

MECHANIC MOTOR VEHICLE

NSQF LEVEL - 4

2nd Year

TRADE PRACTICAL

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**

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

Sector : Automotive

Duration : 2 Years

Trade : Mechanic Motor Vehicle - 2nd Year - Trade Practical - NSQF Level - 4 (Revised 2022)

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various 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 Motor Vehicle, 2nd Year Trade Practical - NSQF Level - 4 in Automotive** Sector under yearly Pattern required for ITIs and related institutions imparting skill development. The NSQF Level - 4 (Revised 2022) will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) will help the trainers and trainees of ITIs, and all stake holders 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

Additional Secretary/Director General(Training)
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

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

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

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

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

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

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

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

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

Chennai - 600 032

EXECUTIVE DIRECTOR

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material (**Trade Practical**) for the trade of **Mechanic Motor Vehicle 2nd Year NSQF Level - 4 (Revised 2022)** under **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. These exercises are designed to ensure that all the skills in compliance with NSQF Level - 4 (Revised 2022) syllabus are covered.

The manual is divided into Eleven modules.

Module 1	Transmission System
Module 2	Steering and Suspension System
Module 3	Brake System
Module 4	Motor vehicle act and trouble shooting
Module 5	Electronic Control System
Module 6	Charging and Starting System
Module 7	Lighting System
Module 8	Air Conditioning System
Module 9	Electrical components trouble shooting
Module 10	Vehicle information and driving practice
Module 11	Electricity Vehicle Technology

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **Mechanic Motor Vehicle 2nd Year NSQF Level -4 (Revised 2022) in Automotive**. The contents are sequenced according to the practical exercise contained in NSQF Level - 4 (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 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

S.No	Learning Outcome	Ref. Ex.No.
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2	Plan & perform maintenance, diagnosis and servicing of Vehicle Control System. (Mapped NOS:ASC/N9437)	2.2.99 - 2.3.126
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SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 185Hrs; Professional Knowledge 50 Hrs	Plan & perform maintenance, diagnosis and servicing of transmission system. (Mapped NOS: ASC/N1404, ASC/N1405)	<p>84 Identify different major components of Heavy vehicle and their function & placement study of different make lorry busin Institute with different dealers or organizations. (18 Hrs)</p> <p>85 Practice on adjusting clutch pedal play removing gearbox and clutch assembly from Light & Heavy Vehicle. (09 Hrs)</p> <p>86 Perform Dismantling clutch assembly, cleaning inspecting parts. (10 Hrs)</p> <p>87 Carryout Removing & fitting of new pilot bearing, removing & fitting of ring gear in fly wheel relining a clutch plate, checking condition of flywheel and pressure plate surface for reconditioning. (10 Hrs)</p> <p>88 Perform Assembling of pressure plate adjusting the fingers checking run out of fly wheel and aligning clutch assembly with flywheel. (08 Hrs)</p> <p>89 Perform Dismantling cleaning and assembling of gearshift mechanism changing oil in gear box. (10 Hrs)</p> <p>90 Practice Dismantling a synchromesh gear box, cleaning, inspecting parts replacing worn out defective parts assembling & testing for correct performance identifying noises from gear boxes and rectifying. (10 Hrs)</p>	<p>Introduction: Study of different major components & assemblies of heavy vehicle, and different make (indigenous). Name plate constructional differences and their merits. leading manufacturers in Heavy vehicle Industry</p> <p>Clutches & Manual Transmissions- Clutch principles, Single-plate clutches, Multi-plate clutches, Dual mass flywheels, Operating mechanisms Clutch components- Pressure plate, Driven/ centre plate, Throw out bearing.</p> <p>Manual transmissions- Gear ratios, Compound gear trains, Gear selection, Bearings, Oil seals & gaskets, Brief about Automated Manual Transmission (AMT)</p> <p>Gearbox layout & operation Gearbox layouts, Transaxle designs, Gearbox operation, Baulk ring synchromesh unit, Transaxle synchromesh unit. Gear shift mechanism. (18 hrs)</p>
		<p>91 Practice on Removing open type propeller shaft from vehicle, Practice on removing universal joints, cleaning replacing worn out parts, re-assembling & refitting to vehicle- and their alignment, including front wheel drive and all wheel drive of LMV. (15 Hrs)</p> <p>92 Practice on FWD Driveshaft Removal and Replacement. (15 Hrs)</p> <p>93 Practice on overhauling & inspection of rear axle. (15 Hrs)</p> <p>94 Practice on overhauling & inspection of differential assembly. (15 Hrs)</p> <p>95 Perform Trouble shooting – causes and remedy for clutch slip, clutch noise, clutch binding, hard clutch, gearbox noise, gear slip, rear axle noise, propeller shaft noise, universal joint noise, differential noise. (15 Hrs)</p>	<p>Final Drive & Drive Shafts - Basic layouts</p> <p>Front-wheel drive layout, Rear-wheel drive layout, Four-wheel drive layout, All-wheel drive layout, 4WD v/s AWD</p> <p>Front-wheel drive, Front-wheel drive shafts, Front-wheel final drives, Front-wheel differentials</p> <p>Rear-wheel drive- Propeller shaft, Type of Universal joints, Type of Constant velocity Joints, Rear-wheel final drives, Salisbury axles,</p> <p>Rear-wheel drive differentials, Limited slip differentials.</p> <p>Four-wheel drive- Four-wheel drive shafts, Four-wheel final drive, Four wheel drive transfer case,</p>

			<p>Freewheeling hubs, Four-wheel drive differentials</p> <p>All-wheel drive- four wheel final drives, All-wheel drive transfer case, Transfer case differential action. (18 hrs)</p>
		<p>96 Identify Automatic transmission components (5 Hrs)</p> <p>97 Check automatic transmission fluid and replace transmission fluid & filter. (10 Hrs)</p> <p>98 Practice on oil pressure control cable play adjustments, Inspection of shift lever switch, throttle position sensor, speed sensor and automatic transmission wiring harness coupler. (20 Hrs)</p>	<p>Automatic Transmissions - Torque converters, Torque converter principles, drive plate, Converter operation, Torque multiplication, Fluid flow, Heat exchanger, Lock-up converters, clutches. Planetary gearing- Planetary gears, Simple planetary gear sets, Compound planetary gear sets, Automatic transmission brake bands, Multi-disc clutches, Electronic control transmission Electronic control Unit, Fully hydraulically controlled transmission, Electronic shift programs, Manual selection. Layout & operation for P,R,N&D (First & Second) Selector positions, Planetary gear set, High range power flow, Low range power flow Servos & clutches-Rear servo, Front servo, One way clutch, Multi-plate front clutch, Clutch pack, Rear clutch.</p> <p>Hydraulic system & controls^Hydraulic system components, Spool valves, Regulating or flow control valves, Control valves, Orifices</p> <p>Valve types & functions^Basic valve action, Regulator & control valves, Shift & governor valves</p> <p>Pressure regulation- The primary regulating valve, Line pressure variation, Modulator valve pressure, The governor, Governor pressure, Kick down pressure.</p> <p>Flow control- Gear position 1, 1-2 shift valve, 2-3 shift valve assembly, The servo orifice control valve, 3-2 kick down</p> <p>Continuously variable transmission (C.V.T.) - Continuously variable transmission, Drive or reverse, The steel belt, Secondary pulley shaft. (14 hrs)</p> <p>Steering Systems: - Description and function of Steering systems, Principles of steering, Rack-and pinion steering system, Recirculation ball & nut steering system, Four-wheel steering systems, collapsible steering system.</p>
<p>Professional Skill 245 Hrs;</p> <p>Professional Knowledge 62 Hrs</p>	<p>Plan & perform maintenance, diagnosis and servicing of Vehicle Control System. (Mapped NOS: ASC/N9437)</p>	<p>Following practical to be Practiced On Light & Heavy Vehicle:</p> <p>99 Practice on removing the drop arm, Check and adjust the turning angle, align the drop arm and steering wheel with the front wheel. Check and correct toe-in. (08 Hrs)</p>	<p>Steering boxes & columns - Description and function of Steering columns, Rack-and-pinion gearbox, Helix, Variable ratio steering, Worm gearbox, Power Assisted steering, Steering process, Flow-control valve, Electric power assisted steering, Basic electric power steering operation Steering arms & components- Forward control vehicle steering, Steering linkages, Joints, Bushes/bushings Wheel alignment</p>

		<p>100 Practice on removing steering wheel, steering gearbox. (09 Hrs)</p> <p>101 Inspect and overhaul steering boxes, adjusting steering gear backlash, pre load and adjust toe in, toe-out, camber angle, castor angle, kingpin inclination and wheel run out. (08 Hrs)</p> <p>102 Check & top up power steering fluid, (5 Hrs)</p> <p>103 Carryout Pressure testing a power steering system, Flushing a power steering system, (10 Hrs)</p> <p>104 Carryout Inspecting & adjusting an engine drive belt, (5 Hrs)</p> <p>105 Carryout Servicing a steering system, (08 Hrs)</p> <p>106 Practice servicing wheel bearings. (07 Hrs)</p> <p>107 Perform Troubleshooting- Causes and remedy for abnormal wear of tyre, wheel wobbling, poor self centring, hard steering, and vehicle pulling to one side. (5 Hrs)</p>	<p>fundamentals:- Basic principles of wheel alignment, wheel base, wheel track, king pin inclination, Caster, Camber, Scrub radius, Toe-in & toe out, Toe-out on turns, Turning radius, Thrust angle & centrelines. (15 hrs)</p>
		<p>Following practical to be Practiced On Light & Heavy Vehicle :</p> <p>108 Practice on visual Inspection of chassis frame for crack, bent and twists. (10 Hrs)</p> <p>109 Carryout Overhauling and Inspection of shackle, leaf spring, front & rear suspension. (09 Hrs)</p> <p>110 Practice on removing, inspection and assembling of shock absorber (09 Hrs)</p> <p>111 Practice Lubricating a suspension system. (08 Hrs)</p> <p>112 Perform Trouble shooting for Suspension system defects: Wheel hop, ride height (unequal and low), noises under operation, fluid leakage, excessive travel, bounce, worn dampers, worn joints/damaged linkages, vehicle "crabbing". (09 Hrs)</p>	<p>Suspension Systems:- Principles of suspension, Suspension force, Unsprung weight, Wheel unit location, Dampening. Types of suspension Suspension systems, Solid axle, Dead axle, Description, function and advantages of non independent suspension Independent suspension, Rear independent suspension, Rear wheel drive independent suspension, electronically controlled air suspension (ECAS), Adaptive air suspension operation. Types of springs - Description and function of Coil springs, Leaf springs, Torsion bars, Rubber springs. Shock absorber types- Description and function of Hydraulic shock absorbers, Gas pressurized shock absorbers, Load adjustable shock absorbers, Manual adjustable-rate shock absorbers, Electronic adjustable-rate shock absorbers, Automatic load adjustable shock absorbers Front suspension types & components- Mc person Strut suspension, Short/long arm suspension, Torsion bar suspension Rear suspension types & components-Rigid axle leaf spring suspension, Rigid axle coil spring suspension, Independent type suspension, Rigid non-drive suspension.(15 hrs)</p>

		<p>113 Practice on removing wheels from light & Heavy vehicle, dismantling tyres and tubes checking puncture. (10 Hrs)</p> <p>114 Practice Assembling & inflating tyres to correct pressure. (10 Hrs)</p> <p>115 Check & adjust tire pressure by use of air or by Nitrogen(10 Hrs)</p> <p>116 Rotate the wheels in vehicle minor repairs to wheels and tyres, wheel balancing & alignment. (10 Hrs)</p> <p>117 Check for tyre wear patterns. (10 Hrs)</p>	<p>Wheels & Tyres-Wheel types & sizes Wheels, Rim sizes & designations, Types of wheels</p> <p>Tyre types & characteristics^Tyres, Radial ply tyres, Radial ply tyre sidewalls, Tyre pressure monitoring systems, Run flat tyres, Space-saver tyres, Tyre distortion, Center of gravity.</p> <p>Tyre construction-Tyre construction, Types of tyre construction, Tyre materials, Hysteresis, Tyre sizes & designations, Tyre information, Tyre tread designs, Tyre ratings for temperature & traction.</p> <p>Descriptions Tirewear Patterns and causes Nitrogen v/s atmospheric air in tyres (12 hrs)</p>
		<p>118 Practice on Adjusting brake pedal play, Overhauling and inspection of tandem master cylinder assembly. (5 Hrs)</p> <p>119 Perform Overhauling and inspection of front and rear brake assembly, overhauling and inspection of wheel cylinder assembly. (5 Hrs)</p> <p>120 Bleed hydraulic brakes & Disk brakes. (10Hrs)</p> <p>121 Carryout Overhauling and inspection of vacuum assisted brake assembly. (10 Hrs)</p> <p>122 Perform Overhauling and inspection of disc brake. (10 Hrs)</p> <p>123 Practice Adjusting Air brakes- repair to tank unit, air compressor, wheel brake adjuster^locating air leaks in the brake lines and rectifying – general maintenance and care. (10 Hrs)</p> <p>124 Perform Brakes service procedures-Checking & adjusting brake fluid, Replacing brake fluid, Checking brake pads, Replacing brake pads, Removing & replacing a rotor, Replacing brake linings, Adjusting a parking brake cable. (15 Hrs)</p> <p>125 Carryout Trouble tracing in braking system of a heavy vehicle adjusting all four wheel brakes, precautions to be observed while testing brakes points to be remember while preparing the vehicle for brake certificate. (15 Hrs)</p> <p>126 Practice of maintaining of ABS system. (05 Hrs)</p>	<p>Braking Systems :- Principles of braking, Drum & disc brakes, Lever mechanical advantage, Hydraulic pressure & force, Brake pad, Regenerative braking.</p> <p>Braking systems - Brake type - principles, Air brakes, Exhaust brakes, Electric brakes, Parking brakes, Engine brakes, Regenerative braking</p> <p>Braking system components^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, Electro hydraulic braking (EHB), Applying brakes, Brake force, Brake light switch</p> <p>Drum brakes & components -Drum brake system, Drum brake operation, Brake linings & shoes, Back plate, Wheel cylinders Disc brakes & components - Disc brake system, Disc brake operation, Disc brake rotors, Disc brake pads, Disc brake callipers, Proportioning valves, Proportioning valve operation, Brake friction materials</p> <p>Antilock braking system & components ABS brake system, Antilock braking system operation, Principles of ABS braking, ABS master cylinder, Hydraulic control unit, Wheel speed sensors, ABS with EBD electronic control unit.</p> <p>The construction and operation of heavy vehicle Anti-Slip Regulation / Traction Control (ASR) system. Introduction to Electromagnetic retarder brake (EMR) and Engine exhaust brake.(20 hrs)</p>

Professional Skill 35Hrs; Professional Knowledge 05 Hrs	Troubleshoot vehicle Engine components and ascertain repair. (Mapped NOS: ASC/N9438)	127 Perform Trouble shooting Practice with Heavy vehicle for Engine Not starting – Mechanical & Electrical causes, High fuel consumption, Engine overheating, Low Power Generation, Excessive oil consumption, Low/High Engine Oil Pressure, Engine Noise. (35 Hrs)	Engine trouble shooting (5 Hrs)
Professional Skill 50Hrs; Professional Knowledge 24 Hrs	Plan & service of electronic control system and check functionally. (Mapped NOS: ASC/N1438)	128 Carryout Identification of Electronic control Unit. (10 Hrs) 129 Perform Set up for testing, Testing of Electronic Control Circuit. (10 Hrs) 130 Perform Identification of various sensors installed in engine & it's mounting. (10 Hrs) 131 Check instruments & Gauges on dash board & replace defective gauges. (10 Hrs) 132 Test Temperature sensor, Pressure sensor, potentiometer, magnetic induction sensor, cam shaft sensor, crankshaft position sensor. (10 Hrs)	Introduction to EFI Engine Management - EFI operation Modes of EFI, Electronic fuel injection, Idle speed control systems, Feedback & looping, Cold start systems, Air measurement, Air-flow monitoring, Variable intake manifold system, Electrical functions, EFI wiring diagram Electronic control unit (ECU) - EFI system ECU, Electronic control unit settings, Engine speed limiting, Malfunction indicator lamp. Importance of Diagnostic Trouble Code (DTC) & its general format. Use of scan tool and retrievals of codes. EFI sensors- Intake Temperature sensor, Mass airflow sensor, Manifold absolute pressure sensor, Air vortex sensor, Fuel system sensor, Throttle position sensor, Exhaust gas oxygen sensor, Crank angle sensor, Hall effect voltage sensor. (24 hrs)
Professional Skill 25 Hrs; Professional Knowledge 10 Hrs	Diagnose & rectify the defects in vehicle to ensure functionality of vehicle. (Mapped NOS: ASC/N1438)	133 Carryout Diagnosis Possible causes and remedy for Engine cranks, but will not or hard to start, Poor fuel economy or engine performance. (10 Hrs) 134 Practice Checking ignition timing, Checking & changing a spark plug, Identification and testing of Hall Effect sensor, Optical sensor. Tracing and testing of sensor circuits. (15Hrs)	Ignition principles and Faraday's laws, Primary and secondary winding of transformer, Ignition components, Spark plugs, Spark plug components, Vacuum & centrifugal units, Plug firing voltage, Induction, Inductive system operation, Induction wiring, Hall effect sensors, Hall effect operation, Optical type sensors Distributor less ignition systems, Insulated coils, Distributor less ignition system timing. (10 hrs)
Professional Skill 40Hrs; Professional Knowledge 10 Hrs	Carryout overhauling of charging system. (Mapped NOS: ASC/N1438)	135 Check charging system for the cause of undercharge, No charge, and over charge conditions. (10 Hrs) 136 Perform Removing & replacing an alternator, Inspection of rotor for ground, open circuit – field coil resistance, slip ring surface, Fan, bearing. Inspection of stator for ground, open circuit, Inspection of Drive end bearing rotation, Rectifier, brush length compare with service manual. Slip ring surface. (10 Hrs) 137 Practice Inspecting & adjusting an engine drive belt, Replacing	Charging system- The purpose of Charging system, charging system components, charging system circuit, Alternator principles, Alternating current, Alternator components, Rectification, Phase winding connections, Rotor circuit, Voltage regulation, System operating voltage, High voltage charging systems, Rotor, Stator, Alternator end frames, Slip ring & brush assembly, Rectifier assembly, Alternator cooling fan. (10 hrs)

		<p>an engine drive belt/ pulleys / Tensioner and their alignments. (10 Hrs)</p> <p>138 Carryout Trouble shooting, possible causes and remedy for warning lamp does not glow when ignition switch is on, Warning lamp glows dim when ignition switch is on, warning lamp 'on' while the alternator is running, Warning lamp glows 'dim' while the alternator is running, warning lamp flickers considerably. (10 Hrs)</p>	
<p>Professional Skill 35Hrs;</p> <p>Professional Knowledge 10 Hrs</p>	<p>Carryout overhauling of starting system. (Mapped NOS: ASC/N1438)</p>	<p>139 Remove starter motor from vehicle, and carryout Performance test for pull-in test, Hold-in test, pinion (plunger) return test, No-load performance test. (15 Hrs)</p> <p>140 Perform Trouble shooting, possible causes and remedy for starter motor not running, Starting motor running but too slow (small torque), starting motor running, but not cranking engine. Noise, starting motor does not stop running. Growler testing for rotors. (15 Hrs)</p> <p>141 Check a starting system, Jump start a vehicle. (5 Hrs)</p>	<p>Starting system- purpose of starting system, Starting system components, Starter motor principles, study of starter control circuits. Starter motor construction, Starter magnet types, Starter motor engagement, Commutation, Switching, solenoid construction.(10 hrs)</p>
<p>Professional Skill 85 Hrs;</p> <p>Professional Knowledge 20 Hrs</p>	<p>Troubleshoot electrical components of vehicle and ascertain repair. (Mapped NOS: ASC/N1438)</p>	<p>142 Trace the light circuit - test bulbs, align head lamps, aiming headlights. Changing a headlight bulb, checking of a head light switch and to replace if faulty. (5 Hrs)</p> <p>143 Perform Trouble shooting and remedy for turn signal and hazard warning lights -Flash rate high or one side only flashes, No Flashing, flash rate low. (5 Hrs)</p> <p>144 Perform Trouble shooting and remedy for clearance, tail and license plate lights - All lights do not light up, some lights do not light up. (5 Hrs)</p> <p>145 Perform Trouble shooting and remedy for fuel meter and fuel gauge unit - Fuel meter shows no operation or incorrect operation. (5 Hrs)</p> <p>146 Perform Trouble shooting and remedy for Engine coolant Temp (ECT) meter and ECT Sensor – Engine coolant temp meter shows no operation or incorrect operation. (5 Hrs)</p> <p>147 Perform Trouble shooting and remedy for oil pressure light – Oil</p>	<p>Lighting system, Lamps/light bulbs, Lamp/light bulb information, LED lighting, Headlights-description of standard sealed beam, halogen sealed beam, composite and High intensity discharge (HID) headlights. Headlight & dimmer circuits, Park & tail light circuits, Brake light circuits, turn signal circuit, Cornering lights, Fog lights circuit, interior lights- courtesy, reading and instrument panel lights, Smart lighting , Reverse lights (10 hrs)</p>

		<p>pressure warning light does not light up when ignition switch is on at engine off. (5 Hrs)</p> <p>148 Perform Trouble shooting and remedy for brake and parking brake warning light- Brake warning light does not light up when fluid flow level, Brake warning light does not light up when parking brake pull up, Brake warning lights stay on. (5 Hrs)</p> <p>149 Perform Trouble shooting and remedy for interior light- Interior light do not light up. (5 Hrs)</p> <p>150 Perform Trace the wiring circuit of traffic signal flashers light circuit^tracing defects in the flasher circuits, replacing fuse bulb. (5 Hrs)</p>	
		<p>151 Perform Trouble shooting and remedy for Horn- No horn operation, poor sound quality, horn sounds continuously and to replace the horn if faulty. (5 Hrs)</p> <p>152 Remove and install wiper motors and wiper switches. Checking & replacing wiper blades. (5 Hrs)</p> <p>153 Perform Trouble shooting and remedy for windshield wiper and washer - no operation, intermittent operation, continuous operation, and wipers will not park. (5 Hrs)</p> <p>154 Diagnose causes for improper operation of the windshield washer system and to replace the pump if faulty. (5 Hrs)</p> <p>155 Diagnose the power window system for – all power window motors do not operate, some switches do not operate. (5 Hrs)</p> <p>156 Diagnose the power door lock control for – All power door locks do not operate, only one power door lock not operate. (5 Hrs)</p> <p>157 Diagnose for remote keyless entry and immobilizer system. (5 Hrs)</p> <p>158 Diagnose automatic seat belt systems, Diagnose air bag system and service warnings. (5 Hrs)</p>	<p>Accessories: Horn circuit, wiper circuit, power window components and circuit. Power door lock circuit, automatic door lock circuit, remote keyless entry system circuit, antitheft system, immobilizer system.</p> <p>Description and function of Airbags, Seatbelt, Vehicle safety systems, Crash sensors, Seat belt pre^tensioners, Tire pressure monitoring systems Integrated communications, Proximity sensors, Introduction to Hybrid & Electronic vehicle, Hydrogen fuel cell vehicle. (10 hrs)</p>
<p>Professional Skill 35 Hrs;</p> <p>Professional Knowledge 12 Hrs</p>	<p>Overhaul, service and testing Vehicle Air Conditioning system, its parts and check functionality. (Mapped NOS: ASC/N1438)</p>	<p>159 Identify Air conditioning components, Performance test on A/c unit, (5 Hrs)</p> <p>160 Check Charged state of refrigerant, Inspecting & adjusting an engine drive belt, Replacing an engine drive belt. (10 Hrs)</p>	<p>Heating Ventilation Air Conditioning (HVAC) legislation, Vehicle heating, ventilation & cooling systems, Basic air^conditioning principles, Air^conditioning capacity, Air^conditioning refrigerant, Humidity Description and function of Fixed orifice,</p>

		<p>161 Perform Refrigerant recovery evacuating – charging of A/c system. Replenishing compressor oil level. Troubles diagnose and remedy for No cooling or warm air, Cool air comes out only intermittently, Insufficient cooling. (10 Hrs)</p> <p>162 Check abnormal noise from compressor, Magnetic clutch, condenser, evaporator, Blower motor. (5 Hrs)</p> <p>163 Carryout Diagnosis test for High pressure gauge – pressure high and low, Low pressure gauge for pressure high and low. (5 Hrs)</p>	<p>Control devices, Thermostatic expansion valve system, Thermal expansion valves, Air conditioning compressors, Condensers & evaporators, Receiver drier, Lines & hoses, TX valve construction, Temperature monitoring thermostat, Refrigerants, Pressure switches, Heating elements</p> <p>Air-conditioning ECU, Ambient air temperature sensor, Servo motors, Electric servo motors, Automatic climate control sensors, Evaporator temperature sensor, Blower speed control, Ventilation systems. (12 hrs)</p>
<p>Professional Skill 50Hrs;</p> <p>Professional Knowledge 08 Hrs</p>	<p>Drive vehicle following Traffic Regulations and maintenance of good road conduct. (Mapped NOS: ASC/N14040)</p>	<p>Driving Practice :</p> <p>164 Practice in straight driving on wide roads. (10 Hrs)</p> <p>165 Driving through lanes and curves. (10 Hrs)</p> <p>166 Practice in reversing. (10 Hrs)</p> <p>167 Practice overtaking another vehicle. (10 Hrs)</p> <p>168 Practice in driving through sand and wet surfaces. Practice in parking and Diagonal parking. (10 Hrs)</p>	<p>Traffic rules, Signals & controls. Locating vehicle information, Obtaining & interpreting scan tool data. (08 hrs)</p>
<p>Professional Skill 55 Hrs;</p> <p>Professional Knowledge 15 Hrs</p>	<p>Identify and study of Electric vehicle components and Performance comparison of EV and IC engine vehicles. (Components of Electric Vehicle such as Motor, Motor Controller, Battery Pack, Battery Management System, Charging System etc.) (Mapped NOS: ASC/N9439)</p>	<p>169 Study report on current adoption status of BEV, HEV, PHEV, FCEV type vehicles. (15 hrs)</p> <p>170 Identify and study performance of Electric vehicles, in comparison to IC engine vehicles. (10 hrs)</p> <p>171 Identification and study of basic components of EV (05 hrs)</p> <p>172 Identify various gauges/instrument on dashboard of an electric vehicle and identify differences in instrumentation panel with IC engine vehicle. (10 hrs)</p> <p>173 Basic motor power calculation. (5 hrs)</p> <p>174 Identify and test different types of Batteries, diodes and transistors (10 Hrs)</p>	<p>Introduction to Electric Vehicle Technology, EV Terminology Comparison of Electric Vehicle with IC engine vehicle based on emissions, range, fuel type. Types of electric vehicle, BEV, HEV, PHEV and FCEV.</p> <p>Architecture of Electric Vehicle, working principle of fully electric vehicle, Major component, performance parameter, Basics of Motors, Selection, sizing and characteristic of Motor, calculation for motor effort, electric transmission.</p> <p>Principle, working and operation of propulsion system, DC Motor - Drives Armature Voltage, chopper circuit, step up, Step down chopper, control strategy, chopper amplifier</p> <p>Brushless DC Motor – principle working, features, speed control system of brushless DC motor, efficiency, calculation.</p> <p>Battery management system (15 Hrs)</p>

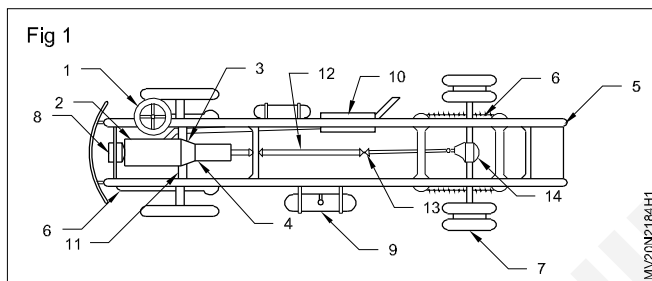
Identify major components of heavy motor vehicle

Objective: At the end of this exercise you shall be able to
 • locate various units on a vehicle.

Requirements			
Tools / Instruments		Materials	
• Double end spanner set	- 1 set	• Soap oil	- as reqd.
• Oil can	- 1 No.	• Grease	- as reqd.
Equipments		• Kerosene	- as reqd.
• Heavy vehicle / chassis	- 1 No.	• Banian cloth	- as reqd.

PROCEDURE

TASK 1 : Identify the aggregates / parts in the given vehicles (Fig 1)



- 1 Position of the steering wheel (1) - whether it is left hand or right hand drive.
- 2 Location of the engine (front, centre, rear) (2).
- 3 Location of the clutch (3) and the gearbox (4).
- 4 Keep the vehicle on the ram. (Consult your instructor.)
- 5 Type of chassis and frame (5) (rectangular, 'I' shape, channel type).
- 6 Type of suspension (6) (rigid, independent).
- 7 Type of brakes used (mechanical, hydraulic, air or vacuum disc/drum).
- 8 Specifications of tyre (7) (width, diameter and ply rating - embossed on tyre).
- 9 Location of radiator (8).
- 10 Location of fuel tank. (9).

- 11 Location of the silencer (muffler) (10).
 - 12 Type of front axle (dead, live) (11).
 - 13 No. of propeller shaft (12) and universal joints (13) in between the gearbox and differential.
 - 14 Location of differential (14) and rear axle.
 - 15 Record the details in table 1.
- List out the vehicles in your institute.

Table - 1

Sl.No	Vehicle name	Make	Numbers
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Table- 2

Item No.	Name of Part/Aggregate	Part/Aggregate type-Tick as applicable	Remark
1	Steering wheel/Assembly	Mechanical/Hydraulic/Electrical/ any other power assistance	
2	Engine assembly Engine HP	Natural aspirated/Turbo charged, Maximum HP.....at.....RPM	
3	Clutch assembly	Actuation type, Mechanical/ hydraulic / pneumatic/hydro-pneumatic	

4	Gear box assembly	Sliding mesh/constant mesh/ synchromesh / semi automatic /automatic, number of forward gears 3/4/5/6/7, 1st gear ratio, overdrive fitted if any	
5	Chassis and Frame	Tubular, C- section, Number of cross members, bolted/riveted	
6	Suspension	Front-no of springs Rear- number of springs Air Suspension, Non-reactive suspension Shock absorber fitted in front and rear	
7	Tyre specifications	9.00x20, 10.00x20, PR/PD/Nylon, with tube or tubeless, Front tyres=xx Nos, Rear tyre= xx Nos Make/brand name.....	
8	Radiator	Aluminium/Copper with/without De-aeration tank. Coolant type, Capacity of coolant in litres =xx	
9	Fuel Tank	Cylindrical/rectangular/Capacity in litres, located in LH/RH Side, sheet metal/PVC type	
10	Silencer	No of pipes in exhaust system including muffler and no of holding brackets=	
11	Stub Axle	Live/Dead-Elliot/Rev Elliot type Single front axle or multi front axle	
12	No of propeller shafts	1/2/3/4	
13	Propeller Shaft U-joints	Total number of 'U' joints fitted	
14	Differential	Rear axle ratio	
15	Rear axle	Single/twin axle in rear Fully floating/semi floating	
	Chassis name plate information	Engine number Chassis number Rear axle ratio	
	Dash board Gauges	Speedometer, RPM meter, oil pressure gauge, water temperature gauge Signal lamps like, brake, ignition, steering lock. Turn signal lamp, Head lamp,	
	Battery type and volts	12 /24volt type, No of batteries	

Remove the gear box and clutch assembly from a vehicle

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

- adjust clutch pedal play
- disconnect the gearbox linkages
- remove the gearbox from the vehicle
- remove the clutch from the vehicle.

Requirements			
Tools / Instruments		Materials	
• Trainee tool kit	- 1 No.	• Soap oil	- as reqd.
• Double end spanner set	- 1 Set	• Grease	- as reqd.
• Ring spanner set	- 1 Set	• Kerosene	- as reqd.
• Socket spanner set	- 1 Set	• Banian cloth	- as reqd.
• Centre punch	- 1 No.	• Rope	- as reqd.
Equipments / Machineries			
• Hydraulic jack floor type	- 1 No.		
• Steel horse stand	- 1 No.		

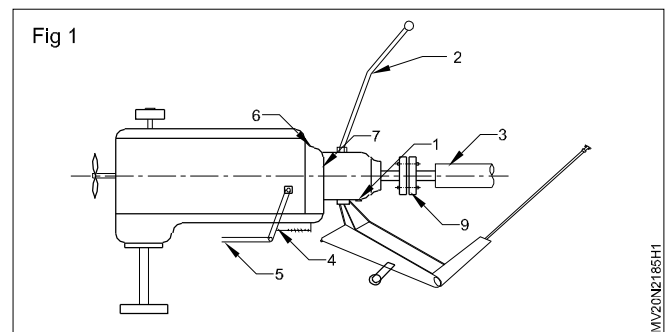
PROCEDURE

TASK 1: Adjust the clutch pedal play

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|--|---|
| <ol style="list-style-type: none"> 1 Check the play of the clutch pedal and observe the play in the range of 6 mm to 10 mm 2 Chosen the lock - nut 3 Tighten if the play is more or loosen if the play in less. | <ol style="list-style-type: none"> 4 Set the free play 10 mm 5 Again check the free play of the pedal 6 Tighten the lock nut to the required free play of pedal is achieved. |
|--|---|

TASK 2: Disconnect gear box linkages

- 1 Put wheel chocks.
- 2 Drain the gear box oil and refit the drain plug
- 3 Remove the gear shift lever (2).
- 4 Disconnect the propeller shaft (3) from the gearbox and tie the propeller shaft with the chassis side member by a rope/wire.
- 5 Disconnect the clutch lever (4) from the clutch rod (5). If necessary tie the clutch lever (4) with the clutch housing (7) to avoid falling of the lever (4) in housing (7).
- 6 Disconnect the speedometer cable.



TASK 3: Remove gearbox from the vehicles

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 If necessary support the engine on a horse/tripod stand. 2 Support the gearbox on a trolley jack. 3 Remove diagonally opposite mounting nuts of the gearbox by loosening two turns at a time. | <ol style="list-style-type: none"> 4 Move the gearbox away from the engine and lower down the gearbox in such a way that it does not fall from the jack. 5 Take out the gearbox along with the jack. |
|---|--|

Dismantle clutch assembly

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

- locate the clutch in vehicle
- dismantle clutch from vehicle
- identify the parts of a clutch assembly
- clean the clutch parts
- check for defects in clutch parts

Requirements			
Tools / Instruments			
• Trainees tool kit	- 1 Set	• Vehicle workshop manual	- 1 No.
• Centre punch 10cm	- 1 No.	• Dial Gauge / Dial indicator with magnetic base	- 1 No.
• Circlip pliers 15 cm expanding type	- 1 No.	• Aligning arbors	- 1 No.
• Micrometer outside 0 - 25 mm, 25 - 50		• 'Z' gauge	- 1 No.
• Clutch jig	- 1 No.	Equipments / Machineries	
• Torque wrench 5 to 35 Nm, 12 – 68 Nm & 50 – 225 Nm	- 1 No.	• Vehicle	- 1 No.
• Feeler gauge 20 blades (metric)	- 1 No.	Materials	
• Oil can 0.5/ 0.25 litter capacity	- 1 No.	• Soap oil	- as reqd.
• Cleaning tray 45x30 cm	- 1 No.	• Grease	- as reqd.
• Bearing puller screw powered / hydraulic powered with attachments Max spread 80, 200 and 300 mm	- 1 No.	• Kerosene	- as reqd.
• Pullers screw powered 2 mm gap with bearing puller	- 1 No.	• Banian cloth	- as reqd.
		• Gear oil (SAE 90)	- as reqd.

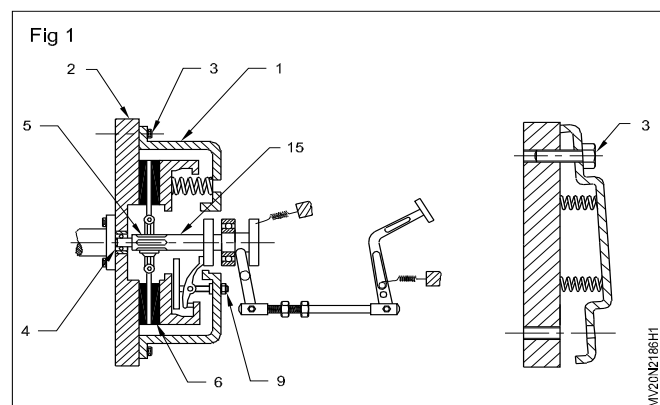
PROCEDURE

TASK 1: Locate the clutch in vehicle

- 1 The clutch connects the flywheel and gearbox.
- 2 Identify the clutch.

TASK 2: Dismantle the clutch assembly from vehicle

- 1 Mark with some paint the position of the clutch cover (1) and flywheel (2). (Fig.1)
- 2 While resetting, this mark will be aligned to ensure the original position of the clutch cover and the flywheel so that the balancing of the flywheel and clutch cover does not get disturbed.
- 3 Remove the locking wire of the clutch cover mounting set screws (3). Count the total number of setscrews.



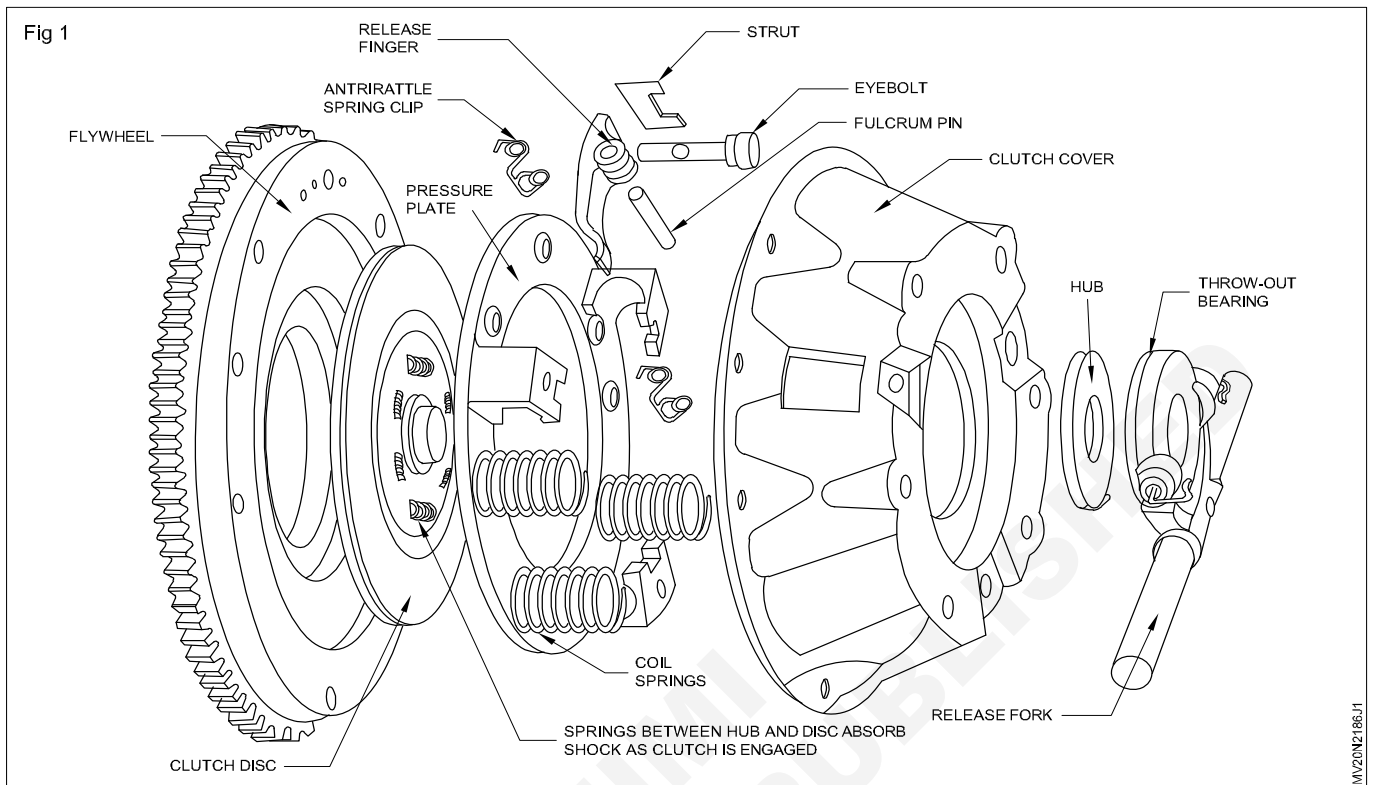
TASK 3 : Dismantling clutch assembly

Dismantling

- 1 Mark the pressure plate and clutch cover's position with respect to each other.
- 2 Place the clutch assembly on the clutch jig aligning the slots on the clutch jig with the thrust pad's seat on the pressure plate.
- 3 Compress the spring cups by the clutch jig.
- 4 Loosen the pressure pad's mounting screw and remove the pressure pads. (Fig 1)
- 5 Release the load from the spring cups.

- 6 Remove the pressure plate, springs, clutch cover assembly and the pressure pads from the clutch jig.
- 7 Loosen the mounting set screws of the retaining plate and remove the retaining plate.

- 8 Loosen the mounting set screws of the clutch finger bracket and remove the clutch fingers, brackets and eccentric pin.



TASK 4: Identify the parts of a clutch assembly

Dismantle the clutch part on using aligning arbor and clutch jig.

- 1 Clutch cover
- 2 Flywheel
- 3 Mounting set screw
- 4 Pilot bearing

- 5 Shaft spline
- 6 Clutch plate
- 7 Pegs
- 8 Alingning arbor
- 9 Drive shaft

TASK 5: Clean the clutch parts

- 1 Clean the parts of the clutch (pressure plate, face plate, clutch plate, spring, withdrawal plate, release

bearing, release lever and pilot bearing etc.) with kerosene and then dry and clean with a cloth.

TASK 6: Check for defects in clutch parts

- 1 Check the clutch plate for

- i Lining wear
- ii Burning marks
- iii Loose reverts
- iv Broken springs
- v Crack in linings
- vi Wear in spline

- iii Taper

- 2 Check the pressure plate and face plate for

- i Radial heat cracks
- ii Wear

- 3 Springs for cracks
- 4 Measure free length of springs and match with specifications. Check on a spring compression tester.
- 5 Check wear of fingers
- 6 Check the pilot bearing and releasing bearing for wear pitting and burn markings.
- 7 Check withdrawal plate for wear, replace the defective parts as guided in the manual.

Remove and refit a new pilot bearing

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

- remove and refit the pilot bearing
- remove and refit the fly wheel ring gear
- relining the clutch plate
- checking the condition of fly wheel and pressure plate.

Requirements	
Tools/ Instruments	Materials
<ul style="list-style-type: none"> • Trainees tool kit - 1 No. • Straight edge - 1 No. • Box spanner - 1 Set • Special tool (bearing puller) - 1 No. • Torque wrench - 1 No. 	<ul style="list-style-type: none"> • Cotton waste - as reqd. • Cleaning tool - as reqd. • soap oil - as reqd. • Pilot bearing - as reqd.
Equipment / Machineries	
<ul style="list-style-type: none"> • Heavy vehicle - 1 No. 	

PROCEDURE

TASK 1: Removing, cleaning, inspecting and refitting pilot bearing

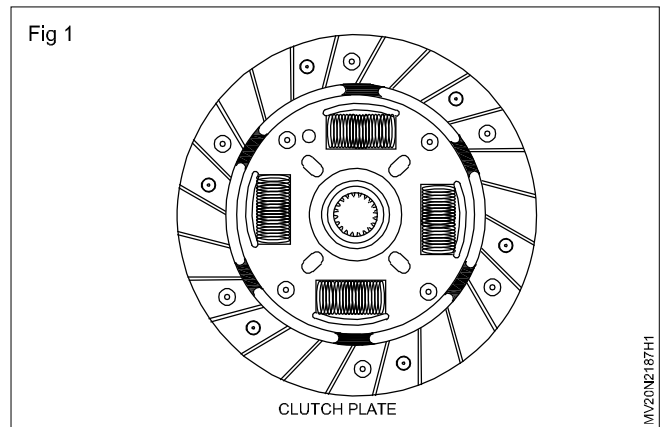
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| <ul style="list-style-type: none"> • Remove the gear box assembly • Remove the clutch assembly • Loosen the fly wheel mountings • Remove the fly wheel mounting bolts and flywheel assembly • Clean the flywheel mounting flange and pilot bearing which is rear end of the crankshaft • Fix the special tool to remove the pilot bearing • Gradually pull the pilot bearing by using bearing pulley and take out • Place the bearing on the tray • Clean the bearing by use of kerosene • Clean the bearing with air pressure to remove micro particales • Inspect the bearing for damages. | <ul style="list-style-type: none"> • Check the bearing noise • Replace the damaged pilot bearing with new part • Apply grease on bearing fixing spot • Place the bearing on the rear end of crankshaft • Use brass drift and hammer to fix the bearing • Fix the bearing and ensure bearing is properly fitted • Check the bearing play with the help of clutch shaft • Ensure there is no excess play and noise in the bearing • Mount the flywheel and clutch assembly and used clutch shaft for aligning the clutch plate. • Fix the thrust bearing and gearbox assembly • connect clutch pedal linkages and transmission linkages |
|---|--|

TASK 2: Removing the flywheel ring gear

- | | |
|--|--|
| <ul style="list-style-type: none"> • Loosen the flywheel mountings • Remove the flywheel mounting bolts and take out the fly wheel with safety measures • Place the fly wheel on the work bench • Clean the fly wheel assembly • Check the fly wheel ring fitting • Remove the fly wheel ring with help of brass drift and hammer (if unable to remove the fly wheel ring heat the ring and remove it) | <ul style="list-style-type: none"> • Clean the dust and rust formed on the fly wheel • Refitting the fly wheel ring gear • Select the new fly wheel ring with help of propane torch before place on the fly wheel • Heat the fly wheel ring evenly around 300° F • Place the fly wheel ring on the fly wheel • Use the hammer and brass draft to clamp on the fly wheel. |
|--|--|

TASK 3: Relining clutch plate (Fig 1)

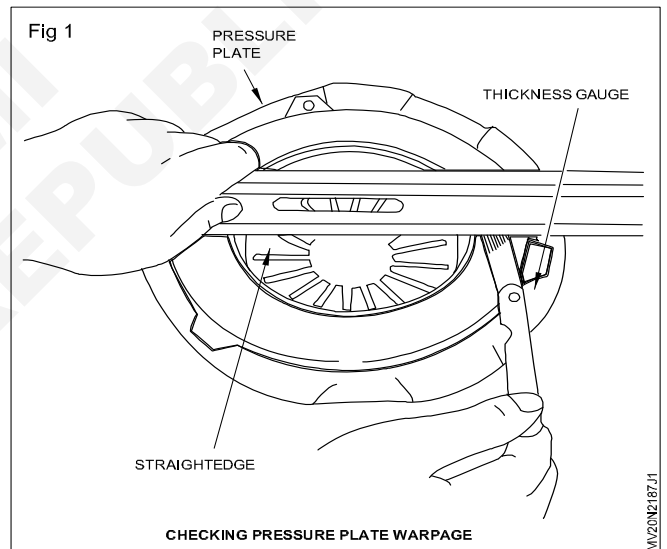
- Inspect the clutch plate and lining
- Remove the old rivets by use of drilling or centre punch with hammer.
- Remove the old linings
- Clean the clutch hub and cushion springs
- Inspect the clutch hub flange, torsion spring, cushion spring for damage or cracks and noise
- If any damage found in clutch hub or cushion spring repair or replace the unit.
- select the correct size of clutch lining and rivets.
- clean the clutch linings and hub unit before relining
- Align the rivet holes on the clutch spring with clutch lining
- Clamp the linings to the clutch plate with hand vice or 'C' clamps



- Adjust the clamps as close as possible to rivet holes
- Start riveting with foot operate riveting machine in sequence under instructor's guidance
- After riveting check the lining rivets tightness.
- Ensure the clutch linings are properly riveted before use

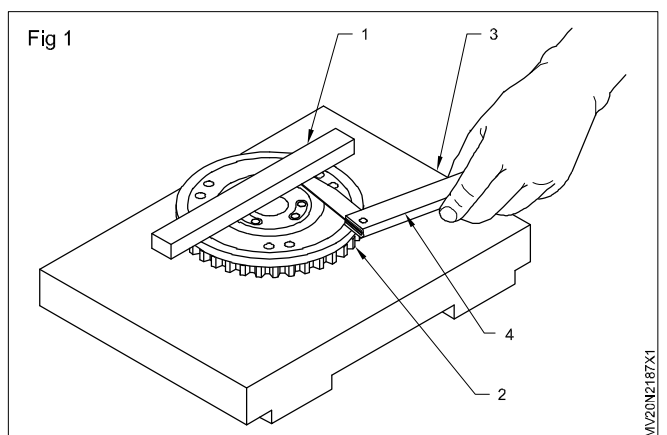
TASK 4: Inspecting pressure plate (Fig 1)

- 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 recommend for resurfacing do not grind below the minimum specified thickness.



TASK 5: Inspecting fly wheel (Fig 1)

- Check visually the flywheel surface for cracks, burnt and scored face.
- 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 minimum limit specified by the manufacturer. then the flywheel should be reground. Check ring gear for worn or damage. Check pilot bearing for its serviceability.
- Mount the flywheel on the crankshaft and keep it on the inspection table.
- Note down the face out of the flywheel with the help of a dial indicator.
- If the face out of the flywheel is more than the minimum limit specified by the manufacturer than the flywheel should be reground.



- Ensure that, after grinding, the thickness of the flywheel remains within the limit specified by the manufacturer.

Assemble pressure plate and aligning clutch assembly with fly wheel

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

- assemble the pressure plate assembly
- adjust the pressure plate fingers height
- check the run out of the flywheel
- aligning the clutch assembly with flywheel.

Requirements		
Tool / Instruments		Equipment / Machineries
<ul style="list-style-type: none"> • Trainees tool kit • Torque wrench • Depth gauge • Box spanner • Clutch aligner • Dial indicator • Surface plate 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No. - 1 No. - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Heavy vehicle - 1 No. Materials • Cotton waste - as reqd. • Soap oil - as reqd. • Clutch finger - as reqd. • Roller & strut - as reqd. • Release lever spring - as reqd. • Bolt & pin - as reqd. • Pressure spring - as reqd.

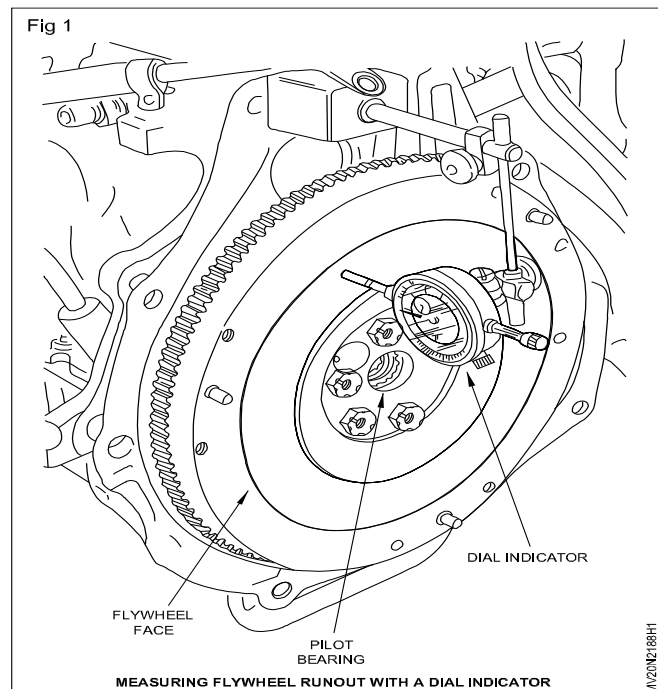
PROCEDURE

TASK 1: Assembling the pressure plate

- Place the pressure plate on surface plate
- Place the pressure spring on the pressure plate
- Fix the release lever with strut, eye bolt and pin
- Fix the release lever spring
- Align marks of the clutch cover and pressure plate
- Place the pressure plate on the clutch jig
- Compress the pressure spring with a clutch jig
- Mount the eye bolt nuts and evenly tighten all nuts
- Release the load from the springs and remove the pressure plate assembly from clutch jig
- Visually check the finger height
- Check and adjust the finger height with help of depth gauge and spanner.
- Ensure finger height is as specified limit by manufacture.

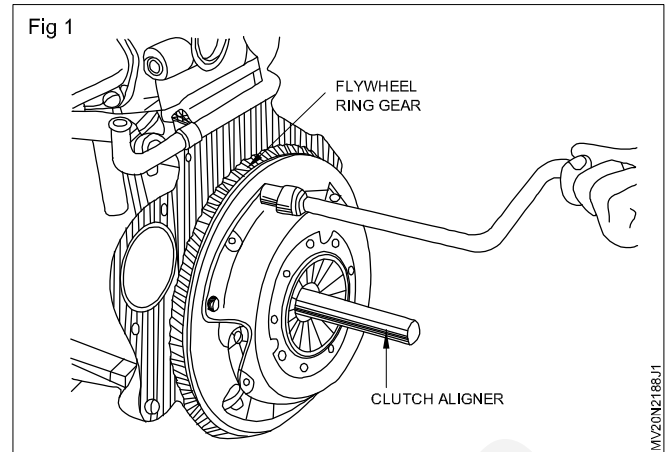
TASK 2: Checking run out of flywheel (Fig 1)

- Mount the fly wheel on crankshaft is flange.
- Tighten the fly wheel mounting bolts as specified torque limit by manufacturer.
- Clean the frictional surface of the flywheel
- Set the dial indicator on fly wheel as shown in figure-1
- Set the dial indicator dial in 'O' mark
- Ensure the proper function of dial indicator
- Rotate the flywheel
- Check the friction surface and run out of the flywheel (It should be within the specified limit)



TASK 3: Aligning clutch assembly with fly wheel. (Fig 1)

- Place the clutch plate on the fly wheel and keeping the clutch plate's hub opposite to the fly wheel
- Place the pressure plate assembly on the flywheel and the mounting holes with pressure plate.
- Fix the pressure plate mounting screws and tighten the screws with hand.
- Fix the clutch aligner and align the clutch plate
- Tighten the pressure plate mounting screws as specified tighten pressure.
- Remove the clutch aligner.



Overhaul the gear shift mechanism

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

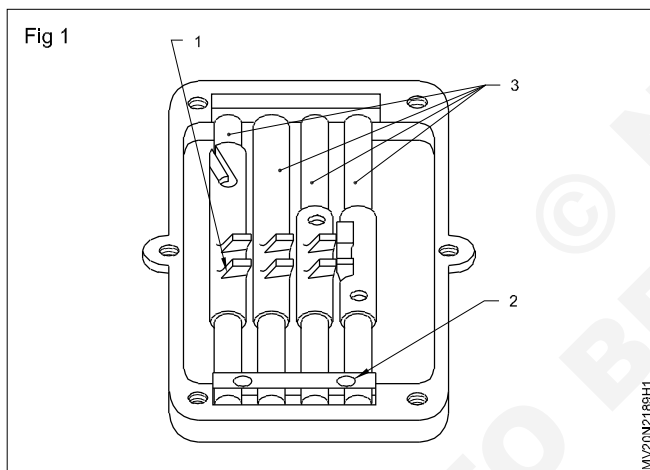
- identify the gear selector fork
- dismantle gear selector fork
- check the condition of bushes in gear selector
- adjust and align the gear selector fork
- change oil in the gear box.

Requirements			
Tools / Instruments		Materials	
• Trainee tool kit	- 1 Set	• Grease/oil	- as reqd.
• Oil can 0.5/ 0.25 liter capacity	- 1 No.	• Kerosene	- as reqd.
• Gear box	- 1 No.	• Banian cloth	- as reqd.
• Torque wrench	- 1 No.		

PROCEDURE

TASK 1: Identify the gear selector fork

1. Identify the gear selector fork as shown in figure 1



- 1 Shifting forks (1)
- 2 Selector rod rear end caps (2)
- 3 Selector rod (3)

TASK 2: Dismantle gear selector fork

- 1 Remove the selector tower and selector assembly from the gearbox
- 2 Keep all the shifting forks (1) in neutral position.
- 3 Remove the front and rear end caps (2) of the selector rod (3).
- 4 Note down the position of the selector forks to fit them in the same position while reassembling.
- 5 Rotate the selector rod in such a way that the ball (4) is lifted off the groove.
- 6 Take out the selector rod (3) along with the fork (1). (If provided, remove the guide plate, interlocking pins and balls.)

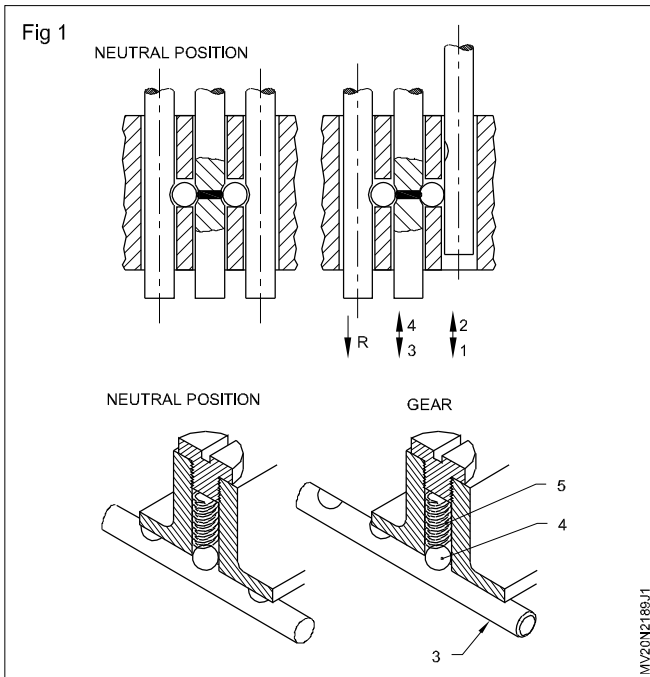
TASK 3: Check the condition of bushes in gear selector

Inspection

1. Clean all the parts and check visually for wear/crack/damage. Replace the defective parts.

TASK 4: Adjust and align the gear selector fork assembly

- 1 Insert the pressure spring (5) with the balls (4) in the forks (1). (Fig 1)

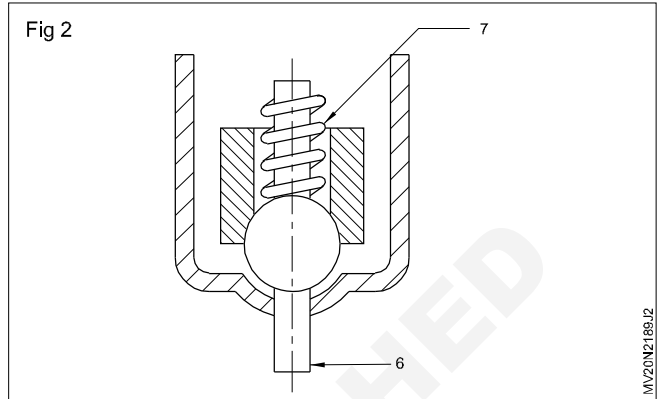


- 2 Insert the selector rod (3) in the fork (1) and rotate the selector rod (3) so that the ball (4) sits in its groove on the selector rod (3).

Fit the guide plate on the selector casing.

Fit the caps on either side of the cover.

- 3 Keep all the gears in the gearbox in neutral position.
- 4 Keep all the forks in the selector assembly in neutral position.
- 5 Apply shellac on the mounting surface and fix the gasket on the mounting surface.



- 6 Fit the gear selector assembly on the gearbox.
- 7 Fit the ball pin (6) and pressure spring (7) in the selector tower. (Fig 2)
- 8 Fit the selector tower on the gear selector assembly.
- 9 Shift all the gears in turn and check for gear engagement.

TASK 5: Changing oil in gear box

- 1 Locate the oil drain plug in gear box
- 2 Place the tray / bucket under the gear box
- 3 Remove the drain plug and drain the oil
- 4 Ensure complete oil, is drained from the gearbox
- 5 Fix the gearbox drain plug
- 6 Fill the specified grade oil
- 7 Check the oil level in gear box

Overhaul the synchromesh gear box

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

- **dismantle the gear box**
- **clean the gears using suitable solvent**
- **check the gearbox and its parts**
- **assemble the gearbox.**

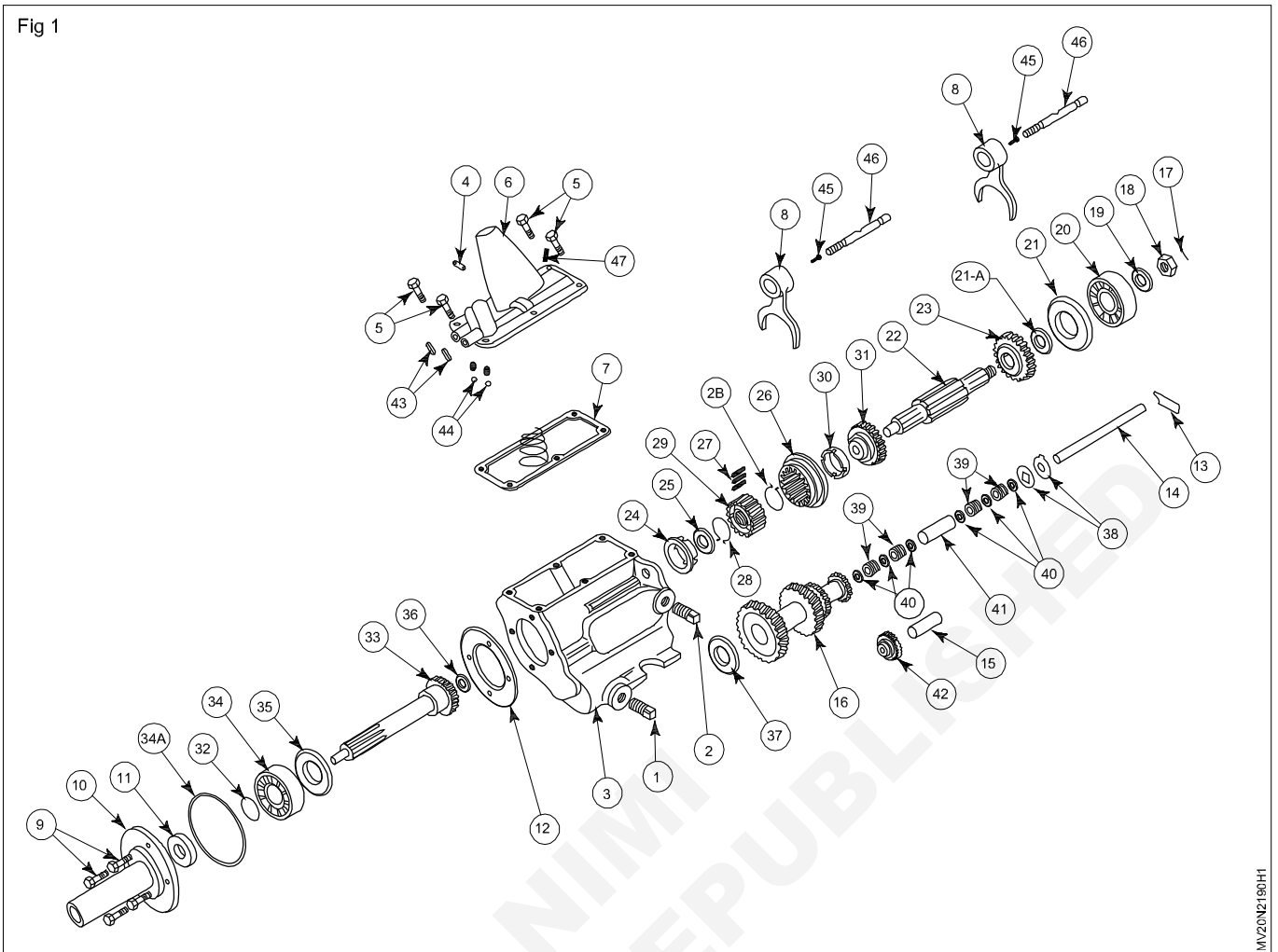
Requirements	
<p>Tools / Instruments</p> <ul style="list-style-type: none"> • Trainee tool kit - 1 Set • Spanners socket pieces with box - 1 Set • outside micrometer - 1 No. • Torque wrench - 1 No. • Feeler gauge 20 blades (metric) - 1 No. • Oil can 0.5/ 0.25 litter capacity - 1 No. • Bearing puller - 1 No. • Electric pedestal grinder with two 18cm. Wheel - 1 No. • Taps and Dies - 1 Set • Cleaning tray - Aluminum 45 X 30 cm - 1 No. 	<p>Equipment / Machineries</p> <ul style="list-style-type: none"> • Vehicle gear box - 1 No. <p>Materials</p> <ul style="list-style-type: none"> • Gear oil SAE.90 - as reqd. • Kerosene - as reqd. • Banian cloth - as reqd. • Grease - as reqd.

PROCEDURE

TASK 1: Dismantle the gear box

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Remove the drain plug (1) and drain the oil (Fig 1) 2 Remove the filler plug (2) 3 Remove the shift lever housing pin (4) 4 Remove the shift lever from the housing. 5 Remove the shift housing bolts (5) 6 Remove the gear shift housing assembly (6) along with the gasket (7) and shifting fork (8) from the gearbox housing (3). 7 Remove the screws (9) and washer of the pinion shaft's (33) bearing retainer (10) with the felt (11). 8 Remove the retainer and gasket (12) 9 Remove the lock plate (13) through the slot cut in the rear end of the countershaft(14) and the reverse idler gear shaft (15) 10 Drive out the countershaft (14) by using the brass drift. 11 Allow the countershaft gear set (16) to drop to the bottom of the gearbox housing. 12 Remove the cotter pin (17) 13 Remove the main shaft nut (18) and washer (19). 14 Remove the main shaft rear bearing (20) 15 Remove the rear bearing spacer (21) 16 Remove the main shaft (22) along with the gear from the case through the rear bearing spacer's (21) opening. | <ol style="list-style-type: none"> 17 Remove the sliding gear (23) (1st and reverse gear) from the main shaft (22) 18 Remove the blocking ring (24) 19 Remove the snap ring (25) 20 Remove the synchronizer clutch sleeve (26). While removing the clutch sleeve take care of the synchronizer plates (27) and remove the synchronizer plates (27) and spring (28) 21 Remove the clutch hub (29) 22 Remove the 2nd blocking ring (30) 23 Remove the 2nd speed gear (31) 24 Remove the bearing lock snap ring (32) 25 Drive out the pinion shaft (33) along with the bearing (34) and washer (35). 26 Remove the pilot needle bearing (36) 27 Remove the countershaft gear set (16) 28 Remove the front and rear thrust washers (37,38) 29 Remove the roller needle bearings (39) from the counter shaft gear set along with the washers (40) and spacer (41). 30 Remove the reverse idler gear shaft (15) by using a brass drift. 31 Remove the reverse idler gear (42) |
|---|--|

Fig 1



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32 Dismantle the gear shift housing assembly by removing the interlock plunger (47) , the rail caps, (43) poppet

balls and springs (44) shifting fork lock pins (45) shifting rails (46) and shifting forks (8).

TASK 2: Clean the gears using suitable solvent

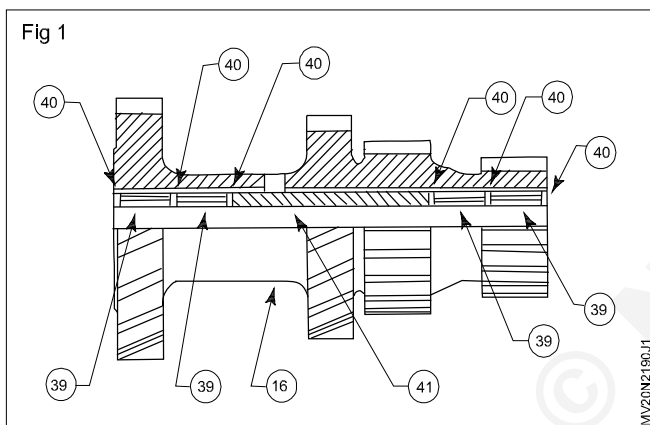
- | | |
|--|--|
| <ol style="list-style-type: none"> 1 Wash the gear box housing (3) thoroughly inside and outside with a cleaning solvent. 2 Clean all the components with a cleaning solvent. 3 Inspect the synchronizer rings and cones for wear, crack and overheat. 4 Inspect the synchronizer clutch sleeve (26) and dog teeth for damage. 5 Inspect the hub's (29) splines for damage and free movement on the main shaft (22) 6 Inspect the synchronizer shifting plates (27) for damage and proper seating. | <ol style="list-style-type: none"> 7 Inspect the blocking rings (24 & 30) for wear, crack and overheat. 8 Inspect hub snap ring (25) for proper tension and seating. 9 Inspect the gear box housing (3) for crack. 10 Inspect the bearings for crack, damage and overheat. 11 Inspect all the gears for wear, crack, damage and overheat. 12 Check the gears for free movement on the main shaft (22) 13 Inspect the bushes for wear and damage |
|--|--|

TASK 3: Check gearbox parts

- 1 Inspect the shaft bores in the gear box housing for wear and true.
- 2 Inspect the main shaft's (22) spline for damage.
- 3 Inspect the countershaft bore with case for damage.
- 4 Inspect the main drive shaft (33) for damage, wear and overheat.
- 5 Inspect the counter-gear set (16) for damage and wear.
- 6 Inspect the countershaft (14) for damage and overheat.
- 7 Inspect the reverse idler gear shaft (15) for damage.
- 8 Inspect the bush, roller bearings (39) for crack, wear and overheat.
- 9 Inspect the bearing seating areas in the gear box housing.
- 10 Inspect the rails (46) of the shifting mechanism for wear and bend.
- 11 Inspect the forks (8) for damage, wear and bend.
- 12 Check all gear teeth for pitting overheating marks wear and breakages and replace where necessary.

TASK 4: Assemble the gearbox

- 1 Assemble the reverse idler gear (42) and shaft (15) into the case (3). When fixing, ensure that the chamfered side of the idler gear faces towards the sliding gear.



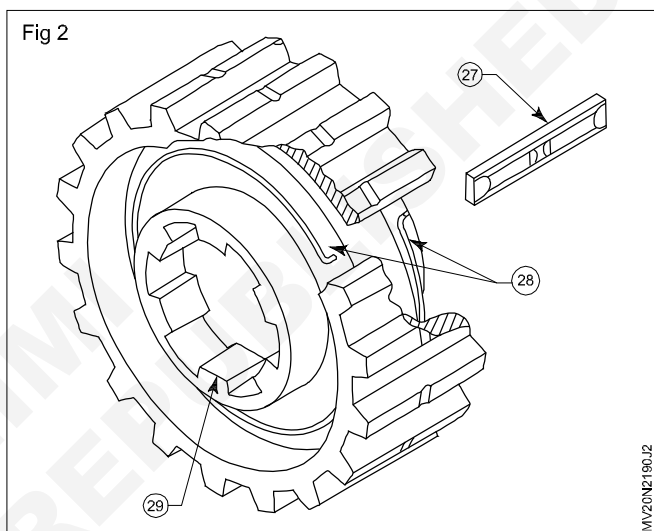
- 2 Align the slot on the reverse gear shaft (15) for proper locking.

Assembling the countershaft gear set

- 1 Insert the spacer (41) into the countershaft gear's (16) hub. (Fig 1)
- 2 Place the washers (40) at each end of the spacer (41) and push needle bearings (39) at each end. Again add washer (40) at both the ends and push the needle bearings (39). Finally place one more washer (40) at both ends and complete the assembly.
- 3 Place the countershaft gear set (16) in the bottom of the gear box housing (3). Ensure that the larger gear faces towards the pinion shaft in the gear housing.
- 4 Apply grease on the front and rear thrust washers (37 & 38) and place them at their respective positions in the gearbox housing.

Assembling the synchromesh unit

- 1 Install two synchronizer springs (28) in the hub (29) with the spring tension opposed. (Fig.2)
- 2 Place the ends of the spring in the slots of hub.



- 3 Install the three synchronizer shifting plates (27) in the three slots in the clutch hub (29) with the smooth side of the plate facing outward.
- 4 Hold the plates in position.
- 5 Slip the clutch sleeve (26) over the clutch hub.
- 6 Install the 2nd speed gear (31) on the main shaft (22). Ensure that its dog teeth face towards the front of the gearbox housing.
- 7 Place the blocking ring (30) on the second speed gear towards the front of the gearbox housing.
- 8 Install the clutch hub (29) with the clutch sleeve (26) on the main shaft front end without disturbing the synchronizer plate.
- 9 Lock the hub with the main shaft by inserting the clutch hub snap ring (25)
- 10 Pass the front end of the main shaft (22) in the case (3) through the rear end bearing opening and assemble the low and reverse sliding gear (23) on the main shaft. Ensure that the shifting groove of gear faces towards the front of the gearbox housing.
- 11 Place the bearing spacer (21A) on the main shaft rear side.
- 12 Fix the rear bearing spacer (21)

- 13 Assemble the rear end bearing (20)
- 14 Place the main shaft washer (19)
- 15 Tighten the main shaft castle nut (18) at the recommended torque.
- 16 Lock the castle nut (18) by the cotter pin (17)
- 17 Apply grease and place the pinion shaft pilot bearing (36) in the pinion shaft spigot.
- 18 Install the bearing washer (35) bearing (34) and the bearing snap ring (34A) on the pinion shaft.
- 19 Install the pinion shaft (33) with bearing on the housing and fix the pinion shaft snap ring (32).
- 20 Place the oil seal (11) in the bearing retainer (10).
- 21 Fix the bearing retainer (10) with a gasket (12) to the case (3).
- 22 Lift the counter-gear set (16).
- 23 Align the countershaft front thrust washer (37) and rear thrust washers (38) with the bore of the countershaft gear set (16).
- 24 Align the counter - gear set bore and gear housing's front and rear bores.
- 25 Insert the countershaft(14) into the counter-gear set (16)
- 26 Tap the countershaft (14) to enter into the front side of the gearbox housing. Ensure the position of the three thrust washers. Please check the gear end plays as per manufacturer's specifications. (Sample data is given Table 1)
- 27 Align the countershaft and idler gear shaft slots.
- 28 Fix the lock plate (13)
- 29 Fix the drain plug (1).
- 30 Fill up gear oil to the specific level and fix the filler plug (2)
- 31 Place the gears in neutral position.
- 32 Invert the gearbox to, _____ and in a vice.
- 33 Install poppet balls and springs (44) in the respective holes provided on the housing.
- 34 Insert two shift rails (rods) (46) in the respective holes on the housing by using a wooden mallet and also insert the shifter forks on the rails simultaneously.
- 35 Lock the forks (8) on rails by lock-pins (45)
- 36 Push the shift rails further inside their respective holes so that the balls locate themselves on the grooves in the shift rails.
- 37 Put the rail caps (43) at the end of the shift rails and press them firmly.
- 38 Assemble the interlock plunger (47) on the shifter rail assembly.

- 39 Insert the gear shift lever in the centre hole on the housing and lock it with the lock-pin and check its movement.
- 40 Place the gasket (7) on the transmission case and align the hold.
- 41 Position the shifting mechanism in neutral position.
- 42 Install the shifting mechanism with forks aligning on to the gear wheel grooves.
- 43 Engage the different gears with the help of the shifting lever and its mechanism and check their performance.

Figure 4 shows a synchroniser set for a gear. If the synchroniser ring is worn out replace the same with a new one.

Figure 3 shows 5-speed synchromesh gear box.

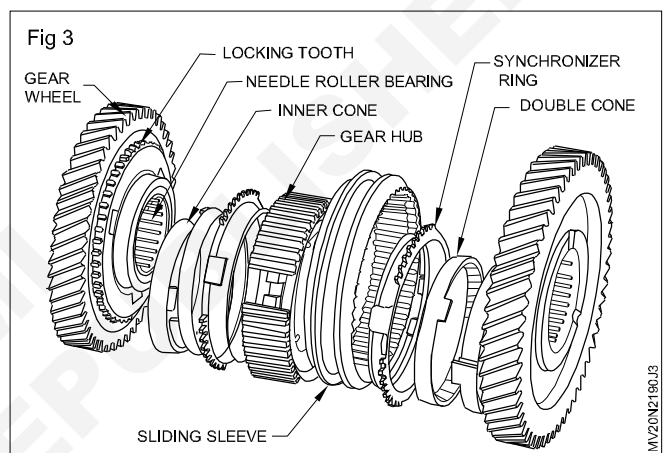


Table 1
Data

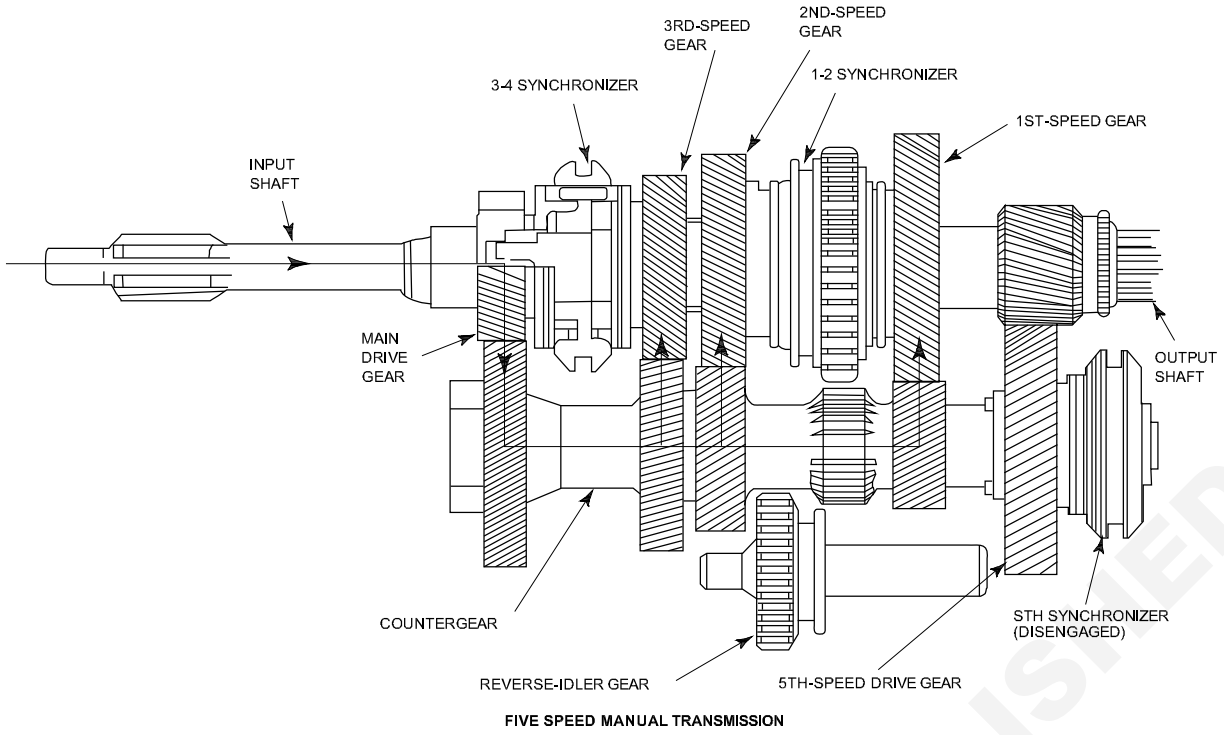
Descriptions	Tolerance limits
Backlash between main shaft and countershaft gears	- 0.10 to 0.17mm
Overall end float of fixed elements (main shaft)	- 0.152/0.813 mm
End play of mainshaft gears	
1st gear	- 0.838/0.99mm
2nd gear	- 0.711/0.864mm
3rd gear	- 0.330/0.483mm
4th gear	- 0.330/0.483mm

- 44 Fix the gear box with vehicle and test the performance of gear box during vehicle running on the road.

Causes and remedies

Cause	Remedy
Low oil level	Fill the oil in correct level
Bearing worn out	Replace bearing
Gear teeth worn out	Replace gear
Excessive back lash	Adjust back lash

Fig 4



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Overhaul open type propeller shaft

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

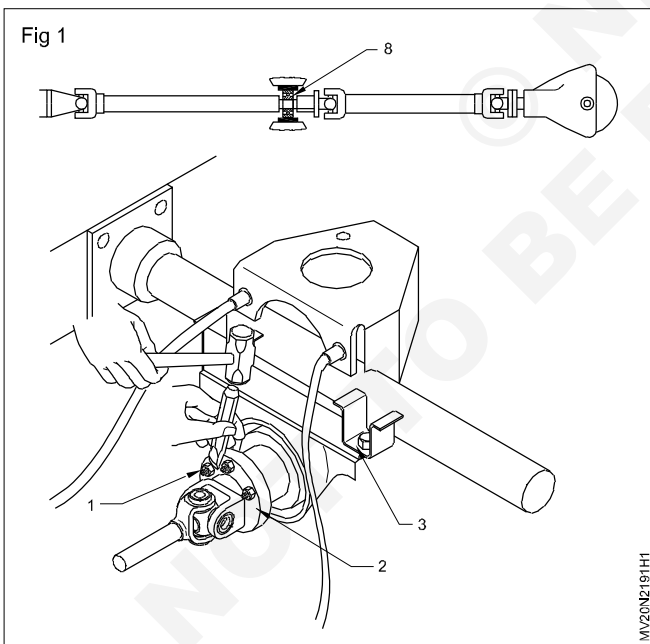
- remove the propeller shaft from the vehicle
- check the propeller shaft for bend by using a 'v' block and dial indicator
- assemble the centre bearing unit.

Requirements			
Tools / Instruments			
• Trainee tool kit	- 1 No.	• Ball pein hammer	- 0.5kg
• Double end spanner set	- 1 Set	• Dot punch	- 1 No.
• Ring spanner set	- 1 Set	• 'V' block	- 1 pair
• Bench vice	- 1 No.	• Dial indicator	- 1 No.
• Bearing puller	- 1 No.	Materials	
• Circlip plier	- 1 No.	• Kerosene	- as reqd.
Equipments / Machineries		• Soap oil	- as reqd.
• Vehicle	- 1 No.	• Grease	- as reqd.
		• Banian cloth	- as reqd.

PROCEDURE

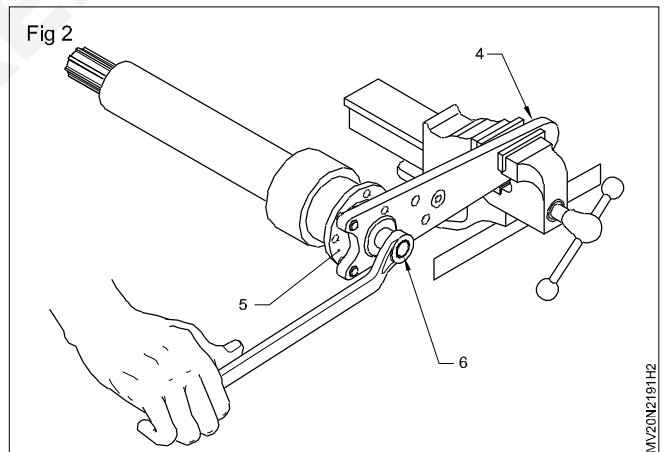
TASK 1: Remove the propeller shaft from the vehicle

- 1 Mark the position of the propeller shaft flange eyes (2). (Fig 1)



- 2 Unlock the propeller shaft's flange nuts (1) and remove them.
- 3 Remove the rear propeller shaft.
- 4 Remove the centre bearing housing mounting bolt(3).

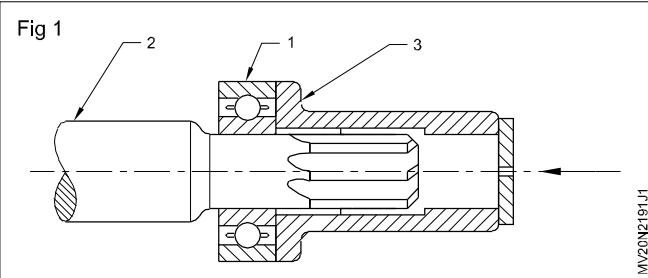
- 5 Remove the front propeller shaft.
- 6 Mount the special tool (4) on the vice and lock the propeller shaft's flange (5). (Fig 2)



- 7 Remove the propeller shaft flange nut.(6)
- 8 Fit the bearing puller (7) to hold the centre bearing (8) and tighten the puller's centre bolt (9) till the bearing comes out from the propeller shaft.
- 9 Remove the spacer ring.

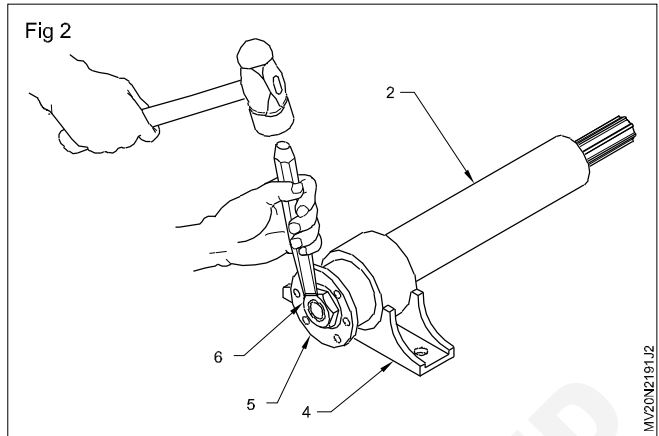
TASK 2 : Dismantle and assemble centre bearing. (Fig 1)

- 1 Place the propeller shaft (1) on the 'v' blocks (2) on the surface table.
- 2 Place the dial indicator (3) on the surface table at the centre of the propeller shaft and set the dial indicator to zero position.
- 3 Rotate the propeller shaft by hand and note down the propeller shaft's bend. If a bend is found more than the specified limit, replace/straighten the shaft.



- 4 Insert the inner spacer ring in the centre bearing bracket.
- 5 Place the centre bearing (1) on the propeller shaft (2).
- 6 Tap the centre bearing (1) with a drift (3) so that the centre bearing sits on the propeller shaft (2) on its seat.
- 7 Fit the centre bearing rubber into the bracket.
- 8 Fit the centre bearing bracket (4) on the propeller shaft.
- 9 Fit the propeller shaft flange (5) on the propeller shaft.

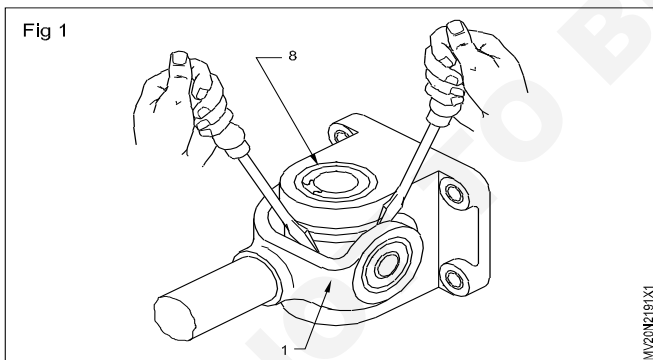
- 10 Tighten the lock - nut (6) (Fig 2) to the specified torque, and lock the nut.



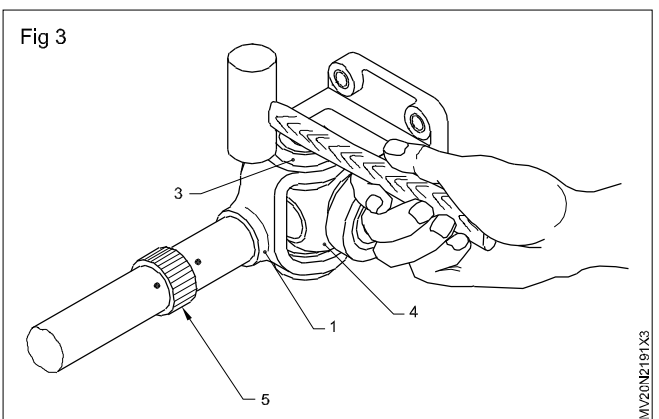
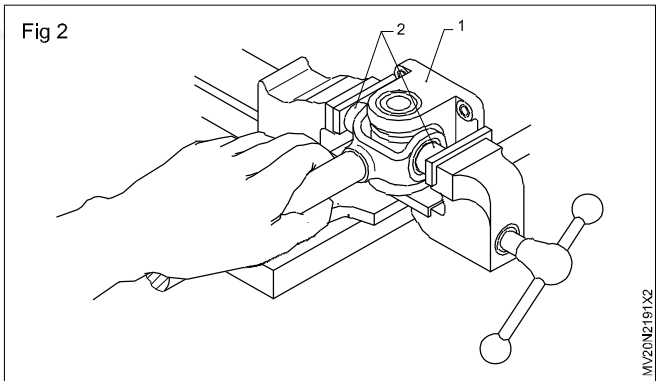
- 11 Fit the centre bearing bracket along with the rear propeller shaft to the cross - member and tighten the mounting bolts (3).
- 12 Connect the propeller shaft and the tail pinion flange, and tighten the mounting nut and bolt.
- 13 Connect the front propeller shaft's flange with the gearbox flange and tighten the mounting nuts and bolts.
- 14 Connect the front and rear propeller shaft's flange at the centre bearing and tighten the mounting nuts and bolts.
- 15 Centre bearing and tighten the mounting nuts and bolts.

TASK 3: Dismantle a universal joint

- 1 Remove all the four circlips (8) from the yoke (1). (Fig 1)



- 2 Mount the yoke (1) on the vice with the special tool (2).
- 3 Tighten the vice jaw till the bearing race (3) moves out 3 to 4 mm.
- 4 Remove the yoke (1) from the vice. (Fig.2)
- 5 Tap the yoke (1) with a mallet around the bearing race's (3) seat till the bearing race (3) comes out of the yoke(1). (Fig 3)

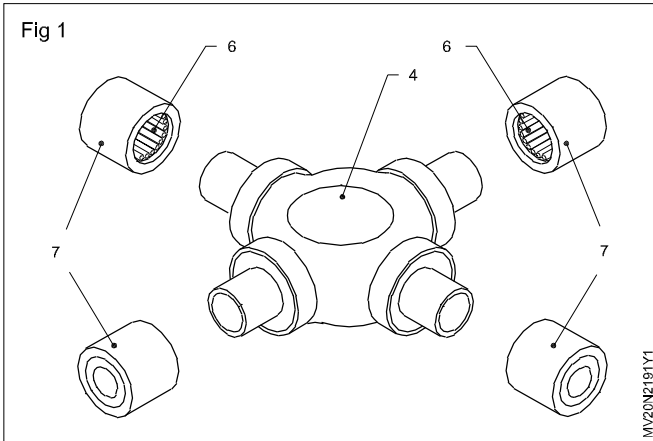


- 6 Repeat the above steps to remove all the 4 races from yoke.
- 7 Remove the spider (4) from the yoke (1).
- 8 Loosen the slip joint locking cap (5) by tapping the propeller shaft yoke with a mallet.

- 9 Mark the position of the yoke (1) and the propeller shaft to assemble in the same position.
- 10 Pull out the slip joint from the shaft.

TASK 4: Inspection of parts

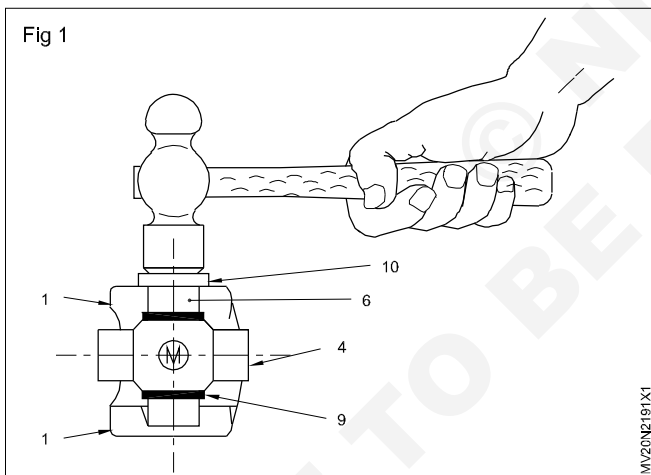
- 1 Check the needle bearings (6) visually for any damage.



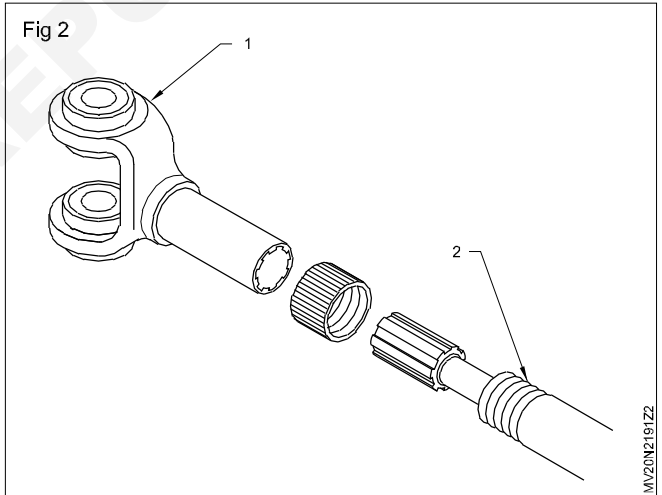
- 2 Replace the bearings, if found damaged. (Fig.1)
- 3 Check the free movement of the yoke of the slip joint on the propeller shaft.
- 4 Check that all the needles are placed in the bearing cup (7). If any needle is missing there will be a gap between the needles.

TASK 5: Assemble a universal joint (Fig 1) and refitting the propeller shaft to vehicle

- 1 Place the spider (4) on the yoke (1). (Fig 1)



- 2 Place the bearing (6) with the retainer (9) in the yoke (1) to 3-4 mm on opposite side.
- 3 Place a flat distance piece (10) on the bearing race (6) and tap it until the bearing race (6) sits in the yoke (1) on its seat.
- 4 Repeat the above steps for all the bearings.
- 5 Fix circlips on all the bearings.
- 6 Coincide the mark of the yoke (1) and shaft (2) and slide the slip joint on the propeller shaft. (Fig 2)



- 7 Tighten the slip joint locking cap (3).
- 8 Fix a dirt boot front and rear.
- 9 Refit the propeller shaft to vehicle
- 10 Tighten the mounting bolts of the shaft as specified torque.

Propeller shaft manufacturer provide arrow marks both in yoke and shaft. Ensure they are kept in one line.

Overhaul the front wheel drive shaft

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

- identify the CV joint
- remove the CV joint
- remove the half shaft assembly
- clean the CV joint and inspect
- check the condition CV joint, bearing and bushes
- lubricate the CV joint using recommended lubricant
- refit the CV joint.

Requirements			
Tools / Instruments		Equipments / Machineries	
• Trainee tool kit	- 1 Set	• Diesel engine /diesel engine car with manual	- 1 No.
• Hollow punch set of seven pieces 6mm to 15mm	- 1 Set	• Diesel Engine car of latest model with manuals	- 1 Set
• Spanners socket set of 28 pieces with box	- 1 Set	Materials	
• Ball pein Hammer 0.5kg	- 1 No.	• Cotton waste	- as reqd.
• Outside micrometer	- 1 No.	• C.V joint	- as reqd.
• Torque wrench	- 1 No.	• Half shaft	- as reqd.
• Bearing puller	- as reqd		
• Crow bar	- 1 No.		

PROCEDURE

TASK 1: Identify the CV joint

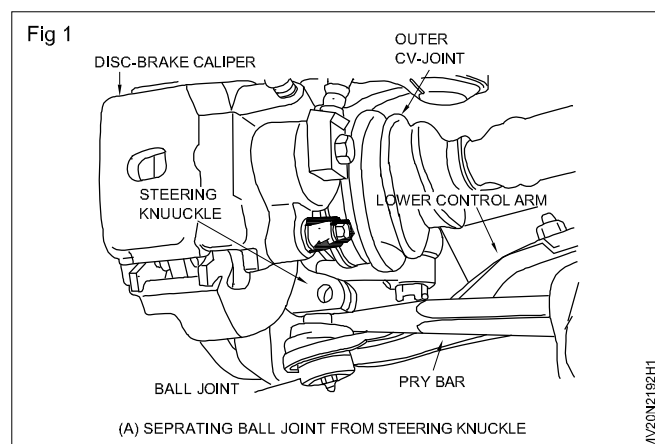
1. CV joint connects the drive shaft and wheels

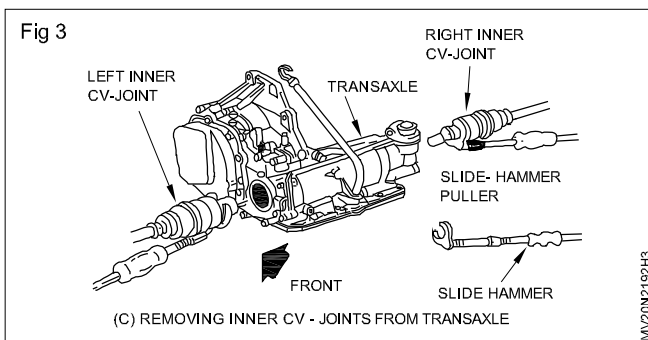
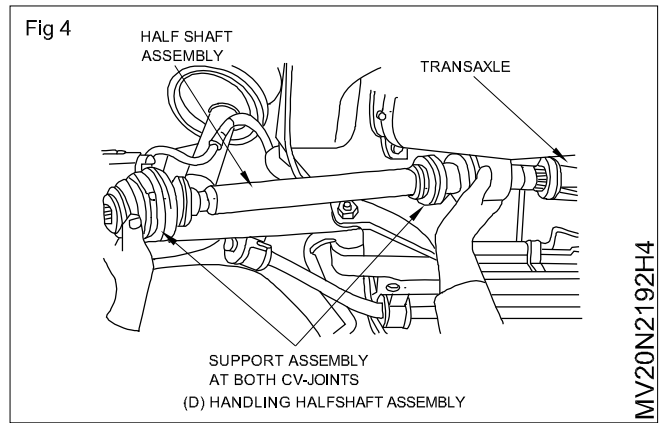
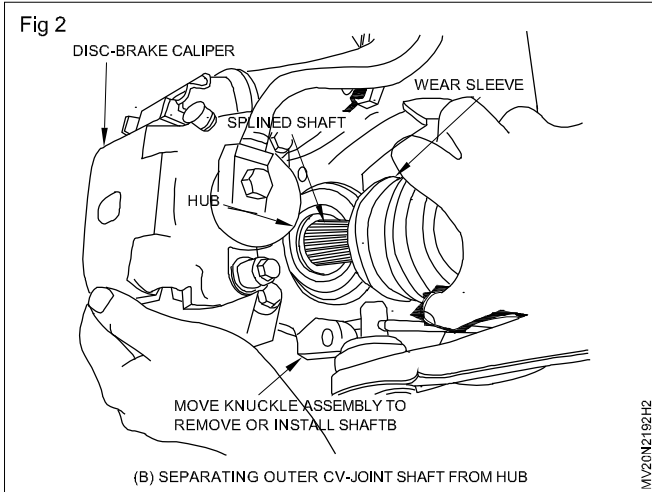
TASK 2: CV- joint removal

- 1 Complete boot and CV-joint service requires removing the half shaft assembly from the car.
- 2 Follow the procedures in the vehicle service manual.
- 3 loosen the front-wheel lug nuts and the hub nut.
- 4 Raise the vehicle on a lift, supporting the vehicle on the suspension.
- 5 Remove the lug nuts, wheels, and hub nut.

TASK 3: Removing the half shaft assembly

- 1 Remove the nut holding the lower ball joint to the steering knuckle.
- 2 Separate the lower ball joint from the knuckle (Fig 1). Swing the knuckle assembly and pull out the CV joint from the wheel bearing and hub (Fig 2).
- 3 Use a slide-hammer puller (Fig 3) and remove the inner CV joint from the transaxle.
- 4 Support both ends of the half shaft assembly and remove it from under the vehicle (Fig 4).
- 5 Place soft jaws on avise and clamp the half shaft in the soft jaws.



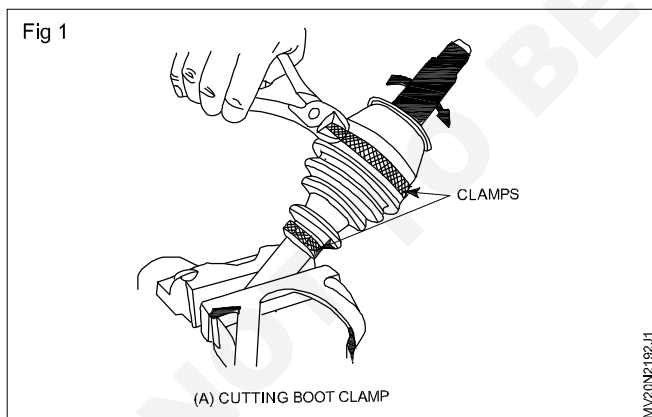


TASK 4: Clean the CV joint

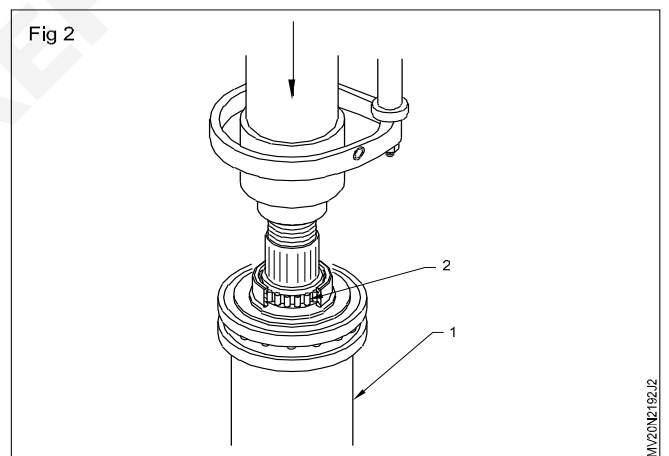
- 1 Clean the CV joint with kerosene thoroughly and then dry.

Inspecting the CV Joint

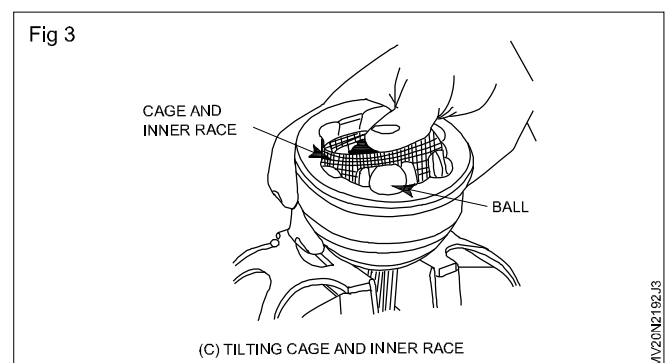
- 1 Inspect the outer CV joint, cut off the boot clamps (Fig 1) and remove the boot.



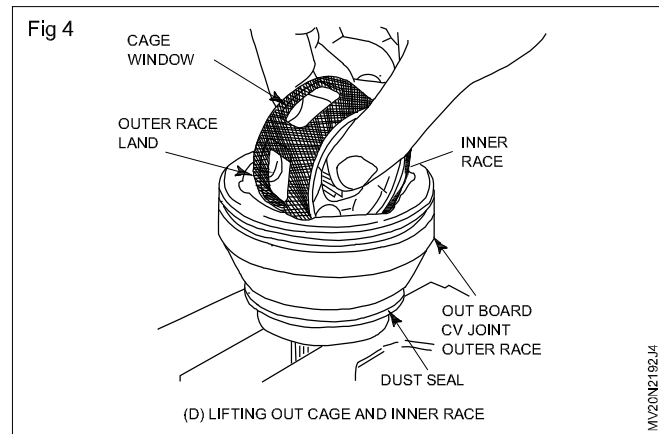
- 2 Rub the grease from the CV joint between fingers (Fig 2).
- 3 If the grease feels gritty, the joint probably is damaged. Wipe away the grease and remove the CV joint from the half shaft.
- 4 Shafts are retained by a snap ring or circlip.



- 5 Force up one side of the cage and inner race, and remove each ball (Fig 3).

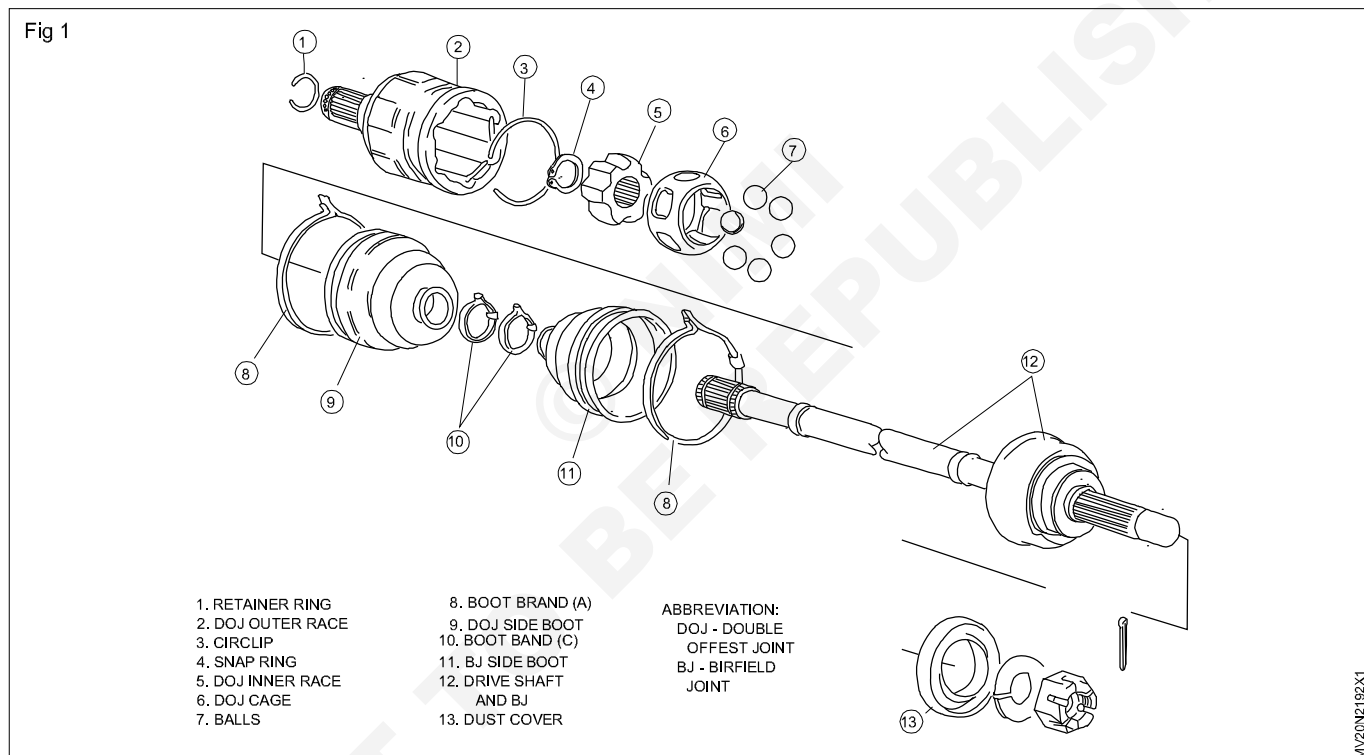


- 6 Then pivot the cage and inner race so the cage windows align with the lands of the outer race.
- 7 Lift out the cage and inner race (Fig 4).
- 8 Figure 9 shows the Rzeppa outer CV joint completely disassembled.



TASK 5: Check the condition cv joint, bearing and bushes

- 1 Inspect the cage for cracks and pitting. This allows excess ball movement and causes a clicking sound during turns. (Fig 1)
- 2 Check the inner and outer races for excess wear in the grooves caused by the balls moving front and back.



- 3 Shiny areas in the grooves and cage windows are normal.
- 4 Replace the CV joint only if a part is broken, cracked, severely pitted, or damaged.

CV- Joint Fault Diagnosis

- 1 Unusual noise in the drive line of a front wheel - drive vehicle usually indicates a damaged or worn CV joint.
- 2 Other conditions in the transaxle, bearings, and tyres also create noise.
- 3 To determine the source of a noise, road test the vehicle. Follow the procedures in vehicle service manual.
- 4 A clicking noise while turning indicates a worn or damaged outer CV joint.
- 5 A clunk when accelerating or decelerating indicates a worn or damaged inner CV joint.
- 6 Shudder or vibration during acceleration is also probably caused by defective inner joint.
- 7 Other possible causes include a bad intermediateshaft bearing, outer joint, engine mount, or torque strut.
- 8 Causes of vibration at highway speed include out-of-balance tyres, out-of-round tires or wheels, or an alignment problem.

- 9 Vibration or growl may also be caused by a bad wheel bearing.
- 10 To check the wheel bearing, raise the wheel with a jack. Place a safety stand under the lower control arm.
- 11 Then spin the wheel by hand while listening at the hub for bearing noise.

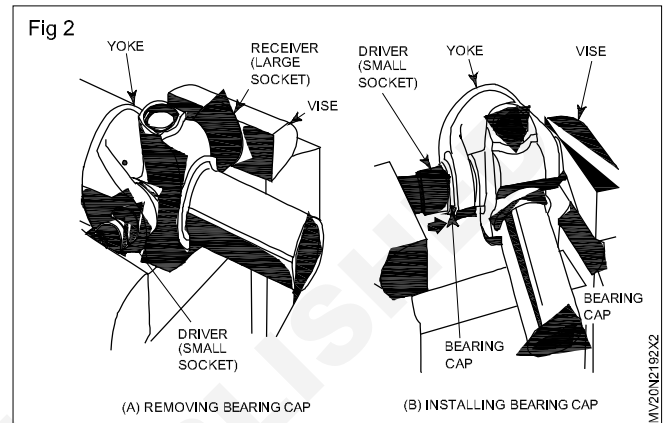
CV- Joint Boot Inspection

- 1 The CV-joint boots deteriorate and may crack or tear during normal use.
- 2 The boots and outer CV joints fail more frequently than the inner boots and joints.
- 3 This is because the front wheels move through greater angles for steering.
- 4 Some manufacturers recommend inspecting the boots every time the engine oil is changed.
- 5 Clean the boots and then check for cracks, tears, and grease leakage.
- 6 The clamps should be in place and tight. If the boot is damaged or leaking, replace it.
- 7 Continued driving will cause the CV joint to fail due to contamination or loss of lubricant.

3. Servicing The Half shaft And CV Joints (Fig 2)

- 1 The CV joints and half shaft assembly may be serviced in three ways.
- 2 A boot kit includes a new boot and clamps to install if the CV joint is reusable.

- 3 A defective CV joint is replaced with a CV-joint kit. This includes a new joint, boot, and clamps.
- 4 If there is damage to the half shaft or both CV joints, a complete half shaft assembly may be installed.
- 5 Follow the procedures in the vehicle service manual and the kit instruction sheets to install the new parts.
- 6 Both the boot kit and the CV-joint kit include a supply of the special grease used in CV joints.
- 7 Apply the recommended amount of the grease to the joint.



- 8 Add the remaining grease to the inside of the boot.
- 9 Then tighten the boot clamps.
- 10 Installation of the half shaft assembly is basically the reverse of removal.

Figure 2 shows removal and installation of a universal joint.

TASK 6: Lubricate the CV joint

- 1 Lubricate the CV joint with lubricate recommended in the service manual.

TASK 7: Refit the CV joint

- 1 Refer figure 1 for refitting the CV joint.
2. Use the same tools used for dismantling to refit the CV joint.

Overhaul the rear axle

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

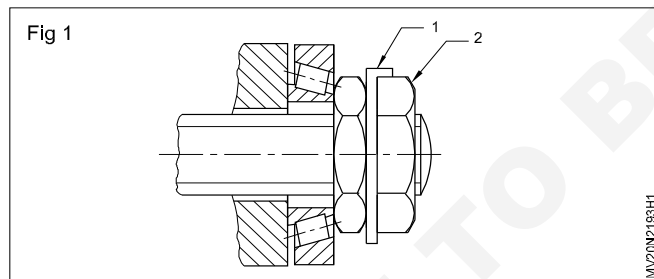
- remove the axle shaft
- check the rear axle parts for defects
- reassemble and adjust the hub end play as per the manufacturer's recommendation.

Requirements	
Tools / Instruments/ Equipments	Materials
<ul style="list-style-type: none"> • Trainee tool kit - 1 Set • Puller - 1 No. • 'V' Block - 1 Set • Dial indicator with base - 1 Set • Circlip plier - 1 No. • Drift - 1 No. 	<ul style="list-style-type: none"> • Kerosene - as reqd. • Soap oil - as reqd. • Banian cloth - as reqd. • Differential oil - as reqd. • Cleaning tray - as reqd. • Grease - as reqd. • Torque wrench - 1 No.
Equipments / Machineries	
<ul style="list-style-type: none"> • Vehicle - 1 No. • Hydraulic jack - 1 No. 	

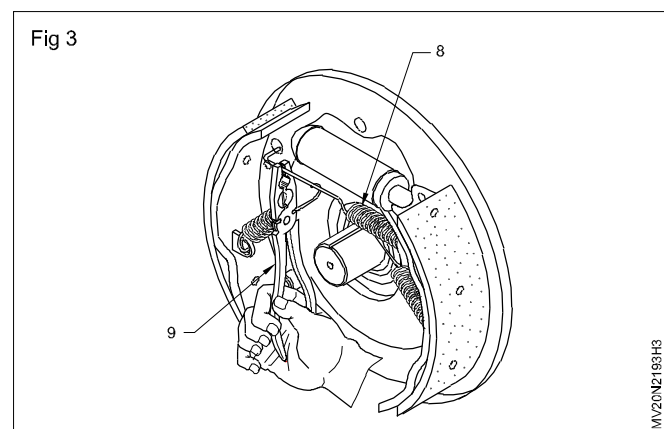
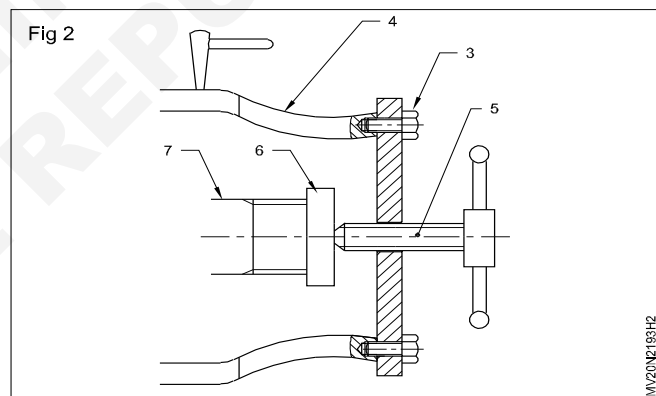
PROCEDURE

TASK 1: Remove the axle shaft

- 1 Remove the axle shaft nuts.
- 2 Remove the axle shaft. Use puller bolts, if threaded holes are provided on the axle shaft.
- 3 Unlock the lip of the locking plate (1) from the check nut (2). (Fig 1)



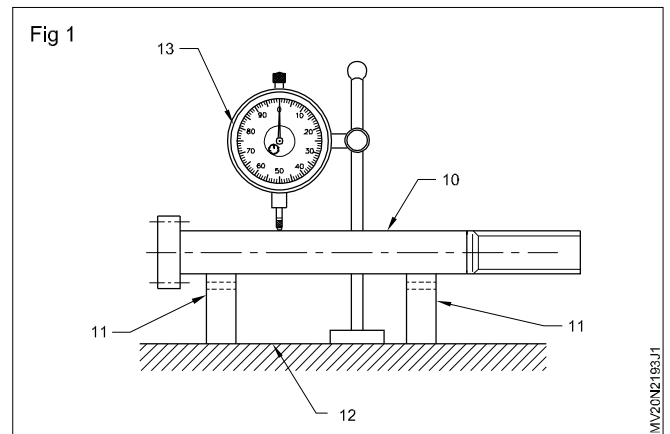
- 4 Remove the check-nut and locking plate and nut, using special spanners.
- 5 Place the puller on the hub (4) and tighten the mounting nuts (3) on the hub (4). (Fig.2)
- 6 Tighten the centre bolt (5). Ensure that the distance piece (6) sits squarely on the axle housing (7).
- 7 Tighten the centre bolt (5) till the hub (4) comes out of the axle housing (7) along with the brake drum.
- 8 Rotate the brake adjusting screw to bring the brake shoes closer.
- 9 Remove the brake shoe return spring (8) by using a spring extractor (9). (Fig.3)



- 10 Unscrew the brake shoe anchor bolts and remove the brake shoe.
- 11 Mark the leading and trailing shoes to fit them in same position later.
- 12 Unscrew the wheel cylinder mounting bolts and remove the wheel cylinder assembly and back plate.

TASK 2: Check the rear axle parts for defects

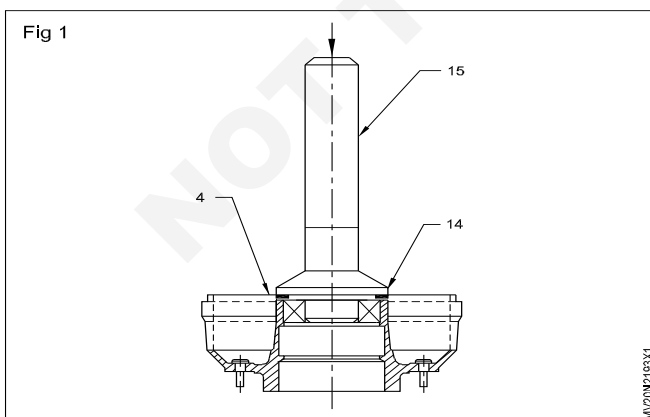
- 1 Check visually the following parts for any damage/wear/overhauling.
 - Axle tube's threads and bearing seats.
 - Wheel studs.
 - Axle shaft splines & flange holes.
 - Bearings for scoring/overheating.
 - Brake linings for wear. (If brake lining's rivets are protruding above the linings, then the brake lining should be replaced)
 - Brake drum for scoring and polishing. (If found scored or polished, it should be turned to next oversize)
 - Brake hoses for puncture, crack.
- 2 Place the axle shaft (10) on the 'V' blocks (11) on the surface table (12). The 'V' blocks should be placed near the splines and flange. (Fig 1)



- 3 Place the dial indicator (13) at the centre of the axle shaft (10) and set the dial indicator to zero.
- 4 Rotate the axle shaft (10) by hand and note down any deflection of the dial indicator. If the bend in the axle shaft is found more than the specified limit the axle shaft should be replaced.

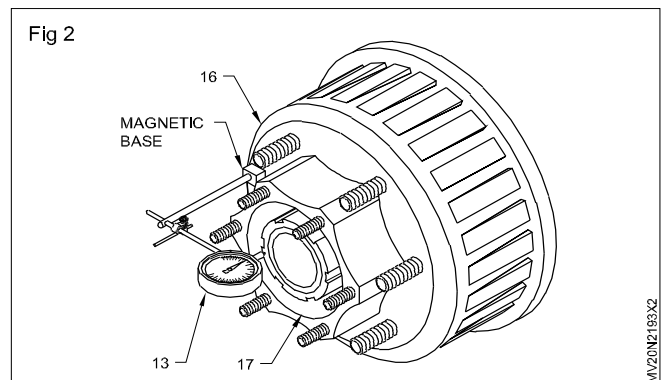
TASK 3: Reassemble and adjust the hub end play as per the manufacturer's recommendation

- 1 Clean all the parts.
- 2 Fit the back plate on the axle casing.
- 3 Fit the wheel cylinder assembly on the back plate.
- 4 Place the oil seal ring on the axle tube.
- 5 Mount the brake shoes on the back plate and tighten the clamp bolts.
- 6 Fit the brake shoes' retractor springs. Use a spring extractor.
- 7 Fit the wheel cylinder's slotted pin to the brake shoes. Check the free movement of the brake shoes by rotating the brake shoe adjusting cam.
- 8 Place the oil seal (14) in the hub (4) and place the drift (15) on the oil seal (14). Tap the drift (15) so that the oil seal (14) sits squarely on its seat in hub (4). (Fig.1)



- 9 Smear the wheel bearing with the recommended grease and place the bearing in the hub.
- 10 If necessary, fit circlips in the hub.

- 11 Place the hub along with the brake drum on the axle tube.
- 12 Fit the outer bearing in the hub.
- 13 Tighten the hub lock-nut with a hub nut spanner, so that the bearing sits on its seat.
- 14 Loosen the nut by half turn and then tighten it till no end play is found. Loosen the nut again by 1/2 turn. (To obtain a play of 0.02" to 0.04" approximately)
- 15 Place the dial indicator (13) with the magnetic base on the brake drum (16). Ensure that the dial indicator pointer rests on the axle casing (17). (Fig 2)



- 16 Measure the end play of the hub; if not found as specified then repeat till the specified end play is achieved.
- 17 Fit the lock-washer and check-nut.
- 18 Tighten the check-nut at the specified torque and lock it by the lock-washer.
- 19 Place the axle shaft gasket on the hub.
- 20 Place the axle shaft in the axle casing and tighten the axle shaft nuts.

Overhaul the differential assembly

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

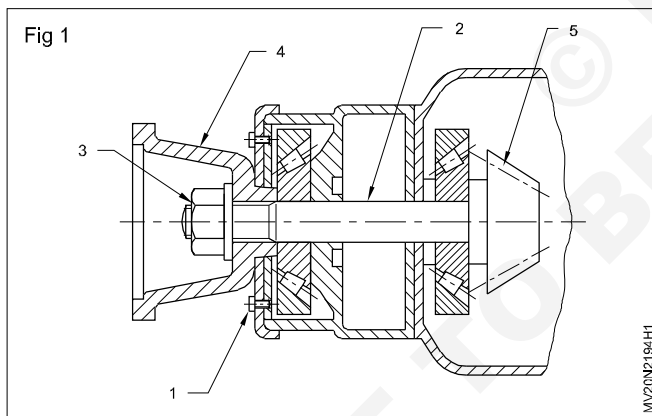
- dismantle the differential assembly
- dismantle the pinion assembly
- inspect the parts of the differential assembly
- assemble the differential assembly.

Requirements			
Tools / Instruments / Equipments		Equipments / Machineries	
• Trainee tool kit	- 1 Set	• Vehicle	- 1 No.
• Bearing puller	- 1 No.	Materials	
• Circlip plier external	- 1 No.	• Kerosene	- as reqd.
• Bench vice	- 1 No.	• Soap oil	- as reqd.
• Special tool	- as reqd.	• Banian cloth	- as reqd.
• Torque wrench	- 1 Set	• SAE 120 oil	- as reqd.
• Dial indicator with stand	- 1 Set	• Cleaning tray	- as reqd.
• Feeler gauge	- 1 Set	• Grease	- as reqd.

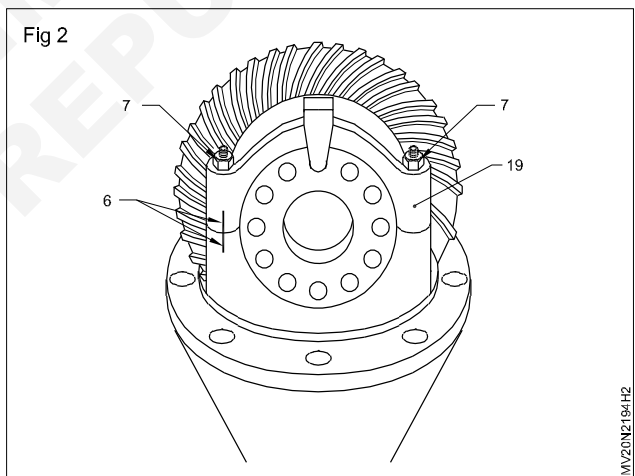
PROCEDURE

TASK 1: dismantle the differential assembly

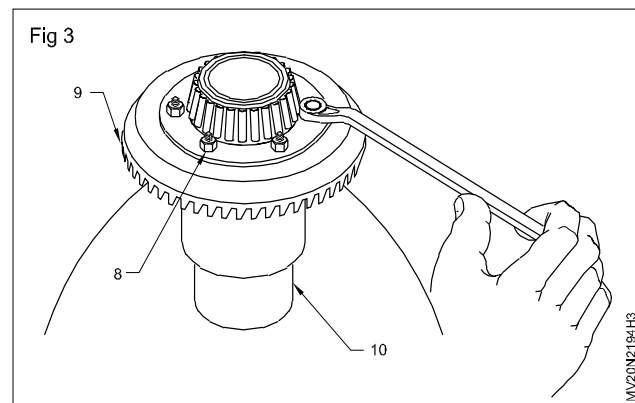
- 1 Hold and lock the differential (1) so that the pinion shaft(2) does not rotate. (Fig 1)



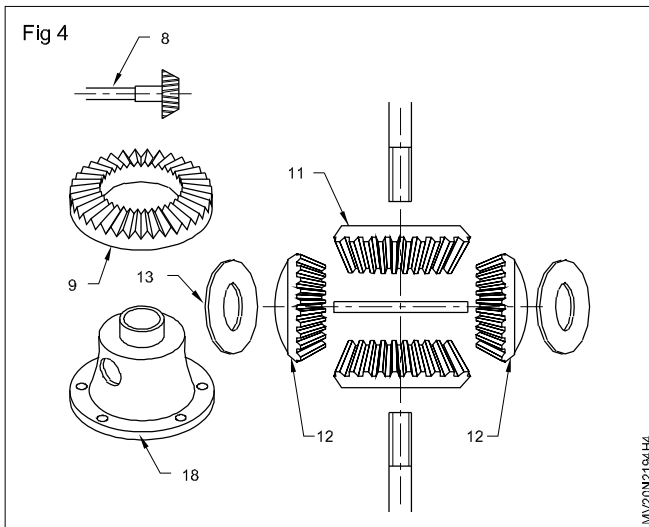
- 2 Remove the pinion shaft nut (3). Use a special tool to lock the pinion. (5)
- 3 Remove the pinion shaft flange (4).
- 4 Drive the end of the pinion shaft (2) with a hammer and brass drift. Take the pinion shaft assembly out.
- 5 Make marks on both the sides of the caps for identification (6). (Fig 2)
- 6 Loosen the stopper bolts on both sides.
- 7 Remove the cap fixing bolts (7).
- 8 Take out both the bearing caps(19). (Fig 2)
- 9 Lift the differential case assembly(10) and hold it on a vice.



- 10 Remove the bolts (8), fastening the bevel gear to the differential case. (Fig 3)



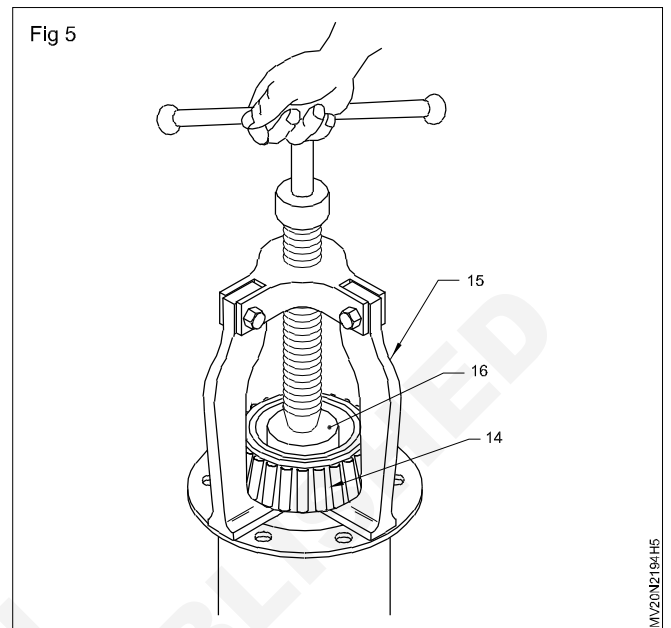
- 11 Take out the bevel gear (9).
- 12 Take out the side pinions (11), side gears (12) and thrust washers (13). (Fig 4)



- 13 Remove the side bearings from the differential case.
- 14 Use an extractor or a special tool (15). Ensure that the washer (16) sits squarely on the differential cage and does not touch the inner race of the bearing. (Fig 5)

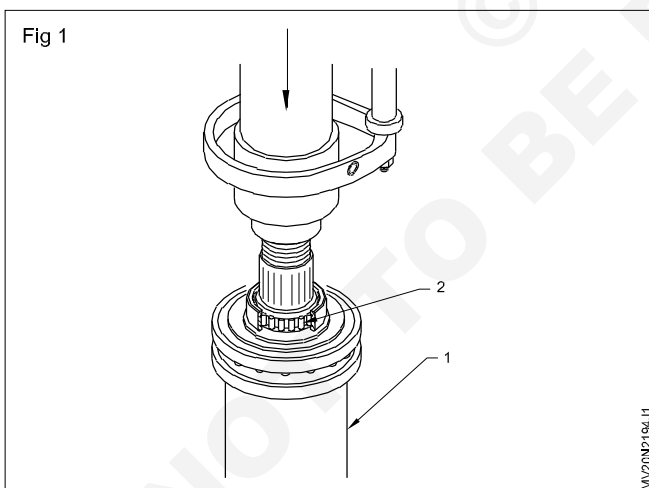
Inspection

- Inspect the pinion for wear.
- Inspect the side pinion and side gear for teeth wear.
- Check the bearings for free rotation.

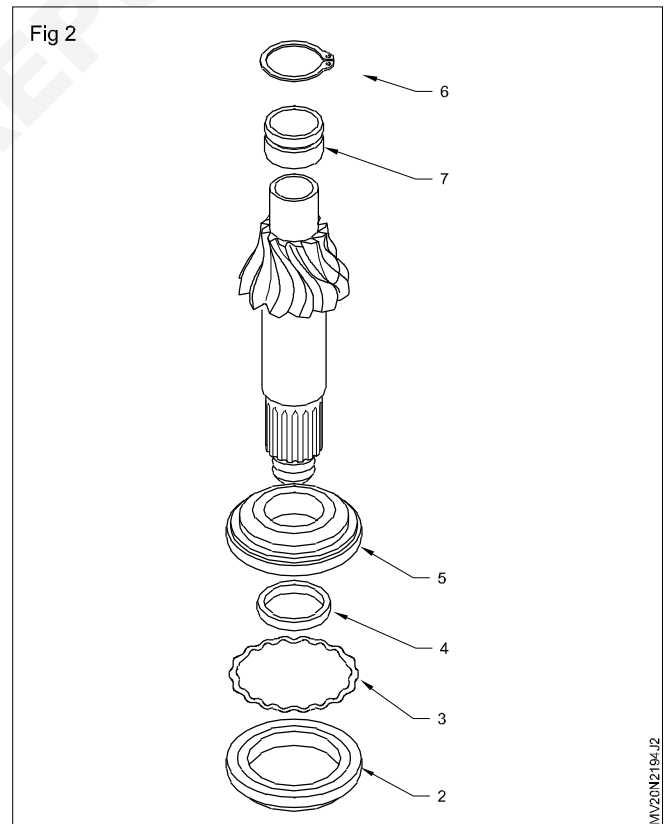


TASK 2: Dismantling of the tail pinion assembly

- 1 Support the inner race of the inner taper roller bearing (2) of the tail pinion on a special tool (1) and press the tail pinion out of the two taper roller bearings. (Fig.1)



- 2 Remove the outer taper roller bearing assembly (2) (Fig 2)
- 3 Remove the split spacer rings (3) between the outer races
- 4 Remove the spacer washer (4) between the two inner races
- 5 Remove the inner taper roller bearing assembly (5).
- 6 Ensure that the outer races of the two taper roller bearings are not interchanged.



- 7 Remove the circlip (6) of the pinion.
- 8 Remove the inner race (7) of the spigot bearing.

TASK 3: Inspect the parts of the differential assembly

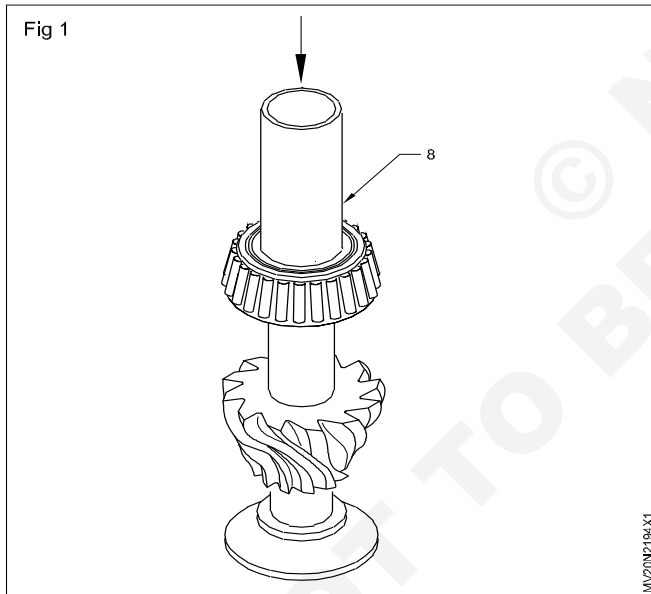
- 1 Check the tail pinion teeth for scoring, burrs, breakage, overheating etc.
- 2 Replace the defective tail pinion.
- 3 Check the bearing seats on the tail pinion for scoring.
- 4 Check the splines on the tail pinion and its coupling flange for wear and burrs.
- 5 Check the threads on the tail pinion.
- 6 Check the circlip grooves on the tail pinion.
- 7 Check all bearings for scoring, pitting, burrs, overheating etc.

The crown wheel and tail pinion are replaced as a set.

- 8 Assembly of pinion in housing
- 9 Fix the inner race of the spigot bearing on the tail pinion. Fit the circlip.

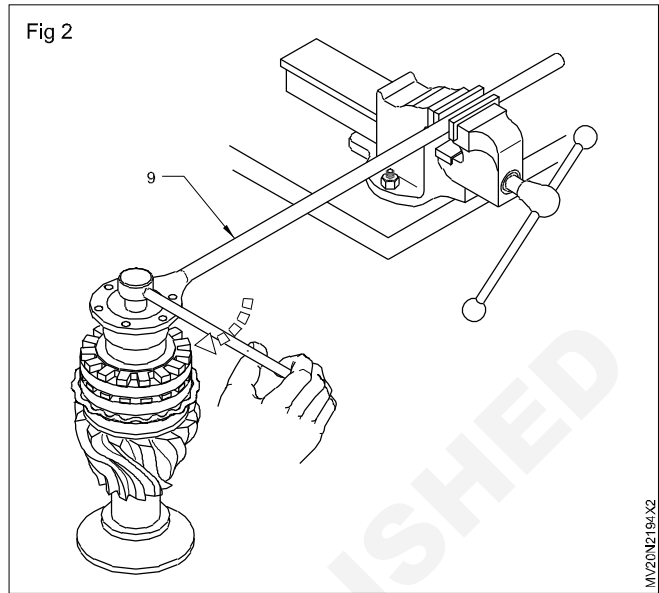
Ensure that the chamfered end of the inner race faces the pinion teeth.

- 10 Press the inner race of the inner taper bearing till it touches on the pinion teeth. Use a special tool (8). (Fig 1)

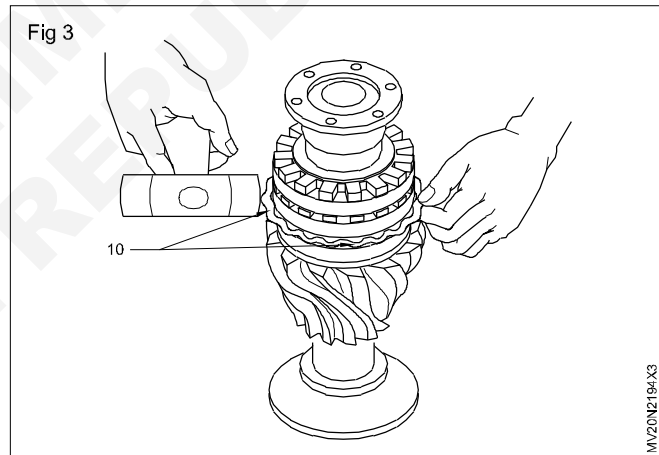


- 11 Slide the spacer washer on the tail pinion.
- 12 Place the outer race of the outer taper roller bearing on the tail pinion.
- 13 Fit the thrust washer on the outer bearing.
- 14 Place the threaded slotted ring, with a new oil seal, on the tail pinion.
- 15 Apply oil on the coupling splines. Press the coupling flange on the splines of the tail pinion.
- 16 Fix a new coupling nut on the tail pinion.

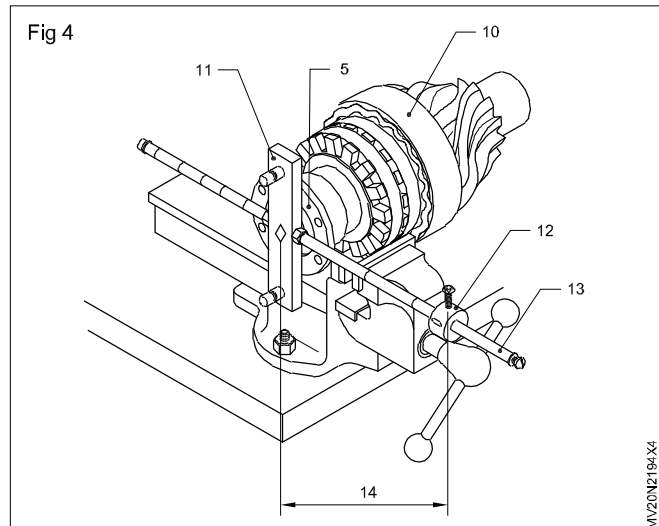
- 17 Fit the special tool (9) (Fig 2) on the coupling flange. Mount the tool on the vice. Tighten the coupling nut at the specified torque.



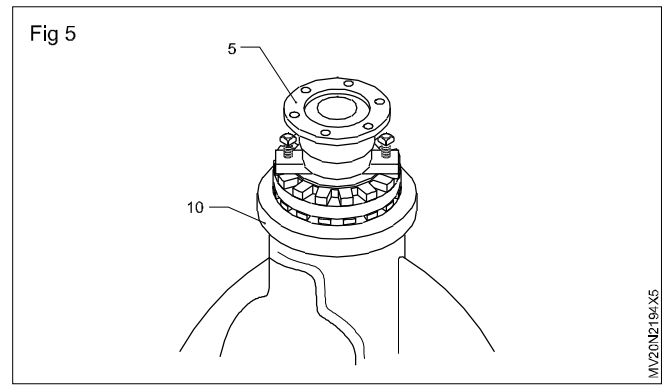
- 18 Fit split spacer rings (10) between the two outer races of the taper roller bearings. (Fig 3)



- 19 Fix a special tool (11) on the pinion flange to find out the pre-load. (Fig 4)

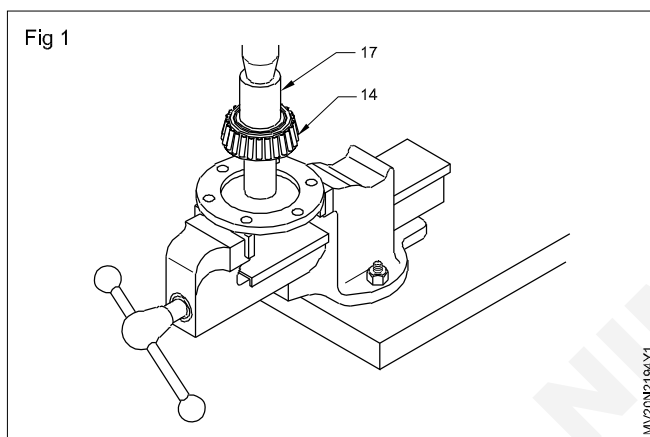


- 20 Move the weight (12) on the bar (13) away from the pinion (5).
- 21 Note down the minimum distance (14) between pinion (5) and weight (12) at which the pinion starts rotating. Multiply (14 & 12). It is the pre-load of the pinion bearings.
- 22 Compare this pre-load with the manufacturer's specification, if specified.
- 23 Select a spacer to obtain the specified pre-load. To increase the pre-load use a thicker spacer.
- 24 Fix the pinion assembly (5) in differential carrier (10). (Fig 5)

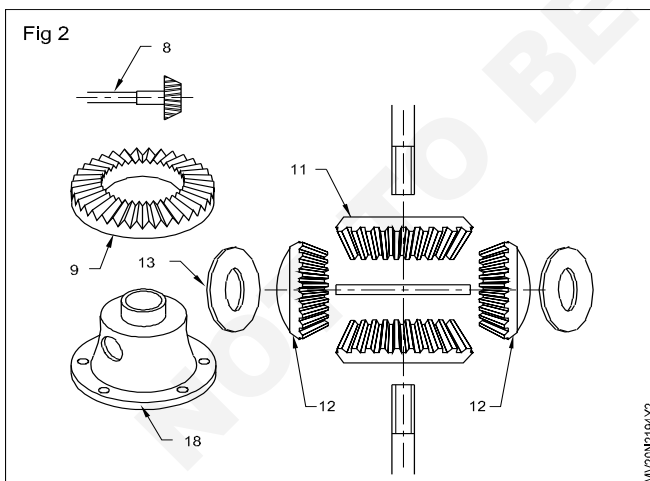


TASK 4: Assemble the differential assembly

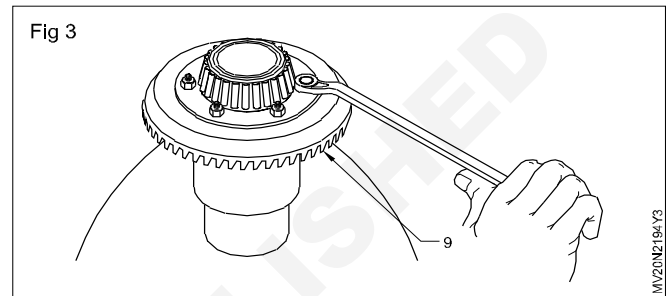
- 1 Fix the side bearings (14) into the differential case by using a special tool (17) i.e. differential side bearing installer. (Fig 1)



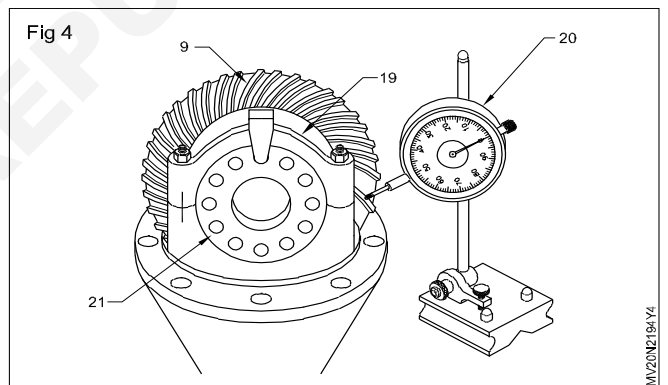
- 2 Assemble the side pinion (11) and the side gear (12) with the thrust washer (13) in the differential cage. (18) (Fig 2)



- 3 Fix a bevel or ring gear (9) on the differential case and tighten the bolts at the recommended torque. (Fig 3)
- 4 Keep the differential case assembly over the carrier case.
- 5 Place the two bearing caps (19) over the case. Align the mark (6).
- 6 Fix the dial gauge (20).



- 7 Fix the dial indicator needle on the crown wheel (9) (on the convex side of the bevel gear tooth).
- 8 Measure the backlash. (Fig 4)



To increase the backlash the crown wheel is to be moved away from the pinion. Loosen the left side adjusting check-nut (22) and tighten the pinion right side check-nut (21). Repeat this till the specified backlash is achieved.

- 10 Tighten the cap bolts at the specified torque.
- 11 Lock the adjusting nut (21 & 22) with the lock plate, if provided.
- 12 Check and set tooth contact between the crown and pinion. (Consult your instructor)
- 13 Fix the crown wheel study brass bolt, if provided.
- 14 Check the differential action by rotating one side wheel; the other side wheel should rotate in the reverse direction.
- 15 Fix packing on the differential assembly cover.
- 16 Fit the cover on the differential assembly.
- 17 Fill the recommended oil to the specified level.

Perform trouble shooting in transmission system

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

- rectify clutch slip
- rectify clutch binding
- rectify hard clutch
- rectify gear slip
- rectify noise in the clutch
- rectify noise in the gear box
- rectify noise in the propeller shaft & universal joint
- rectify rear axle noise.

Requirements			
Tools / Instruments		Materials	
• Trainee tool kit	- 1 Set	• Soap oil	- as reqd.
• Feeler gauge	- 1 Set	• Grease	- as reqd.
• Special tool	- as reqd.	• Kerosene	- as reqd.
• Circlip plier	- 1 No.	• Banian cloth	- as reqd.
Equipments / Machineries		• Cleaning tray	- as reqd.
• Heavy Vehicle	- 1 No.	• SAE- 90EP/140 oil	- as reqd.

PROCEDURE

TASK 1: Rectify clutch slip

Check the following

- | | |
|---|--|
| 1 Pedal free play - adjust if found too little. | 4 Pressure plate/flywheel face - reground / replace if face out was found excessive. |
| 2 Clutch finger - adjust if found wrongly adjusted. | 5 Pressure spring - replace if found weak. |
| 3 Clutch plate - reline if found worn out. | |

TASK 2: Rectify clutch binding

Check the following

- | | |
|--|---|
| 1 Linkages for bent - remove bent/replace if found bent. | 3 Pressure plate/flywheel - replace if found cracked. |
| 2 Pedal free play - adjust if found excessive. | 4 Clutch plate - replace if found cracked. |
| | 5 Clutch fingers - adjust if not adjusted correctly. |

TASK 3: Hard clutch

Check the following

- | | |
|---|---|
| 1 Linkages - remove bent/replace if found bent. | 2 Joints - lubricate if not lubricated. |
|---|---|

TASK 4: Gear slip

Check the following

- | | |
|---|---|
| 1 Gear lever, selector rod - adjust if not adjusted properly. | 3 Locking ball pin - replace if found worn out. |
| 2 Lock spring - replace if found weak. | |

TASK 5: Rectify the noise in the clutch

Sl.No.	Noise	Symptom	Causes	Remedies
1	Noise in the clutch assembly	Noise heard while engaging the clutch.	(1) Insufficient pedal play (2) Improper clutch lever adjustment (3) Seizure of thrust bearing and release levers (4) Broken or weak fork lever return spring (5) Excessive clearance in driven plate hub and clutch shaft splines (6) Dry or dirty clutch linkages	Adjust. Readjust. Rectify or replace. Replace. Replace. Clean & lubricate.
2	Noise in the clutch assembly	Continues to make noise but noise disappears when the clutch is disengaged. (Noise in the engaged position)	(1) Misalignment of engine & transmission (2) Friction disc torsion springs weak/broken (3) Friction disc hub & clutch shaft splines worn out (4) Weak or broken pressure springs (5) Weak or broken anti-rattle spring (6) Pilot bushing in flywheel worn out (7) Cracked pressure plate or flywheel (8) Fulcrum of release bearing holder damaged	Realign. Replace clutch disc. Replace. Replace. Replace. Replace. Replace. Replace.
3	Noise in the clutch assembly	Continuous noise in both driven plate hub engaged and disengaged positions.	(1) Worn splines on clutch shaft (2) Friction disc damper springs broken or weak (3) Misalignment of engine and transmission (4) Worn or dry clutch release bearing (5) Release levers not properly adjusted (6) Pilot bearing in crankshaft worn or dry (7) Retracting spring (in a diaphragm spring clutch) worn out (8) Loose release fork mounting (9) Release levers striking clutch cover	Replace. Replace. Realign. Replace. Readjust. Replace. Replace. Tighten. Rectify defect.

TASK 6: Noise in the gearbox

Sl.No.	Noise	Symptom	Causes	Remedies
1	Noise appearing in the gearbox neutral position	Noise is appearing in gear neutral position.	(1) Worn or dry clutch shaft bearing (spigot bearing). (2) Worn out gear teetes (3) Too much end play in countershaft or gears. (4) Worn out or dry countershaft bearings (5) Transmission misaligned with engine. (6) Too much backlash in driving gears (in between gear wheels). (7) Insufficient and wrong lubricant. type (8) Gear shifting forks rubbing in grooves.	Replace. Replace. Adjust. Replace. Realign. Replace. Change oil of recommended Adjust.

2	Noise appearing in the gearbox	Noise is appearing when gear is engaged. (Particular gear)	(1) Worn, chipped or broken gears. (2) Lack of lubricant. (3) Countershaft gear worn out or damaged. (4) Gear loose on main shaft.	Replace. Top up/flush & refill with correct grad of lubricant. Replace. Replace.
3	Noise appearing in the gearbox	Noise is appearing when gear is engaged. (Particular gear)	(1) Damaged/worn out synchroniser ring gear. (2) Counter gear/bearing worn out or damaged.	Replace. Replace.
4	Noise appearing in the gearbox	Noise in all gears.	(1) Transmission misaligned with engine case. (2) Speedometer drive gear damaged. (3) Input shaft bearings worn out or damaged. (4) Low oil level. (5) Main shaft rear bearing worn out/damaged or dry.	Realign. Replace. Replace. Top up. Replace.
5	Noise appearing in the gearbox	Noise while gear shifting.	(1) Clutch not disengaging (clutch pedal, free play excessive). (2) Idle speed excessive. (3) Shifter fork bent. (4) Gear shift linkage out of adjustment. (5) Idling speed of engine too high. (6) Incorrect lubricant. (7) Shaft splines & gear teeth worn out. (8) Inter-locking device linkage out of adjustment. (9) Shifter lock springs too strong.	Adjust. Adjust. Rectify. Adjust. Adjust. Replace. Replace. Readjust. Replace.

TASK 7: Rectify the Noise in the Propeller shaft & Universal joint

Sl.No.	Noise	Symptom	Causes	Remedies
1	Noise occurring in transmission drive line (Propeller shaft & universal joints)	Noise heard only in the initial movement of the vehicle. Noise heard when vehicle is running.	(1) Loose flanged yoke of universal joints (bolts are loose). (2) Worn out propeller shaft/slip joint splines due to lack of lubrication. (3) Worn or damaged universal joints. (4) Needles in the bearing short in numbers. (1) Loose or missing bolt at the centre bearing support. (2) Bent propeller shaft. (3) Centre joint bearing and support rubber pad damaged. (4) Shaft rubbing on parking brake cable. (5) Unbalanced propeller shaft. (6) Joint or shaft hitting the frame of vehicle. (7) Lack of lubricant in U joints, also in splines of propeller shaft & slip joints.	Tighten bolts. Replace & lubricate. Replace. Replace. Provide a new bolt & tighten. Replace shaft. Replace both. Position brake cable correctly. Replace. Use shims to lift up. Lubricate with grease.

2	Noise occurring in differential	Noise occurring in the rear wheels.	<ul style="list-style-type: none"> (1) Worn out/dry hub bearings. (2) Bent/twisted axle shaft. (3) Excessive axle end play. (4) Bent wheel. (5) Loose rear axle nut. (6) Lack of lubricant on axle bearings. (7) Loose wheel nuts. 	<ul style="list-style-type: none"> Replace or lubricate. Set right defect. Adjust. Replace. Re-tighten. Lubricate with grease. Re-tighten.
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TASK 8: Rectify the rear axle noise

Sl.No.	Noise	Symptom	Causes	Remedies
1	Noise occurring in the differential and rear axle unit	<p>Noise occurring when the vehicle is running straight ahead.</p> <p>Noises on turns.</p>	<ul style="list-style-type: none"> (1) Low oil level in differential. (2) Excessive backlash on crown wheel & pinion. (3) Worn out drive pinion & crown wheel. (4) Loose crown wheel bolts. (5) Worn out or damaged differential case bearings. (6) Worn out drive pinion bearing. (7) Improper drive pinion and crown wheel adjustment. (1) Pinions or sun gears damaged. (2) Pinions or sun gears loose. (3) Backlash between pinion & star gears excessive. (4) Axle shaft end play excessive. (5) Pinions binding on shaft. (6) Damaged surfaces between sun gear & differential case. (7) Worn out sun and star gears and thrust washers. (8) Slack or rough hub bearings. 	<ul style="list-style-type: none"> Fill up to level. Adjust. Change in pairs. Tighten. Replace. Replace. Readjust. Replace. Replace / adjust Reduce by adjustment. (Refer to the Manual) Adjust to correct clearance. Rectify. Replace. Replace. Replace.

Identify automatic transmission components

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

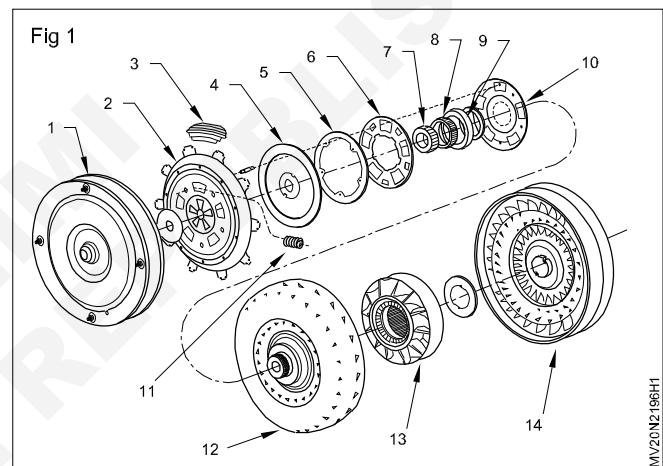
- identify the various parts of automatic transmission.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Tray	- 1 No.
• Ring spanner set	- 1 Set	• Banion cloth	- as reqd.
• Socket spanner set	- 1 Set	• Transmission fluid	- as reqd.
Equipments/ Machineries			
• Vehicle with automatic transmission	- 1 No.		

PROCEDURE

Identify the various parts of an automatic transmission system as shown in Fig 1

- 1 Cover assembly
- 2 Clutch transfer ring
- 3 Shoe assembly
- 4 Washer
- 5 Pressure plate
- 6 Plate
- 7 Inner race
- 8 Roller assembly one way
- 9 Drive hub
- 10 End cover
- 11 Spring
- 12 Turbine assembly
- 13 Reactor and clutch assembly
- 14 Impeller assembly



Check the fluid level and replace the filter in automatic transmission

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

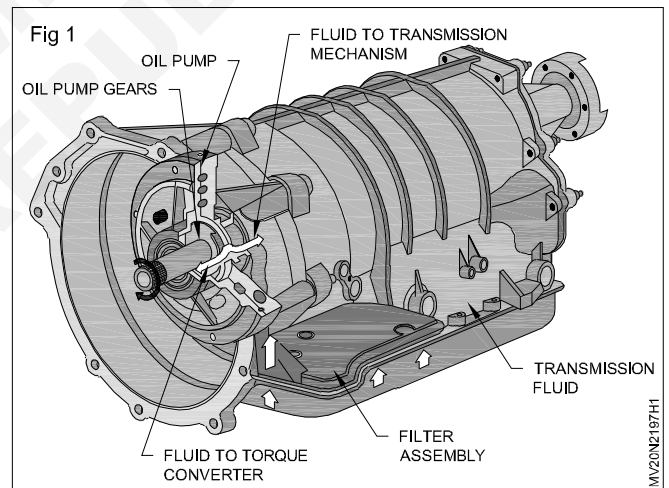
- check the transmission fluid
- remove the old fluid and filter
- fill the new fluid and filter.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Filter	- 1 No.
• Box spanner set	- 1 Set	• Tray	- 1 No.
• Measurer	- 1 No.	• Banian cloth	- as reqd.
Equipments / Machineries			
• Vehicle	- 1 No.		
• Hydraulic jack / ramp	- 1 No.		

PROCEDURE

TASK 1: Remove the old fluid and filter

- 1 Start the engine and get the engine as warm as required
- 2 Stop the engine and after a while check the level of oil
- 3 Use the jack to lift the vehicle or park the vehicle in the ramp. Also we can use the two post hoist to lift the vehicle
- 4 Drain the old oil by loosening the drain plug.
- 5 If the oil pan doesn't have the drain plug, then remove the bolts from the oil sump one by one.
- 6 Slowly drain the old oil.
- 7 Remove the oil filter (Fig 1) by rotating in the counter clockwise or removing the clips or 'O' rings depend upon the model.



TASK 2: Fill the new fluid and filter

- | | |
|--|--|
| <ol style="list-style-type: none"> 1 Fix the drain plug in it's place 2 Fix the oil sump with gaskets and ensure its sealing 3 Measure the oil as recommended by the manufacturer. 4 Pour the oil 5 Measure using dip sticks. | <ol style="list-style-type: none"> 6 Take the new filter 7 Fit it in its position 8 Crank the engine observe it for the leakage. 9 Stop the engine. 10 Start and warm up for few minutes. 11 Again check the oil level. If satisfactory run the vehicle. |
|--|--|

Adjust manual gear shift linkage

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

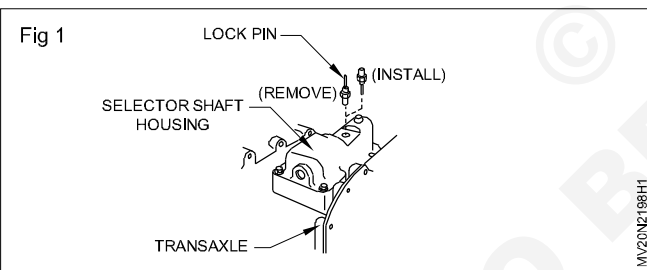
- remove the gear shift mechanism
- adjust the shift linkage and test the gear shift mechanism
- test the throttle position and speed sensors
- test the transmission wiring harness
- Inspect the gear shift lever switch.

Requirements		
Tools / Instruments		Equipments / Machineries
<ul style="list-style-type: none"> • Trainees tool kit • Box spanner set • Allen key set • Torque wrench • Multi meter • 1.5 V, 12 V Battery 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 Set - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Light motor vehicle <p>Materials</p> <ul style="list-style-type: none"> • Tray • Lubricant • Banian cloth
		<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No.

PROCEDURE

TASK 1: Remove the gear shift mechanism

- 1 Park the vehicle in a plain surface
- 2 Choke the vehicle with wooden blocks
- 3 Remove the lock pin from the trans axle selector housing Fig 1

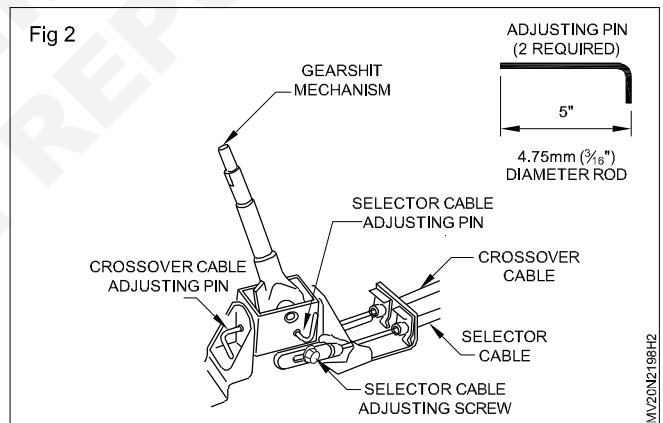


- 4 Reverse the lock pin and install it to lock the 1-2 shift fork shaft in the neutral position.
- 5 Remove the gear shift knob and cover.

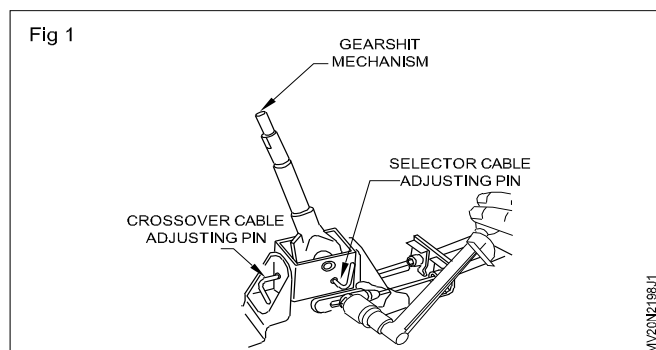
TASK 2: Adjust the shift linkage

- 1 Install the allen key to lock the gear shift rod in a required position.
- 2 Loosen the selector cable adjusting bolt and adjust the cable for the required position then tighten the bolt with torque wrench (Fig 1)
- 3 Remove the allen key from the slot after adjusting
- 4 Fix the gear shifting lever and refix the lock pin in the original position.
- 5 Fix the cover and knob
- 6 Go for the test drive and confirm problem fixed.

- 6 Loosen the selector cable and cross cover cable adjusting bolt with the help of torque wrench. (Fig 2)



The adjustment procedure slightly vary from vehicle to vehicle and model to model.

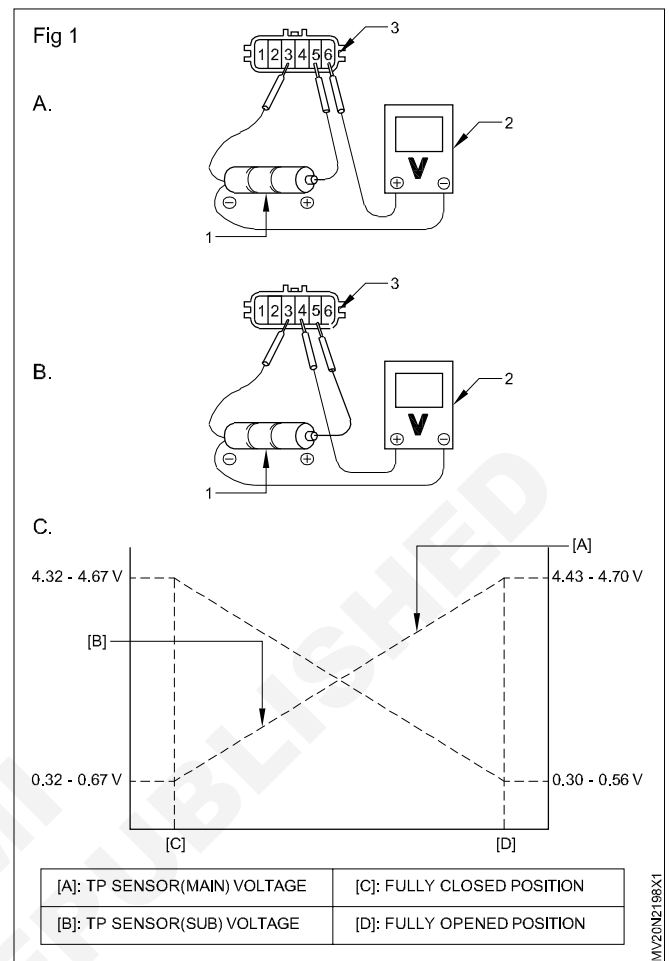


TASK 3: Throttle position sensor check

- 1 Remove the air cleaner assembly
- 2 Turn off the ignition switch
- 3 Disconnect the connector from electric throttle body
- 4 Check the TP sensor main and sub output voltage as follows
- 5 Arrange 3 new 1.5 voltage
- 6 Connect the voltmeter (2) and battery (1) to TP sensor(3) as shown in Fig 1 (A & B).
- 7 Check the voltage linearly varies depending on throttle opening angle as shown in the Fig.1(C) while throttle valve is opened and closed by finger.
- 8 If no reading shown or ready varies abruptly sensor has to be changed.

While testing the following condition to be satisfied.

- 1 Ambient temperature should not exceed 5°C.
- 2 Accelerator pedal should be in idle position, throttle fully closed condition.



TASK 4: Vehicle speed sensor (VSS) check

Visual check

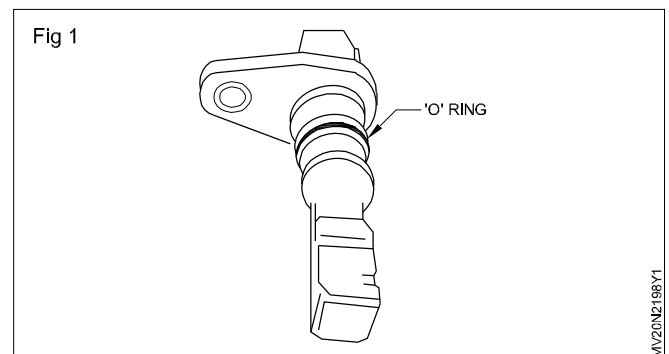
- 1 Check the 'O' ring is free from damage
- 2 Check that end face of sensor and signal rotor tooth are free from any metal particles and damage.

Performance check

- 1 Remove the metal particles at the end face if any
- 2 Arrange 12V battery (1) and connect its positive terminal to Voltage IN terminal (2) and negative terminal to Ground terminal (3) of the sensor. Then using Ohm meter measure resistance between Voltage Out terminal (4) of sensor and negative terminal of battery by passing magnetic substance (iron) (5) while keeping approximately 1mm gap with respect to end face of VSS.
- 3 If resistance does not vary as specified below replace the VSS.

VSS (Vehicle Speed Sensor) inspection (Non-ABS Model)

Visual check (Fig 1)



- Check that O-ring is free from damage.
- Check that end face of sensor and signal rotor tooth are free from any metal particles and damage.

Vss resistance

Resistance varies from less than 100Ω (ON) to infinity (OFF) or from infinity (OFF) to less than 100Ω (ON).

TASK 5: Automatic transmission wiring harness coupler

- 1 Check the wiring harness coupler continuity with multi meter.
- 2 Check, coupling points and automatic transmission control solenoid.
- 3 Check the following transmission wire harness connectivity functional part.

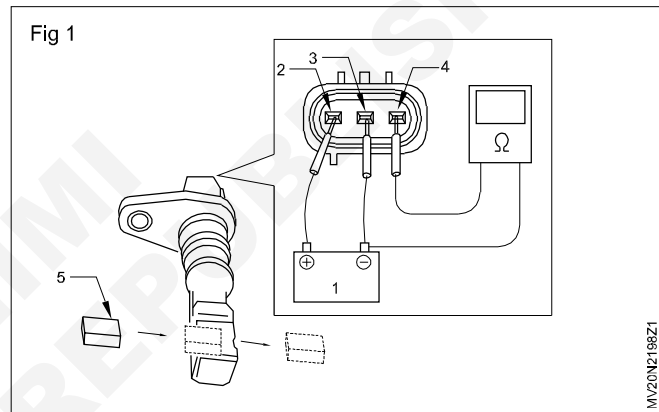
Automatic transmission safety switch

- Automatic transmission safety switch gear selector switch.
- Automatic transmission safety switch kick down solenoid.
- Automatic transmission safety switch speed sensor.

- Automatic transmission safety switch E H gear box switch.
- Automatic transmission safety switch gear position sensor.
- Automatic transmission safety natural safety switch.
- Automatic transmission safety over drive kick down switch.
- Automatic transmission safety control solenoid module.
- Automatic transmission safety position selector switch.
- Automatic transmission safety pulse generator senior.

TASK 6: Inspection of gear shift lever switch. (Fig 1)

- Check the position of power change mode lever for damage.
- Check gear shift lever sensors wire connection.
- Check gear lever movements in manual operation position.
- Change lever position to automatic transmission and check the automatic speed of the vehicle.
- Check panel board light signal of gear position.



Remove and refit the drop arm

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

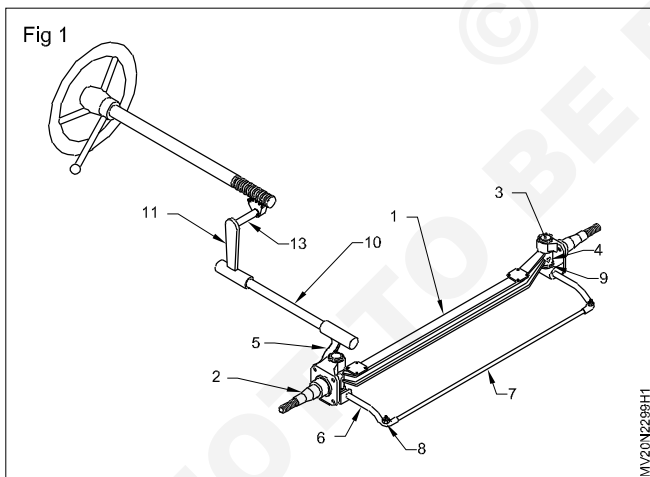
- remove the drop arm
- check and adjust the turning angle
- align the drop arm.

Requirements			
Tools / Instruments		Equipments / Machineries	
• Trainees tool kit	- 1 No.	• Vehicle	- 1 No.
• Wooden block	- 1 Pair	Materials	
• Bearing puller	- 1 No.	• Grease	- as reqd.
• jack	- 1 No.	• Kerosene	- as reqd.
• Grease gun	- 1 No.	• Banian cloth	- as reqd.
• Stand	- as reqd.		

PROCEDURE

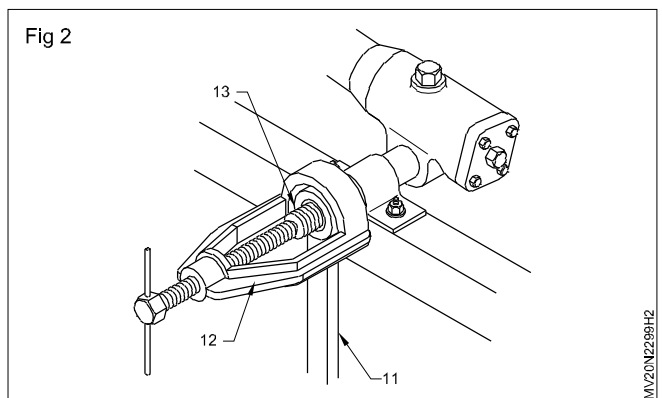
TASK 1: Remove the drop arm

- 1 Chock the rear wheels.
- 2 Jack up the vehicle and place horse stand under the front axle.
- 3 Remove the front wheels.
- 4 Remove the split pin and loosen the nut of the steering arm (6) at both the ends. (Fig 1)



- 5 Give support underneath the steering arm.
- 6 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).

- 7 Loosen the drag link (10) nut connected to the steering arm (5) and remove the same.
- 8 Loosen the drag link (10) nut from the 'drop arm' (11) on the lower side and take out the drag link (10).
- 9 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).
- 10 Remove the drop arm's (11) nut on the top. (Fig 2)
- 11 Pull out the drop arm (11) from the steering rocker shaft (13). Use a special puller (12).



TASK 2: Check and adjust the turning angle

- 1 Clean all the parts in kerosene.
- 2 Check visually all the parts for wear. Replace, if found worn out.

TASK 3: Align the drop arm

- 1 Bring both the front wheel brake drums in straight ahead and parallel position.
- 2 Turn the steering wheel on one side lock.
- 3 Turn the steering wheel to the opposite side lock and count the total number of revolutions.
- 4 Turn the steering wheel half of that number.
- 5 Align the mark of the drop arm (11) and rocker shaft of the steering box and fix the drop arm on the rocker shaft.
- 6 Tighten the drop arm's (11) lock nut.
- 7 Connect the drop arm (11) and drag link (10). Ensure the steering wheel does not rotate while connecting the drop arm and drag link.
- 8 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).
- 9 Connect tie rod's (7) ends to both the steering arms (6).
- 10 Lubricate all the parts with the recommended grease and tighten all ball pin nuts at the recommended torque and replace with new split pins.
- 11 Fix the wheels and tighten the wheel nuts.
- 12 Check the wheel movement and turning angle by rotating the steering wheel.
- 13 Jackup the vehicle and the toe - in and toe - out on turn check if necessary adjust it.
- 14 Release the jack and tighten the wheel nuts.

Remove the steering wheel and gear box

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

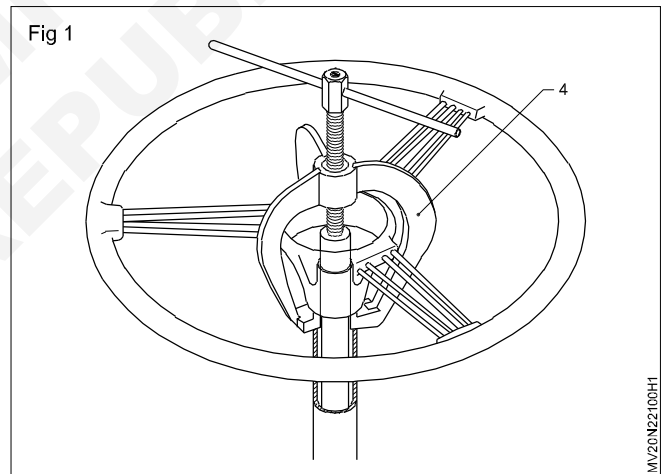
- remove the steering wheel
- remove the steering box from the vehicle.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 Set	• Gasket	- as reqd.
• Puller (steering)	- 1 No.	• Gear oil	- as reqd.
• Puller (bearing)	- 1 No.	• Kerosene	- as reqd.
• Plastic hammer	- 1 No.	• Oil seal	- as reqd.
• Torque wrench	- 1 No.	• Bush	- as reqd.
Equipments / Machineries			
• Vehicle	- 1 No.		

PROCEDURE

TASK 1: Remove the steering wheel

- 1 Disconnect the battery.
- 2 Chock the wheels.
- 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 (4). (Fig 1)



TASK 2: Remove the steering gear box

- | | |
|--|--|
| <ol style="list-style-type: none"> 1 Remove the instrument panel bracket. 2 Remove the exhaust pipe from the manifold. 3 Remove the steering column cover plate on the floor board. 4 Note the position of the steering gearbox and make a mark on the frame and steering gearbox. | <ol style="list-style-type: none"> 5 Remove the steering gearbox mounting bolts and bracket. 6 Remove the steering gearbox and take it out through the bottom side. 7 Place the steering assembly on the workbench. |
|--|--|

Overhaul the steering gearbox and adjust the steering angle

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

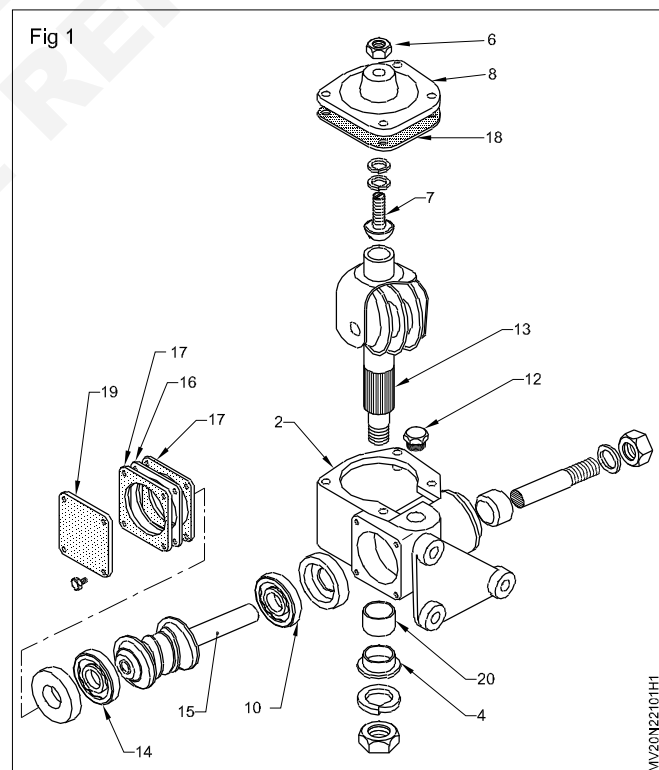
- **dismantle the steering gearbox**
- **inspect the parts of the steering gearbox**
- **assemble the steering gearbox**
- **adjust the backlash in the steering gearbox and pre - load in the steering gearbox**
- **fit the steering box on the vehicle and fit the steering wheel.**
- **check toe - in / toe - out**
- **check the camber angle**
- **check the caster and king pin inclination.**

Requirements		
Tools / Instruments		Materials
• Trainees tool kit	- 1 Set	• Gasket - as reqd.
• Plastic hammer	- 1 No.	• Gear oil - as reqd.
• Torque wrench	- 1 No.	• Kerosene - as reqd.
• Dial indicator	- 1 No.	• Oil seal - as reqd.
Equipments / Machineries		• Bush - as reqd.
• Vehicle	- 1 No.	
• Wheel alignment gauge	- 1 Set	

PROCEDURE

TASK 1: Dismantle the steering gear box (Fig 1)

- 1 Drain the steering gear box oil by removing the drain plug.
- 2 Remove the oil filter plug (12).
- 3 Loosen the lock nut (6) of the adjusting screw (7) by one or two threads.
- 4 Remove the side cover (8).
- 5 Remove the side cover packing (18).
- 6 Remove the roller shaft (13) from the assembly.
- 7 Remove the outer column upper cover with the shims.
- 8 Remove the upper side bearing (10) from the housing (2).
- 9 Remove the bottom end cover (19) with the shims (16) and packing (17).
- 10 Remove the lower bearing (14) from the housing (2).
- 11 Remove the horn wire tube.
- 12 Remove the (inner column) worm gear shaft assembly (15).
- 13 Remove the side oil seal (4).



TASK 2: Cleaning and inspection

- 1 Clean all the parts with kerosene oil.
- 2 Inspect visually the following parts.
 - Bearings for pitting and overheating.
 - Rocker shaft and inner column for pitting/wear.
 - 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 3: 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 4: Adjust the backlash and preload (Fig 1)

- 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).
- 2 Insert the rocker shaft (13) in the housing.
- 3 Place the side cover gasket (18).
- 4 Place the side cover (8).
- 5 Tighten the side cover screws at the specified torque.
- 6 Fix the lower ball bearing in the housing (2).
- 7 Place the bottom cover gasket and shims.
- 8 Place the bottom cover and tighten the bottom cover screws.
- 9 Fix the adjusting screw (7).
- 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.
- 11 Fix the outer column on the steering housing (2).

TASK 5: Fit the steering box and steering wheel (Fig 1)

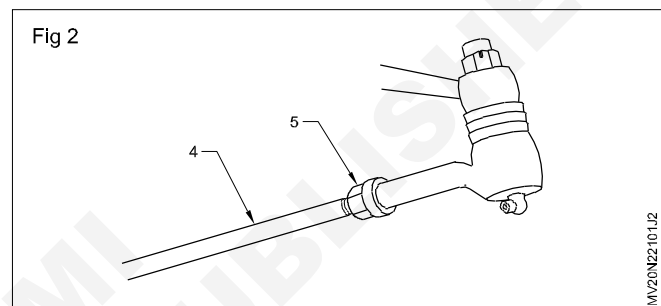
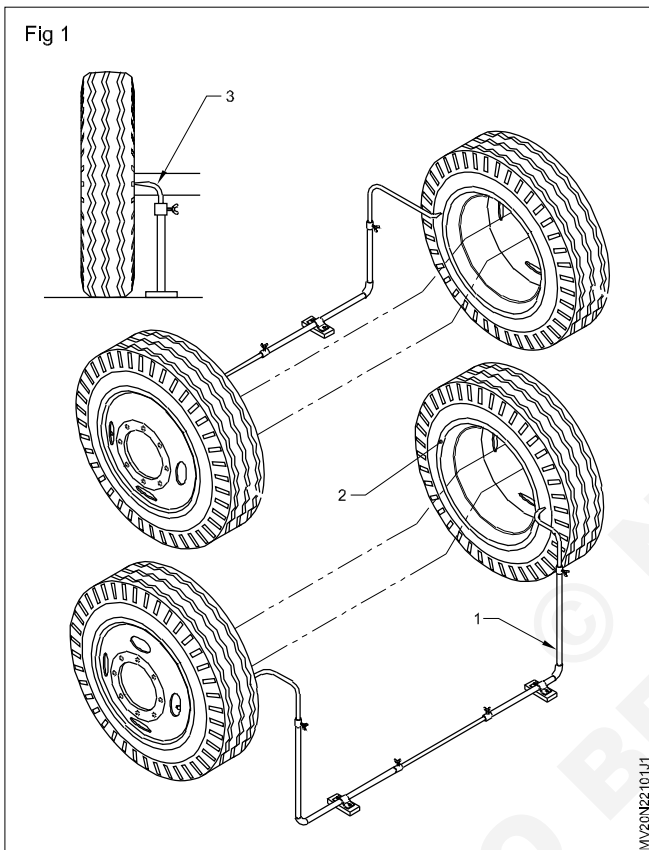
- 1 Insert the steering assembly from the bottom side of the vehicle.
- 2 Align the steering assembly position with the frame and tighten the mounting bolts at the specified torque.
- 3 Place the oil seal in between the steering housing (2) and drop arm (11).
- 4 Align the drop arm (11) and rocker shaft (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 6: Check toe in / toe out (Figs 1 & 2)

- 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 Chock 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 1)

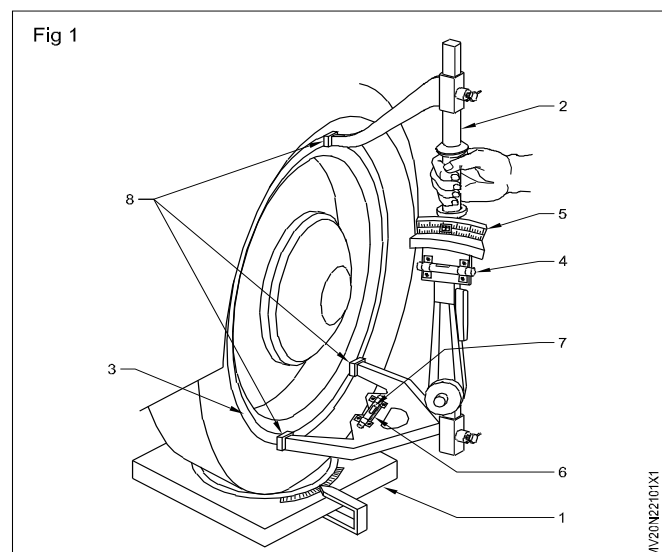
- 14 Place the toe - in gauge (1) in front of the front wheels and adjust the height of the pointer to the centre of the wheels, on both the sides, reading at zero. Mark with chalk on the wheel's rim (2) where the gauge's pointers touch and remove the toe in gauge.
- 15 Move the vehicle forward so that 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).



- 19 Repeat the procedure till the recommended toe - in is set
- 20 Tighten the clamp nuts (5) of the tie rod sockets.

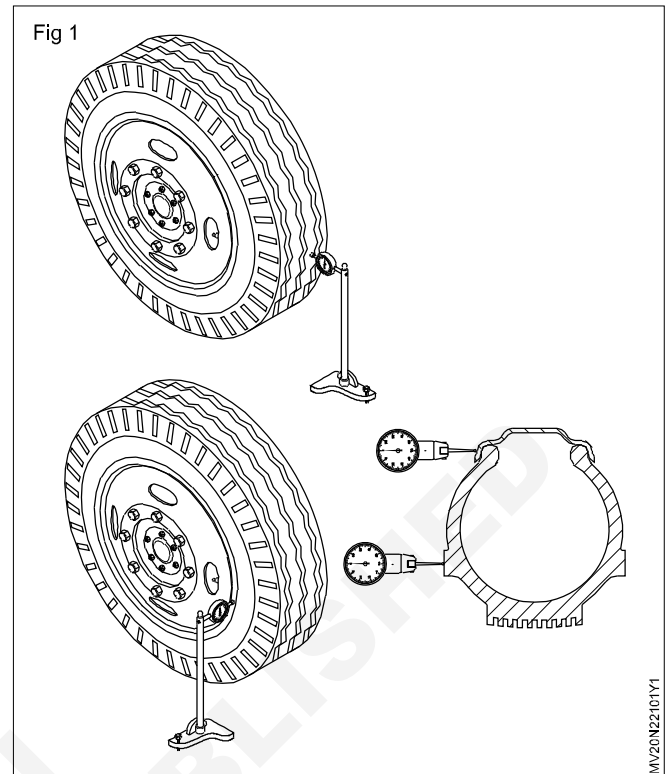
TASK 7: Check camber (Fig 1)

- 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: 8 Castor and king pin inclination (Fig 1)

- 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 1.
- 13 If the rim is found with a bend add some weight (lead piece) on the opposite direction.



Check and top - up power steering fluid

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

- check power steering fluid level and its condition
- Top - up fluid level in power steering system.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 Set	• Cotton clothes	- as reqd.
Equipments / Machineries		• 5w oil	- as reqd.
• Vehicle with power steering	- 1 No.	• Hose	- 2 Nos.

PROCEDURE

TASK 1: Checking steering fluid level

- 1 Make sure the engine is turn off and cool
- 2 Locate the power steering reservoir and bleed valve
- 3 Remove the cap and observe the fluid level most power steering reservoir are made of clear plastic and the cap doses not have to be removed to observe the fluid level.
- 4 Check the fluid condition, if need replace the fluid
- 5 If the fluid level is very low, find the cause for loss of fluid in power steering system.
- 6 If found any part damaged or worn out, replace the defective part
- 7 Top up the fluid in power steering reservoir up to level mark
- 8 If need, bleed the power steering system by operating steering wheel (lock to lock)
- 9 Ensure the proper action of power steering system.

Perform pressure testing and flushing of power steering

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

- **power steering fluid pressure test**
- **fluid flushing a power steering system**
- **fill and bleed the power steering fluid system**
- **adjust the drive belt.**

Requirements		
Tool / Instruments		Materials
• Trainees tool kit	- 1 No.	• Hydraulic oil
• Pressure gauge	- 1 No.	• cotton waste
Equipments / Machineries		• Soap oil
• Power steering vehicle	- 1 No.	• Power steering hose
		- as reqd.
		- as reqd.
		- as reqd.
		- as reqd.

PROCEDURE

TASK :1 Pressure testing

- | | |
|---|---|
| <ol style="list-style-type: none"> 1 Check the power steering fluid level 2 Check the power steering pump drive belt adjust if necessary. 3 Start the engine and listen for noises from the power steering system. 4 Attach a power steering gauge to the pump. | <ol style="list-style-type: none"> 5 Fill and bleed the power steering system. 6 Start the engine and observe pressure gauge reading at high pressure line, pump, control valve and relief valve. 7 When the engine running turn the steering left and right observe pressure gauge reading. 8 When the engine running close the pressure gauge valve and observe pressure reading. |
|---|---|

TASK2: Flush system

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Place a pan under the power steering reservoir 2 Remove the return hose fitting at the reservoir and allow fluid to flow from the reservoir and the return hose into the pan. 3 Plug the return port and fill the fluid to the reservoir. | <ol style="list-style-type: none"> 4 Start the engine and allow the fluid to drain from the return hose into the pan. 5 Add clear fluid to the reservoir as the old fluid drains. 6 Start the engine and allow the fluid to flow from the return hose into the pan. |
|---|--|

TASK 3: Filling and bleeding

- | | |
|--|--|
| <ol style="list-style-type: none"> 1 Make sure the engine is turn off and cool. 2 Remove the power steering reservoir cap and check the fluid level. 3 Add fluid as needed to fill it - up 4 Replace the cap. 5 Locate the power steering bleed valve on the steering box | <ol style="list-style-type: none"> 6 If steering the car becoming nosier and more difficult 7 Open the bleed valve and turn the steering wheel several times lock to lock close one bleed valve (top) 8. Ensure there is no air in power steering fluid line. |
|--|--|

The problem be an air pocket - that trapped in the power steering pump

Check the power steering fluid level before driving.

Check and adjust an engine drive belt

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

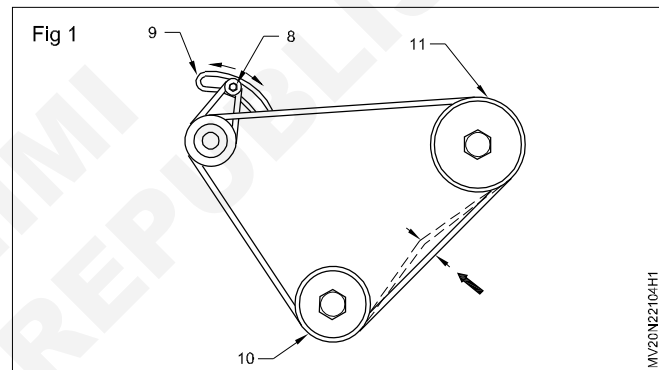
- inspect the engine drive belt
- adjust the engine drive belt.

Requirements			
Tool / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Engine drive belt	- 1 No.
Equipments / Machineries		• cotton waste	- as reqd.
• Heavy vehicle	- 1 No.	• Soap oil	- as reqd.

PROCEDURE

TASK 1: Inspecting and adjusting the engine drive belt

- 1 Visually check the engine drive belt for excessive wear and cracks
- 2 If found wear or cracks in engine drive belt, replace it
- 3 Apply thumb pressure on the fan belt at the centre between the damper and water pump pulleys (10 & 11). the belt should depress by 12 to 18 mm (Fig 1).
- 4 Disconnect the battery negative terminal. Loosen the mounting bolts of an alternator or dynamo.
- 5 Loosen the nuts (8) at the link bracket (9).
- 6 Push the alternator / dynamo away from the engine with a suitable lever until the correct tension is obtained. tighten the bolts and nuts.



- 7 Recheck the belt tension.
- 8 Refit the battery cable.

Perform servicing of electronic power steering system

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

- locate the EPS wiring circuit
- read the EPS wiring circuit
- trouble shoot the EPS.

Requirements	
Tools / Instruments	Materials
<ul style="list-style-type: none"> • Trainees tool kit -1 No. • Working model of EPS/Vehicle with EPS -1 Set • Scan tool -1 No. • Multimeter -1 No. 	<ul style="list-style-type: none"> • Power steering oil - as reqd. • Cotton waste - as reqd. • soap oil - as reqd. • wire - as reqd.
Equipments / Machineries	
<ul style="list-style-type: none"> • Vehicle with power steering -1 No. 	

PROCEDURE

TASK 1: Locate the EPS wiring circuit

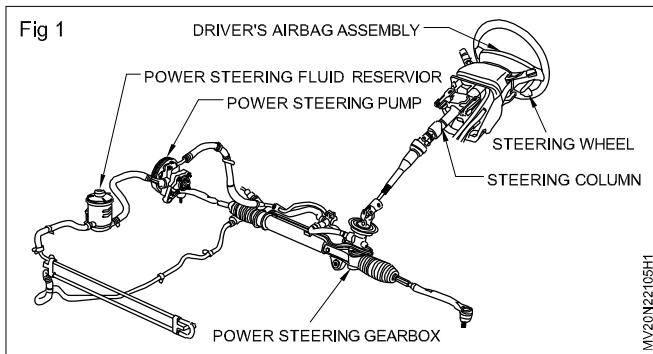
- | | |
|---|---|
| <ol style="list-style-type: none"> 1 Identify the electronic power steering (EPS) components. (Fig 1) 2 Read the wiring. 3 Check the power steering oil level and top up if required. 4 Switch on ignition. 5 Inspect visually EPS warning light lights up. If light does not light up, check warning light circuit as per service manual. 6 Start the engine and check the EPS warning light goes off. If it remains on after starting check the warning light circuit as per service manual procedure. 7 Check the steering function and note down the problem such as hard steering, vehicle pulling to one side poor self centering, excessive steering play, abnormal noise in steering gear box. 8 Turn ignition switch to off position. 9 Connect scan tool with data link connector (DLC) 10 Start engine. 11 Read the diagnostic trouble code (DTC) displayed in the scanner. 12 Turn ignition switch to off condition and remove the scan tool. 13 Troubleshoot the diagnostic trouble code recorded in the ECM. | <ul style="list-style-type: none"> - Checking of sensor - Checking of switches, wiring harness control modules and other parts <ol style="list-style-type: none"> 14 Repair and replace the defective parts as per service manual procedure 15 Switch on start the engine and recheck the EPS for proper functioning. 16 Turn the ignition switch to off position. 17 Connect the scanner to DLC. 18 Turn ignition switch ON position. 19 Erase DTC recorded on the scanner tool. 20 Turn ignition switch off position after erasing the DTC. 21 Remove scan tool. 22 Vehicle speed sensor (1) itself can be checked on its resistance by disconnecting connector. |
|---|---|

Note

- 1 **Function of vehicle speed sensor can be checked by measuring generated pulse as voltage.**
- 2 **For its measurement, use an analog type voltmeter while spinning wheels on lift and with selector lever in D position.**

Vehicle speed sensor (USS) specifications

- Coil resistance - 100-300Ω
- Output voltage at 40km/h



TASK 2: Trouble shoot the EPS

Step	Action	Yes	No
1	1 Disconnect vss coupler with ignition switch off.	Go to Step 2	Replace the (VSS) Vehicle speed sensor
2	2 Check for proper connection to VSS 'or' and "Br/W" wire terminals.		
	3 If OK, then check resistance of VSS. Resistance between terminals: 100-300Ω Resistance between terminal and transmission body: 1MΩ or more are check results satisfactory.	"OR" or "Br/W" wire open or shorted to ground or poor E02-4 or E02-12 connection. If wire and connection are OK, Intermittent trouble or fault PCM. Recheck referring to intermittent trouble on section OA	Clean, repair or replace
2	Check visually VSS and counter shaft gear for the following No damage No foreign material attached Correct installation Are they in good condition?		

Perform servicing wheel bearing

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

- removing the front wheel bearings
- cleaning and inspect the bearings
- assembling and set front wheel bearing play.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Jack	- 1 No.	• Grease	- as reqd.
• Wood blank	- 2 Nos.	• Kerosene	- as reqd.
• Wheel spanner	- 1 No.	• Oil	- as reqd.
• Hammer	- 1 No.	• Split pin	- as reqd.
• Bearing puller	- 1 No.	• Washer	- as reqd.
Equipments / Machineries		• Tapper roller bearing	- as reqd.
• Vehicle running condition	- 1 No.		

PROCEDURE

TASK 1: Removing front wheel

- | | |
|--|---|
| 1 Chock the wheels | 7 Remove the cotter key from the spindle nut. |
| 2 Jack up the frame | 8 Remove the spindle nut and washer |
| 3 Support the frame by screw jack | 9 Remove the hub assembly |
| 4 Remove the wheel from the vehicle | 10 Remove the outer bearing from the hub. |
| 5 In disc brake system remove the brake caliper | 11 Remove the oil seal from the inner hub and discard it. |
| 6 Remove the rotor if it is integral with the hub. | 12 Remove the inner bearing from the hub. |

TASK 2: Cleaning and inspect

- | | |
|--|---|
| 1 Clean the bearing thoroughly | 4 Check the race for wear and damage |
| 2 Inspect the bearing for wear or damage | 5 If any damage in the inner and outer race it should be changed. |
| 3 Clean the bearing outer race and hub interior. | |

TASK 3: Assembling and set wheel bearing play

- | | |
|--|--|
| 1 Pack a small amount of grease in the hub cavity | 6 Install outer bearing |
| 2 Grease the bearings by hand | 7 Install the washer and spindle nut |
| 3 Place the inner bearing in the hub and install the new oil seal. | 8 Adjust bearing / play as per specification |
| 4 Clean the spindle. | 9 Install a new cotter pin |
| 5 Re-install the hub on the spindle | 10 Re-install the rotor |
| | 11 Re-install the caliper |
| | 12 Re-install the wheel |
| | 13 Rotate the wheel and check the wheel bearing free rotation. |

Perform trouble shooting of hydraulic power steering system

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

- rectify abnormal wear of tyre
- rectify wheel wobbling
- rectify poor self cantering
- rectify hard steering
- rectify vehicle pulling to one side.

Trouble Shooting

Fault	Cause	Remedy
Abnormal wear of tyre	Low air pressure improper Toe-in toe out Wheel Bearing worn out king pin Bush worn out, tie rod play Brake binding unbalanced Suspension	Maintain proper air pressure Adjust tol in, Toe out Replace the bearing Replace the bush Adjust brake properly replace damaged suspension parts
Wheel wobbling	Loose wheel nut Wheel bearing worn out King pin worn out Improper air pressure Tie rod loose fitting	Tighten the nut Replace the bearing Replace the king pin Maintain proper air pressure Tighten the fittings
Poor self cantering	Improper linkage adjustment Improper tyre pressure Improper wheel alignment Excess steering wheel pre load improper position of drop arm	Adjust steering linkage Maintain the tyre pressure Adjust wheel alignment Adjust the pre load Remove and refit in proper position
Hard Steering	Low tyre pressure Improper tyre size Dry king pin bearing Axle bearm bend	Maintain proper air pressure Use correct size tyre Lubricate the bearing straighten or replace
Vehicle pulling to one side	One side low tyre pressure Improper size of tyre Improper brake adjustment Front road spring centre bolt broken Disturbed front wheel alignment	Maintain correct are pressure Replace the tyre Adjust brake Replace the centre bolt Adjust as prescribed

Check the chassis frame for bends, twists and cracks

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

- inspect the chassis frame visually
- check the chassis frame for bent twists and cracks.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Plump bob	- 1 No.	• Chalk	- as reqd.
Equipments / Machineries			
• Heavy vehicle	- 1 No.		

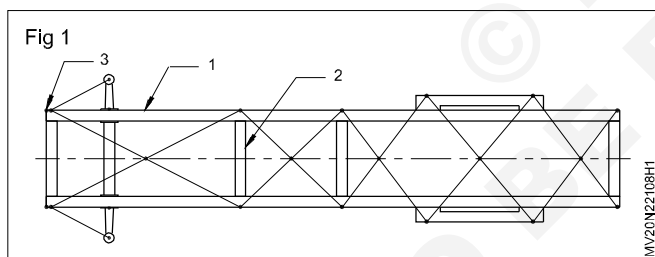
PROCEDURE

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 bent and twists

- 1 Mark a diagram on the floor levelled 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 bent 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 uniform height horse support and coincide the same with the floor diagram.
- 6 Make a number of plumb bob point (3) marks, where the plumb bob 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 then the frame has sagging. Send it for repair.
- 11 Inspect the rivets of the frame by hitting with a ball peen 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.



Crack repair is special welding technique and done by specialist.

Overhaul front and rear suspension system

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

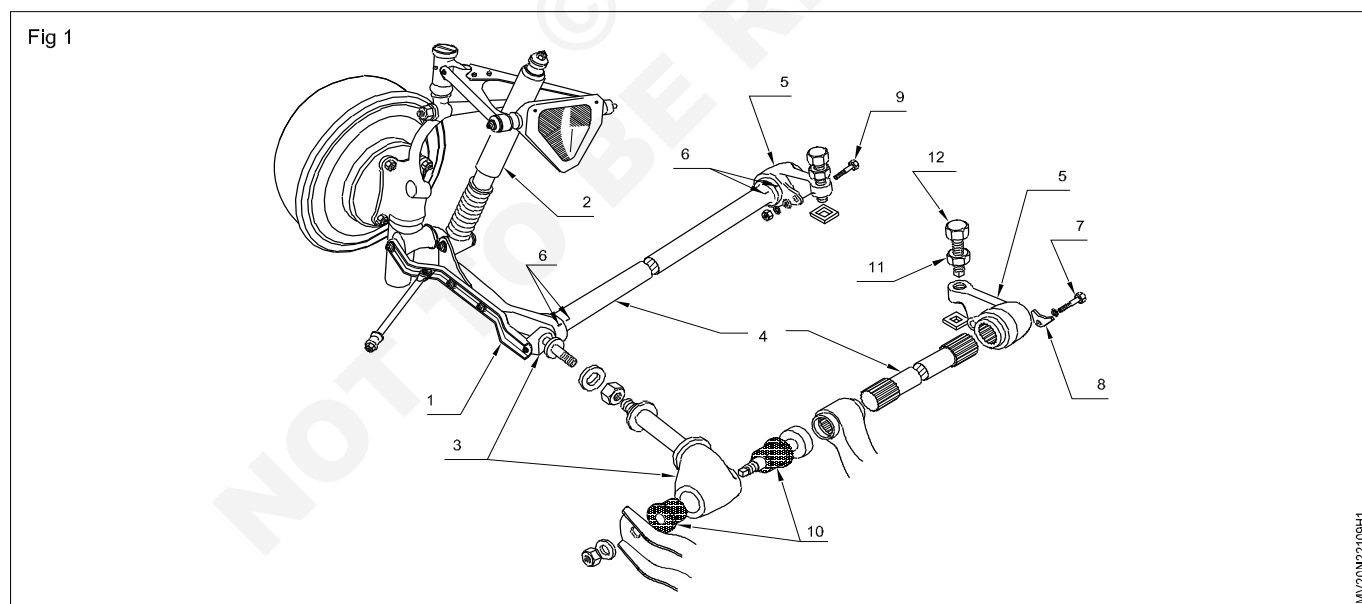
- remove and dismantle the components of the torsion bar
- assemble the torsion bar and fit the torsion bar on the vehicle
- remove the coil spring
- assemble the coil spring and fit on the vehicle
- overhauling shackle
- overhauling leaf spring.

Requirements			
Tools / Instruments		• Vehicle	- 1 No.
• Trainees tool kit	- 1 No.	Materials	
• Jack	- 1 No.	• Cotton waste	- as reqd.
• Drift	- 1 No.	• Grease	- as reqd.
• Hammer (sludge)	- 1 No.	• Oil	- as reqd.
Equipments / Machineries		• Bushes rubber	- as reqd.
• Spring tensioner	- 1 No.	• Leaf spring	- as reqd.
		• shackle	- as reqd.

PROCEDURE

TASK 1: Overhauling of torsion bar suspension

- 1 Park the vehicle on smooth level ground.
- 2 Chock the rear wheels.
- 3 Jack up the front wheels and place horses below the frame
- 4 Remove the split pin and loosen the nut of the steering arm (6) at both the ends. (Fig. 1)
- 5 Remove the wheels.
- 6 Support the lower suspension arm (1)



- 7 Disconnect the shock absorber (2) from the lower arm (1).
- 8 Remove the rear end of the eye bolt (3) extension arm with the rubber bushes (10) from the frame and the suspension arm (1). (Fig .1)
- 9 Remove the support from the arm.
- 10 Mark (6) the position of the torsion bar (4) in relation to the lower arm (1) with chalk/ pencil.
- 11 Mark (6) the position of the torsion bar (4) in relation to the rear bracket (5).
- 12 Take out the set screws (7) from the retaining plate (8).
- 13 Remove the retaining plate (8) from the rear end of the torsion bar (4).
- 14 Remove the nut and bolt (9) securing the rear end adjusting arm (vernier bracket) (5) to the frame.

- 15 Remove the torsion bar (4) with the help of the special tool.
- 16 Remove the left hand and right hand torsion bars.
- 17 Ensure that the right and left hand side torsion bars are not interchanged.

- 18 Inspect visually the serrations at the splined ends and straightness of the torsion bar.
- 19 If the torsion bars are found defective, replace with new ones.

TASK 2: Assemble the torsion bar

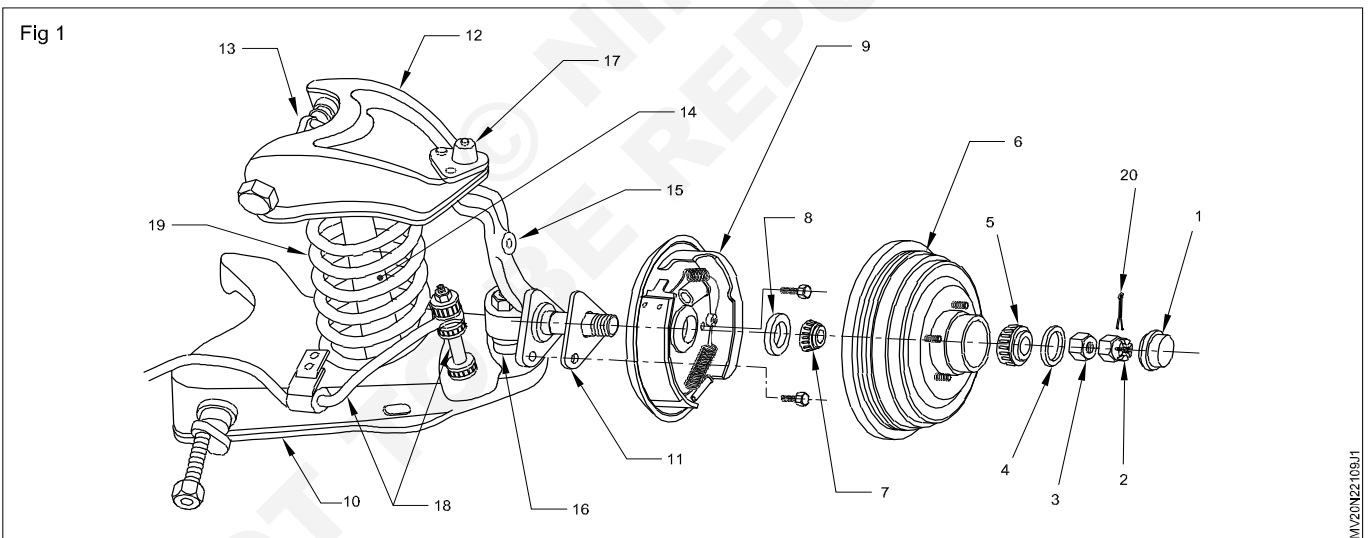
- 1 Assemble the torsion bar by keeping the locking nut (11) slack for necessary adjustments..
- 2 Fit the wheels, remove the horse, lower the jack and take it out.
- 3 Adjust the suspension height by adjusting the vernier bracket (5) by turning the vernier bolt (12) at the rear end.

- 4 Rotate the vernier bracket (5) up and down as per the manufacturer's recommendation.
- 5 Turning the vernier bracket upward reduces the height of the vehicle.
- 6 Check and adjust the suspension height as per the manufacturer's recommendations.
- 7 Tighten the bracket bolts.

TASK 3: Overhauling of coil spring type suspension system

- 1 The coil spring is fitted in between the arms.
- 2 Chock the rear wheels.
- 3 Loosen the wheel nuts - one or two threads.
- 4 Jack up the front suspension and place horses under the side member of the chassis so that there is no load on front wheels.
- 5 Release the jack and take it out.

- 6 Give support to the lower arm (10). (Fig.1)
- 7 Remove the grease cup (1) and cotter pin (20).
- 8 Remove the castle nut (2) and adjusting nuts (3).
- 9 Remove the washer (4).
- 10 Remove the outer bearing (5).
- 11 Remove the brake drum (6).
- 12 Remove the inner bearing (7) along with the grease retainer (8).



- 13 Remove the brake assembly (9) from the steering knuckle or stub axle (15).
- 14 Remove the gasket (11).
- 15 Loosen the upper arm (12) nuts and take out the nut and the inner shaft (13).
- 16 Remove the top of the shock absorber (14) foundation bolt.
- 17 Remove the bottom of the shock absorber foundation bolt.
- 18 Remove the upper arm ball joint (17).
- 19 Remove the lower arm with the lower arm ball joint (16).

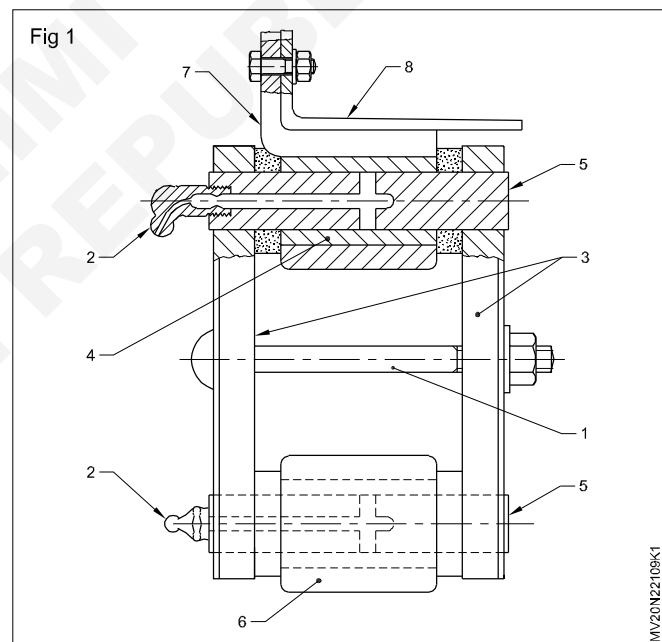
- 20 Take out the spindle (15).
- 21 Remove the stabilizer rod (18).
- 22 Slowly take out the packing under the lower arm (10).
- 23 Take out the coil spring (19) along with the shock absorber (14) and spring seating.
- 24 Cleaning
- 25 Clean all the parts with kerosene.
- 26 Check the
 - ball joint bushes
 - arm links
 - spring seating stabilizer.
 (If necessary replace the worn out parts).

TASK 4: Assemble the coil spring

- 1 Fix the lower arm (10) with a bush and nut.
- 2 Fix the upper arm (12) with a bush and nut.
- 3 Insert the coil spring (19) and shock absorber (14) on the lower arm.
- 4 Put a jack under the lower arm and raise the jack.
- 5 Align the arms and insert the inner shaft (13) with a washer, and tighten the nuts.
- 6 Connect the upper ball joint (17) and the lower ball joint (16) along with the spindle (15) and tighten it.
- 7 Fix the shock absorber nut on the top and tighten the shock absorber nut.
- 8 Fix the gasket (11).
- 9 Fix the brake assembly (9) on the spindle and tighten the bolts.
- 10 Insert the inner bearing (7) along with the grease retainer (8).
- 11 Fix the brake drums (6).
- 12 Insert the outer bearing (5) with a washer.
- 13 Tighten the adjusting nut (3) and adjust the bearing play.
- 14 Fix the spindle castle nut (2) and tighten the same.
- 15 Fix the cotter pin and grease cup (1).
- 16 Take out the jack under the lower arm.
- 17 Fix the wheel and tighten the wheel nuts by hand.
- 18 Jack up the vehicle and take out the horses from the chassis.
- 19 Release the jack.
- 20 Tighten the wheel nuts as per the specified torque.
- 21 Remove the chock from the rear wheels.

TASK 5: Remove shackles

- 1 Chock 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 6: Inspect the shackle.

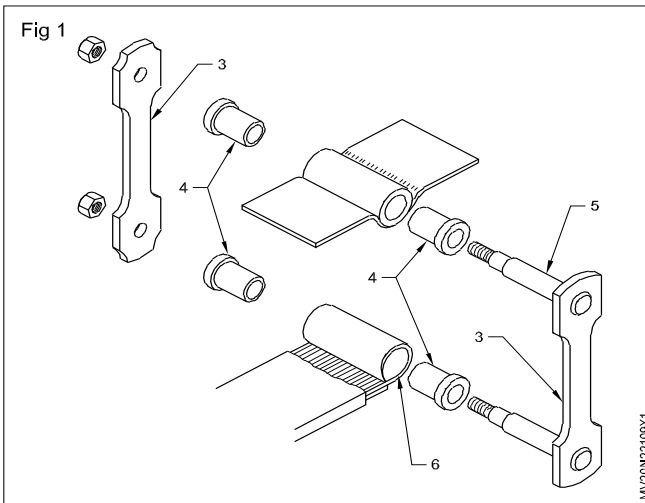
- 1 Clean all the parts with kerosene, high pressure water and air.

TASK 7: 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.

TASK8: Assemble shackles

- 1 Fit the shackle (3) with the shackle pin (5) in the spring eye (6). Replace the assembly if worn out. (Fig 1)

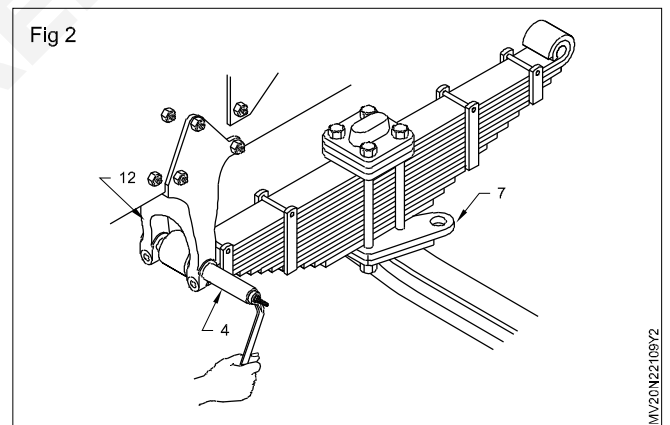
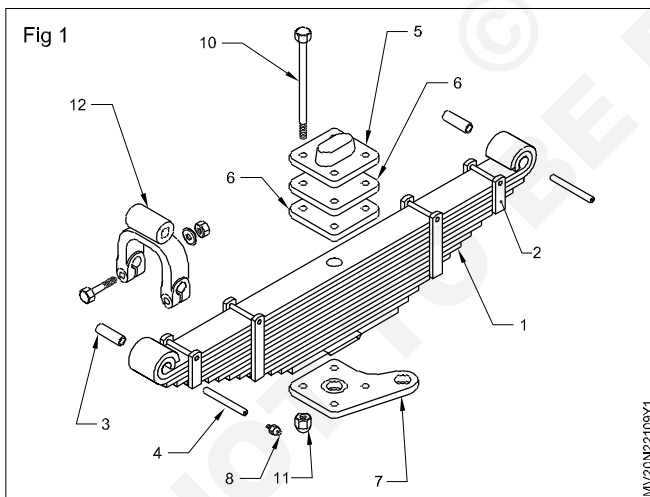


- 2 Fit the shackle with a hanger lock (7) on the frame (8).
- 3 Tighten the draw bolt (1).
- 4 Fit the grease nipple (2) and grease it.
- 5 Lift the vehicle and remove the horse.
- 6 Press the body of the vehicle and check the shackle's proper function.

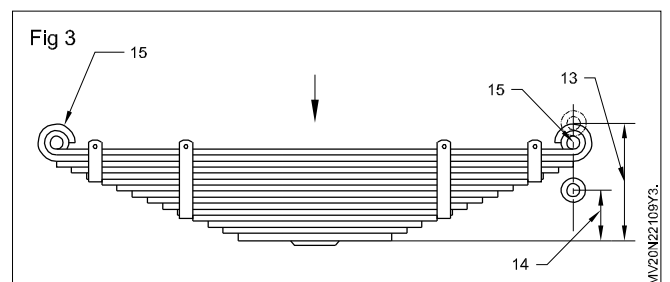
TASK 9: Remove the leaf spring

- 1 Chock the wheels.
- 2 Jack up the frame and lift the vehicle just enough for the wheels to clear the ground.
- 3 Place a horse to support the frame and take out the jack.
- 4 Disconnect the shock absorber, if provided.
- 5 Remove the clamp bolt from the shackle. (Fig. 1)

- 6 Remove the spring fixing bolts and nuts (10 and 11) and pads 5,6 and 7.
- 7 Put the jack to support the axles.
- 8 Remove the grease nipples (8).
- 9 Remove the shackle pins (4) with the help of special tools. (Fig. 2)



- 10 Remove the leaf spring assembly from the axle. (Fig. 3)



TASK 10: Inspection and replacement of worn out parts

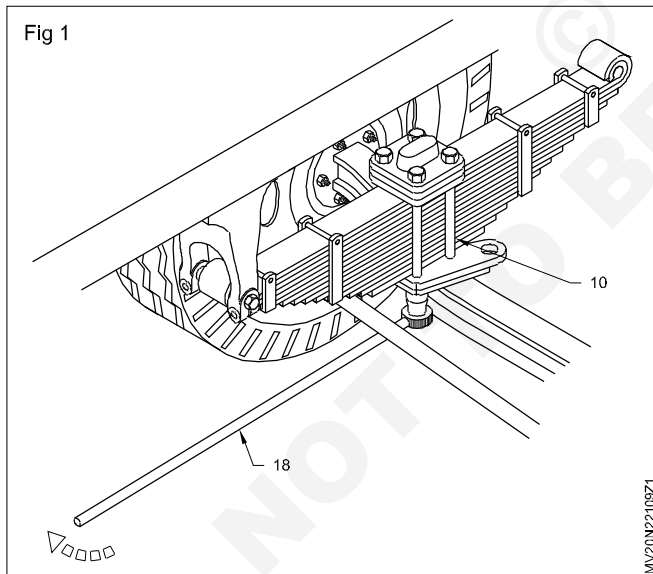
- 1 Put the spring in a press, measure the pre - camber (13).
- 2 Apply full load and observe the camber. This will be the negative camber (14).
- 3 Set the spring eyes (15) at a higher plane on the press.
- 4 Measure the distance between the spring centre and the base plate.
- 5 Apply deflection load as per specification.
- 6 Again measure the distance between the spring centre and the base plate.
- 7 Calculate the deflection of the spring i.e difference between two readings.
- 8 If the deflection is not as per recommendation, hold the spring in a vice firmly and remove the nuts and bolts from the spring, clamp (2) and release the vice slowly.
- 9 Then separate the spring leaf.
- 10 Inspect the each spring leaf for crack or damage.
- 11 Clean the spring leaf with thin oil; apply graphite oil and observe the crack.
- 12 Replace the damaged leaf.
- 13 Coat each leaf with graphite oil or grease, containing 10% graphite.

TASK 11: Assembling of leaf spring

- 1 Assemble the springs.
- 2 Press new bushes (3) into the front spring eyes and fix in position.
- 3 Straighten the clips (2), if distorted.
- 4 Check the parallelism of the spring. Reject if the first leaf is not parallel.
- 5 Finally fit the clips (2) and tighten up the nuts dead tight.

TASK 12: Refitting of leaf spring

- 1 Place the spring perfectly on the spring saddle provided on the axles.
- 2 Drive in the shackle pin (4) after aligning the spring eye into the hanger bracket (12) using a hammer.



Do not use fingers for aligning the spring leaf holes.

- 3 Fix and tighten the clamp bolts of the spring shackle and spring brackets.
- 4 Fix pads (5), (6) & (7) and tighten slightly the U clamp bolt (10) and nut (11), using the special tool (18).
- 5 Release the jack.
- 6 Finally tighten the nuts of the clamp bolt/U bolt nuts to the recommended torque.
- 7 Fit the grease nipple and lubricate.
- 8 At the time of assembling, use special levers (18) for tightening the 'U' bolt clamps. (Fig. 1)

Remove and refit the shock absorber

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

- remove the shock absorber
- inspect the shock absorber
- refit the shock absorber.

Requirements

Tools / Instruments

- Trainees tool kit - 1 No.
- Jack - 1 No.
- Drift - 1 No.
- Hammer - 1 No.

Equipments / Machineries

- Vehicle - 1 No.

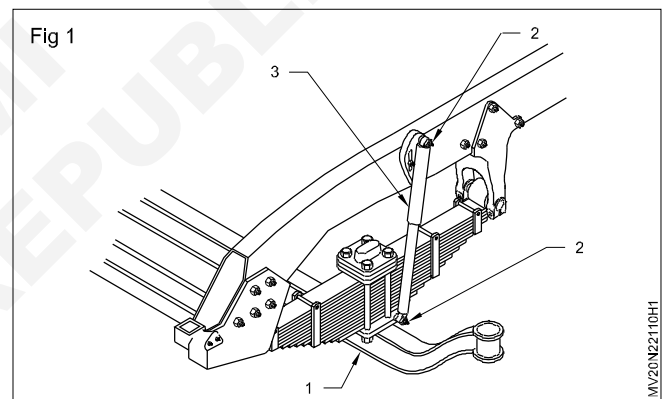
Materials

- Bush - as reqd.
- Oil - as reqd.
- Grease - as reqd.
- Banian cloth - as reqd.
- Cotton waste - as reqd.

PROCEDURE

TASK 1: Removing the shock absorber

- 1 Chock the front and rear wheels.
- 2 Place jacks under the spring pad (1) supporting the axle.
- 3 Jack up the vehicle until the wheels are off the ground.
- 4 Hold the shock absorber (3) and remove the shock absorber mounting bolt (2) from the top and bottom mounting bracket spring pad. (Fig.1)
- 5 Remove the shock absorber from the mounting bracket with a spacer at the top.

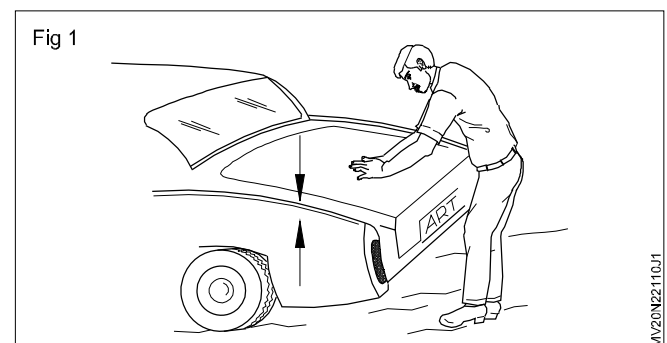


TASK 2: Inspection of shock absorber

- 1 Inspect and replace if found unserviceable.
- 2 Replace the shock absorber rubber bushes.
- 3 Check the shock absorber for compression and leakage of oil.
- 4 Check the shock absorber mounting bolts for looseness or breakage.

TASK 3: Installation of shock absorber

- 1 Hold the shock absorber along with the spacers at the top.
- 2 Hold the shock absorber and tighten the mounting bolts (2) on the bracket.(Fig 1)
- 3 Lock the nut with a split pin.
- 4 Remove the jacks from the vehicle.
- 5 Press the vehicle body by hand and check the shock absorber action.



Perform lubricating suspension system

Objective: At the end of this exercise you shall be able to
 • **Lubricate the suspension system.**

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Grease	- as reqd.
• Grease gun	- 1 No.	• Cotton waste	- as reqd.
Equipments / Machineries		• Soap oil	- as reqd.
• Heavy vehicle	- 1 No.	• Cleaning solvent	- as reqd.

PROCEDURE

- 1 Identify the lubrication points of the vehicle
- 2 Clean the lubrication points with cotton cloth
- 3 Visually check the grease nipples for any damages
- 4 In case of any damage in grease nipples, replace it
- 5 Use power operate gun to apply grease on lubrication points
- 6 Use nipple grease for suspension lubrication points
- 7 Fix the grease gun on shackle pin, grease nipple point and going on pumping the grease gun, till complete old grease comes out, from the shackle pin.
- 8 Lubricate the hanger pin, nipple point as per above procedure
- 9 Lubricate the propeller shaft' s universal joint
- 10 Lubricate the front wheel C.V joint
- 12 Clean all the lubricated points, wiping out surplus grease if present at points.

Greasing points

- 1 Tie rod end
- 2 Strut piston rod bushing
- 3 CV joint
- 4 Stub axle
- 5 Wheel bearing
- 6 Steering cable lubrication
- 7 Brake linkage
- 8 Bush set of front strut
- 9 Gear shift linkage
- 10 Clutch pedal linkage
- 11 Universal joints & slip joint
- 12 Brake caliper unit
- 13 Door hinges and locks
- 14 Water pump bearing
- 15 Steering linkages

Perform trouble shooting in suspension system

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

- identify the troubles in suspension system
- rectify the defects of suspension system.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
Equipments / Machineries		• Leaf spring	- as reqd.
• Vehicle	- 1 No.	• grease nipple	- as reqd.
		• shock absorber	- as reqd.
		• shockle pin	- as reqd.

PROCEDURE

Trouble shooting in suspension system

Trouble	Cause	Remedies
1 Wheel hop	Rim bend Low tyre pressure Wheel mounting loose	Remove bend Maintain pressure Tighten the mounting
2 Unequal height	Leaf spring weak tension Leaf spring hanger broken Uneven tyre pressure shock absorber bush damaged	Temper the leaf spring Replace the hanger Maintain tyre pressure Replace the rubber bush
3 Noises under operation	Dry lubrication Leaf spring hanger pin worn out 'U' bolt mounting loose Unserviceable shock absorber	Lubricate the parts Replace the pin Tighten the nuts Replace
4 Fluid leakage	Fluid pipe union loose fitting pipe line cracked Pipe union thread worn out	Tighten union nuts Repair / replace it Replace the union
6 Spring excessive travel	Weak tempering centre bolt broken Spring fixing bolt broken Hanger bracket broken	Temper the leaf spring Replace Replace Replace
7 Bounce	Centre bolt broken bounce stop damaged wheel bearing loose fitting	Replace Replace Replace bearing
8 Worn dampers	damper pad loose fitting damaged dampers	Replace or tighten Replace
9 Worn joints	Dry lubrication Tight fitting Worn joints	Lubricate Loose Replace
10 Vehicle crabbing	Uneven tyre pressure Improper toe in king pin bearing worn out Leaf spring main leaf broken 'U' bolt indenting loose	Maintain proper tyre pressure Adjust toe in Replace Replace Tighten

Check and repair tube and tubeless tyre puncture

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

- remove a wheel from a vehicle
- dismantle the tyre and tube
- locate the punctures in tube
- set right the punctures
- locate the puncture in tubeless tyre
- apply patch cement on puncture spot.

Requirements			
Tools / Instruments			
• Trainees tool kit	- 1 No.	• Pressure machine	- 1 No.
• Tyre lever	- 1 Set	• Vulcanizing machine	- 1 No.
• Hammer 16 lbs	- 1 No.	• Tyre changer	- 1 No.
• Compressor	- 1 No.		
• Wood cut file	- 1 No.	Materials	
• Water tub with water	- 1 Set	• Vulcanizing paste	- as reqd.
		• Vulcanizing patch	- as reqd.
Equipments / Machineries		• Cotton waste	- as reqd.
• Vehicle	- 1 No.	• soap oil	- as reqd.
• Compressor	- 1 No.	• chalk powder	- as reqd.

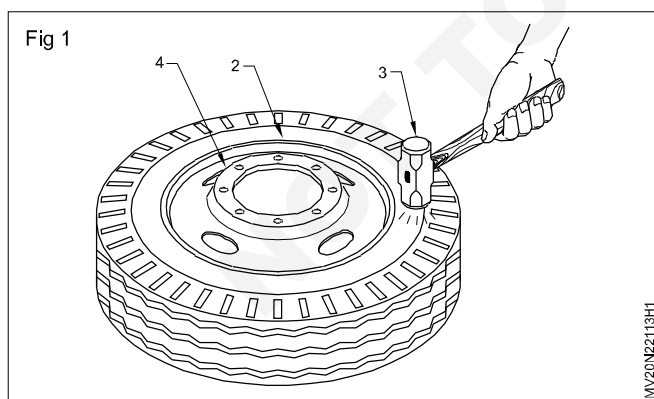
PROCEDURE

TASK 1: Remove wheel from a vehicle

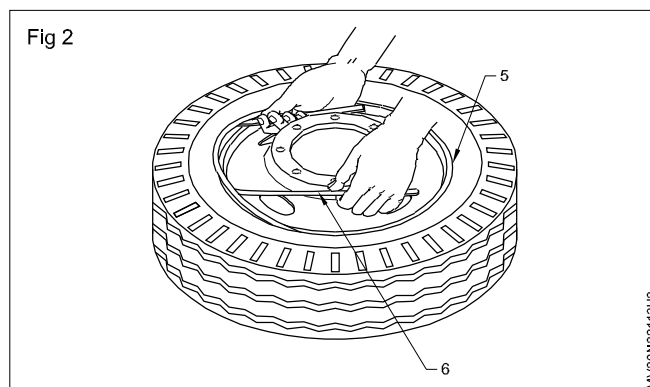
- 1 Check the valve core for leakage with soap water. In case of leakage, there will be bubbles. Replace the valve core with the help of a valve remover and again check for leakage.
- 2 Chock the opposite side of the wheels with wooden blocks.
- 3 Loosen the wheel nuts by a wheel spanner.
- 4 Jack up the wheel by hydraulic / mechanical jack.
- 5 Remove the wheel nuts.
- 6 Remove the wheel from the vehicle.

TASK 2: Remove the tyre and tube

- 1 Tap the tyre portion around (2) with a sledge hammer (3). (Fig.1)
- 2 Tap the tyre at the place adjacent to the rim with the help of the sledge hammer (3) without hitting on the disc (4).
- 3 If the disc is not getting free from the tyre, pour soap water around the beading of the tyre.
- 4 Allow 15 minutes for the water to penetrate in between the disc (4) and the beading (5).
- 5 Insert the tyre lever (6) in between the disc and the beading (5) and force out the tyre from the disc without damaging the tube and the beading area (5) of the tyre. (Fig. 2)

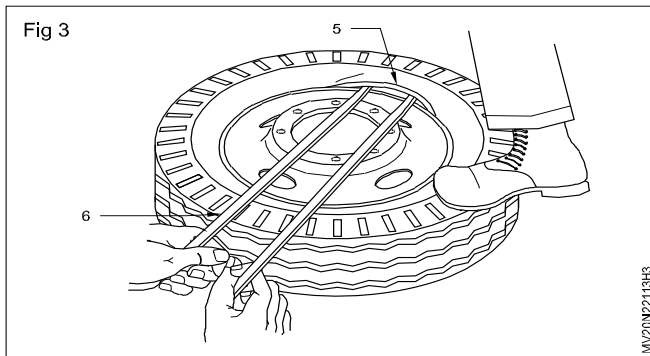


- 2 Tap the tyre at the place adjacent to the rim with the help of the sledge hammer (3) without hitting on the disc (4).
- 3 If the disc is not getting free from the tyre, pour soap water around the beading of the tyre.

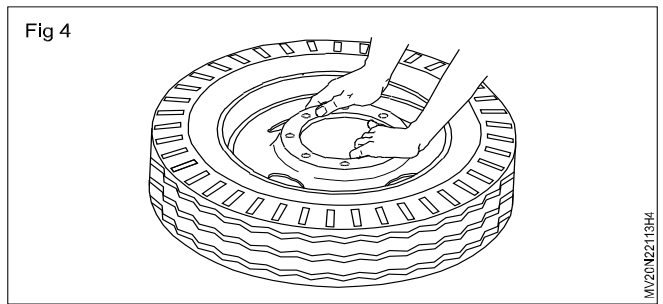


Do not insert the tyre lever fully inside the disc to avoid damage to the tube.

- Repeat the steps on the other side of the tyre for separating the tyre beading from the disc (Fig. 3) or use the tyre changing machine if available in your institute.



- Remove the tube from the tyre. (Fig. 4)



TASK 3: Locate the puncture in tube

- Fix the valve core in the tube.
- Inflate the tube at a pressure of 3 to 5 lbs/sq. in.

- Dip the inflated tube in the water tub. At the punctured area bubbles will come out. Mark the punctured area by a marking material.

TASK 4: Set right the puncture

- Remove the valve core.
- Clean the punctured area by cloth.
- Clean the puncture area with a woodruff file.
- Apply vulcanizing cement on the punctured portion.
- Place a piece of vulcanizing raw rubber on the punctured area.
- Clamp the punctured area on the vulcanizing equipment. (In the presence of your instructor.)
- Switch 'ON' the vulcanizing equipment.

- After 15 minutes, switch ' Off ' the vulcanizing equipment.
- Allow 5 minutes to cool down the tube.
- Unclamp the equipment and remove the tube from the equipment.
- Fix the valve core on the tube.
- Inflate the tube with low pressure 5 to 10 lbs/sq. in.
- If there is any bulge on tube then replace the tube.
- Dip the repaired tube in the water tub and check for any leakage.

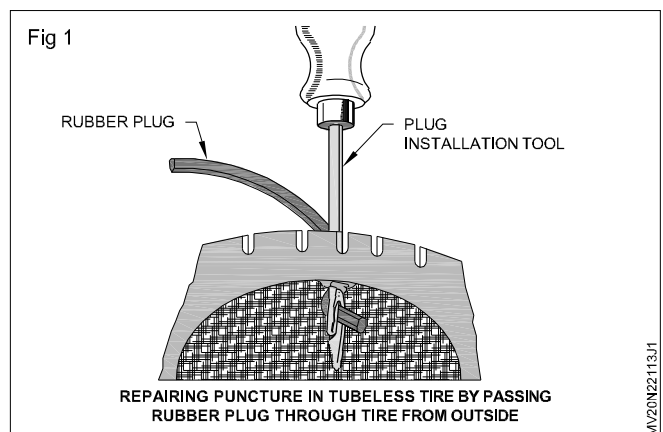
TASK 5: Locate the puncture in tubeless tyre

- Remove the tyre and iron assembly from the vehicle.
- Inspect the inside of the tyre for splits, cracks, punctures.
- Locate and remove the puncturing object and turn mark the damage area with a tyre crayons (or) other easily visible marker.

- Mount the tyre on a tyre repair fixture show the puncture area can be easily reached.
- Use scuffing fool to roughen the inside surface of the tyre at the puncture site. Roughen area larger from the size of the patch and
- Remove all rubber particles

TASK 6: Apply patch cement on puncture spot

- Apply patch cement to the suffered area
- Place the batch over the puncture area
- Pull plug portion of the patch through the puncture
- Apply pressure to the patch to seal it to the inner surface of the tyre. A special tool called a stitching tool is available for this operation. (Fig. 1)
- Reinstall the tyre on the Rim and inflate to the proper pressure.
- Ensure rubber plug is properly installed on puncture spot



Perform assembling and inflating the tyre

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

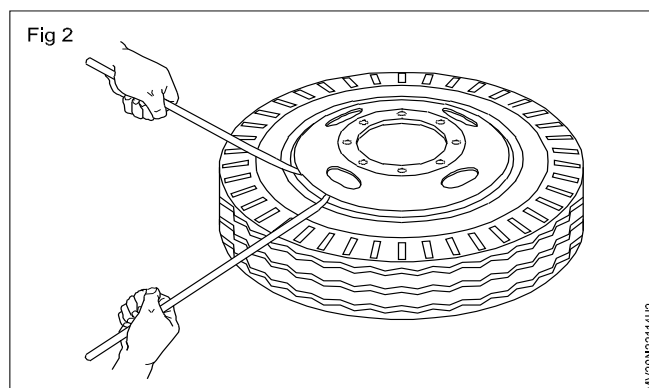
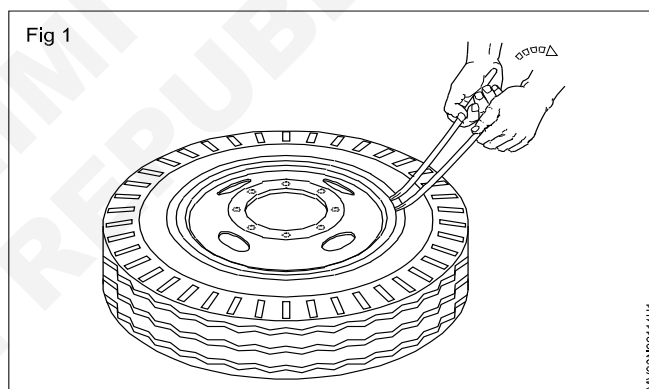
- assemble the tyre and tube
- inflating to correct pressure.

Requirements			
Tool / Instruments			
• Trainees tool kit	- 1 No.	• Air compressor	- 1 No.
• wheel spanner	- 1 No.	• Nitrogen gas cylinder	- 1 No.
• Tyre pressure gauge	- 1 No.	Materials	
• Tyre lever	- 1 Set	• Tyre	- as reqd.
• Jack	- 1 No.	• French chalk powder	- as reqd.
Equipments / Machineries		• Cotton waste	- as reqd.
• Vehicle	- 1 No.	• Soap oil	- as reqd.
		• Wooden chock	- as reqd.
		• Wheel nuts	- as reqd.

PROCEDURE

TASK 1: Assemble tyre and tube

- 1 Check the inner area for nails, stones and damage.
- 2 Apply french chalk powder inside the tyre and outer area of the tube
- 3 If necessary place a patch, at the damaged portion of the tyre.
- 4 insert the tube into the tyre
- 5 Inflate the tube with low pressure 5 to 10 lbs/sq.in
- 6 Insert the tube mouth into the rim
- 7 Lock the mouth with the valve tool.
- 8 Insert the tyre lever (6) in between the disk and beading. Push down the tyre on the rim. Ensure that the tyre lever does not damage the beading of the and tube does not get trapped between the bead and the rim.(Fig 1 & 2)



TASK 2: Inflating to correct pressure

- 1 Inflate the tube slowly until the beads are fully seated, and reinflate according to the manufacture's specification.
- 2 Check the valve core for leakage with soap water.
- 3 Fit the wheel on the vehicle.
- 4 Tighten the wheel nut by hand.
- 5 Remove the jack without any jerk.
- 6 Tighten the wheel nuts as per specification.
- 7 Remove the wheel chock.

Check and adjust tyre pressure by air/nitrogen

Objective: At the end of this exercise you shall be able to
 • **check and adjust tyre pressure by air / Nitrogen.**

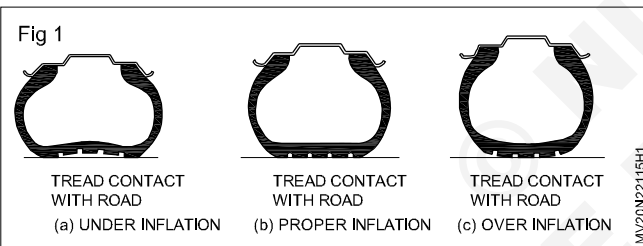
Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Nitrogen gas	- as reqd.
• Tire pressure gauge	- 1 Set	• Cotton waste	- as reqd.
Equipments / Machineries		• soap oil	- as reqd.
• Air compressor	- 1 No.	• wire	- as reqd.
• Vehicle	- 1 No.		

PROCEDURE

TASK 1: 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 figure (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.

Perform tyre rotation and wheel balancing

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

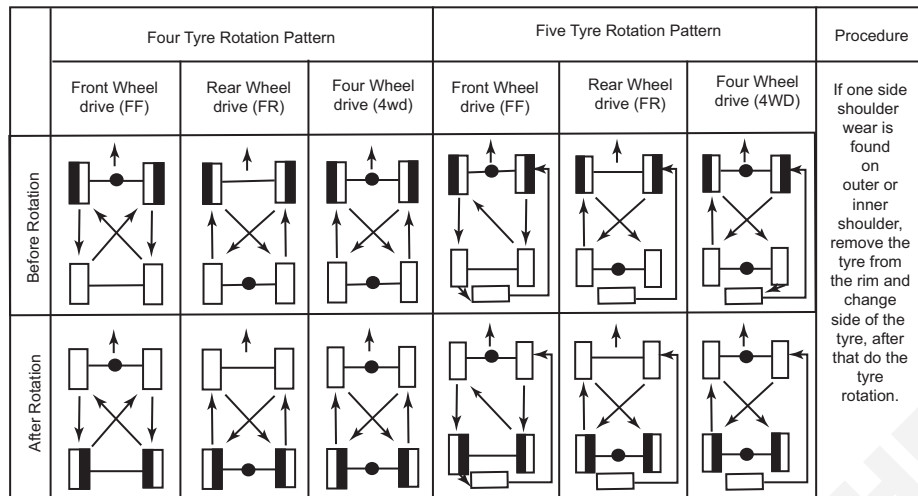
- rotate the tyre according to the manufacturer's recommendation
- maintain tyre card
- fit the wheel assembly on the aligner
- check for dynamic balance & rectify
- check the static balancing
- Fit tyre assembly to the vehicle.

Requirements			
Tools / Instruments			
• Trainees tool kit	- 1 No.	• Air compressor	- 1 No.
• Wheel spanner	- 1 No.	• Pressure gauge	- 1 No.
• Jack	- 1 No.	• Automatic wheel alignment machine	- 1 No.
• Wooden blank	- as reqd.		
Equipments / Machineries			
• Wheel balancing machine	- 1 No.	Materials	
• Vehicle running condition	- 1 No.	• Cotton waste	- as reqd.
		• Wheel balancing weight	- as reqd.
		• Soap oil	- as reqd.

PROCEDURE

TASK 1: Rotate tyres

- 1 Check the vehicle if it has four tyre rotation pattern or 5 tyre rotation pattern.
- 2 Check if the vehicle is Front wheel drive or rear wheel drive or 4 wheel drive.
- 3 Choose the correct tyre rotation pattern to be followed format table - 1
- 4 Check the vehicle has come for normal wear (Table 1) or one side wear (Table 2).
- 5 Mark the tyres for FR ,LH, FR RH, RH, RR LH, RR RH and spare with the crayon/ chalk.
- 6 Jack up the vehicle safely and remove the tyres
- 7 Check whether wheel balancing job is required and fit the tyres accordingly.
- 8 Also check the rim for any bend or rusting.
- 9 After removing the jack, ensure again that all the wheel nuts are tightened for the specified torque.

Table 2Tyre rotation pattern, for one side wear
(Tyre rotation after changing the tyre side)

One side shoulder wear

Note: Tyre rotation should be done at every 5000 kms. or whenever an irregular wear is found.

TASK 2: Maintain tyre card

Fill the data in the tyre card shown in the table 3.

Table 3

S.No	Tyre number	Make	Size	KM run in different positions				
				FL	FR	RL	RR	Total
1	FX 389725 TN	MRF	715 X 16.00 12 ply	5000	5400	5987	4500	19887
2								
3								
4								
5								

TASK 3: Fitting of wheel on the aligner

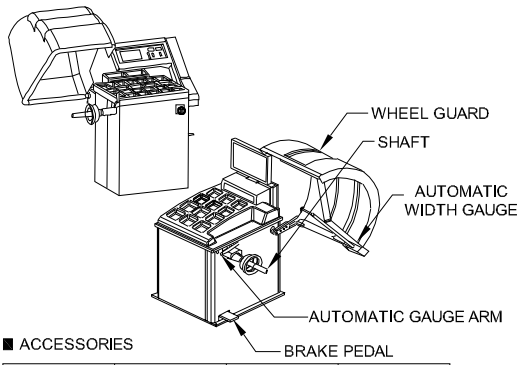
1. Mount wheel properly essential, as the wheel is balanced relative to how it is mounted on the balancer.

If the wheel is not well centered and sitting squarely against the balancer flange plate, accurate balance results will not be achieved.

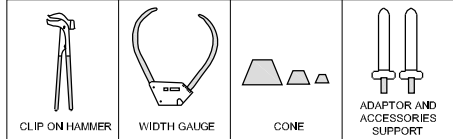
Most stud-centered wheels have concentric center holes, which allow fast and easy cone mounting. (Fig 1)
Adapters should be used only in problem situations and on some aftermarket specialty wheels. Press the unlocking pedal

- 3 Fit the suitable cone (Conicity towards the outer side) and, in sequence, the wheel, the locking complete with hollow sleeve.
- 4 Press the locking pedal
- 5 Replace the hollow sleeve is replaced by the nylon washer for light alloy rims with protrude in a hub. Fig. 1 shows a automatic wheel balancer. Place the wheel to be balanced on the shaft and tighten. Ensure that wheel is in line with the axis of the shaft.
- 6 Tighten the shaft to recommended torque using torque wrench

Fig 1



■ ACCESSORIES

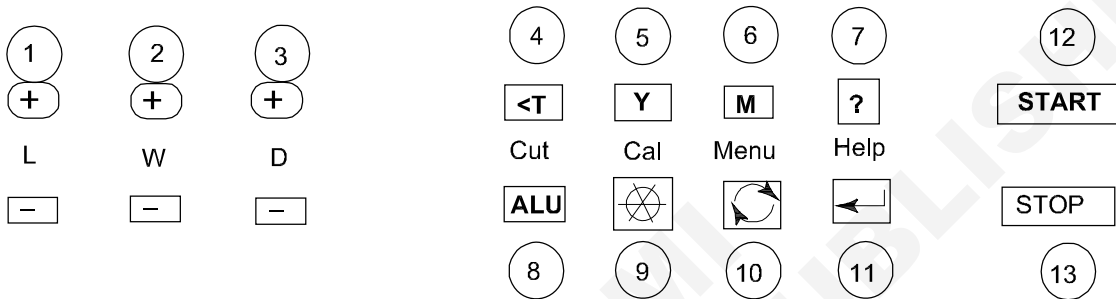


MV20N22116H1

Figs 2 & 3 shows the various options and data information available on the wheel balancing machine.

- 1 L 2 W 3 D 4 cut 5 cal 6 Menu 7 Help 8 Special 9 Divide 10 Position 11 Enter 12 Start 13 Stop

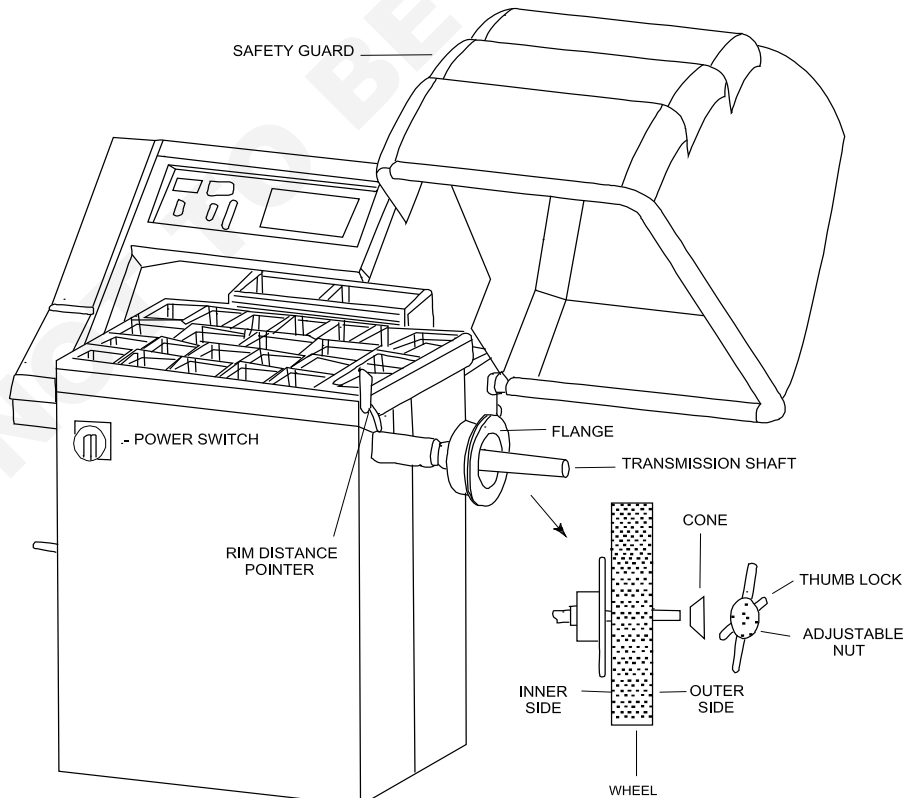
Fig 2



①	L	②	W	③	D	④	Cut	⑤	Cal	⑥	Menu	⑦	Help	⑧	Special
⑨	Divide	⑩	Position	⑪	Enter	⑫	Start	⑬	Stop						

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Fig 3



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TASK 4: Check for dynamic imbalances & rectify the defects

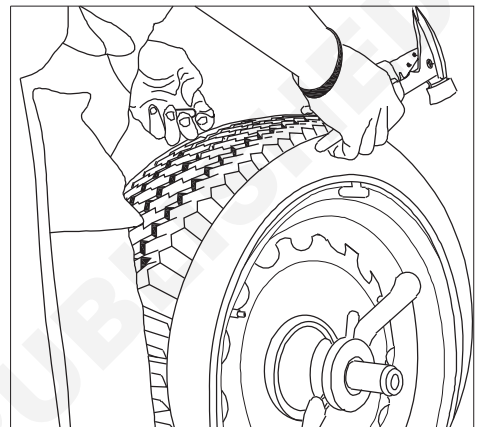
- 1 Mount the wheel. Most original equipment and after mark the wheels can be mounted using some combination of the standard mounting adapters.
 - 2 Select the required Weight Locations. Depress the Mode Select Button repeatedly until the Weight Location Indicators display the chosen locations. (Fig 1)
 - 3 Set the Rim Diameter Knob to the Diameter shown on the tyre sidewall.
 - 4 Set the Rim Width Knob as measured with the caliper.
 - 5 Set the Rim Offset Knob as follows.
 - a. Pull the rim offset scale arm out and position the tip against the rim flange surface.
 - b. Read the rim distance scale arm out and position the tip scale arm at the point where it enters into the housing.
 - c. Set the offset knob to the rim distance value.
 - 6 Switch ON the wheel balancer and Spin the wheel
 - a. Raise wheel using balancer and Spin the wheel
 - b. Turn the spindle crank handle until a beep is heard Release handle immediately. Do not interfere with the machine or wheel during the measuring cycle or wrong readings can occur. Normal balance speed is between 70 and 84 rpm. If spun too fast, the buzzer will sound Continuously until the wheel slows to proper measurement speed.
 - c. Stop the wheel by using the lift crank handle to lower the wheel until it touches the ground.
 - 7 Attach the Weight.
 - a. starting with either side of the wheel, rotate the wheel in the direction of the lit arrow until all 6 Arrow Indicators and the Top Dead centre Indicator are lit. The correct balance weight will now be displayed.
 - b. Securely apply the displayed weight at the top - dead- centre location on the indicated side of the wheel, repeat steps for the other side of the wheel.
 - 8 Do a check spin Repeat the spin cycle Zero weight reading should appear for both sides of the rim.
- Fig. 2 shows the order of checking balance of the wheel.
- 3 For static balancing, the rim and offset dimensions do not need to be entered into the balancer, simply enter the wheel diameter. After the measuring cycle, the inner indicators will light to show the required weight amount and position. For simple and accurate balancing, the Normal mode can be used for all balancing measurements. After the balancing cycle, press the Mode Select Button repeatedly until the LED indicators light for the

Fig 1

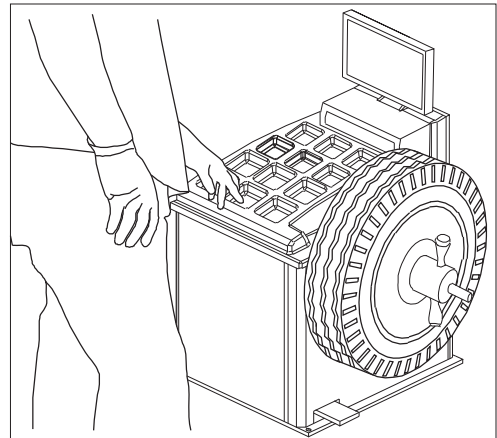
(a)



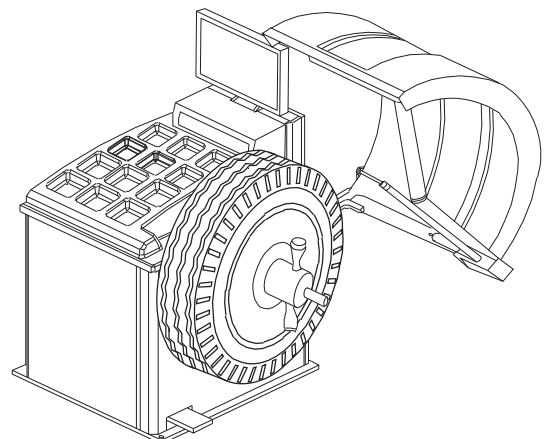
(b)



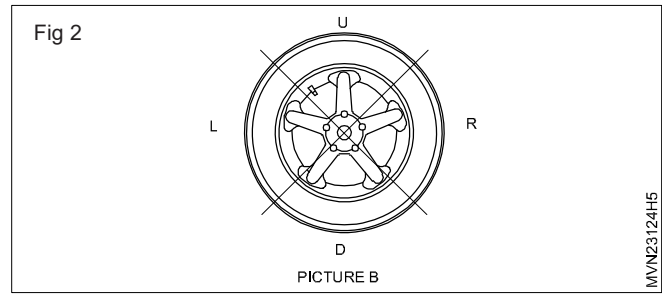
(c)



(d)



desired weight locations. The balancer will automatically recalculate the weight required for each mode.



TASK 5: Static balancing

- 1 Line up the holes of the tyre with the wheel bolts.
- 2 Apply the top wheel nut to secure the tyre in place and rest your foot against the bottom while the remaining wheel nuts are finger tightened.
- 3 If the wheel has four nuts, they should be tightened in diagonally opposite pairs. If there are five, every second one should be tightened until all are tight.
- 4 Lower the car and tighten the wheel nuts fully.

TASK 6: Fitting tyre assembly to the vehicle

- 1 Line up the holes of the tyre with the wheel bolts.
 - 2 Apply the top wheel nut to secure the tyre in place and rest your foot against the bottom while the remaining wheel nuts are finger tightened.
 - 3 If the wheel has four nuts, they should be tightened in diagonally opposite pairs. If there are five, every second one should be tightened until all are tight.
 - 4 Lower the car and tighten the wheel nuts fully.
-

Check the tyre wear pattern

Objective: At the end of this exercise you shall be able to
 • check the tyre wear and its causes.

Requirements	
Tool / Instruments <ul style="list-style-type: none"> FWD Vehicle with workshop Manual & vehicle kit - 1 No. Tyre pressure gauge with accessories - 1 Set Inspection lamp with guard - 1 No. Compressor - 1 No. Trainees tool kit - 1 No. Tyre pressure gauge - 1 No. 	Equipments / Machineries <ul style="list-style-type: none"> Vehicle running condition - 1 No. Compressor - 1 No. Materials <ul style="list-style-type: none"> Tyres (unservicable) - 3 Nos

PROCEDURE

- 1 Check air pressure in the tyre.
- 2 Inspect Tyre Wear (Fig 1) shows the various types of tyre wear in a vehicle.
- 3 Toe wear - a feathered wear pattern across both front tyres. and sometimes shoulder wear on the inner or outer edge of both tyres.
- 4 Camber wear - uneven wear on one side of a tyre may show up when control arm bushings have collapsed.
- 5 Cupped wear - this may be the result of badly worn shocks or struts, or wheel and tyre imbalance.
- 6 Unbalanced right and left tyre wear, size difference.
- 7 Tyres with low pressure will wear both outer edges. Over inflation will wear the centre of the tyres.
- 8 Tyre size and make, if different can cause a vehicle with accurate wheel alignment to have a directional pull or non - cantared steering wheel. If tyre sizes match, but brands and tread design differ, measure each tyre individually.
- 9 Tyre run - out.

Fig 1

Condition	RAPID WEAR AT SHOULDERS	RAPID WEAR AT CENTER	CRACKED TREADS	WEAR ON ONE SIDE	FEATHERED EDGE	BALD SPOTS	SCALLOPED WEAR
Condition							
Cause	UNDER INFLATION OR LACK OF ROTATION	OVER INFLATION OR LACK OF ROTATION	UNDER INFLATION OR EXCESSIVE SPEED	EXCESSIVE CAMBER	INCORRECT TOE	UNBALANCED WHEEL OR TIRE DEFECT	LACK OF ROTATION OF TIRES OR WORN OR OUT-OF-ALIGNMENT SUSPENSION
Correction	ADJUST PRESSURE TO SPECIFICATIONS WHEN TIRES ARE COOL. ROTATE TIRES			ADJUST CAMBER TO SPECIFICATIONS	ADJUST TOE TO SPECIFICATIONS	DYNAMIC OR STAIC BALANCE WHEELS	ROTARE TIRES AND INSPECT SUSPENSION

MV20N22117H1

Overhaul tandem master cylinder and adjust brake pedal free play

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

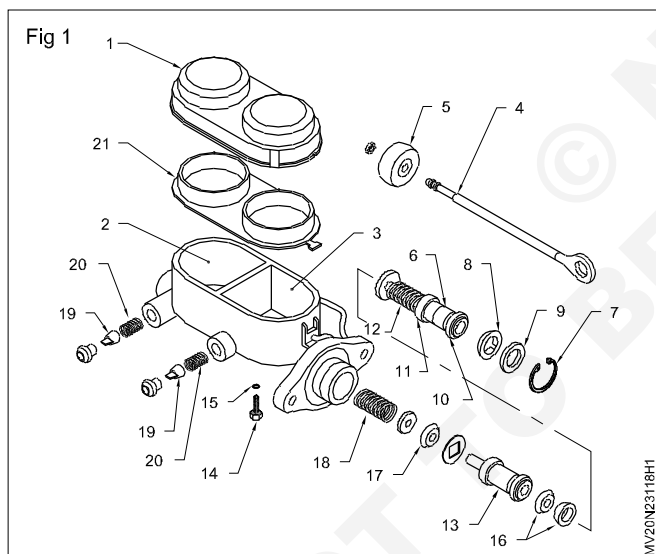
- **dismantle the tandem master cylinder**
- **inspect the parts of the tandem master cylinder**
- **assemble and test the tandem master cylinder.**

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Master cylinder kit	- as reqd.
• Mallet	- 1 No.	• Brake fluid	- as reqd.
• Circlip plier (inside)	- 1 No.	• Cotton waste	- as reqd.
Equipments / Machineries		• Kerosene	- as reqd.
• Bench vice with soft jaw	- 1 Set	• Plastic tray	- as reqd.
• Vehicle with tandem master cylinder	- 1 No.		

PROCEDURE

TASK 1: Dismantle

- 1 Clean the tandem master cylinder externally.
- 2 Remove the reservoir cover (1) along with the diaphragm (21). (Fig.1)



- 3 Drain the brake fluid from the secondary (2) and primary(3) reservoirs.
- 4 Hold the master cylinder in a vice with soft jaws.

TASK 2: Cleaning and inspection

- 1 Clean all the parts with alcohol.
- 2 Ensure that the vent holes and the primary and secondary compensating ports are clear.

Do not clean the internal parts of a tandem master cylinder with kerosene, oil, petrol or diesel.

- 5 Remove both the check valves (19) and springs (20). Drain out the brake fluid from the cylinder by pressing the push-rod.
- 6 Remove the push-rod (4) and dust-boot (5).
- 7 Depress the primary piston (6) slightly and remove the circlip (7) with the help of a nose plier.
- 8 Remove the retaining ring (8) and washer (9) and remove the primary piston (6) along with the secondary cup (10) and primary cup (11).
- 9 Remove the return spring (12).
- 10 Press the secondary piston (13) with a rod and remove the stop-bolt (14) with the gasket (15).

The secondary piston (13) should never be removed without removing the stopper bolt (14); otherwise the piston will get damaged.

- 12 Remove the secondary piston (13) along with the secondary cups (2 Nos.) (16) and primary cup (17).
- 13 Remove the return spring (18).
- 14 Remove all the cups and shims from the primary and secondary pistons without causing damage to the pistons.

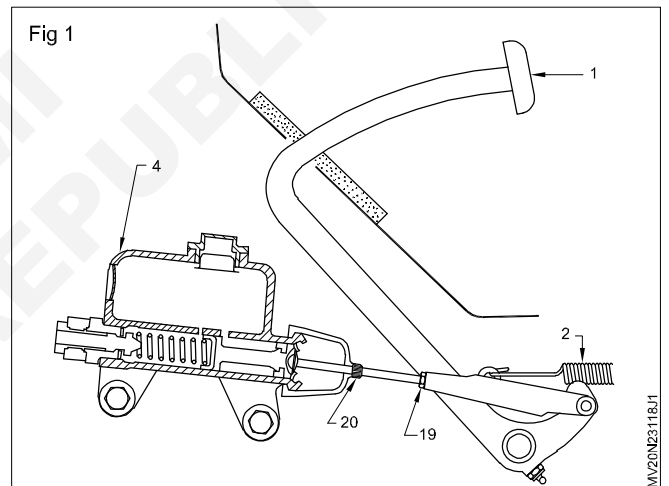
- 3 Check the master cylinder bore for scoring, pitting etc. If it is found damaged replace the master cylinder.
- 4 Check the piston visually for any damage, and replace if necessary.
- 5 Check the return springs, and replace if necessary.
- 6 Replace all the rubber parts. (All these parts come in a kit)

TASK 3: Assembling (Fig 1)

- 1 Hold the master cylinder in a vice with soft jaws.
- 2 Clean and apply brake fluid inside the master cylinder bore.
- 3 Dip all the components in the brake fluid.
- 4 Fix the return spring (18) along with the primary cup (17) in the secondary cylinder.
- 5 Fix the secondary cups (16) on the secondary piston (13).
- 6 Fix the secondary piston (13) along with the secondary cup (16).
- 7 Press the secondary piston (13) with a rod and fix the stop - bolt (14) along with the washer (15).
- 8 Fix the return spring (12) along with the primary cup (11) in the primary cylinder.
- 9 Fix the primary piston (6) along with the secondary cup (10).
- 10 Fix the retaining ring (8) and washer (9).
- 11 Press the primary piston (6) with a rod and fix the circlip(7).
- 12 Assemble the check valves (19) along with springs in the primary and secondary cylinders.
- 13 Fill up the reservoir and fix the cover (1) along with the diaphragm (12).
- 14 Operate the piston and check that the fluid comes out from the check - valves in both the cylinders with pressure.
- 15 Check for any leakage in the primary piston side.
- 16 Fix the dust boot (5) and push rod (4).

TASK 4: Adjusting brake pedal free play. (Fig 1)

- 1 Check the play of brake pedal and observe that play is 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 is more, loosen if the play is less
- 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.



Overhaul front and rear hydraulic brake

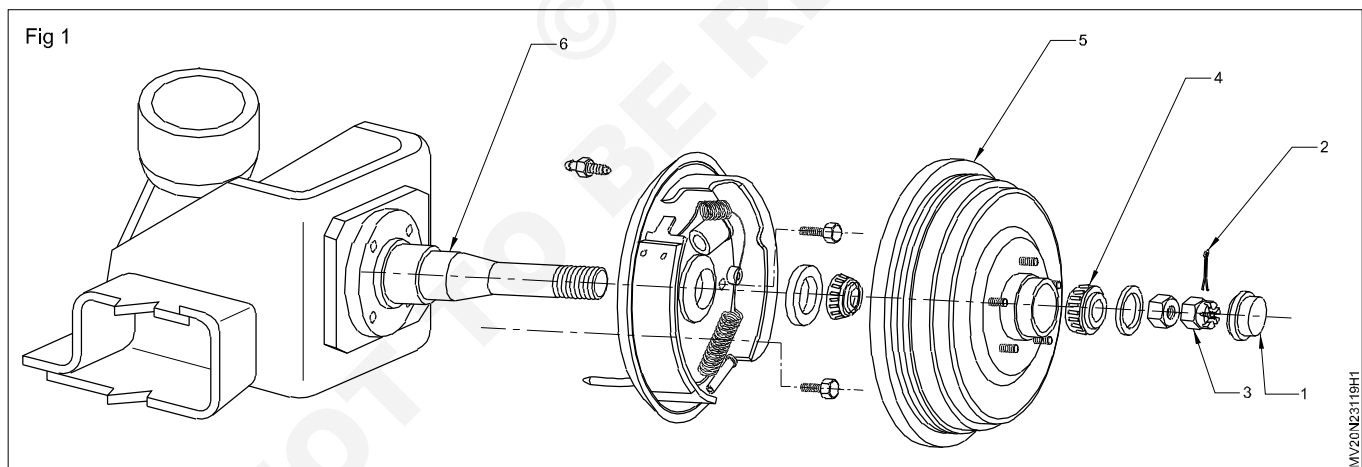
Objective: At the end of this exercise you shall be able to

- 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
- overhauling wheel cylinder.

Requirements			
Tools / Instruments			
• Trainee tool kit	- 1 No.	• Brake fluid	- as reqd.
• Wheel spanner	- 1 No.	• Grease	- as reqd.
• Hub spanner	- 1 No.	• Oil seal	- as reqd.
• Drum puller	- 1 No.	• Cotter pin	- as reqd.
• Bearing puller	- 1 No.	• Emery paper	- as reqd.
		• Cotton waste	- as reqd.
		• Kerosene	- as reqd.
		• Plastic tray	- as reqd.
		• Wheel chock	- 1 Set
		• Wheel cylinder repair kit	- 1 No.
		• spilt pin	- as reqd.
Equipments / Machineries			
• Vehicle	- 1 No.		
• Jack and horse stand	- 4 Nos.		
Materials			
• Brake shoe	- as reqd.		

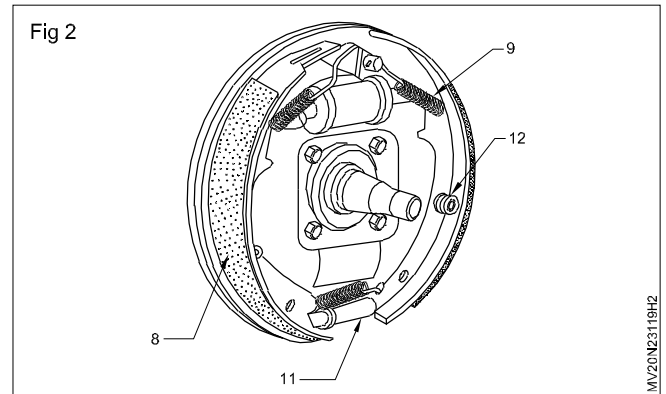
PROCEDURE

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.

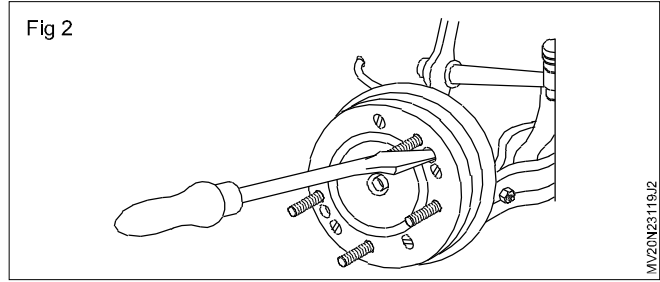
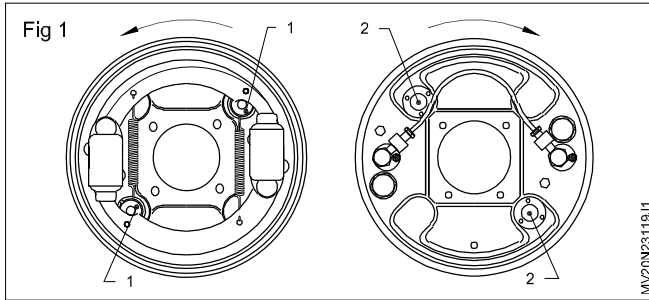
TASK 4: Brake adjusting methods

- 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.1)
- 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.2
- 3 First fully tighten the screws as shown in the fig.2
- 4 Slightly loosen the screws for free rotation.

5 Note the wheel rotates freely and check the efficiency.

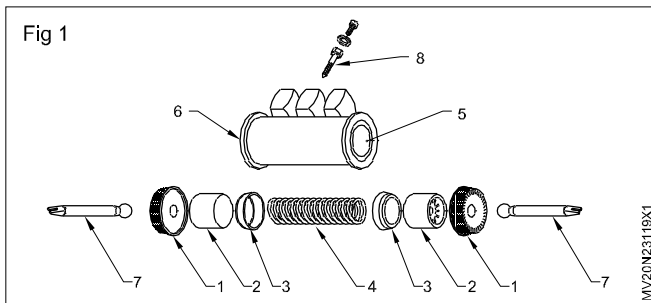
- 6 Jack up the vehicle.
- 7 Remove the horses.
- 8 Insert the cotter pin.
- 9 Tighten the wheel nuts at the specified torque.
- 10 Remove the chocks from the rear end.

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 over-size 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: Overhauling wheel cylinder

- 1 Jack up the vehicle and remove the wheel hub and drum.
- 2 Disconnect the brake pipe line and the fitting on the brake shoes at the toe to fall clear of the brake wheel cylinder.
- 3 Remove the two screws holding the wheel cylinder to the back plate and remove the wheel cylinder (6). (Fig. 1)



- 4 Remove the rubber dust covers or boots (1) at the ends of the cylinder and the brake shoe activating pin (7).
- 5 Remove the pistons (2) and the piston cups (3) and the spring (4).
- 6 Remove the bleeder valve (8).
- 7 Wash the parts in alcohol (if alcohol is not available use brake fluid).
- 8 Check the bleeder valve and clean.
- 9 Check the cylinder bore (5) for roughness or scoring.
- 10 Check the clearance between the pistons (2) and the cylinder bore (5) by using a 0.05 mm feeler gauge.
- 11 Dip the spring (4), pistons (2) and the piston cups (3) in brake fluid, before reassembling.
- 12 Install the spring (4) in the centre of the wheel cylinder (while replacing spring, piston, cup, use a new kit).
- 13 Install the piston cups (3) with the cupped surface towards the spring so that the flat surface will be against the pistons (2).
- 14 Install the piston (2) and dust covers (1) and the bleeder valve.

- 15 Install the wheel cylinder to the back plate.
- 16 Fix the brake shoe actuating pin and align with the shoe.
- 17 Connect the brake line and install the brake shoes and return spring.
- 18 Refit the wheel, hub and drum.
- 19 Remove the piston (9) with the piston seal (8).
- 20 Cleaning and Inspection
- 21 Clean all the parts except the rubber parts in kerosene.
- 22 Check the pads and linings, slide bush, piston seal and disc.

Precaution

While reinstalling wash each part cleanly in brake fluid. (Never use any other fluid or thinner)

While fixing the piston and piston seal to the cylinder apply fluid to them.

- 23 Fix the piston seal (8) and insert the piston (9) in the bore.
- 24 Fix the circlip (11).
- 25 Fix the cylinder boot (10).
- 26 Fix the bleeder screw (6).
- 27 Fix the bleeder dust cap (5).
- 28 Insert the brake pads (12).
- 29 Fix the disc brake caliper (7) on the carrier (15) and align the bush hole and bore.
- 30 Fix the slide bush (4) in the bore.
- 31 Fix the dust boots, (3) on both sides of the slide bush (4) with support (2).
- 32 Fix the caliper pin bolt (1) to the caliper and carrier (15).
- 33 Fix the carrier with the caliper to the caliper holder (13).
- 34 Fix and tighten the carrier bolt (14).
- 35 Connect the brake pipeline.
- 36 Bleed the system and test it.

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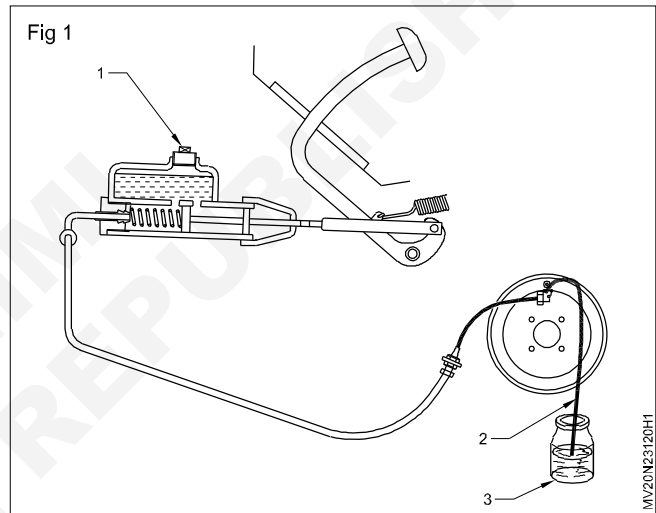
Perform hydraulic brake bleeding

Objective: At the end of this exercise you shall be able to
 • bleed the hydraulic brake system in disc brake.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Brake fluid	- as reqd.
Equipments / Machineries		• Flexible hose	- as reqd.
• Vehicle	- 1 No.	• Glass bottle	- as reqd.
		• Wheel chock	- as reqd.
		• Cotton waste	- as reqd.

PROCEDURE

- 1 Clean all the dirt found around the master cylinder filler cap (1).
- 2 Remove the filler cap (1). (Fig.1)
- 3 Fill the master cylinder up to the lower edge of the filler neck with brake fluid.
- 4 Close the filler cap.
- 5 Clean the wheel cylinder's bleeder connection.
- 6 Connect the bleeder hose (2) to the longest distance of the wheel bleeder screw.
- 7 Place the other end of the tube in a glass jar (3) and submerge it in the brake fluid.
- 8 Apply the brake pedal three or four times until pressing is felt hard.
- 9 Open the bleeder screw one half to three quarters of a turn and observe in the jar. Bubbles will form in jar.
- 10 Repeat this until only the fluid comes out of the bleeder screw forcing all the air in the line.
- 11 Close the bleeder screw.
- 12 Fill the brake fluid again in the master cylinder.
- 13 Close the filler cap.



- 14 Repeat the above steps for all the 4 wheels.
- 15 After removing air from all the 4 wheels fill the brake fluid in the master cylinder reservoir to the required level.
- 16 Close the filler plug and check the tightness of the bleeder screw in all the 4 wheels.

Overhaul vacuum booster assembly

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

- **remove the vacuum booster**
- **dismantle the vacuum booster**
- **inspect the part of the vacuum booster**
- **assemble the vacuum booster**
- **fit the vacuum booster.**

Requirements			
Tools / Instruments		Materials	
• Trainee tool kit	- 1 No.	• Cotton waste	- as reqd.
Equipments / Machineries		• Soap oil	- as reqd.
• Vacuum assisted power brake vehicle	- 1 No.	• hydraulic oil	- as reqd.
• Work bench	- 1 No.	• booster diaphragm	- 1 No.
		• booster diaphragm return spring	- 1 No.
		• vacuum valve	- 1 No.
		• vent valve	- 1 No.
		• vacuum hole	- 1 No.
		• master cylinder	- 1 No.

PROCEDURE

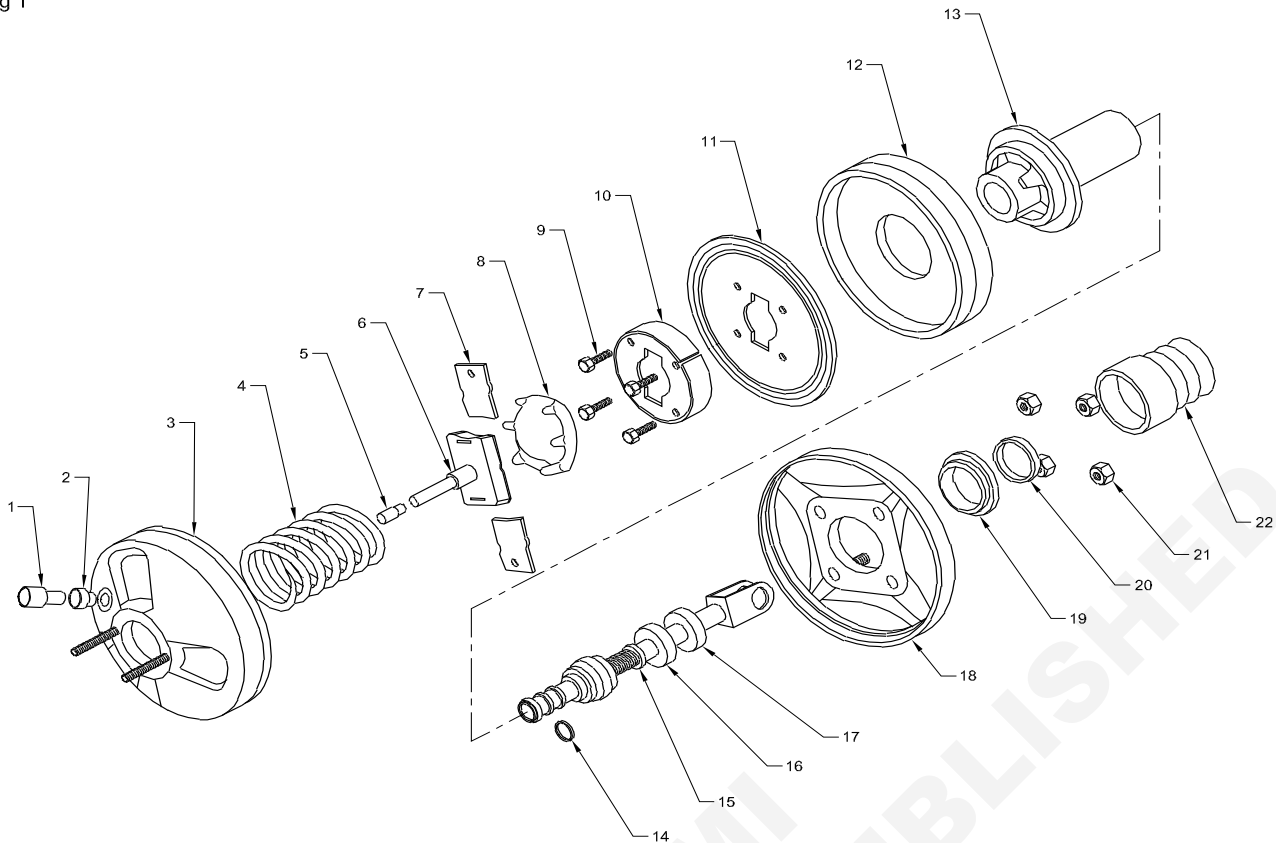
Removal of vacuum booster

- 1 Chock the front and rear wheels and disconnect the battery (-).
- 2 Remove the brake pedal return spring and connection.
- 3 Disconnect the fork pin from the vacuum brake valve.
- 4 Disconnect the hydraulic pipelines.
- 5 Remove the master cylinder.
- 6 Disconnect the vacuum line from the non - return valve.
- 7 Loosen the mounting nut and take out the vacuum
- 8 Dismantling (Fig 1)
- 9 Clean the external side of the vacuum booster.
- 10 Remove the non - return valve (1) and grommet (2).
- 11 Make an aligning mark at the front housing (3) and rear housing (18) of the booster to fit it in the same position.
- 12 Fix the booster on a bench vice.
- 13 Tighten the fixture handle to rest on the swivel block.
- 14 Avoid overtightening.
- 15 Rotate the rod and match the notches in a line.
- 16 The front housing gets unlocked.
- 17 Loosen the fixture handle slowly until the front housing (3) gets separated.
- 18 Remove the diaphragm return spring(4).
- 19 Remove the pivot assembly (5).
- 20 Push the push - rod assembly (6) from the fork end and relieve the segments (7) from the diaphragm disc (11).
- 21 Remove the segments ' retainer (8).
- 22 Loosen the set screw (9) from the valve body (13).
- 23 Remove the spring guide (10).
- 24 Remove the diaphragm disc (11) and diaphragm (12).
- 25 Remove the seal ring (14) from the operating rod piston (23).
- 26 Remove the operating rod (15) assembly with the filters (16, 17) from the valve body.
- 27 Loosen the nuts (21) from the rear housing (18).
- 28 Remove the lip seal (19) from the rear housing (18).
- 29 Take out the filter retainer (20).
- 30 Remove the gaiter (22).

Cleaning and inspection

- 31 Wash and clean all the metal parts and dry them with compressed air.
- 32 Inspect all the part for wear; if necessary replace.
- 33 Check the valve body, diaphragm and the diaphragm disc for any scoring or damage.

Fig 1



34 Use the recommended repair kit. Replace the diaphragm and damaged parts.

35 Lubricate all moving parts.

36 Press the lip seal (19) in the rear housing (18) by using a mallet to tap the seal and set it properly.

37 Grease the lip seal.

38 Fix the filter retainer (20) on the rear housing (18).

39 Fix the diaphragm (12), diaphragm disc (11) and the spring guide (10) in position to the valve body (13).

40 Fix the set screws (9) and tighten.

41 Fix the sealing ring (14) in the operating rod piston groove with filters.

42 Drop the valve body (13) in the rear housing bore and insert the operating rod assembly (15) into the valve body (13) and set the nuts and tighten.

43 Fix the segment retainer (8), and the segment (7) and assemble on the push - rod (6).

44 Push the operating rod (15).

45 Allow the piston to come out from the valve body (13).

Ensure that the groove on the piston projects out to assemble the segments in the groove.

46 Pull out the segments (7) slightly upward and check for proper seating.

47 Fold the segments' retainer (8) and secure the pivot assembly (5) together.

48 Place the rear housing (18) with the valve body (13)

and ensure the operating rod assembly (15) is secured with the pivot assembly (5).

49 Fix the front housing (3) along with the diaphragm return spring (4).

50 Match the mark of the front housing (3) and rear housing (18).

51 Tighten the fixture handle aligning the notches of the front and rear housing.

51 Tighten the fixture handle aligning the notches of the front and rear housing.

52 While tightening the front housing should move freely and contact the diaphragm.

Rotate the rods uniformly; otherwise the diaphragm will get twisted.

53 Loosen the handle and remove the unit.

54 Assemble the grommet (2).

55 Fix the gaiter (22).

57 Mount the unit on the vehicle.

58 Connect the vacuum pump line with the non - return valve (1).

59 Mount the master cylinder and pipelines.

60 Connect the brake pedal and adjust if necessary for free play.

61 Remove the chocks from the wheels.

62 Start engine and feel the vacuum power assistance and stop engine. Again depress the pedal few times for vacuum storage check up.

Overhaul the hydraulic disc brake

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

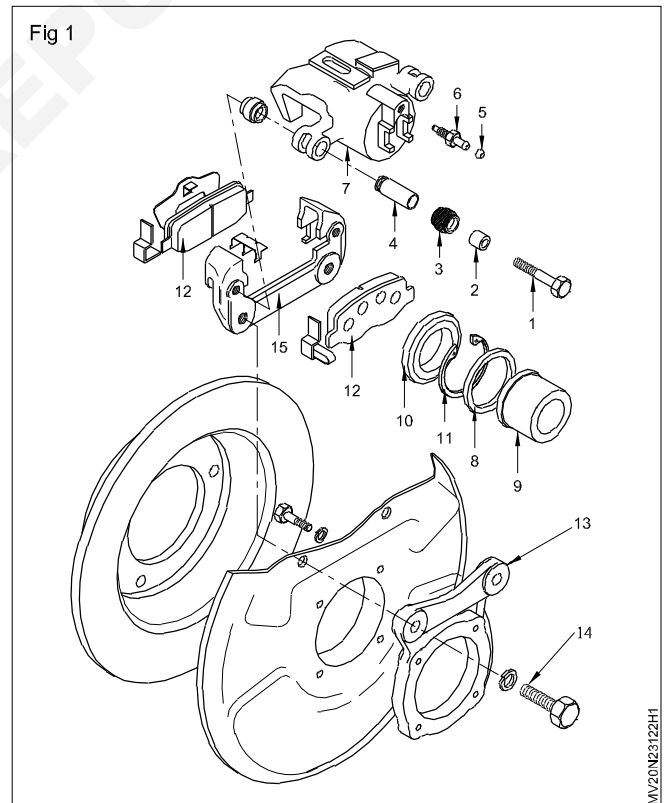
- **dismantle the disc brake assembly**
- **assemble the disc brake assembly.**

Requirements			
Tools / Instruments		Equipment / Machineries	
• Trainees tool kit	- 1 No.	• Vehicle	- 1 No.
• Socket spanner with sliding T. handle	- 1 No.	• Air Compressor	- 1 Set
• Wheel spanner	- 1 No.	Materials	
• disc puller	- 1 No.	• Cottor pin	- as reqd.
• Torque wrench	- 1 No.	• Piston seal	- as reqd.
• Micrometer or vernier caliper	- 1 No.	• Banjo washers	- as reqd.
• Dial gauge	- 1 No.	• Brake fluid	- as reqd.
• Jack and horse stand	- 2 Nos.	• Cotton waste	- as reqd.
		• Wheel chock	- as reqd.
		• Emery paper	- as reqd.

PROCEDURE

TASK 1: Dismantle

- 1 Chock the wheels.
- 2 Loosen the wheel nuts - one or two turns.
- 3 Jack up the wheel.
- 4 Support with horse.
- 5 Remove the wheel.
- 6 Remove the caliper pin bolt (1) from the caliper carrier (15). (Fig.1)
- 7 Remove the dust boot support (2).
- 8 Remove the dust boots (3) on both sides of the slide bush (4).
- 9 Remove the cylinder slide bush (4).
- 10 Remove the carrier bolt (14) from the caliper holder (13).
- 11 Remove the disc brake caliper (7) and carrier (15).
- 12 Remove the disc brake pads (12).
- 13 Dismantle the brake caliper (7).
- 14 Remove the bleeder dust cap (5).
- 15 Remove the bleeder screw (6).
- 16 Disconnect the brake pipeline.
- 17 Remove the cylinder boot (10).
- 18 Remove the circlip (11).
- 19 Remove the piston (9) with the piston seal (8).



- 20 Cleaning and Inspection
- 21 Clean all the parts except the rubber parts in kerosene.
- 22 Check the pads and linings, slide bush, piston seal and disc. if any damage replace it.

TASK 2: Assembling of disc brake

- 1 Fix the piston seal (8) and insert the piston (9) in the bore.
- 2 Fix the circlip (11).
- 3 Fix the cylinder boot (10).
- 4 Fix the bleeder screw (6).
- 5 Fix the bleeder dust cap (5).
- 6 Insert the brake pads (12).
- 7 Fix the disc brake caliper (7) on the carrier (15) and align the bush hole and bore.
- 8 Fix the slide bush (4) in the bore.
- 9 Fix the dust boots, (3) on both sides of the slide bush (4) with support (2).
- 10 Fix the caliper pin bolt (1) to the caliper and carrier (15).
- 11 Fix the carrier with the caliper to the caliper holder (13).
- 12 Fix and tighten the carrier bolt (14).
- 13 Connect the brake pipeline and fill the brake fluid in master cylinder
- 14 Bleed the brake system
- 15 Adjust the brake pedal free play and test the brake

Precaution

While reinstalling wash each part cleanly in brake fluid. (Never use any other fluid or thinner)

While fixing the piston and piston seal to the cylinder apply fluid to them.

Perform servicing air brake system

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

- **servicing air compressor**
- **servicing air tank**
- **servicing slack adjuster**
- **locate and rectify air leak**
- **maintenance of brake system.**

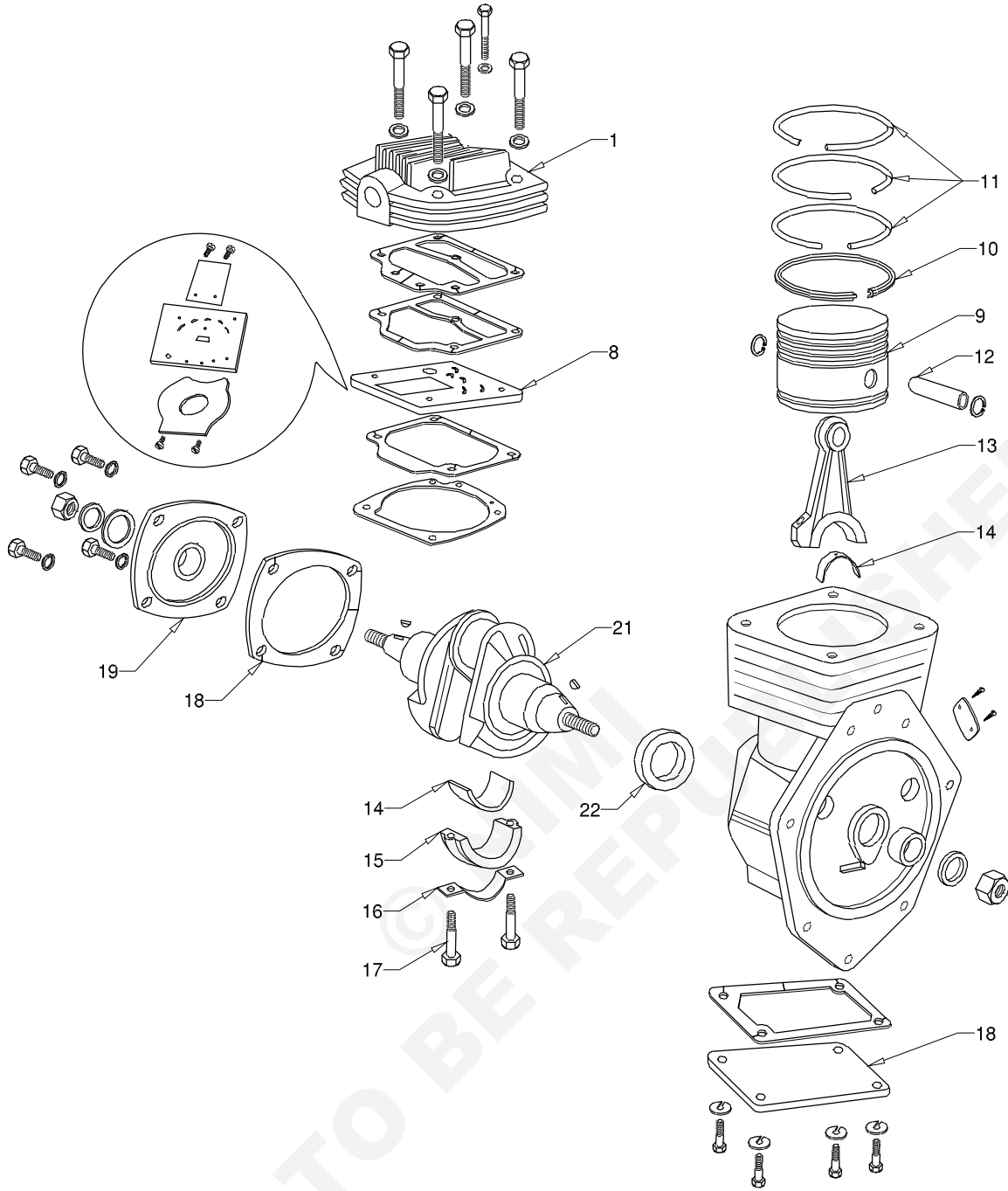
Requirements			
Tools/Instruments		Materials	
• Trainees tools kit	- 1 No.	• Kerosene	- as reqd.
• Socket spanner set	- 1 No.	• Soap Oil	- as reqd.
• Torque wrench	- 1 No.	• Lubricant Oil	- as reqd.
• Outside micrometer	- 1 No.	• Cleaning Oil	- as reqd.
• Cylinder bore gauge	- 1 No.	• Emery paper	- as reqd.
Equipments / Machineries		• Grease	- as reqd.
• Multi cylinder diesel engine vehicle	- 1 No.	• Soap water	- as reqd.

PROCEDURE

TASK 1: Servicing air compressor

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Release air from the system. 2 Remove oil and air lines. 3 Remove fasteners and take out air compressor from its position. 4 Clean air compressor unit externally. 5 Remove the drive connection. 6 Remove air compressor cylinder head (1) (Fig 1). 7 Remove reed valve assembly (8) with valve plate. 8 Remove inlet and delivery reed valves from the valve plate. 9 Remove base cover plate (23). 10 Turn crankshaft and bring the piston to bottom position. 11 Unlock the lock plate (16) and loosen the connecting rod bolts (17) and take out the cap (15) along with bearing shell (14). 12 Remove piston assembly (9). 13 Remove piston oil ring (10) and compression rings (11). 14 Remove gudgeon pin (12) & connecting rod (13) from piston. 15 Remove end cover (19) along with gasket (18). 16 Take out crankshaft (21) and thrust washer (22). 17 Clean all the parts. 18 Clean oil passages in crank shaft and connecting rod and check for free flow of air. | <ol style="list-style-type: none"> 19 Inspect the cylinder bore for wear, taper and ovality. Recommend for reboring if required. 20 Check ring clearance in piston groove. 21 Inspect connecting rod for cracks or any damage. 22 Inspect the crank shaft journal for wear/taper and ovality. 23 Check clearance between crankshaft journals and bearings and if required replace the bearings. 24 Inspect the inlet and delivery reed valve. If necessary replace them. 25 Check crankshaft thrust washer for any damage. 26 Check piston and cylinder head for crack, damage etc. <p>Assembling</p> <ol style="list-style-type: none"> 27 Place crankshaft (21) along with thrust washer (22) in correct position in the cylinder block. 28 Press new oil seal and position new gasket on the end cover. 29 Fit the end cover (19) on compressor body. 30 Tighten end cover screws with washers and check for free rotation of crank shaft. 31 Assemble piston (9) and connecting rod (13) with gudgeon pin (12). 32 Fix piston rings (10) and (11) in piston grooves and stagger these as recommended by manufacturer. |
|---|--|

Fig 1



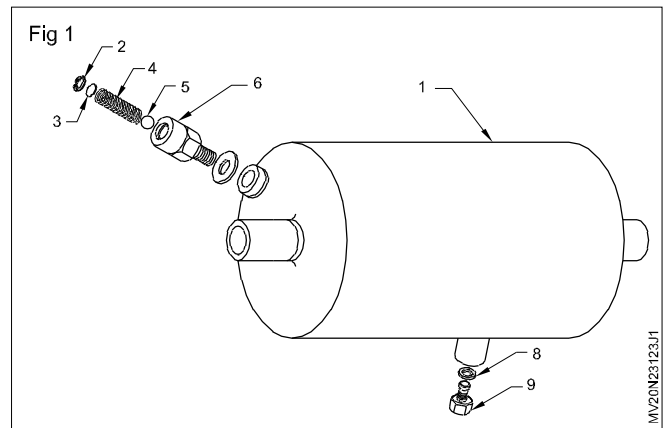
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- 33 Fix connecting rod upper bearing shell (14) in connecting rod.
- 34 Place ring guide on top of bore. Ensure that ring guide aligns with bore at complete periphery.
- 35 Insert piston and connecting rod assembly in ring guide and bore, with a wooden block.
- 36 Fix connecting rod cap (15) with bearing shell (14) and tighten connecting rod cap bolts (17) at recommended torque.
- 37 Fit the delivery reed valve on valve plate.

- 38 Reverse the valve plate and fit inlet reed valve.
- 39 Assemble cylinder head and valve plate using proper gasket. Ensure the gasket does not overlap the valves.
- 40 Apply grease/oil on the gasket.
- 41 Fit the cylinder head and fix fasteners and tighten at recommended torque.
- 42 Fit bottom cover on compressor body.
- 43 Fit air compressor on engine

TASK 2: Servicing air tank

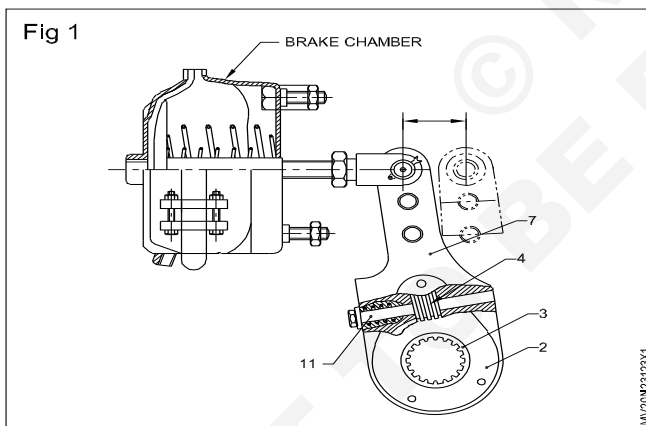
- 1 Remove the drain plug (9) and drain the air tank (Fig.1)
- 2 Disconnect the air lines and plug the open ends of the air lines to avoid entry of dust.
- 3 Unscrew the mounting bracket nuts and bolts and remove the tank (1).
- 4 Unscrew the safety valve body (6) from the tank.
- 5 Remove the circlip (2) and retaining plate (3).
- 6 Withdraw the ball (5) and spring (4).
- 7 Inspect visually air tank for cracks and welded ends. If cracks are found, recommend for re-welding.
- 8 Check visually the ball (5) and the ball seating in the valve body (6) and spring (4) for any damage. Replace if necessary.
- 9 Place the ball (5), spring (4) and the washer (3) in the valve body (6) and lock it with a circlip (2).
- 10 Assemble the safety valve assembly on the tank.
- 11 Fit the drain plug (9) on the tank with the washer (8).



- 12 Mount the tank on the vehicle.
- 13 Connect the air lines.
- 14 Start the engine and fill air in the air tank.
- 15 Check for air leakage from the joints, and rectify if any leakage is found.
- 16 Adjust the air pressure by the unloaded valves adjusting screw.

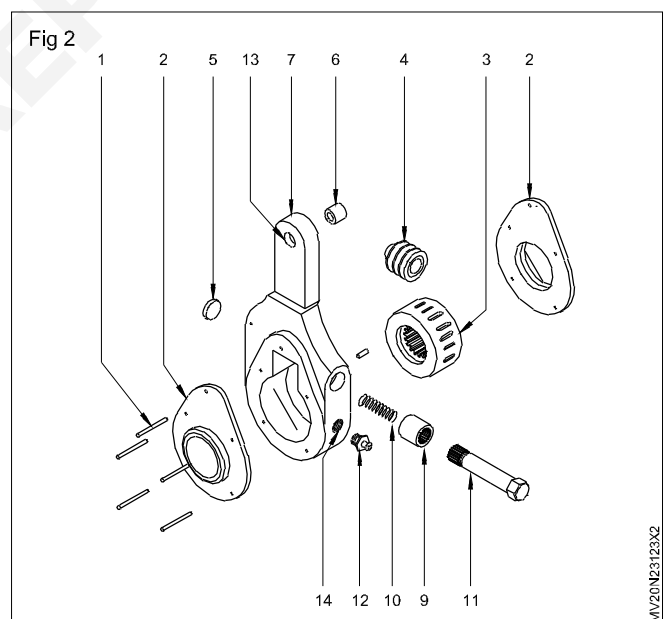
TASK 3: Servicing slack adjuster

- 1 Remove the clamp from the 'S' camshaft.
- 2 Disconnect the yoke / brake chamber push-rod by removing the clevis (folded clips). (Fig.1)



- 3 Take out the slack adjuster.
- 4 Remove the rivets (1) holding the covers (2) and the gear (4).(Fig.2)
- 5 Remove the welch plug (5).
- 6 Remove the worm shaft (11), worm shaft lock (9) and the worm lock spring (10).
- 7 Remove the worm (4) and gear (3) from slack adjuster body (7).
- 8 Clean all the dismantled parts with cleaning solvents.
- 9 Inspect the body (7) for cracks or distortion.
- 10 Check the play in the yoke pin holes (13).
- 11 If the yoke pin is loose in the hole (13) replace the bush (6).

- 12 Ensure that the inside surface of the body (7), where the worm gear (4) rotates, is smooth and free from burrs.



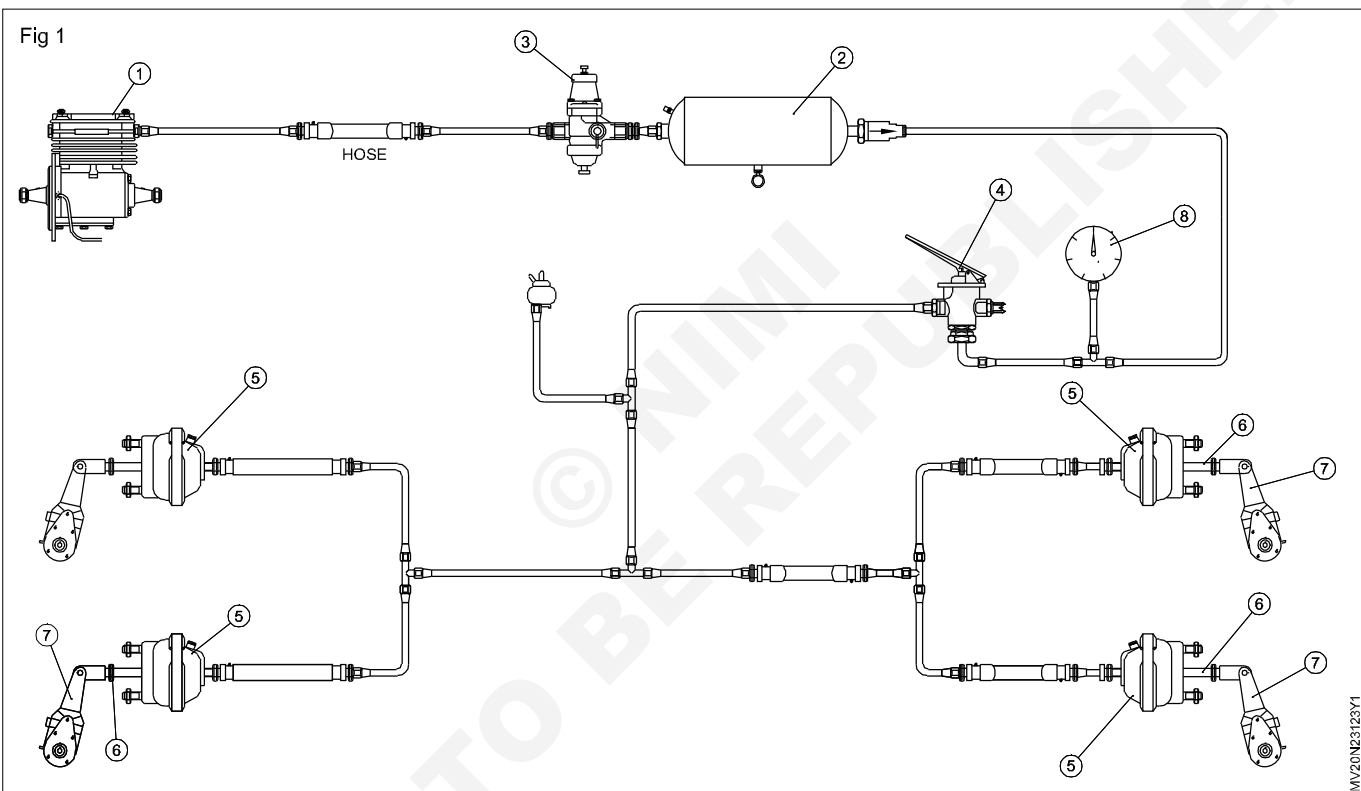
- 13 Ensure the grease hole (14) in the body is clean.
- 14 Check the teeth of the worm gear for damage. Replace the worm gear if necessary.
- 15 Check the worm shaft (11) for bend, damage etc. Replace if necessary.
- 16 Inspect the worm shaft lock (9). If it is worn out, replace.
- 17 Place the worm (4) and gear (3) in the slack adjuster body (7).

- 18 Position and press the worm shaft (11), worm shaft lock (9) and lock spring (10) into the worm (4) and slack adjuster body (7). Ensure the diameter of the shaft is as per specification.
- 19 Fit a new welch plug (5).

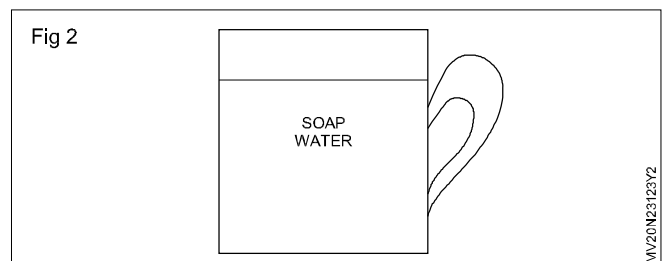
- 20 Fit a lubricating nipple (12).
- 21 Rivet the cover (2) at both ends of the body (7).

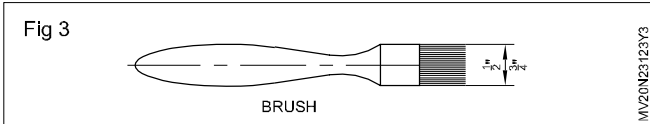
TASK 4 Locating air leaks in brake lines

- 1 Start the engine and fill the air pressure in air tank and check the unloader valve (3) leaks
- 2 Check the air pressure gauge (8) for specified pressure limit (6 kg/cm² - 7 kg/cm²)
- 3 Switch off the engine
- 4 Park the vehicle on safe place and place wooden chocks to rear and front wheels.
- 5 Press the brake pedal and note air pressure gauge for leaks, if found pressure decreased
- 6 In gauge reading check the air line with help of helper.
- 7 Check the brake line from air tank (2) to brake valve (4) by applying soap water on the pipe line joints. (Fig 1)

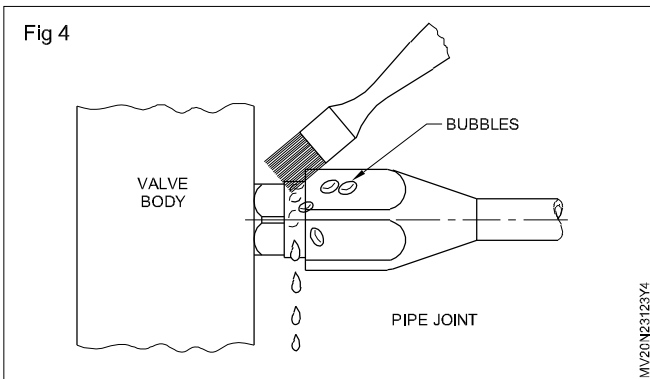


- 8 Check the brake valve on apply position for air leaks
- 9 Check the brake chamber (5) brake line connecting points with help of soap water.
- 10 Check the brake light switch joint point.
- 11 Get soap water (Fig 2 & 3) a handled mug and brush about 1/2" - 3/4".

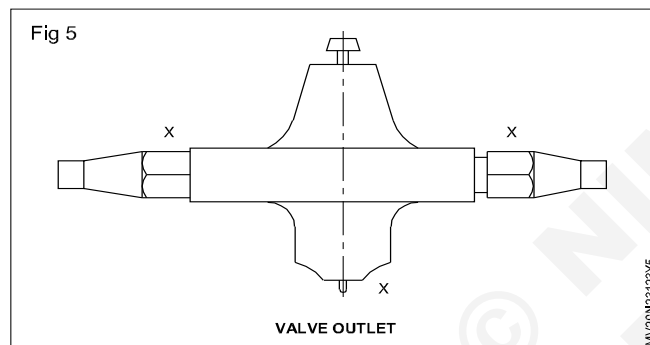




12 Apply soap water (Fig 4) and look at the joint if there is any bubble. Apply soap water to all joints and check leakage.



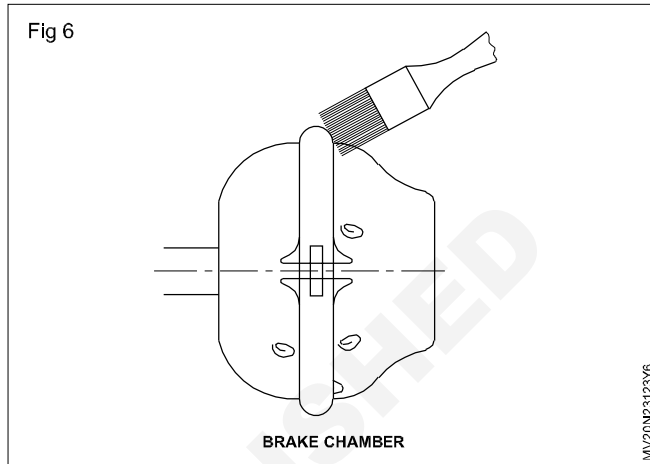
13 Apply brake and check leakage on brake chamber and pressure pipe lines (Fig 5)



Check pipe connection which come under pressure when brake applied.

Check air tank connections when the system is full of air.

Check leak in the brake chamber with brake applied (Fig 6)



TASK 5: General maintenance and care of brake system

- | | |
|--|---|
| <ol style="list-style-type: none"> 1 There should be no oil or grease between the brake shoe and drum or brake pad and disc rotor 2 Ensure there is no leakage oil air brake line 3 Maintain proper clearance between brake shoe and drum 4 keep the axle hub retainer in good condition 5 Clean the brake shoe dust in the drum 6 Always use correct air pressure in air brake system | <ol style="list-style-type: none"> 7 Brake drum/disc surface should be clean 8 Ensure brake shoe return spring tension is as per the specified limit of manufacturer. 9 All wheel's brake shoe clearance should be as same 10 Brake pedal free play should be proper recommended by the manufacturer. 11 Ensure breaker valves are functioning properly. 12 Lubricate the linkages in brake operating system. |
|--|---|

Remove and replace new lining, adjust parking brake cable

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

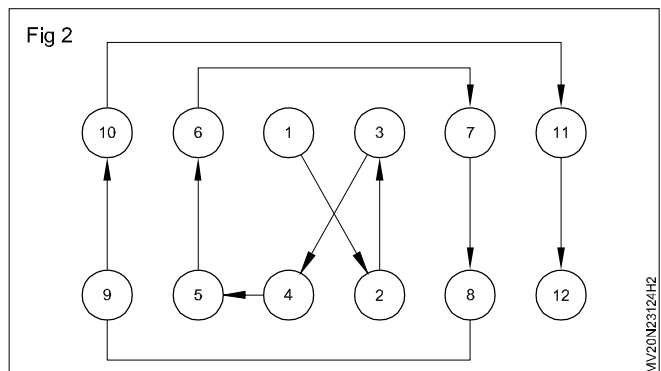
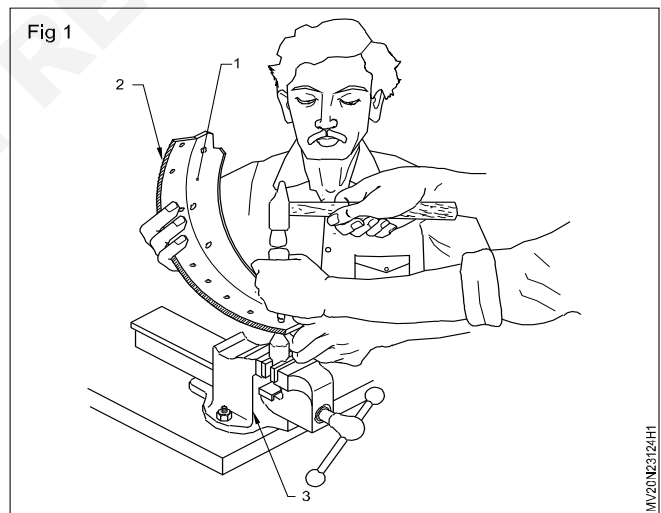
- remove and replace new lining
- replace hand brake cable
- adjust brake pedal free play.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cleaning solvent	- as reqd.
• Feeler gauge	- 1 No.	• Brake liner	- as reqd.
• 'C' clamp	- 1 No.	• Cotton waste	- as reqd.
• Flat read drift	- 1 No.	• Grease	- as reqd.
• Oil can	- 1 No.	• Oil seal	- as reqd.
• Disc puller	- 1 No.	• Cottor pin	- as reqd.
Equipments / Machineries		• Kerosene	- as reqd.
• Vehicle	- 1 No.	• Sand paper	- as reqd.
• Jack and horse stand	- 1 Set	• Wheel chock	- as reqd.
• Bench vice	- 1 No.	• Brake fluid	- as reqd.
		• Brake pad	- as reqd.
		• Rivets	- as reqd.
		• Brake shoe retainer	- as reqd.

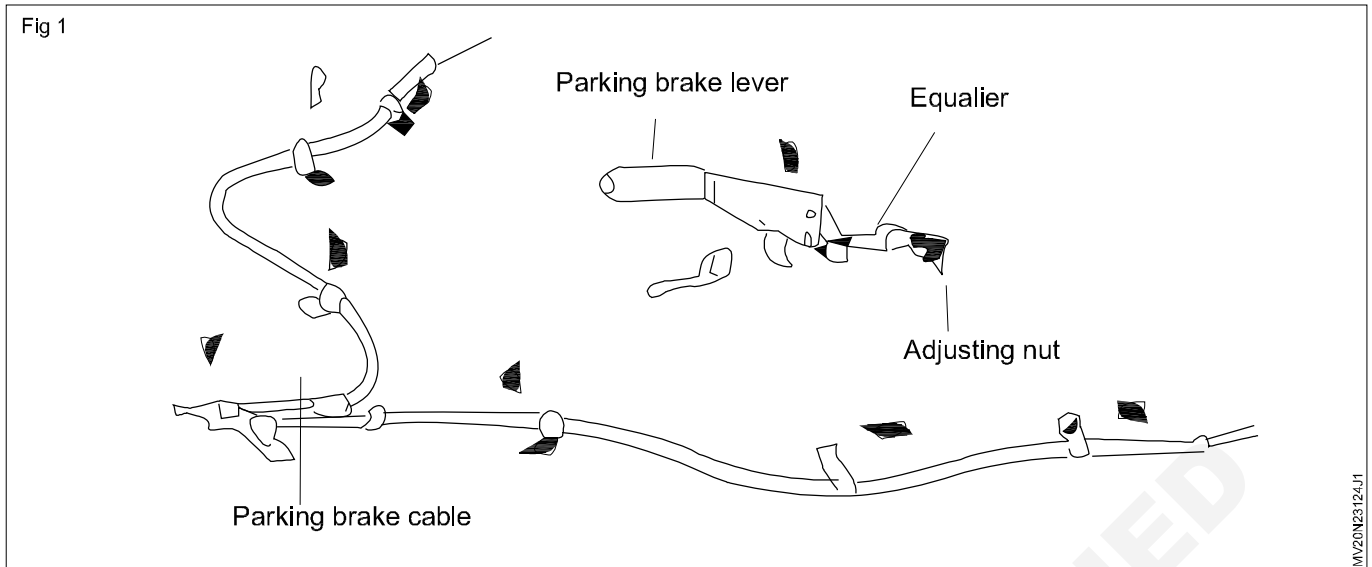
PROCEDURE

TASK 1: 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.1)
- 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.2)
- 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.3)

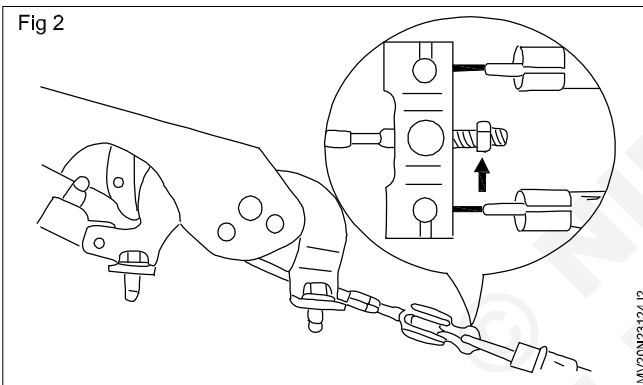


TASK 2: Adjust parking brake cable. (Fig 1)



Removal

1 Remove the console box. (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

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 rear of the backing plate.

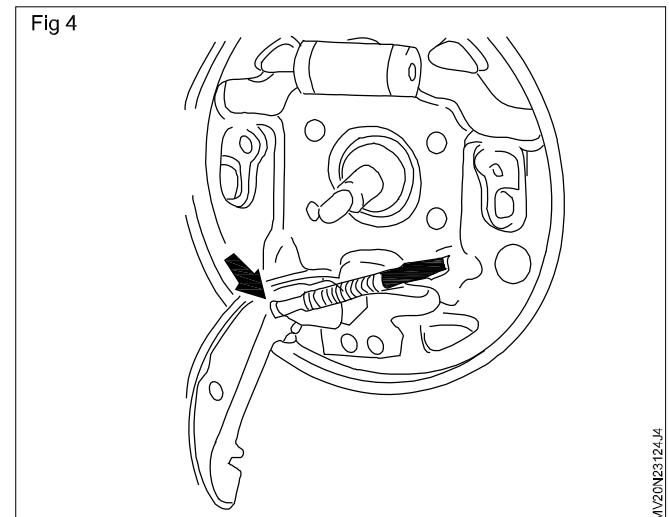
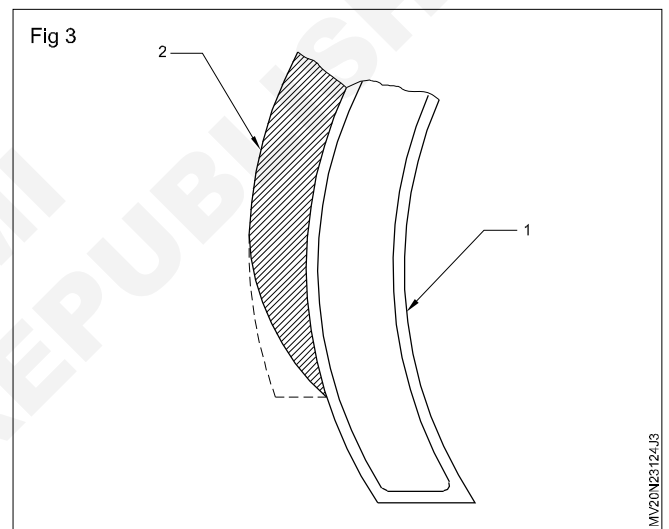
10 Remove the rear seat cushion assembly and roll up the carpet.

11 Loosen the parking brake cable clamp and remove the parking brake cable assembly. (Fig.4)

12 Check the parking brake lever ratchet for wear. (Fig.1)

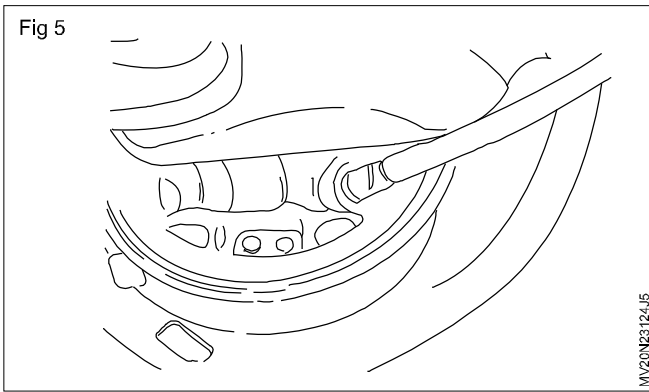
13 Check the parking brake cable for fraying or damage.

14 Check the parking brake cables for left and right identification marks and install accordingly.

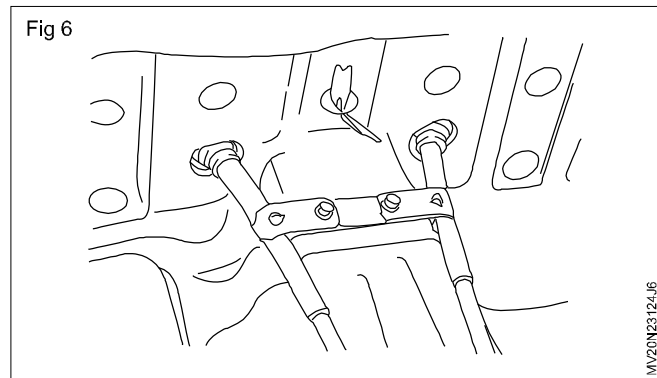


15 Move the adjust lever all the way back when installing the shoe-to-shoe spring.

16 Install the grommets in the direction shown in the illustration (Fig.5)

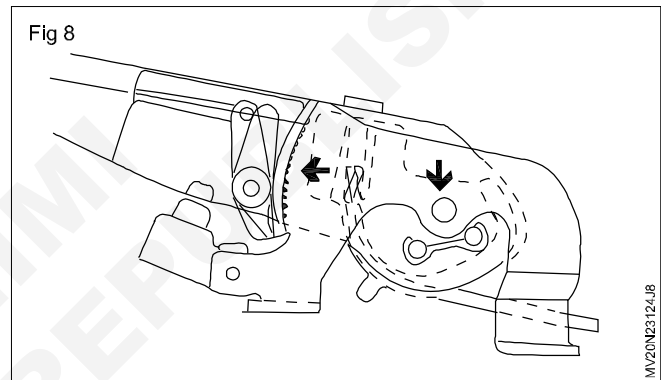
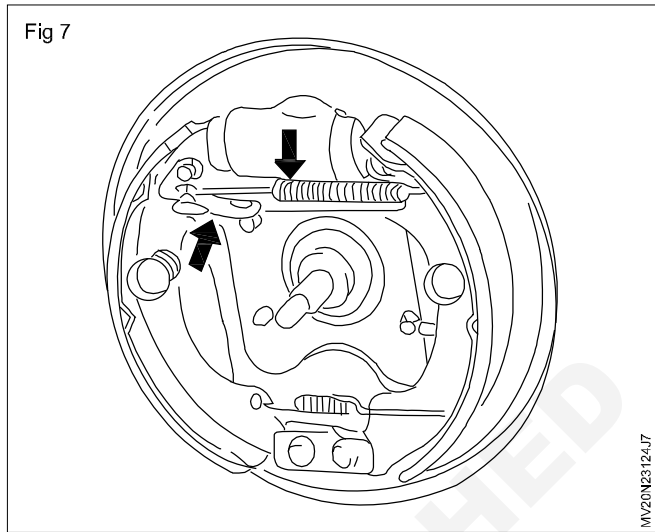


18. Apply a coating of the specified grease to the sliding parts of the ratchet plate and ratchet pawl (Fig.6)
Specified grease



Multipurpose grease SAE J310, NLGI NO.2

19. After installing the cable adjuster, adjust the parking brake lever stroke. (Fig.7 & 8)



Perform trouble tracing in brake system

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

- **trouble tracing in brake system**
- **brake testing points for brake certificate.**

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Jack	- 1 No.	• Soap oil	- as reqd.
• Wooden block	- 1 No.	• Bleeding nipple	- as reqd.
Equipments / Machineries		• Slack adjuster	- as reqd.
• Vehicle	- 1 No.	• Grease	- as reqd.

PROCEDURE

TASK: 1 Trouble tracing in brake system

- 1 Jack up wheels to clear floor
- 2 Loosen eccentric cam of leading brake shoe and hold it
- 3 With help of wrench turn the eccentric towards the front of the vehicle until the brake shoe strike the drum
- 4 Rotate the wheel with one hand and release eccentric unit wheel rotated freely
- 5 Hold the eccentric in position and tighten the lock nut
- 6 Repeat this above operation to adjust reverse shoe, but only turn the eccentric towards the back of the vehicle

- 7 Do this process for all the four wheels brakes

Note: In case hydraulic brake, bleed the brake system before adjust brake and maintain fluid level in the master cylinder.

- 8 Remove the jack from the wheel
- 9 check the brake pedal play
- 10 Start the vehicle and check the boot brake for brake balancing of four wheels
- 11 Ensure brake effect is equal in all wheel

TASK 2: Brake testing point for brake certificate

- | | |
|--|---|
| <ul style="list-style-type: none"> • check the engine serviceability • check the all tyre condition • ensure all tyres are equal wear • check tyre pressure as specified limit • check wheel nuts tightness • check the wheel bearing • check the steering linkages play with in limit • check the suspension serviceability • check the vehicle body fittings • check the brake pedal free play and adjustment • check the master cylinder fluid level and leakages from the fluid line. • Ensure no oil or grease between breaker shoe and drum. | <ul style="list-style-type: none"> • Ensure there is no air leaks in air brake system. • Ensure brake linkages are properly lubricated. • Check lights and switches in the vehicle • Check vacuum booster functionality in vacuum assisted brake • Use panel board of engine. • Release the hand brake. • Check the performance of moving vehicle • Apply foot brake at 10 km speed and check the effect brakes • Apply brake at high speed and check the all wheels braking effect are equal. • Ensure vehicle brake is fit for road worthy before issue brake fitness certificate to the vehicle. |
|--|---|

Perform maintenance of ABS brake system

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

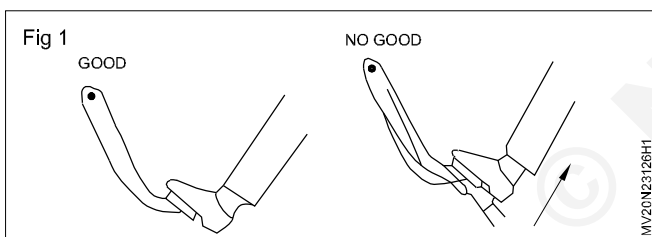
- handle the regular brake maintenance
- handle ABS maintenance.

Requirements			
Tools / Instruments		Materials	
• Trainee tool kit	- 1 Set	• Brake fluid	- as reqd.
• Steel rule	- 1 No.	• Flexible tube	- as reqd.
Equipments / Machineries		• Banian waste	- as reqd.
• Vehicle	- 1 No.		

PROCEDURE

TASK 1: Regular brake maintenance

- 1 Check the brake fluid level in both sections of the master cylinder
- 2 Top - up brake fluid to the proper level with manufactures specified level
- 3 Check the brake pedal for proper free play (Fig 1)



- 4 Adjust the brake pedal free play to the manufacturers specified level.
- 5 Check all the brake lines and fittings for leaks
- 6 Inspect all the brake tubing for rust and corrosion leaks and damages
- 7 Check each wheel for free rotation. If the on the wheels is hard to rotate, the brakes are likely not releasing properly.
- 8 Conduct road test for checking efficient braking
- 9 Ensure proper brake pedal feel during brake application
- 10 Ensure proper spring action of hand lever of hand brake.

TASK 2: ABS maintenance

- 1 Check all the ABS wiring harness for damage, or worn insulation.
- 2 Inspect all the line and fittings for leaks
- 3 Start the engine and observe the ABS working light
- 4 The light should remain on for approximately 5 seconds and turn off

- 5 If the warning light switches ON continuously then it seems that same problem with the ABS.
- 6 The fault can be identified with the scan tool and then rectified as per the instructions given by the service manual.

Check the tooth ring

- 1 Check the toothed rings on the wheel for find out the damage.
- 2 If any damages in the toothed ring, replace the damaged toothed ring.

TASK3: ABS bleeding

- 1 Turn the ignition key on and pump the brake pedal until the hydraulic pump motor starts.
- 2 Wait for hydraulic pump motor shut off.
- 3 Switch on ignition and ask the assistant to apply the brake pedal.

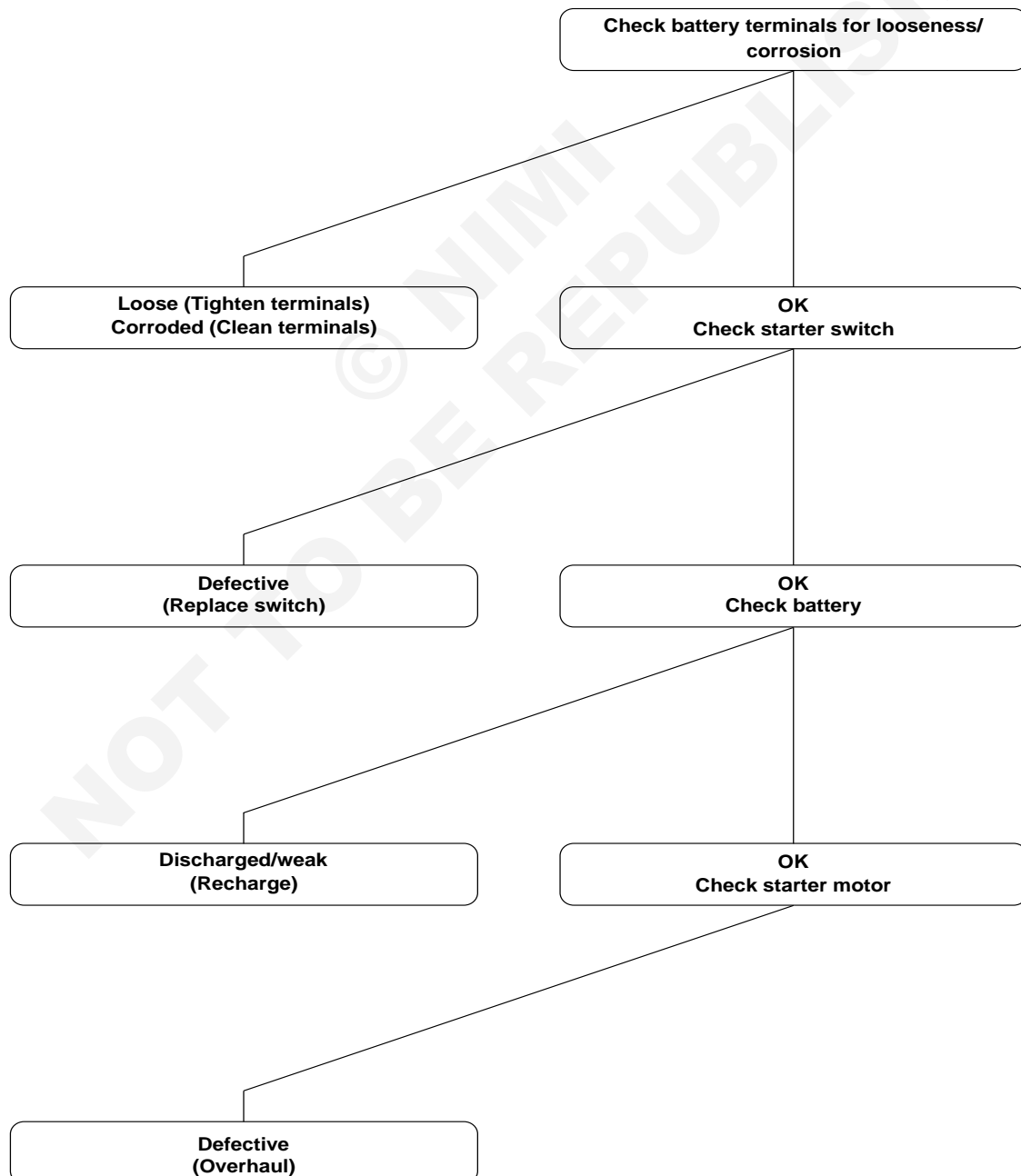
- 4 Bleed air from the hydraulic system with help of hose and glass container (Loosen and tighten the bleeder screw).
- 5 Fill the brake fluid in the master cylinder reservoir as required

Perform on trouble shooting procedure in heavy vehicle

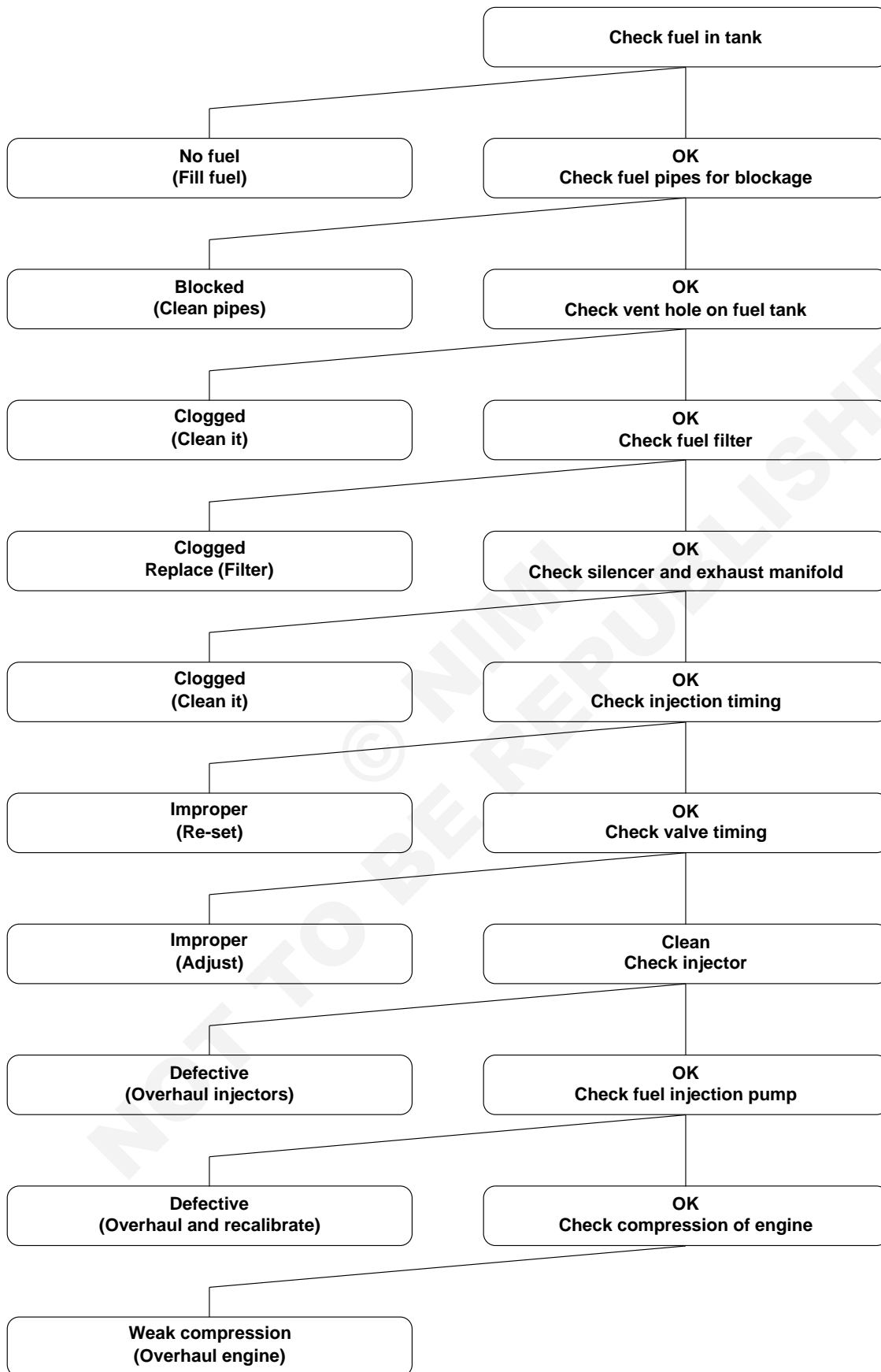
Objectives : At the end of this exercise you shall be able to

- rectify the causes for engine does not start (Electrical causes)
- rectify the causes for engine does not start (Mechanical causes)
- rectify the causes for high fuel consumption
- rectify the causes for engine over heating
- rectify the causes for low power generation
- rectify the high oil consumption
- rectify the causes for low engine oil pressure
- rectify the causes for high engine oil pressure
- rectify the causes for engine Noise.

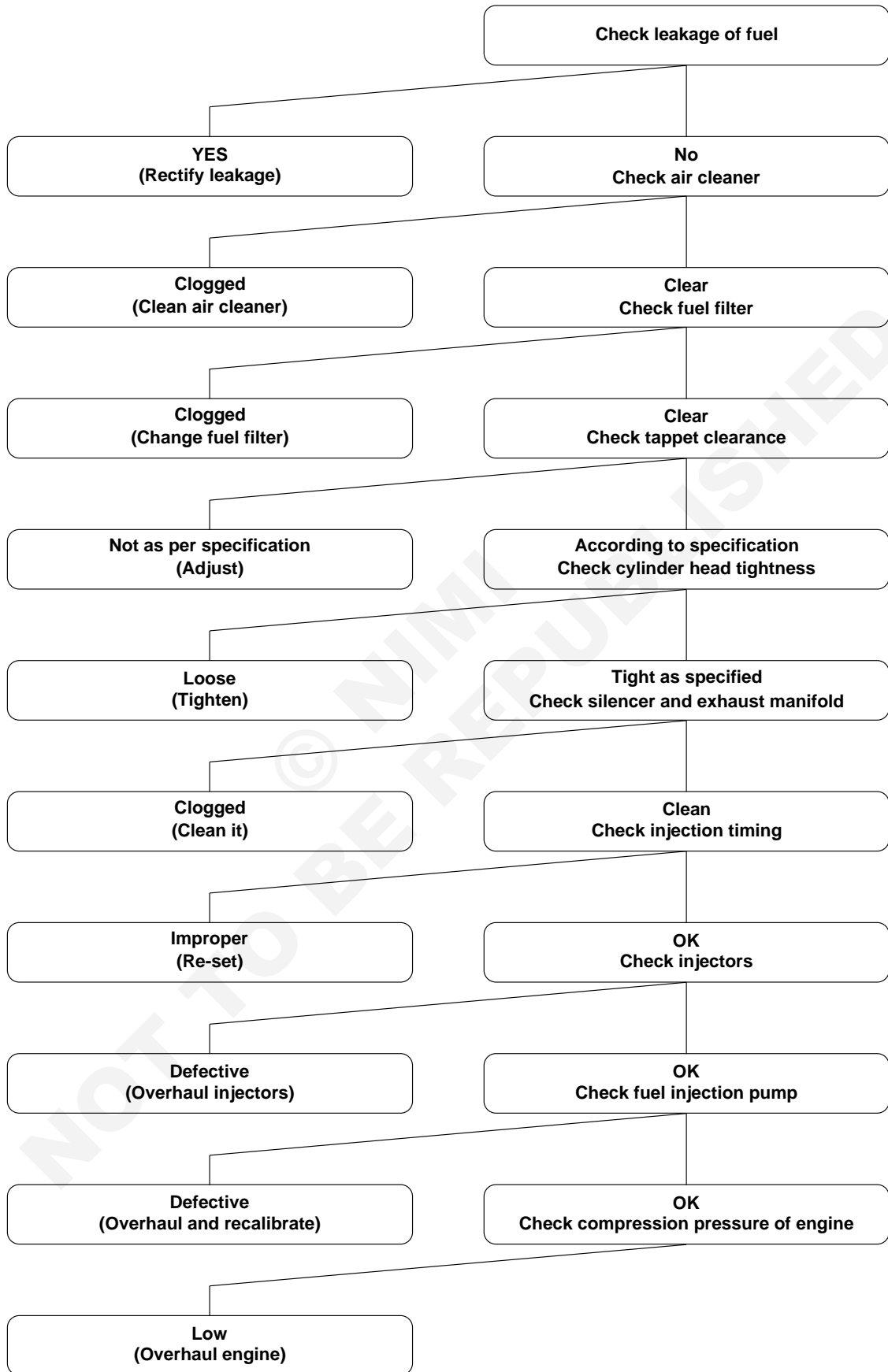
(I) Engine does not start (Electrical causes)



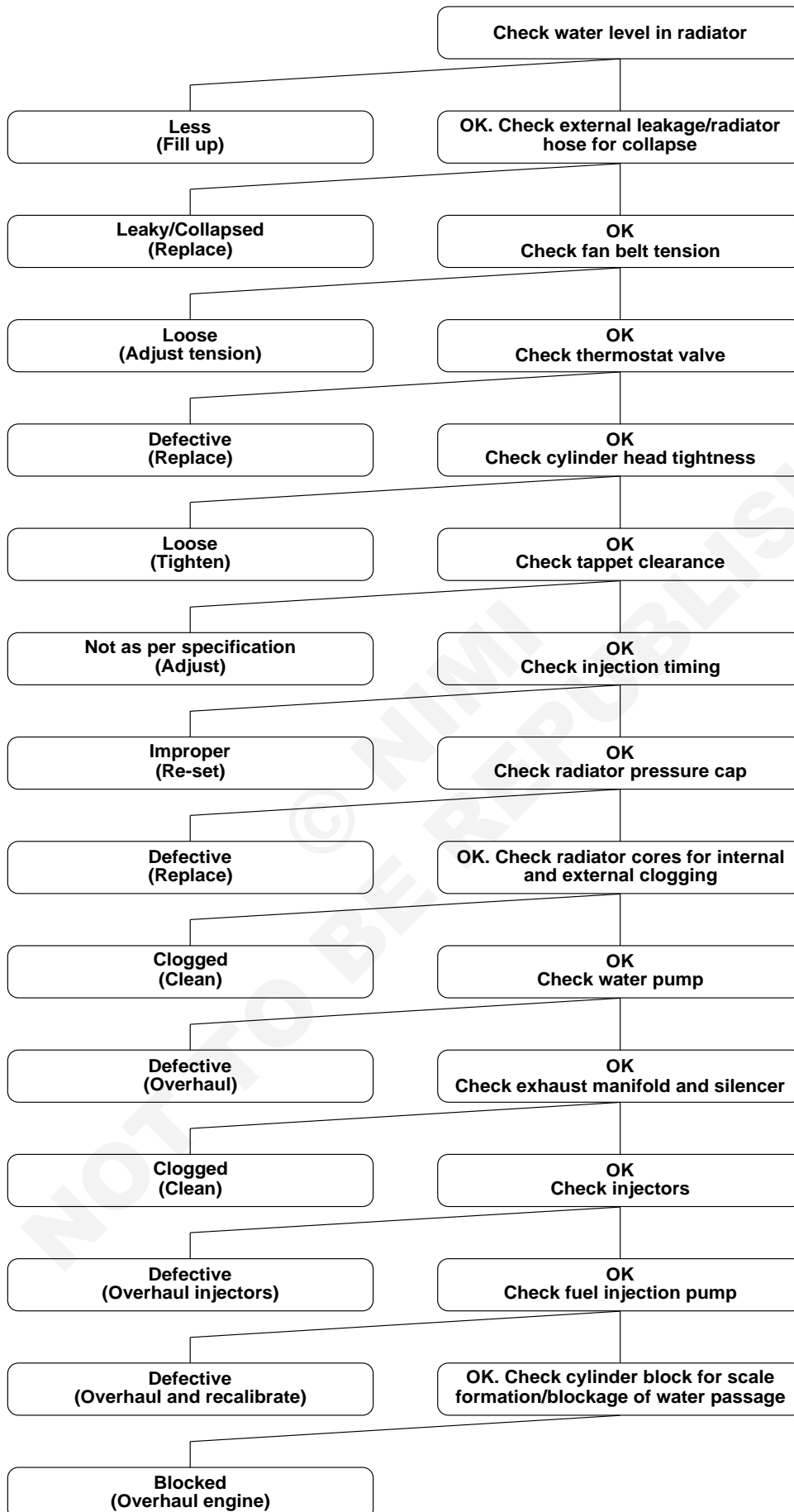
(II) Engine does not start (Mechanical causes)



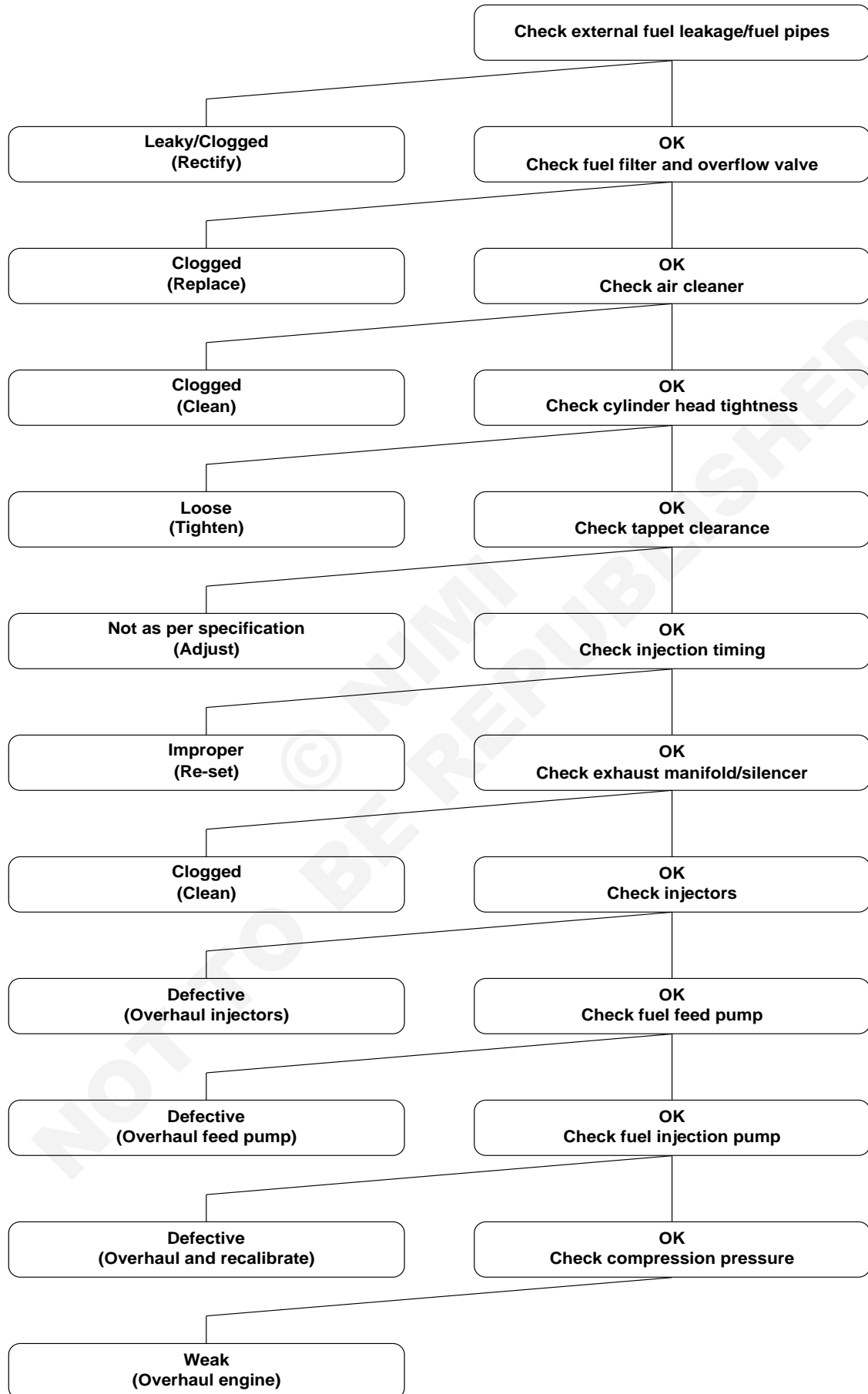
(III) High fuel consumption (diesel)



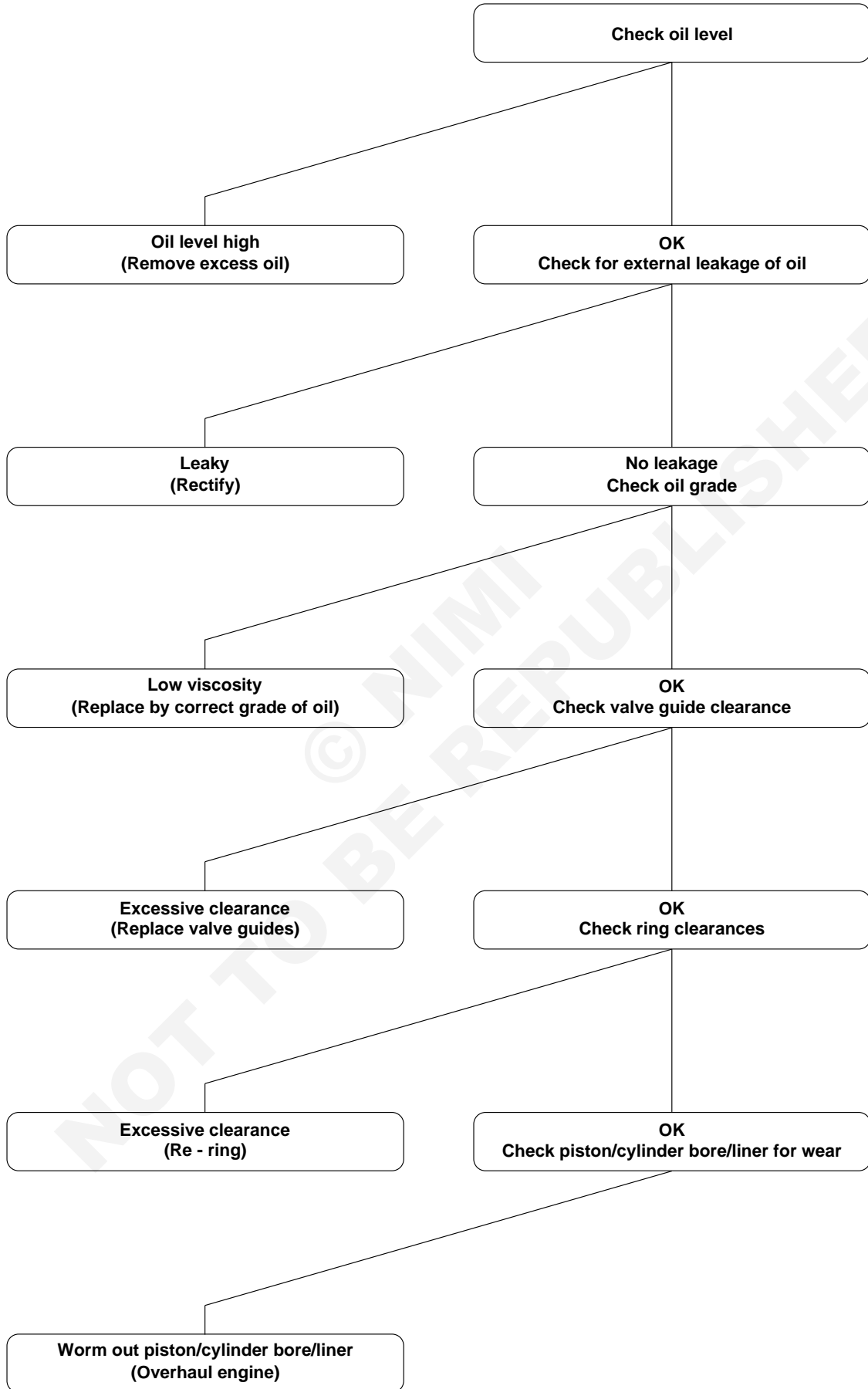
(IV) Engine over heating



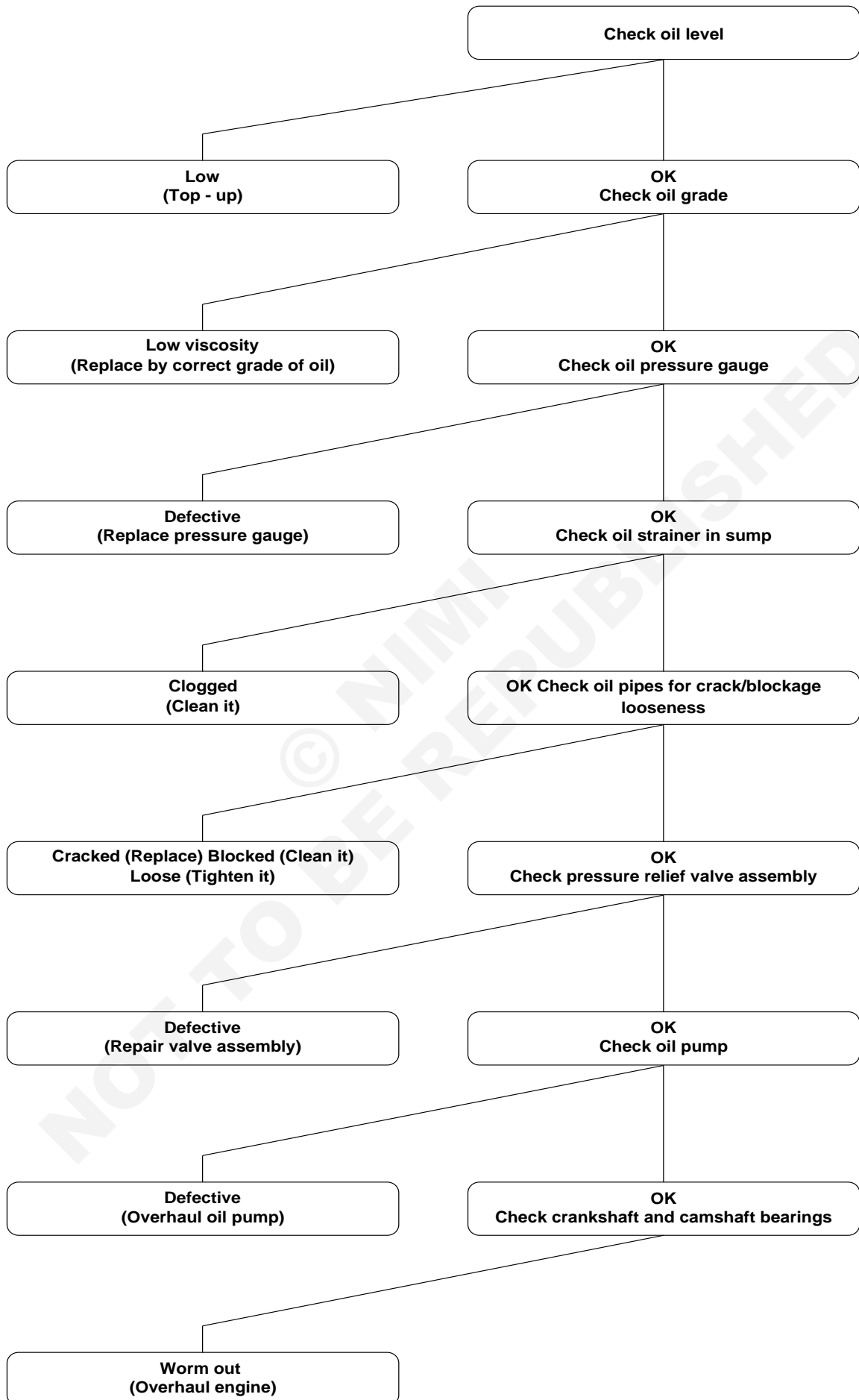
(V) Low power generation



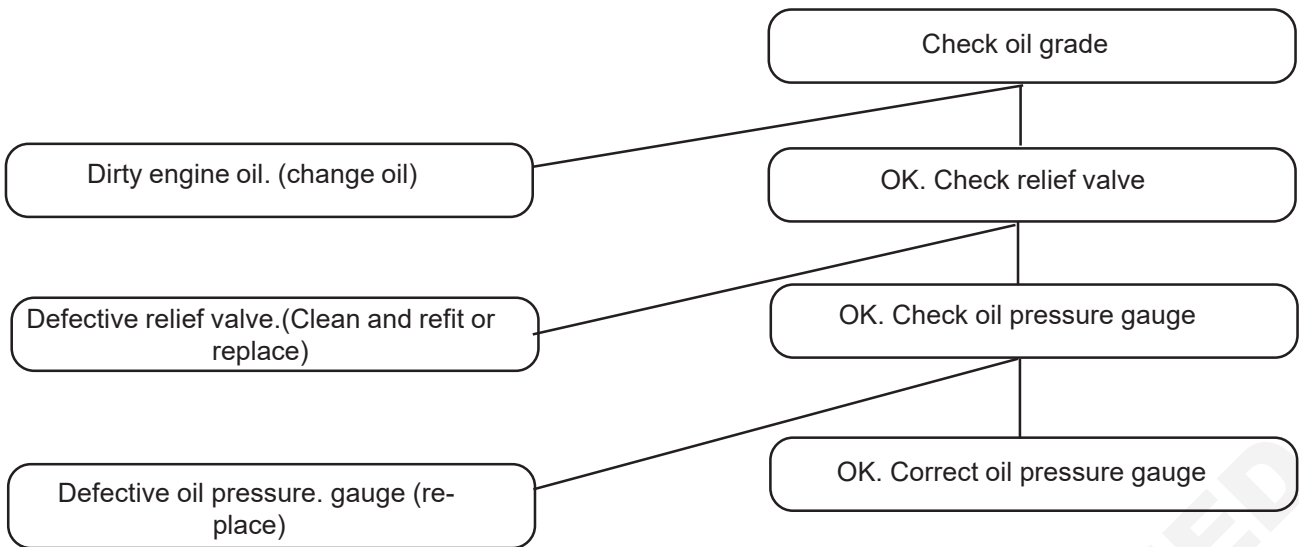
(VI) Excessive oil consumption



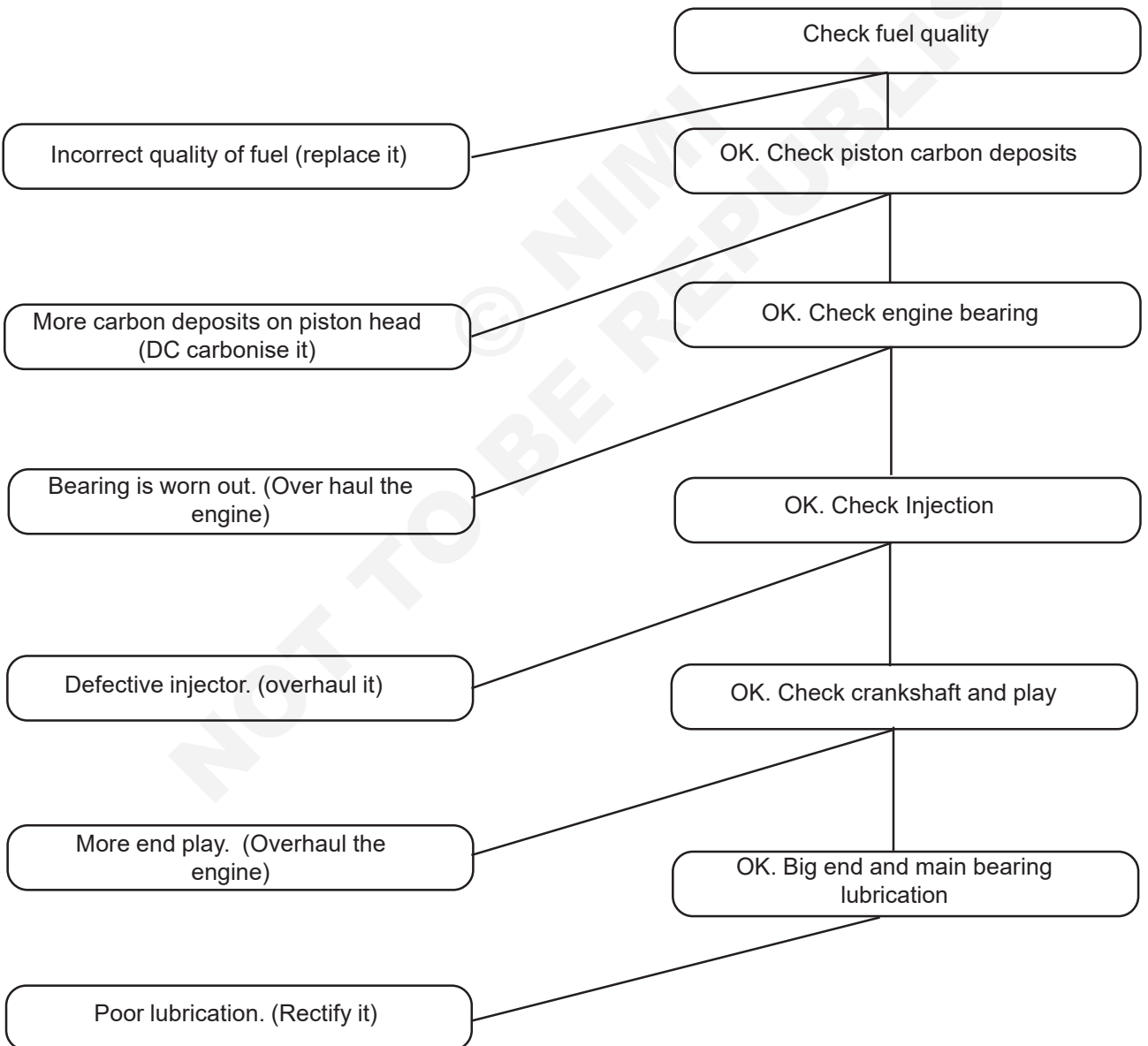
(VII) Low oil pressure



(VIII) High oil pressure



(IX) Engine noise



Identify the electronic control unit

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

- **Identify the location of ECU**
- **describe the function of ECU**

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Task lamp	- 1 No.	• soap oil	- as reqd.
Equipments / Machineries			
• Latest Vehicle	- 1 No.		

PROCEDURE

Identification of ECU

- Select the latest vehicle
- Park the vehicle and apply wooden chock for front and rear wheel
- Every vehicle manufacturer sells specific ECU which belongs to that vehicle.
- For example lets look at the popular BMW x 3 driven 28 i sports utility vehicle
- ECU have different part numbers with in the same make /model/year and with in a particular modal there can also be multiple options available for
- Example ECU stickers show the ECU exact part number. Arrow mark indicator the part number on sticker.
- 3780 - POA - A51
- 351 - 197338
- a) 37820 POA 0 A 51 is an ECM for a hard accord
- b) 15768288 is a term for a carolled truck
- C) F7uf - 12A650 - AFB- is an ECM for a fordan
- Identify the diagnostic connector
- Connect the OBD scan tool with connector
- Switch on the ignition key
- Read display on the scan tool it will indicate the ECU modal, serial number, make and fault diagnostic codes
- Incase ECU number is unknown, switch of the ignition key and remove the battery terminals.
- Disconnect the ECU wire connection and loose the mounting screw of ECU
- Remove the ECU and clean it
- Check the ECU sticker posted on the ECU and note the identification number.
- Even unable to identify the ECU ask the manufacturer (give details of vehicle name, modal, year of manufacturing and VIN number details to the manufactures)

Perform testing of electronic control unit by using scan tool

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

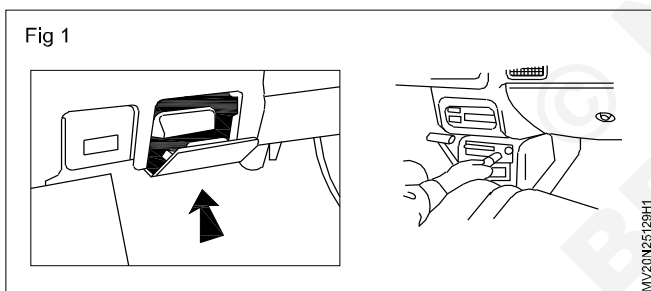
- Identify the E.C.U and engine scanner
- test the electronic control unit.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Engine scan tool	- 1 No.	• soap oil	- as reqd.
Equipments / Machineries			
• A running condition of E.F.I vehicle	- 1 No.		

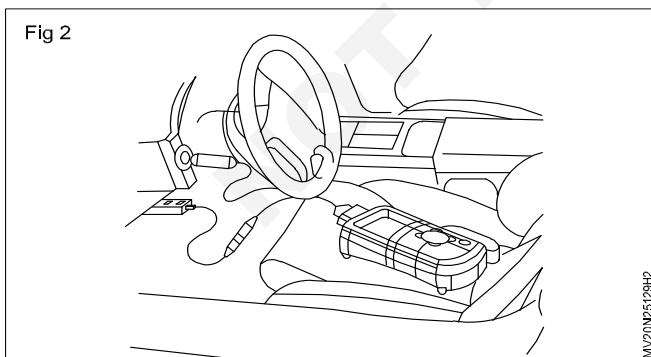
PROCEDURE

TASK 1: Identify the E.C.U and engine scanner and test the electronic control unit

- 1 Select the scan tool related service manual for the vehicle.
- 2 Attach the proper test connector cable and power lead to the scan tool.
- 3 Ensure that the ignition switch is in the 'OFF' position.
- 4 Attach the correct diagnostic connector. (Fig1)



- 5 Attach the scan tool test connector cable to the diagnostic connector. If necessary, use the proper adapter to connect the scan tool. (Fig. 2)



OBD II scan tools are powered from terminal 16 of the diagnostic connector, and no other power connection are needed.

- 6 Observe the scan tools screen to ensure that the scan tool is working properly. Most scan tools will complete an internal self check and notify the technician if there is a software (or) communication problem.
- 7 Enter vehicle information's needed to program the scan tool
 - Most OBD II scan tools automatically read the vehicle identification number (VIN). When the ignition switch is turned to the 'ON' position. This gives the scan tool the information needed to check for codes and perform other operation.
 - Older scan tools are programmed with the proper vehicle information by entering the vehicle year, engine type and other information. This information is usually contained in certain numbers and letters in the VIN.
- 8 Turn the ignition key to the 'ON' position.
- 9 Observe the scan tool to determine whether any trouble codes are present.
- 10 List all trouble codes as indicates in scan tool.
- 11 List all trouble codes as indicated in scan tool.
- 12 Use the scan tool literature (or) service manual to determine the meaning of the codes.
- 13 Erase the trouble codes shown in the scan tool.
- 14 Switch 'OFF' the 'ignition and switch on again.
- 15 Erase the trouble codes shown in the scan tool.
- 16 Switch 'OFF' the ignition and switch on again.
- 17 Check the engine indicator in OFF position. If not, some problems with the electronic management system (EMS.)
- 18 When the test is completed turn the ignition switch to the 'OFF' position.
- 19 Remove the scan tool test connection cable from the diagnostic connector.

Identify the MPFI components and its sensors

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

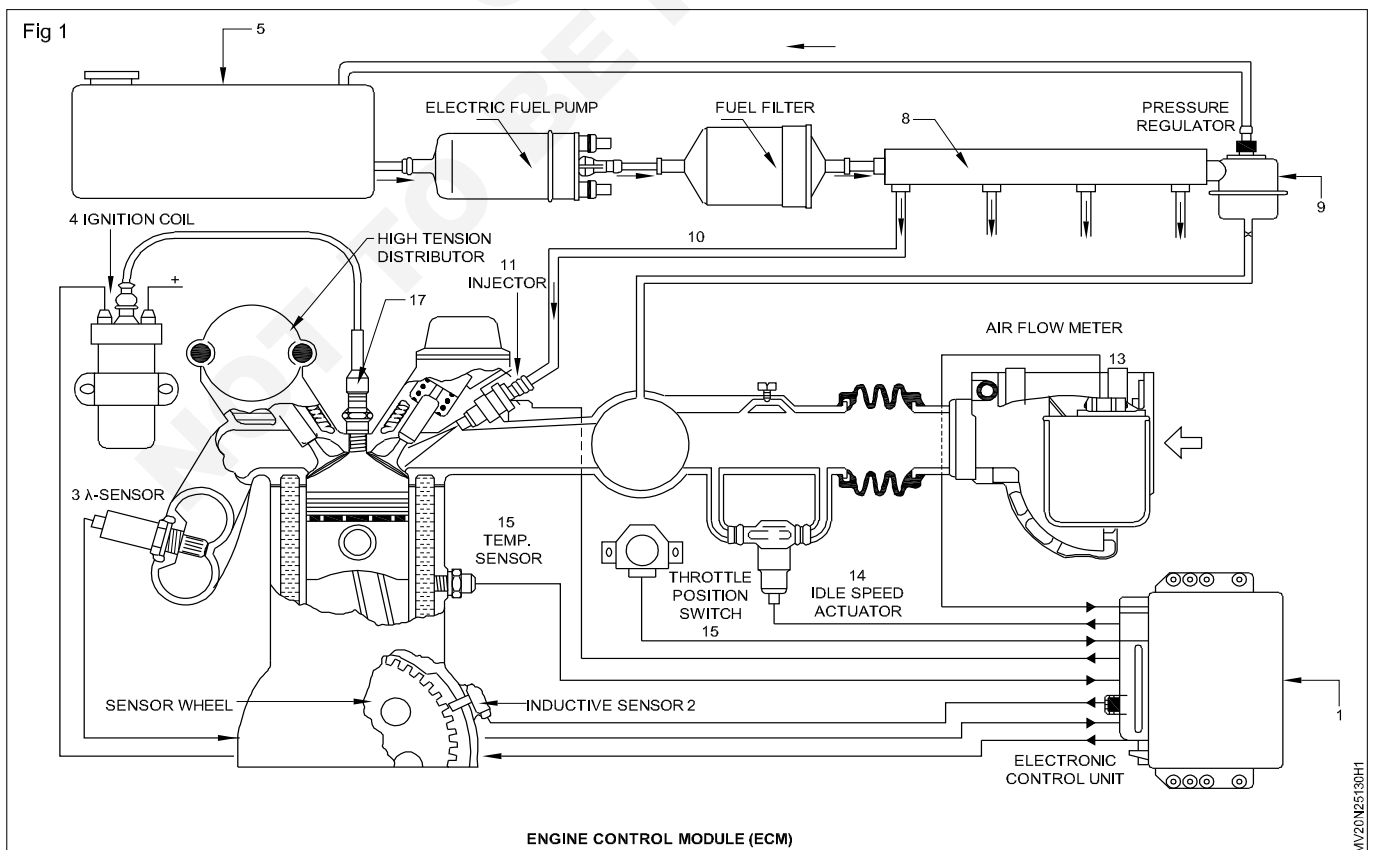
- locate the various parts of MPFI and sensors.

Requirements	
Tools / Instruments	Materials
<ul style="list-style-type: none"> • Trainees tool kit 	<ul style="list-style-type: none"> - 1 Set
Equipments / Machineries	
<ul style="list-style-type: none"> • Vehicle with MPFI 	<ul style="list-style-type: none"> • Tray - 1 No. • Banian cloth - 1 No.

PROCEDURE

TASK 1: Locate the various parts of MPFI and sensors (Fig. 1)

- | | |
|--|---|
| 1 Locate the ECM (1) | 9 Locate the pressure regulator (9) |
| 2 Locate the fly wheel and the crank shaft position sensor (2) | 10 Locate fuel delivery line (10) |
| 3 Locate the oxygen sensor (3) | 11 Locate the petrol injector (11) |
| 4 locate the ignition coil (4) | 12 Locate the accumulator (12) |
| 5 Locate the fuel tank (5) | 13 Locate the intake air pressure sensor (13) |
| 6 Locate electric fuel pump (6) | 14 Locate idle speed actuator (14) |
| 7 Locate the fuel filter (7) | 15 Locate the throttle speed switch (15) |
| 8 Locate the common rail (8) | 16 Locate the engine temperature sensor (16) |
| | 17 Locate the spark plug (17) |



Check dash board instrument and gauges

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

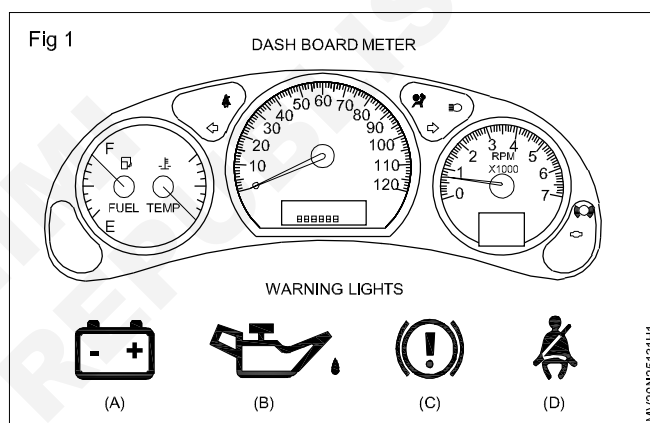
- Check the instruments and gauges function
- Replace the instruments and gauges.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Multi Meter	- 1 No.	• Soap oil	- as reqd.
Equipments / Machineries		• Gauges	- as reqd.
• vehicle	- 1 No.	• Bulbs	- as reqd.
		• Wire	- as reqd.

PROCEDURE

TASK: Check the instruments on dash board. (Fig 1)

- 1 Park the vehicle on surface floor.
- 2 Apply wooden chock to the wheels.
- 3 Apply hand brake and check parking brake light glow on dash board.
- 4 Switch on the main switch and check the warning lights and instruments on dash board.
- 5 Check the warnings signal light of engine, Lub oil in pump, seat belt, battery charging , head light, side indicator, warning light, safety warning light, cabin temperature indicators etc.
- 6 Start the engine and observe the RPM meter, Fuel gauge temperature gauge.



TASK:2 Replace the defective gauges and instruments

- 1 Start the engine and check the warning lights fitted in panel boards
- 2 If not glow any warning lights, check the connection and bulbs if defective replace the bulb and rectify the loose wire connections
- 3 Check RPM meter if defective replace it.
- 4 Check the fuel gauge and temperature gauge for defects and replace the defective gauges
- 5 Move the vehicle and check the speedometer of RPM meter during vehicle run
- 6 If odometer & RPM meter is found defective, check the wire and cable connections, and replace the defective gauge sensor wire connections.
- 7 After replacing the defective gauges and instruments check the all gauges and warning lights functions (before starting and after starting the engine)

Perform testing of sensors

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

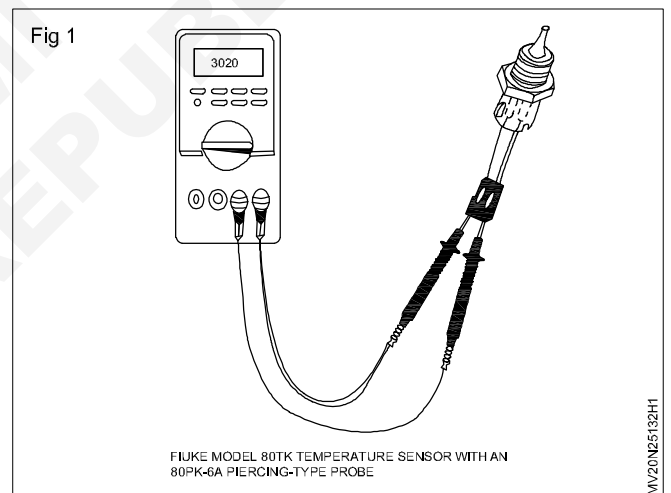
- test the temperature sensor
- test the pressure sensor
- test the potentiometer
- crankshaft position sensor
- test the camshaft sensor.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Tray	- 1 No.
• Multi Meter	- 1 No.	• Banian cloth	- 1 No.
Equipments / Machineries			
• Vehicle			

PROCEDURE

TASK 1: Temperature sensor (Fig.1)

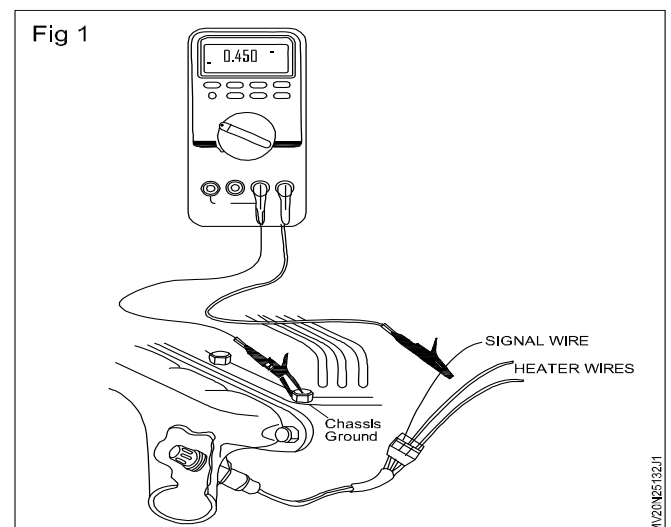
- 1 First open the bonnet by removing the lock
- 2 Locate the temperature sensor, mostly it is located in the thermostat valve region.
- 3 Set the multi meter in the resistance measuring mode.
- 4 Ground the black terminal, connect the red terminal to the temperature sensor, measure the resistance.
- 5 Turn the engine on, run for two to three minutes to warm up the engine.
- 6 Now measure the resistance with the same procedure.
- 7 If the difference in resistance is more than 200 ohms the sensor is in good condition.
- 8 If the difference is not more than 200 ohms. Replace the temperature sensor.



TASK 2: Pressure sensor (Fig.1)

Air intake pressure, atmospheric pressure, vapor pressure in the fuel tank and fuel injection pressure sensors are used in the vehicle. But the testing procedure of the sensors used in the vehicle is same for all the sensors.

- 1 Identify the location of the sensor.
- 2 Use the multi meter, set in AC mV range.
- 3 Start the engine, keep it in running.
- 4 Ground the black terminal
- 5 Touch the red terminal
- 6 If any voltage say at about 200 to 400mV then the sensor is functioning correctly.
- 7 If not develops any voltage then replace the sensor.



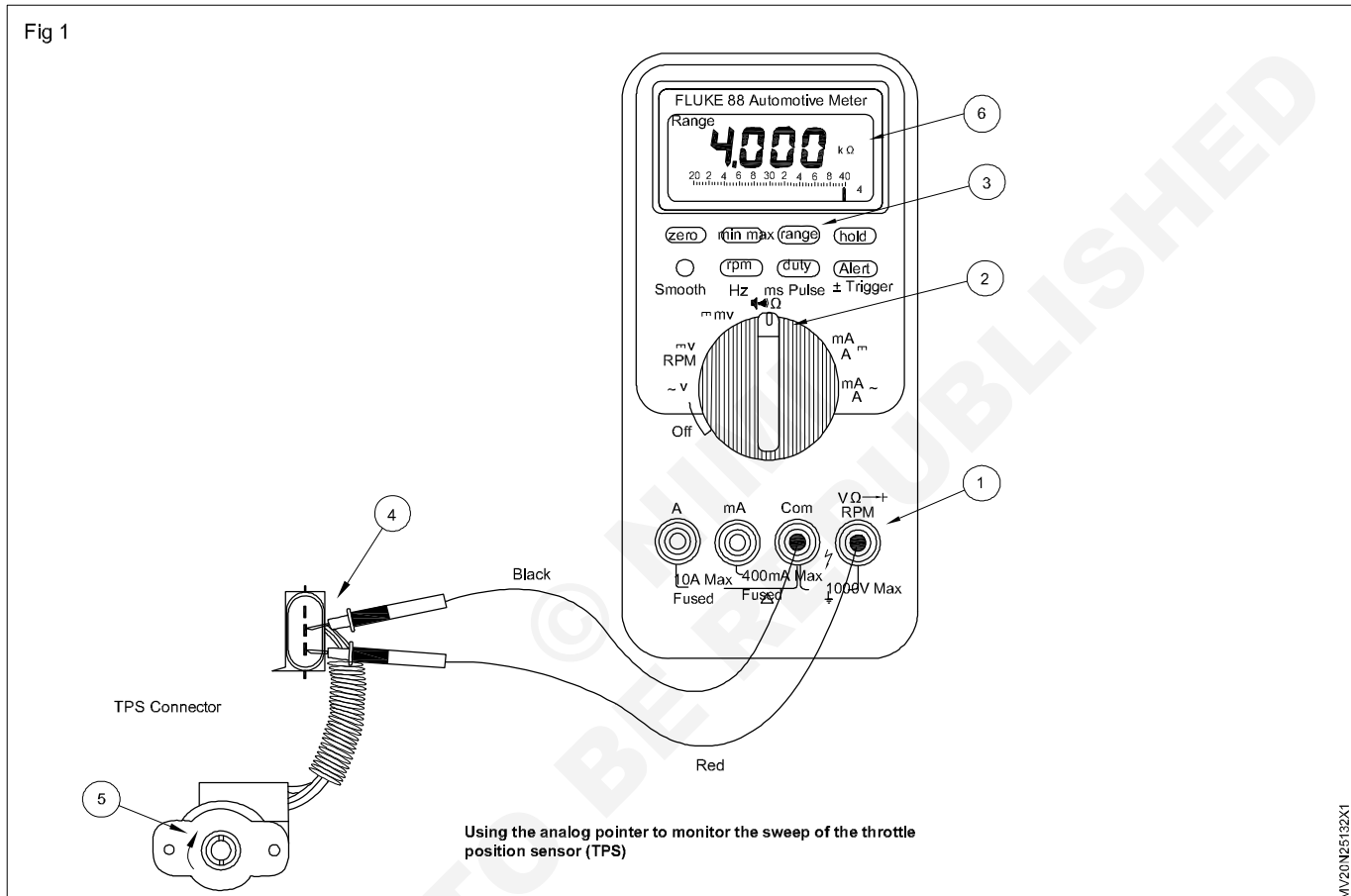
TASK 3: Throttle position sensor (Potentiometer) test (Fig.1)

- 1 Remove the air cleaner assembly
- 2 Turn off the ignition switch
- 3 Disconnect the connector from electric throttle body.
- 4 Check the TP sensor main and sub output voltage as follows.
- 5 Arrange 3 new 1.5 voltage batteries in series and check the voltage is 4.5 to 5.0 voltage.
- 6 Connect the voltmeter and batteries to TP sensor as shown in the figure.

- 7 Check the voltage linearly varies depending on throttle opening angle as shown in the figure while throttle valve is opened and closed by finger.

While testing the following condition to be satisfied.

- 8 Ambient temperature should not exceed 5°C.
- 9 Accelerator pedal should be in idle position. i.e fully closed condition.



TASK 4: Crank shaft position sensor (CKP) (Fig.1)

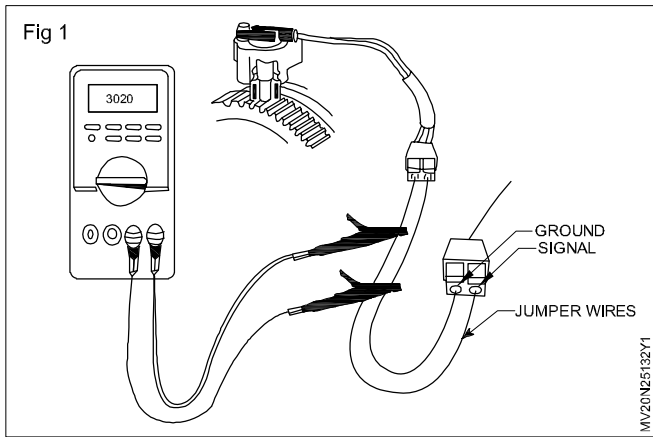
These sensors are called by so many different names like: Hall effect sensor, CKP sensor, CMP sensor, pickup coil, Magnetic pulse generator, variable reflector and the list goes on with a few more names.

There are two types

Three pin type and two pin type.

If the car engine fails to start properly, there may a defect in crank shaft position sensor and cam shaft position sensor. This sensor measures the crank shaft position and speed. Both the sensor have the control injection and ignition timing.

- 1 It is comprises of very simple procedure.
- 2 Locate the sensor. Normally it is located either end of the crank shaft.
- 3 Run the engine and set the multi meter in the AC mille volt range.
- 4 Measure the voltage using the probes.
- 5 Normal range would be 200mV. Also refer the manufacturer's manual for the exact readings. It may vary manufacturer to manufacturer.
- 6 If not develops any voltage sensor may be opened. Replace it.



TASK 5: Cam shaft position sensor CMP

- | | |
|--|--|
| <ol style="list-style-type: none"> 1 It is also of very simple procedure like CKP. 2 Locate the sensor. Normally it is located either end of the head assembly. 3 Run the engine and set the multi meter in the AC millivolt range. | <ol style="list-style-type: none"> 4 Measure the voltage using the probes. 5 Normal range would be 200 mV. Also refer the manufacturer's manual for the exact readings. It may vary manufacturer to manufacturer. 6 If not develops any voltage sensor may be opened. Replace it. |
|--|--|

TASK 6: Magnetic induction sensor

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Locate the magnetic induction sensor normal it is used in electronic ignition system 2 Magnetic sensor is fitted in pulse generator 3 Magnetic sensor develops voltage and then passes signal to ECU. | <ol style="list-style-type: none"> 4 Connect the multi meter between magnetic sensor and ECU 5 Start the engine and check voltage reading in multi meter. 6 If voltage signal not found, check wire connections 7 If sensor is defective replace the sensor. |
|---|--|
-

Perform an engine trouble shooting

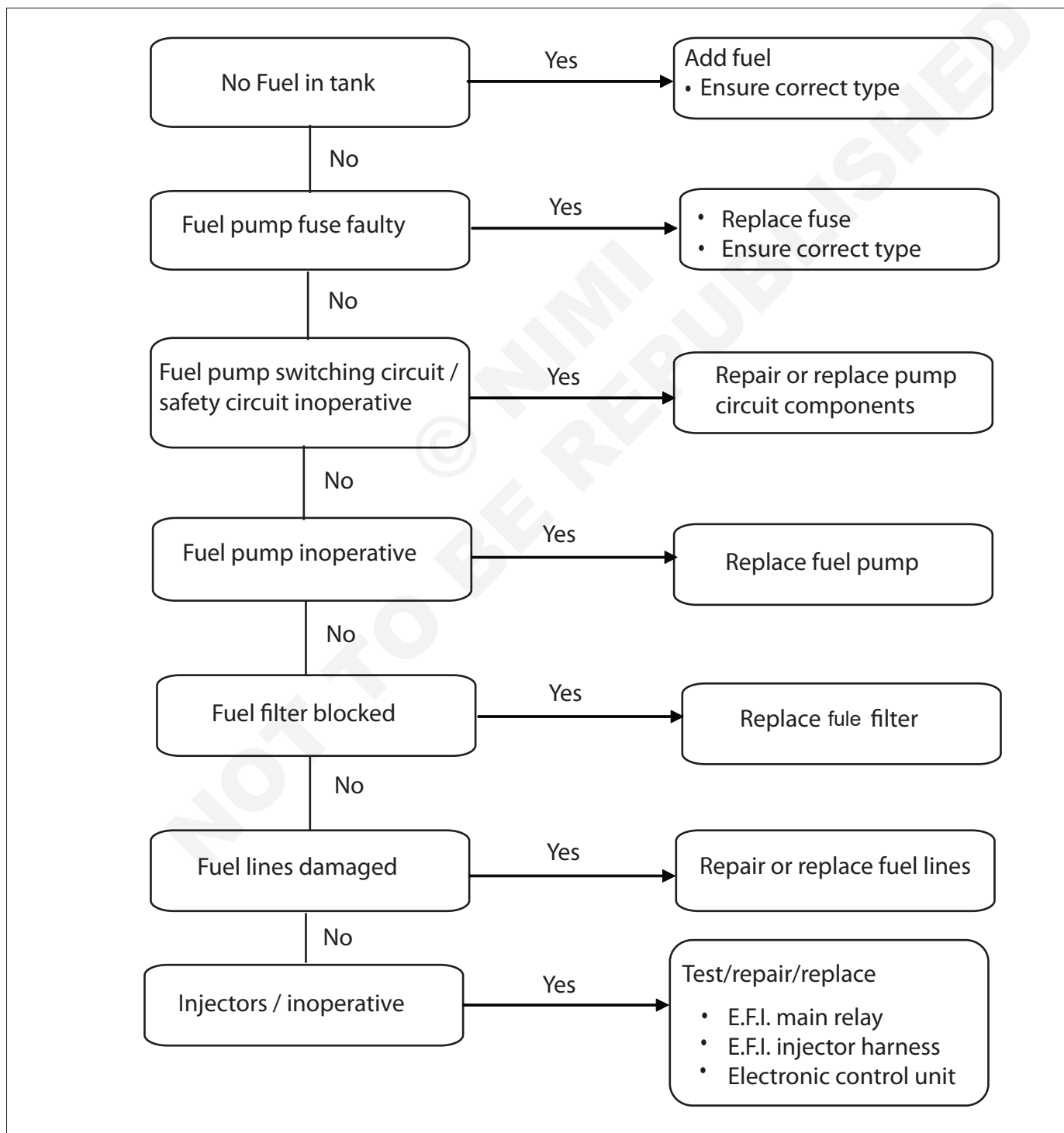
Objective: At the end of this exercise you shall be able to

- Identify the causes and remedies for engine does not start
- Identify the causes and remedies for poor engine performance.

PROCEDURE

Procedures for electronic petrol injection systems

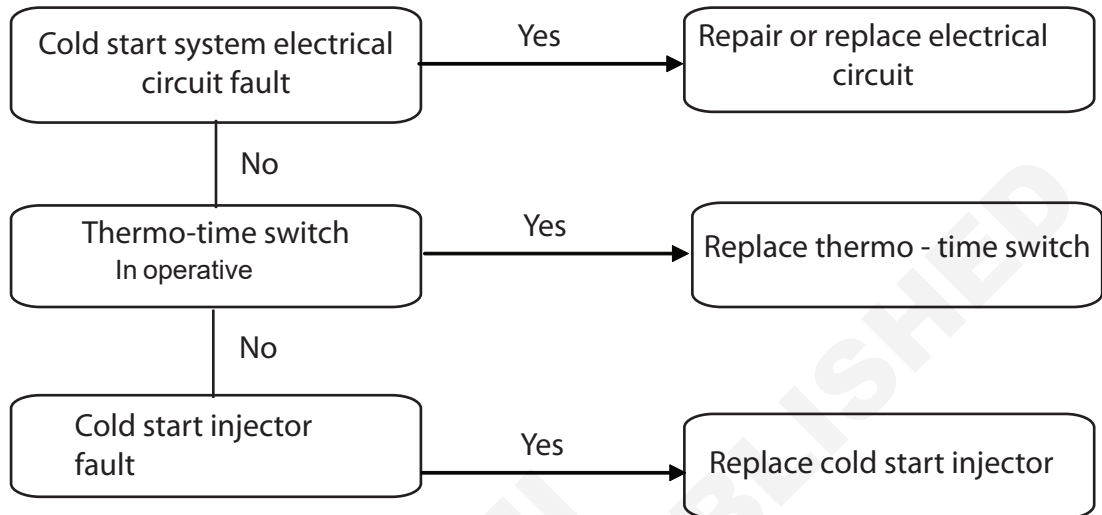
Chart 1 - Engine cranks but will not start



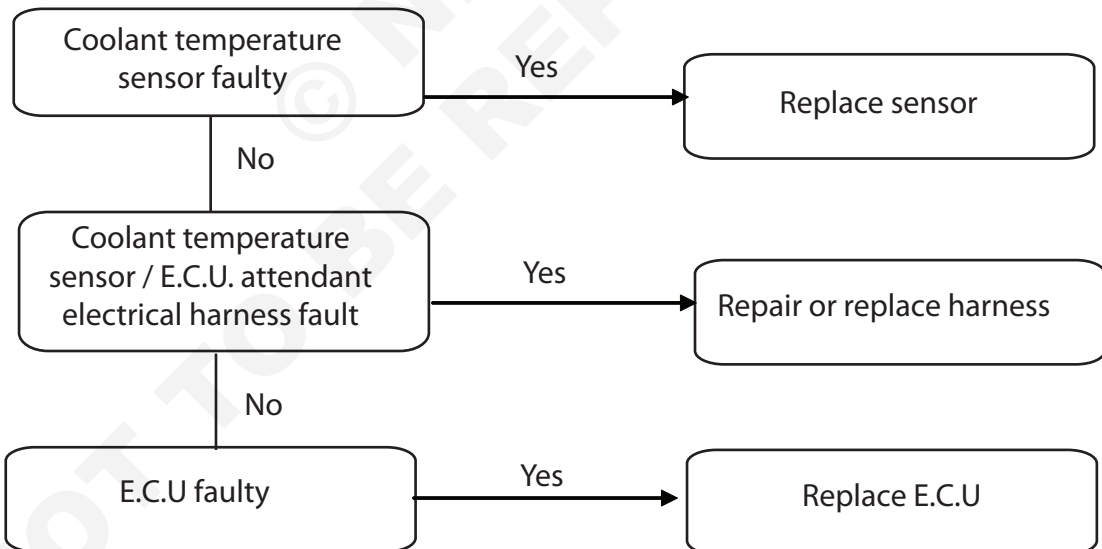
- Engines fitted with cold start injectors may start cold, run for a few seconds, then stop.
 - The short run time is evidence that the fuel pump is operating satisfactorily.
 - It is also evident that the main injectors or injector control circuits is fault.

Cold start via separate system

Chart 2 - Engine hard to start - cold

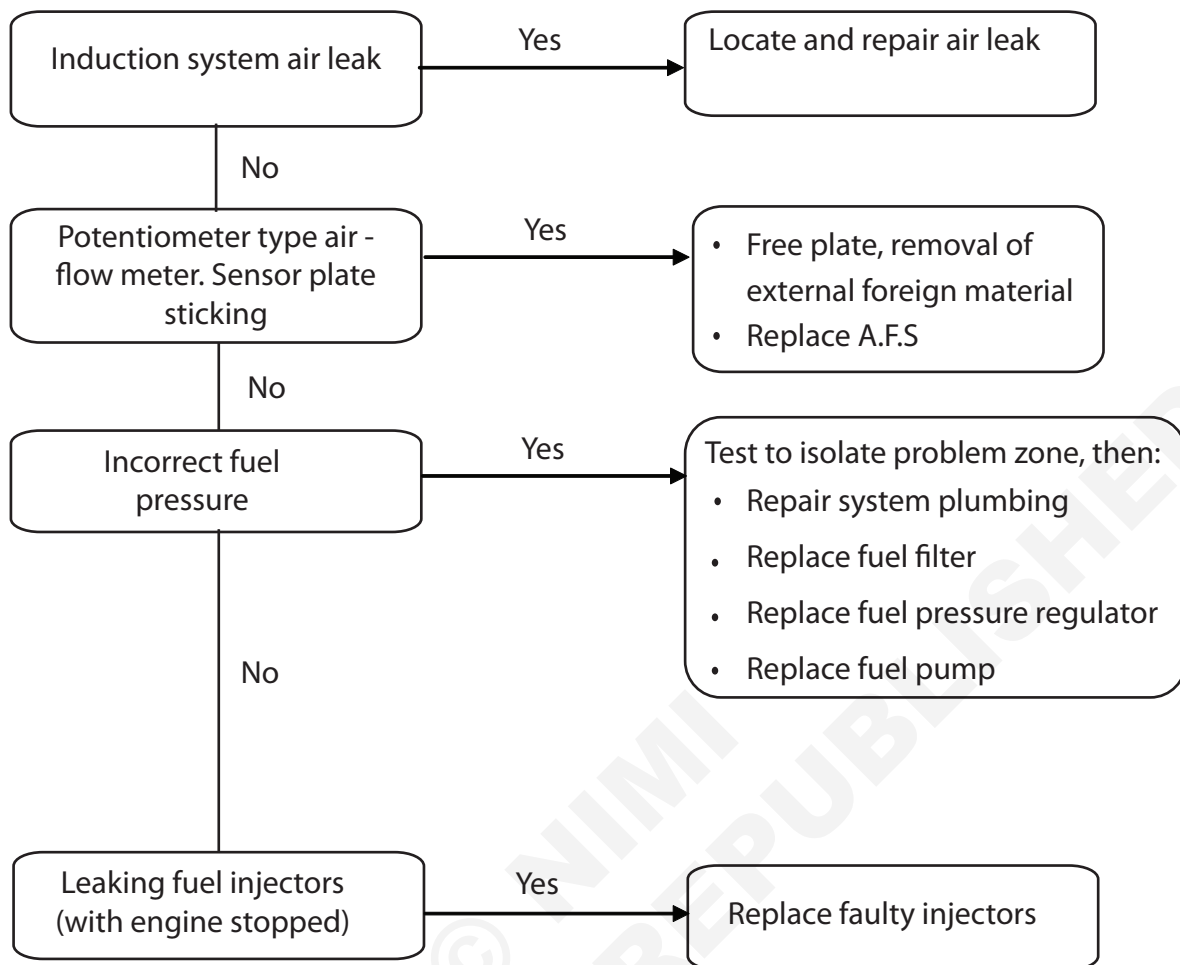


Cold start promoted by E.C.U



Electrical problems involving the system harness will most likely lie in the area of component / harness coupling.

Chart 3 - Engine hard to start - Hot



A faulty cold start injector or cold start injector circuit may cause the cold start injector to operate during a hot start. The resultant semi-flood condition may make starting difficult.

Set ignition timing

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

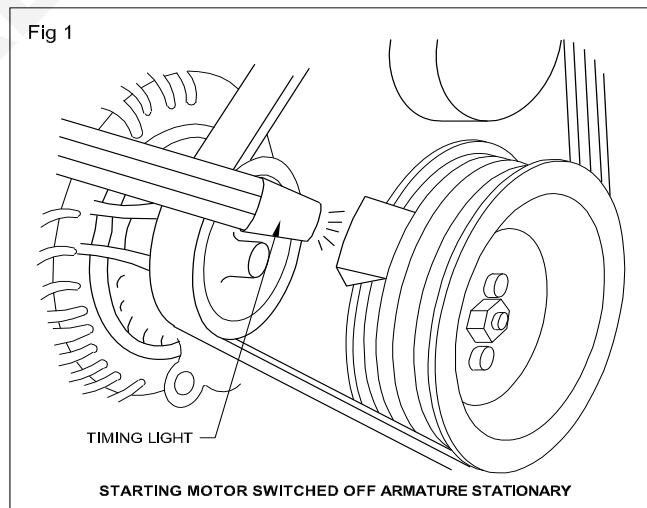
- inspect distributor less ignition timing
- setting ignition timing in electronic distributor ignition system
- remove spark plug
- clean and inspect spark plug
- adjust spark plug gap
- check ignition spark
- install spark plug
- tracing and testing of hall effect sensor
- tracing and testing oxygen sensor circuit.

Requirements			
Tools / Instruments			
• Trainees tool kit	- 1 Set	• Spark plug tester	- 1 No.
• Timing light	- 1 No.	• Air compressor	- 1 No.
• Spark plug spanner	- 1 No.	Materials	
Equipments / Machineries		• Emery paper	- as reqd.
• A motor vehicle with distributor less ignition	- 1 No.	• Cleaning solvent	- as reqd.
• Multi scan tool	- 1 No.		

PROCEDURE

TASK 1: Inspect distributor less ignition timing

- 1 Switch off the ignition.
- 2 Connect multi scan tool with the data link connector.
- 3 Start the engine and warm up to normal operating temperature.
- 4 Switch off all electrical connections except ignition.
- 5 Check the idle speed of the engine is within the specification.
- 6 For inspecting ignition timing, select the correct mode in the scan tool. For mode selection, collect the details from the shop manual.
- 7 Connect timing light with the ignition coil no.1 and check the ignition timing (Fig.1). The timing advance differs from different vehicles. Confirm with the shop manual.
- 8 If the ignition timing is out of specification, check the crank shaft position sensor, cam shaft position sensor, throttle position sensor and knock sensor.



- 9 Replace the sensors if necessary.
- 10 Disconnect the multi scan tool.

TASK 2: Setting ignition timing in electronic distributor ignition system

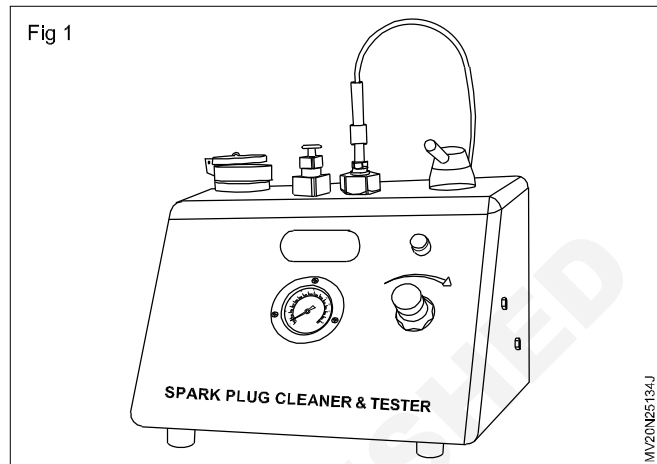
- 1 Remove spark plug from cylinder No. 1
- 2 Place compression gauge hose fitting a spark plug hole.
- 3 Crank the engine by hand till the compression appears on the gauge align the timing marks.
- 4 Locate the No. 1 spark plug wire position in the distributor cap.
- 5 Loosen the clamp of the distributor body and positioned it by rotating distributor body slightly both directions until a high point of reflector is align with the head on the pickup coil.

- 6 Tighten the distributor body at the above position.
- 7 Clamp the distributor cap.
- 8 Connect high tension leads from distributor cap to all spark plugs as per firing order.

- 9 Start the engine and adjust if requires with the help of timing light.

TASK 3: Remove spark plug

- 1 Remove air cleaner assembly.
- 2 Disconnect high tension lead from the spark plug.
- 3 Remove ignition coil assembly if required.
- 4 Loosen the spark plugs.
- 5 Apply air blow around the spark plug to avoid foreign particles entering into the cylinder.
- 6 Remove spark plug from the engine cylinders.
- 7 Check the spark plug in a standard spark plug tester shown in Fig. 1

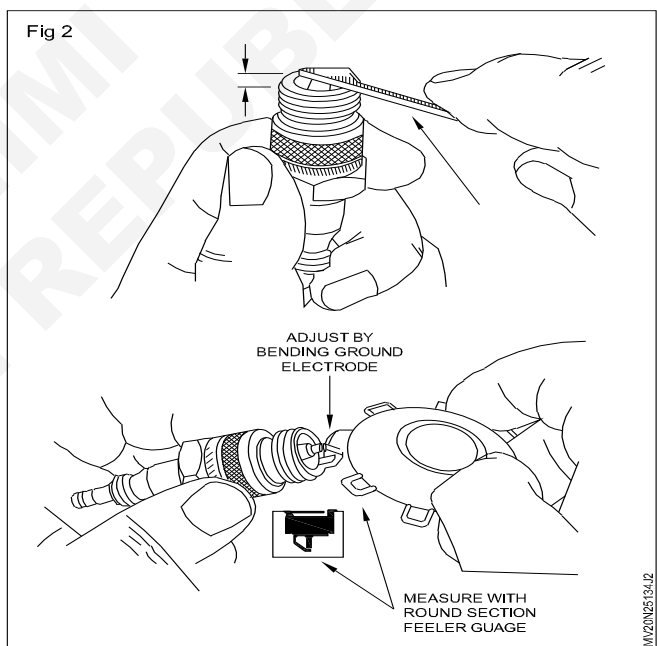


Clean and inspect spark plug

- 1 Check the spark plug for carbon deposition, cracks and damage.
- 2 Clean the spark plug with spark plug cleaning machine.
- 3 Check the spark plug for wear or insulator damage.

Adjust spark plug gap

- 1 Check the spark plug gap with the spark plug gauge. (Fig.2)
- 2 Adjust the gap as per the manufacturer's specification.



Check ignition spark

- 1 Connect ignition coil with the engine.
- 2 Connect the high tension leads with the spark plug.
- 3 Ground the plug.
- 4 Crank the engine and check ignition spark visually. If not, replace the spark plug.

Install spark plug

- 1 Install the spark plug to the engine.
- 2 Install the ignition coil.

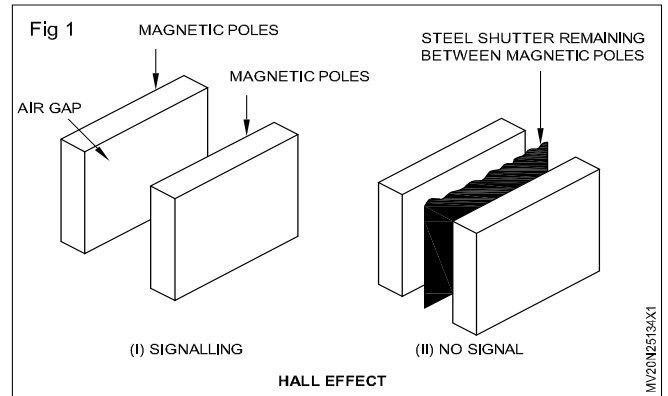
- 3 Connect the high tension leads with the spark plugs as per the firing order.
- 4 Start the engine and check the performance of the engine.

TASK 4: Sensor testing

- 1 Park the vehicle on level surface and check the wheels
- 2 Visually check the hall effect (Fig 3) and optical sensors for harness loose connection or coupler disconnections, dust water formed between signal point
- 3 Connect the scanner tool to diagnostics coupler

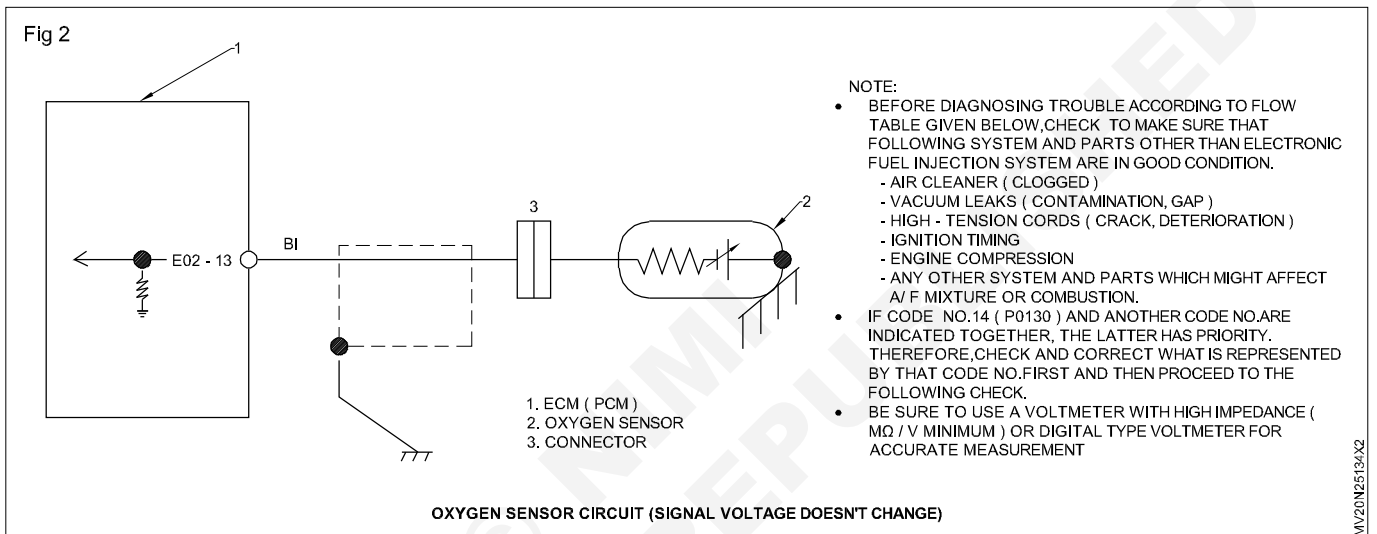
- 4 Switch on scanner tool and turn on ignition key wait for scanner warm up and screen display.
- 5 Check the scanner display on the screen
- 6 Follow the instructions codes from display select the manufacturer of the vehicle

- 7 Select the model, make & manufacturing year.
- 8 Select the electrical ignition circuit and select auto defect in scanner.
- 9 After detecting check faulty memory
- 10 If any fault memory is present it will displayed
- 11 Read the system fault memory and rectify the loose connections or replace the defective sensors indicated in scan tool
- 12 Repeat the above steps for check the all sensor circuits and wire harness.



Tracing and testing

Oxygen sensor circuit (Signal voltage doesn't change) (Fig 2)



Step	Action	Yes	No
1	1) Warm up engine to normal temperature. 2) Connect voltmeter between E02 - 13 terminal of ECM coupler and body ground. 3) Maintain engine speed at 2000 rpm and after 60 seconds, check voltmeter Does the voltage deflect between above and below 0.45 V repeatedly ?	Oxygen sensor and (Closed loop system, A/F ratio feed back system) are in good condition. Intermittent trouble or faulty ECM (PCM).	Go to Step 2.
2	Does the voltage remain unchanged at 0.45 V above ?	"BI" circuit shorted to power circuit or rich A/F Mixture. If circuit is OK, check MAP sensor, ECT sensor, fuel pressure, injectors and their circuit. If all above are OK, check ECM (PCM) and its circuit.	Go to Step 3
3	1) Maintain engine speed at 2000 rpm for 60 seconds 2) Check voltmeter while repeating 3) Does it indicate 0.45 V or more even once?	Poor E02 - 13 connection or lean A/F mixture If connection is OK, check MAP sensor, engine. ECT sensor, fuel pressure injectors and their circuit.	"BI" circuit open/short or oxygen sensor malfunction. If wire and connection are OK, replace oxygen sensor and recheck.

Check the charging system

Objective: At the end of this exercise you shall be able to
 • **trouble shoot the charging system.**

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Gloves	- 1 Set
• Multimeter	- 1 No.	• Banian cloth	- as reqd.
Equipments / Machineries		• Emery sheet	- as reqd.
• A motor vehicle	- 1 No.	• Cleaning solvent	- as reqd.

PROCEDURE

TASK 1: Trouble shoot the charging system

- 1 Switch on the ignition. Check the battery charging indicator lights ON.
- 2 Start the engine. Raise the engine to 2000 RPM and check the charging indicator light turns OFF.
- 3 If the charging indicator light does not ON during ignition ON, then follow the steps.
- 4 Check charging circuit fuse.
- 5 If fuse is good, then check the condition of the charging indicator bulb. Replace bulb if necessary.
- 6 Check and tighten the connections. Check the wirings for frayed insulation and other physical damage.
- 7 If charging indicator light does not go out with the engine running, then follow the steps.
- 8 Check drive belt for its correct tension.
- 9 Check battery and its connection.
- 10 Check fuse.
- 11 Connect the multimeter with the battery terminals.
- 12 Set to measure voltage in the range of 6V to 60V.
- 13 Start the engine and check the battery voltage.
- 14 If the battery shows 14.2V to 14.8V then charging system is in good condition. Otherwise decide the problem with the alternator or charging circuit.
- 15 Run the engine and check and squealing noise. This may be because of bearing problem or improperly adjusted drive belt.

Overhaul the alternator

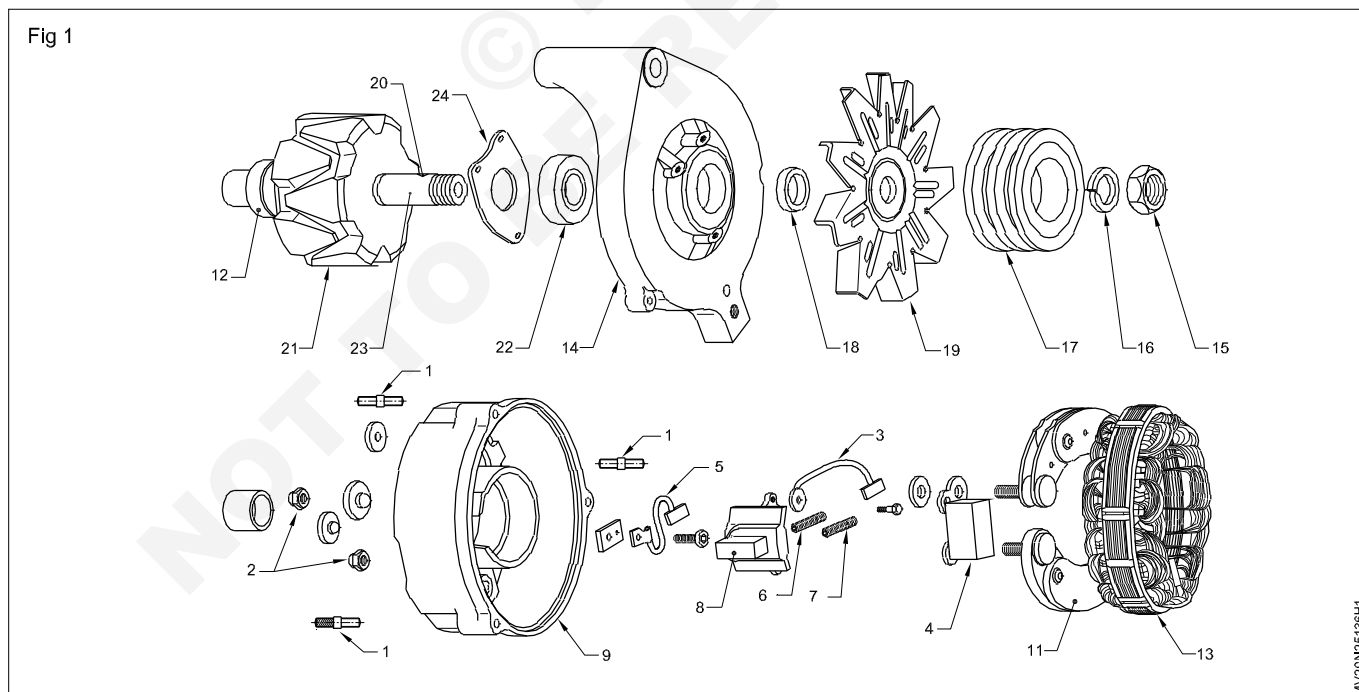
Objective: At the end of this exercise you shall be able to

- **dismantle the alternator and clean the parts**
- **check the stator for open circuit and short circuit**
- **check the rotor for short circuit and open circuit**
- **test the diodes and slip rings**
- **assemble the alternator & testing.**

Requirements			
Tools / Instruments			
• Trainees tool kit	- 1 No.	• Electrical test bench	- 1 No.
• Digital multi Meter	- 1 No.	• Pulley set universal for bearing & bushes	- 1 No.
• Continuity meter	- 1 No.		
• Ohm meter	- 1 No.		
• DE spanner 6 to 32	- 1 Set		
• Electrical tester	- 1 No.		
Equipments / Machineries			
• Vehicle	- 1 No.		
• AC alternator slip ring puller	- 1 No.		
• Executive auto electrical toolkit	- 1 Set		
		Materials	
		• Carbon brush	- as reqd.
		• Diode	- as reqd.
		• kerosene	- as reqd.
		• Clean rag	- as reqd.
		• Brushes	- as reqd.
		• Petrol	- as reqd.

PROCEDURE

TASK 1: Dismantle the alternator and clean the parts (Fig.1)



- 1 Mark a line across both the end shields 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 ceiling pad.
- 6 Remove the screws securing the brush - box to the slip ring end bracket (9) and lift out the brush - box (8).

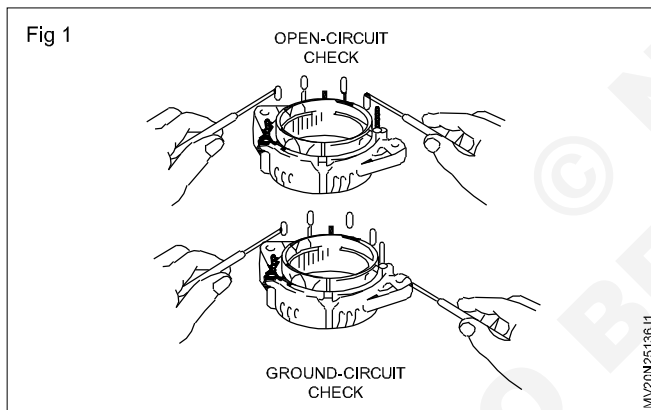
- 7 Release the stator winding cable ends from the rectifier by applying a hot soldering iron to the terminal tags of the rectifier. Gently pull out the cable end when the solder melts.
- 8 Remove the screws securing the rectifier assembly (11) to the slip - ring end bracket and lift the rectifier assembly.
- 9 Remove the fixing bolts.
- 10 Take out the slip - ring end bracket (9).
- 11 Take out the stator assembly (13) from the drive end bracket (14).
- 12 Remove the shaft nut (15), washers (16) and take out the pulley (17), fan (19), wood-ruff key (20) and spacers (18).

13. Push at the rotor shaft (23) end with your thumb to separate the drive end bearing (22) and rotor assembly (21).
- 14 Clean all the parts with kerosene and a nylon brush except the brushes.
- 15 Clean the slip - ring (12) with the fine emery paper and wipe with a clean rag.
- 16 Clean the brushes with petrol.
- 17 Check the bearings visually for any damage. If necessary replace the bearing with the new one.
- 18 Check the brushes for correct dimension, according to the manufacturer's specifications, replace, if required.
- 19 Check for the external crack on drive end bracket and slip - ring end bracket.

TASK 2: Check the stator for open circuit and short circuit

Test for open circuit in the stator (Fig. 1)

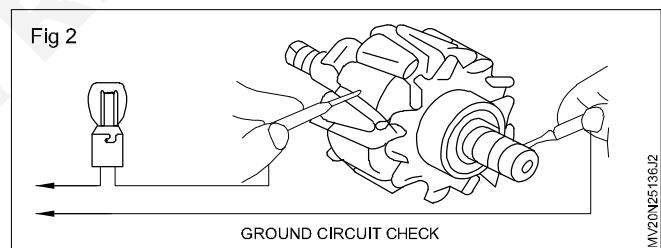
- 1 Check the continuity of the stator windings. First connect any two of the stator winding leads to a 12 V battery in series with a 36 W test lamp. The lamp should glow. If the first part of the test is satisfactory, transfer one of the test lamp leads, to the third lead in the stator.



- 2 The test lamp should glow. If there is any damage or burning or over heating of the winding renew the stator assembly.

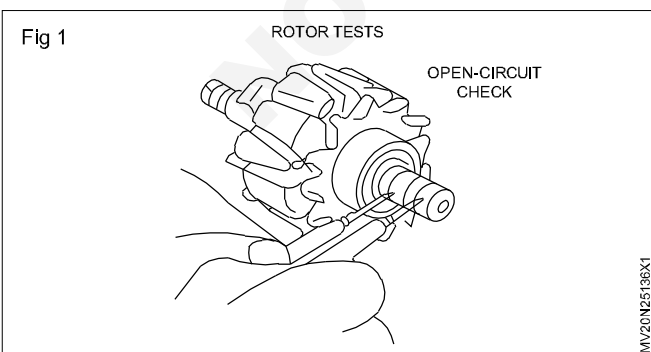
Test for short circuit in the stator (Fig 2)

- 3 Check the insulation of the stator windings by connecting a 110 Volts AC mains with a 110 Volts, 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.



TASK 3: Check the rotor for short circuit and open circuit

Test for short circuit in the Rotor (Fig. 1)



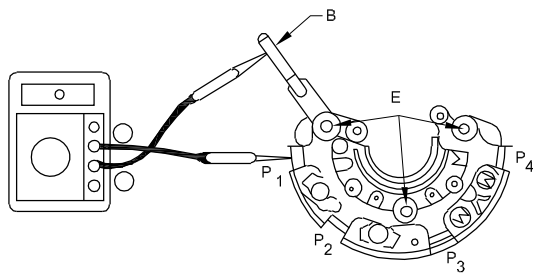
- 1 Check for satisfactory rotor winding insulation by connecting to a 110 V AC mains with a 110 V, 15 W test lamp in circuit between either of the slip rings and the rotor body.

- 2 The lamp should not glow. If the lamp glows then the rotor winding is defective, rotor assembly needs renewal.

Test for open circuit in rotor winding (Fig. 2)

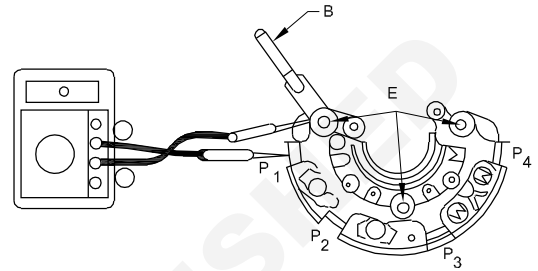
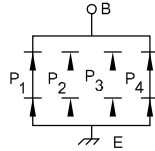
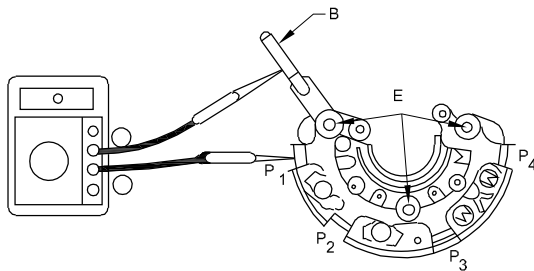
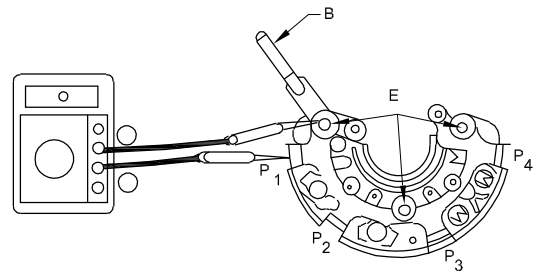
Fig 2

INSPECT POSITIVE SIDE RECTIFIER



DIODE TESTS

INSPECT NEGATIVE SIDE RECTIFIER



MV20N25135X2

- 3 Check the motor winding continuity by connecting a 12 V/ 24 V battery and a moving coil ammeter between the slip-rings.
- 4 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.
- 5 Check the resistance of the rotor winding with an ohmmeter.
- 6 The resistance should be 9.6 to ± 10 ohms for an 24 Volts alternator and 3.2 to ± 0.5 ohms for a 12 volt alternator. If the readings are not within the limit, renew the rotor assembly.

TASK 4: Testing diodes and slip rings

- 1 Test each diode separately by connecting a 12 V battery and 12 V, 15 W bulb in series with the diode.
- 2 Connect one test lead to the diode connecting pin and the other lead to the heat sink.
- 3 Watch if the lamp glows.
- 4 Then reverse the test lead connections.
- 5 The lamp should glow during one direction of the test connection only. Replace the diode if required.

Check the slip-rings

- 6 Check the slip-rings (12) for their trueness in a lathe and with a dial test indicator.
- 7 Check the surface of the slip ring for burnt or dirt. Replace the slip-ring, if required.

TASK 5: Assemble the alternator & testing

- 1 While assembling ensure that the scribed reference lines are in alignment.
- 2 Assemble the rotor assembly (21) with the drive end bearing (22) to the drive end bracket (14) and fix the bearing retainer (24) with screws.
- 3 Assemble the spacer (18) woodruff key (20), fan (19) and pulley (17) on the rotor shaft (23).
- 4 Assemble the stator assembly (13) to the drive end bracket (14).
- 5 Place the rectifier assembly to the slip ring end bracket and fix the screws.
- 6 Place the slip-rings end bracket (9) and fix the fixing bolt/stud.
- 7 Solder the stator winding cable ends to the rectifiers.
- 8 Place the brush box on the slip ring end bracket (9) and fix the screws.
- 9 Place the ceiling pad and place both the brushes.
- 10 Place the delivery brush mounting plate in position and fix the screws.
- 11 Place the regulator (4) on the brush box and connect the regulator leads (3) and (5) and fix the screws.

12 Place the cover and fix the cover securing studs (1) and washer (10) and tighten the nuts (2) firmly.

Alternator Bench Tests

If the on-vehicle checks have indicated that the alternator is defective, it should be removed for bench testing and replacement. Specific procedures for removal, disassembly, inspection, and assembly are noted in the appropriate repair manuals. Only the electrical bench tests are covered here.

- Always disconnect the battery ground (-) cable before removing the alternator.
- Refer to the appropriate repair manual for test specifications.

An ohmmeter is used for electrical bench tests on the rotor, stator, and diode rectifier. The following steps are typical.

Rotor Tests

- Check the rotor for an open circuit by measuring for resistance between the slip rings.
- Some resistance (less than 5 ohms) indicates continuity.
- If there is no continuity (infinite resistance), replace the rotor.
- Check the rotor for grounded circuits by measuring for resistance between the rotor and slip ring.
- Any amount of resistance indicates a ground (continuity). The resistance should be infinite.
- If not, replace the rotor.

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Replace alternator drive belt

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

- remove the drive belt from the vehicle
- inspect the components
- replace the drive belt
- set alternator belt tension.

Requirements		
Tools / Instruments		Equipments / Machineries
<ul style="list-style-type: none"> • D.E. spanner set • Ring spanner set • Pry bar • Socket spanner set • Tension gauge 	<ul style="list-style-type: none"> - 1 Set - 1 No. - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Motor vehicle running condition
		Materials
		<ul style="list-style-type: none"> • Drive belt - as reqd. • Bolts/nuts - as reqd.

PROCEDURE

Remove the drive belt from the vehicle (V belt type)

- 1 Disconnect the negative terminal from the battery.
- 2 Remove the side engine cover if available.
- 3 Loosen the alternator mounting bolts.
- 4 Move the alternator towards the engine slightly.
- 5 Remove the drive belt from the vehicle.

Some manufacturers provide a belt tension scale. Replace the belt if the belt out of the range.

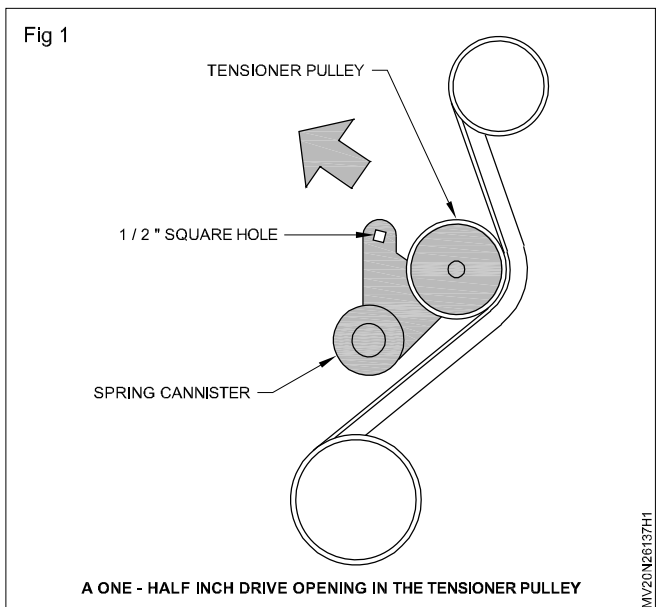
- 6 Inspect the belt for cracks, cuts, deformation and wear. Replace the belt if found defective.

Replace the belt if it completes its life time as per the manufacturer's specification.

- 7 Inspect the bracket and bolts / nuts for wear or damage. (v belt type)
- 8 Clean the belt before fitting on the vehicle.
- 9 Clean the pulley and tensioner.
- 10 Check the belt pulleys aligned properly.
- 11 Insert the belt and check the belt seated properly.

Set alternator belt tension (Fig.1)

- 12 Pry against the alternator housing with a pry bar to tighten the alternator belt.
 - 13 Check the belt tension with the tension gauge
- The belt tension is normally 12-13mm in 30 cm length.**
- 14 Adjust if necessary and tighten the alternator mounting bolts.
 - 15 Connect the negative terminal of the battery.



Check the faults in charging system

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

- identify the cause of no charge when engine is running and rectify
- identify the cause of low output voltage for alternator and rectify
- identify the cause of high charge/over charge and rectify
- identify the cause of alternator noisy and rectify.

Requirements			
Tools / Instruments		Equipments / Machineries	
• Trainees tool kit	- 1 Set	• Motor vehicle running condition	- 1 No.
• Multi Meter	- 1 No.	Materials	
• Battery 12V	- 1 No.	• Emery paper	- as reqd.
		• Cleaning solvent	- as reqd.

PROCEDURE

S. No.	Trouble (TASKS)	Causes	Remedy
1	Warning lamp does not glow when ignition switch on Dead battery	Blub fuse Loose connection	Replace Tighten Charge battery/ Replace
2	No charge when engine running	Drive belt loose Broken drive belts Loose connections worn or dirty slip rings and brush Open field circuit Open charging circuit Open circuit in stator winding Open rectify circuit Defective diodes	Adjust belt tension Replace Tighten Replace Rectify Rectify Rectify Rectify Replace
3	Low output voltage from alternator	loose connections on alternator slip rings dirty and worn out faulty regulator grounded stator low regulator setting shorted rectifiers	Adjust belt tension Tighten Clean/replace Replace Adjust Replace Replace
3	High charging / over charging	Poor regulator ground connection Sticky regulator contacts Voltage regulators setting	Rectify Rectify Reset
4	Alternator noisy	Loose mountings Loose drive pulley wornout bearings brushes not seating properly	Tighten Tighten Replace Rectify

Remove the starter motor from vehicle and test its performance

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

- pull and hold test performance
- pinion return test
- no-load performance test.

Requirements		
Tools / Instruments		Materials
<ul style="list-style-type: none"> • Trainees tool kit • Box spanner set • 10mm rod 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Emery paper • Hack saw blade • Grease
Equipments / Machineries		
<ul style="list-style-type: none"> • Running vehicle 	- 1 No.	<ul style="list-style-type: none"> - as reqd. - as reqd. - as reqd.

PROCEDURE

TASK 1: Test the starter motor for performance

1 Remove starter motor assembly from vehicle

Pull in test

- Connect the test leads as shown in the figure 1.
- Check that the pinion (over-running clutch) jumps out; if it does not, replace it.

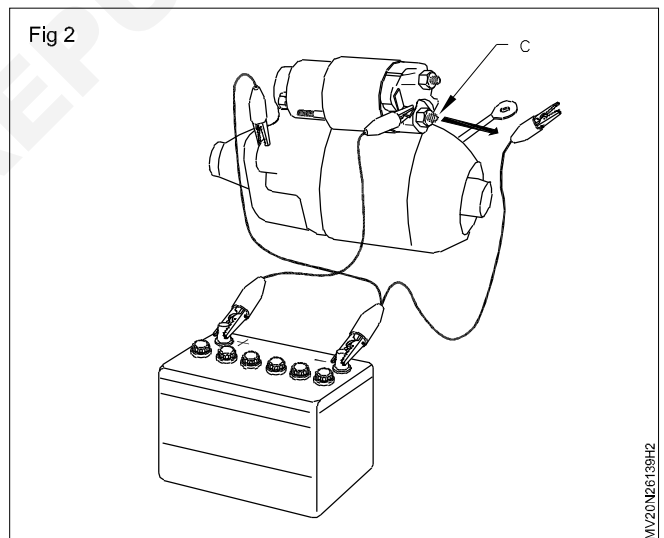
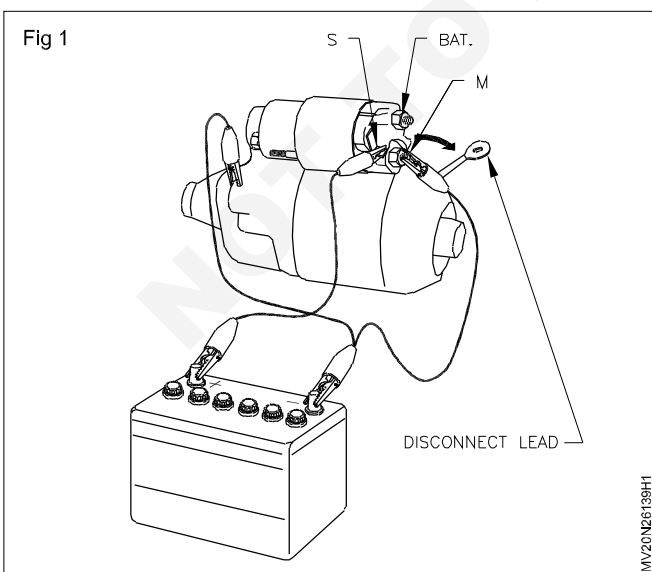
Before testing disconnect the field coil lead from the terminal.

Hold in test

- While connecting as stated above with the pinion out, disconnect the negative lead from terminal 'C'
- Check that the pinion remains out; if not, replace the magnetic switch.

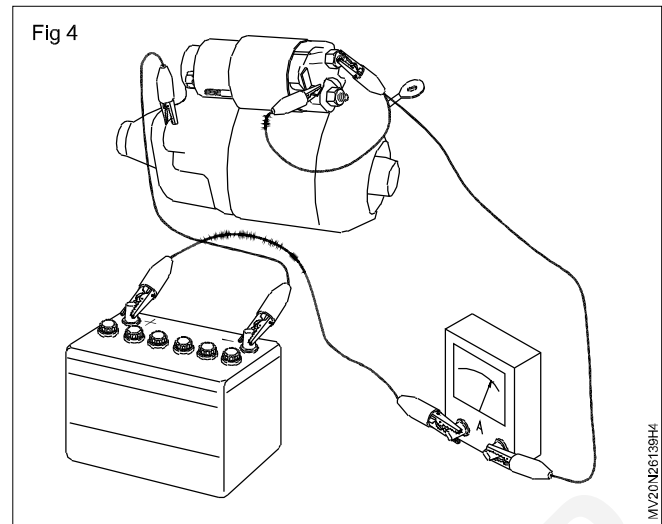
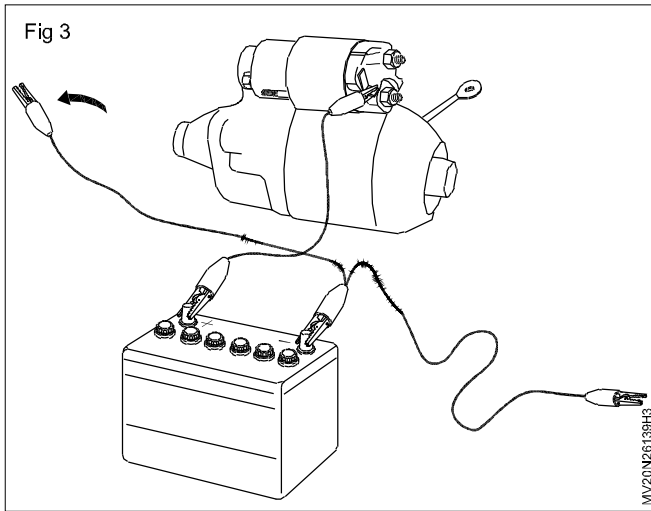
Pinion return test

- Disconnect the negative lead. (Fig 2)
- Check to make sure that the pinion returns inward quickly.



No-load performance test

- Connect the test leads as shown in the figure.(Fig.3)
- Check the motor runs without fail with the pinion moved out.
- Check that the ammeter indicates the specified current. (No-load current - less than 53 A at 11.5 v) (Fig 3 & 4)



TASK 2: Fit the starter motor on the engine

- 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.

Perform trouble shooting in starting system

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

- rectify problem of “engine not cranking
- rectify problem of “engine crank too slowly to start”
- rectify problem of “starter spins but engine is not cracking”
- rectify problem of “starter not engaging or disengaging properly.

Requirements		
Tools / Instruments		Materials
<ul style="list-style-type: none"> • Trainees tool kit • Multi Meter 	<ul style="list-style-type: none"> - 1 Set - 1 No 	<ul style="list-style-type: none"> • Cotton waste - as reqd • Magnetic switch - as reqd • Petroleum jelly, brush, - as reqd

Refer to the chart below for the possible causes and needed actions, for each symptom and follow the action as per sequence, till the cause identified and do rectification.

Symptom (TASKS)	Possible cause	Action needed
Starter motor not running.	<ul style="list-style-type: none"> • Melting of fusible link • loose connections • If battery is dead • For faulty ignition switch • Faulty magnetic switch 	<ul style="list-style-type: none"> • Replace fusible link • Clean and lighten connections • Check battery and charge as needld • Check switch operation; replace as needed. • replace
Engine cranks too slowly to start	<ul style="list-style-type: none"> • weak battery • loose or corroded connections • Check mechanical problems with engine or starter • Faulty starter motor 	<ul style="list-style-type: none"> • Check battery and charge as needed. • Clean and tighten connections • Check engine and starter; worn out parts • Test starter / replace
Starter keeps running	<ul style="list-style-type: none"> • Binding ignition key • Faulty control components • Damaged pinion or ring gear • Faulty plunger in magnetic switch 	<ul style="list-style-type: none"> • Check key for damage/replace • Check switch and circuit • Replace • Replace
Starter spins, but engine not for cranking	<ul style="list-style-type: none"> • Faulty over-running clutch • Check for damaged or worn pinion gear or ring gear 	<ul style="list-style-type: none"> • Repair the over-running clutch proper operation • Replace as needed
Starter does not engage/ disengage properly	<ul style="list-style-type: none"> • Faulty magnetic switch • Damaged or worn pinion gear or ring gear; 	<ul style="list-style-type: none"> • Replace • Replace as needed.
Starter motor noise	<ul style="list-style-type: none"> • Pinion worn out • Bearing worn out • Mounting loose • Ring gear worn out 	<ul style="list-style-type: none"> • Replace • Replace • Tighten • Replace
Starter motor does not stop running	<ul style="list-style-type: none"> • Starter switch short circuited • Starter in relay contact • Binding ignition switch 	<ul style="list-style-type: none"> • Replace • Replace • Replace

Check the starting system

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

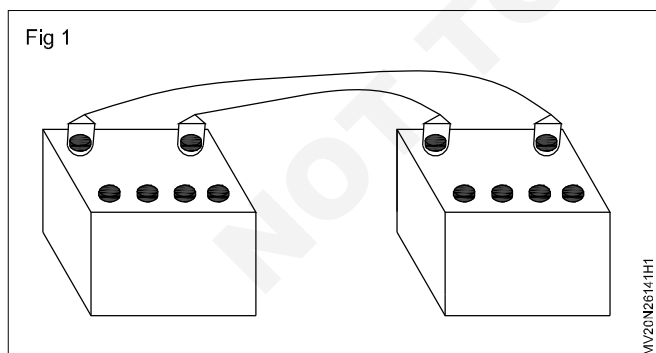
- check the starting system
- use a jumper start a vehicle.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 Set	• Cotton waste	- as reqd.
• Test lamp	- 1 No.	• Emery sheet	- as reqd.
• Multi Meter	- 1 No.	• Wire with clip	- as reqd.
Equipments / Machineries		• Battery	- as reqd.
• Running Vehicle	- 1 No.	• Jumper cable	- as reqd.

PROCEDURE

Check the starting system of the vehicle (Fig 1)

- 1 Place the vehicle on surface floor.
- 2 Use wooden choke for front and rear wheels.
- 3 Check the battery terminal connections for sulfur deposit.
- 4 If sulfur is deposited on battery terminals, remove the terminals and clean it with hot water.
- 5 Clean the battery post and cable connectivity by use the emery sheet.
- 6 Connect the battery terminals and ensure the proper tightness.
- 7 Check the battery charge condition with help of hydro meter and volt meter.
- 8 Check the starter motor battery cable connections and mountings.
- 9 Switch on the ignition key.
- 10 Turn on the glow plug and ensure the combustion chamber warmed up by glow plug light glow off.
- 11 Turn on the self starter switch and carefully watch the pinion contact with engine flywheel ring gear.
- 12 Check the fly wheel rotation if fly wheel turning speed is slow that means battery low charge.
- 13 Take one full charge battery with jumper cable.
- 14 Place battery and connect by use of jumper cable in parallel connections to the vehicle battery.
- 15 Check the battery voltage by use of volt meter.
- 16 Turn on the starter motor switch and start the engine and check the battery charging system.
- 17 Disconnect the jumper cables and spare battery.



Perform tracing the lighting circuit in a vehicle

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

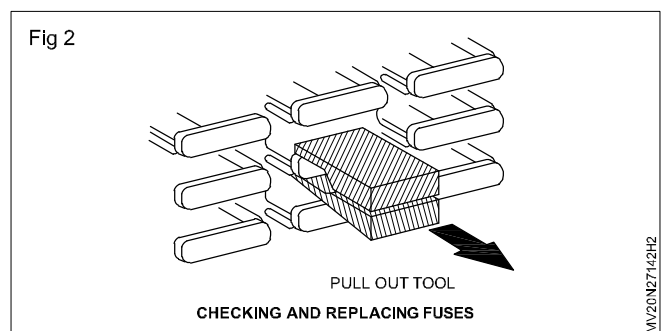
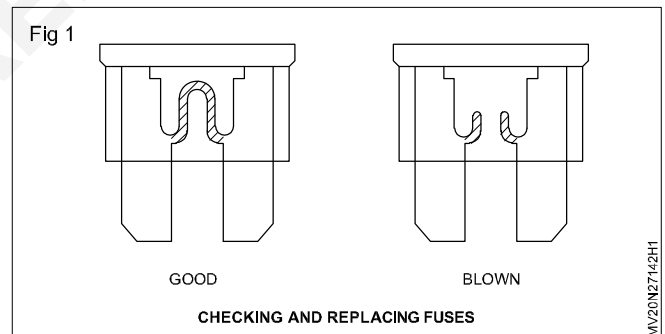
- locate the circuit from
 - the battery to the junction box via the ammeter
 - the junction box to the headlamp switch
 - the switch to the fuse box
 - the fuse box to the headlamp
 - the fuse box to the parking lamp and the tail-lamp
 - the fuse box to the roof lamp
 - the fuse box to the mist lamp (fog lamp)
 - the circuit from the fuse box to the instrument panel lamps
 - the warning lamp circuit (brake light)
- align head lamps.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 Set	• Auto electrical wire	- as reqd.
• Soldering iron	- 1 No.	• Insulation tape	- as reqd.
Equipments / Machineries		• Cotton waste	- as reqd.
		• Emery paper	- as reqd.
• Running Vehicle	- 1 No.	• Bulb	- as reqd.

PROCEDURE

TASK 1: Check the fuses of all the lighting units

- 1 Check the battery 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 out 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. If blown, replace it using pull out tool. (Fig 1 & Fig 2)



TASK 2: To find out open and short circuit in the lighting circuit

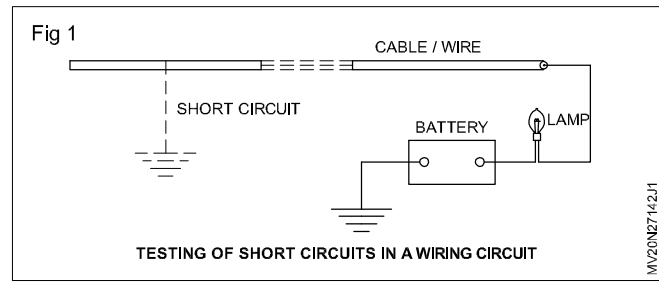
Check the wiring for open circuit by connecting an ohmmeter between the two terminals.

If there is an open circuit the ohmmeter reading will be more.

Trace the open circuit and rectify.

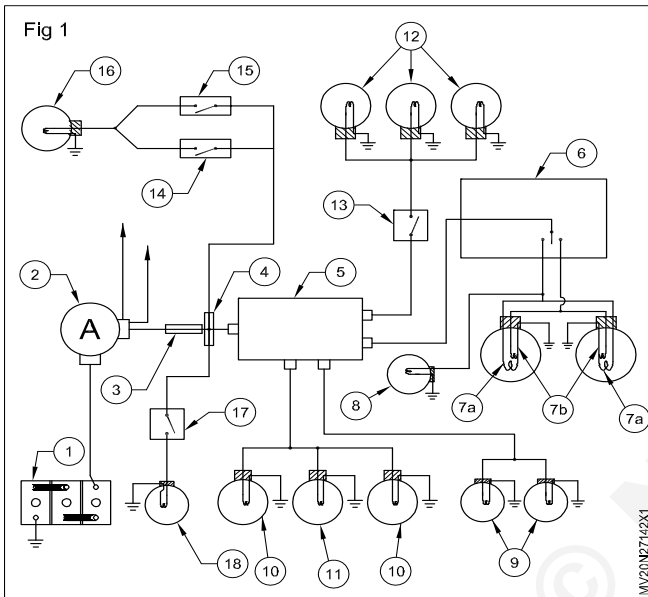
Check the wiring for short circuit with the test lamp. (Fig 1)

If there is a short circuit the test lamp will glow before the circuit is completed and also the fuse will be blown off.



TASK 3: Trace the lighting circuit

- Trace the battery cable from the battery (1) to the ammeter (2) and check for proper connections. (Fig 1)



- Trace the wire from the ammeter (2) to the fuse unit (3) (or circuit breaker) and check for proper connections.
- Trace the wire from the fuse unit (3) to the junction box (4) and check for proper connections.
- Trace the wire from the fuse unit (4) to the headlamp switch (5) and check for proper connections.
- Trace the wire from the headlamp switch (5) to the

dipper switch (6) and check for proper connections.

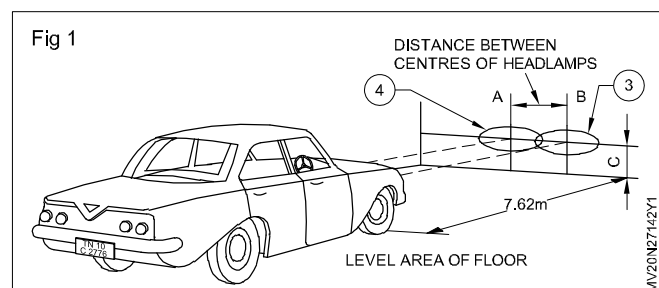
- Trace the wire from the dipper switch (6) to the connection of the headlamp's high beam (7a) and low beams (7b) and check for proper connections.
- Trace the wire from the high beam (7a) circuit to the beam indicator lamp (8) in the instrument panel.
- Trace the wire from the headlamp switch (5) to the parking lamp (9) and tail-lamp (10) and check for proper connections.
- Trace the wire from the headlamp switch (5) to the number-plate lamp (11) and check for proper connections.
- Trace the wire from the junction box (4) to the dome light pillar switch (14) and automatic door switch (15) and to the roof light (16) and check for proper connections.

The roof light pillar switch and the automatic door switch are connected in pillar. Trace the wire from the junction box (4) to the stop light (warning light) switch (17) and to the stop-light (18) and check for proper connections.

- Replace deflection bulbs, where they are fused.

TASK 4: Do preliminary checks

- Check the air pressure in the tyres and inflate them to the correct pressure
- Check the headlamp mountings. (Fig 1)
- Position the car 7.62 meters away in front of a white screen or a plain wall.
- Mark the distance between the centres (A & B) of the headlamps with respect to the axis of the car.
- Ensure that the front of the car is square to the screen.
- Load the car as it will be being driven for most of the time.
- Cover up one lamp while aligning the other by a cloth or paper.



- Mark the height (C) of the headlamps on the screen, two inches below the actual height of the headlamps.
- Normal value of C (figure) is equal to the height from the floor to the centre of headlamp minus 2" when headlamps are 25 ft. or 7.62 m apart from the screen.

Perform trouble shooting in turn signal

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

- trace the turn signal light troubles
- identify the troubles in hazard warning light circuit.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Multi meter	- 1 No.	• Soap oil	- as reqd.
Equipments / Machineries		• Bulb	- as reqd.
• Running vehicle	- 1 No.	• Indicator light switch	- 1 No.
		• Hazard light switch	- 1 No.

PROCEDURE

- Check the battery connection for sulfur deposit on battery
- Check the indicator turn switch wire connections
- Check the Hazard switch wire connections
- Start the engine and ensure the battery charging.

Sl. No	Trouble	Causes	Remedies
1.	Turn signal light not glowing	- Indicator switch defective - Flasher unit defective - Fuse blown out - Switch wire open circuit	- Replace - Replace - Replace - Connect wire and tighten the wire connection.
2.	No flashing the signal lights	- Flasher unit defective - Flasher unit loose wire	- Replace - Tighten the wire connection
3.	One side signal light only flashing	- One side bulb burned out - Wire connection disconnected - Indicator switch contact point burnt	- Replace the bulb - Connect the wire - Replace the switch
4.	Turn signal light flash rate low	- Indicator switch breaker breaker point dirty - Low power supply - Low power bulb used - Poor ground earth	- Clean the point - Check power supply - Replace the bulb - Correct the earthing point.
5.	Turn signal light flash rate high	- Bulb power high - Defective flasher unit	- Use correct power bulb - Replace.
6.	Hazard warning lights no flashing	- Flasher unit defective - Hazard warning switch defective - Bulb burned out - Wrong wire connection	- Replace - Replace - Replace - Replace.

Perform trouble shooting in lighting circuit

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

- check the clearance between bulb and license plate
- identify the causes for all lights not glowing
- replace the defective bulbs.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Test lamp	- 1 No.	• Soap oil	- as reqd.
Equipments / Machineries		• Bulb	- as reqd.
• Running vehicle	- 1 No.	• Wire	- as reqd.
		• Insulation tape	- as reqd.

PROCEDURE

- Check the Clearance between tail light bulb and number plate.
- Check the causes for all lights not glowing
- Check the height wiring circuit for trace the defects
- Check the fuses is a lighting circuit
- Check the bulb power values, if in proper replace the bulb.

Sr. No	Trouble	Causes	Remedies
1.	All lights not glowing	<ul style="list-style-type: none"> - Switch defective - No power supply - Loose wire connections - Poor ground earthing wires - Light fuse burned out - Open wire circuit - All bulb are burned 	<ul style="list-style-type: none"> - Replace - Provide proper power - Check and tighten wire connections - Clean and property connect the - Replace the fuse - Connect the wires - Replace the bulb.
2	Low clearance between bulb and license plate.	<ul style="list-style-type: none"> - Improper fitting the license plate. - Damaged number plate. 	<ul style="list-style-type: none"> - Maintain the space distance between and number plate. - Repair or replace the number plate.
3	One side light or same lights do not glowing	<ul style="list-style-type: none"> - Bulb fused - wire ear thing disconnected 	<ul style="list-style-type: none"> - Replace the bulb - Connect the wire property.

Perform trouble shooting in fuel gauge/meter unit in a vehicle

Objective: At the end of this exercise you shall be able to
 • trace out the defects in fuel meter/gauge circuit.

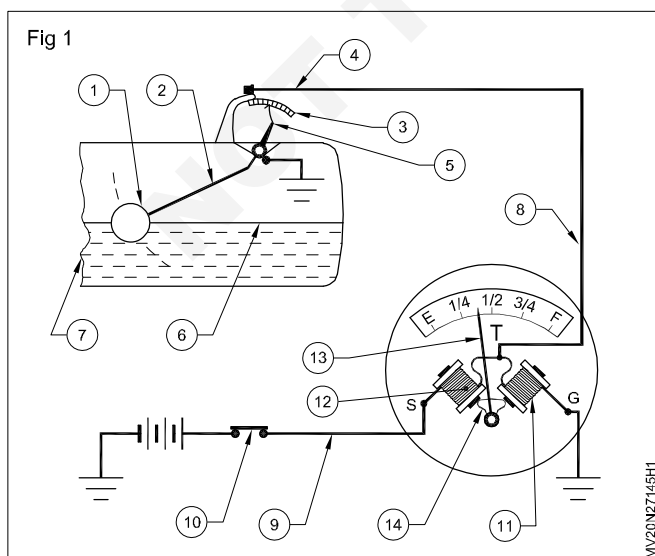
Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Multi Meter	- 1 No.	• Fuel gauge	- as reqd.
Equipments / Machineries		• Wire	- as reqd.
• Running Vehicle	- 1 No.	• Soap oil	- as reqd.
		• Fuel tank unit	- as reqd.

PROCEDURE

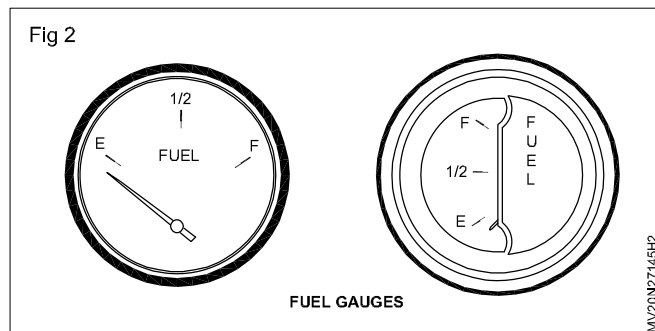
Troubles in fuel gauge unit (Fig 1 & 2)

SI.No	Causes	Remedies
1	Float punctured	- Replace the float
2	Break up wire connection	- Check the wire connection
3	Empty fuel tank	- Fill up fuel in tank
4	Defective sending unit	- Change the sending unit
5	Damaged resistance	- Change the resistance
6	Fuel gauge defective	- Replace the gauge
7	Fuel gauge wire connection	- Loose - Tighten the wire connection
8	Sticky float unit	- Replace the float unit
9	Damaged ground wire in tank unit	- Check and correct it
10	Erratic float movement	- Repair or replace
11	Deformed bimetal element	- Replace
12	Open circuited heat wire	- Replace

Tank unit (A)



Gauge unit (dash unit) (B)



Perform trouble shooting in coolant temperature meter

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

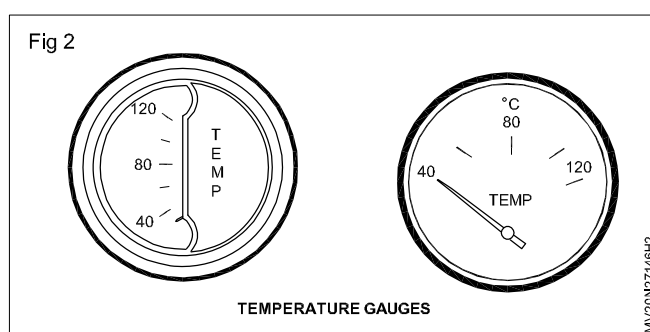
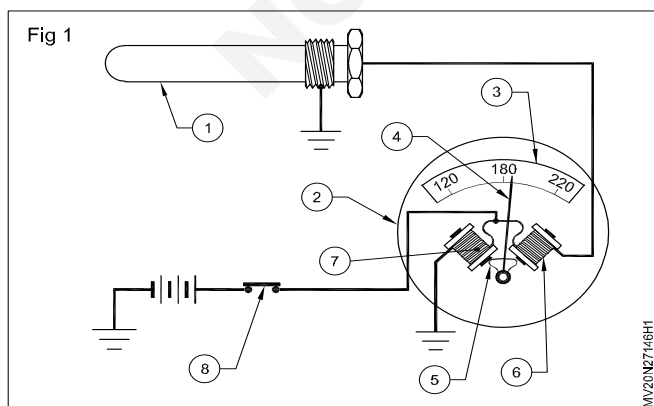
- identify the cause for engine coolant temperature
- replace the defective temperature and sensors (ECT).

Requirements	
Tools / Instruments	Materials
<ul style="list-style-type: none"> • Trainees tool kit - 1 No. • Multi meter - 1 No. • Wire cutter - 1 No. • Battery - 1 No. 	<ul style="list-style-type: none"> • Emery sheet - as reqd. • Insulation tape - as reqd. • Bulb - as reqd. • ECT sensor - as reqd. • Thermostat - as reqd. • Wire 3 mm, 4 mm - as reqd. • Cotton waste - as reqd. • Cleaning solvent - as reqd. • Soap oil - as reqd.
Equipments / Machineries	
<ul style="list-style-type: none"> • Vehicle with ECU - 1 No. 	

PROCEDURE

- Check the coolant level in radiator before start the engine.
- Check the sensor wire connections
- Check the power supply to sensor with help of multi meter
- Check the engine working temperature (thermostat valve) during engine.
- Check wire connection of temperature gauge before start (Fig 1 & 2)
- Check temperature meter operation in running engine

SI No	Causes	Remedies
1	Defective meter	- Change the meter
2	Defective sensor	- Change the sensor
3	Water (coolant) level is low	- Fill up coolant
4	Poor electrical connection	- Replace
5	Dirty coolant	- Replace
6	Defective thermostat	- Replace
7	Wire short circuited	- Repair/replace the wires
8	ECM defective	- Replace
9	Poor power supply to sensor	- Check and rectify



Perform trouble shooting in oil pressure warning light

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

- identify the cause for oil pressure warning light dose not glow
- rectify the defects in oil pressure warning light.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• insulation tape	- 1 No.
• Multi Meter	- 1 No.	• Bulb	- 1 No.
• Wire cutter	- 1 No.	• Socket	- 1 No.
• Battery	- 1 No.	• Sensor	- 1 No.
Equipments / Machineries		• Wire	- as reqd.
• Running Vehicle	- 1 No.	• Cotton waste	- as reqd.
		• Soap oil	- as reqd.

PROCEDURE

- Check the oil pressure switch wire connections
- Check the oil pressure warning light bulb
- Check the engine oil viscosity and oil level
- Check the oil pressure sensor connections
- Check the sensor wire short circuits
- Check the oil pump and filter.

Oil pressure warning light does not light up when ignition switch is on at engine off.

SI No	Causes	Remedies
1	Lubrications system not working properly	- Check the lubrication system
2	Oil level is low	- Correct it / Top up
3	Defective gauge	- Change the gauge
4	Oil pump pressure relief valve defective	- Check the valve
5	Cogged oil filter	- Change the filter
6	Defective, sensor oil pressure	- Replace
7	Warning light bulb fuse	- Replace
8	Oil pressure switch defective	- Replace
9	Oil pressure warning light wire short circuited	- Repair/Rectify
10	Oil pressure sensor wire loose connection	- Tight it.

Perform trouble shooting in brake and parking warning light

- Objectives:** At the end of this exercise you shall be able to
- identify the cause for brake and parking warning light
 - rectify the defects in brake warning light.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Bulb	- as reqd.
• Multi meter	- 1 No.	• Cotton waste	- as reqd.
• Wire cutter	- 1 No.	• Wire	- as reqd.
• Battery	- 1 No.	• Soap oil	- as reqd.
Equipment / Machineries		• Brake fluid	- as reqd.
• Running Vehicle	- 1 No.		

PROCEDURE

Brake warning light dose not light up

- Check the brake fluid level in master cylinder
- Check the brake light switch wire connections
- Check the master cylinder operation
- Check the brake light wire connections
- Check the brake and parking light bulb.
- Check the brake light wire continuity by multi meter

- Check the parking brake mechanical linkage operation
- Check the brake light wire ear thing
- Check the brake light wire short circuit
- If brake light stay on, check brake light switch and wire connection short circuited.

Brake warning light does not light up when parking brake, pull up, brake warning light stay on.

SI No	Causes	Remedies
1	Wear and rust in linkage	- Change the linkage
2	Corrosion in joints	- Check and lubricate
3	Defective switch	- Replace
4	Hand brake lever not fully release	- Check and release
5	Brake light wire connection loose	- Tighten
6	Brake light bulb fuse	- Replace
7	Poor earthing in brake light	- Clean and refit the earthing wire
8	Brake fluid level low in master of cylinder	- Top-up
9	Defective brake light bulb holder	- Replace the holder
10	Improper power supply to brake light	- Check/Rectify
11	Brake pedal linkage disconnected	- Connect the linkage
12	Brake light switch short circuited	- Rectify

Perform trouble shooting in interior lights

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

- identify the cause for interior light do not lightup.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Switch	- as reqd.
• Multi meter	- 1 No.	• Bulb	- as reqd.
• Test lamp	- 1 No.	• Cotton waste	- as reqd.
• Wire cutter	- 1 No.	• Wire	- as reqd.
• Battery	- 1 No.	• Soap oil	- as reqd.
Equipment / Machineries			
• Running Vehicle	- 1 No.		

PROCEDURE

- Check interior light switches
- Check interior light bulb
- Check bulb voltage power
- Check bulb holder
- Check wire short circuits
- Check bulb wire earth connections
- Check wire continuity by multi meter
- Interior light does not glow.

SI No	Causes	Remedies
1	Light switch defective	- Replace
2	Interior wire short circuited	- Rectify
3	Light sensor defective	- Replace
4	Bulb fuse	- Replace
5	Improper light connection	- Correct the connected
6	Bulb improperly seated	- Correct it.
7	Moisture in the bulb holder	- Clean and refit
8	Correction in the ear thing point	- Clean
9	No power supply to the bulb	- Check wire correction.

Check the flasher circuit

Objective: At the end of this exercise you shall be able to
 • identify the flasher light do not light up.

Requirements			
Tools / Instruments		Materials	
• Trainees tool kit	- 1 No.	• Fuse	- as reqd.
• Multimeter	- 1 No.	• Relay	- as reqd.
Equipment / Machineries		• Cotton waste	- as reqd.
• Running Vehicle	-1 No.	• Soap oil	- as reqd.

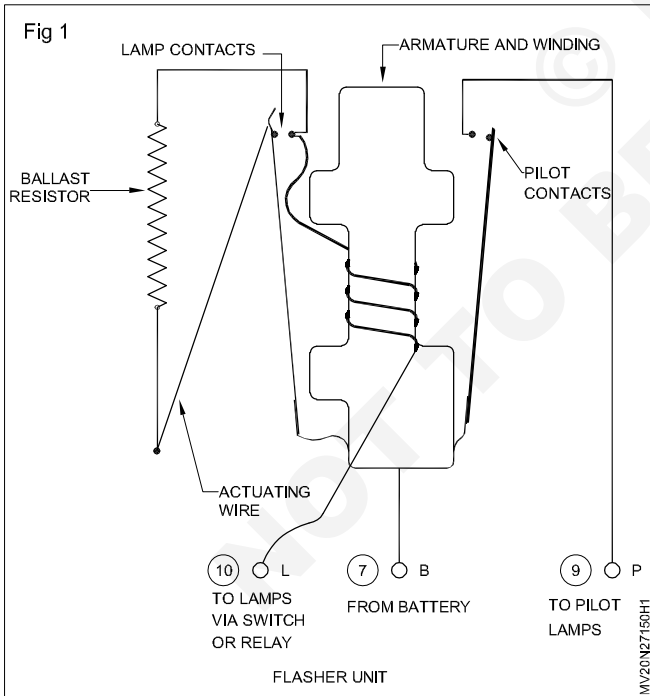
PROCEDURE

TASK 1: Check the flasher unit circuit

- Check the battery voltage with high rate discharge tester for its correct voltage.
- Check the specific gravity of the battery with the aid of a hydrometer.
- Check the fuse for proper condition.
- Check the bulbs if found fused replace the bulb
- Refer to the vehicle wiring diagram and check all the flasher circuit connections. (Fig 1)
- Check with a voltmeter and ensure that the flasher unit terminal B is at battery voltage with respect to earth.
- Connect the flasher unit terminal 'B' and 'L' together, and operate the direction indicator switch. If the flasher lamp glow, then the flasher unit is defective and must be replaced. Note the flasher unit cannot be repaired.

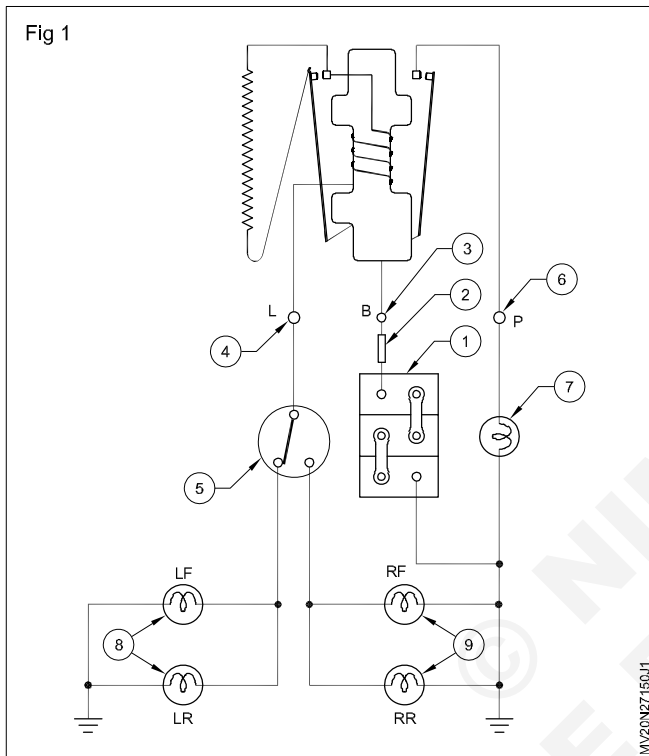
While replacing a flasher unit or when installing a flashing light system, test the circuits before connections to the flasher terminals 'L' 'B' and 'P' are made.

While testing, join the cables normally connected to these terminals together and operate the indicator switch. If the connections are wrong, the ignition auxiliaries fuse will blow but no damage will be done to the flasher unit.



TASK 2: Checking the flasher switch

- 1 Check the wire connections to the flasher switch terminals for proper tightness.
- 2 Replace the switch, if found defective.
- 3 Check the bulbs for fused filaments.
- 4 Check the bulbs for any damage to the cap or contact point.
- 5 Replace the bulbs if found fused or damaged.
- 6 Trace the wiring from the battery (1) to the fuse (2).
- 7 Trace the wiring from the fuse (2) to the flasher unit 'B's terminals (3).
- 8 Trace the wiring from the flasher unit 'L's terminal (4) and to the two-way switch (5).
- 9 Trace the wiring from the flasher unit 'P's terminal (6) to the pilot lamp (7) in the dashboard.
- 10 Trace the wiring from the switch (5) to the left front lamp (8).
- 11 Trace the wiring from the switch (5) to the right rear lamp (9).
- 12 Trace the wiring from the switch (5) to the right rear lamp (9).



Perform trouble shooting in horn assembly

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

- fault finding in horn circuit
- fault rectification in horn circuit.

Requirements			
Tools/Instruments		Materials	
• Trainee tool kit	- 1 No.	• Cotton waste	- as reqd.
• Test lamp	- 1 No.	• Soap oil	- as reqd.
Equipments / Machineries		• Insulation tape	- as reqd.
		• Wire	- as reqd.
• Running car	- 1 No.	• Fuse	- as reqd.

PROCEDURE

- Replace the defective horn from the vehicle.
- Locate the horn assembly.
- Check the horn connections.
- Check the function of the horn assembly.
- If found defective horn, remove the horn electrical connections.
- Dismount the horn mounting bolts.
- Remove the horn assembly from the vehicle.
- Select the suitable horn assembly.
- Mount the horn assembly on the vehicle and connect horn wires and test and tune up the horn.

Horn trouble shooting

Horn not operate		
SI No	Causes	Remedies
1	Horn push button defective	- Replace
2	Horn contact point burnt	- Replace
3	More gap between horn point	- Adjust
4	Wire disconnected	- Connect wire
5	Loose earthing contact	- Tighten the earth wire
6	Damaged diaphragm	- Replace

Poor sound quality		
SI No	Causes	Remedies
1	Low voltage supply	- Check battery, charging system
2	Improper horn tone adjustment	- Adjust for proper turning
3	Wire loose connection	- Tighten the wire connection
4	Improper contact of horn switch	- Replace
5	Horn diaphragm assembly defective	- Replace

Horn sounds continuously		
SI No	Causes	Remedies
1	Horn switch defective	- Replace
2	Horn magnetic switch defective	- Replace
3	Power continues supply	- Disconnect the power

Overhaul wiper motor assembly

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

- remove the wiper blades and wiper motor assembly from the vehicle
- dismantle the wiper motor assembly, clean and inspect parts
- assemble the wiper motor and test
- refit wiper motor assembly and blades on vehicle and check for operation.

Requirements

Tool/Instruments

- Trainees tool kit - 1 Set
- Multimeter - 1 No.

Equipments / Machineries

- Running car - 1 No.

Materials

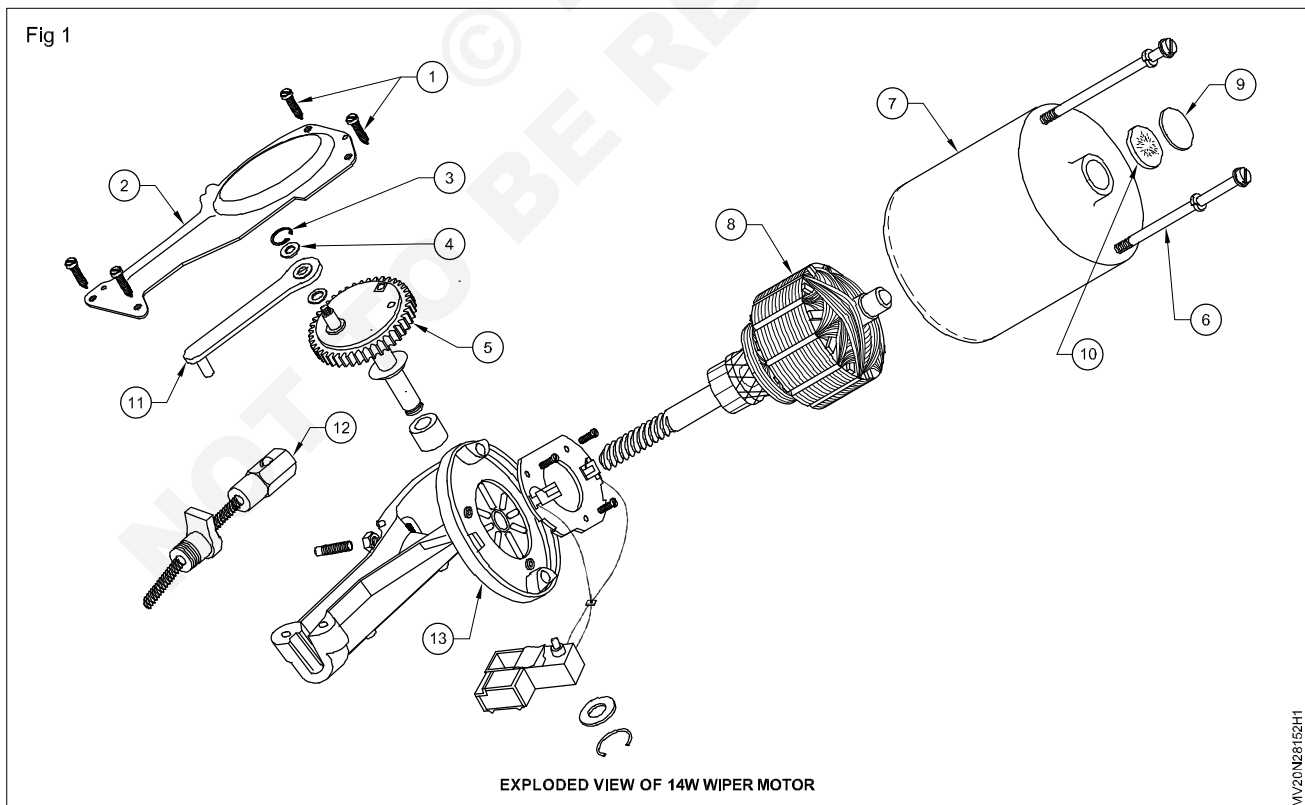
- Wiper blade - as reqd.
- Emery sheet - as reqd.
- Cotton waste - as reqd.
- Soap oil - as reqd.

PROCEDURE

TASK 1: Remove the wiper blades and wiper motor assembly from the vehicle

- Loosen the wiper blades fixing bolt/screw.
- Pull out the blade assembly from the milling
- Disconnect the wires from the wiper motor.
- Disconnect the operating lever/cables.
- Loosen the mounting bolts and nuts.
- Remove the motor with the extending arm.

TASK 2: Dismantle the wiper motor assembly, clean and inspect parts (Fig 1)



- 1 Remove the gearbox's cover fixing screws (1) and lift the cover (2). Remove the circlip (3) and the flat washer (4).
- 2 Remove the gear (5) assembly and connecting rod (11)
- 3 Remove the through bolts (6) from the motor housing (7)

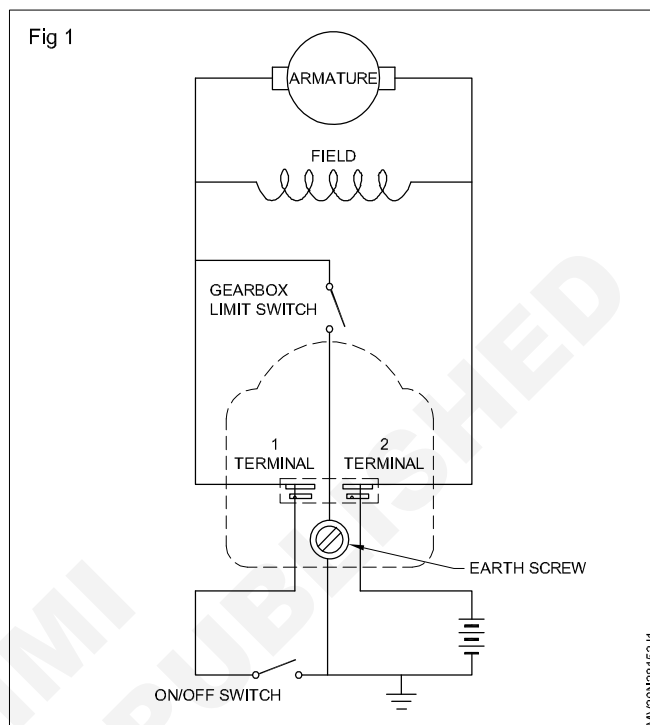
- 4 Remove the housing carefully and place it vertically.
- 5 Remove the armature (8) from the gearbox housing.
- 6 Clean the dust and dirt from all the parts by using a nylon brush and cloth.
- 7 Testing motor field winding armature brush and brush tension spring.
- 8 Visually check the gear wheel teeth for damage or wear. Replace, if necessary.

TASK 3: Assemble the wiper motor and test

- 1 Before assembling lubricate the following parts - gear wheel and worn with grease, and the armature shaft bearing surface, bearing bushes, gearwheel shaft and crankpin with SAE-40 oil.
- 2 Refit the armature to the housing, ensure that the thrust disc (9) and the felt washer (10) are in place. Place the armature through the housing (7) and tighten the through bolts (6) with the gearbox mounting cover (13).
- 3 Fit the gear and plate assembly (5) with the bush.
- 4 Fit the connecting rod (11) with a flat washer (4) and circuit (3).
- 5 Check the connecting rod and pin, fixed in the cable rack assembly (12).
- 6 Fit the gearbox cover (2) in its position and tighten the fixing screws (1).

Testing (Fig 1)

- 7 Measure the supply voltage, by connecting the wiper as shown in Fig 2. Switch on the motor and measure the voltage between the motor supply terminal (2) and the good ear thing point with a voltmeter.
- 8 If the reading is low, check the battery cable connections and the panel switch (1) .
- 9 Disconnect the cable rack and measure the no-load running current with an ammeter connected in the supply line. (2.5 A to 3.5 A)
- 10 Carry out no-load test
- 11 Connect the wires to the motor and effect supply. Check at what voltage the motor starts functioning at no-load.



- 12 For a 12 volt system the motor should start running from 4 volts.
 - 13 Check the cable rack.
 - 14 Check the maximum force to move the cable rack by hooking the spring balance.
- The maximum permissible force is 2.7 kgs.**
- 15 Check out final checking.
 - 16 Test the wiping speed of the motor. It should be between 45 and 50 cycles/ minute.

TASK 4: Refit wiper motor assembly and blades on vehicle and check for operation

- 1 Place the motor in its place.
- 2 Tighten the mounting bolts and nuts.
- 3 Connect the wires to the motor.
- 4 Ensure that the gearbox spindles are in the correct position by switching on and switching off and allowing them to come to rest at the end of the cycle.
- 5 Fit the arms and blades to the splinted driving drums on the gearbox spindle at the correct parking angle.
- 6 Press the headpiece until the retaining clip sound is heard to snap over the end of the drum.
- 7 Switch on and note the wiped areas. If necessary, change the position of the arms by removing and refitting them in the appropriate position.
- 8 Do not attempt to turn the spindle by hand force.

Mechanic Motor Vehicle - Electrical components trouble shooting

Perform trouble shooting in wind shield wiper

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

- identify the defects in wiper motor and blades.

Requirements			
Tools/Instruments		Materials	
• Trainees tool kit	- 1 No.	• Wiper motor	- 1 No.
Equipments / Machineries		• Wiper blade	- 1 No.
• Running car	- 1 No.	• Wiper nozzle	- 1 No.
		• Washer	- 2 No.
		• Washer container	- 1 No.

PROCEDURE

- 1 Check the wiper switch and blade
- 2 Check the wiper washer
- 3 Check the electrical wire connections
- 4 Check the wiper blade movements.

Wind shield wiper trouble shooting		
SI No.	Causes	Remedies
1.	Wiper blade unserviceable	- Replace
2.	Wiper motor not work	- Repair / replace
3.	Wiper blade loose mounting	- Tighten the mounting
4.	Wiper motor loose fitting	- Tighten the loose fitting
5.	Wiper motor gear teeth worn out	- Replace the gears
6.	Wiper connecting rod bend	- Replace
7.	Wiper motor noise	- Repair / Lubricate
8.	Wiper motor armature short circuit	- Replace armature

Wind shield wiper trouble shooting		
SI No.	Causes	Remedies
1.	No water in washer container	- Fill water
2.	Washer operating switch defective	- Replace
3.	Washer spray jet nozzles defective	- Replace
4.	Water leak in jet nozzle connection	- Rectify
5.	Washer water pumping motor defective	- Repair / replace
6.	Wire loose connection	- Tighten the water connection

Check and replace wind shield washer

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

- diagnose causes for improper operation of wind shield washer
- replace the wind shield washer pump.

Requirements			
Tools/Instruments		Materials	
• Trainees tool kit	- 1 No.	• Pump	- 1 No.
Equipments / Machineries		• Cotton waste	- as reqd.
• Running car	- 1 No.	• Soap oil	- as reqd.
		• Rubber tube	- as reqd.

PROCEDURE

- Switch on the ignition key
- Check water level in wind shield washer bowl
- Check the wire connections and switches, if defective switch replace it
- Check the water spray jets for jet holes and water tube connection
- Operate the wind shield washer pump and check the function of it
- If found pump is defective, replace the pump
- Check the jet spray if improper spray clean the hole or replace the spray jets
- If found clogged water tube, replace water tube (Pump to jet)
- If found water spray in low pressure, means Low power supply to the pump, provide proper power to the motor
- If found dirty water replace the water.

Check and replace power window

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

- diagnose the fault in power window
- rectify the fault of power window.

Requirements			
Tools/Instruments		Materials	
• Trainees tool kit	- 1 No.	• Power window	- as reqd.
Equipments / Machineries		• Mounting bolts	- as reqd.
• Running car	- 1 No.	• Washers	- as reqd.
		• Cotton waste	- as reqd.
		• Soap oil	- as reqd.

PROCEDURE

- Switch on the ignition Key
- Locate the power window switches
- Check the all power window operating switches function
- Operate the power window switches one by one
- If found switch is defective replace it
- Check the window glass movements/operation, if found the improper operation of power window glass then check the door glass channels and power window motor
- If window glass door channels are unserviceable, replace it
- When power window glass operating switch is on but there is no window glass movement, means motor is defective, replace the motor
- If motor is running properly but glass is not lifting means window glass lifting regulator is defective, replace it.
- Check the power window for external and internal damages, if any major damage in door, replace the door with new one

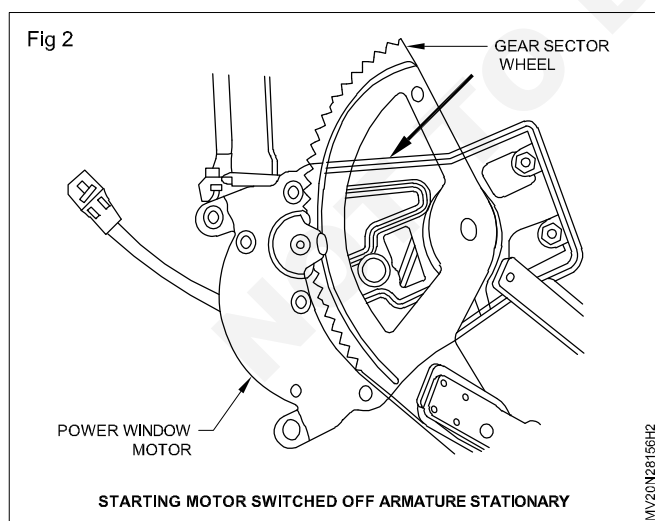
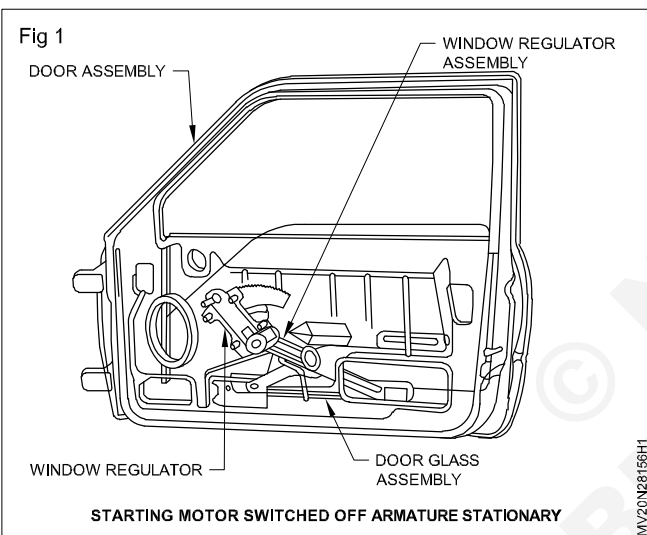
Check the door lock mechanism and rectify the defects

Objective: At the end of this exercise you shall be able to
 • diagnose and service power door lock problems.

Requirements	
Tools/Instruments	
• Trainees tool kit	- 1 Set
• Multi meter	- 1 No.
Equipments /Machineries	
• Vehicle with power window	- 1 No.
Materials	
• Cotton waste	- as reqd.
• soap oil	- as reqd.
• Door switch	- as reqd.

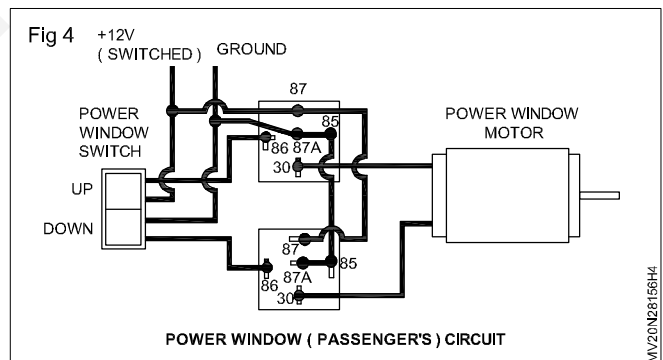
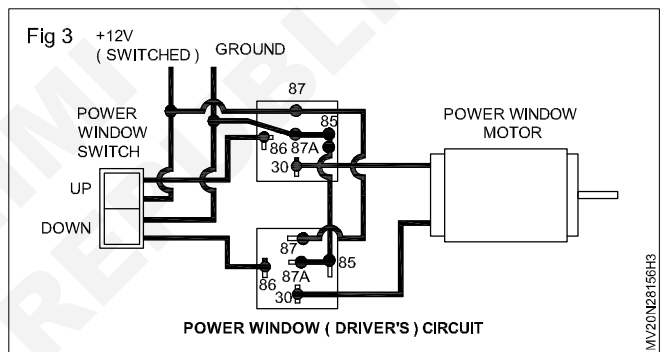
PROCEDURE

TASK 1: Power door lock problem (Fig 1 & 2)



- 1 Remove the door lock control switch
- 2 Disconnect the probes
- 3 Check power is available at the probes

4 If the power is not available with the probes, trace the circuit till the problem is located (Fig 3 & 4)



- 5 Check the switch for continuity. If there is no continuity, switch faulty. replace the switch.
- 6 Remove the door panel. check the continuity in the door lock solenoid.
- 7 If there is no continuity, check the wiring between the switch and solenoid.
- 8 Check the lock mechanism and the linkage for sticking, misaligned or bent linkage.
- 9 Check the solenoid is properly earthed.
- 10 Reassemble the solenoid, locks and door panel.

Check the immobilizer by scan tool

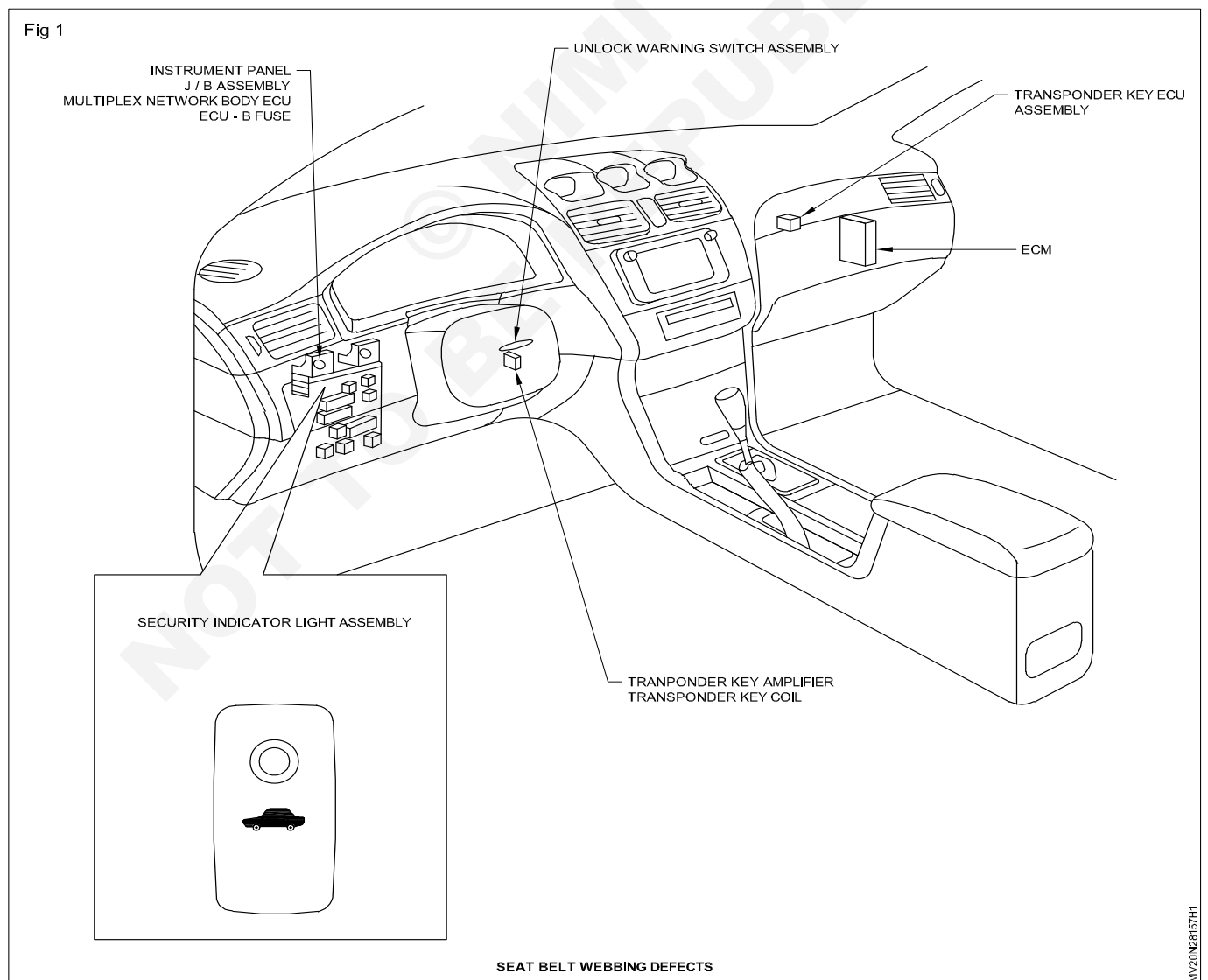
- Objectives:** At the end of this exercise you shall be able to
- connect the scanning tool with DLC (Data Link Connector)
 - diagnose immobilizer problems
 - Remote keyless entry system.

Requirements			
Tools/instruments <ul style="list-style-type: none"> • Trainees tool kit • Spanner set • Scan tool (DLC) • Screw driver 	<table border="0"> <tr> <td style="vertical-align: top;"> <ul style="list-style-type: none"> - 1 No. - 1 Set - 1 Set - 1 No. </td> <td style="vertical-align: top;"> Equipments / Machineries <ul style="list-style-type: none"> • Modern car Materials <ul style="list-style-type: none"> • Cotton waste • Fuse </td> </tr> </table>	<ul style="list-style-type: none"> - 1 No. - 1 Set - 1 Set - 1 No. 	Equipments / Machineries <ul style="list-style-type: none"> • Modern car Materials <ul style="list-style-type: none"> • Cotton waste • Fuse
<ul style="list-style-type: none"> - 1 No. - 1 Set - 1 Set - 1 No. 	Equipments / Machineries <ul style="list-style-type: none"> • Modern car Materials <ul style="list-style-type: none"> • Cotton waste • Fuse 		

PROCEDURE

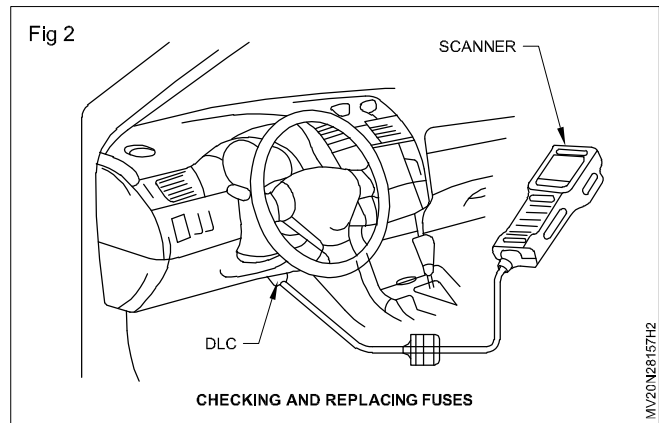
TASK 1: Connect the scanning tool with DLC

- 1 Switch on the ignition with engine stop and check immobilizer indicator light on (Fig.1)



MY20N28157H1

- 2 Start the engine and check immobilizer switches off.
- 3 Turn off the ignition.
- 4 Connect scan tool with data link connector. (Fig 2)
- 5 Read the complaints shown in the scan tool.



TASK 2: Diagnose immobilizer problem

- 1 The following possibilities of error occur in the immobilizer system.
- 2 The immobilizer indicator does not come on with ignition switch, check combination meter wiring and indicator bulb.
- 3 Refer circuit diagram (Fig 1).

S.No	Trouble	Possible causes
1	Transponder response error	Unregistered ignition key Poor transponder in key ECM problem. Immobilizer control module problem
2	Immobilizer communication line error	Blown fuse Poor connection at connectors Power supply circuit problem Ground circuit problem
3	Unregistered transponder	Use of unregistered ignition key
4	Immobilizer antenna error	Immobilizer control module problem ECM problem

DTC Check /clear

1 Check diagnose trouble code DTC

- a Connect the scanning tool to the DLC
- b Turn the ignition switch ON
- c Read the DTCs by following the directions on the testers screen

HINT

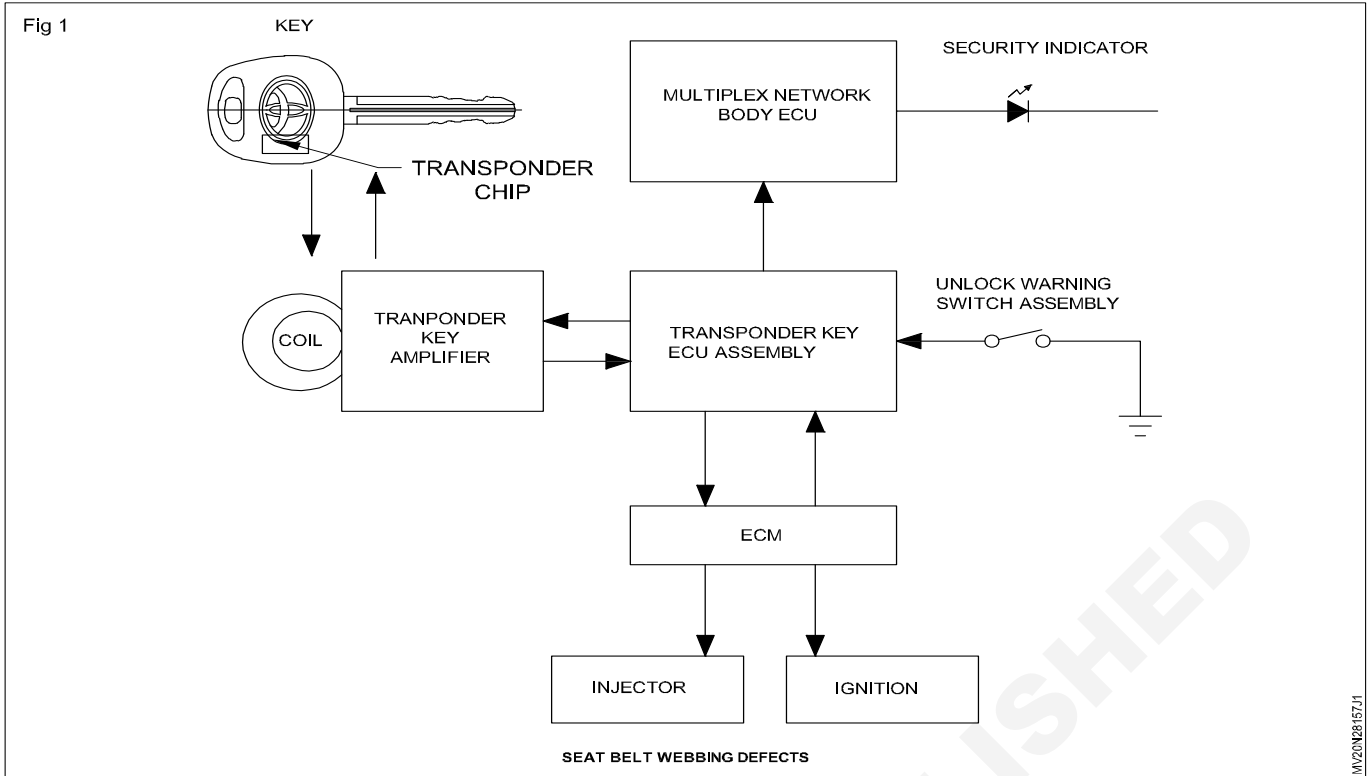
Refer to the intelligent tester operator's manual for further details.

2 Clear diagnose trouble code DTC

- a Connect the intelligent tester to the DLC
- b Turn the ignition switch ON.
- c Erase the DTCs by following the directions on the tester's screen.

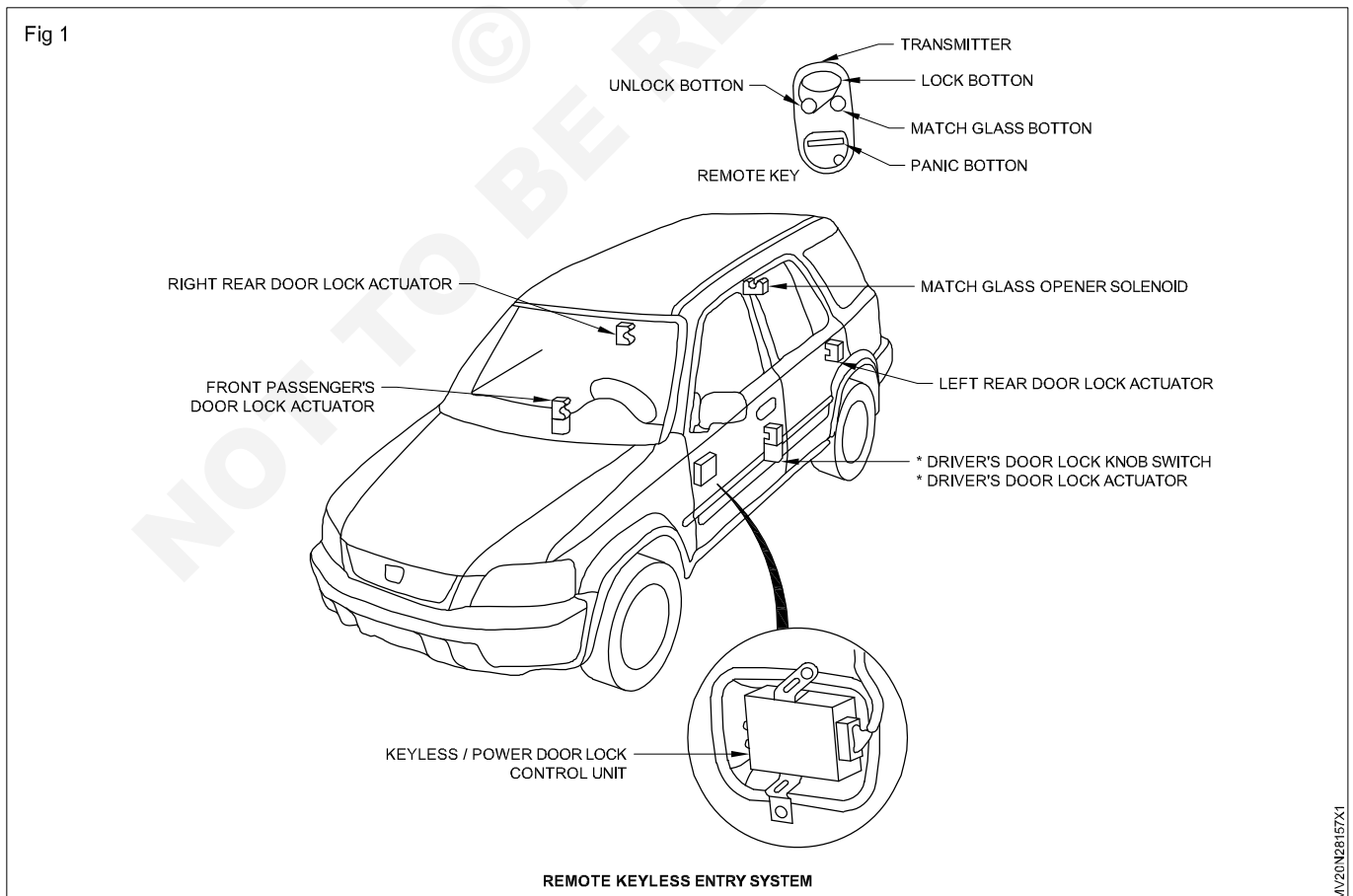
HINT

Refer to the intelligent tester operator's manual for further details.



TASK 3: Remote keyless entry system (Fig 1)

- 1 Check the power door lock system operates properly from the door controls.
- 2 Check for radio interference from the nearby electrical devices, signal blockage from other vehicles, trees or buildings.
- 3 Replace the battery and recheck the operation.
- 4 Check the body control module fuse.
- 5 Check the body control module wiring for defects and loose connections.



Perform tracing and diagnose air bag and seat belt

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

- diagnosis the air bag system
- service the air bag system
- diagnose the seat belt for defects.

Requirements			
Tools/instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Spanner set	- 1 Set	• Fuse for air bag circuit	- as reqd.
• Scan too	- 1 Set	• Required auto wires	- as reqd.
• Screw driver	- 1 No.	• Seat belts	- as reqd.
Equipments / Machineries		• Seat buckles.	- as reqd.
• LMV with air bag system	- 1 No.		

PROCEDURE

TASK 1: Diagnosis of an air bag system

- 1 Roll the driver's window down
- 2 Turn the ignition switch off and disconnect the negative battery cable. wait for the time period specified by the vehicle manufacturer.
- 3 Connect the scan tool to the DLC (Data Link Connector) under the dash board
- 4 Move the scan tool through the driver's window opening and stand outside the vehicle.
- 5 Reach into the vehicle and turn the ignition switch on, Be sure there is no one in the vehicle.
- 6 Reconnect the negative battery cable.
- 7 Select air bag system on the scan tool and read and record and air bag DTCs (Diagnostic Trouble code)
- 8 Disconnect the negative battery cable and wait for the time period specified by the vehicle manufacturer.
- 9 Turn the ignition switch off and disconnect the scan tool.
- 10 Reconnect the negative battery cable.

TASK 2: Air bag system service

- 1 Disable the air bag system to prevent accidental air bag deployment on a vehicle with driver's side, passenger's side, and side impact air bags.
 - b Passengers side air bag two wire connector behind the passenger's side air bag inflator module.
 - c Driver's side impact inflator module two wire connector under the driver's seat.
 - d Passenger's side impact inflator module two-wire connector under the passenger's seat.
- 2 Turn the steering wheel until the front wheels are in the straight ahead position.
- 3 Turn the ignition switch off and remove the ignition key from the switch
- 4 Remove the air bag fuse from the fuse block.
- 6 Perform the necessary service work on the air bag system.

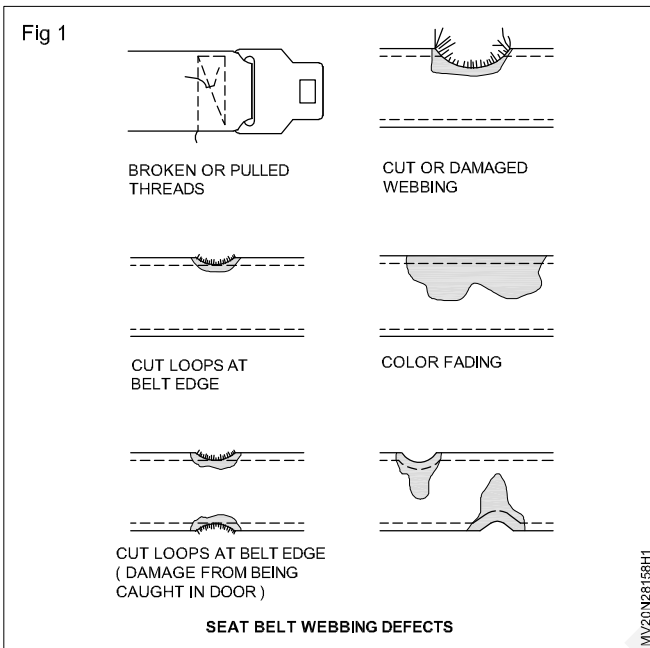
You should know

Some air bag system wiring connectors are retained with a connector position assurance (CPA) pin. This pin must be removed before the connector can be disconnected.

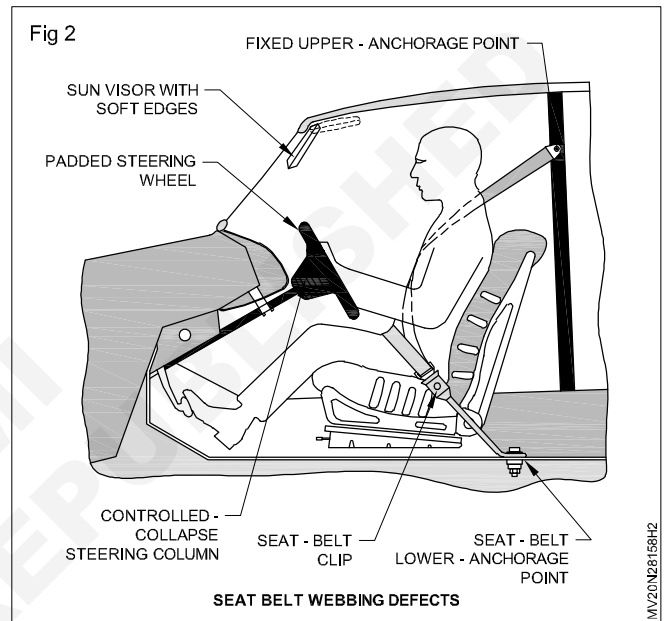
- 5 Disconnect the following connectors.
 - a Driver's side air bag two-wire air bag system connector at the base of the steering column.
 - 7 Connect all the disconnected air bag system connectors and install the CPA pins in each connector.
 - 8 Install the air bag system fuse.
 - 9 Turn the ignition switch on and check the air bag system warning light for proper system operation.

TASK 3: Diagnose the seat belt for defects

- 1 Inspect the seat belts for webbing damage.
- 2 Extend each seat belt fully from the retractor.
- 3 Check the webbing for cuts, broken or pulled threads, cut loops at the belt edge and bowed conditions as shown in (Fig. 1)



- 4 Replace the seat belt assembly, if any of these conditions are present as shown in (Fig. 2)
- 5 Check the seat belt buckles for damage and proper latching and unlatching.
- 6 Check the seat belt retractors for proper operation and proper retention on the vehicle chassis.
- 7 Inspect the belts for free movement in the tracks if the vehicle has passive seat belts.
- 8 Confirm the seat belt moves through its complete travel without sticking when the door is opened and closed.



Identify the HVAC components

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

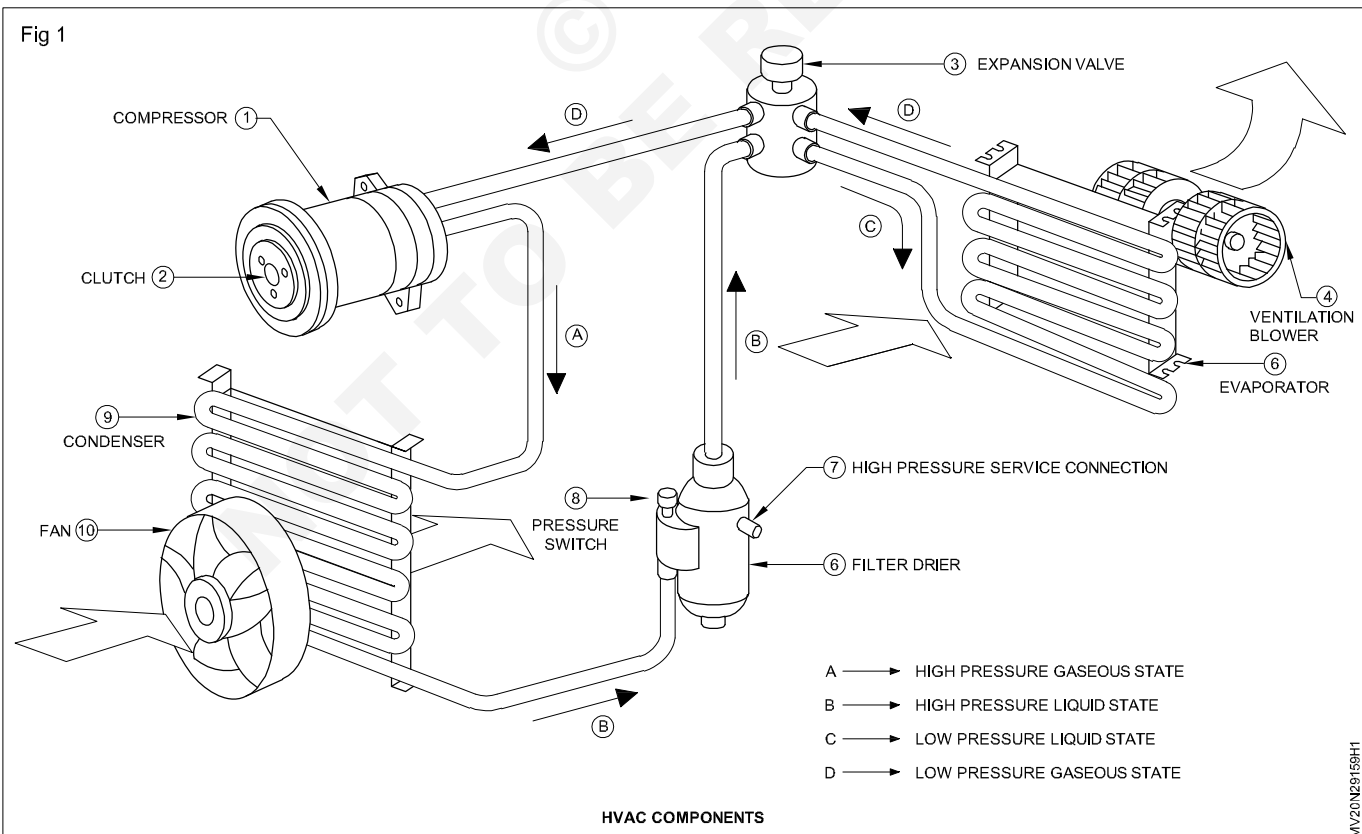
- identify all HVAC components of a motor car.

Requirements			
Tool/Instruments		Materials	
• Trainees tool kit	- 1 Set	• Cotton waste	- as reqd.
Equipments / Machineries		• Pointer	- 1 No.
• Vehicle with A/C	- 1 Set		

PROCEDURE

Identify all HVAC components of a motor car (Fig 1)

- 1 Place the vehicle in park or neutral with the emergency brake set.
- 2 Raise the hood and disconnect the negative battery cable.
- 3 Locate the compressor (1) and supporting device
- 4 Identify the compressor clutch (2)
- 5 Locate the expansion valve (3) and its supporting device.
- 6 Locate ventilation blower (4) and its support system.
- 7 Locate filter drier (6).
- 8 Locate high pressure service connections (7)
- 9 Locate the pressure switch (8)
- 10 Locate the condenser (9)
- 11 Locate fan (10)
- 12 High pressure pipe in gaseous state (A)
- 13 High pressure pipe connection in liquid state (B)
- 14 Low pressure pipe connections (7) in liquid state (C)
- 15 Low pressure pipe in gaseous state (D)



Performance test on A/C unit

1 Install manifold gauge set

- a Close high pressure and low pressure valves
- b Connect the high pressure hose to the discharge service valve of the compressor
- c Connect the low pressure hose to the suction service valve of the compressor
- d Run the engine and operate the car AC
- e Set the blower switch at high speed in AC switch on temperature control at cool and air flow control at vent.
- f Keep all window glasses open
- g Position the thermometer bulb in cool air outlet (supply grill outlet)
- h Place psychomotor close to the inlet of the cooling unit (place the psychomotor near the cool air outlet)

2 Wait until A/C system stabilizes (for about 20 to 30 minutes)

- a Check that the reading on high pressure gauge is 14.0 to 15.5 kg/cm² (200 to 230 PSI). If the reading is too

high pour water on the condenser. If reading too low cover the front of the condenser.

- b Check that the reading on the dry bulb thermometer at the air inlet is 25-35°C (77-95F)

3 Check the performance of the air conditioning system

- a Compare the dry bulb and wet bulb temperature with psychomotor chart and dry bulb readings of the psychomotor at the air inlet.

After measuring the temperature of the wet and dry bulb thermometer at the evaporator air inlet relative humidity percentage can be obtained Ex;- supporting dry and wet bulb temperature at the evaporator air inlets are 25°C (77°F) and 19.5°C (67°F) respectively. The point of inter section of the dotted lines in the graphic is 60%.

- b Measure the dry bulb temperature at cool air out let and calculate the difference between inlet dry bulb and outlet bulb temperature.
- c Check the intersection of the relative humidity and temperature difference between two hatched lines.

Check charged state of refrigerant and engine drive belt

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

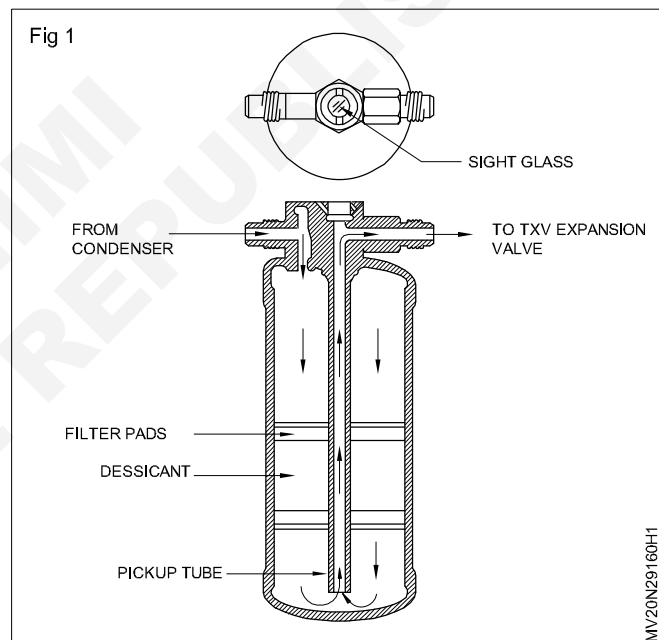
- check the charged refrigerant
- check the engine drive belt
- replace the engine drive belt.

Requirements			
Tool/Instruments		Materials	
• Trainees tool kit	- 1 No.	• Refrigerant	- as reqd.
Equipments / Machineries		• Engine drive belt	- as reqd.
• Car with A/C	- 1 No.	• Compressor drive belt	- as reqd.
		• Cotton waste	- as reqd.
		• Soap oil	- as reqd.

PROCEDURE

TASK 1: Check refrigerant charge

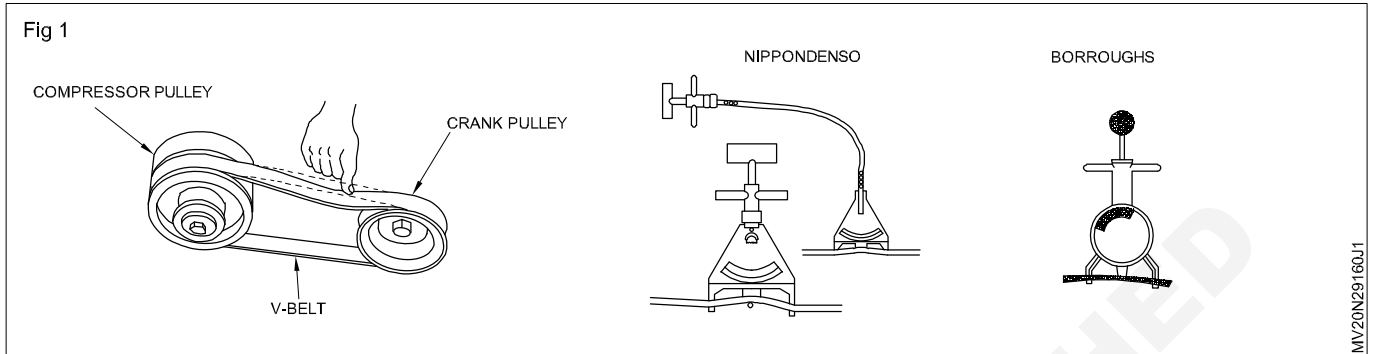
- 1 Run engine at fast idle
- 2 Operate air conditioner at maximum cooling for a few minutes.
- 3 Check amount of refrigerant.
Observe the sight glass on the receiver. (Fig 1)



Item	Symptom	Amount of refrigerant	Remedy
1	Bubbles present in sight glass	Insufficient	Check for leak with gas leak test
2	No bubbles present in sight glass	None, sufficient or too much	Refer to items 3 and 4
3	No temperature difference between compressor inlet and outlet	Empty or nearly empty	evacuate and charge system. Then check for leak with gas leak tester.
4	Temperature between compressor inlet & outlet is noticeably different.	Proper or too much	Refer to items 5 and 6
5	Immediately after the air conditioner is turned off, refrigerant in sight glass stays clear.	Too much	Discharge the excess refrigerant to specified amount.
6	When the air conditioner is turned off, refrigerant foams and then stays clear.	Proper	

TASK 2: Visual inspection of engine drive belt

- 1 **Check V-belt tension.** A slack V - belt slips, reducing compressor speed and limiting refrigerative capacity. To prevent such trouble, the following preinspection is recommended.
- 2 Push down on the centre of the V - belt with a finger and check the distance it moves. (Fig 1)
- 3 This distance varies between vehicles.
- 4 A worn V - belts must be replaced with a new one of appropriate size and model.



TASK 3: Check drive belt condition

- 1 Visually check the condition of the drive belt.
- 2 If found damaged engine drive belt.
- 3 Fit the new fan belt and pull the belt and check the tension of the belt.

TASK 4: Check and adjust belt tension

- 1 Check the tension of the belt in comparison with the commended value given in service manual.
 - 2 Measure the tension value using a tension gauge.
 - 3 Normally the belt running time is about 600 kms but if the belt is in good condition just check the belt for any broken or torn cords/portions.
 - 4 Some cars may have an idler pulley to adjust belt tension. Adjust the idler pulley and accordingly adjust belt tension.
-

Check heating system, compressor rotation and air gab

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

- check the car AC heating system
- check the compressor rotation
- check the air gab.

Requirements			
Tool/Instruments		Materials	
• Trainees tool kit	- 1 No.	• Refrigerant	- as reqd.
• High pressure gauge	- 1 No.	• Cotton waste	- as reqd.
• Low pressure gauge	- 1 No.	• Soap oil	- as reqd.
Equipments / Machineries			
• Car with A/C	- 1 No.		

PROCEDURE

a Checking the AC heating system

- Check the battery condition
- Check the fuse connection
- Check the heater relay switch and wire connections
- Check the hot water circulation coil and blower rotation
- Check the blower motor mountings and wire connection
- Check the blower switch
- Check the heater coil and thermometer
- Malfunction of this heating system should be checked according to this diagram.



Cause for blower motor does not turn on

- Broken wiring between battery positive terminals and blower unit
- Broken wire harmless
- Broken ignition switch circuit
- Broken heater relay circuit
- Loose or disconnected connectors
- Blown out fuse
- Broken thermo switch circuit
- Broken heat mode switch circuit
- Broken blower resistor
- Broken power servo circuit
- Broken blower switch circuit
- Improper body grounding
- Defection blower resistor
- Check the magnetic clutch operation.
- Check the compressor oil level and vacuum creation in compressor.
- Start the engine and check the compressor rotation
- Check the noise from the compressor during compressor operation if found any noise rectify it.
- Check the compressor inlet and outlet hose connections.
- Check the compressor maximum refrigerant pressure at 100°C.
- Check the compressor's rotation in idle and high speed of the engine.
- Run the vehicle at 1500 RPM and record the cooling ratio

b Check the compressor rotation test

- Check the compressor mountings
- Check the compressor driven belt tension and condition.

c Check the air gab

Clutch hub removal

- Remove magnetic clutch retaining ring or nut.
- Attach the tool to the end plate by threading the outer nut of the tool into the center hole of the clutch end plate.

- Tighten the inner tool arbor against the end of the compressor shaft to life the plate.

Tech Tip:- Proper air gab between the clutch pulley and hub armature is critical to compressor overall performance failure to maintain the proper spacing as indicated in the service manual. Specification can lead to problems such as clutch burning or slippage.

Clutch hub installation

- Position the shaft key in place
- Slide the clutch hub on the shaft of the compressor.

Be careful not to damage the components by using excess force.

- Thread the inner part of the tool onto the shaft. Tighten the outer nut of the tool to push the shaft key.
- Set the air by use of feeler gauge. Add or remove shims to obtain the manufacture's specification. Always set at the minimum number and measure at multiple points around the circumference.
- Reinstall the retaining or nut.
- Check oil level and rotate the hub with the hose of the compressor down to help lubricate check the case of the compressor rotation.

Drain, evacuate and charge the refrigerant in air conditioning system

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

- drain refrigerant in A/C system
- evacuate refrigerant in A/C system
- charge the system with refrigerant.

Requirements

Tool/Instruments

- Trainees tool kit - 1 No.
- Owners repair manual - 1 No.
- Socket set - 1 No.

Equipments / Machineries

- Vehicle with A/C system - 1 No.
- Recovery vacuum pump - 1 No.
- Recovery tank - 1 No.
- Manifold gauges - 1 No.
- Car with A/C - 1 No.

Materials

- Cotton waste - as reqd.
- Soap oil - as reqd.
- AC compressor drive belt - as reqd.
- Engine drive belt - as reqd.
- Refrigerant - as reqd.

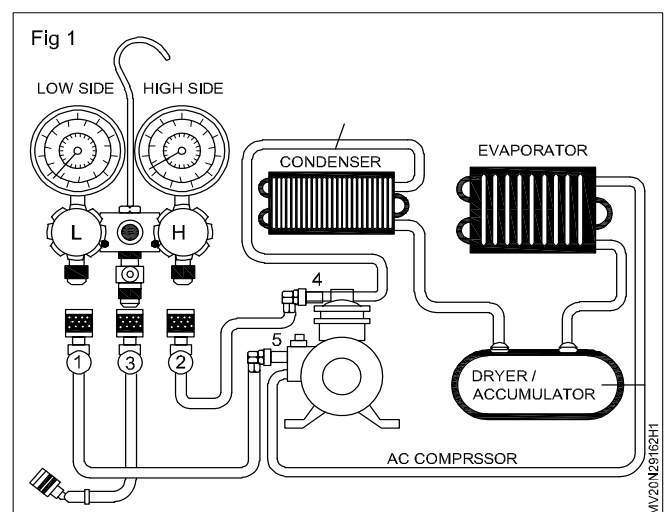
PROCEDURE

TASK 1: Drain refrigerant in A/C system

- 1 Place the vehicle in park or neutral with emergency brake set.
- 2 Raise the hood and disconnect the negative battery cable.
- 3 Place the recovery/recycle machine and plug it into a socket with machine off condition.
- 4 Hang a manifold gauges from the hood in plain view. (Fig 1)
- 5 Connect the high pressure side hose of manifold gauges (normally blue in colour) to the low side on your A/C.
- 6 Connect the low pressure side hose of manifold gauge (normally red in colour) to the low side on youre A/C line.

While connecting the hoses you must unscrew a small dust cap from the low/high side nozzle and push hoses on to the quick - release nozzle. (Fig 2)

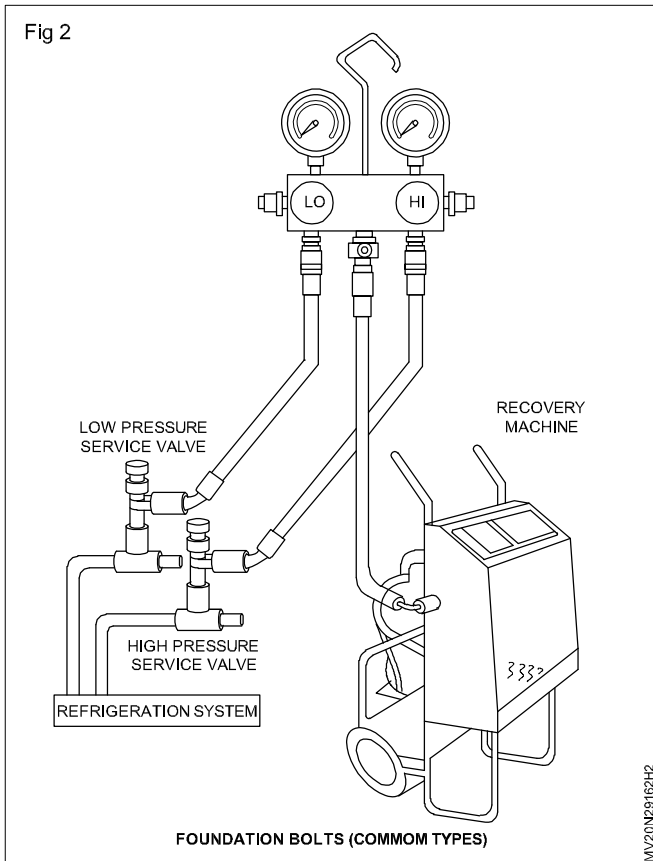
Refer to your owner's manual for the proper location of your low/high side nozzle fitting if you cannot find it. The



cap has an "L" / "H" stamped on it, which stands for low side/high side.

- 7 Connect the centre hose of manifold gauge (normally yellow in colour) to the proper fitting of machine. (as described by machine manufacturer). (Fig 1)

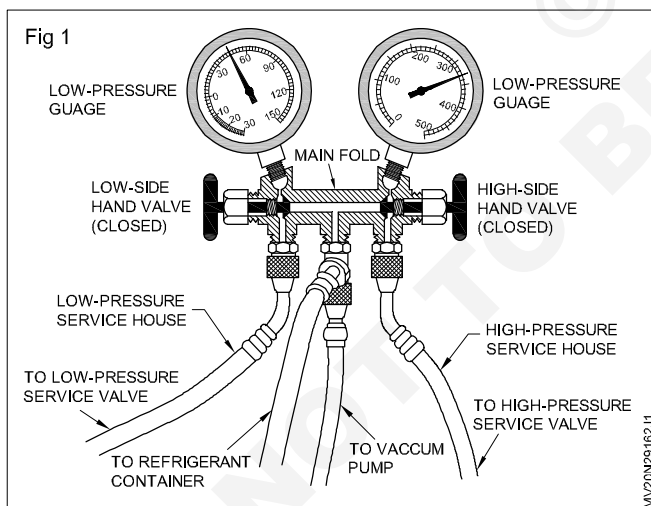
Fig 2



- 8 Turn on the recovery/recycling machine. (Fig 2)
- 9 Switch on the compressor on the recovery recycling machine.
- 10 Operate the compressor until the vacuum as indicated on the gauge of recovery/recycling machine.
- 11 Compressor may shut off it have automatic shut off feature otherwise switch off compressor manually.
- 12 Observe the gauges on the machine for minimum of 5 min.
 - a If the vacuum rises but remains changes at 0 psi or below, the system is leaking, repair it after recovery process.
 - b If the vacuum reading changes to a pressure above 0 psi, the refrigerant was not completely removed from the system, then repeat steps above from 5 to 10.
 - c If the vacuum holds steady for a minimum 2 minutes, then the recovery is good.
- 13 close all the manifold gauge hand valves, service hose valves and recovery system inlet valve.
- 14 Disconnect all the manifold gauge and cap all fittings.

TASK 2: Evacuate refrigerant in A/C system

- 1 When the refrigerant in the system is discharged or recovered the system needs to be evacuated. Connect the vacuum pump to the system as shown in Fig 1.



- 2 Recommended refrigerant oil is to be added before evacuating the system (use mineral oil for R-12 and PAG oil for R-134 a system)
- 3 The oil circulates with the refrigerant through the system.
- 4 During discharge and recovery the refrigerant oil is trapped into oil separator during discharging.
- 5 Drain this oil into a measuring cup and add same amount of oil during evacuating.
- 6 Switch ON the vacuum pump. The vacuum pump pumps out air and creates vacuum thereby allowing moisture in the system to boil and vaporise.
- 7 Continued pumping action will remove moisture laden vapour.
- 8 The pump may also be attached to the manifold high pressure side fitting.
- 9 Close the centre hose fitting to which refrigerator container is attached.
- 10 Switch ON the vacuum pump and follow the instructions given in service manual.
- 11 After the pump has run for about 10 minutes make a quick check for leakage.
- 12 Then close both manifold valves (low and high side) Check the vacuum in the gauges it should not drop more than 2 psi in 5 minutes.
- 13 If no leak is detected continue the vacuum pump operation until the entire refrigerant in the system is completely evacuated and the vacuum gauge reads a vacuum of 30" of mercury.
- 14 Evacuate the system for about 20 minutes after the maximum vacuum is reached. Close the valves and switch off the pump.
- 15 The system is now ready for charging the refrigerant. The unit tank must contain a sufficient amount of R-134a refrigerant for charging. Check the amount of

refrigerant in the tank. If there is less than 3.6 kg (8 pounds) of refrigerant, add new refrigerant to the tank. Refer to the manufacturer's instructions for adding refrigerant.

- 16 Verify that the high-side and the low-side hoses are connected to the A/C system. Open both the high-side and the low-side valves on the unit's control panel.
- 17 Open both the gas and the liquid valves on the tank.

Refer to the manufacturer's instructions for the charging station in use. It is necessary to evacuate the system before recharging it with new or recycled refrigerant.

- 18 Start the vacuum pump and begin the evacuation process. Non-condensable gases (mostly air) are vented from the tank automatically during the recycling process. You may hear the pressure being released.
- 19 Check for leaks in the system. Refer to the manufacturer's instructions for the charging station in use.

Change the vacuum pump oil frequently. Refer to the manufacturer's instructions for the charging station in use.

Once the system is evacuated, the system is ready for charging the refrigerant. Before charging pour recommended quantity of refrigerant oil through the suction port (refer service manual for quantity)

TASK 3: Charge the system with refrigerant

The system can be charged in many ways.

- Using portable service/charging station.
- Using manifold gauge set and a charging cylinder

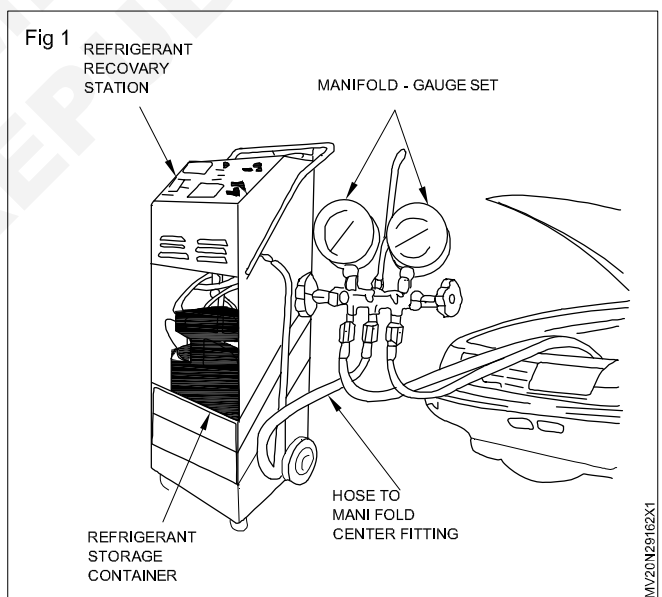
Using charging station

- 1 Connect the charging station vacuum pump to the middle service valve off the manifold gauge and switch on the pump.
- 2 The refrigerant from the cylinder will flow through the pump and into the compressor suction through the low pressure service valve in the manifold gauge set.
- 3 Before charging weigh the cylinder and switch OFF the charging station once the required quantity of refrigerant is charged. (refer service manual for proper quantity of refrigerant to be added).
- 4 Some charging station switch off automatically once the required amount of discharges done from the charging system.

Using manifold gauge set

- 1 Connect the charging cylinder with the manifold gauge as shown in (Fig 1)
- 2 Open the valve from the charging cylinder and allow refrigerant to flow through the low pressure side of manifold gauge set.
- 3 The pressure gauge will show the rise in pressure once the refrigerant flows into the system.
- 4 The charging cylinder should be weighed before and after charging so that the net change in weight is equal to the quantity of refrigerant to be added.
- 5 Once charging is over close all the service valves with caps and disconnect the charging cylinder. The system is now charged with required quantity of refrigerant.
- 6 Start the vehicle and switch ON the A/C with blower speed minimum
- 7 Note down the temperature readings after about 10 minutes time.

- 8 Ensure that there is sufficient cooling in the cabin and that all the components are working properly.
- 9 Take suitable correction action if there is any leak or malfunctioning.
- 10 Check the compressor running and battery voltage check the watch glass of receiver and drier for proper refrigerant flow.



A/C system oil charge replenishing

Any oil removed from the A/C system during the recovery process must be replenished at this time.

- 1 Use the correct graduated bottle of PAG oil for the R-134a system.

Keep the oil bottles tightly capped at all times to protect the oil from moisture and contamination. You must have an accurate A/C vacuum for this operation. Never open the oil injection valve while there is positive pressure in the A/C system. This will result in oil blow back through the bottle vent. Never let the oil level drop below the pickup tube while

charging or replenishing the system, as this will allow air into the A/C system.

- 2 Refer to the manufactures instructions for the charging station in use. Add the proper amount of PAG (polyalkylene glycol) oil to the system.
- 3 Close the valve when the required oil charge has been pulled into the system.

Charging

Evacuate the A/C system before charging

- 1 Close the low side valve on the control panel.
- 2 Open the high-side valve on the control panel.
- 3 Refer to the manufacturer’s instruction for the charging station in use.
- 4 Enter the amount of refrigerant needed to charge the A/C, making sure to use the correct system of measurement, i.e kilogram (kg) or point (lb).
- 5 Begin the charging process.

Trouble shooting in car air conditioning system

Trouble	Causes	Remedies
1.No cooling	<ul style="list-style-type: none"> - Air ducts clogged - Compressor drive belt loose fitting. - Low refrigerant level in compressor - Defective condenser - Condenser fins damaged. - Air filter clogged. 	<ul style="list-style-type: none"> - Tighten the belt - Charge refrigerant - Replace - Clean it - Replace it
2.No warm air	<ul style="list-style-type: none"> - Defective blower - Heater coil burnt - No power supply to heater coil - Blower resistor defective 	<ul style="list-style-type: none"> - Replace - Replace - Check wire connections - Replace
3.Cool air comes out only intermittently	<ul style="list-style-type: none"> - Slipping blower drive - Loose electrical connections to motor - Dust accumulated air filter 	<ul style="list-style-type: none"> - Check the motor shaft - Check for loose wiring - Clean the air filter
4.Insufficient cooling	<ul style="list-style-type: none"> - Compressor drive belt slip - Blower motor not work - Window glass open - Low refrigerant level in compressor 	<ul style="list-style-type: none"> - Replace - Repair - Close the window glass - Charge refrigerant

Check abnormal noise from air conditioning components

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

- check abnormal noise from compressor
- check abnormal noise from magnetic clutch
- check abnormal noise from condenser
- check abnormal noise from evaporator
- check abnormal noise from blower motor.

Requirements		
Tool / Instruments		Materials
• Trainees tool kit	- 1 No.	• Cotton waste
• Decibel meter	- 1 No.	• Soap oil
Equipments / Machineries		- as reqd. - as reqd.
• Car with AC	- 1 No.	

PROCEDURE

Check abnormal noise from compressor

- Start the engine and switch on the AC
- Check the compressor mountings for noise
- Check the compressor drive belt tension for noise
- Check the compressor rotor bearing for noise
- Check the metallic sound from compressor Check oil level in compressor.

Check abnormal noise from magnetic clutch

- Check the magnetic clutch plate
- Check the magnetic clutch bearing
- Check the magnetic clutch mountings
- Check the magnetic coil power supply
- Check the puller
- Check the air gab between coil and pulley
- Check abnormal noise from condenser

Check abnormal noise from condenser

- Check the condenser fins for blockage or damage for noise
- Check the condenser mounting or lose fittings for noise
- Check the hose connection vibration and noise
- Check for bend/broken blades of fan.

Check the abnormal noise from evaporator

- Check the fins for damage and noise
- Check the mountings for lose fitting
- check the hose vibration noise
- Check for tight fittings of blower coil unit
- Check for bend/loose end blower wheel from the shaft

Check the abnormal noise from blower

- Check the blower mountings
- Check the blower blade touch with body
- Check the blower (drive) motor mountings

Perform diagnosis test for high pressure and low pressure by manifold gauge

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

- test the high pressure gauge performance
- test the low pressure gauge performance.

Requirements			
Tool/Instruments		• Car with A/C	- 1 No.
• Trainees tool kit	- 1 No.	Materials	
• Owners repair manual	- 1 No.	• Cotton waste	- as reqd.
• Manifold gauges	- 1 Set	• Soap oil	- as reqd.
Equipments / Machineries		• Refrigerant	- as reqd.
• Recovery vacuum pump	- 1 No.		

PROCEDURE

Checking of refrigeration system with manifold high / low pressure gauge.

Read the manifold gauge pressure with the following established conditions

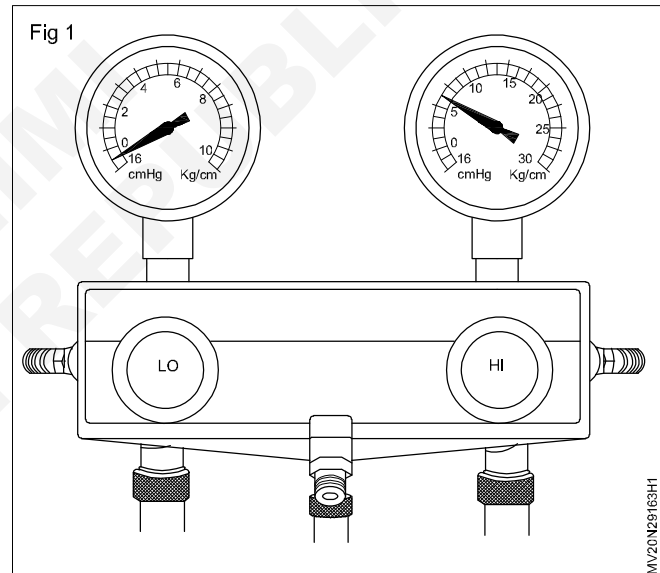
- a Temperature at the air inlet 30-35°C (86-95°F)
- b Engine running at 2000 rpm.
- c Blower speed set at high
- d Temperature control lever set at cool.

Note: It should be noted that the gauge indications may vary slightly due to ambient temperature conditions.

1 Normally functions refrigeration system (Fig 1)

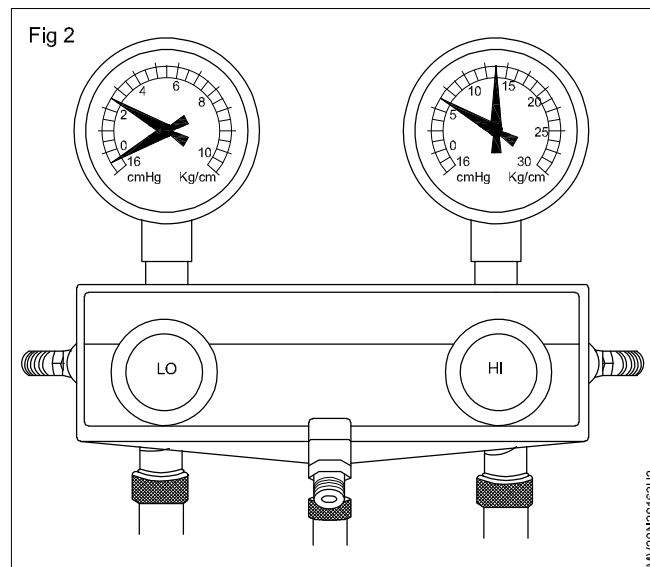
Low pressure side: 1.5-2.0 kg/cm² (21-28 psi, 147-196 KPa)

High pressure side: 14.5-15.0 kg/cm² (206-213 psi, 1422-1471 KPa)



2 Moisture functions refrigeration system (Fig 2)

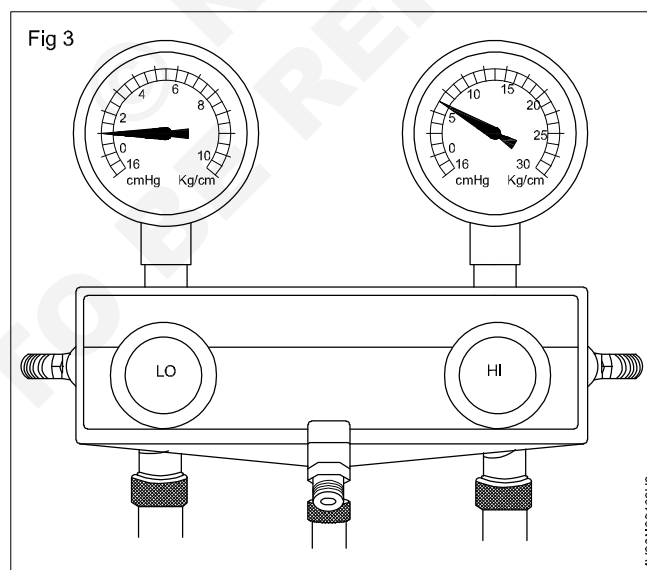
Symptom seen in refrigeration system	Probable cause	Diagnosis	Remedy
During operation, pressure on low, pressure side sometimes becomes a vacuum and sometimes normal.	Moisture entered in refrigeration system freeze at expansion valve orifice and stops cycle, but normal state is restored after a time when the ice melts	Drier in oversaturated state Moisture in refrigeration system freezes at expansion valve orifice and blocks circulations of refrigerant	1. Replace receiver & drier 2. Remove moisture in cycle through repeated vacuum purging method. 3. Charge new refrigerant to proper amount.



3 Insufficient refrigerant (Fig 3)

Condition, periodically cools and then fills to cool

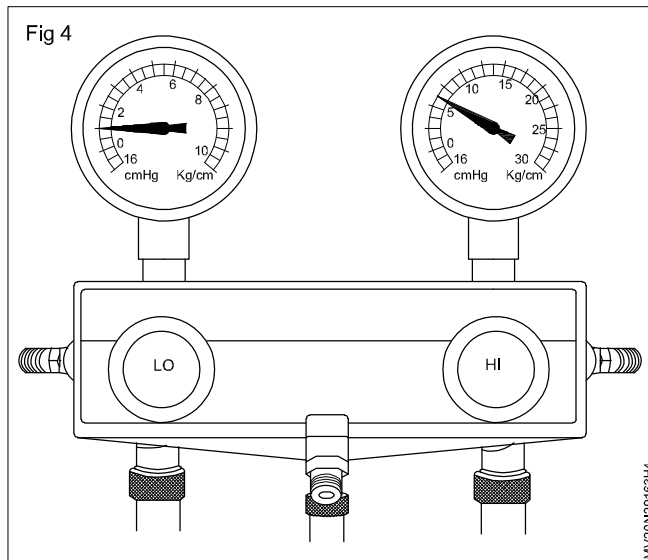
Symptom seen in refrigeration system	Probable cause	Diagnosis	Remedy
Pressure low on both low and high pressure sides.	Gas leakage at some place in refrigeration system.	Insufficient refrigeration in system	Check with leak detector repair
Bubbles seen in sight glass insufficient cooling performance	Refrigerant system	Refrigerant leaking	Charge refrigerant to proper amount.



4 Poor circulation of refrigerant (Fig 4)

Condition: Insufficient cooling

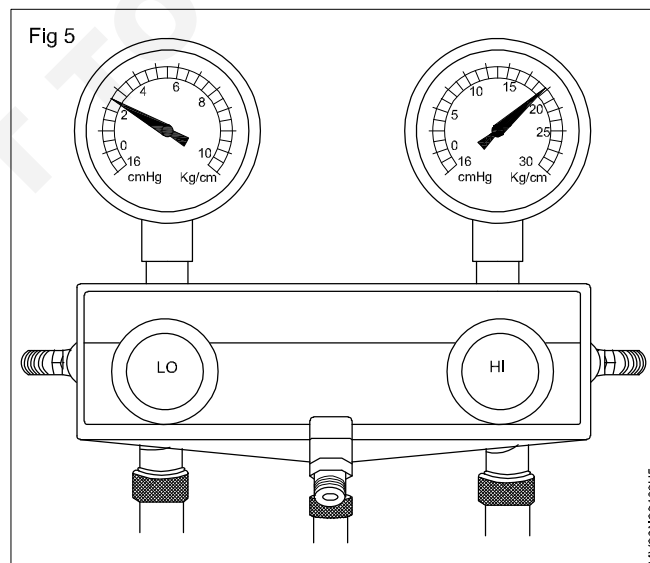
Symptom seen in refrigeration system	Probable cause	Diagnosis	Remedy
Pressure low on both low and high pressure sides.	Refrigerant flow obstructed by dirt in receiver	Receiver clogged	Replace receiver
Frost on tubes from receiver to unit.			



5 Refrigerant overcharge or insufficient cooling of condenser (Fig 5)

Condition: Does not cool sufficiently

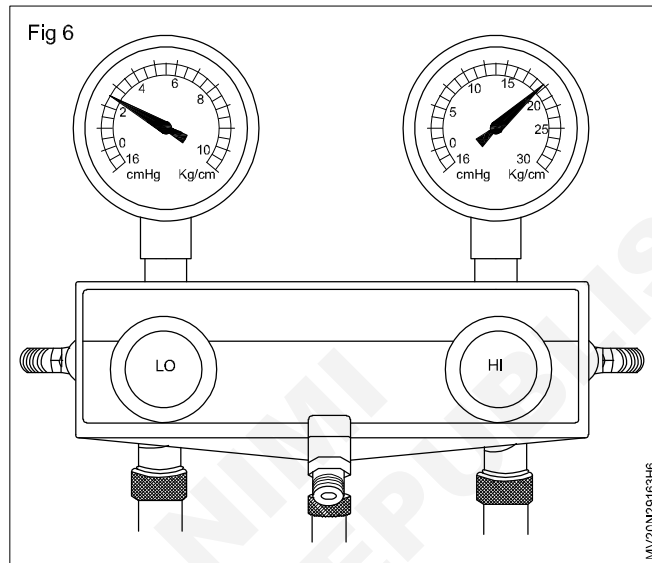
Symptom seen in system	Probable cause	Diagnosis	Remedy
Pressure too high on both low and high pressure sides.	Unable to develop sufficient performance due to excessive refrigerant in system condenser cooling insufficient	Excessive refrigerant in cycle refrigerant overcharged Condenser cooling in sufficient condenser fins clogged or fan motor faulty	1. Clean condenser 2. Check fan motor operation 3. If (1) and (2) are in normal state check amount of refrigerant. Note. Vent out refrigerant through gauge manifold low pressure side by gradually opening



6 Expansion valve improperly mounted/Heat sensing tube defective (opens too wide) (Fig 6)

Condition: Insufficient cooling

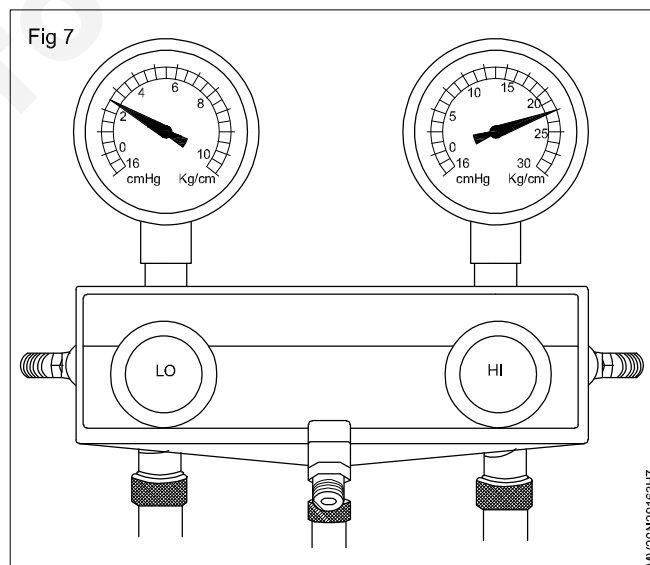
Symptom seen in refrigeration system	Probable cause	Diagnosis	Remedy
Pressure too high or both low and high pressure sides.	Trouble in expansion valve or heat sensing tube not installed correctly. Refrigerant flow out of adjustment.	Excessive refrigerant in low pressure piping. Expansion valve opened too wide.	1. Check heat sensing tube installed condition. 2. If (1) is normal, test expansion valve is unit form. Replace if defective



7 Air present in refrigeration system (Fig 7)

Condition: Does not cool down sufficiently

Note: These gauge indications are shown when the refrigeration system has been opened and the refrigerant charged without vacuum purging.

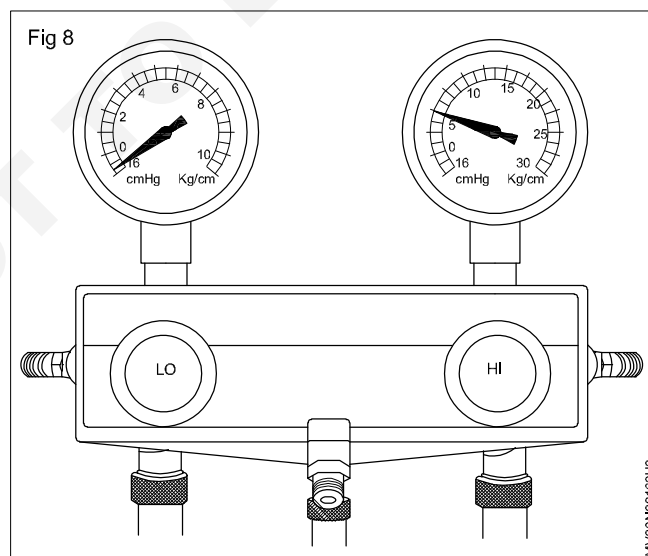


Symptom seen in refrigeration system	Probable cause	Diagnosis	Remedy
Pressure too high on both low and high pressure sides.	Air entered in refrigeration system	Air present refrigeration system. Insufficient vacuum purging.	1. Replace receiver & drier 2. Check compressor oil to see if dirty or insufficient. 3. Vacuum purge and charge new refrigerant.

8 Refrigerant does not circulate: (Fig 8)

Condition: Does not cool (Cools from to time in some cases)

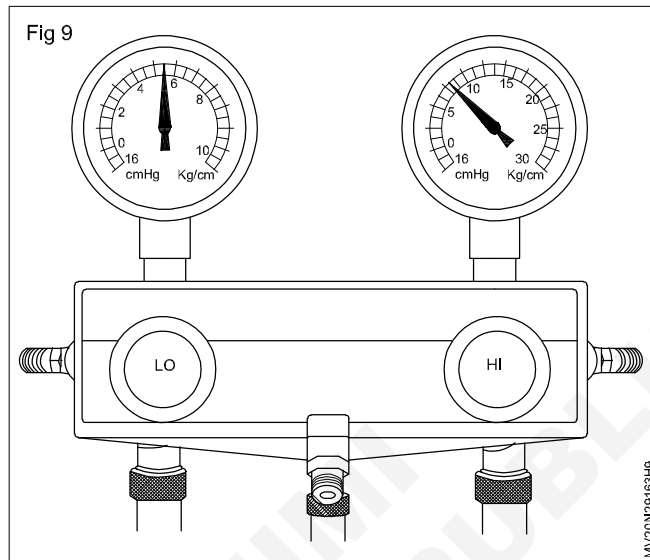
Symptom seen in refrigeration system	Probable cause	Diagnosis	Remedy
Vacuum indicated on low pressure side, very low pressure indicated on high pressure side Frost or dew seen on piping before and after receiver and drier or expansion valve.	Refrigerant flow obstructed by moisture or dirt in refrigerant freezing or adhering to expansion valve orifice Refrigerant flow obstructed by gas, leakage from expansion valve heat sensing tube.	Expansion valve orifice clogged Refrigerant does not flow.	Allow to stand for some time and then restart operation to determine if trouble is caused by moisture or dirt. If caused by moisture refer to procedure step 2. If caused by dirt, remove expansion valve and clean off dirt by blowing with air. If unable to remove dirt, replace valve. Vacuum purge and charge new refrigerant to proper amount. For gas leakage from heat sensing tube. Replace expansion valve.



9 Defective compression compressor: (Fig 9)

Condition: Does not cool

Symptom seen in refrigeration system	Probable cause	Diagnosis	Remedy
Pressure too high or low pressure side. Pressure too low at high pressure side.	Internal leak in compressor.	Compression defective Valve leaking or broken. Sliding parts (piston, cylinder, gasket, connecting rod, etc.,)	Replace compressor



PROCEDURE

Diagnosis test for high pressure gauge-pressure high and low

Normal operating pressure ranges of car AC using HFC-134 a at an ambient conditions of 32°C to 35°C are

- a Low pressure side: 1-3 kg/cm²
- b High pressure side 12-22 kg/cm²

- 1 Clamp the gauge manifold of testing station to observe pressure conditions of car AC system.
- 2 Connect low side and high side hoses to service ports of car AC system.
- 3 Start the car and switch on AC, accelerate the engine shaft (Gear in Neutral) the RPM of the engine/compressor shaft should be around 2600 for about 15 to 20 minutes.
- 4 If the high side of car AC system is higher than normal, check for:-
 - A Dirty condenser
→ Clean the condenser
 - B Air in the system condenser
→ Recover and recharge the refrigerant
 - C Excess refrigerant charge.
→ Purge out and reduce the refrigerant and check for normal cabinet temperature conditions.
- 5 If high side of car AC system is lower than normal, check for

A Leakage of refrigerant

→ use soap solution to detect the leakage points of all fitting joints. If any leakage point is observed with soap bubbles, tighten the flare-fitting joint. If there is no leakage,

B Check for under charge of refrigerant in such case, the low pressure side gauge reads lower than normal.

→ Refrigerant may be charged if the system dose not have leakage.

→ If there is leakage of refrigerant, arrest the leak, and reprocess the refrigerant charging.

6 If the low side of car AC system is lower than normal, check for

A Leakage points, arrest the leakage and reprocess the system for refrigerant charging.

B If the compressor has poor pumping, check the performance of compressor. The symptom in car cabinet is either poor or no cooling effect.

7 If the low side of car AC system is higher than normal, check for

A Over charge of refrigerant and the high side pressure also becomes higher than normal.

B If compressor has poor pumping, check the performance of compressor.

Mechanic Motor Vehicle - Vehicle information and driving practice**Drive a vehicle on a straight road**

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

- drive a vehicle on a straight road
- shift the gears smoothly using double declutching and single declutching
- apply the brakes effectively.

Requirements			
Tools/Instruments		Equipments / Machineries	
• Trainees tool kit	- 1 Set	• Vehicle with Stepney	- 1 No.
• Vehicle regd certificate	- 1 No.	Materials	
• Insurance certificate	- 1 No.	• Cleaning cloth	- as reqd.
• Fitness certificate	- 1 No.	• Soap oil	- as reqd.
• Driving license	- 1 No.		
• 'L' boards	- 1 No.		
• Jack lever	- 1 No.		

PROCEDURE**Driving vehicle on a straight road**

- 1 Start the engine
- 2 Release the parking brake.
- 3 Press the clutch pedal fully.
- 4 Move the gear shifting lever into the 1st gear smoothly and retain your hand on the steering wheel. (First gear is not synchromesh)
- 5 Raise the engine speed a little and hold it there. This extra power is needed to move a stationary vehicle.
- 6 See the rear-view mirror for traffic coming from behind.
- 7 Release the clutch pedal slowly till you feel the car is moving forward.
- 8 Hold the clutch pedal.
- 9 Look around over your right shoulder.
- 10 Press the accelerator pedal further down gradually, and simultaneously release the clutch pedal slowly. Allow the vehicle to move slowly.
- 11 Keep both the hands on the steering wheel, look ahead and lift the left foot off the clutch pedal.
- 12 Let the car move steadily forward for a few yards.
- 13 shift the gear using either double declutching or single de-clutching smoothly.
- 14 Hold the gear lever knob.
- 15 Increase the car speed and then release the accelerator pedal.
- 16 Declutch fully just as the accelerator pedal comes up to the top.
- 17 Shift the 1st gear to neutral.
- 18 Engage the 2nd gear.
- 19 Increase the car speed by pressing the accelerator pedal.
- 20 Repeat the above procedure for changing the gear from the 2nd to the 3rd.
- 21 For changing the gear from 3rd to 2nd and 2nd to 1st, repeat the same procedure.
- 22 prepare yourself for braking
- 23 Look into the rear-view mirror, and signal for stopping.
- 24 Release the accelerator pedal gradually to avoid jerky movement.
- 25 Apply the brake gradually.
- 26 Just a little before the car stops, declutch. if it is not done properly. The engine will stop running.
- 27 Stop the vehicle and put the gear shift lever to neutral position. Switch off the ignition.
- 28 Apply the hand brake.
- 29 Do not drive a vehicle at a speed more or less than what is specified by the manufacturer for a particular gear.

Drive a vehicle through curves

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

- drive through curves
- drive through narrow lanes.

Requirements		
Tools/ instruments		Equipments / Machineries
<ul style="list-style-type: none"> • Trainees tool kit • Vehicle regd certificate • Insurance certificate • Fitness certificate • Driving license • 'L' boards • jack lever 	<ul style="list-style-type: none"> - 1 Set - 1 No. - 1 No. - 1 No. - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Vehicle with Stepney
		Materials
		<ul style="list-style-type: none"> • Cleaning cloth • Soap oil
		<ul style="list-style-type: none"> - 1 No. - as reqd. - as reqd.

PROCEDURE

TASK 1: Drive through curves

Left turn at road junctions

- 1 See the rear-view mirror for any vehicle coming behind.
- 2 Show the signal to left (either by the traffic indicator or by hand signalling).
- 3 Move the vehicle to the left lane.
- 4 Slow down the vehicle.
- 5 Turn the vehicle to the left as shown in route 'A'.

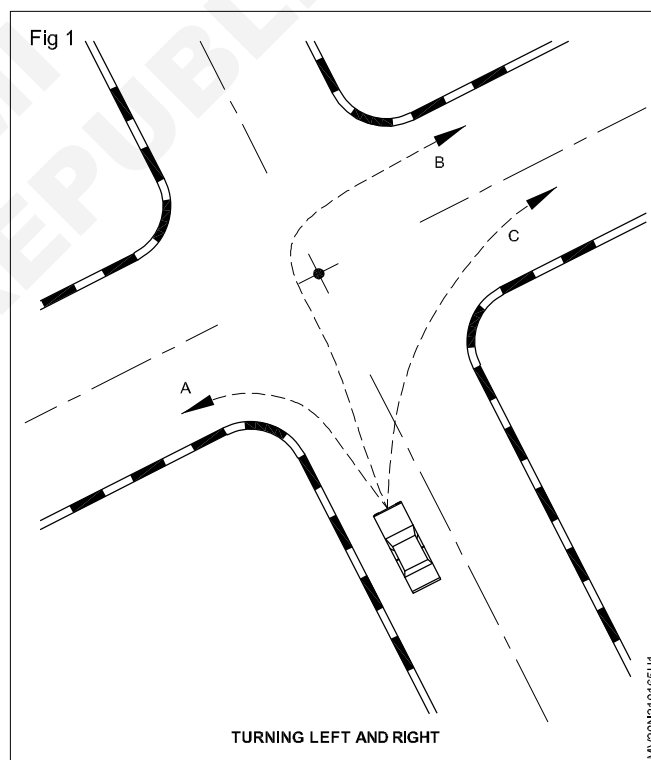
The vehicle should not be too close to the left side kerb.

Right turn at road junctions

- 6 See the rear-view mirror for any vehicle coming from behind.
- 7 Show the signal for turning to the right (with the traffic indicator or by hand signalling).
- 8 Slow down the vehicle and move to the right lane. (Do not cross the centre lines.)
- 9 Move the vehicle to the right as shown in route 'B'.
- 10 The driver should not move the vehicle as shown in route 'C'. Route 'C' is taken by some drivers against the law and is full of hazards.

Turning right into a main road (Fig. 1)

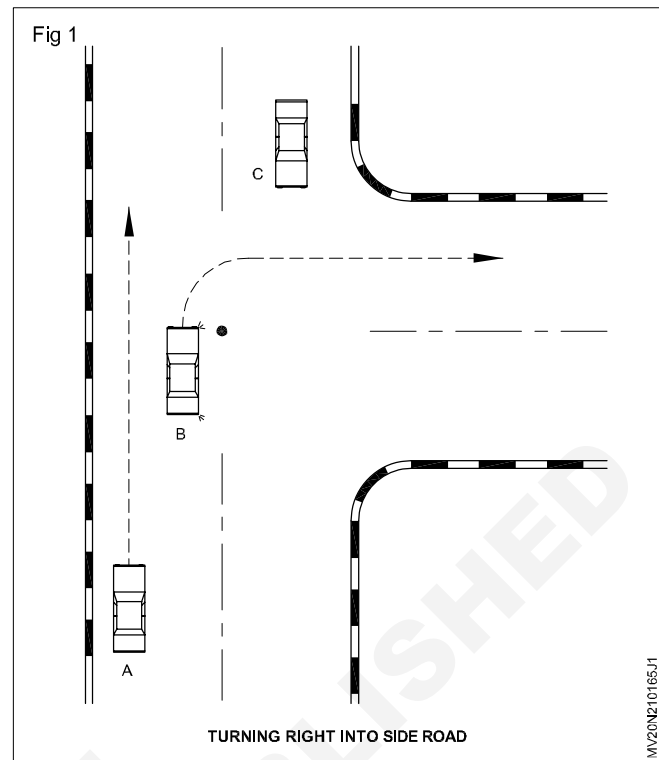
- 11 Drive the vehicle with in your left half of the road as shown in the figure.
- 12 Do not cut at the corners.
- 13 Turning right into a side road (Fig. 2)



- 14 See if any car is coming opposite to you as shown in the figure.
- 15 Show the indicator to turn right.
- 16 Wait for the opposite traffic to clear.
- 17 slowly move the vehicle as shown in the figure.
- 18 Cars coming from behind. A in fig. are permitted to overtake on the left side.

TASK 2: Drive through narrow lanes

- 1 Slow down the vehicle.
- 2 See if any vehicle is coming in the opposite direction.
- 3 Ensure that the lane is clear.
- 4 Show the signal by switching on the headlamp.
- 5 Slowly drive through the lane.
- 6 While driving on narrow lanes you should not overtake any vehicle and should always go in line one behind the other.
- 7 use of indicators correctly.
- 8 Signal your intention well in advance so that the vehicles coming in front and from behind will be alert.



Drive a vehicle in reverse direction

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

- **reverse the vehicle from the parking**
- **reverse the vehicle when the vehicle is moving with traffic.**

Requirements			
Tool/Instruments		Equipments / Machineries	
• Trainees tool kit	- 1 Set	• Vehicle with Stepney	- 1 No.
• Vehicle regd certificate	- 1 No.	Materials	
• Fitness certificate	- 1 No.	• Cleaning cloth	- as reqd.
• Driving license	- 1 No.	• Soap oil	- as reqd.
• 'L' boards	- 1 No.		
• Jack lever	- 1 No.		

PROCEDURE

TASK 1: Reverse the vehicle from the parking

Reversing the vehicle from the parking

- | | |
|---|---|
| <ol style="list-style-type: none"> 1 While reverse the vehicle ensure that <ul style="list-style-type: none"> - there is nothing hidden behind the vehicle - pedestrians, cyclists or other vehicles are not approaching you - the path is clear from all directions. 2 Get into the vehicle. | <ol style="list-style-type: none"> 3 Start the vehicle 4 Shift the gear in the reverse direction position 5 See the rear view mirror 6 Sound the horn 7 Look back over your right / left shoulder 8 Reverse the vehicle by slow acceleration and gradual operation of clutch. |
|---|---|

TASK 2: Reversing the vehicle when driving on the road

- | | |
|--|---|
| <ol style="list-style-type: none"> 1 Give signal for stopping. 2 Slow down the speed. 3 Pull the vehicle as close to the left of the road as possible. 4 Look for any obstructions. 5 Stop the vehicle. | <ol style="list-style-type: none"> 6 Shift the gear in the reverse position. 7 See the rear view mirror 8 Look back over the right/left shoulder 9 Sound the horn. 10 If the rear view is not clear, then take the help of others. 11 Reverse slowly to the desired location. |
|--|---|

Drive and overtake another vehicle

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

- overtake another vehicle on road.

Requirements			
Tools/Instruments		Equipments / Machineries	
• Trainees tool kit	- 1 No.	• Running vehicle	- 1 No.
• Vehicle registration certificate	- 1 No.	Materials	
• Vehicle fitness certificate	- 1 No.	• Cotton cloth	- as reqd.
• Driving license	- 1 No.	• Soap oil	- as reqd.
• 'L' board	- 1 No.	• Lube oil	- as reqd.
• Vehicle tool kit	- 1 No.	• Coolant	- as reqd.

PROCEDURE

Overtaking a vehicle

1 While overtaking a vehicle

- looking at the rear-view mirror and ensure that no vehicle behind you is too close
- Give proper signal to the vehicle that you are overtaking
- Sound the horn
- Dim and dip (at night)
- Never try to overtaking near an intersection, curves, any obstruction which makes the road not clearly visible
- Ensure that there is enough road length before you without any on coming vehicle.

2 Maintain a safe distance from the vehicle moving in front.

3 Change the gear down and accelerate to increase speed.

Given maximum acceleration and overtake when a clear signal for overtaking is given by the vehicle (in front)

Always overtake on the right side only. Maintain some distance from the vehicle you have overtaken, and then move leftwards slowly.

Drive on wet / sandy surface

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

- park the vehicle on diagonally
- park the vehicle in parallel position.

Requirements			
Tools/Instruments		Equipments / Machineries	
• Trainees tool kit	- 1 Set	• Vehicle with stepney	- 1 No.
• Vehicle regd certificate	- 1 No.	Materials	
• Insurance certificate	- 1 No.	• Cleaning cloth	- as reqd.
• Fitness certificate	- 1 No.	• Soap oil	- as reqd.
• Driving license	- 1 No.		
• 'L' boards	- 2 No.		
• Jack	- 1 No.		

PROCEDURE**TASK :1 Driving a vehicle through sandy road**

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Do not accelerate much, otherwise the wheels will spin. 2 Use the first or second gear and give sufficient acceleration. | <ol style="list-style-type: none"> 3 If the wheels begin to spin declutch and switch off the engine then use any of the techniques like chain on the wheels, etc. to bring the vehicle to the solid road surface. |
|---|--|

TASK 2: Driving a vehicle on wet surface

- | | |
|---|---|
| <ol style="list-style-type: none"> 1 Driving the vehicle very carefully. 2 Use mud and snow thread tyres to get more grip between the wheels and the surface. 3 The speed must be 10kmph-as low as possible. Do not accelerate much. | <ol style="list-style-type: none"> 4 Switch on the headlights, the rear lights and the side lights. 5 If you are crossing a causeway ensure that the water level is below the exhaust pipe. 6 If the rear wheel begins to spin, engage the front wheel drive and take out the vehicle from the sand, using the 1st/2nd gear. Disengage the front wheel drive. the moment the vehicle comes on the solid surface. |
|---|---|

TASK 3: Braking or stopping

- | | |
|--|--|
| <ol style="list-style-type: none"> 1 Check for any vehicle in the rear-view mirror. 2 See if there is any vehicle behind your vehicle. 3 Show the slowing down signal, and slow down the vehicle. 4 Press the brake pedal gradually. | <ol style="list-style-type: none"> 5 Just a little before to stop the car declutch fully.(If it is not done properly the engine will stop running.) 6 Apply the brake and stop the vehicle. 7 Put the gear in neutral. Switch off the engine. 8 Apply the hand brake. |
|--|--|

Practice to study the electric car batteries current adoption status

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

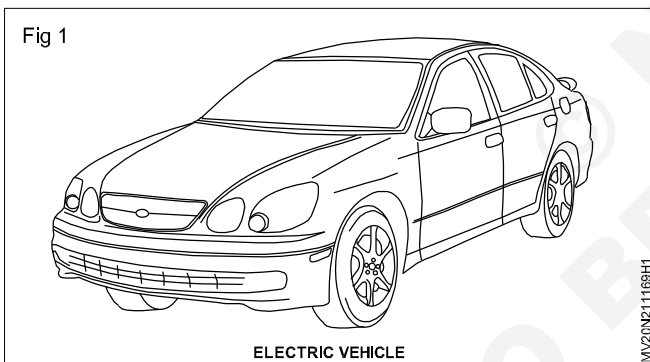
- Identify the type of electrical vehicles
- Identify the type of battery used in EV
- Study the current adoption of batteries

Requirements	
Tools/Instruments	Materials
<ul style="list-style-type: none"> • Trainees tool kit - 1 No. • Hydro meter - 1 No. • Multimeter - 1 No. • Test Lamp - 1 No. • Battery manual - 1 No each 	<ul style="list-style-type: none"> • Cotton waste - as reqd. • Soap oil - as reqd. • Distilled water - as reqd. • Energy shot - as reqd. • Gel - as reqd.
Equipments / Machineries	
<ul style="list-style-type: none"> • Electric Vehicle - 1 No. • Work bench - 1 No. 	

PROCEDURE

Task 1 : Identify the electric vehicle type

- Park the electric vehicle on hard surface (Fig 1)



- Clean the vehicle and open the vehicle bonnet cover
- Check the battery connections and identify the battery type
- Disconnect battery circuit wire connecting Loosen the battery mounting and remove the battery and place it on the work bench (easy type of electric vehicle BEV, HEV,PHEV,FCEV) (Fig 2)

Layout the batteries of each types of electric cars (Fig 3 & 4)

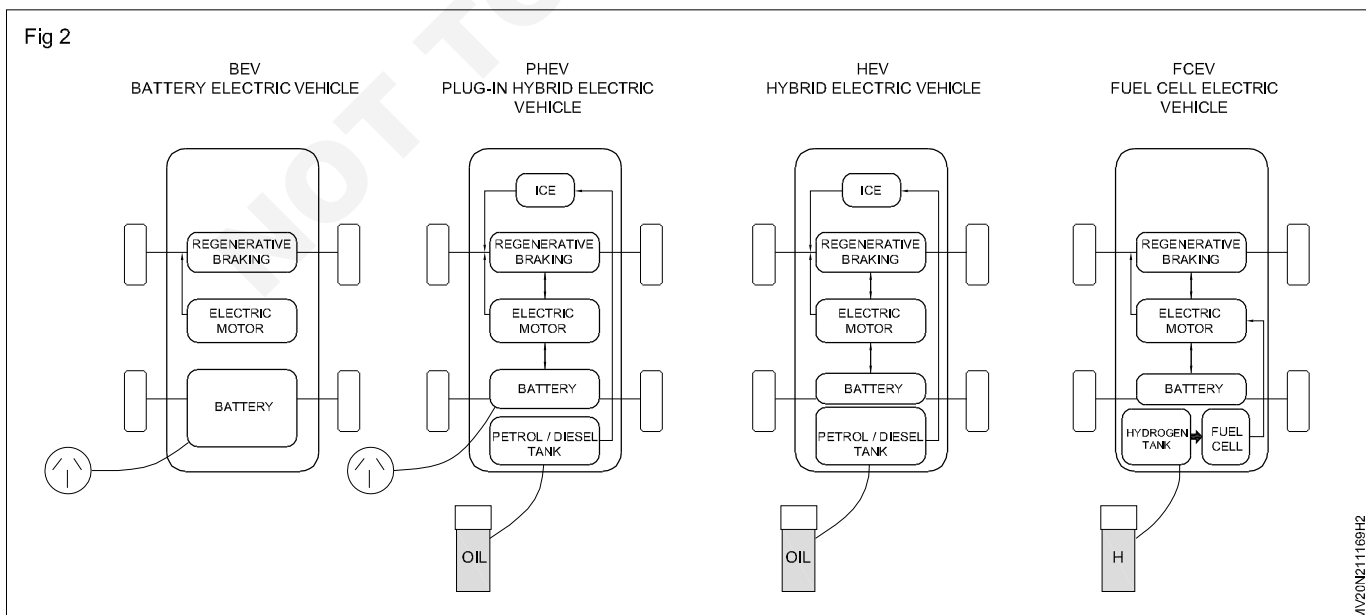
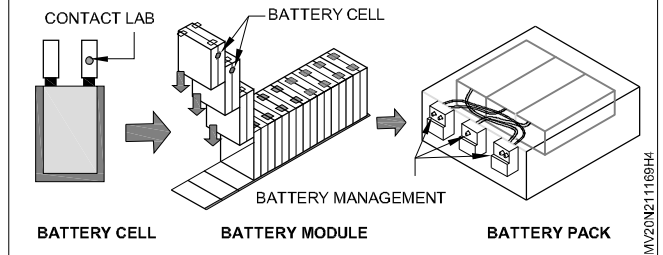


Fig 3



Fig 4



- Study the battery manual and compare it with electric car batteries land on the work bench
- Identify the type of batteries and their capacity of current storage (Lithium ion, lead –acid battery, Nickel metal hydride, and super capacitor battery)

Task 2 : **Measure the current adoption status of each battery**

- Clean the battery terminal before check the battery storage current
- Study the battery manual and note the each battery current storage capacity and battery life.
- Visually check the battery charge indicator adopter in battery by color indication
- Check the battery for damage and leakages
- If battery is OK; then check the battery voltage/current with suitable testing instrument
- Select the multimeter and set battery current and voltage measuring range
- Connect the multimeter terminal cable with multimeter terminal points
- Touch the multimeter red and black cable point.
- Check the continuity on the meter display
- If it is OK then test the batteries one by one by connecting the multimeter
- Note each battery reading on the paper
- Compare the reading with the manual specification
- If need recharge the battery, incase battery is not charging replace the battery for the same capacity of current adoption
- Full charge the battery as direction given by the battery manufactures
- Check the following test while test while test the current adoption of batteries
- Battery robustness for vibration
- Thermal shock and cycling
- Mechanical shock and integrity
- Fire resistance
- External short circuit
- Overcharge and over discharge protection
- Over temperature protection
- Battery independence test
- Electro chemical test
- Load bank testing
- Partial discharge testing
- Battery monitoring system

Note:

Use the electronic and digital battery testers for the remaining capacity of battery. Battery capacities is measured in milli amps x hours (MAH)

Note:

UL 2580 Batteries are use in electric vehicle
UL 2271 Batteries are use in light electric vehicle
ISO 26262 road vehicles

Practice to identify and study performance of electric vehicle and I.C engine vehicle

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

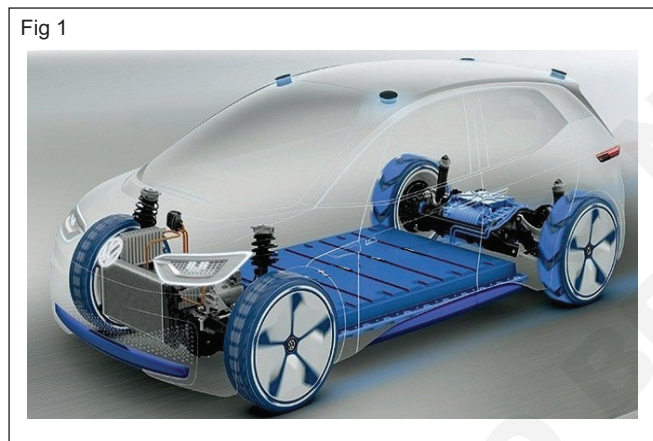
- **Identify and study the performance of electric vehicle**
- **Identify and study the performance of I.C engine vehicles**
- **Electrical vehicle performance comparison to I.C engine vehicles**

Requirements			
Tools/Instruments			
• Trainees tool kit	- 1 No.	• I.C engine vehicle	- 1 No.
• Electric vehicle manual	- 1 No.	Materials	
• Manual	- 1 No.	• Cotton waste	- as reqd.
Equipments / Machineries		• Soap oil	- as reqd.
• Electric Vehicle	- 1 No.	• Cleaning solution	- as reqd.

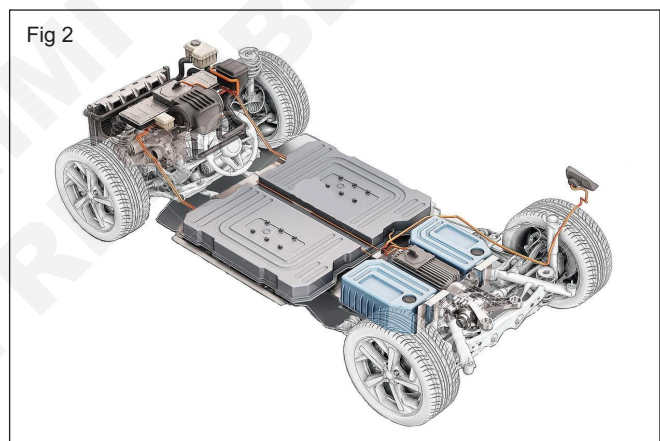
PROCEDURE

Task 1 : Identify and study the performance of electric vehicle

- Park the electric vehicle on the shop floor (fig 1)



- Clean the vehicle and identify the parts of electric vehicle
- Check the battery charge condition of electric vehicle
- If need full charge the battery with on board charger
- Check the vehicle thermal system (cooling)
- Check the EV DC/DC converter power electronic controller , electric traction motor, Traction battery pack and transmission system (Fig 2)



- Read the EV manual before start it
- Start the electric vehicle as direction given by the vehicle manufacturers
- Check the vehicle performance while electric motor transmission drive
- Ensure the there is no any noise from the vehicle
- Move and drive the vehicle on the road ,check the vehicle speed and load carrying capacity.

Task 2 : Check the performance of internal combustion engine

- Park the vehicle near the electric vehicle
- Clean the vehicle and check all system of vehicle including engine system
- If found any defects on the vehicle, rectify the defects before start the engine.
- Start the engine and check the engine performance (petrol/diesel) including noise emission, fuel consumption, power loss engine starting and stoping engine heat etc.,
- Absorbe the performance of IC engine vehicle's off road drive and on road drive.

- Note the performance of I.C engine vehicles off road drive and on road drive

Task 3 : **Comparison of electric vehicles Vs I.C engine vehicles performance**

- Compare the constructional features of both vehicle
- Compare the emission control of both vehicle
- Compare the noise of the engine of vehicle
- Compare the cost of the vehicle of both vehicle
- Compare the battery charging method of both vehicle
- Compare the durability of both vehicle
- Compare the on road facilities available for both vehicle

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Practice to identify the basic components of electric vehicle

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

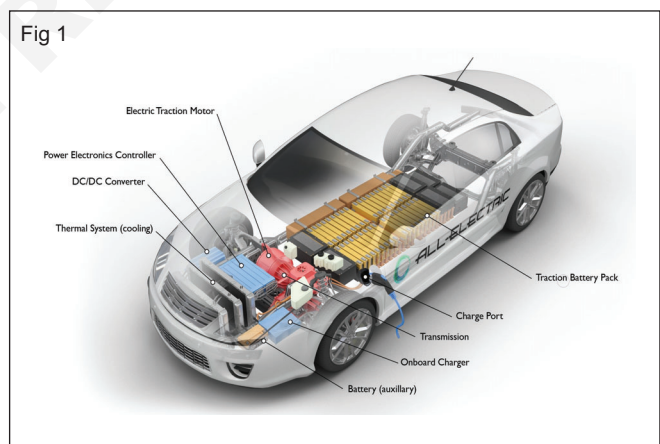
- Identify the basic components of each type of electric vehicle

Requirements			
Tools/Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
• Electric vehicle manual	- 1 No.	• Soap oil	- as reqd.
• I.C Engine vehicle	- 1 No.	• Vehicle cleaning materials	- as reqd.
Equipments / Machineries			
• Electric Vehicle	- 1 No.		

PROCEDURE

Task 1 : **Identify the basic key components of all electric car**

- Park the electric vehicle on the shop floor
- Clean the vehicle and open the bonnet and doors of the vehicle
- Study the EV manual for identify the basic components of electric vehicle
- Identify the location of the battery of vehicle
- Identify the EV charge port location on the vehicle
- Identify the DC/DC converter location on the vehicle
- Identify the rear view of a reversing screen display
- Identify the location and their connection of electric traction motor
- Identify the on board charger point on the vehicle
- Identify the location of power electronic controller fixed on the electric vehicle
- Identify the thermal system (cooling system) of electric vehicle
- Identify the vehicle slip ratio indicator
- Identify the traction battery pack location of the electric vehicle
- Identify the display of turning status
- Identify the schematic of fault diagnosis system
- Identify the transmission transfers mechanical power from the electric traction motor to drive the wheels in the electric vehicle
- If the hybrid electric vehicle (HEV) identify the internal combustion engine and its fuel tank and other system related to ICE.
- Identify the control module of HEV and PHEV vehicles
- Identify the battery pack with controller & inverter
- Identify the fuel cell stack incase of fuel cell electric vehicle (FCEV)
- Identify the hydrogen storage Tank (FCEV)



Identify the various gauges/instruments on dash board of an electric vehicle

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

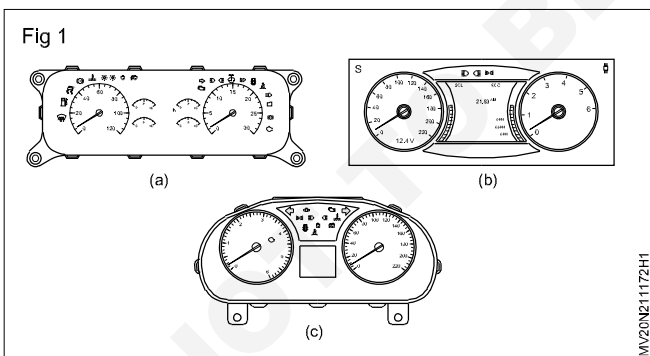
- Identify the various gauges and instruments of electric vehicle
- Identify the various gauges and instruments of IC engine vehicle

Requirements		
Tools/Instruments		Materials
• Trainees tool kit	- 1 No.	• Cotton waste
• Electric vehicle manual EV & ICEV	-1No each.	• Soap oil
Equipments / Machineries		• Paper
• Electric Vehicle	- 1 No.	• Pencil
• I.C engine vehicle	- 1 No.	• Eraser
		- as reqd.
		- as reqd.
		- as reqd.
		- as reqd.
		- as reqd.

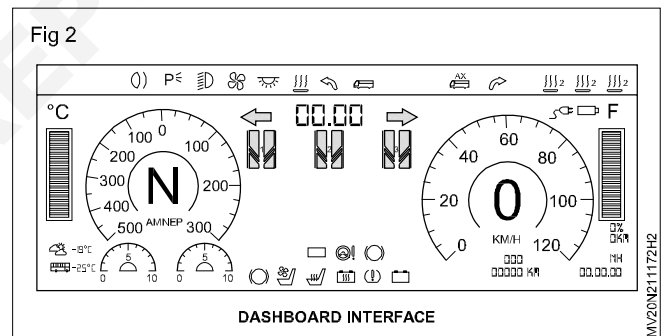
PROCEDURE

Task 1 : Identify the various gauges/instruments provided electric vehicle dashboard

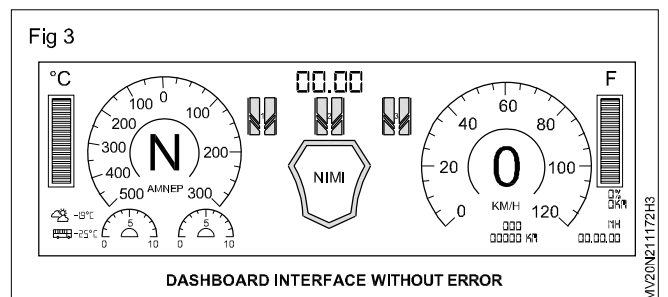
- Park the vehicle on the shop floor
- Clean the vehicle and open the electric vehicle doors
- Study the particular electric vehicle manual to identify the dash board gauges/instruments
- Study the function of each gauge/ instruments provided on the dashboard of the vehicle
- Inspect the electric vehicle dash board gauges/ instruments
- Find out the type of gauges (Anlog type, digital type, combined type) (Fig 1)
- Identify the temperature scale inside of the E.V
- Identify the speed dial indicator
- Identify the fuel gauge if hybrid electric vehicle
- Identify the time display (Fig 2)



- Identify the ammeter
- Identify the brake circuit pressure indicator
- Identify the temperature scale outside of vehicle information display



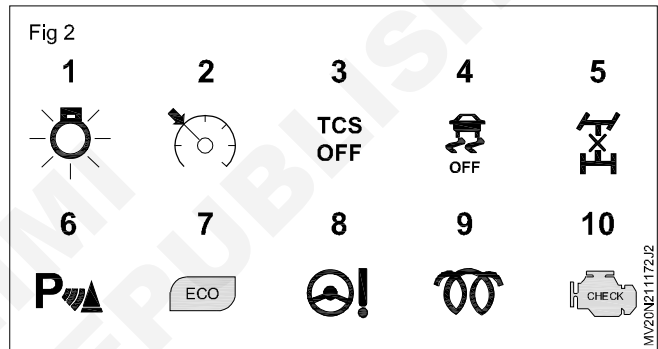
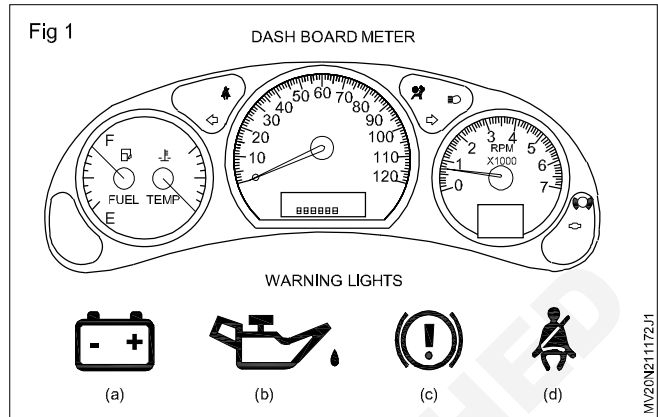
- Identify the battery current storage indicator
- Identify the logo while moving the vehicle
- Identify the display is reserved for status lights (Fig 3)



Task 2 : Identify the various gauges/Instruments provided in internal combustion

- Select the any one type of I.C engine vehicle
- Park the vehicle on shop floor
- Clean the vehicle and open the vehicle doors
- Identify the types of gauges/instruments/indicators provided on the dash board
- Identify the speedo meter and RPM gauge (Fig 1)
- Identify the fuel gauge(Fig 1)
- Identify Ampier meter/indicator (Fig 1)
- Identify the temperature charge gauge
- Identify parking brake indicator (Fig 1)
- Identify engine warning indicator (Fig 1)
- Identify seat belt warning indicator (Fig 1)
- Identify the glow plug warning light (Fig 2)
- Identify the side turn warning indicator (Fig 1)
- Identify the traction control indicator (Fig 2)
- Identify the stability control indicator (Fig 2)
- Identify the center differential lock indicator (Fig 2)
- Identify the proximity sensor indicator (Fig 2)
- Identify the brake indicator (ABS)(Fig 2)

- Identify the head light and parking light indicator (Fig 2)
- Identify the battery charge indicator (Fig 2)
- Air condition car inside temperature indicator (Fig 2)



Task 3 : Write the differences in instrumentation panel with IC engine vehicle while comparing with electrical vehicle

Sl.NO	Gauges/instruments are EV not provided in IC engine vehicle	Gauges/instruments with IC engine vehicle dash board

Practice to electric vehicle motor power calculation

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

- Calculate the basic motor power consumption.

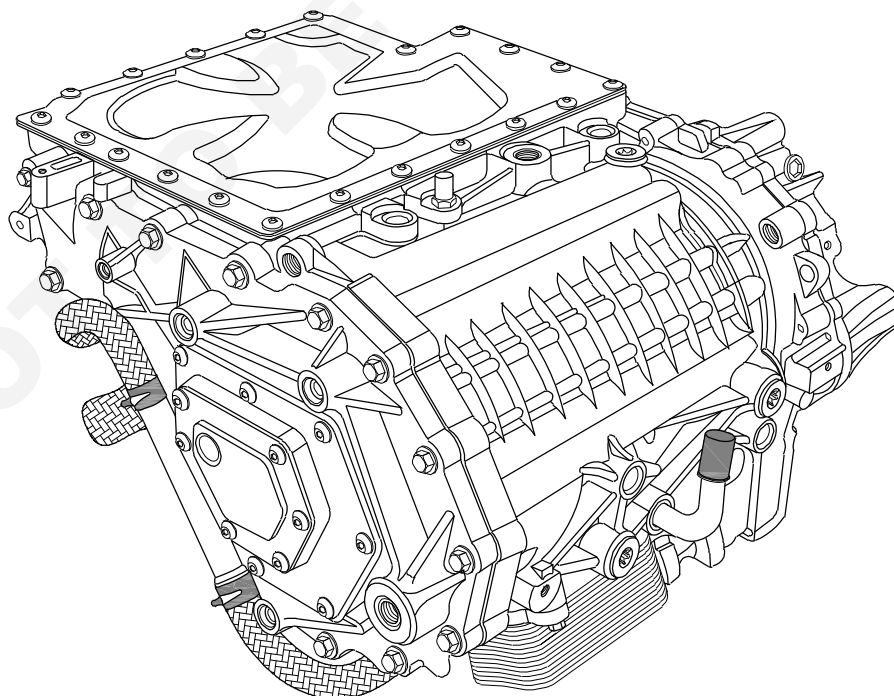
Requirements			
Tools/Instruments		Materials	
• Trainees tool kit	- 1 No.	• Cotton waste	- as reqd.
Equipments / Machineries		• Soap oil	- as reqd.
• Electric Vehicle	- 1 No.	• Energy paper	- as reqd
• Work bench	- 1 No	• Carbon brush	- as reqd

PROCEDURE

Task 1 : Electric vehicle motor power calculation method

- Select the electric vehicle type
- Park the vehicle on the shop floor (Fig 1)
- Study the electrical vehicle construction and their motor power drive
- Study the electrical vehicle power flow methods
- Identify and check the components like charging module, converters, controllers, batteries, electric motor and power flow from battery to (wheel drive) output power to wheel.
- Disconnect the battery terminal wire connection
- Dismount the EV motor (Connection) power transmission to wheel
- Note the power rating of electric vehicle dynamics. The force required for driving a vehicle is calculated by below formula $Watt = voltage \times time \text{ current}^t$
Force total = rolling force + grading force + aero dynamic force
- Remove the electric motor from the vehicle (Fig 1)
- Identify the type of motor (DC series motor, 3 phase induction motor, permanent

Fig 1



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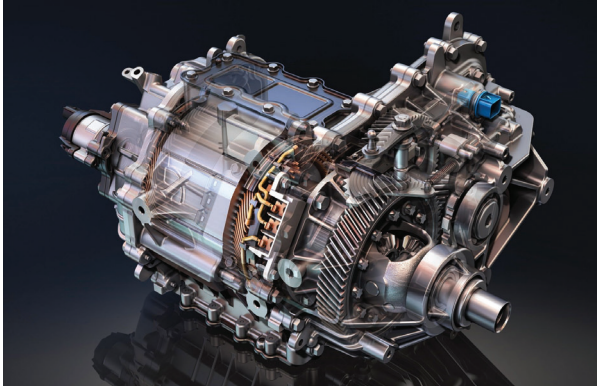
- Magnet motor or brush less DC motor

Note:

Most of the electric vehicle use the DC brushless motor is selected as the traction motor for an electric car of load 450 kg A 48 v, 3 KW BLDC motor of 24 slot, 8 pole designed is battery is prepared.

- Place the motor on the work bench
- Check the motor slot and poles (Fig 2)

Fig 2



- Connect the battery power to motor and drive the motor.
- Check the output power verses speed
- Note the power losses of motor designed like.

Parameter	Values
Input power	4.2 KW
Output power	3.3 KW
Maximum output power	4.8 KW
Total loss	1.21

If you use the motor in an electric car of 450 kg is to be achieved as above table. If the value is less than spaciad value you repair or replace it.

- If check the motor in no load speed and rated speed of motor should be as follows

Parameter	Values
No load speed	4057 RPM
Rated speed	2950 RPM

The above values of torque parameter achieved a sufficient rated torque of motor

- Check the cogging torque of the motor, which is needed characteristics of a motor, if motor is not taking specified load repair/replace the motor.
- Check the motor outer diameter, length and total weight before use in EV.
- Check the rated motor parameter like as rated out put power, -5 KW rated voltage, -72 V rated speed – 2950 RPM rated torque -9.710 N.M, simulator output of 3.KW brushless D.C motor designed based on the rating calculation done as above method.

Note:

Follow the formula to calculate power

Power = Energy x time in second

W = V x A (Watt = voltage X current)

DC motor torque calculation = Torque = Force x radius

Electric motor size - motor power car weight = motor weight

- If you found correct value of the motor as specified by the motor manufacturers for a particular type of car module .you can fit on the car and connect the wire and mechanical connections
- Start the vehicle and drive the vehicle for load test on the road.

Practice to identify and test the different type of batteries, diodes and transisters.

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

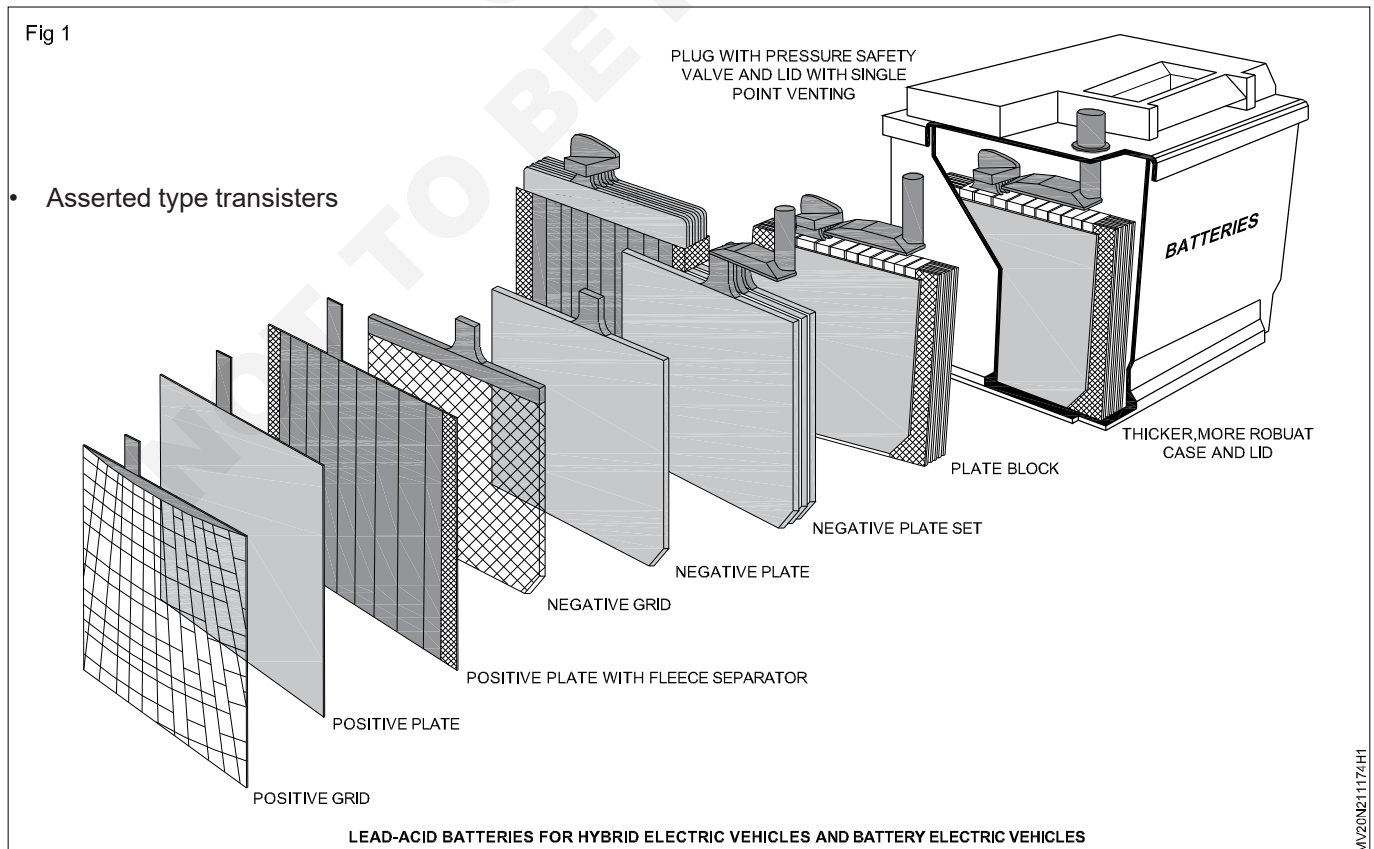
- identify and test the different types of batteries
- identify and test the different types of transisters
- identify and test the different types of diodes.

Requirements			
Tools/Instruments			
• Trainees tool kit	- 1 No.	• Work bench	- 1 No.
• Hydro meter	- 1 No.	Materials	
• Multimeter	- 1 No.	• Cotton waste	- as reqd.
• Cell tester	- 1 No.	• Soap oil	- as reqd.
• Test Lamp	- 1 No.	• Soldering wire	- as reqd.
• Soldering iron	- 1 No.	• Soldering paste	- as reqd.
Equipments / Machineries		• Assereted type diodes	- as reqd.
• Electric Vehicle	- 1 No.		

PROCEDURE

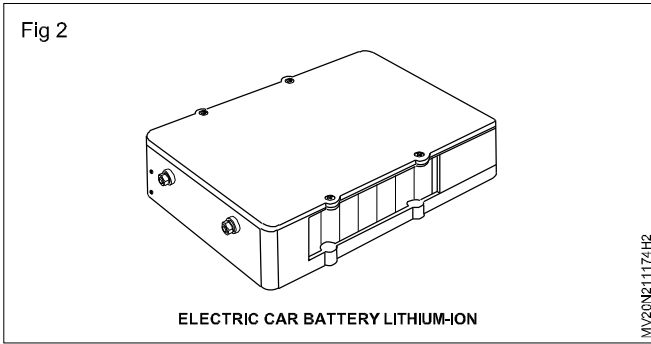
Task 1 : Identify and test the different types of batteries

- Select the different type of battery used in electric vehicle
- Park the vehicle on the shop floor
- Clean the vechile and open the bonnet of the vehicle
- Disconnect the battery cables
- Dismount the battery pack and remove the battery and place it on the work bench for battery test.
- Identify the different type of batteries as follows
 - (a) Lead acid batteries for hybrid electric vehicle (Fig 1)

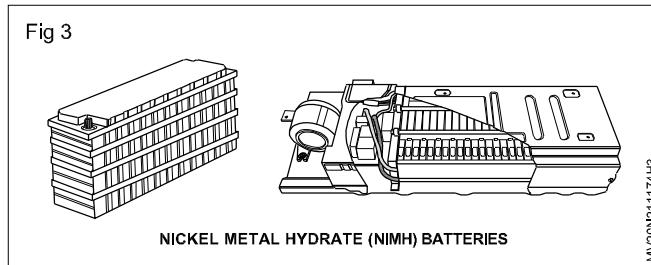


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(b) Lithium ion electric car battery (Fig 2)



(c) Nickel - metal - hydrate electric car battery (Fig 3)



(d) Super capacitor energy storage electric car battery (Fig 4 & 5)

- Place the test battery near the battery tester.
- Connect to be tested lead acid or Lithium - ion battery for electric vehicle as below drawing with test equipment.

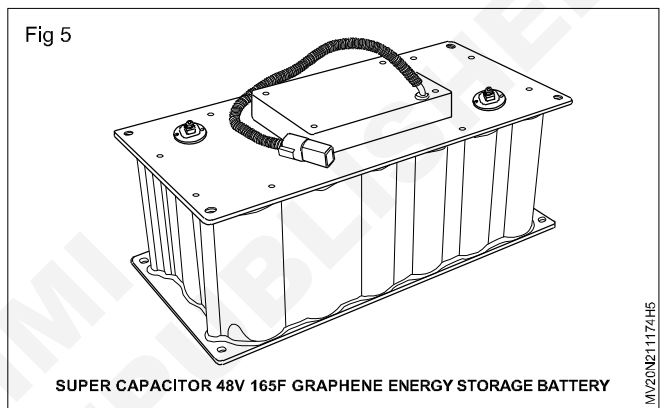
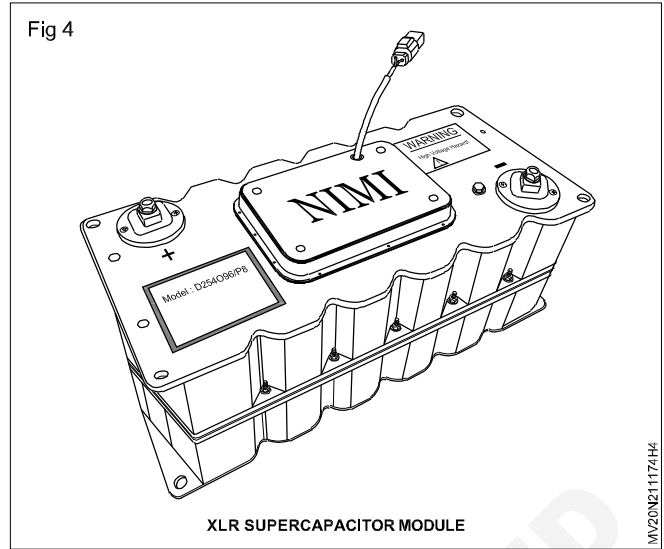
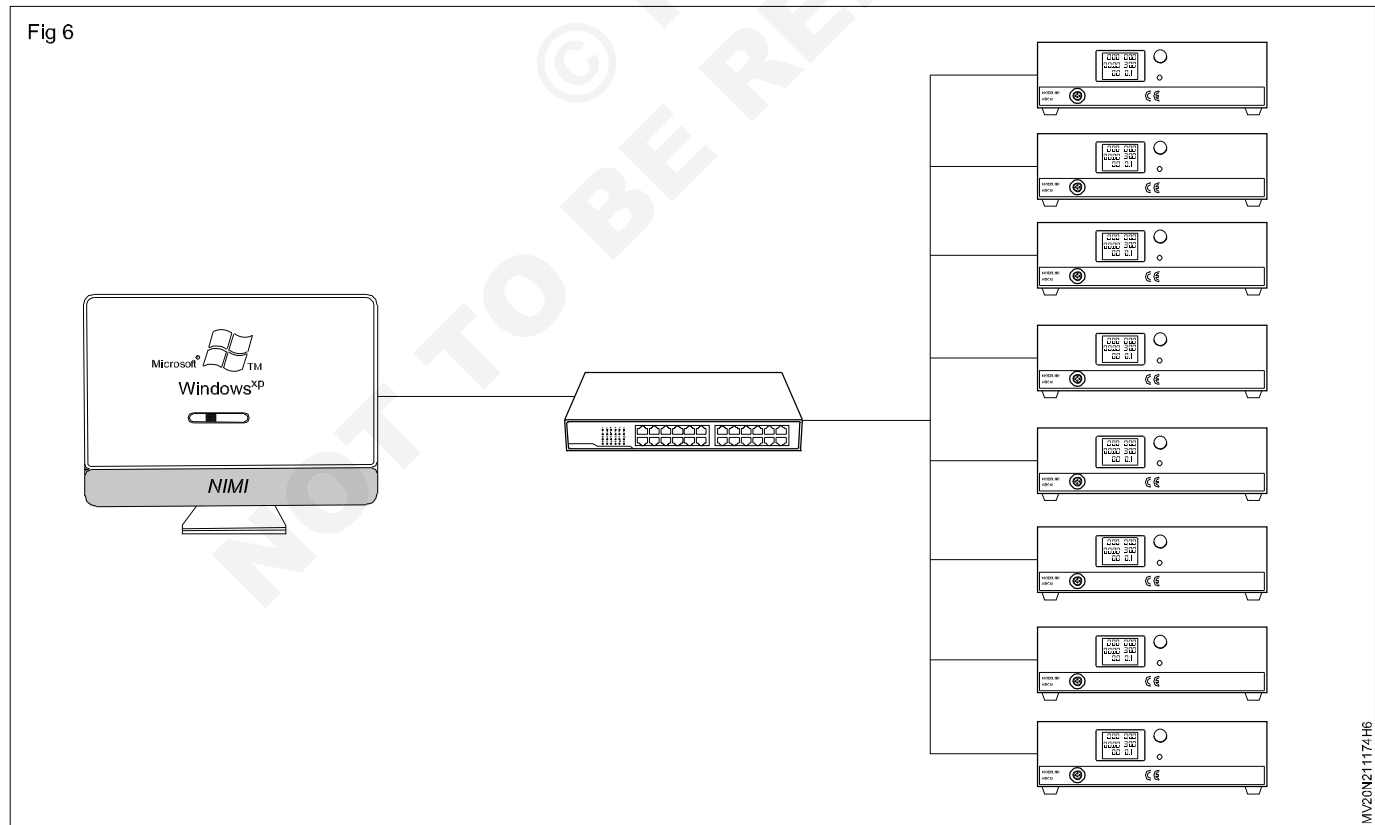
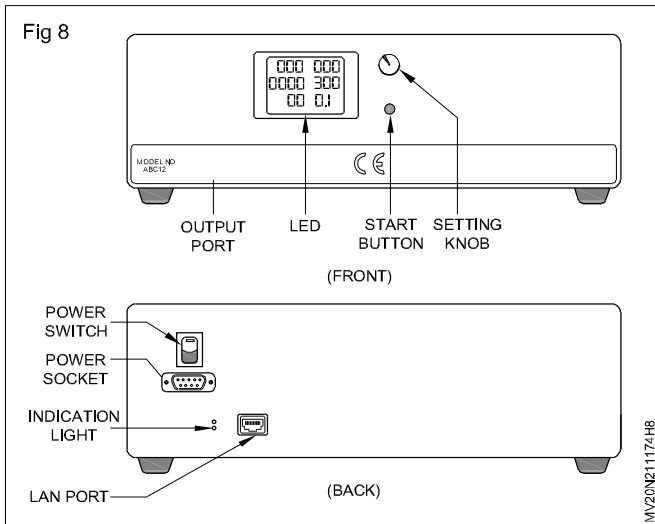
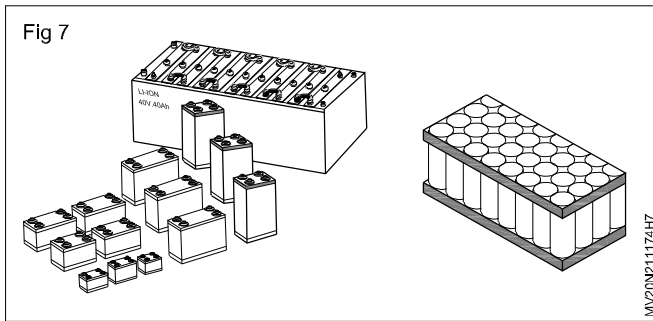


Fig 6





- Disconnect the battery from the battery tester
- If found any variation, as per the objects, you can charge, repair, replace the battery.
- Use the super capacitor to test the electrical.

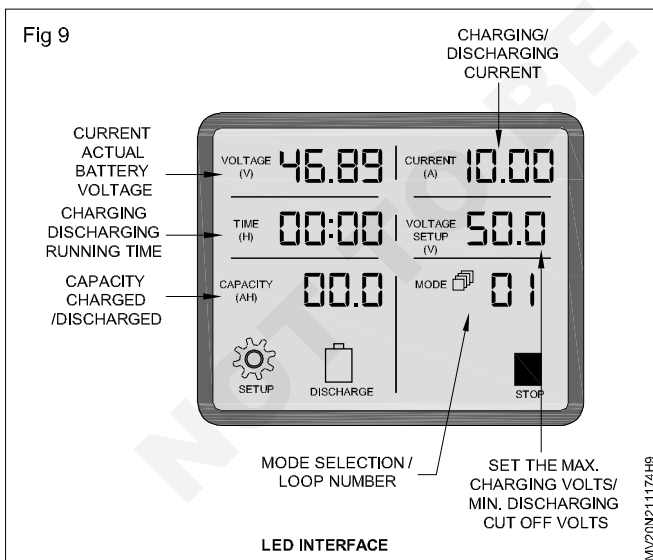
Vehicle super capacitor batteries include the applications as below

- Super cap charge/discharge cycles and advanced real world simulations.
- ON line DC - ESR & leakage current measurement
- Dynamic leakage current measurement.
- Self discharge voltage monitoring.
- HPC measurements (Coulombic efficiency)
- Reverse polarity testing available with +/- voltage range.
- Connect the electric vehicle super capacitor battery with selected battery tester and switch on the tester and test one by one as mentioned above.
- Note the battery tester LCD display reading in a paper and compare with actual battery capacity data given by the super capacitor battery manufacturers.

Note : Many type of battery testers are available in the market, you have to study the tester to be used for test the EV battery to avoid wrong decision taken.

- Before test the battery, study and note the technical data from particular brand and type of battery.
- Select the battery type and manufacturers details in test equipment software.
- Now switch ON the test equipment and test the following and note the reading displayed on the LED screen.

- Use the Nickel metal hydrate battery, software based tester for check the electric vehicle nickel metal hydrate battery.
- Connect the nickel metal hydrate battery with battery tester
- Switch on the tester and test the following one by and note the reading in separate paper.



- Test the battery current, voltage, power, load, terminal resistance, internal resistance, drive cycle simulation mathematical functions.
- Check the battery temperature by using thermistor or thermocouples to monitor battery cell temperature.
- Compare the reading shown in battery test equipment with battery manufacturers original technical specification data

- Charging rate
- Discharge rate
- Battery life cycle
- Electric vehicle drive cycle
- Dynamic stress test
- Cranking Amp tests
- Battery pack test
- Battery grid storage
- Battery functional safety
- Wireless action test (Charging)
- EMF testing
- Protocol testing
- Climate testing
- Ultra vibration radiation, corrosion test
- Mechanical and material strength test
- Glow wire test
- Flammability test
- Compare the battery tested reading with battery manufacturer specified technical data
- If need repair / Charge / Replace the Nickel - metal - hydrate batteries depend up on the condition of battery.

Identify different types of diode, diode modules and their specifications

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

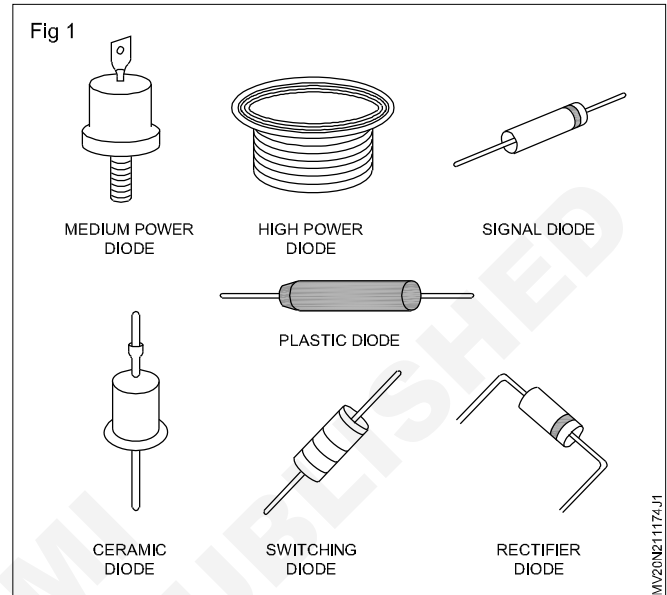
- Identify the diode type, module and specification
- Test the diode by using multimeter
- Determine the for reverse resistance rate

PROCEDURE

Task 1 : Identify the different type of diodes

The instructor has to label the different types of diodes used for this exercise.

- 1 Pick one of the labelled diode from the given assorted lot.
- 2 Observe the code number printed on the diode and record in the Table 1.
- 3 For chosen diode, refer semiconductor data book/ manual and identify the type of diode, semiconductor material type of package.
- 4 Also record the maximum forward current I_1 , peak inverse voltage. PIV, forward Voltage Drop, V_1 .
- 5 Repeat step-2 to 4 for all the remaining diodes, and record it in Table 1.
- 6 Get the work checked by the instructor



Table

Label No	Code No. of diode	Types of diode	Semiconductor Material	Type of package	Maximum forward current I_1	Peak inverse Voltage PIV	Forward Voltage Drop V_1
1							
2							
3							
4							

Task 2 : Test the diode by using multimeter

Label No	Code No. of diode	Forward Resistance (FR)	Reverse Resistance (RR)	Ratio of FR/RR	Servicable/ Unservicable
1					
2					
3					
4					

Task 3 : Measure the voltage and current through a diode in a circuit and verify its forward characteristics

- 1 Check to confirm the good physical and electrical working condition of the given diode.
- 2 Identify the anode and cathode terminals of the diode.
- 3 Construct the circuit as shown in Fig 1.
- 4 Switch ON the regulated power supply and increase the output voltage of the RPSU, such that the diode drop V_1 varies from 0 to 1V in steps as given in Table-1.
- 5 At each step record the values of I_r .
- 6 Switch OFF the RPSU, from the recorded values of V_1 and I_r , calculate and the forward resistance R_1 of the diode.
- 7 From the recorded readings in Table-1, plot a graph taking V_1 and I_r .
- 8 Get the work checked by the instructor.

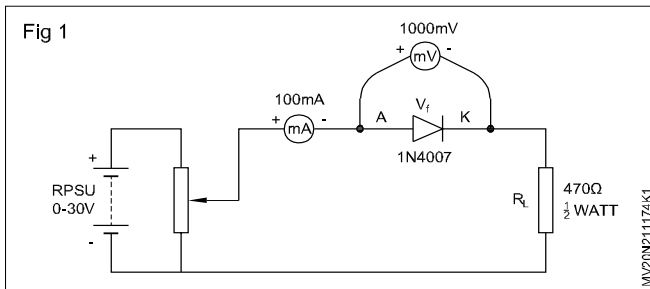


Table 1

Diode type Nos.....	Forward resistance _____ Ω	Reverse resistance _____ Ω
Forward voltage drop across Diode V_1 in mV	Forward current I_1 in mA	Forward Diode Resistance Ω
100mV		
200mV		
300mV		
400mV		
500mV		
600mV		
700mV		
800mV		
900mV		
1 Volt (1000mV)		

Identify the different type of transistor

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

- Identify the different type of transistors.
- Test the condition of different transistors by using ohm/multimeter

PROCEDURE

Task 1 : Identify the transistor by different package type and pin configuration

- Lay out the different type of transistors data book for identify the various transistor.(Fig 1)
- Study the transistors data book for identify the various transistors
- Pick one of the labelled transistors from given / layout assorted transistor as shown in figure 1.
- Identify the transistor type of package and all other detail, by refer the transistor data book.
- Record the transistors data identified by you in table=1.
- Report the above steps for remaining labelled transistor one by one.

Note:
The instructor should be select the labelled transistor used for exercise and layout the transistor on the table minimum of one number in each type of package has to be arranged.

Table 1

Sl.No.	Label No.	Transistor code number	Transistor package type	Package diagram with pin description	Current & Voltage		Power rating	Application uses
					Current rating	Voltage rating		

Task 2 : Testing transistor using analog multimeter

- 1 Pick one of the labelled transistor from given assorted lot and enter its number in the Table -1.
- 2 Verify the label number, and other details recorded in the Table 1 of Exercise No.2.1.102. Refer the databook, identify the transistor type, pin diagram and record details in Table 1.

In some power transistor, the metal body itself is connected to the collector terminal. All transistors will not have shield pin.

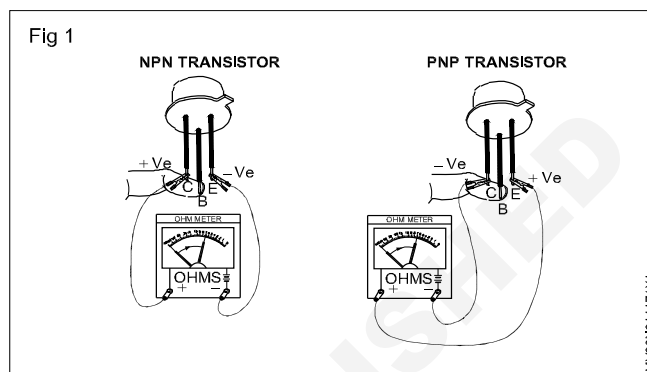


Table 1

Sl.No.	Label No	Code no.of transistor	Package type	Forward/Reverse	Measured resistance between			Remarks
					B-E	B-C	E-C	
1				Forward				
2				Reverse				
3				Forward				
4				Reverse				
5				Forward				
6				Reverse				
7								
8								
9								
10								

- 3 Connect crocodile clip probes to the analog multimeter & select ohms range for testing.

In using analog multimeter, select resistance range RX100 Ohm, low range may damage low power transistors.

- 4 Identify the transistor terminals as Base, Emitter and Collector.

Testing the transistor using the analog type Ohm meter is shown in Fig 1 for guidance.

Note :

- 1 The instructor has to arrange a minimum of one number in each type and lable the transistors used for this exercise.

2 In case, the Analog type multimeter is not available skip the Task 1 and proceed with Task 2 of this exercise using Digital multimeter.

- 5 Test resistance value between Base & Emitter terminals in forward and reverse direction by connecting probes as shown in Fig 1 and record readings in Table 1.
- 6 Repeat the above step between Base & collector terminals and record readings.
- 7 Repeat the step between Emitter & collector and record readings.
- 8 Repeat steps 4 to 7 for all the remaining labelled transistors.
- 9 Get the work checked by the Instructor.

Task 3: Testing the condition of transistor using Digital multimeter (DMM)

- Pick one of the labelled transistor from the given lot, enter its number in Table 2.
- Verify the details like transistor type, pin configuration etc recorded in the Table 1, identify all the details required.
- Connect the crocodile clip probe to the DMM and set the selector, switch to the Diode testing position/range.
- Connect the positive test probe of the DMM to the Base (B) terminal and the negative probe to the Emitter (E) of the transistor as shown in Fig 2.

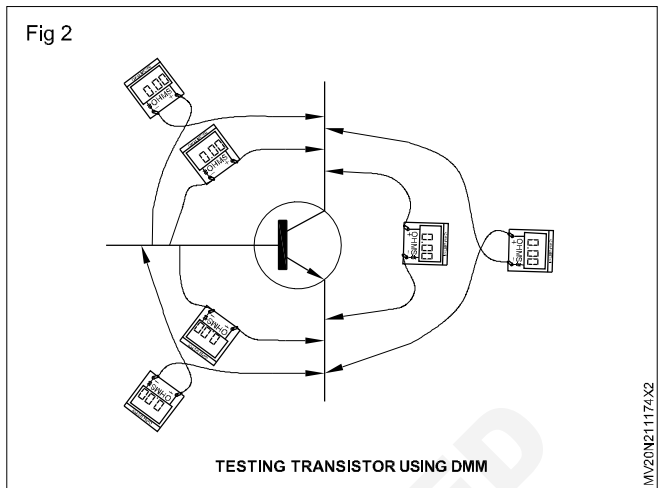
- Get the work checked by the Instructor.

For a good NPN transistor, the meter should show between 0.45V to 0.9V and for a PNP transistor, the meter should show "OL" (Over Limit) means infinity.

- Observe the reading displayed on the DMM, record the value in Table 2.
- Keep the positive probe at Base and connect the negative probe to the collector (C) terminal, observe the reading on the DMM, record it in Table 2.

For a good NPN transistor the meter should show between 0.45 to 0.9V and for a PNP type transistor, the meter should show "OL" (Over Limit) means infinity.

- Repeat steps 4,5 and 6 with reversed polarities of DMM and record those readings in Table 2.
- Connect the positive probe to the Emitter terminal and negative probe to the Collector (C) of transistor as shown in Fig 2; Record the observations in Table 2.
- Repeat step 8 with reversed polarities of DMM.
- Carry out steps 4 to 9 for all the remaining labelled transistors and record readings in Table 2.



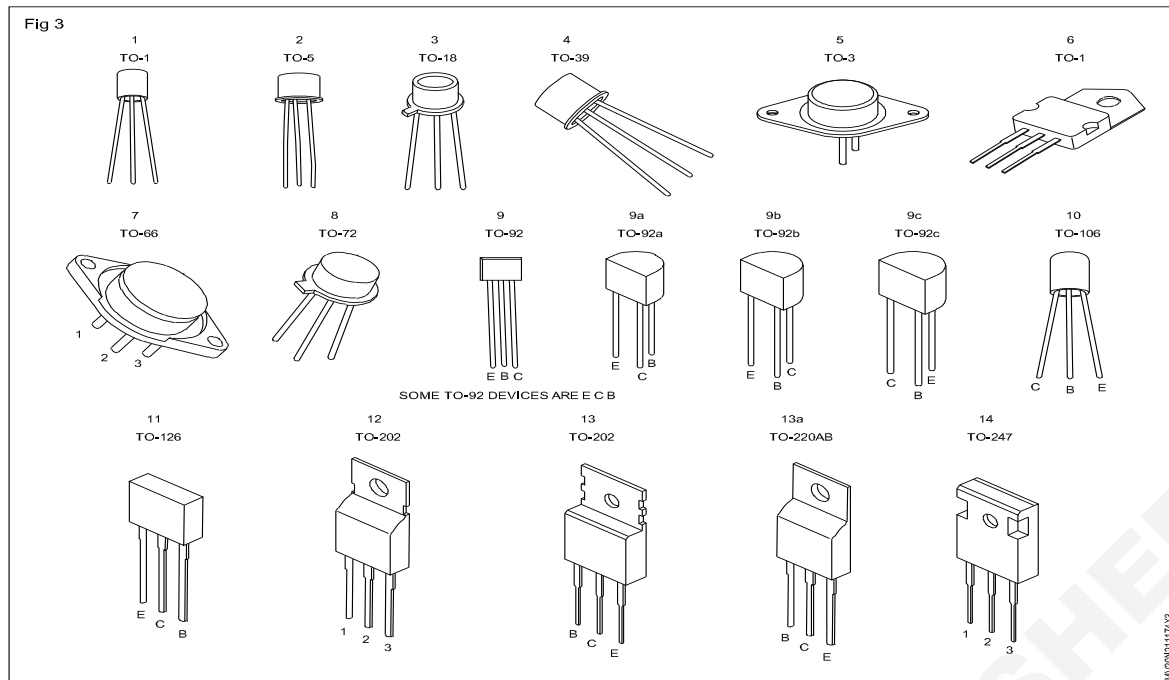
Note:
Compare the resistance values recorded in forward and reverse directions between B-E, B-C and E-C terminals.
Conclude the condition of tested transistor is defective/unserviceable if the resistance value is same on both directions for B-E or B-C junctions, shorted / open junctions show same resistance value in both directions otherwise, the transistor is good/serviceable.

Note : In case the transistor is fitted on the heatsink , it may be tested without removing the heatsink.

Table 2

Sl.No.	Lable No NPN/PNP	Transistor Code No and type	Meter reading between the terminals			Remarks
			Direction	Base to emitter	Base to collector	
1			Forward			
2			Reverse			
3			Forward			
4			Reverse			
5			Forward			
6			Reverse			
7			Forward			
8			Reverse			
9			Forward			
10			Reverse			

Fig 3



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