MECHANIC MACHINE TOOL MAINTENANCE

NSQF LEVEL - 4

2nd Year

TRADE PRACTICAL

Sector: C G & M

(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 : C G & M

Duration : 2 Years

Trade : Mechanic Machine Tool Maintenance - 2nd Year - Trade Practical - NSQF Level - 4 (Revised 2022)

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2022 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 comprising 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 **Mechanic Machine Tool Maintenance - 2nd Year - Trade Practical - NSQF Level - 4 (Revised 2022) in C G & M Sector under** 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, 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,
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January 2024
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 syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Practical 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 practical 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 **Mechanic Machine Tool Maintenance** under the **C G & 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 intented to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course of the **Mechanic Machine Tool Maintenance** 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) syllabus are covered.

This manual is divided into Eleven modules.

Module 1 : Welding

Module 2 : Hydraulics and pneumatics

Module 3 : Pipes and Valves

Module 4 : Milling

Module 5 : Grinding

Module 6 : Electrical & Electronics

Module 7 : PLC

Module 8 : CNC Turning

Module 9 : Pump and compressor

Module 10 : Material Handling Equipments

Module 11 : Maintenance & Testing

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **Mechanic Machine Tool Maintenance 2nd Year NSQF LEVEL - 4 (Revised 2022)** in **C G & M**. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 4 (Revised 2022) syllabus on Trade Practical attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

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

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

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

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl.No.	Learning Outcome	Exercise No.
1	Make / Produce different joints by setting up of gas and arc welding machines and carry out the welding. (Mapped NOS: CSC/N0304)	**2.1.122 - 2.1.127**
2	Identify, dismantle, replace and assemble different pneumatics and hydraulics components. [Different components – Compressor, Pressure Gauge, Filter Regulator, Lubricator, Valves and Actuators.] (NOS:CSC/N9488)	**2.2.128 - 2.2.139**
3	Construct circuit of pneumatics and hydraulics observing standard operating procedure& safety aspect. (NOS:CSC/N9489)	**2.2.140 - 2.2.150**
4	Make pipe/tube fittings and valve connections for lubricants and coolants, test for leakages. (Mapped NOS: CSC/N0901)	**2.3.151 - 2.3.158**
5	Conduct preventive maintenance, perform dismantling and assembly of different components machine and test for accuracy of milling machine. (Mapped NOS: CSC/N0901)	**2.4.159 - 2.4.161**
6	Set the different grinding machine and produce component to appropriate accuracy. [Different machine:- Surface & cylindrical grinding; appropriate accuracy ±0.02mm] (Mapped NOS: CSC/N0304)	**2.5.162 - 2.5.167**
7	Conduct preventive maintenance, perform dismantling & assembly of different components of grinding machine and test for accuracy. [Different components grinding head, lead screw, table, hydraulic cylinders] (Mapped NOS: CSC/N0901)	**2.5.168 - 2.5.170**
8	Identify and explain basic functioning of different electrical equipment, sensors and apply such knowledge in industrial application including basic maintenance work. [Different electrical & electronics equipment- DC/ AC motors, passive & active electronic components, resistor, capacitor, inductors, rectifier, diode transistor, SCRS & ICS; Different sensors – proximity & ultrasonic] (Mapped NOS: CSC/N0305)	**2.6.171 - 2.6.189**
9	Programme PLC and interface with other devices to check its Applications. (NOS:CSC/N9490)	**2.7.192 - 2.7.198**
10	Prepare part programme, test on simulation software and interpret different errors. (NOS:CSC/N9491)	**2.8.199 - 2.8.212**
11	Troubleshoot & Overhaul of pumps, fans, blowers & compressors and perform preventive maintenance. (Mapped NOS: CSC/N0901)	**2.9.213 - 2.9.224**
12	Identify fault carryout maintenance work and break down of different machineries/ equipments viz., shaper, surface grinding, drilling, lathe, milling, in the shop floor, using appropriate tools &equipments to ensure its functionality. (Mapped NOS: CSC/N0901)	**2.10.225 - 2.11.236**

SYLLABUS

2nd Year **Duration: Two years**

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
Professional Skill 40 Hrs; Professional Knowledge 10Hrs;	Make / Produce different joints by setting up of gas and arc welding machines and carry out the welding. (Mapped NOS: CSC/N0304)	122. Setting up an Arc welding machine. (5hrs) 123. Edge preparation of material for Arc welding. (5hrs) 124. Perform square lap joint, butt joint, tee joint and Pipe Joint in Arc welding. (10hrs) 125. Making straight beads in gas welding. (4hrs) 126. Perform square lap joint, but joint & tee joint in Gas welding. (08hrs) 127. Perform gas cutting of MS plate. (08hrs)	**Arc Welding:**Introduction to arc welding and its safety. Welding types, Common tools used in welding. Basic Electricity as applied to Welding Arc Length & its effects Arc Welding Machines: - advantages & disadvantages of AC & DC Arc Welding Machine. Electrodes: - Sizes & Coding. Edge Preparation: Nomenclature of butt & fillet welding. Welding Symbols & Weld defects. **Gas Welding:**Introduction to gas welding process, its classifications, accessories and its safety. **Gas Cutting:** Principle of gas cutting. Systems of Oxy-Acetylene Welding- Flashback & backfire. Types of Oxy-Acetylene flames: - Gases used in welding & Gas flame combination. Safety in gas cutting process. (10 hrs)
Professional Skill 60Hrs; Professional Knowledge 18Hrs .	Identify, dismantle, replace and assemble different pneumatics and hydraulics components. [Different components – Compressor, Pressure Gauge, Filter Regulator Lubricator, Valves and Actuators.] (NOS:CSC/N9488)	128. Demonstrate knowledge of safety procedures in hydraulic systems (Demo by video). (4 hrs) 129. Identify hydraulic components – Pumps, Reservoir, Fluids, Pressure relief valve (PRV), Filters, different types of valves, actuators, and hoses. (07 hrs) 130. Inspect fluid levels, service reservoirs, clean/replace filters. (10hrs)	**Hydraulics & Pneumatics** Basic principles of Hydraulics - Advantages & limitation of hydraulic system, hydrostatic transmission, Pascal's law, Brahma's press, pressure Temperature & flow, speed of an actuator. Control valves: Different type of control valves used in hydraulic System. Function of pressure control valve, directional control valve, check valve, flow control valve. (06 hrs)
		131. Identify pneumatic components – Compressor, pressure gauge, Filter-Regulator-Lubricator (FRL) unit, and Different types of valves and actuators. (2 hrs)	Compressed air generation and conditioning, Air compressors, Pressure regulation, Dryers, Air receiver, Conductors and

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		132. Dismantle, replace, and assemble FRL unit. (5 hrs) 133. Demonstrate knowledge of safety procedures in pneumatic systems and personal Protective Equipment (PPE). (2 hrs) 134. Identify the parts of a pneumatic cylinder.(1 hr) 135. Dismantle and assemble a pneumatic cylinder.(4 hrs) 136. Construct a circuit for the direction & speed control of a small-bore single-acting (s/a) pneumatic cylinder. (5 hrs) 137. Construct a control circuit for the control of a double acting pneumatic cylinder with momentary input signals. (5 hrs) 138. Construct a circuit for the direct & indirect control of a double acting pneumatic cylinder with a single & double solenoid valve. (08 hrs) 139. Dismantling &Assembling of solenoid valves. (07 hrs)	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. 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 (12 hrs)
Professional Skill 110Hrs; Professional Knowledge 30Hrs .	Construct circuit of pneumatics and hydraulics observing standard operating procedure& safety aspect. (NOS:CSC/ N9489)	140. Inspect hose for twist, kinks, and minimum bend radius, Inspect hose/tube fittings. (5 hrs) 141. Identify internal parts of hydraulic cylinders, pumps/motors. (10 hrs) 142. Construct a circuit for the control of a single acting hydraulic cylinder using a 3/2-way valve (Weight loaded double acting cylinder may be used as a single acting cylinder), 4/2 & 4/3 way valves. (10 hrs) 143. Perform overhauling of hydraulic pump. (10hrs) 144. Maintenance, troubleshooting, and safety aspects of pneumatic and hydraulic systems (The practical for this component may demonstrated by video). (13 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, cavitations, Hazards & safety precautions in hydraulic systems - Hydraulic reservoir & accessories, Pumps, Classification – Gear/ vane/ piston types, Pressure relief valves – Direct acting and pilot-operated types - Pipes, tubing, Hoses and fittings – Constructional details, Minimum bend radius, routing tips for hoses - 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

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
			- Hydraulic valves: Check 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, cavitations, and proper sampling of hydraulic oils (13 hrs)
.		145. Construct Electro Hydraulic circuit –Speed and Pressure control of double acting cylinder.(10 hrs) 146. Perform overhauling of pneumatic cylinders. (12hrs) 147. Perform overhauling of hydraulic actuators. (10hrs) 148. Disassembly of power pack, hydraulic pipes, ferrules, hydraulic cylinders, pistons etc. (10hrs) 149. Replacing &refitting of hydraulic pipes, seals etc. (10hrs) 150. Assemble the parts and testing of the power press after air bleeding. (10hrs)	Electro hydraulic circuit, Electrical components - Switches - Solenoid - Relay Introduction to Pneumatic actuators Pneumatic Symbols Pneumatic circuit Electrical control components - Switches - Solenoid - Relay Study & working of a hydraulic press along with its components. Breakdown & preventive maintenance of a hydraulic press. Safety in use of and maintenance of hydraulic presses. Proximity Sensors Classification And Operation-Proximity Sensor-Types Of Proximity Sensor And Their Working-Industrial Application Sensors For Distance And Displacement -LVDT-Linear (17 hrs)
Professional Skill 80Hrs; Professional Knowledge 20Hrs	Make pipe/tube fittings and valve connections for lubricants and coolants, test for leakages. (Mapped NOS: CSC/N0901)	151. Flaring of pipes and pipe joints. (3 hrs) 152. Cutting & Threading of pipe length. (3 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.

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		153. Fitting of pipes as per sketch observing conditions used for pipe work. (09 hrs) 154. Bending of pipes- cold and hot. (7 hrs) 155. Fit & assemble pipes, valves and test for leakage & functionality of valves.(17 hrs) 156. Visual inspection for visual defects e.g. dents, surface finish.(3hrs)	Standard pipefitting- Methods of fitting or replacing the above fitting, repairs and erection on rainwater drainage pipes and house hold taps and pipe work. Inspection & Quality control -Visual Inspection - Basic 7 Quality tools (10 hrs)
		157. Dismantle & assembly of globe valve, gate valve, butterfly, diaphragm, direction control valve, pressure relief, non return& flow control valve. (30hrs) 158. Making & replacement of gaskets, washer. (08hrs)	Pipe colour code. Safety precautions to be observed while working at pipeline. Constructional detail of different type of valve & their uses like: Gate, Globe, butterfly, Diaphragm. (10 hrs)
Professional Skill 40Hrs; Professional Knowledge 10Hrs	Conduct preventive maintenance, perform dismantling and assembly of different components machine and test for accuracy of milling machine. (Mapped NOS: CSC/ N0901)	159. Dismantle and assemble of head stock, gear box lead screw, table of milling machine. (27hrs) 160. Check the accuracy of milling machine of after assembly. (08hrs) 161. Do the preventive maintenance of milling machine. (5hrs)	Breakdown maintenance and preventive maintenance of a milling machine. (10 hrs)
Professional Skill 60Hrs; Professional Knowledge 18Hrs	Set the different grinding machine and produce component to appropriate accuracy. [Different machine:- Surface & cylindrical grinding; appropriate accuracy ±0.02mm] (Mapped NOS: CSC/ N0304)	162. Demonstrate working of grinding machine. (05 hrs) 163. Set the machine, stroke length & do wheel balancing. (10 hrs) 164. Perform grinding of parallel and perpendicular surfaces (accuracy ±0.02mm). (15 hrs) 165. Perform grinding of angular surfaces grinding (accuracy ±0.02mm). (10hrs) 166. Setting the cylindrical grinding machine for grinding internal and external surfaces. (10hrs) 167. Setting the machine for grinding taper holes. (10hrs)	**Grinding:** Grinding machine – introduction, parts & constructional details, types – surface grinding and cylindrical grinding machines. Safety precaution followed while working on grinding machines. Grinding wheels – abrasives, bond and bonding process, grit, grade, and structure of grinding wheels and its marking system. Procedure for mounting of grinding wheels, balancing of grinding wheels, dressing and truing of grinding wheels, glazing and loading in grinding wheel. (18 hrs)

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
Professional Skill 40Hrs; Professional Knowledge 10Hrs	Conduct preventive maintenance, perform dismantling & assembly of different components of grinding machine and test for accuracy. [Different components grinding head, lead screw, table, hydraulic cylinders] (Mapped NOS: CSC/N0901)	168. Dismantle and assembly of grinding head, lead screw, table, hydraulic cylinders of grinding machine. (20hrs) 169. Check the accuracy of grinding machine after assembly. (10hrs) 170. Do the preventive maintenance of surface grinder and cylindrical grinding machine. (10hrs)	Preventive and breakdown maintenance of grinding machine. (10 hrs)
Professional Skill 110Hrs; Professional Knowledge 30Hrs	Identify and explain basic functioning of different electrical equipment, sensors and apply such knowledge in industrial application including basic maintenance work. [Different electrical & electronics equipment- DC/ AC motors, passive & active electronic components, resistor, capacitor, inductors, rectifier, diode transistor, SCRS & ICS; Different sensors – proximity & ultrasonic] (Mapped NOS: CSC/N0305)	171. Behaviour of Proximity Sensors. (5hrs) 172. Behaviour of ultrasonic sensors. (5hrs) 173. Logical Operation of Sensors. (5hrs) 174. Limit & Level Control using Sensors. (5hrs) 175. Interfacing of Sensors with Electrical Actuators. (5hrs) 176. Making simple wiring circuits and measurement of current and voltage. (5hrs) 177. Testing of power supply (AC & DC).(5 hrs) 178. Demonstration of use of test lamp and megger. (5 hrs) 179. Connections of DC/AC motors and its speed control - demonstration only. (5 hrs)	Switches, Fuse And Circuit Breakers. Introduction To Sensors--Fundamental Of Sensor. Potentiometer -Ultrasonic And Optical Sensors-Industrial Application. Basic principles of DC generators and motors, Alternators and AC motors and transformers. Various types of switches, circuit breakers, fuses, lamps, proximity switches, relays and contactor in electrical circuits. Passive circuit elements – resistors, capacitors and inductors. Its identification and testing. Colour code.(12 hrs)
		180. Identification of passive & active electronic components. (8hrs) 181. Use of oscilloscope. (05hrs) 182. Demonstrate of logic gate operations. (5hrs) 183. Testing and measurement of resistors, capacitors, inductors using multimeter. (8hrs) 184. Perform soldering and de-soldering of components on printed circuit board. (PCB). (10hrs) 185. Study of rectifiers and testing with multimeter. (5hrs) 186. Preparing and checking of rectifier circuits. (6hrs)	**BASIC ELECTRONICS** Introduction to electronics and its industrial applications. Introduction to digital electronics – numbers system and logic gates. Study of electronic circuit – macro level with block diagram. (18 hrs)

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		187. Demonstrate of solid state devices –diode transistors. (5hrs) 188. SCRS & ICS –identification &testing. (5hrs) 189. Assembly of simple battery eliminator circuit using bright rectifier & fitter capacitor. (8hrs)	
Professional Skill 40Hrs; Professional Knowledge 10Hrs	Programme PLC and interface with other devices to check its Applications. (NOS:CSC/N9490)	192. Ascertain various modules, controls, and indicators of given PLC. (6 hrs) 193. Program and configure the PLC to perform a simple start/stop routine. (6 hrs) 194. Program the PLC using Timer and Counter instructions. (10 hrs) 195. Program the PLC to perform Move, Arithmetic, and Logical operations. (3 hrs) 196. Program the PLC for performing comparator operations. (3 hrs) 197. Practice on PLC wiring. (9 hrs) 198. Program PLC for controlling analog parameter(s). (3 hrs)	**PLC:** Overview of different control systems. Introduction about PLC. Block diagram of PLC. Different types of PLC, PLC Architectures (Fixed and Modular). Selection of PLC. Advantages of PLC. Applications of PLC. Various types of modules used in PLC. Familiarization of AND, OR and NOT logics with examples. Registers Basics. Timer Functions. Counter Functions. Introduction and importance of Sequential Control Systems. Communication protocols used in PLC: RS-232, RS-485, Ethernet, Profibus. Different programming languages of PLC: LDR, STL,FBD, CSF. Basic ladder programming of PLC. Configuration of PLC and its modules. Wiring of PLC. (10 hrs)
Professional Skill 60Hrs; Professional Knowledge 18Hrs	Prepare part programme, test on simulation software and interpret different errors. (NOS:CSC/ N9491)	199. Knowledge rules of personal and CNC machine safety, safe handling of tools, safety switches and material handling equipment using CNC didactic/simulation software and equipment. (5hrs) 200. Identify CNC lathe machine elements and their functions. (5hrs) 201. Understand the working of parts of CNC lathe, using CNC didactic/ simulation software. (05hrs) 202. Identify common tool holder and insert shapes by ISO nomenclature. (5hrs) 203. Select cutting parameters from tool manufacturer's catalogue. (2hrs)	Concept of Co-ordinate geometry, concept of machine coordinate axis, axes convention on CNC lathes, work zero, machine zero. Converting part diameters and lengths into co-ordinate system points. Absolute and incremental programming. Programming – sequence, formats, different codes and words. ISO G codes and M codes for CNC turning. Describe CNC interpolation, open and close loop control systems. Co-ordinate systems and Points. Cutting tool materials, application of various materials.

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		204. Write CNC programs for simple tool motions and parts using linear and circular interpolation; check on program verification/ simulation software. (04hrs) 205. Write CNC part programs using canned cycles for stock removal, grooving, threading operations, with drilling and finish turning. Use TNRC commands for finish turning. Check simulation on program verification/ simulation software. (06 hrs) 206. Avoiding collisions caused by program errors. Knowing causes and effects of collisions due to program errors, by making deliberate program errors and simulation on program verification/ simulation software. (6hrs) 207. Simple turning & Facing (step turning) without using canned cycles, on CNC simulator. (06 hrs) 208. Program checking in dry run, single block modes, on CNC simulator (2hrs) 209. Absolute and incremental programmingassignments and simulation. (6hrs) 210. Checking finish size by over sizing through tool offsets, on CNC simulator. (2hrs) 211. Recovering from axes over travel, on CNC simulator. (1 hr) 212. Interpret different messages generated against different errors. (05hrs)	Cutting tool geometry for internal and external turning, grooving, threading, face grooving, drilling. Insert holding methods for each. Writing part programs as per drawing & checking using CNC program verification/ simulation software. Process planning, work holding, tool and cutting parameters selection according to the part geometry and dimensions. Collisions due to program errors, effects of collisions. Costs associated with collisions – tool breakage, machine damage, injuries. Find out alarm codes and meaning of those codes. Program execution in different modes like MDI, single block and auto. Process planning & sequencing, tool layout & selection and cutting parameters selection. Work and tool offsets. Inputs value to the offset/ geometry page into machine. First part checking: Program checking in single block and dry run modes – necessity and method. (18 hrs)
Professional Skill 90Hrs; Professional Knowledge 20Hrs	Troubleshoot & Overhaul of pumps, fans, blowers & compressors and perform preventive maintenance. (Mapped NOS: CSC/ N0901)	213. Demonstrate various types of machine related centrifugal pump and their parts. (8hrs) 214. Overhauling of pumps with fitting of gland packing. (15hrs) 215. Priming of pump. (4hrs) 216. Testing of pump. (2hrs) 217. Perform preventive and schedule maintenance. (4hrs) 218. Trouble shooting in pump operation. (12hrs)	**Centrifugal Pump, Fan, Blower and Compressor:-** **Pump** Function of pump. Types and working principle of centrifugal pump (machine related). Constructional detail of pump Starting and stopping Pump performance and characteristics.

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
			Capitation & aeration Preventive & schedule maintenance of pumps. Gland packing changing procedure. Concept of Mechanical seal Trouble shooting in pump. (10 hrs)
		219. Identification of various types of fans, blowers and their parts. (5hrs) 220. Dismantle, inspect, repair/ replace work out part and assemble the same. (10hrs) 221. Demonstrate compressors and their parts. (8 hrs) 222. Cleaning and changing of filters of compressors. (8 hrs) 223. Perform schedule and preventive maintenance of blower & compressor. (6hrs) 224. Change compression ring & oil rings in a reciprocator compressor. (8 hrs)	**Fan & Blowers:** Types and working principle Constructional detail of Fans & Blowers. Starting and stopping of Fans and Blowers Different parts of Fans & Blowers Concept of surge. Preventive & scheduled maintenance. **Compressors:** Compression theory, Types of compressors Constructional detail of compressors, working mechanism Different parts and their function. Loading unloading system Concept of air dryer. Preventive & schedule maintenance. (10 hrs)
Professional Skill 110Hrs; Professional Knowledge 30Hrs	Identify fault carryout maintenance work and break down of different machineries/ equipments viz., shaper, surface grinding, drilling, lathe, milling, in the shop floor, using appropriate tools &equipments to ensure its functionality. (Mapped NOS: CSC/ N0901)	225. Demonstrate mechanical & hydraulic jack, rope puller, chain puller, chain block, and winch. (8 hrs) 226. Inspection of tools and tackles of material handling equipments. (6 hrs) 227. Shift a small machine from layout to loading centre/ different work place. (10 hrs)	Different type of jacks, chain block and pull lift. Knowledge of different types of scaffolding. Material movement by using different rigging tools and techniques. Safety appliances & precautions in rigging. Maintenance of tools and tackles. (09 hrs)
		228. Practice various belt & chain joining methods. (20 hrs) 229. Demonstrate belt conveyor system, vibratory screen & feeder. (Video demo)(6 hrs)	Bulk Material Handling (Conveyor belt, Vibratory screen, Feeders) Principle & mode of material handling.

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
			Various components used in belt conveyor system & their functions. (Pulleys, idlers, scrapers, skirts, belt, take up unit system and safety devices). Vibratory screen- working mechanism. Feeders- types, working mechanism. Maintenance practice-Pulley lagging, belt sway control belt joining methods. (06 hrs)
		230. Trouble shooting on machine tools such as drill, shaper, lathe & power saw machine. (15 hrs) 231. Perform overhauling of feed units of lathe milling & grinding. (15hrs) 232. Geometrical testing of machine tools. (10hrs)	Breakdown Maintenance, Preventive Maintenance, Predictive Maintenance & Concepts of TPM, OEE.(without calculations) Difference between breakdown and preventive maintenance – Its importance in productivity, types. Normal procedure followed for maintenance of machine tools on the shop floor. Accuracy testing of machine tools. Various maintenance practices. Concepts & Measurement of machine performance: MTBF, MTTR. (without calculations) (09 hrs)
		233. Preparation of check list for inspection of different machine tools. (5hrs) 234. Temperature measurement of machine tools. (5hrs) 235. Vibration measurement of machine tools. (5hrs) 236. Fault finding practice on machine tools. (05 hrs)	Inspection & Condition Monitoring. Maintenance strategy – Reactive, Preventive, Predictive and proactive. Corrective Maintenance & Plan Maintenance. Condition Base Maintenance (CBM), Reliability Centered Maintenance (RCM), Importance of inspection. Type / methods of equipment inspection. Commonly used gadgets for inspection. Concept of inspection check-list. Importance of condition monitoring and Various techniques used for condition monitoring. (vibration, temperature, sound and lubricant condition) Concept of Industry 4.0 and Digital Manufacturing. (09 hrs)

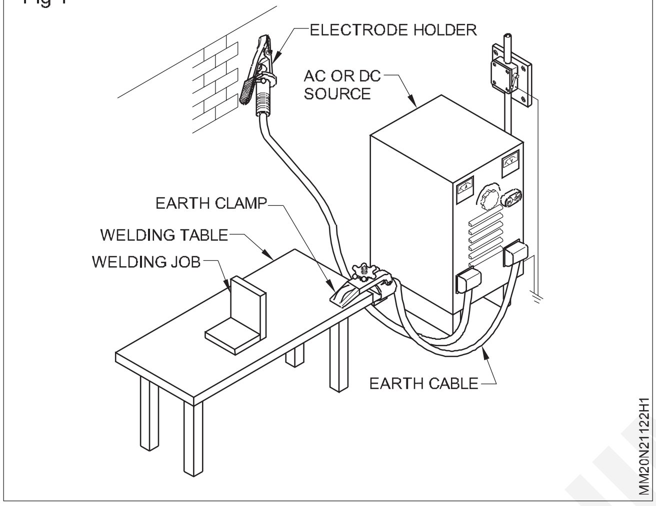
Setting up an arc welding machine

Objective: At the end of this exercise you shall be able to
- **set the arc welding machine**

Job Sequence

Setting of Arc Welding machine (Fig 1)

Fig 1



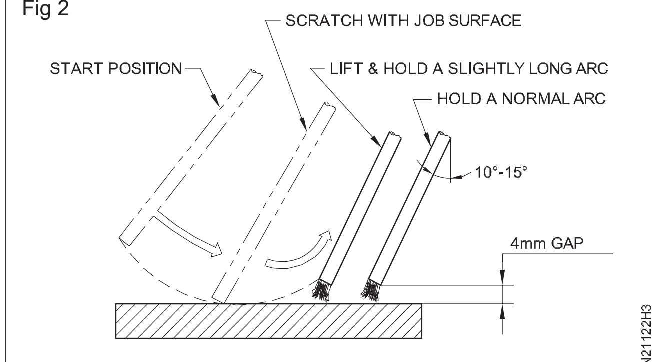
- Select an appropriate installation location
- Set the machine at least 30 cm away from the wall and the place must be dry and clean.
- Check the work of power source for the welding machine and it should be in a firm and level place
- Connect the welding cables with welding machine
- Attach the earth cable with the welding table at proper place
- Keep the electrode-holder at a safe place
- Set the welding current as per the diameter of the electrode to be used (Table 1).
- Select the electrode as per the thickness of the metal to be welded as recommended (Table 1).

Table 1

Plate Thickness in mm (approx.)	Electrode Size mm	Current Range (amperes)
1.6	1.6	40-60
2.5	2.5	50-80
4.0	3.2	90-130
6.0	4.0	120-170
8.0	5.0	180-270
25.0	6.0	300-400

- Hold the electrode about 25 mm above the job piece at one end perpendicular to the surface.
- Strike the arc by dragging electrode quickly and softly across the welding job using wrist movement only.
- Withdraw the electrode approximately 6mm from the surface for a few seconds and then lower it to (approx) 4mm distance. (Fig 2)

Fig 2

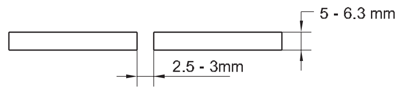


SCRATCH METHOD

Edge preparation of material for Arc welding

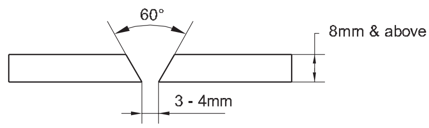
Objective: At the end of this exercise you shall be able to
- **prepare edges for different Butt joints in Arc welding.**

TASK:1



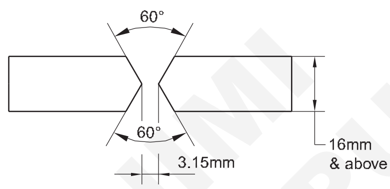
SQUARE BUTT JOINT WITH GAP

TASK:2



SINGLE VEE BUTT WITH GAP

TASK:3



DOUBLE VEE BUTT WITH GAP

Job Sequence

- Clean the job tube welded to remove any dirt, grease and other contaminants
- Measure the job as per the given sketches Task 1, Task 2, Task 3
- Mark and draw a line along the edge of job piece with help of try square, steel rule and scriber.
- Fix the job in the bench vice, and remove excess material by filing or grinding.
- Filing and grinding to be continued until the proper edge shape formed as shown in drawings.
- Check the job as per drawing and finish and keep the job ready for weld with good edge formation.

02	50 ISF 16-150	-	Fe 310	-	3	-
02	50 ISF 8-150	-	Fe 310	-	2	-
02	50 ISF 6-150	-	Fe 310	-	1	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 2.1.123

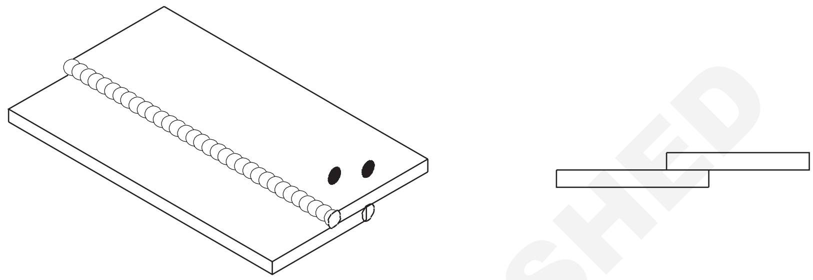
SCALE NTS	EDGE PREPARATION OF METAL	TOLERANCE ±1	TIME
		MM20N21123E1	

Perform welding joints by arc welding

Objectives: At the end of this exercise you shall be able to
- **perform square lap joint by arc welding**
- **perform butt joint by arc welding**
- **perform tee joint by arc welding**
- **perform pipe joint by arc welding.**

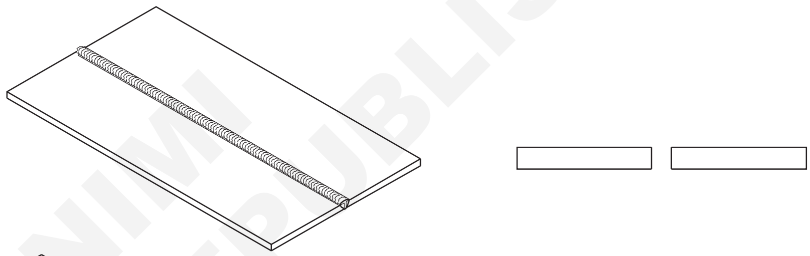
TASK - 1

Square lap joint



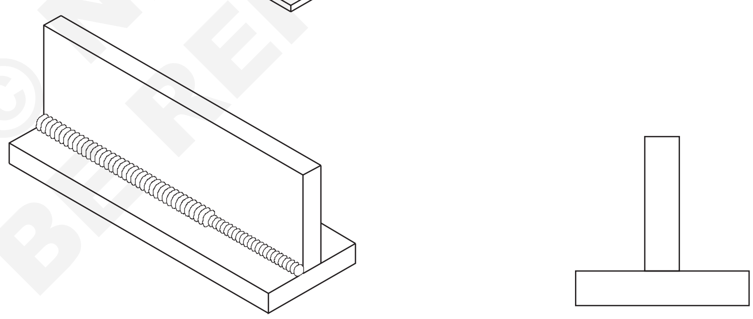
TASK - 2

Butt joint



TASK - 3

Tee joint



TASK - 4

Pipe joint

02	Ø 50 X 3 -100	-	Fe 310	-	4	-
02	50 ISF 6-150	-	Fe 310	-	3	-
02	50 ISF 6-150	-	Fe 310	-	2	-
02	50 ISF 10-150	-	Fe 310	-	1	-
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 2.1.124

SCALE NTS	WELDING JOINTS BY ARC WELDING	TOLERANCE ±1	TIME
		MM20N21124E1	

Job Sequence

TASK 1: **Square lap joint**

- Cut the plate pieces by gas cutting as per drawing.
- Grind the gas-cut edges to square.
- Remove the grinding burrs and clean the surfaces by wire brush.
- Set the pieces in the form of a lap joint as per drawing.
- Select DCEN polarity, in case of a DC machine.

Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 3.15mm dia. medium coated M.S electrode with 100-110 amps current.

Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Wear chipping goggle for the protection of eyes.
- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Deposit the final covering run with a weave motion using a 4.00 mm dia. medium coated M.S. electrode with 150-160 amps welding current.

Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

— — — —

TASK 2**: Butt Joint**

- Square butt joint by an arc. (Flat position)
- Obtain, and clean the job pieces, as per drawing.
- Set the pieces on the welding table as butt joint with gap in alignment. (Refer to drawing.)
- Select a 3.15mm ⌀ M.S. electrode and set a 120 amps current**.**

Connect the electrode to negative, if the power source is D.C.

- Tack the pieces at both ends and also in the centre.

Ensure safety apparel is worn.

- Check the alignment of the tacked pieces, and reset, if necessary.
- Place the joint in a flat position on the welding table, well grounded. (Tacks side down.)
- Select a 4.0mm ⌀ M.S. electrode and set a 150-160 amps current.
- Deposit the first bead along the joint line with a:
  - Correct arc length
  - Correct electrode angle
  - Correct welding speed.
- Chip the slag from the bead, brush and inspect.

Use tongs to hold the hot job, chipping hammer and wire brush for cleaning, and chipping goggles for the protection of the eyes.

- Clean the back side of the first bead thoroughly and grind tacks flush.
- Deposit the second bead on this side, using the same settings.
- Chip the slag from the bead, brush and inspect for faults.
- Practice this exercise until you can produce a sound butt weld.

— — — —

TASK 3: **Tee joint**

- Obtain and clean the job-pieces as per drawing.
- Set and tack the job-pieces at both ends as 'T' joint . (Refer to drawing).
- Ensure that a ⌀ 3.15mm electrode and a 130 amps current are used. Safety apparel should be worn.
- Clean the tacks, check alignment and reset the job, if necessary.
- Place the joint on a welding table in a flat position. (Tack side down.)
- Select a ⌀ 4mm M.S. electrode and set a 150-160 amps current.
- Deposit the first bead along the joint line with a correct and uniform
  - Arc length
  - Travel speed
  - Electrode angle.

Ensure the electrode angle is 45° with the corner and 70° to 80° with the welding line in the direction of travel.

Clean the weldment and inspect for faults.

- Clean the other side of the joint and grind the tacks flush.
- Set the joint in a flat position (weld side down).
- Make a second weld along the joint line with the same setting and technique as used for the first bead.

Clean the weld and inspect for the following weld characteristics.

- Smooth and close ripple appearance. Uniform width and height equal leg lengths.
- Good fusion at the toe of the weld without undercut and overlap
- Leg length of the fillet weld equal to the plate thickness

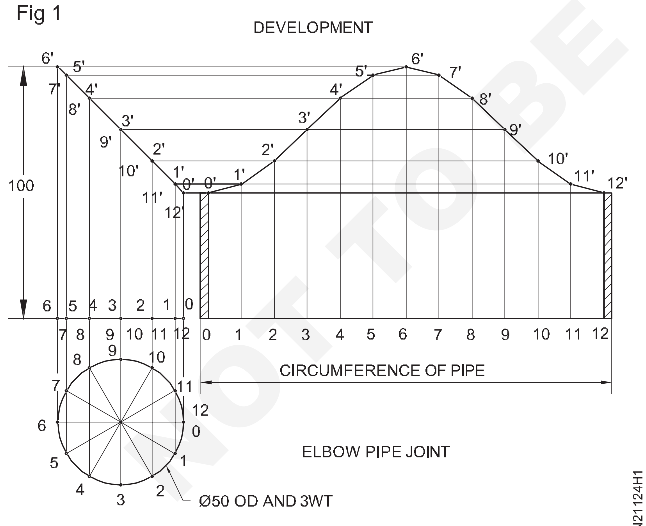
- Repeat the exercise until you can produce good welds.

— — — —

TASK 4: **Pipe joint**

- Ensure the correct size of the pipes are used.
- Draw development for an "elbow" joint. Fig 1 on a drawing sheet scale full size.

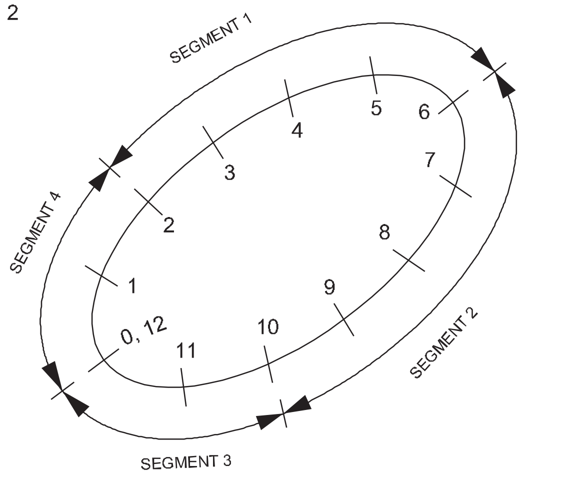
Fig 1



DEVELOPMENT OF ELBOW JOINT FOR Ø50 PIPE

- Cut the development of the pipe elbow from the drawing sheet and paste it on one end of both the 100mm long pipes.
- Make punch marks along the profile of the development on the pipes and cut the pipe along the punch marks using a hacksaw.
- Deburr the cut edges and file it to correct any irregularity on the cut edges.
- Clean the surface of the pipe of any oxide and other contaminants.
- Set and align the pipe to on angle of 90°.
- Select nozzle No. 7 and ø3mm CCMS filler rod with 0.15 kg/cm2 pressure for both gases.
- Set neutral flame.
- Follow necessary safety precautions.
- Tack weld the joints at 4 places with 1.6mm root gap and keep the joint in alignment. Check the 90° angle between the pipe axes using try square.
- Use leftward and vertical welding technique.
- Weld the joints by manipulating the blowpipe and filler rod in one run using 3mmø CCMS rod dividing the weld into 4 segments.
- The joint which will be in the form of an ellipse has to be welded in 4 segments. Fig 2 The order of sequence of welding is 2 to 6 (segment 1). 10 to 12 (segment 3) 10 to 6 (segment 2) and 2 to 0 (segment 4). This order of welding sequence will help to keep the tacked joint such that the welding is partially done in vertically upwards and partially in flat position.

Fig 2



- Ensure maintaining keyhole and ending the weld of each segment properly to get the root penetration without fail.
- Avoid excessive penetration.
- Clean the welded joint and inspect for weld defects.

Skill Sequence - 1

Setting and tacking the lap joint

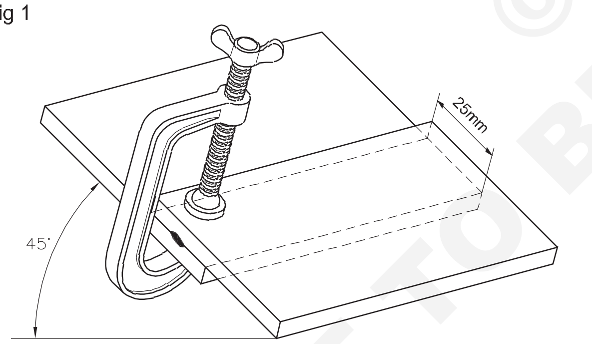
Objectives: This shall help you to
- **set the task the work project as lap joint in correct alignment**
- **weld a lap joint in a position**
- **inspect the completed lap joint.**

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. (Fig.1) Ensure the two lapping surfaces are perfectly cleaned and they contact each other properly. Use a ⌀ 3.15mm MS electrode with 120 amp current for tacking.

Fig 1



SETTING TACKING A LAP JOINT.

Set the joint in a flat position using angle iron (Fig.2).

Welding the lap fillet joint in flat position

Deposit root run with a ⌀ 3.15mm medium coated MS electrode with 100-110 amp. current.

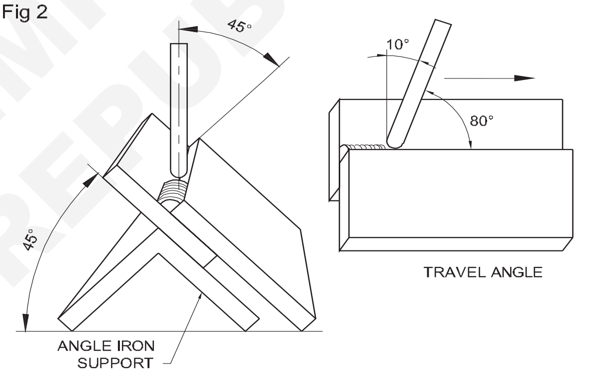
Maintain 80° angle to the line of the weld and 45° between the weld faces. (Fig.2)

Maintain a short arc to get uniform fusion and root penetration.

Avoid side-to-side movement of the electrode.

De-slag and clean the root bead thoroughly.

Fig 2



Deposit the final covering run with a ⌀ 4mm medium coated MS electrode and 160 amp current.

Give side to side movement to the electrode not more than 2.5 time its dia

Use the same electrode angles was used for the root bead

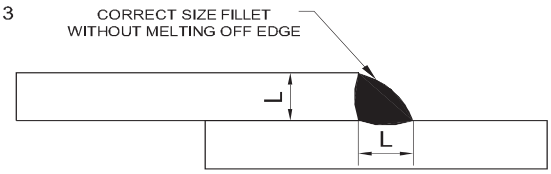
Remove the slag with a chipping hammer. Clean the weld with a steel wire brush

Inspect the lap fillet weld (Fig 2) and ensure

It has equal leg length with slight convexity

The upper edge of the plate has not melted off it is free from surface defects

Fig 3



INSPECTION OF LAP FILLET WELD

Skill sequence - 2

Square butt joint by arc flat position

Objectives: This shall help you to
- **weld a square butt joint in a flat position**
- **inspect the completed butt weld.**

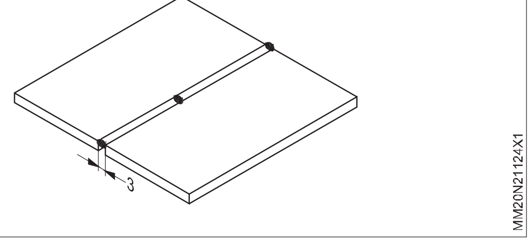
This type of joint is used very extensively in industry. If welded from both the sides (6 mm plate thickness), a sound weld can be obtained.

Setting and tacking

Set the pieces as butt joints with a 3 mm gap in a welding.

Tack at both the ends and one in the centre. (Fig 1)

Fig 1



Use a ⌀ 3.15 mm M.S electrode. Set the current 120 -130 amps and length of the tack 15 mm.

Ensure the tacks are fused.

Check the alignment after tacking and reset if necessary (Fig 2).

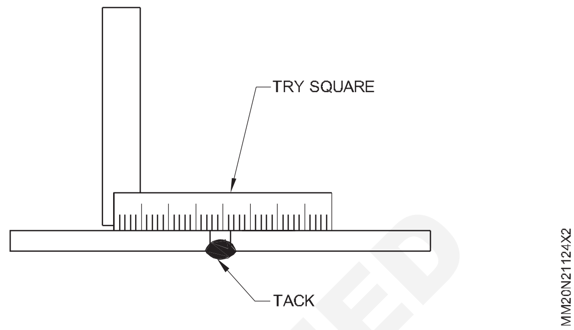
Check the tack-welds thoroughly.

Welding butt joint

Place the joint in a flat position.

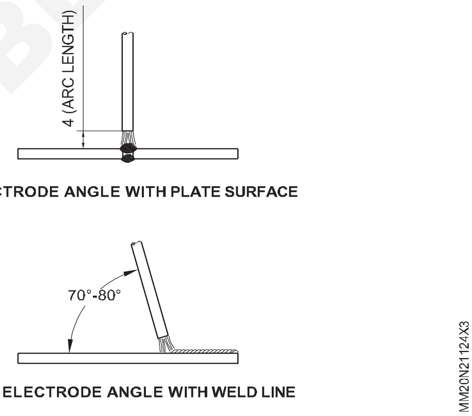
Deposit the first bead, using a ⌀ 4mm M.S. electrode and 150-160 amps current with a correct.

Fig 2



- Electrode angle
- Travel speed, and
- Arc length. (Fig 3)

Fig 3



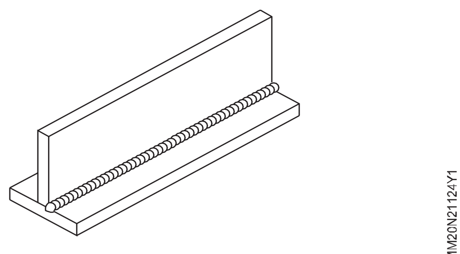
Skill sequence - 3

'T' fillet joint by arc (Flat position)

Objectives: This shall help you to
- **weld 'T' fillet joint by arc in a flat position free of distortion**
- **inspect the completed butt weld.**
- **inspect the completed butt weld.**

The weld deposited on a 'T' or lap joint is called a fillet weld. Often the 'T' joint is called a fillet joint. (Fig 1) This joint is mostly used in industrial fabrication work.

Fig 1



Setting and tacking (Fig 2)

Set the pieces in alignment, forming a 90° 'T'.

Tack the pieces at both ends.

Use ⌀ 3.15mm M.S. electrodes.

Set current at 30 amps.

Ensure the tacks are well fused having a 15 mm length.

Check the alignment after tacking.

Fig 2

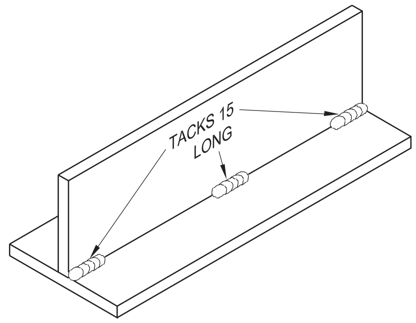


Fig 3

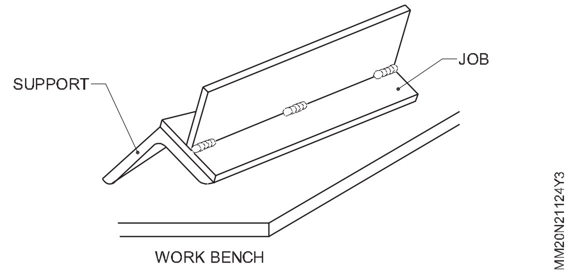
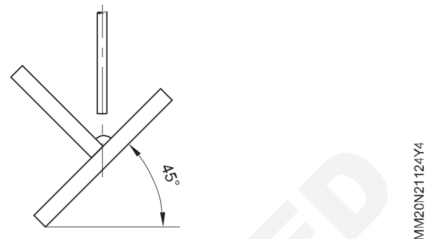


Fig 4



Welding a fillet joint

Place the joint for flat position welding. (Fig 3)

Hold the electrode, pointing at the corner of the joint at an angle of 45° to the plate surface. (Fig 4)

Skill sequence - 4

(ELBOW) Joint on MS pipe ø50×3mm wall thickness in flat position

Objective: This shall help you to

- **prepare and weld (ELBOW) joint on MS pipe ø50×3mm wall thickness in flat position.**

Fix no. 7 nozzle to the blowpipe to help in fusing both the edges of the joint (which is 3mm thick) to the full depth and get good root penetration.

Also the joint which is elliptical in shape can be welded properly with good fusion and root penetration only if the tack welded pipes are welded in 4 segments.

The segments are divided on the tacked pipe elbow joint as shown in Fig 2 under job sequence.

This division into 4 segments will help to keep the job in the required position. so that the welding is done partially by vertical welding technique and partially by flat position.

In addition, the distortion in the pipe joint due to welding can be controlled by welding the segment in the sequence 1,3,2 and 4.

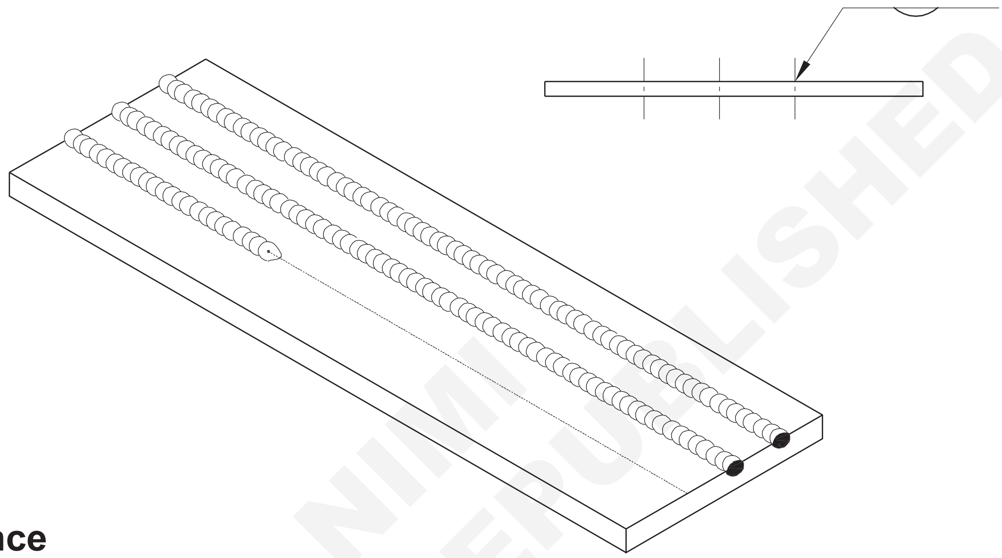
Maintaining a continuous keyhole as done in pipe square butt joint will help in getting good root penetration.

During welding fuse the tacks fully and also ensure proper fusion of edges and root of the joint of each segment.

Use the blow pipe and filler rod angles of 60° - 70° and 30° - 40° to the tangent at the point of welding. Give a very slight side to side motion to the blowpipe.

Making straight beads in gas welding

Objective: At the end of this exercise you shall be able to
- **fusion run by adding filler metal using leftward technique with correct types of flame**



Job Sequence

- Obtain the job piece as per the drawing and clean its surface.
- Set the work piece on the welding table with the left edge raised about 15mm.
- Select the nozzles size 5 (IOL make-safire type) and set the acetylene/oxygen pressure at 0-15 kg/cm2.
- Wear safety apparel and set the neutral flame.
- Hold the blowpipe at an angle of 60°-70° on a punched line of sheet and make a small molten pool at the right hand edge.

Keep a flame cone distance of 2.0 to 3.0 mm from the job surface.

- Hold the filler rod in the left hand, pointing near the molten pool with an angle of 30°-40° with the line of weld.
- Dip the end of the filler rod into the molten pool and add the filler metal on the job surface to form a weld bead.
- Move towards the left with a uniform speed along the punched line with a slight circular motion of the blowpipe and piston-like motion of the filler rod.

Add enough rod into the molten pool to build up the bead evenly in height and width.

Co-ordinate the rate of travel with the filler rod to control the size of the bead and the required penetration.

- Stop at the left edge, extinguish the flame and cool the nozzle.
- Clean the weld surface. Inspect for even ripples and uniform width/height of the weld bead.
- Repeat the exercises till you get good results.

1	160 ISF 2.5 - 50	-	Fe310	-	-	2.1.125
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	STRAIGHT BEADS IN GAS WELDING	DEVIATIONS	TIME :
		CODE NO. MM20N21125E1	

Skill Sequence

Fusion runs with filler rod on steel plate in flat position by gas

Objectives: This shall help you to
- **make fusion runs with filler rod in a straight line using leftward technique**
- **clean and inspect the element for faults.**

During gas welding, most of the joints require filler metal to obtain a proper, strong weld.

The feeding of the filler metal in the molten pool requires special skill, which is outlined here.

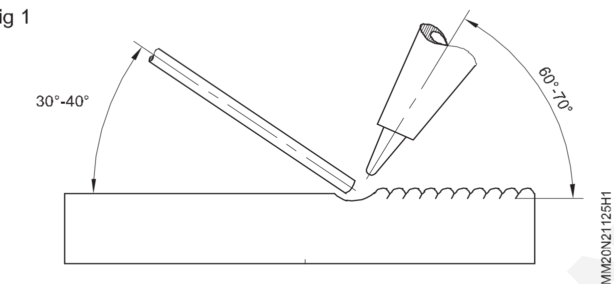
Correct position of the blowpipe and filler rod.

Hold the blowpipe and the filler rod in the correct position in respect of the job.

The blowpipe angle should be 60° - 70° with the weld line (towards right).

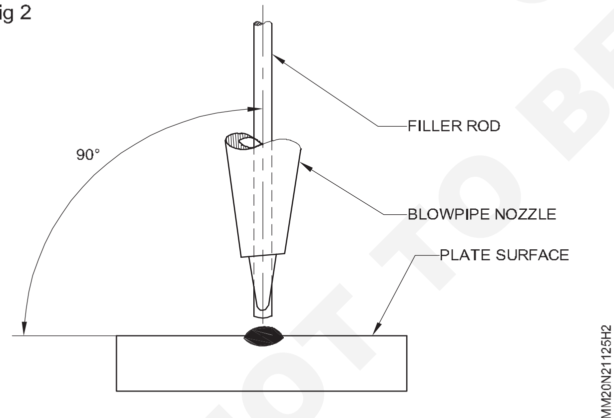
The filler rod angle should be 30° - 40° with the weld line (towards left). (Fig 1)

Fig 1



Keep the blowpipe and the filler rod at 90° to the plate surface. (Fig 2)

Fig 2



Surface fusion and filler rod addition

Fuse the metal surface and add the filler metal with proper motions circular motion for the blowpipe and piston-like motion for the filler rod. (Fig 3)

> **Maintain a flame cone distance from 2 to 3mm from the metal surface.**

Direction of welding

Move the blowpipe and the filler rod in a leftward direction along a straight line to complete the weld. (Fig 4)

Fig 3

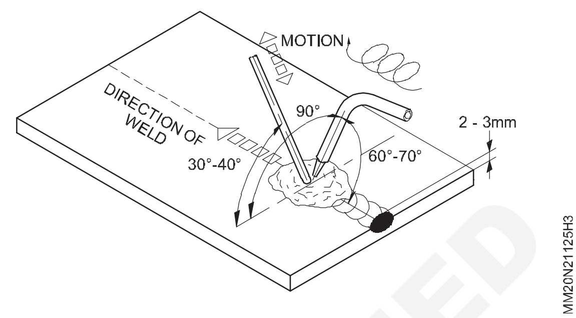
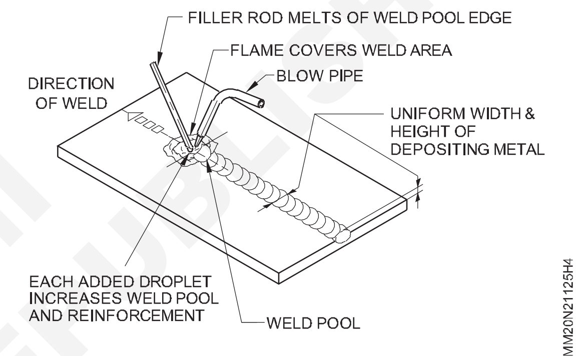


Fig 4

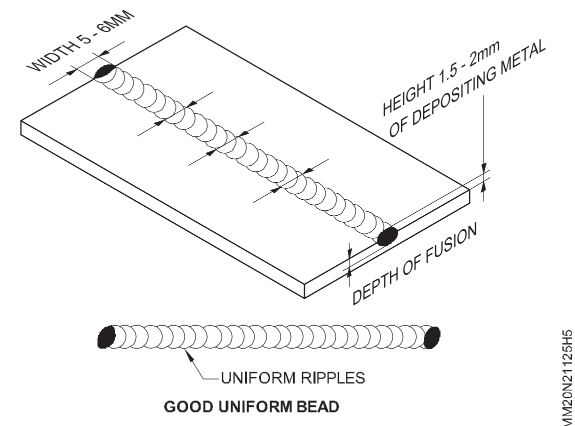


> **Maintain constant speed and the correct angle and motion of the blowpipe and the filler rod during the welding.**

Inspection of weld

Inspect the weld bead after cleaning properly with a steel wire brush, for a uniform width and height of the fused bead, uniform ripples and proper depth of fusion. (Fig 5)

Fig 5

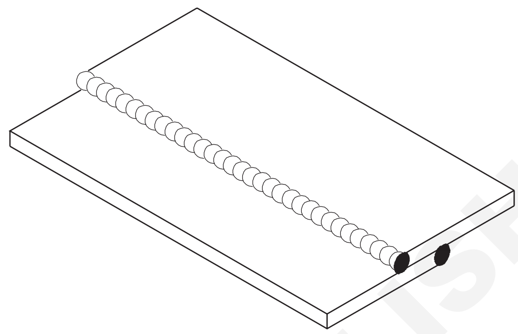


Perform Square lap joint, butt joint and tee joint by gas welding joints

Objectives: At the end of this exercise you shall be able to
- **perform square lap joint by gas welding**
- **perform butt joint by gas welding**
- **perform tee joint by gas welding.**

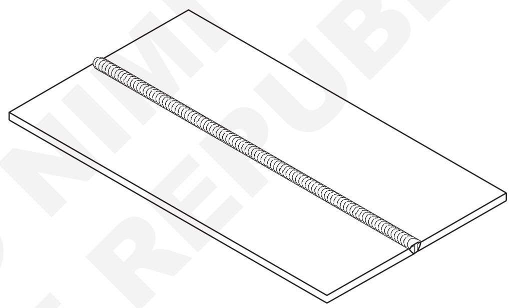
TASK - 1

Square lap joint



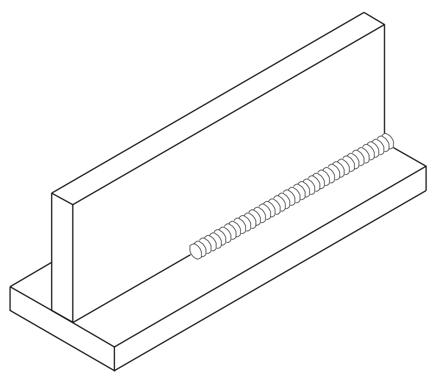
TASK - 2

Butt joint



TASK - 3

Tee joint



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 2.1.126
02	ISST 160 X 2.5-50	-	Fe310-W	-	3	-
02	ISST 160 X 2.5-50	-	Fe310-W	-	2	-
02	ISST 50 X 2.0-150	-	Fe310-W	-	1	-

SCALE NTS	WELDING JOINTS BY GAS WELDING	TOLERANCE ±1	TIME
		CODE NO. MM20N21126E1	

Job Sequence

TASK 1: **Square lap joint**

- Obtain the work pieces, clean the edges as per drawing and clean the edges.
- Set the work pieces on the welding table to form a lap joint with correct overlapping. (Refer to the drawing.)
- Set a gas welding plant, attach nozzle No.5 and set pressure of 0.15kg/cm^2 for both gases.
- Select a C.C.M.S filler rod ⌀ 1.5mm for tacking and ⌀ 3mm for welding.
- Wear safety apparel.
- Set neutral gas flame.
- Tack-weld the pieces at both ends and also in the centre.
- Check the alignment of pieces, clean the tacks and set on the welding table in a flat position.
- Start welding using the leftward technique using the filler rod.

Fuse the edges uniformly, add filler metal to obtain correct penetration and reinforcement and proceed towards the left.

Maintain correct travel speed and motion for the blowpipe and filler rod to produce a uniform weld bead.

- Stop at the left edge and fill the crater to complete the weld.
- Extinguish the flame, cool the nozzle and place the blowpipe in a safe place.

Clean the welded joint and inspect visually for:

- Correct size fillet weld.
- Shape of weldment. (slight convex uniform width and height)
- Bead formation. (uniform ripples without any surface defects)

- Weld the job from the other side also, following the above steps.
- Repeat the exercise till you get good results.

— — — —

TASK 2: **Butt joint**

- Obtain the job-pieces, clean the edges as per drawing.
- Set the job-pieces on a welding table to form a square butt joint (open) with a root gap 1.5 mm.
- Set a gas welding plant, attach nozzles No.5 and set a pressure of 0.15kg/cm^2 for both the gases.
- Select a C.C.M.S. filler rod 1.5mm ⌀ for tacking and 3.00mm ⌀ for welding.
- Wear safety apparel.
- Set the neutral flame.
- Tack the pieces at both the ends and also in the centre using a 1.5mm ⌀ filler rod. (Keep a shrinkage allowance of 2 mm)

Tacks should be well fused and penetrated.

- Check the alignment and gap between the pieces and reset, if necessary.
- Clean the tacks land reset the job on the welding table in a flat position.
- Start welding, using the leftward technique with the correct angle of the blowpipe and filler rods of ⌀ 3mm.
- Fuse the edges uniformly and add filler metal. (maintain a correct travel speed and motion of the blowpipe and filler rod, to produce a uniform weld bead.)
- Stop at the left edge, fill the crater to complete the weld.
- Extinguish the flame, cool the nozzle and place the blowpipe at a safe place.

Clean the welded joint and visually inspect for;

- a slight convex uniform width and height of bead.
- a slight penetrating bead on the reverse side of the ripples joint near the root.

- Repeat the exercise till you get good results.

— — — —

TASK 3: **Butt joint (gas welding)**

- Prepare job pieces as per drawing.
- Clean the surface and edges of the sheets to be welded.
- Set the sheets in the form of a 'Tee' joint on the welding table.
- Wear safety apparels and gas welding goggles.
- Set the gas welding plant, fix nozzle No.7 and set pressure at 0.15 kg/cm^2 for both gases.
- Set the neutral flame, tack at both ends of the joint also in the centre with a 1.6 mm C.C.M.S rod.
- Check the alignment of the joint with a try square and clean the tacked portion.
- Keep the job on the welding table in a flat position.
- Start welding with the leftward technique and melt the right hand end of the joint.
- Fuse the area to be welded (i.e. equally the part of the horizontal sheet and the vertical sheet) and apply the filler rod in the molten pool to form a fillet weld at the joint.
- Maintain correct travel speed, manipulate the blowpipe and filler rod to produce a uniform weld bead.
- Stop the weld at the left hand end of the joint after filling up the crater at the end of the weld.
- Extinguish the flame, cool the nozzle and place the blowpipe at its place.
- Clean the weld meant and inspect for defects in the fillet weld.

Visual inspection

- Slight convexity, uniform width, uniform ripples indicate a good weld bead. A weld without undercut, overlap, porosity, etc. will ensure a good quality weld.
- Weld on the other side of the joint for more practice.

— — — —

Skill Sequence

Lap fillet joint in flat position by gas

Objectives: This shall help you to
- **set and tack the job pieces for a lap fillet joint maintaining alignment**
- **produce a uniform, well penetrated fillet weld in flat position.**

Fillet joint is used extensively in industries such as fabrication of tanks, ship construction and structural works.

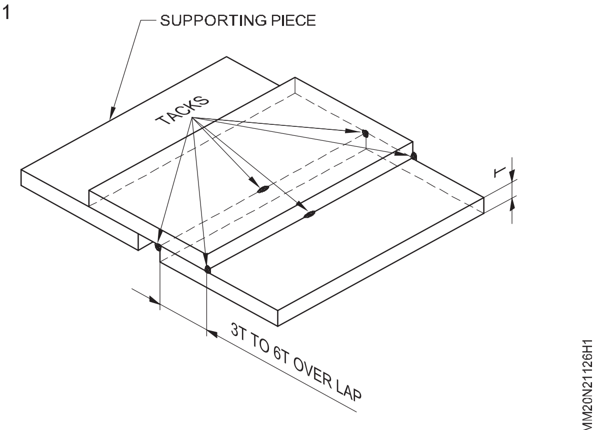
It is an economical joint and requires very little joint preparation but it is difficult to weld successfully without sufficient practice.

Penetration should be complete without undercut and without melting the edge of the upper plate.

Setting and tacking the job pieces

Set and tack the job pieces in correct alignment with overlapping as per drawing and tack-welds at correct locations. (Fig 1)

Fig 1



Welding of a fillet joint

The fillet joint should be uniform, well penetrated and of correct size.

For this purpose a proper positioning of the joint, (Fig 2) maintaining the angles of the blowpipe and filler rod and (Figs 2 and 3) manipulation of the blowpipe and the rod (leftward technique) and maintaining a uniform travel speed and feed are important.

Clean the weld meant and visually inspect for: (Fig 4)

- Uniform weld size and shape of the whole length (reinforcement and contour)
- Equality of leg length
- Undercut at the toe of the weld.
- Fusing resulting in an undersized top plate edge.
- Smooth ripple appearance.
- Unfilled crater.

Fig 2

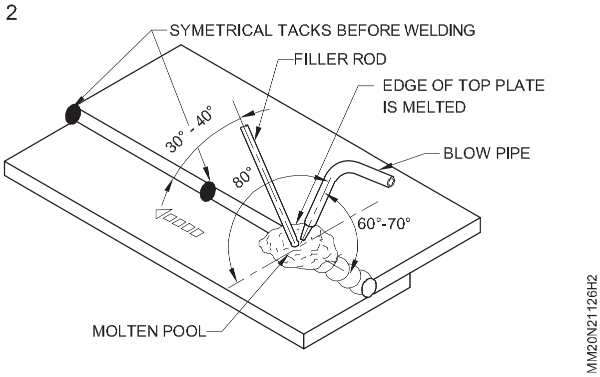


Fig 3

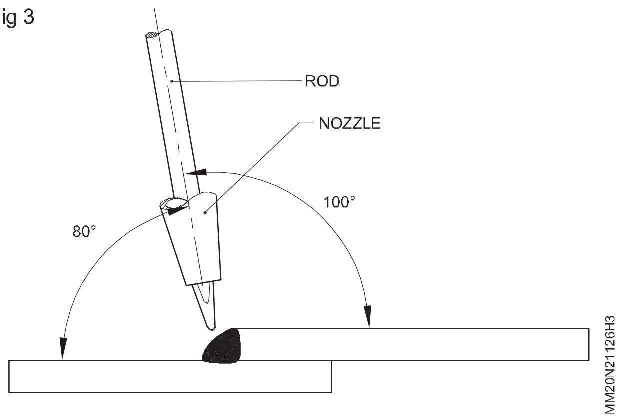
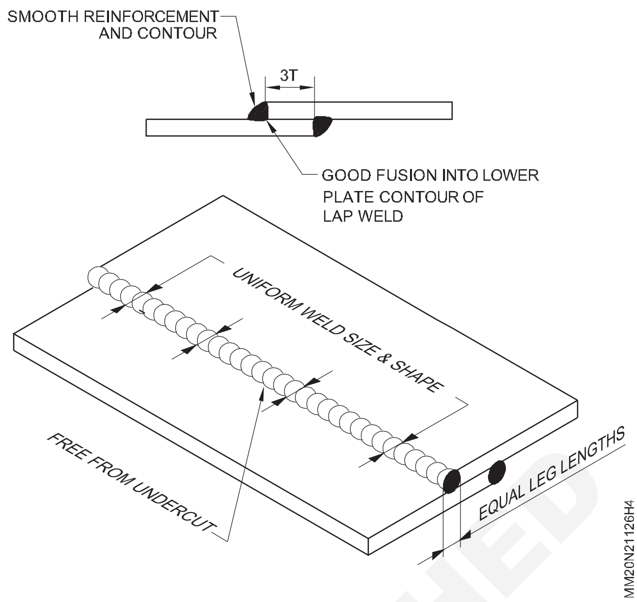


Fig 4



Square butt joint in flat position by gas

Objectives: This shall help you to
- **set and tack the work pieces in alignment for a square butt joint**
- **produce a uniform and well penetrated bead on an open square butt joint in a flat position**
- **visually inspect the completed joint.**

The requirements of a good welded joints are:

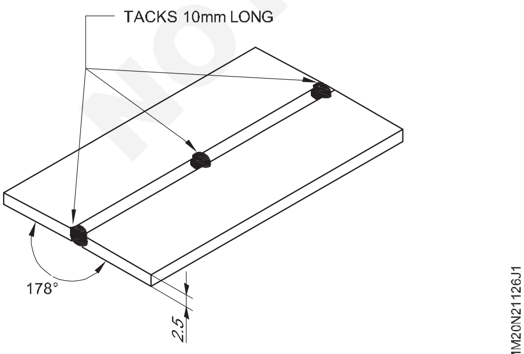
The joint must be in correct alignment (distortion free)

The weld must be well fused, well penetrated, uniform in width and height, of correct size and free from internal or external faults.

Setting and tacking

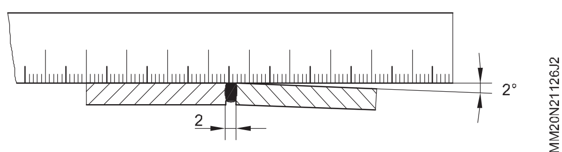
Set and tack the job-pieces in correct alignment with a proper gap and for distortion allowance. (Fig 1)

Fig 1



Check the alignment after tacking, and reset, if necessary. (Fig 2)

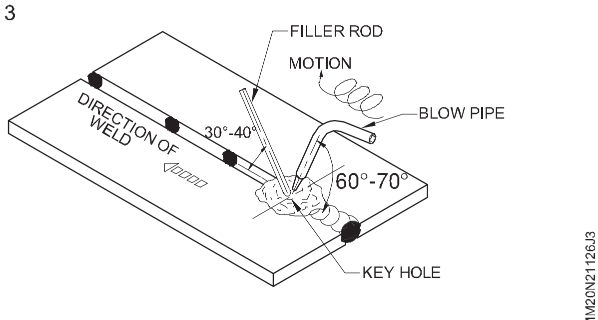
Fig 2



Welding

Produce a well-fused uniform bead with complete penetration using a leftward technique (Fig 3) by;

Fig 3



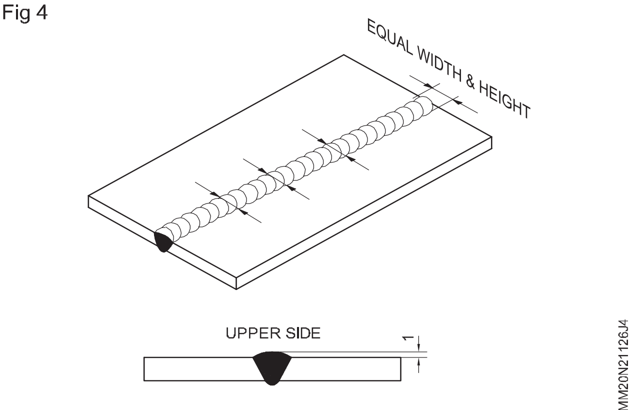
- Holding and manipulating the blowpipe and rod in the recommended angles.
- Maintain a uniform travel speed and feed.
- Forming a correct size key hole.

Finish the job.

Check alignment - remove distortion, if required, and inspect for:

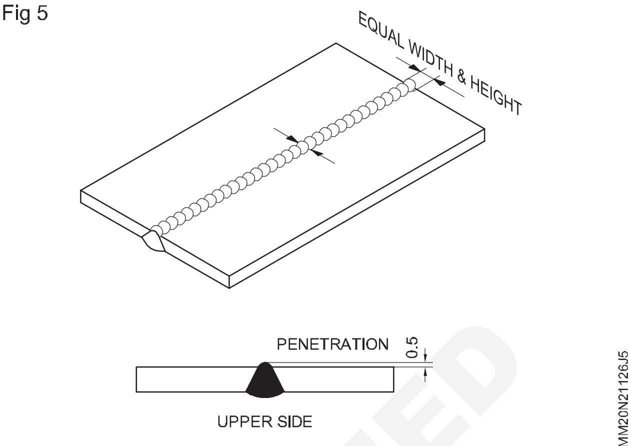
Uniform width and height of weld bead in size. (Fig 4)

Fig 4



- Uniform ripples and fusion, complete penetration. (Fig 5)
- Absence of faults such as undercut, lack of fusion, unfilled crater etc.

Fig 5



Fillet 'T' joint in flat position

Objectives: This shall help you to

- **set and tack the job pieces for a 'T' fillet joint maintaining alignment**
- **produce a uniform, well penetrated 'T' fillet in flat position**
- **inspect visually the weld meants for defects.**

'T' fillet joints are used extensively in industry i.e., fabrication of under frames, vertical supporters for oil and water containers and other similar structural work.

It is an economical joint with very little edge preparation but difficult to weld without defects (i.e. unequal leg length, undercut, etc.) unless the operator gets proper practice.

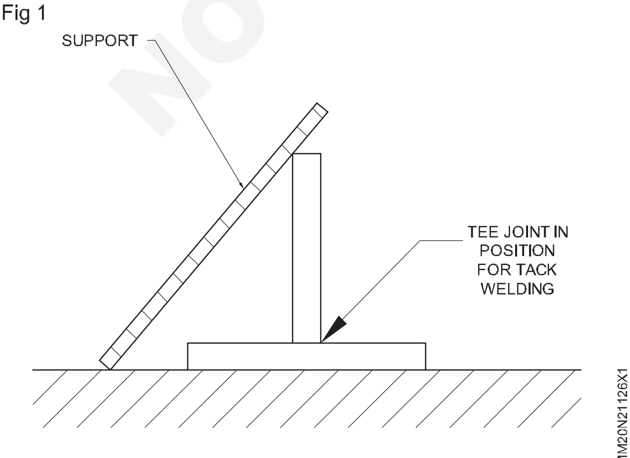
Root penetration must be obtained completely and undercut is to be avoided.

Setting and tacking the job pieces

Place the pieces on the welding table as Tee joint.

Hold the pieces in position using support. (Fig 1)

Fig 1



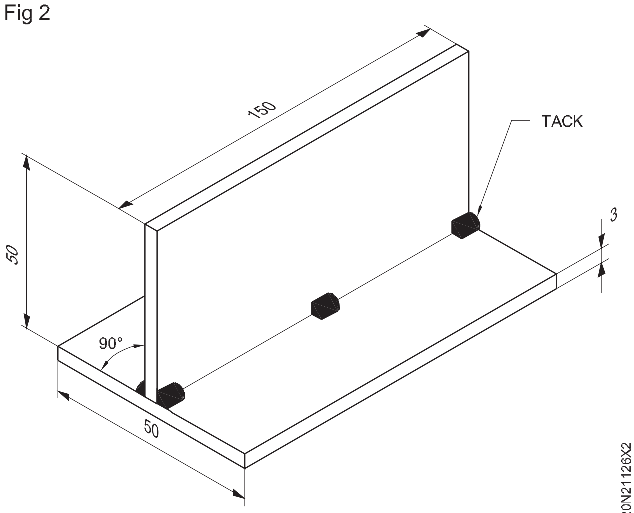
Ensure the vertical piece is perpendicular to the horizontal piece without gap of the joint.

Fillet 'T' joint in flat position

Check with a try square for perpendicularity.

Tack-weld the joint at both ends (Fig 2) on one side of the joint.

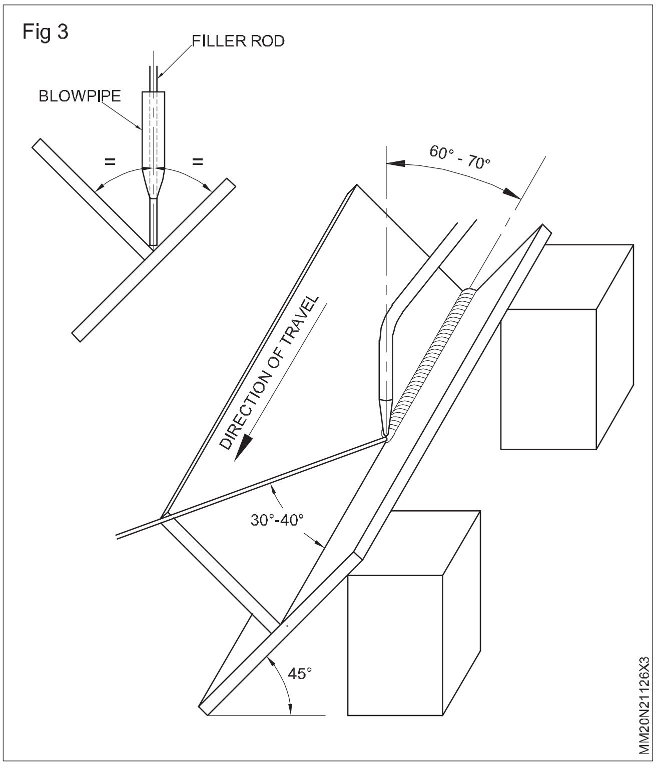
Fig 2



TACK WELDING A TEE JOINT

Welding of fillet 'T' joint in flat position (Fig 3)

Place the tacked joint in flat position by tilting and supporting it. (Fig.3)



Start welding at the right hand end of the joint by fusing the tack-weld and the parent metal to form a molten pool. Keep the blowpipe in the leftward direction at an angle of 60° to 70° and the filler rod at an angle of 30° to 40° to the line of travel. The blow pipe and filler rod should be held at 45° between the two surfaces of the joint. This will ensure root penetration. Watch the molten metal closely to make sure that both pieces melt uniformly. Change the angle of the blowpipe if the pieces do not melt uniformly. When the molten pool is formed add the filler rod in the centre of molten pool. Give slight side-to-side movement to the flame (blowpipe) and a piston like motion to the filler rod.

Adjust the rate of travel of the blowpipe and the filler rod to secure even penetration at the root and into both sheets and to produce a fillet weld of equal leg length.

Visual inspection (Fig 4)

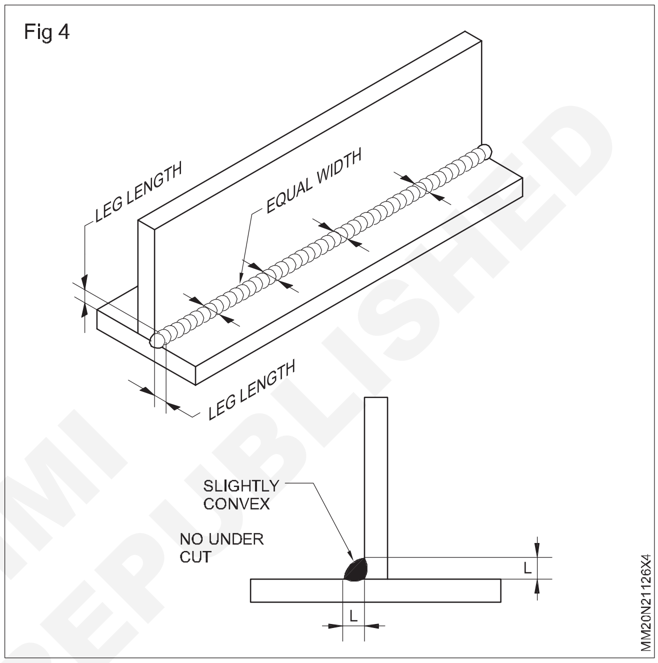
Clean the weld meant and inspect for:

– uniform weld size and shape of bead

  (reinforcement and contour slightly convex)

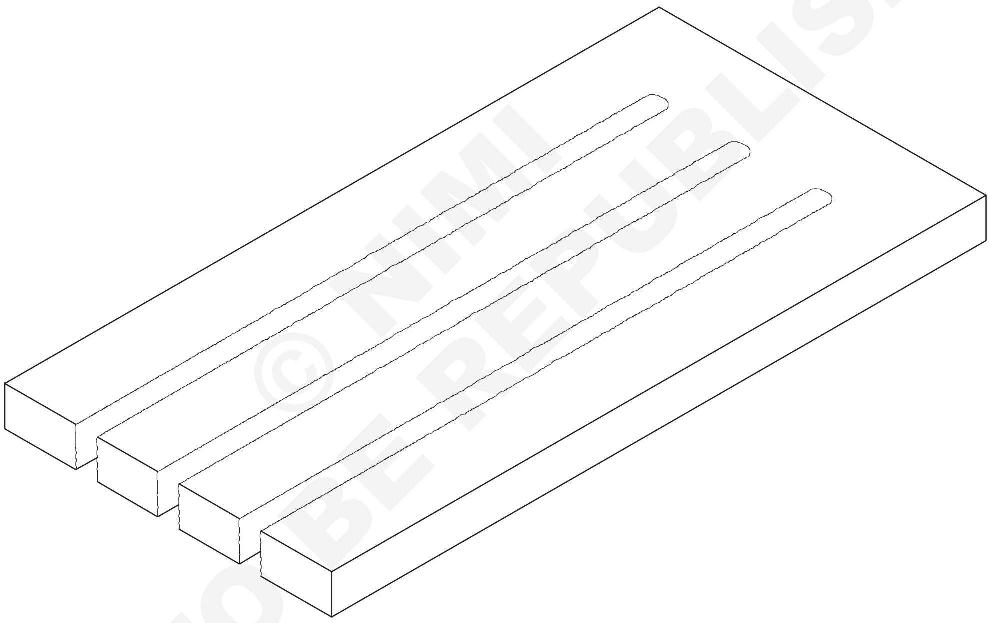
– equal leg length, no undercut at the toes of the weld.

– no porosity, overlap.



Perform gas cutting of Ms plate

Objective: At the end of this exercise you shall be able to
- **gas cutting of ms plate by adjusting the gas cutting flame.**



01	100 ISF 12-200	-	Fe310	-	-	2.1.127
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	GAS CUTTING OF MS PLATE	DEVIATIONS	TIME:
		CODE NO. MM20N21127E1	

Job Sequence

- Wear complete safety apparel.
- Set the gas welding plant with a cutting blowpipe.
- Attach the correct cutting nozzle according to the thickness of the metal.
- Adjust the gas pressure of acetylene and cutting oxygen according to the thickness of the metal and the cutting nozzle.
- Clean the surface to be cut.
- Punch a straight line.
- Adjust proper cutting flame.
- Hold the cutting blowpipe at 90° to the cut line and plate surface.
- Hold at one end of the plate on the punch line up to cherry red hot.

Keep a distance of about 5mm between the workpiece and the nozzle.

- Release the cutting oxygen and observe the cutting action.
- Move the cutting blowpipe towards the other end, following the punched line.

Maintain a correct speed and distance of the nozzle.

- Close the cutting oxygen and shut off the flame on the completion of the cut.
- Clean the cut and inspect for its accuracy.
- Repeat the exercise till a good and smooth cut is achieved.

Skill Sequence

Straight cutting along by hand

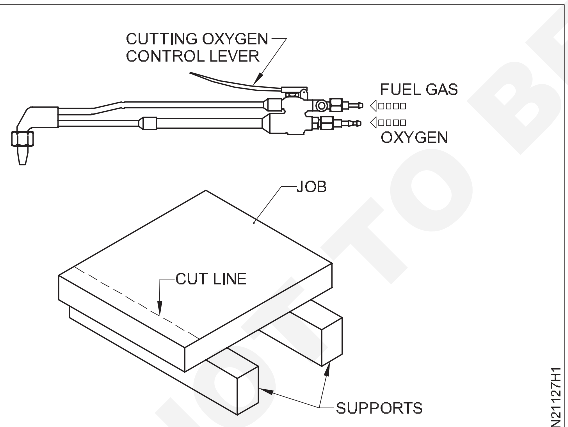
Objectives: This shall help you to
- **set an oxy-acetylene plant for gas cutting**
- **gas cut in a straight line by hand**
- **inspect the faults in a gas cut.**

Setting the gas cutting plant

Set an oxy-acetylene plant and connect the cutting blowpipe.

Setting the job for cutting (Fig 1)

Fig 1



CUTTING JOB SET ON SUPPORTS

Set the job for cutting on a rigid surface.

Provide overhang so that the parting piece is free to fall.

Ensure the underside of the cut line is free from any obstruction.

Wear safety apparel while gas cutting.

Adjusting the cutting flame

Select the cutting nozzle and set the gas pressure as per the cutting job thickness. (Table 1)

Set the cutting nozzle in the blowpipe correctly. (Fig 2)

Data for cutting - Table 1.

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	Cutting oxygen pressure
(1)	(2)	(3)
mm	mm	kg/cm2
0.8	3-6	1.0-1.4
1.2	6-19	1.4-2.1
1.6	19-100	2.1-4.2
2.0	100-150	4.2-4.6
2.4	150-200	4.6-4.9
2.8	200-250	4.9-5.5
3.2	250-300	5.5-5.6

Adjust the neutral flame for pre-heating. (Fig 3)

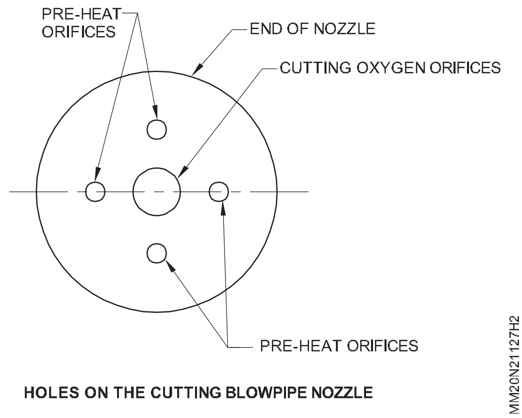
Ensure that the flame adjustment is not disturbed while operating the control lever for cutting oxygen.

Straight cutting

Hold the cutting blowpipe at 90° with the plate surface, and cut along the line. (Fig 4)

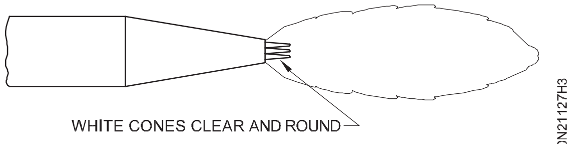
Pre-heat the starting point to red heat. (Fig 4)

Fig 2



HOLES ON THE CUTTING BLOWPIPE NOZZLE

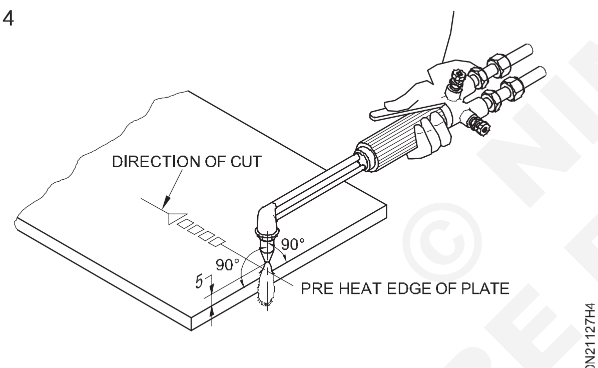
Fig 3



CORRECT FLAME ADJUSTMENT FOR CUTTING

Keep the distance between the workpiece and the nozzle about 5mm to avoid backfire. (Fig 4)

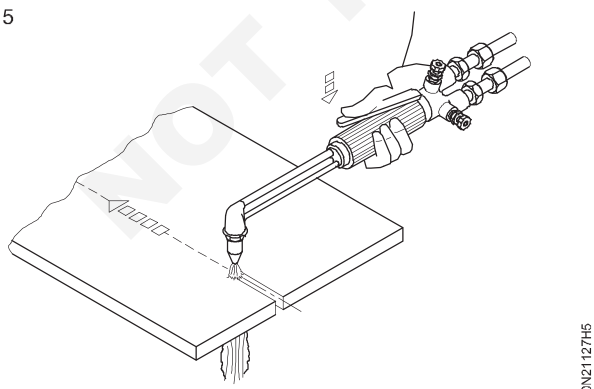
Fig 4



STARTING OF CUT

Release the extra oxygen, observe the cutting action and start travelling along the punched line at a uniform speed. (Fig 5)

Fig 5



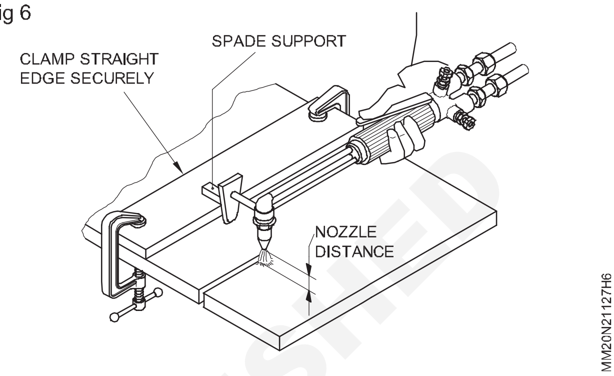
CUT IN PROGRESS

While gas cutting ensure

Straight travel of the cutting blowpipe without side-to-side movement and correct nozzle position with the plate surface till the cutting oxygen valve is fully open.

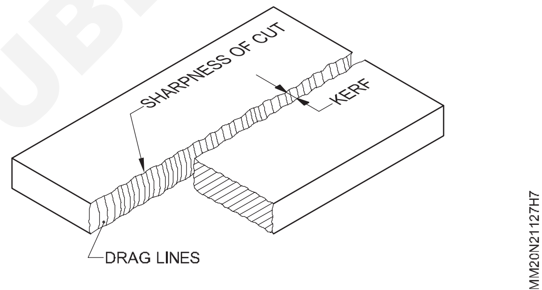
If possible, fix the straight edge to the plate and also the spade support to ensure a straight cut (Fig 6) and to maintain correct nozzle distance.

Fig 6



Inspection of gas cut (Fig 7)

Fig 7



Clean the gas cut with a chipping hammer, chisel and wire brush.

Inspect for uniform

1 Smooth cut or drag lines

2 Straightness of cut

3 Sharpness of cut

4 Width of cut

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**
- **ensure safety for personal and machine.**

Instructor shall arrange video locally and demonstrate to the trainees on safety procedure in the hydraulic system.

1 Three Kinds of hazards
   - Burns from hot
   - High pressure fluid
   - Cuts or abrasions from hydraulic lines

2 Relieve the pressure before the work begins

3 Pin hole leak injuries

4 Improper compiling

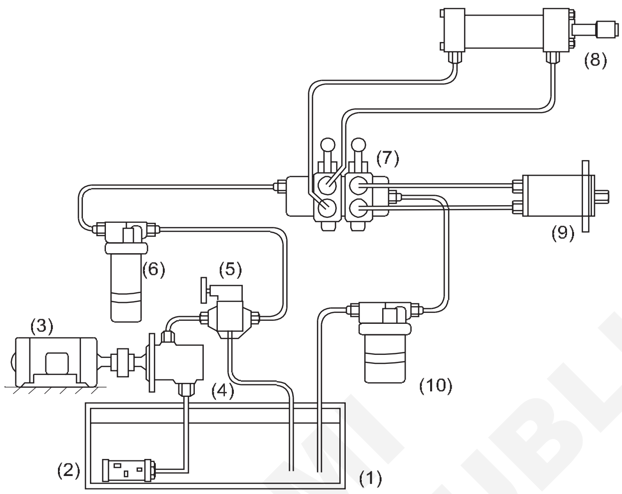
5 Maintenance
   - periodical checking of oil lines and work hoses
   - replace contaminant oils & filters
   - prevent cylinder rods from rusting

6 Safe hydraulic operations

Identify hydraulic components - Pumps, Reservoir, Fluids, Pressure Relief Valve (PRV), Filters, different types of valves, actuators and hoses

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.**

Fig 1



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	Symbols
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

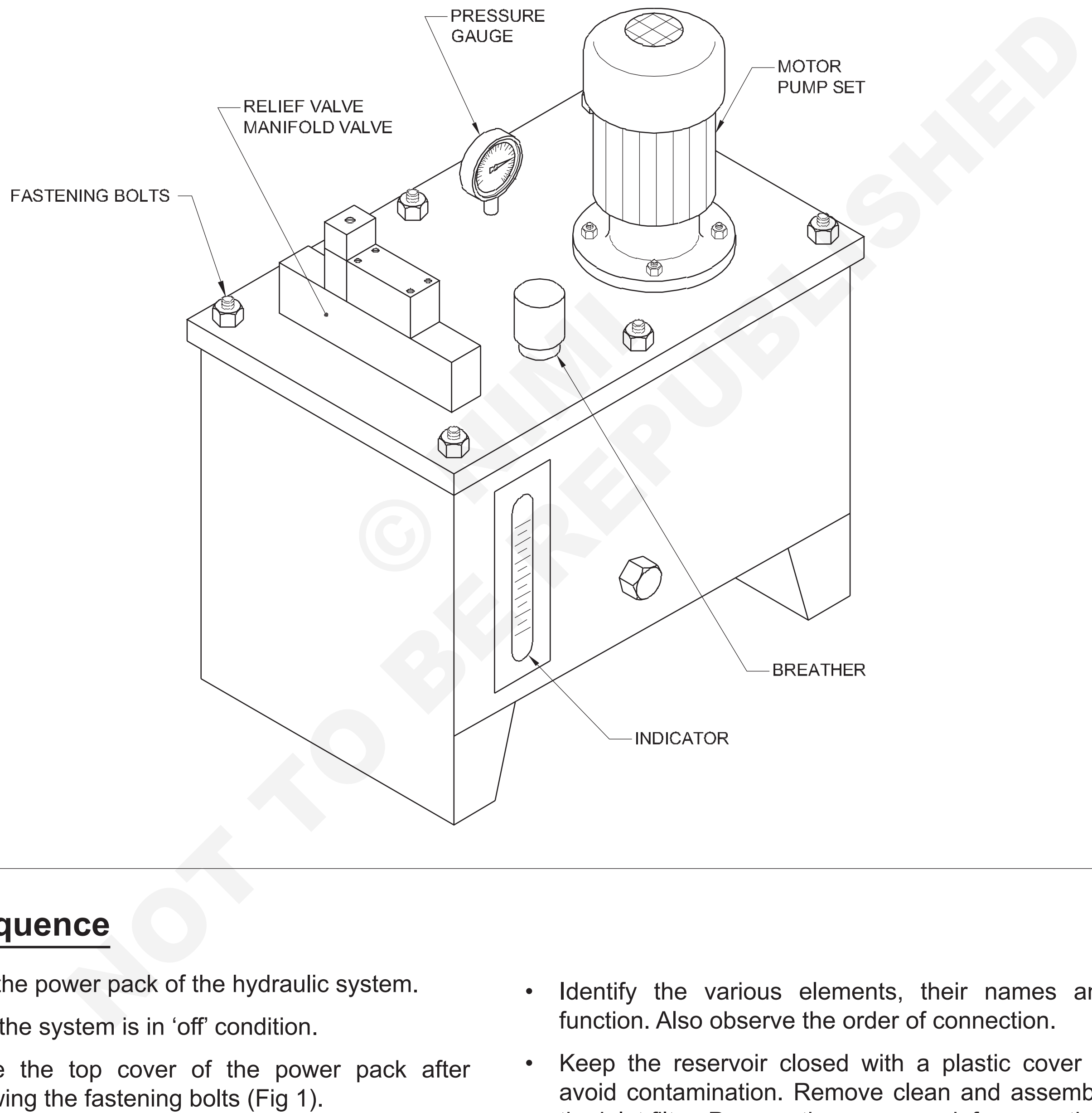
- Get it checked by your instructor.

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.**

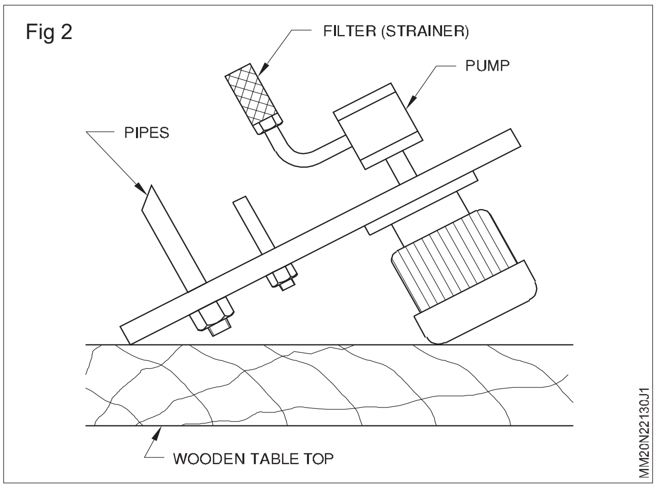
Fig 1

TASK 1



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 filter cartridge (Fig 1), wipe at the excess sludge collected on the filter.

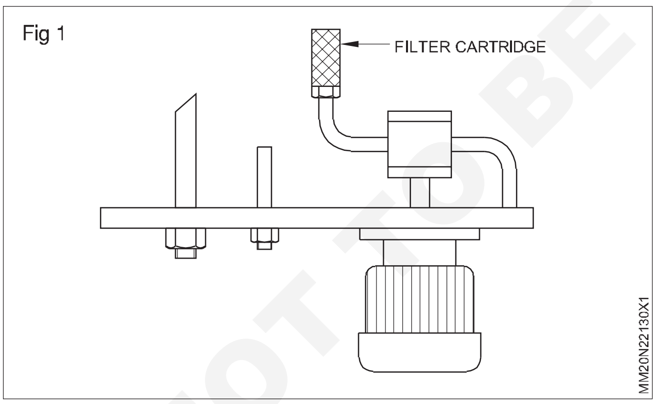
Soak it in kerosene and remove the sludge.

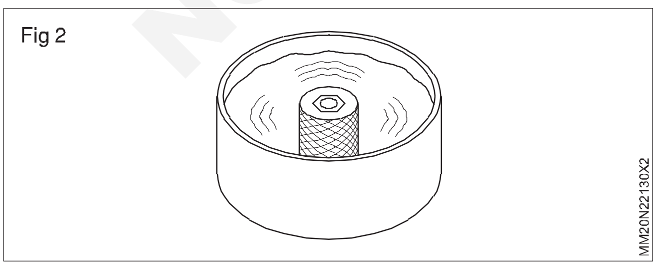
Flush the strainer with clean kerosene (Fig 2)

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.

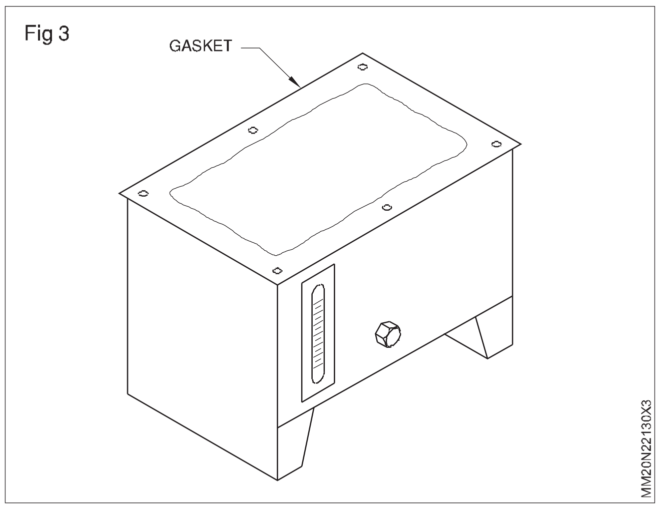
While replacing new strainer, care should be taken to select the correct strainer.

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.



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)

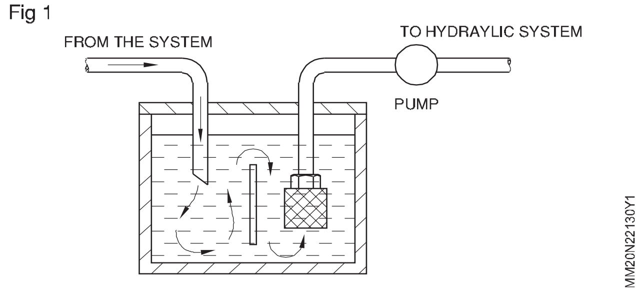


Fig 1

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)

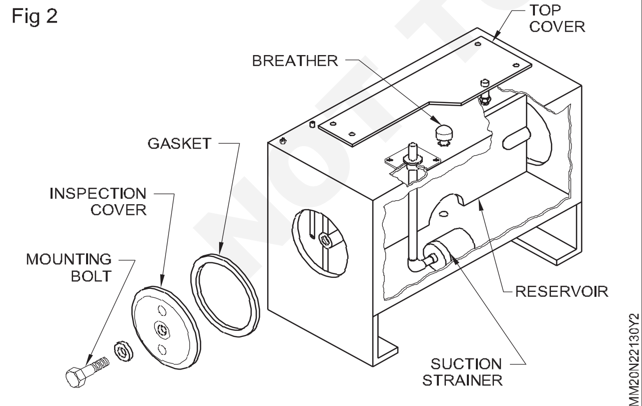


Fig 2

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)

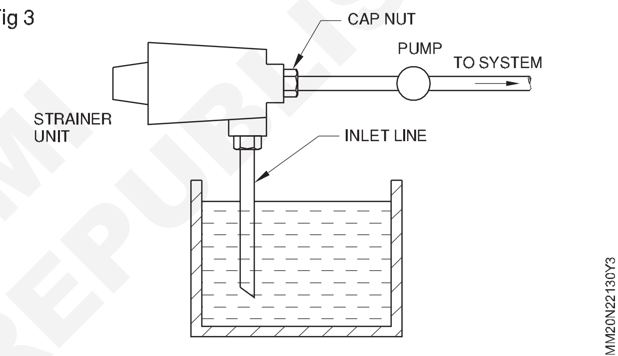


Fig 3

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 bench vice 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.

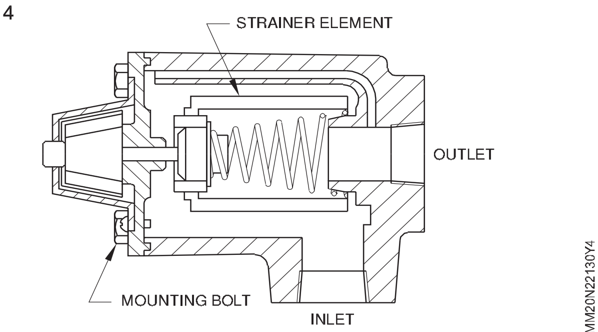


Fig 4

Identify pneumatic components - Compressor, Pressure gauge, Filter - Regulator- Lubricator (FRL) unit - Different types of valves and actuators

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

TASK 1**: Identification of compressor part**

Instructor shall arrange and show the compressure to trainees and give demo explaining all the parts. Ask the trainee to record in the Table 1.

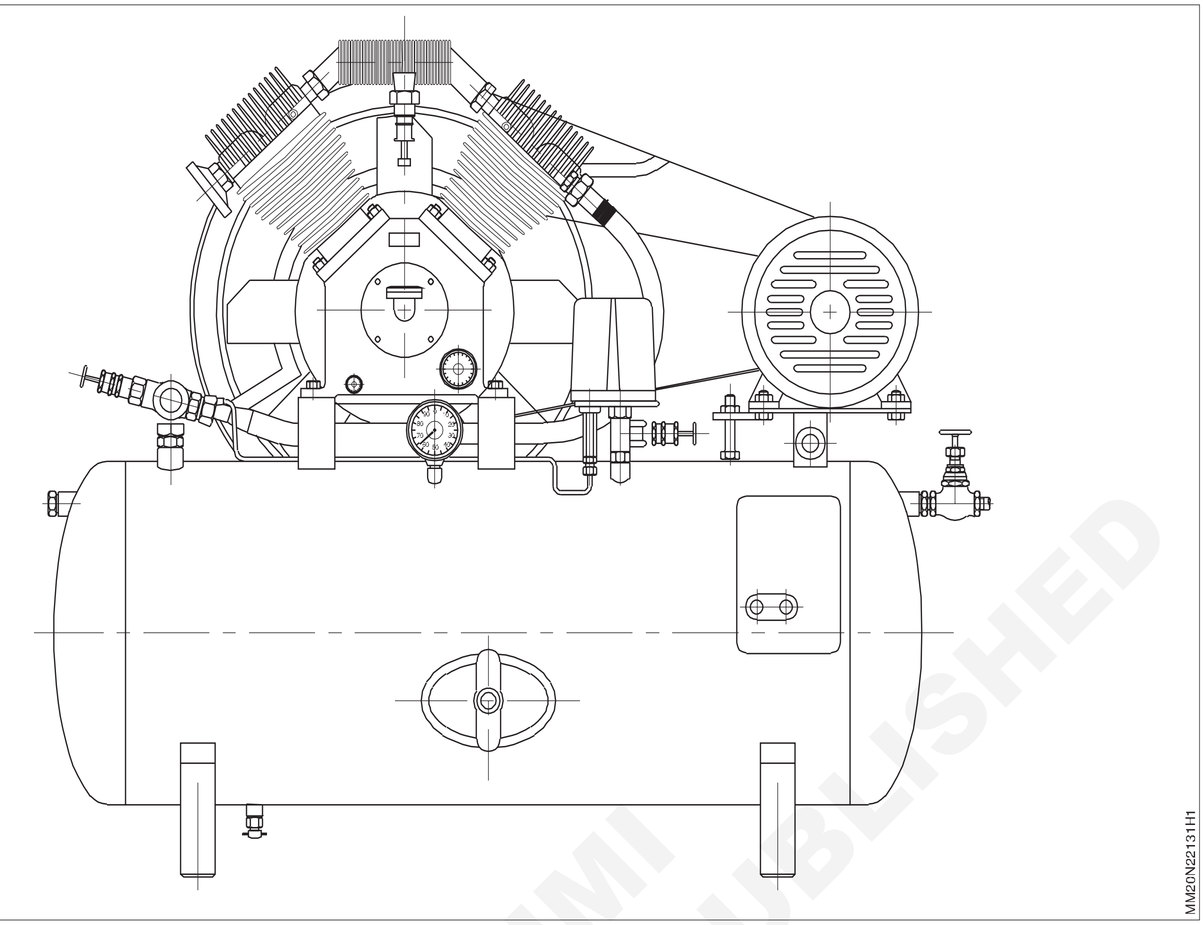
- Observe the compressor.
- Identify the parts.
- Record the parts name in Table 1.

Table 1

Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

- Get it checked by your instructor.

Fig 1

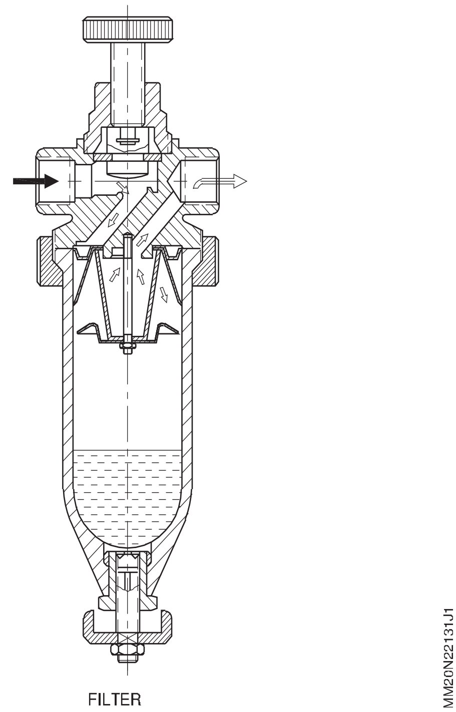


TASK 2: **Identification of Parts of FRL unit**

Instructor shall arrange and circuit a hands - on demonstration with an actual FRL unit. Instruct them to label the parts on a diagram or record in the Table 2.

- Point out each part and explain the function.
- Identify the parts.
- Record the parts name in Table 2.

Fig 1



FILTER

Table 2

Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

- Get it checked by your instructor.

TASK 3**: Identification of valves**

Instructor shall arrange and conduct a hands - on demonstration with an actual two valves. Instruct them to label the parts on a diagram or record in the Table 3.

- Point out each part and explain its function.
- Identify the parts.
- Record the parts name in Table 3.

Fig 1

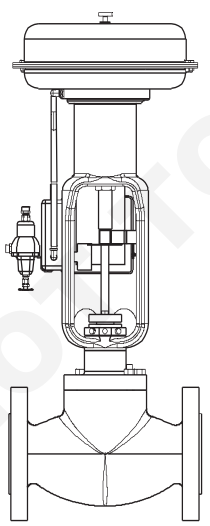


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Fig 2

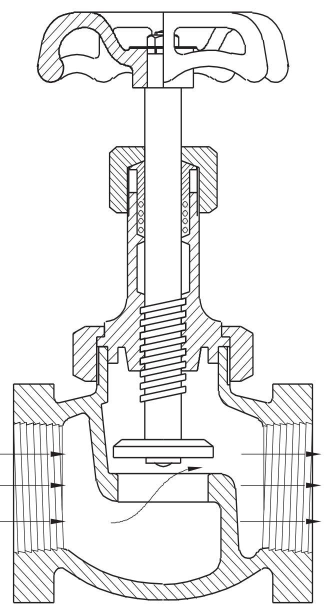

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Table 3

Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	

— — — —

TASK 4**: Actuators**

Instructor shall arrange and conduct a hands - on demonstration with an actual two valves. Instruct them to label the parts on a diagram or record in the Table 3.

- Point out each part and explain its function.
- Identify the parts.
- Record the parts name in Table 4.

Fig 1

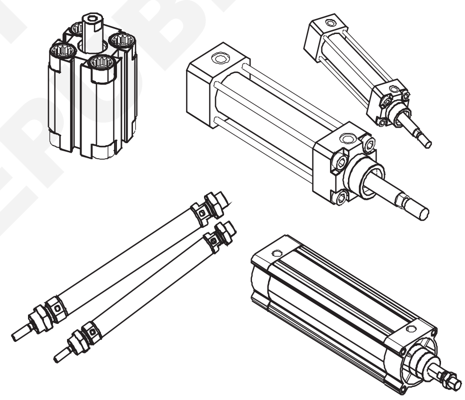

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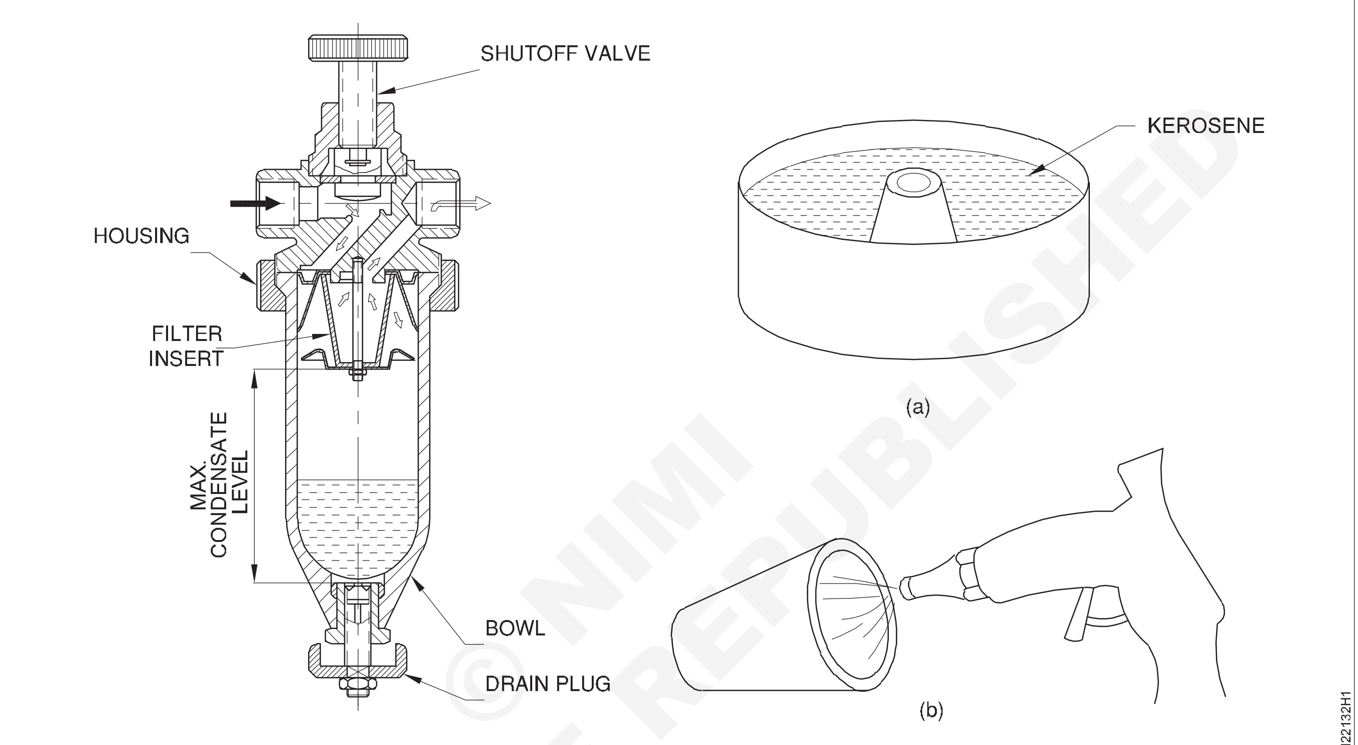
Table 4

Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	

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.**

Fig 1



FILTER

Job Sequence

- Overhauling a filter of FRL unit and Lubricator.
- Drain the water from the filter unit. (Fig 1)
- Hold the FRL unit in a bench vice in a horizontal position between soft jaws.
- Drain water from lubricator, by rotating drain plug. (Fig 1)
- 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 (Fig 1a).
- Blow the inner side of filter using compressed air (Fig 1b).
- 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 it position tightly.

Open the inlet valve.

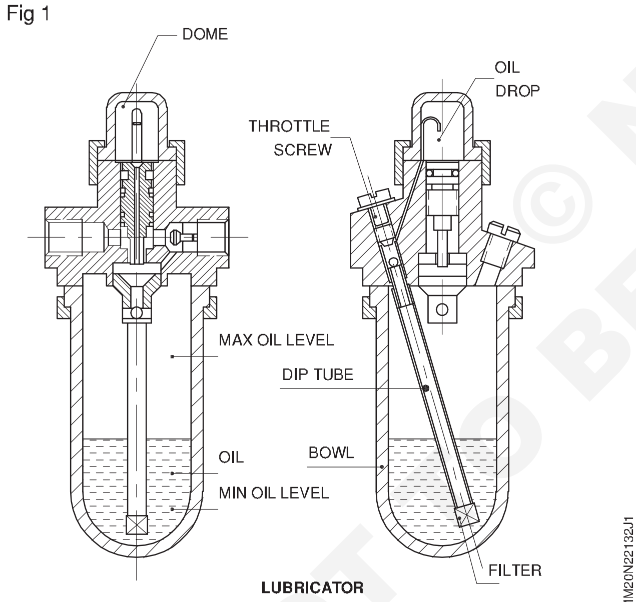
Observe the pressure gauge.

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)

Fig 1



Mounting and reading of pressure

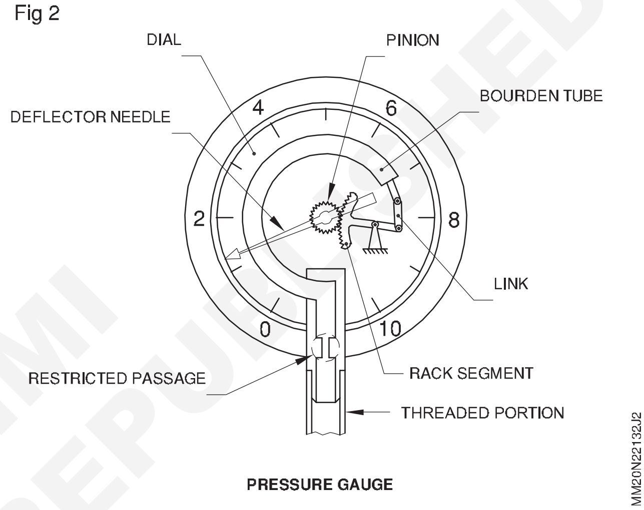
Mount the FRL unit on the trainer kit.

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.

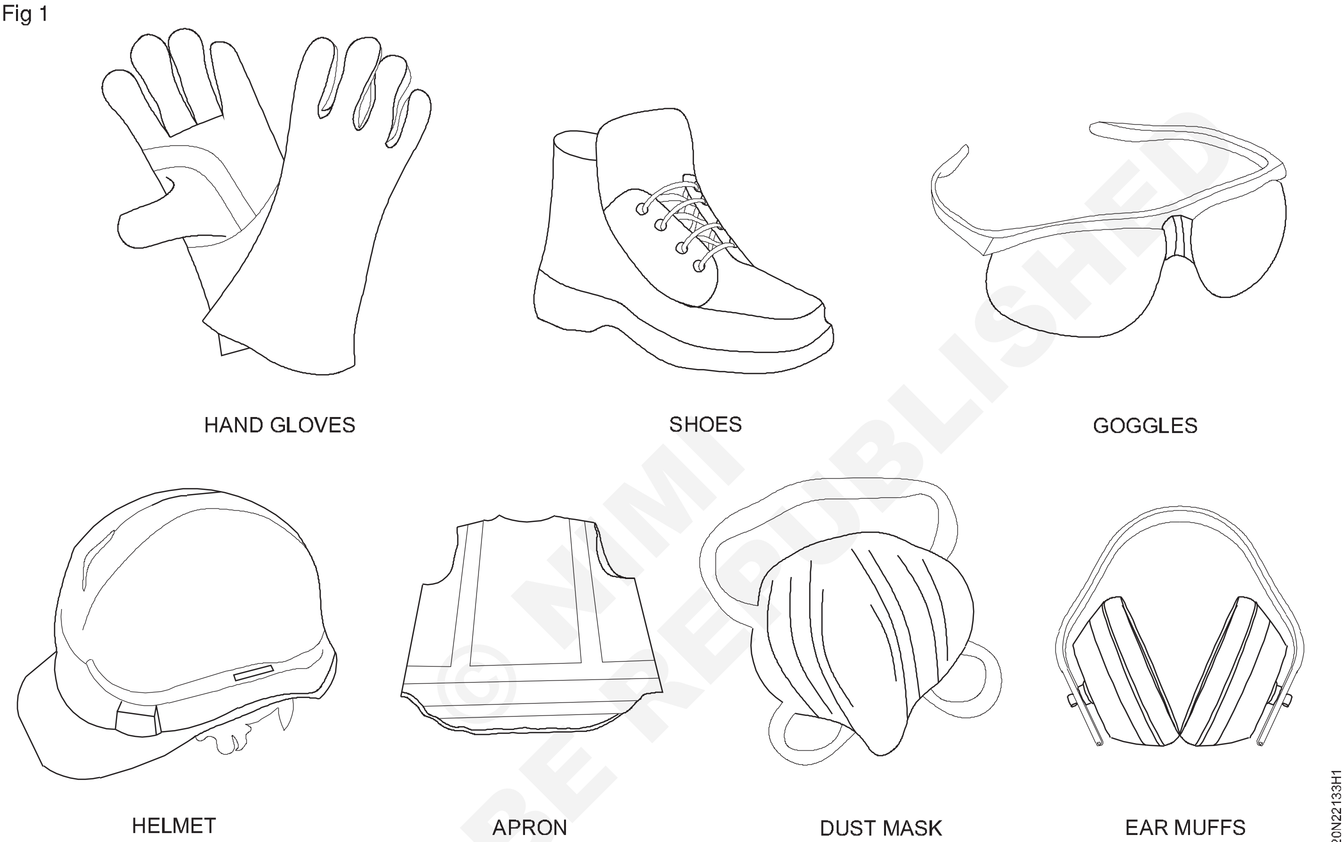
Fig 2



Demonstrate knowledge of 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.**

Fig 1



Job Sequence

- Should not operate pneumatic machine without knowledge.
- Protect your self 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 person 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 personal protective equipment.

Identify the parts of a pneumatic cylinder

Objectives: At the end of this exercise you shall be able to
- **identify pneumatic 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

Fig 1

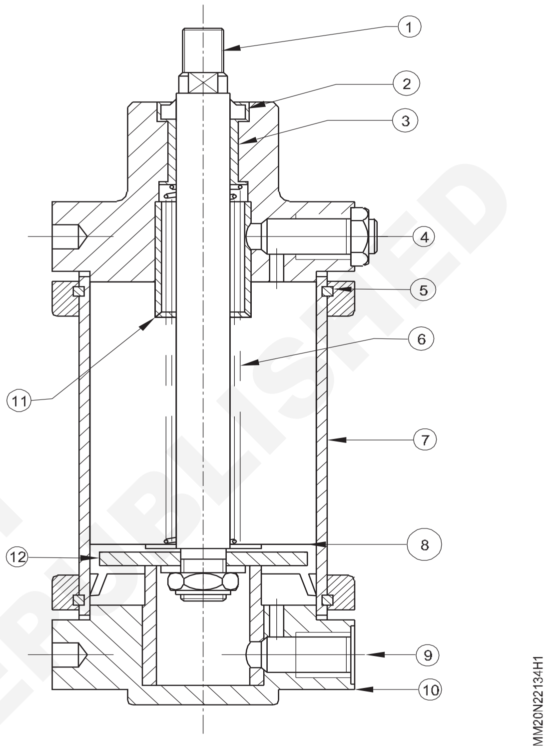


Table 1

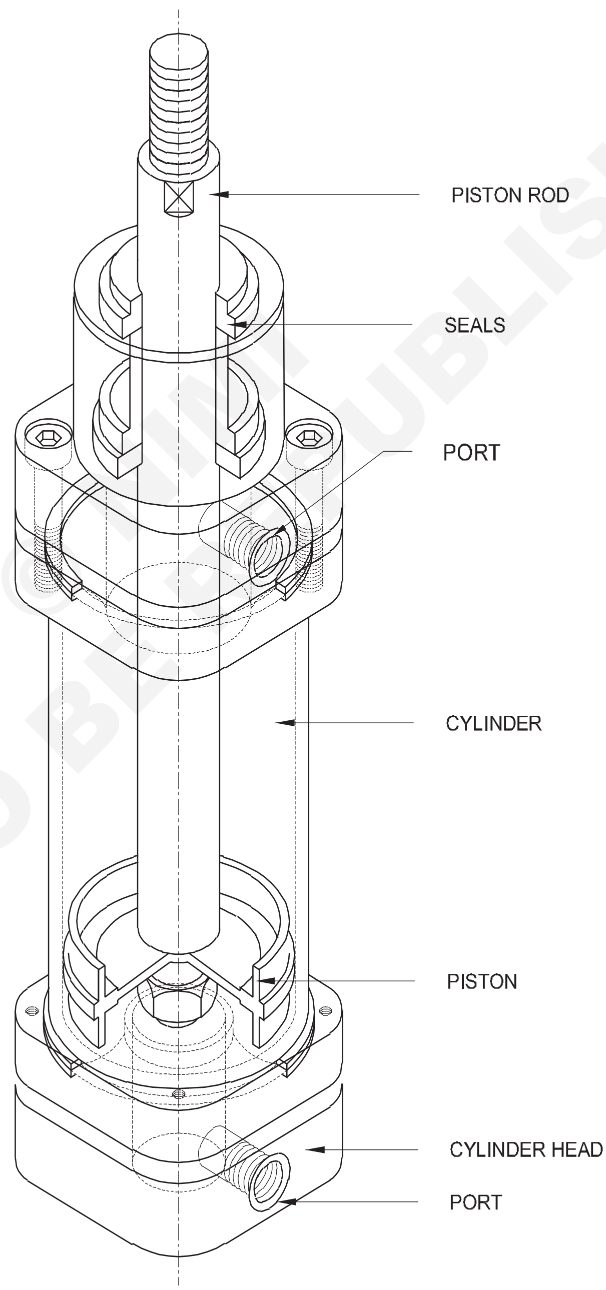
Serial No	Part Name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

- Get it checked by your instructor.

Dismantle and assemble a pneumatic cylinder

Objectives: At the end of this exercise you shall be able to
- **dismantle the pneumatic cylinder**
- **clean and inspect the parts for worn out and damage parts**
- **assemble the pneumatic cylinder**
- **test the cylinder for proper function.**

Fig 1



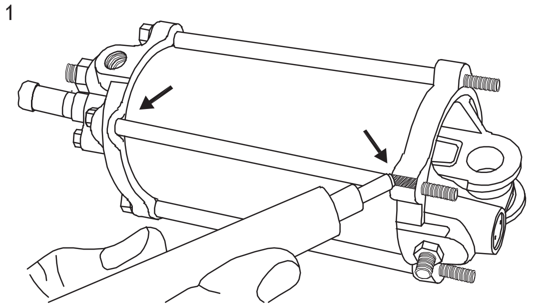
CYLINDER

Job Sequence

Disassembly

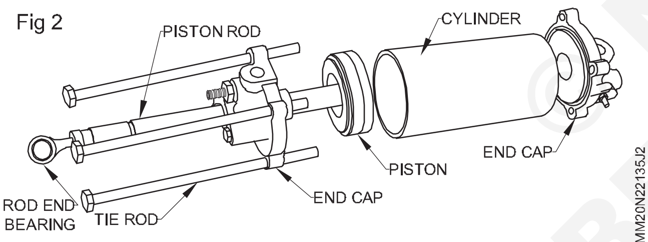
- Disconnect air and electrical connections to the cylinder assembly and remove the cylinder from machine.
- Remove and retain air lines and any other accessory items(solenoid valve, flow controls, etc.) from the cylinder assembly.
- Scribe an index mark on both end caps to show orientation to each other. These marks will assist when re-assembling the cylinder (Fig 1).

Fig 1



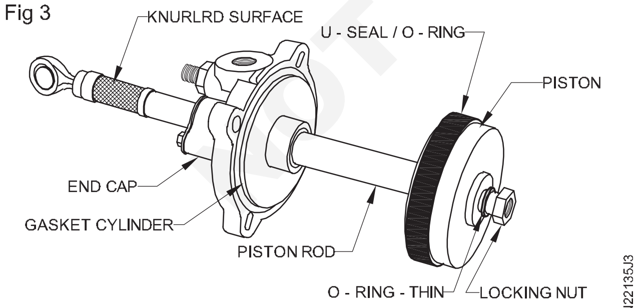
- Remove and retain all the rod nuts, lock washers and tie rods from the cylinder end caps. Remove the end caps from the cylinder tube and discard the cylinder gaskets. (Fig 2).

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)

Fig 3

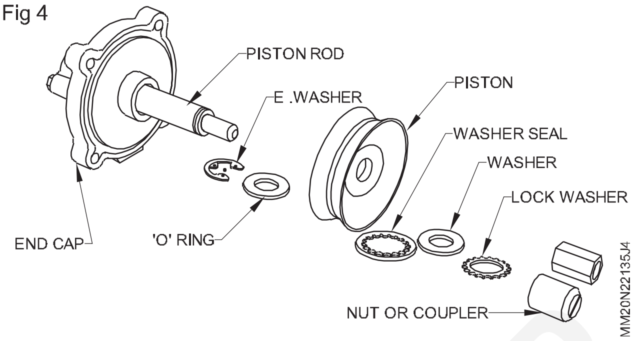


TYPES OF BEARING LOADS

- **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-washer and miscellaneous hardware from the piston rod and pull the front end cap from the piston rod (Fig 4).

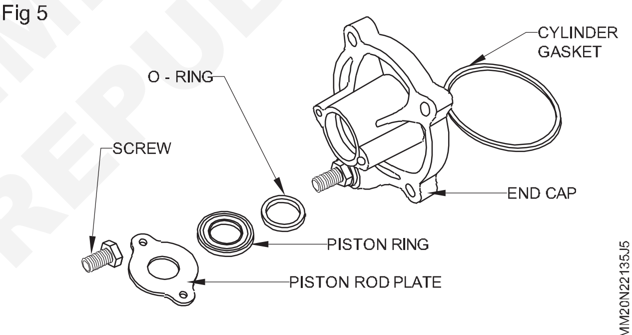
Fig 4



Prior to removing the end cap, remove any burrs or nicks from the piston rod surface with fine emery cloth (400 grit). Remove dust emery by before removing the front end cap.

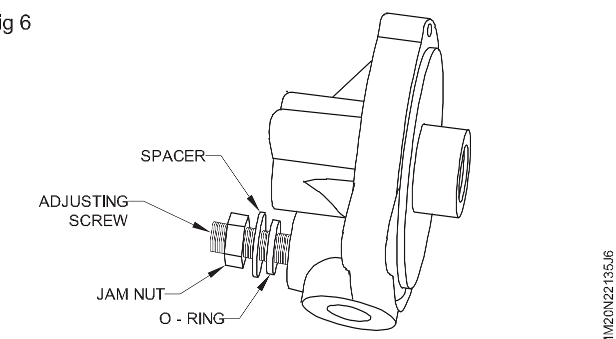
- Remove and retain the two screws, lock washers and the piston rod plate from the front end cap. Remove and discard the packing ring and the O-ring (Fig 5).

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)

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.
- Pneumatic source - 1 No.

Material / Component

- P U Tube - as req
- Paper - as req.
- Pencil - as req
- Single Acting Cylinder - 1 No
- 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.

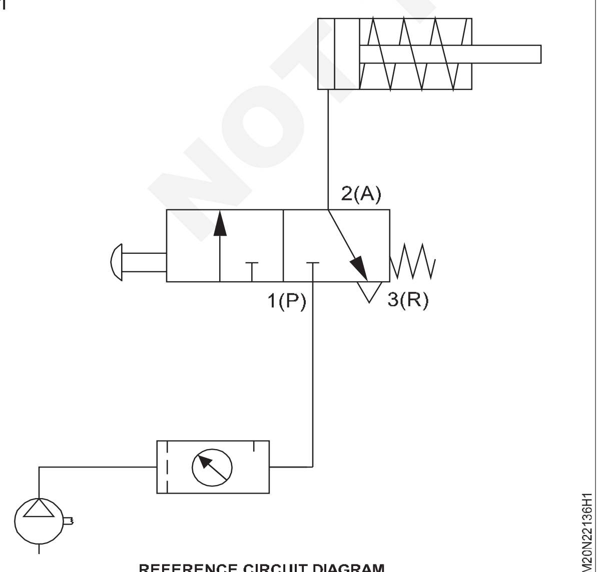
The instructor shall arrange trainer board with components mentioned

Component	Symbol
Pneumatic Source	
Single Acting Cylinder	
3/2 Way valve	
FRL	

— — — —

TASK 2**: Redraw circuit diagram, Indicate components with arrow and explain functions.**

Fig 1



REFERENCE CIRCUIT DIAGRAM

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 the table**

Action	Expected result	Confirm result (put)
Press push button Release push Button	Piston moves forward Piston retracts	

Conclusion

Conclusion drawn	Remarks
Motion of single acting cylinder can be controlled by 3/2 way valve.	

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 single acting cylinder using 5/2way valve**
- **draw circuit diagram**
- **check function of the circuit.**

Requirements

Tool/ Instrument/ Equipment/ Machines

- Trainer board - 1 No.
- Pneumatic source - 1 No.

Material / Component

- P U Tube - as req
- Paper - as req.
- Pencil - as req
- FRL - 1 No
- 5/2 way valve - 1 No

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.

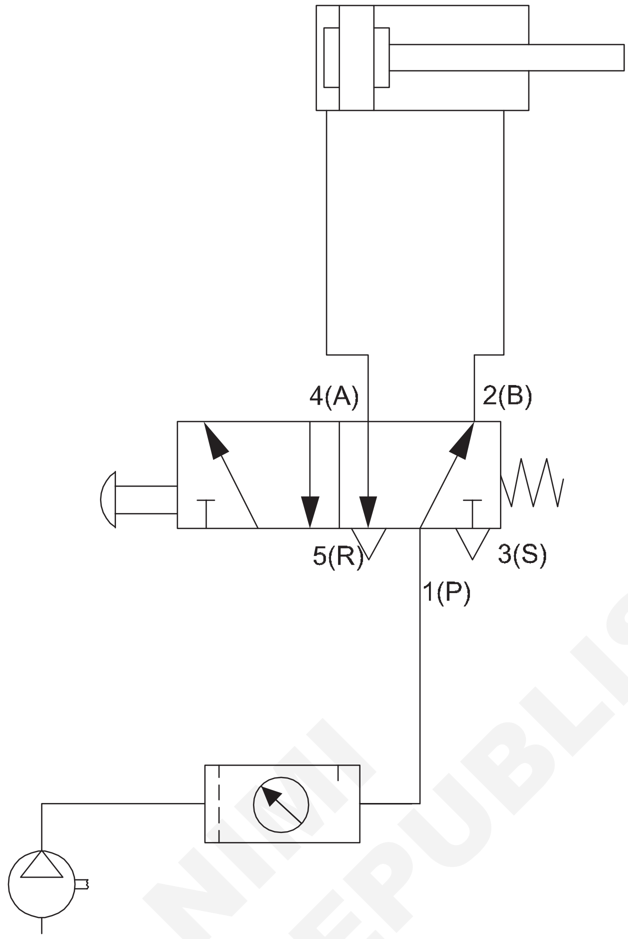
The instructor shall arrange trainer board with components mentioned

Component	Symbol
Pneumatic Source	
Single Acting Cylinder	
3/2 Way valve	
FRL	

— — — —

TASK 2: **Draw circuit diagram. (Fig 1)**

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 Release push button	Piston moves forward 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

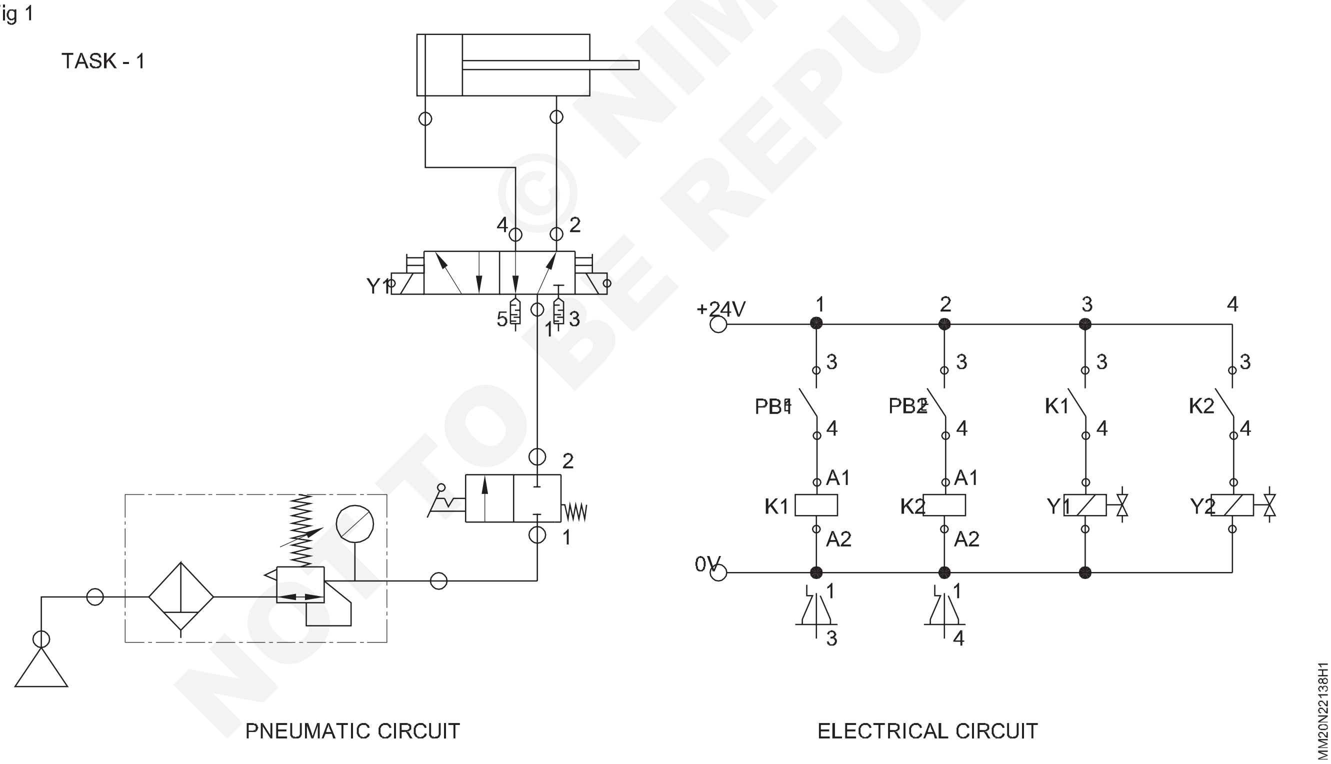
Objectives: At the end of this exercise you shall be able to
- **construct a circuit**
- **select the component**
- **assemble the circuit on the trainer board**
- **check the function of the circuit.**

Requirements	
Tool/ Equipment/ Machines / Component	
• Double acting cylinder • 5/2 DC double solenoid valve (y_1 y_2) • Shut - off value	• 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**

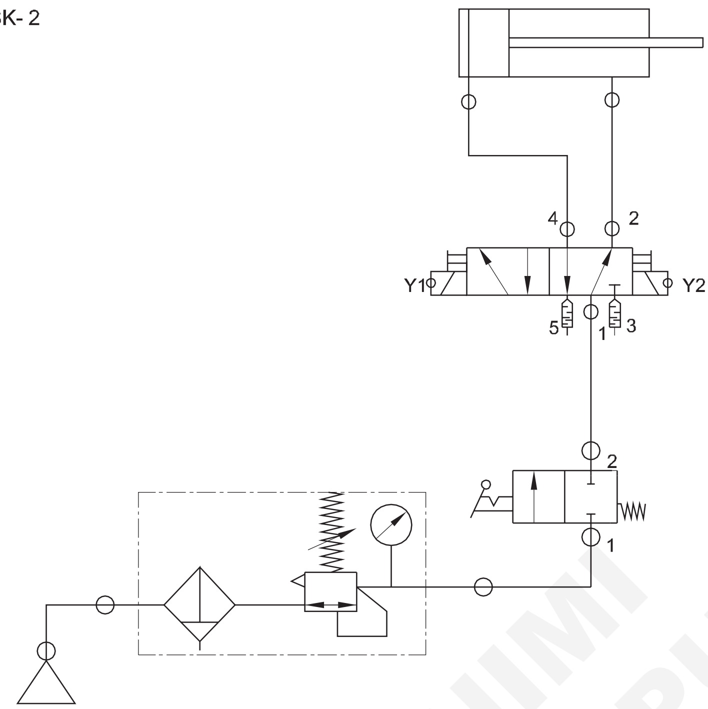
Fig 1



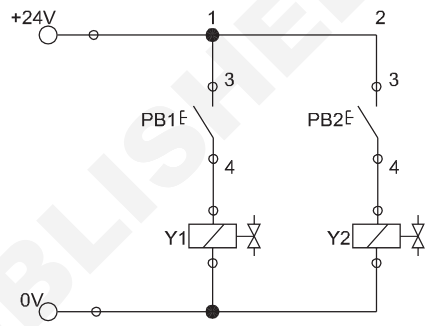
TASK 2 : **Construct a circuit for the direct control of a double-acting pneumatic cylinder with a double solenoid valve**

TASK 3 : **Construct a circuit for the indirect control of a double-acting pneumatic cylinder with a single solenoid valve**

TASK- 2

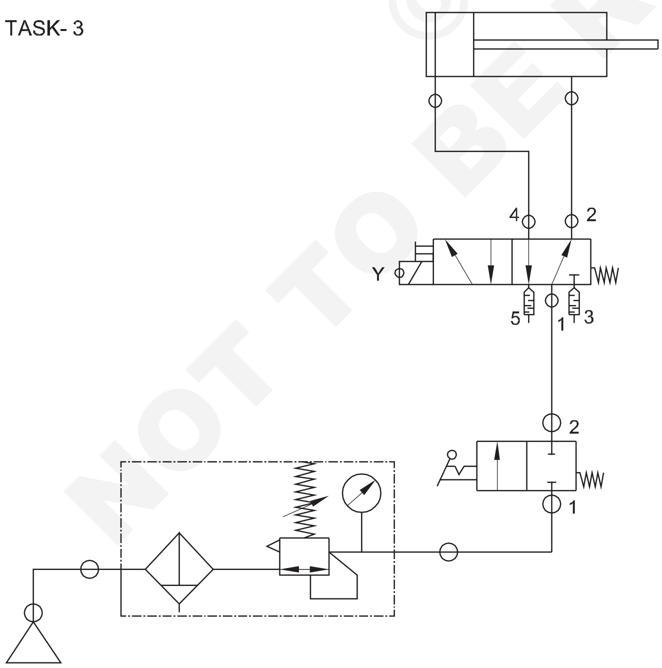


PNEUMATIC CIRCUIT

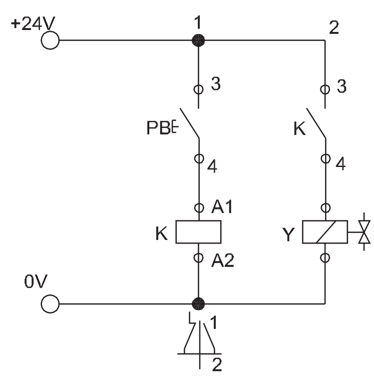


ELECTRICAL CIRCUIT

TASK- 3



PNEUMATIC CIRCUIT



ELECTRICAL CIRCUIT

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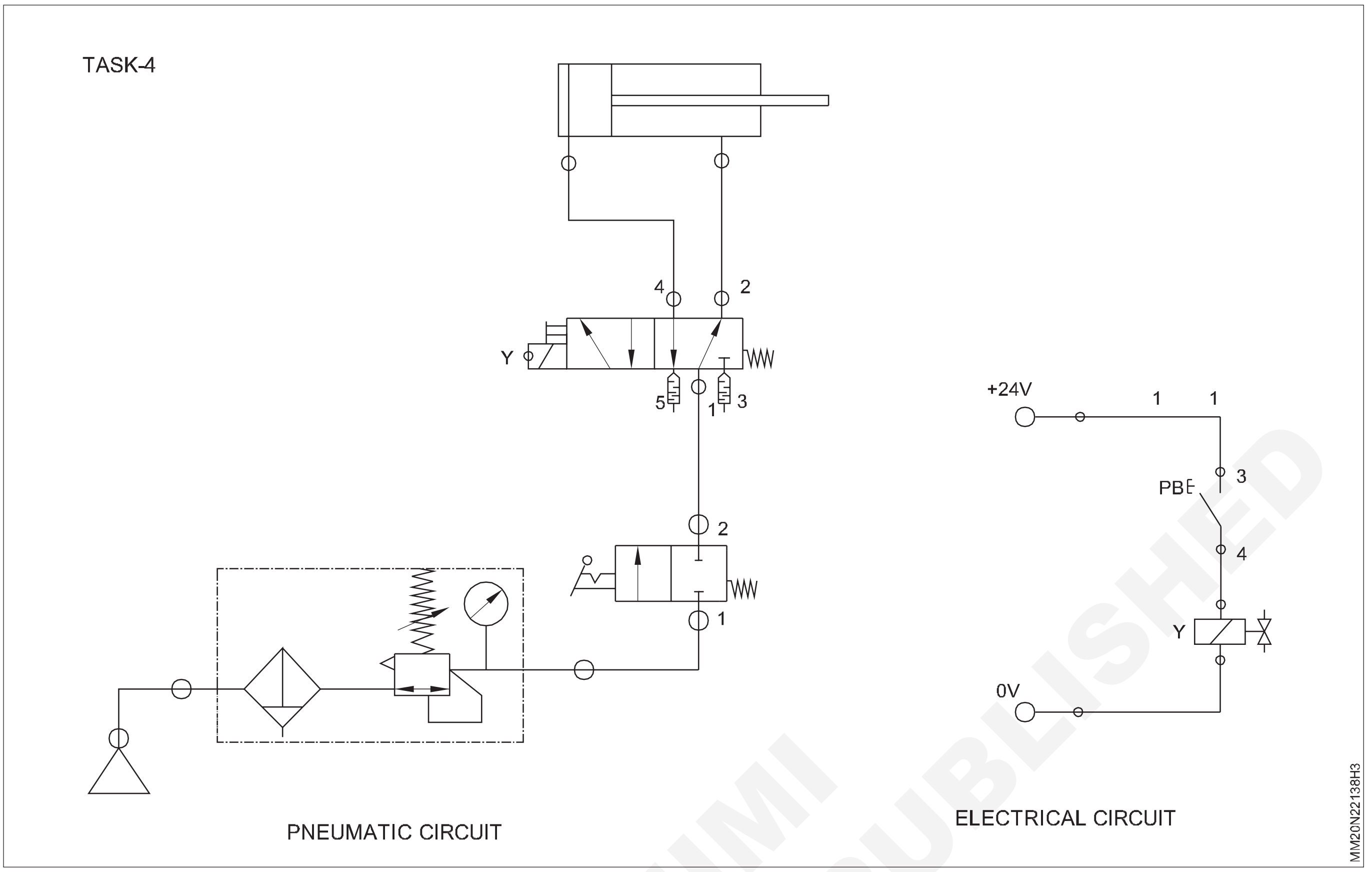
TASK 4: **Construct a circuit for the direct control of a double - acting pneumatic cylinder with a single solenoid valve**



Job Sequence

- Construct circuit diagram
- Assemble according to circuit diagram
- Carry out the exercise

Practice exercise

Set the following

- Operating pressure p (50 bar)
- One - way throttle valve, position 2

Enter the following in the table

- Flow paths,operating positions
- Pressures p_{o2} and p_{o3}
- Forces F_1 and F_2 and Δ F (to be calculated)

Safety precautions

Only switch on the power unit upon directions from the instructor.

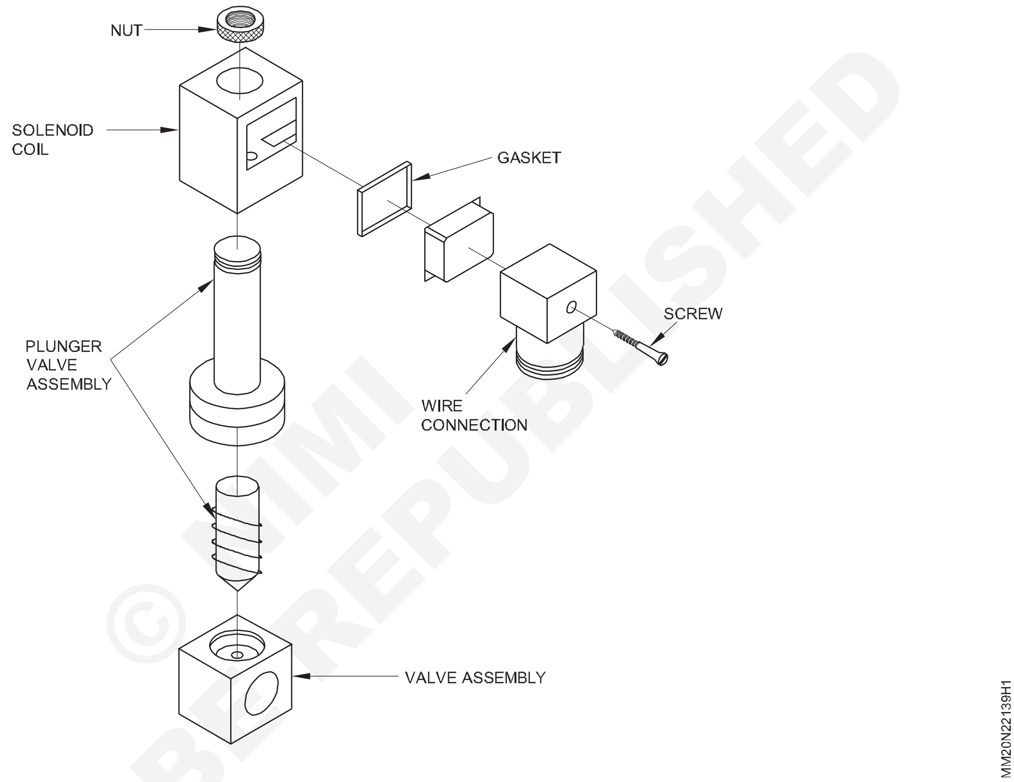
Hydraulic	**4/2 way valve I**		**Pressure bar**		**force kgf or daN**		**effective kgf or daN $dF = F_1 - F_2$**
	Flow paths	operating positions	ρ_{o2}	ρ_{o3}	piston rod side F_1	piston rod side F_2	
Forward stroke							
return stroke							

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.**

Fig 1



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

- First thing to note is that the valve actually is two major components. The coil and the valve mechanism. You can safety 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. (Fig 1)

Remove the top nut to remove the coil

- For the following steps are disassembling 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. (Fig 2)

Fig 1

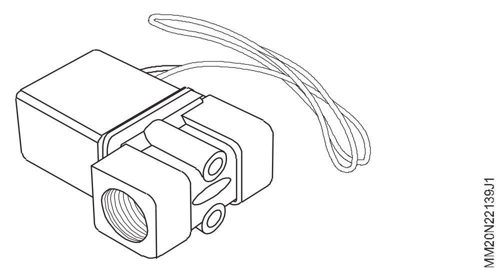
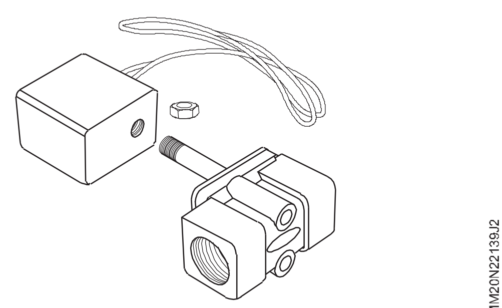
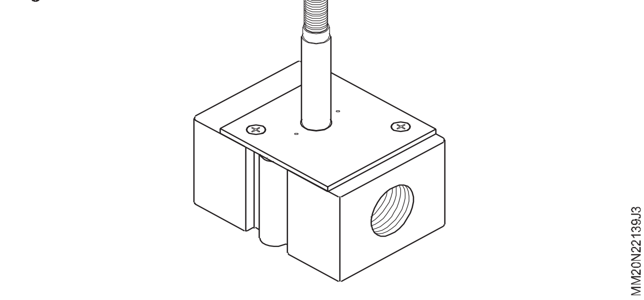


Fig 2



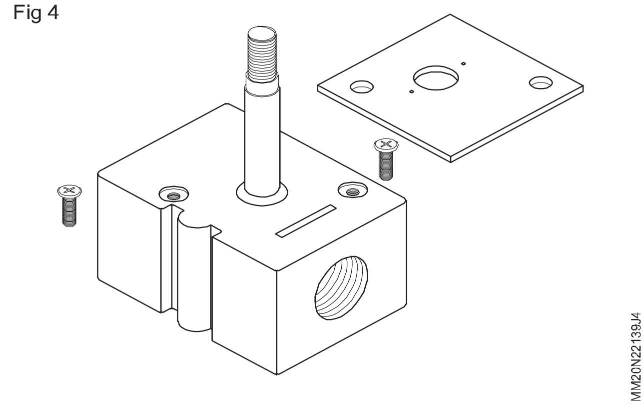
- Here, note the two screws holding the metal plate on. remove these to disassemble the valve. (Fig 3)

Fig 3



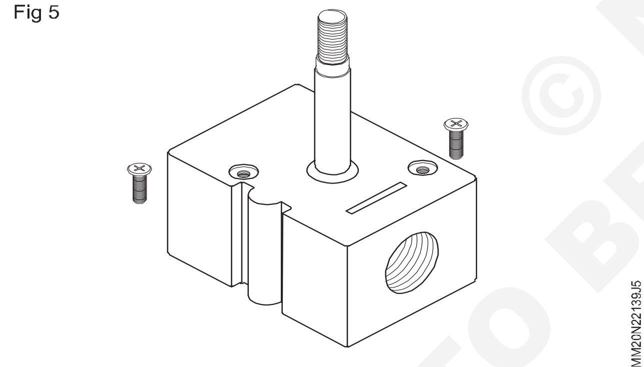
- Remove the two screws. (Fig 4)

Fig 4



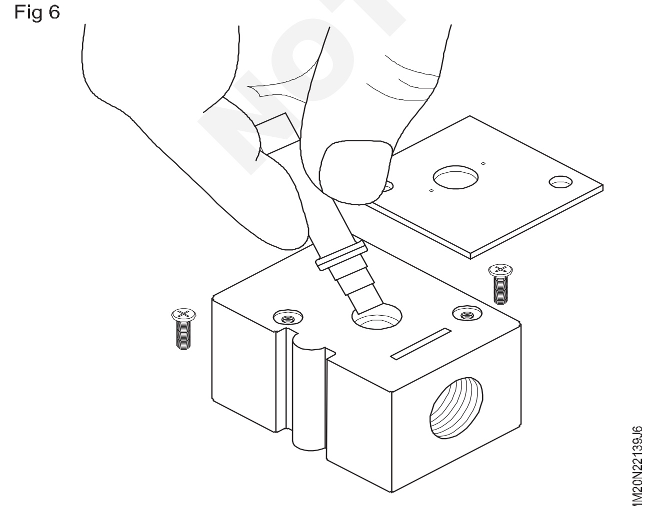
- Remove the metal plate. (Fig 5)

Fig 5



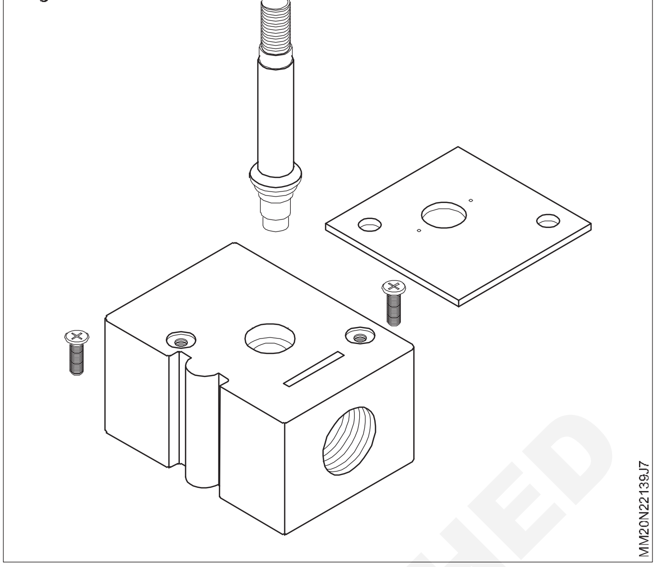
- With a twisting motion, grab the valve stem and pull it upward. (Fig 6)

Fig 6



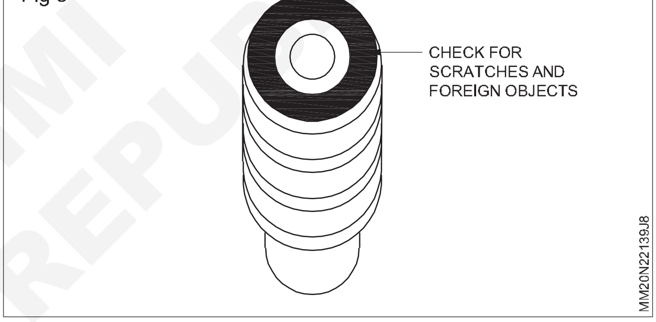
- The valve with the stem removed. (Fig 7)

Fig 7



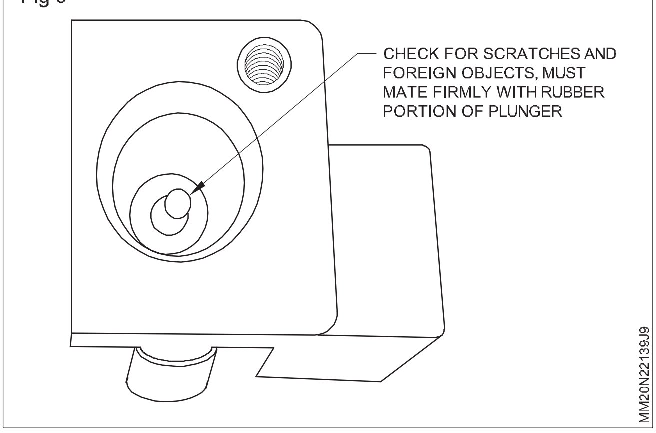
- The stem itself can be disassembled (and cleaned). Note that the plunger (with the spring) should just fall out of the stem. (Fig 8)

Fig 8



- Observe inside the stem and the surface of the plunger and clean any trace of foreign objects. (Fig 9)

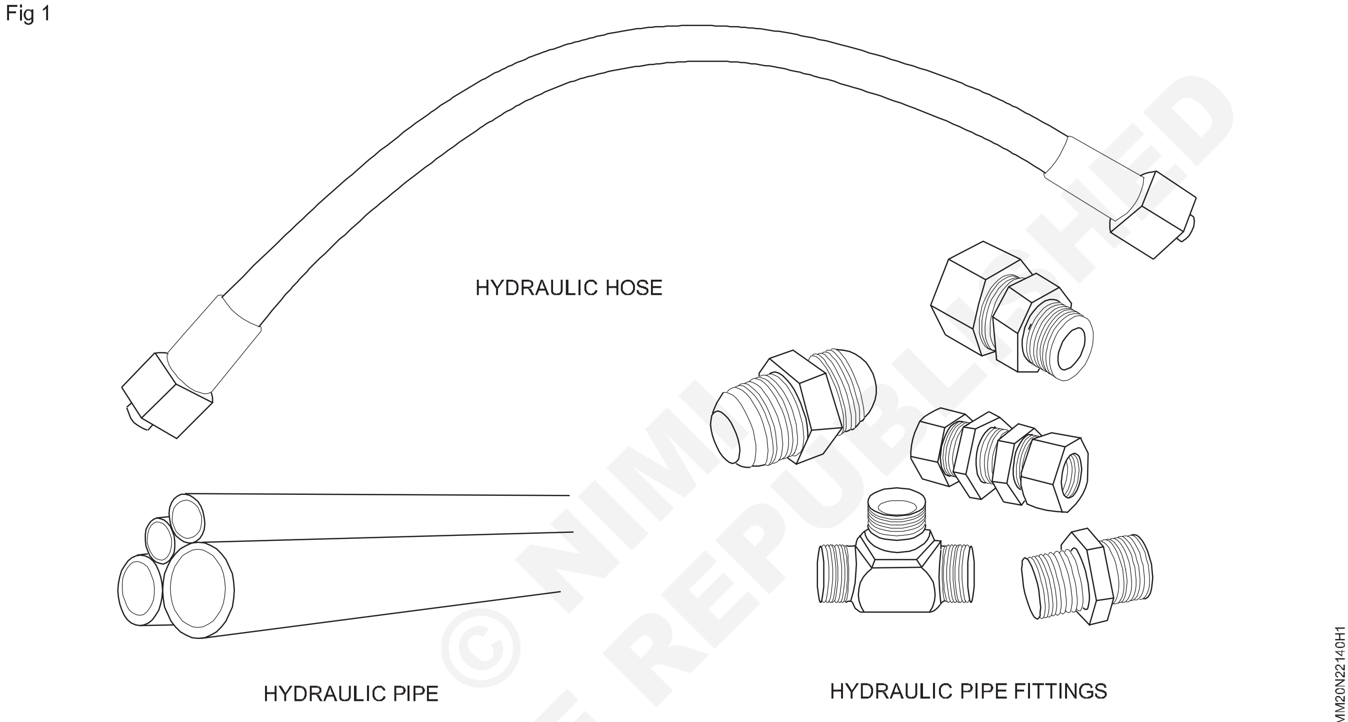
Fig 9



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.**

Fig 1



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/ motors

Objectives: At the end of this exercise you shall be able to
- **dismantle the gear pump**
- **replace the worn out component and reassemble the gear pump**
- **test the pump for proper functioning.**

Requirements

Tools / Instruments
- Bench Vice
- Allen head socket wrench
- Internal snap ring pliers

Equipment/ Machine
- Gear Pump - 1 No.

Material/Components
- 'O' ring - as reqd.
- Oil seal - as reqd.

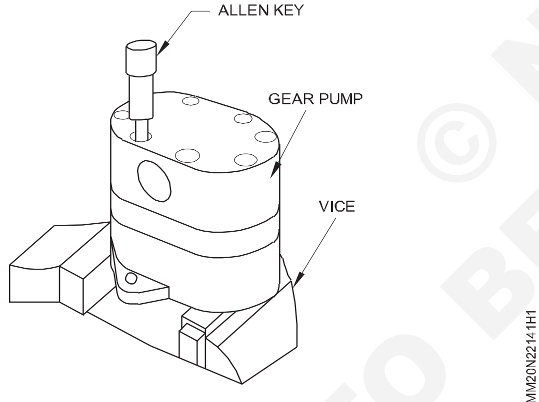
Instructor shall give the proper instruction before dismantling of pump

Job Sequence

TASK 1**: Dismantle the gear pump**

1 Clamp the unit in a vice from the flange side. (Fig 1)

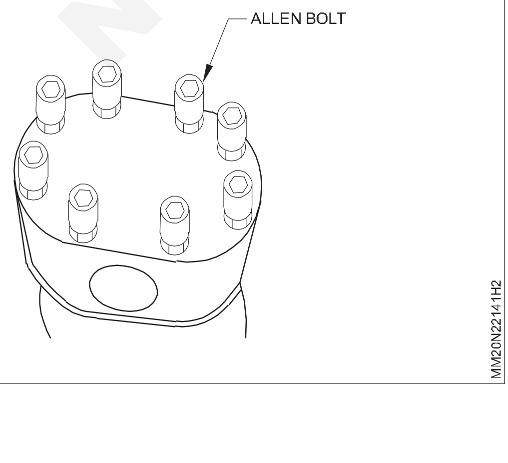
Fig 1



Make sure the vice jaws are clean and have smooth surfaces

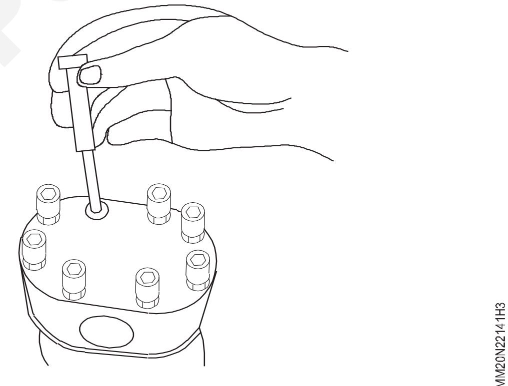
2 Use an Allen head socket wrench to loosen the bolts on the cover assembly. (Fig 2)

Fig 2



3 Unscrew the bolts completely and remove them. (Fig 3)

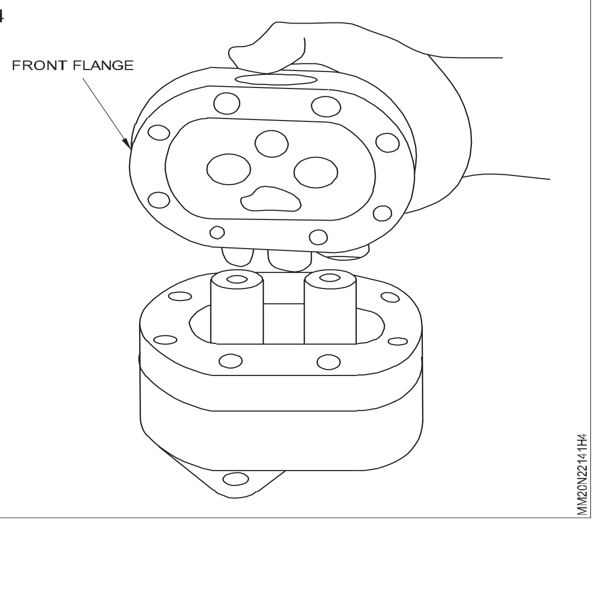
Fig 3



Inspect the threads for damage

4 Remove the cover assembly carefully.(Fig 4)

Fig 4



Some of the pumps may have a shaft seal, in such a case remove the cover assembly with care to prevent any damage to the seal.

5 Place the cover assembly on the work bench. Inspect the wear plate for wear and tear.

Remove the wear plate and seal ring from the cover assembly.(Fig 5)

Do not use sharp tools to remove the seal

6 Carefully remove the gear plate and remove the dowel pins.(Fig 6)

Fig 5

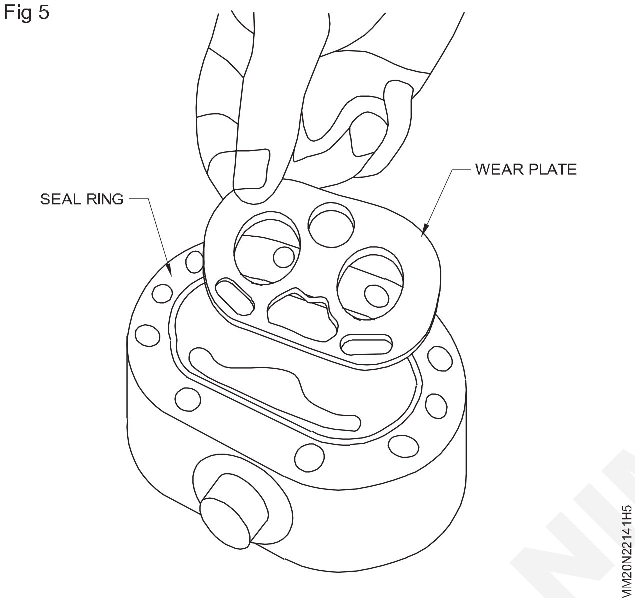
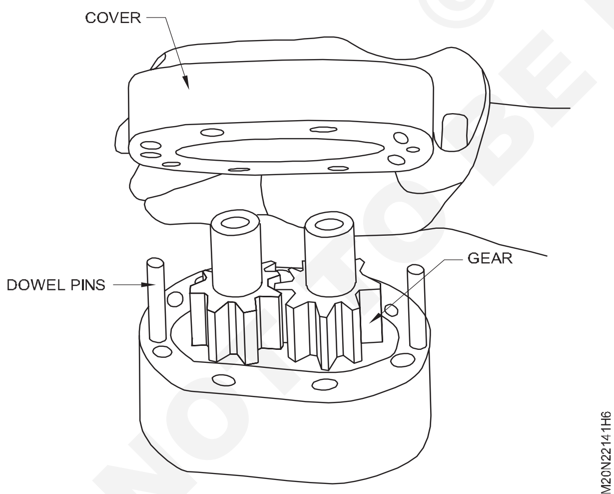


Fig 6



During disassembling the unit,mark the relative positions of the gear mesh and the body that helps during reassembly.

7 Remove the idler shaft and drive shaft from it's bearing bore (Fig 7 & 8).

Fig 7

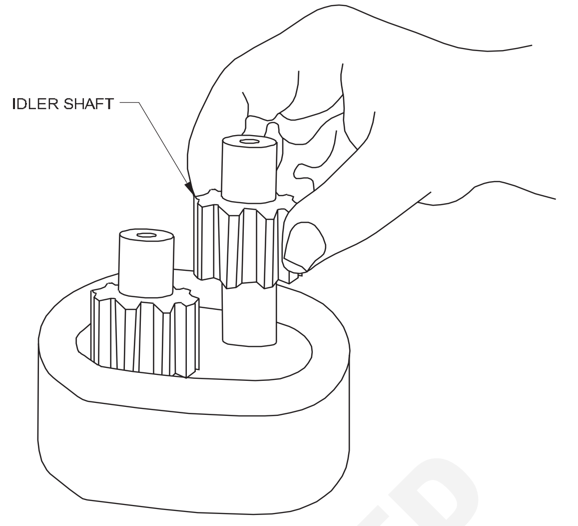
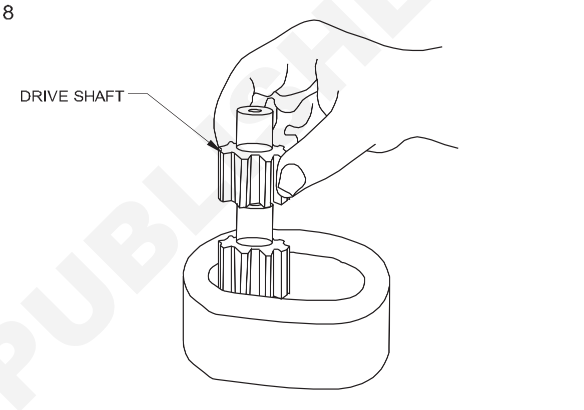


Fig 8

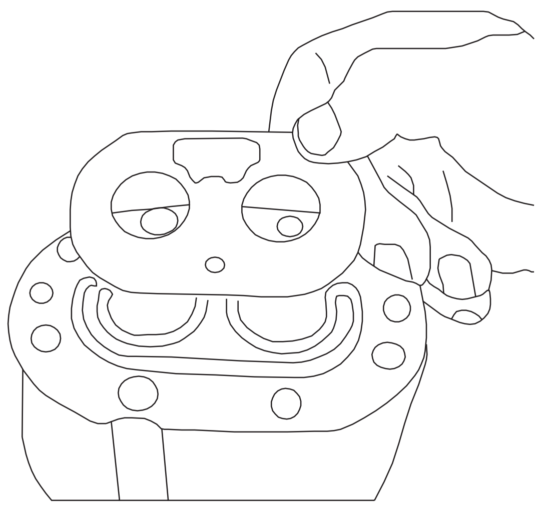


Inspect the journals and the flat faces top and bottom of the gears. Ensure these surfaces are free from burrs or scratches. If scratches are found, clean them with very fine emery cloth.

8 Rewash the gears with light oil.

9 Remove the wear plate from the assembly. (Fig 9)

Fig 9



REMOVE WEAR PLATE

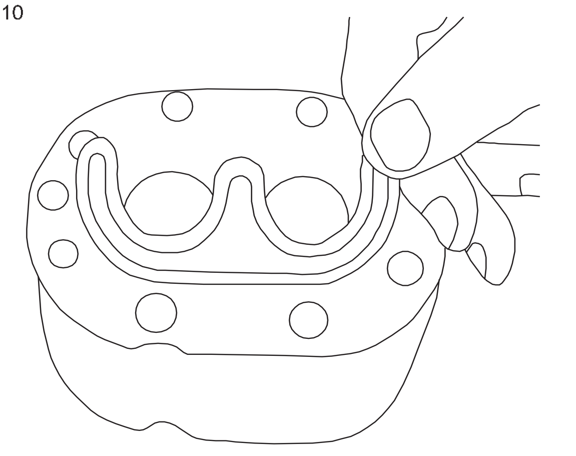
- **Inspect the lower wear plate for wear, or marks caused by overheating.**
- **Replace if necessary.**

10 Remove the shaft seal and snap ring from the body assembly. (Fig 10)

Use internal snap ring pliers to remove snap ring

Keep all the components of pump in proper manner and in clean place.

Fig 10



REMOVE SEALS

— — — —

TASK 2: **Replace the worn out components and reassemble the gear pump**

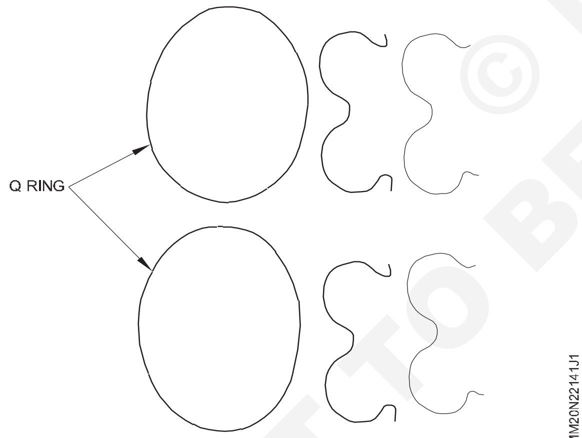
1 Take the entire seal kit required and compare the old seal kit to the new one to ensure you have the correct one. (Fig 1)

Apply grease in all seals before use it

2 Prepare the body by cleaning it. Inspect the internal and mating surfaces.

Ensure the surfaces are free of burrs an scratches

Fig 1



3 Install the shaft seal into the body assembly.

4 Apply light lubricant in the body and shaft seal. Place the seal in the body assembly by hand. Then, press the seal using a shaft seal installation tool. This will insure the seal is in proper depth. (Fig 2)

5 Place the body assembly, with the E- ring seal grooves facing up.(Fig 3)

6 Place the wear plate on top of the E- ring with the bronze side facing up towards the gear. The 0.25” pressure hole is to be positioned on the E-ring side of the body. (Fig 4)

Fig 2

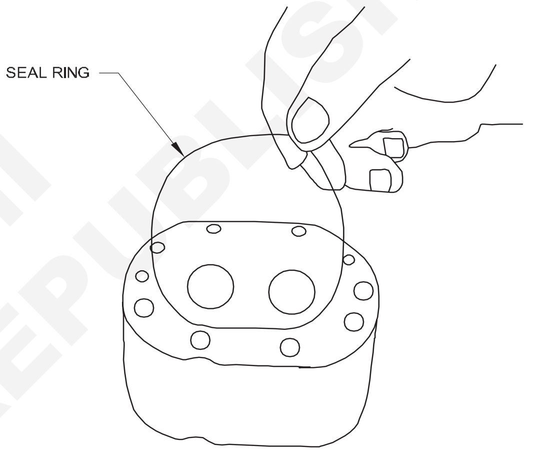


Fig 3

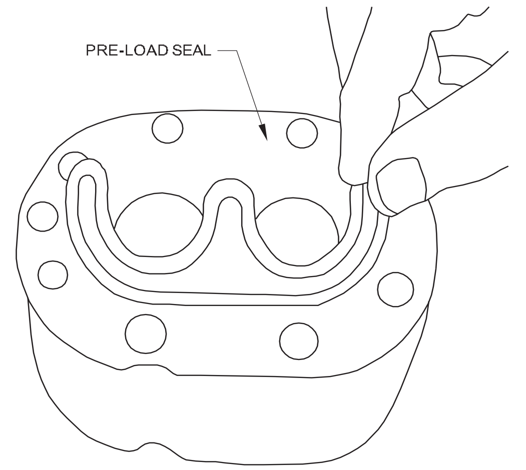
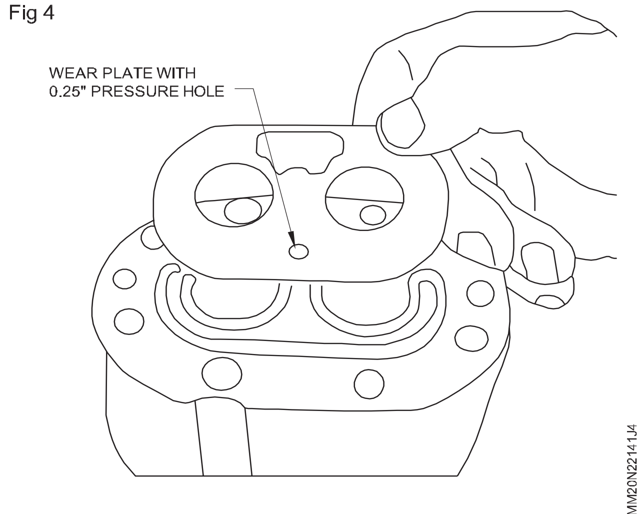
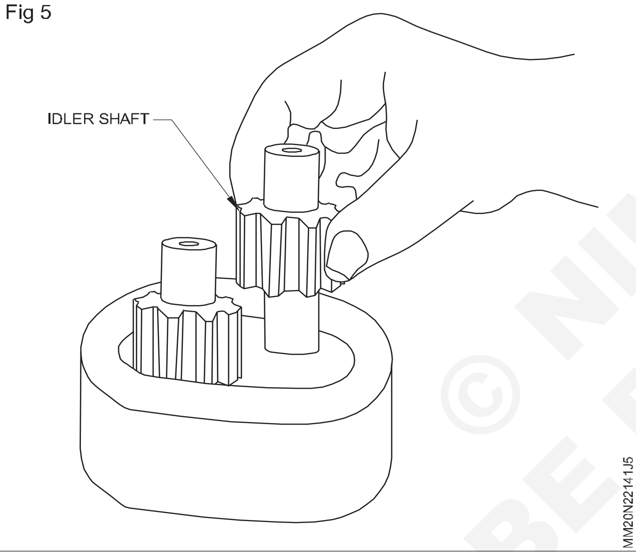


Fig 4



7 Lubricate the spine end of the drive shaft with grease. Insert the drive shaft and the idler shaft in the correct bearing bore.(Fig 5)

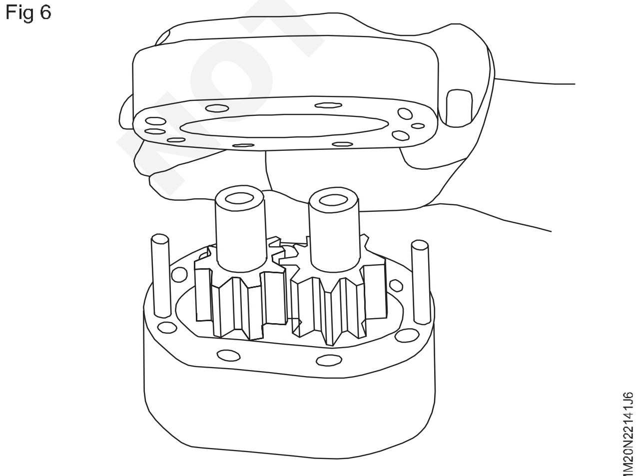
Fig 5



8 Inspect gear teeth for alignment. Lubricate the complete gear set using clean light oil.

9 Insert the two dowel pins into the body assembly. Place the gear plate over the dowel pins.(Fig 6)

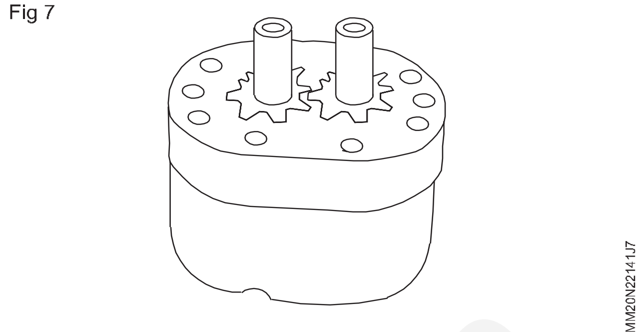
Fig 6



Make sure the gear plate is seated properly. (Fig 7)

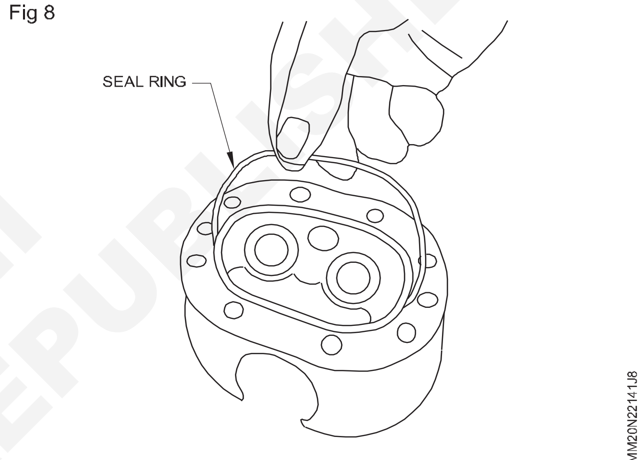
10 Place the cover assembly on a bench with the machined surface facing up.

Fig 7



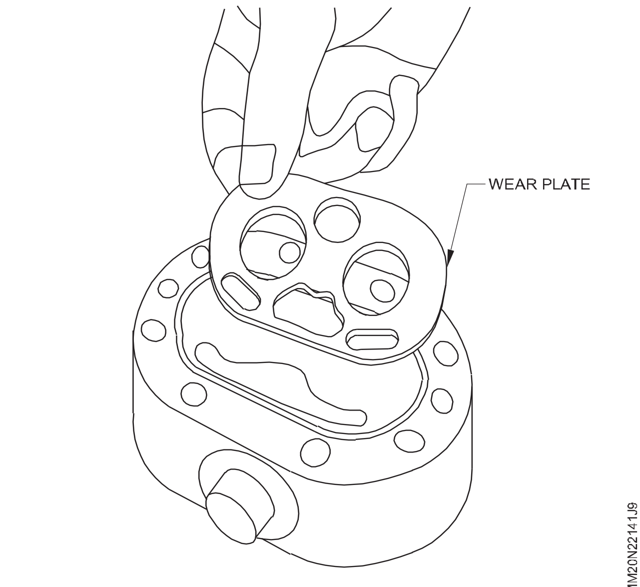
11 Place the rubber seal ring in the cover seal ring groove. (Fig 8)

Fig 8



12 Position the wear plate in the cover with the bronze side facing up (towards gears). (Fig 9)

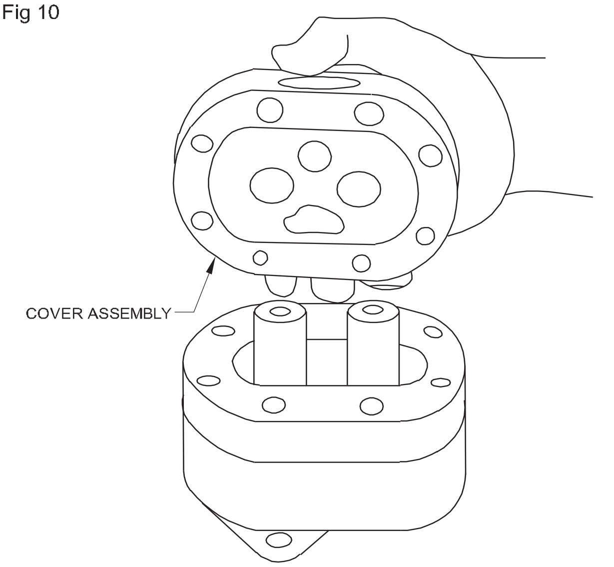
Fig 9



Pressure hole located over the circular holes in the cover.

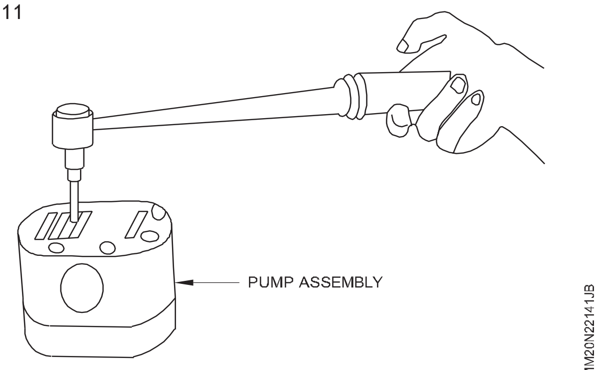
13 Place cover assembly over the body assembly. (Fig 10).

Fig 10



14 Fasten assembly using torque wrench. (Fig 11)

Fig 11



If componants are replaced by new componant, run the pump in idle for some time dismantle and wash with solvent to clear off pre-setting wear particles.

TASK 3**: Test the pump for proper functioning**

Rotate the pump and check the flow rate, smoothness of rotation and sound of pump.

Observation

1 Flow rate of pump as per specification.

2 Operation of pump should be smooth.

Conclusion: ______________________________

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

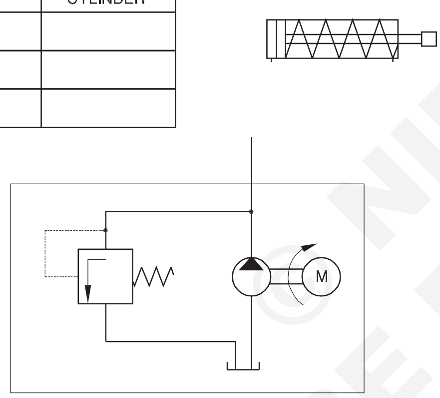
Objectives: At the end of this exercise you shall be able to
- **design a circuit to actuate a single acting cylinder**
- **design a circuit to actuate double acting cylinder**
- **design a circuit to actuate hydro motor**
- **select the various elements as per the circuit**
- **construct the above circuits**
- **test the above circuits for its function, duly arresting and leakage.**

Fig 1

TASK - 1

TABLE - 1

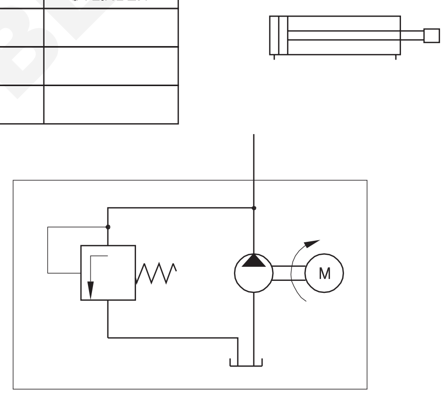
POSITION OF	
VALVE	CYLINDER



TASK - 3

TABLE - 3

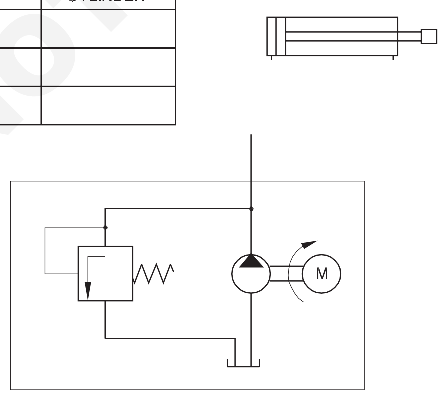
POSITION OF	
VALVE	CYLINDER



TASK - 2

TABLE - 2

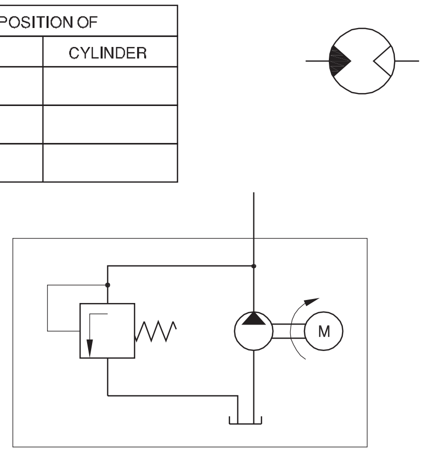
POSITION OF	
VALVE	CYLINDER



TASK - 4

TABLE - 4

POSITION OF	
VALVE	CYLINDER



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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 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**

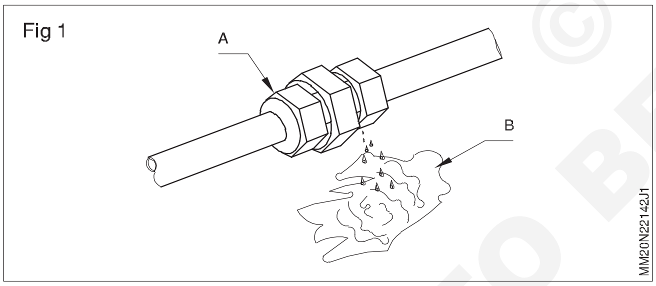
- Design, construct and test a circuit to actuate a hydrometer using a 4/3 D.C. Valve.

— — — —

TASK 1: **Design, construct and test a circuit to activate a single acting cylinder.**

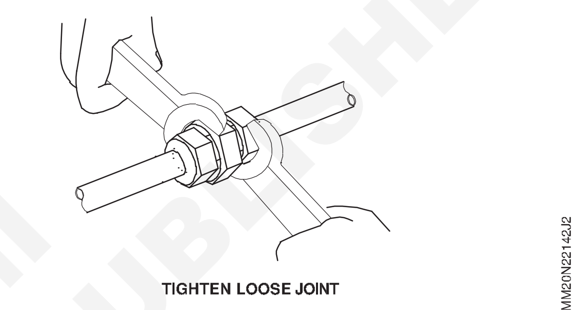
- Draw a circuit diagram to actuate a single acting cylinder in the given format and get the approval of instructor.
- Include elements to actuate cylinder and also to monitor pressure at various points in the circuit.
- Select the hydraulic elements as per the approved circuit diagram drawn.
- Mount and connect the elements on the trainer kit.
- Get the approval of your instructor before switching “ON” hydraulic pump.
- Switch ON the hydraulic pump.

Fig 1



- Inspect the circuit for any leakages. (Fig 1)
- Eliminate any leakages by (Fig 2) retightening connectors pipes.

Fig 2



- Put off hydraulic pump, while tightening connector and pipes.

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.

— — — —

Perform Overhauling of hydraulic pump (Vane pump)

Objectives: At the end of this exercise you shall be able to
- **dismantle the hydraulic pump**
- **replace the worn out component and reassemble the hydraulic pump vane type**
- **test the pump for proper functioning.**

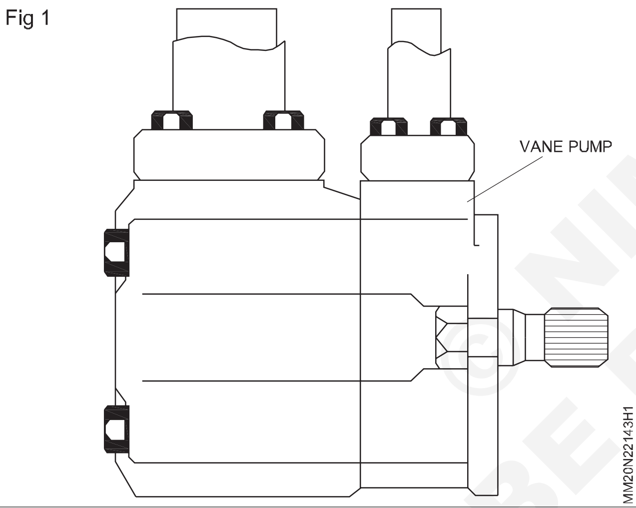
Job Sequence

TASK 1 : **Dismantle the hydraulic pump (vane type)**

Mark all pieces during disassembly so that the unit can be reassembled correctly. Incorrect assembly of components could damage the components and cause malfunctioning.

- Clamp the pump in vice or keep it on the proper base. (Fig 1)

Fig 1



- Remove all four bolt of intake port with the help of Box spanner.
- Remove outer cover by unfastening the two bolts. (Fig 2)
- Remove carefully the centre main rotor assembly (cartridge). (Fig 3)
- Keep the cartridge on clean surface for dismantling. (Fig 4)
- Use Allen head socket wrench or Allen key to loosen the bolts from the cover assembly. Next completely unscrew the bolts and remove them.(Fig 5)

Inspect the threads for damage.

- Remove both side plates of cartridge and Inspect the side plate for evidence of any damage. (Fig 6)

Fig 2

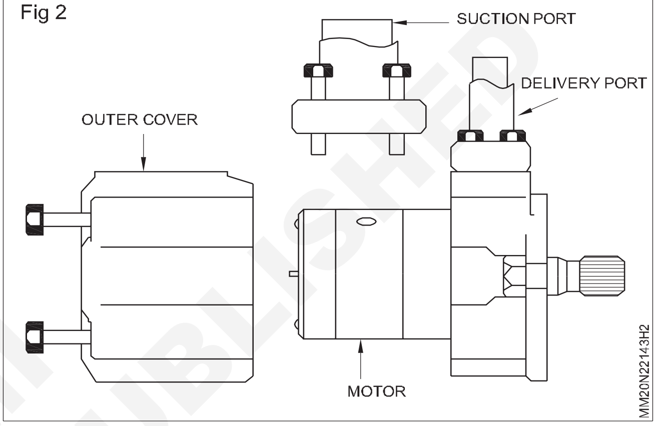


Fig 3

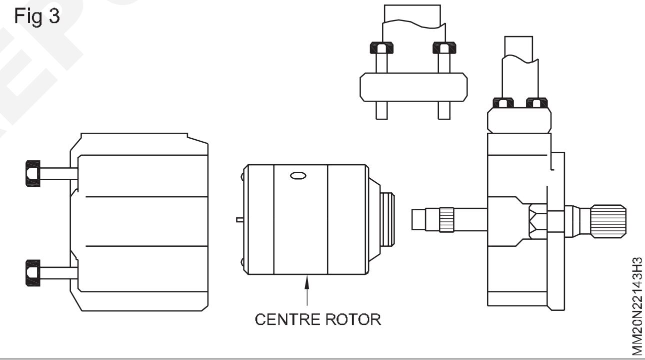


Fig 4

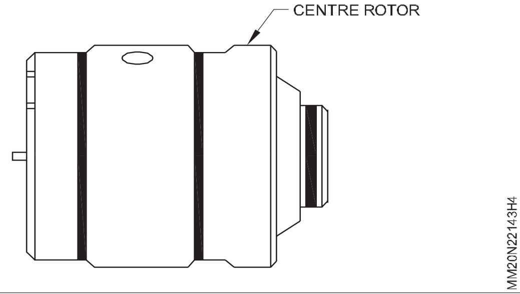


Fig 5

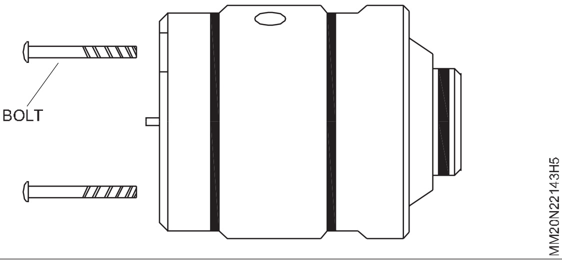
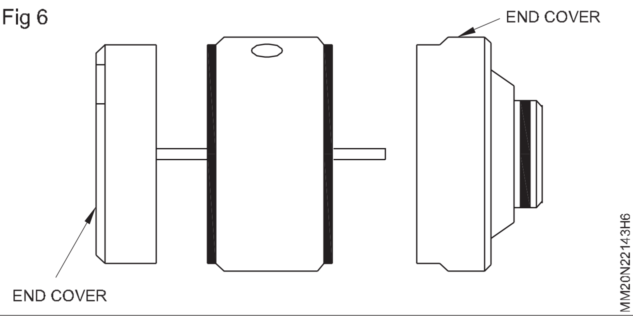
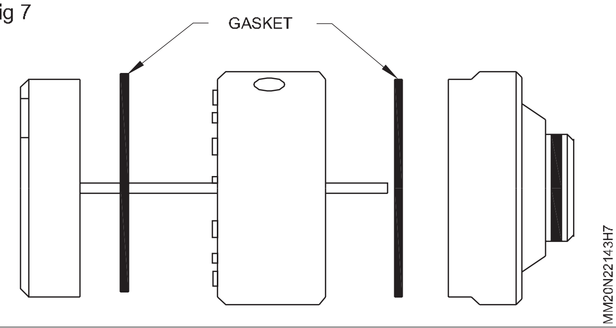


Fig 6



- Remove the gaskets from both side of centre rotor. Check the gasket for any sign of damage. (Fig 7)

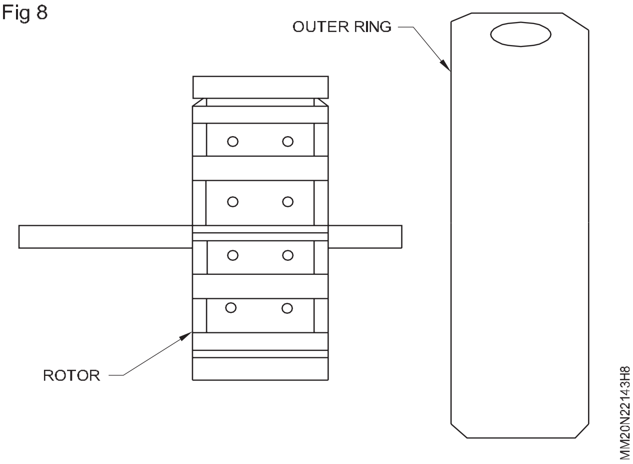
Fig 7



Avoid sharp edges to remove the gasket otherwise it will damage the face of rotor.

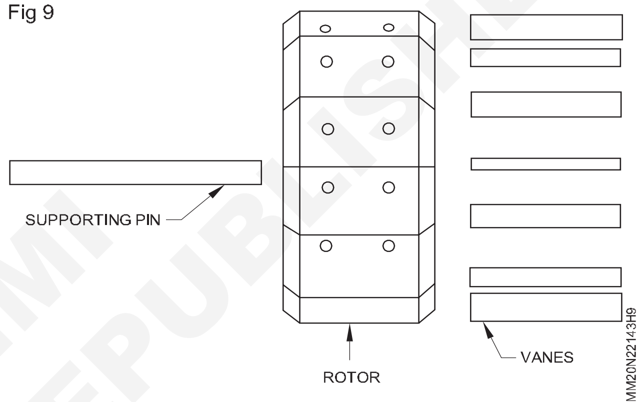
- Remove the cover of rotor and check the internal surface of rotor for any kind of wear.(Fig 8)

Fig 8



- Remove all vanes, springs and supporting pin from rotor and check the physical condition of components. (Fig 9)

Fig 9

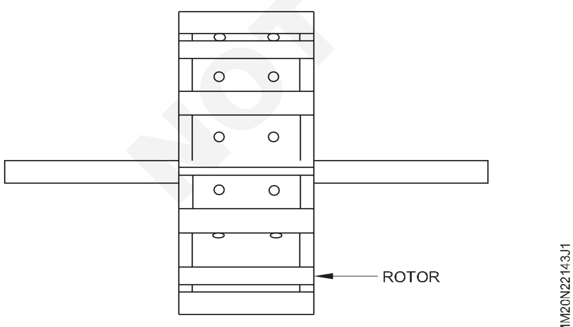


TASK 2 : **Replace the worn out component and reassemble the vane pump**

Before going to assemble the pump, replace the damaged components by new components. Replace the seals with new seal kit. Clean all components using cleaning agent.

- Install the vanes, supporting pin and springs in proper location at rotor. (Fig 1)

Fig 1



- Assemble both side plates with gaskets properly. (Fig 2)
- Tighten both the allen bolt with the help of allen key. (Fig 3)

Fig 2

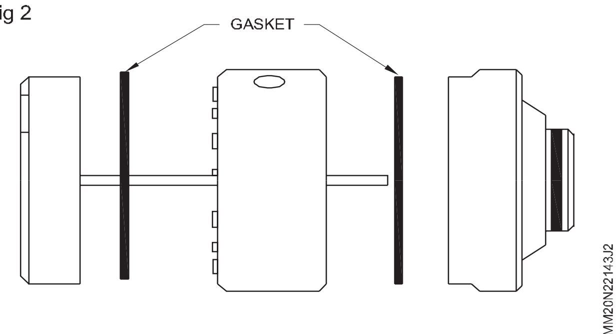
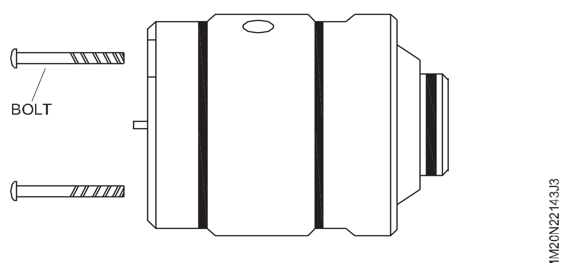


Fig 3



- Now centre main component or cartridge is ready to be assembled in the pump. (Fig 4)
- Connect cartridge with the drive shaft.(Fig 5)

Fig 4

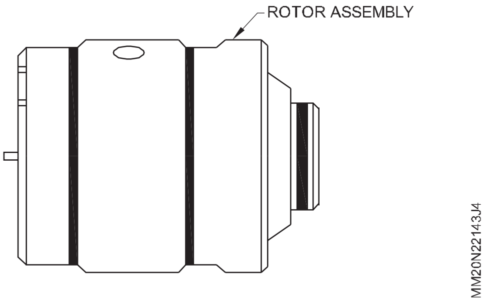
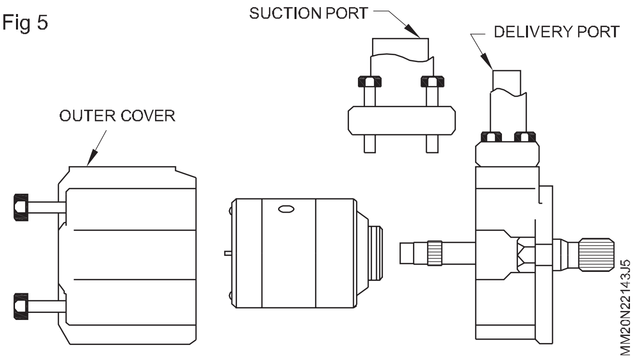
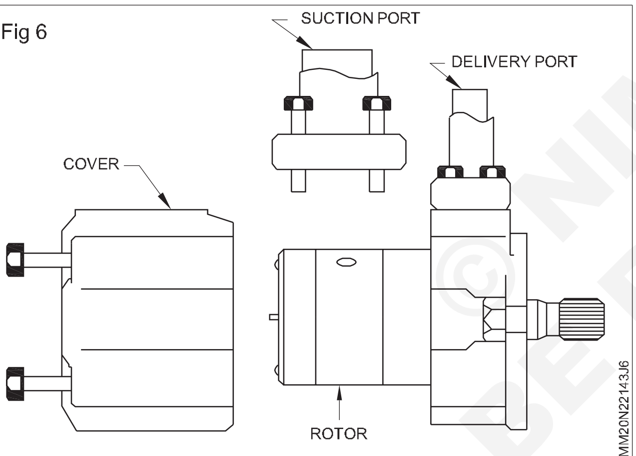


Fig 5



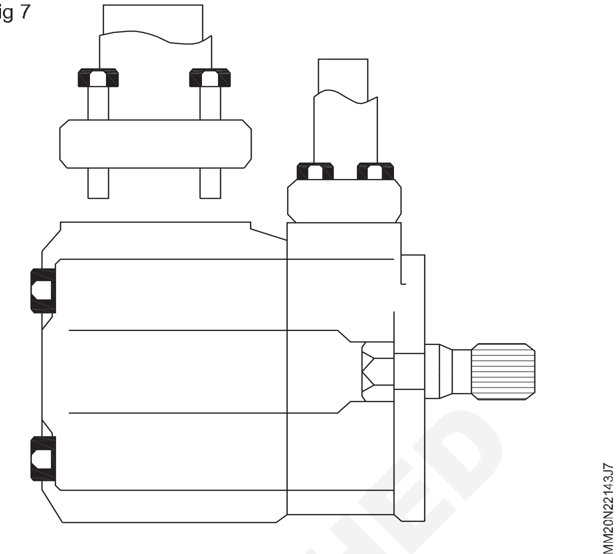
- Assemble the outer cover with the help of two bolts. (Fig 6)

Fig 6



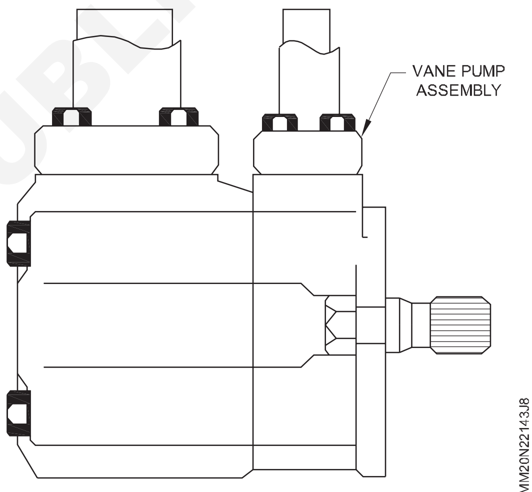
- Install suction port over pump body with the help of four bolts. (Fig 7)

Fig 7



- On completion of assembly check shaft for free rotation. Now pump is ready to use. (Fig 8)

Fig 8



TASK 3 : **Test the pump for proper functioning**

- Rotate the pump and check the flow rate, smoothness of rotation and sound of pump.

Observation

1 Flow rate of pump as per specification.

2 Operation of pump should be smooth.

Conclusion:

____

____

____

____

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**
- **to know about trouble shooting**
- **follow safety on pneumatic and hydraulic.**

The practical for this, component may demonstrated by video.

Instructor may arrange video's locally and demonstrate to the trainees.

Note : Task to check /rectify following points on pneumatic System

1 Safety
2 Understand your system
3 Visual inspection
4 Run the system / observe
5 Isolate sub systems
6 List - test possibillities
7 Repair/Replace
8 Test.

Points on Hydraulic Systems:

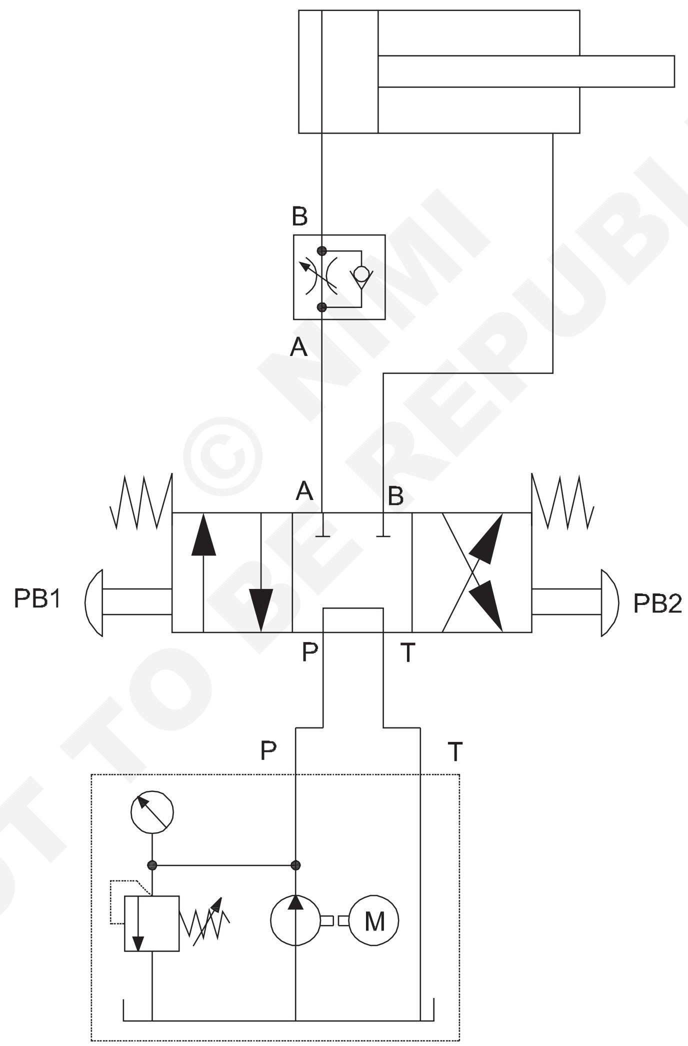
1 System inoperative/operative erratically/ slowly/Fast
2 Over heating of oil in system / foaming
3 Noisy pump
4 Blown seal / Leaky
5 Load drops
6 control value leaks.

Construct Electro hydraulic circuit - speed an Pressure control of double acting cylinder.

Objectives: At the end of this exercise you shall be able to
- **draw meter in speed control circuit for double acting cylinder**
- **assemble and test the circuit for its proper functioning.**

Fig 1

TASK: **Draw Electro hydraulic circuit of speed and pressure control of double acting cylinder & explain. get it check by instruction:**



MM20N22145H1

Job Sequence

TASK 1 : **Draw meter in speed control circuit for double acting cylinder**

- Identify and list the components required in the Table 1.

The instructor shall arrange trainer board with components mentioned.

Table 1

Component	Symbol
Double Acting Cylinder 4/3 Way Valve One way flow control valve Hydraulic pump Pressure relief valve	

— — — —

TASK 2 : **Assemble and test the circuit for it's proper functioning**

- Connect the delivery line of pump to the P port of 4/3 way valve.
- Connect the T port of 4/3 way valve to the tank port (or return line port).
- Connect A port of 4/3 way direction control valve to the one way flow control valve as per circuit.
- Join another port of one way flow control valve to the piston end of double acting cylinder.
- Connect B port of 4/3 way valve to the rod end of double acting cylinder.
- Check function of the circuit as per Table 2.

Table 2

Sl. No.	Action	Expected result	Confirm result
1	Start pump and check pressure in gauge	Less pressure & no movement in cylinder	
2	Press PB1 of 4/3 way valve and check forward speed of cylinder	Cylinder moves forward with normal speed	
3	Press PB2 of 4/3 way valve and check return speed of cylinder	Cylinder retract with normal speed	
4	Tune the one way flow control valve and press PB1 of valve.	Cylinder moves at slower speed	
5	Press PB2 of valve.	Cylinder retract with normal speed	

Conclusion

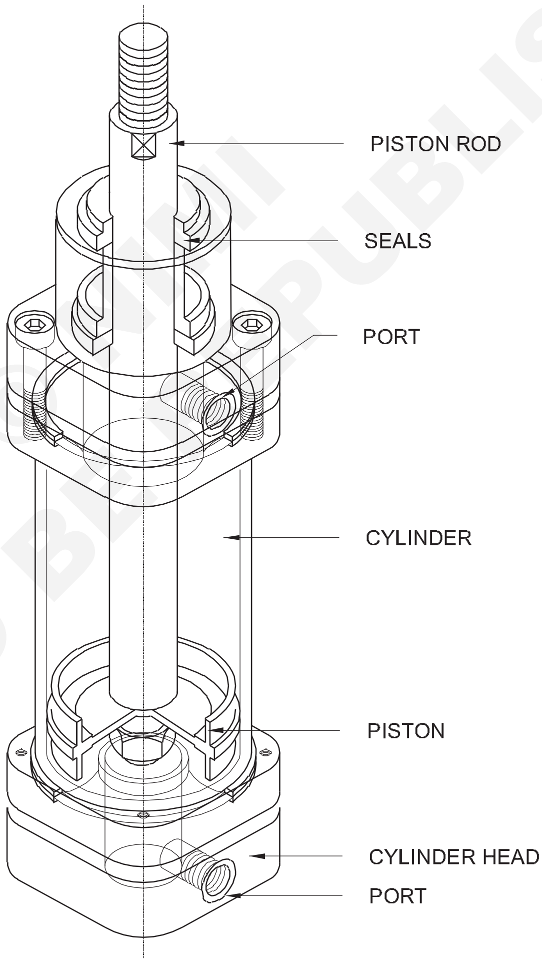
Expected conclusion	Confirm conclusion
Forward speed of cylinder is controlled because fluid which is going inside the cylinder is controlled by one way flow control valve, while return speed is normal.	

— — — —

Perform Overhauling of a pneumatic cylinder

Objectives: At the end of this exercise you shall be able to
- **dismantle the pneumatic cylinder**
- **clean and inspect the parts for worn out and damage**
- **assemble the pneumatic cylinder**
- **test the cylinder for proper function.**

Fig 1



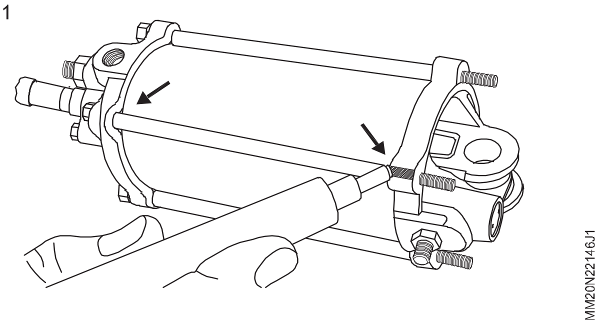
CYLINDER

Job Sequence

Disassembly

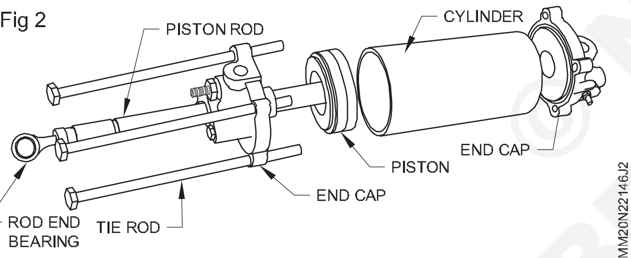
- Disconnect air and electrical connections to the cylinder assembly and remove the cylinder from machine.
- Remove and retain air lines and any other accessory items(solenoid valve, flow controls, etc.) from the cylinder assembly.
- Scribe an index mark on both end caps to show orientation to each other. These marks will assist when re-assembling the cylinder. (Fig 1)

Fig 1



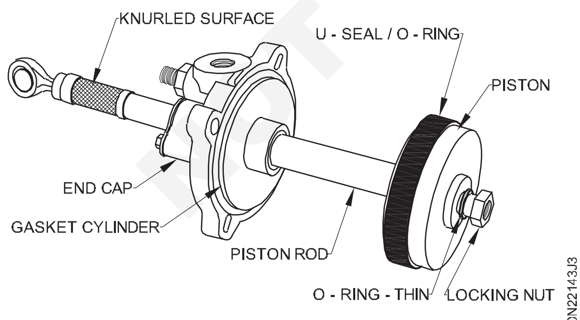
- Remove and retail all the rod nuts, lock washers and tie rods from the cylinder end caps. Remove the end caps from the cylinder tube and discard the cylinder gaskets. (Fig 2)

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)

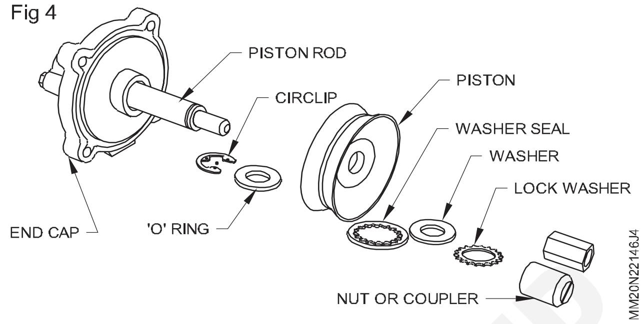
Fig 3



TYPES OF BEARING LOADS

- 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 circlie and miscellaneous hardware from the piston rod and pull the front end cap from the piston rod. (Fig 4)

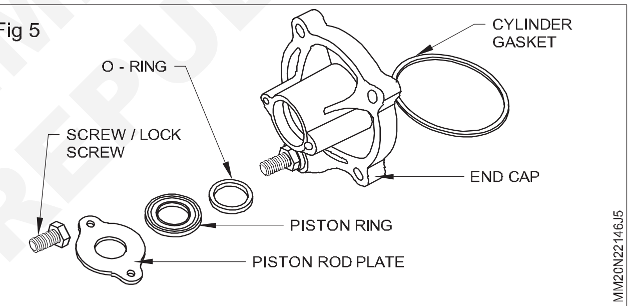
Fig 4



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.

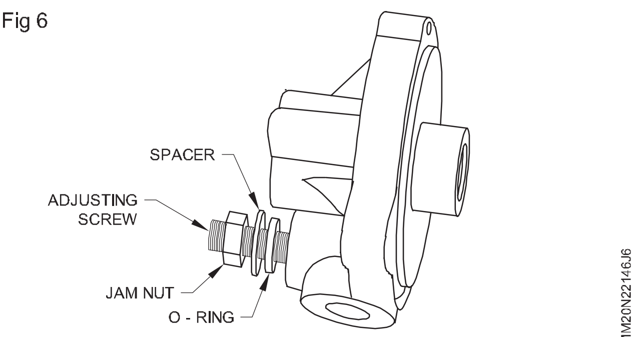
- Remove and retain the two screws, lock washers and the piston rod plate from the front end cap. Remove and discard the packing ring and the O-ring. (Fig 5)

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)

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 circle, 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.

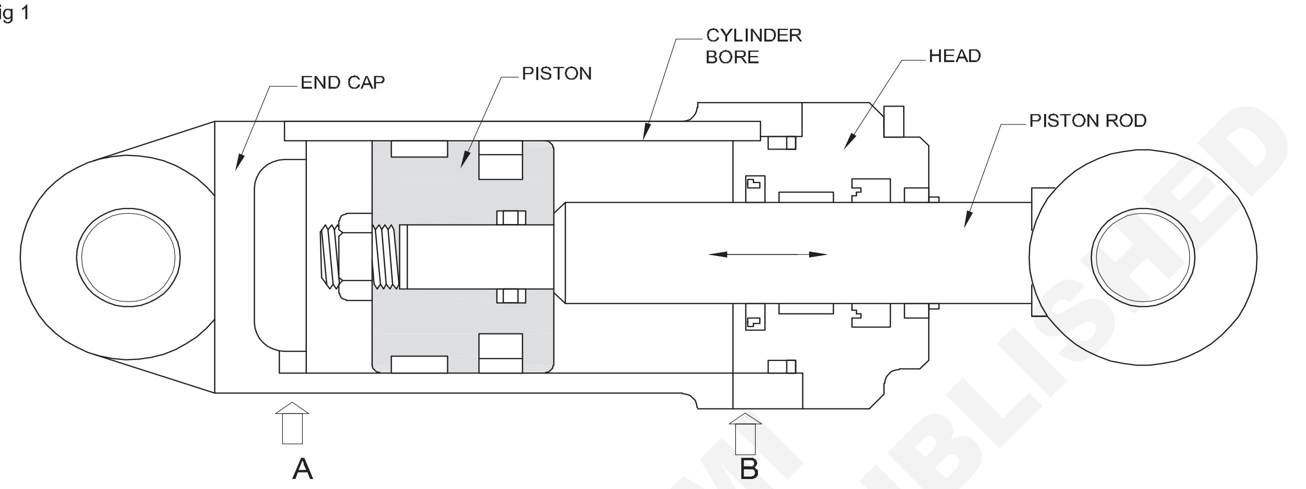
Testing the cylinder

- 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.

Perform Overhauling of hydraulic actuators/cylinder

Objectives: At the end of this exercise you shall be able to
- **dismantle the hydraulic cylinder**
- **replace the worn out parts**
- **assemble the hydraulic cylinder**
- **check the working of hydraulic cylinder.**

Fig 1



Job Sequence

Dismantle the hydraulic cylinder (Fig 2)

- Disconnect hydraulic connections to the cylinder assembly and remove it from the machine.
- Clean the cylinder assembly with clean cloth.
- Drain all the hydraulic oil in the hydraulic tank by unscrewing plug (Part No.11).
- Loosen the bolt (Part No.14) and remove the valve block (Part No.1) from the assembly.
- Remove the tube (Part No.13), Seal Ring (Part No.17) and ball (Part No.16) from the valve block.
- Remove the seal ring (Part No.12), Copper washer (Part No.2), top nut (Part No.7), O-ring (Part No.8) and sealing gasket (Part No.9) carefully and take out the cylinder(Part No.3) with ram (Part No.6) assembly from the oil tank(Part No.10).
- Then remove the ‘O’ ring (Part no.4) and ‘O’ ring retainer (Part no. 5)
- Remove the cotter pin (Part No.29), shaft (Part No.28) and take out the handle (Part No. 26) from the handle socket (Part No. 27).
- Remove the plunger (Part No.24) from the pump cylinder(Part No.21) after the removal of O-ring (Part No.30)
- Then remove back up ring (Part No.23) and ‘U’ cup seal (Part No.22), copper washer (Part no 20) and ball (Part no 19).
- Remove the pump link (Part No.25) from handle socket
- Keep all the parts in a clean tray.

Replace the worn out parts

- Clean all the dismantled parts with kerosene and wipe it with a clean cloth.
- Check visually each O-rings and seals for worn out and replace it if necessary.
- Check the inner surface of the cylinder for scratches.
- Visually check the exterior surface of the ram for any scratches or wear.
- Apply a small amount of fresh hydraulic oil around ram and inner portion of cylinder.
- Check the inner portion of oil tank and also check the plug hole as well as oil plug.

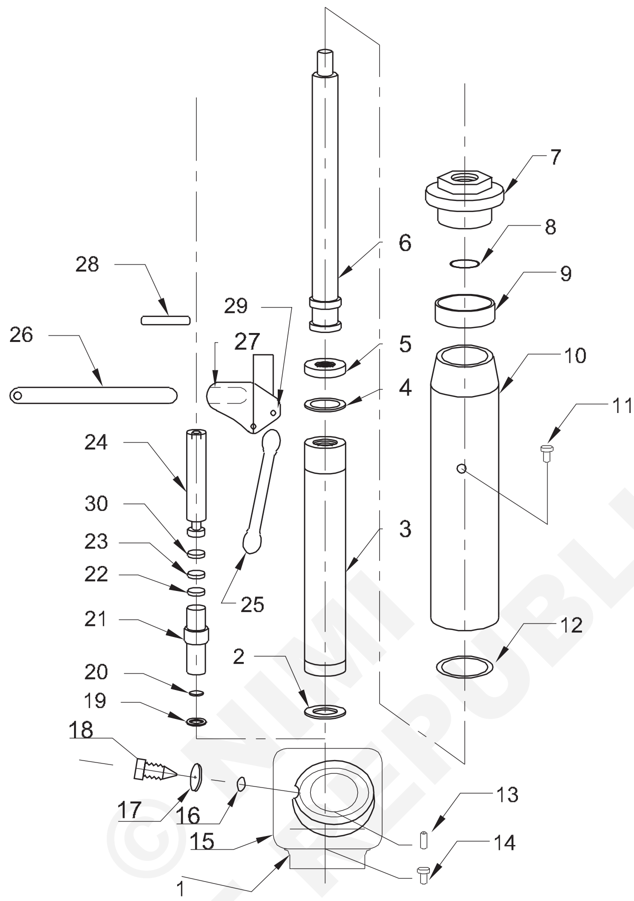
Assemble the hydraulic cylinder

- Assemble all the parts of hydraulic cylinder assembly in the reverse as stated in the dismantling procedure.

Check the working of hydraulic cylinder

- Mount the hydraulic cylinder assembly with the machine.
- Fill sufficient quantity of hydraulic fluid recommended by the manufacturer.
- Apply hydraulic fluid pressure by providing sufficient movement of handle and check the lifting of ram from the cylinder.
- Check visually if there is any leak in the assembly.
- If any leakage rectify it.

Fig 2



PARTS LIST

PARTS	DESCRIPTION	QTY	PARTS	DESCRIPTION	QTY
1	VALVE BLOCK	1	16	BALL	1
2	COPPER WASHSER	1	17	SEAL RING	1
3	CYLINDER	1	18	RELEASE SPINDLE	1
4	O-RING	1	19	BALL	1
5	O-RING RETAINER	1	20	COPPER WASHER	1
6	RAM	1	21	PUMP CYLINDER	1
7	TOP NUT	1	22	**U- CUP SEAL**	1
8	O-RING	1	23	BACK UP RING	1
9	SEALING GASKET	1	24	PLUNGER	1
10	OIL TANK	1	25	PUMP LINK	1
11	OIL PLUG	1	26	HANDLE	1
12	SEAL RING	1	27	HANDLE SOCKET	1
13	**TUBE**	1	28	SHAFT	1
14	BOLT	1	29	COTTER PIN	1
15	PORT	1	30	O-RING	1

MM20N22147H2

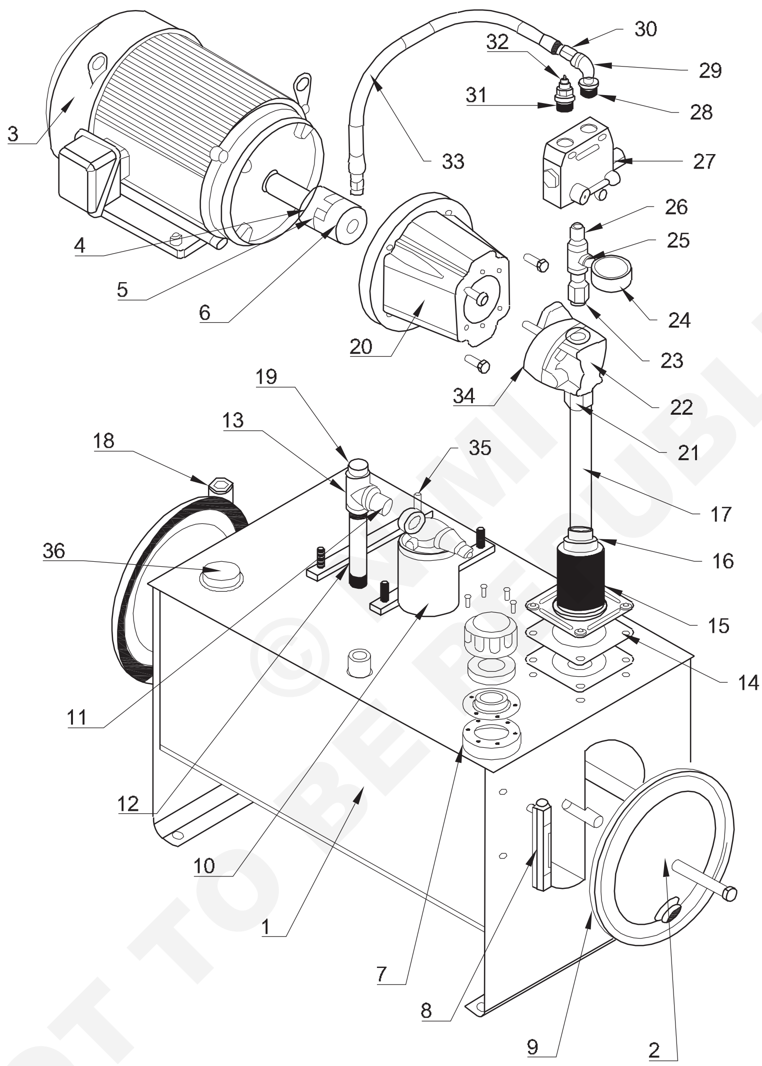
Disassembly of power pack, hydraulic pipes, fuels, hydraulic cylinders, pistons etc.

Objective: At the end of this exercise you shall be able to
- **overhauling of hydraulic power pack**

Fig 1

overhauling of hydraulic power pack

TASK 1



Name of the parts

1 Reservoir
2 Cover plate
3 Motor
4 Hub
5 Spider
6 Hub
7 Vencor cap
8 Oil level gauge
9 Gasket
10 Spin on filter
11 Steel nipple
12 Steel nipple
13 Tee
14 Flange kit
15 Pipe size strainer
16 Brass hex bush
17 Steel nipple
18 Tapped bush
19 Hexagonal bush
20 Pump casing
21 Adapter
22 Pump
23 Adapter
24 Pressure gauge
25 Tee
26 Steel nipple
27 Flow control valve
28 Hexagonal bush
29 Elbow
30 Hose fitting
31 Hexagonal bush
32 Connector
33 Hydraulic hose
34 Hexagonal bolt
35 Adapter
36 Switch for power pack

MM20N22148H1

Job Sequence

TASK 1: **Detach power pack assembly from hydraulic press**

- Switch off the machine and disconnect all the electrical connections and hydraulic pipes from the power pack unit.
- Remove the power pack unit from the hydraulic press.
- If the oil is seen contaminated and lost its properties.
  - Drain out hydraulic oil inside of the reservoir (Part no 1) through drain plug and store it in a clean container.
  - Measure the drain hydraulic oil.
  - Arrange new hydraulic oil of measured quantity if necessary.

Dismantle the power pack assembly

- Remove the hose fitting (Part No 30) by loosening hexagonal nut in the elbow (29).
- Remove the connector (Part No 32) from flow control valve (27).
- Take out the flow control valve (Part No 27), and adaptor (Part No 23) along with pressure gauge (Part No 24).
- Loosen all the (Part No 34) bolt of the pump motor.
- Loosen all the nuts and bolts of pump casing.
- Detach the pump (Part No 22), motor(Part No 3), Hub (Part No 4 & 6) and pump casing (Part No 20) separately.
- Take out the hydraulic pump by loosening the adaptor nut (Part No. 21) and keep it in a tray.
- Remove the steel nipple (Part No.17) and loosen all the screws of flange kit.
- Take out the pipe size strainer (Part No.15) flange kit packings (Part No. 14) separately.
- Remove the vescor cap (Part No.7) by loosening all screws at the top.
- Take out the spin on filter (Part No.10) from the unit.
- Remove both cover plates (Part No.2) by loosen the bolts.

Inspect all the parts of power pack unit

- Check the working of motor by giving power supply and watch if there is any unusual noise is coming.
- If such noise is found then replace the motor shaft bearings.
- Check visually the flow control valve and clean it with kerosin, apply few fresh hydraulic oil on its surface.
- Check the opening passage through the steel nipple and clean it thoroughly by kerosene or petrol, apply fresh hydraulic oil in it.
- Inspect the pressure gauge and its needle.
- Check the working of the hydraulic pump by simply rotate its shaft in clockwise direction after assuring hydraulic oil through inlet of the pump by using a temporary transparent hose dipped into a oil jar.
- Close the outlet port of the pump with a finger and feel the oil pressure.
- Remove the finger from the port and watch the flow of hydraulic oil through outlet port.
- Check the inner portion of the hydraulic oil reservoir of the power pack assembly and clean it with fresh hydraulic oil.

Replace the worn out parts

- Clean thoroughly all the strainers and replace it if necessary.
- Replace all the packings, gasket(Part No 9), bushes (Part no 16,18,19 and 28,31) by a new one.
- Check the spider (Part no 5) in the coupling and replace it if found to be worn out.
- Replace the old contaminated hydraulic oil with new oil of required quantity and specification.
- Replace the hydraulic hose (Part no 33) if there is any leakage is found through its hose fitting or hose itself.

Assemble the power pack

- Assemble all the parts of the hydraulic power pack unit in a reverse manner as specified under the task of dismantling.

Check the performance of Power Pack unit

- Fix the power pack unit with the machine in its position by tightening the bolts.
- Fill required quantity of new hydraulic oil in the reservoir.
- Connect all the hydraulic lines and electric lines with the power pack unit.
- Switch on the power supply and press the power pack switch (Part No 36).
- Carefully watch the reading shown by the oil pressure gauge and (Part No 24) thus to ensure proper pumping of hydraulic pump.
- Inspect all the oil lines for oil leakage and rectify it if necessary.
- Observe the working of the hydraulic press and its movement of ram.

— — — —

Replacing and refitting of hydraulic pipes, seals in the gear pump

Objectives: At the end of this exercise you shall be able to
- **dismantle the gear pump and hydraulic pipes**
- **replace the wornout components and reassemble the gear pump**
- **test the gear pump.**

Requirements

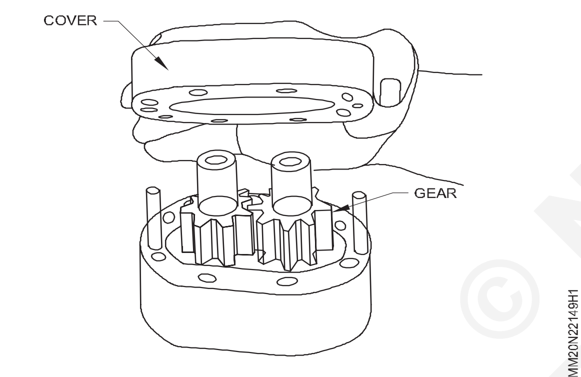
Tools / Instruments

- Trainee tool kit - 1 No
- Allen head socket wrench - 1 Set
- Allen key set - 1 No
- Internal snap/ring pieces - 1 Set
- Shaft seal installation tool - 1 No
- Torque wrench - 1 No
- Feeler gauge - 1 No

Equipment/ Materials

- Kerosene - as reqd
- Baninan cloth - as reqd
- SAE/light oil - as reqd
- Grease - as reqd
- Wear plates - as reqd
- Sealant - as reqd
- Hydraulic gear pump - 1 No
- Seal adhesive material - as reqd

Fig 1



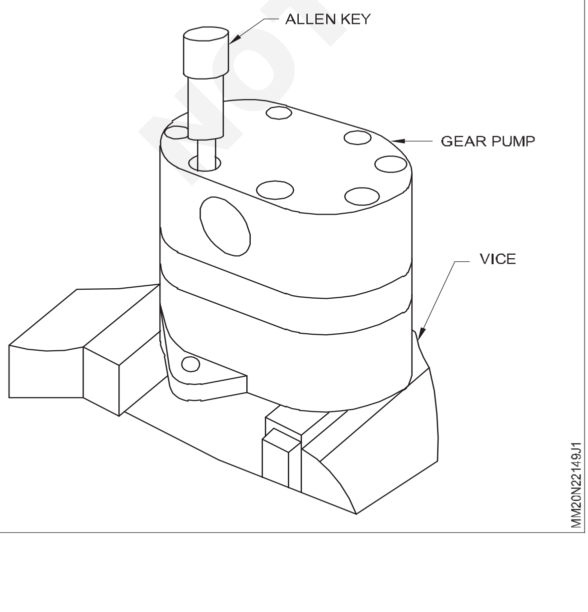
Job Sequence

TASK 1**: Dismantle the gear pump**

- Clamp the unit in a vice from the flange side. (Fig 1)

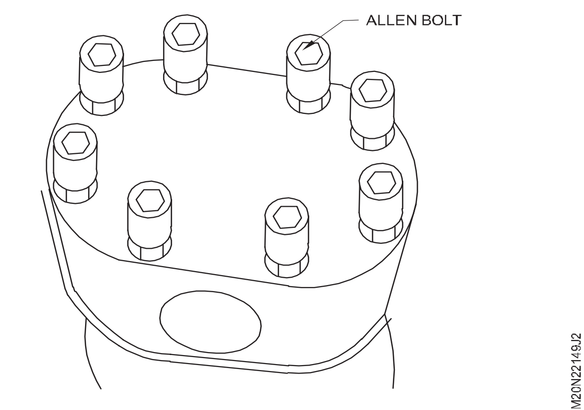
Make sure the vice jaws are clean and have smooth surfaces.

Fig 1



- Use an Allen head socket wrench to loosen the bolts on the cover assembly. (Fig 2)

Fig 2



- Unscrew the bolts completely and remove them. (Fig 3)

Inspect the threads for damage.

- Remove the cover assembly carefully.(Fig 4)

Fig 3

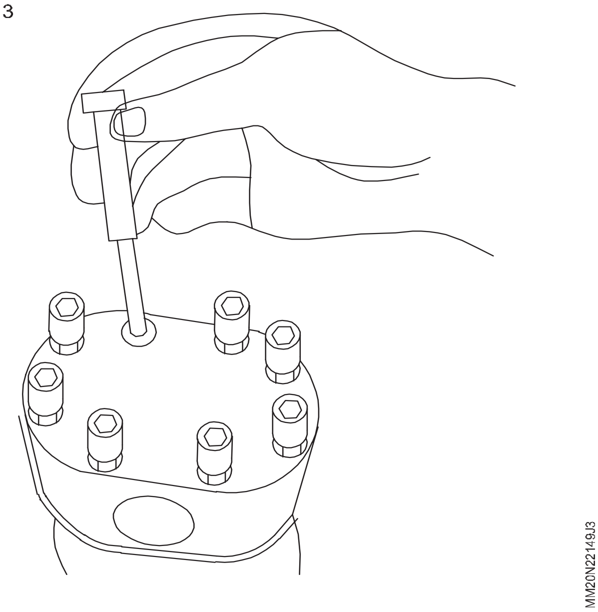
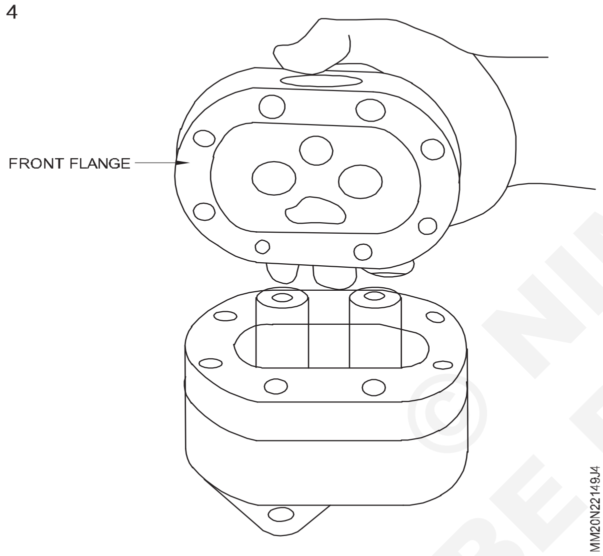


Fig 4



Some of the pumps may have a shaft seal, in such a case remove the cover assembly with care to prevent any damage to the seal.

- Place the cover assembly on the work bench. Inspect the wear plate for wear and tear.
- Remove the wear plate and seal ring from the cover assembly.(Fig 5)

Do not use sharp tools to remove the seal.

- Carefully remove the gear plate and remove the dowel pins.(Fig 6)

During disassembling the unit,mark the relative positions of the gear mesh and the body that helps during reassembly.

- Remove the idler shaft and drive shaft from it's bearing bore (Fig 7 & 8).

Fig 5

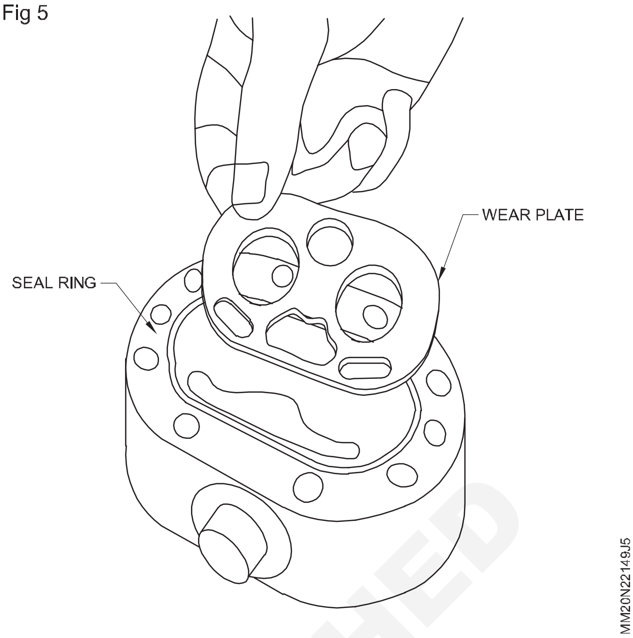


Fig 6

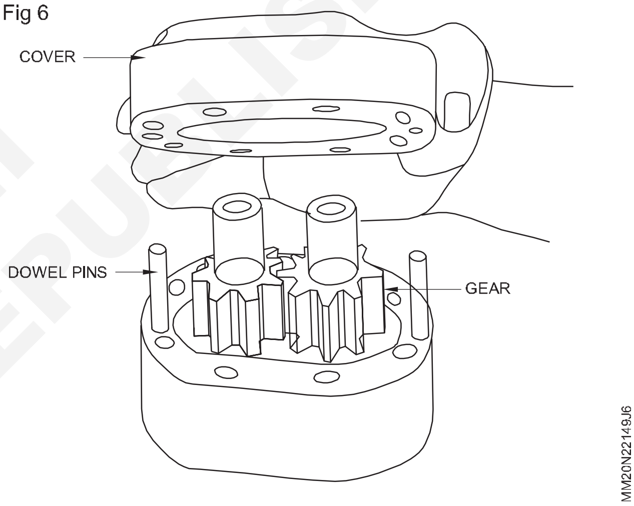


Fig 7

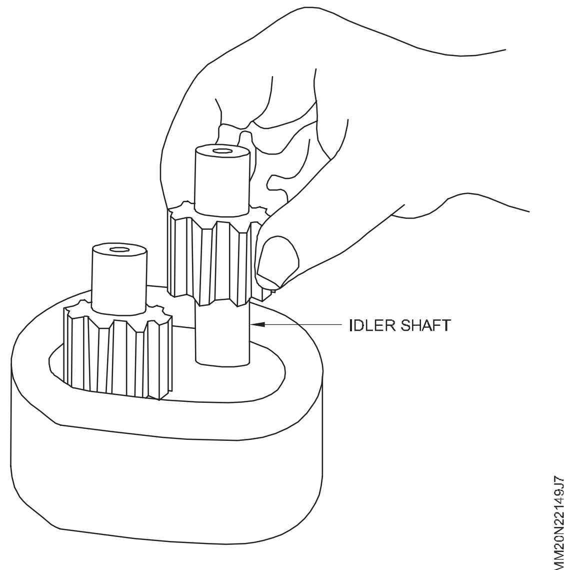
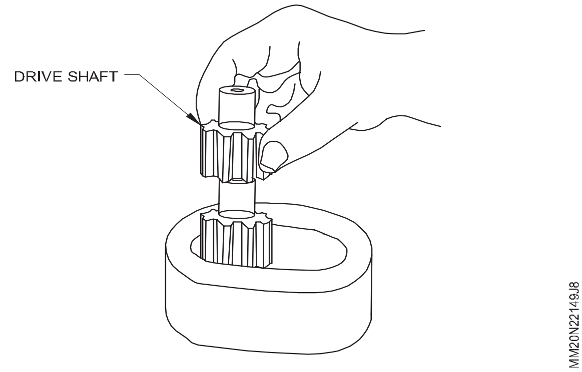


Fig 8



Inspect the journals and the flat faces top and bottom of the gears. Ensure these surfaces are free from burrs or scratches. If scratches are found, clean them with very fine emery cloth.

- Rewash the gears with light oil.
- Remove the wear plate from the assembly. (Fig 9)

• Inspect the lower wear plate for wear, or marks caused by overheating.

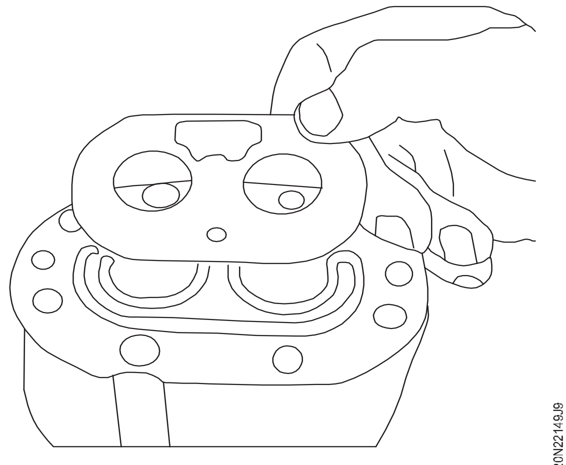
• Replace if necessary.

- Remove the shaft seal and snap ring from the body assembly. (Fig 10)

Use internal snap ring pliers to remove snap ring.

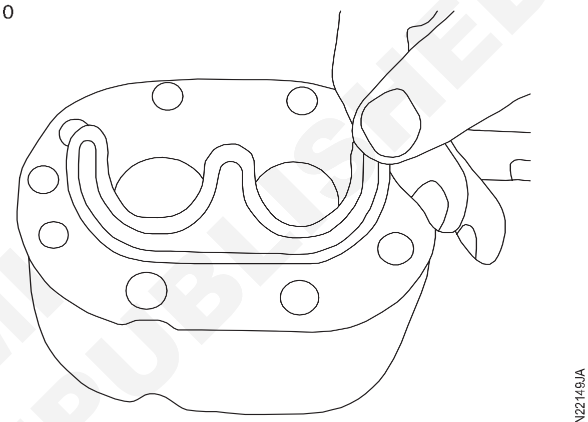
Keep all the components of pump in proper manner and in clean place.

Fig 9



REMOVE WEAR PLATE

Fig 10

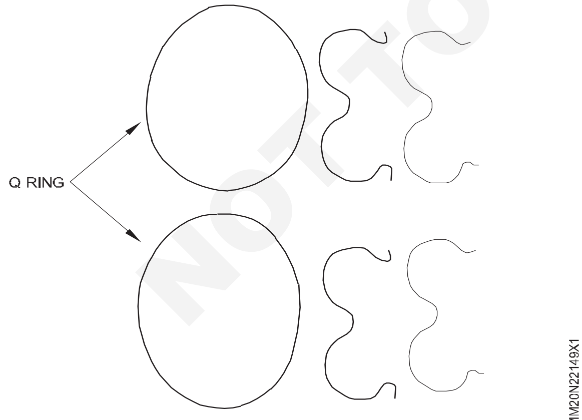


REMOVE SEALS

TASK 2 **: Replace the worn out components and reassemble the gear pump**

- Take the entire seal kit required and compare the old seal kit to the new one to ensure you have the correct one. (Fig 1)

Fig 1



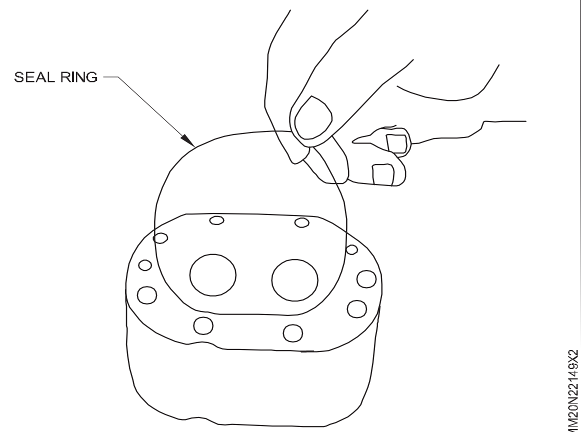
Apply grease in all seals before use it.

- Prepare the body by cleaning it. Inspect the internal and mating surfaces.

Ensure the surfaces are free of burrs and scratches.

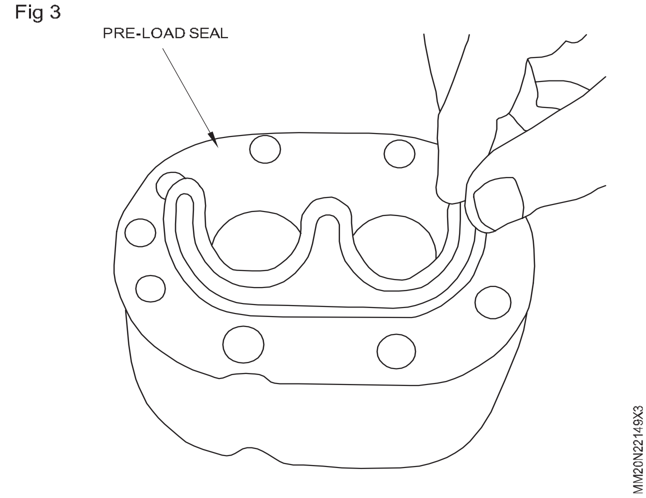
- Install the shaft seal into the body assembly.
- Apply light lubricant in the body and shaft seal. Place the seal in the body assembly by hand. Then, press the seal using a shaft seal installation tool. This will insure the seal is in proper depth.(Fig 2)

Fig 2



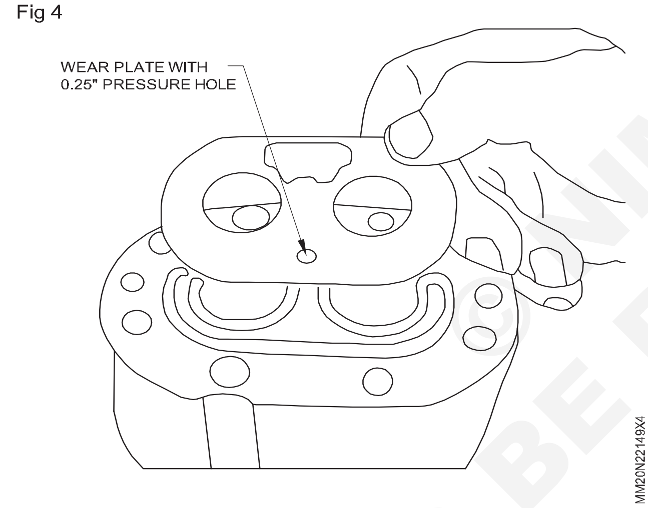
- Place the body assembly, with the E- ring seal grooves facing up.(Fig 3)

Fig 3



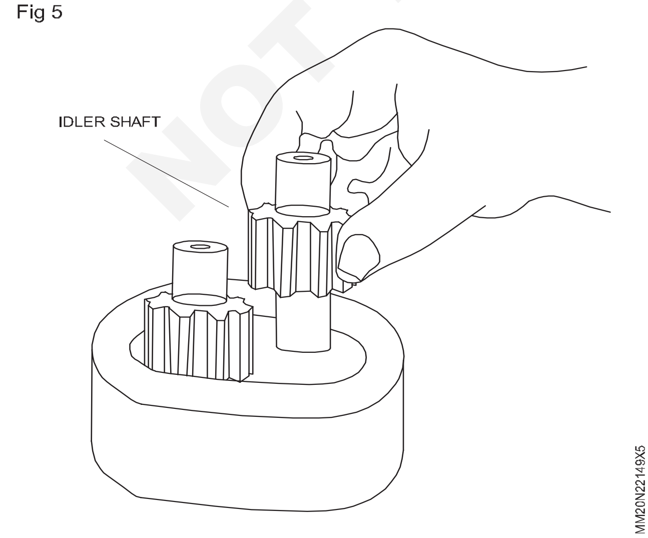
- Place the wear plate on top of the E- ring with the bronze side facing up towards the gear. The 0.25” pressure hole is to be positioned on the E-ring side of the body. (Fig 4)

Fig 4



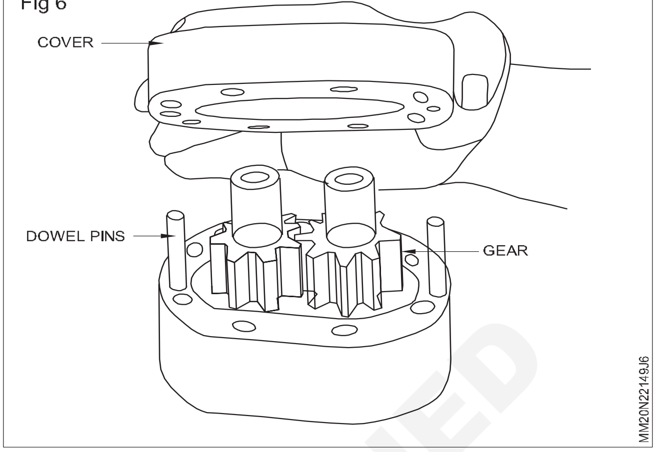
- Lubricate the spine end of the drive shaft with grease. Insert the drive shaft and the idler shaft in the correct bearing bore.(Fig 5)

Fig 5



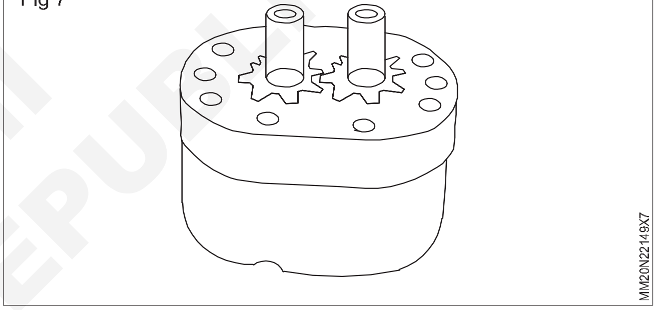
- Inspect gear teeth for alignment. Lubricate the complete gear set using clean light oil.
- Insert the two dowel pins into the body assembly. Place the gear plate over the dowel pins.(Fig 6)

Fig 6



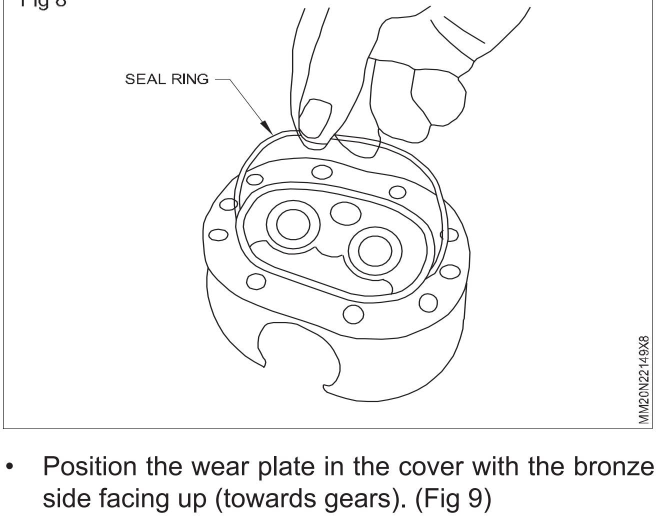
Make sure the gear plate is seated properly. (Fig 7)

Fig 7



- Place the cover assembly on a bench with the machined surface facing up.
- Place the rubber seal ring in the cover seal ring groove. (Fig 8)

Fig 8



- Position the wear plate in the cover with the bronze side facing up (towards gears). (Fig 9)

Pressure hole located over the circular holes in the cover.

- Place cover assembly over the body assembly. (Fig 10)

Fig 9

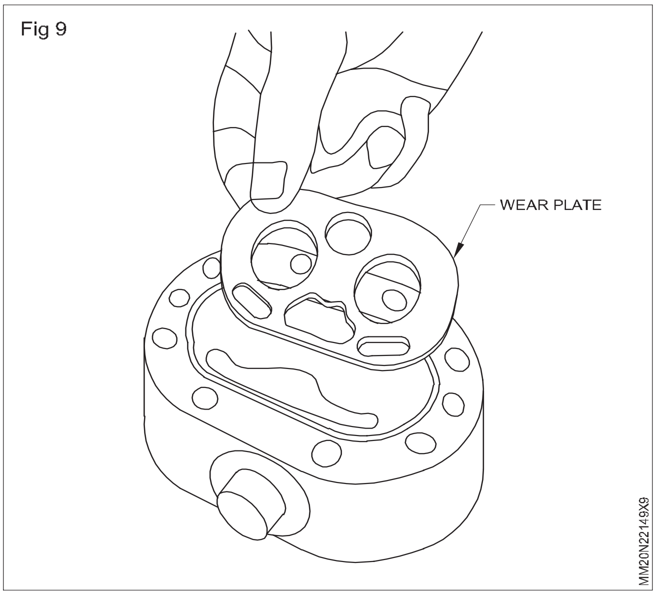
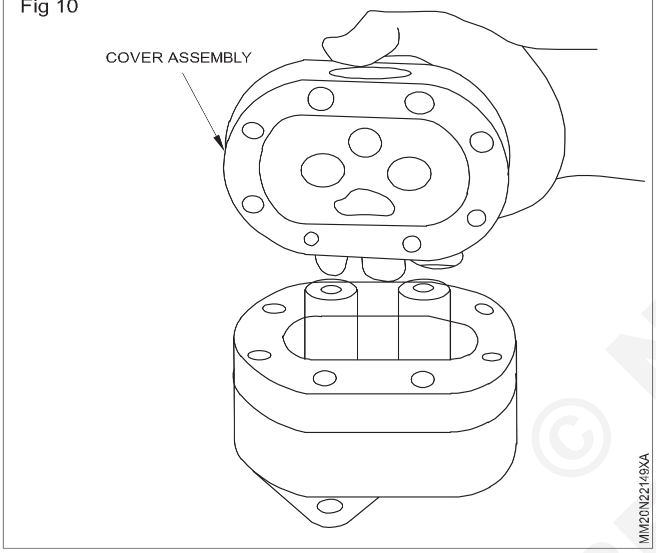


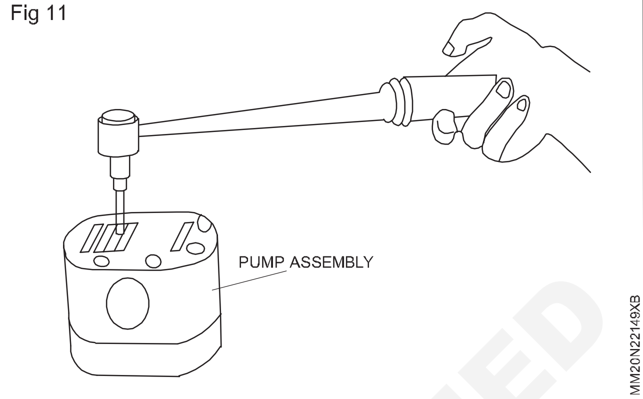
Fig 10



- Fasten assembly using torque wrench. (Fig 11)

If components are replaced by new componant, run the pump in idle for some time dismantle and wash with solvent to clear off pre-setting wear particles.

Fig 11



TASK 3 **: Test the pump for proper functioning**

- Rotate the pump and check the flow rate, smoothness of rotation and sound of pump.

Observation

- Flow rate of pump as per specification.
- Operation of pump should be smooth.

Conclusion:

Assemble the parts and testing of the power press after bleeding

Objectives: At the end of this exercise you shall be able to
- **assemble the parts of power press**
- **prepare the hydraulic press for use**
- **bleed air from the hydraulic system of power press**
- **operate the hydraulic power press.**

Job Sequence

TASK 1**: Assemble the parts of power press**

- Place the base casting (Part (1) on flat floor
- Place the cylinder block (Part (2)) on base casting (1)
- Assemble the all the remaining power press parts as shown in table from part No. 3 to Part No.74 in proper sequence order
- Check power press alignment, prescribed by manufacturer
- Fill up hydraulic power press oil up to prescribed level
- Ensure power pressure as specified by the manufacturer.

Fig 1

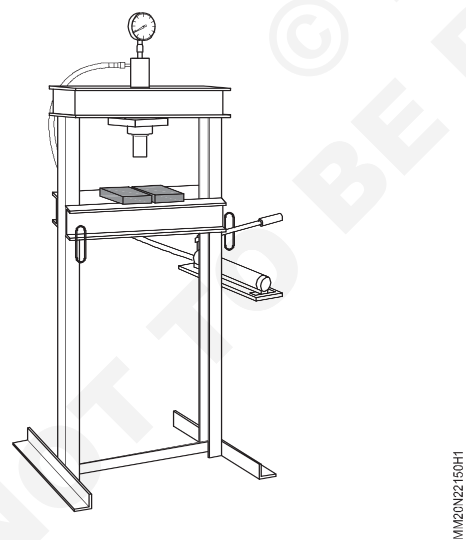


Fig 2

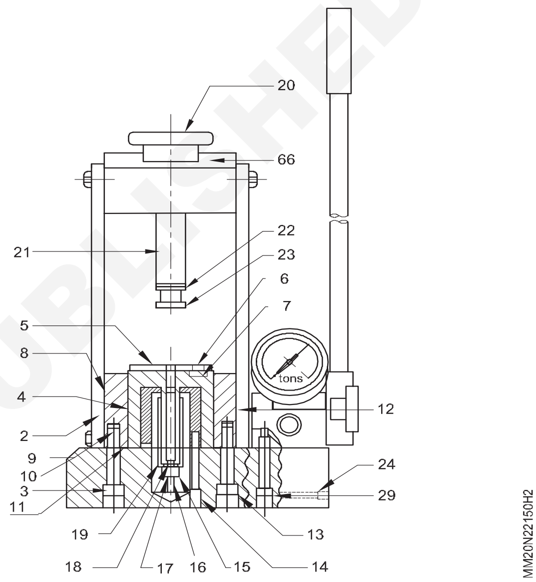


Fig 3

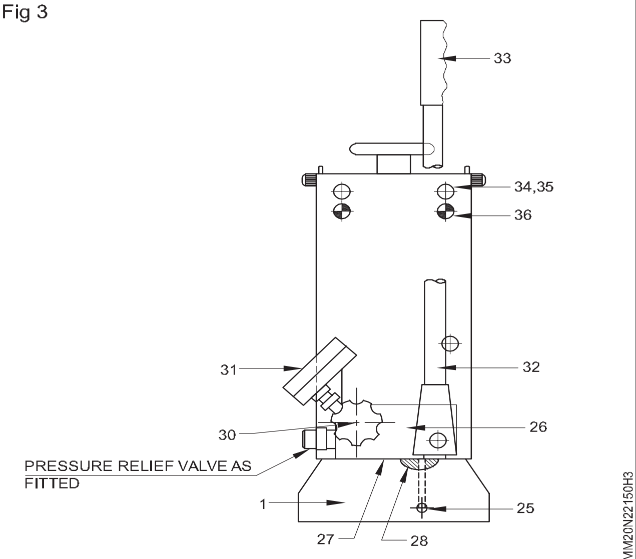


Fig 4

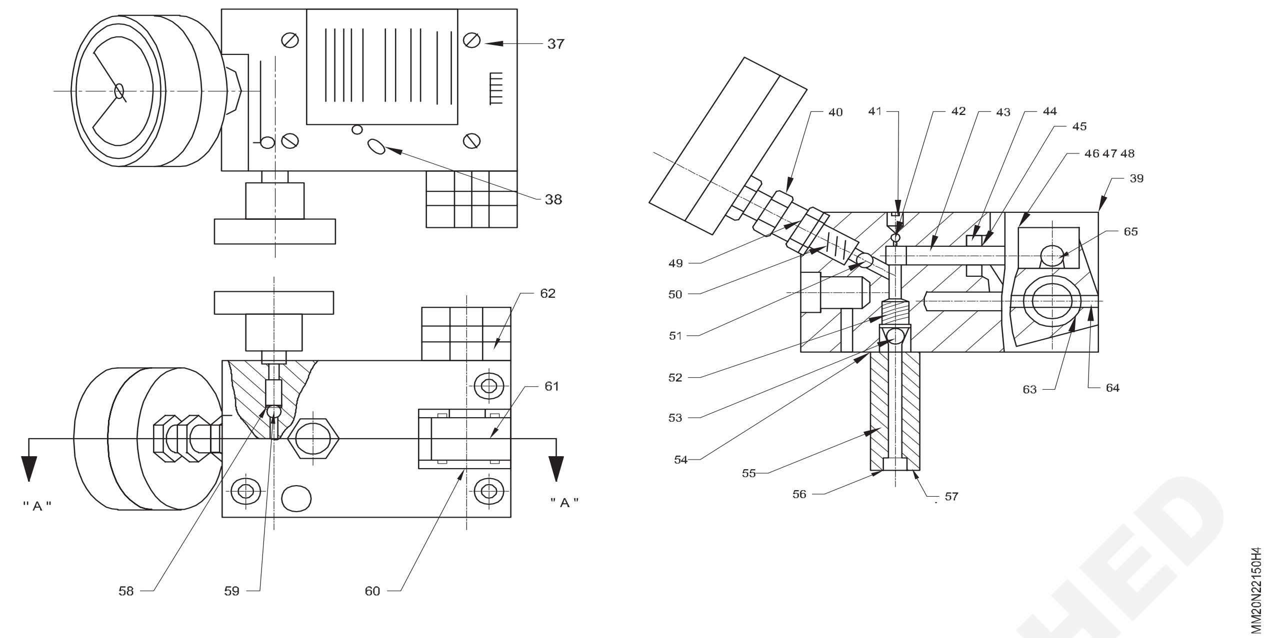
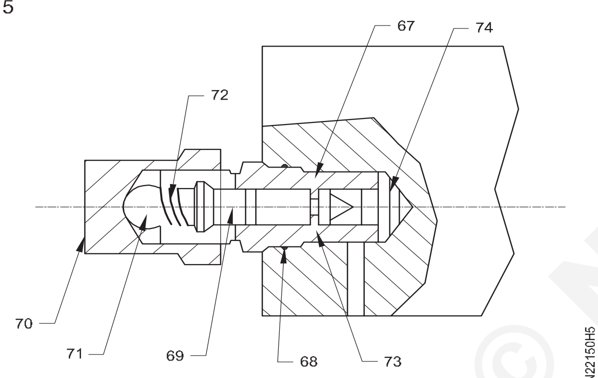


Fig 5



DETAILS OF PRESSURE RELIEF VALVE ASSEMBLY

Parts List

Part no.	Item
1	Base casting
2	Cylinder block
3	Cylinder block screw
4	Piston
5	Lower bolster
6	Bleed screw
7	Bleed ball
8	Wiper ring piston
9	“O” ring piston
10	Upright bolt
11	“O’” ring cylinder block
12	Spring housing
13	Copper sealing washer
14	Spring housing screw
15	Spring spacer
16	Spring stud
17	Spring nut
18	Spring washer
19	Spring
20	Screw handle
21	Screw top bolster
22	“O” ring top bolster
23	Top bolster
24	Oilway plug seal
25	Oilway plug
26	Pump block
27	Pump block gasket
28	Pump block “O” ring
29	Pump block screw
30	Pressure release handle
31	Pressure gauge
32	Pump handle
33	Pump handle grip
34	Upright bolt
35	Upright bolt washer
36	Upright dowel
37	Pump plate
38	Pump vent screw
39	Pump gasket upper
40	Gauge connector
41	Bleed screw
42	Bleed ball

43	Pump piston
44	Pump piston seal
45	Pump piston “O” ring
46	Pump piston sealing housing
47	Pump piston gasket
48	Pump piston screws
49	Gauge seal
50	Non return spring
51	Non return valve ball
52	Non return spring
53	Non return valve ball
54	Intake seal
55	Intake pipe
56	Intake filter
57	Intake circlip
58	Release screw “O” ring

59	Release ball
60	Crank pin circlip
61	Crank
62	Crank shaft
63	Crank shaft bush
64	Crank fixing pin
65	Crank pin
66	Safety visor
67	Relief valve body
68	Relief valve seal
69	Relief valve poppet
70	Relief valve set knob
71	Relief valve ball
72	Relief valve spring
73	Relief valve poppet ‘”O” ring
74	Relief valve seating

— — — —

TASK 2**: Preparing press for use**

- Remove pump plate, 37 (Fig 2) and gasket, 39. (Fig 3)
- Remove lower bolster, 5 (Fig 2) and slacken bleed screws, 6 and 41. (Fig 4)
- The oil capacity of the press is about 1 pint (0.6 litre). Pour oil into 0.5 inch diameter hole in top of pump block until oil level can be seen about 2 inch below the top of pump block. (Part no. 26)(Fig 3)
- Prime pump as described as per the procedure under air bleeding. (Fig 3)
- Firmly tighten pressure release screw, 30 (Fig 3) and continue pumping until oil begins to issue from bleed hole in top of piston. At first the oil will contain air bubbles but continue gently pumping until oil is free of air.
- Top up oil reservoir until oil level is again about 2 inch below top surface of pump block.
- Pump until piston rises to one inch above the cylinder block at this height a red ring will appear around piston.

Do not pump beyond this red ring.

- Release valve, 30 and piston slowly return to its lowest position.
- If the piston is sticky then return back it by means of upper screw.
- Repeat the procedure a few times until the piston gives a free movement.
- Re-bleed the whole system. Ensure that bleed screws, 6 and 41, are tight and secure.
- Re fix pump plates (37) and its gasket (39).
- If press is required to be transported, replace vent screw (38).(Fig 4)

— — — —

TASK 3**: Bleeding of air from the hydraulic pump**

- Slacken the bleed screw (Part No.41).(Fig 4)
- Pump the handle gently (Part No.33).(Fig 3)
- Observe the air expelling from the system through bleed screw.
- Keep pumping until all the air is expelled from the pump i.e, the full flow of air free oil issues around the screw..
- Pump the handle forward an tight the bleed screw firmly.

Bleeding of air from piston and cylinder

- Repeat the same procedure and perform the bleeding of air from cylinder piston assembly.

— — — —

TASK 4: **Operate the hydraulic press (Fig 2 & 3)**

- Raise safety visor, place the work on the lower bolster 5(Fig 1), ensure that it is positioned in the centre of the bolster, lower safety visor.
- Screw top bolster 23 (Fig 2) onto work by means of handle 20.(Fig 2)
- Rotate release handle 30 (Fig 3) clockwise and tighten firmly.
- Pump by means of handle 32 (Fig 3) until required load is indicated on gauge 31.(Fig 3)

Warning - ENSURE THAT SAFETY VISOR IS DOWN BEFORE PUMPING. DO NOT pump beyond prescribed load by the manufacturer. When Red. Ring around piston shows, STOP PUMPING FAILURE to observe either of these warnings will result in damage to the press mechanism.

- To release load on work rotate release handle 30 Part number anti-clockwise, about one turn.
- Lower bolster will then return to its original position.
- Set the desired load below from the maximum load in the pressure relief valve (Part No.30).
- Rotate handle of pressure relief valve clockwise to increase the force to get the desired load.
- When the set load is obtained, the relief valve will blow off so that further pumping will not increase the load applied to the ram.
- To reduce pressure, rotate the milled head anti-clockwise and then open and close pressure relief handle then pump again until the reduced load is obtained.

— — — —

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.**

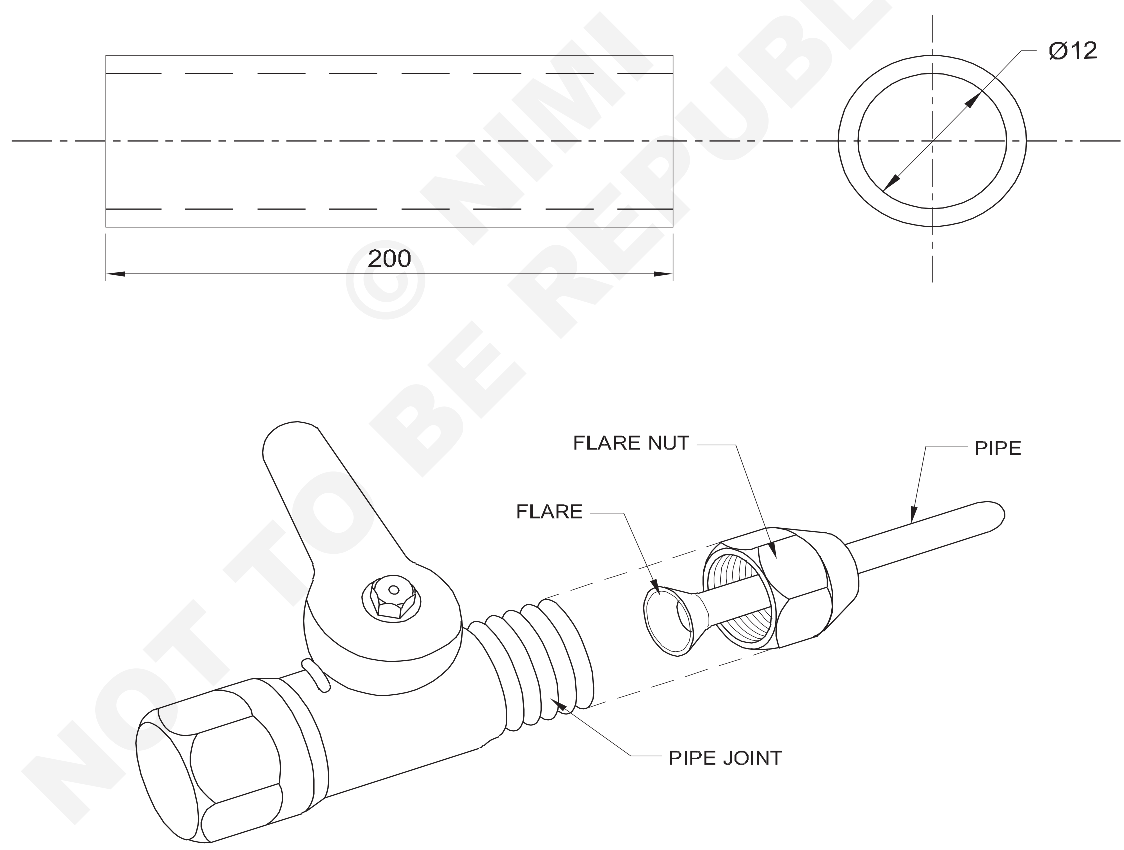
Requirements

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 gauge

Materials

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



1	Ø 12 x 200L		GI PIPE (Fe 310)			2.3.151
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE: 1:1	FLARING OF PIPES AND PIPE JOINTS	DEVIATIONS	TIME : 3 Hrs
		CODE NO. MM20N23151E1	

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 - 1

Make flare joints and test them with flare fittings

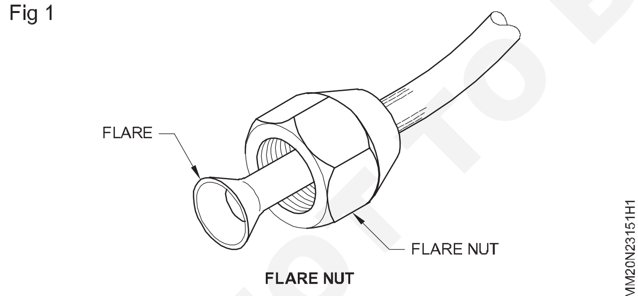
Objectives: This shall help you to
- **flare the end pipe**
- **join the flare nut with flare fitting and test it.**

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).

Fig 1



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

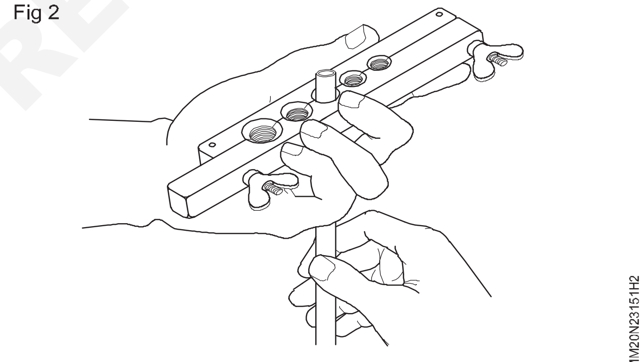
Examine the pipe flaring tool. Make sure that you understand how it works before starting to flare the end of a pipe.

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:

a Place the flare nut on the pipe

Fig 2



b 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).

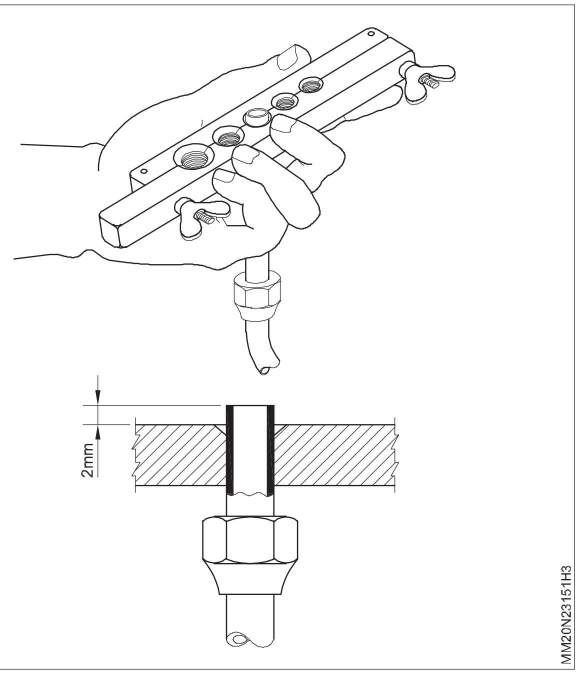
Fit the yoke to the flaring block (Fig 3)

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.

Fig 3

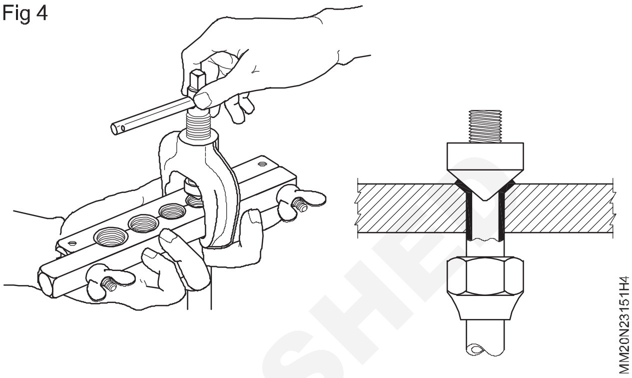


Examine the flare. If it has cracked, the cone was screwed down too quickly.

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.

Fig 4



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

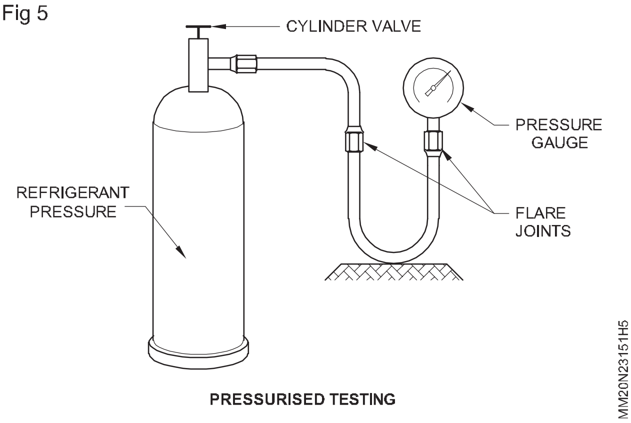
Push back the flare nut and place the flared pipe on the fitting, then tighten the flare nut using adjustable wrench or suitable double end spanner.

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.**

Fig 5



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 - 2

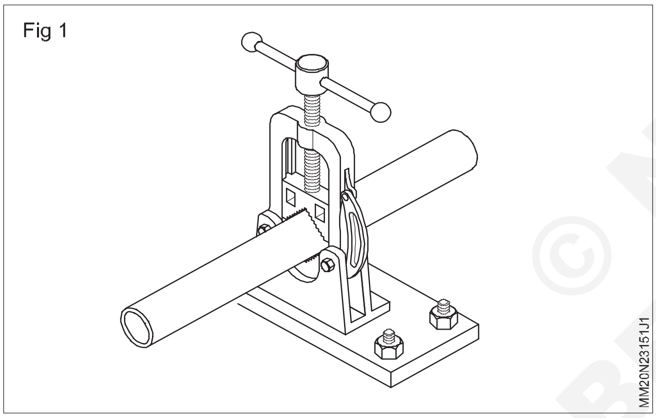
Handling of pipe flaring & cutting tools

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)

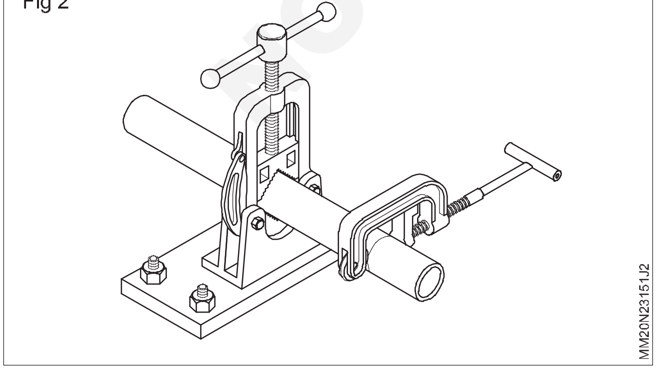
Fig 1



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)

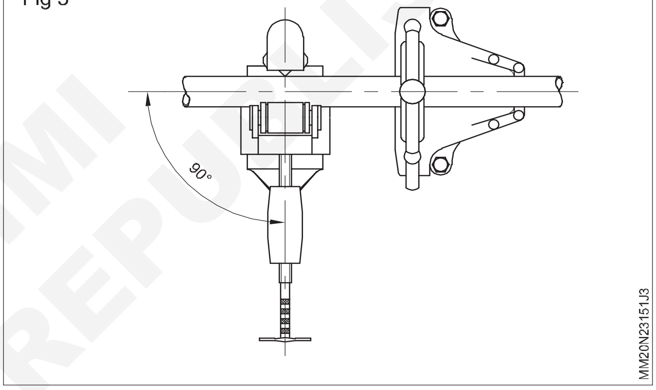
Ensure that the pipe is kept horizontal and parallel to the serrations such that the marking is visible at the top.

Fig 2



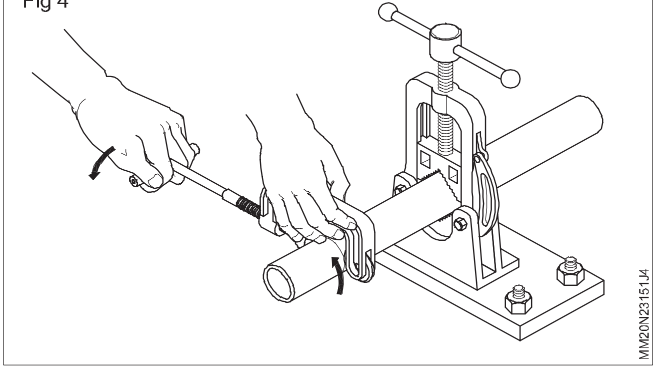
Rotate one or two turns to ensure that the cutting wheel is sitting exactly on the scribed line at 90° to the pipe (Fig 3).

Fig 3



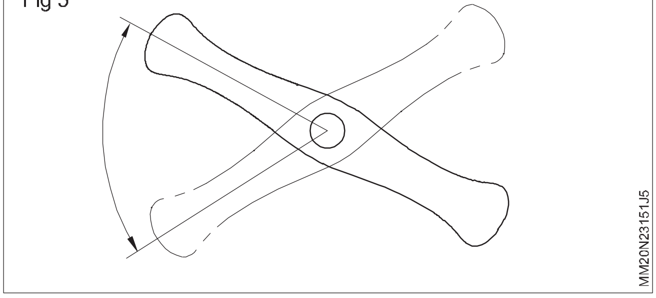
Rotate the pipe cutter around the pipe (Fig 4).

Fig 4



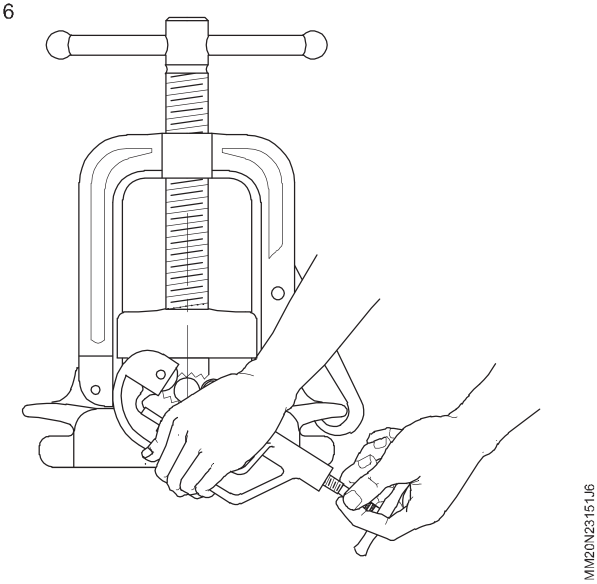
After two or three turns use the jacking screw to apply pressure on the cutting wheel (Fig 5).

Fig 5



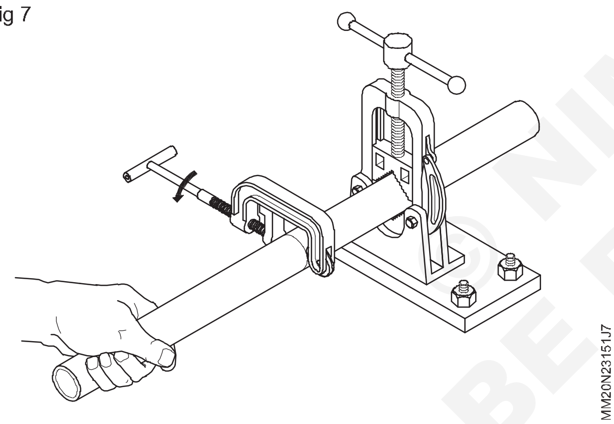
Keep rotating the pipe cutter around the pipe. Increase the pressure to the cutter by repeating the cycle until the pipe is cut through (Fig 6).

Fig 6



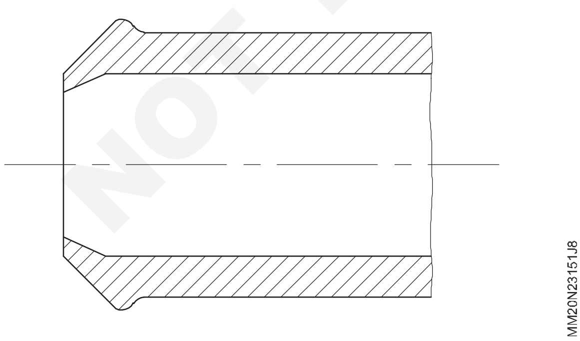
Support the pipe with your left hand so that the free end of the pipe does not fall. (Fig 7)

Fig 7



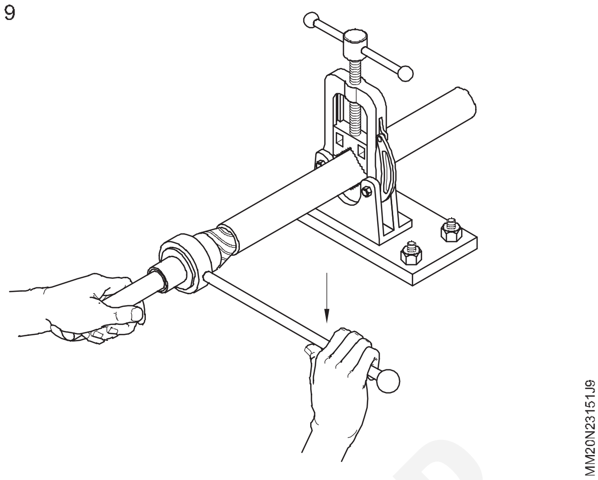
The cut portion of the pipe will appear as shown in Fig 8.

Fig 8



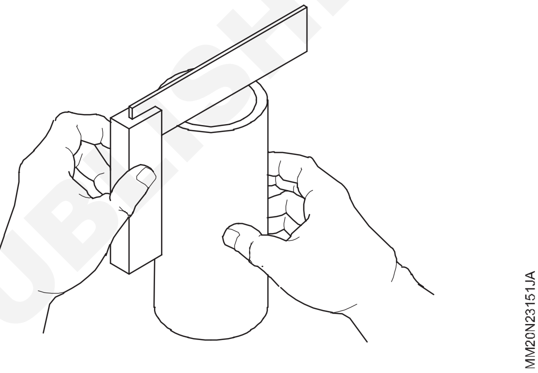
Remove burrs using a pipe reamer. (Fig 9)

Fig 9



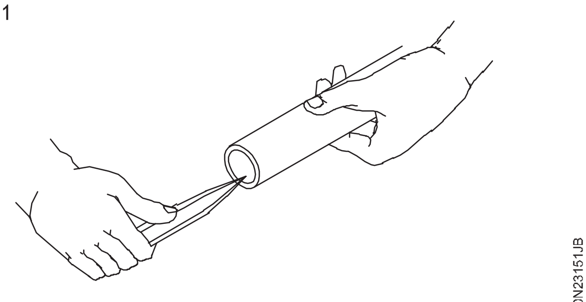
Check that the pipe ends are square. (Fig 10)

Fig 10



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

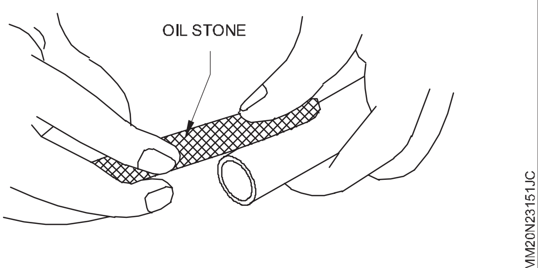
Fig 11



INSIDE EDGE OF THE PIPE MUST BE SLIGHTLY DEBURRED

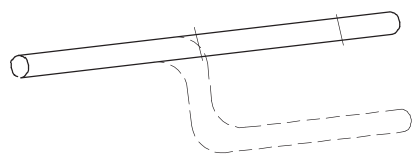
Outside edge of the pipe must be slightly deburred (Fig 12).

Fig 12



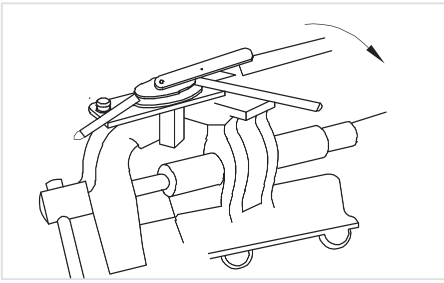
With this edge as reference the pipe is marked for bending (Fig 13).

Fig 13



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

Fig 14



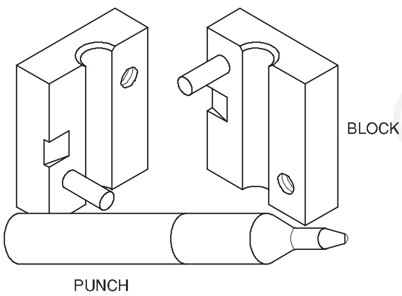
ALWAYS USE PIPE BENDING FIXTURE FOR PROPER BENDING OF THE PIPE

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).

Fig 15

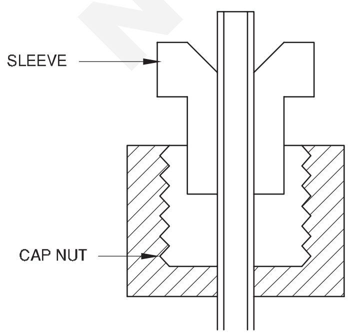


Pipe which is cleaned off burrs and bent should be selected

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

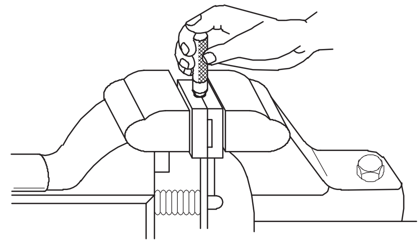
Sleeve and cap nut should be assembled before flaring (Fig 16).

Fig 16



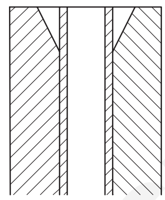
The flaring unit is held in a bench vice with the pipe (Fig 17).

Fig 17



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

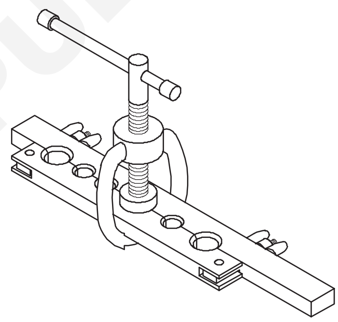
Fig 18



Using the flaring punch, flare the pipe end.

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

Fig 19



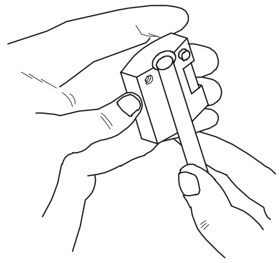
COMPRESSION-TYPE

Installing a flare fitting

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

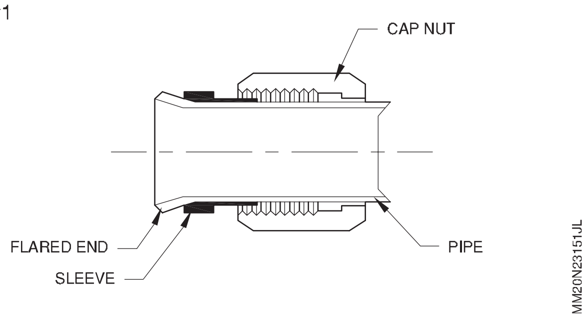
Check the flare angle is suitable to the sleeve angle (Fig 20).

Fig 20



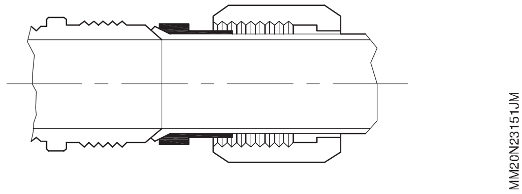
Place the flare on the connector end. Confirm the angle is same (Fig 21).

Fig 21



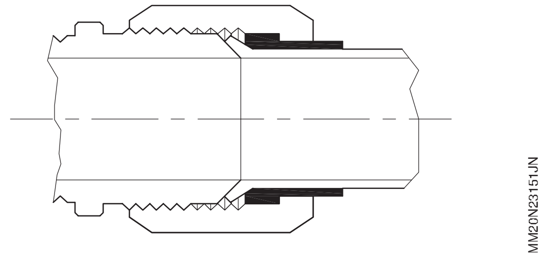
Screw the cap nut on the connector thread by hand (Fig 22).

Fig 22



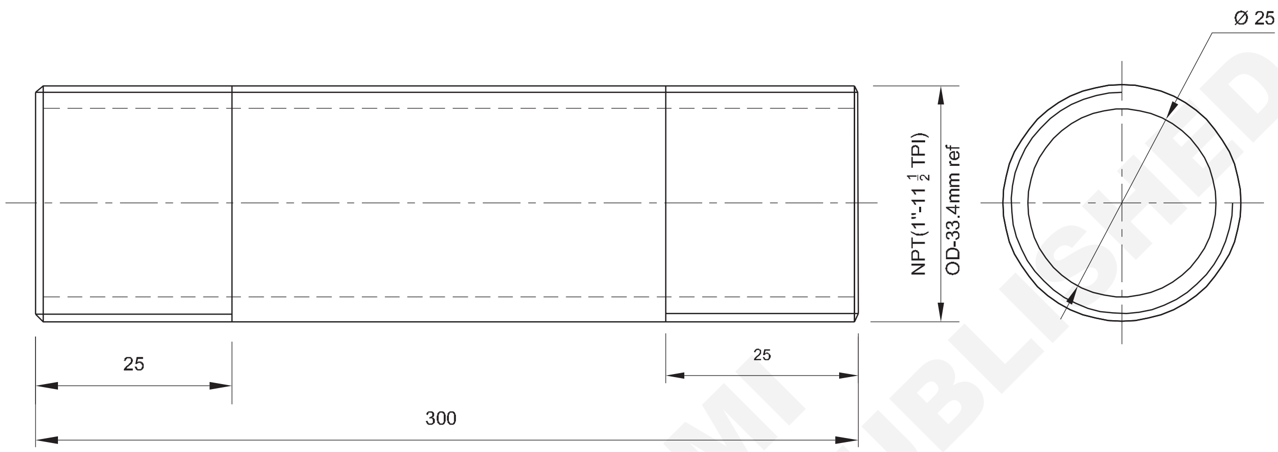
Use a suitable spanner and tighten the cap nut until the pipe does not rotate in the joint (Fig 23).

Fig 23



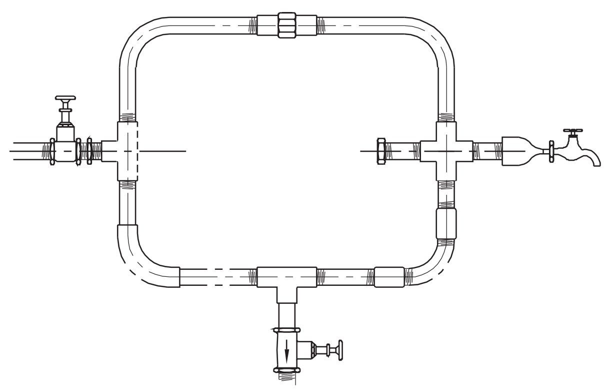
Cutting and threading of pipe length

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.
- Select die set 1 - 11½ TPI
- Fix in die stock
- thread the pipe (use lubricant)
- check with female thread part.



1	Ø25 - 300L		G.I	-	-	2.3.152
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	CUTTING & THREADING OF PIPE LENGTH	DEVIATIONS	TIME :
		CODE NO. MM20N23152E1	

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 rather - type die stock (Figs 1 &2)

Fig 1

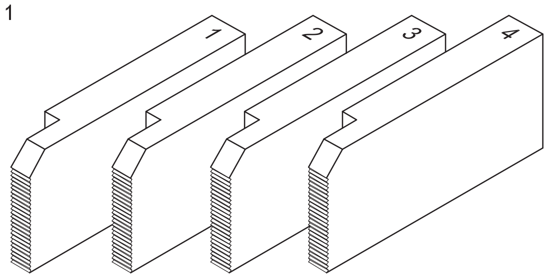
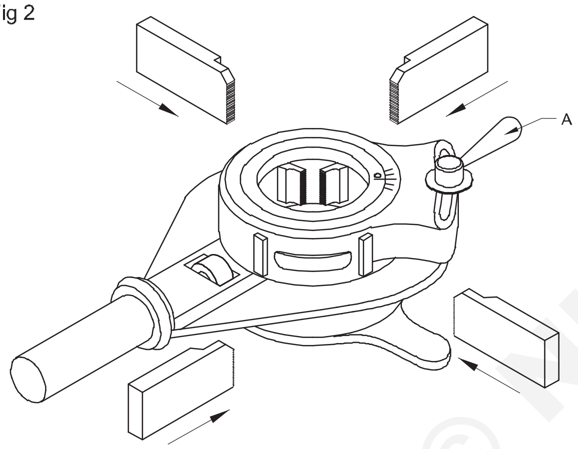


Fig 2



Open the adjustment lever. (A)

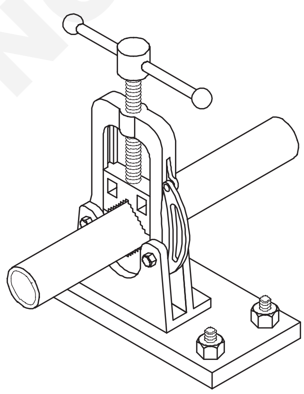
Coincide the zero setting mark '0' die stock and then insert the four dies according to the number on the dies and die stock respectively.

Ensure that the dies set 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)

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.

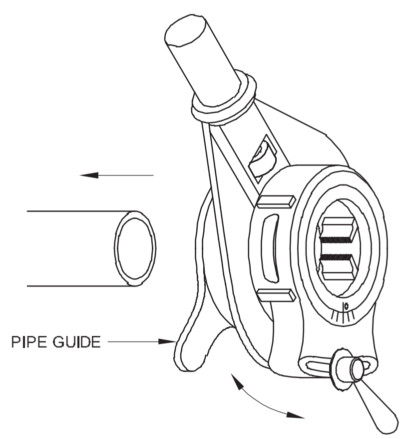
Clean the thread with a wire brush.

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.

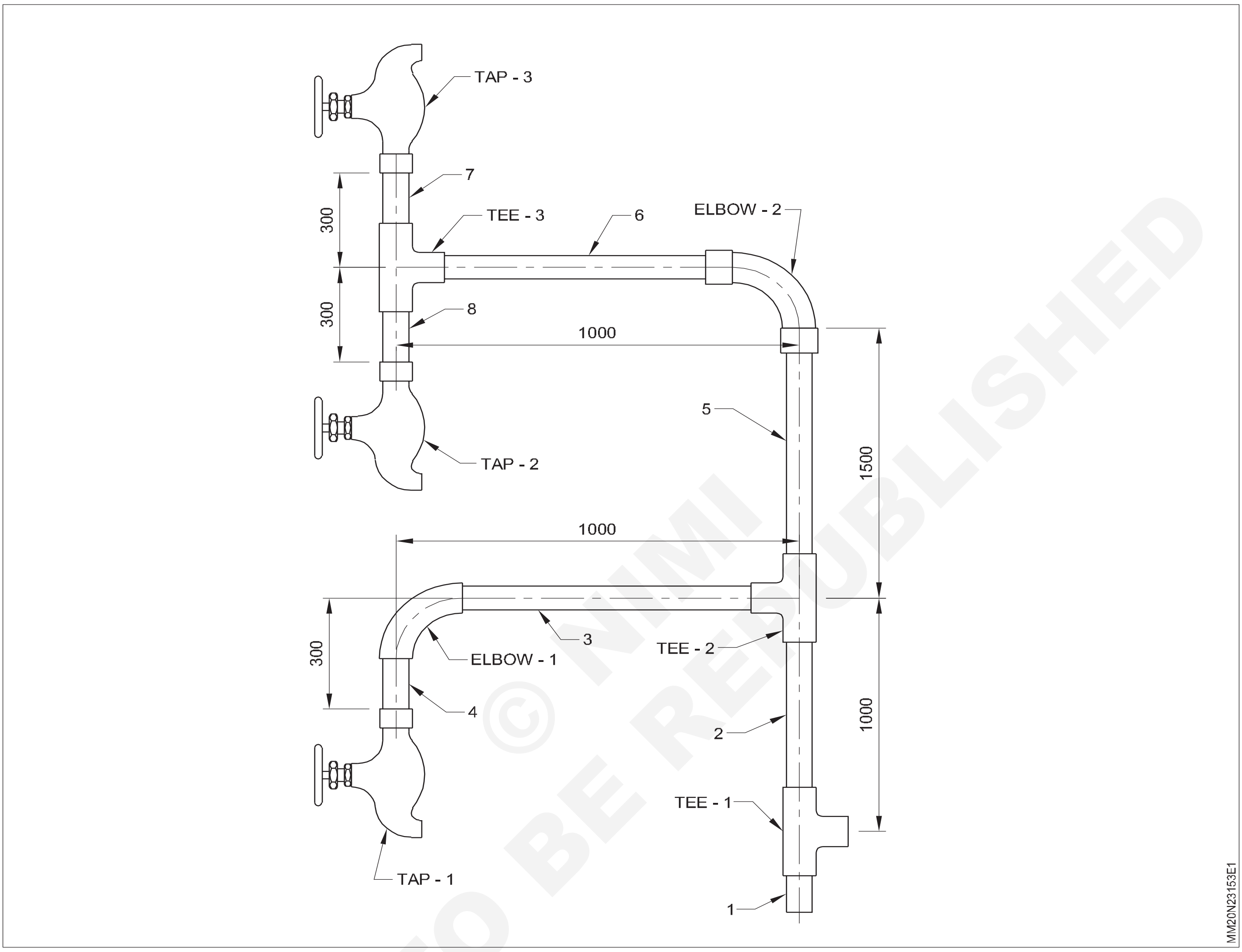
Check the formation of thread with a standard fitting.

Fig 4



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

Objectives: At the end of this exercise you shall be able to
- **fix the GI Pipes with fittings as per drawing.**



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.

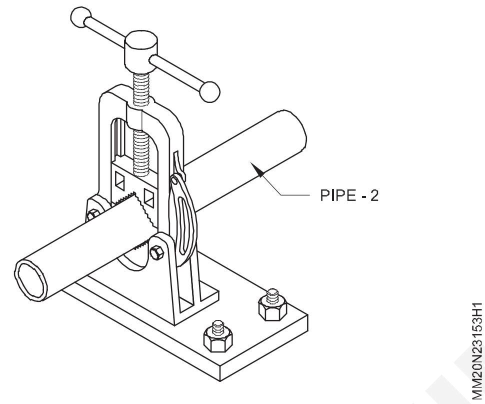
- Fit pipe 6 to socket using pipe wrench after adopting the procedure.
- Fit tee 3 to pipe 6 using pipe wrench after adopting the procedure.
- Fit pipe 7and 8 to tee - 3 using pipe wrench after adopting the procedure.
- Fit socket to pipe 7 and 8 using pipe wrench after adopting the procedure.
- Fit 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

Objective: This shall help you to
- **assemble pipe and pipe fittings.**

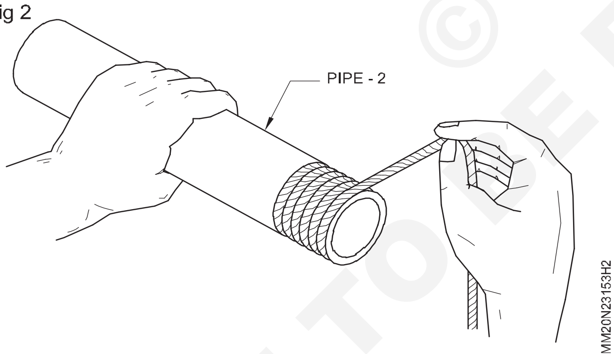
Hold the pipe No. 2 in a pipe vice (Fig 1).

Fig 1



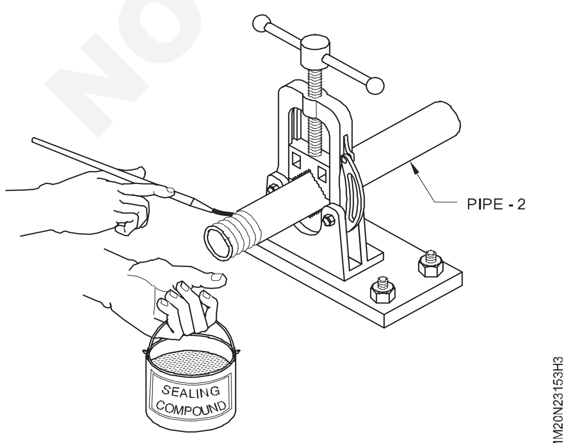
Wind the hemp packing/cotton thread material on the external threads of the pipe (Fig 2).

Fig 2



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

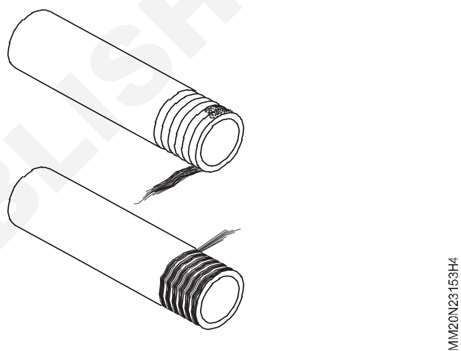
Fig 3



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

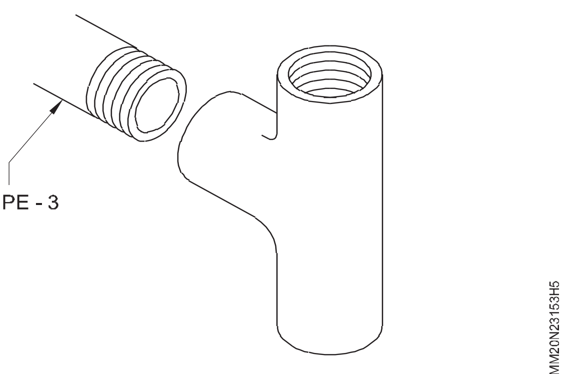
Wind the hemp packing to external threads of all the pipes and standard fittings and apply sealing compound over the threads before joining with the other one (Fig 4).

Fig 4



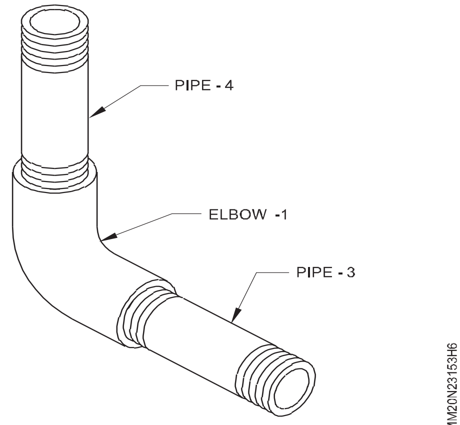
Fit pipe No. 3 with Tee-2 (Fig 5).

Fig 5



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

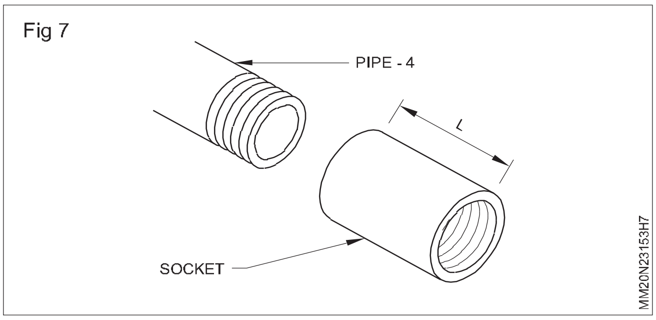
Fig 6



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

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

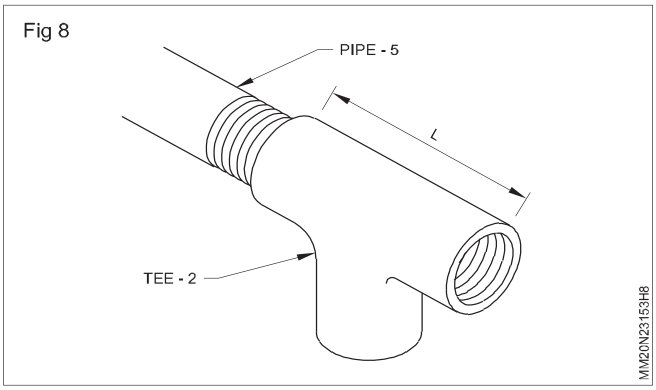
Fig 7



Fit bib cock to socket.

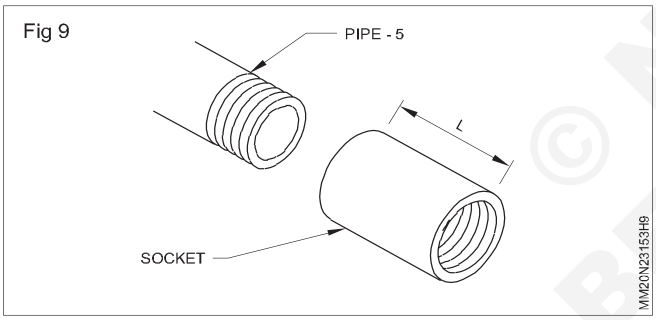
Fit Pipe No - 5 to Tee - 2 (Fig 8).

Fig 8



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

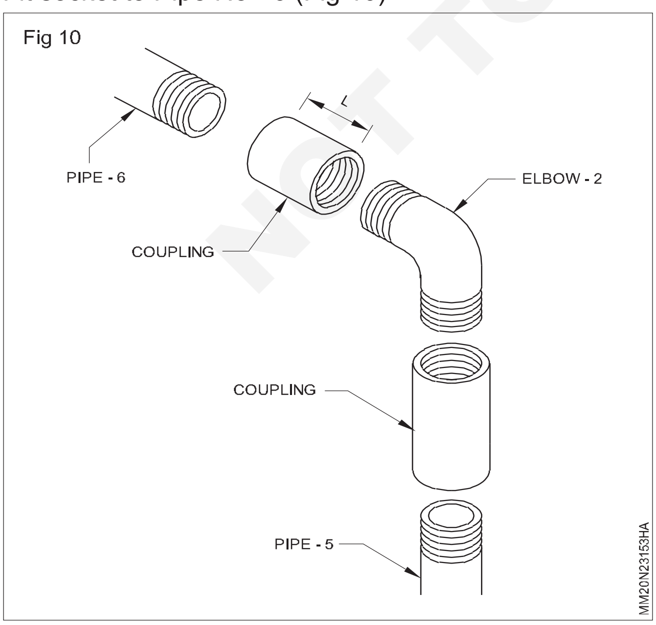
Fig 9



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

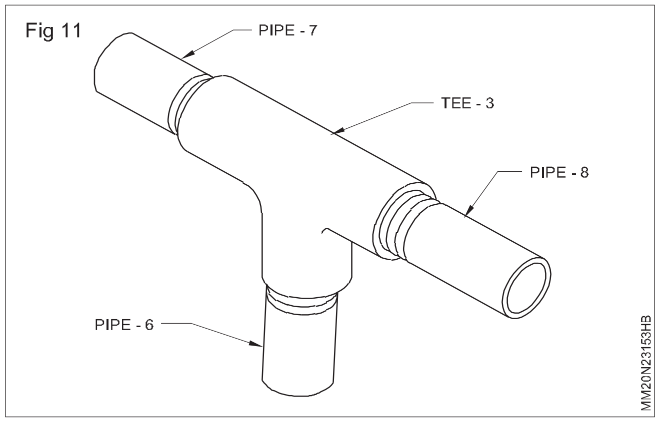
Fit socket to Pipe No - 6 (Fig 10)

Fig 10



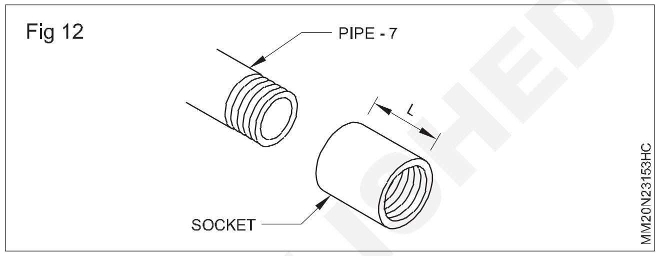
Fit Tee - 3 to Pipe No - 6 , 7, 8 (Fig 11).

Fig 11



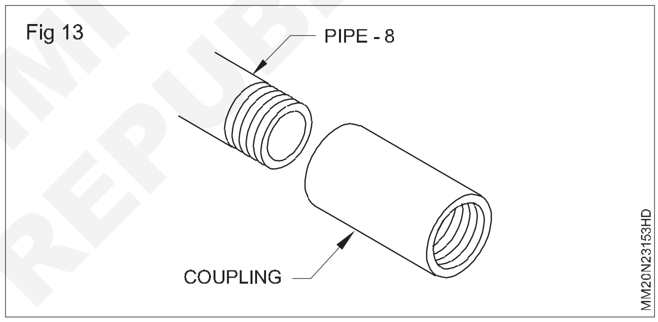
Fit socket to Pipe No - 7 (Fig 12).

Fig 12



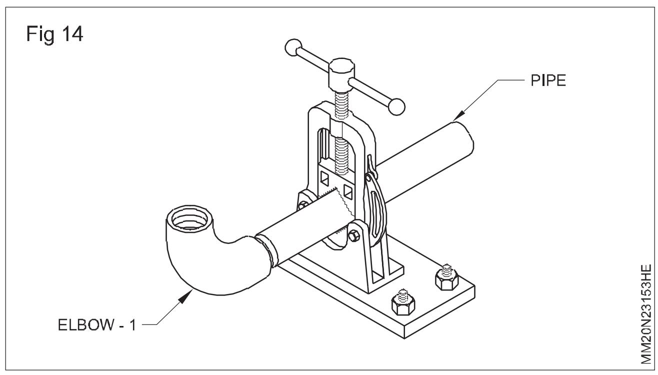
Fit socket to Pipe No - 8 (Fig 13)

Fig 13



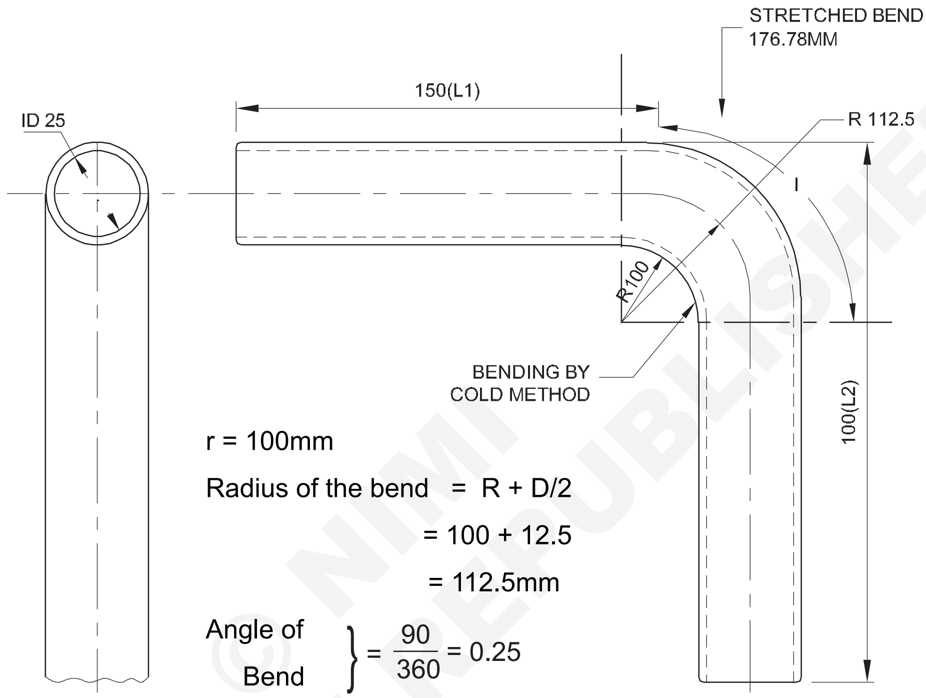
Assembling Elbow with pipe (Fig 14).

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.**



r = 100mm

Radius of the bend = R + D/2

= 100 + 12.5

= 112.5mm

Angle of Bend $\Big\} = \frac{90}{360} = 0.25$

Stretch of the bend = l

$l = \Pi \times D \times \varnothing$

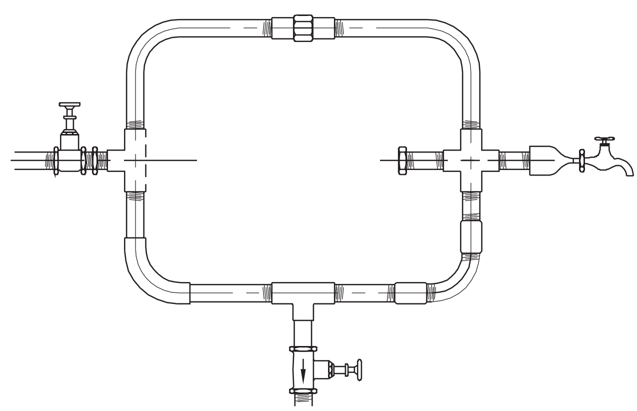
$l = \Pi \times 112.5 \times 2 \times 0.25$

= 176.78 mm

$\therefore$ L = (length of pipe) = L1 + L2 + l

= 150 + 100 +176.78

= 426.78 mm



1	Ø 25 - 430 L		G.I	-	-	2.3.154
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

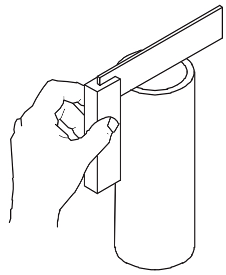
BENDING OF PIPES - COLD AND HOT
(PIPE BENDING BY COLD METHOD)

CODE NO. MM20N23154E1

Job sequence

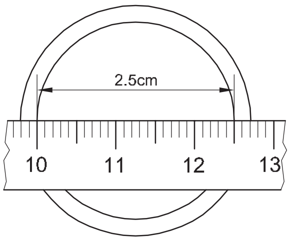
- File the pipe ends and check up its square ness. } (Fig 1)

Fig 1



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

Fig 2



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

  r = radius of bend

  Ø = angle of bend

  l = length of curved portion

  then

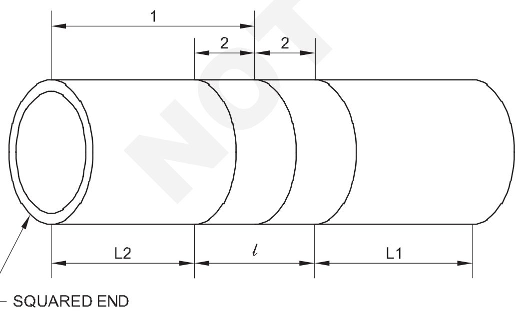
  $= \frac{\Pi \times D \times Ø}{360}$ $\quad D = 2xr$

  L = Total length

  = L1 + l + L2

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

Fig 3



- Select the standard former to suit the size of the pipe. (Fig 4)
- Fix the bending machine in a bench vice and ensure it is tightened properly. Locate the tube stop bar at the required position. (Fig 5)

Fig 4

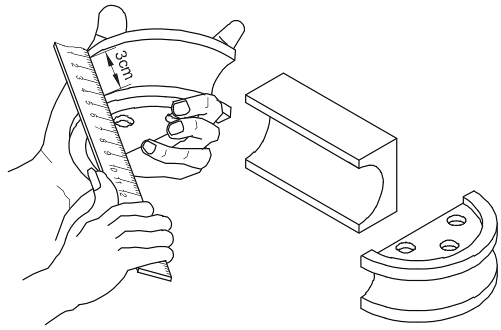
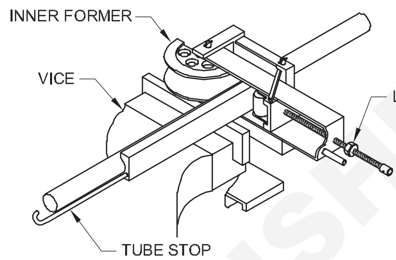
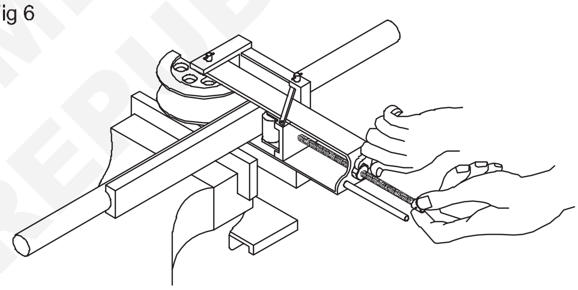


Fig 5



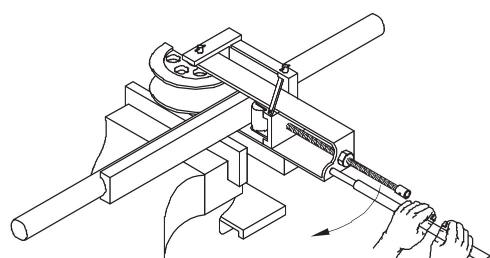
- Set the roller on the bending arm by adjusting the screw and lock nut. (Fig 6)

Fig 6



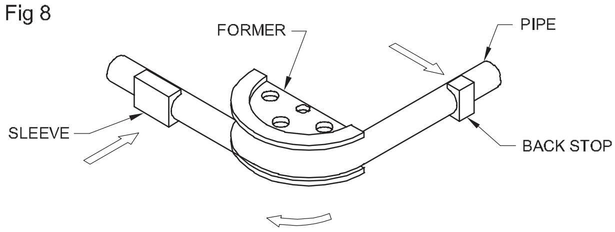
- Bend the pipe by pulling the bending arm towards your body. (Fig 7)

Fig 7



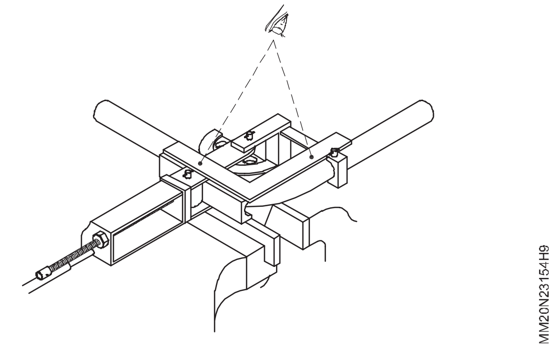
- The sleeve bends the pipe round the former as the bending arm is pulled. The back stop holds the tails end of the pipe in position. (Fig 8)

Fig 8



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

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)

Fig 10

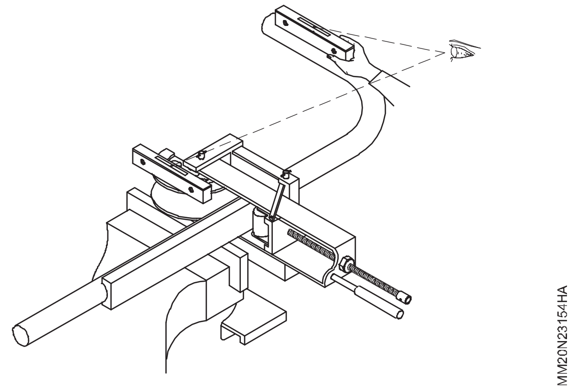
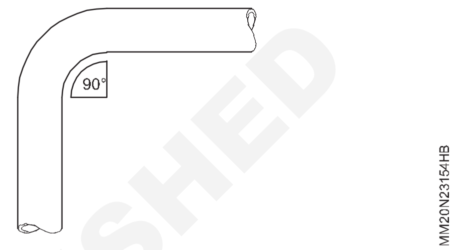


Fig 11



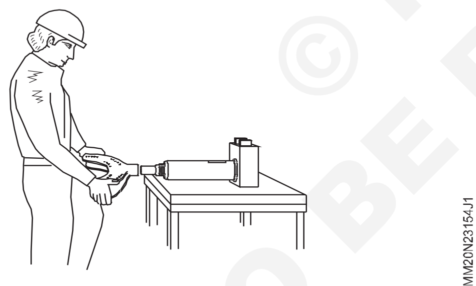
Skill Sequence

Bending 120° by Hydraulic bending machine

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.**

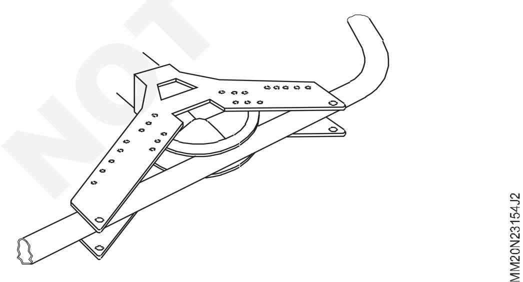
Fit the pipe former on to the cylinder arm. (Fig 1)

Fig 1



Place the pipe between the forming head plates and against the former. (Fig 2)

Fig 2



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 3)

Close the pressure release valve on the pump body then start pumping to push the former against the pipe. (Fig 4)

Fig 3

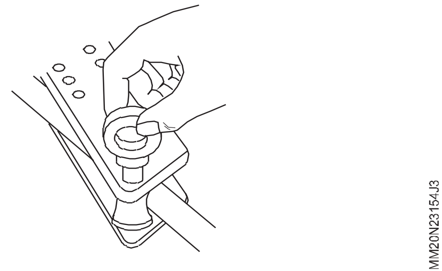
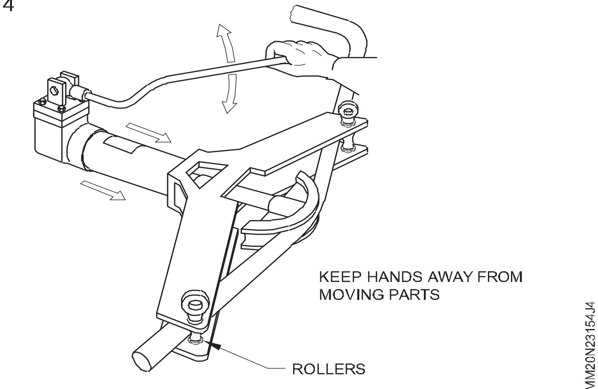
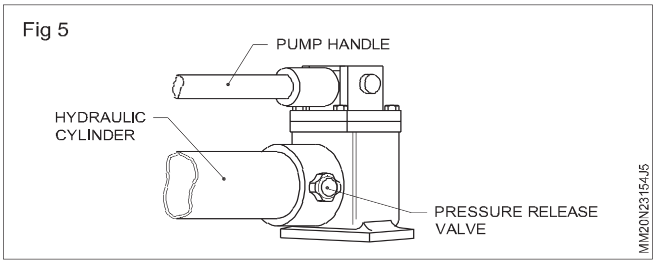


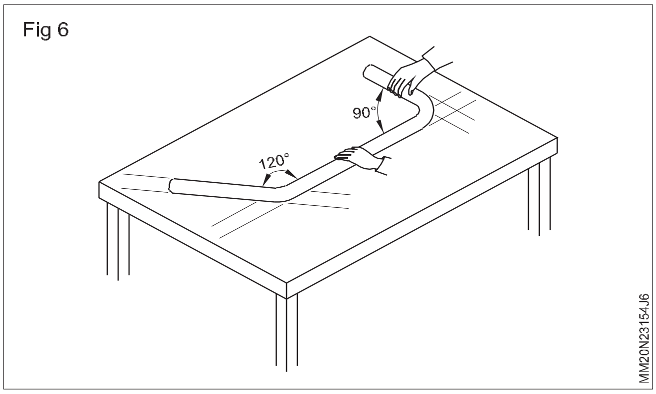
Fig 4



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 5)



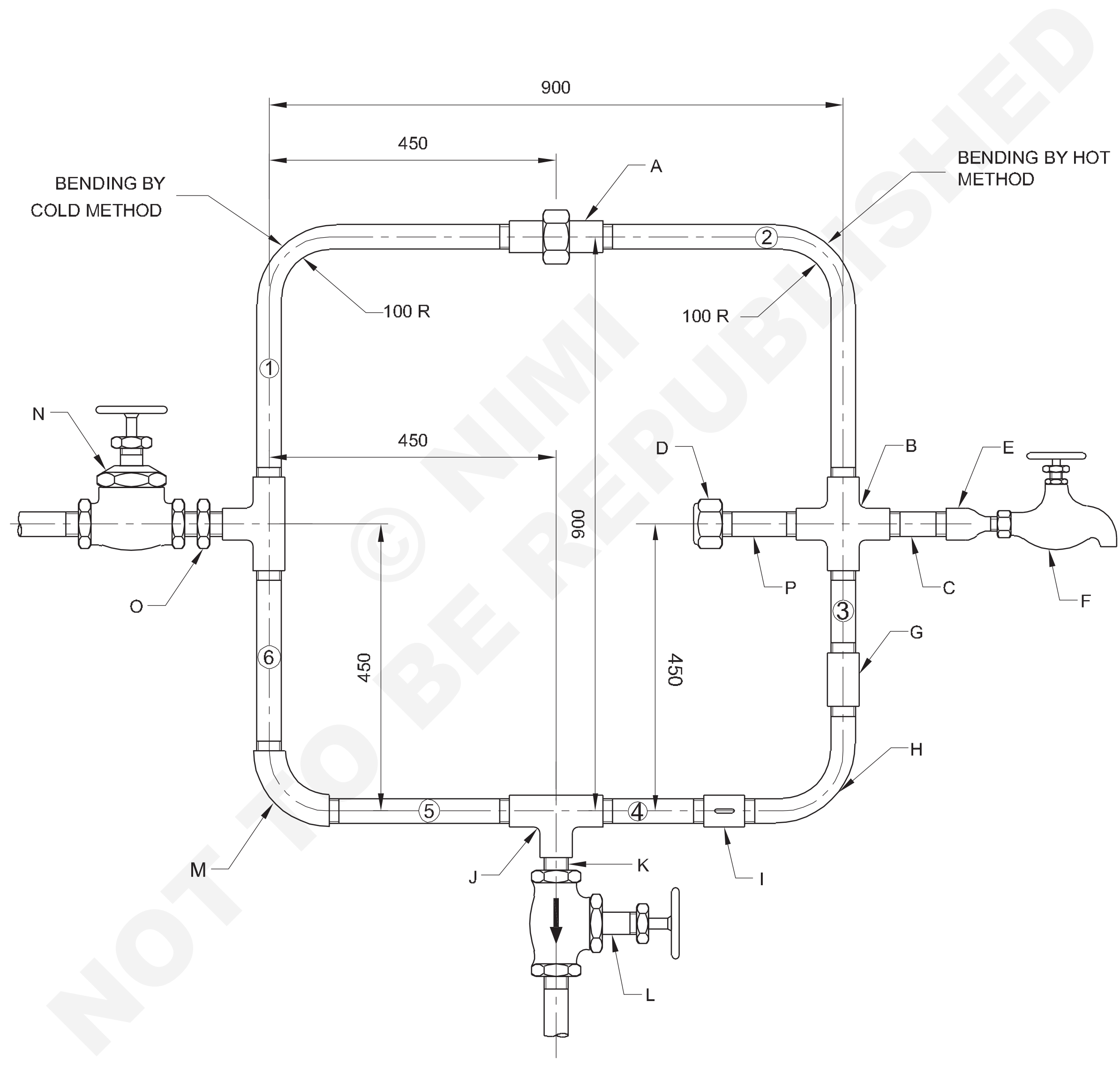
Check both bends 90° and 120° by placing pipe on the layout. (Fig 6)



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



-	-	-	-	-	-	2.3.155
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE:NTS	FIT & ASSEMBLE PIPES , VALVES AND TEST FOR LEAKAGE & FUNCTIONALITY OF VALVES	TOLERANCE	TIME : 22 Hrs
		CODE NO. MM20N23155E1	

BILL OF MATERIALS FOR PIPE ASSEMBLY						
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	2.3.155
NO.OFF	STOCK SIZE	DESCRIPTION	MATERIAL	DRG. NO. (ASSY)	PART NO.	EX. NO.
					CODE NO.	MM20N23155E2

Job sequence

TASK 1 : **Assembling of pipes and valves**

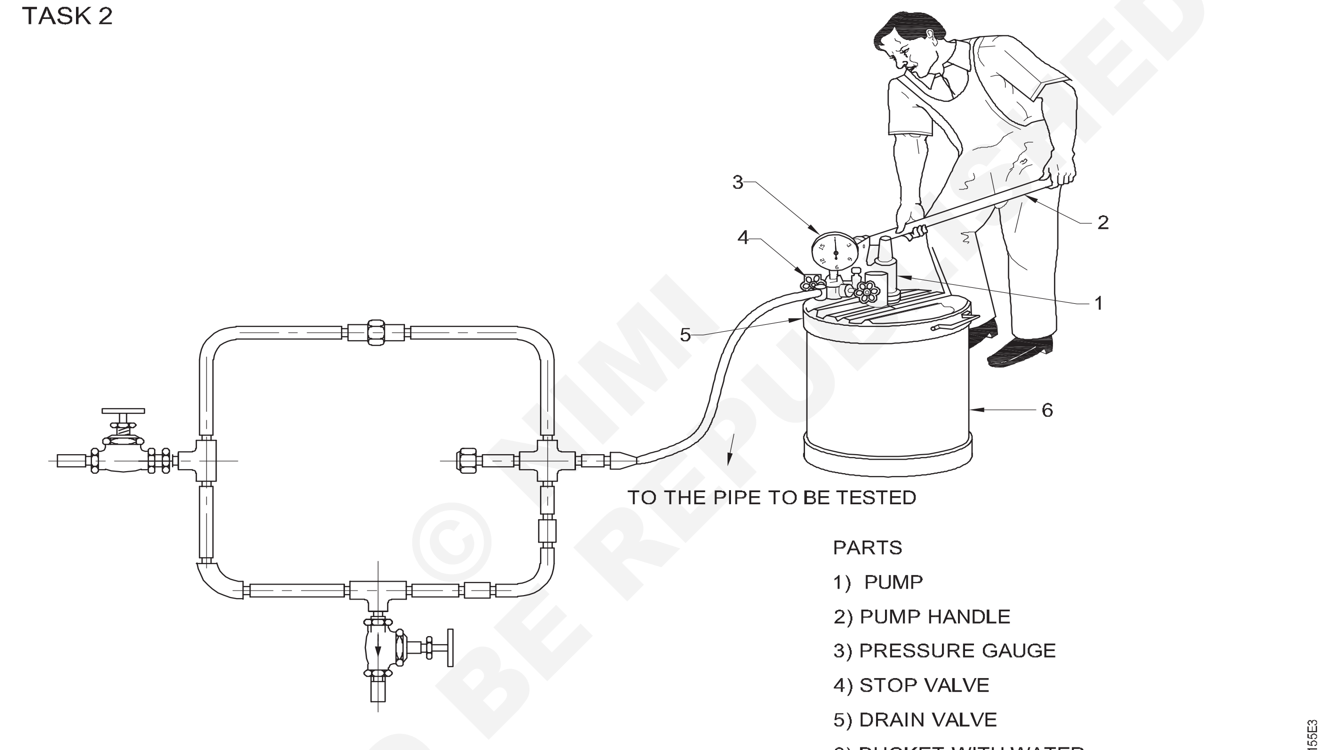
- Join pipe No. 2 with the 4-way cross. (B)
- Fit pipe No. 3 with the 'cross'. of (B)
- Join plain coupling (G) to the other end of the pipe No. 3.
- Assemble G.I. bend (H) to the plain coupling. (G)
- Fit the ribbed coupling (I) to the other end of the bend. (H)
- Join pipe No. 4 to the ribbed coupling. (1)
- Fit 'T' (J) with pipe No. 4.
- Join pipe No. 5 to the opposite end of 'T'.
- Assemble elbow (M) with pipe No. 5.
- Fit pipe No. 6 with the other end of the elbow.
- Join 'T' with pipe No. 6.
- Fit pipe No. 1 with the opposite end of 'T'.
- Join pipe Nos. 1 & 2 with union. (A)
- Fit 150mm barrel nipple (P) to the left side of the 'cross' and put cap (A) for it.
- Put another 100mm barrel nipple (C) to the right side of the cross.
- Join the reducer (E) to the barrel nipple.
- Assemble the bib-cock (F) to the other end of the reducer.
- Fit 100mm barrel nipple (K) to bottom 'T'.
- Assemble the globe valve (L) to the nipple.
- Put the hexagonal nipple (0) to the left side 'T'.
- Assemble the gate-valve to the nipple.
- Test the joints for leakage.

TASK 2 : **Test for leakage and functionality of valves**

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

TASK 2



SMOKE TESTING OF HOUSE SEWER LINES AND SULLUGE WATER LINE

Skill Sequence

Assemble G.I pipes with standard fittings

Objective: This shall help you to
- **assemble pipe and pipe fittings.**

1 Hold the pipe No2 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.

Fig 1

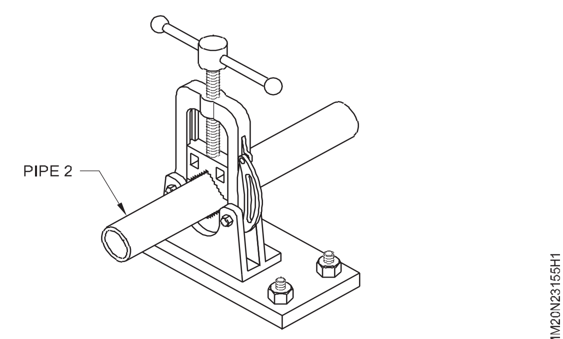


Fig 2

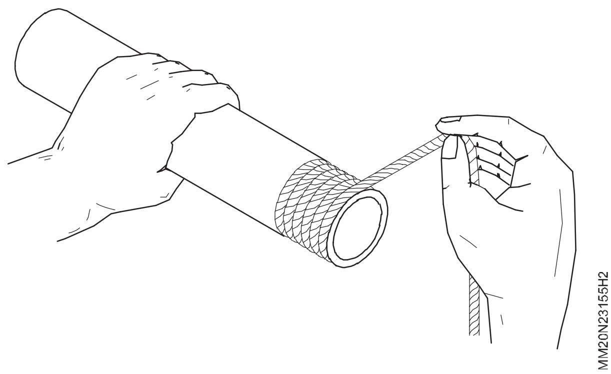
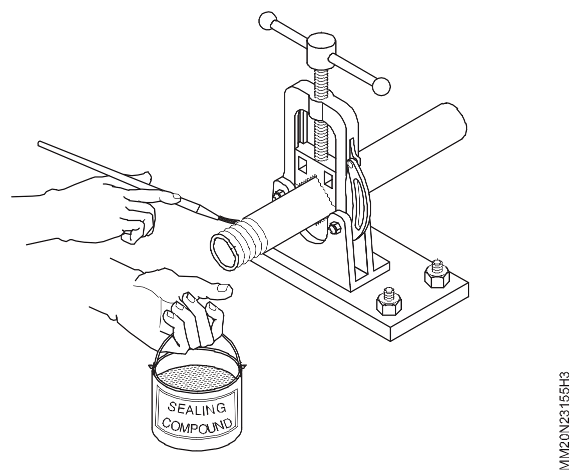
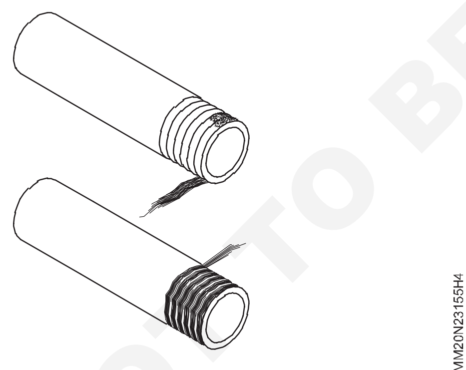


Fig 3



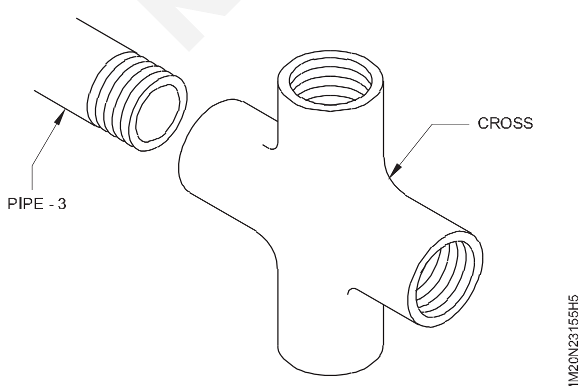
Wind the hemp packing to external threads of all the pipes and standard fittings and apply sealing compound over the threads before joining with the other one (Fig 4).

Fig 4



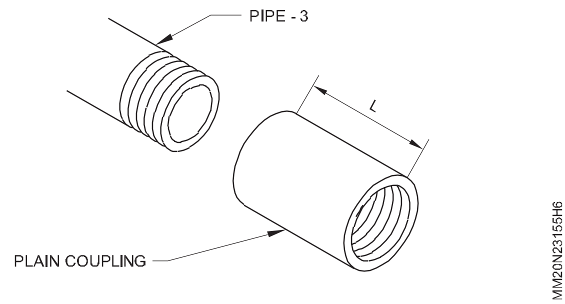
5 Fit pipe No.3 with the cross. (Fig 5)

Fig 5



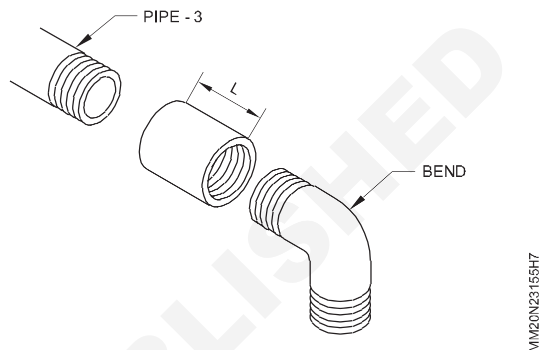
6 Join the plain coupling to the other end of the pipe No.3. (Fig 6)

Fig 6



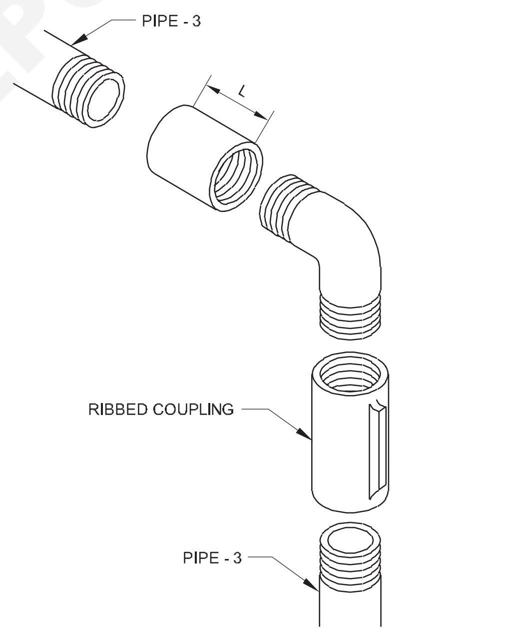
7 Fit the G.I. bend to the plain coupling.(Fig 7)

Fig 7



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

Fig 8



9 Connect pipe No.4 to the nabbed 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)

Fig 9

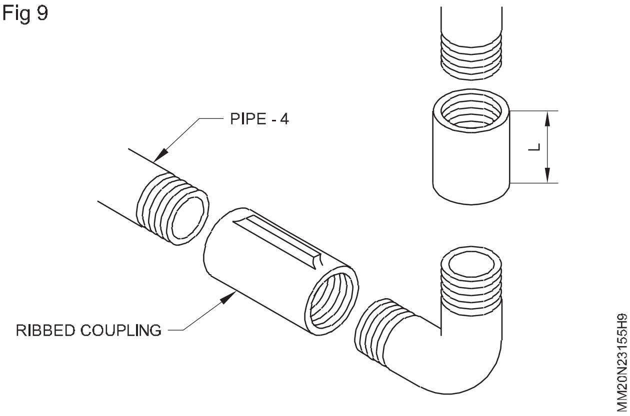


Fig 10

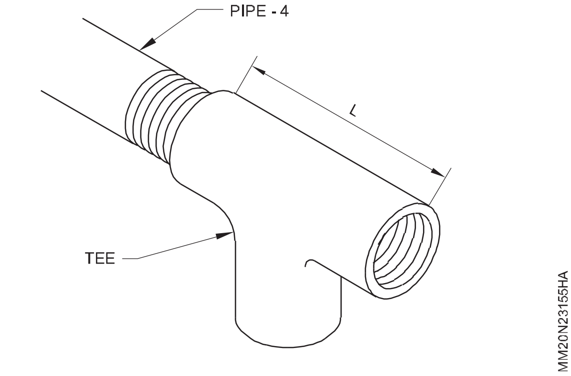


Fig 11

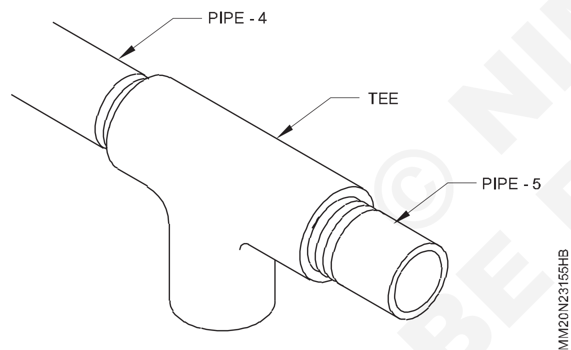
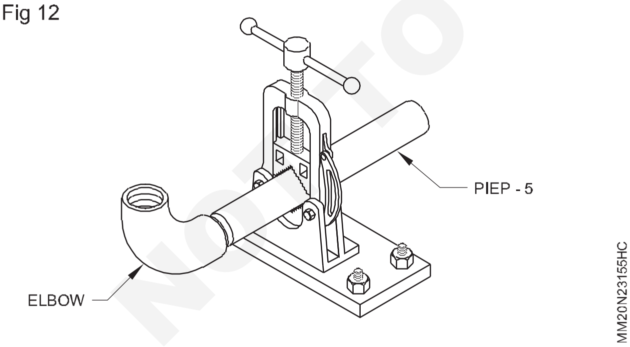


Fig 12



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)

Fig 13

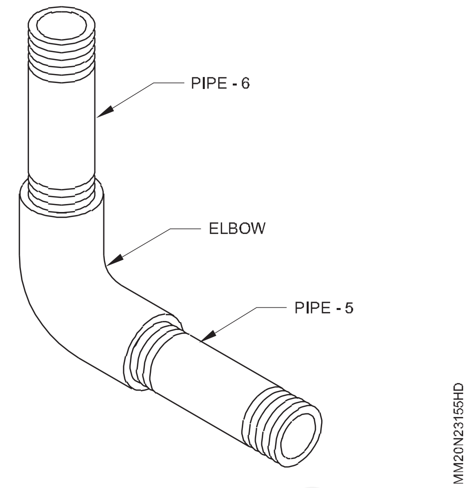


Fig 14

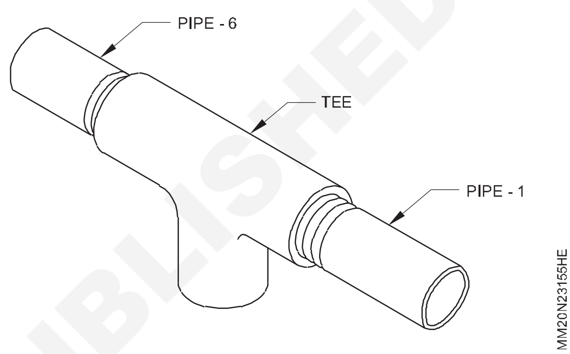


Fig 15

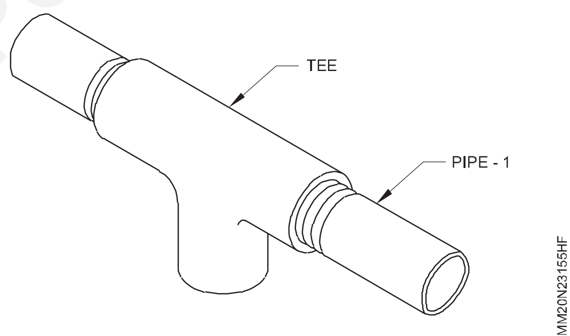
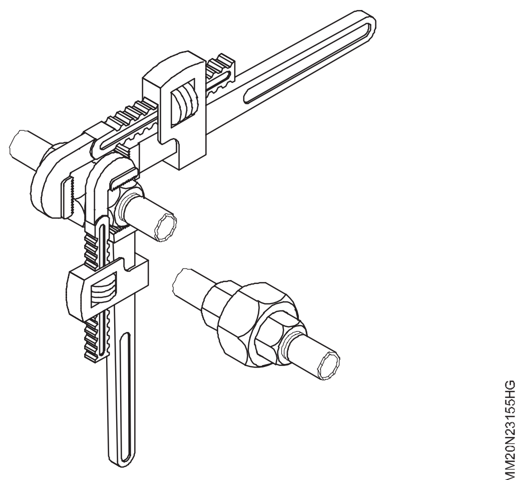


Fig 16

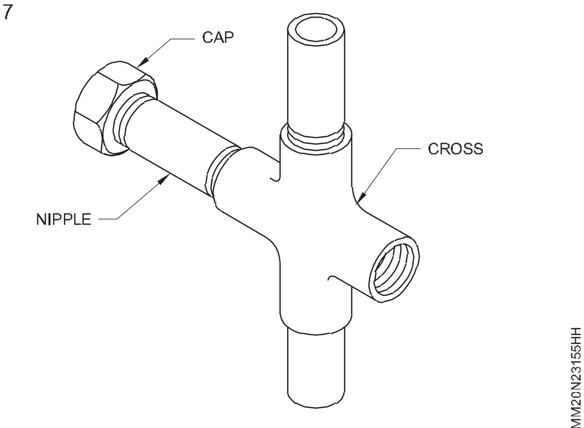


19 Turn the two pipe wrenches gently in opposite directions and assemble.

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

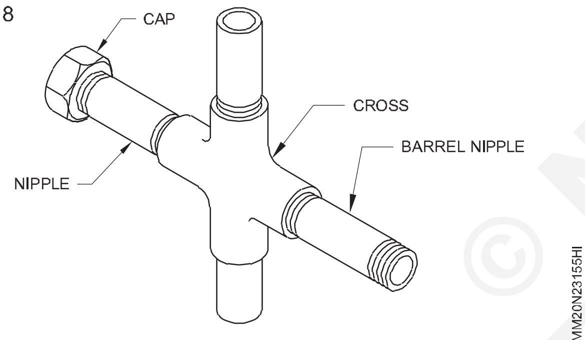
20 Fit a 150 mm barrel nipple to the left side of the cross and put a cap for it. (Fig 17)

Fig 17



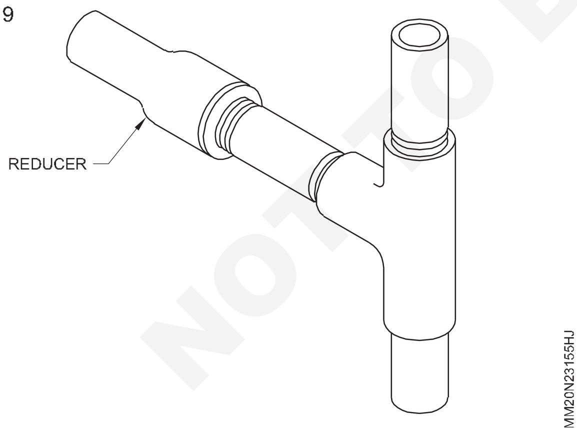
21 Join another 150 mm barrel nipple to the right side of the cross. (Fig 18)

Fig 18



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

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)

Fig 20

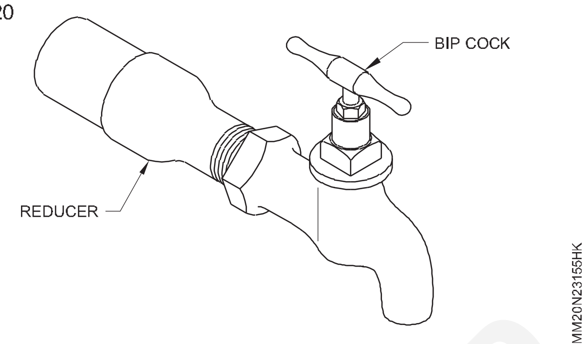
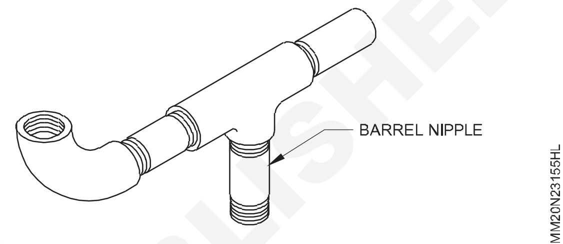


Fig 21



25 Assemble the gate-valve to the 100 mm barrel nipple.

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

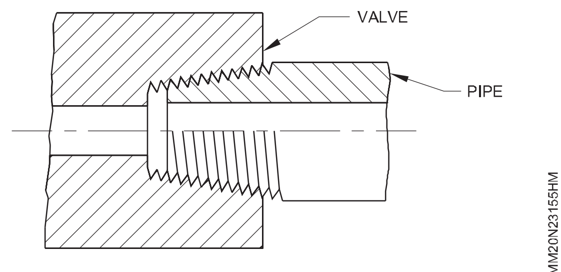
27 Join a hexagonal nipple to the left side 'T'.

28 Assemble a globe valve to the hexagaonal nipple.

29 Check the joint for leakage.

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

Fig 22

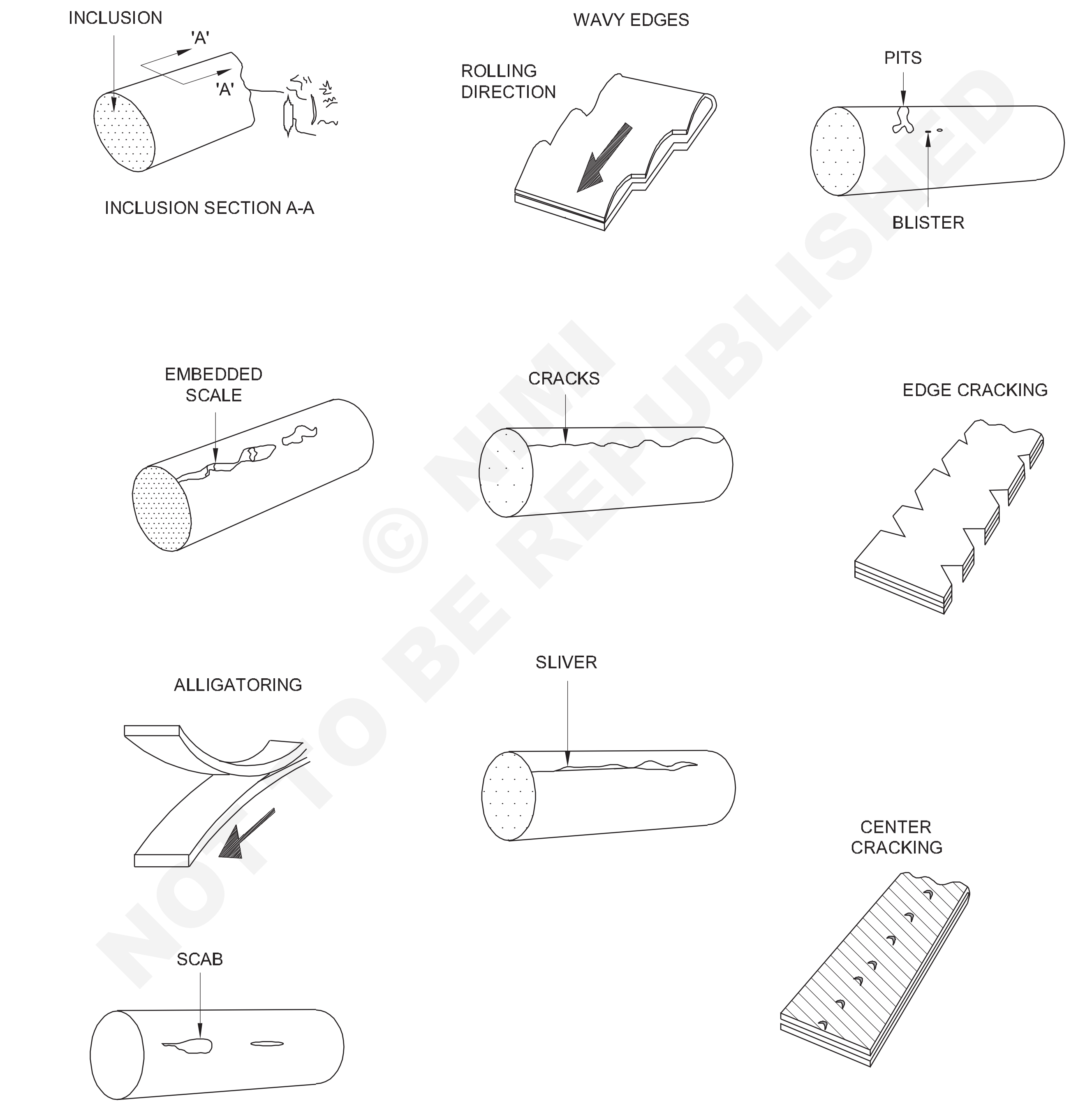


Visual inspection for visual defects e.g. dents, surface finish

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

Fig 1

Task

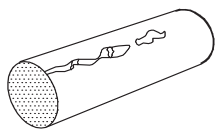
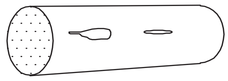
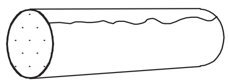
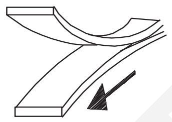
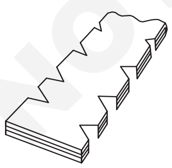


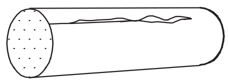
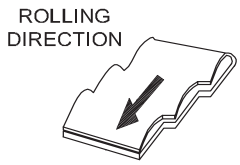
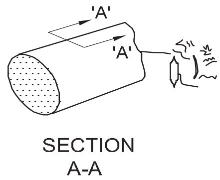
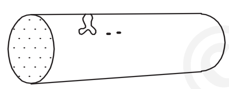
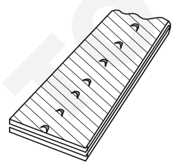
VISUAL INSPECTION FOR VISUAL DEFECTS (e.g) DENTS,SURFACE FINISH

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 visuals and record it in table.

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

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

Get it checked by the instructor

Dismantle & assembly of different valves

Objectives: At the end of this exercise you shall be able to
- **dismantle and assembly of gate/sluice valve**
- **dismantle and assembly of butterfly valve**
- **dismantle and assembly of diaphragm valve**
- **dismantle and assembly of direction control valve**
- **dismantle and assembly of pressure/air relief valve**
- **dismantle and assembly of non return valve.**
- **dismantle and assembly of globe valve/flow control valve**

Job sequence

TASK 1**: Sluice valve/gate valve**

Fig 1

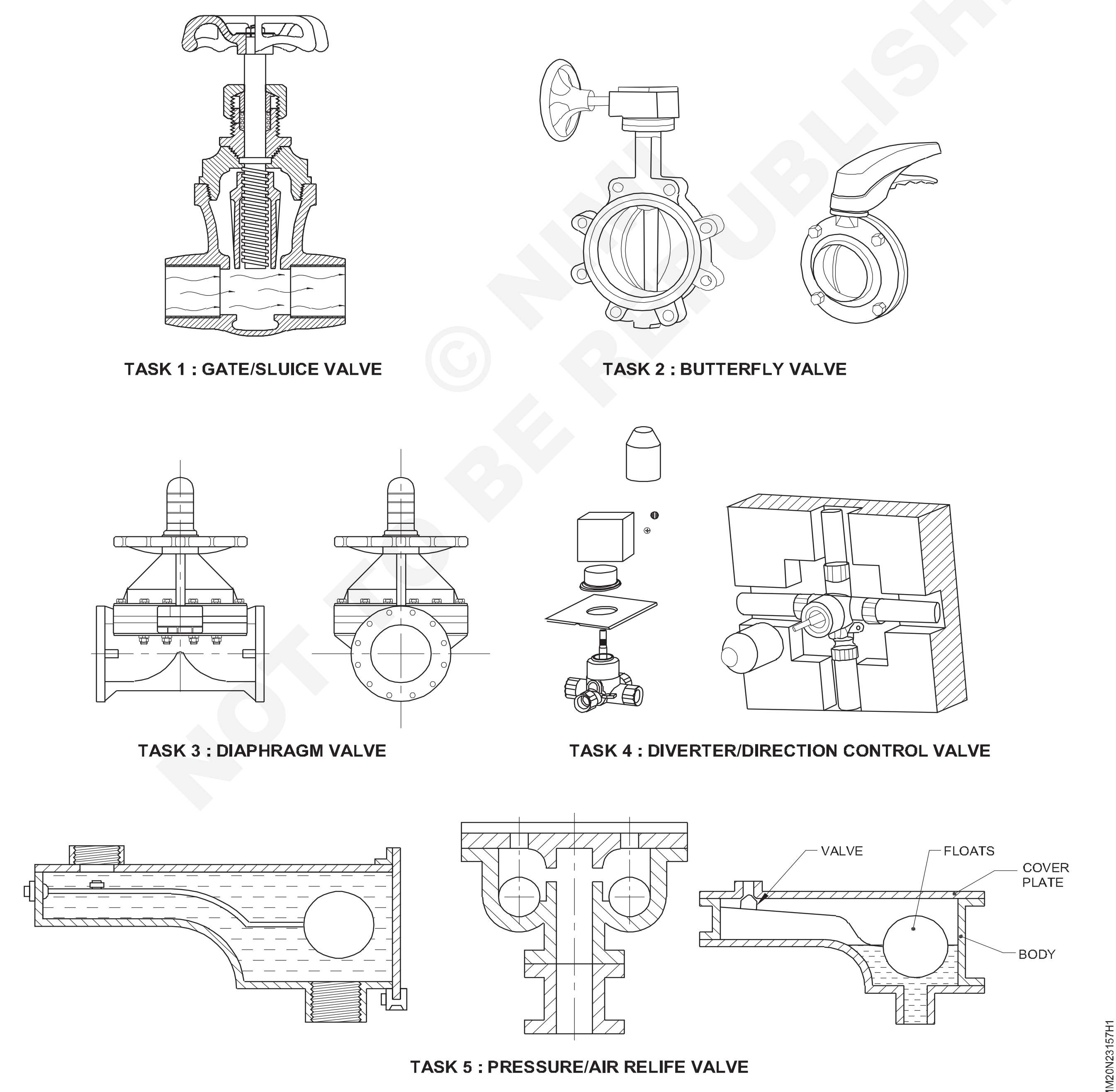
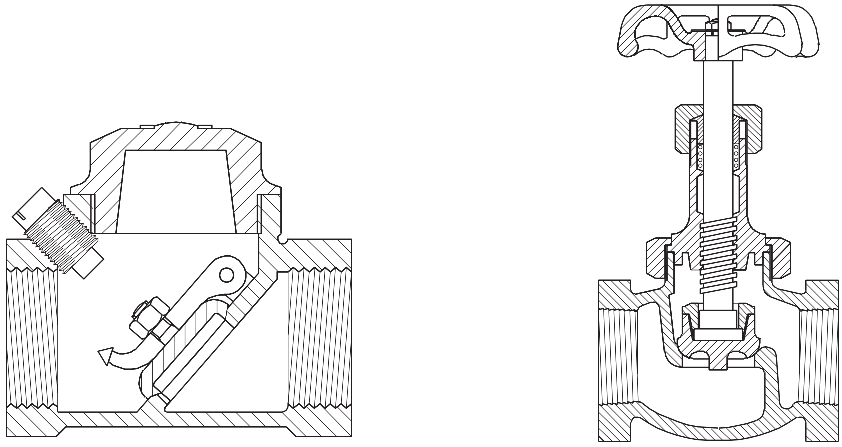


Fig 2



TASK 6 : NON RETUN VALVE

TASK 7 : GLOBE VALVE

- Shut off the water by closing the main valve.
- Close the gate valve and remove the wheel nut with a spanner.
- Remove the gland nut from the bonnet.
- Clean out the old packing in the stuffing box.
- Remove the bonnet with the spindle from the body and clean all the parts.
- Coil the asbestos rope, smear it with water pump grease and push it down with a screw driver.
- Assemble the spindle gate to the bonnet.
- Assemble the gland nut, hand wheel and tighten the hand wheel nut.
- Open the gate value and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping from the gland nut.

Do not use the gate valve to regulate the flow. It should be either in fully opened or fully closed condition.

— — — —

TASK 2**: Butterfly valve**

Shut off the water by closing main valve

- Close the butterfly valve and remove the wheel nut with spanner
- Dismantle all the remaining parts i.e shaft, body, disc
- Clean the all parts with cloth and apply oil
- Assembly the seat and disc to the body
- Assembly the shaft, hand wheel and tighten the hand wheel nut
- Assemble and fit the butter fly valve, where it removed from the pipe line
- Open the main valve test the functioning

— — — —

TASK 3**: Diaphragm valve**

- Shut off the water by closing main valve
- Close the diaphrgm valve and remove the wheal hut with spanner
- Dismantle bonnet, spindle, diaphragm, from valve body
- Inspect the diaphrgm for damage and clean with cloth
- If it is damaged replace with new diaphragm
- Clean valve body and other parts
- Reasonable the all parts to the valve body
- Fit the diaphragm valve, where it is removed from the pipeline
- Open the main valve test the functioning

— — — —

TASK 4: **Diverter/direction control valve**

- Remove diverter from the pipe line
- Remove cover plate from main body
- Dismantle remaining all parts such as adjustive cover handle, screw etc
- Clean all parts with dry cloth
- Check & conform all parts are free from dirt (or) damage
- Re assemble all parts followed by proper sequence
- Fix the divert to the pipe line test the functioning.

TASK 5: **Pressure relief valves/Air relief valves**

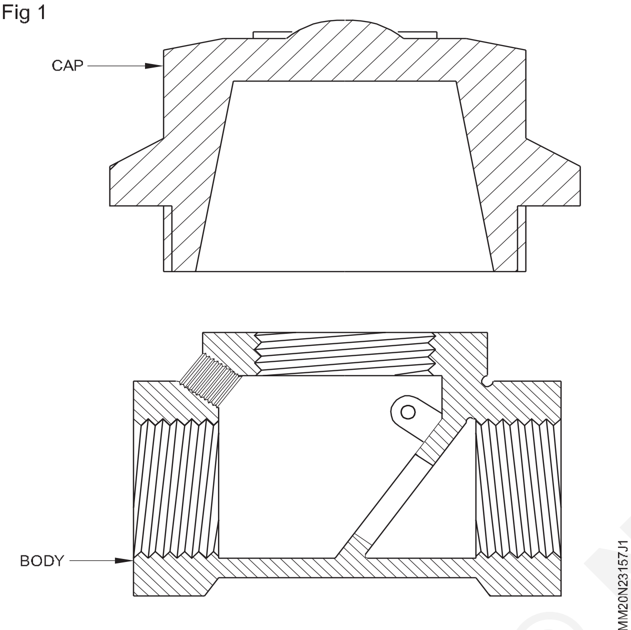
- Shut off the water by closing main valve
- Remove relief valve foam pipe line
- Remove cover plate foam body
- Dismantle remaining all parts such as float etc.
- Inspect condition of float
- Replace warnoot parts
- Clean body other dismantle parts with dry cloth.
- Fit the valve to the pipe line and test the functioning

— — — —

TASK 6 : **Non return value**

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

Fig 1



- Remove the hinge pin and take out the disc.
- Separate the disc from the hinge. (Fig 2)
- Clean the seating area and the other parts of the disc.
- Assemble the disc and hinge plate with the pin.
- Check the function of the hinge unit.
- Replace the sealing material and assemble the cap to the body. (Fig 3)
- Open the main gate valve and check for leakage.

Fig 2

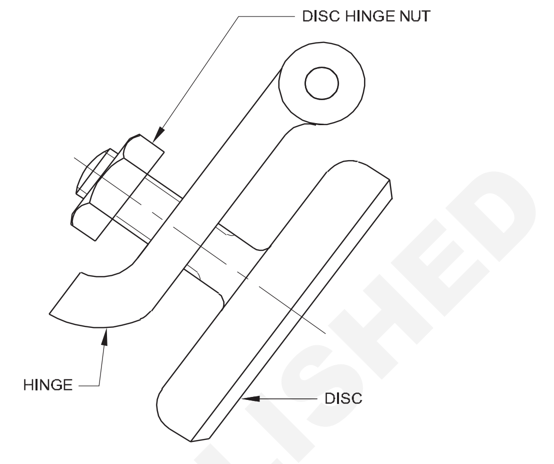
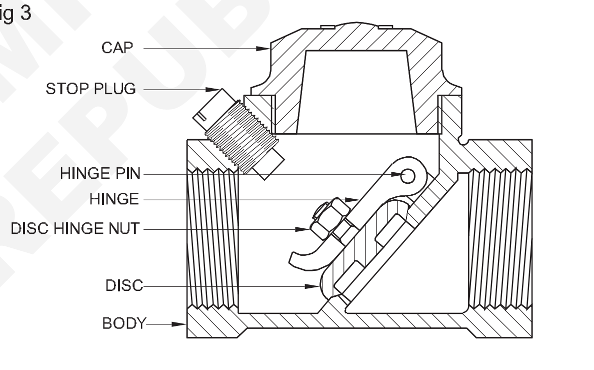


Fig 3



Note

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

— — — —

TASK 7 : **Globe valve**

- Indicate the parts on drawing
- Write the dismantle and assembly sequence.
- Dismantle the valve
- Assemble the valve

Get it checked by the instructor

— — — —

Making & replacement of gasket, washer

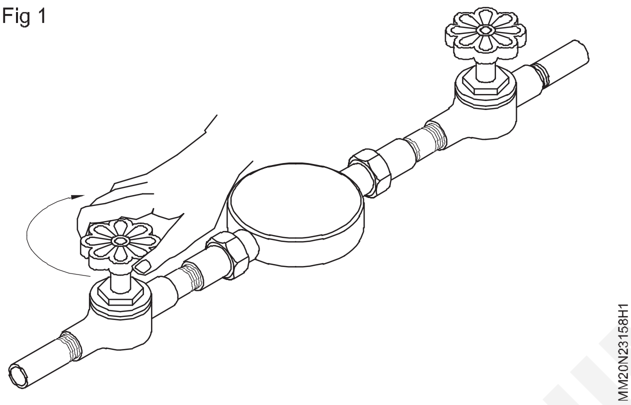
Objective: At the end of this exercise you shall be able to
- **repair the water tap by replacing with washer.**
- **repair water tap replacing replacing of packing material.**

Job sequence

TASK 1: **Repairing of water tap replacing of washer**

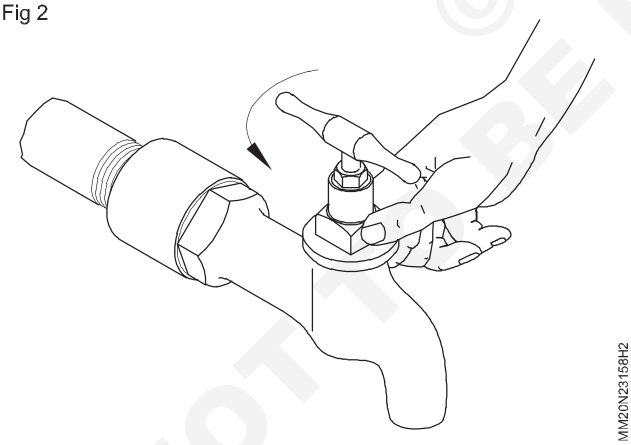
1 Shut off the water supply by closing the main stopcock or the main gate valve. (Fig 1)

Fig 1



2 Keep the water tap to be repaired in the “open” position. (Fig 2)

Fig 2



3 Remove the bonnet from the water tap with a spanner (Fig 3).

4 Inspect the washer for damage (Fig 4).

Fig 3

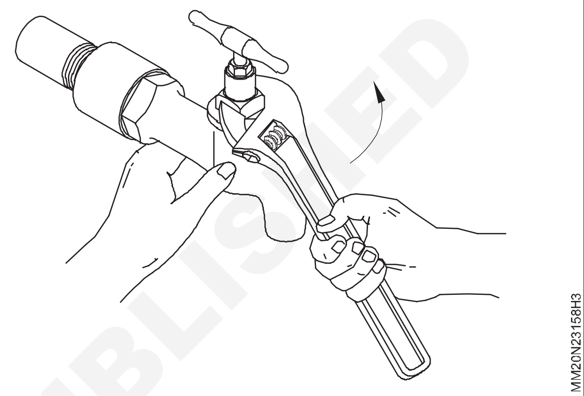
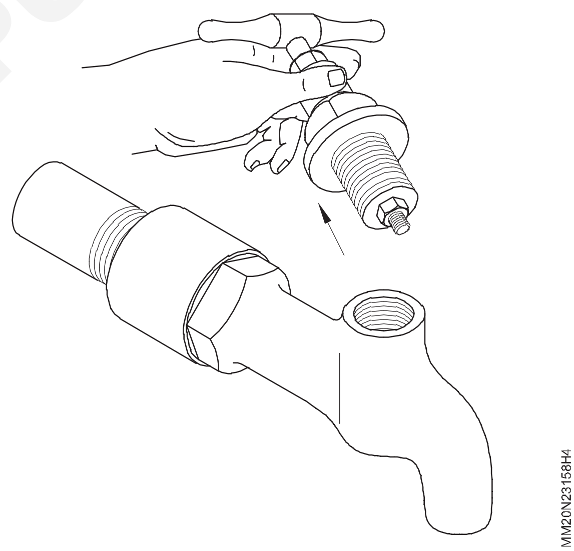


Fig 4

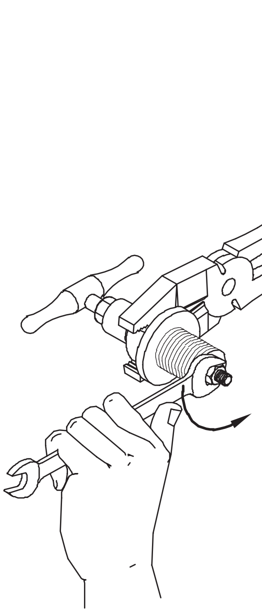


5 Hold the metal disk plate with a pliers and unscrew washer nut with a spanner (Fig 5).

6 Remove the washer from its seating.

7 Press the new washer into position.

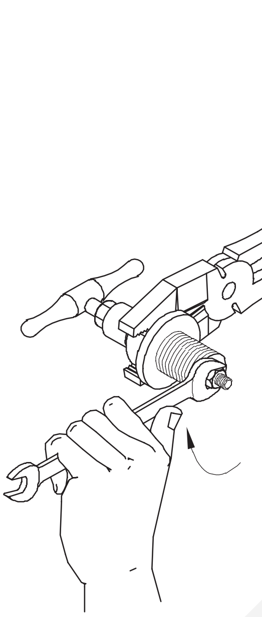
Fig 5



Use fiber washer for hot water tap.

8 Refit the washer nut and tighten it firmly (Fig 6).

Fig 6



9 Replace the repaired bonnet into the water tap (Fig 7 & 8). Tighten the bonnet with a wrench. Do not over tighten it as this would damage the thread of the water tap body.

Fig 7

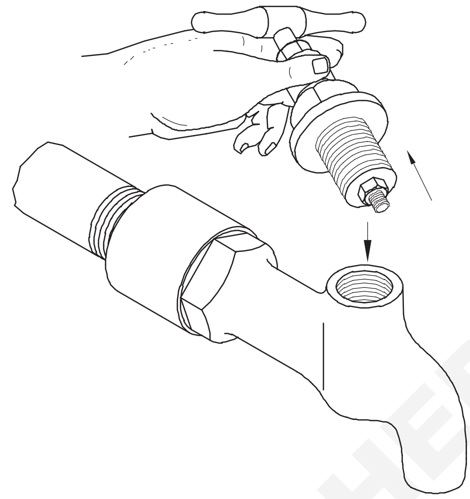
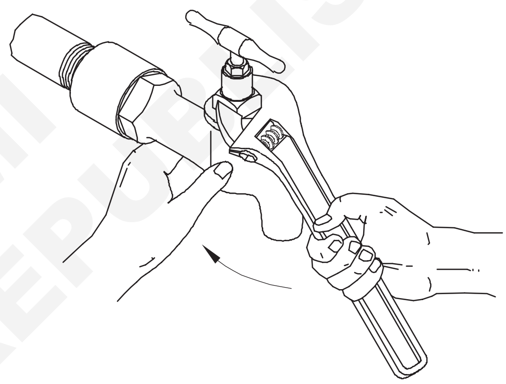


Fig 8



TASK 2: **Repair water tap replacing of packing material**

1 Another repair job which a plumber may need to perform is to change the packing in the stuffing box.

2 If water escapes from the water tap's gland nut, close the stopcock by turning the handle clockwise as this will stop the water in the tap to be repaired (Fig 1).

3 Tighten the gland nut to compress the packing around the shaft (Fig 2).

4 Now open the water tap to check if the leak has stopped. If the water tap still leaks, the packing in the stuffing box should be replaced (Fig 3).

Fig 1

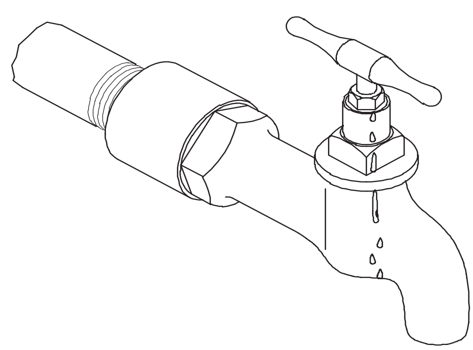
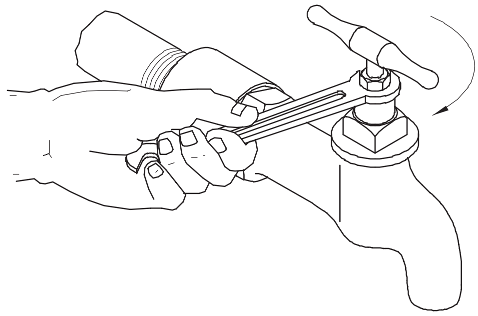
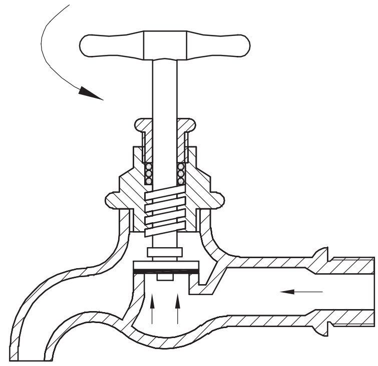


Fig 2



MM20N23158J2

Fig 3

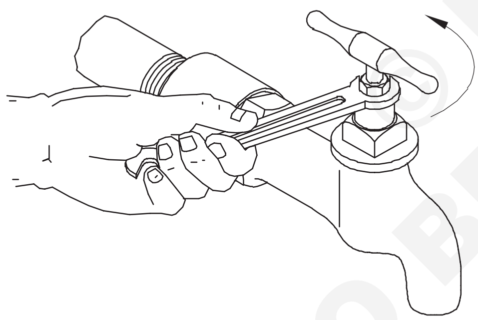


MM20N23158J3

5 Shut off the water supply by closing the main gate valve.

6 Loosen the gland nut from the bonnet by turning it anticlockwise with a spanner (Fig 4).

Fig 4

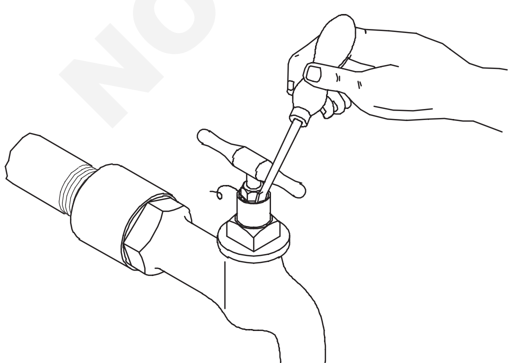


MM20N23158J4

7 Lift up the gland nut and clean out the old packing from the stuffing box (Fig 5).

Do not damage the bore of the stuffing box.

Fig 5

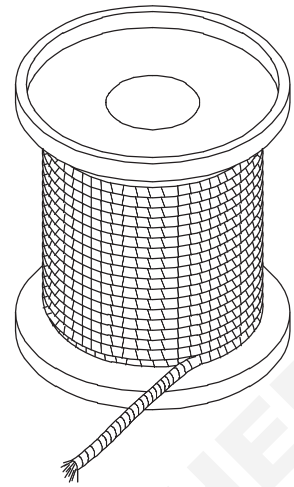


MM20N23158J5

8 Make a new packing out of asbestos rope (Fig 6).

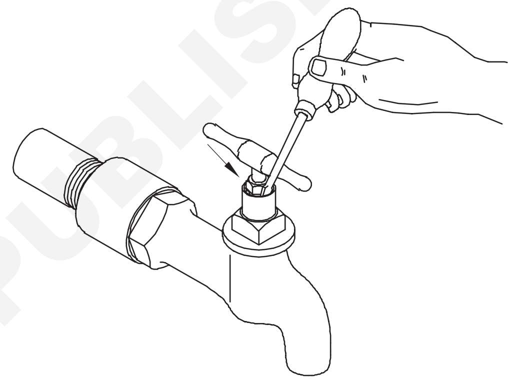
9 Coil the new packing around the shaft and push it down with a small screw driver (Fig 7).

Fig 6



MM20N23158J6

Fig 7

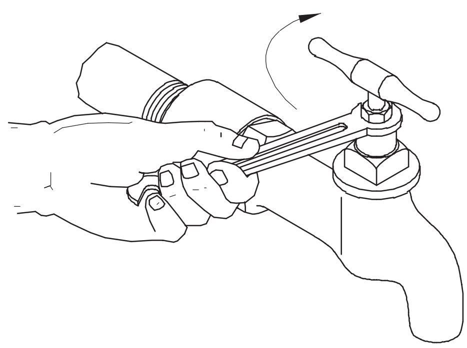


MM20N23158J7

10 Re-assemble the gland nut and tight (Fig 8).

11 Open the main gate valve and test the water tap for leakage.

Fig 8

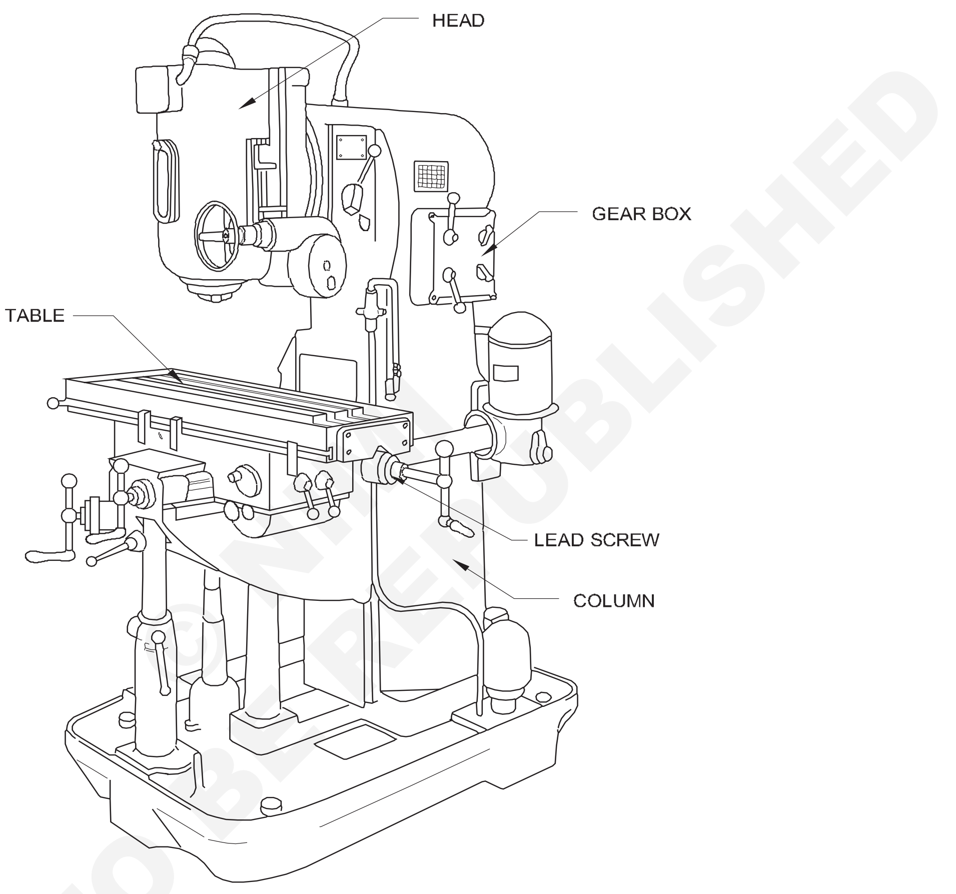


MM20N23158J8

Dismantle and assemble of head stock, gear box, lead screw table of milling machine

Objectives: At the end of this exercise you shall be able to
- **dismantle and assemble of head stock**
- **dismantle and assemble of gear box**
- **dismantle and assemble of lead screw and table.**

Fig 1



Job sequence

TASK 1 : **Dismantle and assemble of head stock**

Dismantle the Milling Machine Head stock

- Switch off the machine
- Drain the lubrication oil from head
- Clean the machine head with clean cloths
- Remove the housing of belt and cover of machine head
- Remove all the parts one by one as given in fig-1 serially numbered from one to eighty four.
- Take out all parts from head stock.

Note:- Give identification marks for all parts of head stock according to their sequence of order at the time of removing to avoid problems in assembling the parts.

- Inspect and replace worn out parts.
- Clean all the parts with kerosene
- Inspect all the parts and replace them if changed or worn out.
- Inspect all springs, washers, bearings, lock nuts screws, rings, pins, keys and belts and replace it if necessary.

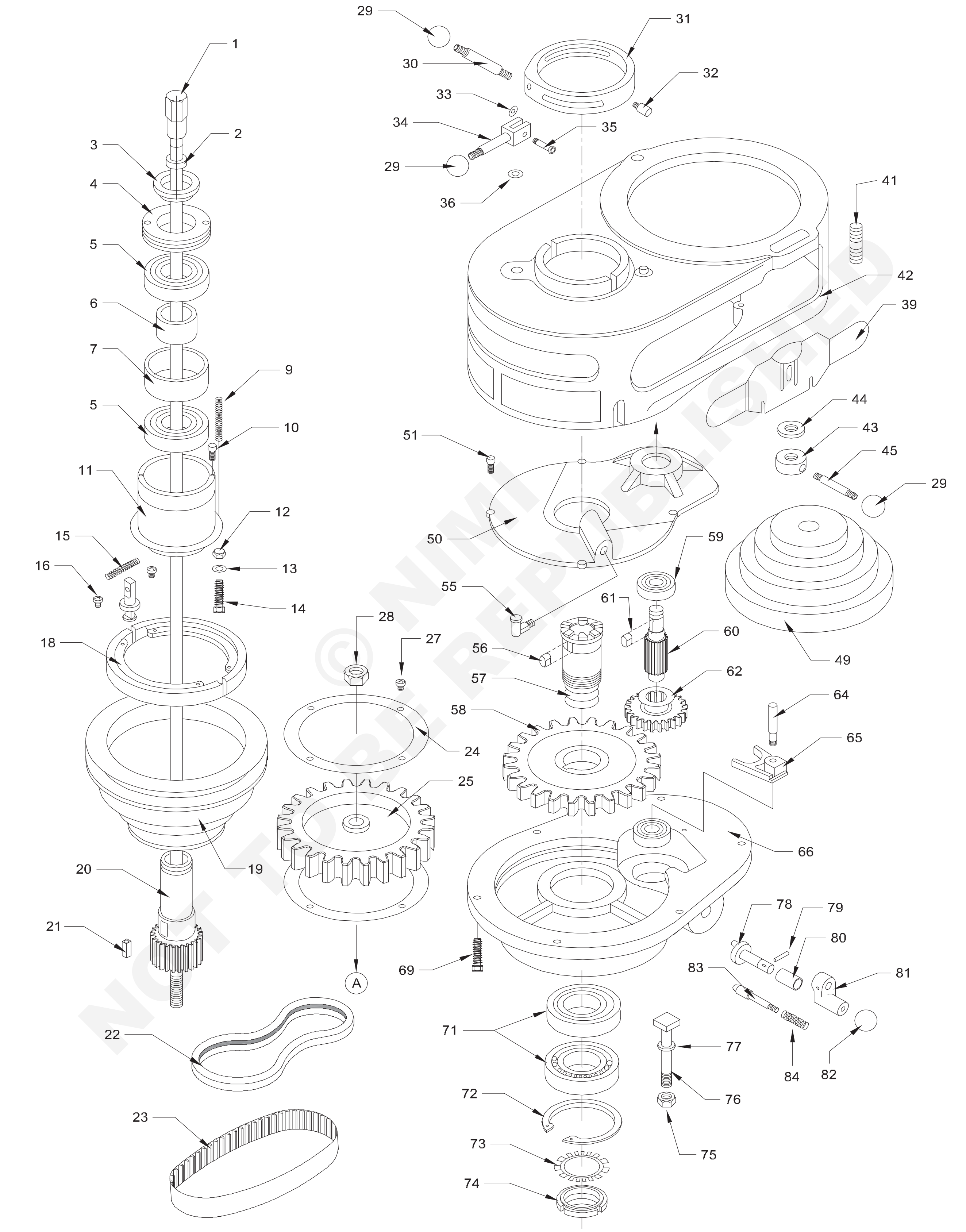
Assemble the head stock

- Assemble all the parts of head in reverse order is specified with dismantling order
- Assemble all the lubrication pipes properly.
- Fill sufficient lubrication oil in the head
- Fix the all housing covers properly

Test run the machines

- switch on the machine
- Test the running condition of head
- Observe if any abnormal noise is coming from head
- Check if any noise is generating from head, if so rectify the fault.

Fig 1



UPPER HEAD ASSEMBLY

Parts List For The JTM-1/2 Turret Mills

Upper Head Assembly

Index No.	Description	Size	Qty
1	Draw Bar	R8	1
2	Draw Bar Washer		1
3	Upper bearing Lock Nut		1
4	Bearing Sleeve Lock Nut		1
5	Ball Bearing		2
6	Upper Bearing Spacer (small)		1
7	Upper Bearing Spacer (large)		1
9	Compression Spring		4
10	Set Screw	M3 x 10	4
11	Spindle Pulley Bearing Sleeve		1
12	Hex Jam Nut.	5/16	1
13	Lock Washer .	5/16	1
14	Brake Ring Screw		1
15	Spring		2
16	Screw	3/16 x 1/2	4
17	Brake Lock Stud		1
18	Brake Assembly		1
19	Spindle Pulley		1
20	Spindle Pulley Hub		1
21	Key	6 x 6 x 25	1
22	V-belt		1
23	Timing Belt		1
24	Timing Belt Flange		2
25	Timing Belt Pulley		1
27	Flat Head Screw		8
28	Hex Jam Nut	5/8-18NF	1
29	Plastic Ball		3
30	Spin.die Clutch Lever		1
31	Cam Ring		1
32	Cam Ring Pin		2
33	E-Ring		1
34	Brake Lock Hand le		1
35	Brake Lock Pin .		1
36	Washer	1 /2	1
37	Spindle Speed.Plate {JTM-1)		1
	Spindle Speed Plate {JTM-2)		1
39	Belt Guard Assembly		2
41	Motor Mount Studs		2
42	Belt Housing		1
43	Motor Lock Nut		2
44	Washer		1
45	Motor Lock Nut Handle		4
49	Motor Pulley		1
50	Clear Housing Cover		1
51	Hex Socket Cap Screw	M5 x 14	
55	Oil cup		1
56	Key		1
57	Spindle Gear Hub		1
58	Spindle Bull Gear Assembly		1
59	Ball Bearing		1
60	Shaft		1
61	Key	5x5x15	1
62	Gear		1
63	Ball Bearing		1
64	Dowel pin		1
65	Back Gear Shifter Fork		1
66	Gear Housing		1
69	Hex Socket Cap Screw	M6 x 16	6
71	Ball Bearing		2
72	Snap Ring		1
73	Lock Washer		1`
74	Bearing Lock Nut		1
75	Hardened Nut		1
76	T-Bolt		3
77	Bolt Washer		3
78	Shift Crank		1
79	Spring Pin		1
80	Back Gear Shift Bushing		1
81	Shaft Crank Handle		1
82	Plastic Ball		1
83	Gearshift Plunger		1
84	Compression Spring		1
	Motor (not shown - 2HP,3Ph, 220V)		
	Switch (not shown)		1
	Switch Speed Plate (not shown)		1

	Switch Knob (not shown)		1
	Switch Bracket (not shown)		1
	Metal Switch Box (not shown		1
	Motor (not shown - 2HP, 1 Ph, 115/230V)		1
	Switch Assembly CP (not shown)		1

	Switch (not shown)		1
	Switch Plate (not shown)		1
	Switch Plate Mounting Screw (not shown)		1
	Motor - Switch Wiring Harness (not shown)		1

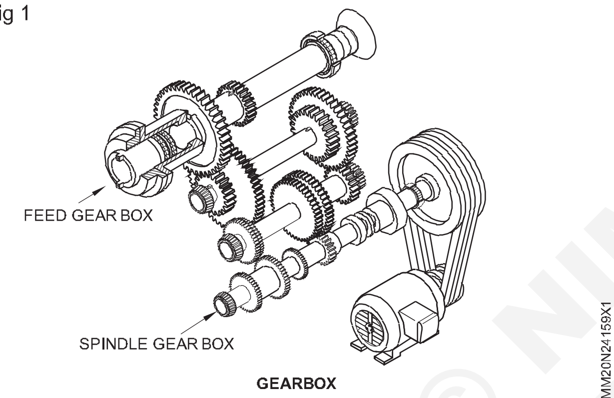
— — — — —

TASK 2 : **Dismantling & assembling of gear box**

Dismantle the gear box

- Switch off the machine
- Drain the Lubrication all from the gear box sump.
- Clean the machine thoroughly with clean clothes
- Remove the gearbox side cover along with gear shitting livers and forks (Fig 1)

Fig 1



- Remove the gear shaft end covers by unscrewing allen headed cap screws
- Remove all circles using crop pliers
- Remove the gear shat by using pulling bolt and supports
- Take out all the gears and spacers out from the gear box

> **Note down and give identification marks for all gears and spacers according to their sequence of arrangement while at the time of removing of gears and spacers from the gear box.**
>
> **Identification marks will lead easy assembling of gear box**

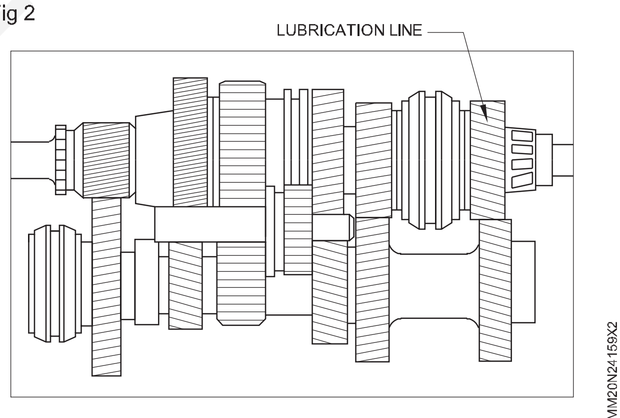
Inspect and replace worn out parts

- Clean all the parts with kerosene
- Inspect all the gears for teeth damage and wear if needed replace A
- Inspect and splines for wear needed replace it Inspect all the bearings if needed replace t
- Inspect all the static seals and replace it if necessary

Assemble the gear box

- Assemble all the parts of the gearbox in reverse order as specified in the dismantling order
- Fit all the lubrication pipelines
- Fill sufficient quantity of lubrication of in the of sump as recommended by the OEM
- Fix the gear box side cover forks and shift covers property

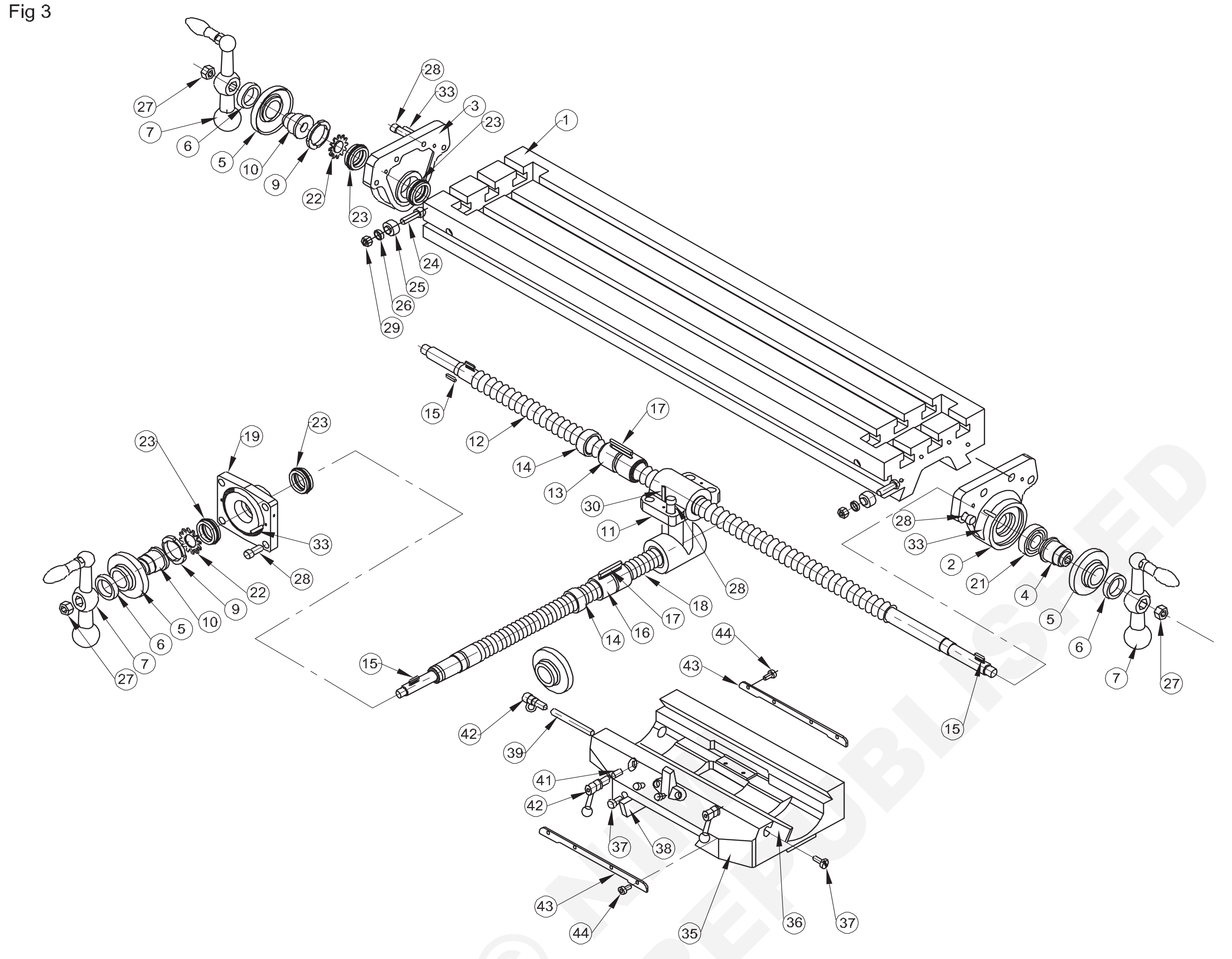
Fig 2



Test run the machine

- Switch on the machine
- Run the machine at slow, medium and high speed at least 15 minutes
- Listen if any abnormal noise is hearing from gear box
- Check if any excess heat is generating from the gear box if so rectify the fault

Fig 3



LEAD SCREW ASSEMBLY

Part no	Description	Qty
1.	Table	1
2.	Right lead screw bracket	1
3.	Left lead screw bracked	1
4.	Right dial holder	1
5.	Dial (inch)	3
6.	Dial nut	3
7.	Ball crank handle	3
9.	Lock nut	2
10.	Left dial holder	2
11.	Feed nut bracket	1
12.	‘X’ lead screw	1
13.	‘X’ lead screw nuts (inch)	2
14	Backlash adjustment nut	2
15.	Key, 3x3x20	3
16.	Cross feed screw nut (inch)	2
17.	Key 5 x 5 50	2
18.	’Y’ lead screw	1
19.	Cross feed bearing bracket	1
21.	Bearing	1
22.	Bearing washer	2
23	Bearing	4
24.	‘T’ bolt	2
25.	Table stop piece	2

Part no	Description	Qty
26.	Washer	2
27.	Nut. ½	3
28.	Screw, 3/8 x 1	16
29.	Nut, 3/8”	2
30.	Overload clutch lever spring plunger, 5 x 30	2
33	Overload clutch lever spring plunger, 6 x 25	6
35.	Saddle	1
36.	Saddle table jib	1
37.	Adjusting screw	4
38.	Gib (left & right)	1
39.	Saddle lock plunger	1
41.	Table lock plunger	2
42.	Table lock bolt handle	3
43.	Felt wipers	2
44.	Cross-recessed head screw 3/16 x 3/8	8
45.	Table stop bracket	1
46.	Hexagon socket screw	2

TASK 3 : **Dismantle & Assemble of lead screw**

- Switch off the machine power supply
- Clean the machine thoroughly with clean clothes

Dismantle right side bracket (Fig 1)

- Loosen and remove the nut (Part No 27)
- Remove ball crank handle (Part No 7)
- Remove dial nut ((Part No 6), dial (Part No 5) and right dial holder (Part No 4).
- Unscrew the allen cap screws. (Part No 28)
- Unscrew the allen cap screw (Part No 28)
- Remove the left lead screw bracket (Part No 3) along with bearing washer (Part No 22) and hearing (Part No 23)

Dismantle table cross feed assembly

- Loosen and remove the nut (Part No 27)
- Remove cross feed ball crank handle (Part No 7)
- Remove dial nut (Part No 6), dial (Part No 5) and cross feed dial holder (Part No 10).
- Loosen the lock nut (Part No 9)
- Unscrew the allen cap screw (Part No 28)
- Remove the cross feed bearing bracket (Part No 19) along with bearing (Part No 22) bearing plunger (Part No 23) and over load clutch lever spring plunger (Part No 33).
- Loosen and remove table stop bracket (Part No 46,45)
- Loosen the table lock bolt handle (Part No 42)
- Unscrew adjusting screw. (Part No 37)
- Remove saddle table gib. (Part No 36)
- Remove the right lead screw bracket (Part No 2) along with over load clutch lever.
- Spring plunger (Part No 33) and bearing (Part No 21).

Dismantle left side bracket

- Loosen and remove the nut (Part No 27)
- Remove ball crank handle (Part No 7)
- Remove dial nut (Part No 6), dial (Part No 5) and left dial holder (Part No 10)
- Loosen the lock nut, (Part No 9)

Build the platform up to the saddle top, such that the table can be pushed or pulled on the platform safely without causing damages, injurious.

- Pull the table from the machine on to the platform
- Clean the removal parts thoroughly with cleaning solvents
- Check/inspect the removal parts for damages/wear out.
- Replace/Rebuild the worn out/damaged parts.
- Assemble in reverse order as dismantling procedure

Check the movement of the table

- Manually move the table both 'x' and 'y' axis
- Check free movement of the table, if there is any tightness adjust the gibs
- Switch on the machine
- Test the free movement with power feed in 'x' and 'y' axis
- If any tightness reset the table assembly

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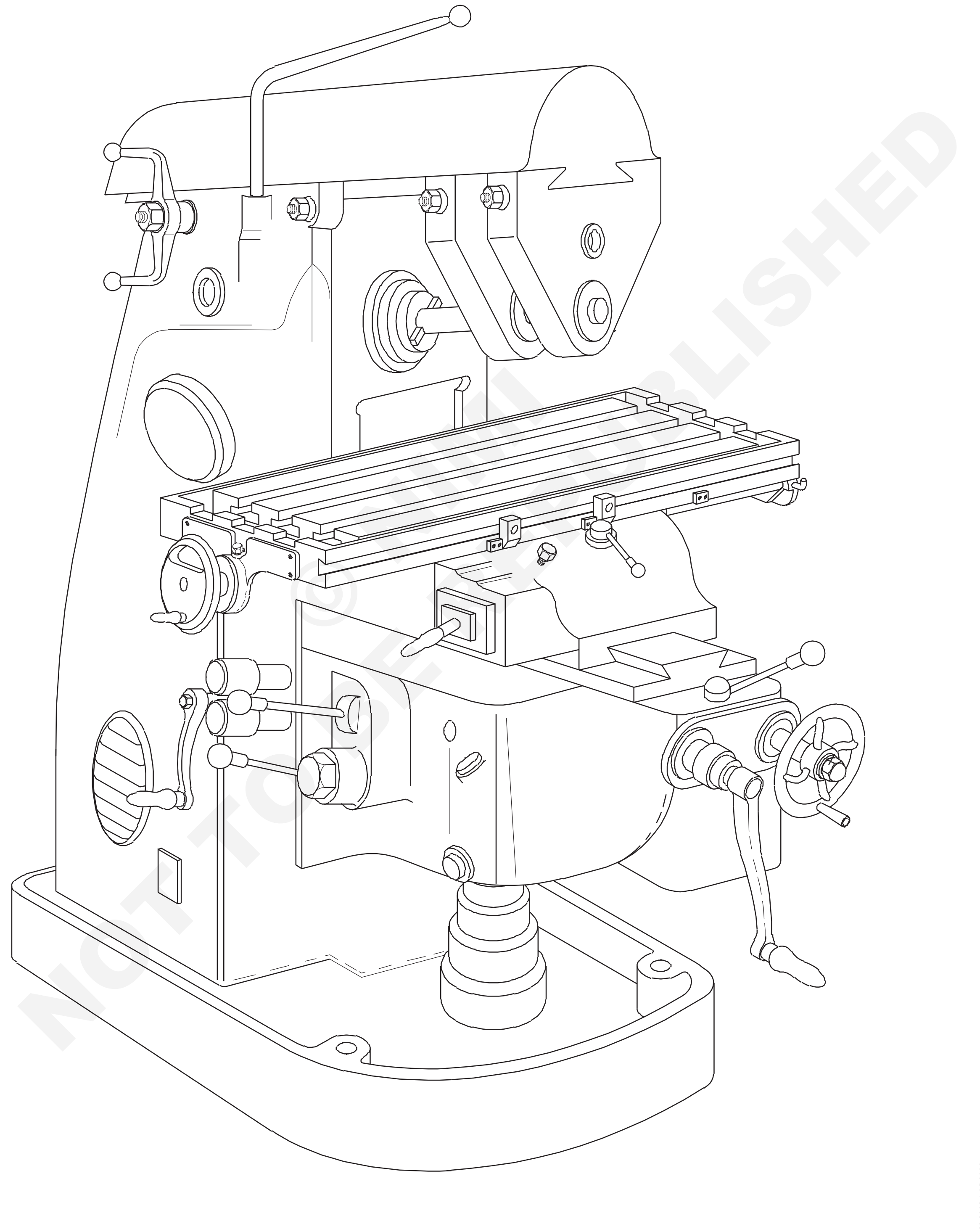
Check the accuracy of milling machine after assembly

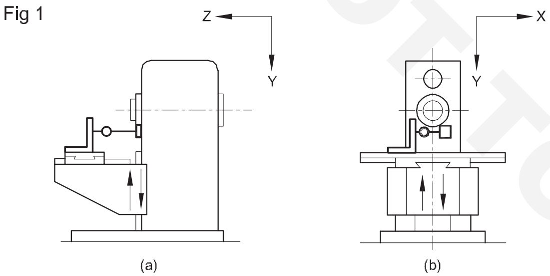
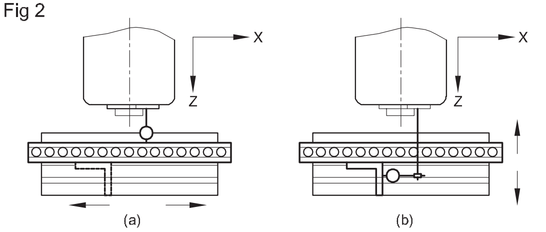
Objectives: At the end of this exercise you shall be able to

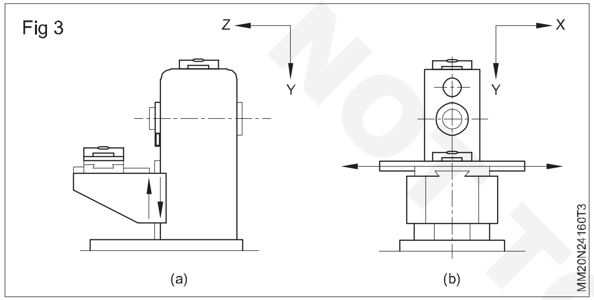
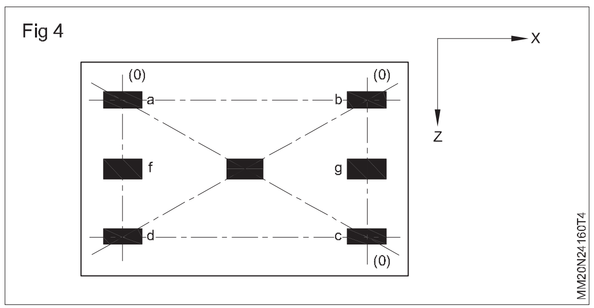
- **check the accuracy of milling machine by geometrical testing.**

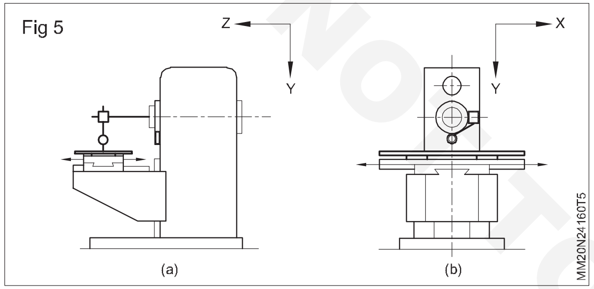
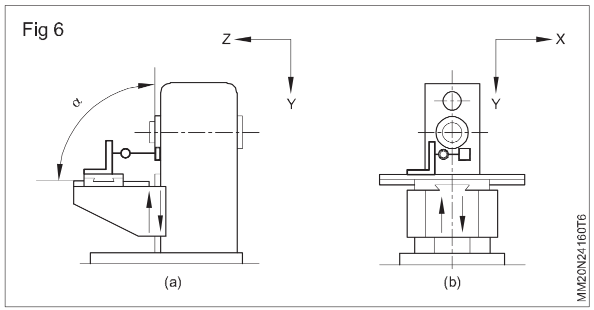
Fig 1

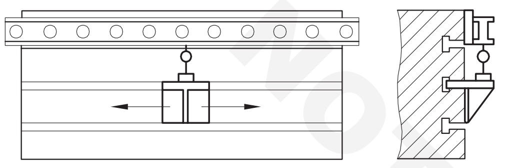
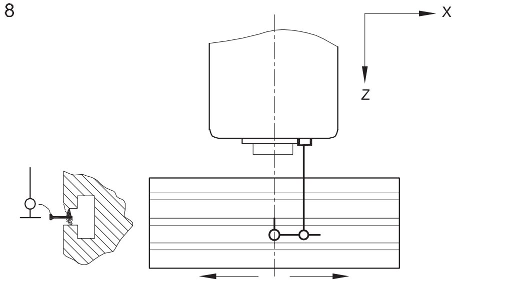


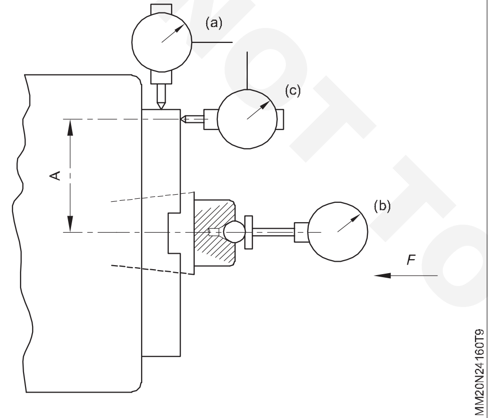
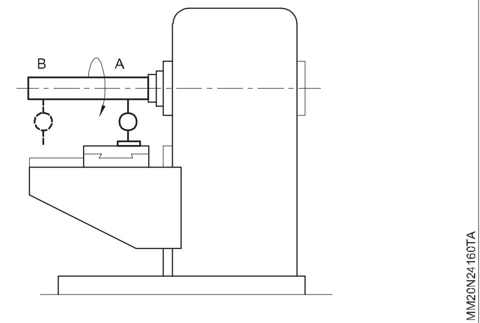
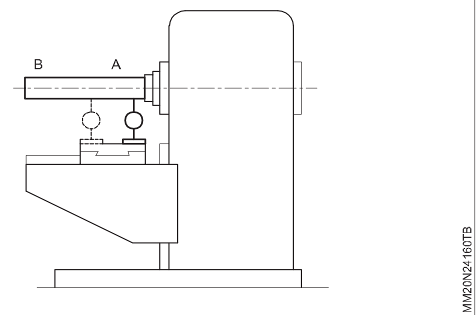
Geometric tests
Axis of motion

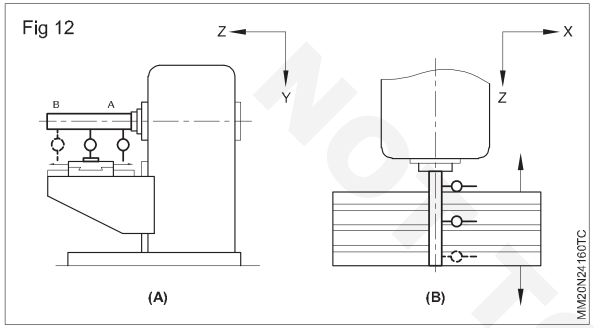
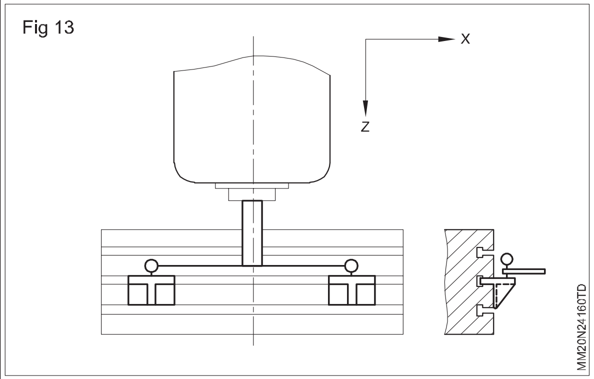
Sl. No	Figure	Objective (in mm)	Tolerance (in mm)	Measured deviation (in mm)	Measuring instruments (in mm)	Observations & references to ISO 230-1
G1	Fig 1  	Checking of straightness of the vertical movement of the knee (y axis a) in the vertical plane of symmetry of the machine (YZ plane). b) in the plane perpendicular to the vertical plane of symmetry of the machine (XY plane)	For a) and b) 0.02 for any measuring length of 300		Dial gauge & square	Instead of a straightedge use the vertical arm of the square Adjust the square to obtain similar readings at both ends of its measuring length so that straightness deviation can be calculated as the maximum difference of dial gauge readings Table in central position a) Cross size (Z axis) locked b) Tale (X axis) locked. If the spindle can be locked. The dial gauage may be mounted on it the spindle cannot be locked the dial gauge shall be placed on a fixed part of the machine.
G2	Fig 2  	Checking of square ness between the transverse cross side movement (Z axis) and the longitudinal table movement (X axis)	0.02 for a measuring length of 300 mm.		Straight edge, dial gauge and square	Knee (y axis) locked a) The straightedge shall be set parallel to the longitudinal table movement (X axis) then the square shall be placed against straight edge. The table shall then be locked in central position The test can be performed as well without the straight edge aligning the long arm of the square parallel to the X axis b) The transverse cross side movement (z axis) shall then be checked. If the spindle can be locked, then the dial gauge may be mounted on it. If the spindle cannot be locked the dial gauge shall be placed on a two part of the machine.

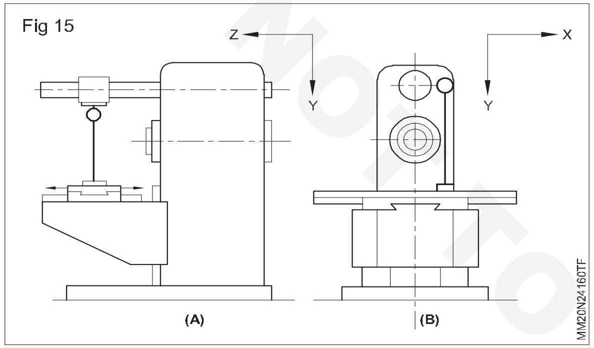
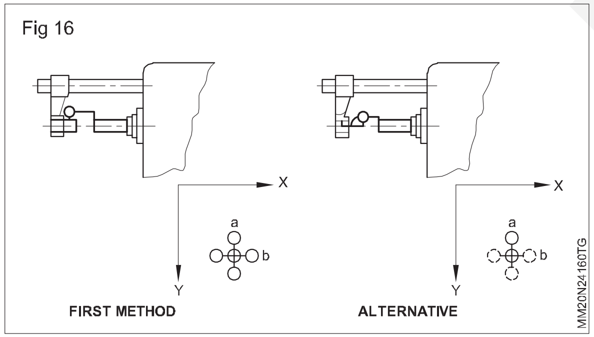
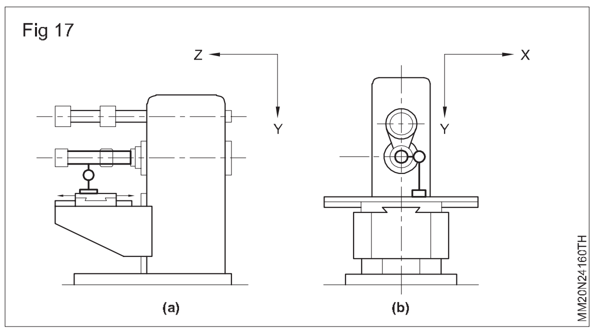
Sl. No	Figure	Objective (in mm)	Tolerance (in mm)	Measured deviation (in mm)	Measuring instruments (in mm)	Observations & references to ISO 230-1
G3		Checking of angular deviation of the table in its longitudinal movement (X axis): a) In the vertical YZ plan, perpendicular to the table movement. b) In the vertical XY plane parallel to the table movement.	a) 0.04/1000 (or 40 micron or 8") b) X ≤1000 0.08/1000 (or 80 micron or 16")X >1000 0.12/1000 or 120 micron		Precision level	These tests should only be performed when the knee (Y axis) is clamped on the column. The level shall be placed in the centre of the table: a) Transversely; b) Longitudinally; Measurements are taken at several positions moving the table by 200 mm or 250 mm steps. When X axis motion causes an angular movement of both spindle head and work holding table, differential measurements of the two angular movements shall be made and this shall be stated. The reference level shall be located on the column. The difference between the maximum and the minimum readings (excluding the above angular contribution) of both directions of movement shall not exceed the tolerance.
G4		Checking of flatness of the table surface.	0.04 for a measuring length upto 1000 mm, concave only. For each1000 mm increase in table length, add 0.005. Maximum tolerance :0.05. Local tolerance :0.02 for any measuring length of 300 mm.		Precision level or straightedge and slip gauges.	Table (X axis) and cross slide (Z axis) in central position, table not locked, knee and cross slide locked. The alphabetical references on the diagram correspond to those used in Fig 41 of ISO 230-1:1996

Sl. No	Figure	Objective (in mm)	Tolerance (in mm)	Measured deviation (in mm)	Measuring instruments (in mm)	Observations & references to ISO 230-1
G5	 Fig 5	Checking of parallelism between the table surface and : a) the transverse cross slide movement (Z axis), in the vertical YZ plane; b) its longitudinal movement(Xaxis), in the vertical XY plane	For (a) and (b) 0.025 for any measuring length of 300 mm maximum tolerance : 0.05 mm		Straightedge and dial gauge.	The stylus of the dial gauge shall be placed at approximately the working position of the tool. The measurement may be made on a straight edge laid parallel to the table surface. If the table length is greater than 1600 mm, carry out the inspection by successive movements of the straightedge. Knee (Y axis) locked) : a)Table (X axis) locked; b)Cross slide (Z axis) locked. If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on a fixed part of the machine.
G6	 Fig 6	Checking of square ness between the table surface and the vertical movement of the knee (Yaxis) in three positions : in the middle and near the extremities of the travel a)in the vertical plane of symmetry of the machine (YZ plane) b)in the plane perpendicular to the vertical plane of symmetry ofthe machine(XY plane)	a) 0.025m for a measuring length of 300 with≤ 90° b) 0.025 for a measuring length of 300 mm		Dial gauge and Square.	Table in central position, knee(Y axis) locked when taking measurements : a) cross slide (Z axis) locked; b) table (X axis) locked; If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on a fixed part of the machine.

Sl. No	Figure	Objective (in mm)	Tolerance (in mm)	Measured deviation (in mm)	Measuring instruments (in mm)	Observations & references to ISO 230-1
G7	Fig 7 	Checking of straightness of the median or reference T-slot of the table.	0.01 mm for any measuring length of 300 mm Maximum toler- ence : 0.03 mm		Straightedge and dial gauge or slip gauges, or taut wire and microscope or autocollimator.	The straightedge may be placed directly on the table. 5.212, 5.212.1 and 5.212.23 (ISO 230 -1)
G8	Fig 8 	Checking of parallelism between the median or reference T-slot and the longitudinal move- ment of the table.	0.015 mm for a measuring length of 300 mm. Maximum tolerance : 0.04 mm		Dial gauge.	5.422.1 and 5.422.21 (ISO 230 -1) Cross slide (Z axis) and Knee (Y axis) locked. If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on a fixed part of the machine.

Sl. No	Figure	Objective (in mm)	Tolerance (in mm)	Measured deviation (in mm)	Measuring instruments (in mm)	Observations & references to ISO 230-1
G9	Fig 9 	a) Checking of run-out of the external centering surface on the spindle nose(for machines having this feature) b) Checking of periodic axial slip. c)Checking of camming of the face of the spindle nose (including periodic axial slip).	a) 0.01 mm b) 0.01 mm c) 0.02 mm		Dial gauge.	a) 5.612.2 b) 5.622.1 and 5.622.2 A force F, specified by the supplier/ manufacturer of the machine, can be exerted by pressing toward the housing for tests (b) and (c) c) 5.632 The distance A of the dial gauge (c) from the spindle axis shall be as large as possible.
G10	Fig 10 	Checking of the run-out of the internal taper of the spindle: a)at the spindle nose; b)at a distance of 300 mm from the spindle nose.	a) 0.01 mm b) 0.02 mm		Dial gauge and test mandrel	5.612.3
G11	Fig 11 	Checking of parallelism between the spindle axis and the table surface.	0.025 mm for a measuring length of 300 mm (free end of the test mandrel inclined downwards		Dial gauge and test mandrel	5.412.4 Table (X axis) and cross slide (Z axis) not locked, knee(Y axis) locked. The measurement shall be at the mean position of rotation; i.e., measure at a position of spindle rotation and then repeat the measurement after rotating the spindle with mandrel 180° and take the mean value of the two measurements.

Sl. No	Figure	Objective (in mm)	Tolerance (in mm)	Measured deviation (in mm)	Measuring instruments (in mm)	Observations & references to ISO 230-1
G12	 Fig 12	Checking of parallelism between the spindle axis and the transverse move- ment of the table (Z axis) a) in the vertical y z plane; b) in the horizontal z x plane	a) 0.025 for a measuring length of 300 (free end of the test mandrel inclined downwards) b) 0.025 for a measuring length of 300 mm		Dial gauge and test mandrel	5.422.3 Table (X axis) in central position. Knee (Y axis) locked. The measurement shall be at the mean position of rotation; i.e., measure at a position of spindle rotation and then repeat the measurement after rotating the spindle with mandrel 1800 and take the mean value of the two measurements.
G13	 Fig 13	Checking of squareness between the spindle axis and the median or reference T-slot of the table.	0.02/300 where 300 mm is the distance between the two measuring points touched.		Dial gauge	5.512.1 and 5.512.42 Table (X axis) in central position. Table (X axis), cross slide(Z axis) and knee (Y axis) locked.

Sl. No	Figure	Objective (in mm)	Tolerance (in mm)	Measured deviation (in mm)	Measuring instruments (in mm)	Observations & references to ISO 230-1
G14	Fig 15 	Checking of parallelism between the arbor sup- port guide on the over- arm(s) and the transverse movement of the table (Z axis).	a)0.02 mm for a measuring length of 300 mm (over arm inclined downward) b)0.02 mm for a measuring length of 300 mm		Dial gauge and possibly precision level	5.422.3 and 5. over-arm(s) locked.
G15	Fig 16 	Checking co-ability of the axis of the bore of the arbor support with the spindle axis. a) in the vertical YZ plane. b) in the horizontal ZX plane.	a) 0.03 mm (axis of the bore of the arbor support lower spindle than the axis) b) 0.03 mm		Dial gauge and test mandrel	Arbor-support located 300 mm away from the spindle nose. Over-arm locked and arbor support not connected to the knee. The measurement shall be made a) in case of the first method, as close as possible to the arbor support; b) in case of the alternative, close to the middle of the arbor support bore. The reading on the dial gauge shall be divided by 2 to be compared with the tolerance.
G15 (alternative)	Fig 17 	Checking co-axiality of the bore of the arbor support with the spindle axis (parallelism between the supported arbor and the transverse slide cross movement (Z axis) a) in the vertical YZplane; b)in the horizontal ZX plane	a) 0.04 mm for a measuring length of 300 mm (mandrel inclined downwards on the bore end of the arbor support) b) 0.03 mm for a measuring length of 300 mm.		Dial gauge and test mandrel	a) The end of the mandrel or cutter arbor is held by the arbor support. b) The arbor support is positioned midway along the mandrel or cutter arbor. The reading on the dial gauge shall not be divided by 2.

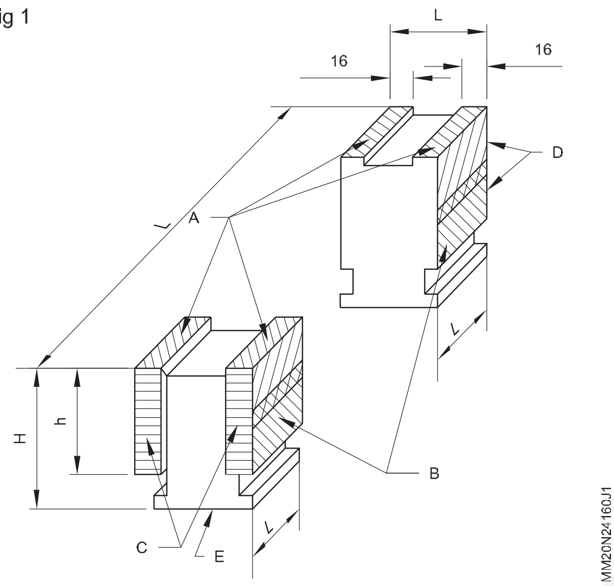
Skill sequence

Machining test

Objectives: This shall help you to
- **milling of surface B by automatic longitudinal movement of the table and manual vertical movement of the knee, in two cuts overlapping by about 5 mm to 10 mm**
- **milling surfaces A,C and D by automatic longitudinal movement of the table, automatic vertical movement of the knee and manual transverse movement of the cross slide.**

Dimension in millimetres

Fig 1



L is the length of the test piece of distance between the opposite faces of two test pieces, and is equal to 1/2 the longitudinal travel.

l is equal to h, and corresponds to 1/8 of the longitude travel.

l_{max} = 100 mm for L ≤ 500 mm

= 150 mm for 500 mm < L ≤ 1000 mm

= 200 mm for L > 1000 mm

l_{min} = 50 mm

Notes :

1. Longitudinal travels of ≥ 400 mm; one or two test pieces, machined in the longitudinal direction over a length l at each end, can be used.
2. Longitudinal travels of <400 mm; one test piece, machined over the entire length, shall be used.
3. Material : Cast iron

Cutting conditions

a) With a shell end mill.

b) Slab milling with the same cutter.

Checks to be applied

a) Surface B on each block shall be flat.	b_1) The planes containing the surfaces C, A and D shall be perpendicular to each other and each one perpendicular to the surface B.	b_2) The height H of the block(s) shall be constant.

Tolerance

a) 0.02 mm	b_1) 0.03 mm	b_2) 0.02/100	**(Measured deviation)**

Measuring instruments

a) Straightedge and gauge blocks or amplifier	b_1) Square and gauge blocks.	b_2) Micrometer calipers

Observations and references to ISO 230 - 1 4.1 and 4.2

Before beginning the test, surface E shall be flat.

Test pieces shall be placed along the longitudinal axis of the table so that the length L is equally distributed on either side of the table centre.

Note :

Subject to agreement between the user and the supplier/manufacturer, the form of the test piece shown in the diagram may be replaced by a simpler form of test piece having sides of full width, in which case tests carried out using this form will be at least as severe as those carried out using the form in the diagram.

The cutter should be sharpened on its arbor and, when mounted, should conform to the following tolerance.

1) Run-out: ≤ 0.02 mm

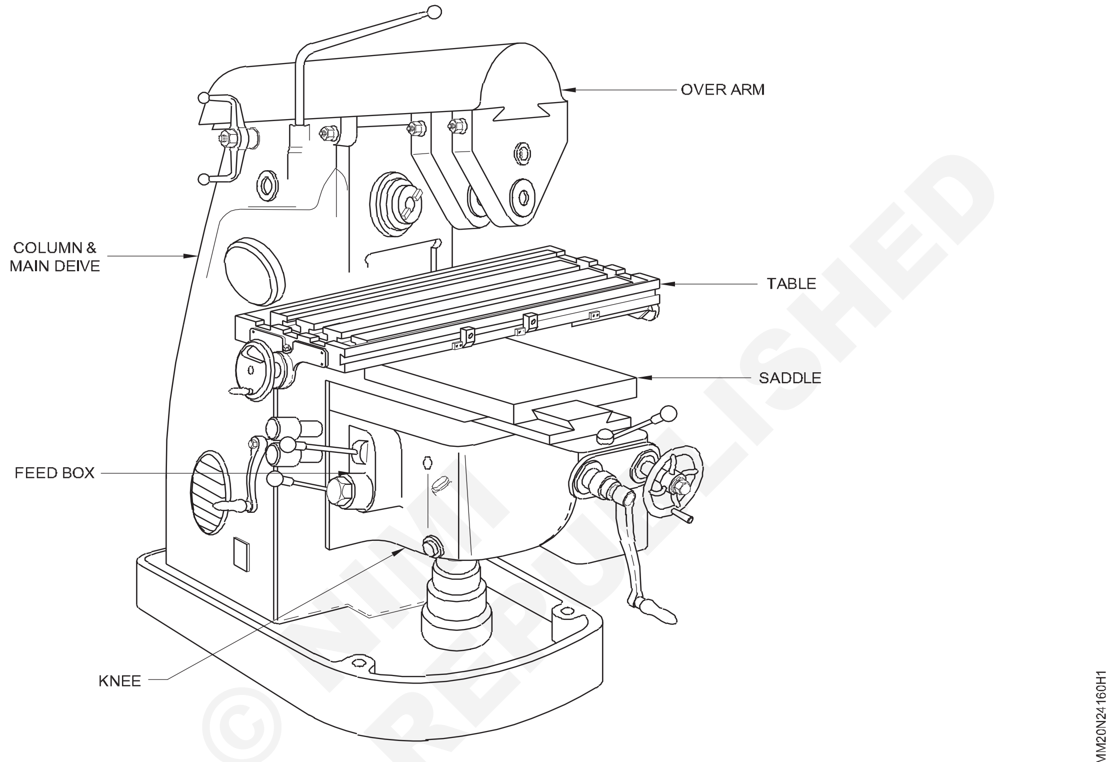
2) Cramming: ≤ 0.03 mm

All non-operating slides shall be locked during cutting.

Do the preventive maintenance of milling machine

Objectives: At the end of this exercise you shall be able to
- **list preventive maintenance schedule of milling machine**
- **explain various problems and their remedies.**

Fig 1



Job sequence

Preventive maintenance

Daily

- Clean all exposed surface of limit switches and trip dogs
- Lubricate points as specified in the manual under heading instructions for lubrications
- Use correct grad of oil as mentioned in the manual under heading “Recommended lubricants”

Weekly

- Wipe clean the entire machine
- Lubricate oil nipple for the hand wheel of vertical milling head as per instructions in the manual under heading “Instruction for Lubricants”
- Refill the reservior of feed box and distribution box to lever marked on oil sight glass to compensate the lost oil.
- Check coolant level in the base plate & fill if necessary
- Check all flexible conduits for any damage

Monthly

- Refill the reservoir of column and over arm bearing brackets to level marked on oil sight glass to compensate the lost oil.
- Fill anti friction bearing grease in bearings of vertical milling head and smear grease on bevel gear as per instructions in the manual under heading “Instructions for lubricants”.
- Clean the coolant sump and fill fresh coolant.
- Clean the inter of electrical cabinet preferably with a vacuum cleaner.

Disconnected before attempting to cleaning.

- **Six monthly**
- Drain out old from column feed box and distribution box, flush the sumps and refil fresh oil.
- All terminal connections to be inspected and tightened, if necessary. All electrical elements to be properly cleaned.
- Electromagnetic clutches to be checked for proper functioning.
- Climb milling attachment tobe adjustment if required.

Yearly

- Check the machine level
- Check machine adjustment and slide shakes.
- Proper tightening of all fasteners and fitting of pins to be done, if required.
- Fill antifriction bearing greases in motor bearings.

Causes and remedies related to milling machine break down are listed in table - 1

Table1

Problems	Causes	Remedies
Column and main drive a Excessive heating of main spindle.	Improper adjustment of axial and radial plays of the spindle bearings. Less or excessive quantity of lubricants	Adjust the play of the spindle taper roller bearings. Check the pipe connection from pump to the bearing housing Proper greasing of V.M. Head spindle bearings for 'V' machine.
b Lubrication pump noisy or does not pump sufficient quantity of oil.	Pump plunger loose in the bore. Choking of suction filter	Replace worn-out parts if necessary. Clean filter
c Too much instantaneous noise near main motor at starting.	Flexible coupling rubber bushes might have failed.	Repalce rubber bushes of the coupling
d Main spindle does not stop quickly after switching off the main motor.	Brake not functioning Excessive Armature play of the elctro magnetic brake	Check all the relevant electrical connections & tighten them Adjust the Armature play to the recommended value.
Knee a Knee movement jerky	Knee gab screws may be too loose or too tight improper lubrication.	Adjust the screws for easy movement. Ensure correct lubrication.
b Vertical feed screw heats up or sizes when the knee is taken up or down.	Insufficient lubrication.	Check for proper lubrication
c Power feed movements oc-cur when the crank handle is in vertical or cross cranking dia	Interlocking limit switches in front cover of knee not fixed or connected properly	Check the connection
d Vertical power drive engaging lever does not stay in engaged in horizontal position.	The spring loaded locating bush does not have sufficient force.	Replace compression spring if re-quirked
e Loud noise in knee at starting the vertical power drive or rapid.	Improper backlash setting of feed box to knee dive spur gear pair	Adjust the play with two screws at the top of feed box after taking out the taper pin lock with larger dia taper pin.
Feed box a Lubrication pump noisy or does not pump sufficient quantity of oil.	Pump plunger loose in the bore .	Repalce worn out parts, if necessary.
b To much instantaneous noise near feed motor at starting.	Flexible coupling rubber bushes might have failed.	Replace rubber bushses of the coupling.
c Feed/rapid electromagnetic clutch not engaging to give feed/rapid.	Faulty electrical connections	Check all the relevant connection of cloches, contactor, limit switches and push buttons etc.
d The feed drive is not being braked properly when switched off.	Faulty electrical connections The two clutches in feed box, which should energies simultane-ously for braking action, are not functioning as desired	Check all the relevant connection of cloches, contactor, limit switches and push buttons etc

Problems	Causes	Remedies
Distribution box and saddle a Longitudinal or cross motion not occuring in spite of the feed box output shaft rotation and selector lever being in engaged position b Too frequent shearing off of the safety shear pin. c Saddle hand movement very tight or jerky movement in power feed	Safety sheer pin broken Excessive resistance to free movement of the machine Too less a clearance in gib Cross feed screw driving gear keyway is blocked by dirt or small chips. Improper lubrication	Replace the shear pin. Check the easy movement of slides by hand and remove the cause of overloading before operating on power drive. Adjust the gib Clean the parts and assemble back Ensure proper lubrication. Check the lubrication pump in distribution box and all pipe connections.
Table and over arm a Chatter when heavy cut is given b Overarm support bracket too tight on the guideways	Excessive axial and radial play in main spindle. Gibs of table,saddle or knee may be loose. Arbor support bushes running loose in the bronze bearings of the over arm bracket Clamping of knee saddle or table not effective Improper foundation and bad levelling. Excessive backlash in screw feed drive. Nuts may be tight	Adjust axial and radial play Adjust the gibs properly. Adjust ring nut on bronze bearing Check and improve clamping Follow the instructions on foundation, level the machine as per chart & tighten all grouting bots. Replace worn out parts. Loosen the nuts

General		
a Lubrication distribution not effective	Dirt in the sump	Clean the sump and filter
b Coolant not flowing.	Coolant motor running in opposite direction. Dirt in the sump Dirt clogged in the mesh Low voltage supply	Interchange any two phases in the electrical connection of coolant motor. Clean the sump Clean the mesh Check voltage supply
c Electrical motors do not start	Blown out fuse. Loose contact in circuit Defective contact points in the contactor.	Replace fuse Tighten all screws and electrical contacts. Clean or replace contacts if necessary
d Indicating light on electrical cabinet do not light up in spite of switch being in ‘ON’ position	Loose connections Defective light bulb	Check and tighten the electrical connections Replace the bulb
e Excessive noise of electric motor/ and excessive drive vibrations.	Faulty motor/s	Replace the motor/s.

Demonstrate working of grinding machine

Objectives: At the end of this exercise you shall be able to
- **prepare the surface grinding machine for grinding operations**
- **working of surface grinding machine**
- **Identify parts and their functions.**

Note: Instructor to brief the parts & its function of surface grinding machine.

Job sequence

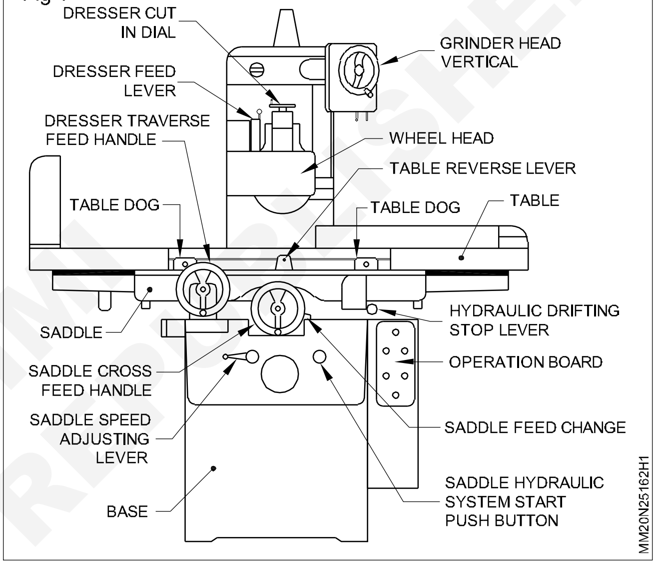
TASK 1: **Prepare the surface grinding machine for grinding operations**

Preparing wheel spindle.

It is very essential to check the different controls of the machine before actually starting the grinding operation. This preparation will help to operate the machine for work. Check the following before the grinding operation.

- Checking and oiling before start
- Supply oil to all the lubrication points. (Consult your instructor)
- Check that the button on the operation board is at the stop position (Fig 1)
- Check that the clutch of the table traverse feed handle is out.
- Check that the table dog is fixed.

Fig 1



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TASK 2: **Working of surface grinding machine**

Manual feed of table

Set the table reverse lever at the 'neutral' position (Fig 1). Engage the clutch of the table traverse feed handle.

Move the table to the right and left by turning the handle clockwise and anticlockwise respectively.

Manual and automatic feed of saddle

- Move the saddle forward by turning the saddle cross fedd handle clockwise. (Fig 1)
- Move the saddle backward by turning the saddle cross fed handle anticlockwise
- Set in the automatic feed by turning the saddle feed change lever upward and downward. (Fig 2) (When the lever is pushed up or down, the saddle moves forward or backward respectively)
- Raise and lower the grinding wheel.
- Disengage the fine feed knob. (Fig 2)
- Turn the grinding wheel elevation handle anticlockwise to lower the grinding wheel. (Fig 1)
- Turn the grinding wheel elevation handle clockwise to raise the grinding wheel.

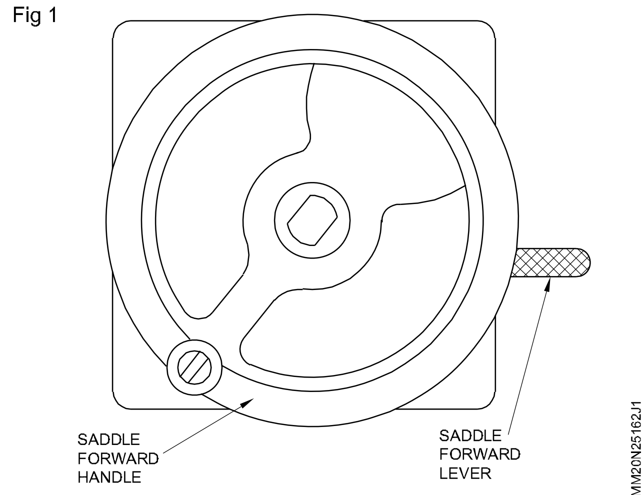


Fig 1

Hydraulic operation of table

- Pull the table traverse feed handle to the front side to disengage the clutch.
- Push the hydraulic driving push button to drive the table hydraulically.
- Adjust the table speed by the use of the table speed adjusting lever. (When the lever is pushed up, the table speed is increased. The speed is decreased by lowering the lever and the hydraulic drive is stopped at the lowest position of the lever.)
- Stop the hydraulic drive by pushing or pulling the hydraulic drive stop lever. (The table is stopped at the right end position.)

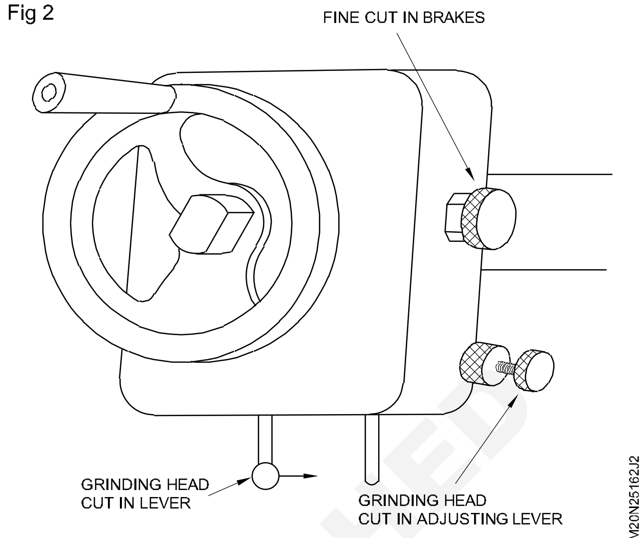


Fig 2

— — — — — — — — —

TASK 3: **Identify parts and functions of surface grinding machine**

S.No	Name of the part	Function
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

— — — — — — — — —

Machine stroke length setting & wheel balancing of surface grinding m/c

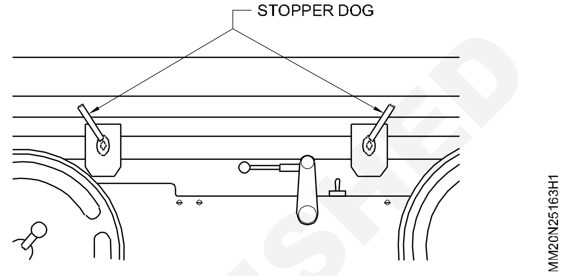
Objectives: At the end of this exercise you shall be able to
- **stroke length setting**
- **balancing a grinding wheel.**

Job sequence

TASK 1: **Stroke length setting**

- Clean the table slot burrs if any and remove with an abrasive stone.
- Mount the magnetic chuck on machine table
- Align the chuck parallel to table traverse by dial gauge
- Place the work piece centrally over the section of magnetic chuck
- Set the table reverse lever at the neutral position engage the clutch of table traverse feed handle
- Move the table to right and left by turning the handle clockwise and anticlock wise
- Determine correct end points on either side of the table (stroke length) full length machining of the work.

Fig 1



- Fix the table dogs at that determine points & set stroke length
- Ensure correct stroke length turn feed handle clockwise & anti clockwise directions.

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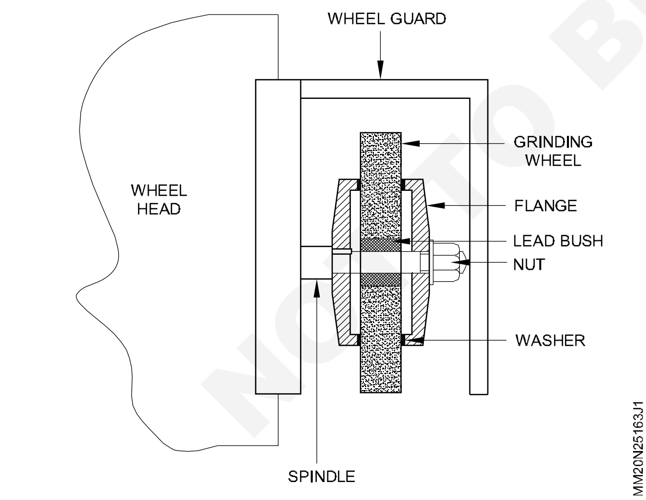
TASK 2: **Balancing a grinding wheel**

- Mount wheel on machine spindle and tighten lock nut.
- Fix wheel guard. (Fig 1)

Fig 1



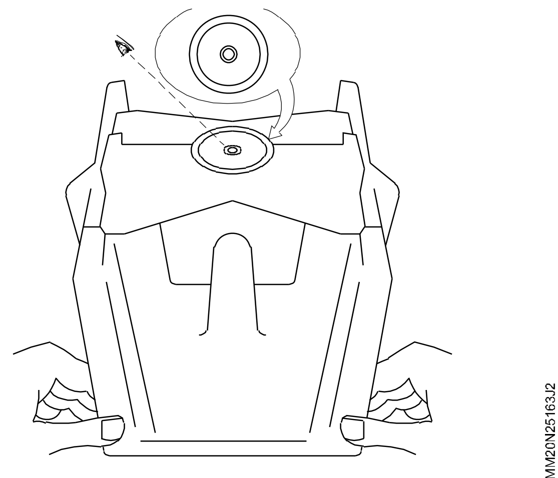
- Dress the wheel to remove uneven surface
- Remove wheel guard & lock nut
- Remove grinding wheel assembly

Use both hands when removing the wheel assembly. Take care not to knock on any machine part to prevent any damage to the wheel.

Preparing the balancing unit

- Place the levelling plate on the balancing stand. (Fig 2)

Fig 2

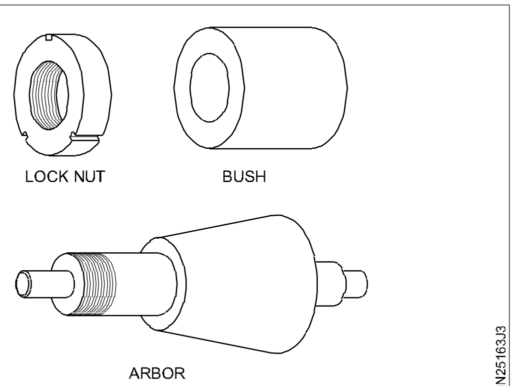


- Adjust the unit, using two knurled Screws on the base until the bubble in the levelling plate is concentric with the circle engraved on the glass. (Fig 3)

Positioning Wheel on unit

- Clean the bore of the unit (Fig.3) and the balancing Mandrel, then mount the Wheel assembly on the mandrel. (Fig.4a)
- Tighten the nut on the mandrel.

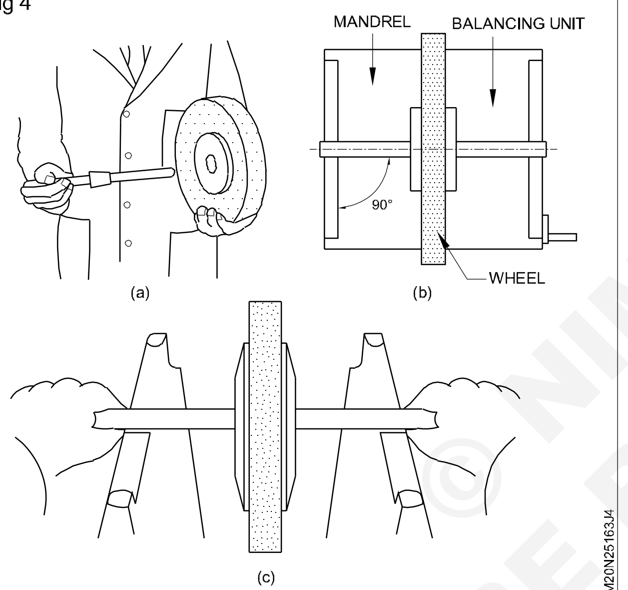
Fig 3



BALANCING ARBOR COMPONENTS

- Raise the protection guards.
- Place the wheel to be balanced on the top of the protection slides on to the balancing stand.(Fig.4c)

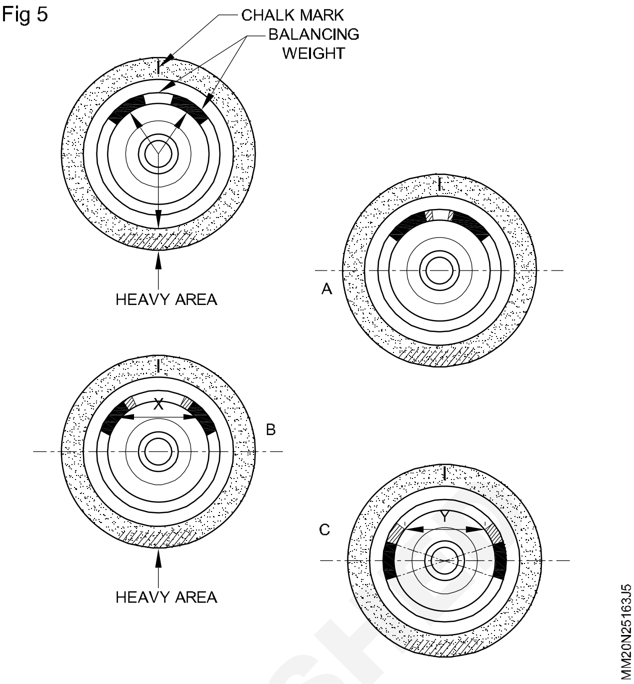
Fig 4



(ii) Balancing the wheel

- Visually ensure that the balancing mandrel is at right angles to balancing ways.
- Allow the wheel to revolve slowly, by its own momentum until stationary.
- Place a chalk mark at the bottom to indicate a heavy point. (Fig 5)

Fig 5

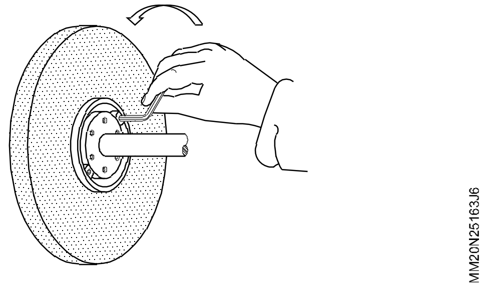


- Turn the wheel 90° to the heavy point, and diametrically opposite.

If the wheel finds the heavy points quickly, the balancing weights could be moved approximately 180°. (This indicates that the wheel is considerably out of balance). Move the weights equally towards the lighter side, approximately 3 mm at a time. Fig 6)

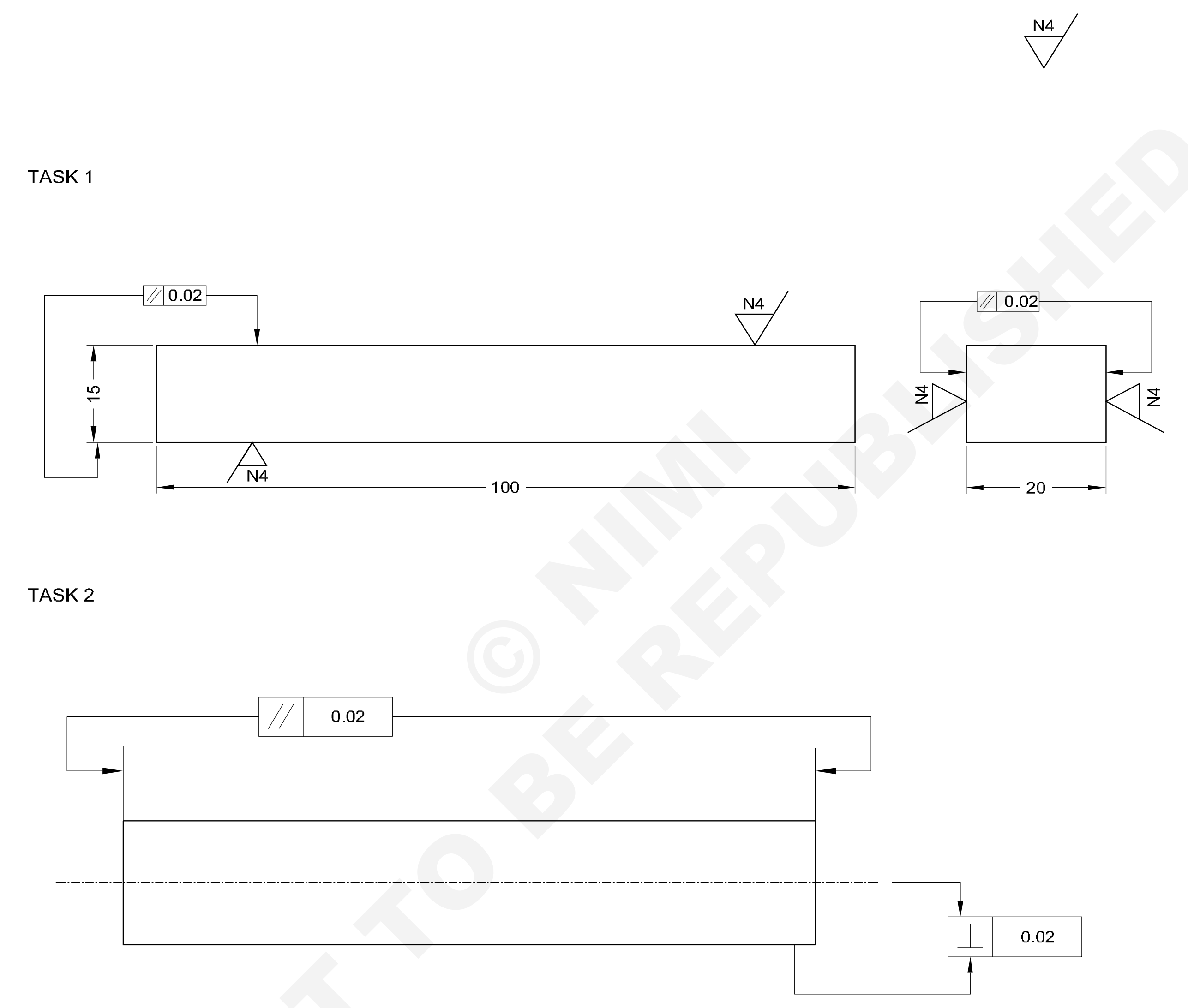
- Repeat until the assembly remains static in any position.
- Remount the assembly on the wheel head, replace the guard and re-dress the wheel before putting it into further operation.

Fig 6



Perform grinding of parallel and perpendicular surfaces (accuracy ± 0.02mm)

Objectives: At the end of this exercise you shall be able to
- **grind parallel surfaces to an accuracy of ± 0.02 mm**
- **grind perpendicular surfaces to an accuracy ± 0.02 mm.**



1	20 X 105 X 25	-	Fe310	-	-	2.5.164
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	GRINDING BY SURFACE GRINDING MACHINE WITH AN ACCURACY OF ±0.02 mm				TOLERANCE	TIME hrs
					CODE NO. MM20N25164E1	

Job sequence

- Machine the jobs and determine the grinding allowance for each surface to be ground.
- Prepare the surface grinding machine for grinding.
- Rough grind both the opposite sides of the pieces and maintain to 15.04mm thick.
- Dress the wheel for finish grinding.
- Finish grind the pieces 15.00 thick to an accuracy of ±0.02mm. Measure the size with a 0-25 outside micrometer.
- Set the job with the angle plate (150x150) by 2 'C' clamps of 100mm size for grinding adjacent surfaces at 90°.
- Rough grind the adjacent sides individually leaving half of the grinding allowance for the opposite surfaces to 20.03mm thick.
- Mount the job on the magnetic chuck keeping down the surfaces already ground and rough grind the opposite surfaces of 20.03mm thick.
- Finish grind and bring the thickness to 20.00 to an accuracy of ± 0.02mm.
- Remove the parallels from the magnetic chuck.
- Clean thoroughly and deburr with a fine abrasive stone.
- Measure the width and thickness for dimensional accuracy with an outside micrometer.
- Also check for parallelism with an outside micrometer on the four corners on each piece.
- Demagnetize the block.

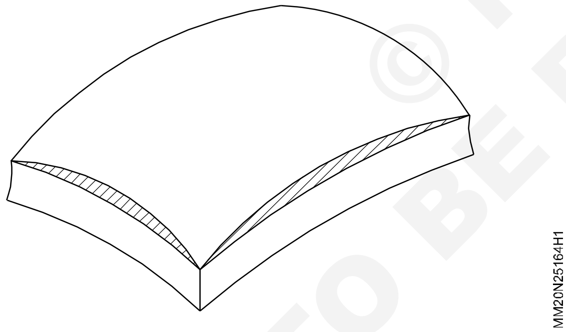
Skill Sequence

Grinding parallel surfaces

Objective: This shall help you to
- **grind parallel surfaces to an accuracy of ± 0.02 mm.**

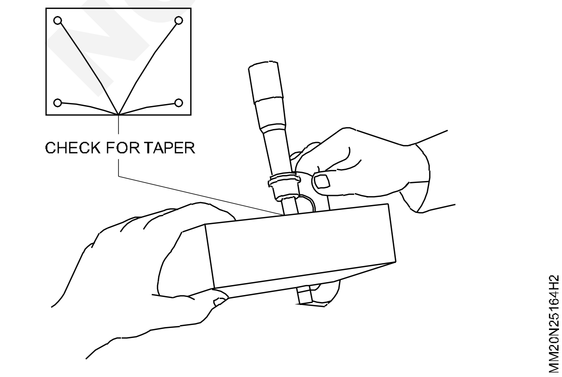
Always assume that the work piece is distorted in one or more planes. (Fig 1) For this reason a true reference face must first be produced.

Fig 1



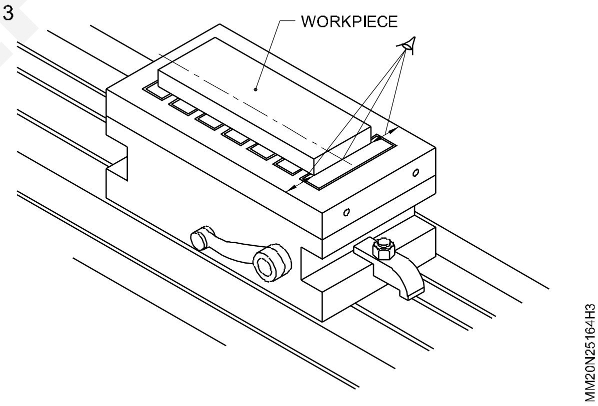
Check the flatness with a straight edge and locate the lowest spot by visual examination. Check the parallelism using an outside micrometer and mark the high spot. (Fig 2)

Fig 2



Clean the work table surface and the bottom of the magnetic chuck. (Fig 3)

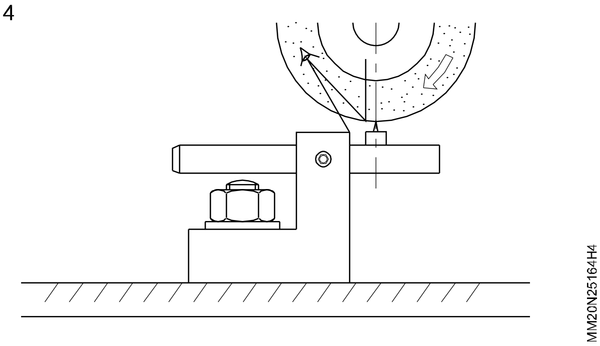
Fig 3



Place, align and clamp securely the magnetic chuck over the work table.

Dress the grinding wheel for rough grinding. (Fig 4) (Seek the help of your instructor.)

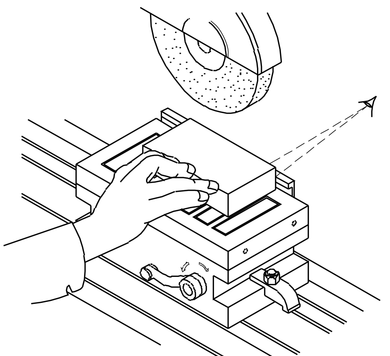
Fig 4



Clean the abrasive particles spread over the magnetic chuck and table.

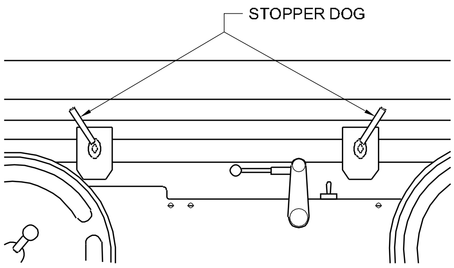
Mount the workpiece on the magnetic chuck, (Fig 5) resting the lengthier surface with the side stopper plate of the magnetic chuck.

Fig 5



Set the table traverse-stopper dog considering the (Fig 6) approach length and over travel. Also set for the clearance of the job width.

Fig 6



Set the feed rate of the table to 10 to 15 m/mm.

Hand-feed the wheel head down and watch the narrowing of the gap. Stop at 0.25 mm gap approximately.

Clear the job from the grinding wheel.

Switch on the grinding wheel spindle.

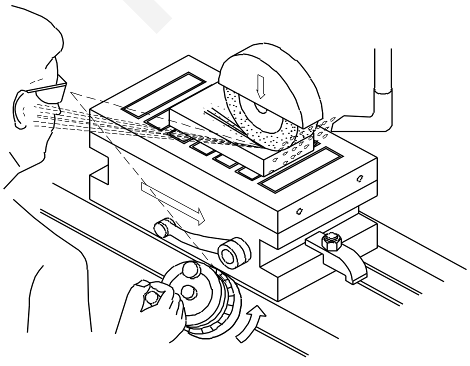
Engage the longitudinal power traverse using the fine feed mechanism and 'pick up spark' at the high spot.

Cross-traverse the work piece to clear the wheel.

Start the coolant pump and direct the stream of the coolant between the wheel and the work piece. (Fig 7)

This will reduce the heat of the job, and the ground particles will be washed away.

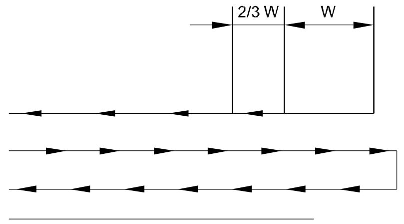
Fig 7



Apply a 0.03 mm depth of cut by the fine feed mechanism when the workpiece clears the grinding wheel after each cut. (Fig 8)

Keep your hands away from the revolving wheel at all times to avoid injuries to yourself.

Fig 8



Repeat rough grinding till the grinding allowance for that side is ground away.

Cross-traverse the workpiece to clear the wheel.

Re-dress the grinding wheel for finish grinding. (Seek the help of your instructor.) Clean the table and workpiece thoroughly.

Engage the longitudinal travel feed.

Apply a 0.012 mm cut and finish grind the workpiece allowing the wheel to 'spark out'.

Always apply the depth of cut at the end of the stroke.

Stop all traverses and turn off the coolant. Position the work piece away from the wheel.

Remove the workpiece from the magnetic chuck. While so doing see that no scratches are formed on the magnetic chuck. (Consult your instructor.)

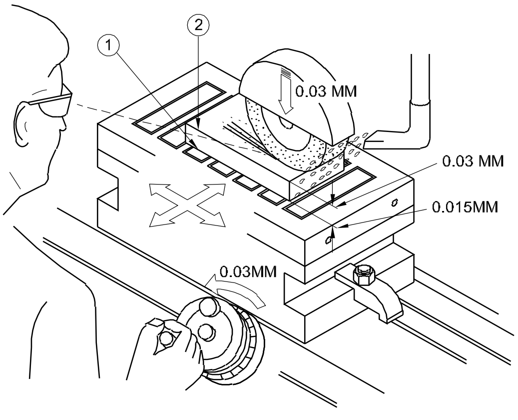
Remove the sharp edges of the work piece by using a fine abrasive stick or stone.

Check the ground face with a straight edge and the thickness with an outside micrometer. This will be the reference surface for grinding the other surfaces.

Dress the grinding wheel for rough grinding.

Clean the magnetic chuck face and mount the ground surface of the workpiece over the face of the magnetic chuck. (Fig 9)

Fig 9



Set table traverse stops.

Clean up the face by removing minimum material.

Remove the workpiece, deburr and clean it.

Determine the stock of material to be removed with an outside micrometer.

Check parallelism with an outside micrometer and determine the amount of taper if any. (To correct taper ask your instructor for advice.)

Remount the workpiece in the same position and continue rough grinding, leaving an allowance of 0.012 mm for finish grinding.

Remove the workpiece and dress the wheel for finish grinding.

Remount the workpiece and give a depth of cut of 0.005 mm and grind the surface.

Remove the work piece from the magnetic chuck.

Thoroughly clean the work piece and the surface of the chuck.

Measure the thickness and parallelism and decide the remaining allowance.

Remount the work piece and apply another 0.005 mm depth of cut and finish grind.

Using the graduated dial of the wheel head, down feed for grinding the remaining allowance.

Allow the wheel to spark out.

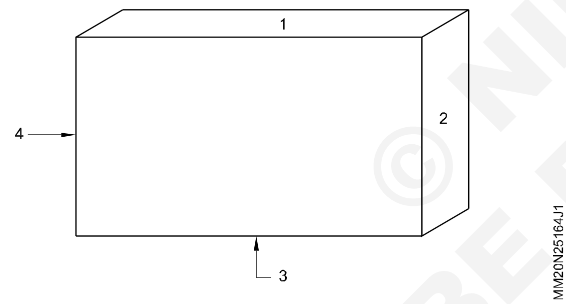
Remove the work piece and clean thoroughly. Check the thickness, parallelism and flatness of the surface texture.

Grind a surface at 90° to an accuracy of 5'

Objectives: This shall help you to
- **set the workpiece for grinding a surface at 90°**
- **grind surface at 90°.**

Clean and remove all burrs from the work piece, the angle plate and the magnetic chuck. All the four sides (Fig 1)

Fig 1



Are to be ground perpendicular to each other.

Place a piece of paper which is slightly larger than the angle plate on the magnetic chuck.

Place one end of the angle plate on the paper.

Place the flat ground surface of the work piece against the angle plate so that the top and one edge of the work piece project about 12 mm beyond the edges of the angle plate. (Fig 2)

Be sure that the edge of the work does not project beyond the base of the angle plate.

If the work piece is smaller than the angle plate length, a suitable parallel must be used to bring the top surface beyond the end of the angle plate. (Fig 3)

Hold the work firmly against the angle plate and turn on the magnetic chuck.

Clamp the work securely to the angle plate and set the clamps so that they will not interfere with the grinding operation.

Turn off the magnetic chuck and carefully place the base of the angle plate on the magnetic chuck for grinding the surface(1). (Fig 3)

Fig 2

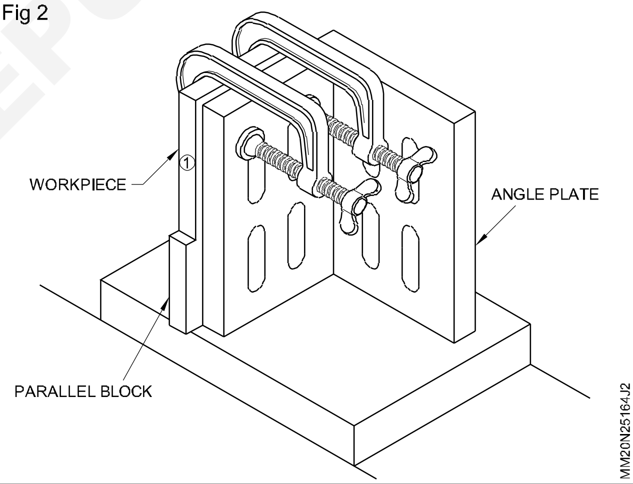
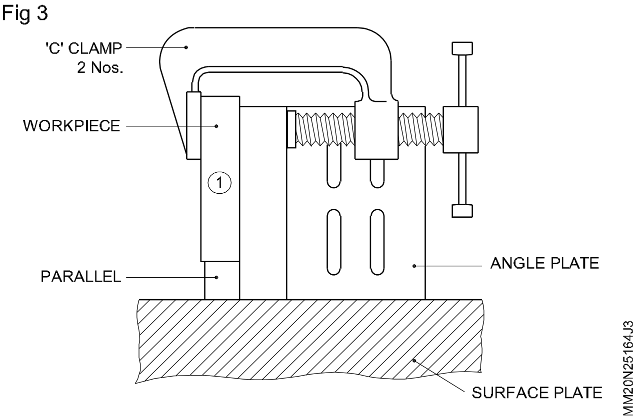
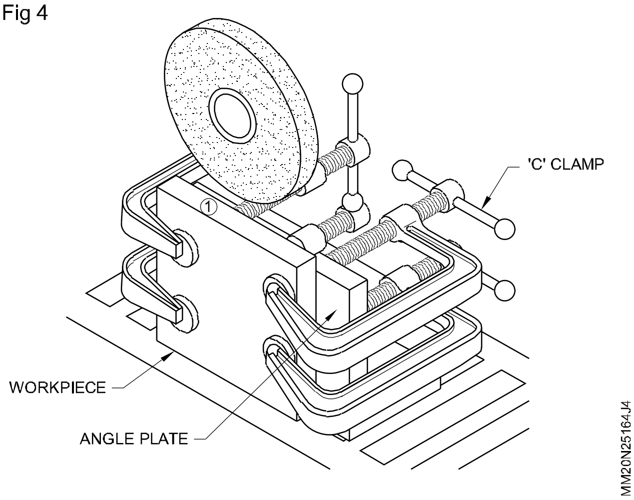


Fig 3



Carefully fasten two more clamps on the end of the work piece to hold the work securely. (Fig 4)

Fig 4



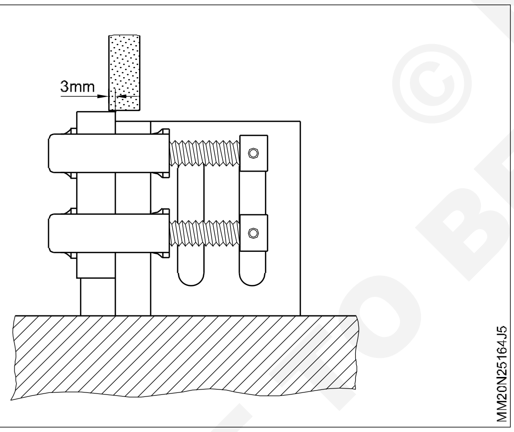
After the work has been properly set up on the magnetic chuck the following steps are to be followed for grinding the edges of the work piece.

Raise the wheel head so that it is about 12 mm above the surface of the job.

Adjust the table reverse dogs so that each end of the work clears the grinding wheel by about 25 mm.

With the work under the centre of the wheel, turn the cross-feed handle until about 3 mm of the wheel overlaps the edge of the work. (Fig 5)

Fig 5



Start the grinding wheel and lower the wheel head until the wheel just sparks the work.

Move the work clear of the wheel with the cross-feed handle.

Check for further high spots by feeding the table by hand so that the entire length of the work piece is under the wheel.

Engage the table reverse lever and grind the surface until all the marks are removed.

The depth of cut should be 0.03 to 0.15 mm for the roughing cuts and 0.01 to 0.02 mm for the finishing cuts.

Stop the machine and remove the clamps from the right hand end of the work.

Turn off the magnetic chuck and remove the angle plate and work piece as one unit. Be careful not to disturb the work set up.

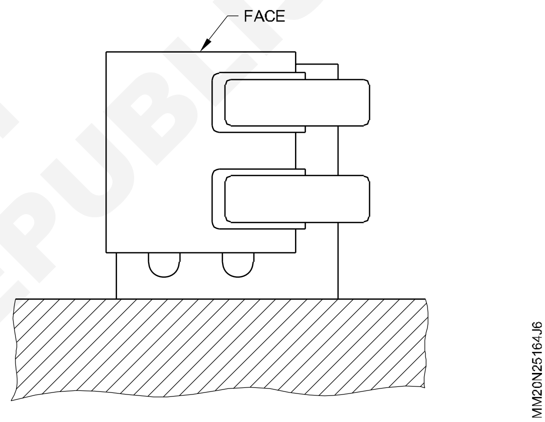
Clean the chuck and the angle plate.

Place the angle plate (with the attached work piece) on its end with the surface to be ground on the top. (Fig 6)

Fasten two clamps to the right hand side of the work piece and the angle plate.

Remove the original clamps from the top of the set up.

Fig 6



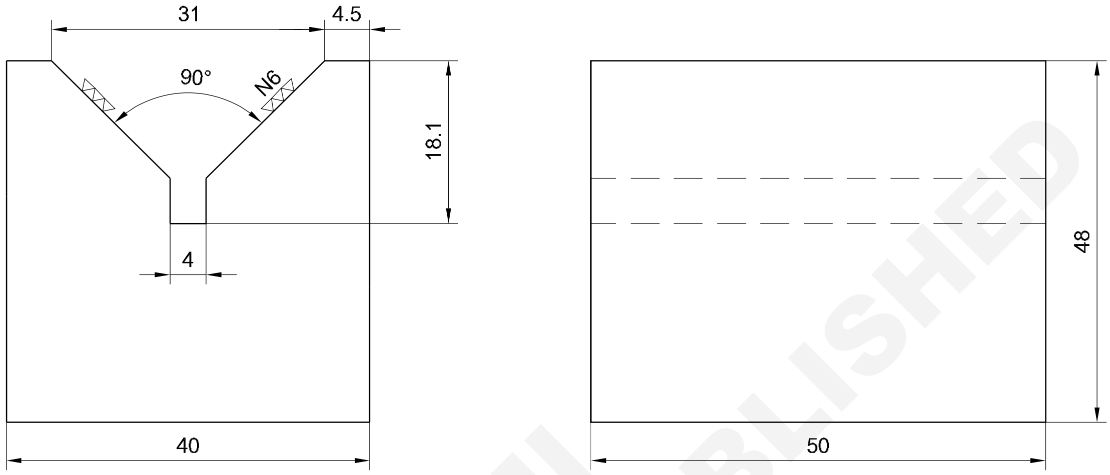
Repeat the above steps and grind the second edge.

When two adjacent sides have been ground, they are then used as reference surfaces to grind the sides (3) and (4) square and parallel.

If the workpiece is atleast 25 mm thick and long enough to span three magnetic poles on the chuck no angle plate is required.

Angular surface grinding

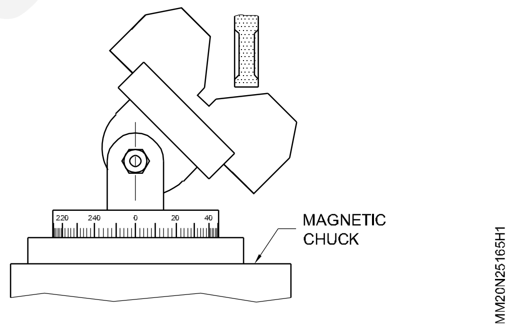
Objective: At the end of this exercise you shall be able to
- **perform angular surface grinding ± 0.02 mm.**



Job Sequence

- Study the drawing. Observe the surface to be ground and determine the grinding allowance for each surface by measuring.
- Prepare the machine dress the grinding wheel for grinding angular surface.
- Mount the suitable universal vice on the magnetic chuck and align its fixed jaw parallel to the grinding wheel axis by using the dial test indicator.
- Ensure that all the swivel base graduations coincide with the O degree dead mark before aligning
- Take prefilled block for angular grinding with 3mm allowance for grinder
- Hold the job in the vice and tilt the vice to 45° (Fig1)
- Rough and finish grind the surface, (a) using the face of the grinding wheel. Record the amount of materials removed by noting down the divisions on the graduated dial of the wheel head.

Fig 1



- Remove the same amount of material from the surface (b) using the front side of the grinding wheel by manual cross-feeding in the same setting.
- Remove the job. Deburr and demagnetize the job.

1	-	50 X 40 X 48	CAST IRON	-	-	2.5.165
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	SET AND PERFORM ANGULAR GRINDING USING UNIVERSAL VICE / SINE VICE TO STANDARD ANGLE	TOLERANCE ±0.01mm	TIME:
		CODE NO. MM20N25165E1	

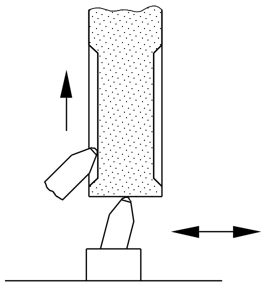
Skill Sequence

Grinding angular surface using universal vice

Objective: This shall help you to
- **grind angular surfaces using a universal vice.**

Dress the grinding wheel on the sides for relief and on the face for trueness. (Fig 1)

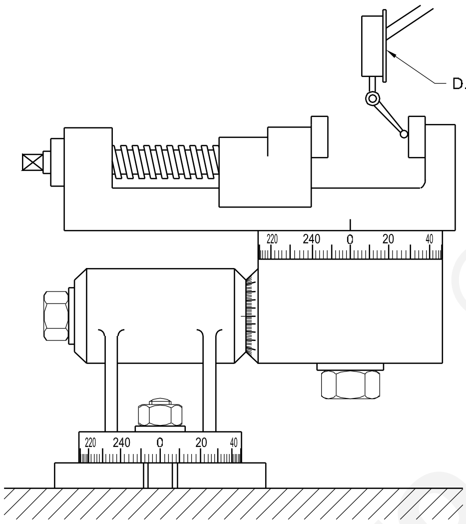
Fig 1



Clean the machine table and mount the universal vice.

Align the fixed jaws of the vice perpendicular to the axis of the spindle. (Fig 2)

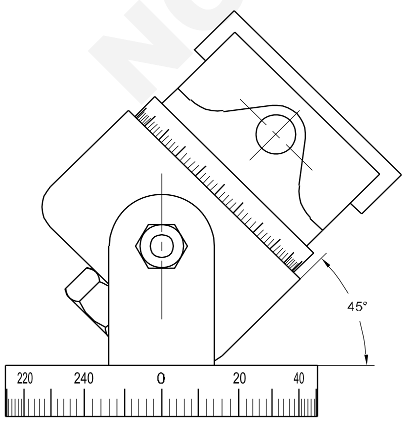
Fig 2



Ensure that the swivel base graduation coincides with 'O' degree dead mark before aligning.

Tilt the vice to 45° with reference to the graduated plate at the bottom of the vice. (Fig 3)

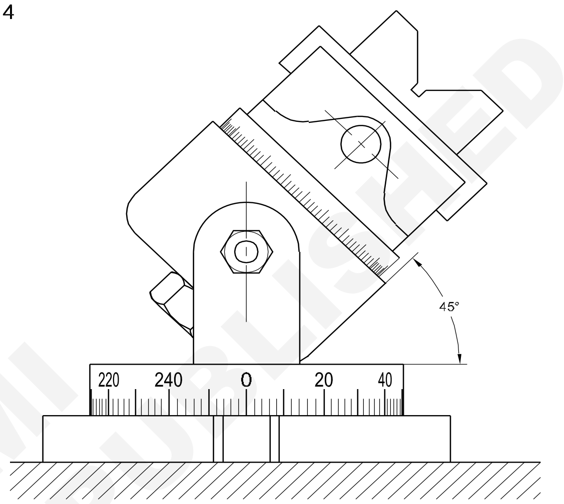
Fig 3



Clean the job and measure it to determine the grinding allowance. (Ask your instructor for help in determining the allowance)

Hold the job in the vice such that the horizontal surface to be ground is aligned parallel to the surface of the table using a dial test indicator. (Fig 4)

Fig 4



Position the stop dogs for longitudinal traverse.

Start the wheel and lower the wheel head until the wheel just sparks the high spot of the job.

Start the table travelling automatically and feed the entire length of the job and clear off the job from the wheel.

Engage the vertical depth for rough and finish cut as predetermined, and feed from the cross-feed manually. (Fig 5a)

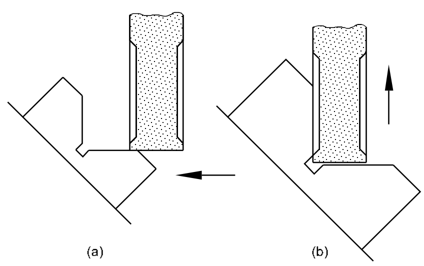
Grind the longitudinal surface up to the corner relief.

Remove only that much of material pre-determined as grinding allowance, and record the amount of material removed.

Raise the wheel head to 0.20mm and without releasing the wheel, plunge the wheel little by little against the vertical surface of the job to be ground to the depth equal to the horizontal surface.

Raise the wheel gradually to finish grind the vertical surface. (Fig 5b)

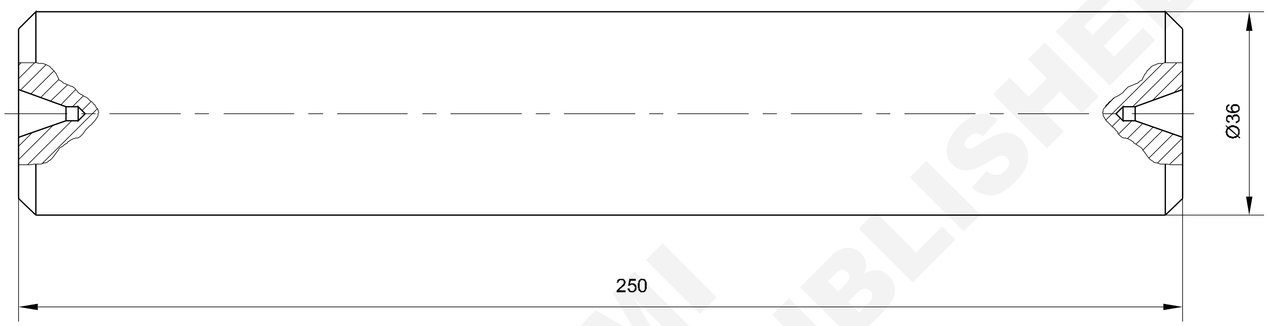
Fig 5



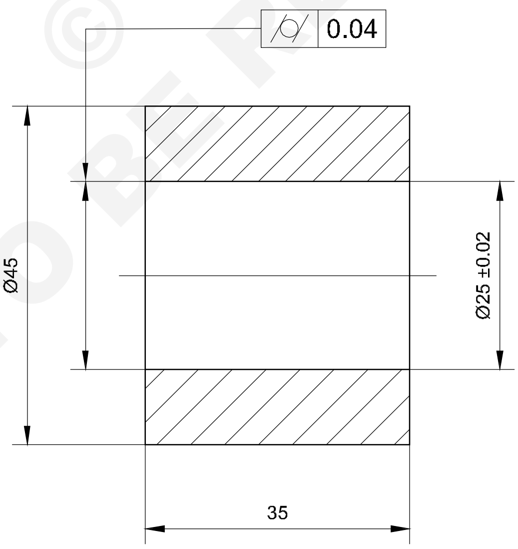
Cylindrical grinding (External & Internal)

Objectives: At the end of this exercise you shall be able to
- **setting & grinding of external cylindrical surface**
- **setting & grinding of internal cylindrical surface**

TASK 1



TASK 2



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	–	ID 25.5 X OD 45 - 35	Fe310	-	2	-
1	–	Ø36.5 - 250	Fe310	-	1	2.5.166

SCALE 1:1	**PROJECT : GRINDING OF PLAIN MANDREL**	DEVIATIONS ±0.02 / TIME : Hrs
		CODE NO. MM20N25166E1

Job sequence

- Lubricate all moving parts.
- Run the machine idle for few minutes, keeping longer length of stroke to warm up the machine system.
- Ensure that the work head and foot stock is properly positioned with respect to the wheel head and the work piece.
- Make sure that the work piece is provided with proper centres of the desired shape and depth.
- Check the grinding allowance in the workpiece.
- Wear goggles, start the coolant and dress the wheel.
- Apply grease to the tip of the centres and mount the job between centres.

Set proper tension at the foodstock centre and lock.

- Select and fix suitable driving dog/ carrier on one end of the job.
- Set stroke length by adjusting table trip dogs, such that 1/3rd of wheel clears the foot stock end of work piece, and about 30.0 mm from the work head end of work piece to allow the grinding wheel to clear the carrier.

Make sure that the running wheel or carrier do not hit any other part of the machine.

- Set job speed, and table speed as per diameter and type workpiece.
- Run the machine, bring wheel head forward slowly by rotating cross feed hand wheel till you see sparks.
- Give a light cut 0.01 mm, at a time till it touches both ends.
- Measure at both ends of the work piece by using outside micrometer.
- If there is any taper, adjust by table adjusting screw by unlocking the binding screws.

While measuring taper, ensure the wheel is taken back.

- Repeat this till you get zero, zero on both ends.
- Start giving depth of cut, and finish to the required size.

Take care to give depth of cut, when the job clears from the wheel at R.H. side.

- Reverse the job, take care to give soft packing under the carrier screw to avoid damage of the ground surface.
- Set the stroke length, grind the end of the job previously covered by the carrier, to the required size.
- Check the size.
- Remove burrs by smooth oil stone at the edges.
- Remove work piece from the centres and detach carrier.

TASK 2

- Measure the bore diameter and determine allowance for grinding.
- Dress wheel for roughing out. (By using carborundum dressing stick)
- Hold the job in four jaw chuck and true the bore with dial test indicator.
- Select suitable internal grinding wheel spindle and fix it to internal attachment.
- Connect the belt between motor and internal grinding spindle and fix the guard.
- Set the stroke length and set job speed.
- Grind minimum material and check for taper, if any taper exists adjust the table.
- Rough grind and check with internal micrometer.
- Dress wheel for finishing cut, grind to the required size and check with internal micrometer.
- While checking the bore, make sure the work head is sufficiently taken back i.e. towards left.
- Finally check the bore by plug gauge and ensure ‘Go’ side only enters into job.
- Remove sharp corners, remove workpiece from chuck.

Skill sequence

Cylindrical grinding

Objectives: This shall help you to
- **set the machine for cylindrical grinding**
- **set the job between centres**
- **check parallellism with an outside micrometer.**

Setting the machine for cylindrical grinding

Ensure work head at 0°, fix suitable centre.

Check all the guards are properly fitted in their positions.

Lubricate all the moving parts.

Run the machine idle for few minutes to warm up the machine and to avoid jerky movement of the table.

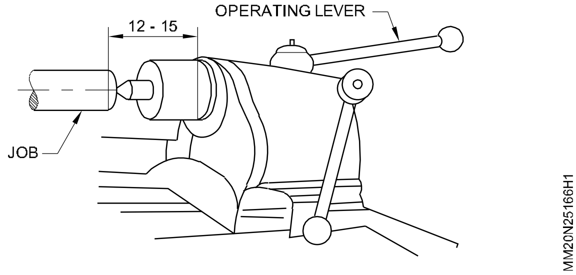
Ensure the wheel is free from cracks or damage etc.

Dress the wheel by diamond dresser.

Setting the table traverse: Mount the work piece between centres.

Adjust the tension of the foot stock centre. To do this move foot stock about 12 to 15 mm from the edge of the job and lock. (Fig.1)

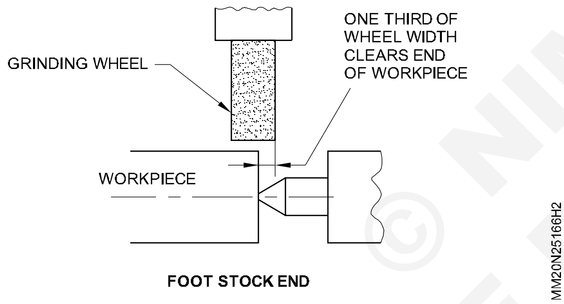
Fig 1



Move the table to the left until the right hand side of the grinding wheel clears off the foot stock end of the work piece.

Set the right hand trip dog at such position to reverse the table with about 1/3rd of the wheel width at the foot stock end of the work piece. (Fig.2)

Fig 2



Move the work table to the right and set the left hand trip dog to reverse the table, as the carrier approaches the wheel by 30 mm from the carrier. (Fig.3)

Move the wheel back about 20 to 30 mm from the job to allow the wheel to clear the carrier. (Fig.3)

Ensure table setting reading is at '0'.

Starting the feed

Wear goggles.

Start the machine and coolant.

Engage the table traverse.

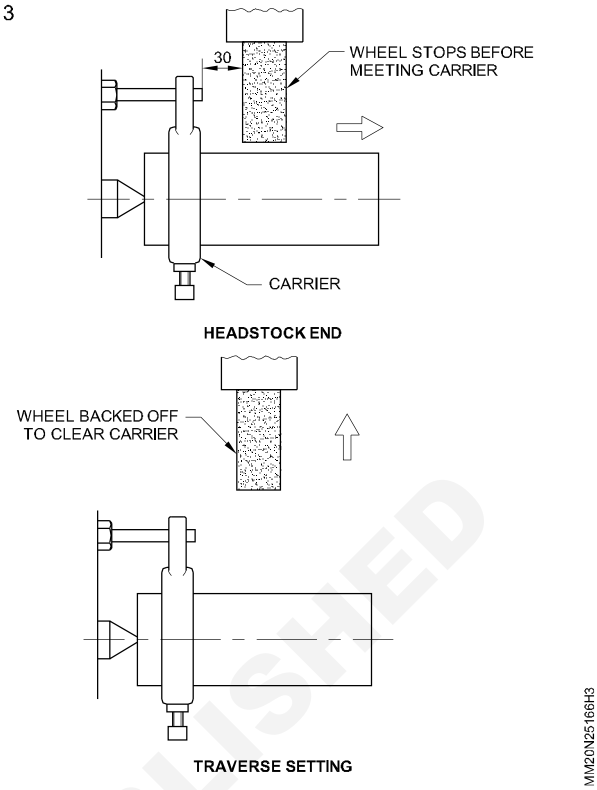
Move the wheel forward to come in contact with the work piece by engaging cross feed hand wheel.

Take minimum cut of 0.01 to 0.03 mm and check at both ends of the job for parallelism by an outside micrometer.

If there is any taper adjust as follows.

If plus (+) is on R.H. side, take the wheel sufficiently back, loosen the table locking screws on both sides, rotate the table adjusting knob provided at the R.H. side, such that R.H. side table moves towards the wheel side and lock the table locking screws.

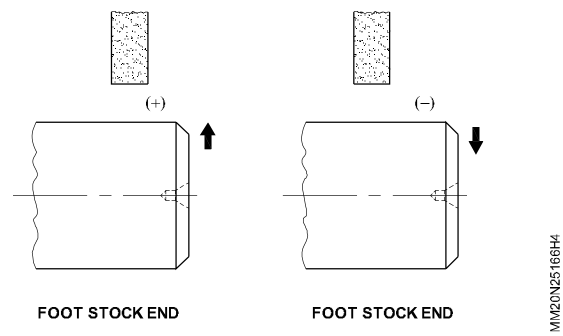
Fig 3



Again take a small cut and check for taper, repeat this till you get parallel.

If minus (-) is on R.H. side of the job the procedure is reversed. (Fig.4)

Fig 4



Continue grinding, giving the depth of cut at the end of the each traverse until the job is within 0.04-0.08 mm of the required final size.

Again dress the wheel for finish grinding and finish the job of the required size.

Reverse the job, place a soft shim between the carrier and the work piece.

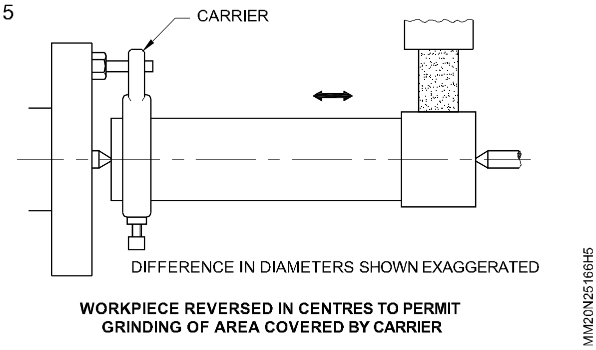
Set the stroke length and grind the other end of the job to the final size as previously ground size. (Fig.5)

Check both ends and at middle of the work piece by micrometer to ensure parallelism.

Remove burrs from the edges with smooth oil stone.

Remove the work piece from the centres and detach carrier.

Fig 5



WORKPIECE REVERSED IN CENTRES TO PERMIT GRINDING OF AREA COVERED BY CARRIER

Set the machine for internal grinding

Objective: This shall help you to
- **set the internal grinding spindle on an universal grinding machine.**

Position the internal grinding attachment as shown in Fig.1

Fix the spindle align the spindle pulley to the driver pulley and clamp it.

Fix the flat belt between driver pulley and internal attachment pulley.

Adjust the belt tension.

Disengage the power operated cross-feed.

Place the guards in position.

Select the grinding wheel.

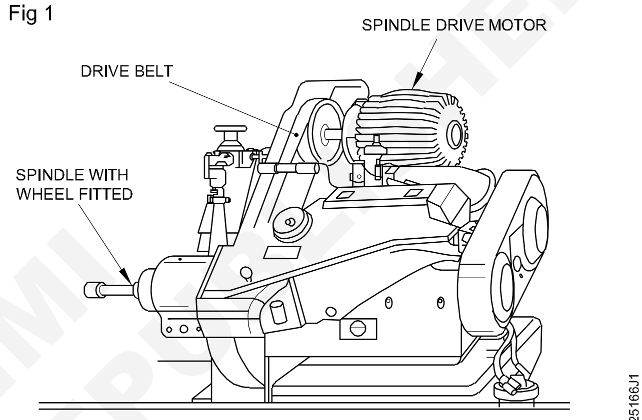
Check the grinding wheel for any damage or crack.

Fix the wheel to the spindle.

Fix the spindle to the internal grinding attachment.

True the wheel.

Fig 1



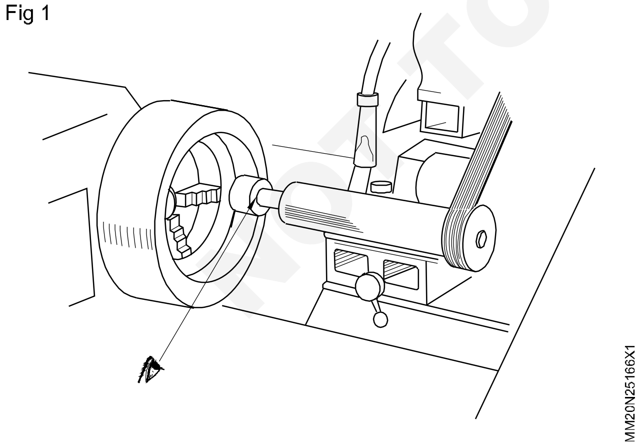
INTERNAL GRINDING SPINDLE MOUNTED ON WHEELHEAD OF UNIVERSAL GRINDING MACHINE

Grind a parallel bore

Objective: This shall help you to
- **grinding parallel bore.**

Set the machine for internal grinding. (Fig.1)

Fig 1



Fix the spindle and mount the internal grinding wheel.

Dress the grinding wheel with a diamond dresser.

Check the bore and determine the grinding allowance.

Set the work speed and wheel speed.

Mount the job on the chuck and true it with the help dial test indicator.

Adjust the table traverse so that the wheel should not touch the chuck and wheel should not leave the job.

Start the grinding wheel.

Start the work spindle.

> **Make sure that the wheel and workpiece are rotated in opposite direction.**

Switch on the coolant button.

Move the wheel towards the job by hand and advance the grinding wheel against bore.

Take light cut.

Clean the bore and measure the diameter of the bore and parallelism with an inside micrometer.

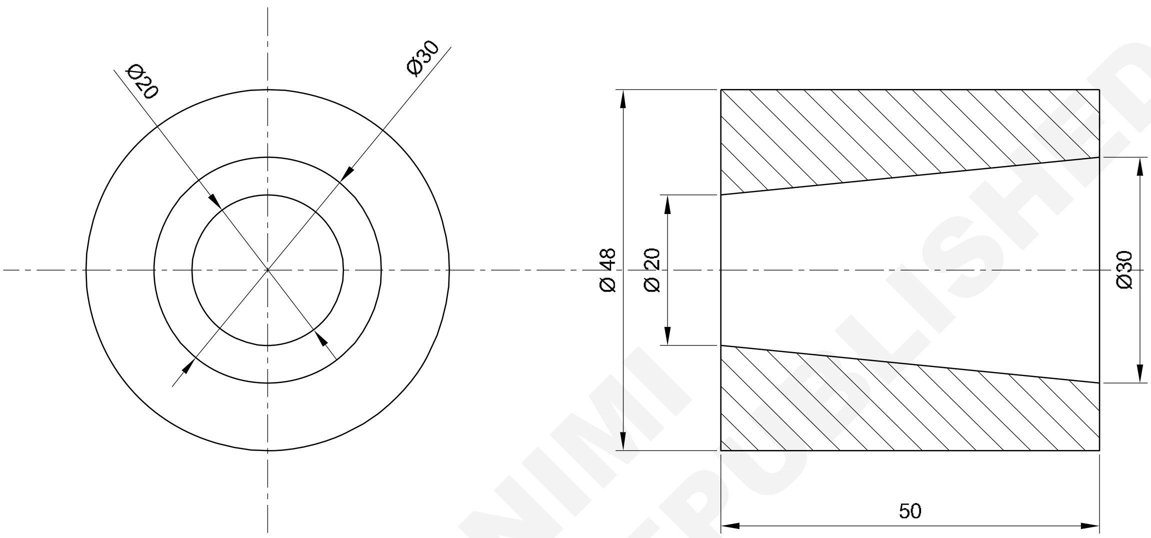
If there is any taper adjust it by swivelling the table.

Dress the wheel for finish grinding.

Grind the bore and check the bore diameter and parallelism.

Setting the machine for grinding taper holes

Objectives: At the end of this exercise you shall be able to
- **setting the machine for internal taper grinding**
- **grinding internal taper.**



Job sequence

- Turn the part as per drawing with required grinding allowance
- Measure the taper bore diameter
- Dress the wheel for roughing cut (by using carborundum dressing stick)
- Hold the job in four jaw chuck and true it.
- swing the work head to half of the included angled tighten tock unit.
- Select suitable internal grinding wheel spindle and fix it to internal attachment.
- Connect the belt between motor and internal grinding spindle and fix the guard.
- Set the stroke length and set spindle speed
- Grind minimum material and check the taper
- Rough grind and check with taper plug gauge
- Dress the wheel for finishing cut
- Remove sharp corners and remove work piece from chuck

1	ISR Ø50x55	–	Fe310	–	–	2.5.167
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**INTERNAL TAPER GRINDING**	DEVIATIONS ±0.03 mm	TIME
		CODE NO. MM20N25167E1	

> **Note: Check angle by gange check taper by smearing of purssiam blue on gauge and take impression.**
>
> **It impression is not uniform adjust table accordingly**

$$\tan\theta = \frac{D-d}{2l}$$

$$\tan\theta = \frac{30-20}{2x50}$$

$$\tan\theta = \frac{10}{100}$$

$$\tan\theta = \frac{1}{10}$$

$$\tan\theta = 0.1$$

Skill sequence

Grinding internal taper

Objective: This shall help you to
- **grind internal tapered bore.**

The method for grinding a internal taper bore is similar to that of grinding a parallel bore.

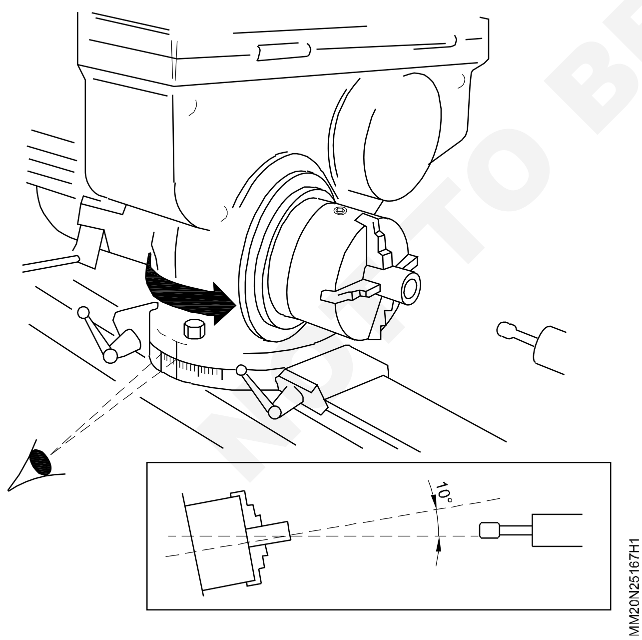
To grind a taper bore the work head is swung to half of the included angle of the taper required. This brings the side of bore in line with the table axis of traverse.

Determine the grinding allowance.

Set the work piece on the four jaw chuck and true it with a dial test indicator.

Loosen the work head locking nut and swivel the work head to half the included angle of taper. (Fig.1)

Fig 1



Tighten the clamping nut.

Set the machine for internal grinding.

Dress the wheel for rough grinding.

Take light cut on the taper.

Check the taper by taper plug gauge. If required adjust the angle in the work head.

Dress the wheel for finish grinding.

Finish grind the bore.

Check taper with appropriate plug gauge.

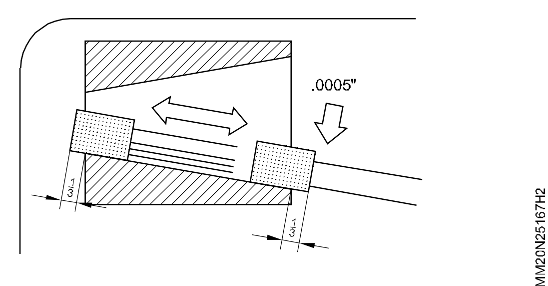
Remove sharp corners.

Dismount the work piece from the chuck.

Clean and oil the machine.

Adjust the table traverse so that the wheel should not completely pass the bore. (Fig.2)

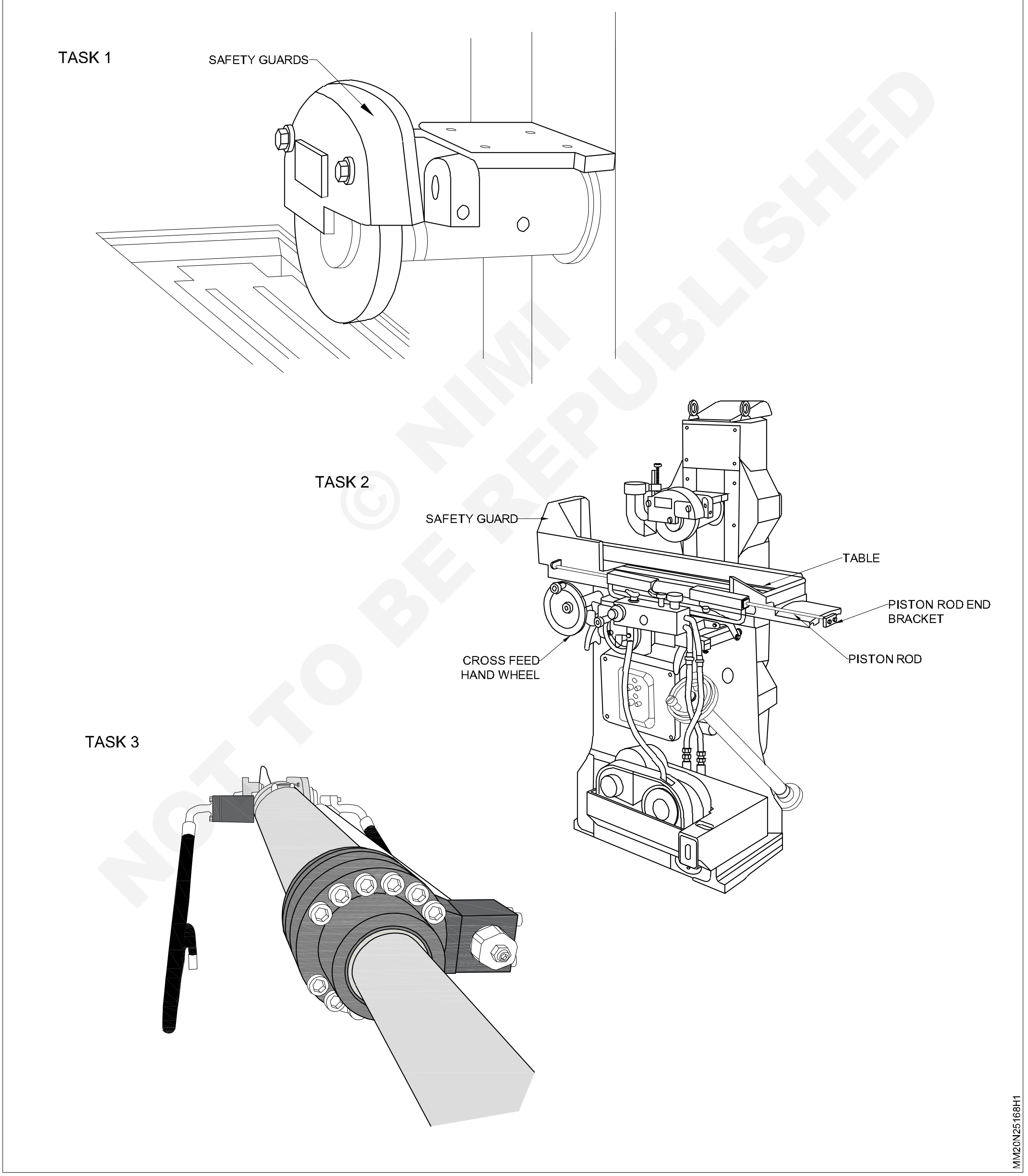
Fig 2



Dismantling & Assembling of surface grinding machine

Objectives: At the end of this exercise you shall be able to
- **dismantle and assemble grinding head of surface grinding machine**
- **dismantle and assemble of surface grinding machine table and lead screw**
- **dismantle and assemble to hydraulic cylinders**

Fig 1



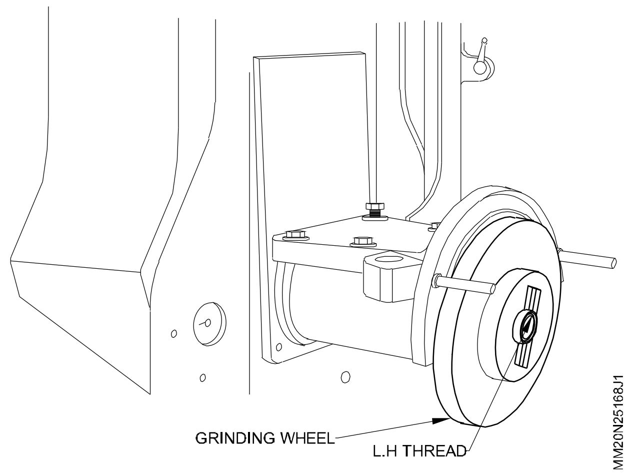
Job sequence

TASK 1: **Dismantling and assembling of grinding head of surface grinding machine**

Dismantling the surface grinding head

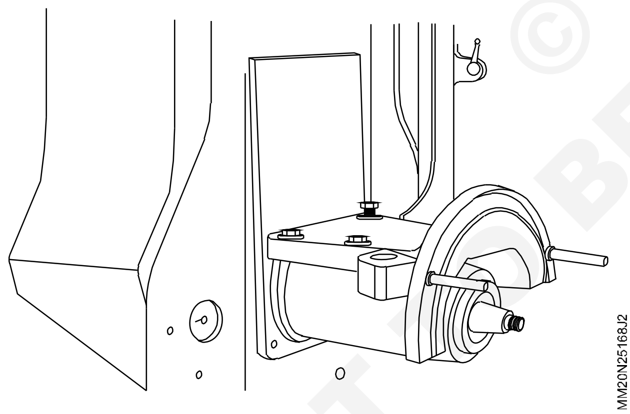
- Switch off the machine
- Remove all the safety guards from the machine. (Fig 1).
- Clean the grinder head with cotton cloth.

Fig 1



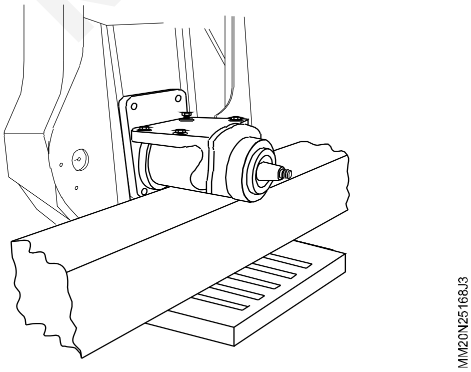
- Remove the left hand thread nut (Fig 1) and take out the grinding wheel. (Fig 2)

Fig 2



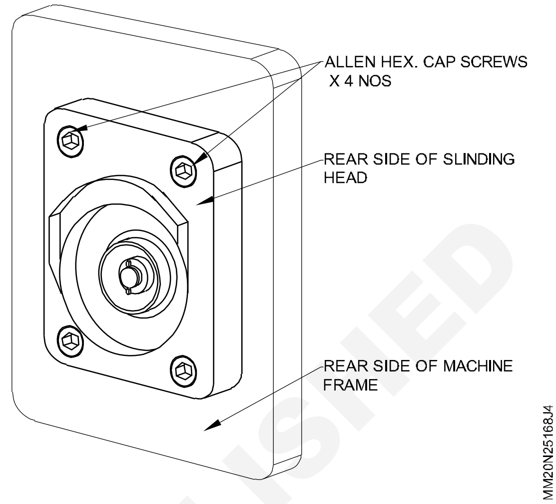
- Support the grinding head with a wooden plank placed on the machine table. (Fig 3)

Fig 3



- Go to the rear side of the machine and loosen the allen hexagonal cap screws of the spindle head attached with machine frame. (Fig 4)

Fig 4



- Pull out the grinding head assembly from the machine. (Fig 5 & 6)

Fig 5

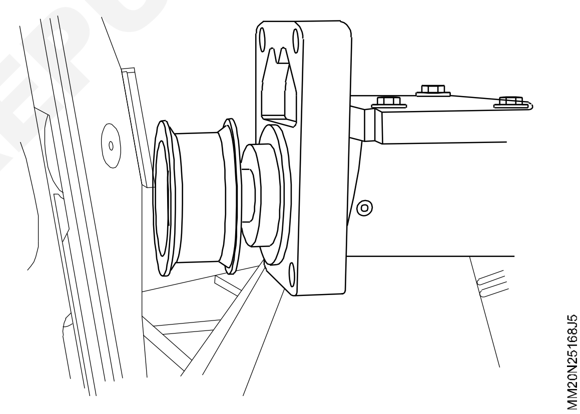
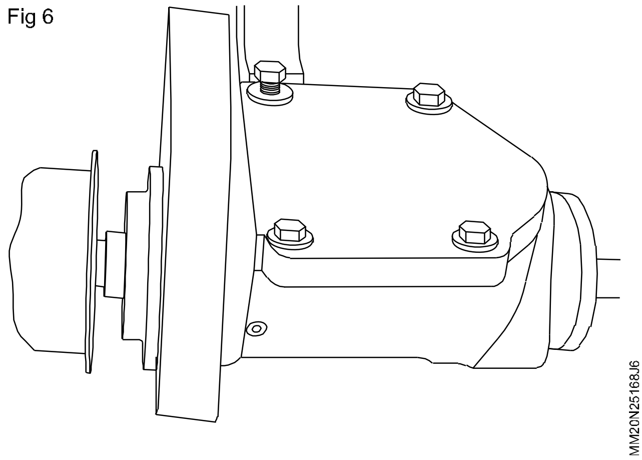
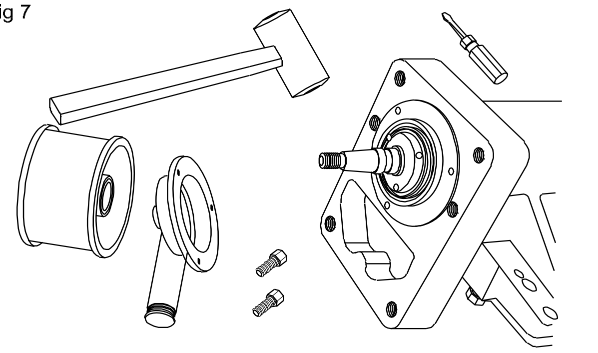


Fig 6



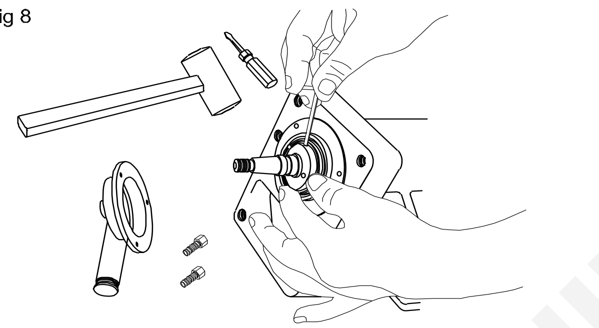
- Place the grinding head assembly on the work table. (Fig 7)

Fig 7



- Loosen the rear side L.H. nut and take out the pulley from the assembly. (Fig 8)
- Loosen the allen cap screws of rear bearing cap and take out the bearing.

Fig 8



- Unlock the grab screw and remove the bearing adjusting ring nut. (Fig 9)
- Remove the rear self alligning ball bearing by slightly hammered by soft hammer at front end of the grinding head spindle. (Fig 10)

Fig 9

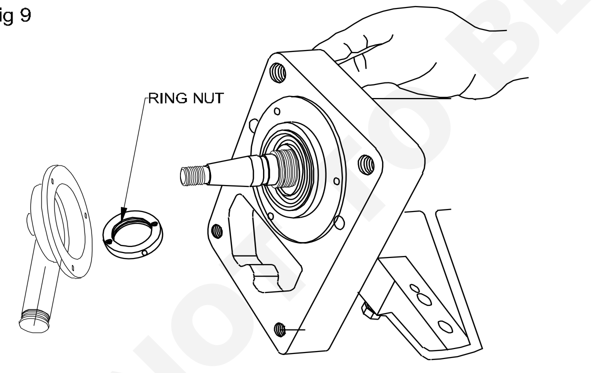
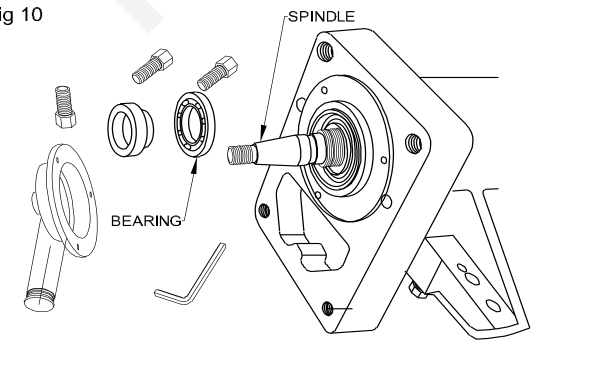
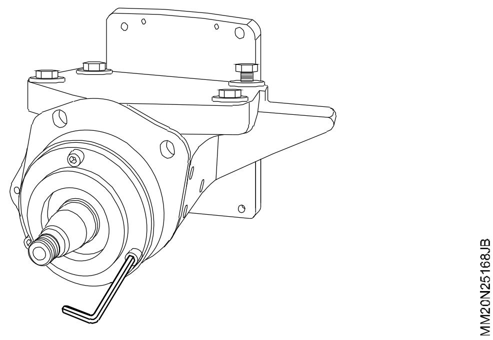


Fig 10



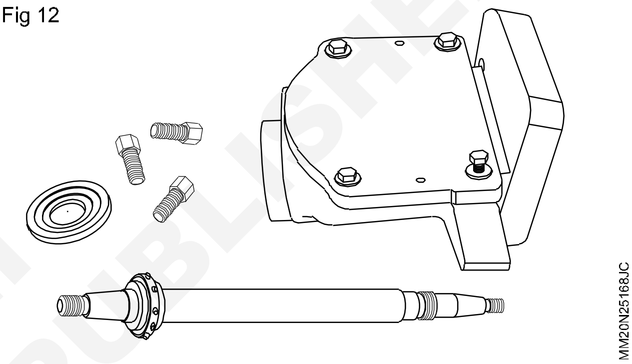
- Remove the front end bearing cap by unscrewing the allen hexagonal cap screws. (Fig 11)

Fig 11



- Take out the grinding wheel head spindle along with the front end self aligning ball bearing by slight hammering at rear end of the shaft.(Fig 12)

Fig 12



- Check and replace worn out/damaged parts.
- Clean all the parts thoroughly by using kerosene and wipe out using a clean cloth.
- Check all the cleaned parts for worn out or damage.
- Replace the worn out/damaged parts.

Assemble the surface grinding head

- Lubricate/greese wherever necessary.
- Assemble all the parts in the reverse order as in the case of dismantling.

Carry out test run of the machine

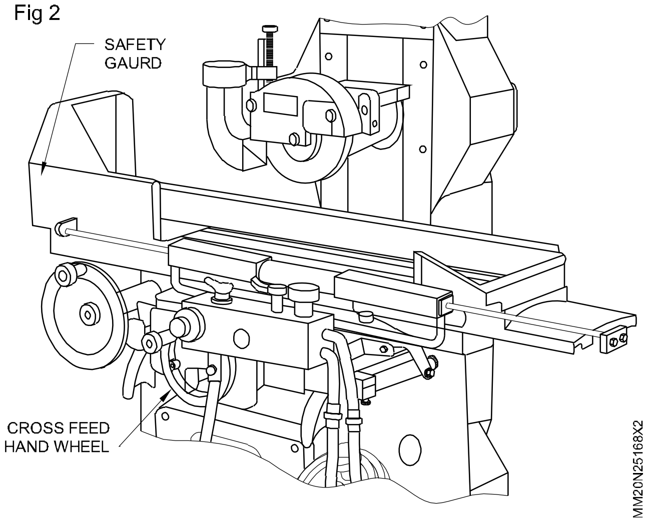
- Switch on the machine.
- Run the machine for minimum of 5 minutes.
- Check any unusual noise or vibration or excessive heat generation from the grinding head.
- If found any discripancies as above, switch off the machine and adjust the spindle bearing.

TASK 2: **Dismantling and assembling of surface grinding machine table and lead screw**

Dismantle the table

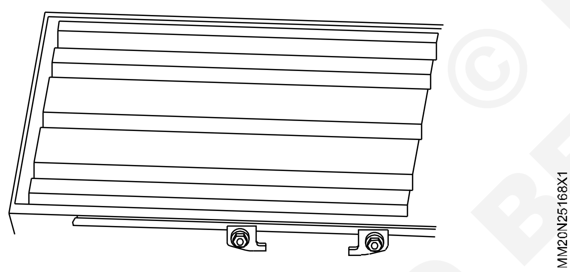
- Switch off the machine.
- Remove all the safety guards from the machine.
- Clean the machine table with cotton cloth.
- Remove hexagonal nuts and end brackets at the two ends of piston rod. (Fig 1)

Fig 2



- Lift the table up and take it out from the machine. (Fig 2)

Fig 1



Dismantle the cross feed lead screw

- Remove the cross feed hand wheel
- Remove the fine adjusting worm shaft casing
- Remove the hexagonal nut which connect the lead screw and fine adjusting unit
- Unscrew the knurled nut of automatic feed rate control lever and pull out the whole fine adjusion unit away from the machine.
- Remove the feather key.
- Slide out the front end thrust bearing from the flange.
- Remove the flange take out the rear end thrust bearing from the lead screw.
- Remove the lead screw from the machine by unscrewing it in anticlockwise direction.

Check and replace the worn out parts

- Clean all the parts by using kerosene.
- Check all the parts, if necessary replace the worn out parts.

Assemble the table and cross feed screw

- Assemble all the parts in the reverse manner as specified in the dismantling procedure.

Check the free movement of table and cross feed

- Apply lubrication oil between table and saddle.
- Rotate the cross feed hand wheel and check the free traverse movement.
- Switch on the machine and check the longitudinal free movement of the table.

— — — — — — — —

TASK 3: **Dismantling and assembling of hydraulic cylinder**

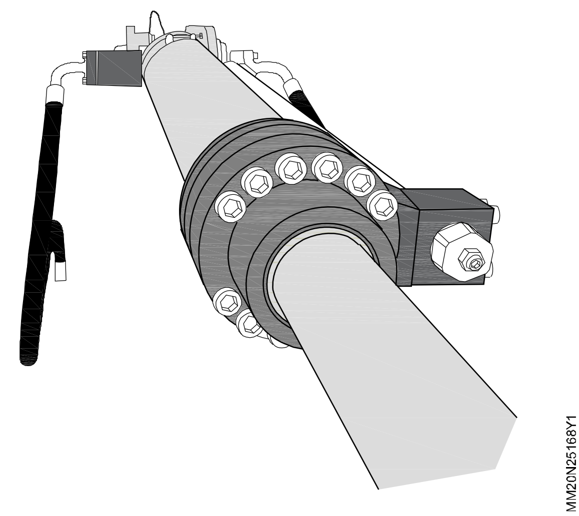
Reasons of dismantling

- Leakage of hydraulic oil out of to cylinder
- The piston rod may bent or will not move in and out of the cylinder housing
- The cylinder housing is damaged
- The piston rod may broken
- Wants to replace the piston seals

Preparation of hydraulic cylinder for dismantling

- Shut down the machine properly
- Clean dust, dirt, grease and hydraulic fluid fo the cylinder housing and attached hydraulic hoses.

Fig 1



- Disconnect the hydraulic hoses from the cylinder ports.
- Plug the cylinder ports and hoses to prevent debris from getting into them.
- Remove the clevis pins from the cylinder mounts, detach the cylinder from machine, place the cylinder in suitable place. Use floor vice/bench vice.

Dismantling

- Lossen the set screw and remove with spanner,
- Carefully remove the rod by pulling, with glard assembly piston and rod from the cylinder housing
- Piston can remove piston nut on the rod end.
- Slide the gland assembly/end cap.
- Remove the seals.
- Check the cylinder or for scoring, distortion and or rust damage.

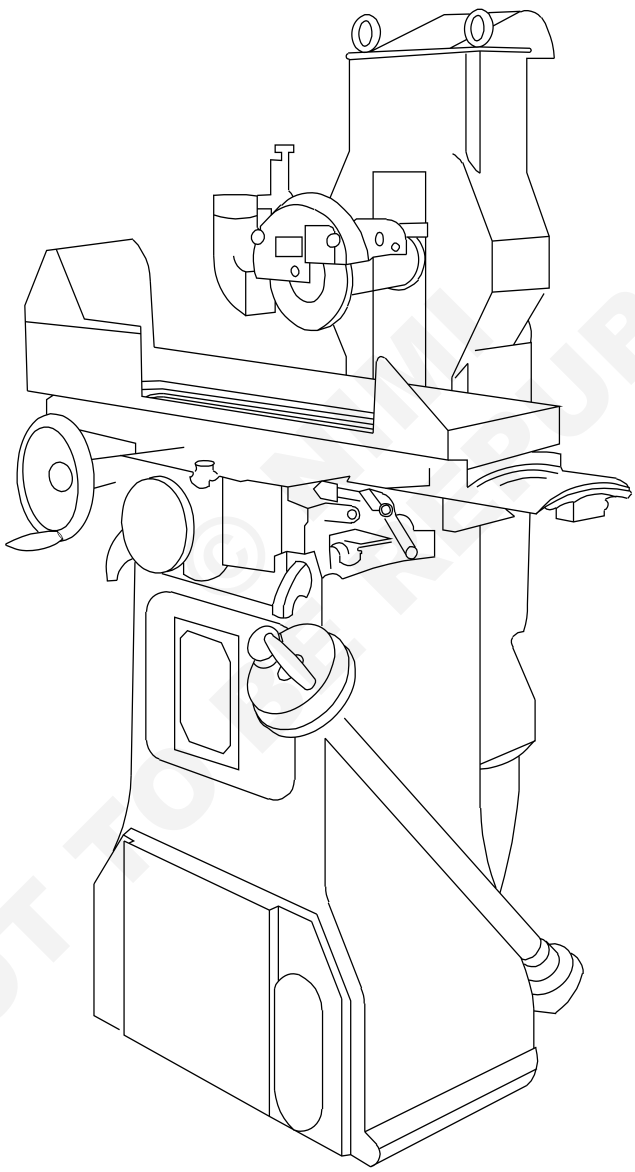
Assembling of hydraulic cylinder.

- Perform the above steps in reverse order.

Checking accuracy of surface grinding machine after assembly

Objectives: At the end of this exercise you shall be able to
- **checking accuracy of surface grinding machine as per test chart.**

Fig 1



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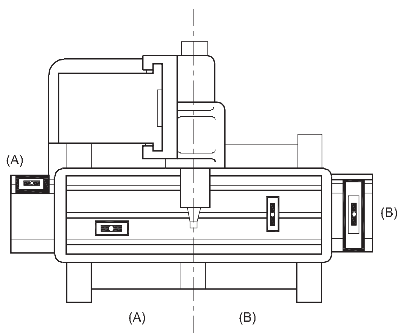
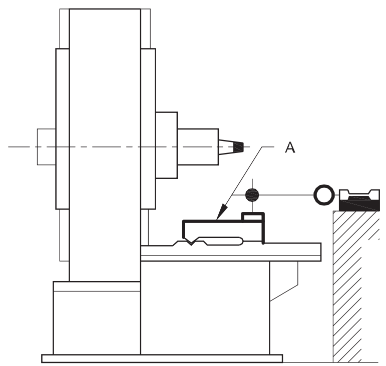
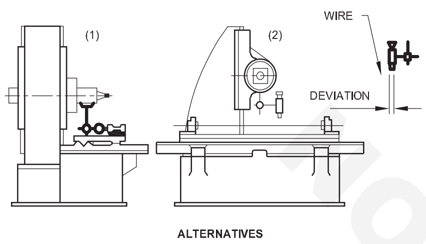
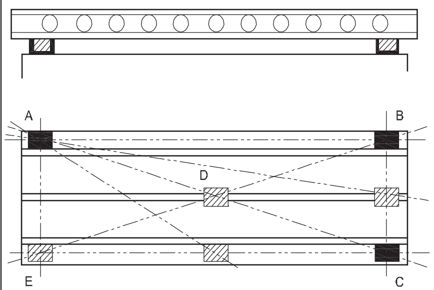
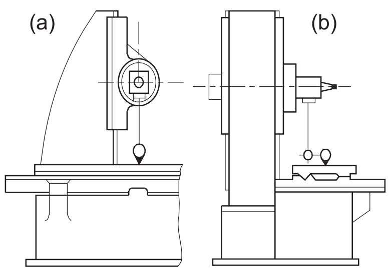
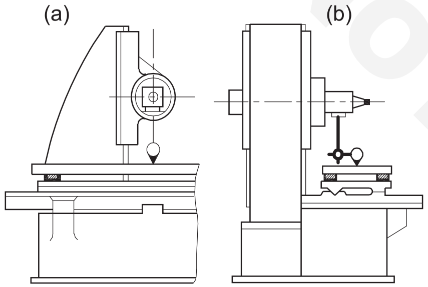
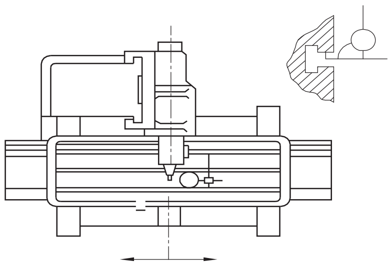
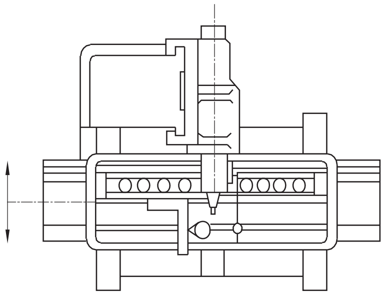
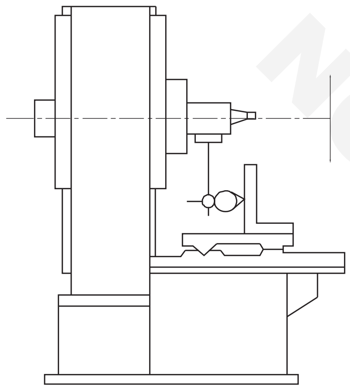
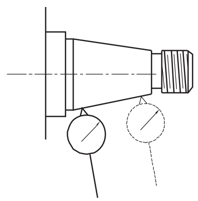
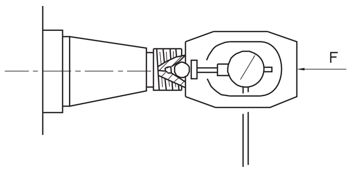
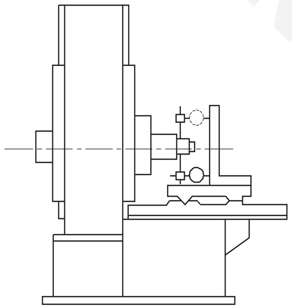
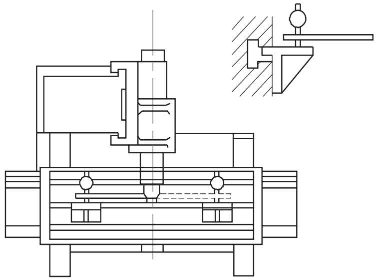
TASK 1: **Checking accuracy of surface grinding machine**

No.	Diagram	Object	Permissible deviation		Actual duration	Measuring instruments	Observation and references in test code ISO/R 230	Remarks
			mm	In				
G0		Verification of leveling of slideways: a)Logitudinal verification Straightness of slideways in the vertical plane˙ b) Transverse verification Slideways should be in the same plane	a) 0.02 upto 1000 For each 1000 mm increase in length, add 0.015 Maximum permissible deviation: 0.05 a)Variation of level: 0.02/1000	a) 0.0008 mm up to 40 mm For each 40 mm increase in length, add 0.0006 mm Maximum permissible deviation:0.002 mm b) Variation of level: 0.0008/40		Precision levels Optical or other methods	a)Clauses 3.11,3.21,5.212.21 and 5.212.22 Measurements should be made at a number of positions equally spaced along the length of the slideways. For machines standing on three support points or having a table travel less than 1500 mm (60 in) the table need not be removed. In this case the level should be placed successively on the exposed portions of the slideways and on the table. The table should be in its central position. b)Clause 5.412.7 A level should be placed transversely on the slideways, and measurements should be taken at a number of positions equally spaced along the length of the slideway. The variation of level measured at any position should not exceed the permissible deviation.	
G1		Verification of straightness of slideways in a horizontal plane.	0.02 mm upto 1000 mm For each 1000 mm increase in length, add 0.02 mm Maximum permissible deviation : 0.05 Local tolerance : 0.01 mm Over any measuring length of 300	0.0008 mm upto 40 mm For each 40 in increase in length, add 0.0008 Maximum permissible deviation 0.002 mm Local to tolerance 0.004 mm Over any measuring length of 12 mm.		Straightedge, support and dial gauge, or taut wire and microscope	Clause 5.232.1 The dial gauge should be fixed on a support A of a suitable form such that it can slide in the slideways with the stylus touching a straightedge laid parallel to the slideways.	

		These alternatives are for small machines where the table is not to be dismantled. Verification of the straightness of the longitudinal movement of the table.	0.01mmupto 1000mm For each 1000 mm increase in length, add 0.01 mm Maximum permissible deviation 0.025 mm	0.0004 mm up to 40 mm For each 40 mm in increase in length, add 0.0004 mm Maximum permissible deviation: 0.001 mm			Clauses 5.232.1 or 5.213.3 – 5.232.2 In alternative 1) the dial gauge support should be placed on a fixed part of the machine, the styles touching a straight edge laid parallel to the general direction of the longitudinal movement of the table.	
G2		Verification of flatness of the table surface	0.01 mm upto 1000mm For each 1000 mm increase in length, add 0.01 mm Maximum permissible deviation : 0.04 mm Local tolerance : 0.005 mm Over any measuring length of 300	0.0004 up to 40 For each 40 in increase in length, add 0.0004 mm Maximum permissible deviation: 0.0016 Local tolerance : 0.0002 mm Over any measuring length of 12		Straight edges, ship ganges (or) precision level.	Clauses 5.322 & 5.323 Table not locked and position at centre of the travel.	
G3		Verification of parallelism of the table surface. a) to its longitudinal movement; b) to its transverse movement or to the transverse movement of the wheelhead.	a) $0.010x \frac{L^*}{1000}$ Maximum permissible deviation : 0.030 Local tolerance : 0.003 Over any measuring length of 300 b) $0.007x \frac{L^*}{1000}$ (this permissible deviation should be >0.001)	a) $0.004x \frac{L^*}{40}$ Maximum permissible deviation : 0.0012 Local tolerance : 0.00012 Over any measuring length of 12 b) $0.007x \frac{L^*}{40}$ (this permissible deviation should be >0.00004)		Dial gauge	Clause 5.422.21 1) Checking by direct contact with the table. If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge should be placed on a fixed part of the machine. The stylus to be placed approximately in the wheel spindle axis. • L = measuring length.	

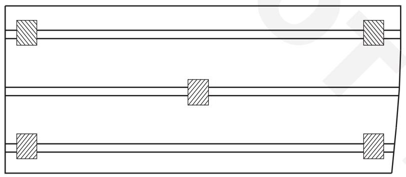
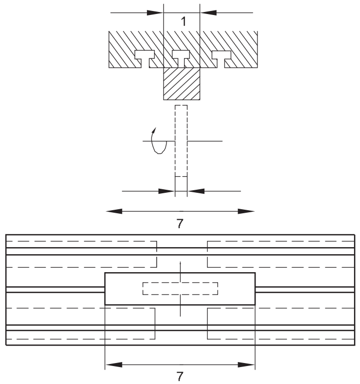
No.	Diagram	Object	Permissible deviation		Actual duration	Measuring instruments	Observation and references in test code ISO/R 230	Remarks
			Mm	In				
G3		Verification of parallelism of the table surface. a) to its longitudinal movement; b) to its transverse movement or to the transverse movement of the wheelhead.	a) $0.007x \frac{L^*}{1000}$ Maximum permissible deviation : 0.020 b) $0.007x \frac{L^*}{1000}$ (this permissible deviation should be >0.001)	a) $0.003 \times \frac{L^*}{40}$ Maximum permissible deviation : 0.0008 b) $0.0003 \times \frac{L^*}{40}$ (this permissible deviation should be >0.00004)		Dial gauge and precision straight edge	2) Checking with a straightness It is unnecessary to follow the test code ISO/R 230. The checking should be made on a straight edge laid parallel to the table surface and placed in the direction of the movement concerned. ● L = measuring length.	
G4		Verification of parallelism of the median or reference T slot to the longitudinal movement of the table.	0.015 up to 1000 For each 1000 mm increase in length, add 0.01 Maximum permissible deviation : 0.05 Local tolerance : 0.008 Over any measuring length of 300	0.0006 up to 40 For each 40 in increase in length, add 0.0004 Maximum permissible deviation: 0.002 Local tolerance : 0.0003 Over any measuring length of 12		Dial gauge	Clause 5.422.21 and 5.422.21 If the spindle can be locked, the dial gauge may be mounted on it, if the spindle cannot be locked, the dial gauge should be placed on a fixed part of the machine.	
G5		Verification of squareness of the longitudinal movement of the table to its transverse movement or to the wheelhead movement.	0.03/300	0.0012/12		Straight edge square and dial gauge.	Clause 5.522.4 a) Place the straightedge parallel to the longitudinal movement of the table and then place the table in its central position. b) Place the square in contact with the straight edge. c) Check the transverse movement of the table or the wheelhead.	

No.	Diagram	Object	Permissible deviation		Actual duration	Measuring instruments	Observation and references in test code ISO/R 230	Remarks
			Mm	In				
G6		Verification of squarness and straightness of the vertical movement of the wheelhead to the table surface in a transverse vertical plane	0.04/300	0.0016/12		Dial gauge and square	Clause 5.522.2 Clamp the wheelhead if possible when taking measurements. If the spindle can be locked, the dial gauge can be mounted on it. If the spindle cannot be locked, the dial gauge should be placed on a fixed part of the wheelhead.	
G7		Measurement of run-out of the wheel spindle nose.	0.01	0.0004		Dial gauge	Clause 5.612.1 and 5.612.2 The stylus of the dial gauge should be set normal to the surface which is to be checked. Checking should be carried out at each extremity of the taper. This is not stated in the test code ISO/R 230.	
G8		Measurement of periodic axial slip of the wheel spindle.	0.01	0.0004		Dial gauge	Clause 5.622.1 and 5.622.2 A force F, specified by the manufacturer of the machine, should be exerted co-axially with the spindle. The line of action of the stylus of the dial gauge should be co-axial with the spindle.	

No.	Diagram	Object	Permissible deviation		Actual duration	Measuring instruments	Observation and references in test code ISO/R 230	Remarks
			Mm	In				
G9		Verification of parallelism of the axis of the wheel spindle to the table surface.	0,025/300	0.001/12*		Dial gauge and square	Clauses 5.512.1 and 5.512.42 Table in central position. Wheelhead clamped when taking measurements. • Distance between the two points touched.	
G10		Verification of squareness of the axis of the wheel spindle to the median or reference T slot of the table.	0,015/300*	0.0006/12*		Dial gauge and square	Clauses 5.512.1 and 5.512.42 Table in central position. Wheelhead clamped when taking measurements. • Distance between the two points touched.	

TASK 2: **Test chart after assembly**

Practical test

No.	Diagram and sizes of test pieces	Nature of test and cutting conditions	Check to be applied	Permissible deviation mm	Permissible deviation In	Measuring instruments
P1	 Number of test pieces should be five. Material from which the test pieces should be manufactured may be either: a) Cast iron; b) Steel The test pieces should be of equal hardness and should be suitably fixed to the table. The dimensions of the functional surfaces of the test pieces should be as small as possible, for instance: 50 mm x 50 mm (2 in x 2 in) square or 50 mm (2 in) diameter.	Grinding of five cylindrical or rectangular test blocks which are the test pieces. The surface of the test blocks in contact with the table should be ground before carrying out the test. The test pieces should be positioned as follows: One at the central point of the table; One at each of the four corners of the table.	After grinding test pieces should have the same thicknesses.	1) Distance between the test blocks < 1000: 0.005 for 300 (Distance between the test blocks < 300 : A permissible deviation proportional to the distance should be taken which does not fall below 0.001) 2) Distance between the test blocks >1000: Add 0,01 to the tolerance for each 1000 mm increase in length. Maximum permissible deviation: 0,05	1) Distance between the test blocks < 40 0.0002 for 12 (Distance between the test blocks < 12 : A permissible deviation proportional to the distance should be taken which does not fall below 0.0004) 2) Distance between the test blocks > 40 : Add 0.0004 to the tolerance for each 40 in increase in length. Maximum permissible deviation: 0.002	Precision dial gauge
P2		This practical test should be carried out with combination of the longitudinal and transverse movements which are particular to every machine. Grinding of a rectangular block. The test piece should be clamped to the table by mechanical means.	For any given position of the test piece on the table, the thickness of the test piece should be constant.	0.005 For a distance of 300 between measurements. Maximum permissible deviation 0.03	0.0002 For a distance of 12 between measurements Maximum permissible deviation 0.0012	Precision dial gauge

Test chart after assembly

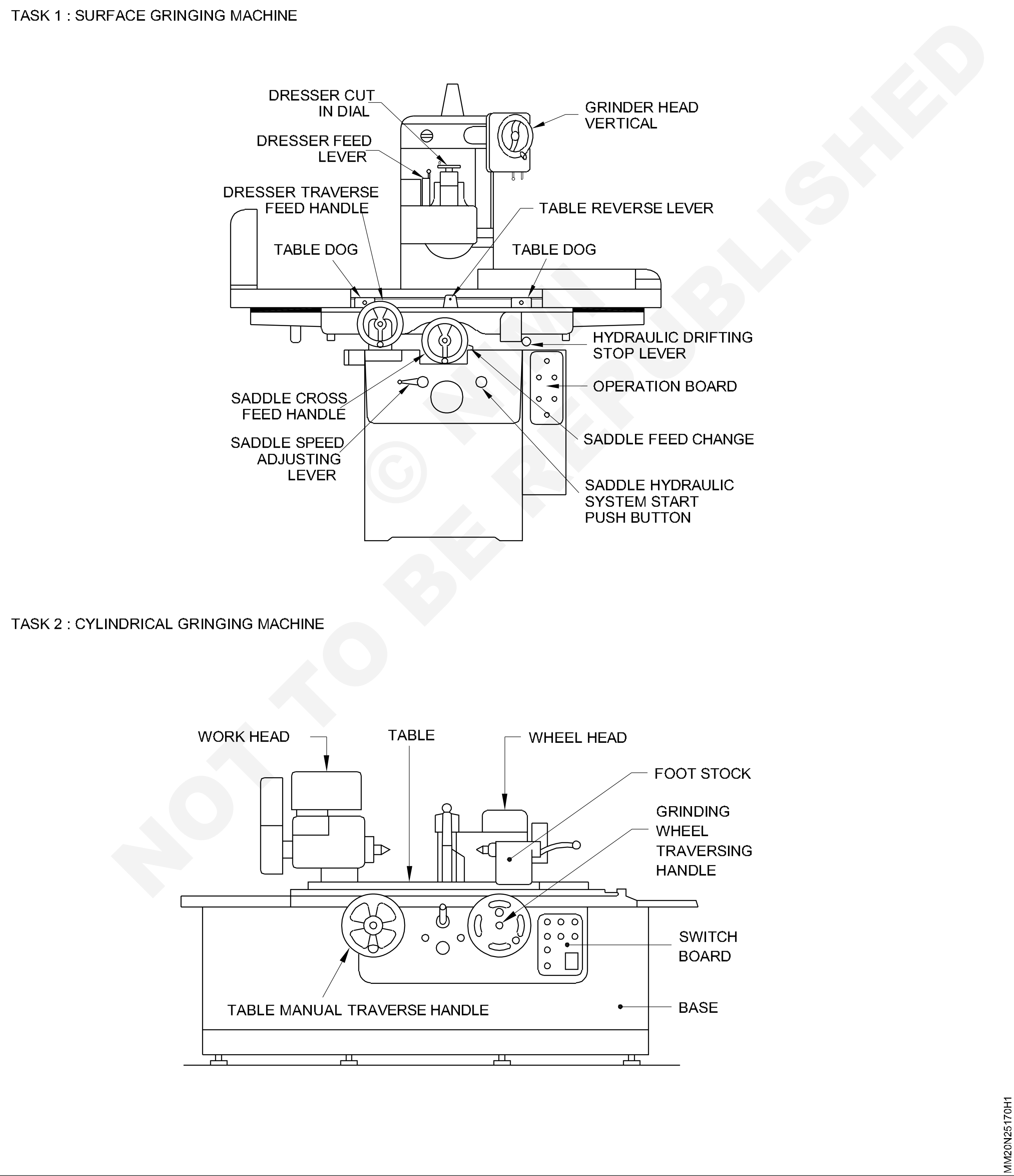
Practical test

	$\triangleright$ 3e $L > \frac{C}{2}$ e = width of grinding wheel I = width of test piece L = length of test piece C= length of table travel Material from which the test pieces should be manufactured may be either: a) Cast iron; b) Steel.	The rigidity of the test piece must be such as to prevent the clamping causing any deformation of the test piece. For the first test, the test piece should be fixed at the central position on the table. For any additional tests, the test pieces may be fixed at any other position on the table. The reference surface in contact with the table should be ground before carrying out the test.				

Do the preventive maintenance of surface grinder and cylindrical grinding machine

Objectives: At the end of this exercise you shall be able to
- **test how to do preventive maintenance of surface grinder**
- **test hot to do preventive maintenance of cylindrical grinding machine**

Fig 1

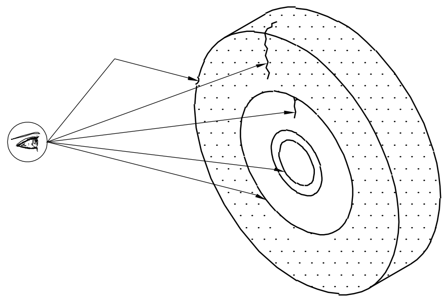


Job sequence

TASK 1: **Preventive maintenance of surface grinder**

- Check and correct any loose bolts machine
- Check and replace the damaged or cracked grinding wheel (Fig 1)

Fig 1



CHECK FOR FAULTS

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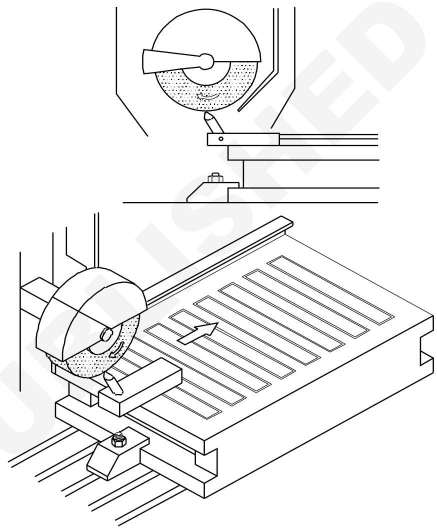
- Check the wheel to make sure that there is a wheel blotter on each side.
- Check the table, check burrs and remove with an abrasive stone..
- Check different controls of the machine
- Checking oil level before start.
- Check the start/stop buttons on the operation board.
- Check table dog is fixed
- Check raise and lower of the grinding wheel
- Check hydraulic operation of table
- Clean the magnetic chuck throughly with a cloth and then remove it if feel for any dirt with your plan.
- Check grinding wheel, if loaded then tobe dressed (Fig 2)
- Lubricate the table cross ways grease all fittings
- Check all guards secure and function correctly.

Fig 2



MM20N25170J2

Daily

S.No	Task	Date	Status	sign
1	Check for and correct loose mounting bolts			
2	Check for and damaged and craked grinding wheel			
3	Check for and correct damaged wires			
4	Clean protection table			
5	Vaccum metal savings from machine			
6	Correct any other. unsafe condition.			

Weekly

S.No	Task	Date	Status	sign
1	Remove the table clean and relubricate the ways bull's bearing's rack and pinion			
2	Lubricate the column grease, fitting with two pump of grease			
3	Lubricate the table cross way grease fittings two pump of grease			
4	Clean and grease all three lead screws			

Monthly

S.No	Task	Date	Status	sign
1	Inspect for damage to switch gear, wiring and conducts			
2	Check insulator is lockable in off position			
3	Check operation of start/switch			
4	check emergency stop where fitted			
5	Check all guard secure and function correctly			

Annually

S.No	Task	Date	Status	sign
1	Clean machine off all foreign matter			
2	Check that wheels re not chipped, clogged, glazed or created			
3	Check operation of quick change gear box is filled			
4	Lubricate guide ways and slides			
5	Check and adjust apron screws.			

— — — — — — — —

TASK 2: **Preventive maintenance of cylindrical grinding machine**

- Check throughly clean the machine
- Check , the oil level in the work head and wheel head. (Fig 1)
- Check and apply oil in oil points use oil gun
- Apply grease in all grease point with grease gun.
- Check the wheel guards are in proper position.
- Check the start/stop switches. replace if damaged as show in(Fig 2)
- Check the work head and wheel guard
- Check and clean the wheel head
- Check power supply wiring and conduct

Fig 1

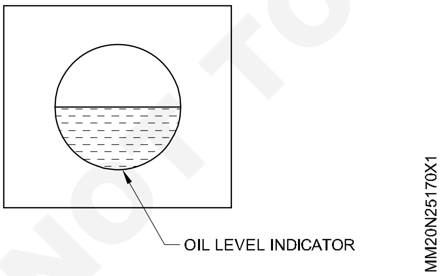
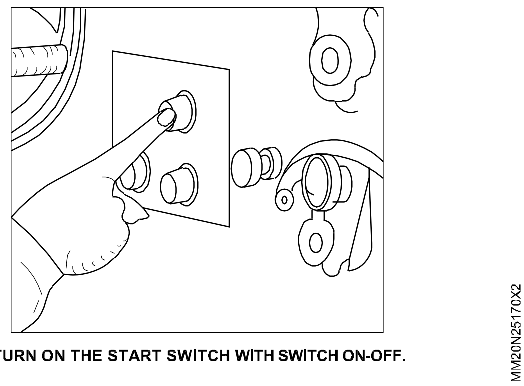


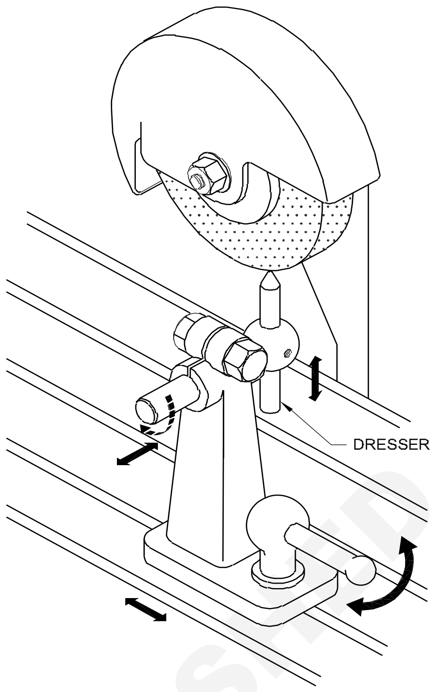
Fig 2



TURN ON THE START SWITCH WITH SWITCH ON-OFF.

- Lubricant all the parts and fittings with grease
- Check rear end thrust bearings and apply grease regularly
- Check grinding wheel if loaded then dress the wheel by diamond dresses as shown in fig 3

Fig 3



TASK 3**: Preventive maintenance of cylindrical grinding machine**

Daily

S.No	Task	Date	Status	sign
1	Check mounting bolts			
2	Check for damaged wheel			
3	Check for and rectify/replace			
4	Clean table			
5	Check and adjust apran screws.			

Weekly

S.No	Task	Date	Status	sign
1	Remove the table clean and lubricate the ways bull's bearing's rack			
2	Lubricate all the parts and fitting with grease			
3	Lubricate fittings of pumps			
4	Clean and grease all lead screws			

Monthly

S.No	Task	Date	Status	sign
1	Inspect for damage to switches wiring and conduits			
2	Check start/stop switch			
4	check all guards and secure correctly			

Passive components - Resistors

Objectives: At the end of this exercise you shall be able to
- **construct inductive proximity sensor circuit and test it**
- **construct photo electric proximity sensor circuit and test it**
- **construct capacitive proximity sensor circuit and test it.**

Requirements

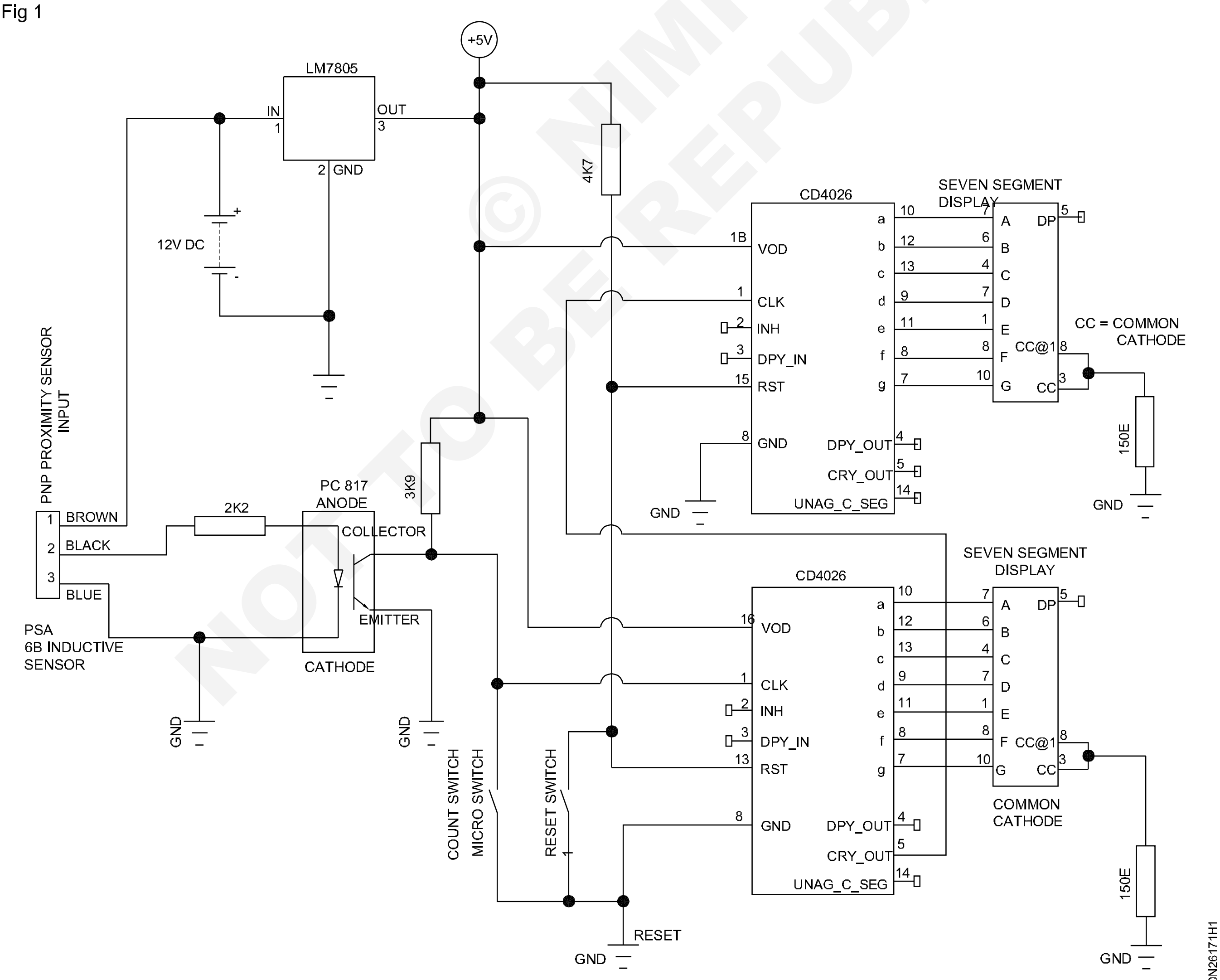
Tools / Instruments

- Trainees tool kit - 1 Set
- Soldering iron 25 watts/240 V - 1 No.
- Regulated power supply 0-30V/2A - 1 No.
- DMM with probes - 1 No.

Materials

- IC CD 4026 - 2 Nos.
- 7 Segment display common cathode - 2 Nos.
- Resistor CR 25-2k2, 3k9, 4k7 - 1 No.each
- Resistor 150 Ohm/ W/CR25 - 2 Nos.
- PC 817 Opto coupler - 1 No.
- Bread board - 1 No.
- Proximity sensor PNP type - 1 No.
- Photo electric sensor - 1 No.
- Micro switch - 2 Nos.
- LM 7805 - 1 No.
- PSA - 6B inductive sensor - 1 No.
- Hook up wire - 2m
- Resin cored solder - as reqd.

Fig 1



CIRCUIT CONNECTION AND ITS COMPONENTS

Job sequence

TASK 1: **Construction and testing the inductive type proximity sensors**

The instructor has to guide the trainees to fix the proximity sensor (inductive/photo electric sensors) and adjust the distance for detection sensitivity to detect the objects.

1 Collect all the components, plan the layout of the display device, counter IC and all other components on the bread board / PCB

2 Check all the components and assemble the circuit as per the schematic diagram shown in Fig 1.

3 Switch ON the 12V DC power supply, press the reset switch1 and observe the seven segment display shows zero

4 Pick and identify the terminals of the inductive proximity sensor, connect it on the circuit as input.

5 Bring a piece of iron object and move it in front of the sensor such that it detect the object and the display changed to show the number '1'.

6 Repeat the object number of times and observe the display shows incremental numbers confirming the detection of the object.

7 Record the number observed in Table - 1

Table - 1

S. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	....		
	....		

8 Get the work done checked by the Instructor and switch OFF the circuit

— — — — — — — —

TASK 2: **Construction and testing of photo electric type of proximity sensor**

1 Use the assembled counter circuit as per the step 1 to 3 of Task -1

2 Pick the photoelectric proximity sensor, identify the terminals and replace it to the input circuit.

3 Switch ON the 12 V DC power supply and observe the display.

4 Pick any item/object, bring it closer to the proximity sensor and observe for any changes in the display

5 Repeat the above step with any ferrous or non-ferrous objects and observe the change in display to confirm the detection of the object.

6 Record the number observed in Table - 2

7 Get the work done checked by the instructor and switch OFF the circuit

Table - 2

S. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	....		
	....		

— — — — — — — — —

TASK 3: **Construction and testing of capacitive proximity sensor**

1 Use the counter circuit assembled and tested for Task - 2.

2 Pick the three wire capacitive proximity sensor and identify the terminals, and replace it to the input circuit.

3 Switch ON the 12V DC power supply and observe the display.

4 Pick any object and bring it very closer to the proximity sensor input and observe the display for any change.

5 Repeat the above step number of times and observe the increment of number in the display to confirm the detection of the object.

6 Record the number observed in Table - 3.

7 Get the work checked by the instructor and switch OFF the circuit.

Table - 3

S. No.	No. of attempts	Number displayed	Remarks
1	First		
2	Second		
3	Third		
	....		
	....		

The circuit will display upto the number 99. Exceeding this limit another set of IC CD 4026 and seven segment display may be added.

Behavior of ultrasonic sensors

Objectives : At the end of this exercise you shall be able to
- **assemble the Ultrasonic transmitter and receiver circuit**
- **operate and test the behavior of ultrasonic sensors.**

Requirements

Tools / Instruments

- Trainees tool kit - 1 Set
- DMM with probes - 1 No.
- Regulated power supply 0-30 VDC/2A - 1 No.
- Soldering iron 25W/240V - 1 No
- Semiconductor data manuals - as reqd

Materials

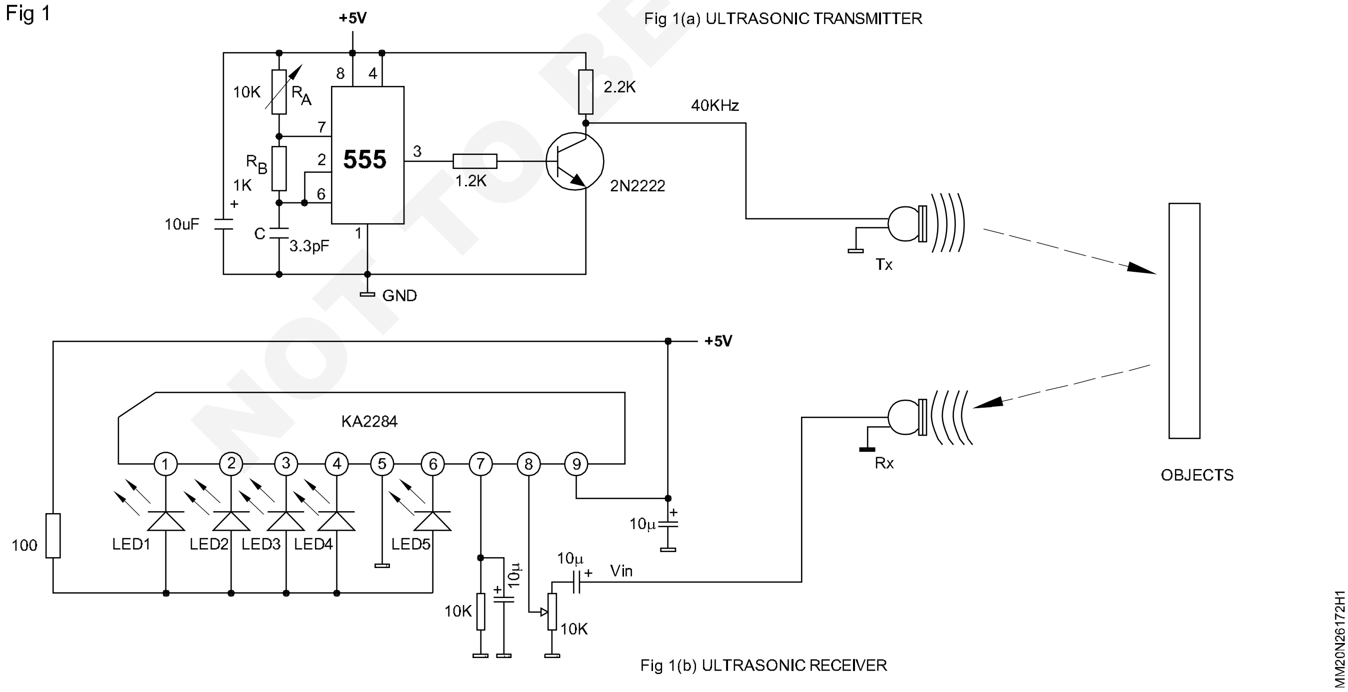
- IC 555 timer - 1 No.
- IC KA2284, - 1 No.
- LED 5mm Red - 5 Nos
- Piezo buzzer, - 1 No.
- General purpose PCB - 1 No.
- Ultrasonic transmitter and receiver 40kHz, - 1 No each
- Resistors CR25 - 100,1K, 2.2K,10K (Ohms) - 1 No each
- Potentiometer 10Lin - 2 Nos
- Capacitor (25VDC working)10 uF - 4 Nos
- Capacitor (25VDC working)3.3nF - 1 No.
- Transistor 2N2222 or equivalent - 1 No.
- Bread board / general purpose PCB - 2 Nos
- Hook up wire jumpers/ flexible wires - as reqd.
- Rosin cored Solder wire - as reqd.

Safety precaution:

The instructor has to guide the trainess to

1. **Plan the layout of components on the breadboard before assembling the circuit.**
2. **Handle the ICs carefully when inserting the pins into the breadboard slots.**

Fig 1



Job Sequence

1 Collect all the components required and check them.

2 Refer to the data manual, of the IC_s used identify the pin connections/ terminals and arrange them accordingly..

3 Assemble the circuits as per the circuit diagrams Fig-1 (a), Fig-1(b) on separate bread boards and verify their connections and get it checked by the instructor.

4 Switch ON the 5 VDC power supply and position the transmitter and receiver circuit boards side by side.

5 Keep an object in front of the transducer on the ultrasonic transmitter circuit board and observe the LEDs on the receiver board.

6 Adjust the position of object for maximum brightness of LEDs on the receiver board.

7 Measure the distance between the transducer and the object; record your observation in Table-1.

Table 1

Sl No.	Distance between Transducer and object	LED Status (Dim / Bright)	Remarks
1			
2			
3			
4			

8 Change the distance between the object and transducer on the transmitter board, observe the LEDs and record your observation in Table-1.

9 Change the position of the transmitter/ receiver board and repeat steps 5 to 7.

10 Get the work done checked by the Instructor.

Logical Operation of Sensors

Objectives : At the end of this exercise you shall be able to
- **assemble the circuit and test the and logical operation**
- **assemble the circuit and test the or logical operation**
- **assemble the circuit and test the or logical operation.**

Requirements

Tools / Instruments

- Trainees tool kit - 1 No.
- DMM with probes - 1 No.
- Regulated Power Supply 0 -15v /1 A - 1 No.

Materials

- Opto-coupler MCT2E or equivalent - 1 No.
- Micro limit switch - 2 Nos
- 1N4007 diode - 1 No.
- Transistor BC 548 or equivalent - 1 No.
- LED 5mm Red - 1 No.
- Relay 5V/2 c/o contact - 1 No.
- Resistors CR25 - 1KΩ,220Ω,150Ω - 1 No.
- Bread board - 1 No.
- Hook up wire jumpers - as reqd.

Safety precautions:

The Instructor has to guide the trainees to

1 **Plan the layout of components on the bread board before assembling the circuit.**

2 **Handle the ICs carefully when inserting the pins into the breadboard slots.**

Job sequence

TASK 1: **AND logical operation of sensor**

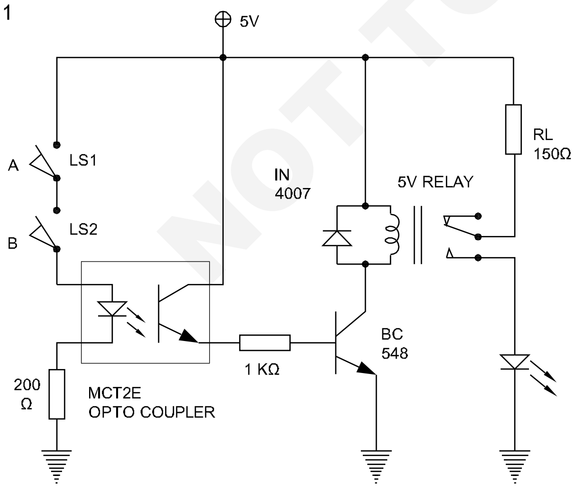
1 Collect all the components, identify their terminals and test their working condition.

2 Assemble the circuit as per the circuit shown in Fig 1 verify their connections and get it checked by the instructor.

3 Switch ON the 5 VDC supply, observe the status of the LED and relay.

4 Press limit switch-LS1 only, observe status of the LED, relay and record the observations in Table 1.

Fig 1



AND LOGIC OPERATION OF SENSOR

MM20N26173H1

Table 1 - AND logic gate truth table

Sl. No	Input A	Input B	Output Y
1	0	0	0
2	0	1	0
3	1	0	0
4	1	1	1

Observation Table

SI No	LS1 ON/OFF	LS2 ON/OFF	LED ON/OFF
1			
2			
3			
4			

5 Press the limit switch-LS2 only, repeat step 3 and record the observations.

6 Press both the LS1 & LS2 simultaneously and observe the LED, relay and record the observations.

7 Confirm the sensor activated as per the AND logic gate truth table.

8 Get the work checked by the Instructor.

— — — — — — — —

TASK 2: **OR logical operation of sensor**

1. Re-arrange the limit switch connections as per the circuit shown in Fig 1 and get it checked by the instructor.

2 Repeat steps 3 to 6 of Task 1 and record the observations in table 2.

Fig 1

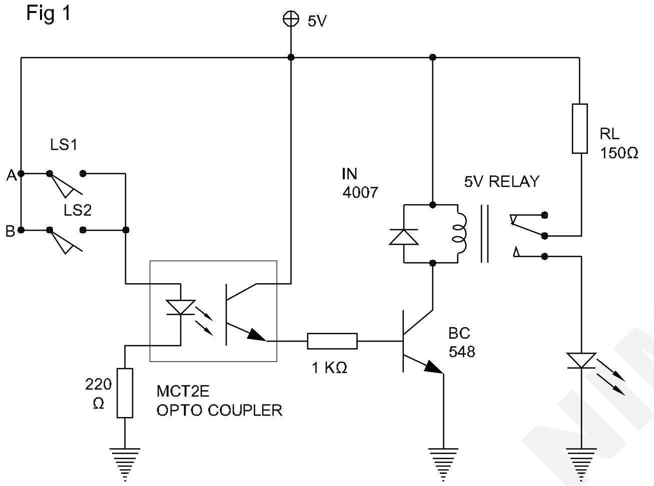


Table 2 - OR logic gate truth table

SI. No	Input A	Input B	Output Y
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

OR LOGIC OPERATION OF SENSOR

MM20N26173J1

Observation Table

SI No	LS1 ON/OFF	LS2 ON/OFF	LED ON/OFF
1			
2			
3			
4			

3 Confirm the sensor activated as per the OR logic gate truth table.

4 Get the work done checked by the instructor.

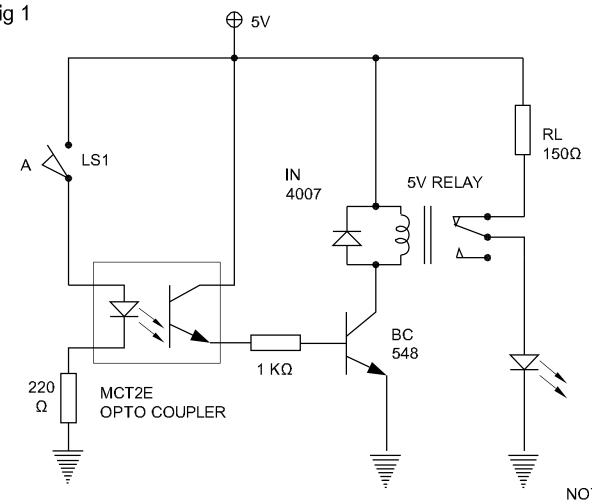
— — — — — — — —

TASK 3: **NOT logical operation of sensor**

1 Re-arrange the limit switch connections as per the circuit diagram shown in fig 1 and get it checked by the instructor.

2 Repeat steps 3 and , 4 and 7 of Task 1.

Fig 1



NOT LOGIC OPERATION OF SENSOR

MM20N26173X1

Table 3 - NOT logic gate truth table

Sl. No	**Input A**	**Output B**
1	0	1
2	1	0

SI No	LS1 ON/OFF	LED ON/OFF
1		
2		

3 Confirm the sensor activated as per the NOT logic gate truth table.

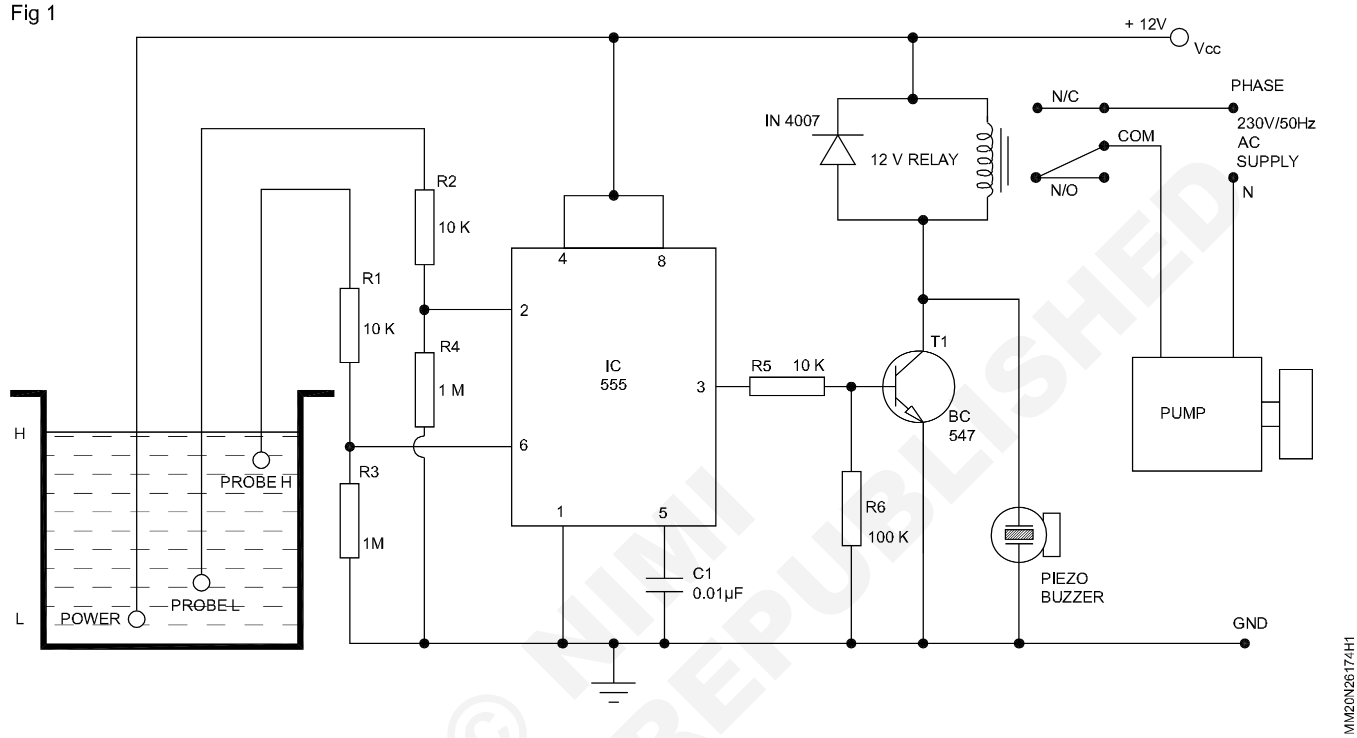
4 Get the work done checked by the Instructor.

— — — — — — — —

Limit & Level control using sensors

Objectives : At the end of this exercise you shall be able to
- **construct and test the water level**
- **control using controllers.**

Fig 1



Requirements

Tools / Instruments

- Trainees tool kit - 1 No.
- DC power supply 12 volt/1A - 1 No.
- Digital multimeter with probes - 1 No.
- Soldering iron 25w/240v - 1 No.

Materials

- General purpose PCB for IC circuit - 1 No.
- IC 555 with IC base - 1 No.
- Transistors BC 547 (NPN) - 1 No.
- Relay 12 V/2CO contracts/10A - 1 No.
- Resistors
  - 1 MΩ 1/4 W - 2 Nos
  - 10 kΩ 1/4 W - 3 Nos
  - 100 kΩ 1/4 W - 1 No.
- Capacitor 0.01 μF/25 VDC - 1 No.
- Diode 1N 4007 - 1 No.
- Connecting wires - as reqd.
- Solder, flux - as reqd.
- Buzzer (5V to 25 VDC) - 1 No.

Job sequence

1 Collect all the components materials required for the circuit shown in fig 1.

2 Check and conform good condition of given components.

3 Assemble the circuit as shown in the circuit using general purpose PCB.

4 Get the assembled circuit checked by your instructor.

5 Insert the probes L and H and set sensing elements for the low level and high level into the tank.

6 Connect the power supply and observe the working of the circuit.

7 Adjust the water level reaches low level (in diagram below L) relay gets ON and connects power to motor to run.

8 Set water level reaches high level (in diagram it is indicated as H) circuit buzzer indicator ON.

9 Get the working of the circuit checked by your instructor.

Interfacing of sensors with electrical actuators

Objectives : At the end of this exercise you shall be able to
- **connect the light sensor with electrical actuator circuit**
- **operate the circuit and verify the principle of operation.**

Requirements

Tools / Instruments

- Trainees tool kit – 1 Set.
- Regulated power supply 0-30V DC/ 2A – 1 No.
- Digital multimeter with probes – 1 No.
- Data sheet of the IC – 1 No.

Materials

- Bread board – 1 No.
- Timer IC555 – 1 No.
- 12V relay 2co/10A – 1 No.
- Transistor BC 547 – 1 No.
- LDR (Light sensor) – 1 No.
- 10L in. pot/preset – 1 No.
- 1N4007 diode – 1 No.
- LED – 5mm Red – 1 No.
- 1/4N resistors -22k Ω – 1 No.
- 1K Ω – 2 Nos.
- 100k Ω – 3 Nos.
- Bulb 12V/ 3W – 1 No.
- Hook up wire jumper – as reqd.
- Flexible wire – as reqd.

Job sequence

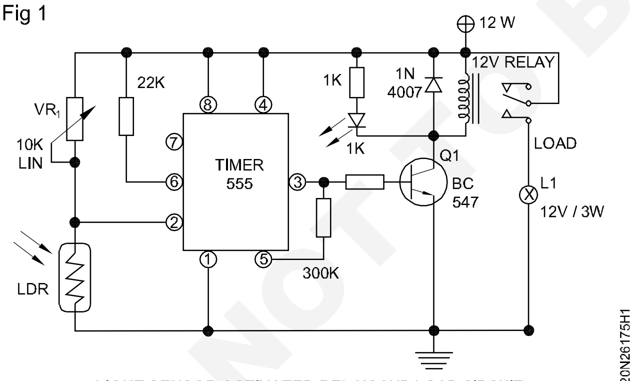
1 Collect all the required components, materials etc for the circuit diagram shown in Fig 1 and check their condition.

2 Plan the layout and assemble the circuit using bread board: connect the relay and load.

3 Verify the connections with reference to the circuit diagram and get if checked by the instructor.

4 Connect 12 VDC to the circuit setup; switch ON and observe the operation of relay.

Fig 1



LIGHT SENSOR ACTIVATED RELAY AND LOAD CIRCUIT

Note:

1 Cover the LDR completely dark; adjust the VR1 pot slightly for the relay just to become ON.

2 Remove cover, show light on LDR, observe the relay operation; slowly readjust the VR1for switching OFF the relay.

3 Fine adjust, remove light; switch OFF 12 VDC and cover the LDR

5 Open the cover, allow bright light to fall on the LDR.

6 Switch ON 12VDC and observe the operation of relay; record your observations in Table 1.

7 Cover the LDR, observe the relay and load, close and confirm the operations repeated again.

Table -1

Sl.No	LDR staters open/closed	Relay staters ON/OFF	Load stanters ON/OFF
1			
2			
3			
4			

8 Get the work done checked by the instructor.

Making simple wiring circuits and measurement of current

Objectives : At the end of this exercise you shall be able to
- **make a simple circuit wiring**
- **measure the current and voltage in the wired circuit.**

Requirements

Tools / Instruments

- Trainees tool kit - 1 Set.
- Ammeter (0-5A) MI - 1 No.
- voltmeter (0-300) MI - 1 No.

Materials

- Testing board with 100W/240V lamp - 1 No
- PVC flexible copper wire 1.5.SQ mm - as reqd.
- PVC insulation tape - 1 No.

Job sequence

TASK 1: **Wiring a simple circuit**

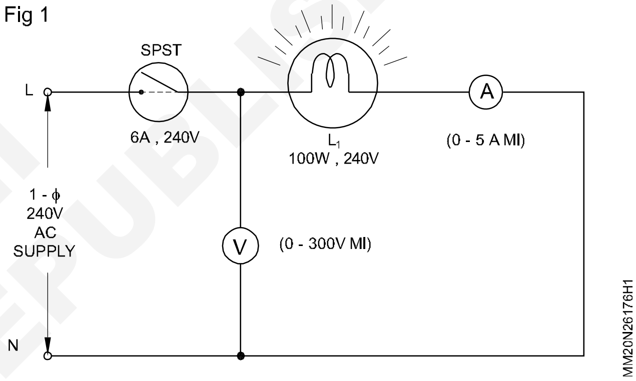
1 Collect all the required items, check their good working condition, connect the circuit as shown in figure 1.

2 Switch ON the supply and verify the connections and get it checked by the instructor.

3 Observe the lamp glows or not;

4 Switch OFF the mains supply and get the work done checked by the instructor.

Fig 1



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TASK 2: **Measurement of current and voltage in the wired circuit**

1 Connect the circuit as shown in figure 1.

2 Switch ON the mains supply

3 Observe the readings in the ammeter and voltmeter

4 Note down the readings of ammeter and voltmeter in table 1; and switch OFF the mains supply.

5 Calculate power by taking Cosθ = 0.8 in the formula given

6 Get the work done checked by the instructor.

Table - 1

S.I. No	Voltage (v)	Current (I)	Power P=VI cos θ

— — — — — — — —

Testing of power supply

Objectives : At the end of this exercise you shall be able to
- **test DC power supply and measure DC voltages**
- **test AC power supply and measure AC voltages.**

Requirements

Tools / Instruments

- Trainess Tool Kit - 1 Set.
- Digital multimeter with probes - 1 No
- Variac 0-270 VAC - 1 No.

Equipment/Machines

- DC regulated power supply 0-30V/2A - 1 No

Materials

- Lead acid battery 12V/7AH - 1 No.
- Probes - as reqd.
- Testing board with 100 W/240V Bulb - 1 No.

Job sequence

TASK 1: **Testing of DC power supply**

> **Safety Precaution:**
>
> **1 Observe the positive, Negative terminals of the battery and connect multimeter/voltmeter terminals accordingly**
>
> **2 Be cautions**

1 Collect all required items/materials i.e lead acid battery and regulated DC power supply unit etc. and check their good condition.

2 Set the multimeter function selector knob to DC voltage with required range.

3 Identify the polarities of lead acid battery, and measure the terminal voltage.

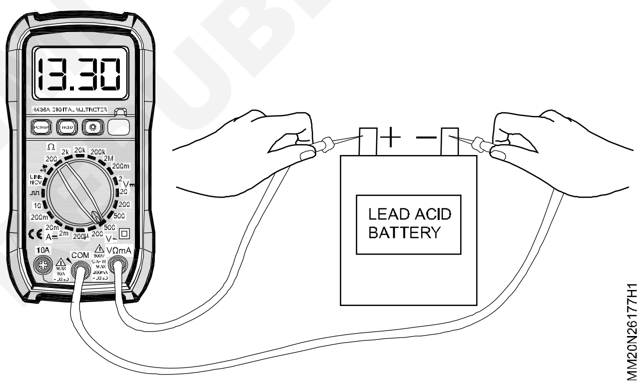
4 Note down the reading shown in the display of the multimeter and record your observation in Table 1.

5 Connect the regulated power supply to mains AC supply and DMM across the DC, output terminals

6 Switch ON the supply main and note down the minimum position reading of regulated power supply

7 Adjust the output knob to mid position in regulated power supply and again at max position. Measure the DC output record the observations in Table 1.

Fig 1



8 Get the work checked by the instructor.

Table 1

Sl.No	Measured across	DC voltage output
1	Lead acid battery	
2	RPS set at min.position	
3	RPS set at mid position	
4	RPS set at max position	

— — — — — — — —

TASK 2: **Testing of AC Power supply**

1 Arrange all required items as per the circuit set up shown in Fig 1 for testing AC voltage measurement.

2 Connect the variac to the AC mains supply.

3 Set the multimeter function selector knob to AC higher voltage range.

4 Set the variac at some voltage range and connect the output terminals to multimeter as shown Fig 1 and note down the reading displayed by the multimeter in Table 2.

5 Change the position of knob to 25% approxmately on the dial and measure the corresponding voltage readings on multimeter.

6 Record your observations in Table 2

7 Repeat steps 5,6 at 50% and 75% position on the dial.

8 Get the work done checked by the instructor.

Fig 1

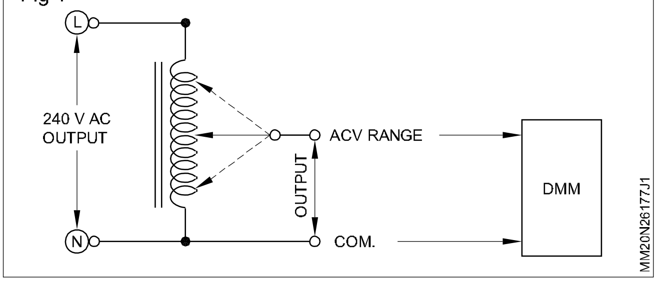


Table 2

Sl.No	Variae setting	Measured AC voltage
1	Minimum position	
2	25% rotation position	
3	50% rotation position	
4	75% rotation position	

— — — — — — — —

Demonstration of use of test lamp and meggar

Objectives : At the end of this exercise you shall be able to
- **test the single phase & three phase supply by using the test lamp**
- **measure the insulation resistance by using the meggar.**

Requirements

Tools / Instruments

- Trainees tool kit - 1 Set.
- Insulation tester/Meggar -500 V the testing leads - 1 No.
- Digital multimeter with probes - 1 No.
- Test lamp -100W/240V - 2 Nos.
- Armoured cables of different sizes and length - 2Nos.
- PVC connecting leads - as reqd.

Job sequence

1 **Safety precautions: The instructor has to guide the trainees to be cautions while measuring AC voltages in three phase supply.**

2 **Guide the learners white using the meggar.**

TASK 1**: Testing the single phase supply using test lamp.**

1 Check the presence of earth conductor connection visually in the panel board.

2 Connect one lead of test lamp to the earth point as shown in fig 1 and connect the other lead to R-phase observe phase terminal and record the brightness of the lamp in table -1.

3 Repeat the step 2 across the earth point and, Y-terminal, B - terminal and N - terminal.

Fig 1

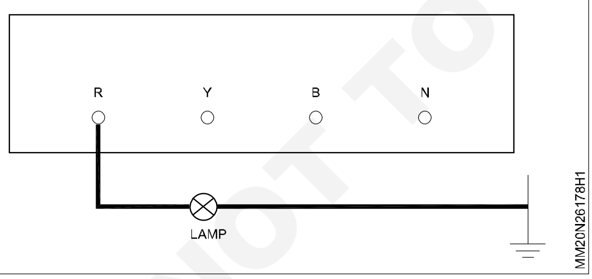


Table 1

Sl. No	Terminals	Glowing Dim/Bright	Not-glowing
1	R to Earth		
2	Y to Earth		
3	B to Earth		
4	Neutral to Earth		
5	R to Neutral		
6	Y to Neutral		
7	B to Neutral		

4 Change test lamp connection across neutral to R,Y,B terminals and record your observations in Table -1.

5 Get the work done, checked by the instructor.

— — — — — — — —

TASK 2: **Testing the three phase supply using test lamps**

1 Join two test lamps in series for testing purpose.

2 Connect one lead of test lamp to 'R' phase and other lead into 'Y' phase as shown in the fig 2 and record the glowing condition of the bulbs in Table -2.

3 Repeat step 2 across Y phase to B phase and also across B phase to R- phase.

Fig 2

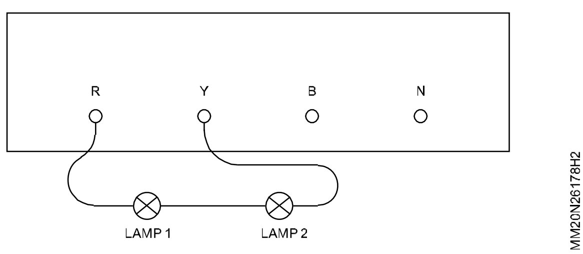


Table 2

Sl. No.	Test terminals	Series test lamp condition	
		Bright	Dim
1	R - Y		
2	Y - B		
3	B - R		

4 Get the work done checked by the instructor.

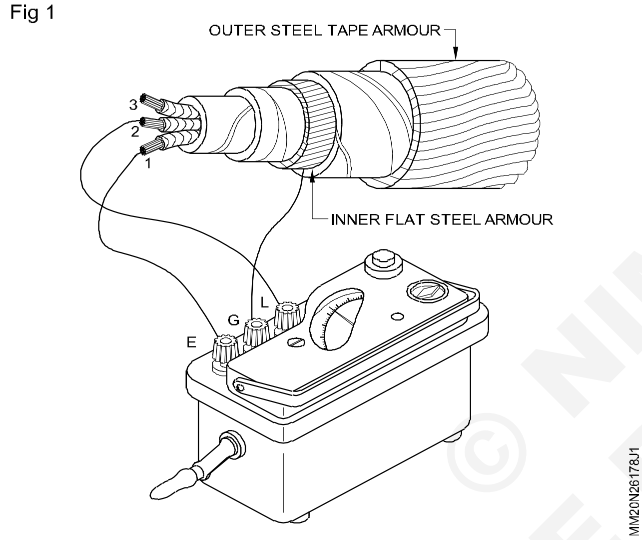
— — — — — — — —

TASK 3: **Measure the insulation resistance between conductors of an armoured cable using meggar**

1 Position the meggar at a level place on the work table.

2 Connect the armoured cable terminals across the terminals of meggar as shown in Fig 1.

Fig 1

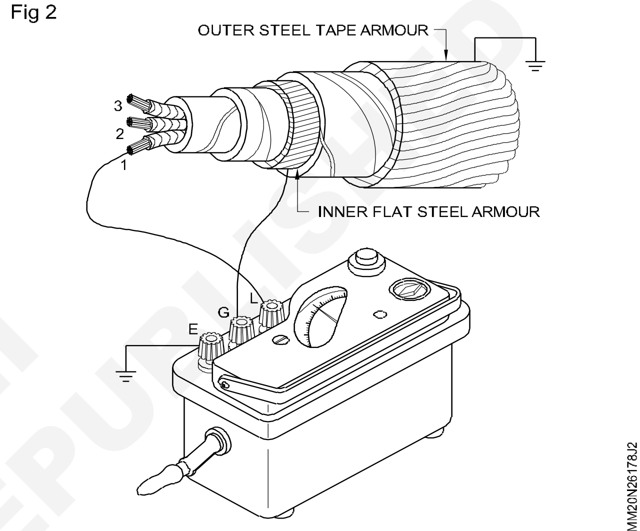


3 Connect the guard terminal of the meter with the armour (metal sheath) of the cable. Measure the insulation resistance between the conductors and record the readings in Table 1.

Table 1

Measurement	Insulation resistance in megohms
Between conductors	
Conductor R and conductor Y	
Conductor Y and conductor B	
Conductor R and conductor B	
Between earth and conductors	
Conductor R and earth	
Conductor Y and earth	
Conductor B and earth	
Conductor 1, 2, 3 shorted and earth	

Fig 2



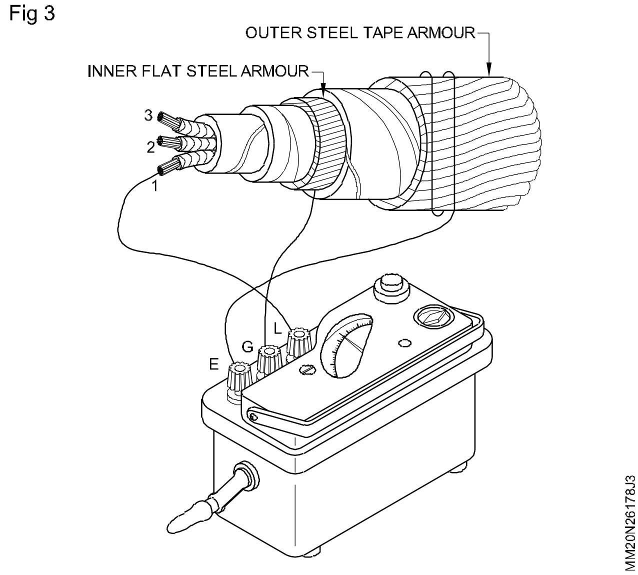
4 Hold the megger firmly, rotate the handle continuously at a constant speed approx 160 r.p.m.

5 Repeat steps 4 and 5 for all the combinations across R,Y and B.

6 Measure the insulation resistance between earth and R,Y,B and record your observation in Table -1 and conductors of an armoured cable.

7 Get the workdone checked by the instructor.

Fig 3



Connections of DC/AC motors and its speed control demonstration

Objectives : At the end of this exercise you shall be able to
- **connect DC motor and control its speed**
- **connect AC motor and control its speed.**

Requirements

Tools / Instruments

- Insulated cutting plier 200 mm - 1 No.
- Screwdriver 200mm - 1 No.
- Electrician knife (100 mm) - 1 No.
- Ammeter 0 - 1A - 1 No.
- Voltmeter 0 - 300 V - 1 No.
- Tacho meter 2000 - r.p.m - 1 No.
- Meggar - 500 V/Insulation Tester-500V - 1 No.
- Test lamp 100W/240V - 1 No.
- Ammeter 0 - 15 A M.I type - 1 No.
- Three phase variac - 1 No.

Equipment/Machines

- DC shunt motor 220 V 3HP - 1 No.
- Rheostat 220 ohms/15 Amp - 1 No.
- DOL starter three phase - 1 No.
- Rheostat 20 Ohms 15 Amps - 1 No.
- AC 3 phase sequirre cage induction motor 3 Hp, 50 Hz - 1 No.

Materials

- PVC Insulated multistrand flexible cable 2.5 Sq mm - 10 M
- Linear graph sheet - A4 size - as reqd

Job sequence

TASK 1: **Connection and speed control of DC motor (By field control method)**

1 Read the name plate details and identify the terminals of the give DC shunt motor.

2 Test for insulation and ground using insulation tester.

3 Select suitable range of rheostat, ammeter, voltmeter, switch and fuse according to the specification of the given DC shunt motor.

4 Make the connection as per the circuit diagram shown in Fig 1.

5 Verify the connections made and get if checked by the instructor.

6 Keep the field rheostat in the cut out position to have minimum resistance value.

The rheostat position must be in teh cut out position at the time of starting to have a low starting speed.

7 Apply the rated supply voltage through the switch and start the motor by charging the ohmic value of rheostat.

8 Measure the speed, field current, voltage and enter them in table 1.

9 Decrease the field current by increasing the field control resistance in steps by rheostat.

Calculate 130% of the speed value from the name plate details. The speed should not be more than 30% of the rated value.

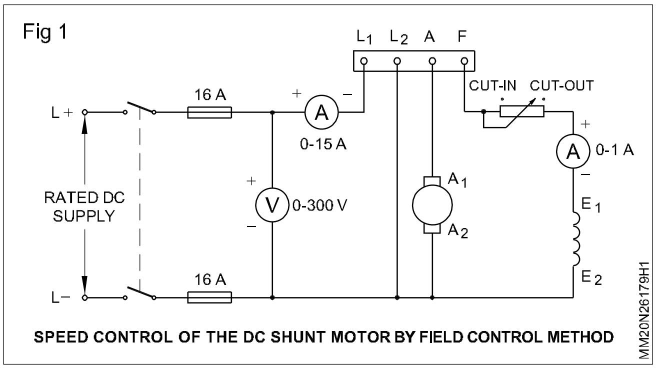
10 Measure the speed, field current and the applied voltage for each step and enter these values in Table - 1.

11 Switch OFF the DC of motor.

12 Draw the speed versus field current curve in a graph sheet, keeping the field current on the X axis and the speed on the Y axis.

13 Get the workdone checked by the instructor.

Fig 1



SPEED CONTROL OF THE DC SHUNT MOTOR BY FIELD CONTROL METHOD

Table 1

Sl. No	Voltage across E1 - E2	Line current (I_L)	Field current (IS_L)	Speed rpm
1				
2				
3				
4				
5				
6				

— — — — — — — —

TASK 2: **Connection and speed control of AC motor**

1 Read the name plate details of the AC motor and identify terminals.

2 Check the insulation and continuity of the motor winding using insulation tester.

3 Make connections as per the circuit diagram shown in Fig 1.

4 Verify the connections made and get it checked by the instructor.

5 Switch ON the main 'S1' and then press push button.(Keep start).

6 Start moving the variac output adjusting knob such that the induction motor start getting more voltage in stages upto full voltage.

7 Reduce the applied voltage to the induction motor in steps of 25V.

8 Use tachometer measure rpm record observations in Table -2.

Table 2

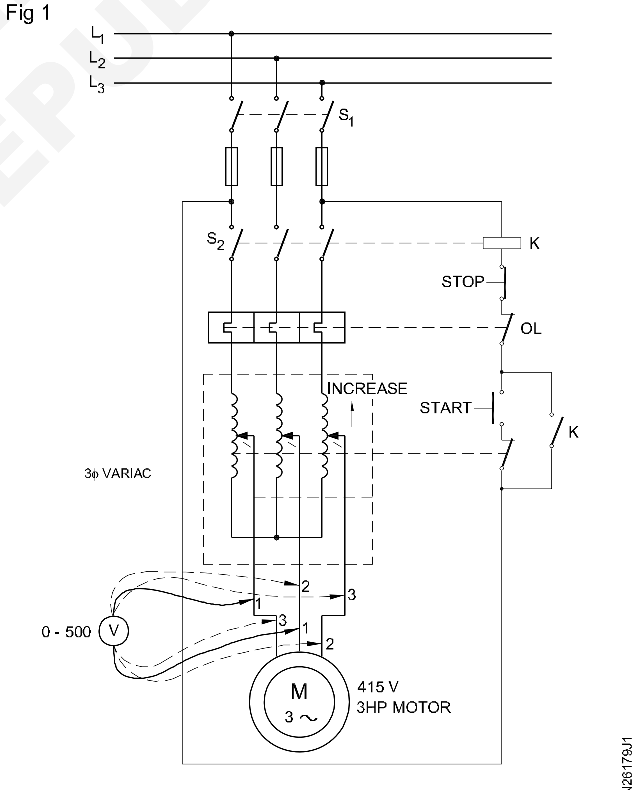
Sl.No.	Line voltage (V1) R-Y Y-B B-R	rpm
1		
2		
3		
4		
5		

9 Repeat stpes 7 and 8, measure the rpm of the induction motor at every stage and note in Table -2.

10 Get the work done checked by the instructor.

- Switch off by pressing stop button and then switch off the main switch (S1)

Fig 1



CIRCUIT DIAGRAM OF THE 3ϕ INDUCTION MOTOR & D.O.L STARTER WITH ICTP SWITCH

Identify of passive and active electronic components

Objectives : At the end of this exercise you shall be able to
- **passive components and categories them under resistors capacitor and inudctors**
- **identify the different types of active electronics components by referring to the pictorial representation.**

Requirements

Tools / Instruments/Equipments

- Trainees tool kit - 1 set.
- Magnifying glass - 1 set.
- Semiconductor data sheet/ Manual with lead identification - 1 No.
- Pictorial chart showing different - 1 No each.
- types of Resistors - 1 No.
- types of capacitors - 1 No.
- types of inductors - 1 No.
- types of active components - 1 No.

Materials

- Assorted types of active components consisting of assorted types and values of ressistors capacitor, inductorstype value of resistors - 1 No each.
- Diodes - 1 No each.
- Zener diode - 1 No each.
- Transistor - 1 No each.
- unijunction transistor (UJT) - 1 No each.
- Field effect transistor (FET) - 1 No each.
- DIAC - 1 No each.
- TRIAC - 1 No each.
- Silicon controlled rectifier (SCR) - 1 No each.
- integrated circuit (IC) - 1 No each.

1 **The instructor has to label the different types, sizes and ratings of carbon resistors capacitors, inductors and active components from simple diodes to ICs used for this exercise.**

2 **Arrange them seperately under each category and ensure that these component vahes/code numbers and available clearly on ther body.**

Job sequence

TASK 1: **Identification of different types of resistors**

1 Pick one of the labelled resistor from the given lot.

2 Identify the types of carbon refer to the chart -1 and observe the details of resistors.

3 Draw the free hand sketch of the outline of carbon resistor.

4 Record the power rating of carbon resistor in Table 1.

5 Repeat above steps for the remaining labelled resistors.

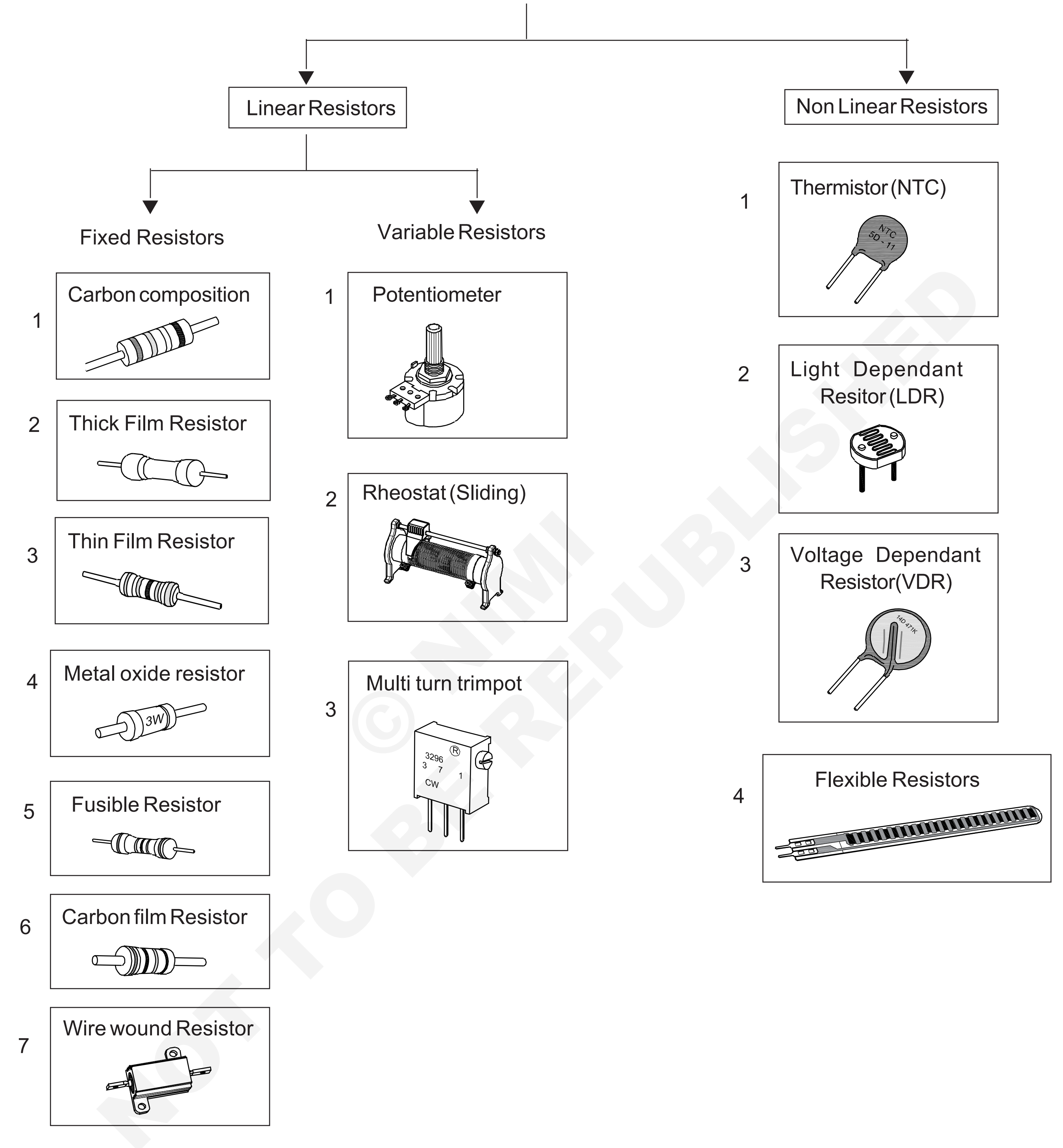
Table -1

Lable No	Name of the passive component, Resistor	Circuit symbol	Physical shape outline	Value of the resistor	Power rating	Remarks

6 Get the workdone by the instructor.

Chart - 1

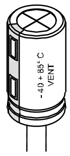
TYPES OF RESISTORS



Types of Capacitors - Chart - 2

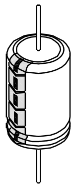
Electrolytic capacitor (Aluminium)

a Radial type lead

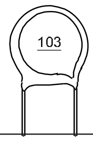


1a

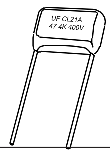
b SMD Capacitor



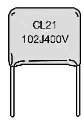
2 Ceramic capacitor



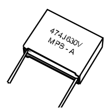
3 Metalised polyster capacitor



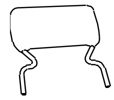
4a Metalised polypropylene film capacitor



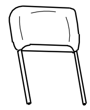
4b



5 Wound polyester capacitor

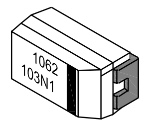


6 Mylar cpacitor



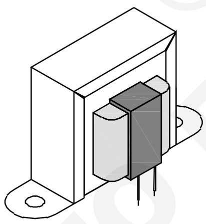
7 Tantalum capacirtor

8 SMD Capacitor

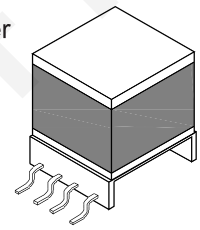


Types of Inductors - Chart - 3

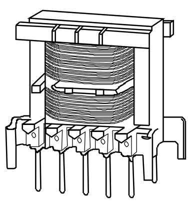
1 Laminatedcore transformert



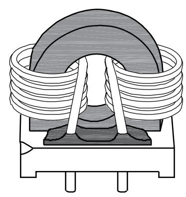
2a Ferrite core transformer



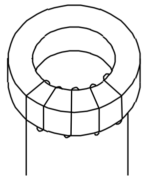
2b



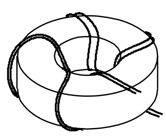
3 Ferrite core inductor



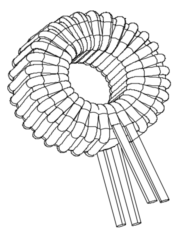
4a Bobbin Inductor

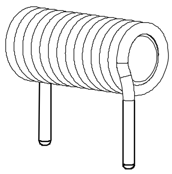
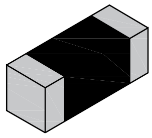
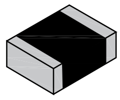
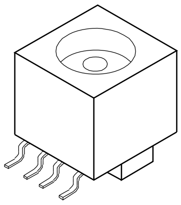
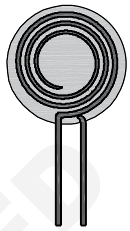


5a Toroiodal



5b



6 Air core inductor 	8a Multilayer chip inductor  8b 
7 shielded variable indutor 	9 Wireless charging coil 

Measure V_{DC}, V_{AC}, time period using CRO/DSO sine wave parameters

Objectives : At the end of this exercise you shall be able to
- **measure D.C voltage (VDC) using cathode ray oscilloscope (CRO)**
- **measure the values of AC voltage (VP.P) using CRO**
- **measure the time period and sine wave parameters using CRO.**

Requirements

Tools / Instruments/Equipments

- Trainees tool kit - 1 Set.
- Oscilloscope, 20MHz with probe kit & instruction manual - 1 Set.
- Regulated power supply 0-30V DC/ 2A - 1 No.
- Digital multimeter with probes - 1 No.

Materials

- Step-down transformer, 240CV 0-12V 500mA - 1 No.
- Linear graph sheet - A4 size - 1 No.
- Dry cell 1.5V gv battery - 1 No each.
- Hook-up wire - 1 m

Note :

1 The instructor has to demonstrate the operation of CRO, make the trainees familier with the controls.

2 Guide the trainees to make measurement of the built in calibration signal before proceeding to start this exercise.

Job sequence

TASK 1 : **Measurement of DC voltages using CRO**

1 Identify the controls on the front panel of the CRO with reference to the instruction manual, and their fuctions.

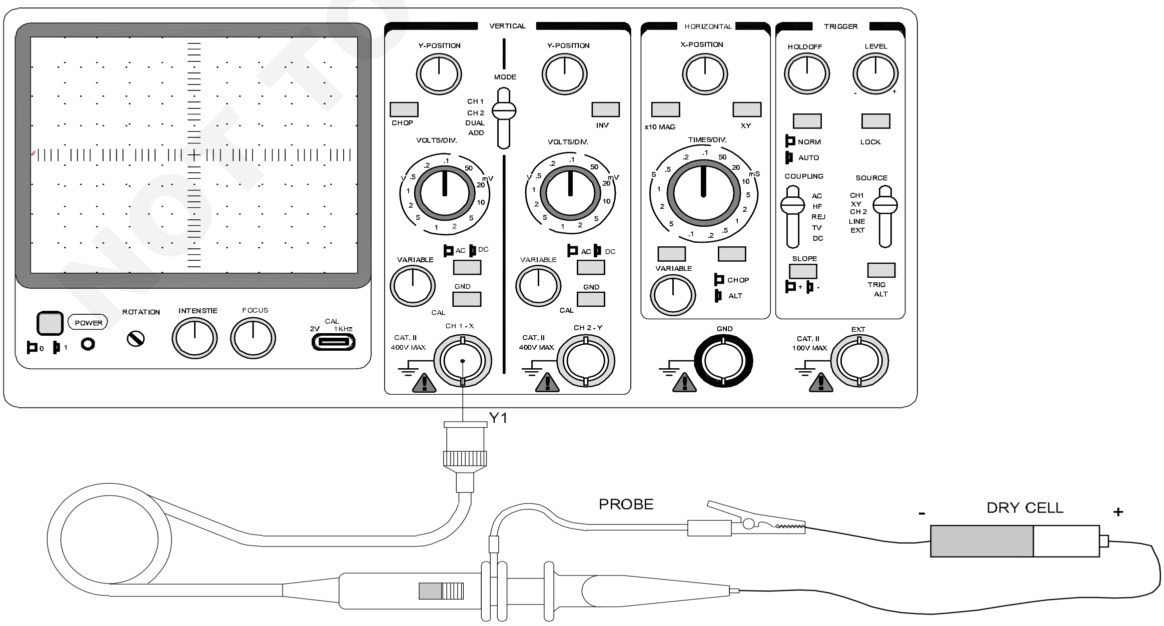
2 Connect the power cord to the AC main supply and switch ON the CRO.

3 Observe the screen, allow warn up time to get the trace; adjust for a sharp trace by intensity, focus and position controls, move it on to the X-axis as demonstrated by your instructor.

4 Connect the direct probe into the channel -1 (Y-1) input, adjust the alternator (Volt/Div) control to 0.5/Div setting.

5 Connect -Ve terminal of the 1.5V cell at Gnd terminal of the probe and +Ve terminal at lot end as shown in Fig 1.

Fig 1



MEASUREMENT OF DC VOLTAGES

MM20N26181H1

6 Observe the shift in position of the trace on the graticule scale of CRO, measure the number of divisions on the graticule, record your measurement in Table -1.

Table 1

Sl.No	Rated voltage of battery	Volt/Div Setting	No.of Div moved up	Measured voltage Volt/Div X No. of Div.
1	1.5 V			
2	9 V			
3	12V			

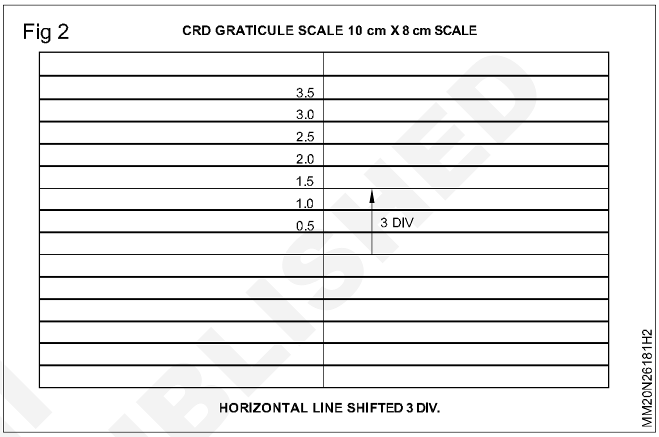
7 Observe and draw the shifted horizontal line on teh linear graph sheet taking the some seale of CRO shown in Fig 2.

8 Calculate the measured voltage by using the formula measured voltage = volt/div. setting X no.of div. on YAXIS.

9 Repeat the steps 5 to 7 with 9V/12V batteries; measuire the voltage by reading insting the alternator setting as required for observation .

10 Get the work done checked by the instructor.

Fig 2



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TASK 2 : **Measurement of AC voltage and other parameters on the sine wave**

1 Prepare the CRO for measurement of adjusting necessary controls at appropriate settings.

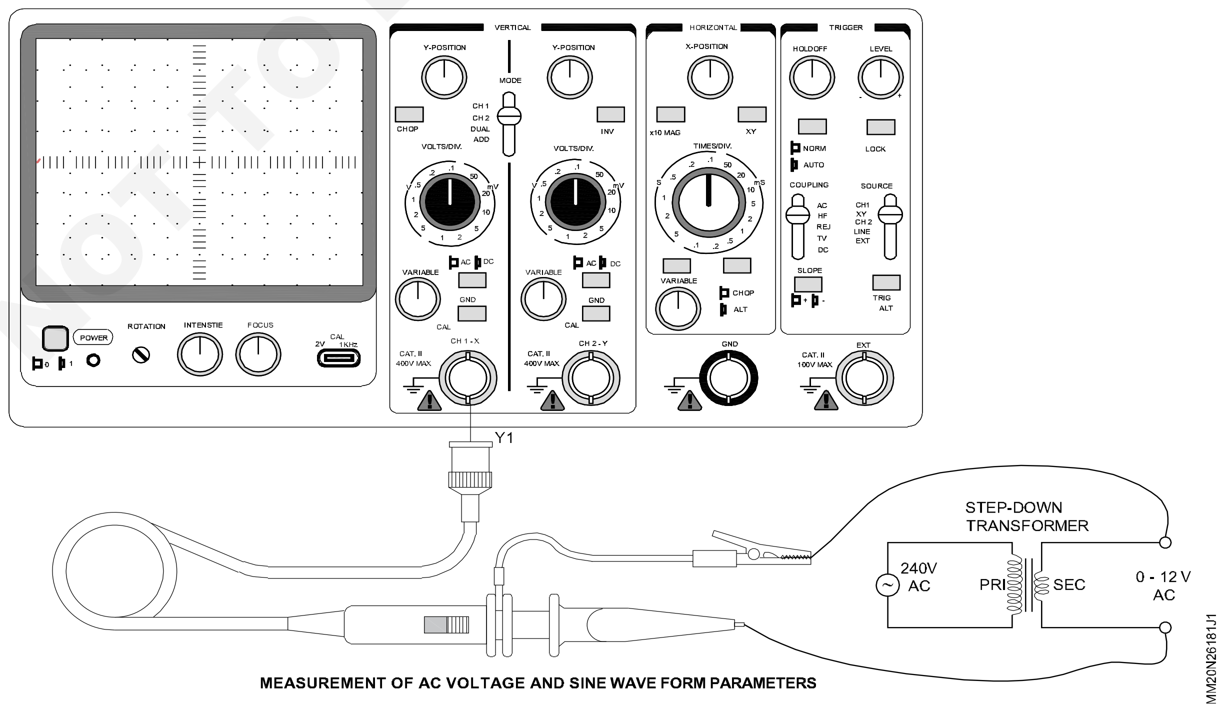
2 Set the AC - DC switch to AC position.

3 Set the alternator (Volt/Div) control to 5V/Div. position and time /Div (Time base) control to 10msli second (ms/Div) position.

4 Switch ON the step down transformer primary and connect the secondary across the channel -1 import probes as shown in Fig 1.

5 Observe the wave form height on the screen, change the alternator settings to fill around 70& on the screen.

Fig 1



6 Readjust the Time/Div control to get 2 or 3 sine wave forms on the screen; use the trigger control to stabilize the wave form to a stationary position on the center as shown in Fig 2.

7 Observe and draw one sine wave form on a linear graph sheet taking the same seale, as shown in Fig 3.

8 Count the number divisions on X-axis for one complete cycle of sine waveform, record it in the Table -2 and calculate the Time (T), and Frequency F= 1/T, record the results.

9 Count the number of divisions on Y-axis from 'O' point to peak amplified on +ve side as shown in Fig 6; record your measurements on Table -3.

Fig 2

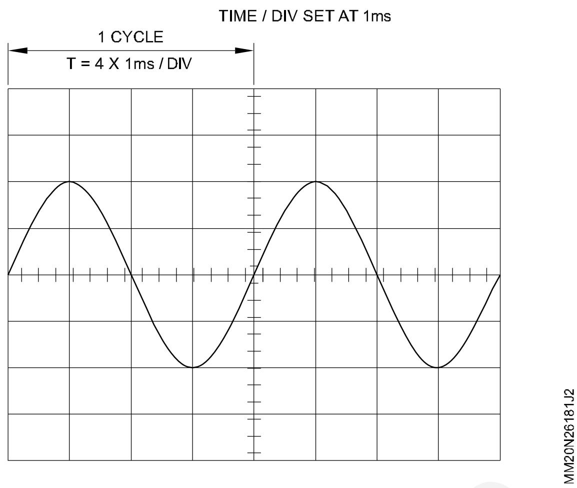


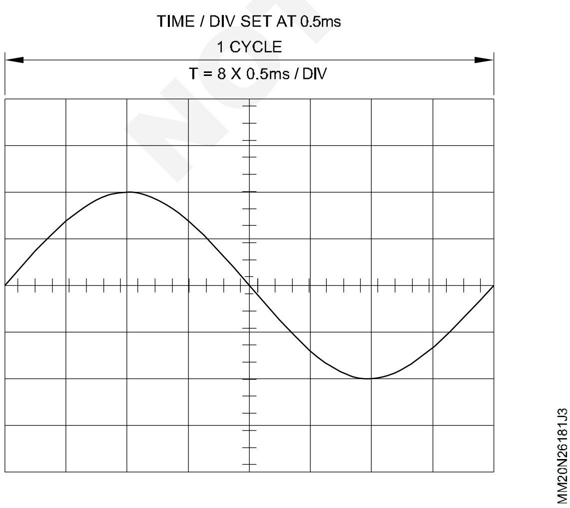
Table 2

Time/Div control Position	No of Div for one cycle	Time taken by one cycle (T)	Frequency = 1/T in hertx (H_z)

Table 3

Alternator position (Volt/Div)	No.of Div. on Y axis ⊕ ve side	No.of Div. on Y axis ⊖ve side	Peak value (V_p)	RMS Value (V_{rms})	Peak to peak value (VP-P)

Fig 3



Note: Move the waveform using the "X -shift" control if required for correct measurement.

10 Repeat step 9 on the -Ve side and record your measurements.

11 Calculate the RMS value by taking the peak valve (Vp), by substituting in the Formula Vrms = Vp x (0.707 % of Vp), mark it on the grpah ash shown in Fig 3.

12 Mark the peak value Vp-p (Vp x Z) on the graph (Fig 4 & 5).

13 Get the work done checked by the instructor.

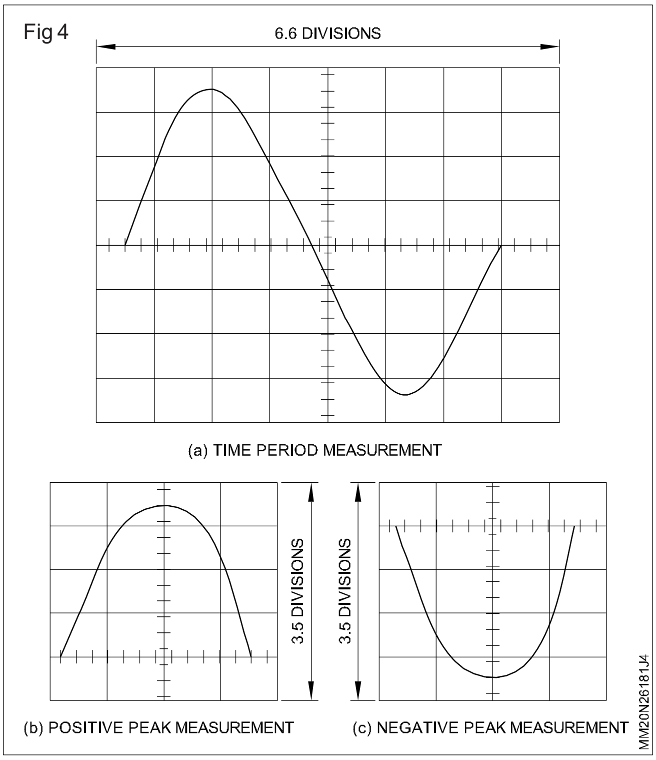


Fig 4
6.6 DIVISIONS
(a) TIME PERIOD MEASUREMENT
3.5 DIVISIONS
3.5 DIVISIONS
(b) POSITIVE PEAK MEASUREMENT
(c) NEGATIVE PEAK MEASUREMENT
MM20N26181J4

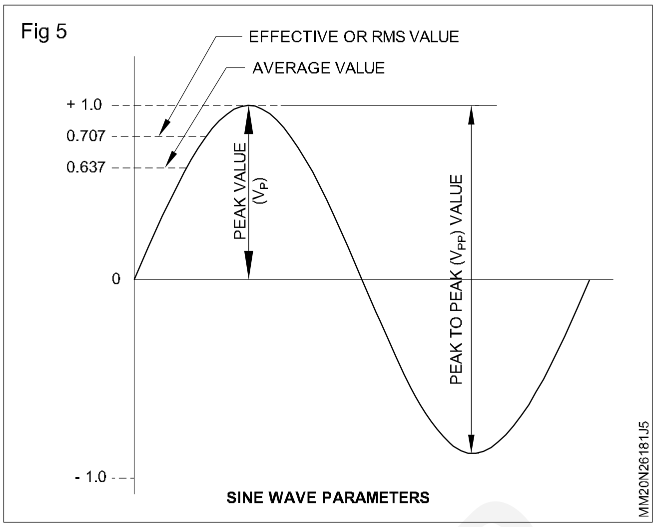


Fig 5
EFFECTIVE OR RMS VALUE
AVERAGE VALUE
+ 1.0
0.707
0.637
0
- 1.0
PEAK VALUE (V_P)
PEAK TO PEAK (V_{PP}) VALUE
SINE WAVE PARAMETERS
MM20N26181J5

Demonstrate of logic gate operations

Objectives : At the end of this exercise you shall be able to
- **construct the AND logic gate and verify the truth table**
- **construct the OR logic gate and verify the truth table**
- **construct the NOT logic gate and verify the truth table.**

Requirements

Tools / Instruments

- Trainees tool kit - 1 set
- Digital multimeter with probes - 1 No

Equipments

- DC regulated power supply 0-30V/1A with manual - 1 No.

Materials

- Bread board - 1 No.
- Connecting wire Jumpers - as reqd
- SPST switch - 2 Nos
- LED (Red) 5 mm - 2 Nos
- Carbon resistor 1KΩ/¼W - 2 Nos.

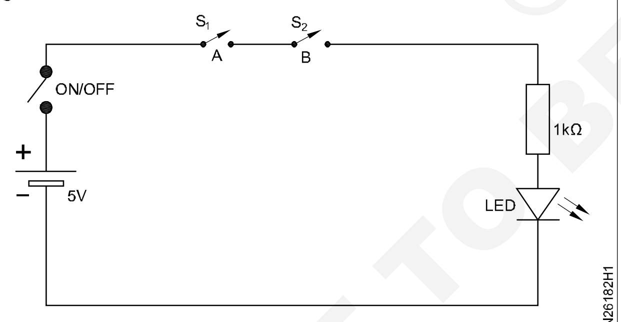
Job sequence

TASK 1 : **Construction of AND gate using two switches LED and verify its truth table**

1 Collect all the items required and check them for good working condition.

2 Construct AND gate circuit using bread board and single pole (SPST) switches in series with the LED as shown in Fig 1.

Fig 1



AND GATE FUNCTION

3 Get the wired circuit checked by your instructor.

4 Switch ON the circuit apply 5VDC and activates switches A&B as given in Table 1; record your observations in the corresponding output of LED status.

5 Get the workdone checked by the instructor.

TABLE 1

(A) Observation table

Sl. No.	Input Switch		
	S1(A)	S2(B)	LED Status (ON/OFF)
1	OFF	OFF	
2	OFF	ON	
3	ON	OFF	
4	ON	ON	

(B) Truth table of AND gate

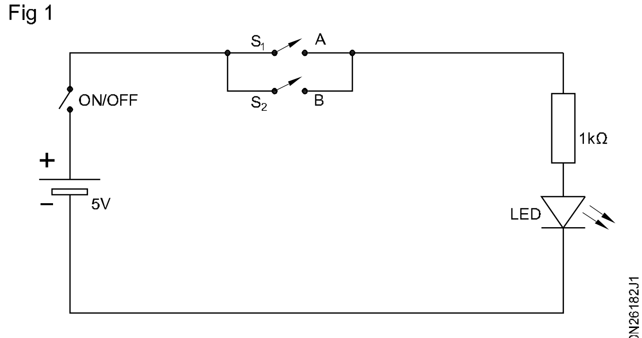
Sl. No.	Input		Output
	A	B	Y = A.B
1	0	0	0
2	0	1	0
3	1	0	0
4	1	1	1

— — — — — — — —

TASK 2 : **Construction of OR gate using two switches in parallel LED and verify its truth table**

1 Refer to Fig 2 and assemble OR gate circuit using two SPST switches in parallel as shown.

Fig 1



OR GATE FUNCTION

2 Get the assembled circuit checked by the instructor.

Table -2

Sl. No	Input switch S1 (A)	Input switch S2 (B)	LED status ON/OFF
1	OFF	OFF	
2	OFF	ON	
3	ON	OFF	
4	ON	ON	

3 Switch ON the circuit and activate switches A & B as given in TABLE 2.

4 Record your observations of LED indication in TABLE 2 and verify the truth table.

5 Get the work done, checked by the instructor.

Truth table 2

Truth table of OR gate

TRUTH TABLE 2

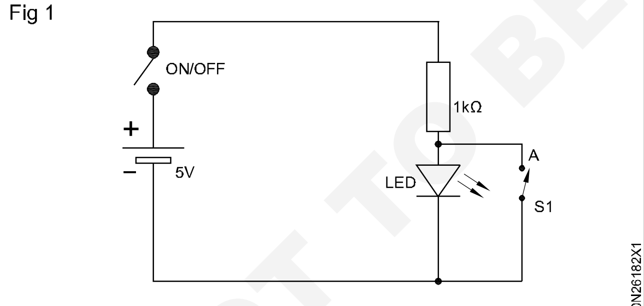
Sl. No	Input		Output
	A	**B**	**Y = A+B**
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

— — — — — — — —

TASK 3 : **Construction of NOT gate using switch, LED and verify its truth table**

1 Refer to Fig 3 and assemble the NOT gate circuit using the switch and LED as shown.

Fig 1



NOT GATE FUNCTION

2 Get the assembled circuit checked by the instructor.

3 Switch ON the 5VDC, and activate the switch S1 as shown in TABLE 3.

TABLE 3 (Observation table)

Sl. No.	Switch S1	LED status
1	OFF	
2	ON	

Truth table of NOT gate

Sl. No.	Input A	Output $Y = \overline{A}$
1	0	1
2	1	0

4 Observe the status of LED and record your observations in TABLE 3 for both steps.

5 Verify the observations with the truth table of NOT gate and get the work done, checked by the instructor.

— — — — — — — —

Testing and measurement of resistors, capacitors, inductors using multimeters

Objectives : At the end of this exercise you shall be able to
- **identify the value of resistor and its colour code/print code measure the value using multimeter**
- **test and measure the capacitor value using multimeter**
- **test and measure the inductor value using multimeter.**

Requirements

Tools / Instruments
- Digital multimeter with probes - 1 Set.
- pictorial chart of Resistor capacitors, inductors - 1 No each.

Materials
- Capacitors, inductors, resistors (Asorted size, shape and values) - Each 3 Nos.

Job sequence

TASK 1 : **Identify, test and measurement of resistors using multimeter.**

Note:

1 The instructor has to provide different types / sizes of components and label the components so that the trainees can visually identify the category and group them accordingly.

2 The instructor has to provide colour coding chart, guide the trainees to decode the values of colour coded/ print coded resistors.

3 Demonstrate the use of multimeter as ohm meter function and the method of mesurement of resistance value.

1 Pick one of the components identify the components which are resistors, capacitors and inductors refering to pictorial charts EX.No 2.6.180.

2 Select all the resistors from the assorted components, group them seperately.

3 Pick one of the labelled resistors, observe the colour bands, refer to the colour cooding chart, decode the value and record in Table -1.

4 Repeat the above step for all the resistors; note down the printed value directly in Table -1.

5 Select the ohms range on multimeter; short the test probes and ensure the motor shows 'Zero' ohms and open the shoritng as demeonstrated by the instructor.

6 Connect the test probs across resistor, observe the reading shown by the motor and record it in Table -1.

7 Repeat the above step for all the resistors, and get the work checked by the instructor.

Table 1 (For Resistors measurement)

Sl.No	Label No	Colour	Code given		Tolerance colour	Decoded value in Ω	Multimeter measured value	Result servieeable/ unservieeable
		1st colour brand	2nd colour brand	3rd colour brand				
1								
2								
3								
Print code:			**Calculated value**			**Measured value**		
1								

— — — — — — — —

TASK 2: **Testing and measurement of capacitor uisng multimeter**

> **Note:General purpose multimeters do not measure capacitor value. only very few manufacturers design for capacitance measurement. check your multimeter, whether it has provision for capacitor measurement and proceed.**

1 Pick one of the labelled capacitor observe the printed information, polarity etc; record your observations in Table -2.

2 Repeat the above step for all the labelled capacitors.

3 Select the capcitance measurement range if available in your multimeter, otherwise select ohms range (preferably 1M Ω range).

4 Observing the dial, touch the test probes shorted for a zero display and release them. as shown Fig 1

5 Connect the test probes across one of the capacitors observe the display number changes to increase for charging action for few seconds and remove.

6 Reverse the polarities of probes, connect and observe the display shows the discharge action to ensure the capacitor in good condition (serviceable).

7 Record the observations in the Table for both and get it verified by the instructor.

8 Repeat the steps 5 to 7 for all the labelled capacitors.

> **Note:**
>
> **1 The multimeter does not change display but shows "Zero" means the capacitor is short circuited (Unserviceable)**
>
> **2 The multimeter shows "Infinity" means the capacitor may be servicceable or open circuited, confirm it from your instructor.**

Table 2 (For capacitor measurement)

Sl. No	Label No	Printed information	Voltage rating	Multimeter measured value		Serviceable/ Unserviceable (Good/Shorted/Leaky)
				Value Forward	Reverse	
1						
2						
3						

— — — — — — — — —

TASK 3: **Testing and measurement of inductor using multimeter**

1 Pick one of the labelled inductor, observe any printed information available on it, record your observations in Table 3.

2 Repeat the above step for all the labelled inductors.

3 Select the ohms range in the multimeter check continuity and measure the resistance value of the inductor by connecting the test probes as shown in Fig 1

4 Record the mesured value in Table -3 and repeat the above step for all the labelled inductors (if required change the range suitable)

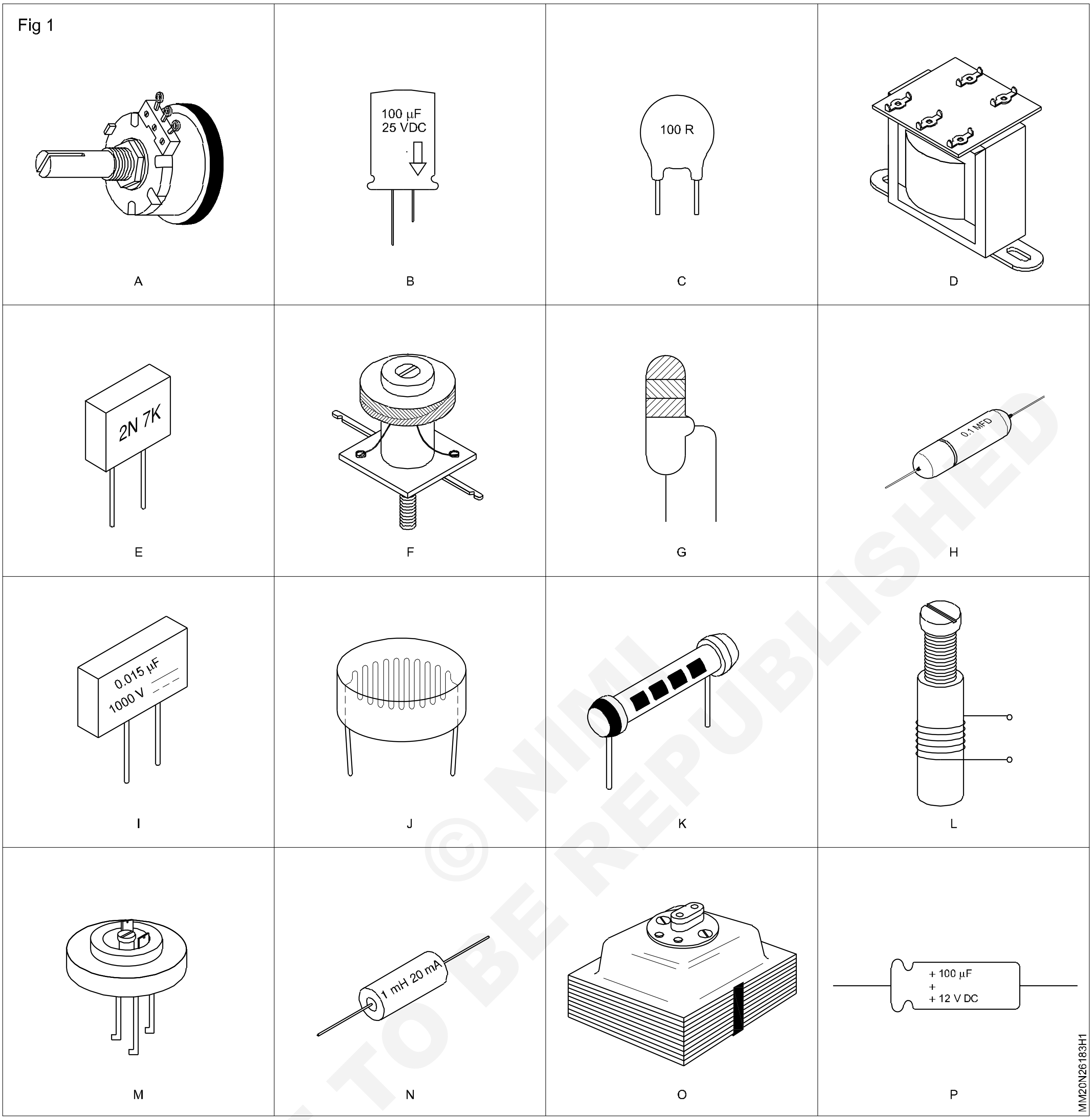
5 Get the workdone checked by the insturctor.

> **Note:**
>
> **1 The multimeter shows a resistance value for good inductor and infinity value for open circuited ones.**
>
> **2 Resistance value depends upon the size and inductance value; confirm it forms your instructor.**

Table 3 (For inductor measurement)

Sl. No	Label No	Printed information	type transformer /Coil type	Multimeter measured value/ continuity	Serviceable/ Unserviceable (Good/Shorted/Leaky)
1					
2					
3					

Fig 1



A
100 µF
25 VDC
B
100 R
C
D
2N 7K
E
F
G
0.1 MFD
H
0.015 µF
1000 V
I
J
K
L
M
1 mH 20 mA
N
O
+ 100 µF
+
+ 12 V DC
P
MM20N26183H1

Perform soldering and desoldering of components on printed circuit board

Objectives : At the end of this exercise you shall be able to
- **mount and solder different types of components on PCB**
- **desolder components from PCB using desoldering pump.**

Requirements

Tools / Equipments / Instruments

- Trainees tool kit - 1 set
- Side cutting pliers 150 mm - 1 No.
- Nose pliers 150 mm - 1 No.
- Soldering iron 25w, 240V - 1 No.
- Desoldering pump - 1 No.
- Tweezer - 1 No.

Materials / Components

- General purpose PCB - 1 No.
- Resin core solder 60/40 - 20 g
- Soldering flux /paste - as reqd
- Capacitor 0.01µF/25V - 4 No.
- Capacitor 4700µF/25V - 1 No.
- Resistor 2.7 kΩ /½ watt - 1 No.
- LED (Light Emitting Diode) 5mm (Red) - 1 No.
- Diode IN4007 - 4 Nos
- Hookup wire (Red,Black colours) - as reqd
- Desoldering wick - as reqd

Note:

1 The instructor has to demonstrate the method of soldering components - step by step.

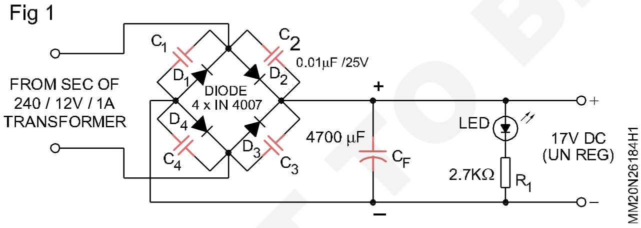
2 Guide the trainees soldering the component on to the PCB.

Job sequence

TASK 1 : **Mount and solder different types of components on PCB**

- Refer to circuit diagram given in Fig 1 and collect the list of components, and quantity required to assemble, and check their good condition.

Fig 1



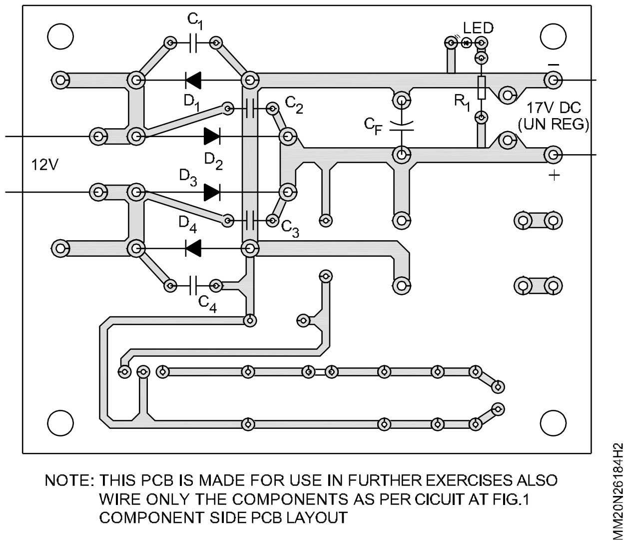
- Clean the leads of component and bend/form the leads using nose plier to fit them in PCB holes/tracks given in Fig 2.
- Clean the solder side pattern of PCB general purpose PCB such that copper tracks look bright and shiny, without damaging the track.

Do not use coarse emery paper for cleaning the tracks of PCB; it may damage a large quantity of copper from the tracks.

Make sure that all the stress relief measures are used while bending component leads.

- Get the bent leads of the components checked by the instructor.

Fig 2



NOTE: THIS PCB IS MADE FOR USE IN FURTHER EXERCISES ALSO
WIRE ONLY THE COMPONENTS AS PER CICUIT AT FIG.1
COMPONENT SIDE PCB LAYOUT

- Switch ON the soldering iron for soldering work; allow it ti heated up to melt the solder wire.
- Insert terminals of each components on the PCB one by one in the order and method given below;.
  - Resistors clinched method
  - Capacitors - Unclinched method
  - Diodes and LEDs clinched method

- Carryout the soldering of each terminal on the PCB as demonstrated by the instructor
- Clean the soldered component leads using a brush to remove excess of flux.
- Get the assembled board checked by the instructor.

— — — — — — — —

TASK 2 : **Desoldering components from PCB using desoldering pump**

- Choose and get the components to be desoldered Identify the solder joints to be desoldered.
- Prepare the soldering iron ready for desoldering work.
- Clean the nozzle of the desoldering pump.
- Push the plunger of pump such that it is ready to suck molten solder.
- Hold the desoldering pump firmly in one hand Position the nozzle of the pump at an angle on one side of the solder joint to be desoldered.
- Place the tip of the heated soldering iron on the solderied point and allow it to melt solder at the joint; hold the tip of the heated soldering iron till the solder melts at the solder joint to be desoldered (around 15 sec).
- Remove the tip of the iron from the joint and quickly release the button of desoldering pump to suck the molten solder.
- Repeat the steps till all the solder at the joint is removed.
- Use tweezer/nose plier and pull out the component from the PCB; get the work checked by the instructor.
- Repeat steps 3 to 9 for all other component lead joints and remove them.

If the solder at the soldered joints are not getting cleared with the desoldering pump, use a piece of desoldering wick and remove the solder completely.

- Remove excess solder on the leads of the desoldered\ components and at the PCB holes.
- Get the work done, checked by the instructor.

— — — — — — — —

Study of rectifiers and testing with multimeter

Objectives : At the end of this exercise you shall be able to
- **identify rectifier diodes and their terminals**
- **test the condition of rectifier using multimeter.**

Requirements

Tools / Equipments / Instruments

- Digital multimeter with probes - 1 set
- Data sheet of diodes, bridge rectifier - 1 No each.

Materials / Components

- Assorted types of rectifiers, diodes - ordinary diodes, SMD types, power rectifiers, and bridge rectifiers modules - 10 Nos

Note:

1 **The instructor has to arrange different types of rectifier diodes in various package styles including bridge rectifier modules with data sheets.**

2 **Label them serially and provide a pictorial chart for identification.**

3 **Demonstration the method of testing the diodes using multimeter and reading the data sheet for specifications of diodes.**

Job sequence

TASK 1: **Identification of rectifier diodes and their terminals**

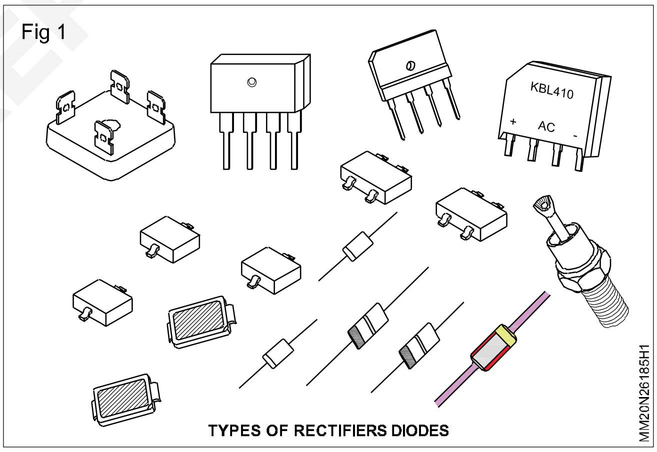
1 Pick one of the labelled diode from the assorted lot; refer to the pictorial chart of types of diodes. identify it and select the data sheet.

2 Identify its anode, cathode terminals the maximum forward current, reverse peak voltage, maximum power etc as required in table 1; record them.

3 Repeat the above steps for all the labelled diodes; similarly for the bridge rectifier modules identify the AC input terminals and DC output terminals. Draw the outline diagram and mark them accordingly.

4 Get the work done checked by the instructor.

Fig 1



TYPES OF RECTIFIERS DIODES

Table 1

Sl. No	Label No.	Code no. of diode	Package style	Max forward current	Peak reverse voltage	Temperature	outline diagram
1							
2							
3							
4							
5							

— — — — — — — —

TASK 2: **Test the condition of rectifier diode using multimeter**

The instructor has to label the different types of diodes used for this exercise

1 Pick one of the labelled diode from the given assorted lot.

2 Set the multimeter to x 100Ω range. Carry out resistance zero setting of the meter. (For analog type meter)

3 Connect the multimeter probes across the diode terminals as shown in the Fig 1a. Record the resistance reading shown by the meter in Tabel 2.

4 Reverse the meter probe connected to the diode as shown in the fig 1b and record the reading shown by the meter in Table - 1.

5 Select the range marked with ⊣▶⊢ (diode symbol) on the DMM and proced steps 3 and 4.

Note:

For good diodes, resistance will be less than 100 in one direction and very high or almost infinity Ω ohms in the other direction.

In most of the cases the ration between low to high resistance would be at 1:1000.

If get zero both ways, the diode is shorted.

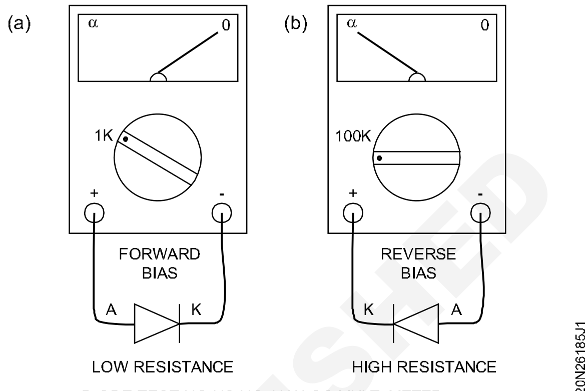
If get infinity both ways, the diode is open

6 Repeat step-3 to step 5 for all the remaining diode and record in Table 1.

7 Observe the markings on the bridge rectifier modules and test the forward and reverse resistance values; record your observartions in Table 3.

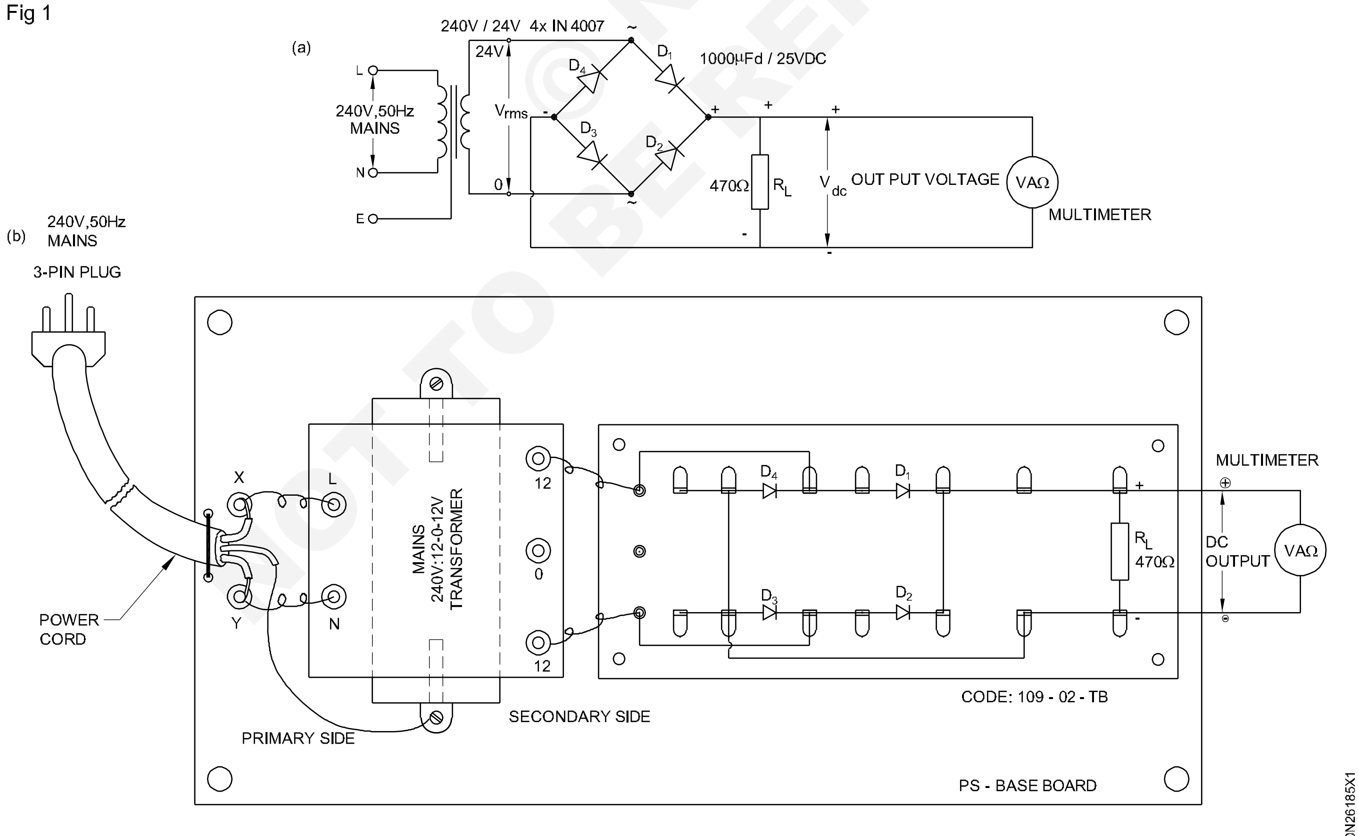
8 Get the work checked by the instructor.

Fig 2



DIODE TESTING USING ANALOG MULTI-METER

Fig 1



NOTE: USE RED HOOK-UP WIRES FOR ALL BOARD WIRING EXCEPT 13 - 16 - 17 - 19

Table 2

Label No.	Code No.of diode	Forward Resistance (FR)	Reverse Resistance (R_R)	Serviceable/ Unserviceable	Remarks
1					
2					
3					
4					

Table 3

Label No.	Code No.of bridge rectifier module	Resistance value between terminals				Remarks
		+ve to N forward	N to + - Reverse	-Ve to N Forward	N to - Reverse	
1						
2						
3						

— — — — — — — —

Construct and test Half-wave, Full wave and Bridge rectifier circuit

Objectives : At the end of this exercise you shall be able to
- **construct and test half-wave rectifier**
- **construct and test a two diode full-wave rectifier**
- **construct and test a full-wave bridge rectifier.**

Requirements

Tools / Equipments / Instruments

- Trainees tool kit - 1 set.
- Oscillioscope 0-30MHz, Dual Trace with probe kit - 1 No.
- Digital Multimeter with probes - 1 No.

Materials / Components

- SPST switch 250v/5A - 1 No.
- Lug Board/PCB - 1 No.
- Semiconductor diode, 1N4007 or equivalent - 1No.
- Step-down Transformer, 240V/12V/500mA - 1 No.
- Centre tapped step-down Transformer, 240V/12-0-12V/500mA - 1 No.
- Mainscord with three pin plug - 1 No.
- resistor, 470/1W - 1 No.
- Hook up wire different colours (Red, black, blue, yellow, green) - 1 m each.

Job sequence

TASK 1: **Construction and testing of Half-wave rectifier**

1 Collect all the required items and to confirm the good condtion of given components.

2 Use lugboard/PCB, construct the Half-wave rectifier as shown in Fig 1.

3 Get the assembled circuit checked by the instructor.

4 Connect AC mains to the transformer and switch ON mains. Measure and record the AC ains supply voltage and transformer secondary AC voltage $V_{S(rms)}$ to the rectifier in the Table -1.

5 Calculate the expected DC voltage V_{dc} across the load resistor R_L using the formula,

$V_{dc} = 0.45\ V_{s(rms)}$

where, $VS_{(rms)}$ is the AC input to the rectifier.

6 Measure and record the rectifier output DC voltage V_{dc} across R_L using multimeter/Voltmeter.

7 Record the difference in the calculated and measured values.

8 Prepare the CRO for measurements and connect the two channel input probes of the CRO. Set the Volt/div and Time/div of CH-1 and CH-2 such that the two wave forms are seen clearly.

9 Measure the displayed wave forms on the screen and record the following parameters;

a) Peak value of source voltage V_s (input volt to rectifier).

b) Frequency of source voltage V_s

c) Peak value of pulsating DC - V_{dc}

d) Frequency of Pulsating DC - V_{dc},

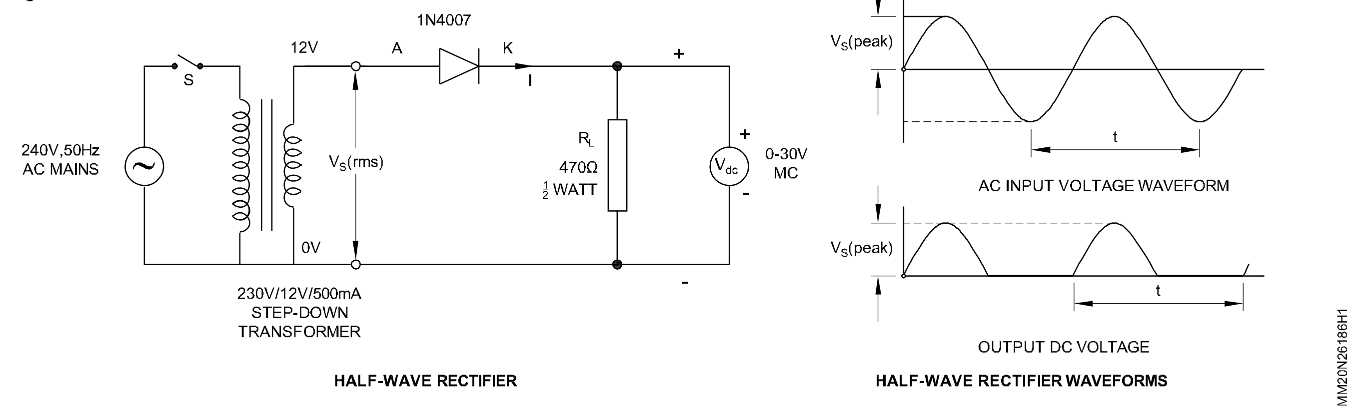
10 Get the work done checked by the instructor.

Table 1

- Type of Transformer:
- Rated primary voltage:
- Rated secondary voltage:

AC Mains Voltage (1)	Secondary voltage $V_{S(rms)}$ (2)	Calculated V_{dc} (3)	Measured V_{dc} (4)	Difference between (3) and (4)	Peak Value V_s	Frequecncy of V_s	Peak Value of pulsa ting V_{dc}	Frequency of pulsating V_{dc}

Fig 1



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TASK 2: **Construction and testing of a two diode full-wave rectifier**

1 Collect all the required items, check and construct the two diode Full-wave rectifier as shown in Fig 1.

2 Get the assembled circuit checked by the instructor.

3 Connect AC mains to the centre tapped transformer and switch ON mains.

4 Measure and record the mains voltage and transformer secondary AC voltage Vs(rms) to the rectifier in the Table-2.

5 Calculate the expected DC voltage Vdc across the load resistor RL using the formula,

Vdc = 0.97VS(rms)

Where VS(rms) is the AC input to the rectifier.

6 Measure and recored the rectifier output DC voltage Vdc across RL using multimeter/voltmeter.

7 Record the difference in the calculated and measured values.

8 Prepare the CRO for measurements and connect the two channel input probes of the CRO. Set the volt/div and Time/div of CH-1 and CH-2 such that the two waveforms are seen clearly.

9 Measure the displayed waveforms on the screen, and record peak value of Source, voltage Vs(Input volt to Rectifier), frequency of source, voltage Vs, Peak value of pulsating DC-Vdc, frequency of pulsating DC - Vdc.

10 Get the workdone checked by the instructor.

Fig 1

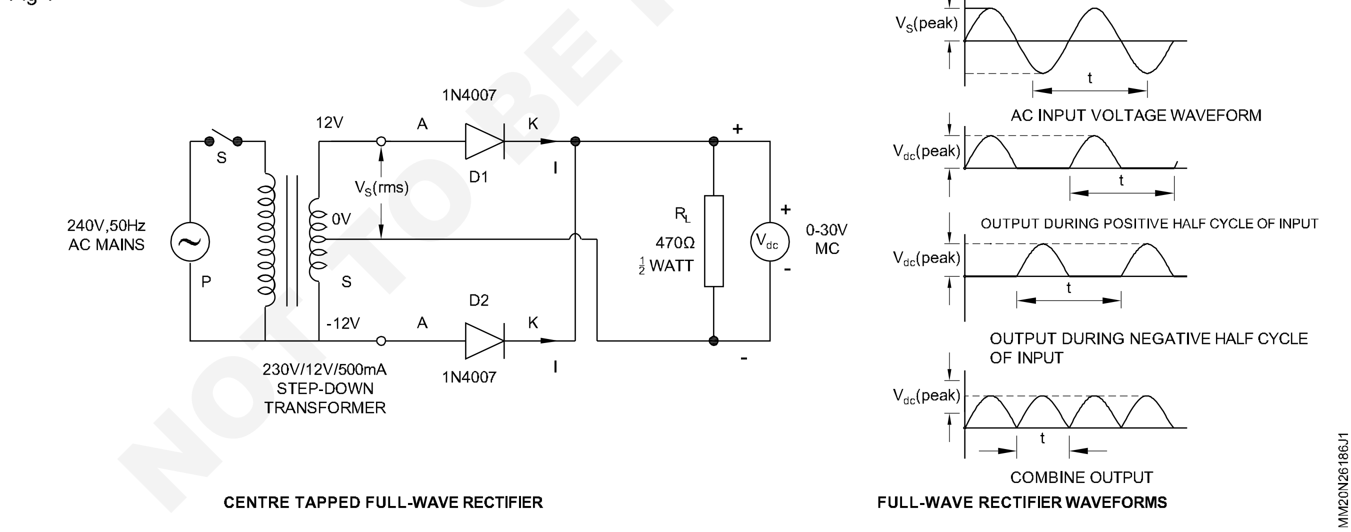


Table 2

- Type of Transformer:
- Rated primary voltage:
- Rated secondary voltage:

Mains Voltage (1)	Secondary voltage $V_{S(rms)}$ (2)	Calculated V_{dc} (3)	Measured V_{dc} (4)	Difference between (3) and (4)	Peak Value V_s	Frequecncy of V_s	Peak Value of pulsa ting V_{dc}	Frequency of pulsating V_{dc}

— — — — — — — —

TASK 3: **Construction and testing of four diode full wave bridge rectifier**

1 Collect all the required items, check and construct the Full-wave bridge rectifier as shown in Fig 1.

2 Get the assembled circuit checked by the instructor.

3 Connect AC mains to Transformer and switch ON mains.

4 Measure and record the mains voltage and transformer secondary AC voltage VS(rms) to the rectifier in the Table-3.

5 Calculate the expected DC voltage Vdc across the load resistor RL using formula,

Vdc = 0.9 VS(rms)

Where, VS(rms) is the AC input to the rectifier.

6 Measure and record the rectifier output DC voltage Vdc across RL using multi-meter/voltmeter.

7 Record the difference in the calculated and measured values.

8 Prepare the CRO for measurements and connect the two channel input probes of the CRO. Set the volt/div and Time/div of CH-1 and CH-2 such that the two waveforms are seen clearly.

9 Measure the displayed waveforms on the screen and record the following parameters;

- Peak value of source voltage Vs (Input volt to rectifeir)
- Frequency of Source Voltage Vs
- Peak value of pulsating DC - Vdc
- Frequency of pulsating DC - Vdc.

10 Get the workdone checked by the instructor.

Fig 1

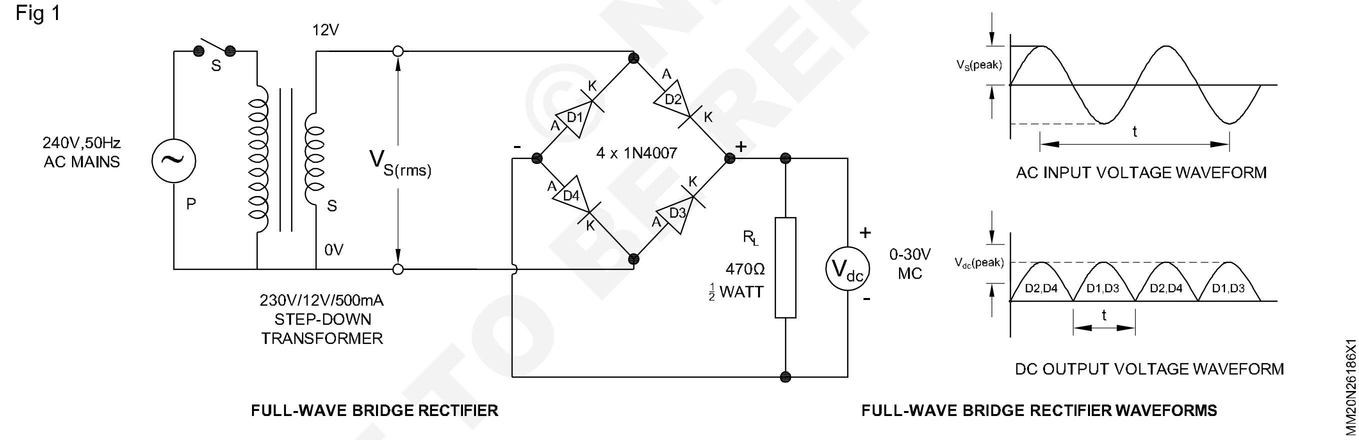


Table 3

- Type of Transformer:
- Rated primary voltage:
- Rated secondary voltage:

Mains Voltage (1)	Secondary voltage $V_{S(rms)}$ (2)	Calculated V_{dc} (3)	Measured V_{dc} (4)	Difference between (3) and (4)	Peak Value V_s	Frequecncy of V_s	Peak Value of pulsa ting V_{dc}	Frequency of pulsating V_{dc}

Demonstration of solid state devices diode and transistor

Objectives : At the end of this exercise you shall be able to
- **identify the diode and its specifications**
- **identify the transistor and its specifications.**

Requirements

Tools / Equipments / Instruments

- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Data sheet of diodes and transistors utilized - as reqd.

Materials / Components

- Transistors - as reqd.

Note:

1 **The instructor has to arrange a minimum of one number in each type of diode and transistor for this exercise.**

2 **Guide the trainees to refer to the data sheet of the diode/transistor and read the important parameters given by the manufacturer.**

3 **Provide the pictorial chart of diodes shown in Fig 1 and direct trainees to refer the Ex.No 2.6.185 for identification and testing of diodes.**

4 **In case analog type multimeter is used, guide the trainees to test transistor as per the diagram shown in fig 2, otherwise to follow steps uisng DMM as per Fig 3.**

Job sequence

TASK 1: **Identification of transistor by different package type, pin configuration, power rating, type transistor**

1 Pick one of the Labelled transistors from given assorted lot, identify the code number, and record them in Table-1.

2 Refer to the Chart 1 semiconductor data sheet, identify the type of package, all other details as required in Table 1 and record them.

3 Repeat the above for all the labelled transistors and record your observations.

4 Get the work done checked by the instructor.

Fig 1

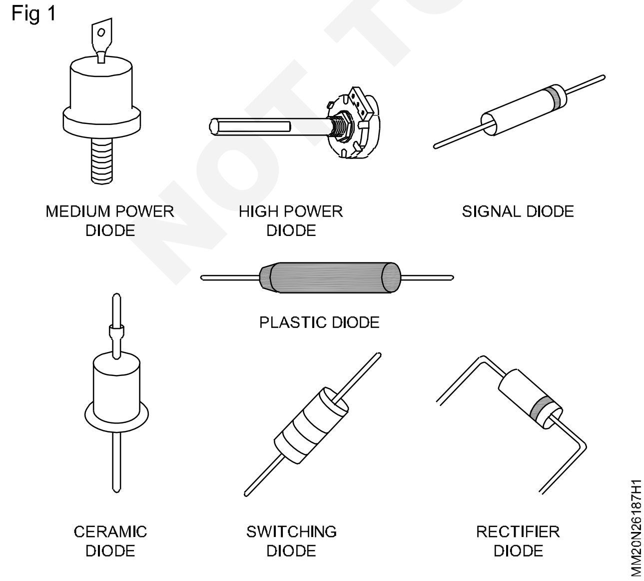


Fig 2

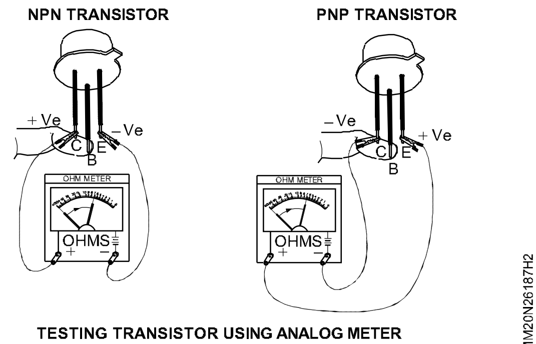
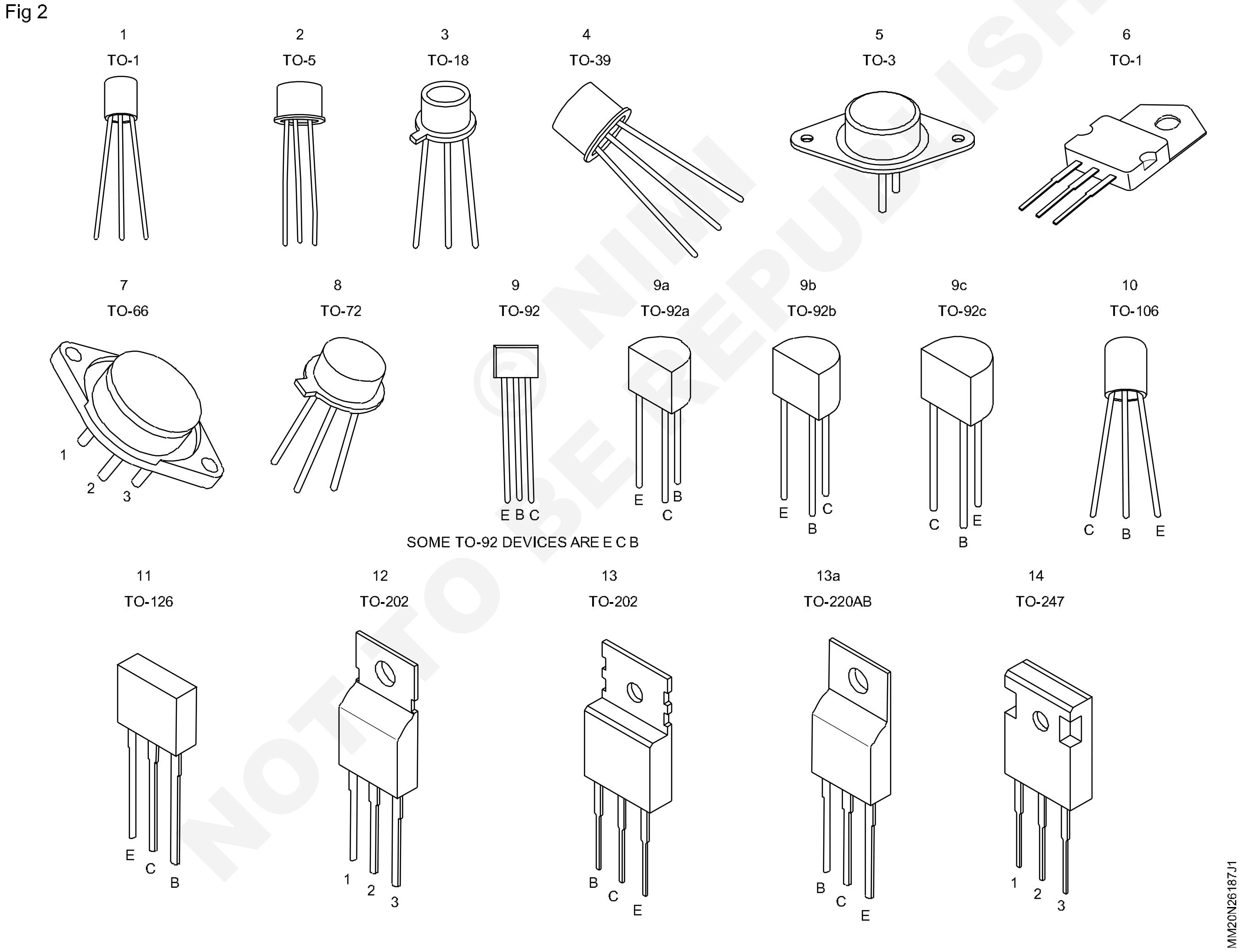


Table 1

Sl.No.	Label No	Transistor code number	Transistor package type	Package diagram with pin description	Current & Voltage		Power rating	Suitable Heatsink type
					Current rating	Voltage rating		
1								
2								
3								
4								
5								
6								
7								
8								
9								

Fig 2



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TASK 2: **Testing the condition of transistor using digital multimeter (DMM)**

1 Pick one of the labelled transistor from the given lot, enter its number in Table -2.

2 Identify the transistor package, pin configuration of terminals collector, Base, Emitter; verify with the data sheet also.

3 Connect the crocodile clip probe to the DMM and set the selector, switch to the diode testing position/range.

4 Connect the positive test probe of the DMM to the Base (B) terminal and the negative probe to the Emitter (E) of the transistor as shown in Fig 1.

For a good NPN transistor, the meter should show between 0.45V to 0.9V and for a PNP transistor, the meter should show " OL" (Over Limit) means infinity.

5 Observe the reading displayed on the DMM, record the value in Table -2.

6 Keep the positive probe at Base and connect the negative probe to the collector (C) terminal, observe the reading on the DMM, record it in Table 2.

For a good NPN transistor the meter should show between 0.45 to 0.9V and for a PNP thpe transistor, the meter should show "OL" (Over Limit) means infinity.

7 Repeat steps 4,5 and 6 with reversed polarities of DMM and record those readings in Table 2.

8 Connect the positive probe to the emitter terminal and negative probe to the collector(C) of transistor as shown in Fig 1. Record the observations in Table 2.

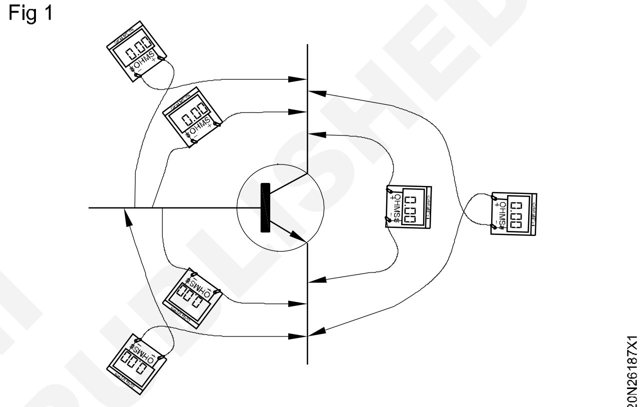
9 Repeat step 8 with reversed polarities of DMM.

10 Carry out steps 4 to 9 for all the remaining labelled transistors and record readings in Table 2.

Note: Compare the resistance values recorded in forward and reverse directions between B-E, B-C and E-C terminals.

Conclude the condition of tested transistor is defective/unservicable if the resistance value is same on both directions for resistance value in both directions otherwise, the transistor is good/serviceable.

Fig 1



TESTING TRANSISTOR USING DMM

Table 2

Sl.No.	Label No	Code no. of transistor	Package type	Forward/ Reverse	Measured resistance between B-E	B-C	E-C	Remarks
1				Forward				
2				Reverse				
3				Forward				
4				Reverse				
5				Forward				
6				Reverse				
7				Forward				
8				Reverse				
9				Forward				
10				Reverse				

11 Get the word done checked by the instructor.

— — — — — — — —

SCR and IC's identification and testing

Objectives : At the end of this exercise you shall be able to
- **identify SCR and test using multimeter**
- **identify and test.**

Requirements

Tools / Equipments / Instruments
- Trainees tool kit - 1 No.

Equipments / Instruments
- Digital multimeter with probes - 1 No
- Digital IC tester - 1 No.
- Data sheet of SCRs and ICs used - as reqd.

Materials / Components
- Assorted types of SCR - as reqd.
- Assorted types of IC's - as reqd.

Note:

1 The instructor has to label the SCRs and ICs used for this exercise.

2 Guide the trainees to refer to the data sheet of the SCR parameters.

3 Demonstrate the use of IC tester for this exercise to trainees.

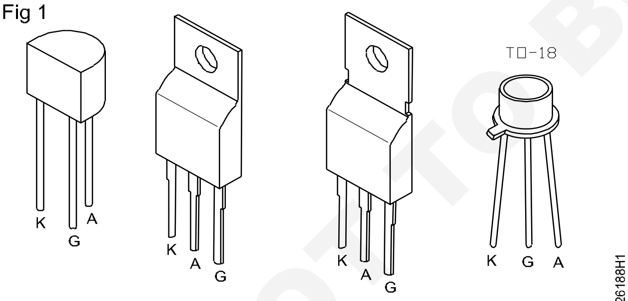
Job sequence

TASK 1: **Identification of SCR and testing**

1 Collect the components from the instructor and pick one of the labelled SCR from the assorted lot, note down the SCR label number and its code number printed on the SCR in Table 1.

2 Draw the package/pinout diagram of SCR identify the anode cathode and gate terminals of SCR referring to the data manual, and record the specifications in Table 1.

Fig 1



DIFFERENT PACKAGES OF SILICON CONTROLLED RECTIFIERS

3 Select ohms range on multimeter connect the test probes across the anode and cathode of SCR as shown in Fig 2 and note down the reading shown by the meter in Table -1.

4 Use a jumper, connect in momentarily across the anode and gate; observe the reading and record it.

In some power SCRs, the metal case itself will act as anode. Mark "A' on the case using a pencil or put a RED colour dot using colour marker pen.

5 Repeat above stepes for remaining labelled SCRs from the assorted lot.

6 Get the work done checked by the instructor.

Fig 2

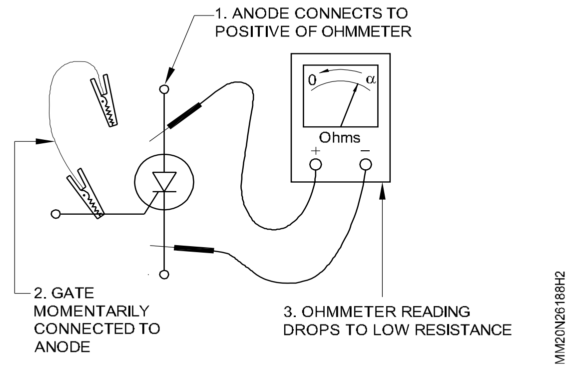


Table -1

Sl. No	Label No.	Package/ Pin out diagram	Code number of SCR	V_{rrm}	$IT_{(rms)}$	I_{tsm}	I_{gt}	V_{gt}	I_h	Resistance across anode to cathode		Result serviceable /Unserviceable
										Gate open	Gate Connected	

TASK 2: **Identification and testing of given IC by its code number**

Note: the instructor has to label all the IFs serially.

Keep a minimum of 10 numbers of assorted labeled TTL and CMOS ICs for this exercise. Instruct the trainees to pick one IC at a time and carryout the exercise.

Demonstrate setting the controls and testing ICs using digital IC tester. No detailed procedure for using IC tester is given as different IC testers used in different institures may have different operating procedure and specification.

1 Identify operator controls, switches and IC socket on the digital IC tester as shown in Fig 1 with reference to the instruction manual.

2 Pick one of the labeled IC from the assorted lot and record its label number.

3 Refer to the data manual interpret the manufacturer's logo given on the IC or alphabets used for the IC type identify and record the details in Table 1.

4 Identify and record the logic family supply voltage and function of the IC referring the data manual.

5 Count and record the number of pins on the IC Fig 2.

6 As demonstrated by the instructor, test and record the condition of the IC using digital IC using digital IC tester for atleast 10 different ICs both in TTL and CMOS types.

Note: Follow the procedure demonstrated by the instructor for setting the controls on digital IC tester while testing the IC.

7 Get the recorded information checked by the instructor for 10 different ICs.

Fig 1

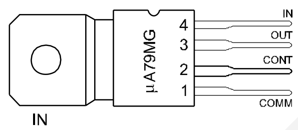


Fig 2

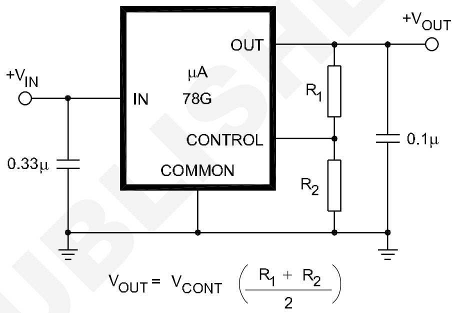
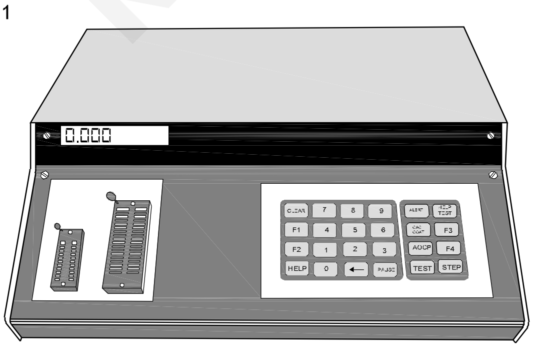


TABLE 1

Sl. No.	Label No. IC	Code No. of IC	No.of pins	Logic family	Function	Package type	Maximum V_{CC} voltage	Condion of IC tested
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Fig 1



DIGITAL IC TESTER

Assemble a simple battery eliminator circuit using bridge rectifier & filter capacitor

Objectives : At the end of this exercise you shall be able to
- **assemble a battery eliminator ranging from 1.5V to 12V at 500 mA**
- **connect the filter capacitor and test the elimintor circuit.**

Requirements

Tools / Equipments / Instruments

- Trainees tool kit - 1 Set.
- Connector screw driver 150mm - 1 No.
- Neon tester 500V - 1 No.
- Digital multimeter with probes - 1 No.
- soldering iron 25W, 240V - 1 No.

Materials / Components

- Transormer 240V/1.5V - 12V, 500mA - 1 No.
- Diodes 1N4001/4007 - 4 Nos.
- Capacitor 1000 mFd, 25V - 2 Nos.
- Resitor 1W /5W - 1 No.
- Resitro 470W / 1W, 1KW/ 1/2W - 1 No.
- LEd 5 mm (Red) - 1 No.
- Connecting wires - as reqd.
- Selector switch 1 pole 7 ways - 1 No.
- Tag Board/General purpose PCB - 1No.
- Resin cored solder 60/40 - as reqd.
- Chassis - 1 No.
- Screws/nut and bolt - 1 No.
- Mains cord (Two core) - 1 No.
- SPST/5A switch - 1 No.

Note: the instructor has to guide the trainees to check and identify different tappings on the secondary side of the transformer used.

Job sequence

TASK 1: **Assembling a battery eliminator ranging from 1.5V to 12V at 500 mA**

Verify the number of tappings in secondary winding. Start from common terminal and arrange the windings in steps of 1.5Volt upto 9 volt tappings on the rotary selector switch. Connect the 12V tap at the next contact.

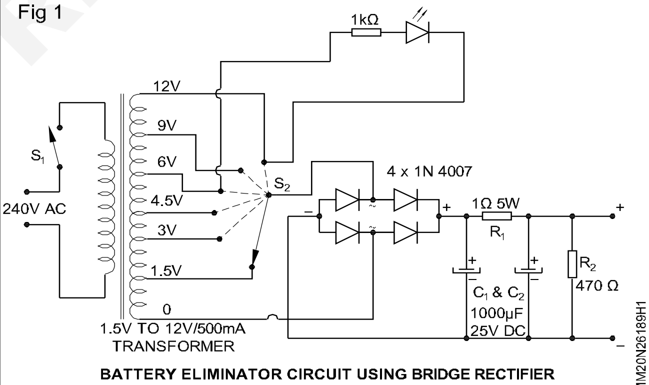
1 Collect and check all the components for its good working condition before mounting/assembling.

2 Connect the primry of transformation to AC mains supply and measure output voltages.

3 Checkand identify the secondary windings in sequential order; solder each one on the rotary selector swtich terminals.

- Connect all other components as per the circuit diagram shown in fig 1.
- Connect the mains cord to the A/C supply and switch ON.
- Rotate the selector switch S2 from 1.5V to 12V AC position.
- Measure the secondary AC voltage, output DC voltage with multimeter and record the readings, in Table 1 for each position of the selector switch.
- Get the work done, checked by the instructor.

Fig 1



BATTERY ELIMINATOR CIRCUIT USING BRIDGE RECTIFIER

TABLE 1

Sl No.	Selection switch(S1) position (AC Volt)	DC output reading
1	0 - 1.5V AC	.... DC
2	0 - 3V AC	.... DC
3	0 - 4.5V AC	.... DC
4	0 - 6V AC	.... DC
5	0 - 9V AC	.... DC
6	0 - 12V AC	.... DC

Ascertain various modules, Controls and Indicators of given PLC

Objectives : At the end of this exercise you shall be able to
- **identify the make, model numbered product code of given PLC**
- **refer to the manufacturer's reference manual and interpret the terminals, controls and indicators of given PLC.**

Requirements

Equipment/Machines

- "PLC - Nano type along with the manufacturer's reference manual - 1 No.
- **"Visual aid:** Chart showing parts identification with serial numbers. - 1 No.

Note:

1 **The instructor has to prepare a chart showing the PLC utilized for this experiment with input , Output terminals, indicators by serially numbering as Label numbers**

2 **Provide the manufacturer's reference along with the PLC to the trainees.**

Job sequence

1 Collect the PLC and its manufacturer's reference manual.

2 Observe the make, model number and product code of the PLC; note down them in Table-1.

3 Start from label no.1, identify the name of the terminal; refer to the Reference manual and record your observations in the Table.

4 Repeat the above step for all the label numbers marked.

Table-1

PLC make:	Model no.		Product Code:
Sl. No.	**Name of the terminal**	**Label no.**	**Markings on the PLC**
1	Supply terminal		
2	Power ON indicator		
3	Digital Inputs		
4	Digital outputs		
5	Communication terminal for relay output		
6	Analog Inputs		
7	Analog outputs		
8	RS-485 Communication terminal		
9	Communication Status indicator		
10	Fault status indicator		
11	Indicators for RUN		
12	Indicators for Program		
13	Indicators for STOP		
14			

5 Get the work checked by the Instructor.

Program and configure the PLC to perform a simple start/stop routine

Objectives : At the end of this exercise you shall be able to
- **use the basic, bitwise instructions of the PLC programming**
- **apply the ladder logic concepts in programming for simple start/stop routing.**

Requirements

Tools/Equipment/Instruments

- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Desktop PC system or Laptop (PLC software pre-installed) - 1 No.
- Communication cable - 1 No.

Aids: PLC reference manual

Materials/Components

- PUSH Button Switches N/O,5Amp - 2 Nos.
- Buzzer 24 V DC - 1 No.
- jumper wires - as reqd.

Note:

1. The instructor has to refer to the reference manual of the PLC available in the Lab.

2. Modify the steps and procedures if required, make the modifications accordingly.

Job sequence

1 Collect PLC and all other required items, check and ensure that they are in good condition.

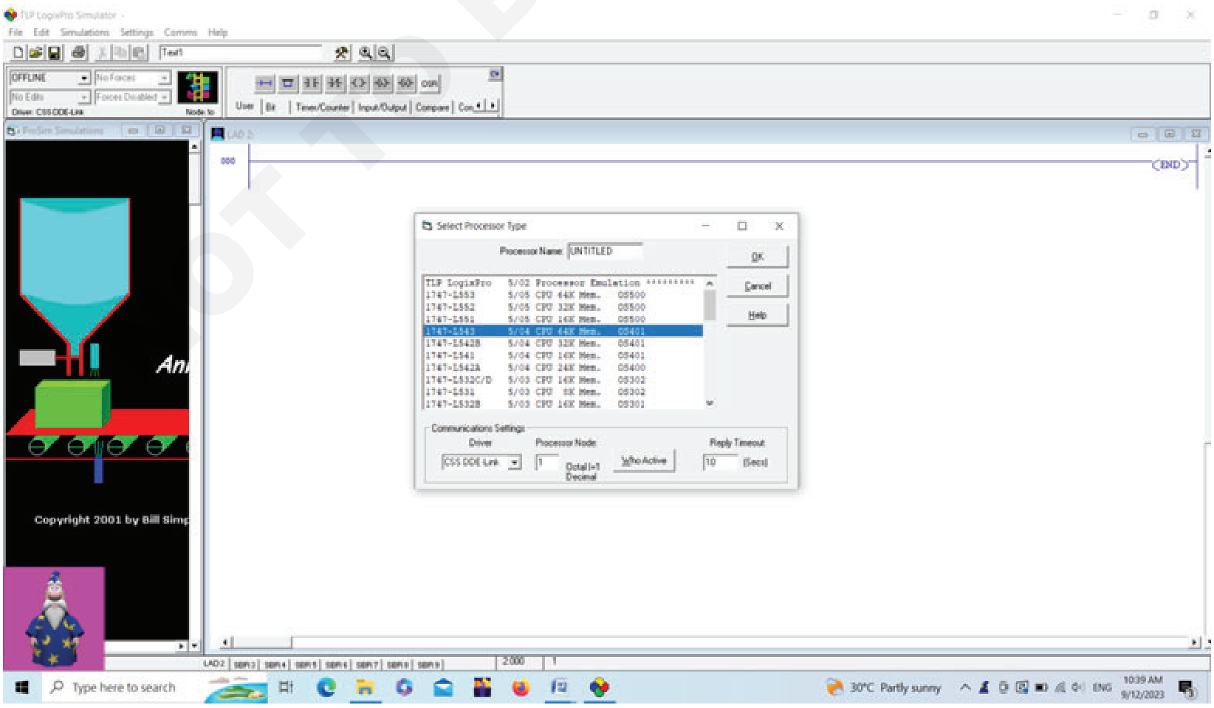
2 Switch ON the computer, and open the pre-loaded PLC software by clicking the shortcut icon on the desktop.

3 Open the FILE menu, in the opening window, enter the project name, controller type and PLC type.

4 Refer to the PLC reference manual and nameplate details for the controller type and PLC type the information in the window as shown in Fig 1 and click OK.

5 On the left side of the project window find the programme menu and right click over it. Select NEW option, type the program name in the window and select your language as Ladder diagram and click OK as shown in Fig 1.

Fig 1



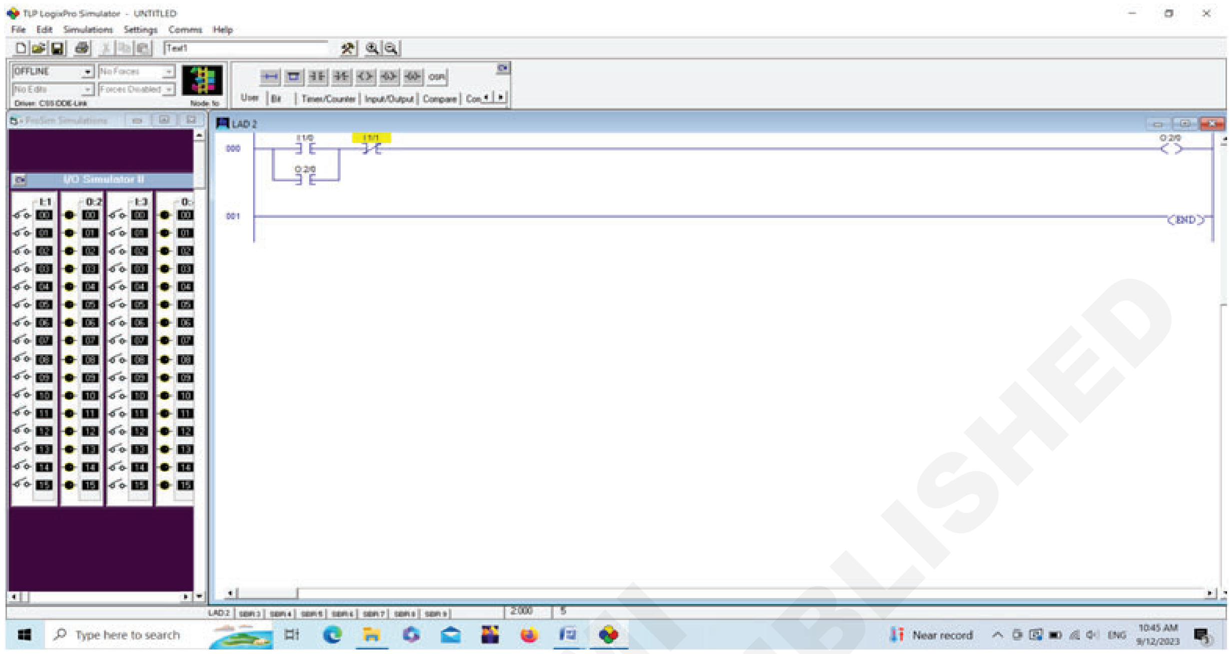
6 Move the cursor over the TOOL BAR and select CONTACT icon; click over the program area and observe the default ladder line.

7 Click on the Contact and click on the existing ladder line twice and get two contacts.

8 Select the coil on the tool bar and click over the ladder line and get one coil as shown in Fig 2.

9 Select the ARROW TOOL from the tool bar and double click over the any one of the contacts and select the options NC/NO from the drop down menu.

Fig 2



10. Click over the question mark (?....???)over the elements on the ladder line; and type address for each element as I:1/0, I:1/1,and O:2/0.

Note: The terminology of address may vary with the PLC manufacturers which can be confirmed from the reference manual.

11 Get the ladder logic program and address checked by the instructor.

12 Move the cursor over the tool menu, select COMPILE tool and click compile option.

13 Observe the OUTPUT window in Fig 3.

14 Read the error message, move the cursor over it and rectify the error.

15 Follow the3 steps 13 and 14, till the error message becomes ZERO.

16 Click the DOWNLOAD button and transfer the ladder logic program to the PLC.

17 Connect the buzzer, and switches to the PLC according to the address lines as per the circuit diagram shown in Fig 3.

18 Get the circuit connections verified by the Instructor.

19 Set the PLC into RUN mode by clicking the run command.

20 Push the start switch and observe the sound from the buzzer.

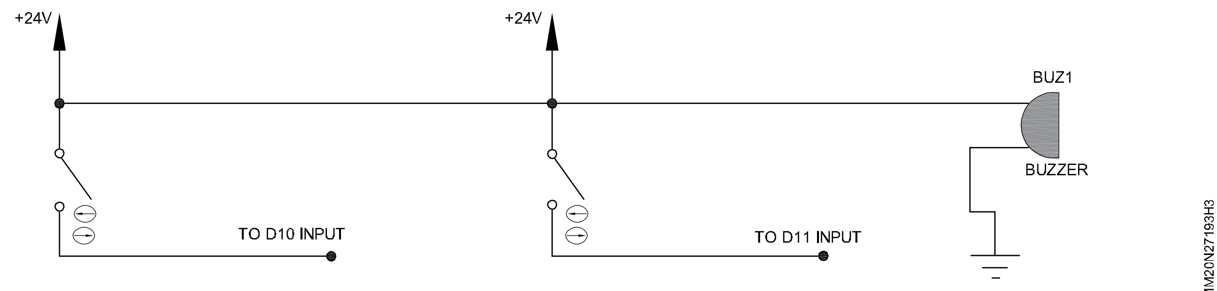
21 Push the stop switch and observe the sound from the buzzer stops.

22 Record your observations in Table-1 and get the work checked by the instructor.

Table 1

Start Switch	Stop Switch	Buzzer
OFF	OFF	
ON	OFF	
OFF	ON	

Fig 3



Program the PLC to perform timer/counter instructions

Objectives : At the end of this exercise you shall be able to
- **use the basic, bitwise instructions of the PLC programming**
- **apply the ladder logic concepts in programming for simple start/stop routing.**

Requirements

Tools/Equipment/Instruments

- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Desktop PC system or Laptop (PLC software pre-installed) - 1 No.
- Communication cable - 1 No.

Aids: PLC referencemanual

Materials/Components

- PUSH Button Switches N/O,5Amp - 2 Nos.
- Buzzer 24 V DC - 1 No.
- jumper wires - as reqd.

Note:

1 The instructor has to refer to the reference manual of the PLC available in the Lab.

2 Modify the steps and procedures if required, make the modifications accordingly.

Job sequence

TASK 1

1 Collect PLC and all other required items, check and ensure that they are in good condition.

2 Switch ON the computer, and open the pre-loaded PLC software by clicking the shortcut icon on the desktop.

3 Open the FILE menu, in the opening window, enter the project name, controller type and PLC type.

4 Refer to the PLC reference manual and nameplate details for the controller type and PLC type the information in the window as shown in **Fig-1of EXNO.193** and click OK.

5 On the left side of the project window find the programme menu and right click over it. Select **NEW** option, type the program name in the window.

6 Move the cursor over the **TOOL BAR** and select **CONTACT** icon; click over the program area and observe the default ladder line.

7 Click on the Contact and click on the existing ladder line and a TON BLOCK .

8 Select the coil on the tool bar and click over the ladder line and get one coil as shown in Fig 1.

9 Click over the question mark (?....???) over the elements on the ladder line; and type address for each element as I:1/0, I:1/1,and O:2/0 and for timer T4:0.

10 Click the **PRESET** value on the timer block PRE and enter a value in decimal e.g 50.

Note: The terminology of address may vary with the PLC manufacturers which can be confirmed from the reference manual.

11 Get the ladder logic program and address checked by the instructor.

12 Move the cursor over the tool menu, select COMPILE tool and click compile option.

13 Read the error message, move the cursor over it and rectify the error.

14 Follow the3 steps 13 and 14, till the error message becomes ZERO.

15 Click the DOWNLOAD button and transfer the ladder logic program to the PLC.

16 Connect the buzzer, and switches to the PLC according to the address lines as per the circuit diagram shown in Fig 2.

Fig 1

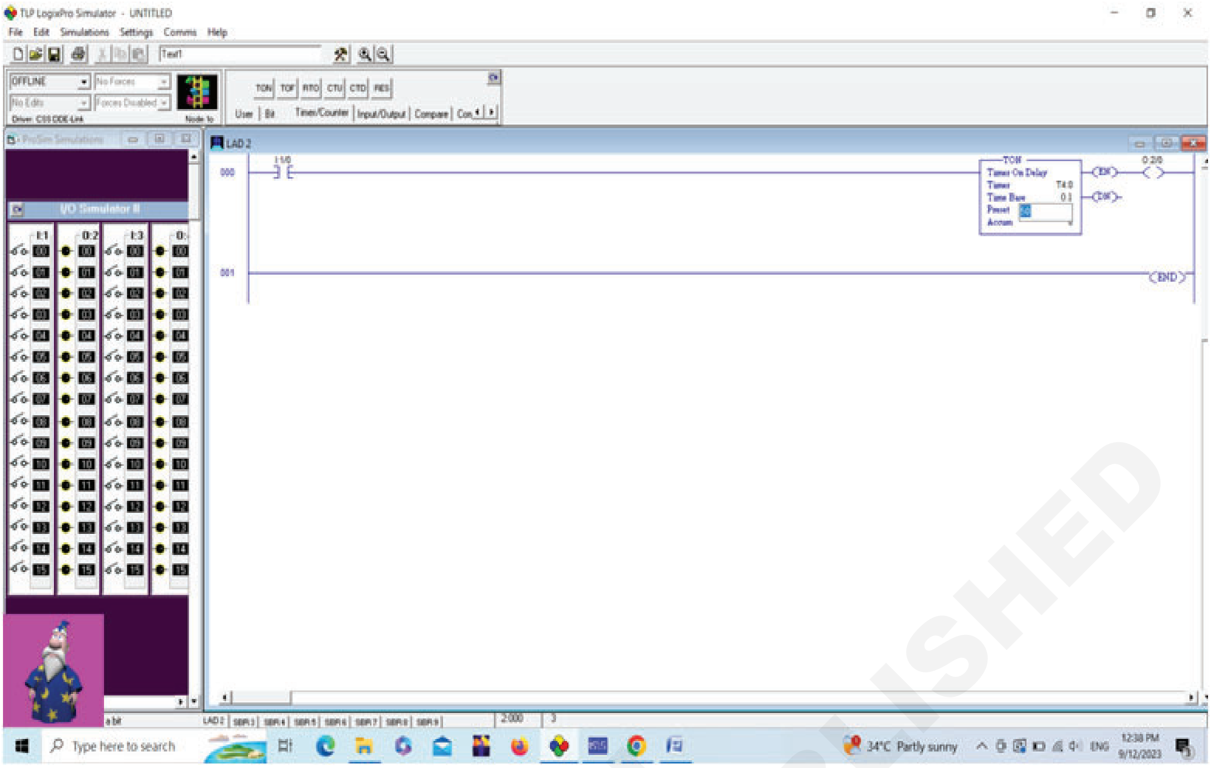
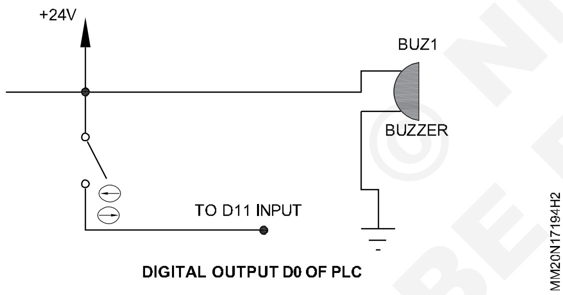


Fig 2



17 Get the circuit connections verified by the Instructor.

18 Set the PLC into RUN mode by clicking the run command.

19 Push the start switch and observe the sound from the buzzer.

20 Push the stop switch and observe the sound from the buzzer stops.

21 Record your observations in Table-1 and get the work checked by the instructor.

Table 1

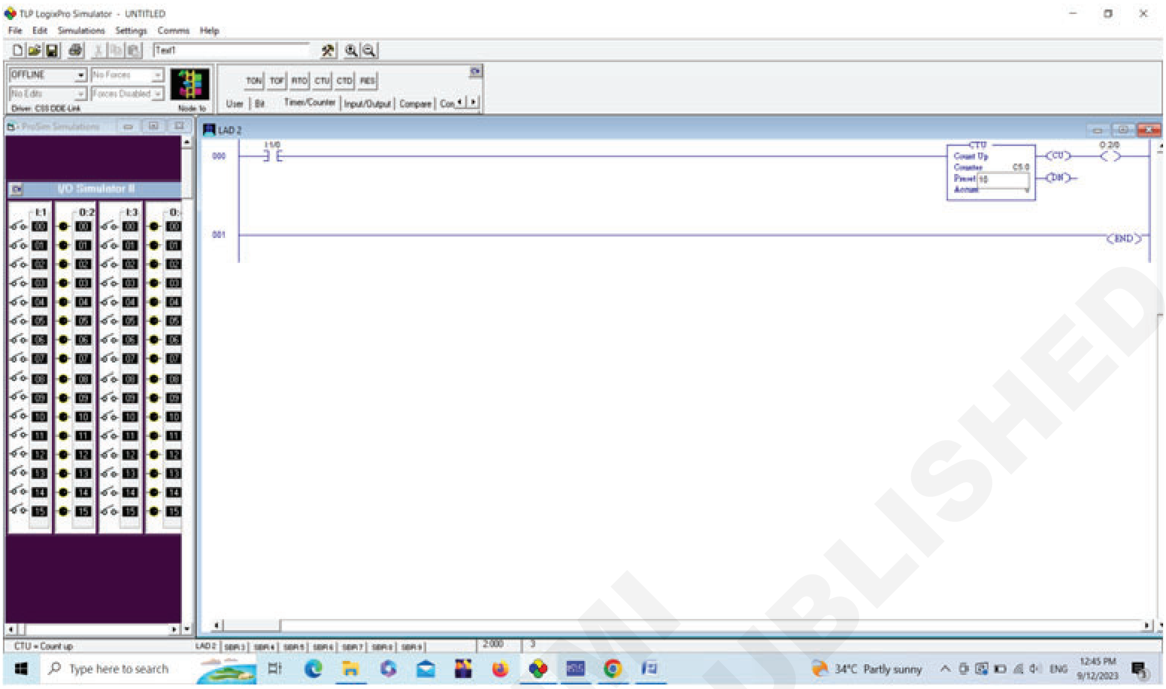
Start switch	Preset value	Buzzer delay

— — — — — — — —

TASK 2

1 Delete the Timer block and add CTU(Counter UP) in the ladder diagram as shown in Fig 3. CTU address should be C5:0, and preset value will be 10 or as u desired.

Fig 3



2 Compile and down load to PLC

3 Make and count the No. ON/OFF (toggle) the switch

4 When the No. of ON/OFF equal to the preset value then the coil will be energized; which further can be used for other applications

5 Record your reading in the Table 2.

Table 2

No.of ON/OFF	Preset	ACC	Coil status

— — — — — — — —

Program and configure the PLC to perform move, arithmetic and logical instructions

Objectives : At the end of this exercise you shall be able to
- **use the move instructions of the PLC programming**
- **use the arithmatic instructions of the PLC programming**
- **use the logical instructions of the PLC programming.**

Requirements

Tools/Equipment/Instruments

- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Desktop PC system or Laptop (PLC software pre-installed) - 1 No.
- Communication cable - 1 No.

Aids: PLC referencemanual

Materials/Components

- PUSH Button Switches N/O,5Amp - 2 Nos.
- Buzzer 24 V DC - 1 No.
- jumper wires - as reqd.

Note:

1 The instructor has to refer to the reference manual of the PLC available in the Lab.

2 Modify the steps and procedures if required, make the modifications accordingly.

Job sequence

TASK 1: **Move operation**

1 Collect PLC and all other required items, check and ensure that they are in good condition.

2 Switch ON the computer, and open the pre-loaded PLC software by clicking the shortcut icon on the desktop.

3 Open the **FILE** menu, in the opening window, enter the project name, controller type and PLC type.

4 Refer to the PLC reference manual and nameplate details for the controller type and PLC type the information in the window as shown in Fig-1 of ex 193 and click OK.

5 On the left side of the project window find the programme menu and right click over it. Select **NEW** option, type the program name in the window.

6 Move the cursor over the **TOOL BAR** and select **MOVE icon;** click over the program area and observe the default ladder line.

7 Specify the source address and destination address (Source may be a value/data, destination may be a register,output register, timer/counter preset value)

8 Select the coil, and a contact on the tool bar and click over the ladder line Fig -1.

Note: The terminology of address may vary with the PLC manufacturers which can be confirmed from the reference manual.

9 Get the ladder logic program and address checked by the instructor.

10 Move the cursor over the tool menu, select **COMPILE** tool and click compile option.

11 Observe the OUTPUT window located at the left hand bottom of the window.

12 Read the error message, move the cursor over it and rectify the error.

13 Follow the3 steps 13 and 14, till the error message becomes ZERO.

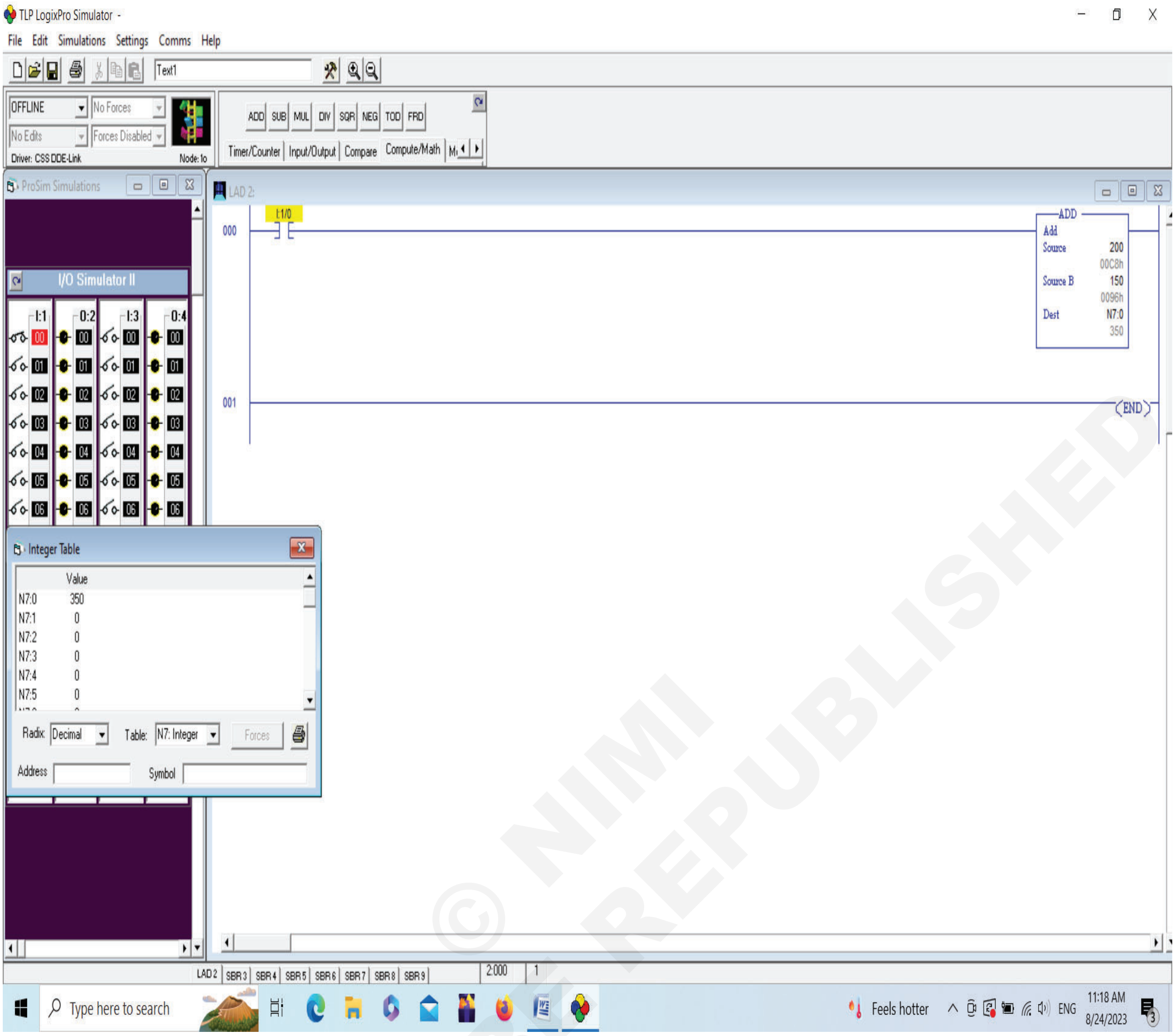
14 Click the **DOWNLOAD** button and transfer the ladder logic program to the PLC.

Get the circuit connections verified by the Instructor.

15 Set the PLC into **RUN** mode by clicking the run command.

16 Push the start switch and observe the data moved to the destination address.

Fig 1



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TASK 2: **Arithmatic operation**

1 Select the ADD command, a CONTACT from the tool bar

2 Place these elements as shown in fig-2.

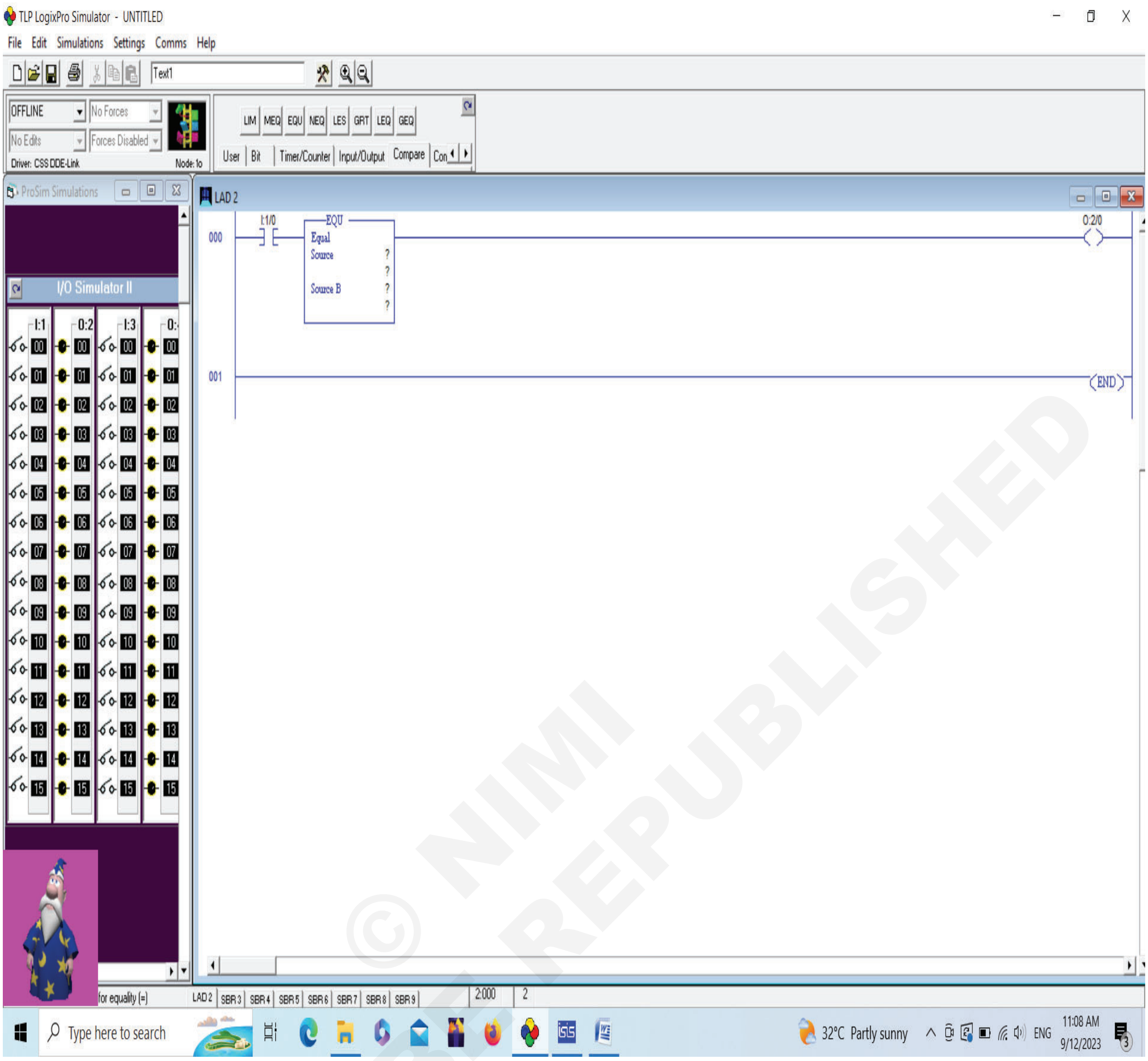
3 Enter the source A and Source B address, they may a data also. Give the address of the destination it may output register(O2:0 or Input register I1:0 or the N7:0 integer register.

4 Repeat the steps 10- 15 and observe the result.

5 When the contact is enabled PLC execute the Function

6 Same way you can verify the SUB (subtraction), MUL(multiplication),DIV(division), SQR(square root) functions.

Fig 2



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TASK 3: **Logical operation**

1 Select the AND command, a CONTACT from the tool bar

2 Place these elements as shown in fig.

3 Enter the source A and Source B address, they may a data also. Give the address of the destination it may output register(O2:0 or Input register I1:0 or the N7:0 integer register.

4 Repeat the steps 10- 15 and observe the result.

5 When the contact is enabled PLC execute the Function

6 Same way you can verify the OR (Logical OR), AND(Logical AND);XOR functions.

Program and configure the PLC to perform compare instructions

Objective : At the end of this exercise you shall be able to
• compare instructions of the PLC programming.

Requirements

Tools/Equipment/Instruments

• Trainees tool kit	- 1 Set.
• Digital multimeter with probes	- 1 No.
• Desktop PC system or Laptop (PLC software pre-installed)	- 1 No.
• Communication cable	- 1 No.

Aids: PLC reference manual

Materials/Components

• PUSH Button Switches N/O,5Amp	- 2 Nos.
• Buzzer 24 V DC	- 1 No.
• jumper wires	- as reqd.

Note:

1 The instructor has to refer to the reference manual of the PLC available in the Lab.

2 Modify the steps and procedures if required, make the modifications accordingly.

Job sequence

1 Collect PLC and all other required items, check and ensure that they are in good condition.

2 Switch ON the computer, and open the pre-loaded PLC software by clicking the shortcut icon on the desktop.

3 Open the FILE menu, in the opening window, enter the project name, controller type and PLC type.

4 Refer to the PLC reference manual and nameplate details for the controller type and PLC type the information in the window as shown in Fig-1of exno.193 and click OK.

5 On the left side of the project window find the programme menu and right click over it. Select NEW option, type the program name in the window .

6 Move the cursor over the TOOL BAR and select EQU icon; click over the program area and observe the default ladder line.

7 Specify the source address and destination address (Source may be a value/data, Source B may be a register, data)

8 Select the coil, and a contact on the tool bar and click over the ladder line Fig -1.

Note: The terminology of address may vary with the PLC manufacturers which can be confirmed from the reference manual.

9 Get the ladder logic program and address checked by the instructor.

10 Move the cursor over the tool menu, select COMPILE tool and click compile option.

11 Observe the OUTPUT window located at the left hand bottom of the window.

12 Read the error message, move the cursor over it and rectify the error.

13 Follow the3 steps 13 and 14, till the error message becomes ZERO.

14 Click the DOWNLOAD button and transfer the ladder logic program to the PLC.

Get the circuit connections verified by the Instructor.

15 Set the PLC into RUN mode by clicking the run command.

16 If source and Source B values are Equal then the it energize the coil otherwise the coil is in logical zero condition

17 Record your observations in Table-1 and get the work checked by the instructor.

Same way verify the NEQU(NOT Equal to), LES(less than) GRT(greater than)LEQ(less than equal to)GEQ(GREATER THAN EQUAL TO) Functions.

Fig 1

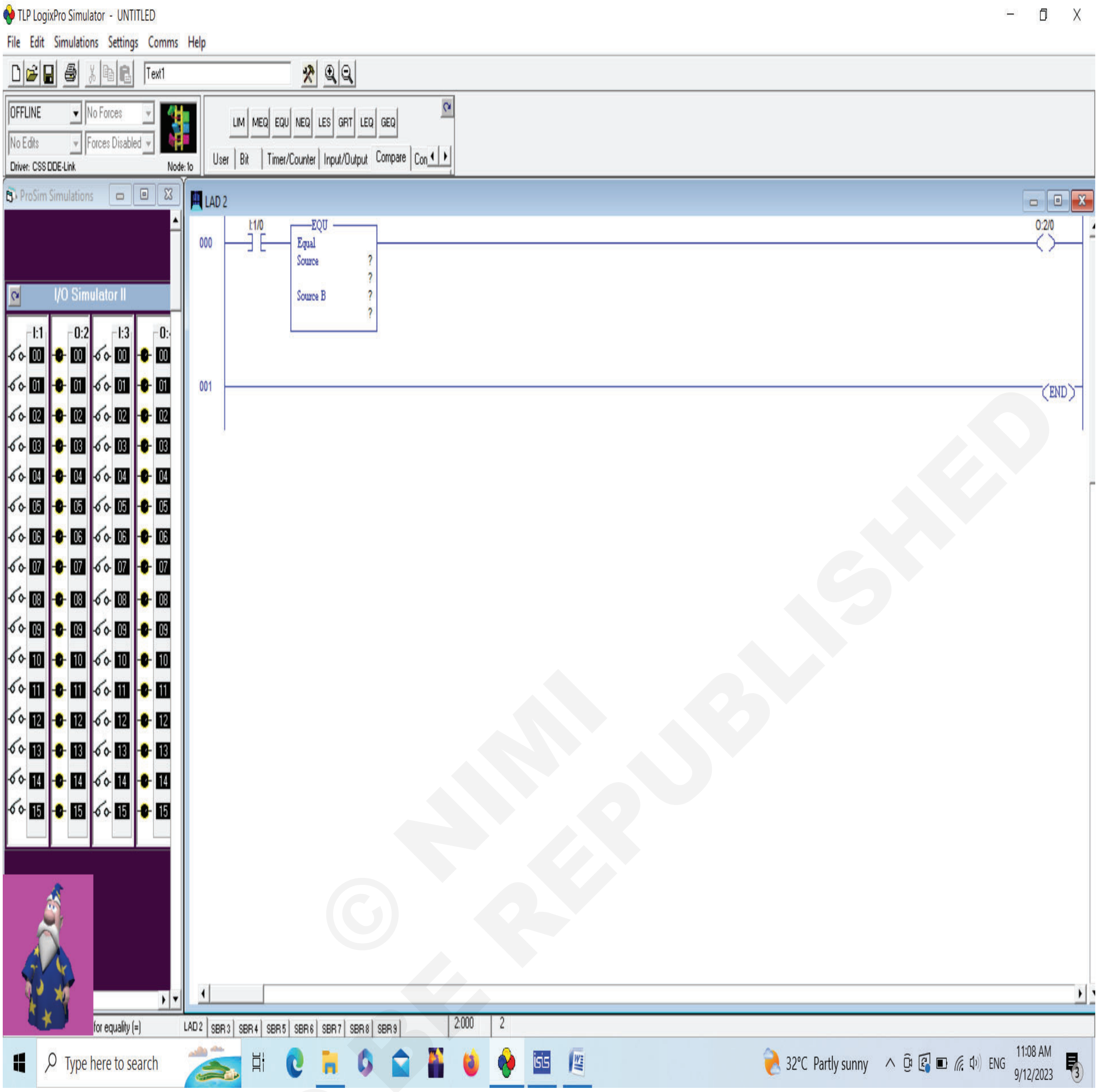


Table1

Source A	Source B	Output coil status

Program and wire the PLC to perform simple applications

Objective : At the end of this exercise you shall be able to
- **wire the plc with different switches, sensors and actuators.**

Requirements

Tools/Equipment/Instruments

- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Desktop PC system or Laptop (PLC software pre-installed) - 1 No.
- Communication cable - 1 No.

Aids: PLC reference manual

Materials/Components

- PUSH Button Switches N/O,5Amp - 1 No.
- PUSH Button Switches N/C,5Amp - 1 No.
- Toggle switches, 5 Amp - 1 No.
- Relay 24V coil, SPST, 10A, 250V - 1 No.
- Proximity sensor NPN magnetic type 4 mm - 1 No.
- PT 100 - 1 No.
- jumper wires - as reqd.

Note:

1. The instructor has to refer to the reference manual of the PLC available in the Lab.

2. Modify the steps and procedures if required, make the modifications accordingly.

Job sequence

1 Collect PLC and all other required items, check and ensure that they are in good condition.

2 Switch ON the computer, and open the pre-loaded PLC software by clicking the shortcut icon on the desktop.

3 Open the FILE menu, in the opening window, enter the project name, controller type and PLC type.

4 Refer to the PLC reference manual and nameplate details for the controller type and PLC type the information in the window as shown in Fig-1of exno.193 and click OK.

5 On the left side of the project window find the programme menu and right click over it. Select NEW option, type the program name in the window .

6 MAKE a RAIL of +24V and GND and connect it to the PLC 24V and GND terminal

7 To connect the proximity sensor select any one of the Digital input(X0) and connect it DATA/output terminal.

8 Connect the +24 terminal with the PLC 24V Line, and GND with the GND LINE.

9 Connect one end of the NO pushbutton to the Next DIGITAL INPUT(X1 or I:1/0). The other end of the switch connect it to the 24V line

10 Connect one end of the Nc pushbutton to the Next DIGITAL INPUT(X2 or I:!/1). The other end of the switch connect it to the 24V line

11 Connect the one end of the Relay coil one of the Digital output terminal(O:2/0) and the other end to GND line as shown in Fig 2.

12 Select the coil, and s contact on the tool bar and click over the ladder line Fig 1.

Note: The terminology of address may vary with the PLC manufacturers which can be confirmed from the reference manual.

13 Get the ladder logic program and address checked by the instructor.

14 Move the cursor over the tool menu, select COMPILE tool and click compile option.

15 Observe the OUTPUT window .

16 Read the error message, move the cursor over it and rectify the error.

17 Follow the steps 13 and 14, till the error message becomes ZERO.

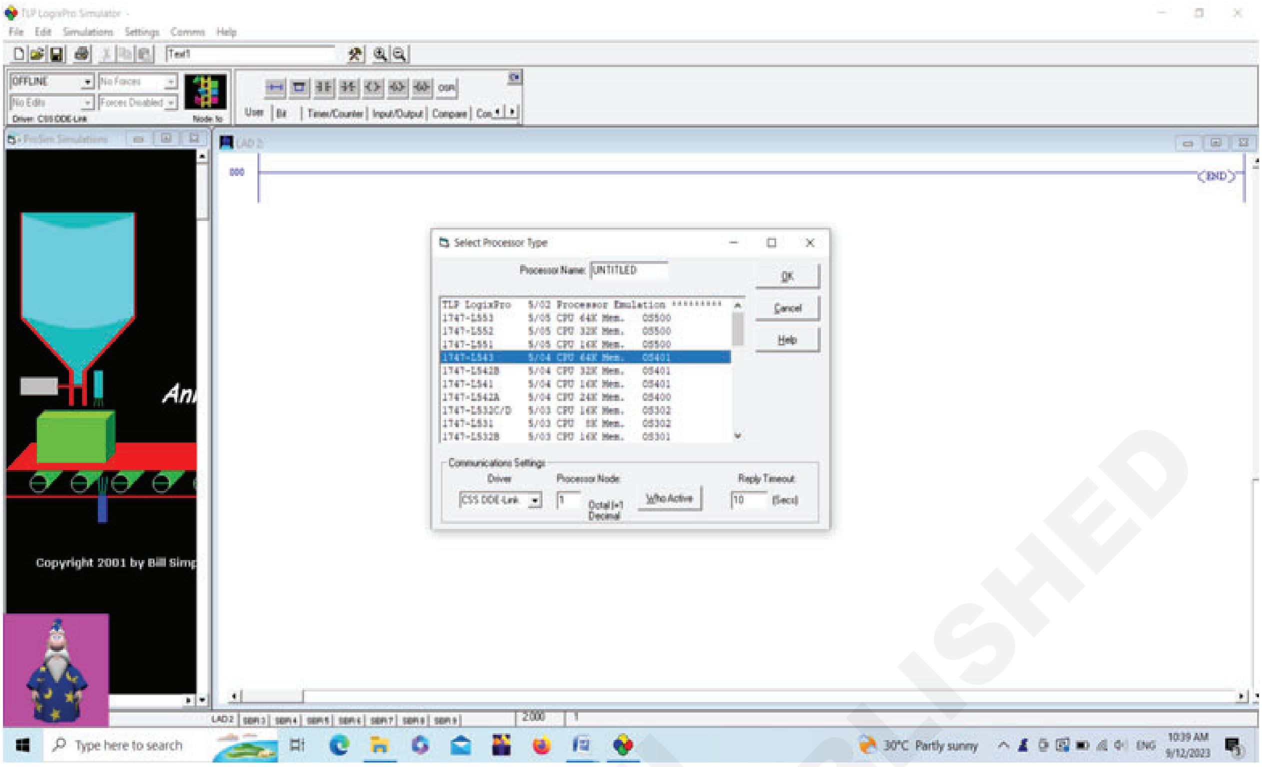
18 Click the DOWNLOAD button and transfer the ladder logic program to the PLC.

Get the circuit connections verified by the Instructor.

19 Set the PLC into RUN mode by clicking the run command.

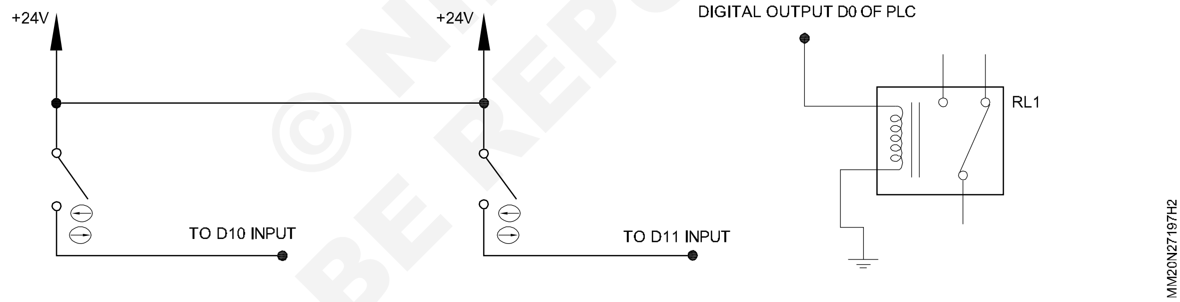
20 Make the Logical Diagram as START/STOP application.

Fig 1



TLP LogixPro Simulator
File Edit Simulations Settings Comms Help
Select Processor Type
Processor Name: UNTITLED
OK
Cancel
Help
Communications Settings
Driver
Processor Node
Reply Timeout
Who Active
Copyright 2001 by Bill Simp
Type here to search
30°C Partly sunny

Fig 2



+24V
+24V
DIGITAL OUTPUT D0 OF PLC
RL1
TO D10 INPUT
TO D11 INPUT
MM20N27197H2

Program PLC for controlling analog parameters

Objective : At the end of this exercise you shall be able to
- **use the PID module of the PLC programming.**

Requirements

Tools/Equipment/Instruments

- Trainees tool kit - 1 Set.
- Digital multimeter with probes - 1 No.
- Desktop PC system or Laptop (PLC software pre-installed) - 1 No.
- Communication cable - 1 No.

Aids: PLC reference manual

Materials/Components

- Temperature sensor (RTD) - 1 No.
- jumper wires - as reqd.

Job sequence

1 Collect PLC and all other required items, check and ensure that they are in good condition.

2 Switch ON the computer, and open the pre-loaded PLC software by clicking the shortcut icon on the desktop.

3 Open the FILE menu, in the opening window, enter the project name, controller type and PLC type.

4 Refer to the PLC reference manual and nameplate details for the controller type and PLC type the information in the window as shown in Fig-1of Ex no. 193 and click OK.

5 On the left side of the project window find the programme menu and right click over it. Select NEW option, type the program name in the window.

6 Move the cursor over the TOOL BAR and select PID icon; click over the program area and observe the default ladder line.

7 Move the cursor over the TOOL BAR and select AI icon; click over the program area and observe the default ladder line.

8 specify the source address and destination address (Source may be a analog input, Source B may be a PID module PV)

Note: The terminology of address may vary with the PLC manufacturers which can be confirmed from the reference manual.

9 Using MOVE command move the CV output of the PID module to any analog output module.

10 Enter any data for the SP Input.

11 Select the MODE PID from the drop down menu

12 Put suitable value in P.GAIN and enable I and D functions.

Get the ladder logic program and address checked by the instructor.

13 Move the cursor over the tool menu, select COMPILE tool and click compile option.

14 Observe the OUTPUT window .

15 Read the error message, move the cursor over it and rectify the error.

16 Follow the3 steps 13 and 14, till the error message becomes ZERO.

17 Click the **DOWNLOAD** button and transfer the ladder logic program to the PLC.

Get the circuit connections verified by the Instructor.

18 Set the PLC into **RUN** mode by clicking the **run command.**

19 If source and Source B values are Equal then the it energize the coil otherwise the coil is in logical zero condition

20 Record your observations in Table-1 and get the work checked by the instructor.

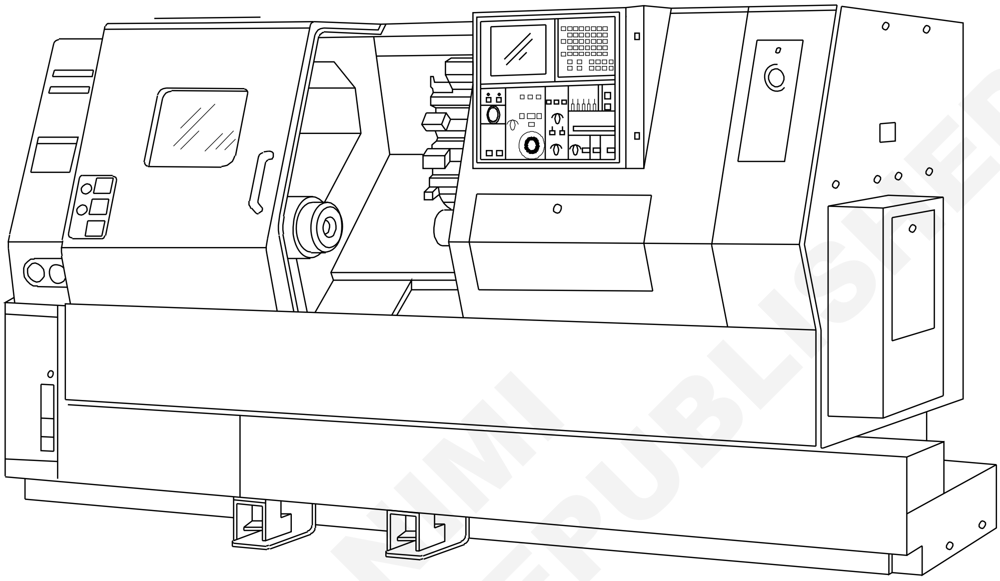
Table 1

SP	MV	P.Gain	CV

Knowledge rules of personal and CNC Machine safety safe handling of tools & Safety switches and material handling equpiment using CNC didatic/ Simulation software and equipment

Objectives : At the end of this exercise you shall be able to
- **follow personal safety in CNC workshop**
- **maintain safety of CNC machine .**

Fig 1



MM20N28199H1

Do's

- A well trained operator should operate the CNC Machine.
- Only one operator should operate the machine at a time.
- Check the lubrication oil and Hydraulic oil level before starting the machine.
- Ensure doors are closed before switching ON the Machine.
- Keep less speed while operating in JOG mode, especially when the tool is near the chuck/Job.
- Operator should ensure the machine zero point while starting the machine.
- Operator should check the work offset for every tool setting and the same to be entered in the program.
- Special care should be taken while changing the tool.
- Check the part program for correction before operating.
- Learn all G codes, and M codes, of the control installed in your machine .
- Learn all offset, Reference points pertaining to your machine.
- Learn the basic maintenance schedule for your machine as per Autonomous maintenance.
- Ensure that the stabilizer is ON before starting.

Don'ts

- Do not operate machine without the working knowledge of the machine.
- Do not operate the machine when covers are removed.
- Do not insert any bar or tool holder in the spindle while rotation.
- Do not open the control panel, without switching OFF power.
- Do not operate the machine without trying in simulation.
- Do not attend electrical fault, without removing the main fuse carriers.

CNC machine safety system

The built-in safety system on a CNC machine includes guards and protective devices which should be securely fitted and always kept in position while the machine is being used. It may include.

Emergency Stop Button

Used to shut down the machine immediately. It is located on the control panel and at other points on the machine, for example the hand held unit.

Soundproof Casing

Reduces noise emission generated by the operating section and protects the operator from the risk of flying objects or tool fragments.

Curtain Guards

Made of PVC and designed to protect the operator from the risk of airborne chips or tool fragments.

Guard Fence

The fence marks the working area in which the machine moves. It protects the operator from the risk of interference with moving parts. The guard may be of an open type or made of mesh.

Contact Mats

When the operator stands on the mat, the machine stops immediately, protecting the operator from moving parts of the machine.

Below are some general personal safety rules that you can use as a guide only. You might like to add any other rules that apply to you.

Tool Safety

Below are some general tooling safety rules that you can use as a starting guide. You might like to add any other rules that apply to you.

Do:

- Always check that the machine is not operating when loading a tool magazine.
- Always check that tools are in good condition, for example, sharp and free from cracks.
- Always check that tools are set correctly.
- Always check that the correct tool data is entered into the CNC program.
- Always test tools before use.
- Always check that the seating surfaces are clean before installing tools.
- Always check that spindle direction is correct for right-hand or left-hand operation.
- Only use tools within the limits specified by the manufacturer.
- Only tighten tools to recommended torque values.

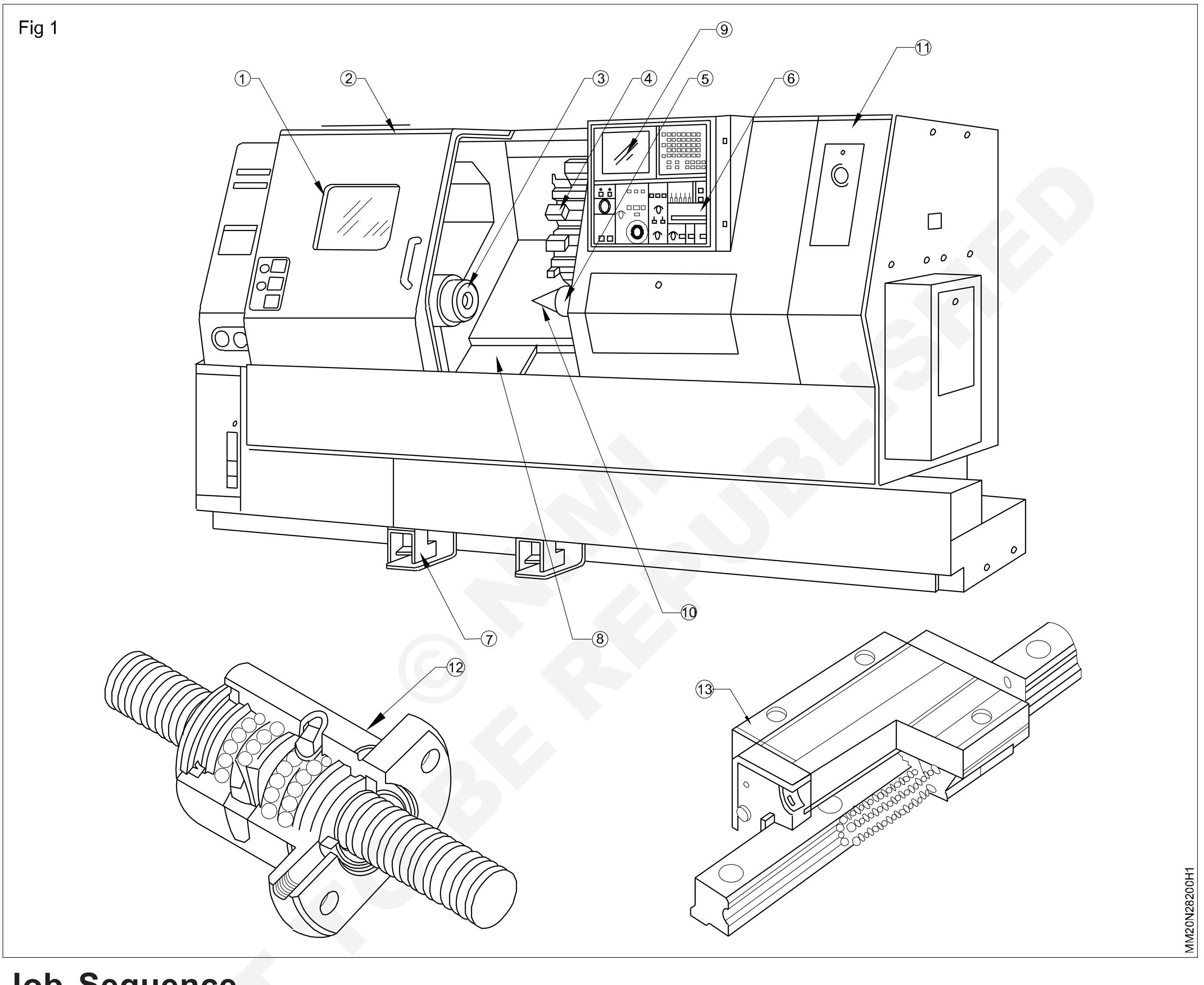
Material handling

Material handling now features technology that matches the sophistication of the machines that prepare the pieces. Swing arm panel feeders ensure continuous operation; panel stackers provide many options for storage and retrieval; robotics transfer pieces from machine to machine; conveyors and lift systems speed the transfer of materials with a minimum of human involvement; fully automated stacking/destacking machines easily handle input from multiple conveyors and trolleys.

Identify CNC lathe machine elements and their functions

Objectives : At the end of this exercise you shall be able to
- **identify the parts of CNC lathe machine**
- **list out the functions of each part of the CNC lathe machine.**

Fig 1



Job Sequence

- Identify the parts of CNC lathe machine and its function.
- List out the name of the parts shown in figure, in the given table 1
- Instructor will demonstrate the parts.

Instructor to guide to identify CNC machine parts and axis control.

Table 1

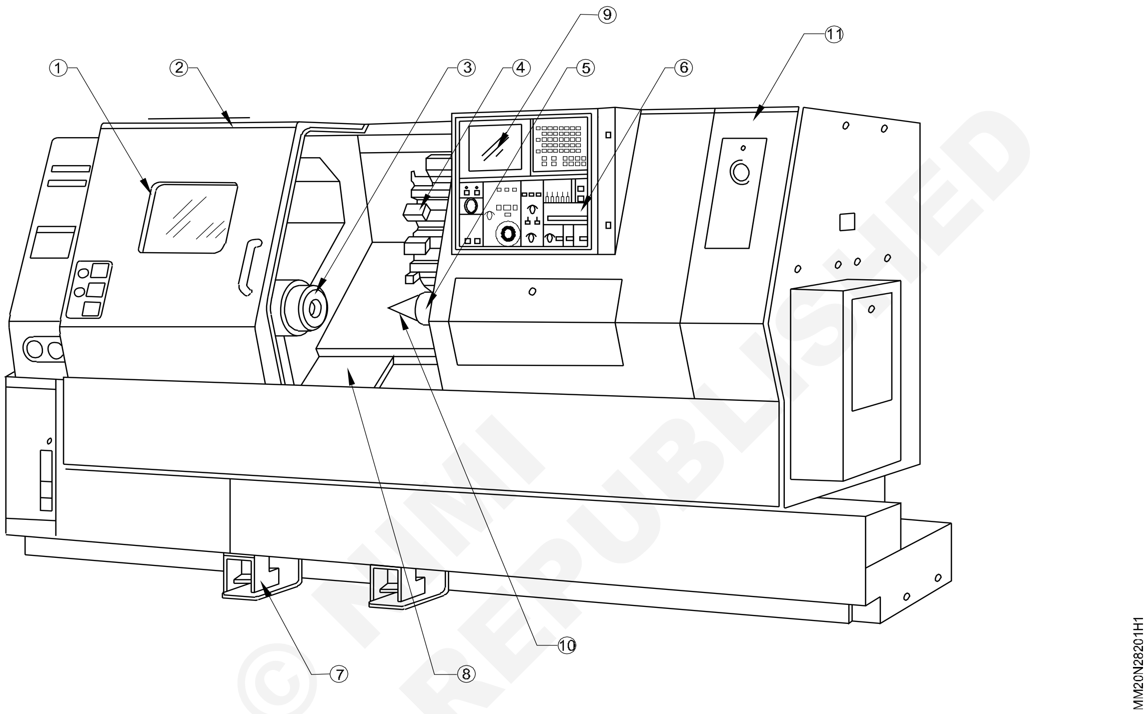
Part No.	Name of the parts	Function of the part
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

- Get it checked by the instructor.

Understand the working of parts of CNC lathe, using CNC didactic/simulation software

Objectives: At the end of this exercise you shall be able to
- **operate the multimedia based simulator**
- **identify the CNC machine simulator parts.**

Fig 1



- **Instructor will show the C.N.C Machine parts by using multimedia basd simulator Trainees should identify and understand the working parts and write in the parts given below table 1**
- **Instructor to refer the previous exercise.**

Table 1

Sl No.	CNC parts Identified by trainee
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Identify common tool holder and insert shapes by ISO nomenclature

Objectives: At the end of this exercise you shall be able to
- **identify the tool depending upon the feed movement**
- **identify the clamping systems and design on inserts and tool holders**
- **identify the shapes of insert commonly used.**

Job Sequence

TASK 1: **Identify the hand of tools in Fig 1 and record in Table 1**

Fig 1

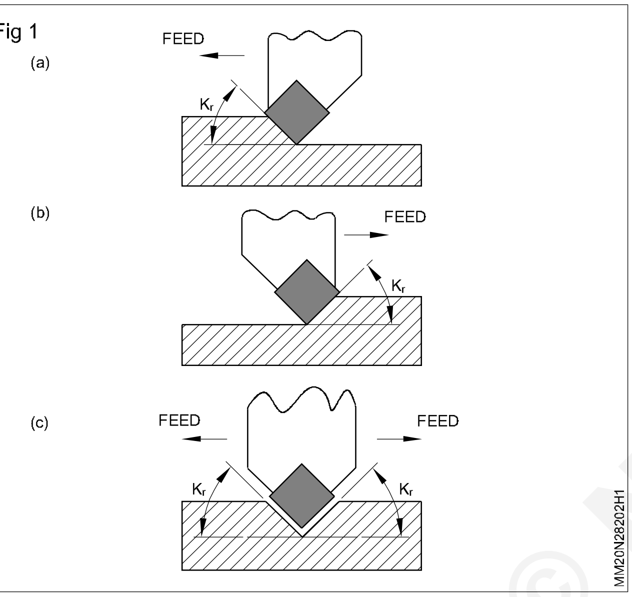


Table 1

	Hand of tool
a	
b	
c	

— — — — — — — —

TASK 2 : **Identify the clamping system shown in Fig 1 and record it in Table 2.**

Fig 1

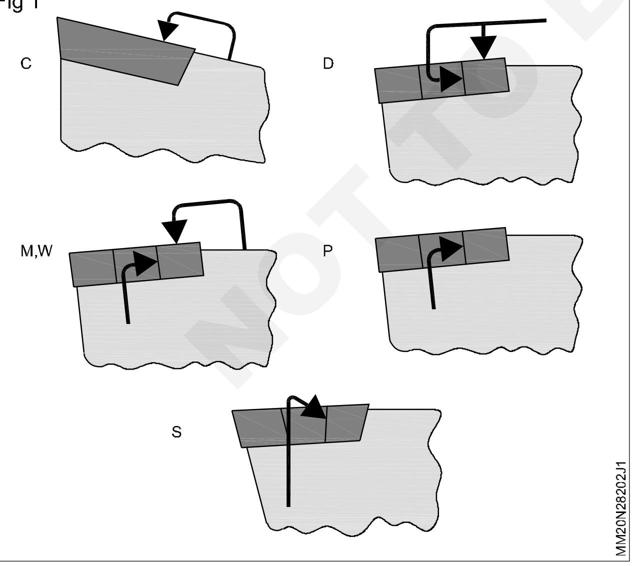


Table 2

	Clamping system
C	
D	
M.W	
P	
S	

— — — — — — — —

TASK 3: **Identify the clamping design shown in Fig 1 and record it in Table 3**

Fig 1

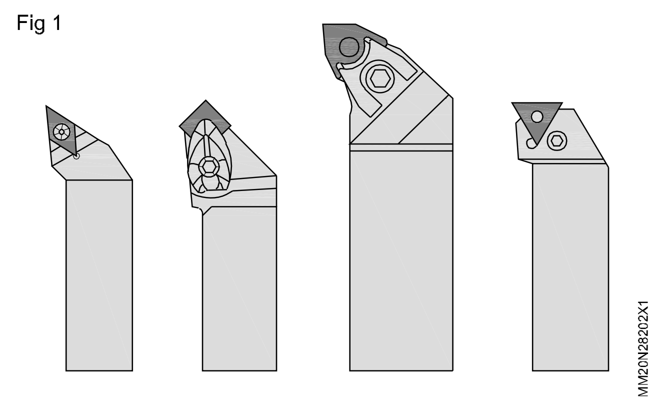


Table 3

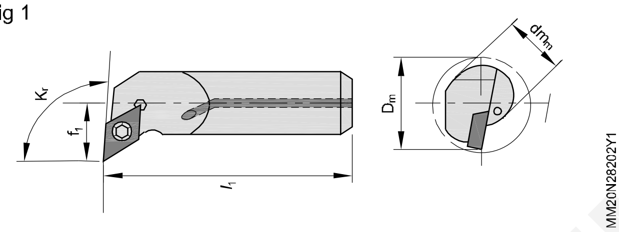
	Clamping design
a	
b	
c	
d	

— — — — — — — —

TASK 4: **Identify the tool shown in Fig 1 and record it.**

Name of tool…………

Fig 1



— — — — — — — —

TASK 5: **Identify the insert shape shown in Fig 1 and record in Table 4.**

Fig 1

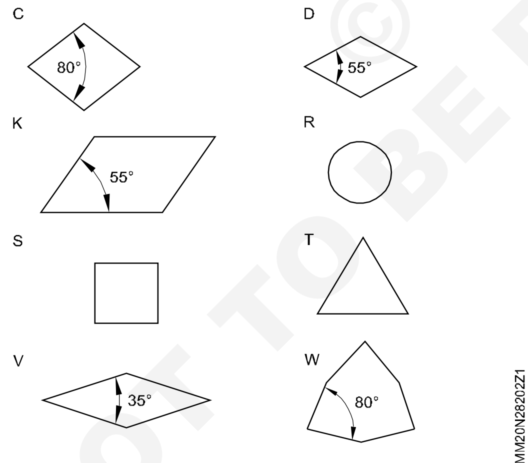


Table 4

	Insert shape
C	
D	
K	
R	
S	
T	
V	
W	

Note: Trainer shall display all the tool holders, inserts and explain the purpose and its technical names.

— — — — — — — —

Select cutting parameters from tool manufactures catalogue

Objective: At the end of this exercise you shall be able to
- **select the recommended cutting parameters by using catalogue.**

Job Sequence

Trainer shall collect catalogue from tool manufacturer and ask the trainees to fill the data in Table 1 according job material.

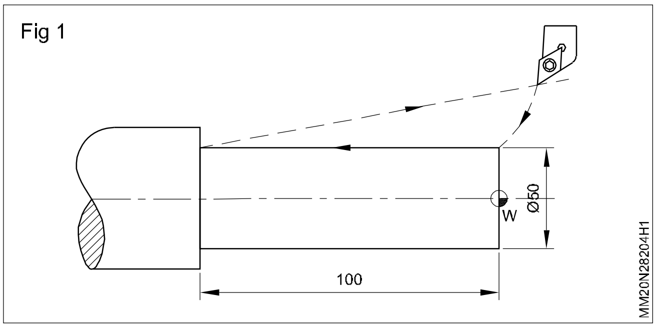
Table 1

	Speed / feed /depth of cut for general turning			
Part Material	**Cutting speed**	**Feedrate /mm/rev**		**Depth of cut mm**
	Vc m/min	**Rough**	**Finish**	**Finish** **0.4 R**
Mild steel				
High carbon steel				
Aluminium				
Copper				
Cast Iron				
Tool steel				

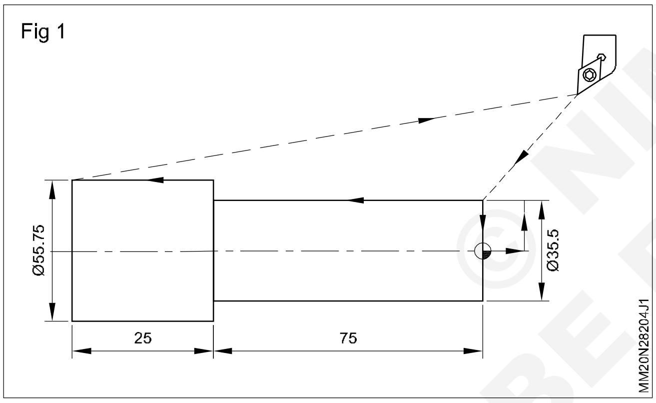
Write CNC programs for simple tool motions and parts using linear and circular interpolation check program verification/simulation software

Objectives: At the end of this exercise you shall be able to
- **write CNC program with G00 & G01**
- **write CNC program with G02 & G03**
- **enter and verify the program in Simulator.**

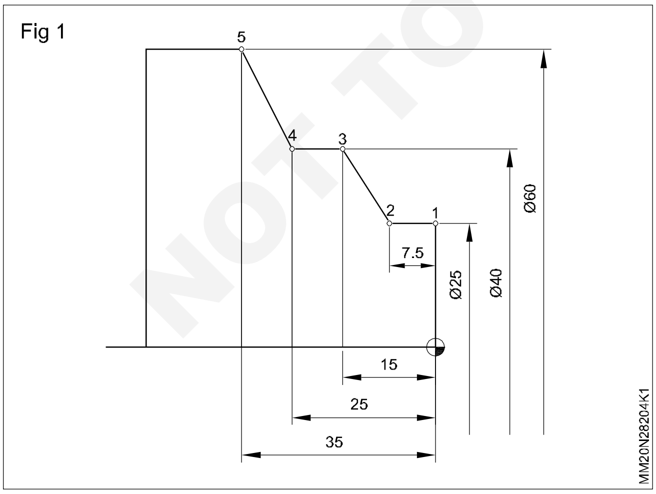
TASK 1**: Plain turning**



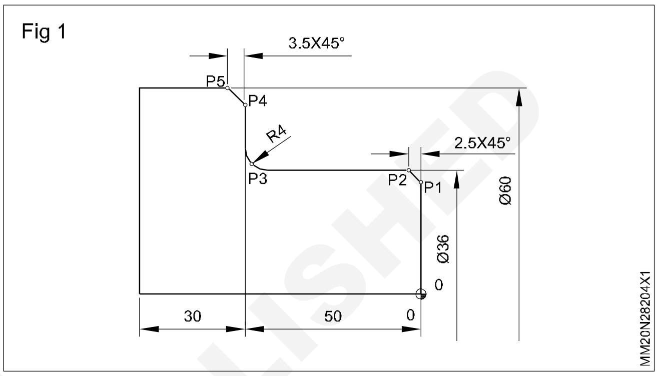
TASK 2 **: Facing, plain turning step turning**



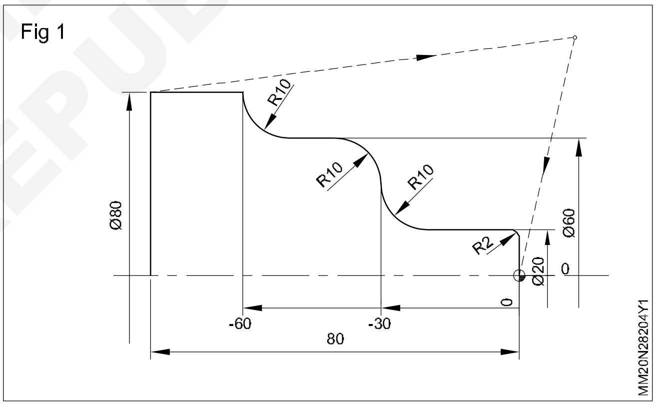
TASK 3**: Programing with linear interpolation**



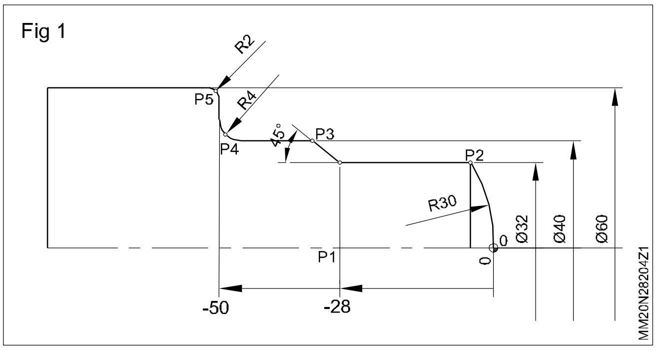
TASK 4**: Programming with G01, G02**



TASK 5 **: Programming with G01, G02 & G03**



TASK 6 **: Part program**



Job Sequence

TASK 1: **CNC Programming for Plain turning - (Fanuc control)**

```
N5 G90, G55, G95;
N10 T0101, S500 M04;
N15 G00 X55.00 Z2.00;
N20 G01 X-0.1 Z0.00;
N25 G00 X-0.1 Z5.00;
N30 G00 X50 Z 5.00;
N35 G01 X50 Z-100.0;
N40 G00 X100 Z100.0;
N50 G28 G91 X0 Z0 T0100;
N55 M05;
N60 M30;
```

TASK 2 & TASK 3: **Write the CNC Program in fanuc control**

TASK 4 : **Programming with G01& G02**

```
N5 G90 G55 G95;
N10 T0404 S500 M04 ;
N15 G00*65 Z0.0;
N20 G01 X-0.1 Z0.0;
N25 G00 X-0.1 Z5.0;
N27 G00 X62.0 Z5.0;
N30 G01 X62.00 Z-80;
N35 G00 X64.00 Z2.00;
N40 G01 X31.00 Z0.00;
N45 G01 X36.00 Z-2.50;
N50 G01 X36.00 Z-46.00;
N55 G02 X44.00 Z-50 I4.0 K0.00;
N60 G01 X53.00 Z-50;
N65 G01 X60.00 Z-53.50;
N70 G01 X60.00 Z-80;
N75 G00 X100.00 Z-100.00;
N80 G28 G91 X0 Z0T0400 M05;
N85 M30;
```

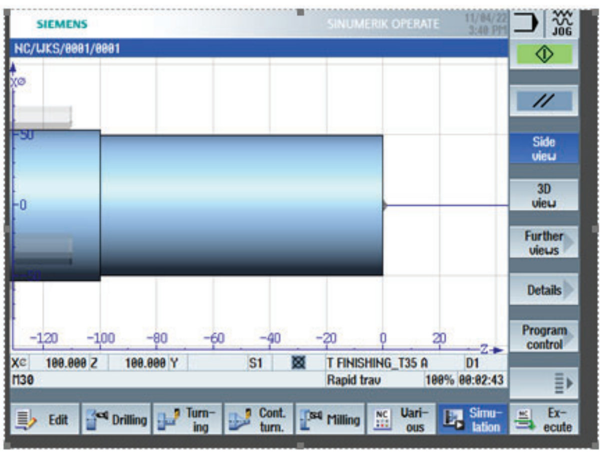
TASK 5 & TASK 6: **Write the CNC program using G01, G02, G03 with I, J and R**

- Enter the CNC program task 1 to task 6 in CNC simulator
- Verity the program by simulating with CNC simulator.

TASK 7: **Sienumeric program in simulator**

```
G90 G55 G95
WORKPIECE(,,,"CYLINDER",0,0,150,110,54)
T="FINISHING_T35 A"
S500 M04
G00 X55.00 Z2.0
G01 X-0.1 Z0.0 F0.1
G00 X-0.1 Z5.0
G00 X50.0 Z5.0
G01 X50.0 Z-100.0
G00 X100 Z100
M04
M30
```

Fig 1



TASK 8 : **Sinumeric program in CNC simulator**

N10 G90 G55 G95

N15 WORKPIECE(,,,"CYLINDER",0,0,150,110,60)

N20 T="FINISHING_T35 A"

N25 S500 M04

N30 G00 X65 Z0

N35 G01 X-0.1 Z0 F0.1

N40 G00 X-0.1 Z5

N45 G00 X62 Z5

N50 G01 X62 Z-80

N55 G00 X64 Z2

N60 G01 X31 Z0

N65 G01 X36 Z-2.5

N70 G01 X36 Z-46

N75 G02 X44 Z-50 I4 K0

N80 G01 X53 Z-50

N85 G01 X60 Z-53.5

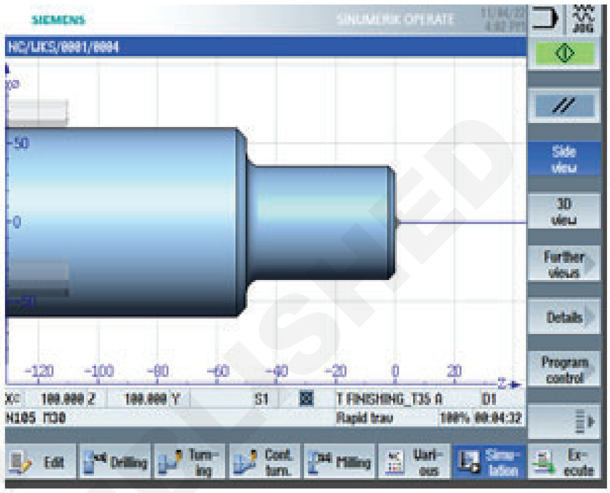
N90 G01 X60 Z-80

N95 G00 X100 Z 100

N100 M05

N105 M30

Fig 1



— — — — — — — —

Skill Sequence

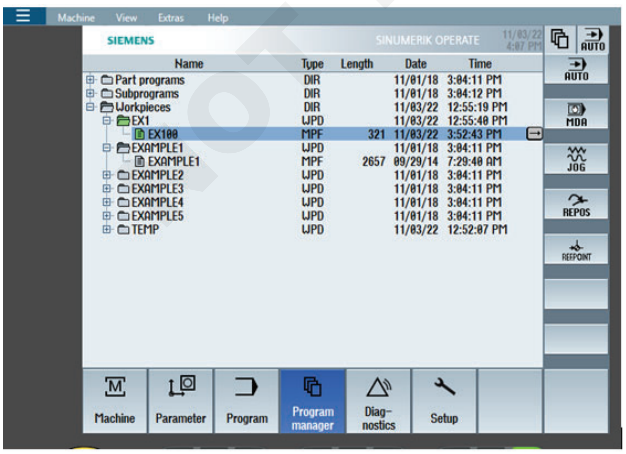
Entering and simulatating program in sinutrain

Objective: This shall help you to
- **open the simutor**
- **enter new program**
- **verify the program by simulation method**

Open simulator

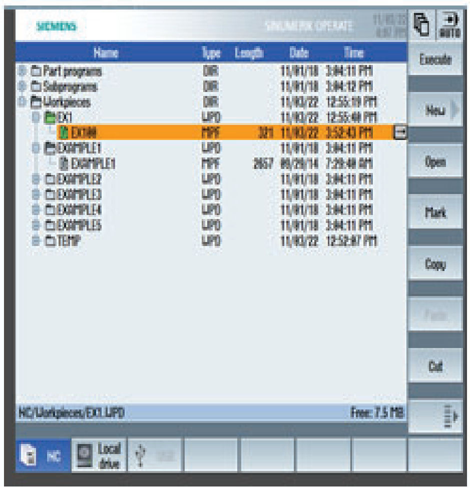
Press program manager (Fig1)

Fig 1



The screen will display as in Fig 2.

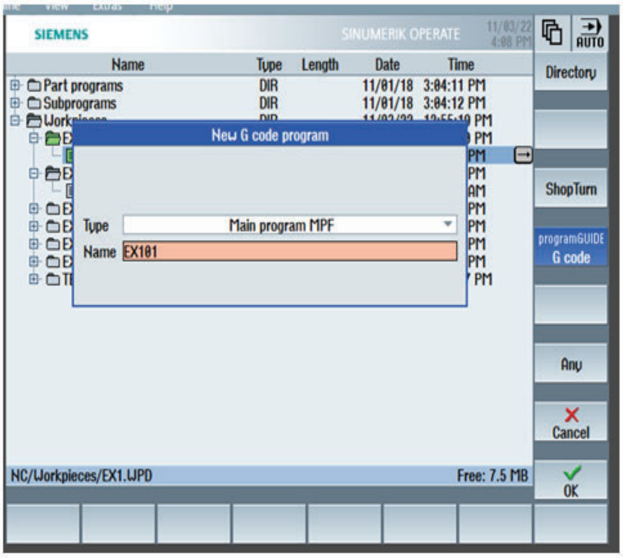
Fig 2



Press new

The screen will display as in Fig 3.

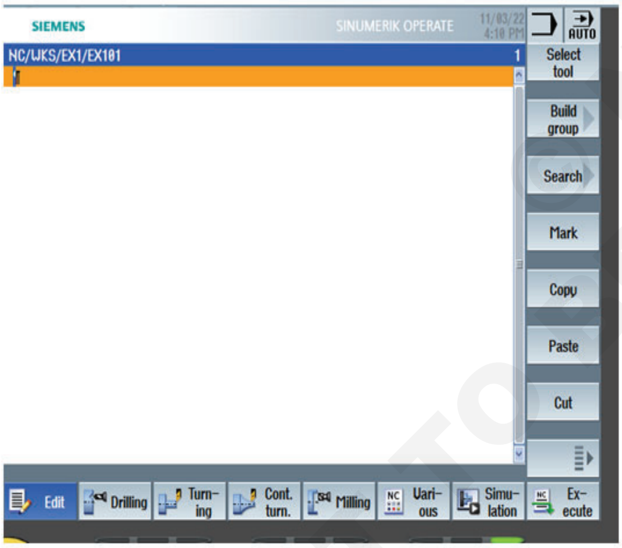
Fig 3



Enter the name of the program and press ok

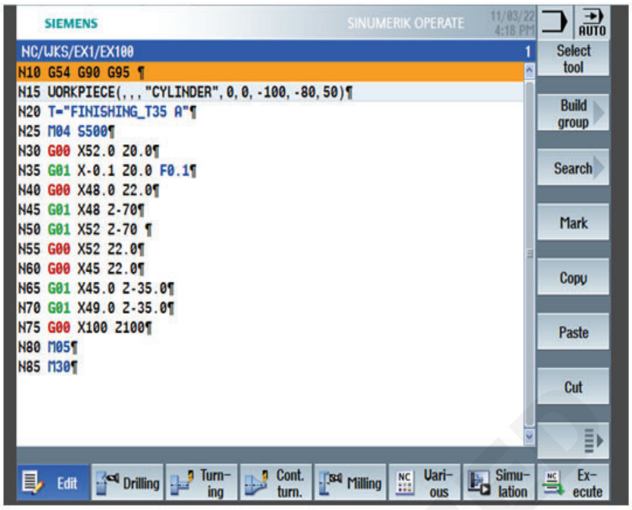
The screen will display as in Fig 4

Fig 4



Type the program using computer key board as in Fig 5

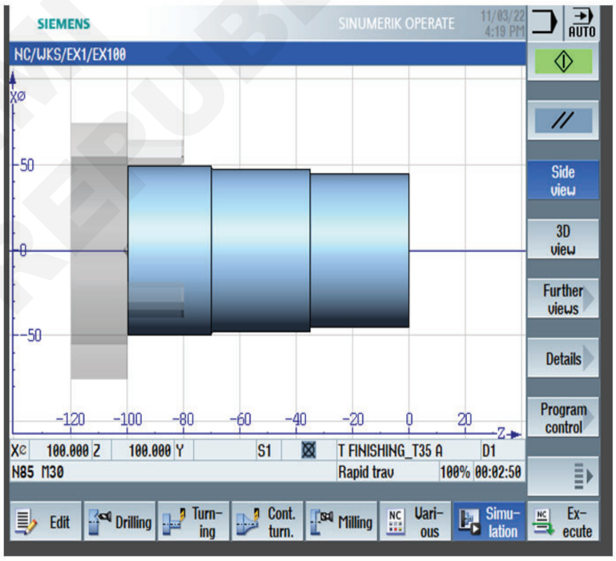
Fig 5



Press simulation as in Fig 6.

The screen will display the simulation.

Fig 6



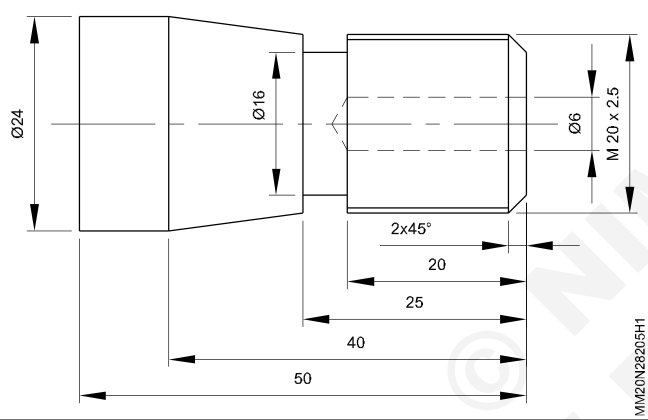
Write CNC part programs using cycles and check simulation on simulator

Objectives : At the end of this exercise you shall be able to
- **switch on the CNC machine simulator**
- **write part program in fanuc control**
- **input the program & simulate.**

Job Sequence

- Write the part program in fanuc system.
- Check up with the instructor.
- Input the part program in the simulator.
- Run and check the correctness of the program using the simulator.

Fig 1



Control system

Fanuc - series oimate TD

Part program

```
O0009;
N1 ; (Turning)
G28   U0     W0;
G92   S2000  T0101 ;
G96   S200   M03 ;
G00   X30.0  Z5.0    M08 ;
Z0.0 ;
G01   X-1.0  F0.1 ;
G00   X28.0  Z2.0;
G71   U1.0   R1.0 ; ;
G71   P10    Q20     U0.0   W0.0   F0.1 ;
N10   G01    Z0.0    F0.1 ;
X16.0 ;
X20.0 Z-2.0 ;
Z-25.0 ;
X24.0 Z-40.0;
N20   G01    Z-50.0  F0.1 ;
G00   X30.0  Z5.0    M09 ;
G28   U0     W0 ;
M05 ;
M01 :
N2 ; (Centre drill)
G28   U0     W0 ;
T0202 ;
G97   S800   M04 ;
G00   X0.0   Z5.0    M08 ;
G01   Z-6.0  F0.08 ;
G00   Z5.0   M09 ;
G28   U0     W0 ;
M05 ;
M01 ;
N3 ; (∅6 Drill)
G28   U0     W0 ;
T0404 ;
G97   S1000  M04 ;
G00   X0.0   Z5.0    M08 ;
G74   R2.0 ;
G74   Z-20.0 Q10000  F0.06 ;
```

```
G00     Z5.0     M09 ;
G28     U0       W0 ;
M05 ;
M01 ;
N4 ; (OD Grooving 3 mm width)
G28     U0       W0 ;
T0303 ;
G97     S600     M03 ;
G00     X22.0    Z5.0     M08 ;
G01     Z-23.0   F0.1 ;
G75     R2.0 ;
G75     X16.0    Z-25.0   P500     Q2000    F0.06 ;
G00     X25.0 ;
Z5.0    M09 ;
G28     U0       W0 ;
M05 ;
M01 ;
N5 ; (Threading)
G28     U0       W0 ;
T0505 ;
G97     S600     M04 ;
G00     X22.0    Z5.0     M08 ;
G01     Z3.0     F0.1 ;
G76     P030060  Q150     R20 ;
G76     X16.755  Z-22.0   P1622    Q300     F2.5 ;
G00     X25.0    Z5.0     M09 ;
G28     U0       W0 ;
M05 ;
M01 ;
M30 ;
%
```

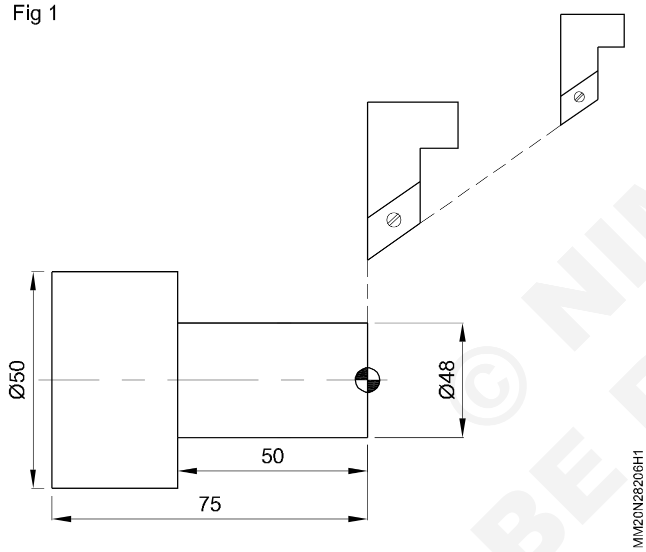
Avoiding collisions caused by program errors, knowing causes and effects of collisions due to program errors by making deliberate program errors and simulation on program verification/simulation software

Objectives: At the end of this exercise you shall be able to
- **various causes for collisions**
- **effects of collisions and rectification.**

Job sequence

- Plain turning and Facing operation program is written.
- Verify the program on simulation software.
- Identify the errors if any.
- Rectify the errors.

Fig 1



Wrong program

```
O5555
N1   G28    U0      W0;
N2   G97    S1000   M03;
N3   T0101;
N4   G00    X60.0   Z0.0   M08;
N5   G00    X0.0    F0.1;
N6   G00    X48.0   Z2.0;
N7   G00    Z-50.0  F0.1;
N8   G00    X60.0   Z0.0   M09;
N9   G28    U0      W0;
N10  M05;
N11  M30;
```

Correct program

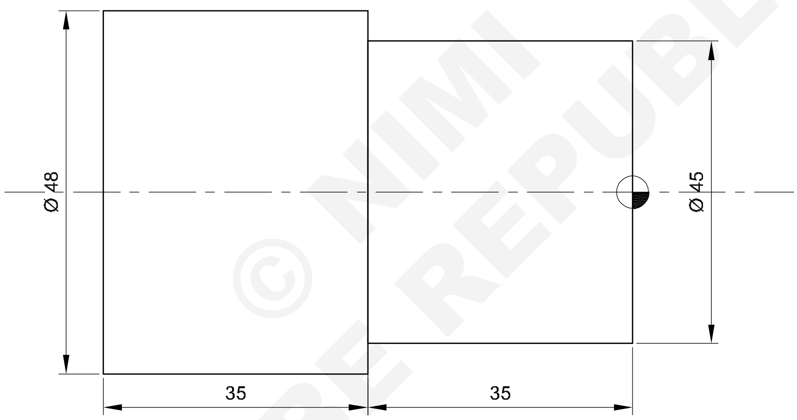
```
     O5555;
N1   G28    U0      W0;
N2   G97    S1000   M03;
N3   T0101;
N4   G00    X60.0   Z0.0   M08;
N5   G01    X0.0    F0.1;
N6   G00    X48.0   Z2.0;
N7   G01    Z-50.0  F0.1;
N8   G00    X60.0   Z0.0   M09;
N9   G28    U0      W0;
N10  M05;
N11  M30;
```


Collisions and rectifications

Sl No	Identification of errors	Effects	Rectification of errors
1	G00 X0.0 F0.1;	Will damage turret & Tool holder, Machine Alignment, and affect Accuracy	G01 X0.0 F0.1;
2	G00 Z-50.0 F0.1;	- do -	G01 Z-50.0 F0.1;
3	Operator alter the programme in wrong format.	- do -	Check the programme and correct it.
4	Improper holding the job and tool.	- do -	Check the reason for improper holding and correct it.
5	Wrong selection and mismatch the tool for operation	- do -	Select proper tool for the particular operation.
6	Wrong offset for Job and Tool	- do -	Check offset for Job and Tool.

Simple turning & facing (Step turning) without using canned cycles on CNC simulator

Objectives : At the end of this exercise you shall be able to
- **prepare CNC program for the given drawing**
- **enter the program in CNC simulator using edit mode**
- **verify the program by simulation on CNC simulator.**



01		-		-	-	2.8.207
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**FACING AND TURNING PROGRAM**	DEVIATIONS	TIME :
		CODE NO. MM20N28207E1	

Job Sequence

- Write the CNC program for facing operation
- Write the CNC program for plain turning operation.
- Write the CNC program for step turning
- Enter the program in CNC simulator using edit mode
- Verify the program by simulation in simulator

Program (facing and turning)

03001 - program number

N5 G90 G55 G95; - preparatory functions

N10 T0505; - Tool change with spindle on ccw

N15 G00 X52.00 Z0.00; - Positioning for facing

N20 G01 X-0.1 Z0.00 F0.1;

M25 G00 X48.00 Z5.00;

N30 G01 X48.00 Z -70.00;

N35 G01 X52.00 Z-70.00;

N40 G00 X52.00 Z2.00;

N45 G00 X45.00 Z2.00;

N50 G01 X45.00 Z - 35.00;

N55 G01 X49.00 Z 35.00

N60 G00 X100 Z100;

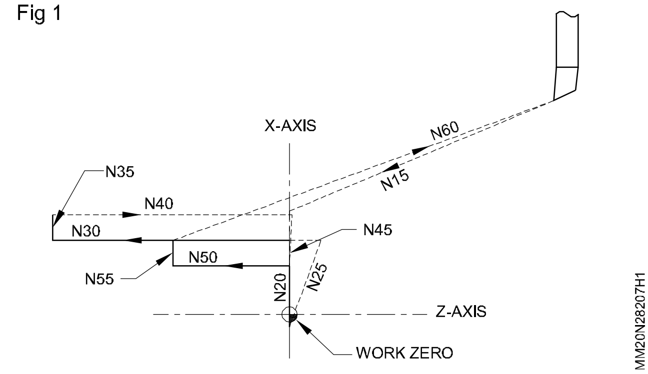
N65 G28 G91 X0.00 Y0.00 T0500 M05;

N70 M90;

N75 M30;

Tool path shown in Fig 1.

Fig 1



SIEMENS CNC SIMILATION PROGRAM,

N10 G54 G90 G95

N15 WORKPIECE(,,, "SYLINDER", 0,0,-100,-80,50)

N20 T= "FINISHING_T35A"

N25 M04 S500

N30 G00 X52.0 Z0.0

N35 G0.1 X-0.1 Z0.0 F0.1

N40 G00 X48.0 Z2.0

N45 G01 X48 Z-70

N50 G01 X52 Z-70

N55 G00 X52 Z2.0

N60 G00X45 Z2.0

N65 G01X45.0Z-35.0

N70 G01 X49.0 Z -35.0

N75 G00 X100 Z100

N80 M05

N85 M30

Skill Sequence

Enter CNC program in edit mode

Objective: This shall help you to

- **enter the programme in fanue control.**

Fanuc control

Go to JOG mode

↓

Press part program

↓

Press edit

↓

Enter % and new program number of job

↓

Press Select program

↓

(blank space open for entry of program)

↓

Write program using numerical key and edit key

Program checking in dry run single block mode on CNC simulator

Objectives : At the end of this exercise you shall be able to
- **load the program to run in auto mode operation**
- **check the program in dry run using single block mode.**

Job sequence

- Load the program to run in auto mode operation
- Keep the rate and rapid knobs to zero position
- Press cycle start
- Press dry run and single block mode
- Open the rapid switch to 30%
- Press cycle start button, the execution of the program is stopped after the current block is executed.
- Press cycle start button to execute next block.
- Similarly continued until the end of program that is M30;

Skill Sequence

Running program in auto mode/memory operation

Objective: This shall help you to
- **load the program to run in auto mode**
- **execute the program in auto mode.**

Memory operation

- Programs are registered in memory in advance. When one of these programs is selected and the cycle start switch on the machine operator's panel is pressed, automatic operation starts, and the cycle start LED goes on.

Steps in memory operation

- Press the MEMORY mode selection switch.
- Select a program from the registered programs. To do this, follow the steps below.
- Press PROG to display the program screen.
- Press address O
- Enter a program number using the numeric keys.
- Press the [O SRH] soft key.
- Press the cycle start switch on the machine operator's panel. Automatic operation starts, and the cycle start LED goes on. When automatic operation terminates, the cycle start LED goes off.

To stop or cancel memory operation midway through, follow the steps below.

Stopping memory operation

- Press the feed hold switch on the machine operator's panel. The feed hold LED goes on and the cycle start LED goes off. The machine responds as follows.
- When the machine was moving, feed operation decelerates and stops.
- When dwell was being performed, dwell is stopped.
- When M, S, or T was being executed, the operation is stopped after M, S or T is finished.
- When the cycle start switch on the machine operator's panel is pressed while the feed hold LED is on, machine operation restarts.
- Terminating memory operation
- Press the RESET key on the MDI panel.

Automatic operation is terminated and the reset state is entered.

- When a reset is applied during movement, movement decelerated and stops.

Dry run and single block mode

Objective: This shall help you to
- **run the program in dry run mode and single block mode.**

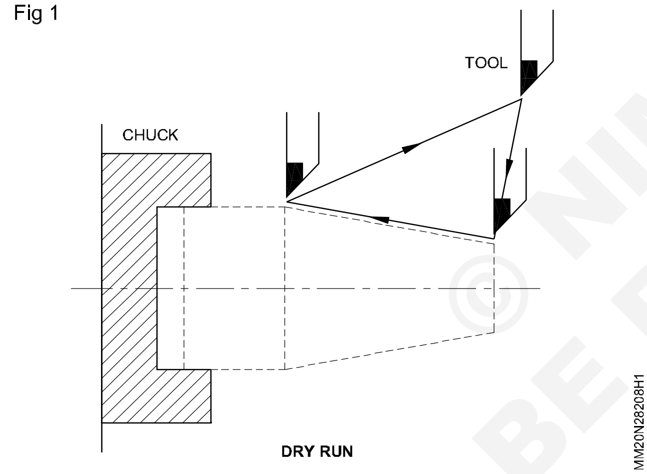
Dry run

- The tools is moved at the federate specified by a parameter regardless of the federate specified in the program. This function is used for checking the movement of the tool under the state that the workpiece is removed from the table.

Steps for dry run operation (Fig 1)

- Load the program
- Select auto mode operation
- Press the dry run switch on the machine operator's panel during automatic/memory operation.
- Press cycle start. The tool moves at the feed rate specified in a parameter.
- Rapid traverse switch can also be used for changing the feed rate.

Fig 1



Single block operation

Pressing the single block switch starts the single block mode. When the cycle start button is pressed in the single block mode, the tool stops after a single block in the program is executed. Check the program in the single block mode by executing the program block by block.

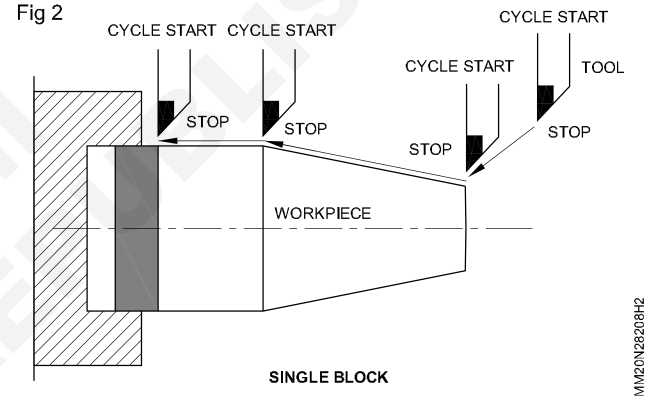
Steps for single block (Fig 2)

Press the single block switch on the machine operator's panel. The execution of the program is stopped after the current block is executed.

Press the cycle start button to execute the next block. The tool stops after the block is executed.

Refer to the appropriate manual provided by the machine tool builder for single block execution.

Fig 2



Absolute & incremental programming assignment and simulation

Objective: At the end of this exercise you shall be able to
- **program with absolute and incremental system.**

TASK 1 :

Method of Programming

There are two methods of dimensioning .

1 Absolute system of programming (or) fixed

2 Incremental system of Programming (or) floating zero system of dimensioning. (or) previous point zero system of dimensioning. Fig 1

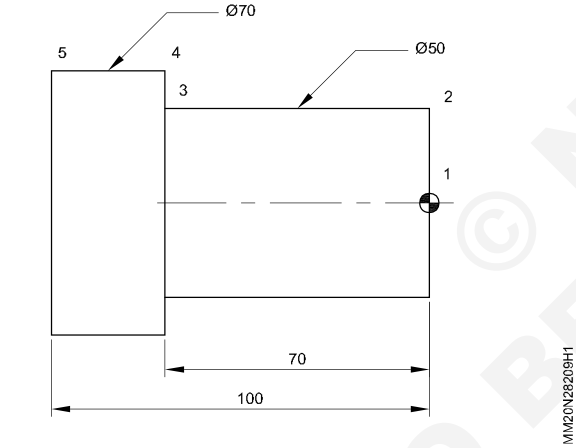
Absolute Programming

In absolute dimensions programming all the point of the tools is coming from the datum point (or) zero point.

Incremental Programming

In this system, tool move form the previous point.

Fig 1



Example 1 : The points 1 to 5 in the drawing indicates the absolute in Table 1 and Incremental in Table 2

Absolute program in table 1.

TABLE 1

Absolute		
Position	**X**	**Z**
1	0. 0	0. 0
2	50.0	0. 0
3	50.0	-70.0
4	70.0	-70.0
5	70.0	-100.0

Incremental program in table 2.

TABLE 2

Incremental		
Position	**U**	**W**
1	0.0	0.0
2	50.0	0.0
3	0.00	- 70.0
4	20.0	0.0
5	0.0	- 30.0

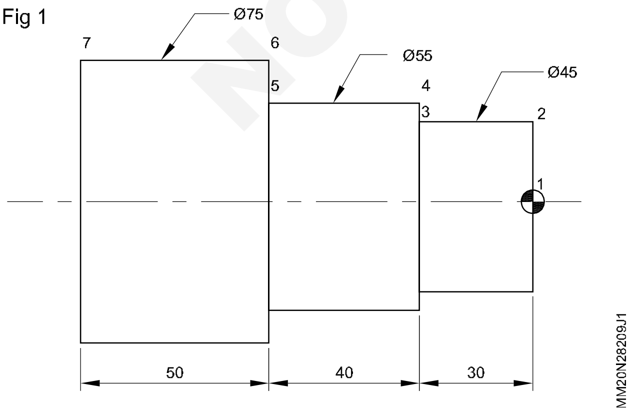
Exercise for Absolute & Incremental Methods

Write the points for the following figures in absolute & incremental programming.

— — — — — — — —

TASK 2 :

Fig 1



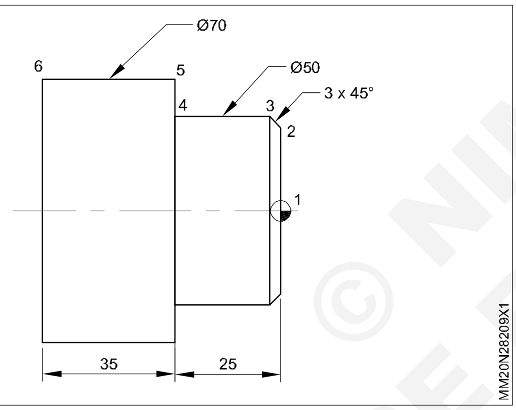
Absolute		
Position	**X**	**Z**
1		
2		
3		
4		
5		
6		
7		

Incremental		
Position	U	W
1		
2		
3		
4		
5		
6		
7		

TASK 3 :

Trainees to indicate the co-ordinate values in the given tables Fig 1.

Fig 1



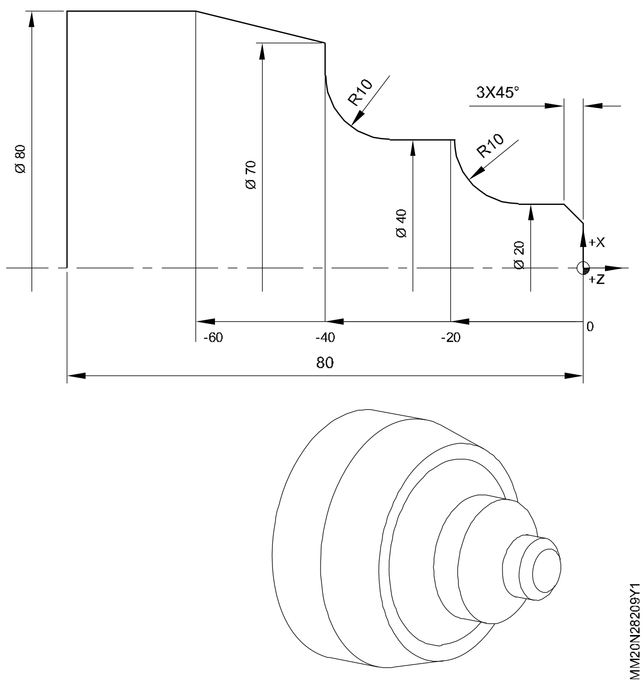
Absolute		
Position	X	Z
1		
2		
3		
4		
5		
6		

Incremental		
Position	U	W
1		
2		
3		
4		
5		
6		

TASK 4 :

Write the tool path using G01, G02 & G03 with G90 +G91 Fig 1

Fig 1



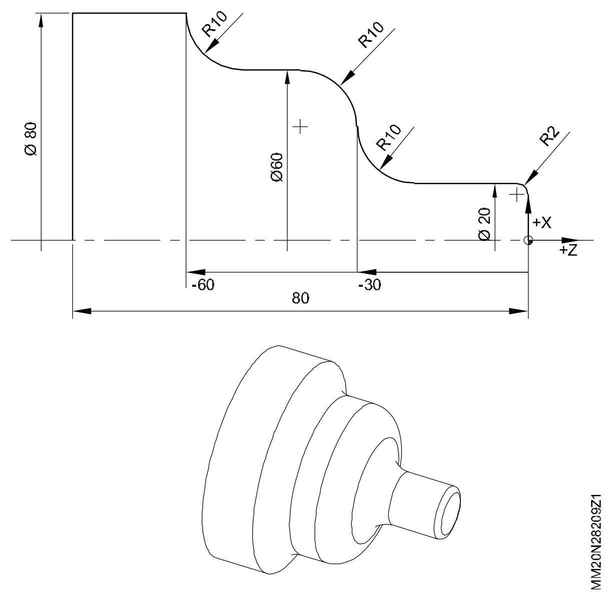
G91					
N	G	X	Z	I	K
N1					
N2					
N3					
N4					
N5					
N6					
N7					
N8					
N9					
N10					
N11					
N12					
N13					

G90					
N	G	X	Z	I	K
N1					
N2					
N3					
N4					
N5					
N6					
N7					
N8					
N9					
N10					
N11					
N12					
N13					

TASK 5 :

Write the tool path using G01, G02, G03 with G90/G91. Fig 1

Fig 1



G90					
N	G	X	Z	I	K
N1					
N2					
N3					
N4					
N5					
N6					
N7					
N8					
N9					
N10					
N11					
N12					

G91					
N	G	X	Z	I	K
N1					
N2					
N3					
N4					
N5					
N6					
N7					
N8					
N9					
N10					
N11					
N12					

Checking finish size by over sizing through tool offset on CNC simulator

Objective: At the end of this exercise you shall be able to
- **do the correction of size in tool offset.**

Job sequence

- Switch ON machine as per procedure
- Enter the program as per drawing
- Run the simulation on dry run with machine
- If there is no error run the machine in SBL or Auto mode
- Check the finished dimensions
- If there is any error compared to the required dimension calculate the difference
- Add the difference in value to the respective axis in the tool offset
- Run and produce a sample to the correct measurement.

After completing the operation enter actual value of job in Table 1

Table 1

Tool Numbers	X axis Value	Z axis Value
1	20.02	45.05
2		
3		
4		

Note

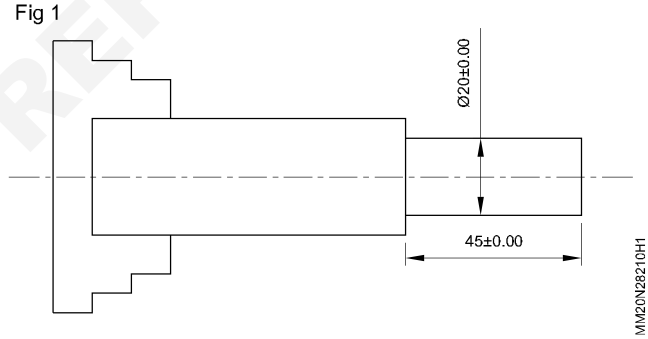
- Required size of the is job X 20 ± 0.00
  Z 45 ± 0.00
- Go to wear offset page and input the X,Z difference value
- Add the Tool wear offset difference value on the table column in Table 2.

Table 2

Tool Number	X axis Value	Z axis Value
1	- 0 .02	- 0.05
2		
3		
4		

- To avoid the rejection of job the first piece is made, slightly increased in size in offset.
- After completion of the first piece,check all the dimension without removing the chuck.
- Observe the difference value of drawing size and Acutal size, and this difference, if any, should be 'input' in the wear off set.

Fig 1



Recovering from axes over travel, on CNC simulator

Objective: At the end of this exercise you shall be able to
- **axes over travel to be released.**

Job Sequence

- Observe on CNC simulator monitor screen the axes over travel in 'x' or 'z' axes
- Press reset button to clear over travel alarm
- Select MPG mode.
- Accordingly select the axis
- Move the axis in opposite direction to re cover the over travel limit
- Continue the further operation (AUTO, MDI)

Note: The trainer shall demonstrate on how to recover the axes over travel in X and Z axis using CNC simulator and ask the trainees to practice it.

Interpret different messages generated against different errors

Objective: At the end of this exercise you shall be able to
- **identify different type of errors**
- **interpret messages generated against different errors with solution.**

Job sequence

TASK 1 **: Different types of errors**

- Programming errors
- Block preparation and execution errors
- Hardware errors
- PLC errors
- Serve errors
- Table data errors
- Errors of the MC work mode

Allarams that are displayed on the screen to alert you for system related issues. The system alarms are an integrated past of the controllor. They help you diagnose problemes and at the same time help you machine safety. Let see all the different alaram, that triggers them, and how to clear them listed in table.

Table 1

Message	Cause detection	Solution
'Empt line'	While editing of the CNC(or) while executing a programme transimitted via DNC when typing to enter into a programme (or) execute an empt block (or) containing the lable (block number)	The CNC cannot enter into the program (or) execute amptline
Improper data	When editing an axis 1 cooording after the cutting conditions (F,S,T (or) D) (or) the 'M' funtioning 2 While programming a block number greater than 999999995 While programming in ISO code	1. Programming codes ex: programme No. - Lable No. - Function - Axis co ordinates (XYZ) - Machining condition (F,S,T,O) 2 Correct the syntax of the block programme the (along between 0 and 99999999
Repeated information	While at the CNC executing a program transmitting via DNC. The same data has been entered twice in a block	Correct the syntax of the block. The same data cannot be defined twice in a block
Incomplete 'G' functions	While editing at the CNC (or) while executing program transmilted via DNC possible causes are 1. When programming in the same block two 'G' functions which are incompatible with each other.	There are group of 'G' functions which cannot go together in the block because they involve actions imcompatible with each other ex: G41/G42 linear and circular interpolation

Message	Cause detection	Solution
Incorrect order of axes	While editing at the CNC (or) while executing a programm transmited via DNC the axes co ordinates have not been programmed in the correct order (or) an axis has been programmed twice in the same block.	Correct the programme in the correct order X.Y.Z.U.V.W.A.B.C all axes need not be programmed.
Program Lable No.	While editing at the CNC (or) While executing a program transmitted via DNC. While programming, a block number out of range has been programmed.	Programming format should be with programm block number. The block number should be with in specified range
Lubricant low alaram	On machines where have lubricant system to lubricate machine slides. The system often switches/ sensors to trigger when lubricant flow low	Check and rectify lubricant sensor Fill lubricant up to mark
Airpressure low alaram	• Tool magazine not working • Check not clamping properly • Faulty sensor • Faulty air pipes and air filter. • Faulty air compressor.	Rise the air pressure by filling air in compressure tank.
Homing alaram	This alaram basically tells you that controller does not know position of the axis and its needs to home axis	To clear this alaram, you need to move home position of the machine.
Door alaram	This alaram is displayed on the screen when the machine door is in the open position While the door is open, no G-codes can be run on the machine and JOG can be done	1. Check and set faulty door sensor 2. Close the door properly before gun the machine.
Probe alaram (or) Spindle alaram	1. When you do a probing cycle you ask the axis to move contain distance and the probe is not triggered within this motion. 2. If your probe is already touching the workpiece	Enter a valid G-code command Generally G00 (or) G01 motion command will clear this alaram
Tool error alaram	Tool no is beyond the specified No. limit	Give tool No. specified limit
Motor drive alaram	This alaram is triggered stepper (or) servo motor drives when they go into any faulty condition (or) any electrical issue. (or) The motor might be stuck.	• Stop the spindle apply emergency button • Solve electrical problem
Insufficient memory	During execution the CNC doesnot have enough memory to internally calculate paths	Delete the old files. and create memory space
Inch programming limit exceeded	During execution an attempt has been made to execute in inches a program edited in millimeteres	Enter function G20 (inch programing) (or) G21 (mm programming) at the begining of the programme
Wrong password	While assigning protection (Enter) has been pressed before selecting the type of code to be assigned a password	Use soft keys and type correct password.

Message	Cause detection	Solution
Tool offset does not exist	Tool offset entered wrongly (or) greater than specified limit	Set correct tool offset
There is no enough path information	Wrongly given tool radius compensation i.e Chemfer, rounding	Set and correct tool radius compensation
Chamfer value tool large	During execution, in the chamfer function the programmed chamfer value is larger than the specified value	Give (or) set correct specified value.
Following error of spindle out of limit	• During execution of CNC, spindle stops the movement of the axes of the spindle the possible causes of errors are • Servo drive errror faulty drive • Enable signal missing power supply missing drive adjusted incorrectly • Motor error faulty motor power cable • Feed back failure defective feedback defective feedback cable • Mechanical failure spindle mechanically locked • CNC error defective CNC	• Rectify the servo drive • Rectify motor • Replace the cable • Rectify mechanical failure • Parameters adjusted

Contactor

Contactor is used for separately establishing and interrupting an electric power Circuit. The size of contactor is very compact and operating frequency is very high. Problems and remedy of the contactor is given in Table 2.

Table 2

Problem: Chattering	
Reason	**Remedy**
Loose connection in control circuit.	Tighten the terminals.
Persistent under voltage	Select coil of proper range.
Inadequate capacity of control transformer.	Both short time and continuous rating of transformer should be specified at 5% regulation.
Excessive over voltage and thereby increased bouncing time.	Check and prevent over voltage.
Due to low voltage.	Correct voltage.

Problem: Frequent Burning of Coil	
Reason	**Remedy**
Excsessive over voltage.	Check and prevent over voltage.
Under voltage & associated chattering.	Follow the measures given above to prevent chattering
Any obstruction in operation.	Check contactor and remove the obstruction.

Precaution During Maintenance

i) Switch off the contactor and upsteam fuse-switch before inspecting contactor.

ii) Do not alter contact arrangement e.g. NO to NC or vice-versa.

iii) Do not remove any unutilised contact from the contactor.

iv) Do not use abrasives to clean the contacts e.g do not file contacts, do not use emery paper.

v) Do not grease the contacts e.g. do not use petroleum jelly.

vi) If short circuit has occurred, inspect contacts before re-starting the feeder.

vii) When mechanical life of the contactor is over, replace the complete contactor. Following symptoms indicate the of end of mechanical life.

- Air gap between the central limbs of the two magnets has reduced to zero. In a new contractor it is about 0.1 to 0.2 mm, depending upon design.
- Broken shading ring of magnet
- Flaring of magnet faces ; hence difficulty in removing coil.
- Incurable humming
- Sluggish operation

Thermal Overload Relay

It is a device which is operative by a variation in the conditions of one in the same or another electric ckt. Relay provides overload protection to control circuit. when used with contactor and other motor control equipment . There is one thin strip mounted upon overload relay. When ever overload relay trips check the setting of the overload according to ckt. And reset it by pressing the thin strip. If problem still exists then take action as given in Table 3.

Table 3

Problem	Probable Cause	Corrective Action
Failure to trip	i) Mechanical binding corrosion ii) Relay damaged	Clean and adjust Replace
Trips at too low current	Heater assembled i) Heater in high ambient temp	Replace the overload relay Install relay and controller near motor in cooler place.
Trips on starting	Starting cycle of motor too long	Refer to factory
Failure to reset	i) Broken mechanism	Replace relay or broken part. Allow more time to cool and then reset.
Burning of relay contacts	i) Short circuit ii) High coil current iii) Dirt & corrosion	Check wiring Check holding coil current. Clean and adjust.

Contact Relay

In operation these are similar to the contactors except actuating voltage & current capacity. These are operated at 24V DC applied to the coil. When energized, NO (normally open) become NC (normally close) and vice-versa. Various problems with probable cause and remedy are given in Table 4.

Table 4

Problem	Probable Cause	Corrective Action
Contact chatter or pumping	i) Poor contact in control circuit ii) Broken shading coil iii) Low control voltage	Check control circuit Replace Provide voltage between 85% to 110% of normal
Short contact life	i) Low contact pressure	New contacts or spring
Over heating	i) Corroded or badly eroded tips ii) Overload iii) Weak contact pressure vi) Loose connection	Dress or replace Reduce load Clean and adjust. Replace contact spring if weak. Clean and tighten.
Weak pressure	i) Low voltage magnet not sealing ii) Worn tips	Correct voltage Replace tips
Welding of contacts	i) Bouncing of contactor and mechanical difficulties ii) Short circuit iii) Low spring pressure vi) Abnormal current	Eliminate over voltage Check short ckt. protection New spring New welding contact tips

Magnets		
Failure to close	i) Low or no control voltage ii) Blown control ckt. fuse or C.B. tripped iii) Loose wire iv) High resistance pilot on control contacts v) Overload tripped vi) Operating coil failure	Provide 85% to 110% of normal voltage as control voltage Check control circuit and replace fuse. Tighten connections Clean or replace contact. Reset Replace coil
Noisy	i) Low voltage ii) Dirt	Check control ckt. for voltage drop Clean sealing surface of magnet and bearing points. Lubricate with good grade of white machine oil
Fail	i) Grease on magnet surface ii) Contact welded	Clean Replace
Coil failure	i) Machanical injury ii) Over voltage iii) Improper magnet seal	Replace coil check circuit Clean and adjust

Sliding Contacts		
Over heating	Over current or weak contact pressure	Replace contacts
Irregular	Lack of maintenance	Smooth over contacts surface and lubricate. Do not use emery paper.
Abrasion	Lack of lubrication	Apply light coat of vaseline.

Limit switch

Limit switches are used to make or break the control circuit when mechanically actuated by a moving member. The limit switches contacts may be of the actuated, or may be normally close (NC) type which would open when the switch is actuated. Actuation of limit switch depends upon the position and surface of the stop dogs. worn off trip dog would be unable actuate the switch properly.

All the limit switches are factory set.

Limit Switch Adjustments

To adjust the limit switches proceed as follows:-

i) Move the component to the point at which the related limit switch is to be actuated.limit switch is to be actuated.

ii) Position the dog against the arm in such a manner as to trip the limit switch contact. Secure the dog in this position.

iii) If the trip dog is fixed, adjust the position of the limit switch by loosening screws securing the limit switch to the frame. Move the switch to the propr position and tighten screws.

Circuit breaker

A device designed to close the circuit by non-automatic means and to open the circuit automatically at a predetermined overload current. when properly applied with in its rating. There are basically two types of circuit breakers

i) Thermal

ii) Hydraulic

We are using thermal circuit braker. A thermal circuit braker responds only to temperature in a bimetallic element. Heat is generated in element because of I (current) square losses, it bends or deforms to unlatch the mechanism and open the circuit. Hence circuit breaker offers dual protection i.e. protection against overload through accurately caliberated thermal bimetal strip and short circuit tripping through matallic coil.

Pressure coil

The funciton of pressure switch is to make or break the control circuit. Whenever pressure bellows actuate the switch contacts. Pressure switches use single pole double throu (SPDT) microwswitches as the switching element.

Demonstrate various types of machine related centrifugal pump and the parts

Objectives : At the end of this exercise you shall be able to
- **identify various types of centrifugal pumps and their uses**
- **identify the parts of centrifugal pump.**

Job sequence

TASK 1: **Identify various types of centrifugal pumps and their uses**

Fig 1

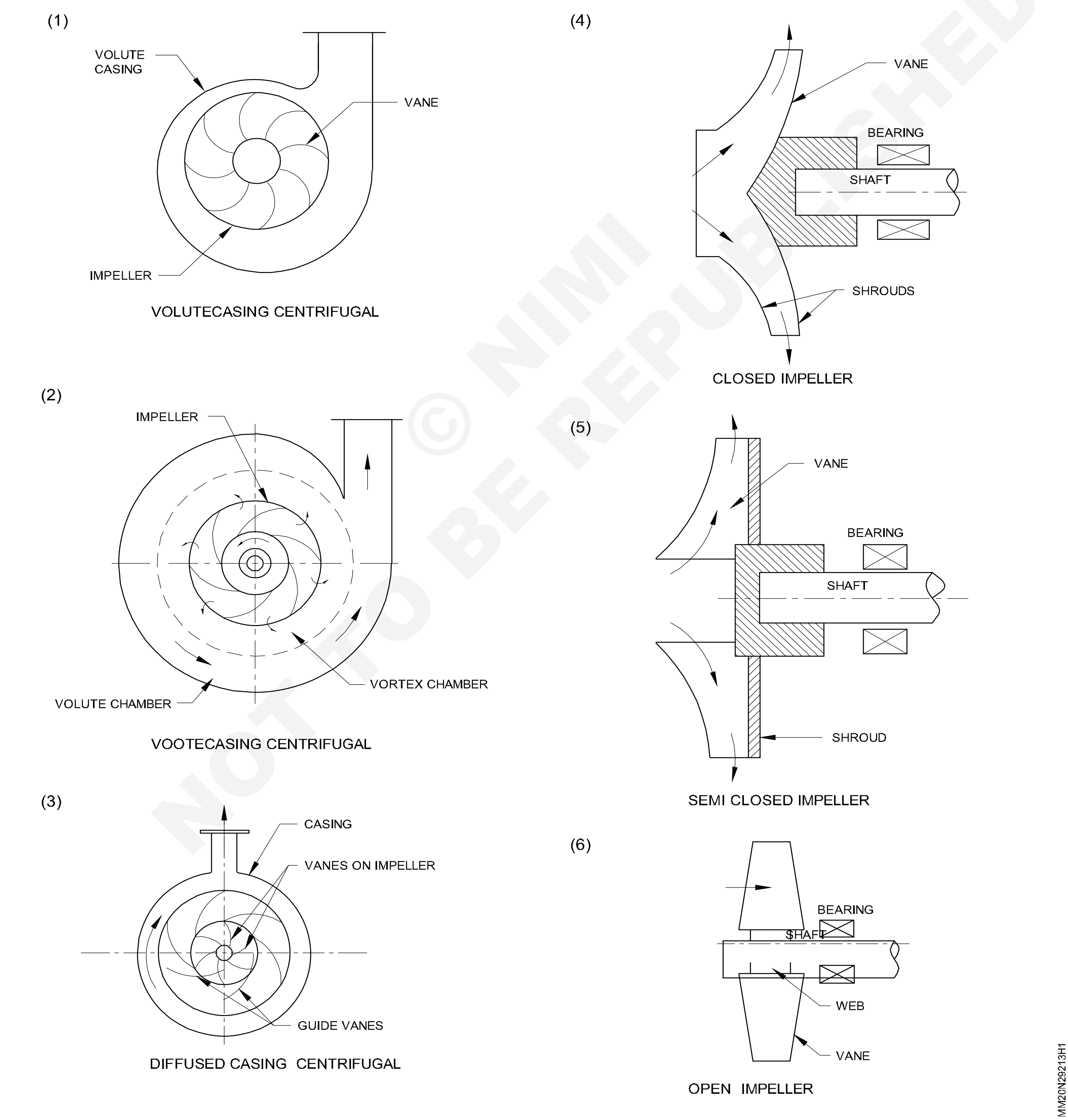
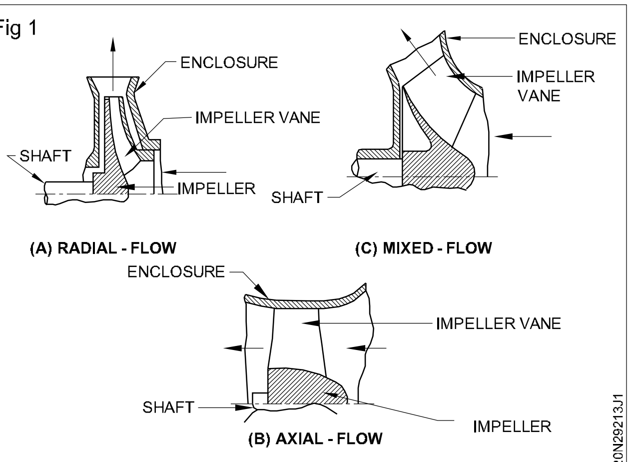
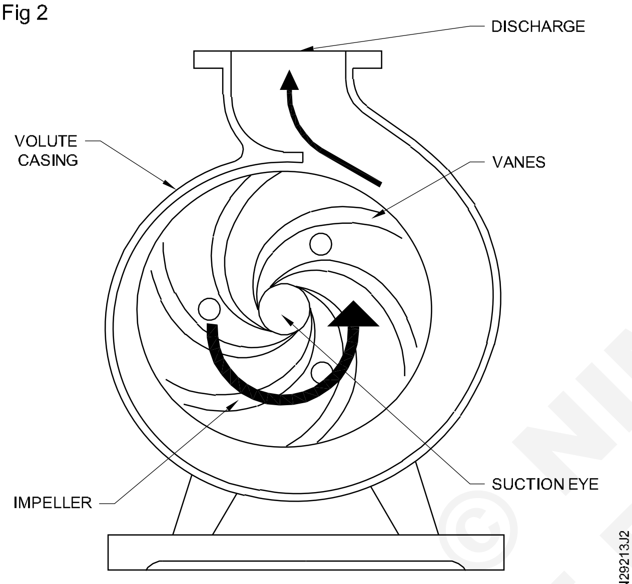


Fig 1



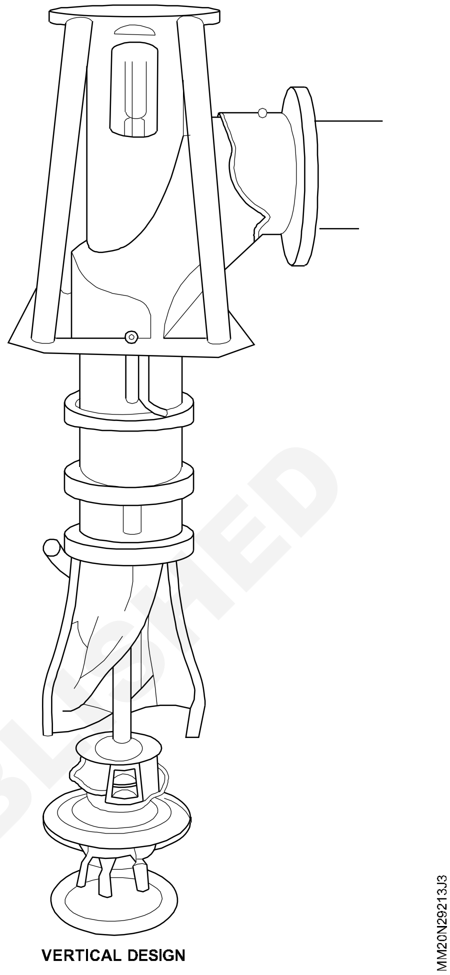
CENTRIFUGAL PUMP DIRECTION OF FLOW

Fig 2



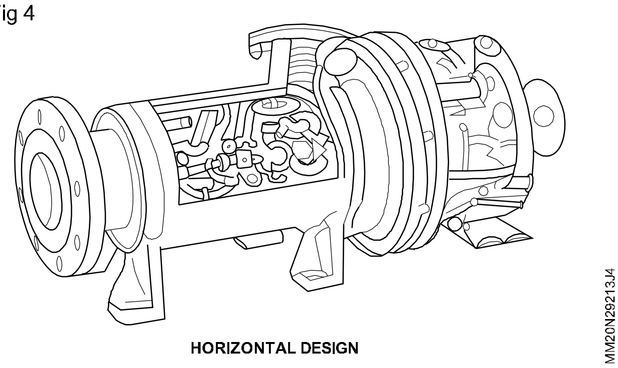
VOLUTE CASING CENTRIFUGAL PUMP

Fig 3



VERTICAL DESIGN

Fig 4



HORIZONTAL DESIGN

Fig 5

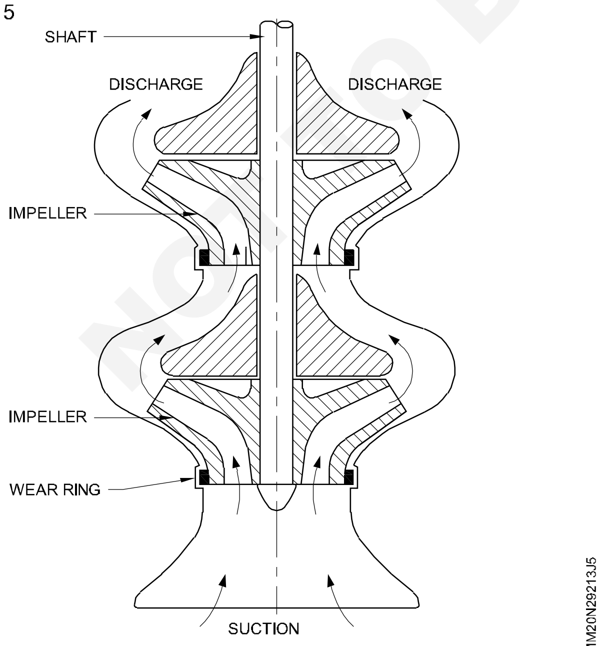
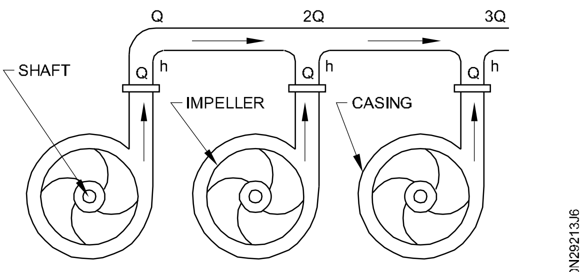


Fig 6



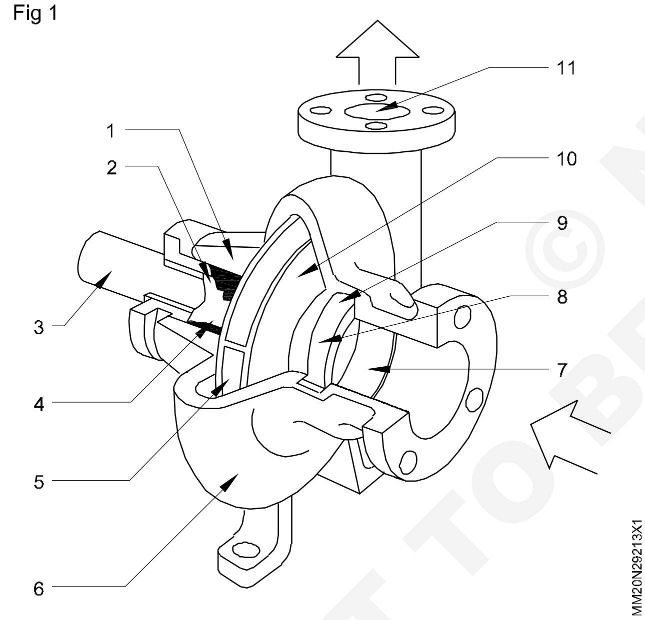
IMPELLERS IN PARALLEL

Sl. No.	According to	Type	Uses
1	Casing	1	
		2	
		3	
2	Impeller	1	
		2	
		3	
3	Direction of flow	1	
		2	
		3	
4	Position of shaft	1	
		2	
5	Stage	1	
		2	

— — — — — — — —

TASK 2: **Identify the parts of centrifugal pump**

Fig 1



Job Sequence

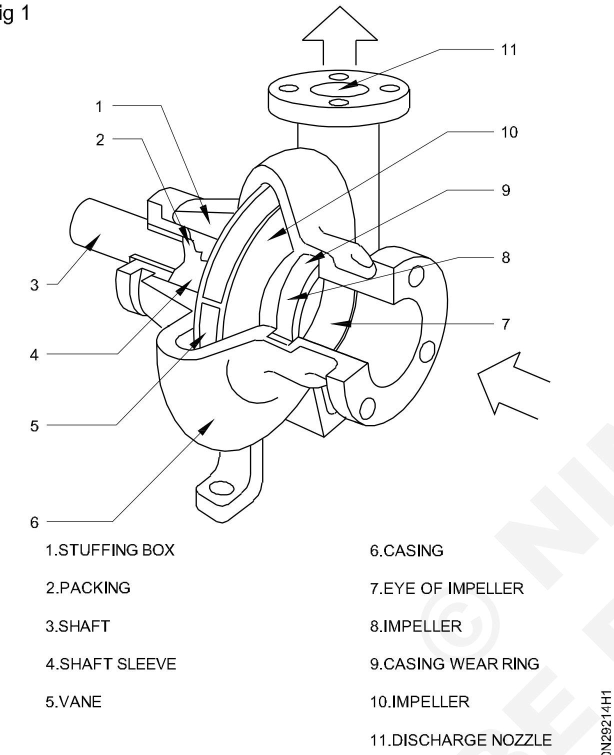
- Identify the external parts of the pump set
- Dismantle the pump set
- Clean the internal parts of the pump set
- Identify the internal parts of the pump set
- List the parts name in TABLE 1.

Sl. No	NAME OF THE PARTS
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

Overhauling of pumps with fitting of gland packing

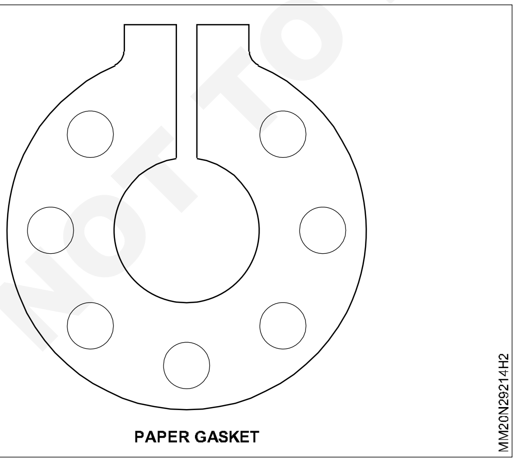
Objectives : At the end of this exercise you shall be able to
- **dismantle a centrifugal pump**
- **clean a centrifugal pump**
- **identify worn/wear out parts**
- **assemble a centrifugal pump**
- **start up the pump.**

Fig 1



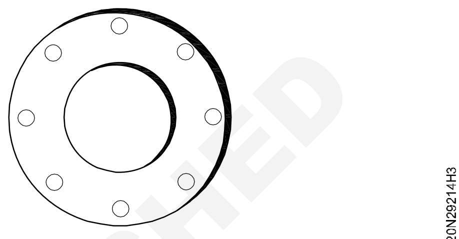
PUMP HEAD

Fig 2



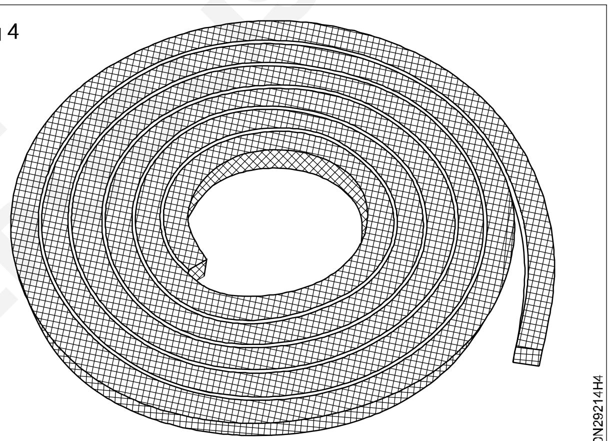
PAPER GASKET

Fig 3



RUBBER WASHER

Fig 4



POLYTHENE PACKING ROPE

Job Sequence

TASK 1 **: Dismantling of a centrifugal pump** (Fig 1)

- Before dismantling drain the oil from bearing bracket.
- Unscrew filling and drain plug.
- Drain the oil into bucket.
- Remove the nuts which hold the bearing bracket to pump casing.
- Pull the bearing bracket to remove the complete bearing bracket with rotor, impeller, bearings and shaft
- Remove the 'O' Ring.
- Remove the impeller nut, washer and lock washer.
- Pull the impeller off the rotor.
- Pull the rotor off the shaft.
- Pull rotor housing off the recess pump casing.
- Remove the 'O' Ring.
- Unscrew Allen screws and remove packing from the bearing bracket.
- Remove shaft seal key.
- Pull the shaft seal off the shaft.
- Pull the shaft seal seat carefully out of the recess of the rotor hub.
- Remove key from the shaft and remove screws.
- Pull the bearing cover with oil sealing ring off the shaft.
- Remove the paper gasket.
- Pull out the shaft with bearing bracket, allowing inspection of the bearing.

— — — — — — — —

TASK 2: **Cleaning of centrifugal pump**

- Clean all the parts by wiping with soft waste cloth.
- Use cleaning oil to clean the parts
- Clean the recess in the rotor.
- When fitting the seat, remove the protective coating, if any, without scratching the upper surface.

— — — — — — — —

TASK 3 : **Identify the worn/wear out parts of a centrifugal pump**

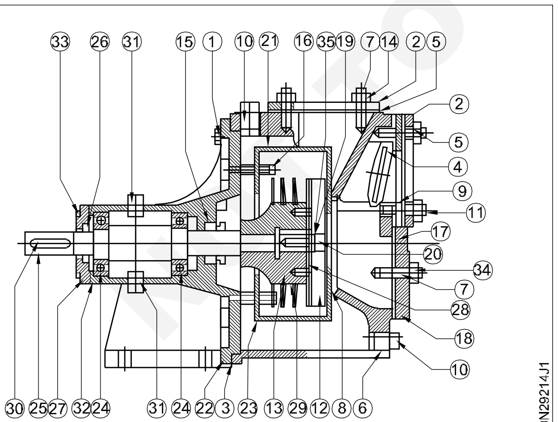
- Inspect and identify the worn /wear out parts by checking visually and dimensionally

— — — — — — — —

TASK 4: **Assembling of a centrifugal pump** (Fig1)

- Mount the 30 (Fig 1) Key in the shaft.

Fig 1



PUMP CROSS-SECTION VIEW

- Dip the outer rubber ring 15 of the seat into soapy water.
- Press the seal into place with fingers and check that all the parts are correctly embedded
- Lubricate the inner diameter of the slide ring rubber bellows with soapy water and push it over shaft.
- Push the slide ring 26 over the shaft with hand. (Note if rubber bellows is light, use a fitting tool and take care that the slide ring is not damaged), (If the carbon ring is not fixed, it is important to check that it is fitted correctly)
- Fit key (29) for rotor in the shaft and lead the rotor over the shaft and all the way to the shoulder of the shaft.
- Place the two guide (28) pins in front of the rotor.
- Place the impeller (12) on the rotor in such a way that the two guide pins are located in the impeller
- Secure the impeller with a disc 19, a lock washer (35), and an allen screw (20)
- Place the O-ring (8) that seals between pump casing (6) and (22) bearing bracket on the bearing bracket where it can be held with a little silicon grease.
- Lead the bearing bracket into place and fasten with screws.
- Mount filling 31 and drain 10 plug.

- When the pump has been assembled, check that the shaft rotates freely.
- Replace worn / wear out parts if needed.
- Place O-ring on the collar of the rotor housing and press into place in the inlet of the pump casing.
- Fasten rear plate to the bearing bracket with allen screws.
- Lead the shaft into the bearing bracket
- Mount oil sealing ring in bearing cover.
- Place paper gasket on the bearing cover and lead the cover over the shaft.
- Fastern with screws

— — — — — — — —

TASK 5: **Start up of a centrifugal pump**

- Check that the shaft 25 rotates freely without noise.
- Check that the pump casing is filled with liquid.
- Switch on the pump for a moment to check the direction of rotation.
- If the direction is correct the pump may be started.

Spare parts list

Pos . No.	Description	Qty
01	Allen screw M8x25	6
02	Counter flange	2
03	O-ring	1
04	Check valve	1
05	Flange gasket	2
06	Pump casing	1
07	Stud M10 x 25 A4	6
08	O-ring	1
09	Seat for check valve	1
10	Drain plug ½”	2
11	Stud M10 x 30 A4	4
12	Impeller	1
13	Rotor	1
14	Nut M10	8
15	Shaft seal	1
16	Allen screw M6 x 40	4
17	Inspection cover	1
18	Gasket for inspection cover	1

Pos . No.	Description	Qty
19	Disk M8	1
20	Allen screw M8 x 20 A4	1
21	Rotor housing	1
22	Bearing bracket	1
23	Rear plate	1
24	Ball bering 6206	1
25	Shaft	1
26	Oil sealing ring	1
27	Bearing cover	1
28	Guide pin 4 x 8	2
29	Key for rotor	1
30	Key for shaft	1
31	Filling plug 3/8”	2
32	Paper gasket	1
33	Stud M6 x 20	4
34	Nut Nyloc M10	2
35	Lock washer M8	1

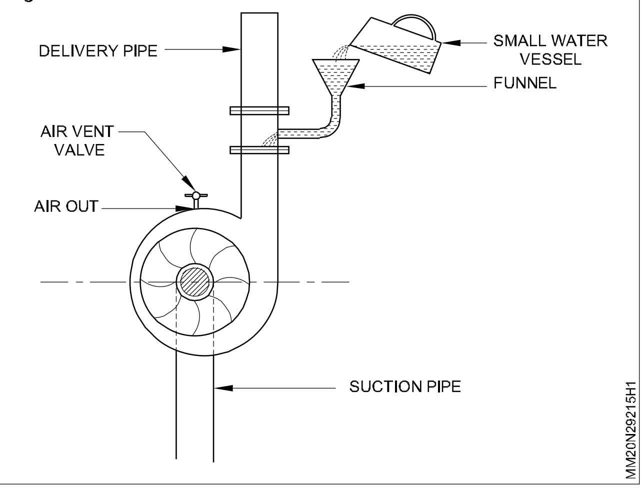
— — — — — — — —

Priming of pump

Objective : At the end of this exercise you shall be able to
- **prime the centrifugal pump.**

Job Sequence

Fig 1



- Ensure that the pump is switched off and unplugged before starting the priming process
- Check for any visible damage, leaks or loose connections.
- Ensure that all valves are in the correct position.
- Open the vent valve, to allow any trapped, air to escape from the pump and piping.
- Fill the priming chamber with water untill it overflows.
- Ensure that the water level in above pump impellar.
- Turn on the pump and observe the water flow
- Close the vent valve once water flows steadily.
- Observe the pump for a few minutes to ensure stable and efficient operation.

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Testing of pump

Objective : At the end of this exercise you shall be able to
- **testing of water flow and pressure.**

Fig 1

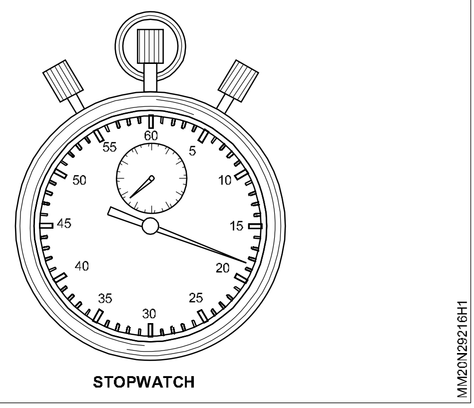
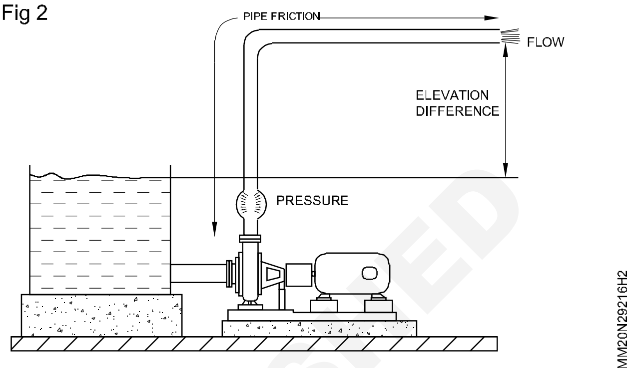


Fig 2



Job Sequence

Testing of flow and pressure

1 Check electrical connections of the pump set is correct (or) not

2 Check pump set bolts and nuts have sufficient tightness (or)not

3 Prime the pump set if needed

4 Fit the pressure gauge in the discharge pipe of the pump set.

5 Run the pump set sometime

6 Place the bucket at discharge outlet pipe and start the stop watch note down the time and pressure after reach required level of bucket

7 Repeat the step 7 several time note down the readings i.e., pressure time & capacity in the given Table.

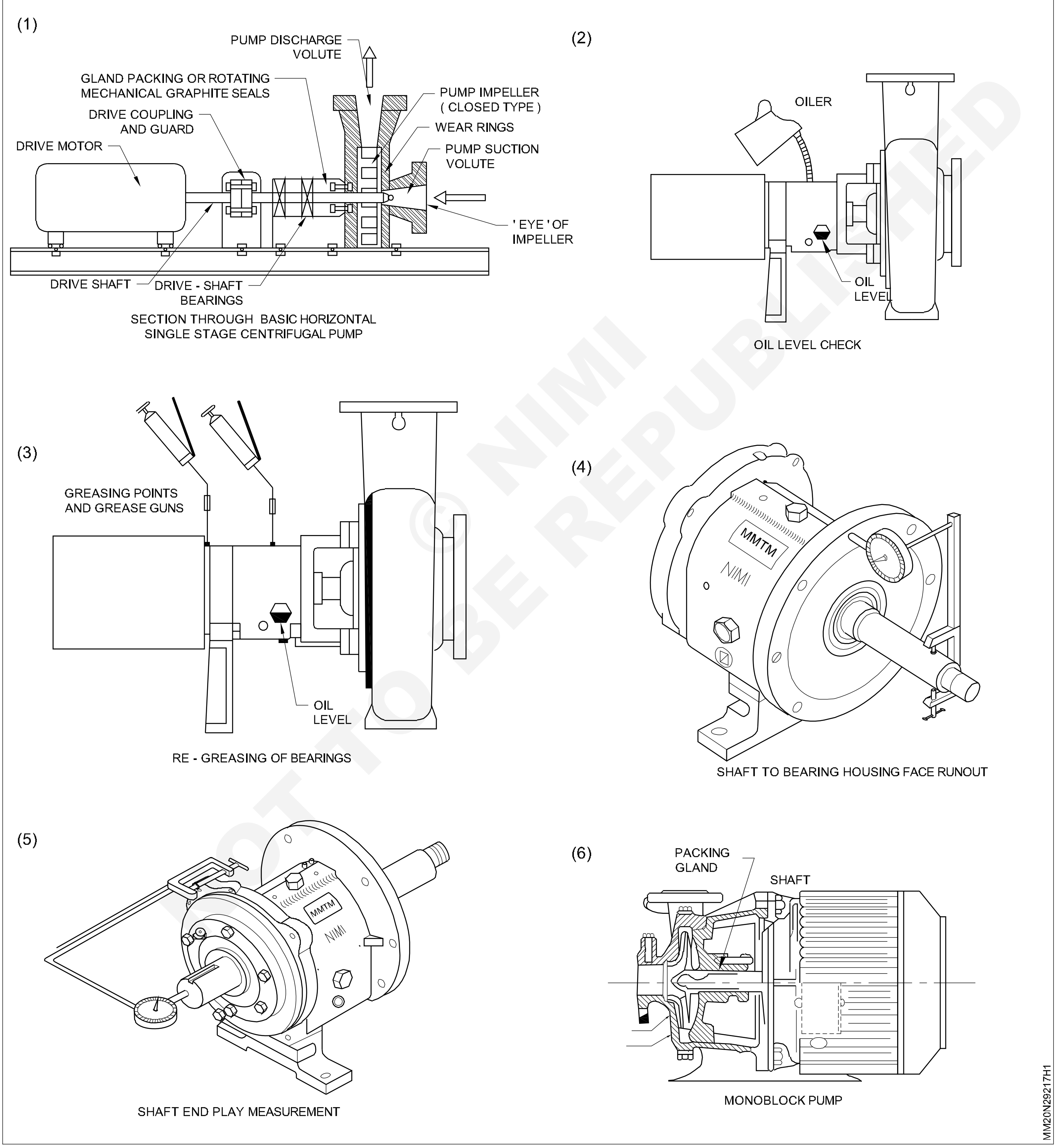
S. No.	Time (SWC/Min)	Pressure (Kg/cm^2)	Capacity
1			
2			

— — — — — — — —

Perform preventive & schedule maintenance

Objectives : At the end of this exercise you shall be able to
- **inspect centrifugal pump as per checklist**
- **carryout preventive scheduled maintenance.**

Fig 1



Job Sequence

Inspect the following items and tick in the appropriate column and list the remedial measure for the defective items.

- Check the motor noise by sound absorption (Fig 1).
- Check the power supply (Ampere and Voltage)
- Check the oil level in bearing housing (Fig 2)
- Check and Regreasing the greasing points (Fig 3)
- Check shaft the bearing housing face run out (Fig 4)
- Check and adjust shaft end play (Fig 5)
- Check and adjust play in joint coupling
- Check suction and deliver pipe lines in any leakage
- Check water leak in gland packing (Fig 6)
- Check foundation bolts if any vibration
- Run and check the proper working of pump.

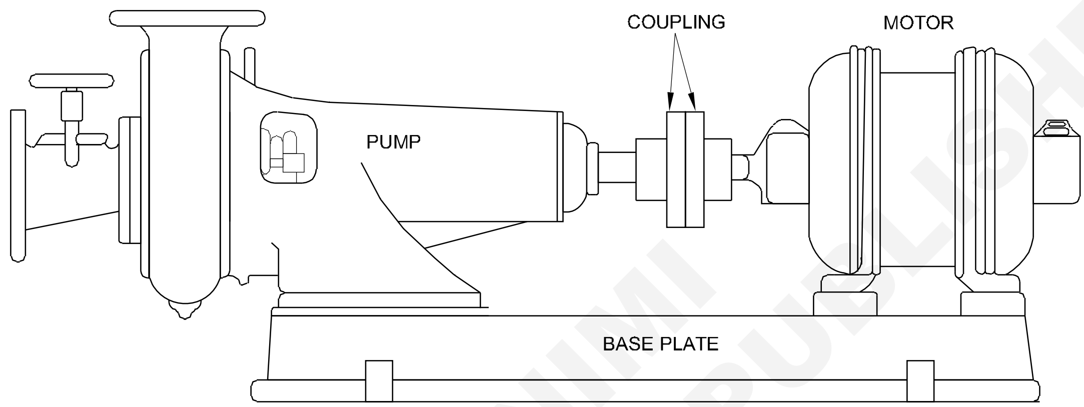
Items to be checked	Good working / satisfactory	Defective	Remedial measure carried out
Check Motor noise			
Motor power supply			
Check Ampere and Volt			
Check mechanical seal/gland			
Check stuffing box			
Check coupling bushes			
Check pump noise			
Check suction pipe			
Check delivery lines			
Check alignment of pump drive			
Check foundation for vibration			

— — — — — — — —

Trouble shooting in pump operation

Objectives : At the end of this exercise you shall be able to
- **rectify the causes for no water delivered**
- **rectify the causes for insufficient discharge**
- **rectify the causes for pump stops often, working a short duration**
- **rectify the causes for pump take too much powder**
- **rectify the causes for pumps run noisy**
- **rectify the causes for bearing heat up**
- **rectify the causes for stuffing box overheat**
- **rectify the causes for excessive leakage of stuffing box.**

Fig 1



Job Sequence

- Inspect the centrifugal pump
- List out the faults defects noticed.
- Take necessary corrective steps (actions) as per recommendations given in table 1.
- Get the approve from instructor

TABLE 1

Sl. No.	Troubles	Causes	Remarks
1	No water delivered	a. Faulty priming	Remove air completely by reprinting it
		b. Speed too low	Check the speed of the pump by tachometer Check Voltage too
		c. Clogging of suction pipe line and impeller inspect and clean	Examine carefully for solids or foreign matter lodged in suction pipe line and impeller.
		d. Wrong direction of rotation	Check the direction of rotation as marked in the casing and rectify
		e. Air leakage	Check the pipe line and joints and make it air tight
		f. Suction lift too high	Check the height and reduce it by fixing the pump at lower level.
		g. Total static head is much	Check with pressure gauges and fit the pump to the higher designed static head.

2	Insufficient discharge	a. Foot valve too small b. Damaged impeller c. Defective packing d. Worn wearing ring	Fit new one to the correct size Replace with a new one Replace th packing and properly pack it Inspect the ring visually, if they are badly worn out replace it.
3	Pump stops often, working a short duration	a. Improper priming of leakage suction line and in casing b. Excessive suction lift	Remove air by repriming. Check the pipe joints and make it air tight Check with vaccum gauge or by actual measurement and alter it.
4	Pump takes too much power	a. speed too high b. Head may be too low c. Wrong rotation d. Misalignment e. Tight bearing f. Tight packing	Check the speed by tachometer Check the head and alter it Change the rotation as indicated in the pump casing Check the alignment and resign the pump Replace it Check and replace
5	Pumps run noisy	a. Air leakage b. Misalignment c. Cavitations d. Loose bolt and nut	Check pipe lines and casing and make it air tight Check bearing impeller, shaft alignment and rectify the defects. Reduce the high vacuum produced at the eye Tight properly
6	Bearing heat up	a. Misalignment b. Pump shaft worn out c. Defective of excessive d. Insufficient of excessive lubrication e. Incorrectly fitted bearings	Realign the shaft Replace with a new one Replace with a new one Properly lubricate by using specified lubricant Remove and fit it correctly
7	Stuffing box over heat	a. Packing too light b. Poor grade to packing	Loose the gland Replace and use good one material
8	Excessive leakage of stuffing box	a. Seal ring fitted incorrectly b. Misalignment c. Pump shaft worn out d. Incorrect packing e. Impeller out of balance	Remove and fit it correctly Check the alignment and correct it Chang the shaft Remove all packing and pack it properly Check the impeller and balance it.

Identification of various types of fans blowers and their parts

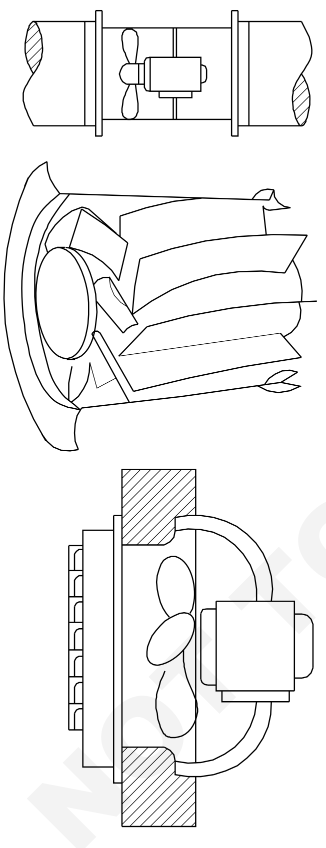
Objectives : At the end of this exercise you shall be able to
- **various types of fan's**
- **identification different part of fan**
- **types of bowers**
- **identification different parts of blower**

Job sequence

TASK 1 **: Type of Fan's**

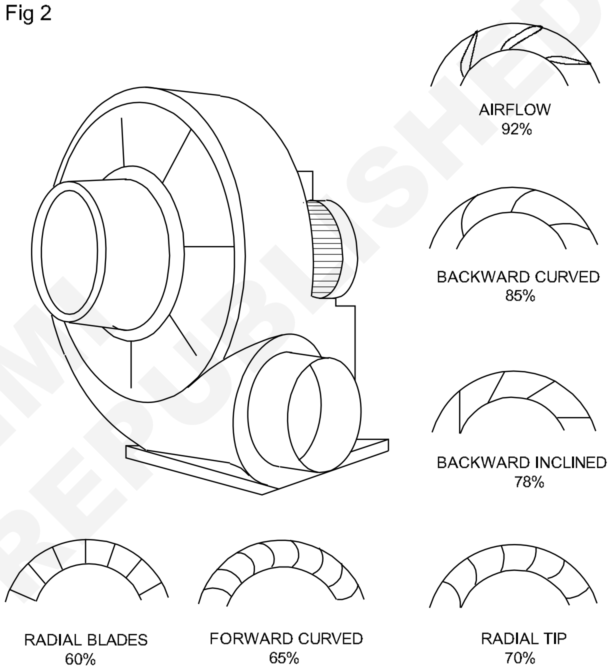
- **Fan types :** Fans are classified according to the direction of flow through the impeller.
- **Axial flow:** Air flows through the impeller parallel to, and at a constant distance from the axis. The pressure rise is provided by the direct action of the blades (Fig 1)

Fig 1



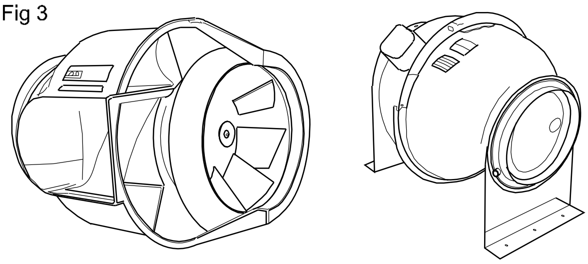
- **Centrifugal or radial flow:** Air enters parallel to the axis of the fan and turns through 90° and is discharged radially through the blades. The blade force is tangential causing the air to spin with the blade and the main pressure is attributed to this centrifugal force (Fig 2)

Fig 2



- **Mixed flow:** Air enters paralled to the axis of the fan and turns through an angle which may range from 30° to 90°. The pressure rise is partially by direct blade action and partially by centrifugal action. (Fig 3)

Fig 3



- **Cross flow:** Air enters the impeller at one part of the outer periphery flows inward and exits at another part of the outer periphery.

Trainee fill the table with help of Instructors

Table 1

S. No.	Type of Fan	Characteristics	Applications
1	Arial fliow		
2	Centrifugal or radial flow		
3	Mixed flow		
4	Cross flow		

— — — — — — — —

TASK 2: **Identification different part of fan**

- Thoroughly clean the fan.
- Dismantle the fan using proper tools.
- Identify all the parts against the numbers in Fig 1 & 2.
- List out the parts name in given TABLE 1 & 2.

Fig 1

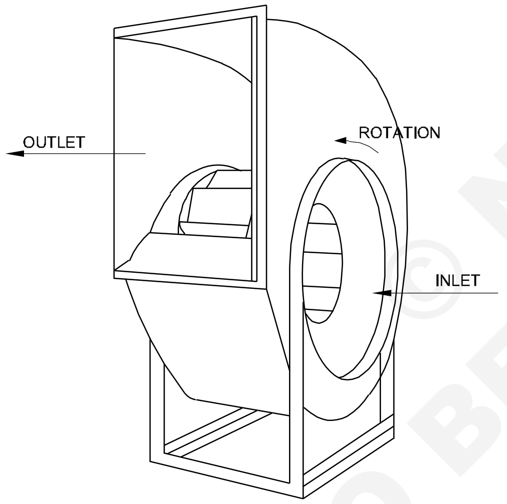


Fig 2

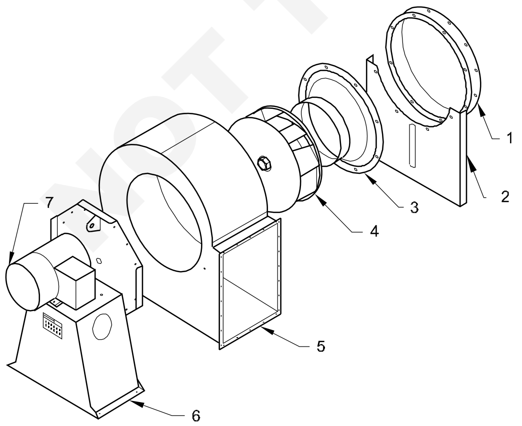


Fig 3

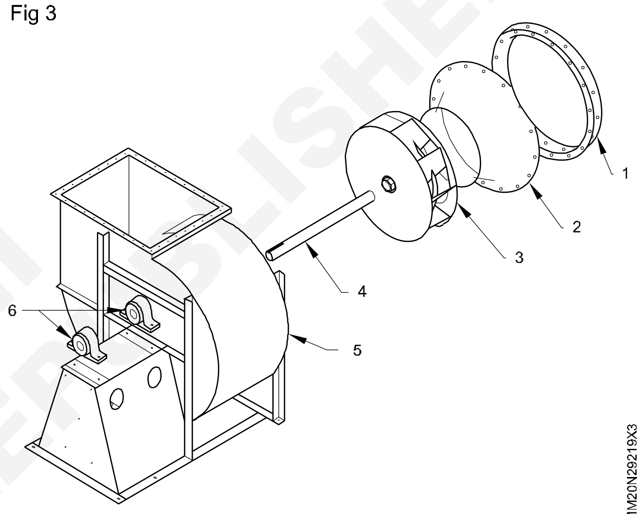


TABLE 1 (Fig 1)

Part No.	Name of the parts
1	
2	
3	
4	
5	
6	
7	

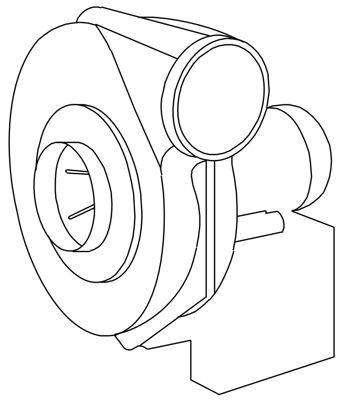
TABLE 2 (Fig 2)

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

— — — — — — — —

TASK 3: **Types of Blowers**

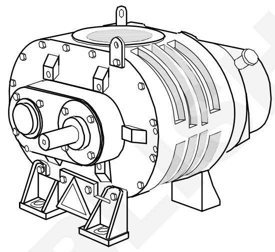
Fig 1



CENTRIGUGAL BLOWERS

MM20N29219Y1

Fig 2



BLOWER

MM20N29219Y2

Types of blowers

Centrifugal blowers (Fig 1)

- Centrifugal blowers use high speed impellers or blades to impart velocity to0 air or other gases. They can be single or multi-stage units. Like the fans, centrifugal blowers offer a number of blade orientations, including backward curved, forward curved and radial. Blowers can be multi-or variable speed units. They are usually driven by electric motors.

Positive displacement blowers

- Positive displacement blowers are similar in principle to positive displacement pumps in that they use mechanical means to squeeze fluid and thereby increase pressure and or velocity. Centrifugal designs, on the other hand, in part velocity and pressure to media by flinging them outward with impellers. Among positive displacement blowers the Roots, or rotary lobe, type is common, which uses two counter-rotating lobed rotors to move fluid through the blower, much the way a gear pump moves oil or other viscous liquids. A cutaway blower (Fig 2) shows one of the two rotors. Positive displacement blowers are often driven by direct-coupled electric motors but they can be driven by gas engines, hydraulic motors, etc in unusual circumstances.

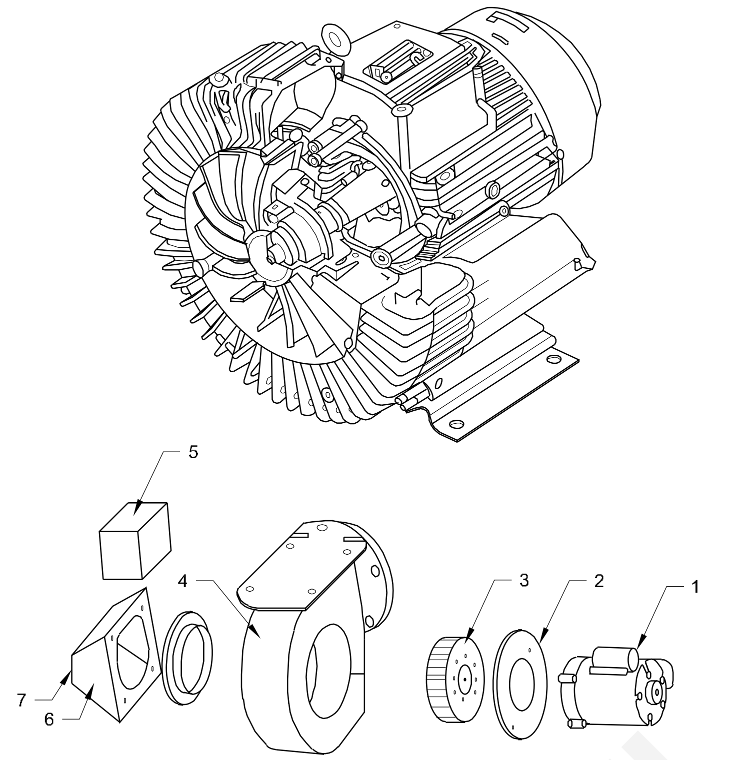
Trainee to be fill the Table 2 with the help of Instructor / trainer

S. No	Type of Blower	Characteristics	Application's
1	Centrifugal Blower		
2	Positive Displacement Blower		

— — — — — — — —

TASK 4: **Identification different parts of Blower**

Fig 1



SL. NO	NAME OF THE PARTS
1	
2	
3	
4	
5	
6	
7	

MM20N29219Z1

Job Sequence

- Thoroughly clean the blower
- Dismantle the parts.
- Identify and list out the parts in TABLE 1.

— — — — — — — —

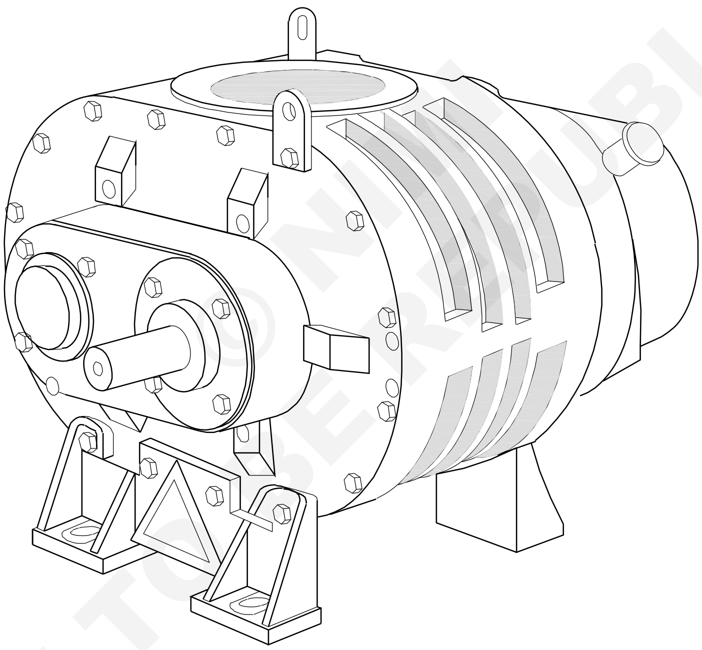
Dismantle, inspect repairs/replace worn out and assembly the same (Fan / Blower)

Objectives : At the end of this exercise you shall be able to
- **disassemble the fan / blower**
- **clean, check and replace the worn out parts**
- **assemble the fan / blower**
- **trial run of the fan / blower**
- **follow the safety instructions / precautions.**

Requirements

Tools/Instruments		Materials / Equipments	
• Trainee Tool Kit	- 1 No.	• Seals / Gaskets	- as reqd.
• Wooden blocks	- 2 No.	• Grease	- as reqd.
• Gear puller	- 1 No.	• Banian Cloth	- as reqd.

Fig 1



MM20N29220H1

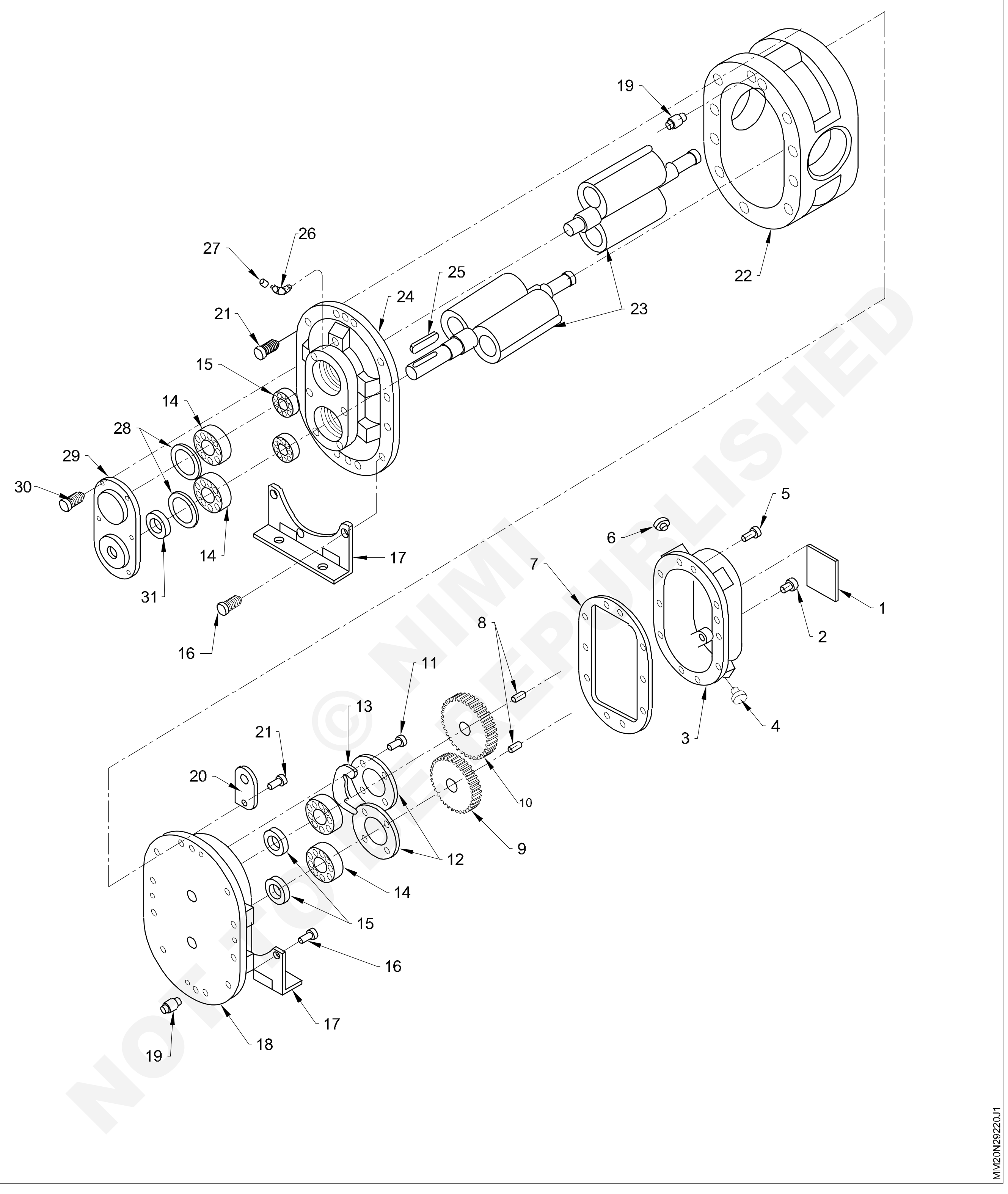
Job Sequence

Exploded view of the blower is given in Fig 1

Disassembly

- Drain oil from gear case by removing drain plug 4. (Fig 1)
- Remove the socket head screws 5 from the gear case 3. (Fig 1).
- Remove the gear cover from the gear head plate.

Fig 1



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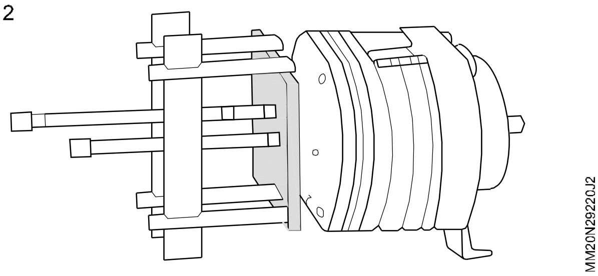
31
MM20N29220J1

Part No.	Description	Qty.
1	Nameplate	1
2	Oil level plug	2
3	Gear case	1
4	Drain plug	1
5	Capscrew-gear case to bearing housing	6
6	Vent plug	1
7	Gasket gear case	1
8	Taper pin	2
9, 10	Timing gear	1
11	Screw-bearing retainer to Bearing	8
12	Bearing retainer	2
13	Shim set	1
14	Bearing	4
15	Main seal	4
16	Capscrew-Foot to bearing housing	6
17	Foot group	1
18	Head plate	1
19	Dowel pin	4
20	Lifting lug	2
21	Screw-bearing housings to impeller	14
22	Impeller case	1
23	Shaft assembly group	1
	Assembly shaft – Long	
	Assembly shaft – Short	
24	Drive head plate	1
25	Drive key	1
26	Grease fitting	2
27	Grease fitting cap	2
28	Wavy washer	2
29	Drive cover	1
30	Screw-drive cover to bearing housing	6
31	Drive seal	1

- Using a gear puller, remove timing gears. The taper pin should back out with the gear as the gear is being removed (Fig 2).

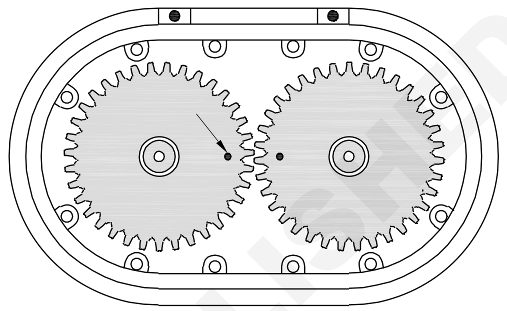
Take care not to damage gear teeth while using puller as gears are to be used again.

Fig 2



- If timing gear appear to be reusable, match mark timing gear tooth mesh by making small punch marks on the ends of meshing gear teeth with a pin punch and hammer (Fig 3)

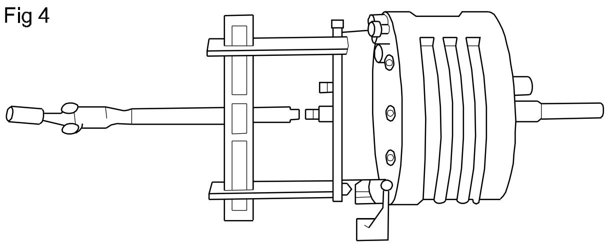
Fig 3



The impeller tip to valley (throat) and the case to head plates should also be match marked to facilitate blower reassembly.

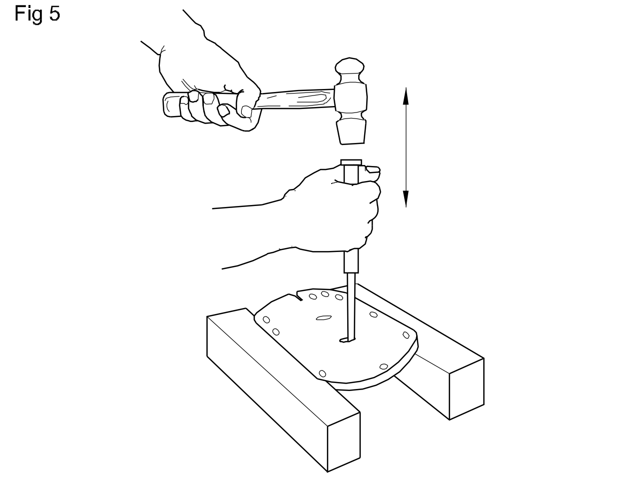
- Blowers with mechanical seals have two wavy washers (28) located between the bearings and the cover on the drive end.
- Remove the socket head cap screws (30) from the drive end bearing cover (29) and remove the cove. Drive shaft oil seal (31) should come free when cover is removed.
- Remove mounting foot (17) from the drive head plate (24) by removing the cap screws (16).
- Remove the cap screws (21) which secure the drive head plate (24) to the impeller case (22).
- Using a puller plate, bolt to the drive head plate using the tapped holes used to secure the drive cover
- Install a gear puller to each shaft and attach puller arms to the plate. Turn each puller only half a revolution at a time keeping the advance of the shafts as uniform as possible (Fig 4). After the head plate(18) has been removed, detach the puller plate.

Fig 4



- Remove the two drive end seal (15) from the drive head plate (24) using a ball pen hammer and punch (Fig 5)

Fig 5



Exercise care, not to damage the head plate bearing bores when removing bearings.

- The grease seals can now be driven out of the drive head plate with hammer and punch (Fig 5). Discard the seals as they will not be reused. Replace grease seals each time the head plate is removed.
- Remove the four cap screws (11) which fasten the bearing retainers (12) to the gear head plate.
- Attach puller plate to the gear head plate using that tapped holes used to secure the bearing retainers.
- Install a gear puller to one of the shafts and attach puller arms to the plate (Fig 4)
- Remove mounting foot (17) from the gear head plate by removing 4 cap screws (16).
- Push the impeller shaft through the gear head plate and remove the impeller assembly (23) (Fig 6). Remove the caps screws (21) securing the gear head plate to the impeller case located near each dowel pin on the head plate in a threaded holes. Tig men the screws evenly until the head plate separation from the impeller case.
- Remove the two gear and bearings (14) from the gear head plate (18).
- Remove the oil seals (15) from gear head plate (18).
- Clean all the parts with kerosene. Wipe with dry cloth.
- Check and replace the worn out parts.

Assembly

- Make sure all metallic parts are clean and free of any nicks or burns.
- Lubricate the outside diameter of the lip seal (15) with a light oil or grease. Install seals in both the drive head plate (24) and gear head plate (15). The seal lip should always face towards the bearing or lubricant
- Now seals should be installed each time the head plate is removed.

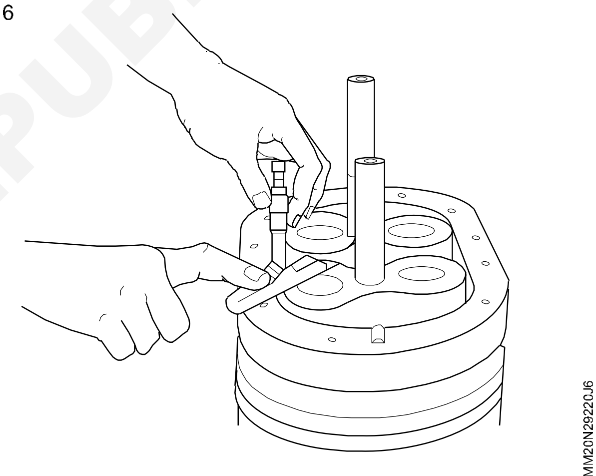
Make sure seals are fully seated. Use extreme care when installing

- Assemble a gear head plate (18) and mounting foot (17) to the impeller case with cap screws (21) and where the mounting foot is secured to the head plate, use cap screws (16). The two positioning dowel pins (19) will ensure proper alignment of the head plate and impeller case. Also secure lifting lugs using cap screws (21)

Seals are delicate: Use extreme care when installing impeller shafts in the head plate boxes. A piece of light shim stock wrapped around the shaft keyway will prevent cutting the seal lip.

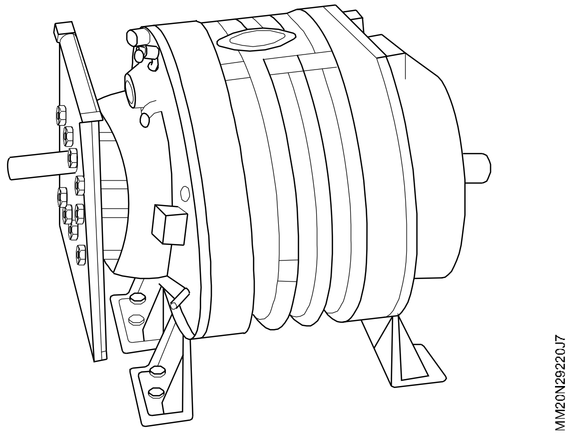
- Apply a light oil or grease on the shaft seal areas and the bearing areas. Insert impellers into the gear head plate using the same head plate boxes as used in the original assembly.
- Position blower so that impellers are vertical with the drive and on top. It will be necessary to use blocks in order for the unit to set level. Measure the total end clearance using a depth micrometer. (Fig 6)

Fig 6



- Assemble drive head plate (24) to impeller case as in step 3 with gear head plate. If shims were required, place shims between drive head plate and impeller case.
- Apply a light oil to the drive head plate bearing bore, bearing inside diameter and shaft seat. Install the drive end bearings (14) as far as possible without force.
- Attach the puller plate shown in Fig 7 to the drive head plate using the tapped holes used to secure the drive cover.
- Tighten the bolts so that the advance of the bearings stay as uniform as possible. Bearings should be pressed until flush with the drive head plate.
- Lubricate the gear end bearing fits with a light oil as described previously. Install gear end bearings (14) as far as possible without force.

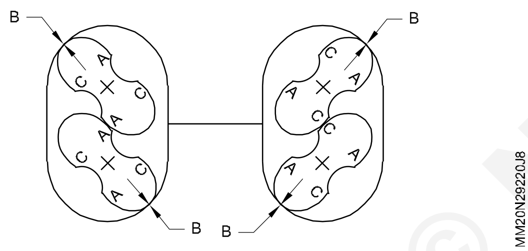
Fig 7



Bearing will not be flush with gear head plate bores when completely seated.

- Impellers should now be checked for the axial movement by hitting the ends of the impeller shafts with the pain of your hand.
- Push the impellers against the gear head plate and recheck the total and clearance between the drive head plate and the impellers. (Fig 8).

Fig 8



- Impeller tip to case clearance should be checked at this time by inserting the correct thickness feeler gauge between the tip and the case and rotating the impeller (Fig 8) repeat the procedure on both impellers.
- Apply a light grease or oil on the shaft area where the timing gear will be positioned.
- Install the timing gears.
- Assemble the drive-cover to the head plate
- Replace drive shaft grease seal (31) in the drive end cover (29). The seal lip should always face towards the bearing or lubricant. Pack bearing cavities with recommended grease and secure drive cover with cap screw (30) to driver head plate

Exercise care not to damage the seal lip as it passes over the shaft keysway.

- Assemble the gear case (3) and gasket (7) to the gear head plate (18) using cap screws (5). Tighten the cap screws alternately and evenly.
- Place the Fan / blower on the feet on a flat surface. Loosen cap screws (16) and level the unit up. The fan / blower base flatness should be within 0.02 of an mm. Re-tighten cap screws (16)
- Now run precaution

Safety precautions

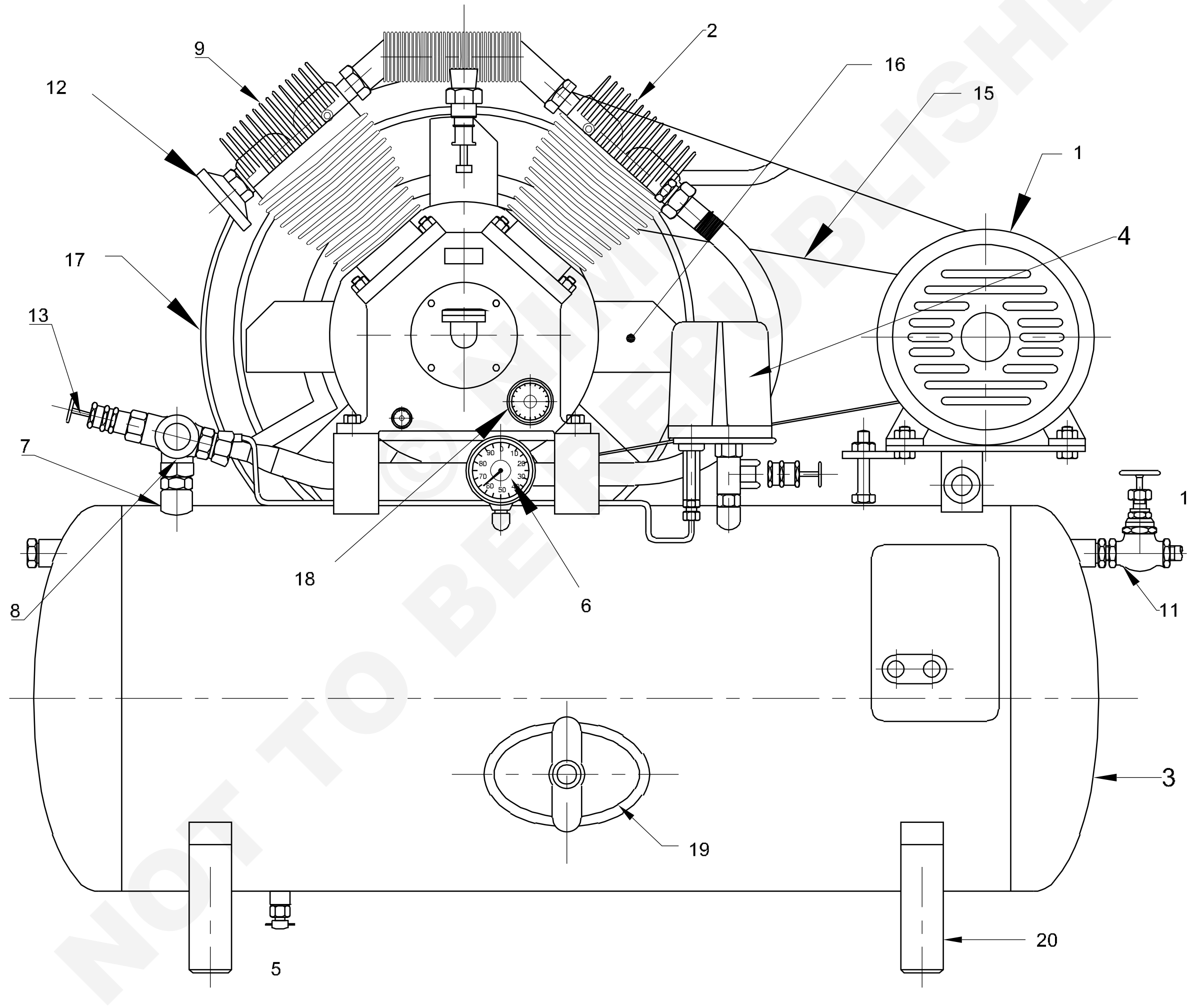
- Do not operate the Fan / blower with open inlet or outlet port
- Do not operte above or below recommended Fan / blower speed range.
- Fan / Blower is not to be used where non-sparking equipment is specified.
- Do not operate without belt guard or coupling shield.
- The fan / blower discharge piping may be extremely hot and cause skin burns on contact.

— — — — — — — —

Demonstrate Compressor and their parts

Objectives : At the end of this exercise you shall be able to
- **identify the different parts of compressor**
- **list out the parts in Table 1.**

Fig 1



COMPRESSOR

Job Sequence

- Clean the compressed thoroughly
- Clean all the parts of dismantled compressor.
- Identify all the parts
- List out the parts in given table.
- Start the compressore
- Adjust the Pressure
- Put off the compressor

TABLE 1

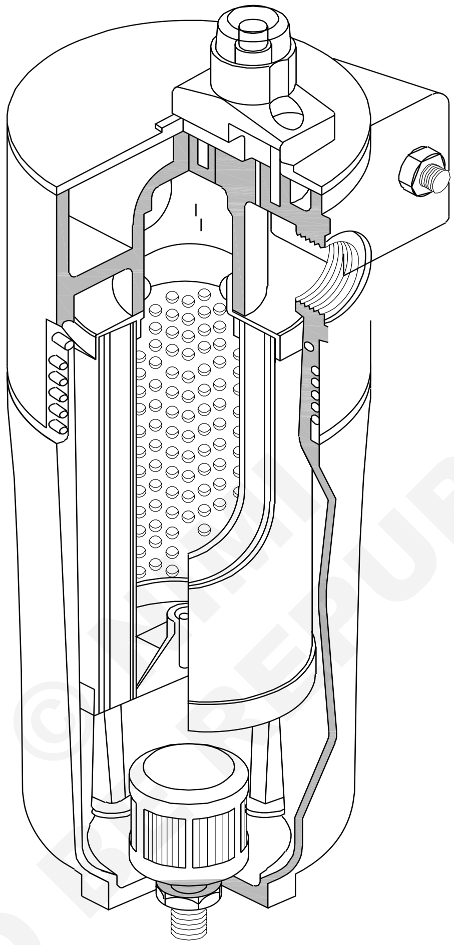
Parts No.	Name of the parts
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

— — — — — — — —

Cleaning and changing of filters of compressor

Objectives : At the end of this exercise you shall be able to
- **dismantle and clean filter components**
- **replace filter components.**

Fig 1



Job Sequence

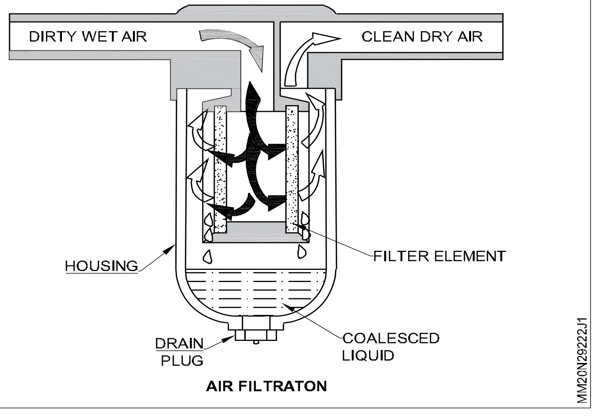
Dismantle and clean filter components

- Turn off the main system air supply
- Place a container under the drain plug to collect the liquid accumulated in the filter.
- Remove the drain plug and collect the coalesced liquid.
- Unscrew the housing of filter.
- Remove the filter element.
- Thoroughly wash all components in warm water.
- Inspect the filter screen mesh carefully.
- Inspect the filter element for its damage and its lifespan.
- If required procure new filter elements.

Replace the filter components.

- Replace all the components in reverse order as dismantled.
- Use proper 'O' ring gasket Teflon tape while fixing housing and drain plug to avoid leakage.

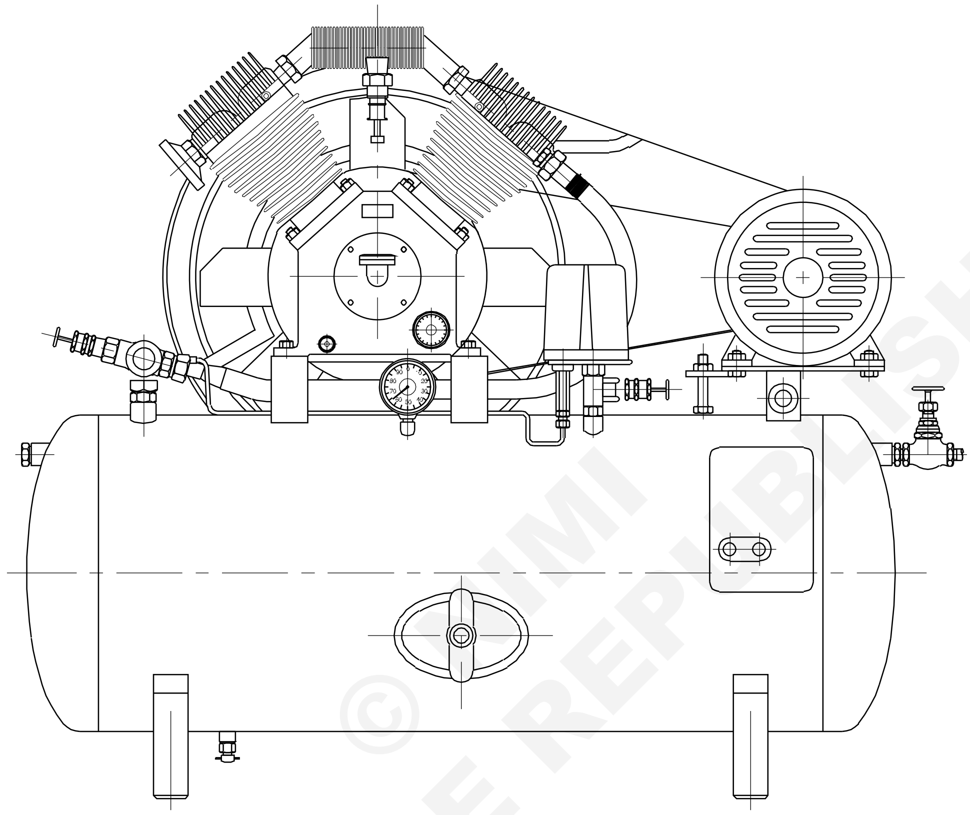
Fig 1



Perform schedule and preventive maintenance of compressor blowers

Objectives : At the end of this exercise you shall be able to
- **inspect the compressor as per check list and carry out schedule and preventive maintenance**
- **inspect the Blower as per check list and carry out schedule and preventive maintenance.**

Fig 1



Job Sequence

TASK 1:

- Inspect the following parameters and list remedial actions for the defect.

Daily preventive maintenance inspection

Date	Parameters to be checked	Condition	Defects	Remedy
	Pressure of air			
	Temperature of air			
	Inter cooler air pressure			
	Lubrication oil level			
	Noise			
	Vibration			
	Any air leaks			
	Unloader operation			

Quarterly preventive maintenance

Date	Parameters to be checked	Condition	Defects	Remedy
	a) Compressor valve b) Wear and dirt c) Safety valve operation d) Piston rod wear e) Crank case sludge f) Cylinder head bolts g) Belt tension h) Bearing wear i) Lubricator oil cups			

Yearly Preventive Maintenance Inspection

Date	Parameters to be checked	Condition	Defects	Remedy
	1. Cylinder a. Wear b. Scoring c. Corrosion 2. Piston Rod a. Scoring 3. Piston Ring a. Damage b. Wear c. Tightness 4. Packing glands wear 5. Crank case wear 6. Crank shaft bearings 7. Fly wheel bearings 8. Alignment of compressor with drive			

Job Sequence

TASK 2:

Inspect the following items and tick in appropriate column and list the remedial measures for the defective items

- Check the motor noise by sound absorption
- Check the power supply (Ampere and Voltage)
- Check the oil level / grease in bearing
- Check a the re-greasing points
- Check shaft bearing housing face run out
- Check and adjust shaft play
- Check suction and delivery pipe lines in any leakage
- Check foundation bolts if any vibration
- Remove the dust with Air pressure and dry cloth.

Trainee fill the table with help of instructor as per schedule

Items to be checked	Good working / satisfactory	Defective	Remedial measure carried out
Check Motor noise			
Motor power supply			
Check Ampere and Volt			
Check mechanical seal			
Check coupling bushes			
Check suction pipe			
Check delivery lines			
Check lubrication points			
Check alignment of pump drive			
Check foundations for vibration			

Maintenance Records

Name of the machine/Equipment :

S.No	Date	Nature of fault	Details of rectification done	Signature of in-charge

Change the compressor rings and oil rings in a reciprocator compressor

Objectives : At the end of this exercise you shall be able to
- **servicing compressor**
- **change the piston rings.**

Requirements

Tools/Instruments		**Materials**	
• Trainee Tool Kit	- 1 No.	• Kerosene	- as reqd.
• Socket spanner set	- 1 No.	• Soap oil	- as reqd.
• Torque wrench	- 1 No.	• Lubricant oil	- as reqd.
• Outside micrometer	- 1 No.	• Cleaning oil	- as reqd.
• Cylinder bore gauge	- 1 No.	• Emery paper	- as reqd.
Equipments/Machines		• Grease	- as reqd.
		• Soap water	- as reqd.
• Single acting compressor		• Piston ring (oil /pressure)	- as reqd.

Job Sequence

TASK 1 **: Servicing air compressor**

1 Release air from the system.

2 Remove air lines..

3 Remove fasteners and take out air compressor from its position

4 Clean air compressor unit externally.

5 Remove the drive connection.

6 Remove air compressor cylinder head (1) (Fig 1).

7 Remove reed valve assembly (8) with valve plate.

8 Remove inlet and delivery reed valves from the valve plate.

9 Remove base cover plate.

10 Turn crankshaft and bring the piston to bottom position.

11 Unlock the lock plate (16) and loosen the connection rod bolts (17) and take out the cap (15) along with bearing shell (14).

12 Remove piston assembly (9)

13 Remove piston oil ring (10) and compression rings (11).

14 Remove gudgeon pin (12) & connecting rod (13) from piston.

15 Remove end cover (19) along with gasket (18).

16 Take out crankshaft (21) and thrust washer (22).

17 Clean all the parts.

18 Clean oil passages in crank shaft and connecting rod and check for free flow of air.

19 Inspect the cylinder bore for wear, taper and ovality Recommend for re-boring if required.

20 Check ring clearance in piston groove.

21 Inspect connecting rod for cracks or any damage.

22 Inspect the crank shaft journal for wear/taper and ovality.

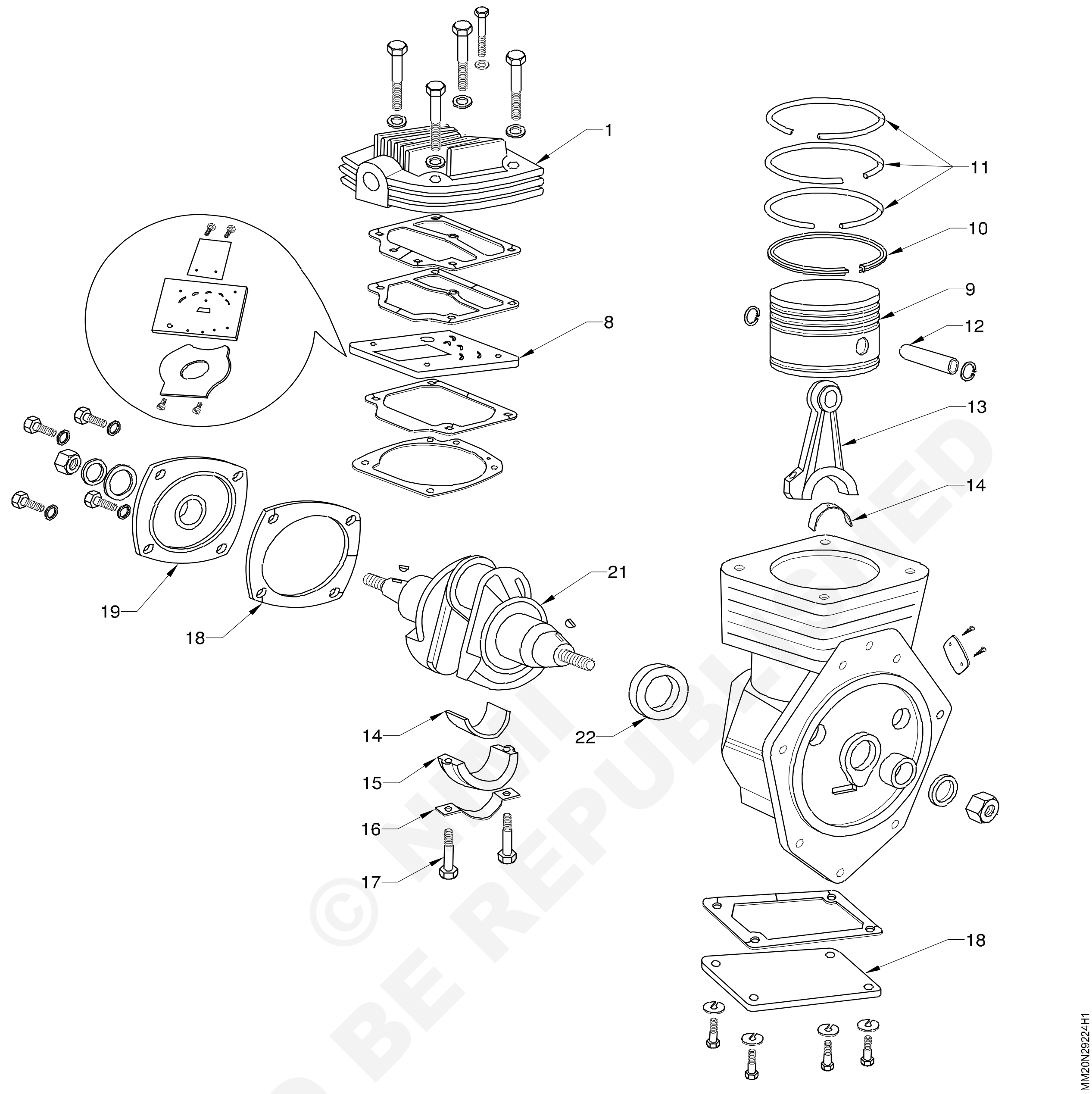
23 Check clearance between crankshaft journals and bearings and if required replace the bearings.

24 Inspect the inlet and delivery reed valve. If necessary replace them.

25 Check crankshaft thrust washer for any damage.

26 Check piston and cylinder head to crack, damage etc.

Fig 1



TASK 2: **Assembling (Change the piston rings)**

1 Place crankshaft (21) along with thrust washer (22) in correct position in the cylinder block.

2 Press new oil seal and position new gasket on the end cover.

3 Fit the end cover (19) on compressor body.

4 Tighten end cover screws with washers and check for free rotation of crank shaft.

5 Assemble piston (9) and connecting rod (13) with gudgeon pin (12).

6 Fix new piston rings (10) and (11) in piston grooves and stagger these as recommended by manufacturer.

7 Fix connecting rod upper bearing shell (14) in connecting rod.

8 Place ring guide on top of bore. Ensure that ring guide aligns with bore at complete periphery.

9 Insert piston and connecting rod assembly in ring guide and bore, with a wooden block.

10 Fix connecting rod cap (15) with bearing shell (14) and tighten connecting rod cap bolts (17) at recommended torque.

11 Fit the delivery reed valve on valve plate.

12 Reverse the valve plate and fit inlet reed valve.

13 Assemble cylinder head and valve plate using proper gasket. Ensure the gasket does not over-lap the valves.

14 Apply grease/oil on the gasket.

15 Fit the cylinder head and fix fasteners and tighten at recommended torque.

16 Fit bottom cover on compressor body.

17 Fit air compressor on Tank.

Demonstrate mechanicals & hydraulic jack, rope puller, chain puller, chain block and winch

Objectives : At the end of this exercise you shall be able to
- **measure working of mechanical / hydraulic jack**
- **measure working of rope puller**
- **measure working of chain puller, and chain block**
- **measure working of winch.**

Fig 1

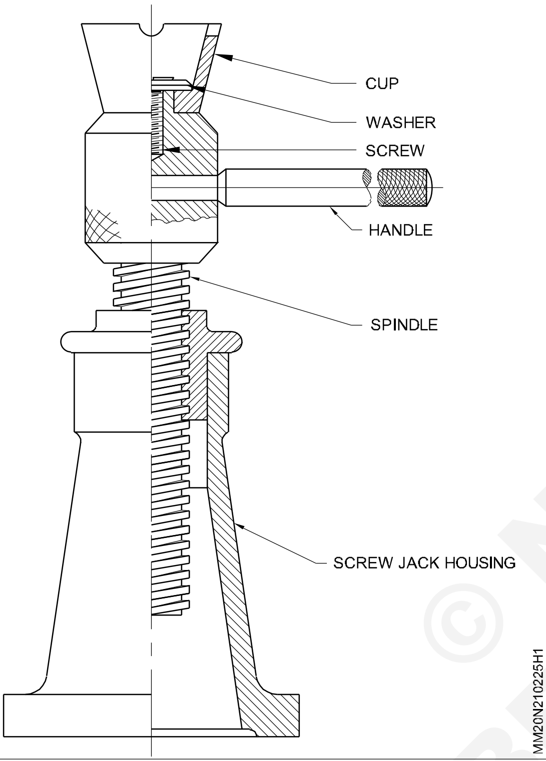
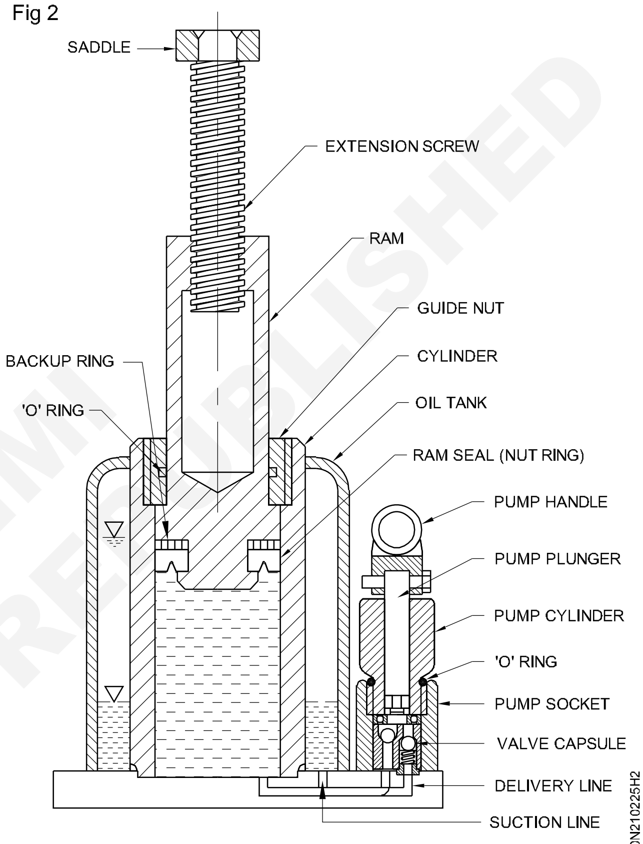


Fig 2



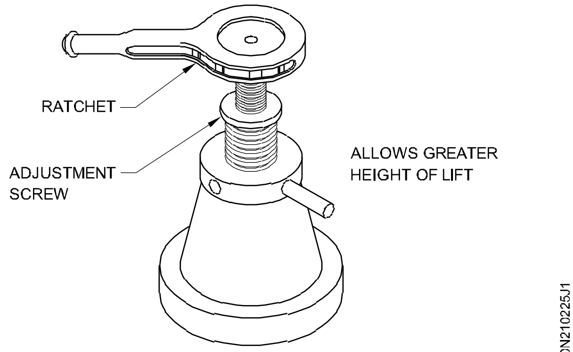
HYDRAULIC JACK

Job Sequence

TASK 1: **Mechanical / Hydraulic Jack**

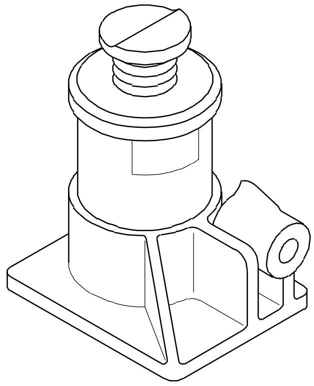
- Screw jack (Fig 1) is used for lifting and lowering load to a smaller height (35 cm, maximum) by screwing the jacking screw. Capacity upto 24 tonne.
- Hydraulic jack (Fig 2) is also used for lifting and lowering up to 35 cm, capacity 2 -1000 tonne.
- Select jack considering its safe working load. (SWL)
- Choose appropriate jacking point for balanced lifting of load.
- Select correct type of jack for the load to be lifted.

Fig 1



SCREW JACK

Fig 2



HYDRAULIC JACK

MM20N210225J2

While selecting the type of jack the following points to be considered.

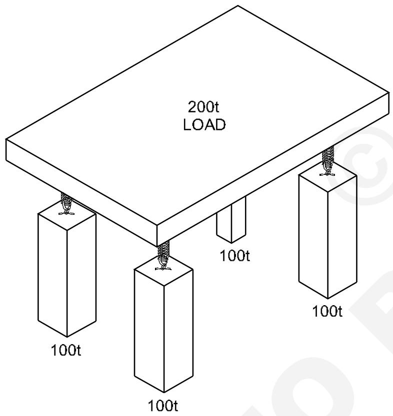
Capacity of the jack.

Number of jacks to be used for a particular work.

Lifting stroke in case of hydraulic jack.

- For lifting say 200 tonne load of bigger size 4 x 100 tonne hydraulic jacks may be used for proper balancing and uniform distribution of load. (Fig 3)

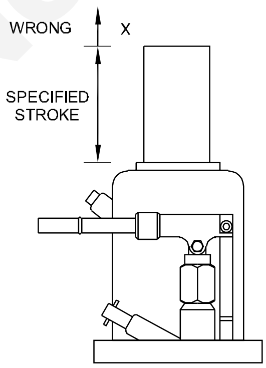
Fig 3



MM20N210225J3

- Raise the ram up to its specified stroke limit only. (Fig 4)
- Strictly avoid shock load on the ram.

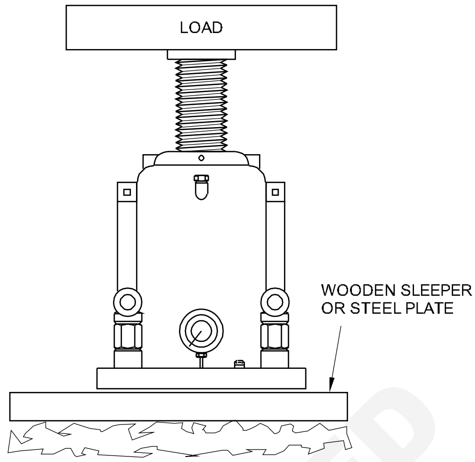
Fig 4



MM20N210225J4

- Use heavy steel plates or wooden sleeper on the ground, if the surface is soft. (Fig 5)

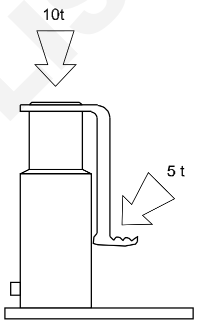
Fig 5



MM20N210225J5

- Avoid loading more than 50% of the jack capacity on the toe lifting. (Fig 6)

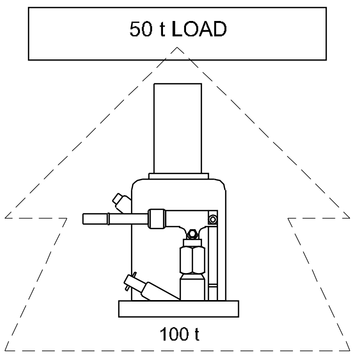
Fig 6



MM20N210225J6

- Use hydraulic oil (IOC No. Servo system 46 or 57) for filling up oil tank.
- Avoid using extra force to close the release valve.
- Normal hand tightening is recommended.
- Use banian cloth only for cleaning all internal parts of hydraulic jack.
- Strictly avoid cotton waste or fluffy cloth for cleaning.
- Select jack or jacks considering its capacity (SWL) and operating range.
- Fit the jack in centralised jacking point for balanced loading (Fig 7).

Fig 7



MM20N210225J7

- Keep the jack on stable footing and at its low level for jacking. Use wooden, sleeper or steel plate for soft ground surface.
- Use wooden wedge block on wheels of vehicle to prevent movement while lifting.
- Operate hand lever/ratchet lever in clockwise direction threaded spindle of screw jack until it takes up the load.
- Continue to operate for lifting the load to desired height in balanced condition.
- Rotate the hand lever/ratchet lever in anticlockwise direction to bring down the load.
- For hydraulic jacking, check the oil level, if necessary fill up servo system 46 or 57 as recommended.
- Check the operating condition of the hydraulic jack, if it is not functioning satisfactorily look into the following points.

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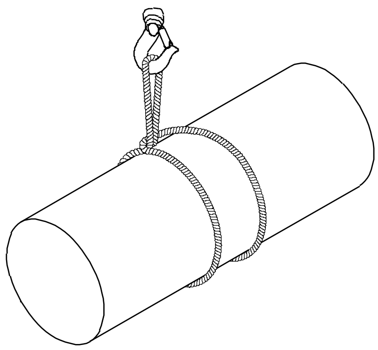
TASK 2: **Rope Puller Chain pulley**

Sling load with fibre rope

- Select the type and dia of fibre rope considering the shape and weight of the load.
- Prepare a square or reef knot on the rope to make it endless.
- Turn the rope around the cylindrical object as shown in Fig 1.

Fig 1



MM20N210225X1

- Position the rope in the middle approximately to balance the load.
- Place the other end of the rope on the safety hook.
- Strain the rope to check the object is well balanced. If not shift it to the desired spot.

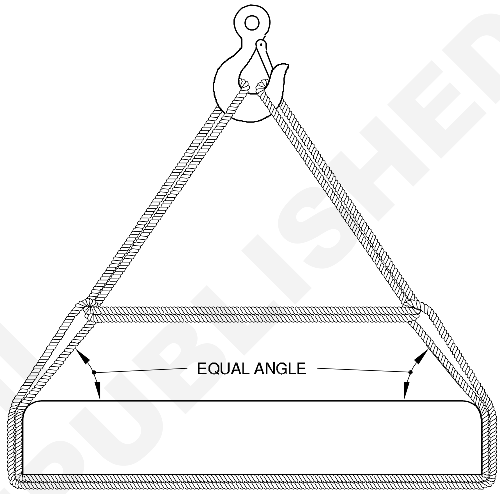
Method of using two manila rope sling

- Take two spliced rope to make them endless.
- Turn the rope around the load as shown in Fig 2.
- Insert both the ends of the second rope through the first one as in Fig 2 and fasten both the ends to the hook.
- Check whether it is balanced as before. If not, adjust the rope, slightly to make the angles equal.
- Lift and shift the load to desired position.

Sling rope using two ropes. (Fig 3) If it is well balanced, distribution of load will be even.

- Always put packing on sharp edges to prevent damage to the rope.

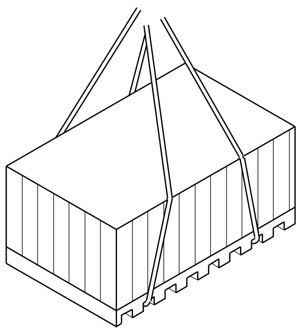
Fig 2



METHOD OF USING TWO SLINGS

MM20N210225X2

Fig 3



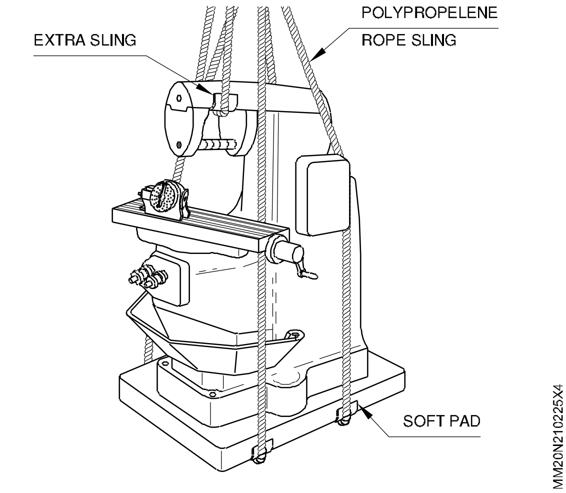
MM20N210225X3

- Avoid putting a sling around a radius of less than three times the rope diameter
- When included angle of the sling is 120º or more, the SWL of sling must be reduced to half.

Vertical machine slinging

- Vertical machine is likely to be toppled easily due to a slight imbalanced condition.
- Use polypropylene rope sling of 25 mm dia which a strong reliable and durable for carrying load around 2 tone.
- Prepare two slings for the machine body and an additional one for the ram as shown in Fig 4.

Fig 4



- Put soft packing bags on the sharp edges.
- Strain the rope to lift the machine about 50 mm from the ground to check well balanced condition.
- Shift the machine to the desired position, if it is well balanced.

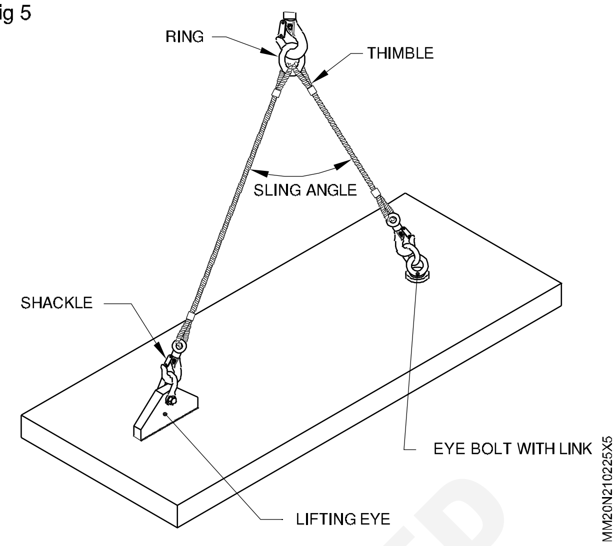
Shift load by wire rope sling using shackle and eye bolt

- Fix up eye bolt with link in screwed hole and a bracket with “Dee” shackle/eye bold with link on to the other hole as shown in Fig 5.

Shift unbalanced load by wire rope sling

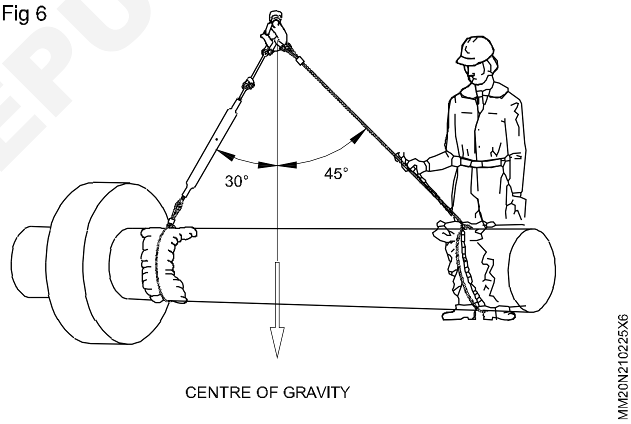
- Usually slinging marks are painted on components and machineries to sling in well balanced condition. If not, determine the possible centre of gravity to put the sling.
- Use union bolt, turn buckle/straining screws for unbalanced loads, which are adjustable for balancing the load.
- Select one short and another length sling to suit the load.
- Fix up a turn buckle/union bolt to the shorter length sling for required adjustment.

Fig 5



- Tie up the component with the slings using sack packing all around as show in Fig 6. Keep the crane hook right above the approximate centre of gravity point.
- Inch the crane to check the load for balancing. If not balanced, adjust the turn buckle by a Tommy bar till proper balancing is achieved.
- Shift the load to its position

Fig 6



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TASK 3: **Chain sling and chain Black**

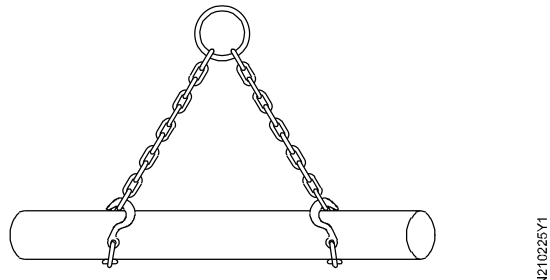
Shift load by chain sling

- Put double legged chain sling for shifting cylindrical object as shown in Fig 1. Ensure that the open end of the hook must be always facing outside and job is well blanced.
- Shift the load to its position

Shift load by four legged chain using two endless chains (Fig 2)

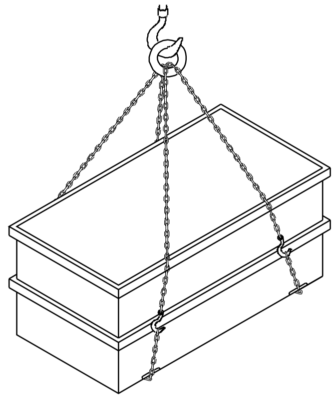
- Select one four legged chain and two endless chain.
- Put the slings (endless) around the marked position of the object. Fasten four sling hooks, two in the front and two in the back side to the endless chains (Fig 2).

Fig 1



METHOD OF HOOKING DOUBLE LEG CHAINS

Fig 2



- Lift the load by inching. It is well balanced because slinging is made on the marked position.
- Shift the load to its position.
- Return the hooks to the master ring.

Sling an object/machine tool using only endless chain (Fig 3)

Fig 3

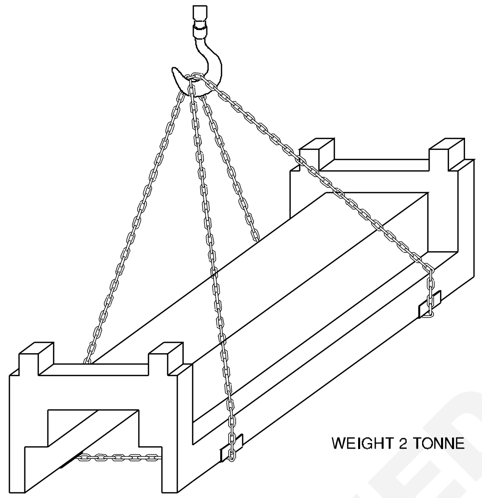
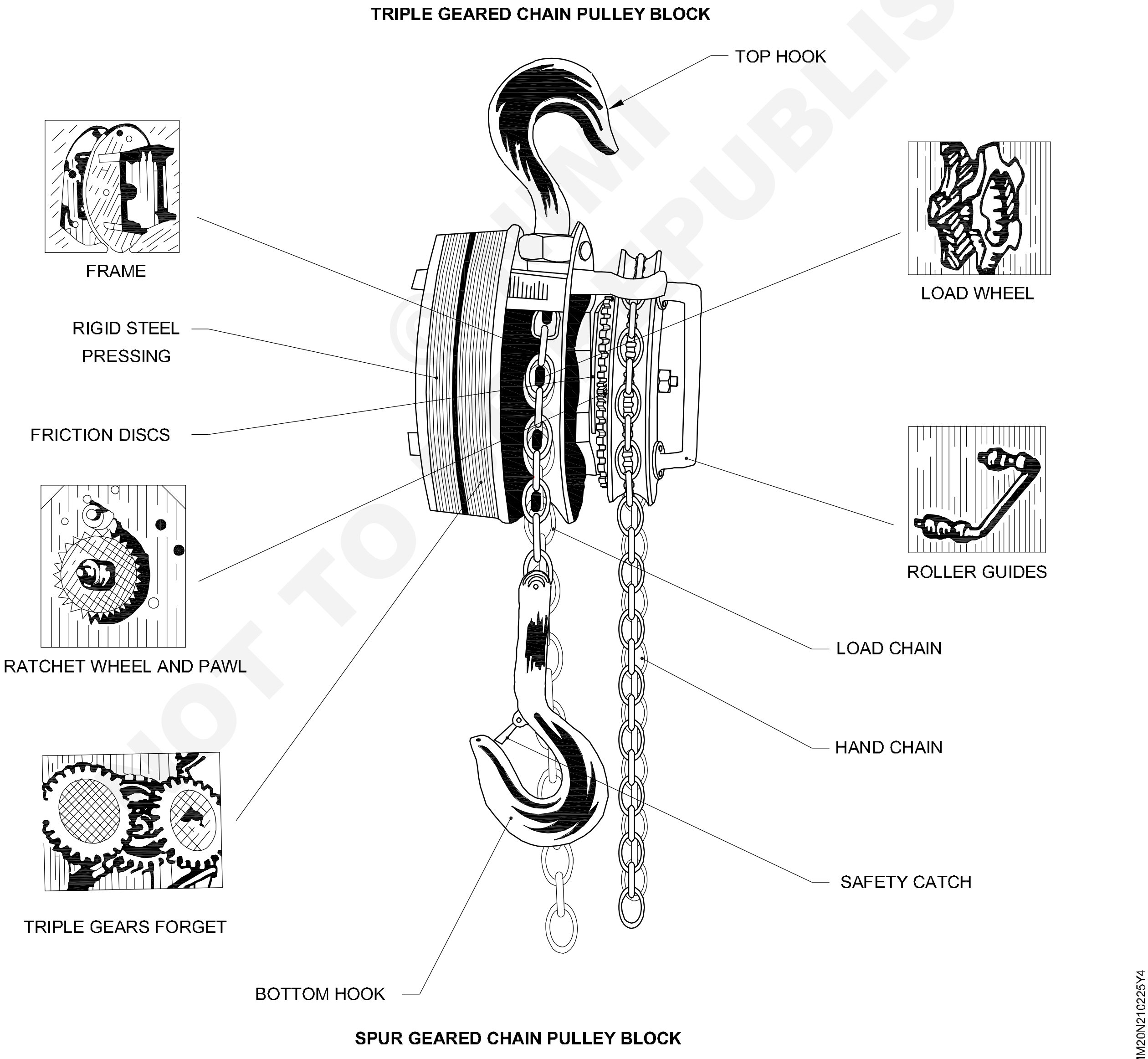


Fig 4

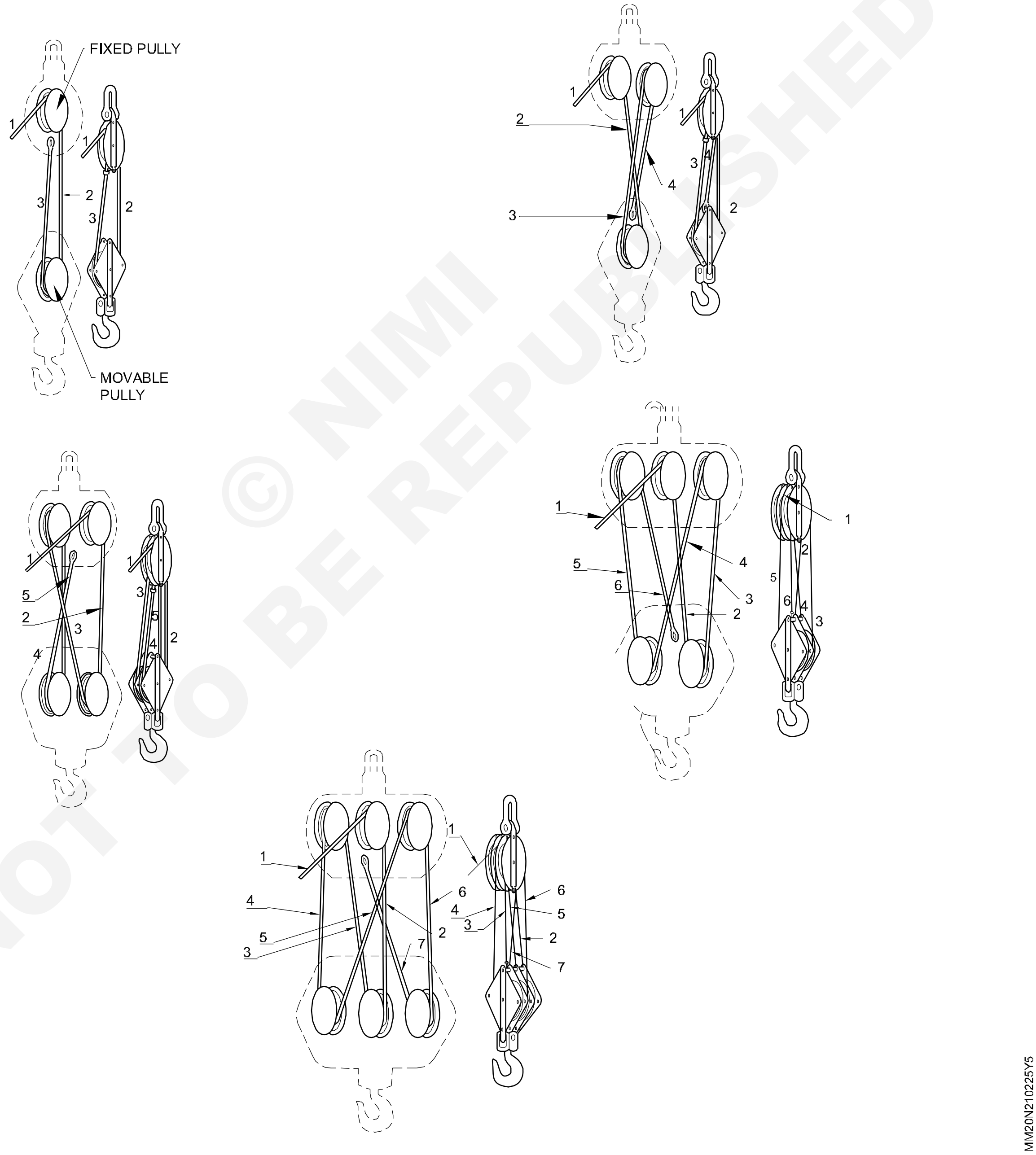


- Select two endless chain of proper length and capacity.
- Lift one side of the object frame by crow bar and insert a wooden block of 150 x 150 x 75 mm height approximately. Similarly insert wooden blocks in all the sides.
- Pass the chain through bottom side of the object/frame and pull it to fasten into the crane hook.
- Lift the crane by inching. Check whether the job/frame is well balanced, if so shift the load to the desired spot.
- Place two equal size wooden log as support and lower the job on the supports.
- Check for the stability of the job/frame as shown in Fig 3.

Chain pulley block

- A chain pulley block is a portable device used to lift and lower heavy loads using a chain.
- Two wheels are functioning in it which the chain is wound around.
- When the chain dragged, it winds around the wheels and starts to lift the item that is connected to the rope or chain via a hook.
- It can also be connected to lifting slings or chain bags to lift the load more smoothly.
- A chain pulley block comprises a lifting hand chain and holding hook, chain pulley block's function usually by electricity or manually hand operated. (Fig 4&5)

Fig 5



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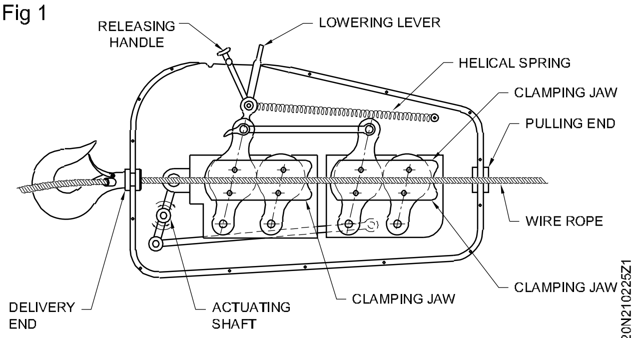
TASK 4: **Working of Winch**

- Hand operated winches are sued commonly for shifting load and hoisting or lowering load.
- A special type of wire rope is used for its application.

Parts of hand operated winch (Fig 1A&1B)

> **Precautions: Avoid forming loop in the wire rope while handling.**
>
> **Loop formation my lead to form kink and damage the wire rope.**

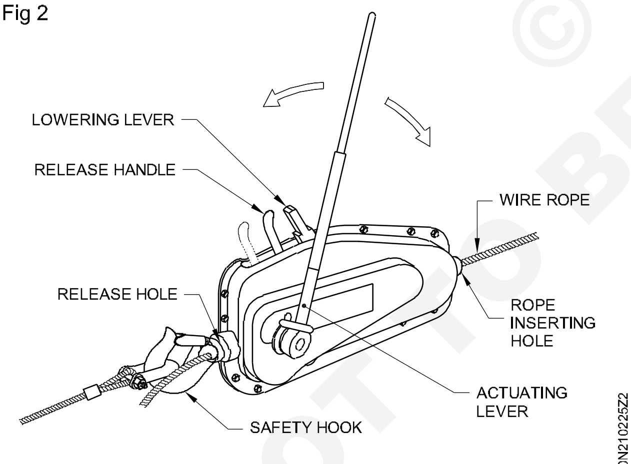
Fig 1



MECHANISM OF HAND OPERATED WINCH

- Select appropriate winch considering its pulling and lifting capacity.
- Lay the special wire rope on the floor in a straight line.
- Push the release handle to notched position which will open up the jaws inside the machine. (Fig 2)

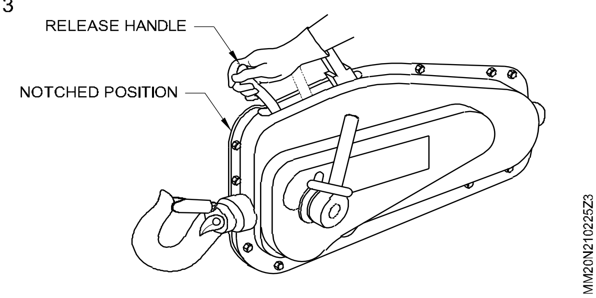
Fig 2



HAND OPERATED WINCH-PARTS

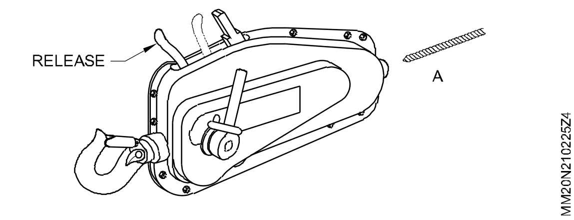
- Insert the tapered end of the wire rope through the back side hole (A). (Fig 3)

Fig 3



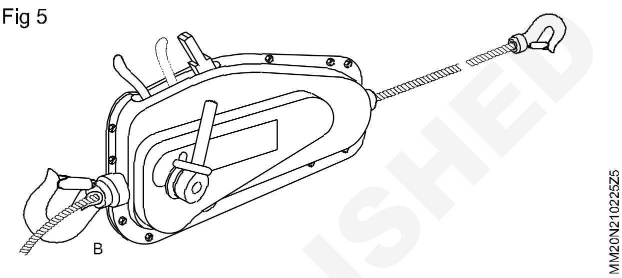
- Push the rope through the machine until it emerges at exit B (Fig 4)

Fig 4



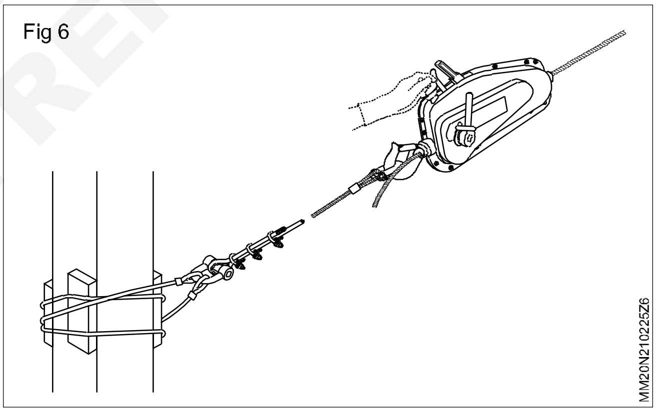
- Fit a sling in to the safety hook of the machine to anchor it a strong support. (Fig 5)

Fig 5



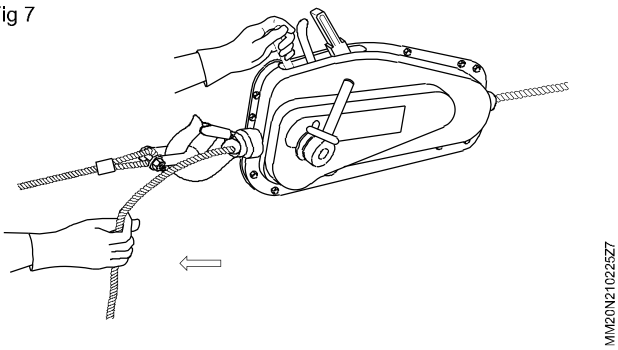
- Pull the wire rope to the required length, until the rope becomes light on the load. Lift the release handle from the notch position to come back to its operating position automatically under spring pressure. Now the rope is firmly gripped by the machine jaws inside. (Fig 6)

Fig 6



- Fit the operating handle on the actuating lever and move it to and fro. This pulls the rope for shifting load. As soon as the operating handle is released, the jaws locks the rope automatically in position. (Fig 7)

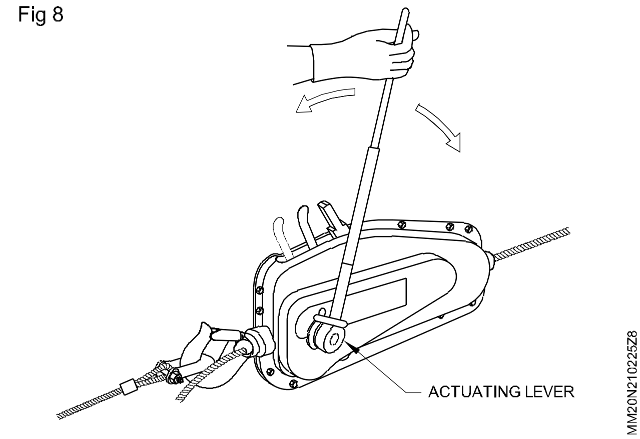
Fig 7



Hoisting and lowering the load

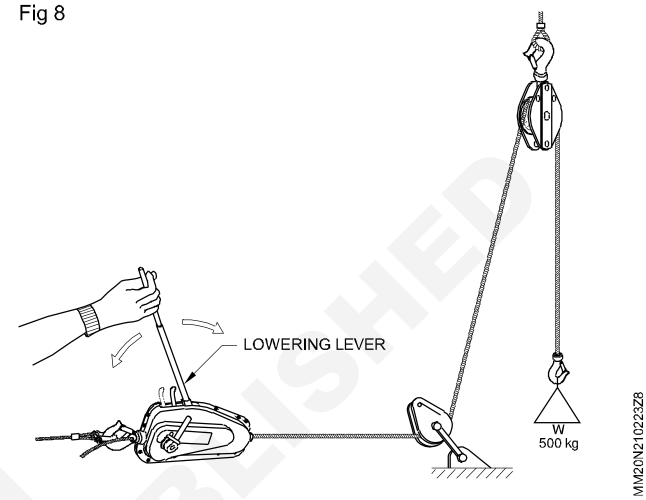
- For hoisting the load the same procedure can be adopted as mentioned.
- For lowering the load fit the operating handle to lowering lever and move the handle to and fro.
- This action pulls back the rope through the winch. As soon as the handle is ceased to move, the inside jaws of the machine automatically locks the rope finally in position. (Fig 8)

Fig 8



- Releasing the wire rope from the machine.
- Fit the operating handle on to the lowering lever and move the handle to and fro until all the tension is taken of the rope.
- Remove anchoring slings push the release handle to the notched position to open the jaws inside the machine.
- Pull the rope back through the machine.(Fig 9)

Fig 8



Inspection of tools and tackles of material handling equipment

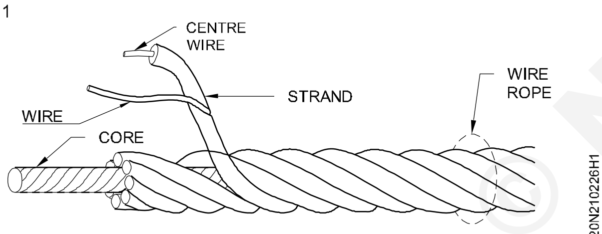
Objectives : At the end of this exercise you shall be able to
- **examine tools and wire ropes for each defect**
- **prepare the inspection report.**

Job Sequence

TASK 1: **Examine tools/ tackles**

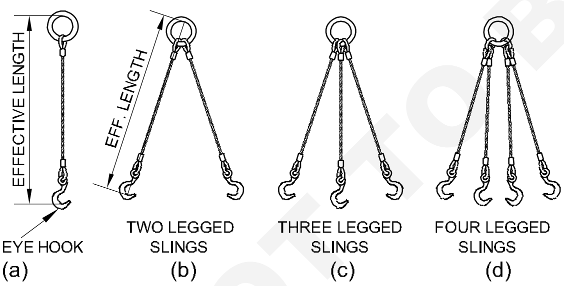
- Place the tool / tackle in position so that the inspection can see it fully.
- Clean the dirt grease etc from the took tackle rope to be inspected with wire brush or cloth
- Examine Entire tool / tackle thoroughly with torch
- Inspect Worn out (or) damaged portions of tool / tackle
- Label the inspected tool / tackle and keep it separately
- Prepare and maintain inspection reports with date condition of tool / tackle and remedial action
- Destroy immediately the rejected tool / tackle
- Store the tool / tackle that can be reuse
- Separately in a right place away from heat, dirt environment

Fig 1



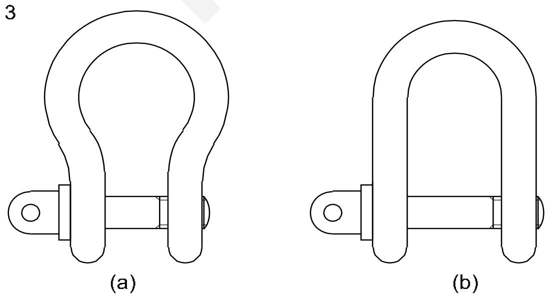
METAL ROPE

Fig 2



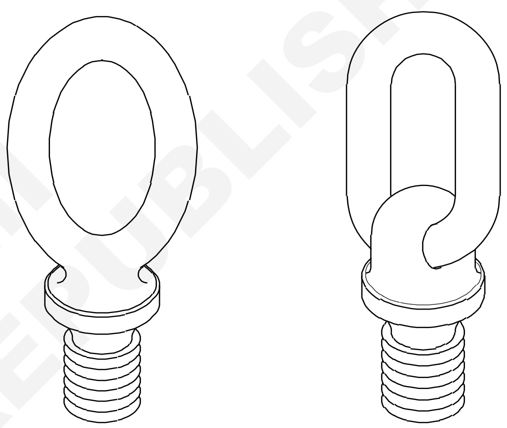
SINGLE LEG SLING MULTIPLE LEG SLINGS
CHAIN SLING

Fig 3



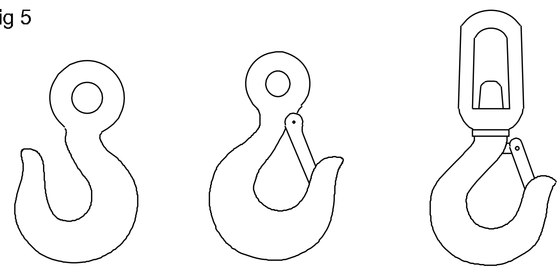
SHACKLESS

Fig 4



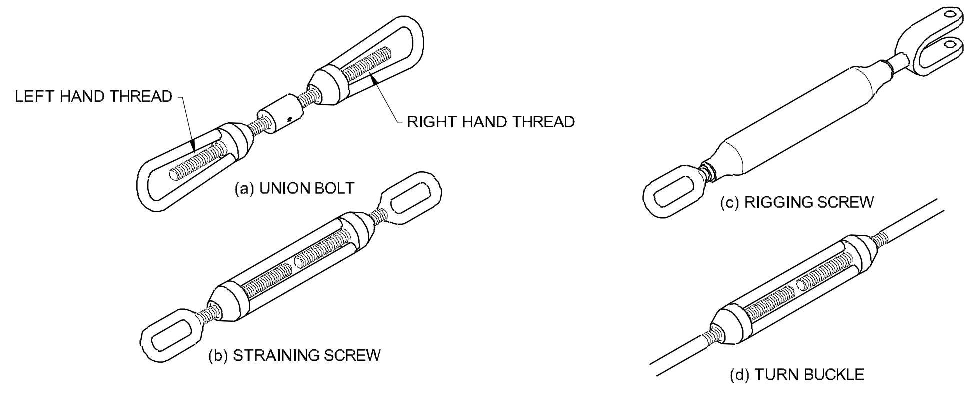
EYE BOLTS

Fig 5



HOOKS

Fig 6



SCREW/BOLTS

— — — — — — — —

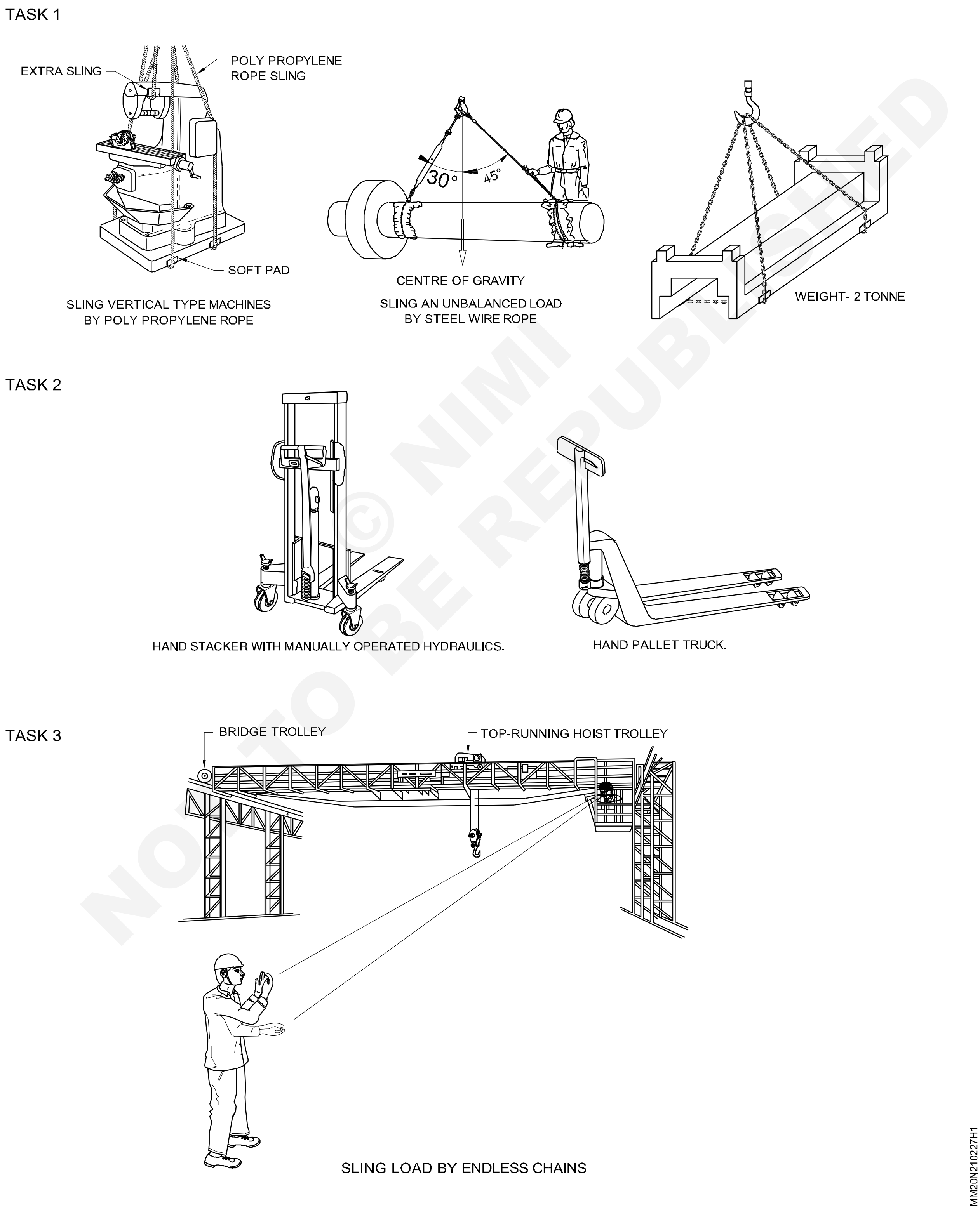
TASK 2: **Inspection report**

S. No.	Tool / Tackle name	Inspection Date	Condition of tool / tackle	Recommended Remedy
1	Steel rope			
2	Chain slings			
3	Shackle			
4	Eye bolt			
5	Hooks			
6	Screws / bolts			

Shift a small machine from layout to loading center / different work place

Objectives : At the end of this exercise you shall be able to
- **sling load for shifting**
- **load lift by fork lift and hand ballet truck**
- **hand signals followed to lift & Shift the load by cranes.**

Fig 1



Job Sequence

TASK 1 & 2: **Sling Load for shifting**

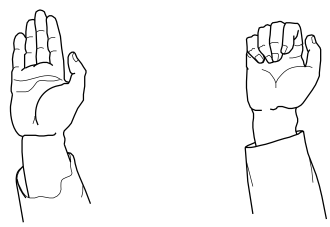
Note: Trainees shall write the job sequence for TASK 1 & 2

— — — — — — — — —

TASK 3:**Lift and shift load by cranes by following hand signal**

- Hand signaling is to used to direct the crane operator for performing various operations, signaler called rigger should face the crane operator.
- Raise arm to clench and unclench the fingers to signal “take the strain or inch the load” (Fig 1)

Fig 1



CLENCH AND UNCLENCH FINGERS TO SIGNAL 'TAKE THE STRAIN'

MM20N210227X1

- Raise right arm with the index finger up and roate the arm to signal “hoist” (Fig 2)

Fig 2

HOIST

MM20N210227X2

- Lower the right arm with index finger pointing down and rotate the arm to signal “lower”. (Fig 3)

Fig 3

LOWER

MM20N210227X3

- Place your left hand on the top of your helmet, keep your right arm parallel with the thumb pointing up and bend the arm from the elbow up and down to signal jib up. (Fig 4)

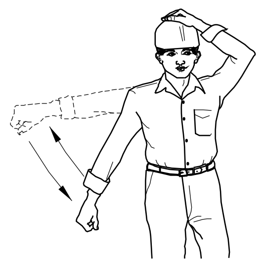
Fig 4

JIB UP

MM20N210227X4

- Similarly, keep your left hand on the top of your helmet and stretch your right arm parallel with the thumb pointing downward. Allow the arm to fall down to the side and raise back to horizontal position to signal jib down. (Fig 5)

Fig 5



JIB DOWN

MM20N210227X5

- Keep your right arm facing downward and to crossing movement with the arm to signal “slew left”. (Fig 6)

Fig 6

SLEW LEFT

MM20N210227X6

- Similarly, keep your left arm facing downward and do crossing movement with the arm to signal "Slew right´ (Fig 7)

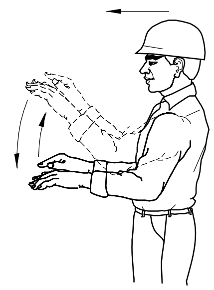
Fig 7

- Keep both the palms facing you, raise and lower the arms from horizontal to vertical position by bending the elbows signal "travel towards me" (Fig 8)

Fig 8

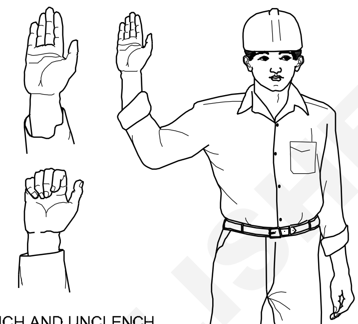
- Similarly, keep the palms facing downward raise and lower the arms from horizontal to vertical position by bending from the elbow to signal "travel away from me". (Fig 9)

Fig 9



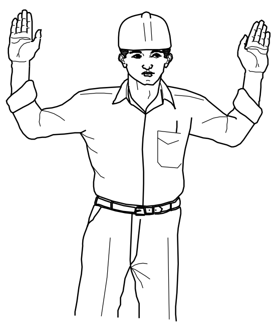
- Raise your right arm to vertical position by keeping the palm facing forward to signal "stop" (Fig 10)

Fig 10



- Raise both of your arms to vertical position by keeping the palms facing forward to signal "emergency stop" (Fig 11)

Fig 11



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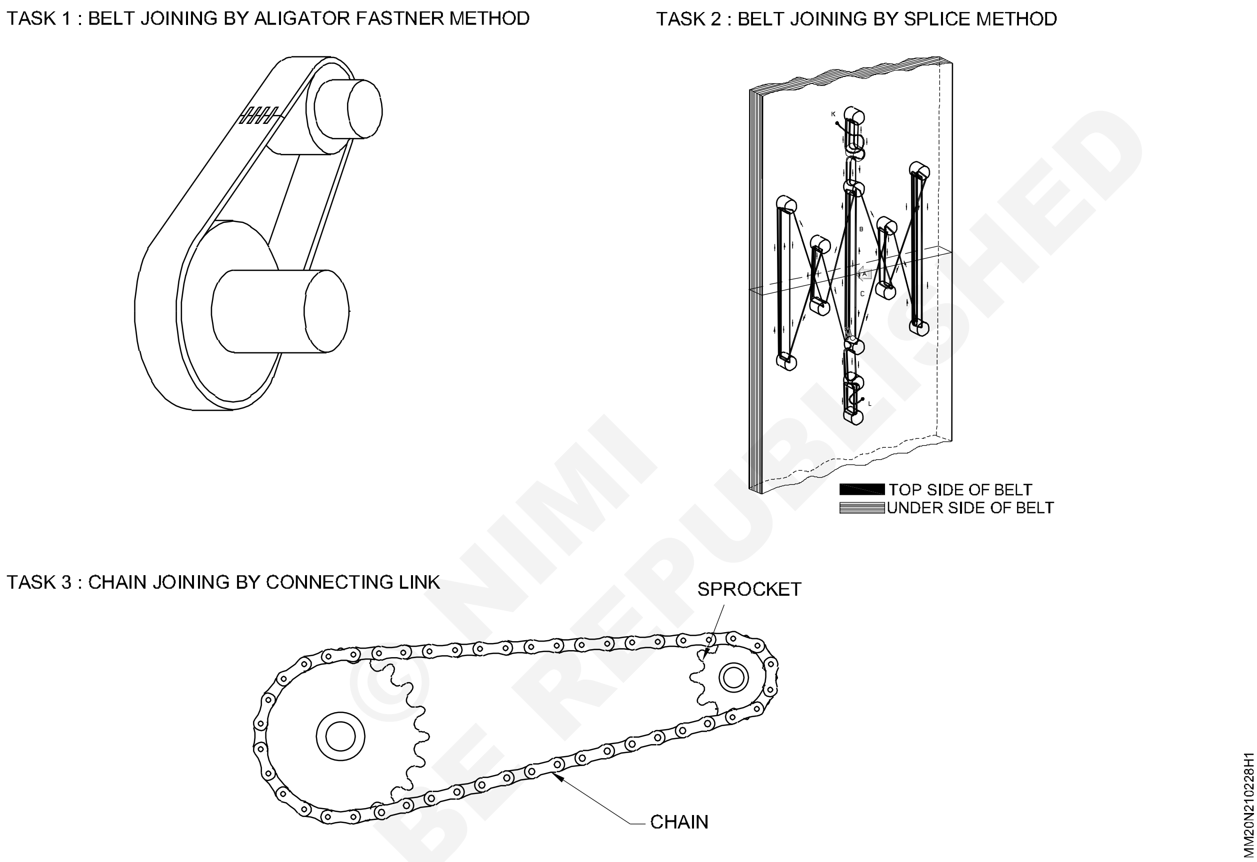
Practice various Belts &chains, Joining methods

Objectives : At the end of this exercise you shall be able to
- **test the belt joining by aligator fastner method**
- **test belt joining by splice method (lacing)**
- **test chain joining by connecting link.**

Fig 1

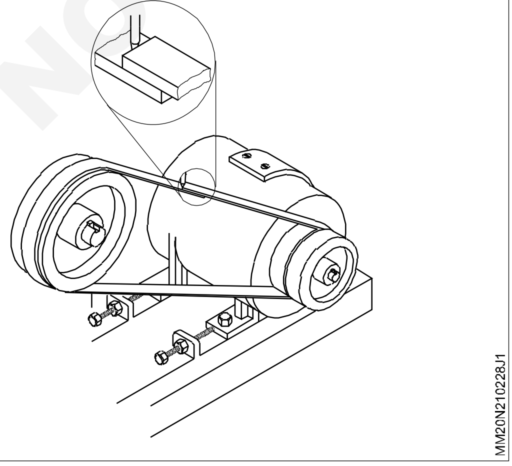


Job Sequence

TASK 1: **Belt joining by alligator fastener method**

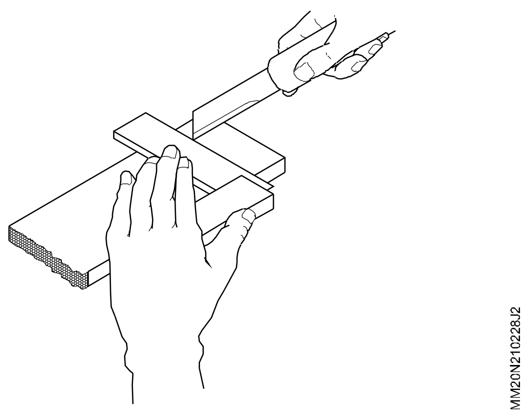
Mark and cut the belt to the required length (Fig 1)

Fig 1



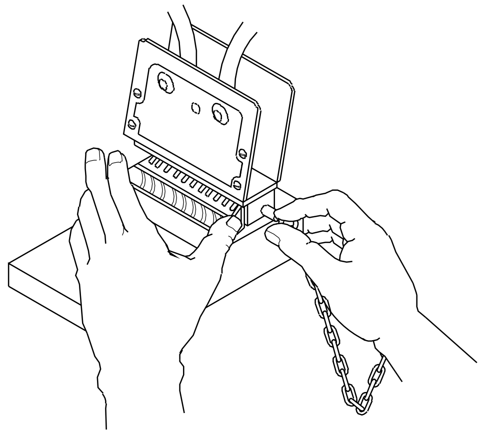
Trim both ends of the belt square (Fig 2)

Fig 2



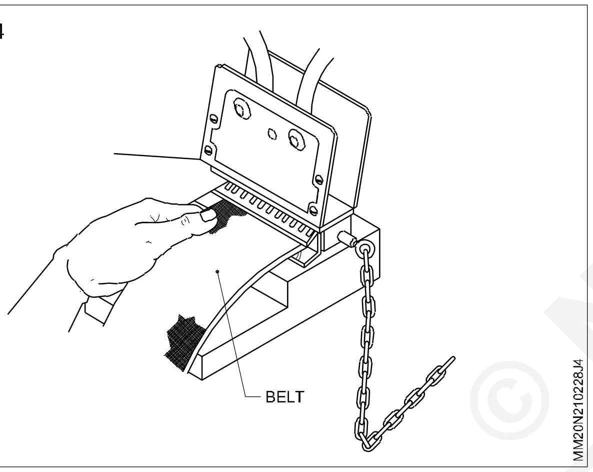
Fit an alligator fastener centrally into the jaws of the lacing machine and fit the pin into the side of the jaws to hold the fastener in the machine. (Fig 3)

Fig 3



Put the belt centrally between the jaws of the machine (Fig 4)

Fig 4



Operate the machine to pressure 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 sides against the pulleys and join both the ends by the pin (Fig 7)

Fig 5

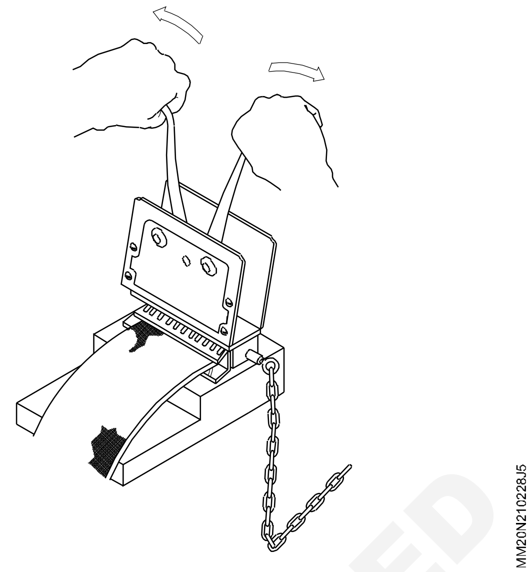


Fig 6

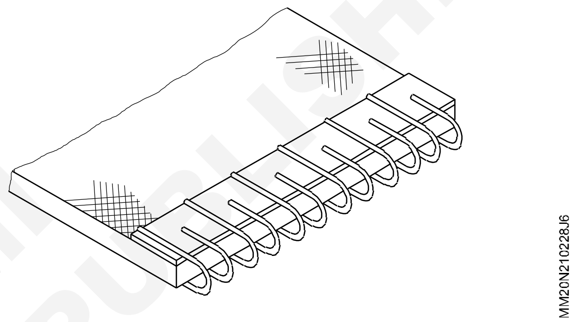
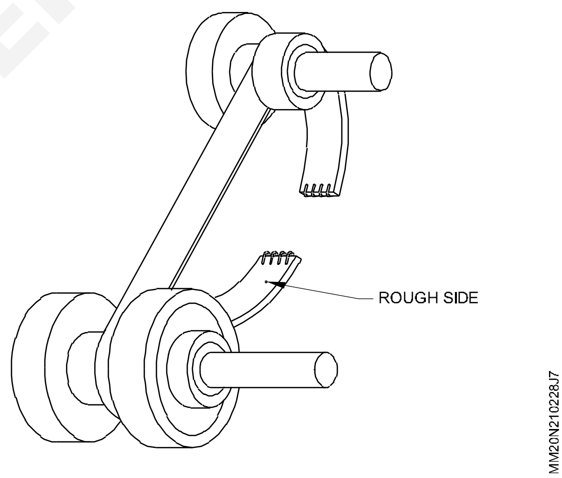


Fig 7



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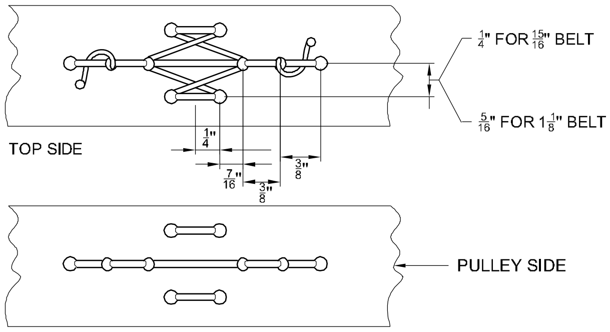
TASK 2: **Belt joining by splice method**

- Trim the ends the belt square (Using a try -square)
- Punch or drill 1/8 inches holes in equal spaces (Fig.1,2&3)
- place the belt around the cone pulleys.
- Mark the centre of lace and placed at the marked midpoint at “A” (Fig.4)
- Start towards “B” and thread half of the lace in the direction of arrow heads and finish “K”.
- Repeat with the half of the lace starting toward as “C” and ending at L”.
- Fasten the ends and the burn the ends close with a match to prevent them from pulling out.

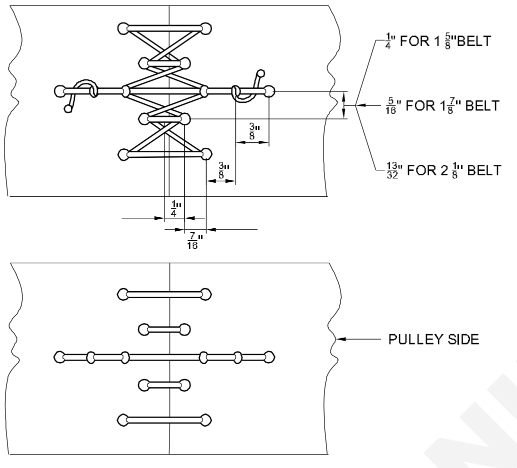
Fig 1



SPACING OF HOLES FOR $\frac{15}{16}$" AND $1\frac{1}{8}$" BELT

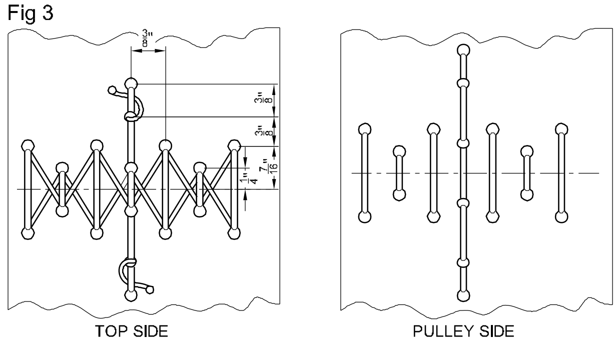
SPACING OF HOLES FOR 15/16" AND $1\frac{1}{8}$" BELTS

Fig 2



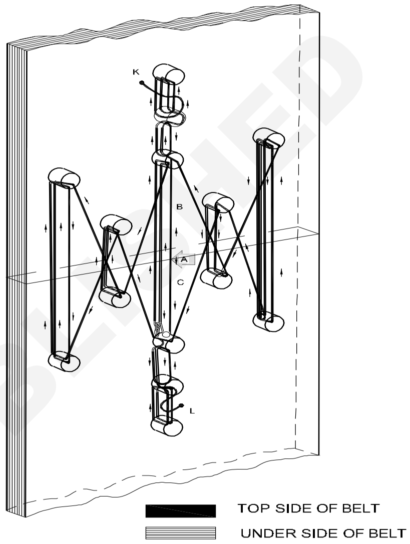
SPACING OF HOLES FOR $1\frac{5}{8}$", $1\frac{7}{6}$" ,AND $2\frac{1}{8}$" BELT

Fig 3



SPACING OF HOLES FOR A $2\frac{7}{8}$ " BELT

Fig 4

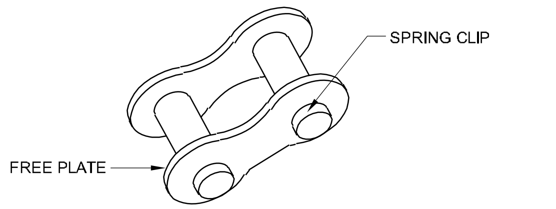


CORRECT METHOD OF LACING A LEATHER BELT

TASK 3: **Chain joining by connecting link**

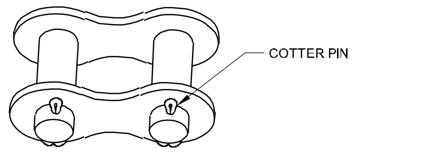
- Before joining the chain inspect it to be sure it is free from dirt and grit .If it is dirty thoroughly clean it in a solvent (kerosene)
- Calculate the length of the chain as per shaft centre distance.
- Bringing the free chains ends together on one sprocket.
- Insert the pin of the connecting link in the two end links of the chain and then install the free plate of the connecting link.
- Fasten the free plate with cotters of spring clip depending on the type used Figs 1& 2
- After the fastener is in the position , tap back of the ends of the connecting link pins until come outside of the plate rests snugly against fastener
- This will prevent the connecting link from squeezing the sprocket teeth.

Fig 1



CONNECTING LINK ASSEMBLY SECURED WITH SPRING CLIP

Fig 2



CONNECTING LINK ASSEMBLY SECURED WITH COTTER PIN

Demonstrate belt conveyor system, vibrating screen & feeder (video demo)

Objectives : At the end of this exercise you shall be able to
- **test belt conveyor system, vibrating screen & feeder.**

TASK: **Instructors are requested to arrange a factory visit for the above demo**

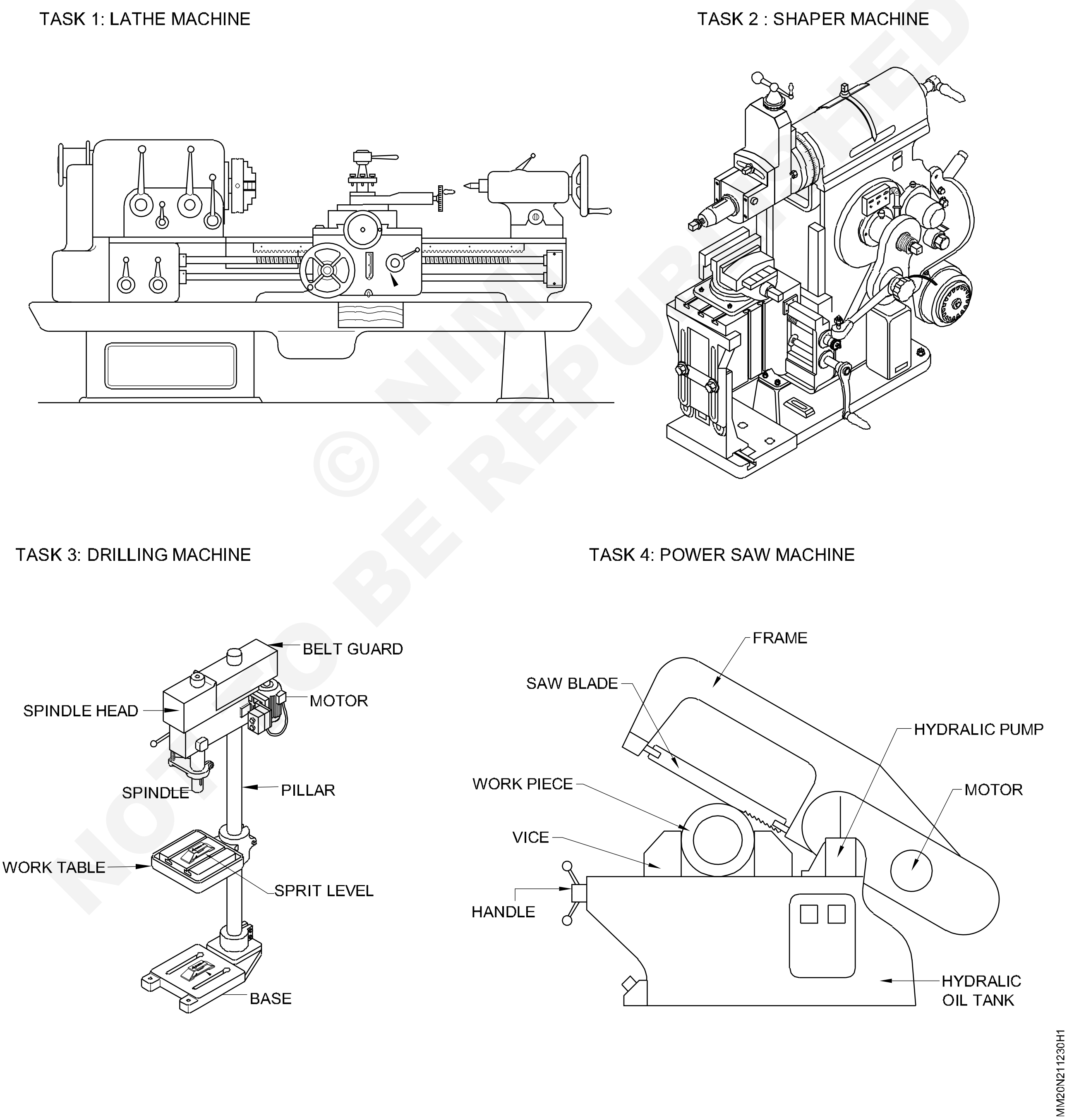
–	–	–	–	–	–	2.10.229
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	DEMO OF BELT CONVEYOR SYSTEM,VIBRATORY SCREEN AND FEEDER	DEVIATIONS	TIME
		CODE NO. MM20N210229E1	

Trouble shooting on machine tools

Objectives : At the end of this exercise you shall be able to
- **trouble shooting of drilling machine**
- **trouble shooting of shaper machine**
- **trouble shooting of shaper machine**
- **trouble shooting of Lathe machine**
- **trouble shooting of power saw machine.**

Fig 1



TASK 1 : **Trouble shooting and remedy of drilling (Pillar)**

S.No	Trouble	Cause	Remedy
1	Noisy operation	A) Dry spindle B) Broken bearing C) Motor bolts loose D) Belts loose.	A) Remove the spindle and lubricate B) Replace the bearing C) Tighten the screws D) Pull the belts
2	excessive wobbling (eccentric rotation) of the spindle.	A) Lose spindle B) Worn spindle shaft or bearings C) Broken spindle.	A) Tighten the spindle B) Replace the shaft or the bearing C) Replace the spindle
3	The motor will not start	A) Power supply B) Motor connection C) Connections of the switches D) Burnt motor windings E) Broken switch	A) Check the main power B) Check the motor connections C) Check the switch connections D) Replace the motor E) Replace the switch
4	The tip is jammed in the work piece.	A) Excessive pressure on the feed hand -wheel B) loose tip C) Speed is too fast	A) Apply less pressure B) Tighten the tip C) Change the speed
5	The tip is burning or smoking	A) Incorrect speed revolutions per minute B) Shavings will not discharge C) Tip is worn or does not cut the material well D) Needs lubrication E) Incorrect feeding pressure	A) See the table speed B) Clean the tip C) Check the sharpness and taper D) Lubricate while drilling E) Apply less pressure
6	The tip vibrates, the hole is not round	A) The tip was sharpened off centre B) Bent tip	A) Sharpen the tip correctly B) Replace the tip
7	The temperature of the spindle holder is too high	A) Insufficient lubrication	A) Lubricate the spindle holder
8	The spindle will not stick to the wheel	A) Dirt, grease or oil in the morse taper B) You are executing an unauthorized operation	A) Use detergents (alcohol) to clean the conical part of the spindle B) Milling operations causing the fall
9	Spindle runs to tight and bearing become too hot head stock.	A) Preloading of main spindle is not correct.	Adjust preloading of main spindle.
10	Machine cuts taper on job held between center.	A) Tail stock alignment not proper. B) Improper machine level C) Tool worn out	Re align tail stock. Level machine properly. Re grind or replace tool.
11	Gear train in end feed mechanism makes sound during running.	A) Backlash of change gear not set properly B) Fixing nut and bolt not properly tight C) some damage mark on gear teeth D) Lubrication is not done.	Set proper back lash between changes gears. Tighten fixing nut and bolt. Inspect change gear and deburr damage mark. Provide proper lubrication.

S.No	Trouble	Cause	Remedy
12	Machine is not able to take heavy cut or spindle stops under load.	A) Belt tension is not proper. b) Safety key spear head C) Feed clutch slipping.	Set proper belt tension. Replash safety key in 1st pick up gear. Set proper spring tension in feed clutch.
13	Noise in head stock	A) Lubrication not sufficient. B) Gear damage. C) Bearing seized or damage.	Check oil level and maintainproper oil level. Replace damage gear. Inspect and replace bearings.
14	Noise in main motor.	A) Motor shaft bearing failure. B) Motor fan may be loose. C) Fan cover touches with fan.	Replace bearing. Tighten motor fan. Realign and tight fan cover.
15	Lead screw does not stops under load.	A) Safety key sheared.	Replace safety key.
16	Main motor does not start	——	Check fuse/ MCB/DOL etc.
17	Main motor does not start after some time In operation.	A) Due to too frequent reversal, thermal relay might have tripped.	Wait for the motor to cool down and reset relay.
18	Threading overlaps	A) Excessive axial play of lead screw. B) Excessive play in half nut. C) Gear train or lever position of feed box is not ok. D) Engagement of half nut is not proper.	Set axial play of lead screw Set half nut play Set proper gear train and feed box knob and lever Engage half nut lever as per instruction given in head of thread dial indicator

TASK 2: **Trouble shooting and remedies for sequence**

Trouble	Possible cause	Remedy
Machine will not start	1. Fuse blown or circuit breaker tripped 2. Cord damaged.	1. Replace fuse or reset circuit breaker 2. Have cord replaced by authorized service person
Over load kicks out frequently.	1. Extension cord too light or long 2. Feed stock too fast 3. Cutting tool is dull or has gum on it.	1. Replace with adequate size cord 2. Feed stock more slowly 3. Clean or replace cutting tool
Tool does not come up to speed.	1. Extension cord too light or too long 2. Low current 3. Motor not wired for current Voltage. 4. Spindle is locked.	1. Replace with adequate size cord 2. Contact local electric company 3. Refer to motor nameplate for correct wiring 4. Replace spindle lock knob
Machine makes un satisfactory cuts	1. Dull tool 2. Gum or pitch on tool 3. Gum or pitch on table causing erratic feed. 4. Feeding work in wrong direction	1. Replace tool 2. Remove cutter and clean tool with turpentine and steel wool 3. Clean table with turpentine and steel wool 4. Feed work against cutter rotation
Stocks burn	1. Dull tool 2. Cutter too deep 3. Forcing work	1. Sharpen by Lapping on flat side 2. On hardwoods take light cuts attain full depth of cut with several passes. 3. Feed slowly and steadily.
Machine vibrates excessively	1. Damage tool 2. Stand on bench or uneven floor 3. Bad 'V' belt 4. 'V' belt not tensioned correctly 5. Bent pulley 6. Improper motor mounting	1. Replace tool 2. Reposition on flat , level surface 3. Adjust belt tension by moving motor bracket 4. Replace pulley 5. Check and adjust motor mounting
Edge splits off on cross- grain cut.	Charecterstic of cut.	1. Make cross chain cuts first and then finish with grain 2. Use scrap block to support at end of cut.
Raised area on shaped edge.	Variation in pressure which holds work against tool	1.Keep work firmly against fence or collars throughout pass. 2. Use hold downs
Works pulled from hand of cut	Not support	1. Use meter gauge with hold -down to start cut when free hand: hold work firmly against fence 2. Adjust the tension of spring plate
Depth of cut not uniform	1. Misalignment 2. Side pressure not uniform.	1. Adjust out- feed fence 2. Use hold- downs; keep pressure against fence or collars consistent.
Variation in height of cut.	Variation in pressure which holds work down on table.	1. Keep pressure throughout pass 2. Use hold- downs 3. Make pass slowly and steadily 4. Whenever possible keep cutter under stock.
Cuts not smooth	1. Wrong R.P.M 2. Feeding too faast 3. Working against grain 4. Cutting too deep	1. Use faster speed. 2. Pass stock more slowly. 3. Work with grain whenever possible. 4. On very deep cuts make several passes.
Spindle does not raise freely	Saw dust and dirt in raising mechanisms	Brush or blow out loose dust and dirt.

TASK 3: **Trouble shooting and remedy of Centre Drilling**

S.NO	Trouble	Cause	Remedy
1.	Machine vibrates while running	A) Improper levelling	Level the machine properly and tighten on the foundation.
		B) Job not balances	Balance job by adding counter weight and reduce spindle speed.
2.	Machine vibrates while machining and chatter marks on job.	A) Improper leveling	Level the machine.
		B) Improper tensioning of 'V' belt	Adjust 'V'belt tension.
		C) Excessive tool overhang	Reduce overhang of tools and clamp rigidly.
		D) Wrong tool	Check proper tool material and tool geometry.
		E) Wrong cutting parameters	Select proper tool feed and depth of cut considering job material, tool material, job diameter.
		F) Improper tool centre	Adjust correct tool height.
		G) Work holding not rigid	Check holding of job.
		H) Clearance between saddle surface slide job not proper.	Adjust proper clearance of all jobs.
		I) Preload of main spindle is not correct.	Adjust preloading of main spindle.

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TASK 4: **Trouble shooting of Power Saw machine**

Trouble	Cause	Remedy
The angle of the machine is inaccurate.	1. The tensioning bolts on the bow are loose. 2. The blade is not tight. 3. The blade is dull. 4. The setting on the vice is in accurate.	1. Tighten the belts. 2. Tighten the blade. 3. Replace the blade. 4. Set the vice at 0 using a right angle and adjust the pointer to match.
No power	1. Oil level is low 2. The tensioning bolts are loose.	1. Check oil and fill up as required 2. Tighten the bolts.
Saw is not cutting properly	1. Pressure from the saw arm is too light. 2. The stroke of the blade is incorrect. 3. Saw blades wrong type. 4. Saw blade is worn.	1. Attach the heavier weight to the arm. 2. Adjust the stroke. 3. Use a different TPI blade. 4. Replace the blade.
Saw blade does not rise when cutting.	1. Hydraulic pressure is low. 2. Compressing arm is low. 3. The cam is loose. 4. Air is in hydraulic system.	1. Check the pressure refill if needed. 2. Adjust the compressing bracket to a higher position. 3. Tighten the cam. 4. Pump the arm a few times manually.
Excess noise	1. The saw is low on lubricant. 2. The pulley is touching the pulley guard. 3. The gears are worn out. 4. Screws, bolts and other moving parts are loose.	1. Check lubricant and refill as required . 2. Adjust the pulley so that it does not touch the guard. 3. Replace the gears. 4. Tighten loose parts as required.
Coolant delivery is weak.	1. Sediment have been collected in the cooling tank.	1. Clean the cooling tank.

NOTE:

1. Instructors should follow the manuals and do the required steps.

2. As per manual specifications of manufacturer, replace the components and oils.

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Perform Overhauling of feed units of lathe milling & grinding

Objectives : At the end of this exercise you shall be able to
- **overhauling of lathe feed gear box**
- **overhauling of milling machine feed gear box**
- **overhauling of surface grinding machine table and lead screw.**

Note: Gear oil and Grease oil specification specified by the manufacture of the machine.

Job Sequence

TASK 1: **Overhauling of Lathe feed gear box**

- Switch off the machine and disconnect the driven gear.
- Loosen internal thread pin (part no 42) as disconnect the feed shaft and lead screw.
- Loosen the drain plug and drain oil. (Part No 46,47,48)
- Loosen and remove the feed box from the head stock, using proper supports.

Removal of all parts of feed box

- Loosen the socket cap screws. (Part No 38)
- Remove the flange and oil seal (Part No 37 & 39) from shaft III
- Remove the shear pin (Part No 8) and then remove bush, collar, shearpin bushes, and bearing bush. (Part No 40,41,34,35,36)
- Remove the internal circlip (Part No 26) and external circlip (Part No 6,9,49)
- Push the shaft III using copper rod.
- Remove gears. (Part No 27,28,30 & 32)
- Remove keys (Part No 24 & 29) and keep it safe.
- Remove bearing (Part No 11) circlip (Part No 26)
- Loosen and remove (Part No 51,52,58,60,56)
- Loosen the caps screws (Part No 4) and remove external circlip (Part No 8)
- Use the pull bolt and remove shaft (Part No 1)
- Remove bush, flange, spacer, gear andbush (Part No 2,3,5,7 and 59)
- Remove the external circlip (Part No 6 and 9)
- Push and remove the shaft II (Part No 25) using copper rod.
- Remove clutch, spacer, gears, splinded bush, bush and key (Part No 10 & 24)
- Clean all the dismantled parts and dry it.
- Keep all disassembled parts in a separate tray in proper order while dismantling.

Identification of worn out and damaged parts

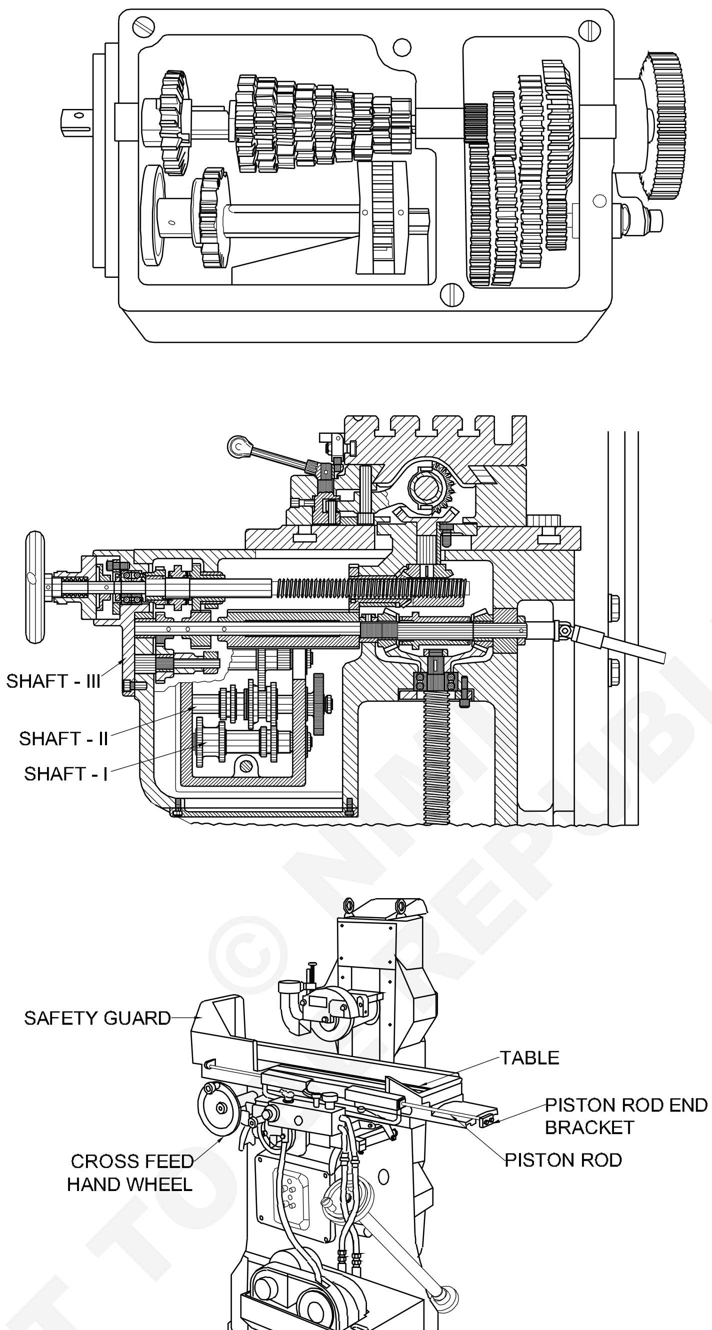
- Check all dismantled parts of feed box. Thoroughly and list out of the damaged, worn out parts and fill up the table given.

Fig 1

TASK 1

TASK 2

TASK 3



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

Replacement of the worn out and damaged parts

Ensure the replacement bearing before assembling the feed box.

- Replace the worn out or damaged parts other than bearing if required as per above table.

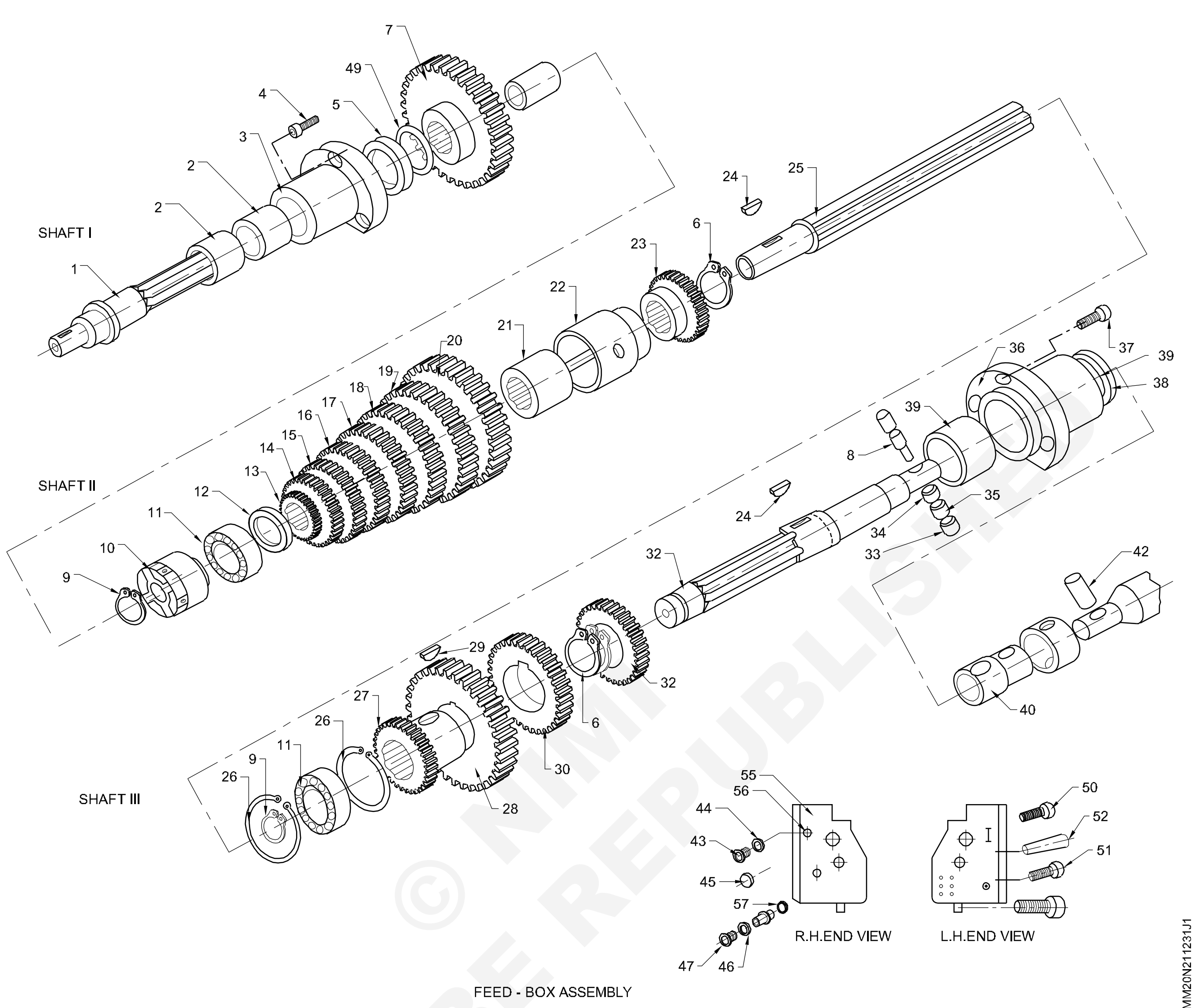
Assembling of feed box

- Assemble all the parts of feed box in the reverse order and apply grease. Lubricating oil at necessary parts.

Care should be taken while fixing new bearings and retaining ring.

- Mount the feed box to the lathe.

Fig 1



- Mount the drive gear and handles
- Connect the feed shaft and lead screws.
- Connect the feed shaft and lead screws.
- Fix the cover plates.

Test runs the feed movement

- Select and run various feed movement
- Mount the drive gear and handles.
- Connect the feed shaft and lead screws.
- Fix the cover plates

Test runs the feed movement

- Select and run various feed movement
- Select and run different type of Thread pitches
- Check all positions or feed movements.
- If any problems in engagement. Rectify and run the machine.

Trainees shall be able to practice this exercise with the available feed box assembly in their shop floor.

Feed –box assembly

Ref. No.	Part Name	Qty
1	Shaft	1
2	Bush	2
3	Flange	1
4	Soc. Cap Screw M6 x 16	3
5	Spacer	1
6	Ext. Circlip A22	3
7	Gear 55T	1
8	Shear pin	1
9	Ext Circlip A17	2
10	Clutch	1
11	Deep groove B/B 17x40x12	2
12	Spacer	1
13	Gear 16T	1
14	Gear 18T	1
15	Gear 20T	1
16	Gear 22T	1
17	Gear 24T	1
18	Gear 26T	1
19	Gear 28T	1
20	Gear 30T	1
21	Splined bush	1
22	Bush	1
23	Gear 17T	1
24	Woodruff key 5x6.5	2
25	Shaft – 1A	1
26	Int. Circlip B40	2
27	Gear 18T	1
28	Gear 36T	1
29	Woo-druf key x6x16	1
30	Gear 27T	1

Ref. No.	Part Name	Qty
31	Gear 33T	1
32	Shaft IB	1
33	Shear pin bush	1
34	Shear pin bush	2
35	Bearing bush	1
36	Flange	1
37	Soc. Cap screw M6x12	3
38	Oil seal A25x35x7	1
39	Bush	1
40	Collar	1
41	Int. Thread pin 8x40	1
42	'O' Ring 20 29x2.62	1
43	Cyl. Scr plug	1
44	Oil window	1
45	Socket for drain plug	1
46	Washer	1
47	Drain plug	1
48	External circlip A30	1
49	Gasket	1
50	Soc. Cap scr. M6x25	1
51	Int. thread pin 8x70	6
52	Gasket	1
53	Gasket	1
54	Feed Box body	1
55	F.b cover	1
56	Fiber washer	1
57	Soc. Cap Screw M8x70	2
58	Bush	1
59	Soc. Cap Screw M8x30	1

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TASK 2: **Overhauling of milling machine feed gear box**

- Switch off the machine.
- Drain the oil and collect.
- Remove dowel pins in shifting handle.
- Remove all shifting levers.
- Disconnect the telescope drive.
- Remove the feed gear box cover plates.
- Identify the fault in cross feed movement
- Dismantle all the parts in shafts 1 & 2 by pull bolt method.
- Clean all the parts and dry it.
- Identify the defective parts.
- Replace / repair the defective part.
- Assemble all the parts in the reverse manner of dismantling.

- Replace all gaskets oil seals ‘O’ rings.
- Fix the cover plate, position the shifting lever and fix it.
- Fill with recommended oil to the required level.
- Switch on the m/c and trail run.

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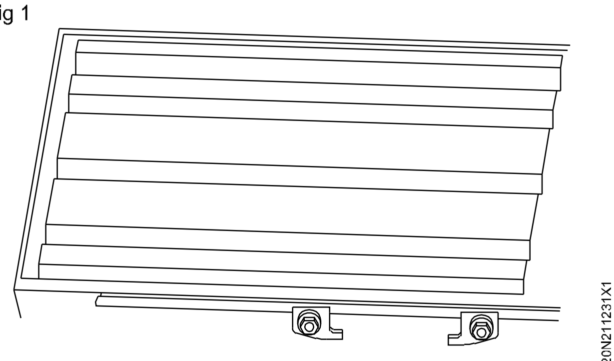
TASK 3: **Overhauling of surface grinding machine table and lead screw**

- Switch off the machine.
- Remove all the safety guards from the machine. (Fig 1)
- Clean the machine table with cotton cloth.
- Remove hexagonal nuts and end brackets at the two end of piston rod. (Fig 1)

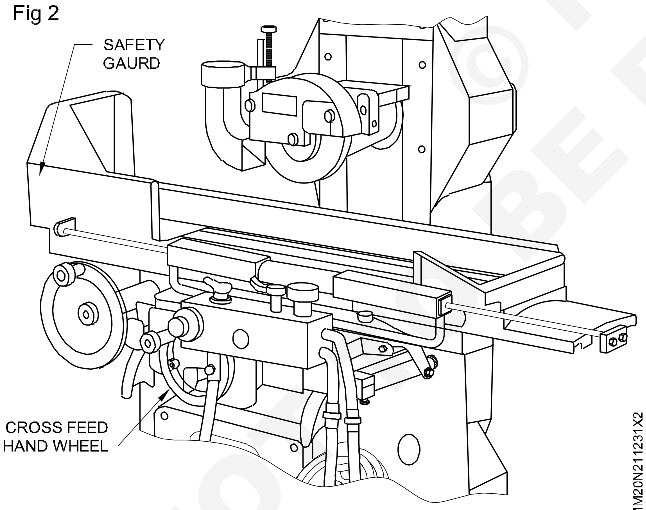
Fig 1



DISMANTLE THE CROSS FEED LEAD SCREW

- Lift the table up and take it out from the machine (Fig 2).

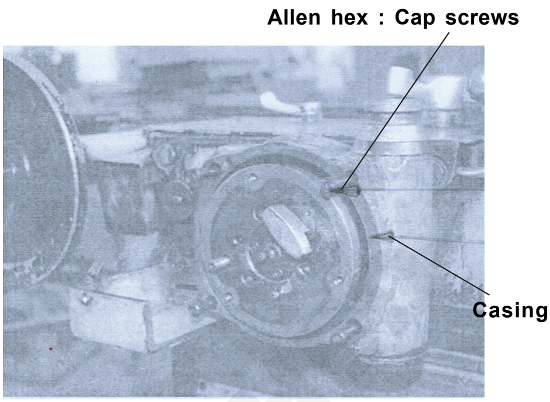
Fig 2



Dismantle the cross feed lead screw

- Remove the cross feed hand wheel by loosening the allen hexagonal cap screws.
- Remove the fine adjusting worm shaft casing by loosing the allen hexagonal cap screws. (Fig 3)

Fig 3



- Remove the hexagonal nut which connect the lead screw and fine adjusting unit by removing the cap. (Fig 4 & Fig 5)

Fig 4

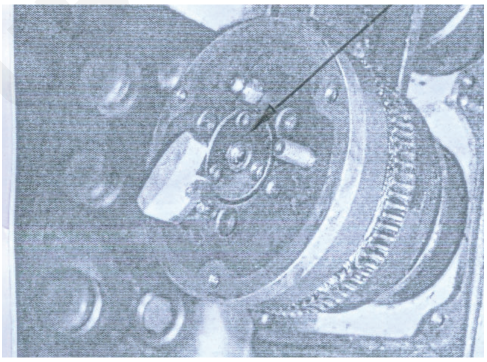
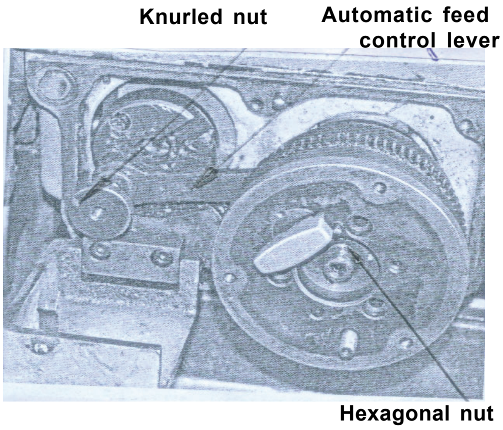
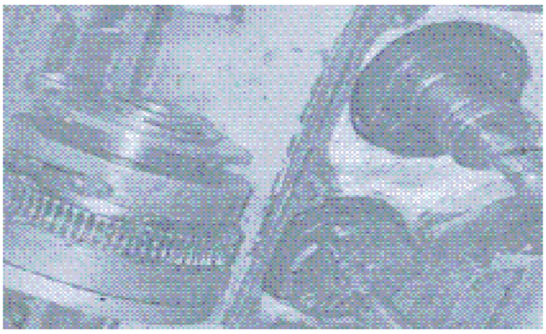


Fig 5



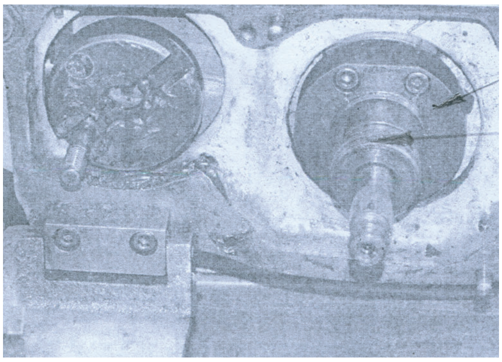
- Unscrew the knurled nut of automatic feed rate control lever and pull out the whole fine adjust it on unit away from the machine. (Fig 6)
- Remove the feather key .(Fig 6)

Fig 6



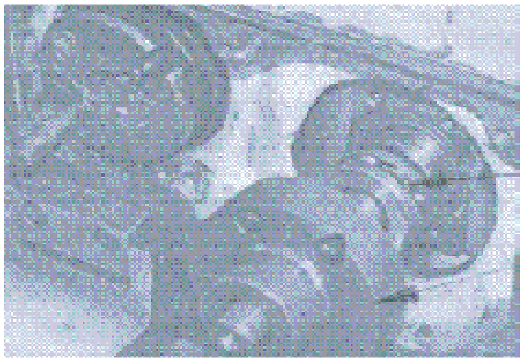
- Slide out the front end thrust bearing from the flange. (Fig 7)

Fig 7



- Remove the flange by unscrewing the allen hexagonal cap screws and take out the near end thrust bearing from the lead screw. (Fig 8)

Fig 8



- Remove the lead screw from the machine by unscrewing it in anti clock wise direction.

Check and replace the worn out parts

- Clean all the parts by using kerosene.
- Check all the parts, if necessary replace the worm out parts

Assemble the table and cross feed screw

- Assemble all the parts in the reverse manner a specified in the dismantling procedure.

Check the free movement of table and cross feed

- Apply lubrication oil between table and saddle.
- Rotate the cross feed hand wheel and check the free traverse movement.
- Switch on the machine and check the longitudinal free movements of the table.

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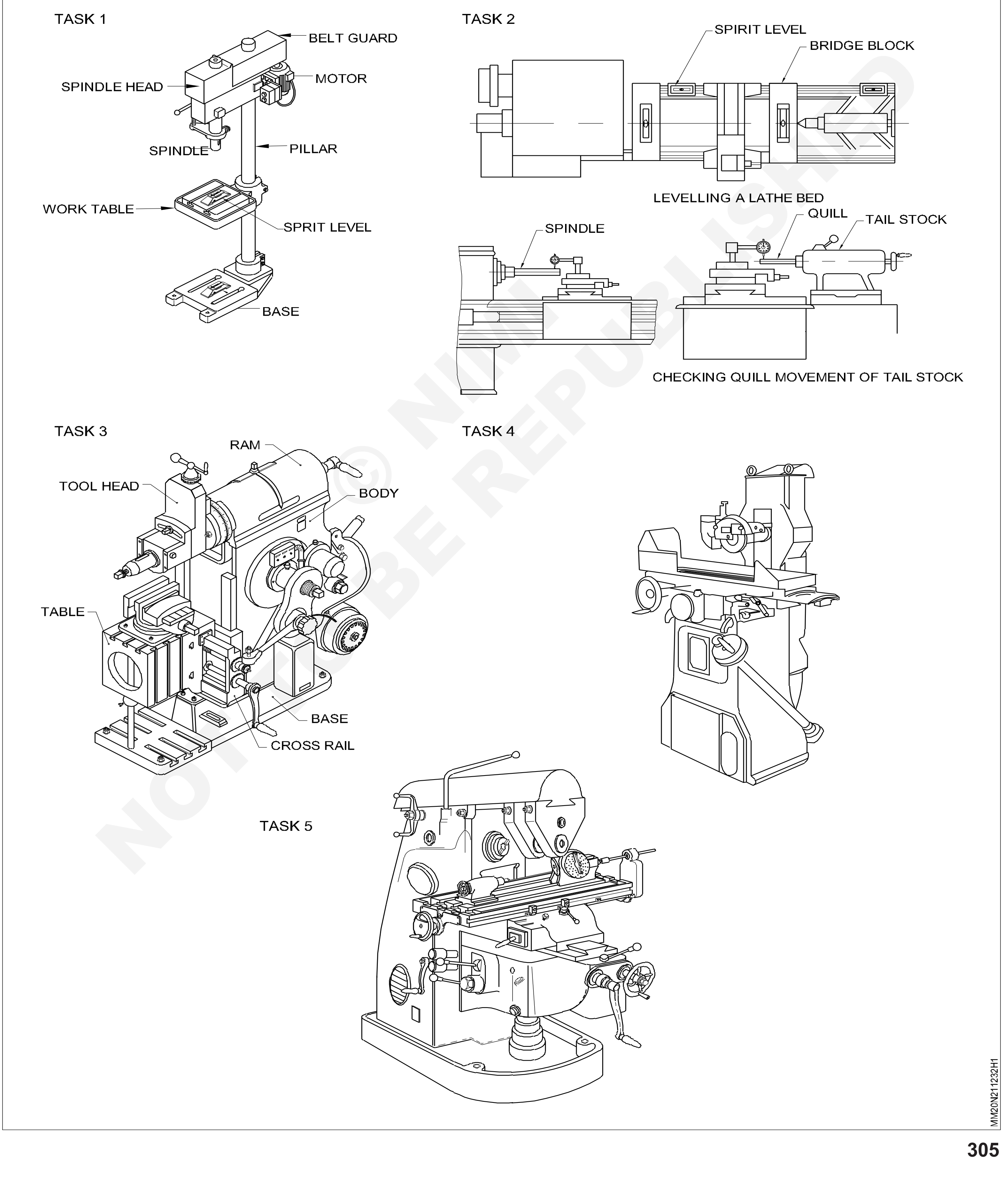
Geometrical testing of machine tools

Objectives : At the end of this exercise you shall be able to
- **geometrical testing of pillar drilling machine**
- **geometrical testing of centre lathe machine**
- **geometrical testing of Shaping machine.**

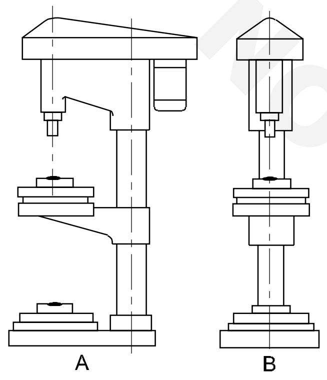
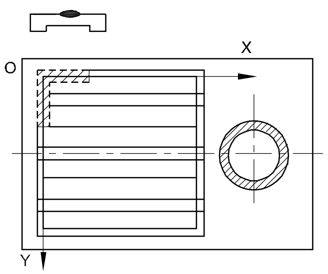
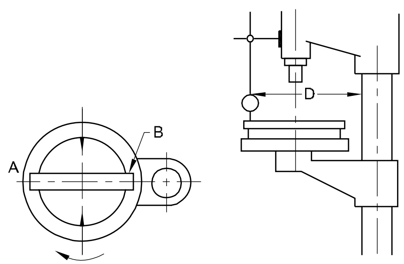
Fig 1

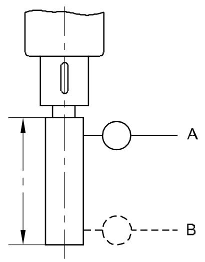
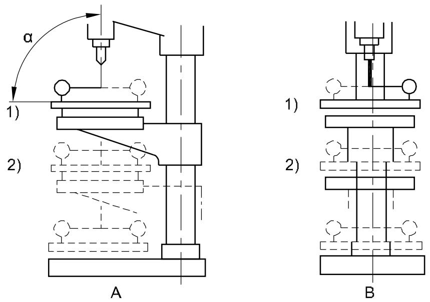
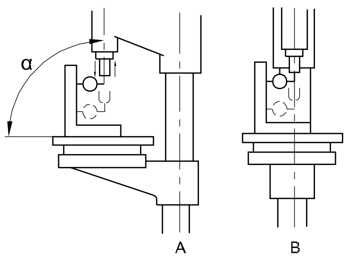


TASK: 1

Test chart for pillar drilling machine

Geometrical tests

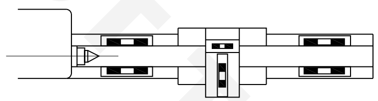
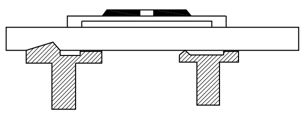
Sl. No	Figure	Object	Measuring Instruement	Instructions for Testing	Permissible Deviations	Actual Error
1		Leveling of the machine a) In the plane of symmetry of the machine and b) In the plane perpendicular to the plan of symmetry of the machine and passing through the spindle axis.	Sprit level and straight edge	Set the table in the center position and lock place the sprit level on the top place of the table	0.01 mm in both direction	
2		Flatness of the table surface (and of the base plate if it is machined)	Precision level or straight edge and gauge blocks	Set the straight edge in the direction of x y and check the gap by feeler or light gap method.	0.02 in all the direction	
3		Caming of the rotating table (for machines having this feature)	Straight edge and dial gauge with stand	Set the straight edge approximately in a dia-meter plan of the table touch point A placed on the table periphery then touch point B after rotationg the table by 180º.	0.005 mm	

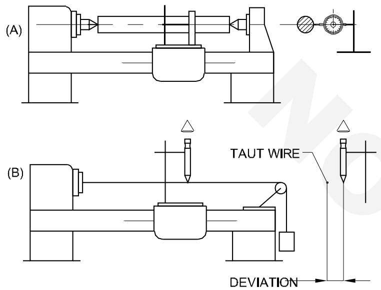
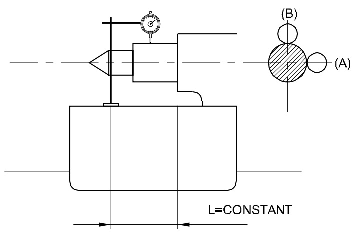
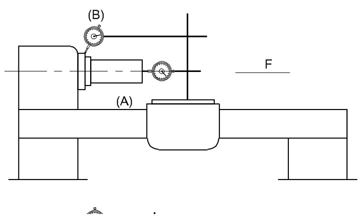
				Repeat the same operation setting the straight edge in another diameteral plane ⊥r to the proceeding one and lock the table before taking any measurement.	0.005 mm	
4		Run out of the internal taper of the spindle. a) Near the spindle nose b) At a distance / from the spindle nose.	Dial test indicator and test mandrel	Hold the test mandral in the spindle Set the dial test indicator in the position 'A' and 'B' Check the run out.	0.005 mm	
5		Straightness of the pillar and squareness of the spindle axis to the table surface and the base plate. a) in the plane of symmetry of the machine b) In a plane ⊥r to the plane of symmetry of the machine.	Dial gauge and straight edge	Straightness checking shall be carried out at a number of position equally spaced. Squarness checking shall be carried out first with the table in upper position next in the lower position, table and knee locked spindle head locked in center position.	0.005mm ±5’	
6		Squareness of the table surface to the vertical movement of the spindle housing or quill. a) in the plane of symmetry of the machine and b) in the plane of perpendicular to the plans of symmetry of the machine.	Dial test indicator straight edge and square	Spindle head table and knee locked in middle position	0.005 mm	

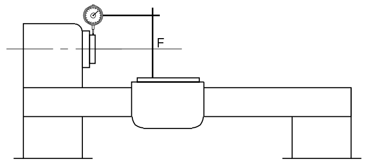
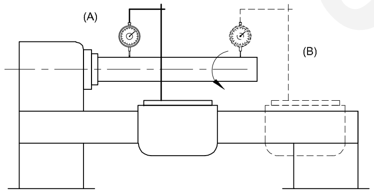
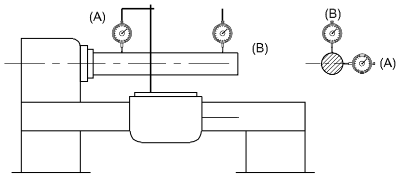
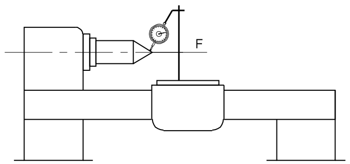
I Gemotrical Tests

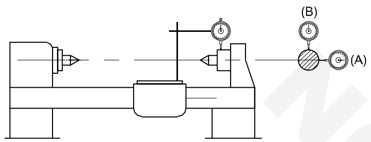
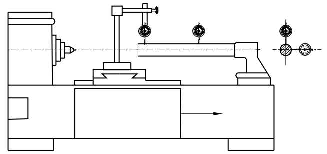
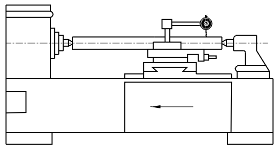
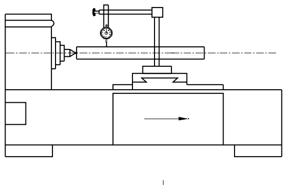
All dimensions in millimetres.

TASK 2: Geometrical test of centre lathe

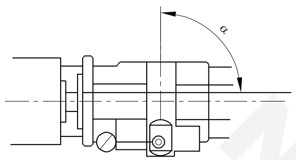
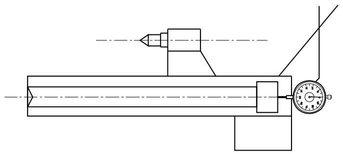
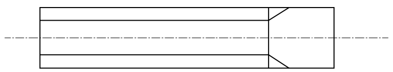
Sl No.	Figure	Object	Measuring Instruments	Reference to IS 2063 : 1988 and/ or Instructions for Testing	Permissible Deviations
1	 a)	Verification of levelling of slidways a) Longitudined 1 direction: Straightness ofslideways in the Vertical plane	Precision levels straight edge optical or other methods	a) 3.11, 3.21, 5.212.21 and 5.2i2.22 Make the measurement at a number of positions equally spaced along the length of the bed the levels may be placed on the transverse siide. When the slideways are not horizontal use a straight edge	DC< 500 0·0i (convex) < .... 500 < DC 1 000 0·02 (convex) Local tolerance : 0.007 5 for any length of 250 DC > i 000 for each l000 increase in distance between centres beyond 1000, add to the corresponding preceding tolerance: 0·01
	 b)	b)Transverse direction: shall be in the same plane	Precision levels	Apply on the slideways and take measure-ments at a number of positions equally spaced along the length of the s!ideways The variation of level measured at any position shall not exceed	Localtolerance: 0·015 for any length of 500 *(see* Annex A) Variation of level: 0-04/1 000

2		Checking of straightness of carriage movement in a horizontal plane or, possibly. in a plane defined by the axis of the centres and the tool point	a) For DC< l 500Dial gauge and mandrel between centres or straightedge b) Whatever the value of DC, taut wire and microscope or optical methods	a) **5.232.3** (a) or **5.232.1**Touch the front generatrix of the mandrel (instead of the mandrel, a straightedge with parallel faces may be used)Length of mandrel between centres shall be as nearly as possible equal to the value of DC b) **5.212.3** and **5.232.3** (b)The deviation of straightness of carriage movement shall, other than in exceptional cases, be concave relative to the axis of the centres NOTE - Whenever test (b) is carried out, test t (a) is not necessary	DC< 500 0·015 500 < DC < 1 0000·02 DC > **1000**For each **1 000** increase in distance between centres beyond l 000, add to the corresponding preceding tolerance 0·005Maximum permisable deviation 0·03
3		Checking of parallelism of Tailstock movement to carriage movements: a) in the horizontal plane; b) in the vertical plane	**Dial gauge**	**5.422.5** With the tailstock as close as possible to the carriage take the readings when both are moved together; keep the tailstock sleeve locked so that the dial gauge fixed on the carriage always touches the same point	DC< l 500 (a) and (b) 0·03 Local tolerance: 0·02 for any length of 500 DC > 1 500 (a) and (b) 0·04 Local tolerance: 0·03 for any length of 500
C - HEAD STOCK SPINDLE					
4		a) Measurement of periodic axial slip b) Measurement of caroming of face plate re ting surface	Dial gauge and possibly a special device	5.62, 5.621.2, 5.622.2 and 5.632 If necessary the value of axial force *F**, to be applied for the tests (a) and (b), shall be specified by the manufacturer	a) 0-01 b) 0·02 including periodic axial slip

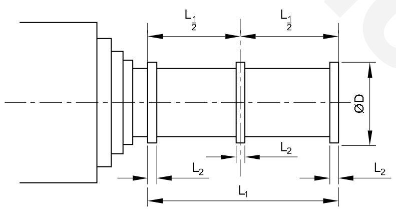
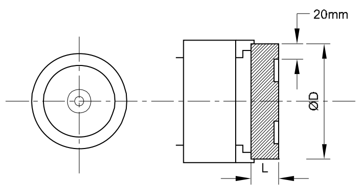
5		Measurement of runout of spindle nose centring sleeve Measurement of **run-out of axis of centre:**	Dialgauge	5.612.2 **and** 5.621.2 If necessary, the value of force *F** to be applied shall be speci- fied by the manufacturer In the case of a tapered spindle nose fix the dial gauge perpen-dicular to the generating line of the taper	0·01
6		a) near the spindle nose of the housing b) at a distance from the spindle nose equal to Da/2 or not more than 300	test **mandrel**	5.612.3	a) 0·01 b) 0·02 for a measuring length of 300
7		Checking of parallel ism of spindle axis to carriage longitu-dinal move ment on a length equal to Da/ 2 or a maximum equal to 300 a) in the horizontal plane b) in the vertical plane	Dial gauge and test mandrel	5.412.1 **and** 5.422.3	a) 0·15/300 free end of mandrel front wards b) 0·02/300 free end of mandrel upwards
8		Measurement of runout of head- stock centre	Dial gauge	5.612.2 and 5.621.2 The dial gauge being placed perpendicularly to the taper surface of the head centre, and tolerance being given in a plane perpendicular to the spindle axis, divide the readings observed by cos Jt,oc being the semi-cone angle of the ta per. If necessary, the value of force *F** to be applied shall be specified by the manu facturer	0·015

9		Checking of parallelism of the axis of the outside of tailstock sleeve to carriage movement: a) in the horizontal plane b) in the vertical plane	Dialgauge	5.422.3 After the tailstock sleeve has been sufficiently extended, it shall be locked as under normal working conditions of the taper	a) 0·015/100 free end of the sleeve frontwards b) 0·02/100 free end of the sleeve upwards
10		Checking of parallelism of taper bore of sleeve to carriage movement on a length equal to Da/4 or a maximum equal to 500 mm a) in the horizontal plane **b) in** the vertical plane	Dial gauge and test mandrel	**5.422.3** Lock the tailstock sleeve as under normal working conditions	a) 0·03/300 free end of the mandrel front-wards b) 0·03/300 free end of the mandrel upwards
			E - CENTRES		
11		Checking of difference in height between headstock and tailstock centres	Dial gauge and test mandrel	**5.422.3** Touch the top generatrix of the mandrel. Take readings at the extremities of the test mandrel with the tailstock and tailstock sleeve locked as under normal working conditions	0·04 Tailstock centre higher than headstock centre
			F - UPPER SLIDE		
12		Checking of parallelism of the longitudinal movement of the upper slide to the spindle axis	Dial gauge and test mandrel	**5.422.3** Make the measurement in the vertical plane (after setting up the upper slide parallt:l with the spindle axis in the horizontal plane), only in the working position of the upper slide	0·04/300

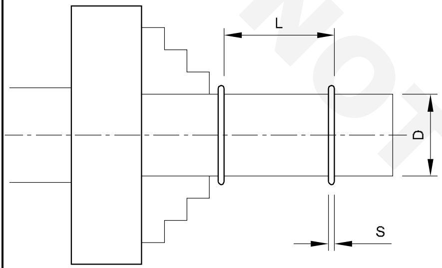
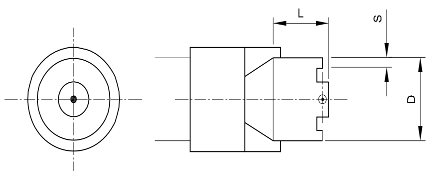
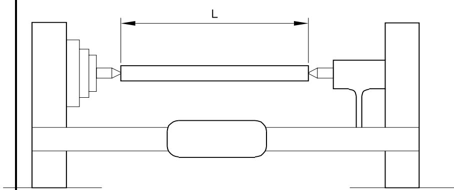
G - CROSS SLIDE

13		Measurement of squareness of the transverse movement of the cross slide to the spindle axis	Dial gauge and flat disk or straight edge	**3.22 and 5.522.3**	0·02/300Direction of deviation IX;;.,, 900
		H - LEAD SCREW			
14		Measurement of periodic axial slip of each thrust bearing	Dial gauge	**5.622.1** and **5.622.2** This operation may be deleted if practical test No. 3 is carried out	**0·015**
15		Checking of the cumm:ulative pitch error generated by the lead screw	Dial gauge length bars, etc	**6.1** and **6.2** Length bars will be used associated with a dial gauge so as to compare the carriage travel to the number of corresponding revolutions of the spindle. However, a record of the lead screw accuracy (over a specified length and checked along four generators shifted 90° forward) should be satisfactory. NOTES 1 By agreement between the manufacturer and the user on the measuring method and the values of permissible deviation, total error may be checked over 300mm 2 This test is to be carried out only if a certified lead screw is required by the customer	i) DC< 2000 0·04 For any measured length of 300 ii) DC> 2000 For each 1000 increase in distancebetween centres beyond 2 000, add to the corresponding preceding tolerance: 0·005 Maximum permissible deviation:0.005 iii) 0·015 for any measured length of 60

G - CROSS SLIDE

Sl No.	Figure	Nature of Test	Cutting Condi-tion	Checks to be Applied	Measuring Instruments	Ref to IS 2063 : 1988 and/or Instructions for Testing	Permissible Deviations	Actual .. Error
1		Machining of cylindrical test pieces held in a chuck (the cylindrical test piece mav be inserted in the ta per bore of the spindle) *D Da/8* $/1$ = 0·5 *Da* 1_1 *max*= 300 *l, max*= 20 *Material* : Test pieces shall be made of free cutting steel or cast iron	Machining of three diameters on a cylinder with a single point tool. It may be two diameters if/ ,< 50	a) Circularity-Variation in diameter at the location end of the test piece for atleast four readings b) Consistency of machined diameters(bands) Variation betweenmachined diameters at either end of the test piece measured in a single axial plane. Any taper shall be such that the major dia is near the headstock	Roundness measuring instrument and micrometer	3.1, 3.22 4.1 and 4.2	a) 0·02 b) 0·04 per $/_1$ = 300 The difference between adjacent bands (except when these are only two) shall not exceed 75percent of the measured difference between the outside bands	
2		Machining of 2 cylindrical test piece held in a chuck *D* > 0·5 *D.* Lmax =Da/8 *1viaterial:*Testpieces shall be made of free cutting steel or cast iron	Facing of flat surfaces perpendicular to thespindle (facing only two or three surfaces,one of which is central)	Surface flatness Deviation of flatness should only be allowed in aconcavedirection	Straight edge and slip gauges	3.1, 3.22 4.1 and 4.2	0·025 for a diameter of 300	

Practical Tests (All dimensions in millimeters for lathe)

Sl. No.	Figure	Nature of Test	Cutting Conditions	Checks to be Applied	Measuring Instruments	Instruction for Testing (Reference to Test Code IS : 2063 – 1962)	Permissible Deviations
1.		Turning of cylindrical test piece held in chuck (the cylindrical test piece may be inserted in the taper of the spindle) $D \geq \frac{Da}{8}$ $L = \frac{Da}{2}$ Or Max 300	Machining of two diameters on a cylinder over a maximum length of S = 20	a) Roundness b) Cylindricity Any taper should be such that the larger diameter is near the headstock centre	Micrometer or any other precision testing equipment	3.1, 4.1 and 4.2	a) 0.01 b) 0.04 for L – 300
2.		Facing of cylindrical test pieces held in a chuck $D \geq \frac{Da}{2}$ $L = \frac{Da}{8}$ Max	Facing of flat surfaces perpendicular to the spindle axis (Facing only 2 or 3 surfaces one of which is central) S = 20	The machined surfaces shall be flat or concave only	Straight edge and slip gauges or any other optical or other instruments	3.1, 4.1 and 4.2	0.025 for a dia of 300
3.		Thread cutting (conforming to IS : 4218-1967) a cylindrical test piece. Measuring length L = 300	The start of the screw thread is taken from any point on the lead screw Diameter and pitch shall be as close as possible to those of the lead screw	Accuracy of the pitch a) Deviation over any length of 300 b) Deviation over any length of 50	Special precision equipment or instruments for inspection of threads	3.1, 4.1, 4.2 and 6.2 Note : This test is to be carried out only if specifically required by the customer	a) 0.04 for DC ≤ 2000 For each supplementary length of 1000 for DC beyond 2000 add 0.005 without exceeding the maximum deviation 0.05 b) 0.015

Note : Da = Maximum permissible diameter above the bed (Swing)

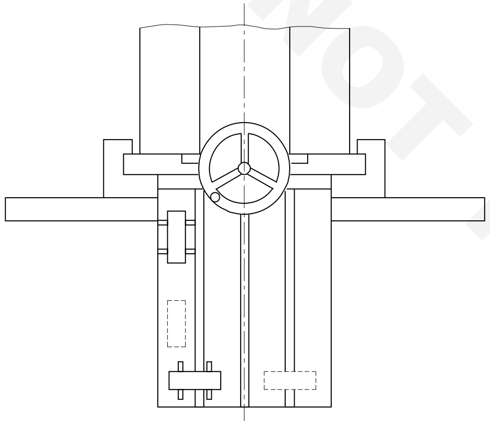
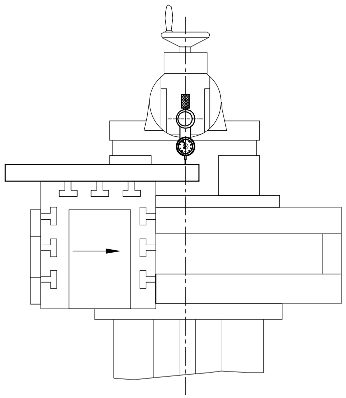
DC = Distance between centres

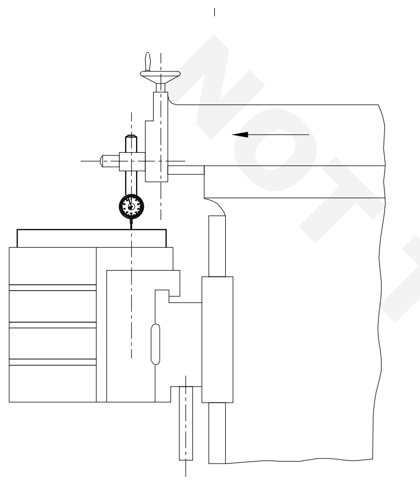
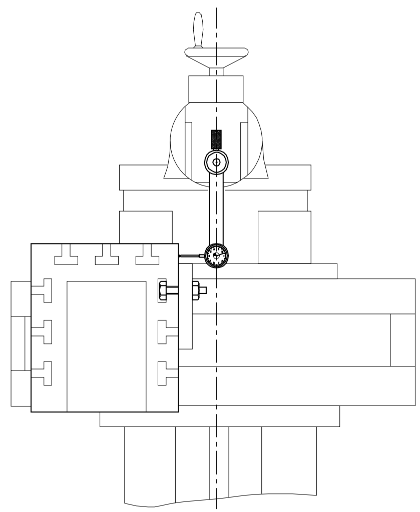
1. The specifications concerning local tolerance are given only to eliminate in case of linear slideways, the possibility of too large deviations in straightness concertrated on a small length (2.3.2.2 (d) of IS : 2063 - 1962.

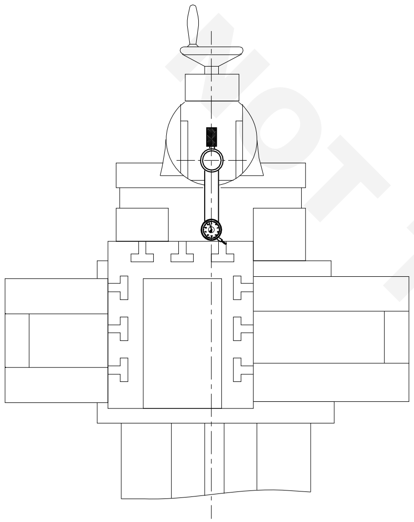
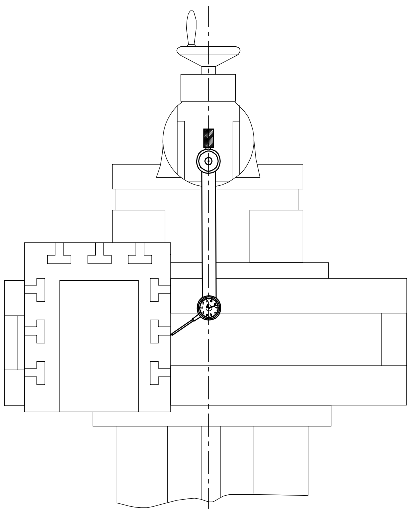
However, in the case of slideways with a regular convex which is approximately symmetrical with respect to the middle of their length, the specifications for local toleranxce are too restirictive at the extremities of the slideway. In such cases the specifications for local tolerance may be doubled for the outer quarter sof the slideway.

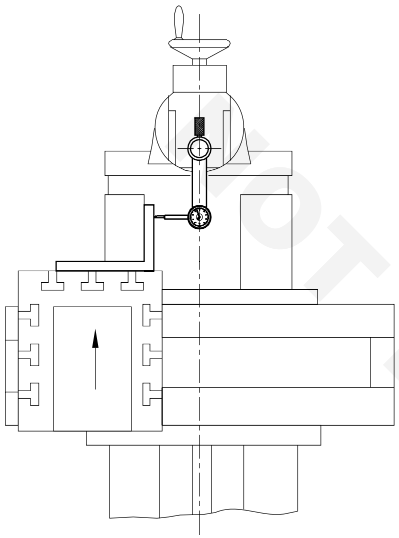
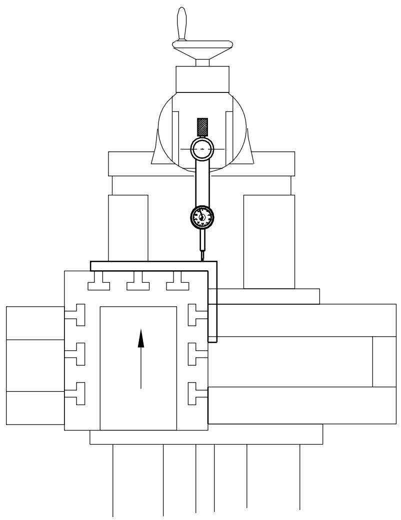
TASK: 3

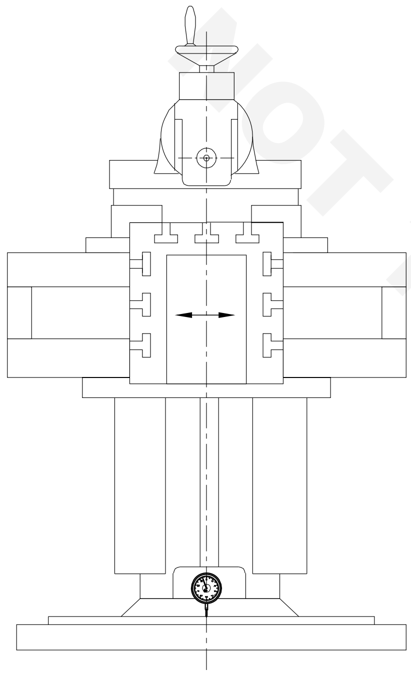
Test chart for Shaping Machines
I. Geometrical Tests

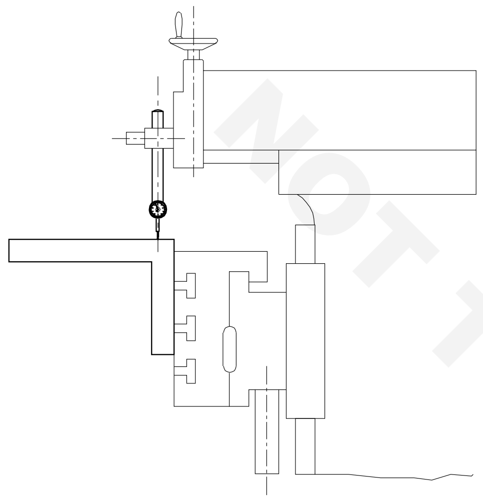
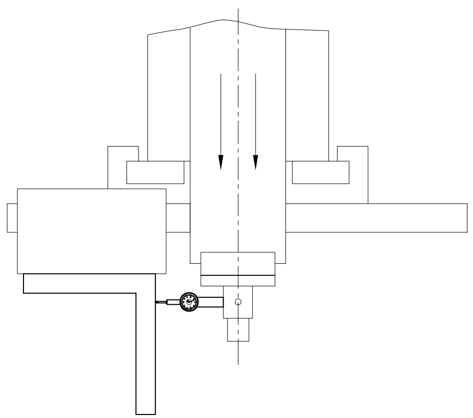
Sl. No.	Figure	Object	Measuring Instruments	Instructions for Testing	Permissible Deviations	Actual Error
1		Measurement of flatness of table top face	Spirit level and gauge blocks	Set the table in the central position. Place spirit level on top face on gauge blocks. Readings shall be recorded in longitudinal and transverse directions at various position (Note : Maximum distance between two successive position of level shall be between to the area of top face)	0.04 for 1000 mm Top face shall be convave only	
2		Measurement of parallelism of table top face to its transverse movement	Straight edge dial gauge	Set the straight edge in the direction of transverse movement. Mount the dial gauge on the ram. Move the table in the transverse direction. Note the readings of dial gauge. Note : the straight edge should be placed at mimimum 3 positions on the table top face (that is two ends, and centre) and readings noted.	i. 0.02 for 300 mm ii. Maximum 0.04 over entire movement of table.	

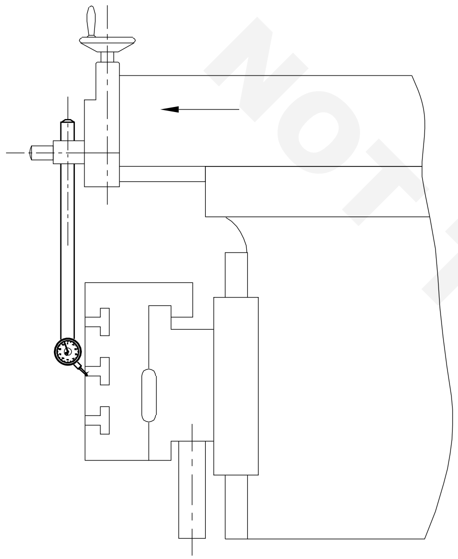
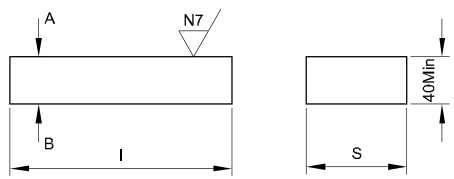
Sl. No.	Figure	Object	Measuring Instruments	Instructions for Testing	Permissible Deviations	Actual Error
3		Measurement of parallelism of table top face to the ram movement	Straight edge and dial gauge	Set the table in central position and ram to the end of the stroke position Mount straight edge on the table top face in the direction of movement of ram alternatively on the left and right side of table. Mount dial gauge on the ram. Move the ram and note the readings	i. 0.02 for 300 mm ii. Maximum 0.04 over the entire length of table. Table shall rise towards free end only.	
4		Measurement of parallelism of table side face to the movement of ram	dial gauge	Mount the dial gauge on the ram. Move the ram through the length of table by hand. Note the readings on dial gauge. Readings should be recorded at 3 position - 2 ends and centre. Repeat the process for other side	0.03 per 300 mm. Maximum 0.05 on entire length of table	

Sl. No.	Figure	Object	Measuring Instruments	Instructions for Testing	Permissible Deviations	Actual Error
5		Measurement of parallelism reference 'T' slot on top face to the movement of ram	Dial gauge	Set the dial gauge on the ram and measure the readings by moving the ram slowly through entire stroke length	i. 0.02 for 300 mm ii. Maximum 0.04	
6		Measurement of parallelism of reference 'T' slot on side face - to the movement of ram. (only for Tables with horizontal slots)	Dial gauge	Set the dial gauge on the ram and note the readings by moving ram slowly and through entire length	0.03 per 300 mm. Maximum 0.06 The slots to rise towards free and of table only	

Sl. No.	Figure	Object	Measuring Instruments	Instructions for Testing	Permissible Deviations	Actual Error
7		Measurement of squareness of table top face to its vertical movement (As well as to vertical travel of tool slide)	Dial gauge and square	Bring the table to its lower most position. Mount dial gauge on ram set the squar on the top face. i. Move the table invertical direction and not the dial gauge readings ii Move the tool post by hand in vertical direction down and then up. Note the readings on dial gauge.	i. 0.02 for 300 mm ii. Maximum 0.05	
8		Measurement of squarness of side face of table to its transverse movement	Dial gauge and square	i. Set square on one of the side faces. Set dial gauge on ram and move the table in transverse direction. Note the dial gauge reading. ii Replace the procedure for other face.	0.02 per 300 mm. Maximum 0.06	

Sl. No.	Figure	Object	Measuring Instruments	Instructions for Testing	Permissible Deviations	Actual Error
9		Measurement of parallelism of guideways for table support to the transverse movement of table (Test shall be applicable to machines with table support)	Dial gauge and square	Set the dial gauge on table bottom and/ or front face. Remove table support. Move the table in the transverse direction and note the dial gauge reading.	0.03 per 300 mm Maximum 0.05.	

Sl. No.	Figure	Object	Measuring Instruments	Instructions for Testing	Permissible Deviations	Actual Error
10	 	Measurement of squareness of table fixing face to the ram movement (For machines with detachable tables only) a In vertical plane b In the horizontal plane	Dial gauge and square	a Set the square on the fixing face, set dial gauge on the ram. Move the ram. Note the dial gauge readings. b Set the square on the fixing side face, set dial gauge. Move the ram and note the dial gauge readings.	a 0.02 per 300mm measuring ram of square to rise towards the free end only. b 0.03 per 300 mm	

Sl. No.	Figure	Object	Measuring Instruments	Instructions for Testing	Permissible Deviations	Actual Error
11		Measurement of parallelism of 'T' slot in table carriage to its transverse movements. (For machines with detachable tables only)	Dial gauge	Set the dial gauge on ram and engage pointer vertically on 'T' slot. Move table carriage and note the dial gauge readings. (If 'T' slots are not provided locating face shal be checked).	i. 0.03 for 300 mm ii. Maximum 0.04	
12		Measurement of parallelism of machined surface A to the bearing surface B.		i. The bottom face B shall be properly machined; if necessary shall be scraped. Machined face A with finishing cut. ii Note readings with micrometers at several points along length and width of work piece.	0.03 per 300 mm	

TASK 4: **Geometrical test for surface grinding machine**

Refer Ex. No 2.5.169 TASK 1 & 2

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TASK 5: **Geometrical tests Axis of motion milling machine**

Refer Ex. No. 2.4.160

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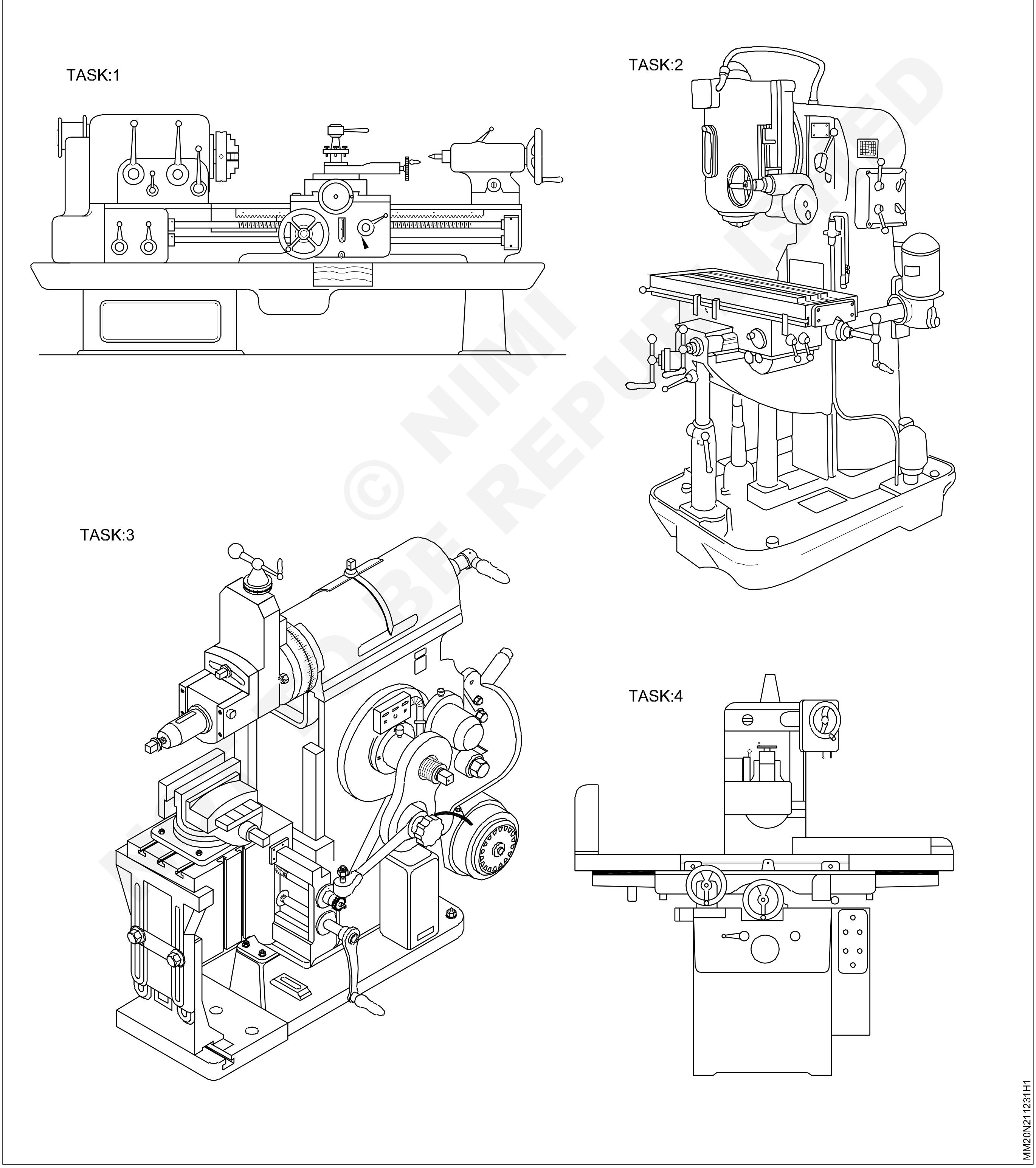
Preparation of check lists for inspection of different machine tools

Objectives : At the end of this exercise you shall be able to
- **inspect the lathe as per check list**
- **inspect the milling machine as per check list**
- **inspect the shaping machine as per check list**
- **inspect the surface grinder as per check list.**

Fig 1



Job Sequence

TASK 1:

- Inspect the item as listed in the annexure and fill the format.
- Carry out the maintenance for defective item.
- Trail run the machine.

Prepare the checklist for the any other machine/ equipment not listed in the annexure available in your trade with the help of instructor.

Name of the Machine :

Location of the machine:

Machine Number :

Model No & Make :

CHECK - LIST FOR MACHINE INSPECTION OF LATHE

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 and its tension			
Bearing sound			
Driving clutch and brake			
Exposed gears			
Working in all the speeds			
Working in all feeds			
Lubrication system			
Coolant system			
Carriage and its travel			
Cross - slide & its movement			
Compound slide & its travels			
Tailstock's parallel movement			
Electrical controls			
Safety gaurds			

Inspection by

Signature

Name :

Date :

Signature of in - charge

TASK 2:

Name of the Machine : Location of the machine:

Machine Number :

Model No & Make :

CHECK - LIST FOR MACHINE INSPECTION (of Milling machine)

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 and its tension			
Bearing sound			
Driving clutch			
Working in all the speeds			
Working in all feeds			
Lubrication system			
Coolant system			
Table travel			
Cross - slide & its movement			
Saddle & its travels			
Knee up & down movement			
Electrical controls			
Safety gaurds			

Inspection by

Signature

Name :

Date : Signature of in - charge

TASK 3:

Name of the Machine : Location of the machine:

Machine Number :

Model No & Make :

CHECK - LIST FOR MACHINE INSPECTION (Shaper)

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 and its tension			
Bearing sound			
Table elevation			
Exposed gears			
Working in all the speeds			
Working in all feeds			
Lubrication system			
Ram and its travel			
Saddle & its movement			
Tool head angle rotation			
Stroke length adjustment			
Position of the stroke			
Safety guards			

Inspection by

Signature

Name :

Date : Signature of in - charge

TASK 4:

Name of the Machine : Location of the machine:

Machine Number :

Model No & Make :

CHECK - LIST FOR MACHINE INSPECTION (Surface grinder)

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 and its tension			
Bearing sound			
All feed movements			
Condition of bellows			
Dust collecting system			
Lubrication system			
Coolant system			
Condition of magnetic chuck			
Electrical controls			
Safety guards			

Inspection by

Signature

Name :

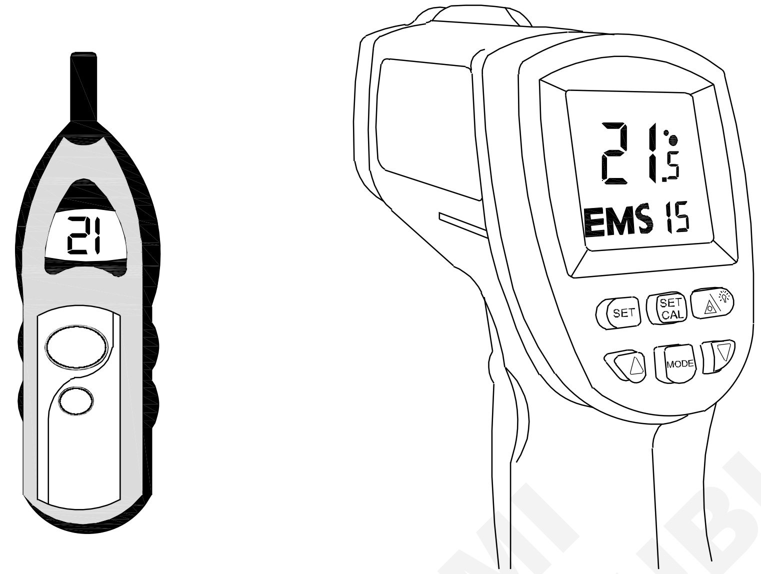
Date : Signature of in - charge

Temperature measurement and machine tools

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

- **read and measure temperature of various machine tools.**

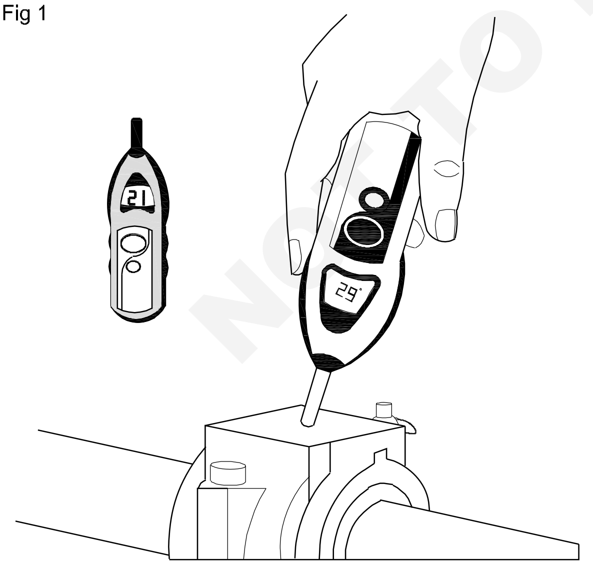
Fig 1



Job Sequence

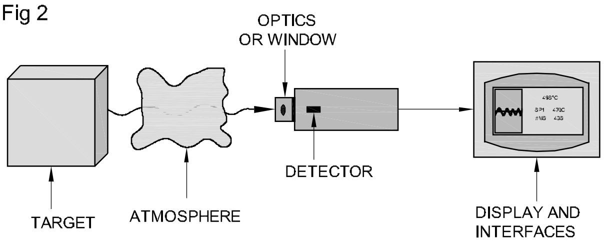
- Switch on the machine and run under load continuesily for some time (about 15 - 20 min)
- Place the thermometer's (Fig 1) flexible probe tip on the surface where the heat generation to be checked and note down the reading form display unit.

Fig 1



- Keep the temperature gun (Fig 2) at a distance maintaining distance to spot ratio (D:S 12 :1 (The diameter of the measuring area is one twelth of the distance to object) and note down the temperature from display unit.
- Identify the reason for over heating if any by checking oil levels, oil flow , any friction in the bearing sliding parts, gears and any other driving parts.
- Rectify the identified defect by repair / replace the part.
- Test run the machine under load for prescribed time measure and ensure the temperature is within the control.

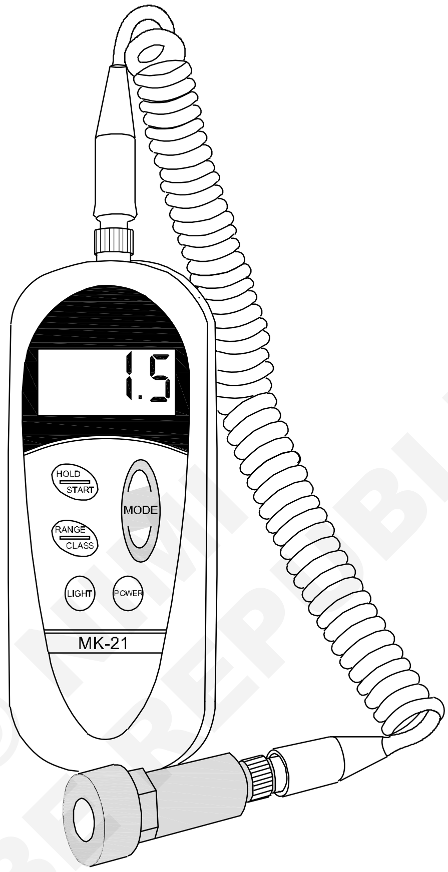
Fig 2



Vibration measurement of machine tools

Objectives : At the end of this exercise you shall be able to
- **test how to measure vibration of machine tools.**

Fig 1



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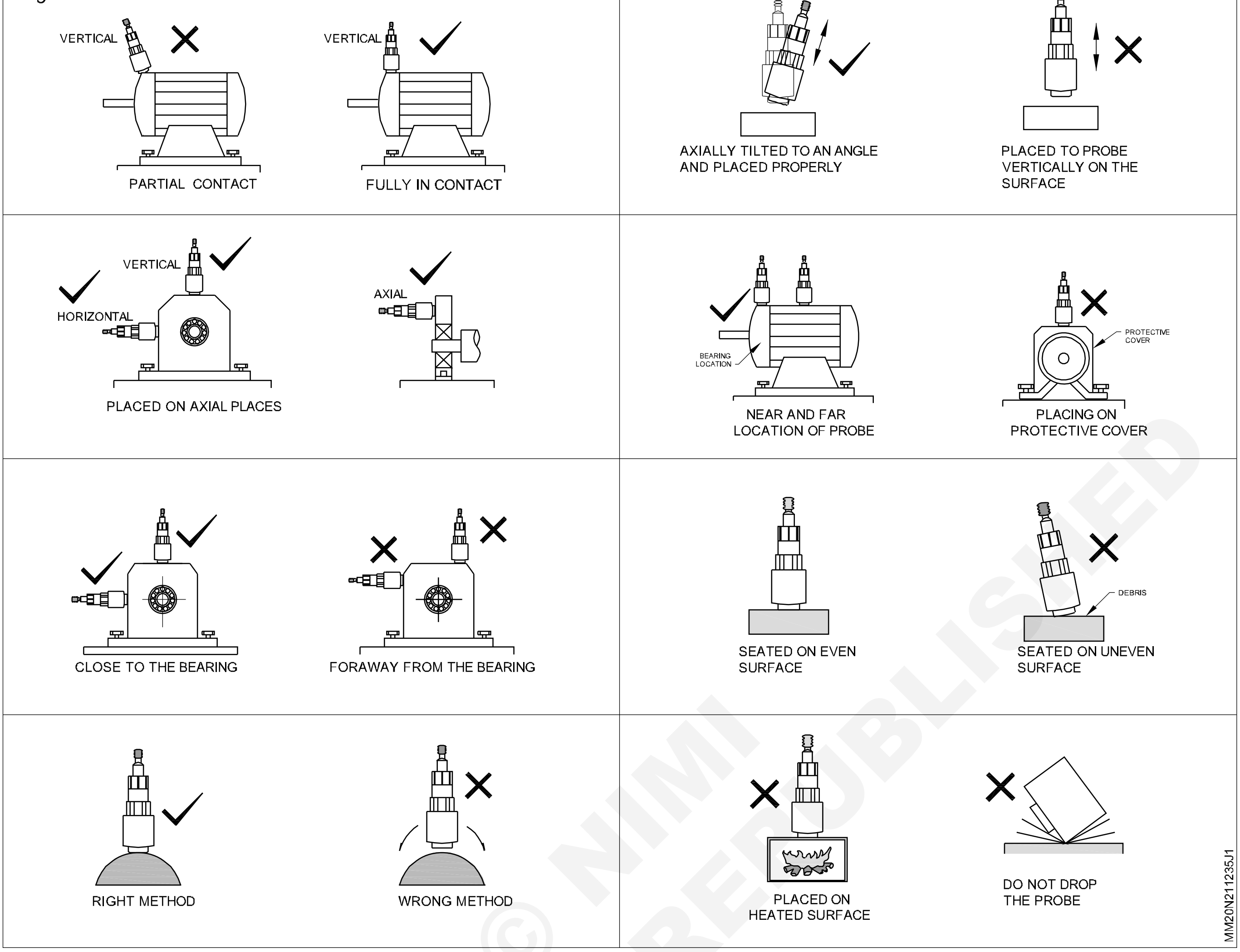
Job Sequence

- Clean the area at which vibration to be checked.
- Place the probe nearer to the rotation / moving elements and also at centre line of the axis.
- Run the machine.
- Observe the reading.
- Place the probe in various place and observe the reading at various speed and loads
- Place the probe properly as explained in the Fig 1.
- If the reading is not with in the permissible limit control the vibration by any one of the following method.
  - By lightening the foundation bolt.
  - By checking and lightening the sliding jibs / clamps.
  - By checking the condition of the bearing and replacing it.
  - By checking and arresting the play in the revolving parts.

Fig 1


VERTICAL
PARTIAL CONTACT
VERTICAL
FULLY IN CONTACT
AXIALLY TILTED TO AN ANGLE AND PLACED PROPERLY
PLACED TO PROBE VERTICALLY ON THE SURFACE
VERTICAL
HORIZONTAL
PLACED ON AXIAL PLACES
AXIAL
BEARING LOCATION
NEAR AND FAR LOCATION OF PROBE
PROTECTIVE COVER
PLACING ON PROTECTIVE COVER
CLOSE TO THE BEARING
FORAWAY FROM THE BEARING
SEATED ON EVEN SURFACE
DEBRIS
SEATED ON UNEVEN SURFACE
RIGHT METHOD
WRONG METHOD
PLACED ON HEATED SURFACE
DO NOT DROP THE PROBE
MM20N211235J1

Faults finding practice on machine tools

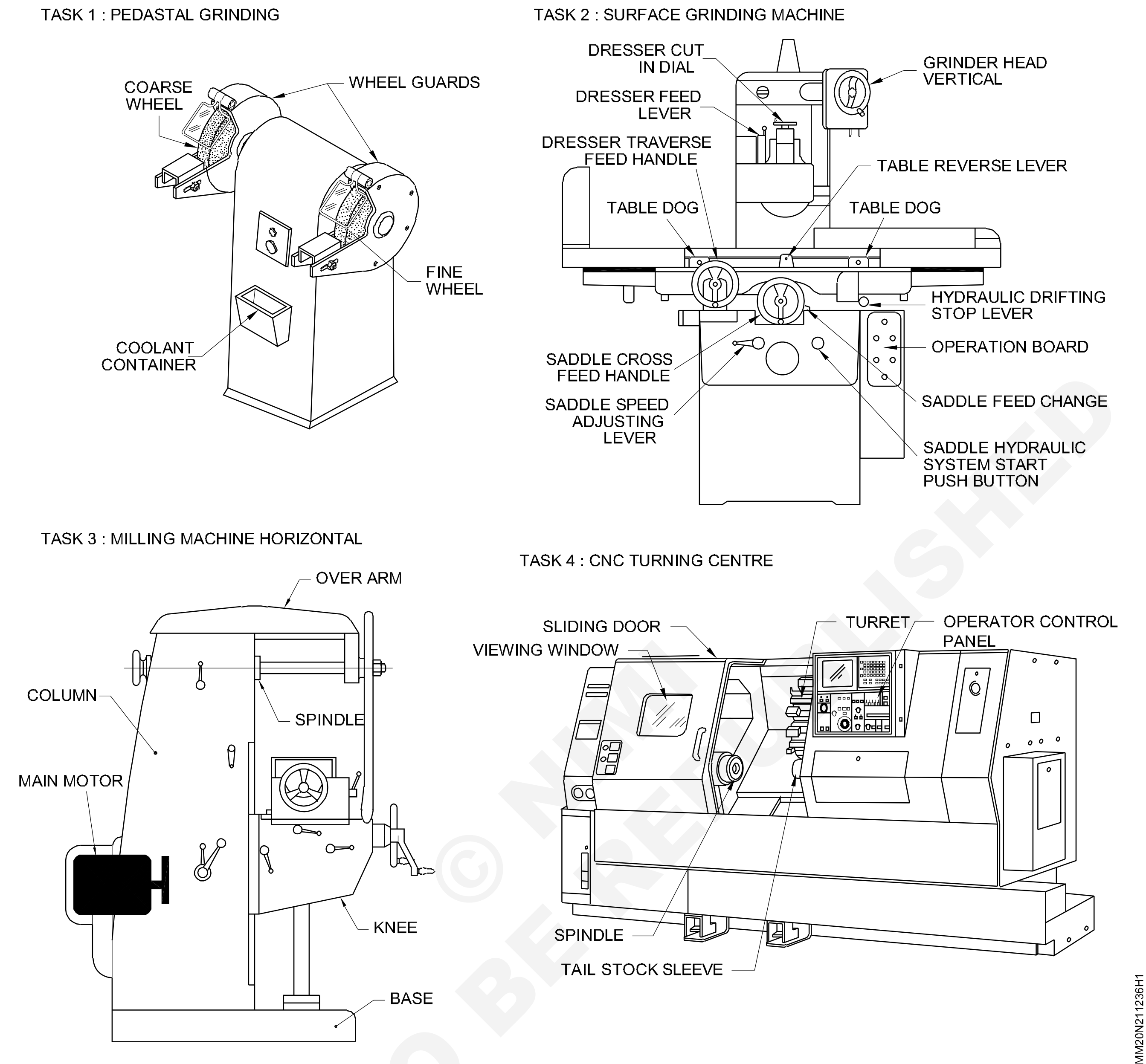
Objectives : At the end of this exercise you shall be able to
- **faults finding and rectification of pedestal grinding machine**
- **faults finding and rectification of surface grinding machine**
- **faults finding and rectification of milling machine**
- **faults finding and rectification of CNC turning centre.**

Job sequence

TASK 1 : **Faults finding and rectification of pedestal grinding machine**

Fault	Fault Cause	Rectification
Excessive consumption of grinding wheel/ cracking of grinding wheel	Incorrect grade of grit on grinding wheel for parent material.	Verify that the correct grade of grinding is suited for the parent material being ground.
	Excessively feed rate, forcing the parent material on to the grinding wheel.	Reduce the feed rate onto the grinder, else it might cause the parent material to break and cause harm to the operator.
	Cracking due to sudden force onto grinding wheel (Jarring of grinding wheel)	Do not abruptly force the parent material onto the grinding wheel. Instead, the material should be fed onto the grinding wheel at a steady but constant rate.
Minimal material removed on the parent part when fed onto the grinder wheel	Clogged or worn grinding wheel.	Replace the grinding wheel.
	Incorrect grade of grit on grinding wheel for parent material.	Verify that the correct grade of grinding is suited for the parent material being ground.
The machine would not operate.	Broken or worn component.	Replace with new component.
	The electrical component is worn.	Replace with new component.

Fig 1



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TASK 2 : **Faults finding and rectification of surface grinding machine**

No.	Faults	Fault Cause	Rectification / Remedy
1	Chatter marks usually caused by variation in the machine itself. The machine does not run free from vibration	Machine foundation is not firm enough.	Improve the foundation.
		The leveling screw in machine base are loosen.	Tight and lock them.
		Table not fully supported.	Re-scrap the contact surfaces of table and bed side ways.
		Grinding wheel does not sit firmly on the wheel flange.	Replace the washer between wheel and flange, tighten them well.
		Flanges does not fit firmly on the grinding spindle taper nose.	Clean both taper contact surfaces make sure they are well contacted and fitted firmly.

No.	Faults	Fault Cause	Rectification / Remedy
1		Wheel and flange are not well balanced.	Balance them well again.
		Wheel is un homogeneous.	If wheel and flange can not be well balance, dress wheel on periphery and both sides and balance it again. If one can't make it balanced, replace a new wheel.
		Use of improper wheel.	Select a proper one to suit the work piece material.
		Wheel is not dressed correctly.	The dressing diamond must be turn an angle or replace a new one if it is not contacted wheel with an edge diamond tool not firmly fixed.
		Too much pressure on the grinding spindle.	Re-adjusting the spindle pressure by qualified technician.
		Vibration transferred to machine from outside, such as rough-running machine, traveling cranes of the building and street vehicles.	Improve the foundation, to make it vibration free, or place machine to another vibration free position.
		Coupling of motor and spindle is loosen or rubber broken.	Fix couplings well, or replace a new one.
2	Flutter marks appear in the front of small flat surface distributed over the surface of the work piece unevenly	Unsteady running of grinding wheel.	3 Phases voltage of power source are unbalance, please check and balance it or replace a new spindle.
		Stroke removal too much	Reduce In feed
			Reduce cross feed
		Grinding wheel too hard or dull	Use softer or coarser wheel.
			Increase table speed.
			Reduc e in feed
			Roughen the wheel.
			Check diamond of the dresser.
		Travelling cranes or hoist of the building.	Improve the foundation.
			Change the position
		Travelling vehicle in the building or street.	Use anti-vibration plates.
3	Ray pattern parallel lines, hardly perceptible to the naked eye.	Grinding spindle bearings have defects. Too much pressure on. Wheel head guide way. Wheel badly dressed.	See in No.1 chatter marks.
4	Comma shaped lines appeared when grinding to get precision finish	Coolant too dirty.	Clean coolant or use automatic paper scrip filter.
		Grinding wheel chips off.	Clean inside of the wheel cover.
			Choose proper wheel.

No.	Faults	Fault Cause	Rectification / Remedy
5	Burn marks and grinding cracks caused by intense local heating of the work piece.	Grinding wheel too hard	Use softer or coarser wheel.
			Increase table speed.
			Reduce peripheral speed of wheel.
		Grinding wheel is dull or clogged	Dress the wheel make it. roughen and bit better.
		Stock removal too great	Reduce infeed.
			Reduce cross feed.
		Table speed too low	Increase table speed.
		Inefficient cooling	Increase coolant.
			Use stronger mixture coolant (Fill up with fresh oil)
6	Grinding spark abnormally.	It cannot be "spark" out ".	Re-align the machine by adjusting the jack bolt and checked it with spirit level.
7	Worktable cannot start.	The electric magnetic chuck does not switch on, so that pump motor does not work.	Switch on the chuck or automatic demagnetizer switch if it is used on the machine.
		Over load relay of pump motor cut off the magnetic switch, so that pump motor does not work.	Push reset lever of the over load relay.
		Oil pump can't deliver oil.	Check motor direction is wrong or not.
			Fill in oil from "P" port, then switch on pump motor.
		Turn clockwise the "Table longitudinal control lever" to it's open position, the table still can't start	Open and close lever several times if still doesn't start, regulate the relief valve and increase the pressure.
8	Work table doesn't run smoothly	Use un proper hydraulic oil.	Mobil vacuole No 1409 or it's equivalent is recommended.
		Hydraulic pump does not deliver sufficient oil level is too low.	Top up hydraulic oil.
		Suction filter is dirty and clogged	Change the oil, clean the filter.
		Air leave in the cylinder.	Start work table at slow speed with full stroke and stop a little while at both ends, repeat these processes several times
9	Auto, cross feed does not reverse, and runs to one direction.	Limit switch for stroke adjustment is defective or trip dog loose and can't control	Fix trip dog well and change new limit switch if necessary.
		Magnetic contractor for cross feed motor does not function.	Check weather the contractor coil is loose or not.
			Check weather the contractor coil is burnt out or not if so replace new one.

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TASK 3 : **Faulty finding and rectification of horizontal milling machine**

S. No	Faults	Fault Cause	Rectification /Remedy
1	The work piece milled is not flat	The spindle bearing is loose	Adjust the spindle breaking gap
		The gibs of X, Y axis are loose	Adjust the gib's gap
		The processing around is too much	Choose reasonable processing amount
		The tools are damaged	Change the tools
2	The machine shakes when cutting work piece	The machine is located unsteadily	Retighten the machine
		The cutting condition is not good	Choose suitable cutting feed
3	Handle feeling is heavy	The wedge is too tight	Adjust the wedge
		The gap between lead screw and screw nut is not right	Adjust the gap
		Oil line is blocked	Check the oil line and repair it
		No oil in oil pump	Add oil
		The oil pump does not work	Check the oil pump and oil line
4	The spindle sleeve is tight	The spindle sleeve lacks of oil	Add oil
		The spindle sleeve is dirty	Clean the spindle sleeve and repair it
5	No coolant liquid	The water pump does not work	Check the water pump
		The water pump turns in reverse direction	Change its rotation direction
6	The spindle feed is not smooth	The fixed bar of hi-lo sleeve is not loosened	Loosen the fixed bar
7	The spindle brake does not work normally	The brake circle is damaged	Change the brake circle
8	The spindle does not rotate	The switch has poor contact	Check the power switch
		The belt is too tight	Adjust it
		Something with the motor	Repair it
9	Wrong rotation direction	The power switch turns to the wrong direction	Change the switch indication position

Note: Instructor find the fault and rectify the problem as per the concern machine tool manual.

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TASK 4: **CNC Machine Tool common mistakes / faults and rectfiation**

S. No.	Fault	Fault description	Fault rectification / Solution
1	Using the wrong cutting tools/ setting	- Choosing the wrong cutting tool - poor quality of cutting tool	Choose correct tool and setting for the job material
2	Errors in programming	- Lack of understanding of the different G and M codes used for the controller - Wrong set up - Wrong data variables into the CNC controller	- Use qualified operators in CNC machine can be programmed.
3	Poor maintenance of CNC machine tool	Irregular maintenance of CNC machine tool - Failure due to dirt material and other debris could result in a build up which over time can result in in accuracies in machining (or) machine failures.	- Operator follow a detailed main tenance regime for the machine tools in use - Check air filters, to ensure operations continue to be smooth and un interrupted
4	Lack of adequate skill and training	- Improper setting of machine tool - Consume more time	Give proper training on CNC machines.
5	Clamping/Unclamping problems of chucks and fixtures	- Work piece cannot be securely gripped by chuck - An improperly clamped machine part can lead to accident damage (or) worse - injury to operator	- Check the part is correct positioned ensure clamping - Check hydraulic pump and the hydraulic pressure is adequately set up - Check jaws and set correctly
6	Power supply problems	- Sometime the CNC machine Tool's display (or) different parts may not work due to issue with power supply.	- Ensure that correct power and voltage is used for the input side of the power and supply.
7	A.T.C (Automatic Tool changer problems)	- Problems in sensors. - Problem in tool holder - Pneumatic /hydraulic problem.	- rectify the sensors. - Clean the arm and correct it. - Maintain correct pressure of air/oil.
8	Machine vibration chatter	- While machining on CNC noise generated.	- Adjust the spindle / tool R.P.M. of machine process.
9	Over heating of machine tool	- High spindle speed. - CNC machine channels contaminated with dirty soil and materials.	- Adjust correct spindle speed. - Clean regularly. - Proper lubrication.
10	Wrong CNC machine tool operations.	- Human errors.	- Work with established and experienced CNC machine tool operators.

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