

# MECHANIC TRACTOR

NSQF LEVEL - 3

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**TRADE PRACTICAL**

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SECTOR: AUTOMOTIVE

(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**

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

**Sector : Automotive**

**Duration : 1 Year**

**Trades : Mechanic Tractor - Trade Practical - NSQF Level - 3 (Revised 2022)**

**Developed & Published by**



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## FOREWORD

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

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Mechanic Tractor - Trade Practical NSQF Level - 3 (Revised 2022)** in **Automotive Sector under Yearly Pattern**. The NSQF Level - 3 (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 - 3 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 3 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

**SHRI. ATUL KUMAR TIWARI., I.A.S.,**  
Secretary  
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## **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 Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

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

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 Tractor** under the **Automotive** Sector for ITIs.

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

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

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

# INTRODUCTION

## TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course of the **Mechanic Tractor** 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 - 3 (Revised 2022) syllabus are covered.

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

- Module 1 - Safety Workshop Practices**
- Module 2 - Measuring & Marking Practice**
- Module 3 - Fastening & Fitting**
- Module 4 - Basic Electrical & Electronics**
- Module 5 - Manufacturing, Hydraulic and Pneumatics components**
- Module 6 - Engine and engine components**
- Module 7 - Cooling and lubrication system**
- Module 8 - Intake of exhaust and fuel system**
- Module 9 - Transmission and control system**
- Module 10 - Agricultural implements of starting & charging system**

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

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

## TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the Mechanic Tractor, Trade Theory NSQF LEVEL - 3 (Revised 2022) in Construction. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 3 (Revised 2022) syllabus on Trade Theory 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 perceptual capabilities for performing the skills.

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

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

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

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## LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

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1	Make choices to carry out marking of the components for basic fitting operations in the workshop following safety precautions	1.1.01 - 1.2.09
2	Perform precision measurements on the components in automotive workshop practices.	1.2.10
3	Use different types of fastening and locking devices in a vehicle.	1.3.11 - 1.3.12
4	Use cutting tools in the workshop, following safety precautions while grinding	1.3.13 - 1.3.14
5	Use different types of tools and workshop equipment in the workshop	1.3.15
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## SYLLABUS FOR MECHANIC TRACTOR

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With indicative hour)	Professional Knowledge (Trade Theory)
Professional Skill 76 Hrs.; Professional Knowledge 12 Hrs.	Make choices to carry out marking of the components for basic fitting operations in the workshop following safety precautions.	<ol style="list-style-type: none"> <li>1 Familiarization with institute, Job opportunities in the automobile sector, Machinery used in Trade. (07hrs.)</li> <li>2 Types of work done by the students in the shop floor. (08hrs.)</li> <li>3 Practical related to Safety and Health, Importance of Maintenance and cleanliness of Workshop. (03hrs.)</li> <li>4 Interaction with health centre and fire service station to provide demo on First aid and Fire safety, Use of fire extinguishers. (02hrs.)</li> <li>5 Demonstration on safe handling and Periodic testing of lifting equipment, and Safety disposal of used engine oil. (02hrs.)</li> </ol>	<p>Admission &amp; introduction to the trade:</p> <p>Introduction to the Course duration, course content, study of the syllabus. General rule pertaining to the Institute, facilities available- Hostel, Recreation, Medical and Library working hours and timetable.</p> <p>Occupational Safety &amp; Health Importance of Safety and general Precautions to be observed in the shop. Basic first aid, safety signs - for Danger, Warning, caution &amp; personal safety message. Safe handling of Fuel Spillage, Fire extinguishers used for different types of fire. Safe disposal of toxic dust, safe handling and Periodic testing of lifting equipment, Authorization of Moving &amp; road-testing vehicles.</p> <p>Safety disposal of Used engine oil, Electrical safety tips. (04 Hrs.)</p>
		<ol style="list-style-type: none"> <li>6 Practice using all marking aids, like steel rule with spring calipers, dividers, scribe, punches, Chisel etc. ( 11 hrs.)</li> <li>7 Layout a work piece- for line, circle, arcs and circles. (10 hrs.)</li> <li>8 Practice to measure a wheelbase of a vehicle with measuring tape. (10 hrs.)</li> <li>9 Practice to measure valve spring tension using spring tension tester Practice to remove wheel lug nuts with use of an air impact wrench Practice on General workshop tools &amp; power tools. (23 hrs.)</li> </ol>	<p><b>Hand &amp; Power Tools: -</b></p> <p>Marking scheme, Marking material- chalk, Prussian blue. Cleaning tools- Scraper, wire brush, Emery paper, Description, care and use of Surface plates, steel rule, measuring tape, try square. Calipers- inside and outside. Dividers, surface gauges, scribe, punches- prick punch, center punch, pin punch, hollow punch, number and letter punch. Chisel- flat, crosscut. Hammer- ball peen, lump, mallet. Screw drivers- blade screwdriver, Phillips screw driver, Ratchet screwdriver. Allen key, bench vice &amp; C-clamps, Spanners- ring spanner, open end spanner &amp; the combination spanner, universal adjustable open-end spanner. Sockets &amp; accessories, Pliers - Combination pliers, multi grip, long nose, flat-nose, Nippers or pincer pliers, Side cutters, Tin snips, Circlip pliers, external circlip pliers. Air impact wrench, air ratchet, wrenches- Torque wrenches, pipe wrenches, car jet washers Pipe flaring &amp; cutting tool, pullers- Gear and bearing. (08 hrs.)</p>

Professional Skill 56 Hrs.; Professional Knowledge 15 Hrs.	Perform precision measurements on the components in a u t o m o t i v e workshop practices.	10 Practice on measuring the various components using precision instruments Vernier Caliper, Micrometer, Dial Bore Gauge, Telescopic Gauge, Feeler Gauge, Pressure Gauge, Dial Test Indicator by given Job. (56hrs)	<b>Systems of measurement</b> , Description, care & use of - Micrometers- Outside and depth micrometer, Micrometer adjustments, Vernier calipers, Telescope gauges, Dial bore gauges, Dial indicators, straightedge, feeler gauge, thread pitch gauge, vacuum gauge, tire pressure gauge.(15 hrs.)
Professional Skill 14 Hrs.; Professional Knowledge 05 Hrs.	Use different types of fastening and locking devices in a vehicle.	11 Practice on General cleaning, checking and use of nut, bolts, & studs etc. (7 hrs.) 12 Removal of stud/bolt from blind hole. (7 hrs.)	<b>Fasteners</b> - Study of different types of screws, nuts, studs & bolts, locking devices, Such as lock nuts, cotter, split pins, keys, circlips, lock rings, lock washers and locating where they are used. Washers & chemical compounds can be used to help secure these fasteners. Function of Gaskets, Selection of materials for gaskets and packing, oil seals. (05Hrs.)
Professional Skill 14 Hrs.; Professional Knowledge 05 Hrs.	Use cutting tools in the workshop, following safety precautions while grinding.	13 Practice on cutting tools like Hacksaw, file, chisel, Sharpening of Chisels, center punch, safety precautions while grinding. (7 hrs.) 14 Practice on Hacksawing and filing to given dimensions. (7 hrs.)	Cutting tools :- Study of different type of cutting tools like Hacksaw, File- Definition, parts of a file, specification, Grade, shape, different type of cut and uses., OFF-hand grinding with sander, bench and pedestal grinders, safety precautions while grinding. (05Hrs.)
Professional Skill 14 Hrs.; Professional Knowledge 05 Hrs.	Use different types of tools and workshop equipment in the workshop.	15 Practice on Marking and Drilling clear and Blind Holes, Sharpening of Twist Drills Safety precautions to be observed while using a drilling machine. (14 hrs.)	Limits, Fits & Tolerances: - Definition of limits, fits & tolerances with examples used in auto components.  Drilling machine - Description and study of Bench type Drilling machine, Portable electrical Drilling machine, drill holding devices, Work Holding devices, Drill bits. (05 Hrs.)
Professional Skill 14 Hrs.; Professional Knowledge 05 Hrs.	Perform basic fitting operations used in the workshop practices and inspection of dimensions.	16 Practice on Tapping a Clear and Blind Hole, Selection of tap drill Size, use of Lubrication, Use of stud extractor. (6 hrs.) 17 Cutting Threads on a Bolt/ Stud. (2 hrs.) 18 Adjustment of two - piece Die, reaming a hole/ Bush to suit the given pin/ shaft, scraping a given machined surface. (6 hrs.)	<b>Taps and Dies:</b> Hand Taps and wrenches, Calculation of Tap drill sizes for metric and inch taps. Different type of Die and Die stock. Screw extractors. <b>Hand Reamers</b> - Different Type of hand reamers, Drill size for reaming, Lapping, Lapping abrasives, type of Laps. (05 Hrs.)
Professional Skill 7 Hrs.; Professional Knowledge 01 Hrs.	Produce sheet metal components using various sheet metal operations.	19 Brazing of Pipes. (7 hrs.)	Brazing fluxes used on common joints. (1 hrs.)
Professional Skill 14 Hrs.; Professional Knowledge 03 Hrs.	Construct electrical circuits and test its parameters by using electrical measuring instruments.	20 Practice in joining wires using soldering Iron, Construction of simple electrical circuits, measuring of current, voltage and resistance using digital multimeter, practice continuity test for fuses, jumper wires, fusible links, circuit breakers. (14hrs.)	<b>Basic electricity</b> , Ground connections, Multimeter, Conductors & insulators, Wires, Shielding, Length vs. resistance, Resistor ratings. (03 Hrs.)

Professional Skill 14 Hrs.; Professional Knowledge 03 Hrs.	Perform basic electrical testing in a vehicle.	21 Diagnose series, parallel, series-parallel circuits using Ohm's law, check electrical circuit with a test lamp, perform voltage drop test in circuits using multimeter, measure current flow using multimeter/ammeter, use of service manual wiring diagram for Troubles hooting. (14 hrs.)	Fuses & circuit breakers, Ballast resistor, Stripping wire insulation, cable colour codes and sizes, Resistors in Series circuits, Parallel circuits and Series-parallel circuits, Capacitors and its applications, Capacitors in series and parallel. (03Hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 03 Hrs.	Perform battery Testing and charging operations.	22 Cleaning and topping up of a lead acid battery, Testing battery with hydrometer, connecting battery to a charger for battery charging, Inspecting & testing a battery after charging, Measure and Diagnose the cause(s) of excessive Key-off battery drain (parasitic draw) and do corrective action. (16 hrs.) 23 Testing of relay and solenoids and its circuit. (12 hrs.)	Description of Batteries & cells, Lead acid batteries & Stay Maintenance Free (SMF) batteries, Thermistors, Thermo couples, Relays, Solenoids, Charging system circuit (03Hrs.)
Professional Skill 14 Hrs.; Professional Knowledge 05 Hrs.	Construct basic electronic circuits and testing.	24 Identify and test power and signal connectors for continuity, Identify and test different type of Diodes, NPN & PNP Transistors for its functionality, Construct and test simple logic circuits OR, AND & NOT and Logic gates using switches. (14 hrs.)	<b>Basic electronics:</b> Description of Semiconductors, Solid state devices- Diodes, Transistors, Thyristors, Uni Junction Transistors (UJT), Metal Oxide Field Effect Transistors (MOSFETs), Logic gates-OR, AND & NOT and Logic gates using switches. (05Hrs.)
Professional Skill 14 Hrs.; Professional Knowledge 3 Hrs.	Manufacture components with different types of welding processes in the given job.	25 Setting of Gas welding flames, practice to make a straight beads and joints Oxy- Acetylene welding (14 hrs.)	<b>Introduction to welding and Heat Treatment Welding processes</b> - Oxy - Acetylene welding principles, equipment, welding parameters, edge preparation & fit up and welding techniques. (3 Hrs.)
Professional Skill 56 Hrs.; Professional Knowledge 6 Hrs.	Identify the Hydraulic and pneumatic components in a vehicle.	26 Identification of Hydraulic components used in vehicle. (13 hrs.) 27 Tracing of hydraulic circuit on hydraulic jack, hydraulic power steering, and Brake circuit. (15 hrs.) 28 Identification of different type of Vehicle. (6 hrs.) 29 Demonstration of vehicle specification data; Identification of vehicle information Number (VIN). (11 hrs.) 30 Demonstration of Garage, Service station equipments. Vehicle hoists - Two post and four post hoist, Engine hoists, Jacks, Stands. (11 hrs.)	<b>Introduction to Hydraulics &amp; Pneumatics:</b> - Definition of Pascal law, pressure, Force, viscosity. Description, symbols and application in automobile of Gear Pump-Internal & External, single acting, double acting & Double ended cylinder; Directional control valves-2/2, 3/2, 4/2, 4/3 way valve, Pressure relief valve, Non return valve, Flow control valve used in automobile. (03 Hrs.) Auto Industry - History, leading manufacturers, development in automobile industry, trends, new product. Brief about Ministry of Road transport & Highways, Definition: - Classification of vehicles on the basis of load as per central motor vehicle rule, wheels, final drive, and fuel used, axles, position of engine and steering transmission, body and load. Brief description and uses of Vehicle

			hoists - Two post and four post hoist, Engine hoists, Jacks, Stands. (03 Hrs.)
Professional Skill 56 Hrs.; Professional Knowledge 6 Hrs.	Demonstrate Major Assemblies of different types of Tractor.	31 Demonstration of tractor specification data. (5 hrs.) 32 Identification of different major assemblies of tractor and cleaning of tractors, oil greasing and lubricating all moving parts of tractor. (12 hrs.) 33 Practice on starting and stopping of tractor engine. (12 hrs.) 34 Dismantling of tractor engine as per procedure & Inspection of components for dimension and wear. (27 hrs.)	Tractor Industry in India - leading manufacturers, development in Tractor industry, trends, new product. Study of tractors, Different type of Tractor starting method and stopping. (01 Hrs.)  <b>Engine Basics:</b> Classification of engines, <b>Principle &amp; working of 2 &amp; 4-Stroke diesel engine (Compression ignition Engine (C.I), Principle of Spark Ignition Engine (S.I), differentiate between 2-stroke and 4-stroke, C.I engine and S.I Engine, Direct injection and Indirect injection. Brief on common rail diesel injection engine. Engine output, compression pressure, Compression ratio. (05 Hrs.)</b>
Professional Skill 77Hrs.; Professional Knowledge 16 Hrs.	Overhaul Diesel Engine of Tractor.	35 Remove cylinder head from engine. (5 hrs.) 36 Overhauling of cylinder head assembly with use of service manual for clearance and other parameters. (11 hrs.) 37 Practice on removing rocker arm assembly manifolds, fitting of valve guide. (11 hrs.) 38 Cylinder block overhaul. (5 hrs.) 39 Measurement of cylinder liner & crankshaft for ovality and taperness. (5 hrs.) 40 Overhauling piston and connecting rod assembly with use of service manual for clearance and other parameters. (10 hrs.) 41 Practice on removing oil sump and oil pump - clean the sump. (5 hrs.) 42 Practice on removing the big end bearing, connecting rod with the piston. (2hrs.) 43 Practice on removing the piston rings, Dismantle the piston and connecting rod. (5hrs.) 44 Check the side clearance of piston rings in the piston groove & lands for wear. (3hrs.) 45 Check piston skirt and crown for damage and scuffing, clean oil holes.	<b>Engine Components</b> - working principle & construction of cylinder heads, types of combustion chambers. Function of Engine Valves, different types, materials, Type of valve operating mechanism. Importance of Valve seats & inserts, importance of Valve movement, Valve stem, oil seals, Valve-timing diagram and concept of Variable valve timing. (04 Hrs.)  <b>Description of Cylinder block, Cylinder block construction</b> , types of cylinder blocks & cylinder liners. Description & functions of different types of pistons, piston rings and piston pins and materials. Used recommended clearances for the rings and its necessity precautions while fitting rings, common troubles and remedy. (06 Hrs.)  Description & function of connecting rod, importance of big end split obliquely, Materials used for connecting rods big end & main bearings. Shells piston pins and locking methods of piston pins. Recommended clearances for the cylinder liners & rings. Bearing failure & its causes- care & maintenance.  Description of crankshaft & Camshafts. Types of their drives. Description of Overhead camshaft, importance of Cam lobes. Crankcase venti-

		<p>Measure -the piston ring close gap in the cylinder, clearance between the piston and the liner, clearance between crank pin and the connecting rod big end bearing. (2hrs.)</p> <p>46 Check connecting rod for bend and twist. (3hrs.)</p> <p>47 Setting of Connecting rod big end &amp; main bearing. (2hrs.)</p> <p>48 Assembling crank shaft, main bearings, connecting rods and piston assembly in the engine, fitting cylinder head. (5hrs.)</p> <p>49 Setting valve timing. (3hrs.)</p>	<p>lation (PCV). Camshaft, Crank-shaft balancing, Firing order of the engine.</p> <p>Description and function of the fly wheel and vibration damper. Timing mark. (06 Hrs.)</p>
<p>Professional Skill 56 Hrs.;</p> <p>Professional Knowledge 6 Hrs.</p>	<p>Perform servicing of Cooling and Lubrication system of Tractor in a workshop.</p>	<p>50 Checking cooling system for overheating under-cooling. (6 hrs.)</p> <p>51 Dismantling, cleaning, assembling &amp; testing of water pumps, reverse flushing the system. (11 hrs.)</p> <p>52 Checking of thermostat valve, pressure cap. (6 hrs.)</p> <p>53 Adjusting the fan belt tension. (5 hrs.)</p> <p>54 Identification of lubrication oil flow circuit in an engine. (6 hrs.)</p> <p>55 Overhauling oil pump, servicing of oil cooler &amp; centrifugal oil filter. (11 hrs.)</p> <p>56 Testing oil pressure. (11 hrs.)</p>	<p><b>Cooling systems:-</b>Purpose, types, Heat transfer method, effect of boiling point &amp; pressure, coolant properties, preparation and recommended change of interval, use of anti-freezer.</p> <p><b>Cooling system components,</b> water pump, function of thermostat, pressure cap, Recovery system &amp; Thermostat switch. Function &amp; types of Radiator. (03 Hrs.)</p> <p><b>Lubrication system:</b> - purposes &amp; characteristics of oil, type of lubricants, grade as per SAE, &amp; their application, oil additives, type of lubrication system.</p> <p>Lubrication system components- different type of Oil pump, Oil filters &amp; oil cooler. Probable reasons for low / high oil pressure, high oil consumption and their remedies. (03 Hrs.)</p>
<p>Professional Skill 28 Hrs.;</p> <p>Professional Knowledge 04 Hrs.</p>	<p>Service Intake and Exhaust System of Tractor in a workshop.</p>	<p>57 Servicing of air cleaner (Oil bath) Checking &amp; changing an air filter. (5 hrs.)</p> <p>58 Dismantling &amp; assembling of turbo charger, check for axial clearance as per service manual. (6 hrs.)</p> <p>59 Checking of Exhaust Gas Recirculation. (5 hrs.)</p> <p>60 Check Exhaust system for rubber mounting for damage, deterioration and out of position; for leakage, loose connection, dent and damage; Practice on Exhaust manifold removal and installation. (6 hrs.)</p> <p>61 Practice on Catalytic converter removal and installation. (6 hrs.)</p>	<p><b>Intake &amp; exhaust systems</b> - Description of Diesel induction &amp; Exhaust systems. Description &amp; function of air compressor, Super charger, Intercoolers, turbo charger, variable turbo charger mechanism.</p> <p><b>Intake system components-</b> Description and function of Air cleaners, Different type air cleaner, Description of Intake manifolds and material. <b>Exhaust system components-</b> Description and function of Exhaust manifold, Exhaust pipe, Mufflers- Reactive, absorptive, Combination, Electronic mufflers, Catalytic converters, Backpressure, Diesel particulate filter, Exhaust Gas Recirculation (EGR). (04Hrs.)</p>

Professional Skill 56 Hrs.; Professional Knowledge 7 Hrs.	Service Fuel Feed System of Tractor in a workshop.	62 Practice in engine tune up in a vehicle -testing vacuum and compression of engine, (6 hrs.) 63 Tracing of different parts of fuel system. (5 hrs.) 64 Repairing fuel leaks in pipe line and unions, Servicing and testing of fuel feed pump. Servicing of fuel filters. Servicing of fuel Injection Pump. (8 hrs.) 65 Servicing of pressure pump of (C.R.D.I.). (7 hrs.) 66 Regulator's and Elect/Electronic injectors, checking operation of C.R.D.I. system. Overhauling & testing of injectors. (8 hrs.) 67 Setting injection timing. Bleeding fuel lines for Air locks. (8 hrs.) 68 Testing cylinder compression, checking idle speed, Obtaining & interpreting scan tool data. (7 hrs.) 69 Fault finding & remedy, care & maintenance. (7 hrs.)	Diesel fuel characteristics, concept of Quiet diesel technology & Clean diesel technology, Fuel feed system used in Tractor's description and layout. Diesel fuel system components, Description and function of Diesel fuel injection system, types of fuel injection pumps, type of drive, injectors-types and function. Governor and their types. Distributor-type injection pump, Glow plugs, Cummins & Detroit Diesel injection. Diesel electronic control- Diesel electronic control systems (DEC), Common rail diesel injection System. Method of bleeding fuel supply system. (7 hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 05 Hrs.	Overhaul Clutch and Gearbox of Tractor in a workshop.	70 Dismantle clutch assembly. (4 hrs.) 71 Inspect the parts of clutch. (2 hrs.) 72 Relining of clutch plate & assemble. (3 hrs.) 73 Coupling the clutch with flywheel & join the engine with gear box. (5 hrs.) 74 Adjust clutch pedal free play. Dismantle gear box of a tractor & inspect the parts. (5 hrs.) 75 Assemble the gear box. (5 hrs.) 76 Overhauling Transfer case and auxiliary gear box. (4 hrs.)	<b>Clutch</b> -types, construction and function. Components of clutch -driver & driven plates, torsion spring, cushion springs, operating fingers, clutch shaft, Slave cylinder & oil seal. Clutch release bearing & linkages. <b>Manual transmissions</b> - Function, description, types and their application. Gearbox layout. Components of tractor gear box. Principle of epicyclical gear box. Necessity of torque convertor, need of 4 x 4 wheel drive / Front wheel drive, Low & high gear ratio, universal joint and propeller shaft. (05 Hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 07 Hrs.	Overhaul Differential and PTO Unit of Tractor in the workshop.	77 Overhauling of differential. (6 hrs.) 78 Servicing of reduction gear, rear axle wheel hub. (11 hrs.) 79 Servicing of PTO (Power Take Off). Measure rpm of PTO shaft & speed of belt pulley. (11 hrs.)	<b>Final Drive &amp; Drive Shafts</b> Differential carriers double reduction gearing, differential lock, crown wheel and pinion adjustments, function and types of power take off (PTO) mechanism. Types of front & rear axles. Common trouble and their remedies, care and maintenance. (05 Hrs.)
Professional Skill 56 Hrs.; Professional Knowledge 9 Hrs.	Overhaul Steering System of Tractor in the workshop.	80 Checking, Layout of Mechanical steering system. Checking/ Inspection of Steering linkage and necessary repair. (6 hrs.) 81 Remove steering wheel. Overhauling of steering gear box of tractor. (5 hrs.)	<b>Steering Systems</b> - Function and types of steering system. Description, construction and function of mechanical steering system steering wheel, steering gear box, tie-rod, arms link, ball and socket joints etc. their movement and adjustment. Description and mechanism of foot steering pedal as incorporated in tractors.



		<p>82 Remove front axle and spindle hub and steering linkage. (6 hrs.)</p> <p>83 Reassembling steering assembly and Test for correct function. (6 hrs.)</p> <p>84 Checking, inspect layout of different parts of Hydraulic steering system. (11 hrs.)</p> <p>85 Practice on visual Inspection of chassis frame for crack, bent and twists. (6 hrs.)</p> <p>86 Overhauling and Inspection of shackle, front &amp; rear suspension. (10 hrs.)</p> <p>87 Lubricating a suspension system. (5 hrs.)</p>	<p>Description, working and principle of hydraulic steering system. Different parts such as pump, distributor valves, pipe line and hoses etc Development of mechanical framing. Use of Power tiller, Tractor &amp; Bulldozer, Chassis frame of tractor. (9 hrs.)</p>
<p>Professional Skill 28 Hrs.;</p> <p>Professional Knowledge</p> <p>05 Hrs.</p>	<p>Carryout Repair of Wheels and Tyres of Tractor in the Workshop.</p>	<p>88 Remove wheels from tractor. (4 hrs.)</p> <p>89 Dismantle wheel for checking rims, tyres for wear and tubes for leaks. (6 hrs.)</p> <p>90 Repairing, de-rusting, painting. (5 hrs.)</p> <p>91 Fitting of tyres and tubes on rim &amp; inflate to correct pressure. (5 hrs.)</p> <p>92 Balancing of Tractor wheels. Practice of tyre rotation. Fitting wheels on tractors. Tightening of wheel in correct sequence. (5 hrs.)</p> <p>93 Checking &amp; adjusting tire pressure by use of air or by Nitrogen. (4 hrs.)</p>	<p><b>Wheels &amp; Tyres-</b> Description, construction and function of Wheel. Rim sizes. Types &amp; sizes of tyres. Solid, pneumatic &amp; Radial. Ply rating. Tyre materials, Hysteresis &amp; designations, Tyre information, Tyre tread designs, Tyre ratings for temperature &amp; traction. Importance of in-Flatting tyres to correct pressure. Repair and maintenance of tyres and tubes. Storage of tyres. Descriptions Tire wear Patterns and causes Nitrogen vs atmospheric air in tyres. (05Hrs.)</p>
<p>Professional Skill 28 Hrs.;</p> <p>Professional Knowledge</p> <p>9 Hrs.</p>	<p>Overhaul Brake system of Tractor in the workshop.</p>	<p>94 Overhauling brakes including cleaning and inspection of all components, relining shoes, setting and actuating shoe clearance. (6 hrs.)</p> <p>95 Inspection spring of both shoe and lever. (5 hrs.)</p> <p>96 Inspecting and setting parking brakes. (5 hrs.)</p> <p>97 Inspecting and setting hydraulic main brake including replacement of washer and oil seals. (4 hrs.)</p> <p>98 Overhauling serve mechanism (as applicable) inspecting piston and valves. (2 hrs.)</p> <p>99 Bleeding and adjustment of brakes. (2 hrs.)</p> <p>100 Fault tracing and remedy. (2 hrs.)</p> <p>101 Skimming of brake drum and disc plate. (2 hrs.)</p>	<p><b>Braking Systems -</b> Braking fundamentals Principles of braking, Drum &amp; disc brakes, Lever/mechanical advantage, Hydraulic pressure &amp; force, Brake fade.</p> <p><b>Braking systems -</b> Brake type used on tractor -principles, Air brakes,</p> <p><b>Braking system components-</b> Park brake system, Brake pedal, Brake lines, Brake fluid, Bleeding, Master cylinder, Divided systems, Tandem master cylinder, Power booster or brake unit, Hydraulic brake booster, Applying brakes, Brake force, Brake light switch Drum brakes &amp; components - Drum brake system, Drum brake operation, Brake linings &amp; shoes, Backing plate, Wheel cylinders Disc brakes &amp; components-Disc brake system, Disc brake operation, Disc brake rotors, Disc brake pads, Disc brake calipers, Proportioning valves, Proportioning valve operation, Brake friction materials. (9hrs.)</p>

Professional Skill 21 Hrs.; Professional Knowledge 04 Hrs.	Overhaul Major Assemblies of Power Tiller and carryout Field Operation.	102 Overhauling power tiller transmission system includes main clutches, steering clutch/brakes mechanism-gear box and wheel hub testing for field operation without implements and with implements. (13 hrs.) 103 Driving practice with trolley/trailer. (8 hrs.)	Description, working principle & use of power tiller (two wheel tractor) power unit. Method of power transmission to wheel from engine. Main clutch assembling working procedure steering Clutch/brakes mechanism method of power transmission to implement (Rotation), irrigation pump, thresher. Hitching of M.B. Plough, trailer disc harrow. (04 Hrs.)
Professional Skill 15 Hrs.; Professional Knowledge 07 Hrs.	Overhaul Implements of Tractor.	104 Checking implements such as ploughs, harrows, cultivators, seed drills, tractor trailer, & P.T.O. units etc. for serviceability before use. (5 hrs.) 105 Lubricate them as required. Hitching practice (single & three points). (5 hrs.) 106 Exercise in driving a tractor with different implements. (5 hrs.)	<b>Tractor equipment:-</b> Description, function of harrows, cultivators, seed drills & tractor trailer. Hitching of equipment. Danger in overloading & incorrect field operation. Average life of Agriculture implements. Description and function of tractor accessories such as Draw bar, top link & Belly Pulley. Setting of draw bar to correct height. Use of Hydraulic lift. Maintenance of tractor accessories.(07Hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 05 Hrs.	Overhaul Charging and Starting System of Tractor.	107 Practice on removing alternator from vehicle dismantling, cleaning checking for defects, assembling and testing for motoring action of alternator & fitting to vehicles. (11 hrs.) 108 Practice on removing starter motor vehicle and overhauling the starter motor, testing of starter motor. (11 hrs.) 109 Servicing storage batteries, tracing lighting circuit fault rectification. (6 hrs.)	<b>Tractor Electrical Maintenance:</b> Lighting arrangement in tractors (As applicable). Description of charging circuit. Operation of alternator, regulator unit ignition warning lamp troubles and remedy in charging system. Fault finding in electrical system. Description of starter motor circuit, common troubles and remedy in starter circuit. Description of lighting circuit. Charging & discharging of lead acid battery.(05Hrs.)

**Familiarization with institute, job opportunities in the automobile sector machinery used in trade**

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

- prepare the list of proper staffs name and designation of ITI
- draw the sketch of ITI sections layout.
- Identify the job opportunities in automotive sector
- Identify the machinery in workshop floor.

<b>Requirements</b>			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Cotton waste	- as reqd.
• ITI layout chark	- 1 No.	• Soap oil	- as reqd.
• Tray	- 1 No.		
<b>Equipment / Machines</b>			
• Trade machineries	- 1 No.		
• Work bench	- 1 No.		

**PROCEDURE**

**TASK 1: Visit the various section of ITI and acquaint with the staff members and list the trades.**

**Instructor will lead the new recruits (students) to various section of ITI and introduced to staffs.**

**Table 1**

- 1 Collect information like the designation of staff member, their name.
- 2 Identify the section of ITI and list the trade in which training is given.

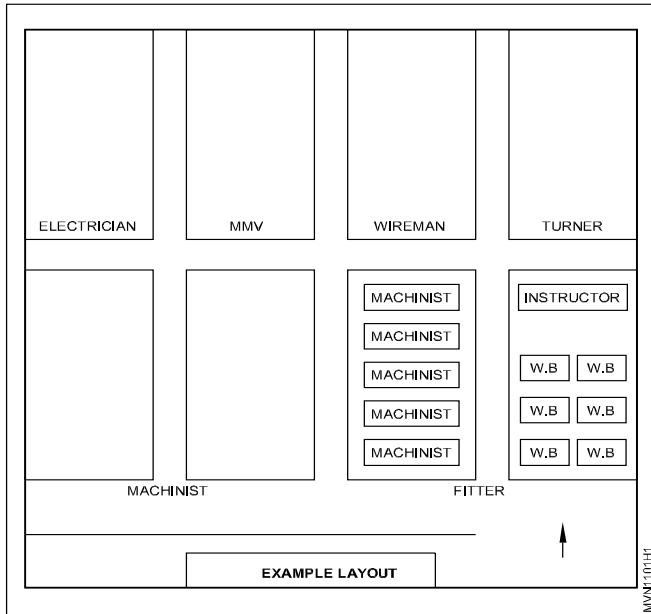
<b>Sl. No</b>	<b>Trade Name</b>

**TASK 2: Location of your ITI.**

- 1 Identify the location of ITI with respect to railway station and bus stand and list of bus route numbers which play near the ITI.
- 2 Collect the telephone numbers of ITI office, nearest hospital, police station and fire station.

**TASK 3 : Draw the layout of your section of the ITI**

- 1 Draw the plan of the section to the suitable scale in a separate sheet of paper. (A4 Size)
- 2 Take the length and the breadth measurements of a machine foundations, work benches, panels, wiring cubicles, doors windows, furniture etc.
- 3 Draw the layout of the machines work benches panels and furniture etc. The section plan should be same scale as in step 1 as per the actual placement of the machine foundation, panels, furniture work benches etc.



**TASK 4: List the job opportunities in Automobile sector**

- 1 List the leading automobile Industries within the country.
- 2 List the automobile ancillary industries.
- 3 List automobile service workshop in your locality
- 4 List the automobile repair garage by self - employed.
- 5 List the driving school in your locality.
- 6 Prepare the list of automobile dealer service institution for in your locality.
- 6 list out the job opportunity in center automobile sector

**TASK 5: Types of work done**

SI.No	Jobs	Work done	Remark
1	Electrical system	Dynamo	
2	Lubrication system		
3	Cooling system		
4	Brake system		
5	Steering system		
6	Transmission system		

**TASK 6: List the machineries used in trade**

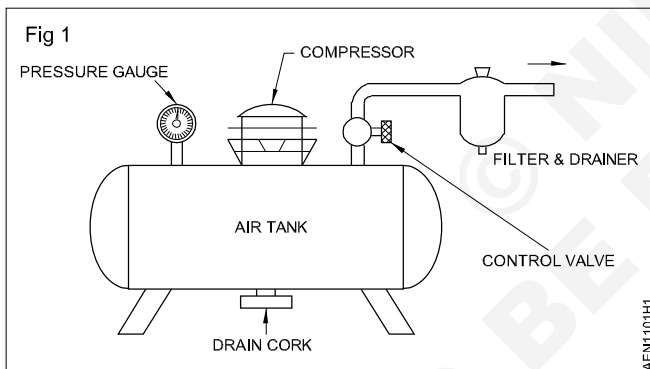
S. No.	Name of the Machine	Purpose of Machine	Number of machines
1.	Air Compressor		
2.	Car Washer		

**TASK 7: Brief about the ITI and its functions**

- 1 Visit to all sections in the workshop.
- 2 Visit to ITI office and introduce to all sections and explain nature of work in the office.
- 3 Explain the organization structure of ITI through chart.
- 4 Explain the facilities provided by the ITI.
- 5 Give brief details to the students about the trade syllabus.
- 6 Give brief details about job opportunities in the automobile sector.
- 7 Ask the students to write the machineries and equipments available in the trade.
- 8 Ask the students to write the job opportunities in private and government sectors.

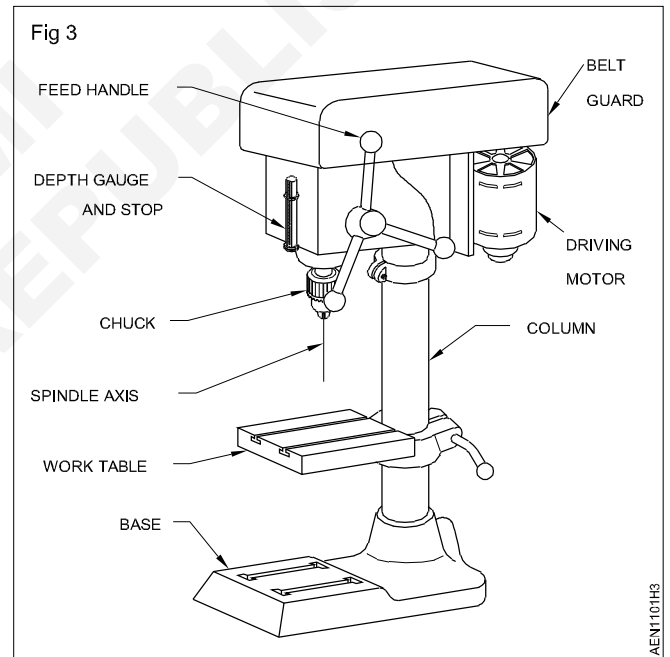
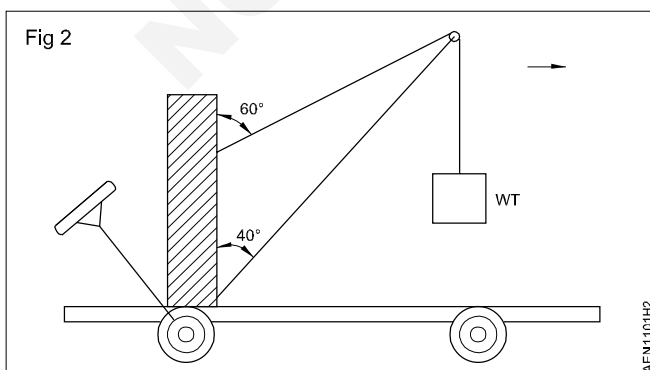
**TASK 8: Introduction to the workshop machineries and equipments**

- 1 Take the trainees around the workshop.
- 2 Identify the major workshop machinery like compressor, drilling machines, spark plug tester
- 3 Explain the constructional features and the use of compressor, air receiver.
- 4 Explain the use of compressed air and its applications.
- 5 Explain bench drilling machine, pillar drilling machine.
- 6 Explain through display charts, the features of all equipments in an automobile workshop.
- 7 Air compressor (Fig 1)
- 11 Sensitive bench drilling machine (Fig 3)
- 12 This machine is capable of drilling holes up to 12.5 mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle.
- 13 For normal drilling, the work-surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted.



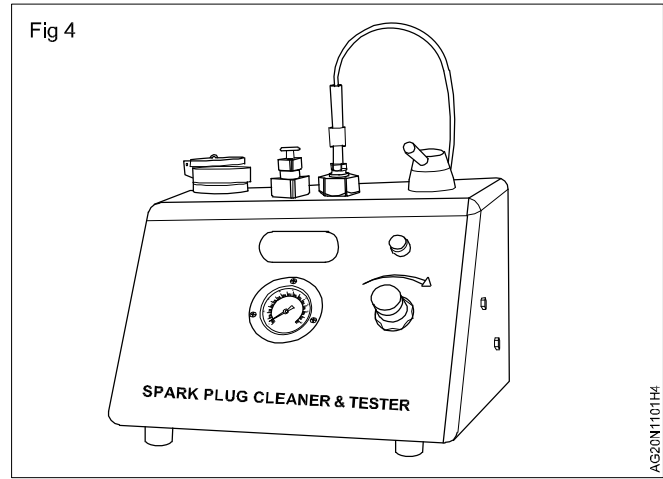
- 8 Compressor is an equipment to produce compressed air at required pressure through air hoses.
- 9 Jib crane (Fig 2)

**Jib crane is used to transport the objects, from one place to another shop floor.**



**Spark plug tester (Fig 4)**

- Spark plug tester is used to clean the dirty spark plugs
- Spark plug tester is used for test the service ability of spark plug



**Table 1**

Ask the trainee's to write the workshop equipments name in table - 1

S.No	Equipment name	Use of the equipment	Remarks

**Identify various work done in the shop floor**

**Objective:** At the end of this exercise you shall be able to  
 • **identify various work done in the shop floor.**

<b>Requirements</b>			
<b>Tools / Instruments</b>			
• Trainee's tool kit	- 1 No.	• Work bench	- 1 No.
• Test lamp	- 1 No.	• Armature tester	- 1 No.
• Tester	- 1 No.	• Battery charger	- 1 No.
• Multimeter	- 1 No.		
<b>Equipment / Machines</b>			
• farm equipment each type	- 1 No.	<b>Materials</b>	
• Spark plug tester	- 1 No.	• Cotton waste	- as reqd.
		• Wire (automobile circuit)	- as reqd.
		• Soap oil	- as reqd.

**PROCEDURE**

**Identify the various works done in the shop floor**

**Work done in the workshop:**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Check the tractor is electrical circuits</li> <li>2 Check the battery charge condition</li> <li>3 Check the tractor is all lights</li> <li>4 Replace the defective bulbs</li> <li>5 Replace the defective fuses</li> <li>6 Check and overhaul the alternator and replace the damaged parts of alternator</li> <li>7 Check and overhaul the starter motor and replace the damaged parts of starter motor</li> <li>8 Check and repair the horn and replace the damaged parts of horn assembly</li> <li>9 Use the hydrometer to check battery charge condition</li> <li>10 Check the circuit coupler connections</li> </ol> | <ol style="list-style-type: none"> <li>11 Check the circuit continuity by multimeter</li> <li>12 Replace the damaged wires and circuit breakers</li> <li>13 Replace the flasher unit</li> <li>14 Check the panel board switches and replace the defective switches and gauge bulbs</li> <li>15 Check the all sensors and replace defective sensors</li> <li>16 Check the ECU wire connections</li> <li>17 Check the ABS sensors and brake lights</li> <li>18 Check the fuel function systems</li> <li>19 Check the steering system.</li> <li>20 Check the EDC fuel systems.</li> <li>21 Check the engine cooling systems</li> <li>22 Check the engine lubrication system.</li> <li>23 Check the engine exhaust and air intake system.</li> </ol> |
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**Practice to safety in workplace signs, workshop rules and PPE**

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

- **work safety in shop floor**
- **Follow the safety workshop rules**
- **Follow the safety signs**
- **Use the PPE**
- **Identify the various occupational hazards**
- **Take personal safety precaution to safe from hazards.**

<b>Requirements</b>			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Cotton waste	- as reqd.
• First aid kit	- 1 set	• Soap oil	- as reqd.
<b>Equipment / Machines</b>		• Bandage	- as reqd.
• Workshop machineries	- as reqd.		

**PROCEDURE**

**TASK 1: Practical related safety in work place**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1 It is your responsibility to follow the work safety to protect yourself from injuries.</li> <li>2 Always use Personal Protective equipment to avoid accidents in the work place.</li> <li>3 Avoid the malfunction of a machine operation or tools handling.</li> <li>4 Don't work in poor working environment.</li> </ol> | <ol style="list-style-type: none"> <li>5 Always use proper wearing of cloth during work in workshop.</li> <li>6 Use safety shoes with non-slip soles.</li> <li>7 Always use clean cloth to wear in work place which is strong and fits well for easy to work.</li> <li>8 Always use safety measure against injury or burns.</li> <li>9 Use hand gloves - when you are lifting heavy rough surface items or removing hot parts of a vehicle.</li> </ol> |
|--|--|

**TASK 2: Safety workshop rules**

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1 Always keep the work place neat and clean before and after the work.</li> <li>2 Dispose the used waste items or materials in the designated containers in the work place.</li> <li>3 Vehicle should be proper parked in designated place for repair work.</li> <li>4 Use proper tools to check electrical circuits and components.</li> <li>5 Don't leave the tools and parts on the work place. Make a habit of putting them on a work bench or work stand.</li> </ol> | <ol style="list-style-type: none"> <li>6 Don't install the electrical components temporarily in the vehicle.</li> <li>7 Clean up spilled fuel, oil, grease immediately to prevent slip on the work place.</li> <li>8 Clean the tools after finishing a job, check the item by item and stored in the tool box.</li> <li>9 Remove the dirt and oil from the special service tools, tester and gauges and put them in safe place.</li> <li>10 Follow the safety precautions while handling electrical equipment as your instructors guideline.</li> </ol> |
|--|---|

**TASK 3: Safety Signs (Fig 1)**

**Instructor may provide various safety signs chart categories and explain their categories and their meaning, description. Ask the trainee to identify the sign and record in table**

- 1 Identify the safety sign from the chart.
- 2 Record the name of the category in table1.
- 3 Mention the meaning and description of the safety sign in table1.



Fig 1



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Table 1

Fig No.	Basic categories of safety sign	Meaning - descriptions
1		
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**TASK 4: Personal protective equipments (Fig 2)**

The instructor may provide or arrange the different types of personal protection equipment or chart and explain how to identify and select the PPE devices suitable for the work and ask the trainees to write names in the given table.

- 1 Read and interpret the personal protective equipments by visually on real devices or from the charts.
- 2 Identify and select the personal protection equipment used for suitable type of protection.
- 3 Write the name of the PPE to the corresponding type of protective safety equipments in Table 2.



**Table - 2**

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

Get it checked by your instructor

-----

**TASK 5: PPE Instruction and uses**

- 1 Some cleaning agents are toxic. Refer to the information about handling; use and storage of chemicals that may be hazardous, follow any recommendations made by the supplier before using it.
  - 2 Do not use flammable cleaners or water on electrical equipment.
  - 3 Make sure designated walkways are kept clear of any obstructions.
  - 4 Always wear protective clothing and the appropriate safety equipment.
  - 5 Make sure that you understand and observe all legislative and personal safety procedures when carrying out the tasks. If you are unsure of these procedures, ask your instructor.
-

## TASK 6: Various types of occupational hazards

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

- 1 Identify the occupational hazard to the corresponding situation with a potential harm given in Table 3.

Table 3

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

Fill up and get it checked by your instructor.

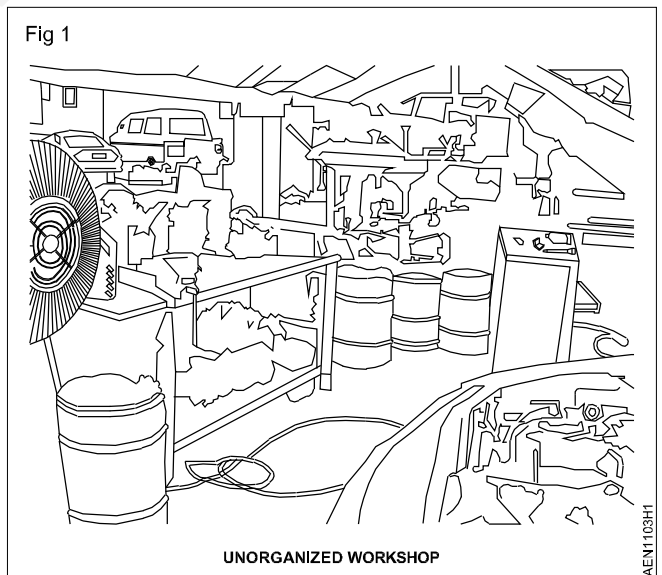
## Practice to maintain workshop tools and equipments

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

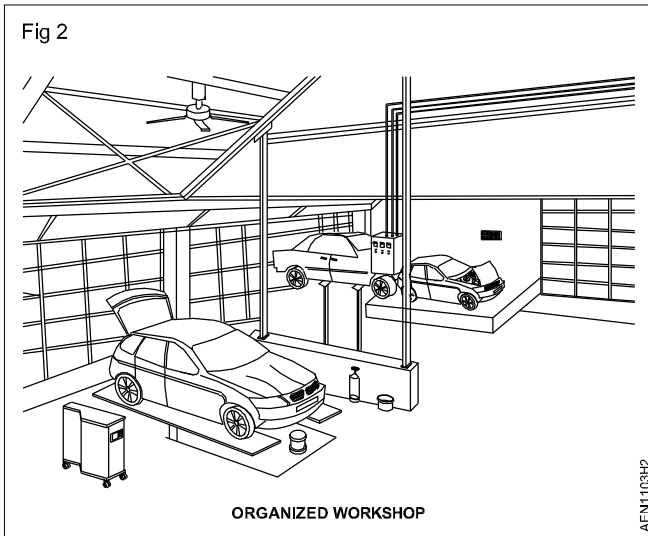
- carryout the maintenance of equipment
- clean the tools and equipment
- perform practical related safety in work
  - workshop safety rules
  - personal protective equipments and its uses
  - Identification of safety signs.

### TASK 1: Maintenance of tools and equipment

- 1 Clean the tools and equipment for work more efficiently. At the end of each working day clean the used tools and equipment and check them for any damage. If you note any damage, tag the tool as faulty.
- 2 Electrical current can travel over oily or greasy surfaces. Keep electrical power tools free from dust and dirt and make sure they are free of oil and grease.
- 3 All workshop equipment should have a maintenance schedule. Always complete the tasks described on the schedule at the required time. This will help to keep the equipment in safe working order.
- 4 Store the commonly used tools in an easy-to-reach location.
- 5 If a tool, or piece of equipment, is too difficult to be returned, it could be left on a workbench or on the floor where it will become a safety hazard. (Fig 1)
- 6 Keep your work area cleanly. This will help you work more efficiently and safely. (Fig 2)
- 7 Have a waste bin close to your work area and place any waste in it as soon as possible.



- 8 Dispose of liquid and solid waste, such as oils, coolant and worn components, in the correct manner.
- 9 Do not pour solvents or other chemicals into the sewage system. This is both environmentally damaging and illegal.



- 9 Always use hand gloves when using any chemical cleaning material because excessive exposure to cleaning materials can damage skin.
- 10 Some solvents are flammable. Never use as a cleaning materials near an open flame or cigarette.
- 11 The fumes from cleaning chemicals can be toxic, so wear appropriate respirator and eye protection whenever you are using these products.

Get it checked by your instructor

## TASK 2: Clean the hand tools, jack, power tool and machinery

### 1 Clean hand tools.

Keep your hand tools in, clean condition with two sets of cabinet. One cabinet should be lint-free to handle precision instruments or components.

The other should be oily to prevent rust and corrosion.

### 2 Clean floor jacks.

Wipe off any oil or grease on the floor jack and check for fluid leaks. If you find any leaks, rectify the leaks and top up the hydraulic fluid.

Occasionally, apply a few drops of lubricating oil to the wheels and a few drops to the posts of the safety stands.

### 3 Clean electrical power tools

Keep power tools clean by brushing off any dust and the electrical cables for dirt, oil or grease, and for any chafing or exposed wires.

With drills, inspect the chuck and lubricate it occasionally with machine oil.

### 4 Clean air powered tools

Apply a few drops of oil into the inlet of your air tools every day. Although these tools have no motor, they need to do regular lubrication of the internal parts to prevent wear.

### 5 Clean hoists and heavy machinery.

Locate the checklist or maintenance record for each hoist or other major piece of equipment before carrying out cleaning activities.

**Clean operating mechanisms and attachments of excess oil or grease.**

**Practice on first aid and use of fire extinguishers**

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

- rescue breathing for an unconscious victim of different condition
- perform treatment for stopping of bleeding.

Requirements			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Old tyre	- as reqd.
• First aid kit	- 1 No.	• Wood, Paper, Cloth & Grease	- as reqd.
<b>Equipment / Machines</b>		• Gas and Liquefied gas	- as reqd.
• Fire extinguishers (different type)	- 1 No each.	• Metal and Electrical equipment	- as reqd.
• Cut - Models of fire extinguisher	- as reqd.	• Soap oil	- as reqd.
• Fire extinguisher (different type)	- as reqd.	• Bandage	- as reqd.

**PROCEDURE**

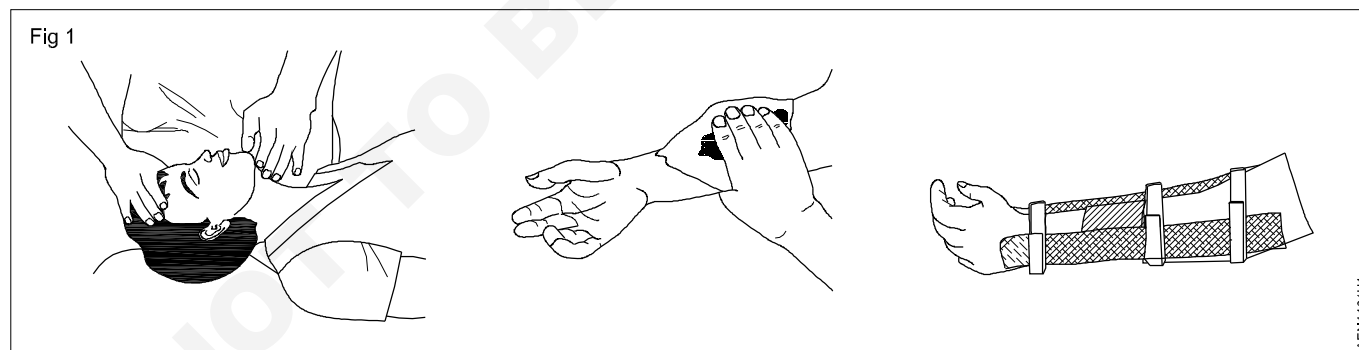
**TASK 1: Prepare the victim to receive artificial respiration**

- 1 Ask the health center staff to give demo on first aid.

**Assumption - For easy manageability, Instructor may arrange the trainees in group and ask each group to perform one method of resuscitation as per health center demo on first aid.**

- 2 Loosen the tight clothing which may interfere with the victim's breathing.
- 3 Remove any foreign materials or false teeth from his mouth and keep the victim's mouth open.

- 4 Bring the victim safely to the level ground, taking necessary safety measures. (Fig 1)
- 5 Start artificial respiration immediately without delay. Do not waste too much time in loosening the clothes or trying to open the tightly closed mouth.
- 6 Avoid violent operations to prevent injury to the internal parts of the victim.
- 7 Send to a doctor immediately.



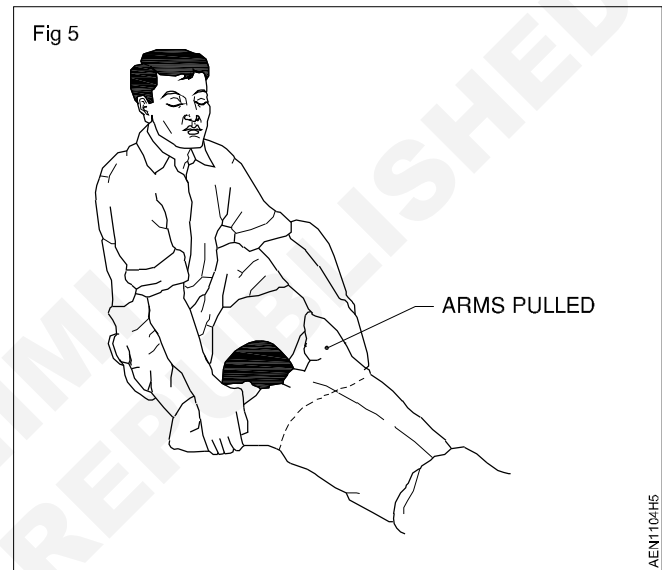
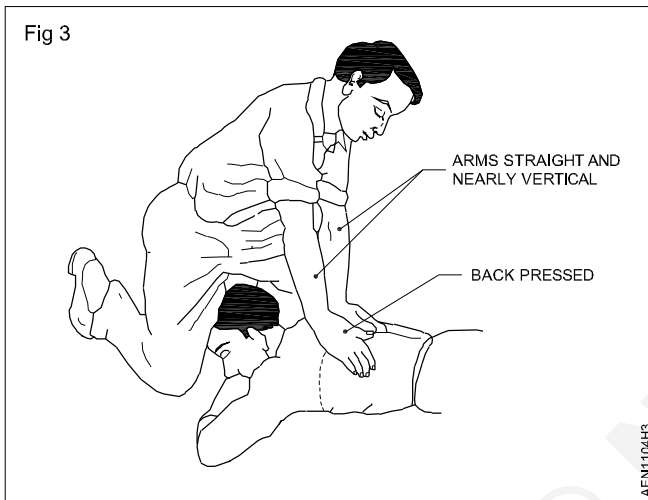
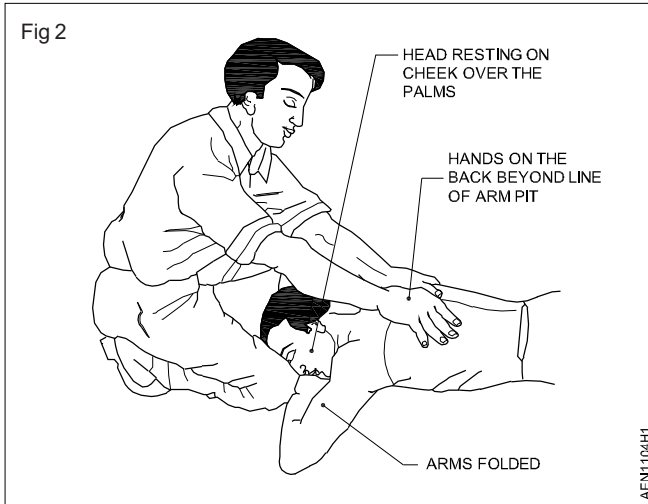
**TASK 2: Resuscitate the victim by Nelson's arm - Lift back pressure method**

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

- 1 Place the victim prone (that is face down) with his arms folded with the palms one over the other and the head resting on his cheek over the palms. Kneel on one or both knees near the victim's hand. Place your hands on the victim's back beyond the line of

the armpits, with your fingers spread outwards and downwards, thumbs just touching each other as in (Fig 2).

- 2 Gently rock forward keeping your arms straight until they are nearly vertical, and steadily pressing the victim's back as shown in (Fig 3) to force the air out of the victim's lungs.



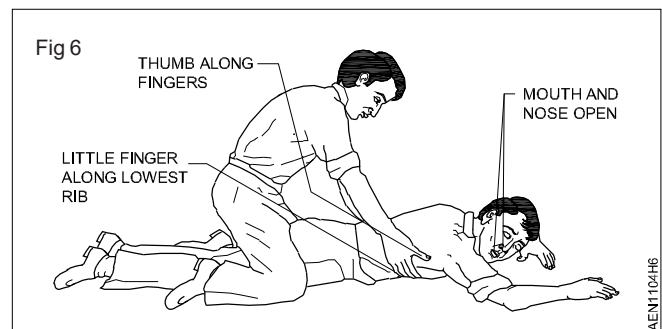
- 3 Synchronize the above movement of rocking backwards with your hands sliding downwards along the victim's arms, and grasp his upper arm just above the elbows as shown in (Fig 4). Continue to rock backwards.
- 4 As you rock back, gently raise and pull the victim's arms towards you as shown in (Fig 5) until you feel tension in his shoulders. To complete the cycle, lower the victim's arms and move your hands up to the initial position.
- 5 Continue artificial respiration till the victim begins to breathing naturally. Please note, in some cases, it may take hours.

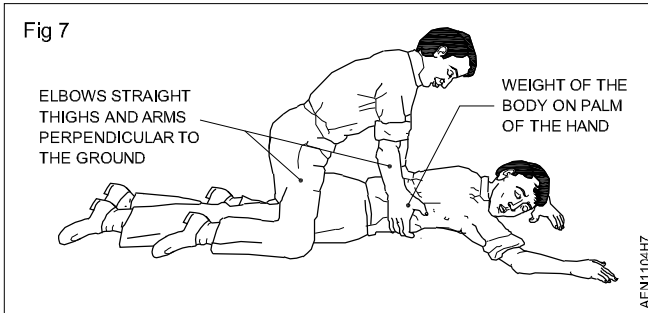
- 6 When the victim revives, keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.
- 7 Keep him in the lying down position and do not let him expert himself.

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

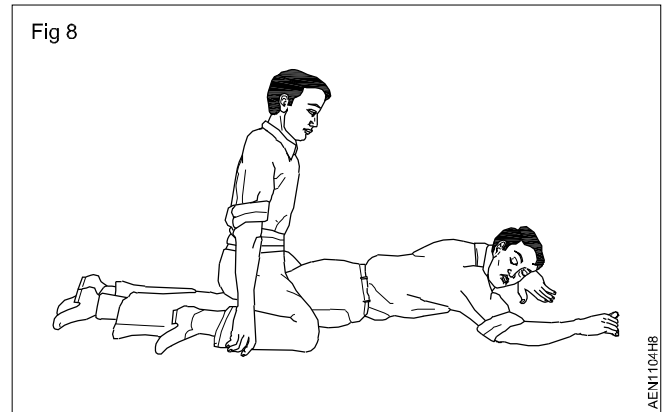
**TASK 3: Do not use this method in case of injuries to victim on the chest and belly.**

- 1 Lay the victim on his belly, one arm extended direct forward, the other arm bent at the elbow and with the face turned sidward and resting on the hand or forearm as shown in (Fig 6).
- 2 Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned as in (Fig 6).
- 3 With the arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the lower ribs of the victim to force the air out of the victim's lungs as shown in (Fig 7).





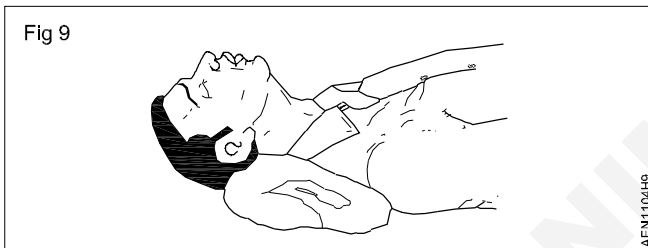
- 4 Now swing backward immediately removing all the pressure from the victim's body as shown in (Fig 8) thereby, allowing the lungs to fill with air.
- 5 After two seconds, swing forward again and repeat the cycle twelve to fifteen times a minute.



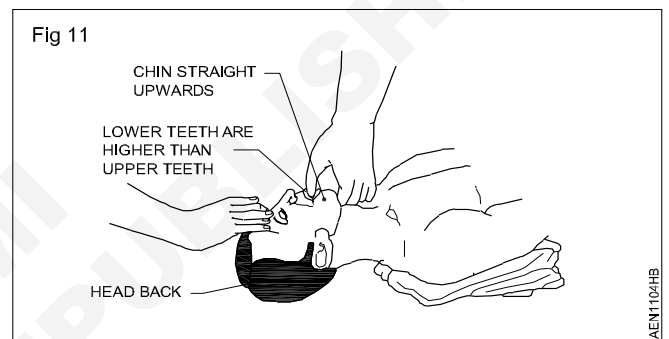
- 6 Continue artificial respiration till the victim begins to breathe naturally.

#### TASK 4: Resuscitate the victim by mouth-to-mouth method

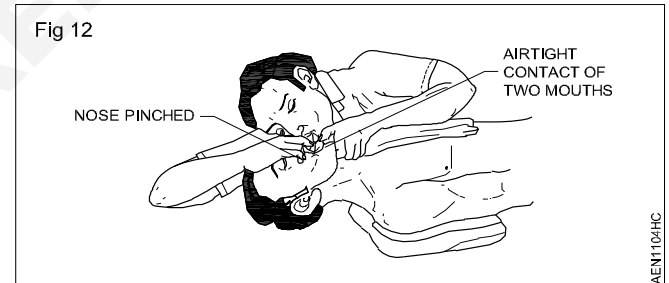
- 1 Lay the victim flat on his back and place a roll of clothing under his shoulders to ensure that his head is thrown well back. (Fig 9)



- 2 Tilt the victim's head back so that the chin points straight upward. (Fig 10)



- 3 Grasp the victim's jaw as shown in (Fig 11), and raise it upward until the lower teeth are higher than the upper teeth; or place fingers on both sides of the jaw near the ear lobes and pull upward. Maintain the jaw position throughout the artificial respiration to prevent the tongue from blocking the air passage.



- 4 Take a deep breath and place your mouth over the victim's mouth as shown in (Fig 12) making airtight contact. Pinch the victim's nose shut with the thumb and forefinger. If you dislike direct contact, place a porous cloth between your mouth and the victim's. For an infant, place your mouth over his mouth and nose. (Fig 12)
- 5 Blow into the victim's mouth (gently in the case of an infant) until his chest rises. Remove your mouth and

release the hold on the nose, to let him exhale, turning your head to hear the rushing out of air. The first 8 to 10 breathings should be as rapid as the victim responds, thereafter the rate should be slowed to about 12 times a minute (20 times for an infant).

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

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

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

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

- 1 Use the fingers of one hand to keep the victim's lips firmly shut, seal your lips around the victim's nostrils and breathe into him. Check to see if the victim's chest is rising and falling. (Fig 13)
- 2 Repeat this exercise at the rate of 10 - 15 times per minute till the victim responds.
- 3 Continue this exercise till the arrival of the doctor.

Fig 13



AEN1104HD

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

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

- 1 Check quickly whether the victim is under cardiac arrest. (Fig 14)

**Cardiac arrest could be ascertained by the absence of the cardiac pulse in the neck (Fig 1) blue color around lips and widely dilated pupil of the eyes.**

Fig 14



AEN1104HE

- 2 Lay the victim on his back on a firm surface.
- 3 Kneel alongside facing the chest and locate the lower part of the breastbone. (Fig 15)

Fig 15

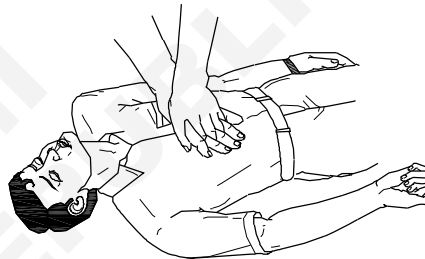


AEN1104HF

- 4 Place the palm of one hand on the center of the lower part of the breastbone, keeping your fingers off the

ribs. Cover the palm with your other hand and lock your fingers together as shown in (Fig 16).

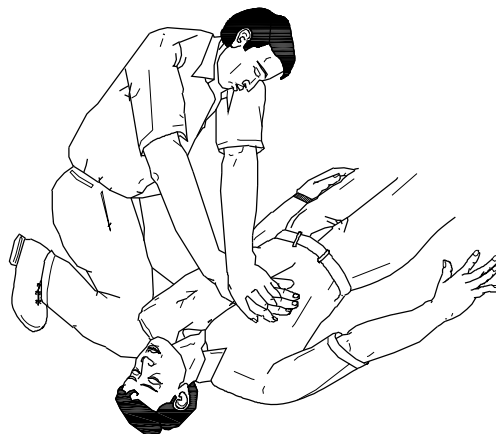
Fig 16



AEN1104HG

- 5 Keeping your arms straight, press sharply down on the lower part of the breast bone; then release the pressure. (Fig 17)

Fig 17

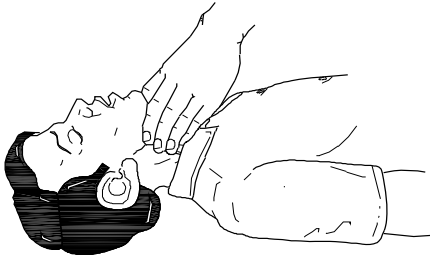


AEN1104HH

- 6 Repeat step 5, fifteen times at the rate of at least once per second.
- 7 Check the cardiac pulse. (Fig 18)
- 8 Move back to the victim's mouth to give two breaths (mouth-to-mouth resuscitation) (Fig 19)

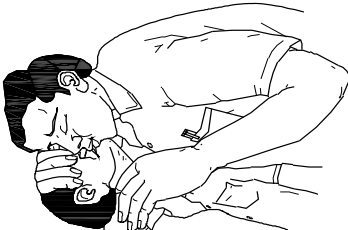


Fig 18



AENT104HI

Fig 19



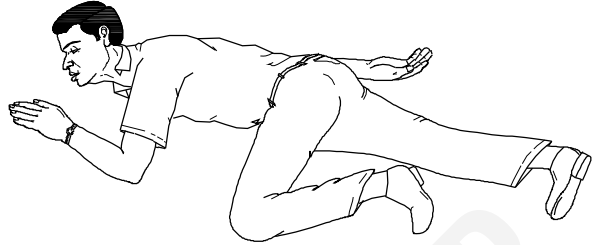
AENT104HU

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

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

11 Place the victim in the recovery position as shown in (Fig 20). Keep him warm and get medical help quickly.

Fig 20



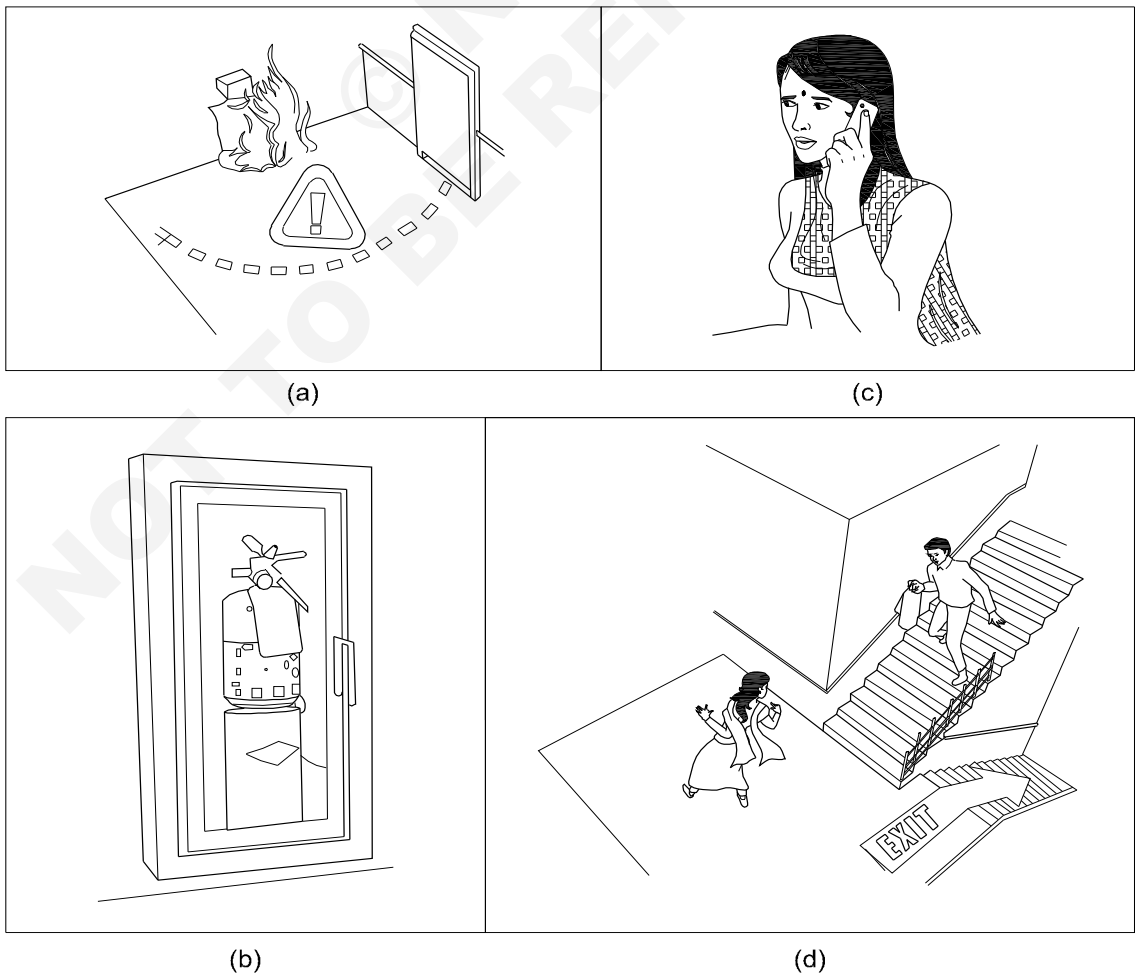
AENT104HK

**Other steps**

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

**TASK 7: Perform fire extinguisher**

Fig 1



**First extinguishers practice as demonstrate by fire service station.**

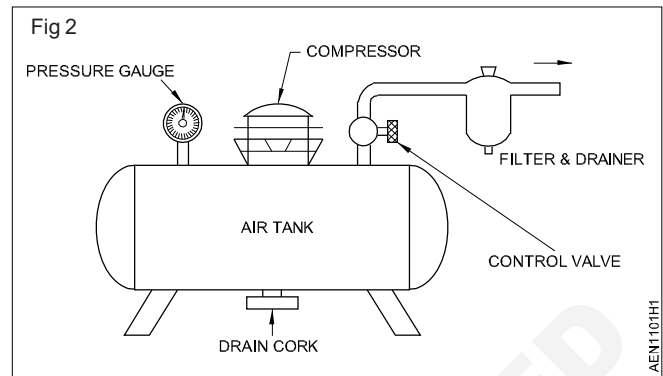
- Alert people surrounding by shouting fire, fire, fire when you observe fire. (Fig 1a)
- Inform Fire Service or arrange to inform immediately. (Fig 1b)
- Open emergency exit and ask them to go away. (Fig 1c & 1d)
- Put "Off" electrical power supply.

**Do not allow people to go nearer to the fire**

- Analyze and identify the type of fire. Refer Table1.

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

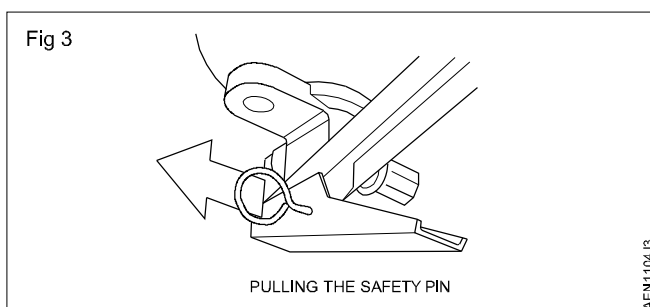
- Select CO<sub>2</sub> (carbon dioxide) fire extinguisher
- Locate and pick up CO<sub>2</sub> fire extinguisher. Check for its expiry date.
- Break the seal. (Fig 2)



**Table1**

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

- Pull the safety pin from the handle. (pin located at the top of the fire extinguisher) (Fig 3)

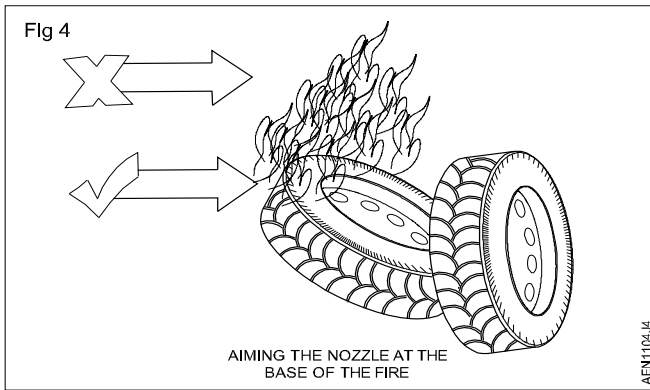


- Aim the extinguisher nozzle or hose at the base of the fire. (this will remove the source of fuel fire) (Fig 4)

**Keep your self low.**

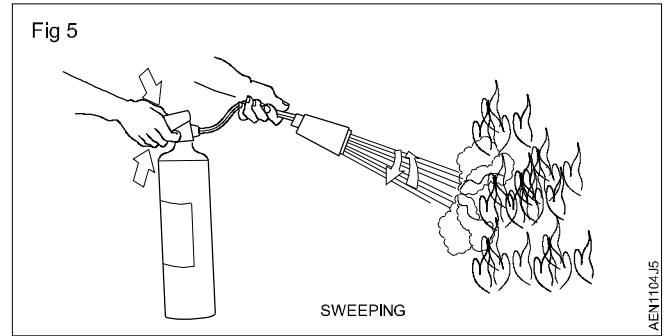
- Squeeze the handle lever slowly to discharge the agent (Fig 5)
- Sweep side to side approximately 15 cm over the fuel fire until the fire is put off.

**Fire extinguishers are manufactured for use from the distance.**



### Caution

- 1 While putting off fire, the fire may flare up.
- 2 Do not be panic so long as it put off promptly
- 3 If the fire doesn't respond well after you have used up the fire extinguisher move away yourself away from the fire point.
- 4 Do not attempt to put out a fire where it is emitting toxic smoke, leave it to the professionals.



- 5 Remember that your life is more important than properly. So don't place yourself or others at risk.

**In order to remember the simple operation of fire extinguisher.**

**Remember.**

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

**P** for pull.

**A** for aim.

**S** for squeeze.

**S** for sweep.

**Practice to safe handling and testing of lifting equipments and safe disposal of used engine oil**

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

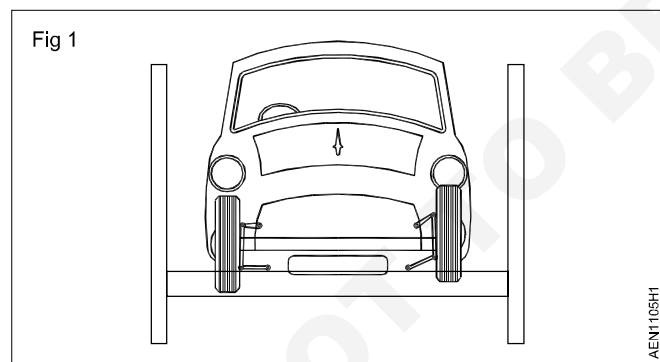
- practice on safe handling of lifting equipments
- do the periodic testing of lifting equipments
- safety measures in disposal of used engine oil.

Requirements			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Oil	- as reqd.
<b>Equipment / Machines</b>		• Water	- as reqd.
• Air compressor	- 1 No.	• Kerosene	- as reqd.
• Vehicle	- 1 No.	• Cotton waste	- as reqd.
		• Soap oil	- as reqd.

**PROCEDURE**

**TASK 1: Check the test certificate.**

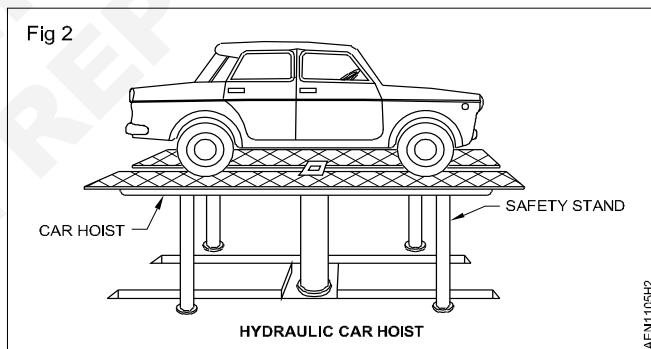
The lifting equipment is subjected to statutory Testing and Certification. (Fig 1) the test calibration certificate should be attached to, or displayed near the lifting equipment that it refers to. Before using this equipment, make sure that the most recent inspection record is still within the prescribed time limit, and ensure that the certificate has not expired.



**M/s. ABCD.**  
**Vehicle Hoist Service.**  
**044-12345678.**  
**Chennai - 78.**  
**SERVICE.**  
**Date Serviced: 20/05/2022**  
**Next Service: 19/05/2023**

**Check the equipment**

- 1 Carry out regular periodic checks on the service ability of all of the hydraulic lifting equipment. (Fig 2)



- 2 Refer to the manufacturer's handbook to find out how often they recommend maintenance tests and make sure that these occur.
- 3 Check whether the test equipment for its proper functioning.
- 4 Ensure that there are no leakage in the hose, control valves and oil pump
- 5 Before operating the lift, ensure that the car is correctly placed in the platform.
- 6 Check whether it is lifting properly.
- 7 And also check whether it is holds the oil or not.

**Note: Vehicle hoist is not included in the equipments list. This practical can be given at any service station.**

- 8 After the completion of the work, lower the ram to its normal position.

## TASK 2: Disposal of used engine oil

- 1 Wear protective clothing, such as gloves, mask, shoes, apron etc.,
- 2 Do not spill any oil or grease on the ground.
- 3 Put your used motor oil in a clean plastic container with a tight lid. Never store the used oil in a container that once held chemicals, food, or beverages.
- 4 Do not mix the oil with anything else, such as antifreeze, solvent, or paint.
- 5 Take used motor oil to a service station or other location that collects used motor oil for recycling.

**Recycled used motor oil can be re-refined into new oil, processed into fuel oils and used as raw materials for the petroleum industry.**

- 6 While storing used oil, meant for disposal keep them in a separate place with proper identification mark in the container. (Fig 3)

**Never keep the used oil near the hot area or near flame.**

**While transporting ensures that there is no spillage of oil. (Fig 4)**

- 7 Maintain a record of oil disposed for reference and record as shown in Table below.

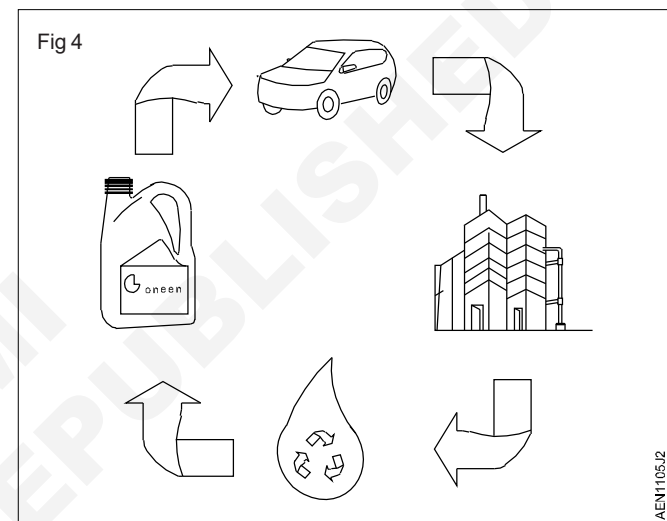


Table 1

Sl. No	Date	Qty per can (liter)	No of cans delivered	Total qty. disposed in liters	Remarks
1	Example 23 - 7 -19	20	05	100	
2	-	-	-	-	
3					
4					
5					

**Practice to use various marking tools**

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

- draw the lines, parallel lines, angles, circles, and curves by suitable marking tools.

**Requirements**

**Tools / Instruments**

- Trainee's tool kit - 1 No.
- Scriber, Divider, 'V' groove - 1 No. each
- Bevel Protractor - 1 No.
- Centre punch & Angle plate - 1 No. each
- Surface gauge & Depth gauge - 1 No. each

- Outside & Inside Jenny caliper - 1 No. each
- Surface plate - 1 No.

**Materials**

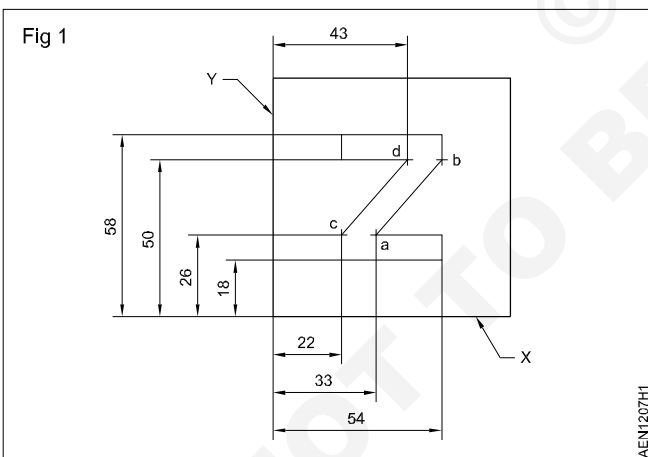
- Chalk powder - as reqd.
- MS Plate - as reqd.

**PROCEDURE**

**Use various marking tools**

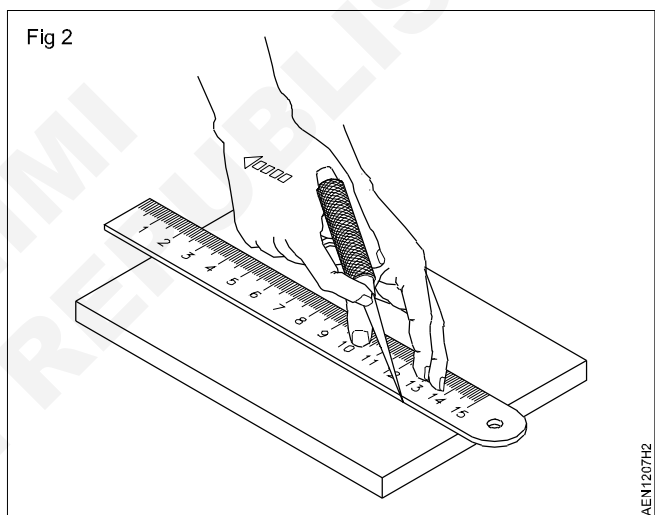
**Marking 1**

- 1 Check the raw material for its size and its squareness.
- 2 Apply copper sulphate solution on one side of the job and allow it to dry.
- 3 Scribe parallel lines to the edges 'x' and 'y' using a surface gauge. (Fig 1)



**To avoid confusion, do not scribe the line longer than necessary.**

- 4 Scribe two lines by joining points ab and cd, using a steel rule and scriber. (Fig 2)
- 5 Punch witness marks and complete 'Z' shape

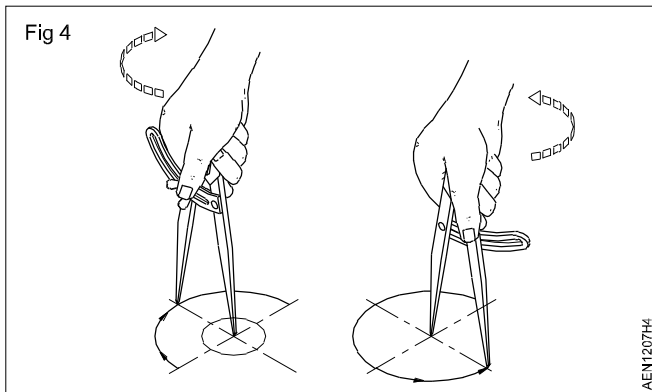
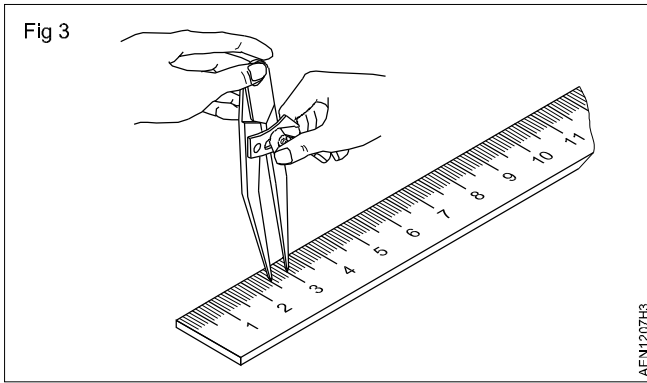


**Marking 2**

- 6 Apply the marking medium on the other side of the job and allow it to dry.
- 7 Mark the center lines of three circles and one semicircle using the jenny caliper.
- 8 Punch all the four centers using a 30° prick punch. (Fig 5)
- 9 Open and set the divider to 5 mm. (Fig 3)

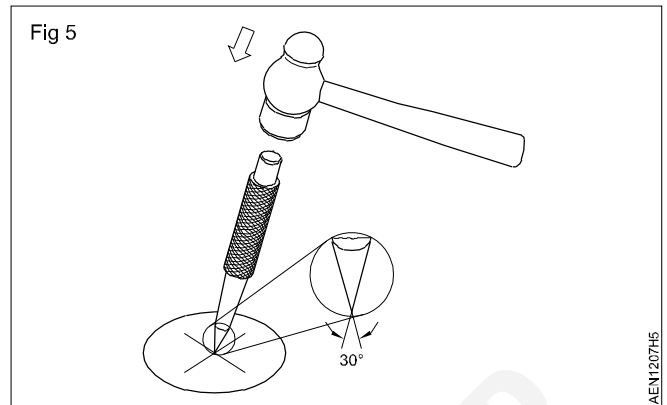
**Make sure that both the legs of the divider are of equal length.**

- 10 Draw two circles of  $\varnothing 10$  using the divider. (Fig 4)



11 Set the divider and draw  $\varnothing 12$  circle and R35 semicircle.

12 Punch witness marks on the circles and semicircles. (Fig 5)



13 Use the different type of the chisels to cut the marked work piece

**Reuse the same material for marking 3 and 4**

**Practice to layout a work piece for line, circle, arcs and circles**

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

- draw the line on the work piece
- draw the circle on the work piece
- draw the arcs and circles on the work piece

**Requirements**

**Tools / Instruments**

- Trainee's tool kit - 1 No.
- Scriber, Divider, 'V' groove - 1 No. each
- Bevel Protractor - 1 No.
- Centre punch & Angle plate - 1 No. each
- Surface gauge & Depth gauge - 1 No. each

- Outside & Inside Jenny caliper - 1 No. each
- Surface plate - 1 No.

**Materials**

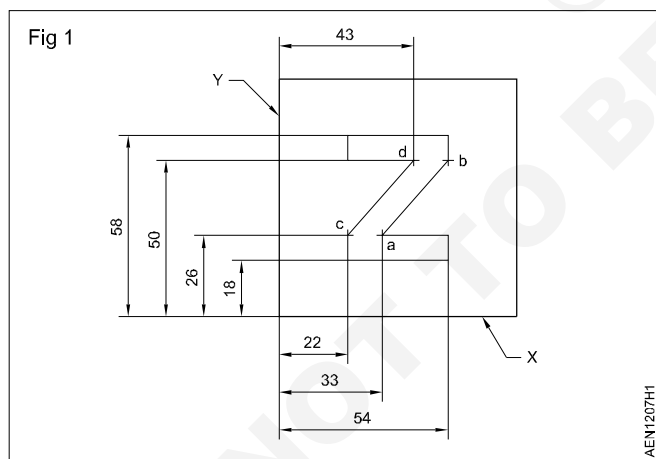
- Chalk powder - as reqd.
- MS Plate - as reqd.

**PROCEDURE**

**Use various marking tools**

**Marking 1**

- 1 Check the raw material for its size and its squareness.
- 2 Apply copper sulphate solution on one side of the job and allow it to dry.
- 3 Scribe parallel lines to the edges 'x' and 'y' using a surface gauge. (Fig 1)

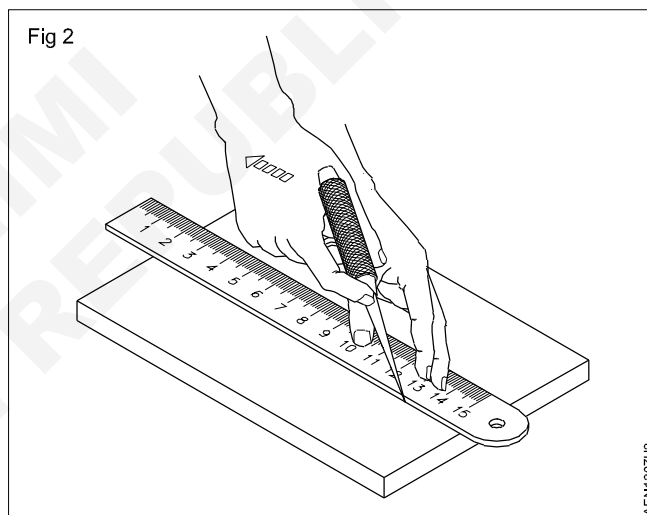


**To avoid confusion, do not scribe the line longer than necessary.**

- 4 Scribe two lines by joining points ab and cd, using a steel rule and scriber. (Fig 2)
- 5 Punch witness marks and complete 'Z' shape

**Marking 2**

- 6 Apply the marking medium on the other side of the job and allow it to dry.



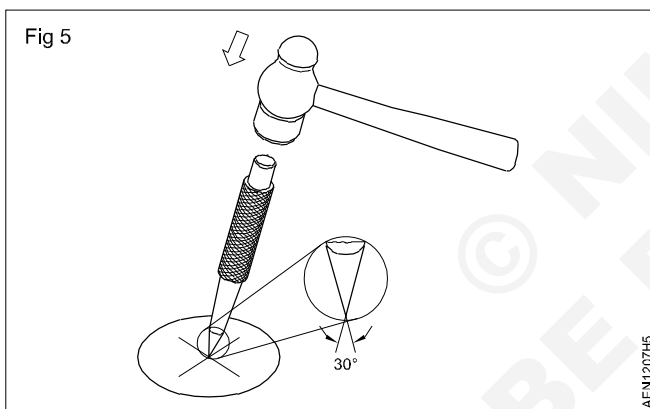
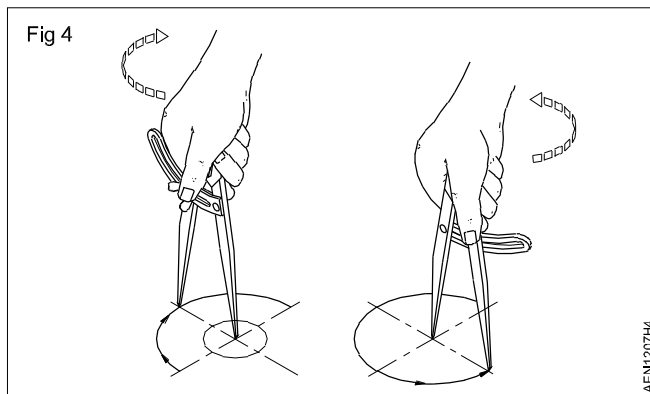
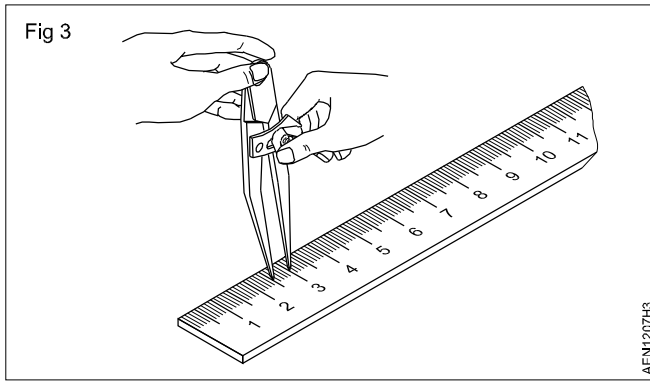
- 7 Mark the center lines of three circles and one semicircle using the jenny caliper.
- 8 Punch all the four centers using a 30° prick punch. (Fig 5)
- 9 Open and set the divider to 5 mm. (Fig 3)

**Make sure that both the legs of the divider are of equal length.**

- 10 Draw two circles of  $\varnothing 10$  using the divider. (Fig 4)
- 11 Set the divider and draw  $\varnothing 12$  circle and R35 semicircle.
- 12 Punch witness marks on the circles and semicircles. (Fig 5)

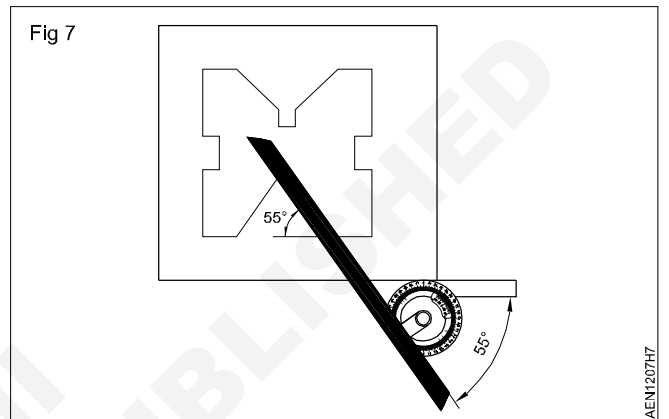
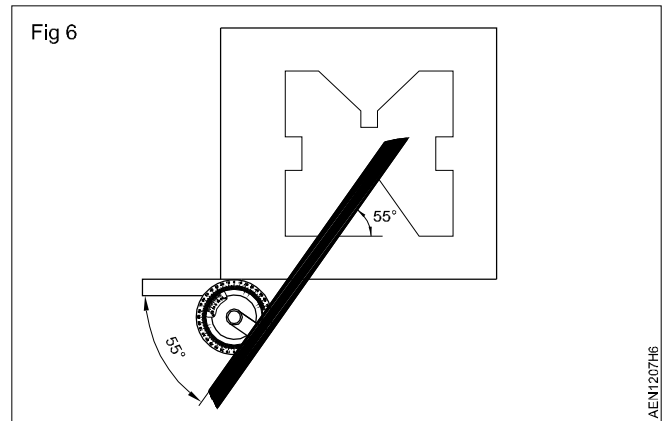
**Reuse the same material for marking 3 and 4**



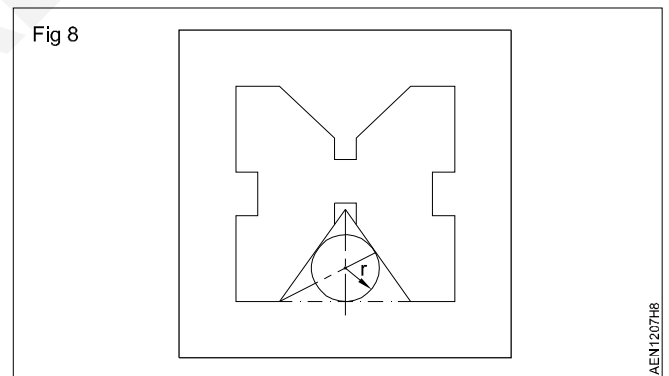


### Marking 3

- 13 File and finish one of the marked surfaces flat and deburr.
- 14 Apply copper sulphate solution on the finished side.
- 15 Butt the job against the angle plate.
- 16 Mark all the parallel lines to the edges using the surface gauge.
- 17 Also mark the starting points of the Vee groove.
- 18 Set and lock the bevel protractor at  $55^\circ$ .
- 19 Butt the bevel protractor on to the edge of the job and mark one side of the Vee groove. (Fig 6)
- 20 Continue the same procedure and complete the  $44^\circ$  Vee groove.
- 21 Complete the Vee block marking.
- 22 Bisect any two sides of the triangle formed by the  $55^\circ$  Vee groove, and get the center and radius of the circle. (Fig 7)



- 23 Draw the circle on the  $55^\circ$  Vee groove. (Fig 8)
- 24 Similarly draw the circle on the  $44^\circ$  Vee groove.
- 25 Punch witness marks.

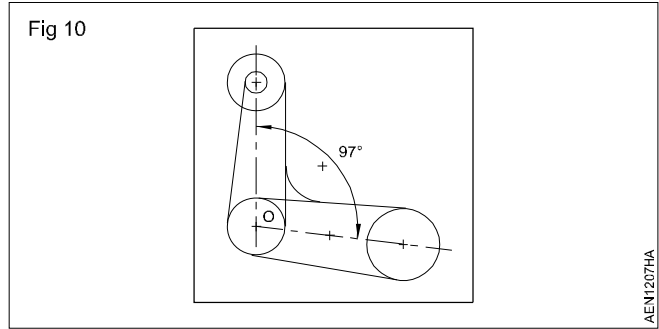
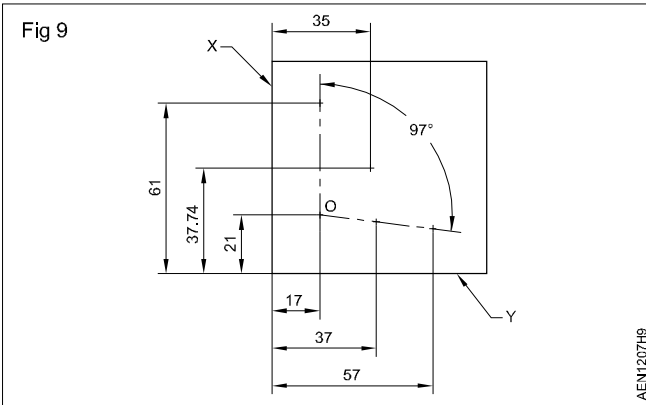


### Marking 4

- 26 File and finish the other surface flat, deburr and apply the marking medium.
- 27 Scribe the center lines and parallel lines to the edges 'x' and 'y'. (Fig 9)
- 28 Set  $97^\circ$  on the bevel protractor.
- 29 Mark  $97^\circ$  line through point 'O' and get the centers of the other two circles. (Fig 10)
- 30 Punch center marks on all the four circles.
- 31 Draw all the four circles using a divider.
- 32 Draw R8, R8 and R10 curves a little more than the length required.

33 Draw two tangents close to the edges of the 'x' and 'y' circles using a steel rule and scribe. (Fig 10) and complete the marking as per shape given.

34 Punch witness marks.



## Skill sequence

### Marking parallel lines using surface gauge

**Objectives:** This shall help you to

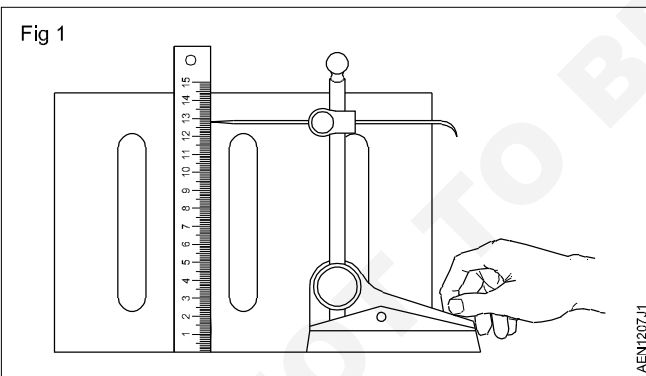
- mark parallel lines using a surface gauge
- set the surface gauge to any height dimension.

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

Clean the base of the surface gauge.

Keep the surface firmly on the surface plate.

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

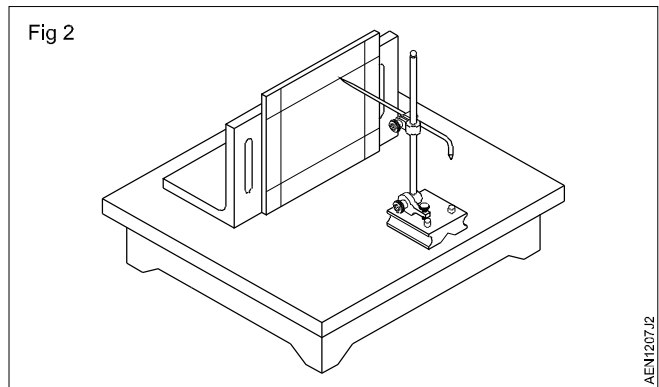


Make sure that the job has no burrs and has been properly cleaned.

Apply a thin and even coating of the marking media.

But the job against the angle plate.

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



### Marking lines parallel to the edge of the job

**Objectives:** This shall help you to

- mark parallel lines using a jenny caliper.

Apply marking medium on the surface to be marked.

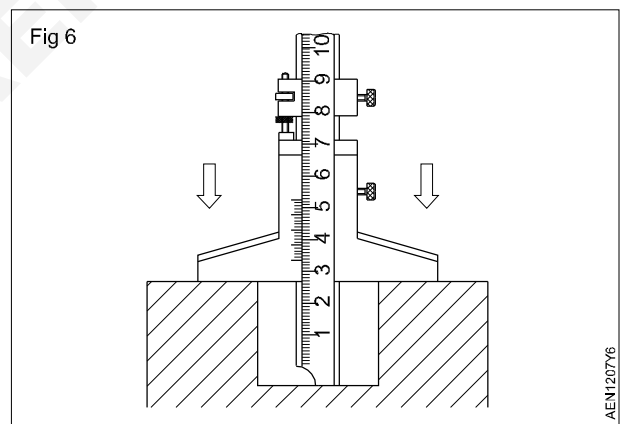
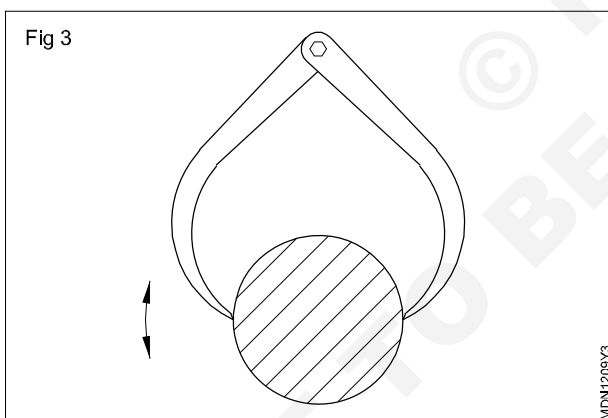
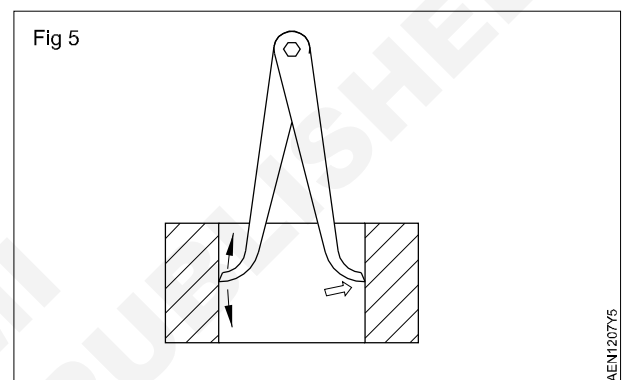
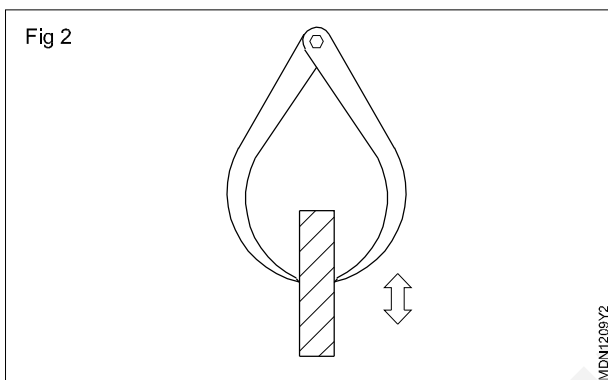
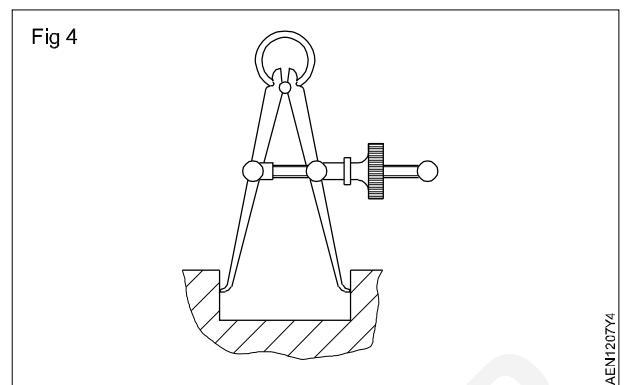
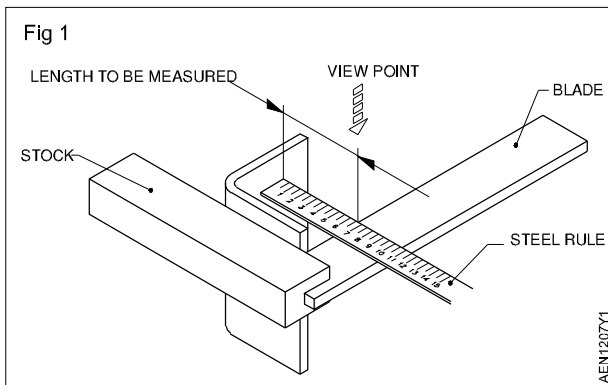
Set the jenny caliper to the size to be marked (i.e. dimension) with the help of a steel rule. (Fig 1)

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

Incline slightly and move the jenny caliper with uniform speed and mark lines. (Fig 3)

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

**Note to the instructor: Provide old exercise and models as much as possible to the trainees for acquiring measuring skills with simple measuring instruments. (Fig 4,5 and 6)**



**Practice to measure the wheel base of a vehicle**

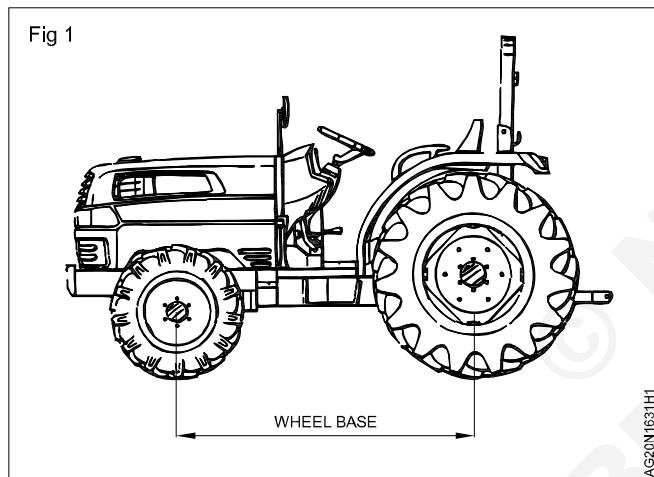
**Objective:** At the end of this exercise you shall be able to  
 • **measure the wheel base of a vehicle.**

Requirements			
<b>Tools / Instruments</b>		<b>Equipment / Machines</b>	
• Trainee's tool kit	- 1 No.	• Vehicle	- 1 No.
• Measuring tape and Plumb bob	- 1 No. each	<b>Materials</b>	
		• Cotton waste	- as reqd.

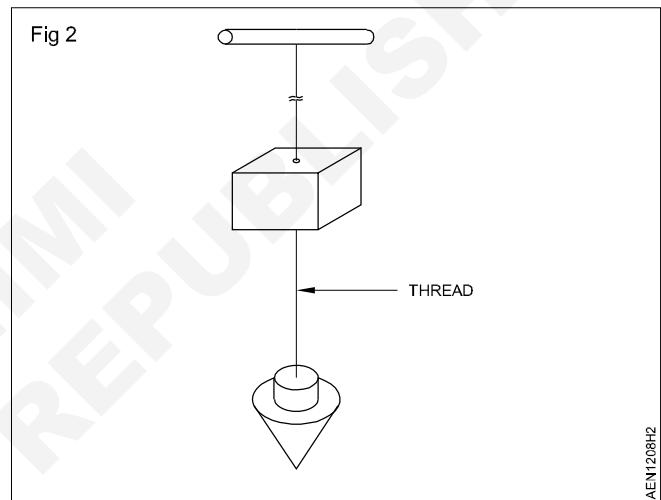
**PROCEDURE**

**Measure the wheel base of a vehicle**

1 Place the vehicle on a plain ground (Fig 1)



- 2 Make the wheels straight ahead
- 3 Apply the vehicle hand brake
- 4 Apply wheel chokes on front and rear wheels
- 5 Close all the doors
- 6 Use the plumb bob and mark the vehicle front wheel center (from the side view of vehicle) on the ground. (Fig 2)



- 7 Similarly mark the vehicle rear wheel center (from the same side view of the vehicle) on the ground
- 8 Measure the wheel base using measuring tape between the two markings

**Skill sequence**

**Practice on use of tape and plumb bob**

**Objective:** This shall help you to  
 • **measure wheel base front overhang and rear overhang.**

- Select the correct measurement tape (Fig 4)
- Select the proper length of measuring tape
- Release the lock of the tape & pull it out for measurement

- Front end of the tape should be coinciding with the center mark line on the ground
- Keep the tape straight till the other end of the marked line

Note down the measurement line of the tape coincide with the marked line on the ground

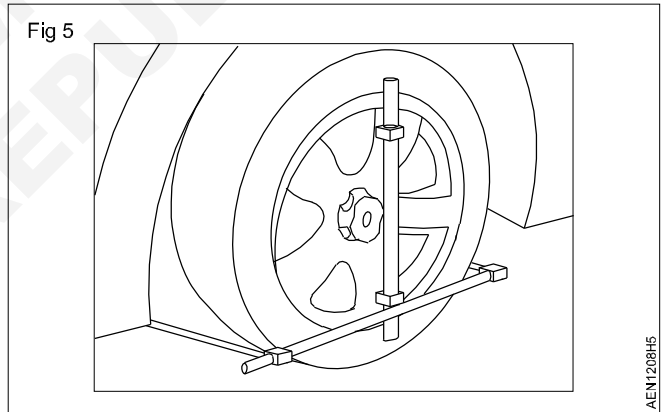
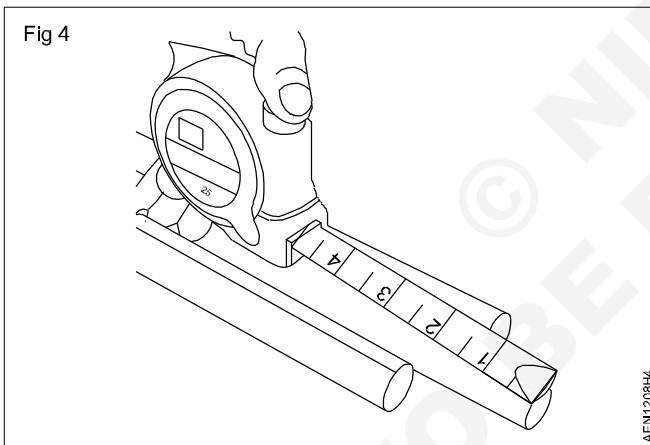
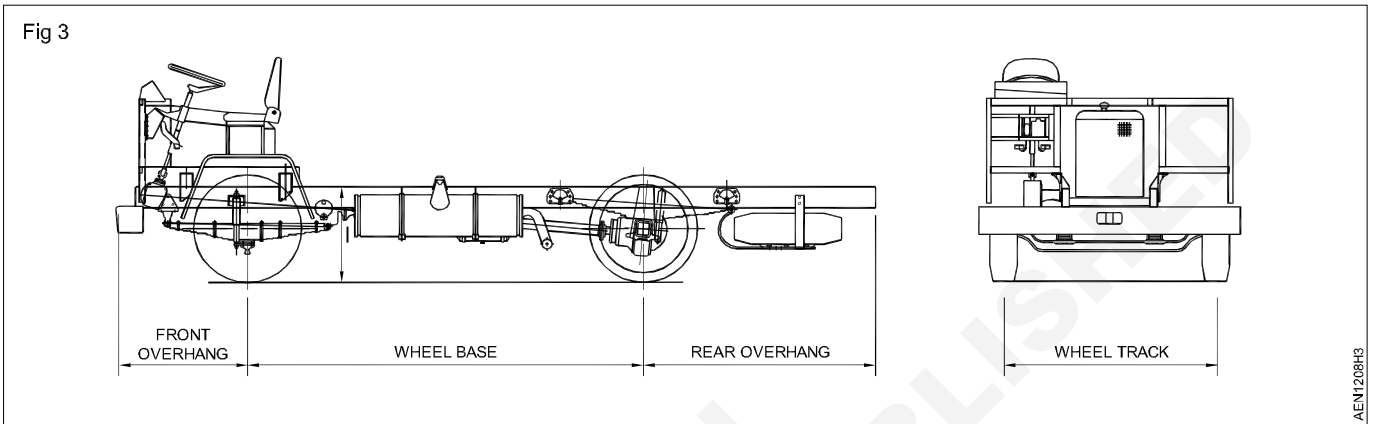
Take the measurement & check with the manufacturer's specified wheel base data. (Fig 5)

Measure the distance between center of front wheel so center of rear wheel, which wheels are in straight ahead position. This is wheel base. (Fig 3)

Measure the distance between center of front LH tyre to center of front RH tyre. This is wheel track. (Fig 3)

Measure the distance between center of front wheel to the farthest point of the vehicle in front direction. This is front overhang. Measure the distance between center of rear wheel to the farthest point in the rear (normally rear bumper).

This is rear overhang. (Fig 3)



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**Practice to use valve spring tester and remove wheel lug nuts with use of an air impact wrench - general workshop tools and power tools**

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

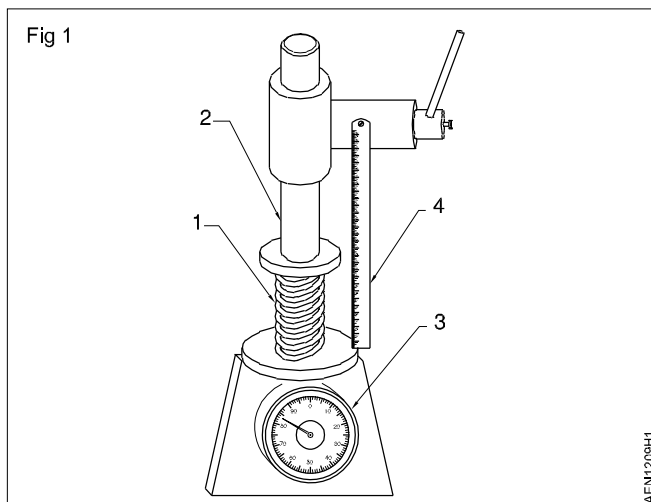
- check the spring tension on spring tester.
- handle an air impact wrench
- loosen and tighten wheel nuts
- identify screw driver for specific purpose and handle it
- identify spanner & wrenches for specific purpose and handle it
- identify pliers for specific purpose and handle it
- operate workshop equipments.

<b>Requirements</b>			
<b>Tools/Instruments</b>			
• Trainees tool kit	- 1 No.	• Air compressor	- 1 No.
• Air impact wrench	- 1 set	• Car washer	- 1 No.
• Screw driver	- 1 Set.	• Jack mechanical and hydraulic	- 1 No.
• Ring and D/E spanners	- 1 Set.	• Hydraulic press	- 1 No.
• Pliers	- 1 Set.	• Flaring equipments	- 1 No.
• Try square	- 1 No.	• Grease gun and oil spray gun	- 1 each.
<b>Equipments</b>		• Pipe vice	- 1 No.
• Work bench	- 1 No.	• Pipe cutter	- 1 No.
• Coil spring tension tester	- 1 No.	• Puller	- 1 No.
		<b>Materials</b>	
• Vehicle	- 1 No.	• Cotton waste	- as reqd.
• Air compressor unit	- 1 No.	• Pipe	- as reqd.
• Pullers	- 1 No.	• Steel wire	- as reqd.

**PROCEDURE**

**TASK 1: Measure valve spring tension**

- 1 Clean the spring to be tested
- 2 Place the spring (1) vertically on the spring tester. (Fig 1) Ensure that the moveable spindle (2) does not touch the spring (1).
- 3 Note down the height of the spring (1) on the graduated scale (4). This is the free length of the spring.
- 4 Press the spring (1) by moving the column (2) downward. The gauge (3) will show the load on the spring. Press column (2) till the testing load (specified by the manufacturer) is obtained.
- 5 Note down the height of the spring (1) at the testing load.
- 6 Replace the spring, if the free length of the spring and the height at the testing load (or either of these two) is less than the minimum limit specified by the manufacturer.



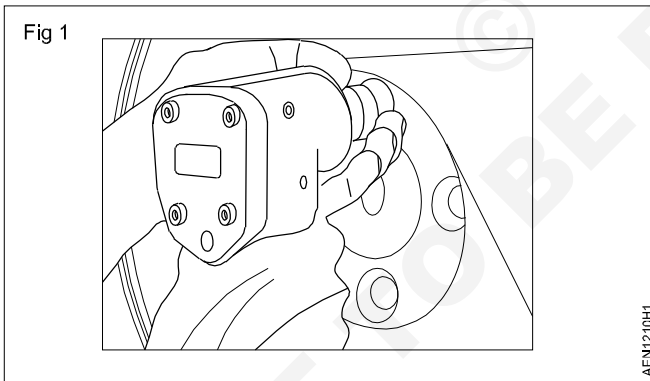
**Note down the free length of the spring and the height of the testing load in Table 1.**

Table 1

Sl. No.	Free length of used spring	Testing load height of spring
1		
2		
3		
4		
5		

**TASK 2: Practice to remove wheel lug nuts**

- 1 Park the vehicle on level ground.
- 2 Apply Hand Brake.
- 3 Close the all the doors.
- 4 Put wheel chocks to front and rear wheels.
- 5 Remove the wheel cap.
- 6 Check the Air impact wrench is connected to the Air lines.
- 7 Select correct size of socket/special socket for wheel lug nut which can with-stand sudden impact force (six-point Impact Socket).
- 8 Fit the socket on the Air-impact wrench. (Fig 1)
- 9 Set the direction of spin forward or backward with the help of wrench lever.
- 10 Set the torque by turning the valve to increase or decrease the torque.
- 11 Insert impact socket on the wheel lug nut.
- 12 Trigger the switch of the impact wrench to loosen and remove the wheel lug nuts.
- 13 After removing all wheel nuts, place one or two nuts on the wheel bolt to avoid slipping of the wheel while jack up the vehicle for wheel removing.



**Do not use an Impact wrench to tighten the wheel lug nuts**

**Wear ear protection device such as ear muffs and ear plugs**

**Wear safety glasses for eye protection**

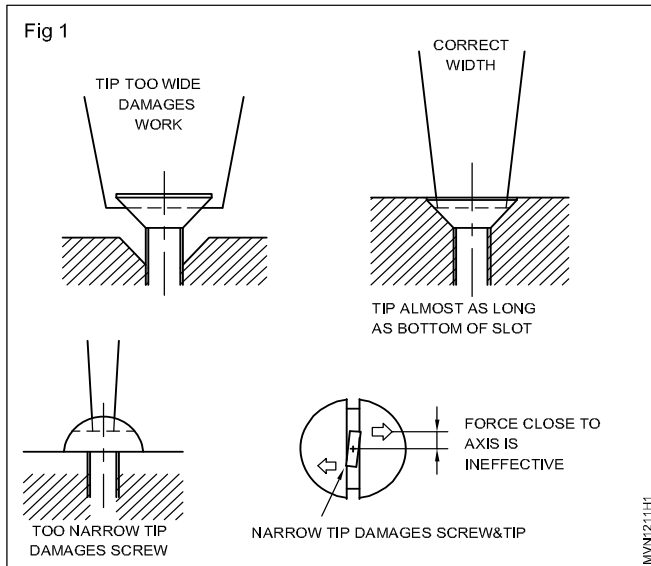
**Apply a few drops of oil to inlet of the air impact wrench before using**

**Ensure there is no air-leakage on the line and adequate air pressure is available.**

**TASK 3: Identify the screw driver for specific purpose and handle it**

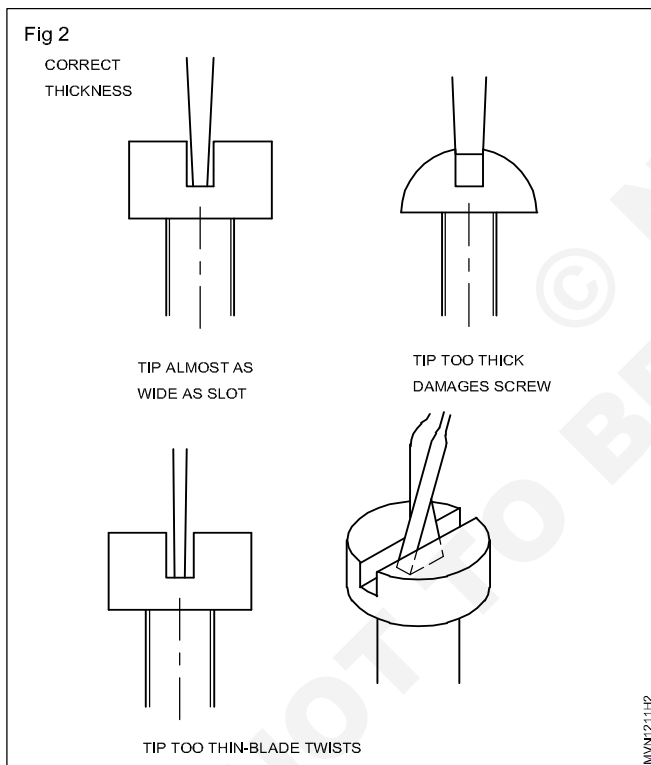
**Checking the condition of the fastener to be removed**

- 1 Clean the surface of the fastener to be removed by using kerosene, banian cloth.
- 2 Check the cornering faces of the fastener for any wear or damage.
- 3 If it is found good, then proceed as follows
- 4 Select the correct size screwdriver to suit the screw slot. (Fig 1)



- 5 Select the longest suitable screwdriver with that size of tip. (Fig 2)

**Make sure your hands and the handle are dry and not greasy.**



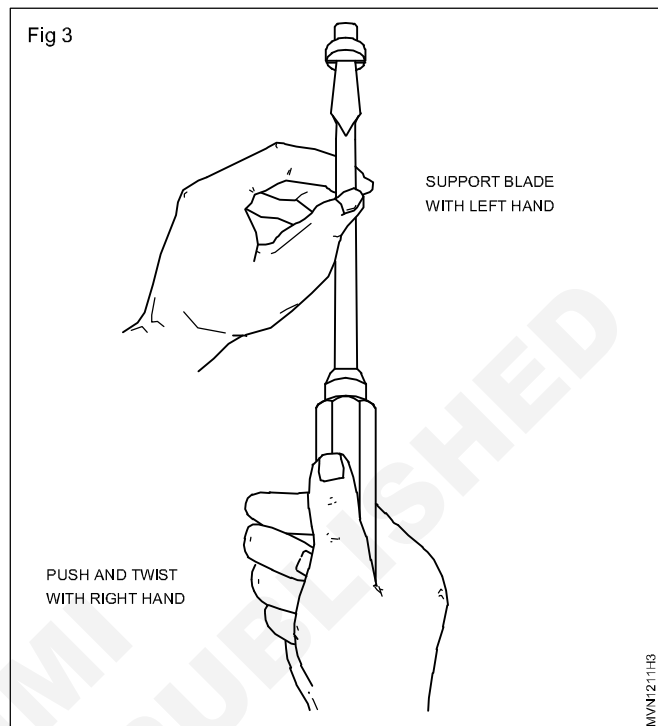
- 6 Hold the screwdriver with its axis in line with the axis of the screw.
- 7 Guide the blade with the left hand. Apply a little pressure with the right hand to keep the tip in the slot. (Fig 3)
- 8 Twist firmly and steadily.

**Keep the tip centered in the slot and the axis of the blade in line with the axis of the screw.**

**Always brace small works against the bench or other firm support before using a screwdriver.**

**Never hold a small work in your hand while using a screw driver.**

- 9 Turn large screws, use a screwdriver with a square blade. Apply extra twisting force with the aid of a close fitting spanner. (Fig 4)



**Never use pliers or toothed wrenches to apply twisting force to a screwdriver.**

- 10 A Standard screwdriver blade should be ground to 9° so that the faces will be almost parallel with the sides of the screw slot. The end of the blade should be made as thick as the slot in the screw will permit.

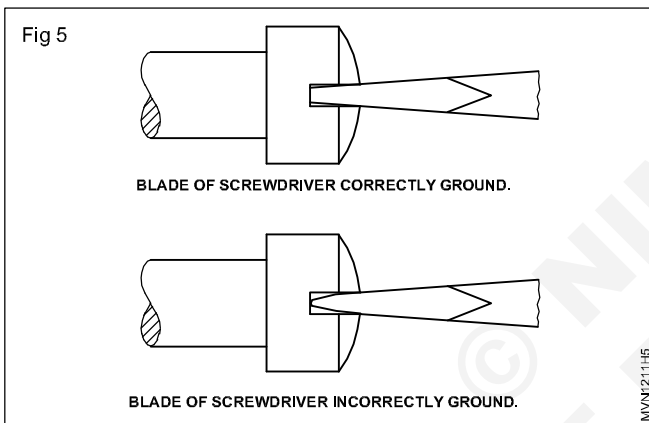
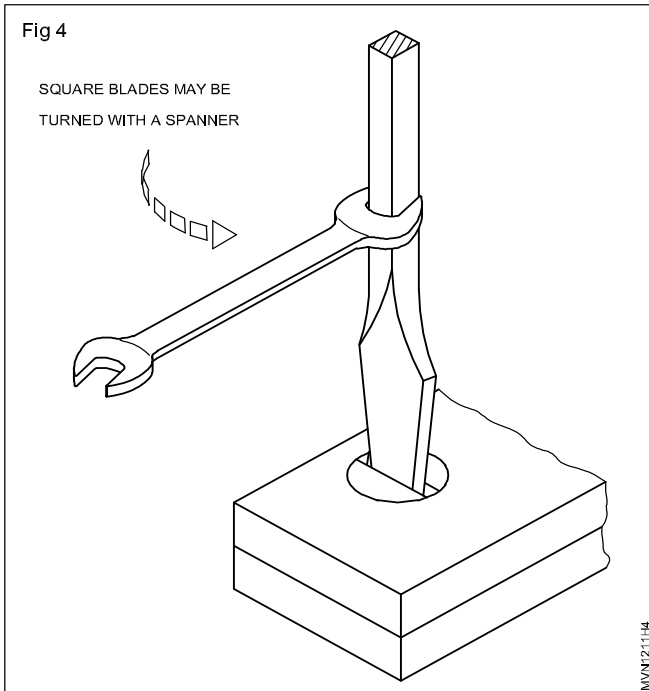
**Do not grind the blade to a chisel point, as it has a tendency to slip out of the screw slot.**

- 11 Grind the width on both sides to an angle of 11°. The width should be equal to the diameter of the head.

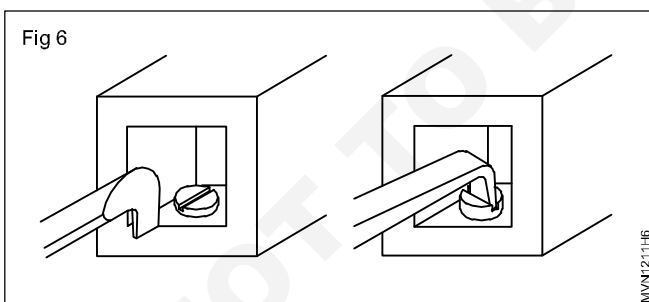
**Never grind screwdrivers on a silicon carbide grinding wheel.**

**Standard screwdrivers (Fig 5) can be dressed by filing if they are worn out. Begin filing on the end of the tip. After dressing, the tip must be symmetrical about the axis of the blade. All corners must be square. The end must be at right angles to the axis in both planes.**





12 Use offset screw driver (Fig 6) in a restricted place.

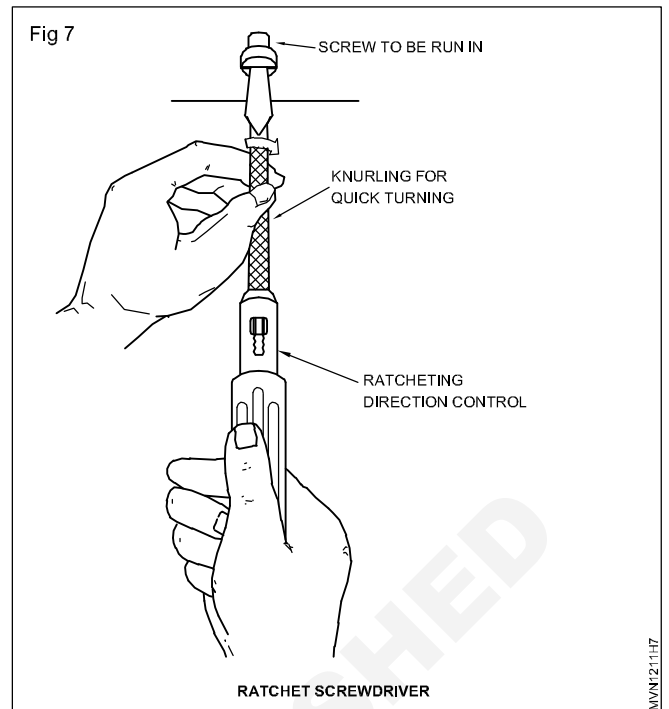


13 Reverse the screwdriver after one end to get on quarter turn on .

14 Use the other end to get the next quarter turn and so on.

**Keep pressing the tip into the slot as you turn.**

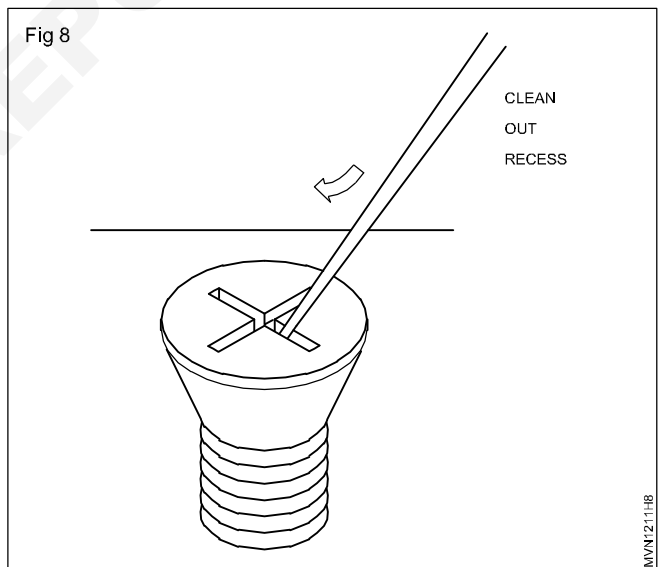
15 Use ratchet screwdriver (Fig 7) for quick turning.



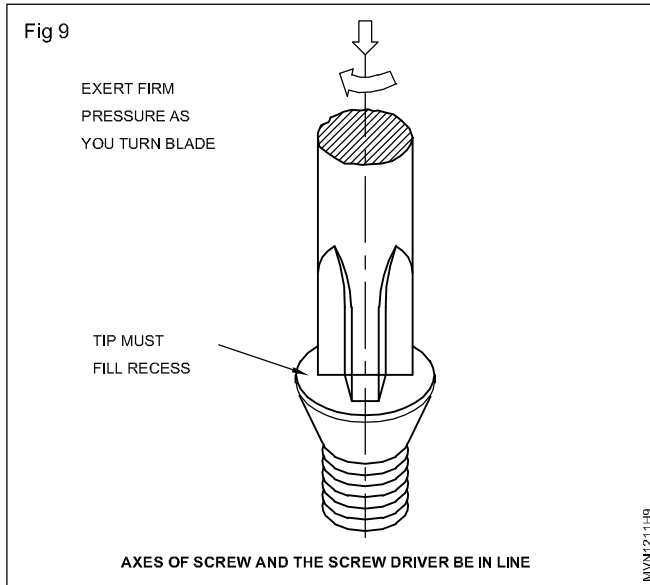
16 Keep the left hand on knurling, right hand on the ratchet head.

17 Change the direction of control depending on your movement.

18 Clean out recess for proper grip (Fig 8).



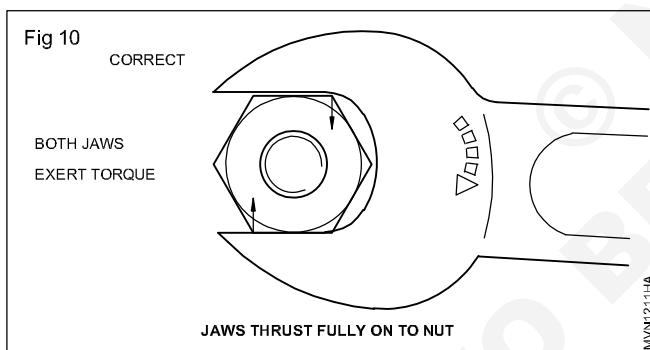
19 Phillips (cross-recess) screwdrivers tip must fill recess (Fig 9)



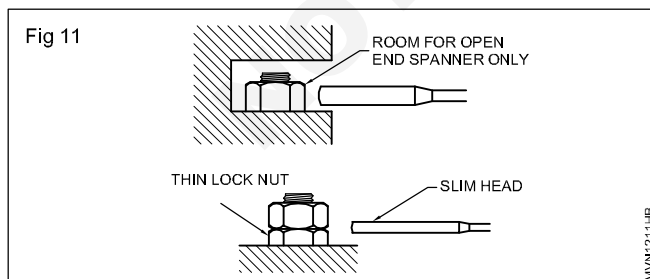
**TASK 4: Identify spanner & wrenches for specific purpose and handle it**

**Identifying the correct size of the tool**

- 1 Determine the distance across the flats of a nut or bolt to be removed. (Fig 10)

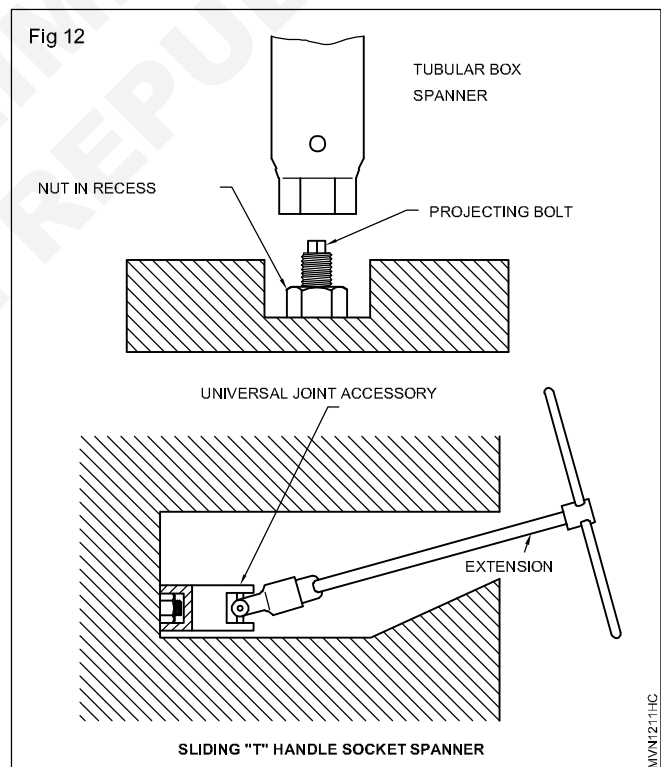


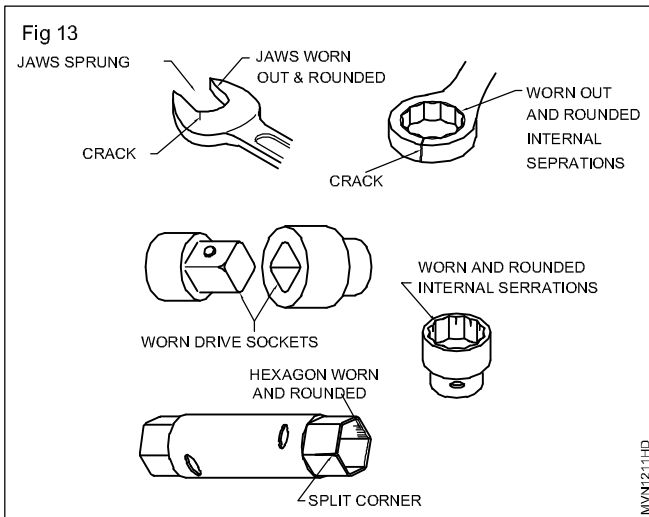
- 2 Decide the size of the spanner.
- 3 Choose the spanner that allows sufficient room without excess clearance for use. (Fig 11)



**Handling the Tool** excess clearance will cause slipping of spanner & fasteners corners gets damaged.

- 4 Select the correct size of the socket. (Fig 12, Fig 13)





- 5 Take a sliding offset handle and insert the drive attachment with square driving ends of a socket.
- 6 Insert the socket wrench on the bolt or nut and confirm whether it inserts fully.

- 7 Keep the position of the handle perpendicular to your forearm which enables you maximum leverage.
- 8 Pull the socket handle and drive out the nut/bolt head.

**Never use worn out or cracked spanners. They will slip and cause injury.**

- 9 Insert the ring spanner on the bolt or nut.
- 10 Keep the position of the shank perpendicular to your forearms which enables you maximum leverage.
- 11 Use D.E. Spanner where ring spanner is not suitable.

**Always try to pull the spanner.**

**If you are forced to push the spanner, use the base of your hand and keep your hand open.**

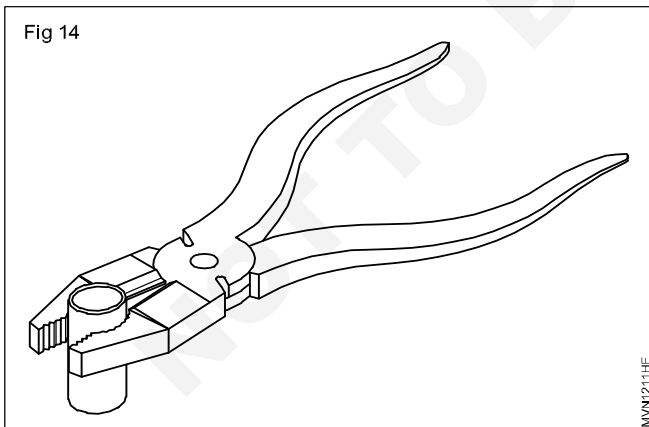
**Use both hands for large spanner.**

**Keep yourself balanced and firm to avoid slipping.**

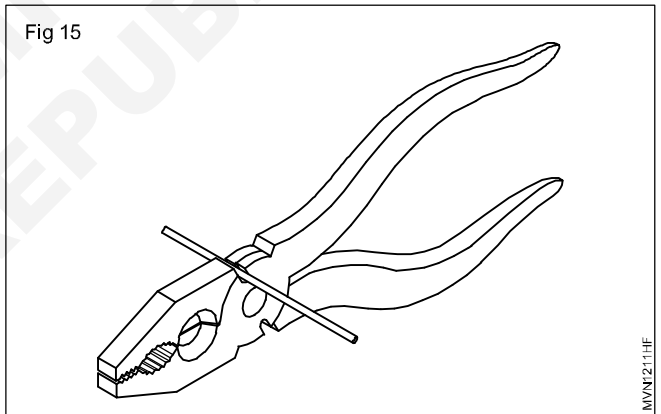
### TASK 5: Handling of Plier

**Use of combination plier**

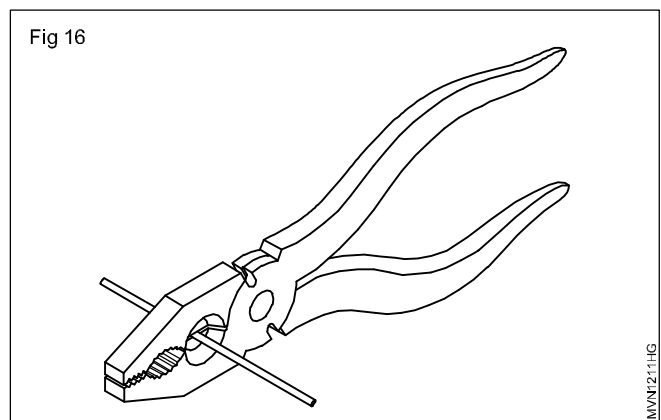
- 1 Select a component with lock wire to nut, which is to be removed.
- 2 Use the combination plier flat grip for untwist the lock wire.
- 3 After untwisting, pull the lock wire from the nut.
- 4 Remove the nut with proper spanner.
- 5 Select a brake pipe line to be removed from a junction.



- 6 Hold the brake pipe line with serrated pip grip portion at combination pliers. (Fig 14)
- 7 Select proper size of proper double open end spanner & remove the union nut.
- 8 Select a 3 mm electrical wire to be cut.
- 9 Place the wire between joint cutters at the point which is to be cut. (Fig 15)



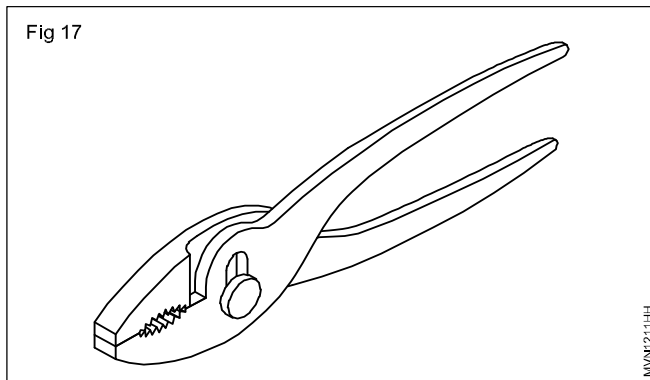
- 10 Press the handle to cut the wires.
- 11 Select a steel wire to be cut. (Fig 16)



- 12 Place the steel wire in between side cutter.
- 13 Press the handle to cut the wire.

### Use of flat nose plier

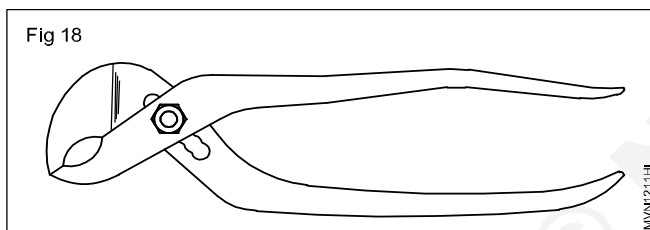
- 1 Select a nut with tab washer to be removed.
- 2 Unfold the tab washer with help of flat nose pliers. (Fig 17)



- 3 Use a proper spanner to remove the nut.

### Use of slip joint plier

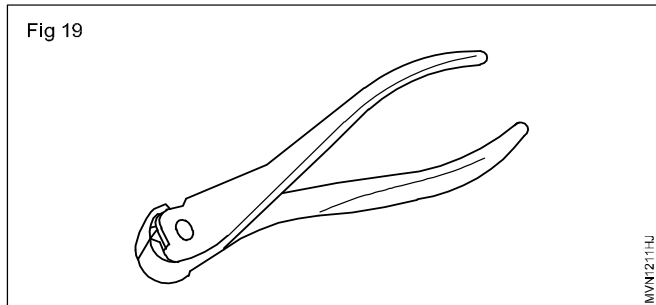
- 1 Select a cylindrical component with nut.
- 2 Hold the cylindrical shaft with help of slip joint pliers jaws. (Fig 18)



- 3 Remove the nut with proper spanner.

### Use end cutting plier

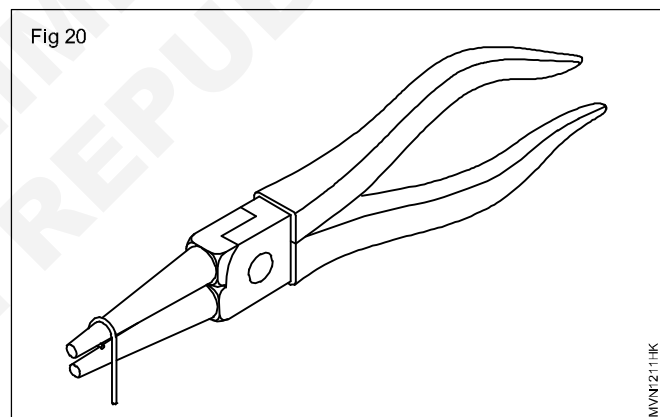
- 1 Select a wire to be trimmed.
- 2 Place the end of the wire to be trimmed by end cutting plier in between the cutting end. (Fig 19)
- 3 Apply pressure on handles to cut the wire.
- 4 Select the steel wire to be cut close to the component surface.



- 5 Cut the steel wire by slip joint multigrip plier applying pressure on the handles.
- 6 Use the cutting pliers to spread the cotter pin.
- 7 Select a stand with lock nut, from which lock nut has to be removed.
- 8 Hold the stand by locking pliers adjusting the screw in the handle lock with lever.
- 9 Use a proper spanner to remove the locking nut.

### Use of round nose plier

- 1 Select a wire which has to be converted into loop.
- 2 Hold the wire between the jaws. (Fig 20)
- 3 Form a loop by tuning the round nose pliers.



## TASK 6: Handling the Various Workshop Equipments

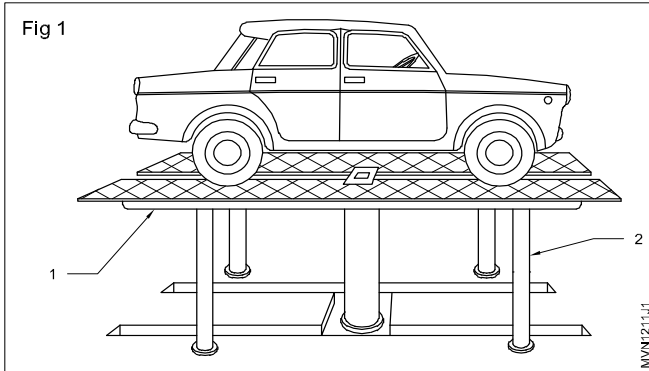
### Hydraulic car hoist

- 1 Park the vehicle in the centre of the car hoist (1).
- 2 Clamp the front and rear axle or chock wheels.
- 3 Open the air cock gradually and observe that the car hoist (1) is moving upward.
- 4 Close the cock when it reaches the required height.
- 5 Provide safety stands (2) underneath the hoist. Open the outlet cock slowly so that the vehicle moves down without jerk. Ensure that the hoist side rail sits firmly on the stand.

- 6 After finishing the required job, slightly open the inlet cock and raise the car hoist slightly up. Close the inlet cock.
- 7 Remove the safety stands.

**Ensure that nobody is present underneath the vehicle. (Fig 1)**

- 8 Open the outlet cock slowly so that the hoist comes down without disturbing the vehicle's position.
- 9 Remove the clamps/chocks and remove the vehicle from the hoist.



### Car washer

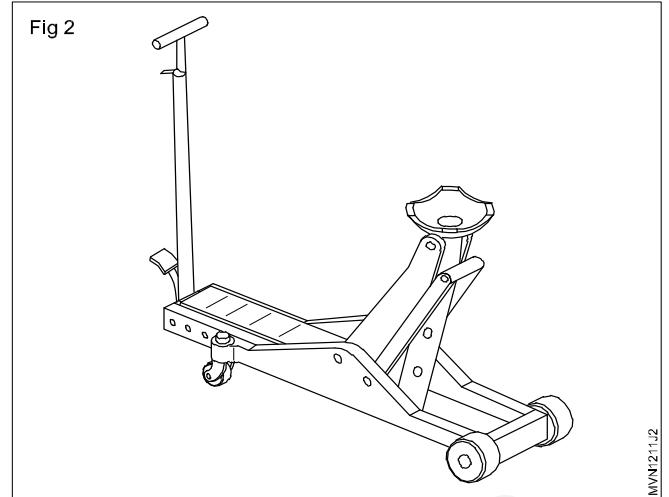
- 1 Check the oil level.
- 2 Check the belt tension.
- 3 Check the belt guard for its position.
- 4 Inspect the electrical connection visually for looseness, disconnections or cuts.
- 5 Open the water tank.
- 6 Check the water level.
- 7 Hold the gun before starting the car washer.
- 8 Switch 'ON' the car washer and adjust the pressure gauge for the required pressure. (200 psi)
- 9 Open the water gun.
- 10 Check the water jet and adjust for force and spray.
- 11 Use the gun for the required purpose.
- 12 After completing the cleaning, stop the car washer.
- 13 Close the water intake cock (water supply).

### Mechanical jack/hydraulic jack

- 1 Park the vehicle on level ground.

**In case of jacking up the front axle, chock the rear wheels and vice versa.**

- 2 Check the free movements of threads in a mechanical jack by hand and in the hydraulic jack, check the oil level and its operations.
- 3 Place the jack (Fig 2) under the vehicle.
- 4 Rotate the screw gradually with the jack lever and lift the vehicle and in the case of a hydraulic jack move the jack's lever slowly so that the axle jacks up without any jerk.
- 5 Place the support horses below the chassis frame/ axle.
- 6 Lower down the jack and remove it.
- 7 Jack up again after completing the specific job .
- 8 Remove the support horses.
- 9 Lower down the jack after remove the supports.



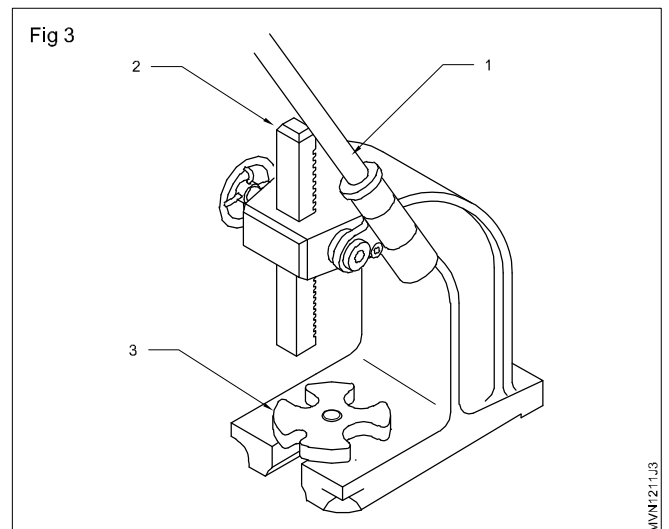
### Grease gun

- 1 Select the grease gun according to the vehicle. (Consult your instructor.)
- 2 Check visually the washer, the grease nipple-holder for any damage.
- 3 Fill up the gun with the specified grease.
- 4 Close the grease gun and operate the lever till the grease comes out continuously from the nipple with pressure.
- 5 Use the grease gun for the required purpose.

### Oil spray gun

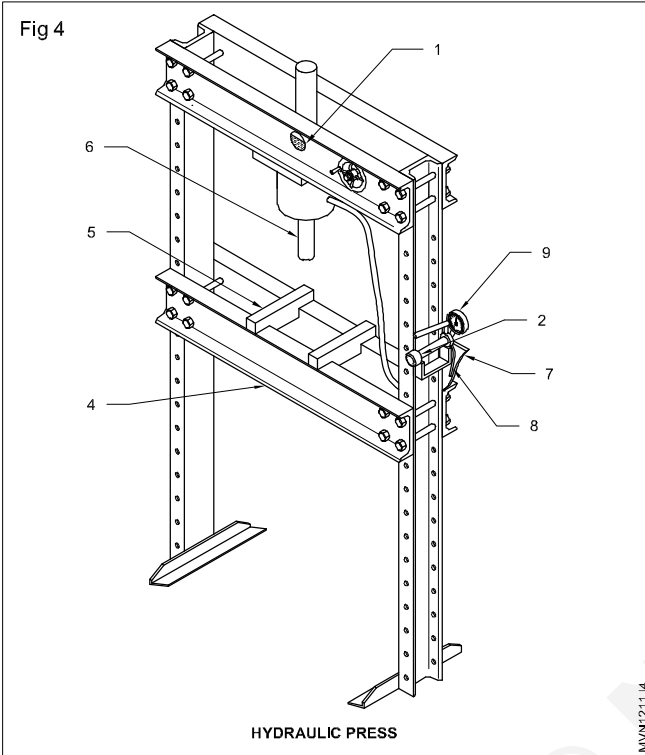
- 1 Check visually the oil spray gun nozzle, nozzle holder, operating lever, air hose for any damage.
- 2 Fill the specified oil in the oil spray gun.
- 3 Connect the oil spray gun to the air hose connection.
- 4 Operate the oil spray gun.
- 5 See that the oil is sprayed at pressure.
- 6 Use the spray gun for the required purpose.
- 7 Close the air-hose connections and take out the oil spray gun.

### Mechanical press



- 1 Check for easy movement of the operating lever (1) and rack (2) of mechanical press. (Fig 3)
- 2 Select the plate (3) according to the work.
- 3 Place the component on the plate.
- 4 Press the work slowly.

#### Hydraulic press (Fig 4)



- 1 Clean the press.
- 2 Check the oil level (1).
- 3 Check the hydraulic press (Fig 4) for its free function and leakage.
- 4 Lock the cylinder plunger releasing knob (2).
- 5 Adjust the bed (4) to the required height so that, after placing the job, there will be 100 mm clearance between the plunger (6) and the bed (4).
- 6 Align the anvil (5) according to the job.
- 7 Place the job on the anvil (5).
- 8 Select the distance piece in such a way that while pressing the shaft/bush, it does not touch the body (minimum 10 mm gap to be given between the plunger (6) and the distance piece).
- 9 Place the distance piece on the shaft/bush. Ensure that it does not touch the body.
- 10 Operate the low pressure lever (7) and make the plunger (6) to have a contact on the job.
- 11 Operate the heavy pressure lever (8), observe the load on the gauge (9) and the job simultaneously. Ensure the job comes out gradually.

**If the load exceeds more than the specified limit, stop the pressing.**

- 12 Releasing knob (2) after finishing the work loosen the plunger.
- 13 Remove the job and clean.

## Skill Sequence

### Cutting a G.I pipe

**Objective:** This shall help you to

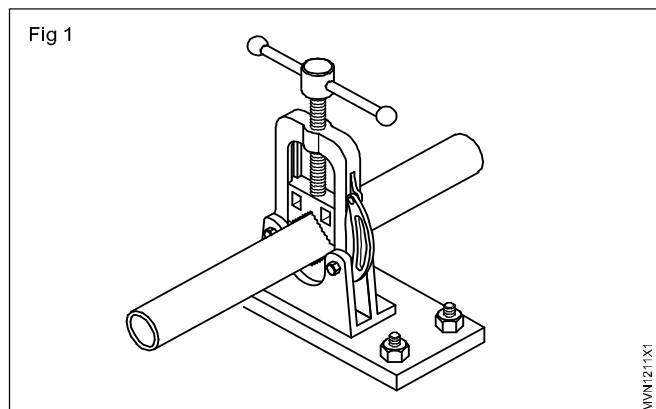
- cut a G.I pipe using a pipe cutter.

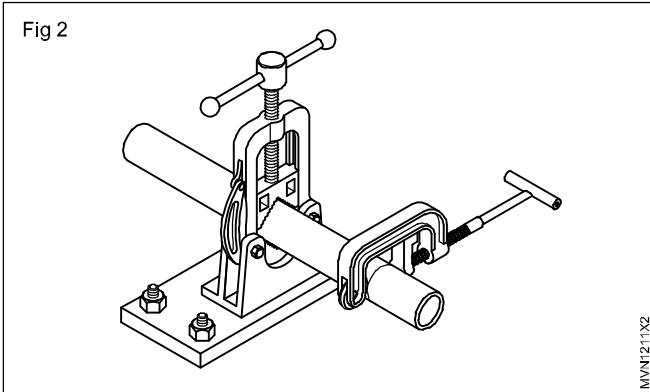
Measure the required length of pipe and mark it with chalk.

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

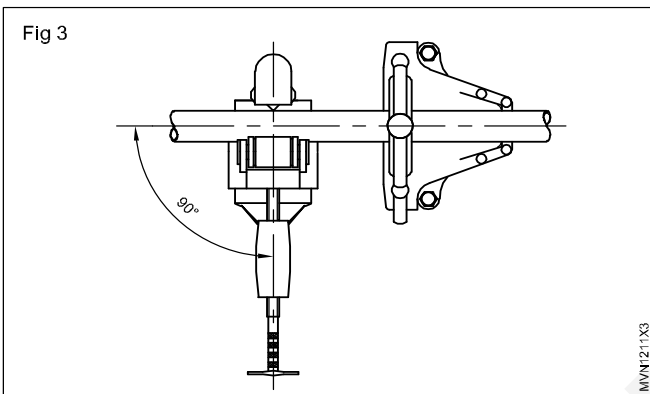
Fit the pipe cutter on the G.I. pipe (on the scribed line) and tighten the jacking screw so that the cutting wheel is touching the pipe. (Fig 2)

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

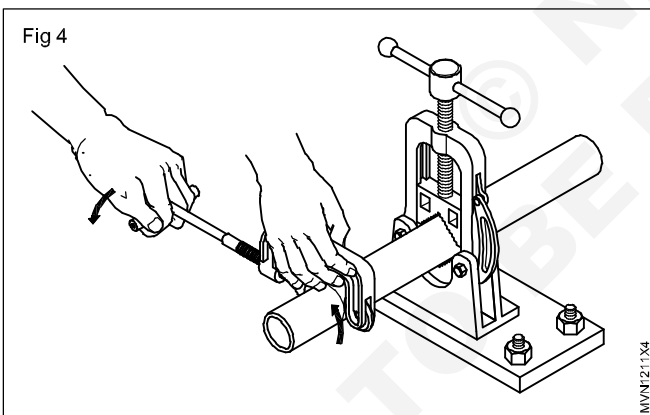




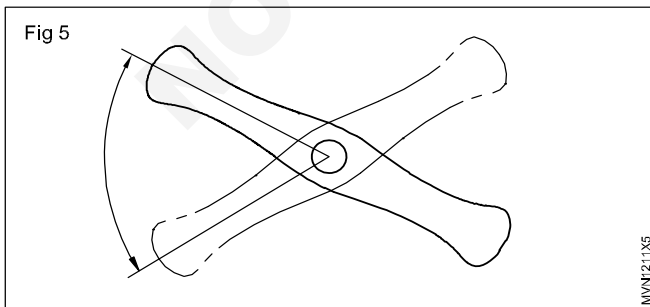
Rotate one or two turns to ensure that the cutting wheel is sitting exactly on the scribed line at 90° to the pipe. (Fig 3)



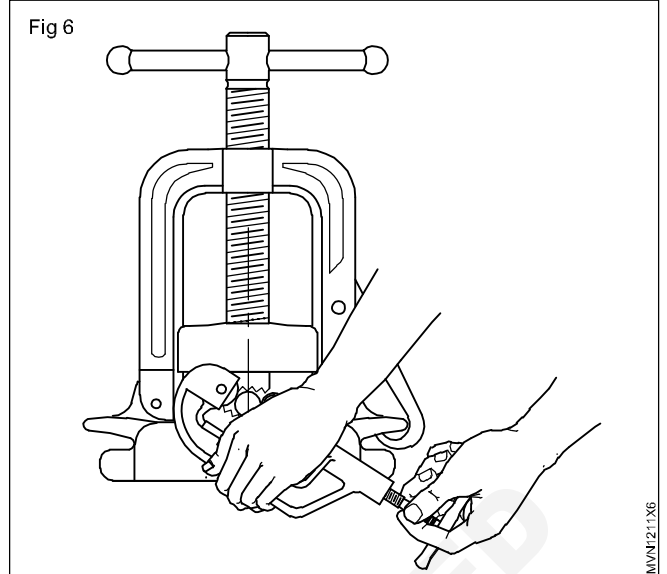
Rotate the pipe cutter around the pipe. (Fig 4)



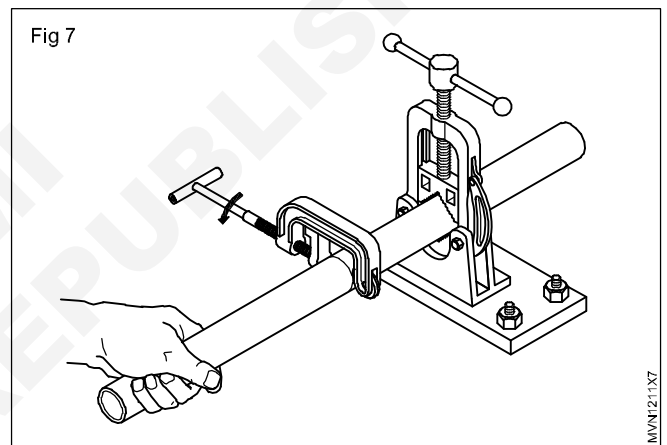
After two or three turns use the jacking screw to apply pressure on the cutting wheel. (Fig 5)



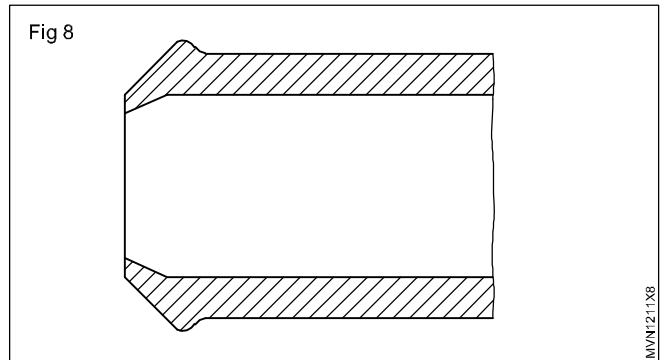
Keep rotating the pipe cutter around the pipe. Increase the pressure to the cutter by repeating the cycle until the pipe is cut through. (Fig 6)



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

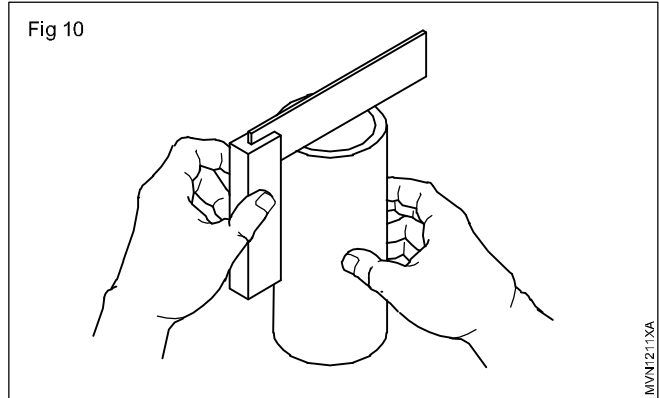
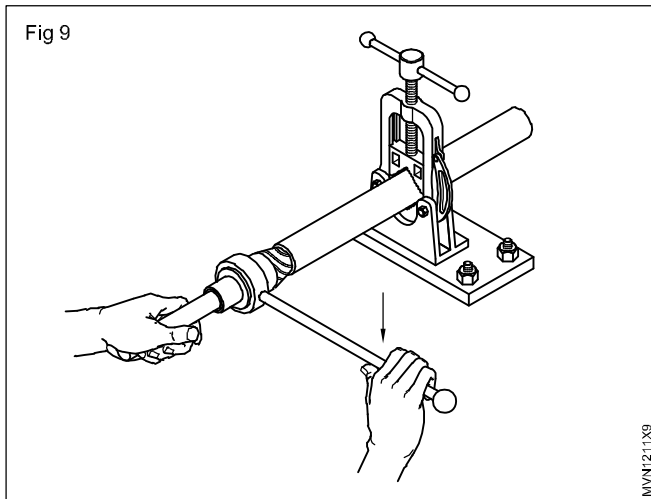


Check the cut portion of the pipe which will appear as shown in Fig 8.



Remove burrs using a pipe reamer. (Fig 9)

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



## Make flare joints and test them with flare fittings

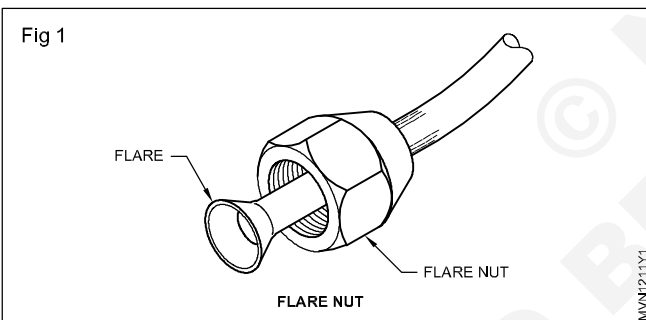
**Objectives:** This shall help you to

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

### Flaring

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

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



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

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

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

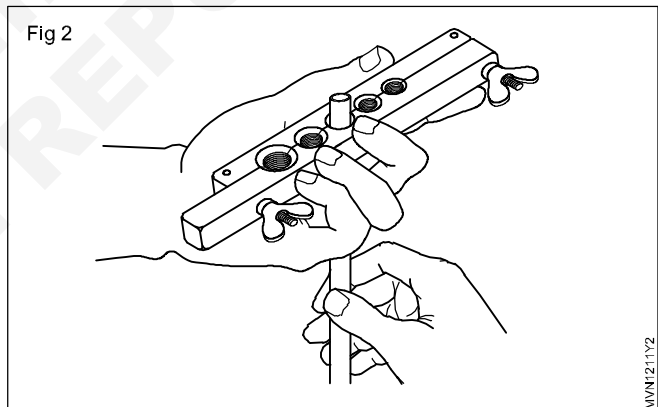
Place the pipe in the tool (Fig 2). Make sure that you have:

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

If the pipe is  $\frac{1}{4}$  inch (6 mm) in diameter, position the pipe so that the end is at least 2 mm above the top of the flaring block (Fig 3). (This distance is calculated as "pipe

diameter divided by 3"; in this case, 6 mm divided by 3 = 2 mm).

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



Fit the yoke to the flaring block (Fig 3)

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

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

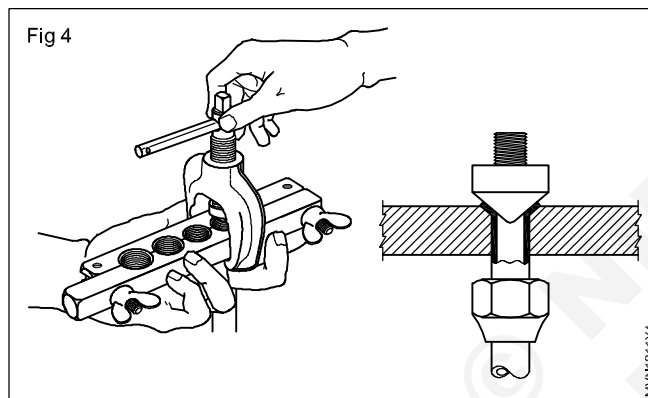
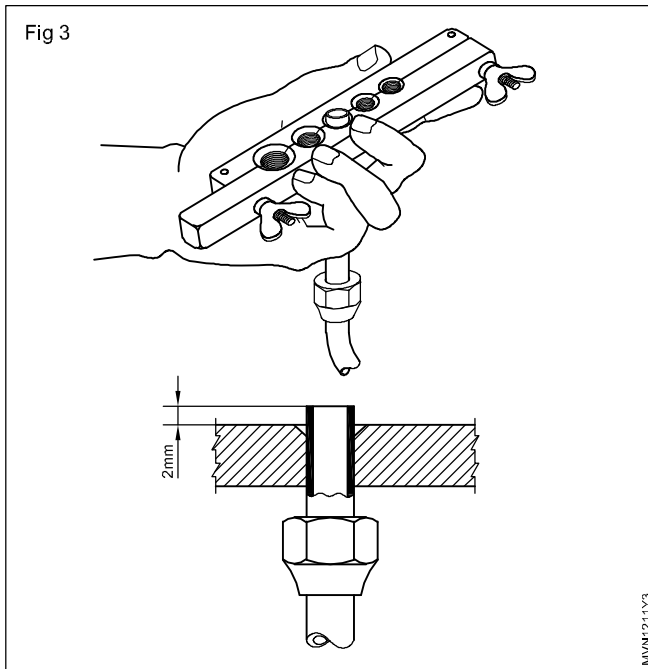
Unscrew & remove the flaring block remove the flared pipe from the block.

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

Make sure that the flare is the correct size. It should just fit inside the flare nut. If it is too loose, cut off the flare and start again at instruction 5.

At instruction 7, use 3 mm instead of 2 mm. Repeat until the flare is the correct size for the flare nut-not too loose and not too tight.





**Observation Table - 1**

SI. 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 copper tube**

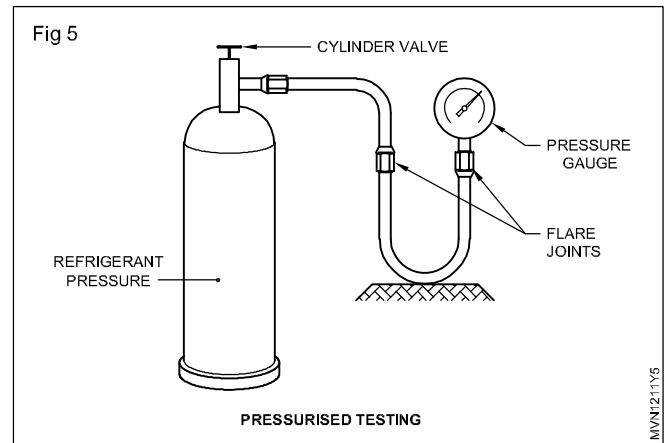
### Joining with flare fittings

Put thread seal tape on the thread

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

Tighten the one end of the tube 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 tube.**

**Observation Table - 2**

SI. 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 tube firmly, open the cylinder valve with 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**

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

## Perform handling of puller

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

- select, install to use a puller for removing gear from shaft
- select, install to use of puller for removing bearing from shaft.

Identify the object to be removed, i.e Gear / Bearing.

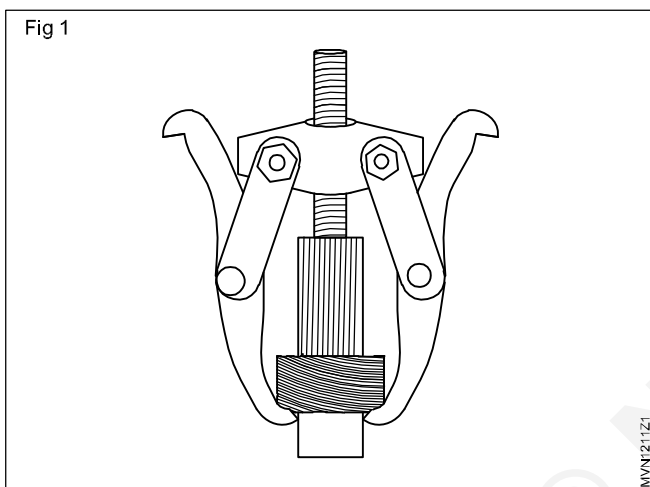
Determine the size of the Gear / Bearing to be removed.

Choose a puller according to Gear / Bearing i.e, 2 or 3 Jaw & External or Internal Jaw puller.

Unscrew the forcing screw of the puller to the optimum length.

Split open the jaw of the puller.

Position the jaws of the puller over gear as shown in the diagram. (Fig 1)



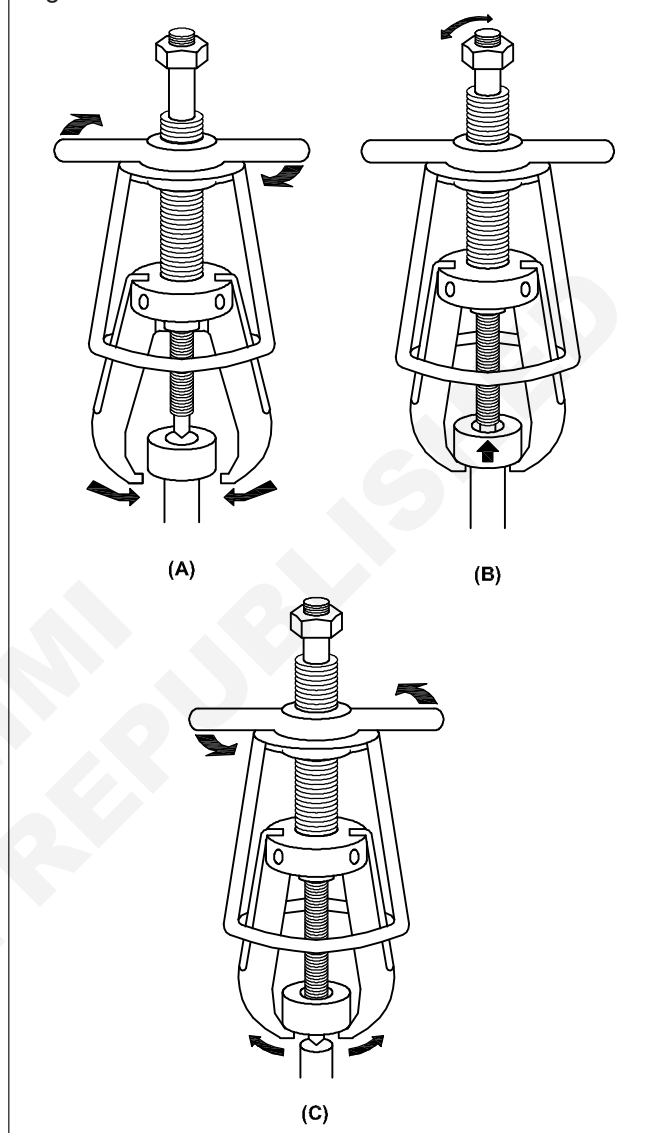
Position the tip of forcing screw on the shaft, as shown in the diagram. (Fig 2)

Tighten the forcing screw till the forcing screw end touches the shaft.

Check the puller is not going to slip from the center of shaft & readjust if necessary.

Tighten the forcing screw till the gear comes out from the shaft.

Fig 2



### Warnings

**Always wear proper personal protective gear (i.e. gloves, safety glasses)**

**Never use a tool to strike the puller. Hitting the puller may cause breakage.**

**Applying heat to the puller may damage it, causing the puller to fail at lower than rated load.**

**Practice to measure the various components using vernier caliper, micrometer, dial bore, telescopic, feeler, pressure - gauges & dial test indicator**

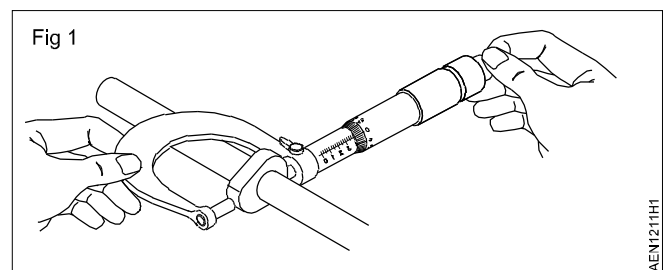
**Objectives:** At the end of this exercise you shall be able to

- measure cam height using outside micrometer
- measure camshaft journal diameter using outside micrometer
- measure crankshaft journal diameter using outside micrometer
- measure valve stem diameter using outside micrometer
- measure piston pin & piston skirt diameter using outside micrometer
- measure the cylinder bore diameter using telescopic gauge
- measure the connecting rod big end diameter using telescopic gauge
- measure the camshaft bearing inside diameter using telescopic gauge.
- remove the connecting rod with piston
- clean the cylinder bore
- measure the cylinder bore diameter, wear/ovality/tapperness with a micrometer and bore dial gauge.
- check wear of crank shaft
- check end play of crank shaft
- check the wear of the valve guide.
- check the piston ring end gap
- check piston to cylinder wall clearance.
- check existing tyre pressure on a vehicle.

Requirements			
<b>Tools / Instruments</b>		<b>Equipment / Machines</b>	
• Vernier caliper	- 1 No.	• Work bench	- 1 No.
• dial bore gauge	- 1 No.	• V blocks	- 1 Pair
• Telescopic gauge	- 1 No.	• Engine	- 1 No.
• Feeler gauge	- 1 No.	<b>Materials</b>	
• Pressure gauge	- 1 No.	• Camshaft	- 1 No.
• dial test gauge	- 1 No.	• Crankshaft	- 1 No.
• Vaccum gauge	- 1 No.	• Valve	- 1 Set
• Dial test indicator	- 1 No.	• Piston	- 1 Set
• Trainee's tool kit	- 1 No.	• Piston pin	- 1 Set
• Outside micrometer (0 - 25mm)	- 1 No.	• Cotton waste	- as reqd
		• Kerosene	- as reqd

**TASK 1: Check the cam height (Fig 1)**

- 1 Check the camshaft visually for crabs
- 2 Clean the camshaft using a small brush with recommended cleaning solvent
- 3 Clear sludge and gum deposit
- 4 Blow out the passages with compressed air with the help of micrometer measure the reading of cam height.
- 5 Before taking the measurement, ensure that micrometer is adjusted for zero setting
- 6 Record the main scale reading and thimble reading
- 7 Check the cam shaft at 2 or 3 places on the table and arrive at the observed value.
- 8 Use the micrometer to measure the cam lobe height and record the results in a table 1.



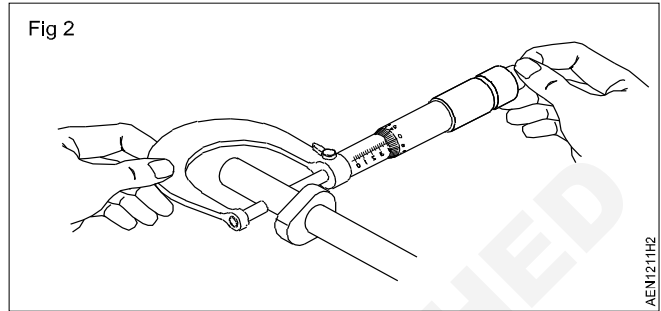
**Note: Measuring Cam height, Camshaft Journal dia, crankshaft journal dia, Valve stem dia, piston diameter, and piston pin dia with outside Micrometers.**

**Table 1**

Component Name	Main scale Reading	Coinciding Thimble scale (div)	Least count	Result
	(a)	(b)	(c)	$R = a + (b \times c)$
Cam lob height			0.01	

**TASK 2: Check the cam shaft journal diameter (Fig 2)**

- 1 Clean the camshaft before measuring camshaft-journal diameter
- 2 Inspect the journal diameter of the camshaft and record the results in a table 2.

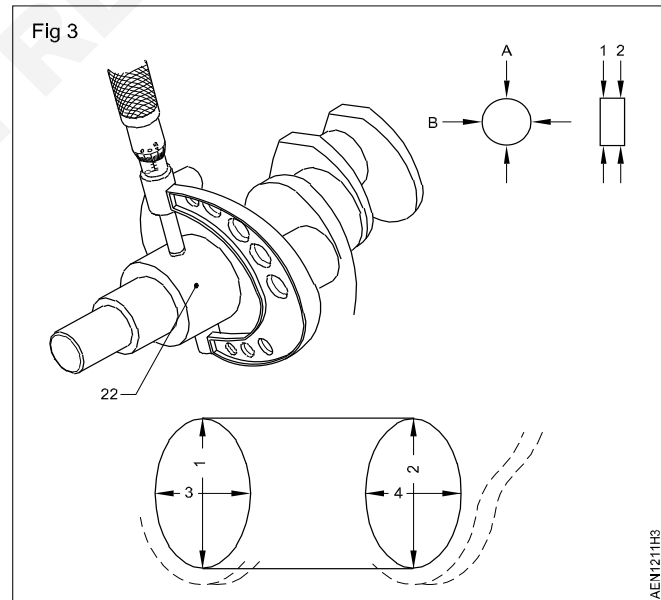


**Table 2**

Component Name	Main scale Reading	Coinciding Thimble scale (div)	Least count	Result
	(a)	(b)	(c)	$R = a + (b \times c)$
Cam shaft journal diameter			0.01	

**TASK 3: Check the crankshaft journal diameter (Fig 3)**

- 1 Use a micrometer to measure crankshaft journal diameter at two places, 180° apart and at two points along its length. Record the result in a Table 3.
- 2 Put the bearing caps at their respective places with the same bolts.
- 3 Clean the crankshaft using a small brush with the recommended cleaning solvent.
- 4 Clear the sludge and gum deposits from the drilled oil passages in the crankshaft by the wire brush.
- 5 Blow out the passages with compressed air



**With the help of a micrometer measure the journal diameter at '1' '2' '3' & '4'. The difference in reading between '1' & '3' and '2' & '4' will give the ovality. (Fig 3)**

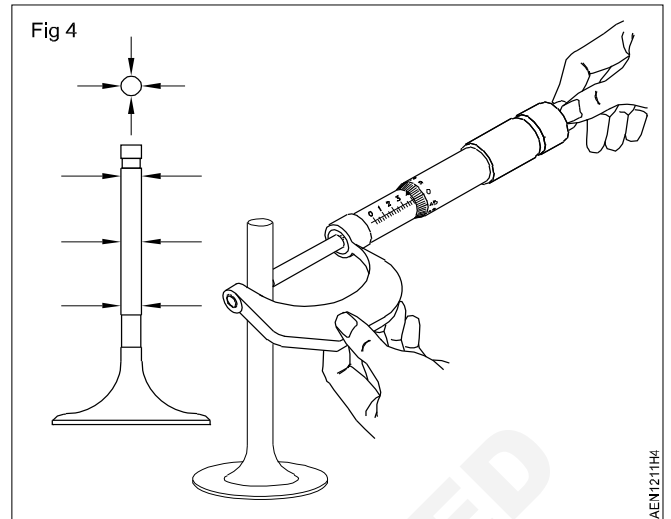
- 6 Measure the oil clearance between the crankshaft main journal and the bearing shell.

**Table 3**

Component Name	Main scale Reading	Coinciding Thimble scale (div)	Least count	Result
	(a)	(b)	(c)	$R = a + (b \times c)$
Cam shaft journal			0.01	

**TASK 4: Check the diameter of the valve stem (Fig 4)**

- 1 Use a micrometer to measure the diameter of the valve stem and record the results in a table 4.

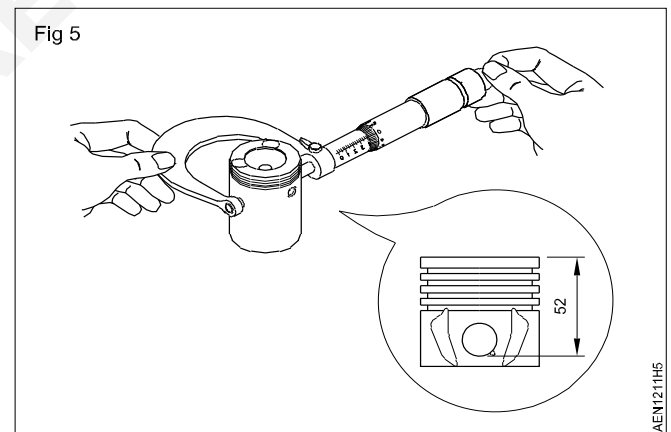


**Table 4**

Component Name	Main scale Reading	Coinciding Thimble scale (div)	Least count	Result
	(a)	(b)	(c)	$R = a + (b \times c)$
Valve stem diameter			0.01	

**TASK 5: Check the piston and piston pin (Fig 5)**

- 1 Use a micrometer to measure the piston diameter at right angles to the piston pin center line, and at a position 52 mm (2.05 in.) from the top of the piston head and record the results in a table 5.



**Table 5**

Component Name	Main scale Reading	Coinciding Thimble scale (div)	Least count	Result
	(a)	(b)	(c)	$R = a + (b \times c)$
Piston diameter			0.01	

- 2 Use a micrometer to measure the external diameter of the piston pin (Fig 6) and record the results in a table - 6

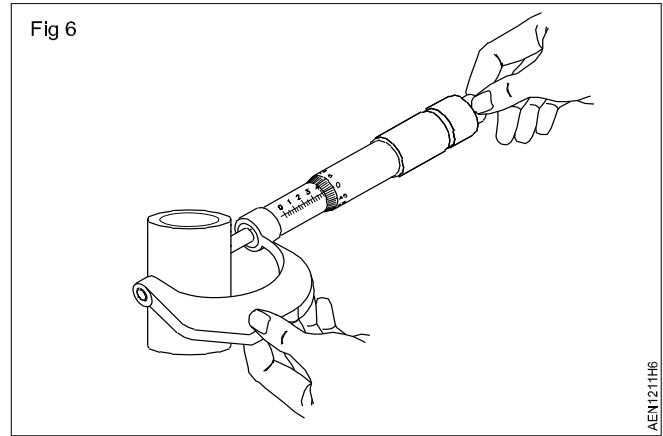


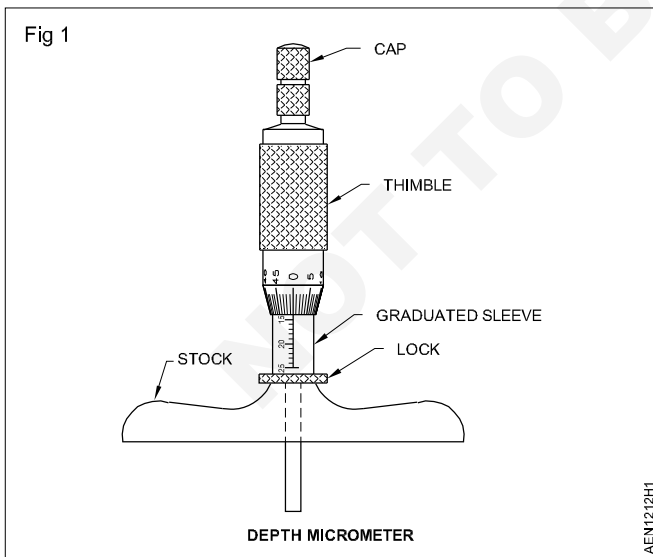
Table 6

Component Name	Main scale Reading	Coinciding Thimble scale (div)	Least count	Result
	(a)	(b)		
Piston pin diameter			0.01	

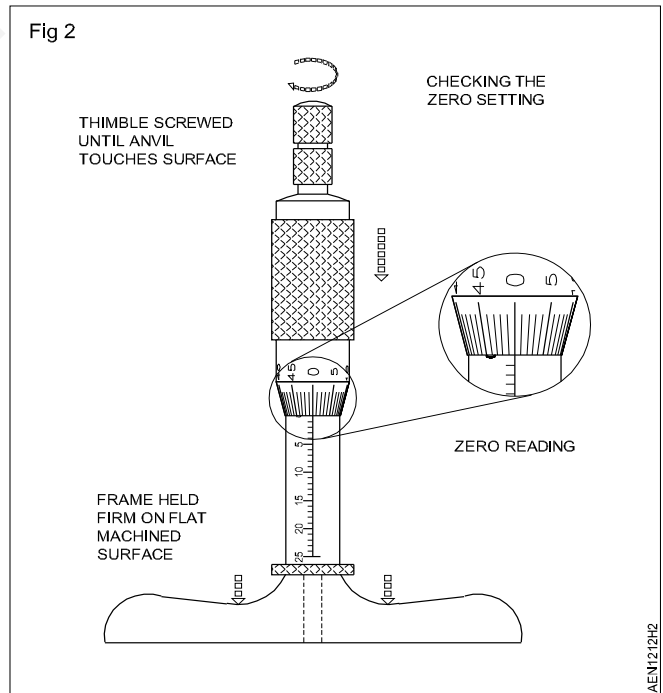
**TASK 6: Measure the depth of the oil pump body**

- 1 Adjust the zero reading of the depth micrometer. (Fig 2)
- 2 Fix the frame surface with surface of the oil pump rotor body.
- 3 Rest your left hand on the surface of the work being measured and hold the anvil to touch the surface. (Fig 1)

**When you are satisfied with the feel. Lift the micrometer carefully from the gap. Zero graduation of the sleeve is on the top. (Fig 2)**

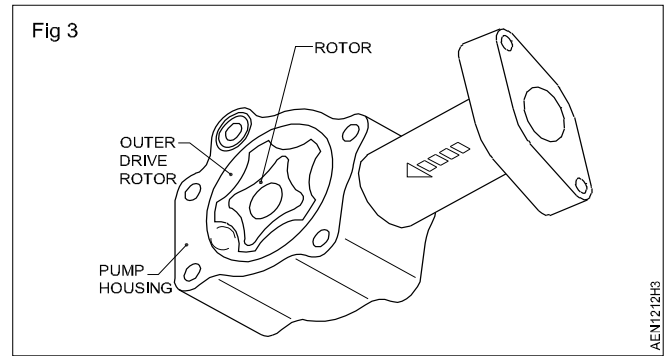


- 4 Turn the micrometer thimble with your thumb and finger until you feel the anvil to touch the surface of the oil pump rotor body.
- 5 Read the actual reading hidden by thimble.



### Rotor type oil pump

- 6 Measure the actual reading in the gap between housing surface to rotor's surface. (Fig 3)
- 7 Measure the actual reading the height of the rotor from the surface of the oil pump housing.



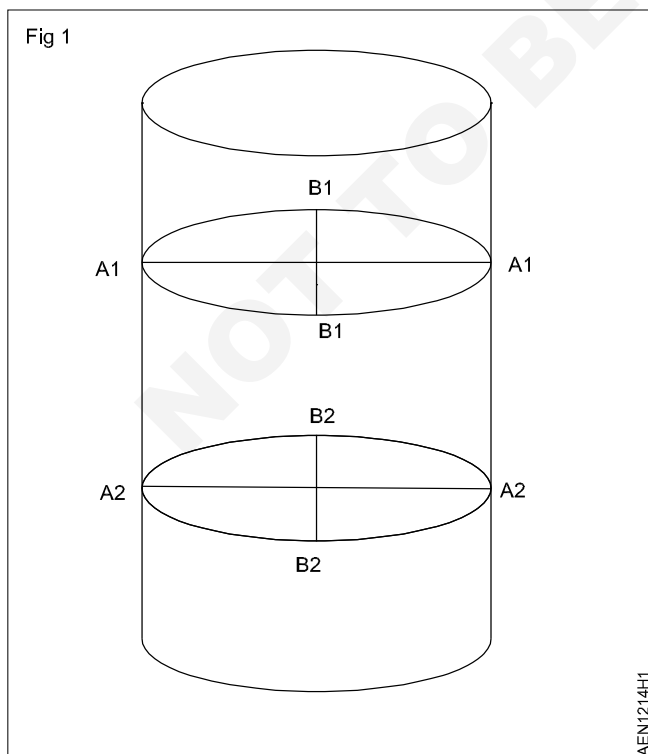
### TASK 7: Measure the inside diameter of a bore using telescopic gauge

- 1 Clean the cylinder bore with a piece of cloth.
- 2 Measure the approximate size of the cylinder bore.
- 3 Select the suitable range of a telescopic gauge.
- 4 Press the moving leg gently and place it inside the cylinder bore.
- 5 Release the pressure and allow both the legs to touch on the wall of the cylinder bore.
- 6 Keep the telescopic gauge perpendicular to the diameter of the cylinder bore. (Fig 2)
- 7 Move the gauge slightly inside the hole and correct 'feel'.
- 8 Lock the telescopic gauge.

Remove it gently from the cylinder bore.

Transfer the measurement to an outside micrometer and read.

Take the measurement at A<sub>1</sub>, A<sub>2</sub> and note down. (Fig 1)



Take the measurement at B<sub>1</sub>, B<sub>2</sub> and note down.

Sl. No.	A	B
1	A <sub>1</sub>	B <sub>1</sub>
2	A <sub>2</sub>	B <sub>2</sub>

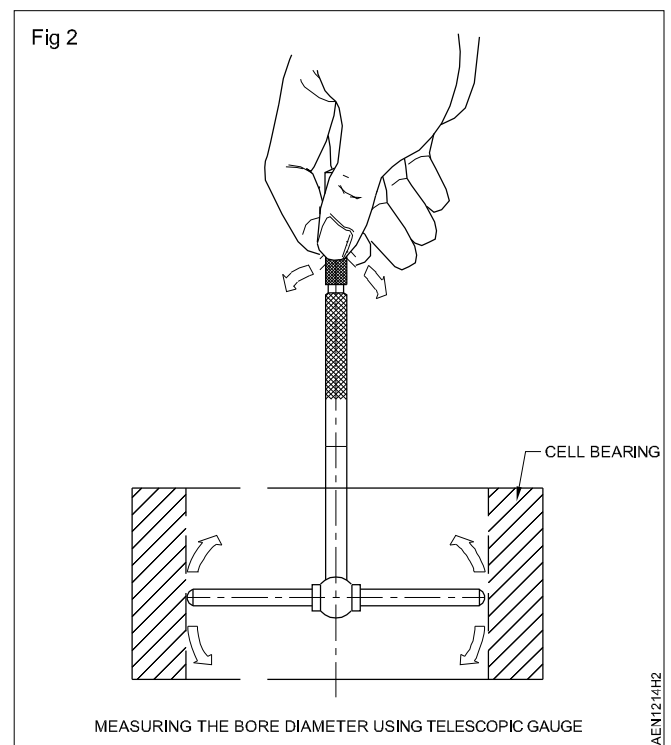
A = Non thrust side.

B = thrust side.

The difference of measurement between A<sub>1</sub> - B<sub>1</sub> and A<sub>2</sub> - B<sub>2</sub> are the ovality

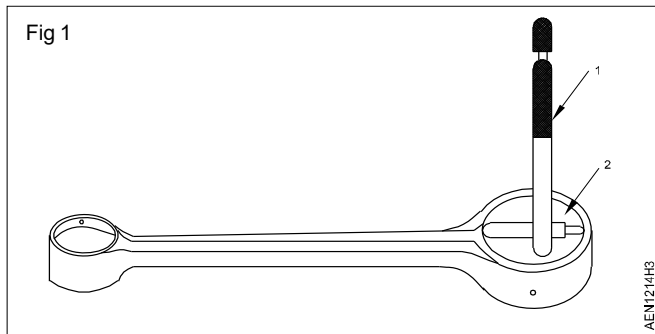
The difference in measurement between A<sub>1</sub> - A<sub>2</sub> and B<sub>1</sub> - B<sub>2</sub> is the taper.

Note down the maximum ovality and taper. If any one of it is found more than the specified limit by the manufacturer, then recommend for reboring or replacement of the liner.



### TASK 8: Measure the connecting rod big end diameter by using telescopic gauge

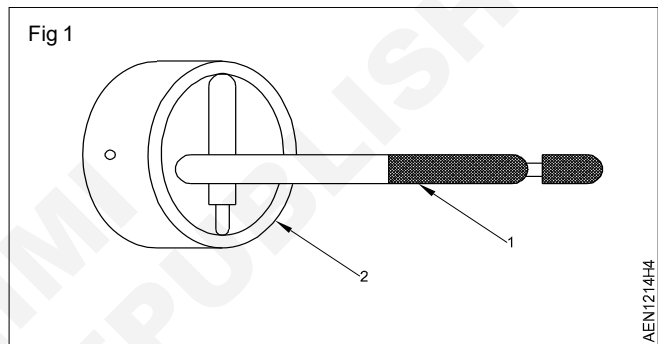
- 1 Measure the approximate size of connecting rod bore with steel rule.
- 2 Select a suitable range of a telescopic gauge (1) (Fig 1).



- 3 Press the moving leg gently and place it inside the connecting rod bore (2).
- 4 Release the press and allow both the legs to touch on the wall of the connecting rod bore (2).
- 5 Keep the telescopic gauge perpendicular to the diameter of the connecting rod bore.
- 6 Move the gauge slightly inside the connecting rod bore and get the correct feel.
- 7 Lock the telescopic gauge (1).
- 8 Remove it gently from the connecting rod bore.
- 9 Transfer the measurement to an outside micrometer & read and compare the reading with service manual specified limit.

### TASK 9: Measuring practice on inside diameter of a cam-shaft bearing with telescopic gauge

- 1 Measure the approximate size of cam-shaft bearing (2) with steel rule.
- 2 Select a suitable range of a telescopic gauge (1). (Fig)
- 3 Press the moving legs gently and place it inside camshaft bearing (2).
- 4 Release and press and allow both legs to touch on the wall of the cam-shaft bearing (2).
- 5 Keep the telescopic gauge perpendicular to the diameter of the cam-shaft bearing.
- 6 Move the gauge slightly inside the cam-shaft bearing & get the correct feel.
- 7 Lock the telescopic gauge.
- 8 Remove it gently from the cam-shaft bearing.

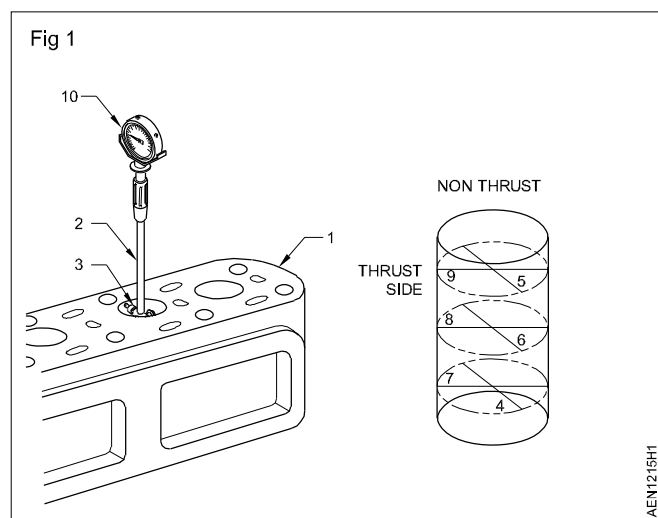


- 9 Transfer the measurement to an outside micro-meter & read the measurement and compare with manufactures standard specification.

### TASK 10: Checking taper ovality of cylinder bore. (Fig 1)

- 1 Clean cylinder bore with a piece of cloth.
- 2 Measure inside diameter of the bore with an inside micro meter
- 3 Select the correct size of extension rod (1) which is more than measuring range.
- 4 Assemble the extension rod on the stem of the dial test indicator (2) with the help of 75-100mm outside micrometer set "0".
- 5 Press the spring loaded plunger end (3).
- 6 Tilt the bore gauge and insert into the bore, check gauge parallel to measuring spindle note the needle returning point.
- 7 Take measurement at (5) with the bore gauge and note down the reading.
- 8 Take another reading at 6 & 4 note down the reading.
- 9 Repeat above at three places (9, 8 & 7).
- 10 The difference in measurement between (9) & (5), (8) & (6) and (7) & (4) is ovality. The difference in measurement between (9) and (8), (8) and (7), and (9) and (7) is taper.

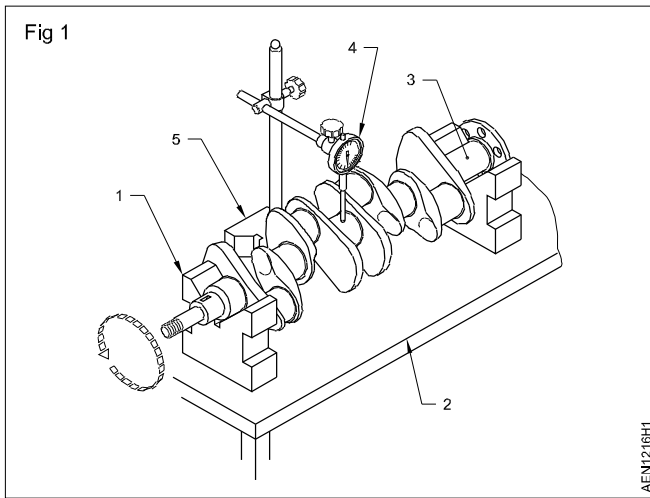
- 11 Note down maximum ovality and taper. If any one of them is more than the specified limit, recommend for reborng/replacement of liner.





### TASK 11: Check wear of crank shaft (Fig 1)

- 1 Place two 'V' blocks (1) on the surface table (2).
- 2 Place the shaft (3) on the 'V' blocks and adjust the distance between the 'V' blocks in such a way that on either side of the 'V' block the shaft does not over hang more than 1/10th of its total length

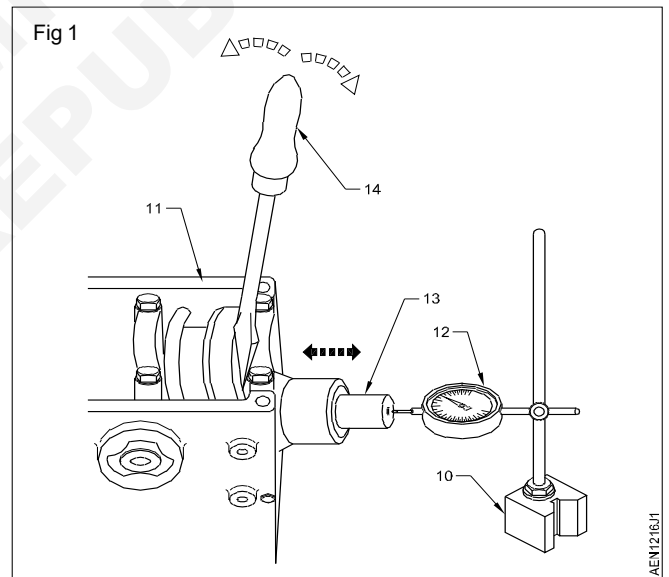


- 3 Place the dial indicator with the magnetic base (5) on the surface table.
- 4 Bring the dial indicator (4) at the center of the shaft (3) Push the dial indicator's (4) needle on the shaft so that the needle shows some deflection.
- 5 Adjust the indicator's needle to 'O' position by rotating the dial.
- 6 Rotate the shaft (3) by hand and note down the deflection of the needle. This will give the bend of the shaft at the center.
- 7 Repeat the above steps at three places, so as to cover the complete length of the shaft (3).
- 8 Note down the maximum wear at all the places.

**Replace the shaft, if the maximum bend at any one or more places is found more than the limit specified by the manufacturer.**

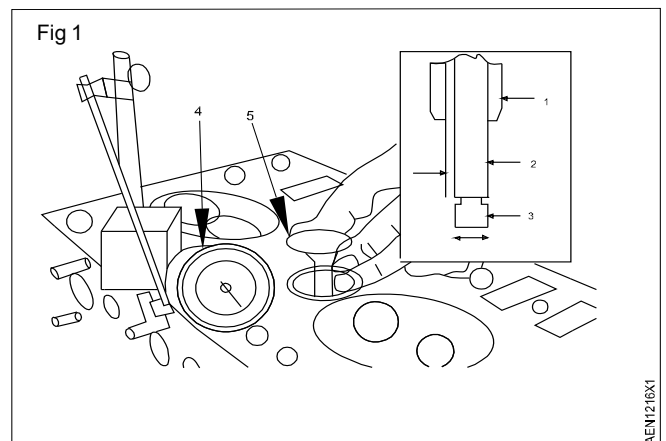
### TASK 12: Checking crankshaft end play (Fig 1)

- 1 Fix the magnetic base (10) on the cylinder block (11) or on inspection table.
- 2 Set the dial gauge (12) on the crankshaft flange (13)
- 3 Set the dial gauge for 'O' (zero).
- 4 By using the lever (14) move the crankshaft forward and backward.
- 5 Note down the crankshaft end play and compare with the manufacturer's specifications.



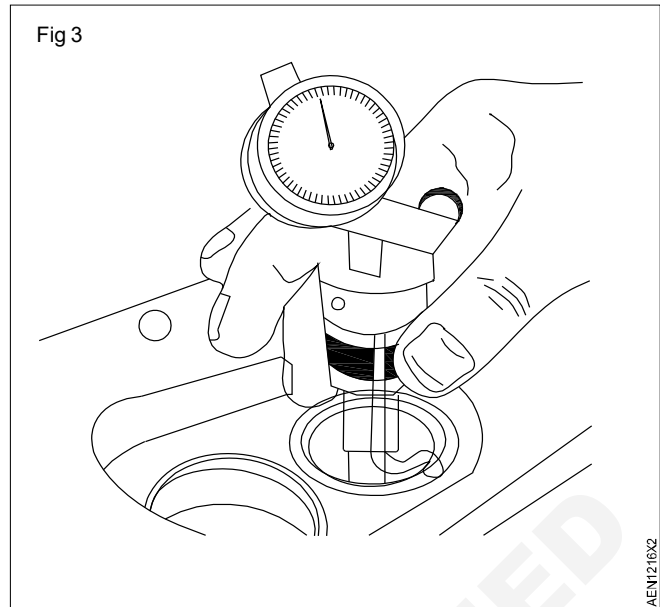
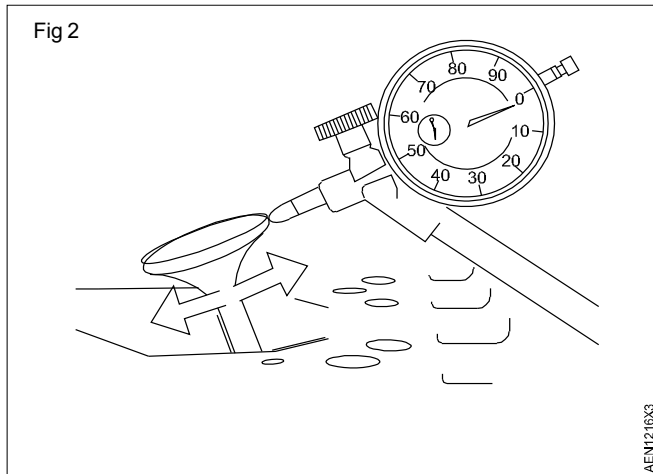
### TASK 13: Check the wear of valve guides

- 1 Place the dial indicator with a magnetic base on the face of the cylinder head (Fig 1).
- 2 Set the position of the needle of the dial indicator to zero (Fig 2).
- 3 Move the valve in a radial direction away from the dial indicator as far as possible (Fig 3).
- 4 Position the contact point of the dial indicator on the edge of the valve head (Fig 3).
- 5 Move the valve in a radial direction towards the dial indicator as far as possible (Fig 3).
- 6 Note the distance of movement on the dial indicator.



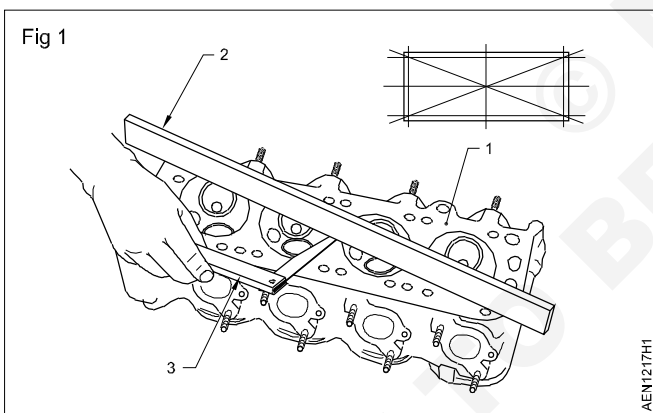
If the distance is greater than the maximum clearance of the valve in the valve guide, replace the valve guide. This is called service wear.

**Note:** All lubricant must be removed from the outside of the inlet and exhaust valve guides before the valve seal is installed. Do not cut valve seat before the valve guide is installed.



**TASK 14: Check the engine head flatness by straight edge and feeler gauge**

- 1 Clean the cylinder head surface to be checked. (Fig 1)



- 2 Place the cylinder head (1) on a plain surface, so that surface, to be checked, faces upward.

- 3 Keep the straight edge (2) on the surface of cylinder head and press the straight edge at the center with your left hand.
- 4 Insert the feeler gauge (3) leaves between the straight edge (2) and the surface.
- 5 Note down the thickness of the thickest leaf/leaves which can be inserted between the straight edge (2) and the surface. This thickness gives the maximum face out in that direction.
- 6 Repeat the above steps in 4 directions and note down the maximum face out in all the 4 directions.
- 7 Recommend for resurfacing/replacement of parts (1) if maximum face out in any one or more directions is more than the limit specified by the manufacturer.

**TASK 15: Check end gap of piston ring and piston to cylinder wall clearance with the feeler gauge (Fig 1)**

- 1 Clean the cylinder bore (1) thoroughly.
- 2 Insert the piston ring inside the cylinder bore squarely.
- 3 Use a bore piston to place the piston ring square in the liner/bore.
- 4 Insert feeler gauge and measure the piston ring end gap (4).
- 5 Remove the piston ring and Clean the cylinder bore.
- 6 Insert the piston without piston ring inside the cylinder bore. (Fig 1)

- 7 Insert long leaf feeler gauge between piston and cylinder wall.

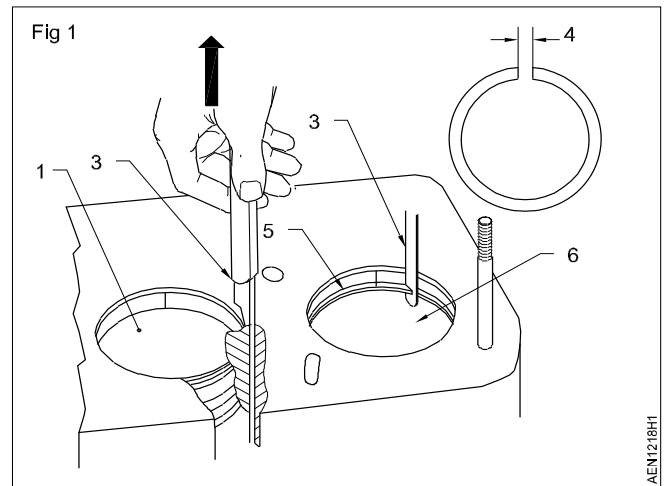
**If it is tight, reduce the thickness of feeler gauge leaf and verify with the bore piston.**

**If the piston moves very free in the bore, increase the feeler gauge leaf thickness.**

- 8 Calculate the thickness of feeler gauge, which allows movement of piston with a slight pressure.

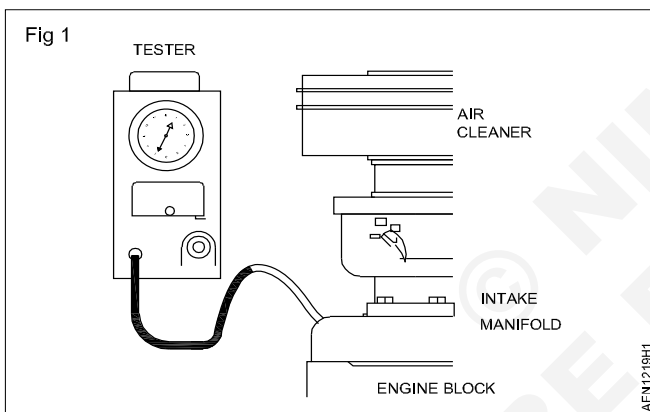
**This thickness is the piston to cylinder wall clearance match the same with the company specification.**

- 9 Remove the piston from the cylinder bore.



### TASK 16: Check the engine manifold vacuum

- 1 Warm up the given engine.
- 2 Connect the vacuum gauge to the intake manifold (disconnect vacuum booster) (Fig 1).
- 3 Read the vacuum gauge reading at idle speed, normal speed & high speed.

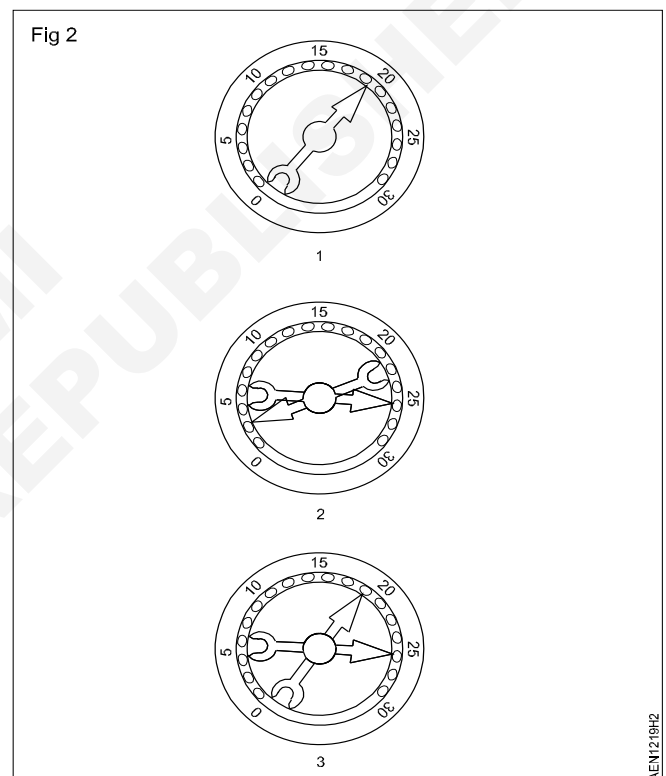


List the reading (measurement) one by one.

**Adjust the gauge damper until needle moves easily without excessive flutter.**

**Normal reading:** needle between 15 and 22 in holding steady. (Fig 2)

**Intake leak:** A low, steady reading can be caused by an air intake manifold or carburetor mounting flange gasket leak.



**Blown head gasket:** A regular drop of fair magnitude can be caused by a blown head gasket or warped head the block surface.

**Deduct 1 inch for each 1,000 feet of elevation.**

### TASK 17: Check tyre air pressure

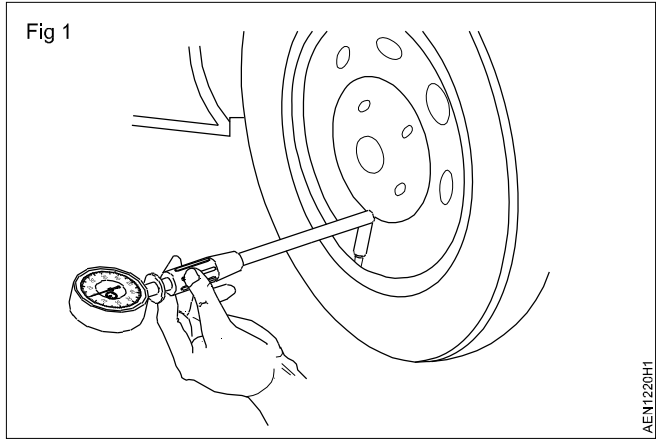
- 1 Remove valve cap / clean the valve externally.
- 2 Insert tyre pressure gauge & take the reading. (Fig 1)
- 3 Compare with the recommended pressure.
- 4 Check if tyre needs inflation or deflection.
- 5 If it is to be inflated, insert the air inflator & watch the tyre pressure reading in the gauge.

**Some equipment's than the facility to preset the air pressure. Once the preset pressure is achieved, it automatically trips.**

- 6 Check the air valve leaking.
- 7 If there is no leak, place the valve cap.

**Caution:**

- 1 Never check tyre pressure, when tyre is hot after a long run.**
- 2 Ensure there is sufficient air in Air tank and free from contamination like water, oil, dust etc.**



**Skill Sequence**

**Practice on measuring vernier caliper**

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

- practice the least count of vernier calipers
- state how graduations are made on vernier calipers with 0.02mm least count
- practice vernier caliper measurements.

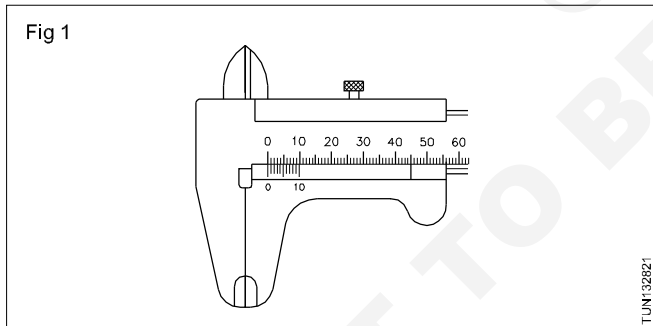
**Vernier calipers**

Vernier calipers are available with different accuracies. The selection of the vernier caliper depends on the accuracy needed and the size of the job to be measured.

This accuracy/least count is determined by the graduations of the main scale and vernier scale divisions.

**Determining least count of vernier calipers**

In the vernier caliper shown in Fig 1, the main scale divisions (9mm) are divided into 10 equal parts in the vernier scale.



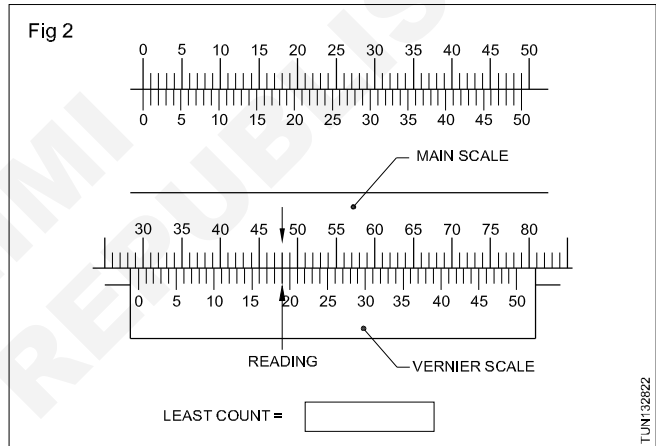
- i.e. One main scale division (MSD) = 1 mm
- One vernier scale division? (VSD) = 9/10 mm
- Least count is 1 mm - 9/10 mm = 1/10 mm
- The difference between one MSD and one VSD = 0.1 mm

**Example**

Calculate the least count of the vernier given in Fig 2.

**Reading vernier measurements**

Vernier calipers are available with different graduations and least counts. For reading measurements with a vernier caliper the least count should be determined first. (The least count of calipers is sometimes marked on the vernier slide).



The figure above shows the graduations of a common type of vernier caliper with a least count of 0.02 mm. In this, 50 divisions of the vernier scale occupy 49 divisions (49 mm) on the main scale.

- i.e One main scale division (MSD) = 1mm
- One Vernier scale division? (VSD) = 49/50 mm
- Least count = 1 MSD - 1 VSD
- = 1mm - 49/50
- = 50 - 49/50 = 1/50 = 0.02 mm

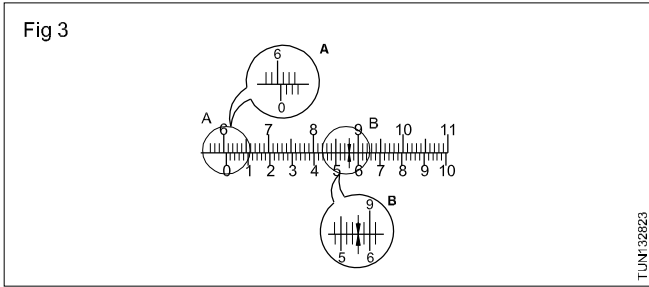
**Example for vernier caliper (Fig 3)**

Main scale reading 60 mm.

- The vernier division coinciding with the main scale is the 28th division. Value = 28 x 0.02
- = 0.56 mm
- Reading = 60+0.56 = 60.56mm

**workshop Exercise**

In figures 3, 4, 5, 6 and 7, 49 main scale divisions are divided into 50 equal parts on the vernier scale. Value of one M.S.D. is 1 mm.



- 1 Calculate the least count.
- 2 Record the reading of each, figure in the space provided.

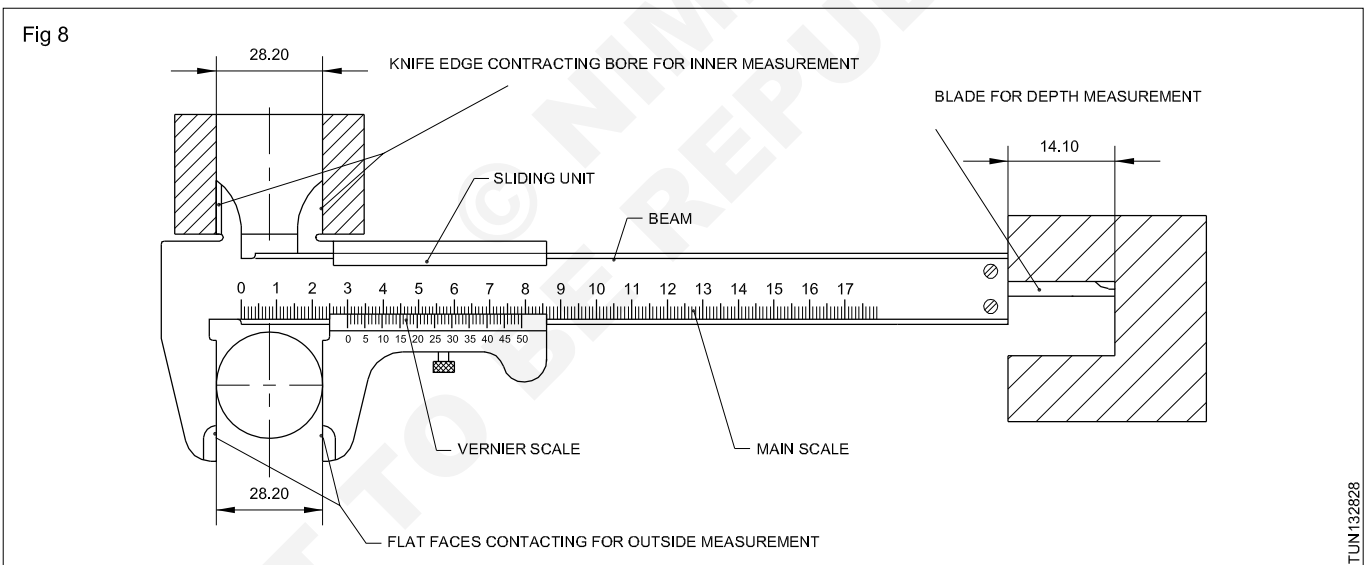
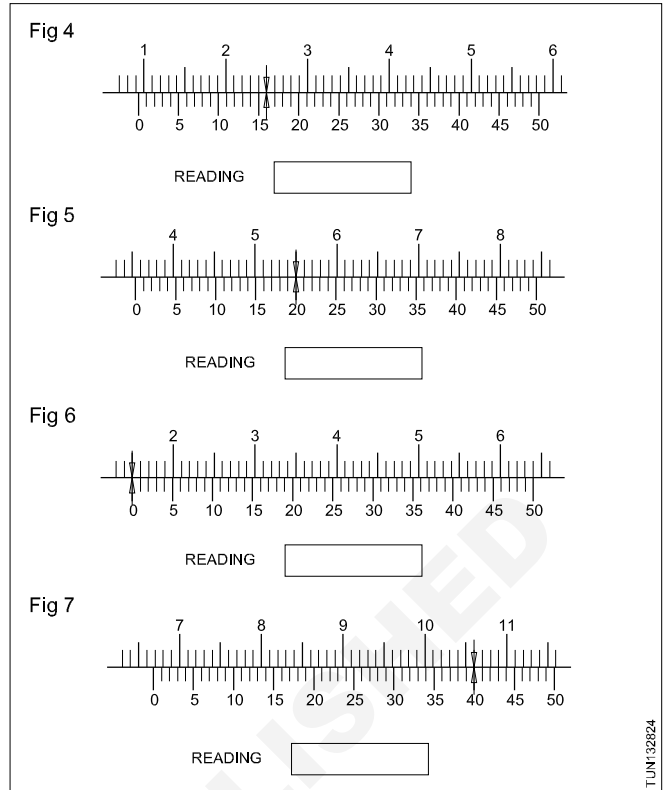
**To read a measurement**

Note the number of graduations on the main scale passed by the zero of the vernier. This gives the full mm.

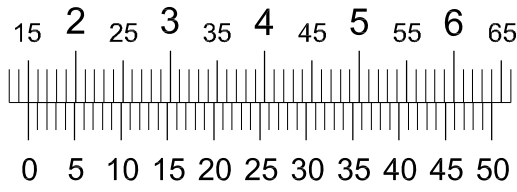
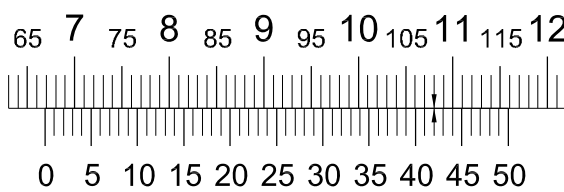

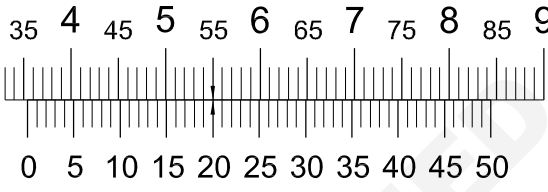
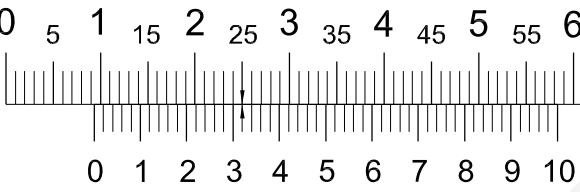
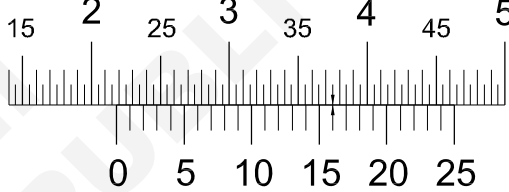
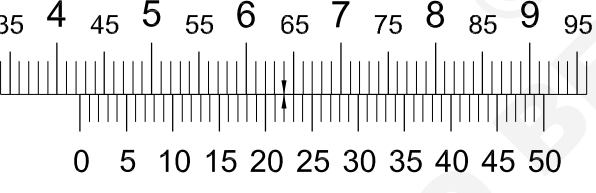
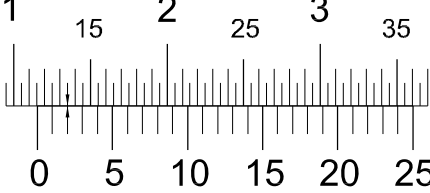
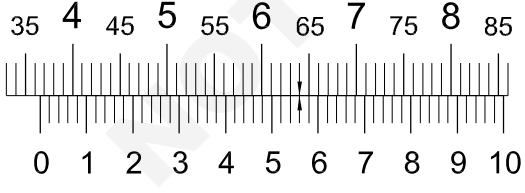
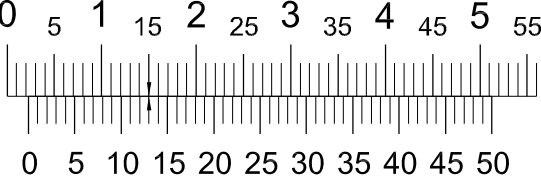
Note which of the vernier scale division coincides with any one line on the main scale.

Multiply this number with the least count.

Add the multiplied value to the main scale reading.



Metric vernier reading exercises

 <input type="text"/>	 <input type="text"/>
 <input type="text"/>	 <input type="text"/>
 <input type="text"/>	 <input type="text"/>
 <input type="text"/>	 <input type="text"/>
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**Practice to clean and check the fasteners**

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

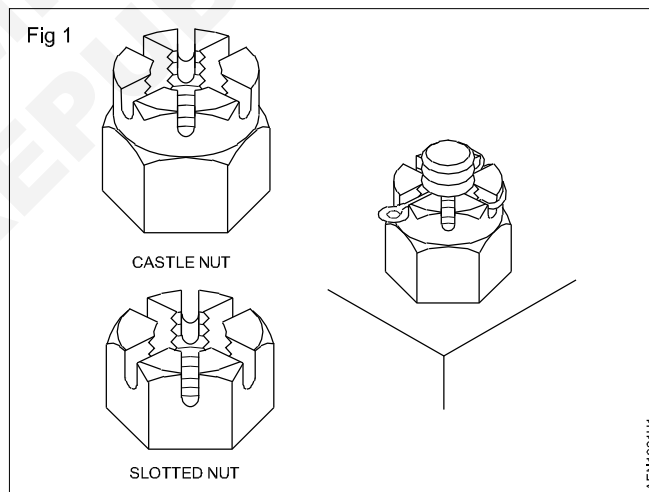
- fasten castle nut on axle shaft
- fasten self-locking nut on propeller shaft
- fasten hexagonal nut on two flat surfaces
- fasten hexagonal nut with collar on tappet cover.

Requirements			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Kerosene & Cotton waste	- as reqd.
• Spanner (DE & Ring)	- 1 set each	• Axle shaft and castle nuts	- as reqd.
• Nose plier, copper drift	- 1 set each	• Propeller shaft and self-locking nut & bolt	- as reqd.
<b>Equipment / Machines</b>		• Hexagonal nut with washers	- as reqd.
• Work bench & vice	- 1 No. each		

**PROCEDURE**

**TASK 1: Fasten castle nut**

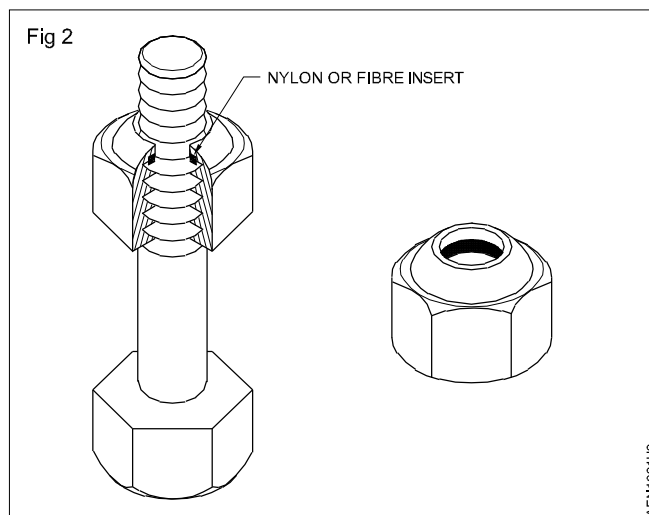
- 1 Clean the Axle Shaft threaded end.
- 2 Note down the thread size & type of thread.
- 3 Select the proper size of castle nut. (Fig 1)
- 4 Tighten the castle nut by hand, one or two threads only.
- 5 Select proper spanner for tightening the castle nut.
- 6 Tighten the castle nut.
- 7 Align the Axle Shaft hole and slot of the castle nut.
- 8 Insert a split pin through the Axle Shaft hole & slots of castle nut.
- 9 Spread the split ends of the split pin.



**TASK 2: Fasten self-locking nut**

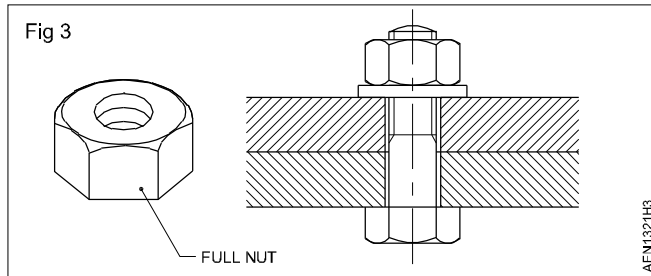
- 1 Clean the flange of the propeller shaft.
- 2 Select the proper size of nut & bolt to be fitted.
- 3 Insert the bolt into the slot of the flange.
- 4 Tighten the self-locking nut by hand one or two threads only. (Fig 2)
- 5 Select proper spanner for tightening the self-locking nut.
- 6 Tighten the self-locking nut.

**Do not overtight on the self-locking Nut**



### TASK 3: Fasten hexagonal nut

- 1 Select the two flat surface components to be fastened.
- 2 Select a proper size of hexagonal Nut & Bolt. (Fig 3)



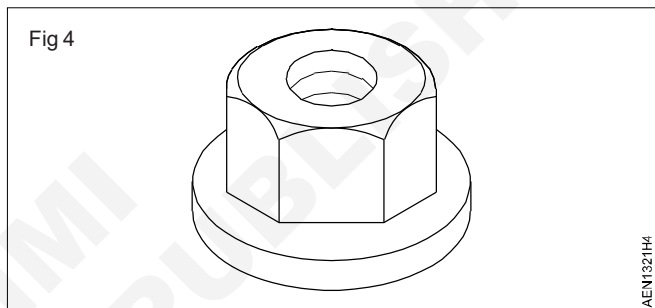
- 3 Insert the Bolt in the hole of matching components.
- 4 Place a flat washer at the threaded end.

- 5 Select the correct spanner to tighten the particular size of that nut.
- 6 Tighten the hexagonal nut.
- 7 Select a same size of hexagonal lock nut.
- 8 Tighten the lock nut by holding the earlier tighten nut with spanner.

**Correct size of ring spanner should be used.  
Nut & Spanner should be free of oil and dirt.**

### TASK 4: Fasten hexagonal nut with washer.

- 1 Clean the Bolts of Tappet cover.
- 2 Select proper size of hexagonal nut with caller. (Fig 4)
- 3 Tighten the hexagonal nut with collar by hand one or two threads only.
- 4 Select proper spanner for tightening the nut.
- 5 Tighten the nut with specified torque.



**Do not overtighten.**

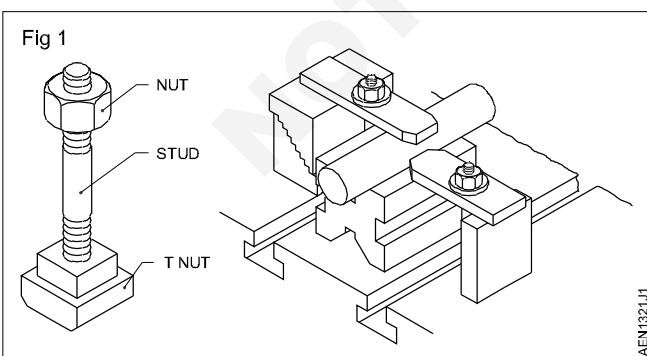
**Safety: Avoid using oversized spanner from slippage and getting hurt.**

## Skill sequence

### Fastening of stud

- Objectives:** This shall help you to
- measure the pitch of the thread
  - select the correct size of stud
  - fasten the given job with stud.

Select the components to be joined. (Fig 1)



Select the correct size of stud, according to the tapping on the component.

Insert the stud on the tap and turn, the stud use 2 nuts to lock the stud.

Tighten the stud with help of a proper spanner.

After tightening the stud lock the stud shank with the vice grip plier.

Use two spanners to remove the nuts from stud.

**Studs are used in assemblies which are to be separated frequently.**

**Safety precaution:**

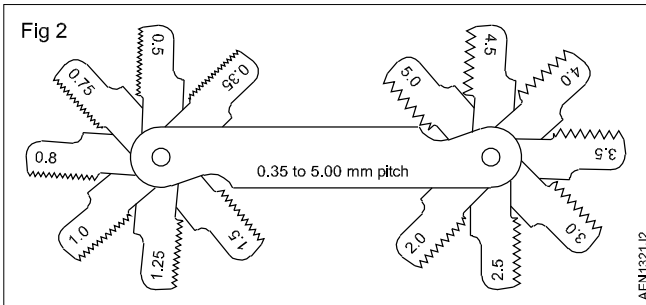
**Before inserting the stud. Taps holes & stud threads to be cleaned properly.**

Measure the thread with the thread Pitch Gauge (Fig 2)

Select the stud of internal thread to be measured.

Clean the surface of the thread.





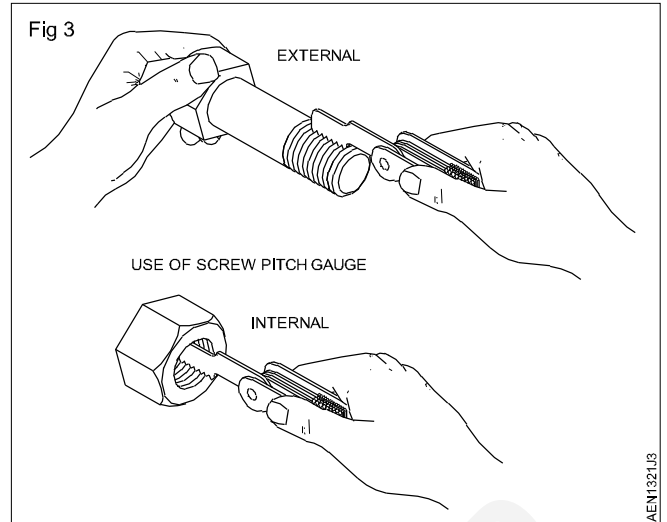
Select any one of the blade from the screw pitch gauge.

Place the blade on the thread to be measured. (Fig 3)

If the pitch matches with the thread, then the pitch of the thread will be the same as marked on the blade.

If not, select other blades and identify the blade perfectly matches with the thread.

The number marked on the blade which matches perfectly the same will be the pitch of the thread.



**For accurate results, the full length of the stud to be placed on the threads.**

**Practice to remove broken stud/bolt**

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

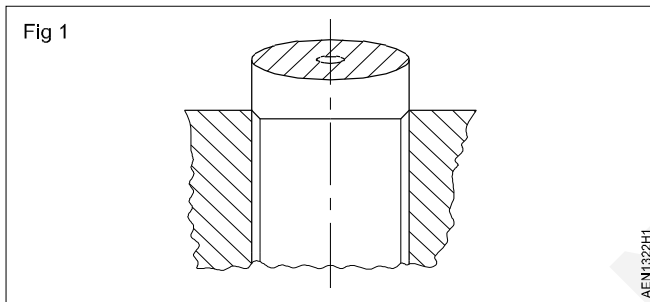
- remove the broken stud below the surface using the ezy-out (stud extractor).

Requirements			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Cylinder block with broken stud	- as reqd.
• Tapwrench	- 1 set	• Cotton waste	- as reqd.
• Stud extractor	- 1 set		

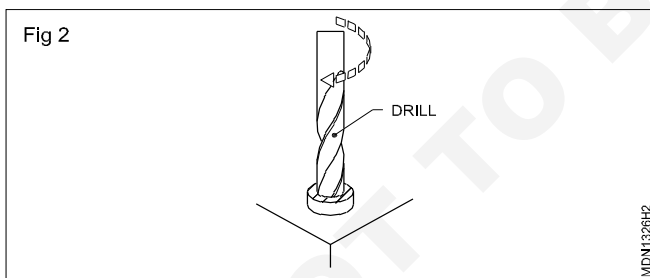
**PROCEDURE**

**Remove broken stud/ bolt**

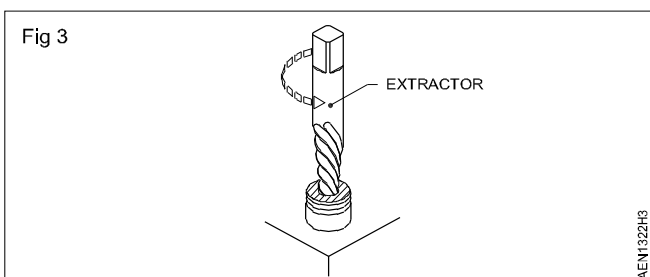
- 1 File flat on the top surface of the stud. (Fig 1)



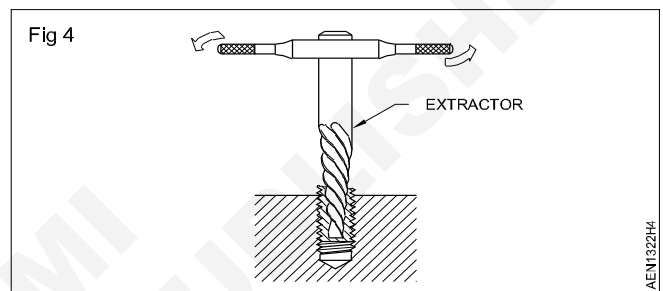
- 2 Locate the center and center punch it.
- 3 Select the ezy-out and the recommended drill size from Table 1.
- 4 Drill a hole on the center punch mark. (Fig 2)



- 5 Check the hole is perpendicular.
- 6 Set the ezy-out (stud extractor) on the drilled hole. (Fig 3)



- 7 Turn it anticlockwise by a tap wrench. (Fig 4)



**As the ezy-out penetrates into the stud, the grip increases and gradually the broken stud portion unscrews.**

- 8 Replace a new stud in position after lubricating the threads.
- 9 File two sides of the studs flat above the surface.
- 10 Use a wrench and unscrew to remove the broken stud out. (Fig 4)

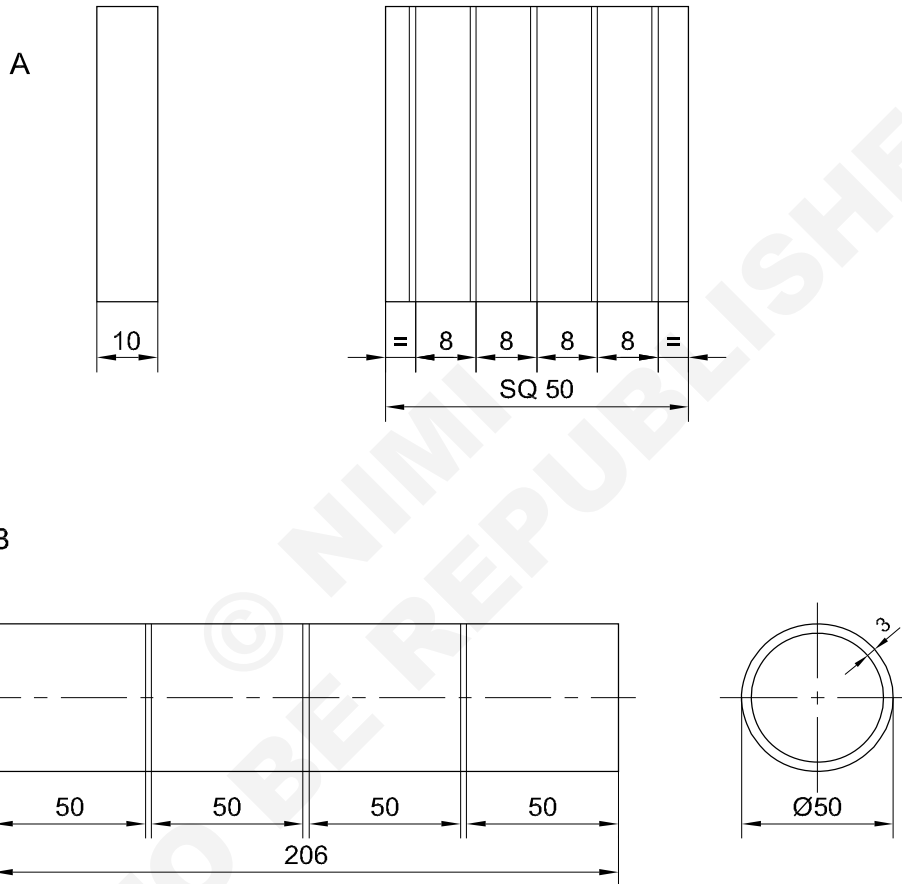
**Table 1**

Recommended drill and Ezy-out size for the extraction of broken stud and bolt.

Suitable for screw size	Drill size to be used	Ezy-out No. to be used
1/8" to 1/4" (3 to 6 mm)	5/64" (2 mm)	1
Over 1/4" to 5/16" (6 to 8 mm)	7/64" (2.8 mm)	2
Over 5/16" to 7/16" (8 to 11 mm)	5/32" (4 mm)	3
Over 7/16" to 9/16" (11 to 14 mm)	1/4" (6.3 mm)	4
Over 9/16" to 3/4" (14 to 19 mm)	17/64" (6.7mm)	5

**Practice to use various cutting tools**

- Objectives:** At the end of this exercise you shall be able to
- cut a mild steel flat along a straight line using a hack saw
  - flat filing practice along with flatness checking.

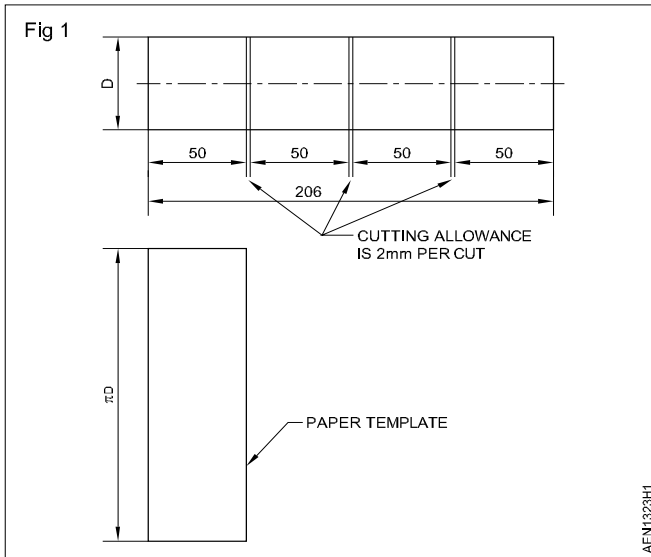


1	Ø50 x 3 - 206		Fe 310		B	
1	50 ISF 10 - 50		Fe 310		A	1.03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS		HACK SAWING			TOLERANCE ±0.5	TIME 5h
					CODE NO. AEN1323E1	

**Job Sequence**

**Marks lines as per drawing**

- Check the size of the given M.S flat Job. (Fig 1A)
- Apply copper sulphate solution and allow it to dry
- Layout lines as per drawing using a scribe taking measurement from the edge and punch mark the lines using a dot punch and hammer.
- Cut by hacksaw along the lines.



- Remove burrs, if any by filing.
- Mark lines as per drawing using a paper template and punch mark the line. (Fig 1B)

## Skill Sequence

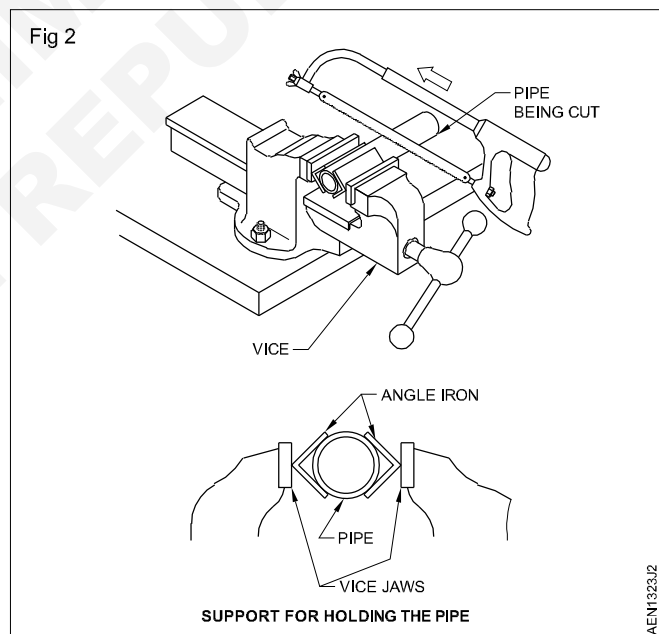
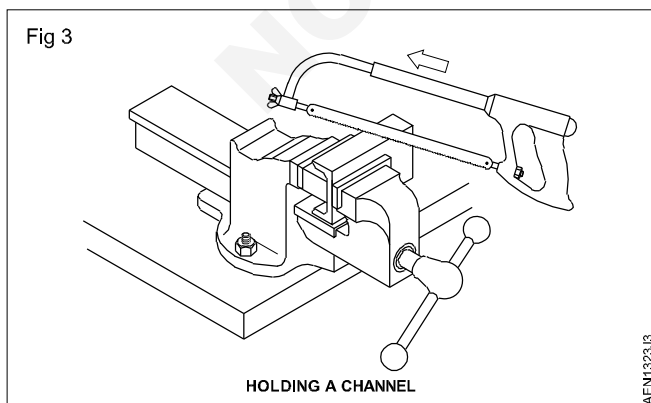
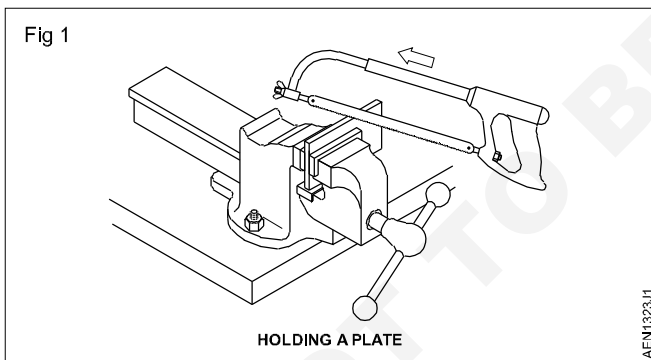
### Practice to hold the work piece

**Objectives:** This shall help you to

- holding the work piece
- fixing of hacksaw blades.

**Holding the work piece:** Position the metal to be cut according to the cross-section i.e a plate, a pipe or a channel for hacksawing.

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

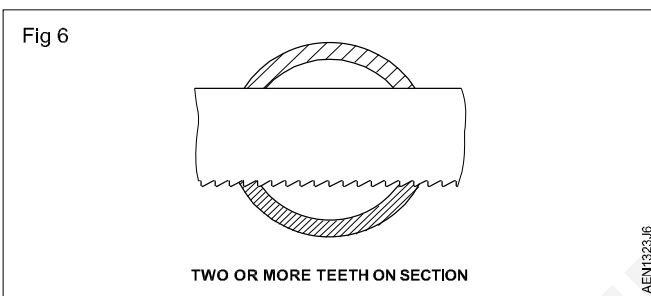
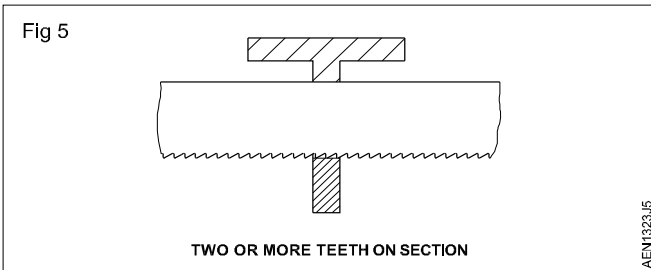
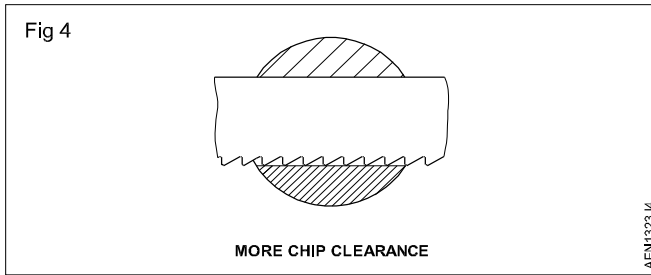


The selection of the blade depends on the shape and hardness of the material to be cut.

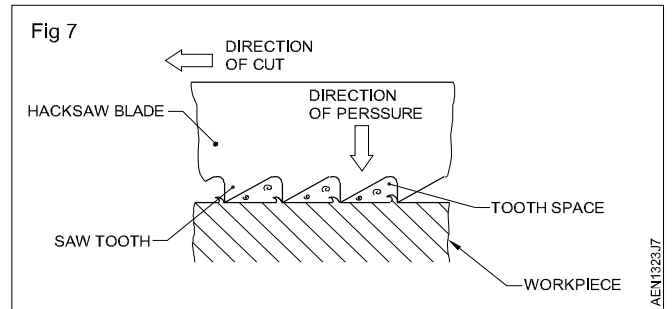
**Pitch selection:** For soft materials such as bronze, brass soft steel, cast iron etc. use a 1.8 mm pitch blade. (Fig 4)

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

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



**Fixing of Hacksaw Blades:** The teeth of the hacksaw blade should point in the direction of the cut and away from the handle. (Fig 7)



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

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

Notch means a small groove on the job surface.

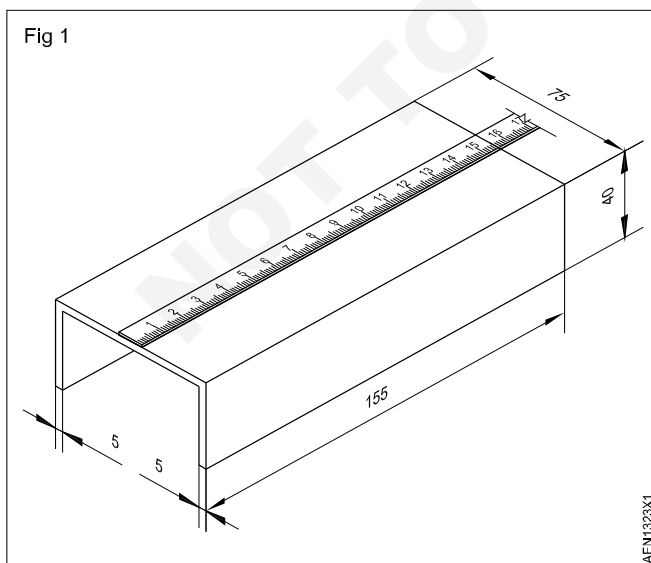
The cutting movement should be steady and the full length of the blade should be used.

## Practice to use file and hacksaw

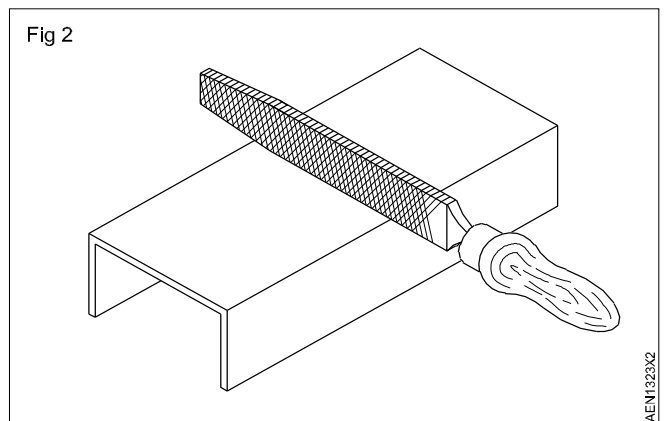
**Objectives:** This shall help you to

- file M.S channel
- cutting pipe by hacksaw.

Check the material size 155 x 75 x 40 mm equal angle MS channel. (Fig 1)

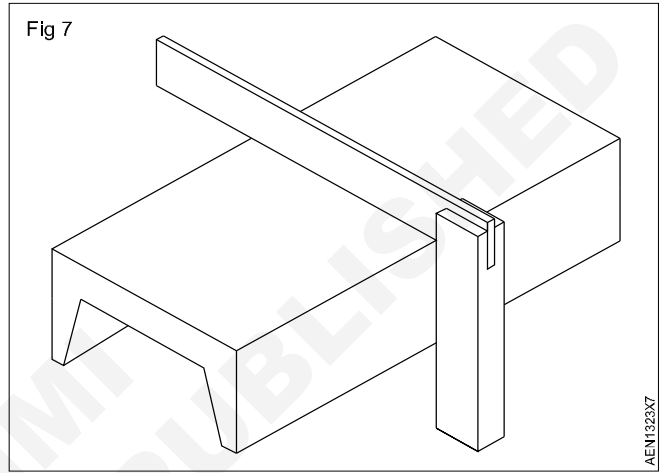
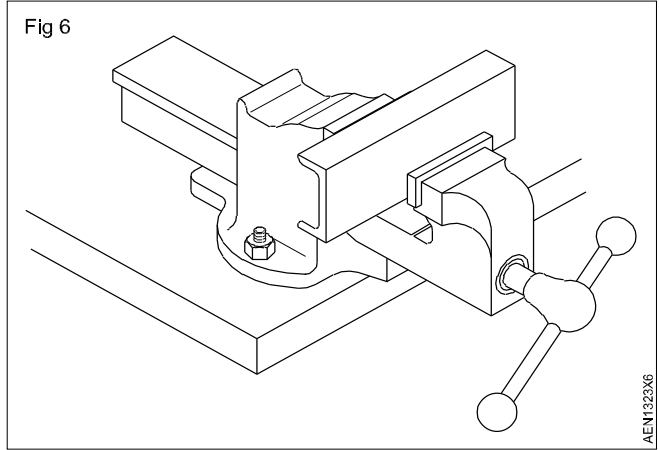
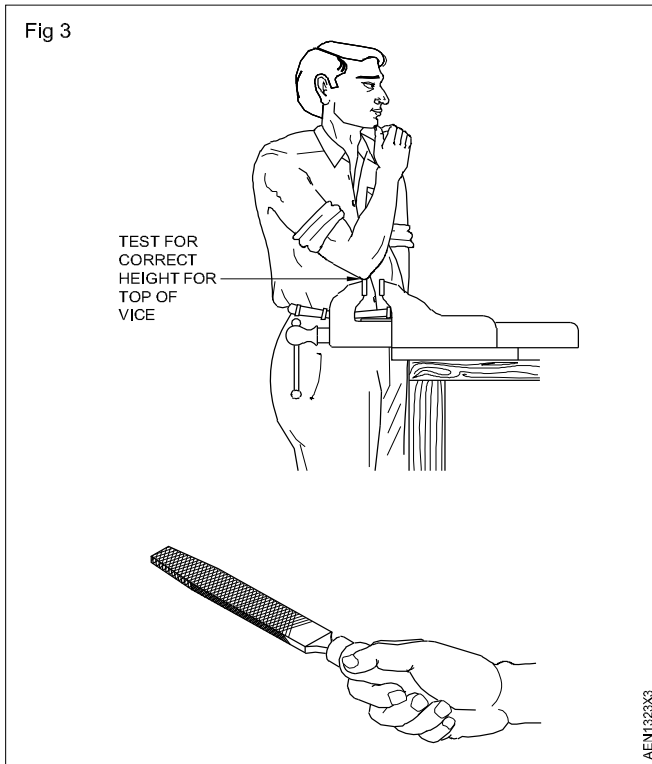


Remove all the rust from all the surfaces by the edge of file, clean by cotton waste. (Fig 2)

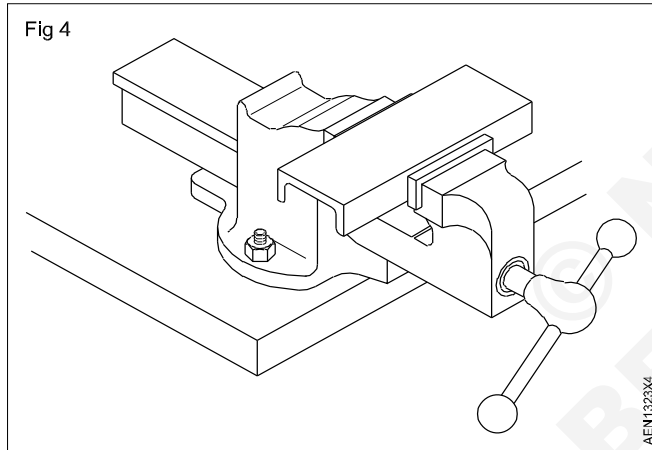


Hold the file handle with thumb will be placed firmly to grip the file, left leg will be in forward direction right leg will 300 mm from the front leg. Also check the height of your vice should be on the level of your elbow as in (Fig 3).

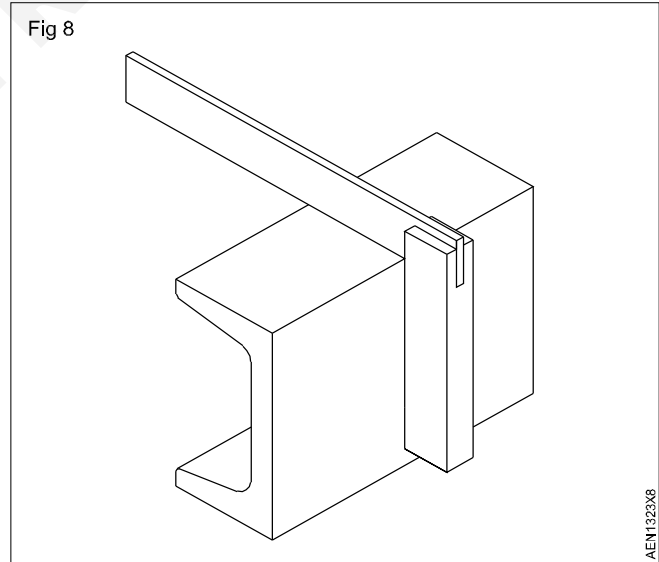
Hold the job in bench vice grip firmly from width of the channel. (Fig 4)



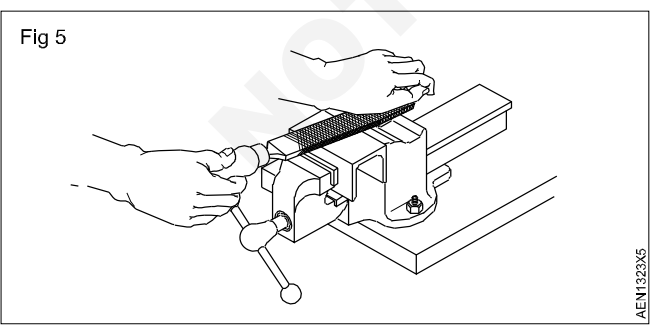
Open the job and start on (D) (Fig 6) side filing as directed previously. Check the squareness along with (A). (Fig 8)



Place file on the job and start filing while file will go in forward direction develop pressure on job, at return stroke release (Fig 5) the pressure and changes the place file and go for next area. (Fig 6) Like that complete operation and check flatness with the help of try square blade.

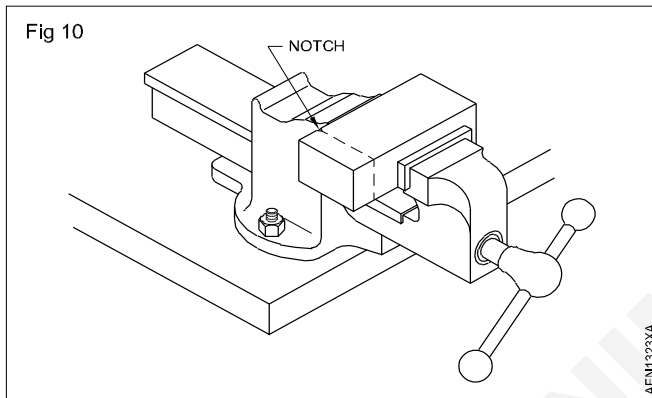
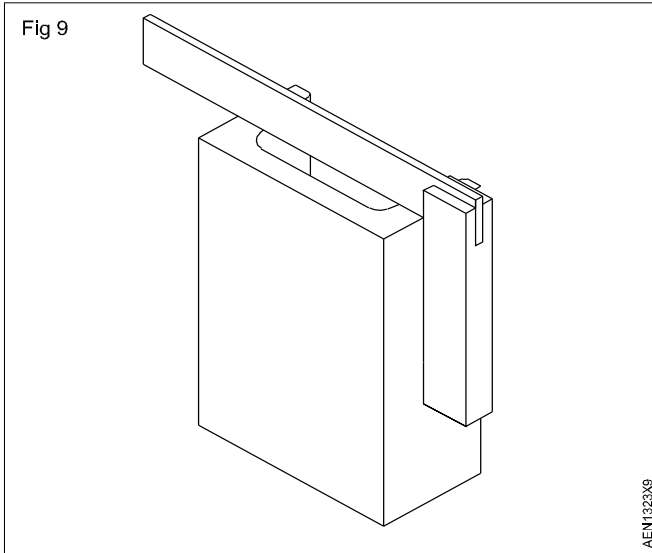


Open the job and start on (C) side filing as directed previously. Check the squareness along with (A,B&D). (Fig 9)



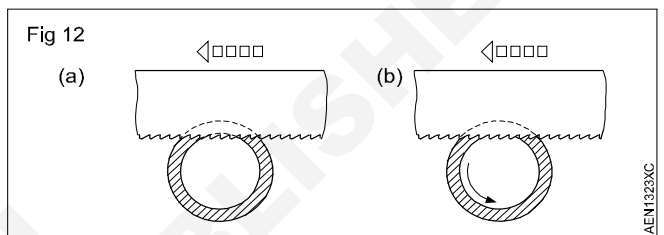
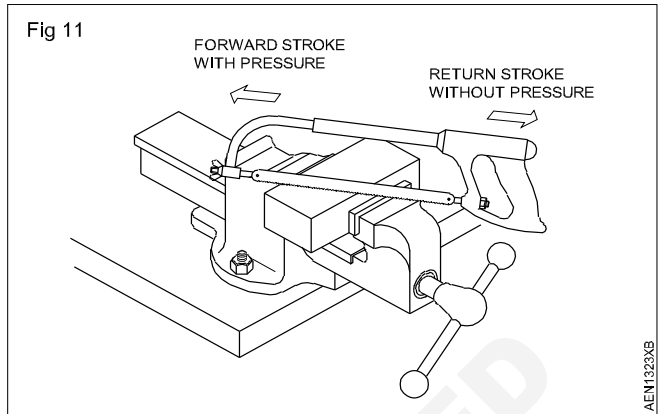
Open the job and start on (A) side filing as directed previously. Check the squareness along with (B). (Fig 7)

Open the job and start on (F) side filing as directed previously. Check the squareness along with (AB&D). (Fig 10)



0.8 or 1 mm pitch for thin work and for cutting pipes. (Fig 12a)

Turn and change the position of the pipe while hacksawing (Fig 12b)



Apply pressure only during the forward stroke. (Fig 11)

At least two to three teeth should be in contact with the work while cutting. Select fine pitch blade i.e

While cutting pipes by hacksawing a paper template is made and wrapped over the pipe to get the line of cut marked on the circumference of the pipe.

Normally, a coolant is not necessary while hacksawing.

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

## Practice to Cut M.S sheet by chisel

**Objectives:** This shall help you to

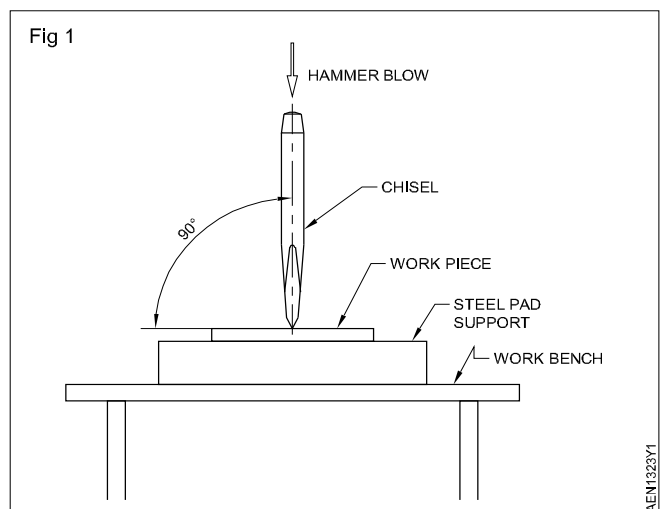
- cut the M.S sheet by chisel
- sharp the chisel
- sharpen the center punch
- check the center punch angle.

### Cutting M.S.sheet by chisel

A hard and strong support is essential under the sheet to ensure the chisel properly penetrates into the job and cuts the sheet. (Fig 1)

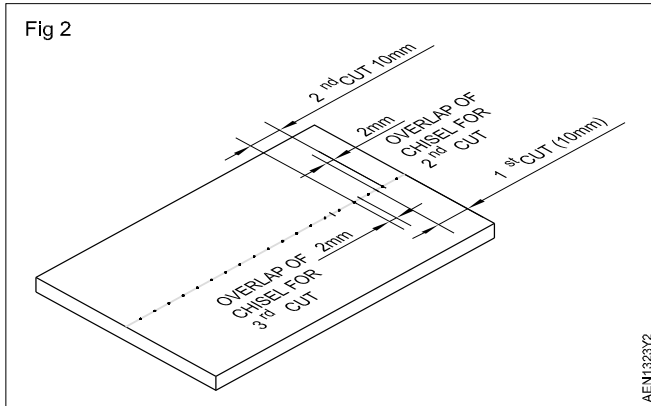
The chisel has to be held vertically to get an effective cutting action.

Sometimes the job is clamped to the work bench or to the steel pad by "C" clamps so that the job will not slip while chiseling. After making cut on the marked line, move the chisel approximately for 80% of the length of the first cut and again make a cut. This is done to ensure that the cutting action continues progressively along the marked line and no portion of metal will be left uncut. In addition, the cutting edge of the chisel can be positioned properly



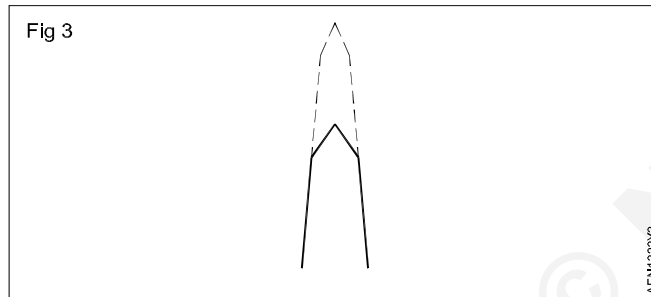
along the line of cut which will avoid a zig zag cutting. (Fig 2)

Proceed to make cuts by the flat chisel as explained above until the entire length (i.e 150mm) of the job is cut on the punch marked line.

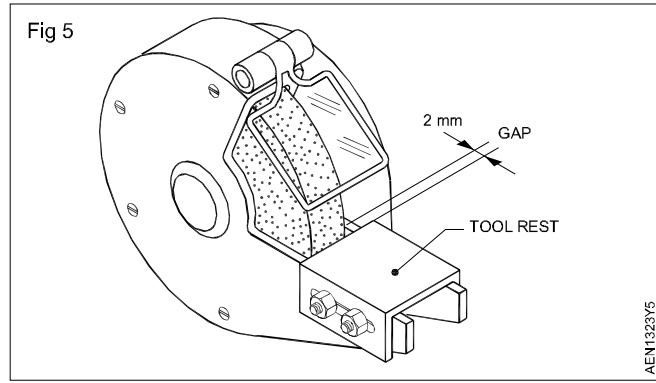
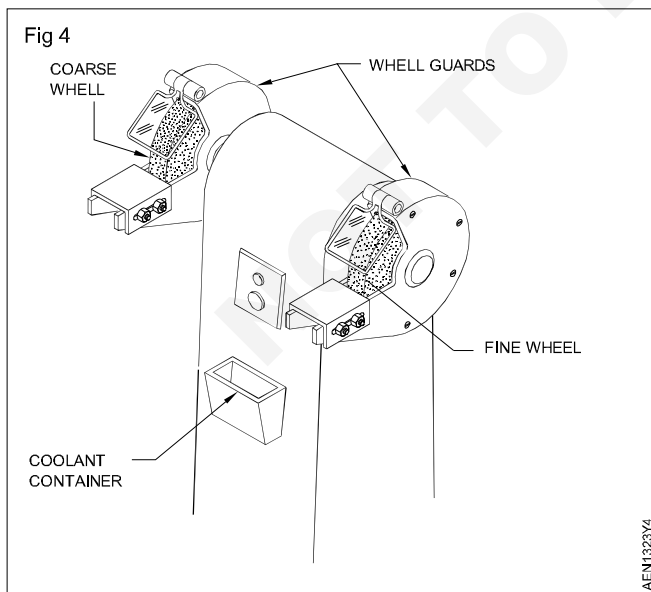


### Sharpening the chisel

Chisels will become blunt due to use. For efficiency in chipping, the chisels are to be re-sharpened regularly. (Fig 3)



Chisels are sharpened on grinding machines. (Fig 4) Inspect the tool-rest. If there is too much of a gap between the tool-rest and the wheel, adjust it, and position it as close to the wheel as possible. (Fig 5)

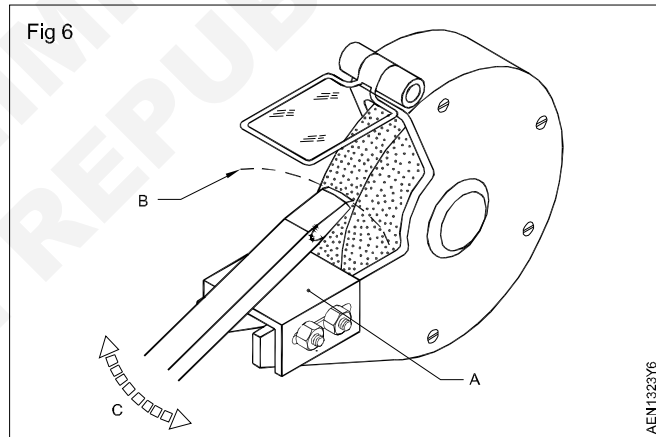


**Ensure that there is sufficient coolant in the container.**

**While grinding, rest the body of the chisel on the tool-rest (A), and allow the point to touch the wheel.**

Rock the point slightly on both sides in an arc (B) to provide a slight convexity at the cutting edge. This will help to avoid digging in of the sides while chipping.

Keep moving the chisel across the face (C) to prevent formation of curves and grooves at the cutting edge. (Fig 6)



**After re-grinding many times, the cutting edges become too thick. Such chisels are unsuitable for reshaping. They should be forged and brought to shape before grinding.**

**Check the wheel guards are in place, and are securely fastened.**

**Inspect the condition of the grinding wheel for breakage and cracks.**

**Wear safety goggles.**

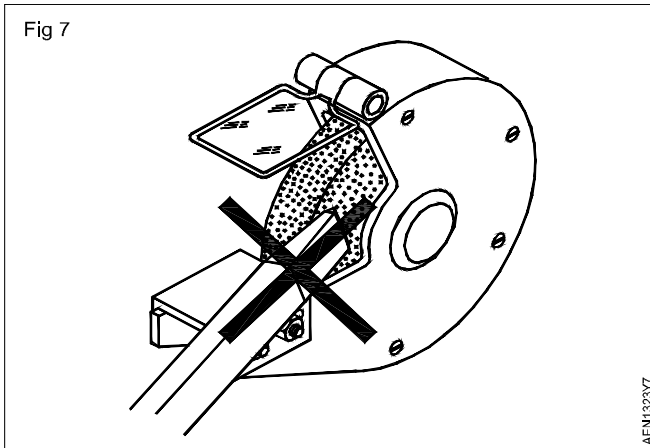


**When switching on the grinding machine, stand aside until the wheel reaches the operating speed.**

Dip the chisel frequently in the coolant to avoid overheating. Overheating will draw the temper of the chisel.

Clean by grinding, If the chisel-head is mushroomed.

Use only the front of the grinding wheel. Do not grind on the sides. (Fig 7)

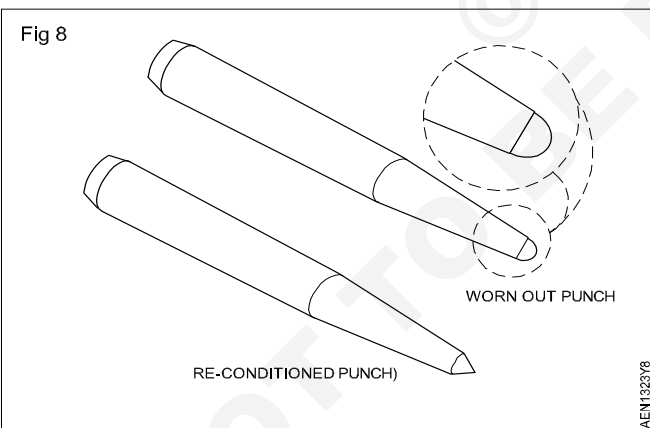


Report to instructor, if any damage to the grinding wheel is noticed.

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

### Sharpen the center punch

Arrange workplace & prepare working material. (Fig 8)



Saw the round material to length (only if a original tool is not available).

Face grind on one face:

Press the work piece in vertical direction against the wheel and turn it slowly around its axis.

Grind 4 mm chamfer on face (Horizontal or Vertical Position)

Press workpiece against the wheel with a setting angle or  $45^\circ$ , in doing so, turn it speedily and uniformly around its axis.

Grind on a 50 mm long taper proceeding from the other face horizontal position:

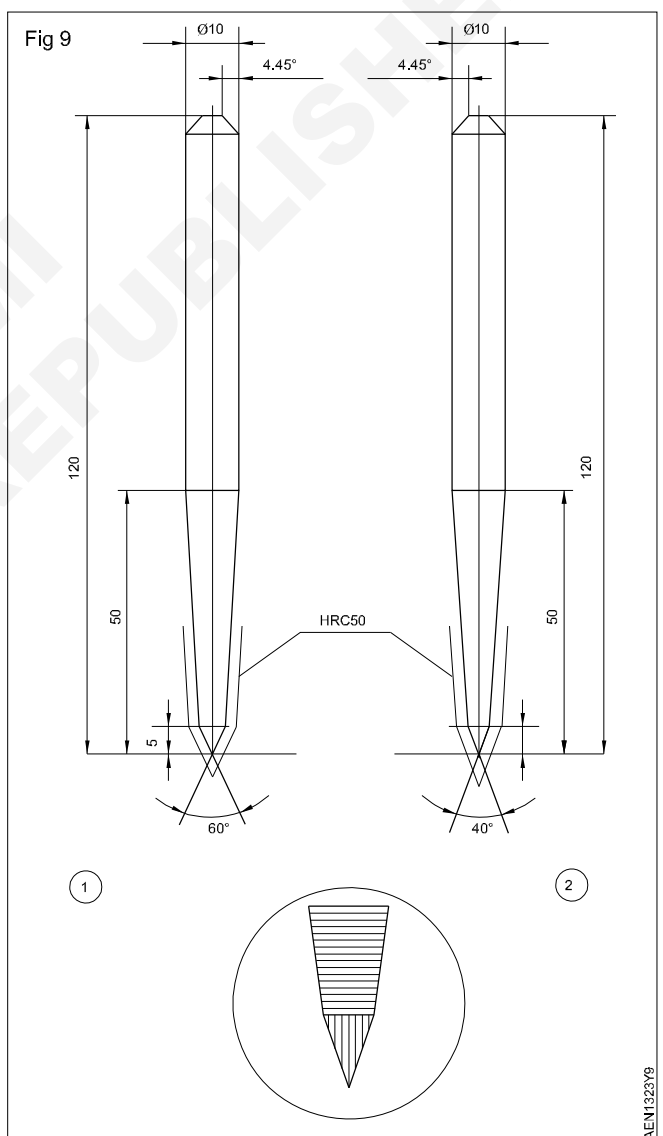
The right hand guides the workpiece, the left fore finger lies between the workpiece and the grinding support - press workpiece in horizontal direction against the wheel, turn it speed as well as turn it forward and back.

Grind the point - vertical position (Fig 9)

- i Centre punch  $60^\circ$
- ii Scribing / Prick punch  $40^\circ$

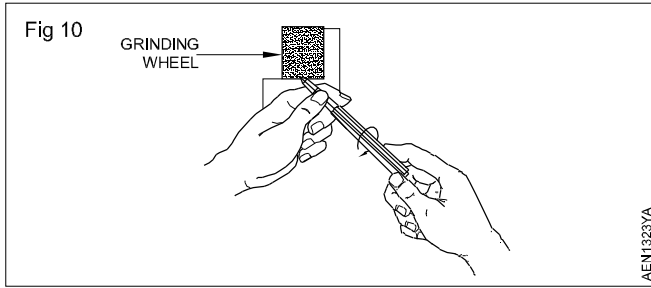
Press against the wheel only slightly with quick turning or it around its axis.

Check it finally for angle accuracy (as per drawing).



### Check the center punch angle

Sharpen a center punch hold the end of the punch between the index finger and thumb or one hand as shown in Fig 10, resting that hand on the tool rest or the grinder.



Move the punch into light contact with the rotating wheel or the grinder with the center line of the punch forming about a  $45^\circ$  angle with the face of the wheel. This will give the approximate  $90^\circ$  included angle required for a center punch.

Rotate the punch as shown by the direction arrow in Fig 10 with the thumb & index finger or the other hand.

Keep the point cool by using only light pressure on the wheel and by frequently dipping the punch in a can of cooling water.

Sharpening a prick punch in the same way only with the exception that the included angle should be  $30^\circ$  other than  $90^\circ$ , the angle between the center of this punch and the wheel should be about  $15^\circ$ .

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**Practice to use hacksaw and file to given dimensions**

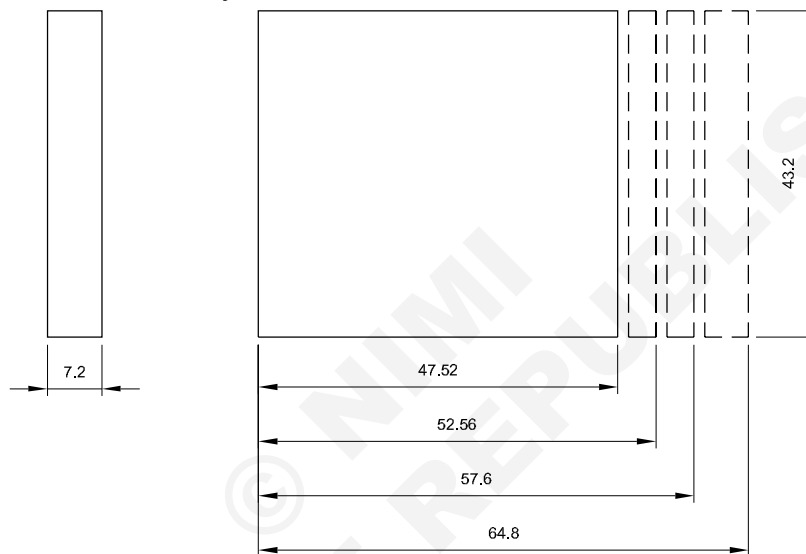
**Objectives:** At the end of this exercise you shall be able to

- mark straight lines using a scribing block
- cut on marked lines using a hacksaw blade.

**Job Sequence**

**Hacksawing and filing on raw material**

- Draw the markings to given diameter of the job.
- Study the job drawing dimensions
- Select the raw material for the job
- Mark dimensions on the selected raw material
- Make a punch mark on the marked dimensions line.



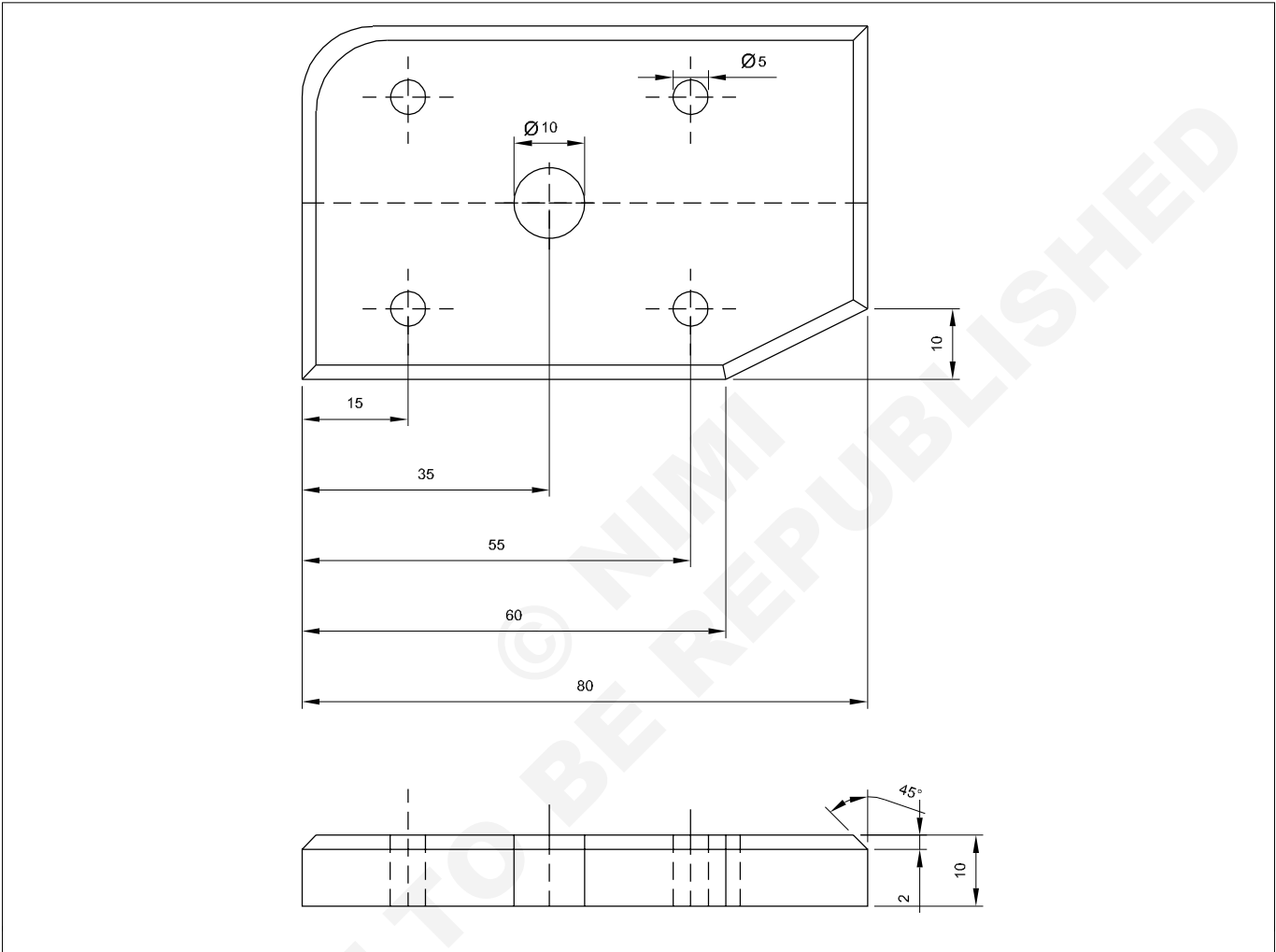
- Fix the raw material on the work bench vice
- Select the hacksaw blade and hacksaw frame
- Fix the hacksaw blade on frame at right direction
- Take suitable position for cut the raw material piece
- Cut the raw material and remove the work piece
- Fix the work piece on the vice and file it to remove the excess metal
- File with suitable flat file in both side of work piece for its correct dimensions
- Ensure the work piece shape and diameter is as per given drawing.

1		From exercise 2	Fe 310			
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO1.3.24
SCALE NTS		HACK SAWING			TOLERANCE $\pm 0.5$	TIME 5h
					CODE NO. AEN1324E1	

**Practice to mark and drill to given dimensions**

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

- file surfaces flat within + 0.5 mm
- file angular surfaces
- chamfer edges by filing
- drill through holes.



1	65ISF 12x85		Fe 310			
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	
SCALE NTS	DRILLING AND FILING RADIUS				DEVIATIONS ±0.1	
					CODE NO. AEN1325E1	

**Job sequence**

**Mark and drill to given dimensions**

- Check the raw material for its size.
- File flat the top face first.
- File the two adjacent sides flat and square to each other as well as with top surface.
- Mark the dimension as per the drawing file and finish the block.

- Mark horizontal, vertical angular curved lines as per the drawing using scribe block and dividers.
- Fix the M.S. plate in a vice.
- File the radius and angle.
- Locate the centers for holes to be drilled.
- Drill  $\phi$  5mm and  $\phi$  10mm through holes as per drawing.
- Remove the burrs from drill holes
- File with knife edge file to finish the surface.

## Skill sequence

### Drill through hole

**Objective:** This shall help you to

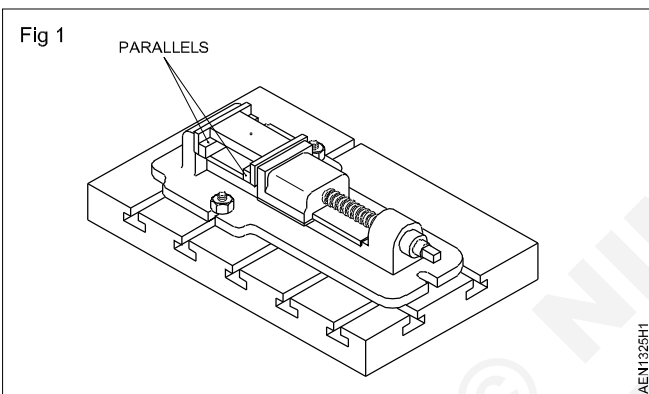
- drill through hole to the required size.

#### Method of Drilling

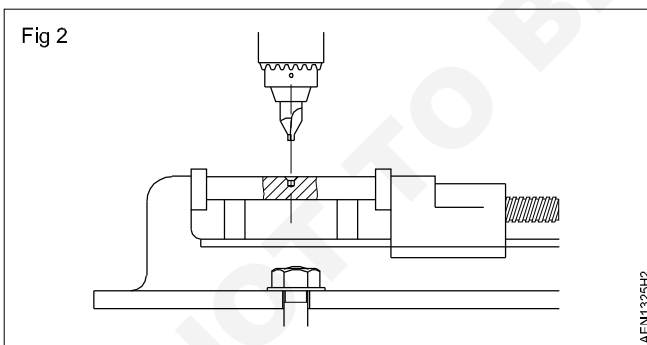
Check the given raw material for its size.

Mark and locate the centers for the hole to be drilled.

Mount the job in the machine vice on the parallel and clamp it securely to the drill-press-table. (Fig 1)



Set the work table (Fig 2) in such a manner that a drill can be fixed and removed without disturbing the vice or the job.



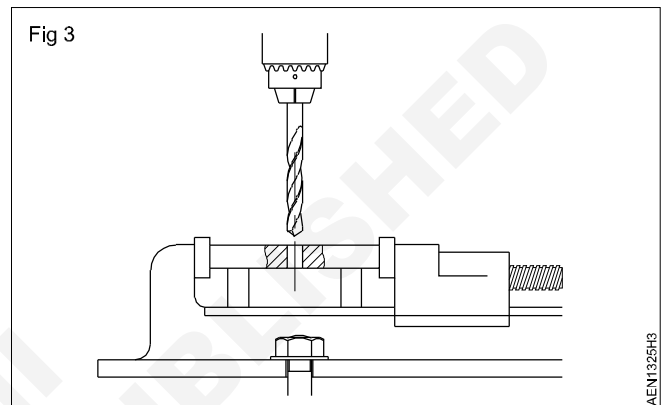
Fix the center drill on the drilling machine spindle and align with the centre mark on the job.

Spot the hole location with a center drill.

Remove the center drill and fix 8 mm drill for pilot hole.

Start the drilling machine.

Feed the drill and drill through hole. (Fig 3)



Set the spindle speed of the drilling machine to the nearest calculating r.p.m.

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

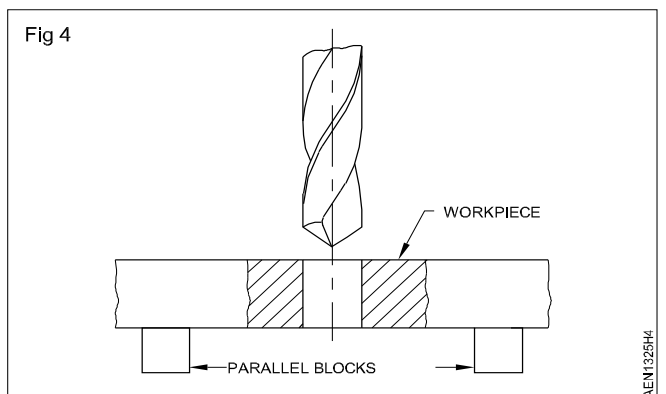
Remove drill from the machine without disturbing the set up.

Fix 14.5 mm drill and drill through hole.

**While drilling use cutting fluid.**

Release the drill frequently from the hole for the chips to be flushed out by the cutting fluid.

Remove the drill and job from the machine. (Fig 4)



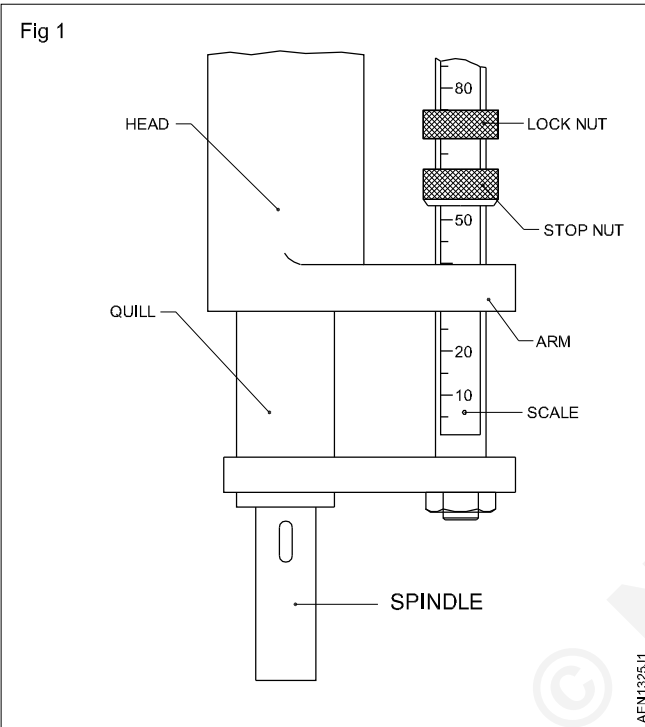
# Drill blind holes

**Objective:** This shall help you to

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

## Method of controlling depth of blind holes

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



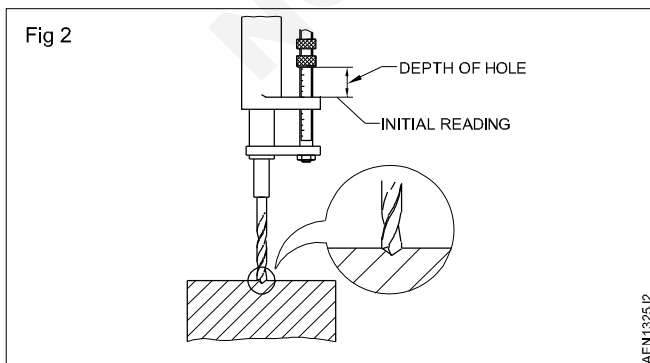
Most depth stop arrangements will have graduations by which the advancement of the spindle can be observed.

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

## Setting for drilling blind holes

For blind hole-depth setting, first the work is held on the machine and the hole is located correctly.

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



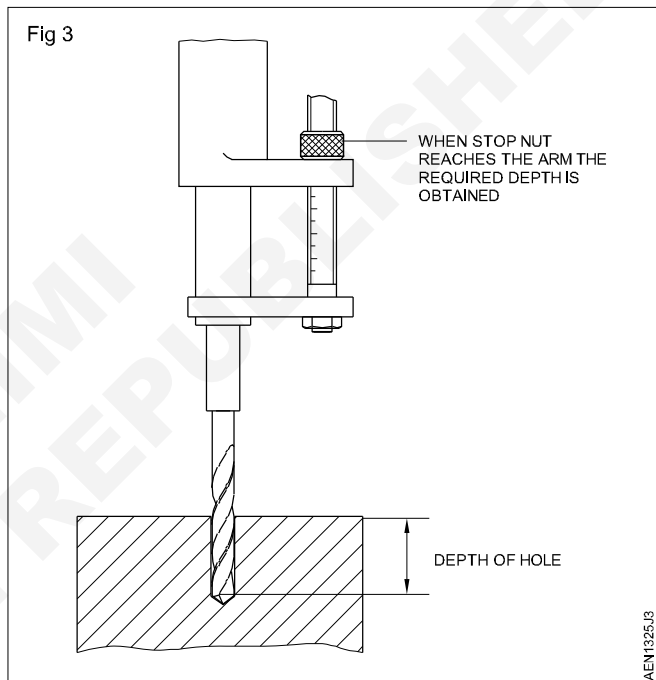
Add the initial reading to the depth of the blind hole to be drilled.

Initial Reading + Depth of Hole = Setting

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

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

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



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

**Do not drill on a light component without clamping. If not clamped, the job will rotate along with drill.**

# Re-sharpen a twist drill

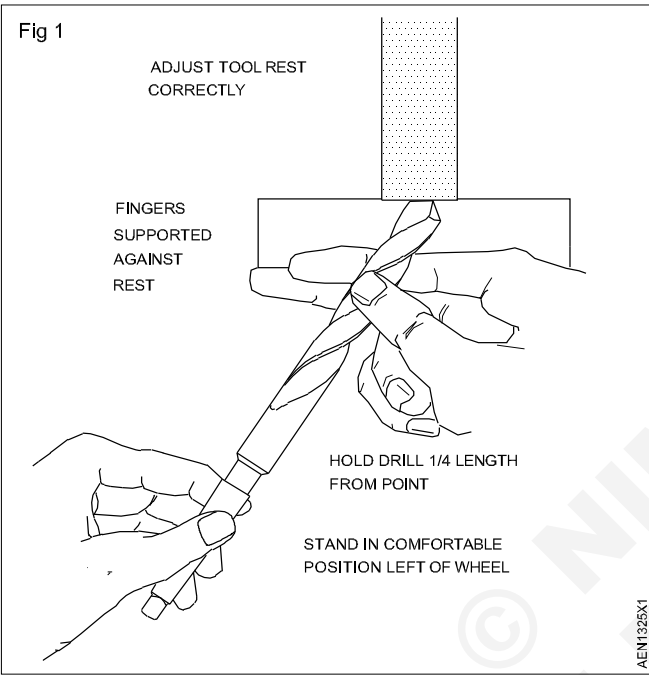
**Objectives:** This shall help you to

- re-sharpen a twist drill
- test the drill that has been re-sharpened by drilling a through hole.

A twist drill can be successfully sharpened on a bench or pedestal grinder by adopting the following procedure.

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

**Ensure that the tool-rests are adjusted correctly and tightened. (Fig 1)**

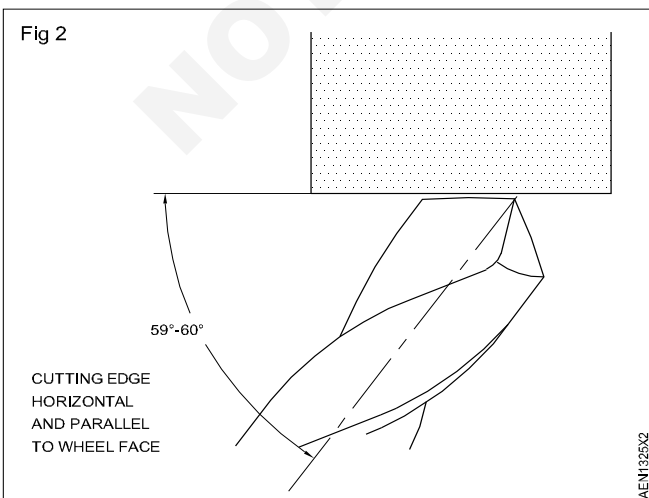


Wear safety goggles.

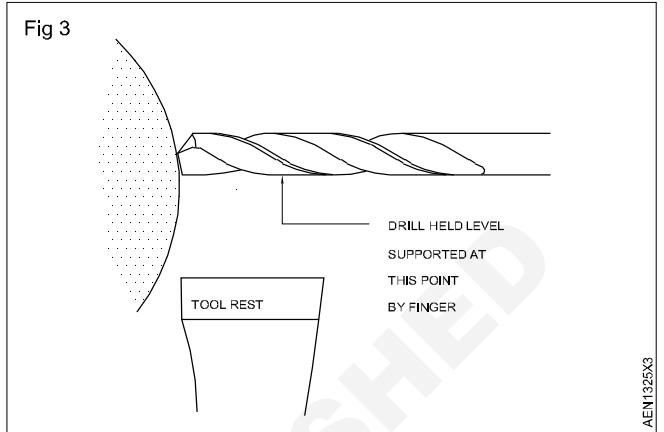
Stand in a comfortable position in front of the machine. Hold the drill at about one quarter of its length from the point, between the thumb and the first finger of the right hand.

Keep both elbows against the side.

Position yourself in such a way that the drill makes an angle of 59° to 60° to the wheel face. (Fig 2)

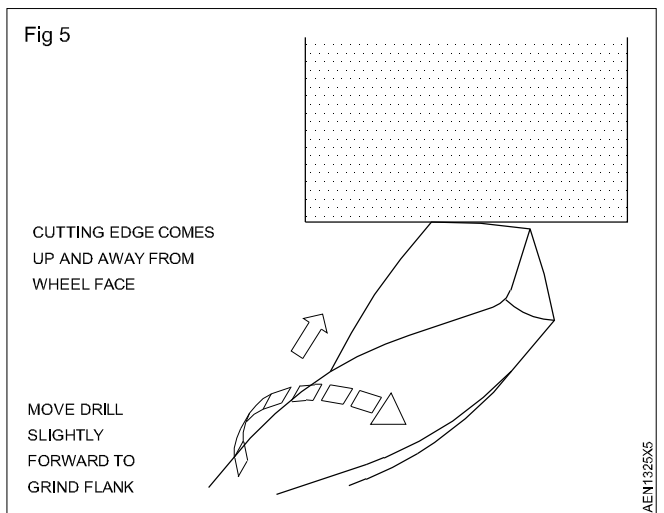
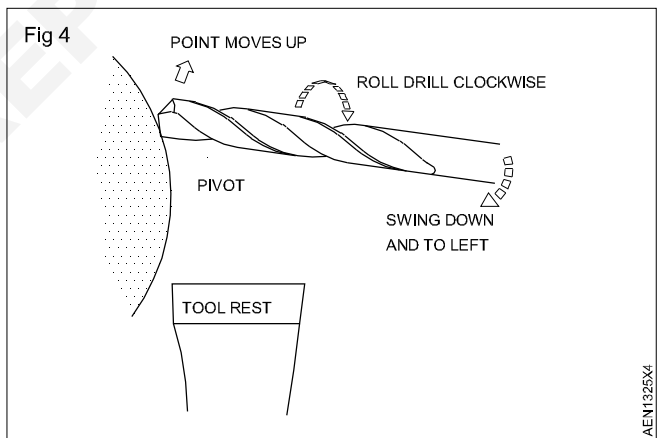


Hold the drill level. Twist it until one cutting edge is horizontal and parallel to the wheel face. (Fig 3)



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

Watch the cutting edge against the wheel. Note that, as the shank swings down, the cutting edge comes slightly upwards and away from the wheel face. (Fig 4 & Fig 5)



**Supply a slight forward motion to your hands.**

This will bring the flank of the point against the wheel to produce a lip clearance.

Coordinate the three movements of swinging down, twisting clockwise and forward movement. These movements should not be heavy movements. If they are performed correctly, they will produce a cutting edge that has the correct lip clearance and cutting angle.

Practice these movements against a stationary wheel, using a new or correctly sharpened drill.

Notice how only a small movement is required to produce the required clearance.

Also not that, if the drill is twisted too far, the other cutting edge will swing down to contact the wheel face.

Proceed now to sharpen one edge, removing as little metal as possible.

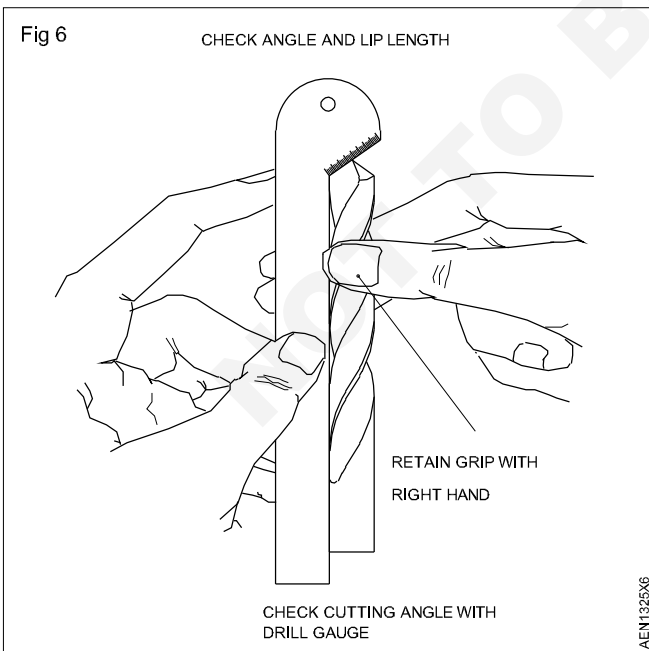
**Procedure to obtain equal angles**

Move the drill back, clear of the wheel face.

Turn the drill over without moving the position. This presents the second edge to the wheel face at the same angle as the first cutting edge.

Proceed to sharpen the second cutting edge, using the same amount of drill movement as before. When these actions are carried out carefully, the drill will be sharpened with equal cutting angles. The lip clearance will be correct and equal.

Use a drill angle gauge to check that the cutting angle is correct (118° for mild steel), the cutting edges are of equal length and the lip clearances are equal and correct (about 12°). (Fig 6)



Lift the drill off the wheel face. Retain the grip on the drill with the right hand.

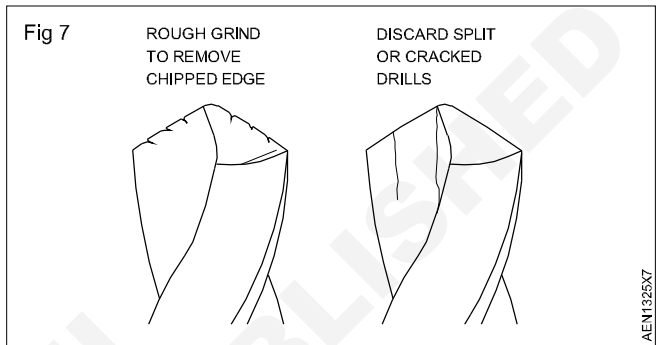
Make such inspection or checks as are necessary. Move the right hand back on the tool-rest in the same position as before.

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

**Points to be considered when sharpening drills**

Grind as little as possible from the drill. Remove only enough to sharpen the cutting edges.

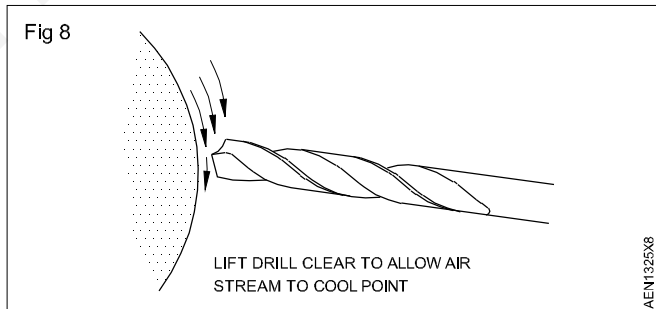
Rough down the drill point with a coarse grit wheel when the edges are badly chipped. (Fig 7)



**Never re-sharpen a cracked or split drill.**

**Avoid overheating the drill.**

Apply light pressure against the wheel face. Lift the edge clear of the wheel face frequently. This allows the air stream produced by the wheel to cool the drill point. (Fig 8)



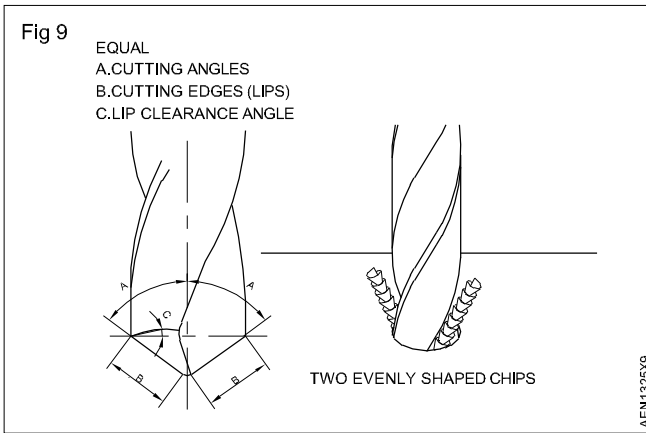
**Cooling a drill rapidly by quenching in cold water may cause cracking of the cutting edge.**

Re-sharpening of very small drills required great skill. They require proportionally less movement to produce the cutting angles.

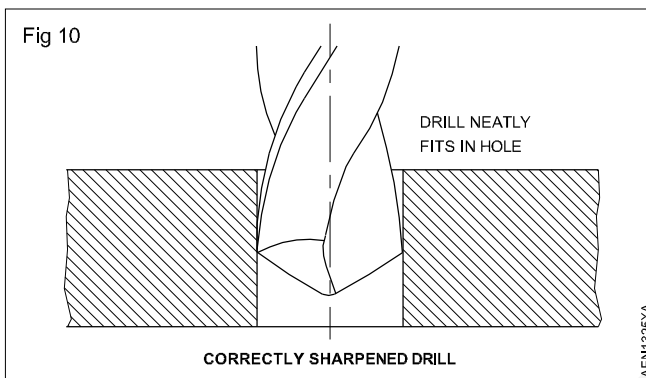
Set the spindle revolution of the drilling machine to give a cutting speed of 25 to 30 meters per minute. A drill that has been re-sharpened correctly will: (Fig 9)

Produce two evenly curled chips from its cutting edges. Require only moderate pressure to feed it into the work.





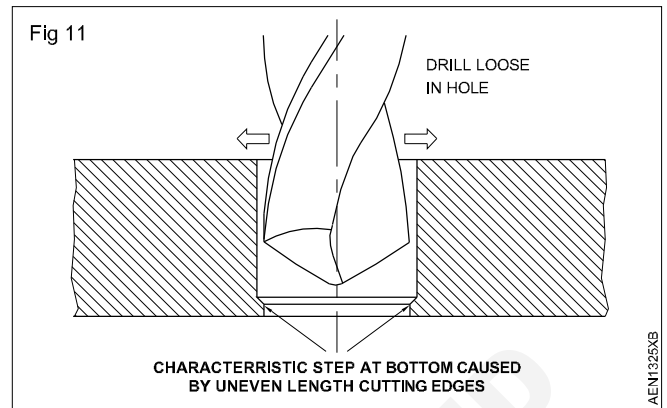
If the drill fits without any play it means that (Fig 10)



The cutting edges and angles are equal

The drill has produced a hole of the correct size.

Any looseness of the drill in the hole means: (Fig 11)



The cutting edges are of uneven length

The drill has produced an oversized hole.

A drill that has been ground with uneven or too great a clearance will tend to chatter during starting procedure an out - of round hole.

## Safety precautions while using drilling machine

**Objectives:** This shall help you to

- follow personal safety
- follow drilling machine safety
- follow job safety
- follow drill bit safety.

Wear a dress suitable for work

Ensure that the spindle head and table is locked properly.

The work piece and the drill should be rigidly held.

Switch off power when not in use.

Clean and oil the machine after use.

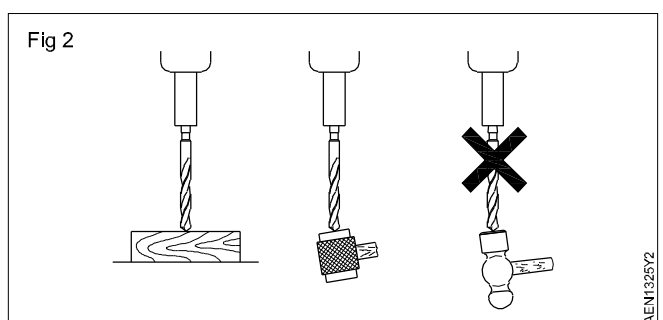
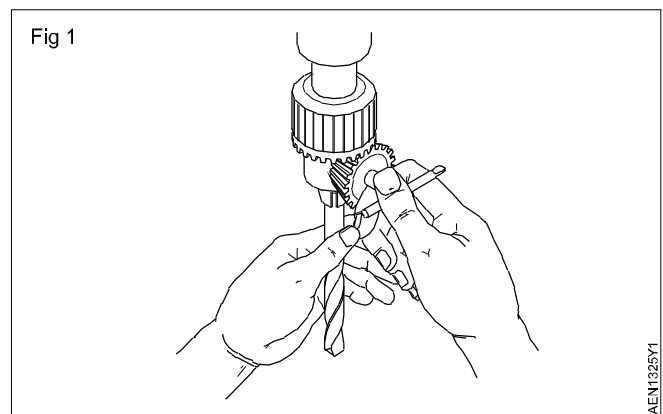
Use a brush to clean the chips and swarf.

Select proper cutting speed according to material.

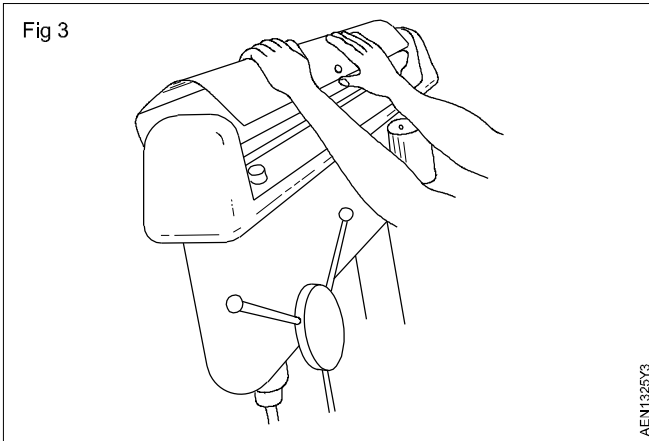
Select proper cutting fluid according to material.

Remove the work piece only after getting cooled or with a tong.

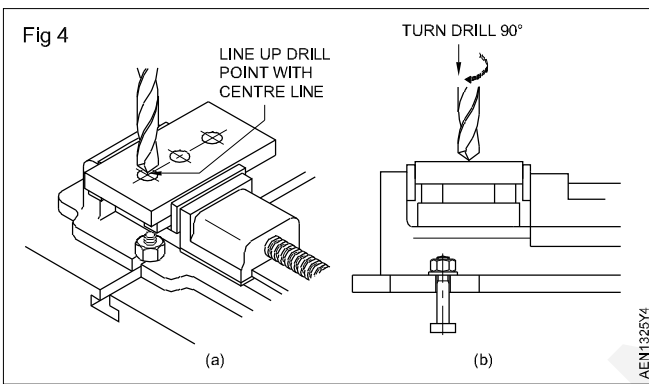
While fixing the drill in a socket or sleeve, the tang portion should align in the slot. (Fig 1 & Fig 2) This will facilitate the removal of drill or sleeve from the machine spindle.



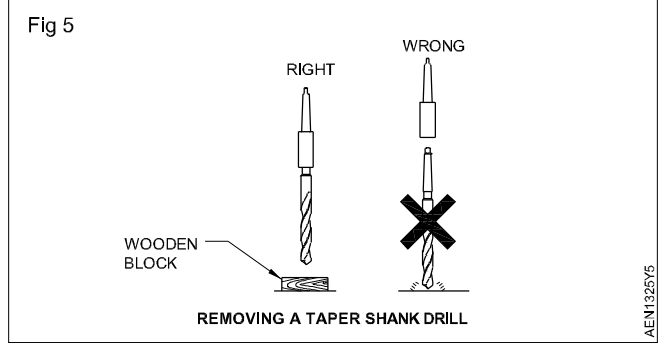
Ensure the belt safe Guard properly placed before drilling (Fig 3)



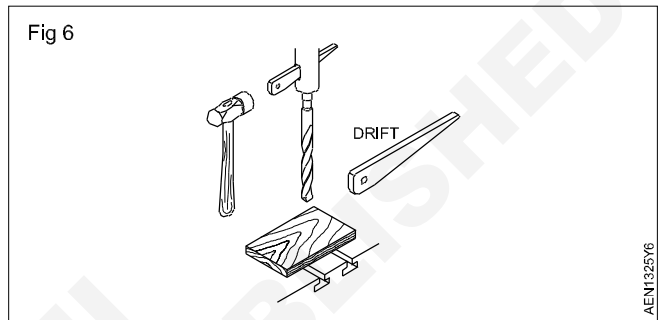
Before drilling ensure that drill point tip properly sits on the punched marking of the job (Fig 4)



While removing the drill from the sockets/sleeves, don't allow it to fall on the table or jobs. (Fig 5)

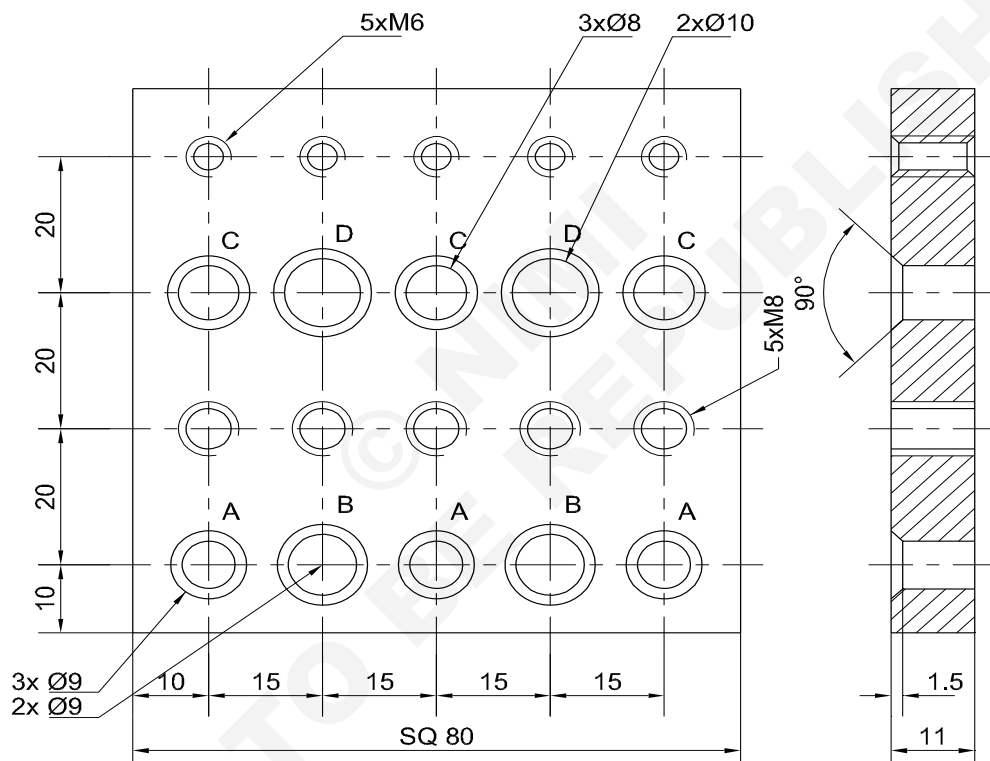


Use a drift to remove drills and sockets from the machine spindle. (Fig 6)



**Practice on tapping a clear and blind hole**

**Objective:** At the end of this exercise you shall be able to  
 • tap a clear drill hole.



1	5x45		Fe310		1	1.3.26
1	90ISF12x85	-	Fe310		2	1.3.26
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex.No.
SCALE 1:1					DEVIATIONS ±0.1	
<p style="text-align: center;"><b>CUTTING INTERNAL THREADINGS</b></p>					CODE NO. AEN1326E1	

## PROCEDURE

### Drill various size holes in given job

- 1 Check the raw material for its size.
- 2 File and finish the plate 80 x 11 x 80 within + 0.2 mm.
- 3 Locate centers for holes to be drilled, tapped and countersunk.
- 4 Center punch the centres.
- 5 Drill five,  $\varnothing$  5 mm tapping drill size holes for M6 tapping.
- 6 Drill five,  $\varnothing$  6.8 mm tapping drill size holes for M8 tapping.
- 7 Drill four  $\varnothing$  8 mm through holes as per drawing. Enlarge by drilling  $\varnothing$  10 mm the 2nd and 4th hole of the second row.
- 8 Drill five  $\varnothing$  7 mm through holes as per drawing.
- 9 Enlarge the 2nd and 4th holes by drilling  $\varnothing$  9 mm on the 4th row
- 10 Countersink  $\varnothing$  8 and  $\varnothing$  10 holes with 90° countersink as per standard. (Refer to the table.)
- 11 Countersink  $\varnothing$  7 and  $\varnothing$  9 mm holes with 120° countersink as per standard. (Refer to the table.)
- 12 Cut M6 internal thread in the four  $\varnothing$  5 mm drilled holes.
- 13 Countersink 120° all the four  $\varnothing$  6.8 mm holes on both sides as per drawing.
- 14 Cut M8 internal threads in all the five  $\varnothing$  6.8 mm drilled holes with M8 taps.
- 15 Check M6 and M8 tapped holes with the supplied M6 and M8 screws, respectively.

## Skill sequence

### Internal threading of through holes using hand taps

**Objectives:** This shall help you to

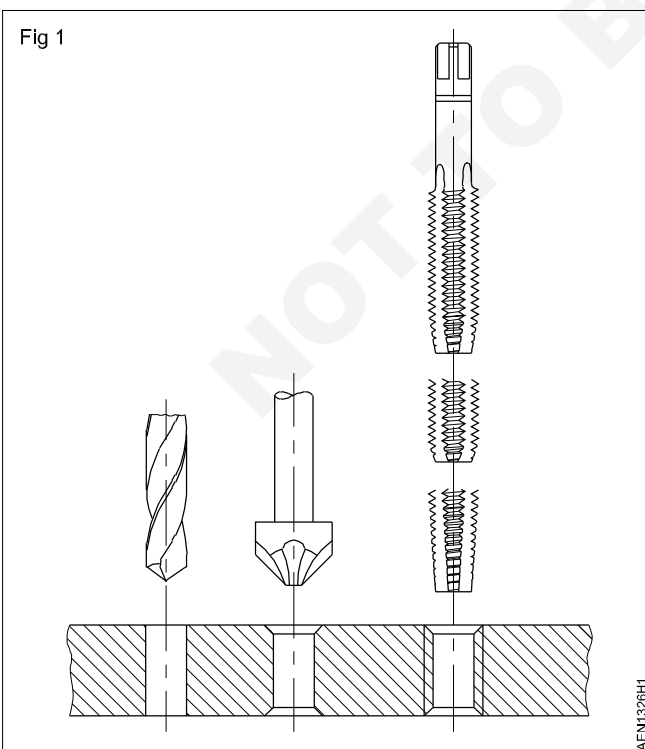
- determine the tap drill sizes for internal threading
- cut internal threads using hand taps.

#### Determining the tap drill size

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

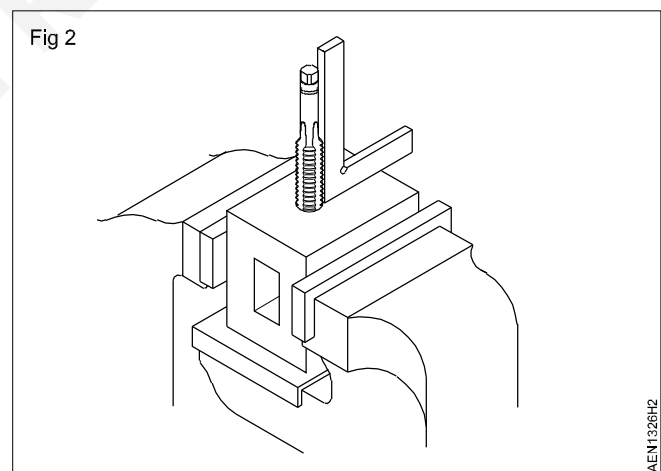
Drill the hole to the required tap drill size.

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



Hold the work firmly and horizontally in the vice. The top surfaces should be slightly above the level of the vice jaws.

This will help in using a try square without any obstruction while aligning the tap. (Fig 2)



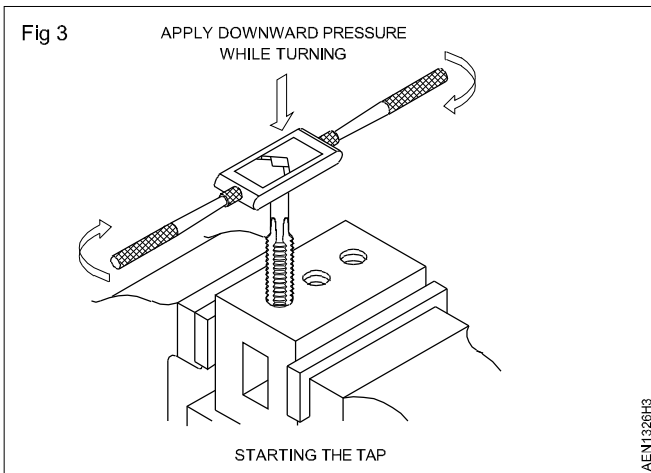
Use soft jaws while holding the finished surface on a vice.

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

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

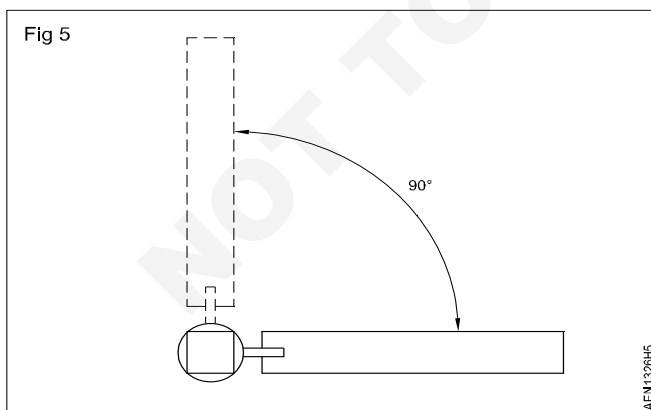
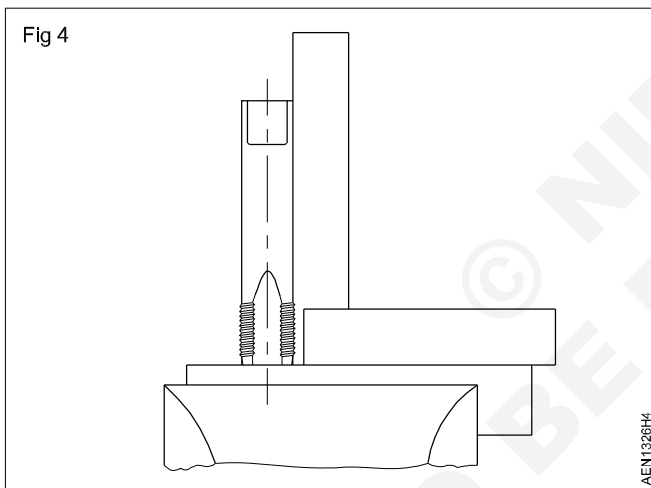
Position the tap in the chamfered hole vertically by ensuring the wrench is in the horizontal plane.

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



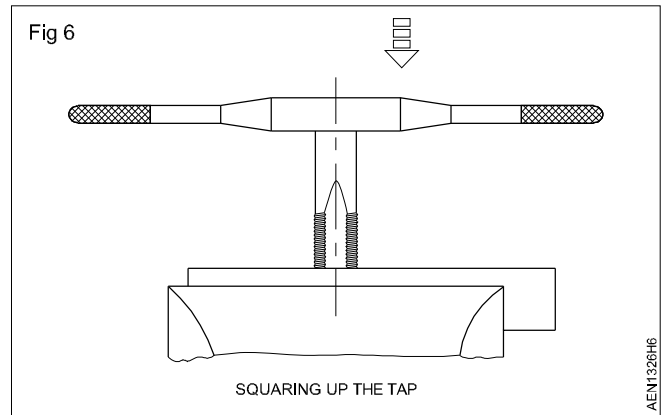
When you are sure of starting of the thread, remove the tap wrench without disturbing the tap alignment.

Check and make sure the tap is vertical, use a small try square for help. Place the try square in two positions, 90° to each other. (Fig 4 & Fig 5)



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

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

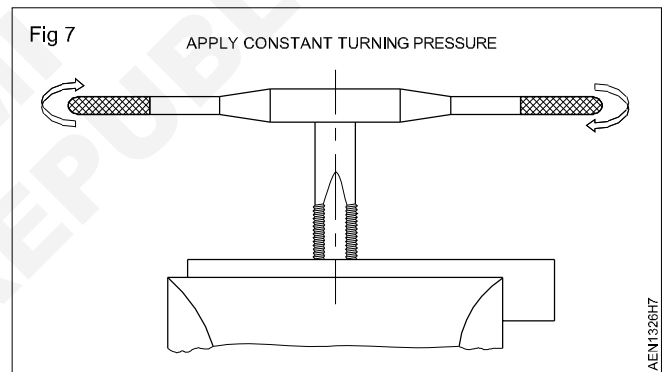


Check the tap alignment with a try square.  
Fit the tap wrench, and tighten without disturbing the tap alignment.

Make one or two turns and check the alignment.

The tap alignment should be corrected within the first few turns.

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

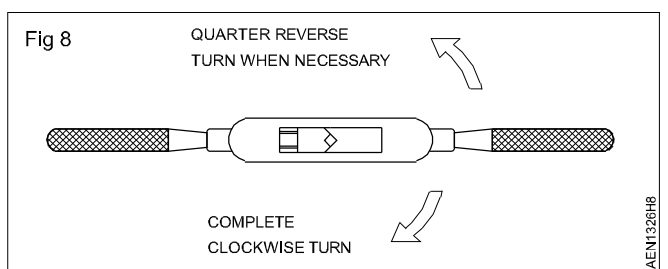


While turning the wrench, the movement should be well balanced. Any extra pressure on one side will spoil the tap alignment and can also cause breakage of the tap.

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

**Use a cutting fluid while cutting the thread.**

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



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

Remove chips from the work with a brush.

Check the threaded hole with a matching screw.

Clean the tap with a brush, and place it back on the stand.

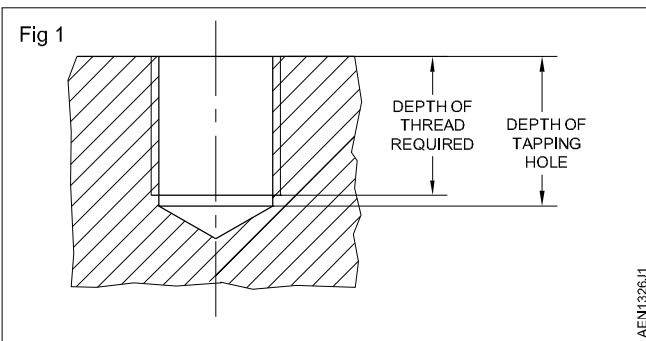
## Internal threading blind holes using hand taps

**Objective:** This shall help you to  
 • cut internal threads in blind holes.

### Drilling a blind hole

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

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

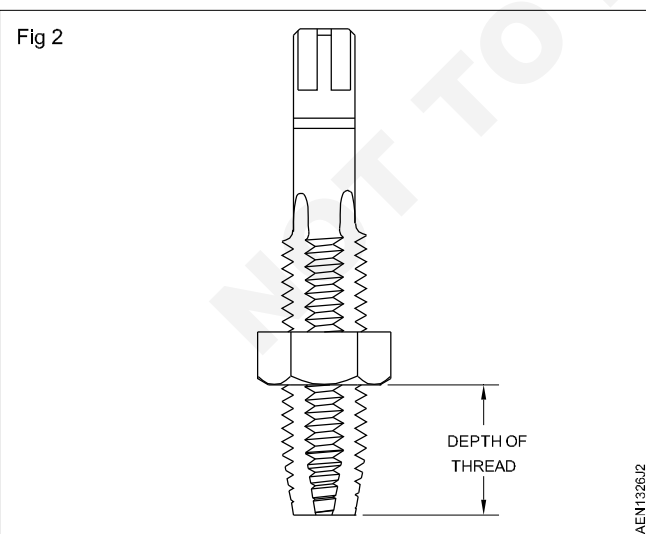


### Procedure for threading

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

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

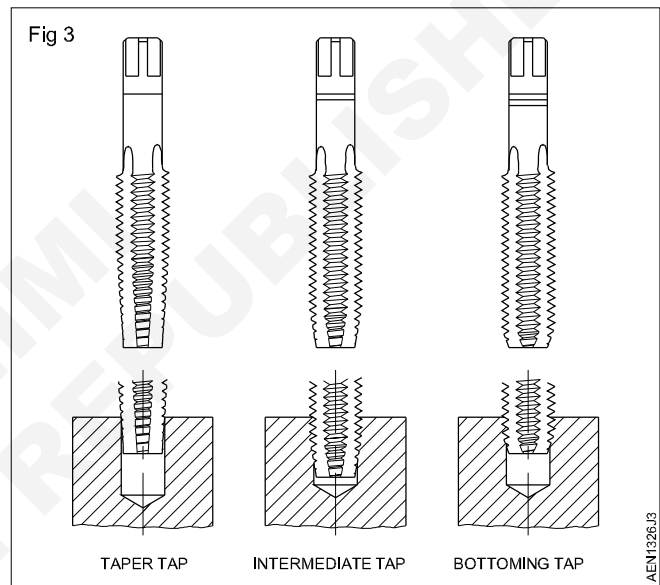
Screw a matching nut on the first tap to act as a depth stop. (Fig 2)



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

Remove the chips from the hole frequently, using a flattened and bent wire.

Finish tapping the hole with intermediate and bottoming tap. Set nut to control the depth of thread. (Fig 3)



**Practice to cut the External threads on a bolt/stud by using dies**

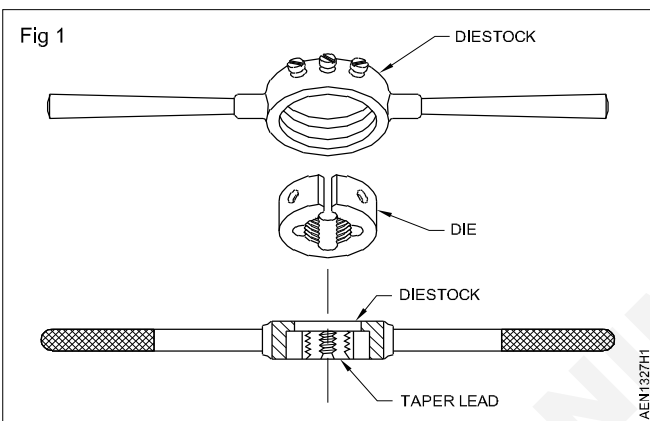
**Objective:** At the end of this exercise you shall be able to  
 • cut external threading on bolt by using dies.

**PROCEDURE**

**External threading by using dies**

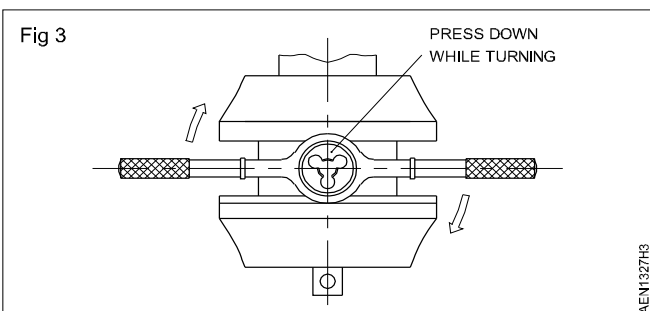
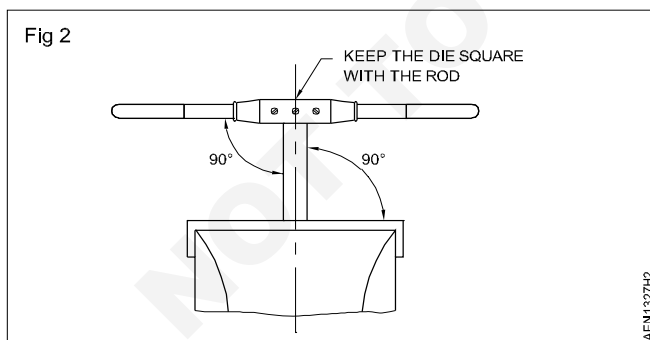
**Check blank size**

- 1 Blank size = thread size - 0.1 x pitch of thread
- 2 Fix the die in the die stock and place the leading side of the die opposite to the step of the die stock. (Fig 1)

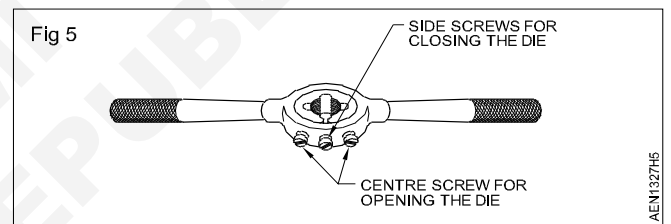
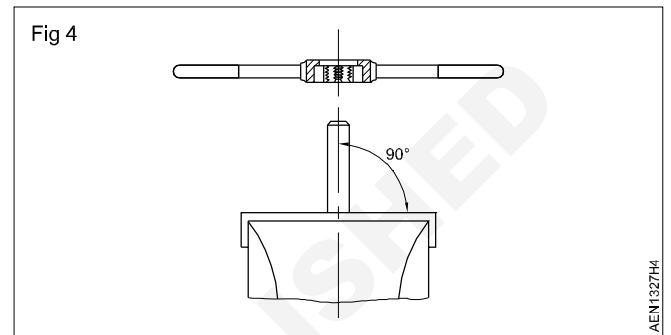


**Use false jaws for ensuring a good grip in the vice.**  
**Project the blank above the vice-just the required thread length only.**

- 3 Place the leading side of the die on the chamfer of the work. (Fig 2 & Fig 3)



- 4 Make sure that the die is fully open by tightening the center screw of the die stock. (Fig 4 & Fig 5)



- 5 Start the die, square to the bolt center line.
- 6 Apply pressure on the die stock evenly and turn in the clockwise direction to advance the die on the bolt blank.
- 7 Cut slowly and reverse the die for a short distance in order to break the chips.

**Use a cutting lubricant.**

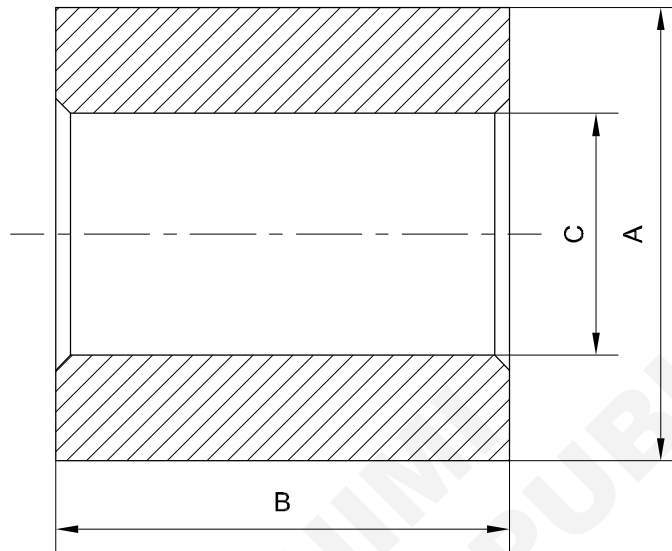
- 8 Increase the depth of the cut gradually by adjusting the outer screws.
- 9 Check the thread with a matching nut.
- 10 Repeat the cutting until the nut matches.

**Too much depth of cut at one time will spoil the threads. It can also spoil the die.**  
**Clean the die frequently to prevent the chips from clogging and spoiling the thread.**

**Practice to ream a hole**

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

- ream through hole with a hand reamer
- check the reamed hole by using a plug gauge.



A			
B			
C			

**Job sequence**

**Ream a hole**

- Hold the job in a vice.
- Select the correct type and size of reamer
- Hold the reamer in tap wrench
- Ream the hole by using sufficient coolant.
- Give uniform hand feed while reaming.
- Check the hole with a 'Go' and 'No-Go' plug gauge.

1	-	-	Fe310	-	-	1.3.28
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex No.
SCALE 1:1		REAMING			DEVIATIONS ±0.1	
					CODE NO. AEN1328E1	



## Skill sequence

### Practice to ream drilled holes using hand reamers

**Objective:** This shall help you to

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

#### Determining the drill size for reaming

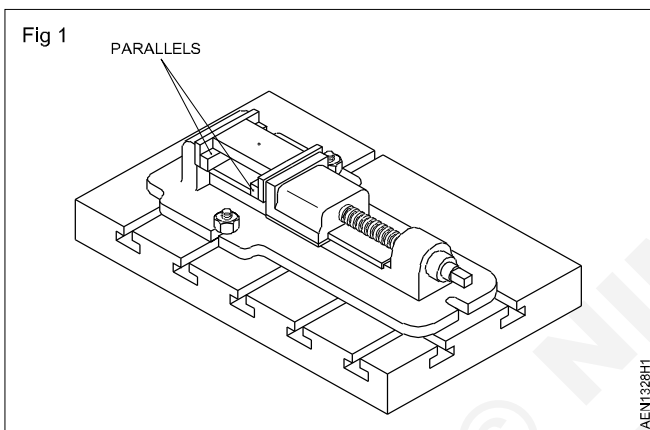
Use the formula,

Drill diameter = reamed hole size. (undersize + oversize)  
[Refer to the table for the recommended under sizes in related theory on drill sizes for reaming].

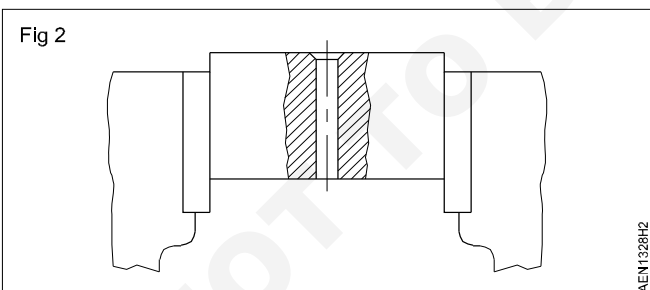
#### Procedure for hand reaming

Drill holes for reaming as per the sizes determined.

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



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

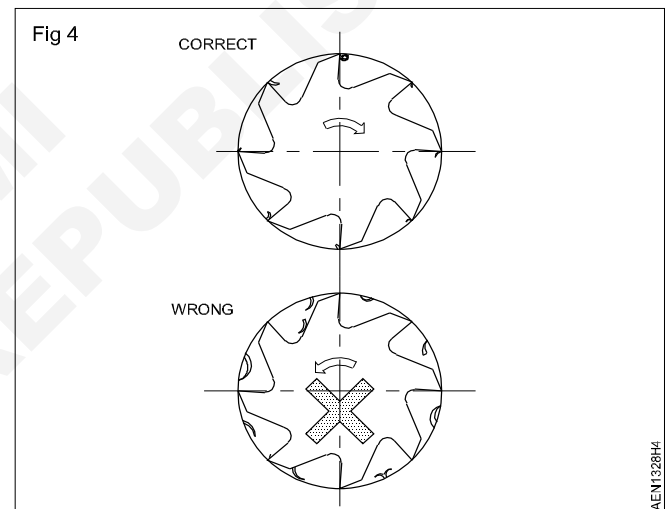
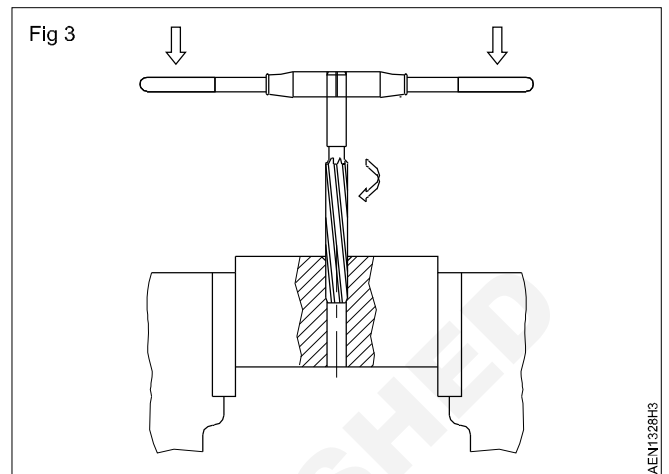


Fix the tap wrench on the square end and place the reamer vertically in the hole. Check the alignment with a try square. Make corrections, if necessary. Turn the tap wrench in a clockwise direction applying a slight downward pressure at the same time. Apply pressure evenly at both ends of the tap wrench.

Apply cutting fluid.

Turn the tap wrench steadily and slowly, maintaining the downward pressure. (Fig 3)

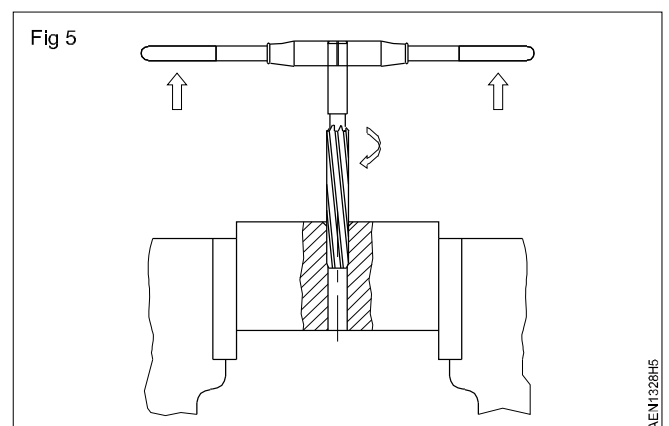
**Do not turn in the reverse direction for it will scratch the reamed hole. (Fig 4)**



Ream the hole through. Ensure that the taper lead length of the reamer comes out well and clear from the bottom of the work.

**Do not allow the end of the reamer to strike on the vice.**

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



Remove the burrs from the bottom of the reamed hole.

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

## Scraping curved surfaces

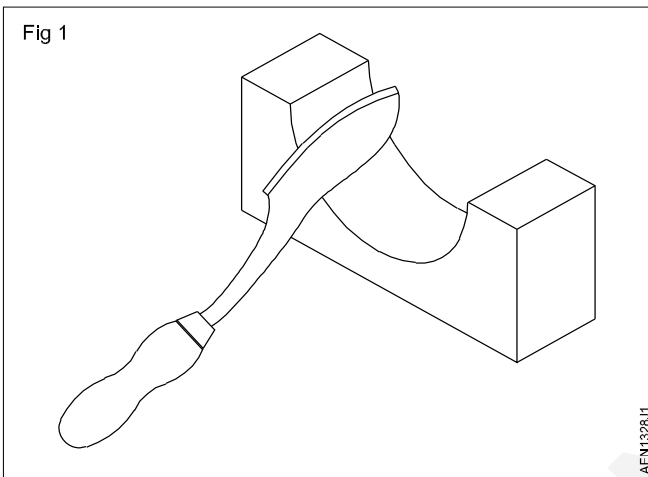
**Objective:** This shall help you to

- **scrape and test curved surfaces.**

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

### Method

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

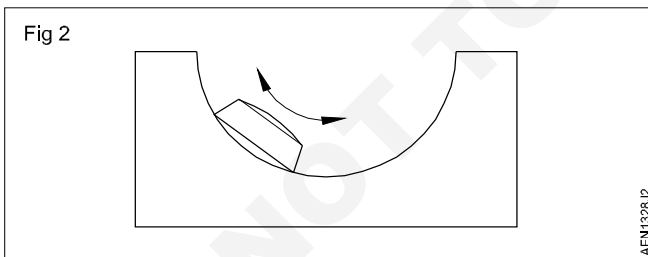


Pressure is exerted with the other hand on the shank for cutting.

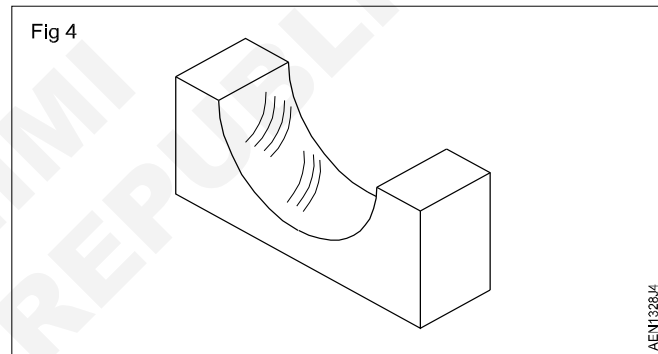
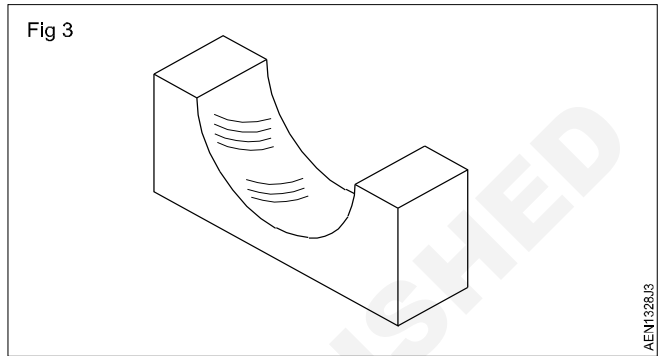
Rough scraping will need excessive pressure with longer strokes.

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

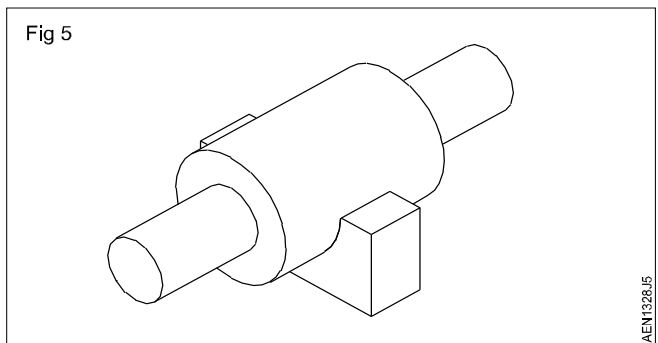
Cutting action takes place both on forward and return strokes. (Fig 2)



During the forward movement one cutting edge acts, and on the return stroke, the other cutting edge acts. After each pass, change the direction of cutting. This ensures a uniform surface. (Figs 3 & 4)



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



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

## Sharpening scrapers

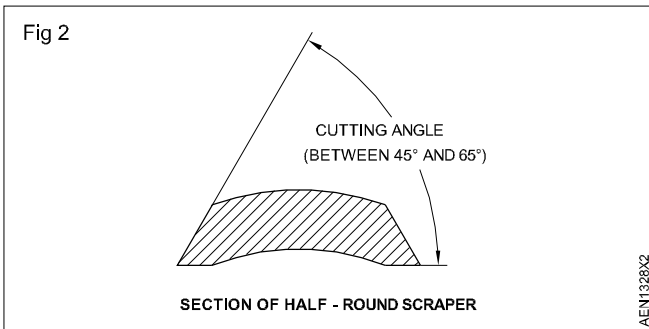
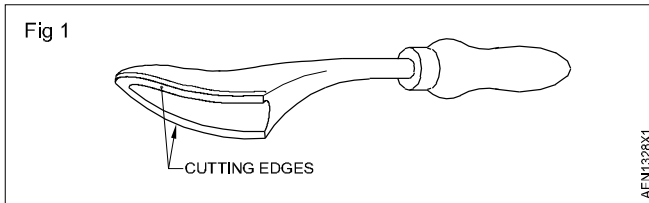
**Objectives:** This shall help you to

- **sharpen a half round scraper**
- **sharpen a three-square scraper.**

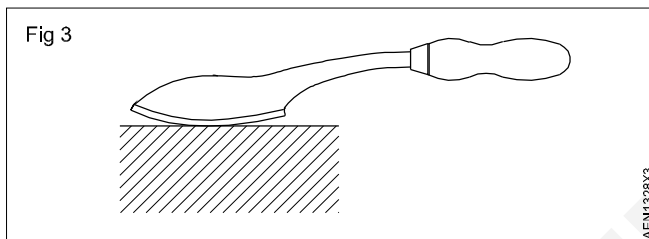
### Sharpening half round scrapers

Locate the two cutting edges on the rounded back (Fig 1) for the half round scrapers.

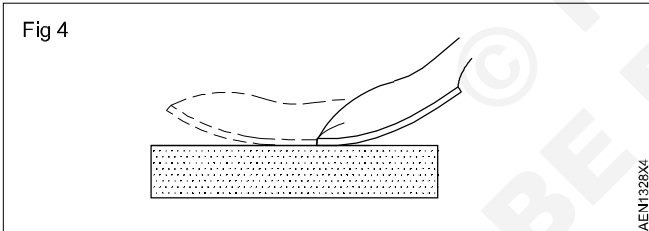
Check the cutting edges are formed by the bottom surface, and the flat surfaces are ground on the rounded back of the scraper. (Fig 2)



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



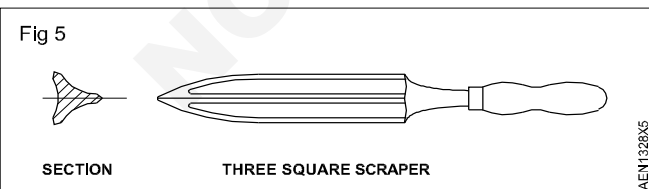
Rub the bottom surface with a rocking motion on the oilstone for re-sharpening. (Fig 4)



Re-sharpened by grinding the bottom surface, when the cutting edge is blunt.

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

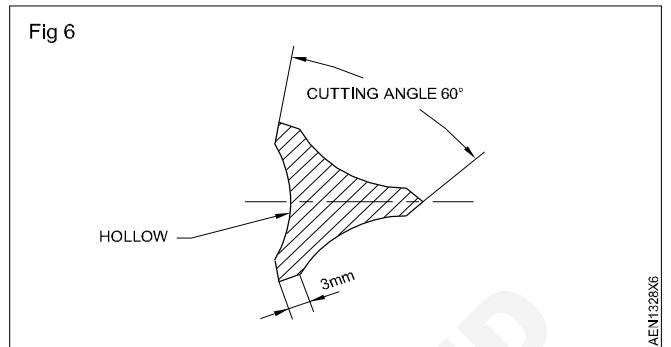
These scrapers have triangular cross-section which tapers to a point. (Fig 5)



The center of each face is hollow and this makes sharpening easy. (Fig 6)

The angle of each cutting edge is 60°.

Re-sharpening is done on an oilstone and the method adopted is similar to that for the half round scraper.



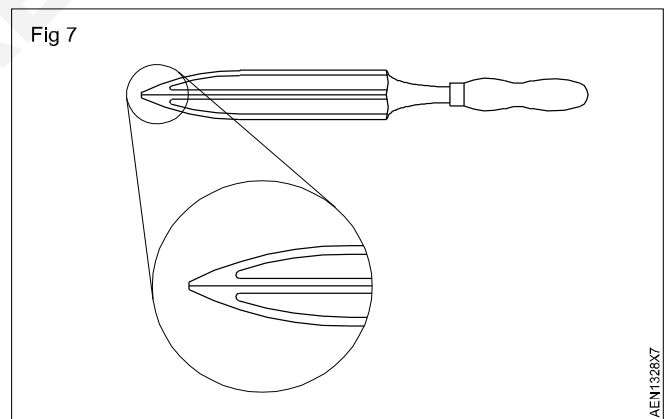
While grinding, the movement should be such that it tapers to a point with a uniform movement.

The cutting edges of three-square scrapers are likely to be overheated quickly as they are very thin.

**Apply only light pressure.**

Maintain the cutting edge width to about 3 mm. (Fig 6)

**A three-square scraper is very sharp instrument and has to be handled carefully. Flatten the sharp tip for about 1 mm for safety while handling. (Fig 7)**



**Practice to soldering and brazing of pipes**

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

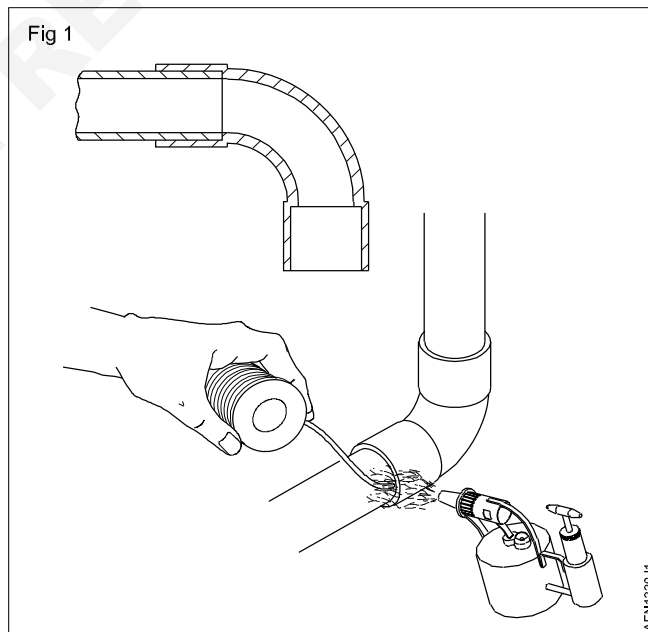
- prepare a layout for pipe bending job
- file wipples and using in pipe
- capillary fitting at pipe
- capillary joints soldering & brazing.

Requirements			
<b>Tools / Instruments</b>			
• Trainee's tool kit	- 1 set	• M.S. Tube	- as reqd.
• Soldering Iron	- 1 No.	• Solder- as reqd.	
• Blow lamp	- 1 No.	• Brazing rod	- as reqd.
• Tong	- 1 No.	• Flux	- as reqd.
<b>Equipment / Machines</b>			
• Work bench	- 1 No.	• Water	- as reqd.
• Anvil	- 1 No.	• Bucket	- as reqd.
• Oxy - acetylene welding set	- 1 No.	• Sand paper	- as reqd.
<b>Materials</b>			
• Cotton waste	- as reqd.	• Silver brazing flex	- as reqd.
		• Silver brazing rod	- as reqd..
		• Copper tube	- as reqd.
		• M-3 tube	- as reqd.
		• Clean cloth	- as reqd.

**PROCEDURE**

**TASK 1: Capillary fitting**

- 1 Cut the pipe end. Square with a pipe cutter.
- 2 Remove the burr from inside and outside of the pipe with a reamer.
- 3 Clean the outside of pipe and inside of the fitting with sand paper.
- 4 Apply a thin film of flux to the outside of pipe and inside of fittings with brush.
- 5 Insert the pipe into the fitting cup till the pipe end touches the base of the fitting cup.
- 6 Apply heat to the pipe and fitting.
- 7 Add the solder to the side which is opposite to the heat when the flux begins to boil. (Fig 1)
- 8 Wipe of excess solder.



**TASK 2: Using capillary joint (Integral solder ring fitting) (Fig 2)**

- 1 Cut the pipe with a cutter.
- 2 Remove the burr from inside the pipe with a reamer.
- 3 Clean the outside of the pipe and inside of the fittings with sand paper.
- 4 Apply flux on outside surface of pipe and inside of fittings.

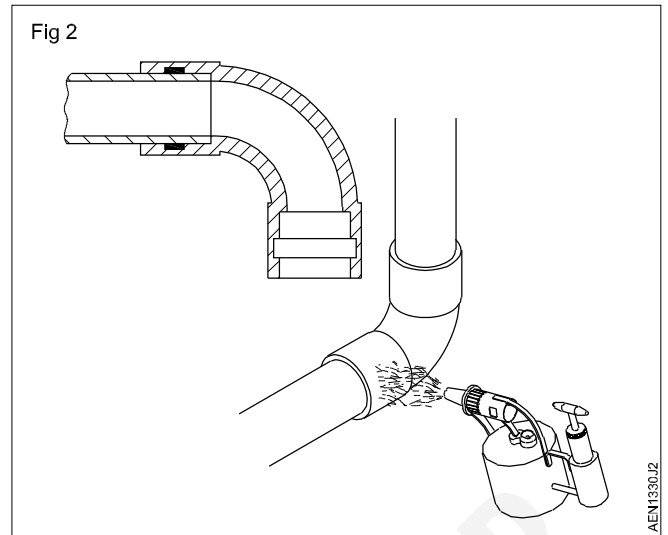
- 5 Heat the fittings and pipe until a complete ring of solder appears at the mouth of the fittings. (Fig. 2)
- 6 Allow the joint to cool without disturbance.

**Non manipulate compression fittings**

- 7 Cut tube to correct length.
- 8 Remove burrs from pipe and fittings.
- 9 Insert tube into fittings until it makes contact with the tube stop.
- 10 Choose the correct size grip jaw.
- 11 Compress the fitting until the grip jaw stops.
- 12 Check the joints by pulling them apart with the hands.

**Manipulate compression fittings**

- 13 Slip the compression fitting nut and compression ring over the tube.
- 14 Flare the end of the pipe.
- 15 Place the cone end of adopter piece on the flared pipe end.

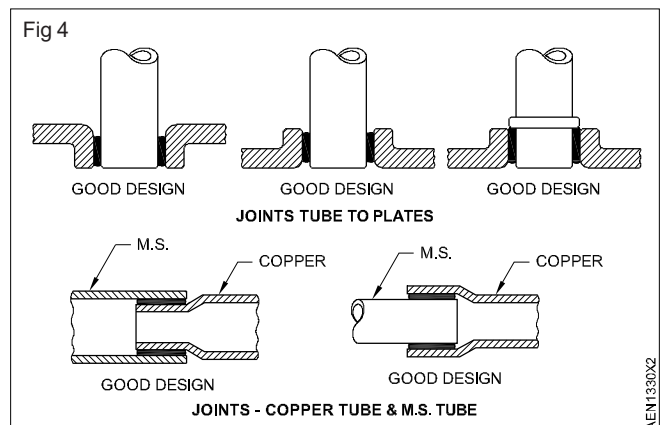
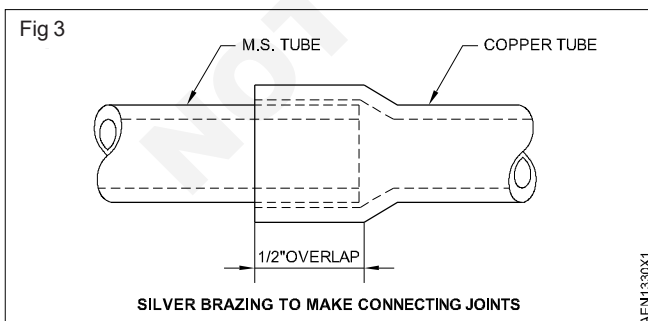


- 16 Engage the compression nut onto the body thread.
- 17 Tighten with spanner.

**TASK 3: Brazing**

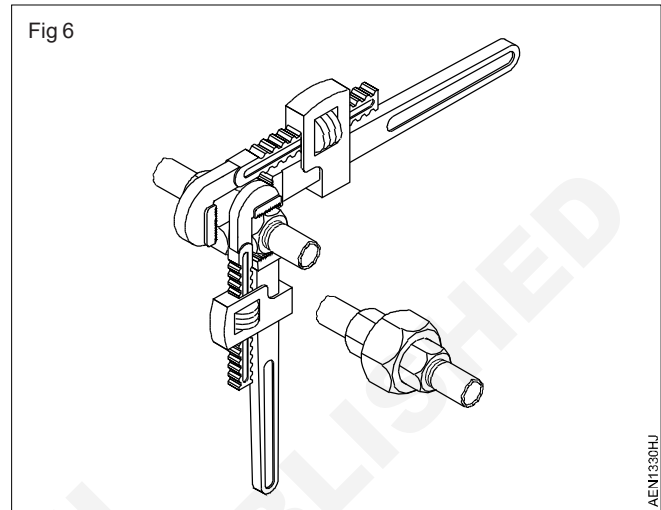
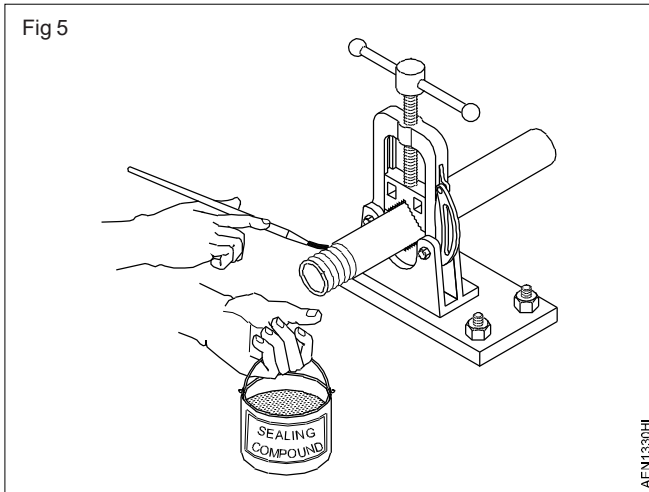
- 1 Place the tube in V- guide of cutter
- 2 Tighten the thumb screw until considerable pressure is applied
- 3 Revolve the cutter slowly around the tube so that the sharp cutting wheel feeds gradually on the tubings to apply pressure thumb screw till tube is completely cut
- 4 Ream and file the edges of the tubing
- 5 Use sand paper to clean the outer surface of the tube and clean inside by wire brush
- 6 Make a paste of silver brazing flux by mixing it with little bit of water and apply a thin coat of flux to outside of the fitting
- 7 Insert the pipe into MS pipe and see that the fit is not too easy (Fig 3)

- 8 Clamp the pipe in the flaring block and mount the block in the vice
- 9 Light the oxy - acetylene torch using the spark lighter
- 10 Heat the connection at safe distance from the joint until the water vaporizes
- 11 Continue heating until the flux turns milky and finally turns clean (Fig 4)
- 12 Apply the silver solder to both edges of the MS tube until the solder flows on both pipes
- 13 Remove silver solder rod and allow the joint to cool
- 14 After cool the assembly and test the connector to 10.5 kg/cm<sup>2</sup> pressure.



#### TASK 4: Fitting union in pipe line

- 1 Hold the pipe in a vice. (Fig 5)
- 2 Apply sealing compound over the nipple thread (Fig 5).
- 3 Adjust the pipe wrench to suit the union sleeve nut.
- 4 Screwing the union nut on the nipple threads.
- 5 The same process repeated to the another nipple with nut.
- 6 Apply sealing compound on the union threads.
- 7 Hold both nipple with nut by pipe wrench.
- 8 Tighten the nut up to air tight. (Fig 6)



**Practice to crimp solder wires**

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

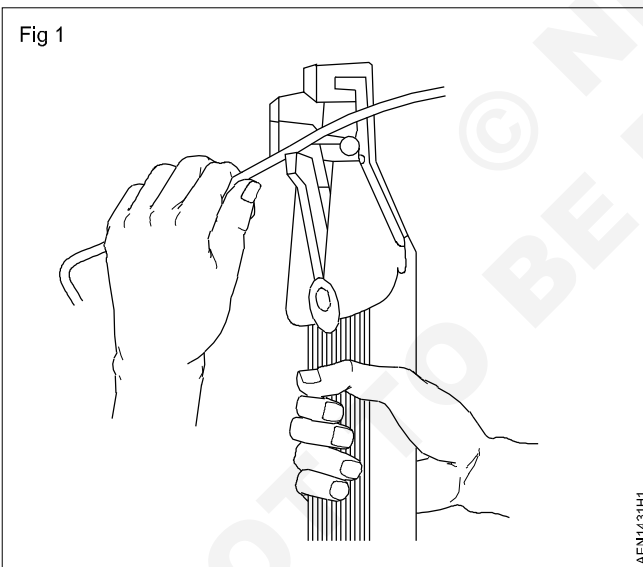
- prepare the crimping joints with connector
- solder the cable using soldering iron.

Requirements			
<b>Tools / Instruments</b>			
• Trainee's tool kit	- 1 No.	• Wooden plank	- as reqd.
• Crimping plier	- 1 No.	• Solder	- as reqd.
• Blow lamp	- 1 No.	• Brick	- as reqd.
• Tong	- 1 No.	• Insulating sleeve	- as reqd.
• Combination plier	- 1 No.	• Flux	- as reqd.
<b>Materials</b>		• Lug socket	- as reqd.
• Cotton waste	- as reqd.	• Cloth/Cotton tape	- as reqd.
		• Grade sandpaper	- as reqd.

**PROCEDURE**

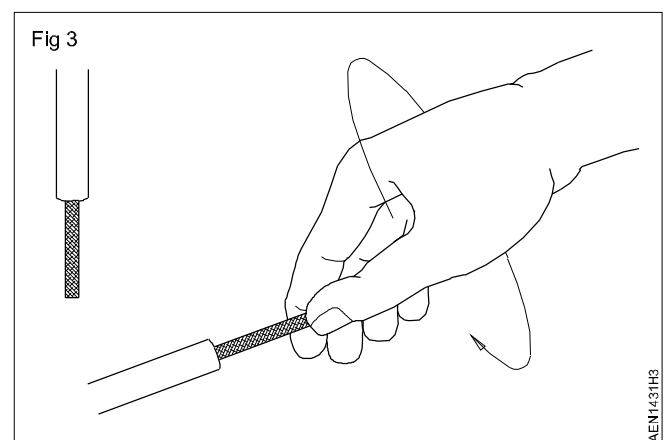
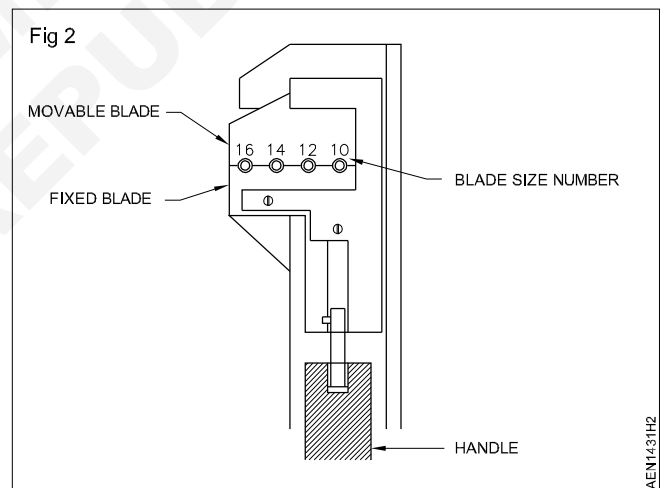
**TASK 1: Prepare the crimping joints with connector**

- 1 Strip off the required length of insulation from the cable that suits the terminal size. (Fig 1)

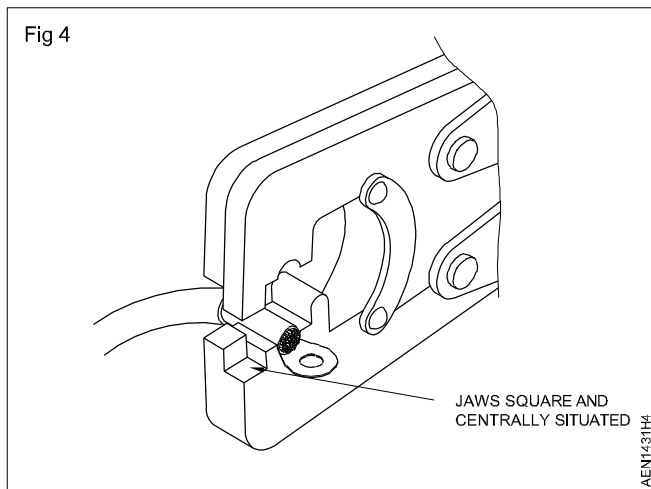


**Be sure not to cut or damage the wire core, and use correct size wire stripper blade. (Fig 2)**

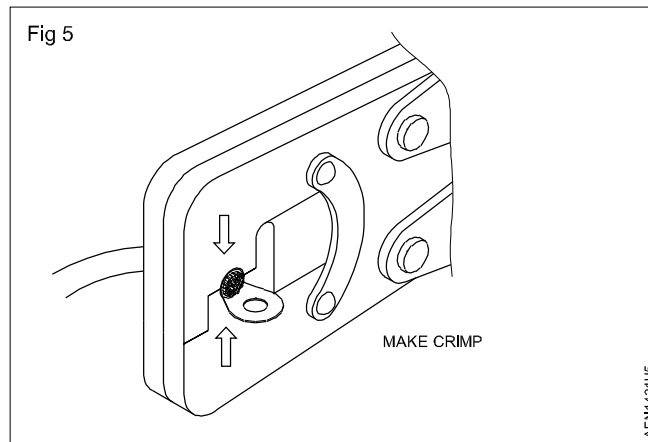
- 2 Twist the strands of the wire slightly clockwise. (Fig 3)
- 3 Clamp the spade connector with the crimping pliers in the matching position of the jaws. (Use a suitable spade connector and crimping plier). (Fig 4)
- 4 Insert the wire far enough in the connector.
- 5 Apply slight pressure to create a light impression on the connector.



- 6 Check whether the connector is located in the middle of the band of the connector, and, if necessary, make final adjustments.



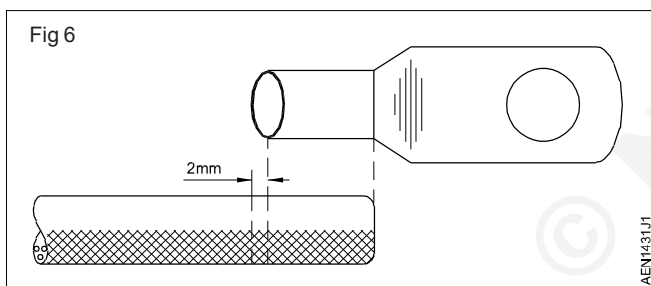
- 7 Apply sufficient pressure in the handle to press the connector fully. (Fig 5)



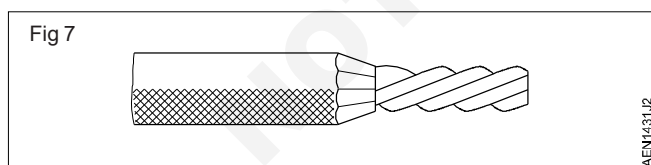
- 8 Check whether the prepared crimping joint is firm by pulling the cable and connector.
- 9 Repeat the crimping of connectors for various sizes of copper and aluminum conductors of different lengths.

## TASK 2: Solder the cable lugs by using blow lamp

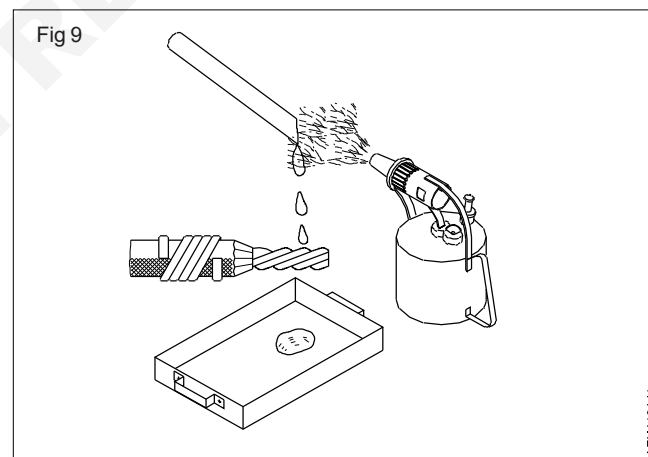
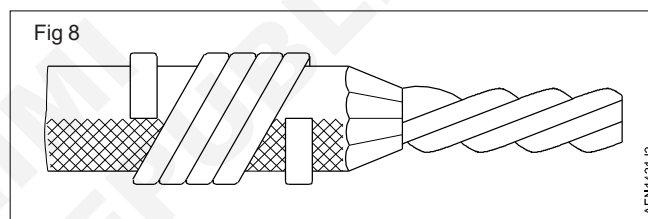
- 1 Solder a lug to a copper conductor. (Fig 6)



- 2 Clean the inner surface of the cable lug using 00 grade sandpaper.
- 3 Put the cable lug to one end of the cable and mark the cable according to the depth of the cable lug. Add about 2 mm to the marking.
- 4 Remove the insulation from the cable and clean the strands. (Avoid damage to the strands of the cable while skinning). (Fig 7)

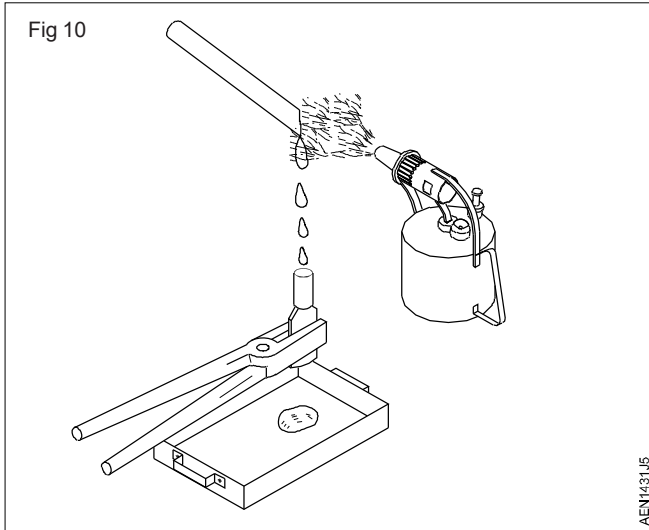


- 5 Wrap a cloth/cotton tape on the insulation of the cable to a length of 30 mm and wet it with water. (Use minimum water to wet the cloth/tape. Do not allow water to drip). (Fig 8)
- 6 Light the blowlamp and let it emit a blue flame. (Fig 9)
- 7 Apply a thin coat of flux to the cable end.

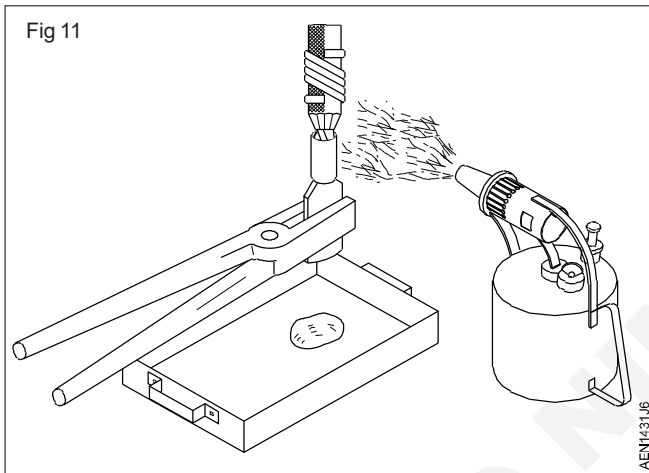
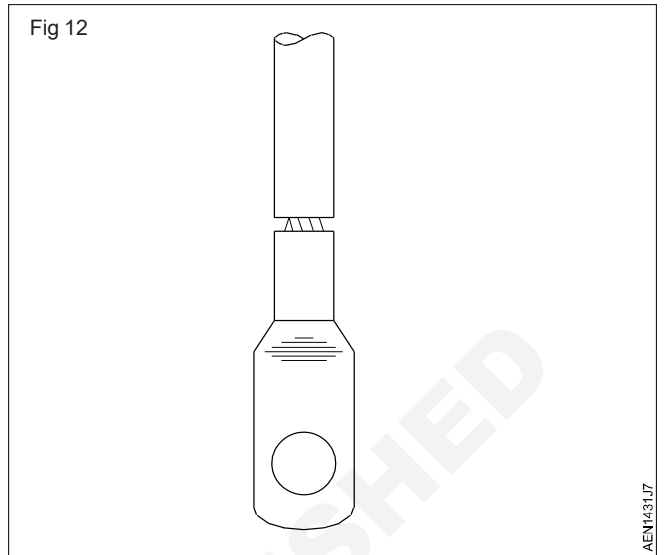


- 8 Tin the cable end by monitoring the blowlamp on the solder stick and by allowing the molten solder to fall on the bar stranded cable end. Place a clean tray below the cable end to collect the excess solder.
- 9 Apply a small quantity of flux inside the lug socket. Tin the lug by melting the solder stick to fill the socket and collect the excess molten solder in the tray. (Fig 10)
- 10 Apply some flux to the cable end and socket interior. (Fig 11)
- 11 Fill up the socket of the lug with the molten solder.





- 12 Monitor the blowlamp flame on the socket; insert the cable in the socket and hold the cable vertically.
- 13 Remove the blowlamp and hold the cable and socket without shaking. (Fig 12)

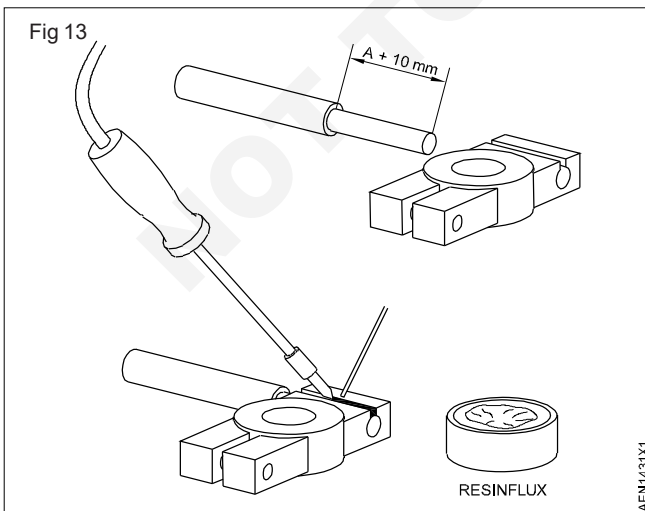


- 14 Remove the extra solder from the lug and the cable by wiping with a piece of cotton cloth while the solder is still hot.
- 15 Keep holding the cable and lug until the solder solidifies.

**Do not use water to cool the lug.**

### TASK 3: Solder the cable using soldering iron

- 1 Clean the strands and get a copper face free from sulphate.
- 2 Insert the wire end as shown in the Fig 13.



- 3 Hold the clamp in a vice in between two wooden blocks to prevent heat flow to vice.

- 4 Connect a 1000w/220v soldering iron to an AC source. Keep the iron on a brick.

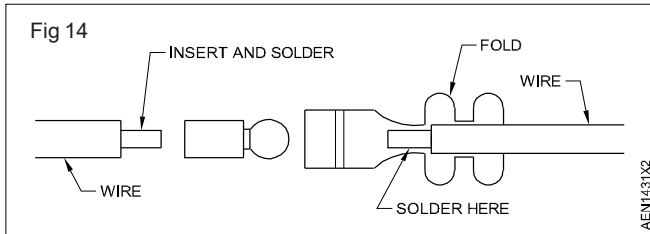
**Do not over heat the iron. Overheating would impair wetting of iron. Wetting means coating soldering iron with solder.**

- 5 Solder the end with clamp face with molten solder.
- 6 Hold the clamp horizontally and solder the split and close the split with solder.
- 7 Hold the clamp as shown in the Fig 13 and solder around the cable without melting the insulating sleeve.

**Wound the insulation material with a wet cloth near the soldering end to prevent melting.**

### Soldering the circuit wire terminals

- 1 Remove the insulation as shown in the Fig 14 without cutting conductor strands.
- 2 Connect a soldering iron of 300w/220v to an AC supply and keep the iron on a brick.
- 3 Clean the copper strands with emery paper.



- 4 Twist the end neatly.
- 5 Keep the end on a wooden plank.
- 6 Wet the iron with soft solder.

**Do not over heat the iron**

- 7 Coat the end with solder.
- 8 Insert the end into the small loop on the eyelet terminal.

- 9 Fold the terminal tabs one by one and crimp with a tool.
- 10 Now keep the clamp on wooden plank.
- 11 Keep the iron so that a wide area of contact is achieved for better heat transfer to obtain a molten flow of soft solder.
- 12 Wait for solidification of solder and inspect the result. Repeat the same operation for other terminal soldering.

#### Insulating the wires and cables

**For small wires and cables various sizes of insulation sleeves are available. These sleeves can be inserted before soldering the terminals.**

- 13 Construct a simple circuit by using wire and soldering iron. Solder the wires as given circuit diagram.

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**Practice to diagonal series, parallel series circuits**

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

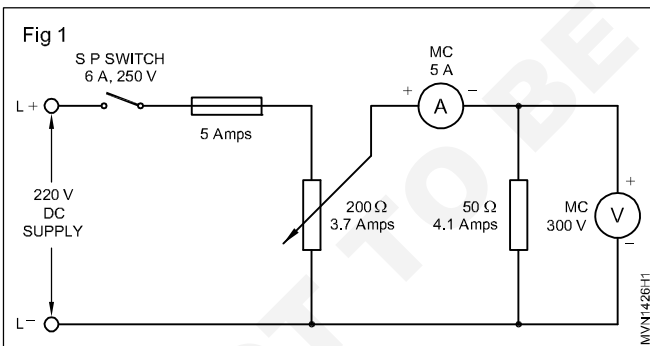
- verification of ohm's law
- check the DC series circuit joints
- check the DC parallel circuit joints
- check the DC series parallel circuit.

Requirements			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Wires 4 mm	- as reqd.
• Multimeter	- 1 No.	• Insulation tape	- as reqd.
• Ohm meter	- 1 No.	• Emery paper	- as reqd.
<b>Equipment / Machines</b>		• Soap oil	- as reqd.
• Battery 12V	- 1 No.	• Cotton waste	- as reqd.
• Vehicle	- 1 No.	• Wire clip	- as reqd.

**PROCEDURE**

**TASK 1: Verification of ohm's law**

- 1 Identify the voltmeter and ammeter.
- 2 Verify the range of the voltmeter and ammeter.
- 3 Identify the rheostat to be connected as potential divider and the standard resistance.
- 4 Connect the power supply, switch, fuse, meters and rheostat as shown in Fig 1.
- 5 Keep the moving arm of the potential divider to have a low voltage at the output of the circuit.
- 6 Close the switch.
- 7 Increase the voltage in the output circuit so as to get 0.5 ampere in the circuit.
- 8 Measure the corresponding voltage and the current (0.5 A) from the instruments and record the values in Table 1.
- 9 Increase the output voltage gradually such that the ammeter reads 1, 2 and 3 amps and measure the corresponding voltages and the currents and record the values in Table 1.
- 10 Switch off the circuit.
- 11 Calculate the resistance value at each step of measurement and record the value in Table 1.
- 12 Write the conclusion based on the following.
  - a) The proved relationship between the current that flows through the resistance and the voltage applied across the resistance shows that the current \_\_\_\_\_.
  - b) The relation between current and voltage could be written as  $V/I$  is a constant  $V / I = R$ .  
R is the resistance of the circuit which is \_\_\_\_\_.

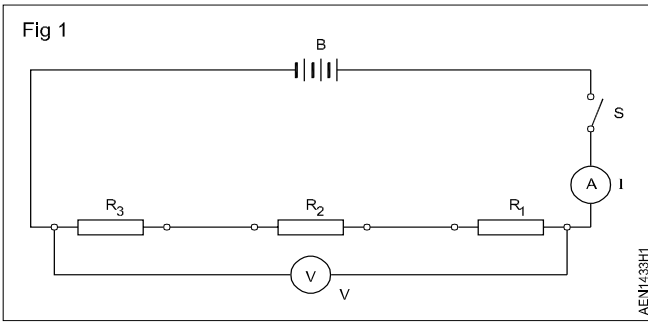


**TABLE 1**

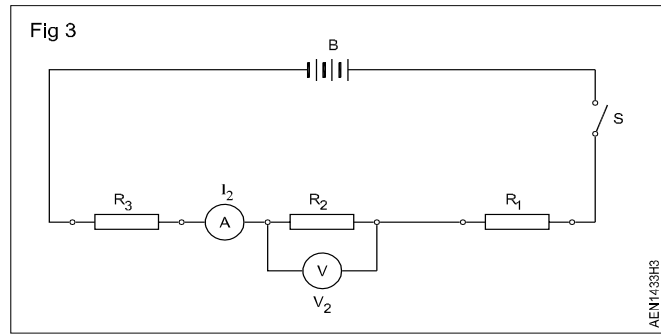
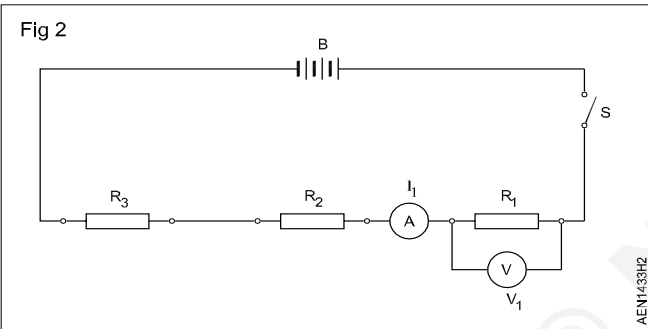
S.No.	Potential difference (Volts)	Current (Amps)	R=Voltage/ Current in Ohms

## TASK 2: DC series circuit

- 1 Prepare the D.C series circuit diagram
- 2 Form a circuit as shown in the Fig 1.



- 3 Close the switch 'S', measure the current 'I' and voltage 'V'.
- 4 Enter the measured values in Table 1.
- 5 Switch off the supply, connect the ammeter and voltmeter as shown in the Fig 2. Switch on the supply and measure voltage  $V_1$  and current  $I_1$  through  $R_1$ .



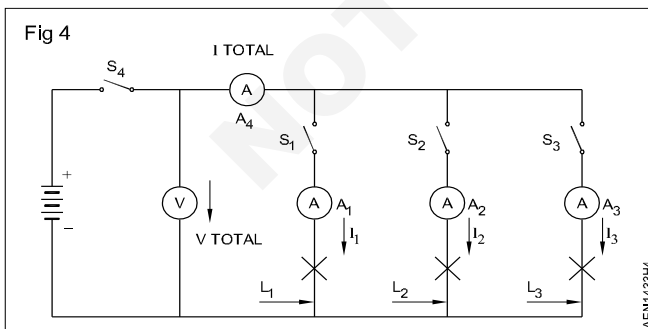
- 6 Switch off the supply, connect the ammeter and voltmeter as shown in the Fig 3. Switch on the supply and measure the voltage  $V_2$  and the current  $I_2$  in  $R_2$ .
- 7 Draw circuit diagram showing the position of 'A' and 'V' in the circuit to measure the current  $I_3$  and voltage  $V_3$  across  $R_3$ .
- 8 Connect and measure  $I_3$  and  $V_3$  across  $R_3$ .
- 9 Enter the measured values in Table 1.

Table 1

Values	Total circuit	$R_1 = 10$	$R_2 = 20$	$R_3 = 10$
Current	$I =$	$I_1 =$	$I_2 =$	$I_3 =$
Voltage	$V =$	$V_1 =$	$V_2 =$	$V_3 =$
Resistance	$R =$	$R_1 =$	$R_2 =$	$R_3 =$

## TASK 3: DC parallel circuit

- 1 Prepare the D.C parallel circuit diagram
- 2 Form the branches 1,2,3 by connecting double contact single filament 20W bulbs  $L_1$ ,  $L_2$ ,  $L_3$  with a holder, an ammeter  $A_4$  of 0-30 Amp DC (1 Amp.DIV) and switch 'S4' in series. (Fig 4)



- 3 Connect the lamp terminals of the three branches connect with the lead of the switch  $S_4$ .
- 4 Form the circuit as shown in circuit diagrams with voltmeter (V), ammeter ( $A_4$ ), switch 'S4' and battery.

- 5 Close the switch 'S4' and switch 'S1' in branch 1.
- 6 Read the ammeters 'A4' and 'A1' and record the values in Table 2.
- 7 Close the switches 'S4', 'S1' and 'S2' in branch 2.
- 8 Read the ammeters 'A4', 'A1' and 'A2' and record the values in Table 2
- 9 Close the switches 'S4', 'S1', 'S2', and 'S3' in branch 3.
- 10 Close the switches 'S4', 'S1', 'S2' and 'S3' in branch 3.
- 11 Read the ammeters 'A4', 'A1', 'A2' and 'A3' and record the value in Table 2.
- 12 Repeat the above steps after clamping the torch lamp in any one branch with 6v 300 mA lamp and record the results in Table 2.
- 13 Repeat the exercise by replacing all the three 'lamps with holder' by wire-wound resistors' (two numbers of 100 ohms and one of 150 ohms).

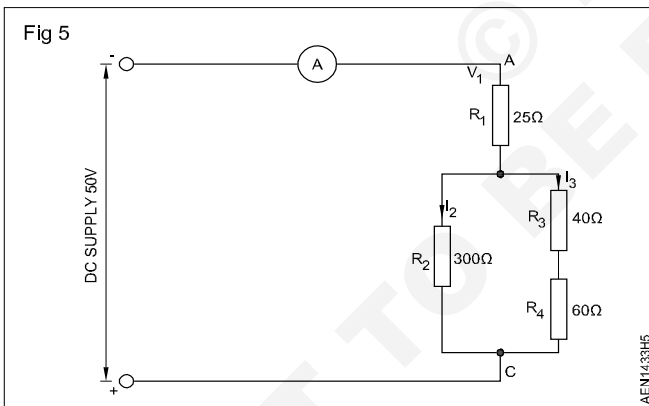
**Table 2**

Sl. No.	I <sub>1</sub>	I <sub>2</sub>	I <sub>3</sub>	I	Total	Switches closed	Components in the branches
1						S <sub>4</sub> , S <sub>1</sub>	3 lamps of 1.7 Amps each
2						S <sub>4</sub> , S <sub>1</sub> , S <sub>2</sub>	„
3						S <sub>4</sub> , S <sub>1</sub> , S <sub>2</sub> , S <sub>3</sub>	„
4						S <sub>4</sub>	„
5						S <sub>4</sub> , S <sub>1</sub>	2 lamps of 1.7 Amps lamp and one 300mA
6						S <sub>4</sub> , S <sub>1</sub> , S <sub>2</sub>	„
7						S <sub>4</sub> , S <sub>1</sub> , S <sub>2</sub> , S <sub>3</sub>	„
8						S <sub>4</sub> , S <sub>1</sub>	Resistors two-one 100 ohms and another 150 ohms
9						S <sub>4</sub> , S <sub>1</sub> , S <sub>2</sub>	„
10						S <sub>4</sub> , S <sub>1</sub> , S <sub>2</sub> , S <sub>3</sub>	„

**TASK 3: DC Series parallel circuit.**

**Prepare the D.C series parallel circuit diagram**

1 Calculate the voltage and currents for the series parallel circuit shown in Fig 5. Enter the values in Table 3.



- 2 Calculate the total resistance  $R_T$  and total current  $I_s$  for  $V_s = 50V$  and enter in Table 4.
- 3 Set the value of the rheostat resistances equal to the value given in Fig 5 (i.e.  $R_1 = 25$  ohms,  $R_2 = 300$  ohms,  $R_3 = 40$  ohms and  $R_4 = 60$  ohms by measuring the resistance value between one end and the variable point of the rheostat)
- 4 Form the circuit and measure the voltage and current. Record them in your note book.
- 5 Calculate the value of  $R_T$  from  $V_s$  and  $I_s$  and record them in your note book and Compare with the value obtained in step 3.

**Table 4**

Calculated Values	$R_T = R_1 + R_1 \{R_2 \parallel (R_3 + R_4)\} =$
Measured Values	

**Table 3**

		V <sub>R1</sub>	I <sub>s</sub>	I <sub>2</sub>	V <sub>R2</sub>	I <sub>3</sub>	V <sub>R2</sub>	I <sub>3</sub>	V <sub>R3</sub>	R <sub>3</sub> +R <sub>4</sub>	R <sub>2</sub> ∥ (R <sub>3</sub> +R <sub>4</sub> )
V <sub>s</sub> = 50V	Calculated Values										
R <sub>1</sub> = 25W											
R <sub>2</sub> = 300W	Measured Values										
R <sub>3</sub> = 40W											
R <sub>4</sub> = 60W											

**Practice to clean and top - up of lead acid battery**

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

- clean the battery terminals and the body of the battery
- check the level of the electrolyte and top-up
- check the specific gravity of the electrolyte with hydrometer
- measure the cell voltage & battery voltage.

Requirements	
<b>Tools / Instruments</b>	<b>Materials</b>
<ul style="list-style-type: none"> <li>• Trainee's tool kit - 1 No.</li> <li>• Hydrometer - 1 No.</li> <li>• Multimeter - 1 No.</li> <li>• Lead acid battery 6V or 12V 80AH - 1 No.</li> </ul>	<ul style="list-style-type: none"> <li>• Distilled water - as reqd.</li> <li>• Vaseline - as reqd.</li> <li>• Cotton rag - as reqd.</li> <li>• Sand paper - as reqd.</li> <li>• Soda bicarbonate - as reqd.</li> <li>• Sulphuric acid - as reqd.</li> </ul>
<b>Equipment / Machines</b>	
<ul style="list-style-type: none"> <li>• Vehicle - 1 No.</li> <li>• Battery Charger - 1 No.</li> </ul>	

**PROCEDURE**

**TASK 1: Cleaning and Top-up of lead acid battery.**

- 1 Clean the battery terminals, if corroded, with sandpaper: if sulphated, clean with wet cotton waste or with soda bicarbonate.

**Do not damage the battery terminal by scraping with any metal strip.**

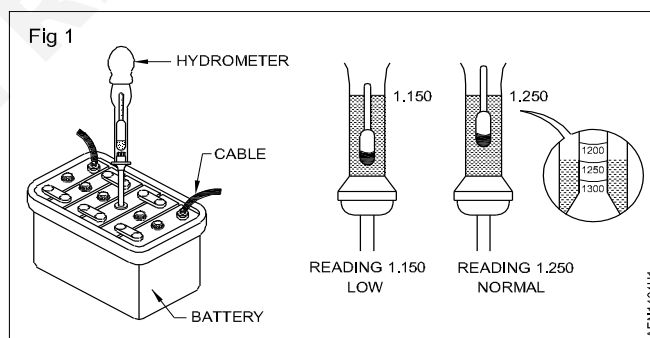
- 2 Unscrew all the vent plugs and check the level of the electrolyte.

**Do not clean the battery top surface keeping the vent plugs open. The accumulated dirt may fall inside the cells and form sediments.**

- 3 Top up the electrolyte to the marked level in all the cells with distilled water.

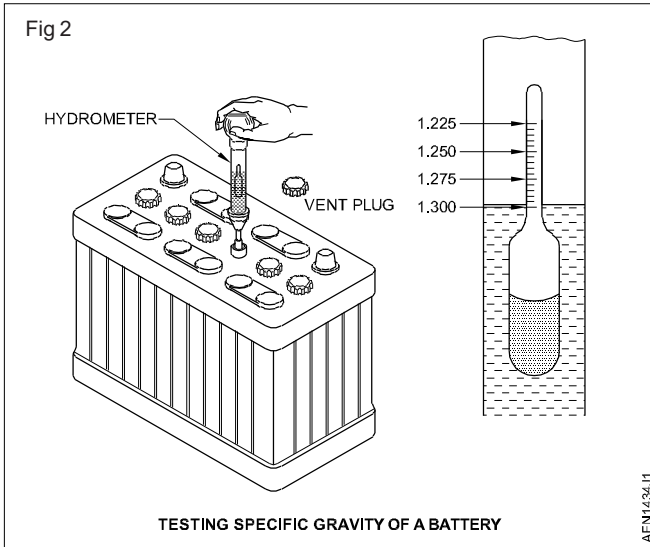
**No electrolyte to be used to top up battery.**

- 4 Open seal cap of battery and keep Hydrometer inside. Pump electrolyte up to reference mark.
- 5 Check the initial specific gravity of the electrolyte of each cell using a hydrometer (Fig 1)



**TASK 2: Check the specific gravity and open circuit voltage test**

- 1 Disconnect the negative cables first from the battery terminal.
- 2 Disconnect the positive cables from the battery terminal.
- 3 Remove the mounting clamp nuts.
- 4 Lift the battery from the vehicle.
- 5 Clean the top of the battery with water and cotton rag.
- 6 Clean the battery terminals by a non-metallic wire brush or emery-paper.
- 7 Check and top up the electrolyte level with distilled water. (if necessary)
- 8 Keep the battery on a leveled wooden workbench.
- 9 Remove all the vent plugs.
- 10 Hold the hydrometer vertically. (Fig 2)



- 11 Place the nose of the hydrometer in the cell. Ensure that the nose is dipped in the electrolyte.
- 12 Press the rubber bulb of the hydrometer.
- 13 Release it to draw the electrolyte upwards. Ensure that the electrolyte does not come into the bulb.
- 14 Note the float level which is floating in the electrolyte.
- 15 Record the reading in Table 1.

**Table 1**

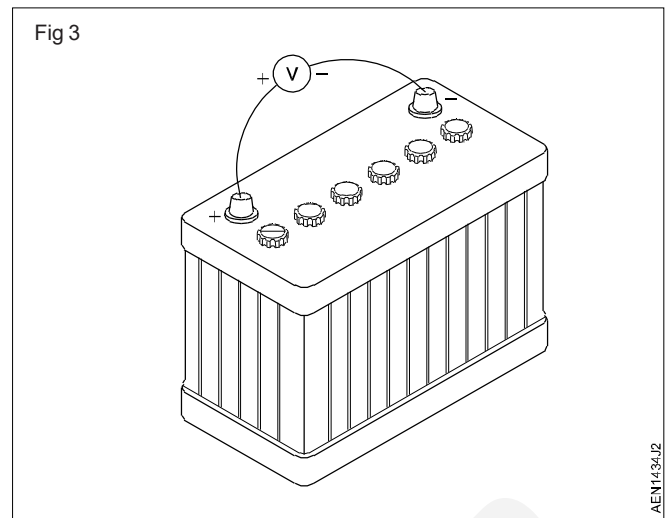
1	2	3	4	5	6

- 16 Repeat the same procedure for all the cells and record the readings.

**The above reading should not vary more than 25 points between cells.**

**Protect your hands and clothes from the battery acid.**

- 17 Connect the leads of the DC voltmeter (2) to the battery terminal (+ve to -ve). (Fig 3)



- 18 Take the reading from the voltmeter and record.
- 19 The voltmeter should read at least 13.2 volts per battery. After carrying out the above tests compare the readings with the manufacturer's specifications. Recharge/replace the battery if it is in poor condition.
- 20 Clean the vent holes and tighten all the vent plugs.
- 21 Smear the battery terminals with Vaseline.
- 22 Place the battery in its position in the vehicle.
- 23 Tighten the battery mounting clamp nuts.
- 24 Clean the battery lugs with baking soda solution and water.
- 25 Connect the battery +ve cable first and tighten it.
- 26 Connect the battery -ve cable and tighten it.
- 27 Start the engine. Check whether the battery supplies sufficient current.

**Disconnect the ground cable (-ve cable) first.**

**This will minimize the possibility of arcing and a resultant battery explosion.**

**Check the relays, solenoid and electrical circuit using test lamp**

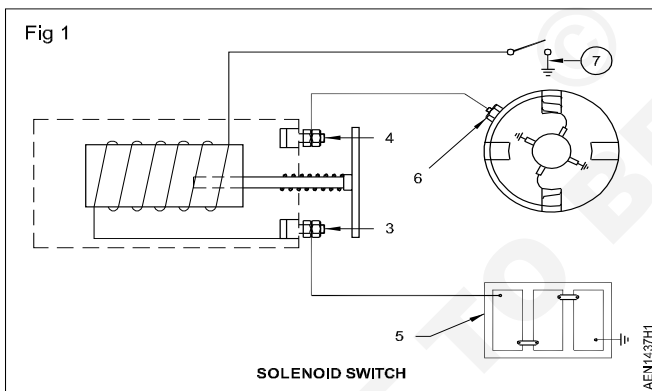
- Objectives:** At the end of this exercise you shall be able to
- check the condition of the solenoid switch in the starting system
  - check the condition of the relay in the wiring circuit
  - check the electrical circuits with the test lamp
  - check the solenoid electrical circuit with a test lamp
  - check the wiper motor electrical circuit.

Requirements	
<b>Tools / Instruments</b>	<b>Materials</b>
<ul style="list-style-type: none"> <li>• Trainee's tool kit - 1 No.</li> <li>• Test lamp - 1 No.</li> <li>• Multimeter - 1 No.</li> </ul>	<ul style="list-style-type: none"> <li>• Fuse - as reqd.</li> <li>• Switch - as reqd.</li> <li>• Cable/Wire - as reqd.</li> <li>• Insulation tape - as reqd.</li> </ul>
<b>Equipment / Machines</b>	
<ul style="list-style-type: none"> <li>• Vehicle - 1 No.</li> <li>• Battery - 1 No.</li> </ul>	

**PROCEDURE**

**TASK 1: Check the solenoid switch**

- 1 Check the solenoid switch terminals (3 & 4) and clean them. (Fig 1)



- 2 Check the battery cable connections from the battery (5) to the solenoid switch terminals (3). Tighten if found loose.

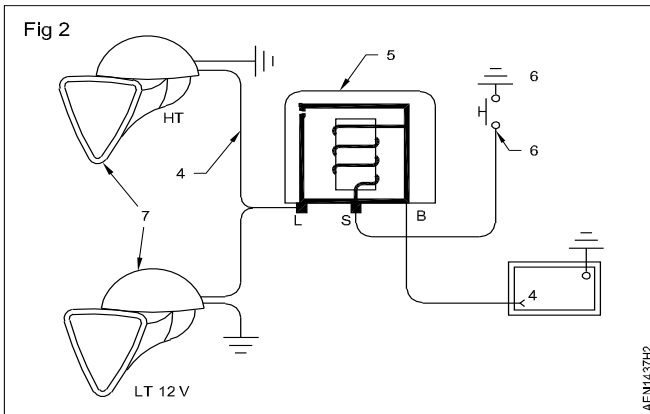
- 3 Check the battery cables from the solenoid switch terminals (4) to the starter motor terminals (6). Tighten it if found loose.
- 4 Check the wire connection from the solenoid switch terminals to the starting switch (7).
- 5 Connect the test lamp to the brake light switch terminal (1&2). If the switch is not closed, the lamp will glow.
- 6 Disconnect the cable wires from the solenoid switch.
- 7 Connect one end of the test lamp with the solenoid switch terminal (3) and ground the other end of the test lamp.
- 8 It will burn, but this test will not indicate short circuit.
- 9 Connect one end of the test lamp with starter switch terminal and the other end to the earth with switch open. If the lamp burns bright, the solenoid is shorted. Replace the switch.

**TASK 2: Check the relay in horn circuit**

- 1 Disconnect the electrical connection from the horn relay (5) as shown in Fig 2.
- 2 Loosen the mounting nuts of the horn relay and remove it
- 3 Check the condition of the horn relay using a rheostat and volt meter.

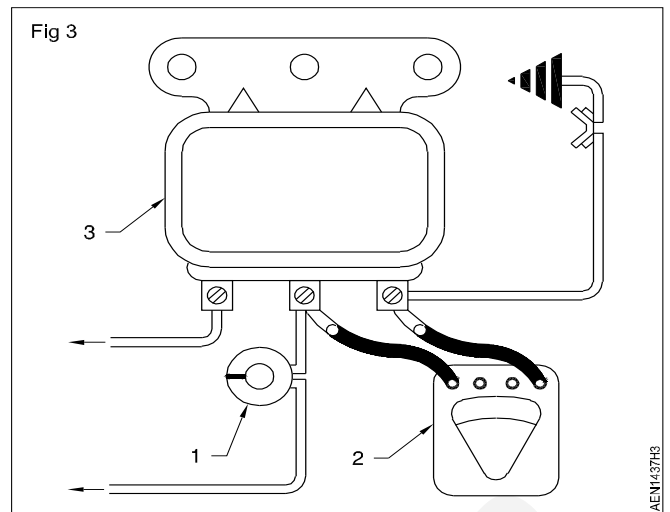
- 4 Connect the rheostat (1) in series to the battery and horn relay (3) (Fig 3)
- 5 Connect the volt meter (2) across the winding of the relay (3) to measure the closing voltage as shown in Fig (3)
- 6 Start the full resistance in the circuit. Slide the knob to increase or decrease the voltage on the relay winding.





**If there is an error when the relay point closes, adjust by bending the armature spring post**  
**[Increasing the spring tension increases the closing voltage]**

- 7 Replace the relay, if necessary.
- 8 Place the horn relay in its position and tighten the mounting nuts.
- 9 Refit the spring and the horn switch.
- 10 Fit the retainer and press it.



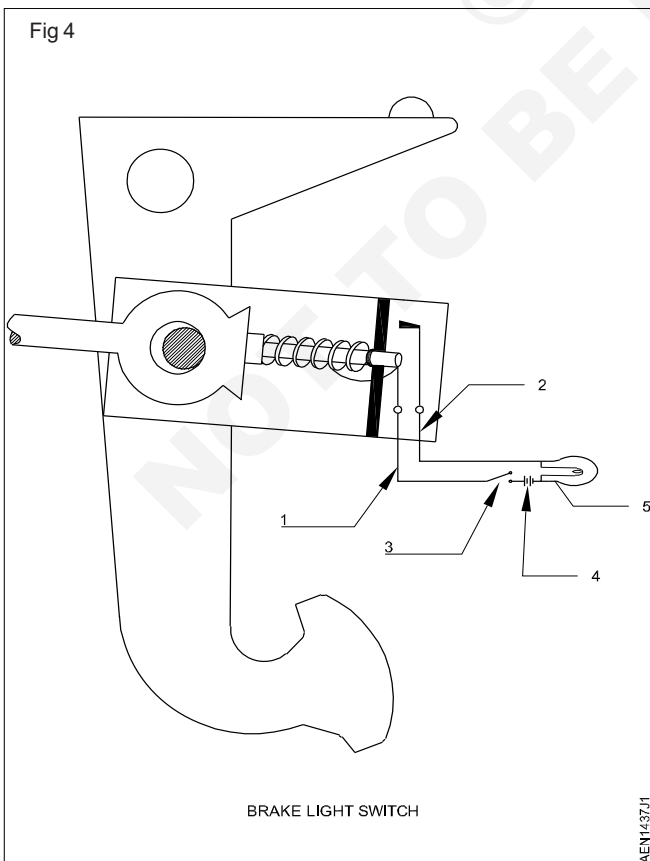
- 11 Connect the wires to the switch of the horn relay and sound the horn.
- 12 Operate the horn switch and test for the correct horn.

**Note:**

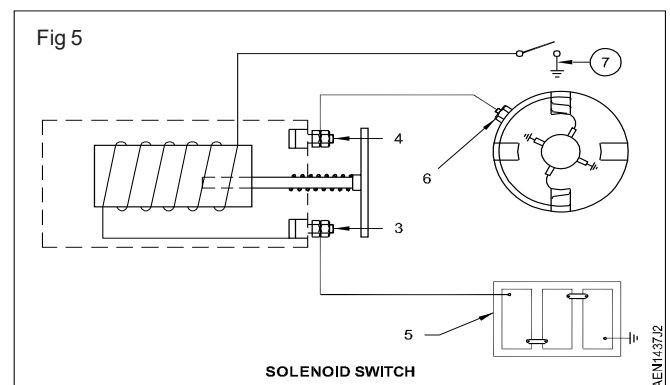
**Checking HL & Wiper motor relay.**  
**Repeat the Task of checking the Relay.**

### TASK 3: Check solenoid circuit

- 1 Check the brake light and solenoid switch visually. If there is any damage externally, replace.
- 2 Check the brake light switch terminal (1) & (2) and clean it. (Fig 4)



- 3 Check the wire connections from the brake light switch terminals (1 & 2) to the brake light lamp. Tighten, if they are found loose.
- 4 Check the battery cable connections from the battery (5) to the solenoid switch terminal (3). Tighten, if they are found loose.
- 5 Check the battery cable from the solenoid switch terminal (4) to the starting motor terminal (6). Tighten if it found loose. (Fig 5)



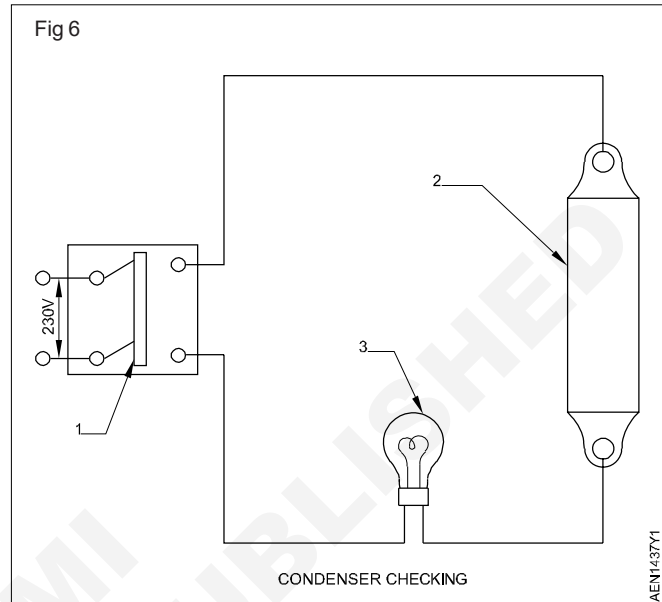
- 6 Check the wire connection from the solenoid switch terminal to the starting switch (7).
- 7 Connect the test lamp to the brake light switch terminal (1 & 2). If the switch is not closed, the lamp will glow.
- 8 Disconnect the cable wires from the solenoid switch.

- 9 Connect one end of the test lamp with the solenoid switch terminal (3) and ground the other end of the test lamp.
- 10 It will burn, but this test will not indicate short circuit.

- 11 Connect one end of the test lamp with starter switch terminal and the other end to the earth with switch open. If the lamp burns bright, the solenoid is shorted. Replace the switch.

#### TASK 4: Check condenser

- 1 Check the fiber head for wear; if necessary replace it. Connect the condenser as shown in the Fig 6. One side of the double pole, double throw switch (1) must be connected to the main, and the other side must be connected to the condenser (2) and test bulb (3) in series.
- 2 Put on the switch (1). If the bulb glows the condenser must be replaced by a new one.
- 3 If the bulb is not glowing, then the condenser is in proper condition.
- 4 Visually, check the cam, and replace, if required.
- 5 Check the magneto coils for open and short circuit with the help of an AVO meter. If found damaged replace the coil with a new one.



#### TASK 5: Test wiper motor circuit

- 1 To measure the supply voltage, connect the wiper as shown in Fig 7. Switch on the motor and measure the voltage between the motor supply terminal (2) and the good earthing point with a voltmeter.

**If the reading is low, check the battery cable connections and the panel switch (1).**

- 2 Disconnect the cable rack and measure the no-load running circuit with an ammeter connected in the supply line. (2.5 A to 3.5 A)

#### No-load test

- 3 Connect the wires to the motor and effect supply check at what voltage the motor starts functioning in no-load.

**For a 12-volt system the motor should start running from 4 volts.**

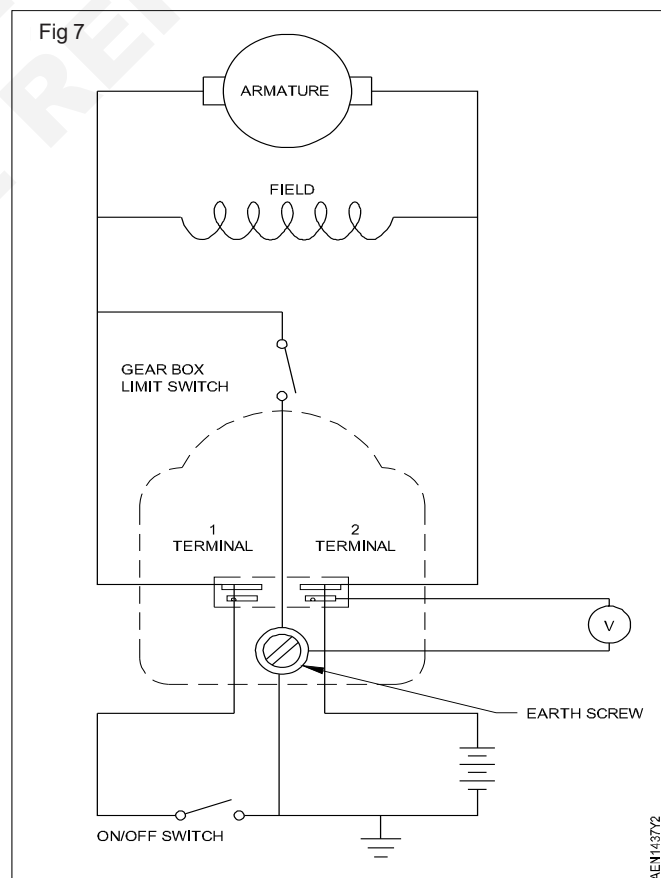
#### Checking the cable rack

- 4 Check the maximum force to move the cable rack by hooking the spring balance.

**The maximum permissible force is 2.7 kgs.**

#### Final checking

- 5 Test the wiping speed of the motor. It should be between 45 and 50 cycles/minute.



**Practice to identify and check the power & signal connectors**

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

- identify the power and signal connector
- verify selected connector continuity.

Requirements			
<b>Tools / Instruments</b>			
• Trainee's tool kit	- 1 No.	• Cable connector	- as reqd.
• Multi meter	- 1 No.	• Sensors	- as reqd.
• Transistor	- 1 No.	• Insulation tap	- as reqd.
• Data book	- 1 No.	• Cables	- as reqd.
<b>Equipment / Machines</b>		• Assorted types of diodes/Transistor	- 20 No./ each.
• CRDI- Engine	- 1 No.	• Blue, yellow, black Red color Red color sleeve wire	- 10 cms. each
<b>Materials</b>		• Patch cords	- as reqd.
• Cotton waste	- as reqd.		

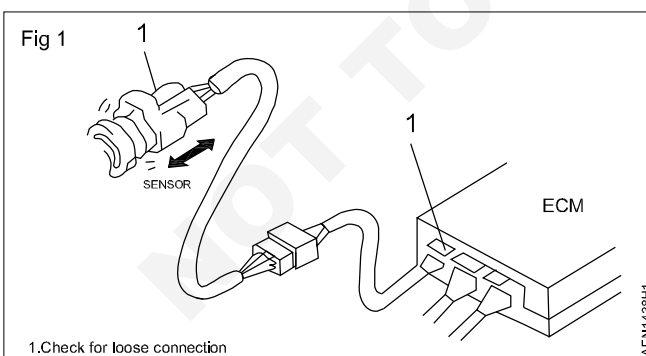
**PROCEDURE**

**TASK 1: Open circuit check**

- 1 Loose connection of connector
- 2 Poor contact of terminal (due to dirt, corrosion or rust on it, poor contact tension, entry of foreign object etc.
- 3 Wire harness being open power & signal connection for continuity

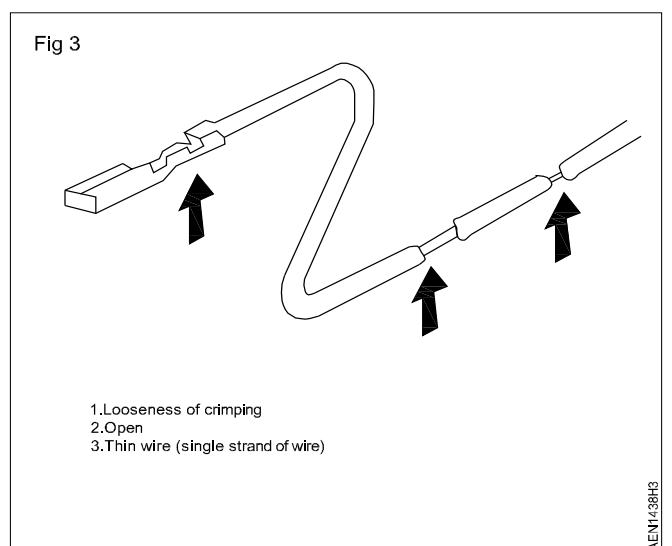
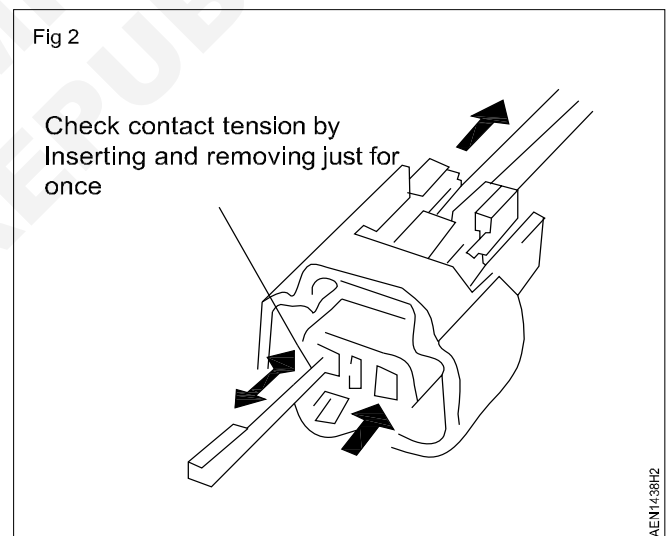
**Check for cable loose connection (Fig 1)**

- 1 Disconnect negative cable from battery.
- 2 Check each connector at both ends of the circuit being checked for loose connection (Fig 1). Also check lock condition of connector if equipped with connector lock.

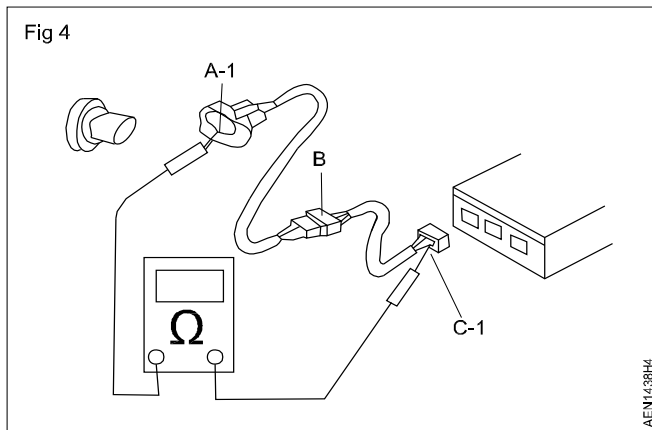


- 3 Using a test male terminal, check both terminals of the circuit being checked for contact tension of its female terminal. by dirt, corrosion, rust entry of foreign object, etc) (Fig 2)

At the same time, check to make sure that each terminal is locked in the connector fully. (Fig 3)



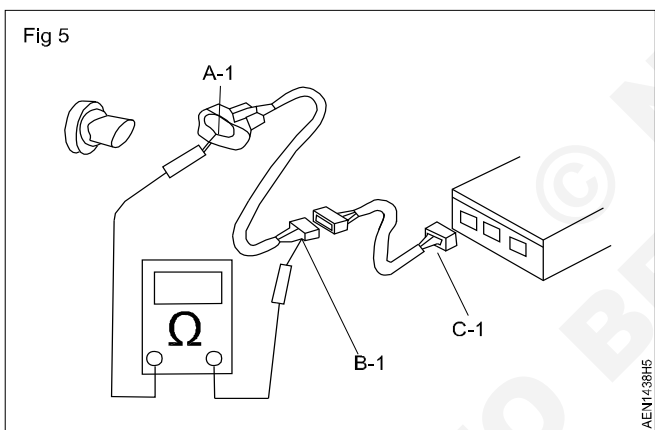
- 4 Using continuity check or voltage check procedure described in the following, check the wire harness for open circuit and poor connection with its terminals. Locate abnormality, if any. (Fig 4)



### Continuity check

- 5 Measure resistance between connector terminals at both ends of the circuit being checked (between A-1 and C-1 in the figure).

If no continuity is indicated (infinity or over limit), that means that the circuit is open between terminals A-1 and C-1. (Fig 5)



- 6 Disconnect the connector included in the circuit (Connector-B in the figure) and measure resistance between terminals A-1 and B-1.

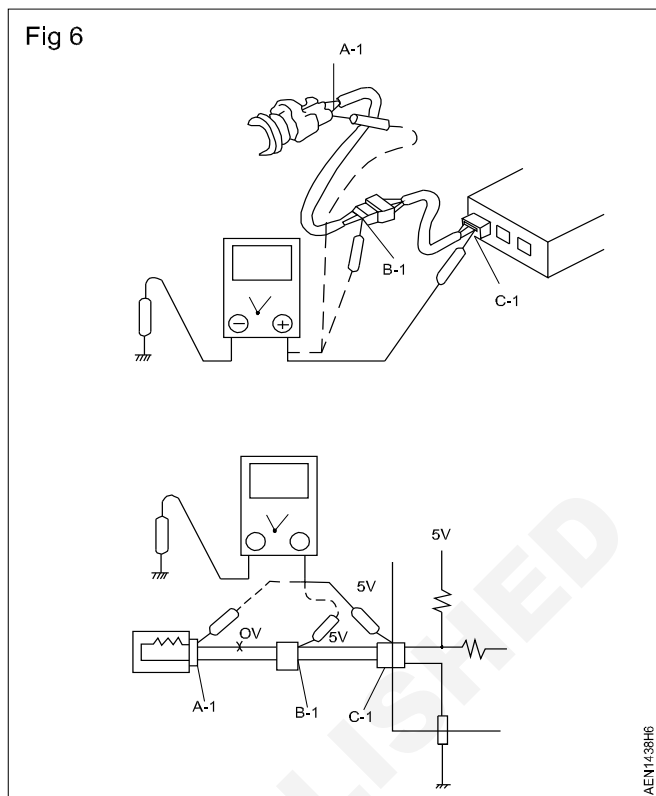
If no continuity is indicated, that means that the circuit is open between terminals A-1 and B-1. If continuity is indicated, there is an open circuit between terminals B-1 and C-1 or an abnormality in Connector-B.

### Voltage check (Fig 6)

If voltage is supplied to the circuit being checked, Voltage check can be used as circuit check.

- 7 With all connectors connected and voltage applied to the circuit being checked, measure voltage between each terminal and body ground.

If measurements were taken as shown in the figure at the left and results were as listed below, it means that the circuit is open between terminals B-1 and A-1.



### Voltage Between:

- C-1 and body ground: Approx. 5V
- B-1 and body ground: Approx. 5V
- A-1 and body ground: 0V

Also, if measured values were as listed below, it means that there is a resistance (abnormality) of such level that corresponds to the voltage drop in the circuit between terminals A-1 and B-1.

### Voltage Between:

- C-1 and body ground: Approx. 5V
- B-1 and body ground: Approx. 5V 2V voltage drop
- A-1 and body ground: Approx. 3V

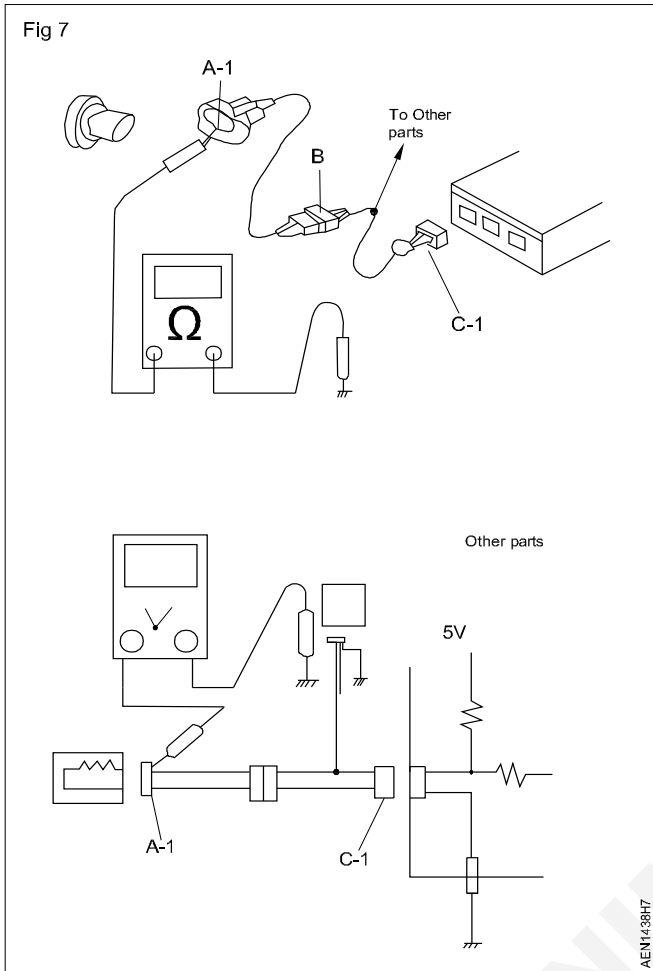
### Short circuit check (Wire harness to ground) (Fig 7)

- 8 Disconnect negative cable from battery.
- 9 Disconnect connectors at both ends of the circuit to be checked.

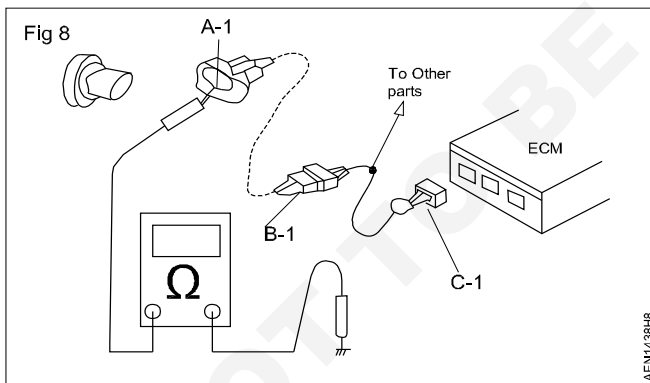
**Note: If the circuit to be checked is connected to other parts, disconnect all connectors of those parts. Otherwise, diagnosis will be misled.**

- 10 Measure resistance between terminals at one end of circuit (A -1 terminal in figure) and body ground. If continuity is indicated, it means that there is a short to ground between terminals A-1 and C -1 of the circuit.

- 11 Disconnect the connector included in circuit (connector B) and measure resistance between A-1 and body ground. (Fig 7)



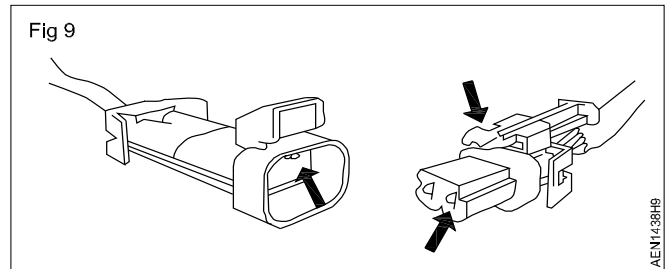
If continuity is indicated, it means that the circuit is shorted to the ground between terminals A-1 and B-1. (Fig 8)



### Intermittent and poor connection (Fig 9, 10)

Most intermittents are caused by faulty electrical connections or wiring, although a sticking relay or solenoid can occasionally be at fault. When checking it for proper connection, perform careful check of suspect circuits for:

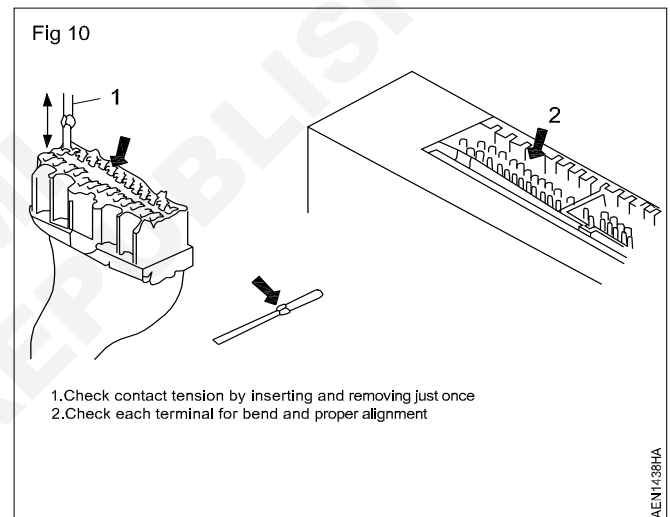
- 12 Poor mating of connector halves, or terminals not fully seated in the connector body (backed out).
- 13 Dirt or corrosion on the terminals. The terminals must be clean and free of any foreign material which could impede proper terminal contact.



14 Damaged connector body, exposing the terminals to moisture and dirt, as well as not maintaining proper terminal orientation with the component or mating connector.

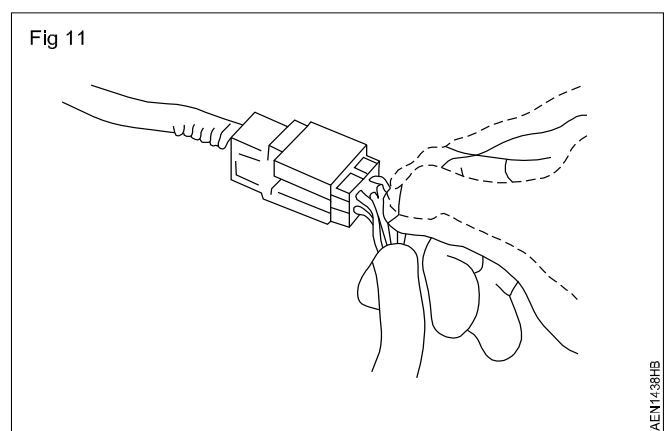
15 Improperly formed or damaged terminals.

Check each connector terminal in problem circuits carefully to ensure good contact tension by using the corresponding mating terminal. If contact tension is not enough, reform it to increase contact tension or replace.



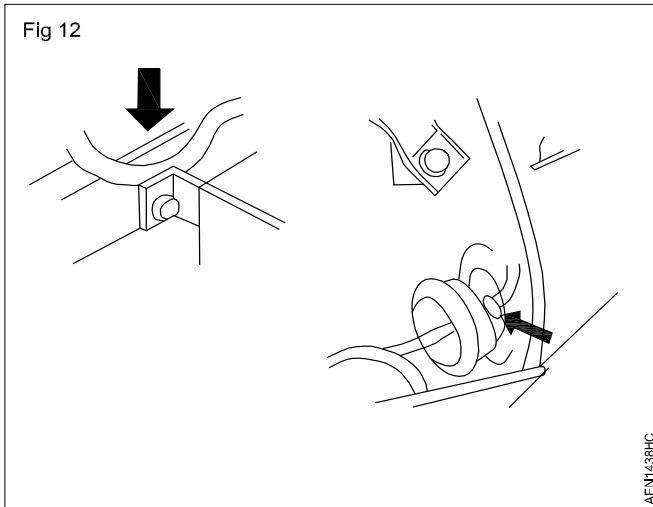
16 Poor terminal - to - wire connection. (Fig 11)

Check each wire harness in problem circuits for poor connection by shaking it by hand lightly. If any abnormal condition is found, repair or place.



17 Wire insulation which is rubbed through, causing an intermittent short as the bare area touches other wiring or parts of the vehicle.

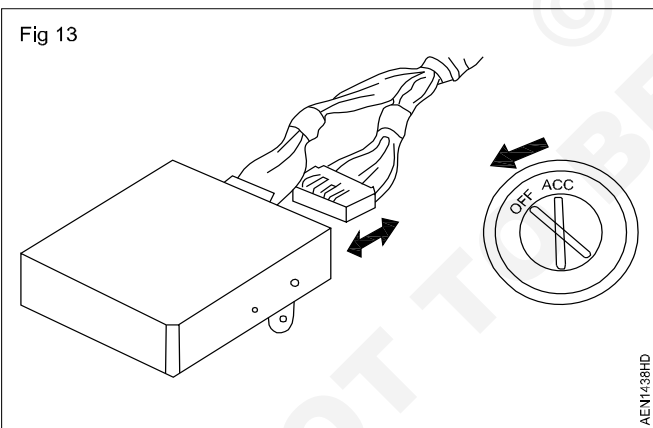
18 Wiring broken inside the insulation (Fig 12). This condition could cause continuity check to show a good circuit, but if only 1 or 2 strands of a multi-strand-type wire are intact, resistance could be far too high. If any abnormality is found, repair or replace.



### Precautions for electrical circuit service

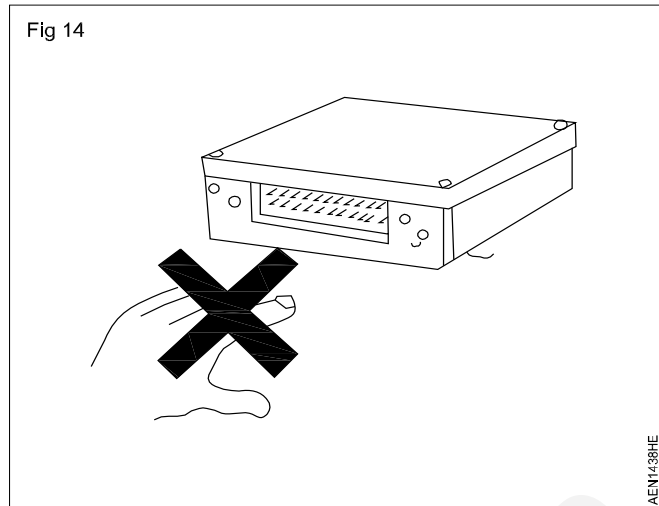
19 When disconnecting and connecting coupler, make sure to turn ignition switch OFF, or electronic parts may get damaged.

20 Be careful not to touch the electrical terminals of parts which use microcomputers (e.g. electronic control unit like as ECM, P/S controller, etc.). The static electricity from your body can damage these parts. (Fig 13)

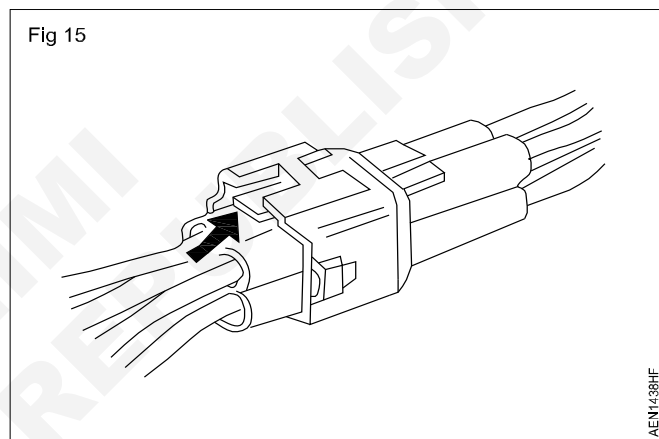


21 When disconnecting couplers, don't pull wire harness but make sure to hold coupler itself. With lock type coupler, be sure to unlock before disconnection. Attempt to disconnect coupler without unlocking may result in damage to coupler. When connecting lock type coupler, insert it till clicking sound is heard and connect it securely.

22 Never connect any tester (voltmeter, ohmmeter,) to electronic control unit when its coupler is disconnected. Attempt to do it may cause damage to it.(Fig 14)

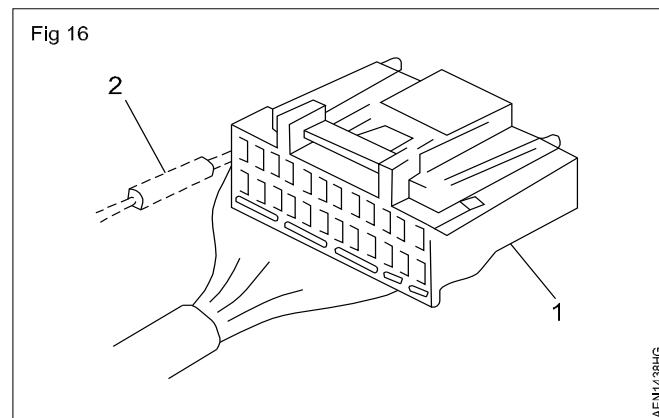


23 Never connect an ohmmeter to electronic control unit with its coupler connected to it. Attempt to do it may cause damage to electronic control unit and sensors. (Fig 15)



24 Be sure to use a specified voltmeter/ohmmeter. Otherwise, accurate measurements may not be obtained or personal injury may result. If not specified, use a voltmeter with high impedance ( $M \Omega$  minimum) or a digital type voltmeter.

25 When taking measurements at electrical connectors using a tester probe, be sure to insert the probe (2) from the wire harness side (backside) of the connector (1). (Fig 16)



# Practice to identify and test different types of diodes, NPN, PNP for it's functionality

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

- identify the type of diodes and its terminals
- check the diodes function with help of ohm meter/multimeter
- identify the transistor and test the transistor functions.

## TASK 1: Identify diode package and terminals

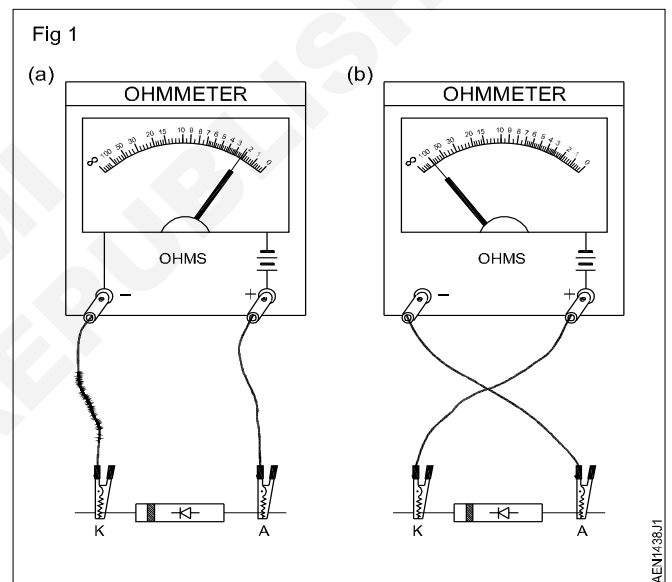
- 1 Pick any one diode from the given assorted lot. Record the code number printed on the diode in O&T sheet.
- 2 For the chosen diode, refer chart and identify and record the type of package (such as glass/plastic/ ceramic/metal etc.).
- 3 For the chosen diode referring to Chart identify and put a small red color sleeve over the anode terminal of the diode.
- 4 Repeat step 1 to 3 for at least 5 diodes of different types and get your work checked by your instructor.

## TASK 2: Check diodes using ohmmeter/multimeter

- 1 Set the ohmmeter/multimeter to 100 ohms range. Carryout resistance-zero-setting of meter.

### Choose other ohms range if necessary.

- 2 Pickup one of the identified diodes in Task 1. Connect the ohmmeter probes across the diode terminals as shown in Fig 1a. Record the resistance reading shown by the meter in Table 1 of O&T sheet.
- 3 Reverse the meter probes connected to the diode as shown in Fig 1b and record the reading shown by the meter in the Table 1.
- 4 From the readings noted in steps 2 and 3, calculate and record the ratio between forward and reverse resistance.
- 5 From the recorded information give your conclusion about the condition of the diode. Use the tips given - below for making conclusion;
  - In good diodes, resistance will be less than 100 ohms in one direction and very high or almost infinity/open in the other direction. In the worst cases the ratio between low to high resistance could be at least 1:1000.
  - Shorted diodes show zero or very low resistance in both directions.



- Open diodes shows infinity/open in both directions.
- 6 Repeat step 2 to 4 for at least ten more given diodes of different types.
  - 7 Get the work checked by your instructor.

**Observation & Tabulation Sheet**

Table - 1

Label Number	Code Number printed on the DIODE	Type of package	Resistance value in		Ratio between forward and reverse resistance	Condition of diode FIT/UNFIT
			one direction	opposite direction		

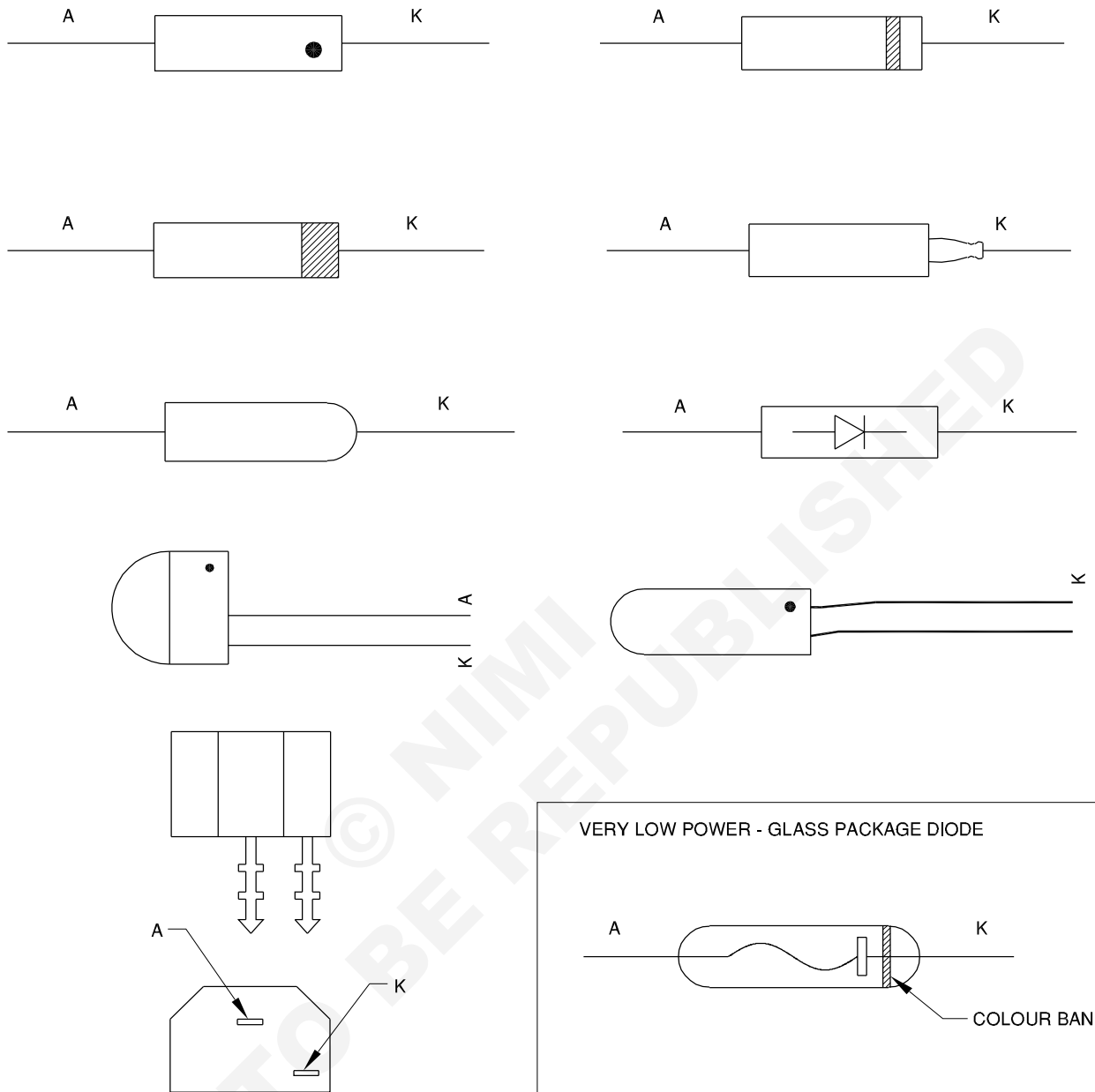
(Trainee)

(Instructor)

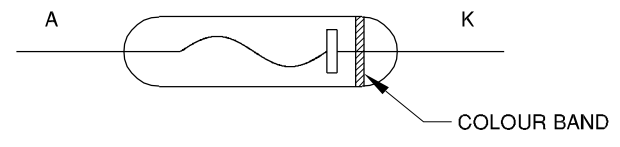


Fig 1

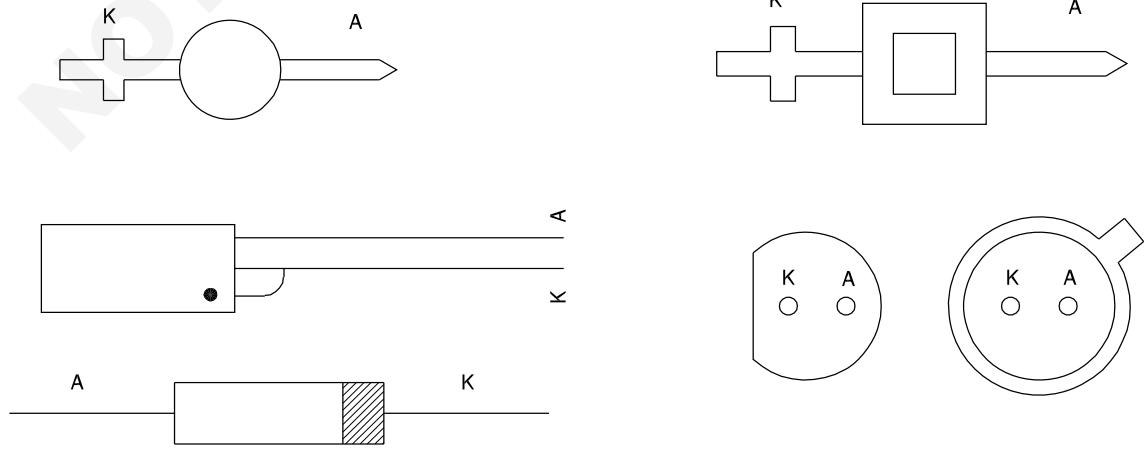
LOW POWER - PLASTIC PACKAGE DIODE



VERY LOW POWER - GLASS PACKAGE DIODE



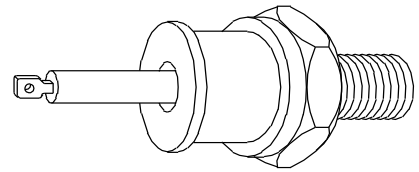
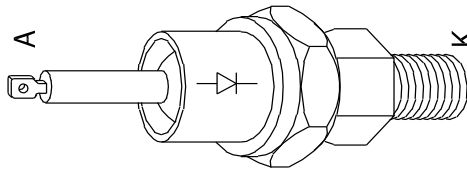
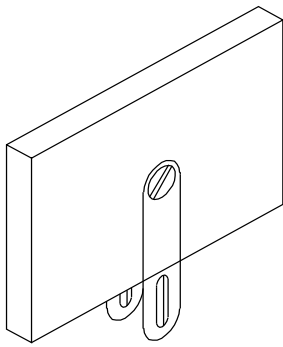
LOW POWER - METAL PACKAGE DIODE



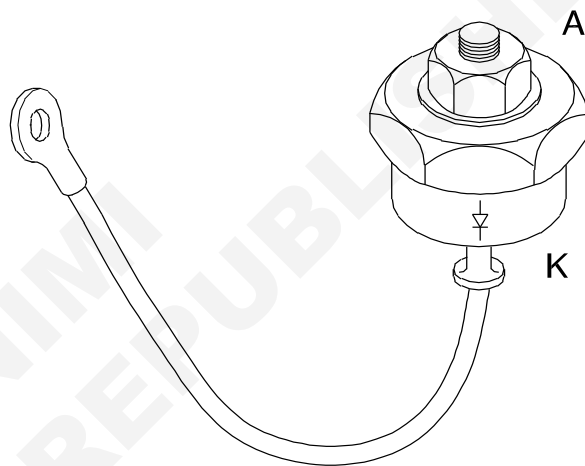
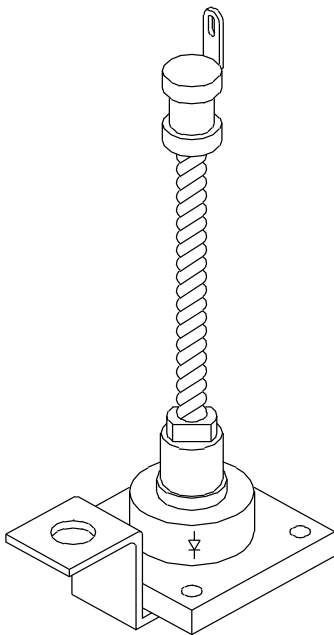
AEN1438C1

Fig 2

HIGH POWER - METAL PACKAGE DIODE



VERY LOW POWER - METAL PACKAGE DIODE



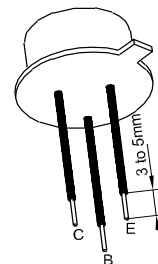
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**TASK 3: Identify transistor type and leads, referring to data manual**

- 1 Take any one transistor from the given assorted lot, enter its label number and transistor type number in Table 1.
- 2 Refer to transistor data manual and find and record the following details of the transistor in Table 1 of O&T sheet.
  - Whether silicon or germanium
  - Whether NPN or PNP
  - Type of packaging or case outline (Example: TO5, TO7 etc.)
- 3 From the type of package recorded, the transistor data manual and draw the pin diagram indicating base, emitter and collector for the transistor, in Table 1.
- 4 Put sleeves of suitable length, as shown in Fig 1, to the identified pins of the transistor using the color scheme given below.

- |           |   |                     |
|-----------|---|---------------------|
| Base      | - | Blue color sleeve   |
| Emitter   | - | Red color sleeve    |
| Collector | - | Yellow color sleeve |
| Shield    | - | Black color sleeve  |

Fig 1



AEN1438X1

**Note: In some power transistors, the metal body itself will be the collector. In such cases mark 'C' on the metal body using a pencil. All transistors will not have shield pin.**

5 Repeat steps 1 to 4 for atleast five transistors of different types in the given lot and get your work checked by your instructor.

1 Identify which terminal of the ohmmeter being used is connected to the +ve terminal of the internal battery of the meter. Set the meter range to Rx100W.

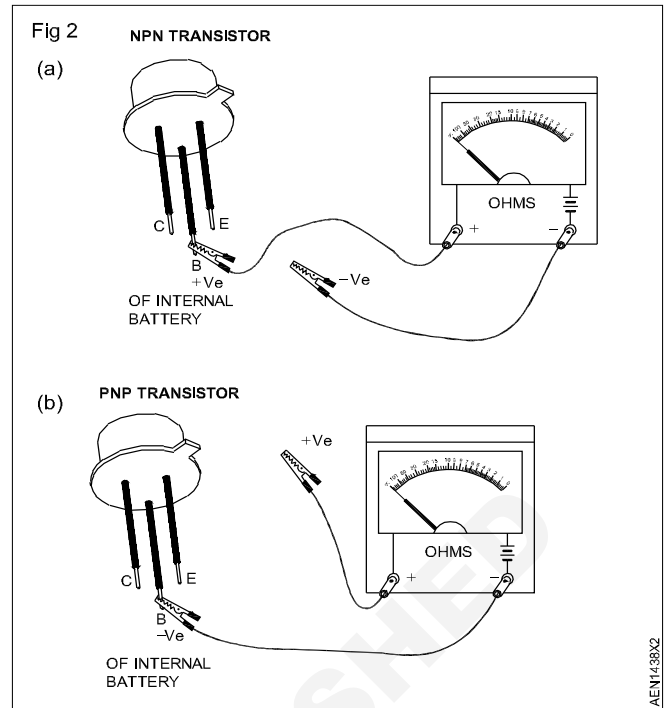
Ohmmeters in very low or very high ohms range can produce excessive current/voltage and may damage low power transistors while testing.

2 Take a transistor whose pins are identified and sleeved at Task 3. Depending on whether the chosen transistor is NPN or PNP, clip/hold the +ve or -ve of the meter prod to the base of the transistor as shown in Figs 2a and 2b.

3 Clip the other meter prod to the emitter. Check if the base-emitter junction diode of transistor shows low resistance (few tens of ohms) or very high resistance (few tens of kilo ohms). Record your observation in Table 1.

4 Reverse the polarity of the prod connected across the base-emitter and check if the base-emitter junction diode of transistor shows low resistance or very high resistance. Record your observation in Table 1.

5 From the recorded observations in steps 3 and 4, and referring to the table given below, conclude and record, the condition of the base-emitter junction diode of the transistor as GOOD, open or shorted in Table 1 of O&T sheet.



**Note: If the resistance of the junction measured in both directions is high, in addition to the condition of the junction given in table, one other possibility is, your identified base pin may be wrong. You may be measuring resistance across emitter-collector. In case of doubt, recheck the identified pins of the transistor and repeat steps 2, 3 and 4.**

Table 1

Resistance of P-N junction with meter prods in one direction	Resistance of P-N junction with meter in reversed direction	Condition of P-N junction
Low	Very High	Good
Low	Low	Shorted

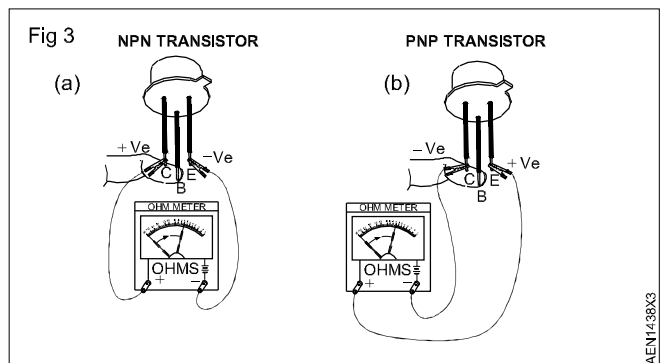
6 Repeat the steps 2,3,4 and 5 and check the condition of the base-collector junction diode of the transistor.

7 Measure the resistance across the emitter-collector and record the observation as V-HIGH (> 1MW) or LOW (< 500W).

**Note: In a good transistor the resistance between the emitter and collector will be very high. A low resistance indicates that the transistor is leaky.**

8 Clip the meter across the emitter-collector with correct polarity as shown in Fig 3. Touch the base-collector with moist fingers as shown in Fig 3 and check if the resistance shown by the meter decreases indicating that the transistor is turning ON. Record your observation as YES or NO in Table 1 of O&T sheet.

9 From the observations recorded at steps 5,6,7 and 8, give your conclusion on the overall condition of the transistor under test.



10 Repeat steps 1 to 9 for atleast five more transistors of different types.

11 Get your work checked by your instructor.

## Practice to make a straight beads and joints Oxy-Acetylene welding film on heat

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

- setup the oxy-acetylene gas welding plant connecting all components
- test for gas leakages at all connections
- set the required gas pressures on the regulators
- set neutral, oxidising and carburising flames.

### Requirements

#### Tools / Instruments

- Trainee's tool kit - 1 No.
- Spanner D/E - 1 No.
- Cylinder key - 1 No.
- Pressure gauge - 1 No.
- Trolley - 1 No.

#### Equipment / Machines

- Air compressor - 1 No.

- Oxy-acetylene plant - 1 No.
- Regulator (Left and Right threads) - 1 No each.
- Nozzle cleaner - 1 No.

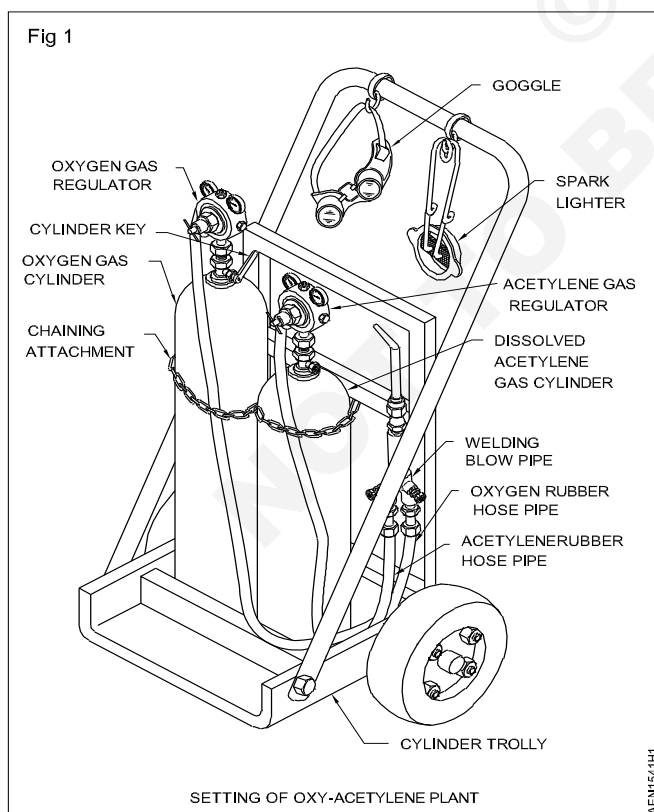
#### Materials

- Soap oil - as reqd.
- Cotton rag - as reqd.
- Filler rod - as reqd.

## PROCEDURE

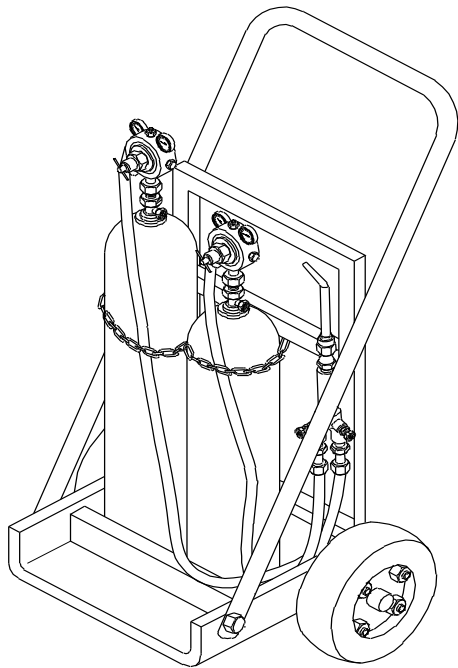
### Oxy-acetylene welding

#### 1 Setting up oxy-acetylene plant Fig 1



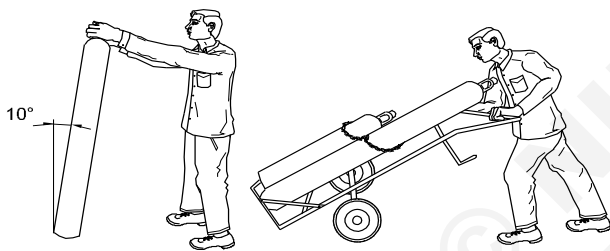
- 2 Move oxygen and acetylene cylinders with the caps from the store to the gas welding area. An oxygen cylinder is identified by the black color painted on it. An acetylene cylinder is identified by the maroon color painted on it. Also the oxygen cylinder will be taller than an acetylene cylinder and the diameter of oxygen cylinder will be less than the diameter of an acetylene cylinder.
- 3 Ensure full cylinders are kept separately from the empty cylinders.
- 4 Position the gas cylinders in a trolley and secure them with a chain.
- 5 Always keep the cylinders upright/vertically in the cylinder stand/on the floor. (Fig 2)
- 6 While moving, the gas cylinder should be kept slightly
- 7 inclined to the vertical position and the protector cap used to avoid damage to the cylinder valves. (Fig 3)
- 8 Do not roll the cylinder horizontally on the ground.
- 9 Remove the cylinder caps. Crack the gas cylinder valves by quickly opening and closing them using the cylinder key. (Fig 4).
- 10 Dirt and dust particles from the cylinder valve sockets are cleaned by cracking the cylinder valve. This will avoid leakage of gas due to improper seating of the cylinder valve and also to prevent the dust particles from entering into the regulators which may cause damage to the regulators.

Fig 2



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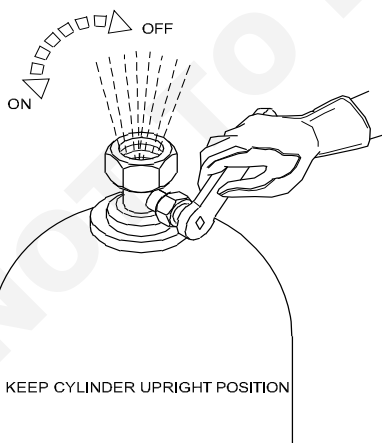
Fig 3



AEN1541H3

Fig 4

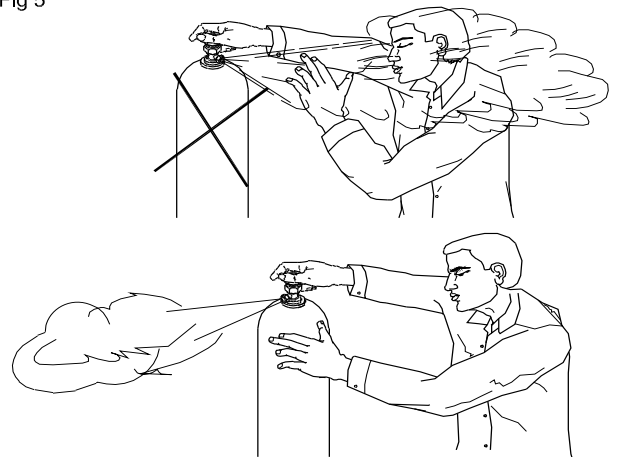
BLOW OUT THE CYLINDER VALVE SOCKET BEFORE CONNECTING THE REGULATOR CRACKING OPEN THE CYLINDER VALVE MOMENTARILY



AEN1541H4

11 Always stand opposite to the valve outlet while cracking the cylinders. (Fig 5)

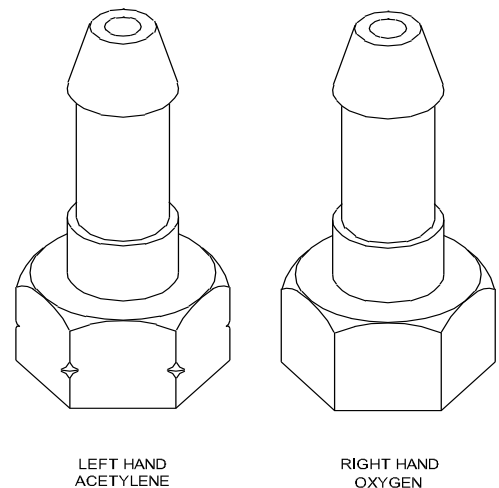
Fig 5



AEN1541H5

- 12 Ensure that your hands are free from grease or oil.
- 13 Connect the oxygen regulator to the oxygen gas cylinder (right hand threads).
- 14 Connect the acetylene regulator to the acetylene gas cylinder (left hand threads)
- 15 Ensure the pressure adjusting screws of both regulators are in a released condition.
- 16 Be sure to connect the correct regulator on cylinders. Acetylene connections have left hand thread and oxygen has right hand thread.
- 17 The acetylene regulator connecting nut will have a groove cut on it (Fig 6) and the pressure gauge dial will be of maroon color.

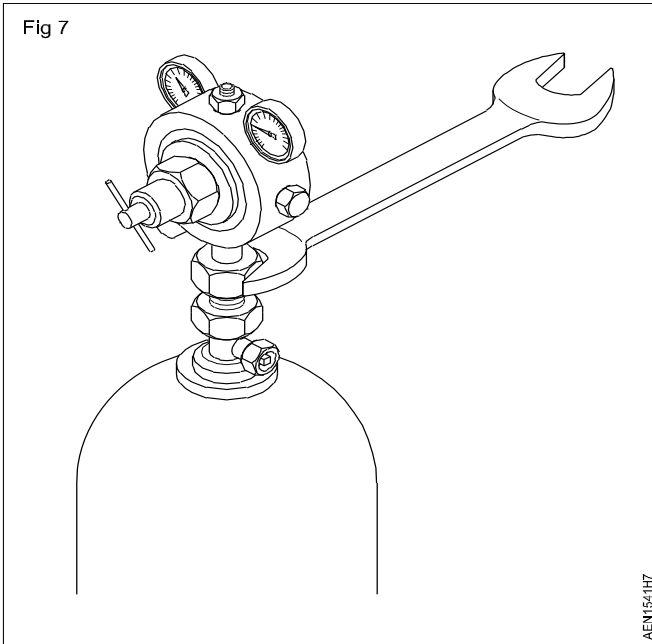
Fig 6



AEN1541H6

- 18 All threaded connections should be fixed initially by tightening by hands and then only a spanner should be used. This will help to avoid assembly with cross thread leading to damage to threads.
- 19 Always use the correct size spanner to prevent damage to the threads. (Fig 7)

Fig 7

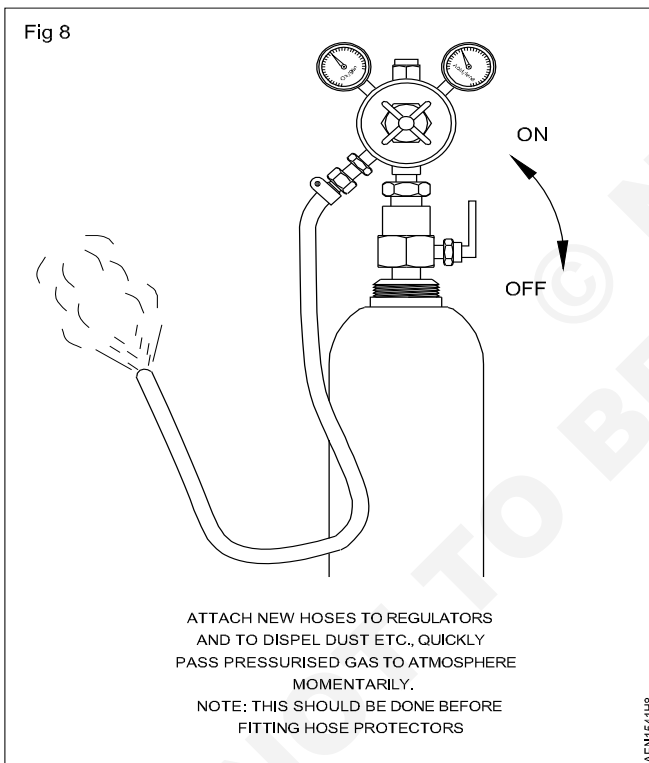


AEN15/117

### Attaching blowpipe

20 The other end of the hose-pipe is to be attached to the blowpipe inlets. (Fig 8)

Fig 8



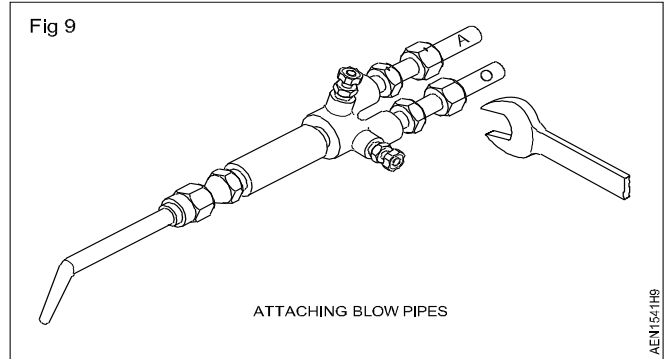
ATTACH NEW HOSES TO REGULATORS AND TO DISPEL DUST ETC., QUICKLY PASS PRESSURISED GAS TO ATMOSPHERE MOMENTARILY.  
NOTE: THIS SHOULD BE DONE BEFORE FITTING HOSE PROTECTORS

AEN15/118

21 Fix the hose-protectors at the blowpipe ends. The hose protectors with a groove at the corners are fixed on the acetylene hose-pipe and connected to the acetylene inlet of the blowpipe. The hose-protectors without cutting marks are fixed on the oxygen hose-pipe and connected to the oxygen inlet of the blowpipe. (Fig 9)

22 The hose-protectors protect against the return of gas from the blowpipe to the rubber hoses. They act as non-return valves.

Fig 9



ATTACHING BLOW PIPES

AEN15/119

### Adjusting the gas pressure

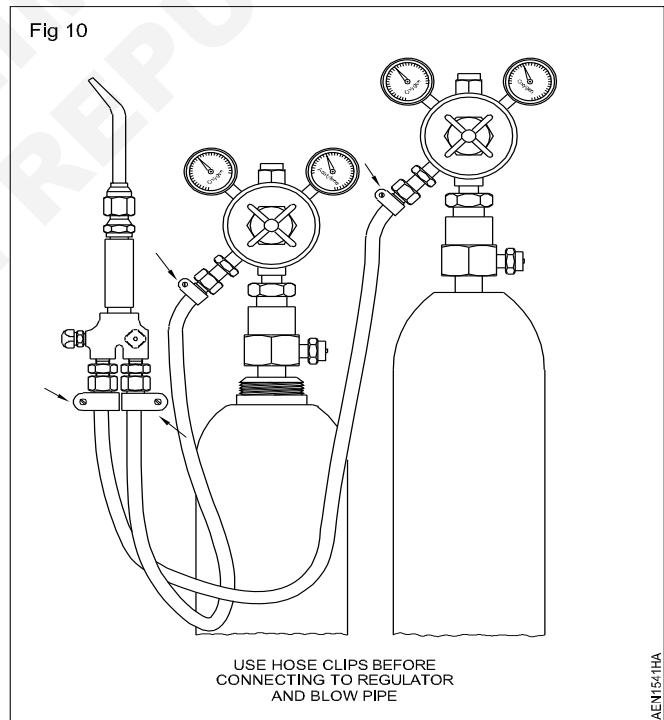
34 The gas pressure for both oxygen and acetylene has to be adjusted at regulators according to the size of the nozzle.

24 The size of the nozzle is selected according to the material and thickness.

25 For adjusting the gas pressure, open the valves of both the cylinders slowly by on turn and set the pressure on both regulators as 0.15 kg / cm<sup>2</sup> for small size nozzle tightening the pressure adjusting screws. (Fig 10) Ensure the blow pipe control valves are kept open while setting gas pressure.

26 The pressure can be read on the working pressure of gas regulators.

Fig 10



USE HOSE CLIPS BEFORE CONNECTING TO REGULATOR AND BLOW PIPE

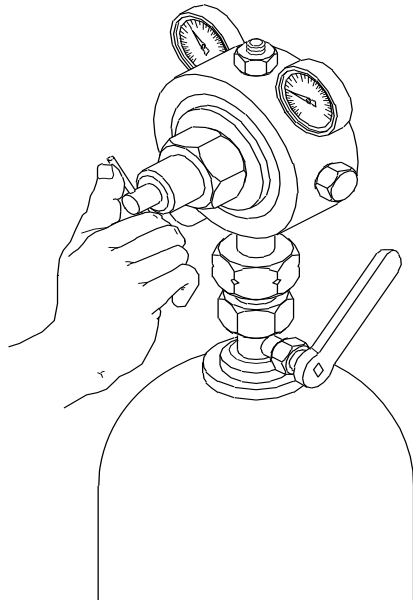
AEN15/114

### Testing for leakage

27 All connections must be tested for leakage.

28 Apply soap water solution for acetylene connections and fresh water for oxygen connections. (Fig 11)

Fig 11



AEN1541HB

29 Use of soap water on oxygen connections may lead to fire hazards.

30 Never use matches or flame light during leakage test.

**Lighting the flame**

31 Attach the recommended size of nozzle to the neck of the welding blowpipe i.e nozzle No.3.

32 Open the gas cylinders and adjust the recommended gas pressure on the regulators.

33 The pressure of oxygen and acetylene is 0.15kgs/cm<sup>2</sup> for nozzle No.3.

34 Open cylinder valves very slowly.

35 While setting pressure on the regulator, keep the blowpipe control valve open for accurate setting.

36 Open the acetylene control valve 1/4 turn on the blowpipe and ignite with a spark lighter. (Fig 12) Acetylene burns using the oxygen in the atmospheric air with a black smoke.

37 Avoid using any other source of fire other than the spark lighter.

38 Point the blowpipe in a safe direction in the open space, away from you and others.

39 Increase the acetylene till the black smoke disappears. (Fig 13)

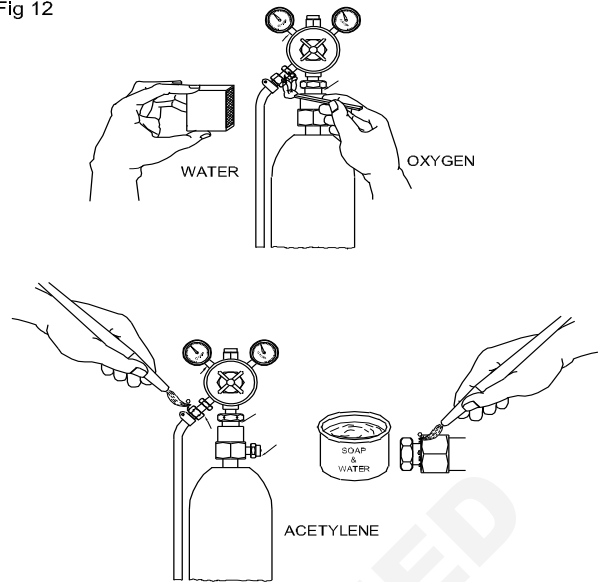
40 Observe the flame and add oxygen by opening the oxygen control valve of the blowpipe. Now a bright white cone starts appearing at the tip of the nozzle. (Fig 14)

**Flame adjusting to set different types of oxy-acetylene flames.**

41 To adjust the neutral flame, and sufficient oxygen to make the white cone clear and round. (Fig 15)

42 The gas mixture from the blowpipe has equal volume of oxygen and acetylene.

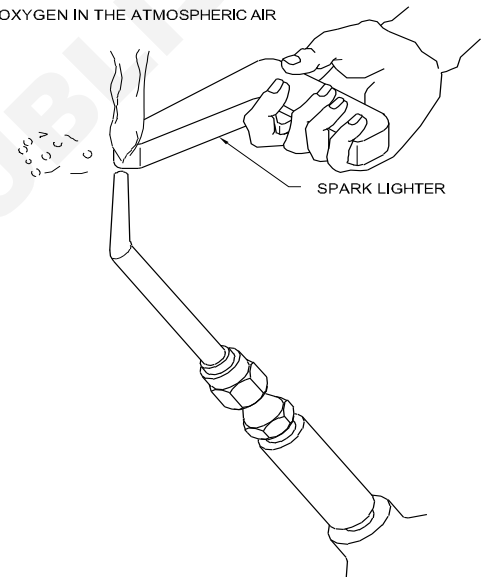
Fig 12



AEN1541HC

Fig 13

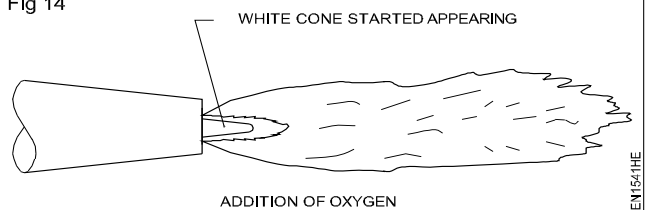
ACETYLENE BURNS USING OXYGEN IN THE ATMOSPHERIC AIR



AEN1541HD

Fig 14

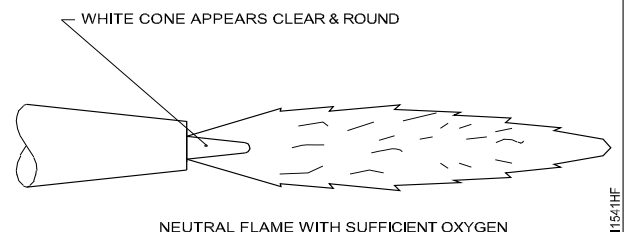
WHITE CONE STARTED APPEARING



AEN1541HE

Fig 15

WHITE CONE APPEARS CLEAR & ROUND

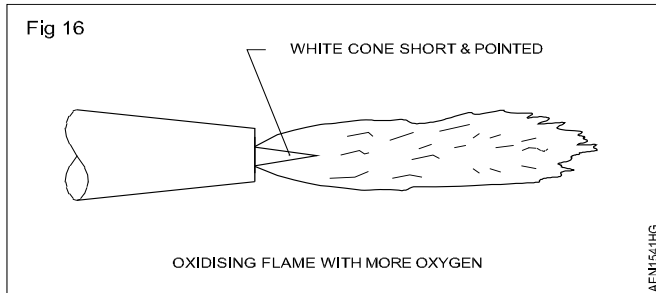


AEN1541HF

43 To adjust the oxidising flame, from neutral flame decrease acetylene flow.

44 The white cone will become short and sharp.

45 The flame will produce a hissing sound and will have a short length. (Fig 16)

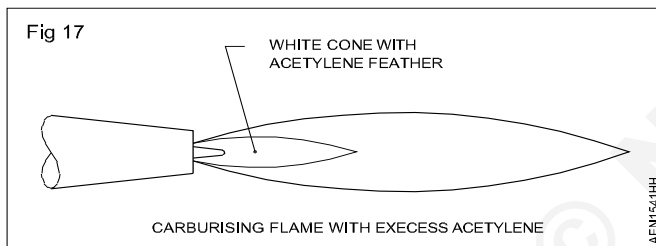


46 The gas mixture from the blowpipe has more volume of oxygen than acetylene.

47 To adjust the carburising flame, adjust the flame to neutral and then add acetylene.

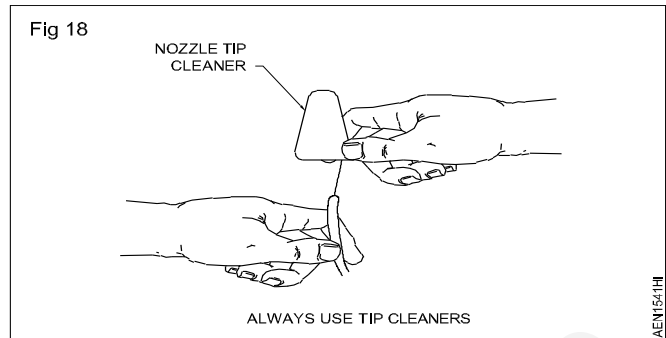
48 The white cone will become long surrounded by a feather like portion.

49 The flame will burn quietly having more length. (Fig 17)



50 The gas mixture from the blowpipe has more volume of oxygen than acetylene than oxygen.

51 After continuous use of the blow pipe during welding the nozzle may get blocked by metal particles or spatters. This blockage has to be removed to get continuous flow of gases by using a nozzle cleaner. (Fig 18)



52 Close the acetylene cylinder valve.

53 Close the oxygen cylinder valve.

54 Open the blowpipe acetylene valve and release all the gas pressure.

55 Open the blowpipe oxygen valve and release all the gas pressure.

56 Both the pressure gauges on the regulators should read zero.

57 Release the acetylene regulator pressure adjusting screw.

58 Close the blowpipe acetylene valve.

59 Close the blowpipe oxygen valve.

Ensure

- there is no fire around the equipment
- the gas is completely exhausted by dipping the nozzle in water.

## Skill Sequence

### Fusion runs without filler rod in flat position

**Objectives:** This shall help you to

- fusion runs without filler rod in flat position
- fusion runs with filler rod in flat position.

#### Fusion runs without filler rod in flat position

Mark and cut the M.S. sheet pieces of size 152 x 122 x 3.15mm using a hand lever shear.

**Care should be taken to keep the fingers off from the shearing blades. Wear gloves to avoid injury.**

Straighten the cut pieces by hammering on an anvil.

File and finish the sheet to dimensions as per drawing.

Mark and punch parallel lines on the sheet surface as per sketch and set the job piece on the welding table in flat position with fire brick support.

Select and attach nozzle size 3 to the blowpipe.

**Wear safety apparels and gas welding goggles.**

Set acetylene and oxygen pressure 0.15 kg/cm<sup>2</sup> on the regulators.

Ignite the oxy-acetylene gases and adjust the neutral flame.

Hold the blowpipe on the job at its right hand end at the required angle.

Start heating the surface on the right end of the sheet with slight circular motion to the blowpipe and produce a molten pool on the marked line.



Move the blowpipe from right to left direction maintaining a uniform speed and blow pipe angle.

Avoid excessive concentration of heat at any one point.

**If the metal becomes too hot, lift the blowpipe momentarily away from the molten pool.**

**Do not touch the inner cone with the molten pool, to avoid backfire and flashback.**

Keep the molten pool in correct size by adjusting the rate of travel and giving slight circular motion to the blowpipe.

Stop at the left end and lift the blowpipe quickly.

Extinguish the flame and cool the blowpipe in water.

Clean the fused surface with a steel wire brush and inspect for the uniformity of fusion runs.

**If the speed of travel and blowpipe motion are correct, the fusion runs will appear with uniform width and even ripples.**

**Repeat the above 4 more times to achieve uniform fusion and better manipulation of blow pipe.**

#### **Fusion run with filler rod in flat position**

Select and fix the nozzle size and set acetylene /oxygen pressure 0.15 kg/cm<sup>2</sup>

Select copper-coated, mild steel, (CCMS) filler rod of  $\varnothing$ 1.6 mm.

Wear safety apparels and gas welding goggles.

Ignite the oxy-acetylene gases and set the neutral flame.

Hold the blowpipe on the right hand at an angle of 60°-70° with the punched line of the job and make a small molten pool at the right hand edge of the line.

Keep the flame cone distance 2.0 to 3.0 mm above 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.

Melt the base metal at the right end of a punched line and create a molten pool/puddle.

Fuse the end of the filler rod by dipping at the center of the molten pool and add filler metal on the job surface to form a weld bead.

Move both the blow pipe and the filler rod towards left with uniform speed along the punched line with a slight circular motion to the blowpipe.

Move the filler rod up and down (piston like motion) at a constant speed.

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

Adjust the rate of travel of the blowpipe with the filler rod to control the size of the bead and the required penetration/depth of fusion.

Keep the filler rod end within the flame outer flame to avoid oxidation.

Stop at the left hand end of the punched line by filling the crater properly.

Extinguish the flame and cool the nozzle.

Clean the weld surface. Inspect for even ripples and uniform width/height of weld bead.

Repeat this for the remaining 4 more punched lines to achieve better manipulation of blow pipe and filler rod.

#### **Heat treatment process**

Instructor provide the different type of heat treatment process video in the class room

Ask the trainees to write the purpose of heat treatment

Ask the trainees to write the different type of heat treatment process

Ask the trainees to write the name of auto components and type of heat treatment process

## **Fusion run with and without filler rod MS sheet 3.15mm**

**Objectives:** This shall help you to

- clean and setting the job piece making fusion run without filler rod
- making fusion run with filler rod
- restarting and stopping of weld.

The beginner for gas welding must practice:

- holding the blowpipe in the correct position
- fusing of the metal by using a proper blow pipe manipulation
- getting proper coordination of both hands to manipulate the blow pipe and filler rod together

- deposit fusion run in a straight line from the right end to the left end of the job.

#### **Preparation of sheet for welding**

**Use gloves while handling sheets.**

Shear the MS strip to get job pieces 152 mm long x 122mm wide x 3.15 mm thick size.

2 mm is the shearing allowance so that the finished size after filing will be 150 x 120mm.

Remove buckling of sheet due to shearing by hammer on the anvil.

File the irregular edges of the job to remove burrs and unevenness on the edge to get a sheet size of 150 x 120mm.

### Cleaning and setting job piece

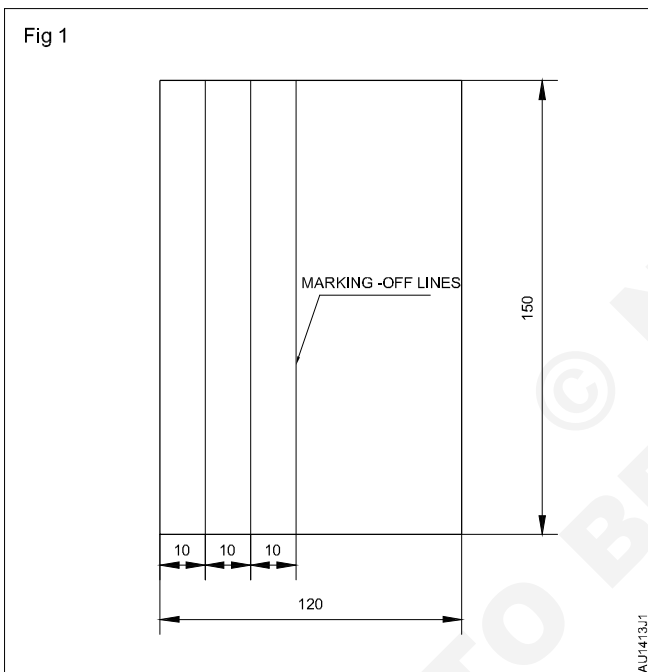
Remove rust if any using a wire brush and emery paper.

Do not rub with heavy pressure on the wire brush.

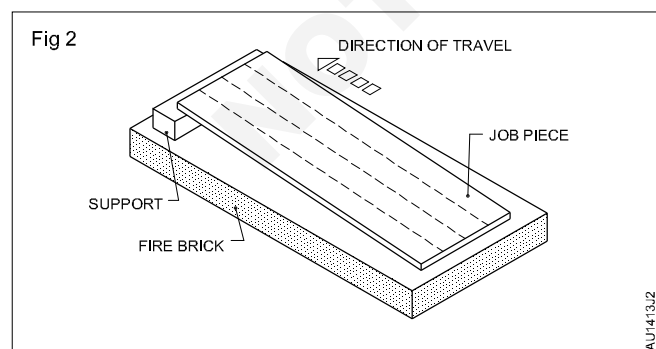
Use the emery paper rolled on a piece of wood while cleaning.

Remove paint, oil or grease by dipping the M.S. sheet in a solvent of dilute hydrochloric acid.

Draw lines parallel to the longer edge of the sheet at 10mm from one edge and punch along the lines to serve as a guide. Fig 1



Keep the job on the work table on a fire brick (Fig 2) to reduce the heat conduction and to position the job flat.

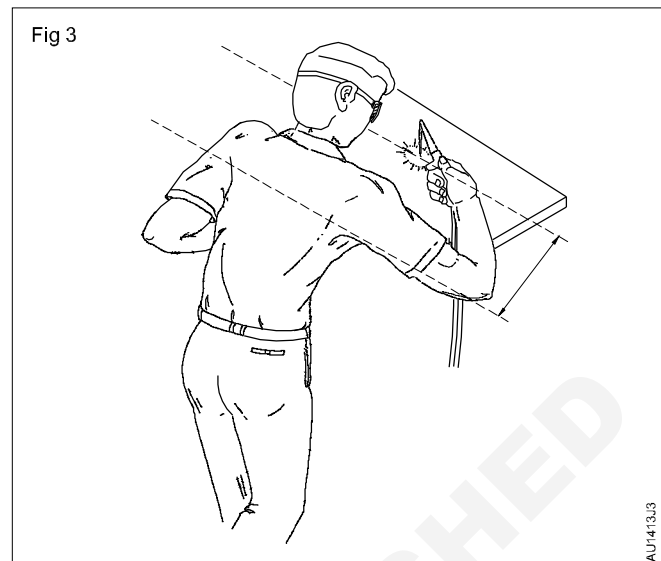


Use welding goggles.

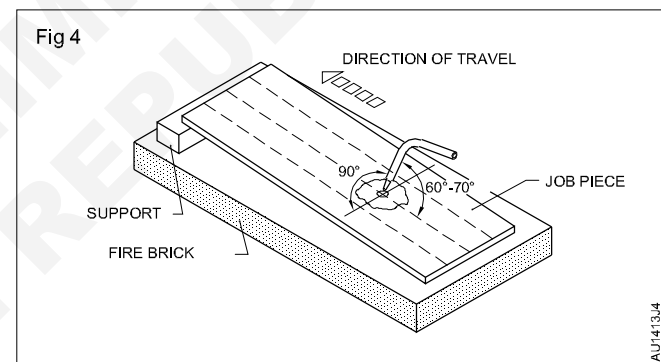
Hold the blowpipe and flame in correct position (angle) for proper fusion.

Position the blowpipe in such a way that:

- the punched lines of the sheet is parallel to the operator (Fig 3)



- there is less fatigue to the hand of the operator
- the angle of the nozzle with the welding line is between  $60^\circ - 70^\circ$ . The angle between the nozzle and the job surface should be  $90^\circ$ . (Fig 4)

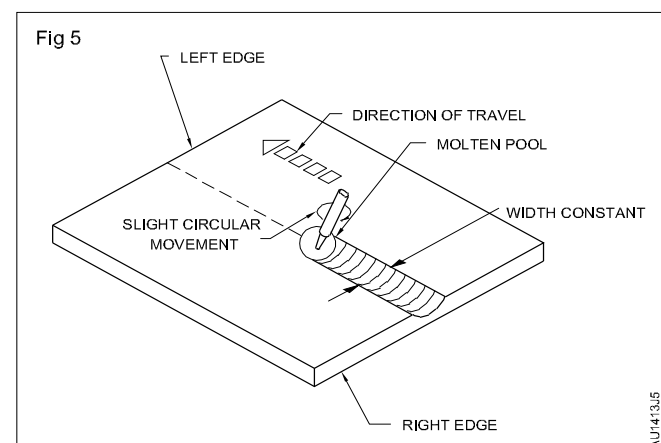


Fuse the metal to form a small puddle of molten pool on the job surface at the right end.

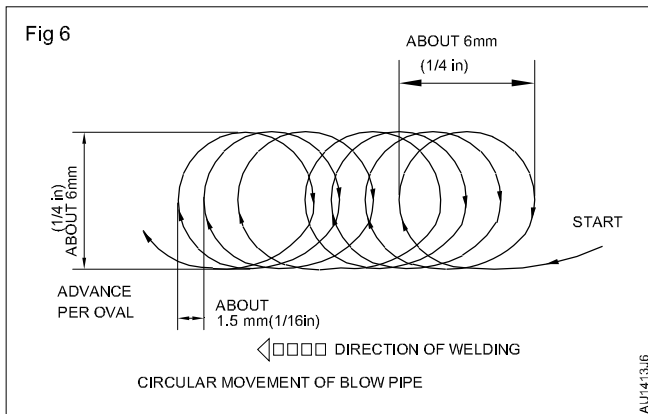
### Making fusion run without filler rod

Move the blowpipe in the leftward direction as local fusion is obtained at the right end of a line.

Keep the molten pool on the punch line. (Fig 5)



Maintain constant speed of travel with slight circular motion to the blowpipe. (Fig 6)



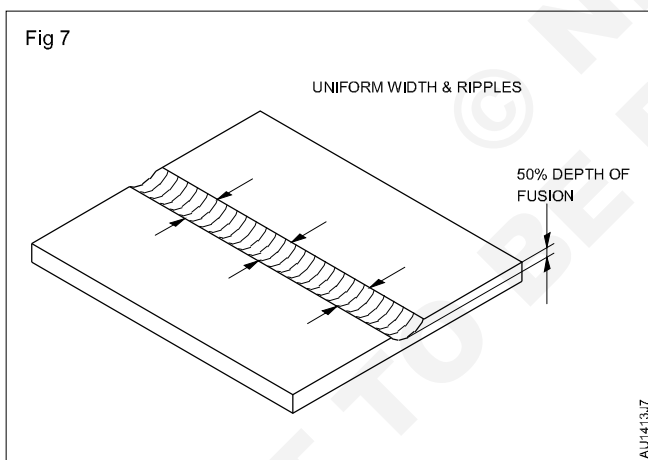
Reduce the blowpipe angle slightly near the left edge and slowly withdraw the flame to avoid burn through at the end.

Maintain a constant distance of 2-3mm between the white cone of the flame and the sheet surface for proper heat input and to avoid backfire.

### Visual inspection of fusion run

Visual examination can be done to ensure uniform width, ripples and proper depth of fusion (penetration) (Fig 7) for the bead after the welded job is cleaned thoroughly to remove the scales from its surface.

**Use tongs while handling hot jobs.**



**Making fusion run with filler rod:** During gas welding, most of the joints require filler metal to obtain proper size of weld and to get a strong joint. So while the flame melts the base metal, it also melts the filler rod to fill the groove or depression in the joint.

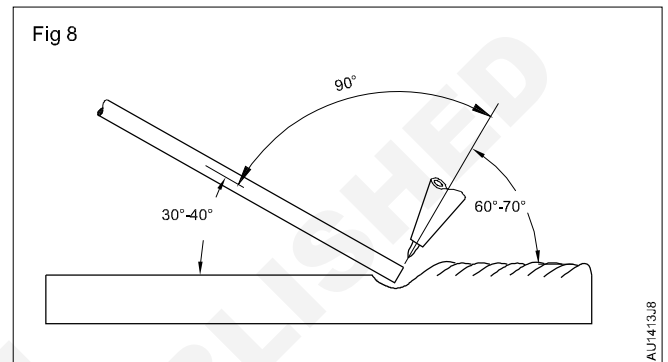
The feeding of filler metal in molten pool requires special skills.

**The heat input by the flame depends on the volume of acetylene and oxygen gas burnt. Different size nozzles will give different volume of gases and heat required to melt the metal depends on the thickness of metal to be welded. So select nozzles based on thickness of base metal to be welded.**

For 3.15mm thick MS sheet select No.5 nozzle and fix it to the blowpipe.

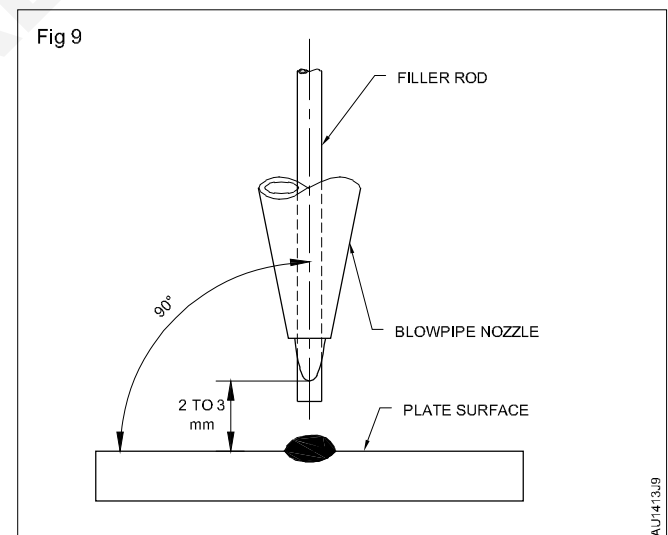
Blowpipe angle  $60^\circ - 70^\circ$  with weld line (towards right). Filler rod angle  $30^\circ - 40^\circ$  with weld line (towards left). (Fig 8)

**This angle helps in moving the molten puddle along the line of weld and keeps the unwanted materials like scale, any dirt, etc. away from the molten pool. This also controls the depth of fusion (penetration) to the required extent. In addition the visibility of the melting region is better.**



Keep the blowpipe and filler rod at  $90^\circ$  to the plate surface, so that the metal melts equally on both sides of the inner cone of the flame. (Fig 9)

Fuse the metal surface, maintain the molten pool and add filler metal with proper motion.



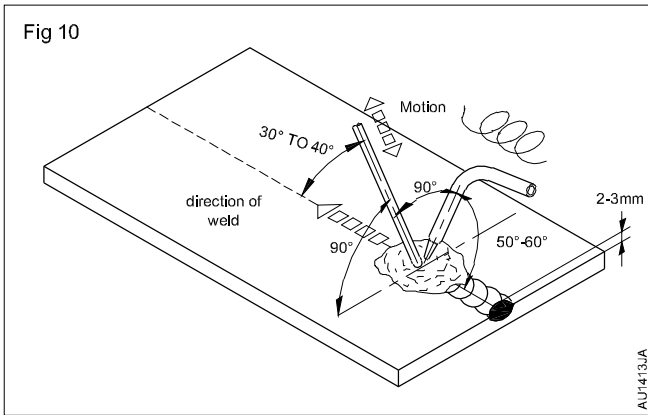
For the blowpipe, a slight circular motion is required and for the filler rod, a piston like motion (Fig 10) (up and down) is required.

Maintain the flame cone distance to metal surface 2-3 mm.

Move the blowpipe and filler rod in leftward direction, along the punch-marked straight line, to progress the weld. (Fig 11)

Add filler rod in the weld pool to get 0.5 to 1 mm weld reinforcement above the sheet surface.

Fig 10



AU1413JA

### Stopping

Reduce the angle of the blowpipe and filler rod as the weld pool reaches the left end to control burn-through.

Build up the crater by adding enough filler metal, by dropping a few drops of molten metal at the crater.

Remove the flame slowly but cover the weld pool with the end of the flame's outer envelope to protect it from atmosphere.

Remove the filler rod end from the weld zone before the weld pool solidifies.

### Inspection of the deposited run

Look for the following on the deposited bead.

**Depression at various points on the bead. (This is due to variation in speed of travel of the blowpipe; improper feeding of the filler rod; wrong restarting; splashing of molten pool due to inner cone of flame touching the molten metal.)**

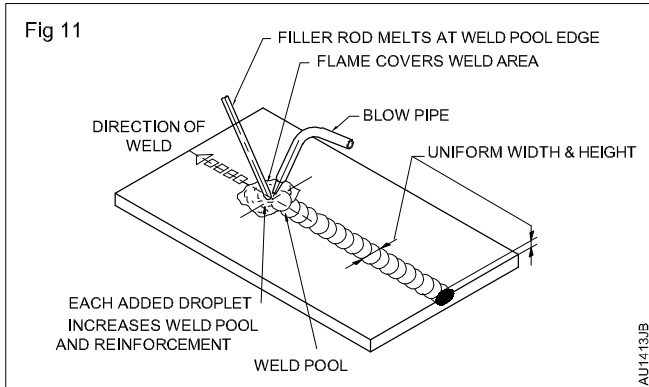
**Undercut at the toes of the bead. (This is due to excessive pressure of gases and setting harsh flame; improper manipulation of the blowpipe; improper feeding of the filler rod.)**

**Concave bead surface. (This is due to harsh flame and excessive pressure of gases; inadequate feed of filler rod.)**

**Porosity. (This is due to improper cleaning of the sheets; rusted filler rod.)**

**The correct bead is shown in Fig 13.**

Fig 11



AU1413JB

Maintain constant speed, angles and motion during welding for the blowpipe and the filler rod.

Keep the end of the filler rod within the outer envelope of the flame to avoid its oxidation.

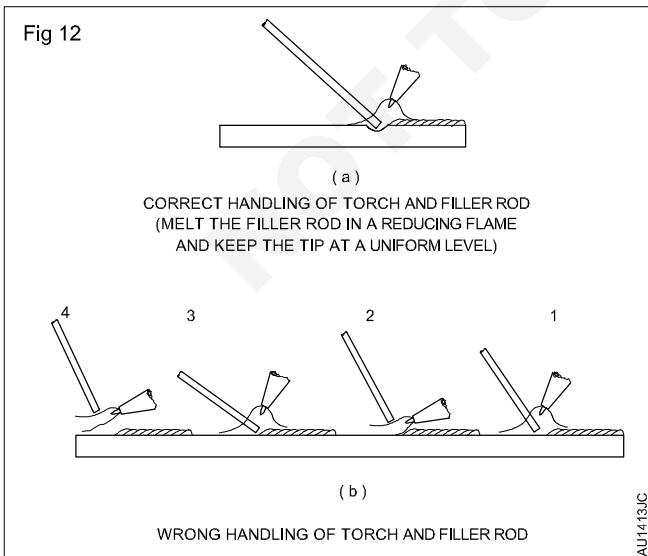
### Restarting and stopping of weld

#### Restarting

Hold the blowpipe nozzle at 80° angle with the cone pointing on the last 3 mm of weld bead deposited i.e. the crater. (Fig 12)

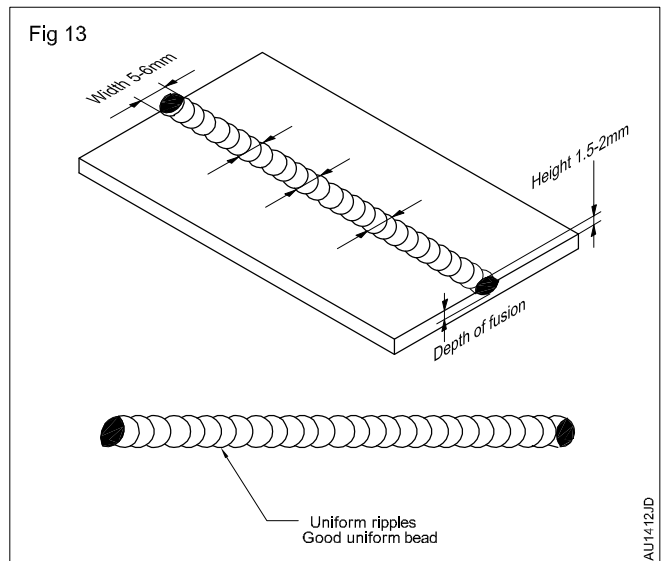
Re-melt the weld bead at crater to form a molten pool, add filler rod and proceed with the deposition.

Fig 12



AU1413C

Fig 13



AU1412JD

**Practice to identify the components hydraulic clutch**

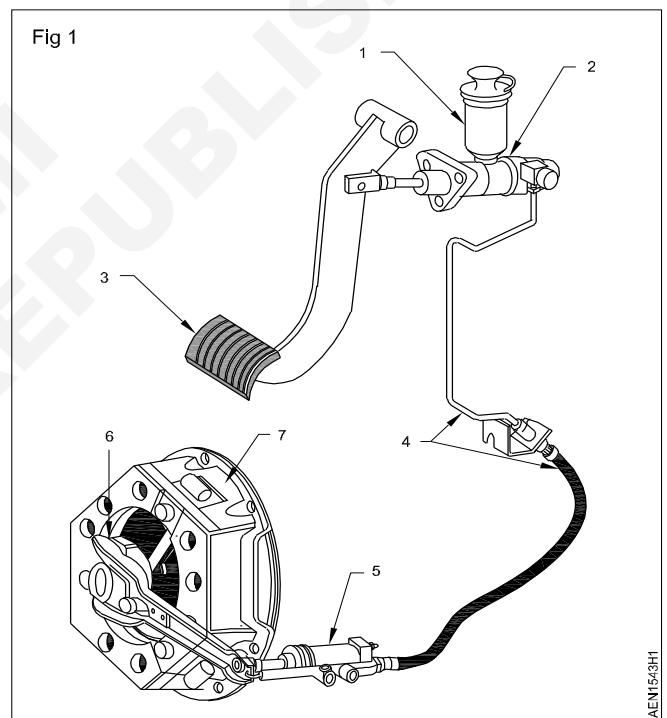
**Objective:** At the end of this exercise you shall be able to  
 • identify the hydraulic clutch components.

Requirements		
<b>Tools / Instruments</b>		<b>Materials</b>
• Trainee's tool kit	- 1 No.	• Hydraulic oil - as reqd.
<b>Equipment / Machines</b>		• Cotton waste - as reqd.
• Hydraulic clutch vehicle	- 1 No.	• Soap oil - as reqd.
• Pneumatic brake vehicle	- 1 No.	

**PROCEDURE**

**Locate hydraulic clutch components on a vehicle**

- 1 Place the vehicle on the level ground.
- 2 Support the vehicle tyre with stoppers (wooden block)
- 3 Apply hand brake.
- 4 Open the bonnet.
- 5 Remove the negative battery cable.
- 6 Trace the hydraulic clutch system and locate the components i.e. Master cylinder reservoir, Master cylinder, Slave cylinder, Hydraulic lines and Throw-cut lever.
- 7 Identify the parts in the system as shown in Fig 1.
- 8 Write the name of the parts in the Table 1.



**Table 1**

Sl. No.	Label No.	Name of the Parts
1	2	Master cylinder
2	5	
3	4	
4	1	
5	3	

**Practice to trace and study of hydraulic circuits**

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

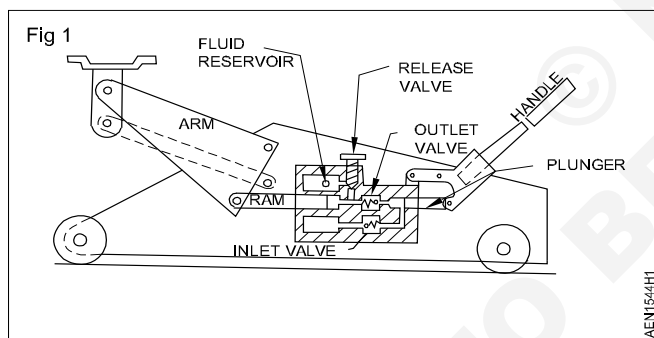
- identify the parts of hydraulic jack
- identify the parts of hydraulic power steering
- identify the parts of hydraulic brake.

<b>Requirements</b>			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee's tool kit	- 1 No.	• Cotton waste	- as reqd.
• Bleeding kit	- 1 No.	• Hydraulic fluid	- as reqd.
<b>Equipment / Machines</b>		• Soap oil	- as reqd.
• Hydraulic jack trolley type	- 1 No.		
• Hydraulic power steering vehicle	- 1 No.		
• Hydraulic brake vehicle	- 1 No.		

**PROCEDURE**

**TASK 1: Hydraulic jack**

1 Place the cut section model of the hydraulic jack on the work bench. (Fig 1)



- 2 Trace the hydraulic jack system and locate the components i.e, reservoir, plunger, Non return valve Ram, Relief valve and shut off valve,
- 3 Identify the parts in the system as shown in Fig 1
- 4 Write the name of the parts in the table 1
- 5 The following parts should be matched as given below column (a), arm (b), fluid reservoir (c), Release valve (d), out let valve (e) handle (f) plunger (g) & Inlet valve (h).

**Table 2**

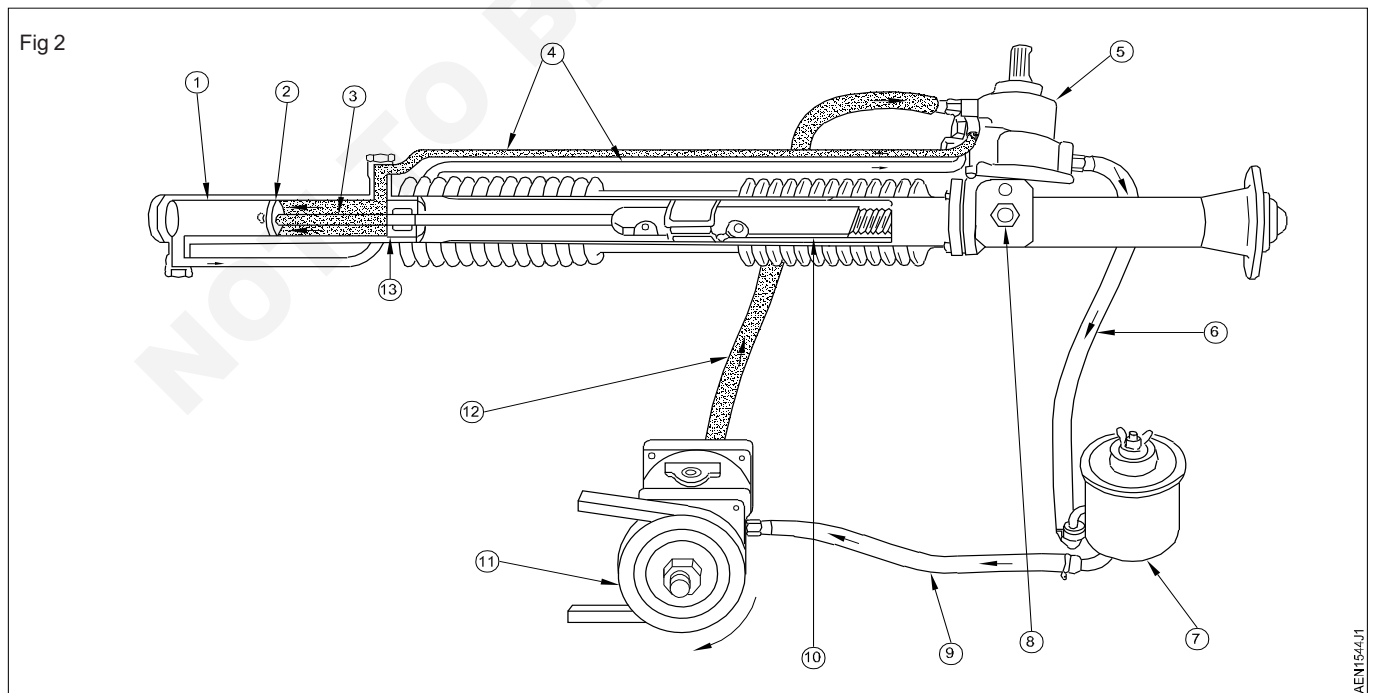
SI. No.	Label word	Name of the parts
1	f	
2	d	
3	b	
4	g	
5	e	
6	a	
7	c	

**TASK 2: Trace and Identify the hydraulic components of power assisted steering**

- 1 Place the cut-section model of the hydraulic power assisted steering (PAS) on the work bench.
- 2 Draw the line diagram of hydraulic power assisted steering system
- 3 Locate the parts of the hydraulic power assisted steering system (Fig 2) i.e. Suction line, Hose, Seal mount with sealing ring, Cylinder, Piston rod, steering gear, return line, Piston, Pressure pad adjusting screw, High pressure pump, Rack and Pressure lines
- 4 Write the name of the parts in the Table 1.

**Table 1**

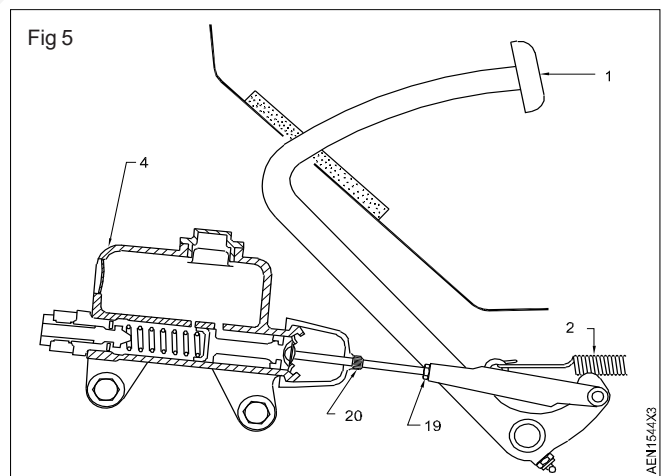
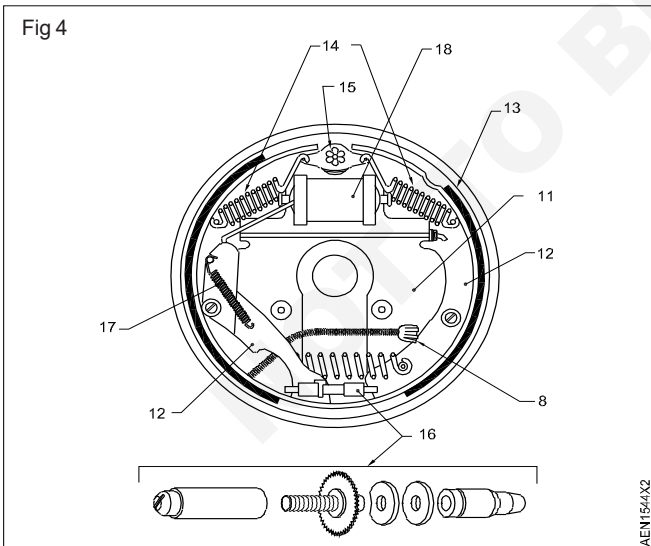
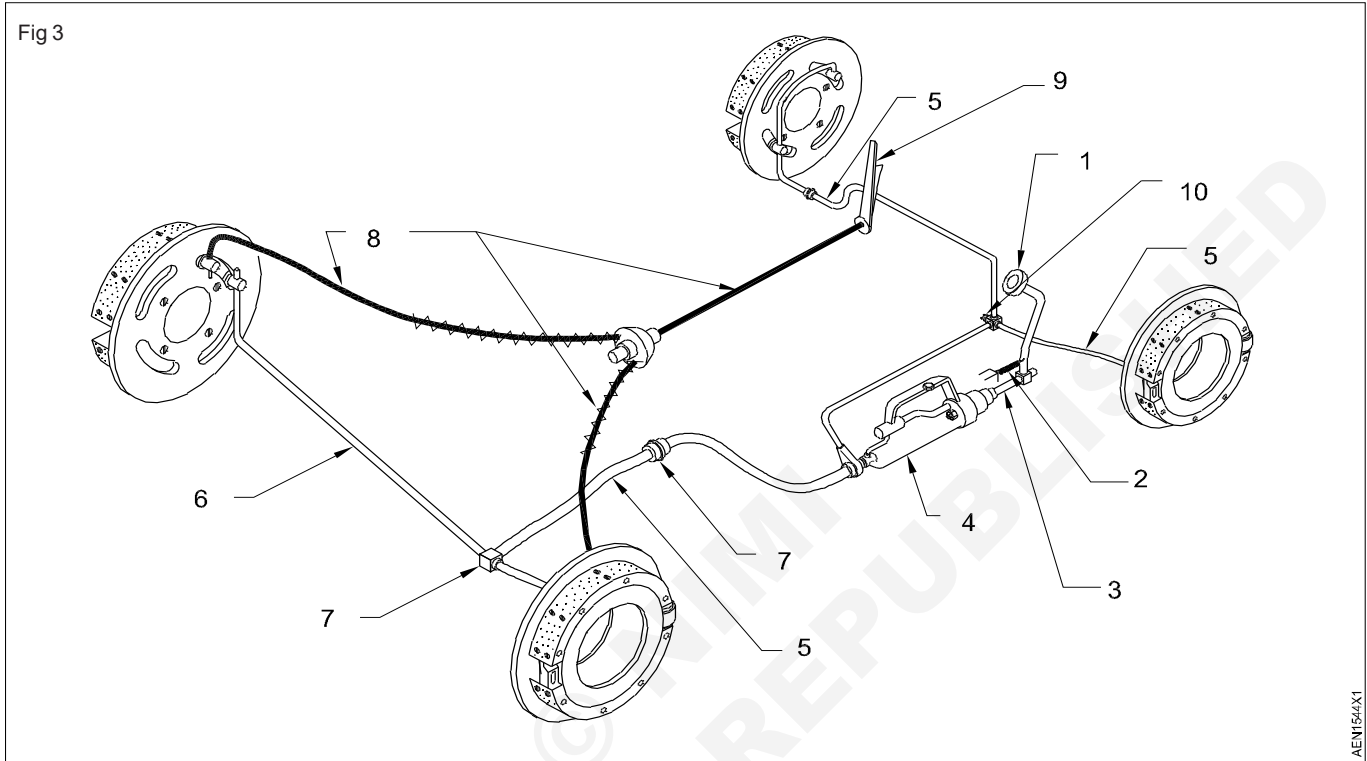
SI. No.	Label word	Name of the parts
1	2	
2	5	
3	4	
4	1	
5	3	
6	11	
7	6	
8	9	
9	12	
10	7	
11	10	
12	13	
13	8	



**TASK 3: Identify the components of the hydraulic brake system**

- 1 Place the cut-section model of the hydraulic brake system on the work bench.
- 2 Draw the line diagram of hydraulic brake system.
- 3 Locate the parts of the hydraulic brake system (Fig 3) and drum braking system. (Fig 4 & 5) i.e. Brake

pipe line unions, Brake push-rod, Brake flexible hoses, Brake pedal return spring, Master cylinder, Hold down spring, Brake lining, Brake steel pipe lines, Brake adjuster, Shoe return spring, Stop light switch, Hand brake lever, Pivot, Brake plate carrier, Wheel cylinder, Parking brake cable, Brake shoe, Brake pedal, Lock nut and Clevis.





4 Write the name of the parts in the Table 1.

Table 1

SI. No.	Label No.	Name of the parts
1	2	
2	5	
3	4	
4	1	
5	3	
6	11	
7	15	
8	17	
9	12	
10	18	
11	14	
12	19	
13	6	
14	20	
15	7	
16	9	
17	13	
18	8	
19	10	
20	15	

-----

Practice to identify different types of vehicle

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

- identify different types of vehicle name.
- study the vehicle specification data

PROCEDURE

1 Locate the type of vehicle name shown in Fig 1.

- a Car
- b Truck punjab body or straight truck
- c Truck Half body
- d Truck flat form type
- e Tractor
- f Tractor with articulated trailer
- g Tanker
- h delivery van
- i Dumper truck

- j Station wagon
- k Pick up
- l Jeep
- m tractor
- n tractor mounted combine harvester
- o straw combine
- p hay rake
- q straw baler
- r sugareane harvester
- s self propelled combine harker

2 Write the name of the vehicle in Table 1 with respect to Fig 1.

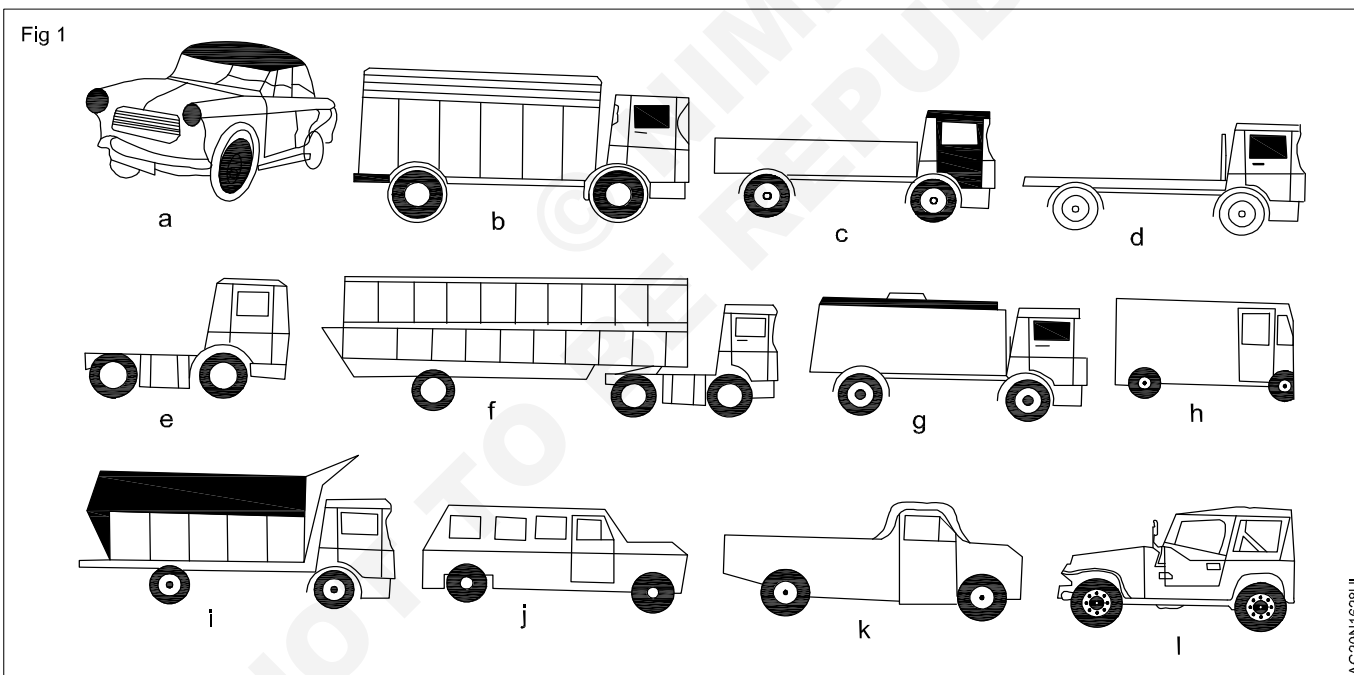


Table 1

Sl. No.	Match the latter	Vehicle Name
1		
2		
3		
4		
5		
6		

Table 1 cond..

Sl. No.	Match the latter	Vehicle Name
8		
9		
10		
11		
12		

**Identify the Vehicle Identification Number (VIN)**

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

- identify the vehicle identification number specification.

Requirements			
<b>Tools/Instruments</b>		<b>Materials</b>	
• Measuring tape	- 1 No.	• Cotton waste	- as reqd.
<b>Equipments</b>		• Paper	- as reqd.
• Car	- 1 No.	• Pencil	- 1 No.
		• Eraser	- 1 No.

**PROCEDURE**

**General information for VIN**

1 Vehicle Identification Number (VIN) is composed of 17 digits and classified into three large groups such as WMI, VDS and VIS. Example:- MALBB5 IBC AMI 73752

	Digit	Passenger Car/MPV/BUS
<b>WMI</b>	1	Geographic Zone
	2	Manufacturer
	3	Vehicle Type
	4	Series
<b>VDS</b>	5	Body Style and Version
	6	Body Type
	7	Restraint System/GVWR/ Brake System
	8	Engine Type
	9	Check Digit / Drive Side
<b>VIS</b>	10	Model Year
	11	Plant of product
	12-17	Serial number

- WMI: World Manufacturer Identifier
- VDS: Vehicle Descriptor Section
- VIS : Vehicle Indicator Section
- MPV: Multipurpose Passenger Vehicle (Ex : MPV,SUV,RV)
- GVWR : Gross Vehicle Weight Rating

**Note: Vehicle code may be vary depend upon manufacture**

- 2 Check the VIN number in your institute vehicle under guide line of instructor.
- Place a car in a plain ground
  - Apply hand brake and chock the wheels
  - Identify the location of VIN number in your vehicle
  - Note the VIN Number of your vehicle on plain paper
  - Decode the VIN Number details as per the manufactures general informations

**TASK 2: Study the vehicle specigation data**

**Note : Instructor should which is available in your workshop demonstrate the vehicle specification Mahindra Balero GLX**

<b>Engine Type</b>	XD-3PF IDiesel 4-stroke oversquare, 4-cylinder, in line
Bore	94.0 mm
Stroke	90.0 mm
Cubic Capacity	2498 cc
Compression Ratio	23 : 1
Max. Gross Power	72.5 hp at 4000 R.P.M. (DIN 70020)
Max. Gross Torque	15.3 kg-m at 2000 R.P.M
Fuel Injection System	Distributor pump
Weight of Engine (dry)	200 kg with flywheel and starter
Cooling System	By Belt driven pump on cylinder head, thermostat controlled
<b>Transmission</b>	5-speed,All synchromesh
Ratios	1st Gear : 4.03 :1 2nd Gear : 2.39 :1 3rd Gear : 1.52 :1 4th Gear : 1.00 :1 5th Gear : 0.84 :1 Reverse : 3.76 :1
Transfer Case	For 4WD only
Ratios	High - 1 : 1, Low - 2.48 :1
<b>Suspension</b>	
Front	2WD : Independent, Coil Spring, Double acting telescopic shock absorber and anti roll bar
4 WD :	Semi -elliptical type, stabilizer bar at front
Rear	Semi-elliptical leaf type
<b>Frame</b>	Rectangular tubular section 5 intermediate cross members (6 for IFS). Rear bumper
<b>Steering</b>	Power steering - worm & roller type with universal joints
Turning Radius	5.4 mts.

<b>Clutch</b>	Hydraulic, single dry plate 235mm (9.25" dia)
<b>Brakes</b>	
Type	Hydraulic with tandem master cylinder with vacuum assisted servo
Front	13 mm disc and calliper type
Rear	Drum : 27.4 x 50.8 mm (11" x 2")
Parking	Internal expanding type on rear wheels. Hand lever and cable type.
<b>Axle</b>	
Front	IFS-2WD: Stub Axle 4WD : Full floating hypoid type
Capacity/Ratio	1000 kg / 4.88 : 1
Rear Capacity/Ratio	Full floating hypoid type 1700 kg / 4.88 : 1
<b>Electricals</b>	
Battery	12 volts, negative earth
Capacity	70 amp. hr
Alternator	65 amp. with built-in regulator and vacuum pump
Drive	Belt drive
<b>Wheels and Tyres</b>	
Wheels	Rim size 6J x 15
Tyre	P215 / 75 R 15 radial
<b>Fuel System</b>	
Capacity	60 litres fitted with electrical float unit
<b>Weights</b>	
Kerb weight	1615 kg (2 WD) 1695 kg (4 WD)
G.V.W.	2200 kg (2 WD) 2280 kg (4 WD)

**Practice to identify the vehicle hoists, engine hoists, jacks and stands**

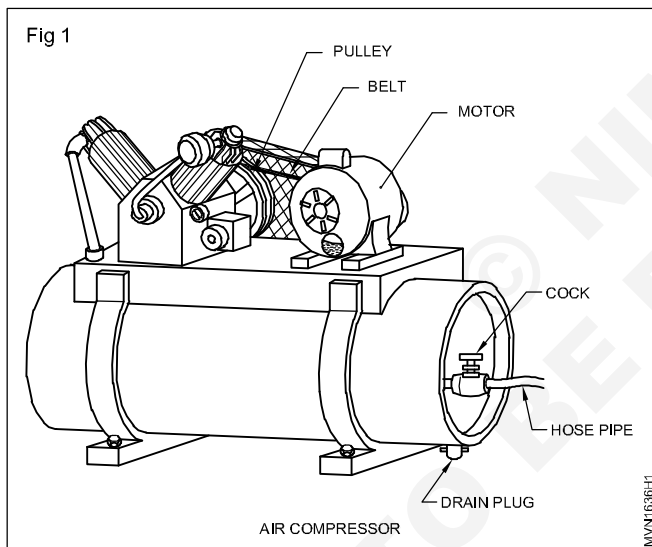
**Objectives:** This shall help you to

- identify the vehicle single poste hoist, two post and four post hoist
- identify the engine hoist, jacks and stands.

Requirements			
<b>Tools/Instruments</b>			
• Trainees tool kit	- 1 No.	• Vehicle	- 1 No.
• garbage equipment manual		<b>Materials</b>	
• Voltage tester	- 1 No.	• Cotton waste	- as reqd.
<b>Equipments</b>		• Soap oil	- as reqd.
• Vehicle hoiste each	- 1 No.	• Lub oil	- as reqd.
• Jack different type	- 1 No.	• greah	- as reqd.

**PROCEDURE**

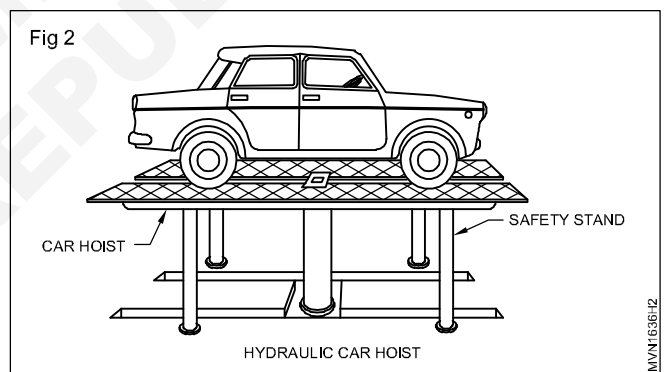
**Air compressor (Fig 1)**



- 1 Check the oil level.
- 2 Check the belt's(1) tension connecting the motor(2) and the compressor's pulley(3).
- 3 Ensure that the belt guard is fixed in its position.
- 4 Drain the water through the drain plug (4) and tighten the drain plug.
- 5 Inspect the electrical connections visually for looseness, disconnections or cuts.
- 6 Switch 'on' the compressor
- 7 Observe the sound of the compressor. If any abnormal sound is found, stop the compressor immediately. (Consult your Instructor)
- 8 Switch 'off' the compressor.
- 9 Hold the hose-pipe (5) and open the cock (6). Use compressed air wherever needed.

10 Close the cock after using the compressed air.

**Hydraulic car hoist (Fig 2)**



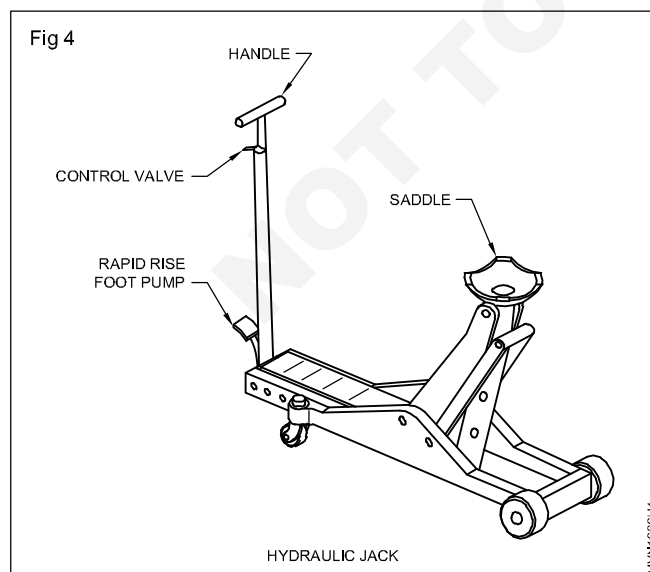
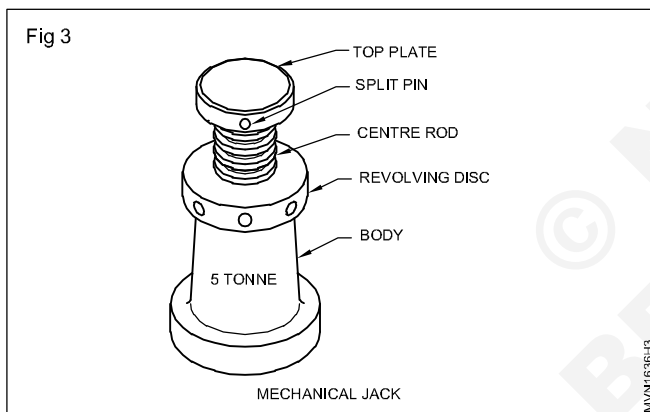
- 11 Park the vehicle in the centre of the car hoist.
- 12 Clamp the front and rear axle or check wheels.
- 13 Open the air cock gradually and observe that the car hoist(1) is moving upwards.
- 14 Close the cock when it reaches the required height.
- 15 Provide safety stands(2)underneath the hoist. Open the outlet cock slowly so that the vehicle moves down without jerk. Ensure that the hoist side rail sits firmly on the stand.
- 16 After finishing the required job, slightly open the inlet cock and raise the car hoist slightly up. Close the inlet cock.
- 17 Remove the safety stands.
- 18 Ensure that nobody is present underneath the vehicle.
- 19 Open the outlet cock slowly so that the hoist comes down without disturbing the vehicle's position.

20 Remove the clamps/chocks and remove the vehicle from the hoist.

### Car washer

- 21 Check the oil level.
- 22 Check the belt tension.
- 23 Check the belt guard for its position.
- 24 Inspect the electrical connection visually for looseness, disconnections or cuts.
- 25 Open the water tank.
- 26 Check the water level.
- 27 Hold the gun before starting the car washer.
- 28 Switch 'ON' the car washer and adjust the pressure gauge for the required pressure.
- 29 Open the water gun.
- 30 Check the water jet and adjust for force and spray at an angle to body panel.
- 31 After completing the cleaning, stop the car washer.
- 32 Close the water intake cock (water supply).

### Mechanical jack (Fig 3)/Hydraulic jack (Fig 4)



33 Park the vehicle on level ground.

34 In case of jacking up the front axle, chock the rear wheels and vice versa.

35 Check the free movements of threads in a mechanical jack by hand and in the hydraulic jack. Check the oil level and its operations.

36 Place the jack under the vehicle in specified place.

37 Rotate the screw gradually with the jack lever and lift the vehicle and in the case of hydraulic jack move the jack's lever slowly so that the axle jacks up without any jerk.

38 Place the support horses below the chassis frame/ axle.

39 Lower down the jack and remove it.

40 After completing the specific job jack up again.

41 Remove the support/horses.

42 Lower down the jack and remove it.

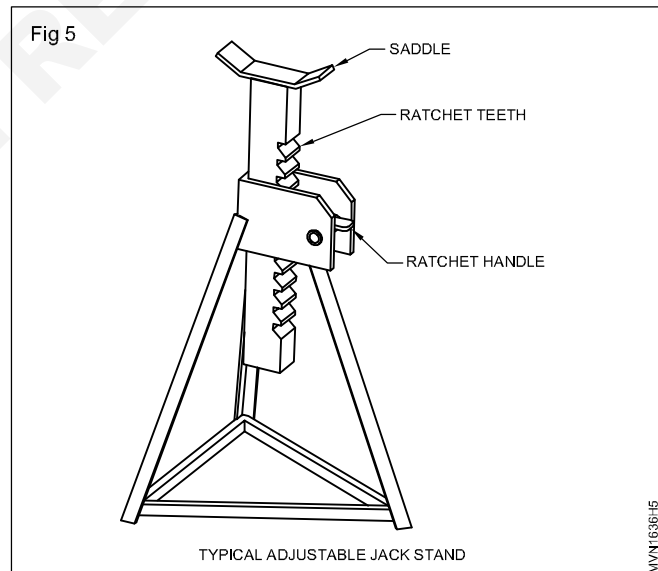
### Safety:

43 Never work under a vehicle supported only by a floor jack.

44 Lift saddles must be properly located and in secured contact.

45 Always check for equipments, parts or personnel beneath the car before lowering.

### Jack stand (Fig 5)

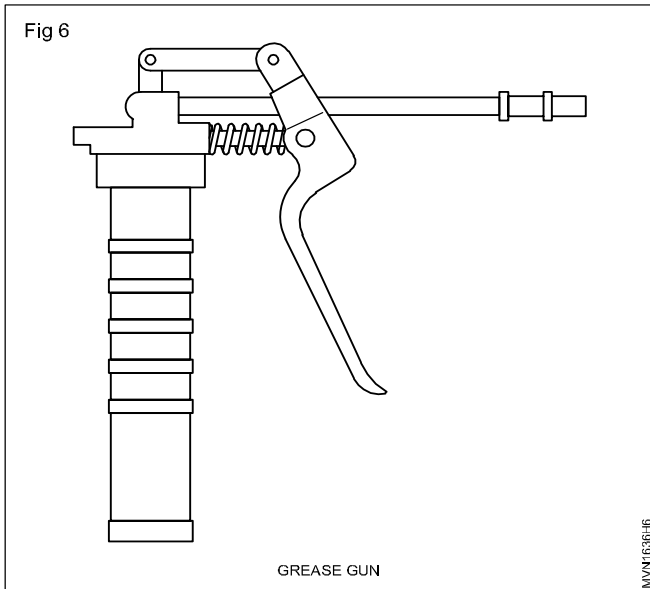


46 The height of the jack stand is adjusted by the ratchet adjustment.

47 Stands must be properly and securely placed.

### Grease gun (Fig 6)

48 Select the grease gun nipple according to the vehicle. (Consult your instructor)



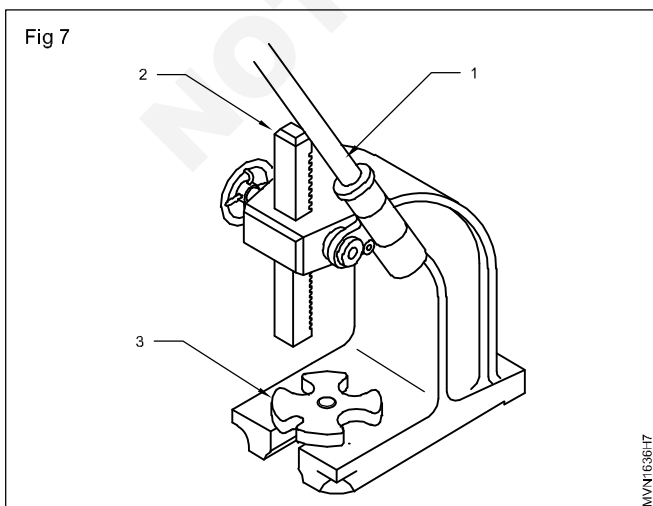
- 49 Check visually, the grease nipple holder for any damage.
- 50 Fill up the gun with the specified grease.
- 51 Close the grease gun and operate the lever till the grease comes out continuously from the nipple with pressure.
- 52 Use the gun for the required purpose.

#### Oil spray gun

- 53 Check visually the oil spray gun nozzle, nozzle holder, operating lever, air hose for any damage.
- 54 Fill the spray gun with SAE20W/40 and kerosene mixture in the ratio of 1:20.
- 55 Connect the oil spray gun to the quick release coupler.
- 56 Operate the oil spray gun.
- 57 See that the oil is sprayed at pressure and spray over panel joints and moving part only.
- 58 Close the air-hose connections and takeout the oil spray gun.

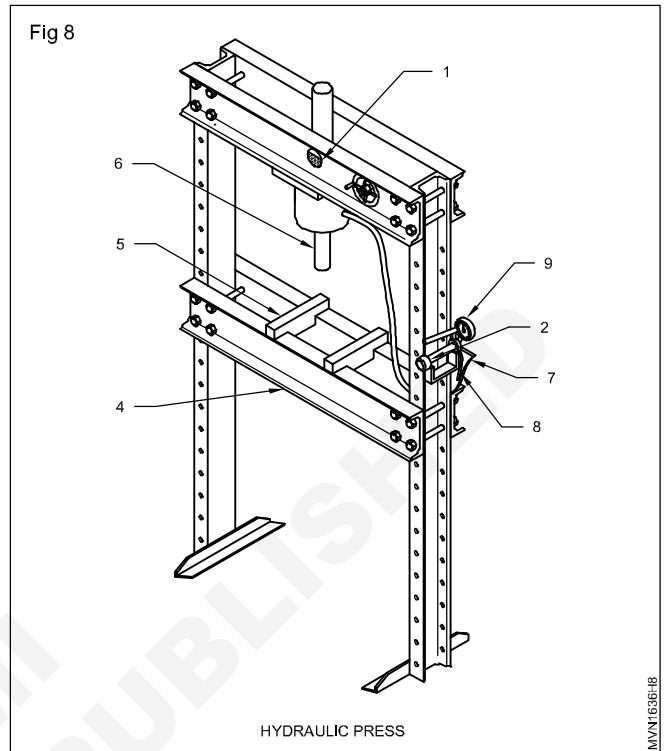
#### Arbor press (Fig 7)

- 59 Check for easy movement of the operating lever(1) and rack if necessary lubricate.



- 60 Select the plate(3)according to the work.
- 61 Place the component on the plate.
- 62 Press the work slowly and listen for abnormal noise.

#### Hydraulic press (Fig 8)



- 63 Clean the press.
- 64 Check the oil level(1) if necessary topup with hydraulic oil
- 65 Check the hydraulic press for its free function and leakage
- 66 Lock the cylinder plunger releasing knob(2).
- 67 Adjust the bed(4) to the required height so that, after placing the job, there will be 100mm clearance between the plunger(6) and the bed(4).
- 68 Align the anvil(5) according to the job.
- 69 Place the job on the anvil(5).
- 70 Select the distance piece in such a way that while pressing the shaft/bush, it does not touch the body (minimum 10mm gap to be given between the plunger(6) and the distance piece)
- 71 Place the distance piece on the shaft/bush. Ensure that it does not touch the body.
- 72 Operate the low pressure lever(7) and make the plunger(6) to have a contact on the job,
- 73 Operate the heavy pressure lever(8), observe the load on the gauge(9) and the job simultaneously. Ensure the job comes out gradually.
- 74 If the load exceeds more than the specified limit, stop the pressing.

## Safety

75 Shield brittle parts such as bearings to protect against flying parts.

76 After finishing the work loosen the plunger releasing knob(2).

77 Remove the job and clean.

## Two post lift hoist

78 Park the vehicle in the centre of the electro mechanical.

79 Adjust and fix the telescopic two post lift lifting arm.

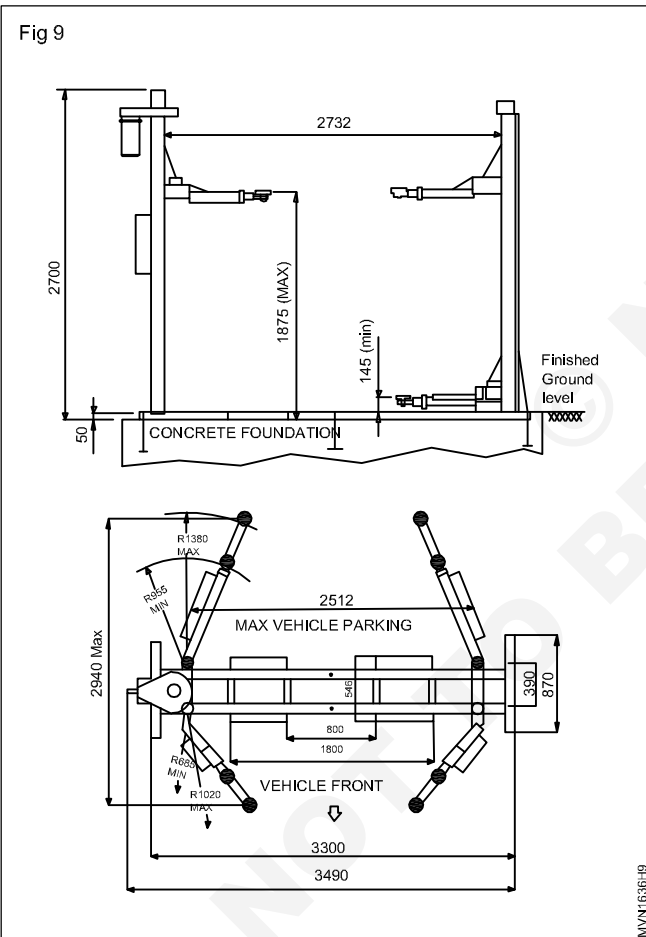
80 Use the automatic arms locking and releasing device while lifting and lowering.

81 Set safety mechanism to prevent uneven lifting.

82 Use the extra safety nut.

83 Check the chain drive and operate the lifting switch.

84 Use the anchoring bolts for safety. (Fig 9).

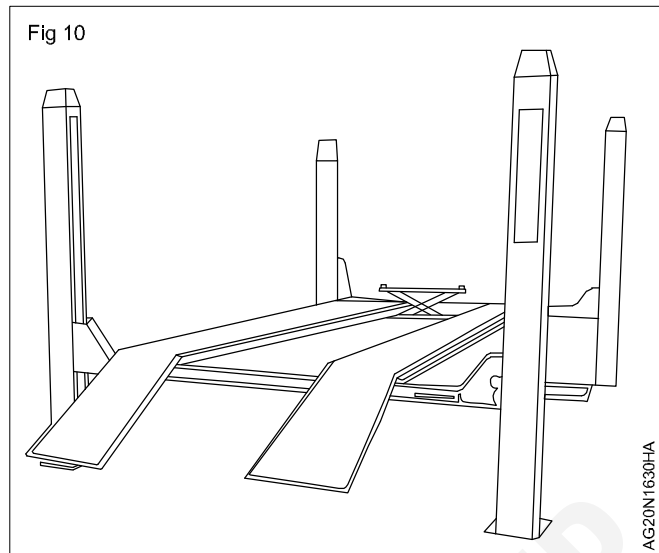


## Four post lift (Fig 10)

85 Drive the vehicle on the leveled ramp of the four post lift.

86 Check the vehicle parked correctly are not on the ramp & use wooden block as a stopper

87 Check the vehicle door & glasses are closed & pull up hand brake lever of vehicle.



88 Drive the hydraulic cylinder in stable & lowering.

89 Offering pull range mechanical protection by using safety block

90 Connected by using steel cables, Forced synchronized movement of the lift in order to effectively prevent the sloping of the vehicle

91 Ton with extended run way length for LCV & Bigger vehicle.

## Engine hoist (Fig 11)

92 Keep the vehicle on level ground.

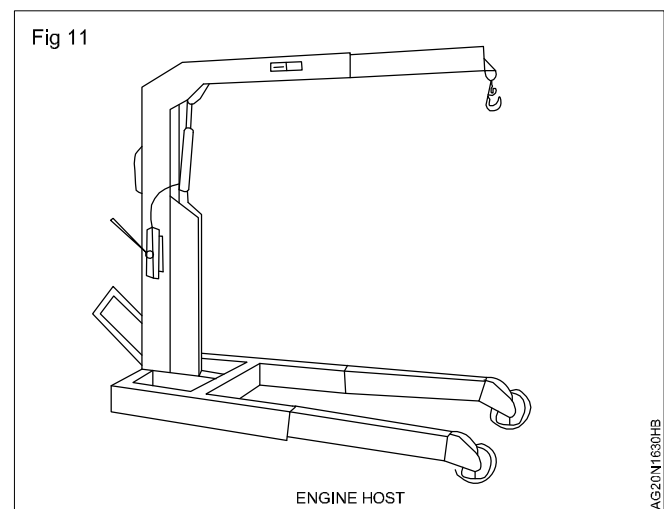
93 If firm ground is not there use big wooden block under the base of hoist.

94 Pull up hand brake lever of vehicle.

95 Place the hoist on firm ground & fix a rope to such part of engine.

96 Lift the hoist slowly till free from the vehicle.

97 Slowly role the wheel hoist and lake hoist to work shop.





**Specification of a tractor**

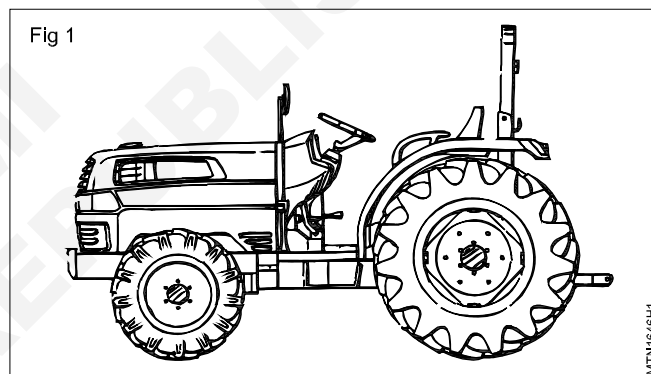
**Objectives:** At the end of this exercise you shall be able to

- identify the data related to tractor specification
- measure overall dimensions of tractor
- indicate parameters related to engine specification.

Requirements			
<b>Tools/Instruments</b>		<b>Materials</b>	
• Trainees tool pack	- 1 No.	• Cotton waste	- as reqd.
• Measuring Tape	- 1 No.	• Paper	- as reqd.
<b>Equipment/Machines</b>		• Pencil	- 1 No.
• Tractor	- 1 No.	• Eraser	- 1 No.

**PROCEDURE**

- 1 Wash the tractor.
- 2 Make a rough sketch of tractor on a plain paper
- 3 Note down the specification of the tractor (Annexure)
  - Read VIN number plate.
  - Note the make of tractor.
  - Note the serial number of tractor.
  - Locate the engine number plate.
- 4 Locate the Gear box number and axle number.



**Take reading of given tractor and Note down the reading on the table**

	Details	Sample	Actual
<b>Overall dimensions of tractor</b>	<b>Rear tyres</b>	<b>16.9 x 28</b>	-
Measure, Overall length A =	PTO type	Live, 68 plines	-
Overall height B =	Steering	Ball & Nut type	-
Ground Clearance C =	Brakes	Multi Disc Oil	
Wheel Base D =	immersed	-	
	Battery	12 V-20 Anphr	

Details	Sample	Actual
Engine	Diesel, TC	
Horse power	58 HP	
Cylinders	4 No's	
FIP type	In-line	
Cooling splines	Coolant	
Clutch	Dual	
Gear box, No. of speed	8F, 2R	
Front tyre	7.5 x 16	

**Identification of major assemblies in tractor**

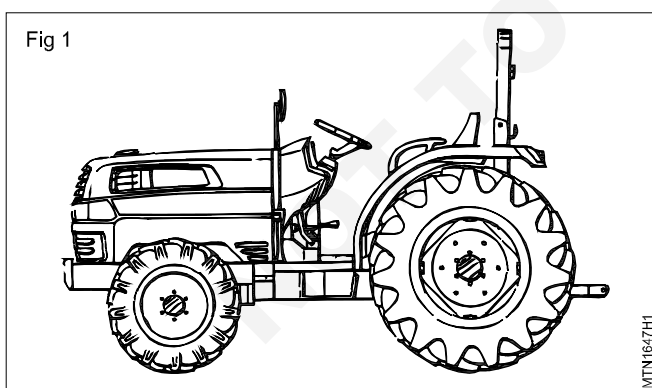
**Objective:** At the end of this exercise you shall be able to  
 • identify the visible parts of tractor aggregate.

Requirements			
<b>Tools/Instruments</b>		<b>Materials</b>	
• Trainees tool kit	- 1 No.	• Waste cotton	- as reqd.
<b>Equipment/Machines</b>		• Grease	- as reqd.
• Grease gun	- 1 No.	• Oil	- as reqd.
• Air compressor	- 1 No.	• Diesel	- as reqd.
• Carjet washer	- 1 No.		

**PROCEDURE**

**TASK 1: Major assembly**

- 1 Make a block diagrams (LHS, RHS) and draw the location of parts listed below. (Fig 1)
  - Engine Assembly
  - Transmission System
  - Fuel and intake, Exhaust System
  - Control System
  - Electrical System
  - PTO System
  - Hitching System
- 2 Write down the visible parts of engine assembly, transmission, wheels & tyre, steering, brake, battery & Accessories, P.T.O and hitch.



S.No.	Externally Visible Parts	Seen /Not Seen
	<b>Identify the Tractor Major Parts</b>	
1	Identify the Cylinder block	
2	Identify the Cylinder head	

S.No.	Externally Visible Parts	Seen /Not Seen
3	Identify the headlight assy	
4	Identify the Turbo charger	
5	Identify the Air cleaner	
6	Identify the Radiator	
7	Identify the Oil filter	
8	Identify the FIP Type	
9	Identify the Fuel filter	
10	Identify the Oil drain plug	
11	Identify the Oil filter cap	
	<b>Identify the Transmission Parts</b>	
1	Identify the Clutch housing	
2	Identify the Clutch pedal	
3	Identify the Gear box	
4	Identify the Gear Lever	
	<b>Identify the Running System</b>	
1	Identify the Rear axle housing	
2	Identify the Frame types	
3	Identify the rear tyres	
	<b>Identify the Control System</b>	
1	Identify the Steering wheel	
2	Identify the Steering box	
3	Identify the Drag link	

S.No.	Externally Visible Parts	Seen /Not Seen
4	Identify the Track rod	
5	Identify the Front axle	
6	Identify the Brake pedals	
	<b>Identify the Electrical</b>	
1	Identify the Battery	
2	Identify the Suf starter	
3	Identify the Alternator	
4	Identify the Dash board gauges	

S.No.	Externally Visible Parts	Seen /Not Seen
	<b>Identify the P.T.O System</b>	
1	Identify the PTO pump	
2	Identify the PTO shaft	
3	Identify the PTO operating lever	
	<b>Identify the Hitch</b>	
1	Identify the hitching point	
2	Identify the operating levers	

### TASK 2: Clean and wash the tractor

- 1 Park the tractor in the washing area.
- 2 Disconnect battery terminal and apply mask on electrical parts before water wash.
- 3 Clean the tractor by using car jet washer.
- 4 Wash the dirt & mud on and under body of tractor.
- 5 Take a wet cloth with diesel and clean the non-painted surface and parts.
- 6 Take a dry cloth and clean the tractor.
- 7 Use the compressed air to clean the parts where high pressure water is prohibited.

**Do not direct water jet to electrical components.**

### TASK 3: Lubricate moving parts of a tractor

- 1 Check and top up oil:
  - Top up oil in air cleaner (wet type).
  - Top up engine oil.
  - Top up transmission, steering with recommended grades of oil.
  - Top up hydraulic oil.
- 2 Lubricate the grease nipples of following lubrication points by using grease gun.
  - 1 Front axle pivot pin
  - 2 Steering kuckle post
  - 3 Differential lock operating lever
  - 4 Clutch pedal shaft
  - 5 Brake pedal shaft
  - 6 Top link
  - 7 Drag link
  - 8 Tie rod
  - 9 Front wheel hub
  - 10 Oil grease points specified by manufacturer.

**Use the good quality grease**

**Practice on starting and stopping of tractor engine**

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

- recheck a tractor before starting
- start a tractor
- stop a tractor.

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
<b>Equipment/Machines</b>		• Cotton Waste	- as reqd.
• Tractor	- 1 No.	• Diesel	- as reqd.
		• Engine Oil	- as reqd.

**PROCEDURE**

**TASK 1: Pre-check the tractor before starting**

- 1 Make sure the tractor is in neutral position and an even surface.
- 2 Walk around tractor and check the tyres, Lighting system, operator's platform & steps, shields, steering, seat adjustment, brakes, fuel, hydraulic and cooling system.
- 3 Check the level of engine oil, diesel, coolant, brake oil, hydraulic oil etc.
- 4 PTO should not be engaged before starting the tractor engine.

**TASK 2: Start a tractor engine**

- 1 Sit on the tractor driver seat.
- 2 Check neutral position of gear box.
- 3 Insert the key in the ignition switch.
- 4 Press the ignition button to start the engine.
- 5 Release the ignition button as soon as the engine is started.

**Do not raise the acceleration.**

**TASK 3: Stop a tractor engine**

- 1 Pull the stopper lever to stop the engine.
- 2 Put the ignition switch in off position.
- 3 Put the parking brake in engaged position.

**Practice on dismantling of tractor engine from the tractor**

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

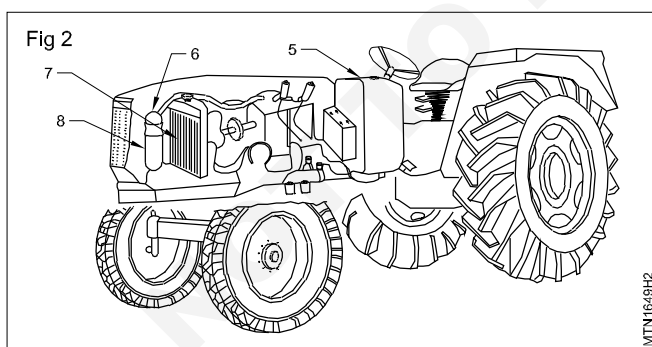
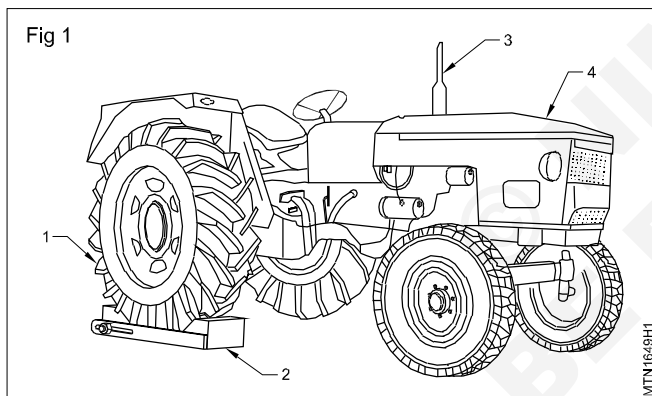
- remove accessories fitted with the engine prior to the engine removal
- remove the engine from the tractor
- inspect the dismantled components.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
<b>Equipment/Machines</b>		• Cotton waste	- as reqd.
• Tractor	- 1 No.	• Wooden block	- as reqd.
• Engine Hoist	- 1 No.	• Soap oil	- as reqd.

**PROCEDURE**

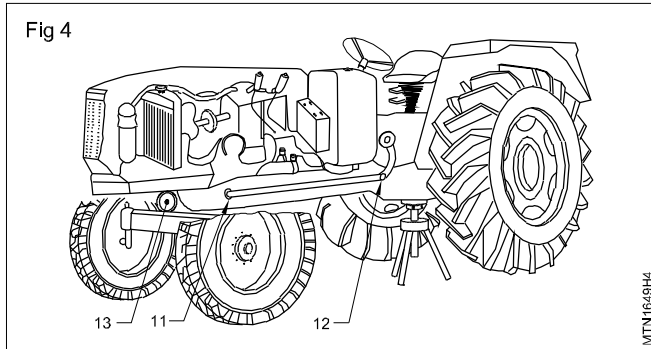
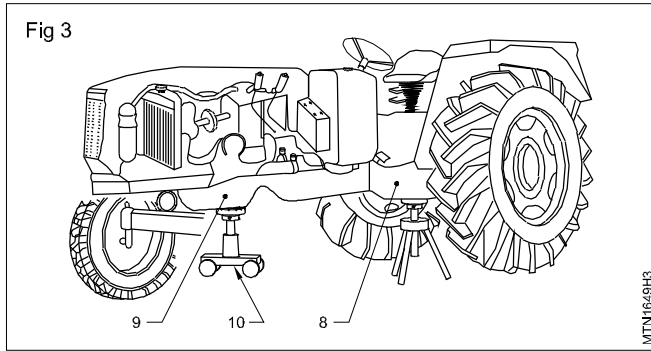
**TASK 1: Remove accessories and engine**

1 Park the tractor on a level surface. (Figs 1 & 2)



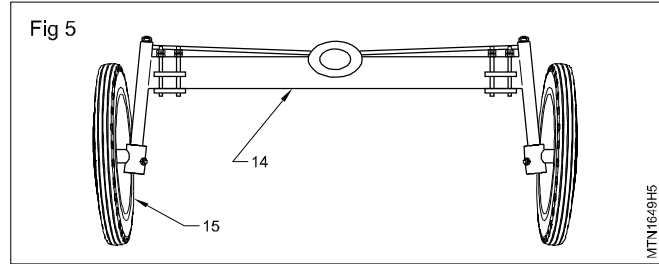
- 2 Choke rear wheels (1) with wooden blocks/wheel choke (2).
- 3 Remove silencer (3).
- 4 Disconnect the wire connection head lights.
- 5 Unscrew the bonnet mountings and remove bonnet (4).
- 6 Disconnect fuel pipe from fuel tank to feed pump and injector/filter overflow pipe.
- 7 Remove fuel tank (5).

- 8 Disconnect the battery connections and take out the battery. First disconnect the earth terminal before disconnecting the positive terminal.
- 9 Drain the engine oil in tray after removing drain plug.
- 10 Ensure that oil and water do not spill on the floor to avoid slippage.
- 11 Remove the air cleaner cover (6) and cover the seating of air cleaner with a cardboard/metal sheet.
- 12 Drain the radiator (7) through drain plug.
- 13 Remove the lower and upper hoses of the radiator.
- 14 Remove the radiator mounting bolts/bracket bolts and remove the radiator (7) without damaging the radiator core.
- 15 Disconnect the wire connections of the starting motor, generator/alternator, heater plugs, and other electrical connections to the dashboard instruments.
- 16 Remove the oil pipe to oil pressure gauge connections.
- 17 Disconnect the fuel supply pipes at feed pump, filter connections.
- 18 Disconnect the temperature gauge connections.
- 19 Remove the throttle control linkage.
- 20 Disconnect the engine stop lever.
- 21 Remove the air compressor connections and air compressor (if provided).
- 22 Support the gear box (8) and engine (9) by wooden blocks/struts (10) or trolley jack (Figs 3 & 4).
- 23 Disconnect steering linkage (11) from drop arm (12).
- 23 Unlock front axle centre pin (13) (Fig 4).
- 24 Remove front axle centre pin.

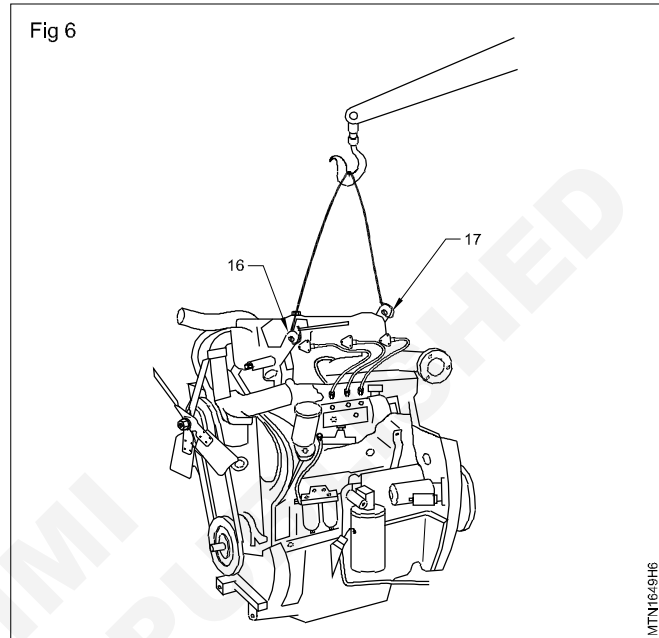


25 Disconnect other linkage of the front axle. (if provided) (Fig 5)

26 Pull out front axle assembly (14) with wheels (15). Ensure that engine and gear box assembly do not shake on its support.

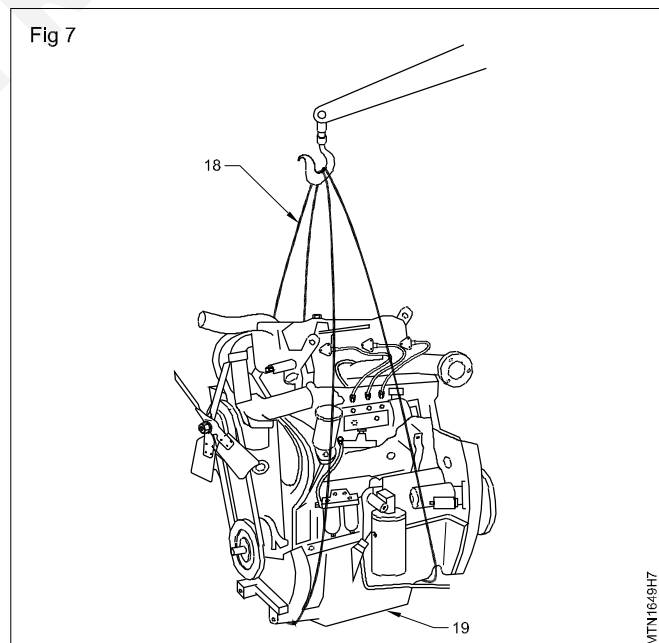


27 Unscrew clutch housing bolts and remove. (Fig 6)



## TASK 2: Removing engine from tractor

- 1 Fit a suitable engine lifting brackets (16) and (17), (if provided) (consult your instructor). (Fig 6)
- 2 If brackets are not provided, use wipe rope or slings (18) to attach engine to engine hoist. (Fig 7)
- 3 Remove pipe lines and required accessories to fit sling or wire ropes.
- 4 Attach the engine lifting bracket to the engine hoist.
- 5 Lift the engine in such a way that it does not vibrate.
- 6 Pull the engine forward till it comes out from the gearbox.
- 7 Lift the engine. Avoid oscillation and jerks. Ensure that the engine hoist does not shift/oscillate while removing it from the tractor.
- 8 Place it on a suitable workbench/engine stand, use suitable support to ensure that the engine does not rest on the oil sump (19).



## TASK 3: Inspection of dismantled components

- 1 Clean the dismantled components with cleaning solvent.
- 2 Clean the Parts with dry cloth.
- 3 Visually inspect the parts for dimension and wear.

**Practice on removing of the cylinder head from an engine**

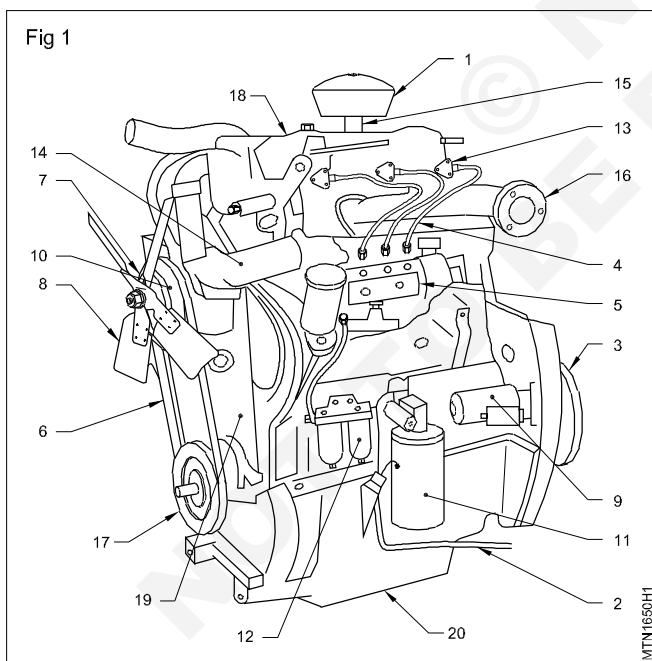
**Objectives:** At the end of this exercise you shall be able to

- remove the tappet cover
- remove the rocker assembly from cylinder head
- remove the cylinder head from the engine.

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Engine	- 1 No.
• Torque wrench	- 1 No.	• Engine Hoist	- 1 No.
• Box spanner set	- 1 No.	<b>Materials/Components</b>	
		• Cotton waste	- as reqd.
		• Soap oil	- as reqd.

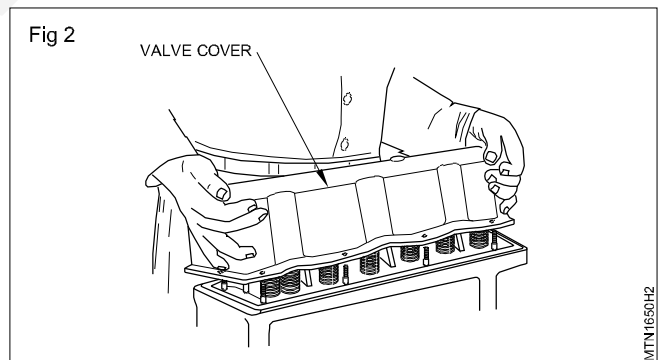
**PROCEDURE**

- 1 Place the vehicle on the surface area
- 2 Drain the engine oil from the oil sump
- 3 Drain water from radiator of engine block
- 4 Remove the air cleaner (1) and keep it in the vertical position (Fig 1).



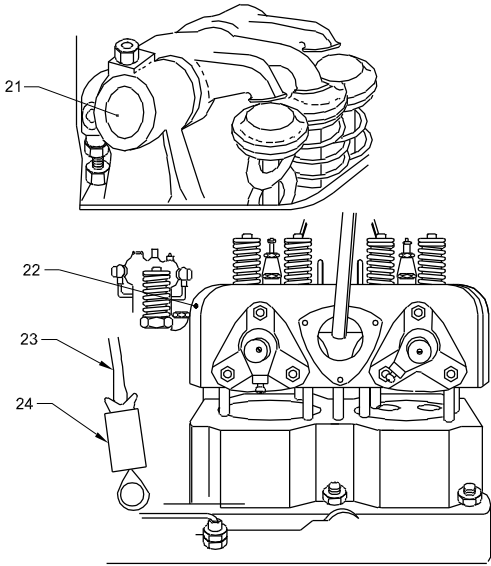
- 5 Disconnect the fuel pipe (2)
- 6 Remove the fuel injection pipes (4)
- 7 Remove the fan belt (6).
- 8 Remove the dynamo (7).
- 9 Remove fan (8).
- 10 Remove the water pump assembly (10).

- 11 Remove fuel filter (12).
- 12 Remove all the injectors (13).
- 13 Remove the intel (15) and exhaust manifolds (16).
- 14 Remove the tappet/valve cover. (Fig 2 & 3).
- 15 Remove rocker assembly (21) from the cylinder head (22).
- 16 Drive out push rods (23).



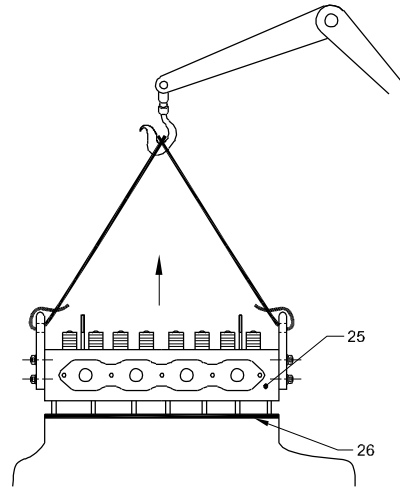
- 17 Remove engine side covers if provided.
- 18 Remove the tappets (24). (Fig 3)
- 19 Remove the cylinder head mounting bolts after loosening properly and sequentially and remove the cylinder head (2) by hoist. (Fig 4)
- 20 Place the cylinder head on workbench.
- 21 Remove the cylinder head gasket safely and place it at proper place.
- 22 Ensure that the cylinder head does not tilt while removing, so as to avoid damage to the cylinder head studs.

Fig 3



MTN1650H3

Fig 4



MTN1650H4



**Overhauling the cylinder head assembly**

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

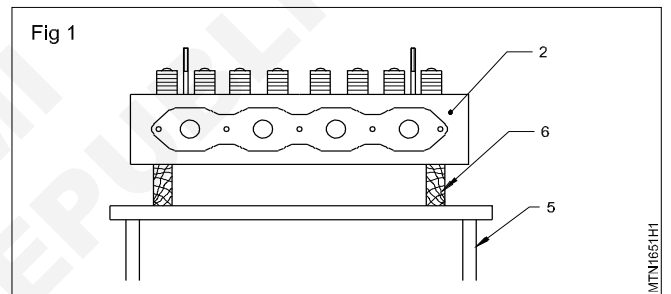
- remove the valves from the cylinder head with the valve spring compressor
- check the cylinder head for surface flatness
- check the spring tension by a spring tester
- assemble the valves with the valve spring compressor
- check the valve leakages.

Requirements		
<b>Tools/Instruments</b>		<b>Materials/Components</b>
• Trainees Tool Kit	- 1 No.	• Cotton waste - as reqd.
• Valve spring lifter	- 1 No.	• Soap oil - as reqd.
<b>Equipment/Machines</b>		• Valve, cotton - as reqd.
• Cylinder head	- 1 No.	• Sealing ring - as reqd.

**PROCEDURE**

**TASK 1: Remove the cylinder head from the engine**

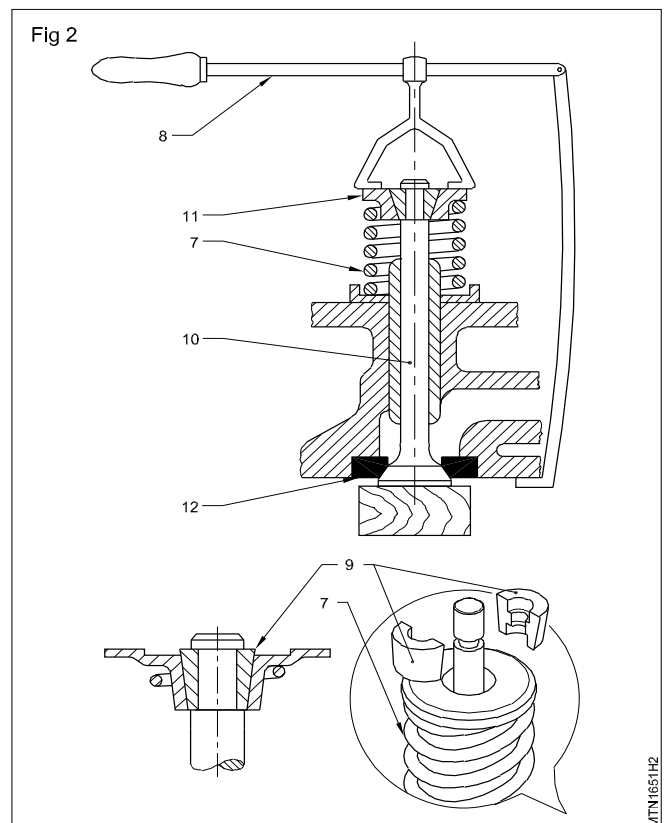
- 1 Remove the cylinder head assembly as per procedure of Exercise No-50.
- 2 Place the cylinder head (2) on the workbench (5) over two wooden blocks stand (6) (Fig 1)



**TASK 2: Remove the valve**

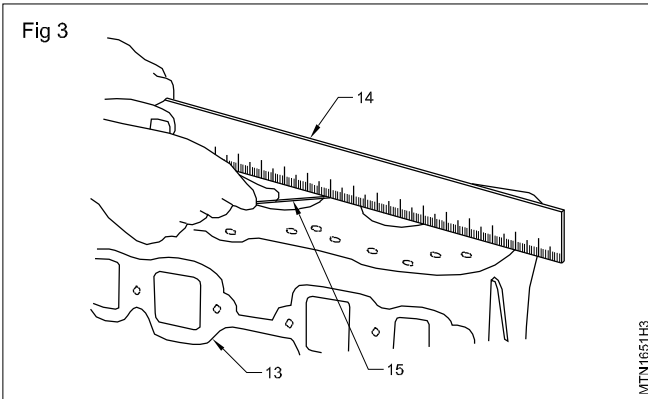
- 1 Press the valve spring (7) with the help of the special tool (8) (Fig 2).
- 2 Take out the cotters (9)/locks /collets. Release the valve spring and take out the special tool. Remove the spring and valve (10) and the retainer (11).

**Mark the respective cylinder number on the valves in order to avoid mixing at the time of reassembling. If the valves are mixed while assembling, valves may not sit properly resulting in compression leakage.**

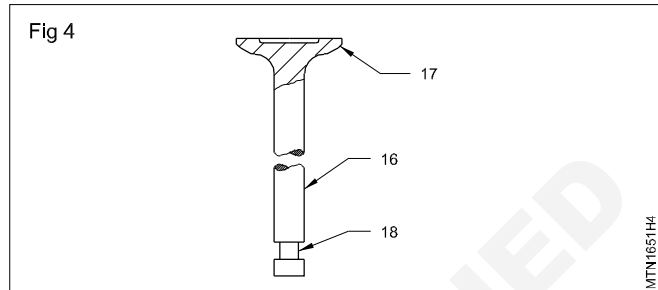


### TASK 3: Clean and inspect

- 1 Clean the valves, springs and spring retainers, cotters and head surfaces using kerosene.
- 2 Remove the carbon deposits, using a wire brush, from the valve seats (12) and combustion chamber's surroundings.
- 3 Check valve seat/seat inserts (12) for pitting and wear.
- 4 If pitted grind valve seats in cylinder head as per manufacturers recommendation. Replace seat inserts if provided.
- 5 Check the surface flatness of the cylinder head (13) using straight edge (14) and feeler gauge (15) (Fig 3).



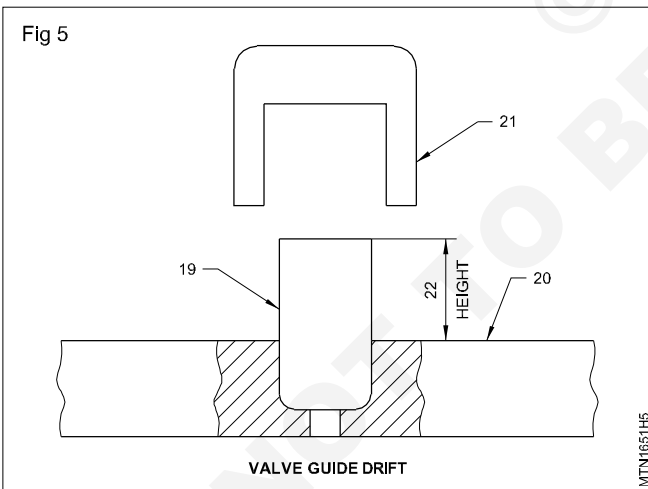
- 6 Check the cylinder head surface visually for pitting and cracks.
- 7 Replace if cracked. If minor cracks weld and regrind surface with the help of surface grinding machine.
- 8 If pitted regrind the surface.
- 9 Inspect the valve stem (16) for bend using a 'V' block and dial gauge (Fig 4).



- 10 Check the valve face (17) for pitting and damage visually. Grind the face if required on valve seat grinding machine
- 11 Check the cotter collar (18) for damage.
- 12 Check the valve spring for breakage/damage.
- 13 Check the valve spring for tension by spring tester.

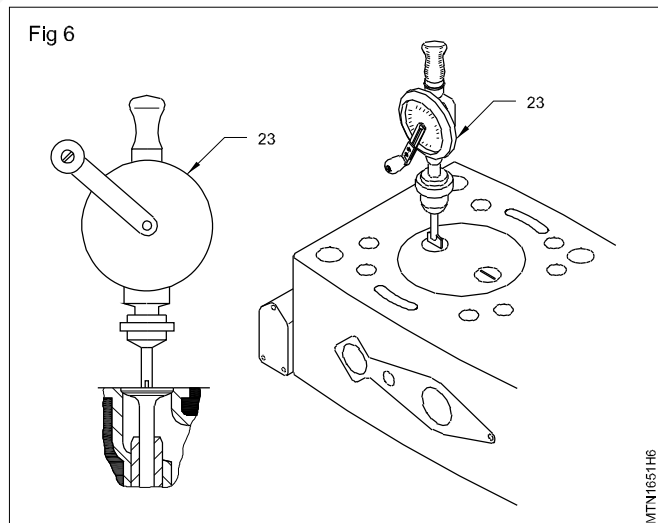
### TASK 4: Replace valve guide

- 1 Drive out the old valve guide from the cylinder head using a suitable drift (Fig 5).



- 2 Place the new valve guide (19) on the cylinder head (20)
- 3 Place the valve guide drift (21) on the valve guide and press the valve guide.
- 4 Measure the height (22) of the valve guide from the spring seating surfaces (Use depth gauge).
- 5 Assemble the valve to the valve seat and check its height with reference to the cylinder head surface.

- 6 De-glaze the seat with an emery paper.
- 7 Apply lapping compound on the valve face.
- 8 Gently turn the valve on the seat with the help of the special tool (23) using light force (Fig 6).

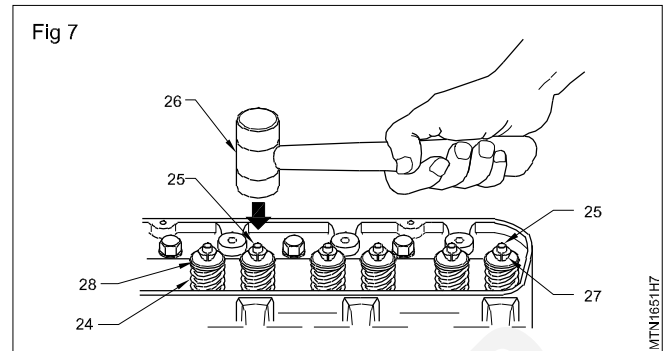


- 9 Repeat this until a clear seating of the valve face and valve seat is obtained.
- 10 Remove all traces of the compound.

### TASK 5: Assemble valve

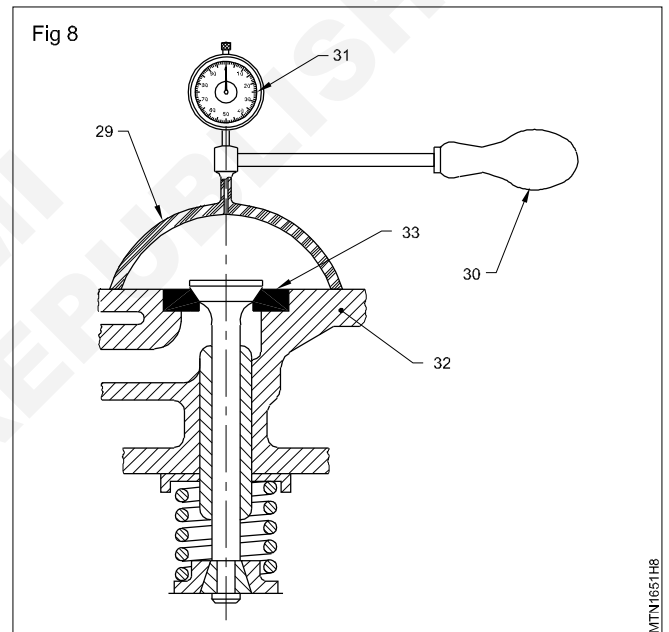
- 1 Oil the valve stem.
- 2 Inspect the valve in the valve guide.
- 3 Support the valve poppet, so that it is held firmly on its seat.
- 4 Fit the valve spring washer on the cylinder head.
- 5 Insert the valve spring.
- 6 Place the valve spring retainer over spring.
- 7 Compress the valve spring with the special tool.
- 8 Insert cotters with the smaller dia at the bottom and release the pressure on the valve springs (24) gradually. Slightly tap the valve stem (25) with a mallet (26) to

ensure that the cotters (27) have locked the valves and spring retainers (28). Take care that the two halves of the cotters are centrally located (Fig 7).



### TASK 6: Checking the valve leakage

- 1 Check the valve leakage using a special tool. Attach a suction cup (29) of special tool with a suction bulb (30) and vacuum gauge (31) on the cylinder head (32) covering the valve seat (33) (Fig 8).
- 2 Create suction with the help of the suction bulb (rubber bulb). Wait for 3 minutes and note any drop of vacuum on the gauge. If there is any drop in vacuum, the valve seat (33) is leaky and requires lapping.
- or
- 3 Check valve seat leakage by using petrol on seats. The ports of inlet and exhaust valves should be closed so that leaks could be found out.



**Overhauling rocker arm assembly**

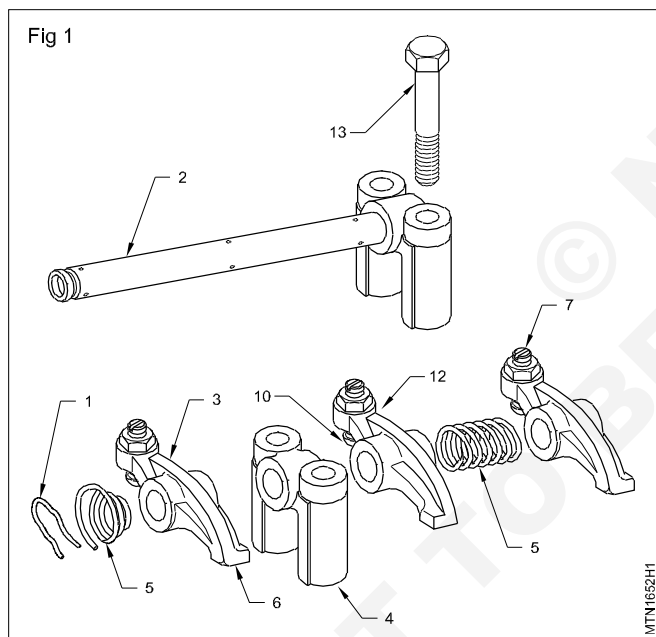
**Objectives:** At the end of this exercise you shall be able to

- **dismantle the rocker shaft assembly**
- **inspect the rocker shaft and levers**
- **align the oil hole with the rocker bracket**
- **assemble the rocker shaft assembly.**

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Rocker arm	- as reqd.
• Torque wrench	- 1 No.	• Rocker arm spring	- as reqd.
<b>Equipment/Machines</b>		• circlip	- as reqd.
• Engine	- 1 No.	• Nut bolts	- as reqd.
• Compressor	- 1 No.	• Cotton waste	- as reqd.
		• Soap oil	- as reqd.

**PROCEDURE**

**Dismantle rocker arm assembly and manifolds (Fig1)**



- 1 Remove the inlet manifold.
- 2 Remove the exhaust manifold.
- 3 Remove the EGR valve.
- 4 Remove the lock screw/circlip (1) at both ends of the rocker shaft (2)
- 5 Remove the rocker levers (3) / (13) rocker bracket (4), rocker springs (5) and spacers from the rocker shaft.
- 6 Remove the rocker bracket which supplies oil to the rocker shaft from the cylinder head. The position of the bracket varies from one make to another (consult your instructor).
- 7 Inspect rocker arm assembly and manifolds.
- 8 Clean all the parts of dismantled.
- 9 Check the manifolds for damages on it.
- 10 Check the tension of the rocker spring. Replace it if necessary.
- 11 Check visually the rocker lever for cracks and pitting on tips (6). Check the condition of the threads by screwing the adjusting screw (7) in threads. If the tip is pitted, recommend for refacing. If cracked/damaged or threads damaged, replace the levers.
- 12 Check the rocker shaft visually for bend, cracks and wear check rocker shaft alignment using dial gauge. If bent cracked or worn out, replace rocker shaft.
- 13 Check the rocker arm bushing (6) for wear tear. Replace if worn out. Align oil hole (9). Check the adjusting screw ball pins (10) for wear and damage. Replace adjusting screw if worn out.
- 14 Check the push rod (11) for bend the socket end (12) for wear. Replace if bent worn out.
- 15 Clean base of the rocker shaft brackets, and the seats on the cylinder head. Check brackets for crack visually, replace if cracked.
- 16 Assemble rocker arm assembly:** Fix the ball pins adjusting screw on the rocker arm.
- 17 Insert the inlet and exhaust rocker lever (13) and spring and the distance piece between the two rocker brackets on the rocker shaft.
- 18 Fit the circlip/lock screw at both ends of the rocker shaft. Unscrew the lock nuts (14). Loosen the adjusting screw to ensure that the push rod do not bend while tightening the rocker brackets nuts/bolts (15) on the cylinder head.
- 19 Assemble the EGR valve.
- 20 Assemble the inlet manifolds.
- 21 Assemble the exhaust manifolds.

**Practice on overhauling the engine block**

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

- clean and inspect the engine block and parts
- check the parent bore
- inspect crankshaft journals and crankpins.

**Requirements**

**Tools/Instruments**

- Trainee's Tool Kit - 1 No.
- Socket spanner set - 1 No.
- Torque wrench - 1 No.
- Straight edge - 1 No.
- Feeler gauge - 1 No.
- Cylinder bore gauge - 1 No.
- Surface plate - 1 No.
- 'V' block - 1 No.
- Dial test indicator - 1 No.
- Outside micrometers - 1 No.
- Scraper - 1 No.

**Equipment/Machines**

- Air compressor - 1 No.
- Engine - 1 No.
- Arbor press - 1 No.

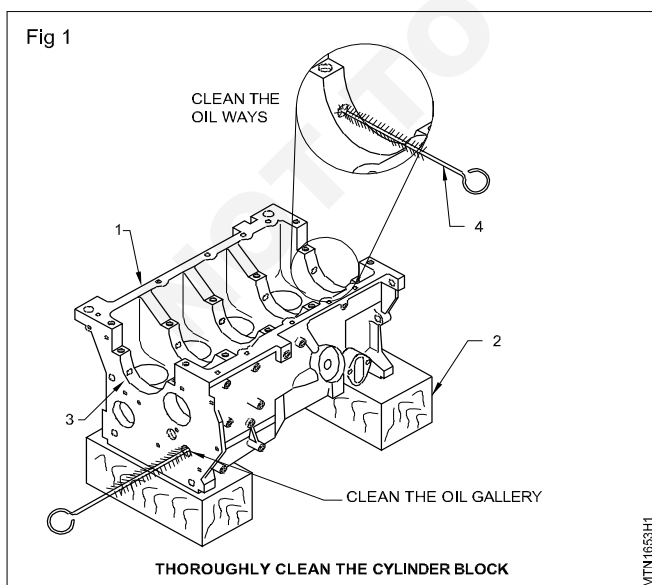
**Materials/Components**

- Soap oil - as reqd.
- Kerosene - as reqd.
- Banian cloth - as reqd.
- Lube oil - as reqd.
- Emery sheet

**PROCEDURE**

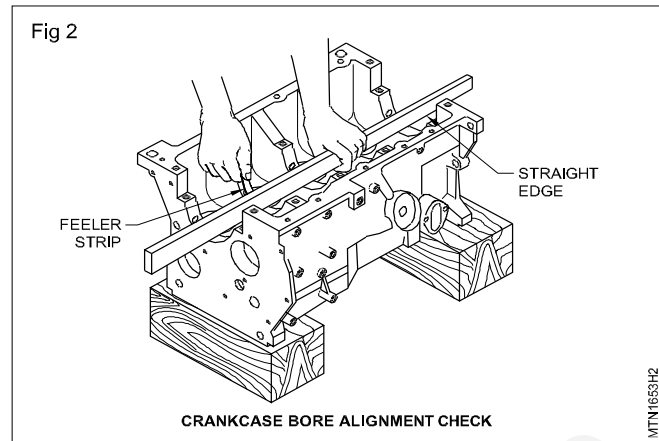
**TASK 1: Clean and inspect the engine block and parts**

- 1 Place the engine block on wooden pieces.
- 2 Clean the cylinder-block with a suitable solvent or the degreasing equipment (if available).
- 3 Clean the oil passages, remove all sludges, dirt and carbon deposits in the cylinder block. Use a scraper to remove hard deposits. Ensure that the highly finished surfaces are not damaged. Examine the surfaces and check for damage (Fig 1).
- 4 Remove the safety plugs. Descal the water passages with pressurised water with a suitable solvent under high-pressure. Fix new safety plugs always.
- 5 Clean and dry the block by using compressed air.
- 6 Clean the crankshaft using a soft brush with the recommended cleaning solvent.
- 7 Clean sludge and gum deposits from the drilled oil passages in the crankshaft with a wire.
- 8 Clean the oil passage with compressed air.
- 9 Check the engine block thoroughly for minute cracks and inspect visually to detect cracks, if needed, use a magnetic crack detector. (Consult your instructor).
- 10 Check for water leakage with a dummy cover and water under pressure. Replace the block if any water leakage is discovered.
- 11 Check the flatness of the machined top and bottom surface of the cylinder block with a straight edge and feeler gauge.



## TASK 2: Check the parent bore and bore in-line alignment

- 1 Inspect the parent bore of the cylinder block for in-line alignment (using line boring bar/straight edge). (Fig 2)
- 2 Measure the taper and of water of parent bore by using a bore dial gauge.
- 3 Measure the cylinder-bore diameter for wear, taper and ovality.



**Measure the cylinder liner & crankshaft for ovality and taperness**

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

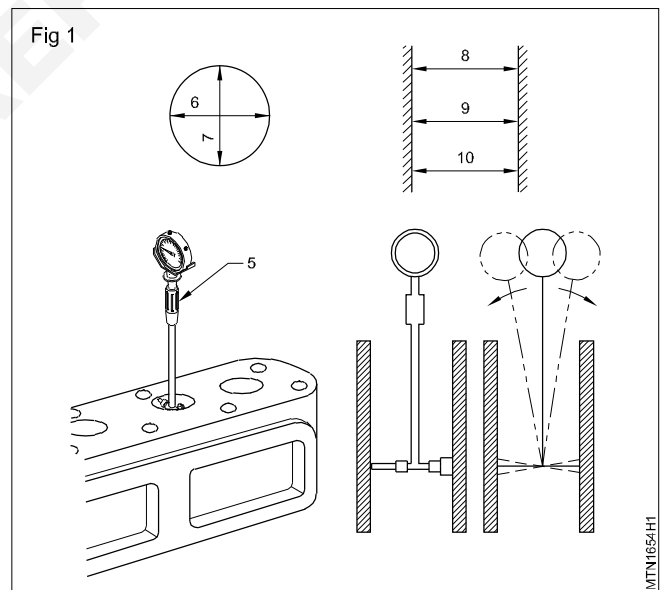
- measure taper & ovality of cylinder liners
- measure taper & ovality of crank shaft.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Soap oil	- as reqd.
• Socket spanner set	- 1 No.	• Kerosene	- as reqd.
• Cylinder bore gauge	- 1 No.	• Banian cloth	- as reqd.
• Outside micrometers	- 1 No.	• Lube oil	- as reqd.
<b>Equipment/Machines</b>			
• Engine	- 1 No.		
• Compressor	- 1 No.		

**PROCEDURE**

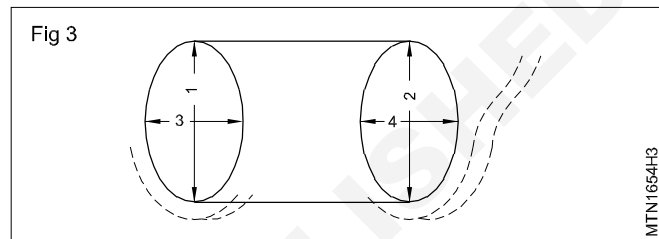
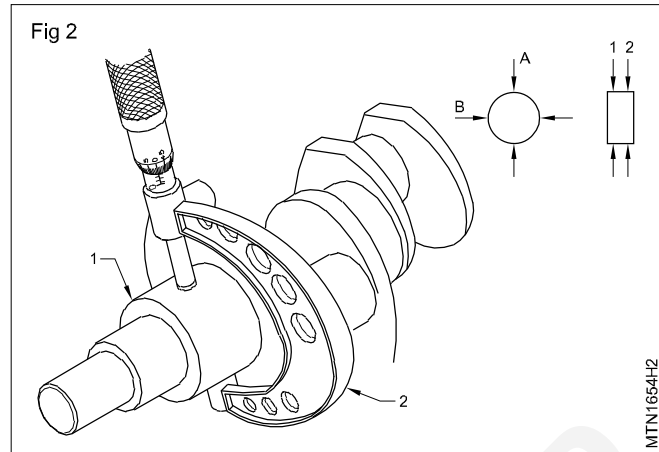
**TASK 1: Measure the taper, ovality of cylinder liner**

- 1 Clean cylinder bore with a piece of cloth.
- 2 Measure inside diameter of the bore with an inside micro meter (80 mm).
- 3 Select the correct size of extension rod (1) which is more than measuring range (80.8 mm).
- 4 Assemble the extension rod on the stem of the dial test indicator (2).
- 5 Press the spring loaded plunger end (3) as it enters inside the bore.
- 6 Keep the bore gauge parallel to the cylinder wall by slightly rotating the gauge (2).
- 7 Set the needle at 'O' in dial indicator (10).
- 8 Take measurement at (6) with the bore gauge and note down the reading.
- 9 Take another reading (5) at right angles to the first reading.
- 10 Report above at three places (7,8 and 9).
- 11 The difference in measurement between (5) and (6) at all places is ovality. The difference in measurement between (7) and (8), (8) and (9), and (9) and (7) is taper.
- 12 Note down maximum ovality and taper. If any one of them is more than the specified limit, recommend for reborning/ replacement of liner. (Fig 1)



## TASK 2: Measuring the crankshaft journal diameter

- 1 Remove the crankshaft from the engine block.
- 2 Clean the crankshaft assembly with cleaning solvent.
- 3 Clean the crankshaft with compressed air and banyan cloth.
- 4 Check the crankshaft visually for cracks and damages.
- 5 With the help of an outside micrometer measure the journal diameter at '1' '2' '3' & '4'. The difference in reading between '1' & '3' and '2' & '4' will give the ovality and '1' & '2' will give taper. (Fig 2 & 3)
- 6 If the taper and ovality is more than the given specified limit, then the crankshaft should be reground to undersize.
- 7 Measure the oil clearance between the crankshaft main journal and the bearing shell.





**Overhauling the piston and connecting rod assembly**

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

- remove the oil pump
- remove the big end bearing
- remove the connecting rod with the piston
- remove the rings from the piston
- inspect the piston skirt and crown section for damage and scuffing
- dismantle the piston and connecting rod
- check connecting rod alignment.

**Requirements**

**Tools/Instruments**

- Trainees Tool Kit - 1 No.
- Ring expander - 1 No.
- Torque wrench - 1 No.
- Mallet - 1 No.
- Drift punch - 1 No.
- Circlip plier - 1 No.
- Outside micrometer - 1 No.
- Connecting rod aligner - 1 No.

**Equipment/Machines**

- Multi-cylinder engine - 1 No.
- Fixture and arbor - 1 No.

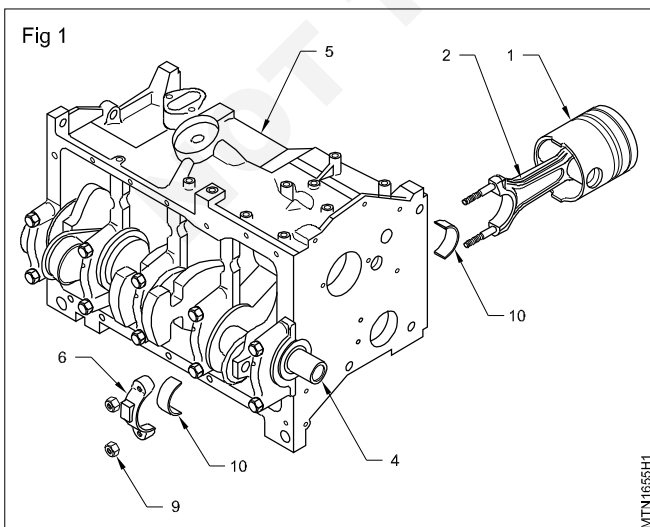
**Materials/Components**

- Tray - 1 No.
- Cotton waste - as reqd.
- Wooden block - as reqd.
- Kerosene - as reqd.

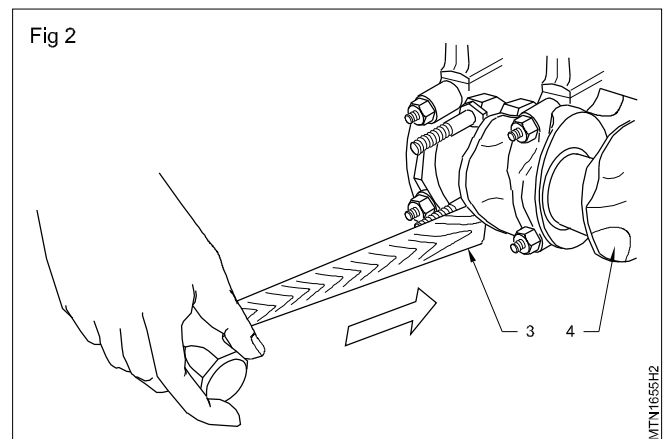
**PROCEDURE**

**TASK 1: Remove the connecting rod with piston**

- 1 Remove the oil sump.
- 2 Disconnect the oil pipe from the oil pump and remove the oil strainer.
- 3 Remove the oil pump.
- 4 Tilt the engine block.
- 5 Clean and check for ridge formation of all cylinders.
- 6 Turn the crankshaft (4) till the piston (1) comes at B.D.C. (Fig 1)
- 7 Remove the bolts/nuts (9) of the connecting rod (2).
- 8 Tap the connecting rod's (2) cap with a mallet and remove the cap (6) along with the bearing shell (10) from the connecting rod.
- 9 Turn the crankshaft (4) till the piston (1) comes at T.D.C. Tap the connecting rod (2) with a wooden block (3).
- 10 Note down the connecting rod cap matching number stamped on it to avoid mismatching while reassembling
- 11 Place the upper and lower bearing shell (10) in the respective positions in the connecting rod and cap (6). Fix the cap on the connecting rod. (Fig 2)



7 Remove the bolts/nuts (9) of the connecting rod (2).

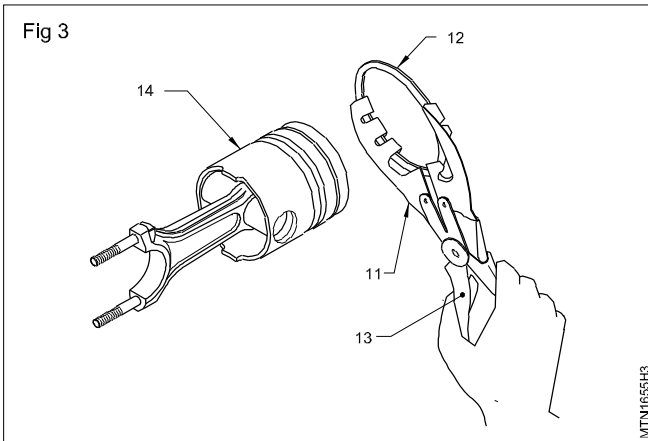


12 Repeat the relevant steps to remove all pistons

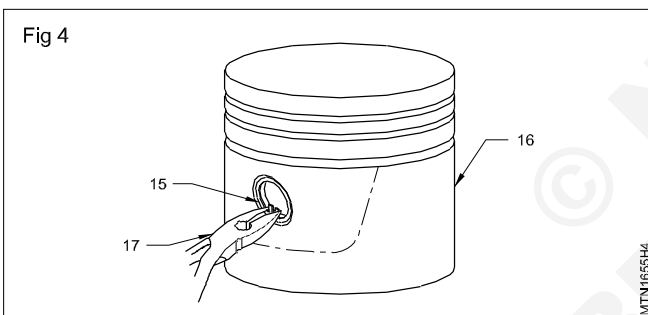
13 Clean all the cylinders.

**Note down the connecting rod cap matching number stamped on it to avoid mismatching while reassembling.**

**14 Dismantling the piston assembly:** Hold the connecting rod on the bench vice. Insert the ring ex-pander (11) in the ring (12) end gap. expand the ring by pressing the expander handle (13) remove the ring from the piston (14). Repeat the above steps and remove all rings. (Fig 3).



**15** Remove the circlips (15) of piston (16) using a circlip plier (17) remove the circlip on the other side of piston Pin following above steps. (Fig 4)



## Job sequence

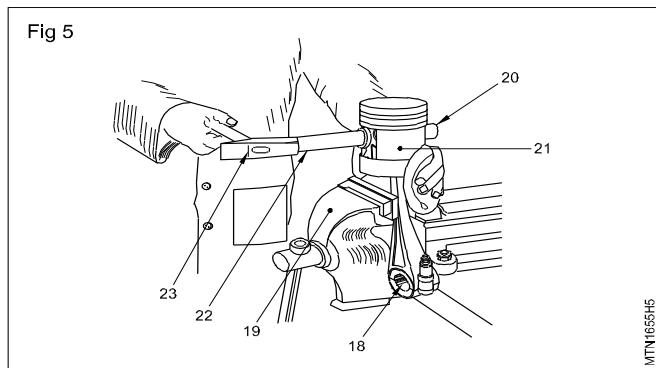
### Installing piston and connecting and assembly in engine

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

- assemble the piston with the connection rod
- install rings on the piston correctly
- install piston & connection rod assembly on engine.

- **Assemble piston & connecting rod:** Fix bush (1) in connecting rod small end (2) by using special tool (3) as recommended by manufacturer. (Fig 1)
- Ensure that the oil hole of bush aligns with that of connecting rod.
- Fit one circlip (4) in the groove (5) of the piston (6) using circlip plier (7) (Fig 2).
- After fixing one circlip keep the piston in boiling water for easy fitting of gudgeon pin. Put the gudgeon pin in piston pin bosses (4A) from the side where circlip is not fixed. (Fig 3).

**16** Hold the connecting rod (18) on the bench (19) vice.



**17** Remove the piston pin (20) from the piston (21) with the help of a drift (22) and hammer (23). repeat the above steps to dismantle all pistons.

**18** inspect the piston, piston pin, connecting rod & rings. Remove the carbon deposits from the piston ring grooves (24) (Fig 6).

**19** Clean the piston, piston rings, piston pins & connecting rods by using kerosene.

**20** Check visually the piston skirt (25) and crown (26) for scuffing crack, scouring etc., If found replace the piston.

**21** Check visually the piston pin circlip grooves in the piston for damage. If damaged replace the pistons.

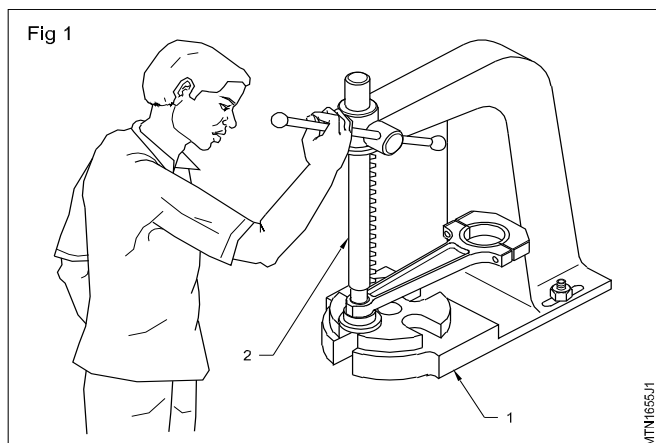
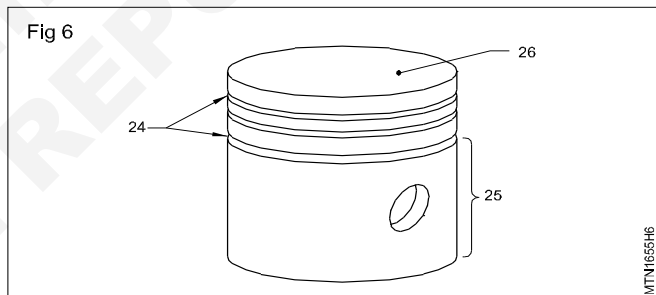
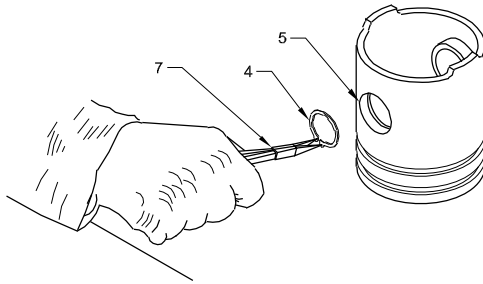
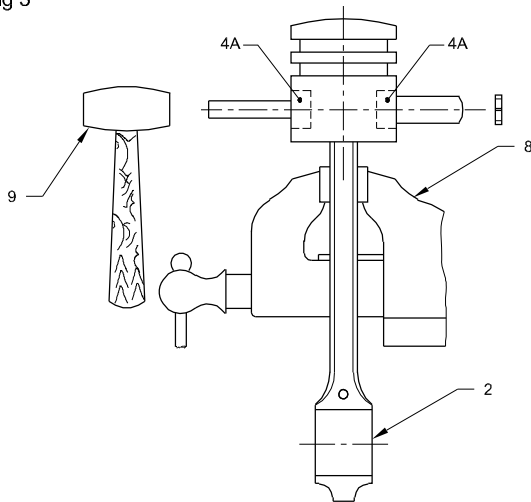


Fig 2



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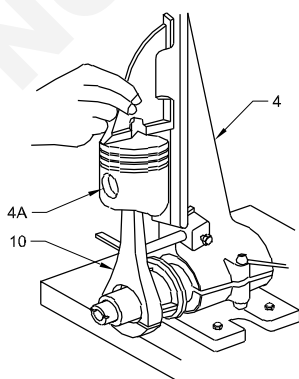
Fig 3



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- Align the connecting rod small end with the gudgeon pin.
- Tap the gudgeon pin in the piston with the help of a mallet (9). While tapping keep on moving the connecting rod to avoid damage to the connecting rod bush.
- Fit other circlip onto the other groove of piston.
- Repeat the above steps for all the piston & connecting rods.
- **Check square seating of the piston pin (Fig 4 ) :** Check the square seating of the gudgeon pin (8) by fixing the connecting rod assembly (10) on the alignment fixture (11). If connecting rod is twisted/bent piston pin will not sit squarely in the boss. If connecting rod is bent/twisted replace the connecting rods.

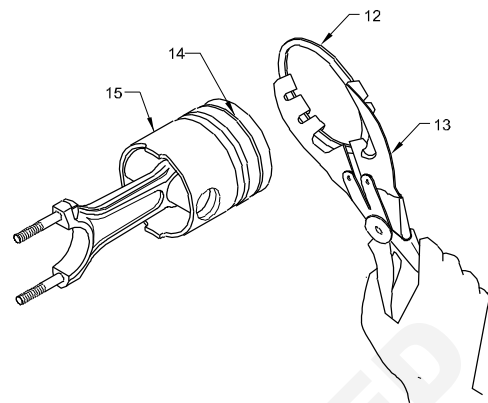
Fig 4



MTN1655J4

- **Installing rings:** Hold the piston ring (12) in the ring expander (13) and fit it in the piston groove (14). Ensure that compression and scraper rings are fitted in the proper grooves of the piston (15) (Fig 5).

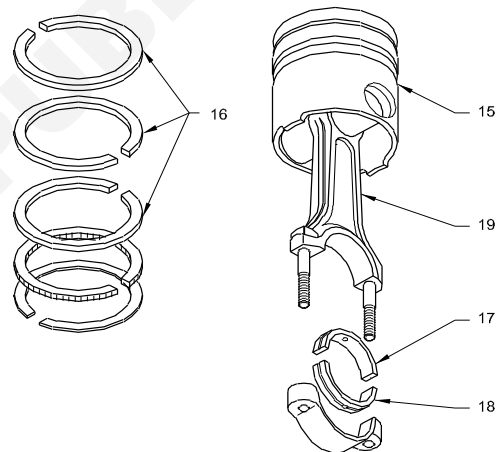
Fig 5



MTN1655J5

- Ensure that top written on the ring faces upward. Fit all the rings to all the pistons.
- The gap of the all rings (16) should be staggered properly. so that the ring gaps are uniformly spaced around the piston (15) (Fig 6).

Fig 6



MTN1655J6

- Fixing piston & connecting rod assembly into the block.
- Place the upper (17) and lower bearing shells (18) in all the connecting rods (19) and caps and keep them in proper order.
- Ensure that the oil hole of the bearing shell aligns with the oil hole of the connecting rod.
- Keep the cylinder block (20) in a tilted position and support it on wooden blocks (21) (Fig 7).
- Lubricate the cylinder wall, piston rings, bearing shell and crank pin with a little engine oil.
- Compress the piston rings into the ring groove by the help of a ring compressor (22). Ensure that the piston ring compressor is not over tightened otherwise the ring will break (Fig 8).
- Bring the respective crank pin to T.D.C and place the piston (23) into the cylinder (24) and ensure that the assembly is installed with piston facing into the right direction as recommended by the manufacturer.

Fig 7

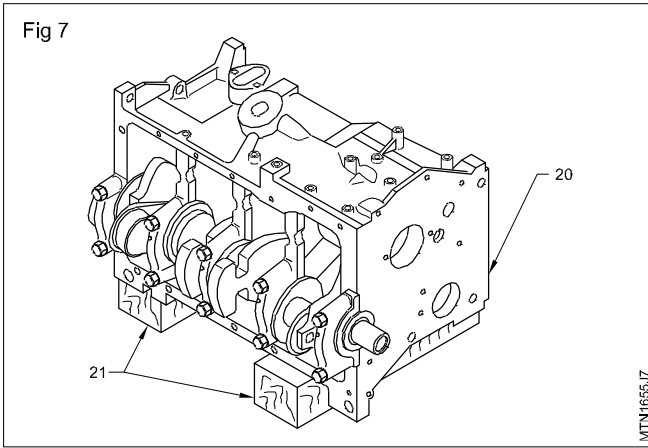
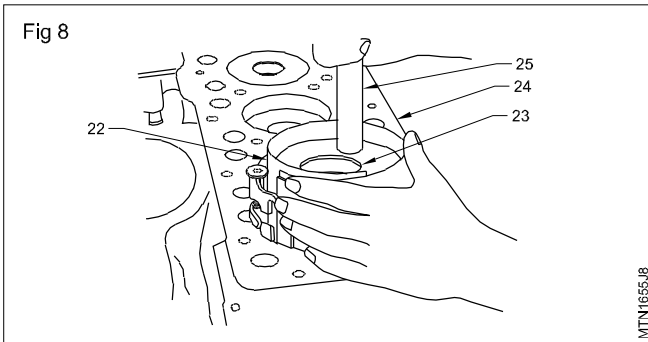


Fig 8

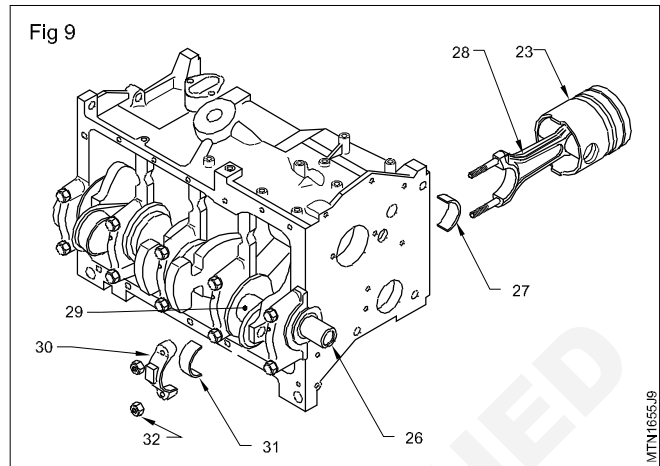


**Note: the projection of the piston ring compressor should be kept towards the bottom of the piston to avoid the entry of the ring compressor in the cylinder bore.**

- Push the the piston with a wooden block or wooden handle (25) of a hammer till the connecting rod resets on the crank pin. Be sure that the shell bearing is in its proper place.

- Push the piston (23) further and simultaneously rotate the crank shaft (26) till it come to the B.D.C. Ensure that the shell bearing (27) and connecting rod (28) do not dislodge form the crank pin (29) while rotating the crank shaft (Fig 9).

Fig 9



- Attach the big end cap (30) along with shell bearing (31) and tighten the nuts/ bolts (32) lightly and tap on the cap's crown lightly to seat it properly.
- Tighten the nuts/ bolts with a torque wrench to the recommended torque.
- Check the float of the connecting rod by hand.
- Rotate the crank shaft and check for the free rotation.
- Repeat the above steps for the all remaining piston assemblies.
- Lock the nuts/bolts of the connecting rods with the proper locking device.

**Practice on removing oil sump and oil pump**

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

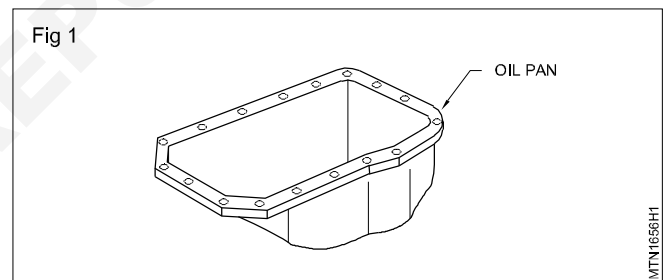
- remove the oil sump from the engine
- remove the oil sump from the engine
- remove the connecting rod from the piston.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Box spanner set	- 1 Set.	• Cotton cloth	- as reqd.
• Feeler gauge	- 1 No.	• Kerosene	- as reqd.
• Mallet hammer	- 1 No.	• Soap oil	- as reqd.
<b>Equipment/Machines</b>		• Lubrication oil	- as reqd.
• Multi cylinder diesel engine	- 1 No.		

**PROCEDURE**

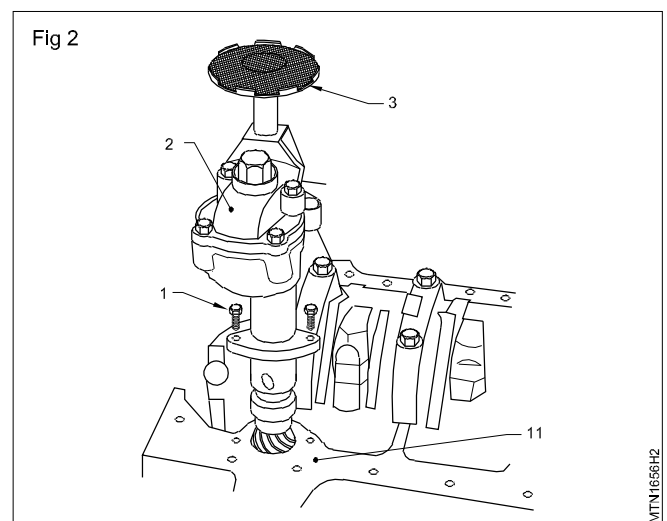
**TASK 1: Removing oil sump.** (Fig 1)

- 1 Loosen the engine oil sump drain plug.
- 2 Place the tray under the sump.
- 3 Remove the drain plug and ensure the complete oil is drained from the oil sump.
- 4 Crank the engine to drain remain oil from the engine.
- 5 Fix the oil sump drain plug.
- 6 Loosen the oil sump mounting bolt.
- 7 Remove the all mounting bolts of oil sump.
- 8 Remove the oil sump and place it on the work bench.
- 9 Remove the gasket from the sump.
- 10 Clean the surface of the gasket fitting.
- 11 Clean the sump with kerosene.
- 12 Clean the dust particals deposited in drain plug.
- 13 Inspect the oil sump for any damages and cracks found any crack, repair it.



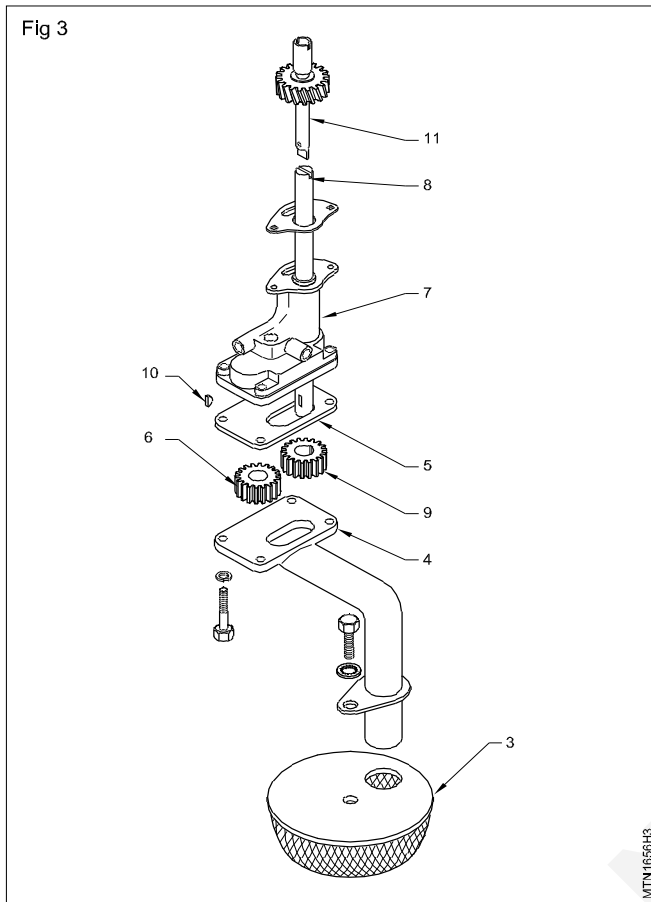
**TASK 2: Removing and dismantling the oil pump**

- 1 Locate the oil pump mountings
- 2 Select the suitable tools to remove the oil pump mountings
- 3 Loosen the oil pump mountings (Fig 2).
- 4 Remove the oil pump mounting bolts/nuts (1). (Fig 2)
- 5 Take out the oil pump (2) along with the strainer (3).
- 6 Place the oil pump on the tray
- 7 Remove the strainer assembly (3) from the pump.
- 8 Remove the oil pump end cover (4).
- 9 Remove the pump cover packing (5).
- 10 Remove the idler gear (6) from the oil pump housing (7).
- 11 Remove the driving gear (9) with the shaft (8).
- 12 Press out the driving gear from the drive shaft.
- 13 Remove the woodruff key (10) from the driving shaft.
- 14 Remove the driving gear by using the puller.

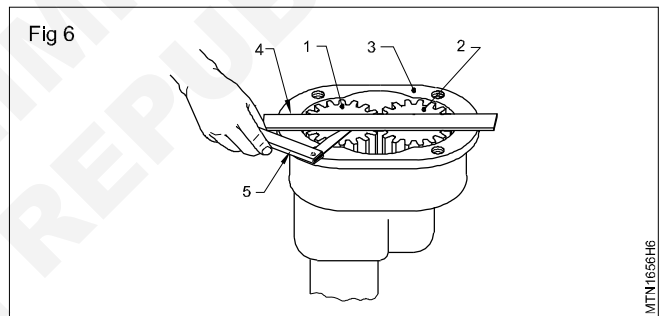
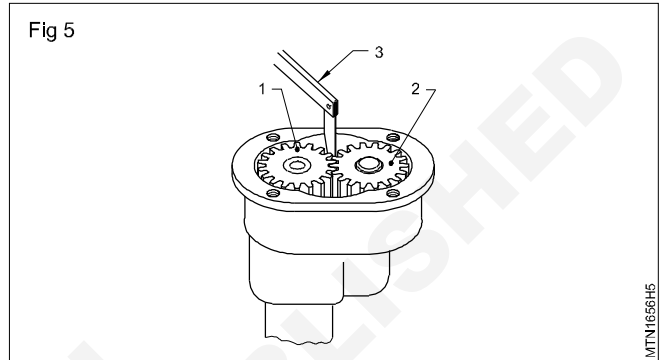
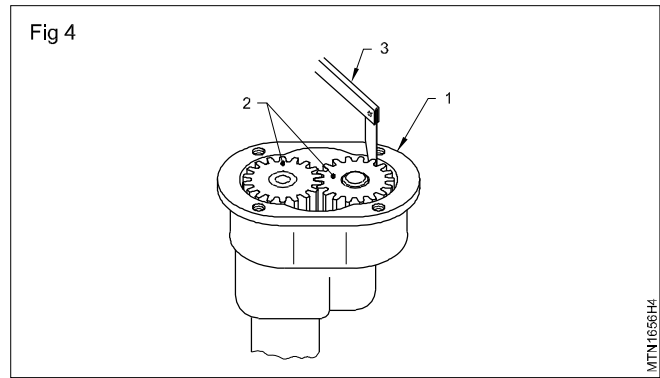


### TASK 3: Cleaning and Inspection

- 1 Clean all the parts by kerosene oil. (Fig 3)
- 2 Clean the suction pipe by compressed air.



- 3 Inspect visually the gears and shafts for pitting and damage.
- 4 Check pump housing for cracks and damage.
- 5 Check visually the contact surface of the oil pump housing and cover for scoring marks.
- 6 Check the radial clearance between the oil pump housing (1) and gear (2) teeth with a feeler gauge (3) (Fig 4).
- 7 Check the backlash between the oil pump gears (1 & 2) with a feeler gauge (3) (Fig 5).
- 8 Check the depth of the gears (1 & 2) from the oil pump housing surface (3) by using a straight edge (4) and feeler gauge (5) as per manufacturer's recommendation. (Fig 6)



- 9 Check the condition of the strainer for damage and blockage.
- 10 Check the suction pipe for cracks, damage and blockage.

### TASK 4: Assembling

- 1 Fix the driving gear (9) on the driving shaft (8) with a new woodruff key by using a press. (Fig 3)
- 2 Place the driving gear (9) with the shaft (8) in the pump housing (7).
- 3 Place the driving gear (6) with spindle in the pump housing.
- 4 Place the pump housing packing (3) and align the holes.
- 5 Place the pump cover, align the holes and tighten the pump cover bolts.
- 6 Check for the free rotation of gears.
- 7 Fit the suction strainer (3).
- 8 Insert the oil pump into the crankcase.
- 9 Tighten the mounting bolts to the specified torque.
- 10 Install the oil sump with a new gasket.
- 11 Fill recommended oil in the sump up to the correct level.
- 12 Start the engine.
- 13 Note down the oil pressure at the various r.p.m.s and compare them with the manufacture's specification.

**Practice on removing connecting rod with piston**

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

- remove the connecting rod with the piston
- remove the rings and pin from the piston
- remove the big end bearing
- measure the clearances.

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Air compressor	- 1 No.
• Socket spanner set	- 1 Set.	• Fixture and arbor	- 1 No.
• Torque wrench	- 1 Set.	• Arbor press	- 1 No.
• Piston Ring expander	- 1 Set.	<b>Materials/Components</b>	
• Drift	- 1 Set.	• Soap oil	-as reqd.
• Mallet	- 1 Set.	• Kerosene	- as reqd.
• Ball pein hammer	- 1 No.	• Banian cloth	- as reqd.
• Ring groove cleaner	- 1 No.	• Lube oil	- as reqd.
• Internal circlip plier	- 1 No.	• Emery sheet	- as reqd.
• Feeler gauge	- 1 No.	• Piston ring	- as reqd.
• Bench vice	- 1 No.		

**PROCEDURE**

**Remove the connecting rod with piston**

- 1 Drain the engine coolant.
- 2 Drain the engine oil and remove the oil pan.
- 3 Remove the cylinder head.
- 4 Use emery cloth remove any carbon deposits from the upper surface of the cylinder liner.
- 5 Remove the big end bearing cap from the connecting rod.
- 6 Push the piston and connecting rod assembly upward.
- 7 Protect the crank shaft journal.
- 8 Push the piston and connecting rod assembly out through the top of the cylinder block.
- 9 Place the piston assembly on the work bench.
- 10 Using snap ring pliers. remove the circlip/ snap rings from the piston skirt.
- 11 Slide out the piston pin and remove the connecting rod from the piston.
- 12 Remove the piston rings from the piston.
- 13 Remove the carbon deposit from the piston head, skirt oil holes and grooves.
- 14 Remove the dirt deposit from the piston pin boss.
- 15 Clean the oil hole of connecting rod and piston parts.
- 16 Discard the used piston pin, bolts/circlips and replace with new one.
- 17 For other parameters on reusing piston assembly components and big end bearing compare with service manual.  
(Care in handling and cleanliness of piston done bearings and piston pin).
- 18 Fix the piston with connecting rod small end.
- 19 Position the piston ring gap on the piston at 90° intervals.
- 20 Push the piston and connecting rod assembly the liner until the piston in free of the ring compressed.
- 21 Push the piston assembly in firmly seated on the crank shaft Journal. (Crankpin)
- 22 Install the bearing cap (as per number marked) on the same side.
- 23 Tighten the connecting rod bolts (Recommended).
- 24 Check the connecting rod side clearance on the Craft pin and compare with the service manual.
- 25 Install the cylinder head with new gasket.
- 26 Fit the rocker arm assembly and adjust tappets.
- 27 Install oil pump with strainer.
- 28 Install oil pan.
- 29 Refill the recommended oil to the proper level.
- 30 Close the drain cocks and fill the recommend coolant.

**Practice on dismantle the piston and connecting rod**

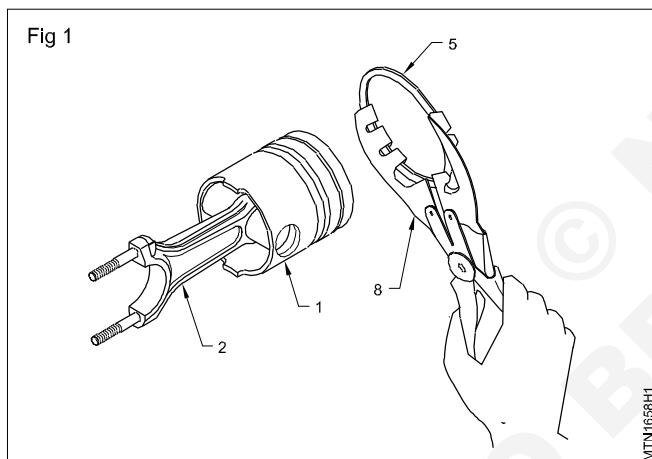
**Objectives:** At the end of this exercise you shall be able to

- remove piston ring and piston pin
- dismantle piston and connecting rod.

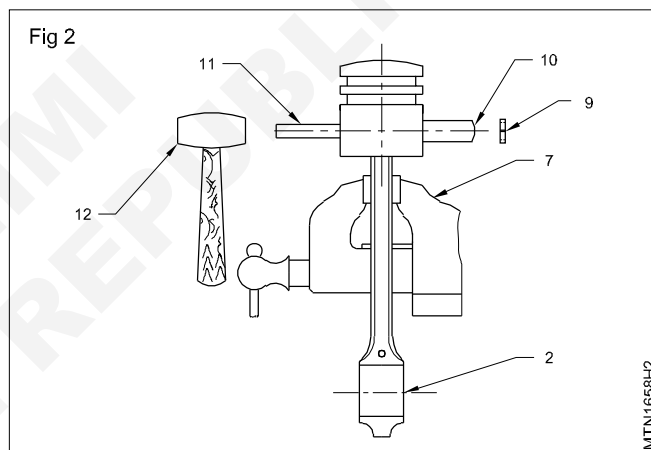
Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Ring expander	- 1 No.	• Cotton waste	- as reqd.
• Circlip plier	- 1 No.	• Wooden block	- as reqd.
• Feeler gauge	- 1 No.	• Kerosene	- as reqd.
<b>Equipment/Machines</b>			
• Multi-cylinder engine	- 1 No.		

**PROCEDURE**

- 1 Remove the piston ring (5) with help of piston ring (8) expander as shown in (Fig 1).



- 2 Remove the circlip (9) of the piston pin (10), using a circlip plier.
- 3 Remove the piston pin (10) with the help of a drift (11) and hammer (12). Repeat the steps to all the pistons. (Fig 2)
- 4 Remove connecting rod from piston.
- 5 Clean the piston, piston pin, piston rings grooves, oil ring holes.



- 6 Remove the carbon deposits from the piston ring grooves.
- 7 Clean the piston rings and the connecting rod by using kerosene.
- 8 Check the piston skirt and crown for scuffing, crack scoring etc.
- 9 Check the piston pin circlip grooves in the piston for damage.



**Practice on measure the side clearance of piston rings**

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

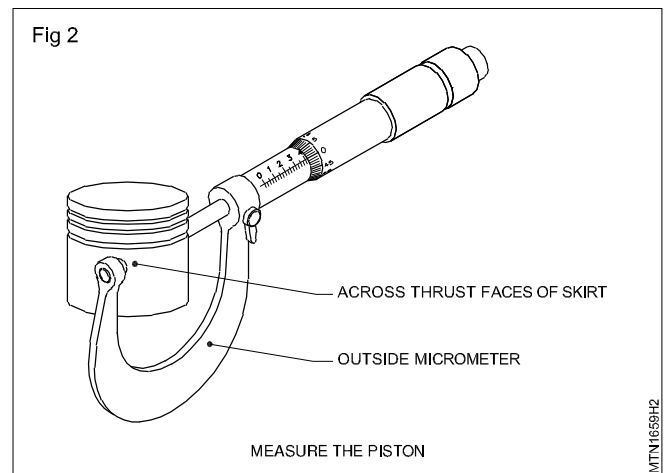
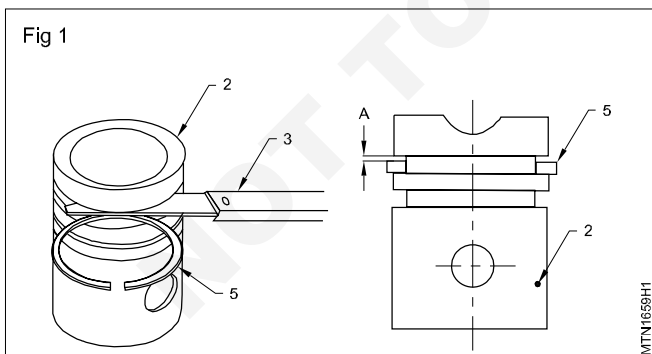
- measure groove clearnace
- measure ring wear clearance
- measure piston land wear clearance.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Ring expender	- 1 No.	• Cotton waste	- as reqd.
• Circlip plier	- 1 No.	• Wooden block	- as reqd.
• Feeler gauge	- 1 No.	• Kerosene	- as reqd.
<b>Equipment/Machines</b>			
• Multi-cylinder engine	- 1 No.		

**PROCEDURE**

**Clean and measure the clearance**

- 1 Remove the piston rings from the piston grooves.
- 2 Remove the carbon deposits from the piston ring grooves.
- 3 Clean the piston, piston rings and the connecting rod by using kerosene.
- 4 Check visually the piston skirt and crown for scuffing, crack, scoring etc.
- 5 Check visually the piston pin circlip groove in the piston for damage.
- 6 Check ring side clearance (A) in the piston's (2) groove with a feeler gauge (3). (Fig 1).
- 7 Check the wear of piston by outside micrometer as (Fig 2).
- 8 Check the piston wear at different point.
- 9 Check the wear of piston ring grooves and land.
- 10 If the wear of piston and piston ring is more them Manufacturers specification replace the recommended piston and piston rings.



**Practice to check the clearance between crank pin and connecting rod big end bearing**

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

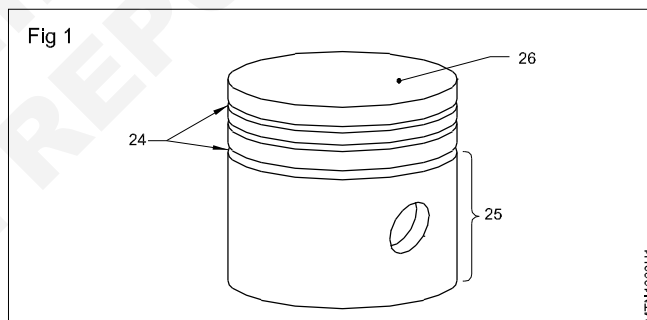
- check the piston ring close gap
- check the piston clearance
- check the clearance between crankpin and connecting rod
- measure land wear clearance.

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Multi-cylinder engine	- 1 No.
• Ring expander	- 1 No.	<b>Materials/Components</b>	
• Circlip plier	- 1 No.	• Tray	- 1 No.
• Outside micrometer	- 1 No.	• Cotton waste	- as reqd.
• Feeler gauge	- 1 No.	• Wooden block	- as reqd.
		• Kerosene	- as reqd.

**PROCEDURE**

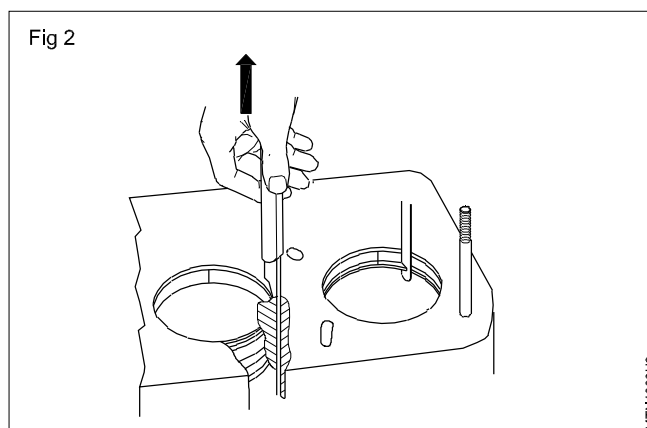
**TASK 1: Cleaning of piston groove and oil holes**

- 1 Inspect the piston pin, connecting rod & piston rings.
- 2 Remove the carbon deposits from the piston ring grooves (24) (Fig 1).
- 3 Clean the piston, piston rings, piston groove, oil holes piston pins & the connecting rods by using kerosene.
- 4 Check visually the piston skirt (25) and crown (26) for scuffing crack, scouring etc. If found, replace the pistons.



**TASK 2: Measure the piston ring close gap (Fig 2)**

- 1 Clean the cylinder bore with banyan cloth.
- 2 Clean the selected piston ring for measure.
- 3 Insert the piston ring inside of the cylinder bore.
- 4 Ensure the piston ring placed in specified level in side of cylinder bore (push the ring in the cylinder by piston head without rings).
- 5 Measure the piston ring, close gap by feeler gauge.
- 6 Note the feeler gauge leaf reading and compare with service manual specification.



**TASK 3: Measure the clearance between the liner and piston (Fig 2)**

- 1 Clean the oil and dust of the piston with kerosene.
- 2 Clean the piston with compressed air and banyan cloth.
- 3 Clean the cylinder bore with banyan cloth.
- 4 Insert the piston (without ring) inside of the cylinder bore/liner.
- 5 Measure the clearance between the liner and the piston below the gudgeon oil by the feeler gauge.
- 6 Note the reading of feeler gauge leaves and compare with service manual specification.

-----

**TASK 4: Measure the clearance between crank pin and big end bearing.**

- 1 Visually check clearance between crankpin & connecting rod bearing.
- 2 Measure the clearance between the crankpin and end connecting rod big end bearing with plastic gauge.
- 3 Remove the connecting rod from the crank shaft and clean the crank pin.
- 4 Measure the taper and ovality of the big end bearing of connecting rod by telescope gauge.
- 5 Measure the crank pin by outside micrometer.
- 6 In case taper and ovality is found more than specified limit, recommend for re-grinding of crank shafts, crank pin.
- 7 Replace bearing shells also while assembling.
- 8 Assemble the connecting rod.
- 9 Ensure proper clearance between crank pin and big end bearing as per specified recommended limits.

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**Practice to check the connecting rod for bend and twist**

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

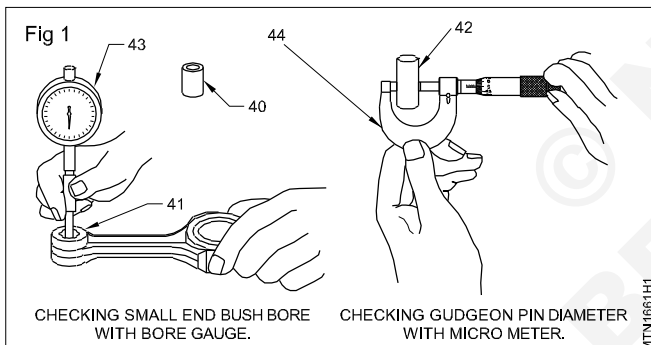
- check the clearance between gudgeon pins and connecting rod bends
- check the connecting rod bend and twist.

Requirements			
<b>Tools/Instruments</b>			
• Trainees Tool Kit	- 1 No.	• Connecting rod aligner	- 1 No.
• Ring expander	- 1 No.	• Fixture and arbor	- 1 No.
• Circlip plier	- 1 No.		
• Outside micrometer	- 1 No.	<b>Materials/Components</b>	
<b>Equipment/Machines</b>		• Tray	- 1 No.
• Multi-cylinder engine	- 1 No.	• Cotton waste	- as reqd.
		• Wooden block	- as reqd.
		• Kerosene	- as reqd.

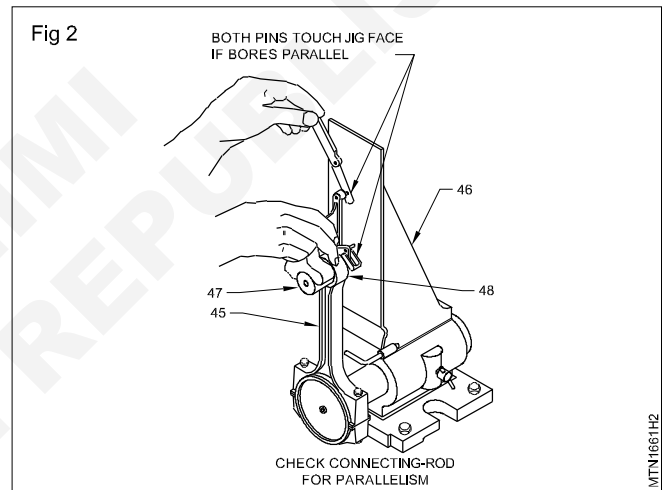
**PROCEDURE**

**Check the connecting rod**

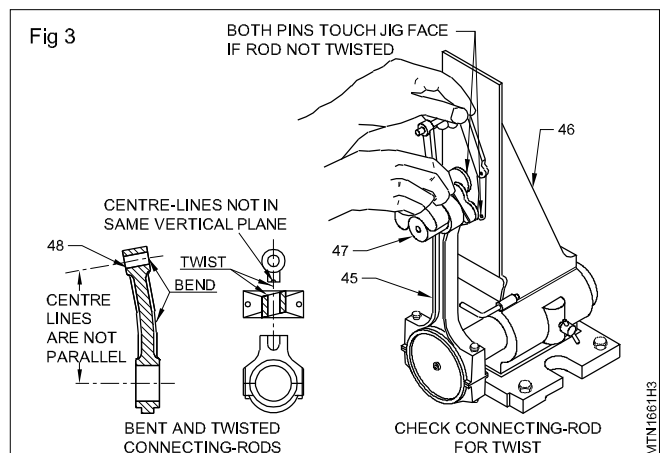
- 1 Check connecting rod small end bush & pin: Check connecting rod small end bush (40) for wear and scouring. Replace if required (Fig 1).



- 2 Check interference of bush in connecting rod small end (41).
- 3 Check gudgeon pins (42) for any damage visually.
- 4 Check clearance between gudgeon pin and connecting rod bush using bore dial gauge (43) and micrometer (44).
- 5 If clearance is more than specified recommendation, replace connecting rod bush.
- 6 Check the connecting rod alignment: Check the connecting rod alignment for bend and twist by mounting the connecting rod on alignment fixtures.
- 7 Check the bend: Place the connection rod (45) on the alignment fixtures (46) (Fig 2).
- 8 Insert the gudgeon pin (47) in the small end bore (45).
- 9 With the scale edge check the square setting of the gudgeon pin.
- 10 If the connecting rod is bent or twisted the gudgeon pin will not sit squarely in the bore.
- 11 Replace the connecting rod if found bend or twisted.



- 12 Check the twist: Place the connecting rod on the alignment fixture. Insert the gudgeon pin in the small end bore with the scale edge of the fixture. Check the square seating of connecting rod small end. If the connecting rod small end does not sit squarely on the scale edge, replace the connecting rod (Fig 3).



**Practice to setting a connecting rod big end and main bearing**

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

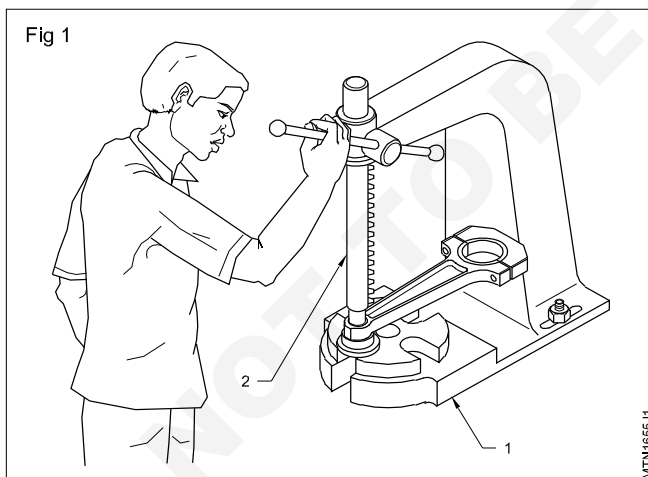
- assemble the piston with connecting rod
- install the piston rings and piston pin
- install the big end bearing of connecting rod
- install the main bearing of the crank shaft
- install the thrust washer.

Requirements		
<b>Tools/Instruments</b>		<b>Materials/Components</b>
• Trainees Tool Kit	- 1 No.	• Cotton waste
• Piston ring expander	- 1 No.	• Oil seal
<b>Equipment/Machines</b>		• Soap oil
• Work bench	- 1 No.	• Piston
• Harber press	- 1 No.	• Piston ring
• Connecting rod alignment fixture	- 1 No.	• Piston bush
		• Piston pin
		• Big and bearing
		• Main bearing
		• Lubrication oil

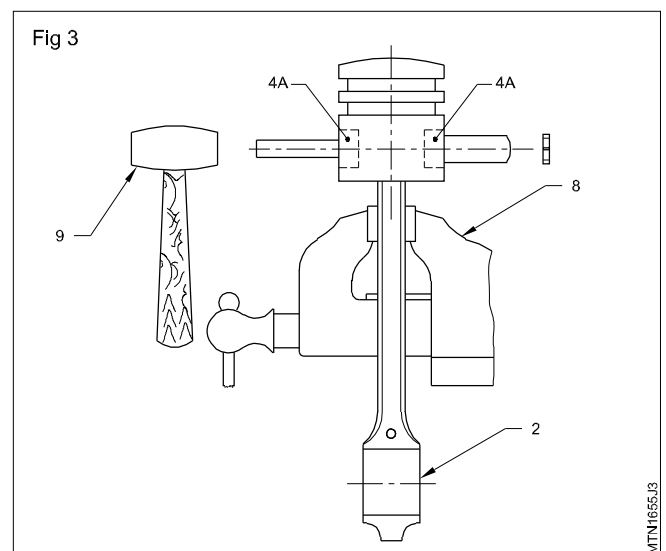
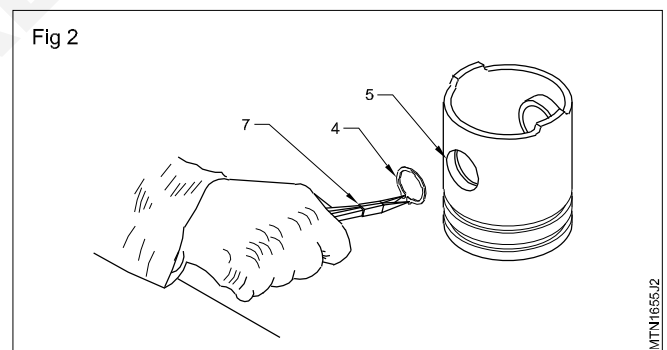
**PROCEDURE**

**Assemble piston & connecting rod**

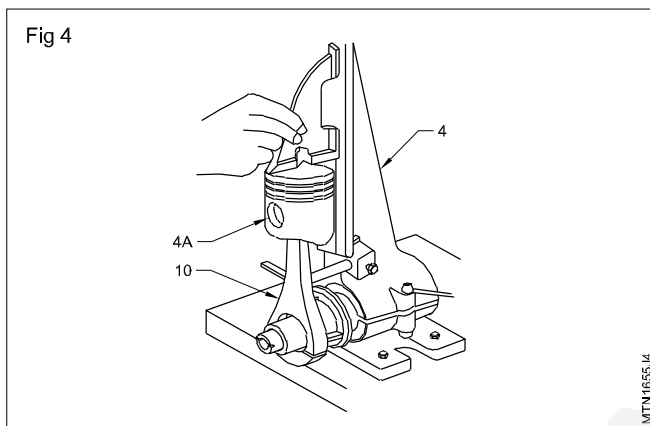
- 1 Fix bush (1) in connecting rod small end (2) by using special tool (3) as recommended by manufacturer.



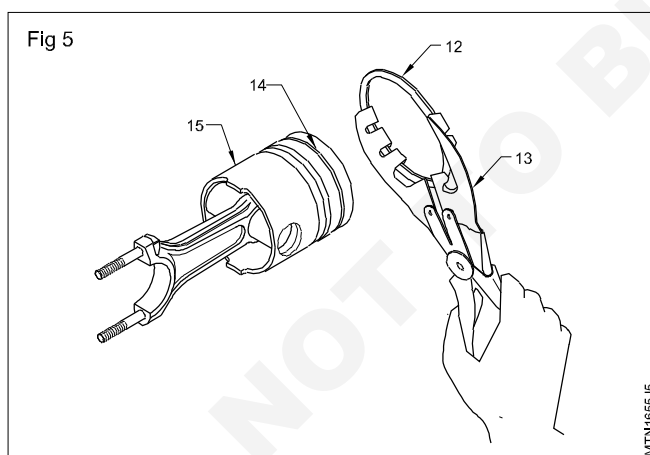
- 2 Ensure that the oil hole of bush aligns with that of connecting rod.
- 3 Fit one circlip (4) in the groove (5) of the piston (6) using circlip plier (7) (Fig 2).
- 4 After fixing one circlip keep the piston in boiling water for easy fitting of gudgeon pin. Put the gudgeon pin in piston pin bosses (4A) from the side where circlip is not fixed (Fig 3).



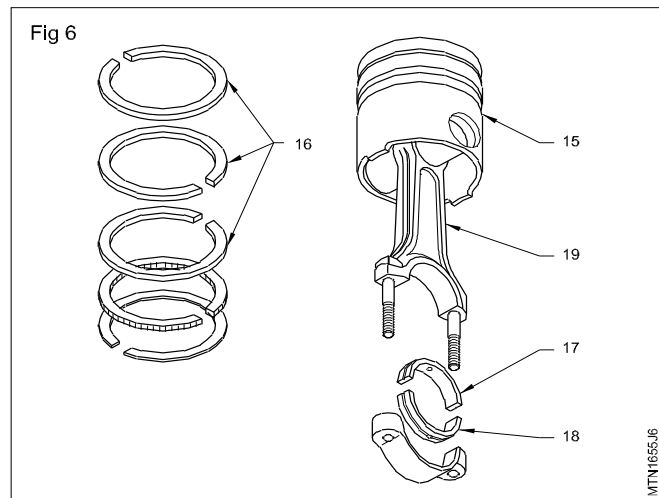
- 5 Align the connecting rod small end with the gudgeon pin.
- 6 Tap the gudgeon pin in the piston with the help of a mallet (9). While tapping, keep on moving the connecting rod to avoid damage to the connecting rod bush.
- 7 Fit other circlip into the other groove of piston.
- 8 Repeat the above steps for all the pistons & connecting rods.
- 9 Check square seating of the piston pin (Fig 4): check the square seating of the gudgeon pin (8) by fixing the connecting rod assembly (10) on the alignment fixture (11). If connecting rod is twisted/bent piston pin will not sit squarely in the boss. If connecting rod is bent/twisted replace the connecting rods.



- 10 Installing rings:** Hold the piston ring (12) in the ring expander (13) and fit it in the piston groove (14). Ensure that compression and scraper rings are fitted in the proper grooves of the piston (15) (Fig 5)



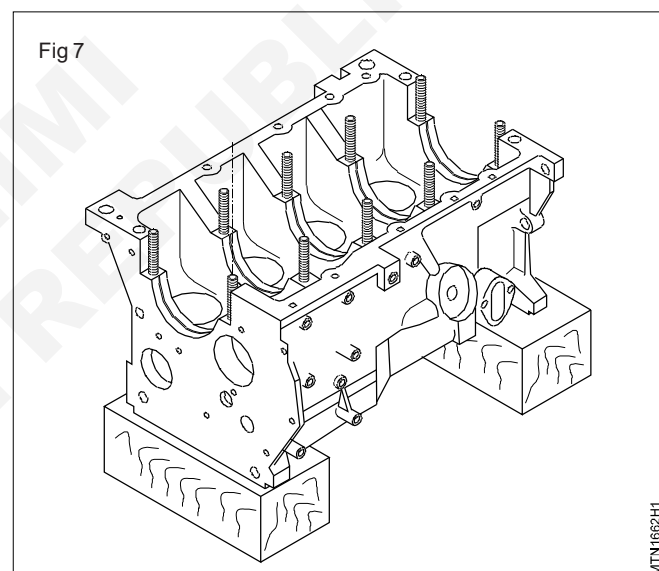
- 11 Ensure that 'top' written on the ring faces upward. Fit all the rings to all the pistons.
- 12 The gap of the all rings (16) should be staggered properly, so that the ring gaps are uniformly spaced around the piston (15) (Fig 6).
- 13 Fixing piston & connecting rod assembly into the block.



- 14 Place the upper (17) and lower bearing shells (18) in all the connecting rods (19) and caps and keep them in proper order.

- 15 Ensure that the oil hole of the bearing shell aligns with the oil hole of the connecting rod.

### 16 Clean engine block (Fig 7)



- 17 Clean the parent bore (2) of the cylinder block(1)

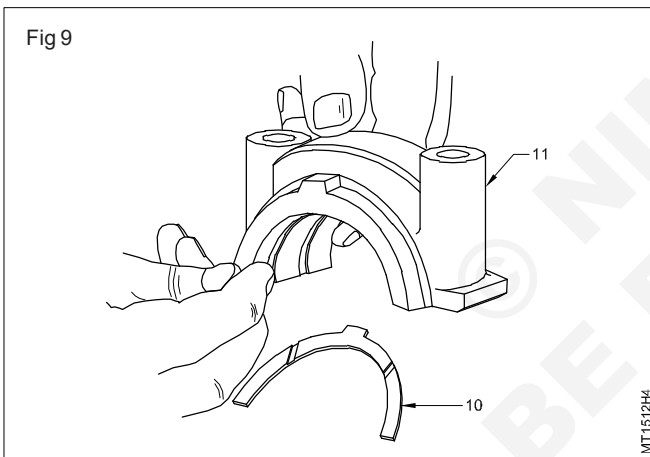
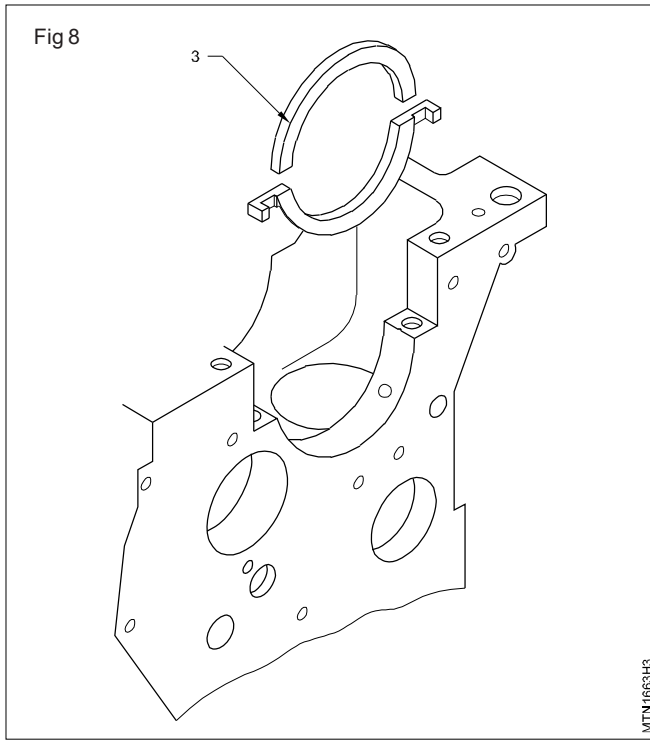
- 18 Clean the oil holes (5) of the parent bore and camshaft bore (6)

- 19 Place the main bearing shell (3) into its respective parent bore. Ensure that oil hole(4) of the bearing shell and that of parent bore align.

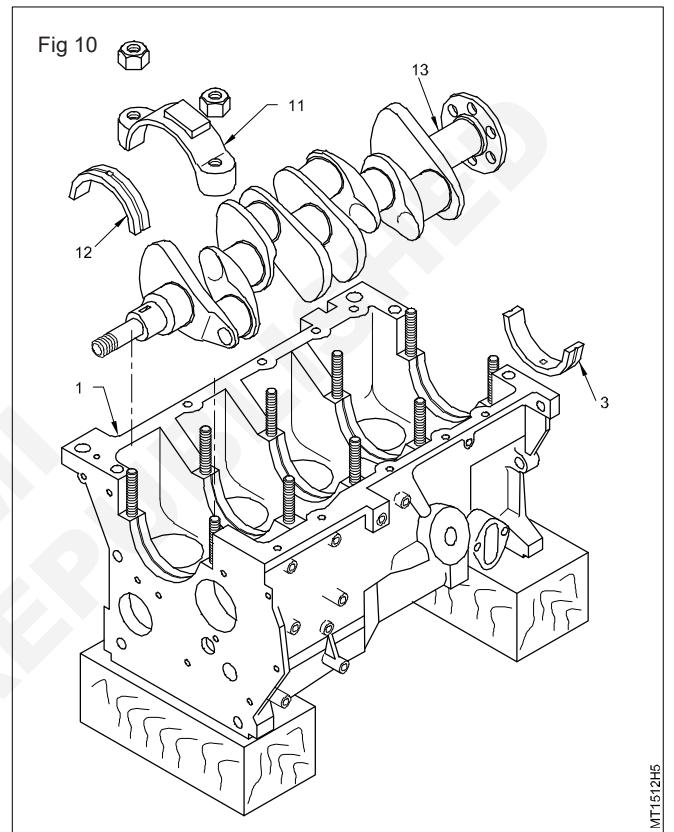
- 20 Install crankshaft rear bearing seal (oil seal) (7) into the parent bore (2) (Fig 8).

- 21 Insert the rubber packing (8) (rubber rod) in the holes (9) between the bearing cap and the cylinder block (1) (Fig 9).

- 22 The protection of the rubber packing should not be more than 6 mm. If it is more than 6 mm, cut the excess length.



- 23 Install the thrust washers (10) into the respective bearings and caps (11) (Fig 10).
- 24 Place main bearing shells (3) in cylinder block (1) (Fig 10).
- 25 Lubricate all the bearing surfaces with clean engine oil
- 26 Place the crankshaft (13) in its position in the cylinder block
- 27 Place the shell bearings (12) into their respective bearing caps (11)



**Practice on assembling the crank shaft**

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

- set the bearings in the cylinder block
- set the crank shaft in the cylinder block
- set the connecting rod bearing cap
- check crank shaft end ply.

**Requirements**

**Tools/Instruments**

- Magnetic base with dial gauge - 1 No.
- Trainee tools kit - 1 No.
- Heavy duty screw driver/bar - 1 No.
- Torque wrench - 1 No.
- Box spanner - 1 Set.
- Piston ring compressor - 1 No.

**Equipment/Machines**

- Multi-cylinder diesel engine - 1 No.
- Work bench - 1 No.
- Wooden block - 2 Nos.

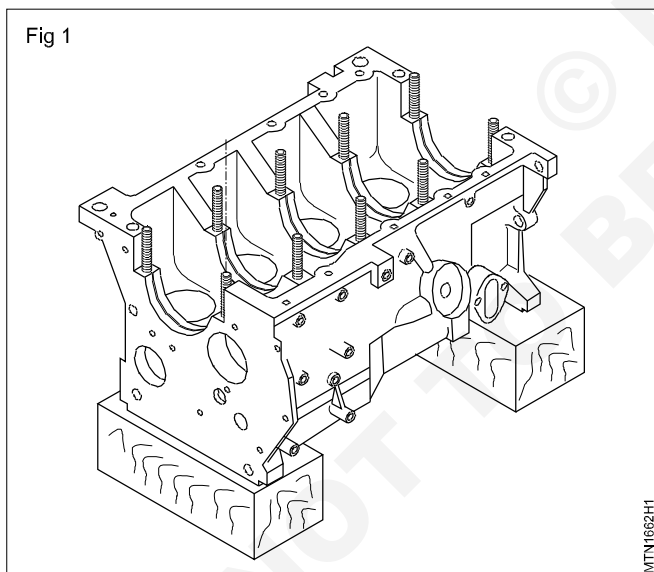
- Oil can - 1 No.

**Materials/Components**

- Main journal bearing - 1 No.
- Big end bearing - as reqd.
- Piston pin - as reqd.
- Nut bolts - as reqd.
- Cotton waste - as reqd.
- Baniyan cloth - as reqd.
- Soap Oil - as reqd.
- Lube oil - as reqd.

**PROCEDURE**

- 1 Place the engine block on the wooden block. (Fig 1)



- 2 Clean the parent bore of the main bearing in the cylinder block.
- 3 Clean the oil holes of the parent bore.
- 4 Place the main bearing shell in its respective parent bore. Ensure that the oil hole of the bearing shell is align with parent bore hole.
- 5 Install the crankshaft rear bearing seal (oil seal). insert the rubber packing (rubber rod) in the holes between the bearing cap and the cylinder block.

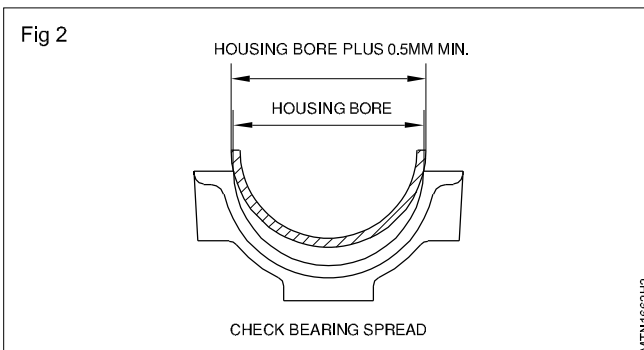
- 6 The protection of the rubber packing should not be more than 6 mm, cut off the excess length.

- 7 Install the thrust washers into the respective bearings.

Lubricate all the bearing surface with clean engine oil. Place the crankshaft in its position in the cylinder block.

Place the shell bearings into their respective bearing caps.

Check the bearing shells for spread. The inserts should 'snap' into position in the housing and cap. (Fig 2)



- 8 Lubricate and install the main bearing caps. Ensure that the bearing caps are fitted into their original positions.

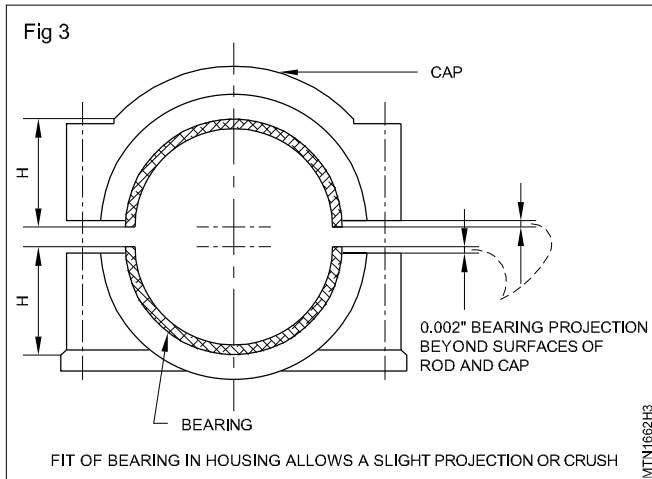
- 9 Hand-tighten the main bearing cap bolts.

- 10 Tighten the middle bearing cap to the specified torque and check the crankshaft for free rotation.

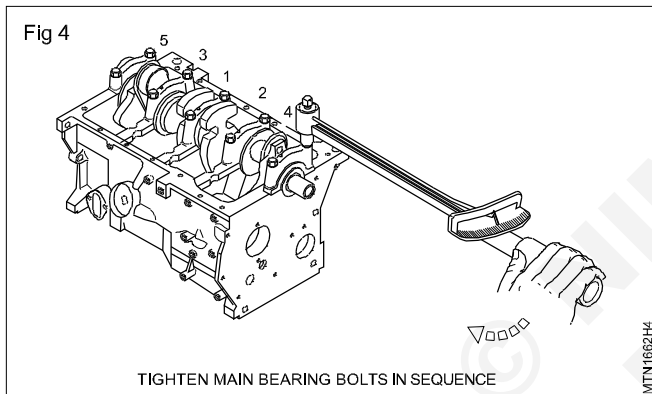
- 11 Loosen the main bearing cap and bolts on one side.



12 Check the gap between the main bearing cap and the cylinder block surface with a feeler gauge. This gap indicates the bearing crush. (Fig 3)

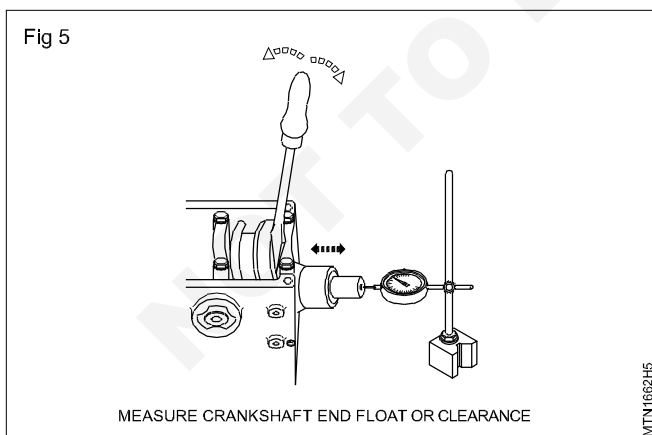


13 Tighten the bolts of the main bearing caps on either side of the centre bearing, one by one to the specified torque. (Fig 4)



14 Check the Crankshaft for its free rotation after tightening each bearing cap's bolts.

15 Check the crankshaft end play. (Fig 5)



16 To Increase the end play use a thinner thrust washer and to reduce the end play use a thicker thrust washer.

17 Clear the cylinder block surface.

18 Keep the cylinder block in a tilted position and support it on wooden blocks.

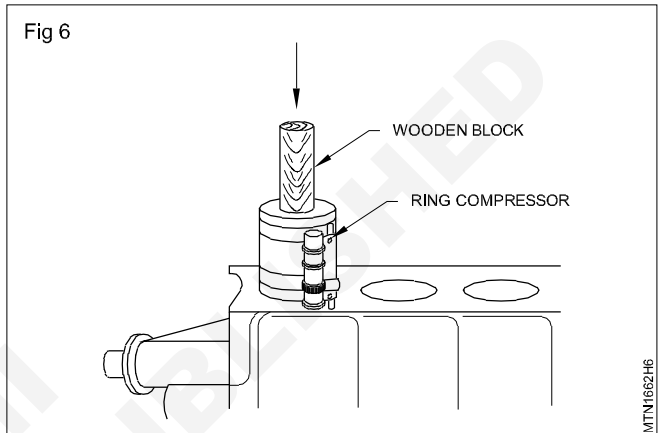
19 Stagger the piston rings as specified by the manufacture.

20 Lubricate the cylinder walls, piston and rings, big end bearing shells and crankpins with engine oil.

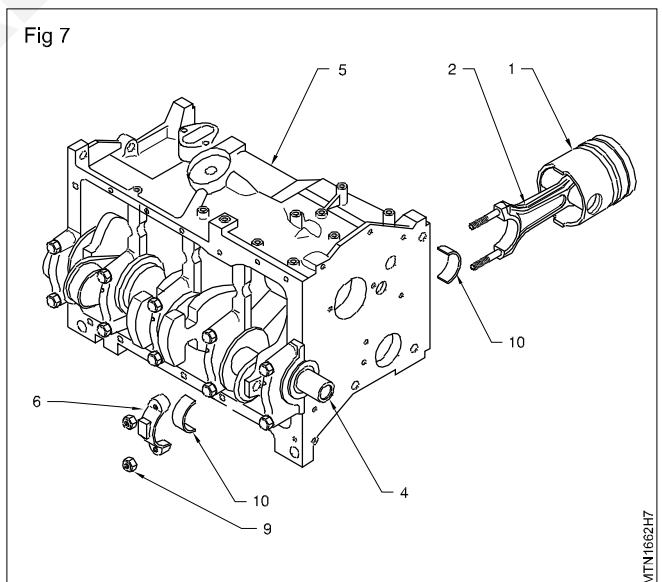
21 Place the piston in the cylinder till the bottom ring touches the cylinder block top. Ensure that the piston is placed in the cylinder in the same direction as specified by the manufacturer.

22 Bring the respective crankpin to T.D.C.

Compress the piston rings by a ring compress (Fig 6)  
Push the piston with a wooden block till the connecting rod big end bearing sits on the crankpin.



23 Push the piston, and simultaneously rotate the crank shaft till it comes to B.D.C. Ensure that the connecting rod does not dislodge from the crankshaft while rotating the crankshaft. (Fig 7)



24 Fit the connecting rod bearing cap, along with the lower bearing shell.

25 Tighten the bearing cap bolts/nuts to the recommend torque.

26 Rotate the crankshaft and check for free rotation.

Repeat the above steps for fitting all the reaming pistons and connecting rod assemblies.

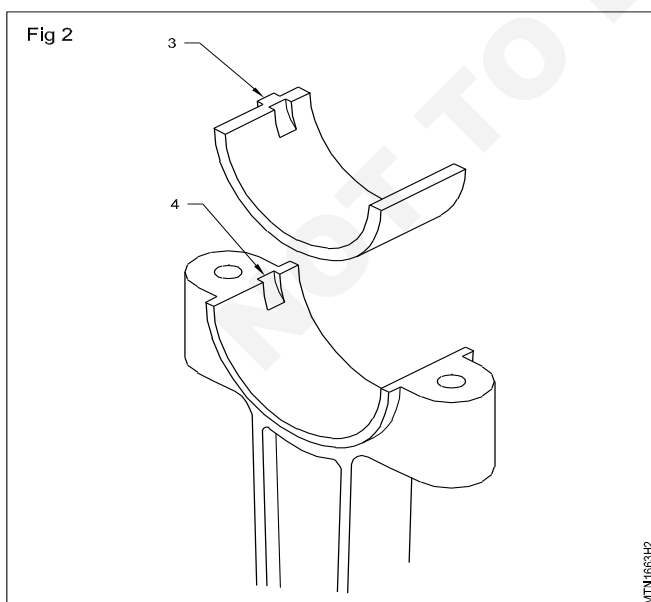
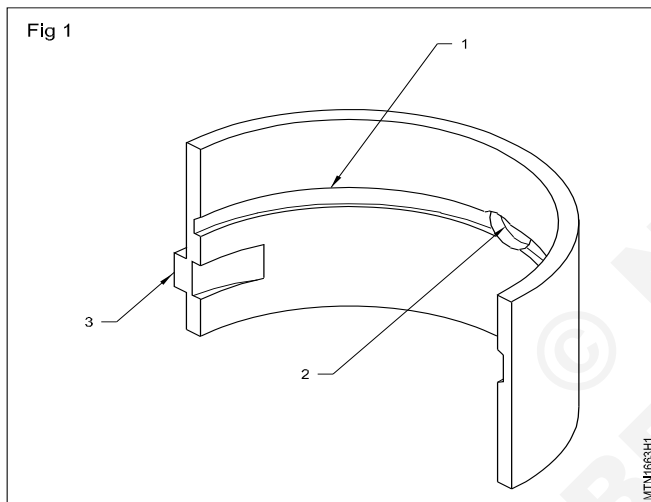
# Assembling the engine

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

- assemble the crankshaft and camshaft
- assemble piston and connecting rod assembly in engine
- fit cylinder head on engine block and assemble rocker arm assembly
- fit FIP, Fuel filter, oil filter, water pump, air cleaner, starter motor and alternator
- adjust tappet clearance
- adjust fuel injection timing
- bleed the fuel system.

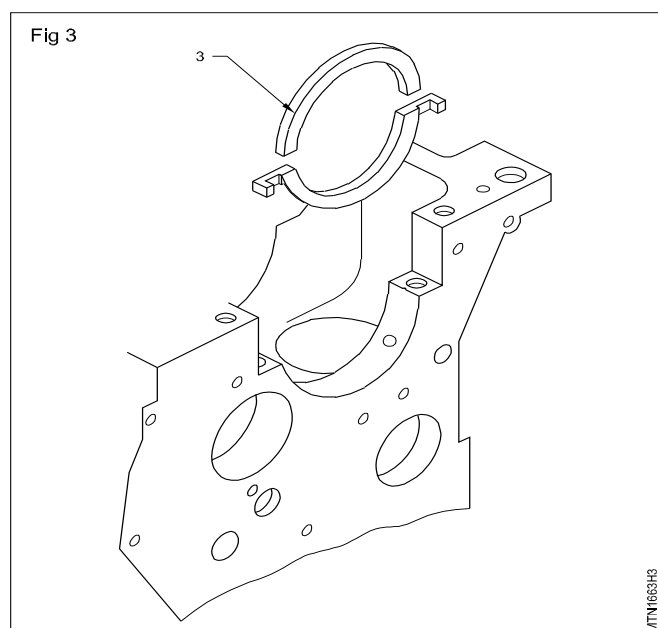
## TASK 1: Assembling the crankshaft and camshaft

- 1 Clean the main oil gallery in a cylinder block.
- 2 Place the cylinder block in inverted position on stand.
- 3 Replace the dummy if necessary.
- 4 Fit main bearing shells in the parent bore of the cylinder block and also in the bearing caps. Ensure that the bearing notches (3 & 4) (Fig 2) sit in position and oil holes (2) of bearing shells and cylinder block are aligned. (Fig 1)



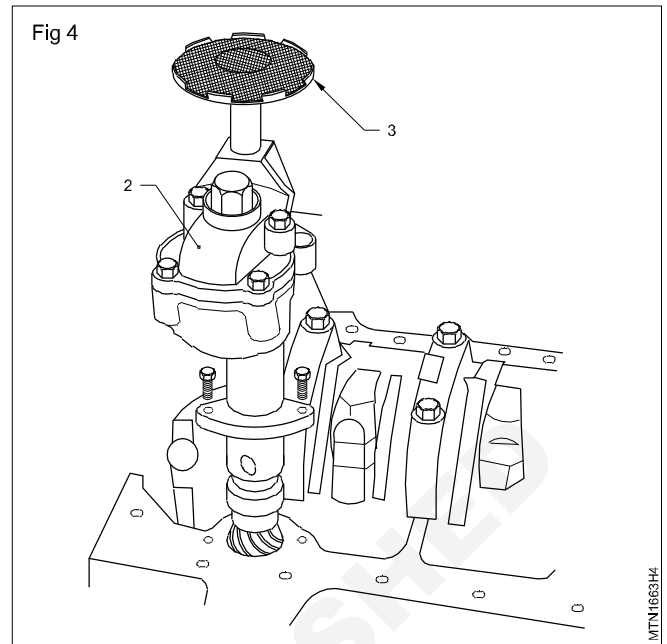
- 5 Apply lube oil on the bearing shells.
- 6 Place the crank shaft.

- 7 Place the thrust washer in its position.
- 8 Fit the bearing caps ensure that the marks are matched, and tighten the caps at the recommended torque in given sequence.
- 9 Check free rotation of crank shaft after tightening each cap.
- 10 Check the end play of crankshaft, if it is not within limits replace the thrust washer to get recommended end play and lock the cap bolts.
- 11 Fit the timing back plate and lock the bolts.
- 12 Fit the camshaft bushes. Ensure that the oil hole in block and bush is aligned.
- 13 Insert camshaft in its position.
- 14 Tighten camshaft thrust plate bolt.
- 15 Check camshaft end play and adjust with shims and lock it. Increasing shims will reduce the end play.
- 16 Fit the flywheel housing and tighten the bolts and lock them.
- 17 Press rear oil seal (3) into retainer and fit the same over the crank shaft. (Fig 3)
- 18 Check for free rotation of crankshaft.
- 19 Fix the flywheel in its position and tighten mounting bolts at the recommended torque.



## TASK 2: Assembling piston and connecting rod assembly in engine

- 1 Tilt the engine block and lubricate cylinder bore.
- 2 Stagger piston rings as specified by the manufacturer. Place the piston in the cylinder till the bottom ring touches the cylinder block's top. Ensure that the piston is placed in the cylinder in the same direction, as specified by manufacturer.
- 3 Bring respective crank pin to TDC.
- 4 Compress piston rings by a ring compressor.
- 5 Push the piston with a wooden block till connecting rod sits on the crankpin. Push the piston and simultaneously rotate the crankshaft till it comes to B.D.C. Ensure that the connecting rod does not dislodge from the crankshaft while rotating crank shaft.
- 6 Fit the connecting rod bearing cap along with the lower bearing shell. Tighten bearing cap bolts/ nuts at the recommended torque.
- 7 Rotate the crankshaft and check for free rotation. Repeat the above steps for fitting all the remaining pistons.
- 8 Fit oil pump (2) and check free rotation of oil pump shaft with the camshaft. (Fig 4)
- 9 Connect strainer (3) with oil pump.
- 10 Fit camshaft gear and coincide its timing mark with mark/ pointer on timing back plate. Coincide flywheel's TDC mark (1/6 or 1/4) with flywheel housing's pointer.
- 11 Fit idler gear and tighten its bolt.



- 12 In some engines timing chain/ belt is provided instead of idler gear to drive camshaft. Follow manufacturer's procedure. (Consult your instructor)
- 13 Replace timing case's oil seal and fit timing case.
- 14 Lock flywheel with wooden block or special tool.
- 15 Fit damper pulley and tighten damper pulley bolt at recommended torque.

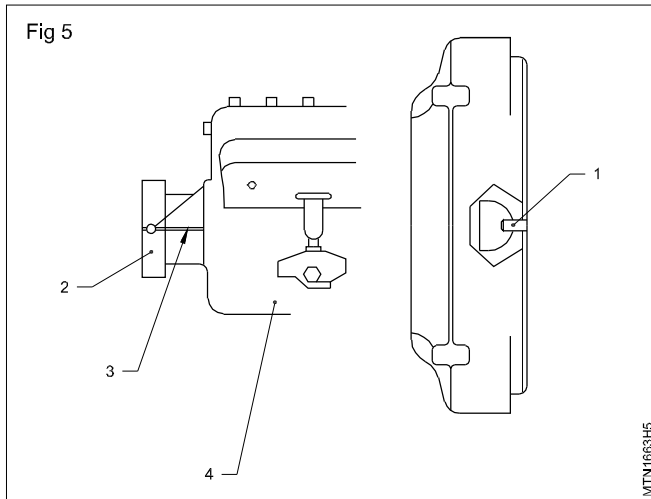
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## TASK 3: Fitting cylinder head assembly, rocker arm assembly

- 1 Check the tightness of the cylinder head studs and if found loose, tighten these at recommended torque.
- 2 Clean the cylinder head surface and engine block surface.
- 3 Place the cylinder head gasket on cylinder block.
- 4 Ensure that 'Top' marked on the gasket faces upwards.
- 5 Lower the cylinder head carefully on cylinder block.
- 6 Ensure that the studs are not damaged.
- 7 Tighten the cylinder head nuts in the given sequence at recommended torque.
- 8 Place tappets in tappet bore.
- 9 Place push rods in push rod holes.
- 10 Place the rocker arm assembly on cylinder head. Ensure that the rocker shaft brackets do not hit the studs.
- 11 Loosen the ball pins of rocker levers.
- 12 Tighten rocker shaft mounting bolts at recommended torque.
- 13 Place new injector washers.
- 14 Fit the injectors and tighten at recommended torque.
- 15 Place the new gaskets on inlet and exhaust flanges.
- 16 Fit the inlet and exhaust manifolds and tighten the mounting nuts at recommended torque.

#### TASK 4: Fitting fuel injection pump, fuel filter assembly, oil filter, water pump, air cleaner, starter motor, dynamo/alternator

- 1 Turn flywheel and coincide its T.D.C. 1/4 or 1/6 marks with flywheel housing's pointer (1). (Fig 5) Confirm that 1st cylinder is in compression stroke by rotating both the push rods of 1st cylinder by hand. In the compression stroke both the push rods will rotate. If both the push rods do not rotate turn flywheel one full round and again coincide 1/6 or 1/4 mark with flywheel housing.

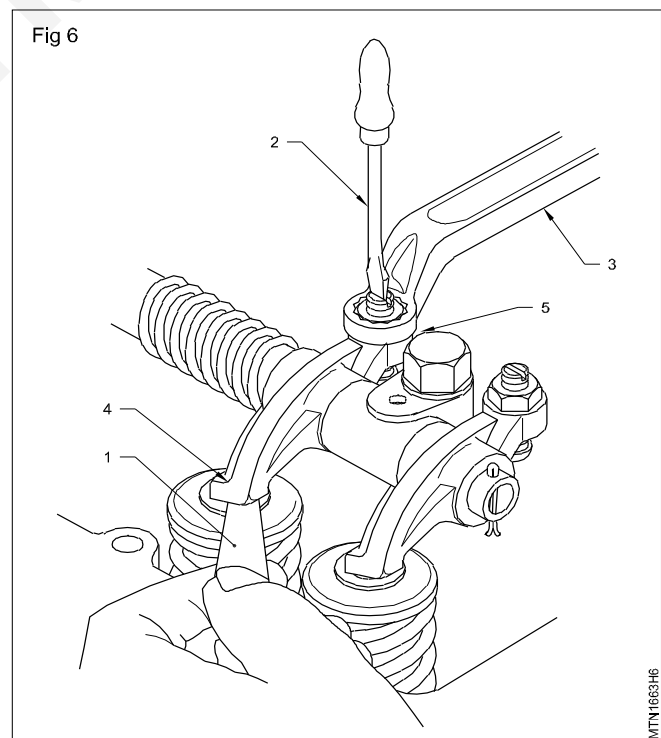


- 2 Rotate the FIP camshaft until the mark on its flywheel (2) is in line with pointer (3) on the pump body (4).
- 3 Install the pump on the bracket at the same time pump flange should go inside the drive flange.
- 4 Ensure that the timing mark is not disturbed.
- 5 Fix bolts and tighten.
- 6 Fit fuel filter assembly and connect fuel lines to feed pump and FIP.
- 7 Connect high pressure lines and fix the clamp.
- 8 Fit overflow lines.
- 9 Fit oil filter assembly and connect the oil pipes.
- 10 Fix the gasket on the water pump body.
- 11 Fit the water pump and fix the fan leaf.
- 12 Fit self starter motor.
- 13 Fit dynamo/alternator.
- 14 Fit fan belt.
- 15 Fit the air cleaner assembly.

#### TASK 5: Adjusting tappet clearance

- 1 Turn crankshaft in clockwise direction and coincide flywheel's TDC 1/6 or 1/4 mark with flywheel housing's pointer. Confirm that 1st cylinder is in compression stroke.
- 2 Place ring spanner (3) on the lock nut (5). (Fig 6)
- 3 Place the specified thickness feeler gauge (1) between the valve stem and the rocker tip (4).
- 4 Tighten the adjusting screw by a screw driver and at the same time move feeler gauge to and fro.
- 5 Stop tightening of the adjusting screw when it moves with the load, but it should not be jammed.
- 6 Rotate the push rod, it should also rotate with a slight load; but it should not be jammed.
- 7 Hold the adjusting screw with the screw driver firmly and tighten lock nut by a ring spanner (3).
- 8 Ensure that the adjusting screw (5) does not rotate while tightening the locking nut.
- 9 Check again the movement of the feeler gauge leaf (1) and push rod.
- 10 Repeat the above steps to adjust the tappet clearance for remaining cylinder according to firing order.
- 11 Rotate engine flywheel in clockwise direction to coincide INJ mark on flywheel with flywheel housing pointer.

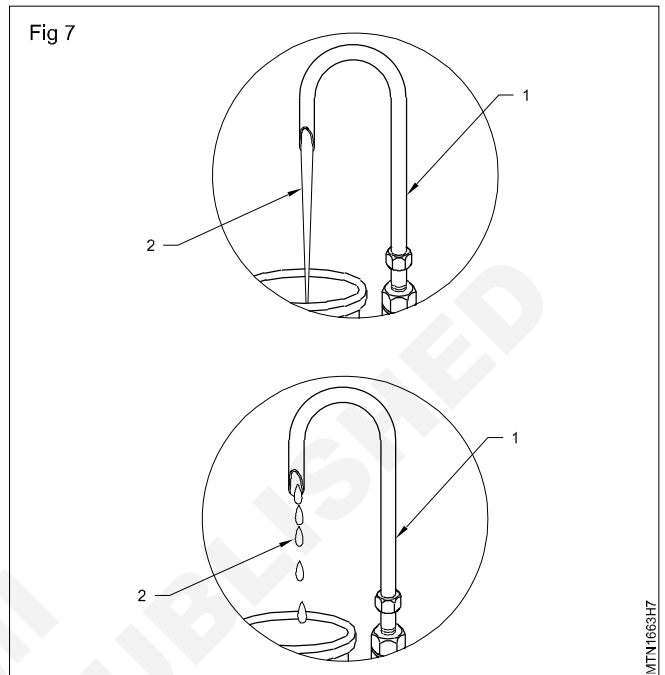
- 12 Rotate FIP camshaft until the mark on its flywheel is in line with pointer on the FIP flange.
- 13 Tighten the FIP flange bolts.



### TASK 6: Adjusting fuel injection timing by spill cut off method

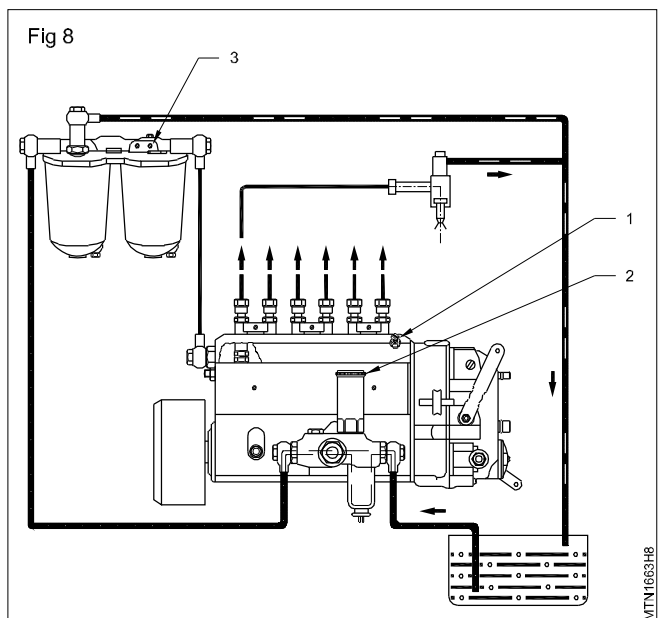
- 1 Loosen F.I.P. flange's bolt.
- 2 Remove 1st delivery valve holder and remove valve peg and spring.
- 3 Fit delivery valve holder.
- 4 Fit swan neck pipe (1) (Fig 7) on 1st delivery valve holder.
- 5 Connect fuel gallery of F.I.P to fuel container placed at a higher level.
- 6 Move F.I.P. towards engine till fuel (2) starts flowing freely through swan neck pipe.
- 7 Now move the F.I.P away from engine till fuel flow cuts-off completely.
- 8 Again move F.I.P. towards engine and stop. When the fuel flow regulates in such a way that there is a flow of each drop between 15 and 20 seconds, at that time tighten the bolts of the F.I.P. flange without varying the flow of drop.
- 9 Remove swan neck pipe (1) and delivery valve holder and replace peg and spring and fit the delivery valve holder.
- 10 Connect the pressure pipes between injectors and fuel injection pump.
- 11 Place the valve door gasket over the cylinder head.
- 12 Fix the valve door cover and tighten bolts.

- 13 Open the oil filling cap/flap and fill the correct grade of engine oil slowly. While filling intermittently check the oil level. This avoids over filling of oil.
- 14 Close the filling cap/flap.



### TASK 7: Bleed the fuel system

- 1 Loosen bleeding screw (3) of filter one or two turns. (Fig 8)
- 2 Pump fuel by hand primer (2) till fuel comes without air through bleeding screw. Tighten bleeding screw.
- 3 Repeat the above procedure to bleed air from F.I.P. through bleeding screw (1).
- 4 Start and test the engine. (Consult your instructor)



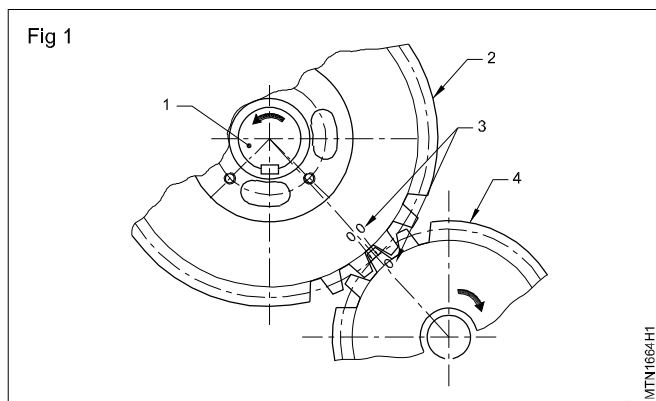
**Practice on setting valve timing**

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

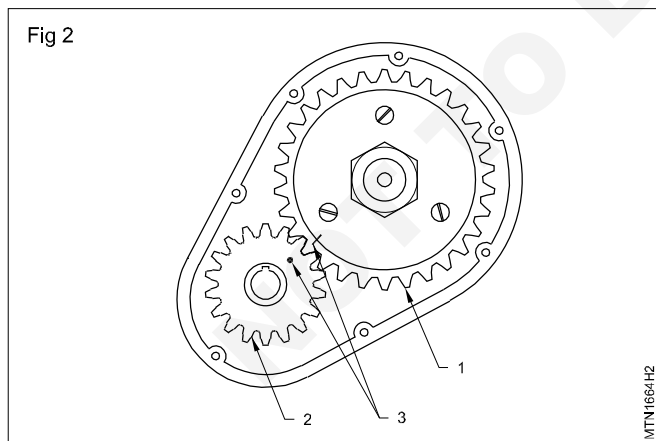
- fit a timing gear
- fit a timing chain
- fit a timing belt
- set the valve timing.

**Job sequence**

- **Set the valve timing (Gear drive):** Rotate the flywheel and coincide the flywheel TDC mark with the belt housing's pointer mark (Fig 1).

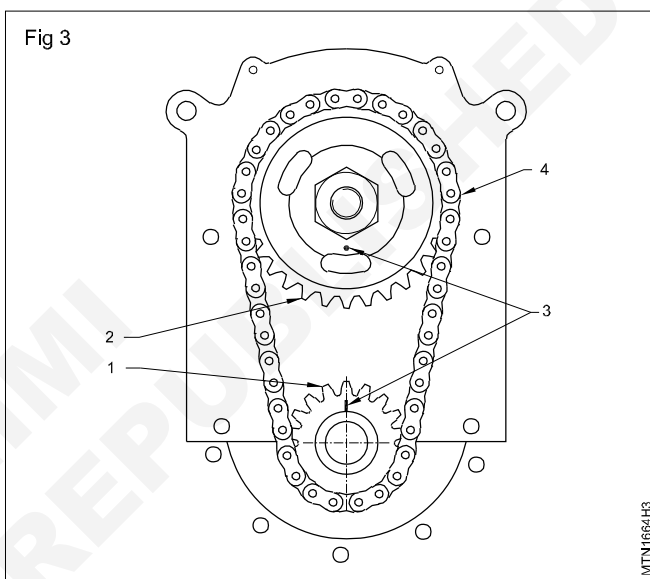


- Pull the camshaft (1) end gear (2) slightly out so that the camshaft can rotate freely.
- Rotate the camshaft (1) and align the timing marks (3) on the crankshaft gear (4) and the camshaft gear (2).
- Push the camshaft inside the block. Now the camshaft gear (1) meshes with the crankshaft gear (2) (Fig 2).



- Rotate the crankshaft and recheck the alignment of the timing marks (3).
- Tighten the camshaft flanges.

- **Set the valve timing (Chain drive):** Rotate the crankshaft sprocket (1) (Fig 3).



- Bring piston number one to TDC.
- Rotate the camshaft with the sprocket (2).
- Align the camshaft with the sprocket (2).
- Align the camshaft and crankshaft valve timing marks (3) in line.
- Check the chain (4) for wear.
- Install the chain on the crankshaft sprocket (1) and camshaft sprocket (2).
- Check and align the timing marks on the sprockets.
- Assemble the timing chain cover and crank pulley and other parts.
- Start the engine and check the engine performance.

**Check the cooling system for overheating and under cooling**

**Objective:** At the end of this exercise you will be able to  
 • trace out the fault in cooling system.

<b>Requirements</b>			
<b>Tools/Instruments</b>			
• Trainees Tool Kit	- 1 No.	• Soap oil	- as reqd.
• Injector learning kit	- 1 No.	• Grease	- as reqd.
<b>Equipment/Machines</b>			
• Running Engine	- 1 No.	• coolant oil	- as reqd.
<b>Materials/Components</b>			
• Cotton waste	- as reqd.	• Rubberhose	- as reqd.
		• Fuel hose	- as reqd.
		• Fuel filter	- as reqd.
		• cleaning solvent	- as reqd.
		• Radiator cap	- as reqd.
		• thermostat valve	- as reqd.

**PROCEDURE**

**Fault diagnostic methods**

**Checking cooling system for overheating/under cooling.**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Check the water level in radiator - if need top the coolant.</li> <li>2 Check the radiator hose pipe for leak, crank, damage - if need replace.</li> <li>3 Check the radiator cores for leak and damage - if need repair it.</li> <li>4 Check the cylinder head gasket leaking - if need replace.</li> <li>5 Check the water pump gasket/seal for leaking - replace.</li> <li>6 Check the thermostat valve function - if need replace the thermostat valve.</li> <li>7 Check the radiator drain plug for lose fitting - tighten it.</li> <li>8 Check the water pump function - if need repair it.</li> </ol> | <ol style="list-style-type: none"> <li>9 Check the fan belt drive - if need adjust the belt tension.</li> <li>10 Check the radiator fins for blockage - clean it.</li> <li>11 Check the water jacket for rust formed - clean it.</li> <li>12 Check the radiator cooling fan function - if need replace.</li> <li>13 Check the thermos witch function - if need replace the switch.</li> <li>14 Check the radiator cooling fan circuit fuse - replace the fuse.</li> <li>15 Check the coolant sensor - if need replace.</li> <li>16 Check the radiator coolant cooling fan blade angle - set that correct angle.</li> <li>17 Improper 'V' belt seating on water pump pulley - set properly.</li> <li>18 Radiator pressure cap defective - replace.</li> <li>19 More coolant oil adds with water - add as per proper ratio.</li> </ol> |
|---|--|

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**Overhauling water pump and reverse flushing system**

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

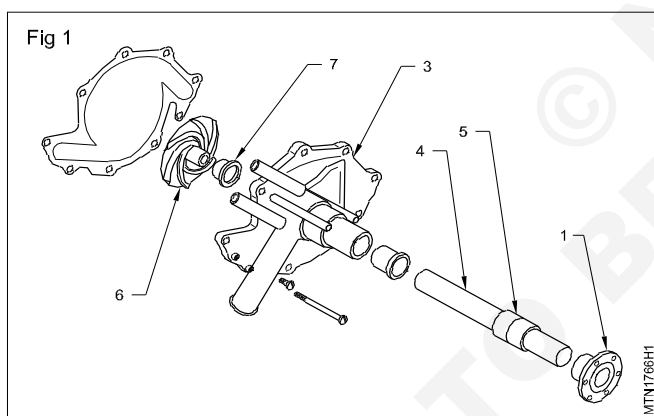
- remove and dismantle the water pump
- inspect and assemble the water pump
- reverse flushing system.

Requirements	
<b>Tools/Instruments</b>	<b>Materials/Components</b>
<ul style="list-style-type: none"> <li>• Trainees Tool Kit - 1 No.</li> <li>• Box spanner set</li> <li>• Puller</li> <li>• Container</li> <li>• Drift and Hammer</li> </ul>	<ul style="list-style-type: none"> <li>• Tray - 1 No.</li> <li>• Cotton waste - as reqd.</li> <li>• Coolant oil - as reqd.</li> <li>• Kerosene - as reqd.</li> <li>• Grease - as reqd.</li> <li>• Soap oil - as reqd.</li> <li>• Water pump repair kit - 1 No.</li> </ul>
<b>Equipment/Machines</b>	
<ul style="list-style-type: none"> <li>• Multi-cylinder diesel engine - 1 No.</li> <li>• Jet Washer - 1 No.</li> </ul>	

**PROCEDURE**

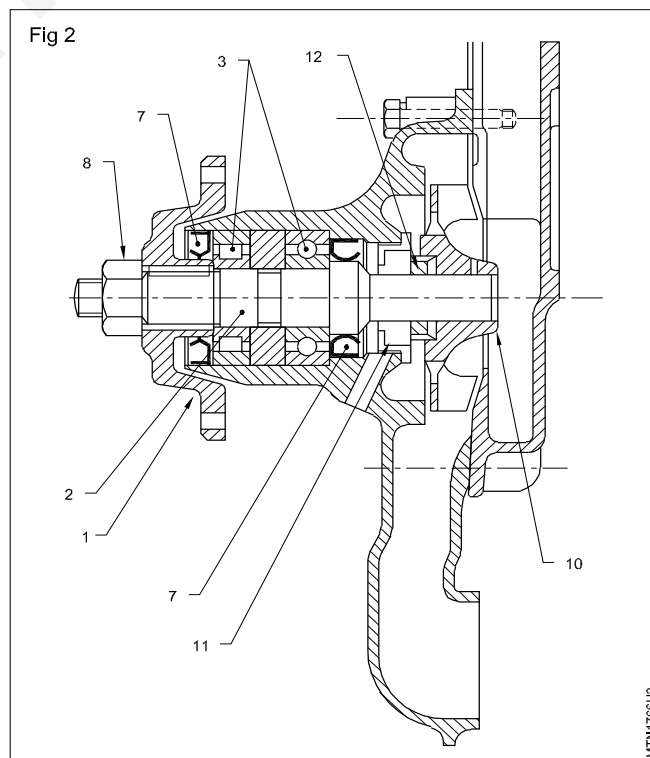
**TASK 1: Dismantling the water pump**

- 1 Remove the water pump from the engine.
- 2 Lock the water pump's pulley hub (1). (Fig 1)



- 3 Remove the water pump pulley hub nut (8).
- 4 Remove the water pump pulley hub. Use a puller.
- 5 Remove the water pump rear cover, if provided.
- 6 Unscrew the oil seal holder and remove the oil seal shims and gasket.
- 7 Place the water pump housing (3) (Fig 2) on support and press out the water pump shaft (4) with the bearing assembly (5) from the impeller (6).
- 8 Remove the inner oil seal (7) from the housing (Fig 1).
- 9 Place the water pump shaft on the tube, supporting the inner bearings inner race, with the shafts taper end facing upward.
- 10 Fix the nut on the threaded end of the shaft to protect the shafts threads from damage.

- 11 Press/tap the shaft till the bearing comes out of its seat, from the water pump shaft.
- 12 Remove the outer race of the bearing from the housing with the help of a drift and hammer.
- 13 Remove the insert (12) with its rubber sleeve from the impeller (10). (Fig 2)



- 14 Remove the water seal (11) from the water pump housing.



## TASK 2: Cleaning and inspection of water pump parts

**Inspect the following parts visually for any crack/damage after cleaning the parts.**

- 1 Water pump shaft.
- 2 Bearing.
- 3 Water seal.
- 4 Impeller.
- 5 Water pump housing.
- 6 Check the water pump shaft for bend.
- 7 Hoses and engine drive belt.

## TASK 3: Assembling the water pump

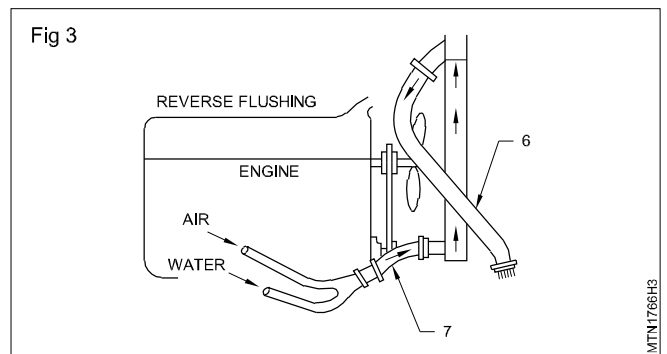
- 1 Press the bearings on the water pump shaft.
- 2 Press the water pump pulley hub on the shaft.
- 3 Fit the oil seal in the water pump housing; use a drift.
- 4 Fit the water seal in the water pump housing; use a drift.
- 5 Press the shaft assembly in the pump housing.
- 6 Invert the water pump housing and press the impeller on the water pump shaft.
- 7 Rotate the water pump shaft and check that the impeller does not touch the water pump housing if the impeller touches the water pump housing, replace it.
- 8 Fit the rear cover with a new gasket.
- 9 Check the water pump shaft for free rotation.
- 10 Fix the water pump pulley and fan.
- 11 Ensure the tightness of fan and water pump pulley.

## TASK 4: Refitting and testing

- 1 Apply grease on both side of the pump gasket
- 2 Fix the gasket between water pump and engine
- 3 Fix the water pump mounting bolts and ensure the specified tightness of mountings
- 4 Connect the fan belt and radiator hoses
- 5 Fill the coolant in the radiator
- 6 Start the engine and check noise from the water pump
- 7 Ensure no noise and leaks from the water pump

## TASK 5: Reverse flush the radiator

- 1 Check the radiator filler cap (1) and its valve mechanism for movement, pressing it by hand.
- 2 Check visually the radiator core for damage, clogging and leakage
- 3 Check the mounting straps on the tanks of the radiator for tightness.
- 4 Check the soldered joints (5) of the top and bottom tanks as well as the filler neck.
- 5 Check visually the radiator mounting brackets for cracks damage etc. Repair/replace the damaged parts.
- 6 Check visually the stay rod end for damage. Replace the damaged parts
- 7 Attach a drain hose pipe (6) at the top of the radiator. (Fig 3)
- 8 Attach a new piece of hose (7) to the radiator outlet at the bottom
- 9 Insert a flushing water and air gun in the mouth of the hose pipe at the radiator outlet.



- 10 Connect the water hose of the flushing gun to a water line and the air hose to an air line
- 11 Start the water line and fill up the radiator
- 12 When the radiator is full of water, switch on the airline and blow air in short blasts. Fill water into radiator again and blow air in short blasts again.
- 13 Continue the flushing operation until the water runs clear through the top hose
- 14 Plug the outlet at the bottom of the radiator.

**Check the thermostat valve and pressure cap**

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

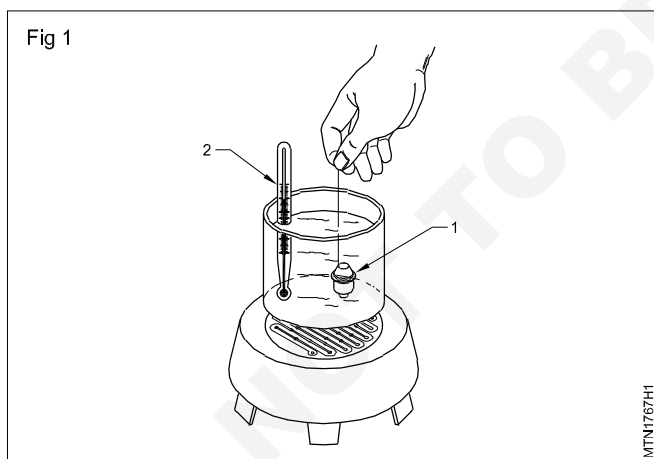
- check the thermostat valve
- check the pressure cap.

Requirements			
Tools/Instruments		Materials/Components	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Thermometer	- 1 No.	• Cotton waste	- as reqd.
<b>Equipment/Machines</b>		• Coolant	- as reqd.
• Multi-cylinder diesel engine	- 1 No.	• Kerosene	- as reqd.
• Electric Oven	- 1 No.	• Thermostat	- as reqd.
• Cooling system pressure tester	- 1 No.	• Soap oil	- as reqd.
		• Radiator cap	- as reqd.

**PROCEDURE**

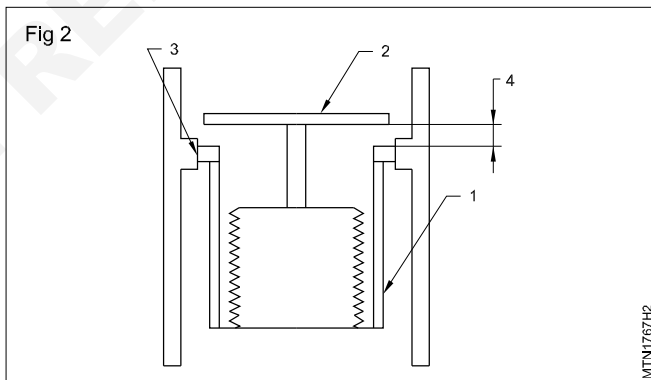
**TASK 1: Checking the thermostat valve**

- 1 Remove the thermostat cover from the thermostat case.
- 2 Remove the thermostat valve.
- 3 Clean the thermostat valve cap, and valve seat.
- 4 Tie the thermostat valves collar with a thread.
- 5 Immerse the thermostat valve in water. Ensure that the thermostat valve (1) is fully merged in the water but does not touch the walls or the base of the jar. (Fig 1)



- 6 Heat up the water.
- 7 Note down the temperature of the water in the thermometer (2) at which the thermostat starts to open.

- 8 Note down the temperature at which the thermostat opens fully.
- 9 Remove the thermostat valve (1) from the hot water and measure the gap between the thermostat collar (2) and the shroud (3) (Fig 2).

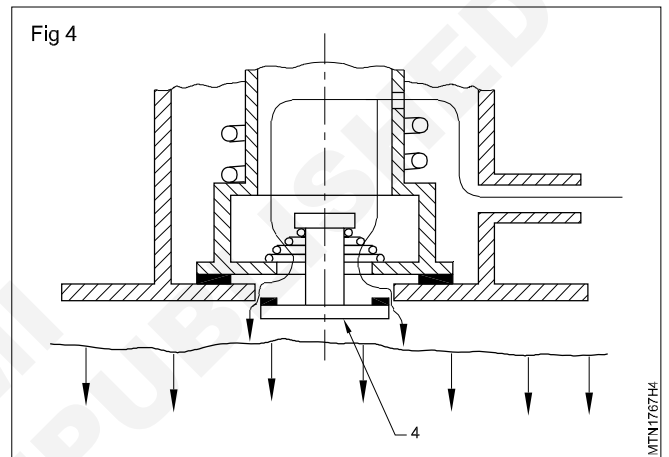
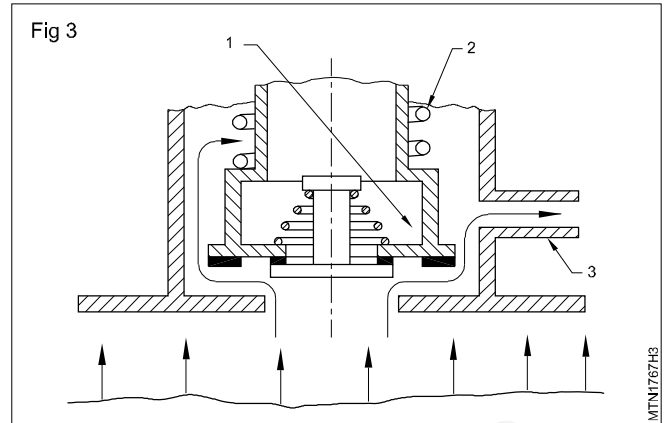


- 10 Compare the thermostat's opening temperature, thermostat's opening (4) and the temperature at which the thermostat opens completely, with the specifications given by the manufacturer. If any of these three observations do not match with the manufacturers specifications, then replace the thermostat valve.
- 11 Fit the thermostat in the thermostat case.
- 12 Fit the thermostat cover in the thermostat case.

## TASK 2: Check the pressure cap (Figs 3&4)

- 1 Place a tray under the radiator.
- 2 Do not attempt to remove the radiator cap while engine is hot.
- 3 Make sure the cooling system is not hot.
- 4 Push down the radiator cap first and then twist it - counter clockwise and then takeout the cap from the radiator neck.
- 5 Attach the pressure tester to the fitter neck of the radiator.
- 6 Pump the pressure tester handle until the pressure builds to the specification written on the radiator cap.
- 7 Check the cap able to hold the max pressure up to five minutes. Identify the gauge should be reach at least 15 PSI.
- 8 Clean sediment or debris off the pressure cap.
- 9 Reset the cap, ensure the leak waste not due to blockages.
- 10 If found damage in radiator cap valve or valve spring replace the pressure cap.

**Note:** Too much pressure in the system can result damage the radiator core tube and radiator pressure cap.



**Check and adjust the fan belt tension**

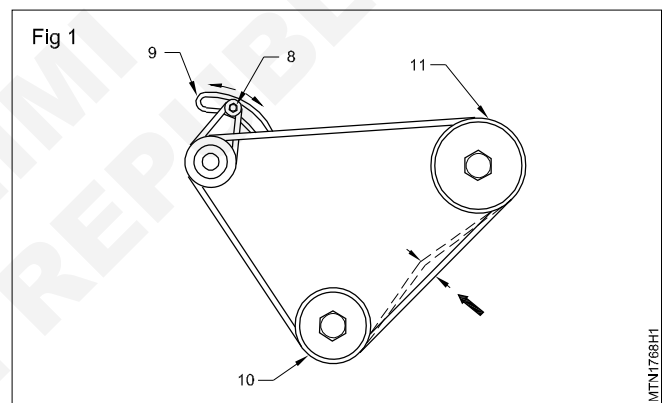
**Objective:** At the end of this exercise you will be able to  
 • **check and adjust the fan belt tension.**

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton waste	- as reqd.
<b>Equipment/Machines</b>		• Grease	- as reqd.
• Multi-cylinder diesel engine	- 1 No.	• Coolant	- as reqd.
		• Fan belt	- 1 No.
		• Soap oil	- as reqd.

**PROCEDURE**

- 1 Adjusting fan belt tension:** Apply thump pressure on the fan belt at the centre between the damper and water pump pulleys (10 & 11). The belt should depress by 12 to 18mm.
- Check the belt for excessive wear and cracks, if need replace the engine drive belt.
- Disconnect the battery negative terminal. Loosen the mounting bolts of the alternator or dynamo.
- Loosen the nuts (8). at the link bracket (9) (Fig 1).
- Push the alternator away from the engine with a suitable lever until the correct tension is obtained. Tighten the bolts and nuts.
- Recheck the belt tension and ensure correct belt tension is obtained.

- 7 Refit the battery cable.
- 8 Start the engine and check the performance of engine drive belt.



**Practice on identify the parts of lubrication oil flow circuit in an engine**

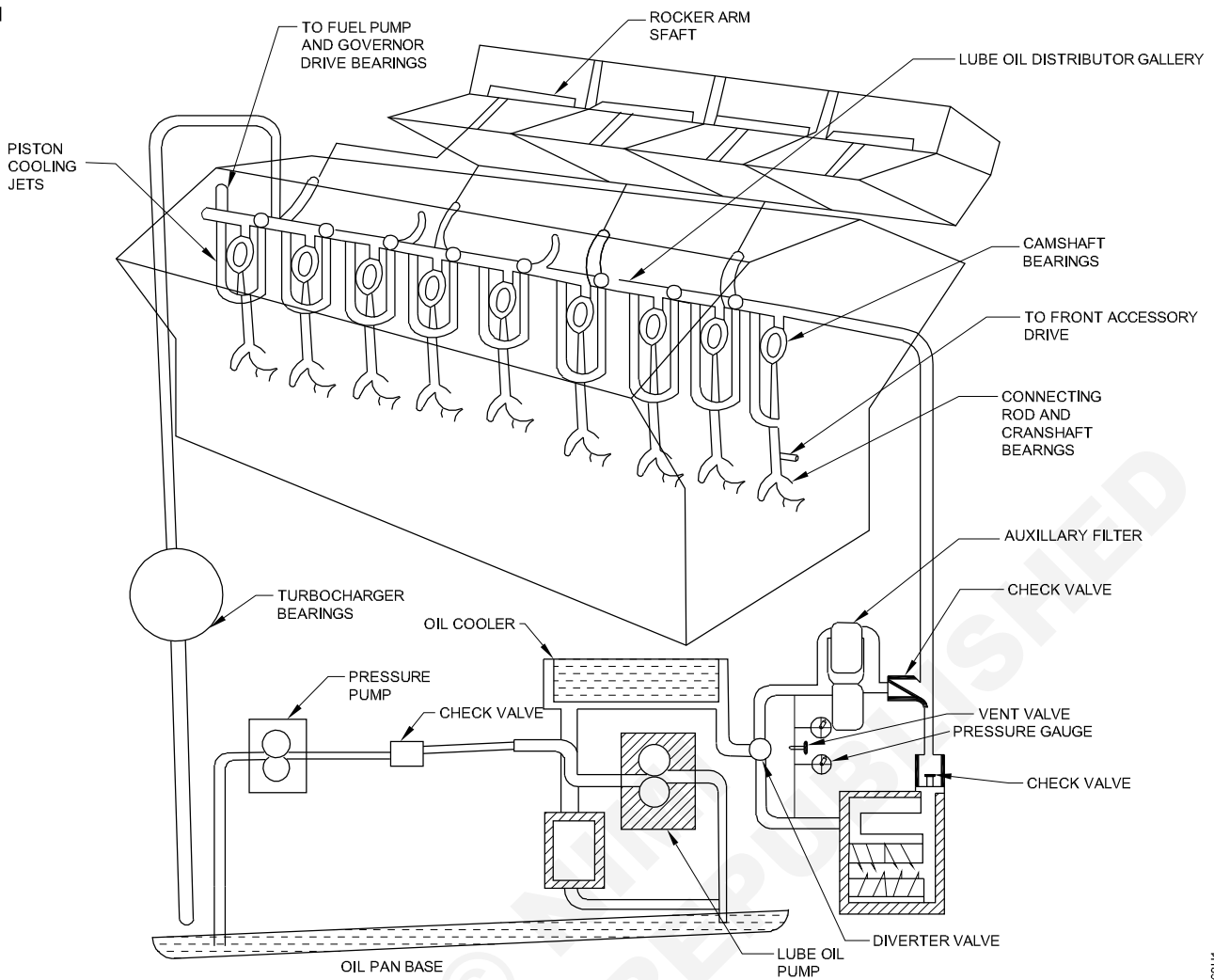
**Objective:** At the end of this exercise you will be able to  
 • **Identify the oil flow circuit in on engine.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton Waste	- as reqd.
• Engine service manual	- 1 Set	• Soap oil	- as reqd.
<b>Equipment/Machines</b>		• Steel wire	- as reqd.
• Engine	- 1 No.	• Engine oil	- as reqd.
• Air compressor	- 1 No.	• Cleaning solvent	- as reqd.

**PROCEDURE**

- 1 Identify the engine make.
- 2 Refer the engine service manual for specification.
- 3 Identify the lubrication oil flow circuit.
- 4 Identify the parts in the lubrication oil flow circuit.
- 5 Study the function of each part along with lubrication circuit.
- 6 Identify the type lubrication system adopted in an engine.
- 7 Identify the oil sump.
- 8 Identify the oil strainer and suction pipe.
- 9 Identify the oil pump.
- 10 Identify the oil pressure relief valve.
- 11 Identify the oil passage from oil pump to oil filter.
- 12 Identify the oil filter and bypass valve at oil filter.
- 13 Identify the passage from oil filter to main gallery.
- 14 Identify the passage from main gallery to crankshaft main journal bearing.
- 15 Identify the oil passage from crankshaft main journal to crank pin and connecting rod big end bearing.
- 16 Identify the oil passage from main gallery to camshaft bush bearing and then from camshaft bush bearing to rocker arm shaft.
- 17 Identify the oil passage from main gallery to timing gear and oil cooler.
- 18 Oil main gallery to piston cooling jets.

Fig 1



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**Overhauling oil pump, oil cooler, oil pressure relief valve**

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

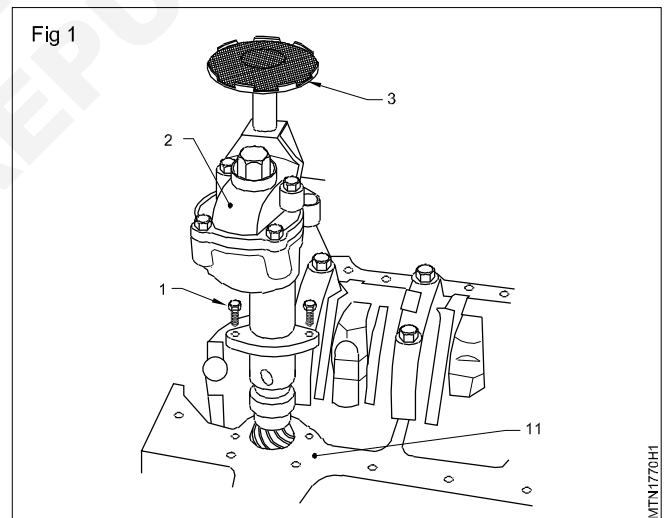
- **dismantle an oil pump**
- **check the radial clearance, back lash and end play**
- **assemble an oil pump and fit on the engine**
- **service oil cooler**
- **adjust oil pressure relief valve.**

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Puller, Feeler gauge	- 1 No.	• Cotton Waste	- as reqd.
• Box spanner set	- 1 Set	• Lubrication oil	- as reqd.
<b>Equipment/Machines</b>		• Kerosene	- as reqd.
• Air Compressor	- 1 No.	• Soap oil	- as reqd.
• Engine with oil pump	- 1 No.	• Oil filter	- as reqd.
		• Oil cooler	- as reqd.

**PROCEDURE**

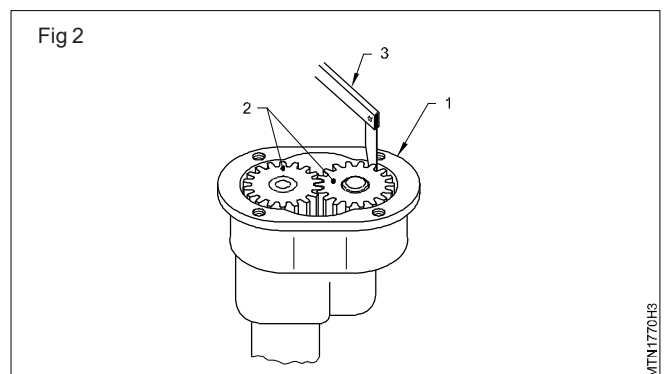
**TASK 1: Dismantling oil pump**

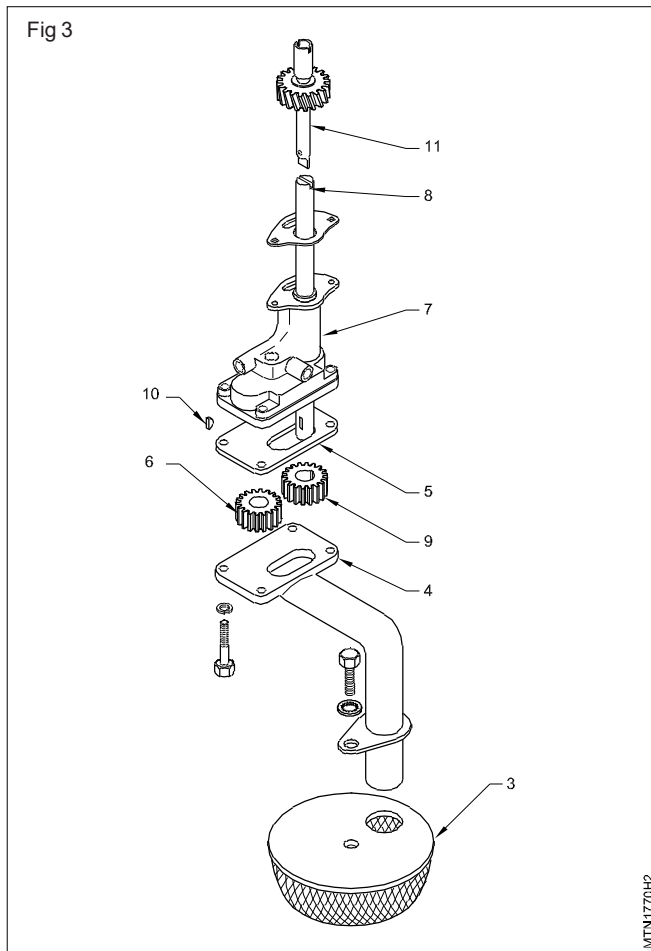
- 1 Remove the oil sump.
- 2 Remove the oil pump mounting bolts/nuts (1). (Fig 1)
- 3 Take out the oil pump (2) along with the strainer (3).
- 4 Remove the strainer assembly (3) from the pump.
- 5 Remove the oil pump end cover (4).
- 6 Remove the pump cover packing (5).
- 7 Remove the idler gear (6) from the oil pump housing (7).
- 8 Remove the driving gear (9) with the shaft (8).
- 9 Press out the driving gear from the drive shaft.
- 10 Remove the woodruff key (10) from the driving shaft.
- 11 Remove the driving gear by using the pulley.



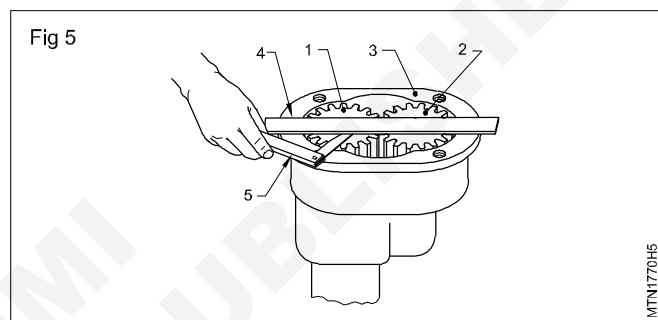
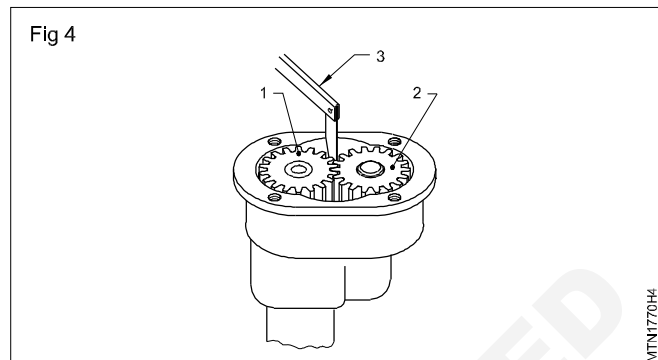
**TASK 2: Cleaning and Inspection**

- 1 Clean all the parts by kerosene oil. (Fig 2)
- 2 Clean the suction pipe by compressed air.
- 3 Inspect visually the gears and shafts for pitting and damage.
- 4 Check pump housing for cracks and damage.
- 5 Check visually the contact surface of the oil pump housing and cover for scoring marks.
- 6 Check the radial clearance between the oil pump housing (1) and gear (2) teeth with a feeler gauge (3) (Fig 3).
- 7 Check the backlash between the oil pump gears (1 & 2) with a feeler gauge (3) (Fig 4).





- 8 Check the depth of the gears (1 & 2) from the oil pump housing surface (3) by using a straight edge (4) and feeler gauge (5) as per manufacturer's recommendation (Fig 5).
- 9 Check the condition of the strainer for damage and blockage.
- 10 Check the suction pipe for cracks, damage and blockage.

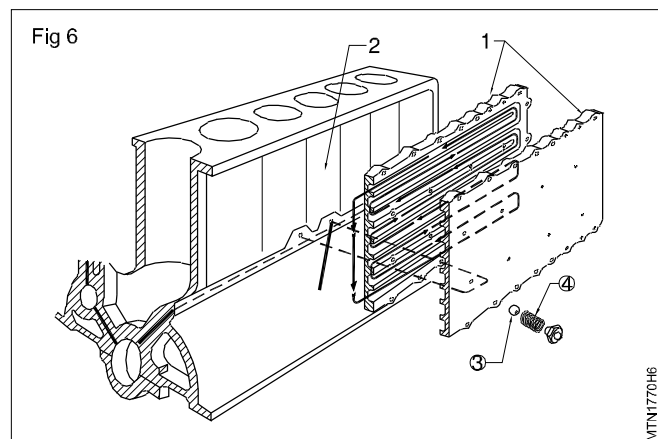


### TASK 3: Assembling

- 1 Fix the driving gear (9) on the driving shaft (8) with a new woodruff key by using a press. (Fig 2)
- 2 Place the driving gear (9) with the shaft (8) in the pump housing (7).
- 3 Place the driven gear (6) with spindle in the pump housing.
- 4 Place the pump housing packing (3) and align the holes.
- 5 Place the pump cover, align the holes and tighten the pump cover bolts.
- 6 Check for the free rotation of gears.
- 7 Fit the suction strainer (3).
- 8 Insert the oil pump into the crankcase.
- 9 Tighten the mounting bolts to the specified torque.
- 10 Install the oil sump with a new gasket.
- 11 Fill recommended oil in the sump up to the correct level.
- 12 Start the engine.
- 13 Note down the oil pressure at the various r.p.ms and compare them with the manufacturer's specification.

### TASK 4: Servicing the oil cooler (Fig 6)

- 1 Remove the oil cooler (1) from the engine block (2) (Fig 6)
- 2 Remove by pass valve (3) and spring (4).
- 3 Clean the oil cooler with kerosene oil and compressed air.
- 4 Check oil cooler for crack.
- 5 Check the bypass valve ball (3). If necessary, replace the bypass valve ball.
- 6 Check the bypass valve spring's (4) free length and tension. Replace the spring if necessary.
- 7 Fix gasket and washer in between oil cooler's halves, with the help of grease and fix the screws.





- 8 Fix gasket on the cylinder block (2).
- 9 Fit the oil cooler and tighten all the screws at recommended torque in correct sequence.
- 10 Fit the bypass valve ball, spring and tighten retaining nut with washer.

### Servicing of tractor engine oil cooler tube and fins type

There is different type of engine lubricant oil cooler is used in tractor engine. Even though mostly fins and types air flow type is used in modern tractors and heavy vehicle. Tractor engine oil circulate through engine and cooler. Oil cooler id mounted in front or rear of the radiator, where air flow rate is very high while turning the tractor engine.

- 1 Trace the oil flow circuit with help of service manual.
- 2 Disconnect the oil cooler loose connections
- 3 Disconnect the oil cooler and take it away from the engine.
- 4 Place the oil cooler on the work bench.

- 5 Clean an oil cooler and inspect the fins and tubes for damage or bend.
- 6 Straighten the fins if it is blocked or bend.
- 7 Apply pressure air flow through the fins to clean the dusk and drink deposited between fines.
8. Apply pressure air through the oil tubes to clean the dirty oil deposit in side of the oil tubes.
- 9 Ensure the fines and tubes are cleaned.
- 10 Mount the oil cooler in its location of the engine and connect the oil hoses with oil cooler
- 11 Top up the oil and ensure the engine oil level up to specified limit by engine manufactures.
- 12 Start the engine and check the oil cooling performance.
- 13 Compare the oil cooling before servicing and after service the engine oil cooler. Ensure the oil cooler is functioning properly.

### TASK 5: Servicing the centrifugal oil filler (Fig 7)

- 1 Loosen the centre bolt (1) of the oil filter assembly by a spanner (2). (Fig 7)
- 2 Hold the filter bowl (3) with one hand and remove the centre bolt by another hand. Ensure that the bowl (3) does not rotate.
- 3 Remove the filter bowl (3).
- 4 Remove the oil filter element (4).
- 5 Remove the bottom washer (5) and the spring (6) from the bowl.
- 6 Remove the bypass valve (7) from the filter head with spanner.
- 7 Remove the oil pressure relief valve closing plug (2) and pressure adjusting screw.

- 8 Remove the oil pressure relief valve pressure spring and pressure relief valve (1).

### 9 Cleaning and inspection

- 10 Clean all the parts by kerosene oil and compressed air.
- 11 Check visually the centre bolt (1) threads for damage.
- 12 Check visually the sandwich type rubber washer (2) for damage. (Fig 7)
- 13 Check the bottom spring (3) for damage and tension.
- 14 Check visually the seal seating area (4) for damage and pitting.
- 15 Check visually the oil pressure relief valve seating area of the crankcase for pitting and groove. Check threads of the pressure adjusting screw and valve closing plug.
- 16 Check the filter bypass valve spring (5) for damage and tension.
- 17 Check the filter bypass valve and seating area (9) for pitting/scoring.

### 18 Assembling

- 19 Insert the spring (6) in the centre bolt (1). (Fig 7)
- 20 Insert the sandwich rubber washer (2) over the spring (6).
- 21 Insert a new filter element (7) into the bowl after soaking it in engine oil.
- 22 Fix the 'O' ring seal on the filter bowl edge.
- 23 Position the bowl centrally on the filter head

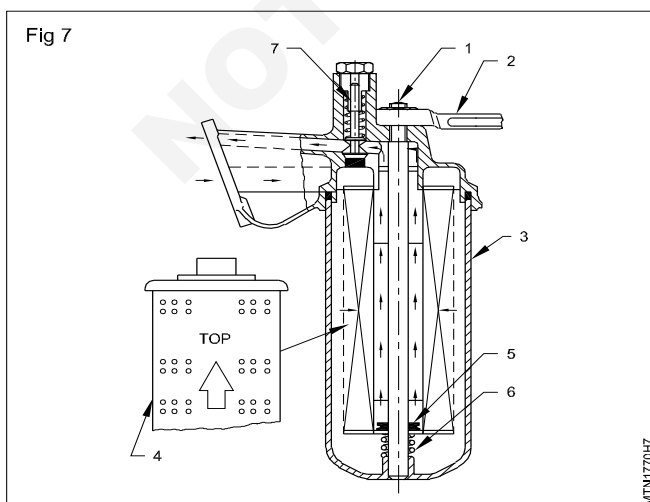
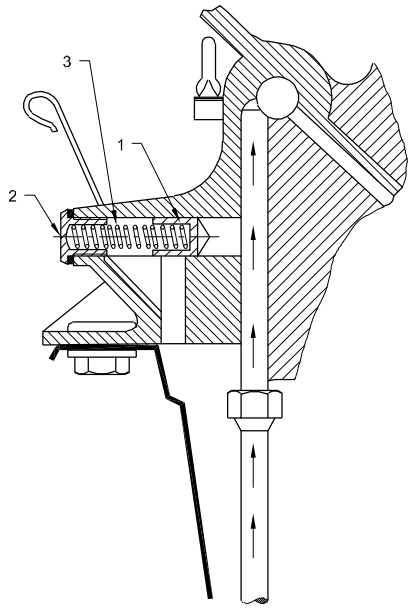


Fig 8



- 24 Hold the bowl by one hand and tighten the bolt first by hand and then by a spanner.
- 25 Place the bypass valve in its seat (9) on filter head.
- 26 Place the spring (10) over the bypass valve. Tighten the bypass valve holder (8). (Fig 8)
- 27 Place the oil pressure relief valve and spring in its seating in the crankcase.
- 28 Fix and tighten the pressure adjusting screw.
- 29 Tighten the closing plug.
- 30 Start the engine and warm up.
- 31 Check for leakage of oil from the filter edge, bypass valve, centre bolt and pipe connection.
- 32 Check the oil pressure, on the oil pressure gauge.
- 33 Correct it if necessary by adjusting the relief valve spring tension. To increase the oil pressure tighten the pressure adjusting screw and to decrease the oil pressure, loosen the adjusting screw.

**Practice on testing of engine oil pressure**

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

- **check and adjust oil pressure in an engine.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Box spanner set	- 1 No.	• Cotton cloth	- as reqd.
<b>Equipment/Machines</b>		• Diesel	- as reqd.
• Multi cylinder diesel engine	- 1 No.	• Relief valve kit	- as reqd.

**PROCEDURE**

**Testing of engine oil pressure**

- 1 Locate the engine oil pressure sender near the oil sump on the engine block.
- 2 Remove the electrical connetcor from the oil pressure sender unit.
- 3 Remove the oil pressure sender from the engine block by using the proper socket.
- 4 Follow the attachment instructions for your oil pressure testing kit.
- 5 Mount the oil pressure test fit in the place of oil sender unit mounting.
- 6 Start the engine and allow engine to reach normal operating temperature.
- 7 With assistance observe and record the oil pressure on test kit oil pressure gauge at 1400 rpm and 2.100 rpm.
- 8 Minimum oil pressure at 1400 rpm is 18 PSI.
- 9 Minimum oil pressure at 2100 rpm is 28 PSI.
- 10 Minimum oil pressure is 100 PSI.
- 11 Turn the ignition switch and battery disconnect switch to the off position.
- 12 Remove the pressure gauge from the engine oil pressure port.
- 13 Install the dust cap on oil pressure port.
- 14 Compare the actual engine oil pressure gauge to review recorded oil pressures as follows.
- 15 If oil pressure is lower than 18 PSI at 1400 rpm speed, refer to low pressure in this work package.
- 16 If oil pressure is lower than 28 PSI at 2100 rpm engine speed refer to low oil pressure in this work package.
- 17 If oil pressure is higher than 100 PSI refer to high oil pressure in this work package.
- 18 If actual oil pressure gauge is within specification, but does not reflect value from cat millet nearby correct operation of cat millet. if measurments are still in correct replace oil pressure sensor.

**Note: Before the test the oil pressure, check the quality of engine oil and function of oil pump the reading on oil pressure test kit gauge should be compared to the manufacturers specifications.**

- 19 If the oil pressure is low, the cause can be any of the following.
  - Worn oil pump.
  - Excess wear on camshaft or crankshaft.
  - Excessive bearing clearance.
  - Weak pressure relief valve spring.
- 20 If the oil pressure is too high the probable cause is,
  - Stuck oil pressure relief valve.
  - Pressure relief valve spring tension too high.



**Servicing of wet type air cleaner**

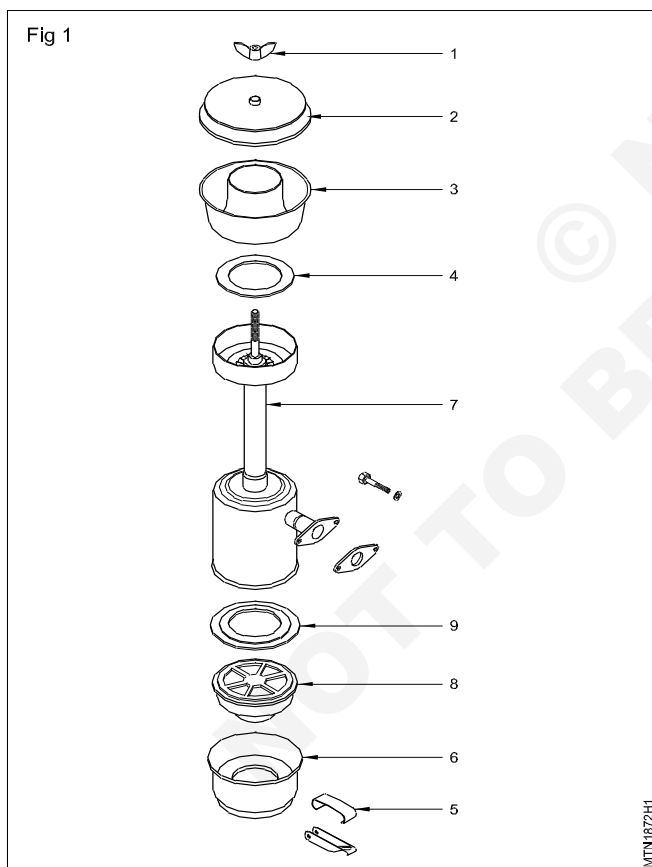
**Objectives:** At the end of this exercise you will be able to

- remove the wet air cleaner form the engine
- clean the filter
- check the oil level in the air cleaner
- fit the air cleaner on the engine.

Requirements	
<b>Tools/Instruments</b>	<b>Materials/Components</b>
<ul style="list-style-type: none"> <li>• Trainees Tool Kit - 1 No.</li> <li>• Box spanner kit - 1 No.</li> </ul>	<ul style="list-style-type: none"> <li>• Tray - 1 No.</li> <li>• Cotton cloth - as reqd.</li> <li>• Gasket - as reqd.</li> <li>• Engine oil - as reqd.</li> <li>• Dust collector - as reqd.</li> <li>• Seating ring - as reqd.</li> </ul>
<b>Equipment/Machines</b>	
<ul style="list-style-type: none"> <li>• Multi cylinder diesel engine - 1 No.</li> <li>• Air compressor - 1 No.</li> </ul>	

**PROCEDURE**

**1 Service air cleaner (Oil bath type):** Open the bonnet grill if needed (Fig 1).



- 2 Disconnect the air cleaner assembly from inlet manifold and place it on the working table.
- 3 Unscrew the bolt or wing nut (1) on the top cover (2) by hand or plier.
- 4 Remove the top cover with the dust collector (3) and seating ring (4). Clean the dust collector seating ring (4).

- 5 Loosen the fixing clip (5) of the lower portion of the air cleaner.
- 6 Remove the bowl (6) from the pre-clean cleaner assembly (7).
- 7 Using a piece of cardboard, block the opening of the air intake on the inlet manifold to avoid entry of foreign material.
- 8 Drain the oil from the bowl and clean the sludge.
- 9 Pour a little diesel/kerosene over the air cleaner element (8).
- 10 Hold it in vertical position. Rotate and stir the element by hand until all the dust is absorbed by the oil. Drain the used oil. Repeat the procedure until all the dust or dirt is removed from the wire mesh.
- 11 Blow compressed air under reduced pressure over the wire mesh from the opposite side and dry the element.
- 12 Clean the bottom case (bowl) (6) of the air cleaner with diesel/kerosene and wipe with clean cloth.
- 13 Check the filter element and the wire mesh for damage and clogging of dust. If damaged, replace with a new one.
- 14 Check the gasket ring (9) and clean it; if damaged replace the gasket ring.
- 15 Check the threads of the top cover mounting bolts/wing nut (1).
- 16 Check the air cleaner bowl (bottom case) for damage.
- 17 Refill the oil in air cleaner bowl/housing up to the oil level mark with clean, recommended grade of oil.
- 18 Place the gasket (9) and install the filter element (8) in the housing bowl (6).
- 19 Mount the bowl (bottom portion) to the pre-cleaner by fastening the clip (5).
- 20 Place the gasket ring (4) and dust collector (3) and fit the cover (2) and tighten the wing nut (1).
- 21 Start the engine and check the performance of the engine for smooth running.

**Overhaul the turbocharger**

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

- remove turbocharger from vehicle
- dismantle turbocharger
- clean, replace or repair defective parts
- assemble and check turbocharger
- refit turbocharger on vehicle and start the engine.

Requirements	
<b>Tools/Instruments</b>	
• Trainee's tool kit	- 1 No
• Circlip plier	- 1 No
• Box spanner	- 1 set
• Dial gauge	- 1 No
• Torque wrench	- 1 No
• Plastic mallet	- 1 No
<b>Equipments/Machineries</b>	
• Work bench	- 1 No.
• Turbocharger vehicle	- 1 No.
<b>Materials/Components</b>	
• Kerosene - as reqd.	- as reqd.
• Cotton cloth	- as reqd.
• Anti -corrosive solution	- as reqd.
• Cleaning brush	- 1 No
• Turbocharger accessories	- as reqd.

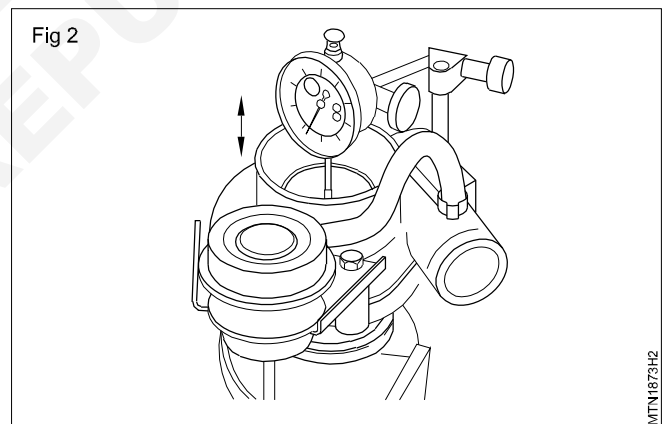
**PROCEDURE**

**Removal**

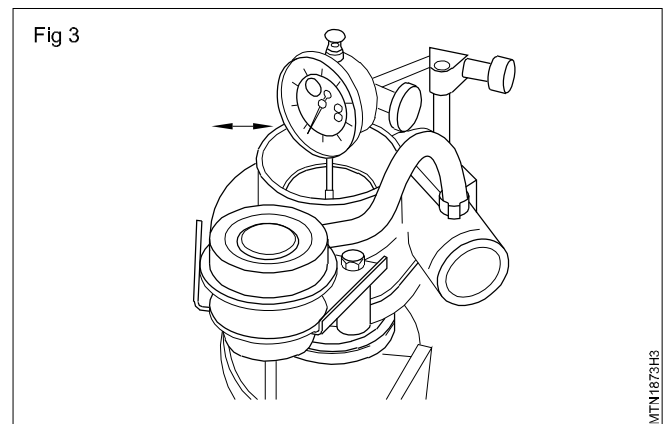
- 1 Park the vehicle on level surface.
- 2 Make sure the engine is cool-down. Open the hood and remove the battery cables.
- 3 Remove the compressor side hose clamp of hose pipe.
- 4 Disconnect the oil connections/pipes from turbo charger and vacuum connections of actuator.
- 5 Remove the mounting bolts of turbine side.
- 6 Remove the turbo charger from vehicle and place it on working table (Fig 1).



- 7 Check visually for cracked, bent or damaged compressor wheel blades.
- 8 Check bearing clearances-secure the turbine housing and check the thrust clearance using a dial gauge. Ensure clearance is within MIN/MAX values. If axial clearance does not meet specification than overhaul to strip and rebuild the turbocharger. (Fig 2)



- 9 Check the radial movement at compressor impeller nose using a dial gauge (Fig 3).

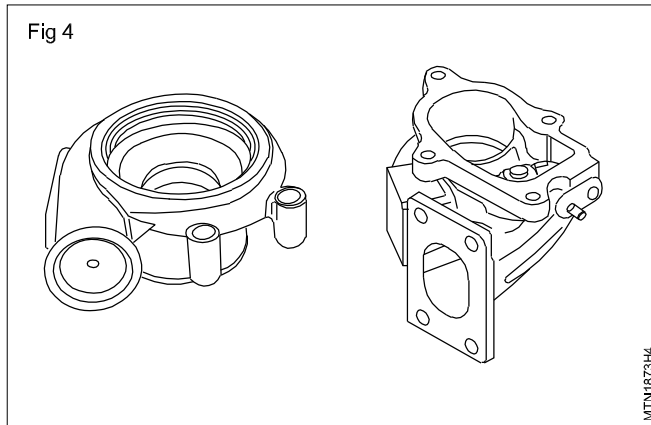


**Ensure movement is within MIN/MAX TIR (Total Indicator Reading) values.**

**If radial movement does not meet specification than overhaul to strip rebuild the turbo charger.**

### Dismantling/Cleaning

10 Clean turbo charger external surface and inspect for cracks and damages (Fig 4).

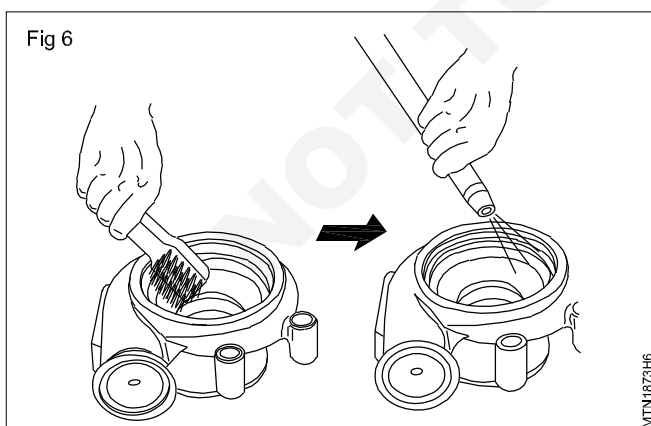
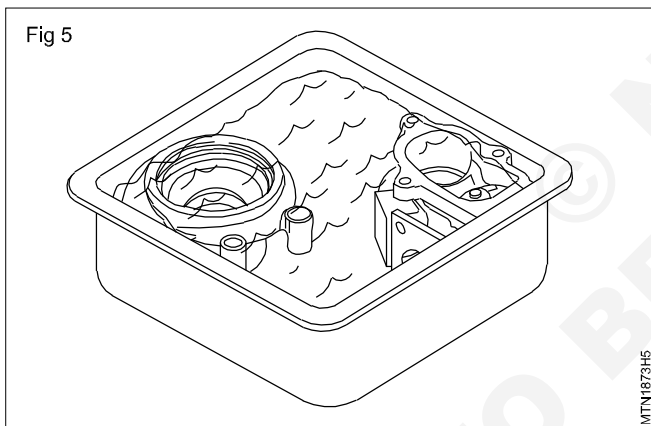


11 Remove actuator and placed in tray.

12 Remove 'V' band clamp and remove turbine body.

13 Remove circlip and remove the compressor body.

14 Remove the drive and driven impeller by loosening the impeller nuts (Figs 5&6).



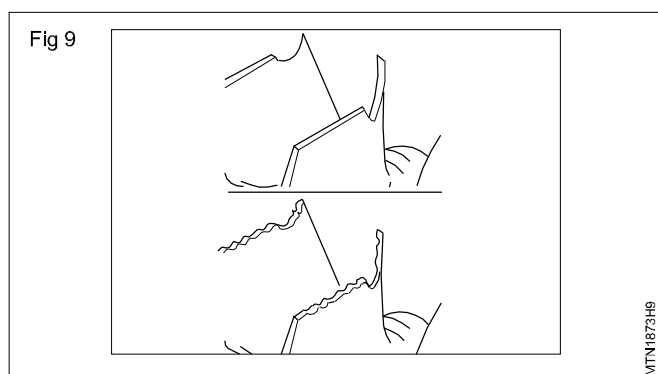
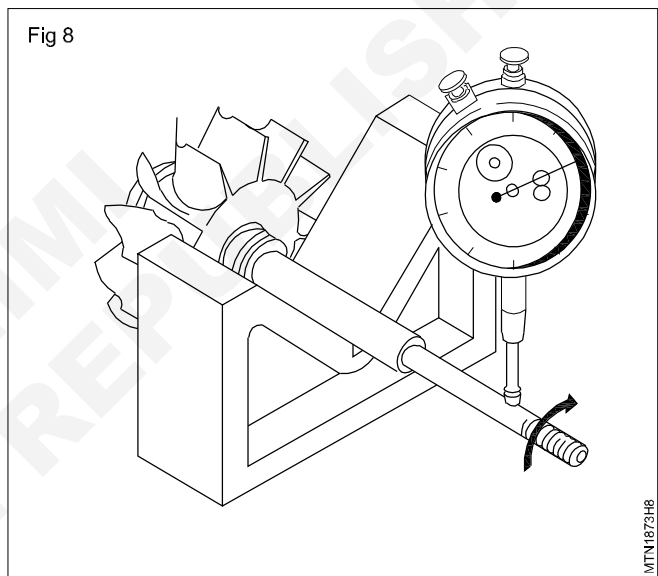
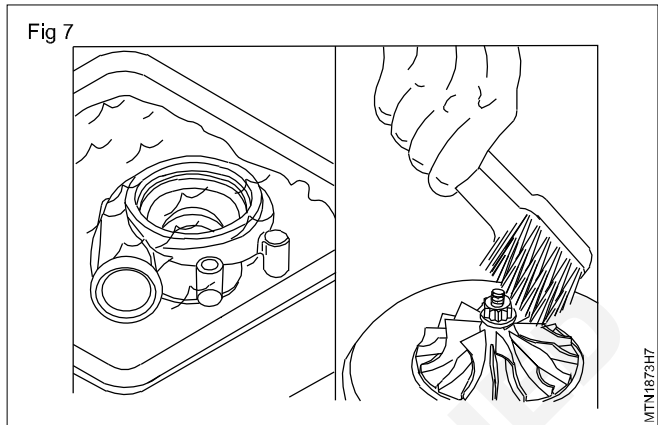
15 Remove both the impellers and place into tray (Fig 7).

16 Remove impellor shaft with bearing.

17 Remove "O" rings from both side of turbo charger body.

18 Remove thrust plate and "O" ring from turbo charger body.

19 Clean the above parts with kerosene except rubber parts (Figs 7,8 & 9).



### Inspection and repair

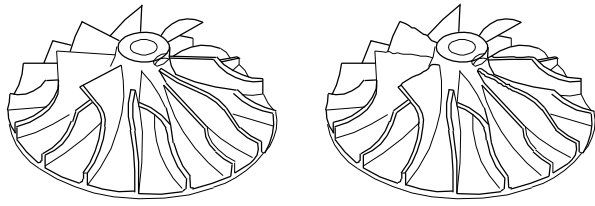
20 Inspect bearing and shaft free play. (Fig.8)

21 Check rubber "O" rings for crack or tear.

22 Check both impellers, shaft, thrust plate. (Fig 10)

23 If necessary, replace faulty parts.

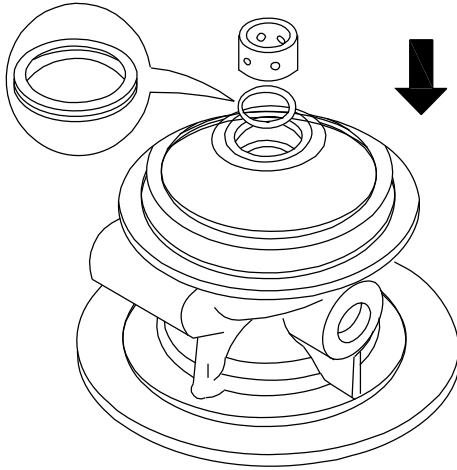
Fig 10



**Assembling and testing (Fig 15)**

24 Assemble rubber “O” ring and thrust washer in turbo charger body (Fig 11).

Fig 11



25 Fit external circlip of thrust washer and insert impeller shaft along with bearing (Fig 12).

26 Fit both the impellers with impeller ruts (Fig 13).

Fig 12

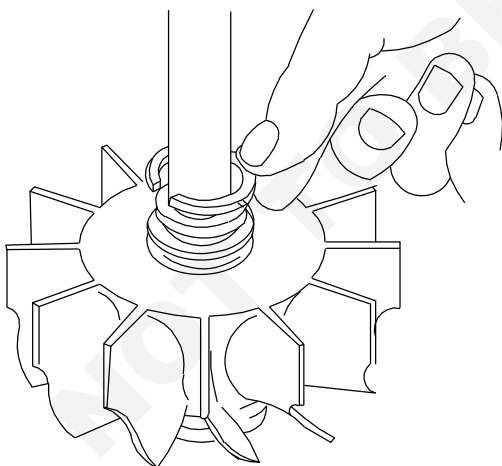
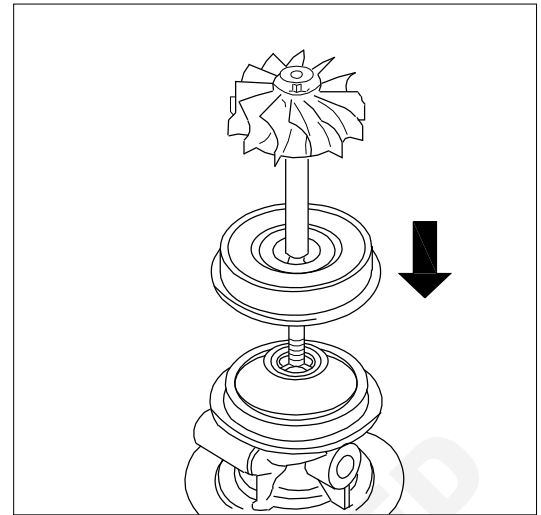
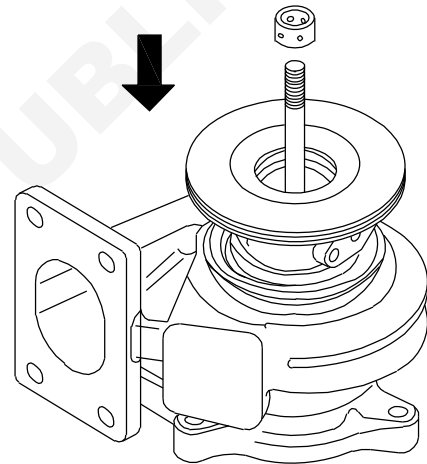


Fig 13



27 Check impeller shaft free-play and end play and check impeller free movement (Fig 14).

Fig 14



28 Fit compressor and turbine flange with circlip and “V” band clamp respectively.

29 Refit actuator on turbo charger.

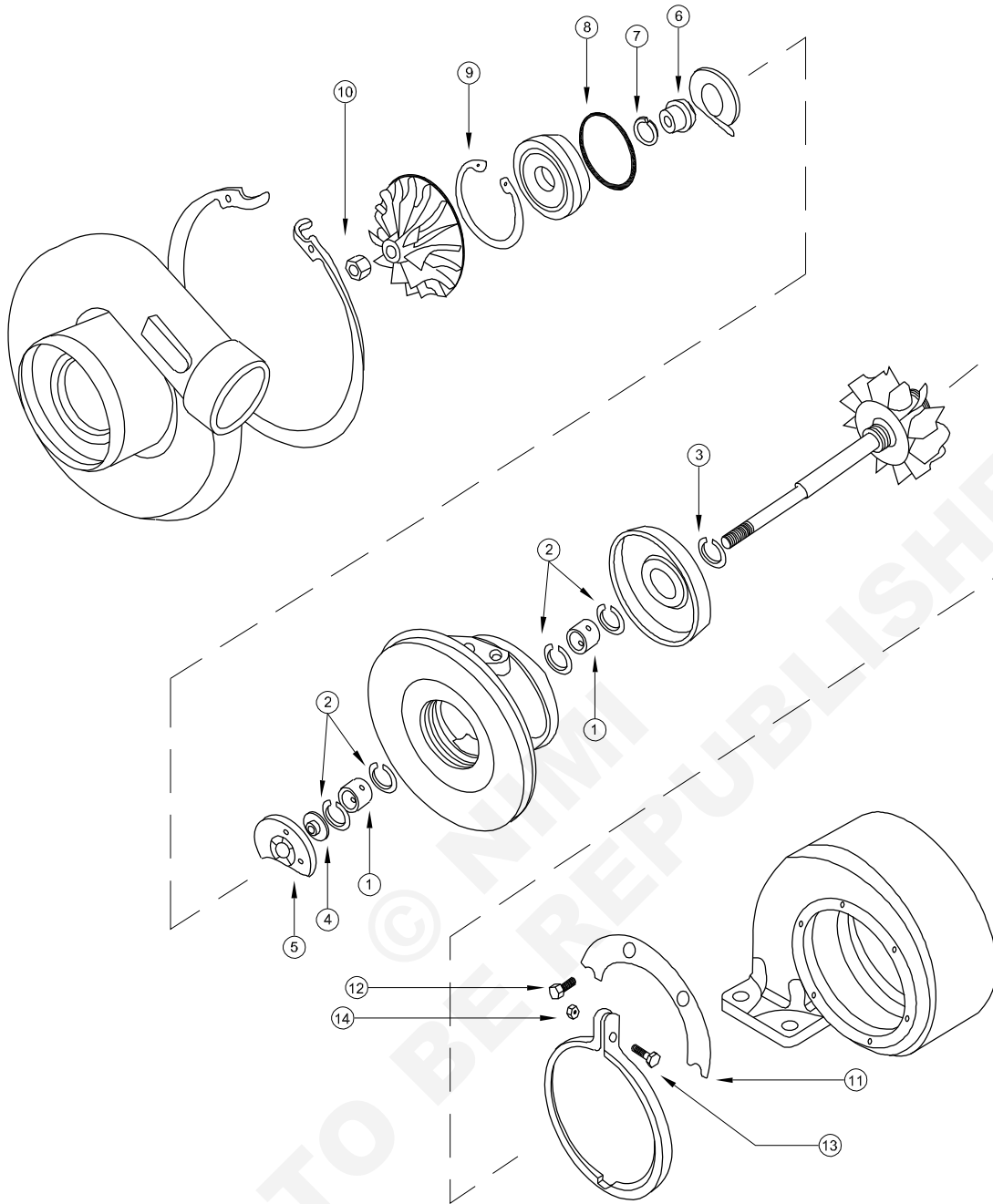
**Refitting**

30 Fit the turbo charger on mounting and tighten the mounting bolts of manifold.

31 Reconnect the oil pipe on turbo charger. Connect hose pipe on compressor side.

32 Start the engine and check for proper functioning of the engine.

Fig 15



MTN1675HF



**Check exhaust gas recirculation (EGR) valve**

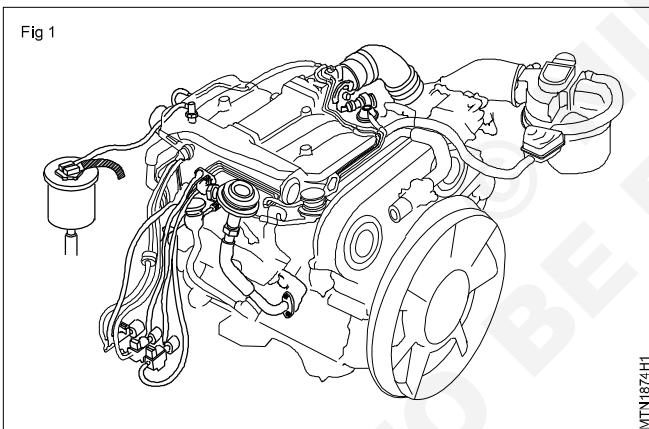
**Objectives:** At the end of this exercise you shall be able to

- identify EGR valve
- disconnect EGR valve connection
- remove EGR valve
- inspect EGR valve
- replace EGR valve.

Requirements		
<b>Tools/Equipments/Instruments</b>		<b>Material</b>
• Trainee's tool kit	- 1 No.	• Tray - 1 No.
• Screw Driver set	- 1 No.	• Cotton waste - 1 No.
• Box Spanner	- 1 No.	• Kerosene - as reqd.
• Digital Multimeter/Ohmmeter	- 1 No.	• Vacuum hose - as reqd.
<b>Equipments/Machineries</b>		• EGR valve - 1 No.
• Diesel Vehicle	- 1 No.	• Soap oil - as reqd.

**PROCEDURE**

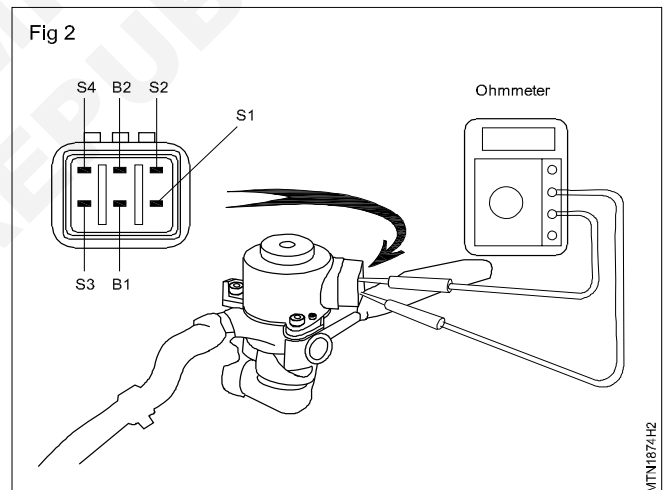
1 Locate the EGR Valve (Fig 1).



2 Disconnect negative terminal cable from battery.

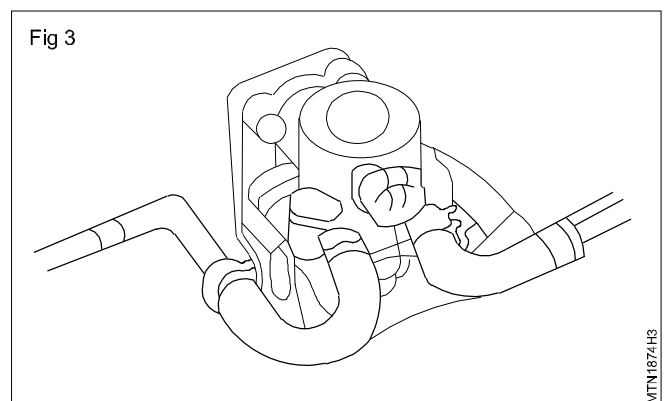
**Warning: Work must be started after 1 min from the time ignition switch is turned on to LOCK position and the negative (-) terminal cable is disconnected from the battery.**

- 3 Disconnect exhaust gas recirculation valve connector. (Fig 1)
- 4 Inspect exhaust gas recirculation valve resistance.
- 5 Using an ohmmeter measure the resistance between terminal B1 (or B2) and other terminals (S1, S2, S3 and S4). (Fig 2)
- 6 Resistance (Cold) should be 19.9 to 23.4 Ohms.
- 7 Drain engine coolant.



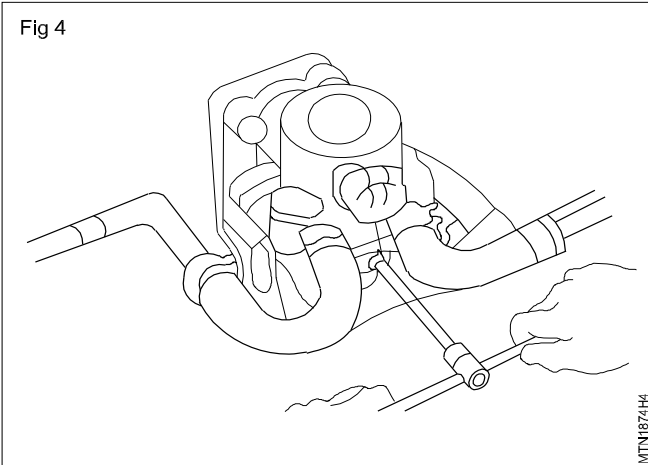
8 Remove exhaust gas recirculation valve.

9 Disconnect the water bypass hose (from IAC Valve (Fig 3) (1)).

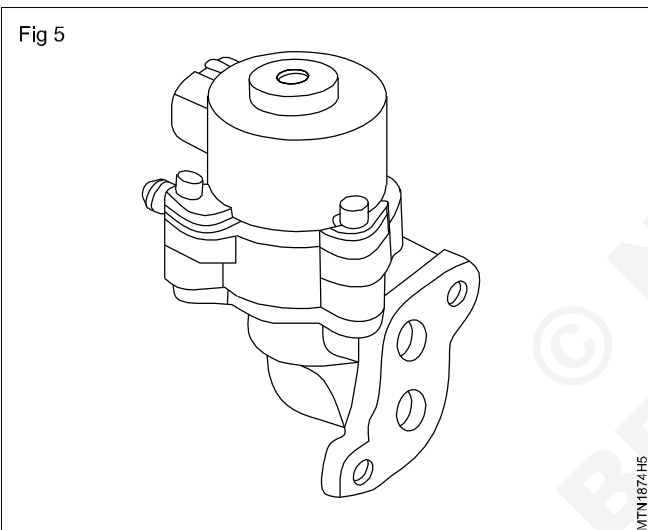


10 Disconnect water bypass hose (from rear water bypass joint) (Fig 3) (2)

11 Remove the nuts of exhaust gas recirculation valve and gasket (Fig 4)



12 Visually inspect EGR valve for sticking and heavy carbon deposits (Fig 5)



13 Check vacuum lines leak and tight

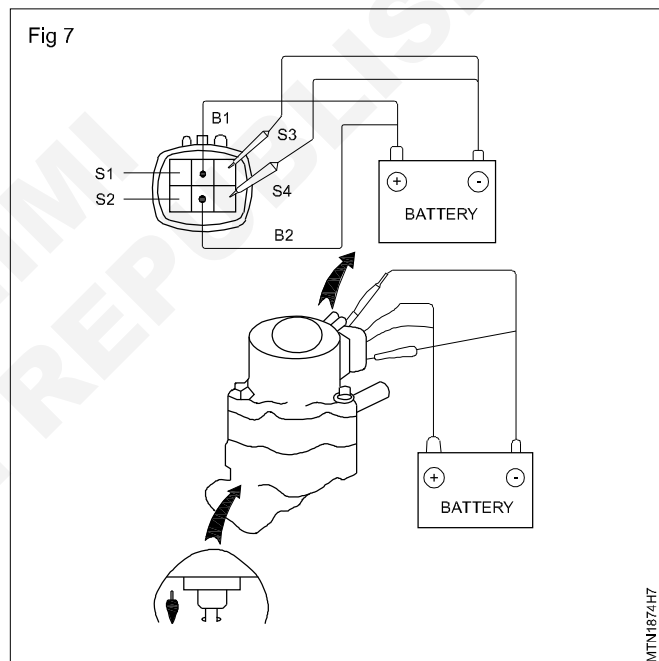
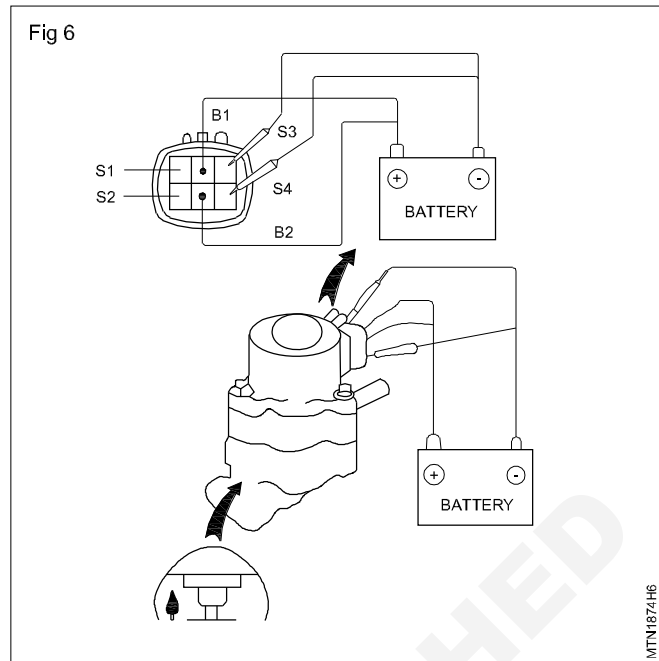
14 Check the electrical connection is pressure transducer and change over switch.

15 Check any leak on the EGR valve and connecting lines.

16 If problem is found replace the EGR valve assembly.

17 If not, Inspect EGR valve operation.

18 Apply battery voltage to terminal B1 and B2, and while repeatedly grounding (Fig 6) (\*S4) - (S4 and \*S3) - (S3 and \*S2) - (S2 and \*S1) - (S1 and \*S4) in sequence, and check that the valve moves towards the open position. (Hint: Keep the terminal marked with an asterisk (\*) grounded to the next grounding.)



19 Apply battery voltage to terminal B1 and B2, and while repeatedly grounding (Fig 7) (\*S1) - (S1 and \*S2) - (S2 and \*S3) - (S3 and \*S4) - (S4 and \*S1) in sequence, and check that the valve moves towards the closed position. (Hint: Keep the terminal marked with an asterisk (\*) grounded while proceeding to the next grounding.)

20 Perform this operation after opening the valve by performing the step above.

21 If operation is not as specified, replace the EGR Valve assembly.

**Check exhaust system for damage rubber mounting**

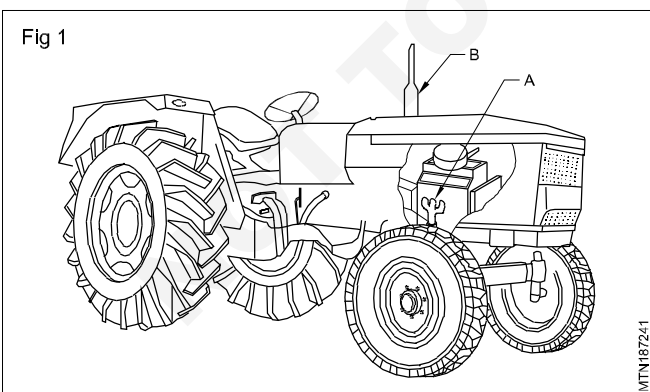
**Objectives:** At the end of this exercise you shall be able to

- trace the exhaust system layout in the tractor engine.
- trace the exhaust gas leakage spot
- check the loose connection of exhaust system components
- check the dent and damages of exhaust system parts
- rectify the fault in the exhaust system.

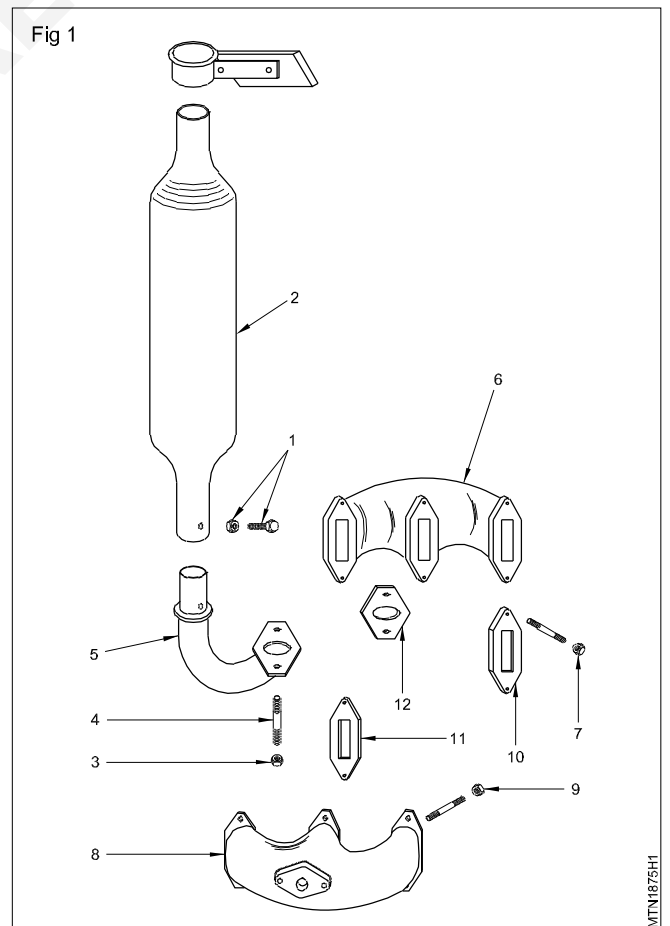
Requirements		
Tools/Equipments/Instruments		Material
<ul style="list-style-type: none"> <li>• Trainee's tool kit</li> </ul>	- 1 No.	<ul style="list-style-type: none"> <li>• Exhaust muffler - 1 No.</li> <li>• Manifold gasket - 1 set.</li> <li>• Nut bolts - as reqd.</li> <li>• Cotton waste - as reqd.</li> <li>• Soap oil - as reqd.</li> </ul>
<b>Equipments/Machineries</b> <ul style="list-style-type: none"> <li>• Tractor</li> <li>• Power tools</li> </ul>	- 1 No. - 1 No.	

**PROCEDURE**

- 1 Check the exhaust system for leakage, look connection dent and damages (Fig 1) (Fig 2)
- 2 Park the tractor on the plain ground or work shop floor.
- 3 Apply parking brake of the tractor.
- 4 Visually check the exhaust system for loose connection, dent of position and damage parts in a system layout
- 5 Check the rubber items of exhaust system for serviceable
- 6 If found loose connection tighten the nut bolts. Ensure the loose nut and bolts (1,7,4,3) are properly tighten.
- 7 Check the exhaust manifold gasket and molting bolts,if need replace the exhaust manifold gasket and nut bolts
- 8 Check the muffler counter balanced cap if need replace it.



- 7 If found any damage or dent on the exhaust muffler (2) repair or replace it
- 8 If rubber items used the exhaust systems, check and replace it start the tractor engine and check the exhaust gas leakage in the system.



## Practice to check the performance of tractor engine exhaust system

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

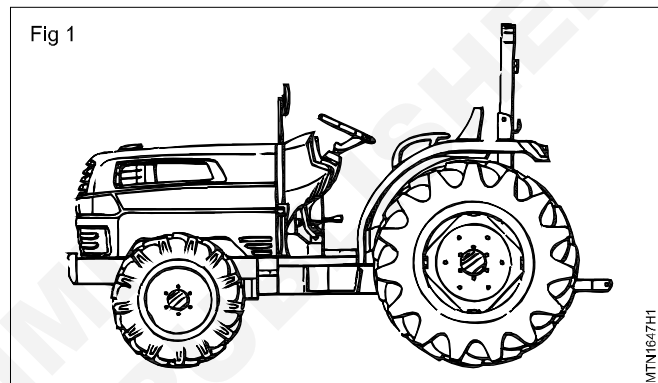
- check the performance of tractor engine exhaust system.

- 1 Check the performance of tractor engine exhaust gases.
- 2 Check the tractor engine exhaust system directs reaction exhaust gases out from a controlled combustion with in an engine.
- 3 Check the exhaust system pipes transports burned gases from the engine, whether it is properly transport burned gases from engine to atmosphere air.
- 4 Check the exhaust gas by lowering the back pressure in the exhaust system.
- 5 Ensure the exhaust pipe must be properly built to transport poisonous or noxious gases away from the tractor engine.
- 6 Check the muffler and silencer mounting position which suitable to transport the exhaust burnt gases easily.
- 7 Check the exhaust pipe in a heat resistance and must not travel trough or near anything that might burn or be harmed by leak.
- 8 Ensure the exhaust back pressure has a minimal of inspect on engine performance as feasible.
- 9 Ensure the exhaust system works flawlessly.
- 10 Check the exhaust gases emissions and tractor engine performance.

**Note:** Before check the emission of exhaust gas, Engine should be turned up.

- 11 Check the exhaust gases noise reduction system, if found any defects in the system repair or replace the defective parts.

**Note:** Performance of exhaust systems help to maintain optional air levels inside of tractor engine.



**Practice on removal and reinstallation of catalytic converter**

**Objective:** At the end of this exercise you shall be able to  
 • remove and clean the manifold, silencer, tail pipe and refit.

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees tools kit	- 1 No.	• Kerosene	- as reqd.
• Scraper	- 1 No.	• Soap oil	- as reqd.
• Straight edge	- 1 No.	• Cleaning cloth	- as reqd.
• Feeler gauge	- 1 No.	• Energy paper	- as reqd.
• Scraper	- 1 No.	• Wire rope	- as reqd.
<b>Equipments/Machineries</b>		• Manifold gaskets	- as reqd.
• Diesel Engine Vehicle	- 1 No.	• Flange, nuts, bolts	- as reqd.
• Wrench	- 1 No.	• Flex joints	- as reqd.
• Rotary saw	- 1 No.		
• Hydraulic Jack	- 1 No.		

**PROCEDURE**

- 1 Park the vehicle in level place
- 2 Jack up the vehicle up at four wheels and support on jack stands
- 3 Allow the vehicles exhaust to cool down
- 4 Locate the catalytic converter
- 5 Remove the O<sub>2</sub> (oxygen) sensor from the catalytic converter (In modern vehicle more sensors are available)
- 6 Apply penetrating oil to the holes
- 7 Unbolt the catalytic converter by socket with ratchet wrench slide it down
- 8 If the converter is actually welded, use a rotary saw. (Make sure to raise the vehicle enough to give space for free movement underneath the vehicle. Set the parking brake and use stoppers or wooden blocks under the tyre.)
- 9 Put the new catalytic converter in the position where it will eventually be installed to check and make sure it is pointed in the right direction (where showed be an arrow indicating correct side is facing down)
- 10 Hold the converter with one hand align it with another hand.
- 11 Replace new gaskets, bolts and nuts.
- 12 Tighten them manually. Make minor adjustments as needed. Tighten the bolts. with help of torque wrench.
- 13 If welding required, use the welding expert (be sure to all the welds to cool to a safe temperature).
- 14 Screw the oxygen sensor back into place.
- 15 Check to make sure the attached wiring is secured.
- 16 Check the engine lighting
- 17 Start the engine check the leakage between the gaskets and welding.

**Installation of catalytic converter**

- 9 Put the new catalytic converter in the position where it will eventually be installed to check and make sure it is

**Caution: While aligning flange and gaskets use mallet hammer.**



**Practice to engine tune up and vacuum & compression test**

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

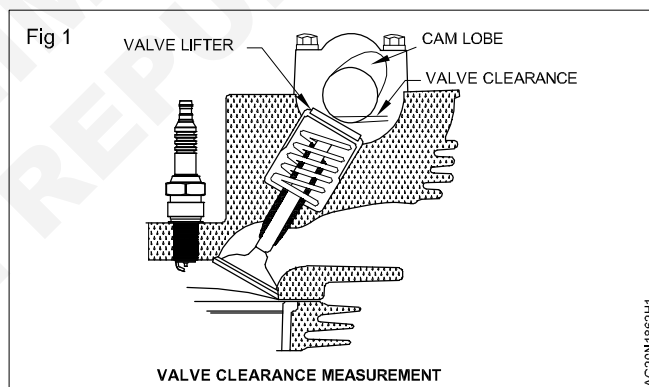
- check the compression test
- check the vacuum test
- adjust tappet clearance

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Feeler gauge	- 1 No.	• Gasket	- 1 No.
• Compressor gauge	- 1 No.	• Kerosene	- as reqd.
<b>Equipment/Machines</b>		• Cotton waste	- as reqd.
• Multi-Cylinder Engine	- 1 No.	• Lubricating oil	- as reqd.
• Spark plug cleaning machine	- 1 No.	• Diesel	- as reqd.
• Air Compressor	- 1 No.		

**PROCEDURE**

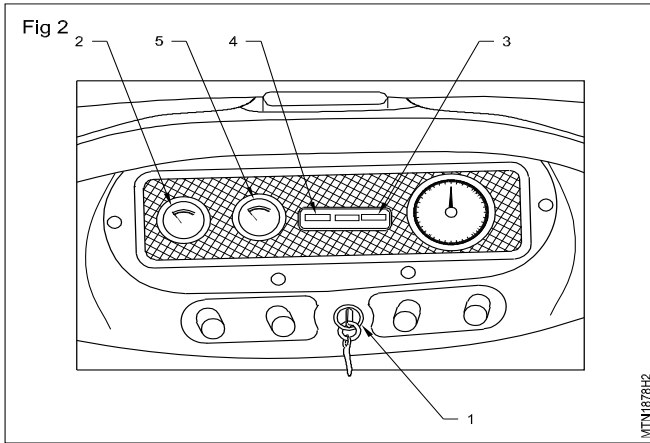
**TASK 1: Adjusting tappet clearance**

- 1 Check and set the valve clearance as per manufacturers recommendation, if the clearance is incorrect loosen the lock nut of tappet for adjusting with tappet adjuster and feeler gauge.
- 2 After adjusting specified clearance, tighten the lock nut of holding screw in the same position.
- 3 Test the injectors serviceability.
- 4 Incase CRDI engine check the injector sensor EDC function.



**TASK 2: Compression test**

- 1 Check the water level in the radiator and top up if needed.
- 2 Check the engine oil level and top up, if needed.
- 3 Check the electrolyte level in the battery and top up with distilled water if needed.
- 4 Insert the key in the main switch (1) and press fully in and turn the key to the 'ON' position. (Fig 2)
- 5 Observe the ammeter (2) on the instrument panel. The indicator of the meter will show slightly on the discharge side (-ve side) of the meter and the ignition bulb (3) will glow red and also the oil pressure indicator (4) will glow.
- 6 Observe the fuel gauge (5). The indicator indicates the fuel in the tank from empty to full. Note down the quantity of fuel in the fuel tank.
- 7 Depress the accelerator lever fully.
- 8 Press the starter 'button' or turn the ignition key further and crank the engine.
- 9 Release the starter button /key as soon as the engine has started.



**Once the engine starts do not touch the starter switch.**

- 10 If the engine does not start immediately do not keep the starter button pressed or key turned beyond 10 seconds otherwise, the battery will get discharged or the teeth of the flywheel ring and pinion will get damaged or the self-starter motor will get damaged.
- 11 Raise the engine r.p.m. steadily and allow the engine to warm up.
- 12 Observe the ammeter. The indicator on the positive side shows charging of the battery.
- 13 Observe the oil pressure indicator.
- 14 Note down the temperature of the water on the temperature gauge.
- 15 Note down the oil pressure at full throttle.
- 16 Compare the observations made with the manufacturer's specification.
- 17 Depress the accelerator steadily to full throttle, and observe the exhaust smoke.
- 18 Note down the colour of the smoke as black/white/blue.
- 19 Start the engine and run it at idle speed for a few minutes to bring it to operating temperature.
- 20 Loosen the injector one or two turns and crank the engine to blow off the carbon and dust around the injector.

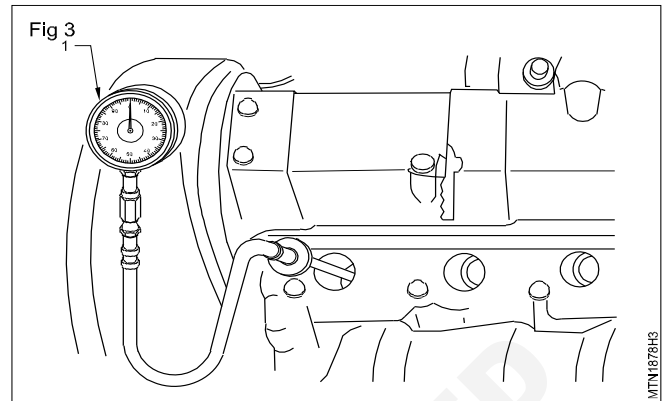
### TASK 3: Vacuum test

- 1 Start the engine and run until its operating temperature is reached.
- 2 Stop the engine.
- 3 Install the vacuum gauge on the inlet manifold.
- 4 Start the engine and run the engine at the specified idling speed.
- 5 Ascertain the correct idling speed by putting a tachometer at the flywheel pulley side.
- 6 Take the reading on the vacuum gauge and compare with the manufacturer's specifications.
- 7 Slowly raise the engine r.p.m. above the idling speed.
- 8 Observe the indicator of the vacuum gauge and note down the reading. (Fig 4)
- 9 Take four readings at different r.p.ms. Use a tachometer to ascertain the speed. Select the r.p.m. ranges so as

- 21 Remove all the injectors.

### Dry test

- 1 Install the compression gauge '1' on the first cylinder.
- 2 Press the accelerator lever. (Fig 3)

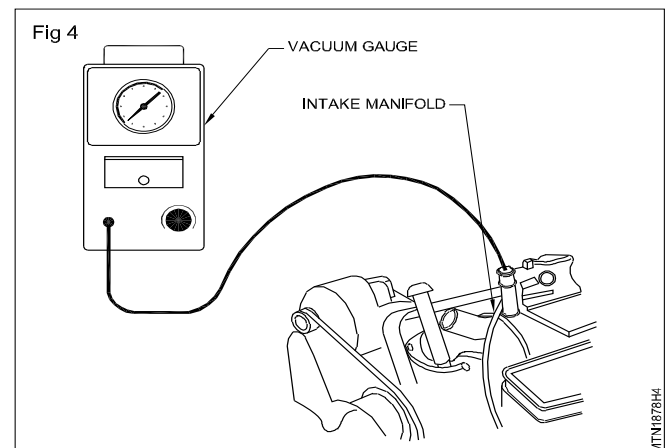


- 3 Crank the engine with the starter motor and read the highest pressure on the compression gauge.
- 4 Note the reading and release the pressure from the compression gauge.
- 5 Repeat the procedure for all the remaining cylinders and note down the reading.

### Wet test

- 1 Put 10 ml of engine oil in the first cylinder.
- 2 Crank the engine to circulate the oil around the piston and piston rings.
- 3 Repeat the procedure to take the compression pressure reading as given in the above steps.
- 4 Take the reading for all cylinders by pouring oil in each cylinder
- 5 Note down the difference of the readings in the dry and wet tests.
- 6 Set back all the injector and tighten at the recommended torque.
- 7 Bleed the fuel system & Remove air.
- 8 Start the engine and check for leakage at the injector.

to cover from idling to maximum r.p.m. specified by the manufacturer.



**Identify the different parts of fuel system**

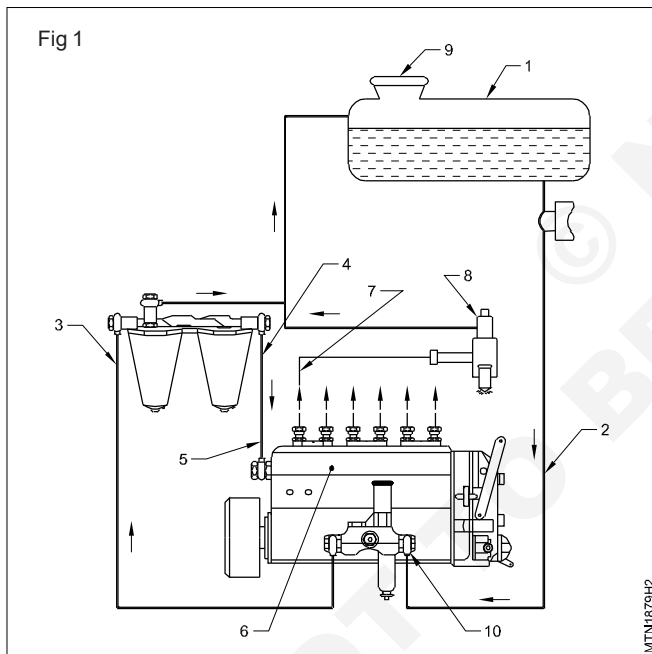
**Objectives:** At the end of this exercise you shall be able to

- Identify the different parts of fuel system
- rectify the defects in fuel line.

Requirements	
<b>Tools/Instruments</b>	<b>Materials/Components</b>
<ul style="list-style-type: none"> <li>• Trainees Tool Kit - 1 No.</li> </ul>	<ul style="list-style-type: none"> <li>• Cotton waste - 1 No.</li> <li>• Rubber pad for mounting the tank - 1 No.</li> <li>• Kerosene - as reqd.</li> <li>• Oil - as reqd.</li> <li>• Pipeline - as reqd.</li> </ul>
<b>Equipment/Machines</b>	
<ul style="list-style-type: none"> <li>• Tractor</li> <li>• Air Compressor</li> <li>• Jet Washer</li> </ul>	

**PROCEDURE**

**Identify the parts of diesel fuel system (Fig 1)**



- 1 Locate the fuel tank (1)
- 2 Locate the fuel tank cap (2)
- 3 Locate the fuel line (3)
- 4 Locate the fuel filter
- 5 Locate the fuel bleeding screw
- 6 Locate the overflow pipe
- 7 Locate the fuel feed pump (6)
- 8 Locate the HP fuel line (7)
- 9 Locate the F.I.P and injectors (8)
- 10 Check the fuel lines and unions for leaks.
- 11 If found leaks tighten the union bolt and ensure there is no fuel leaks.
- 12 Check the line for crack or damage.
- 13 Replace the damaged fuel line and ensure fuel pipe and horse are filtered properly.



**Servicing fuel lines, fuel pump, fuel filter and FIP**

**Objective:** At the end of this exercise you shall be able to  
 • **servicing fuel lines, fuel pump, fuel filter and FIP.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Mallet	- 1 No.	• Cotton Waste	- as reqd.
• Pump Repair Tool Kit	- 1 No.	• Diesel	- as reqd.
<b>Equipment/Machines</b>		• Lubrication Oil	- as reqd.
• Multi cylinder engine (Diesel)			

**PROCEDURE**

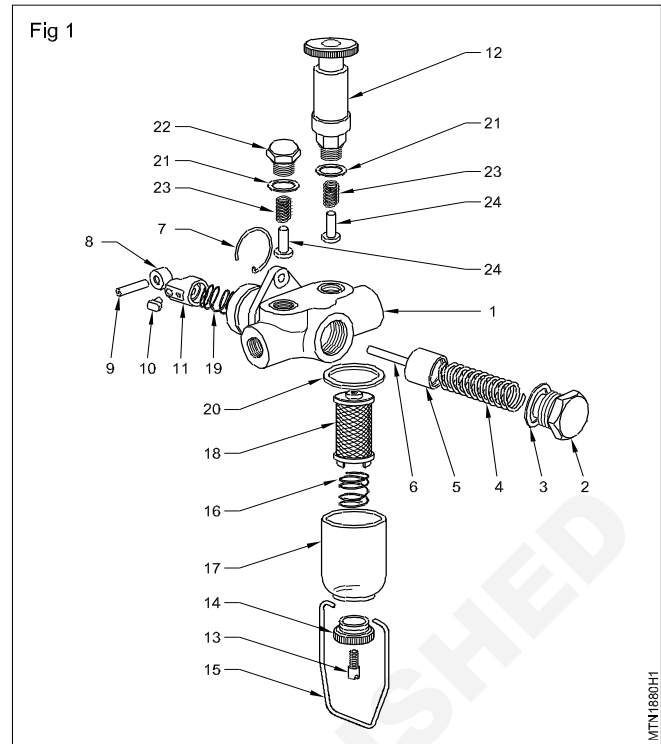
**TASK 1: Servicing fuel lines**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Park tractor on the plain ground.</li> <li>2 Check visually the following fuel line connections for leakages, cracks and daterioration or damage (Fig 2).                     <ul style="list-style-type: none"> <li>- Fuel tank all soldering edges.</li> <li>- Fuel feed line.</li> <li>- Fuel filter connection inlet and outlet pipes.</li> <li>- Connection to fuel injection pump.</li> <li>- Connection to injectors.</li> </ul> </li> <li>3 If found any cracks on metal fuel line repair or replace the fuel pipe.</li> </ol> | <ol style="list-style-type: none"> <li>4 Check the fuel tank filler cap and check for the uniform seating of the gasket on the filler neck. Replace the filler cap if found damaged.</li> <li>5 If fuel leakage at any connection is observed, tighten it. In case leakage does not stop, change banjo washers and unions.</li> <li>6 Start the engine if the engine does not start bleed the fuel system with the help of hand priming pump and recheck ensure no air is in the fuel system.</li> <li>7 Start the engine and stay on idle speed.</li> <li>8 Finally ensure there is no leakage in fuel system.</li> </ol> |
|---|--|

**TASK 2: Feed pump**

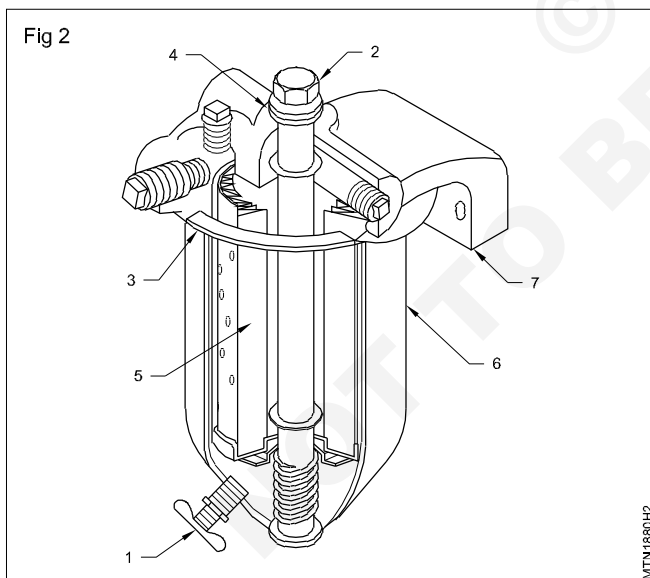
- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1 Disconnect fuel lines of the feed pump. (Fig 1)</li> <li>2 Remove feed pump assembly from fuel injection pump by loosening the mounting nuts uniformly.</li> <li>3 Remove filter housing (17) by loosening the clamping nut (14), screw (13) and clip (15) along with spring (16), filter (18) and washer (20).</li> <li>4 Remove snap ring (7) and take out roller tappet assembly of the feed pump.</li> <li>5 Remove screw plug (2) and washer (3) and take out plunger spindle (5&amp;6) with return spring (4).</li> <li>6 Remove hand priming pump (12) and washer (21).</li> <li>7 Remove screw plug (22), washer (21) and remove valves (24), along with springs (23).</li> <li>8 Remove roller pin (9) and roller (8).</li> <li>9 Remove slider (10), tappet (11) and spring (19).</li> </ol> | <ol style="list-style-type: none"> <li>10 Clean all the parts of fuel feed pump with kerosene or diesel.</li> <li>11 Check visually all the parts for wear and replace if required.</li> <li>12 Check tension of all the springs and replace if necessary.</li> <li>13 Check valve seats.</li> <li>14 Check washer and replace if necessary.</li> <li>15 Clean filter screw.</li> <li>16 Assemble roller tappet assembly in housing and secure it by snap ring.</li> <li>17 Assemble spindle plunger assembly and tighten screw plug.</li> <li>18 Place valves on its seat along with springs.</li> <li>19 Tighten hand priming pump and screw plug.</li> </ol> |
|---|---|

- 20 Fit the filter assembly by locking clamp nut.
- 21 Rotate F.I.P's camshaft so that its eccentric for driving feed pump is at inner most position.
- 22 Fit feed pump on F.I.P.
- 23 Tighten feed pump mounting screws uniformly.
- 24 Connect all the fuel lines.
- 25 Check for operation of fuel pump by hand priming pump.
- 26 Operate the fuel pump and check fuel pump delivery pressure as per specifications



### TASK 3: Dismantling and replacing the fuel filters

- 1 Disconnect fuel lines from the filter.
- 2 Drain fuel, dirt and water from the filter housing by opening the drain plug (1). (Fig 2)
- 3 Loosen the centre stud bolt (2) located at the top of the filter assembly.

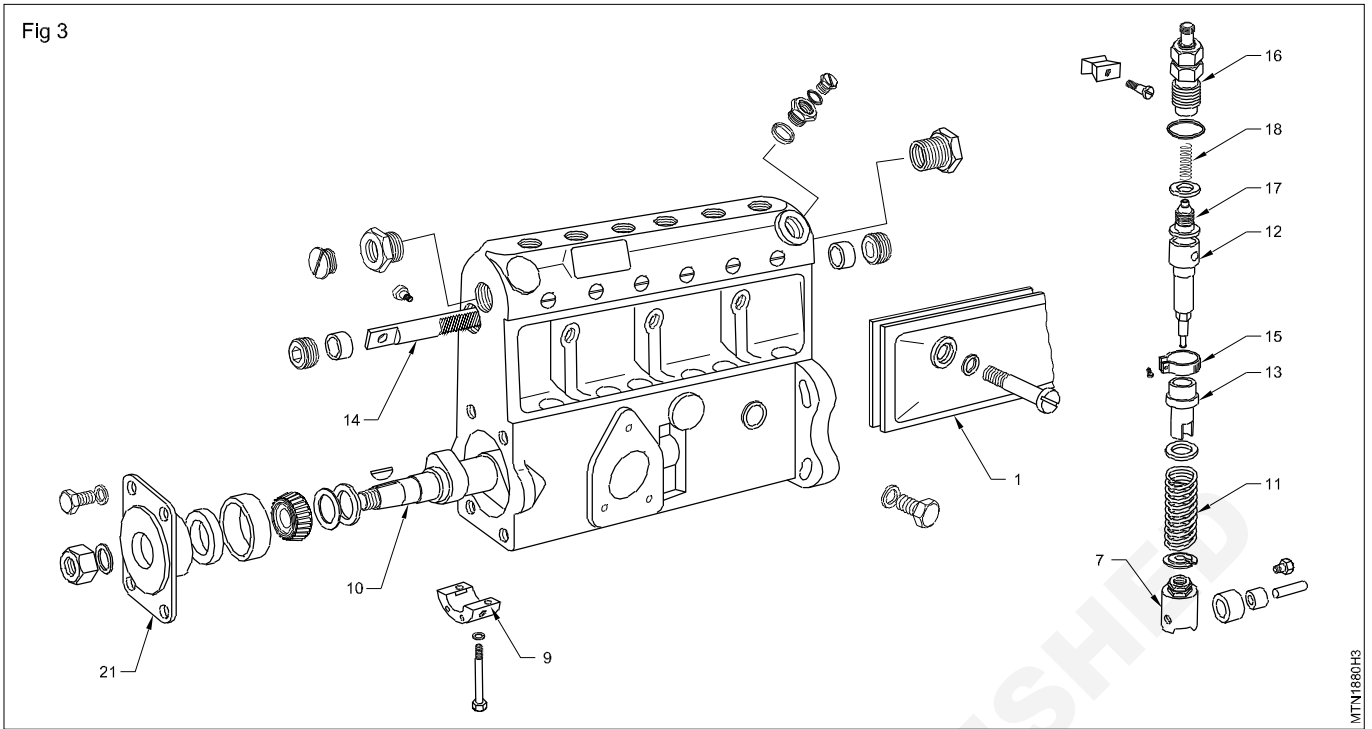


- 4 Remove the top cover (7).
- 5 Remove the used elements (5) from the filter housing (6), discard the element.
- 6 Wipe the inside of the filter-housing.
- 7 Clean fuel residue and other deposits. Use kerosene/diesel for cleaning the housing.
- 8 Place a new gasket (4) on the centre stud bolt.
- 9 Place a new gasket (3) in the filter cover assembly.
- 10 Place a new fuel filter element in the filter housing.
- 11 Assemble the housing with cover and tighten the centre bolt.
- 12 Fit drain plug in the filter housing.
- 13 Connect fuel lines.
- 14 Loosen the bleeding screw by one to two turns so that air can escape through the hole in the bleeding screw.
- 15 Pump the fuel by hand priming pump till fuel flows through bleeding screw without air.
- 16 Tighten the bleeding screw again

### TASK 4: Dismantling and cleaning of F.I.P

- 1 Keep fuel injection pump on the work bench.
- 2 Loosen mounting screws of feed pump. Do not loosen any mounting screw completely. Gradually loosen mounting screws by one or two turns and take out feed pump slowly.
- 3 Remove the inspection cover (1) (Fig 3) and mount injection pump on a swivel vice.
- 4 Remove the plate (22) from governor cover (4).
- 5 Unscrew torque control capsule (2) from tensioning lever (3) after removing lock nut with a combination wrench.

Fig 3

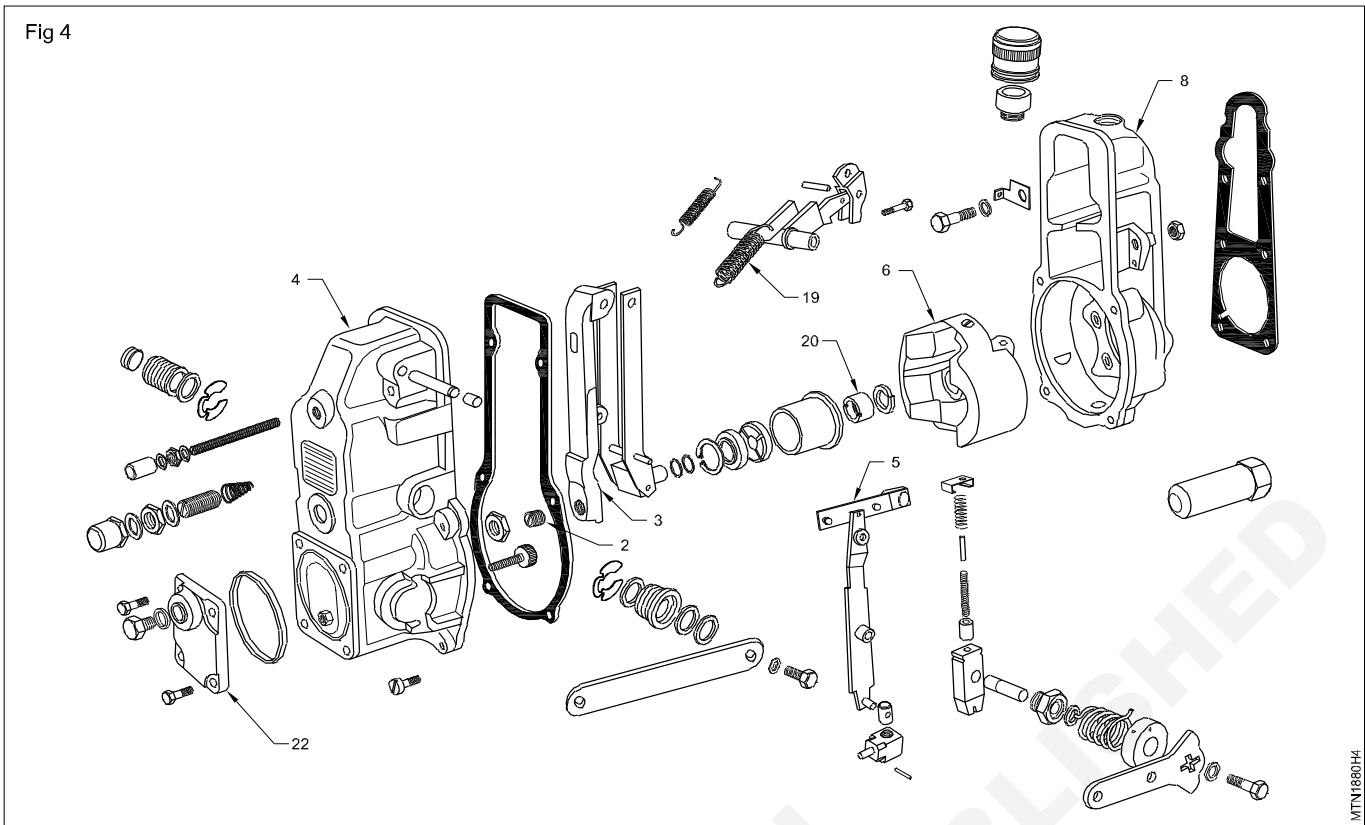


- 6 Remove the screws securing the governor cover (4). Tap the cover lightly with a rubber mallet to loosen it from Governor housing. Drain the lubricating oil by removing drain nut.
- 7 Disconnect shackle (5) by displacing leaf spring with a screw driver.
- 8 Remove starting spring (19).
- 9 Unscrew round nut (20). (Fig 4)
- 10 Remove fly weight assembly (6).
- 11 Remove woodruff key from the cam shaft (10).
- 12 Lift off all the roller tappets (7) from the camshaft and remove the housing (8).
- 13 Remove intermediate bearings (9) and remove cam shaft (10).
- 14 Remove bearing end plate (21).
- 15 Push roller tappets (7) upward and remove tappets.
- 16 Remove all plunger elements (12) with springs (11).
- 17 Remove control sleeve assembly (13-15) together with upper spring plate.
- 18 Remove control rack (14).
- 19 Remove delivery valve holders (16) and delivery valves (17) along with spring (18).
- 20 Take out element barrels.
- 21 Do not interchange barrels and plunger elements
- 22 Place the components in the respective compartments of a clean workshop tray. Ensure that plunger element and barrel are not interchanged.

**TASK 5: Inspection of dismantled parts**

- 1 Inspect plunger and barrel element for wear and replace if abnormal wear is found.
- 2 Clean the plunger with test oil. Withdraw plunger about 1/4 of its length vertically upward from the element barrel. It must slide back slowly by its own weight into the element barrel.
- 3 Inspect delivery valves for wear on relief piston, wear on delivery valve pin and body seat, wear on seating surface. Replace delivery valve if it has any of above defects. These should not be reconditioned.
- 4 Inspect roller tappets for wear and damage. If excessive wear is found replace.
- 5 Inspect camshaft for wear damage.
- 6 Inspect taper roller bearings for pitting/worn out races.
- 7 Inspect control rack for smooth slide in pump housing. If it sticks polish it with fine emery paper.
- 8 Replace control rack, if teeth are found worn out.
- 9 Replace worn guide bushes.
- 10 Inspect plunger spring for corrosion, cracks and damage. Replace them, if necessary.
- 11 Mount pump housing on swiveling vice. Fit fuel gallery plug.
- 12 Rinse elements in clean test oil and insert so that guide groove of barrel engages the locating pins.
- 13 Insert delivery valve and washer. Fit delivery valve spring and delivery valve holder. Tighten delivery valve holder at recommended torque.

Fig 4



MTN1880HA

**TASK 6: Assembling of F.I.P**

- 1 Remove F.I.P. from swivel vice.
- 2 Connect compressed air connection to fuel inlet, close outlets. Dip pump in test oil tank and pass air at 0.5 to 1.0 (kgf/cm<sup>2</sup>). If an air bubble appears only once in a while from the barrel seating, then the pump is considered tight. If more air bubbles appear then the barrel seating surface of pump housing should be smoothed with a reseating cutter.
- 3 Fit F.I.P. on swivel vice.
- 4 Remove plunger assembly.
- 5 Fit control rack and screw in control rack locating screw.
- 6 Insert control sleeve, in the quadrant in such a way, that, the clamping jaws of quadrant with control rack in the centre position, point accurately forward.
- 7 Fit upper spring plate and plunger spring. Insert element plunger in the lower spring plate. The plunger must turn smoothly with the control rack movement.
- 8 Insert roller tappet and align tappet pins into guide grooves in pump housing.
- 9 Push roller tappets and insert tappet holders.
- 10 Press oil seals and outer bearing races into end plate.
- 11 Insert camshaft.
- 12 Fit intermediate bearing on camshaft.
- 13 Force intermediate bearing into pump housing by tapping the camshaft with a rubber mallet.
- 14 Remove tappet holders by rotating the camshaft. Check that the element plunger has a clearance of atleast 0.2mm at TDC position of cam and then lock tappet screws.
- 15 Fit bearing end plate.
- 16 Fit governor housing.
- 17 Insert woodruff key into camshaft and fix fly weight assembly.
- 18 Fit governor assembly.
- 19 Check control rack movement by pushing control rack to stop and release. Control rack must automatically return to full load position.
- 20 Fit end cover.
- 21 Rotate camshaft till eccentric for feed pump is at inner dead centre. Insert gasket and fix feed pump with hexagonal nuts using lock washers.
- 22 Fill the pump and governor with recommended oil upto level.

**Servicing of high pressure fuel feed pump (CRDI)**

**Objective:** At the end of this exercise you shall be able to  
 • **overhead the high prepare fuel feed pump.**

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton waste	- as reqd.
<b>Equipment/Machines</b>		• Soap oil	- as reqd.
• Diesel Vehicle (CRDI)	- 1 No.	• Cleaning solvent	- as reqd.
		• Fuel feed pump repair kit	- as reqd.

**PROCEDURE**

**TASK 1: Servicing of high pressure fuel feed pump**

- 1 Park the vehicle on surface floor.
- 2 Open the bonnet cover.
- 3 Disconnect the fuel lines with high pressure fuel feed pump.
- 4 Dismantle the fuel feed pump mounting with engine.
- 5 Remove the fuel feed pump from the CRDI Engine.
- 6 Place the high pressure fuel feed pump on the tray.
- 7 Dismantle the high pressure fuel feed pump.
- 8 Clean the dismantled parts of the pump (Junction control valve, delivery valve plunger pump shaft pump body).
- 9 Inspect the dismantled parts for wear or damage.
- 10 Replace the damaged/workout parts of fuel feed pump.
- 11 Assemble the fuel feed pump and check the feed pump suction and pressure with help of vacuum/pressure gauge.
- 12 Mount the fuel feed pump in its location on the engine.
- 13 Connect the fuel line with fuel feed pump.
- 14 Check the fuel feed pump drive.
- 15 Operate the engine and check the fuel feed pressure as specified limit, if need adjust the delivery valve.
- 16 Replace the damaged parts with new suitable one.
- 17 Assemble the high pressure fuel feed pump.
- 18 Check the fuel feed pump for free rotation.
- 19 Check the fuel pump vacuum and fuel pressure test with vacuum and pressure test kit.
- 20 Mount the high pressure fuel feed pump on the CRDI engine.
- 21 Connect the fuel lines with fuel feed pump (in and out fuel lines).
- 22 Remove the air from the fuel system under your instructors guide line.
- 23 Start the engine and check the fuel pump working performance.

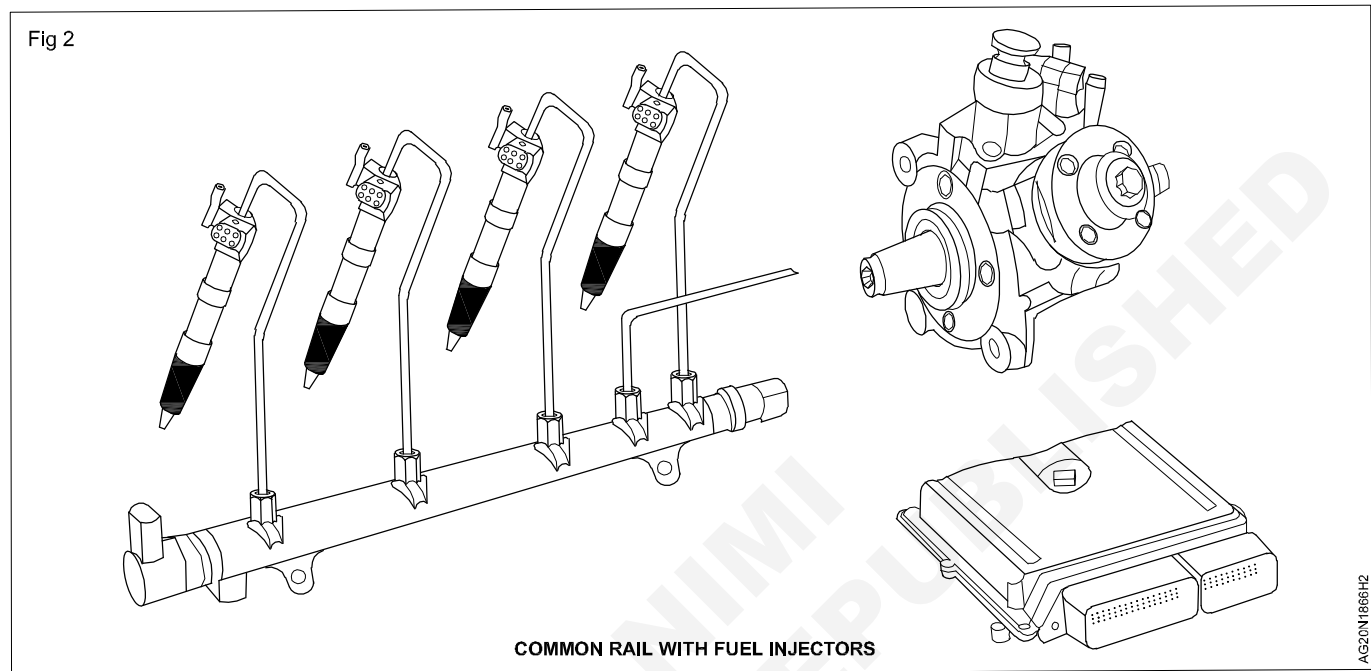
Fig 1



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## TASK 2: Check the function of fuel regulator and fuel injector in CRDI engine

- 1 Tune up the engine and check the fuel line connection and electrical sensor wire connections with injector sensor and fuel regulators sensor, common rail sensors and ECM.
- 2 Start the engine and check fuel outlet of fuel regulator, where excess fuel is delivery into overflow pipe from common rail unit.
- 3 If found defective replace the fuel regulator and sensor with regulator.
- 4 Check the injectors functions by removing and connecting the injectors sensor electrical wire connection, while removing sensor wire access the engine running.



**Over hauling and testing of electronic fuel injectors**

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

- check the regulator and electronic injectors
- checking operation of CRDI system
- over handling and testing of electronic injectors.

Requirements			
Tools/Instruments		Materials/Components	
• Trainees Tool Kit	- 1 No.	• Cotton waste	- as reqd.
• Multi meter	- 1 No.	• Soap oil	- as reqd.
Equipment/Machines		• Sensors	- as reqd.
• CRDI Engine	- 1 No.	• Injectors	- as reqd.
		• Fuel regulator	- as reqd.
		• Fuel pipe	- as reqd.

**PROCEDURE**

**TASK 1: Checking Operation of CRDI Fuel System**

- |   |  |
|---|--|
| 1 Check the fuel level in the fuel tank.  | 7 Check the pressure regulator.  |
| 2 Check the sensor wire connections.  | 8 Check the pressure discharge valve.  |
| 3 Check the fuel line connections.  | 9 Check the injector sensors and injectors functions.  |
| 4 Switch on the ignition key check the warning lights on dash board gauges light. | 10 Check the ECU and EDC.  |
| 5 Start the engine and check the operation of high pressure fuel feed pump.       | 11 Check the all fuel system related sensors with help of multimeter. if found any defect sensor replace it. |
| 6 Check the common rail pressure sensor with multimeter.                          | 12 After checking the CRDI fuel system check the engine running performance.                                 |

**TASK 2: Over hauling and testing of the electronic fuel injectors**

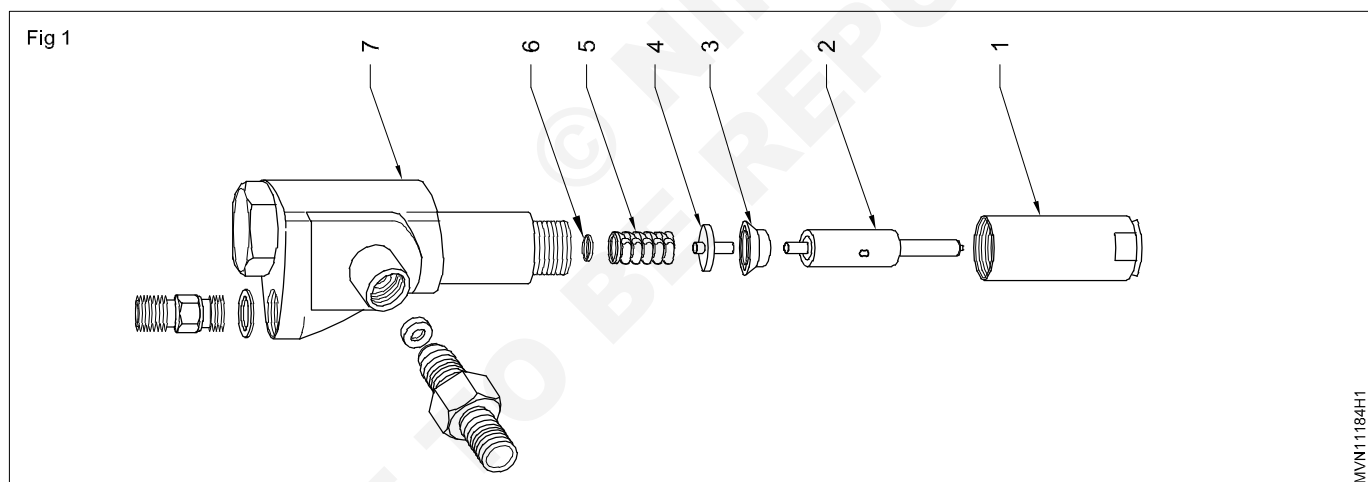
- |   |   |
|---|---|
| 1 Disconnect the injector sensor wire connection.   | 10 Check the fuel system sensors by multimeter.   |
| 2 Disconnect the common rail fuel line connection.  | 11 Check the injector sensors by multimeter.  |
| 3 Disconnect the overflow fuel pipe line.   | 12 Assemble the injectors including solenoid and sensors.                                   |
| 4 Disconnect the injectors  | 13 Fix the injectors on testing machine.  |
| 5 Remove the all injectors and place it on the work bench.  | 14 Connect the fuel lines with injectors.   |
| 6 Dismount the injector sensor and solenoid.  | 15 Oeprate the injectors testing machine and adjust the fuel pressure of the fuel injector. |
| 7 Dismount injectors and clean with recommended cleaning solvent  | 16 Disconnect the fuel lines and remove the fuel injector.                                  |
| 8 Inspect the dismantled parts (nozzle, washer, spring, nozzle tip, pressure bolt, spray holes, nozzle needle). | 17 Fix the fuel injector on the CRDI engine.  |
| 9 Replace the damaged /worn parts.  | 18 Connect the sensor wire and fuel lines.  |
|   | 19 Start the engine and check the engine performance.                                       |

### TASK 3: Identify the defective fuel injector of an engine

- 1 Check the engine oil, water level before start the engine
- 2 Start the engine and run it idle speed
- 3 Record the engine RPM
- 4 Observe the knocking sound/vibration of the engine
- 5 Remove the high pressure pipe nipple from the 1<sup>st</sup> cylinder nozzle to one by one
- 6 Check the rpm of the engine variation
- 7 Which injector's fuel line disconnection is not varying the engine operation, Means the injector is defective.
- 8 Faulty injector indicates same the initial reading and knocking sound
- 9 Stop the engine and remove the faulty injector from the cylinder head
- 10 Place it in a tray and dismantle the injector and clean the dismantled injector parts and injector adjust it.
- 11 Replace the damaged or worn out parts
- 12 Assemble the dismantle parts of the injector and adjust it.
- 13 Test the injector with injector test machine
- 14 Fit the injector on the particular cylinder
- 15 Start the engine observe the engine r.p.m and its smooth running

### TASK 4: Dismantling (Fig 1)

- 1 Remove overflow line of injectors.
- 2 Remove high pressure line.
- 3 Remove injector clamp.
- 4 Remove the injector from cylinder head.
- 5 Plug the inlet (injector seating) and leak-off openings.
- 6 Clean the nozzle tip and wipe off the dirt from the injector.
- 7 Hold the injector in inverted position.
- 8 Unscrew nozzle cap nut (1) and remove the cap nut (Fig 1)
- 9 Remove nozzle (2), intermediate washer (3), pressure bolt (4), spring (5) shims (6)

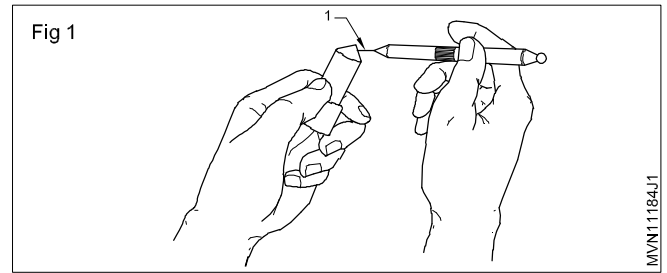


### TASK 5: Cleaning and inspection (Fig 1)

- 1 Keep the components in the respective compartments of a standard work tray.
- 2 Rinse nozzle in clean diesel and withdraw nozzle needle from the nozzle body.
- 3 Inspect the nozzle needle for damage, roughness and wear.
- 4 Inspect the nozzle body (7) for damage
- 5 Clean the nozzle either by blowing air or with a nozzle cleaning wire. Cleaning wire's (1) diameter should be smaller than spray hole's diameter. Ensure that while cleaning wire does not break inside the hole (Fig 1)
- 6 Rinse nozzle needle and nozzle with clean testing oil
- 7 Hold the nozzle vertically, pull out nozzle needle to 1/3 of its engaged length and release the nozzle needle. Nozzle needle should slide down to its seat on its own weight when it is released.
- 8 If it does not slide, lap the needle and nozzle body with paste.
- 9 Clean carbon deposits from inner and outer surfaces of cap nut.
- 10 Inspect cap nut for any crack/damage.



- 11 Inspect spring for crack or any damage, replace if necessary
- 12 Check spring tension on spring tester. Replace spring if necessary
- 13 Dip the body and nozzle in clean oil.
- 14 Ensure that nozzle and nozzle needle are not interchanged.
- 15 Hold nozzle body in inverted position on a vice. Place shim, spring, pressure bolt, intermediate washer and nozzle body

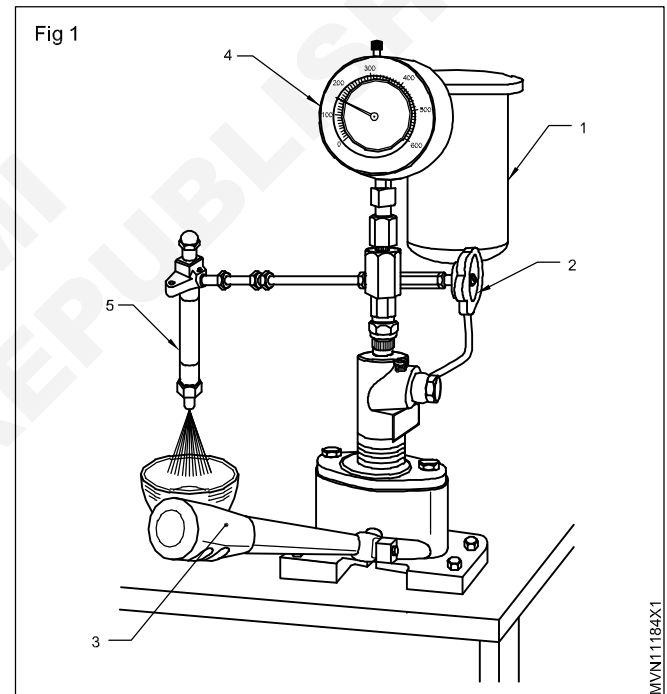


- 16 Tighten the nozzle cap nut by hand and centralise the nozzle. Then tighten nozzle cap nut at recommended torque

#### TASK 6: Testing

- 1 Fit injector (5) on injector tester (Fig 1)
- 2 Fill test oil in container (1)
- 3 Close shut-off-valve knob (2)
- 4 Operate hand lever (3) as fast as possible and observe that test oil is sprayed through nozzle
- 5 Caution do not put your hand underneath the injector being tested
- 6 Open the shut off valve knob
- 7 Operate hand lever and observe the maximum pressure from gauge (4) at which test oil sprays out of nozzle
- 8 If this pressure does not match with manufacturer's recommendation, then adjust it with a shim/adjusting screw. Adding a shim/tightening the screw will increase pressure.
- 9 Observe that the test oil is sprayed from all the holes if nozzle. If not, then clean the nozzle hole.
- 10 Observe that the test oil does not dribble after spraying if it does, then grind the nozzle needle.
- 11 Remove injector (5) from injector tester
- 12 Fit injector on engine with new seating washer

- 13 Connect high pressure pipe.
- 14 Connect over flow pipe.



**Practice on setting injection timing and bleeding air locks**

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

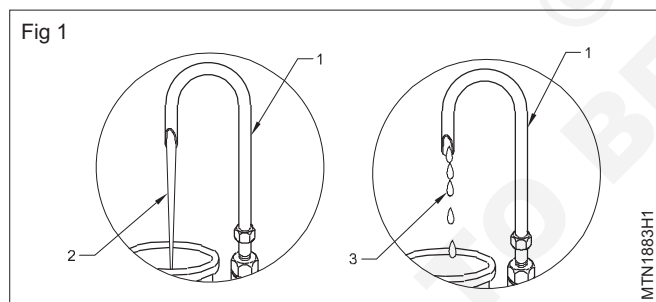
- setting the FIP timing
- bleeding the air from fuel lines
- identify the defective injector and overhaul the injector.

Requirements	
<b>Tools/Instruments</b>	<b>Materials/Components</b>
<ul style="list-style-type: none"> <li>• Trainees Tool Kit - 1 No.</li> <li>• Swan neck pipe - 1 No.</li> <li>• Bleeding Kit - 1 No.</li> </ul>	<ul style="list-style-type: none"> <li>• Cotton waste - as reqd.</li> <li>• Soap oil - as reqd.</li> <li>• Diesel - as reqd.</li> </ul>
<b>Equipment/Machines</b>	
<ul style="list-style-type: none"> <li>• Diesel vehicle - 1 No.</li> </ul>	

**PROCEDURE**

**TASK 1: Spill cut method**

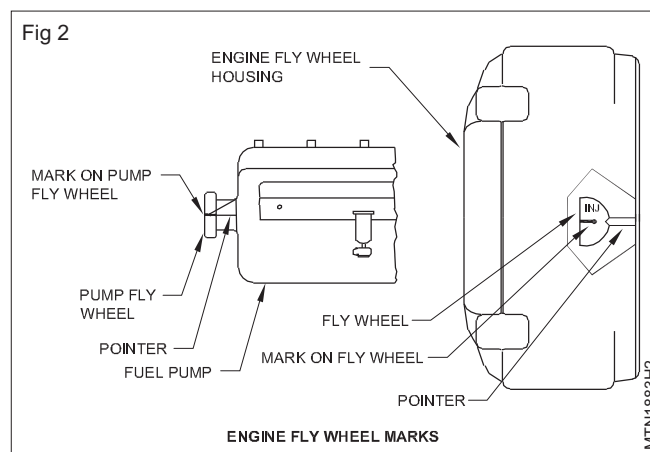
- 1 Disconnect the first injector pipe at the FIP's end.
- 2 Remove the 1st delivery valve holder and remove the valve pin and spring.
- 3 Fit the delivery valve holder.
- 4 Fit the sawn neck pipe (1) on the 1<sup>st</sup> delivery valve holder. (Fig 1)



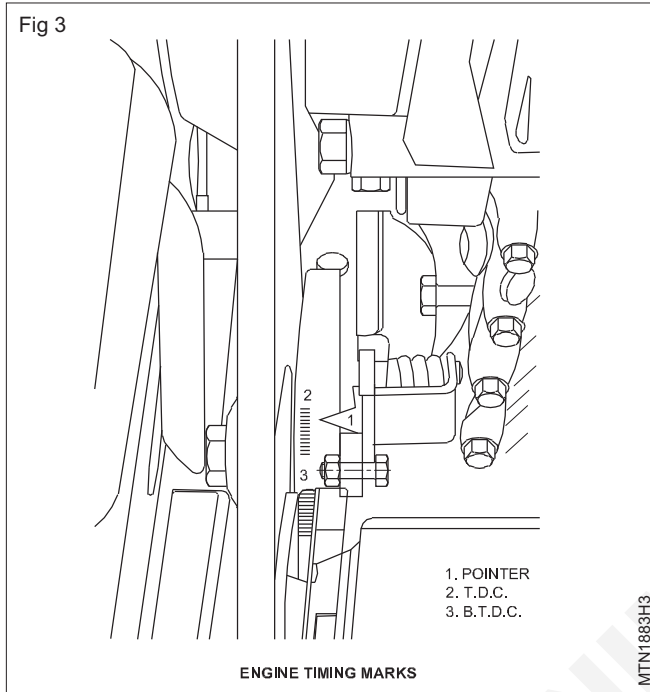
- 5 Connect the fuel gallery of the FIP to the fuel container placed at a higher level.
- 6 Move the FIP towards the engine till the fuel (2) starts flowing freely through the swan neck pipe.
- 7 Now move the FIP away from the engine till the fuel flow is cut off completely.
- 8 Again move the FIP towards the engine and stop when the fuel flow regulates in such a way that there is a flow of a drop (3) between 15 and 20 seconds; at that time tighten the bolts of the FIP flange without varying the flow of the drop.
- 9 Remove the swan neck pipe (1) and delivery valve holder and replace the pin and spring and fit the delivery valve holder.
- 10 Connect the pressure pipes between the injectors and fuel injection pump.

**TASK 2: Setting timing of the FL pump in relation to the engine**

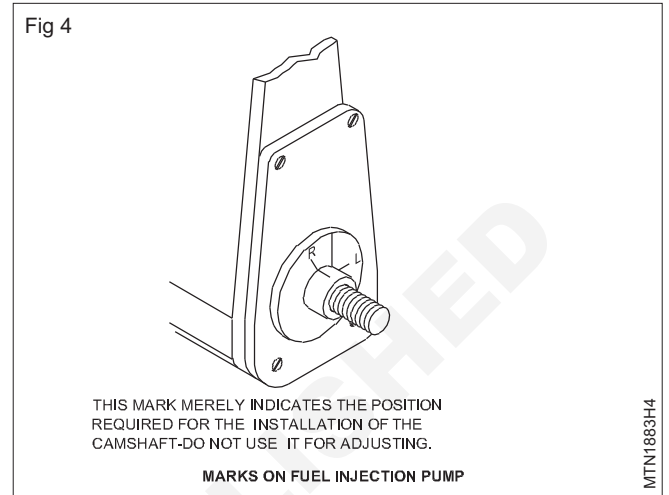
- 1 Before coupling the FL pump to the engine for setting timing, the engine piston No.1 cylinder should be positioned at the injection point before T.D.C.
- 2 Aligning engine timing marks. (Fig 2)
- 3 Observe the TDC/BTDC (Injection marks) and a pointer made in the flywheel, on the 'V' belt pulley or on the vibration damper. (Refer to the figure)
- 4 Crank the engine in a clockwise direction till the injection mark (3) on the flywheel/vibration damper coincides with the pointer (1) on the flywheel housing or timing gear housing.



- 5 Now the engine is ready for coupling with the FL pump.
- 6 Preparing FL pump for coupling to the engine. (Fig 2)
- 7 The pump plunger next to the drive end must be set to the commencement of delivery position for respective direction of rotation.
- 8 Observe the timing marks on FL pump shaft and housing. (Refer to the Fig 3)



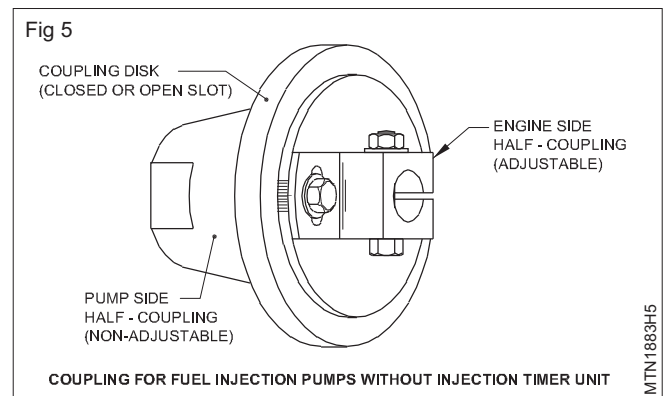
- 9 Rotate the pump camshaft and align the mark on the shaft taper with lines marked as R or L depending on the rotation of the pump shaft.
- 10 Fix the woodruff key on the taper end of the pump shaft and push the non-adjustable pump side half coupling on the shaft and tap it with a mallet.
- 11 Observe the line mark on the coupling boss aligning with R or L mark on the pump housing. (Fig 4)



- 12 Fix the spring washer on the taper end of the shaft-screw in the nut and tighten it to the specified torque value. (Refer to Mico pamphlet) - use correct size spanner and tomy bar.

### TASK 3: Coupling the pump with the engine

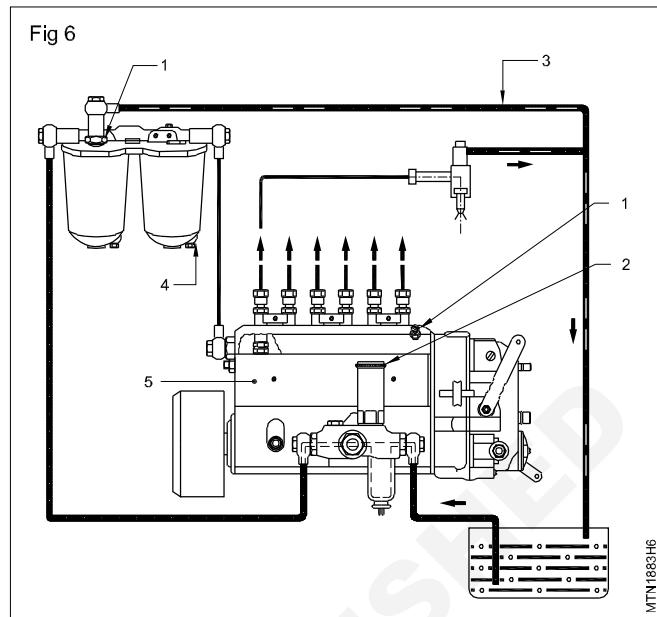
- 1 Assemble the coupling unit on the pump with their zero marks exactly matching. (There are 3 units in all) (Fig 5).
- 2 Measure the end clearance between the coupling flange and the coupling disc of the drive. (Use a feeler gauge) (Minimum clearance is 0.02" or 0.5 mm).
- 3 Fix the FL pump on its engine bracket - move it to the engine side - insert the drive side half coupling on the drive shaft of the air compressor or exhauster (depending on the make of the engine).
- 4 Insert the fastening bolts on the pump mounting holes and tighten them with nuts to the specified torque.
- 5 Crank the engine and check for free rotation of the pump shaft along with exhauster/air compressor shaft.



#### TASK 4: Bleeding

- 1 Check all fuel line connection joints and leakages in fuel lines before start bleeding
- 2 Operate the hand priming pump till fuel/pressure built up.
- 3 Loosen the fuel filter bleeding screw by one to two turns so that air can escape through the hole in the bleeding screw (Fig 6).
- 4 Tighten the bleeding screw (1) again.
- 5 Repeat the operation till the air in the system is fully drawn out in both filter.
- 6 Loosen the bleeding screw (1) at F.1.P. (5) by one or two turns so that air can escape through the hole from the bleeding screw.
- 7 Tighten the bleeding screw (1) again.
- 8 Repeat the operation till the air in the system is fully drawn out.
- 9 Ensure all fuel connections and bleeding screws are securely tighten.

- 10 Start the engine and check to performance.



**Practice to test cylinder compression and fault finding & remedy**

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

- testing cylinder compression
- obtaining of interpreting scan tool data
- checking engine idle speed
- obtaining and interpreting scan tool data.

Requirements		
<b>Tools/Instruments</b>		<b>Materials/Components</b>
• Trainees Tool Kit	- 1 No.	• Cotton waste - as reqd.
• Compression gauge	- 1 No.	• Soap oil - as reqd.
• Scan tool	- 1 No.	
<b>Equipment/Machines</b>		
• Diesel vehicle	- 1 No.	

**PROCEDURE**

**TASK 1: Testing the cylinder compression**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Start the engine and warm up the engine for bring it to operating.</li> <li>2 Check the engine at speed.</li> <li>3 Stop the engine and disconnect the injectors fuel line connection (High pressure fuel line and overflow pipe.</li> <li>4 Loosen the injector and remove the injector.</li> <li>5 Install the compression gauge on cylinder No 1.</li> <li>6 Crank the engine with starter motor and read the highest pressure reading on the compression gauge.</li> </ol> | <ol style="list-style-type: none"> <li>7 Note the reading and release the pressure of compression gauge.</li> <li>8 Repeat the procedure for remaining cylinders and note down the compression pressure reading.</li> <li>9 Compare the reading of all cylinders with manufacturers specification.</li> <li>10 If the compression pressure of any one cylinders is varying from the permissible limit recommend for reboring or replace the liners.</li> </ol> |
|---|--|

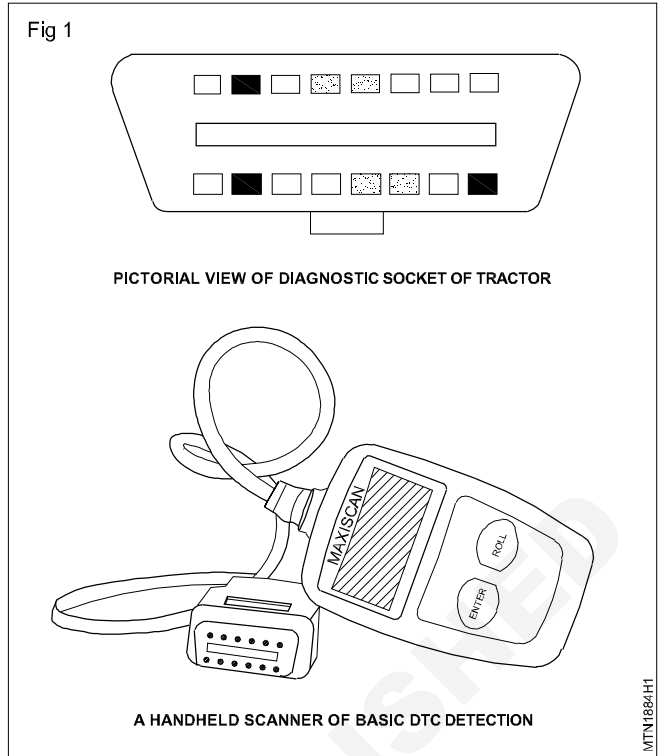
**TASK 2: Checking engine idle speed**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1 Check oil fuel and water level of the specified engine.</li> <li>2 Switch on the ignitin kely and start the engine.</li> <li>3 Stay on at idle speed and check the engine performance.</li> </ol> | <ol style="list-style-type: none"> <li>4 If the engine performance is not satisfied turned up the engine till your satisfaction.</li> <li>5 If need check and service, the engine management system as per your instructor guide line and follow the engine tune up procedure for good performance.</li> </ol> |
|--|--|

**TASK 3: Procedure for checking of electronics system or CRDI**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1 Park tractor on level surface and choke the wheels.</li> <li>2 Visually check all the sensors for loosen or removed connections.</li> <li>3 Connect the scanner to diagnostic socket. (Fig 1)</li> <li>4 Switch on CDRI scanner and turn ignition key on wait for scanner warm up.</li> <li>5 Check display or scanner/computer.</li> </ol> | <ol style="list-style-type: none"> <li>6 Follow the instructions from display. Select the manufacturer for the tractor.</li> <li>7 Select the make and year of manufacture model.</li> <li>8 Select Auto defect in scanner.</li> <li>9 After detecting the Tractor make and madel, check for fault memory.</li> <li>10 If any fault memory is present it will be displaced.</li> </ol> |
|--|--|

- 11 Read fault memory and do the respective repair or remedy for the faults in various circuits.
- 12 For e.g. if DTC code P0116 appears. It suggests malfunction I the engine coolant temperature (ECT) circuit. Accordingly, the Sensor, Coupler and harness has to be checked.
- 13 Repeat the above steps for other sensors and systems.



**Practice on fault finding and remedies care and maintenance of fuel system**

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

- **fault finding and remedies of fuel system**
- **care and maintenance of fuel system.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton waste	- as reqd.
• Scan tool	- 1 No.	• Soap oil	- as reqd.
<b>Equipment/Machines</b>			
• Diesel vehicle	- 1 No.		

**PROCEDURE**

**TASK 1: Causes and remedies of fuel system**

**fuel system defects**

<b>Defect</b>	<b>Cause</b>	<b>Remedies</b>
1 Fuel leak from fuel tank	Crack/damage union loose fitting	Repair tighten
2 Water in fuel	Water with fuel	Drain and clean (filter) the fuel
3 Fuel feed pump defective	defective valve	Repair or overhaul the fuel pump
5 Engine misfiring	Improper fuel supply water mix with fuel	Replace the fuel
6 Diesel fuel system defects	Air lock	Bleed the fuel system
7 Improper fuel supply of the fuel system	Damaged fuel line Dirty fuel filter Low fuel supply Defective fuel pump Low fuel level Defective injectors Fuel leakage is fuel line	Repair/replace Replace Correct it Repair/replace Fill fuel Repair Rectify

**TASK 2: Care and maintenance of fuel system**

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1 Use a good quality of fuel.</li> <li>2 Periodically overhaul the fuel system components.</li> <li>3 Avoid loose connections of fuel line.</li> <li>4 Periodically replace the fuel filters.</li> <li>5 Use a good quality components during repair the fuel injection pump injectors, fuel feed pump, carburetor, electrical/ mechanical fuel pumps, electronic injector, pressure regulator, low pressure fuel pump or high pressure fuel pump.</li> </ol> | <ol style="list-style-type: none"> <li>6 Ensure fuel tank cap vent hole is in open possession</li> <li>7 Ensure the fuel line connections are properly connected.</li> <li>8 Ensure water separator filter is in good condition.</li> <li>9 Ensure fuel pump, electronic fuel injectors are in good working condition.</li> </ol> |
|--|---|

**Dismantle the clutch assembly in a tractor**

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

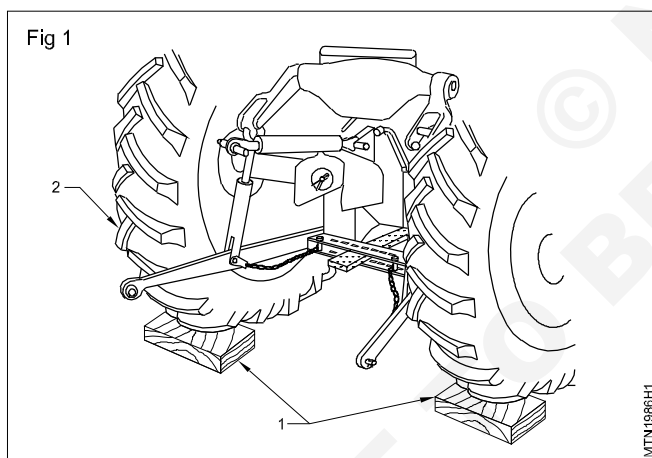
- split engine from transmission
- disconnect clutch assembly from transmission system.

Requirements			
<b>Tools/Instruments</b>			
• Trainees Tool Kit	- 1 No.	• Horse stand	- 2 Nos.
• Torque wrench	- 1 No.	<b>Materials/Components</b>	
• Aligning arbor	- 1 No.	• Wooden block	- as reqd.
<b>Equipment/Machines</b>		• Cotton waste	- as reqd.
• Tractor	- 1 No.	• Soap oil	- as reqd.
• Trolley jack	- 1 No.		

**PROCEDURE**

**TASK 1: Splitting of engine from transmission**

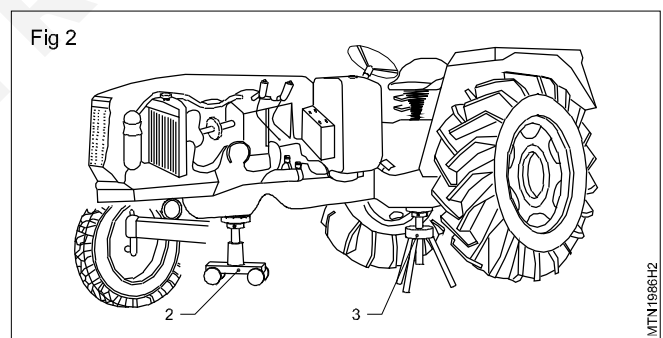
- 1 Park the tractor with both the brakes are in locked position.
- 2 Place suitable wooden blocks in the front and back of the rear wheels (Fig 1)



- 3 Disconnect the ground cable from the battery.
- 4 Disconnect the starter cable from the starter terminal.
- 5 Remove the instrument panel.

**Instrument panel is removed after disconnecting all the wiring, gauge connections and bolt connections etc.**

- 6 Unscrew fuel tank after turning off the fuel.
- 7 Disconnect both steering rods from the steering arms.
- 8 Place the suitable trolley jack (2) underneath engine oil sump and provide suitable support with sport jack (3) under gear box and rear axle central housing. Raise the sport jack until it supports the weight partially and the weight of the tractor is equally distributed. (Fig 2)



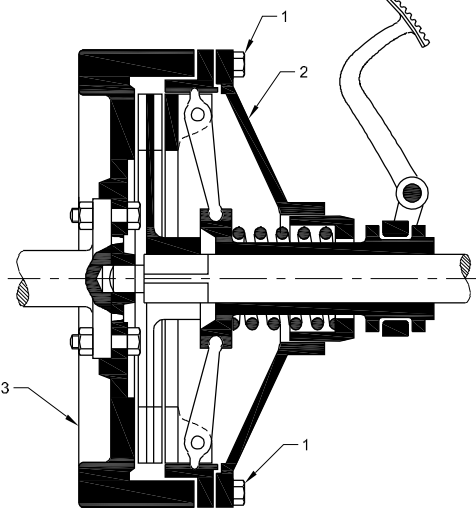
- 9 Remove all the bolts and springs washer attaching the gear box housing to the bell housing.
- 10 Carefully roll the tractor engine forward away from the rear wheels for splitting the tractor engine from the gear box joint.

**TASK 2: Disconnecting clutch assembly (Single plate)**

- 1 Mark with some paint the position of the clutch cover and flywheel. (While resetting, this mark will be helpful to ensure the original position of the clutch cover and the flywheel so that the balancing of the flywheel and clutch does not get disturbed)
- 2 Remove locking wire from pressure plate cover if available. Slacken the bolts (1) or unscrew diagonally across pressure plate cover (2) mounting bolts, until the thrust springs pressure is completely relieved. (Fig 3)



Fig 3



MTN1985H3

**Slacken or unscrew the pressure plate cover mounting bolts/screw diagonal wise. Each screw should be loosened by two turns at a time, until the thrust springs pressure is completely relieved. If these screws are opened without following above instruction, it can spoil clutch pressure cover and threads in flywheel.**

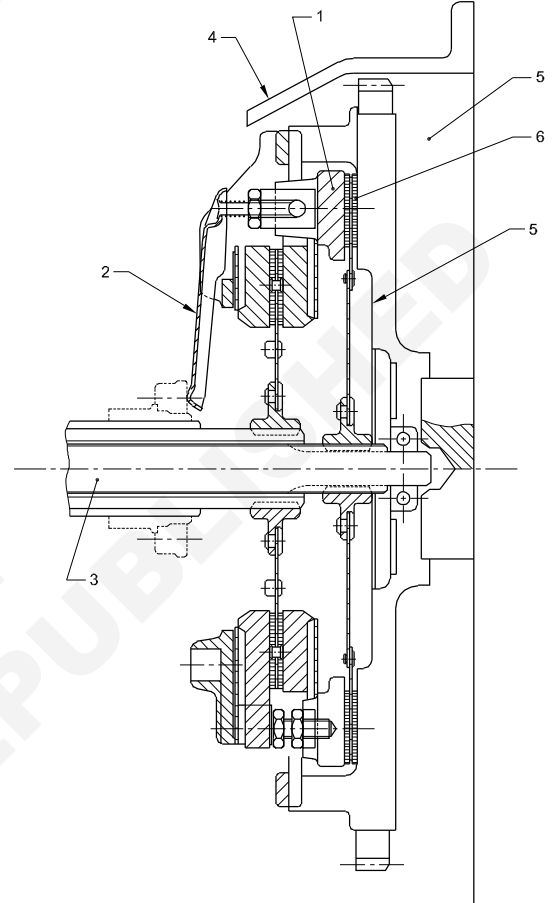
- 3 Remove the bolts, and spring washers and lift the complete clutch assembly from the flywheel (3) to remove clutch plate.

**Hold the pressure plate and cover assembly together with the clutch disc to prevent dropping until when the last bolt is removed.**

- 4 Declutch the dual clutch assembly (Fig 4) pressure plate (1) from tractor drive by a lever.

- 5 Support the three release arm (2) of disengaging lever of tractor drive (3) by putting forks.
- 6 Unscrew bolts from the clutch cover (4) and take out the complete clutch assembly from the flywheel (5)
- 7 Remove the clutch plate (6) from the tractor drive which remained in the fly wheel.

Fig 4



DOUBLE CLUTCH

MTN1985H4

**Practice on inspect the parts of clutch**

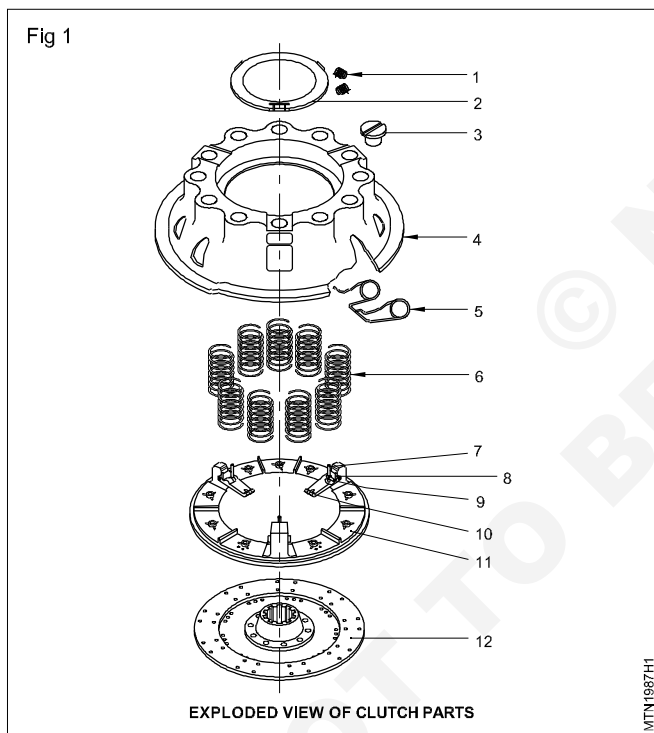
**Objective:** At the end of this exercise you shall be able to

- clean and inspect the clutch.

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Tractor	- 1 No.
• Box spanner	- 1 No.	<b>Materials/Components</b>	
• Outside Micrometer	- 1 No.	• Tray	- 1 No.
• Ball pein hammer	- 1 No.	• Cotton waste	- as reqd.
• Torque wrench	- 1 No.	• Paint	- as reqd.
• Aligning arbor	- 1 No.		

**PROCEDURE**

**TASK 1: Cleaning and inspecting of the clutch plate (Fig 1)**



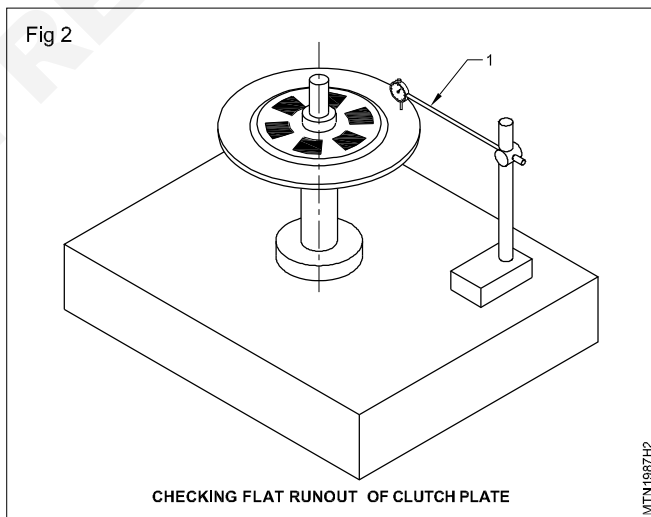
- 1 Clean all the parts with dry brush.
- 2 Check flywheel friction face for polish, scoure or warpage.
- 3 Check visually for burning and cracking.

**If glazed, then skim or grind it as per manufacturer specification. Replace if scored burnt, cracked or warped.**

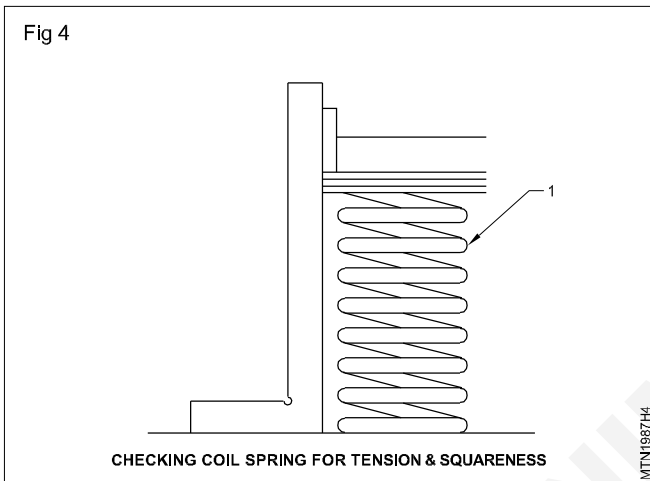
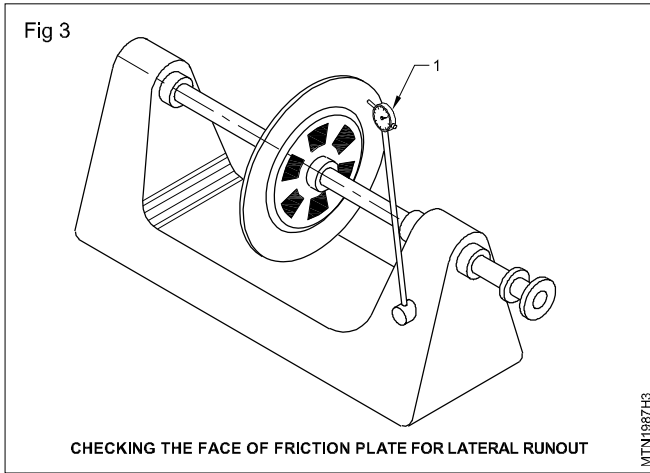
- 4 Check the torsion spring of the friction disc for tension according to the recommendation of the manufacturer.

**If torsion spring are loose or broken then replace.**

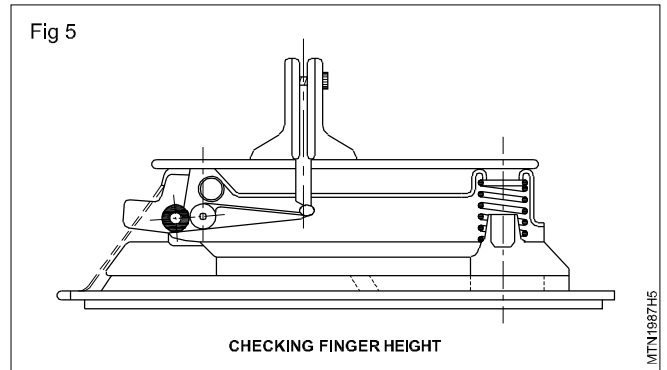
- 5 Check the friction disc hub and clutch shaft splines for wear & tear. If worn, then replace.
- 6 Check the friction lining for excessive wear & tear and see that rivet-heads do not protrude above surface. If so then replace.
- 7 Check the friction face for distortion i.e., flat and lateral runout. (Fig 2 & 3) using dial gauge (1).



- 8 Check rivets for looseness.
- 9 Check alignment of pressure plate with surface plate/straight edge.
- 10 Check the coil spring (1) for tension and squareness. (Fig 4)
- 11 Check the surface of the pressure plate for glazing scouring, crack and warpage visually.
- 12 Check visually the wear of the clutch fingers and their pivot pins.



13 Check the finger height as per manufacturer's specification. (Fig 5) using dial/depth gauge.



**If glazed, then skim or grind it as per manufacturer specification. Replace if scored burnt, cracked or warped.**

14 Check pilot bearing and clutch release bearing for proper fitting in fly wheel and clutch shaft.

15 Check bearing surface for any damage and wear.

16 Check the following parts for any damage/crack visually.

- Clutch fingers
- Clutch fingers bracket
- Thrust pad
- Clutch linkage
- Clutch fork
- Sleeve

**Replace if above parts are damaged/cracked.**

**Practice on relining of clutch plate**

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

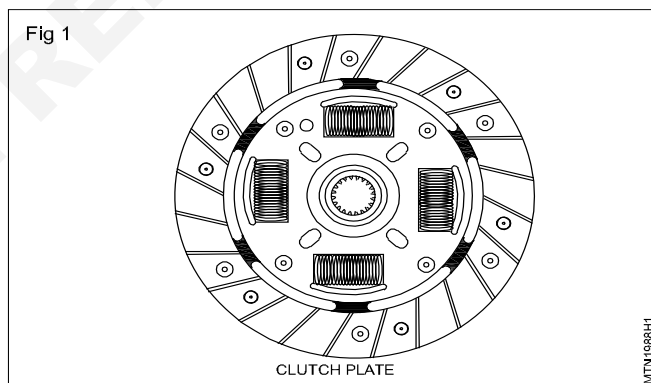
- relining clutch plate
- assembling the clutch.

Requirements			
<b>Tools/Instruments</b>			
• Trainees Tool Kit	- 1 No.	• Trolley jack/ Screw jack	- 1 No.
• Hammer	- 1 No.	<b>Materials/Components</b>	
• Snap plier	- 1 No.	• Tray	- 1 No.
• Special puller	- 1 No.	• Wooden blocks	- as reqd.
• Drift	- 1 No.	• Kerosene oil	- as reqd.
<b>Equipment/Machines</b>		• Cotton waste	- as reqd.
• Tractor	- 1 No.		

**PROCEDURE**

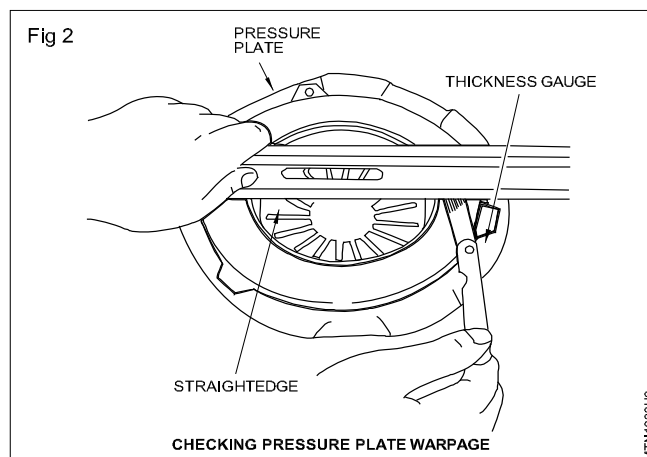
**TASK 1: Relining clutch plate (Fig 1)**

- 1 Inspect the clutch plate and lining.
- 2 Remove the old rivetes by use of drilling or centre punch with hammer.
- 3 Remove the old linings.
- 4 Clean the clutch hub and cushine springs.
- 5 Inspect the clutch hub flange, torsion spring cushion spring for damage or craks and noise.
- 6 If any damage found in clutch hub or cushine spring repair or replace the unit.
- 7 Select the correct size of clutch lining and rivets.
- 8 Clean the clutch linings and hub unit before relining.
- 9 Align the rivet holes on the clutch spring with clutch living.
- 10 Clamp the linings to the clutch plate with hand vice or 'C' clamps.
- 11 Adjust the clamps as close as possible to rivet holes.
- 12 Start riveting with foot operate riveting machine in sequence under instructor's guide nice.
- 13 After reveting check the lining rivets tightness.
- 14 Ensure the clutch linings are properly riveted before use.



**TASK 2: Inspecting pressure plate (Fig 2)**

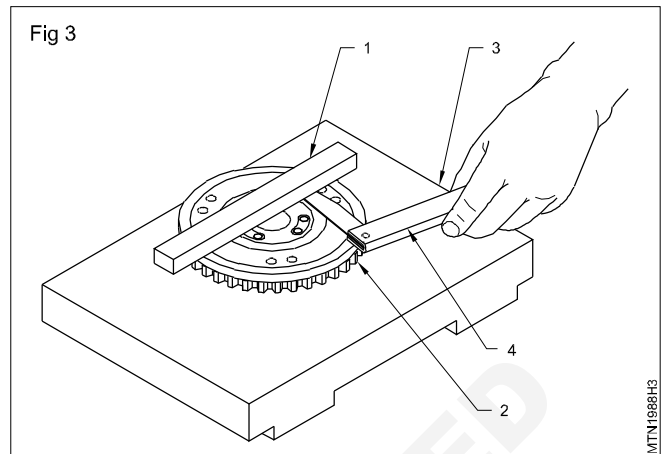
- 1 Clean the surface of pressure plate.
- 2 Visually check the friction face of pressure plate.
- 3 Check the flatness of the friction face of the pressure plate with straight edge and feeler gauge.
- 4 If flatness is not found within the specified limit, then the pressure plate is recommended for resurfacing do not grind below the minimum specified thickness.



### TASK 3: Inspecting fly wheel (Fig 3)

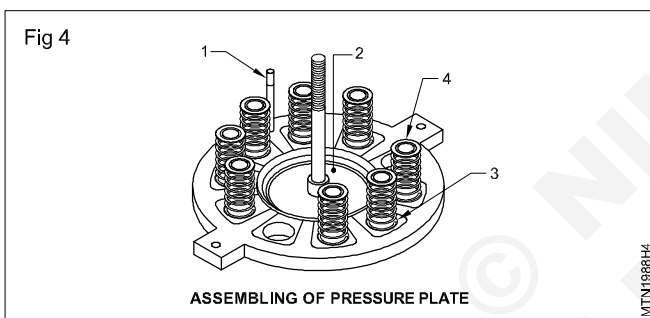
- 1 Check visually the flywheel surface for cracks, burnt and scored face.
- 2 Check for the warpage of the flywheel friction surface by using a straight edge (1) and feeler gauge (4). If the warpage is more than the flywheel should be reground. Check ring gear for worn or damage. Check pilot bearing for its serviceability.
- 3 Mount the flywheel on the crankshaft and keep it on the inspection table.
- 4 Notice down the face out of the flywheel with the help of a dial indicator.
- 5 If the face out of the flywheel is more than the minimum limit specified by the manufacturer than the flywheel should the reground.

- 6 Ensure that, grinding, the thickness of the flywheel remains within the limit specified by the manufacturer.

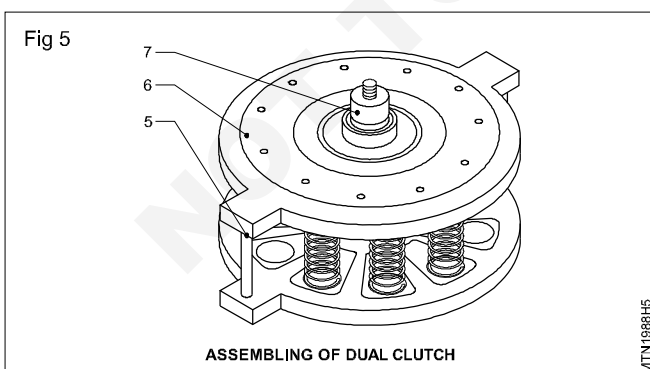


### TASK 4: Assembling clutch

- 1 Place the pressure plate ring of the clutch together with its bolts (1) on the clutch puller cup (2). (Fig 4)

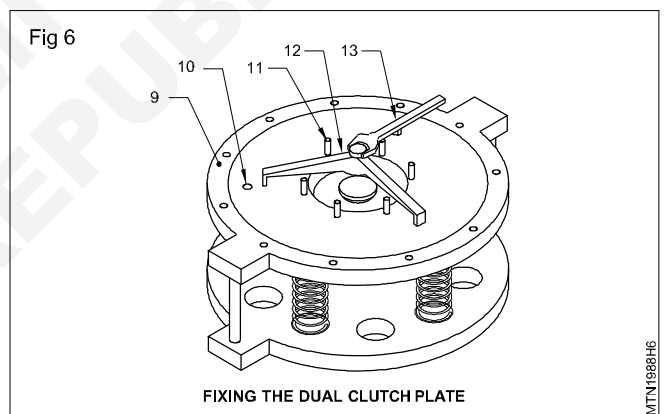


- 2 Place pads (4) clutch springs (3) and again pads into the cavities of the clutch pressure ring.
- 3 Put on the second clutch pressure ring (5) and put on auxiliary drive (PTO shaft drive) friction plate (6) in such a way that the longer side of its hub points towards the engine. (only in case of dual clutch). (Fig 5)



- 4 Insert a centering ring (7) on the bolt of the assembly device and into the hub of friction plate.

- 5 Place the clutch guard (9) fitted with thrust pins (10) and leading pin (11) on the PTO shaft drive friction plate. (Fig 6)



- 6 Slide the tripod (12) on the bolts of the puller and press the pressure ring of the clutch and the clutch guard together by tightening the nut (13) so that the declutching lever bolt are in the holes flush with the thrust and leading pins.
- 7 Slide the disengaging pin into the holes of the clutch guard so that the face of pins rests by the clutch pressure ring.
- 8 Slip on the driving bolts and thrust butteress on the thrust pins.
- 9 Slip the declutching lever and PTO shaft declutching lever (auxiliary drive in case of dual clutch) under the springs and slide on the declutching and driving bolts.
- 10 Then put nosed pad on bolts and tightened uniformly.
- 11 Lock nuts by check nuts.

**Couple the clutch with flywheel and join the engine with gear box**

**Objective:** At the end of this exercise you shall be able to  
 • aligning the clutch assembly with flywheel.

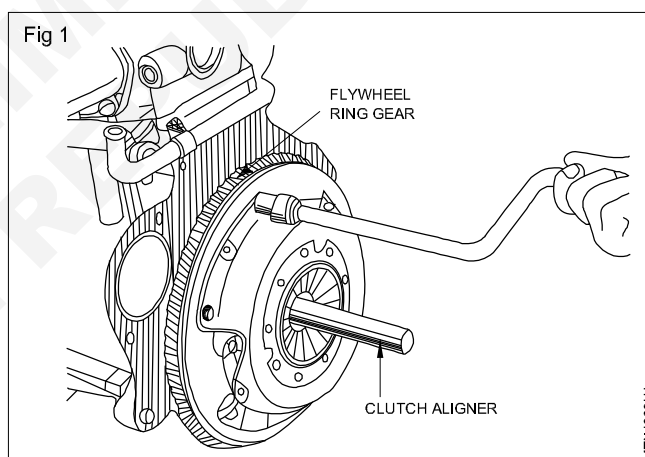
Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Tractor	- 1 No.
• Torque wrench	- 1 No.	<b>Materials/Components</b>	
• Depth gauge	- 1 No.	• Cotton waste	- as reqd.
• Box spanner	- 1 No.	• Soap oil	- as reqd.
• Clutch aligner	- 1 No.	• Paint	- as reqd.

**PROCEDURE**

**TASK 1: Removing and fixing the flywheel**

- 1 Remove the clutch assembly from the flywheel.
- 2 Unlock and unscrew flywheel bolts.
- 3 Pull of the flywheel body from its centering pin.
- 4 Mount the flywheel in reverse order.
- 5 Mounting of the clutch into the flywheel.
- 6 Shift the mandrel (special tool) into the friction plate of the auxiliary drive (PTO shaft drive) in the assembled clutch and slide the tractor drive plate with its longer side of hub pointing towards the engine on the protruding part of the mandrel.
- 7 Shaft the clutch assembly together with the mandrel uniformly into the flywheel body. Ensure that the driving bolts of the clutch fit into recesses of the flywheel body.
- 8 Tighten the clutch guard to the flywheel body.
- 9 Pull out the mandrel, by means of nuts of the disengaging driving bolts, set up the correct position of the declutching levers as per the manufacturer's recommendations.

- 10 Bolts of the disengaging lever should be locked in their adjusted position by check nuts. Ensure that the nosed pads of the driving screws are fitted correctly.



**TASK 2: Joining the tractor engine with gearbox**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1 Check the clutch assembly mounting bolts.</li> <li>2 Check the clutch assembly operation with clutch pedal.</li> <li>3 Aligning the clutch plate with fly wheel and align the gear box with clutch plate.</li> <li>4 Fix the gear box with the tractor engine.</li> </ol> | <ol style="list-style-type: none"> <li>5 Fix the mounting bolts of gear box.</li> <li>6 Tighten the mounting bolts as specified torque.</li> <li>7 Connect all the linkages of clutch and gear box.</li> <li>8 Start the engine and check the performance of clutch and gear operation.</li> </ol> |
|--|--|

**Adjust the clutch pedal free play and dismantle gear box**

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

- adjust the clutch pedal free play.

Requirements			
<b>Tools/Instruments</b>			
• Trainees Tool Kit	- 1 No.	• Trolley jack/ Screw jack	- 2 No.
• Hammer	- 1 No.	<b>Materials/Components</b>	
• Snap plier	- 1 No.	• Tray	- 1 No.
• Special puller	- 1 No.	• Wooden blocks	- as reqd.
• Drift	- 1 No.	• Kerosene oil	- as reqd.
<b>Equipment/Machines</b>		• Cotton waste	- as reqd.
• Tractor	- 1 No.		

**PROCEDURE**

**Adjustment of clutch pedal**

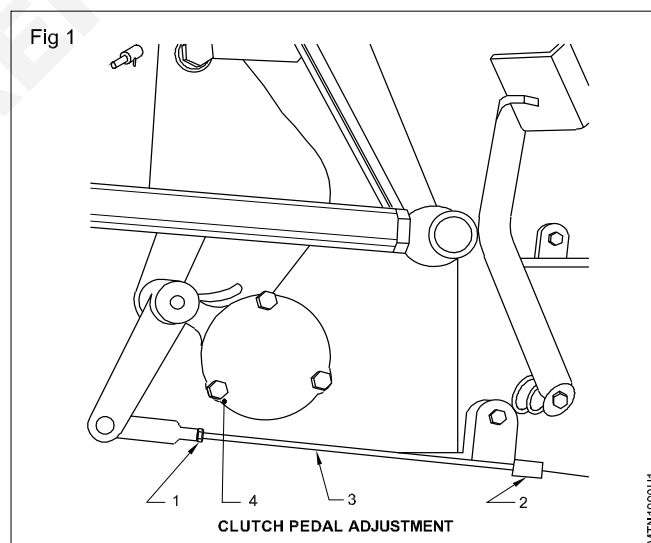
- 1 The maximum clearance between the release bearing and declutching levers must not exceed 4 mm (or as per manufacturer recommendations). This can be checked by depressing the clutch pedal or through inspection plate (4).
- 2 Loosen the lock nut (1) as well as the left hand nut (2) locking the clutch tie rod (3). (Fig 1)
- 3 If it is necessary to decrease the clearance between the release bearing and declutching levers, the clutch tie rod (3) is shortened.

**release bearing is checked by 4 mm thick bar or a feeler gauge inserted by removing the lid on the gear box.**

**Adjustment of the length of the clutch tie rod should be carried out by means of the nut which is welded on the tie rod.**

- 4 After setting correct clearance lock the clutch tie rod by means of locking nuts.

**Distance of the release bearing from declutching levers must be checked from time to time especially when replacing clutch friction plates. The play between the declutching levers and**



**Skill sequence**

**Dismantling and inspection of defective parts of gear box**

**Objectives:** This shall help you to

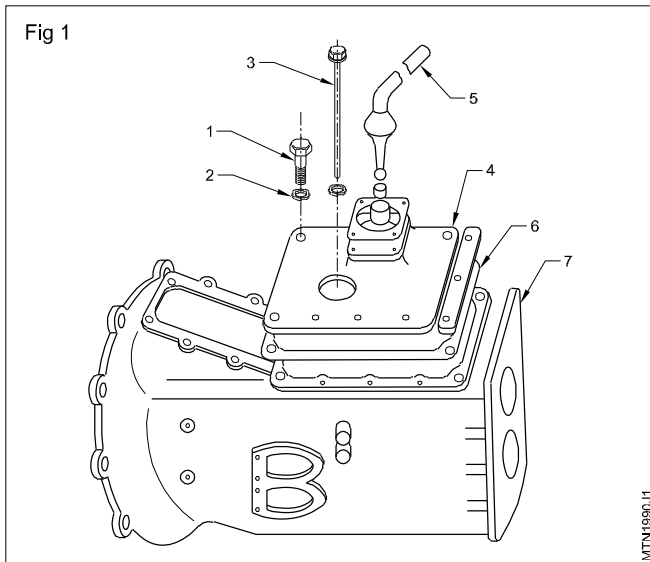
- dismantle the gear box
- inspect all components of the gear box.

Remove clutch shaft from the transmission along with release bearing, hub etc.

Drain the oil from sump of the gear box.

Dismantle top cover of gear box

Open the retaining bolts (1) and spring washers (2) from the cover plate (4). Remove filler hole plug (3). (Fig 1)



Remove the cover plate and levers (5) as one assembly. Simultaneously, disconnect the wires from the starter safety switch, if provided.

Remove housing plate gasket (6).

#### **Dismantle rear end**

Unscrew and remove self-locking bolts securing the rear support plates (7) and lever that support plate assembly to the gear box.

Remove the plate with PTO shaft (8) as an assembly. (Fig 2)

Remove the output shaft assembly (9), secondary counter shaft assembly (10).

#### **Dismantle front end**

Unscrew the self-locking bolts and remove the front support plate along with the release bearing hub support assembly. Remove snap ring and take out main drive input shaft (11) and bearing assembly (2). (Fig 2)

#### **Dismantle main shaft assembly**

Remove the snap ring (7) retaining the main shaft gears (28), (29) with suitable snap plier.

Carefully withdraw the main shaft (9) rearwards removing the thrust washers.

**Taper roller bearing between the gears can be removed with a special puller.**

#### **Reverse idler assembly**

Unscrew the reverse idler shaft (12) retaining bolts.

Push the idler shaft forward/ backward.

With draw the coupling gears 23,24 from the primary counter shaft (10).

Push the reverse idler shaft (12) out and lift out the reverse idler gear (8).

Remove the high low reduction shaft (13). Also remove the hour meter shaft (16) by removing snap ring and support bearing along with gears 20,21.

#### **Main counter shaft**

Place suitable wooden or copper blocks behind cluster gear so that the main counter shaft can be driven out through the rear.

#### **Inspect for worn-out parts**

After dismantling the gear box by removing top cover, rear and front end covers, shifter, front and main shaft assembly, reverse idle assembly and main counter shaft. Clean all the components with kerosene oil.

Check visually the following parts for worn-out, defective etc. and replace the defective parts.

Main shaft (9) and gears (17) and dog teeth. (Fig 2)

Counter shaft (10) and gears.

Drive shaft (11) gear teeth and bearing seats.

Reverse idler gear (18).

Gear casing and bearing seats in the gear case.

Main shaft spline and pilot bearing seats on the main shaft (9).

Bearing (2) of the main shaft counter shaft and pinion shaft.

All bushes.

Sliding dog clutches.

Inspect top cover, gear shift lever ends, all sliding parts and loading dowels for wear and damage.

Install new components, where necessary.

Inspect individual gear and shaft for burrs, chewed up splines, broken teeth and general wear and tear.

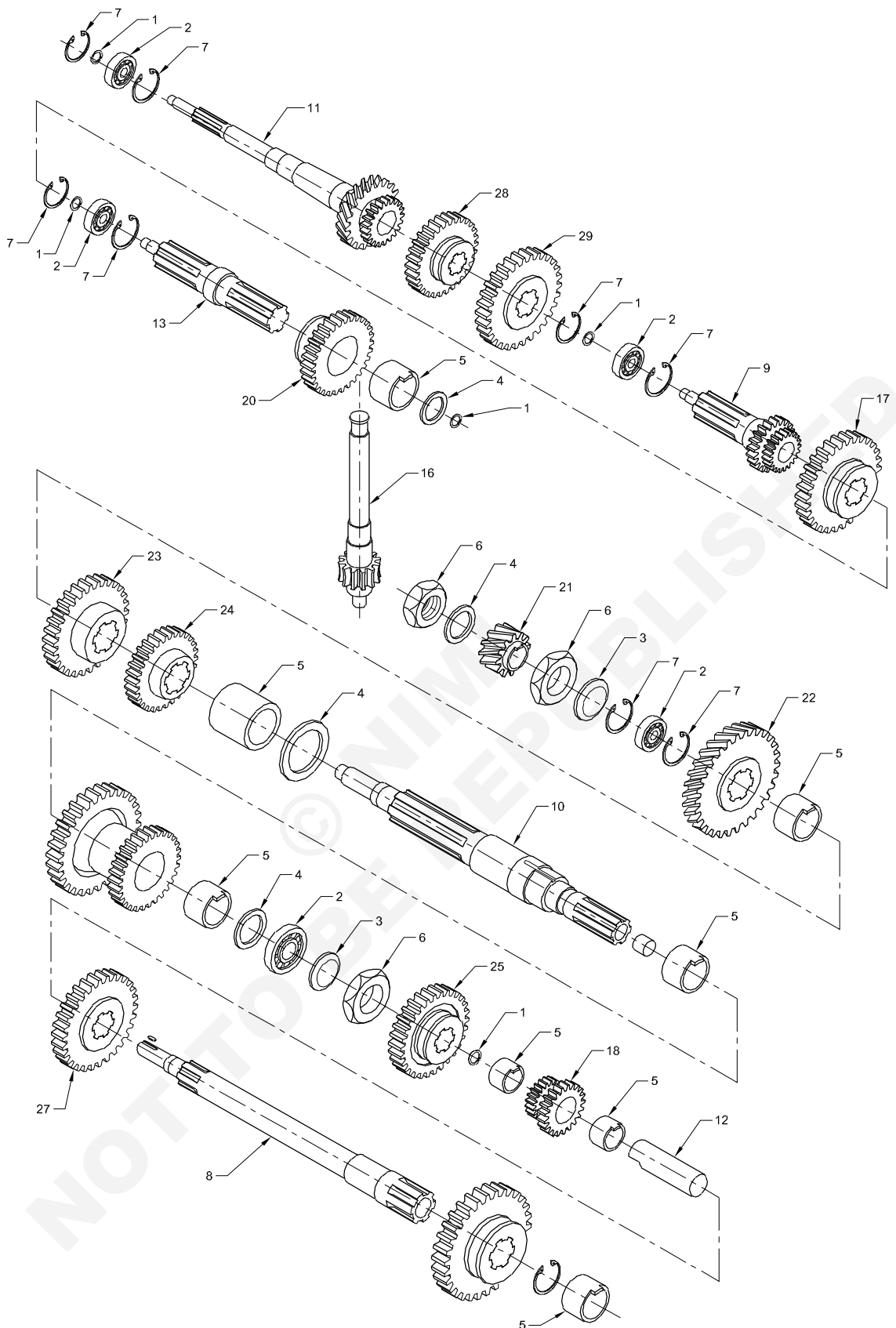
Inspect all circlip for its shape.

Inspect all bearings (19) for wear and tear.

Replace all gasket and seals.



Fig 2



MTN1990J2

**Assemble the gear box**

**Objective:** At the end of this exercise you will be able to  
 • **assemble the gear box.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Hammer	- 1 No.	• Wooden blocks	- as reqd.
• Snapplier	- 1 No.	• Kerosene	- as reqd.
• Special puller	- 1 No.	• Cotton waste	- as reqd.
• Drift	- 1 No.		
<b>Equipment/Machines</b>			
• Tractor	- 1 No.		
• Trolly jack/screw jack	- 1 No.		

**PROCEDURE**

- 1 After inspection of the components all defective parts be replaced with new parts before starting assembling of the gear box.
- 2 Assemble the main gear shaft (9) with gears (17) in the gear box.
- 3 Assemble the counter shaft (10) with gears in the gear box.
- 4 Assemble the main shaft (9) in the gear box.
- 5 Assemble the low or high gear unit (13) in the gear box.
- 6 Assemble PTO shaft (8).
- 7 Connect the wire to the starter safety switch.
- 8 Assemble the shifting mechanism with top cover.
- 9 Removal of end play in output shaft
- 10 It is necessary to eliminate all the end float in the main shaft and output shaft and taper roller bearings by installing suitable shims as explained below:-
- 11 Locate the output shaft retainer assembly in the rear support plate by installing shims.
- 12 Install self- locking bolts and tighten to specified torque.
- 13 Using a standard dial indicator, set the indicator plunger against the end face of output shaft.
- 14 Move the shaft in and out noting the end float reading on the indicator.
- 15 Remove the indicator and four self-locking bolts. Withdraw the retainer and the shim.
- 16 Remove a number of shims, whose total thickness corresponds to the reading obtained on the dial indicator.
- 17 Having selected the correct shim install the retainer, shims and four self -locking bolts and tighten the bolts to the specified torque.
- 18 Reposition the indicator and check for end float.
- 19 While assembling the gear box repeat the above steps in never reorder.

**The total thickness of shims removed can be up to .002" more than the reading on the indicator but must not be less than the reading obtained. Shims for this purpose are a valuable in the thickness of .003", .005" and .012".**

**Overhauling transfer case (Gear box) and auxiliary gear box**

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

- remove the transfer case from the vehicle
- dismantle the transfer case
- inspect the parts of the transfer case
- assemble the transfer case.

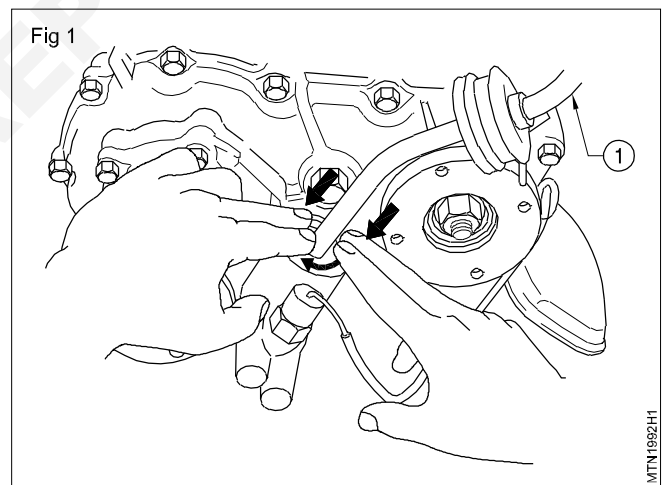
Requirements		
<b>Tools/Instruments</b>		<b>Materials/Components</b>
• Trainees Tool Kit	- 1 No.	• Tray
• Mallet	- 1 No.	• Wooden blocks
• Circlip plier	- 1 No.	• Kerosene oil
<b>Equipment/Machines</b>		• Cotton waste
• Tractor	- 1 No.	- 1 No.
• Trolley jack/ Screw jack	- 1 No.	- as reqd.
		- as reqd.
		- as reqd.

**PROCEDURE**

**TASK 1: Removing transfer case / auxiliary gear box**

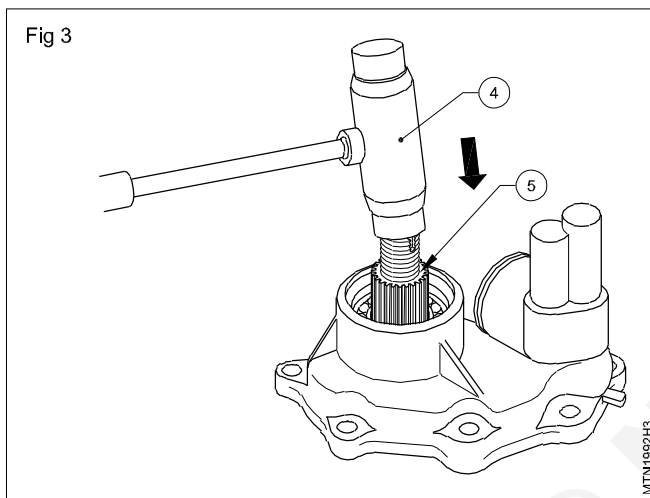
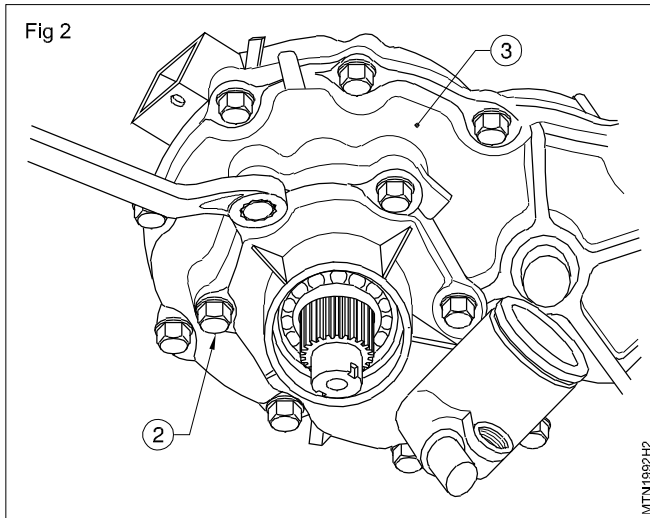
- 1 Jack up the vehicle and put the rear axle on horses.
- 2 Remove the securing bolts of the universal joint and disconnect the propeller shaft from the transfer case (gearbox).
- 3 Remove the clamp and dust boot from the transfer gearbox.
- 4 Remove the control lever (1) by twisting the control lever guide in the counter-clockwise direction and pushing it down. (Fig 1)
- 5 Drain out the oil from the transfer gearbox.
- 6 Disconnect the speedometer drive cable.
- 7 Disconnect the parking brake lever and cable.
- 8 Remove the bolts fastening transfer gear box to main gear box.
- 9 Remove the mounting nuts of the transfer gearbox to the chassis.

10 Bring down the transfer gearbox.

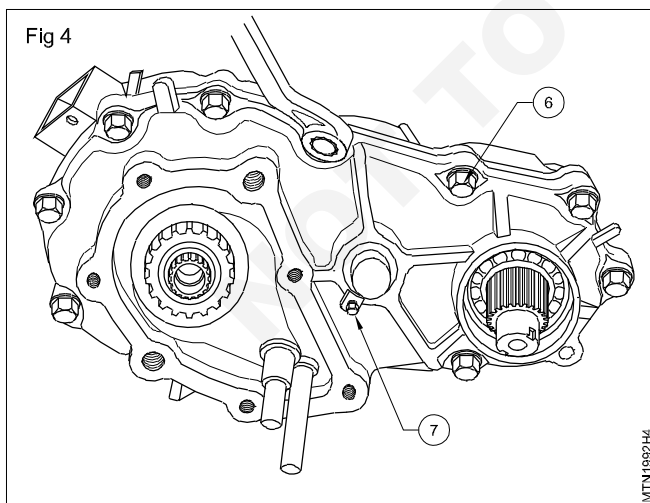


**TASK 2: Dismantling the transfer case**

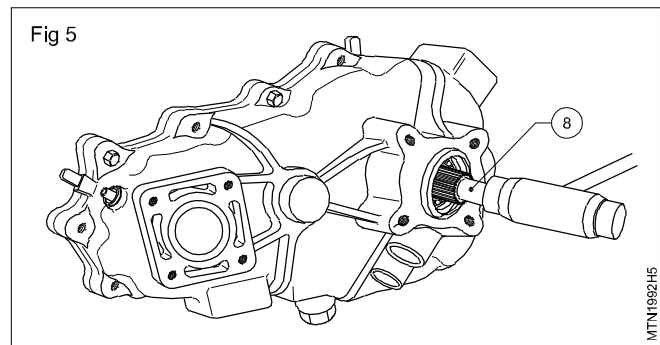
- 1 Remove two flanges of the input shaft and the output shaft.
- 2 Remove the brake drum (if provided along with the transfer case).
- 3 Remove the brake shoes.
- 4 Remove the back plate bolts and take out the back plate assembly.
- 5 Remove the speedometer driven gear case with the gear.
- 6 Remove the indicator light switch.
- 7 Remove the transfer case front bolts (2) and take out the front case (3). (Fig 2)
- 8 By tapping with a plastic hammer (4) remove the front output shaft (5) from the front case. (Fig 3)



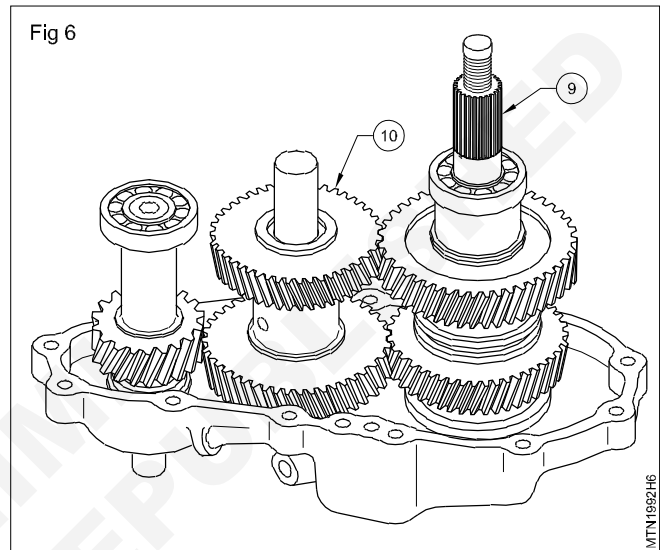
- 9 Remove the front case oil seal.
- 10 Remove the circlip.
- 11 Drive out the front case bearing.
- 12 Remove the bolts (6) fastening the centre and rear cases. Do not loosen the bolt (7). (Fig 4)



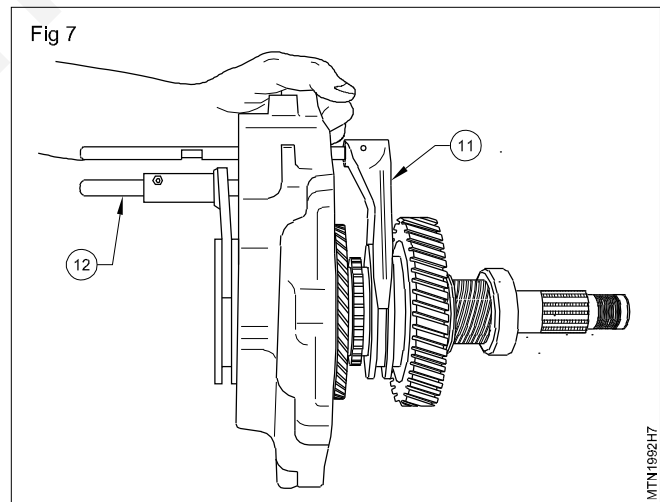
- 13 By tapping the rear output shaft (8) with a plastic hammer, separate the centre and rear cases. (Fig 5)
- 14 Loosen the gear shifting spring plug and take out the spring and the locating ball.



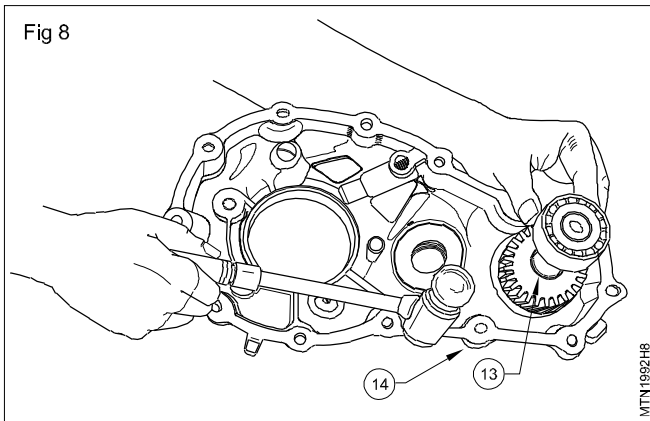
- 15 Remove the spring pins from the front drive shaft (9) and reduction shaft (10). (Fig 6 indicates the position after the removal of the spring pins.)



- 16 Remove the fork (11) and the gear shifting rails (12) with the ball springs. (Fig 7)



- 17 Remove the output rear shaft from the centre case by tapping it with a plastic hammer.
- 18 Remove the counter-gear bearings and spacer.
- 19 Loosen the countershaft lock-plate bolt.
- 20 Remove the countershaft from the centre case.
- 21 Remove the input shaft (13) from the centre case by hammering out the thick part of the case (14) or input shaft centre, using a plastic hammer. (Fig 8)



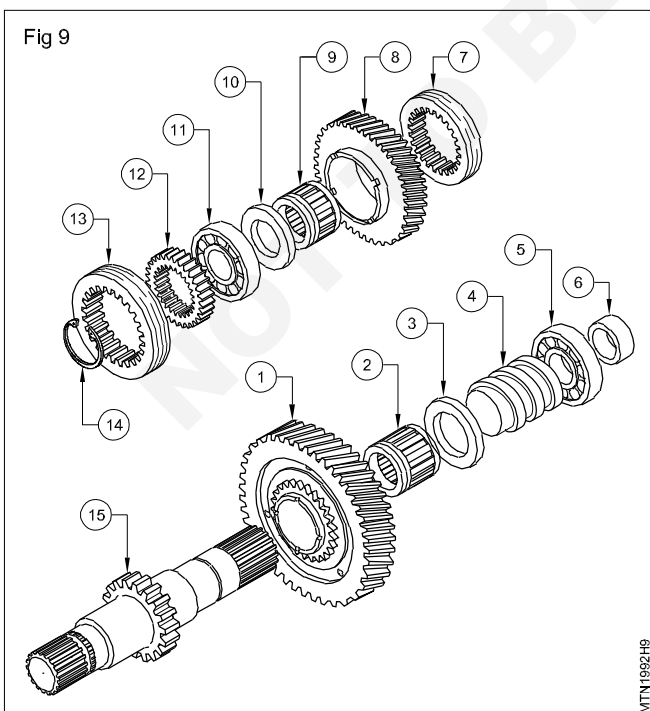
- 22 Remove the front bearing from the centre case.
- 23 Remove the front bearing oil seal and circlip.
- 24 When the centre case and rear case are separated, the input shaft may be left in the rear case. In this case remove the input shaft from the rear case by hammering the thicker part of the case.

### TASK 3: Cleaning and inspection

- 1 inspect the gear teeth for wear, crack and damage.
- 2 Inspect the rear clutch sleeve for wear, crack and damage.
- 3 Inspect the clutch teeth for wear, crack and damage.
- 4 Replace the gear or sleeve, if necessary.
- 5 Check the shifting fork for wear and damage.
- 6 Check the locating ball spring for tension.
- 7 Check the gear shifting rails (12) for wear and damage.
- 8 Inspect the gear shift locating ball for wear and damage. Replace if necessary.
- 9 Check each bearing by spinning its outer race by hand to 'feel' the smoothness of rotation. Holding the inner race firmly, check for wear of the bearing by moving the outer race radially for wear.
- 10 If the sound of the bearing is abnormal or if the bearing is stuck, replace the bearing.
- 11 Check the lower end of the gear shift lever for wear and damage; replace the worn out or damaged shift lever.

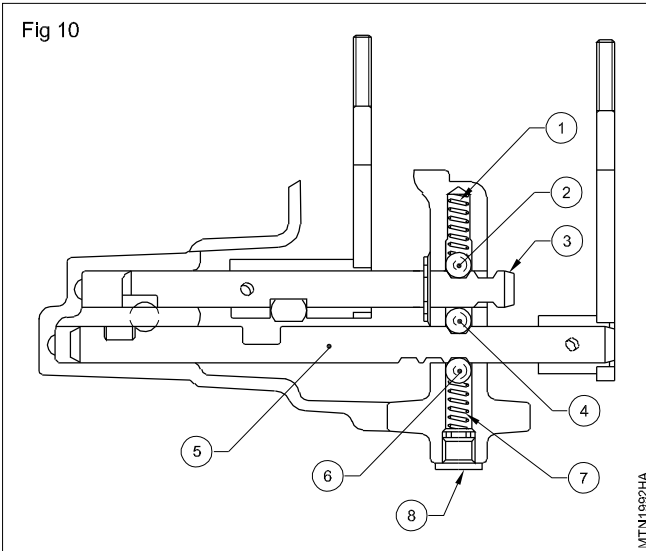
### TASK 4: Assembling

- 1 Press the bearings on both the sides of the input shaft.
- 2 Install the output low gear (1), bearing short (2), thrust washer (3), speedometer drive gear (4), bearing (5) and the retainer (6) on the output rear shaft. (15) (Fig 9)
- 3 Install the sleeve (7) output high gear (8), bearing (9), thrust washer (10), bearing (11), sleeve (12) and sleeve (13) on the other side of the output shaft. (15)
- 4 Fix the circlip (14).



- 5 Fit the oil seal in the rear case.
- 6 Fit the countershaft thrust washer in the rear case.
- 7 Fit the input shaft front bearing and oil seal in the centre case.
- 8 Fit the input shaft in the centre case.
- 9 Fit the countershaft in the centre case and fit the bolt and lock-plate.
- 10 Apply grease on the countershaft thrust washer and fit it in the centre case.
- 11 Fit the needle roller bearings, spacer and counter-gear on the countershaft.
- 12 Fit the outer shaft assembly on the centre case.
- 13 Install the spring (1), ball (2), shaft (3), ball (4), shaft (5), ball (6), spring (7) and plug (8) in the centre case. (Fig 10)
- 14 Fit the forks on the gear shift shafts and lock with spring pins.
- 15 Check the dowel pins on the centre case.

Fig 10



- 16 Place the gasket on the centre case.
- 17 Fit the centre case and rear case together and tighten, securing the bolts at the specified torque.
- 18 Fit the bearing circlip and oil seal to the front case.

- 19 Fit the output front shaft.
- 20 Check the dowel pins between the front case and the centre case.
- 21 Fit the front case on the centre case.
- 22 Fit the speedometer drive gear and its case in the rear case.
- 23 Fill up gear oil of recommended grade into the transfer case.
- 24 Fit the back plate on the rear case.
- 25 Fit the brake drum.
- 26 Fit the brake shoes.
- 27 Fit the transfer case on the vehicle.
- 28 Connect the speedometer cable.
- 29 Fit the control lever.
- 30 Connect the front and rear propeller shafts flanges and tighten nuts to specified torque.
- 31 Operate the shift lever and test transfer case gearbox for proper functioning.

**Overhauling differential assembly and final drive**

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

- remove differential housing from rear axle assembly
- inspect the differential unit
- assemble the differential unit
- adjust pre-loading & backlash adjustment for the bevel & pinions.

**Requirements**

**Tools/Instruments**

- Trainees Tool Kit - 1 No.
- Dial test indicator - 1 No.
- horse stand - 2 Nos.

**Equipment/Machines**

- Line axle assembly - 1 No.
- Work bench - 1 No.

- Tray - 1 No.

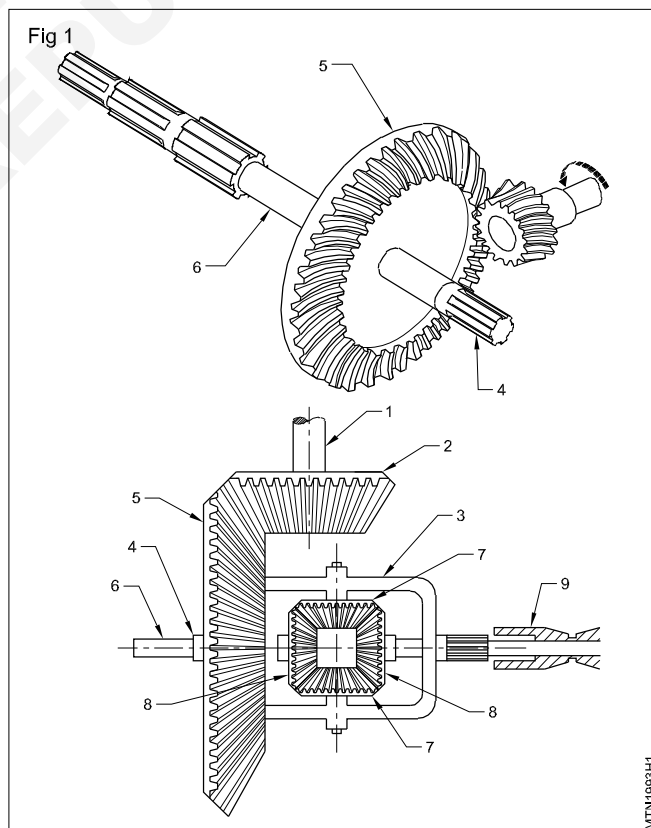
**Materials/Components**

- Cotton waste - 1 No.
- Soap oil - as reqd.
- Cleaning solvent - as reqd.
- Grease - as reqd.

**PROCEDURE**

**TASK 1: Removal of final drive**

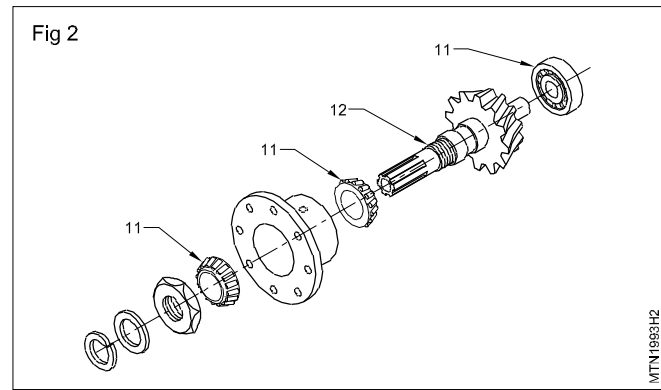
- 1 Remove all the necessary linkages components etc. Care should be taken to disconnect all the links, leverages & forks etc. attached to the rear axles.
- 2 Jack up the tractor at the differential housing with front wheel blocked.
- 3 Remove the rear wheels.
- 4 Unscrew the bear axle flange bolts connected to the main or differential housing.
- 5 Remove the rear axle housing.
- 6 Pull out both the half axles (6).
- 7 Removal of differential assembly.
- 8 Hold the differential lock (9) so that pinion shaft does not rotate.
- 9 Unbolt the bearing housing (4) from differential housing. (Fig 1)
- 10 Remove differential unit with a suitable bar from the differential housing.
- 11 Remove differential cage (3) halves to assist proper disassembly.
- 12 Open the differential cage by unscrewing the Nuts holding the halves. Mark the two halves to assist during reassembly.
- 13 Take out differential sun gears (8), planetary gear (7) along with spider cross.



14 Remove the bevel pinion assembly (2) which is mounted on the differential assembly.

## TASK 2: Inspection

- 1 Remove the bevel pinion (12) and three cup and cone (11) bearing along with all parts of final drive. (Fig 2)
- 2 Clean all the parts.
- 3 Check all the parts for cracks, breakage
- 4 Inspect bevel pinion and slide gear for wear, chipping, pits, peeling and corrosion on the teeth.
- 5 Check all the bearing for free rotation.
- 6 Replace defective, broken or cracked components.



---

## TASK 3: Re-assembling

- 1 The assembling procedure is exactly reverse of disassembly procedure i.e. assemble the subassemblies of differential and bevel pinion.
- 2 Install sub assembly in the differential housing.

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## TASK 4: Adjustments

### a Preloading of final drive bevel pinion

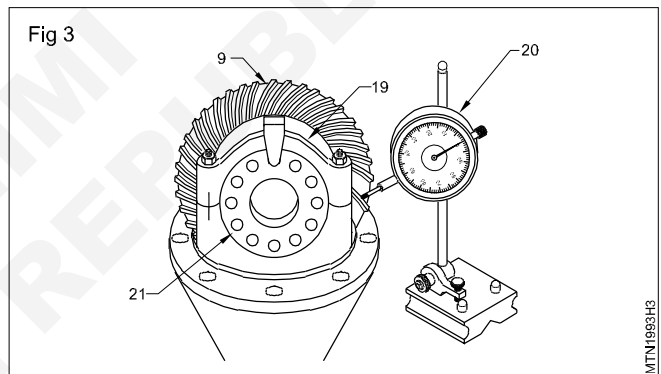
- 1 On some makes of tractor (HMT/Mahindra) shims are added/removed till the pinion shaft revolves without binding. The correct axial clearance amount to between .075 and 0.125 mm.
- 2 Other makes of tractors, Viz., Ford, Massey ferguson and Escort, have a nut system of pre-loading for the bevel pinion shaft. After installing the bevel pinion shaft in its housing, the unit is clamped on the vice and a cord. The scale is pulled while tightening the adjusting nut to get the desired pre-load. The pull range between 7 and 9 kg on the scale.

### b Pre-loading of differential bearing

- 1 On some tractors shims are located between differential bearing housing and sides of differential housing while on few others (HMT, ESCORT 355) nuts are provided on both sides to pre-load. Preloading can be done with the help of these provisions so that the bearing rotate freely.

### c Backlash and tooth contact

- 1 Shims or adjusting nuts used for preloading are also used for adjusting backlash and tooth contact. (Fig 3)
- 2 In order to check tooth contact, cover several teeth of the crown wheel with a paint and revolve it. As it revolves, the impression on the bevel pinion can easily be observed on the crown wheel teeth.



- 3 Tooth contact covering approximately 70 % of tooth links and leaving a uniform impression (normally rectangle) in the centre of the teeth is the most proper situation, otherwise move the gear such a way so as to achieve the above mentioned contact area.
- 4 Backlash is measured by a dial gauge. The bevel pinion is held stationary and the crown wheel moved within the limits of backlash. The dial gauge is applied to the face close to crown wheel outer periphery indicates the backlash.
- 5 Normally this value is measured at several points on the crown wheel. Difference between minimum and maximum back lash should not exceed 0.1 mm.



**Overhauling rear axle drive shaft assembly**

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

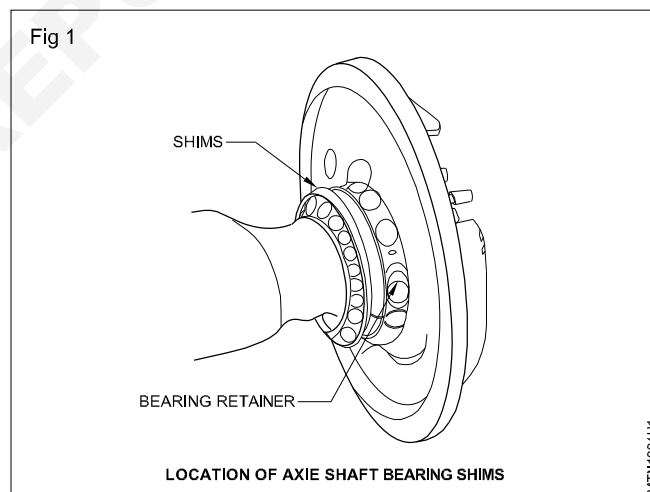
- **dismantle the rear axle shaft assembly**
- **inspect the rear axle components**
- **assemble the rear axle unit**
- **preload the rear axle shaft bearing/ slip clutch**
- **servicing of reduction gear.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Tractor	- 1 No.
• Hammer	- 1 No.	• Trolley jack/ Screw jack	- 1 No.
• Snap	- 1 No.		
• Wrench	- 1 No.	<b>Materials/Components</b>	
• Dial Gauge with stand	- 1 No.	• Tray	- 1 No.
• Chisel	- 1 No.	• Grease	- as reqd.
		• Cotton waste	- as reqd.

**PROCEDURE**

**TASK 1: dismantle the rear axle shaft assembly**

- 1 Remove the wheels and fenders.
- 2 Disconnect electrical wiring
- 3 Disconnect brake linkage.
- 4 Drain oil from the rear axle centre housing.
- 5 Put suitable jack under rear axle.
- 6 Remove the brake drum after loosening the brake adjuster if provided.
- 7 Remove the securing nuts and bearing retainer to the axle shaft housing.
- 8 Remove axle shaft bearing retainers, brake shoes, back plate and brake cam shaft. (As assembly)
- 9 Support the axle to prevent damage to axle housing oil seal. Place the assembly in vertical position on a wooden block to protect axle stud thread.
- 10 Remove the shims (1) from the bearing retainer and identify for easy reassembly purposes. Detach the brake camshaft. (Fig 1)
- 11 Remove the nut retaining the axle shaft using special wrench.



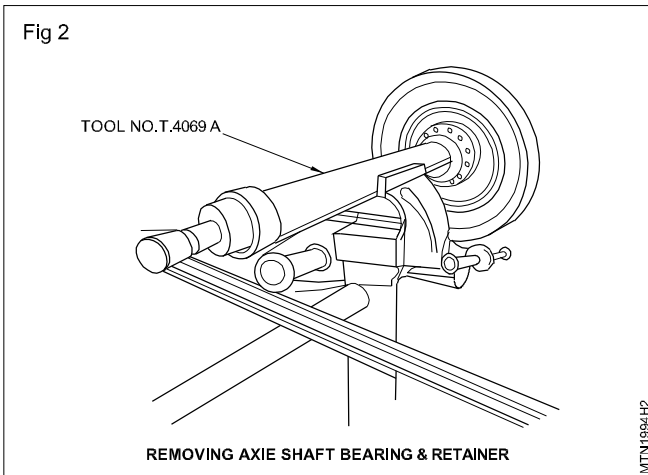
- 12 Remove the bearing retainer (Fig 1), brake assembly and the bearing from the axle shaft using special tool. The bearing spacers may then be removed from the axle shaft and the bearing cone from the retainer.
- 13 Using special tool removes the cup from its location in the retainer.
- 14 The axle shaft oil seal may be removed without removing the bearing cup using special tool.

**TASK 2: Inspection**

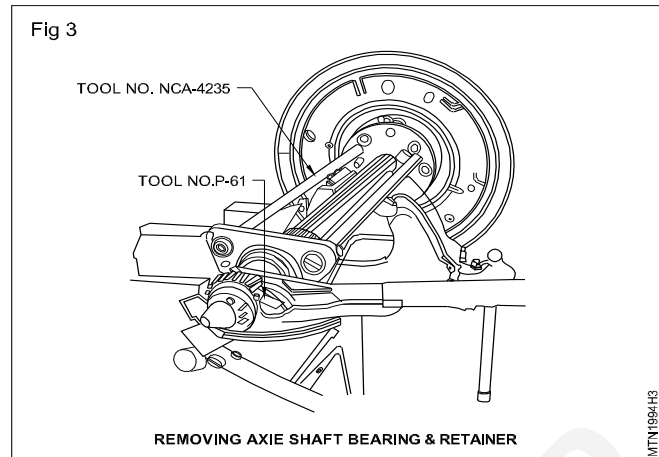
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|--|---|
| <ol style="list-style-type: none"> <li>1 Clean and inspect all parts and install new parts where worn or damaged.</li> </ol> | <ol style="list-style-type: none"> <li>2 New axle housing seal should be replaced if necessary using special tool.</li> </ol> |
|--|---|

### TASK 3: Assembly

- 1 If removed, install the bearing cup and a new seal in the retainer.
- 2 Install the new seal with lip inward using a suitable sleeve of three inches outer dia.
- 3 Place the axle shaft vertical on a block of wood to prevent damage to studs and fit the bearings spacer with the tapered inside edge downwards over the shaft. (Fig 2)



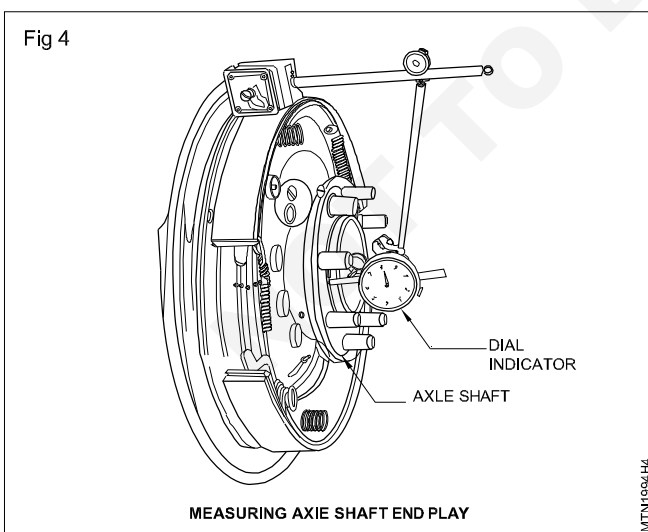
- 4 Install the brake back plate and bearing retainer over the axle shaft and pack the retainer with grease. Install the brake cam shaft. (Fig 3)



- 5 Use a special tool to drive the bearing into the axle shaft.
- 6 Tighten the nut onto the shaft with a special torque wrench.
- 7 Install the shims that were removed from the retainer assembly. Place the assembly into the rear axle housing at the same time locating the brake cam shaft in its support bushing. Be careful not to damage the axle housing seal during installation of assembly.
- 8 It will be necessary at this stage to check the axle shaft bearing preload.

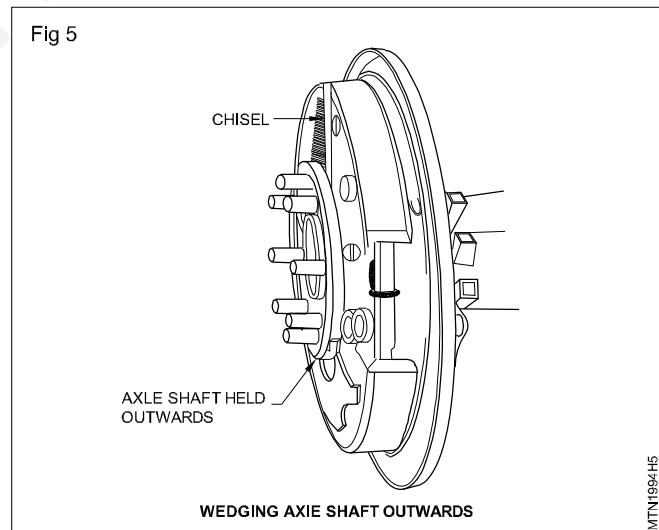
### TASK 4: Checking axle shaft bearing preload

- 1 Using a chisel or similar tool hold axle securely outwards so that the cone and roller is fully seated in its cup. (Fig 4) Place a dial indicator on the opposite brake back plate. Pull out the opposite axle (Axle on which the indicator is set) to be sure, the cone and roller assembly is seated.



- 2 Adjust the indicator gauge to zero and push the axle inward. (Fig 5) The reading taken on the indicator should be between .004" to .012" if the end play is not within prescribed limits, remove shims to decrease the end

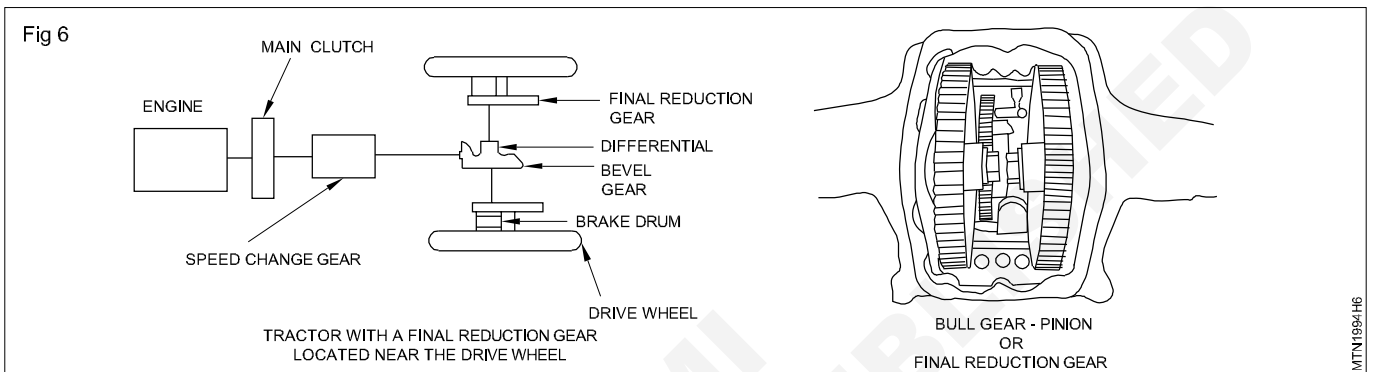
play when the proper end play has been obtained, tighten the retainer to specified torque.



- 3 Clean the brake lining and fit the brake drum if the brake adjuster has been loosened the brake will need to be adjusted.
- 4 Install wheel and fender, connect brake linkage and electrical wiring and refill the rear centre housing with oil of proper grade. Complete the rear portion.

### TASK 5: Servicing of reduction gear (Fig 6)

- 1 Remove the oil from the final drive reduction gear box.
- 2 Jack up the vehicle.
- 3 Remove the wheels.
- 4 Remove the brake drum.
- 5 Remove the wheel bearing and brake shoes.
- 6 Remove the black plate.
- 7 Dismount the reduction gear box housing.
- 8 Remove the reduction gear and axle half shaft.
- 9 Clean the dismantled parts.
- 10 Inspect the dismantled parts for wear and damage.
- 11 If found any damage replace the parts.
- 12 Fit the half shaft with drive gear.
- 13 Fit the reduction gear box housing.
- 14 Fit the black plate and break shoes.
- 15 Fit the wheel bearing and oil retainer.
- 16 Fit the brake drum and mount the wheels.
- 17 Tighten the wheel nut and test drive the tractor.



**Servicing of the P.T.O. shaft and speed of belt pulley**

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

- dismantling of P.TO (power take off)
- cleaning and Inspecting the power take off shaft
- assembling the power take off shaft
- Removing output shaft.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Jack	- 1 No.	• Gear oil	- as reqd.
• Circlip plier	- 1 No.	• Kerosene	- as reqd.
• Puller	- 1 No.	• Cotton waste	- as reqd.
<b>Equipment/Machines</b>		• Grease	- as reqd.
• Tractor	- 1 No.	• PTO shaft	- 1 No.
• Trolley jack/ Screw jack	- 1 No.		

**PROCEDURE**

**TASK 1: Dismantling**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1 Drain the gear box oil. Remove the bottom side cover of the gear box (Fig 1).</li> <li>2 Remove the protecting guard (1) of the P.T.O shaft (2). (Fig 1) Remove the P.T.O shaft bracket cover (3).</li> <li>3 Shift the P.T.O shaft drive lever (4) upwards so that the gear (9) of the Hydraulic Power lift is in disengagement and remove circlip lock (6).</li> </ol> | <ol style="list-style-type: none"> <li>4 Slide off the P.T.O shaft (2) from the gear box and the main transmission housing by means of the puller together with the ball bearing (5).</li> <li>5 Then the P.T.O shaft (2) is slide out from the ball bearing after removing circlip (8). Take out PTO shaft (2).</li> </ol> |
|---|---|

**TASK 2: Cleaning and inspecting the parts**

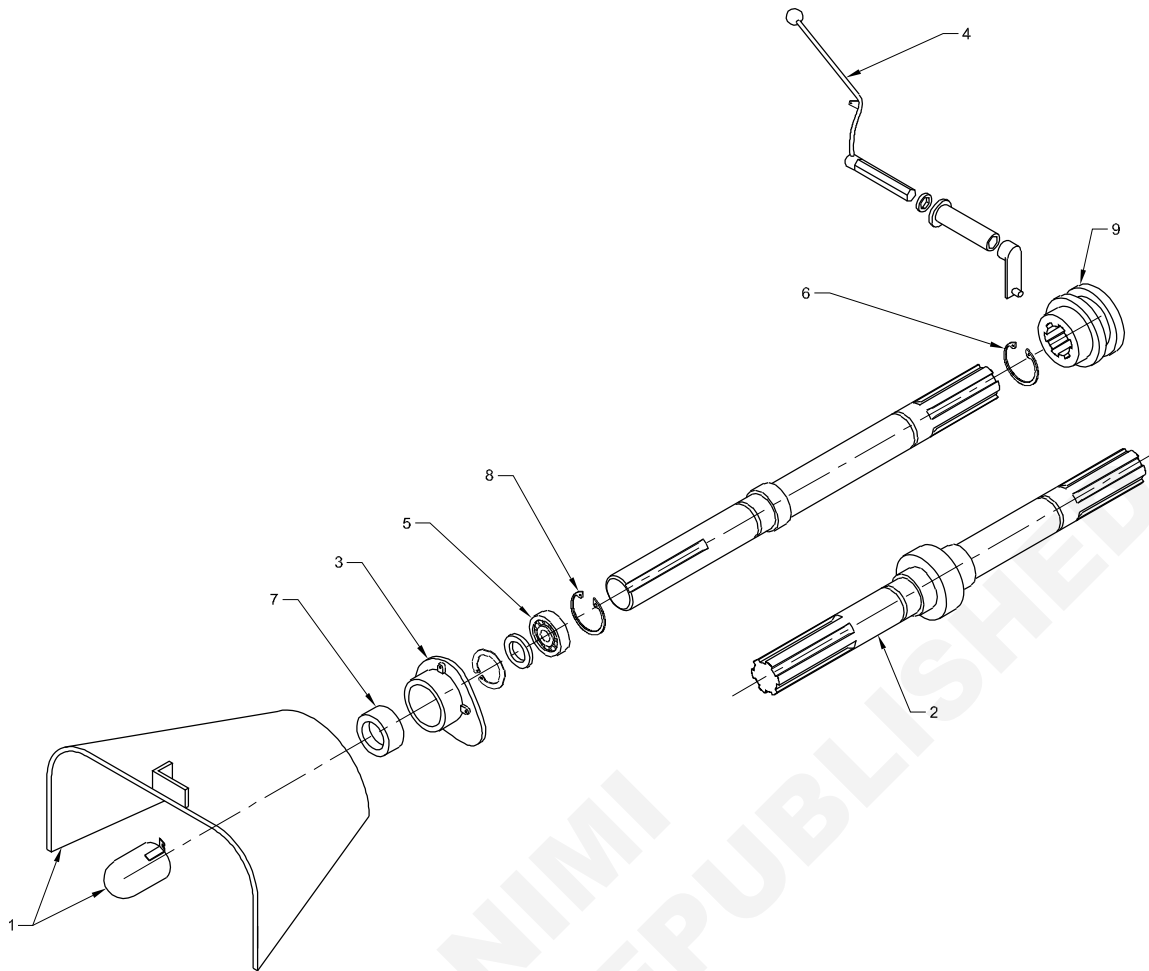
- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1 Clean all the parts with kerosene oil.</li> <li>2 Inspect the bearing for excessive play, pits, rust or breakage.</li> </ol> | <ol style="list-style-type: none"> <li>3 Check the shaft splines for proper fitting, wear and twisted spline.</li> <li>4 Check the lever and the gear of P.T.O shaft for any damage.</li> </ol> |
|---|---|

**TASK 3: Assembly**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Press the bearing (5) on the P.T.O shaft (2) and lock it with a circlip (8).</li> <li>2 Slide the P.T.O shaft (2) into the housing of and slip into the grooves of differential of the P.T.O shaft the binder drive gear.</li> </ol> | <ol style="list-style-type: none"> <li>3 Knock home the P.T.O shaft by slight tapping so that the bearing fits at the circlip in the rear wall of the housing.</li> <li>4 Put a paper sealing under the bracket cover and fix the bracket cover on gear box/differential.</li> <li>5 Put the PTO shaft guard cover. Fix the bottom/side cover and refill the oil.</li> </ol> |
|---|--|

**Before sliding the P.T.O shaft into grooves of the binder drive gear, remove the front bottom side cover from the gear box and through this hole hold the binder driving gear in position to allow correct fitting.**

Fig 1



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#### TASK 4: Measuring rpm of PTO shaft

- 1 Tractor PTO drive shaft torque and power monitoring system monitor the torque, shaft speed and transmitted power accurately.
- 2 PTO Shaft rotate in proportion to the speed of the tractor engine.
- 3 Power rating (mim) measure power 135HP or 101 kw at 540 rpm.
- 4 Measure power 253 HP 188 kw at 100 rpm.
- 5 We can measure contact method and non contact digital out put directly proportional to torque.

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#### TASK 5: Measure the speed of belt pulley

- 1 Speed of belt pulley is depending upon drive pulley diameter
- 2 Pulley system entail two pulley wheels on a shaft jointed by a belt
- 3 The drive pulley drives the driven pulley
- 4 Driven pulley speed is depending upon the drive pulley wheel dia and drive belt tension.
- 5 To increase the speed of driven pulley, we need to change the drive pulley diameter (size)

**Note : it small pulley drive the big driven pulley the speed is reduced and big pulley drive the small driven pulley, the speed is increased.**

**Checking and repair a mechanical steering system**

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

- remove the drop arm
- check and adjust the turning angle
- align the steering wheel with the front wheel
- clean and inspect the dismantled steering linkages
- repair/replace the damaged / workout parts
- assemble and test the steering.

Requirements			
<b>Tools/Instruments</b>			
• Trainees Tool Kit	- 1 No.	• Trolley Jack/ Screw Jack	- 1 No.
• Hammer	- 1 No.	<b>Materials/Components</b>	
• Puller	- 1 No.	• Tray	- 1 No.
• Wrench	- 1 No.	• Grease	- as reqd.
<b>Equipment/Machines</b>		• Kerosene oil	- as reqd.
• Tractor	- 1 No.	• Cotton waste	- as reqd.

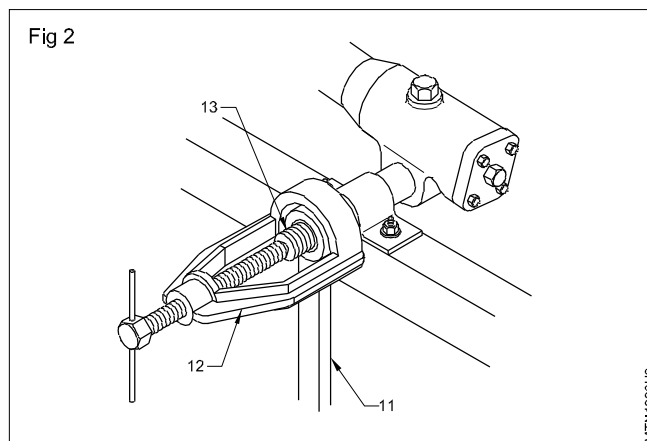
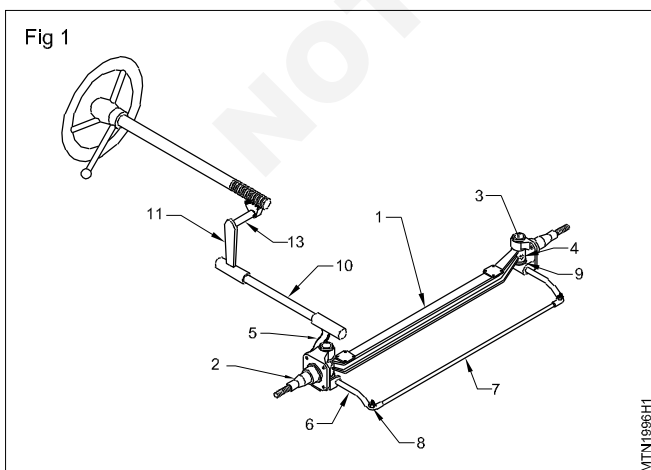
**PROCEDURE**

**TASK 1: Checking of steering linkages**

- |   |                                    |
|---|------------------------------------|
| 1 Check the steering wheel.               | 5 Check the steering arm.          |
| 2 Check the steering column bush bearing. | 6 Check the tie rod end.           |
| 3 Check the steering gear box and drop.   | 7 Check the drag link nut.         |
| 4 Check the pull and push rod.            | 8 Check the steering rocker shaft. |

**TASK 2: Remove the drop arm**

- |   |  |
|---|--|
| 1 Check the front wheels. Jack up the vehicle and place horses under the front axle. Remove the front wheels. | 3 Give support underneath the steering arm.  |
| 2 Remove the split pin and loosen the nut of the steering arm (6) at both the ends. (Fig 1)                   | 4 By using a special tool or wooden block and hammer, hit the nut (without damaging the threads) and remove the ball joints from the tie rod ends (8) and remove the tie rod (7) |



- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>5 Loosen the drag link (10) nut connected to the steering arm (5) and remove the same.</li> <li>6 Loosen the drag link (10) nut from the drop arm (11) on the lower side and take out the drag link (10)</li> <li>7 Mark the position of the drop arm (11) with respect to the steering rocker shaft (13). This mark should be aligned while refitting the drop arm (11) on the steering rocker shaft. (13). (Fig 2)</li> </ul> | <ul style="list-style-type: none"> <li>8 Remove the drop arm's (11) nut on the top.</li> <li>9 Pull out the drop arm (11) from the steering rocker shaft (13) Use a special puller (12)</li> </ul> |
|--|--|

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**TASK 3: Inspect the steering linkages and do a necessary repair**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>1 Clean the dismantled parts of the tractor steering</li> <li>2 Inspect the cleaned steering linkages for damages/workout parts</li> </ul> | <ul style="list-style-type: none"> <li>3 Select the new parts for replace damaged/workout parts of steering linkages.</li> <li>4 If found any bend/crack on the steering linkages, repair it as original shape.</li> </ul> |
|---|--|

— — — — —

**TASK 4: Assembly**

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>1 Bring both the front wheel brake drums in straight ahead and parallel position.</li> <li>2 Turn the steering wheel to the opposite side lock and count the total number of revolutions.</li> <li>3 Turn the steering wheel half of that number</li> <li>4 Align the mark of the drop arm (11) and rocker shaft of the steering box and fix the drop arm on the rocker shaft</li> <li>5 Tighten the drop arm's (11) lock nut</li> <li>6 Connect the drop arm (11) and drag link (10). Ensure the steering wheel does not rotate while connecting the drop arm and drag link.</li> <li>7 Fix the other end of the drag link (10) connected to the steering arm (drive side) (5) and tighten the nut. Ensure that the front wheels and steering wheel do not change their position while connecting the drag link (10) and steering arm (6).</li> </ul> | <ul style="list-style-type: none"> <li>8 Connect tie rod's (7) ends to both the steering arms (6).</li> <li>9 Lubricate all the parts with the recommended grease and tighten all ball pin nuts at the recommended torque and replace with new split pins.</li> <li>10 Fix the wheels and tighten the wheel nuts.</li> <li>11 Check the wheel movement by rotating the steering wheel.</li> <li>12 Jack up the vehicle and remove the horses.</li> <li>13 Release the jack and tighten the wheel nuts. Jack up the vehicle and remove the horses.</li> <li>14 Release the jack and tighten the wheel nuts.</li> </ul> |
|---|---|

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**Overhauling steering gear box - Worm and roller type**

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

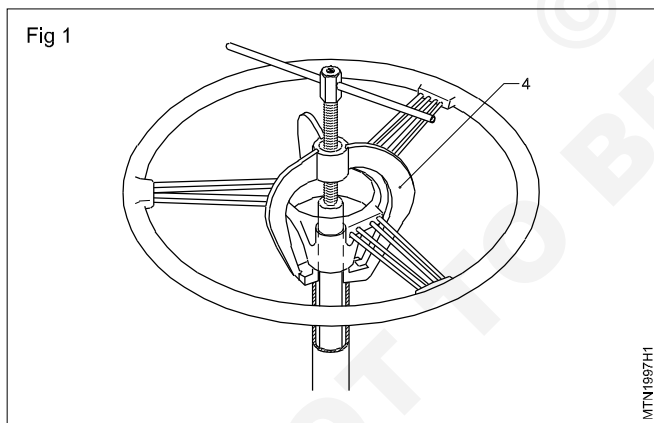
- remove the steering assemble from the vehicle
- dismantle the steering gear box
- inspect the parts of the steering gear box
- assemble the steering gear box.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• V-Block	- 1 No.	• Steering oil	- as reqd.
• Puller	- 1 No.	• Kerosene oil	- as reqd.
• Torque Wrench	- 1 No.	• Cotton waste	- as reqd.
• Dial Gauge	- 1 No.		
<b>Equipment/Machines</b>			
• Tractor	- 1 No.		

**PROCEDURE**

**TASK 1: Removal of steering assemble**

- 1 Disconnect the battery.
- 2 Check the steering wheels (Fig 1).
- 3 Remove the bottom shield of the steering assembly.



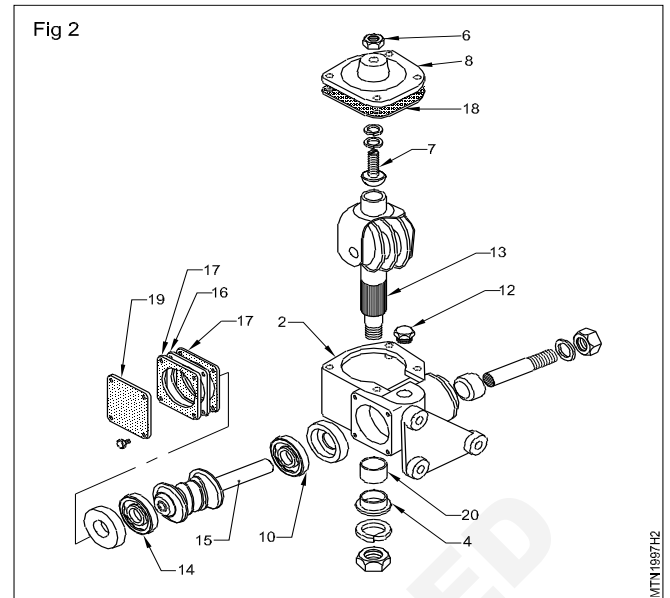
- 4 Disconnect the horn button and horn wire at the bottom of the steering assembly.
- 5 Remove the horn button.
- 6 Release the steering wheel nut lock.
- 7 Remove the steering nut.
- 8 Remove the steering wheel by using the steering wheel puller.
- 9 Remove the instrument panel bracket.
- 10 Remove the exhaust pipe from the manifold.
- 11 Remove the steering column cover plate on the floor board.
- 12 Note the position of the steering gearbox and make a mark on the frame and steering gear box.
- 13 Remove the steering gearbox mounting bolts and bracket.

**TASK 2: Dismantle the steering gear box**

- 1 Remove the steering gearbox and take it out through the bottom side. (Fig 2)
- 2 Place the steering assembly on the workbench.
- 3 Drain the steering gearbox oil by removing the drain plug.
- 4 Remove the oil filter plug (12).
- 5 Loosen the lock nut (6) of the adjusting screw (7) by one or two threads.
- 6 Remove the side cover (8).
- 7 Remove the side cover packing (18).
- 8 Remove the roller shaft (13) from the assembly.
- 9 Remove the outer column upper cover with the shims.



- 10 Remove the upper side bearing (10) from the housing (2).
- 11 Remove the bottom end cover(19) with the shims (16) and packing (17).
- 12 Remove the lower bearing (14) from the housing (2).
- 13 Remove the horn wire tube.
- 14 Remove the (inner column) worm gear shaft assembly (15).



### TASK 3: Cleaning and Inspection

- 1 Clean all the parts with kerosene oil.
- 2 Inspect visually the following parts:
  - a Bearing for pitting and overheating.
  - b Rocker shaft and inner column for pitting/wear.
  - c Steering housing for crack and enlargement of mounting holes.
- 3 Replace the defective parts.
- 4 Check for bend of the inner column with the help of 'V' blocks and a dial indicator. Replace the inner column if the bend is found to be more than the specified limit recommended by the manufacturer.

### TASK 4: Assembling

- 1 Check the bush (20) for its free movement on the roller shaft (13)
- 2 Fix the bush (20) on the side cover of the steering gear box.
- 3 Fix the bush (20) on the steering gear box body.
- 4 Check the free movement of the rocker shaft in the bush by rotating the rocker shaft by hand
- 5 Fix a new ball bearing at the bottom of the housing (20)
- 6 Refit the worm gear shaft inner column in the housing (2)
- 7 Fit the horn wire tube
- 8 Fix the upper ball bearing (10) in the housing (2)
- 9 Fix the top housing cap with the shims
- 10 Tighten the top housing cap screws at the specified torque. Check the pre-load of the inner column. To increase the pre-load reduce the thickness of shims (9).
- 11 Insert the rocker shaft (13) in the housing.
- 12 Place the side cover gasket (18)
- 13 Place the side cover (8)
- 14 Tighten the side cover screws at the specified torque
- 15 Fix the lower ball bearing in the housing (2)
- 16 Place the bottom cover gasket and shims
- 17 Place the bottom cover and tighten the bottom cover screws
- 18 Fix the adjusting screws (7)
- 19 Adjust the pre-load of the roller shaft by loosening or tightening the adjusting screw as per the manufacturer's recommendation. Tightening the adjusting screw (7) will increase the pre-load. Lock the adjusting screw after adjusting the pre-load after adjusting the pre-load
- 20 Fix the outer column on the steering housing (2).
- 21 Insert the steering assembly from the bottom side of the vehicle.
- 22 Align the steering assembly position with the frame and tighten the mounting bolts at the specified torque.
- 23 Place the oil seal in between the steering housing (2) and drop arm (11).
- 24 Align the drop arm (11) and rocker shaft (13) and fix the drop arm on the rocker shaft. Tighten the drop arm's nut and lock it by a split pin.
- 25 Refix the steering column cover plate on the floor board.
- 26 Refix the instrument panel board bracket.
- 27 Press the steering wheel by hitting lightly with a plastic mallet.
- 28 Tighten the steering wheel nut with a washer at the specified torque.
- 29 Lock the steering wheel nut by folding the washer.
- 30 Insert the horn button and wire.
- 31 Lock the horn button.
- 32 Connect the horn wire.
- 33 Refill the oil as per the manufacturer's specification.
- 34 Refit the exhaust pipe with new packing.
- 35 Fix the bottom shield cover of the steering assembly.

**Practice on removing front axle and steering linkages**

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

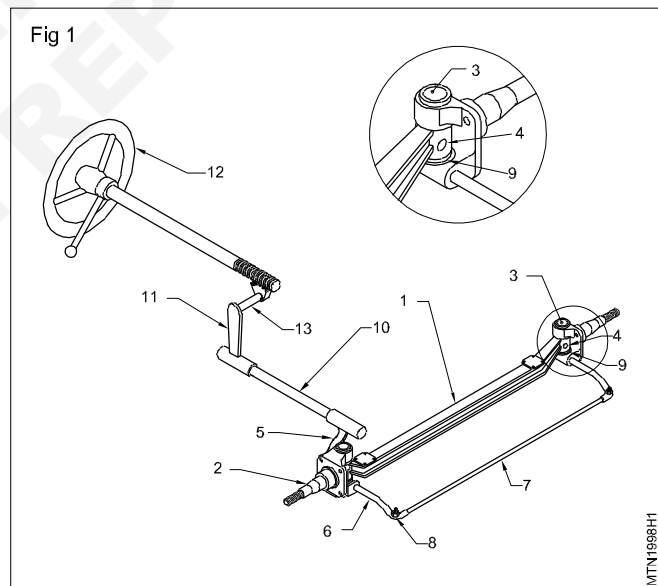
- remove and dismantle the front axle assembly
- check the front axle for bend and twist king pin inclinor
- assemble axle beam and stub axle
- install front axle the vehicle
- adjusts king pin play.

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Tractor	- 1 No.
• Horse / Wheel Chocks	- 2 No.	• Trolley or Screw Jack	- 2 No.
• Hub puller	- 1 No.	<b>Materials/Components</b>	
• Circlip plier	- 1 No.	• Tray	- 1 No.
• Drift	- 1 No.	• Grease	- as reqd.
• Outside Micrometer	- 1 No.	• Cotton waste	- as reqd.
• Straight Gauge	- 1 No.	• Soap oil	- as reqd.

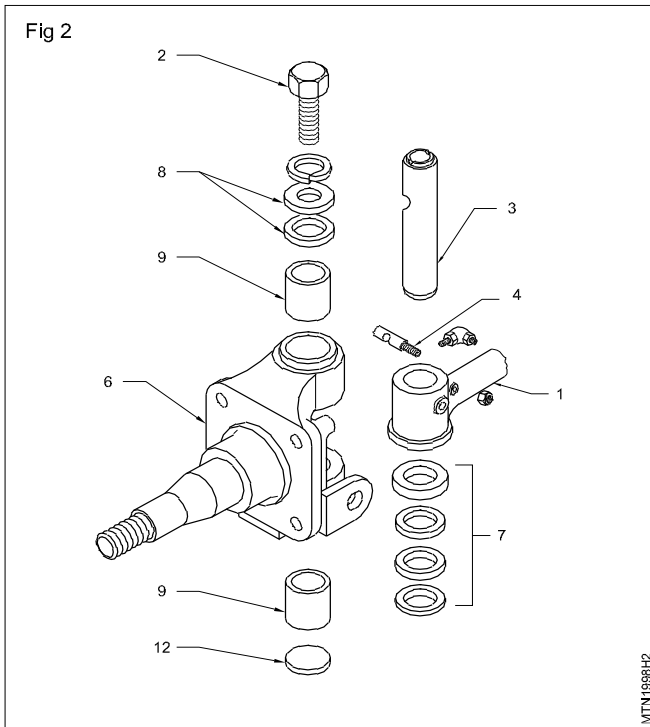
**PROCEDURE**

**TASK 1: remove and dismantle the front axle assemble**

- 1 Place the wheel chocks on the rear wheels.
- 2 Loosen the wheel nut, one or two threads with a wheel spanner.
- 3 Place the jack under the spring support of the front axle.
- 4 Jack up the vehicle until the front wheels are off the ground.
- 5 Place horses under the frame members behind the front springs.
- 6 Remove the wheel nuts and take out the front wheels.
- 7 Disconnect the brake pipe connections and brake flexible connection. Collect the brake fluid in a clean container.
- 8 Unscrew the brake hose from the wheel cylinder.
- 9 Remove the split pin and unscrew the castle nut of the drag link (10), ball pin on the top of the steering arm (5).
- 10 Remove the shock absorber bottom mounting bracket bolts from the front axle.
- 11 Place the trolley jack below the front axle and support the front axle on the trolley jack and remove the steering lonkages. (Fig 1)
- 12 Remove the 'U' bolts from the spring.
- 13 Remove the front axle (1) from the vehicle. (Fig 1)
- 14 Clean the front axle assembly and keep it on the workbench.

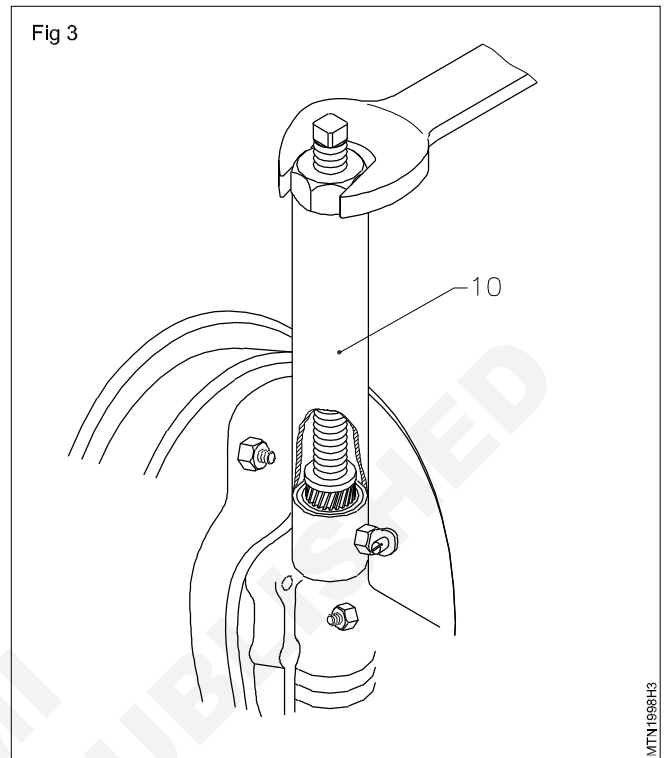


- 15 Remove the split pin and unscrew the castle nut of the ball joint on the rod ends (8).
- 16 Remove the stub axle castle nut and take out the brake drum and hub with bearings. Use a suitable hub puller. (Consult your instructor.)
- 17 Remove the brake assembly and the back plate carrier. (Consult your instructor.)
- 18 Remove both the circlips/ set screw (2) locking king pin plugs at both ends of the king pin (3). (Fig 2)



20 Remove the stub axle (6) thrust bearing (7) and shims along with the thrust washer (8).

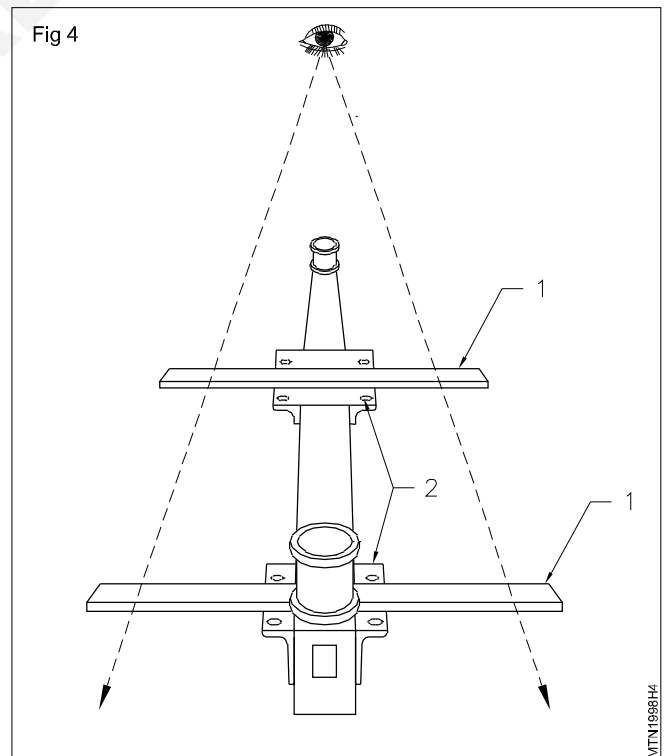
21 Press out the old king pin bushes (9) from the stub axle with the drift/special tool (10).



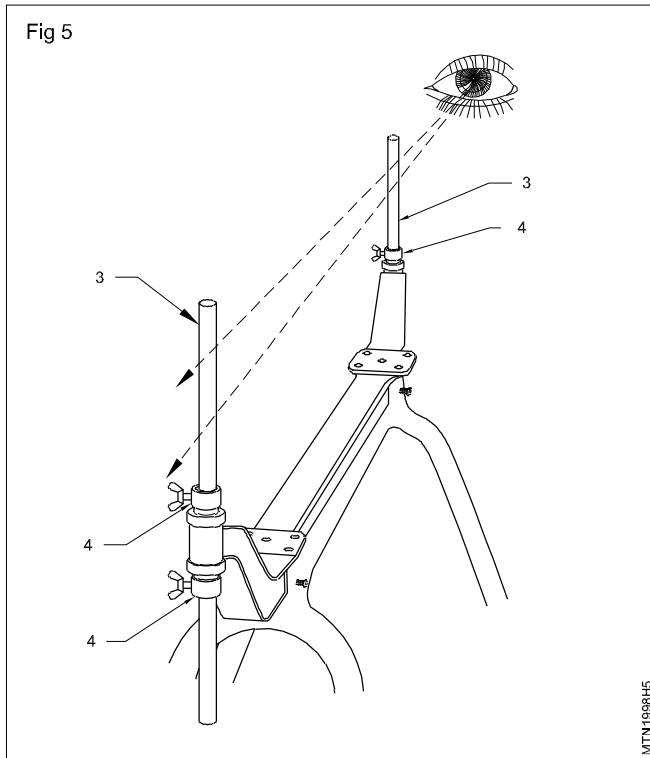
19 Remove the nut from the cotter pin and take out the cotter pin (4) from the front axle beam (1). Remove the king pin by using the special tool or a brass drift. (Fig 3)

## TASK 2: Check axle beam and king pin inclination

- 1 Check visually all the parts for crack, overheating, pitting etc. and replace if necessary.
- 2 Fix new king pin bushes in the stub axle.
- 3 Measure the king pin dia. and the stub axle bush inner dia.
- 4 If needed, ream the bushes according to the size of the king pin.
- 5 Check the front axle for bend and twist with a special axle aligner as per the following procedure.
- 6 Place the straight edges (1) (atleast 400 mm length) on each spring supporting surface (2). Ensure that both the straight edges are projecting equally on both sides of the beam. (Fig 4)
- 7 Visually check across the two straight edges - both the straight edges should be in one plane. If the straight edges (1) are found inclined to each other then the beam has a twist. Send it for repair if recommended by the manufacturer.
- 8 Check the axle beam for twist at the bosses.
- 9 Insert two alignment arbors (3) (Fig 5) in each king pin bore.
- 10 Centre the arbor with the help of cones (4) and clamp them. Ensure that the arbor's (3) height is equal on both the sides.

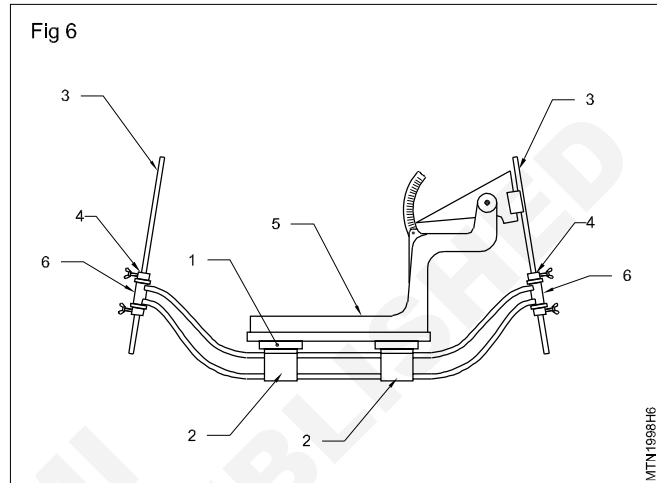


11 Visually check the alignment of the arbors in the same plane. If the arbors are not found in one line then the beam has a twist at the bore. Send it for repair if recommended by the manufacturer.



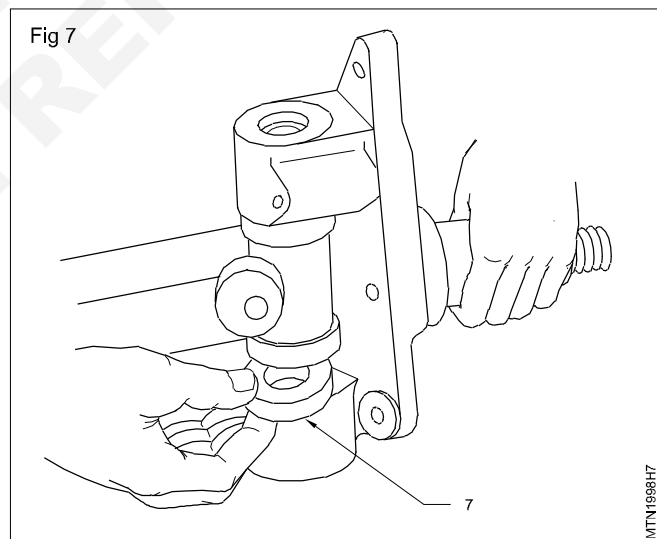
- 12 Check the king pin inclination (king pin on axle hole).
- 13 Place the straightedge (1) across both spring supporting surfaces (2).

- 14 Insert two alignment arbors (3) in each king pin bore (6).
- 15 Centre the arbor with the help of cones (4) and clamp them.
- 16 Set the angle of gauge (5) to the prescribed king pin inclination. (Fig 6)
- 17 Place the gauge on the straight edge (1) and slide towards the arbor (3) one by one and check the edge of the gauge (5) makes full contact with the arbor (3). If not, the king pin's inclination is not as specified by the manufacturer. Send it for repair.



### TASK 3: Assembly

- 1 Place the stub axle on the beam.
- 2 Insert the thrust bearing (7) and dust seal between the stub axle bottom and the front axle. (Fig 7)
- 3 Align the axle beam and stub axle to fix the king pin.
- 4 Fix and press the king pin (or) by hammering the king pin to insert.
- 5 Insert the cotter pin and secure the king pin in position.
- 6 Place a lever/screwdriver in between the stub axle and beam. Shake the stub axle. If play is found add shims at the top. Shims are added to reduce play. Adjust the shims so that the stub axle moves by hand without load but does not shake. (In some vehicles shims are added at the bottom. To reduce play shims are removed.)
- 7 Tighten the nut on the cotter pin.
- 8 Fit the grease nipple to the plugs and grease with a gun.



### TASK 4: Installation of front axle to the vehicle

- 1 Move the front axle assembly to its position below the vehicle.
- 2 Jack up the front axle assembly.
- 3 Check the thread of the 'U' clamp bolt and nut.
- 4 Lubricate the 'U' clamp threads.
- 5 The nut and check-nut should turn freely.
- 6 If threads are damaged replace the 'U' clamp and nut.
- 7 Fix the 'U' bolt. See that the spring is seated on its place.
- 8 Fix the 'U' bolt nut and tighten it.
- 9 Fit the shock absorber along with the mounting brackets.

- 10 Tighten the 'U' clamp bolt at the specified torque.
  - 11 Install the ball joint, pin for the drag link and steering arm.
  - 12 Screw the castle nut and tighten it and fix the new split pin.
  - 13 Assemble the back plate carrier along with the brake assembly.
  - 14 Connect the brake pipe line's flexible hose and connect it to the wheel cylinder.
  - 15 Fix the brake drum.
  - 16 Fix the inner and outer bearing on the hub after applying grease.
  - 17 Tighten the bearing adjusting nut so that the brake drum does not rotate.
  - 18 Loosen the adjusting nut by two threads.
  - 19 Check that the brake drum rotates freely.
  - 20 Check the bearing play by moving the brake drum by hand in the vertical position.
  - 21 If the bearing play is correct, the brake drum should rotate freely but should not show any movement in the up and down position.
  - 22 Lock the bearing adjusting nut and fix the wheel.
  - 23 Raise the jack and take out the horses from the chassis and axles.
  - 24 Release the jack.
  - 25 Tighten the wheel nuts to the specified torque.
  - 26 Remove jack and wooden chocks.
  - 27 Connect the battery connection.
  - 28 Start the engine and drive the vehicle.
  - 29 Check the direction stability and self centering.
-

**Practice on assembling and testing the steering assembly**

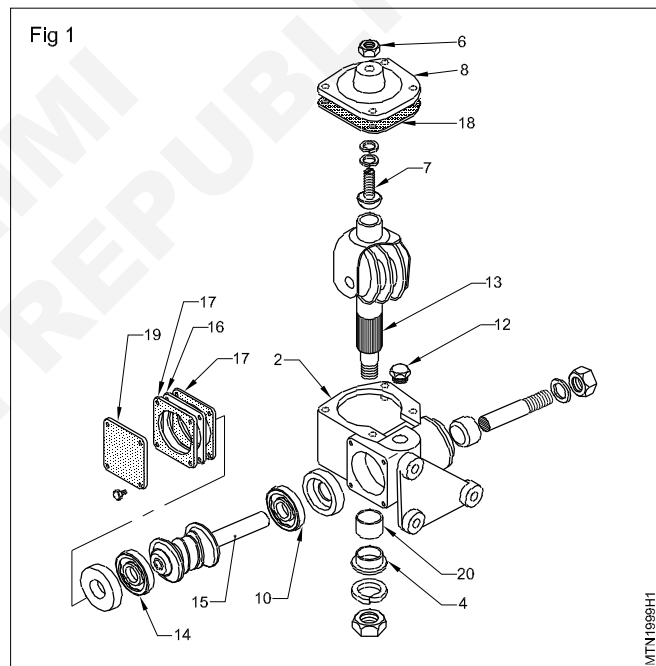
**Objective:** At the end of this exercise you shall be able to  
 • **ressembling the steering assembly.**

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Tractor	- 1 No.
• Horse / Wheel chocks	- 2 No.	• Trolley or Screw Jack	- 1 No.
• Hub puller	- 1 No.	<b>Materials/Components</b>	
• Circlip piler	- 1 No.	• Tray	- 1 No.
• Outside micrometer	- 1 No.	• Grease	- 1 No.
• Straight Gauge	- 1 No.	• Cotton Waste	- as reqd.

**PROCEDURE**

**TASK 1: Assembling (Fig 1)**

- 1 Check the bush (20) for its free movement on the roller shaft (13).
- 2 Fix the bush (20) on the side cover of the steering gearbox.
- 3 Fix the bush (20) on the steering gearbox body.
- 4 Check the free movement of the rocker shaft in the bush by rotating the rocker shaft by hand.
- 5 Fix a new ball bearing at the bottom of the housing (2).
- 6 Refit the worm gear shaft inner column in the housing (2).
- 7 Fit the horn wire tube.
- 8 Fix the upper ball bearing (10) in the housing (2).
- 9 Fix the top housing cap with the shims.



**TASK 2: Adjust the backlash and preload (Fig 1)**

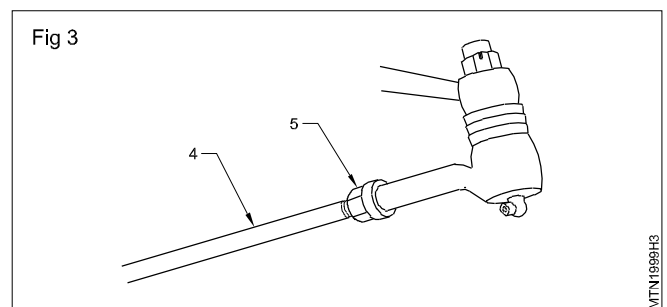
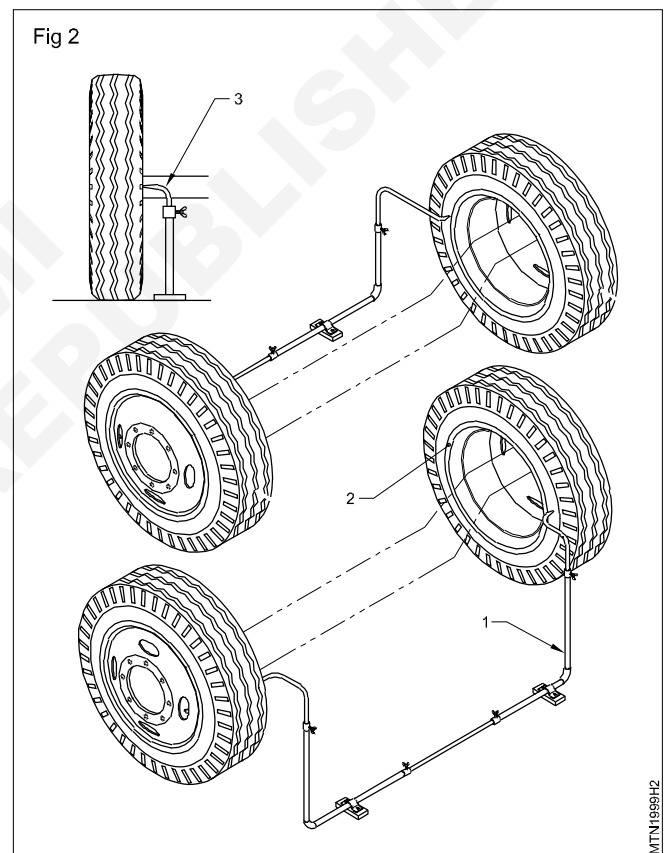
- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Tighten the top housing cap screws at the specified torque. Check the pre - load of the inner column. To increase the pre - load reduce the thickness of shims (9).</li> <li>2 Insert the rocker shaft (13) in the housing.</li> <li>3 Place the side cover gasket (18).</li> <li>4 Place the side cover (8).</li> <li>5 Tighten the side cover screws at the specified torque.</li> <li>6 Fix the lower ball bearing in the housing (2).</li> </ol> | <ol style="list-style-type: none"> <li>7 Place the bottom cover gasket and shims.</li> <li>8 Place the bottom cover and tighten the bottom cover screws.</li> <li>9 Fix the adjusting screw (7).</li> <li>10 Adjust the pre - load of the roller shaft by loosening or tightening the adjusting screw as per the manufacturer's recommendation. Tightening the adjusting screw (7) will increase the pre - load. Lock the adjusting screw after adjusting the pre - load.</li> <li>11 Fix the outer column on the steering housing (2).</li> </ol> |
|---|--|

### TASK 3: Fit the steering box and steering wheel (Fig 1)

- 1 Insert the steering assembly from the bottom side of the vehicle.
- 2 Align the steering assembly position with the frame and tighten the mounting bolts at the specified torque.
- 3 Place the oil seal in between the steering housing (2) and drop arm (11).
- 4 Align the drop arm (11) and rocker shaft (13) and fix the drop arm on the rocker shaft. Tighten the drop arm's nut and lock it by a split pin.
- 5 Refix the steering column cover plate on the floor board.
- 6 Refix the instrument panel board bracket.
- 7 Press the steering wheel by hitting lightly with a plastic mallet.
- 8 Tighten the steering wheel nut with a washer at the specified torque.
- 9 Lock the steering wheel nut by folding the washer.
- 11 Insert the horn button and wire.
- 12 Connect the horn wire.
- 13 Refill the oil as per the manufacturer's specification.
- 14 Refit the exhaust pipe with new packing.
- 15 Fix the bottom shield cover of the steering assembly.

### TASK 4: Check toe in / toe out (Figs 2&3)

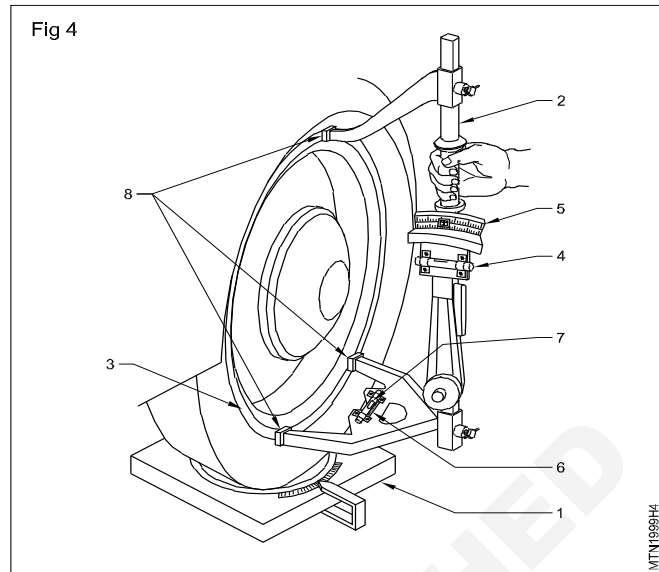
- 1 Park the vehicle on level ground in no load condition.
- 2 Check and ensure that all the tyres are of the same size and uniform tread wear.
- 3 Inflate all the tyres to the recommended pressure.
- 4 Check and ensure that the spring pins (shackle pin) are not worn out abnormally.
- 5 Ensure that the spring cambers are equal on both sides. (trim height)
- 6 Tighten the U- bolts at the specified torque.
- 7 Check and ensure the steering wheel play is within limits.
- 8 Check the king pin end play is at zero; otherwise adjust.
- 9 Check and ensure the wheel bearing play as recommended.
- 10 Check and ensure that the drag link and track rod sockets do not have play.
- 11 Check the rear wheels.
- 12 Bring the front wheels in straight ahead position. (Use turn tables)
- 13 Lock the steering wheel with wheel locking device in straight head position. (Fig 2)
- 14 Place the toe - in gauge (1) in front of the front wheels and adjust the height of the pointer to the centre of the wheels, on both the sides, reading at zero. Mark with chalk on the wheel's rim (2) where the gauge's pointers touch and remove the toe in gauge.
- 15 Move the vehicle forward so that the wheel will complete half a turn and mark on the back side of the front axle at the same height.
- 16 Touch the pointer (3) on the chalk mark and put the toe in gauge behind the front axle.
- 17 Note down the difference of readings in the front and rear.
- 18 If the difference is not as per the recommended value of toe in, adjust the length of the track rod (4) (by loosening the tie rod clamps (5) with a pipe wrench). (Fig 3)



- 19 Repeat the procedure till the recommended toe - in is set.
- 20 Tighten the clamp nuts (5) of the tie rod sockets.

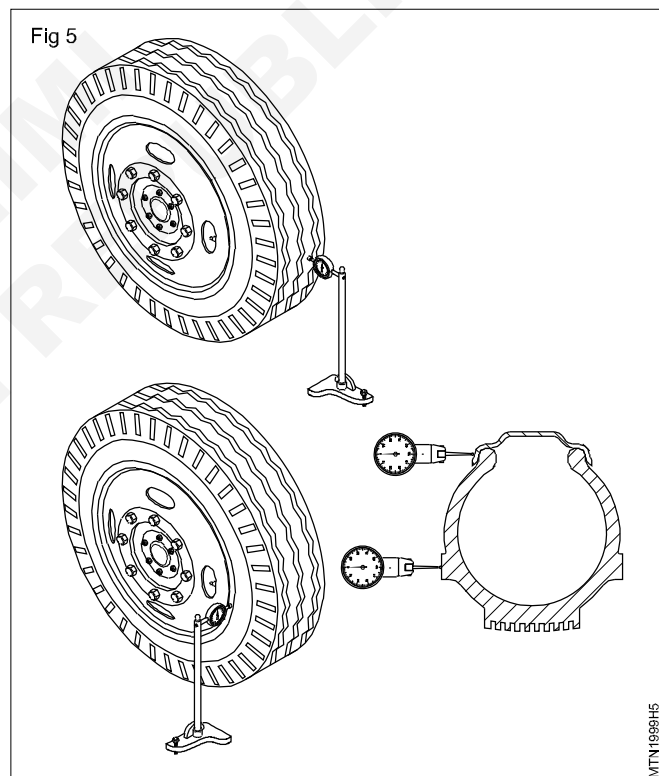
### TASK 5: Check camber (Fig 4)

- 1 Use a turn table (1) under the front wheels and set the reading at zero and lock it.
- 2 Ensure that the wheels are in straight ahead position.
- 3 Clean the surface of the wheel disc / rim.
- 4 Place the gauge (2) and hold with the ends of the single and double arms (8) against the wheel rim (3).
- 5 Tilt the gauge in horizontal position parallel to vehicle axial until the bubble in the spirit - level (4) is in centre.
- 6 Turn the gauge in horizontal position parallel to vehicle axial until the bubble in the spirit - level (4) is in centre.
- 7 See the camber gauge (5) indicates the camber angle and note it.



### TASK 6: Castor and king pin inclination (Fig 5)

- 1 The castor and king pin inclination can be read simultaneously.
- 2 Remove the locks from the turn table.
- 3 Apply the brakes.
- 4 Adjust the castor dial and king pin inclination dial (6) to zero position i.e. bubbles will come to zero. (Turn table)
- 5 Turn the wheels right in the opposite direction i.e. 20° and set zero.
- 6 Note the reading in the scale of the castor and the king pin inclination. The bubble will show the reading after turning the wheel in 40°.
- 7 The castor angle and king pin inclination vary from vehicle to vehicle.
- 8 If the castor is less place the castor wedge in between the front axle and spring. Remove the castor wedge if the castor is more.
- 9 The king pin inclination varies generally 4° to 10° from vehicle to vehicle.
- 10 If the reading does not conform to the manufacturer's specification the front axle bush should be overhauled.
- 12 Rotate the wheel and check the radial and lateral run out with the gauge as shown in the (Fig 5).



- 13 If the rim is found with a bend add some weight (lead piece) on the opposite direction.



**Check and inspect the power steering parts**

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

- checking power steering fluid level and condition
- pressure test a power steering system
- flash power steering system
- fill and bleed power steering system
- adjust the drive belt.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton clothes	- 1 No.
• Special tool	- 1 No.	• 5w oil	- as reqd.
• Pan	- 1 No.	• Hose	- as reqd.
<b>Equipment/Machines</b>		• Soap oil	- as reqd.
• Tractor	- 1 No.		
• Trolley or Screw Jack	- 1 No.		

**PROCEDURE**

**TASK 1: Checking steering fluid level**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Locate the power steering reservoir.</li> <li>2 Remove the cap and observe the fluid level. Most power steering reservoir are made of clean plastic and the cap does not have to be removed to observe the fluid level.</li> </ol> | <ol style="list-style-type: none"> <li>3 Place some of the fluid on a clean white cap check for following condition:                     <ol style="list-style-type: none"> <li>i Discoloration</li> <li>ii Burned odor</li> </ol> </li> <li>4 Describe the condition of power steering fluid if necessary to be changed.</li> </ol> |
|---|--|

**TASK 2: Fluid pressure test**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1 Check the power steering fluid and leak.</li> <li>2 Check the power steering pump drive belt replace or adjust if necessary.</li> <li>3 Start the engine and listen for noises from the power steering system.</li> <li>4 Attach a power steering gauge to the pump.</li> </ol> | <ol style="list-style-type: none"> <li>5 Fill and bleed the power steering system.</li> <li>6 Start the engine and observe pressure reading.</li> <li>7 With the engine running turn the steering all the way to the left and right observe pressure reading.</li> <li>8 With the engine running close the pressure gauge valve and observe pressure reading.</li> </ol> |
|--|--|

**TASK 3: Flush system**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Place a pan under the power steering reservoir.</li> <li>2 Remove the return hose fitting at the reservoir and allow fluid to flow from the reservoir and the return hose into the pan.</li> <li>3 Plug the return port and fluid to the reservoir.</li> </ol> | <ol style="list-style-type: none"> <li>4 Start the engine and allow the fluid to drain from the return hose into the pan.</li> <li>5 Add clear fluid to the reservoir as the old fluid drains.</li> <li>6 Start the engine and allow the fluid to flow from the return hose into the pan.</li> </ol> |
|---|--|

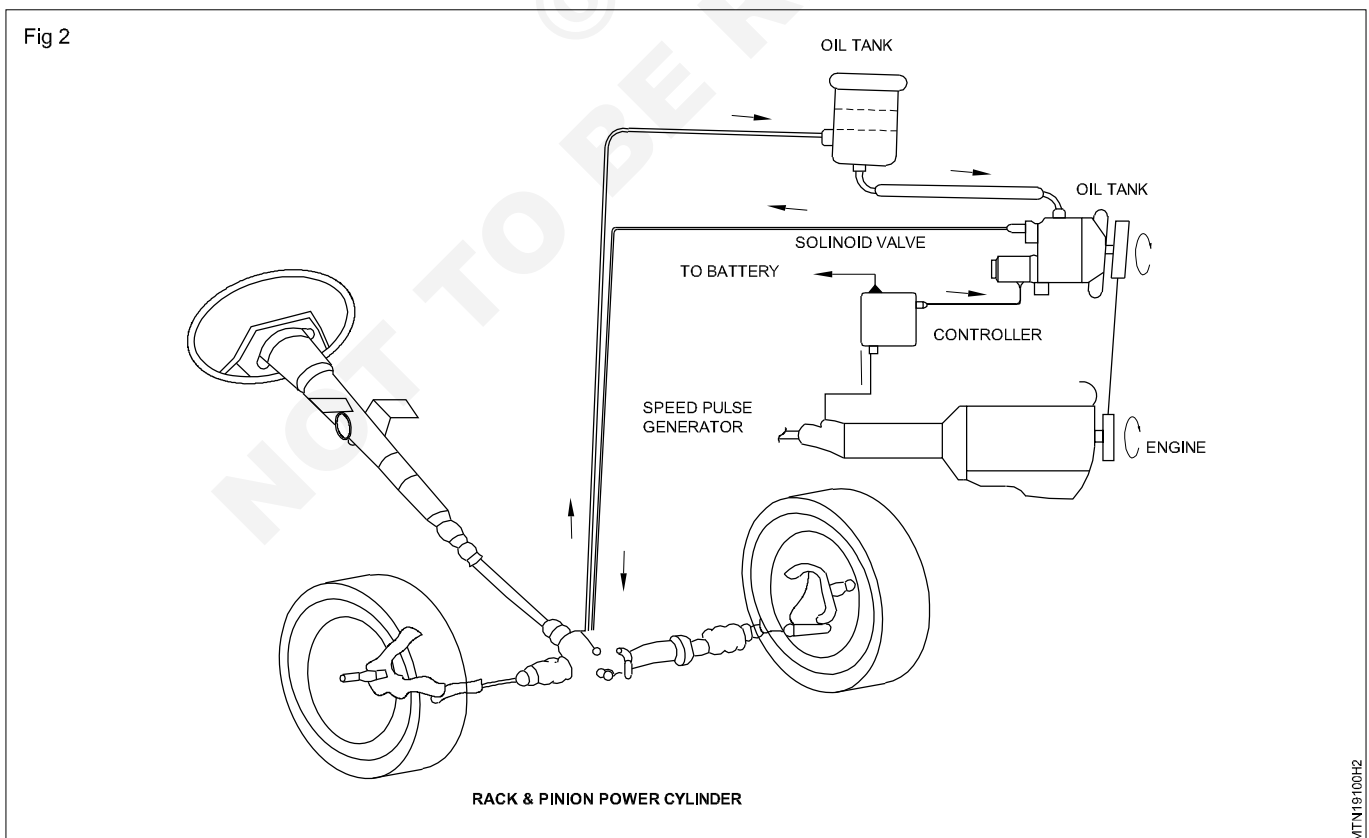
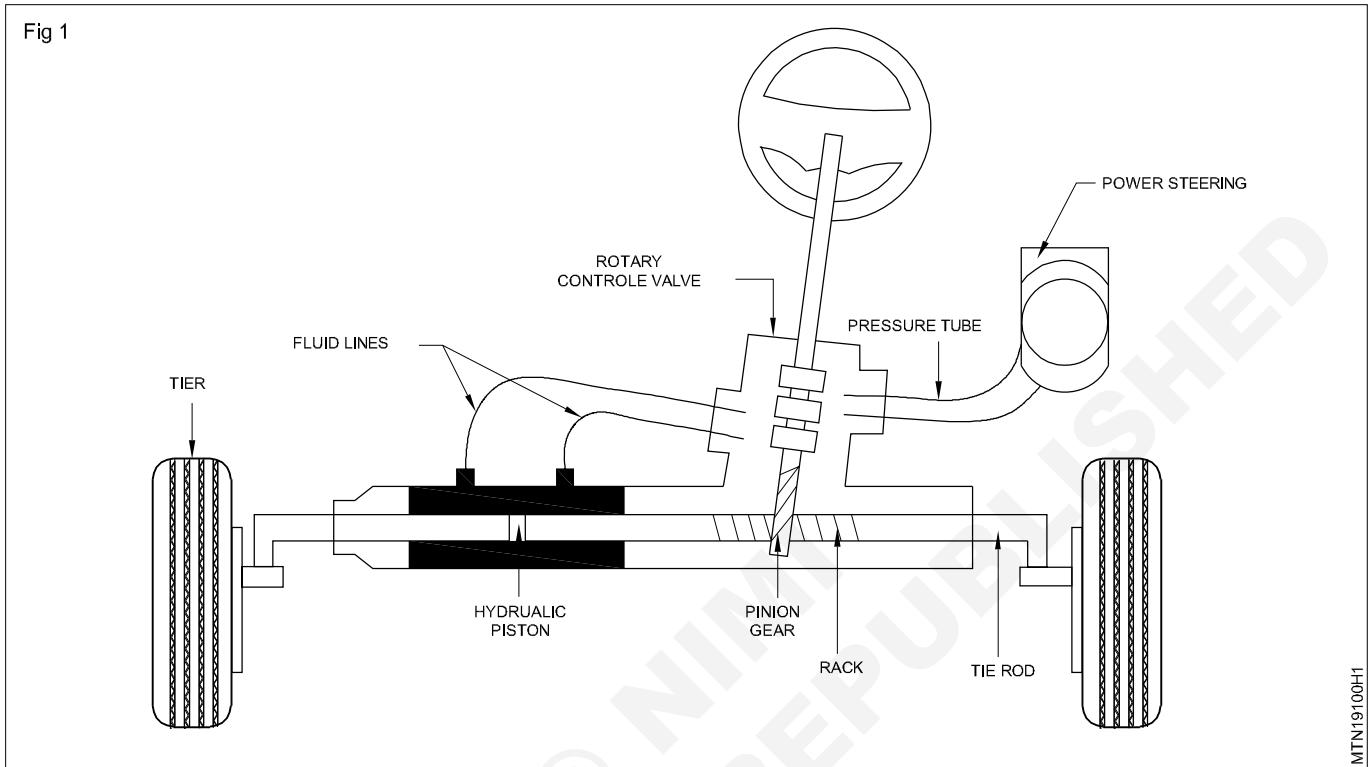
**TASK 4: Fill and bleed**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1 Start the engine.</li> <li>2 With the engine running add fluid to the reservoir until it dyssblixes at the mark.</li> <li>3 Stop the engine and wait approximately 2 minute.</li> <li>4 Add fluid to the reservoir.</li> </ol> | <ol style="list-style-type: none"> <li>5 Start the engine and turn the steering wheel from side to side for about 1 minute.</li> <li>6 Repeat step 3, 4 and 5 until the fluid has no visible bubbles.</li> <li>7 Drive the vehicle and check the performance of power steering operation.</li> </ol> |
|---|--|

**TASK 5: Adjust the drive belt**

- |  |   |
|--|---|
| 1 Re-install the drive belt.                                       | 3 Tighten the pump and belt adjustment fasteners. |
| 2 Adjust the belt skip this step if the belt is a serpentine type. | 4 Add fluid and bleed the system.                 |
|  | 5 Road test the vehicle.                          |

**TASK 6: Inspect the layout of power steering parts (Figs 1 & 2)**



**Practice on visual inspection of chassis frame**

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

- inspect the chassis frame visually
- check the chassis frame for bends twists and cracks.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton waste	- as reqd.
• Plumb bob	- 1 No.	• Chalk	- as reqd.
<b>Equipment/Machines</b>			
• Tractor	- 1 No.		

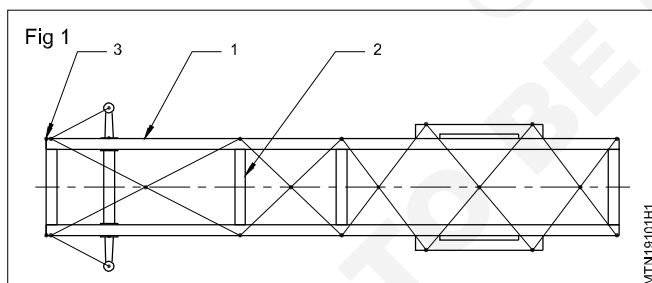
**PROCEDURE**

**TASK 1: Inspect the chassis frame visually**

Check the chassis frame visually for cracks and major damage. If any major damage is found send the chassis frame for repair.

**TASK 2: Check the chassis frame for bend and twists**

- 1 Mark a diagram on the floor according to the manufacturer's specification (in-line and diagonal).
- 2 Place the frame on the floor of the diagram (Fig 1).



- 3 Check the diagonal and in-line measurement of the frame on the floor.
- 4 If the frame is bend or twisted its side members (1) and cross-member's (2) points will not align with the floor diagram. If the deviation found is more than the specified limits of the manufacturer, send the frame for repair.
- 5 Place the frame on the horse support and coincide the same with the floor diagram.

- 6 Make a number of plumb bob point (3) marks, where the plumb point touches on the ground.
- 7 Mark the diagram where the plumb bob touches, and make a diagram.
- 8 Compare the plumb bob's diagram with the manufacturer's diagram.
- 9 By using a plumb bob measure the height of the frame from the floor at different places.
- 10 If there is any difference between the heights than the frame has sagging. Send it for repair.
- 11 Inspect the rivets of the frame by hitting with a ball pein hammer. Loose rivets will give a dull sound, change the particular rivets or send the frame for repair.
- 12 Check for chassis cracks from hanger bracket holes, rivet holes and cross member mounting points.

**Chassis crack repair is used the special welding technique and done by specialists.**

**Overhauling and inspection of shackle pin in front & rear suspension**

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

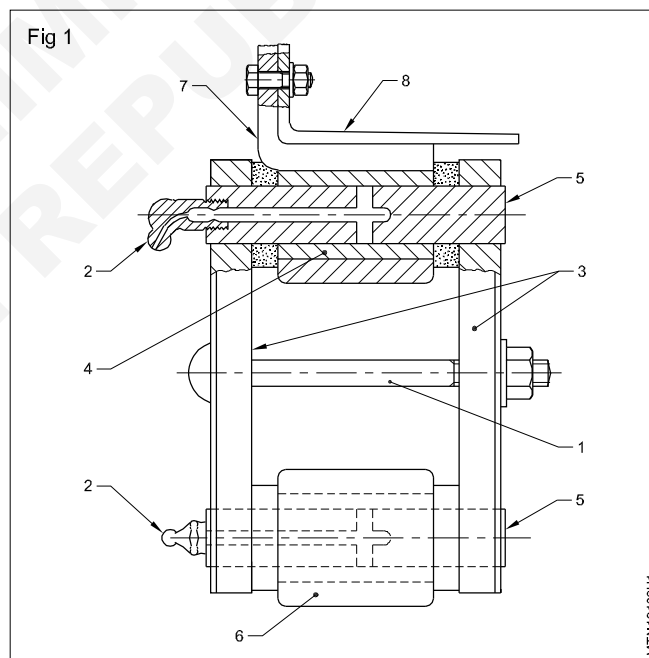
- remove shackles
- inspect the shackle
- replace shackle pin bushes
- assemble shackles.

Requirements			
Tools/Instruments		Materials/Components	
• Trainees Tool Kit	- 1 No.	• Blush	- as reqd.
• Hammer/sludge	- 1 No.	• Chalk	- as reqd.
• Drift	- 1 No.	• Kerosene	- as reqd.
		• Cotton waste	- as reqd.
		• Grease nipple	- as reqd.
		• Shackle pin	- as reqd.

**PROCEDURE**

**TASK 1: Remove shackles**

- 1 Check the wheels and raise the vehicle with a screw jack.
- 2 Place a horse support under the frame, so that the leaf spring will be free from load.
- 3 Remove the draw bolt (1) (Fig 1).
- 4 Remove the grease nipples (2).
- 5 Drive out the shackle (3) with a puller. (Consult your instructor).
- 6 Remove the shackle (3).
- 7 Replace the bush (4), if necessary.



**TASK 2: Inspect the shackle.**

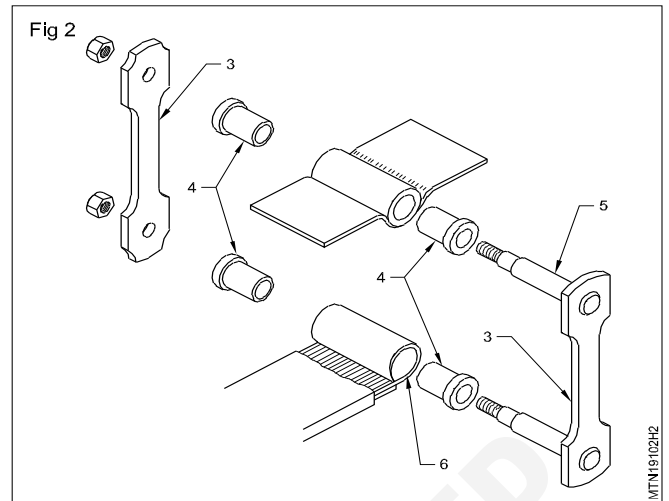
- 1 Clean all the parts with kerosene, high pressure water and air.
- 2 Inspect the dismantled parts.

**TASK 3: Replace shackle pin bushes**

- 1 Replace the worn out parts, if necessary, Align the holes of the spring bush (4) and the shackle. Bracket (3) with a rod. Do not use your finger to align the hole.

#### TASK 4: Assemble shackles

- 1 Fit the shackle (3) with the shackle pin (5) in the spring eye (6). Replace the assembly if worn out. (Fig 2)
- 2 Fit the shackle with a hanger lock (7) on the frame (8).
- 3 Tighten the draw bolt (1).
- 4 Fit the grease nipple (2) and grease it.
- 5 Lift the vehicle and remove the horse.
- 6 Press the body of the vehicle and check the shackle's proper function.



**Lubricate the tractor suspension system**

**Objective:** At the end of this exercise you shall be able to  
 • **lubricate the tractor suspension system.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton waste	- as reqd
• Grease gun	- 1 No.	• Silicon grease	- as reqd.
• Horses/jacks	- 1 No.	• Lithium grease	- as reqd.
• Lithium/silicon sprayers	- 1 No.	• Chassis grease	- as reqd.
• Tractor manual	- 1 No.		
<b>Equipment/Machines</b>			
• Tractor with trailer	- 1 No.		

**PROCEDURE**

- |  |   |
|--|---|
| 1 Park the tractor in level ground.                        | 17 Drag link  |
| 2 Chock the front and rear wheel by wooden blank.          | 18 Tie rod  |
| 3 Disconnect the battery connection.                       | 19 Leaf spring  |
| 4 Make sure the parking bracke is applied.                 | 20 King pin   |
| 5 Keep spare tyre under neeth the tractor.                 | 21 Wheel bearing  |
| 6 Locate the following grease nipple of suspension system. | 22 Knuckle arm  |
| 7 Sway-bar links   | 23 Pedal linkages and other oil / grease points specified by the manufacturers.   |
| 8 Control arm pivots                                       | 24 Open the dust boots, clean the dirt in the nipple with a wrench and clean it by wire or solvent or compressed air fill nipple grease in the grease gun and apply the grease on nipple point. |
| 9 'U' Joint on drive shaft                                 |   |
| 10 Suspension bushes                                       |   |
| 11 Steering joints   |   |
| 12 Shackles  |   |
| 13 Front axle pivot pin                                    |   |
| 14 Steering kunckle post                                   |   |
| 15 Differential lock pedal                                 |   |
| 16 Top link  |   |

**Temporary solution for coil & leaf spring is spray-on lithium grease, silicon spray is better for rubber suspension. Graphite lubed for throughout bearing refer the owner manual for correct grading of grease and greasing points of the tractor.**

**Remove the wheels from tractor**

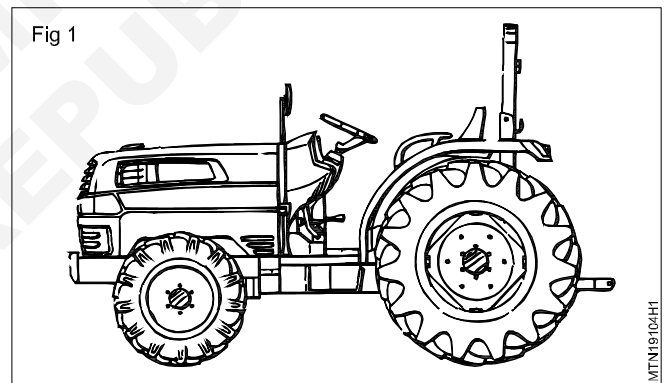
**Objective:** At the end of this exercise you shall be able to  
• **remove a wheel from tractor.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Tire lever	- 1 Pair.	• Cotton waste	- as reqd.
• Heavy hammer	- 1 No.	• Kerosene	- as reqd.
• Valve die	- 1 No.	• Grease	- as reqd.
• Wheel spanner	- 1 No.	• Check powder	- as reqd.
• Hydraulic jack	- 1 No.	• Valve pin	- as reqd.
<b>Equipment/Machines</b>			
• Tractor	- 1 No.		
• Compressor with gauge	- 1 No.		

**PROCEDURE**

**Removing the wheel from tractor (Fig 1)**

- 1 Park the tractor on the surface ground
- 2 Choke the opposite side of the wheels with wooden blocks.
- 3 Loosen the wheel nuts by a wheel spanner.
- 4 Jack up the tractor by hydraulic/mechanical jack.
- 5 Place jack stand or wooden block under the axle remove the wheel nuts.
- 6 Remove the all wheels from the tractor.
- 7 Clean the tyre.



**Dismantle the wheels for checking rims, tyres and tubes**

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

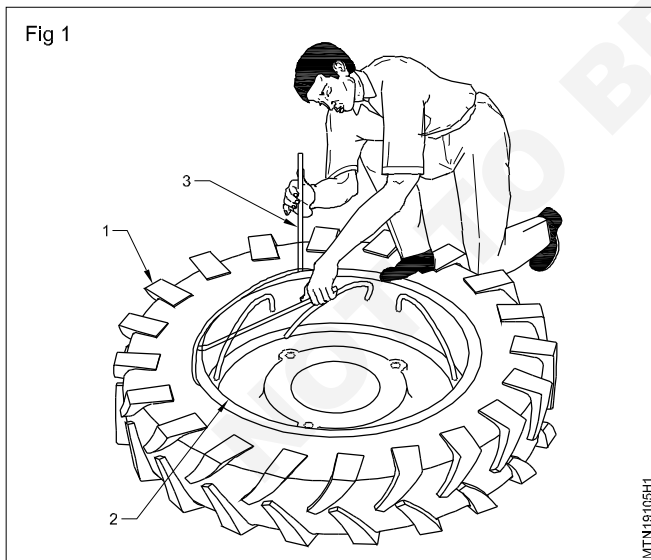
- dismantle the tyre and tube
- locate the puncture in tube
- repair the puncture.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Tire lever	- 1 Pair.	• Cotton waste	- as reqd.
• Heavy hammer	- 1 No.	• Kerosene	- as reqd.
• Valve die	- 1 No.	• Grease	- as reqd.
• Wheel spanner	- 1 No.	• Chalk powder	- as reqd.
• Hydraulic jack	- 1 No.	• Valve pin	- as reqd.
<b>Equipment/Machines</b>			
• Tractor	- 1 No.		
• Compressor with gauge	- 1 No.		

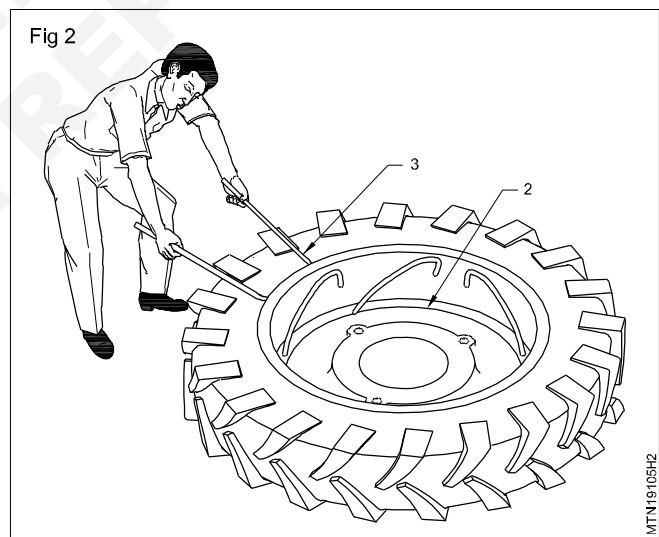
**PROCEDURE**

**TASK 1: Dismantling the tyre/tube**

- 1 Put the wheel with tyre (1) on the ground.
- 2 Deflate air from the inner tube by unscrewing the valve.
- 3 Depress the tyre on the side facing the valve into the hollow of the rim (2). (Fig 1)



- 4 Insert the tyre lever (3) into the rim in the place where the valve is located below the edge of the tyre. (Fig 2)



- 5 Pull out the edge (4) of the tyre above the rim edge and by shifting the tyre levers gradually from place to place.
- 6 Remove the tube from the tyre.

**Do not insert the tyre lever fully inside the disc to avoid damage the tube.**

- 7 If there is any bulge on the tube then replace the tube.



**TASK 2: Locating the puncture in the tube**

- 1 Fix the valve core in the tube.
- 2 Inflate the tube at a pressure of 3 to 5 lbs/sq. inch.
- 3 Dip the inflated tube in the water tub. At the punctured area air bubbles will come out. Mark the puncture by marking pencil.

-----

**TASK 3: Repairing the puncture**

- 1 Remove the valve core.
- 2 Clean the puncture area by cloth.
- 3 Clean the puncture with woodruff file.
- 4 Apply vulcanizing cement on the puncture portion.
- 5 Place a piece of vulcanising raw rubber on the puncture area.
- 6 Clamp the puncture area on vulcanizing machine.
- 7 Switch on the vulcanizing machine.
- 8 After 15 minutes switch off the vulcanizing machine.
- 9 Allow 5 minutes to cool down the tube.
- 10 Unclamp the machine and remove the tube from the equipment.
- 11 Fix the valve core on the tube.
- 12 Inflate the tube with low pressure 5 to 10 lbs/sq.inch.
- 13 Dip the repaired tube in the water tub and recheck for any leakage.

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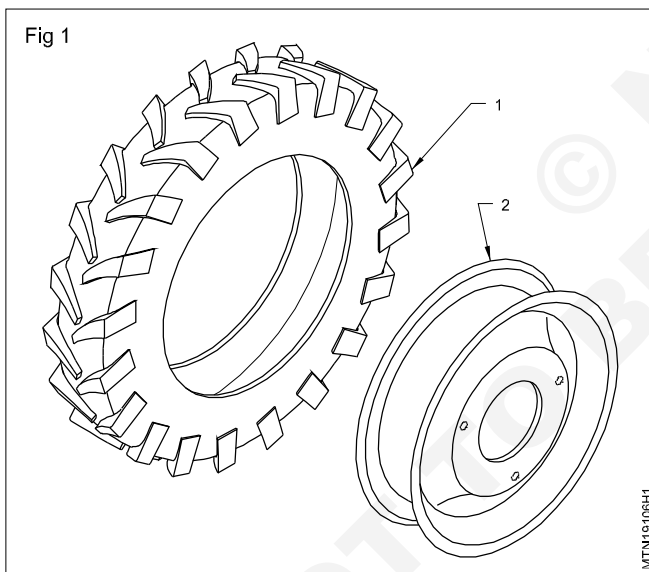
**Practice on repairing & de-rusting painting**

**Objective:** At the end of this exercise you shall be able to  
• **checking, de-rusting, repairing & repainting the wheel rim.**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Tire lever	- 1 Pair.	• Cotton waste	- as reqd.
• Heavy hammer	- 1 No.	• Kerosene	- as reqd.
• Valve die	- 1 No.	• Grease	- as reqd.
• Wheel spanner	- 1 No.	• Check powder	- as reqd.
• Hydraulic jack	- 1 No.	• Valve pin	- as reqd.
<b>Equipment/Machines</b>			
• Tractor	- 1 No.		
• Compressor with gauge	- 1 No.		

**PROCEDURE**

**Checking, repairing, de-rusting and repainting the wheel rim (Fig 1)**



- 1 Remove the wheel from tractor. (Fig 1)
- 2 Dismantle tyre & tube (1) from wheel rim (2).
- 3 Clean the rim and check visually for cracks.
- 4 Repair cracks by welding or replace, if necessary.
- 5 Check the rims for distortion by placing on level surfaces.
- 6 Remove distortion by using proper jig and fixtures.
- 7 Derust rims with emery paper.
- 8 Repaint the rims.

**Practice on fitting of tyres and tubes on rim**

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

- assembling of tyre and tube on rim
- inflate the wheel to the recommended pressure.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Tire lever	- 1 Pair.	• Cotton waste	- as reqd.
• Heavy hammer	- 1 No.	• Kerosene	- as reqd.
• Valve die	- 1 No.	• Grease	- as reqd.
• Wheel spanner	- 1 No.	• Check powder	- as reqd.
• Hydraulic jack	- 1 No.	• Valve pin	- as reqd.
<b>Equipment/Machines</b>			
• Tractor	- 1 No.		
• Compressor with gauge	- 1 No.		

**PROCEDURE**

**TASK 1: Assembling of tyre, tube on rim**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1 Check tyre inner area for nails, stone and damage.</li> <li>2 Apply french chalk power inside the tyre and out area of tube.</li> <li>3 Insert the tube into the tyre.</li> <li>4 Inflate the tube with low pressure 5 to 10 lbs/sq.inch.</li> </ol> | <ol style="list-style-type: none"> <li>5 Insert the valve tube into the rim.</li> <li>6 Lock the valve tube with the locking nut.</li> <li>7 Insert the tyre lever (3) in between the disc and beading. Push down the tyre on to rim.</li> <li>8 Inflate the tube slowly until the beads is fully seated. Inflate according to manufacturer's specification.</li> </ol> |
|---|---|

**TASK 2: Tyre Inflating**

- 1 The front tyre and rear tyres of tractor should be inflated as below:
- 2 Check the valve core for leakages with soap water. Fit valve cap.

Tractor tyre inflation chart	
For field work	Pressure
Front Tyre	2 kg/cm <sup>2</sup> (28 PSI)
Rear Tyre	1 kg/cm <sup>2</sup> (14 PSI)
For road transportation	
Front Tyre	2 kg/cm <sup>2</sup> (28 PSI)
Rear Tyre	1.4 kg/cm <sup>2</sup> (20 PSI)

**TASK 3: Fitting the wheel on tractor**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1 Fit the wheel on the tractor.</li> <li>2 Tighten the wheel nuts by hand.</li> <li>3 Remove the jack without any jerk.</li> </ol> | <ol style="list-style-type: none"> <li>4 Tighten the wheel nuts with wheel spanner in correct sequence.</li> <li>5 Remove the chock.</li> </ol> |
|---|---|

**Wheel track balancing and tyre rotation**

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

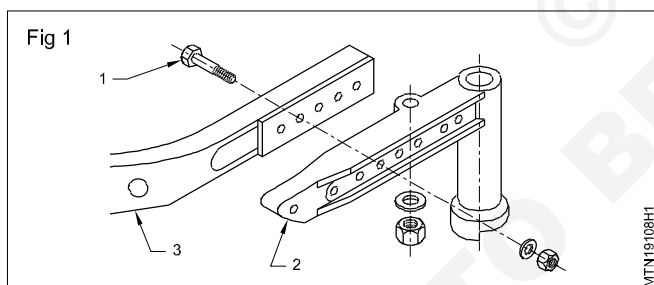
- front wheel track adjustment balancing
- rear wheel track adjustment balancing
- tyre rotation and filling the wheel.

Requirements	
<b>Tools/Instruments</b> <ul style="list-style-type: none"> <li>• Trainees Tool Kit - 1 No.</li> <li>• Tire lever - 1 Pair.</li> <li>• Heavy hammer</li> <li>• Valve die</li> <li>• Wheel spanner</li> <li>• Hydraulic jack</li> </ul>	<b>Materials/Components</b> <ul style="list-style-type: none"> <li>• Tray - 1 No.</li> <li>• Cotton waste - as reqd.</li> <li>• Kerosene</li> <li>• Grease</li> <li>• Check powder</li> <li>• Valve pin</li> </ul>
<b>Equipment/Machines</b> <ul style="list-style-type: none"> <li>• Tractor</li> <li>• Compressor with gauge</li> </ul>	

**PROCEDURE**

**1 Front wheel track adjustment**

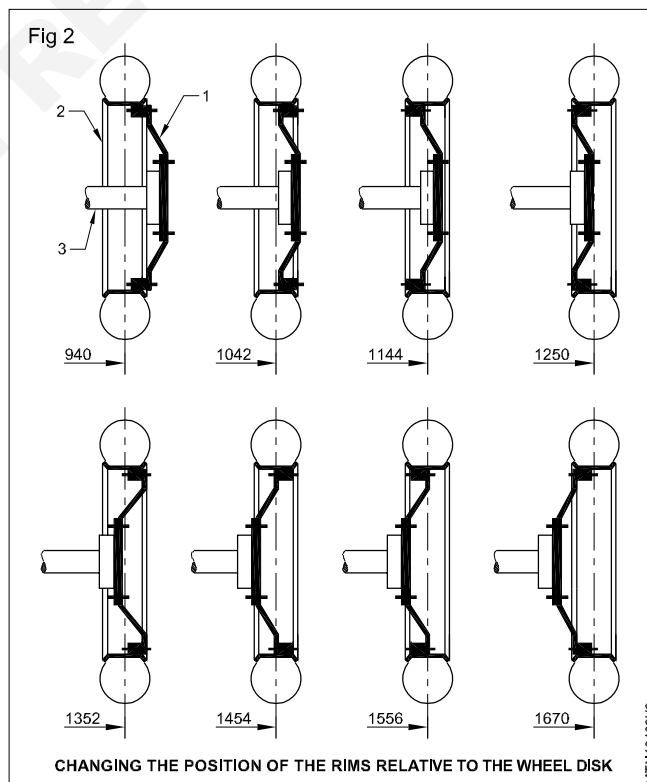
- 2 Set the front wheels in the straight position.
- 3 Align the marks on the steering arms (1) and stub axle (2). (Fig 1)



- 4 Jack up and remove the bolts (3) holding the axle extension beam (4) to the centre beam (5).
- 5 Move the axle extension beam (4) to the desired position.
- 6 Replace the axle beam bolts (3) and tighten the nuts.
- 7 Unscrew the jack and ground the wheel.
- 8 Check toe-in of front wheels by using toe-in setting gauge.
- 9 Loosen the two clamp bolts (6) on the left hand drag link.
- 10 Adjust length of drag link until toe-in marks on the left hand vertical spindle and arm are in line.
- 11 Tighten the clamp bolts.
- 12 Repeat procedure for right hand axle adjustment.

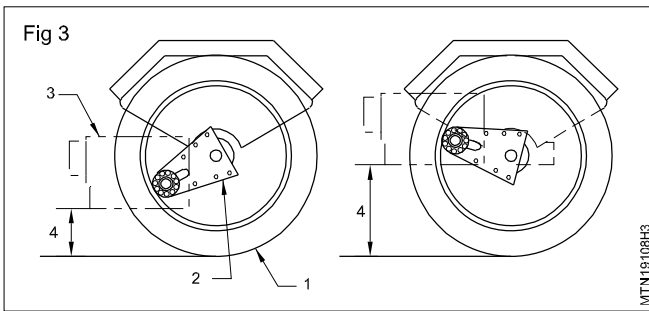
13 The procedure is the same for both sides but starting with left hand axle.

**14 Rear wheel track adjustment (Fig 2)**



15 Change the position of disc (1) and rim (2) relative to the rear axle (3).

- 16 After such a change it is important that the V of the tyre treads remains pointing in the direction of forward travel.
- 17 Adjusting wheel base and ground clearance of Tractor having final reduction. (Fig 3)



- 18 Remove the rear wheel (1).
- 19 Unscrew the bolts fixing the final reduction gear units (2) to the rear axle housing (3).
- 20 Rotate the final reduction gear unit clock wise/Anti clock wise together with axle shaft and brake drum to adjust the desired wheel base and ground clearance (4).

- 21 Replace the bolts fixing final reduction gear unit.
- 22 Tighten the bolts at the recommended torque.
- 23 Refit the wheels.

#### Tyre rotation for front & rear wheels

- 24 Remove the front wheels and interchange the left side and right side wheels.
- 25 Remove the rear wheels.
- 26 Loosen and remove the bolts connecting wheel rims with disc.
- 27 Dismantle the discs from the rims.
- 28 Interchange the discs of the left wheel and the right wheel.
- 29 Interchange the left and right wheels.
- 30 Refit the wheels on the hub.
- 31 Tighten the nuts with wheel spanner.
- 32 After such a change it is important that the "V" of the tyre-thread remains pointing in the direction of forward travel.

**Check and adjust the tire pressure by air / nitrogen**

**Objective:** At the end of this exercise you shall be able to  
 • **check and adjust the tire pressure (air/nitrogen).**

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Valve die	- 1 No.	• Cotton waste	- as reqd.
• Tyre pressure gauge	- 1 No.	• Check powder	- as reqd.
<b>Equipment/Machines</b>		• Valve pin	- as reqd.
• Tractor	- 1 No.		
• Compressor with gauge	- 1 No.		

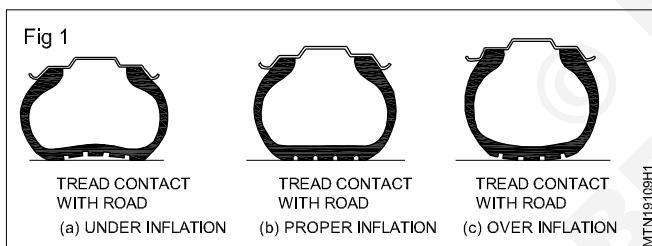
**PROCEDURE**

**Check and adjust tyre pressure**

- 1 Identify the vehicle type.
- 2 visually check the tyre pressure.
- 3 Check the tyre tread contact on road and compare with the (Fig 1) shown.
- 4 Check the tyre pressure with tyre pressure gauge.

- 5 Compare the tyre pressure with manufacturer specified limit.
- 6 Check the tyre pressure media (with air or nitrogen gas).
- 7 If the tyre pressure is low fill the air / nitrogen gas.

**Excessive tyre pressure leads to excessive tread wear low tyre pressure leads to excessive heat and premature failure.**



- 8 Ensure tyre pressure is within the specified limit.
- 9 If excess tyre pressure, adjust the pressure to the correct level.

**Overhaul the front and rear hydraulic brake**

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

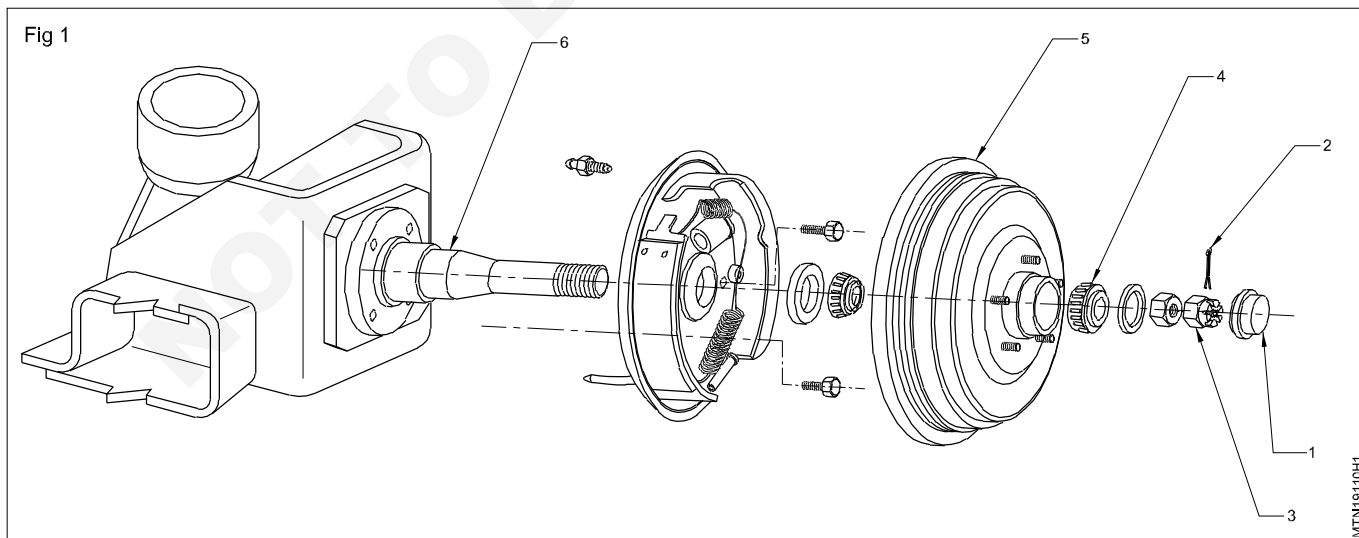
- remove brake shoe assembly and dismantle
- check the brake drums for crack, taper and ovality
- assemble the brake shoe
- test and adjust the brake
- overhauling rear brake
- remove and replace the brake shoe lining.

Requirements			
<b>Tools / Instruments</b>		<b>Materials</b>	
• Trainee tool kit	- 1 No.	• Brake shoe	- as reqd.
• Wheel spanner	- 1 No.	• Brake fluid	- as reqd.
• Hub spanner	- 1 No.	• Grease	- as reqd.
• Drum puller	- 1 No.	• Oil seal	- as reqd.
• Bearing puller	- 1 No.	• Cottor pin	- as reqd.
<b>Equipments / Machineries</b>		• Emery paper	- as reqd.
• Vehicle	- 1 No.	• Cotton waste	- as reqd.
• Jack and horse stand	- 4 Nos.	• Kerosene	- as reqd.
		• Plastic tray	- as reqd.
		• Wheel chock	- 1 Set
		• Wheel cylinder repair kit	- 1 No.
		• spilt pin	- as reqd.

**PROCEDURE**

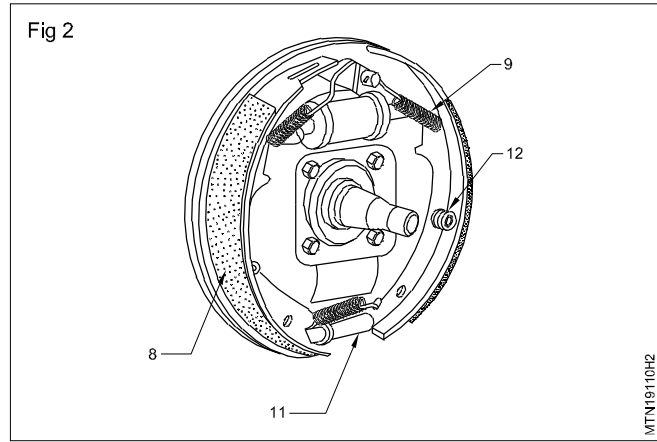
**TASK 1: Remove brake shoe assembly and dismantle**

- 1 Chock the rear wheels.
- 2 Loosen the front wheel nuts.
- 3 Remove the grease cap (1). (Fig.1)
- 4 Remove the cotter pin (2).



- 5 Loosen the axle nut (3).
- 6 Jack up the vehicle.
- 7 Fix horses under the front axle.
- 8 Remove the wheel nuts and wheel.
- 9 Take out the jack.
- 10 Release the brake shoes and make the brake drum free.
- 11 Remove the axle nut and washer.

- 12 Remove the outer bearing (4).
- 13 Remove the hub and drum (5) from the spindle or axle (6).
- 14 Take out the oil seal and inner bearing from the axle.
- 15 Remove the retracting spring (9) with a special tool (plier type or other type). (Fig 2)
- 16 Remove the hold-down spring (12).
- 17 Remove the brake shoes (8), primary and secondary (forward and reverse shoes).
- 18 Remove the adjuster.
- 19 Remove the parking brake cable and strut.



### TASK 2: Inspection

- 1 Check the lining for wear and crack.
- 2 Check the brake drum visually for scoring, pitting, crack etc.
- 3 Measure the brake drum for taper and ovality, and recommend for turning if the taper and ovality found more than the specified limit.
- 4 Reline the brake shoe with an oversize lining if the brake drum is recommended for turning.
- 5 Check the bearings visually for overheating, pitting and damage. Replace if necessary.
- 6 Check the oil seals.
- 7 Check the retracting spring and replace if necessary.

### TASK 3: Assembly

- 1 Fit the adjuster wheel.
- 2 Fit the parking brake strut.
- 3 Keep the primary and secondary shoes on the back plate with the wheel cylinder assembly.
- 4 Connect the primary and secondary shoes with the retracting spring.
- 5 Align the holes of the brake shoes with the back plate.
- 6 Fix the hold-down spring unit.
- 7 Assemble the brake drum and hub assembly.
- 8 New bearing and oil seals are to be inserted on the hub.
- 9 Inspect the brake shoe operation.
- 10 Adjust the brake shoes in a closer position (for inserting the drum easily).
- 11 Check the back plate, the shoe's retracting spring, hold-down spring unit and parking brake unit and wheel cylinder for correct position.
- 12 Fix the hub and drum on the spindle axle.
- 13 Insert the outer bearing washer and tighten it to the specified torque.
- 14 Check the bearing play by the dial test indicator.
- 15 If the play is more (excessive) remove the shim or washer.
- 16 Tighten the hub nut to the specified torque. Check for free rotation of the brake drum and hub.
- 17 If the play is less on the hub slightly loosen the spindle nut and check it.
- 18 The split pin hole is parallel to the insert and the drum rotates freely.
- 19 Fit the wheel on the drum or hub and tighten the wheel hub.
- 20 Adjust the brakes.

### TASK 4: Brake adjusting methods

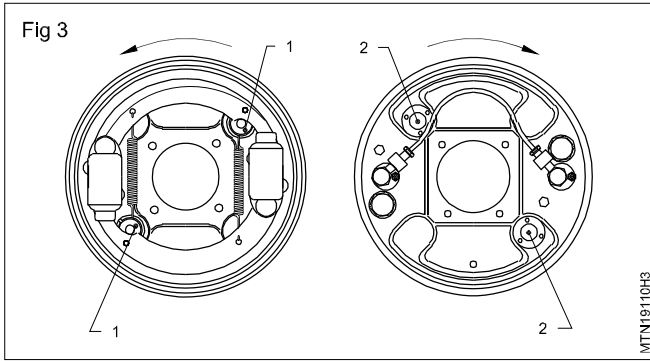
- Cam type adjustment
- Notch type adjustment

#### Cam type adjustment

In the Mahindra jeep this type of adjustment is provided as shown in the figure.

- 1 On the back side of the back plate an eccentric cam's (1) projection rod (2) with a nut is placed. (Fig 3)
- 2 Loosen both the side nuts.
- 3 Adjust the eccentric cam rod lock fully.
- 4 Slightly loosen both the sides and rotate the wheels for freeness.



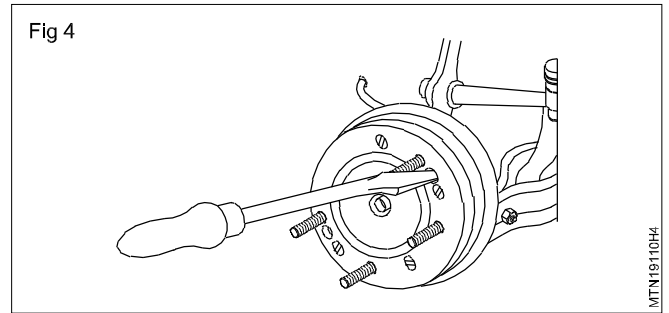


- 5 For some vehicles it is necessary to check with a feeler gauge between the shoe and drum.
- 6 Lock the eccentric cam with special spanners.

#### Screw type adjustment

- 1 Ambassador cars and some other vehicles are provided with this type.
- 2 Locate a hole on the drum as shown in the (Fig 4).

- 3 First fully tighten the screws as shown in the (Fig 4).



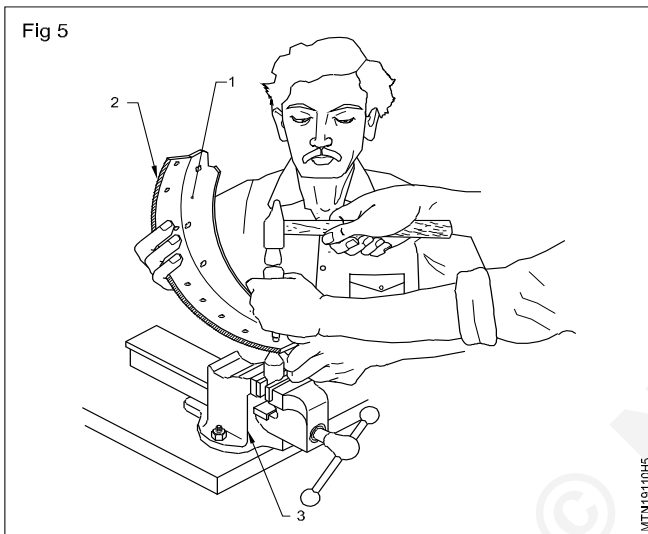
- 4 Slightly loosen the screws for free rotation.
- 5 Note the wheel rotates freely and check the efficiency.
- 6 Jack up the vehicle.
- 7 Remove the horses.
- 8 Insert the cotter pin.
- 9 Tighten the wheel nuts at the specified torque.
- 10 Remove the chocks from the rear end.

#### TASK 5: Rear wheel brakes

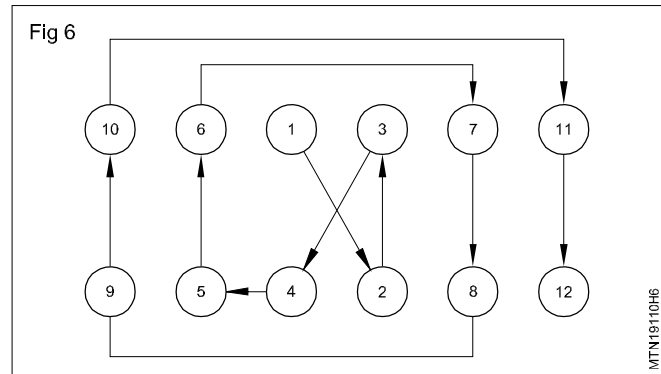
- 1 Place choke on the front side.
- 2 Loosen the wheel nuts.
- 3 Move the axle pin and loosen the nut.
- 4 Jack the rear side and place horses properly.
- 5 Remove the wheels and axles.
- 6 Loosen the brake unit.
- 7 Loosen the hub nut and remove the locks.
- 8 Remove the hub.
- 9 Remove the outer bearing.
- 10 Remove the oil seal and inner bearing.
- 11 Check the bearing sleeve on the hub.
- 12 If the sleeve is rotating then insert a new sleeve on the hub.
- 13 Clean the parts.
- 14 If drum truing is necessary get it done.
- 15 Remove the retracting spring with the special tools.
- 16 Remove the hand brake lever.
- 17 Remove the shoes.
- 18 If it is necessary to line the shoes, re-line with an oversize lining.
- 19 Clean all the parts.
- 20 Refit the shoes, retracting spring, hand brake lever and the hold-down spring.
- 21 Check the correctness of assembling on the back plate.
- 22 Assemble the hub with grease and new parts.
- 23 Insert the hub and tighten the nuts.
- 24 Check the play and if it is necessary to adjust, do it and lock it.
- 25 Fix the wheel and tighten the wheel nuts.
- 26 Insert the axle and tighten the nuts.
- 27 Jack up the vehicle.
- 28 Adjust the brakes.
- 29 Remove the horses and jack.
- 30 Tighten the hub nuts.
- 31 Tighten the wheel's nuts to the specific torque.
- 32 Bleed the brakes.
- 33 If any adjustment is required
- 34 do it.
- 35 Check all the four wheels.
- 36 Take a road test.
- 37 If any adjustment is necessary, do it.

## TASK 6: Remove and replace new lining

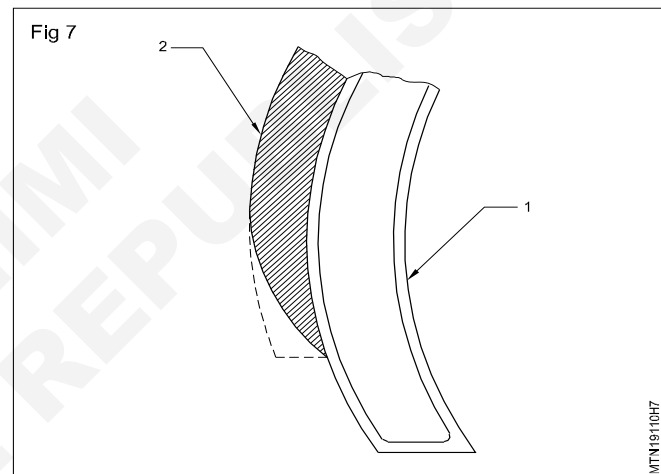
- 1 Inspect the brake shoe and lining for wear.
- 2 Drill the old rivets.
- 3 File off burrs and high spots.
- 4 Remove the old lining.
- 5 Select the correct size of the brake lining according to the size of the drum.
- 6 Select rivets according to the hole size.
- 7 Clean the contact surfaces of the shoe and lining.
- 8 Align the rivet holes on the brake lining with the brake shoe.
- 9 Clamp the linings (2) to the brake shoe (1) with 'C' clamps in the vice (3). (Fig 5)



- 10 Adjust the 'C' clamps as close as possible to the rivet holes.
- 11 Start riveting from the centre towards the ends (or as per manufacturer's specification). (Fig 6)



- 12 Drive the rivets squarely into the holes with a flat head drift.
- 13 After riveting check the clearance between the lining and the shoe with a feeler gauge. Measure the clearance in between the rivets.
- 14 File the lining (2) at both ends to have smooth curved ends. (Fig 7)



**Inspect the spring of both shoe and lever**

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

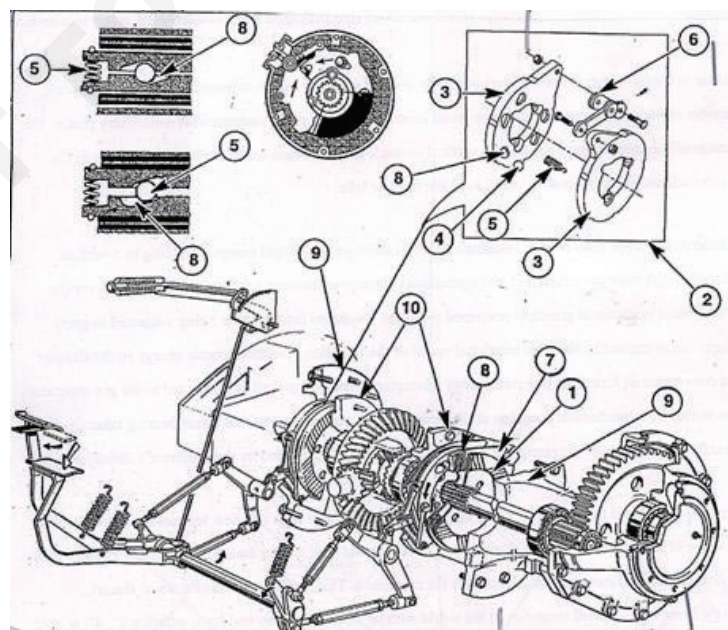
- remove the brake assembly
- inspect the activating assembly
- assemble the activating assembly.

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
<ul style="list-style-type: none"> <li>• Trainees Tool Kit</li> <li>• Circlip plier</li> <li>• Nose plier</li> <li>• Torque wrench</li> <li>• Jack</li> </ul>	<ul style="list-style-type: none"> <li>- 1 No.</li> <li>- 1 No.</li> <li>- 1 No.</li> <li>- 1 No.</li> <li>- 1 No.</li> </ul>	<ul style="list-style-type: none"> <li>• Tractor</li> </ul>	<ul style="list-style-type: none"> <li>- 1 No.</li> </ul>
		<b>Materials/Components</b>	
		<ul style="list-style-type: none"> <li>• Tray</li> <li>• Thinner</li> <li>• Cotton waste</li> </ul>	<ul style="list-style-type: none"> <li>- 1 No.</li> <li>- as reqd.</li> <li>- as reqd.</li> </ul>

**PROCEDURE**

**Removing Rear Wheels and Rear Brake shoes**

- 1 Place the Tractor on plain surface.
- 2 Block the front wheels.
- 3 Jack up the rear wheel support with horses / jack stand.
- 4 Remove battery clamps.
- 5 Remove the yoke pin and dismantle link rod.
- 6 Remove the wheel.
- 7 Remove the activated spring which is holding both disc.
- 8 Remove the balls, disc plate, shoes, lever.
- 9 Clean and inspect all the parts and braking surfaces and brake housing.
- 10 Check the brake shoe retainer spring tension if need replace it.
- 11 Check the linkage and lever.
- 12 Replace damaged linkage and lever.
- 13 Check the friction disc slide freely on the split shaft.
- 14 Check brake housing surface and brake shoe.
- 15 If worn or damage breake shoe replace.
- 16 Assemble all the parts, make sure that the parts are seated properly.
- 17 Hook on the return springs between breake shoe (assembly).



**Inspection and setting parking brake**

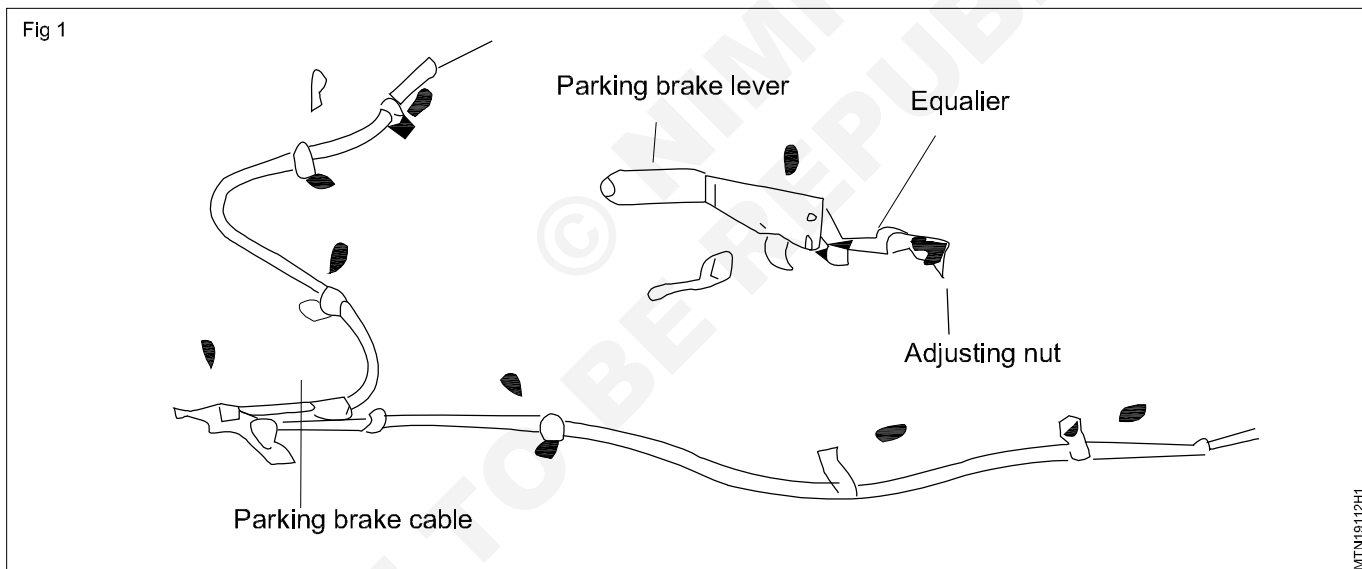
**Objectives:** At the end of this exercise you shall be able you to

- **adjust handbrake for effective handbrake application**
- **replace handbrake cable if old cable found to be out of adjustment range.**

Requirements			
<b>Tools/Instruments</b>		<b>Materials</b>	
• Trainees Tool Kit	- 1 No.	• Lubricating oil	- as reqd.
• Wheel spanner	- 1 No.	• Grease	- as reqd.
• Drum puller	- 1 No.	• Cotton waste	- as reqd.
• Brake shoe retainer	- 1 No.	• Kerosene	- as reqd.
<b>Equipment/Machines</b>		• Wheel chock	- as reqd.
• Jack and horse stand	- 1 No.		

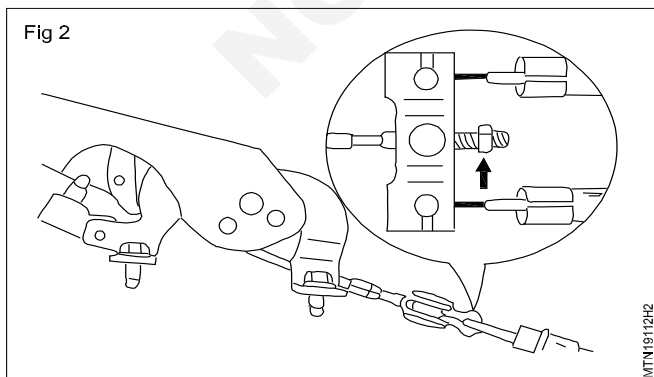
**PROCEDURE**

**Components (Fig 1)**



**Removal**

1 Remove the console (Fig 2)



- 2 Loosen the adjusting nut and detach the parking brake cable.
- 3 Detach the parking brake switch assembly.
- 4 Remove the parking brake lever assembly
- 5 Remove the wheel and tire
- 6 Remove the brake drum
- 7 Remove the brake shoes as outlined before
- 8 Detach the parking brake cable from the brake shoe
- 9 Remove the parking brake cable retaining in the near of
  - Remove the parking brake cable clamp and remove the cable assembly.

### Inspection

- Check the parking brake switch operation.
- Check the parking brake lever ratchet for wear.
- Check the cable for fraying or damage.

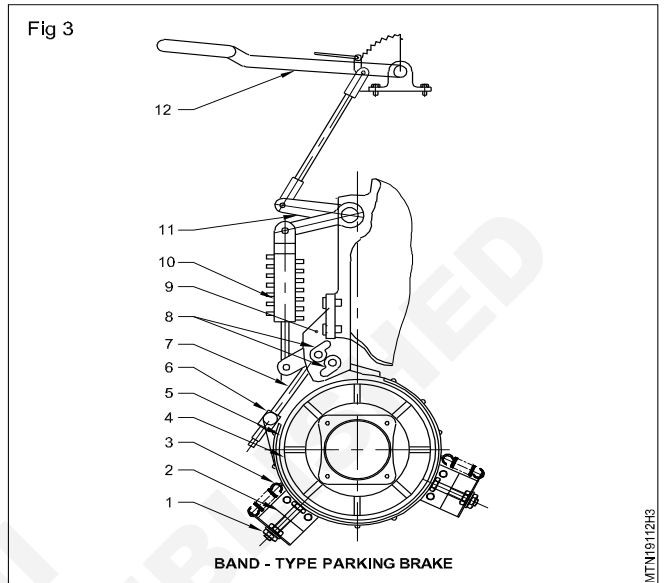
### Installation

- Check the parking brake cables from left and right.
- Check the identification marks and install according.
- Move the adjust lever instale the shoe-to-shoe spring.
- Install the grommets according to direction.
- Apply specified grease to the sliding parts and ratchet power.
- Install the cable adjuster.
- Adjust the parkings brake lever stroke.

### Band type parking brakes Fig (3)

- 10 Inspect the hand operating lever (12).
- 11 Inspect the linkages (11).
- 12 Inspect the retainer spring (10).
- 13 Inspect the operating lever pivot pins (8).

- 14 Inspect band operating lever (7).
- 15 Inspect brake band (5).
- 16 Inspect band operating lower adjusting nut (6).
- 17 Inspect the brake band liner (4).
- 18 Inspect the brake band mounting bracket (2).
- 19 Inspect the brake band mounting balt (1).



**Practice to inspecting and setting hydraulic brake of tractor**

- Objectives:** At the end of this exercise you shall be able you to
- locate the different parts of hydraulic brake system of tractor
  - inspect the parts of hydraulic brake system
  - setting of hydraulic brake and adjust brake pedal free play.

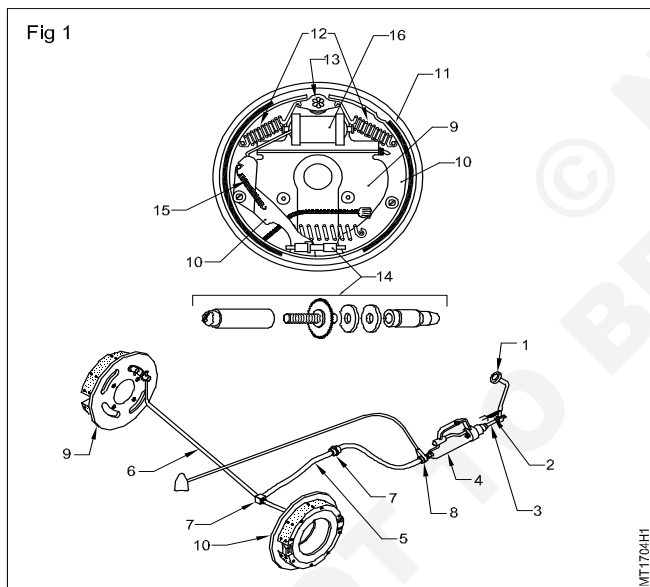
Requirements			
<b>Tools/Instruments</b>		<b>Materials</b>	
• Trainees Tool Kit	- 1 No.	• Brake fluid	- as reqd.
• Tractor service manual	- 1 No.	• Cotton waste	- as reqd.
<b>Equipment/Machines</b>		• Soap oil	- as reqd.
• Tractor	- 1 No.		
• Brake bleeding kit	- 1 No.		

**PROCEDURE**

**1 Inspecting and setting hydraulic brake system of tractor**

- Park the tractor on the level place
- Place the wooden block front and rear side of tractor wheel.

- Check the master cylinder fluid level.
- Check the fluid line leakages.
- Check the function of master cylinder on applied position and dis engage position, check the wheel cylinder function.
- Check the brake pedal free play.
- Check brake fluid pressure from 6.5 to 8.5 if less 6.5 bar overhaul the master cylinder.

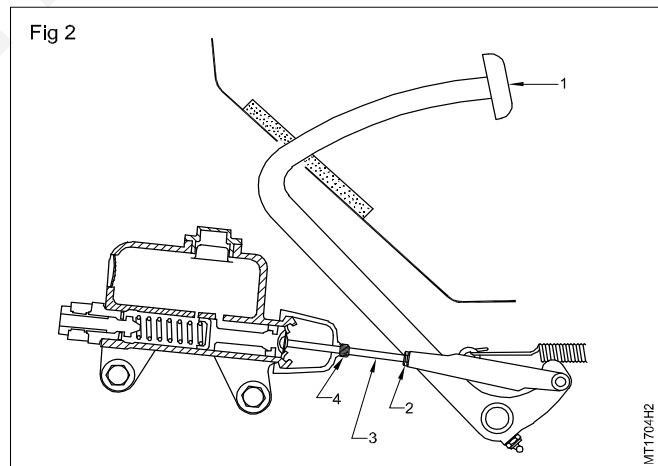


- 2 Locate the different parts of the Brake system
- 3 Brake pedal (1), Brake pedal return spring (2)
- 4 Brake push rod (3), Master cylinder (4)
- 5 Brake steel pipe lines (5) &(6), Brake pipe line unions (7)
- 6 Stop light switch (8), Back plate carrier (9)
- 7 Brake shoe(10), Brake lining(11)
- 8 Shoe return spring (12), Pivot(13)
- 9 Brake adjuster (14), Hold down spring (15)
- 10 Wheel cylinder (16)

**11 Inspection of tractor hydraulic brake system**

- Check the master cylinder mounting.

12 Adjusting brake pedal free play: Check the free play of the brake pedal (1). In case play is not in the range of 6mm to 12mm, adjust it. (Fig 2)



**Loosen the lock nut (2) and adjust the clevis (4) on the brake push rod (3). Increase the effective length of pushrod if play is more. Decrease the effective length of pushrod if play is less.**

13 Again check the free play of the pedal. Tighten the lock nut (2) when the required free play of pedal is achieved.

**Overhauling the master cylinder assembly**

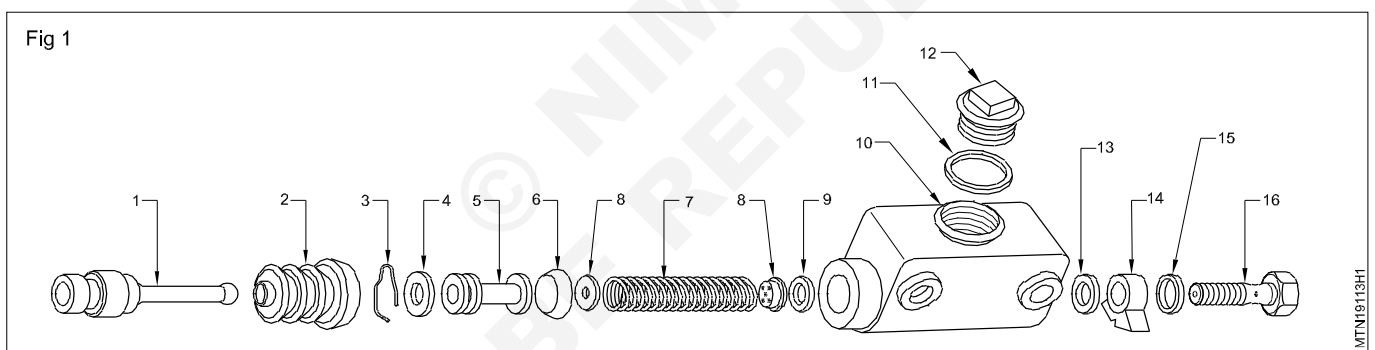
**Objectives:** At the end of this exercise you shall be able you to

- **remove the master cylinder from a tractor**
- **dismantling the master cylinder**
- **inspect the parts of the master cylinder**
- **assembling and testing the master cylinder.**

Requirements		
<b>Tools/Instruments</b>		<b>Materials/Components</b>
<ul style="list-style-type: none"> <li>• Trainees Tool Kit</li> <li>• Vice</li> <li>• Circlip plier</li> <li>• Nose plier</li> <li>• Jack / horses</li> </ul>	<ul style="list-style-type: none"> <li>- 1 No.</li> <li>- 1 No.</li> <li>- 1 No.</li> <li>- 1 No.</li> <li>-1 No/each</li> </ul>	<ul style="list-style-type: none"> <li>• Tray</li> <li>• Brack fluid</li> <li>• Cotton waste</li> <li>• Grease</li> <li>• Wire</li> <li>• Oil seal</li> </ul>
<b>Equipment/Machines</b>		
<ul style="list-style-type: none"> <li>• Tractor</li> </ul>	- 1 No.	<ul style="list-style-type: none"> <li>- 1 No.</li> <li>- as reqd.</li> <li>- as reqd.</li> <li>- as reqd.</li> <li>- as reqd.</li> <li>- as reqd.</li> </ul>

**PROCEDURE**

**Removal and Dismantling Master Cylinder (Fig 1)**



- 1 Drain the hydraulic fluid from the master cylinder through the fluid outlet union and take out the union (14). Clean the master cylinder externally.
- 2 Remove the filler cap (12) along with the gasket (11).
- 3 Drain the fluid from the reservoir (10).
- 4 Hold the master cylinder (10) in a vice with soft jaws.
- 5 Remove the push-rod (1).
- 6 Take out the dust boot (2).
- 7 Remove the circlip lock (3) with the help of a nose plier.
- 8 Remove the piston stop-washer (4).
- 9 Remove the piston (5) along with the secondary cup.
- 10 Remove the primary cup (6).
- 11 Take out the return spring (7) (if provided) along with the check valve (8).
- 12 Remove the check valve seat (9).

**Cleaning and Inspection**

- 13 Clean all the parts thoroughly by washing in brake fluid. (Don't use petrol or kerosene)
- 14 Inspect all the parts visually and replace the unserviceable parts.

- 15 Measure the cylinder bore. Hone it, if found worn out excessively.

**Replace if it is worn out more than the manufacturer's specified limit.**

- 16 Measure the clearance between the piston and the cylinder bore; replace the piston if the clearance found to be more than the specified limit.
- 17 Clean the vent port and the compensating port with a wire and make sure that passages are free and clear from any foreign materials.
- 18 The piston, primary and secondary cups, check valve, and the valve seat are always replaced during a major overhaul. All these parts come in a kit. Soak the new kit in the hydraulic fluid before replacement.

**Assembling the master cylinder**

- 19 Hold the master cylinder in the vice with soft jaws.
- 20 Clean with and apply brake fluid inside the master cylinder bore.

- 21 Dip all the components in the brake fluid.
- 22 Assemble the check valve seat (9).
- 23 Fix the return spring (7) along with the check valve (8).
- 24 Assemble the primary cup (6).
- 25 Assemble the piston (5) along with the secondary cup.
- 26 Fix the piston stop-washer (4).
- 27 Lock the piston (5) with a circlip lock (3).
- 28 Refill fluid in the reservoir (10).
- 29 Refit the filler cap (12) along with the gasket (11).
- 30 Operate the piston with a rod.

- 31 Ensure that the fluid comes out with pressure from the outlet and also that the piston (5) comes to its original position quickly.
- 32 Check for leakage of the piston in the primary cup side.
- 33 Fix the dust boot (2).
- 34 Assemble the push-rod (1).
- 35 Fix the outlet union (14) with new gaskets (13) & (15) and tighten the bolt (16).
- 36 Fit the master cylinder assembly to its position in the tractor.
- 37 Bleed the brake system.
- 38 Test the performance of master cylinder by apply brake.

## Job Sequence

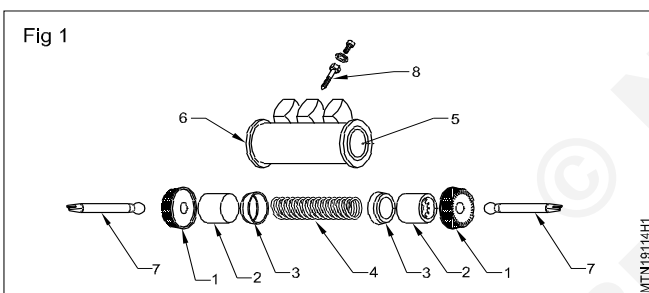
### Overhauling the wheel cylinder

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

- remove rear the wheel cylinder
- clean and inspect
- assemble the brake shoe.

#### Removing wheel cylinder

- Jack up the tractor and remove the wheel hub and drum.
- Disconnect the brake pipe line and the fitting on the brake shoes to get clear access to the brake wheel cylinder (6). (Fig 1)



- Remove the two screws holding the wheel cylinder to the backing plate and remove the wheel cylinder (6).

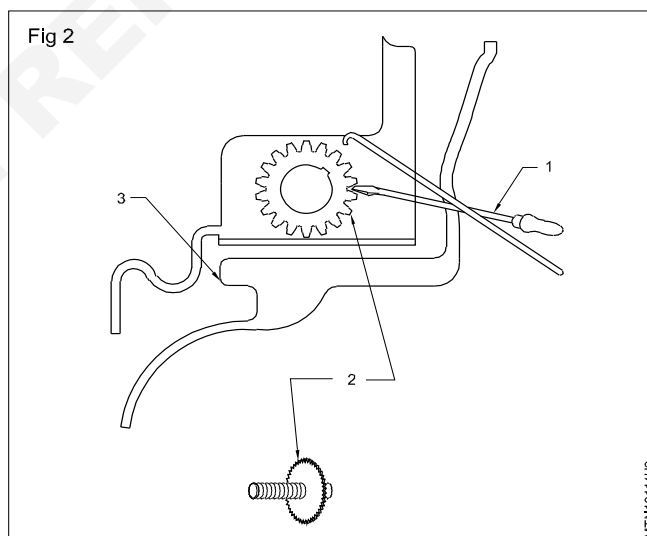
#### Dismantling wheel cylinder

- Remove the rubber dust covers or boots (1) at the ends of the cylinder and the brake shoe activating pin (7).
- Remove the pistons (2) and piston cups (3) and the spring (4).
- Remove the bleeder valve (8).
- Wash the parts in brake fluid.
- Inspecting parts of Wheel cylinder.
- Check bleeder valve (8) and clean.
- Check the cylinder bore (5) for roughness or scoring.
- Check the clearance between the pistons (2) and the cylinder bore (5) by using a 0.05 mm feeler gauge.
- Dip the spring (4), pistons (2) and the piston cups (3) in brake fluid, before reassembling.

#### Assembling wheel cylinder

- Install the spring (4) in the centre of the wheel cylinder (while replacing spring, piston, cup, use new kit).
- Install the piston cups (3) with the cupped surface towards/inside the spring so that the flat surface will be against the pistons (2).

- Install the piston (2) and dust covers (1) and bleeder valve (8).
- Install the wheel cylinder to the backing plate.
- Fix the brake shoe actuating pin (7) and align with the shoe.
- Connect the brake line and install the brake shoes and return spring.
- Refit the drum, hub and wheel.



#### Brake Adjustments

##### A Cam Type Adjustments

- On the back side of the back plate an eccentric cams with a nut is placed
- Loosen both the side nuts.
- Adjust the eccentric cam rod lock fully. Slightly loosen both the sides and rotate the wheels for freeness.
- Check with feeler gauge the gap between shoe and drum according to manufacturer specification and adjust if required.
- Lock the cam.



**Bleeding the brake system**

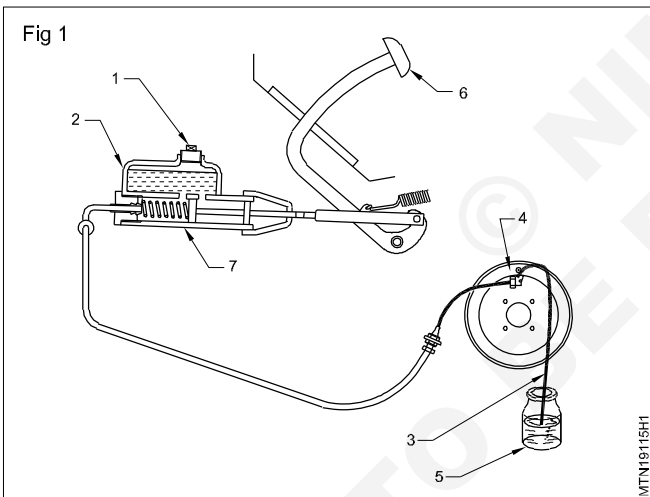
**Objective:** At the end of this exercise you shall be able you to  
 • **bleed the hydraulic brake system.**

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Jack/Horses	-1 No/each	• Brake fluid	- as reqd.
• Feeler gauge	- 1 No.	• Cotton waste	- as reqd.
<b>Equipment/Machines</b>		• Bleeder hose	- as reqd.
• Tractor	- 1 No.	• Bleeder nipple	- as reqd.
		• Soap oil	- as reqd.

**PROCEDURE**

**TASK 1: Hydraulic brake bleeding**

Clean all the dirt found around the master cylinder filler cap (1) (Fig 1).



Remove the filler cap (1).

Fill the master cylinder reservoir (2) up to the lower edge of the filler neck with brake fluid recommended by the manufacturer.

Close the filler cap (1).

Clean the wheel cylinder's bleeder connection.

Connect the bleeder hose (3) to the longest distance of the wheel bleeder screw (4).

Place the other end of the tube in a glass jar (5) and submerge it in the brake fluid.

Apply the brake pedal (6) three or four times until pressing is hard.

Open the bleeder screw one half to three quarters of a turn and observe in the jar. Bubbles will form in jar (5).

Repeat this until only the fluid comes out of the bleeder screw forcing all the air in the line out.

Close the bleeder screw (4).

Fill the brake fluid again in the master cylinder reservoir (2).

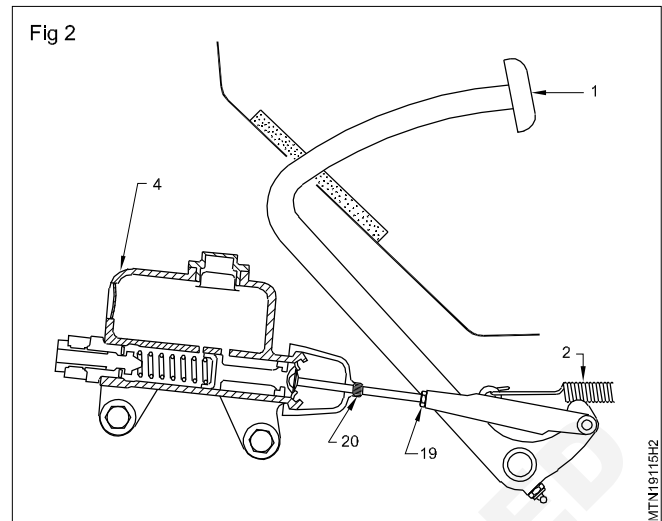
Repeat the above steps for all the wheels.

After removing air from wheel cylinders fill the brake fluid in the master cylinder reservoir (2) to the required level.

Check the tightness of the bleeder screws (4) in all the wheel cylinders.

## TASK 2: Adjusting brake pedal free play. (Fig 2)

- 1 Check the play of brake pedal and observe that play in the range of 6 mm to 12 mm.
- 2 Loosen the lock - nut (19).
- 3 Adjust the clevis (20).
- 4 Tighten if the play of the pedal (1).
- 5 Again check the free play of the pedal (1).
- 6 Tighten the lock - nut (19) when required free play of pedal (1) is achieved.



**Tracing fault tracing in brake system and remedies**

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

- rectify brake scraping noise
- rectify vehicle pulling to one side
- rectify poor braking action.

<b>Requirements</b>			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Cotton waste	- as reqd.
• Brake bleeding kit	- 1 No.	• Brake fluid	- as reqd.
<b>Equipment/Machines</b>		• Master cylinder repair kit	- as reqd.
• Hydraulic brake vehicle	- 1 No.	• Wheel cylinder repair kit	- as reqd.
		• Brake liner and repair kit	- as reqd.

**PROCEDURE**

**Causes and remedies for brake defects**

<b>Brake defects</b>	<b>Cause for defects</b>	<b>Remedies</b>
Low brake fluid	Leakage in brake system	Replace defective component
Low brake pedal	Shoe adjuster on drum brakes sticky	Adjust
Sponge or soft pedal	Improper air bleeding	Bleeding properly
Excessive pedal travel	Miss adjusted/ wear lining	Adjust/ replace the liner
Pedal sinks to floor	Worn internal rubber seats in master cylinder	Replace
Pedal pulsation	Brake rotor face out	Resurface / replace
Scraping noise	Brake shoe liner wron-out	Replace
Squeals	Caliper disc pad w/o	Replace
Grabby brakes	Oil, grease, fluid on the lining	Clean
Dragging brakes	Weak/ broken retraction springs	Replace
Brake pull to one side	Contamimiated linings/ misadjusted	Replace/ adjusted
Hard pedal	Leaky vacumms hose/ defective booster defective master cylinder/ wheel cylinder	Replace Repair

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**Skimming of brake drum and disc plate**

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

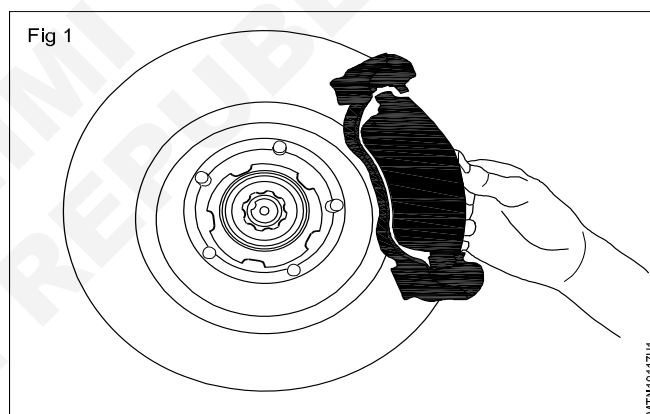
- inspect brake drum and disc plate
- skimming of brake drum and disc plate.

Requirements			
<b>Tools/Instruments</b>		<b>Equipment/Machines</b>	
• Trainees Tool Kit	- 1 No.	• Tractor	- 1 No.
• Surface plate	- 1 No.	<b>Materials/Components</b>	
• Straight edge	- 1 No.	• Cleaning solvent	- as reqd.
• Feeler gauge	- 1 No.	• Cotton waste	- as reqd.
• Micrometer outside	- 1 No.	• Tray	- as reqd.
		• Soap oil	- as reqd.

**PROCEDURE**

**TASK 1: Inspection**

- 1 Check the brake lining/pad wear and crack.
- 2 Check the disc, rusty, wobble and wear.
- 3 Check the brake drum distort, rust and corrosion.
- 4 Measure the brake drum for taper and ovality.
- 5 Measure the thickness of disc plate, scraping and uneven wear.
- 6 Check the brake shoe. (Fig 1)



**TASK 2: Skimming of brake drum and disc plate**

- 1 Skimming is a process done on a brake drum/disc by removing a certain layer to restore its original surface. Brake drums and brake disc are subjected to intense heat during application of brakes. This might cause the metal to warp due to excess heat buildup. (Slight bending or distortion)
- 2 When drum rotating it is likely to wobble so check the brake drum/disc condition
- 3 The brake drum/disc distortions cause of brake shoe or pad friction lining wears beyond recommended levels. This makes metal on metal contact creating some distortions on the surfaces.
- 4 So to remove some distortions both disc and brake drum understand goes skimming.
- 5 A lathe machine is used to perform this exercise. The exercise is carried out by a person who has done machining.
- 6 When the disc or drum is warped it will also be corrected by skimming. The symptom of a warped disc or drum is some pulsating feel on the brake pedal as you apply the brakes.
- 7 Remove the drum/disc from the tractor and clean it.
- 8 Inspect the surface of the drum or disc of the tractor.
- 9 If found more warpage, then set drum/ disc on the lathe for skimming.
- 10 After setting the drum on the lathe, ensure brake drum is properly aligned.
- 11 Rotate the drum again check the alignment. Start the lathe and check by running the drum.
- 12 Set the cutting tool and start the skimming as per instructors guide line up to specified limit recommended by manufacturers.
- 13 Remove the brake drum or brake disc from the lathe and clean the skimmed surface of the brake drum/disc.
- 14 Measure the thickness of drum after skimming final cut maximum up to 0.5 mm only .
- 15 Fix the brake drum/disc on the tractor and assemble the remain brake parts and bleeding the brake.
- 16 Check the braking efficiency of the tractor on the road.

## Overhauling the main clutch of power tiller

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

- **dismount 'V' belts**
- **open the main clutch assembly**
- **inspect the clutch parts**
- **refit the clutch.**
- **remove the steering clutch assembly**
- **servicing and assembling of the steering clutch**

### Requirements

#### Tools/Instruments

- Trainees Tool Kit - 1 No.

#### Equipment/Machines

- Tractor/Power - 1 No.
- Spring loaded cultivator - 1 No.
- Disc plough - 1 No.
- Tractor ridger - 1 No.
- Tractor rotavator - 1 No.
- Jack - 1 No.

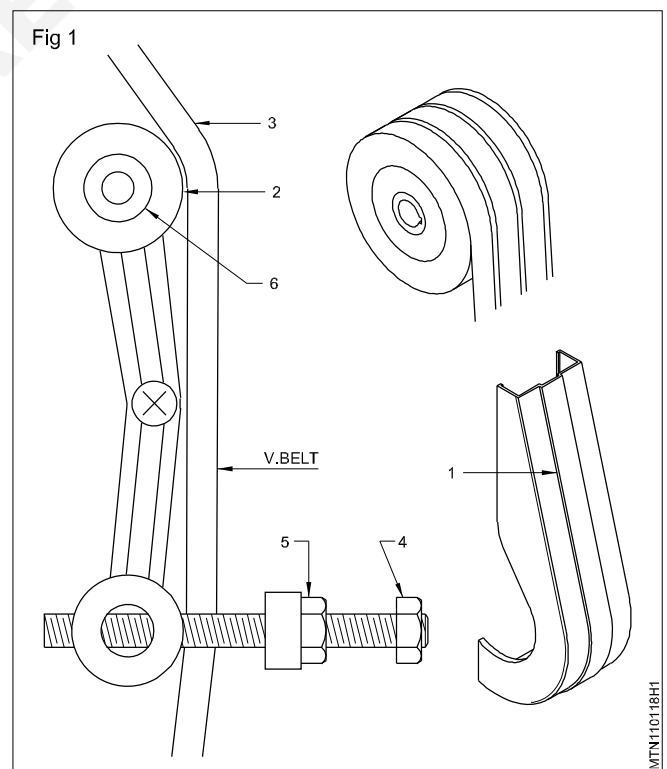
#### Materials/Components

- Cotton cloth - 1 No.
- Lock pin - as reqd.
- Hitch pin - as reqd.
- Oil - as reqd.
- Wooden block - as reqd.
- Tray - as reqd.
- Solvent - as reqd.
- Transmission oil - as reqd.
- 'O' ring - as reqd.

## PROCEDURE

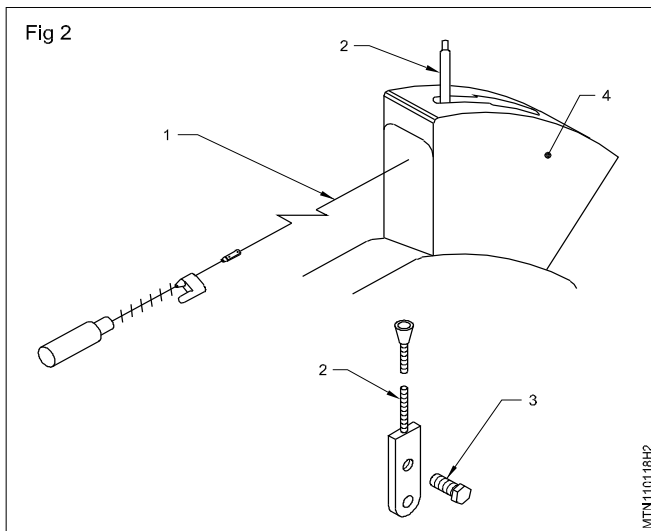
### TASK 1: Dismounting of 'V' belts

- 1 Remove the cover (1). (Fig 1)
- 2 Loosen the belt tensioner (2) with the help of adjusting screw (4) and locknut (5).
- 3 Dismount the belts (3).
- 4 Disconnect clutch release lever cable.
- 5 In certain make of power tiller the engine is mounted on the railing to ease the removal and adjustment of belts. If such facility is available, Loosen the foundation bolts and move engine forward or backward to adjust required tension with the help of adjustable screws.

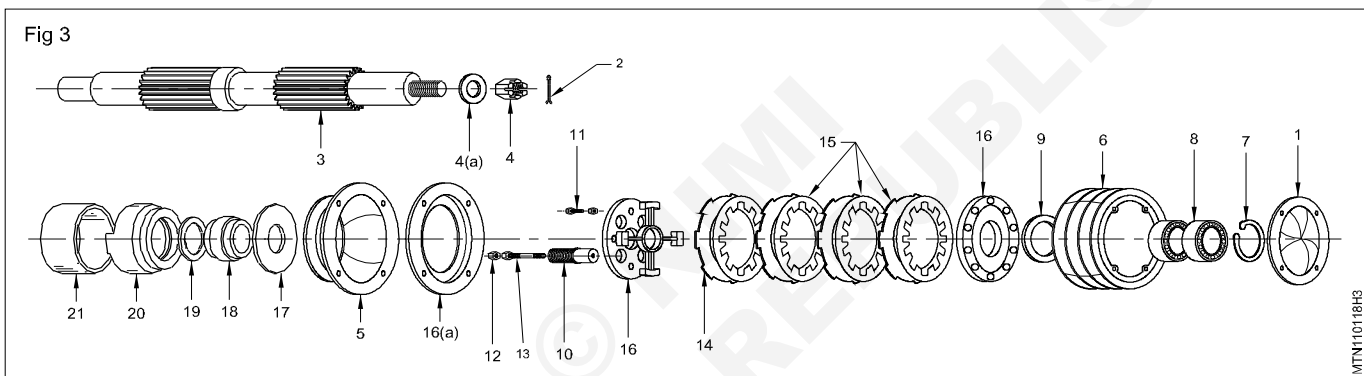


## TASK 2: Opening of the main clutch assembly (Fig 2)

- 1 Disconnect main clutch rod (1) Fig 2 from the clutch release lever (2). (Fig 2) after removing pivot pin 3 (Fig 2) in the lever cover 4 (Fig 2).



- 2 Remove the outer cover (1). (Fig 3)
- 3 Remove the split pin (2) Fig 3 of the clutch shaft (3). (Fig 3)
- 4 Remove locknut (4) and washer (4a). (Fig 3)
- 5 Remove clutch assembly cover of inner side (5). (Fig 3)
- 6 Slide the pulley (6) out.
- 7 Remove circlip (7) from the pulley (6).
- 8 Remove bearing set (8).
- 9 Remove spacer (9) from clutch shaft.
- 10 Slide and remove clutch assembly out with the help of soft hammer striking mildly or by using puller.
- 11 Compress the clutch assembly in a press/vice/clamps to compress all four pressure plate springs (10).
- 12 Loosen its checknuts (12), and studs (13)/fingers. Remove screws (11).
- 13 Remove clutch compression plate (14).



- 14 Separate the frictional plates (15) and pressure plates (16) from clutch driven plate (16a).
- 15 Remove clutch release assembly.
- 16 Remove shifter (17) and release bearing (18).
- 17 Remove spacer (19).
- 18 Remove clutch cam (20) with cover (21).

## TASK 3: Inspection

- 1 Wash all metal parts with recommended solvent.
- 2 Check tensioner bearing (6) (Fig 1) for smooth rotation.
- 3 Check 'V' belts (3) (Fig 1) surface for damage and cracks. Check if threads are exposed.
- 4 Check operating lever rod (1) (Fig 2) pivot pin (3) (Fig 2) for damage.
- 5 Check bearing (8) (Fig 3) fitted to the 'V' pulley (6) (Fig 3) of the main clutch assembly.
- 6 Clean the frictional plate facings (15) (Fig 3) with recommended fluid and check for their serviceability.
- 7 Check compression plate (14) pressure (metal) plate (16) (Fig 3) for overheating.
- 8 Check clutch springs (10) Fig 3 for cracks, squareness and tension.
- 9 Check all the studs and (11) bolts (12) Fig 3 and screws and nuts for corrosion and damage of threads.
- 10 Check the face of clutch shifter (17) Fig 3 for unevenness and check internal spline ridges.
- 11 Check clutch release bearing (18) for wear out.
- 12 Check clutch cams (20) for wear.
- 13 Repair and Service
- 14 Change all the worn-out pivot pins bolts and split pins.
- 15 Replace worn-out and damaged 'V' belts. (Use only recommended belts)
- 16 Replace bearings if they are worn-out or corroded.
- 17 Replace clutch release bearing if worn-out.
- 18 Replace the worn-out clutch facings.
- 19 Replace damaged clutch driven metal plate.
- 20 Replace broken and corroded springs.

#### TASK 4: Assembly

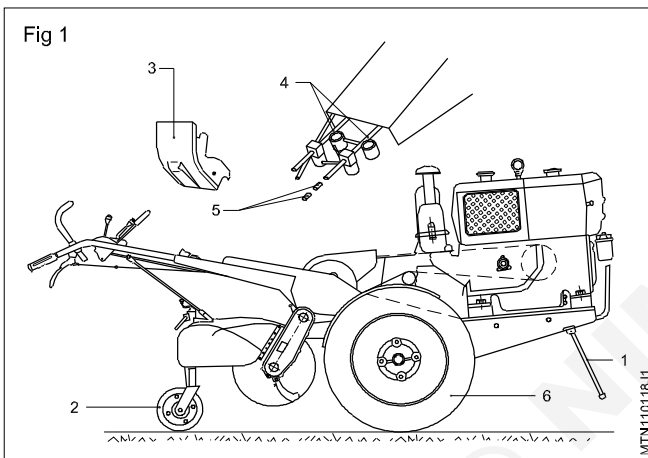
- 1 Reverse the procedure of dismantling to fit main clutch assembly.
- 2 Check the operation.
- 3 Make necessary adjustments as recommended by the manufacturer.

**The clutch plates facings should be evenly placed and positioned for uniform distribution of the pressure. Turn locking nuts of the spring bolts by one or two turns to get uniform placement of plates.**

**Ensure that 1 or 2 mm length of spline is outside the shifter. Adjust the locknut to get the length of spline exposed at required length.**

**Whenever bearings are to be refitted or replaced ensure that bearings are cleaned and lubricated properly with recommended grease.**

#### TASK 5: Remove of steering clutch assembly (Fig 1)



- 1 Install the power tiller on a plane surface supported on front stand (1) and tail wheel (2).
- 2 Drain out oil in a tray from transmission unit.
- 3 Remove front cable cover (3) of the handle.
- 4 Dislink steering clutch wires (4) left and right from the piece ends (5).
- 5 Provide jack stands supporting left and right axles of the power tiller to lift both wheels (6).
- 6 Dismount the wheels (6) and let the power tiller rest on four points, viz. front stand, tail wheel and two jack stands.

- 7 Remove lock bolts (1) from the levers (2). Mark the levers to avoid interchange at the time of fitting.
- 8 Pull out the levers (2) upwards with slight jerk.
- 9 Remove cover bolts (3) of the steering clutch assembly.
- 10 Remove the front transmission cover (4) of the steering clutch.
- 11 Remove the yokes (5) from the cover (left and right) after removing shank key (6). (Note that the yokes are not interchanged while refitting - Mark each yoke suitably.
- 12 Remove the side clutch covers (7) and remove bearings (8) by puller.
- 13 Remove clutch - springs (9) with spacer (10).

**The springs are not interchanged.**

- 14 Remove side clutch (11).
- 15 Retain the side clutch shaft (12) with side clutch gear (13) in position.

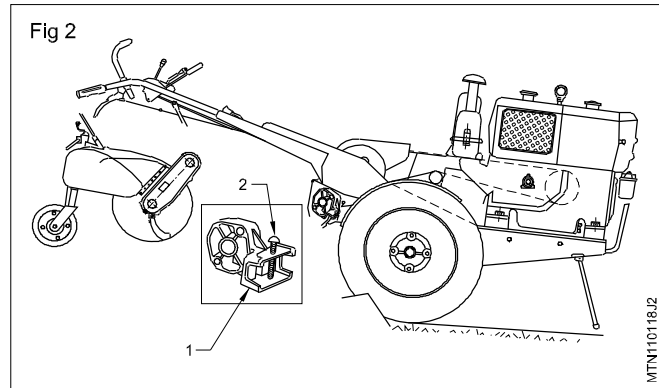
**The side clutch shaft can be removed only after dismantling gear box.**

#### TASK 6: Inspection (Fig 2)

- 1 Clean all the dismantled parts of the steering clutch assembly with suitable solvent.
- 2 Check clutch wires (4) Fig 1 and their sleeves for free movement.
- 3 Check all the pivots bolts and pins for wear and corrosion.
- 4 Check the teeth and flanges of the side clutch for damage and wear.
- 5 Check for play on the shaft.

- 6 Check springs for its proper tension, squareness and cracks.
- 7 Check yoke levers for wear.
- 8 Check play of the yokes in the bosses of the front mission cover.
- 9 Check straightness of the yoke.
- 10 Check side clutch covers for wear and cracks. Check bearings for wear.

#### TASK 7: Repair and Servicing



- 1 Replace the clutch wire (2) (Task 1 Fig 1) and sleeve if found damaged. In case if wires are to be replaced ensure free movement of wire in the sleeves.
- 2 Replace all wornout pivots, of side clutch brake levers pins, 'O' rings and bolts and ensure free movement.
- 3 Change the side clutch if found worn-out or cracked. Replace the bushes if excessive play between shaft and side clutch is observed.
- 4 Change the springs if cracked and deformed.
- 5 Change bushes in the front mission cover (4) Fig 2 if excessive play is observed.
- 6 Replace bearings if worn-out.
- 7 Replace the yoke if it is bent or worn-out or damaged.
- 8 Change the covers if they are cracked or bearing seat is wornout. (Replace the old packing and gasket with new ones).

#### TASK 8: Assembly (Fig 2)

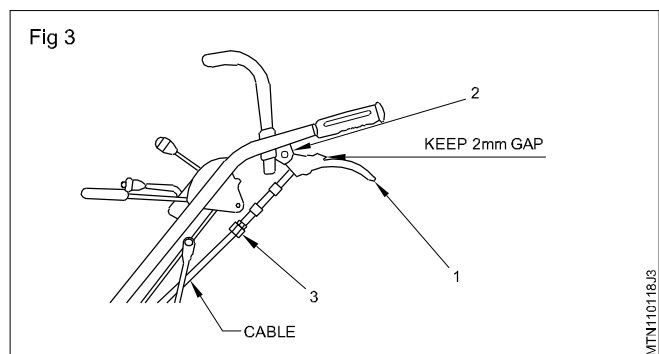
- 1 Fit rear 'O' rings (new) (15) and insert the yokes in the bosses of the front mission cover.
- 2 Fit the front mission cover (4) with new gasket Fig 2 leaving the bolts loose.
- 3 Fit the yoke lever to the stem of the yokes (5) and secure properly with the keys.
- 4 Lock the yoke levers with the yoke by the help of locking screws.
- 5 Fit the end pieces and lock it with the new split pins.
- 6 Insert the side clutches (Dog gear clutch) and ensure free movement.
- 7 Place the springs.
- 8 Insert spacers.
- 9 Fit the bearing to the side clutch covers (7) Fig 2 after smearing them with multi-purpose grease.
- 10 Place new packings.
- 11 Fit the side clutch covers with bearings and secure them with screws.
- 12 Fit the clutch wires to the end pieces. Adjust and lock it.
- 13 Tighten the bolts of the front mission cover.
- 14 Test the operation of steering clutches.

#### TASK 9: Adjustments

- 1 Loosen the cable adjusting nuts (3) (Fig 3) and adjust a gap of 2 mm between (free play) side clutch lever (1) (Fig 3) and handle bracket (2).

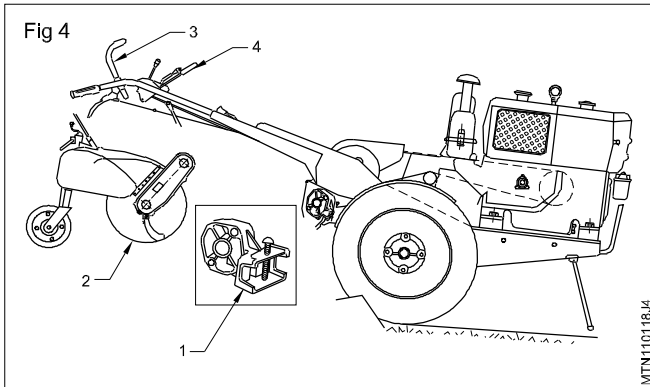
**The power tiller gear and rotary chain gear should be in neutral position while connecting the rototiller to power tiller.**

- 2 Tighten bolts of rotary connector.
- 3 Fit handle stays (11) to rotor assembly to the handles of the power tiller.





- 4 Top up the rotor chain (2) Fig 3 case transmission with recommended lubricating oil after ensuring no leakage of oil between inner (7) Fig 3 and outer case (4) Fig 3 through gasket (6) Fig 3.
- 5 Keep the rotary operating lever (3) Fig 4 and speed change lever (4) Fig 4 to neutral position.



- 6 Start the engine.
- 7 Transportation to the field.
- 8 Lower down the tail wheel (1) Fig 2 to ensure no contact of tynes to the ground.
- 9 Check the movement of rotor, by operating rotary speed change lever.
- 10 Ensure that the shape of tynes (4) Fig 1 are fitted according to the operational conditions. Replace, if necessary.
- 11 Drive the power tiller to the field for operation.

#### Field operation

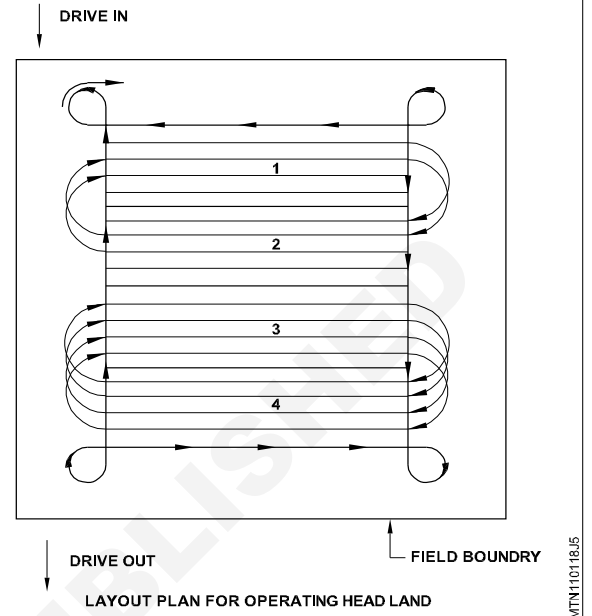
- 12 Raise the tail wheel (1) Fig 2 to adjust the depth of ground tillage.
- 13 Mark head lands, tilling with rototiller in low speed to mark the boundary of the field to be tilled.
- 14 Divide the land in convenient width to facilitate ease of turning. This can be done by rototiller making straight tilled ribbon of field (initially marked land).
- 15 The practice of tilling the land can be carried out either around the opening strip or within the open tilled strips or by alternate strip tilling method as illustrated in the Fig 5.

**Do not operate rototiller on the hard lands.**

- 16 The first operation of tilling on the moderately soft soil shallow filling with low speed is carried out.
- 17 After gaining the confidence, second operation is taken up with high rotor speed with corresponding gears and deeper as recommended by the manufacturer.
- 18 Final runs of rototilling is done on the initially run head lands.

**Slower the speed of the power tiller with higher rotor speed will give finer tillage, you can achieve the required with higher rotor speed will give pulverisation with different rotor tiller and power tiller speed combination.**

Fig 5



- 19 Check the tynes bolt after every 4 hours of operation to ensure safe operation.
- 20 Use pneumatic tyres in dry land tilling operation. (Fig 5)
- 21 Use lugged wheels (cage wheels) for wet land puddling.
- 22 After operation, check and servicing the power tiller.
- 23 Take the power tiller out, after tilling wet dry lands area.
- 24 Lower down the tail wheel to raise rototiller.
- 25 Lift the rubber apron and remove trashes and stubble etc. Stuck in between tynes. Clear the tynes and rotor shaft.
- 26 Take power tiller to the washing place and let it cool for half an hour.
- 27 Wash the power tiller and rototiller.
- 28 Recheck the tynes and tyne bolts.
- 29 Dry and install.
- 30 Replenish fuel.
- 31 Stall the power tiller.

**Slacken the transmission 'V' belts in case use of the power tiller is to be suspended for prolonged period to undertake operation.**

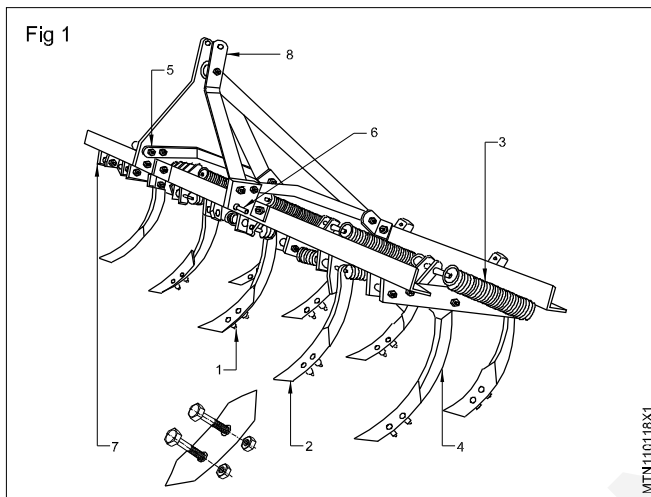
# Operating practice with implements

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

- check spring loaded cultivator
- prepare a cultivator for operation and hitch to the tractor
- field operation of cultivator
- unhitch the cultivator from the tractor
- maintain and service.

## TASK 1: Check spring loaded cultivator (Fig 1)

- 1 Check fastening bolts (1) (Fig 1) of shovels (2) fitted to the spring loaded (3) cultivator tynes (4) of front and rear assemblies.
- 2 Tighten the bolts if loose.

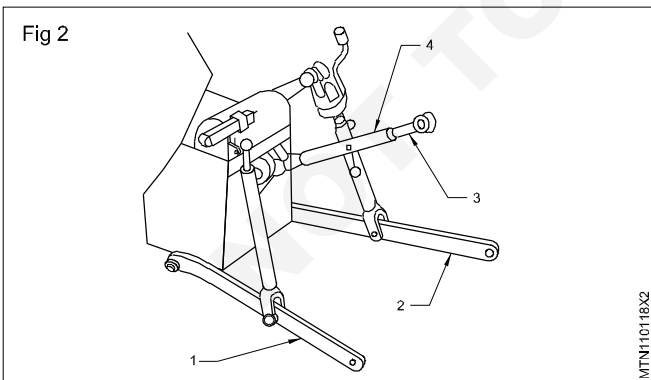


- 3 Replace them if worn out.

- 4 Check side struts bolts (5) for tightness.
- 5 Check lower hitch pin (6) for tightness and damage to the hitch pin holes. Replace them with new ones if found defective.
- 6 Ensure pin (6) diameter is matching with the sockets (balls) of side links of the tractor.
- 7 Check sharpness and shape of the shovels (2) (Fig 1) to ensure for effective tilling.
- 8 Reverse the shovel if found worn out.
- 9 Replace if both points have become unserviceable.
- 10 Check straightness of the tynes (4) (Fig 1). Replace the tynes if found unserviceable or beyond repair.
- 11 Turn the cultivator upside down and check the spring (3) (Fig 1) tension fitted to the tynes by means of pipe socket bar/lever.
- 12 The pipe socket bar is locally prepared to sleeve the shovel. Each shovel is pulled against the line of travel to a certain spring tension.
- 13 Change the spring if found loose and broken.

## TASK 2: Hitch the cultivator

- 1 Before hitching ensure the serviceability of the cultivator.
- 2 Reverse the tractor to align the lower links (1 & 2) (Fig 2) of the cultivator.



- 3 Adjust and align the height of the lower links with the help of hydraulic control lever to the height of lower hitch pins of the cultivator.

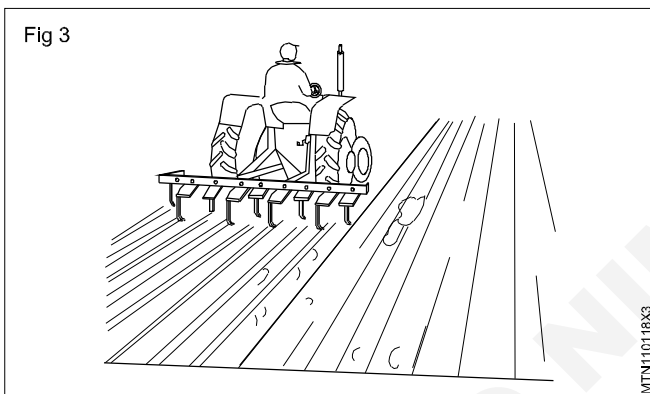
- 4 Connect the left lower link (1) (Fig 2) to the left hitchpin (6) (Fig 1) and fix linchpin.
- 5 Fix the right link (2) (Fig 2) to the right hitchpin (7) (Fig 1) and fix linchpin and connect the top link (3) to the top of the strut (8) Fig 1 of the cultivator.
- 6 Connect the left lower link (1) (Fig 2) to the left hitchpin (6) (Fig 1) and fix linchpin.
- 7 Fix the right link (2) (Fig 2) to the right hitchpin (7) (Fig 1) and fix linchpin. Connect the top link (3) to the top of the strut (Fig 1) of the cultivator.
- 8 Adjust the length of the top link (3) (Fig 2) with screw nut (4). (Fig 2)
- 9 Insert the pin and secure it with linchpin.
- 10 Raise the cultivator with the help of hydraulic control lever to ensure the safe transportation. Fix side chains to the lower links of the tractor to prevent sideways movement of the cultivator.

### TASK 3: Field Practice

- 1 Lock the hydraulic control lever keeping the cultivator in raised position.

**The width of the cultivator is wider than the tractor width. Ensure that the cultivator does not strike any construction or trees while being transported to the field.**

- 2 Stall the tractor at one side of the field proposed to be starting point of operation.
- 3 Raise the depth wheels (1) (Fig 3) if fitted. Lower the cultivator slowly that all the tynes come in contact with the ground evenly. Any deviation from evenness can be corrected with the help of right adjustable link or top link. Ensure that the cultivator frame is parallel to the ground. This will help to cultivate the field with even depth by all the tynes. It is common to operate the cultivator by side by side method as shown in (Fig 4).



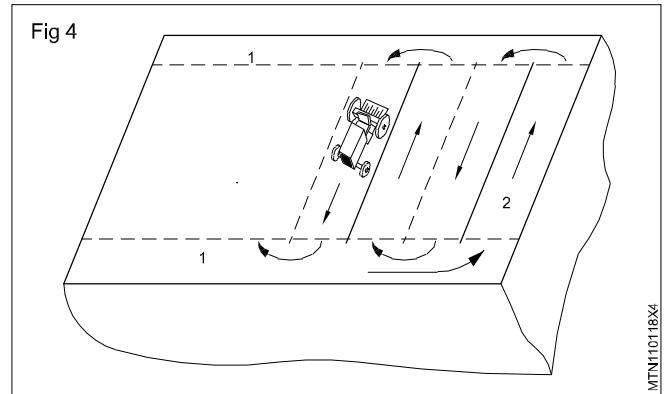
- 4 Leave the ground strip (1) (Fig 5) one and half times to the length of tractor plus cultivator length for turning. (Fig 4)
- 5 Start to till from one side (2) (Fig 4) of the field.

### TASK 4: Unhitch

- 1 Lower down the cultivator.
- 2 Disconnect top link.
- 3 Dislink right lower link.
- 4 Dislink left lower link.

### TASK 5: Maintain and Service

- 1 This is a most common and versatile implement used on the farm.
- 2 Its construction is simple and rigid.
- 3 The main points of maintenance are:
  - The soil engaging part which are shovels need most attention.
  - It should be ensured that a complete set of the shovels are replaced with new ones along with the fastening nut bolts. This is done to ensure uniform depth of cultivating the field. After tilling see that all lower points of the shovel keep in touch with ground level invariably. Every shovel bolted to the tyne is tightened securely. Any looseness if left can make



- 6 Check depth visually. Adjust depth by depth wheels if provided in combination with hydraulic control lever. Lift the cultivator on the other side and turn it.
- 7 Lower the cultivator on the point where previous tilling ended.
- 8 Track the left or right wheels to the line of travel in such a way that no portion of the land remains untilled or overlapped.
- 9 Finally, till the space left for turning on either sides.

**Till the land crosswise to achieve fine tilth of the field.**

- 10 Remove roots and stubble of the crops if found entangled with the tynes during operation.
- 11 Use the speed gear of the tractor as recommended by the manufacturer.
- 12 Raise the cultivator and clean the tynes in the field.
- 13 Take it to the implement shed.

the operation of the cultivator and break the shovel in the field which may further endanger damage to the tyres of a tractor.

- In case the replacement is not met the points can be forged to make desired shape of the shovels.
- Ensure proper tension of the coil spring which is described earlier in this lesson. Slackened and broken spring should be replaced.
- There is no repair done to the hitching pins, if found damaged or the threads are worn out. It should be replaced with new ones tightened securely.
- All nut bolts which are worn out or corroded should be replaced.

## Driving practice of power tiller with trailer

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

- prepare power tiller for operation
- detach rototiller from power tiller
- start the engine
- drive power tiller with trailer.
- drive on special shapes.

### Requirements

#### Tools/Instruments

- Trainees Tool Kit - 1 No.
- Steel rule

#### Equipment/Machines

- Power Tiller
- Jack

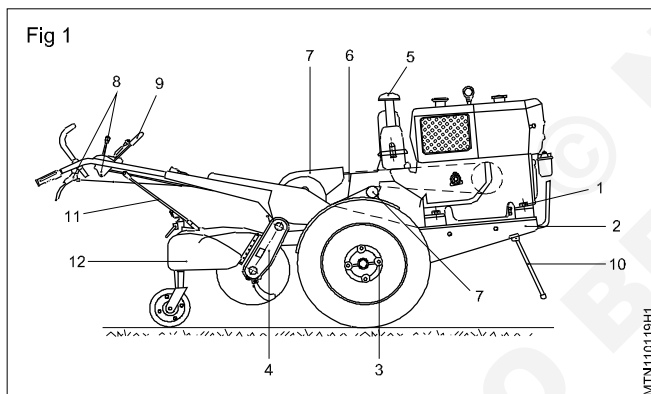
#### Materials/Components

- Tray - 1 No.
- Solvent - as reqd.
- Transmission oil - as reqd.
- 'O' Ring
- Cotton waste

## PROCEDURE

### TASK 1: Prepare Power Tiller for operation

- 1 Clean the Power Tiller. (Fig 1)



- 2 Check and tighten the foundation bolts (1) for proper fixing of engine to the chassis (2).
- 3 Tighten other externally visible fasteners and wheel fastening bolts (3).

- 4 Check oil/fuel/water leakages and rectify the leakages observed.
- 5 Check oil/fuel/water levels. Top up if required.
- 6 Check oil level of transmission chain case and rotary chain case (4).
- 7 Check oil level in air cleaner (5).
- 8 Check fan belt/blower belt tension and adjust according to recommendation.
- 9 Check and adjust main clutch V-belt (6) tension by tensioners (7). (Not visible)
- 10 Check free movement of air blower in air cooled engines.
- 11 Check free play in steering clutch levers (8) and main clutch levers (9) and adjust as per recommendations of the manufacturer.

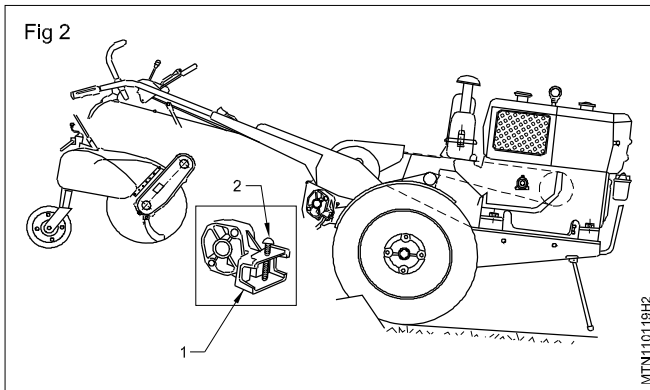
### TASK 2: Detach rototiller from power tiller

- 1 Park the power tiller on level surface.
- 2 Rest the rotavator on front stand (10). (Fig 1)
- 3 Shift power tiller gears and rotary chain gear to neutral position.
- 4 Loosen bolts of both the handle stays (11) and remove.
- 5 Detach handle stays from rototiller assembly.
- 6 Place oil tray underneath of transmission housing.
- 7 Loosen rototiller attachment bolts and remove.

- 8 Pull out rototiller assembly (12) and keep aside.

#### Attach hitch bracket to the power tiller

- 1 Replace rubber packing on rotavator transmission housing.(Fig2)
- 2 Fit hitch bracket (1) on to rotavator transmission housing with bolts.
- 3 Tighten hitch bracket bolts to required torque as per manufacturer's recommendation.



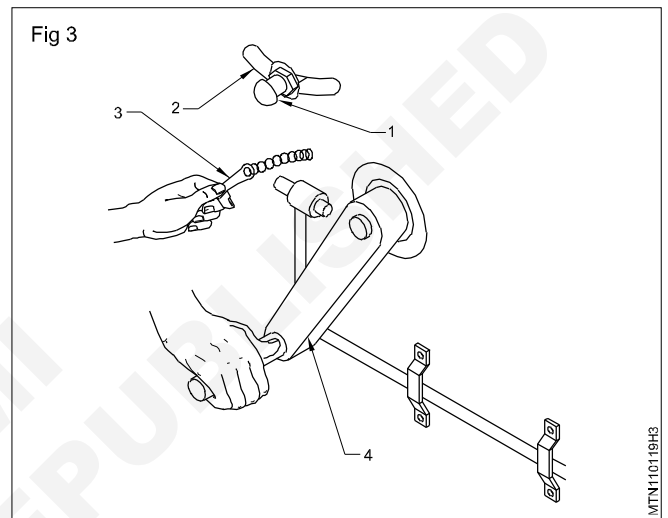
- 4 Insert king pin (2) into hitch bracket and lock it with linchpin.
- 5 Check oil levels in transmission chain case and rotary chain case.

### TASK 3: Starting Engine (Fig 3)

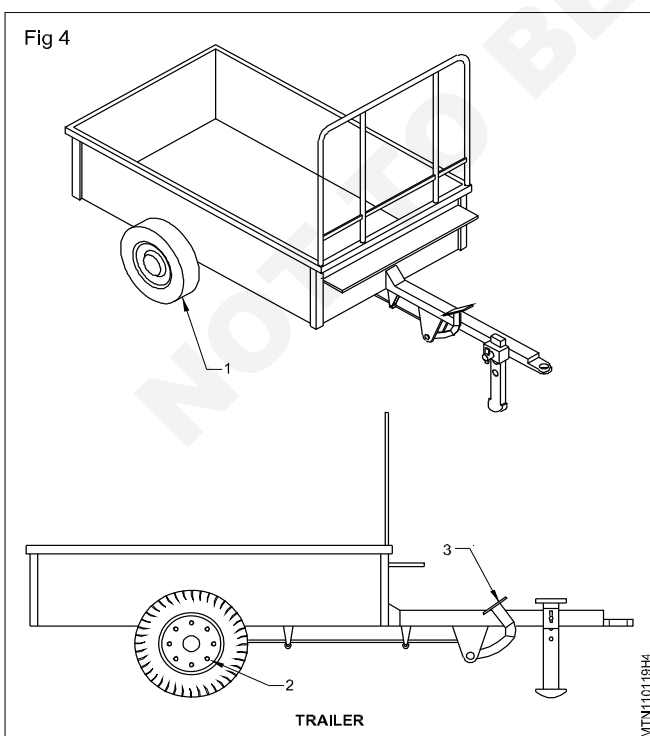
- 1 Adjust the accelerator knob (1) on the quadrant slot (2).
- 2 Press the decompression lever (3) with left thumb and crank the engine with handle (4) till engine attains sufficient momentum. Release the decompression lever. Keep turning the handle till engine starts and speeds up. (If engine fails to start, repeat the above steps).
- 3 Warm up the engine at normal speed.
- 4 Check oil pressure through an indicator as recommended by manufacturer.

**If oil pressure is not observed as per the recommended pressure stop the engine to rectify the defect.**

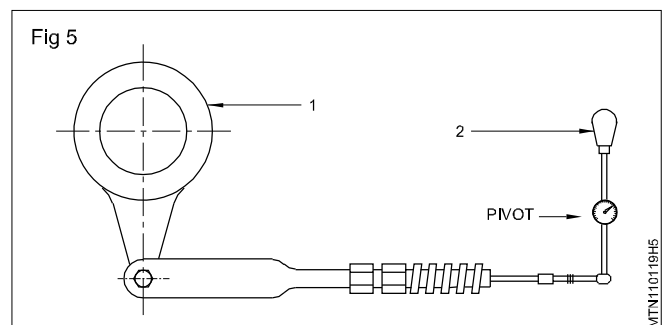
- 5 Check the engine for any abnormal noise or vibration while running. If any abnormality is observed, rectify it. (Consult your instructor).



### TASK 4: Driving Power Tiller with Trailer (Fig 4)



- 1 Check air pressure of the tyres (1) of trailer. Inflate them to the recommended pressure.
- 2 Check and tighten wheel nuts (2).
- 3 Check brake pedal (3) for free play of the trailer as recommended.
- 4 Remove handle bar and mount counter weight to the power tiller. (for stability)
- 5 Attach the trailer to the hitch bracket (1) (Fig 2) of the power tiller. (Fig 5)
- 6 Disengage the main clutch (1) with the help of main clutch lever (2).



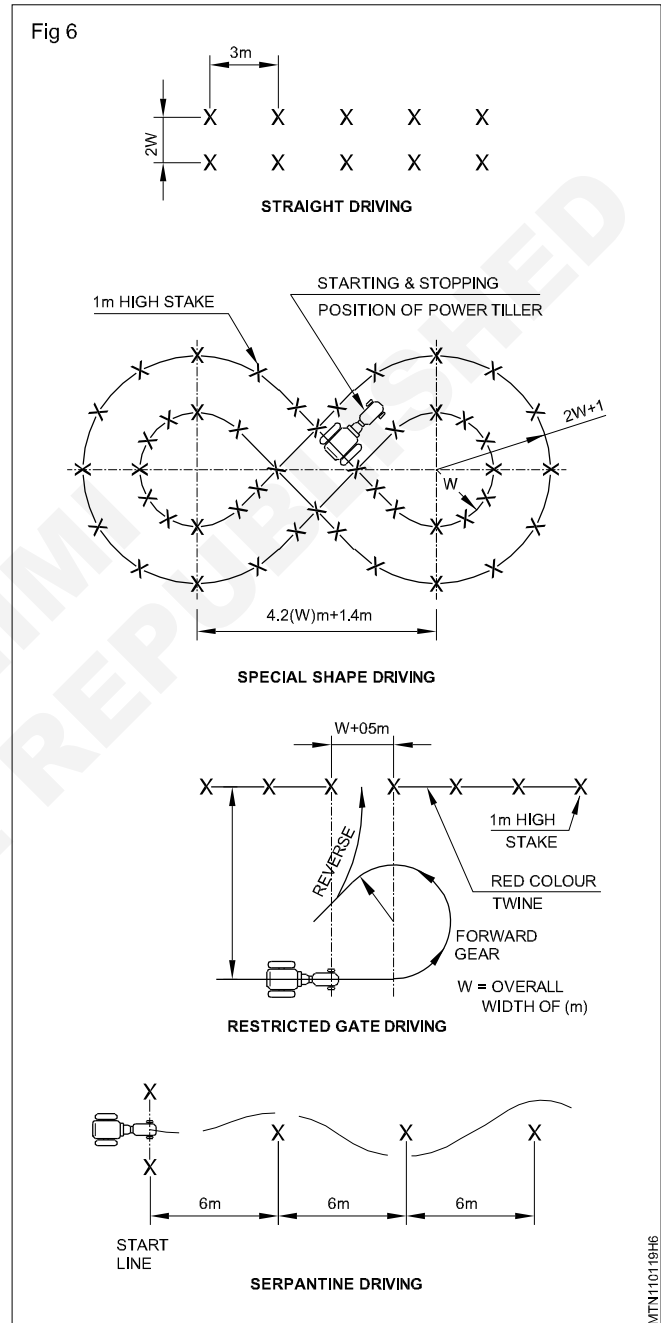
- 7 Take the power tiller and trailer to a plane field. Engage the first gear. Press the power tiller handle downwards. Release main clutch lever slowly and accelerate.
- 8 Engage higher gears as operating skill of the power tiller and engage it to the first gear and apply respective side lever to turn.

**Don't use both the steering clutch levers at the same time.**

- 9 Accelerate the power tiller after taking turn.

**TASK 5: Drive on special shapes (Fig 6)**

- 1 Straight drive
- 2 Eight shape drive
- 3 Restricted gate driving
- 4 Serpentine driving in forward speed for manourvering the controls, such as steering clutch levers, main clutch lever and gear change lever etc.
- 5 Practice driving in reverse direction by using reverse gear in all the above configurations. Practice on farm road.
- 6 Stop power tiller by reducing the acceleration, disengaging the main clutch and simultaneously applying the brake to the trailer.



## Checking the implements serviceability

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

- maintenance disc ploughs
- maintenance disc harrows
- maintenance cultivator
- maintenance seed drills
- maintenance tractor trainer
- maintenance P.T.O units.

**Disc plough:** Maintenance and servicing disc plough replace the wormout nuts and bolts. If disc plough has to remain unused for longtime then clean it & apply a layer of used oil for ruse prevention.

These step will enhance the life of your disc plough Toughly clean the flow after each one.

Cool the soil engaging surfaces with one or other rust inhibition

If long storage touch up paint on the frame as necessary where paint is worm or chipped to prevent rust.

- 1 Inspect disc harrow frame and hitch bar for cracks and bends. In case there is open the assembly, straighten and refit to its position.
- 2 Inspect disc edges for excessive wear and tear wobble. Resharping is recommended to desired angle and thickness if excessive bluntness is observed. The recommended angle on annexed side ranges (mm40° 50°). Cutting edges should be 0.1 to 0.4mm sharp. There are special fixtures provided to obtain varied angles on a grinder.
- 3 Inspect bearing of the gangs. There are two types of bearings used to absorb the thrust.

1 Spool type

2 Bush type

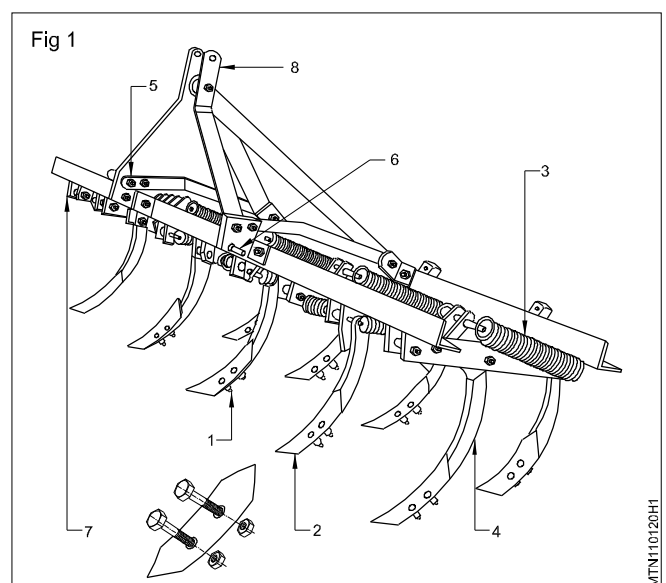
These are frictional type bearings.

- 4 There are two types of gang shaft. When the spool type bearing is fitted, the complete gang revolves with the shaft serves as an arbor bolt having square cross section. In case of bush type bearing, the central long solid round shaft is secured to the frame. The bush bearing is sleeved on the shaft packed with grease. These bushes are held firmly by locknuts. The discs are spaced with the help spools having square webs to grip the discs secured, preventing relative rotation.
- 5 Inspect Bumper/end plate of gange which are litted at the ends of the gangs on convex sides of the last discs. They are made of cast iron and are subjected to cracks due to sudden thrust. The cracked bumper plates should be replace.
- 6 Other attachments, such as gang angle shifting lever, pivot pin all unit bolts and transport a wheels are also inspected for any damage. Ensure movement of the transport wheel. Apply grease to the bearing in case movement is restricted.

## PROCEDURE

### TASK 1: Check spring loaded cultivator (Fig 1)

- 1 Check fastening bolts (1) (Fig 1) of shovels (2) fitted to the spring loaded (3) cultivator tynes (4) of front and rear assemblies.
- 2 Tighten the bolts if loose.
- 3 Replace them if worn out.
- 4 Check side struts bolts (5) for tightness.
- 5 Check lower hitch pin (6) for tightness and damage to the hitch pin holes. Replace them with new ones if found defective.
- 6 Ensure pin (6) diameter is matching with the sockets (balls) of side links of the tractor.
- 7 Check sharpness and shape of the shovels (2) (Fig 1) to ensure for effective tilling.
- 8 Reverse the shovel if found wornout.



- 9 Replace if both points have become unserviceable.
- 10 Check straightness of the tynes (4) (Fig 1). Replace the tynes if found unserviceable or beyond repair.
- 11 Turn the cultivator upside down and check the spring (3) (Fig 1) tension fitted to the tynes by means of pipe socket bar/lever.
- 12 The pipe socket bar is locally prepared to sleeve the shovel. Each shovel is pulled against the line of travel to a certain spring tension.
- 13 Change the spring if found loose and broken.

#### TASK 2: Maintain and Service

- 1 This is a most common and versatile implement used on the farm.
- 2 Its construction is simple and rigid.
- 3 The main points of maintenance are:
  - The soil engaging part which are shovels need most attention.
  - It should be ensured that a complete set of the shovels are replaced with new ones along with the fastening nut bolts. This is done to ensure uniform depth of cultivating the field. After tilling see that all lower points of the shovel keep in touch with ground level invariably. Every shovel bolted to the tyne is tightened securely. Any looseness if left can make the operation of the cultivator and break the shovel in the field which may further endanger damage to the tyres of a tractor.
- In case the replacement is not met the points can be forged to make desired shape of the shovels.
- Ensure proper tension of the coil spring which is described earlier in this lesson. Slackened and broken spring should be replaced.
- There is no repair done to the hitching pins, if found damaged or the threads are worn out. It should be replaced with new ones tightened securely.
- All nut bolts which are worn out or corroded should be replaced.

#### TASK 3: Maintain and Service

- 1 Check the condition of hooper, drives and chains.
- 2 Be sure disc furrow openers are clean and turn freely.
- 3 Be sure depth bands are clean and properly adjusted.
- 4 Check seed ejection tubes for restrictions or blockage
- 5 Be sure row spacings are correct, equal and row makers adjusted.
- 6 Greeting every things including where bearings. If no grease zerk on the hub, remove the dust cap insert grease ripple between rollers on the bearing and continue rollers or bearings and continue pumping until grease comes through the bearings from the inside out. Grease hub should be trouble free service.

#### TASK 4: Air drill maintenance checklist

- 1 Check your air drill for cracked hydraulic hoses or places where they are rubbing through and replace any worn.
- 2 If your drill uses pneumatic packer tires, ensure you have enough spares and they are filled to the manufacturer's recommended PSI.
- 3 Check for worn/missing opener tips, tubes that have rusted through due to moisture/fertilizer residue, loose hoses and loose bolts.
- 4 Check all primary and secondary hoses for wear.
- 5 Ensure there is no rust in the manifolds as it can plug the outlets, hoses or openers.
- 6 Ensure the manifolds have no holes.
- 7 Check the level of the drill to ensure accurate and even/consistent placement.
- 8 Do a calibration to ensure metering system is working properly.
- 9 Test to make sure there is adequate air flow by removing the hose from the opener and pointing it up in the air. Seed and fertilizer should be propelled upwards at least 12 out of the end of the hose.
- 10 Make sure all the seats on the air cart lids and at the manifolds are in place and in good condition.
- 11 Consider mounting a screen on your till auger so you can screen out fertilizer lumps to prevent plugging.
- 12 Test all electronics to makes sure everything is communicating properly and that no wires were chewed by rodents while in storage. Leave plenty of time for diagnosing electrical issues.
- 13 Tighten all linkages that have bushings. In most cases, the bushing is slightly longer than the part that it goes, though, so the nut should be torqued so that the bolt and bushing never move. if they have not been torqued adequately, bolt holes can become egged out, resulting in thin, eorn bolts and causing a loose, unsafe machine that can be costly to repair.



14 Grease everything including your wheel bearings. If there is no grease zerk on the hub, remove the dust cap, insert a grease needle between rollers on bearings comes through the bearing from the inside out. a well-greased hub should provide many years of trouble free service.

15 While the dust cap is off, take the weight off the wheel and check that the bearing is tightened properly.

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#### TASK 5: Checking the harrows serviceability

1 Check the type of harrow.

6 Check the disc and disc gang with scraper.

2 Check the disc harrow hitching assembly.

7 Check the disc harrow line of pull.

3 Check the disc harrow angle.

8 Check the front and rear portion disc harrow.

4 Check the gang shaft line.

9 Check the disc harrows serviceability before use the implements. If found any fault during checking the disc harrow, rectify or repair before use for field operation.

5 Check the adjusting lever.

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#### TASK 6: Checking the seed drills serviceability

Seed drill is a device used in agriculture that sows seeds for corps. so that seeds drill sows the seeds at proper seeding rate and depth. Check the following before use the seed drill implements.

3 Check the seed drill tube.

1 Inspect the seed drill implement.

4 Check the seed drill metering unit.

2 Inspect the seed drill hitching point.

5 Check the row and seed distance adjustment.

6 Check the vacuum precision planter.

7 Check the seed distribution unit.

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#### TASK 7: Checking tractor trailer serviceability

1 Check the trailer hitching hook.

5 Check the lubrication points and suspension systems.

2 Check the tyre air pressure and ensure proper tyre pressure in both wheels.

6 Check the trailer body damages.

3 Check the trailer stand and tool box.

7 Check the tractor electrical connections for brake light.

4 Check the trailer brake and brake hose coupler.

8 If found any damage or defects during inspection the trailer, carried out the repair before use the trailer for agriculture transporting.

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#### TASK 8: Checking PTO units serviceability

1 Check the safety locks and catches.

7 Check that all guards/shields are in place and operational.

2 Check the stub shaft and hitch holes.

8 Check that all hydraulic lines are in good condition securely connected and leak free.

3 Check the PTO driven machine.

4 Check the speed of PTO drive shaft 9 times /sec at 540 rpm or 16.6 times/sec at 1000 rpm.

9 Before using any attachment or implements, always read and understand the manufacturer instructions for checking if found any damage parts it should be repaired or replaced immediately before it use.

5 Check the PTO types and that's universal joint.

6 Check the PTO gear box and other rotating parts.

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## Lubricate the parts of single & three point hitching

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

- lubricate the hitching point
- maintenance disc harrows
- maintenance cultivator
- maintenance seed drills
- maintenance tractor trailer
- maintenance P.T.O units.

### Requirements

#### Tools/Instruments

- Trainees Tool Kit - 1 No.
- Grease gum - 1 No.

#### Equipment/Machines

- Tractor - 1 No.
- Trail disc harrow - 1 No.
- Three point hitch linkage - 1 No.

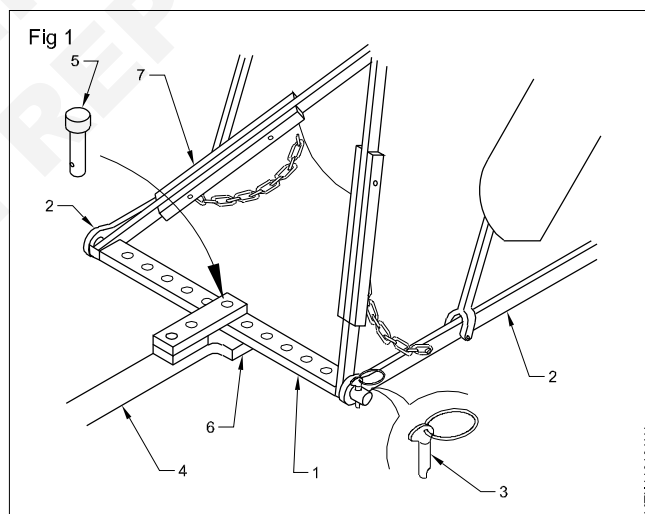
#### Materials/Components

- Cotton waste - 1 No.
- Lock pin - as reqd.
- Nipple grease - as reqd.
- Hydraulic oil - as reqd.
- Soap oil - as reqd.

## PROCEDURE

### TASK 1: Lubrication of single and three point hitching (Fig 1)

- 1 Diagnose the hitching problem in tractor.
- 2 Check the hydraulic operational parts (movable joints) with three point hitching unit.
- 3 Check the hydraulic fluid level if required top-up the fluid.
- 4 Lubricate the hydraulic lift control lever joints.
- 5 Lubricate the upper link joints.
- 6 Lubricate the lower link joints.
- 7 Lubricate the lower hitching joints.
- 8 Lubricate the upper hitching joints.
- 9 Lubricate the lower and upper links.
- 10 Lubricate the swinging bar holes.
- 11 Lubricate the swinging bar joints.
- 12 Lubricate the swinging bar hanger.
- 13 Lubricate the check chain eye bolt.
- 14 Lubricate the lynch pin.
- 15 Lubricate the lower stay strap joint.



16 Lubricate the top link pin.

17 Lubricate the stabilizer bracket.

**Note: Apply nipple to all lubrication points of tractor as per tractor manufacturers specification.**

**Driving a tractor with different implements**

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

- cultivator field operation and adjustment
- disc plough
- ridger
- rotavator
- grass mowers.

Requirements		
<b>Tools/Instruments</b>		<b>Materials/Components</b>
<ul style="list-style-type: none"> <li>• Trainees Tool Kit</li> </ul>	- 1 No.	<ul style="list-style-type: none"> <li>• Cotton cloth - as reqd..</li> <li>• Lock pin - as reqd.</li> <li>• Hitch pin - as reqd.</li> <li>• Oil - as reqd.</li> <li>• Wooden block - as reqd.</li> </ul>
<b>Equipment/Machines</b>		
<ul style="list-style-type: none"> <li>• Tractor</li> <li>• Spring loaded cultivator</li> <li>• Disc plough</li> <li>• Tractor ridger</li> <li>• Tractor rotavator</li> <li>• Tractor grass mowers</li> </ul>		

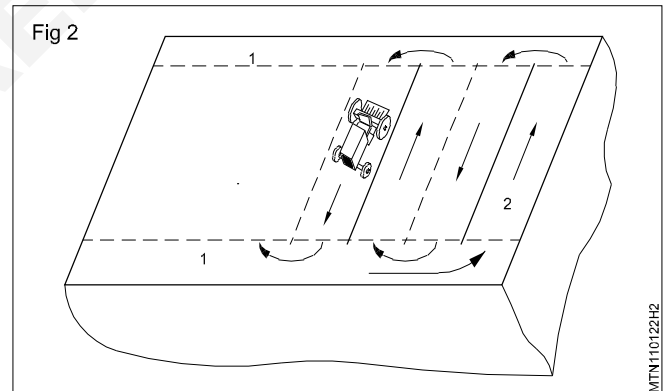
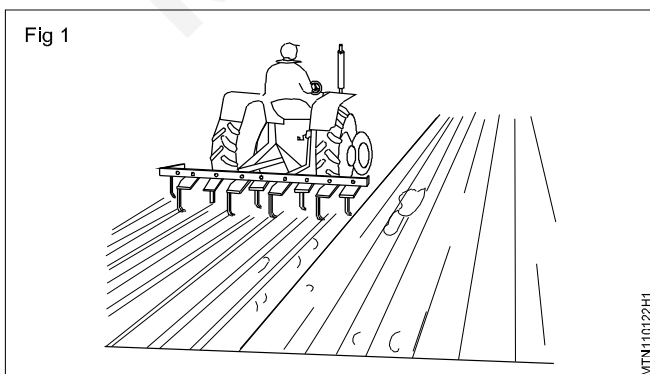
**PROCEDURE**

**TASK 1: Cultivator field operation and adjustment**

- 1 Lock the hydraulic control lever keeping the cultivator in raised position.

**The width of the cultivator is wider than the tractor width. Ensure that the cultivator does not strike any construction or trees while being transported to the field.**

- 2 Stall the tractor at one side of the field proposed to be starting point of operation.
- 3 Raise the depth wheels (1) (Fig 1) if fitted. Lower the cultivator slowly that all the tynes come in contact with the ground evenly. Any deviation from evenness can be corrected with the help of right adjustable link or top link. Ensure that the cultivator frame is parallel to the ground. This will help to cultivate the field with even depth by all the tynes. It is common to operate the cultivator by side by side method as shown in (Fig 2).



- 4 Leave the ground strip (1) one and half times to the length of tractor plus cultivator length for turning. (Fig 2)
- 5 Start to till from one side (2) (Fig 2) of the field.
- 6 Check depth visually. Adjust depth by depth wheels if provided in combination with hydraulic control lever. Lift the cultivator on the other side and turn it.
- 7 Lower the cultivator on the point where previous tilling ended.
- 8 Track the left or right wheels to the line of travel in such a way that no portion of the land remains untilled or overlapped.
- 9 Finally, till the space left for turning on either sides.

**Till the land crosswise to achieve fine tilth of the field.**

10 Remove roots and stubble of the crops if found entangled with the tynes during operation.

- 11 Use the speed gear of the tractor as recommended by the manufacturer.
- 12 Raise the cultivator and clean the tynes in the field.
- 13 Take it to the implement shed.

## TASK 2: Unhitch

- 1 Lower down the cultivator.
- 2 Disconnect top link.
- 3 Dislink right lower link.
- 4 Dislink left lower link.

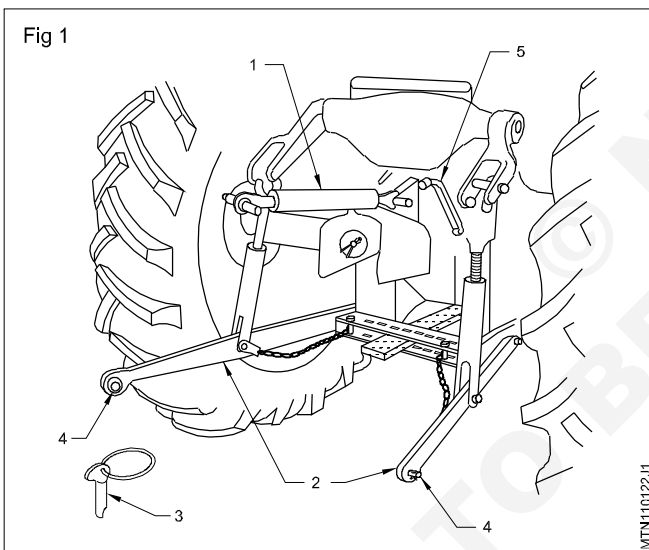
## Skill sequence

### Field operation of disc plough

**Objectives:** This shall help you to

- hitch the disc plough to three point hitch linkage of a tractor
- lift and lower disc plow with hydraulic control lever
- perform field operation of disc plough
- unhitch the disc plough.

Hitching disc plough to the three points hitch system. (Fig 1)

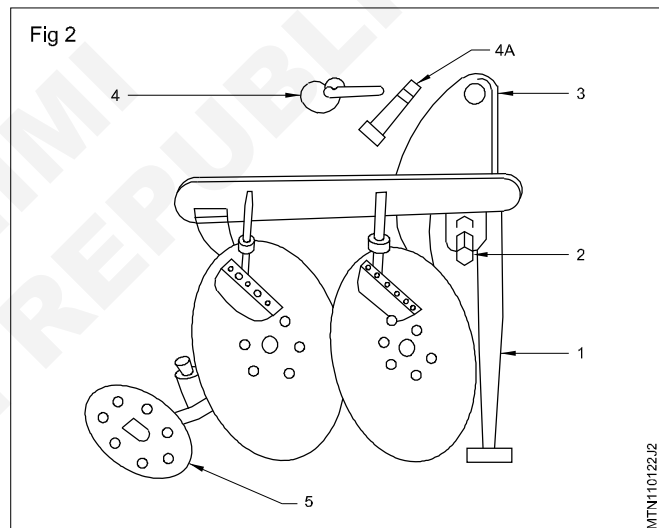


Make the disc plough to support on its stand (1) (Fig 2). So that cross shaft (2) (Fig 2) of the plough is in parallel to the ground.

Attach top link (1) (Fig 1) to top link hitch point 3 (2) of diesel plough.

Reverse the tractor in line with the centre of the plough till lower links 2 (Fig 1) are in line with the cross shaft (2) (Fig 2)

Attach the left lower link (2) Fig 1 first by pulling and pushing of tractor backward and forward till the hitching ball (4) of the cross shaft pin (2) (Fig 2). Secure them with linchpin (Lockpin) (3). (Fig 1).



Line up the right lower link ball (4) (Fig 1) with right pin of cross shaft (2) (Fig 2) of the disc plough by screwing downward or upward using levelling lever (5) (Fig 1). Secure attachment with linchpin (3). (Fig 1)

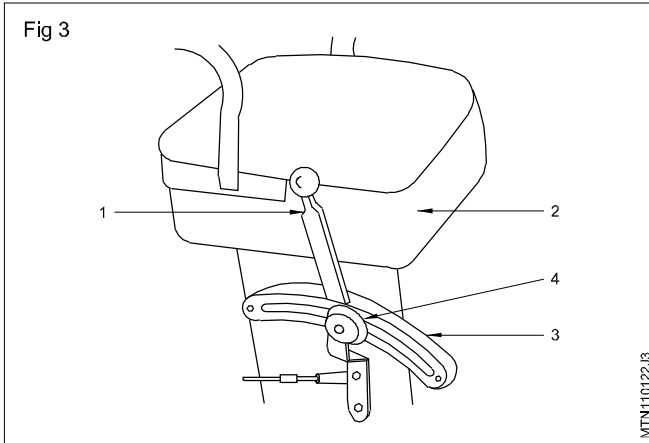
Attach top link (1) (Fig 1) to top link hitch point 3 (Fig 2) of disc plough.

Adjust length of the top link (1) (Fig 1) to attach it to the top hitch point (3) Fig 2 of the disc plough. Insert hitchpin (4a) (Fig 2) and secure it with a linchpin (4). (Fig 2)

Fold the stand (1) (Fig 2) or disconnect it according to the facility provided to the plough.

### Lifting and Lowering of Disc plough

Raise the hydraulic control lever (1) (Fig 3) generally situated on the right side of the driver's seat of the tractor (2). (Fig 3)



Raise the lever (1) up while engine of the tractor is in running condition. The disc plough will be lifted up.

Put the lever down. The plough will lower down.

Set the lift position of the plough and lock the hydraulic lever (1) on the quadrant (3) (Fig 3) for transportation by means of lock stop 4. (Fig 3)

### Adjustments

- A Level of the Plough
- B Adjusting plough position
- C Adjusting width of front furrow
- D Adjusting depth of ploughing
- E Adjusting pre-loading of furrow wheel
- F Adjusting pitch (Tilt angle)
- G Adjusting furrow wheel assembly
- H Adjusting disc scraper

#### A Level of the Plough

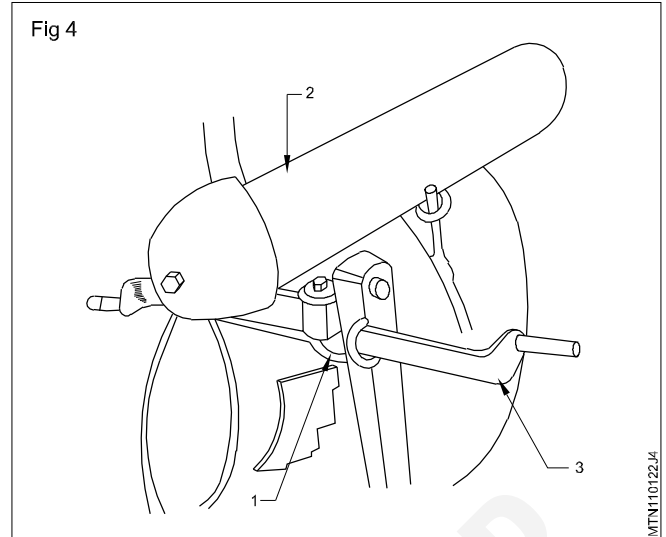
To achieve desired level of the plough there are two provisions given. It is done with the help of right adjustable lever (5) Fig 1 for lateral leveling. In case of variation in depth is observed in front or in rear furrow, it is adjusted by the top link (1) (Fig 1).

#### B Adjusting plough position

Set the position of the disc plough on the cross shaft if the steering of the tractor is pulled sideways, as per the track width of the tractor. Wider the track width, wider the unploughed land between the track wheel furrow and first furrow of the disc plough and greater will be the left side pull on the steering and vice versa. Some reputed manufacturer provide necessary positional fitting of the disc plough according to track width to avoid land or unploughed overlapping while ploughing the field. (Fig 4)

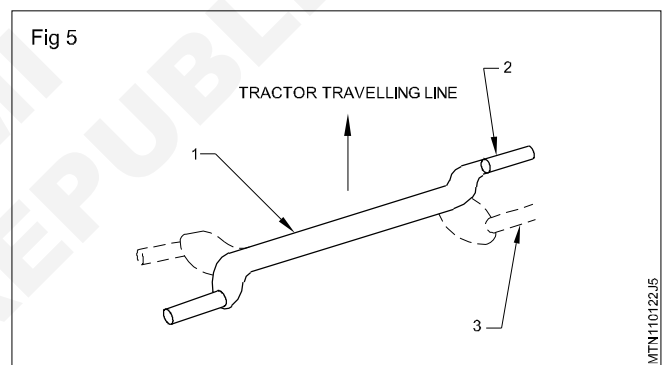
Slacken two 'U' bolts clamps (1) (Fig 4) fitted on the either sides of the plough frame (2). The cross shaft (3) will be free to move sideways.

Move the cross shaft to left, if steering pulls on the right side and move to right if pulls on the left side and tighten 'U' bolts clamps. Insure that the side chains fitted to the lower links remain unstrained. (Adjustment is altered according to the soil conditions)



#### C Adjusting width of front furrow (Fig 5)

Adjust cross shaft right pin (2) (Fig 5) to forward will reduce the width of the front furrow. This is achieved by loosening 'U' clamps (1) (Fig 4) and rotating cross shaft (1) (Fig 5) with the fixed open end spanner provided with the disc plough by manufacturer.



Set the right pin to backward (3) (Fig 5) position to increase the width of front furrow.

**Some heavy duty plough are provided with cross draft adjusting lever.**

#### D Adjusting depth of ploughing

Put the depth control lever (1) (Fig 3) down on the quadrant (3) (Fig 3) of hydraulic control levers.

Check the depth of cut of the furrow.

Lower the lever (1) (Fig 3) further down if required in case depth is not achieved.

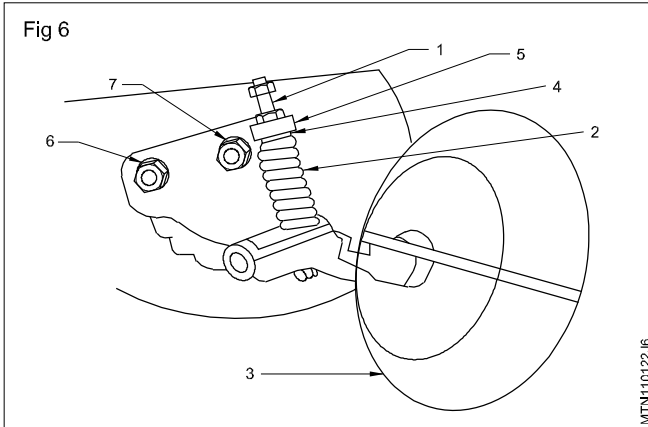
Raise the lever up if depth is more than desired.

Restrict up and down movement of the lever in the quadrant when desired depth is achieved.

Use combination of draft and position control levers to achieve the uniform depth of ploughing according to field condition (Refer the operator's manual of the tractor for setting of position and draft control).

### E Adjusting pre-loading of furrow wheel (Fig 6)

Set the locking screw (1) (Fig 6) of the spring (2) furrow wheel (3) assembly for 4 to 5 mm clearance between spring cap (4) and bracket flange (5). This is a normal adjustment for average soil conditions.



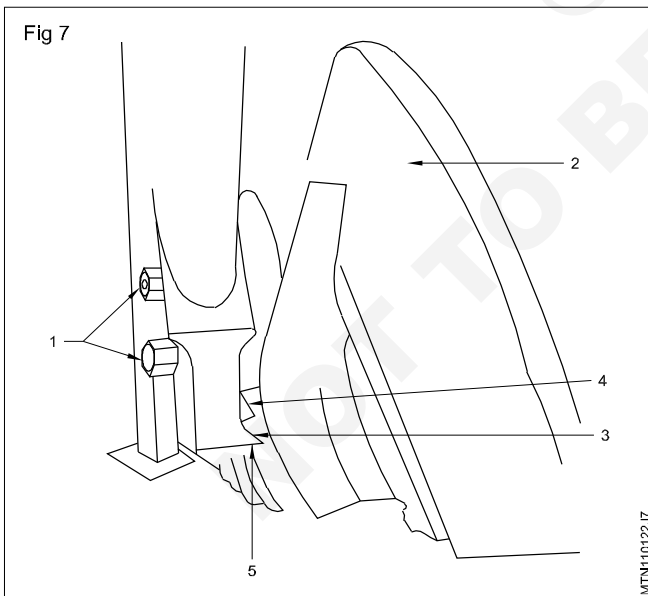
Increase penetration in hard soil by decreasing clearance and reduce penetration of disc by increasing clearance in light soil.

**This adjustment is useful for varied soil conditions. Excessive pre-loading adjustment will adversely affect the rear wheel traction.**

### F Adjusting pitch (Tilt angle) (Fig 7)

Loosen the nuts (1) (Fig 7) at the back of the disc assembly (2).

Slide the groove (3) (Fig 7) up to the projection 4. Pitch angle (Tilt angle) will reduce. This adjustment is suitable for heavy trash and hard friable soil.

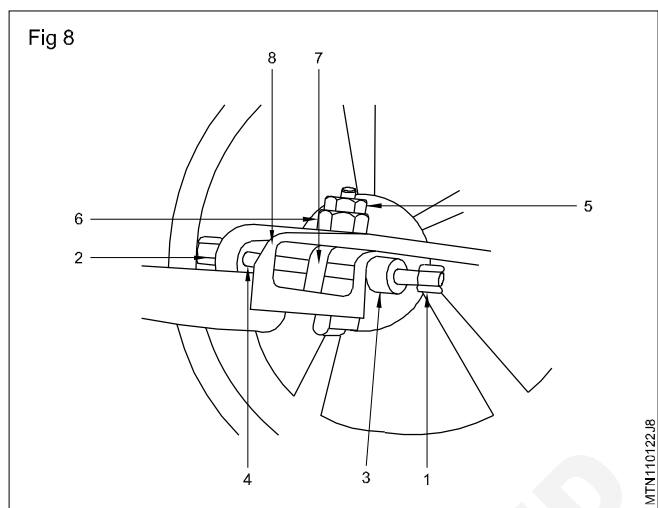


Shifting groove (3) (Fig 8) to lower projection (5) will increase the pitch angle. This adjustment will increase penetration in heavy and sticky soils.

### G Adjusting furrow wheel assembly

Position of the furrow wheel is adjusted on the left from the centre of last furrow bottom. Slacken nut 6 and 7 (Fig 6) and move the bracket laterally to required position.

### Setting furrow wheel lead (Fig 8)



Set the furrow wheel (5) (Fig 2) lead to eliminate side draft with the help of two adjusting bolts 5, 6 (Fig 8) and nuts.

Slacken nuts 5 and 6 (Fig 8) screws 1 and 2 and locknuts 3 and 4 (Fig 8). Screw in screw 2 and screw out screw 1 will reduce the lead and vice versa.

Adjustment of angle is done according to the side draft encountered on the discs. Tighten all the nuts and screws after making adjustment of lead.

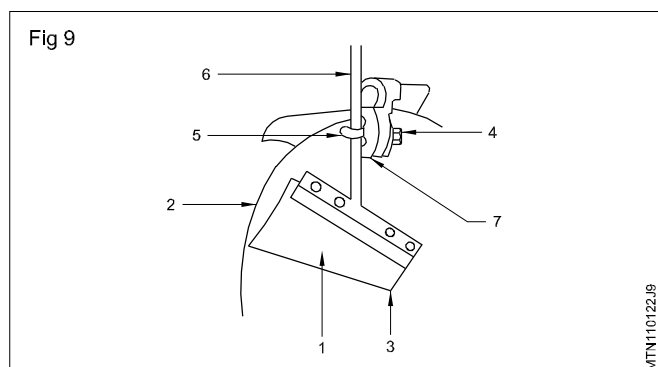
**Screwing out screw 1 and screw 2 in pushes spindle 7 (Fig 8) of furrow wheel out in axle bracket 8 (Fig 8) and vice versa.**

**From the above adjustments, plough lead, in position will be achieved. The reverse adjustment that is screwing out the screw 2 and screwing in screw 1 will give plough lead, out position.**

**The adjustment of lead is made with respect to the field conditions.**

### H Adjusting disc scraper

Set scraper (1) (Fig 9) to the disc (2) of the plough, keeping the inner point (3) of edge at the centre (not touching) and tighten the nut (4) of the eye bolt (5) holding the shank (6) of the scraper by clamps (7). Raise scraper (1) to reduce breaking of furrow slice and lower it to increase the breaking. Shivel the block 8 to achieve closer or wider distance of the scraper edge to the rolling surface of the disc 2.



## Performing field operation

Raise the front bottom of the plow by the help of adjustable right lower link. Open head line furrow (single furrow) turning furrow slice toward land to be plowed. The head line serve as a mark to lower the disc plow to plow and raise the plow at the other end of the field by means of hydraulic lever of the tractor for uniform plowing.

### Divide field for operation.

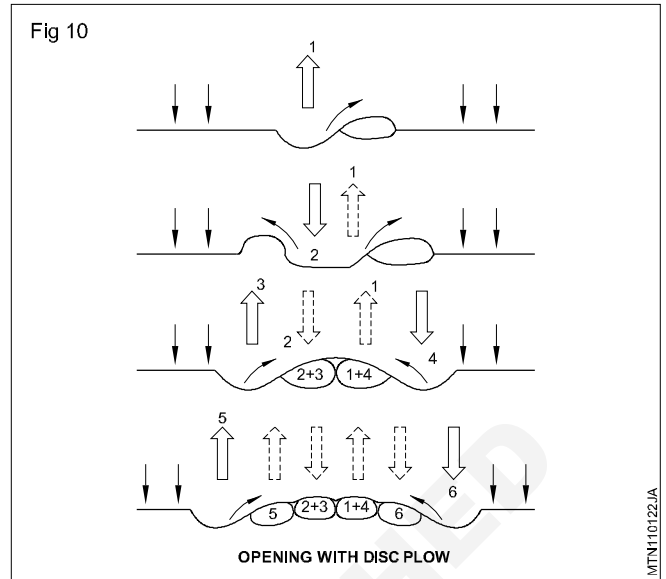
Open a straight full furrow by rear bottom in the middle (1). Turn left to work on unploughed strip of land opposite to first furrow (2). Lower down the first bottom also to engage to the land (3). Keep on plowing around the opening. (4,5,6)

Complete field in between two openings to finish plowing within head land. Finish the head line by turning the furrows in the direction of the plowed field. (Fig 10)

### Unhitching of disc plow

Lift the plow and lock the position to transport the plow. Lower down the plow in the implement shed. Lower down

the plow stand. Remove right adjustable lower link. Remove left non-adjustable lower link.

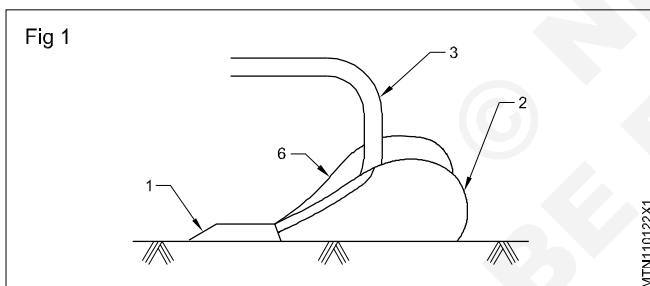


Remove top link.

## Field operation of ridger and adjustment

**Objectives:** This shall help you to

- adjust for operation
- operate in the field.

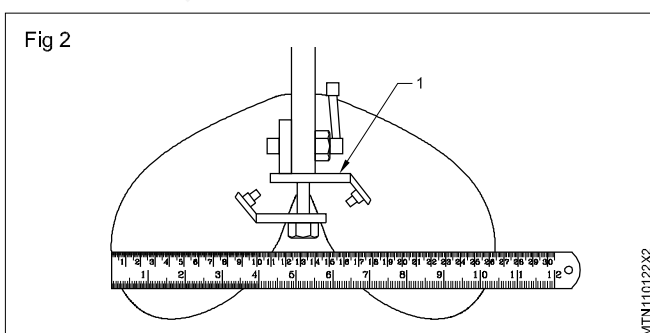


### Adjustment of Ridger for operation

Mould board adjustment.

Adjust expansion (1) (Fig 2) of the mould board with the help of bracket provided at the rear of mould board.

**Expansion of mould board to outer side will collect more earth and raise the height of the ridges forming conical shape, similarly closer mould board adjustment will reduce the height of ridges and top of the ridges will be flatter.**

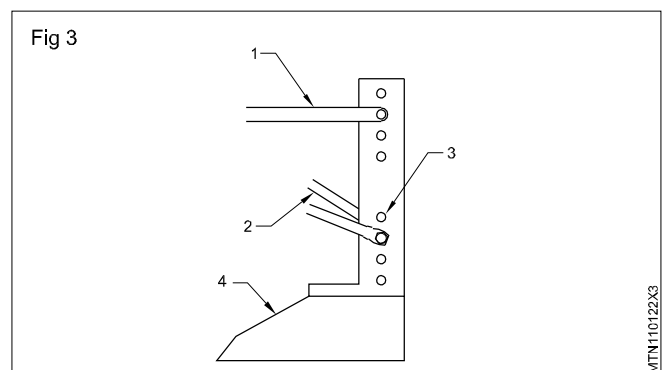


Adjust wheel track of the tractor to prevent moving of wheel on the ridges. (Track width adjustments are given by the manufacturers)

Track width adjustment will be based on ridge to ridge spacing. The suggested table is given as under:-

Ridge spacing	Front wheel track	Rear wheel track
700	1250	1400
750	1500	1500
800	1500	1600
850	1500	1700
900	1500	1800

Adjust the steering fin 4 (Fig 3) fitted at the rear of middle ridger to run deeper than the ridgers.



**The steering fin 4 (Fig 3) is used to stabilize the ridger when operated enabling to make straight ridges.**

Fit ridger beam (1) and stays (2) (left and right) on the upper holes (3) of the fin for deeper steerage and vice versa.

Raise steerage fin in hard soil and lower down for soft and loose soil.

### Field operation

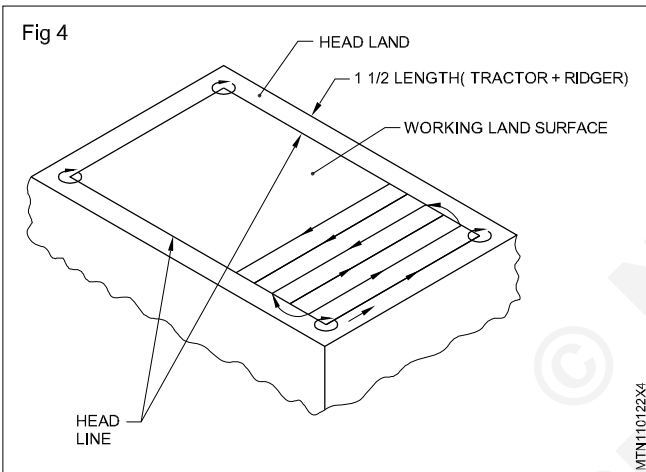
Hitch the ridger to three point linkage of the tractor.

Lift the ridger with the help of hydraulic control lever.

Transport it to the field for operation.

**It is presumed that the field is prepared smooth and moderately level for efficient operation of the ridger.**

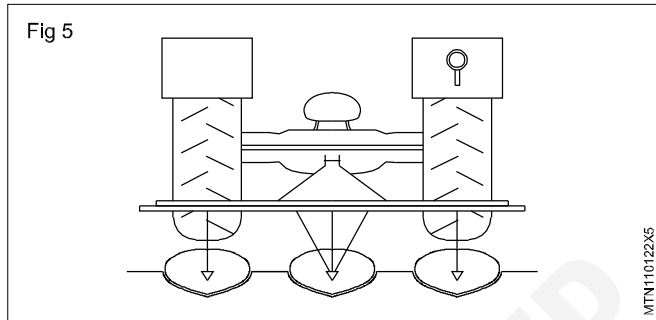
(Fig 4) approximately 1½ times (length of the tractor plus ridger)



Open head land - 4 meter away from the periphery/hedge of the land for ease of turning at the ends access.

Lower the right hand side ridger bottom with the help of levelling lever.

Level the ridger frame after marking the land on both ends of the field. (Fig 5)



Open ridges parallel from one end of the head land mark to and the other end.

Engage at one end mark and lift at the other end of the land. Cross the operation.

**It is advisable to mark the line for subsequent opening of the ridges on both sides for straight operation.**

Use depth control lever to adjust the depth once and limit the downward lever operation.

Subsequent operation is carried out by side by side method.

Complete the left out head land by reversing and forwarding drive of the tractor to form ridges in continuation to the earlier ridges.

## Field operation of rotavator (tractor mounted) and adjustment

**Objectives:** This shall help you to

- adjust rotavator for operation
- operate in the field.

### Adjustments

Check and adjust level of the rotavator with the combination adjustment of three point linkage.

Adjust blade slicing/striking clearance 1 (Fig 2) of all blades.

Adjust skidders 2 (Fig 1) of the rotavator to normal position for transportation.

### Field Operation

Raise the skidders up to required depth of cut. Lower down for shallow depth.

Select the R.P.M of the PTO and speed of the tractor according to soil conditions. (Fig 3)

**Dont operate the rotavator in stony and fallow land.**

**Refer exercise No.4 of unit 3 of Field operation of power tiller.**

**Tighten the nuts (1) (Fig 3) of the slip clutch if power transmission from PTO is slipping as shown in (Fig 3).**

**Adjust depth for shallow depth if the adequate power transmission is not achieved.**

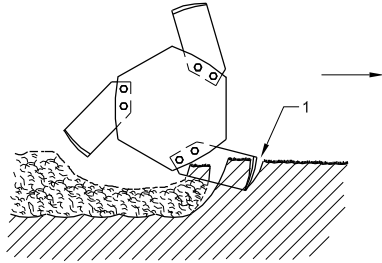
**Use stay links to prevent lateral movement of the rotavator during operation and transportation.**



**Matching propeller shaft (particularly length) should be used to couple PTO connection.**

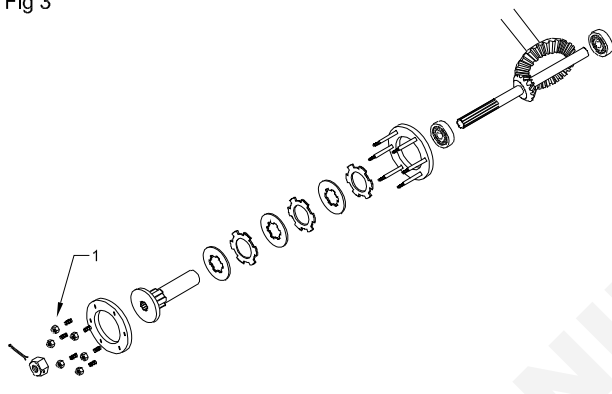
**In raised condition of the rotavator, see that the angle of propeller shaft does not exceed 40° longitudinally.**

Fig 2



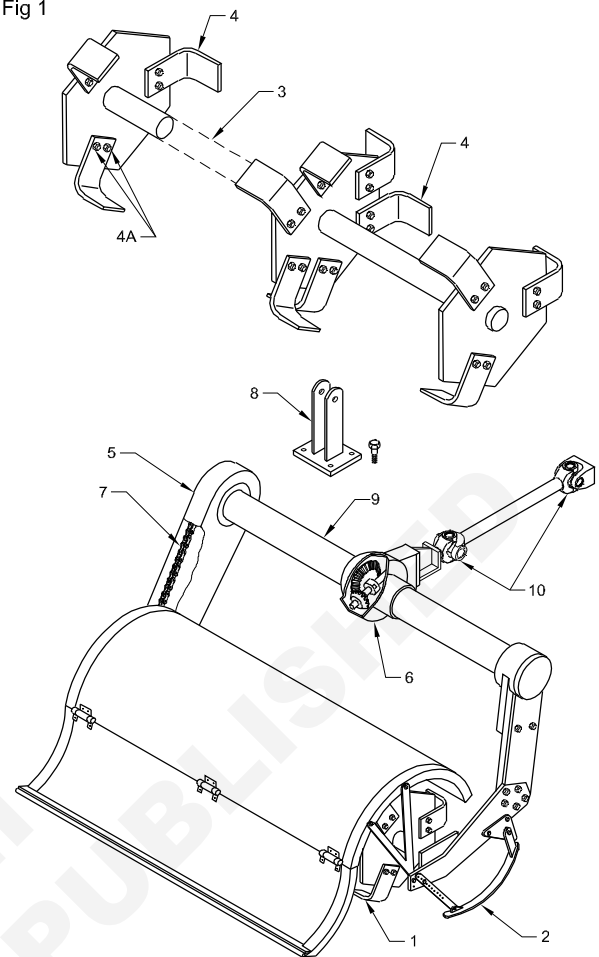
MTN110122Y2

Fig 3



MTN110122Y3

Fig 1



MTN110122Y1

## Field operation of rotary grass mower

**Objective:** This shall help you to

- make operational adjustments and operation.

### Making Operational Adjustment

Take the tractor with the mover to the field.

Lower down the mower and observe the cutting height of the grass or stubble.

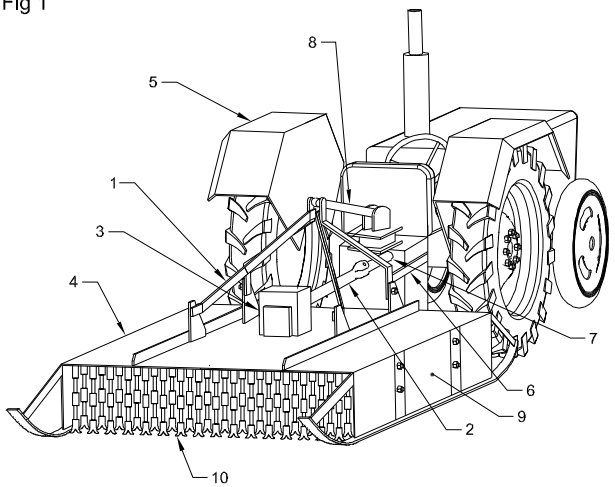
Lower down the skidders Fig 1 to raise the height of cut and vice versa.

Remove all the visible obstacles from the surface of the field.

**A metal sheet cover suitably reinforced and chain shielding are provided for safety and to arrest the flying stubbles and stones respectively.**

Circular or side by side operation are carried out.

Fig 1



MTN110122Z1

## Job sequence

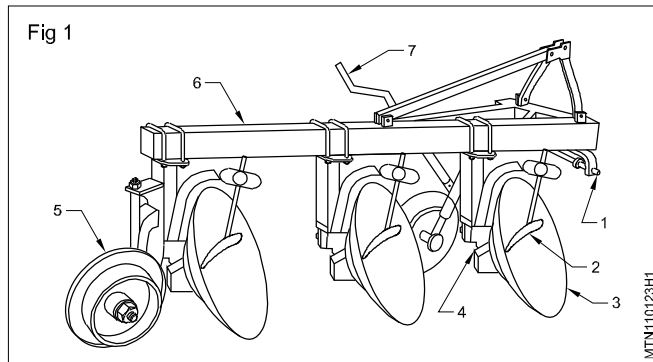
### Practice on adjusting agricultural implements during field operation

**Objective:** This shall help you to

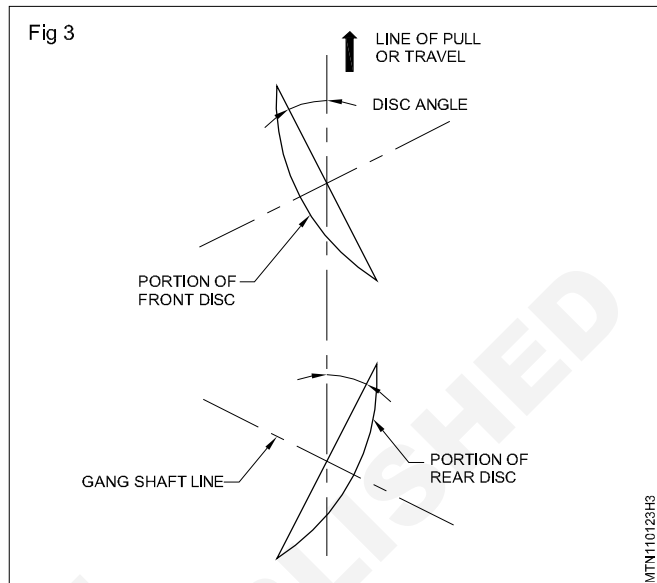
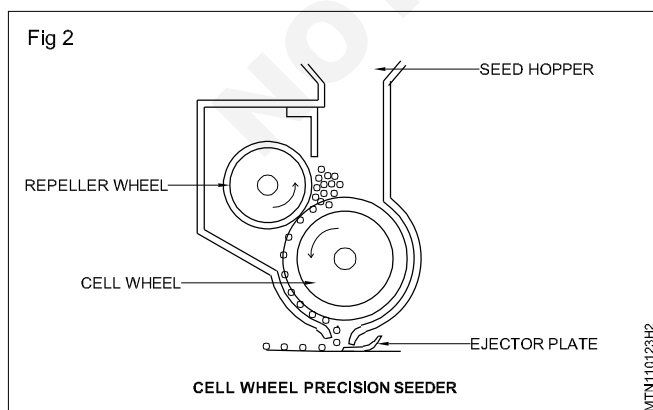
- adjust rotavator for operation

#### Adjustment of disc plough, seed drill, harrow and cultivator

- Adjust the cutting angle of disc plough. (Fig 1)

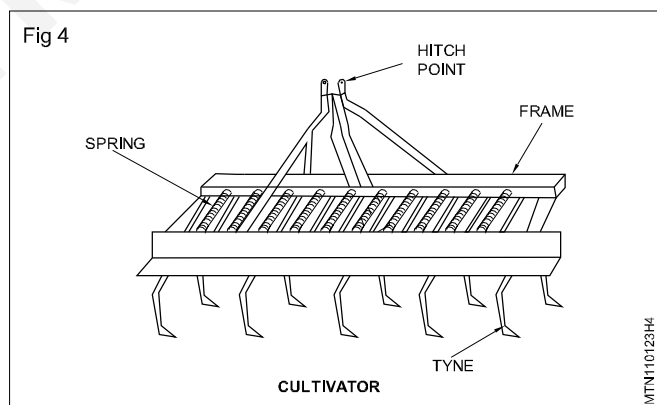


- Adjust the disc tilt angle.
- Sharpen the rolling edge of the disc.
- Refer the disc plough manual for field adjustment.
- Adjustment of disc harrow. (Fig 3)
- Adjust the disc gang angle but adjusting lever. It facilitates the front gang throws the soil on the right side.
- Sharpen the disc by a fixer or grinder to maintain the disc sharp.
- Adjust free rotation of the gang.
- Adjust the position of scraper for proper spacing between the inner disc surface and scraper.
- Refer the disc harrow manual for complete field adjustments.
- Adjust the liver on indexing device to obtain desired



seed rate. (Fig 2)

- Adjust the seed metering device according to land seed used.
- Adjust the penetration indexing mechanism for placement of seed position.



- Adjust the shovels for uniform of penetration is cultivator. (Fig 4)
- Oil and adjust the tension of spring trips of cultivator.
- Adjust wheels to toe-in slightly in cultivator.

**Overhauling the alternator assembly**

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

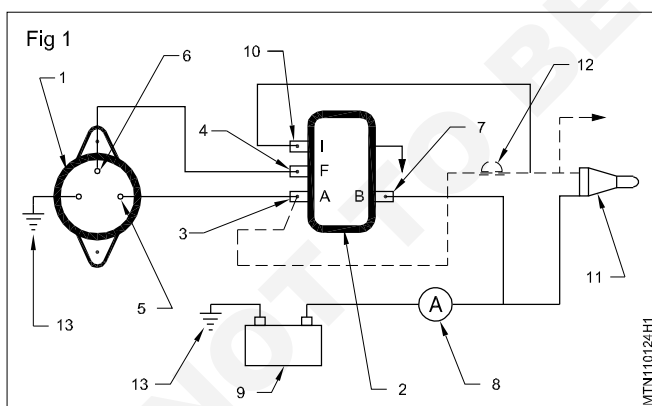
- locate the circuit from the alternator to the battery
- remove the alternator
- dismantle the alternator
- clean and inspect
- test open circuit in the stator
- test short circuit in the stator
- test short circuit in the rotor
- test open circuit in the rotor winding
- test diodes
- assemble the alternator.

Requirements			
<b>Tools/Instruments</b>		<b>Materials/Components</b>	
• Trainees Tool Kit	- 1 No.	• Tray	- 1 No.
• Test lamp	- 1 No.	• Kerosene oil	- as reqd.
• Soldering Iron	- 1 No.	• Distilled water	- as reqd.
<b>Equipment/Machines</b>		• Fine emery paper	- as reqd.
• Tractor	- 1 No.	• Carbon brush	- as reqd.
• Battery	- 1 No.	• Cotton waste	- as reqd.

**PROCEDURE**

**TASK 1: Locate the alternator circuit**

- 1 Locate the circuit from the alternator's (1) output terminal (5) to the voltage regulator's (2) terminal A (3). (Fig 1)



- 2 Locate the feedback circuit from the voltage regulator's (2) 'F' terminal (4) to the alternator's (1) field terminal (6).
- 3 Locate the circuit from the voltage regulator's (2) 'B' terminal (7) to the ammeter (8).
- 4 Locate the circuit from the ammeter (8) to the battery (9).
- 5 Locate the circuit from the voltage regulator's (2) 'A' terminal (3) to the indicator lamp (12).
- 6 Locate the circuit from the indicator lamp (12) to the ignition starting switch (11).
- 7 Locate the ground connection (13).
- 8 Locate the circuit from the ammeter (8) to the ignition starting switch (11).

**TASK 2: Removing alternator**

- 1 Disconnect the earth cable of the battery.
- 2 Disconnect the wires from the alternator.
- 3 Loosen the bolts which secure the alternator with the bracket.
- 4 Take out the alternator.

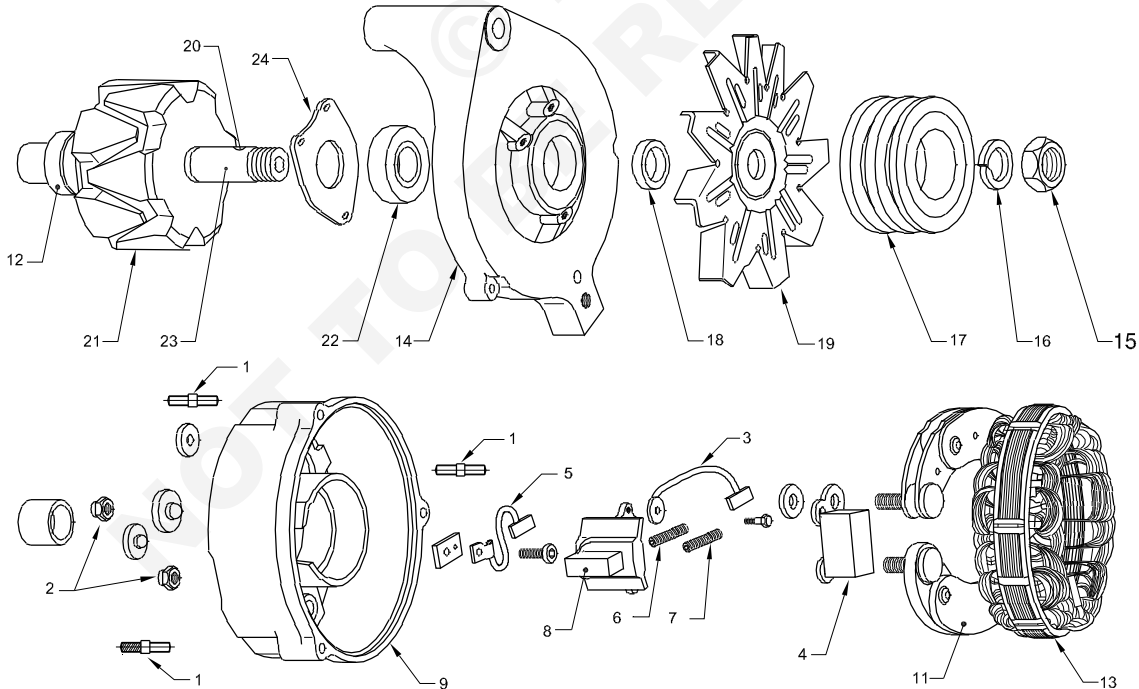
### TASK 3: Dismantling

- 1 Mark a line across both the end shields (14 & 9) and the stator to facilitate alignment during reassembling.
- 2 Remove the cover securing studs and nuts (1 & 2) and lift the cover.
- 3 Disconnect the regulator leads (3) and (5) (+ve, -ve).
- 4 Remove the screw securing the regulator (4) to the brush box and remove the regulator (4).
- 5 Remove both the brushes (6) & (7). Note down the position of the sealing pad.
- 6 Remove the screws securing the brush-box (8) to the slipping end bracket (11) and lift out the brush-box (8).
- 7 Release the stator winding cable ends from the rectifier by applying a hot soldering iron to the terminal tags of the rectifier.
- 8 Gently pull out the cable end when the solder melts.
- 9 Remove the screws securing the rectifier assembly (11) to the slip-ring end bracket and lift out the rectifier assembly.
- 10 Remove the fixing bolts.
- 11 Take out the slip-ring end bracket (11).
- 12 Take out the stator assembly (13) from the drive end bracket (14).
- 13 Remove the shaft nut (15), washers (16) and take out the pulley (17), fan (19), woodruff key (20) and spacers (18).
- 14 Push at the rotor shaft (23) end with your thumb to separate the drive end bearing (22) and rotor assembly (21).

### TASK 4: Cleaning and inspection

- 1 Clean all the parts with kerosene and a nylon brush except the brushes.
- 2 Clean the slip-ring (12) with fine emery-paper and wipe with a clean rag. (Fig 2)
- 3 Clean the brushes with petrol.
- 4 Check the bearings visually for any damage. If necessary, replace the bearing with a new one.
- 5 Check the brushes for correct dimension, according to the manufacturer's specification; replace, if required.
- 6 Check the brush spring tension; replace if required.
- 7 Check for the external crack on drive end bracket and slip end bracket.

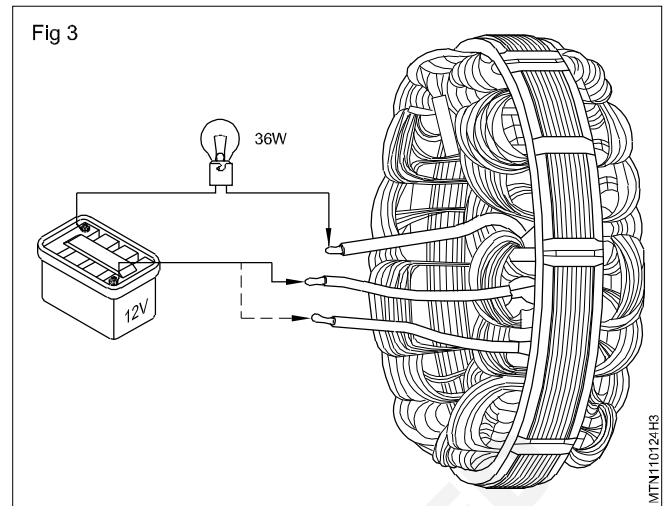
Fig 2



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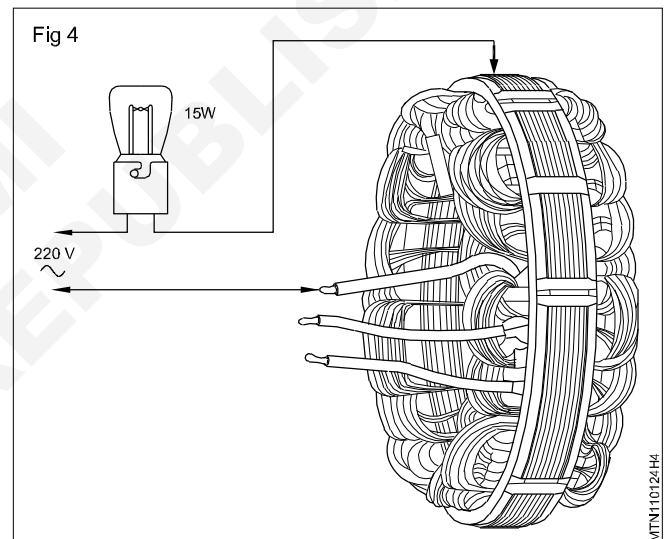
### TASK 5: Test for open circuit in the stator

- 1 Check the continuity of the stator windings. First connect any two of the stator winding leads to a 12 V battery in series with a suitable test lamp. (Fig 3)
- 2 The lamp should glow. If the first part of the test is satisfactory, transfer one of the test lamp leads, to the third lead in the stator.
- 3 The test lamp should glow. If there is any damage or burning or overheating of the winding, renew the stator assembly.



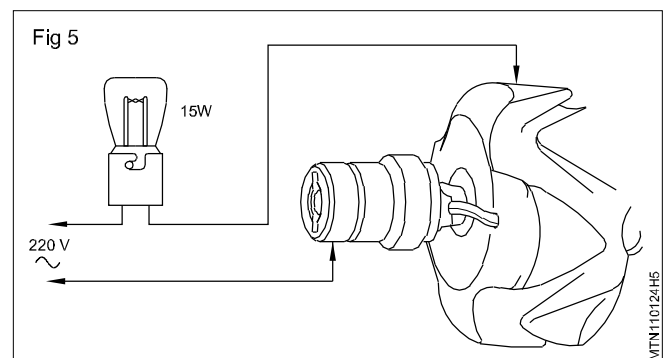
### TASK 6: Test for short circuit in stator

- 1 Check the insulation of the stator windings by connecting a 220 V AC mains with a 220 Volt. 15 W test lamp in series between the stator laminators and each one of the three stator lead one by one. The lamp should not glow. If the test lamp glows then the stator winding is defective, renew the same. (Fig 4)



### TASK 7: Test for short circuit in rotor

- 1 Check for satisfactory rotor winding insulation by connecting to a 220 V AC mains with a 220 V 15-watt test lamp in circuit between either of the slip-rings and the rotor body. The lamp should not glow. If the lamp glows, then the rotor winding is defective; rotor assembly need renewal. (Fig 5)

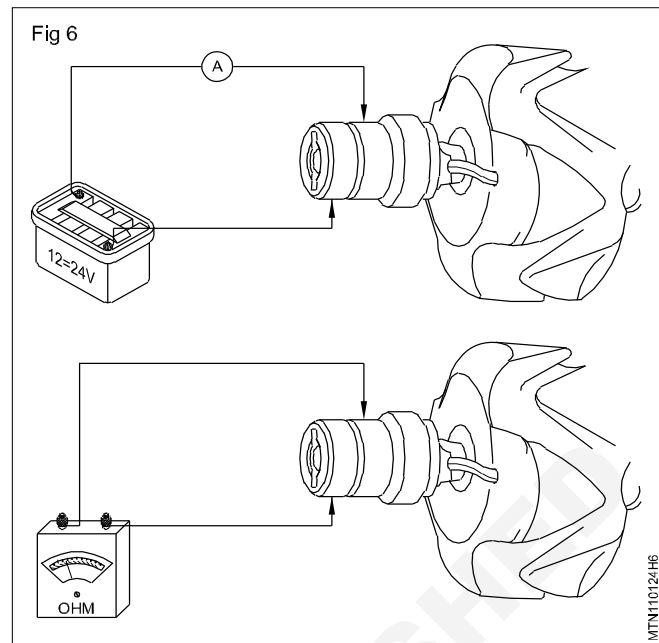


### TASK 8: Test for open circuit in Rotor winding

- 1 Check the motor winding continuity by connecting a 12 V/ 24 V battery and the moving coil ammeter between the slip-rings. (Fig 6)

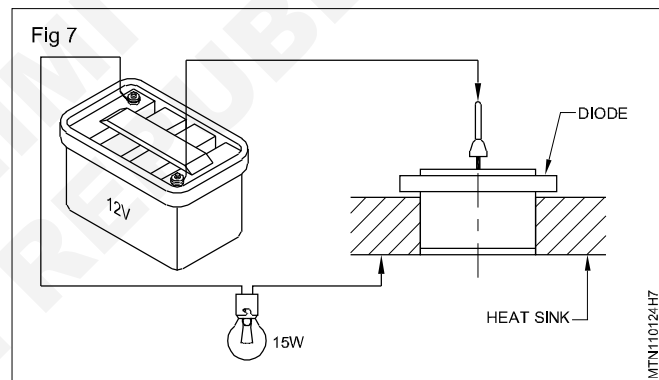
**The current should be 2 to 2.5 A approximately for 12 V. If it is not of the correct value then renew the rotor.**

- 2 Check the resistance of the rotor winding with an ohmmeter.
- 3 The resistance should be 9.6 to +/- 1 ohms for a 24 V alternator and 3.2 +/- 0.5 ohms for a 12 V alternator. If the readings are not within the limit, renew the rotor assembly.



### TASK 9: Testing diodes

- 1 Test each diode separately by connecting a 12 V battery and 12 V, 15 W bulb in series with the diode. Connect one test lead to the diode connecting pin and the other lead to the heat sink. Watch if the lamp glows. Then reverse the test lead connections. The lamp should glow during one direction of the test connection only. (Fig 7)
- 2 Replace the diode if required.



### TASK 10: Assembling alternator

- 1 Check the surface of the slip-ring for burnt or dirt. Replace the slip-ring, if required.
- 2 While assembling ensure that the scribed reference lines are in alignment.
- 3 Assemble the rotor assembly (21) with the drive and bearing (22) to the drive end bracket (14) and fix the bearing retainer (24) with screws. (Refer Fig.2)
- 4 Assemble the spacer (18) woodruff key (20), fan (19) and pulley (17) on the rotor shaft (23).
- 5 Assemble the stator assembly (13) to the drive end bracket (14).
- 6 Place the rectifier assembly to the slip-ring end bracket and fix the screws.
- 7 Place the slip-ring end bracket (9) and fix the fixing bolt/ stud.
- 8 Solder the stator winding cable ends to the rectifiers.
- 9 Place the brush-box on the slip-ring end bracket (9) and fix the screws.
- 10 Place the sealing pad and place both the brushes.
- 11 Place the delivery brush mounting plate in position and fix the screws.
- 12 Place the regulator (4) on the brush-box and connect the regulator leads (3) & (5) and fix the screws.
- 13 Place the cover and fix the cover securing studs (1) and washer (10) and tighten the nuts (2) firmly.

## Skill Sequence

### Refitting alternator on tractor and testing

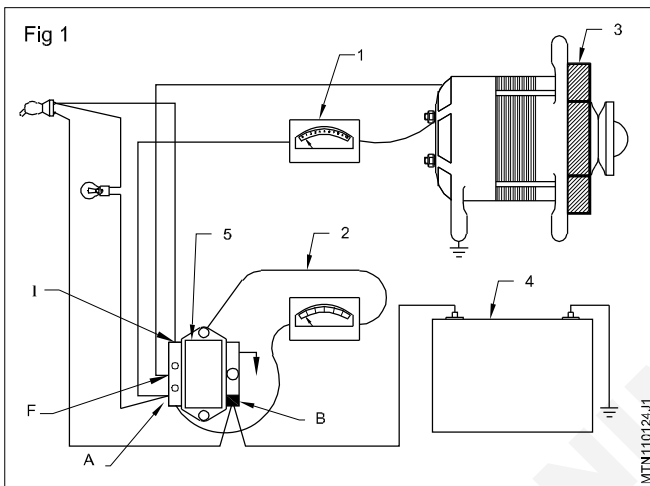
**Objectives:** This shall help you to

- refit an alternator to the tractor and testing
- general maintenance of alternator.

#### Refitting alternator to the vehicle

Place and secure the alternator in its bracket using bolts & nuts.

Connect all the wires of the alternator which you disconnected earlier. Connect the battery cables to the circuit. (Fig 1)



Check the fan belt for overstretched or damaged condition.

Check the fan belt for proper tension. If the fan belt tension is low/high adjust by removing the alternator to the appropriate side.

Check if all the ends of the battery cables are clean. check all the wire connections for loose, dirty or broken connections.

Disconnect the battery earth cable. Connect the ammeter (1) in series. Connect the voltmeter (2) parallel to the alternator terminal and earth. Connect a wire across the field output terminal in the alternator (3). Connect the battery cable and put on the starting switch. Note the ammeter reading.

**The ammeter reading should be 2A approximately in the field current drawn from the battery (4).**

**The 'F' lead should be disconnected from the regulator, and the wire end should be insulated to avoid accidental earthing.**

Run the engine at medium speed. Switch on the lights and other electrical appliances.

**The voltmeter reading should be of 14.2 V approximately.**

**The ammeter reading should also be the maximum.**

If the voltmeter (2) and ammeter (1) read low, the regulator (5) needs replacement.

#### General maintenance of alternator.

**Clean the alternator periodically.**

**Check the mounting bolts from tightness.**

**Check the fan belt condition and tension to the recommended value.**

**Check the specific gravity of the battery electrolyte.**

**Check the battery terminals for tightness and cleanliness.**

**Check the brush once in a year (1000 hours). If necessary, replace it.**

**Check the bearings once in two years. renew, if worn out.**

**Use fine emery-paper to clean the slip rings.**

## Overhauling the starting motor assembly

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

- dismantle the starter motor
- remove solenoid switch assembly
- inspect solenoid switch
- test the armature ground
- test the armature open circuit
- clean and test the commutator
- check the field coil
- check the over-running clutch
- assemble starter motor
- test the starter motor for performance
- fit the starter motor on the engine.

### Requirements

#### Tools/Instruments

- Trainees Tool Kit - 1 No.
- Soldering iron - 1 No.
- Circlip plier - 1 No.
- Multimeter - 1 No.
- Dial gauge with stand - 1 No.
- Vernier caliper - 1 No.
- Hacksaw blade or knife - 1 No.

#### Equipment/Machines

- Tractor with self-starter motor - 1 No.

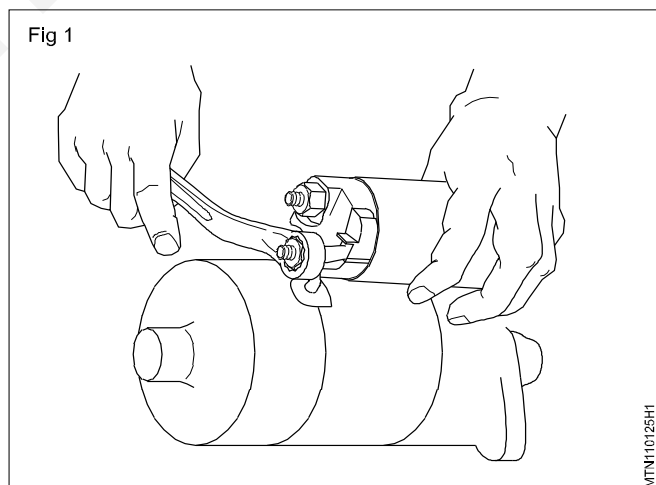
#### Materials/Components

- Carbon brush - as reqd.
- Cotton waste - as reqd.
- Insulation Tape - as reqd.

## PROCEDURE

### TASK 1: Dismounting the starter motor

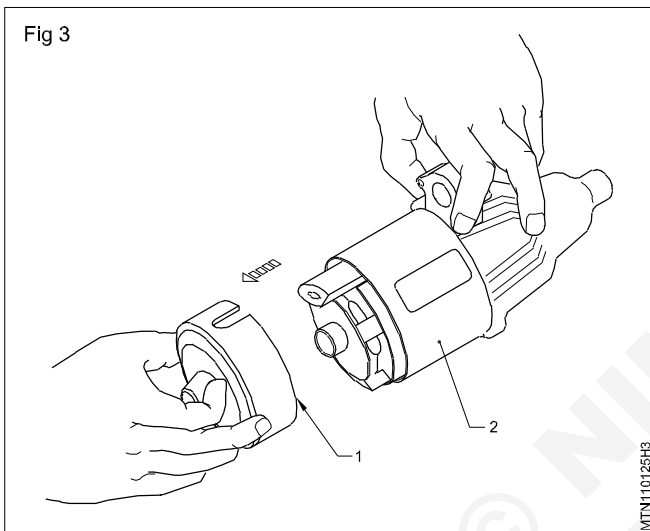
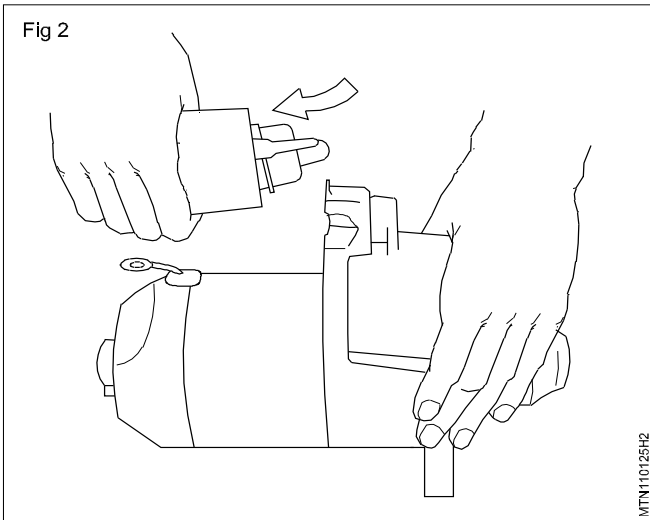
- 1 Disconnect the earth lead at the battery.
- 2 Disconnect the Solenoid (Magnetic) switch lead wires (1) and the battery cable (2) from the starting motor terminals.
- 3 Remove the two mounting bolts (3) (Fig 1)
- 4 Remove the starter motor.



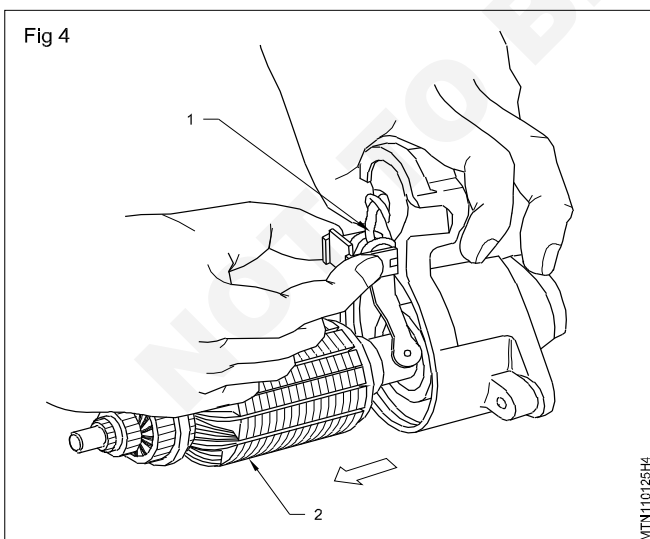
### TASK 2: Removal of the Solenoid switch assembly

- 1 Remove the cable terminal nut and disconnect the lead wires (4) from the solenoid magnetic switch.
- 2 Remove the two mounting nuts (1) and then take out the magnetic switch by slight tilting. (Fig 2)
- 3 Remove the through bolts.
- 4 Take off the commutator end cover (1). (Fig 3)
- 5 Remove the brush holder cover from the brush holder (2).
- 6 Take out the brush springs and copper brushes, and Starter body (3).

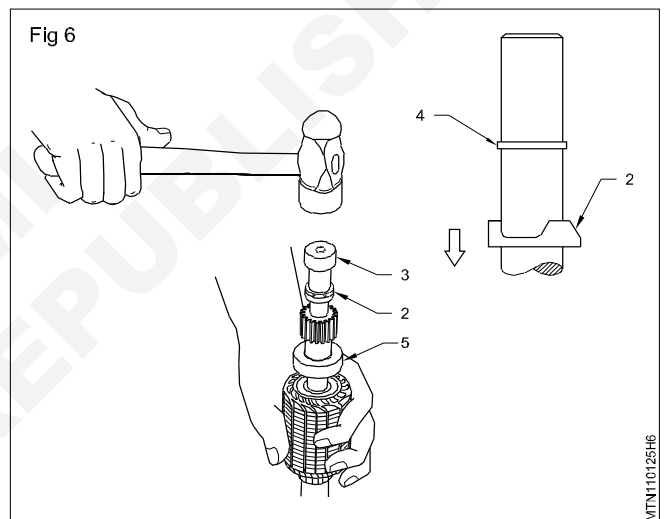
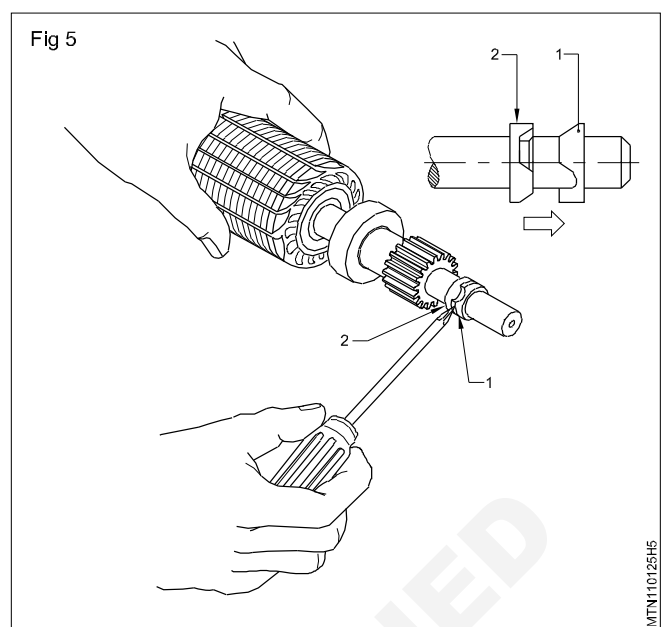




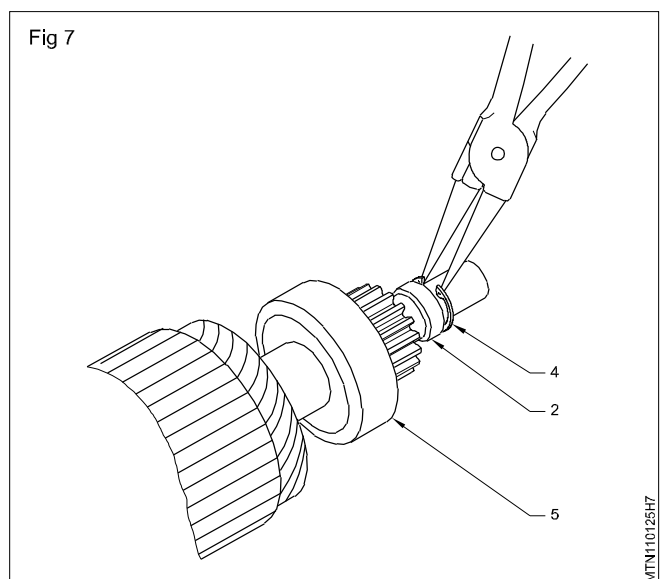
- 7 Remove the yoke assembly (Fig 4)
- 8 Remove the armature (2) along with the pinion drive lever (1).



- 9 Insert the screwdriver tip in the gap between the two stop collars (1) and (2). (Fig 5)
- 10 Push the front collar (1) outward.
- 11 Using a 14 mm socket (3) push the rear stop collar (2) downwards. (Fig 6).

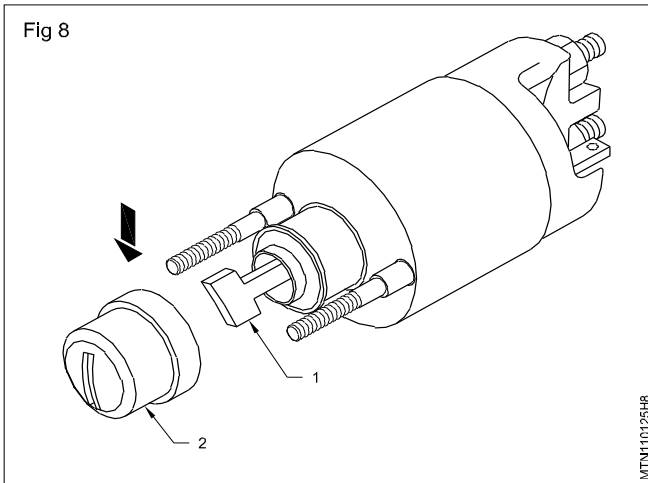


- 12 Remove the armature circlip (4) by using a circlip plier, and with the help of a screw driver.
- 13 Pull out the rear pinion stop collar (2), and over-running clutch (5). (Fig 7)

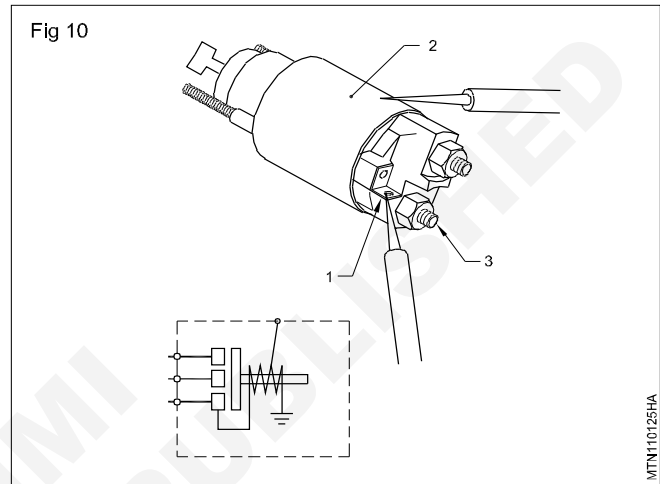
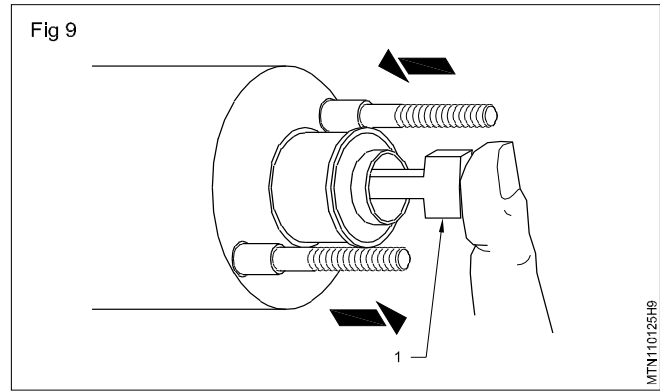


### TASK 3: Inspection Magnetic Switch (Solenoid switch)

- 1 Inspect the magnetic switch boot (2) for breakage. (Fig 8)
- 2 Inspect the plunger (1) for wear or damage. Replace if necessary. (Fig 8)

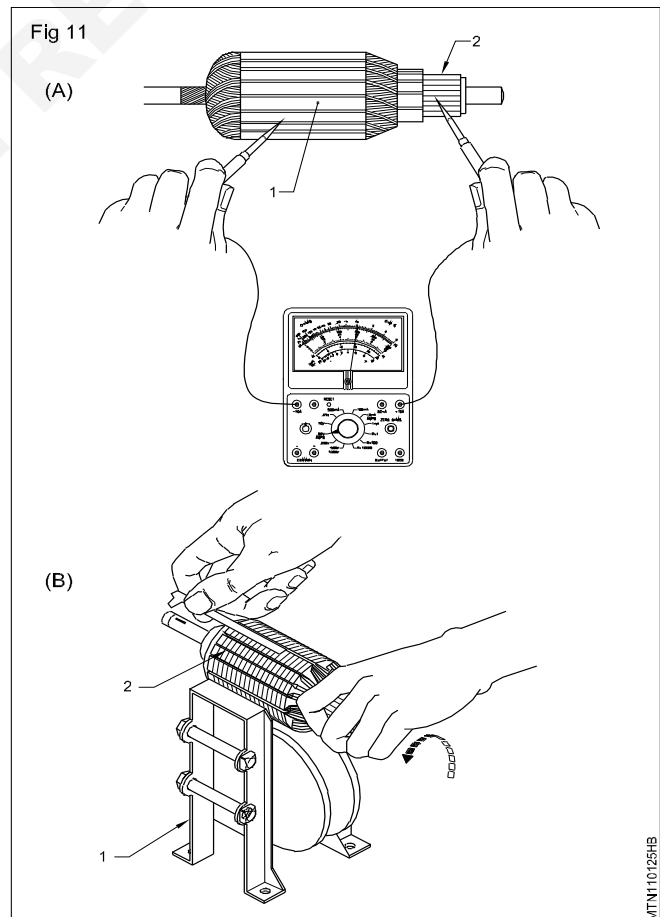


- 3 Push the plunger (1) in and release it. The plunger should return quickly to its original position. Replace if necessary. (Fig 9)
- 4 Check for continuity across the magnetic switch's terminal (1) and coil case (2). If no continuity exists, the coil is open and should be replaced. (Fig 10)
- 5 Check for continuity across magnetic switch terminal (1) and terminal (3). If no continuity exists, the coil is open and should be replaced. (Fig 10)



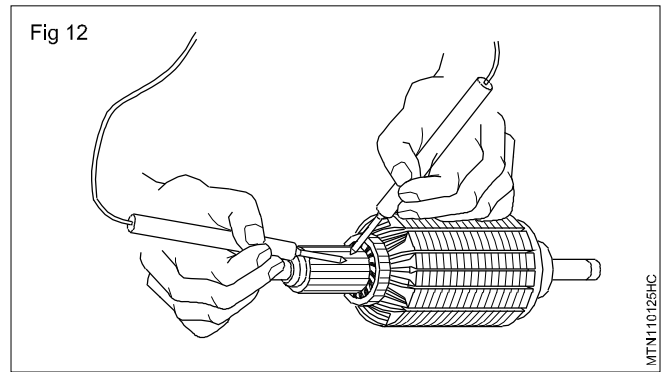
### TASK 4: Armature for ground

- 1 Using an ohmmeter test for continuity between the commutator (2) and armature core (1). The ohmmeter will indicate infinite resistance if the insulation is in sound condition. (Fig 11)
- 2 Placing armature (2) on the growler (1) and switch on.
- 3 Lay a thin steel strip (4) on the armature core with small air gap.
- 4 Rotate the armature slowly by hand. (Fig 11)
- 5 The steel strip will vibrate if a coil is shorted. Then replace the armature.



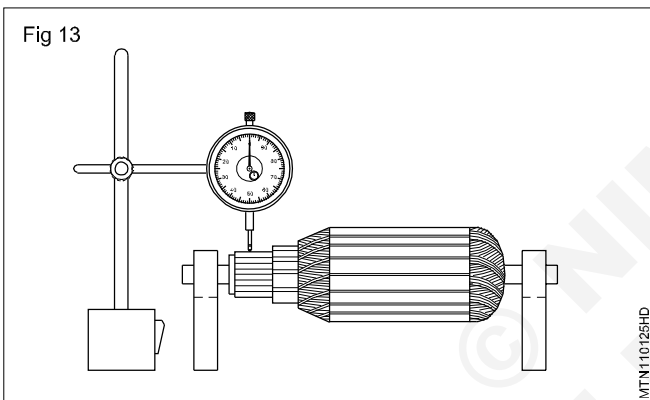
### TASK 5: Open circuit

- 1 Check for continuity between each pair of adjacent commutator segments, using an ohmmeter. (Fig 12).
- 2 If there is any discontinuity the ohmmeter needle will not deflect. Replace the armature assembly. (Fig 12)

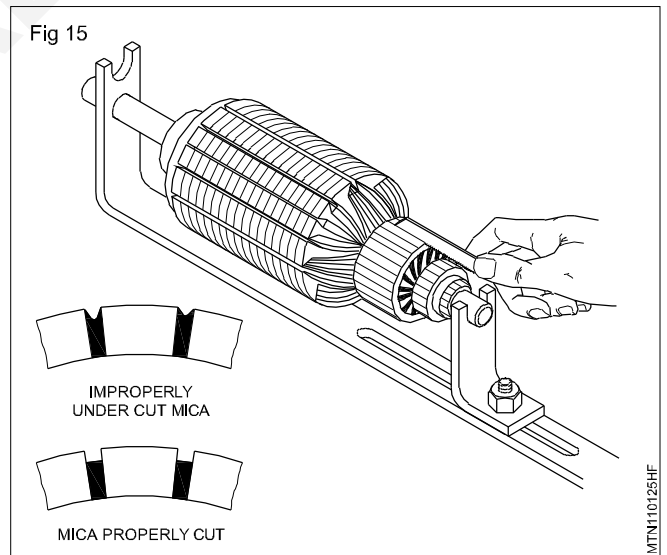
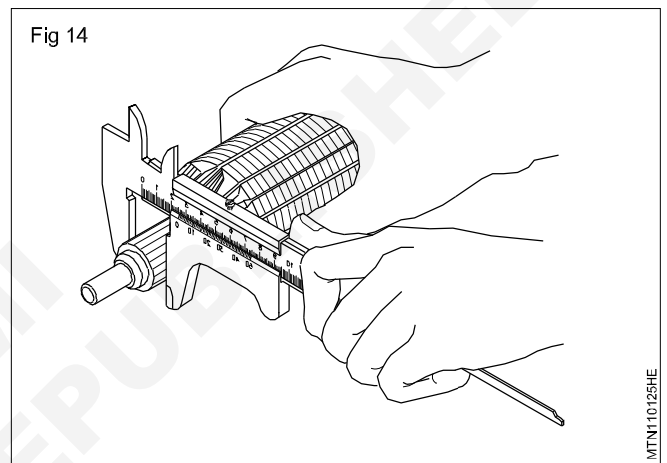


### TASK 6: Testing the Commutator run out

- 1 Place the armature between two 'V' blocks. (Fig 13) or stand.
- 2 Using a dial gauge check the commutator for run out by slowly rotating it by hand. (Fig 13)

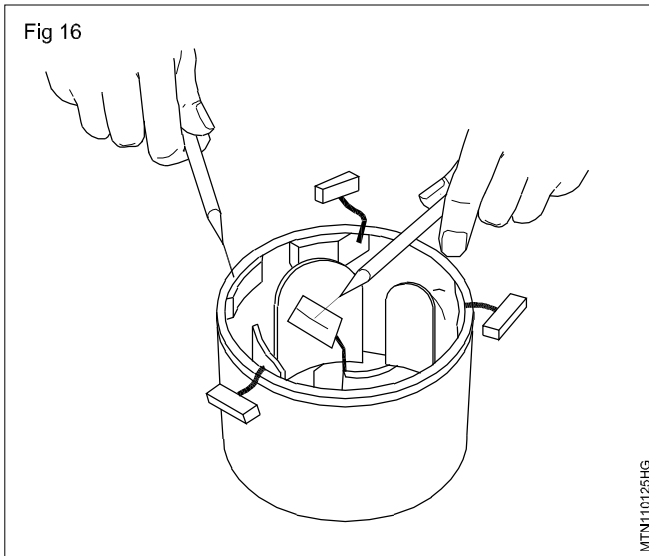


- 3 Correct it on lathe if required.
- 4 Check for wear and replace the commutator if the diameter is below limit. (Figs 14 & 15)
- 5 Clean the surface by using 400 emery cloth. Check the mica depth to a minimum of 0.2 mm and correct by using a hacksaw blade or knife, if required.

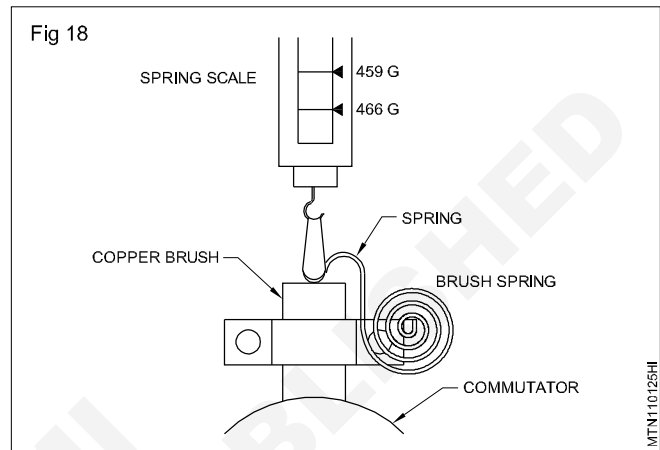
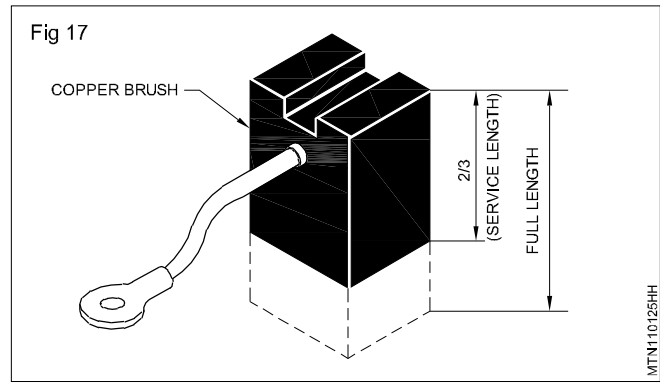


### TASK 7: Check field coil

- 1 Open circuit and short circuit. (Fig 16) Using an ohmmeter or test lamp, check for continuity between the field coil and the insulated brushes. If continuity is not indicated, the insulation has failed. Replace the field coil. Check each field coil for short circuit with self body. If coil is short with body, replace it.
- 2 Measure the length of the copper brushes. If brushes are worn down to the service limit, replace them and self-proper bedding. (Fig 17)
- 3 Check the brush springs (1) for tension, rust or breakage. (Fig 18)

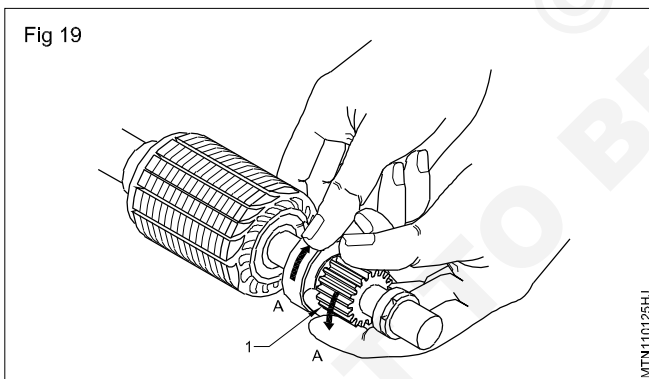


4 Check brush holder for insulation and earth.

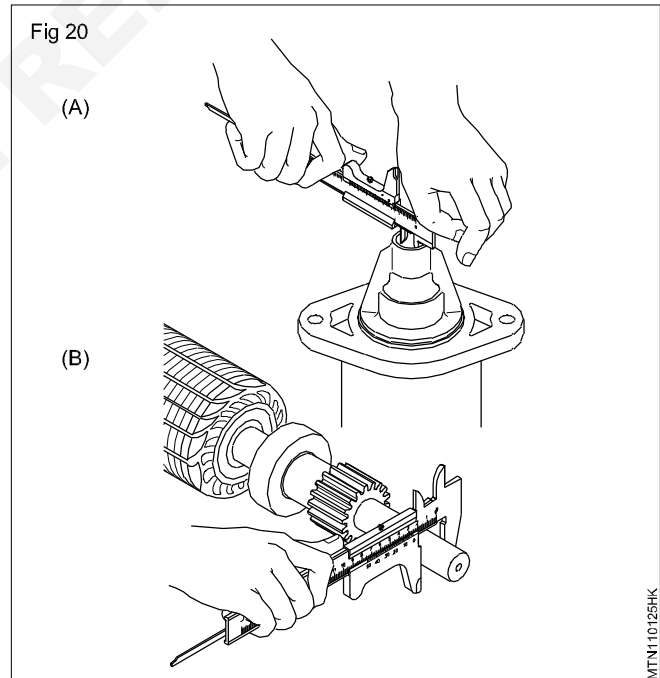


### TASK 8: Over-running clutch

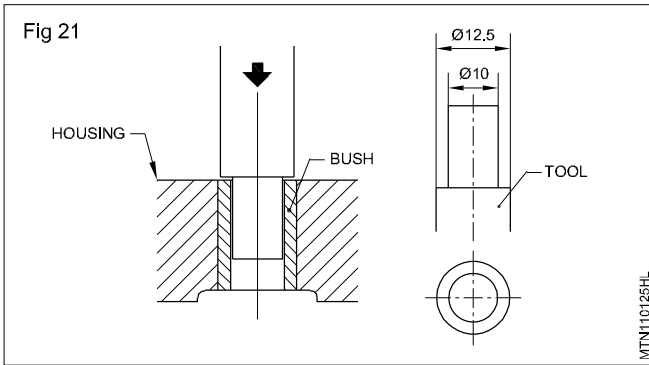
1 Inspect the one-way clutch for free rotation in direction 'A', and locked up the other way round. (Fig 19)



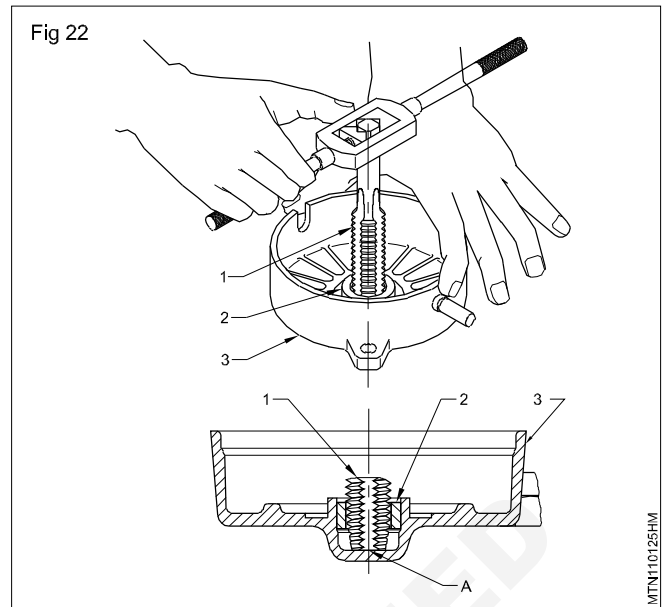
- 2 Check the pinion (1) for abnormal wear and replace it as assembly if required.
- 3 Armature shaft and drive end cover bush.
- 4 Using a 10 mm rod, take out the bush cap.
- 5 Measure the internal diameter of the drive bush. (Fig 20A)
- 6 Measure the outer diameter of the armature shaft at the drive end. (Fig 20B)
- 7 If clearance exceeds the limit, replace the bush.
- 8 Using the tool as shown in the (Fig 21), remove the bush from the drive housing on the arbour press.



- 9 Measure the outer diameter of armature shaft at the commutator end.
- 10 If clearance exceeds the limits, replace the bush. (Fig 22)
- 11 Thread in with a suitable tap (1) in the bush.

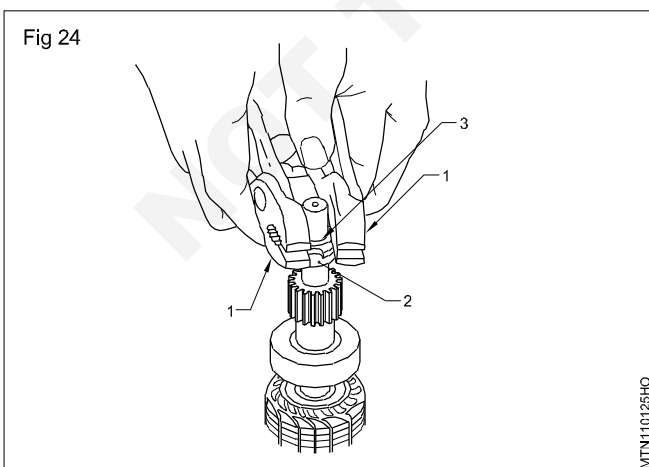
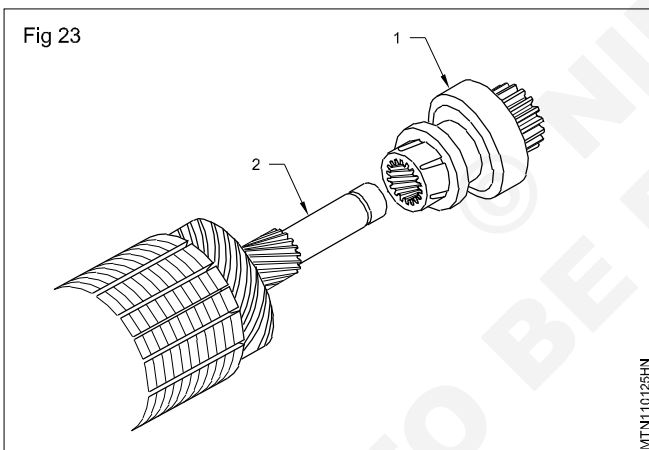


- 12 When the end of the tap reaches the bottom of the frame (3), tighten it further.
- 13 The bush will come out.
- 14 Fit new bushes as press fit on the arbour press.
- 15 Ream the inside surface of the bush to obtain oil clearance (0.05 mm) between the armature shaft and bush.



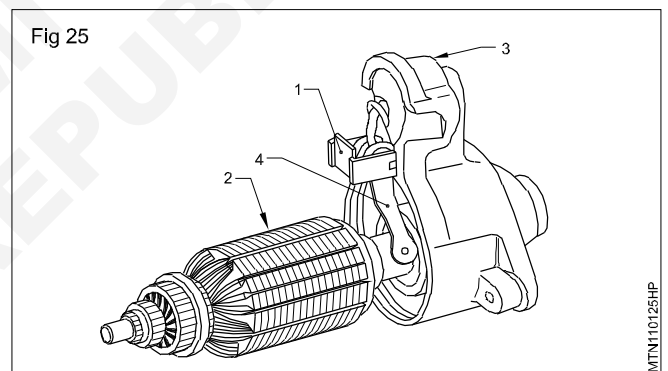
### TASK 9: Assembly

- 1 Apply grease and install the over-running clutch (1) to the armature shaft (2) as shown in the (Fig 23).
- 2 Insert the rear stop collar (2) in the armature shaft (Fig 24)

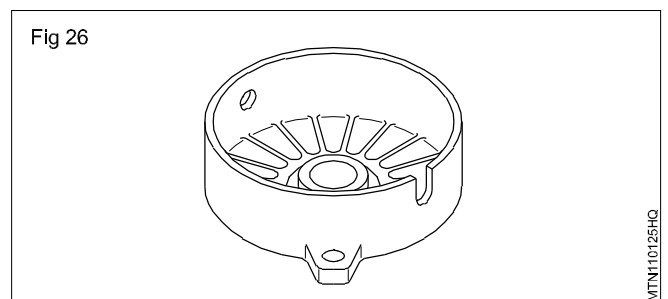


- 3 Insert a circlip in the armature shaft.
- 4 Insert the front stop collar (3) in the armature shaft.

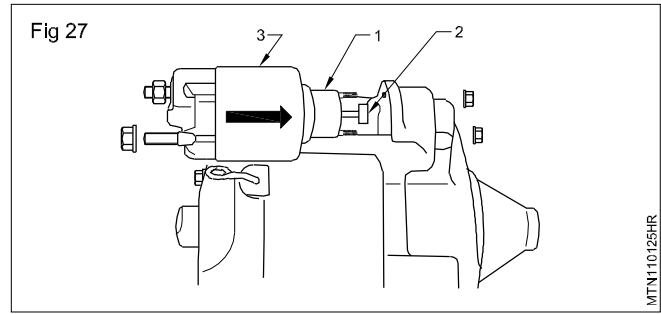
- 5 Press by two pliers (1) as shown in the (Fig 23).
- 6 Apply grease to the drive lever (1). (Fig 25)



- 7 Combine it with the armature (2). (Fig 25)
- 8 Assemble them with the drive housing (3).
- 9 Install the yoke (4).
- 10 Install the brush holder.
- 11 Install 4 sets of brushes with the springs.
- 12 Install the brush holder cover.
- 13 Apply grease and install the commutator end housing as shown in the (Fig 26).



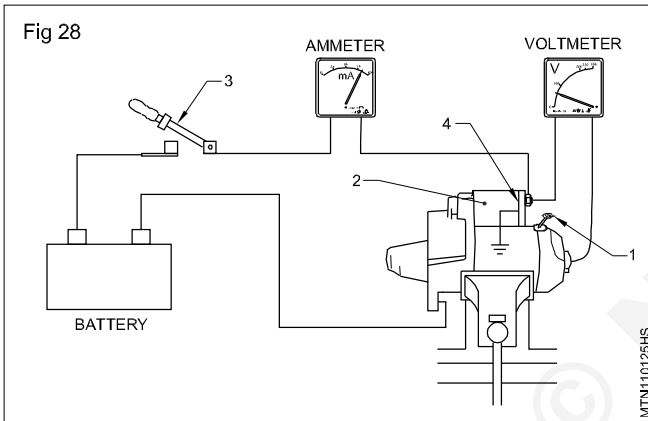
- 14 Replace the magnetic switch (3) and its boot (1) with a new one if required. (Fig 27)
- 15 Apply grease to the plunger's (2) hook. (Fig 27)
- 16 Hook the switch plunger with the drive lever. (Fig. 27)
- 17 Fasten the switch assembly with nuts.
- 18 Connect the lead wires.



## TASK 10: Performance Test

### Pull in test

- 1 Hold starting motor in vice or stand.
- 2 disconnect field coil terminal (1) from solenoid switch.
- 3 Connect the test lead, switch, Ammeter, Voltmeter as shown in the (Fig 28)



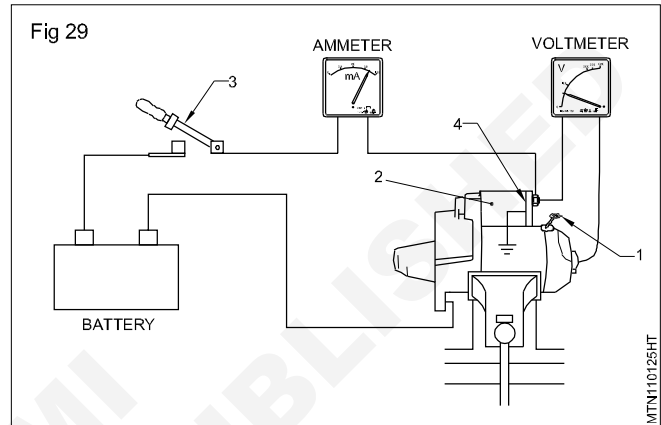
- 4 Operate switch (3) and check that the pinion (overrunning clutch) jumps out if does not rectify the fault.

### Hold in Test

- 1 Remove (Disconnect) negative lead from terminal (4). (Fig 29)
- 2 Check that the pinion remains out, if not rectify the fault of magnetic switch. If necessary, replace it.

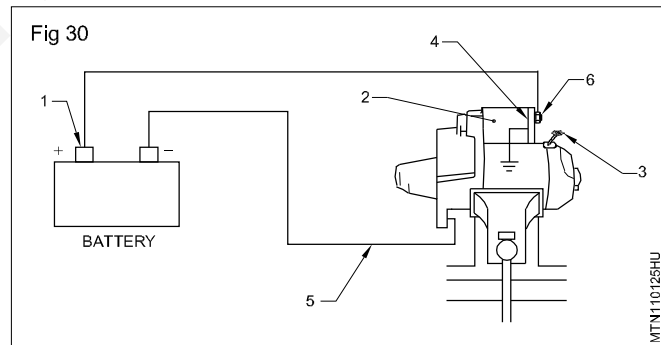
### Pinion return Test.

- 1 Disconnect the switch (3).
- 2 Check to make sure that the pinion returns inward quickly.



### No Load performance test

- 1 Connect the battery leads (5) as shown in the (Fig 30). From Battery Terminal (1) to solenoid switch terminal (6) second battery lead (5) to the starting motor.
- 2 Operate solenoid switch (4) and check the starting motor runs without fail with the pinion moved out.



## TASK 11: Remounting

- 1 Place the starter motor in its position.
- 2 Tighten the two mounting bolts.
- 3 Connect the battery cable and magnetic switch lead wires to the starter motor terminals.
- 4 Connect the negative lead to the battery.

## Storage batteries and tracing trouble in lighting circuits

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

- locate various positions of the circuit in tractor
- check the fuses of all the lighting units
- remove the lighting units
- assemble the light units
- focusing of head light.

Requirements			
Tools/Instruments		Materials/Components	
• Trainees Tool Kit	- 1 No.	• Fuse	- as reqd.
• Test lamp	- 1 No.	• Switch	- as reqd.
• Multimeter	- 1 No.	• Cable wire	- as reqd.
<b>Equipment/Machines</b>		• Insulation Tape	- as reqd.
• Tractor	- 1 No.		
• Battery	- 1 No.		

### PROCEDURE

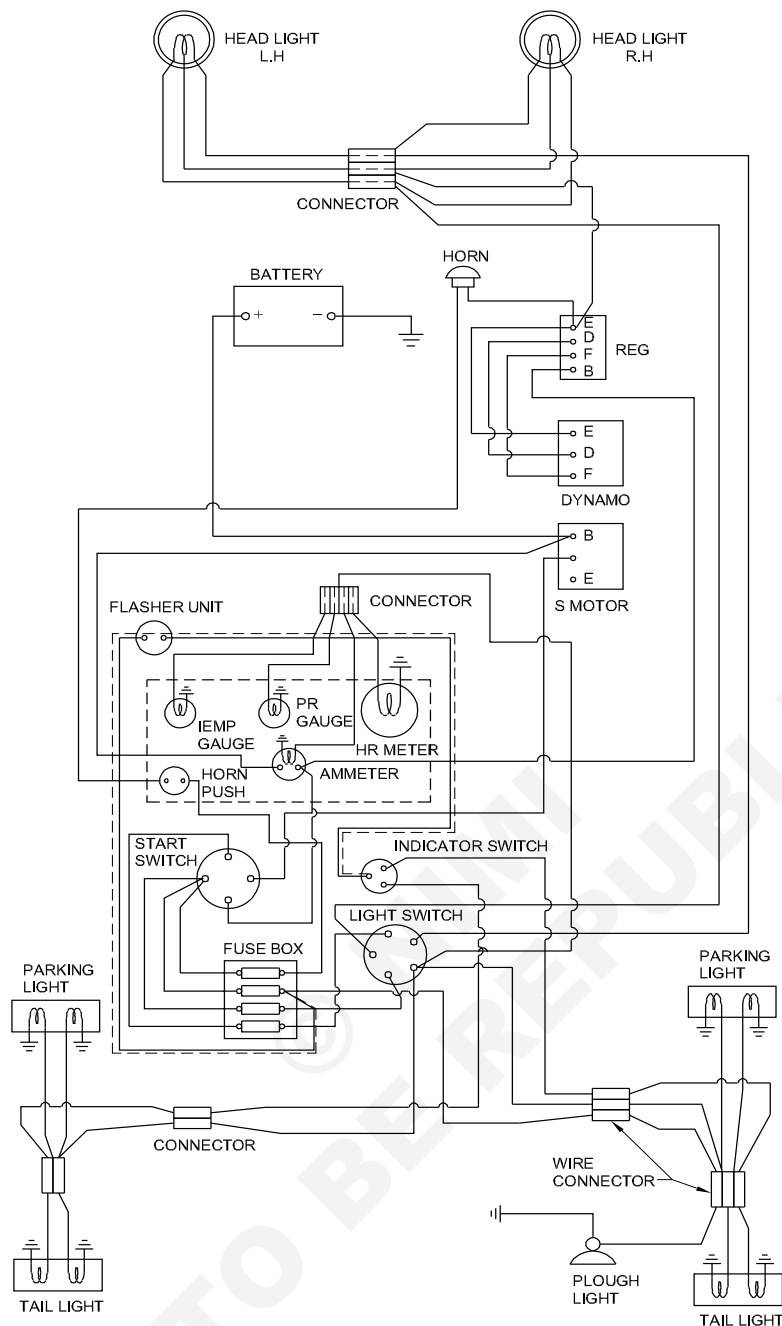
#### TASK 1: Storage batteries

- 1 The batteries should be stored up right.
- 2 The room should provide facilities for battery charging.
- 3 The storage area should be adequate ventilated
- 4 The room temperature should have an annual average of 15°C
- 5 Ensure a dry room atmosphere
- 6 Keep the battery clean to prevent brakage current
- 7 Full charge between 12 7V and 12 8V
- 8 To maintain charge the valtage should be 12.5 v or less.
- 9 Overcharging is a risks
- 10 Take care of the battery and prent corrosion.

#### TASK 2: Tracing the circuits

- 1 Trace, study and check cable from (Fig 1)
  - 1 battery (1) to the self starter (2).
  - 2 self starter (2) to ammeter (3).
- 2 Trace, study and check cable from
  - 1 battery (1) to the self starter (2).
  - 2 self starter (2) to ammeter (3).
- 3 Trace and study circuit from
  - 1 ammeter (3) to starting switch and Fuse box/ Junction box (5).
  - 2 ammeter to dynamo/generator (6) through the regulator (7).
  - 3 fuse box to horn (9) via push button switch (8).
  - 4 fuse box to lighting switch (10).
  - 5 lighting switch (10) to head light 11 /parking lamp (12)/Tail light 17.
  - 6 lighting switch (10) to plough lamp (13) and its switch.
  - 7 plough lamp (13) to reflex reflector (14) (LH-RH).
  - 8 lighting switch (10) to indicator switch (15) and from indicator switch (15) to indicator lamp (16).

Fig 1



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**TASK 2: To check the fuses of all the lighting units**

- 1 Check the battery for its charge.
- 2 Connect the test lamp clip to a good ground. Touch the probe of the test lamp on either end of the fuse. If the test lamp lights, the fuse is in good condition. If the test lamp lights only while touching one side that means the fuse is defective. If the test lamp does not light even on touching both the sides that means the power source is not on or the ground connection is bad.
- 3 Remove the fuse from its spring clip. check whether it is blown or not. (Fig 2)

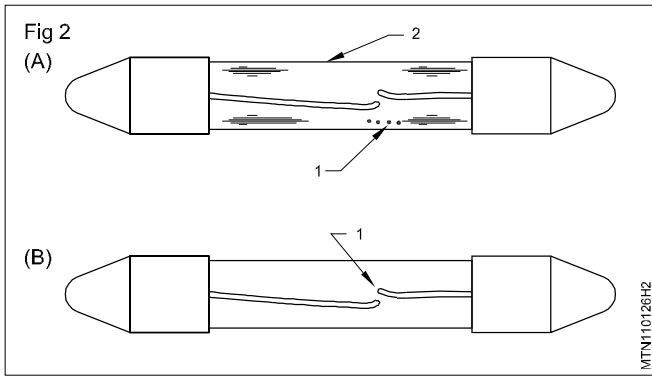
**If it is blown out we can see through the glass tube. (Fig 2)**

**If the fuse is blown due to short circuit the colour of glass tube becomes black or foggy white (2) and the fuse wire melts like small balls (1). (Fig 2)**

**If the fuse is blown (1) due to overload the fuse wire is simply cut off. (Fig 2)**

- 4 To find out open and short circuit in the lighting circuit.





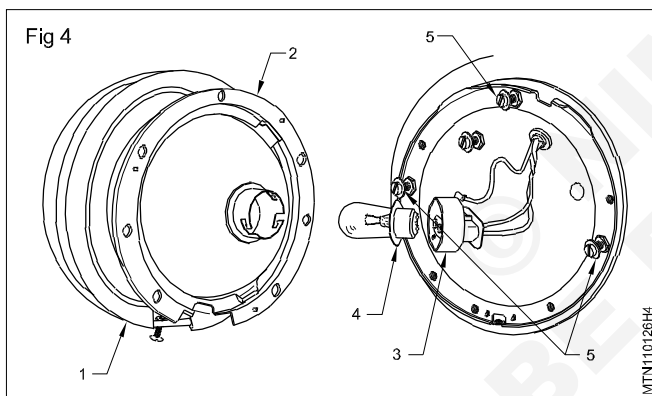
5 Check the wiring for open circuit by connecting an ohmmeter between the two terminals.

**If there is an open circuit the ohmmeter reading will be more.**

6 Trace the open circuit and rectify.

### TASK 3: Removing the lighting units

- 1 Unscrew the screws securing the rim. (Head lamp)
- 2 Take out the rim along with the rubber dust excluder (1).
- 3 Remove the light unit (2). (Fig 4)



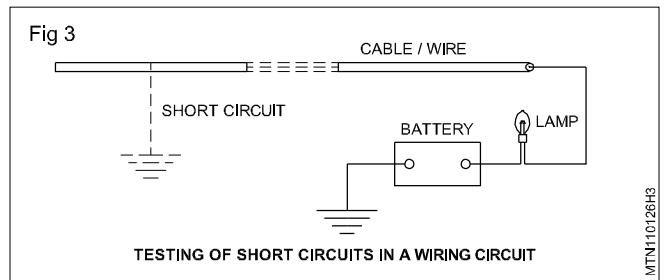
- 4 Turn the bulb holder (3) in the anticlockwise direction to take it out.
- 5 Remove the bulb (4).

**While removing the light unit ensure that adjusting screw (5) are not disturbed.**

### TASK 4: Assembling the light units

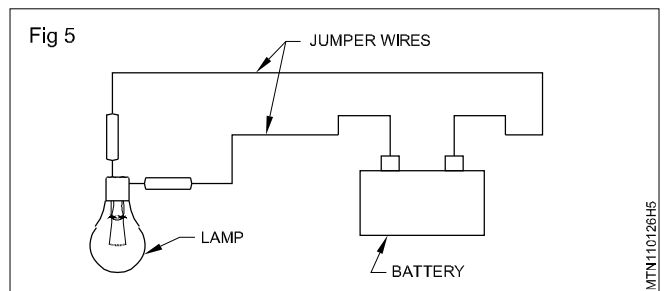
- 1 Check the front lens and reflector and replace, if found damaged.
- 2 Position the new light unit on the rim.
- 3 Ensure that the locating tabs at the edge of the light unit fit into the slots in the rim.
- 4 Ensure that the unit retaining ring is correctly positioned.

7 Check the wiring for short circuit with the test lamp. (Fig 3)



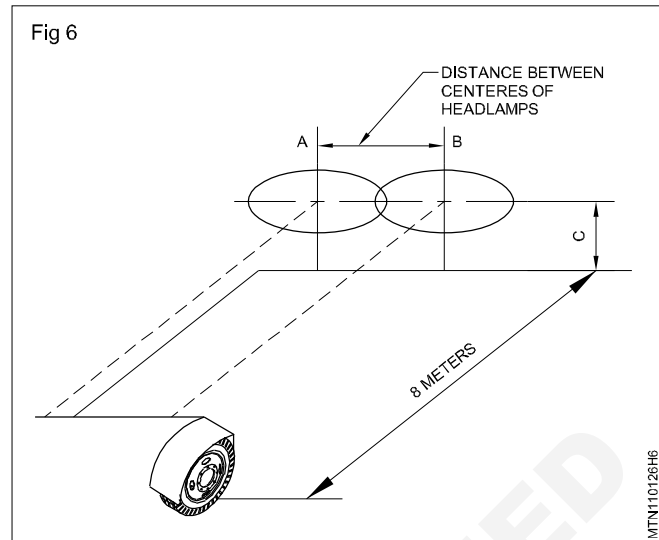
**If there is a short circuit the test lamp will glow before the circuit is completed and also the fuse will be blown off.**

- 6 Unscrew the screws. (other lamps).
- 7 Remove the lock-rings according to the model.
- 8 Remove the light lenses.
- 9 Remove the bulbs.
- 10 Checking the bulbs. (Fig 5)
- 11 While removing the bulbs check for loose fitting.
- 12 Check the bulbs both filaments for fuse by connecting wires from the battery as shown in the Fig 5.
- 13 If the bulb is fused replace it.



## TASK 5: Focusing of Head Light

- 1 Ensure focus of head lights falls at proper angle and height of road.
- 2 Park tractor on level ground before wall 8 metres (approximately) away.
- 3 Switch on the main head lights. Check height and focus of beam on wall.
- 4 The head lights should also be parallel to tractor centre line. The centre of beams should have equal distance from centre line as in (Fig 6).



## TASK 6: Troubleshooting in lighting system

SI.No	Trouble	Causes	Remedies
1	Head light do not glow	<ul style="list-style-type: none"> <li>- Bulb fuse</li> <li>- Wire loose connection</li> <li>- Open circuit in wiring</li> <li>- Head light bulb fuse</li> <li>- Burned out</li> <li>- Head light switch defective</li> </ul>	<ul style="list-style-type: none"> <li>- Replace</li> <li>- Tighten it</li> <li>- Rack for the open circuit</li> <li>- Replace the bulb</li> <li>- Replace the switch</li> </ul>
2	One head light does not glow	<ul style="list-style-type: none"> <li>- Loose wire connection</li> <li>- Bulb burned out</li> <li>- Open wire circuit</li> <li>- Defective wire</li> <li>- Connection</li> </ul>	<ul style="list-style-type: none"> <li>- Tighten the wire connection</li> <li>- Replace the bulb</li> <li>- Repair it.</li> <li>- Replace the wire junction box.</li> <li>- Clean it</li> </ul>
3	High or low beam does not work	<ul style="list-style-type: none"> <li>- Head light bulb one filament burned out</li> <li>- Wire loose connection in bulb holder</li> <li>- Diamond bright switch defective</li> <li>- Defective head light bulb holder</li> </ul>	<ul style="list-style-type: none"> <li>- Replace the bulb</li> <li>- Tighten</li> <li>- Replace the switch</li> <li>- Replace the bulb holder</li> </ul>
4	Turn signal light not glowing	<ul style="list-style-type: none"> <li>- Indicator switch defective</li> <li>- Flasher unit defective</li> <li>- Fuse blown out</li> <li>- Switch wire open circuit wire connection.</li> </ul>	<ul style="list-style-type: none"> <li>- Replace</li> <li>- Replace</li> <li>- Replace</li> <li>- Connect wire and tighten the</li> </ul>
5	No flashing the signal lights	<ul style="list-style-type: none"> <li>- Flasher unit defective</li> <li>- Flasher unit loose wire</li> </ul>	<ul style="list-style-type: none"> <li>- Replace</li> <li>- Tighten the wire connection</li> </ul>
6	One side signal light only flashing	<ul style="list-style-type: none"> <li>- One side bulb burned out</li> <li>- Wire connection disconnected</li> <li>- Indicator switch contact point burnt</li> </ul>	<ul style="list-style-type: none"> <li>- Replace the bulb</li> <li>- Connect the wire</li> <li>- Replace the switch</li> </ul>

SI.No	Trouble	Causes	Remedies
7	Turn signal light flash rate low	<ul style="list-style-type: none"> <li>- Indicator switch breaker</li> <li>- Breaker point dirty</li> <li>- Low power supply</li> <li>- Low power bulb used</li> <li>- Poor ground earth</li> </ul>	<ul style="list-style-type: none"> <li>- Clean the point</li> <li>- Check power supply</li> <li>- Replace the bulb</li> <li>- Correct the earthing point.</li> </ul>
8	Turn signal light flash rate high	<ul style="list-style-type: none"> <li>- Bulb power high</li> <li>- Defective flasher unit</li> </ul>	<ul style="list-style-type: none"> <li>- Use correct power bulb</li> <li>- Replace</li> </ul>
9	Hazard warning lights no flashing	<ul style="list-style-type: none"> <li>- Flasher unit defective</li> <li>- Hazard warning switch defective</li> <li>- Bulb burned out</li> <li>- Wrong wire connection</li> </ul>	<ul style="list-style-type: none"> <li>- Replace</li> <li>- Replace</li> <li>- Replace</li> <li>- Replace</li> </ul>
10	All lights not glowing	<ul style="list-style-type: none"> <li>- Switch defective</li> <li>- No power supply</li> <li>- Loose wire connections connections</li> <li>- Poor ground earthing wires</li> <li>- Light fuse burned out</li> <li>- Open wire circuit</li> <li>- All bulb are burned</li> </ul>	<ul style="list-style-type: none"> <li>- Replace</li> <li>- Provide proper power</li> <li>- Check and tighten wire</li> <li>- Clean and property connect the</li> <li>- Replace the fuse</li> <li>- Connect the wires</li> <li>- Replace the bulb</li> </ul>
11	Low clearance between bulb	<ul style="list-style-type: none"> <li>- Improper fitting the license plate and license plate.</li> <li>- Damaged number plate</li> </ul>	<ul style="list-style-type: none"> <li>- Maintain the space distance between and number plate</li> <li>- Repair or replace the number plate.</li> </ul>
12	One side light or same lights do not glowing	<ul style="list-style-type: none"> <li>- Bulb fused</li> <li>- Wire ear thing disconnected</li> </ul>	<ul style="list-style-type: none"> <li>- Replaced the bulb</li> <li>- Connect the wire property</li> </ul>
13	Brake light not glowing	<ul style="list-style-type: none"> <li>- Bulb fused</li> <li>- Wire open circuit</li> <li>- Brake light switch defective</li> <li>- No power supply to bulbs or clean the earthing wire</li> <li>- No brake oil in master cylinder</li> </ul>	<ul style="list-style-type: none"> <li>- Replace</li> <li>- Replace/connect the wires.</li> <li>- Replace the switch</li> <li>- Connect the power supply wire connections.</li> <li>- Fill the brake</li> </ul>
14	Brake light stay on	<ul style="list-style-type: none"> <li>- Brake light switch defective</li> <li>- Wrong wire connection</li> </ul>	<ul style="list-style-type: none"> <li>- Replace the switch</li> <li>- Correct the wire connections</li> </ul>

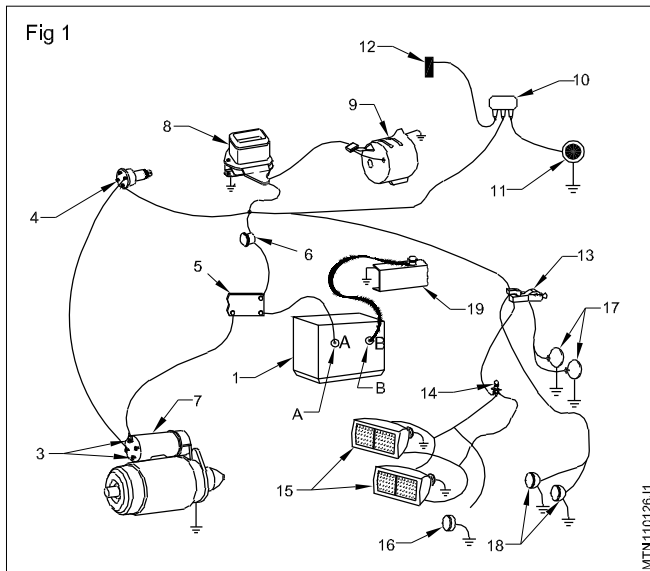
## Skill sequence

### Tracing faulty wires in a tractor electrical system

**Objective:** This shall help you to  
• **check and continuity of wiring.**

Check all the fuses in the circuit. Replace defective fuses.

Check the following wirings for loose connections. open circuit, short circuit. (Fig 1)



Check for loose connections in the battery cable ends A & B. Tighten, if required.

Check the continuity of the battery cable at terminal A and the starter motor terminals (3) and from the starter motor terminal (3) and starting switch (4).

Check the continuity of the battery cable at terminal a to the junction box (5) and

From the junction box (5) terminal to the ammeter terminal (6).

From the ammeter terminal (6) to the starting switch (4).  
From the starting switch (4) to the solenoid switch (7).

From the ammeter (6) to the regulator (8). From the regulator (8) to the alternator (9).

From the starting switch (4) to the horn relay (10).

From the horn relay (10) to the horn push-button (12).

From the horn relay (10) to the horns (11).

From the ammeter (6) to the light switch (13).

From the light switch (13) to the dim-bright switch (14)

From the dim-bright switch (14) to each headlamp (15) and beam indicator light (16). (Flasher)

From the light switch (13) to the tail lights (17).

From the light switch (13) to the parking light (18).

Check the battery earth cable from terminal B to the frame (19) for loose connection and continuity.

Replace the wire wherever continuity is not found.

**Battery terminals are marked A & B for clear identification.**