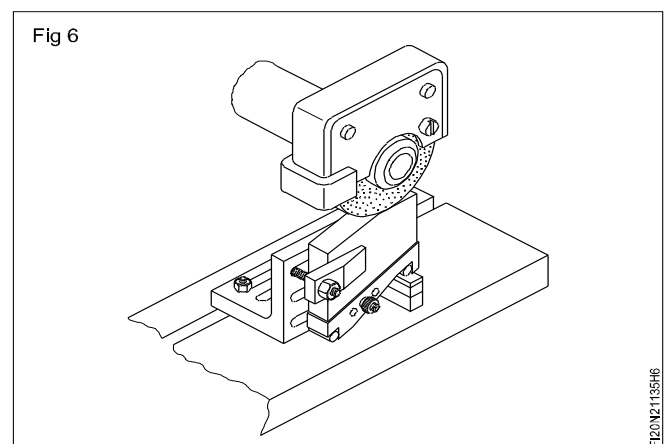
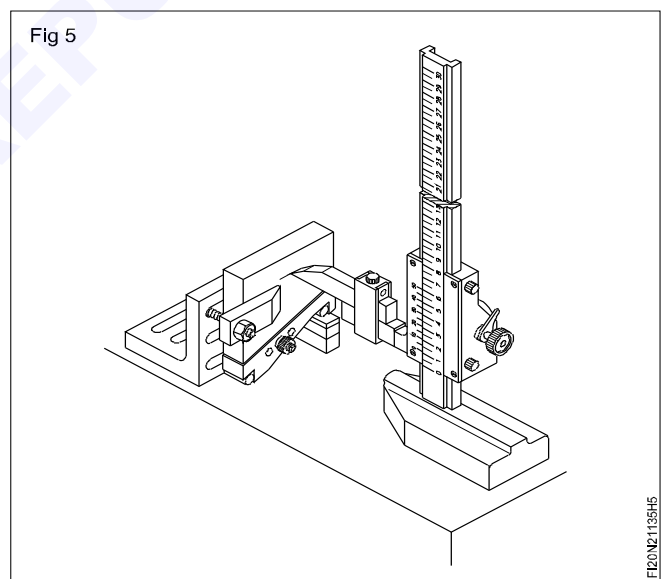
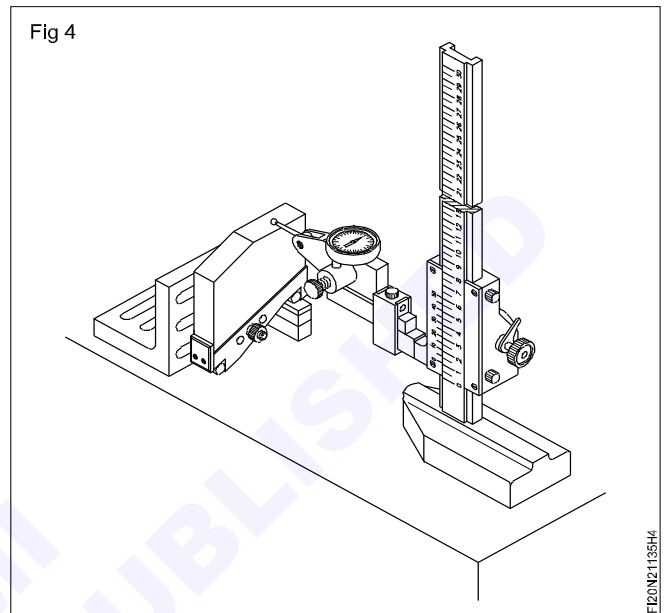
The length of the sine bar is the distance between the centres of the rollers. The commonly available sizes are

100 mm, 200 mm, 250 mm and 500 mm. The size of a sine bar is specified by its length.

Uses

Sine bars are used when a high degree of accuracy to less than one minute is needed for

- measuring angles Fig 4.
- marking out Fig 5.
- setting up for machining Fig 6.



Determining taper using sine bar and slip gauges

Objectives: This shall help you to

- determine correctness of a known angle
- calculate the height of slip gauges to a known angle.

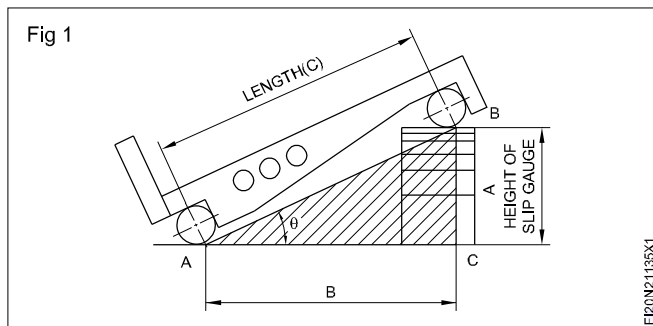
Sine bars provide a simple means of checking angles to a high degree of accuracy of not less than one minute up to 45°

The use of a sine bar is based on trigonometric function. The sine bar forms the hypotenuse of the triangle and the slip gauges the opposite side Fig 1.

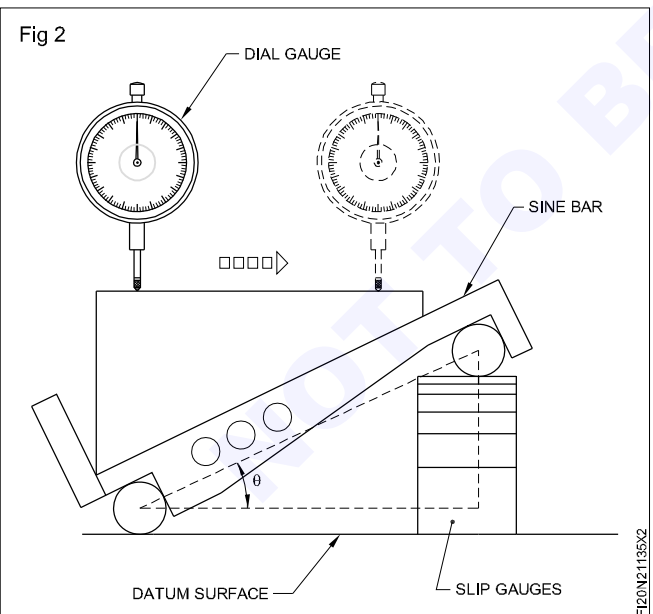
Checking the correctness of a known angle

For this purpose first choose the correct slip gauge combination for the angle to be checked.

The component to be checked should be mounted on the sine bar after placing the selected slip gauges under the roller Fig 1.



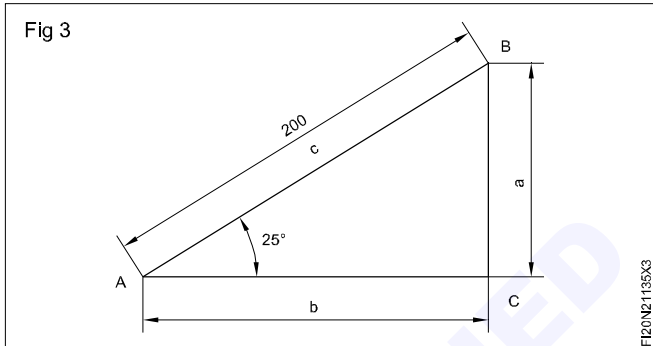
A dial test indicator is mounted on a suitable stand or vernier height gauge Fig 2. The dial test indicator is then set in first position as in the figure and the dial is set of zero.



Move the dial to the other end of the component (second position). If there is any difference then the angle is incorrect. The height of the slip gauge pack can be adjusted until the dial test indicator reads zero on both ends. The actual angle can then be calculated and the deviation, if any, will be the error.

Method calculating the slip gauge height

Example Fig 3



Exercise 1

To determine the height of slip gauges for an angle of 25° using a sine bar of 200 mm long.

$$\begin{aligned} \text{Sine } \theta &= \frac{a}{c} \\ \theta &= 25^\circ \\ a &= C \text{Sine } \theta \\ &= 200 \times 0.4226 \\ a &= 84.52 \text{ mm} \end{aligned}$$

The height of the slip gauge required is 84.52 mm.

The value of sine θ can be obtained from mathematical tables. (Natural trigonometrical functions).

Tables are also available with readily worked out sine bar constants for standard sine bar lengths.

Calculating the angle for tapered components

Exercise 2

The height of the slip gauge used is 84.52 mm. The length of the sine bar used is 200 mm.

$$\begin{aligned} \text{Sine } \theta &= \frac{a}{c} \\ &= \frac{84.52}{200} \end{aligned}$$

$$\text{Sine } \theta = 0.4226$$

The angle whose sine value is 0.4226 is 25°. Hence the angle of tapered component is 25°.

Classroom Assignment

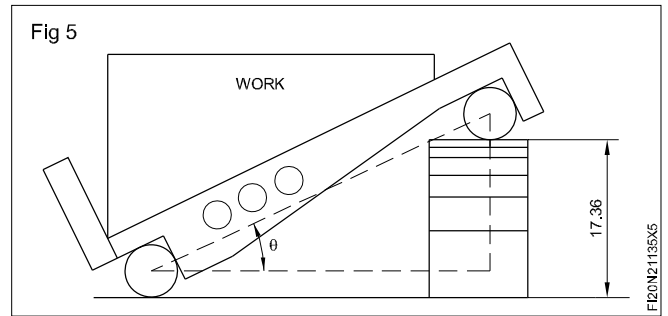
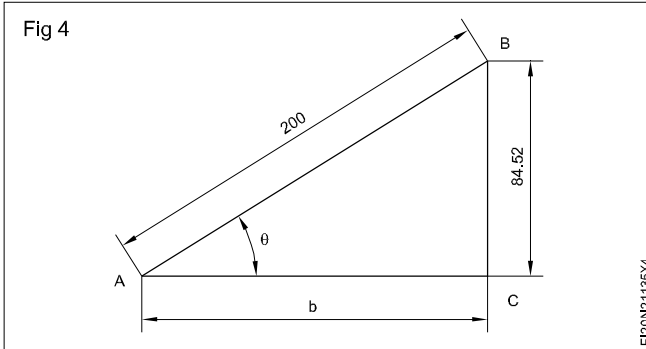
- 1 What will be angle of the workpiece if the slip gauge

pack height is 17.36 mm and the size of the sine bar used is 100 mm? Fig 5.

Answer _____

2 Calculated the height of the slip gauge pack to raise a 100 mm sine bar to an angle of $3^{\circ} 35'$.

Answer _____

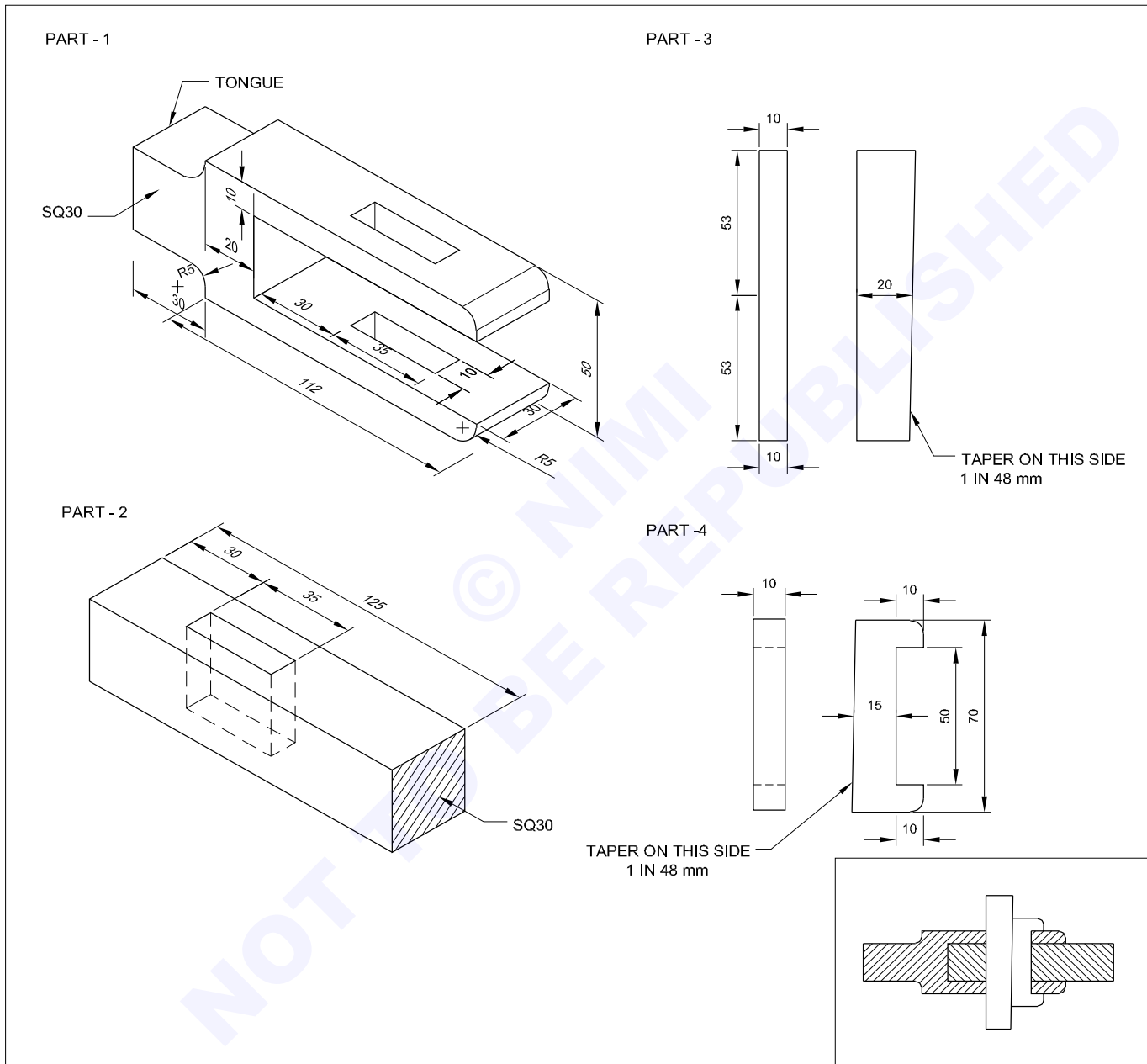


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Make a cotter jib assembly

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

- file flat surfaces to square and parallel
- mark dimensions as per drawing with vernier height gauge
- measure the dimensions with vernier caliper
- file and assemble maintaining accuracy to ± 0.02



1	55X32X145	--	Fe310	--	1	2.1.136
1	32 SQ RODX130	--	Fe310	--	2	2.1.136
1	30X12X80	--	Fe310	--	3	2.1.136
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE					DEVIATIONS	TIME: 20 Hrs
					MAKE A COTTER GIB ASSEMBLY	
					CODE NO. FI20N21136E1	

Job Sequence

Check the raw materials for its sizes as per drawing.

Part 1

- File part 1 raw material to size 50.x 30 x 142 mm maintaining the dimensional tolerance as per drawing, flatness and squareness
- Mark of part 1 with vernier height gauge as per drawing
- Punch witness marks.
- Chain drill hole in part 1 for making 30 x 92 mm open slot and 10 x 35 mm through slot.
- Hack saw and cut off along the chain drilled holes using web chisel and ball pein hammer.
- File the open slot and through slot to size.
- Hacksaw and remove excess metal on tongue side and file to size.
- File radius R5 wherever mentioned.

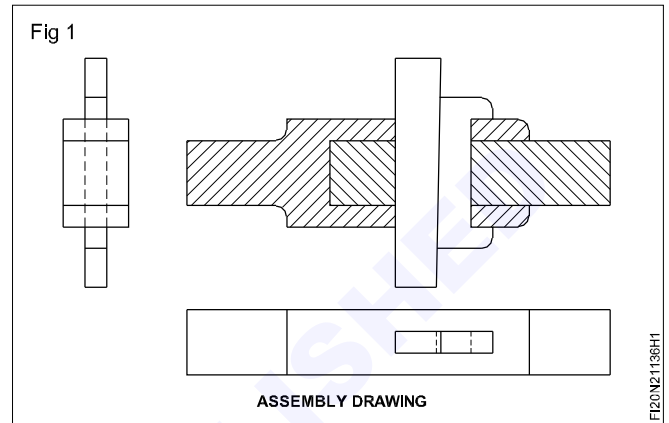
Part 2

- File part 2 raw material to size SQ 30 x 125mm, maintaining the dimensional tolerance as per drawing Flatness and squareness.
- Mark 10 x 35mm through slot and punch witness marks.
- Chain drill hole in part 2 for making through slot.
- Hacksaw and cut off along the chain drilled holes using web chisel and ball pein hammer.

- File the through slot to size.

Part 3 & Part 4

- File part 3 and part 4 to over all size and maintain the dimensional tolerance as per drawing, flatness and squareness.
- Mark part 3 and part 4 according to drawing and file to the size.



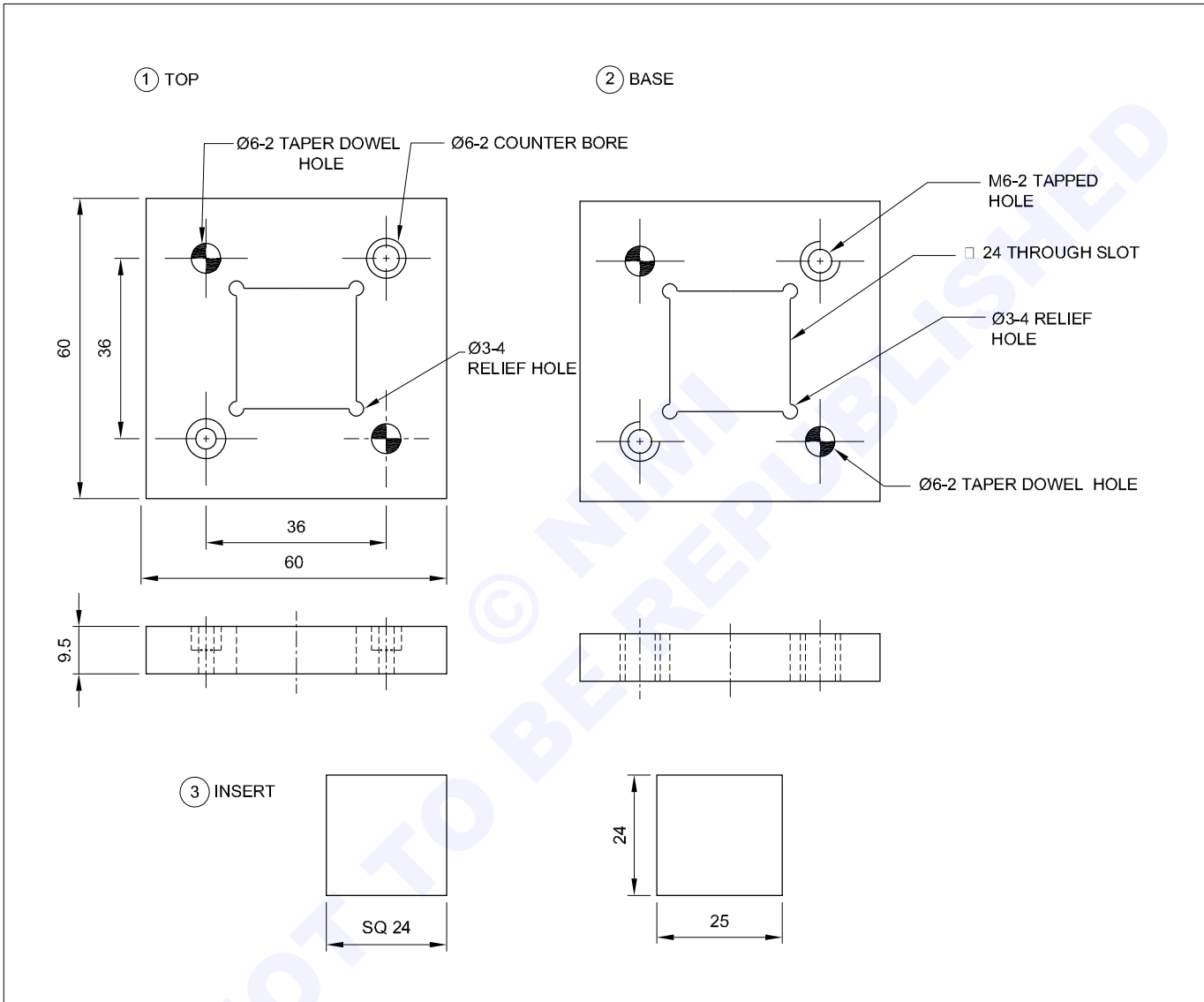
Insert part 2 in part 1 as shown in assemble drawing.

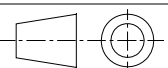
Insert part 3 and part 4 together by aligning part 1 as shown in assembly drawing. (Fig 1)

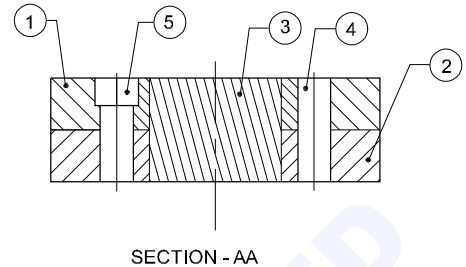
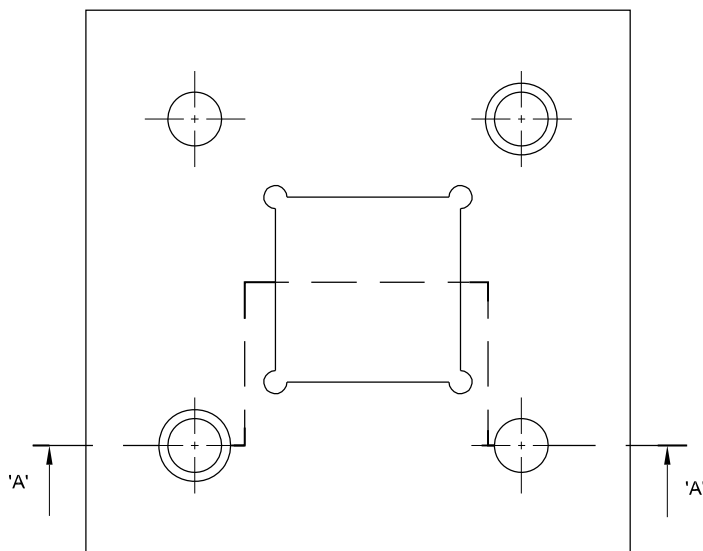
Hand reams and fit taper pin

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

- file to shape and size as per drawing
- mark square and taper dowel pin location
- step drill to ream taper pin hole and drill relief hole, chain drilling
- fix taper dowel pin and cheese head screw as per drawing fit part – 2 in assemble setting as per drawing.



2	M6-18	CHEESE HD SCREW	Fe310	-	5	2.1.137
2	Ø6-18	TAPPER DOWEL PIN	Fe310	-	4	2.1.137
1	SQ 25-27	INSERT	Fe310	-	3	2.1.137
1	65 ISF 10-65	BASE PLATE	Fe310	-	2	2.1.137
1	65 ISF 10-65	TOP PLATE	Fe310	-	1	2.1.137
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE :1:1		HAND REAMS AND FIT TAPER PIN			TOLERANCE : ±0.02mm	TIME: 12 Hrs
					CODE NO: FI20N21137E1	



Job Sequence

- Check the given raw materials for its size.
- File raw metal to size 60 x 60 x 9.5 mm in two pieces and check the dimensions using vernier caliper.
- Check the flatness and squareness using try square.
- Apply marking medium and mark off square and centre line for dowel pin holes and cheese head screw holes and punch witness mark and centre punch marks on the job.
- Place part 2 on part 1 assemble and clamp the setting with parallel clamp and check the squareness of the assembled parts Fig 1.
- Fix centre drill in drilling machine and centre drill to locate all the spot of hole position as per drawing.
- Fix $\varnothing 4$ mm drill in drilling machine and drill a through hole in the place of taper dowel pin assembly.
- Similarly fix $\varnothing 5.7$ mm drill rod step hole to the depth $2/3^{\text{rd}}$ portion of the drilled hole and fix $\varnothing 5.7$ mm drill and step drill hole to the depth of $1/3^{\text{rd}}$ portion of the drilled hole in the place of taper dowel pin assembly Fig 2.

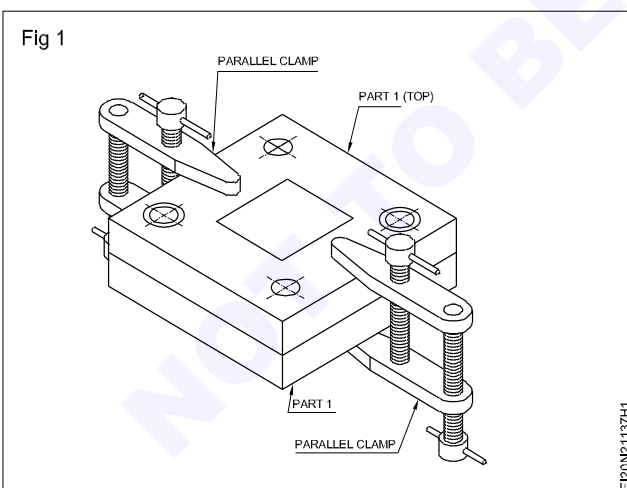
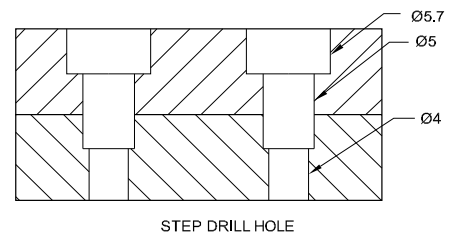
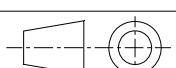


Fig 2

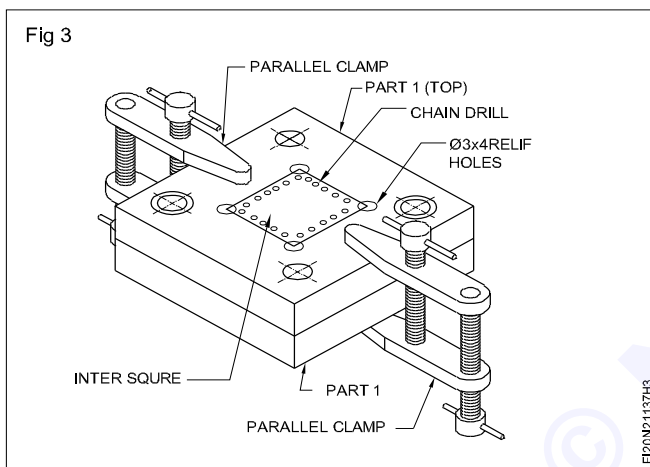


- Fix taper pins reamer in tap wrench and ream a step drill hole to the taper hole to suit taper dowel pin in the assembly without disturbing the assembly setting (use plenty of oil while reaming)
- Fix taper dowel pin in the reamed taper hole through push fit
- Similarly repeat the above working steps and complete the above procedures to fix another taper

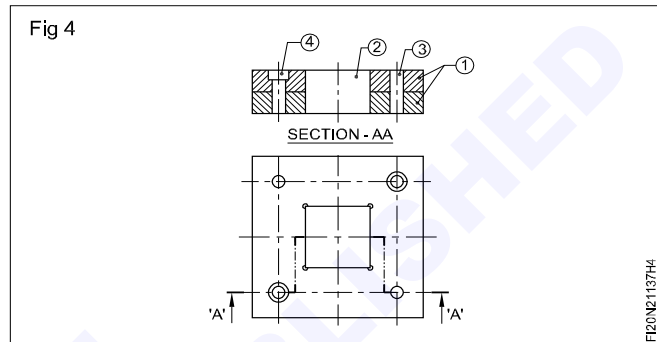
						2.1.137
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	HAND REAM AND FIT TAPER PIN ASSEMBLY				TOLERANCE :	TIME:
					CODE NO: FI20N21137E2	

dowel pin in the assembly through push fit as per drawing.

- Fix $\varnothing 6.0$ mm drill in drilling machine and drill a through hole in the place of cheese head screw assembly.
- Fix $\varnothing 12 \times 6.0$ mm counter bore tool and counter bore to the depth of cheese head screw head thickness in part 2 top plate and cut M 6 internal thread in the place of cheesehead screw assembly in base plate.
- Fix M 6 x 18 mm cheese head screw in the internal threaded hole
- Similarly repeat the above working steps and complete the above procedure to fix outer cheese head screw in the assembly.
- Fix $\varnothing 3$ mm drill in drilling machine and drill relief holes as per drawing.
- Fix $\varnothing 6$ mm drill in drilling machine and drill chain drilling to remove unwanted metal in internal square Part – 1 and Part -2 (Base & top plate) Fig 3.



- Dis assemble the setting from drilling machine table and chip and remove the unwanted metal using .. chisel and ball pein hammer in part of (base) and (top)
- Re-assemble the part – 1 (base) and (top) along with taper dowel pins and cheese head screw and file internal square to size and 90° angle and measure the dimensions with vernier caliper.
- **PART 3**
- File part 3 raw metal to size in square bar $24 \times 24 \times 25$ mm and check the dimensions with vernier caliper
- Check the flatness and squareness in try square.
- Fit Part 3 in push fit in the assemble part - 1 and part -2 (base) and top Fig 4

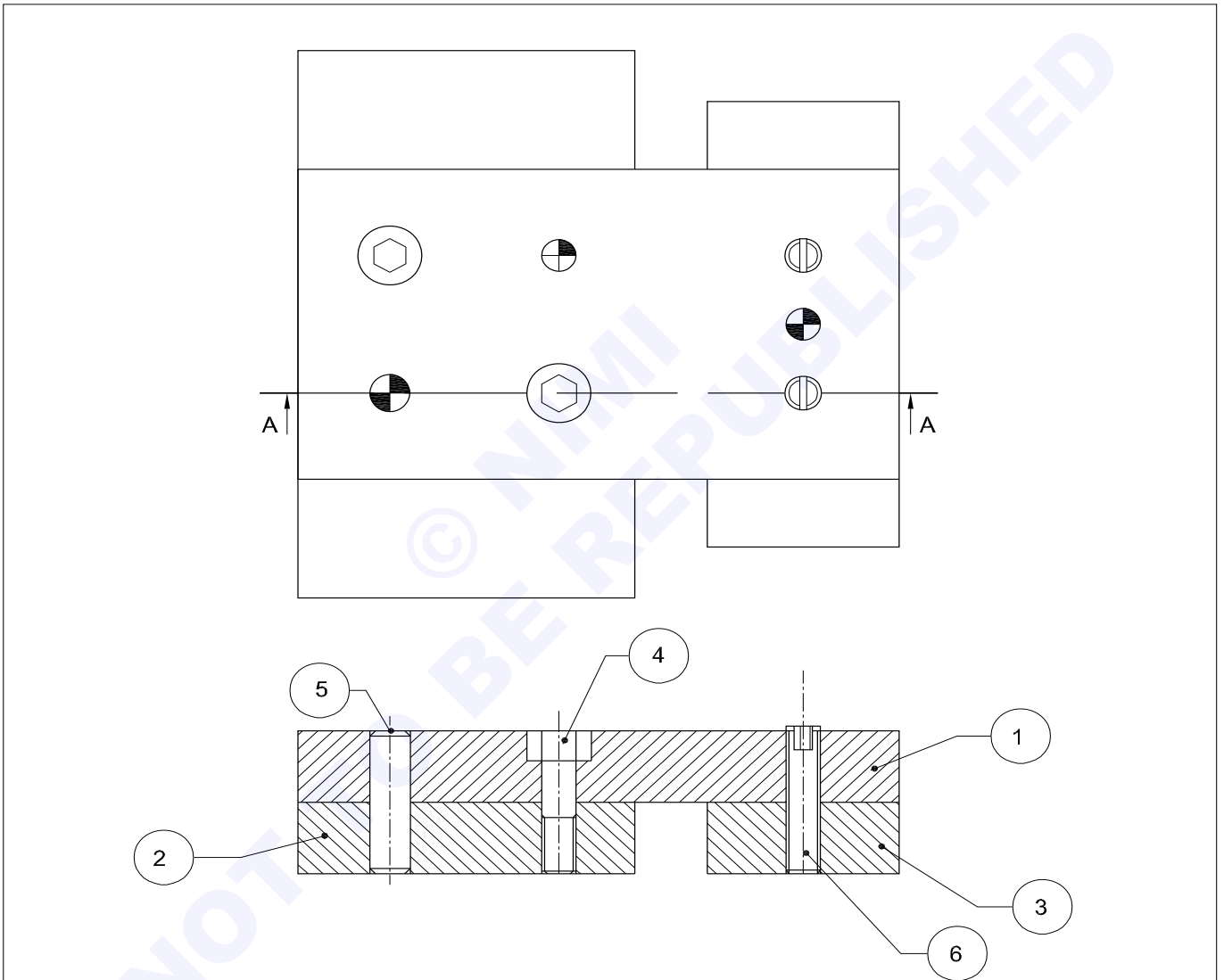


- Dis assemble all the parts and finish all the surfaces and remove burrs from all the corners of the parts of assembly
- Re-assemble all the parts and fit part 3 in push fit and apply little oil and preserve it for evaluation.

Drilling and reaming holes in correct location, fitting dowel pins, stud, and bolts

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

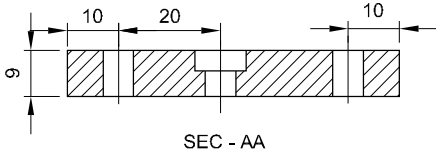
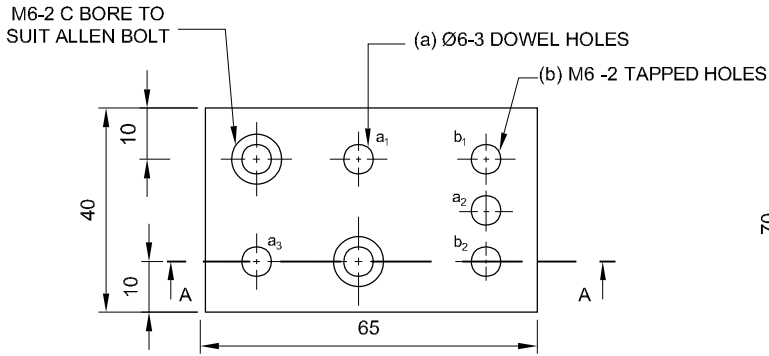
- file to size as per drawing
- mark and punch hole locations
- drill, ream, counter bore as per drawing
- cut M 6 internal thread to suit bolt and stud
- assemble as per drawing.



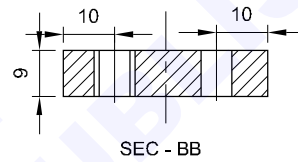
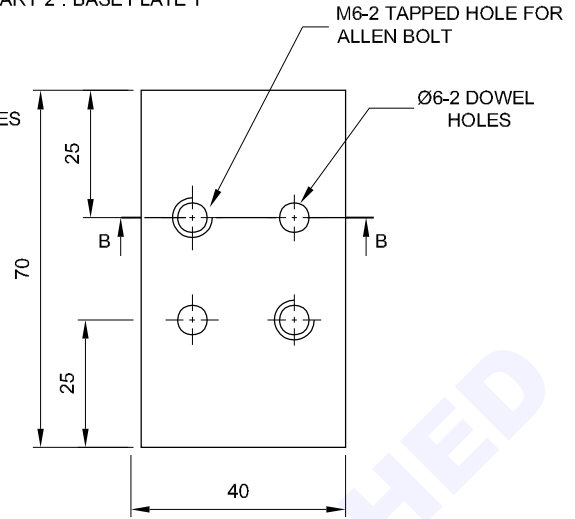
2	M6-18	STUD	Fe310	-	6	2.1.138
3	STANDARD Ø6-18	DOWEL PIN	Fe310	-	5	2.1.138
2	STANDARD M6-16	HEXAGON BOLT	Fe310	-	4	2.1.138
1	65 ISF 10-25	BASE 2	Fe310	-	3	2.1.138
1	50 ISF 10-75	BASE 1	Fe310	-	2	2.1.138
1	50 ISF 10-70	TOP PLATE	Fe310	-	1	2.1.138
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	DRILLING AND REAMING HOLES IN CORRECT LOCATION, FITTING DOWEL PINS, STUD, AND BOLTS	TOLERANCE : ±0.02mm	TIME: 8 Hrs
		CODE NO: FI20N21138E1	

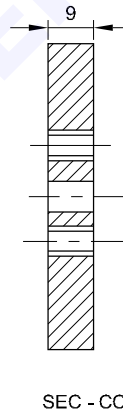
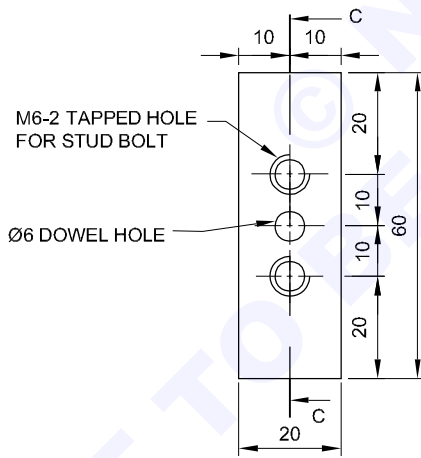
PART 1 : TOP PLATE



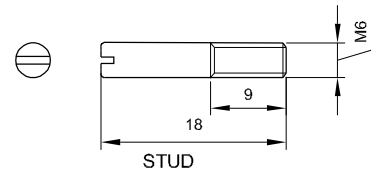
PART 2 : BASE PLATE 1



PART 3 BASE PLATE 2



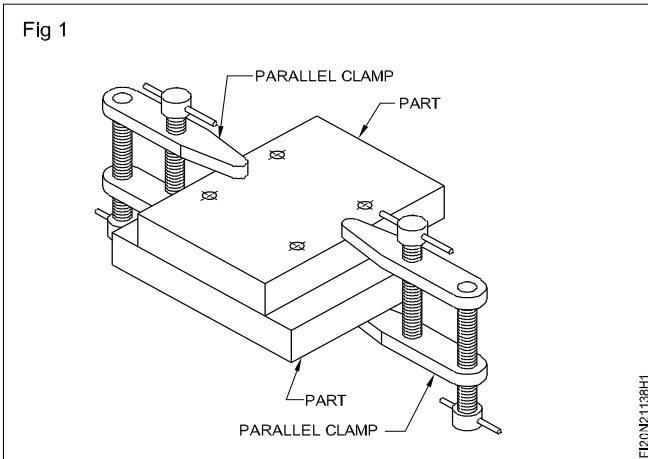
PART 6



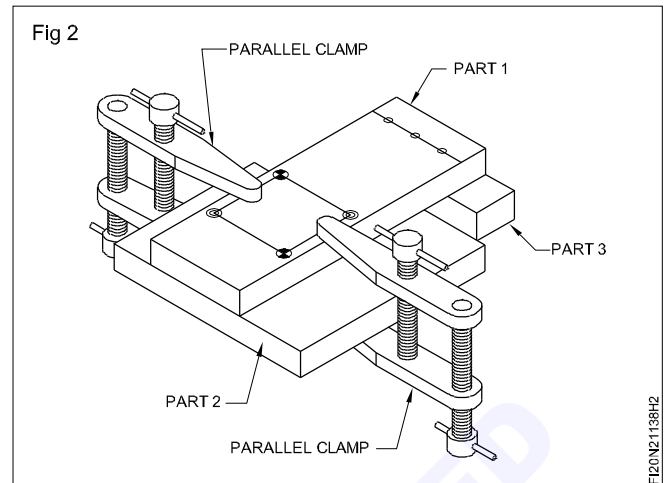
						2.1.138
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE :	DRILLING AND REAMING HOLES IN CORRECT LOCATION, FITTING DOWEL PINS, STUD AND BOLTS				TOLERANCE :	TIME:
					CODE NO: F120N21138E2	

Job Sequence

- Check the raw material for its size.
- File Part 1,2,3 to size and check with vernier caliper
- Apply marking medium and mark as per drawing
- Punch drill hole marks as per drawing
- Set Part 1 and 2 as per drawing and clamp it with parallel clamp as shown in Fig:1



- Fix $\varnothing 5.8$ mm drill in drilling machine and drill through holes and ream the holes of $\varnothing 6$ mm reamer in part 1 and 2.
- Clean the reamed hole with soft cloth and fit $\varnothing 6$ mm dowel pin.
- Similarly drill, ream and fit $\varnothing 6$ another dowel pin with the same setting in part 1 and 2 as shown in Fig 1.
- Then fix $\varnothing 5$ mm drill in drilling machine and drill through hole for M 6 hexagon bolt assembly.
- Similarly drill $\varnothing 5$ mm drill hole in part 1 and 2 for another M 6 hexagon bolt assembly.
- Counter bore to the depth of fixing M 6 allen bolt head side in part 1 as shown in drawing.
- Separate Part 1 and 2.
- Hold counter sink tool in drilling and machine and counter sink $1 \times 45^\circ$ in the place of cutting internal thread on both sides of part 2 (Thread has been cut in part 2 only).
- Cut M6 internal thread in the place of hexagon bolts assembly in part 2.



- Clean the threads without burrs.
- Reassemble part 1 and 2 and set part 3 as shown in Fig:2 and clamp it with parallel clamps.
- Then fix $\varnothing 5.8$ mm drill in drilling machine and drill through hole ream $\varnothing 6$ mm for dowel pin assembly with part 1 and 3.
- Fit $\varnothing 5$ mm drill and drill two through holes in the place of studs assembly in part 1 and 3
- Separate part 1 and 3
- Fix $\varnothing 6$ mm drill and drill through holes in part 1
- Countersink $1 \times 45^\circ$ in part 3 and cut M6 internal thread (thread has been cut in part 3 only).
- Clean the thread and re-assemble part 1 with part 3.
- Prepare stud as per (part - 6) drawing.
- Fix two studs in part 3 and assemble with part 1 as shown in figure.
- Fix M6 bolt along with plain washer and tighten it using suitable spanner.
- Disassemble all the parts (1,2 and 3) and finish with file and deburr on all surfaces of the job.
- Re-assemble all the parts (1,2 and 3) with dowel pins, hexagon bolts, stud and nuts.
- Apply thin coat of oil and preserve it for evaluation.

Making a snap gauge for checking a dia. of $10 \pm 0.02\text{mm}$

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

- file to overall size as per drawing
- mark the profile as per drawing and punch with measurements
- chain drill chip and file profile as per drawing
- turn a round to size and shape
- check the round rod into GO end and NO GO end.

1	50 ISF 10-80	-	Fe-310	-	1	2.2.139
2	Ø12-25	-	Fe-310	-	2	2.2.139
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1					TOLERANCE	±0.02 mm
<p align="center">MAKING A SNAP GAUGE</p>					TIME 20 hrs	
					CODE NO. FI20N22139E1	

Job Sequence

Snap Gauge:

- Check the raw material for its size
- File the raw material to size 75 x 48 x 9 mm maintaining flatness and squareness
- Check the flatness and squareness with try square.
- Apply marking medium cellulose lacquer on the surface of the job.
- Mark all the dimension lines as shown in job drawing Part – 1
- Punch witness marks on the marked lines.
- Chain drill and remove excess metal by chipping and sawing.
- File and finish the profile as per given in the job drawing maintaining the dimensional accuracy of ± 0.02 mm.
- Check the measurement with vernier caliper
- Finish surface and remove burrs in all corners of the job.

Round Rod:

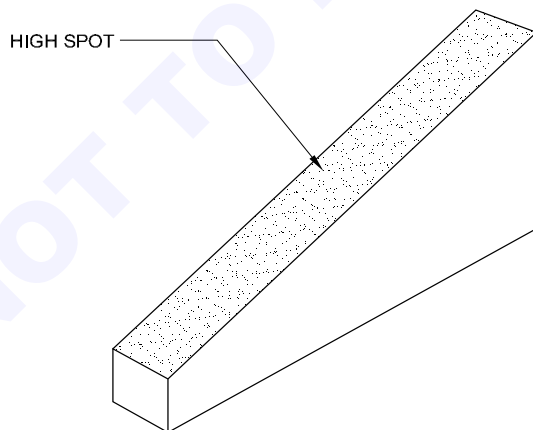
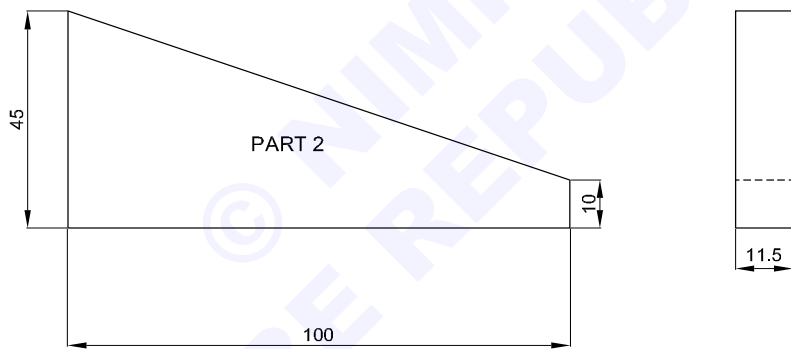
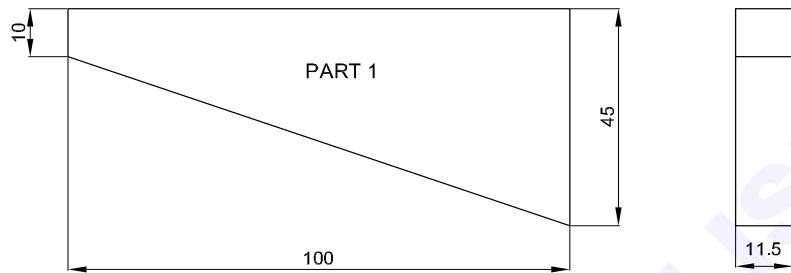
- Hold the round in a centre lathe with three jaw chuck.
- Turn the round rod to size fit of $\varnothing 10 \pm 0.02$ x 60 mm long maintaining the dimension between 9.980 mm and 10.020mm.
- Chamfer both the ends of round in lathe.
- Check the round rod in “snap gauge”.
- Apply thin coat of oil to preserve and for evaluation.

If the round enters into “Go Side” and not enter into “No go side” means, the turned component is equal to minimum permissible dimension, that means the product component is accepted for further process. Instead of that the turned component enters into both “Go” and “No go” end means the turned component is equal to maximum dimensions, that means the product component is not accepted for further process. Simply the maximum permissible dimensions component should be rejected.

Scrape external angular mating surface and check angle with sine bar

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

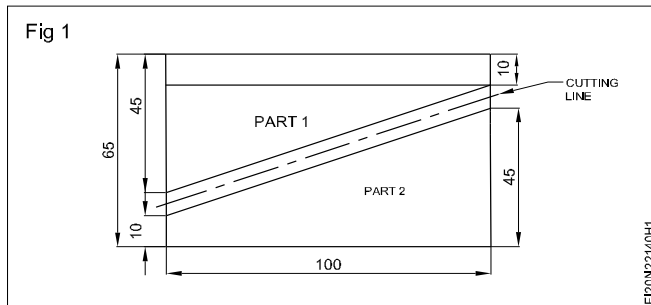
- file to flat and square
- mark as per drawing and punch witness marks
- prepare Part 1 and 2 as per drawing
- check angle with sine bar.



1	65ISF 12-105	-	Fe-310	-	1&2	2.2.140
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	SCRAPE EXTERNAL ANGULAR MATING SURFACE AND CHECK ANGLE WITH SINE BAR				TOLERANCE: ±0.02 mm	TIME : 15 hrs
					CODE NO. FI20N22140E1	

Job Sequence

- Check the raw material for its size.
- File to flatness and squareness to overall size.
- Mark dimensional lines as per drawing and punch witness marks.
- Cut off the material into two pieces (part – 1 and part – 2) by hackwawing as shown in Fig -1

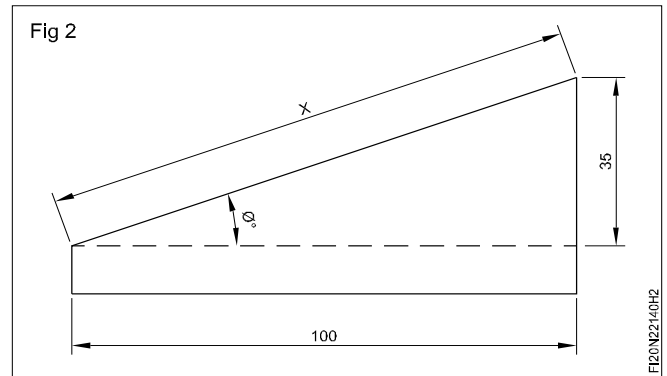


- File part – 1 to size and shape maintaining the dimensional accuracy $\pm 0.02\text{mm}$
- Check the dimensions with vernier caliper.
- Check the angle $19^\circ 17'$ with vernier bevel protractor.
- Similarly file part – 2 to size and shape and also to angle $19^\circ 17'$
- Apply prussian blue evenly on the surface plate to check high spot on angular surfaces.
- Place part – 1 and part - 2 angular surfaces on surface plate and move gently.
- Take the job from the surface plate and notice the high spot (prussian blue spotted marks) on angular surfaces.
- Hold the job in a bench vice, scrap and remove the high spots with a flat scraper.
- Repeat the process until the prussian blue cover the entire angular surfaces of part – 1
- Similarly scrape part – 2 and maintain the angular surface without high spot and angle $19^\circ 17'$.

Calculation of angle

$$\tan \theta = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{35}{100} = 0.3500$$

$\therefore \theta 19^\circ 17' 20''$ (as per trigonometric table)

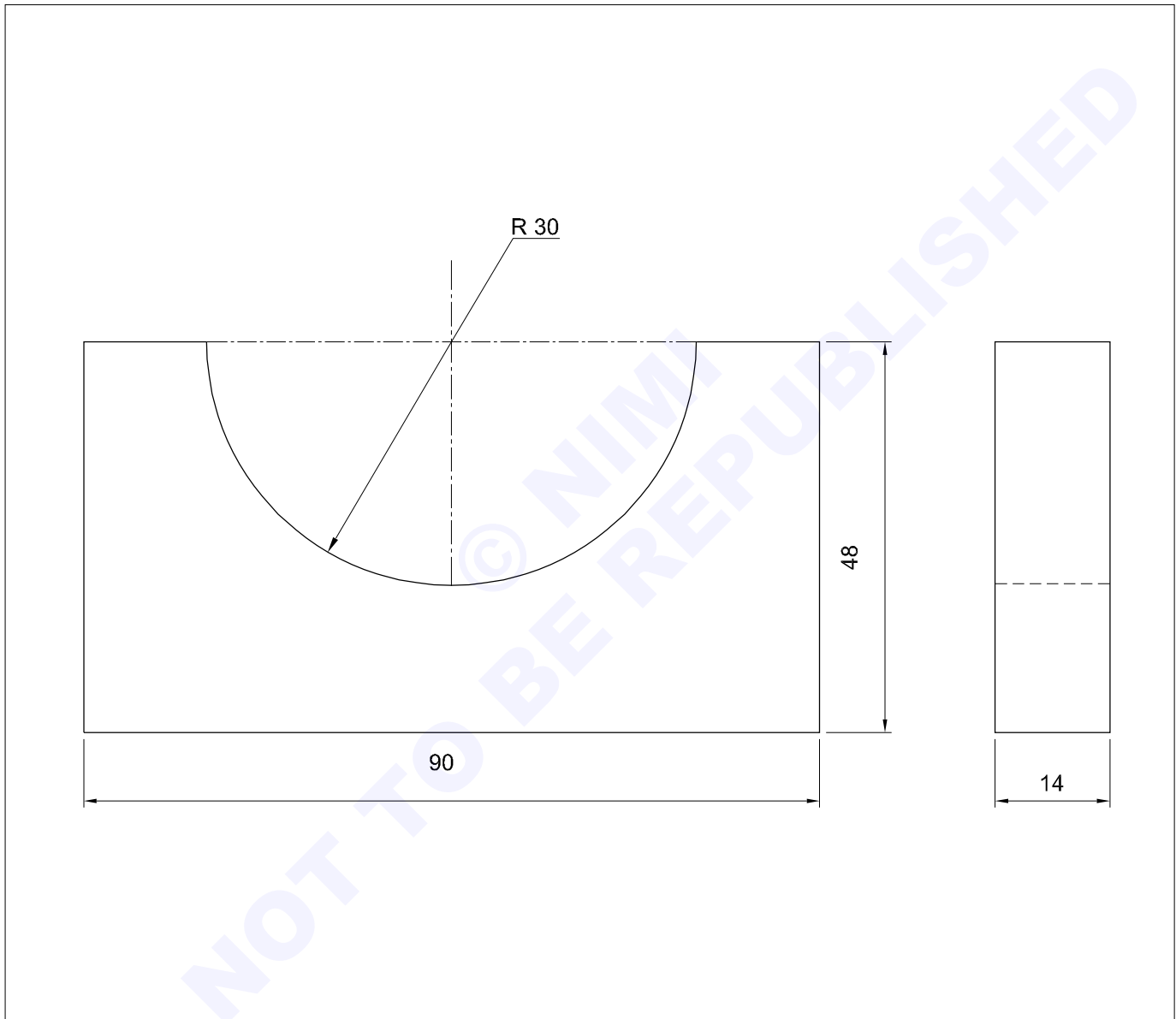


- Clean the surface plate, sine bar and slip gauge with soft cloth.
- Select the slip gauge to the height of 33.024 mm
- Set the part – 1 in sine bar and clamp it properly.
- Fix the dial test indicator in the stand.
- Set the dial test indicator plunger on the angular surface of the job.
- Set the dial test indicator pointer in 'zero' position
- Wring the slip gauges under the sine bar roller.
- Move the dial test indicator from one end to other end and check the parallelism of the angular surface.
- If the dial test indicator pointer does not move plus (or) minus side and stand still in zero position means, there is no deviation in the angular surface of job.
- Instead of that, the dial test indicator pointer moves plus (or) minus side means there is a deviation in the angular surface of the job.
- If you notice any deviation, correct the parallelism of the surface of the job by using suitable slip gauge and calculate the actual angle.
- Dismantle the setting, clean all the instruments and keep it in proper place.
- Make part – 1 and part – 2 angular surface and apply thin coating of oil and preserve it for evaluation.

Scrape on internal surface and check

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

- file to size as per drawing
- mark and punch to the dimensions
- chain drill and chip excess metal
- file profile to shape and size to an accuracy of $\pm 0.02\text{mm}$
- scrape and remove high spots on internal surface.

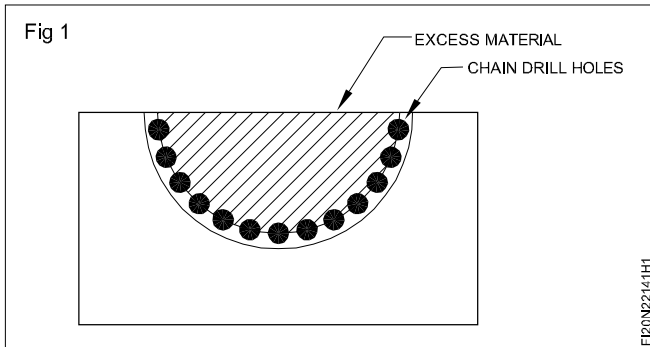


1	50 ISF 15 - 95	-	Fe-310	-	-	2.2.141
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1		SCRAPE ON INTERNAL SURFACE AND CHECK			TOLERANCE : $\pm 0.02 \text{ mm}$	TIME : 10 hrs
					CODE NO. FI20N22141E1	

Job Sequence

Scrape on internal surface and check

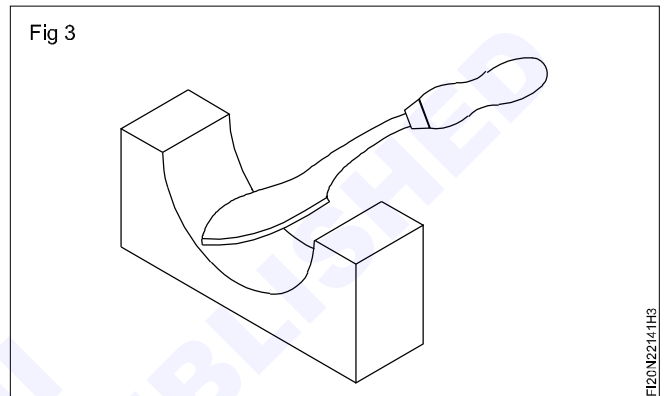
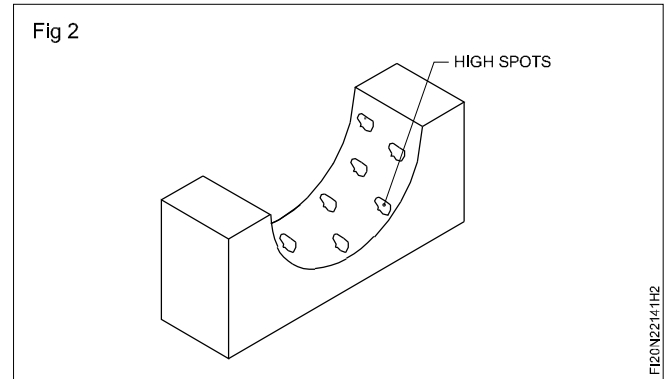
- Check the raw material for its size.
- File metal to over all size 90 X 48 X 14mm and check the size with Vernier caliper.
- Check Flatness and squareness with try square.
- Apply marking media and mark as per drawing and punch witness marks.
- Chain drill holes to remove Excess metal



- Cut and remove the chain drilled portion by chipping.
- File the chipped portion to profile and check with radius gauge and size with Vernier Caliper.
- Hold the test material ϕ 60mm on bench vice and clean with soft cloth.

Use banian cloth / mull cloth for cleaning.

- Apply Prussion blue on the cylindrical surface of material.
- Clean and place the job's curved portion on (bearing surface) on test material and rotate it gently to find high spots. (Fig 2).
- Hold the job in bench vice. Scrape and remove the high spots with half round scraper (Fig 3).



- Similarly, scrape till high spots are spreaded evenly all over the entire curved surface of the job.
- Finish and remove the burrs in all corners of the job.
- Apply little oil and preserve it for evaluation.

Caution:

- Always use scraper with handle.
- Protect the cutting edge of a scraper with a rubber cover when not in use.
- Apply oil, grease on the cutting edges when not in use and keep it in safe place.

Skill Sequence

Scraping and testing curved surfaces

Objective: This shall help you to

- **scrape and test curved surfaces**

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

Method

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

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

Rough scraping will need excessive pressure with longer strokes.

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

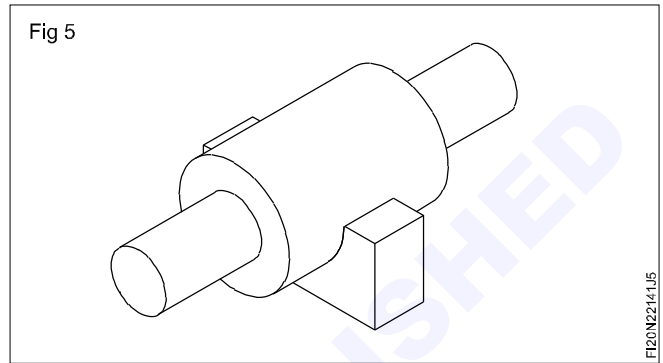
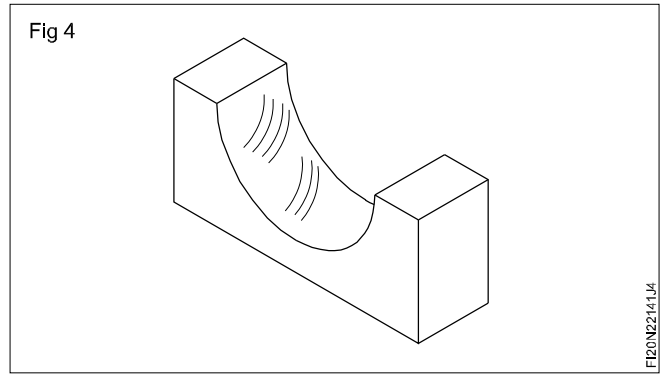
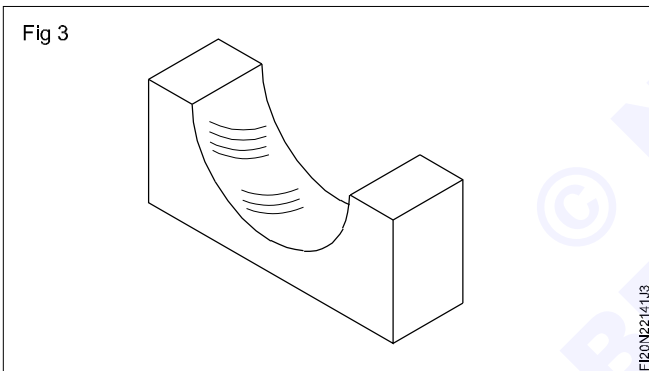
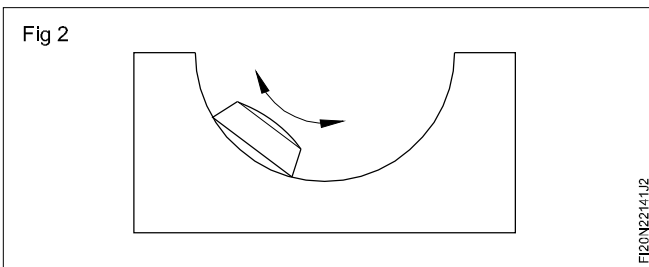
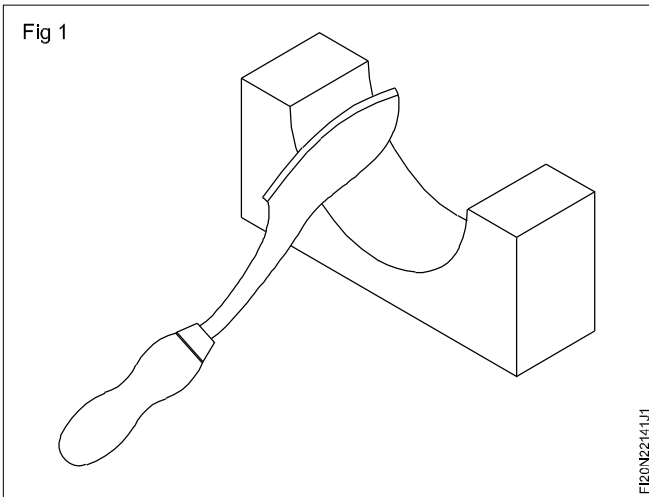
Cutting action takes place both on forward and return strokes Fig 2.

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

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

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

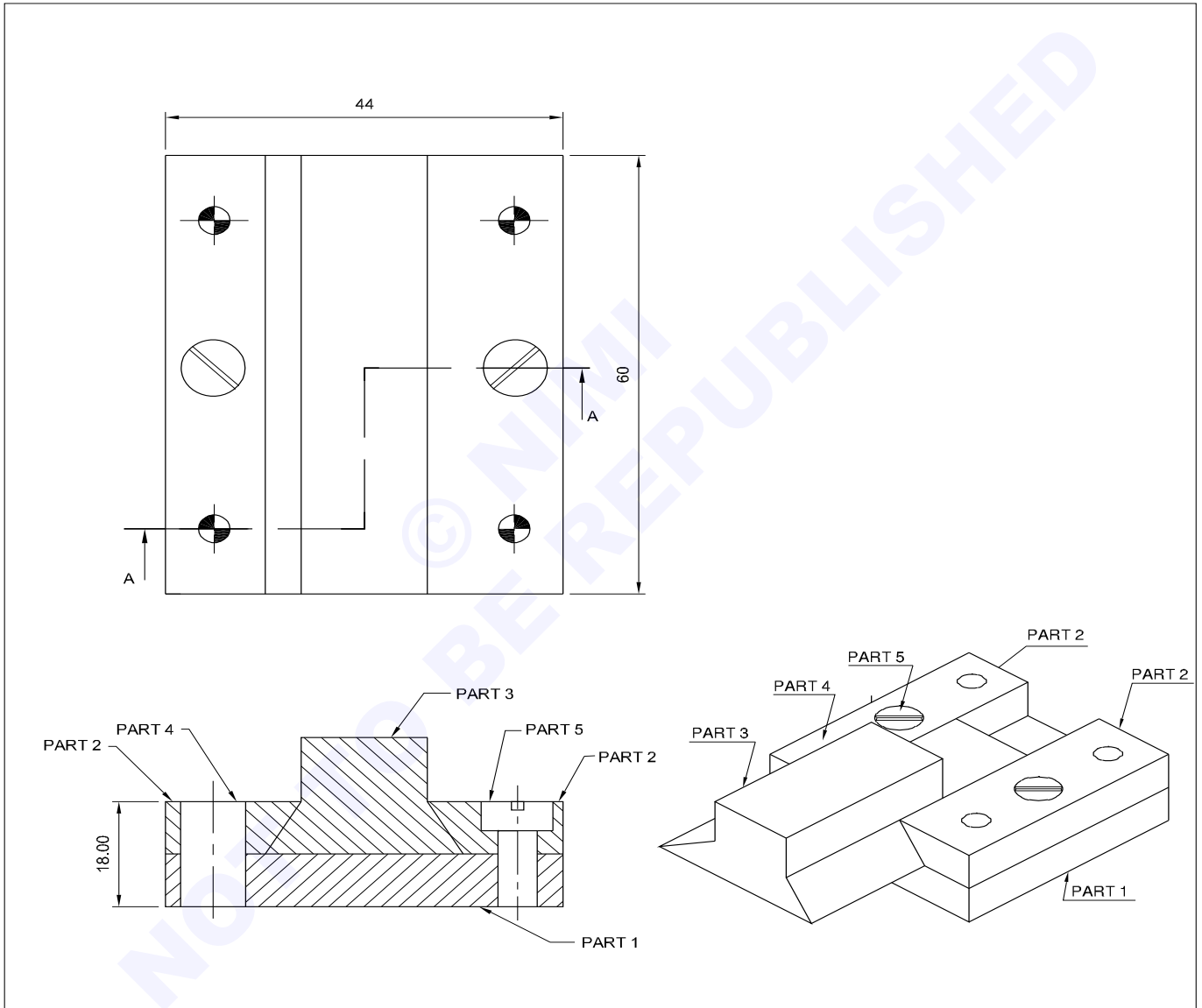
Apply a thin coating of Prussion blue on the master bar to locate the high spots.



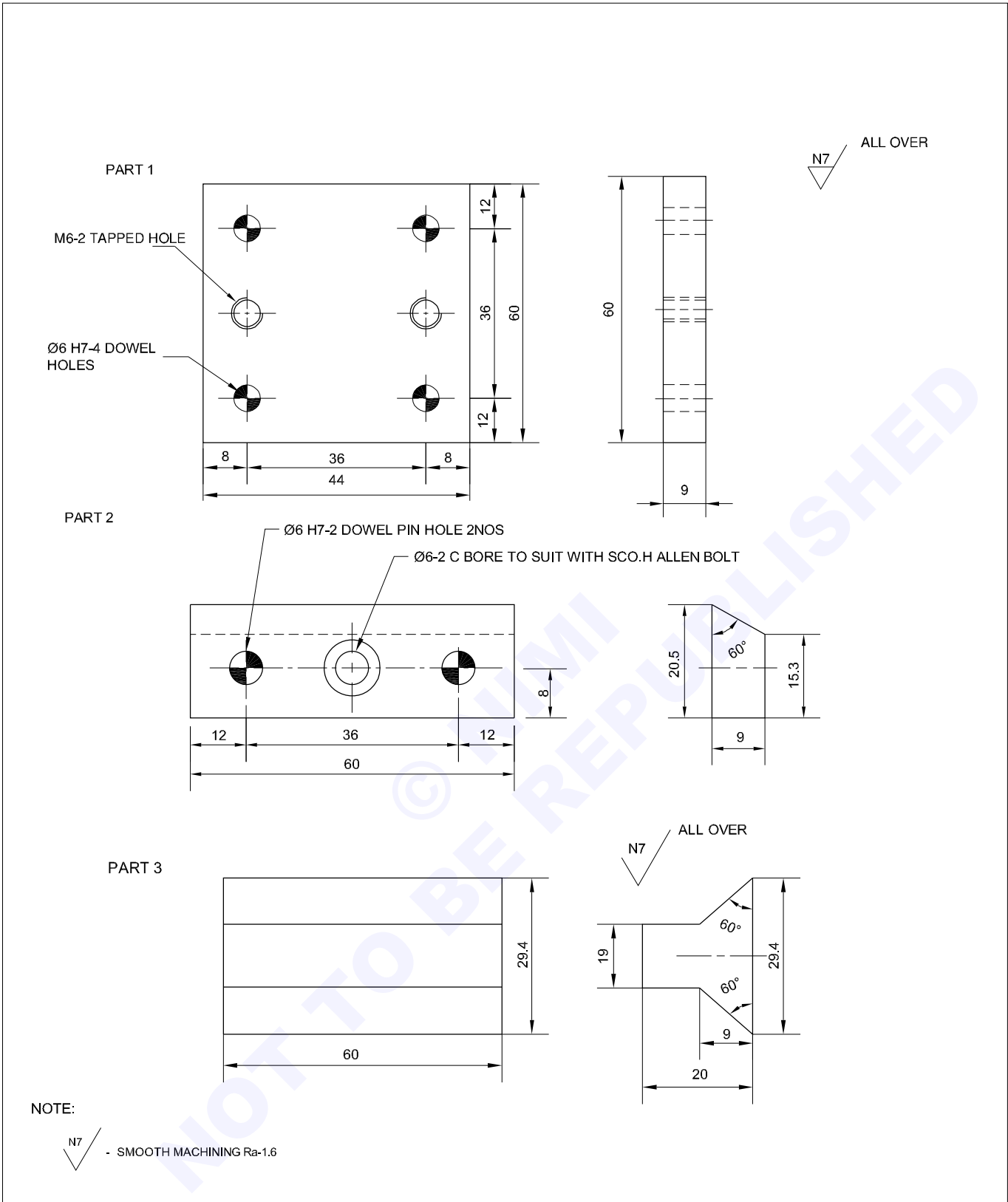
Practice in dovetail fitting assembly and dowel pins and cap screws assembly

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

- mark dimensions with a Vernier height gauge
- file the parts 1, 2, and 3 to size
- drill ream and tap at correct locations
- counterbore to required depth
- assemble the parts 1,2 & 3 with dowel pins and cap screws.



2	M6-12	CAP SCREW IS:3406	Fe 310	-	5	2.2.142	
4	Ø6-18	DOWEL PINS	Fe 310	-	4	2.2.142	
1	35 ISF 25 - 65	DOVE TAIL SLIDE	Fe 310	-	3	2.2.142	
2	25 ISF 10-65	TOP PLATES	Fe 310	-	2	2.2.142	
1	65 ISF 10 - 65	BASE PLATE	Fe 310	-	1	2.2.142	
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.	
SCALE 1:1		PRACTICE IN DOVETAIL FITTING ASSEMBLY AND DOWEL PINS AND CAP SCREWS ASSEMBLY			DEVIATIONS	±0.02 mm	TIME 16 hrs
					CODE NO. FI20N22142E1		



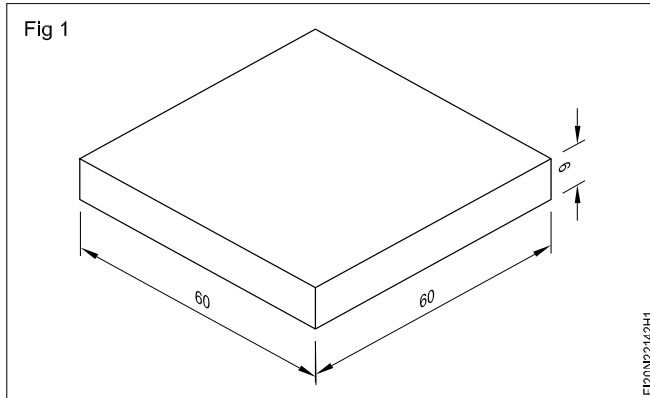
-	-	-	-	-	-	2.2.142
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	PRACTICE IN DOVETAIL FITTING ASSEMBLY AND DOWEL PINS AND CAP SCREWS ASSEMBLY				DEVIATIONS ±0.02 mm	TIME
					CODE NO. FI20N22142E2	

Job Sequence

- Check the raw material for its size, part 1, 2, & 3 as per drawing.

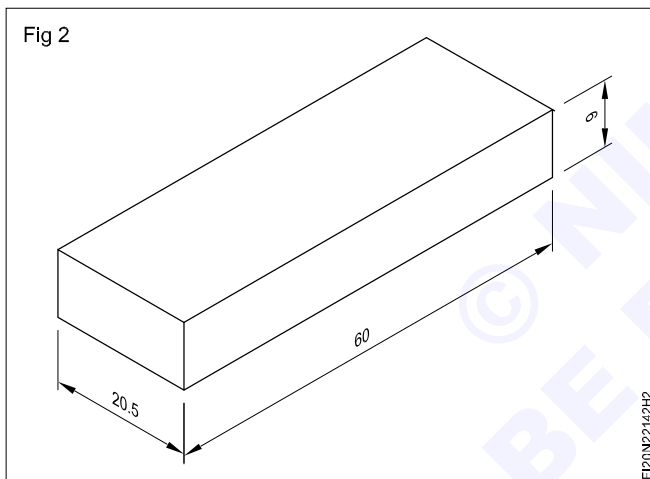
Part 1

- File to size and square. (Fig 1).

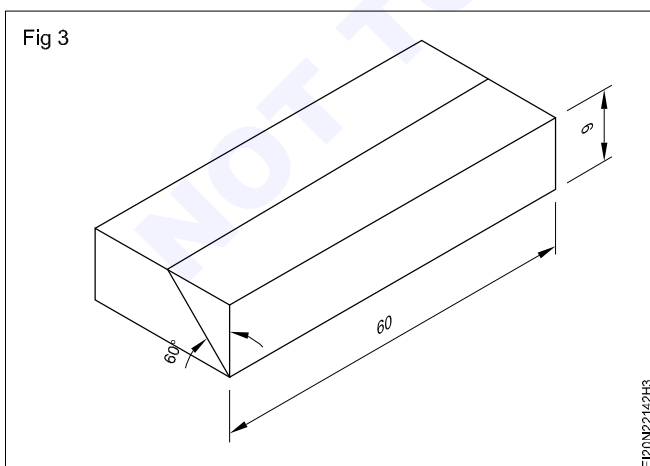


Part 2

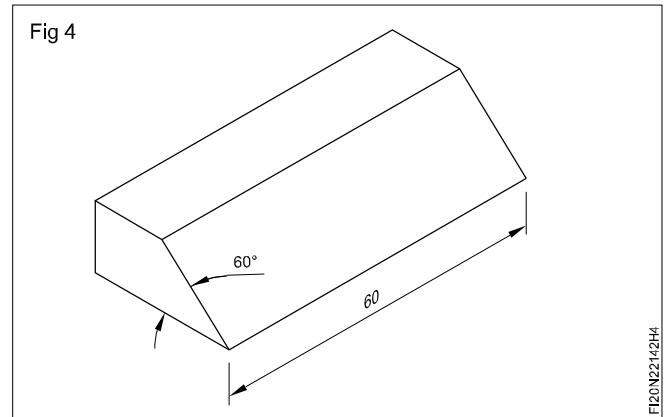
- File to size and square. (Fig 2).



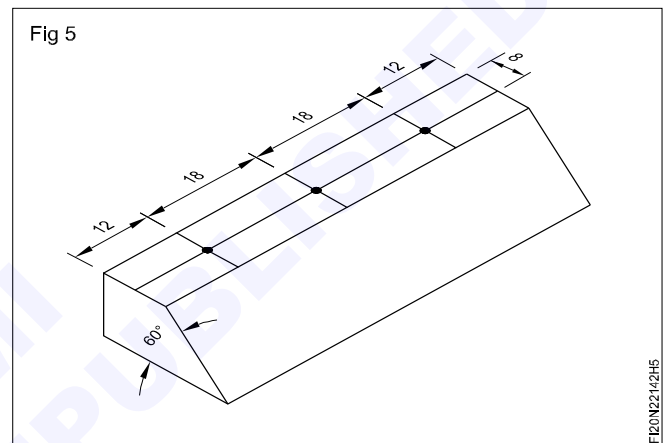
- Mark 60° angle using Vernier bevel protector in two pieces. (Fig 3).



- Cut and file the angular surface to flat and 60° angle and check the angle with Vernier bevel protector. (Fig 4)

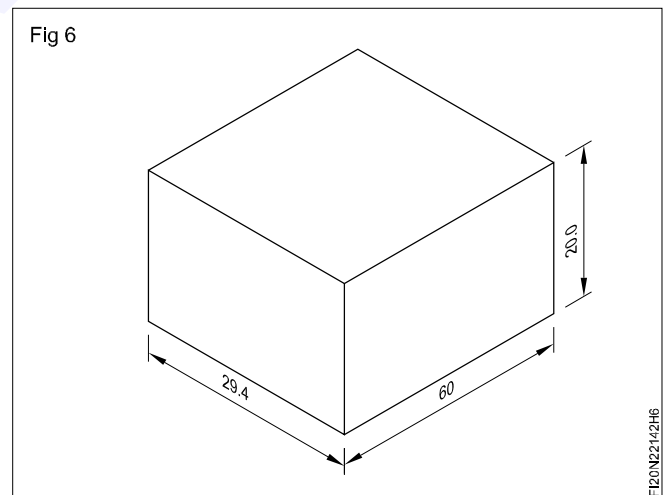


Mark the holes as per drawing in two piece (Fig 5).



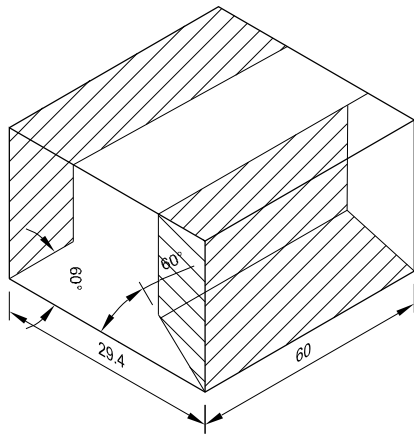
Part 3

- File to size and square to 29.4x60x20 mm (Fig 6).



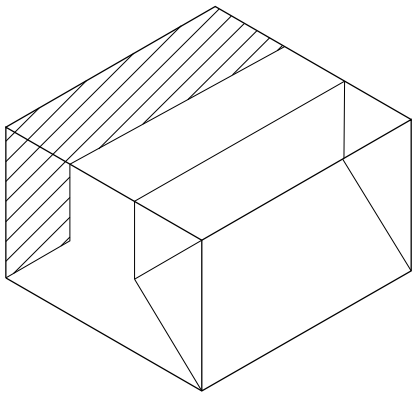
- Mark lines as per drawing with vernier height gauge and angle to 60° with vernier bevel protector. (Fig 7).
- Cut and remove the excess metal of hatched portion in one side by sawing and file to size, shape and angle to 60°. (Fig 8)
- Similarly, repeat the above process in other side of the job.
- Check the size with vernier caliper and angles with vernier bevel protractor (Fig 9).

Fig 7



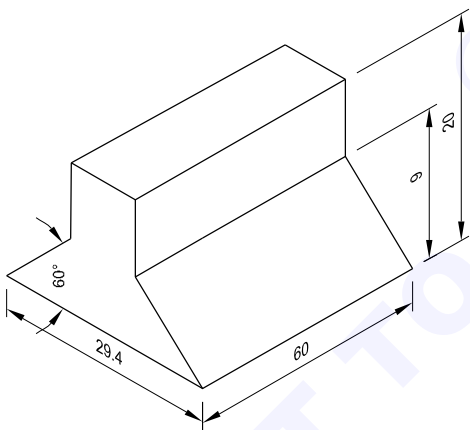
FI20N22142HT

Fig 8



FI20N22142HB

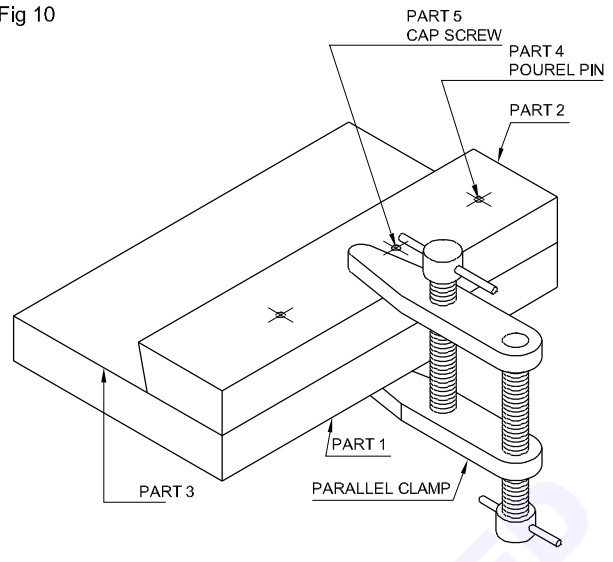
Fig 9



FI20N22142HS

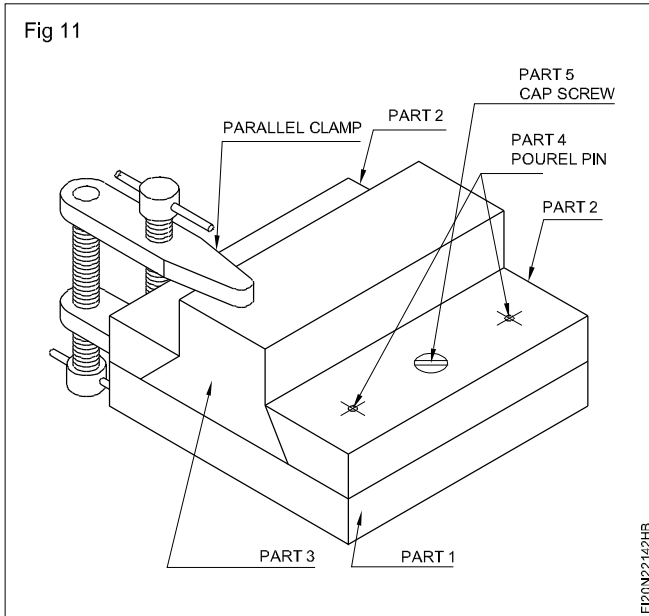
- Place part 2 on part 1, assemble together and clamp the parts with parallel clamp and check the squareness of assembled parts with try square. (Fig 10).
- Hold the assembly in a drilling machine table with machine vice.
- Keep parallel blocks under the assembly, while holding in machine vice for proper seating and levelling the job.
- Fix a centre drill in drilling machine and drill 2 to 3 mm depth, centre drilling on part 2 in the place of dowel pin and cap screw assembly.

Fig 10

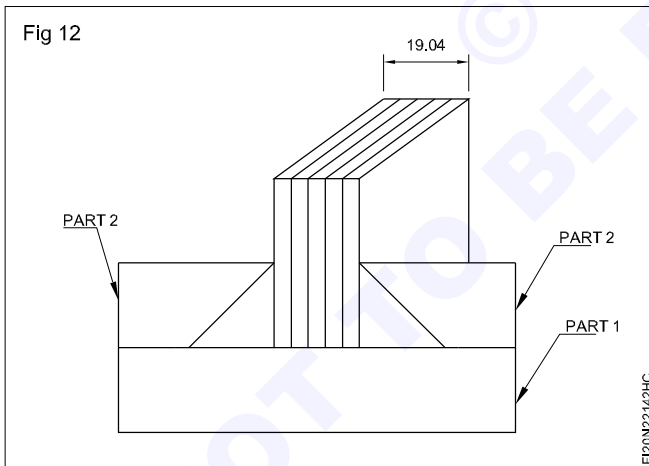


FI20N22142HA

- Remove centre drill and fix $\varnothing 5.8\text{mm}$ drill in drilling machine and drill a through hole in the place of dowel pin assembly.
- Fix $\varnothing 6\text{mm}$ reamer in tap wrench and ream the drilled hole without disturbing the assembly (use plenty of oil while reaming).
- Fix a dowel pin $\varnothing 6 \times 18\text{mm}$ in the reamed hole of dowel pin assembly.
- Similarly, repeat the above drilling and reaming procedures in the other end of the same job without disturbing the assembly and fix another dowel pin in the reamed hole.
- Fix $\varnothing 6\text{mm}$ drill in drilling machine and drill a through hole in the place of cap screw assembly.
- Remove $\varnothing 6\text{mm}$ drill and fix $\varnothing 10 \times 6\text{mm}$ counter bore tool in drilling machine and counter bore to the depth of cap screw head thickness in part 2.
- Dismantle the setting.
- Hold counter sink tool in drilling machine and chamfer the cap screw assembly tapping hole ends in both sides in part 1.
- Cut, four M6 internal thread in part 1.
- Clean burrs from threaded hole.
- Reassemble the dismantled setting and fix dowel pins in reamed holes and fix M6 $\times 18\text{mm}$ cap screw in a threaded hole in part 1 and 2 assembly.
- Place and assemble other two pieces of part 2 and part 3 on part 1 and clamp them with parallel clamp and check the squareness of assembled parts. (Fig 11).



- Follow the above working steps, given in the previous assembly of part 1 and 2 and complete the different operations and fix another two dowel pins and another to cap screws.
- Dismantle the setting of assembly and separate all the parts.
- Re assemble the parts 1 and 2 along with dowel pins and cap screws. Check the dove tail slot gap size with slip gauge. If dovetail slot gap size is not correct, correct the gap size by filing in part 2. (Fig 12). While filing in part 2. Dismantle the assembly and file to size.



Skill Sequence

Determine internal dovetail angle using rollers and slip gauges

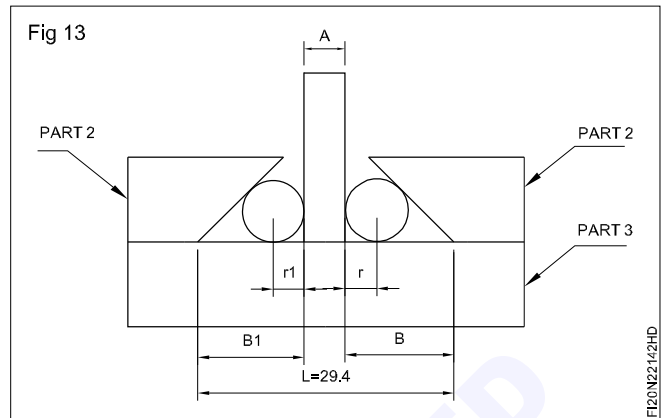
Objectives: This shall help you to

- use of precision balls and rollers.
- calculate internal dovetail angle using rollers and slip gauges.

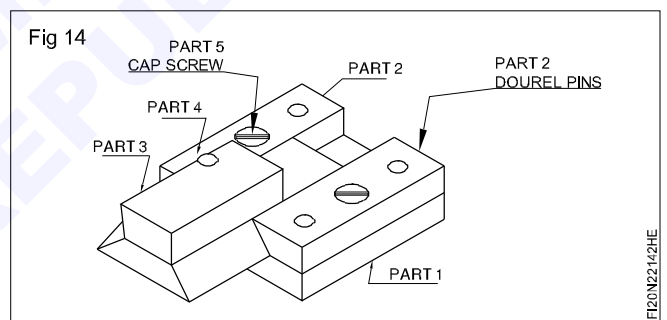
Use of precision balls and rollers

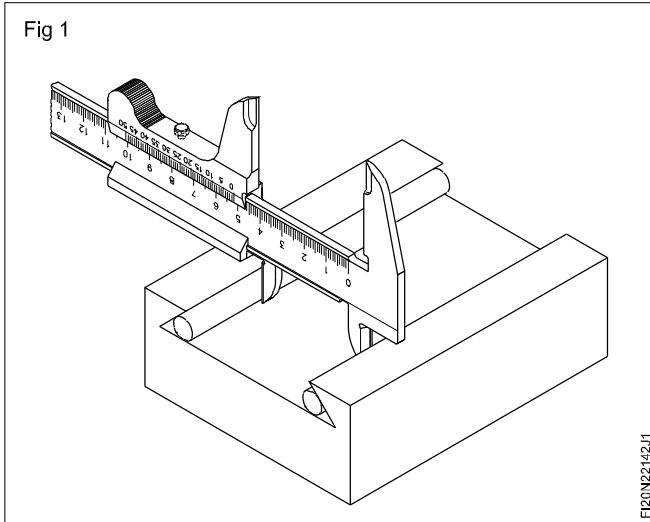
There are situations where measurements of components cannot be taken directly. A typical example of this is a dovetail (internal and external).

- Place $\varnothing 10\text{mm}$ two precision rollers in dovetail slot and calculate the dovetail slot length. If dovetail slot length is not correct, correct the length size by filing in part 2. (Fig 13).



- Fix part 3 in dovetail slot and slide it. (Fig 14).
- Dismantle and separate all the parts and finish all the surfaces and remove burrs on all the corners of the assembly.
- Reassemble all the parts and fit part 3 in dovetail slot and slide it.
- Apply a little oil and preserve it for evaluation.





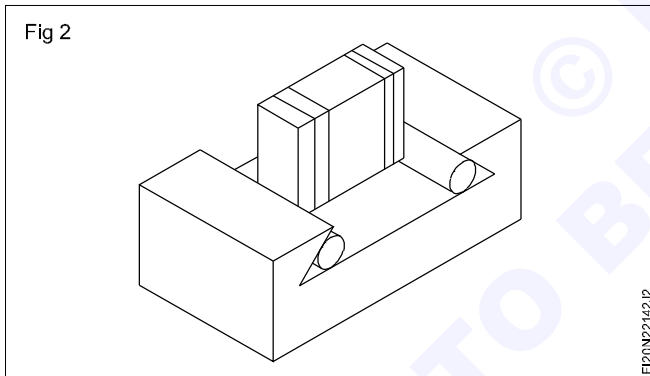
The purpose of the balls or rollers is to provide point or line contact in a known position.

Gap between the rollers can be measured using vernier caliper.

Fig 1 shows how the distance between the rollers is measured with a vernier caliper. It also shows that the point of contact does not lie in the plane of measurement.

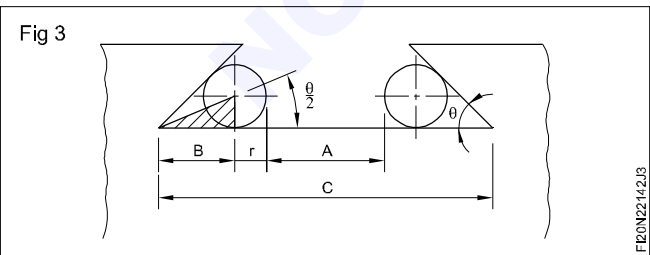
Calculating taper angle of internal parallel dovetail

After cleaning the dovetail and the matched pair of precision rollers, the rollers are positioned in such a way that the rollers will contact the angular faces as shown in Fig 2.



The gap between the rollers can be measured using a slip gauge or vernier caliper.

In the triangle (shaded) (Fig 3)



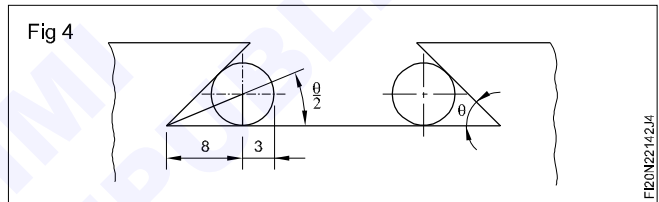
$$\begin{aligned} \tan \frac{\theta}{2} &= \frac{r}{B} \\ C &= A + 2r = 2B \\ 2B &= C - A - 2r \\ B &= \frac{C - A - 2r}{2} \\ \tan \frac{\theta}{2} &= \frac{r}{B} = \frac{r}{\frac{C - A - 2r}{2}} \\ &= \frac{2r}{C - A - 2r} \end{aligned}$$

(The value of C,A,r, are known. Hence the angle $\frac{\theta}{2}$ can be calculated.)

This is the half angle of the dovetail.

Example

Calculate the internal dovetail angle of a workpiece as per data given in the Fig 4.

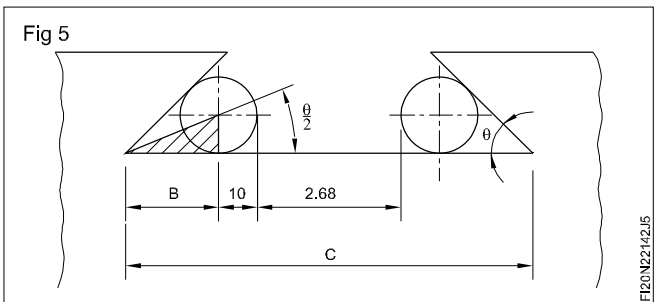


$$\begin{aligned} \tan \theta &= \frac{\text{Opposite side}}{\text{Adjacent side}} \\ \tan \frac{\theta}{2} &= \frac{r}{B} = \frac{3}{8} \\ \frac{3}{8} &= 0.375 \\ \tan \frac{\theta}{2} &= 20^{\circ}30' \end{aligned}$$

Tan θ or dovetail included angle = 41° ...Ans

Classroom Assignment (Fig 5)

Calculate the distance C of the dovetail if the diameter of the roller is 20 mm, angle is 60° and the distance between the rollers is 2.68 mm.



Industrial Visit

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

- **gain industries exposure and its function.**

Note: Instructor shall arrange industrial visit. Following are the general guideline shall be given to trainees.

- Ask trainees to get permission letter from parents or guardians for industrial visit.
- Brief to the trainees about industries health and safety procedure and behaviour expected of them.
- Brief about industrial visit that provide the trainees with an opportunity to learn practically through interaction working method and employment practices.
- Ask trainees to interact with the staff of the industry to get more exposure towards the current working conditions of the industry.
- Ask the trainees to assess the benefits of the industrial visit and write up a mini report.
- Ask the trainees to write a thank you letter to the organisation.

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Preparation of gap gauges

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

- file flat and square
- mark the profile as per drawing
- drill relief holes, chain drilling and hacksawing
- chip, file to size and profile as per drawing
- file GO end and NO GO end to size
- check the gap GO end and NO GO end with slip gauge.

NOTE:
26 H7 - 26 $\begin{matrix} +0.021 \\ +0.000 \end{matrix}$

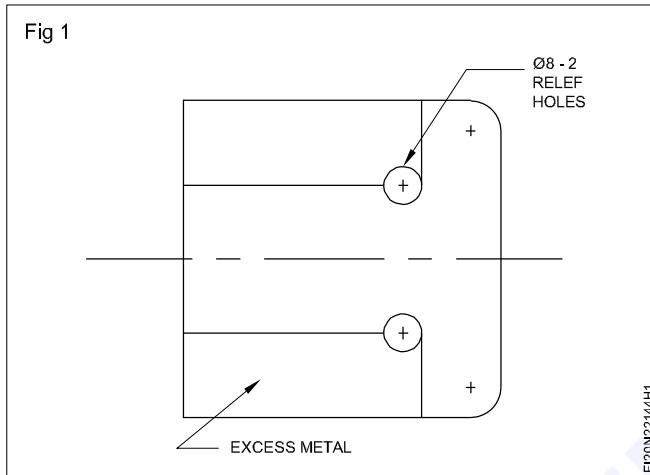
1	70 ISF 10-60	-	Fe 310	-	B	2.2.144
1	60 ISF 10-60	-	Fe 310	-	A	2.2.144
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1					TOLERANCE : ± 0.02 mm	TIME 12 hrs
<p style="text-align: center;">PREPARATION OF GAP GAUGES</p>					CODE NO. FI20N22144E1	

Job Sequence

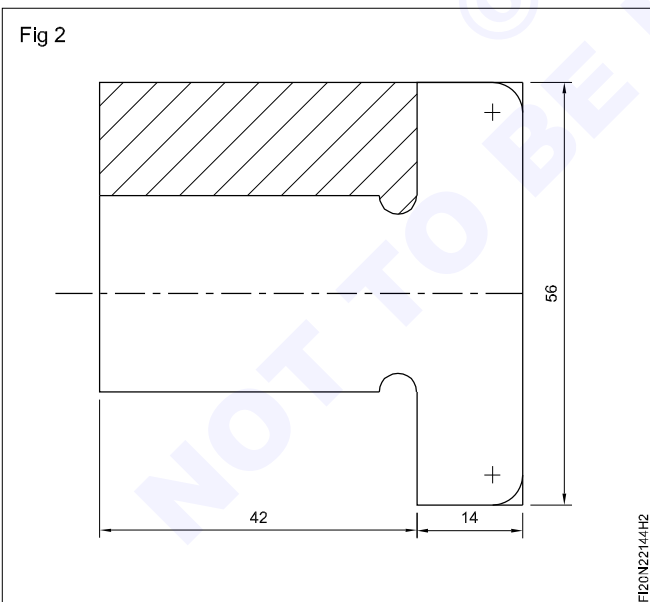
- Check the raw material for its size.
- File metal to size as per drawing.
- Apply marking media on part A and B as per drawing.
- Mark the profile and punch witness marks.

Part A

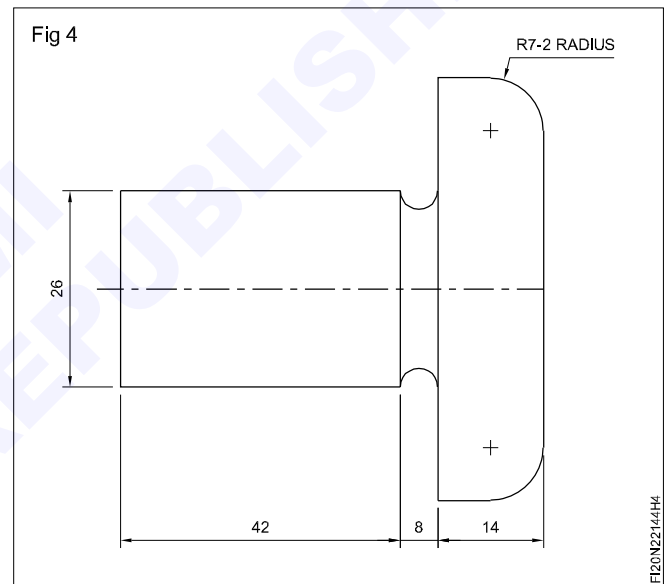
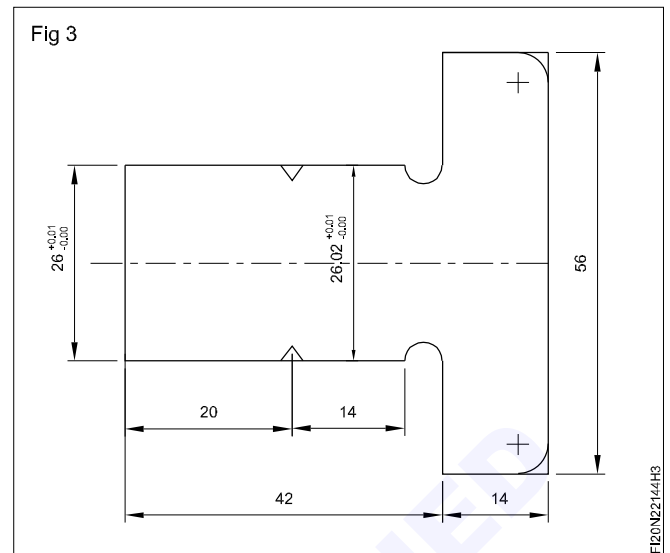
- Hold part A in drilling machine table.
- Fix $\varnothing 8$ mm in drilling machine spindle and drill two relief holes as shown in Fig 1.



- Hold part A in bench vice, cut and remove the hatched portion of excess metal on one side and file the same portion to size maintaining the accuracy as mentioned in the drawing

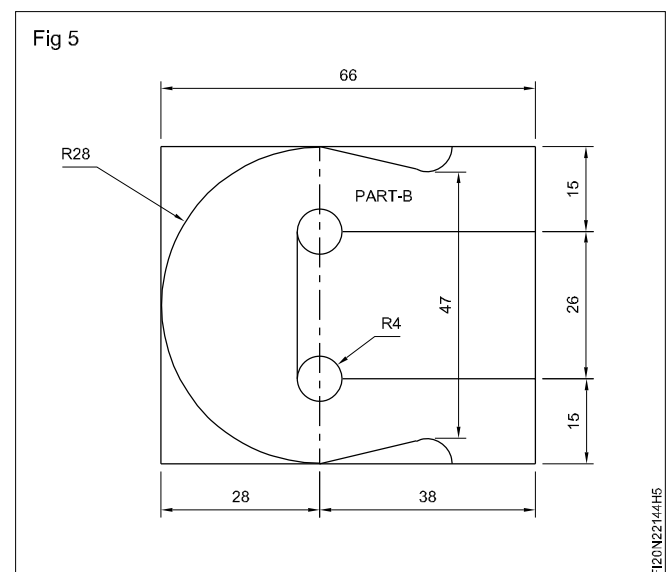


- Similarly, following the above job sequences on the other side of the job, cut and remove the excess metal and file to size Fig 3.
- File radius 7mm as per drawing and check with radius gauge Fig 4.

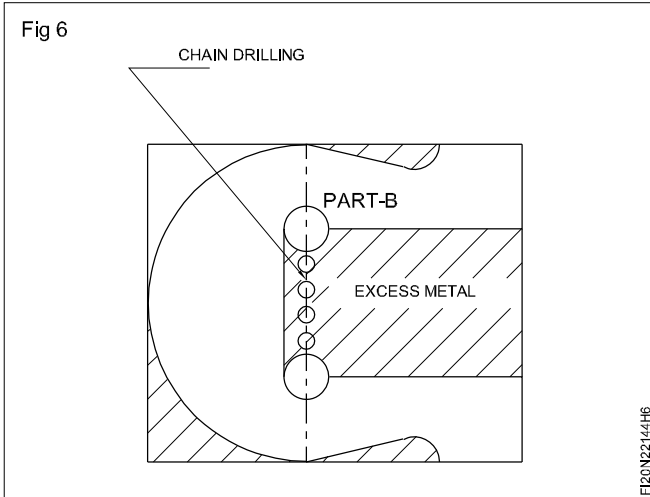


Part B

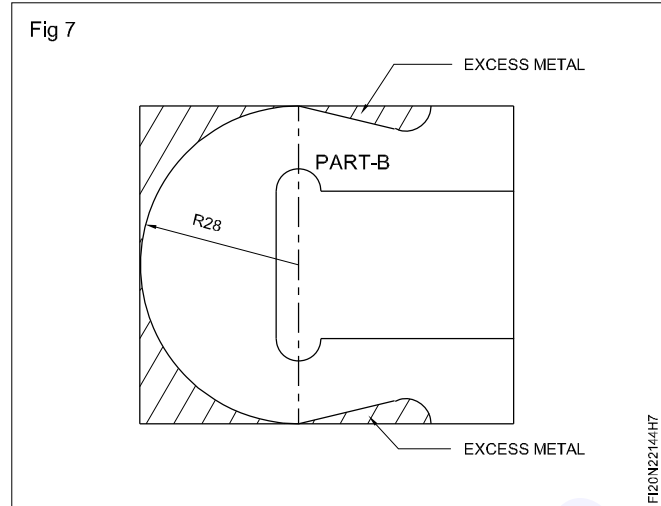
- Hold part B in drilling machine table and drill $\varnothing 8$ mm relief holes as shown in Fig 5.



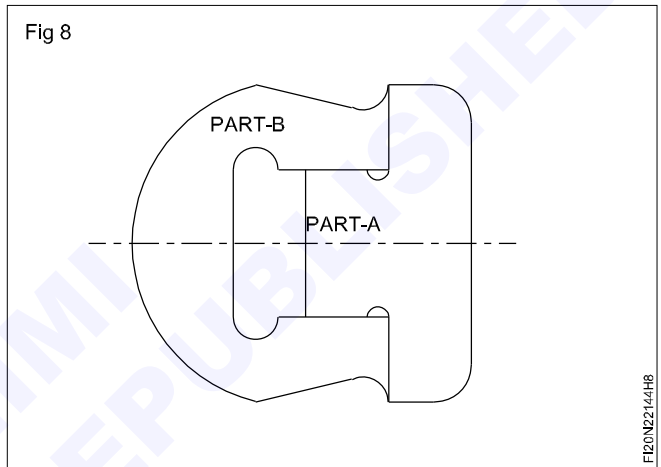
- Chain drill, hacksaw, chip and remove the excess metal in part B as shown in Fig 6.



- File the excess metal in internal portion of part B to size and shape and check the size with vernier caliper.
- Cut and remove the excess metal in outer surface of the part B and file to size and shape as shown in Fig 7.



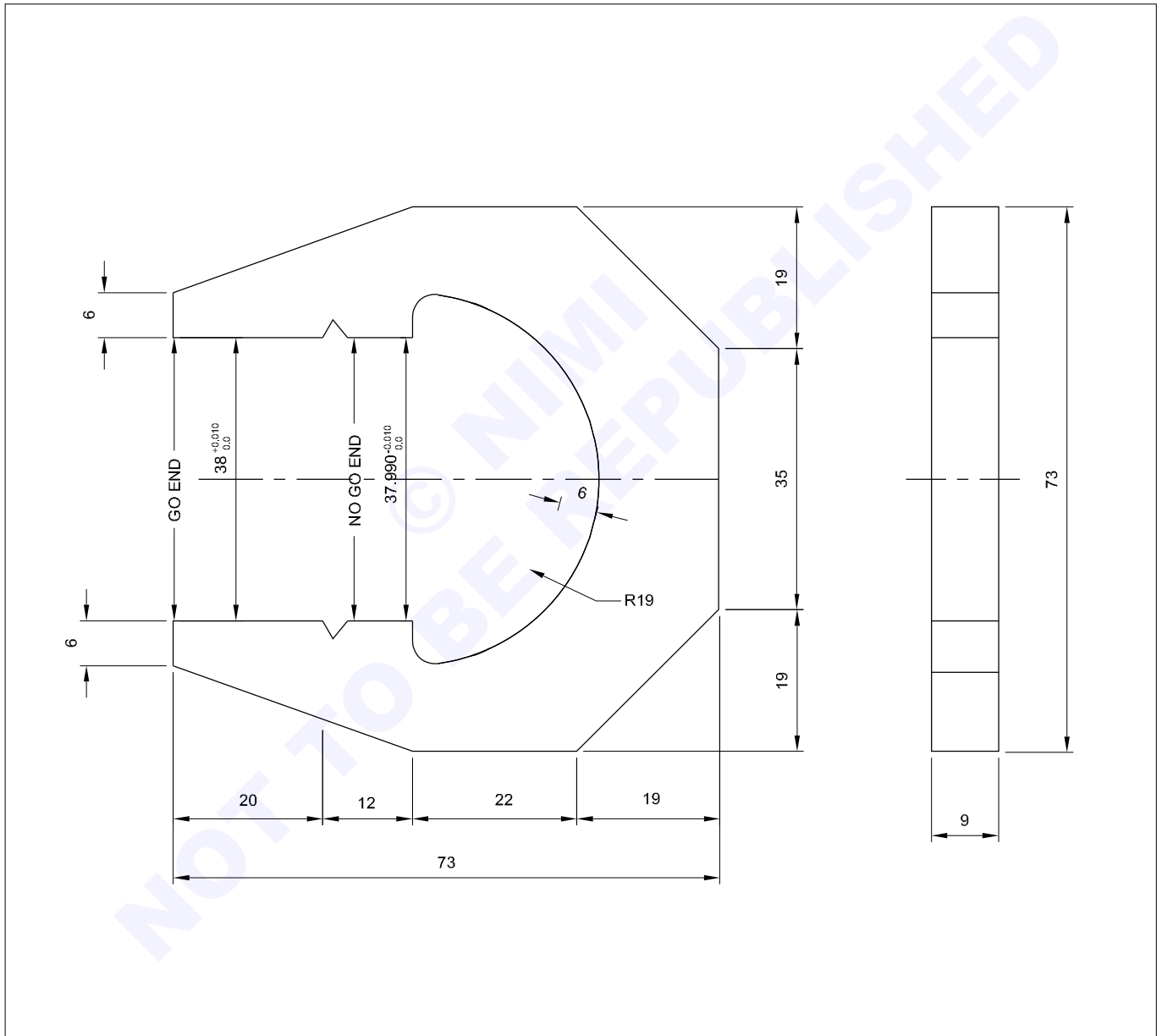
- Match part A and part B as shown in Fig 8.



Perform lapping of gauges (hand lapping only)

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

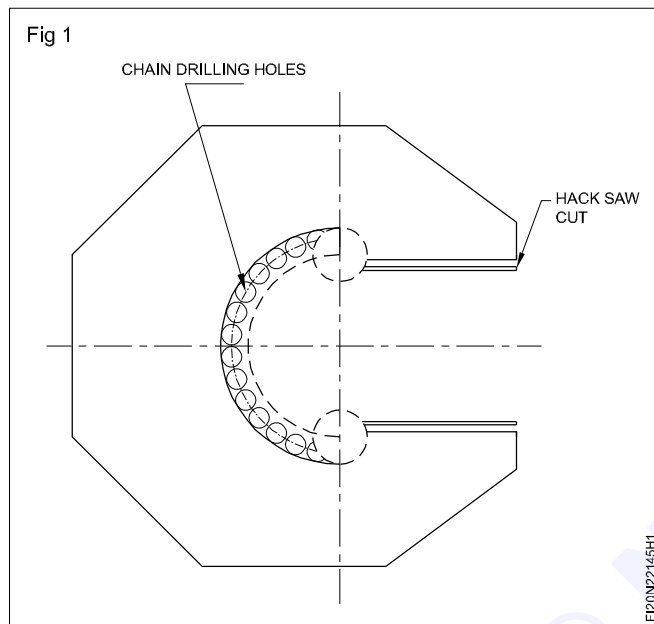
- file flat and square
- check the flatness and squareness
- mark profile as per drawing
- chain drill to remove excess metal
- file Go - end and No go - end to size
- check the gap Go end and No go end with slip gauge
- perform lapping on surface of the gauge.



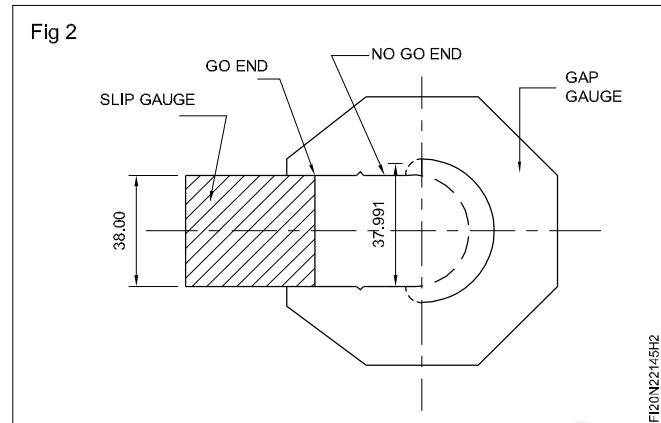
1	75 ISF 10 - 75	-	Fe 310	-	-	2.2.145
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	PERFORM LAPPING OF GAUGES (HANDLAPPING ONLY)				TOLERANCE : ± 0.02 mm	TIME : 10 Hrs
					CODE NO. FI20N22145E1	

Job sequence

- Check the raw material for its size.
- File raw material to size 73 X 73 X 9 mm and check the size with Vernier caliper.
- Check the flatness and squareness with try square.
- Apply marking media and mark the profile as per drawing.
- Punch witness marks.
- Chain drill to remove excess metal, as shown in Fig 1.



- Cut and remove the excess metal by hacksawing and chipping.
- File the profile to size and shape maintaining accuracy of $\pm 0.02\text{mm}$.
- Mark the distance GO end $38^{+0.01}_{-0.00}$ mm maximum limit of size.
- File NO GO end size to $37.991^{-0.010}$ mm minimum limit of size.
- File 'V' notch at GO end and NO GO end meeting line.
- Finish the surface and remove the burrs on the corners of the job.
- Check GO end and NO GO end using slip gauge Fig 2.



Lapping

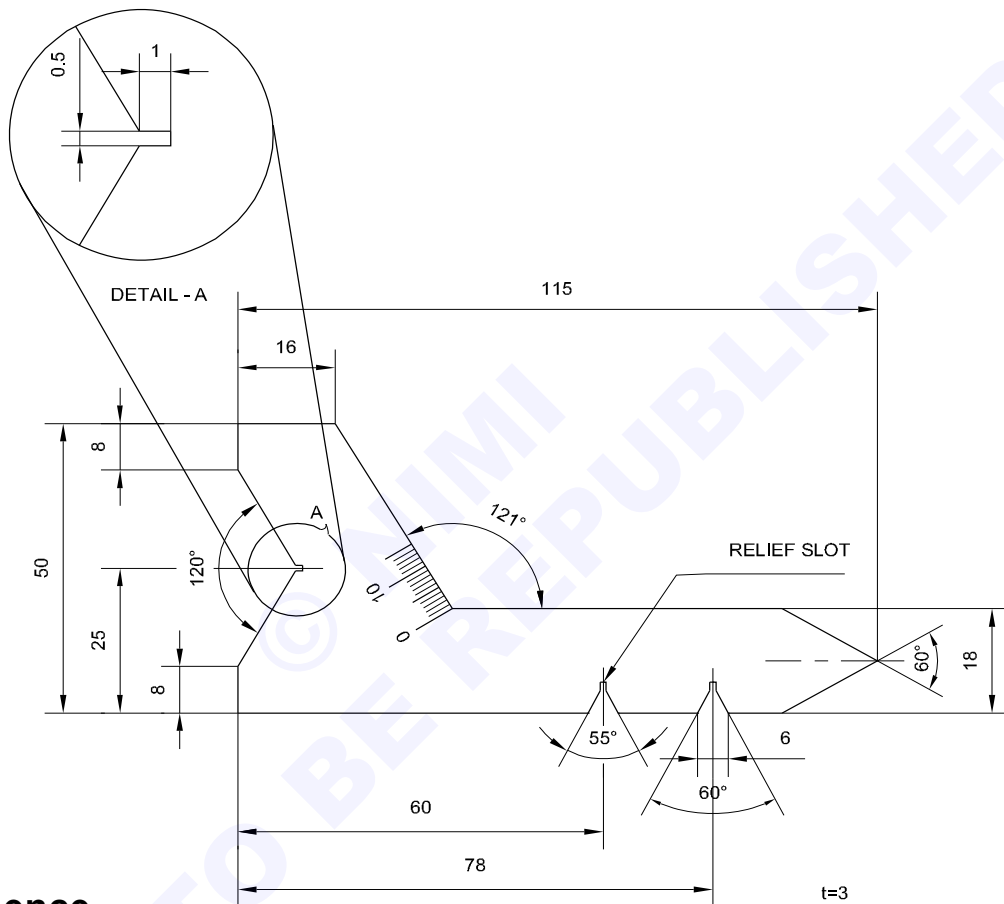
- Select a lapping plate made of closed grain cast iron.
- Charge the lapping abrasive mixed with oil on lapping plate.
- Wash off the surplus oil and abrasive on the lapping plate.
- Take suitable lapping block (which enters into 'GO' and 'NOGO' ends) and charge lapping compound.
- Rub the work against a lap charged with a lapping compound.
- Apply light pressure while lapping.
- Repeat the above procedure to lap in other surface of the job.
- Apply oil and preserve it for evaluation.

- **Lapping compound consists of abrasive particles suspended in a vehicle such as oil, parffin, grease etc.**
- **Lapping can be carried out either in wet and dry condition.**

Preparation of drill gauges

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

- file thin sheet metal to size.
- lay out on sheet metal as per drawing
- file angular surface to an accuracy of $\pm 5'$
- file and finish the gauge to the shape and size as per drawing
- check the drill lip length and angle in drill gauge.



Job Sequence

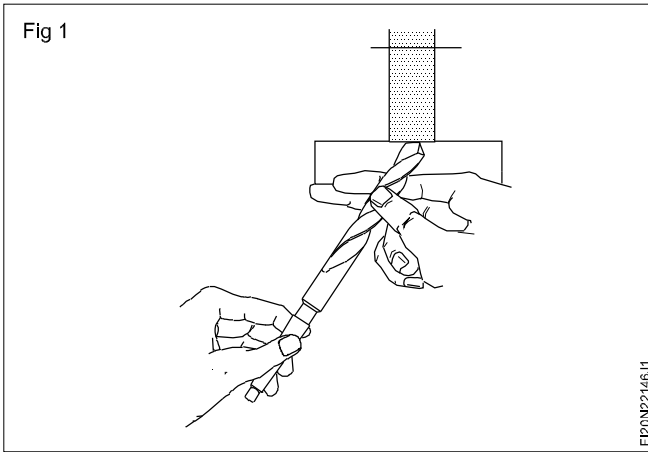
- Check the material size as per drawing
- File the metal to size 115 x 50 x 3 mm and check the size with vernier caliper
- Check the flatness and squareness with try square
- Mark the dimensions as per drawing with vernier height gauge
- Punch the witness marks Fig:1

- Saw and remove excess material by hacksawing (Fig:2)
- Make three relief slots as per drawing by hacksawing.

Ensure that about 1 mm material is left from the witness marks by hacksawing for filing and finishing.

- File and finish 120° angle using triangular file and needle file.

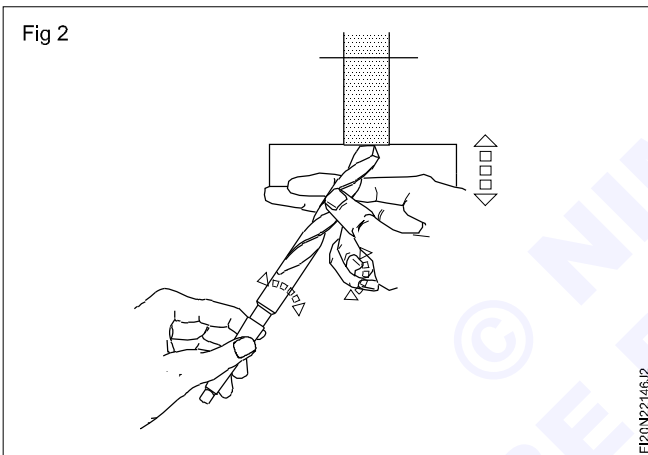
1	ISST125 x 3.55 - 55	-	Fe310	-	2.2.146
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	EX NO.
SCALE 1:1	PREPARATION OF DRILL GAUGES			TOLERANCE: ± 0.02 mm	TIME: 10hrs
				CODE NO. F120N22146E1	



The hand near the point of the drill should be pivoted lightly on the tool rest for easy manipulation.

Hold the drill level Fig 1 and turn it to 59° to the face of the wheel and swing the drill slightly downward and towards left Fig 2.

Rotate the drill the right by turning it between the thumb and the forefinger Fig 2.



This turning movement is not necessary for smaller dia. drills.

While swinging down, apply a slight forward motion. This will help to form the clearance angle.

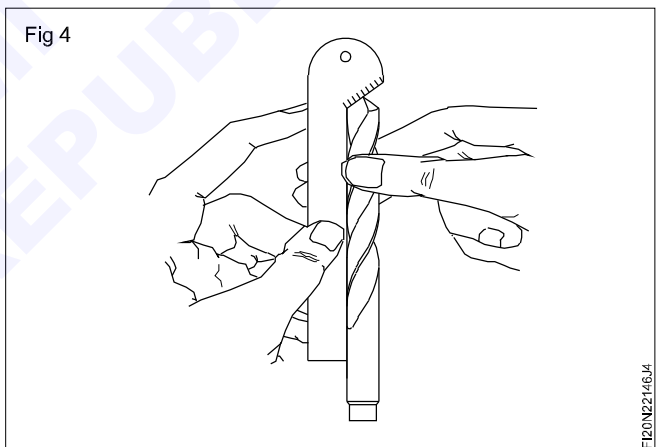
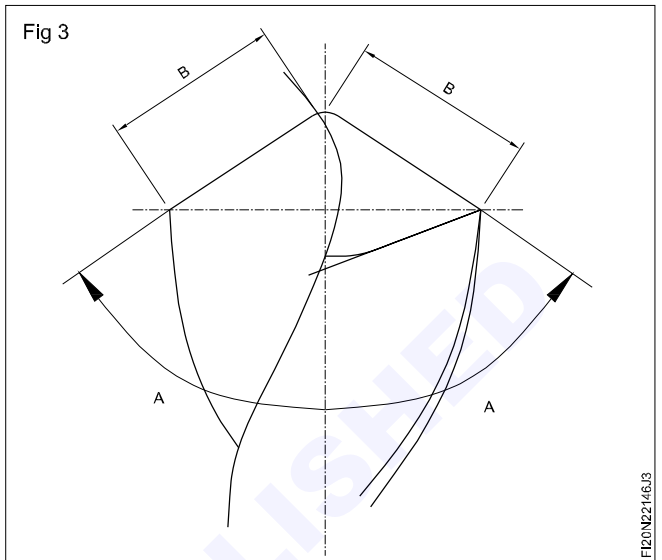
While swinging and turning the drill make sure you do not grind the other cutting edge.

All movements of the drill in angular turning, swinging and forward movements, should be well coordinated. They should result in one smooth movement to produce a uniformly finished surface.

Repeat the process to re-sharpen the other cutting edge.

Check both the cutting edges with a drill angle gauge, for correctness of the lip angle and equality of the lip lengths Fig 3 and 4.

Check the lip clearance angle in Fig 5 visually. The angle should be between 8° to 12° .



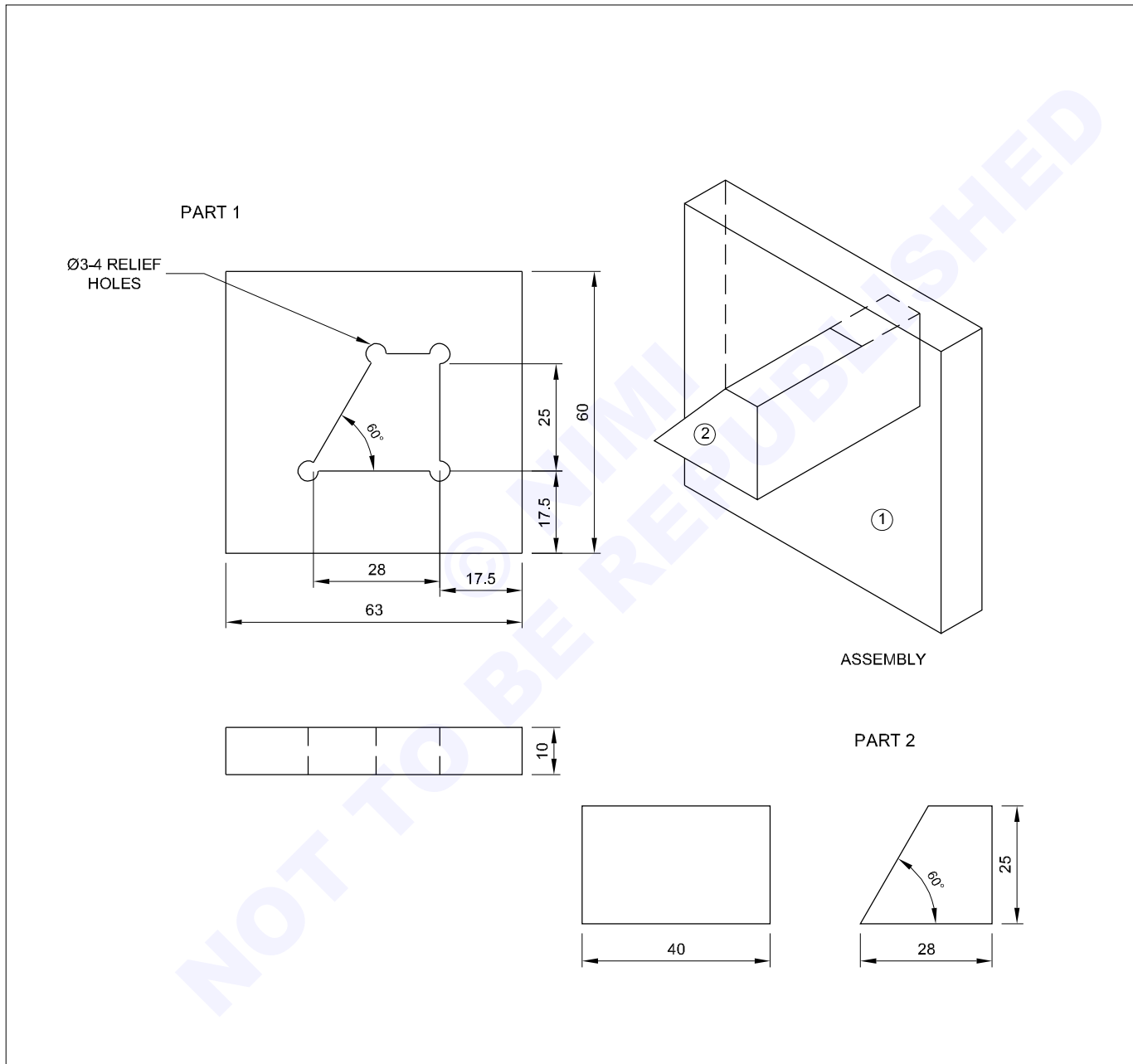
When you are satisfied correct equal angle and equal lip length. Drill a hole in a scrap metal. Before drilling confirm correct drill speed (r.p.m) use cutting fluid.

Verify the condition of the hole while drilling. Did the drill chatter? If chattering happened, this could be caused by too much lip clearance. If the hole is over size by more than 0.12 to 0.25 mm then check lips lengths for uneven or the lip angles for uneven.

File and fit straight and angular surfaces internally

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

- file and finish part 1 & 2 as per dimensions keeping straight
- file angle tolerance of 10 minutes and angle face tolerance of $\pm 0.02\text{mm}$
- to remove internal material by drilling & filing
- assemble part 1 & 2 with a sliding fit.

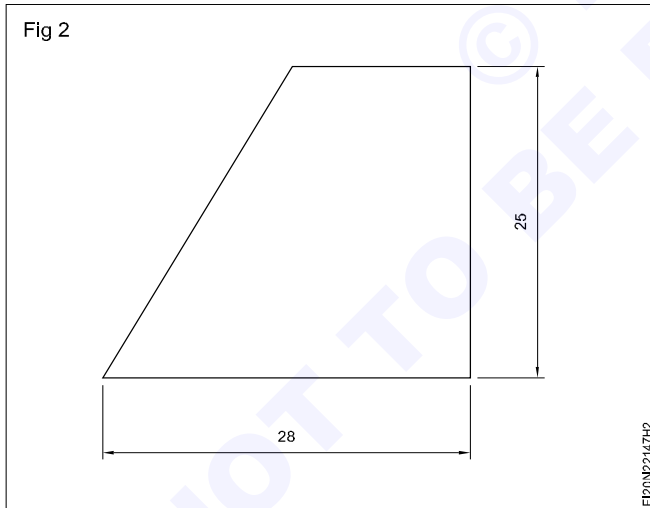
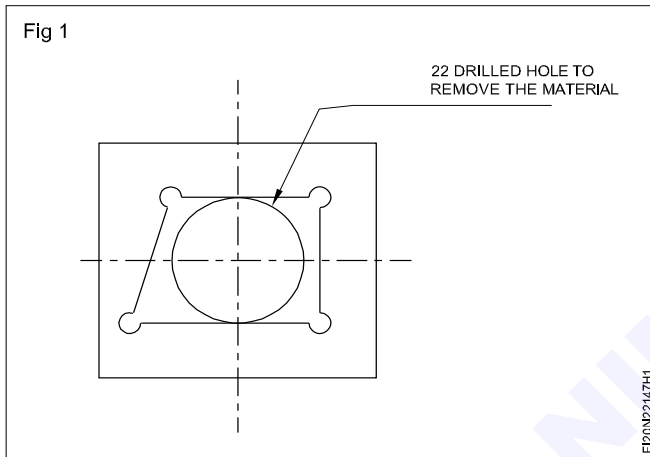


1	SQ 30 - 45	INSERT	Fe-310	-	2	2.2.147
1	65ISF12-70	BASE	Fe-310	-	1	2.2.147
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1					TOLERANCE : $\pm 0.02\text{ mm}$ TIME : 13hrs	
<p align="center">FILE AND FIT STRAIGHT AND ANGULAR SURFACES INTERNALLY</p>					CODE NO. FI20N22147E1	

Job Sequence

Part :1

- Check the raw material for its size.
- File to size and check for flatness and squareness
- Mark all dimensions and angle on work piece using vernier height gauge and vernier bevel protractor.
- Punch on the marked lines
- Drill relief holes of $\varnothing 3$ mm on all corners.
- Remove unwanted internal material by drilling and using square and triangular files.
- Angular edges to be finished with triangular file.
- Straight edges to be finished with safe edge file



Drawings

$$\tan 60^\circ = \frac{\text{opp}}{\text{adj}} = \frac{25}{x}$$

$$1.1732 = \frac{25}{x}$$

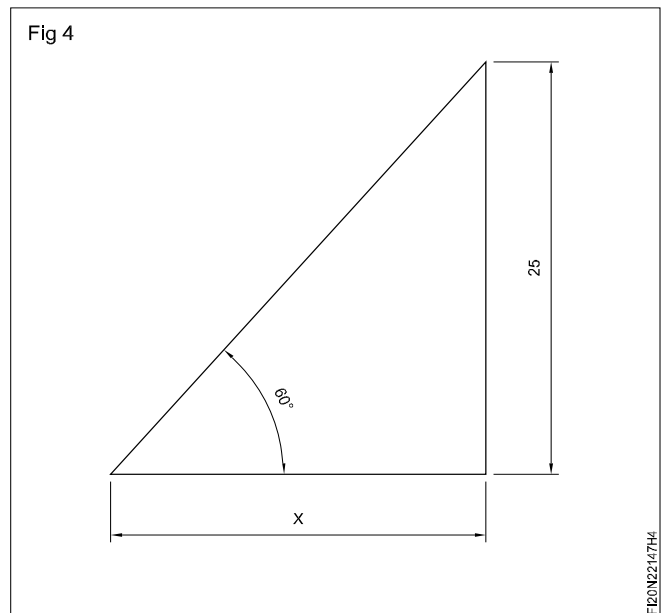
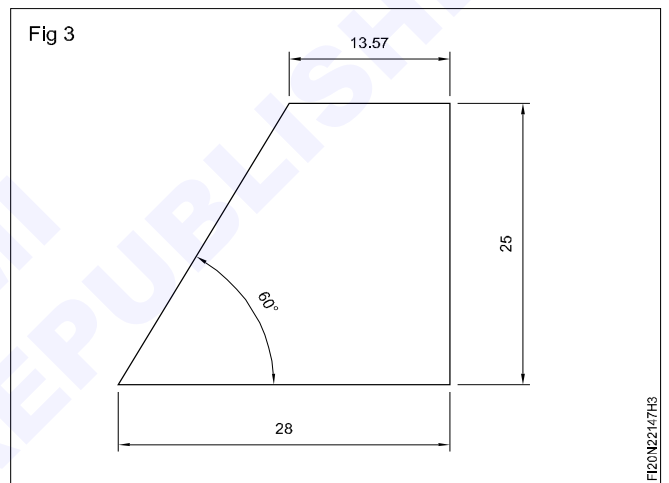
$$\therefore x = \frac{25}{1.1732} = 14.43\text{mm}$$

$$28 - 14.43 = 13.57\text{mm}$$

- Part 1 to be finished to suit with part 2.
- Part 1 and 2 for straight and angular surfaces fit in a sliding way.
- Apply thin coat of oil to prevent corrosion and preserve it for evaluation.

Part :2

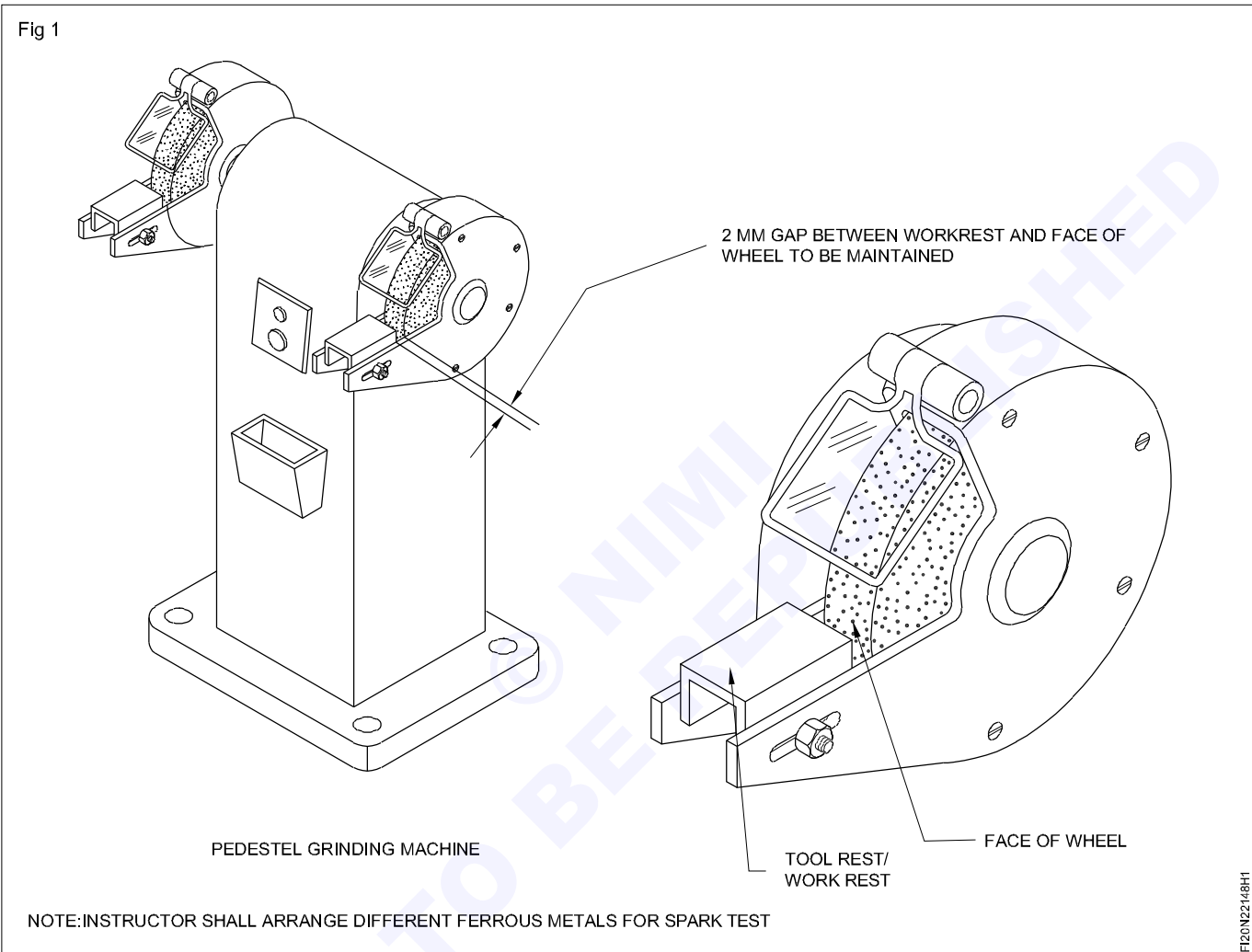
- Check the raw material for its size.
- File to size and check for flatness and squareness
- Mark all dimensions and angle on work piece using vernier height gauge and vernier bevel protractor.
- Punch on the marked lines
- File and finish the part as $28 \times 25 \times 40$ mm and angle to 60° .



Identify different ferrous metals by spark test

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

- support the metals on tool rest
- grind the metals on wheel face
- Identify different ferrous metals by spark test.



Job Sequence

- Prepare the grinding machine for grinding.
- Support the metals on tool rest/work rest.
- Apply light pressure on the face of wheel with metal.
- Grind the metals on wheel face.
- Identify the metal by spark length and colour.

Grind the metal only on the face of the grinding wheel.

- Grind the following different metals and identify the sparks as shown in Fig 1 & 2

Different metals

- Low carbon steel.
- Medium carbon steel.
- High carbon steel.
- High speed steel.
- Stainless steel

Skill Sequence

Spark test

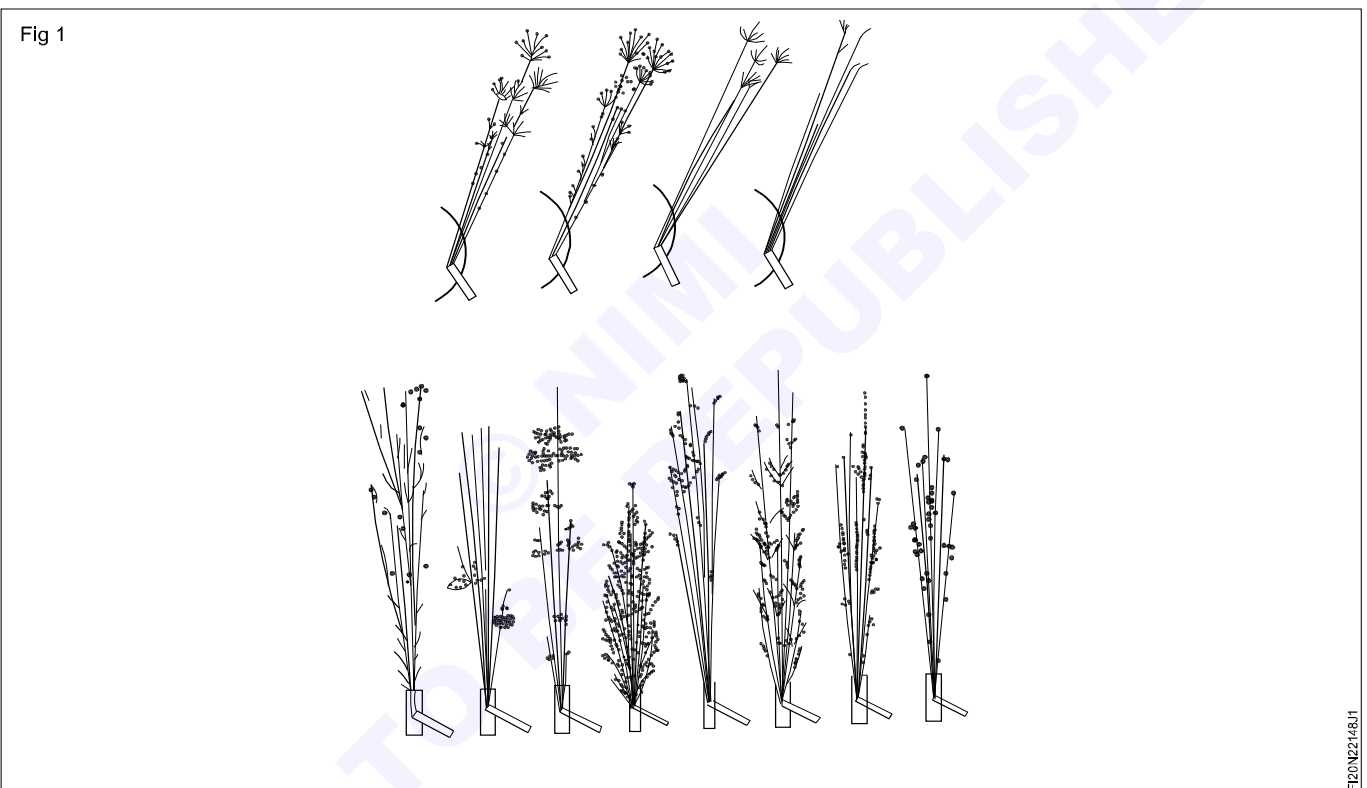
Objectives: This shall help you to

- identify the spark testing in different metals by grinding
- perform grinding process in grinding machines.

It is a method of determining the general classification of ferrous materials. It normally entails taking a piece of metal, usually scrap, and applying it to grinding wheel in order to observe the sparks emitted. These sparks can be compared to a chart or to sparks from a known test sample to determine the classification. Spark testing also can be used to sort ferrous materials, establishing the difference from one another by noting whether the spark is the same or different.

Spark testing is used because it is quick, easy and inexpensive. Moreover, test samples do not have to be prepared in any way, so, often, a piece of scrap is used. The main disadvantage to spark testing is its inability to identify a material positively; if positive identification is required, chemical analysis must be used. The spark comparison method also damages the material being tested, atleast slightly.

Spark testing most often is used in tool rooms, machine shops, heat treating shops, and foundries.



Process

A bench grinder is usually used to create the sparks, but sometimes this is not convenient, so a portable grinder is used. In either case, the grinding wheel must have adequate surface velocity, at least 23 m/s (4500 surface feet per minute (sfpm)), but should be between 38 and 58 m/s (7500 - 11500 sfpm). The wheel should be coarse and hard, therefore aluminium oxide or carborundum often are employed. The test area should be in an area where there is no bright light shining directly into the observer's eyes. Moreover, the grinding wheel and surrounding area

should be dark so that the sparks can be observed clearly. The test sample is then touched lightly to the grinding wheel to produce the sparks.

The important spark characteristics are colour, volume, nature of the spark, and length. Note that the length is dependent on the amount of pressure applied to the grinding wheel, so this can be a poor comparison tool if the pressure is not exactly the same for the samples. Also, the grinding wheel must be dressed frequently to remove metallic build-up.

Fig 2

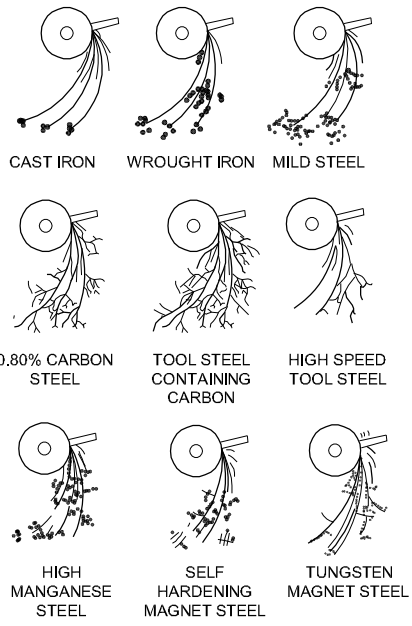


FIG202148J2



Flaring of pipes and pipe joints

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

- cut a G.I pipe using a pipe cutter
- remove burrs using a pipe reamer
- flare the end pipe
- joint flare nut with flare fitting and test it.

Requirements

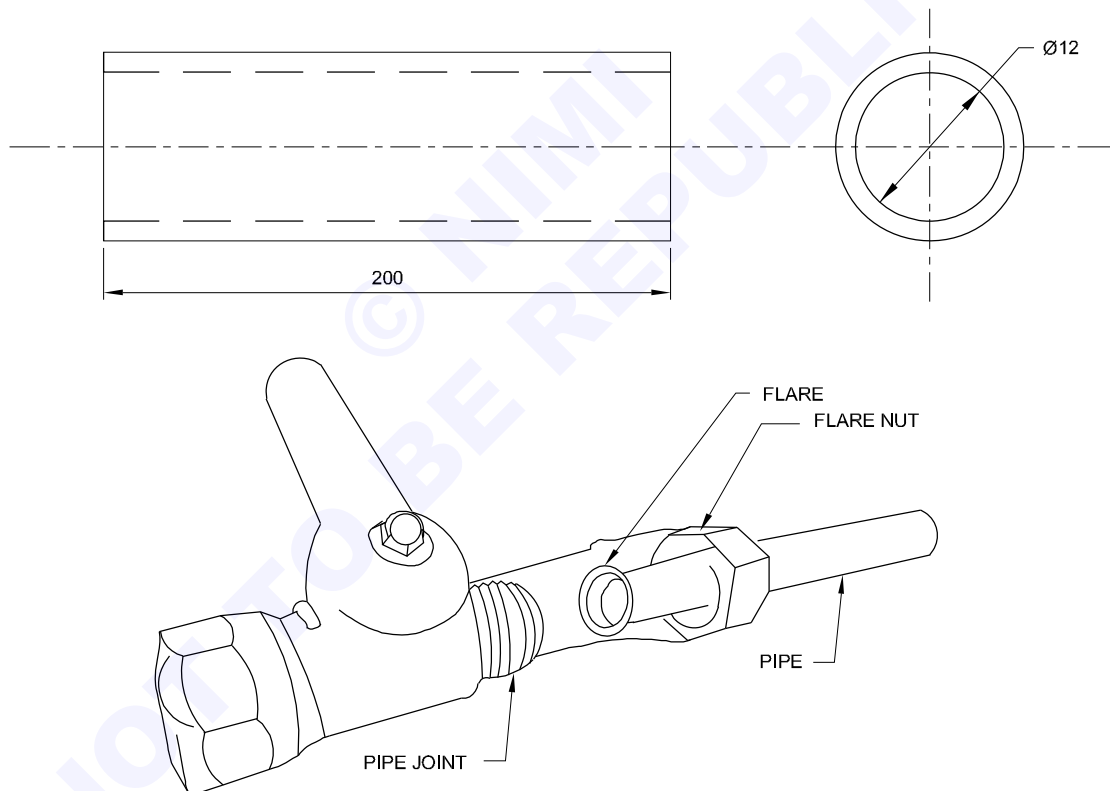
Tools/Equipments

- Flaring block with yoke
- Adjustable wrench - 200 mm
- Valve key 6 mm (cylinder valve opener)
- Pressure gauge with adapter
- Flat file smooth - 200 mm
- Cylinder with pressure

Materials

- G.I pipe
- Flare nut to suit the pipe
- Thread seal tape
- Soap solution with strirrer
- A small quantity of oil

Fig 1



Job sequence

- Check the material size and its conditions.
- File and check that end of the pipe must be exactly perpendicular to the pipe axis.
- Slightly deburr inside and outside edge of the pipe.
- Clean the pipe throughout before installing a flaring block.

- Insert and fix the pipe in to flaring block selected hole.

Examine the pipe flaring tool before starting to flare the end of a pipe.

- Tight the nuts at each end of the flaring block properly.
- Position the pipe end to at least 3.3 mm above the top of the flaring block.

This distance is calculated as pipe diameter divided by 3, in this case 12 mm, divided by 3 = 4.0mm

- Place the yoke (flaring tool) to the flaring block.

Insert the flaring nut before flaring.

- Oil the cone and slowly screw it into the end of the pipe.
- The end of the pipe will be formed into a flare.

Do not over tighten the screws.

- Unscrew and remove the flared pipe from the block.
- Check the flare end for cracks.

Because the cone was screwed down too quickly flare is cracked.

- Make sure that the flare is in correct size. If any crack or too loose while fitting flare nut, cut off the flare and start again as per above instruction, until the flare is in correct size for the flare nut.

Skill sequence

Make flare joints and test them with flare fittings

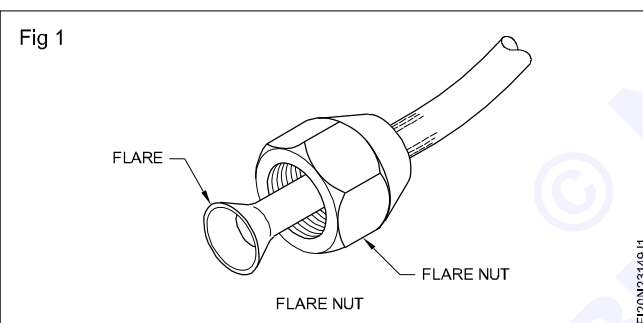
Objectives: This shall help you to

- flare the end pipe
- join the flare nut with flare fitting and test it.

Flaring

Brake line pipes / fuel pipe lines / air conditioner pipe lines are sometimes jointed to fittings by making a flared connection.

The end of the pipe is opened out to form a cone (Fig 1).

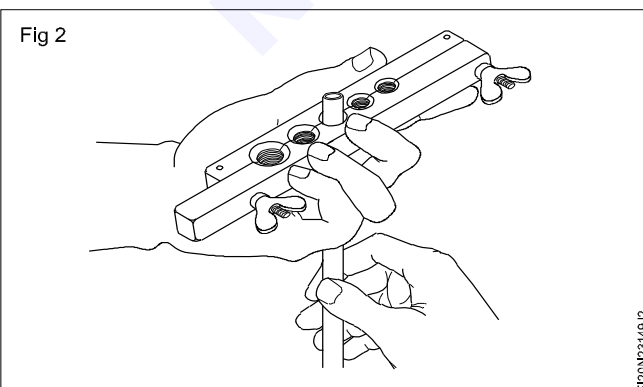


Always place the special flare nut on the pipe first before flaring.

Examine the pipe flaring tool. Make sure that you understand how it works before starting to flare the end of a pipe.

Make sure that the end of the pipe is free of rough edges before flaring.

Place the pipe in the tool (Fig 2). Make sure that you have:



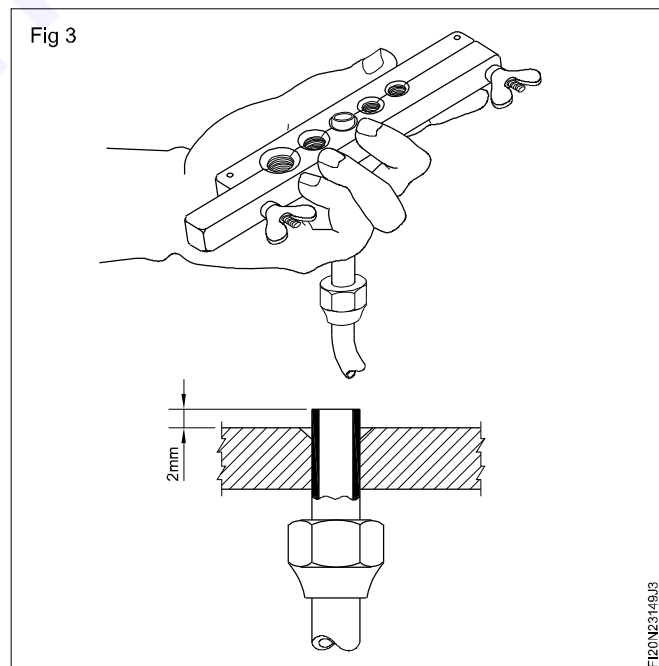
- Place the flare nut on the pipe

- Chose the correct size hole in the flaring tool to fit the pipe; (there are 5 holes to fit different sizes of pipe.)

If the pipe is ¼ inch (6 mm) in diameter, position the pipe so that the end is at least 2 mm above the top of the flaring block (Fig 3). (This distance is calculated as "pipe diameter divided by 3; in this case, 6 mm divided by 3 = 2 mm).

Tighten the nuts at each end of the flaring block (see drawing).

Fit the yoke to the flaring block (Fig 3)



Oil the cone and slowly screw it into the end of the pipe.

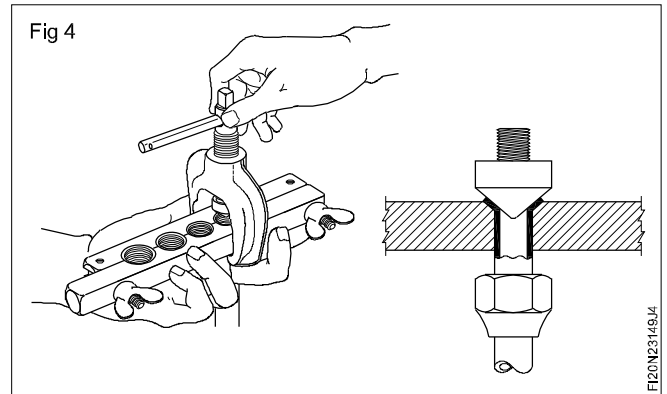
The end of the pipe will be formed into a flare (Fig 4).

Unscrew & remove the flaring block. Remove the flared pipe from the block.

Examine the flare. If it has cracked, the cone was screwed down too quickly.

Make sure that the flare is in correct size. It should just fit inside the flare nut. If it is too loose, cut off the flare and start again as per instruction until the flare is correct size for the flare nut.

As per instruction, use 3 mm instead of 2 mm. Repeat until the flare is in correct size for the flare nut-not too loose and not too tight.



Observation Table - 1

Sl. No.	Skills	Remarks
1	Checking Flaring	Cracked/uneven/too small/too long/correct
2	Number of attempts	One/two/three
Note: Repeat the steps to the various sizes of G.I. pipe		

Joining with flare fittings

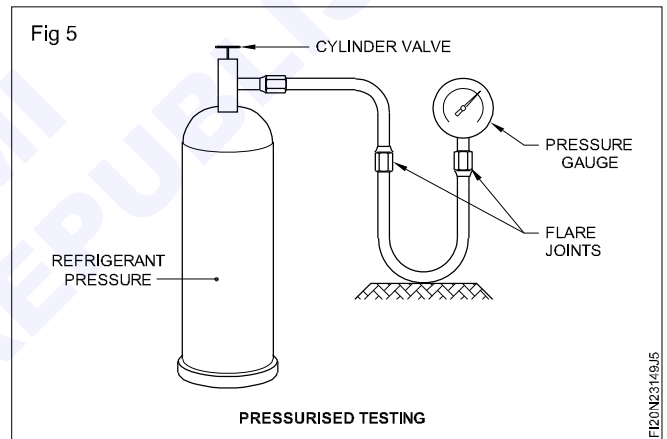
Put thread seal tape on the thread

Push back the flare nut and place the flared pipe on the fitting, then tighten the flare nut using adjustable wrench or suitable double end spanner.

Tighten the one end of the pipe to the cylinder with the flare nut. (Fig 5)

Connect a pressure gauge at the other end of the tube with flare nut.

**Do not give more pressure while tightening since this will spoil flare.
Make sure that they should not be loose in the pipe.**



Observation Table - 2

Sl. No.	Skills	Remarks
1	Selection of correct fittings	Correct/not correct
2	Joining method	Excellent/good/fair
3	Time taken	Less/very less/more

After joining the pipe firmly, open the cylinder valve with the help of valve key or ratchet.

The pressure will be shown in the pressure gauge.

Then close the cylinder valve. Major leaks will make noise and that needs the nut to be tightened.

If there is no leak, the pressure in the pressure gauge will remain constant.

If it decreases, check the joints with soap solution foam. Leak will bubble, then tight the joints. If it stands still then there is no leak.

Observation Table - 3

Sl. No.	Skills	Remarks
1	Selection of tools	Excellent/good/average
2	Detecting leak and arresting	Excellent/good/average

Skill Sequence

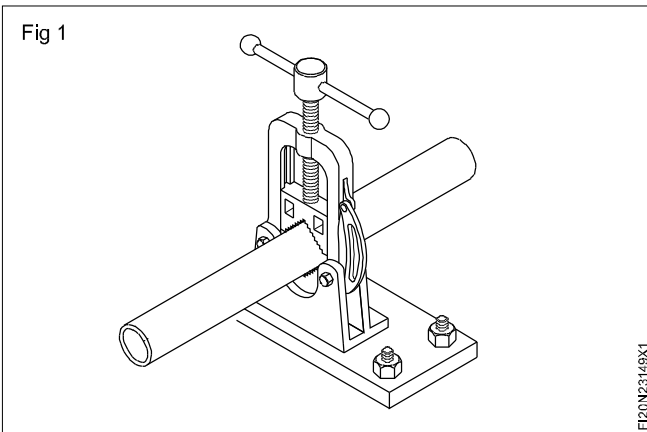
Handling of pipe flaring & cutting tools

Objective: This shall help you to

- cut a G.I. pipe using a pipe cutter.

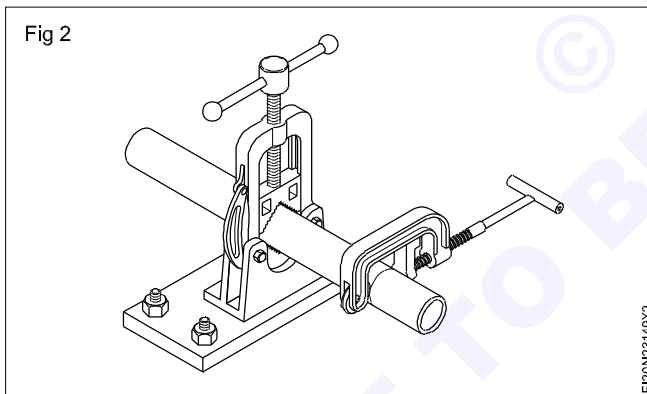
Measure the required length of pipe and mark it with chalk.

Keep the pipe in the pipe vice and tighten it. (Fig 1)

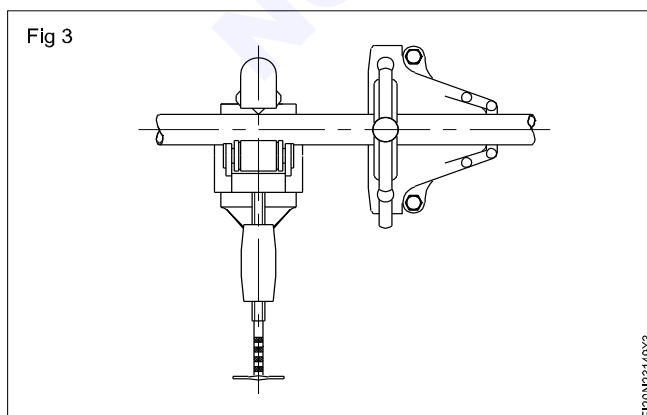


Fit the pipe cutter on the G.I. pipe (on the scribed line) and tighten the jacking screw so that the cutting wheel is touching the pipe. (Fig 2)

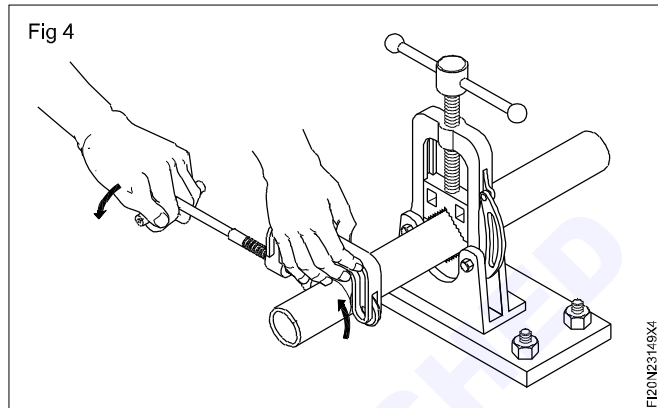
Ensure that the pipe is kept horizontal and parallel to the serrations such that the marking is visible at the top.



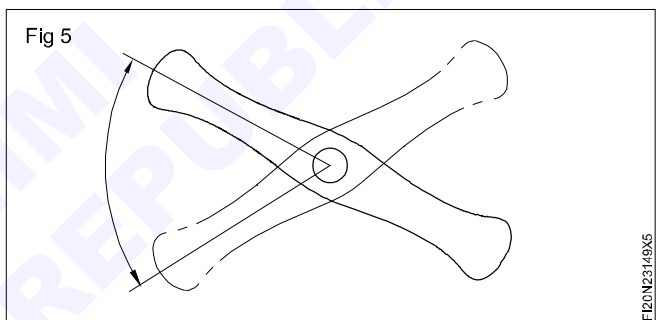
Rotate one or two turns to ensure that the cutting wheel is sitting exactly on the scribed line at 90° to the pipe (Fig 3).



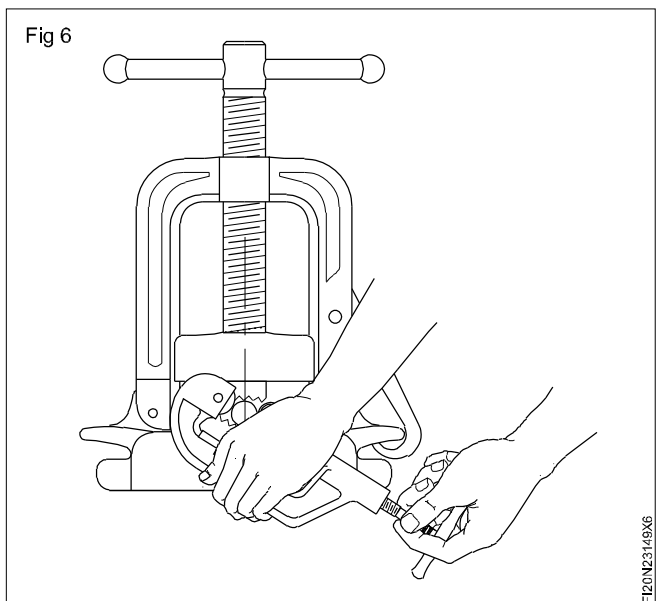
Rotate the pipe cutter around the pipe (Fig 4).



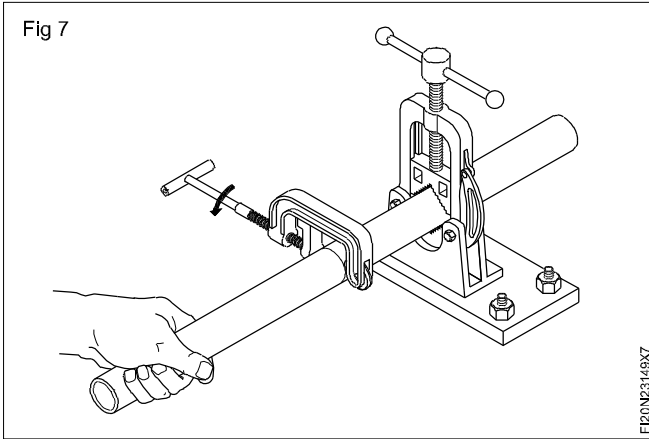
After two or three turns use the jacking screw to apply pressure on the cutting wheel (Fig 5).



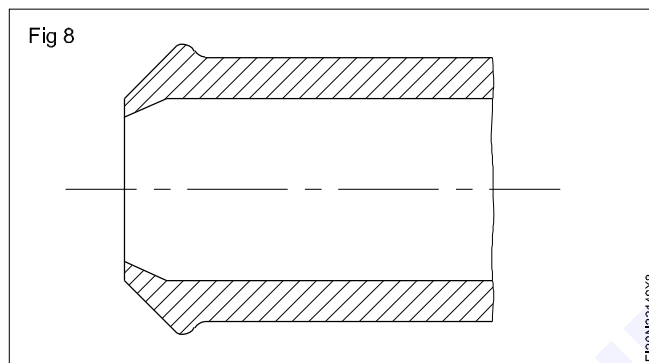
Keep rotating the pipe cutter around the pipe. Increase the pressure to the cutter by repeating the cycle until the pipe is cut through (Fig 6).



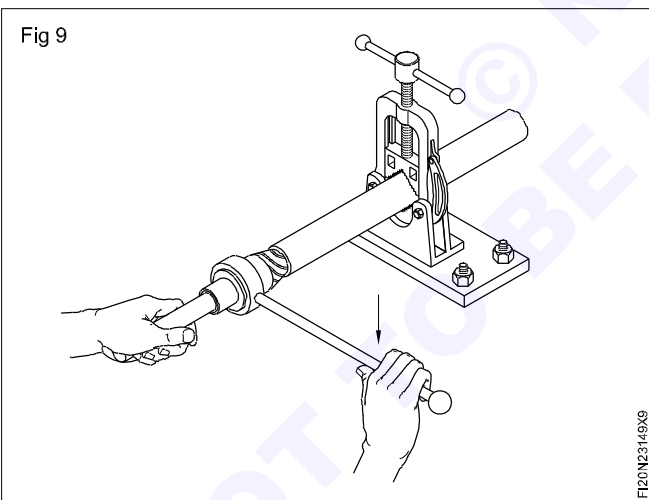
Support the pipe with your left hand so that the free end of the pipe does not fall. (Fig 7)



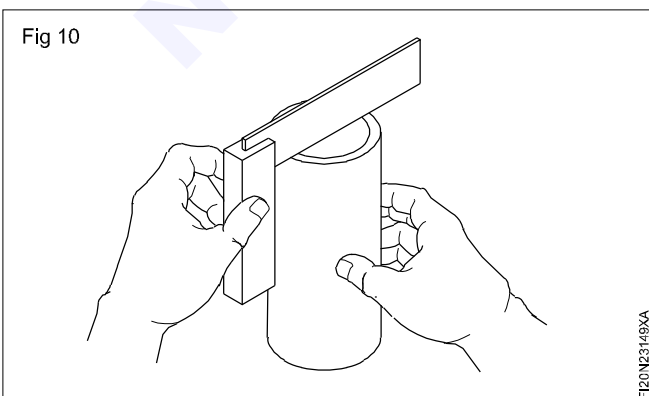
The cut portion of the pipe will appear as shown in Fig 8.



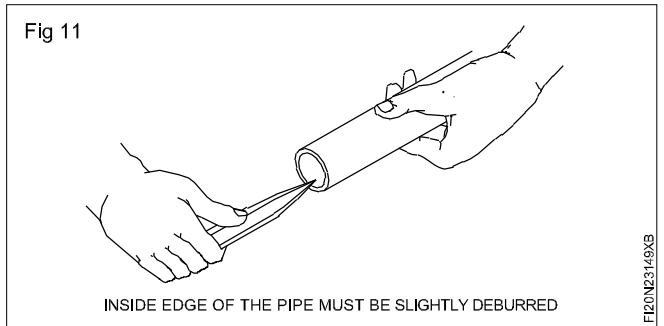
Remove burrs using a pipe reamer. (Fig 9)



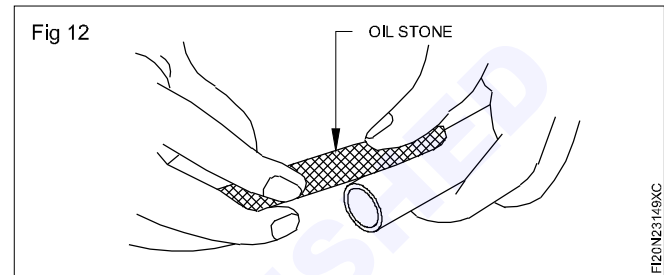
Check that the pipe ends are square. (Fig 10)



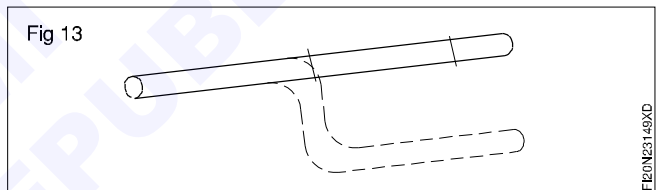
Inside edge of the pipe must be slightly deburred (Fig 11).



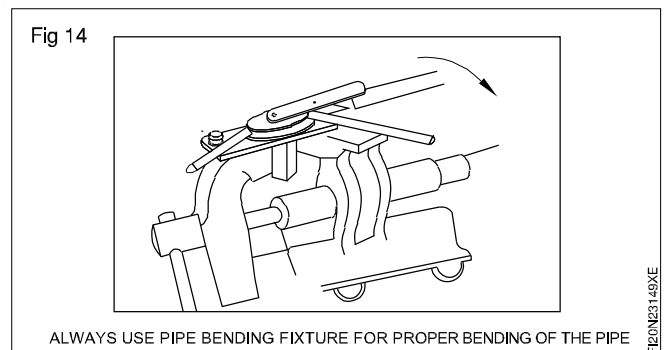
Outside edge of the pipe must be slightly deburred (Fig 12).



With this edge as reference the pipe is marked for bending (Fig 13).



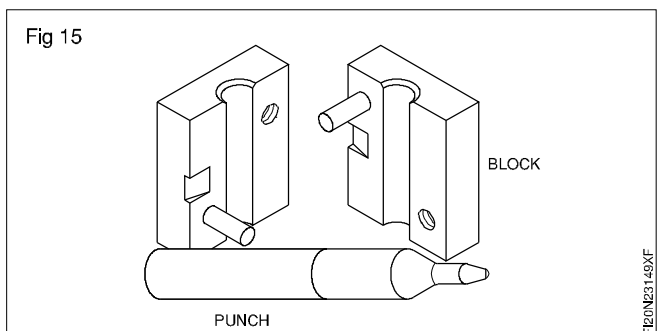
Always use pipe bending fixture for proper bending of the pipe (Fig 14).



Clean the pipe thoroughly before installing in the machine.

Prepare the pipe end for a flare fitting

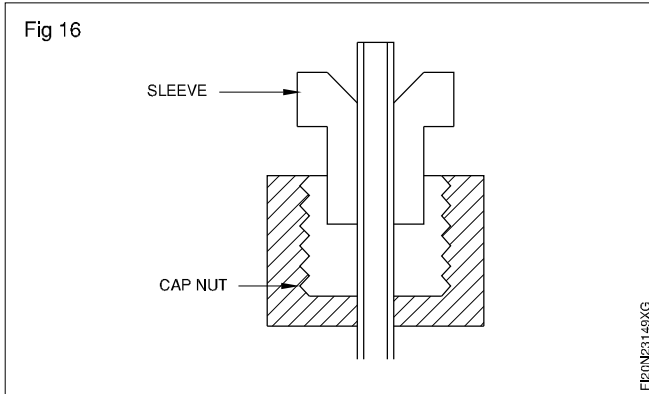
Flaring with block and punch tool (Fig 15).



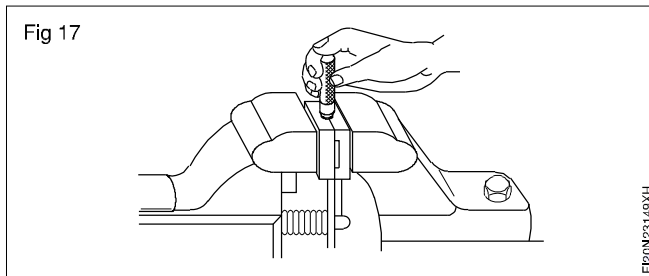
Pipe which is cleaned off burrs and bent should be selected

The pipe end is held in the flaring unit. Select the appropriate size of flaring unit to suit the pipe.

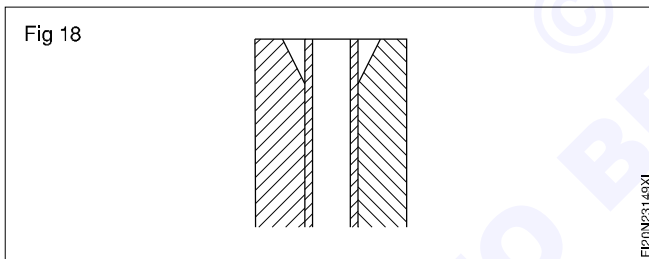
Sleeve and cap nut should be assembled before flaring (Fig 16).



The flaring unit is held in a benchvice with the pipe (Fig 17).

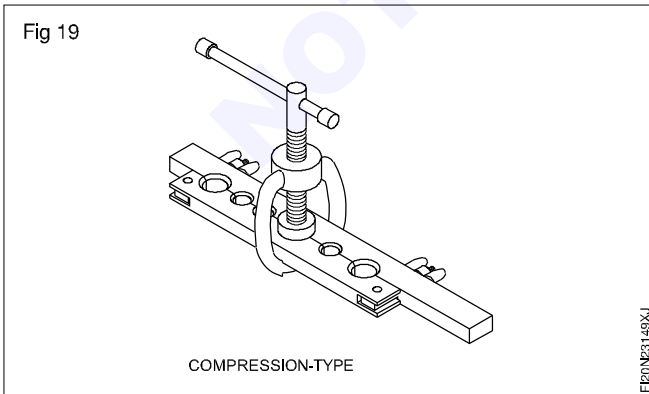


Correct length of pipe should be projecting for flaring pipe edges should be in line with surface (Fig 18).



Using the flaring punch, flare the pipe end.

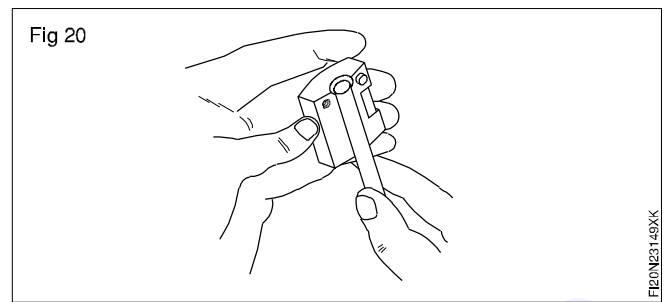
Flaring can also be done by using a compression type flaring tool (Fig 19).



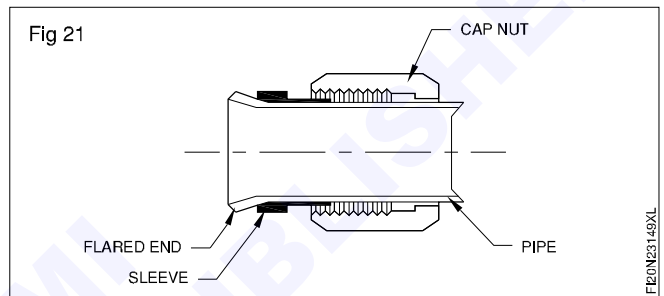
Installing a flare fitting

Flared tube is cleaned and the sleeve and cap nut are positioned on the flare.

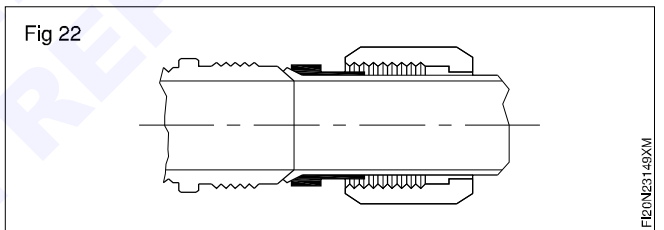
Check the flare angle is suitable to the sleeve angle (Fig 20).



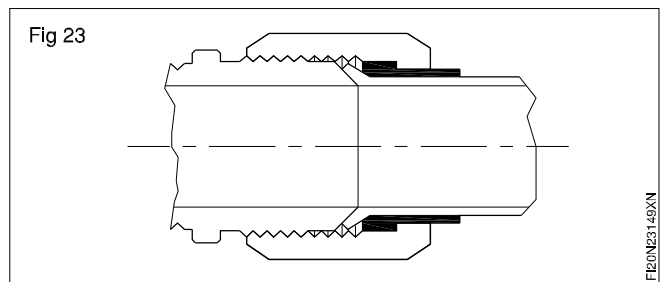
Place the flare on the connector end. Confirm the angle is same (Fig 21).



Screw the cap nut on the connector thread by hand (Fig 22).



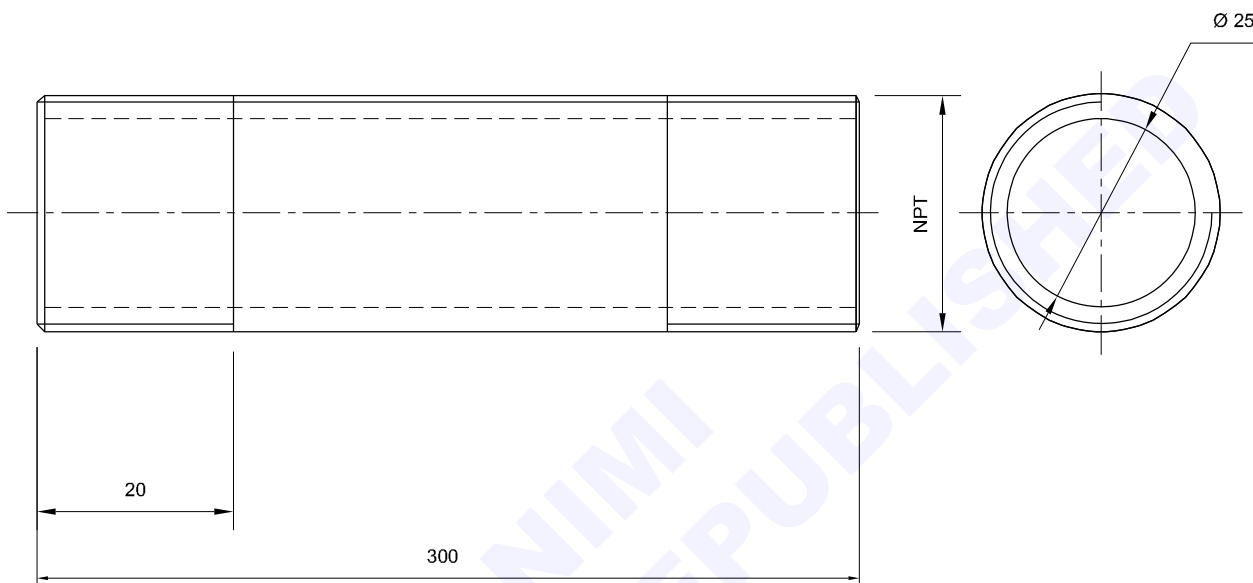
Use a suitable spanner and tighten the cap nut until the pipe does not rotate in the joint (Fig 23).



Cutting and threading on pipe

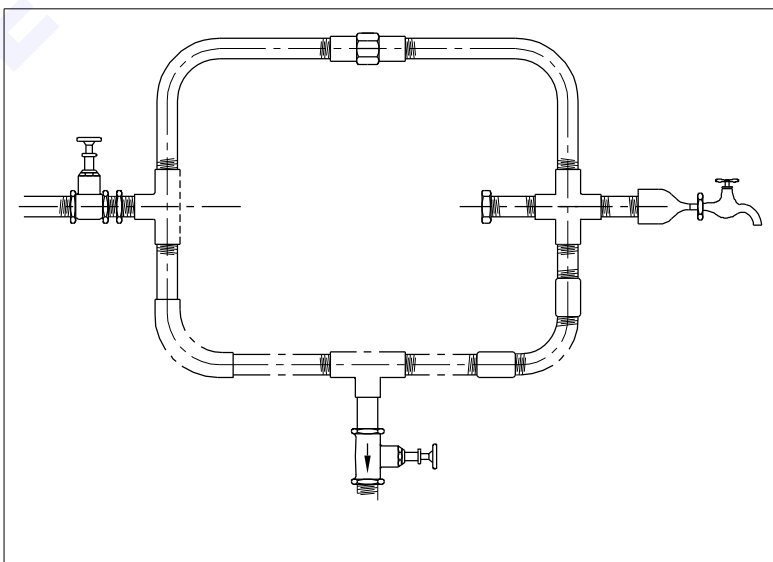
Objectives : At the end of this exercise you shall be able to

- mark and cut pipe to length using pipe cutter
- mark and cut pipe to length using hacksaw.



Job sequence

- Hold the G.I pipe in pipe vice tightly.
- Mark the required length as per drawing.
- Fix the pipe in pipe vice and tighten it to prevent it from rotating.
- Fix the pipe cutter on the G.I pipe.
- Cut G.I pipe for the required length using pipe cutter.
- Remove burrs using pipe reamer.
- Check that the pipe ends with try square for squareness.



1	Ø25 - 300L		G.I	-	-	2.3.150	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.	
SCALE : NTS		CUTTING & THREADING ON PIPE				DEVIATIONS	TIME : 3 Hrs
						CODE NO. FI20N23150E1	

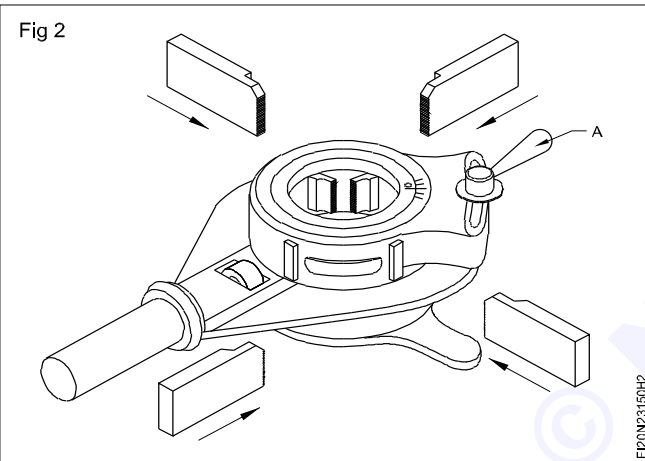
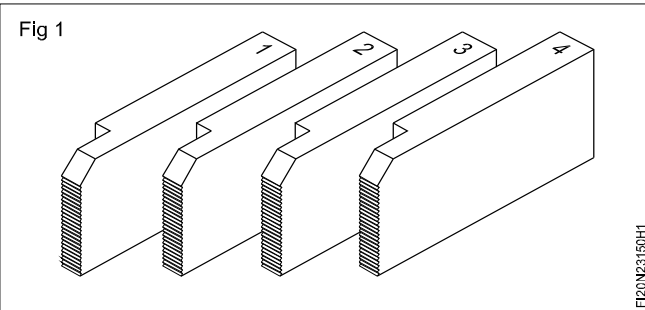
Skill sequence

Threading G.I.pipes using die stocks

Objective : This shall help you to

- cut threads on G.I.pipe using die stock.

Select a set of dies, and ratchet-type die stock. (Fig 1 & 2).



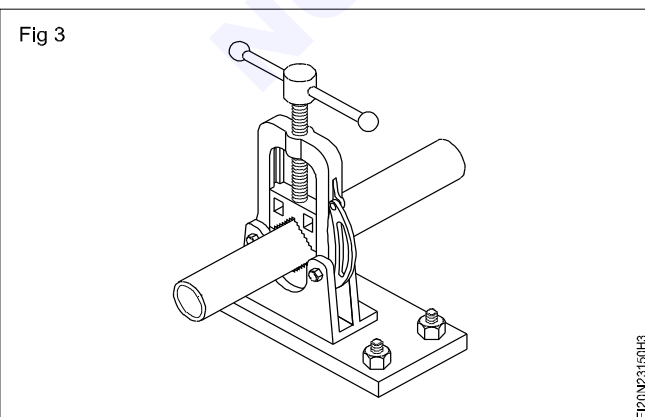
Open the adjustment lever. (A)

Coincide the zero setting mark '0' die stock and then insert the four dies according to the number on the dies and die stock respectively.

Ensure that the dies sit in the correct position.

Be sure that the number on the top edge of the die corresponds with the number of the slot into which it is to be placed.

Fix the pipe in a pipe vice and tighten to prevent it from rotating. (Fig 3)



Ensure that the projection of the pipe is within 150-250 mm from the vice.

Open the self-centering pipe guide and slide the stock over the end of the pipe.

Adjust the pipe guide for correct sliding, fit and lock into position (Fig 4)

Apply a cutting lubricant to the part which is to be threaded.

Use lard oil, or mineral-lard oil when threading G.I.pipes.

Apply a little pressure to the stock and keep the handle at right angle to the pipe axis.

When the dies bite into the pipe, stop pushing and continue the rotation by moving the handle up and down.

Apply the lubricant to the pipe after the first thread has been cut.

Keep rotating the handles clockwise and check the length of the pipe thread.

Ensure that the length of the thread is sufficient to fit half way into the socket or coupling.

If the die stock and the die stick, turn the stock anticlockwise to break the chips.

Reverse the ratchet knob, ease the handle and turn the stock anticlockwise till the stock and dies come out of the pipe.

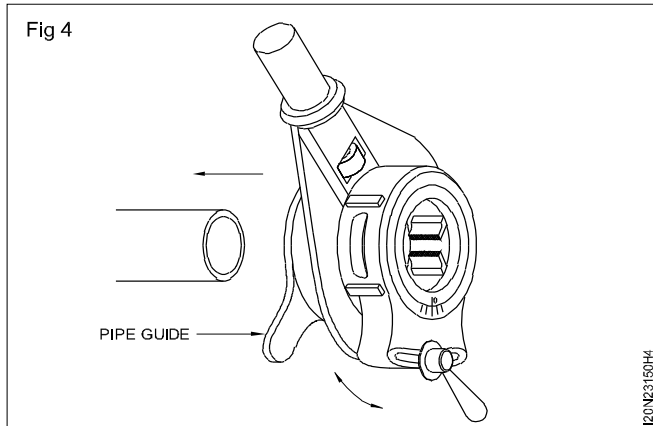
Clean the thread with a wire brush.

Form thread until the pipe extends about one or two threads beyond the end of the stock.

Remove the stock and dies by operating the quick-release lever and clean off the thread with a wire brush.

Check the formation of thread with a standard fitting.

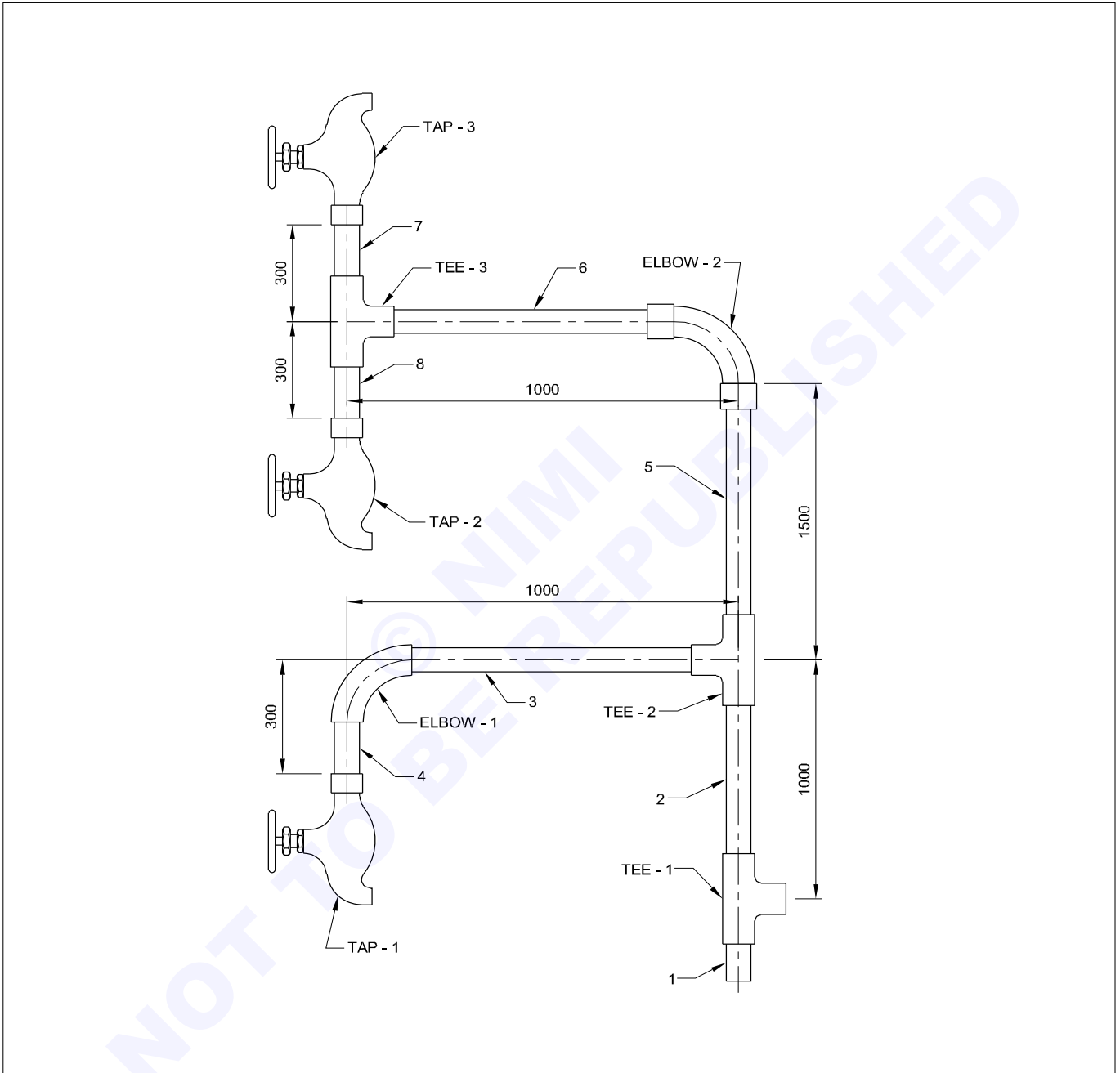
Repeat the operation if the thread is too tight, by adjusting the dies.



Fitting of pipes as per sketch observing conditions used for pipe work

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

- fix the GI Pipes with fittings as per drawing.



5	COUPLING(THD) - 1/2"		GI	-	5		
3	TEE - 1/2"		GI	-	TAP 1,2,3		
2	ELBOW - 1/2"		GI	-	BEND - 1 BEND - 2		
3	BIBCOCK - 1/2"		BRASS	-	TAP 1,2,3		
1	Ø 25 x 4.5 x 6000		GI	-	1 to 8	2.3.151	
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.	
SCALE: NTS		FITTING OF PIPES AS PER SKETCH OBSERVING CONDITIONS USED FOR PIPE WORK				DEVIATIONS	TIME : 10 Hrs
						CODE NO. FI20N23151E1	

Job sequence

- Calculate the length of pipe required based on drawing.
- Cut the pipes as per the calculated length using pipe cutter/ hacksaw.
- Cut thread at the end of all the pipes using die stock.
- Fit tee 1 to the pipe 1 using pipe wrench.
- Fit the pipe 2 to tee 1 using pipe wrench after adopting the procedure.
- Fit tee 2 to pipe 2 using pipe wrench after adopting the procedure.
- Fit pipe 3 to tee 2 using pipe wrench after adopting the procedure.
- Fit elbow to pipe 3 using pipe wrench after adopting the procedure.
- Fit pipe 4 to elbow using pipe wrench after adopting the procedure.
- Fit a socket to pipe 4 using pipe wrench after adopting the procedure.
- Fit bibcock to socket using pipe wrench after adopting the procedure.
- Fit pipe 5 to tee 2 using pipe wrench after adopting the procedure.
- Fit socket to pipe 5 using pipe wrench after adopting the procedure.
- Fit bend to socket using pipe wrench after adopting the procedure.
- Fit socket to bend using pipe wrench after adopting the procedure.
- Fit pipe 6 to socket using pipe wrench after adopting the procedure.
- Fit tee 3 to pipe 6 using pipe wrench after adopting the procedure.
- Fit pipe 7 and 8 to tee - 3 using pipe wrench after adopting the procedure.
- Fit socket to pipe 7 and 8 using pipe wrench after adopting the procedure.
- Fit bibcock to sockets using pipe wrench after adopting the procedure.
- Remove any excess hemp, string or sealing tape after completing the joints, using hacksaw blade or a blow lamp.
- Assemble pipe with standard fittings.

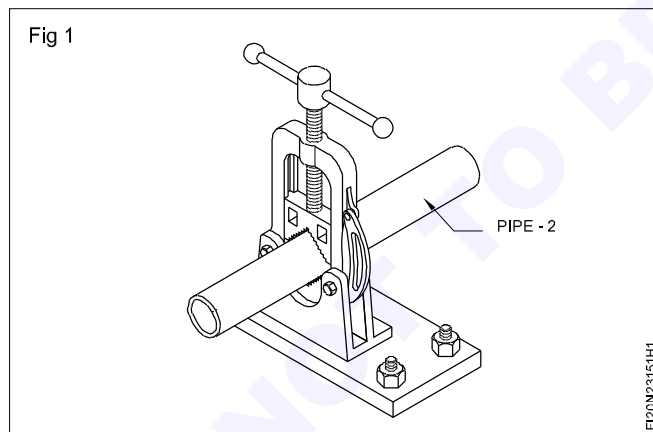
Skill Sequence

Pipe Fitting Assembly

Objective: This shall help you to

- assemble pipe and pipe fittings.

Hold the pipe No. 2 in a pipe vice (Fig 1).

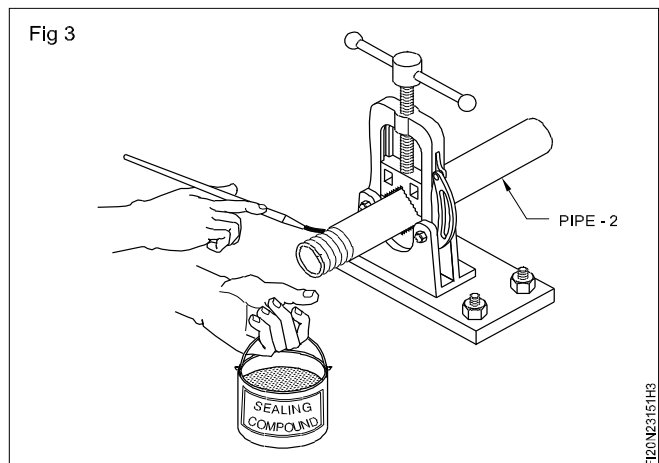
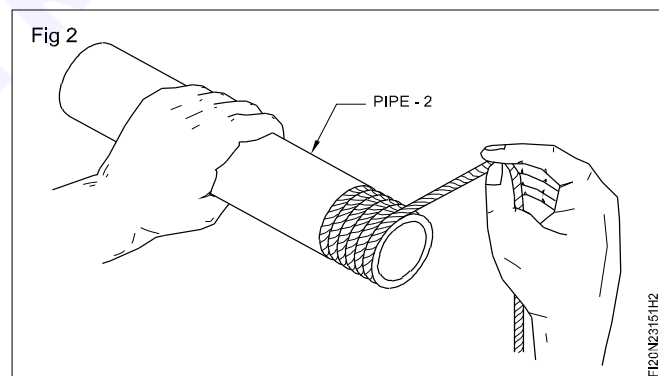


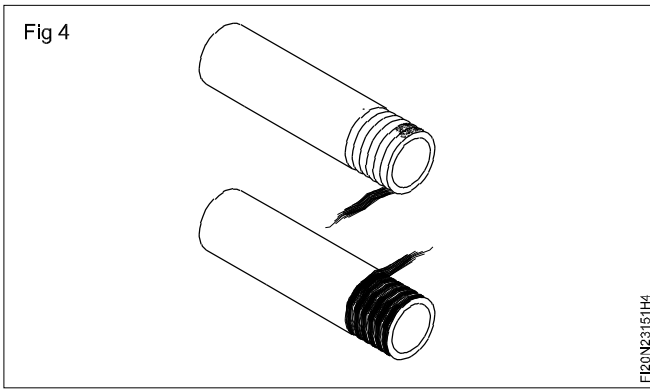
Wind the hemp packing/cotton thread material on the external threads of the pipe (Fig 2).

Apply sealing compound over the pipe threads (Fig 3).

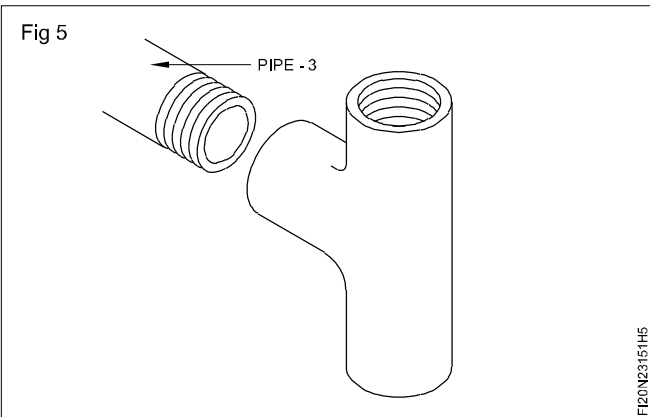
Fit Tee- 2 to pipe No. 2 and tighten it using a pipe wrench.

Wind the hemp packing to external threads of all the pipes and standard fittings and apply sealing compound over the threads before joining with the other one (Fig 4).



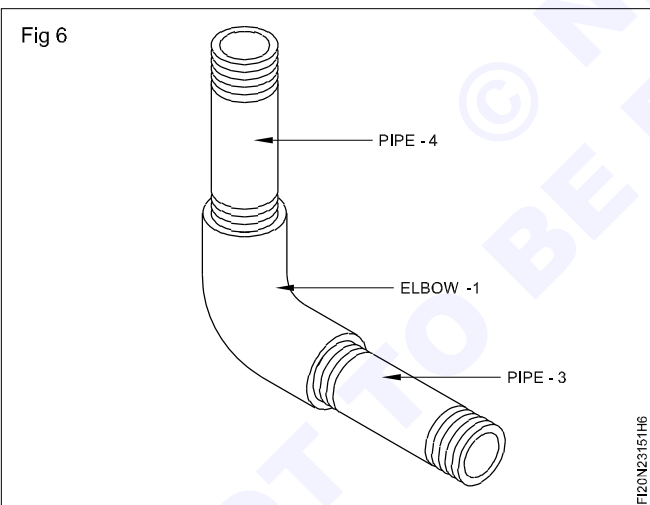


Fit pipe No. 3 with Tee-2 (Fig 5).

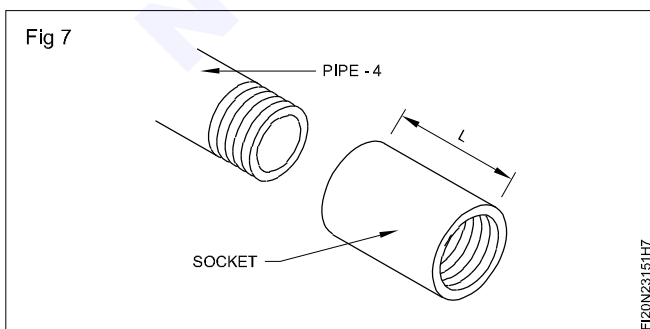


Fit Elbow - 1 to Pipe No -3 (Fig 6).

Fit Elbow - 1 to Pipe No -4 (Fig 6).

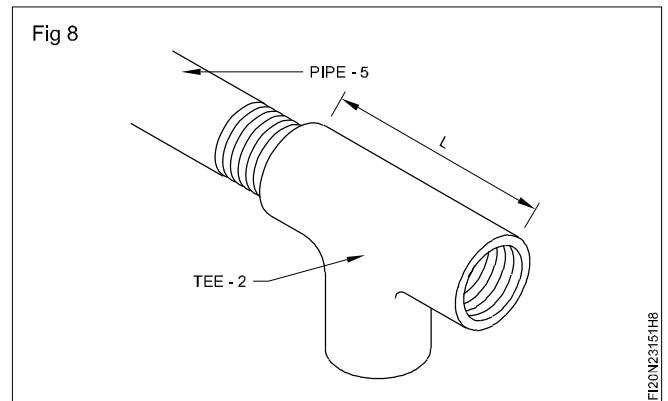


Fit a socket to Pipe No - 4 (Fig 7).

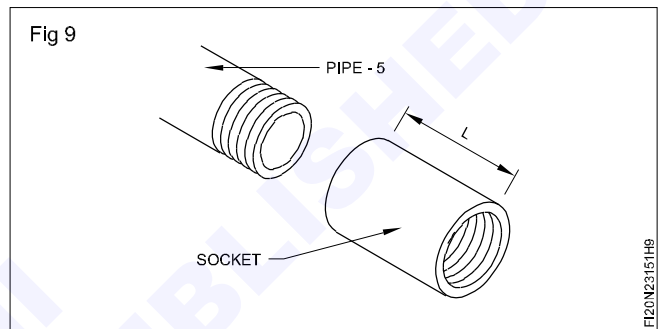


Fit bib cock to socket.

Fit Pipe No - 5 to Tee - 2 (Fig 8).



Fit Pipe No - 5 to socket (Fig 9).



Fit socket to Elbow - 2 on both ends (Fig 10).

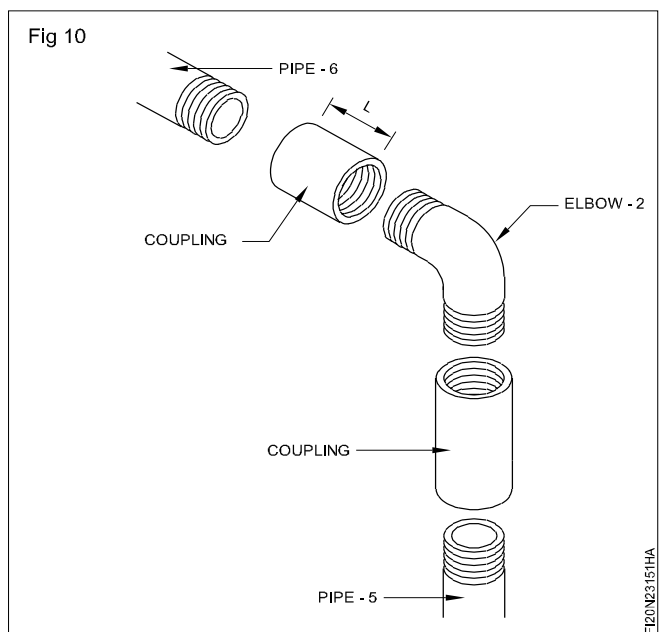
Fit socket to Pipe No - 6 (Fig 10)

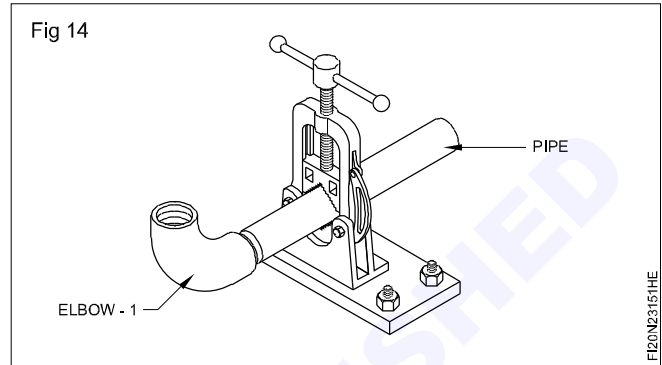
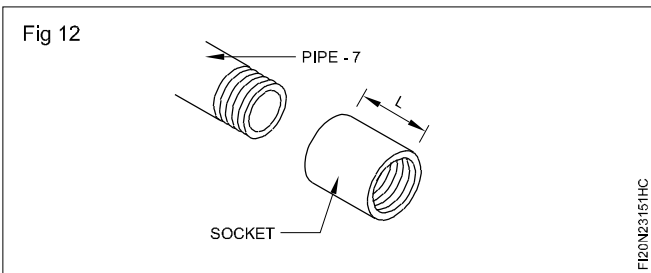
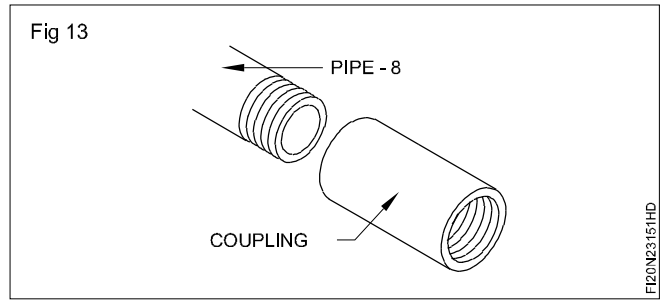
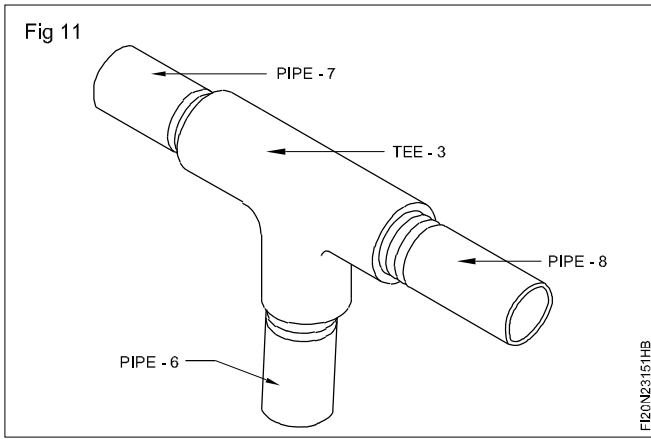
Fit Tee - 3 to Pipe No - 6 , 7, 8 (Fig 11).

Fit socket to Pipe No - 7 (Fig 12).

Fit socket to Pipe No - 8 (Fig 13)

Assembling Elbow with pipe (Fig 14).



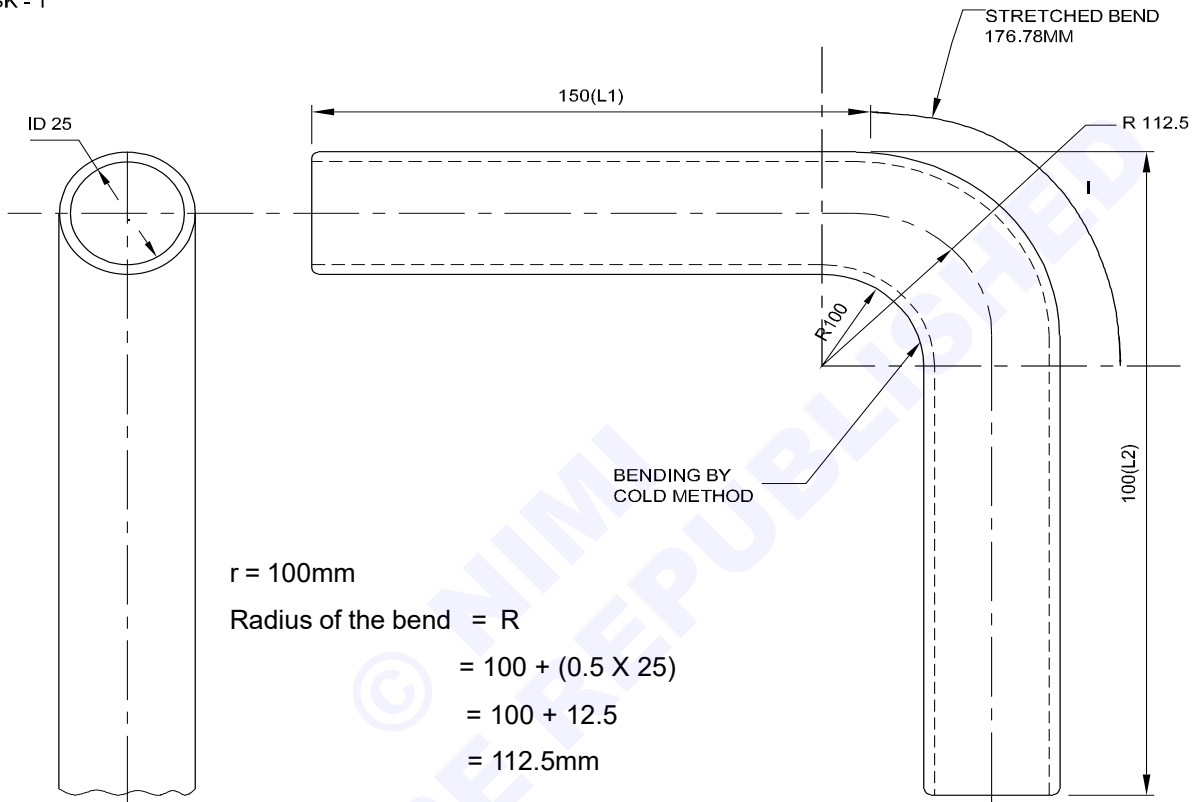


Bending of pipes - cold and hot

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

- bend G.I. pipe by cold method as per template on a pipe bending machine.

TASK - 1



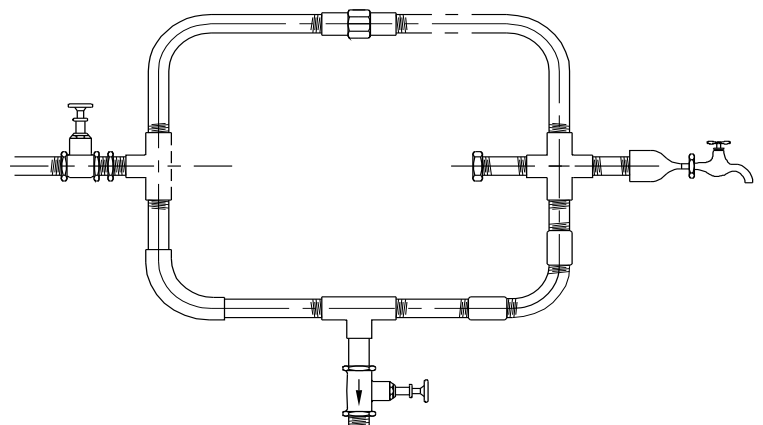
$r = 100\text{mm}$

$$\begin{aligned} \text{Radius of the bend} &= R \\ &= 100 + (0.5 \times 25) \\ &= 100 + 12.5 \\ &= 112.5\text{mm} \end{aligned}$$

Stretch of the bend = I

$$\begin{aligned} &= \frac{90}{360} \times 2 \times \frac{22}{7} \times 112.5 \\ &= \frac{11 \times 112.5}{7} \\ &= 176.78\text{mm} \end{aligned}$$

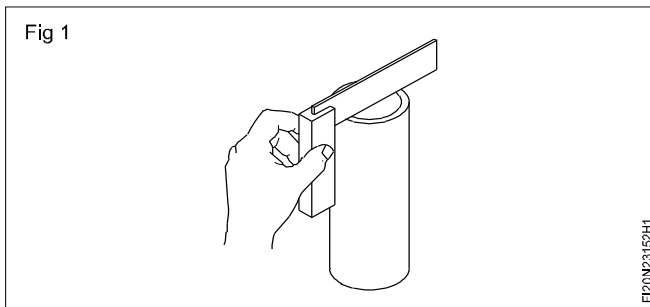
$$\begin{aligned} \therefore L &= (\text{length of pipe}) = L1 + L2 + I \\ &= 150 + 100 + 176.78 \\ &= 426.78 \text{ mm} \end{aligned}$$



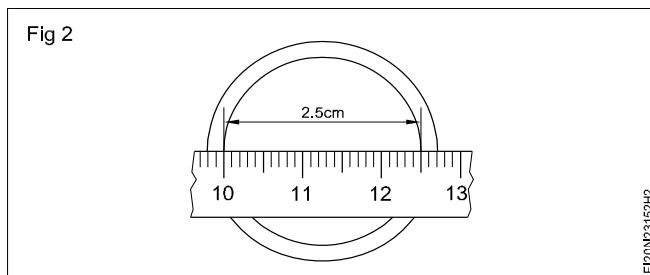
1	Ø 25 - 430 L		G.I	-	-	2.3.152
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE: NTS	BENDING OF PIPES - COLD AND HOT (PIPE BENDING BY COLD METHOD)				DEVIATIONS	TIME : 6 Hrs
					CODE NO. F120N23152E1	

Job sequence

File the pipe ends and check up its squareness. (Fig 1)



Check the inside dia. of the pipe by using steel rule. (Fig 2)



Please change the reading from inside diameter from 10cm. Measure the length of the pipe as per drawing

r = radius of bend (i.e) 150mm

θ = angle of bend

l = length of curved portion

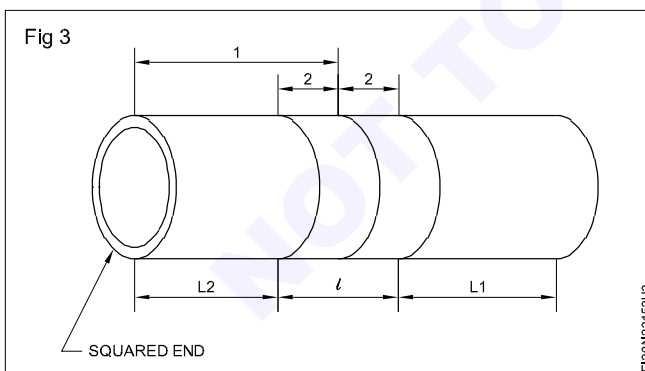
then

$$l = \frac{\pi \times D \times \theta}{360}$$

L = Total length

$$= L_1 + l + L_2$$

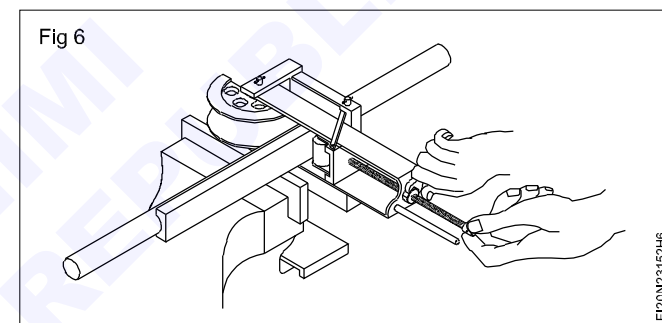
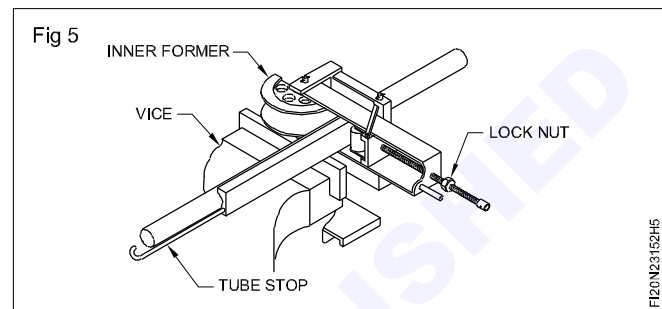
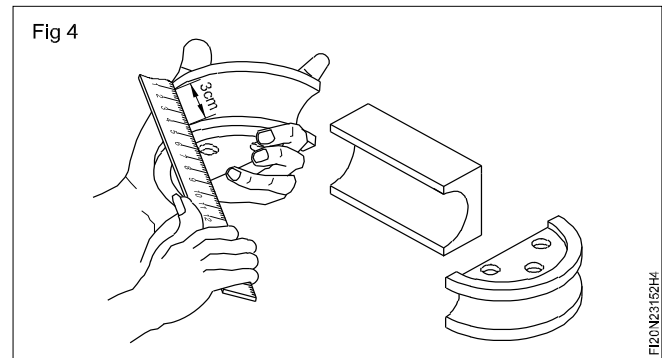
Mark off the beginning and the end of the bend from the centre line. (Fig 3)



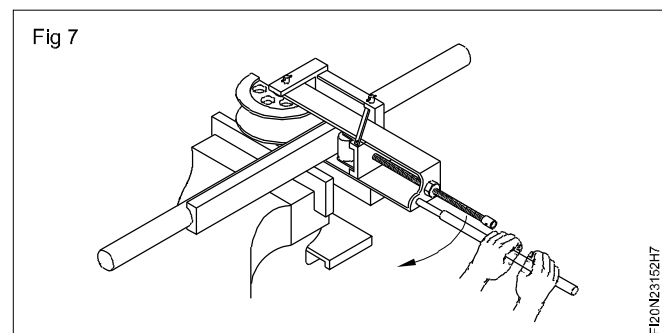
Select the standard former to suit the size of the pipe. (Fig 4)

Fix the bending machine in a benchvice and ensure it is tightened properly. Locate the tube stop bar at the required position. (Fig 5)

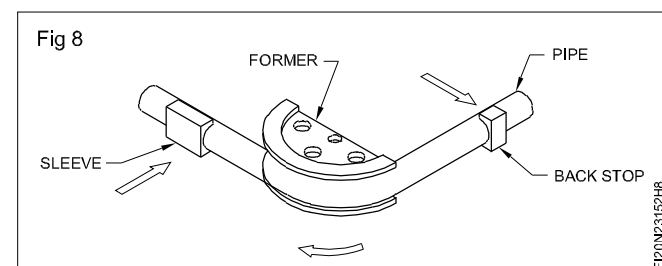
Set the roller on the bending arm by adjusting the screw and lock nut. (Fig 6)



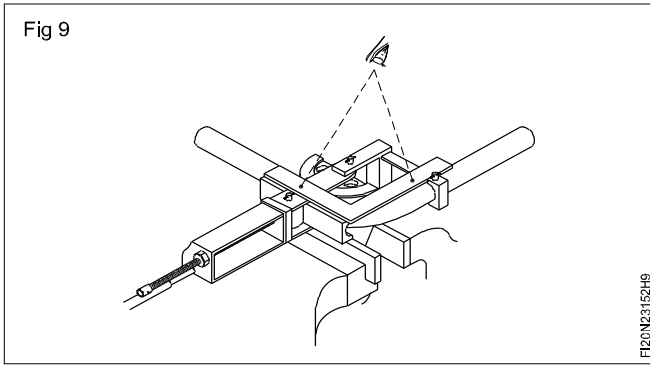
Bend the pipe by pulling the bending arm towards your body. (Fig 7)



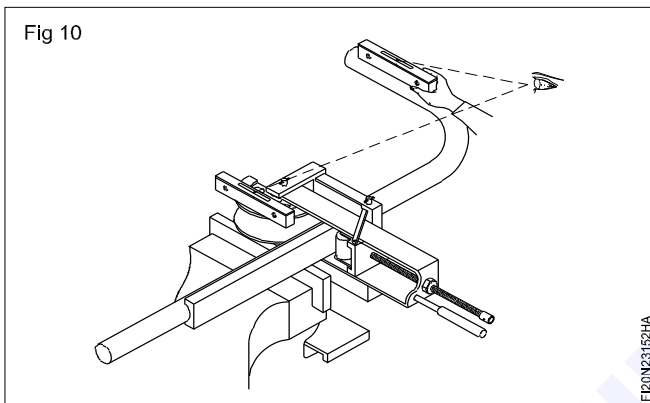
The sleeve bends the pipe round the former as the bending arm is pulled. The back stop holds the tails end of the pipe in position. (Fig 8)



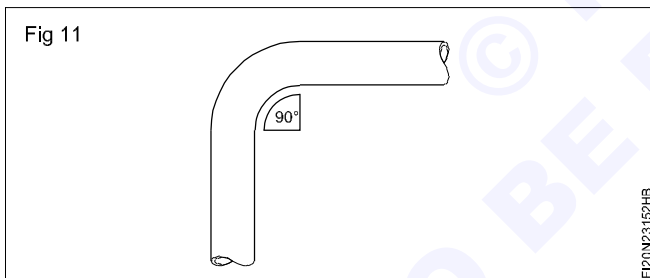
Check the bend for squareness use a set square as shown. (Fig 9)



Check level of former and first leg (90° bend) with spirit level by placing spirit levels as shown in Fig 10.

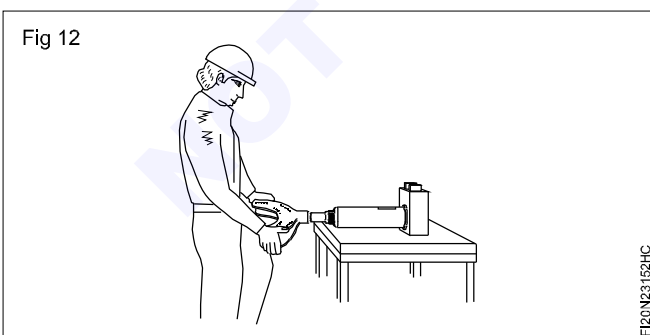


Check the angle of bend and radius using standard template. (Fig 11)



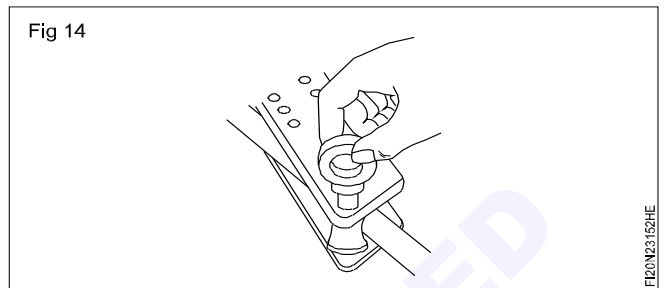
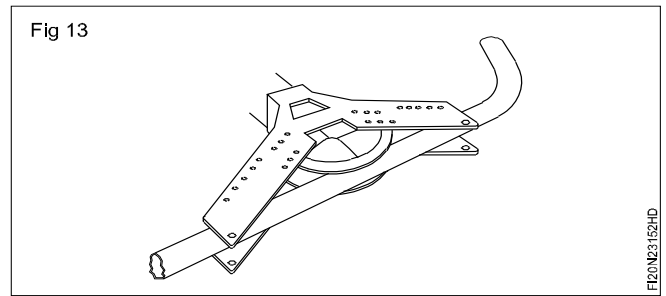
Bending 120° by Hydraulic bending machine

Fit the pipe former on to the cylinder arm. (Fig 12)

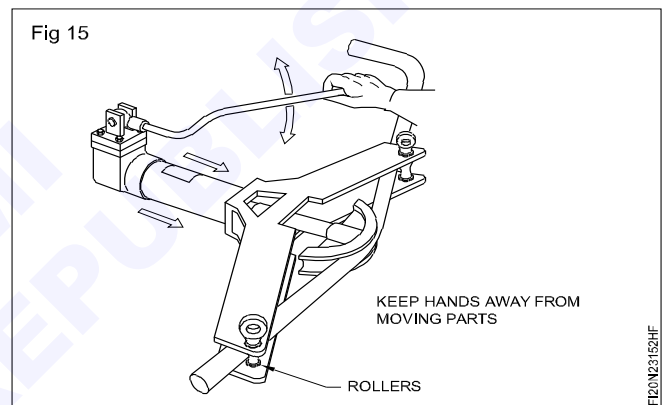


Place the pipe between the forming head plates and against the former. (Fig 13)

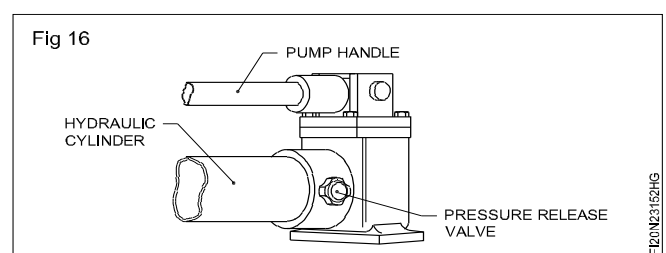
Support the pipe and fit dollies (or rollers) between the upper and lower plates of the forming head. Locate them in position by inserting pins through the plates and the dollies. (Fig 14)



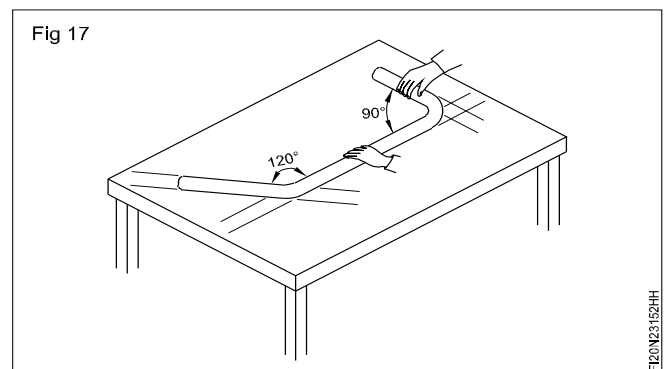
Close the pressure release valve on the pump body then start pumping to push the former against the pipe. (Fig 15)



Turn the pressure release valve anti-clockwise to release the pressure in the hydraulic cylinder. When the arm has moved back about 6 mm to 10 mm close the pressure release valve to hold the ram steady. (Fig 16)



Check both bends 90° and 120° by placing pipe on the layout. (Fig 17)

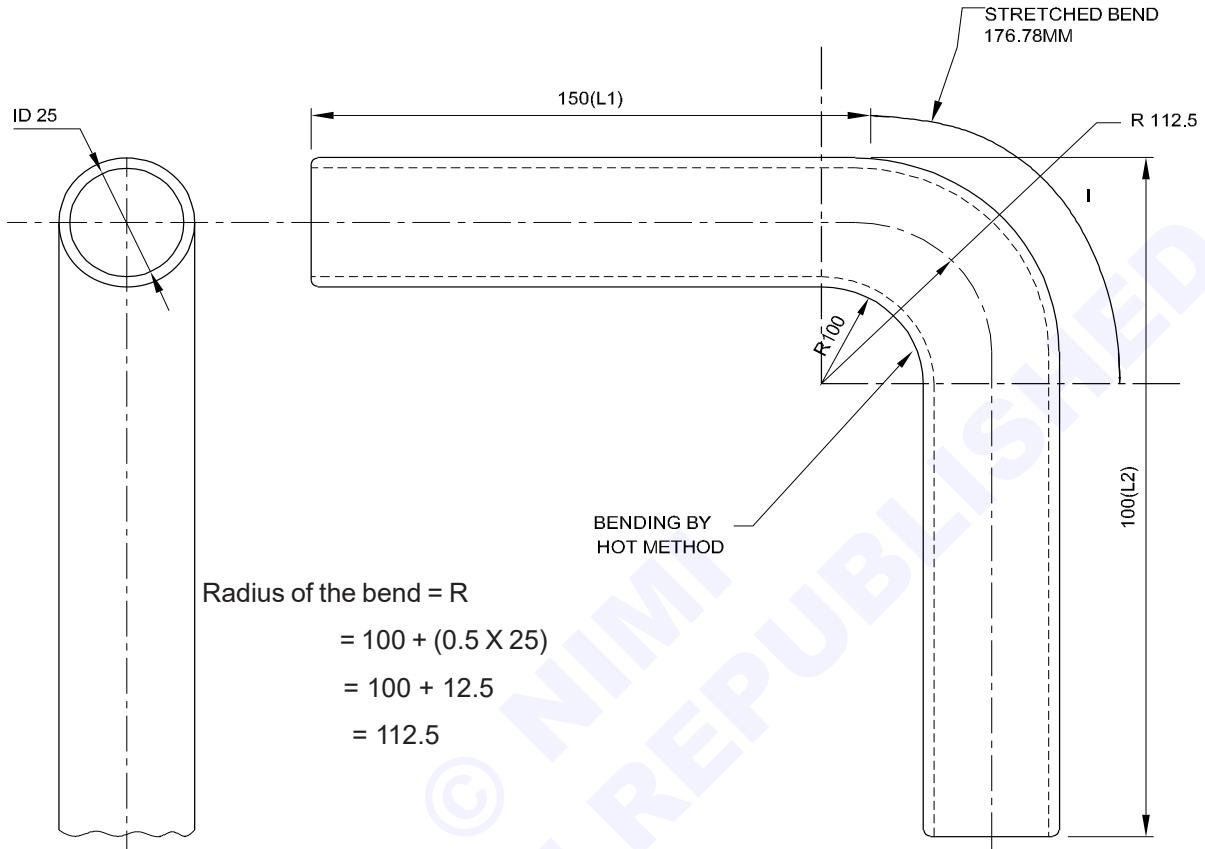


Pipe bending by hot method

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

- bend G.I. pipe by heating and match with template.

TASK - 2



Radius of the bend = R

$$= 100 + (0.5 \times 25)$$

$$= 100 + 12.5$$

$$= 112.5$$

Stretch of the bend = I

$$= \frac{90}{360} \times 2 \times \frac{22}{7} \times 112.5$$

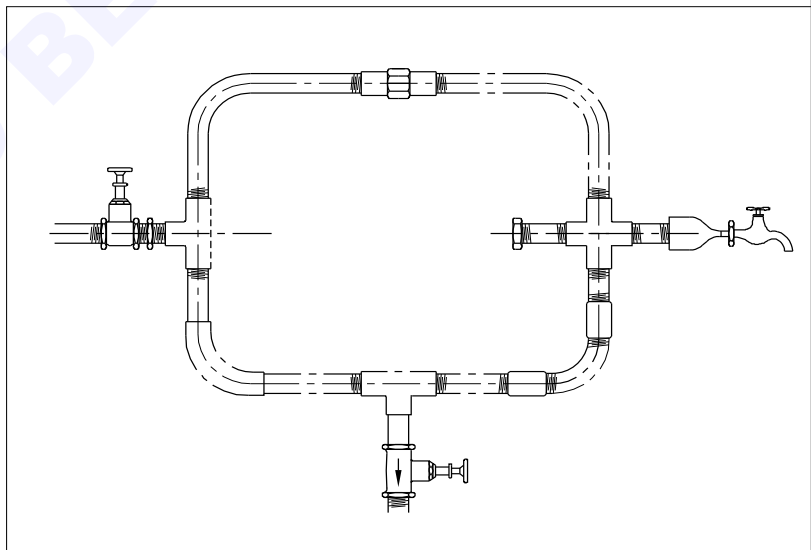
$$= \frac{11 \times 112.5}{7}$$

$$= 176.78 \text{ mm}$$

L (length of pipe) = L1 + L2 + I

$$= 150 + 100 + 176.78$$

$$= 426.78 \text{ mm}$$



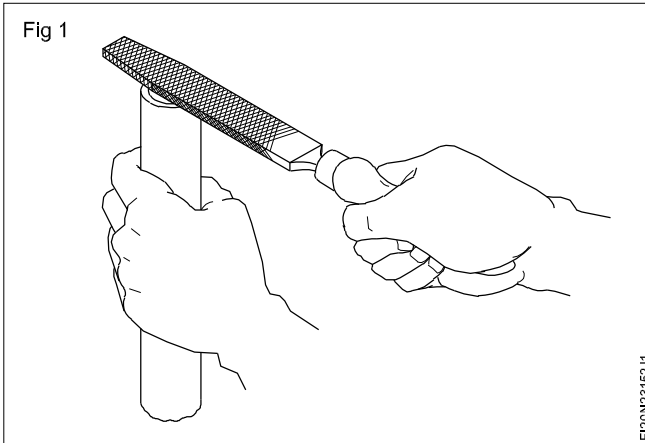
1	Ø 25 - 430 L		G.I	-	-	2.3.152
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE: NTS		PIPE BENDING (BY HOT METHOD)			DEVIATIONS	TIME : Hrs
					CODE NO. FI20N23152E2	

Job Sequence

Bending G.I. pipes using sand and pegs

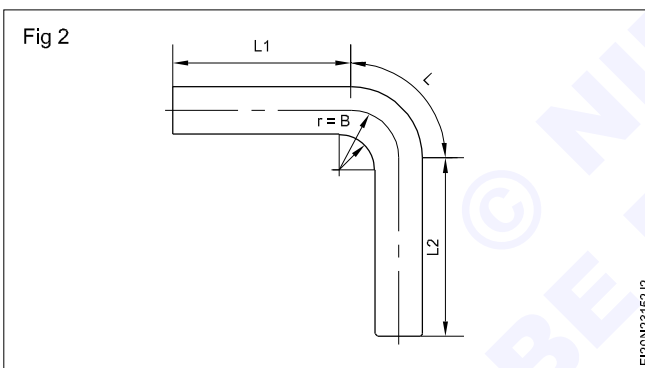
Objective : This shall help you to
 • bend G.I. pipe by hot method.

File the pipe ends square. (Fig 1)



Remove burrs.

Calculate the length of pipe.(Fig 2)



- If D = diameter of bend
 ϕ = angle of bend
 l = length of curved portion

$$\text{then, } l = \frac{\pi \times D \times \phi}{360}$$

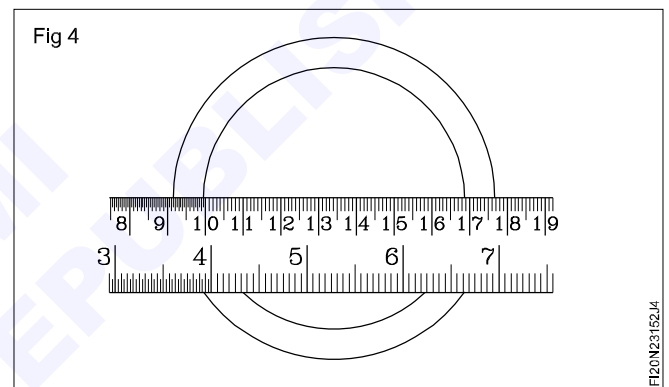
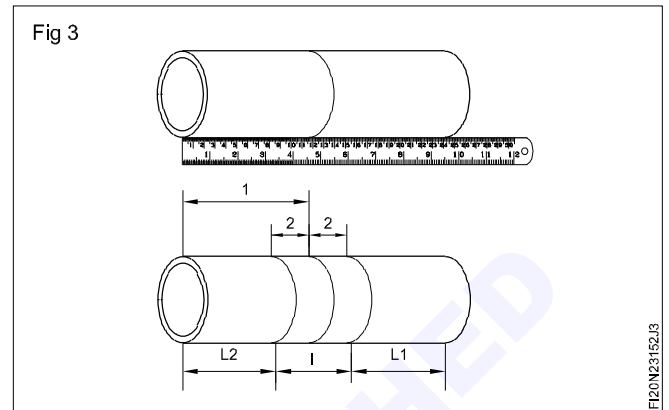
- If OA = inner radius of bend (R)
 AB = radius of pipe (r)
 OB = radius of bend ($R+r$)
 then, $l = (R+r) \times Q \times 0.01745$.

Total length of pipe = $L_1 + L_2 + l$.

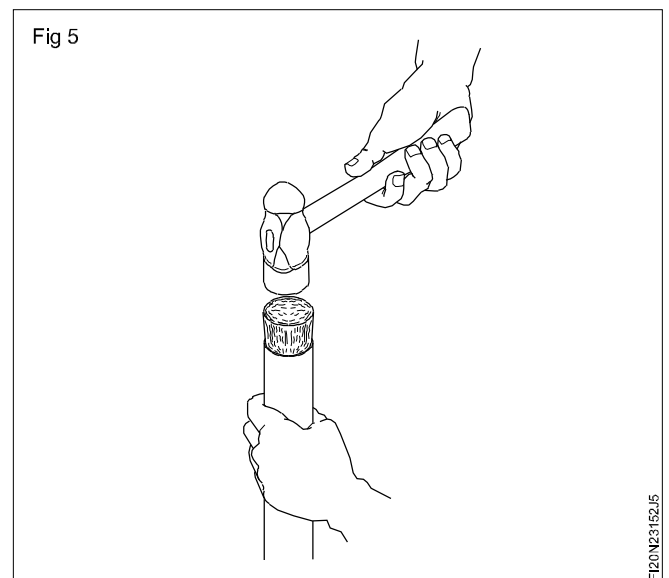
Measure and mark off the:

- centre of the bend (Fig 3)
- beginning and end of the bend from the centre line.

Measure the inside diameter of the pipe and select two suitable wooden pegs for the pipe. (Fig 4)

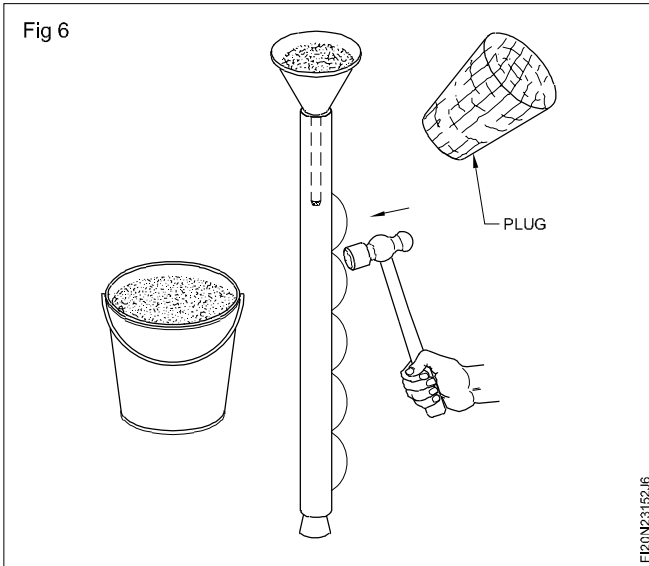


Plug one end of the pipe with a wooden peg.(Fig 5)

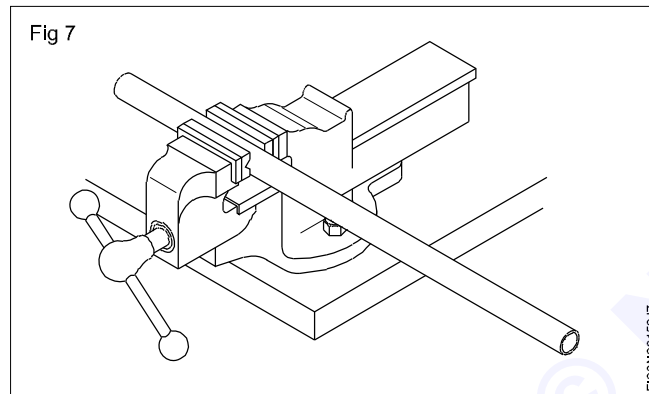


Fill the pipe with clean, dry and fine sand [Compress the sand by tapping the pipe up and down with a soft hammer.] (Fig 6) and plug the end.

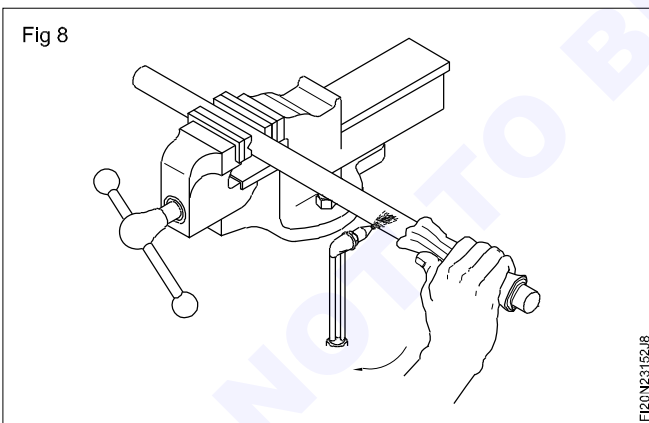
Ensure that the entire pipe is filled with sand.



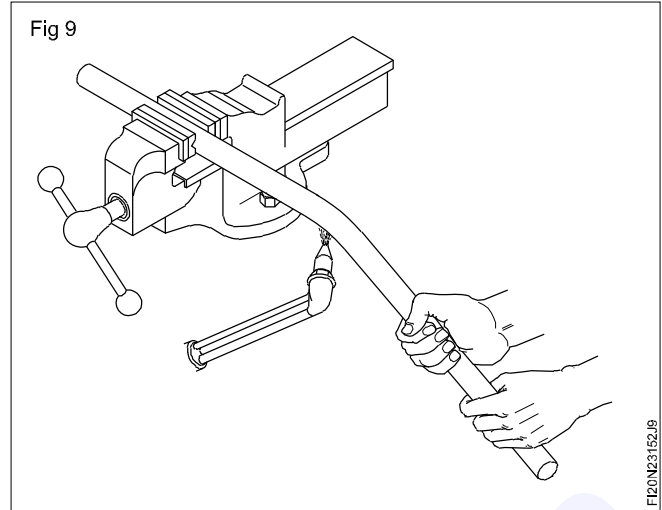
Clamp one end of the pipe in a vice and protect the clamped portion of the pipe with lead or copper shims. (Fig 7)



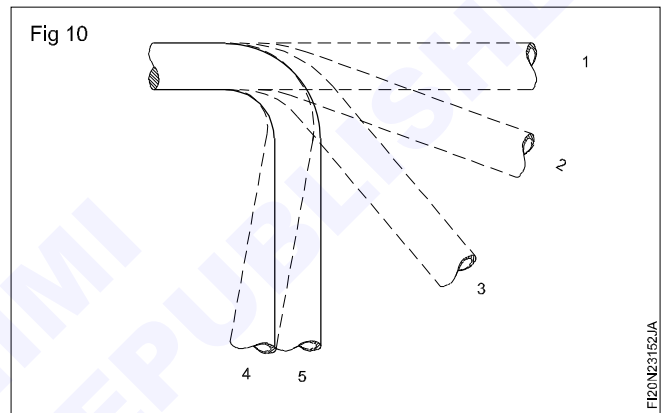
Heat the area to be bent with oxy-acetylene torch evenly until it glows dull red. (Fig 8)



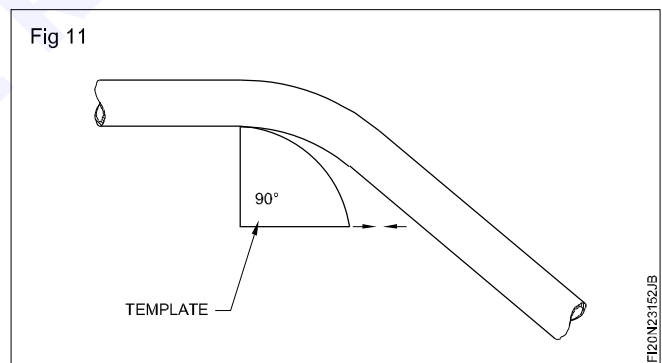
The bend area should not be overheated.
Pull down the pipe gently in the direction of the bend. (Fig 9)



Take short pulls until the correct bend angle is reached. (Fig 10-1,2,3)



Check the bend radius with a template. (Fig 11)



Apply heat throughout the whole operation and overbend slightly and straighten out the final bend. (Fig 10-4,5)

Remove one end of the plug.

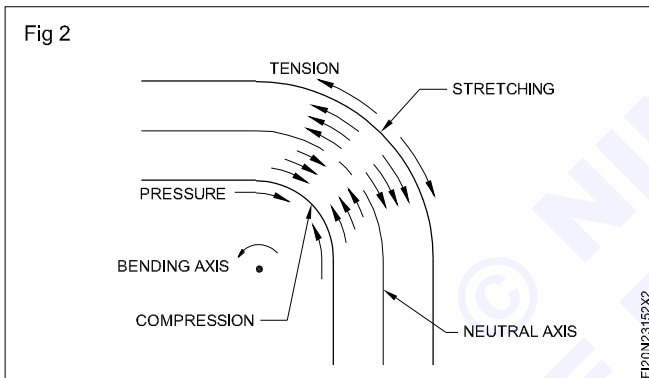
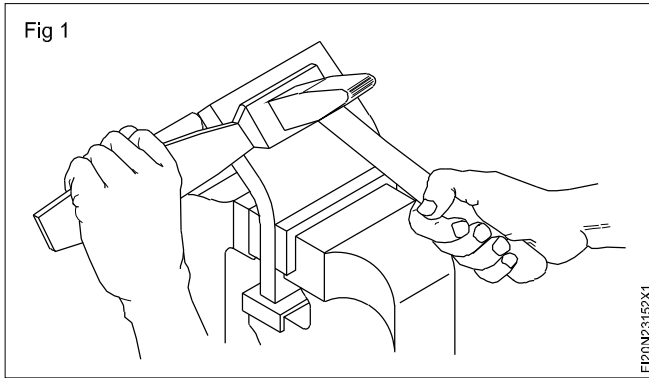
Ensure that the pipe is cooled before removing the plug.

Remove the sand by tapping the pipe gently with a hammer.

Calculate the length of material for bending

Objective : This shall help you to
 • calculate the required length of pipe for bending.

While bending a rod, sheet or pipe, due to the tensile force in the outer part of the material at the bending point, the material is stretched. (Fig 1 and 2) Due to the force of pressure in the inner part of the material at the bending point, the material is compressed.



The layer in the middle of the material is not subjected to either tension or compression.

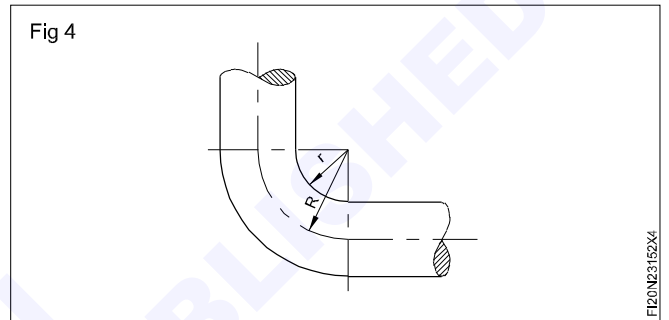
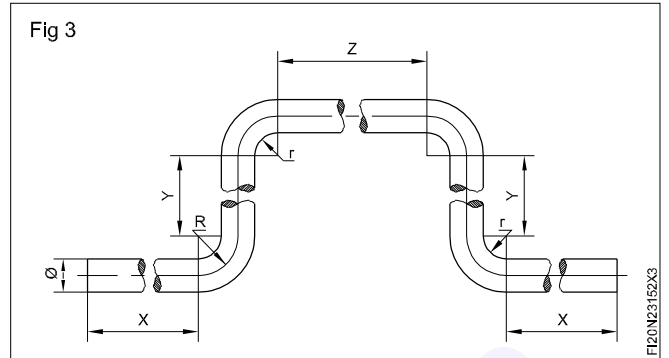
This is called the neutral axis. (Fig 2)

For calculating the length of material for bending, the material length at the neutral axis is taken into account.

The length of the blank/ rod/pipe is the stretched length before bending. The stretched length is determined along the neutral axis. For calculating the stretched/ elongated length of a rod/sheet/pipe while bending (Fig 3), first add all straight portions together.

$$x + y + z + y + x = 2x + 2y + z$$

Then add the bent space distances together. For calculating this:- take the radius of the bent up to the neutral axis and also take the angle of the bend into consideration. (Fig 4).



Radius of the bend up to neutral axis

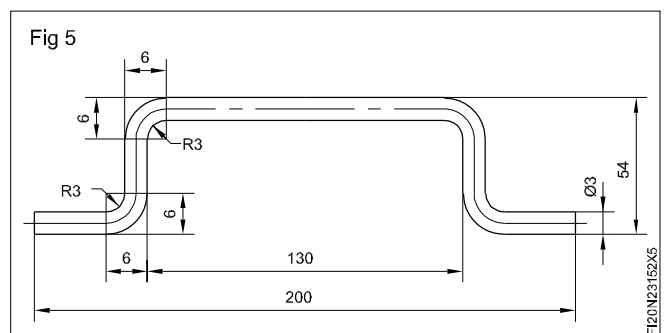
= inner radius + 0.5 x thickness of sheet OR diameter of rod or pipe. Angle of the bend with respect to Figs 3 & 4 is 90.

Length of the curved space

$$= \frac{\text{Angle of curve} \times 2\pi R}{360}$$

where 'R' is the radius of the curve at the neutral axis.

Calculation of stretching length (Fig 5)



Straight spaces length

$$x = \frac{200 - (130 + 6 + 6)}{2} = 29\text{mm}$$

$$y = 54 - (6 + 6) = 42\text{mm}$$

$$z = 130 - (3 + 3) = 124\text{mm}$$

$$2x + 2y + z = 58 + 84 + 124 = 266\text{mm}$$

There are four bends all having a 90° angle.

R (Radius up to neutral axis) = 3 + 1.5 = 4.5 mm

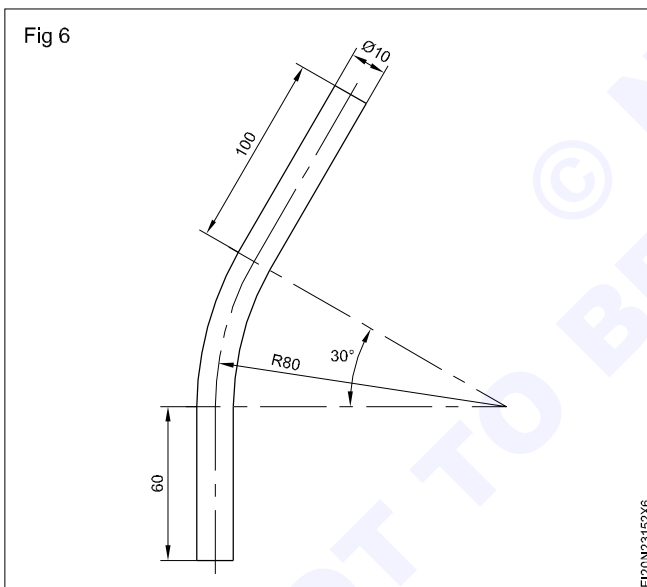
$$\text{Stretch length of one bend} = \frac{90}{360} \times 2 \times \frac{22}{7} \times 4.5$$

$$\text{For all the four bends} = 4 \times \frac{90}{360} \times 2 \times \frac{22}{7} \times 4.5 = 28.28\text{mm}$$

$$\text{Total stretched length} = 266 + 28.28$$

$$= 294.28 \text{ or } = 295 \text{ mm}$$

In the above calculation the angle of the bend is taken as 90°. For calculating the curved length for any bending angles the following formula can be used. (Fig 6).



$$\text{Length of curve} = \frac{\text{angle of curve}}{360^\circ}$$

Where R is the radius of the curve at the neutral axis.

$$\text{Length of curve} = \frac{30^\circ \times 2\pi \times 80}{360^\circ}$$

$$= 41.88 \text{ mm}$$

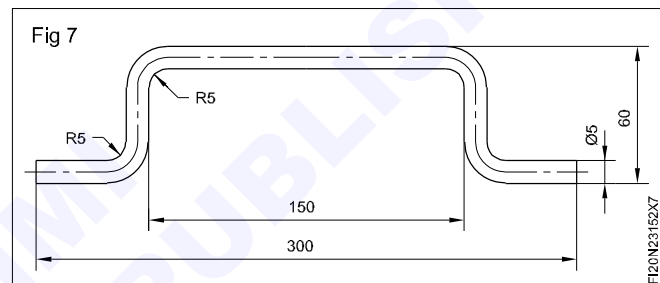
Total length of material of θ 10 mm

$$= 60 + 41.88 + 100 = 201.88 \text{ mm}$$

Assignment

Calculate the total length of the material required for bending the round rod as given in the drawing below.

Answer -



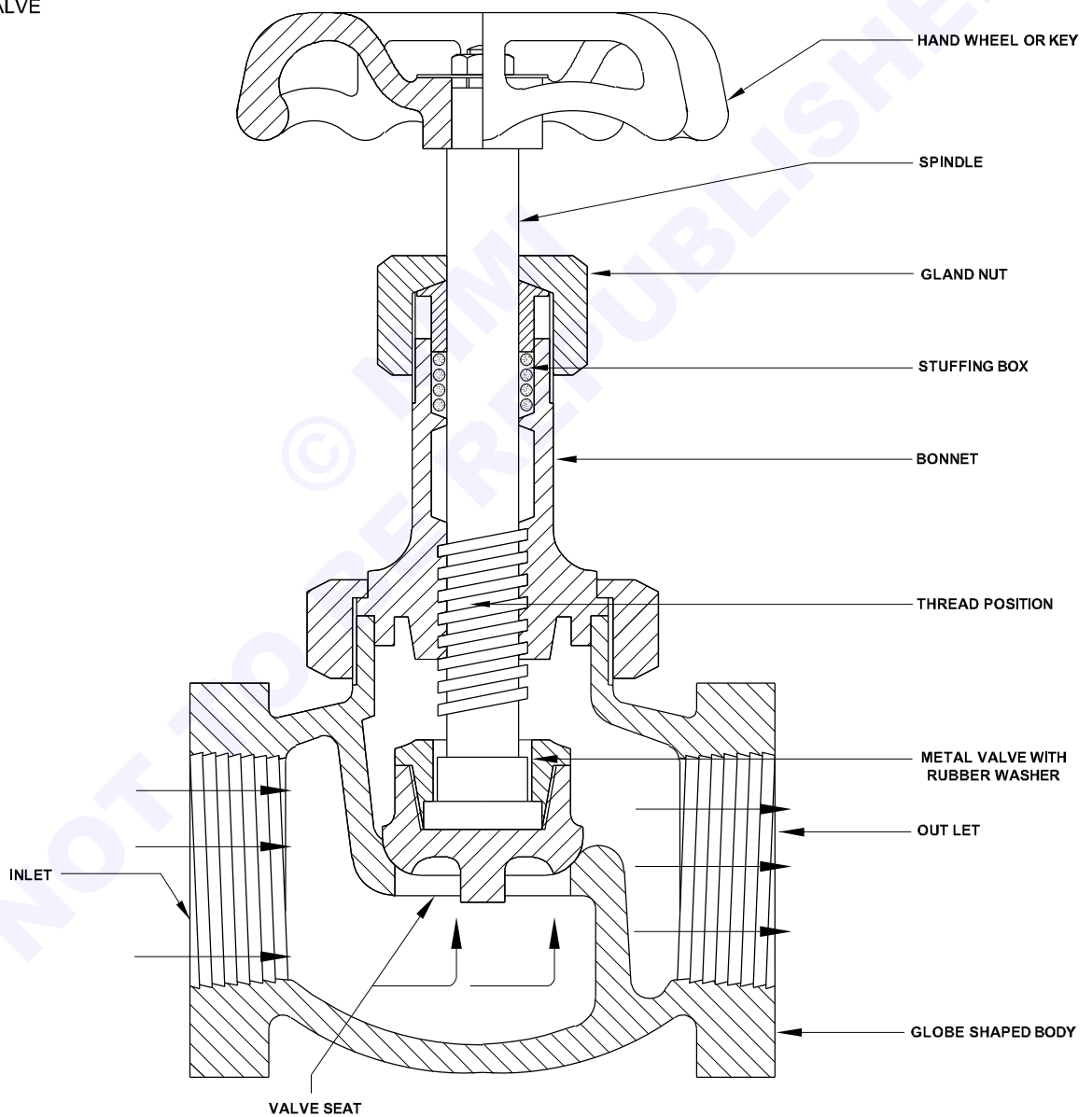
Dismantling & assembling - globe valves, sluice valves, stop cocks, seat valves and non-return valve

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

- dismantle, service and assemble a globe valve
- dismantle, service and reassemble a sluice valve (gate valve)
- dismantle, service and assemble a stop cock
- dismantle, service and assemble a seat valve
- dismantle, service and assemble a non-return valve.

Fig 1

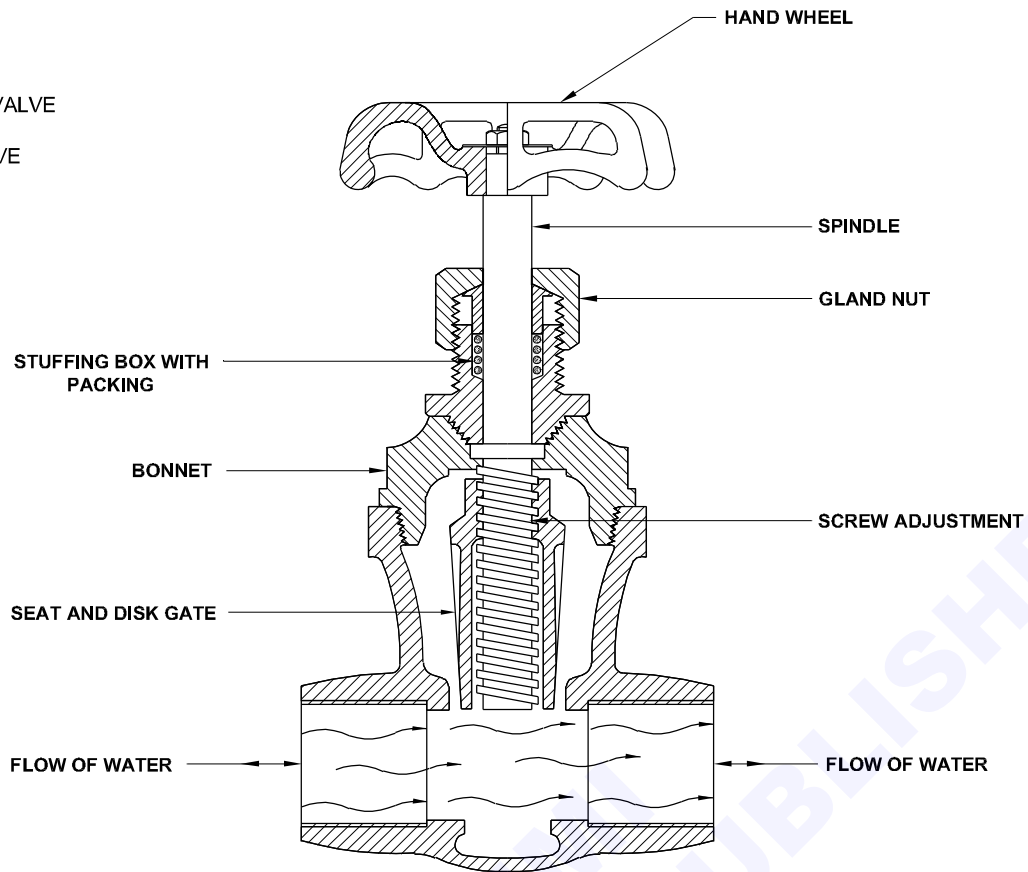
TASK 1
GLOBE VALVE



F120N23153H1

Fig 2

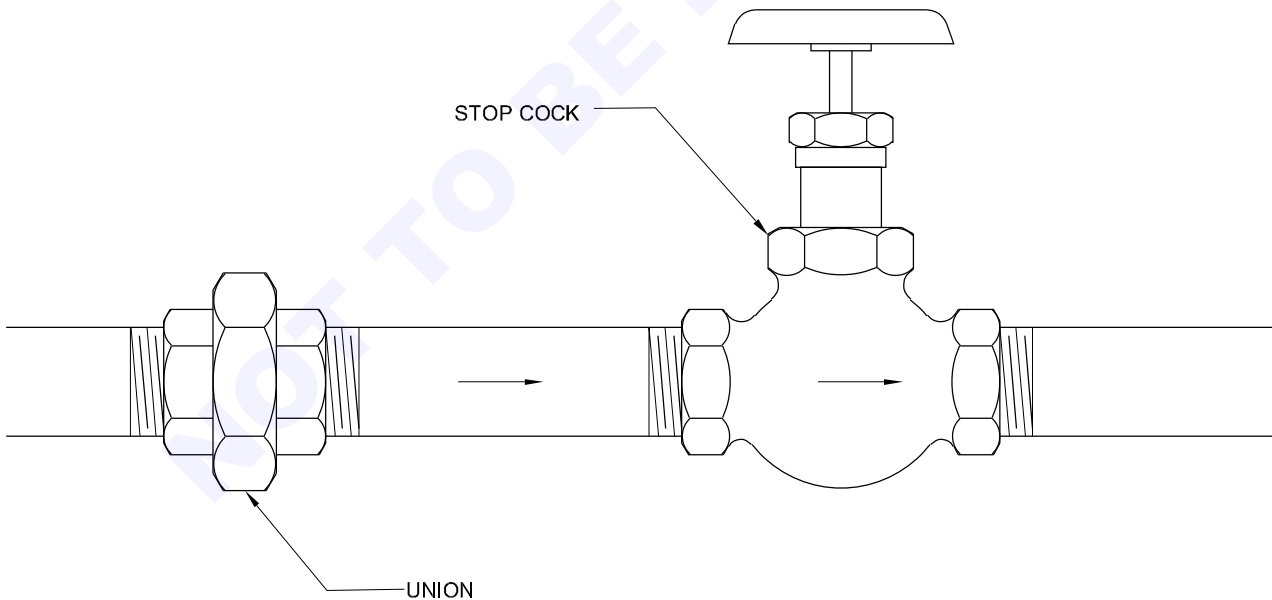
TASK 2
SLUICE VALVE
(or)
GATE VALVE



FI20N23153H2

Fig 3

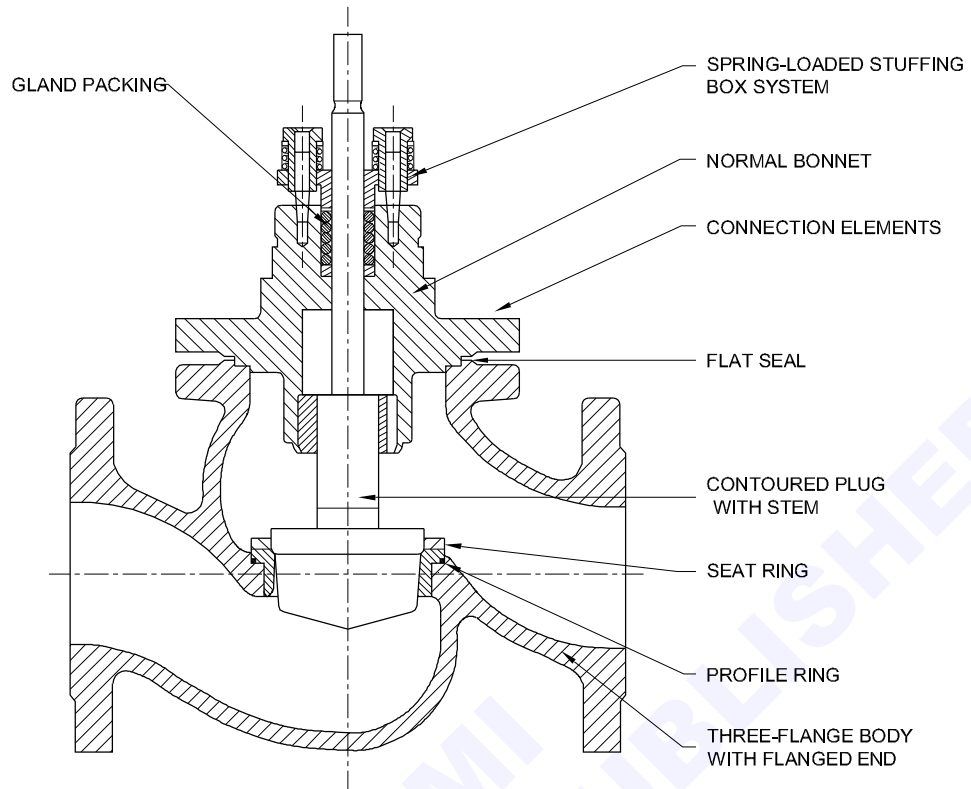
TASK 3
STOP COCK



FI20N23153H3

Fig 4

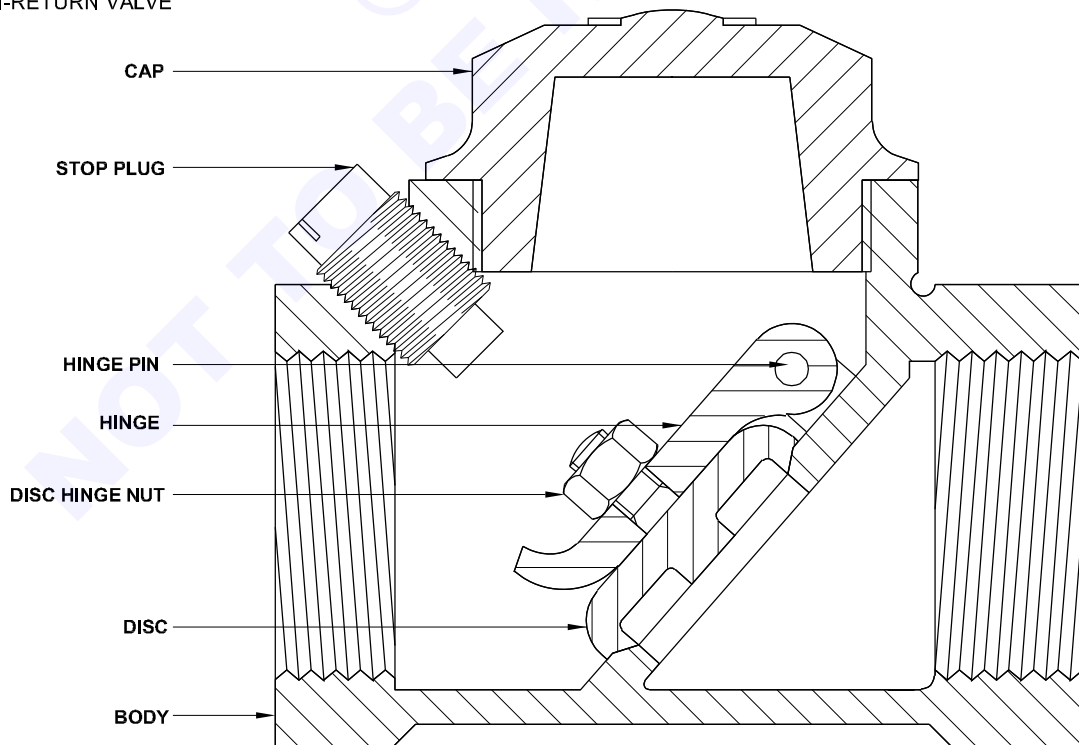
TASK 4
SEAT VALVE



F120N23153H4

Fig 5

TASK 5
NON-RETURN VALVE



F120N23153H5

Requirements

Tools/Instruments

- Spanner
- Screw driver
- File
- Hacksaw
- Hammer
- Pipe wrench
- Die set
- Screw spanner
- Pliers
- Spanner set
- Adjustable spanner
- Water pump pliers

Equipment/Machines

- Pipe vice

- Bench vice
- Oil can

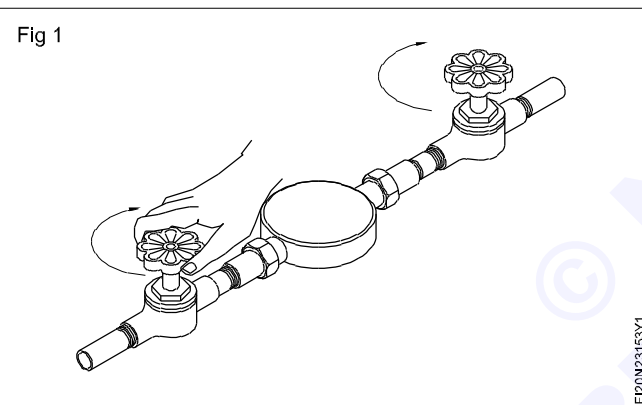
Materials

- Stop cock
- Union
- Thread seal material
- Gate valve
- Asbestos rope
- Rubber sheet
- Leather sheet
- Emery sheet
- Oil
- Grease

Job Sequence

TASK 1 : Globe valve

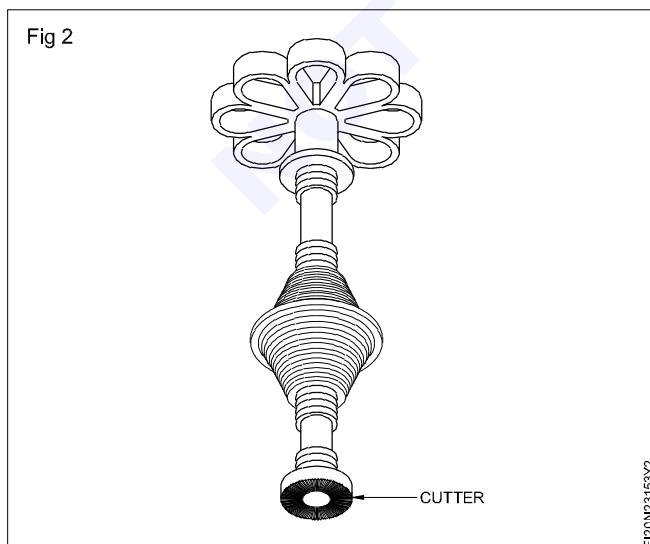
Shut off the water by closing the main gate valve.(Fig 1)



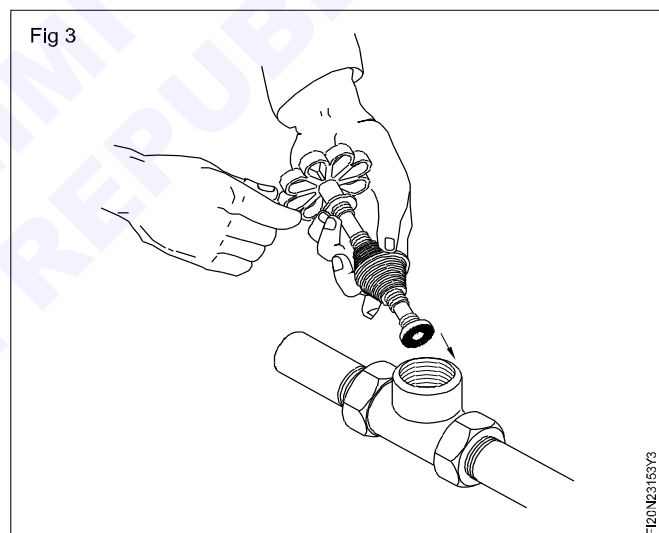
Drain the system and release the water pressure of the system.

Unscrew the bonnet and lift off the bonnet from the body.

Select the correct size cutter and assemble it to the reseating tool. (Fig 2)



Insert the reseating tool into the body of the stopcock. (Fig 3)



Hold the handle on the top of the tool steadily and turn the feed screw clockwise until the cutter just touches the bottom seat. (Figs 4 & 5)

Face the bottom seat with the cutter by rotating the handle by gripping the feed screw. (Fig 6)

Ensure a minimum amount of metal is removed by adjusting the feed screw.

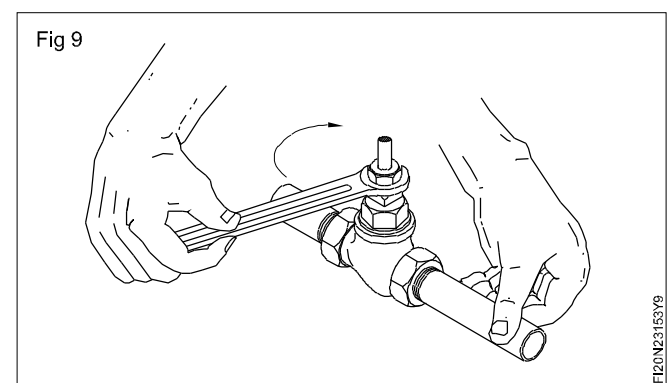
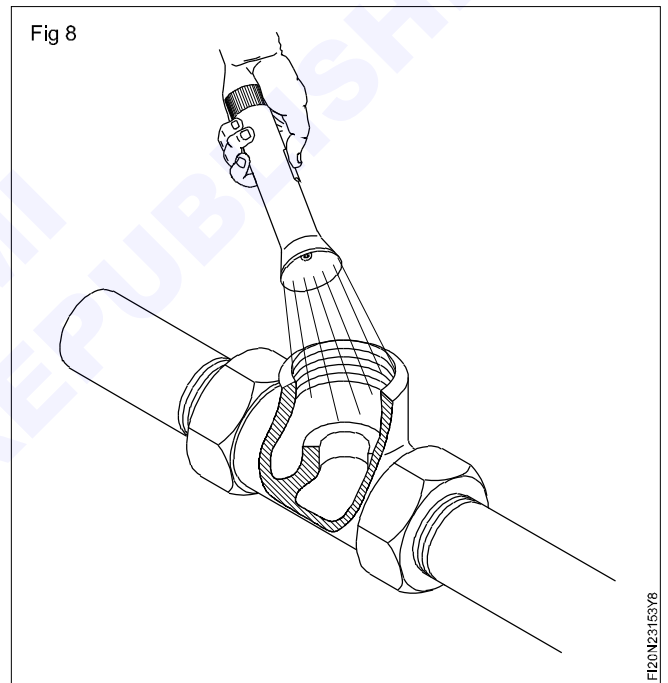
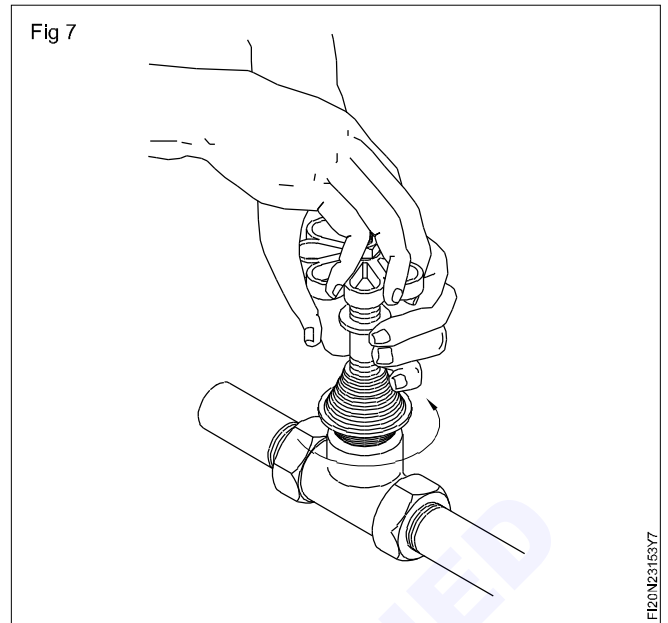
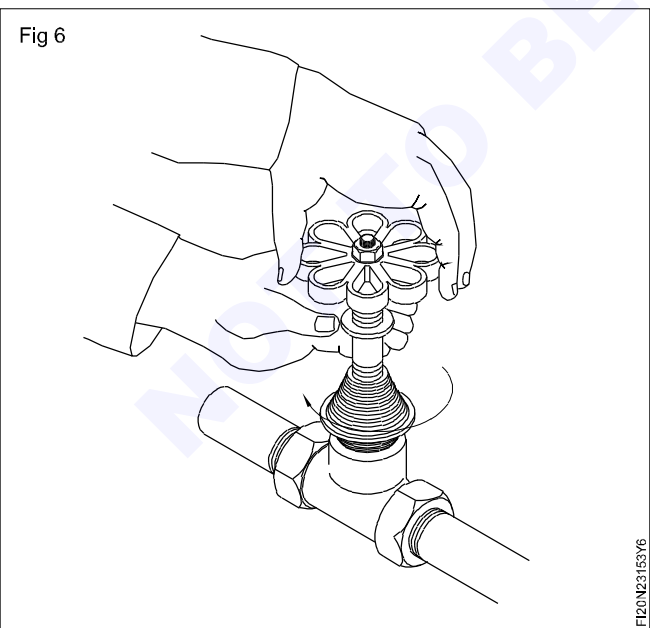
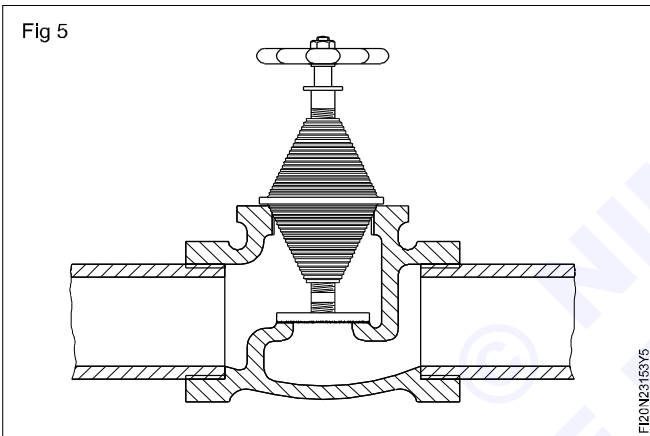
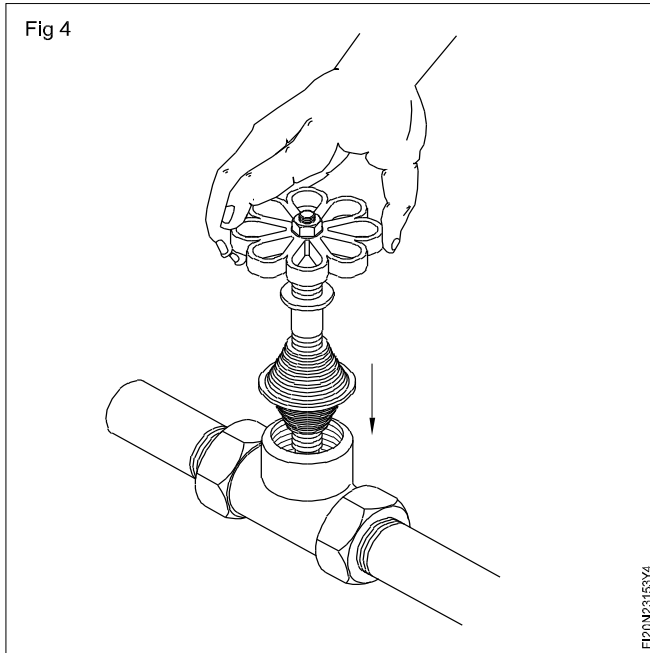
Loosen the feed screw and the adopter and remove the reseating tool from the body. (Fig 7)

Inspect the valve seat using the beam of a flash light. (Fig 8)

Clean the seat and ensure that it is free from burrs, chips etc.

Replace the packing material into the gland box.

Tighten the bonnet. (Fig 9)



Avoid overtightening as this would cause damage to the thread of the body.

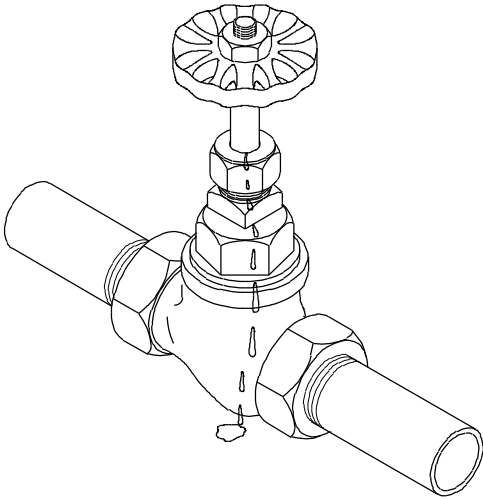
Close all the drain taps and open the main gate valve and check the globe valve for leakage.

TASK 2 : Sluice/gate valve

Close the gate-valve by turning the hand wheel clockwise. (Fig 1)

This will stop the water in the valve to be repaired.

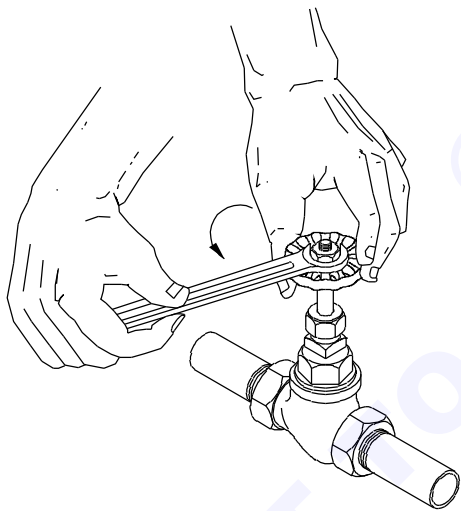
Fig 1



FI20N23153Z1

Remove the nut with a spanner and lift off the wheel. (Fig 2)

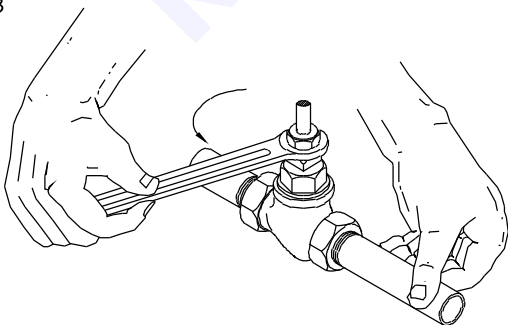
Fig 2



FI20N23153Z2

Remove the gland nut from the bonnet by turning it in the anticlockwise direction. (Fig 3)

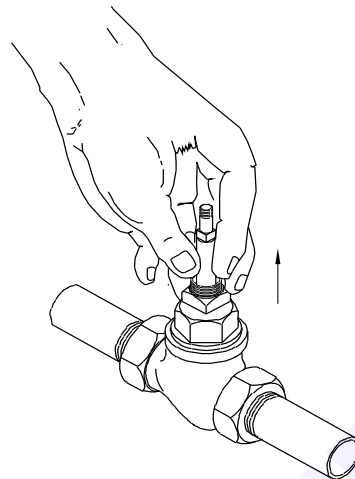
Fig 3



FI20N23153Z3

Remove the stuffing gland. (Fig 4)

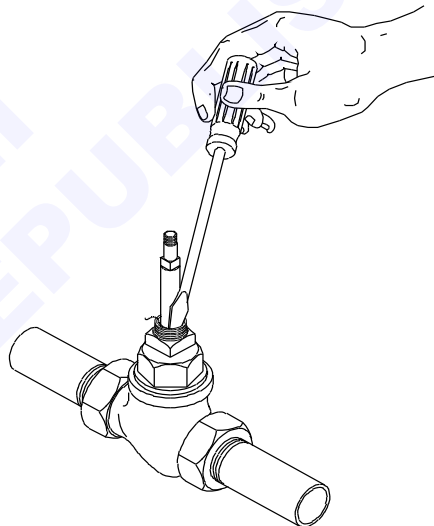
Fig 4



FI20N23153Z4

Clean out the old packing in the stuffing box. (Fig 5)

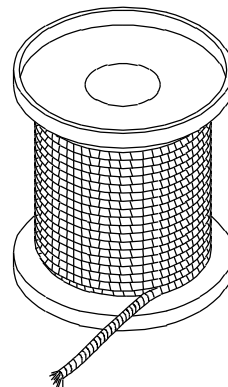
Fig 5



FI20N23153Z5

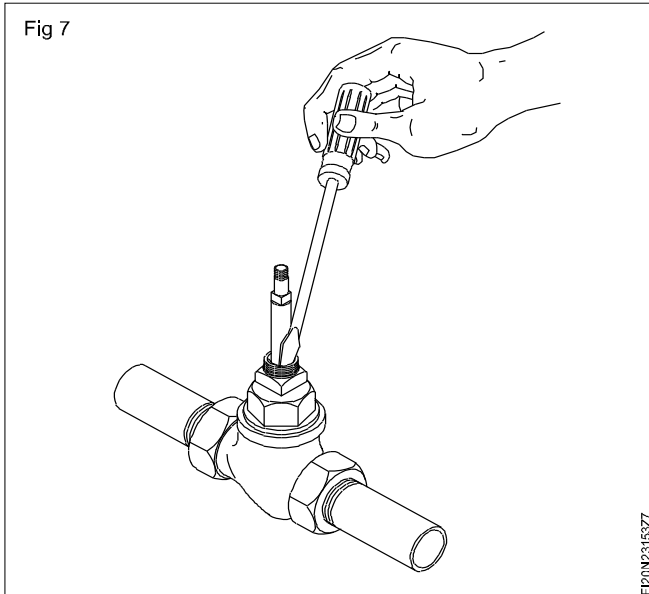
Cut a strand of asbestos rope to make a new packing. (Smear it with water pump grease or graphite paste) (Fig 6)

Fig 6

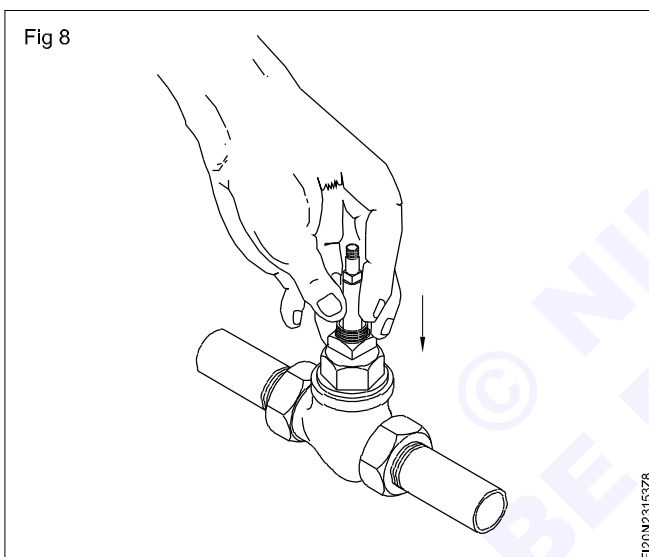


FI20N23153Z6

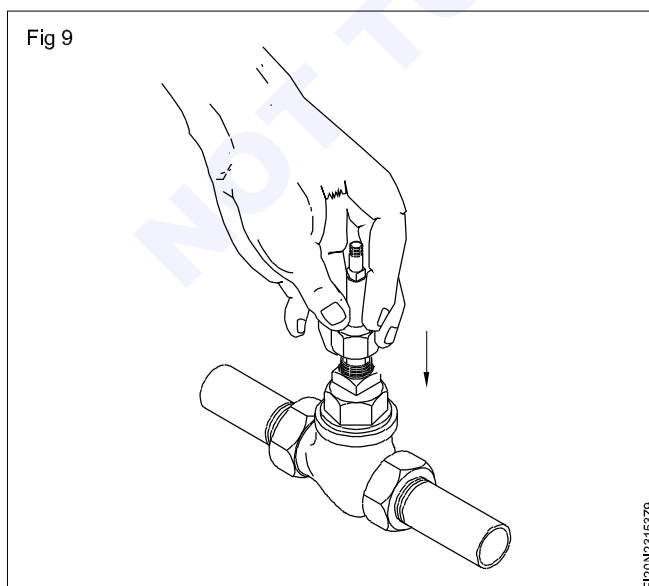
Coil the new packing round the shaft and push it down with a screw driver. (Fig 7)



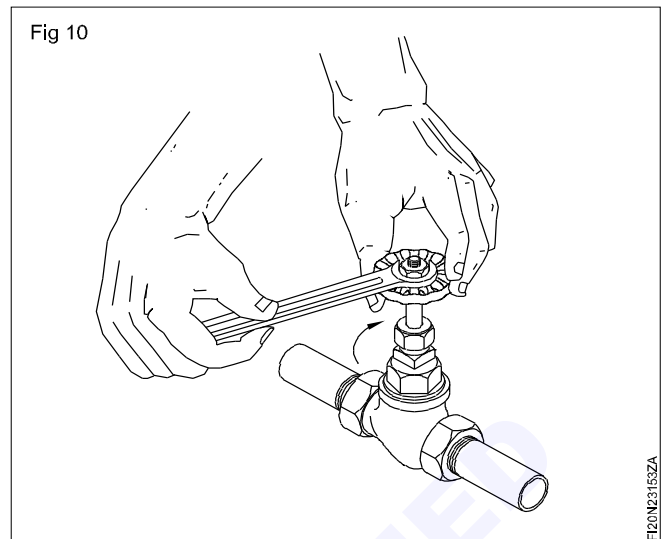
Push in the stuffing gland and check that it fits tightly in the stuffing box. (Fig 8)



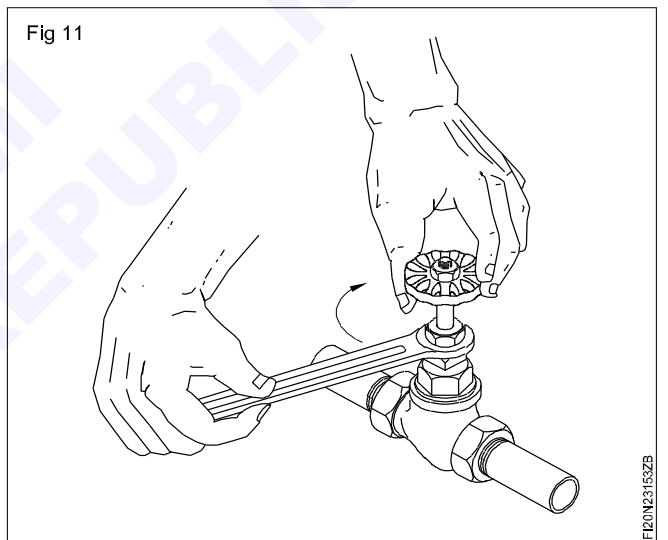
Reassemble and leave the gland nut hand tight. (Fig 9)



Assemble the hand wheel and tighten the hand wheelnut. (Fig 10)



Open the gate valve and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping from the gland nut. (Fig 11)



TASK 3 : **Stop cock**

- 1 Clean the pipe joints free from rust and dirt.
- 2 Loosen the union and separate the pipe joint.
- 3 Loosen and remove the pipe nipple from stop cock.
- 4 Loosen and remove the stop cock from the pipe joint.
- 5 Dismantle the stop cock parts one by one systematically.
- 6 Clean all the parts properly.
- 7 Check the parts of thread, if worn out replace with correct one. If it is in good condition clean it properly and use it.
- 8 Check the washer, whether it is damaged or in good condition. If damaged, change the washer.
- 9 Reassemble the parts to ensure in good condition.
- 10 While assembling the dismantled parts last one should fit first and vice versa sequence.

- 11 If the stop cock is in damaged condition, change it with new stop cock.
- 12 Fit the stop cock to one end in lengthy pipe in the dismantled place pipe joint properly.
- 13 Fit the pipe nipple to other end of stop cock properly.
- 14 Next fit the union with pipe nipple properly.
- 15 Apply pressure and test the pipe joints and stop cock. Check for leakage, if any to ensure proper working.

- **The arrow, embossed on stop cock is to be in the direction of flow of water**
- **Check the direction of arrow before fitting stop cock.**
- **Don't over tighten stop cock, and other pipe fittings.**
- **Use proper tools for dismantling and assembling pipe fittings.**

TASK 4 : **Seat Valve**

- 1 Close the seat valve by turning the hand wheel clock wise.
- 2 Remove the nut with a spanner and lift the wheel.
- 3 Remove the gland nut from the bonnet by turning it in the anticlock wise direction.
- 4 Remove the stuffing gland.
- 5 Clean out the old packing in the stuffing box.
- 6 Cut a standard asbestos rope to make a new packing.
- 7 Assemble and spindle gate to the bonnet.
- 8 Assemble the hand wheel and tighten the hand wheel nut.

- 9 Open the seat valve and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping from the gland nut.

Removal of spindle set and gate part

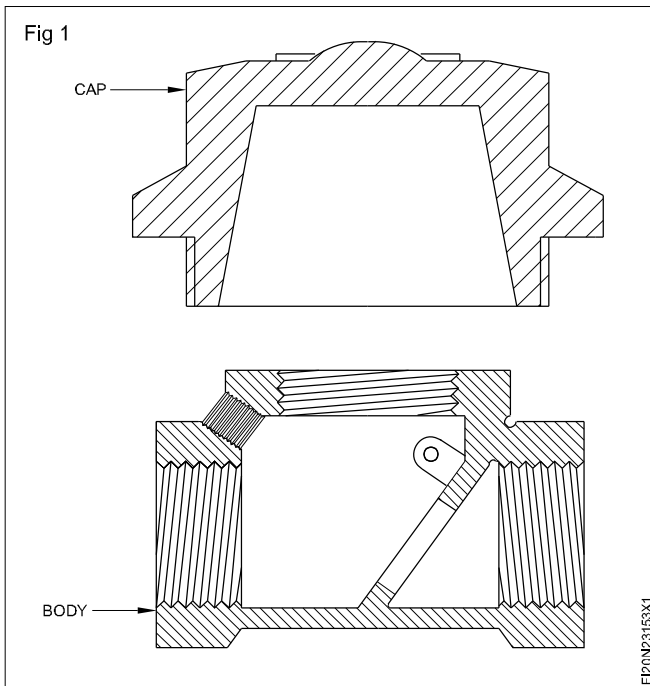
- 1 Hold the spanner at bonnet neck.
- 2 Loosen the bonnet two or three turn, again loosen the bonnet 2 or 3 turn.

Note

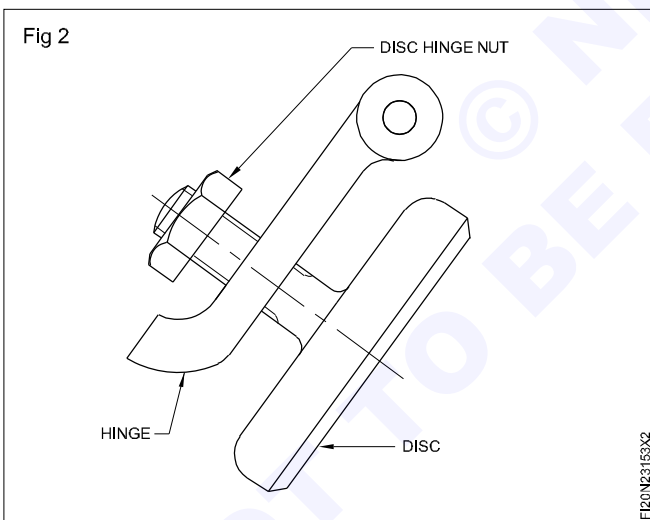
- **Dont over tight the gland nut.**
 - **Filling the gasket should not be too much.**
 - **Clean the disk gate with emery sheet.**
-

TASK 5 : Non return valve

- 1 Shut off the water by closing the main valve.
- 2 Remove the cap from the valve body. (Fig 1)



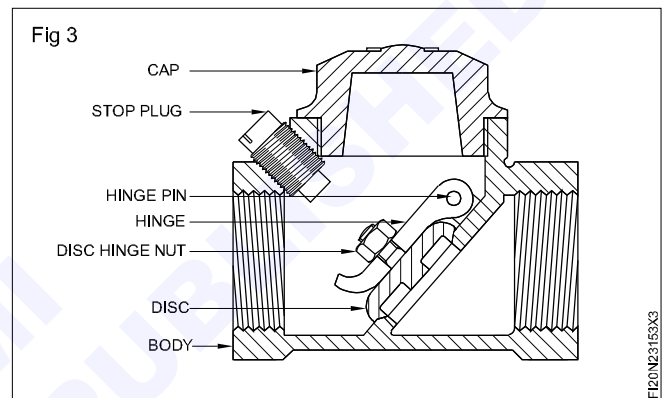
- 3 Remove the hinge pin and take out the disc.
- 4 Separate the disc from the hinge. (Fig 2)



- 5 Clean the seating area and the other parts of the disc.
- 6 Assemble the disc and hinge plate with the pin.
- 7 Check the function of the hinge unit.
- 8 Replace the sealing material and assemble the cap to the body. (Fig 3)
- 9 Open the main gate valve and check for leakage.

Note

- Dont over tight the hinge pin.
- Clean the seating area thoroughly.
- Replace the seating material carefully.

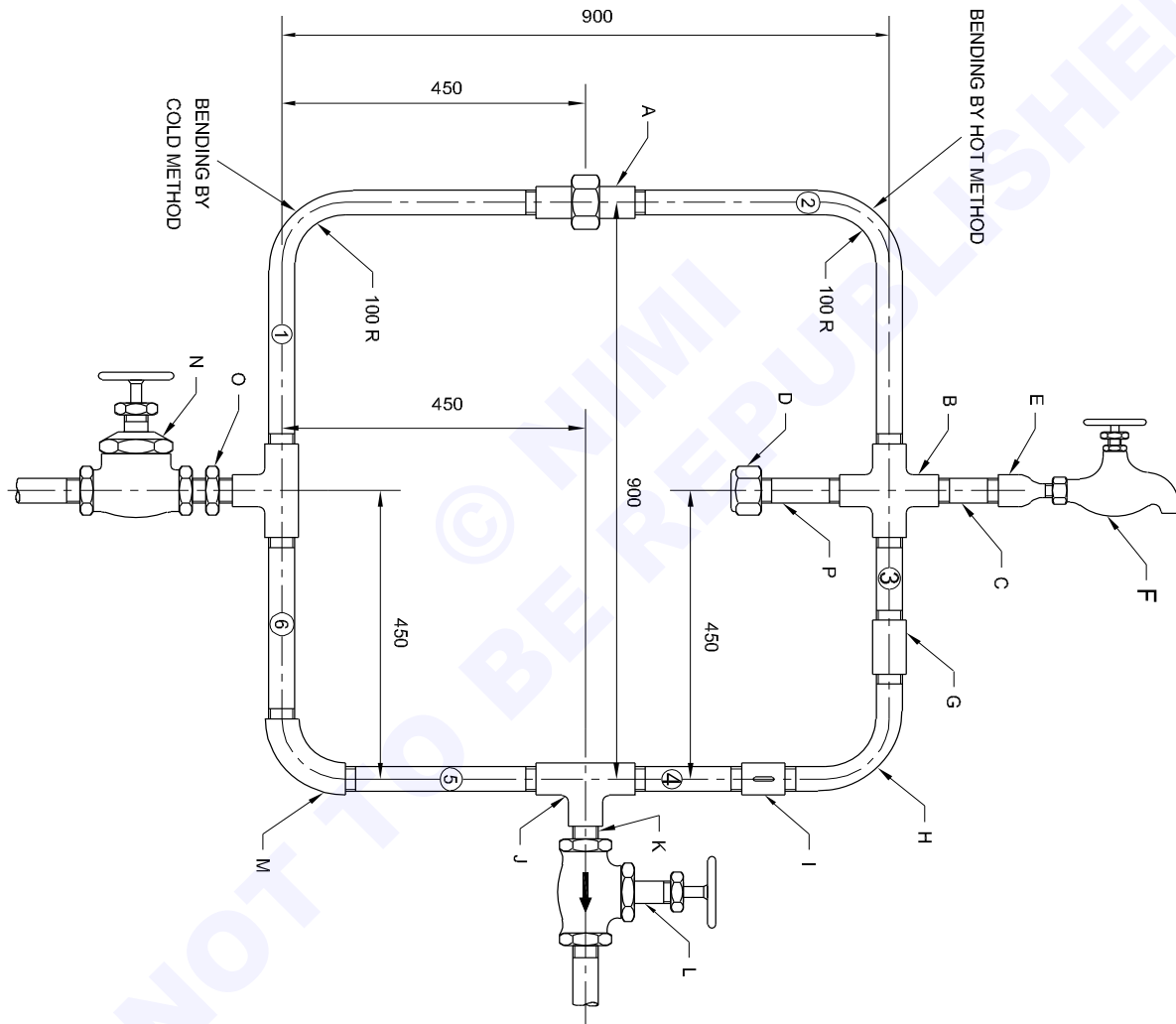


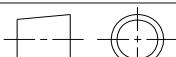
Fit & assemble pipes, valves and test for leakage & functionality of valves

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

- fit the elbow with G.I. pipe
- fit the union with G.I. pipe
- fit valves with G.I. pipe
- assemble pipe with standard fittings.

TASK - 1



-	-	-	-	-	-	2.3.154
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE:NTS					TOLERANCE	
					TIME : 18 Hrs	
					CODE NO. FI20N23154E1	
FIT & ASSEMBLE PIPES , VALVES AND TEST FOR LEAKAGE & FUNCTIONALITY OF VALVES						

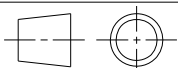
Job Sequence

TASK 1 : Assembling of pipes and valves

- 1 Join pipe No. 2 with the 4-way cross. (B)
- 2 Fit pipe No. 3 with the 'cross'.
- 3 Join plain coupling (G) to the other end of the pipe No. 3.
- 4 Assemble G.I. bend (H) to the plain coupling.
- 5 Fit the ribbed coupling (I) to the other end of the bend.
- 6 Join pipe No. 4 to the ribbed coupling.
- 7 Fit 'T' (J) with pipe No. 4.
- 8 Join pipe No. 5 to the opposite end of 'T'.
- 9 Assemble elbow (M) with pipe No. 5.
- 10 Fit pipe No. 6 with the other end of the elbow.
- 11 Join 'T' with pipe No. 6.
- 12 Fit pipe No. 1 with the opposite end of 'T'.
- 13 Join pipe Nos. 1 & 2 with union. (A)
- 14 Fit 150mm barrel nipple (P) to the left side of the 'cross' and put cap (A) for it.
- 15 Put another 100mm barrel nipple (C) to the right side of the cross.
- 16 Join the reducer (E) to the barrel nipple.
- 17 Assemble the bib-cock (F) to the other end of the reducer.
- 18 Fit 100mm barrel nipple (K) to bottom 'T'.
- 19 Assemble the globe valve (L) to the nipple.
- 20 Put the hexagonal nipple (O) to the left side 'T'.
- 21 Assemble the gate-valve to the nipple.
- 22 Test the joints for leakage.

1	25 x 150 mm	BRASS NIPPLE	G.I.	P	P	
1	25 x 25 mm	HEXAGONAL NIPPLE	G.I.	O	O	
1	25 mm	GATE VALVE	COPPER ALLOY	N	N	
1	25 mm	ELBOW	G.I.	M	M	
1	25 mm	GLOBE VALVE	COPPER ALLOY	L	L	
1	25 x 100 mm	BARREL NIPPLE	G.I.	K	K	
2	25 mm	TEE	G.I.	J	J	
1	25 mm	RIBBED COUPLING	G.I.	I	I	
1	25 mm	BEND 90°	G.I.	H	H	
1	25 mm	PLAIN COUPLING	G.I.	G	G	
1	1/2 INCH	BIB COCK	BRASS	F	F	
1	25 x 15 mm	REDUCER	G.I.	E	E	
1	25 mm	CAP	G.I.	D	D	
1	25 x 100 mm	BARREL NIPPLE	G.I.	C	C	
1	25 mm	CROSS	G.I.	B	B	
1	25 mm	UNION (WITH WASHER)	G.I.	A	A	
1	Ø25 x 4.05 - 405	PIPE (CLASS B)	G.I.	6	6	
1	Ø25 x 4.05 - 410	PIPE (CLASS B)	G.I.	5	5	
1	Ø25 x 4.05 - 290	PIPE (CLASS B)	G.I.	4	4	
1	Ø25 x 4.05 - 300	PIPE (CLASS B)	G.I.	3	3	
2	Ø25 x 4.5 - 820	PIPE (CLASS B)	G.I.	1 & 2	1 & 2	06
NO.OFF	STOCK SIZE	DESCRIPTION	MATERIAL	DRG. NO. (ASSY)	PART NO.	EX. NO.

SCALE : NTS



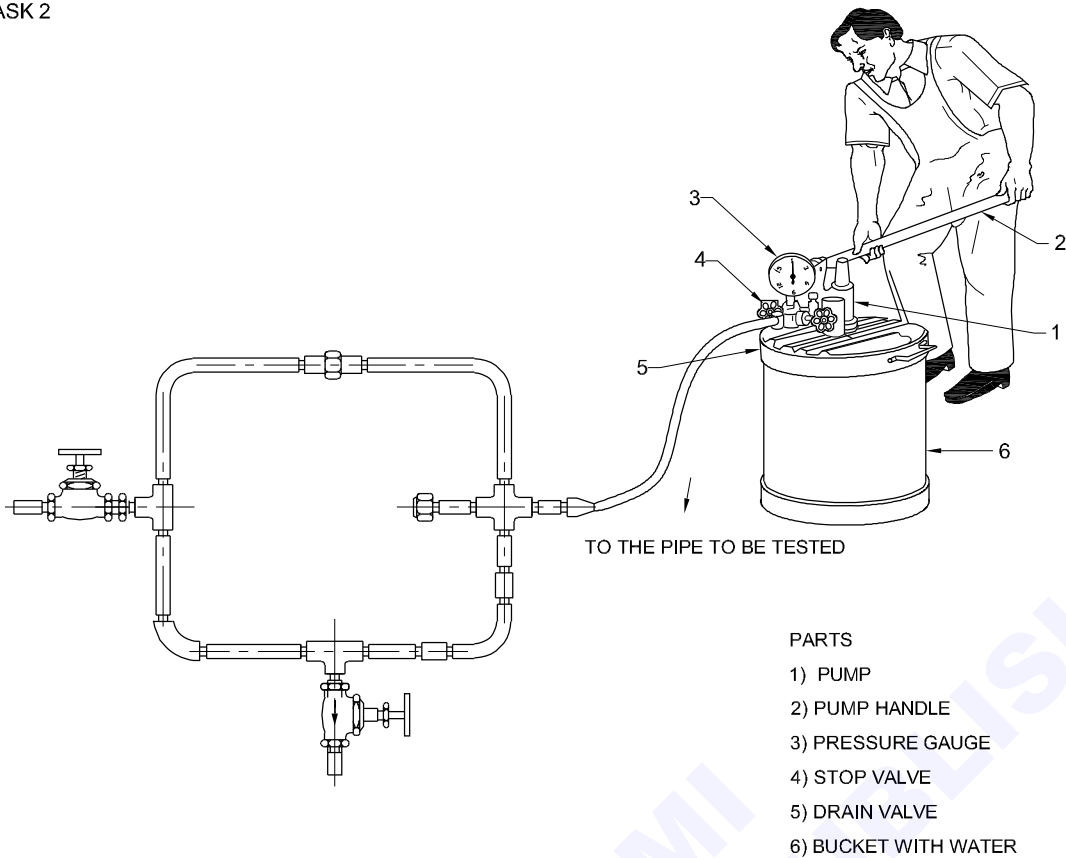
ASSEMBLY OF G.I. PIPES, VALVES AND STANDARD PIPE FITTINGS

DEVIATIONS

TIME

CODE NO. FI20N23154E2

TASK 2



TASK 2 : Test for leakage and functionality of valves

- 1 Prepare the pressure testing machine.
- 2 Fill up water in pressure testing machine.
- 3 Connect the pressure testing machine tube with pipe fittings assembly to be tested.
- 4 Before connecting hose pipe with pipe fittings, plug all the openings in the section of test line with pipe nipples socket and plug.
- 5 Apply the pressure to test the pipe line completely without any air.
- 6 Pump the water into the pipeline.
- 7 Trace the pipe lines to find leakages.
- 8 Tight the pipe fittings properly, if leakage is there.
- 9 Apply pressure again and again test the pipe fittings assembly for proper functioning.
- 10 Remove hose pipe from pressure testing machine if leakages are not there.
- 11 Connect the pipe fittings with the existing pipe line.

- While fixing the pipe fittings with pipe lines use proper materials to avoid leakages.
- Don't over tighten the pipe fittings while fitting with pipes.

Skill Sequence

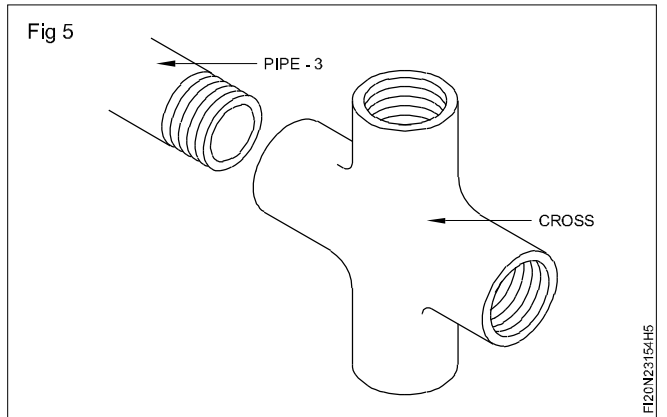
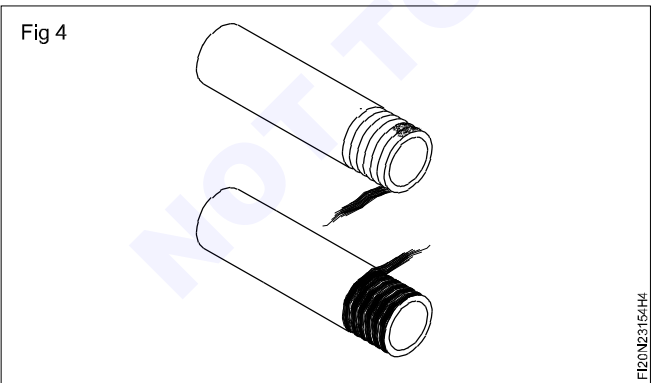
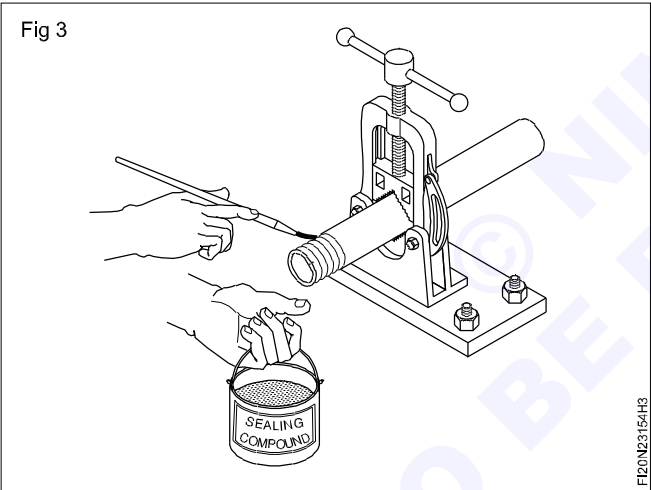
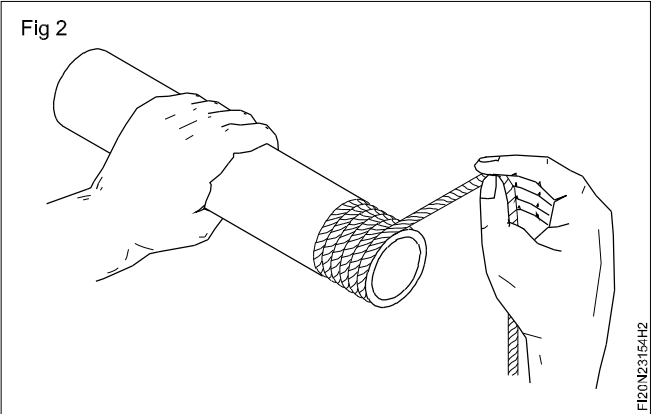
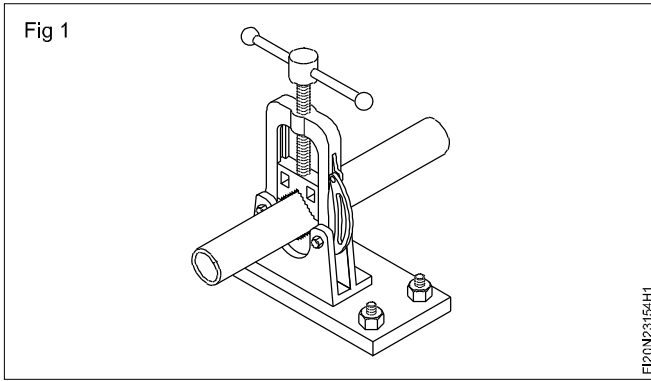
Assemble G.I pipes with standard fittings

Objective: This shall help you to

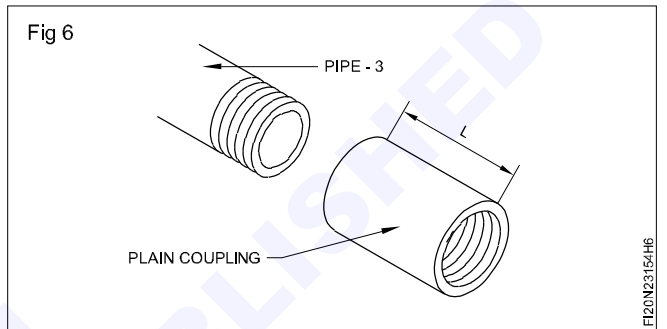
- assemble pipe and pipe fittings.

- 1 Hold the pipe No.2 in a pipe vice. (Fig 1)
- 2 Wind the hemp packing/cotton thread material on the external threads of the pipe. (Fig 2)
- 3 Apply sealing compound over the pipe threads. (Fig 3)
- 4 Fit the 4-way cross to pipe No.2 and tighten it using a pipe wrench.
- 5 Fit pipe No.3 with the cross. (Fig 5)

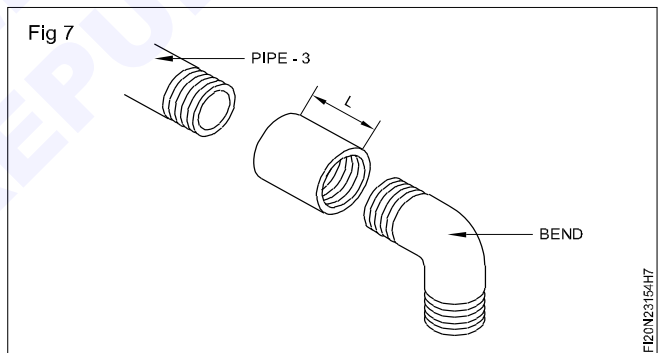
Wind the hemp packing to external threads of all the pipes and standard fittings and apply sealing compound over the threads before joining with the other one (Fig 4).



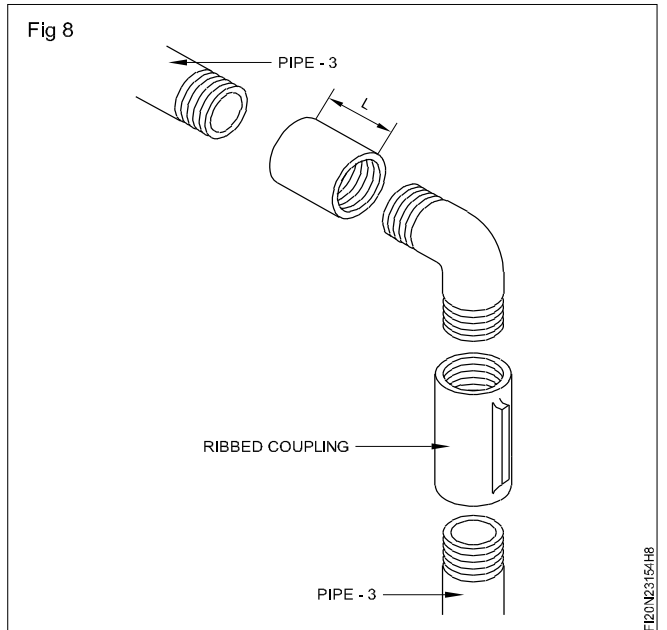
6 Join the plain coupling to the other end of the pipe No.3. (Fig 6)



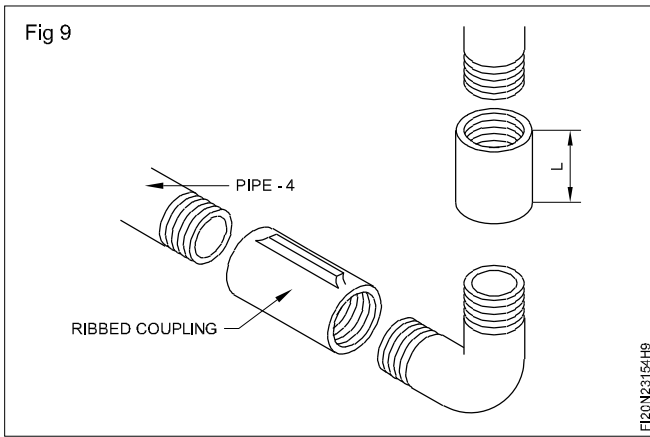
7 Fit the G.I. bend to the plain coupling. (Fig 7)



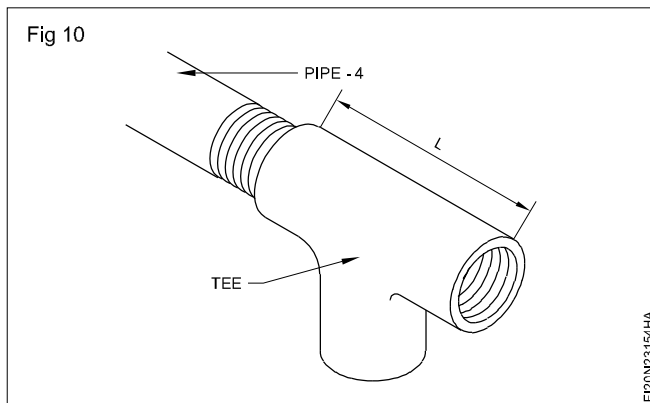
8 Assemble the ribbed coupling to the other end of the G.I. bend. (Fig 8)



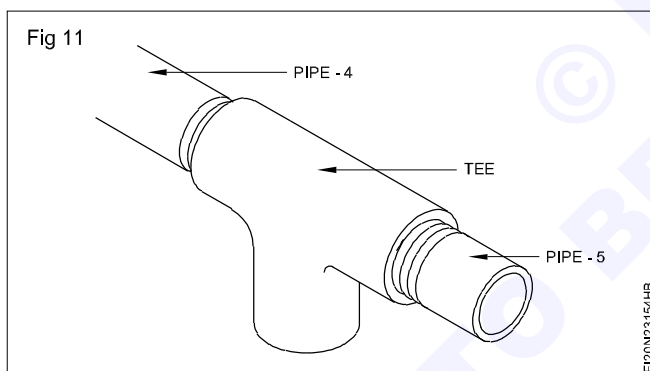
9 Connect pipe No.4 to the ribbed coupling. (Fig 9)



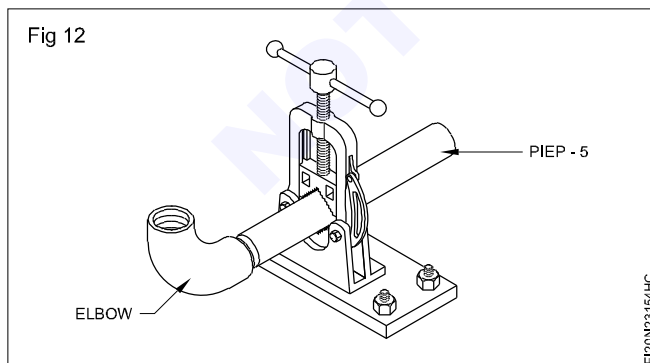
10 Fit 'T' with pipe No.4. (Fig 10)



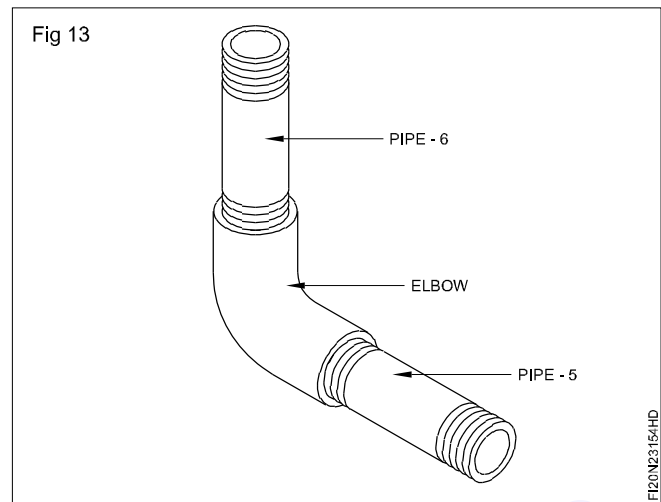
11 Connect pipe No.5 to the opposite end of 'T'. (Fig 11)



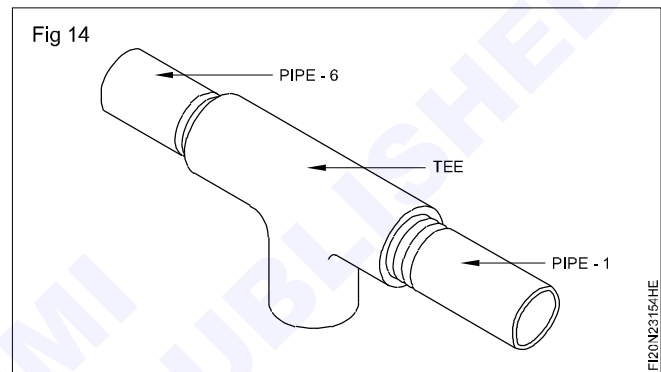
12 Assemble the elbow with pipe No.5. (Fig 12)



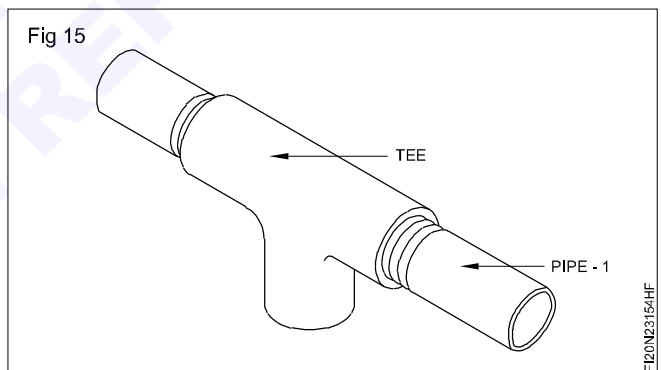
13 Fit pipe No.6 with the other end of the elbow. (Fig 13)



14 Connect 'T' with pipe No.6. (Fig 14)



15 Fit pipe No.1 with the opposite end of 'T'. (Fig 15)



16 Fit the rubber washer into the union.

17 Set pipe Nos. 1 & 2 with the union.

18 Hold one side of the union in one pipe wrench and the ring of the union in the other. (Fig 16)

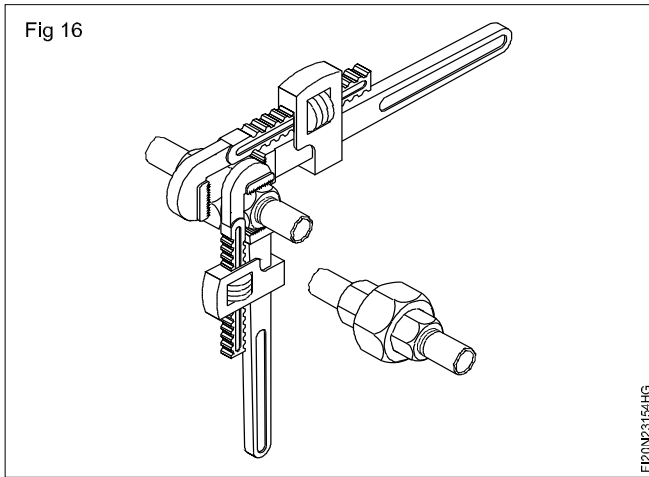
19 Turn the two pipe wrenches gently in opposite directions and assemble.

Use grease or vaseline on the union joint for easy dis-connection.

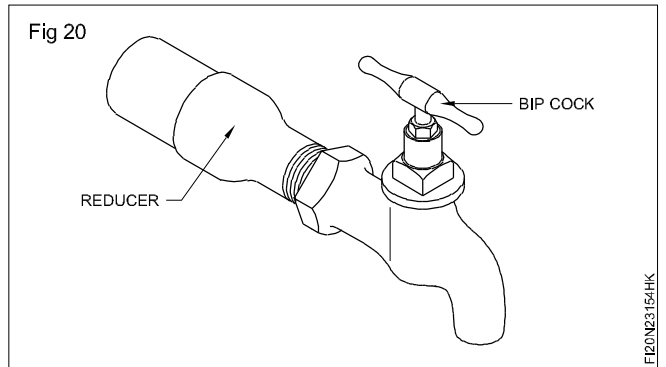
20 Fit a 150 mm barrel nipple to the left side of the cross and put a cap for it. (Fig 17)

21 Join another 150 mm barrel nipple to the right side of the cross. (Fig 18)

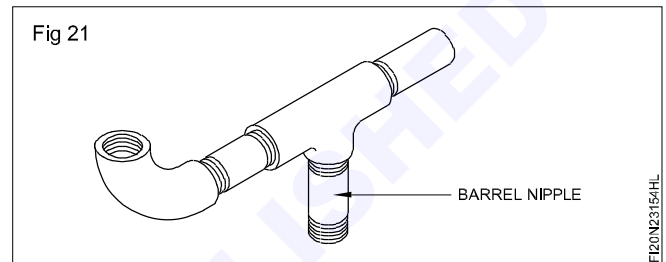
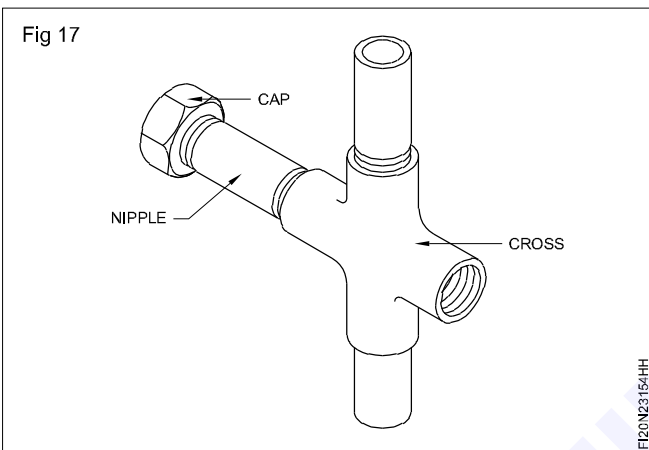
22 Connect the reducer to the barrel nipple. (Fig 19)



23 Assemble a bib-cock to the other end of the reducer. (Fig 20)

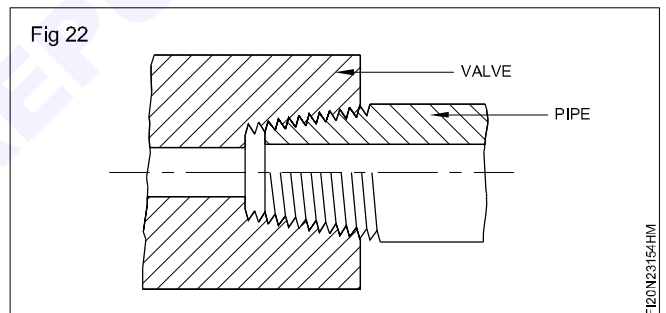
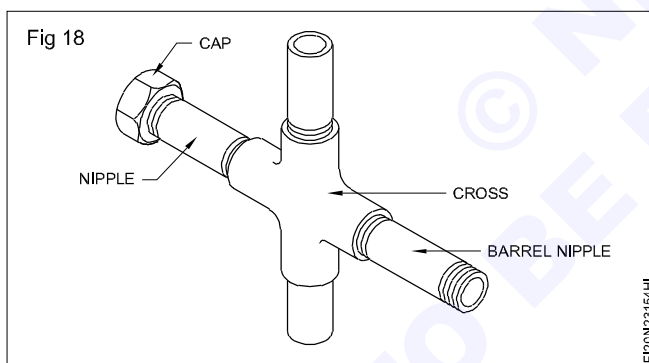


24 Fit a 100 mm barrel nipple to the bottom side of 'T'. (Fig 21)



25 Assemble the gate-valve to the 100 mm barrel nipple. (Fig 22)

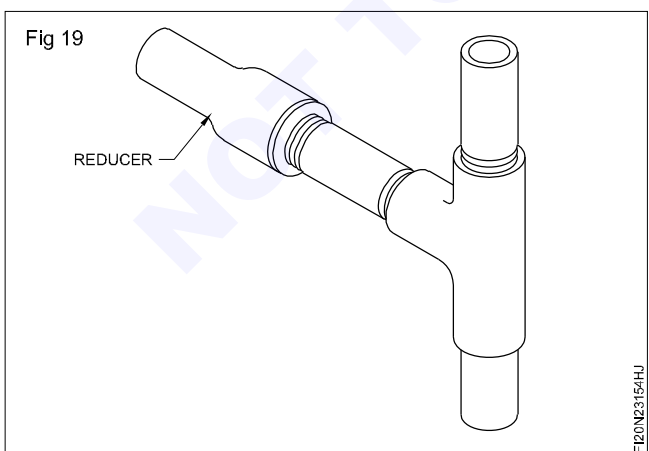
26 Allow a clearance between the valve and pipe. (Fig 22)



27 Join a hexagonal nipple to the left side 'T'.

28 Assemble a globe valve to the hexagonal nipple.

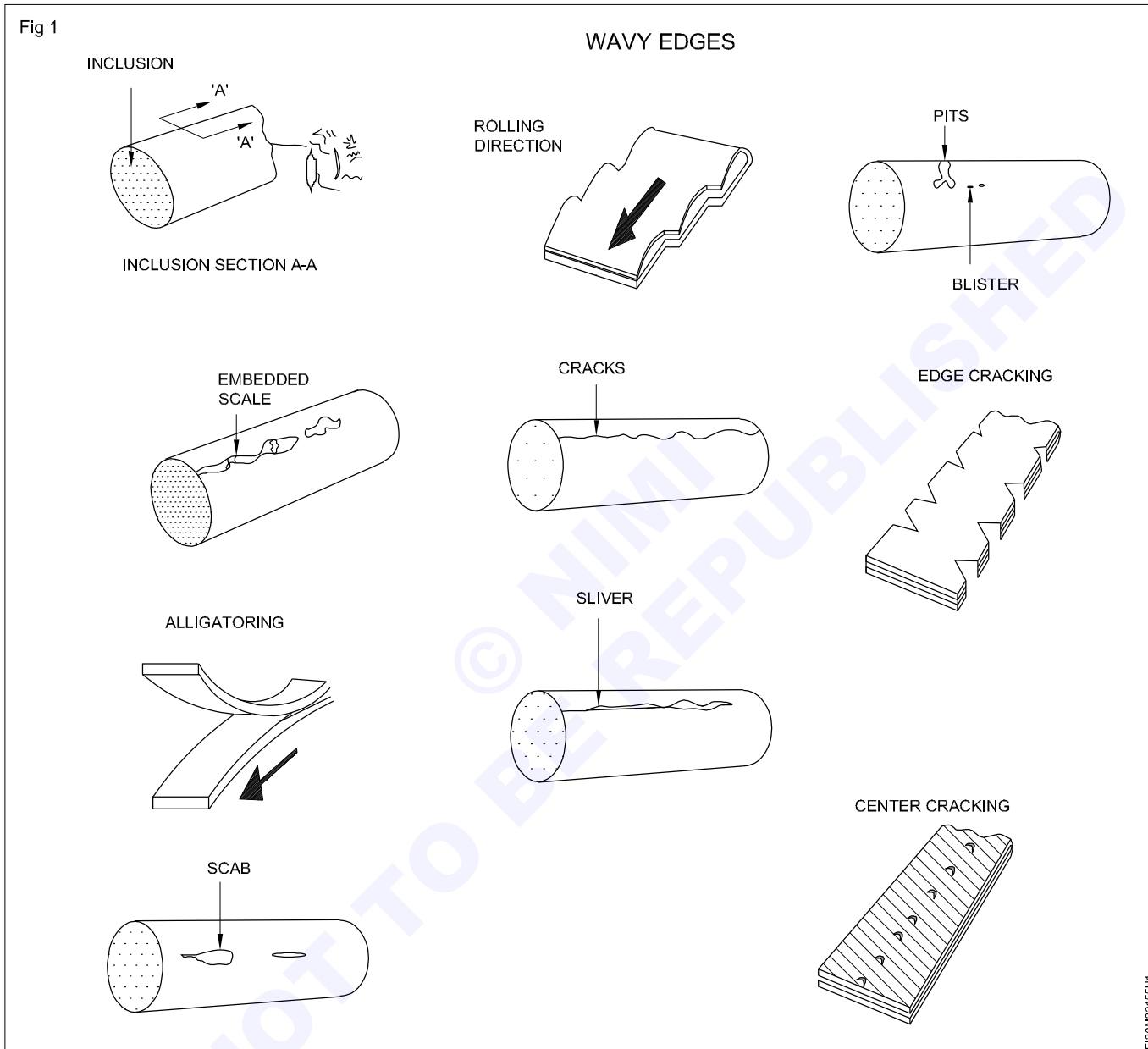
29 Check the joint for leakage.



Do not overtighten the fittings as this may cause the threads to the split.

Visual inspection for visual defects e.g. dents, surface finish

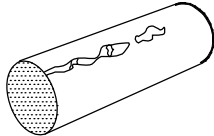


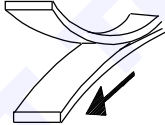
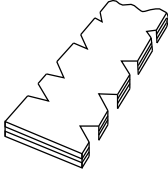
Objective: At the end of this exercise you shall be able to
• visual identification of defects on various metal sections.

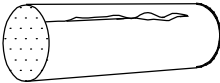
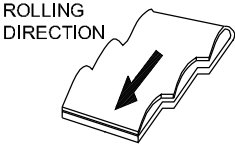
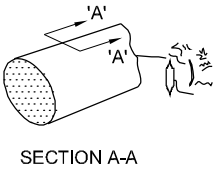
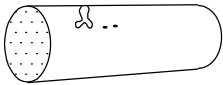
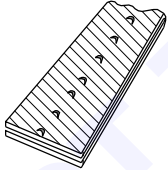


Job sequence

Instructor shall explain various defects on metal surfaces and demonstrate the same with the available surface finish damaged raw material, dent pipes and sheet metal etc.

- Ask the trainees to identify the defects and record it in table.

Sl.No.	Defects	Nature of defect
1		
2		
3		
4		
5		

Sl.No.	Visuals	Nature of defect
6		
7		
8		
9		
10		

- Get it checked by your Instructor.

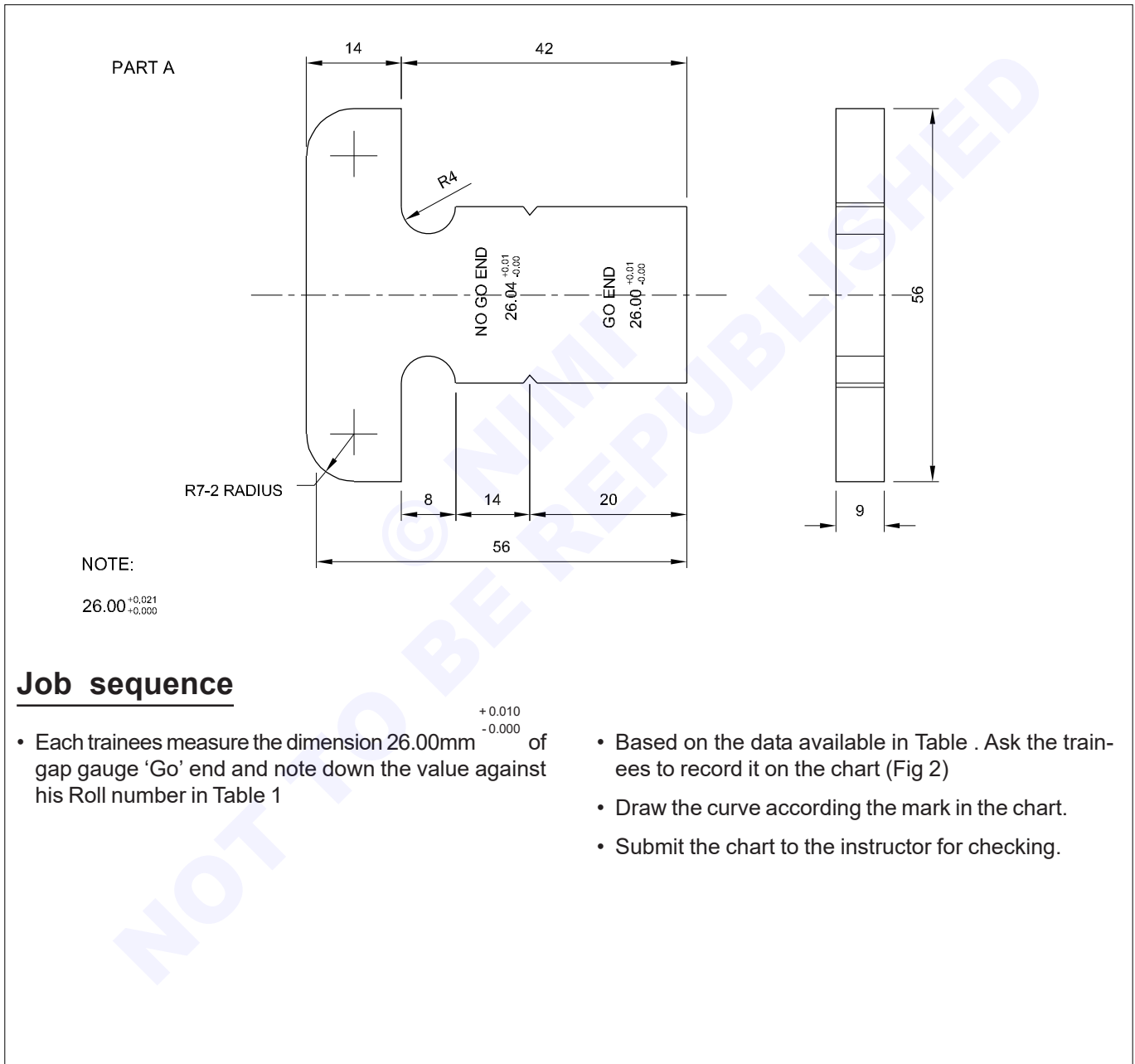
Measuring, checking and recording in control chart

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

- measure the dimensions and prepare the chart.

Instructor has to prepare 20 components as per drawing and keep it ready.

Ask the 20 trainees to check and measure all the 20 components hole size and plot the same reading on the control chart.



Job sequence

- Each trainees measure the dimension 26.00mm ^{+0.010}/_{-0.000} of gap gauge 'Go' end and note down the value against his Roll number in Table 1
- Based on the data available in Table . Ask the trainees to record it on the chart (Fig 2)
- Draw the curve according the mark in the chart.
- Submit the chart to the instructor for checking.

-	-	-	-	-	-	2.3.156	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.	
SCALE: 1:1		MEASURING, CHECKING AND RECORDING IN CONTROL CHART				TOLERANCE	TIME : 2 Hrs
						CODE NO. FI20N23156E1	

Table 1

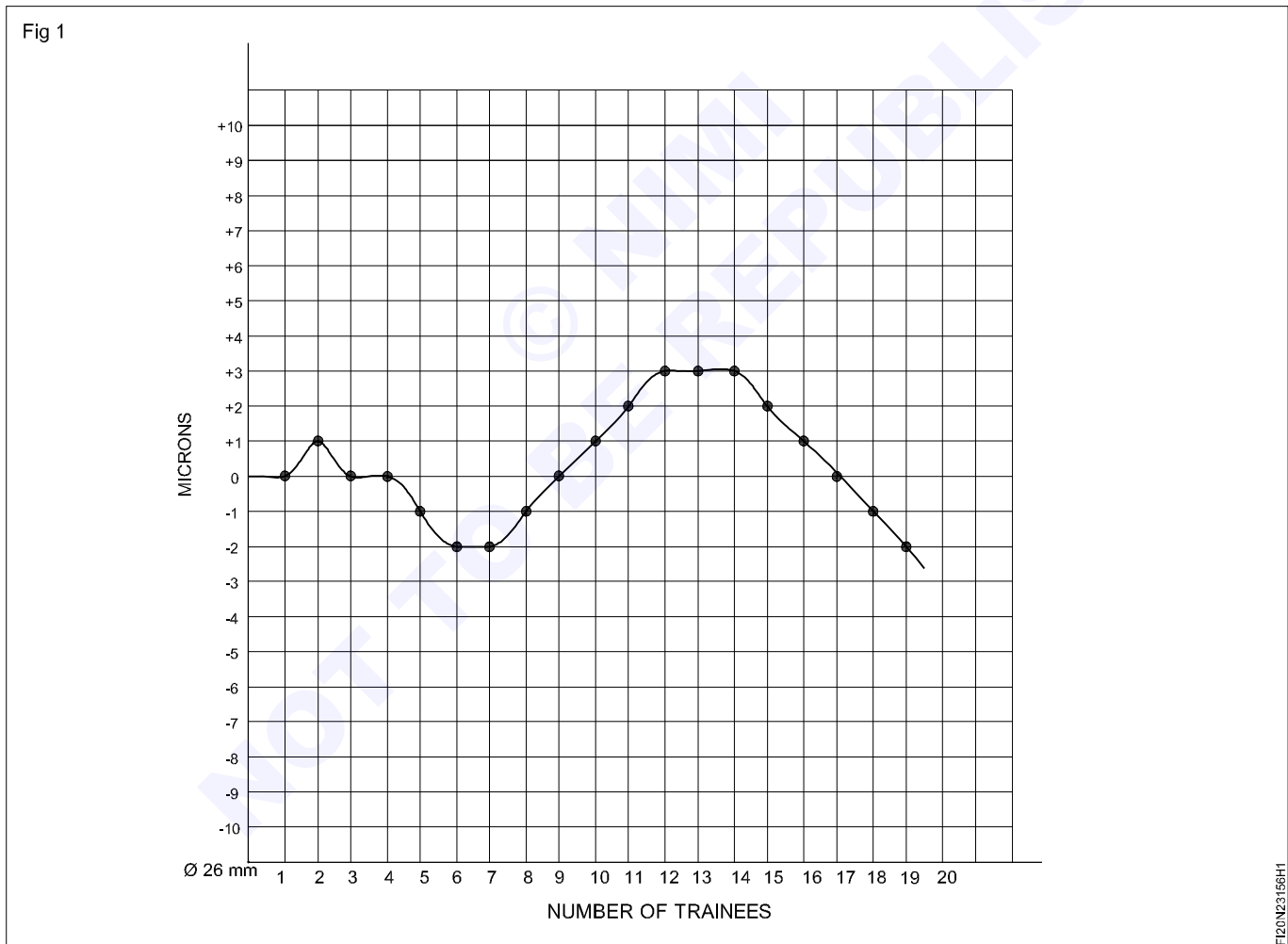
+0.010
-0.000

Enter each trainees component dimension 26.00

Sl.No.	Trainee Roll No.	Reading in mm
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Sl.No.	Trainee Roll No.	Reading in mm
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

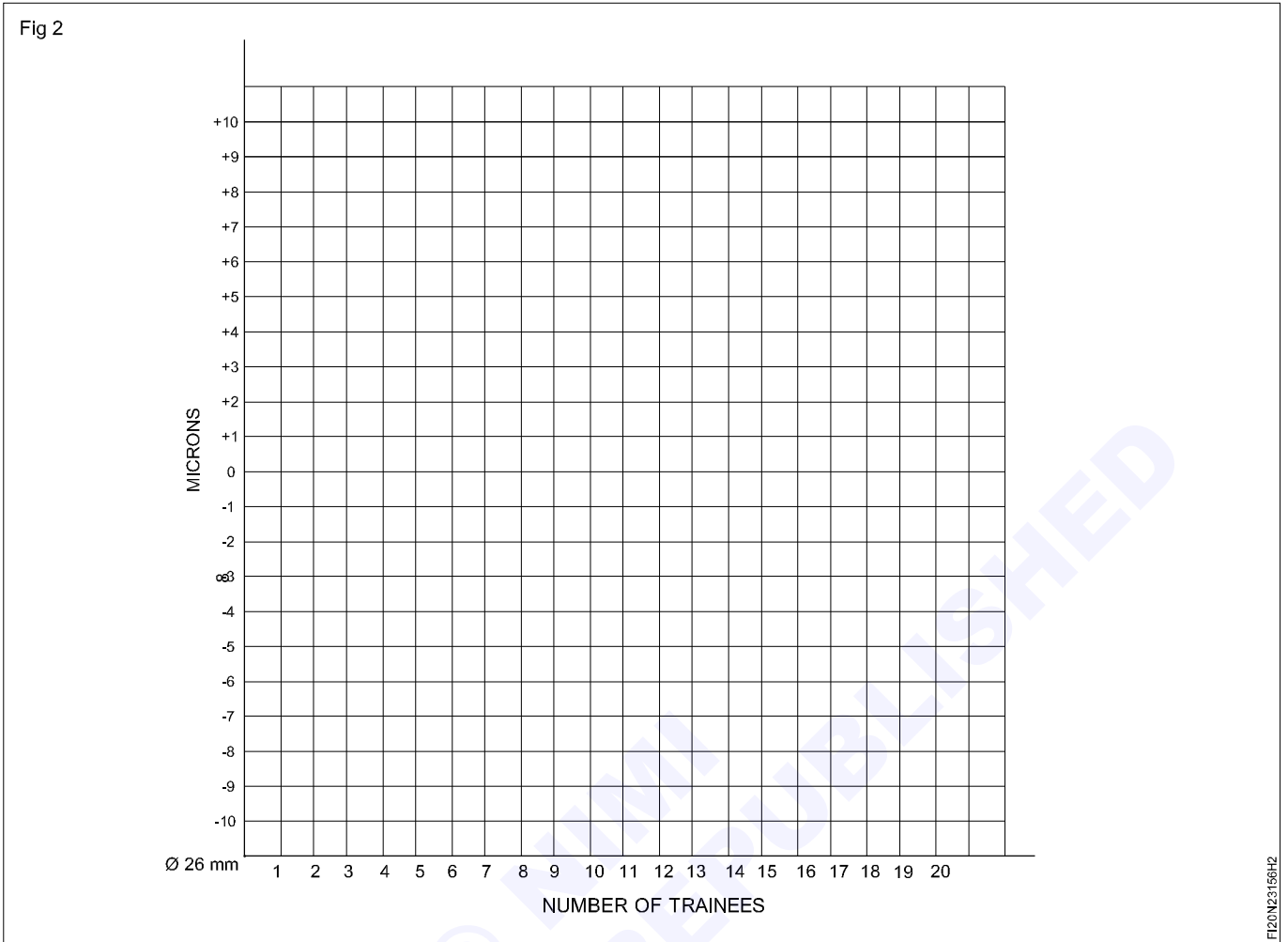
Example of Control chart (Fig 1)



The control chart is a graph used to study how a process changes over time. Data are plotted in time order. A control chart always has a centre line for the average, an upper

line for the upper control limit and a lower line for the lower control limit. These lines are determined from historical data.

Chart - 2



Make a simple drilling jig

- Objectives:** At the end of this exercise you shall be able to
- machine the parts of a drill jig and maintain the same for size
 - assemble the parts of a drill jig as per assembly drawing
 - check the dimensions and locations.

ASSEMBLY

WORK PIECE MS CHENNEL
75X40X5mm THICK

PART-1: TOP PLATE

Ø6 H7-2 HOLES
Ø12 H7-4 HOLES
Ø8- 2 REAMED HOLES

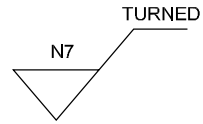
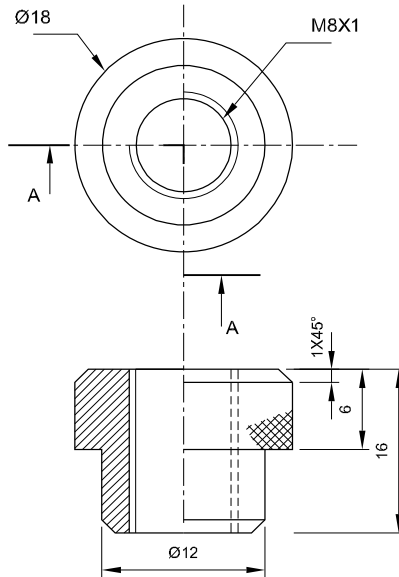
NOTE:

6 H7 - 6 $^{+0.015}_{+0.000}$

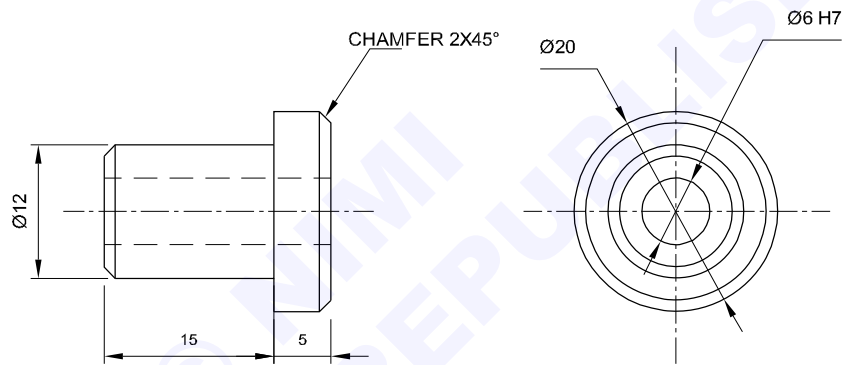
12 H7 - 12 $^{+0.018}_{+0.000}$

2	Ø6-20	DOWEL PIN	Fe310	-	5	2.4.157
2	Ø10-120	-	Fe310	-	4	
4	Ø22-25	-	Fe310	-	3	
2	Ø20-18	-	Fe310	-	2	
1	60 ISF 15-105	-	Fe310	-	1	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1		MAKE A SIMPLE DRILLING JIG			TOLERANCE ±0.02 mm	TIME : 20 Hrs
					CODE NO. F120N24157E1	

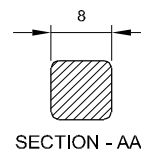
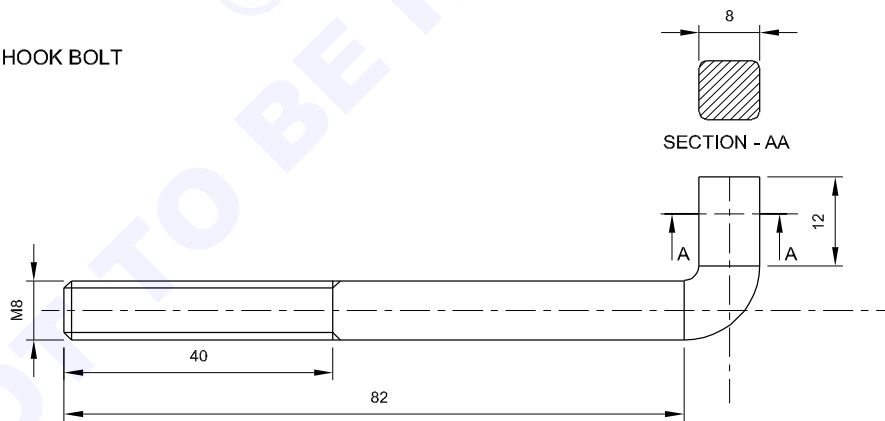
PART-2 : KNOB



PART-3: DRILL JIG BUSH



PART-4 : HOOK BOLT



NOTE:

$6 \text{ H}7 - 6^{+0.015}_{+0.000}$

$N7$ - SMOOTH MACHINING $Ra-1.6$

-	-	-	-	-	3 & 4	2.4.157
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	DRILL JIG BUSH AND HOOK BOLT				TOLERANCE \pm	TIME :
					CODE NO. F120N24157E2	

Job sequence

TASK 1: Top plate (Part 1)

- Check the raw material.
- File and finish the job 58 X 101 X 14 mm as per drawing.
- Mark the hole centres.
- Punch the hole with centre punch and 8mm reamer respectively.
- Set the job on drilling machine.
- Drill the holes $\varnothing 5.8 \text{ mm} + 7.8 \text{ mm}$ for reaming.
- Ream the hole using 6 mm and 8mm for reamer respectively.
- Drill 4 nos of $\varnothing 11.8 \text{ mm}$ for fixing bush.
- Ream the $\varnothing 11.8 \text{ mm}$ hole using 12mm reamer to get H7 finish.
- Remove burr in the sharp corner.

TASK 2: Knob (Part 2)

- Check the raw material.
- Hold the job in 3 jaw chuck.
- Make centre drill and enlarge the hole to $\varnothing 6.8 \text{ mm} \pm 0.1$.
- Turn dia $18^{+0.1}$ to a length of 20 mm.
- Turn step dia $12^{+0.1}$ to length of 10 mm.
- Knurl as per drawing.
- Reverse the job hold the knurled portion with soft packings.
- Face to a length of 16 mm.
- Chamfer as per drawing.
- Remove the job from lathe, hold on bench vice and make the thread of M8 using tap.
- Remove the burrs.
- Repeat the above for other knob.

TASK 3: Jig bush (Part 3)

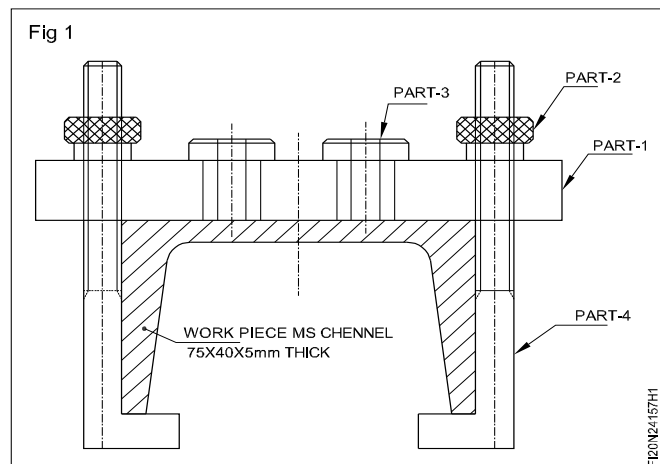
- Check the raw material.
- Hold the job in three jaw chuck.
- Face, centre drill and enlarge the hole to dia 5.8mm.
- Ream the hole $\varnothing 6 \text{ mm}$.
- Turn dia 20 mm to required length.
- Turn step of dia 12 mm to a length of 15 mm.
- Chamfer the end of dia 12 mm.
- Part to a length of 20 mm.
- Repeat the same for 4 pieces.
- Hold the dia 12 mm and face the other side to a length of 20 mm.
- Chamfer as per drawing.
- Remove the burrs.

TASK 4: Hook bolt (Part 4)

- Check the raw material.
- Bend the rod as per drawing using anvil and hammer.
- File flat surface as per section 'AA'.
- Chamfer the length side for threading.
- Make thread using 8 mm hand die with stock.
- Check the thread using $\varnothing 8 \text{ mm}$ nut
- Finish as per drawing.

Drill jig assembly (Part 5)

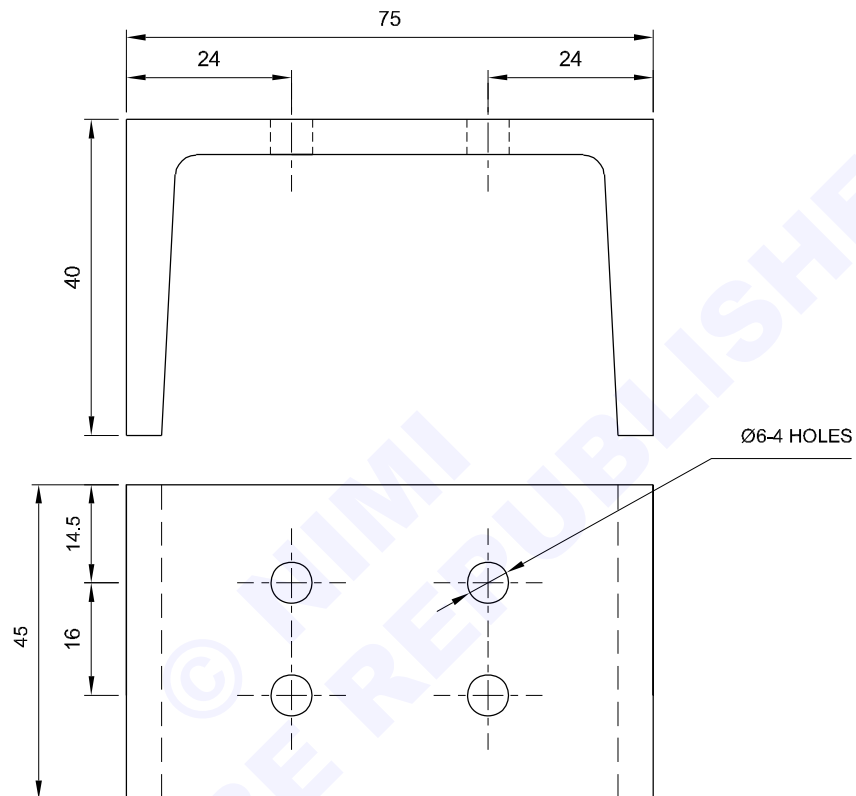
- Clean all the parts.
- Deburr sharp corners if any.
- Fit the bush (Task 3) in the top plate (Task 2).
- Fix the $\varnothing 6 \text{ mm} \times 16 \text{ mm}$ dowel pin on the top plate.
- Fix the hook bolt 2 nos.
- Insert the channel and locate on dowel pin.
- Now the drill jig is ready for drilling.
- Screw the knob in hook bolt for holding the channel with jig.
- Now the drill jig is ready for drilling.



Use simple jigs and fixtures for drilling

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

- locate the work piece in a jig
- drill the hole on MS Channel
- check for the accuracy.



Job sequence

Plate jig - trial

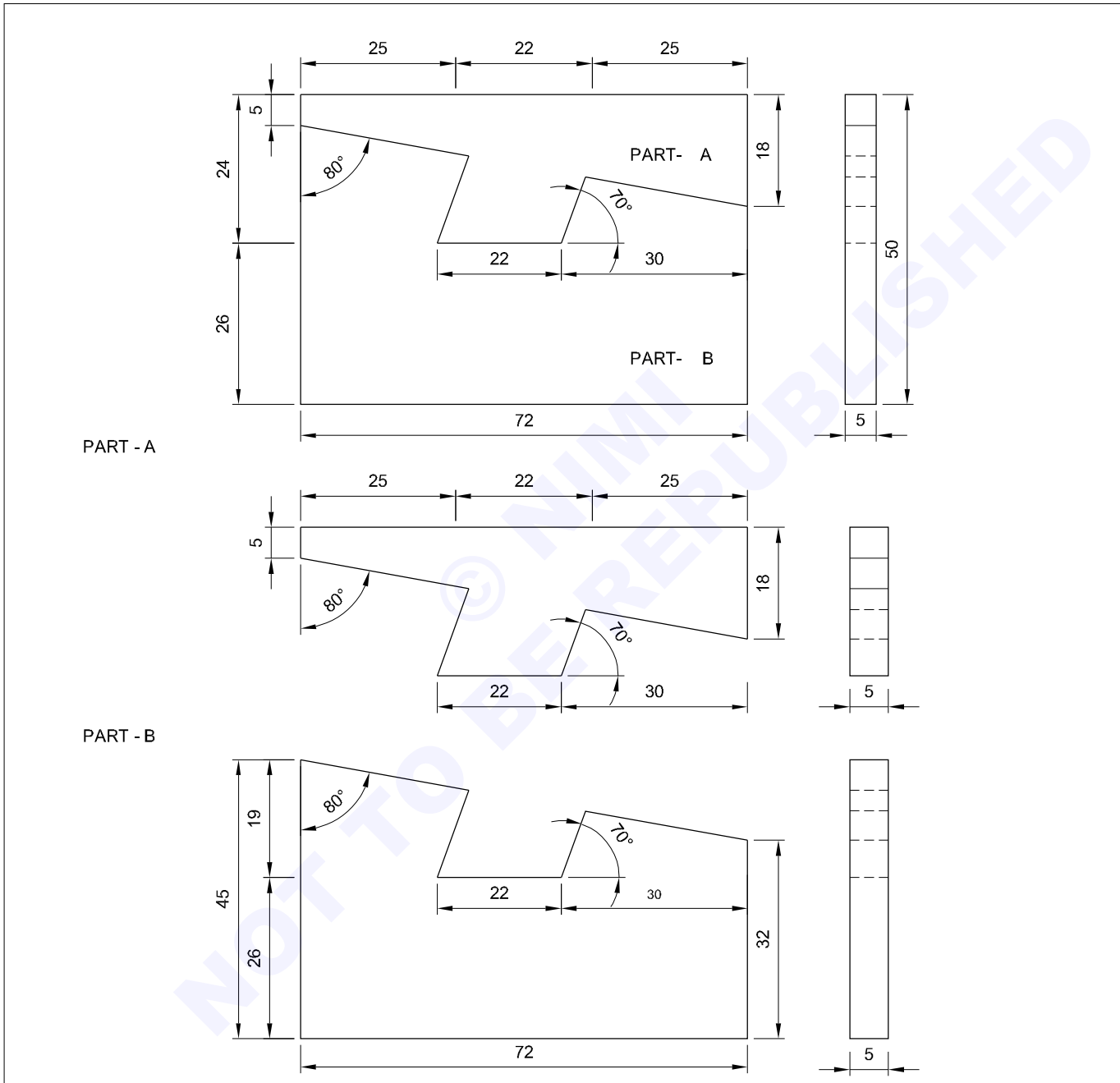
- Use previous Ex.No. 2.4.157 drill jig.
- Remove the top plate from the plate jig.
- Locate component between the hook bolt and top plate.
- Ensure the component touch with \varnothing 6mm dowel pin (stopper pin) of the top plate.
- Clamp the top plate with the knobs.
- Drill dia 6 x 4 Nos.
- Remove the top plate.
- Take out the component from the jig.
- Check the component with a vernier caliper according to the drawing.

1	ISMC 75X40-50	-	Fe310	-	-	2.4.158
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1		USE SIMPLE JIGS AND FIXTURES FOR DRILLING			TOLERANCE ± 0.02 mm	TIME : 4 Hrs
					CODE NO. F120N24158E1	

Marking out for angular outlines, filing and fitting the inserts into gaps

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

- mark an angular out lines on part A & B with an accuracy of $\pm 0.02\text{mm}$
- file part A & B maintain the accuracy of H7/g6 for fitting
- fit inserts.



1	75 ISF 6 - 50	-	Fe310	-	B	2.5.159
1	75 ISF 6 - 28	-	Fe310	-	A	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1					TOLERANCE $\pm 0.02\text{ mm}$ TIME : 6 Hrs	
<p align="center">MARKING OUT FOR ANGULAR OUTLINES, FILING AND FITTING THE INSERTS INTO GAPS</p>					CODE NO. FI20N25159E1	

Job sequence

- Cut the raw materials as per the dimensions
- File right angle and mark off part A & B with vernier height gauge and vernier bevel protractor
- Punch on the marked lines / out lines
- Remove unwanted materials by hacksawing and chain drilling
- File Part A&B with a linear accuracy of $\pm 0.02\text{mm}$ and angular of $\pm 5'$
- Checking the angular dimensions by vernier bevel protractor
- Fit Part : A & B and finish

Safety

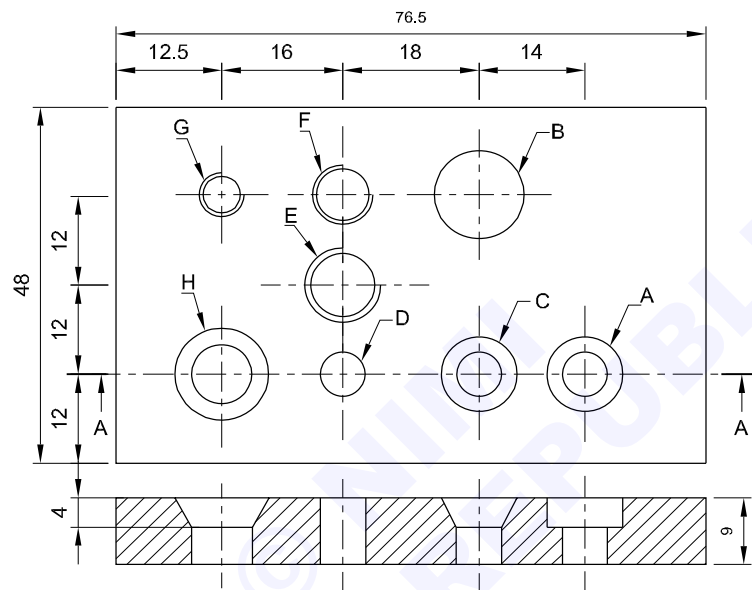
- Do not mark angular dimensions / angle by scale / set square while marking
- Do not use hammer for fitting

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Exercises on finished material, such as aluminium/ brass/ copper/ stainless steel, marking out, cutting to size, drilling, tapping etc. without damage to surface of finished articles

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

- mark on the Aluminium, Brass, Copper with vernier height gauge
- cut extra metal using hacksaw
- drill counter sink, counter bore and ream
- tap, finish and de-burr.



NOTE: COMMON JOB DRAWING FOR TASK 1 TO 4

A - Counter Bore	-	Ø 6	F - Tap	-	M8
B - Drilling	-	Ø12	G - Tap	-	M6
C - Counter Sunk	-	Ø10	H - Counter Sunk	-	Ø12.5
D - Ream	-	Ø 6			
E - Tap	-	M10			

1	75 ISF 10-52	-	STAINLESS STEEL	4	-	2.5.160
1	75 ISF 10-52	-	COPPER	3	-	2.5.160
1	75 ISF 10-52	-	BRASS	2	-	2.5.160
1	75 ISF 10-52	-	ALUMINIUM	1	-	2.5.160
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	TASK	PART NO.	EX. NO.
SCALE : NTS		EXERCISES ON FINISHED MATERIALS, SUCH AS ALUMINIUM/BRASS/ COPPER/STAINLESS STEEL, MARKING OUT, CUTTING TO SIZE, DRILLING, TAPPING ETC. WITHOUT DAMAGE TO SURFACE OF FINISHED ARTICLES			TOLERANCE ±0.02 mm	TIME : 9 Hrs
					CODE NO. FI20N25160E1	

Job sequence

Task 1 to 4

- Check the raw material.
- File adjacent sides and one flat surface.
- Mark the dimensions as per drawing.
- Punch on marked dimension with 'Dot punch' and centre punch.
- Set the job on drilling machine.
- Make the drill holes as per drawing.
- Use kerosene as coolant for task-1 Aluminium.
- Use dry soluble oil or lard oil as coolant for task-2 - Brass.
- Use dry soluble oil or mineral lard oil as coolant for task-3 - Copper.
- Use cutting fluid as coolant for task - 4 stainless steel.
- Make reaming, counter boring, tapping and counter sinking as per dimensions
- Remove burrs and submit work for evaluation.

Caution

Use soft jaw for clamping on the vice use only soft hammer for setting the work piece.

Do not over tight the work piece, handle gently not ot make any scratch on the work piece.

Making an adjustable spanner

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

- prepare different parts referring to the drawing
- prepare for assembly
- assemble all the parts
- check for the accuracy.

1	Ø2h8 x 10 IS : 2393	CYLINDRICAL PIN	Fe310		G	
2	Ø4 x 18 IS : 2155	FLAT CSK HEAD RIVET	Fe310		F	
1	Ø18 - 18	KNURLED NUT	Fe310		E	
1	ISST 125 x 1.6 - 55	SLIDING PLATE	Fe310		D	
1	Ø6 - 58	SPECIAL SCREW	Fe310		C	
1	30 ISF 8 - 70	SLIDING JAW	Fe310		B	
1	40 ISF 8 - 85	FIXED JAW	Fe310		A	2.5.161
NO.OFF	STOCK SIZE	DESCRIPTION	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

4 H7 - 4 ^{+0.012}/_{+0.000}

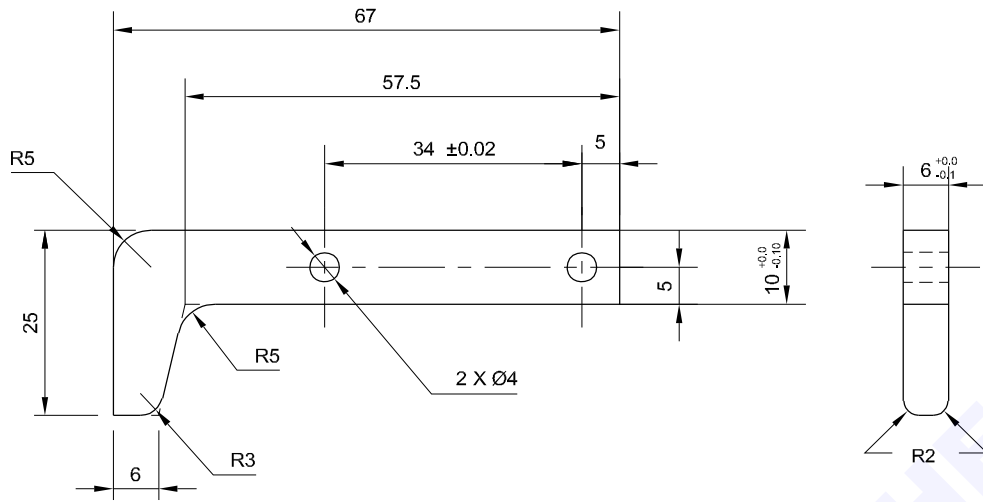
SCALE 1:1

MAKING AN ADJUSTABLE SPANNER

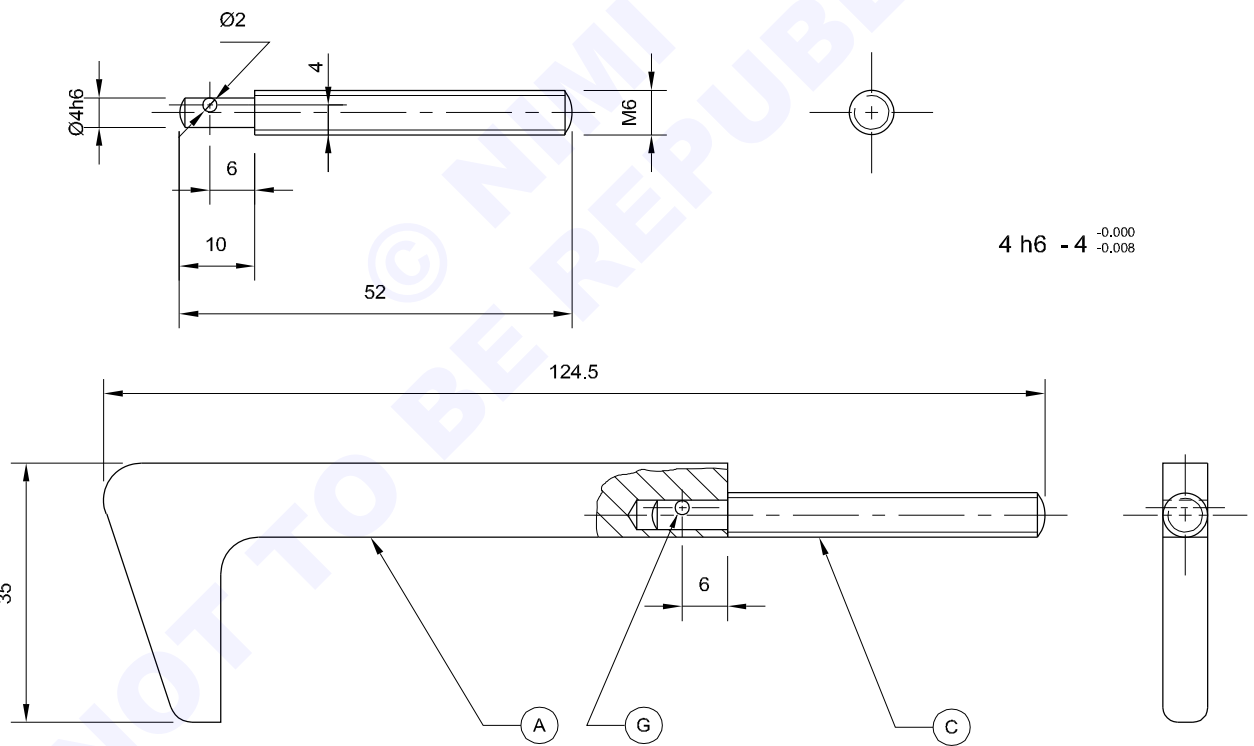
TOLERANCE ± 0.02 mm TIME : 16 Hrs

CODE NO. FI20N25161E1

PART - B SLIDING JAW



PART - C SPECIAL SCREW

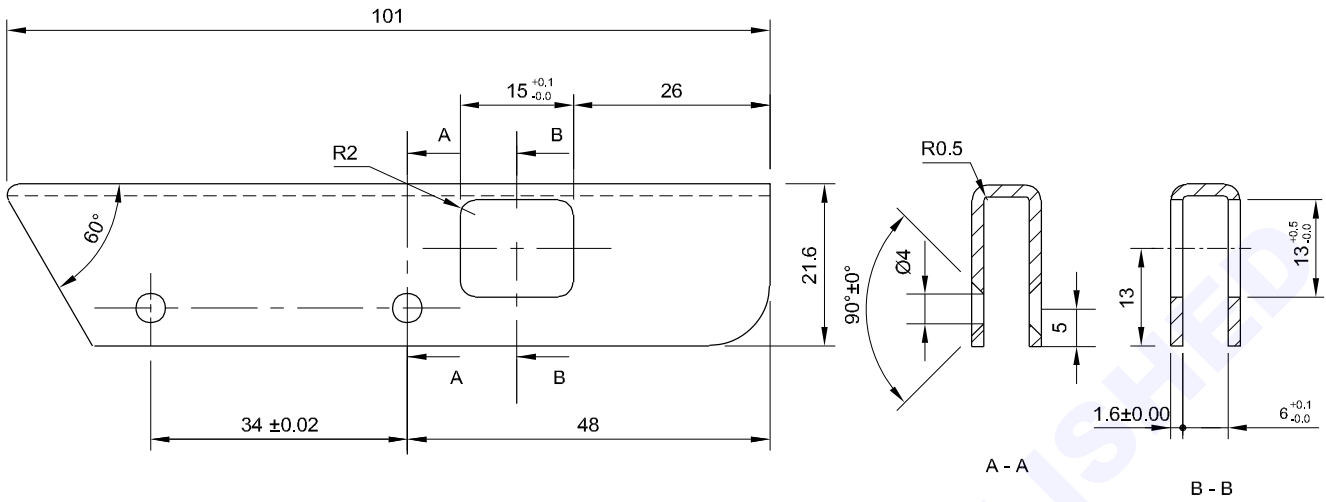


4 h6 - 4 ^{-0.000}/_{-0.008}

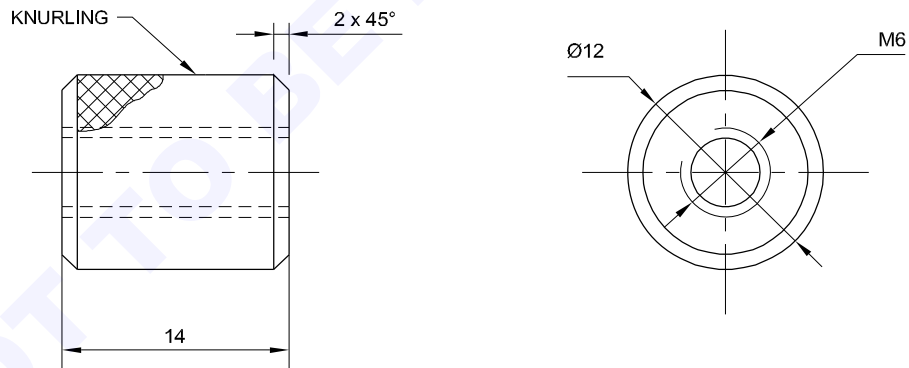
SPECIAL SCREW ASSEMBLED WITH FIXED JAW

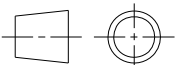
-	-	-	-	-	A & B	2.5.161
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	PARTS OF ADJUSTABLE SPANNER				TOLERANCE ±	TIME:
					CODE NO. F120N25161E2	

PART - D SLIDING PLATE



PART - E KNURLED NUT



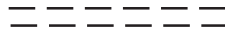
-	-	-	-	-	C	2.5.161
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	PARTS OF ADJUSTABLE SPANNER				TOLERANCE ±	TIME:
					CODE NO. FI20N25161E3	

Job sequence

TASK 1:

Part 'A' - Fixed jaw

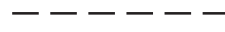
- Check the raw material for the given size
- File the surface and side for straightness
- File the adjacent side for right angle
- Do the marking as per drawing with vernier height gauge
- Remove the excess material by hacksawing or chain drilling
- Drill $\varnothing 10$ hole for the R5 concave
- File and check for the dimension as per drawing
- Check the radius with radius gauge R5 & R3
- Drill the hole $\varnothing 3.8$ mm from the side to the depth of 12mm and ream $\varnothing 4$
- De - burr and finish smooth surface



TASK 2:

Part 'B' - sliding jaw

- Check the raw material for the given size
- File the surface and side for straightness
- File the adjacent side for right angle
- Mark the job as per the drawing with vernier height gauge
- Remove the excess material by hacksawing or chain drilling and $\varnothing 4, 2$ hole
- File the job for the dimension and check the dimension
- File for the radius edges
- File the edges and deburr the job



TASK 3:

Part - 'C' - Special screw

- Check the rod for $\varnothing 6 \times 52$ mm
- Turn the rod holding in 3 jaw chuck for $\varnothing 4$ mm, 10mm length with h6 finish.
- Reduce length to 52mm.
- Do the threading M6 for the entire length
- Check with the die nut for threaded portion

Fixed jaw assembly

- Insert the rod into the fixed jaw and position it.
- Drill $\varnothing 2$ mm hole along with the fixed jaw
- Fit the cylindrical pin $\varnothing 2$,
- Check the dimensions



TASK 4:

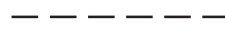
Part D: Sliding plate

- Check the metal sheet for the dimension
- File the sheet metal for straightness and right angle by draw filing
- Mark the layout as per drawing and punch
- Bend the sheet metal into right angle with the help of 6mm flat by hammering
- Check for the dimension after bending
- Mark drill the $\varnothing 4$ hole for the slot opening
- Chain drilling for the slot opening remove excess metal
- File the slot for the dimensions
- Mark drill $\varnothing 4$ mm in the position as per drawing

- File for 60° angle and check with bevel protractor
- Do the radius filing and remove the burr's

Part 'E' Knurled Nut

- Check the raw material as per the drawing size
- Hold the rod in the three jaw chuck and true
- Turn the round for $\varnothing 12$ mm
- Knurled the outer surface with knurling tool upto 15mm length
- Drill $\varnothing 5$ mm and tap the drilled hole by M6 Tap
- Chamfer the side $2 \times 45^\circ$
- Do the parting off and chamfer the other side.



TASK 5:

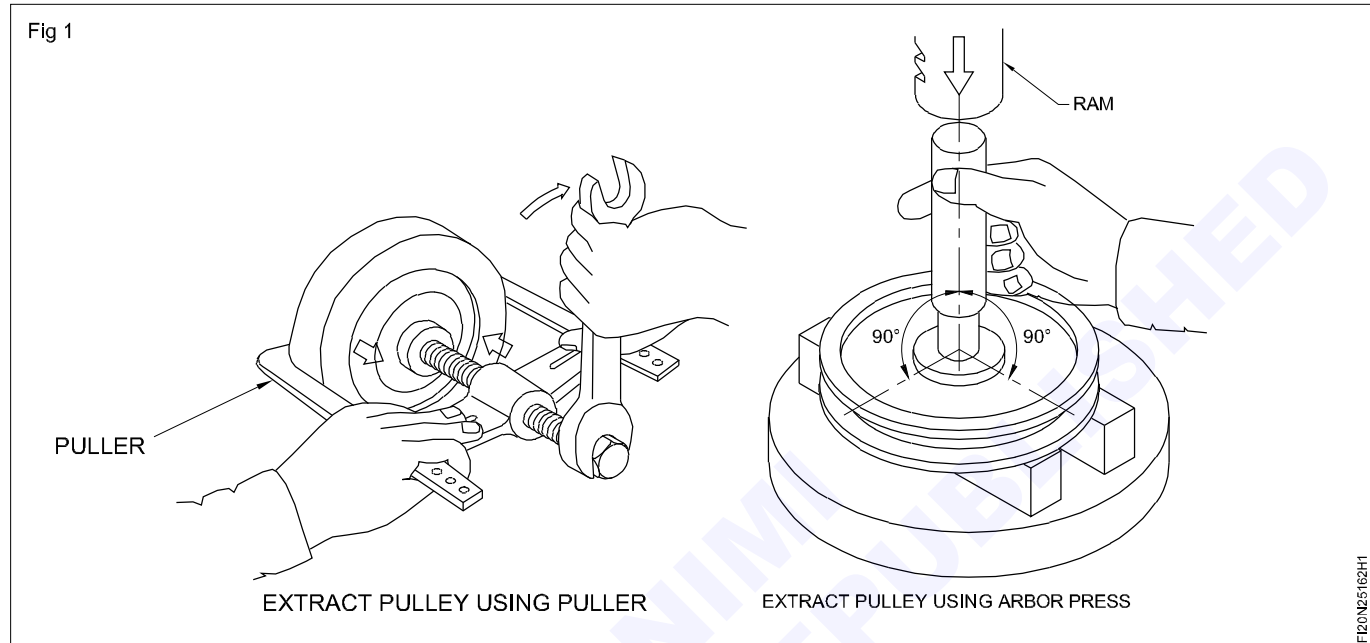
Spanner assembly

- Check material size for all the parts
- File, mark and finish parts A & B to size
- Bend Part 'D' as per drawing
- Remove excess metal and finish to size
- File and finish square slot
- Drill and counter sink holes
- Turn, drill, tap, knurl and part off part E to size
- Step turn, cut external thread using and part off part 'C' to size
- Assemble part C & A
- Rivet and join part B and D
- Assemble all the parts together as shown in the assembly drawing.

Dismantling and mounting of pulleys

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

- extract pulley using puller
- extract pulley using arbor press
- mount pulley on shaft.



Job sequence

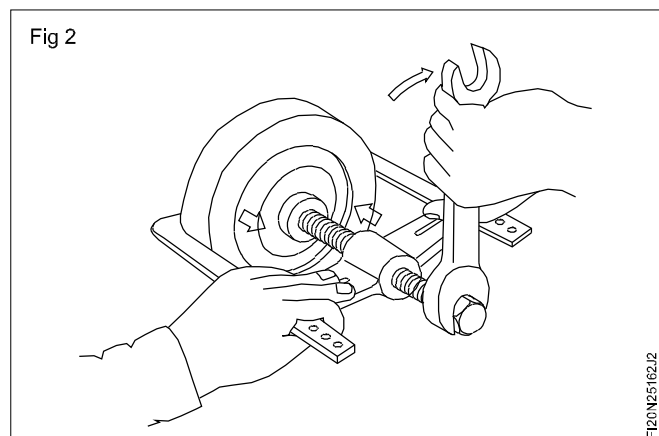
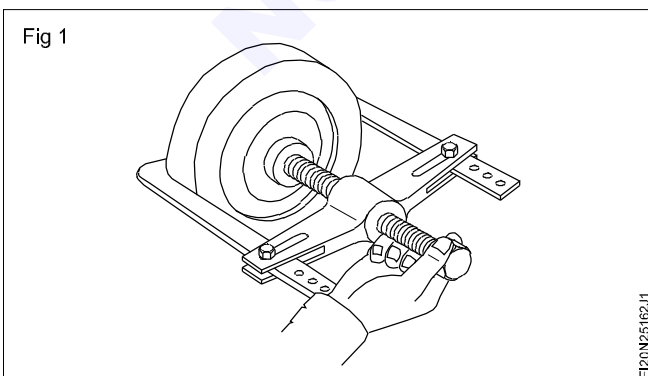
Extract pulley from shaft

- Remove pulley using puller.
- Remove pulley using arbour press.

Extract pulley using puller

- Select correct size of puller, depending upon the size of the shaft and pulley.
- Clean end of the shaft using flat file, to remove any burrs or bulging on the end of the shaft.
- Place the legs of the puller diagonally opposite sides of the pulley to hold the pulley firmly . (Fig 1)

- Position the centre screw of the puller by hand screwing, so that, sufficient centre screw length is available for complete removal of the pulley from the shaft.
- Apply few drops of oil, around the shaft before removing.
- Tighten the centre screw gradually using correct size spanner and check whether the pulley is coming out freely from the shaft, if not slightly hammer on the head of the centre screw, this will cause the pulley to come out from the shaft freely. (Fig 2)

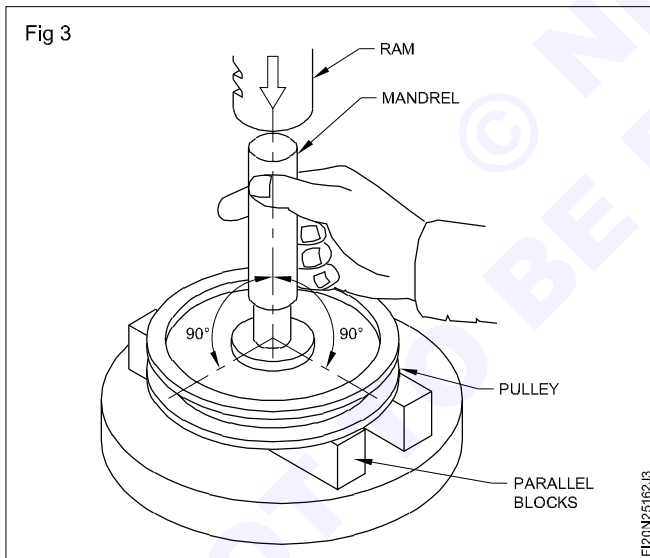


For removing pulley from smaller shaft use Arbor press.

For removing pulley from longer shaft or from the shaft attached to the machine. Use proper puller.

Extract pulley using Arbor press

- Clean the end of the shaft with flat file to remove any burrs or bulging from the end of the shaft.
- Set the Arbor press according to the shaft it should be less than the diameter of the shaft.
- Select the mandrel according to the shaft it should be less than the diameter of the shaft.
- Select a pair of parallel blocks and position them on the bed of the press.
- Place the pulley with shaft on the parallel blocks, such that the shaft in the pulley is in line with the ram of the press. Ensure that the parallel blocks are as close as to the shaft to give maximum support.
- Apply few drops of oil around the shaft to reduce friction during removal.
- Position the mandrel on the shaft and position the ram of the press on the mandrel (Fig 3).

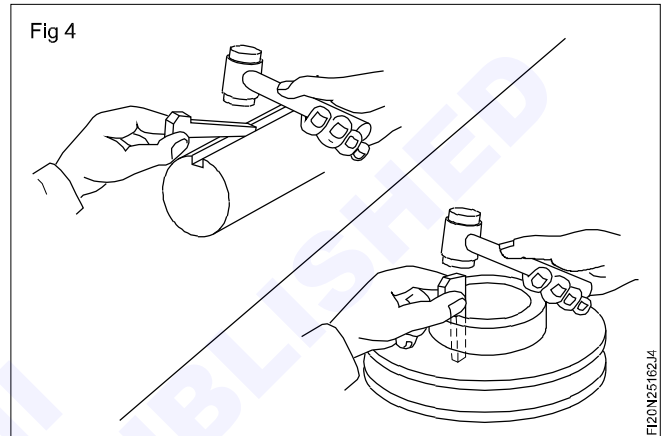


- Apply light pressure with the ram on the mandrel gradually so that the shaft is extracted out of the pulley. Apply same pressure on the ram still the shaft is completely ejected out from the pulley.
- Bring back the ram to its original position gradually and remove the mandrel.

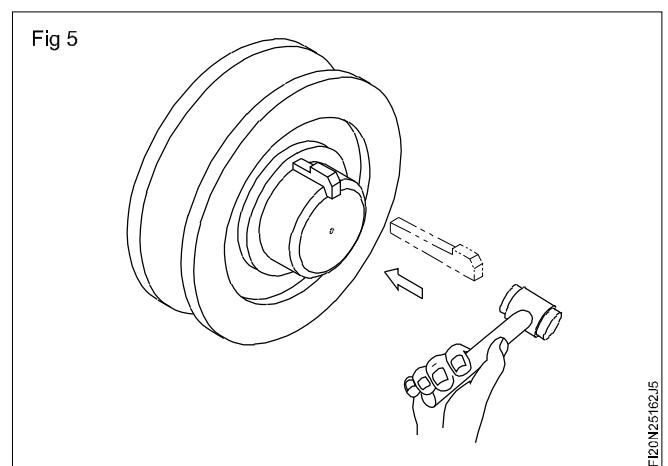
Assemble pulley and shaft

- Deburr the keyway in the shaft and the hub and clean the keyways.

- Check the dimensions of the shaft and the hub and the keyways.
- Check, by inserting the hub on the shaft, so that it is a tight push fit with the hands on to the shaft. Polish the shaft or scrap bore of the workpiece until this fit is obtained.
- Select a Gib head key of the correct section and length.
- Check the key for width by inserting into the keyway of the shaft, draw file the key until it is a light tap fit in the keyway. Similarly, check the key in the keyway of the hub. (Fig 4)



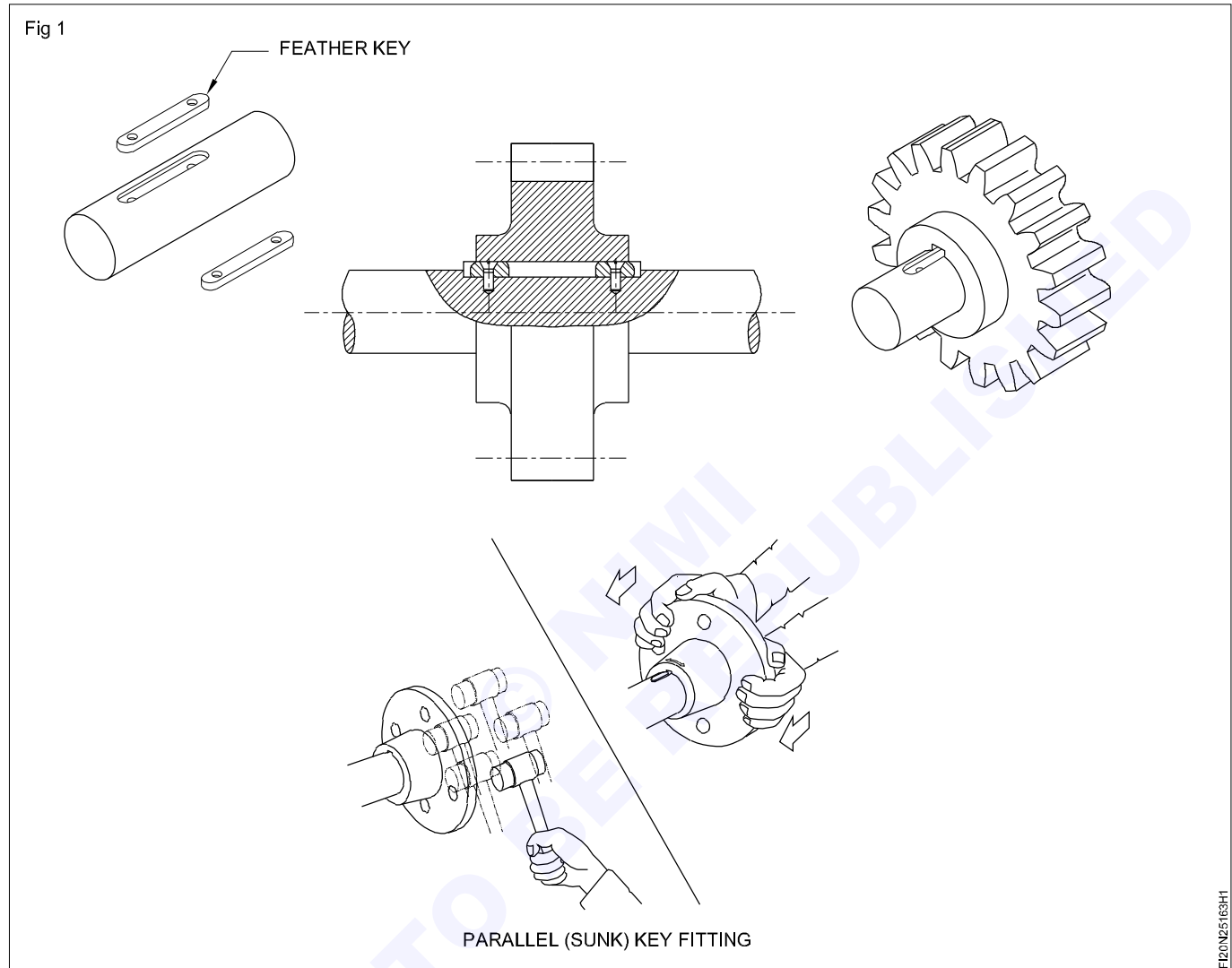
- Fit the hub on to the shaft by taping slightly with a soft hammer.
- Tap the key in to the keyway. Remove the key and check for any high spots, and file away the high spots. Repeat the above operation until the key head is approximately 15mm away from the boss of the hub. (Fig 5).
- Remove the key and check the fit on the faces.
- Fit key with a firm blow with a hammer.



Making and replacing damaged keys

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

- assemble using feather key in hub and shaft

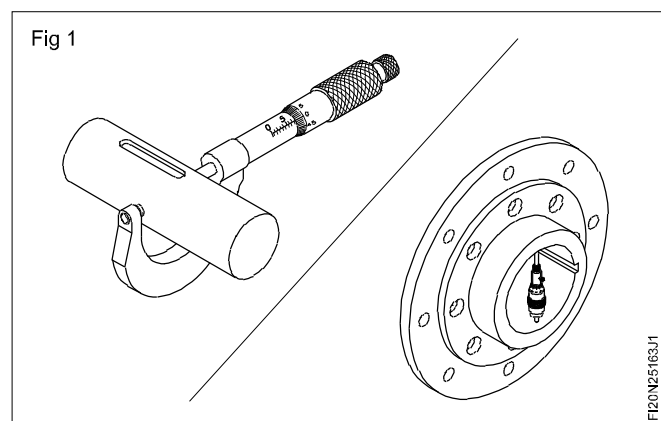


Job sequence

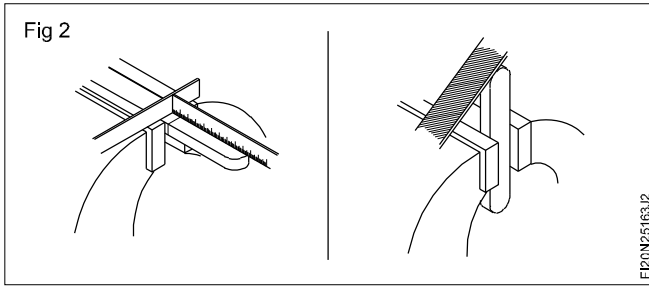
- Assemble hub and shaft with parallel key.

Parallel key fitting

- Deburr the keyways in the shaft and the Hub, clean the keyways.
- Check the dimensions of shaft and Hub and keyways using precision instruments. (Outside dia of shaft, inside dia of hub, length, width and depth of keyway) as per the drawing (Fig 1).
- Select a length of key steel of suitable cross section depending on the size of the keyway.
- File radius at one end of the key and cut to a length plus

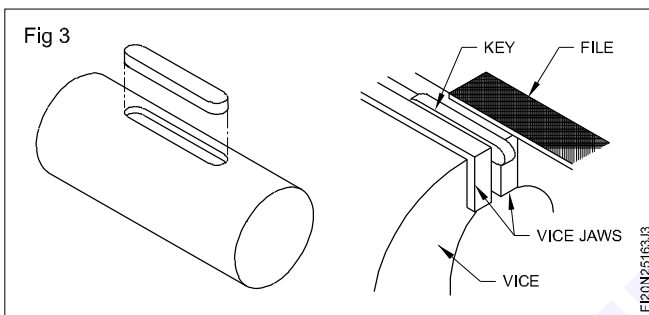


1 mm of the keyway and file other end of the key (Fig 2).

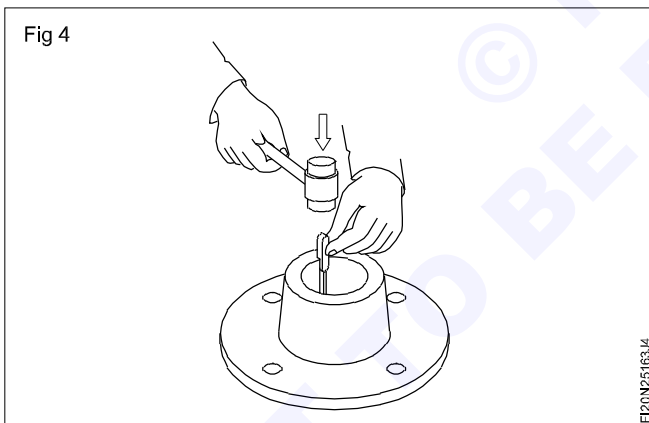


Ensure that the key is chamfered all around in its bottom side edges.

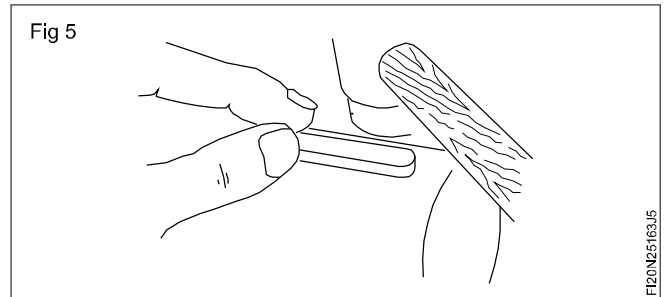
- Check the key width to suit the keyway in the shaft. Draw file the key, so that it is slight tap fit/light keying fit (K7-h6) with the keyway on the shaft (Fig 3).



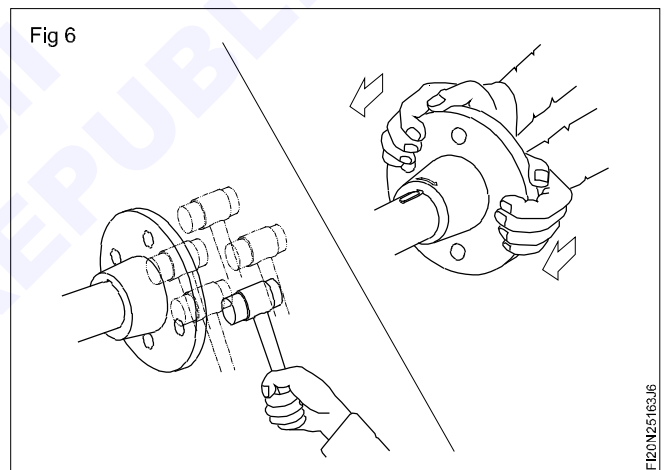
- Check the key for slight tap fit with the keyway in the Hub (Fig 4).



- Apply Prussian blue on all sides and bottom portion of the key so that proper bearing of key on the keyway is ascertained.
- Insert the key in the keyway of the shaft and tap with a light weight soft hammer (Fig 5).



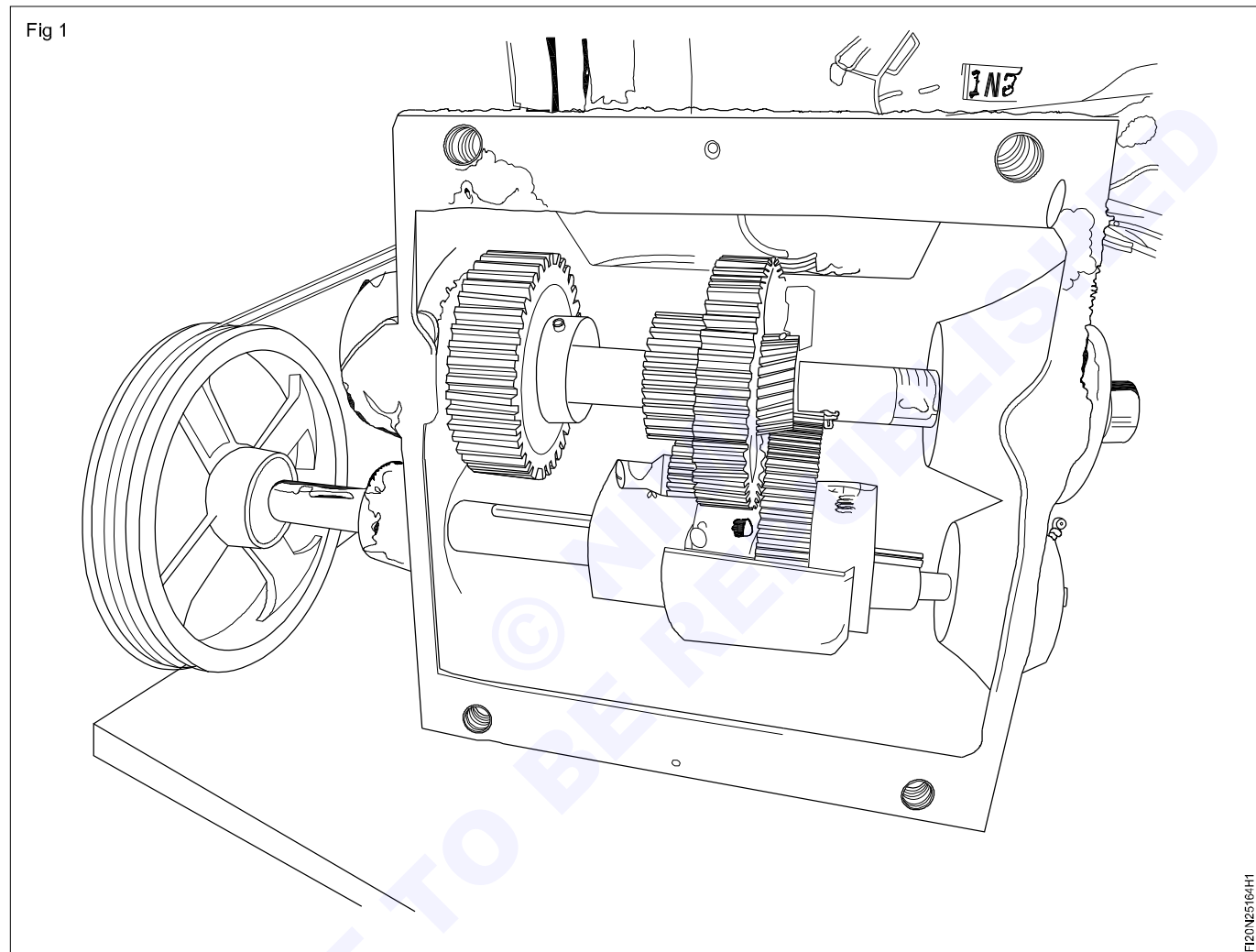
- Tap the hub on the shaft, and remove the hub from the shaft, check the key and note the high spots where the key has made contact with the keyway of the hub.
- Lightly file the high spots away, the top of the key should be approximately 0.1mm clear.
- Repeat the fitting and filing operation until the hub is fit on to the shaft to the desired position (Fig 6).



Repairing damaged gears

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

- dismantle gear box from the machine
- check out and replace wornout or damaged parts
- assemble the gear box
- mount the gear box to the machine, check the test run.



Job sequence

Dismantling the gear box

- Switch of the main power supply
- Inspect the shaping machine gear box.
- Dismantle the guard and belts
- Support the gear box with wooden blanks
- Unscrew the fastener's by using suitable tools (Fig 1).
- Remove the gear box and keep it on the work table
- Remove the driven pulley from the driver shaft using puller. (Fig 2)



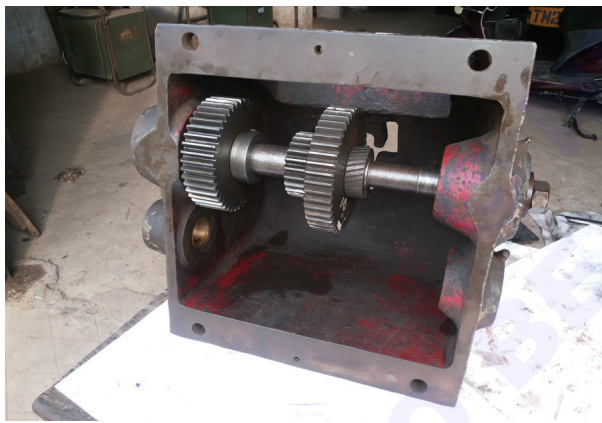
Fig 2



F120N25164H2

- Remove the key from the drive shaft.
- Remove bearing covers and internal circlips.
- Dismantle the driver shaft by tapping the shaft using copper rod and hammer.
- Remove the bearings and sliding gear unit from the gear box by disconnecting spring loaded shifting lever.
- Remove the end nut, bearing covers, circlips and grup screws in the spacer of the driven shaft. (Fig 3)

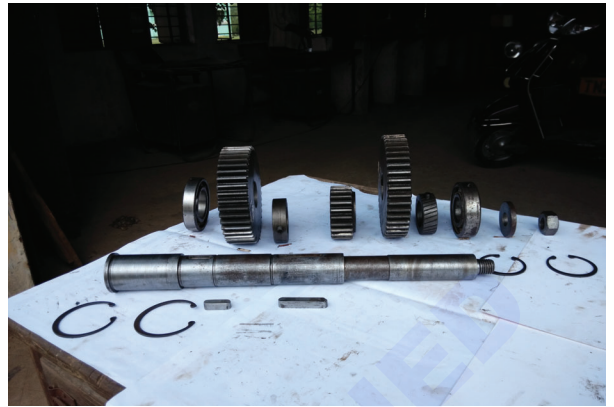
Fig 3



F120N25164H3

- Remove the driven shaft by tapping the shaft using copper rod and hammer then take out the gears, spacers from the gear box.
- Thoroughly clean all the parts using kerosene and wiped out with cotton cloth. (Fig 3 & 4)

Fig 4



F120N25164H4

- Check all the part for wear and tear.
- Repair the damaged gear parts (Refer Ex No.2.5.167).
- Lubricate the parts before assemble (Fig 5)
- Assemble the gear box in reverse manner of dismantle.
- Mount the gear box with the machine.
- Check the test run with different speeds (four speed).

Fig 5



F120N25164H5

Skill sequence

Inspection of gear tooth elements

Objectives : This shall help you to

- check the P.C.D of a given spur gear
- check the spur gear tooth thickness
- check the teeth clearance between mating gears and backlash
- check the concentricity and wear of gears.

Checking of the Pitch Circle Diameter (PCD) of the gear

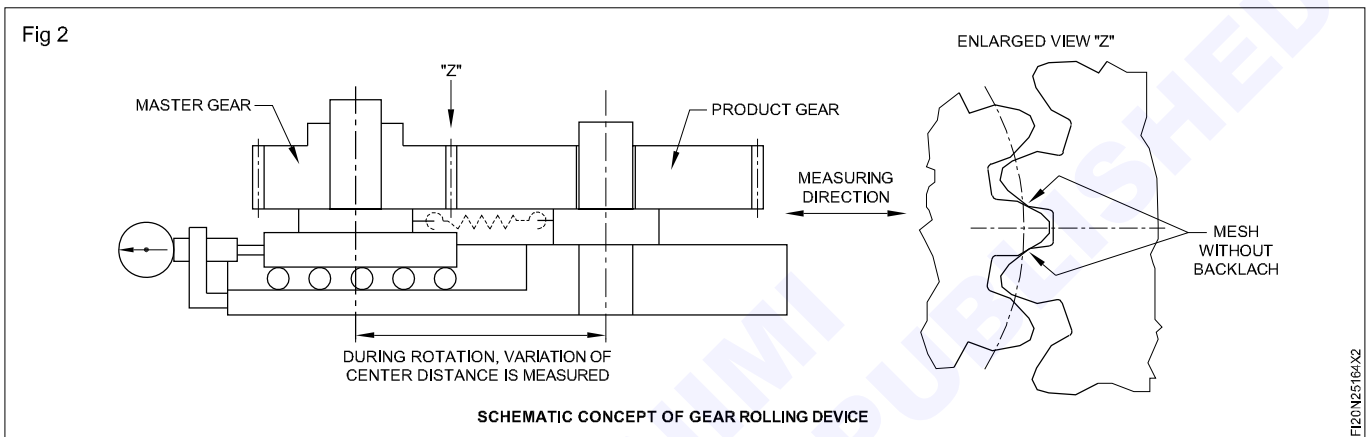
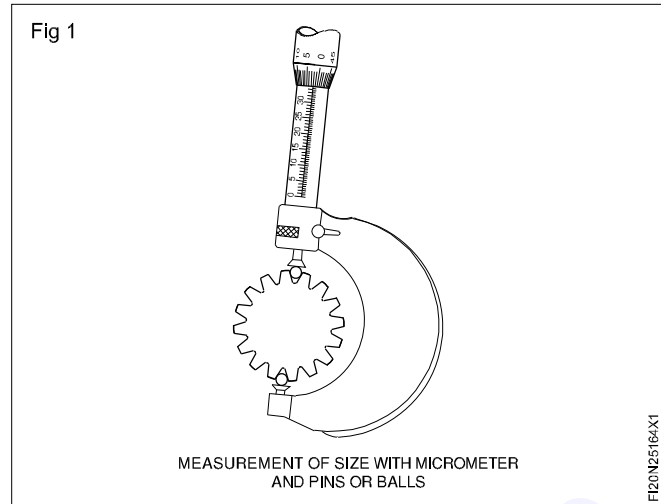
- Select the gear to be measured and place it on the work table.

- Choose the two standard cylindrical pins or balls for measuring the gear size.
- Hold the flange micrometer, select and place cylindrical pins or balls as shown in the figure 1.

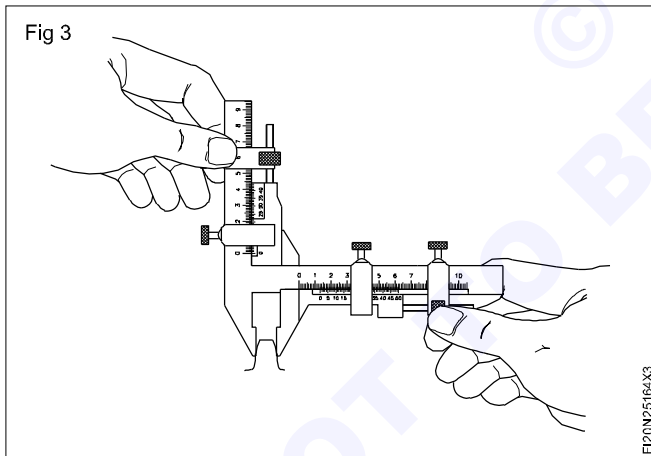
- Note down the flange micrometer reading by locking its thimble and barrel scales.
- Find out the PCD by subtracting the pin or ball diameter from the obtained micrometer reading.

This method is only suitable for gears having even numbers of teeth.

Composite inspection as shown in the figure 2 is a useful shop friendly tool to determine the gear size of having any number of teeth.

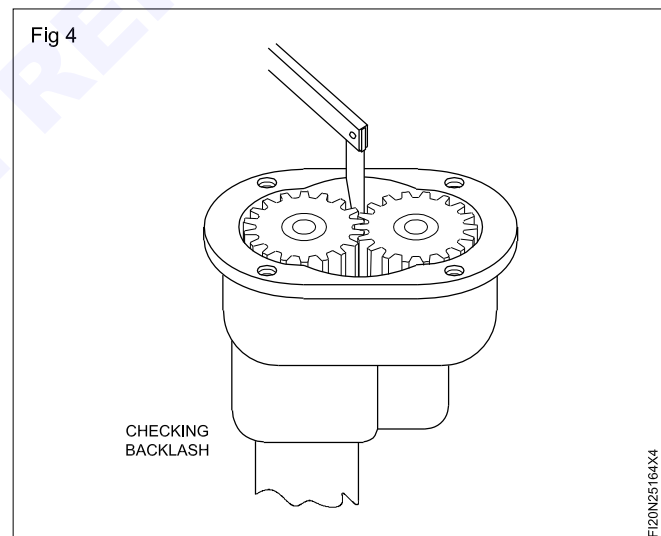


Measuring the gear tooth thickness (Fig 3)



- Select the gear to be measured and hold it with a vice.
- Set the chordal addendum in vertical scale.
- Hold the gear tooth caliper properly as shown in the figure 3.
- Adjust the adjustable tongue of the gear tooth caliper to touch it with the tooth side.
- Note down the reading directly from the caliper and it will be the chordal tooth thickness.

Checking the gear teeth clearance between mating gears and backlash (Fig 4)



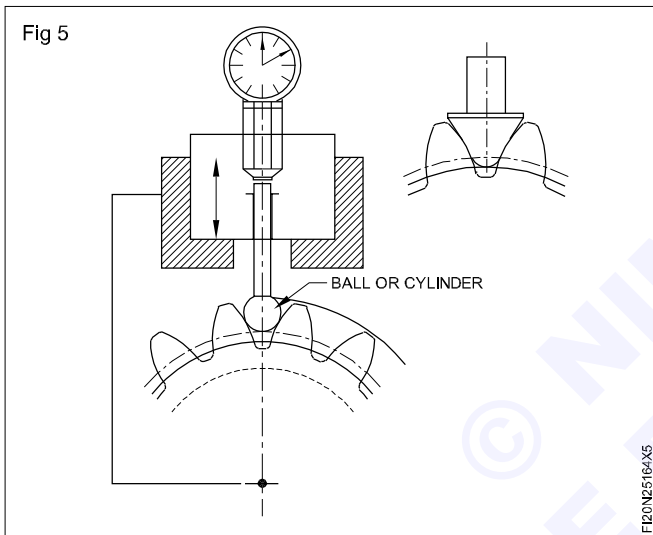
- Arrange the gears to be measured as shown in the figure.
- Hold one gear rigid and insert the feeler gauge through the gap between gear teeth of mating gears as shown.
- Note down the feeler gauge reading and it will be the backlash value.
- Compare the measured backlash value with the given table and ensure it within the permissible value (limit).

Table 1
Backlash Suggestions

Pitch	Backlash
3P	0.013
4P	0.010
5P	0.008
6P	0.007
7P	0.006
8-9 P	0.005
10-13P	0.004
14-32P	0.003
33-64P	0.0025

- Fix the gear to be measured in a mandrel as shown in the figure.
- Select suitable ball or cylindrical pin and place it in between the gap of two teeth.
- Hold the dial indicator in such a way that it will touch the outer periphery of cylindrical pin or ball.
- Note down the dial indicator reading.
- Repeat the same procedure for all the gear teeth and simultaneously note down the dial indicator reading.
- Calculate the total runout or concentricity by subtracting maximum and minimum dial gauge reading.

Checking the concentricity and wear of gears (Fig 5)



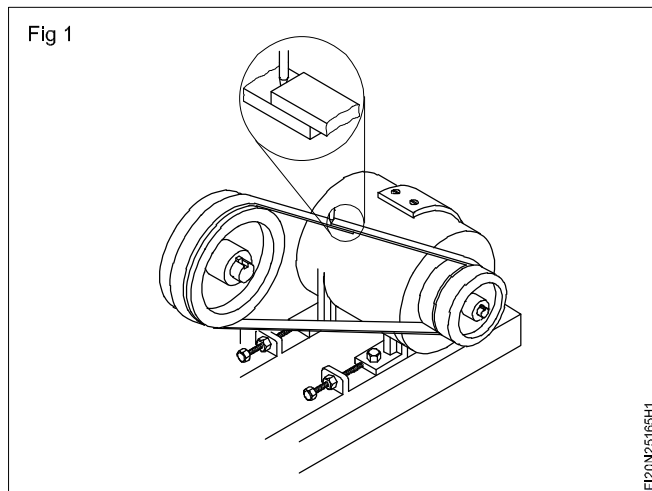
Repair & replacement of belts and check for workability

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

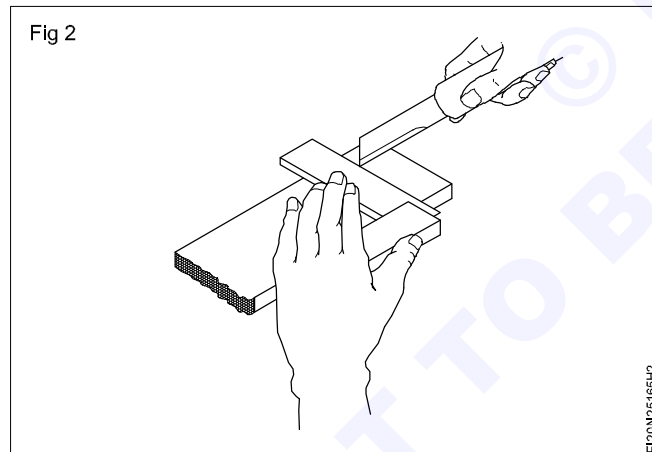
- fix a belt on driver and driven pulley
- measure tension of a 'V' belt drive
- adjust belt tension with a spring balance.

Job sequence

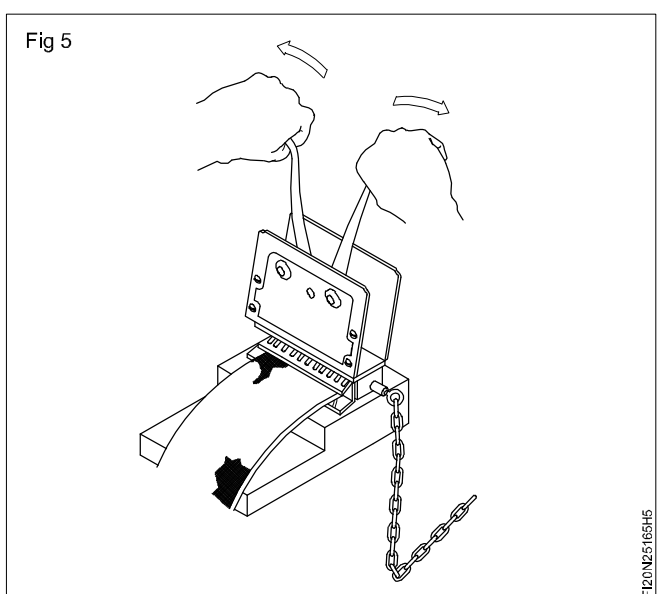
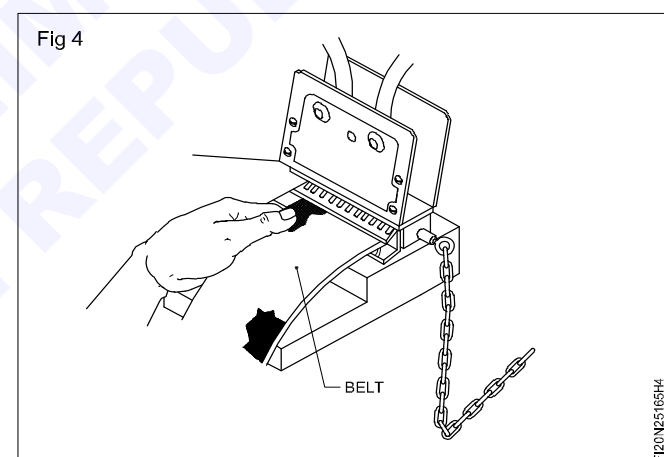
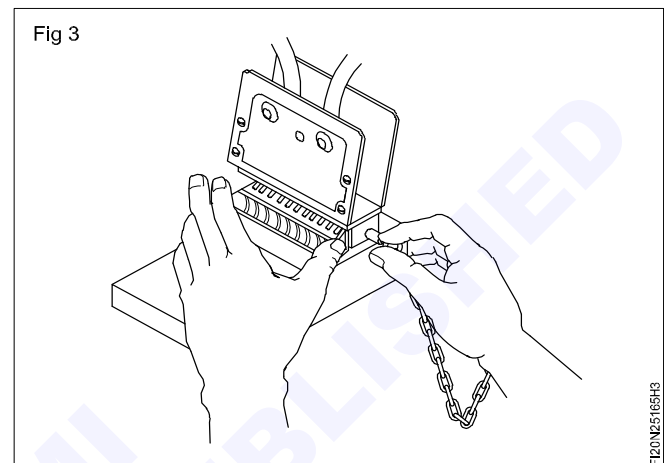
- Mark and cut the belt to the required length (Fig 1).

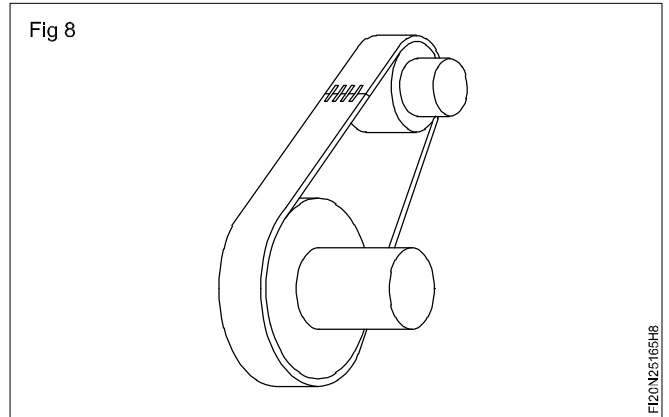
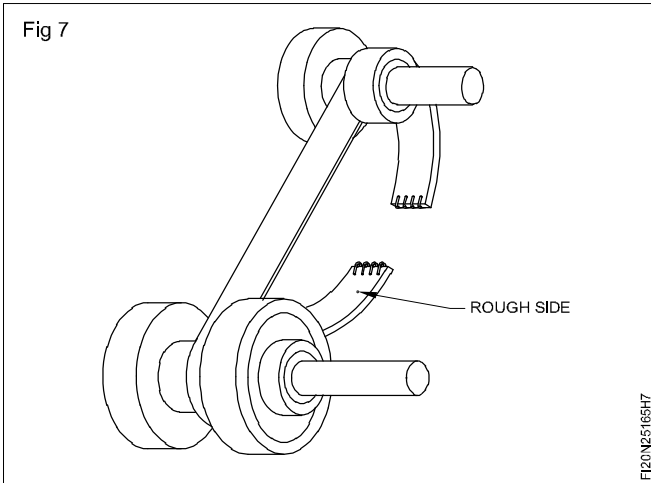
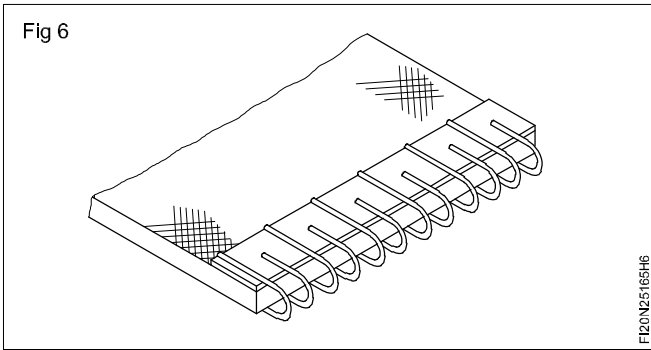


- Trim both ends of the belt square (Fig 2).



- Fit an alligator fastener centrally into the jaws of the lacing machine and fit the pin into the side of the jaws to hold the fastener in the machine (Fig 3).
- Put the belt centrally between the jaws of the machine. (Fig 4)
- Operate the machine to press the fastener into the belt until it is flush with the belt (Fig 5 & 6). Trim the edges of the fastener.
- Place the belt around the shafts beside the pulleys with the rough side against the pulleys and join both ends by the pin (Fig 7).
- Fit the belt to the small pulley end first and then run it on to the big pulley (Fig 8).





Skill sequence

Adjust belt tension in 'v' belt drive

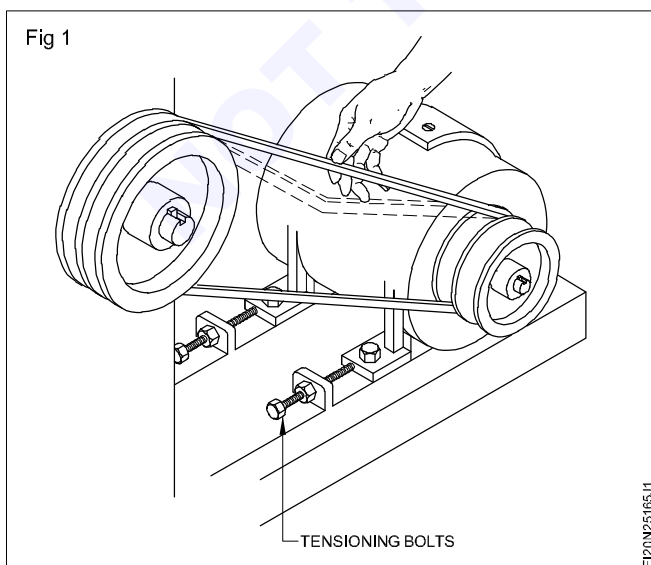
Objectives : This shall help you to

- check belt tension using a spring balance
- adjust belt tension by tensioning bolts.

Measure the longest span length of the belt between the pulleys, using a steel tape.

Find the middle of the longest span of the belt between the pulleys.

Push this mid-point inwards, then pull it out and note the total deflection. (Fig 1)



This indicates the existing tension of the belt.

Loosen the lock-nuts. (Fig 2)

Slacken the clamping bolts. (Fig 2)

Move the pulley with the adjusting screws to alter the tension. (Fig 2)

The adjusting screws must be turned equally to keep the pulleys correctly aligned.

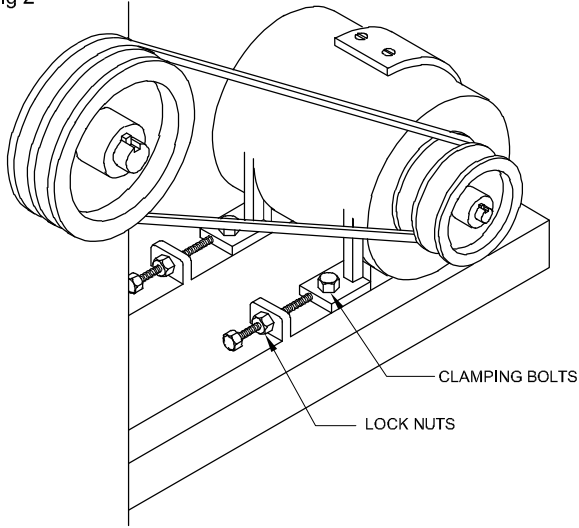
Attach a spring balance and check the tension of the belt. (Fig 3)

Readjust the adjusting screws until the tension is correct.

Tighten the clamping bolts.

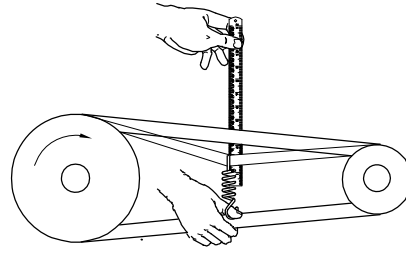
Tighten the lock-nuts.

Fig 2



F120N25165.2

Fig 3



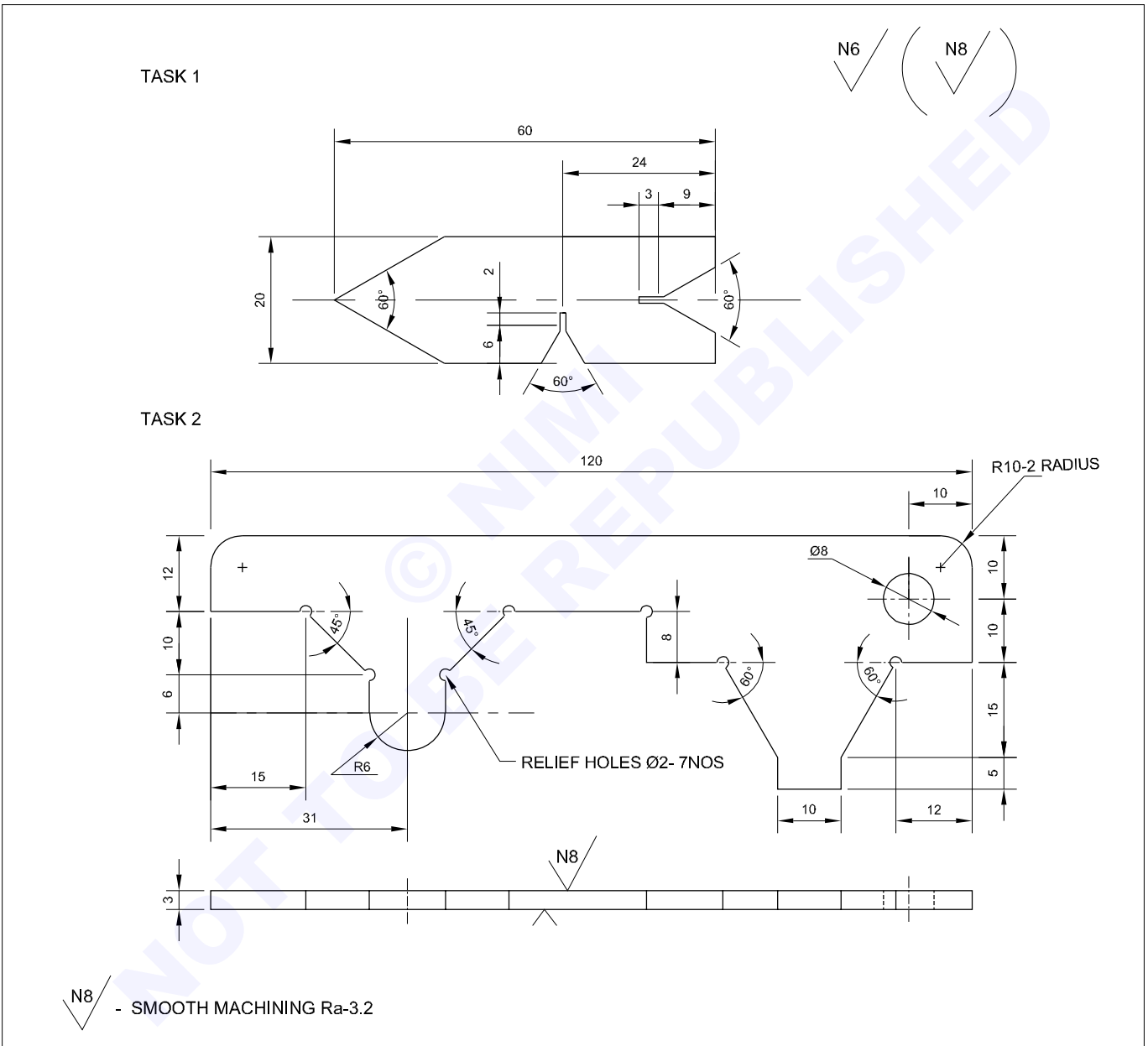
F120N25165.3

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Making of template / gauge to check involute profile

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

- mark dimensions with a vernier height gauge for Task 1 and 2
- mark angles with a vernier bevel protractor for Task 1 and 2
- make relief by hacksawing
- file external and internal 'V' to an accuracy of ± 10 minutes.



1	50 ISF 4-125	-	Fe-310	-	TASK 2	2.5.166
1	25 ISF 4-63	-	Fe-310	-	TASK 1	
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1					TOLERANCE LINEAR : ± 0.02 mm ANGULAR : 5'	
<p align="center">MAKING OF TEMPLATE / GAUGE TO CHECK INVOLUTE PROFILE</p>					TIME : 17 Hrs	
					CODE NO. FI20N25166E1	

Job sequence

TASK 1: Angle gauge

- Check the raw material for its size
- File and finish the plate to size 60 x 20 x 3.8mm (0.4mm thick for grinding allowance)
- Mark centre lines for the 60° external Vee and relief grooves.
- Mark centres for 2 mm relief hacksawing.
- Cut off excess metal with a hacksaw from the plate, for the two 'V' grooves.
- Ensure that punch marks are visible and sufficient metal is left for finish filing
- File and finish the sides of the groove with a knife edge file
- Ensure that the width of the remaining metal on both sides of the 'V' grooves end is equal.
- Check the accuracy of the 60° angle with the template / gauge supplied.
- Repeat the steps for the 'V' groove.
- Cut off excess metal from the plate for external 'Vee' on one side.
- File and finish the side of the 'VEE' correct to the centre line.
- Cut off excess metal from the other side of 'Vee'
- File and finish the 'Vee' to the centre line
- Check the 60° angle with a vernier bevel protractor file, and finish all the edges.
- Remove burrs and check the dimensions.

TASK 2: Template of different profiles

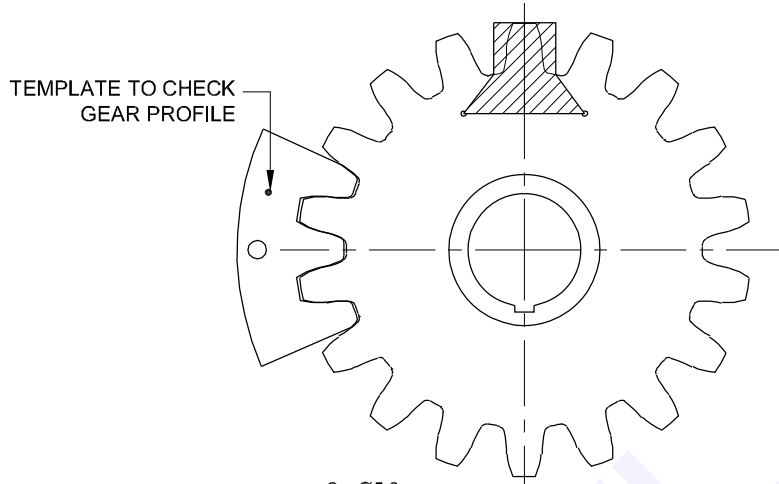
- Check the raw material for its size
- Remove burrs and check the raw material size.
- File the large surface with a 200mm flat second cut file (Hold the sheet on the wooden block)
- File two adjacent sides - flat and square.
- Make relief hole by drilling as per drawing.
- Mark dimensions as per drawing.
- Hacksawing and remove the excess material.
- File and finish the remaining surfaces to size and check the size.
- File and finish 60° and 45° angles and radius check with vernier bevel protractor and gauge.
- File and finish thickness to 3 mm, by fixing work on the wooden block.

Care should be taken to maintain the correct length

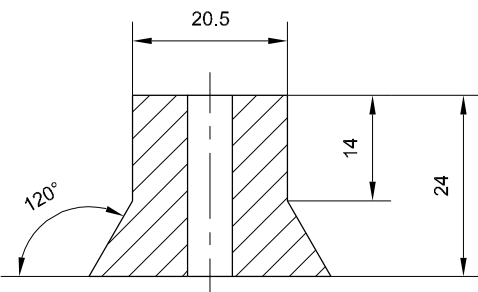
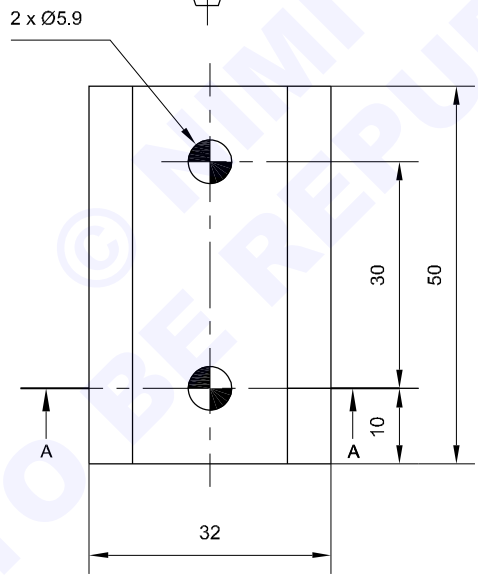
Repair of broken gear tooth by stud and repair broken gear teeth by dovetail

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

- repair gear tooth by stud and welding method
- repair gear tooth by dovetail method.



OUTSIDE DIAMETER = 120
 NO OF TEETH = 18
 MODULE = 6
 TOOTH THICKNESS = 9.42 at P.C.D
 WIDTH OF GEAR = 50

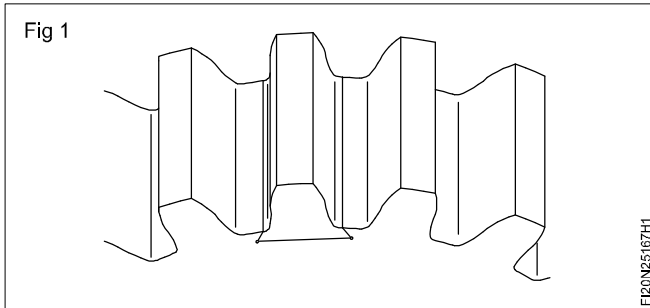


1	□36-55	-	FG 15	-	-	2.5.167
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	REPAIR OF BROKEN GEAR TOOTH BY STUD AND REPAIR BROKEN GEAR TEETH BY DOVETAIL				TOLERANCE : ±0.02 mm	TIME : 17 Hrs
					CODE NO. F120N25167E1	

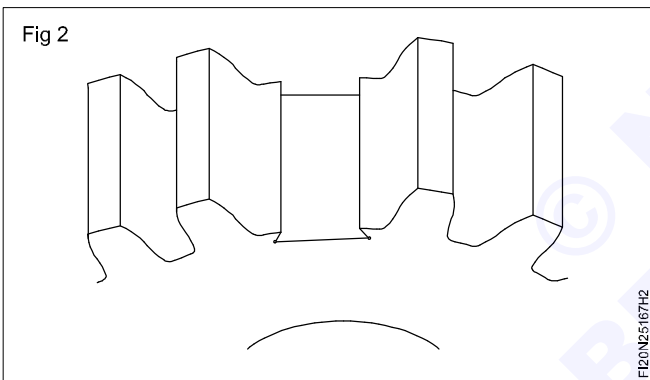
Job sequence

TASK 1: Repair broken gear tooth (dovetail blank method)

- Support the gear against a Vee block and clamp it by parallel clamp.
- Mark the dovetail groove on the gear wheel from both sides using a vernier height gauge and vernier bevel protractor.
- Punch the marking lines (Fig 1).



- Drill 3mm dia. relief holes one each on the corner of the dovetail.
- Remove material from the gear to shape and size of dovetail as per marking (Fig 2).



- File the blank to the profile of the gear tooth as per punch mark.
- File the dovetail portion of the blank.
- Fit the blank into the dovetail groove of the gear wheel. If necessary, file the blank till it fits in.
- Apply Prussian blue on the dovetail groove to check the high spots in the blank piece.
- Remove the high spots and make a snug fit in the dovetail groove.
- Drill 5.9mm dia. - 2 holes up to a depth of 33mm on the blank and gear wheel in assembled condition.
- Ream the holes using a hand reamer.

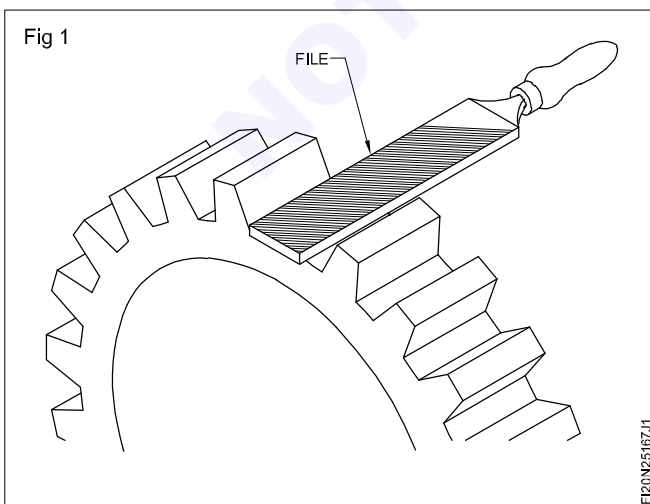
Dismantle the assembly and remove the chips from the holes of the gear and the blank.

- Assemble again and fit the dowel pins in the holes by a slight tapping.
- File the profile of the gear tooth to the correct shape.
- Use a template to check the profile.

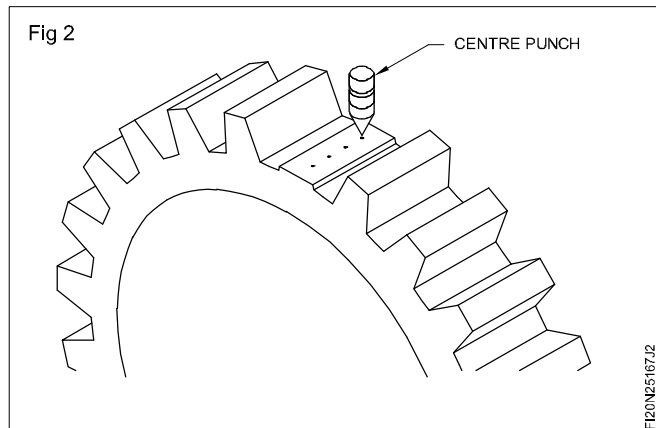
File the sides of the blank, flush with the gear.

TASK 2: Repair broken gear tooth (Welding method)

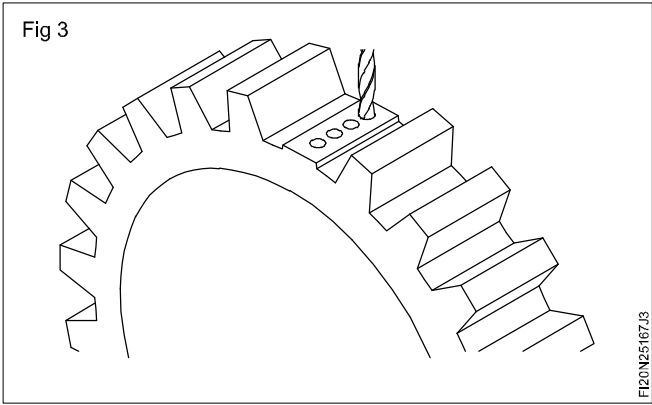
- File the broken tooth surface flat (Fig 1).



- Mark for four holes on the surface with 10mm centre distance between the holes.
- Punch the centres for drill holes (Fig 2).

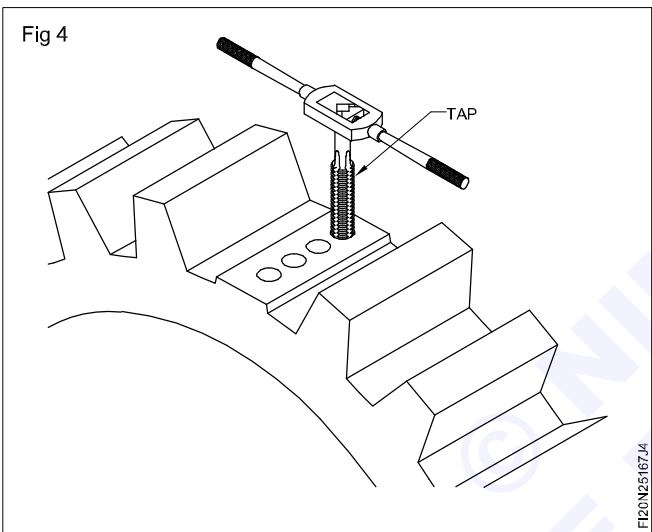


- Drill 5 mm dia. holes on the centres to a depth of 9 mm. (Fig 3).



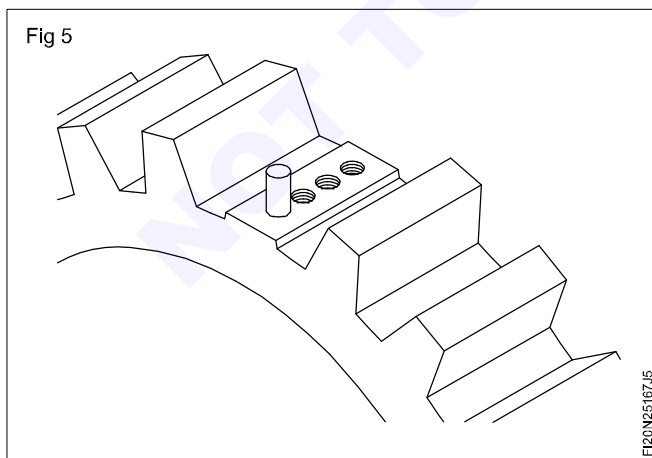
Remove the chips from the holes.

- Tap the holes using a M6 hand tap (Fig 4)

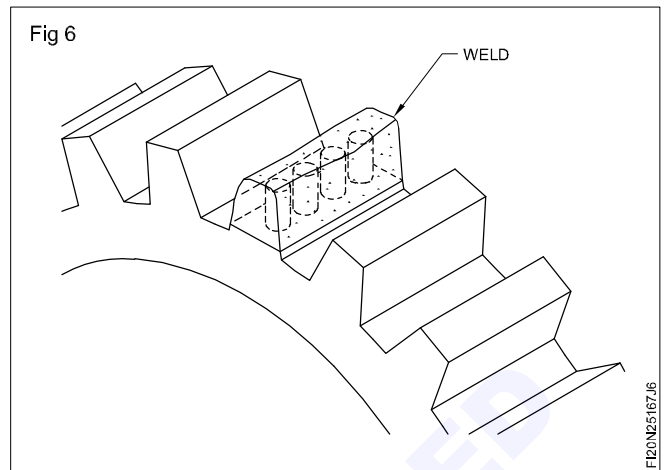


Remove the chips and clean the tapped holes.

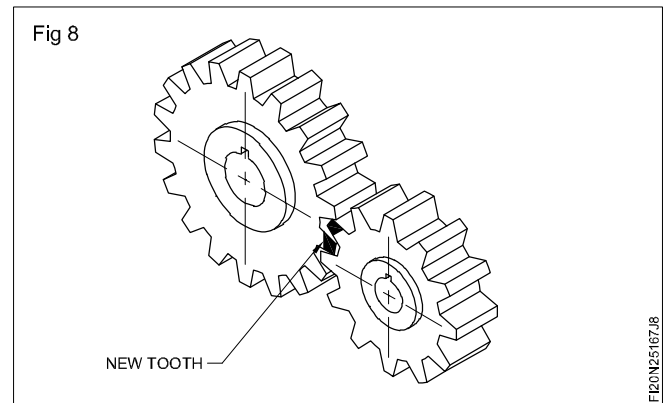
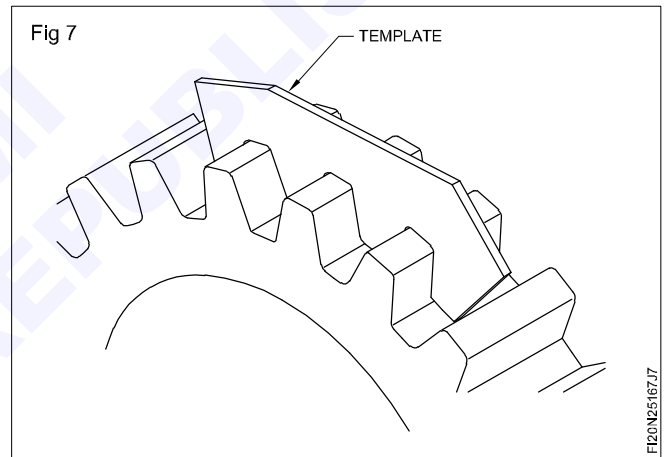
- Fix up four hexagonal headed M6 bolts into the tapped holes and tighten them securely (Fig 5)



- Cut off the hexagonal head of the bolts by hacksawing.
- Build up material by welding just enough to make the tooth profile by filing (Fig 6).



- File the built up material to tooth profile. Use a template frequently to check the profile to have correct shape and pitch (Figs 7 & 8).

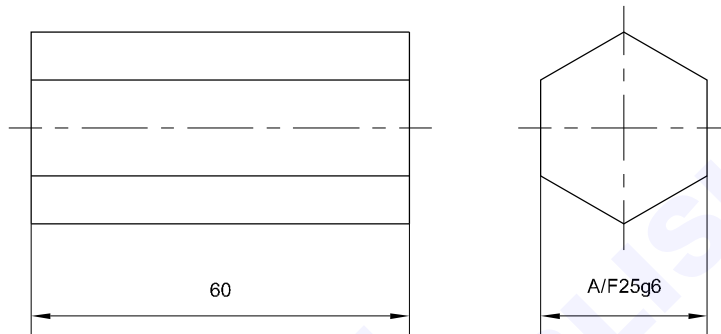


Make hexagonal slide fitting

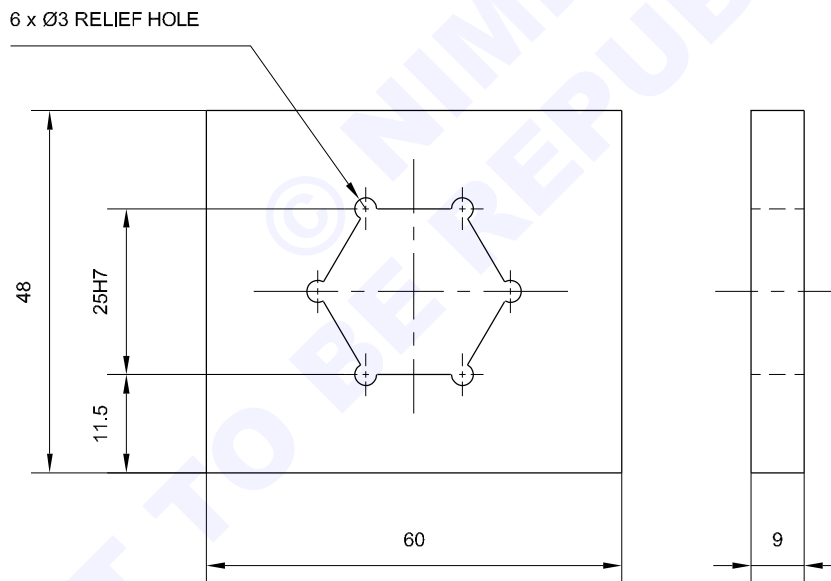
Objectives: At the end of this exercise you shall be able to

- file and finish mating parts within ± 0.02 mm using O.S. micrometer
- file and finish mating parts having angular surfaces within $\pm 10'$ accuracy using vernier bevel protractor.

PART - ①



PART - ②



NOTE:

25 H7 - $25^{+0.021}_{+0.000}$

25 g6 - $25^{-0.007}_{-0.020}$

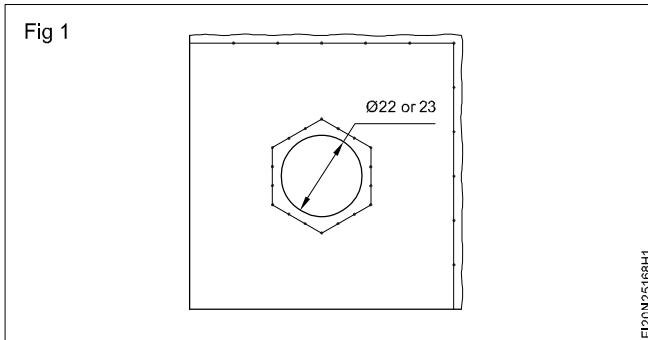
A/F - ACROSS FLATS (OPPOSITE SIDE OF THE HEX BOLT)

1	65 ISF 10 - 52	-	Fe310	-	2	2.5.168
1	HEX A/F 27 - 63	-	Fe310	-	1	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MAKE HEXAGONAL SLIDE FITTING				TOLERANCE ± 0.02 mm	TIME : 16 Hrs
					CODE NO. FI20N25168E1	

Job sequence

Task 1 :

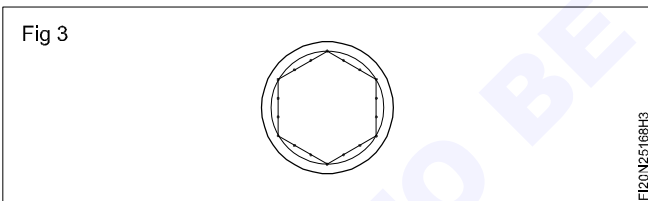
- File the surface and two adjacent edges at right angle to each other.
- Check the squareness.
- Refer the job drawing and do the marking as per the dimensions given (Fig 1).



- File the excess material and maintain the dimension 60 x 48 mm with vernier caliper.
- Check the squareness with square head.

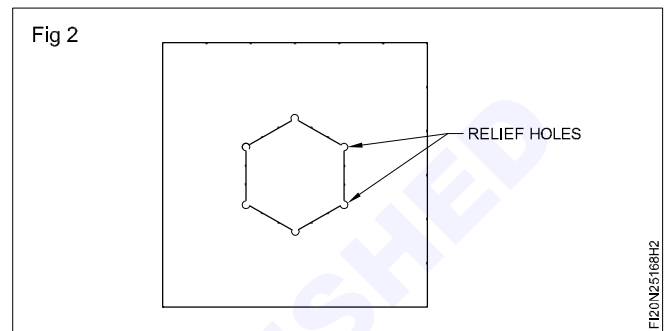
Task 2 :

- Check the dimension in side and parallelism of faces with a vernier caliper.
- File the end of the given rod at right angle to the axis.
- Mark the hexagon as per the dimensions given in the drawing (Fig 3).

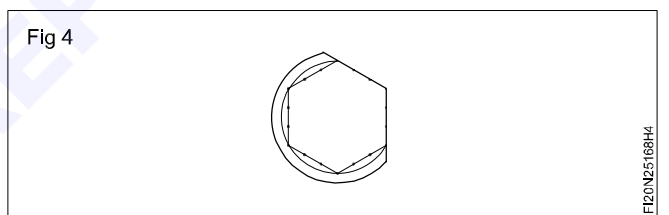


- File one side up to the marked line. Check the parallelism through out the length.
- File the adjacent side and check the angle (120) by protractor head.

- To make the hexagonal cut out, drill a 22 or 23mm dia. drill hole in the centre. File the hexagonal shape with a square file or triangular file (Fig 2).
- At this stage make 6 relief hole in the corners by $\varnothing 3$ mm drill.
- Finish the hexagonal shape and check the angle by the help of protractor head. (120°)



- File and finish the other sides also (Fig 4).



- Finally check the flat dimension and other sizes and assemble in the hexagonal slot.
- Place the female part on a wooden block. File and finish both surfaces with a smooth file and maintain the thickness.
- Remove the burrs from the edges.
- Check for Hexagon slide fitting.

Prepare different types of documentation as per industrial need by different methods of recording information

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

- prepare and fill up batch processing record in format
- prepare and fill up bill of materials (BOM)
- prepare and fill up production cycle time in format
- prepare and fill up daily production report in format
- prepare and fill up manufacturing stage inspection report format.

TASK 1: Documentation 1

Note:

- Instructor/ Training Officer should arrange for a industrial Visit near by your institute, collect inputs and fill up format as required.
- Trainees will be guided by the concerned instructor/ Training Officer.
- Collect necessary information forms and instruct the trainees to reproduce the format and guide them to fill it up.

Job sequence

- Study the different types of documentation provided in (format).
- Visit to the industry and collect the input / information from industry and fill it up in all the format.
- Prepare the required format with the knowledge gained during the industrial visit.
- Record relevant information in the format.
- Get it check by your Instructor / Training Officer.

BATCH PROCESSING RECORD - FORMAT - 1

Batch Processing Record		
Description of job	Batch no. :	
Part no. :	Batch quantity :	
Name of part :	Batch record no. :	
	Purchase order no. :	
Description of process :		
Manufacturing Organisation :		
Period of manufacture (Year - Qtr):	Start date of manufacture:	End date of manufacture:
Number of pages according to batch:	Inserted pages:	Manufacturing facilities:
Total number of pages		
1. Operator / Technician	Date	Name and signature
2. Production in-charge:	Date	Name and signature
3. Section manager	Date	Name and signature
4. Plant in-charge:	Date	Name and signature
5. Production in-charge:	Date	Name and signature
Remarks (if any)		

DAILY PRODUCTION REPORT - FORMAT - 4

		Daily Production Report										Organisation Name:			
Date:		Department:					Section:								
		Process - I		Process-II		Process-III		Process-IV		Quality Control		Packing			
		Planned	Completed	Planned	Completed	Planned	Completed	Planned	Completed	Planned	Completed	Planned	Completed	Planned	Completed
Job Order No.															
Quantity															
Material & Size															
Job Order No.															
Quantity															
Material & Size															
Job Order No.															
Quantity															
Material & Size															
Job Order No.															
Quantity															
Material & Size															

Signature of section Incharge

TASK 2: Documentations - 2

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

- prepare and fill job card in format
- prepare and fill work activity log in format
- prepare and fill batch production record
- prepare and fill estimation sheet in format
- prepare and fill maintenance log in format
- prepare and fill the history sheet of machinery and equipment in format
- prepare and fill maintenance record in format.

Note:

- Instructor / Training Officer should arrange for a industrial visit near by your institute, collect inputs and fill up in format as required.
- Trainees will be guided by the concerned instructor/ Training Officer.
- Collect necessary information forms and instruct the trainees to reproduce the forms and guide them to fill it up.

Job sequence

- Study the different types of documentation provided in (format).
- Visit to the industry and collect the input/ information from industry and fill it up in all the format.
- Prepare the required format with the knowledge gained during the industrial visit.
- Record relevant information in the format.
- Get it checked by your instructor/ Training Officer.

JOB CARD - FORMAT-1

Job Card		Doc No.					
		Rev No.					
		Date					
Order Starting Date							
Customer							
Work Order No.							
Details							
S.No.	Date	Production Line Description	Time (Minutes)			Location Time	Remarks
			Start Time	End Time	Total Time		

WORK ACTIVITY LOG - FORMAT-2

Organisation Name:			
Department:			
Section:			
Employee Name:			
Supervisor Name:			
Date:			
Start / Stop	Operations performed	Equipment / Machinery/ Instruments used	Remarks
8.00 to 9.00 a.m.			
9.00 to 10.00 a.m.			
10.00 to 11.00 a.m.			
11.00 to 12.00 noon			
12.00 to 1.00 p.m.			
1.00 to 2.00 p.m.			
2.00 to 3.00 p.m.			
3.00 to 4.00 p.m.			

BATCH PRODUCTION RECORD - FORMAT-3

<u>Batch Production Record in accordance with batch processing record</u>			
Manufacturing Organisation Name: _____			
Description of job: _____			
Name of part: _____			
Batch No.: _____			
The following deviations have appeared (continued)			
No. process step	Name of processing step	Documented page no.	Short description of deviation
1	<u>Raw material preparation:</u> Operation 1: _____ Operation 2: _____ Operation 3: _____		1. _____ 2. _____ 3. _____ 4. _____
2	<u>Sizing of material:</u> Operation 1: _____ Operation 2: _____		1. _____ 2. _____ 3. _____

ESTIMATION SHEET - FORMAT-4

Part Name: _____		Part No.: _____		Part Drawing	
Assembly: _____		Material: _____			
Assembly No.: _____		Stock size: _____			
Operation No.	Operation description	Machine	Estimated time	Rate / piece per hr.	Tools

Prepared by: _____

Date: _____

Approved by: _____

MAINTENANCE LOG - FORMAT-5

Organisation Name :				
Department :				
Section :				
Name of the machine :				
S. No.	Date	Nature of fault	Details of rectification done	Signature of in-charge

MACHINERY AND EQUIPMENT RECORD - FORMAT-6

Organisation Name :	
Department :	
Section :	
History sheet of machinery & Equipment	
Description of equipment	
Manufacturer's address	
Supplier's address	
Order No. and date	
Date on which received	
Date on which installed and placed	
Date of commissioning	
Size: Length x Width x Height	
Weight	
Cost	
Motor particulars	Watts/H.P./ r.p.m: Phase: Volts:
Bearings/ spares/ record	
Belt specification	
Lubrication details	
Major repairs and overhauls carried out with dates	

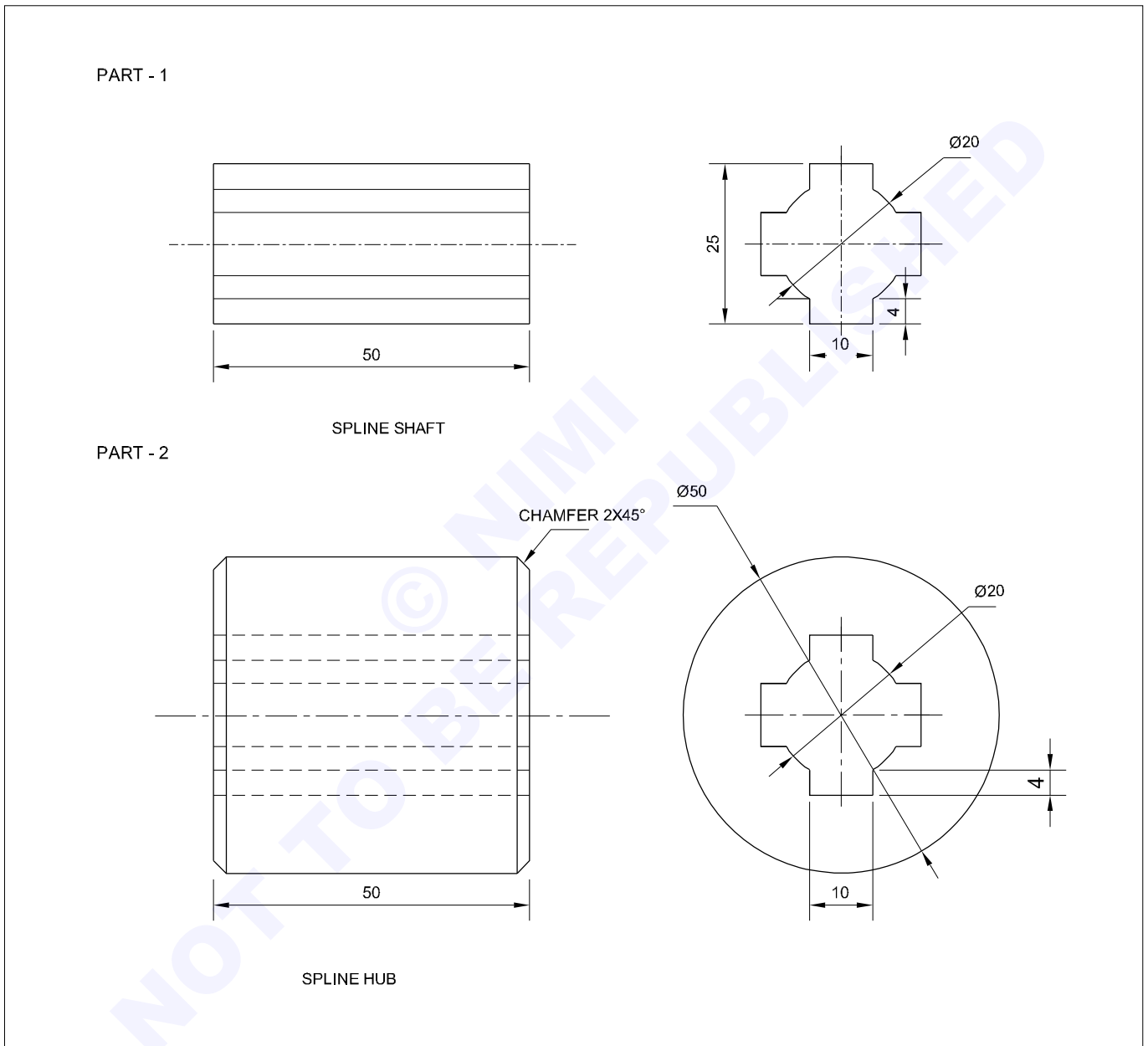
PREVENTIVE MAINTENANCE RECORD - FORMAT-7

Organisation Name :			
Department :			
Section :			
Name of the Machine :		Location of the machine :	
Machine Number :			
Model No. & Make :			
Check list for machine inspection			
Inspect the following items and tick in the appropriate column and list the remedial measures for the defective items.			
Items to be checked	Good working/ satisfactory	Defective	Remedial measures
Level of the machine			
Belt/chain and its tension			
Bearing condition (Look, feel, listen noise)			
Driving clutch and brake			
Exposed gears			
Working in all the speeds			
Working in all feeds			
Lubrication and its system			
Coolant and its system			
Carriage & its travel			
Cross-slide & its movement			
Compound slide & its travel			
Tailstock's parallel movement			
Electrical controls			
Safety guards			
Inspected by			
Signature			
Name:			
Date:			Signature of in-charge

Geometrical shaped fittings

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

- mark and file spline on the shaft
- mark and file internal spline in the hub
- file and assemble hub and spline shaft.



1	Ø50-55		Fe 310	-	2	2.5.170
1	Ø28-55		Fe 310	-	1	
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1		GEOMETRICAL SHAPED FITTINGS			TOLERANCE:±0.02 mm	TIME : 15 Hrs
					CODE NO. FI20N25170E1	

Job sequence

- Check the raw material size using steel rule.
- File raw metal to over all size part 1 $\varnothing 28 - 50\text{mm}$ and part - 2 $\varnothing 50 - 50\text{mm}$.
- Apply marking media on part 1 and part 2.
- Mark off spline key ways on part 1 and 2 by keeping on 'V' blocks using vernier height gauge and try square as per job drawing.
- Punch witness mark on part 1 and part 2.

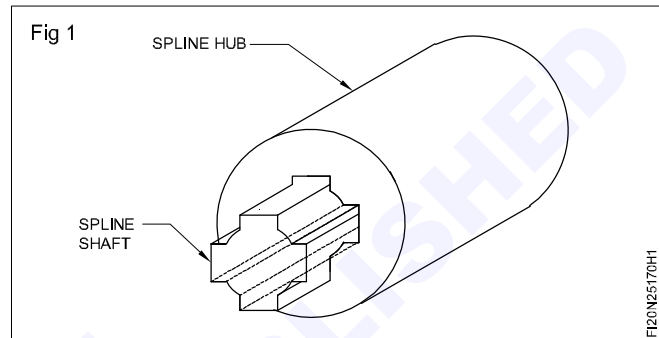
Part 1

- Cut and remove the excess metal in Part 1 by Hacksawing and chipping and file to size and shape using flat file, safe edge file, square file and half round file bastard, second cut and smooth grade of files.
- Check the spline shaft size using vernier caliper.

Part 2

- Hold the part 2 in drilling machine table.
- Fix centre drill in drilling machine spindle.
- Drill centre drill, to locate centre of the round rod.
- Remove centre drill and fix $\varnothing 6\text{mm}$ drill in drilling machine spindle and drill pilot of the hole.

- Similarly, enlarge the pilot hole using different diameter drill and finally drill $\varnothing 20\text{mm}$ and enlarge the hole.
- Hold the job in benchvice and file key way slot size 10mm width X 4mm depth using square file bastard, second cut and smooth grade of file.
- Similarly, file other three keyways slot to the size as per job drawing.
- Check the key way slots sizes using vernier caliper.
- Finish file on part 1 and 2 and assemble as shown in job drawing and slide it (Fig 1).



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

Skill sequence

Marking of a job with vernier height gauge

Objective : This shall help you to

- **mark concentric and eccentric centre lines of a job by using a vernier height gauge.**

The height gauge marking is more accurate than the scribing block marking.

The marking surface must be free from sharp edges and unevenness.

Clamp the finish turned rod in the 'V' block with the help of the clamps.

Apply marking media on both faces of the job.

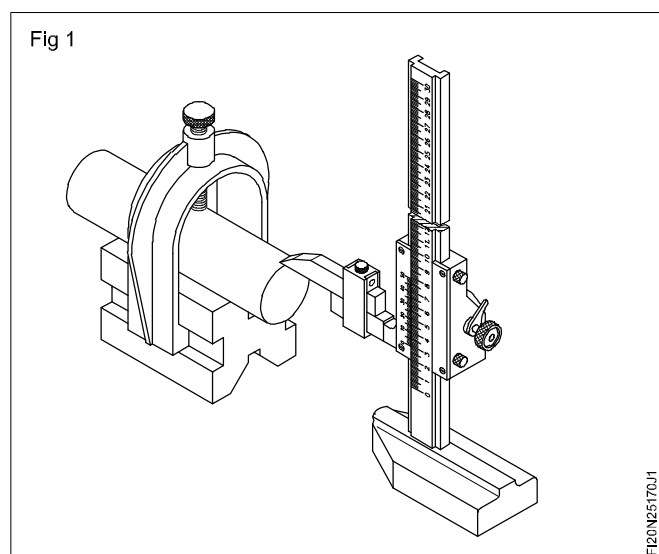
Set the scriber point on the top edge of the job (Fig 1).

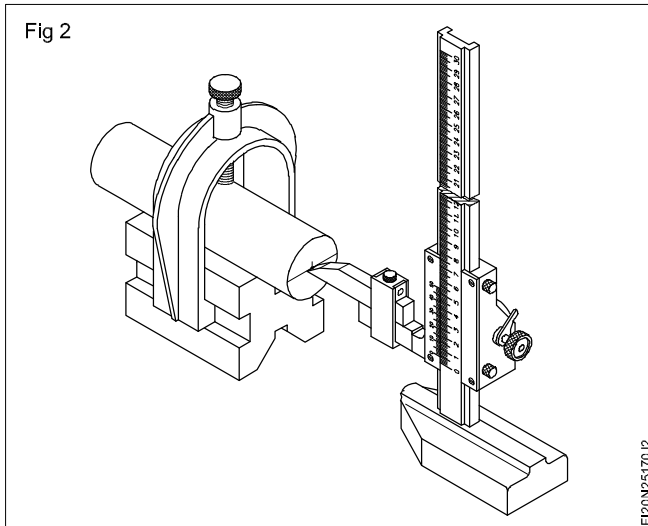
Move the height gauge scriber over the round surface to get a feel that the scriber bottom face is contacting the work periphery (Fig 1).

Lock the slides and note down the reading of the scales.

Subtract half the diameter from the reading and set the height gauge for that reading. (Fig 2)

Scribe a horizontal line on both faces. (Fig 2)





Release the workpiece from the clamp and rotate the workpiece through 90° . Set the line at 90° with the help of a try-square. (Fig 3)

Clamp the workpiece to the 'V' block.

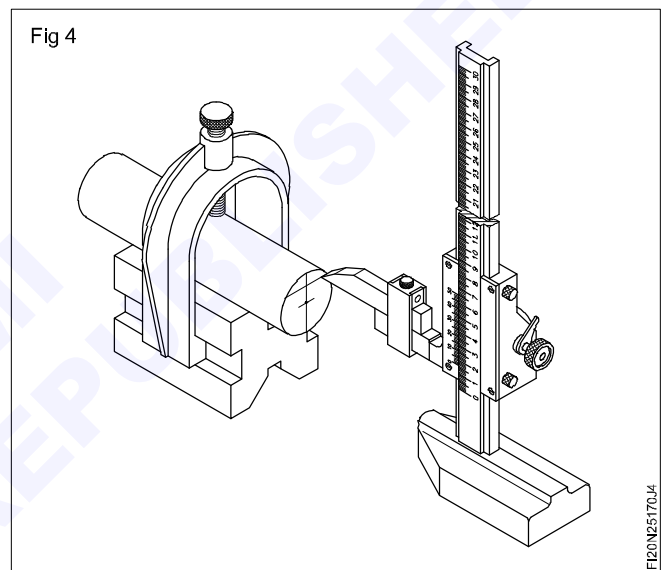
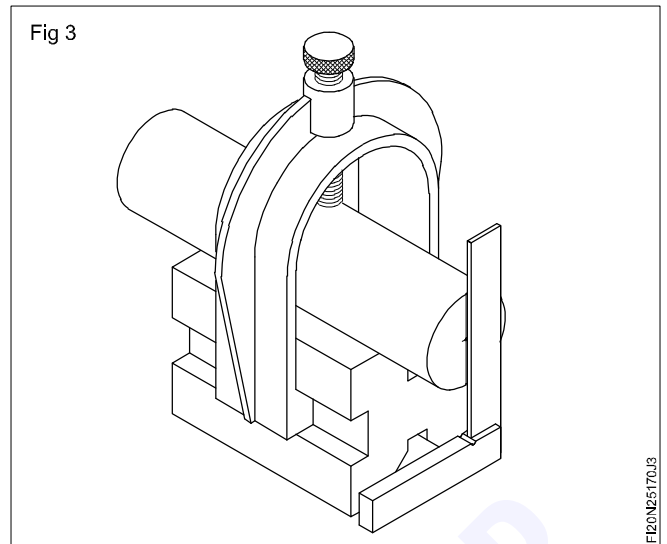
Scribe horizontal lines on both faces with the same reading which is set for centre position. (Fig 4)

Add eccentricity amount to the above reading and reset the height gauge for the new reading. (Fig 4)

Scribe horizontal lines on both faces. (Fig 4)

Release the workpiece from the 'V' block.

Punch mark on both sides both concentric and eccentric centre points.



Checking parallelism using dial test indicator

Objective : This shall help you to

- check parallelism of faces using a dial test indicator.

Checking Parallelism

For checking parallelism and flatness of surfaces, dial test indicators are mostly used.

Procedure

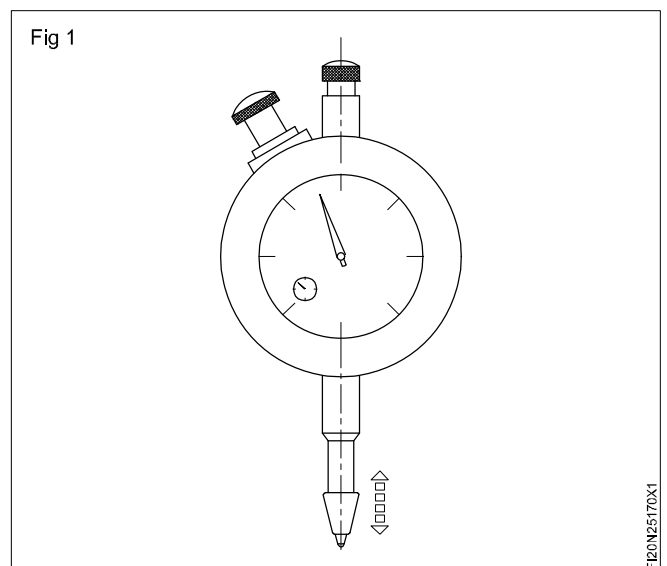
Assemble the dial test indicator on the stand.

Ensure that the surface plate and the dial test indicator stand base are cleaned.

Remove burrs from work surface, and clean.

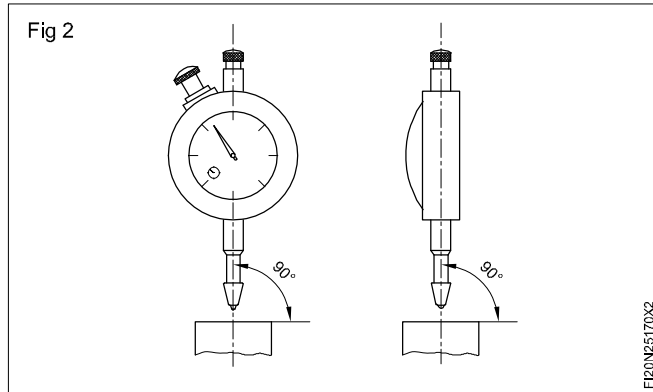
Use fine cotton cloth for cleaning.

Check the free movement of the plunger. (Fig 1)



Place the workpiece below the dial test indicator and set the plunger.

A half-turn pressure of the pointer will be adequate. The plunger should be perpendicular to the work surface. (Fig 2)



Unlock the bezel clamp. Set the reading to zero.

Slide the workpiece on the surface plate below the dial test indicator. (Fig 3)

Note the reading.

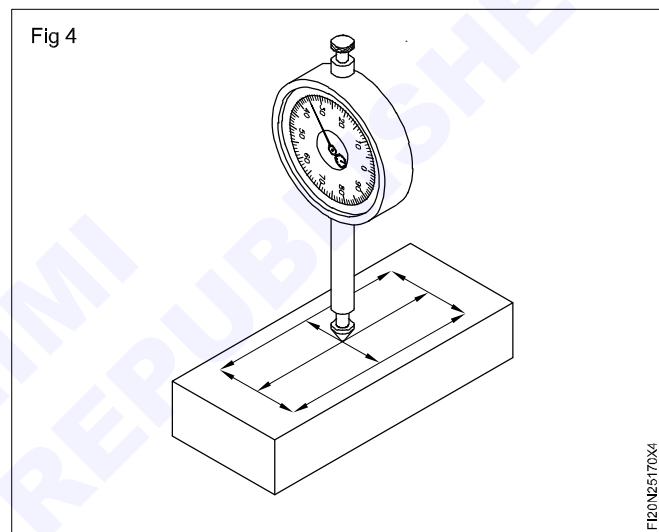
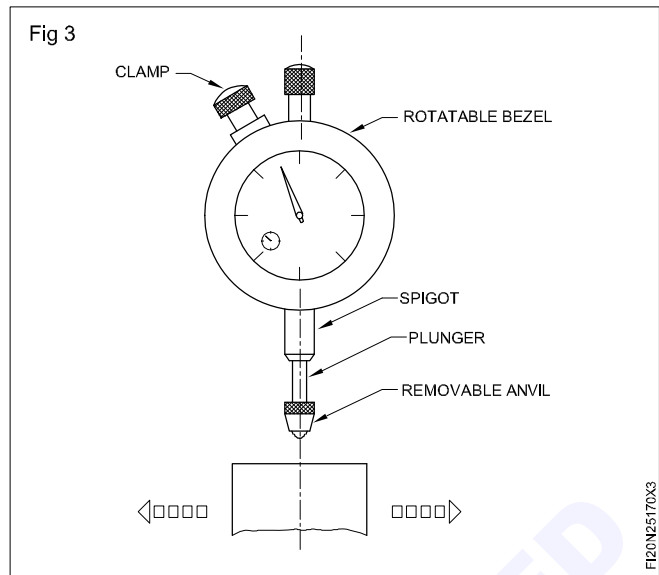
Repeat the same step at three places longitudinally and transversely.

Note the reading and determine the differences. (Fig 4)

Precaution

Do not apply oil on the plunger of the dial test indicator.

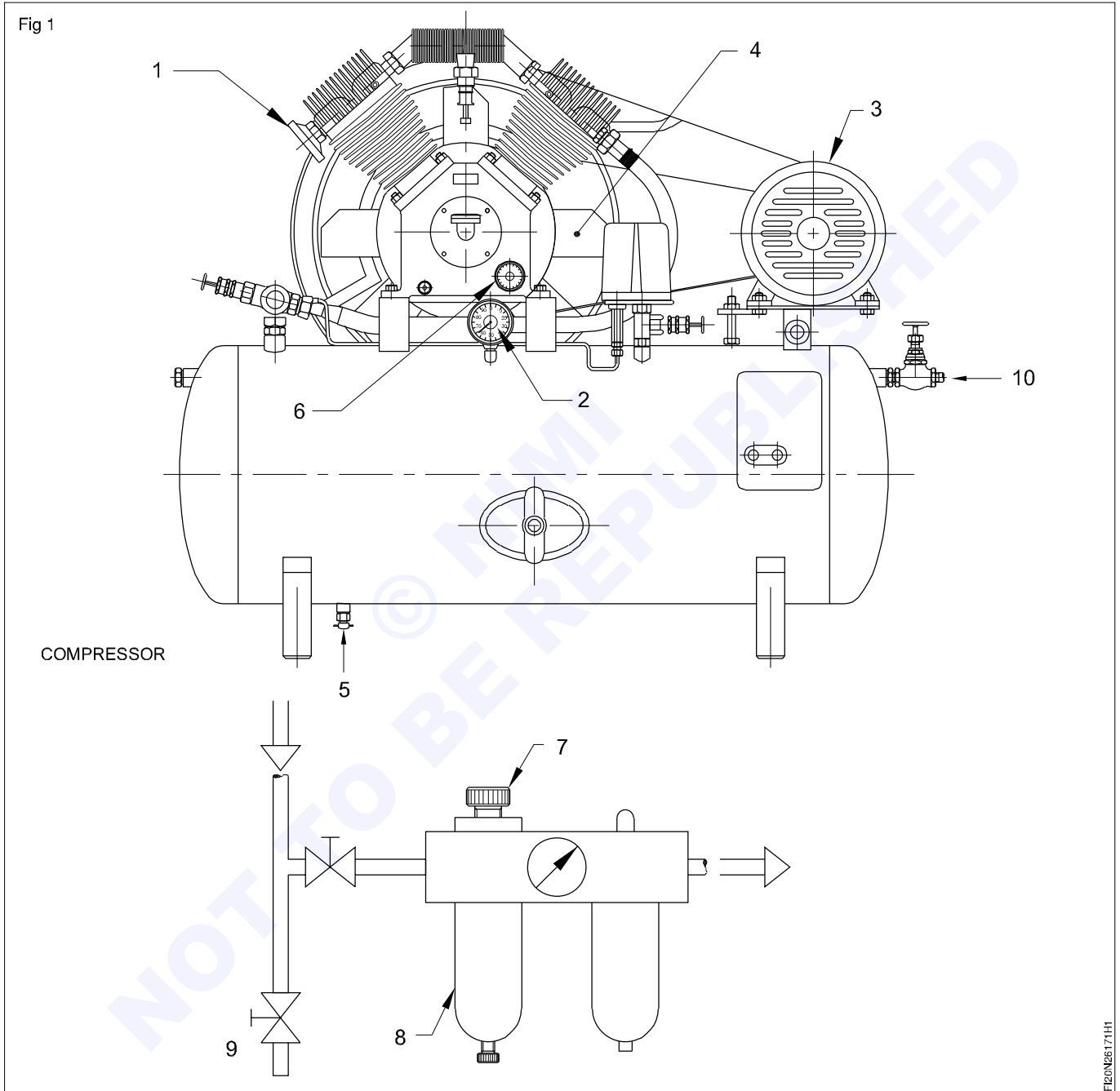
Avoid sudden jerks to the plunger.



Identify pneumatic components

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

- identify the pneumatic components
- enter the name of the parts in table 1.



Job sequence

Instructor shall arrange and show the compressor to trainees and give demo explaining all the parts. Ask the trainee to record in the Table 1.

- Observe the compressor.
- Identify the parts.
- Record the parts name in Table 1.
- Get it checked by your instructor.

Table 1

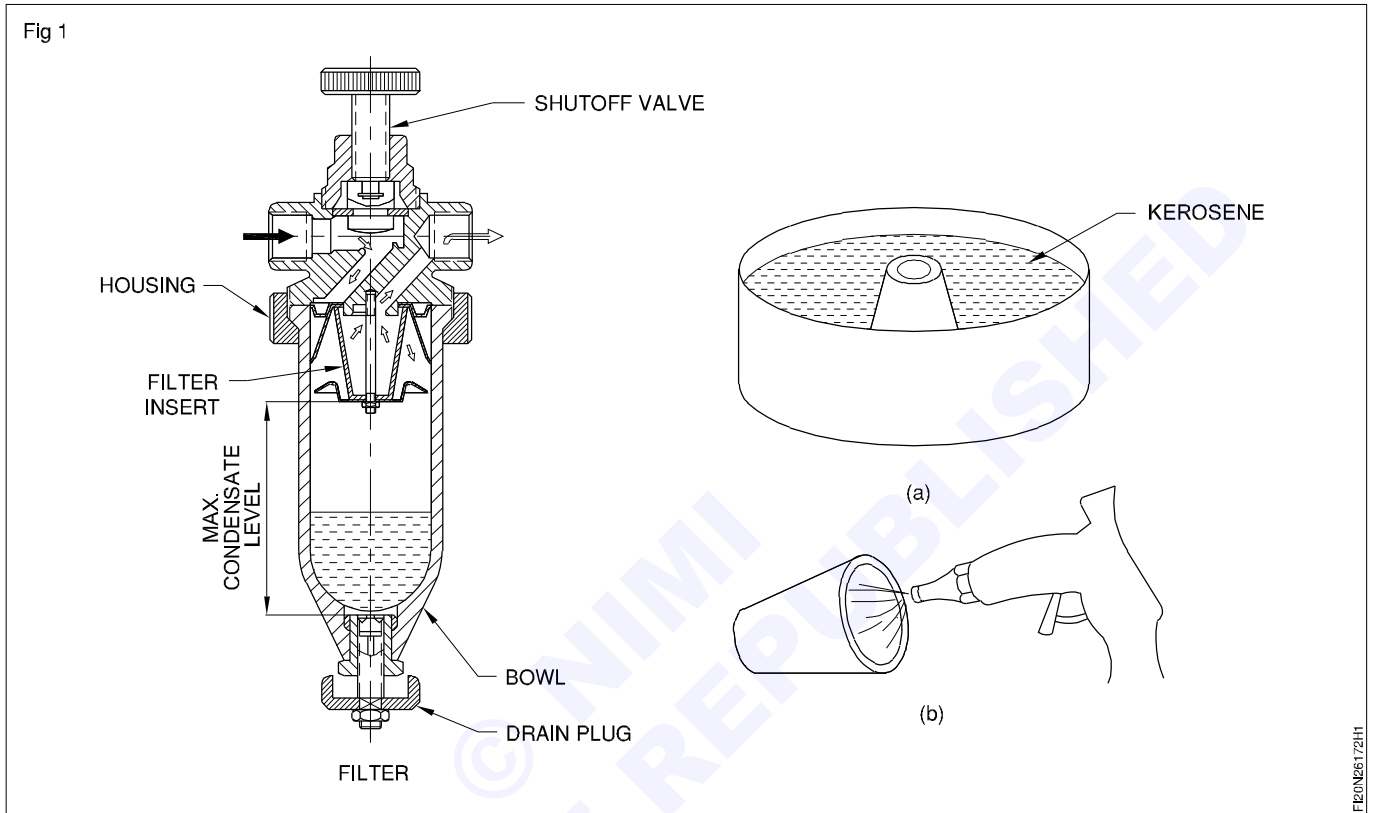
Serial No	Name of the parts
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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Dismantle, replace and assemble FRL unit

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

- overhaul FRL unit
- mount and read pressure on the pressure gauge.



Job sequence

Overhauling a filter of FRL unit and Lubricator.

- Drain the water from the filter unit.
- Hold the FRL unit in a bench vice in a horizontal position between soft jaws.
- Drain water from lubricator, by rotating drain plug.
- Hold the filter bowl with hand and unscrew it.
- Do not use pipe wrench since bowl (mostly of plastic) may break/damage.
- Use a spanner and remove the filter insert.
- Rinse the filter in clean kerosene.
- Blow the inner side of filter using compressed air.
- Rinse the bowl in soap solution and dry it with clean cloth.
- Place the filter insert and tighten the nut.
- Screw the bowl to the housing.
- Confirm the drain plug is in closed condition.

Skill sequence

Overhauling a lubricator of FRL unit

Objective: This shall help you to

- overhaul lubricator.

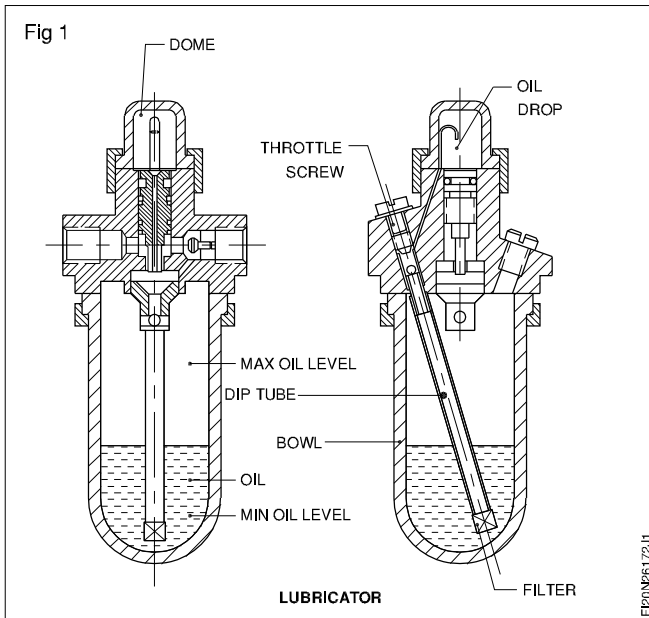
Hold the lubricator body and unscrew the bowl by hand.
(Fig 1)

Drain oil from bowl.

Clean the bowl and rinse it in soap solution.

Dry it with a clean cloth.

Clean the filter at the tip of the dip tube. (Fig 1)



Ensure dip tube in its location.

Screw the bowl into its position tightly.

Open the inlet valve.

Observe the pressure gauge.

Fill it with correct grade of oil as per manufacturers recommendation to the level marked.

Maintain oil level.

Do not fill above or below the marked level. (Fig 1)

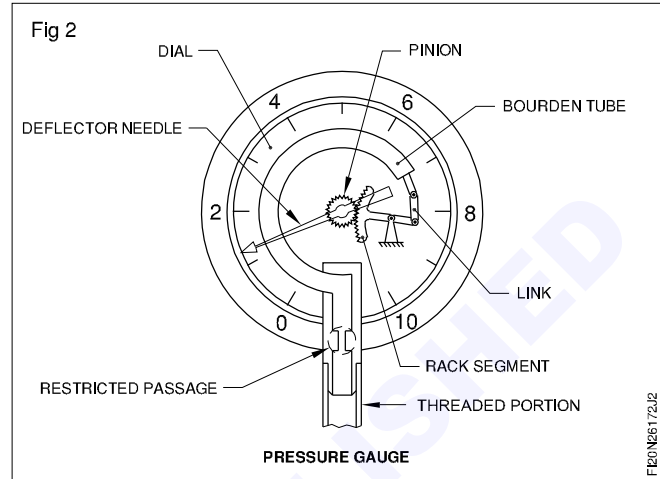
Mounting and reading of pressure

Mount the FRL unit on the trainer kit.

Ensure the flow of air is in line with arrow mark on the FRL unit.

Needle of pressure gauge indicates the pressure on the dial behind it. (Fig 2)

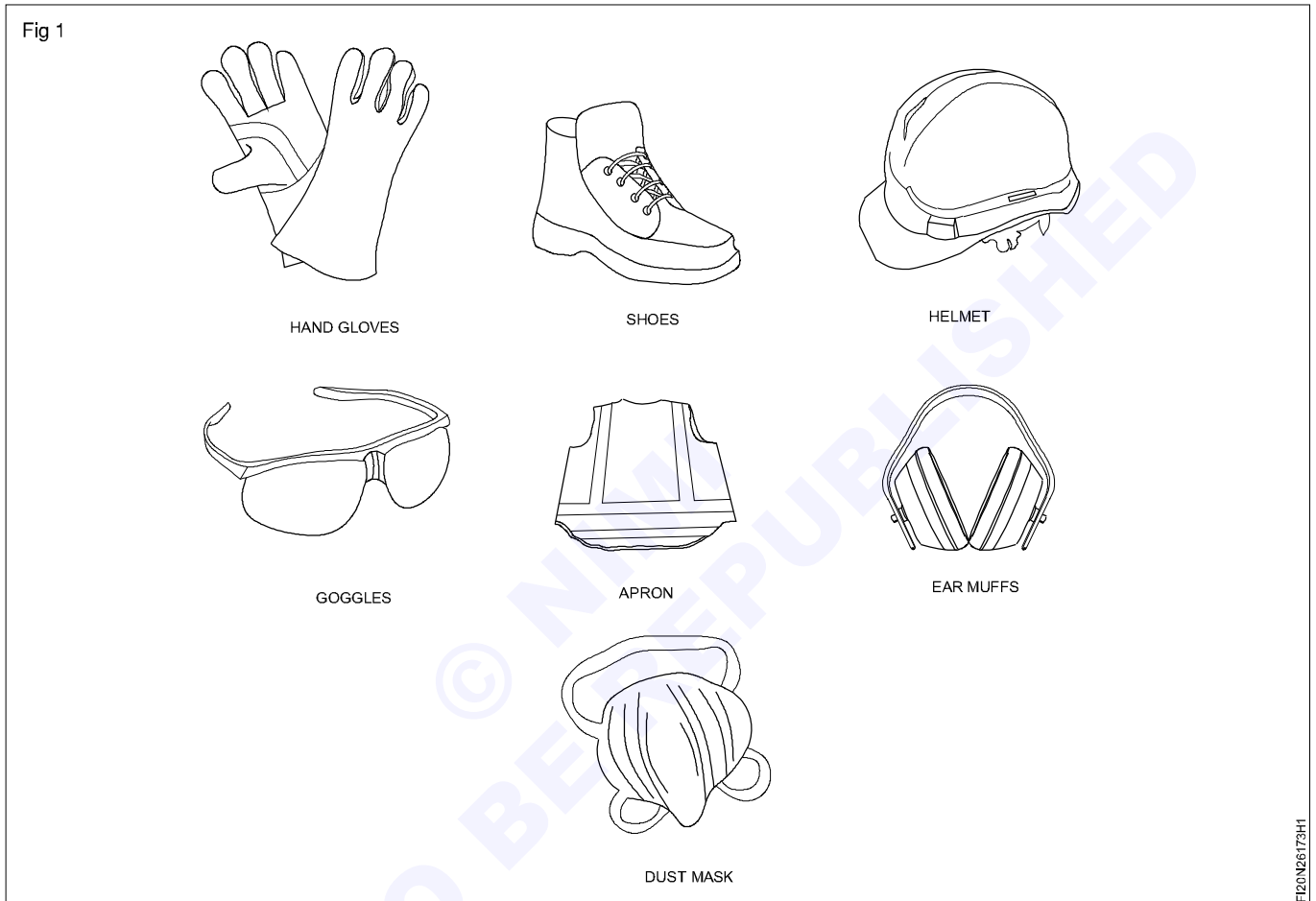
Pressure is measured in kg/cm^2 or kgf/cm^2 .



Safety procedures in pneumatic systems and personal protective equipment (PPE)

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

- follow the safety while working in pneumatic system
- select the personal protective equipment.

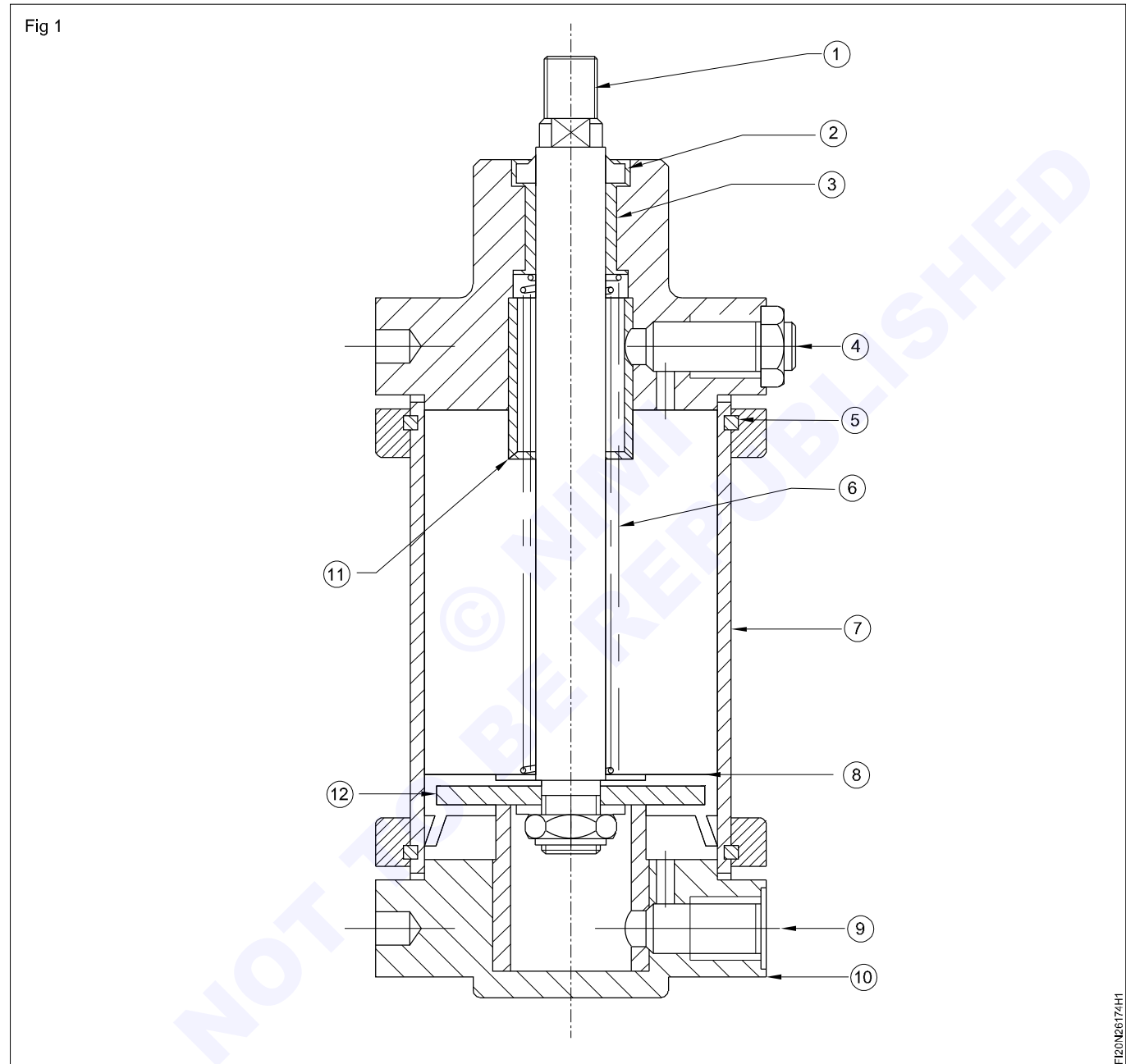


Job sequence

- Should not operate pneumatic machine without knowledge.
- Protect yourself and others from the damaging effect of compressed air.
- Inspect the air hose for cracks or other defects.
- Before opening the control valve, see that nearby personnel are not in the path of the air blow.
- Never stay near to compressed air.
- Do not turn the main air supply on make sure that, the disconnected pipes are connected properly, otherwise disconnected pipe can whip around and cause injury.
- If air is leaking from a joint, close the air valve immediately.
- Always turn air off before altering the circuit.
- Keep your hands away from the piston rods.
- Wear personnel protective equipment. The detailed information has been already given in safety precautions.

Identify the parts of a pneumatic cylinder

- Objectives:** At the end of this exercise you shall be able to
- identify pneumatic cylinder elements from their outlook
 - enter the name of the part in table - 1.



Job sequence

Instructor shall arrange and display the pneumatic cylinder and give demo to trainees showing all the parts. Ask the trainees to record in the table-1.

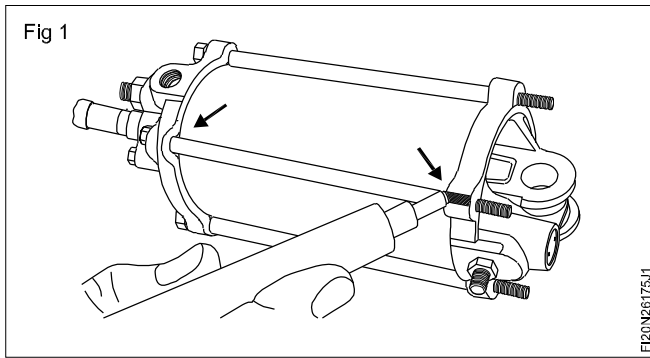
- Observe the given pneumatic cylinder.
- Identify the parts.
- Record the part name in Table. 1

Table. 1

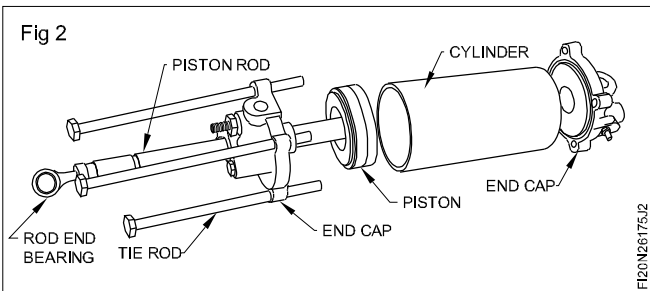
Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

- Get it checked by your instructor.

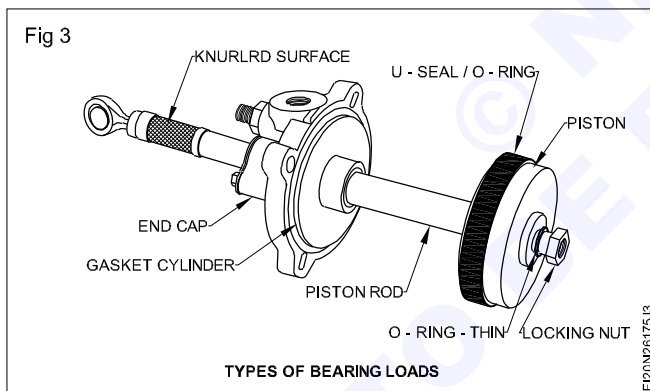
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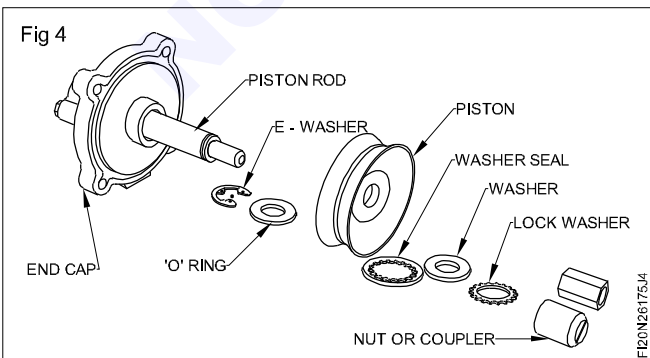
- Remove and retain all the rod nuts, lock washers and tie rods from the cylinder end caps. Remove the end caps from the cylinder tube and discard the cylinder gaskets. (Fig 2).



- For single-acting cylinders :** Use a strap wrench or soft-jaw wrench to hold the piston rod at the knurled surface. Remove and discard the self-locking nut, O-ring, and piston. (Fig 3)



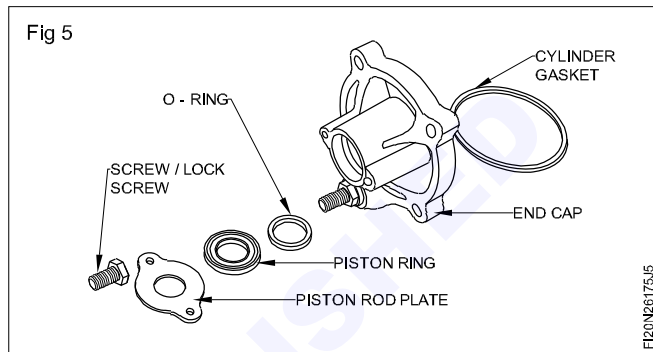
- For double-acting cylinders :** Use a strap wrench or soft-jaw wrench to hold the piston rod and remove and retain the nut and washers. Note two different styles of piston nut in figure. Discard the piston (Fig 4).



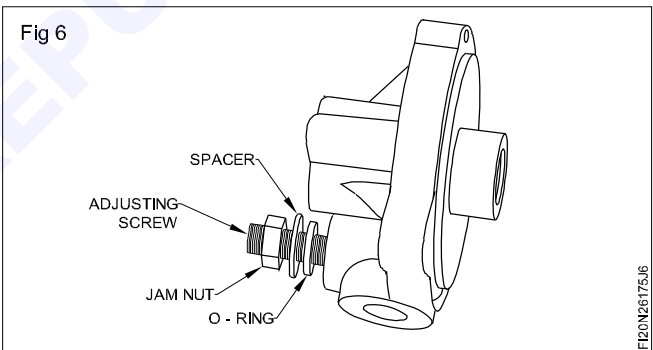
- Remove and retain the E-ring and miscellaneous hardware from the piston rod and pull the front end cap from the piston rod (Fig 4).

Prior to removing the end cap, remove any burrs or nicks from the piston rod surface with fine emery cloth (400 grit). Remove all emery dust before removing the front end cap.

- Remove and retain the two screws, lock washers and the piston rod plate from the front end cap. Remove and discard the packing ring and the O-ring (Fig 5).



- Remove and retain the jam nut and spacer from the speed adjusting screw in the front end cap. Do not remove the adjusting screw. Remove and discard the O-ring. (Fig 6)



- Some rear end caps on single-acting cylinders may contain speed adjusting screws. If so, remove and retain the jam nut and spacer from both adjusting screws. Do not remove the adjusting screws. Remove and discard the O-rings.
- Clean all metallic parts thoroughly with a solvent (mineral sprits recommended).
- Do not soak parts in solvent. Do not clean the spherical rod end bearing with solvent as this will remove lubricant from the bearing.

Do not use trichlorethylene or chlorinated hydrocarbon solvents. Do not clean or soak O-rings or other rubber components in solvent.

- Inspect the inside surface of the cylinder tube and replace if the I.D. is worn out or if there are deep scratches or grooves on the inner surface.

Re-assembly

- Install a new O-ring to the speed adjusting screw on the front end cap. Replace the spacer and jam nut.
- If equipped with speed adjusting screws on the rear end cap; install new O-rings. Replace the spacers and jam nuts.
- Install a new packing ring and O-ring and attach the piston rod plate to the front end cap with lock washers and screws.
- Be sure the piston rod is free of nicks and burrs. Slide the front end cap onto the rod and install the E-ring.
- Assemble the new U-seal and O-ring on the piston, then mount the piston and O-ring on the piston rod and secure with a new lock nut. See Fig 3.
- Mount 'E' ring, washer, piston, washer seal, washer and lock washer on the piston rod. The rubber face of the piston should face towards the rod and bearing. (Fig 4)
- Apply a light coat of grease to the cylinder tube I.D., completely around the U-seal, (if double-acting, apply around piston edge), the front end cap gasket, and working length of the piston rod.
- Install new cylinder gaskets on the end caps.

- Assemble the cylinder tube, rear end cap and front end cap assembly. Install the tie rods, tie rod nuts and lock washers. Finger tighten the nuts. Then cross tighten the nuts equally and then tightened to a final torque. (Fig 2)

Before tightening the nuts, be sure the tie rods are parallel to the long axis of the cylinder. Tie rods must be positioned properly to obtain a good seal at both end caps.

- Re-attach accessory items and air lines to the cylinder.
- Re-install the cylinder in the machine and connect air and electrical lines.
- Verify proper operation of the cylinder.

Testing the cylinder

- Apply air to the inlet port on the front end cap. Use a brush with a soap and water solution to check for leaks. Do not submerge the cylinder.
- With air applied to the speed fitting and the piston rod fully extended, open the air passage in the speed fitting and observe that the piston moves to the rear cap. Check for leakage at the front cap adjustment screw; at the front cap piston rod seal; at the rear cap adjustment screw and adjacent ports (if equipped); from the piping between the speed fitting and the front end cap; from both ends of the cylinder at the cap gaskets; and from the speed fitting exhaust port. Repair any leaks and recheck.

Construct a circuit for the direction & speed control of a small bore single acting (s/a) pneumatic cylinder

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

- select the components, to operate Single Acting Cylinder using 3/2 way valve
- draw circuit diagram on paper
- assemble circuit on the trainer board
- check function of the circuit.

Requirements			
Tool / Instrument / Equipment / Machines			
• Trainer board	- 1 No.	• Paper	- as req.
• Pneumatic source	- 1 No.	• Pencil	- as req.
Material / Component		• Single Acting Cylinder	- 1 No.
• P U Tube	- as req.	• 3/2 way valve	- 1 No.
		• FRL	- 1 No.

Job sequence

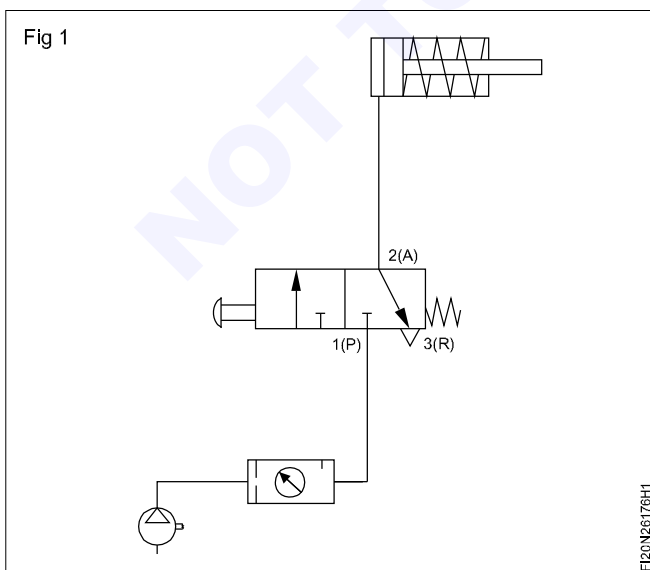
TASK 1: List the components, to operate Single Acting cylinder using 3/2 way valve.

- 1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned

Component	Symbol
Pneumatic Source	
Single Acting Cylinder	
3/2 Way valve	
FRL	

TASK 2: Draw circuit diagram. (Fig 1)



TASK 3: Assemble circuit on the trainer board

- 1 Arrange component on trainer board as shown.
- 2 Connect source to FRL
- 3 Connect FRL to input port “1” of 3/2 Way valve.
- 4 Connect output port “2” of 3/2 Way valve to input port of single acting cylinder.

- 5 Ensure proper connections.
- 6 Supply air.

Correct the assembly if air leaks through joints

TASK 4: Check function of the circuit as per table

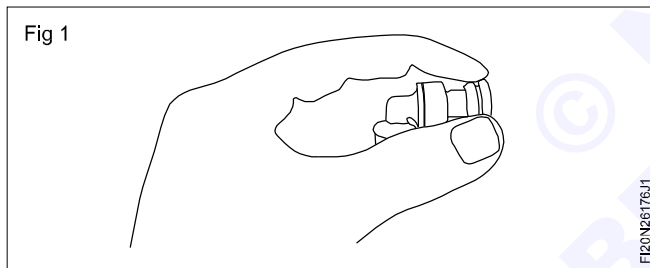
Action	Expected Result	Confirm Result (Put)
Press Push Button	Piston moves forward	
Release push Button	Piston retracts	

Conclusion

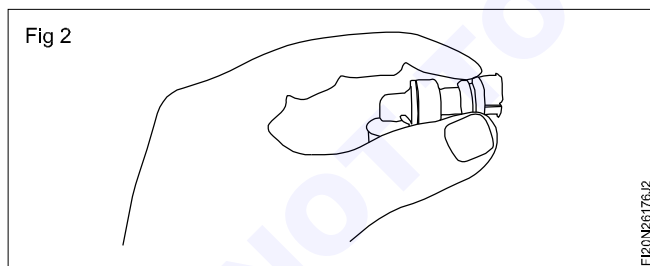
Conclusion drawn	Remarks
Motion of Single Acting cylinder can be controlled by 3/2 Way valve.	

Connect tube using push in fitting

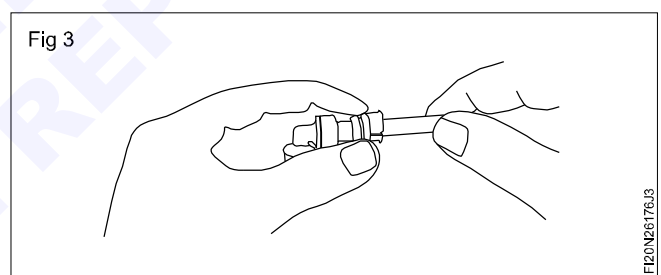
- 1 Grip pull back ring. (Fig 1)



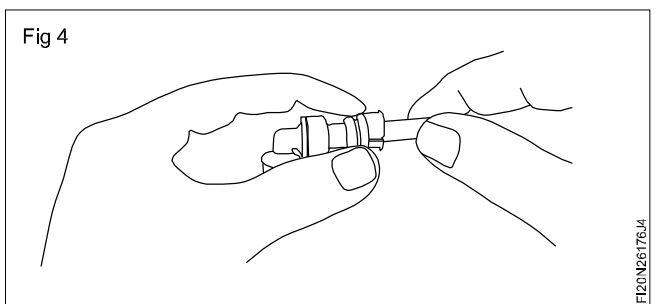
- 2 Pull the ring. (Fig 2)



- 3 Push the P U (poly Urethane) tube into fitting. (Fig 3)



- 4 Push lock ring forward to lock. (Fig 4)



Construct a control circuit for the control of a d/a pneumatic cylinder with momentary input signals

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

- select the components, to operate double acting cylinder using 5/2 way valve
- draw circuit diagram
- check function of the circuit.

Requirements			
Tool/ Instrument/ Equipment/ Machines		<ul style="list-style-type: none"> • Paper • Pencil • FRL • 5/2 way valve 	<ul style="list-style-type: none"> - as req. - as req. - 1 No. - 1 No.
<ul style="list-style-type: none"> • Trainerboard • Pneumatic source 	<ul style="list-style-type: none"> - 1 No. - 1 No. 		
Material/ Component			
<ul style="list-style-type: none"> • P U Tube 	<ul style="list-style-type: none"> - as req. 		

Job sequence

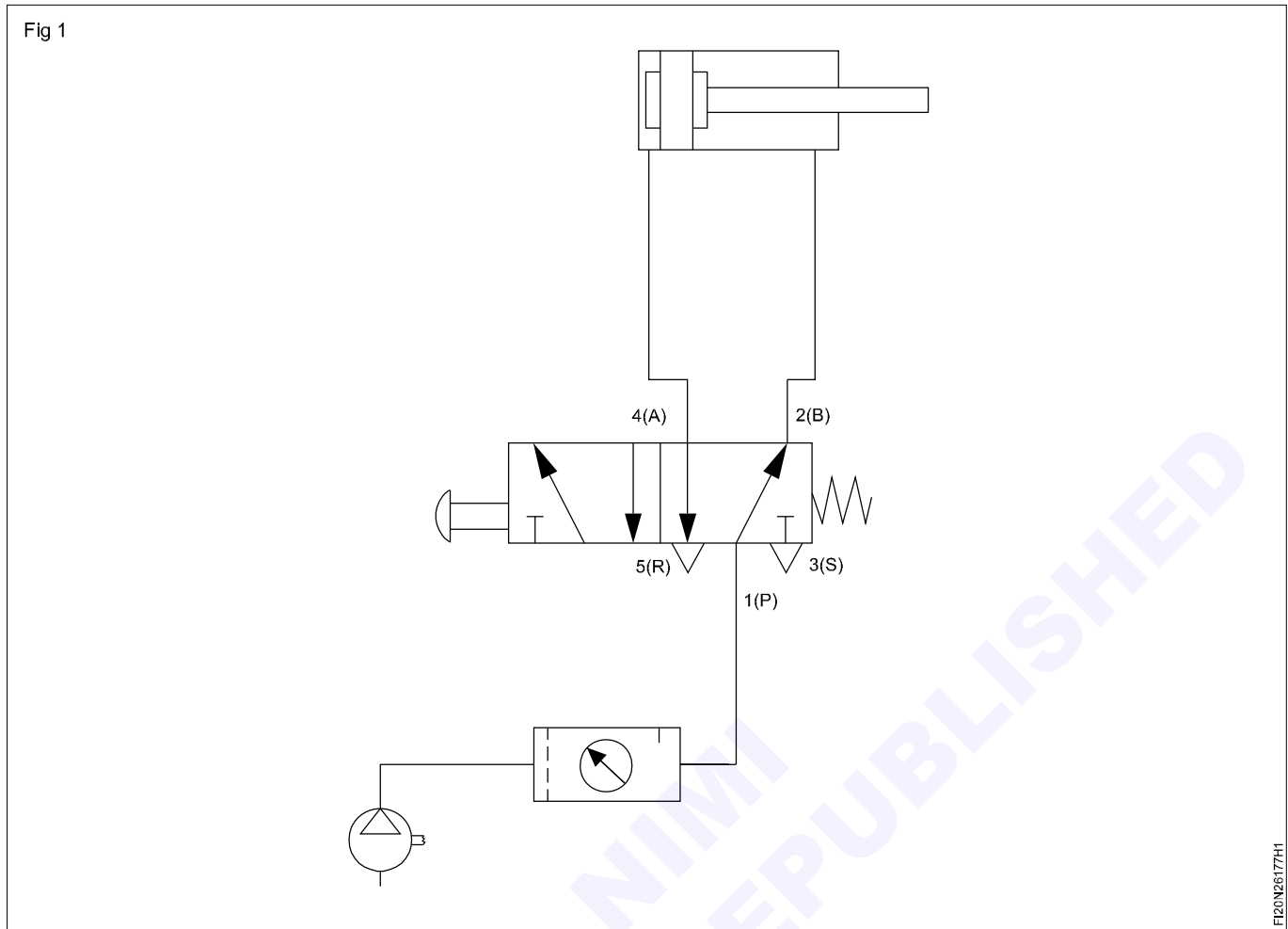
TASK 1: Select and list the components, to operate double acting cylinder using 5/2 way valve.

1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned

Component	Symbol
Pneumatic Source	
Double Acting Cylinder	
5/2 Way valve	
FRL	

TASK 2: Draw circuit diagram. (Fig 1)



TASK 3: Assemble circuit on the trainer board

- 1 Arrange component on trainer board as shown.
- 2 Connect source to FRL
- 3 Connect FRL to input port "1" of 5/2 Way valve.
- 4 Connect output port "2" & "4" of 5/2 Way valve to input port "A & "B" of double acting cylinder.
- 5 Ensure proper connections.
- 6 Supply air.

Correct the assembly if air leaks through joints

TASK 4: Check function of the circuit. (Table I)

Action	Expected Result	Confirm Result (Put)
Press push button	Piston moves forward	
Release push button	Piston retracts	

Conclusion

Conclusion Drawn	Remarks
Motion of double acting cylinder can be controlled by 5/2 way valve.	

Construct a circuit for the direct & indirect control of a d/a pneumatic cylinder with a single & double solenoid valve

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

- construct a circuit
- select the component
- assemble the circuit on the trainer board
- check the function of the circuit.

Requirements

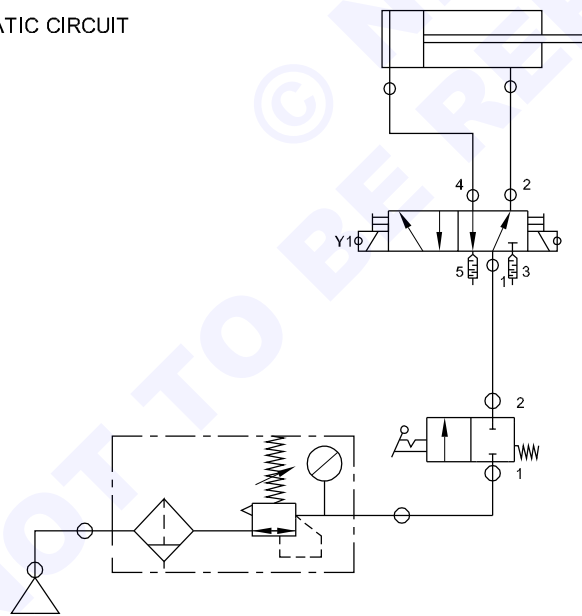
Tool/ Equipment/ Machines / Component

- Double acting cylinder
- 5/2 DC double solenoid valve (y_1, y_2)
- Shut-off valve
- Filter regulator unit
- Pneumatic power source
- Push button (PB_1, PB_2)
- Relay (K_1, K_2)

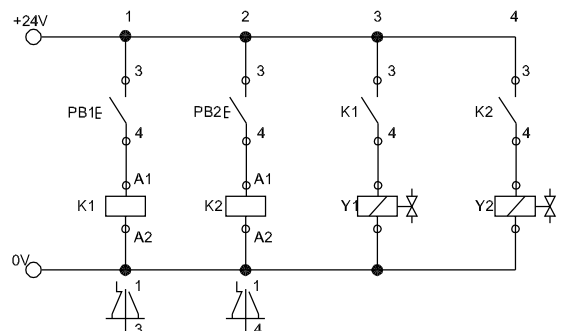
Job sequence

TASK 1: Construct a circuit for the indirect control of a double - acting pneumatic cylinder with a double solenoid valve.

Fig 1
 TASK 1
 PNEUMATIC CIRCUIT



ELECTRICAL CIRCUIT



FIZON26178H1

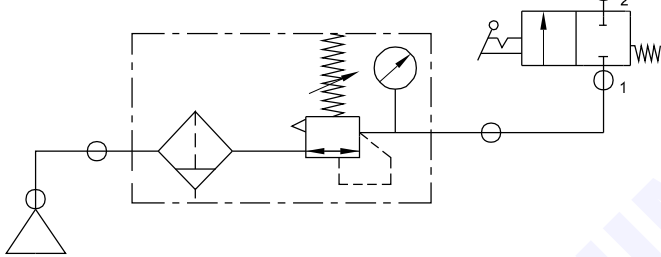
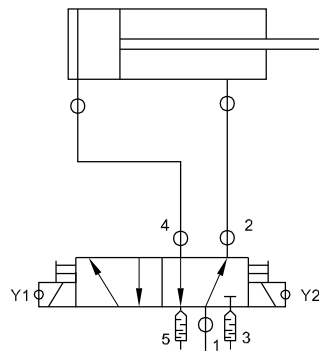
TASK 2 : Construct a circuit for the direct control of a double-acting pneumatic cylinder with a double solenoid valve.

TASK 3 : Construct a circuit for the indirect control of a double-acting pneumatic cylinder with a single solenoid valve.

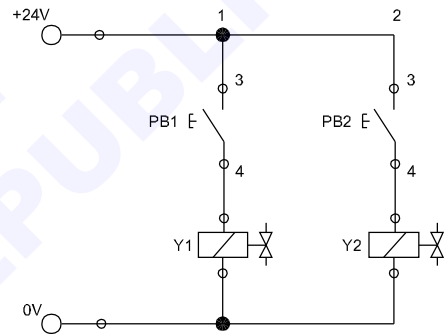
Fig 2

TASK 2

PNEUMATIC CIRCUIT

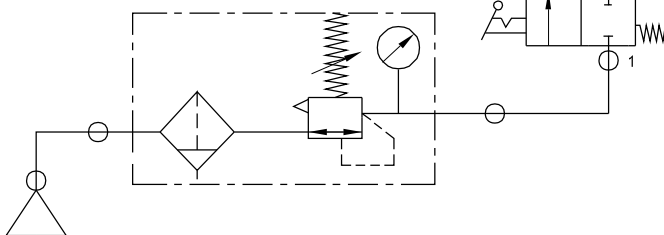
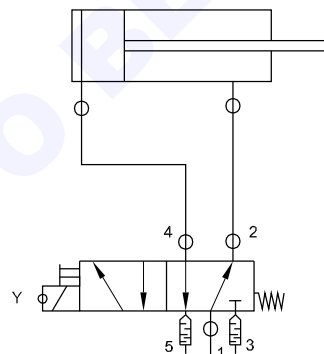


ELECTRICAL CIRCUIT

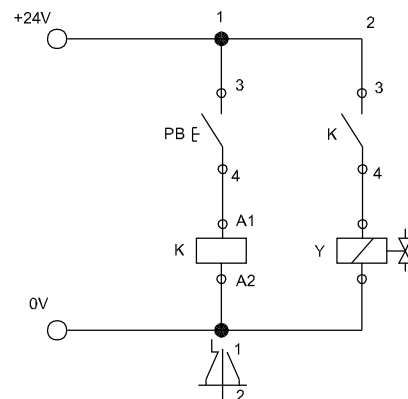


TASK 3

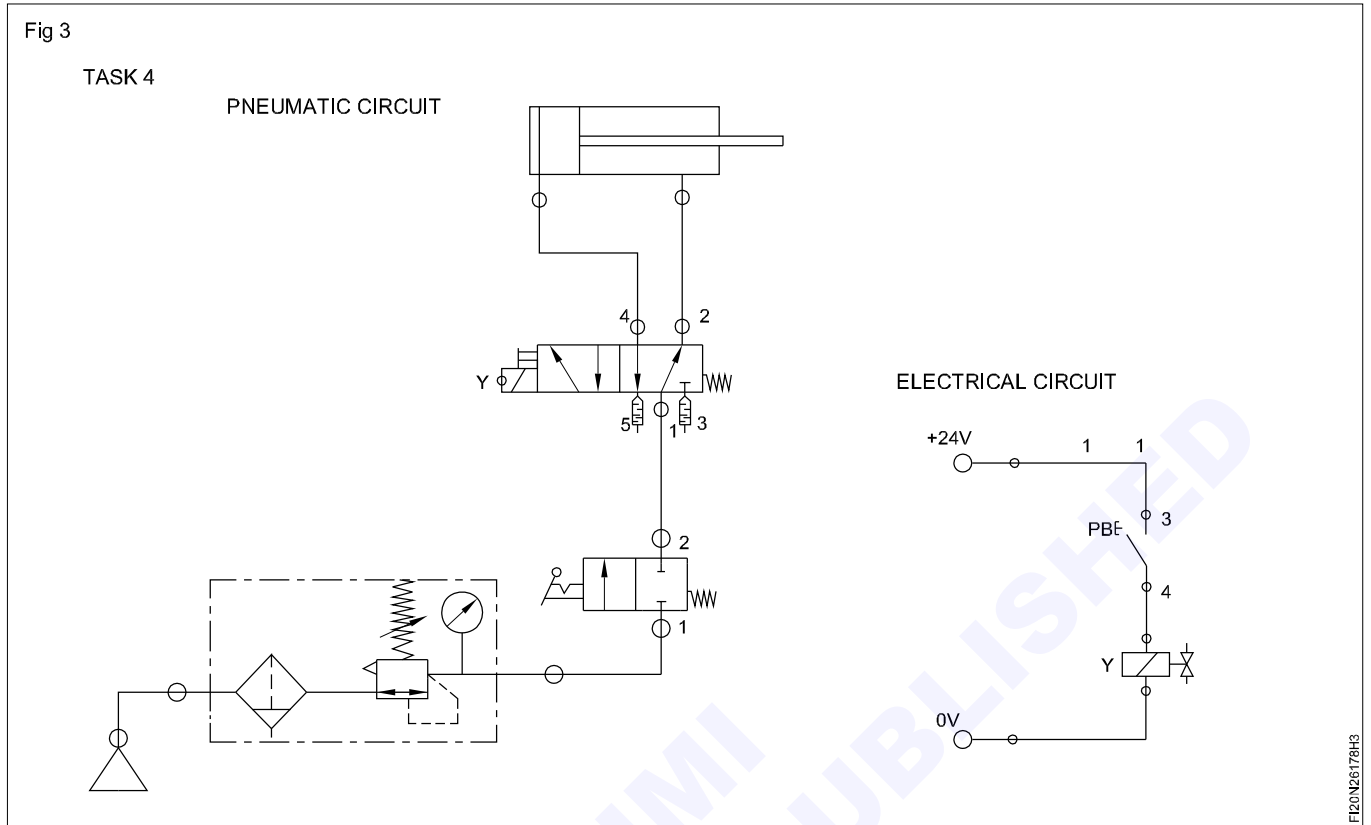
PNEUMATIC CIRCUIT



ELECTRICAL CIRCUIT



TASK 4: Construct a circuit for the direct control of a double - acting pneumatic cylinder with a single solenoid valve.



Job sequence

- construct circuit diagram
- Assemble circuit according to circuit diagram
- carry out the exercise

Enter the following in the table

- flow paths, operating positions
- pressures p_{o2} and p_{o3}
- forces F_1 and F_2 and ΔF (to be calculated)

Practice exercise

Set the following

- operating pressure p (50 bar)
- one - way throttle valve, position 2

Hydraulic cylinder	5/2 way valve I		pressure bar		force kgf or daN		effective force kgf or daN $d F = F_1 - F_2$
	flow paths	operating positions	p_{o2}	p_{o3}	piston rod side F_1	piston rod side F_2	
forward stroke							
return stroke							

Safety precautions

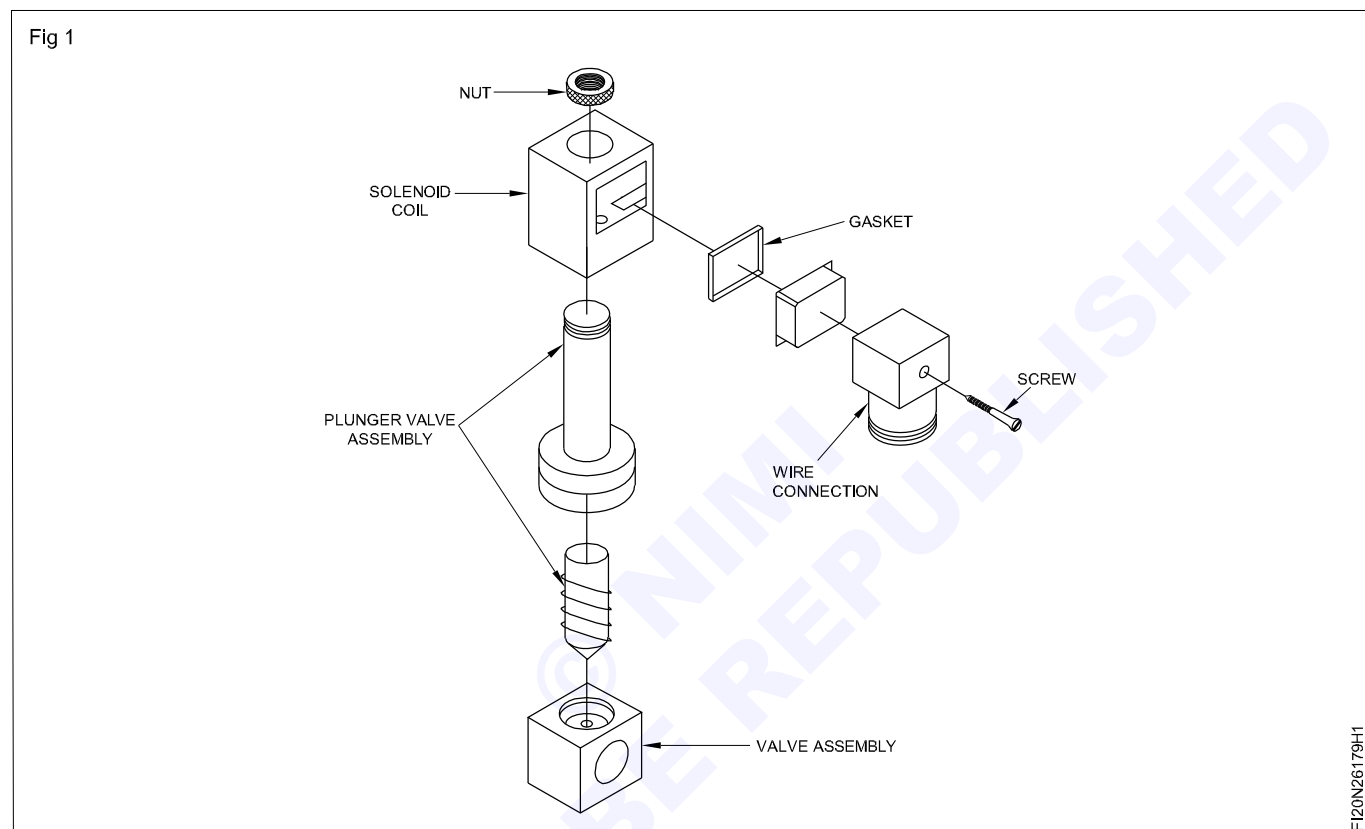
Only switch on the power unit upon directions from the instructor.

Make sure the standing area is safe. Do not spill any oil. Do not work with oily hands (danger of slipping off). Fault finding and dismantling only when the system has been depressurized.

Dismantling and assembling of solenoid valves

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

- remove the nut to remove the coil
- remove the cores / metal plate
- remove the valve
- check for scratches
- clean and reassemble.



Job sequence

- If you ever need to disassemble a 2P025-08 Solenoid Valve, here's a step by step pictorial.

The assembled valve looks like (Fig 1)

- First thing to note is that the valve actually is two major components. The coil and the valve mechanism. You can safely remove the coil even while the valve itself is connected to the water supply and under itself is connected to the water supply and under pressure. Removal of the coil itself will not cause the water to flow and will not cause the valve to leak water.

Remove the top nut to remove the coil (Fig 2)

- For the following steps are dismantling the valve itself. For this you need the water turned off and even then you will get a slight amount of water out of the system when you take the valve apart.
- Here, note the two screws holding the metal plate on. We will remove these to disassemble the valve. (Fig 3)
- Now remove the two screws. (Fig 4)

- Now remove the metal plate.
- Now with a twisting motion, grab the valve stem and pull it upward.
- The valve with the stem removed. (Fig 5)

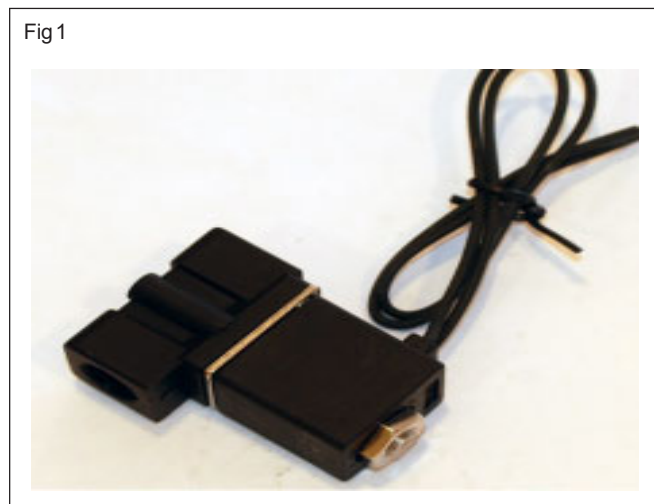


Fig2

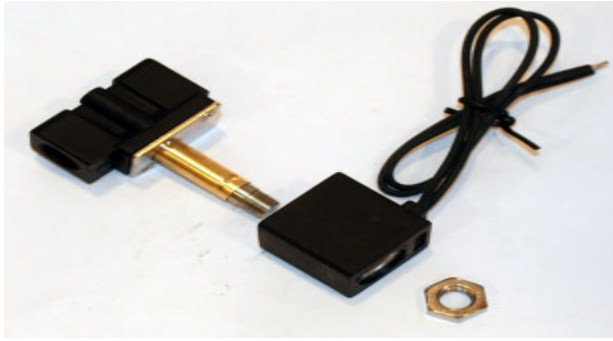


Fig6



Fig3



Fig7



Fig4



Fig8



Fig5

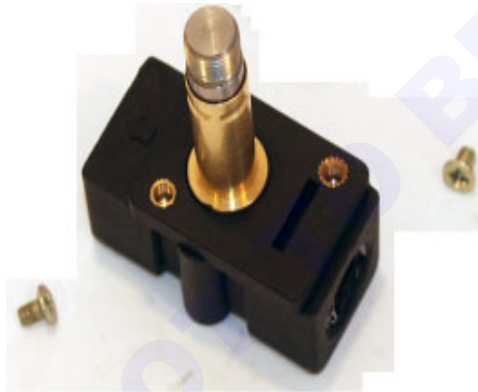


Fig9



- Now the stem itself can be disassembled (and cleaned). Note that the plunger (with the spring) should just fall out of the stem.
- Observe inside the stem and the surface of the plunger and clean any trace of foreign objects.(Fig 6 to 9)
- If any wornout parts notice, replace it by new one.
- Reverse the sequence of operation and assemble the solenoid valve.

Demonstrate knowledge of safety procedures in hydraulic systems (demo by video)

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

- follow all the safety knowledge related to hydraulic systems.
 - ensure safety for personal and machine.
-

Instructor shall arrange video vedio and demonstrate to the trainees.

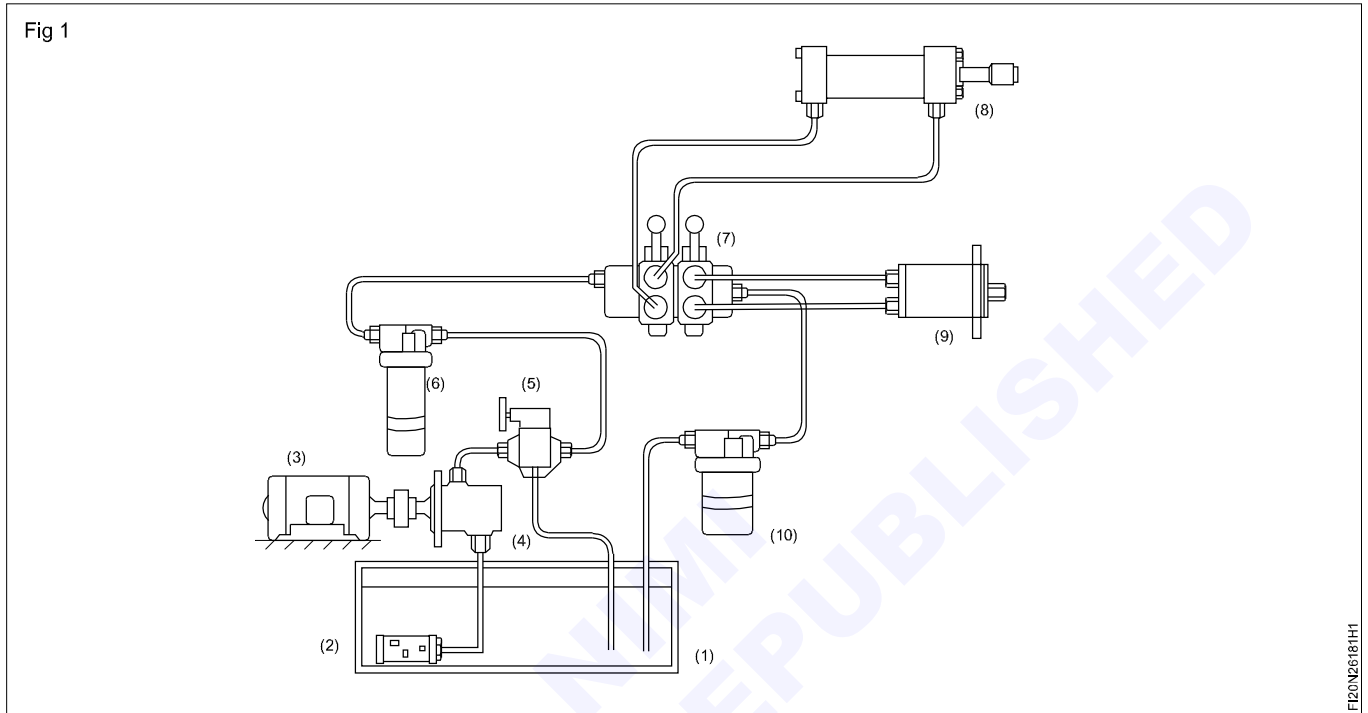
On safety procedure in hydraulic system.

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Identify hydraulic components

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

- identify and locate the element in a hydraulic circuit
- draw symbols as per ISO 1219.



Job sequence

Instructor shall arrange and display the circuit and demonstrate to trainees.

- Study the circuit and record the part name in Table - 1
- Draw the symbol against the part name.

Table. 1

Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

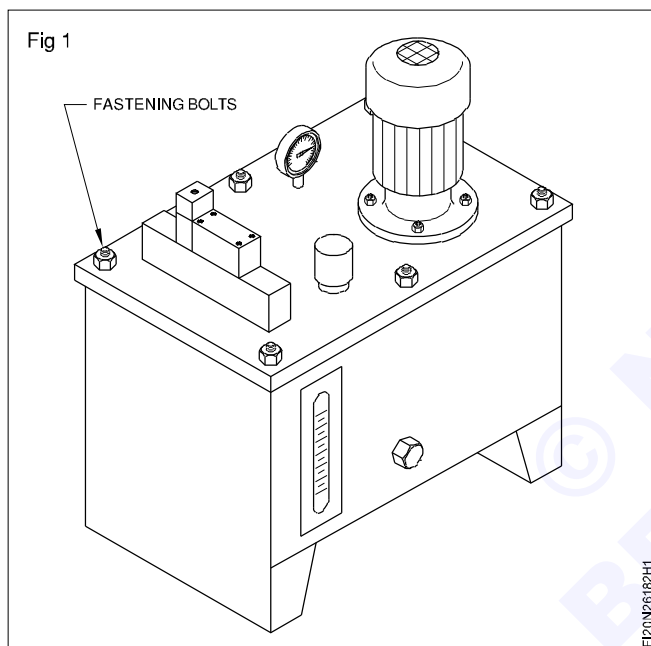
- Get it checked by your instructor.

Inspect fluid levels, service reservoirs, clean/ replace filters

- Objectives:** At the end of this exercise you shall be able to
- identify the various hydraulic elements used in power pack
 - remove, clean and assemble of inlet filter
 - preparing the power pack for operation
 - start and set the pressure in the power pack.

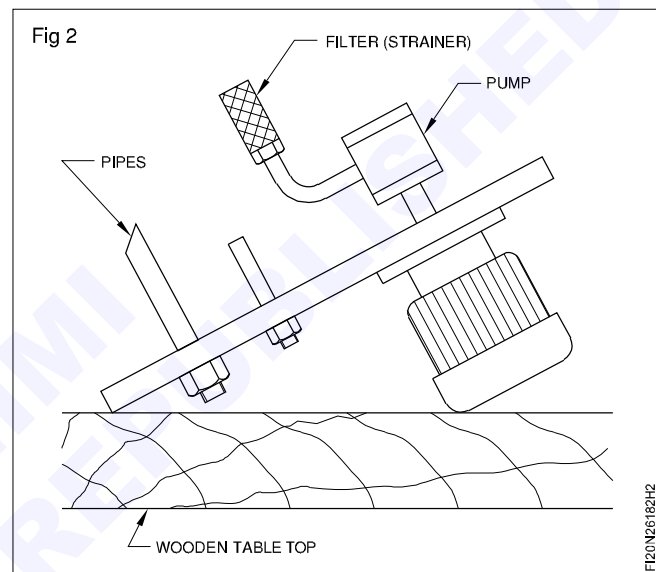
Job sequence

- Locate the power pack of the hydraulic system.
- Ensure the system is in 'off' condition.
- Remove the top cover of the power pack after unscrewing the fastening bolts (Fig 1).



- Pipes are provided below the top cover; place it carefully.

- Place the top cover upside - down with the various elements mounted on it carefully on the workbench (Fig 2).



- Identify the various elements, their names and function. Also observe the order of connection.
- Keep the reservoir closed with a plastic cover to avoid contamination. Remove clean and assemble the inlet filter. Prepare the power pack for operation. Set the pressure of relief valve.

Skill sequence

Removing, cleaning and assembling of inlet filter (for a closed type of reservoir with removable top cover)

- Objective:** This shall help you to
- **dismantle, clean and assemble inlet filter.**

Inlet filter is normally called as suction strainer. Unscrew the inlet cartridge (Fig 1), wipe at the excess sludge collected on the filter.

Soak it in kerosene and remove the sludge.

Flush the strainer with clean kerosene. (Fig 2)

Blow compressed air on the mesh area.

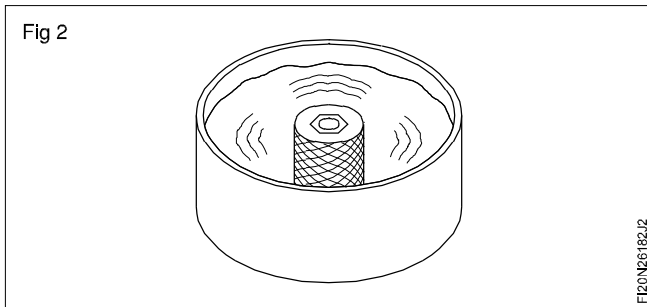
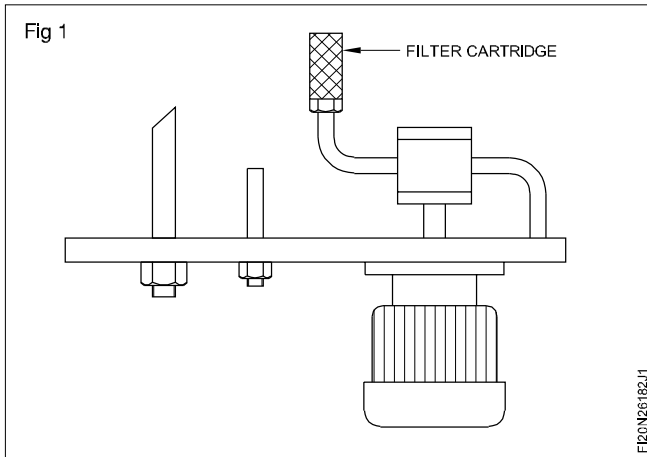
Clean the mounting area of the strainer.

Screw the strainer back in its location.

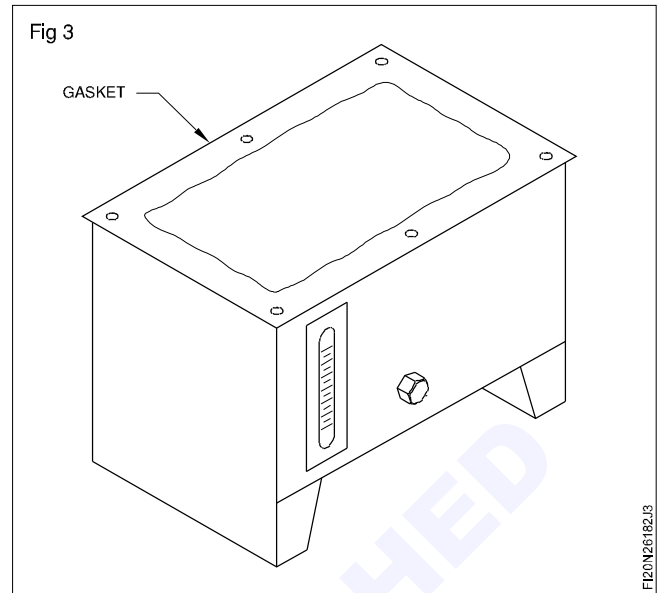
Strainer/Filters should be clean periodically as per recommendation.

Replace with new filter, if the existing filter damaged.

While replacing new strainer, care should be taken to select the correct strainer.



Checking the gasket of the top, cover of the reservoir for proper seating. (Fig 3)



Place the top cover of the reservoir in its place.
Mount the cover by screwing the fastening screws.
Now inspect the cover for proper seating all over.

Preparing the power pack for an operation

Objective: This shall help you to
• prepare the power pack for an operation.

A power pack can perform well only if it is in an ideal condition. So before putting on a hydraulic system, the power pack should be checked for its preparedness.

Check the proper mounting of all units.

Check the coupling between motor and pump for freeness, before mounting the top plate.

Check and confirm oil level. (Fig 1)

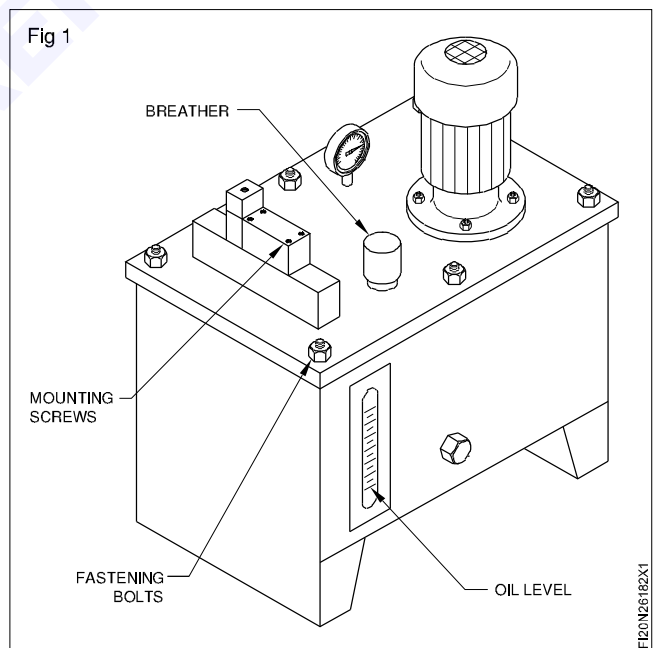
If oil level is less than the mark, fill the correct grade of oil.

Keep the reservoir clean and clear all unnecessary things around and underneath the reservoir.

Check for proper tightening of all connecting hoses.

Check whether the breather is placed properly.

Oil drain hole is plugged and no oil leakage.



Starting and setting the pressure in a power pack

Objective: This shall help you to
• starting and setting the pressure in a power pack.

Switch on the electric motor of the power pack.

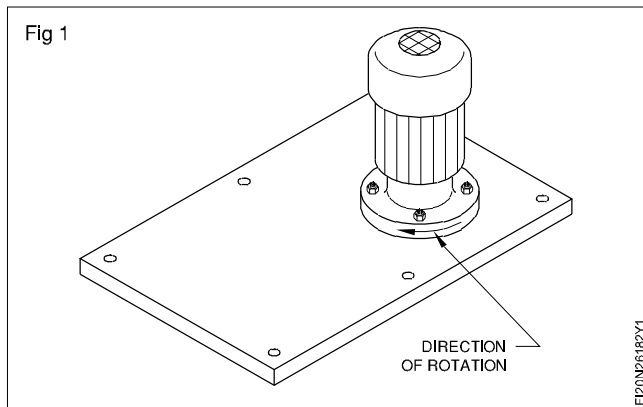
Confirm no loose ends of pipes exist before switch on the motor.

Observe and confirm the direction of rotation of the motor as indicated in the motor body. (Fig 1)

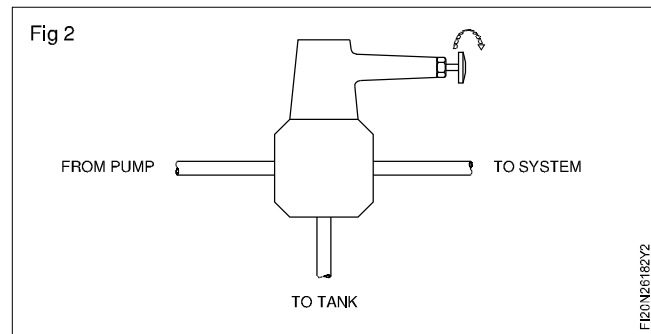
Put off the motor if it rotates in the opposite direction and call electrician.

Observe the pressure in the pressure gauge.

Now get the required pressure on the pressure relief valve. (Fig 2)



Rotate clockwise to increase pressure and vice versa.

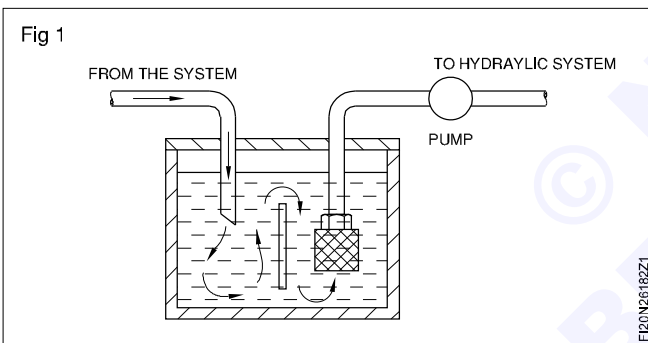


Removal of an inlet filter

Objective: This shall help you to
 • removal of an inlet filter.

The procedure for removing the inlet filter depends on the construction of the power pack. The suction strainer is usually placed immersed in the oil and locating it needs some experience.

Open type of reservoir (Fig 1)



In a open type reservoir, the steps to be followed are

Put off hydraulic system.

Remove the top cover plate.

Keep your hand clean.

Insert your hands inside the oil and locate the suction strainer.

Use a suitable spanner and loose the suction strainer.

Clean the strainer using kerosene and blow with compressed air.

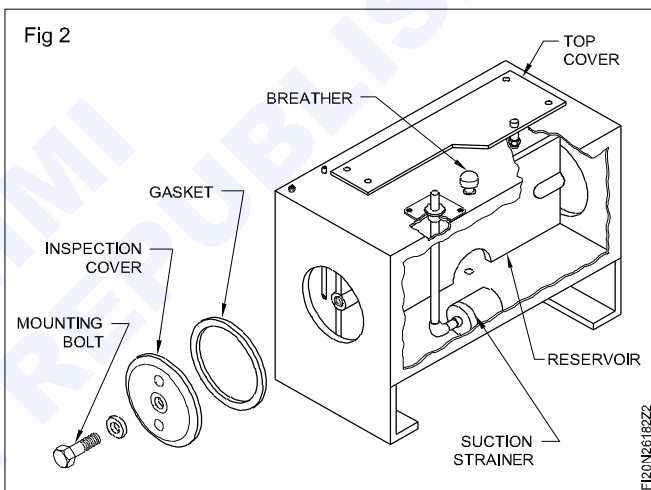
Check for damages, if any replace with new filter.

Screw on the clean filter back into position.

Removal of filter in a closed type of reservoir

Already the procedure for the filter of a closed type of reservoir with removable top cover has been explained. Other type of reservoir is explained below.

All sides welded reservoir (Fig 2)



Put off the hydraulic system.

Drain the oil from the reservoir.

Remove the inspection cover after unscrewing mounting.

Locate and unscrew the suction strainer.

Clean, strainer with kerosene and blow it with compressed air.

Clean inside of the reservoir thoroughly.

Screw the suction strainer after inspecting it for damages.

Replace inspection cover and gasket, tighten mounting screws.

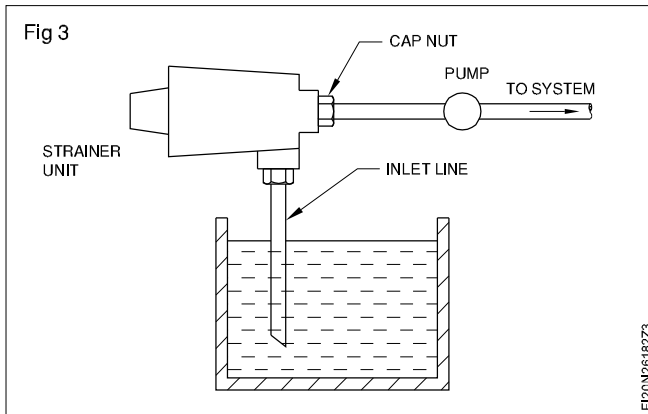
Refill the oil in the reservoir after filtering the oil using mesh.

Check for oil leakage through inspection cover. Confirm no leakage of oil.

Check for oil level.

Now the system is ready for use.

Externally mounted suction strainer (Fig 3)

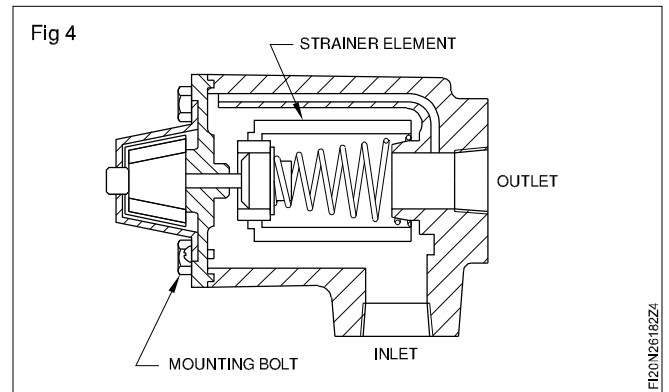


To dismantle this type of suction strainer the steps are as follows

Put off the hydraulic system.

Unscrew both the cap nuts of the lines coming to the filter unit and going out of it.

Hold the filter unit in the benchvice and unscrew the mounting bolt. (Fig 4)



Remove the filter insert clean/replace filter insert.

Clean the casing thoroughly.

Place the insert and screw the mounting bolt.

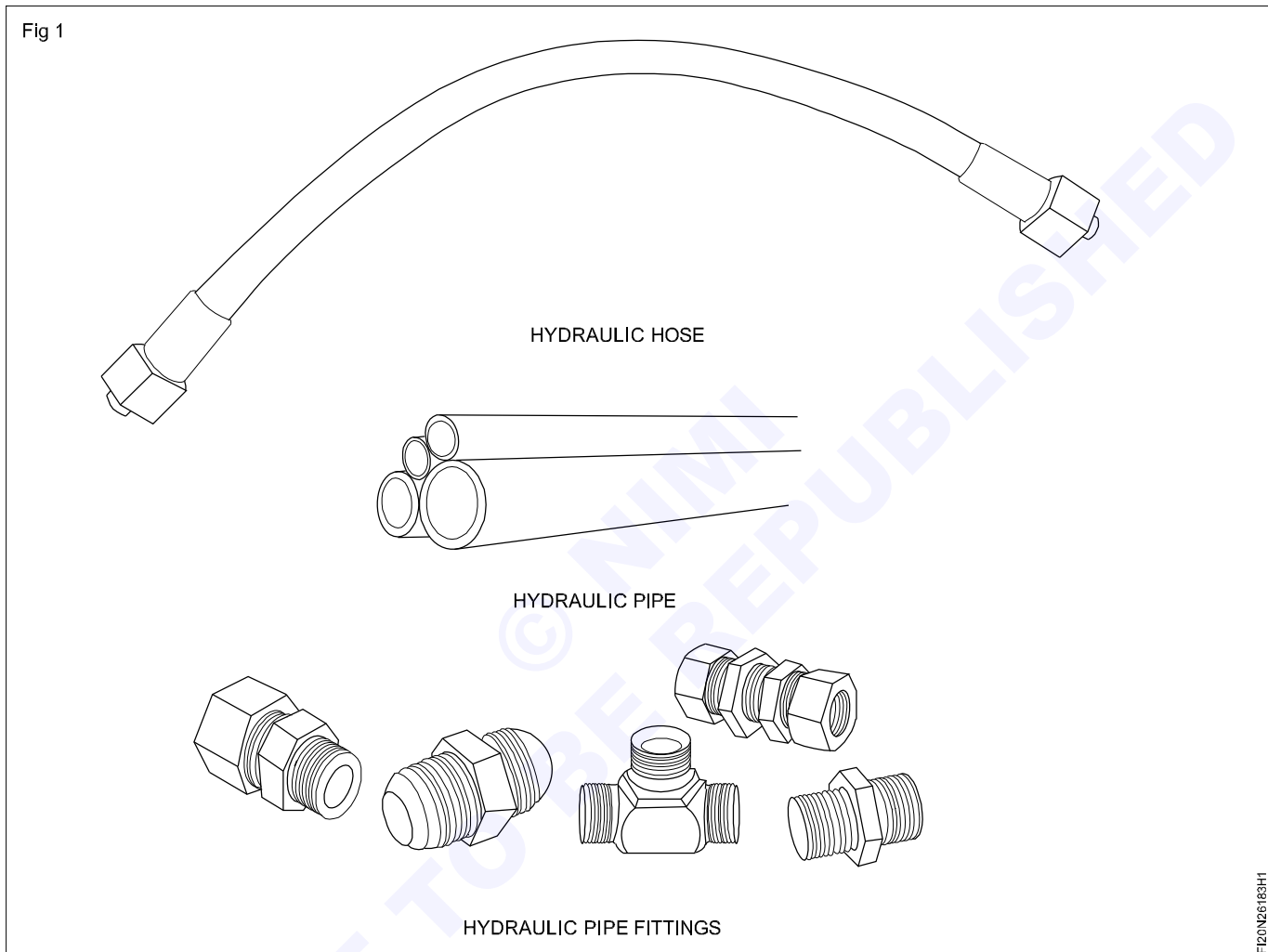
Mount the filter unit back in this position.

Confirm proper tightening of connectors.

Inspect hose for twist, kinks and minimum bend radius. Inspect hose/ tube fittings

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

- check the hydraulic hose
- check the hydraulic pipe
- check the hydraulic pipe fittings.



Job sequence

1 Checking hydraulic hose

- Visually check the hose for any crack.
- Keep the finger over the hose and slowly move along the hose and check for the kinks and twists.
- Check the bend radius according to the diameter of the hose.

2 Checking of hydraulic pipe

- Visually check the pipe for any crack or damage.
- Visually check the pipes for kinks, flat and twist.

- Check the bend radius according to the diameter of the pipe.
- Check the mouth of the pipe for burr.

3 Checking the pipe fittings

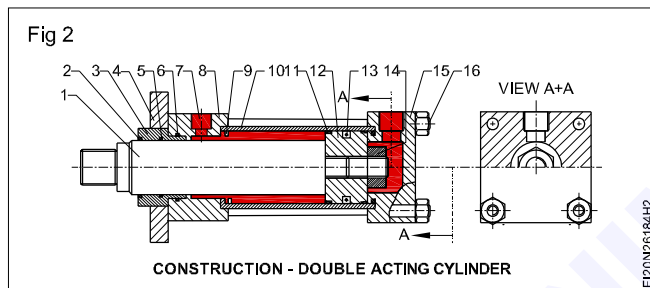
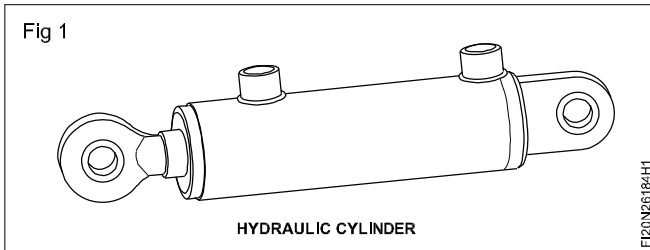
- Visually check the fitting for any damage.
- Check the pitch of the thread using screw pitch gauge.
- Check the fittings on inner edge and outer edge are made chamfer.

Identify internal parts of hydraulic cylinders, pumps and motors

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

- identify the internal parts of Hydraulic cylinders
- identify the internal parts of Hydraulic pumps
- identify the internal parts of Hydraulic motors

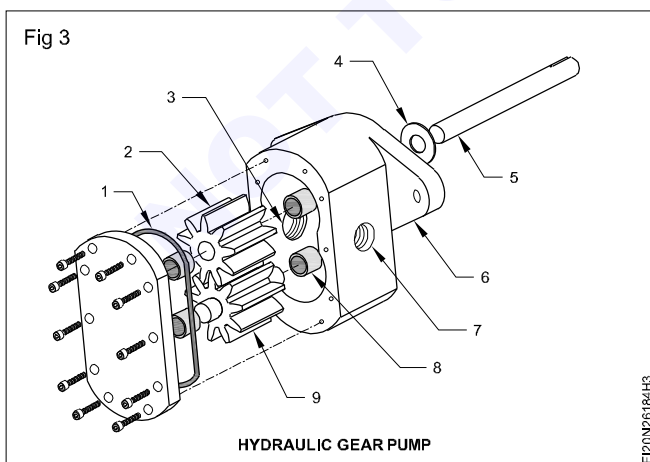
Identify internal Parts of Hydraulic cylinders (Fig 1 to 2)



Insert shall arrange and show the hydraulic double acting cylinder to trainees and give demo explaining all the parts. Ask the trainee to record the part name in table 1

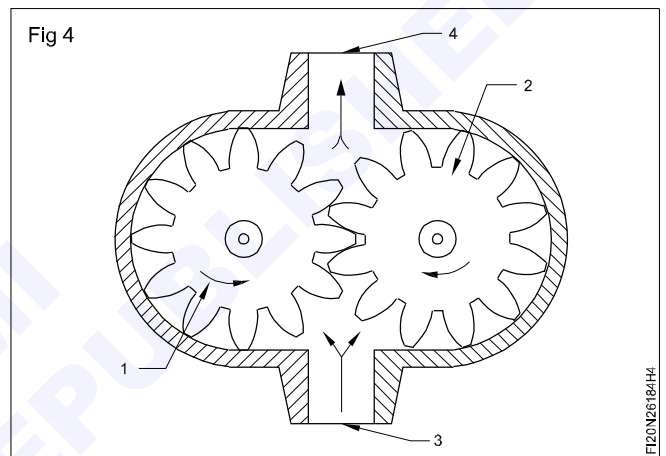
- Observe the hydraulic double acting cylinder.
- Identify the parts.
- Record in the table 1

Identify the internal parts of Hydraulic pumps: (Fig 3)



- Instructor shall arrange and show the Hydraulic Internal gear pump to trainees and give demo explaining the parts.
- Ask the trainees to record the table 2.

Identify the internal parts of Hydraulic motors (Fig 4)



- Instructor shall arrange and show Hydraulic motors to trainees and give demo explaining all the parts.
- Ask the trainees to record the table 3

Table. 1

Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Get it checked by you Instructor

Table. 2

Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	
9	

Get it checked by you Instructor

Table. 3

Serial No	Part Name
1	
2	
3	
4	

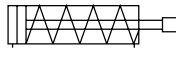
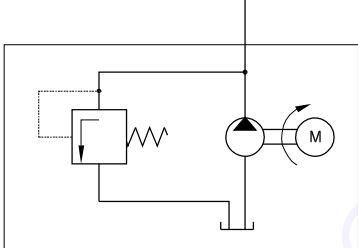
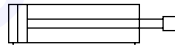
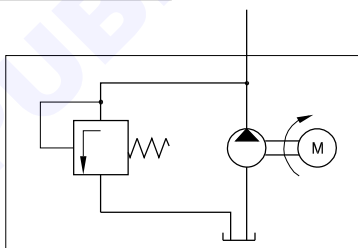
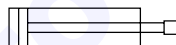
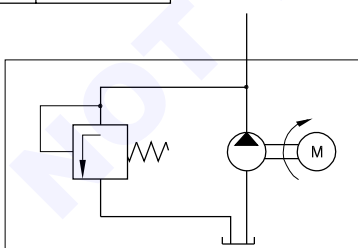
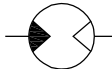
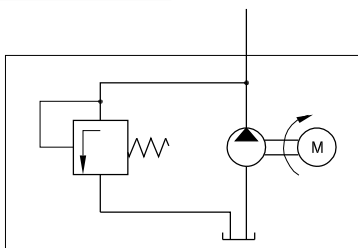
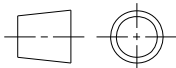
Get it checked by you Instructor

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Construct a circuit for the control of a s/a hydraulic cylinder using a 3/2 way valve (Weight loaded d/a cylinder may be used as a s/a cylinder), 4/2 and 4/3 way valves

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

- design a circuit to actuate a single acting cylinder
- design a circuit to actuate double acting cylinder
- design a circuit to actuate hydromotor
- select the various elements as per the circuit
- construct the above circuits
- test the above circuits for its function, duly arresting and leakage.

<p>TASK - 1</p> <p style="text-align: center;">TABLE - 1</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">POSITION OF</th> </tr> <tr> <th>VALVE</th> <th>CYLINDER</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>  	POSITION OF		VALVE	CYLINDER							<p>TASK - 3</p> <p style="text-align: center;">TABLE - 3</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">POSITION OF</th> </tr> <tr> <th>VALVE</th> <th>CYLINDER</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>  	POSITION OF		VALVE	CYLINDER						
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<p>TASK - 2</p> <p style="text-align: center;">TABLE - 2</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">POSITION OF</th> </tr> <tr> <th>VALVE</th> <th>CYLINDER</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>  	POSITION OF		VALVE	CYLINDER							<p>TASK - 4</p> <p style="text-align: center;">TABLE - 4</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">POSITION OF</th> </tr> <tr> <th>VALVE</th> <th>CYLINDER</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>  	POSITION OF		VALVE	CYLINDER						
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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.															
SCALE NTS	CONSTRUCT A CIRCUIT FOR THE CONTROL OF A S/A HYDRAULIC CYLINDER USING A 3/2 - WAY VALVE (WEIGHT LOADED D/A CYLINDER MAYBE USED AS A S/A CYLINDER), 4/2 & 4/3 WAY VALVES				TOLERANCE	TIME: Hrs															
					CODE NO. F120N26185E1																

Job sequence

- Designing, constructing and testing circuits to actuate a single acting cylinder/double acting cylinder/hydrometer.

TASK 1 : **Circuit for single acting cylinder**

Design, construct and test a circuit to actuate a single acting cylinder.

TASK 2 : **Circuit for double acting cylinder in 4/2 valves**

Design, construct and test a circuit to actuate a double acting cylinder using 4/2 directional control valve.

TASK 1: **Design, construct and test a circuit to activate a single acting cylinder.**

Draw a circuit diagram to actuate a single acting cylinder in the given format and get the approval of instructor.

Include elements to actuate cylinder and also to monitor pressure at various points in the circuit.

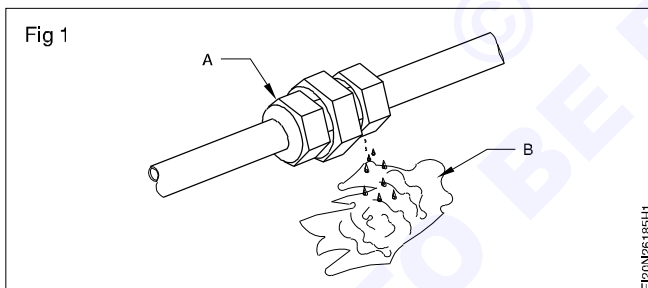
Select the hydraulic elements as per the approved circuit diagram drawn.

Mount and connect the elements on the trainer kit.

Get the approval of your instructor before switching "ON" hydraulic pump.

Switch ON the hydraulic pump.

Inspect the circuit for any leakages. (Fig 1)



Eliminate any leakages by (Fig 2) retightening connectors pipes.

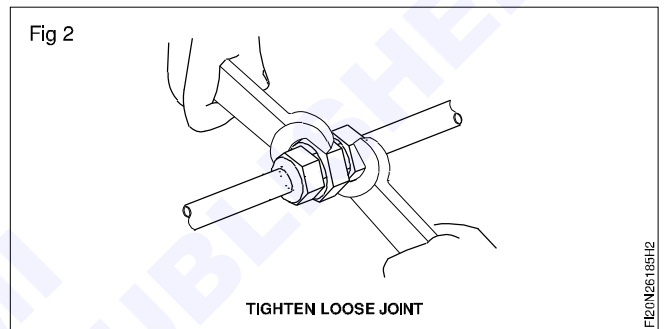
Put off hydraulic pump, while tightening connector and pipes.

TASK 3 : **Circuit for double acting cylinder in 4/3 valves**

Design, construct and test a circuit to actuate a double acting cylinder using 4/3 directional control valve.

TASK 4 : **Circuit activate hydrometer**

Design, construct and test a circuit to actuate a hydrometer using a 4/3 D.C. Valve.



Note the position of valve and position of cylinder in the table 1. (Table given along with circuit diagram)

Actuate the direction control valve and note the new position of valve and cylinder.

Note it in the table 1.

Put off hydraulic pump.

Disconnect the valves and other elements and place it in respective places.

Repeat the above sequence for task 2, 3 and 4 with respective circuit diagram and table.

Maintenance, trouble shooting and safety aspects of pneumatic and hydraulic systems (The practical for this component may be demonstrated by video)

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

- to maintain pneumatic and hydraulic system
- to know about trouble shoot in pneumatic and hydraulic system
- follow safety on pneumatic and hydraulic system.

The practical for this, component may demonstrated by video.
 Instructor may arrange video's locally and demonstrate to the trainees

Maintenance and Trouble shooting of Hydraulic system

Task 1

Trouble / Fault	Probable causes	Remedial action
Pump delivering insufficient or no oil	• Pump shaft running too slowly to prime itself.	• Check the speed of the pump and motor and rectify the fault
	• Clogged strainer or suction pipe line	• Clean strainer and remove foreign matter.
	• Low level of oil in the reservoir	• Add oil recommended as per the indicator line.
Pump making noise	• Misalignment of pump and prime mover	• Check and rectify
	• Air remains in pump casing	• Eliminate air through the air breather.
	• Pump bolts very loose	• Tighten the bolts.
	• Pump runs too fast	• Check the recommended maximum speed.
Faulty or incomplete shifting of direction control valve (DCV)	• Insufficient pilot pressure	• Check and rectify
	• Burned out solenoid	• Check and replace.
Cylinder creeping or drifting	• Valve spool not centering properly	• Check and rectify
	• Leaking through the piston of the cylinder	• Check and overhaul the cylinder
Variation in feed of flow control valve.	• Cylinder or motor leakage	• Overhaul cylinder or motor
	• Change the oil viscosity	• Check and replace oil

Maintenance and Trouble shooting of Pneumatic system

Trouble / Fault	Probable Causes	Remedial Action
Machine is working but weak in performance due to slower operation	• Upstream flow restriction or air starvation.	• Fit larger pipe • Install larger compressor.
	• Down stream flow restriction	• Check twisted tube, blocked silencers.
	• Lack of lubrication	• Lubricate machines
Leakage of air	• Loose joints fitting or glands	• Tighten loose joints fittings or glands.
	• Faulty or damaged fitting or ruptured pipes and hoses.	• Replace or repair the defective part.
Valve is connected but air escapes out of vent hole	• Cap packing is leaking or loose	• Tighten cap packing
	• Valve is defective	• Replace cap packing.
Air escapes at piston	• Groove ring is defective	• Fit a new groove ring
Valve leaks	• Dirt	• Remove dirt
	• Broken seal	• Replace seals
	• Weak or broken spring	• Replace spring
	• Excessive wear	• Lubricate parts
Failure of solinoid coil.	• Coil loosely fixed to the solenoid stem	• Fix coil firmly to solenoid stem
	• Coil vibrates	• Fix coil firmly
	• Mismatched coil and stem	• Use matched coils and stem

Safety precautions in hydraulic system

- Never begin work on a hydraulic system until fully trained.
- Use all required safety equipments.
- Never try to repair a part without having full knowledge.
- Never use hands or fingers to search for hydraulic leaks.
- Tightening of joints should be done on de pressurized condition.
- In order to avoid skin irritation it is necessary to wash contaminated skin immediately.
- To avoid fires, materials and hydraulic fluids should be stored in sealed metal containers and disposed at proper places.

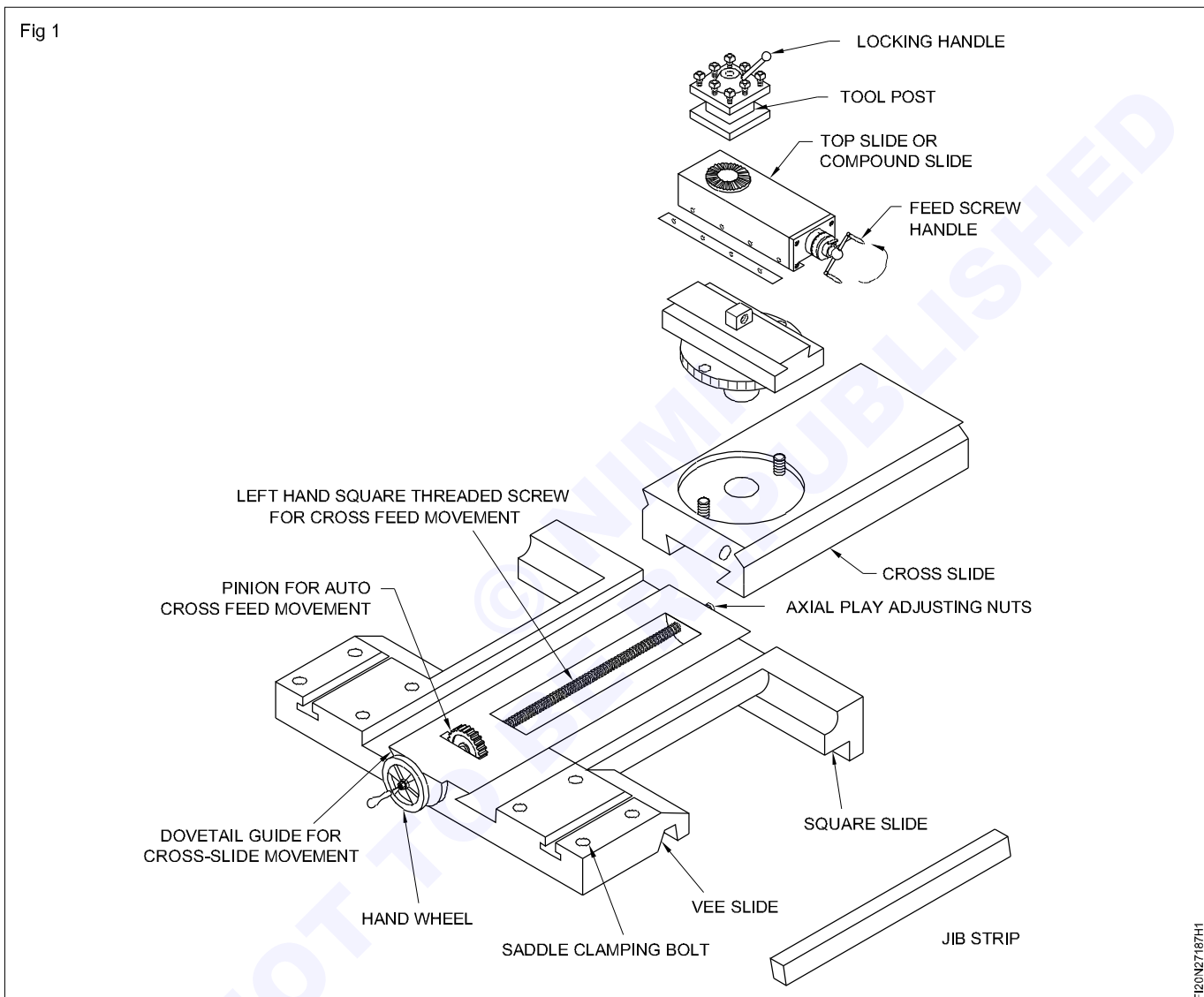
Safety precautions in Pneumatic system

- Use personal protective equipments (PPE) while working on machines.
- Keep your work place clean before and after work
- Follow the standard procedure while operating a machine.
- Inspect daily for damaged tubing fittings.
- Clean the spillage of grease, oil, etc. immediately
- Never use compressed air for cleaning away chips and dust. Flying particles can be dangerous.
- Always be safe to read manufacturers instructions, carefully before use.
- Turn off the air pressure hose when not in use or when changing tools.
- Choose air supply hoses with minimum pressure rating.

Dismantle, overhauling & assemble cross slide & hand slide of lathe carriage

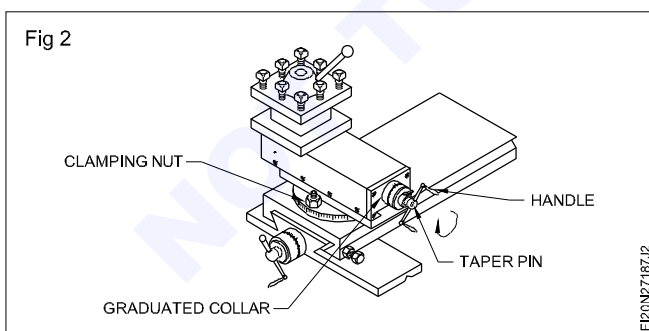
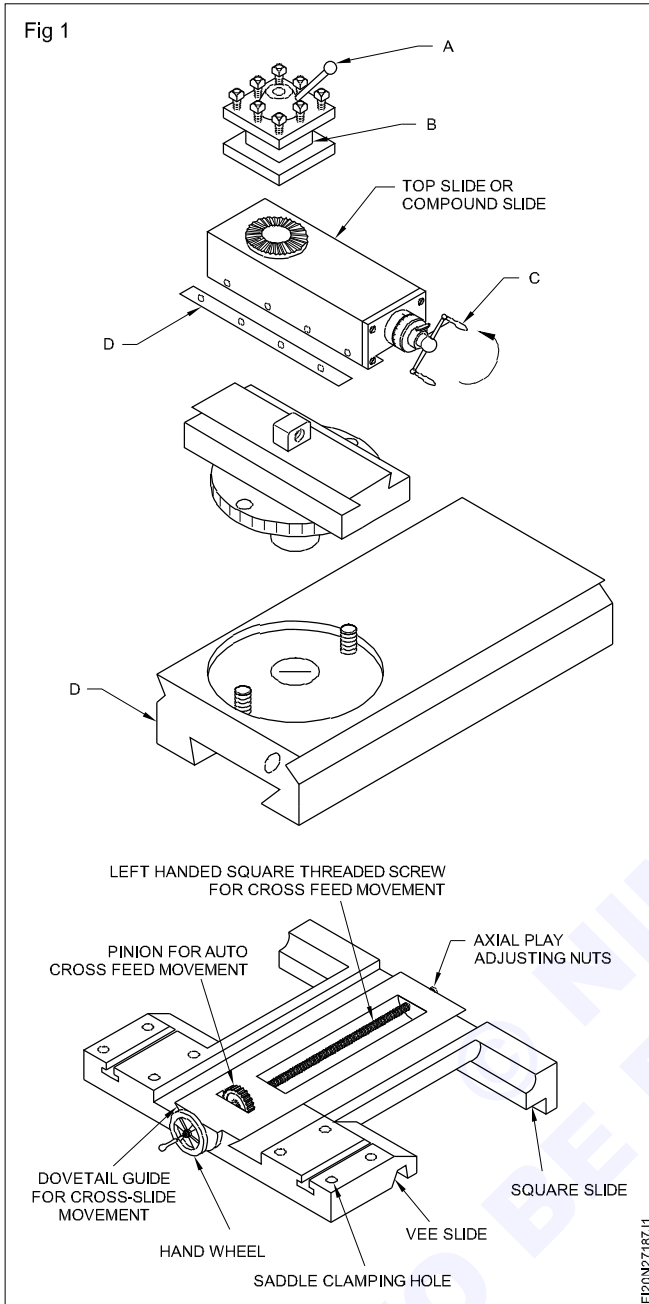
Objectives: At the end of this exercise you shall be able to

- dismantle the compound rest from the cross slide
- remove out the carriage unit from the machine bed
- assemble and test for functions.

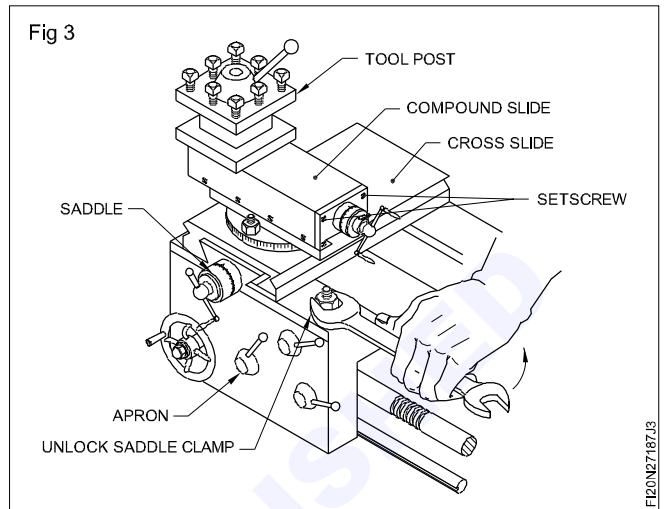


Job sequence

- Unscrew the tool posts locking handle (Fig. 1A) and remove the tool post (1B) from the compound slide.
- Rotate the feed screw handle of the top slide (Fig. 1C) in anticlock wise direction to get it released from the dovetails of the compound slide.
- Take out the jib from the dovetail of the top slide. (Fig 1D)
- Unscrew both the clamping nuts (Fig 2) from the T.bolts, provided on the swivel base of the compound slide and take out the unit.
- Remove the graduated collar (Fig 2) of the compound slide by removing the taper pin.



- Disengage the lead screw from the cross-slide.
- Unscrew the lock nuts from the cross-slide feed screw to remove the graduated collar.
- Take out the jib strip from the dovetails of the cross-slide so that it can be made to slide out easily.
- Unscrew and remove the saddle clamp. (Fig 3)



- Slide way the tailstock unit and take it out of the bed.
- Slide away the saddle unit towards the right end to take it out of the machine bed.
- Clean the parts with kerosene oil, wipe them with banian cloth and keep the parts in tray.
- Inspect the components visually for damage and wear.
- Lubricate the parts with lubricating oil.
- Assemble the parts in the reverse sequence to complete the process of overhauling.
- Check the function.

Simple repair of machinery: Making of packing gaskets

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

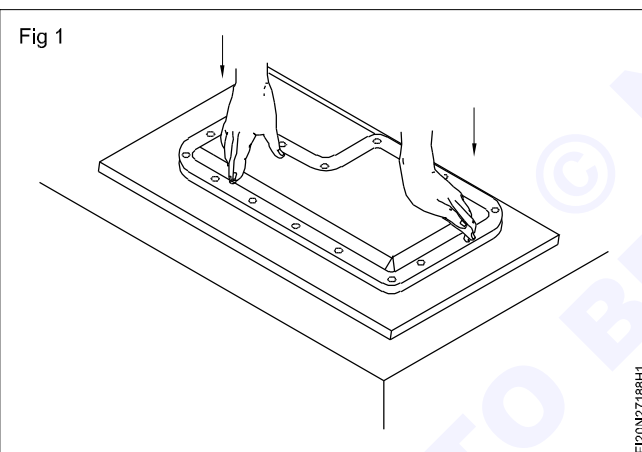
- mark and cut the profile and prepare gasket
- fit new gasket and test the joints for leakage.

Job sequence

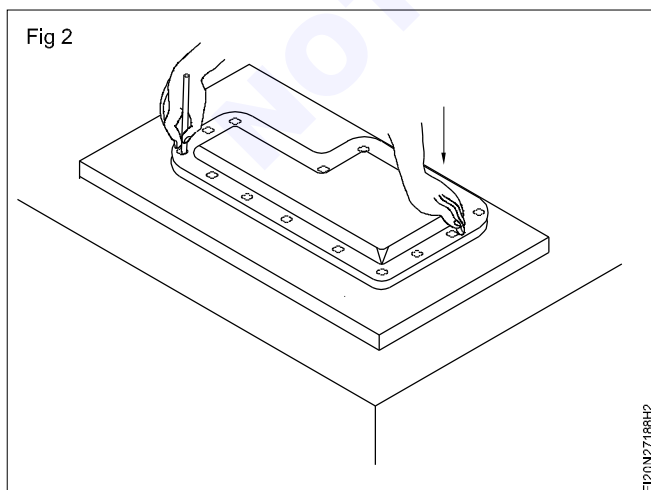
- Remove the cover plate and take out the damaged gasket.

Ensure that no portion of the gasket remains on the surface.

- Clean the surface of the base and the cover plate thoroughly.
- In the case of glue-bonded gaskets, surfaces should be cleaned thoroughly using a blunt scraper.
- Smear marking medium or grease on the cover plate's base surface.
- Place the gasket on to the base of the cover plate and press firmly. (Fig 1)

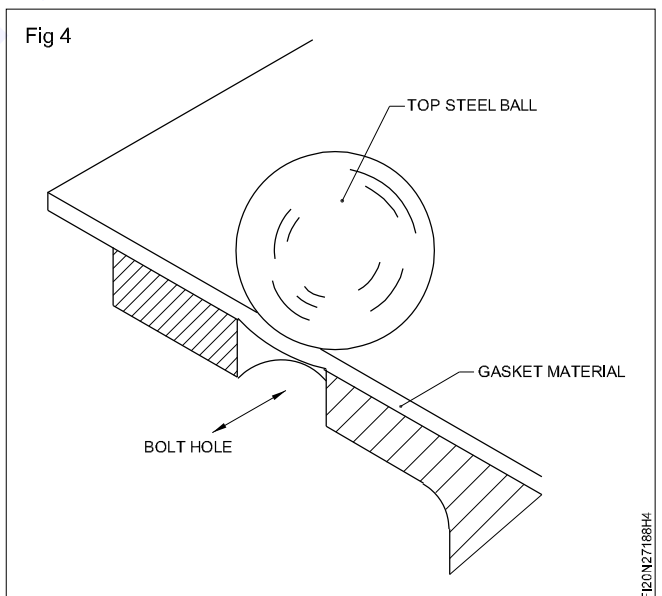
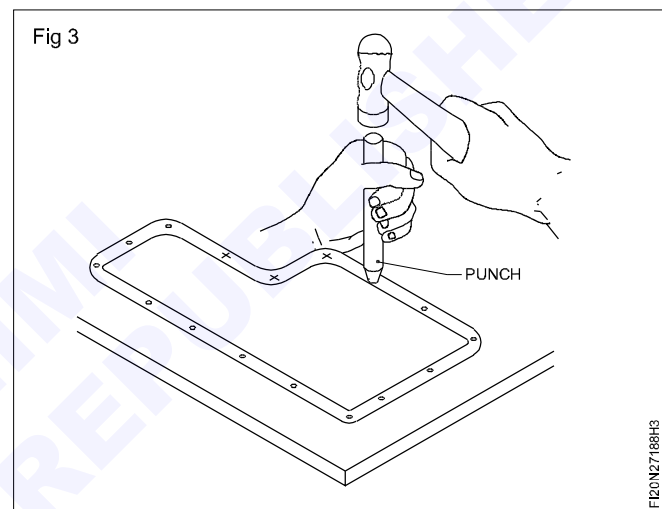


- Mark the geometrical shape of the gasket using a scribe or pencil. (Fig 2)



For smaller or handy objects the article can be placed on to the gasket for marking.

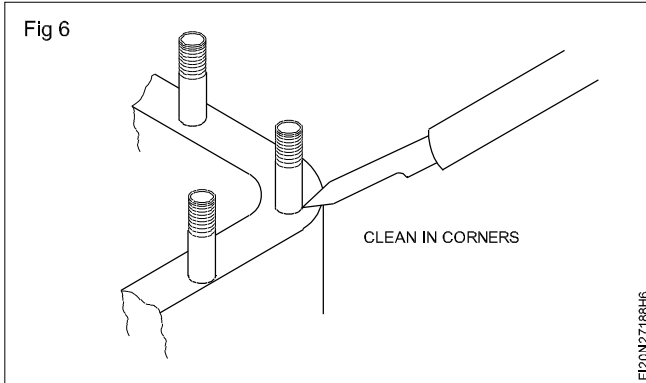
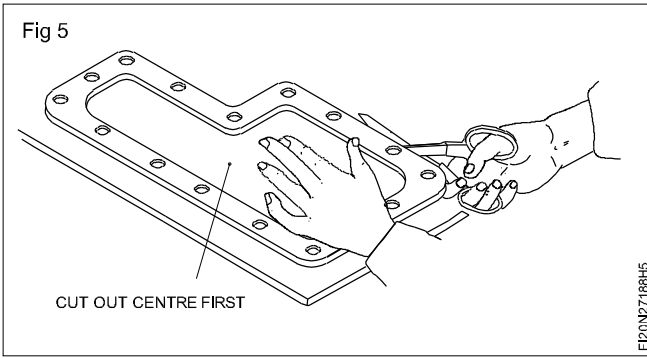
- Punch out the holes using a hollow punch and a hammer or a little over-size steel ball and a hammer. (Figs 3 and 4).



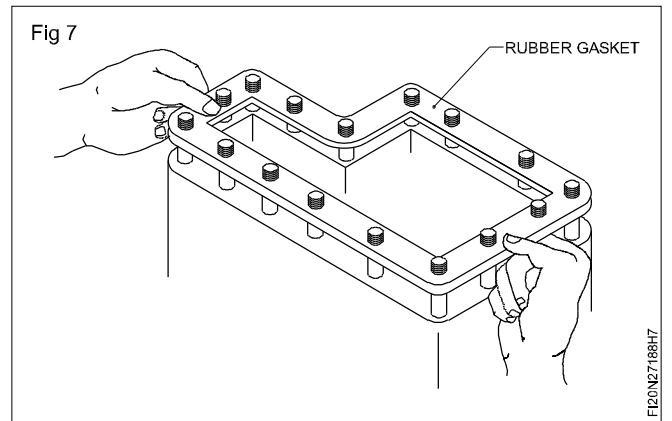
- Cut out the unwanted portion of the gasket using scissors. (Fig 5)

Cut out the centre portion first and then the external profile.

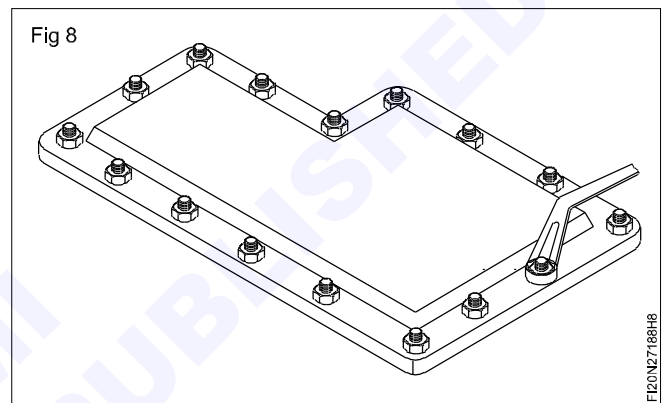
- Clean the corners of the studs. (Fig 6)



- Fit the gasket in position. (Fig 7)



- Replace the cover plate on to the gasket and tighten the screws evenly. (Fig 8)



- Test the sealed joint for leaks and functional aspects.

Check washers, gasket, clutch, keys, jibs, cotter, Circlip etc and replace / repair if needed

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

- replace washer on gasket
- replace clutch and keys
- replace jib, cotter and circlip
- replacing the above components.

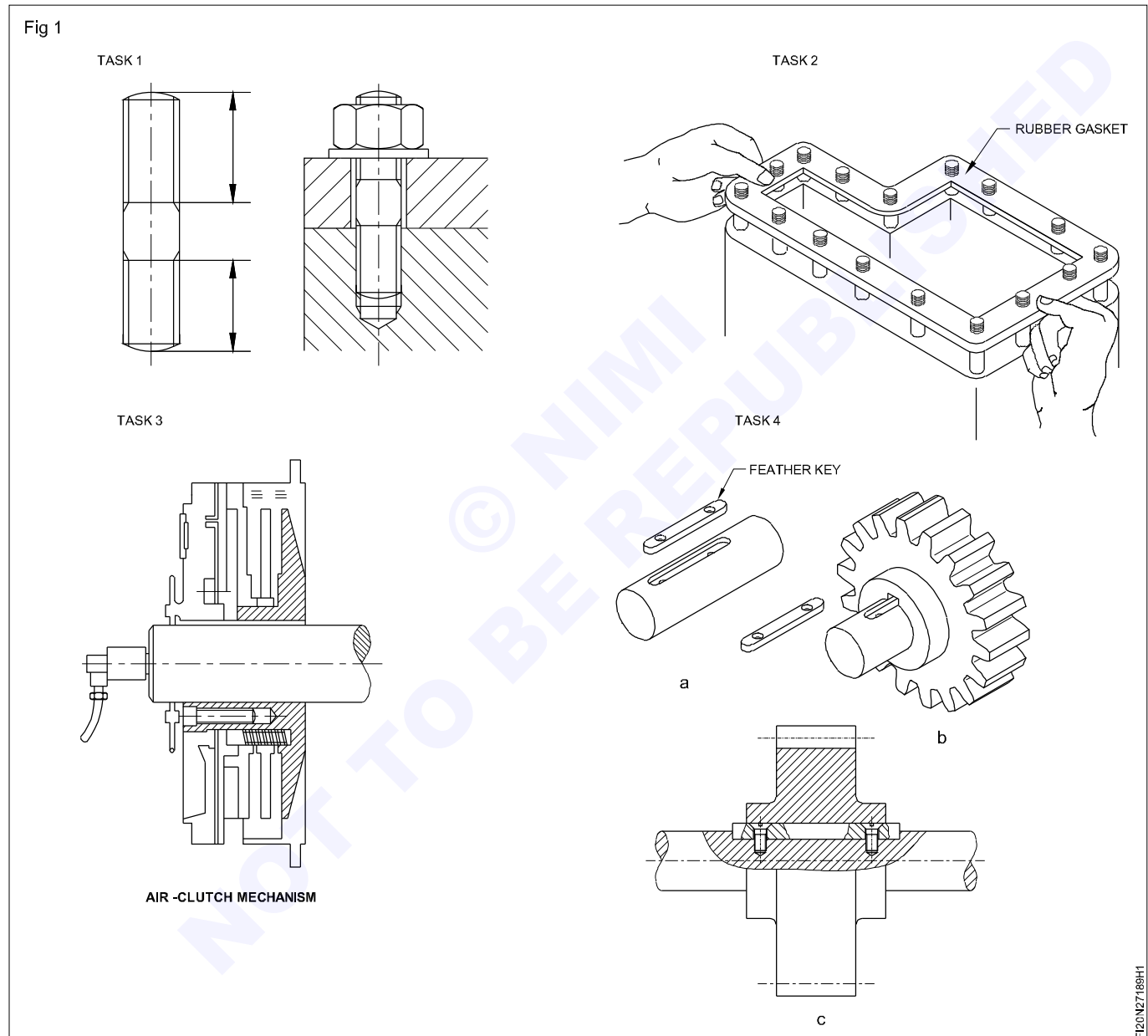
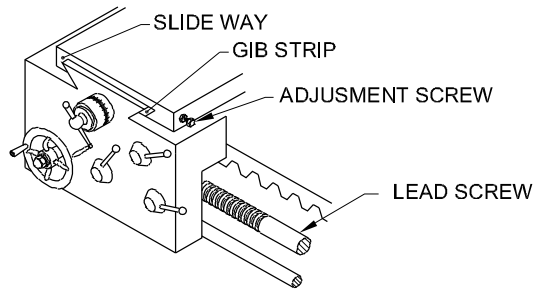
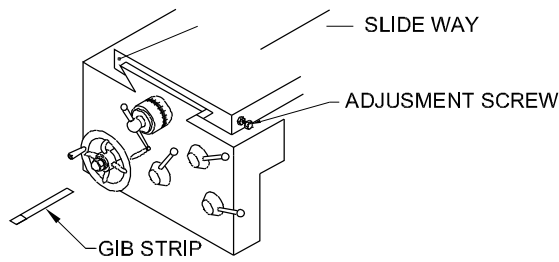
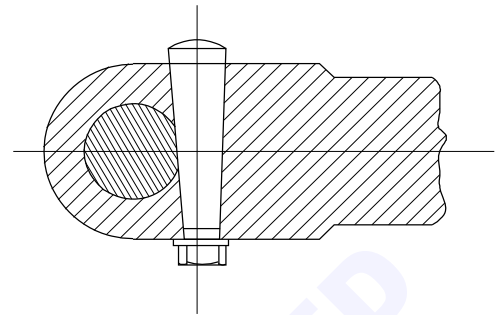


Fig 2

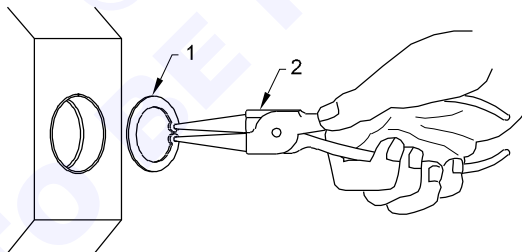
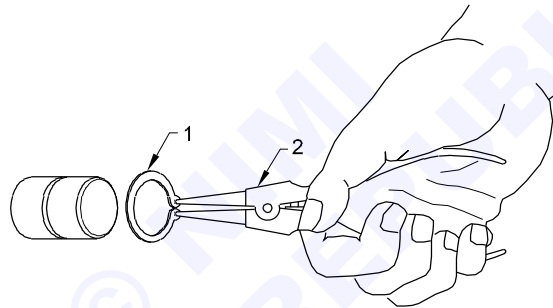
TASK 5



TASK 6



TASK 7



Job Sequence

TASK 1: Replacing washer

- Remove nut using correct size spanner.
- Remove the worn out washer from the assembly.
- Place the correct size washer.
- Tight the nut with washer.

TASK 2: Replacing gasket

- Remove the damaged gasket.
- Clean the surface of the base and the cover plate.
- Place the gasket on the base plate and press firmly.
- Assemble the unit.
- Detailed assemble explained in Ex. No. 1.7.188

TASK 3: Adjusting the clutch

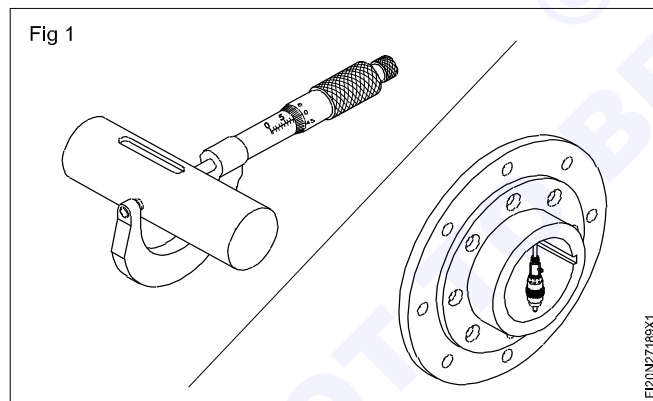
- Remove the both side covers of feed gear box using allen keys after switch off the power supply.
- Remove the terminals by using suitable spanner.
- Use a bend tubular spanner to remove the carbon brushes.
- Remove the circlip form the spline shaft.
- Take out the clutch with spline shaft from the unit by using M 12 bearing puller set.
- Place the assembly on work bench, clean it properly.
- If not getting proper engaging and disengaging of clutch, dismantle the clutch unit and remove clutch plate.
- Identify the following electrical and mechanical faults.
- Check the gap with feeler gauge between clutch plates and ensure that the gap should be as mentioned by the original equipment manufacturer.
- Check the spline shaft and ensure that the splines are proper.
- Assemble all the parts and once again check the unit on a work bench.
- If found satisfactory working of clutch assembly mount it in to the feed gear box of machine.
- Seated the circlip, carbon brushes and terminal.
- Fix the side covers by using allen key and check the working of clutch assembly by switch on the machine.

TASK 4: Replacing key

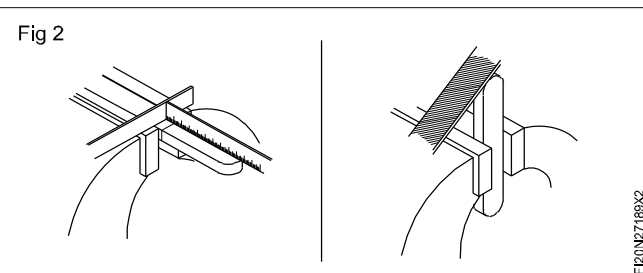
- Assemble hub and shaft with parallel key.
- Assemble hub and shaft with tapered (Gib Head) key.

Parallel key fitting

- Deburr the keyways in the shaft and the Hub, clean the keyways.
- Check the dimensions of shaft and Hub and keyways using precision instruments. Outside dia of shaft, inside dia of hub, length, with and depth of keyways as per the drawing (Fig 1).

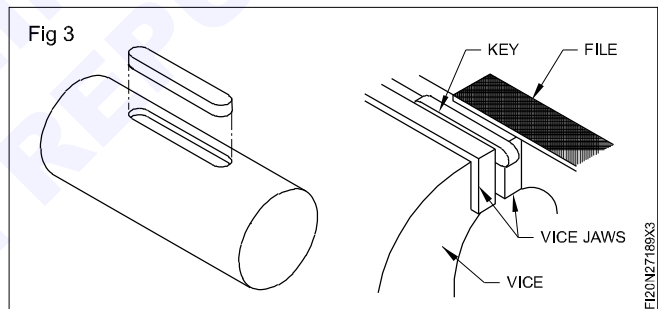


- Select a length of key steel of suitable cross section depending on the size of the keyway.
- File radius at one end of the key and cut to a length plus 1mm of the keyway and the other end of the key (Key2).

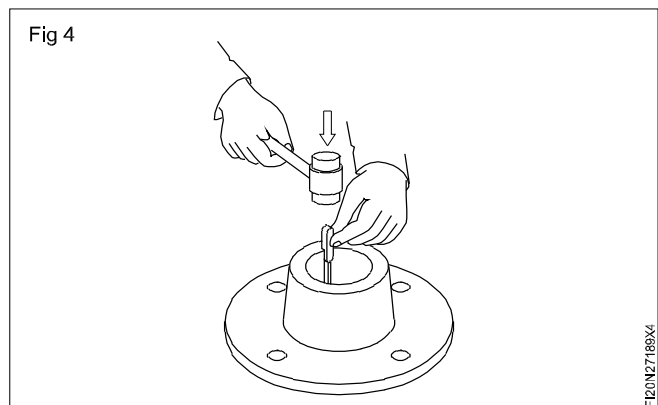


Ensure that the key is chamfered all around in its bottom side edges.

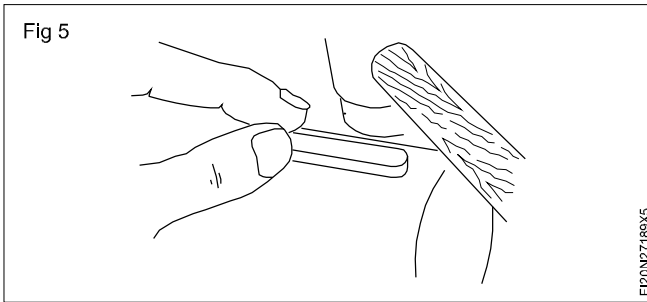
- Check the key width to suit the keyway in the shaft. Draw file the key, so that it is slight tap fit / light keying fit (K7-h6) with the keyway on the shaft. (Fig 3)



- Check the key for slight tap fit with the keyway in the Hub. (Fig 4)

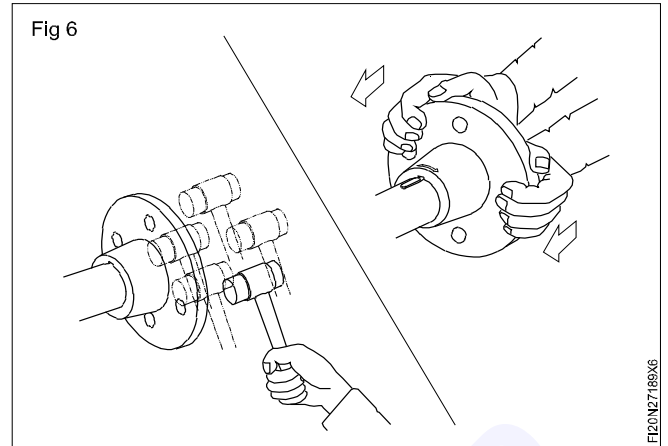


- Apply Prussian blue on all the sides and bottom portion of the key so that proper bearing of key on the keyway is ascertained.
- Insert the key in the keyway of the shaft and tap with a light weight soft hammer.(Fig 5)



- Tap the hub on the shaft, and remove the hub from the shaft, check the key and note the high spot where the key has made contact with the keyway of the hub.
- Lightly file the high spots away, the top of the way should be approximately 0.1mm clear.

- Repeat the fitting and filing operation until the hub is fit on to the shaft to the desired position. (Fig 6)



TASK 5: Replace/ adjust jib

- Remove the adjusting screws from the dovetail slide.
- Dismantle the gib from the cross-slide.
- Clean the slide surfaces, adjusting screws, nuts and gib thoroughly.
- Inspect all the parts for check any damage.
- Lubricate the slideways.

- Assemble the gib.
- Tighten the adjusting screws to give the correct freedom required in the assembly.
- Lock the movement of the adjusting screw by the check- nut.

TASK 6: Replace cotter

- For removing cotter from work unit, loose the nut slightly then slowly strike with soft hammer.
- Then loose the nut completely pull the cotter pin.

- Insert the new cotter pin in the hole strike with hammer.
- After tightening the pin fix the nut.

TASK 7: Replace circlip

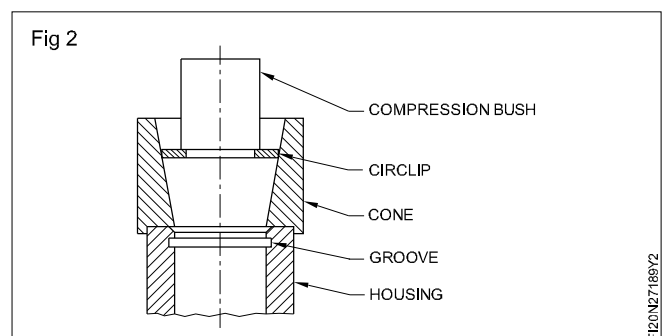
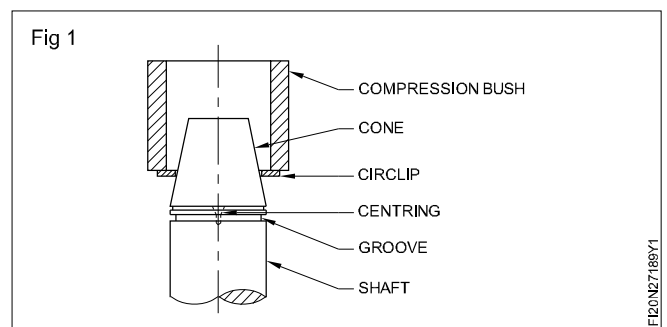
- Assemble external circlip using cone and compressor bush.
- Assemble internal circlip using cone and compression pin.
- Assemble external and internal circlips using pliers.
- Dismantle external and internal circlips using pliers.

- Press the compression bush by suitable means depending upon the size of the circlip, slowly and smoothly until the circlip is seated in the groove.

During assembly, circlip is to be spread or closed as far as it is necessary for positioning on the shaft or installing in the housing bore.

Assemble external circlip using cone and compressor bush

- Circlips without assembly holes are best assembled by means of cones Figs (1) & (2)
- Place the cone over the shaft in which the circlip is to be fixed.
- Place the circlip over the cone.
- Place the compressions bush over the circlip.



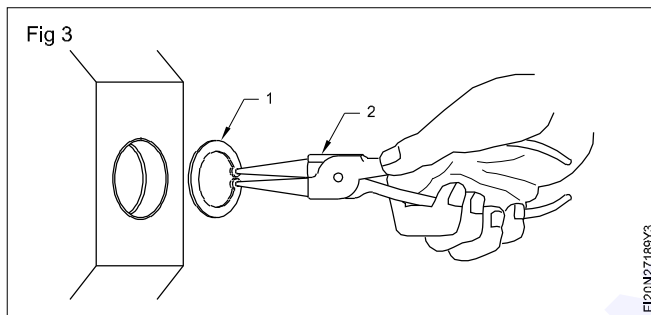
Assemble internal circlip using cone and compression pin

- Place the cone over the bore in which circlip is to be provided as shown in Fig 2
- Place the internal circlip in the tapered bore of the cone.
- Place the compression pin over the circlip.
- Press the compression pin slowly and smoothly until the circlip is seated in the groove in the bore.

Assemble and dismantle circlip using pliers

- Select suitable circlip pliers depending upon the circlips to be used. (External or Internal)
- Remove all sharp edges from the circlip and check for the crack, if any.

Assemble internal circlip (Fig 3)



- Hold the internal circlip (1) with help of an internal circlip piler (2).

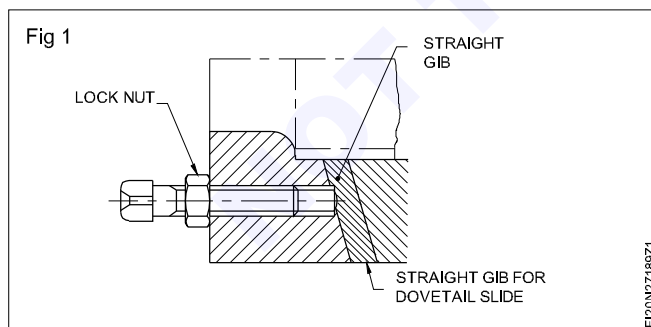
Skill Sequence

Adjust the gib strip

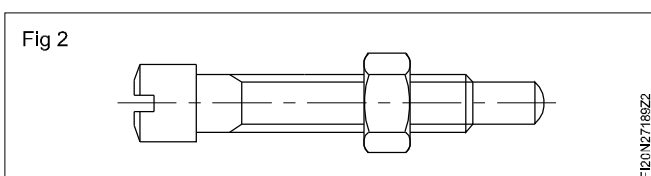
Objective: This shall help you to

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

Loosen the lock- nuts. (Fig 1)



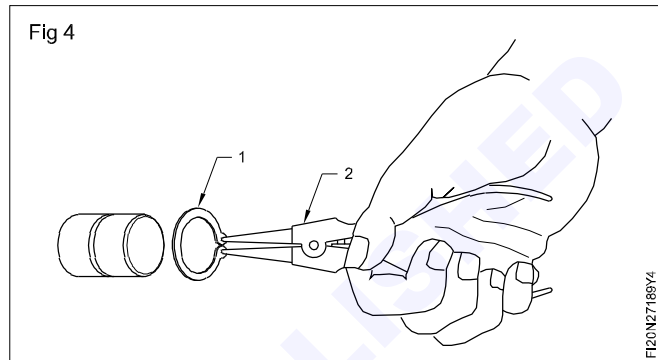
Remove the set screws. (Fig 2)



- Press the circlip (1) with the help of the plier (2) so that its diameter will be smaller than the hole diameter.
- Insert the circlip in this position, in such a manner that it will sit squarely in the groove.
- Take out the plier (2).

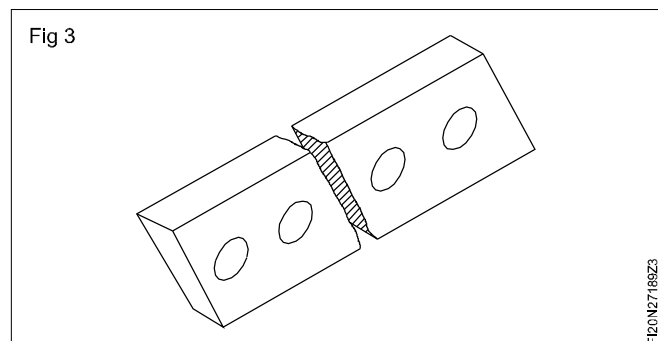
Assemble external circlip (Fig 4)

- Hold an external circlip (1) with the help of an external circlip plier (2).
- Press the external circlip plier (2) so that the circlip (2) will enlarge in diameter.



- Slide the circlip on the shaft in the enlarge position, until it is set in the shaft groove.
- Ensure that the circlip sits squarely in groove (3).
- Take out the plier.
- For dismantling the internal and external circlips the above procedure can be reversed and applied.

Pull the gib out. (Fig 3)

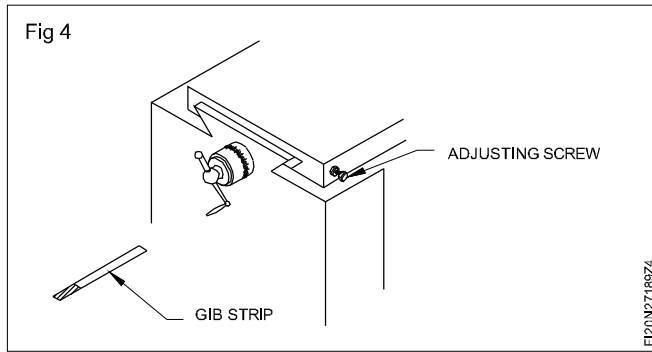


Check the straightness of the gib using Prussian blue.

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

Lubricate all the parts.

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



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

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

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

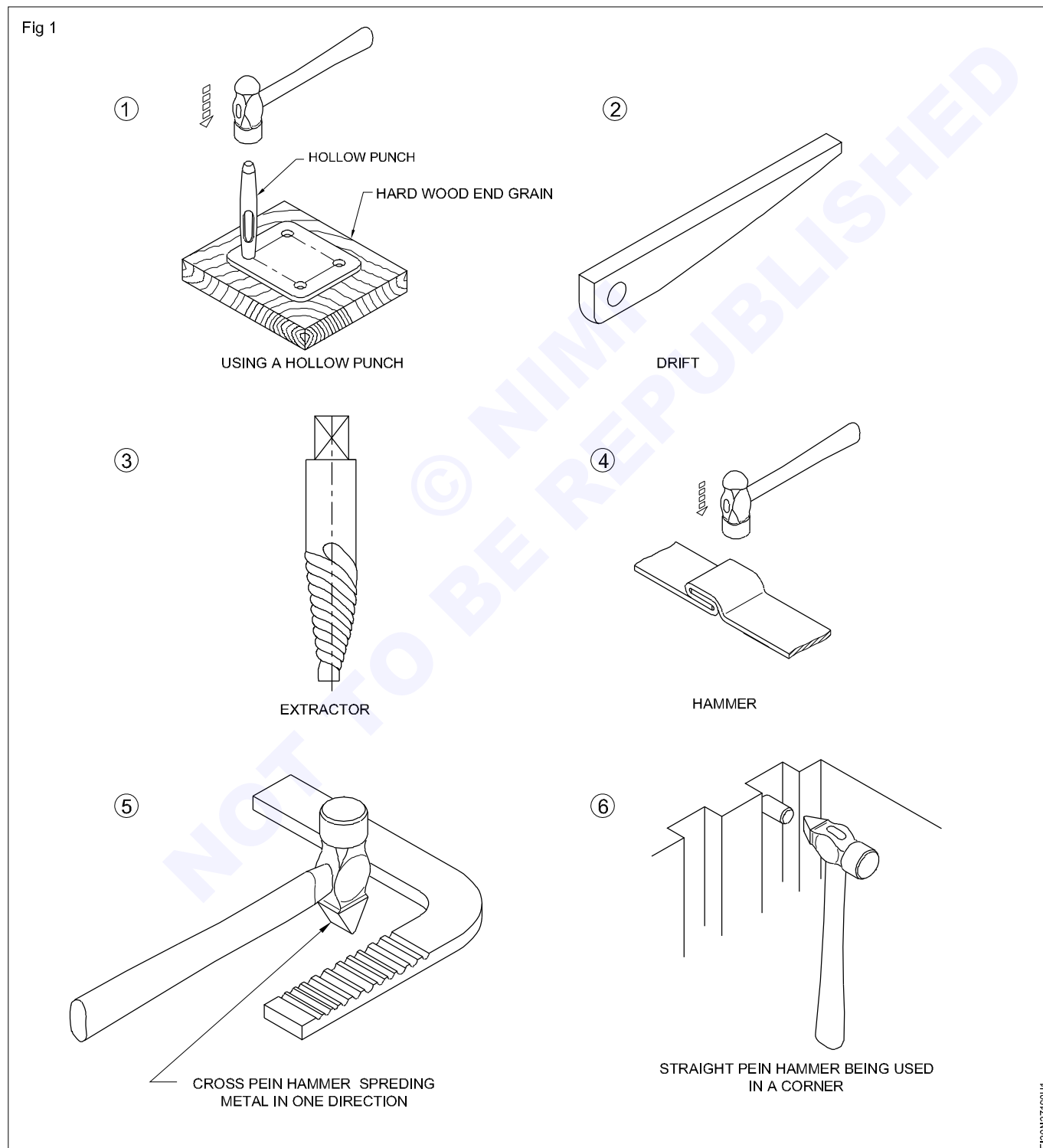
Check the function of the cross- slide.

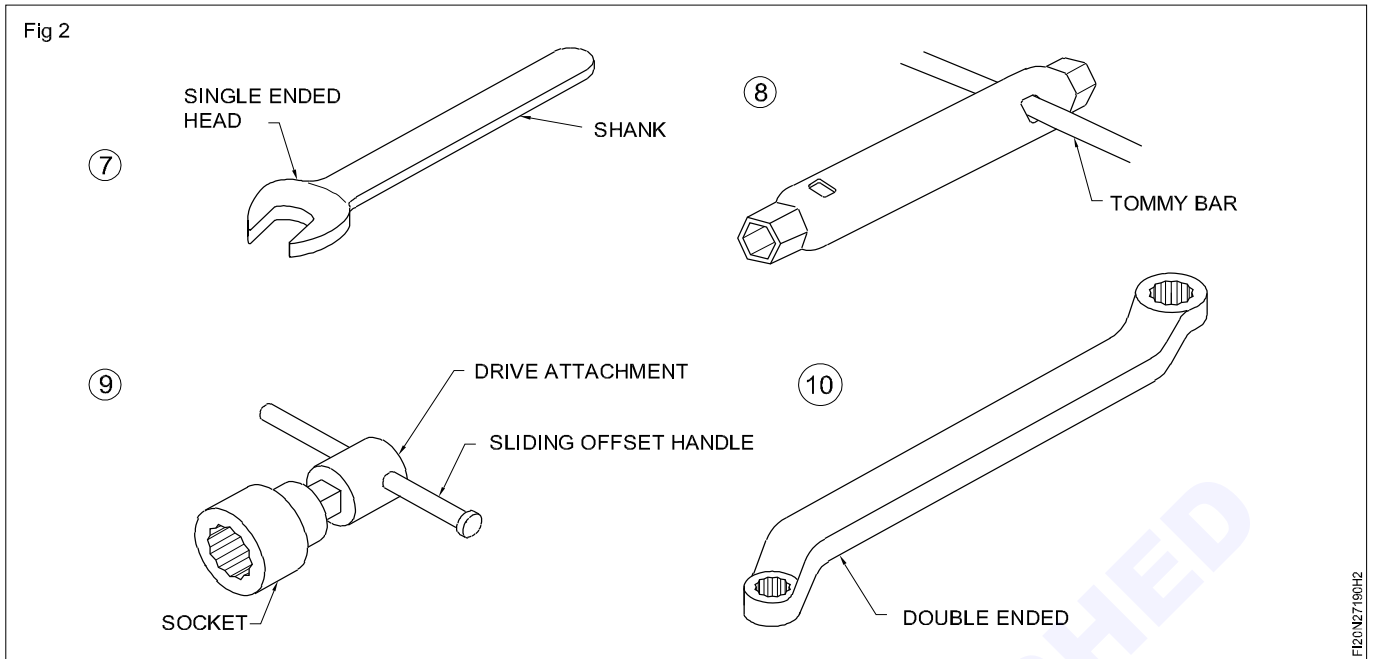
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Use hollow punches, extractor, drifts, various types of hammer and spanners etc for repair work

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

- select the holes for repairing
- use the types of spanners
- use the types of hammers
- use of extractor and punches.





Job sequence

Instructor shall display all the tool shown in Fig 1 - 10 in the section and brief their names and uses.

- Trainees will note down all the tools names and thier uses.
- Record it in Table 1.

Table 1

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

- Get it checked by the instructor.

Dismantling, assembling of different types of bearing and check for functionality

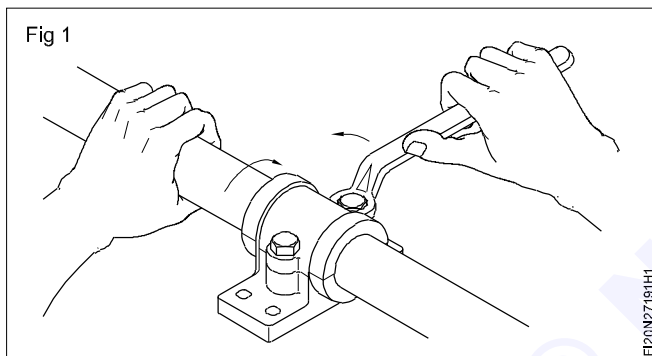
Objectives: At the end of this exercise you shall be able to

- **dismount a shaft from pedestal block**
- **mount a shaft on pedestal block**
- **dismount ball bearing (interference fit on the shaft)**
- **dismount ball bearing (interference fit in the housing)**
- **mount ball bearing.**

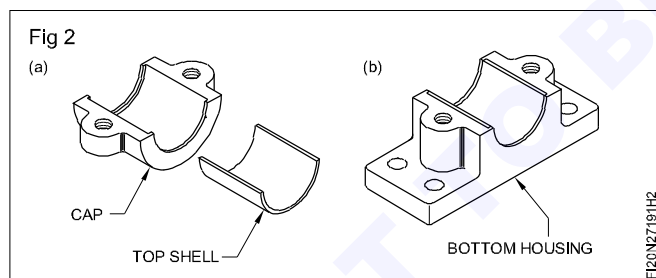
Job sequence

TASK 1: Dismantling and assembling bush bearing

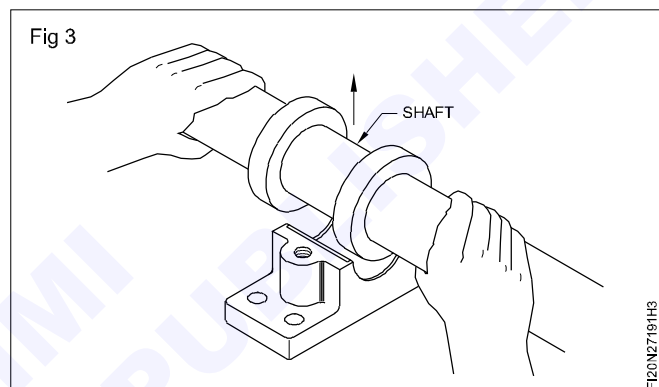
- Dismantle the cap of the block by using proper ring spanner. Hold the shaft with left hand and remove the fastening nut by right hand as shown in Fig 1.



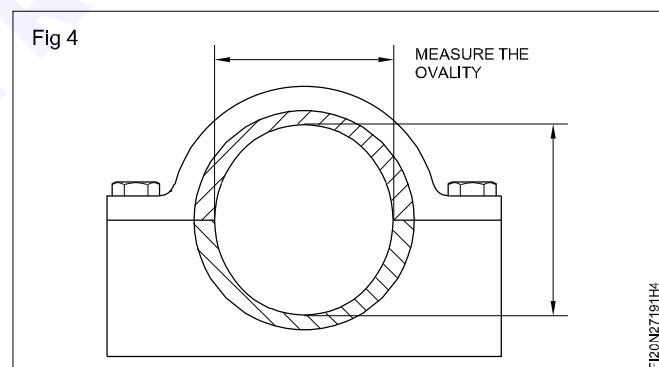
- Remove top shell along with cap Fig. 2a and then remove the shaft and bottom housing as shown in Fig 2b.



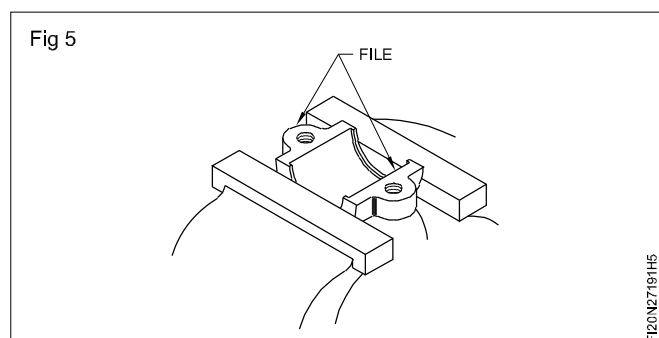
- Thoroughly clean shells, cap, shaft seating (Journal) and housing bottom with kerosene by using small brush. Wipe out all above components with clean banian cloth. Do not use cotton waste to wipe out component.
- Check shells and Journal for any damage, scoring mark etc. Check cap, bottom housing and fastening bolt and nut for any damage and wear. Replace the damaged components with new one before starts assembling. (Fig 3). If it is not possible to replace shaft, it should be built by metal deposition and machined.



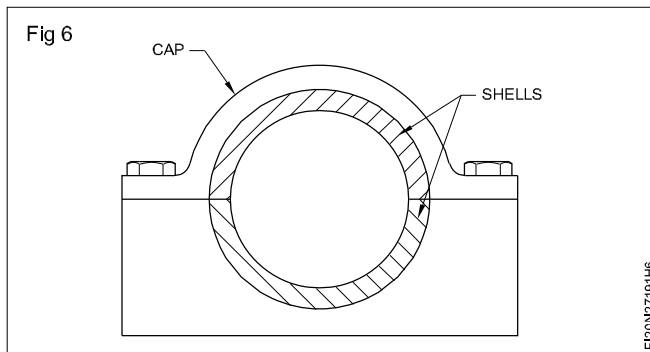
- Check ovality of the bearing bore by fixing cap on the bottom housing as shown in Fig 4.



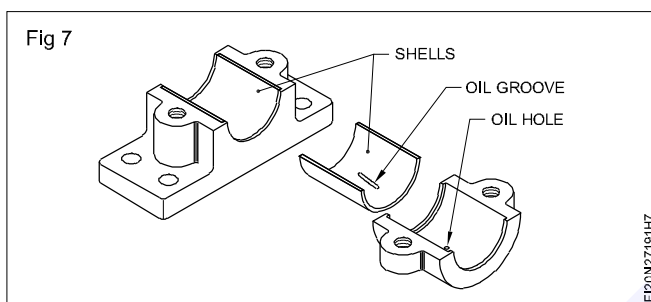
- To remove the ovality. Remove the cap by unscrewing fastening bolts. File the bearing caps equally with flat file to compensate for the ovality by holding the cap into the vice as shown Fig 5.



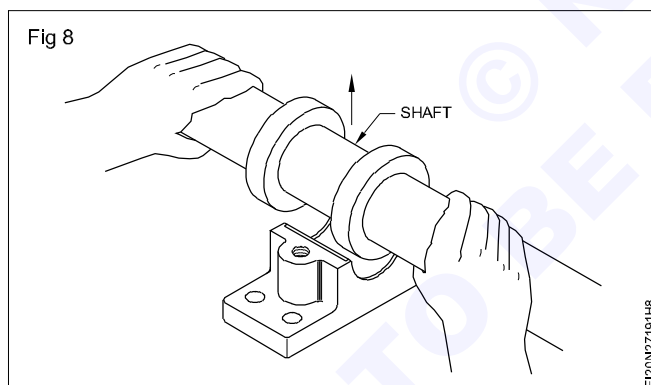
- Fit the two halves of the bearing back together and make sure that, when the bolts are fitted, the load is taken by the caps and not by shells. (Fig 6)



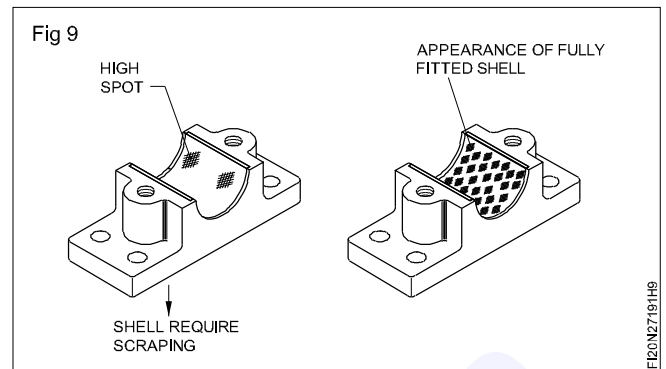
- Fit the shells to their housings. Check that they fit correctly and the oil holes align with those of the housings as shown in Fig 7.



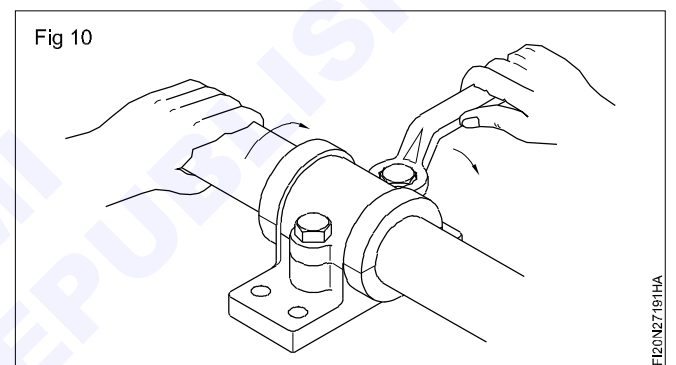
- Apply marking medium around the Journal area and place it into bottom shell for uniform contact. (Fig.8)



- If the number of colour marking on the bottom shell is more, it indicate shaft having proper contact with bottom shell otherwise scrape the shell to have more number of colour marking. (Fig 9)



- Coat all the parts with the correct grade lubricant. Place the Journal on the bottom housing, place top shell and cap on the shaft. Tighten the bolt firmly by holding the shaft. (Fig. 10).



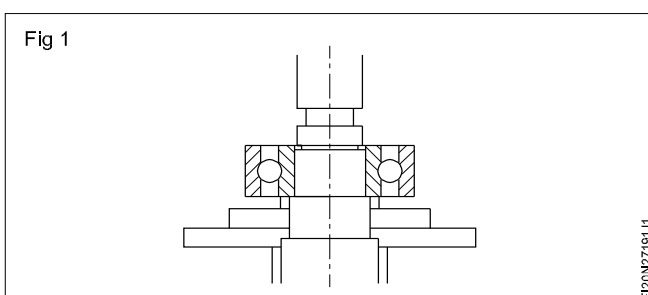
- After mounting pedestal block clear all tools around the work spot.

TASK 2: Dismantling and assembling ball bearing

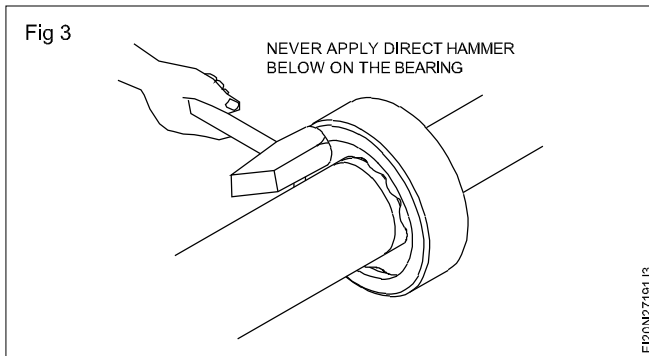
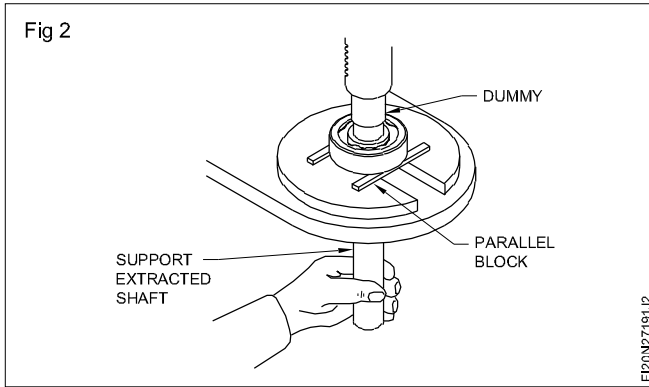
For ball bearings having interference fit on the shaft

Method I using press

- place the bearing with the shaft on a arbour press or hydraulic press. (Fig 1)

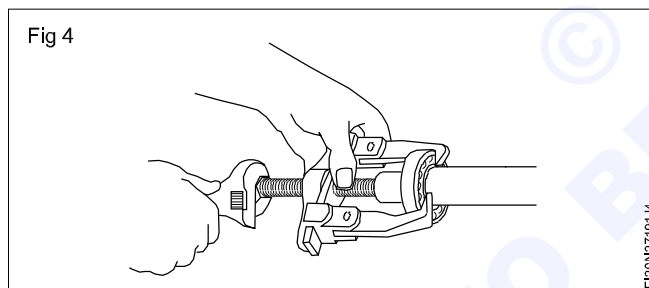


- place a ring or two parallel blocks of equal size to support the inner ring of the bearing. (Fig 2)
- put a dummy between the ram and the shaft
- Gently press the shaft to come out of the bearing. (Fig 2)
- Support the extracted shaft by hand to prevent damage.
- Never apply direct hammer blows on the bearing. (Fig 3)

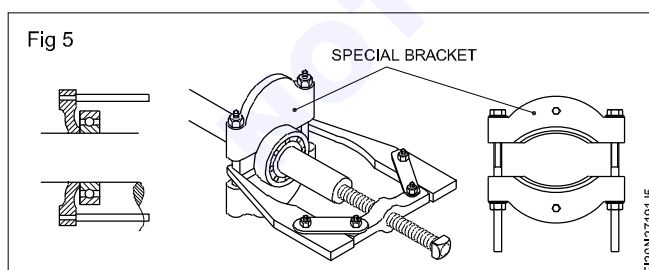


Method II using bearing puller

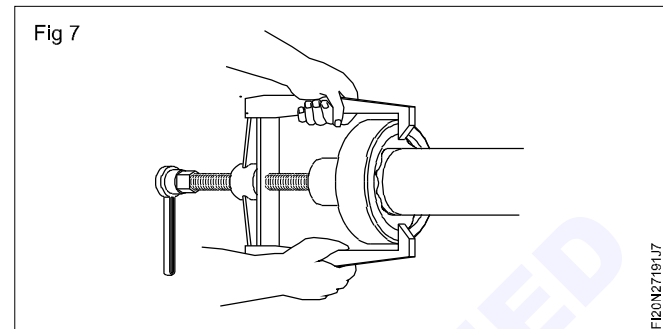
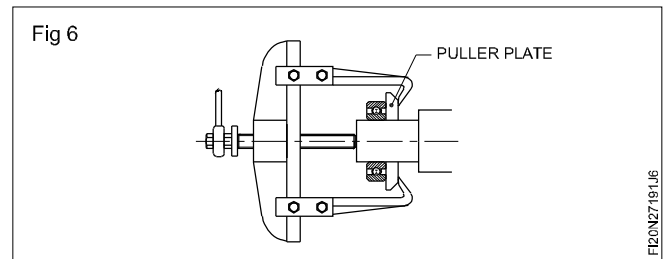
- Fit the bearing pullers spindle on the centre hole of the shaft. (Fig. 4).
- Place the legs of the bearing.
- Slowly tighten the spindle of the puller by a spanner so that the puller is ready to take the strain (Fig 4)



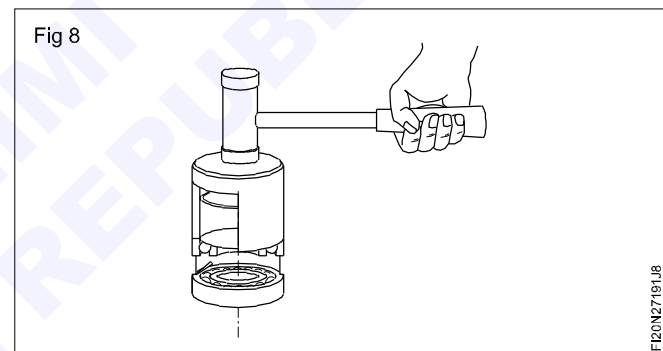
- For dismantling the bearing special type of puller with bracket attachment shown in (Fig 5) is used so that pulling force is applied on the inner ring of the bearing.



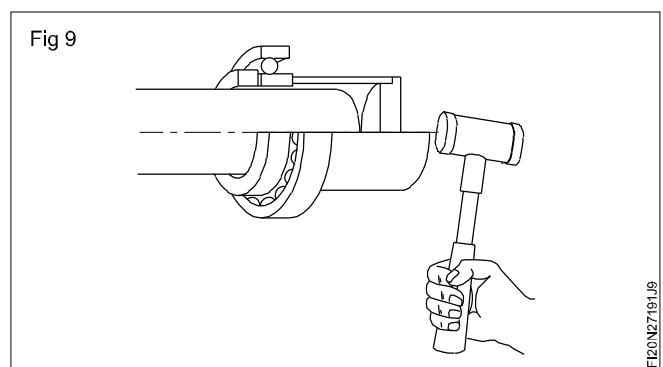
- Use a keeper puller plate along with the puller when pullers legs tend to engage with the outer ring of the bearing. (Fig 6)
- Rotate the outer ring or the puller during dismantling if the pullers legs has to engage the outer ring of the bearing, when the bearing is to be used again. (Fig 7)



- Small bearings can be removed by using a puller or with a metallic sleeve using mild hammer blows.
- To dismount small and medium size bearings, use a hammer and a sleeve a butting the lock nut or the inner ring. (Fig 8)



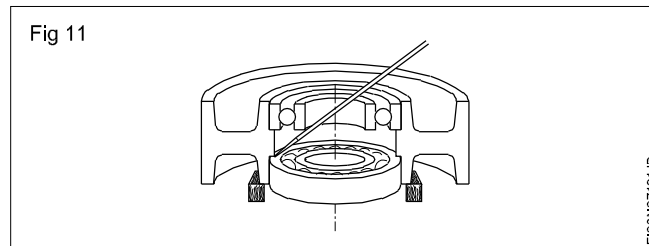
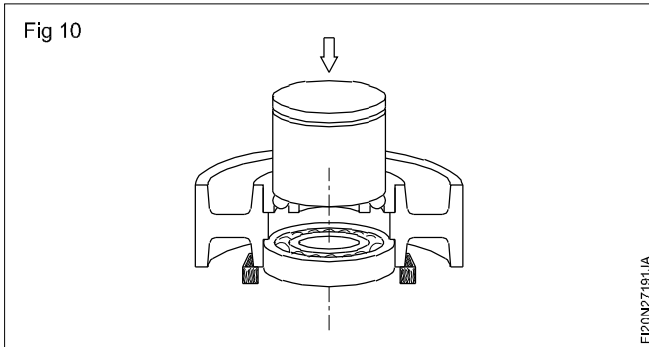
- Place the sleeve against inner ring if the nut is located inward.
- Use hammer blows for dismantling. (Fig 9)



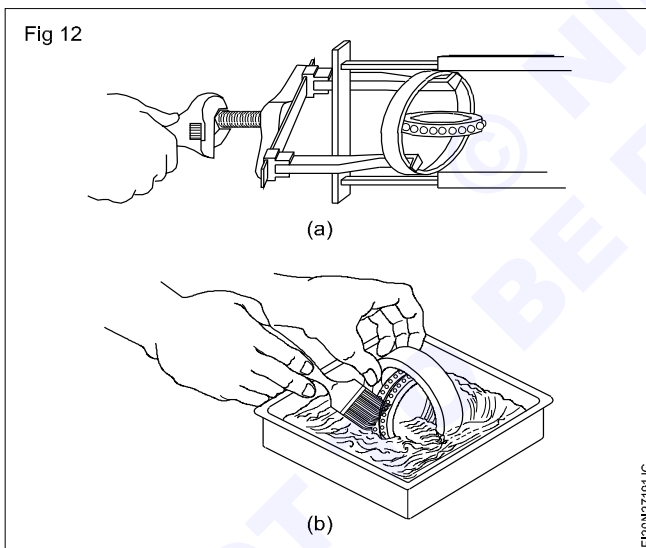
For all bearings having interference fit in the housing

- Place the wheel on two wooden blocks and fit a suitable sleeve on the face of the bearing. Apply pressure on the sleeve to drive out the bearing. This type of dismantling can be done for a housing without any shoulder. (Fig 10)
- Similarly, for a housing with a shoulder between the bearings a soft metal drift is used to strike the bearing

in different positions to drive out. (Fig 11). A suitable puller is also used for dismantling.



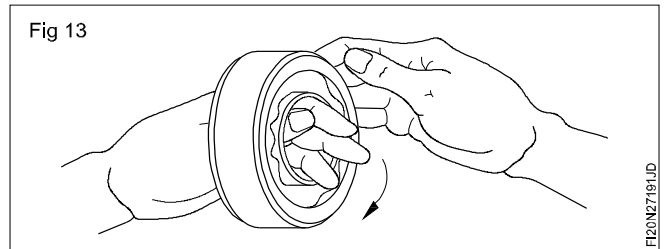
- For dismantling self aligning ball bearing, swivel the inner race as shown in Fig 12a. Fit the legs of the puller on the outer race and tighten the screwed spindle to extract the bearing.
- After dismantling clean the bearing with soft bristle brush using kerosene oil or naphtha. (Fig 12b)



- Wipe off the bearing with banian cloth.

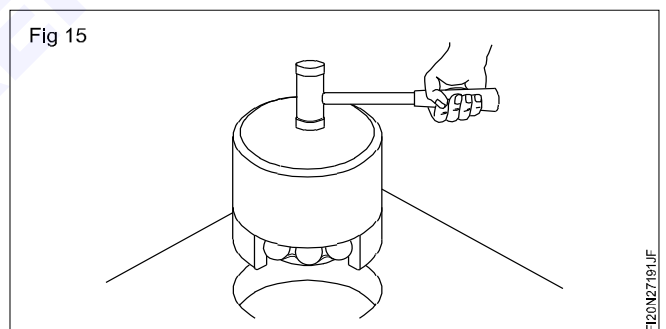
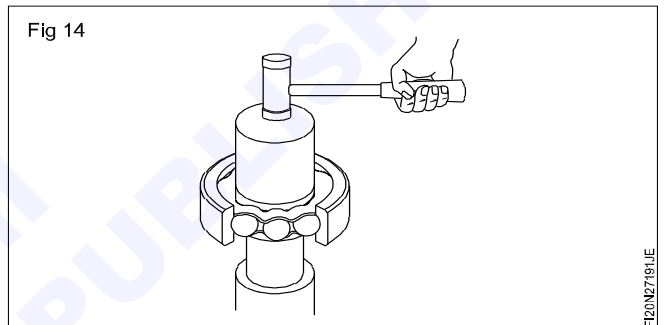
Do not use cotton waste for cleaning or wiping off bearings.

- Inspect visually about corrosion, damage in cage, raceways, rolling elements and outer and inner races.
- Insert the bearing around the fingers of your hand and rotate gently to check that the bearing to rotating smoothly without any distraction and noise. (Fig 13).
- Lubricate the bearing.
- Replace the seal, if any.
- Mounting ball bearings
- Clean and measure the shaft diameter (for shaft fit by

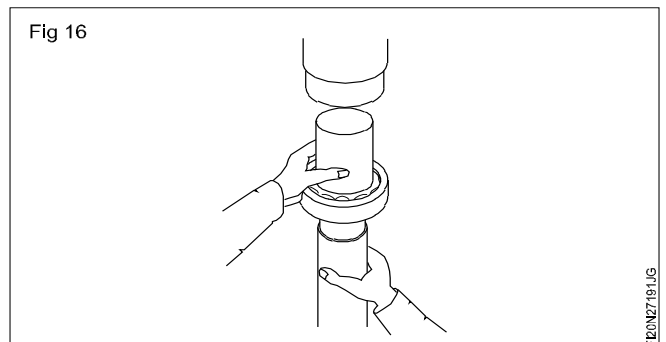


vernier micrometer and for housing fit by vernier inside micrometer) to check the necessary interference fit.

- Lubricate the shaft for mounting.
- Place the correct size sleeve on the inner ring of the bearing. (Fig 14).
- Apply hammer blows using common hammer.
- Slowly drive in bearing until you get the metallic sound.
- Similar process should be adopted for the housing fit by selecting proper sleeve to sit on the outer ring. (Fig 15)
- Use a arbour press whenever possible.



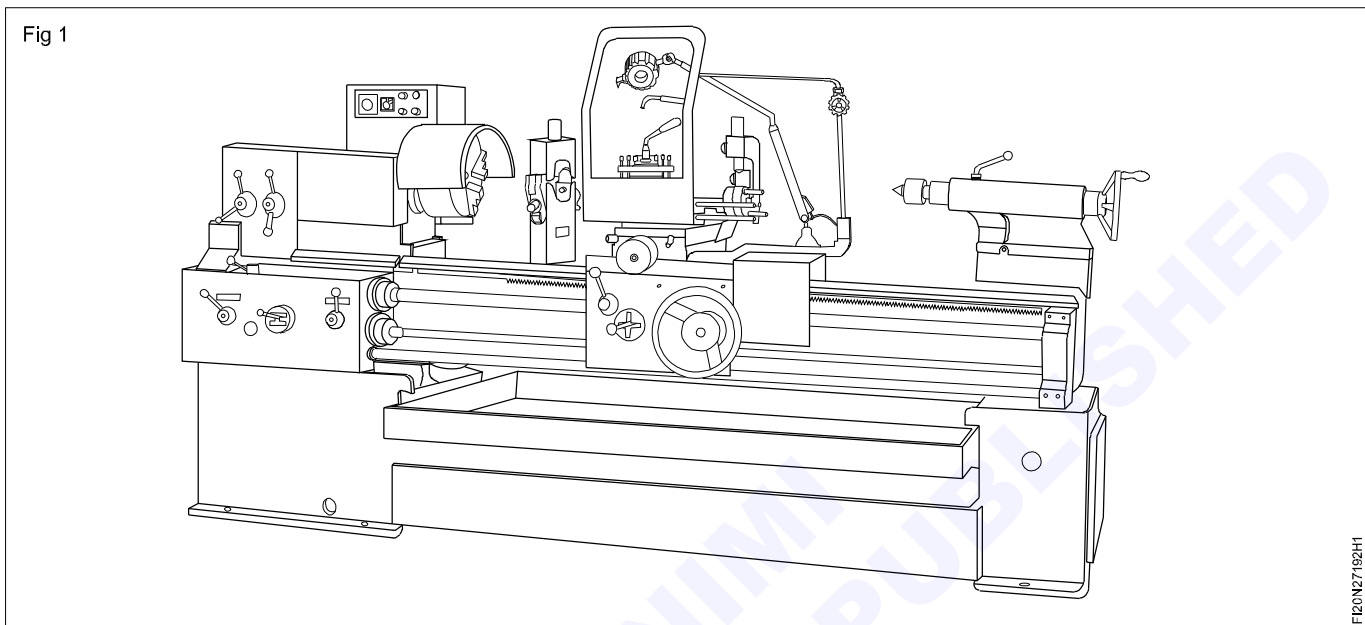
- The use of a arbour press or hydraulic press is particularly suitable, when small bearings are frequently mounted. Lubricate the shaft and place a mounting sleeve between the bearing and press resting it on the ring with interference fit. The end faces should be flat, parallel and burr free.
- Drive in the bearing into the shaft, by applying the force by the press. (Fig 16)



Perform routine check of machine and do replenish as per requirement

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

- check the machine running condition
- check the oil level
- check the sliding movement.



Job sequence

- Turn the machine off from the main power point and fit your tag, Out of order, to avoid someone can try to use the machine during your maintenance procedure.
- **Open side cover and check:**
 - Driving belts, if the belts are damaged, excessive cracks, or an excessive wear, they must be replaced.
 - Check tension of belts.
 - Check brake conditions (on models with pedal brake).
- **Turn the lathe ON and:**
 - Run the lathe for a couple of minutes.
 - Check level of lubricant oil on vison main gear box.
 - Refill if required with gear oil.
- **During running test check that:**
 - All the automatic feeding movement are working properly.
 - Check tail stock locking condition.
 - Both lever must lock properly.
 - Check top bench lubrication manual pump.
 - Pull or pouch lever to verify that oil is coming to the sliding bench.
 - Check level of lubricant oil of tank bench lubrication.
- **Check level of coolant, refill if required:**
- **Lubrication, period - lubricant:**
- **Some point will be required to lubricate with gun oiler.**
 - Head stock - twice a year.
 - Compound slides, by gun oiler - daily.
 - Apron & carriage- handle pump - daily.
 - Tail stock nipple - by gun oiler - daily.
 - Change gear nipple - by gun oiler - daily.
 - Lead screw nipple - by gun oiler - daily.
 - Bed ways - by gun oiler - daily.
- **Coolant:**
 - Empty tank and fill up with new coolant every 4 months.
 - Avoid contact with coolant during the refilling process, you must wear rubber gloves.
 - Test bottom of coolant tank to verify if there are solids.
 - Remove solids and try always to keep coolant tank clean.
 - Run the lathe and test coolant is supplied properly.

- **Electric:**

- Check the main power cable for its conditions. If it is damaged, must be replaced.
- Verify conditions of all external switches.
- All switch with damage must be repair or replace it.
- Check conditions of all limit switches. They must be strong in position. A loose or damage limit switch can generate a continuous fault on the machine.

- **Centre point alignment:**

- Once a year, depending the precision required would be convenient to verify alignment of centre tailsotck with centre of headstock.
- Alignment can be obtain by fitting a total parallel bar between centres, and the with a dial indicator verify parallelism between centres.

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Inspection of machine tools such as alignment, levelling

Objective: At the end of this exercise you shall be able to
 • inspect drilling machine tool such as alignment, levelling

Job sequence

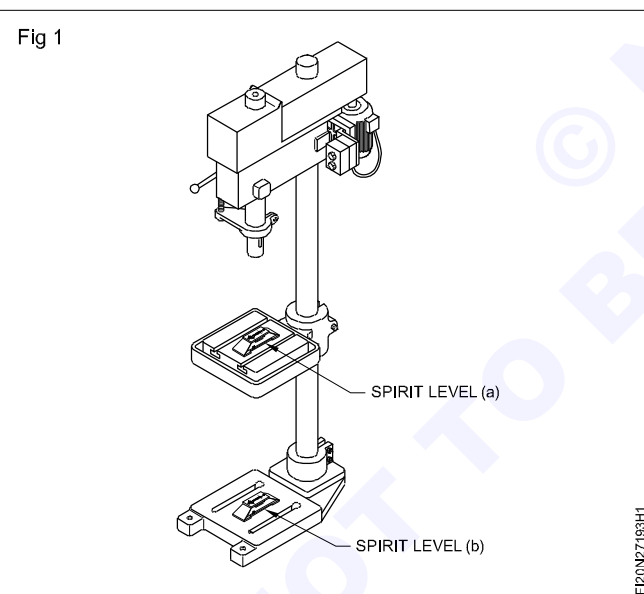
- Lock the table of the pillar drilling machine in mid - position.
- Level the machine using a precision spirit level and a straight edge.
- Check the flatness of the table surface and the base plate of the machine.
- Check the run out of the internal taper of the spindle using a dial test indicator and test mandrel.
- Check the straightness of the pillar in two different planes.
- Check the squareness of the table surface in two different planes.

Skill sequence

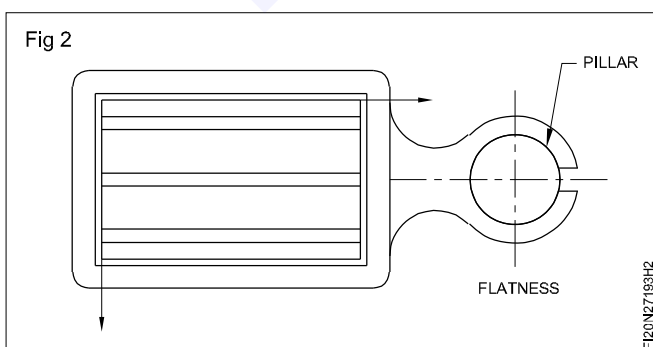
Geometrical test for pillar type drilling machine

Objective: This shall help you to
 • carry out the preventive maintenance of drill machine.

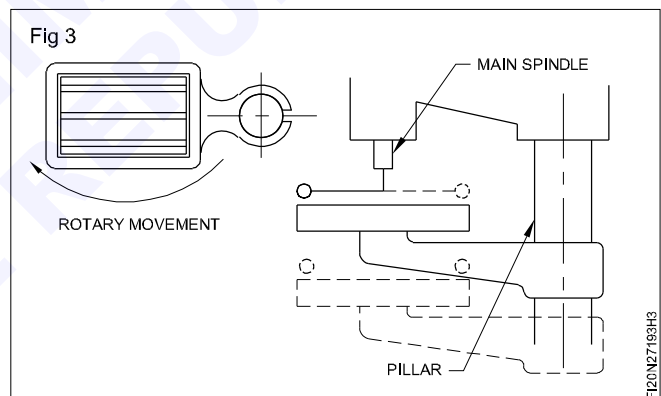
Levelling of the machine at two different positions (a) and (b) should be done before conducting the geometrical test. The permissible deviation is 0.03 per 300 mm. (Fig 1)



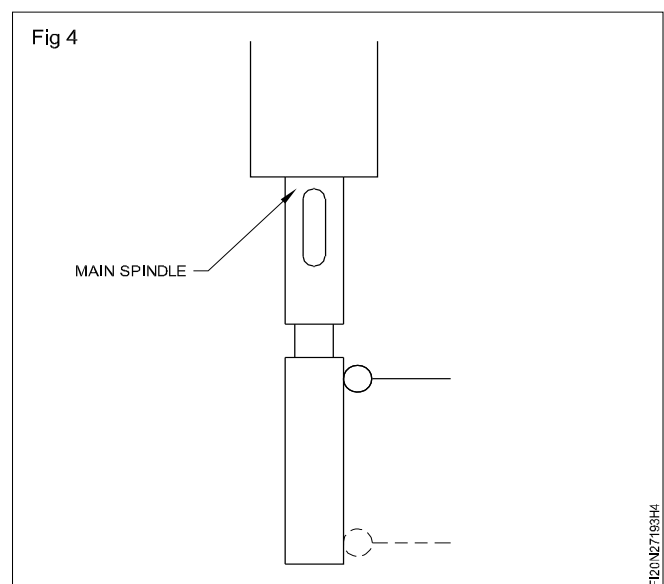
Check the flatness of the work table surface and the base plate if it is machined. (Fig 2)



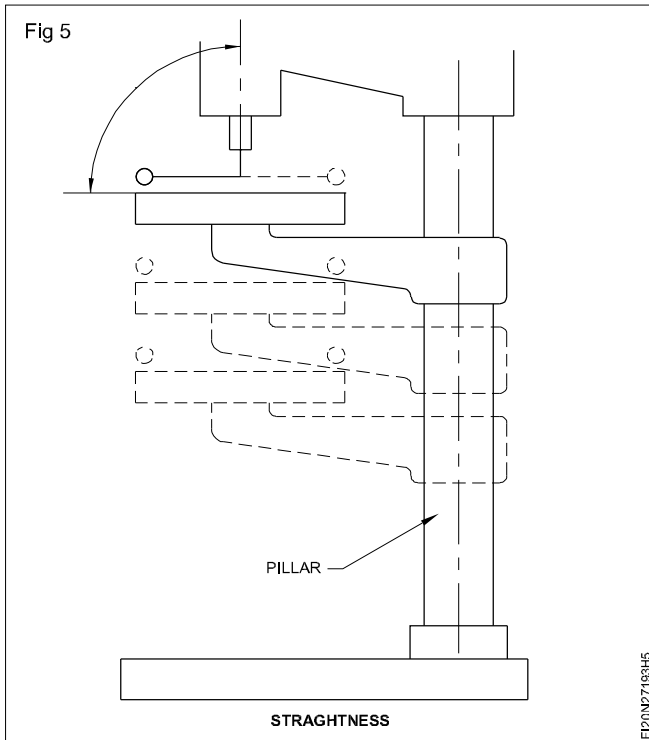
Check the rotation of table, if the machine is provided with rotary movement. (Fig 3)



Check the run out of the spindle internal taper at two positions. (Fig 4)

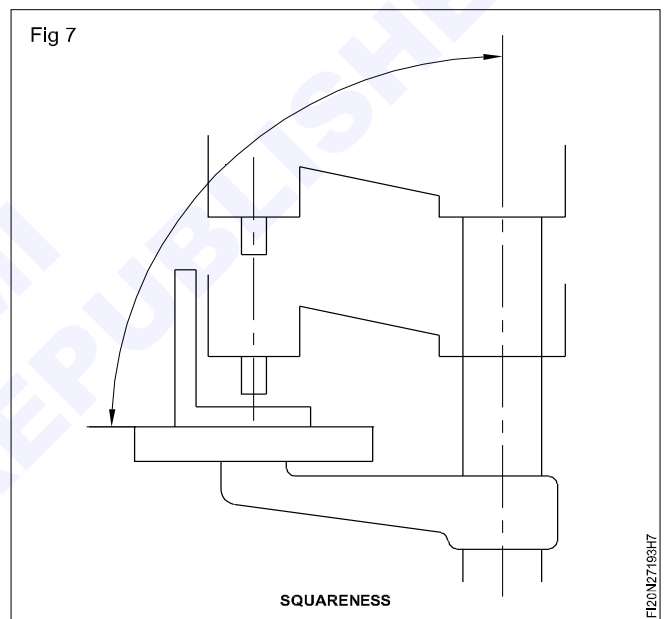
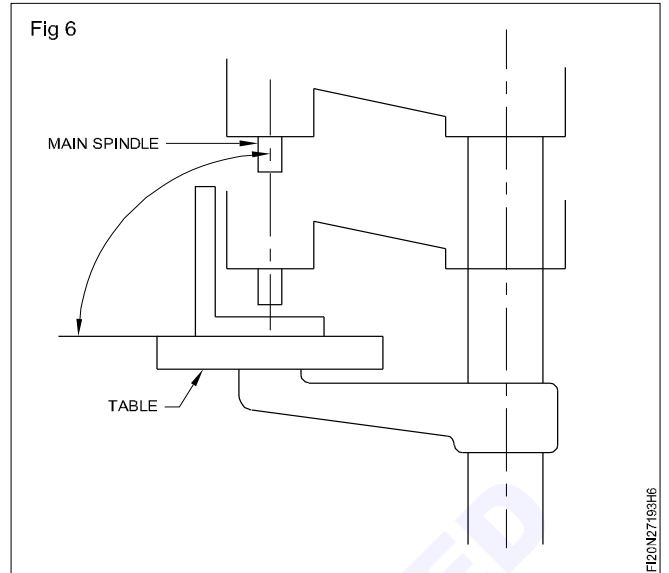


Check the straightness of the pillar and squareness of the spindle axis to the table surface (Fig 5) in two different planes.



Check the squareness of the table surface to the vertical movement of the spindle housing in two planes. (Fig 6)

Check the squareness of the table surface to the vertical movement of the spindle head of machines having an elevated spindle head. (Fig 7)



Lubricating the parts

Apply lubrication oil in main spindle, cam of rotating table, gear box and pillar. Daily by using a oil can with oil.

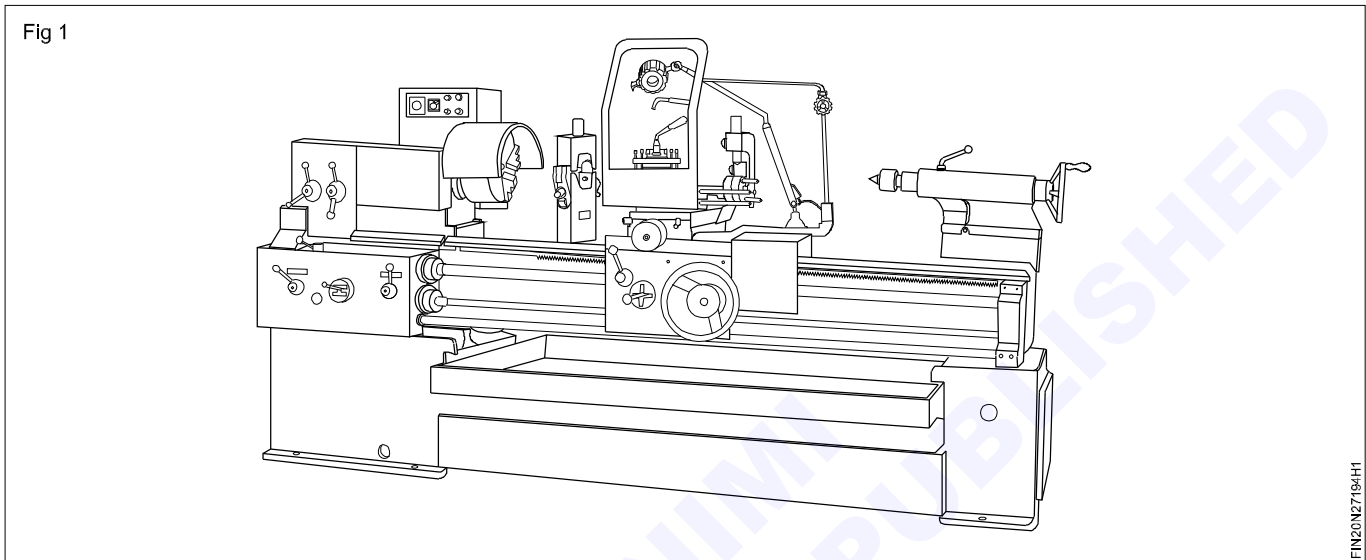
Inspect the following items and tick in the appropriate column and list the remedial measures for the defective items.

Items to be checked	Good working/Satisfactory	Defective	Remedial measures carried out
Level of the machine			
Belt and its tension			
Bearing sound			
Exposed gears			
Working in all the speeds			
Working in all feeds			
Lubrication system			
Coolant system			
Spindle & its travel			
Arm & its movement			
Electrical controls			
Safety gaurds			

Accuracy testing of machine tools such as geometrical parameters

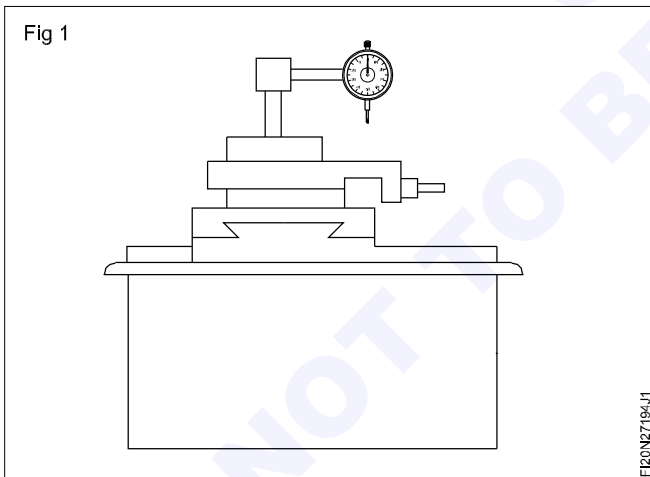
Objectives: At the end of this exercise you shall be able to

- check the level of a centre lathe
- check the true running of a lathe spindle
- check the alignment of the main spindle and the tailstock spindle of a lathe
- check the parallelism of the tailstock sleeve with respect to bedways.
- perform practical test on turned component.

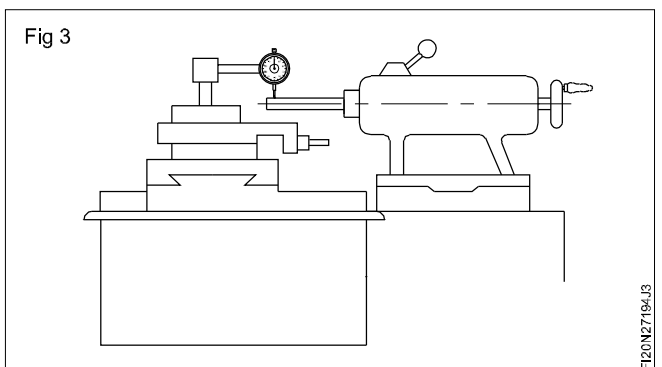
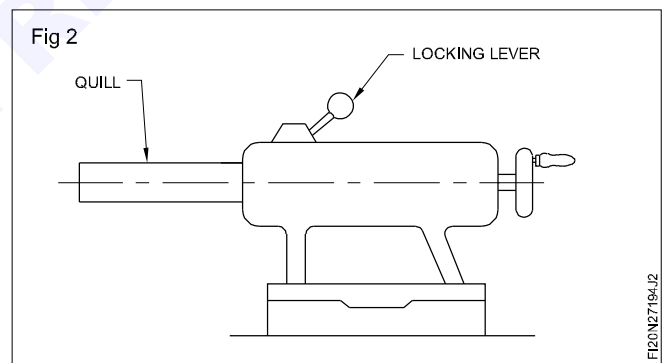


Job sequence

- Fix the dial gauge on the carriage. (Fig 1)

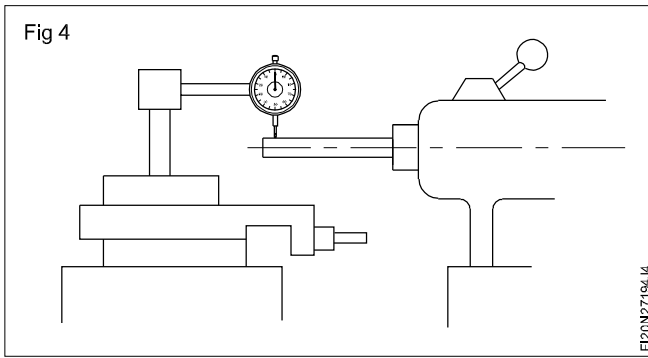


- Project the quill of the tailstock to the maximum extent possible and lock it. (Fig 2) Check the quill in the vertical and horizontal positions by a dial test indicator.
- Clamp the quill during each measurement. If it is not clamped it will affect the measurement.
- Place the dial plunger to contact over the free end of the quill in the vertical plane. (Fig 3)

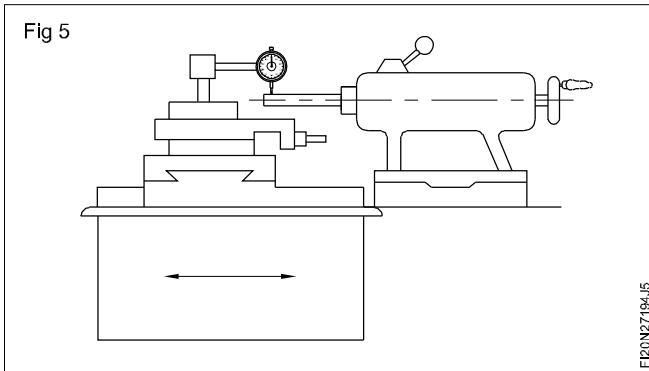


Ensure that the dial is set at the topmost point of the quill.

- Set the dial at the zero position. (Fig 4)

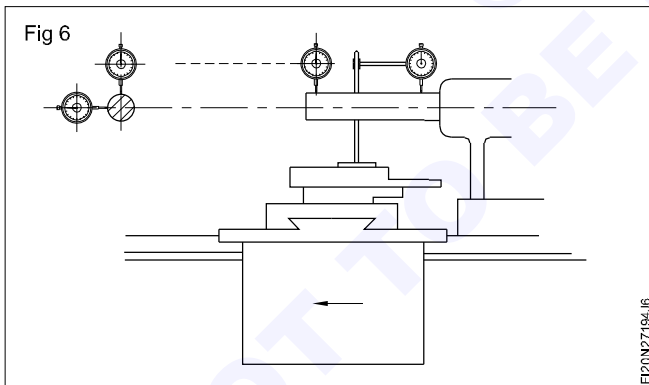


- Move the carriage slowly towards the entire length of the quill. (Fig 5)



- Note the dial reading at the extreme end of the quill.
- Verify the deflection of the dial reading and compare the value with the test chart supplied. (IS: 6040)

For checking in the horizontal plane, set the dial horizontally and repeat the above procedure. (Fig 6)

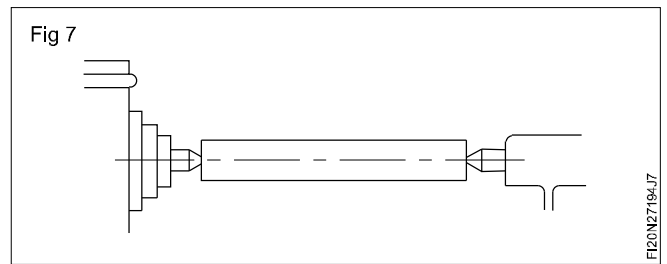


- Fix the test mandrel into the tailstock spindle. Repeat the same procedure to test the accuracy of the tailstock spindle bore in the vertical and horizontal positions as shown in the figure.

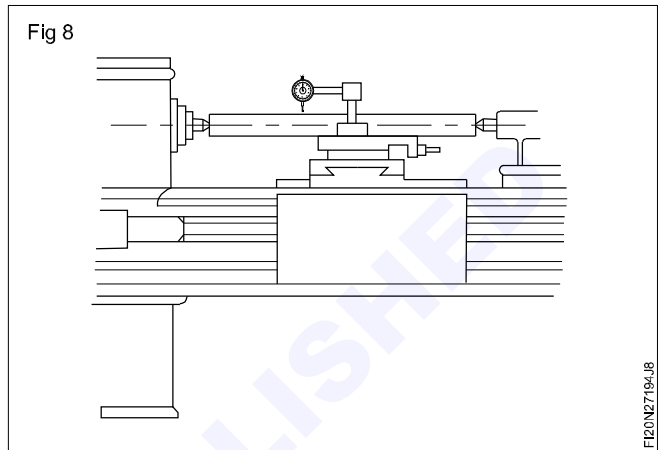
Checking the tail stock

- Insert a hollow test mandrel (300 to 500 mm long) in between the centres. (Fig 7)

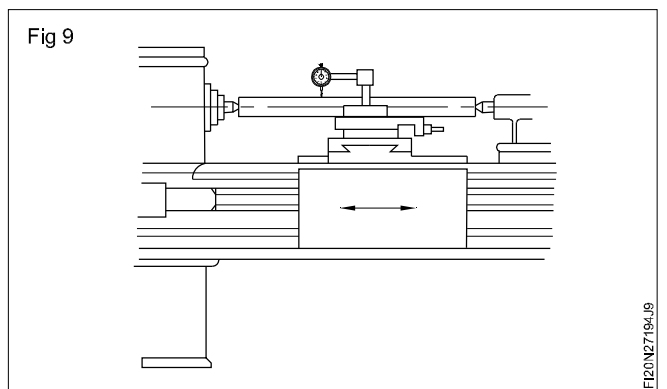
Ensure that the spindle bearing is at its working temperature.



- Fix the dial gauge on the saddle, the plunger touching a position of the mandrel and set it to zero. (Fig 8)



- Move the carriage from one end to the other end of the mandrel to check the mandrel is in correct alignment in the horizontal position.
- Rest the dial plunger at right angles (radially) to the surfaces to be tested.
- Set the dial plunger at the top of the mandrel and move the saddle along the bed slowly to the entire length of the mandrel. (Fig 9)



- Observe the reading of the dial as the saddle moves along the beds and note for variation, if any.

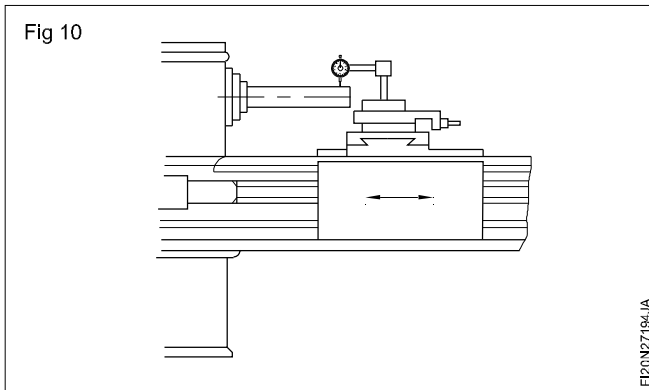
The tailstock centre must be higher than the spindle centre within the permissible limit.

- Verify the deflection of the dial gauge reading and compare the value with the test chart. (IS: 6040)

Checking the true running of a spindle

- Locate the taper shank of the test mandrel in the spindle taper.

- Hold a dial gauge, stationary in the carriage, its plunger contacting the mandrel near its free end (Fig 10) and set it to '0' position.



Rest the dial gauge plunger at right angles (radially) to the surface to be tested.

- Rotate the spindle along with the mandrel slowly by hand.
- Observe and note the reading of the dial gauge.
- Move the dial gauge near the spindle nose. Rotate the spindle along with the mandrel slowly by hand and note the reading.
- Take readings of the dial gauge while the spindle is slowly rotated. Verify the deflection of the dial reading and compare the value with the test chart. (IS: 6040)

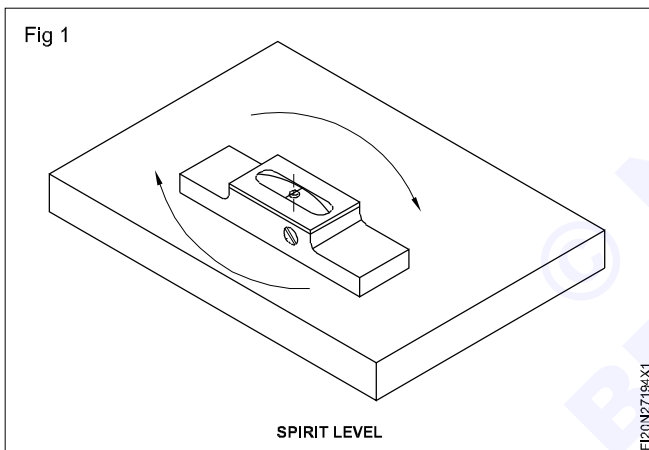
Skill sequence

Adjustment of the spirit level with the plane surface

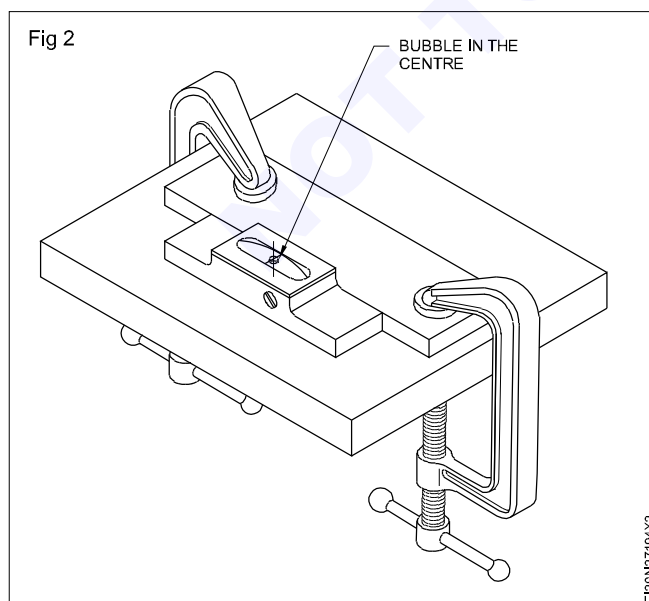
Objective: This shall help you to

- **adjust the spirit level with the plane surface.**

Move the spirit level on the plane surface until the bubble is in the centre of the scale. (Fig 1)



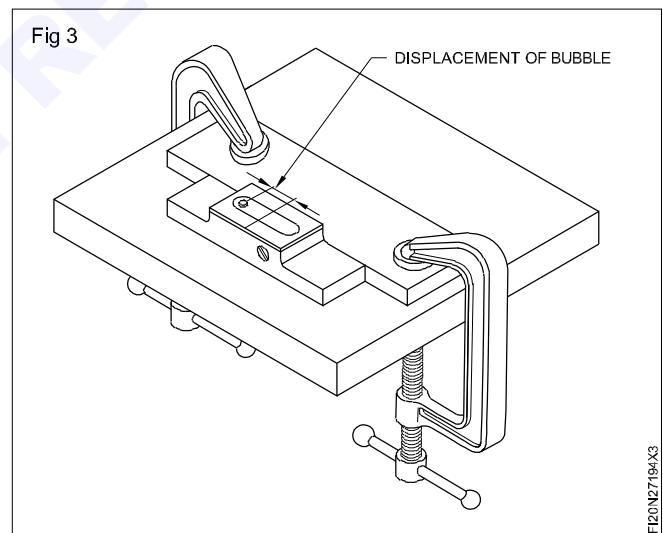
Place a straight edge against the level and clamp to the plate. (Fig 2)

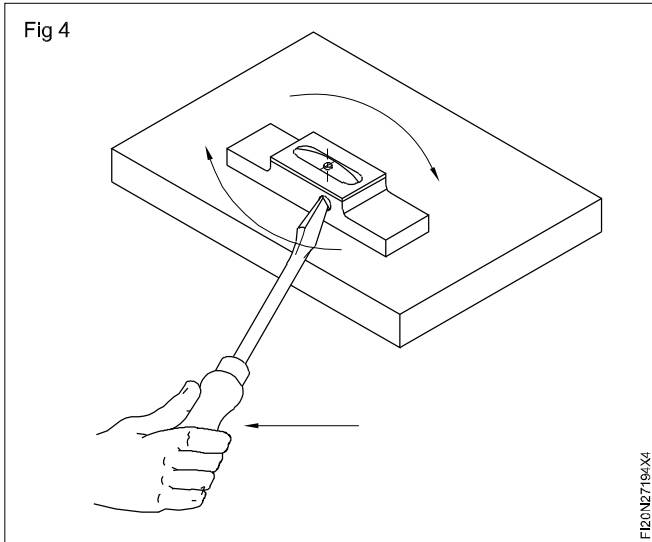


Turn the level through 180° (end for end) and place against the straight edge and note the displacement of the bubble. (Fig 3)

Adjust the vial to half of the total displacement of the bubble. (Fig 4)

Repeat the above sequence until the level is turned end for end without displacement of the bubble.





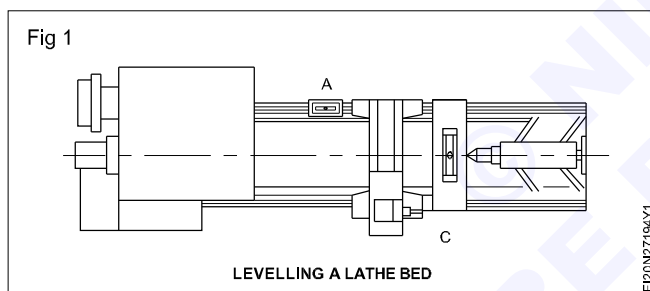
Level the lathe bed

Objective: This shall help you to

- level the lathe horizontally with the help of a spirit level.

Position the carriage in the middle of the bed.

Keep the spirit level on the rear slideway (i.e. the slideway opposite the operator's side) longitudinally at the position 'A'. (Fig 1)

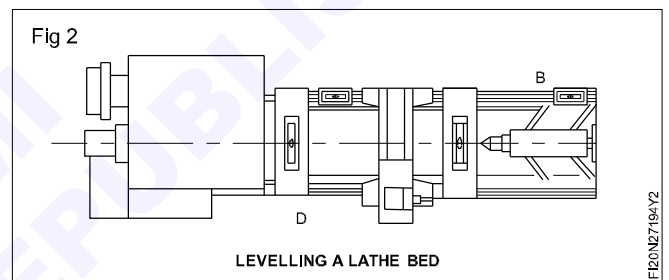


Keep the second spirit level transversally at the position 'C'. (Fig 1)

Take the readings of both the spirit levels.

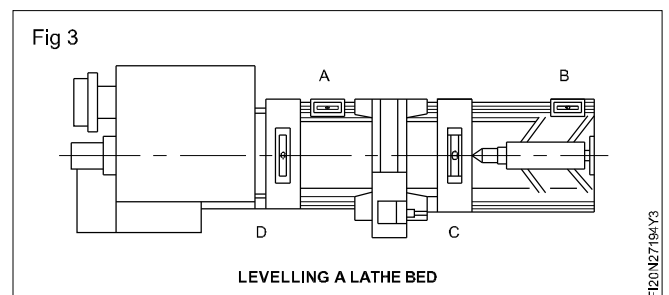
Adjust the level of the bed till both the spirit levels show the same readings.

Keep the spirit levels longitudinally and transversally at positions 'B' and 'D'. (Fig 2)



Adjust the bed till both the spirit levels show the same readings.

Repeat the sequence of operation till both the spirit levels show the same reading in all the positions A, B, C & D. (Fig 3)

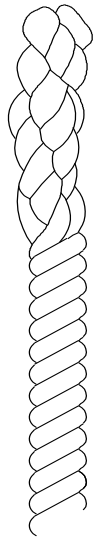


Practicing, making various knots, correct loading of slings, correct and safe removal of parts

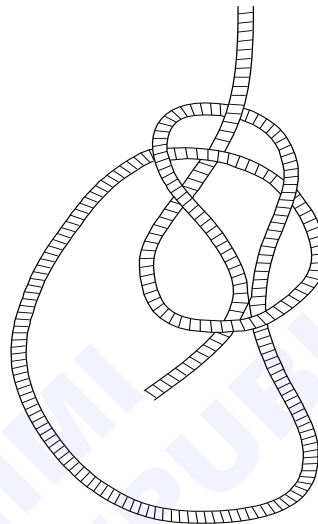
Objectives: At the end of this exercise you shall be able to

- bind the rope ends with binding wire
- tie six type of knots which is used in material handling using manila rope.

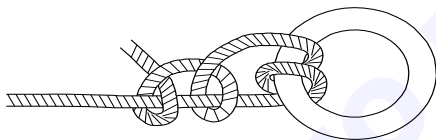
Fig 1



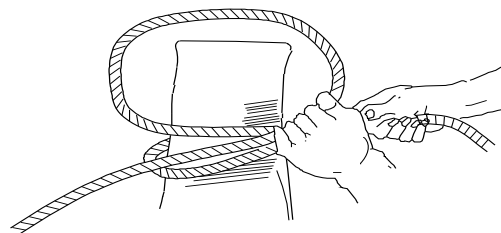
CROWNING



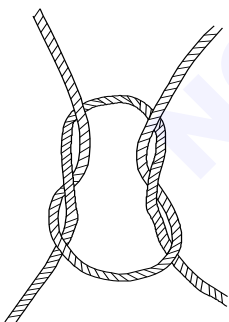
BOWLINE



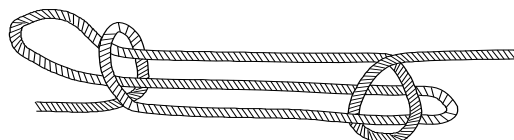
DOUBLE HITCH



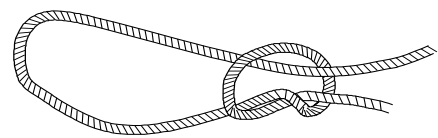
CLOVE HITCH



SQUARE KNOT



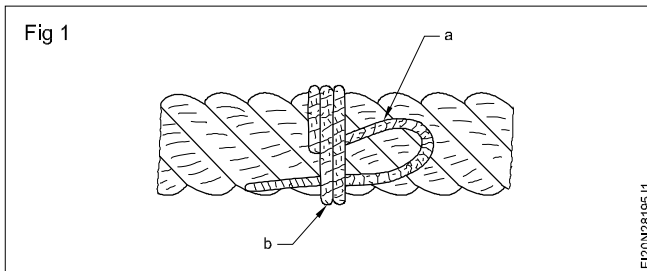
HEEP SHANK KNOT



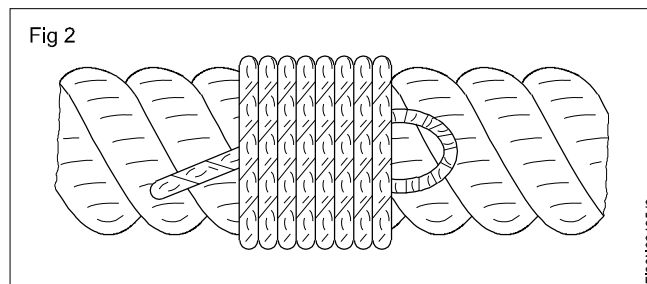
SLIP KNOT

Job sequence

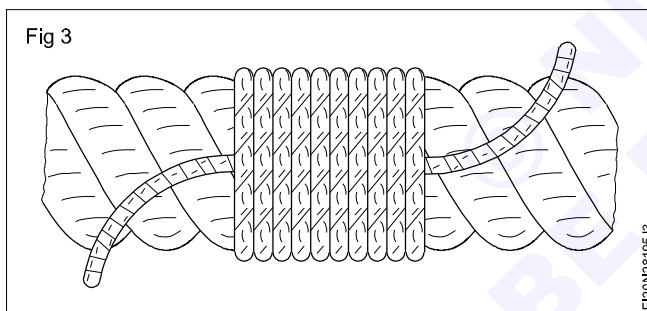
- Place one end of the soft copper or iron wire along the axis of the rope by forming a loop. (Fig 1a)



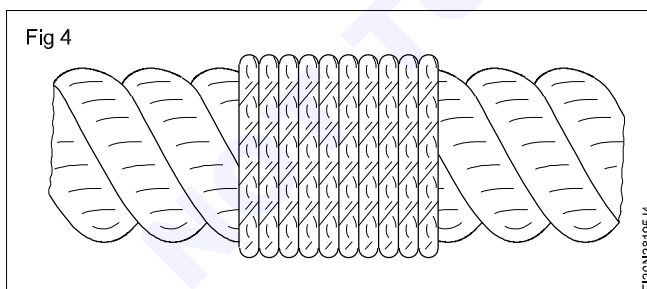
- Wind the other end of the wire around the rope 10 to 15 turns towards the rope end. (Fig 1b)
- Pass the end of the wire through the loop formed by the first end. (Fig 2)



- Pull the first end to make it tight. (Fig 3)

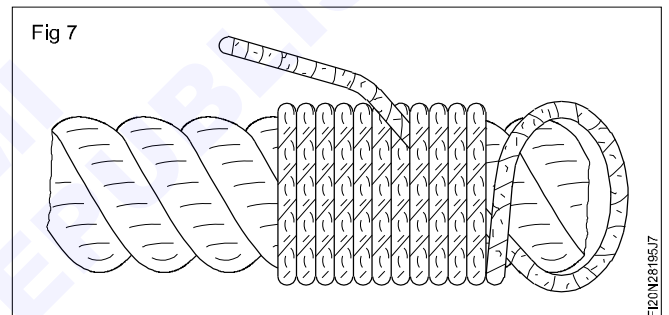
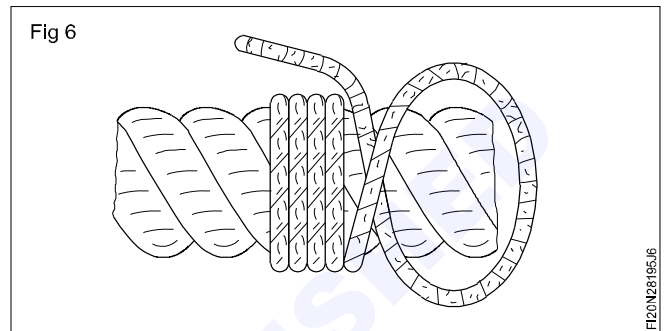
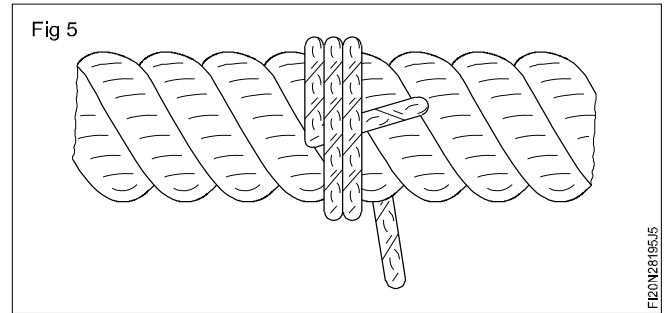


- Cut off the excess wire ends to make simple seizing. (Fig 4)

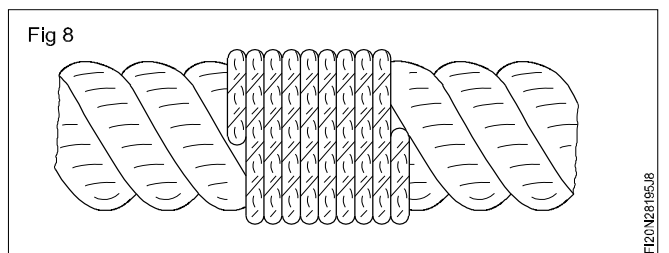


Binding of rope ends by wire adopting self-tightening seizing method

- Take a soft wire and pull one end of the wire between the strands of the rope. (Fig 5)
- Wind around the rope for 5 to 6 turns towards the rope end. (Fig 6)
- Place the second end of the wire along the rope between the strands and wind around by the bights 5 to 6 turns after forming a loop. (Fig 7)



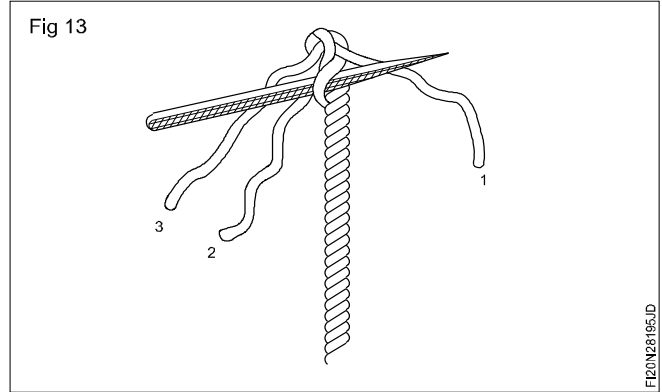
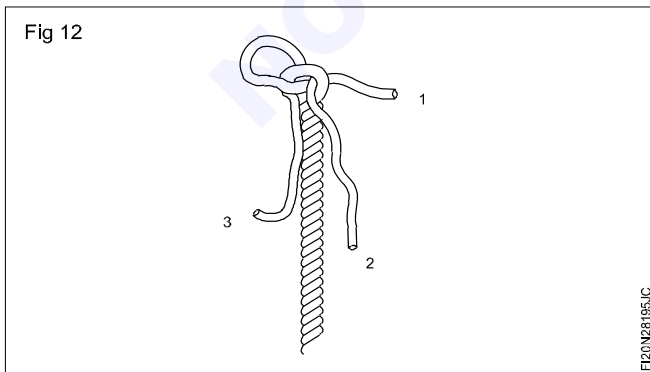
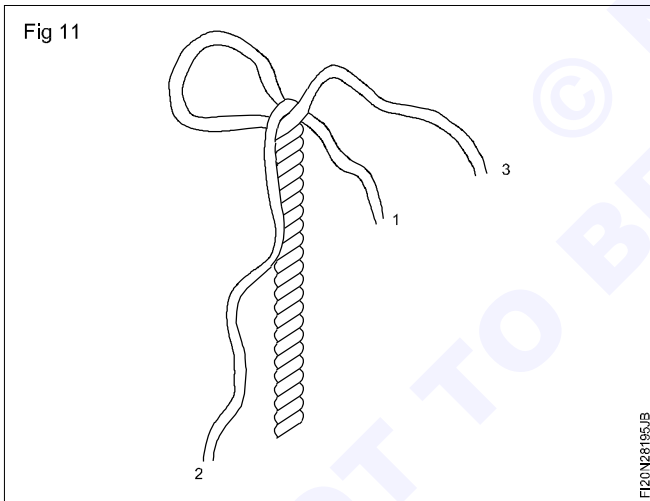
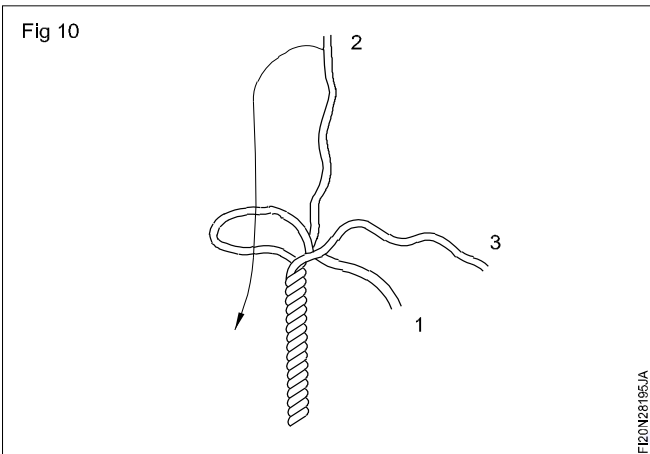
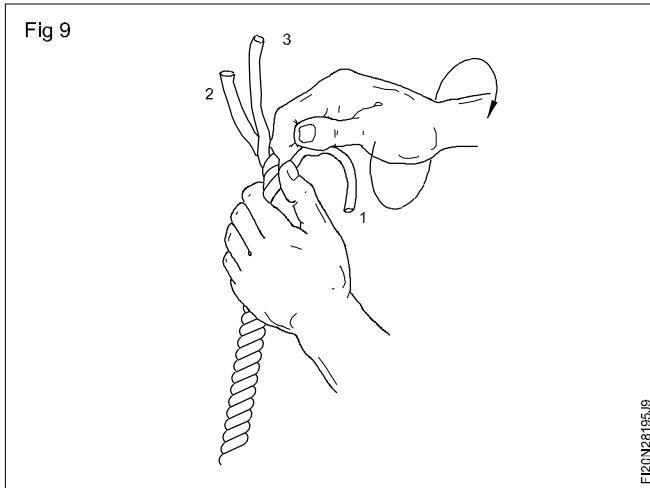
- Pull the free end of the loop under the bights to make it tight (Fig 8).



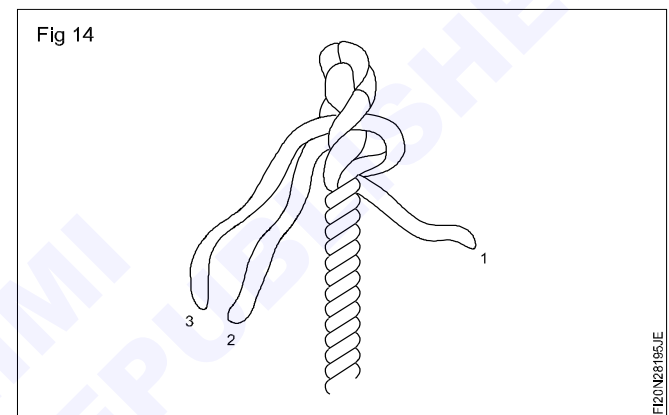
- Cut off the excess wire to form self-tightening seizing.

Binding of rope ends by wire using crowning method

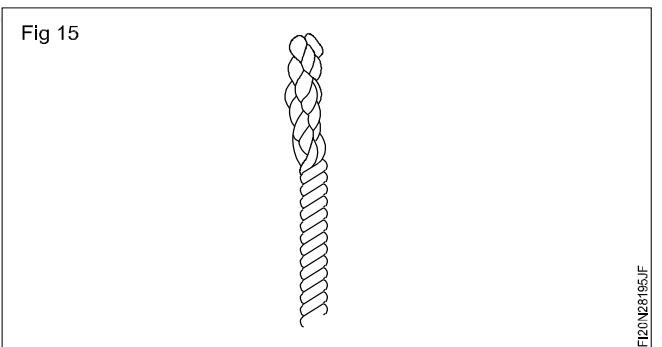
- Unwind the wire strands to separate themselves to a length of 250 to 300mm. (Fig 9)
- Take strand No.1 to form a loop and pass the end in between the strands of the rope. (Fig 10)
- Pass strand No.2 in between the strands as shown in Fig 11.
- Insert strand No.3 through the loop formed by the No. 1 strand and pull it tight. (Fig 12)
- Put a spike inbetween the strands to form a passage. (Fig 13)



- Spike is a tool with pointed end. It is used to poke in as shown in Fig 13 to make room for inserting rope strand end for binding.
- Insert the No.1 strand through the opening passage and pull tight. (Fig 14)

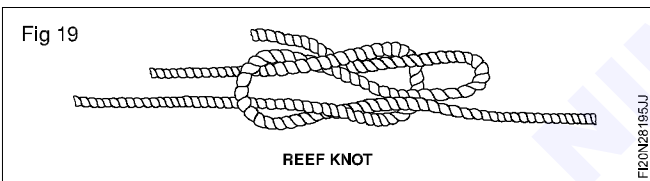
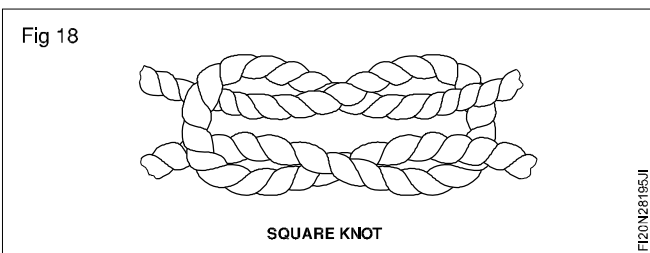
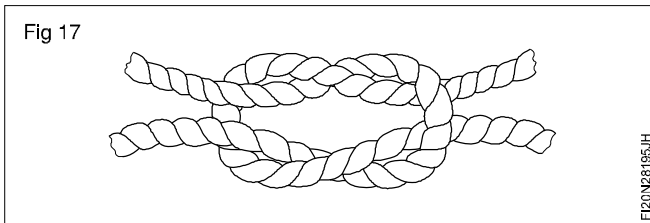
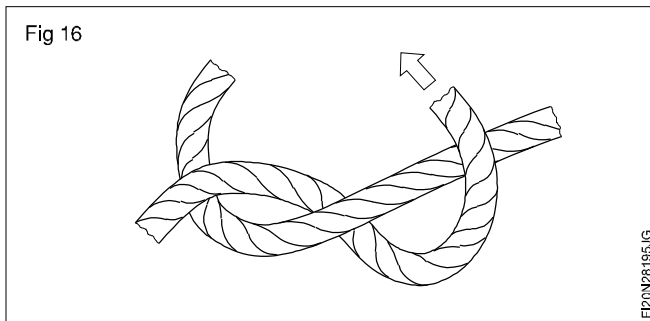


- Insert also strand No.2 in a similar way and pull tight to form crowned binding of rope end. (Fig 15)
- This method is used for fibre and cotton rope binding.



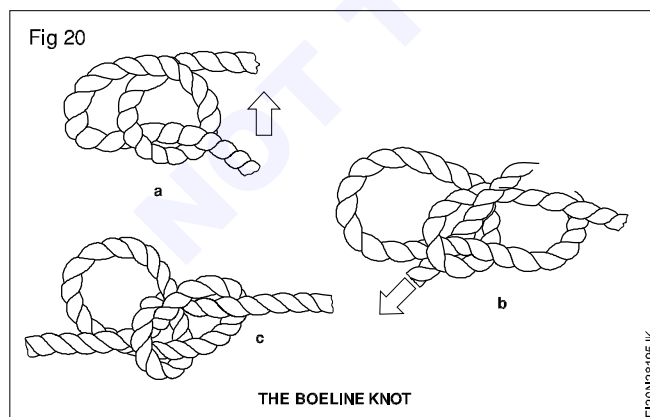
Prepare square and reef knot for slinging

- Take two pieces of manila/cotton/polypropylene ropes of the same diameter. Pass the ends of the ropes one above the other and bend in the opposite direction. (Fig 16)
- Insert the bent ends one above the other in a similar way. (Fig 17)
- Pull the ends tight to get square knot Fig 18.
- Fig 19 Shows the reef knot.



Prepare a bowline knot with a reef knot

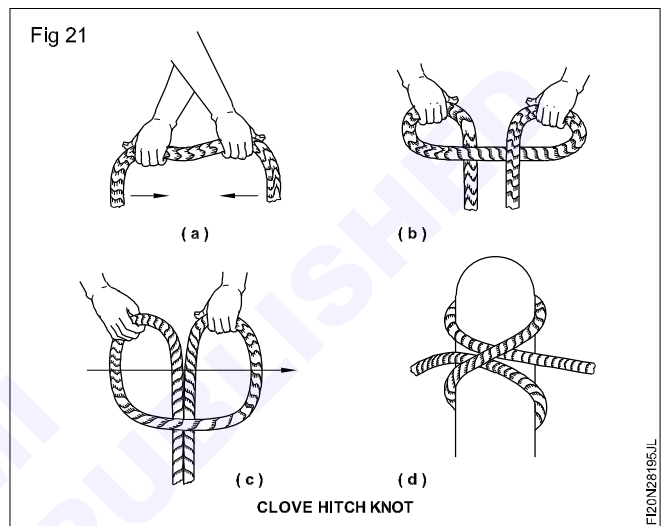
- Hold the A end of the rope by the left hand. (Fig 20a)
- Form a bight and a loop thereafter by the B end.
- Turn and hold end A by the right hand and end B by the left hand. (Fig 20b)
- Pass end A of the rope through the loop formed by end B and pull it tight to form a bowline knot. (Fig 20c)



Forming clove hitch knot using rope and sheep shank knot

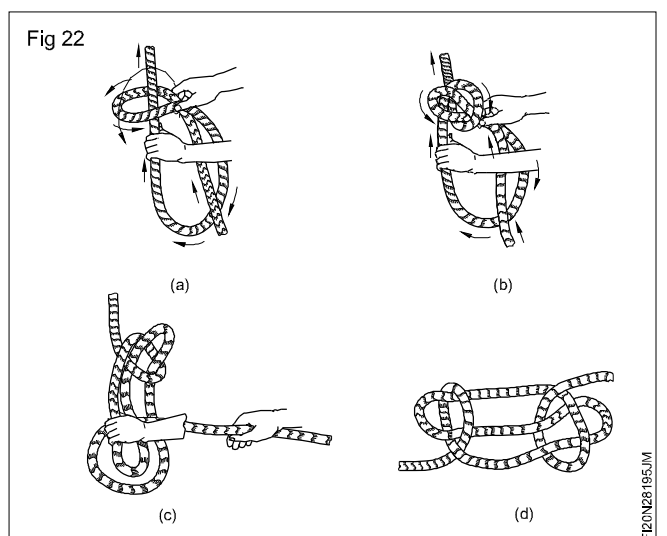
Clove hitch knot

- Hold the rope by both the hands in across way as shown in Fig 21a.
- Turn round the hands to form loops in the rope as shown in Fig 21b.
- Close down the loops together as shown in Fig 21c to put it around a post
- Fasten it to the post to make a clove hitch. (Fig 21d)



Sheep shank knot

- Hold the rope by both the hand and form a loop around one end of the rope (Fig 22a).
- Form a reverse loop around the former loop by the top end of the rope as directed by the arrows in Fig 22b.
- Turn the rope around as shown in Fig 22c to proceed in the final formation
- Turn the rope ends through the loops at the top and bottom ends as shown in Fig 22d to complete the sheep shank knot.



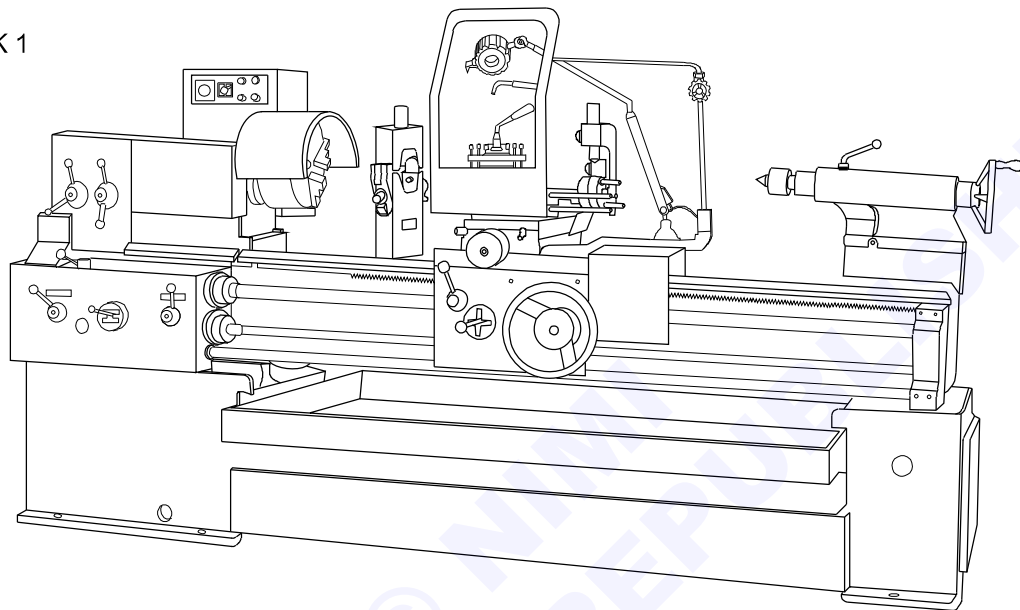
Erect simple machines

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

- erection of lathe machine
- erection of drilling machine
- erection of power hacksaw machine
- testing the machines after erection.

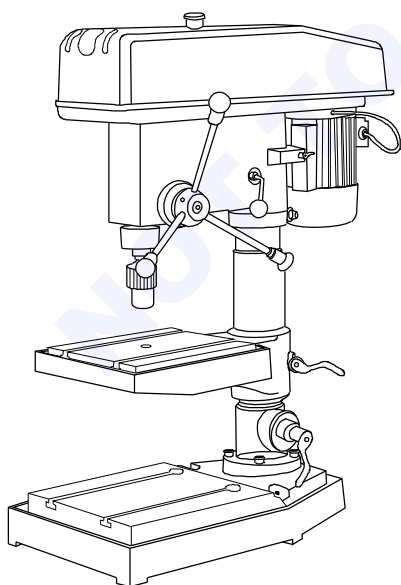
Fig 1

TASK 1



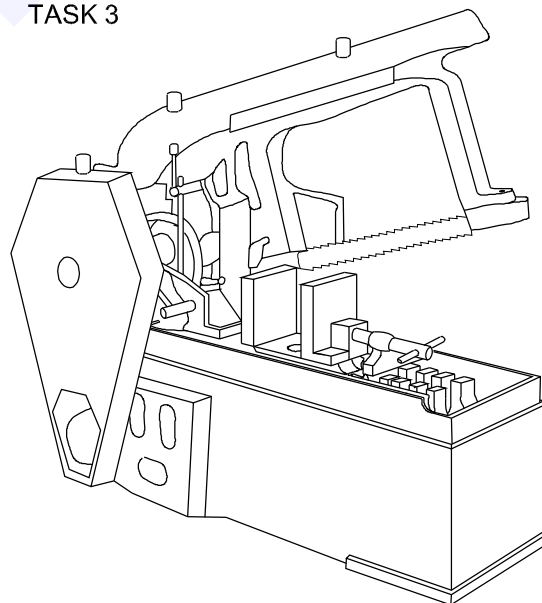
LATHE MACHINE

TASK 2



DRILL MACHINE

TASK 3



POWER SAW MACHINE

FI20N28196EH

Job sequence

TASK 1: Erection of lathe machine

- Select the space for proper functioning of machines such that machines normally must be conveniently accessible.
- Prepare the foundation plan as per the manufacturer instruction.
- As per the plan foundation can be made.
- Insert the holding down bolt before the foundation set down.
- According to the weight of the machine the depth of the foundation be made.
- Machine may be placed in position for levelling and aligning.
- Before setting the foundation, a foundation bolt inserted through the holding down hole in the basic of the machine.
- After setting the concrete the machine is put on the foundation bolt in floor.
- Align the machine perfectly horizontal position using sprit level.
- The sprit level is applied to certain measuring areas, both in longitudinal and cross direction.
- Insert wedges must be driven into the gap under the machine bed.
- After inserting wedge check the level using sprit level.
- Grouting is carried out by pouring creamy mixture of almost pure cement.
- After setting grouting the wedges may be removed.
- The machine base is then tightly screwed to the foundation bolts.
- After tightening the nuts, the correct position of the machine must once more be checked by means of the sprit level.
- Finally do the practical test and geometrical test.

Safety precautions

- When loading, slings should be protected from sharp edged by packing soft wood
- Before lifting ensure the load is securely slung before taking the lift.
- When unloading make sure that you have a firm foundation for your stack, and make provision for the removal of slings without disturbing the stack.

TASK 2: Erection of drilling machine

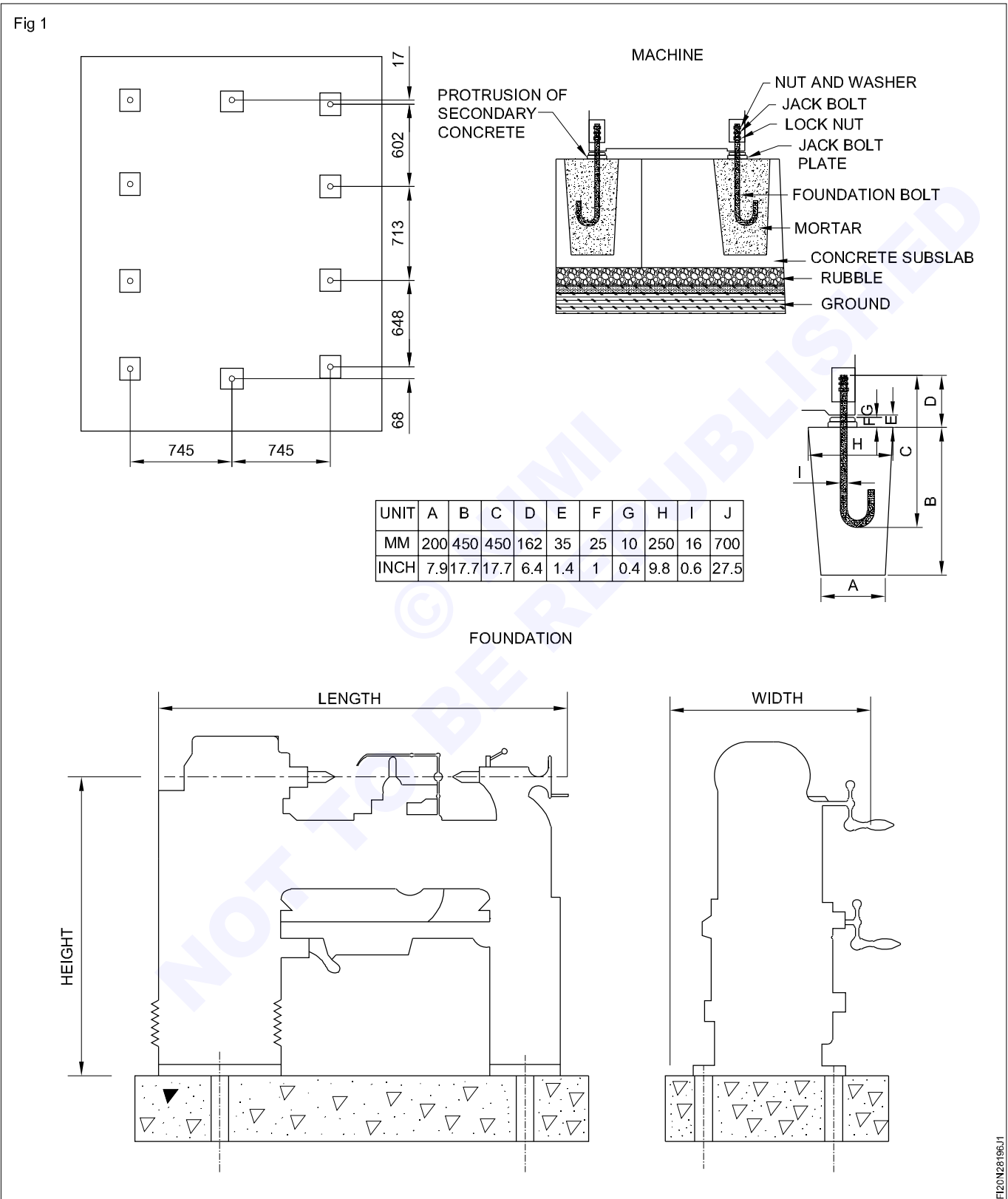
TASK 3: Erection of power hacksaw

- Follow the job sequence of TASK 1.

Skill sequence

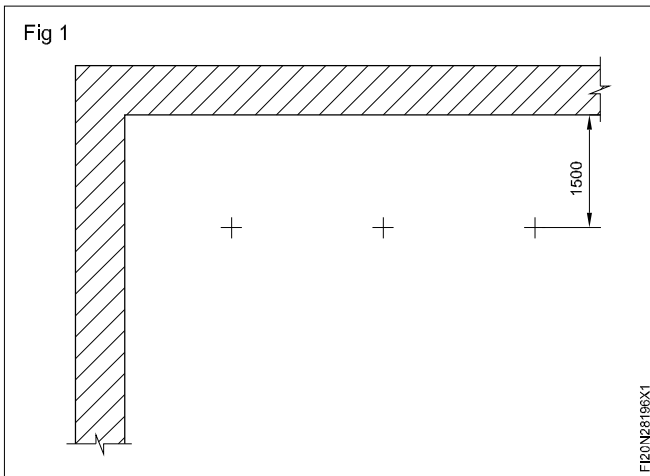
Foundation plan

Objective: This shall help you to.
 • mark foundation layouts.

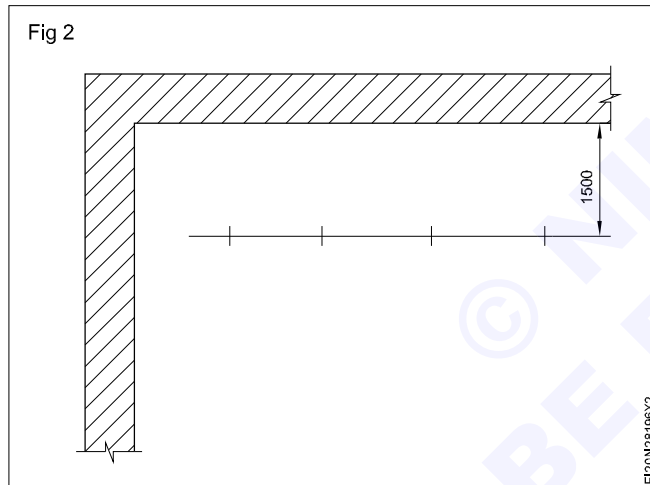


Select the space for the erection of a centre lathe machine.

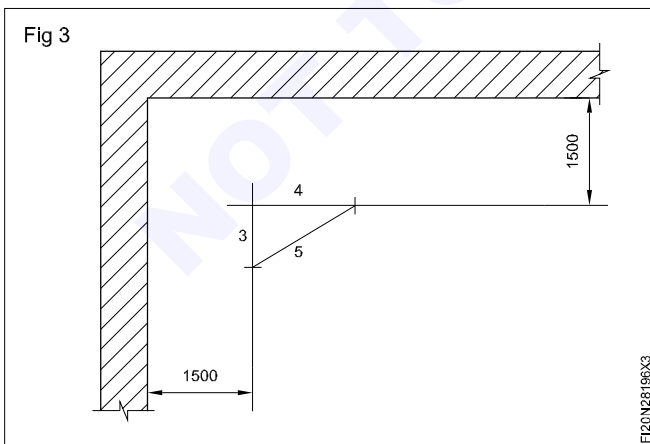
Mark points at a distance of 1.5 m (maximum) from the pillar or wall. (Fig 1)



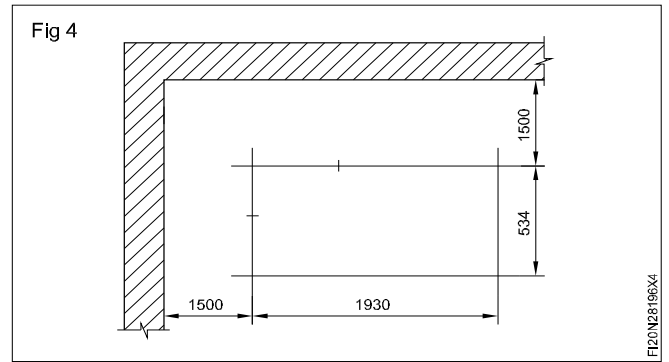
Draw the base line with the help of twine thread dipped in chalk powder or chalk solution. (Fig 2)



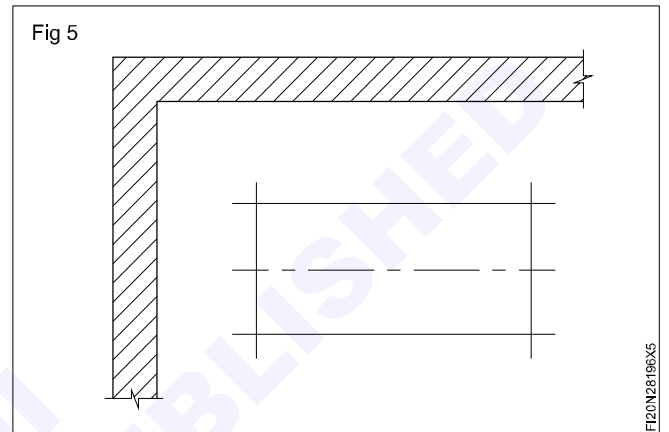
Construct the vertical base line using 3, 4, 5 method (Fig 3) as in a right angled triangle.



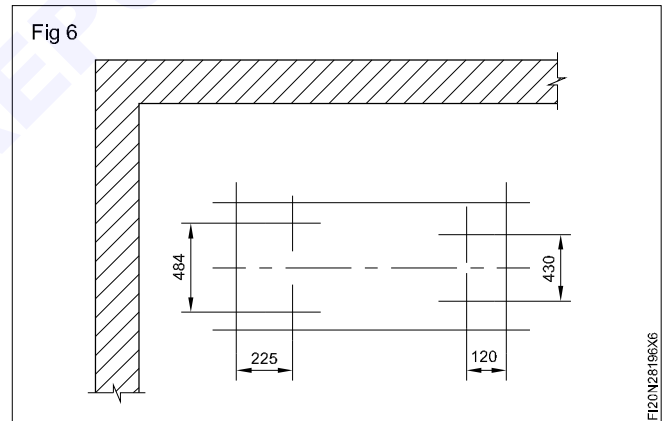
Mark the total base area of the machine. (Fig 4)



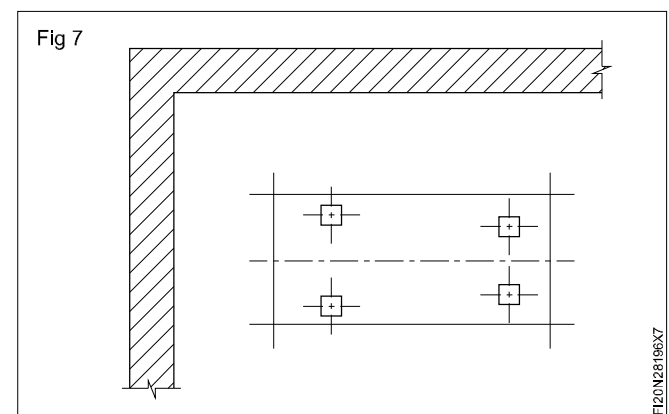
Draw the central line of the base horizontally. (Fig 5)



Locate the position of the holes. (Fig 6)



Mark the foundation holes for grouting. (Fig 7)



Mount and level machine on anti - vibration pads

Objective: This shall help you to.

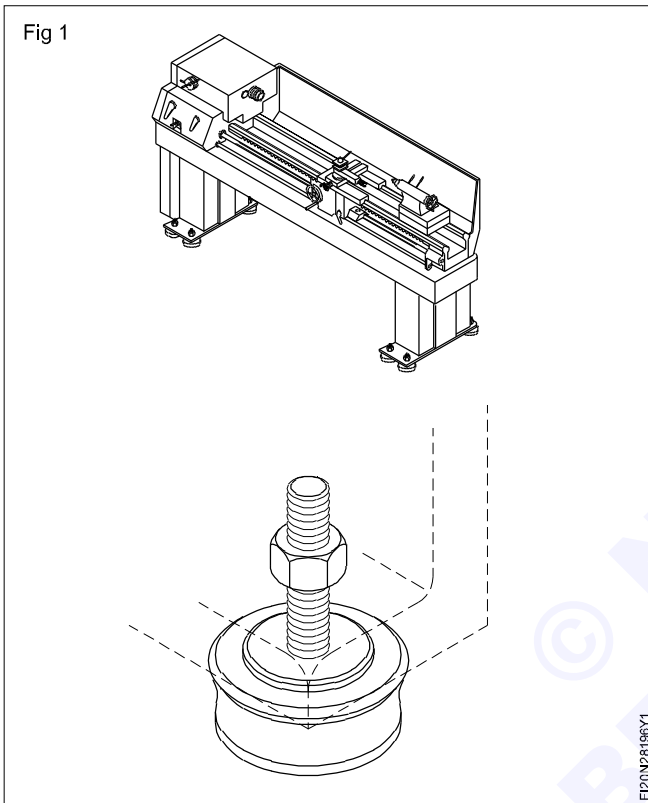
- level the machine on anti - vibration pads.

Lift the machine by crowbars and place wooden blocks under the machine at all the four corners.

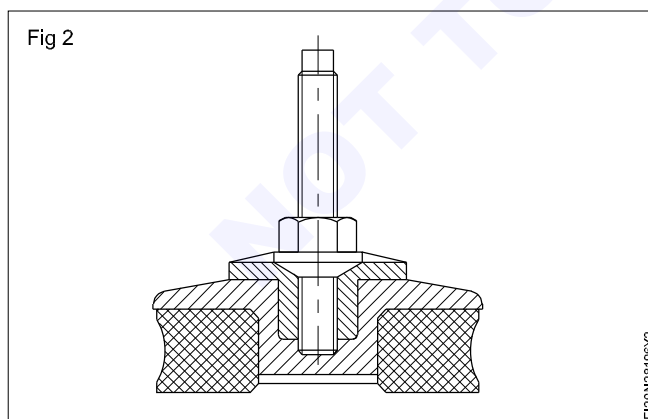
Select suitable anti-vibration pads depending upon the weight of the machine.

Remove the levelling bolts from the metal casting.

Mount anti-vibration pads under the machine. (Fig 1)



Fix levelling bolts to the metal casting through the foundation holes of the machine.(Fig 2)



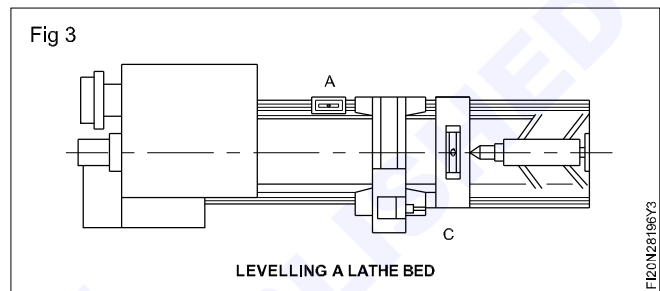
Lift the machine slightly by crowbars and remove the wooden blocks from the machine.

Level the machine both in longitudinal and transverse directions using a precision spirit level of accuracy 0.02 to 0.05 mm/metre.

Position the carriage in the middle of the bed.

Keep the spirit level on the rear slideway (i.e. the slideway opposite the operator's side) longitudinally at the position 'A'. (Fig 3)

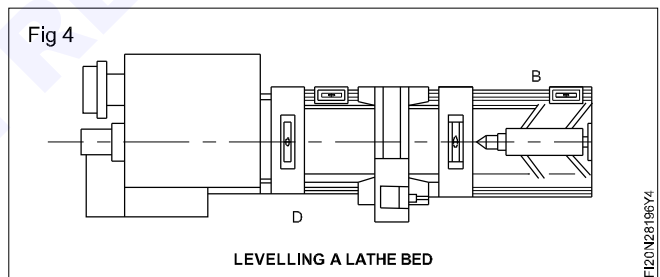
Keep the second spirit level transversally at the position 'C' (Fig 3)



Take the readings of both the spirit levels.

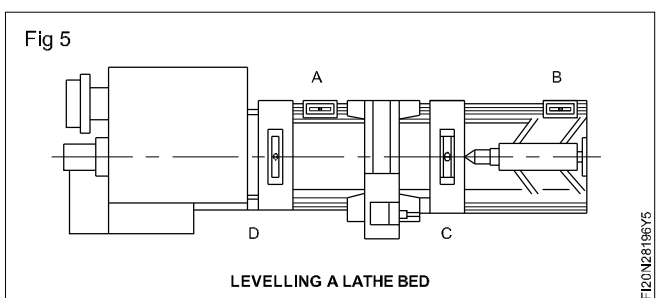
Adjust the level of the bed till both the spirit levels show the same readings.

Keep the spirit levels longitudinally and transversally at positions 'B' and 'D' (Fig 4)



Adjust the bed till both the spirit levels show the same readings.

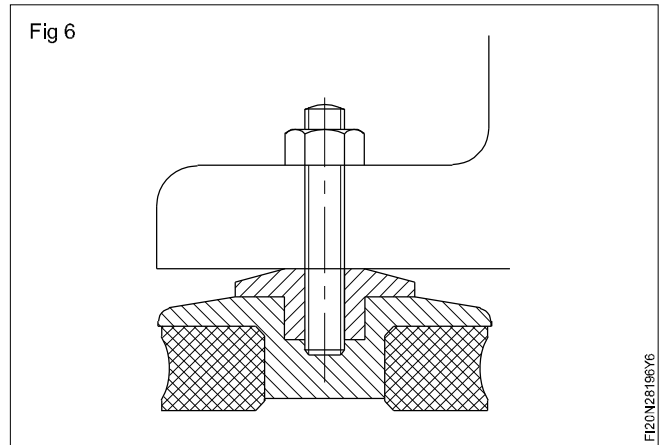
Repeat the sequence of operation till both the spirit levels show the same reading in all the positions A, B, C & D. (Fig 5)



Adjust the level of the machine as required by screwing or unscrewing the levelling bolt.

Finally check the level of the machine with a spirit level.

Lock the position of the machine by levelling lock-nuts after completion of work. (Fig 6)

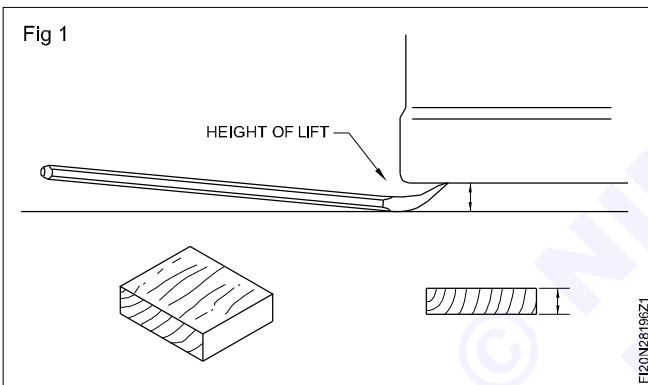


Moving machine on rollers (Drilling Machine & Power Saw Machine)

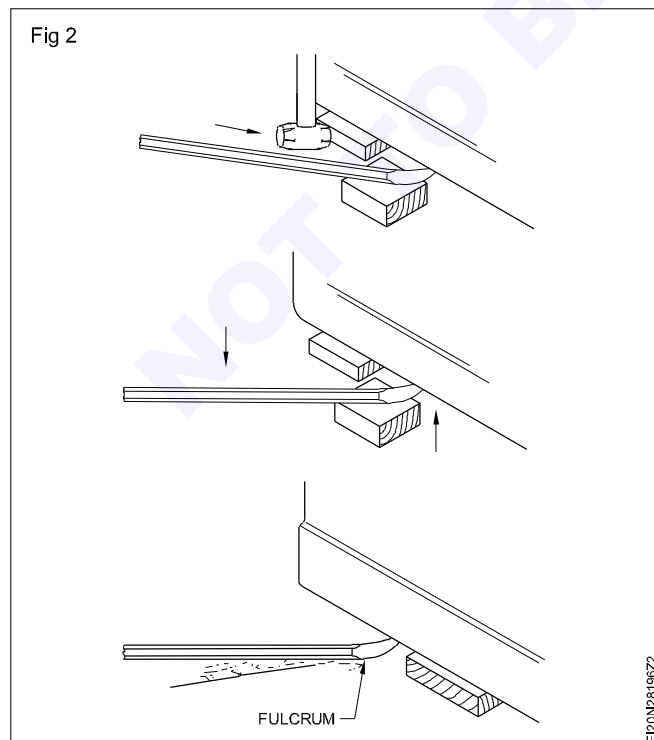
Objective: This shall help you to.

- lift and move a drilling machine and power saw machine to the desired location using rollers.

Keep a wooden block ready to be placed under base of the machine when it is lifted. (Fig 1)



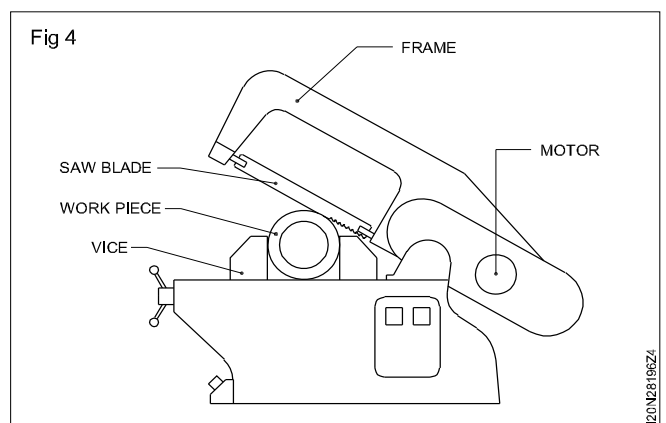
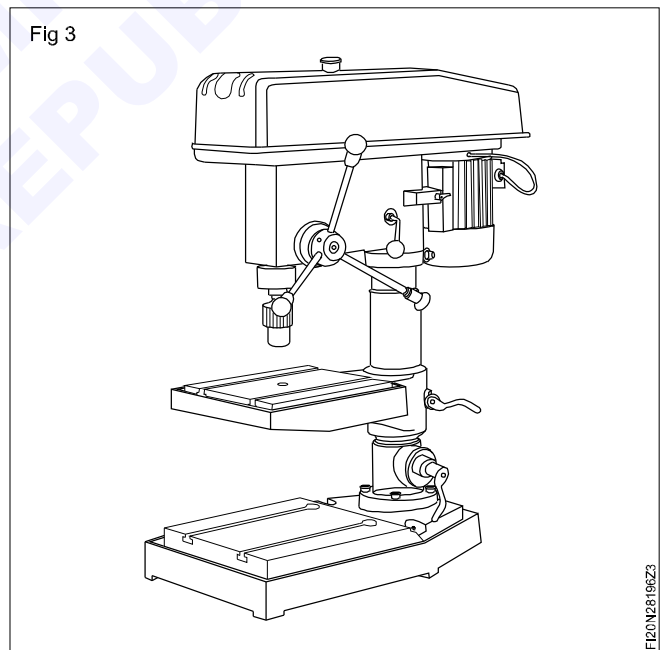
Lift one corner of the machine using crowbars and place the wooden block under the machine. (Fig 2)



Lower the machine on to the wooden block.

Repeat the same procedure for the opposite corner of the machine.

Place three or four rollers evenly distributed under the machine. (Fig 3 & 4)



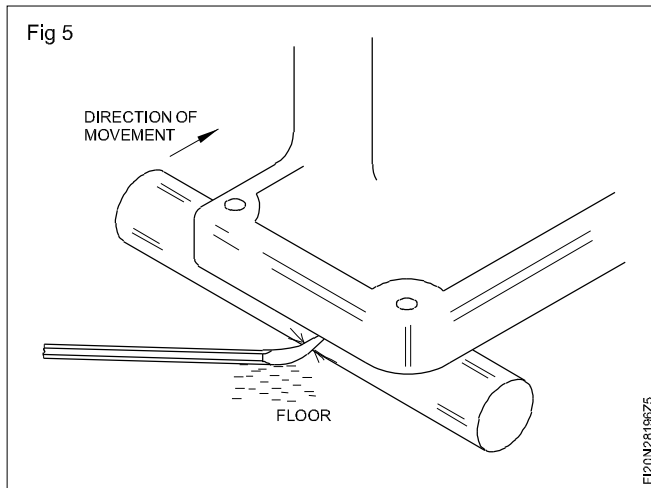
Lift the machine with crowbars and remove the wooden blocks.

Lower the machine evenly on to the rollers. (Fig 3 & 4)

Check that the route is clear of obstacles before moving.

Place a roller in front of the machine.

Push the load forward slowly with the crowbars upto located place. (Fig 5)



As and when a roller is left behind the load, take it out and place the same in front of the load.

Note: Fig 6 shows the correct and incorrect method of handling crow bar.

